FCC CFR47 PART 15 SUBPART E CERTIFICATION

TEST REPORT

FOR

PROXIM CORPORATION

802.11a/b/g CARDBUS

MODEL NUMBER: 8460

BRAND NAME: HARMONY OF SKYLINE 802.11a/b/g

FCC ID: HZB-8460

REPORT NUMBER: 02U1380

ISSUE DATE: JULY 11, 2002

Prepared for
PROXIM COPORATION
510 DEGUINR DR
SUNNYVALE, CA 94085
USA

Prepared by
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TABLE OF CONTENTS

1. TEST RESULT CERTIFICATION

COMPANY NAME: **PROXIM CORPORATION**
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EUT DESCRIPTION: **802.11a/b/g CARDBUS**

MODEL NUMBER: **8460**

DATE TESTED: **JUNE 25, 2002 – JUNE 29, 2002**

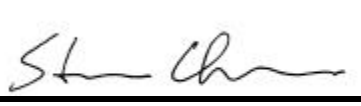
TYPE OF EQUIPMENT	INTENTIONAL RADIATOR
EQUIPMENT TYPE	5.15 – 5.35 GHz TRANSCEIVER *
MEASUREMENT PROCEDURE	ANSI 63.4 / 1992, TIA/EIA 603
PROCEDURE	CERTIFICATION
FCC RULE	CFR 47 PART 15.E

* The 5.2 GHz band is applicable to this report; other bands of operation (2.4 GHz and 5.8 GHz) are documented in a separate report

Compliance Certification Services, Inc. tested the above equipment for compliance with the requirements set forth in CFR 47, PART 15, Subpart E. The equipment in the configuration described in this report, shows the measured emission levels emanating from the equipment do not exceed the specified limit.

Note: This document reports conditions under which testing was conducted and results of tests performed. This document may not be altered or revised in any way unless done so by Compliance Certification Services and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Compliance Certification Services will constitute fraud and shall nullify the document.

Approved & Released For CCS By:



STEVE CHENG
EMC ENGINEERING MANAGER
COMPLIANCE CERTIFICATION SERVICES

Tested By:

MIKE HECKROTTE
CHIEF ENGINEER
COMPLIANCE CERTIFICATION SERVICES

2. EUT DESCRIPTION

The Proxim 8460 is a high performance 802.11a/b/g WLAN client product intended for laptop applications. It operates in the 2.4 – 2.4835 GHz, 5.15 - 5.35 GHz and 5.725 - 5.850 GHz bands with a maximum average Tx output power of 90 mW. The product uses two symmetric integral antennas for diversity operation. Each has a 1.0 dBi gain.

The 8460 design is based on an Atheros AR5001X three-chip solution. The three chips include:

AR5211: Multiprotocol MAC/baseband processor, and CardBus/PCI bus interface.

AR5111 Radio-on-a-Chip (RoC): An all-CMOS single-chip radio transceiver that includes a power amplifier, and integrated dual conversion filters to convert signals from 5 GHz to the baseband range for use by the AR5211. The AR5111 offers fully integrated transmitter, receiver, and frequency synthesizer functions; eliminating the need for external voltage controlled oscillators (VCOs) and surface acoustic wave (SAW) filters.

AR2111 Radio-on-a-Chip (RoC): An all-CMOS single-chip radio transceiver that, when combined with the AR5111,implements a 2.4 GHz 802.11 b/g radio solution. The AR2111 offers fully integrated transmitter, receiver, and frequency synthesizer functions. Like the AR5111, the AR2111 does not require external VCOs or SAW filters.

3. TEST METHODOLOGY

Conducted and radiated testing were performed according to the procedures documented on chapter 13 of ANSI C63.4 and FCC CFR 47 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057, and 15.407.

4. FACILITIES AND ACCREDITATION

4.1. FACILITIES AND EQUIPMENT

The open area test sites and conducted measurement facilities used to collect the radiated data are located at 561F Monterey Road, Morgan Hill, California, USA. The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.

Receiving equipment (i.e., receiver, analyzer, quasi-peak adapter, pre-selector) and LISNs conform to CISPR specifications for "Radio Interference Measuring Apparatus and Measurement Methods," Publication 16.

4.2. LABORATORY ACCREDITATIONS AND LISTINGS

The test facilities used to perform radiated and conducted emissions tests are accredited by National Voluntary Laboratory Accreditation Program for the specific scope of accreditation under Lab Code: 200065-0 to perform Electromagnetic Interference tests according to FCC PART 15 AND CISPR 22 requirements. No part of this report may be used to claim or imply product endorsement by NVLAP or any agency of the US Government. In addition, the test facilities are listed with Federal Communications Commission (reference no: 31040/SIT (1300B3) and 31040/SIT (1300F2)).

4.3. TABLE OF ACCREDITATIONS AND LISTINGS

Country	Agency	Scope of Accreditation	Logo
USA	NVLAP*	FCC Part 15, CISPR 22, AS/NZS 3548,IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, IEC 61000-4-8, IEC 61000-4-11, CNS 13438	200065-0
USA	FCC	3/10 meter Open Area Test Sites to perform FCC Part 15/18 measurements	1300
Japan	VCCI	CISPR 22 Two OATS and one conducted Site	R-1014, R-619, C-640
Norway	NEMKO	EN50081-1, EN50081-2, EN50082-1, EN50082-2, IEC61000-6-1, IEC61000-6-2, EN50083-2, EN50091-2, EN50130-4, EN55011, EN55013, EN55014-1, EN55104, EN55015, EN61547, EN55022, EN55024, EN61000-3-2, EN61000-3-3, EN60945, EN61326-1	ELA 117
Norway	NEMKO	EN60601-1-2 and IEC 60601-1-2, the Collateral Standards for Electro-Medical Products. MDD, 93/42/EEC, AIMD 90/385/EEC	ELA-171
Taiwan	BSMI	CNS 13438	SL2-IN-E-1012
Canada	Industry Canada	RSS210 Low Power Transmitter and Receiver	IC2324 A,B,C, and F

* No part of this report may be used to claim or imply product endorsement by NVLAP or any agency of the US Government.

5. CALIBRATION AND UNCERTAINTY

5.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

5.2. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Radiated Emission	
30MHz – 200 MHz	+/- 3.3dB
200MHz – 1000MHz	+4.5/-2.9dB
1000MHz – 2000MHz	+4.6/-2.2dB
Power Line Conducted Emission	
150kHz – 30MHz	+/-2.9

Any results falling within the above values are deemed to be marginal.

5.3. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

TEST AND MEASUREMENT EQUIPMENT LIST				
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due Date
Spectrum Analyzer	HP	8566B	3014A06685	6/1/03
Spectrum Display	HP	85662A	2152A03066	6/1/03
Quasi-Peak Detector	HP	85650A	3145A01654	6/1/03
Preamplifier	HP	8447D	2944A06833	8/10/02
Log Periodic Antenna	EMCO	3146	9107-3163	3/30/03
Biconical Antenna	Eaton	94455-1	1197	3/30/03
LISN	F.C.C.	LISN-50/250-25-2	2023	8/2/02
EMI Test Receiver	Rohde & Schwarz	ESHS 20	827129/006	4/17/03
Spectrum Analyzer	HP	8593EM	3710A00205	6/11/03
Preamplifier (1 - 26.5GHz)	MITEQ	NSP2600-44	646456	4/26/03
Horn Antenna (1 - 18GHz)	EMCO	3115	6717	1/31/03
Horn Antenna (18 – 26.5GHz)	ARA	3115	6717	1/31/03
Signal Generator	HP	83732B	US34490599	3/29/03
High Pass Filter (4.57GHz)	FSY Microwave	FM-4570-9SS	003	N.C.R.
High Pass Filter (7.6GHz)	FSY Microwave	FM-7600-9SS	002	N.C.R.
Spectrum Analyzer	HP	8563E	3720A07066	3/18/04
Spectrum Analyzer	Agilent	E4404B	US40240772	3/25/03
External Mixer (26.5 – 40 GHz)	HP	11970A	3008A04190	9/22/02
Horn Antenna (26.5 – 40 GHz)	Dico	1149	2	N.C.R.

6. SETUP OF EQUIPMENT UNDER TEST

SUPPORT EQUIPMENT

Device Type	Manufacturer	Model	Serial Number	FCC ID
Laptop	IBM	2656	AA-GBH9B	DoC
AC Power Adapter	IBM	AA21131	2564KF	DoC
Printer	HP	2225C	2541S41679	DoC
Mouse	Microsoft	X03-46340	0070536-00000	DoC

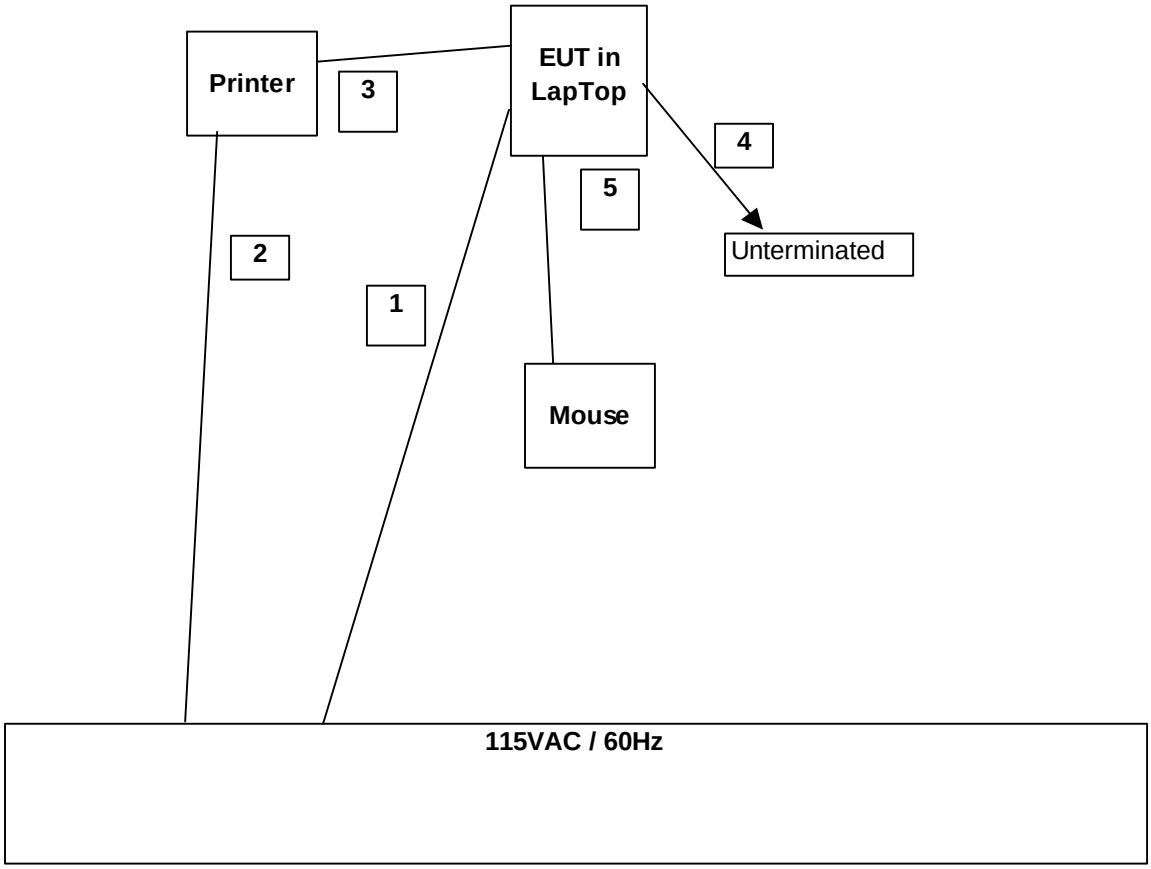
I/O CABLES

Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length	Remarks
1	AC	1	US115	Unshielded	2 m	Integrated with AC Adapter
2	AC	1	US115	Unshielded	2 m	
3	Parallel	1	DB25	Shielded	2 m	
4	RJ45	1	RJ45	Unshielded	2 m	
5	USB	1	USB	Unshielded	1 m	Integral with Mouse

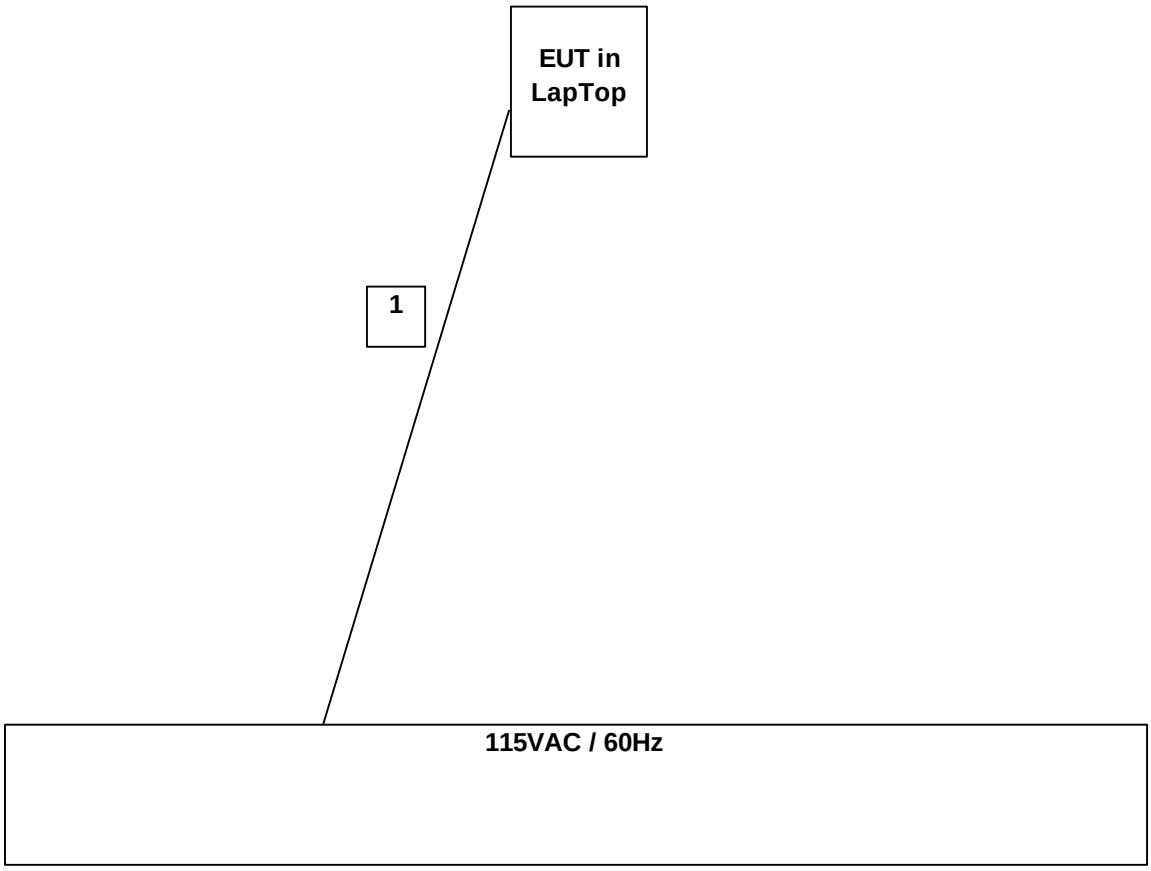
TEST SETUP

The EUT is installed into a laptop computer during the test.

SETUP DIAGRAM FOR DIGITAL DEVICE TESTS



SETUP DIAGRAM FOR TRANSMITTER TESTS



7. APPLICABLE RULES

§15.403- EMISSION BANDWIDTH

(c) Emission bandwidth. For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolutions bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

§15.407(a)- POWER LIMIT

(1) For the band 5.15-5.25 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 50 mW (17 dBm) or 4 dBm + 10 log B, where B is the 26-dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 4 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(2) For the band 5.25-5.35 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 250 mW (24 dBm) or 11 dBm + 10 log B, where B is the 26-dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 11 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Specification Limit:

Base Mode

Channel	Frequency (MHz)	10 Log B (dB)	4 + 10 Log B or 11 + 10 Log B (dBm)	Power Limit (dBm)
Low	5180	14.5	18.5	17
Middle	5260	15.4	26.4	24
High	5320	14.7	25.7	24

Turbo Mode

Channel	Frequency (MHz)	10 Log B (dB)	4 + 10 Log B or 11 + 10 Log B (dBm)	Power Limit (dBm)
Low	5210	16.9	20.9	17
Middle	5250	16.4	20.4	17
High	5290	17.2	28.2	24

§15.407(a)- PEAK POWER SPECTRAL DENSITY

(1) For the band 5.15-5.25 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 50 mW or 4 dBm + 10log B, where B is the 26-dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 4 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(2) For the band 5.25-5.35 GHz, the peak transmit power over the frequency band of operation shall not exceed the lesser of 250 mW or 11 dBm + 10log B, where B is the 26-dB emission bandwidth in MHz. In addition, the peak power spectral density shall not exceed 11 dBm in any 1-MHz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Specification Limit:

Base Mode

Channel	Frequency (MHz)	PPSD Limit (dBm)
Low	5180	4
Middle	5260	11
High	5320	11

Turbo Mode

Channel	Frequency (MHz)	PPSD Limit (dBm)
Low	5210	4
Middle	5250	4
High	5290	11

§15.407(a)- PEAK EXCURSION

(6) The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the peak transmit power (measured as specified above) shall not exceed 13 dB across any 1 MHz bandwidth or the emission bandwidth whichever is less.

Specification Limit: 13 dB

§15.407(b)- UNDESIRABLE EMISSION LIMITS

(1 & 2) For transmitters operating in the 5.15-5.35 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27dBm / MHz.

(5) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in §15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207.

(6) The provisions of §15.205 apply to intentional radiators operating under this section.

§15.407(c)- TRANSMISSION IN CASE OF ABSENCE OF INFORMATION

The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude the transmission of control or signalling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals. Applicants shall include in their application for equipment authorization a description of how this requirement is met.

§15.407(d)- ANTENNA TYPE

Any U-NII device that operates in the 5.15-5.25 GHz band shall use a transmitting antenna that is an integral part of the device.

§15.407(f)- RADIO FREQUENCY EXPOSURE

U-NII devices are subject to the radio frequency radiation exposure requirements specified in §1.1307(b), §2.1091 and §2.1093 of this chapter, as appropriate. All equipment shall be considered to operate in a "general population/uncontrolled" environment. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

§15.407(g)- FREQUENCY STABILITY

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.

§15.205- RESTRICTED BANDS OF OPERATIONS

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

[1] Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
[2] Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

§15.207- CONDUCTED LIMITS

(a) For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 450 kHz to 30 MHz shall not exceed 250 microvolts. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

FCC PART 15.207

FREQUENCY RANGE	FIELD STRENGTH (Microvolts)	FIELD STRENGTH (dBuV)/QP
450kHz-30MHz	250	48

§15.209- RADIATED EMISSION LIMITS; GENERAL REQUIREMENTS

(a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

(b) In the emission table above, the tighter limit applies at the band edges.

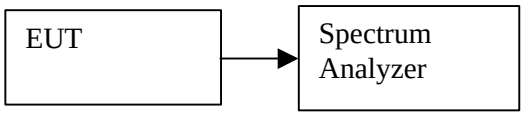
FCC PART 15.209

MEASURING DISTANCE OF 3 METER		
FREQUENCY RANGE (MHz)	FIELD STRENGTH (Microvolts/m)	FIELD STRENGTH (dBuV/m)
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

8. TEST SETUP, PROCEDURE AND RESULT

8.1. EMISSION BANDWIDTH

TEST SETUP



TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The resolution bandwidth is set to approximately 1% of the emission bandwidth and peak detection is used. The emission bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 26 dB.

RESULTS

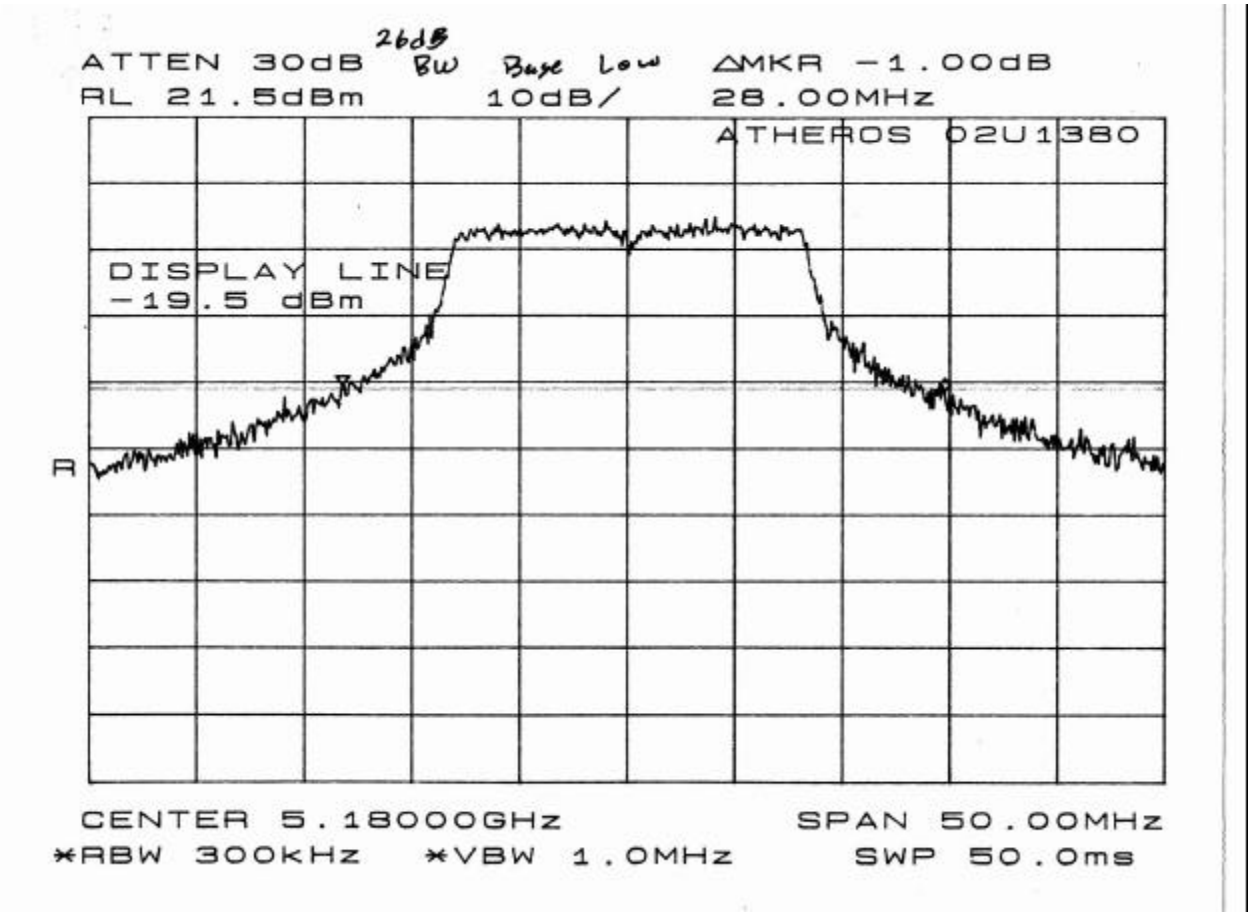
No non-compliance noted:

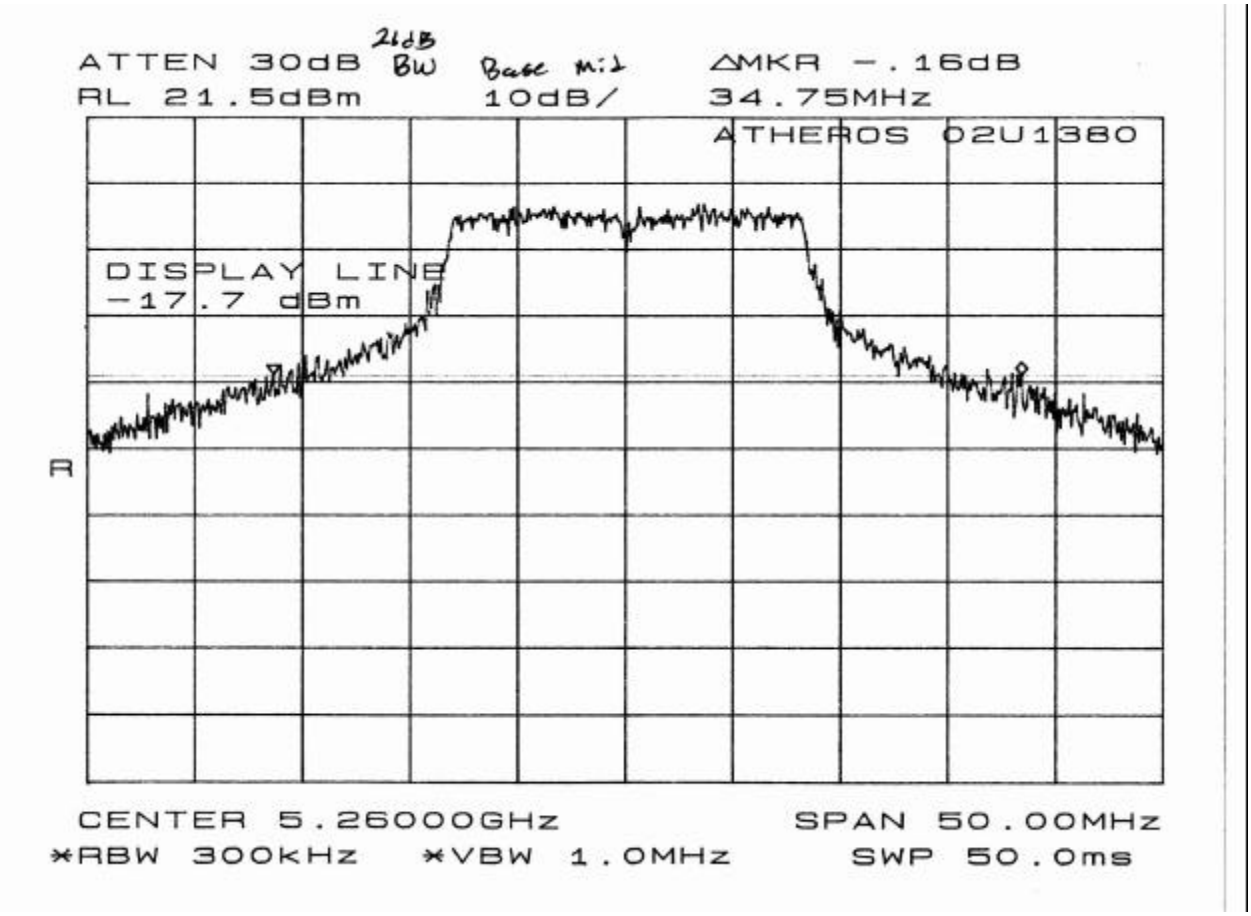
Base Mode

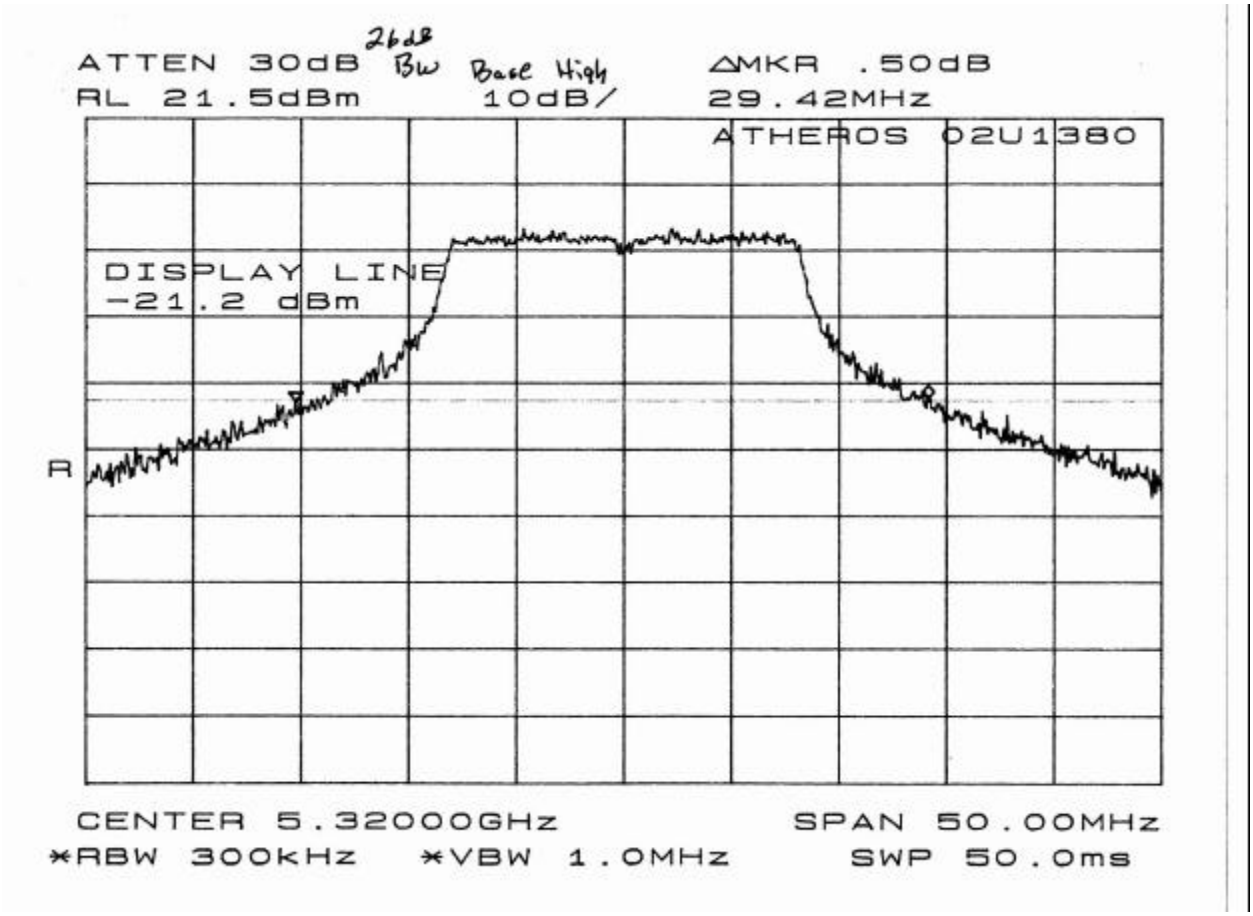
Channel	Frequency (MHz)	B (MHz)	10 Log B (dB)
Low	5180	28.0	14.5
Middle	5260	34.7	15.4
High	5320	29.42	14.7

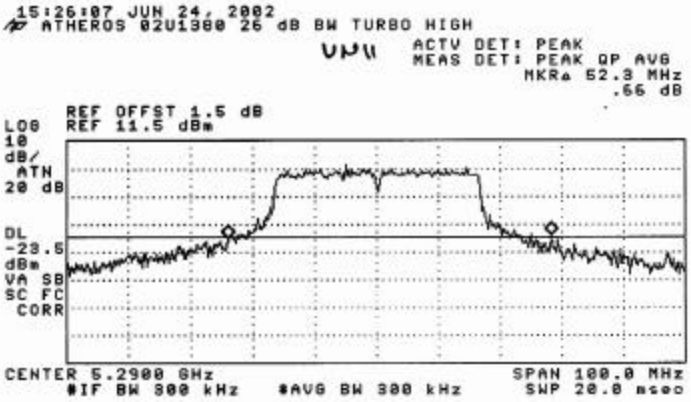
Turbo Mode

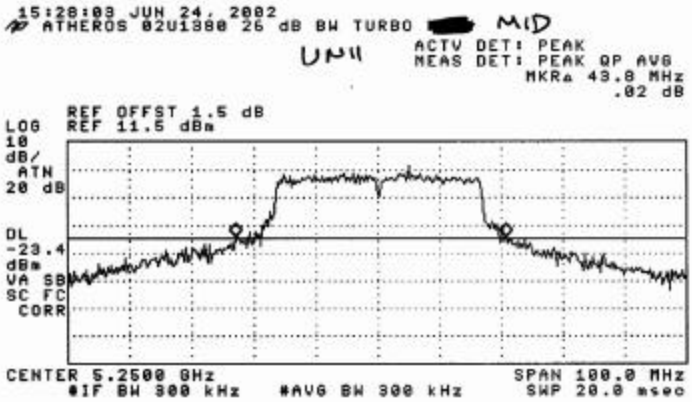
Channel	Frequency (MHz)	B (MHz)	10 Log B (dB)
Low	5210	48.5	16.9
Middle	5250	43.8	16.4
High	5290	52.3	17.2

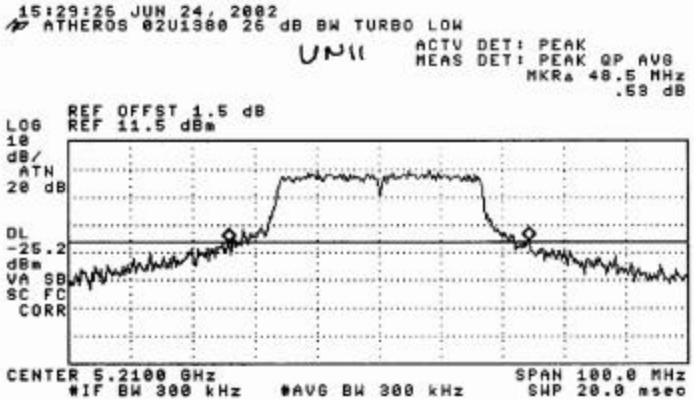






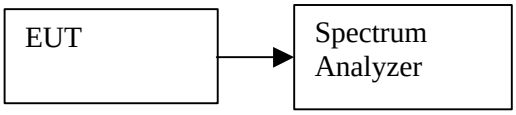






8.2. PEAK POWER

TEST SETUP



TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The resolution bandwidth is set to 1 MHz, and the video bandwidth is greater than or equal to the larger of:
EBW / (2 * pi * 30) where EBW is the emission bandwidth
or 1 / (2 * pi * T) where T is the transmission pulse duration over which the transmission is continuous and average symbol envelope power is constant.

Peak detection is used, and the peak power is determined by channel integration over the previously measured emission bandwidth.

Pulse duration limitation: T = 2.1 msec, VBW = 75 Hz, therefore the minimum video bandwidth is determined by the emission bandwidth rather than the pulse duration.

RESULTS

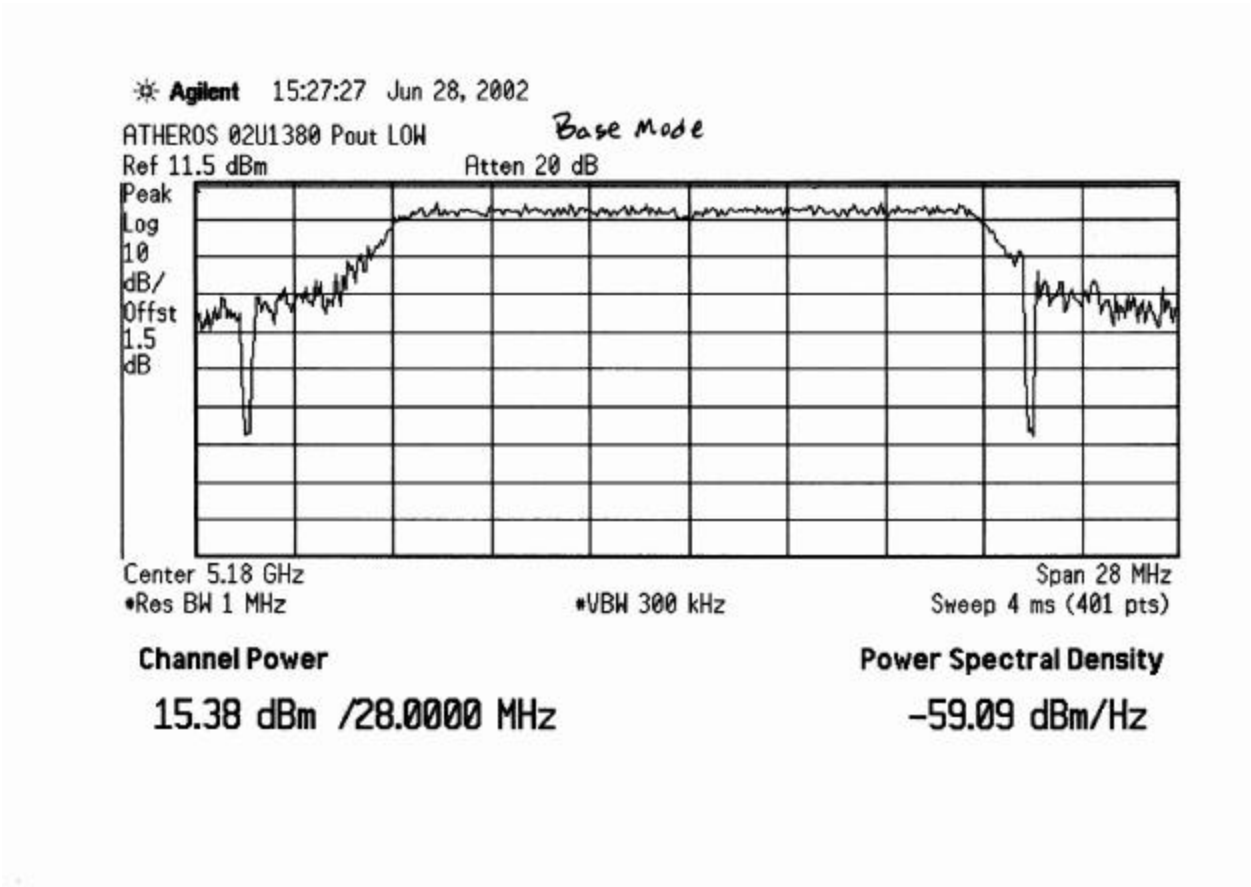
No non-compliance noted:

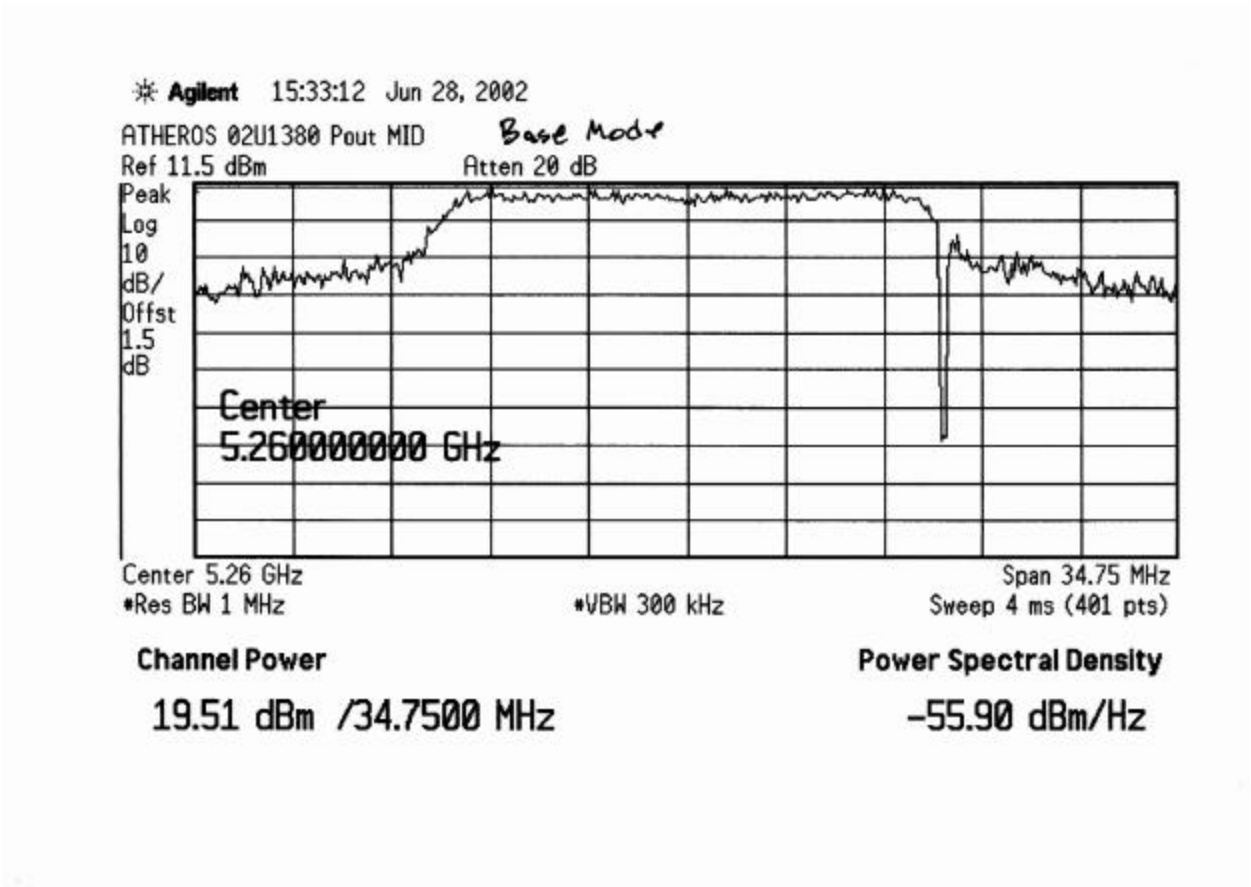
Base Mode

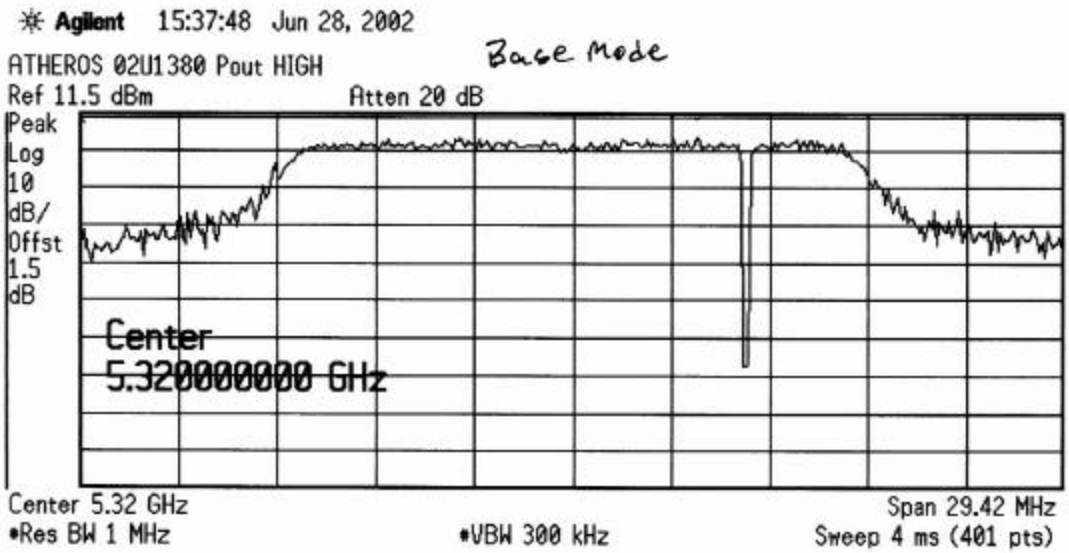
Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin dB
Low	5180	15.38	17	-1.62
Middle	5260	19.51	24	-4.49
High	5320	14.48	24	-9.52

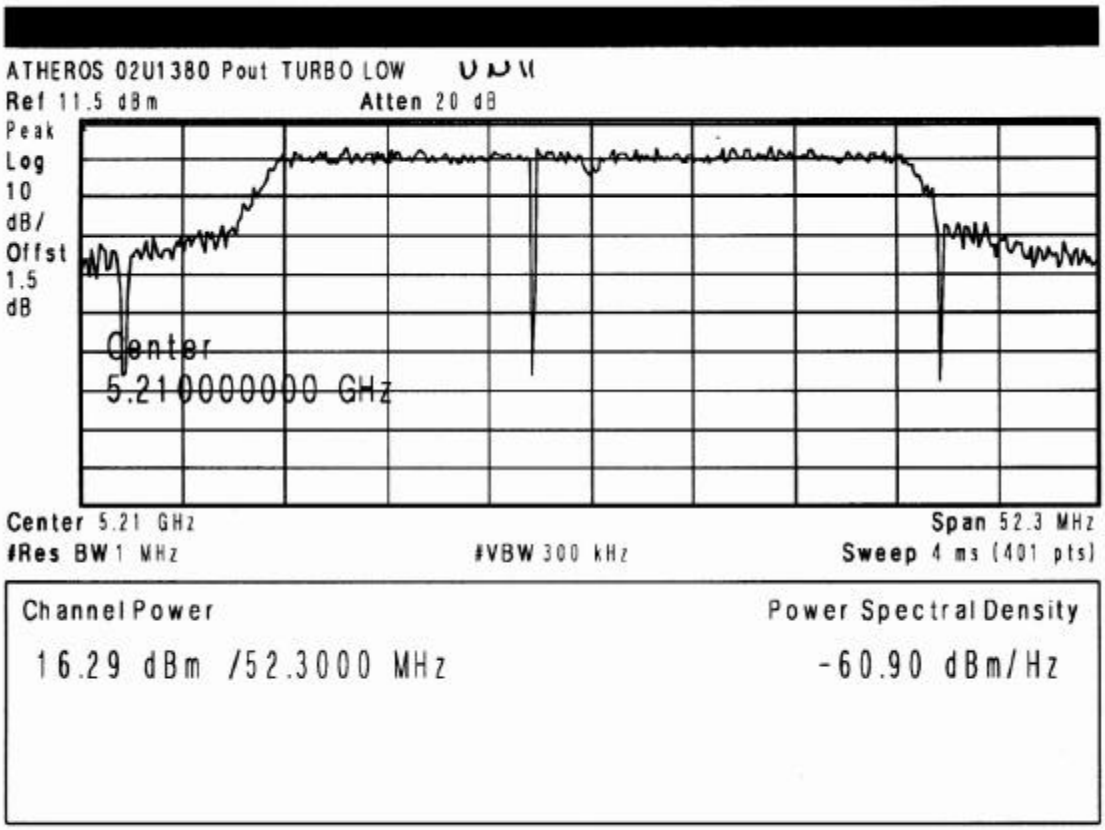
Turbo Mode

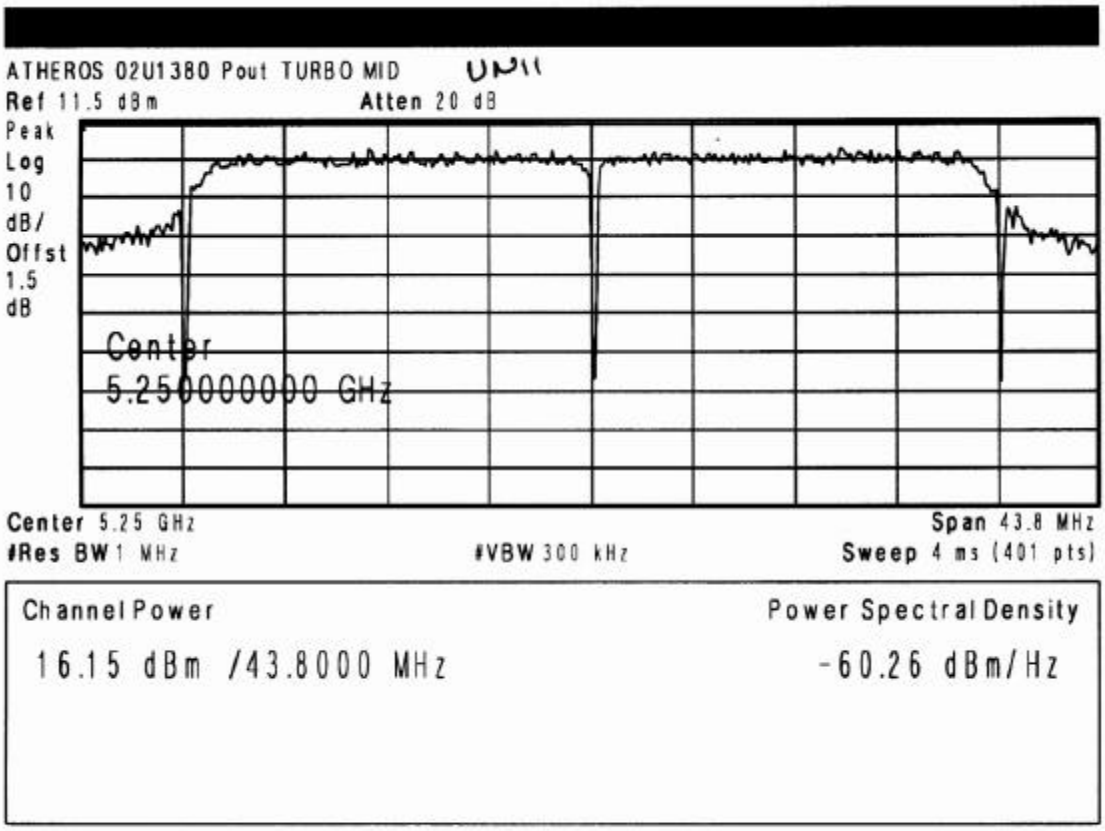
Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin dB
Low	5210	16.29	17	-0.71
Middle	5250	16.25	17	-0.75
High	5290	17.89	24	-6.11

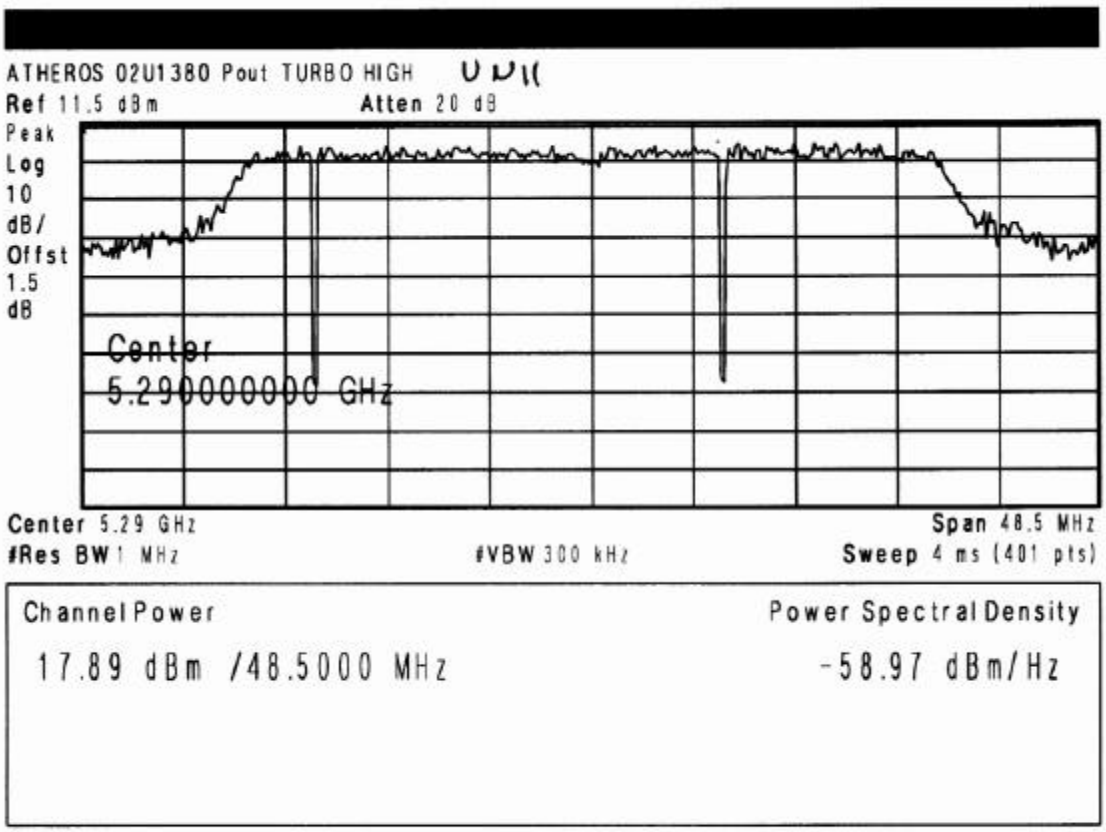






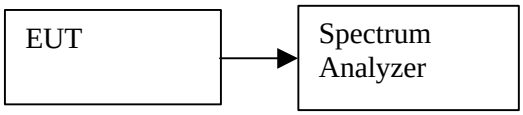






8.3. PEAK POWER SPECTRAL DENSITY

TEST SETUP



TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer, the maximum level in a 1 MHz bandwidth is measured with the spectrum analyzer using RBW =1 MHz, VBW = 3 MHz, and 100 sweeps of video averaging. The PPSD is the highest level found across the emission in any 1 MHz band.

RESULTS

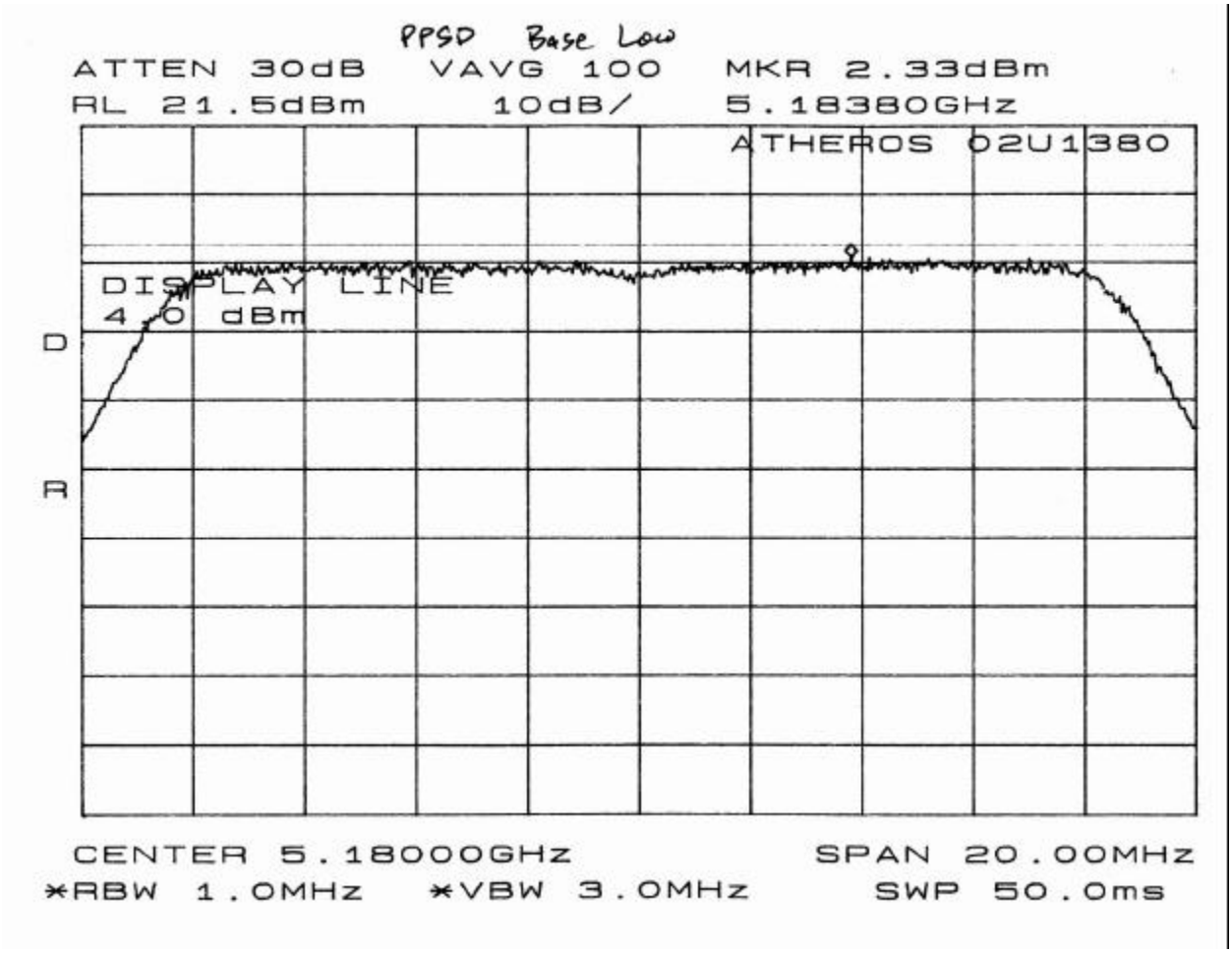
No non-compliance noted:

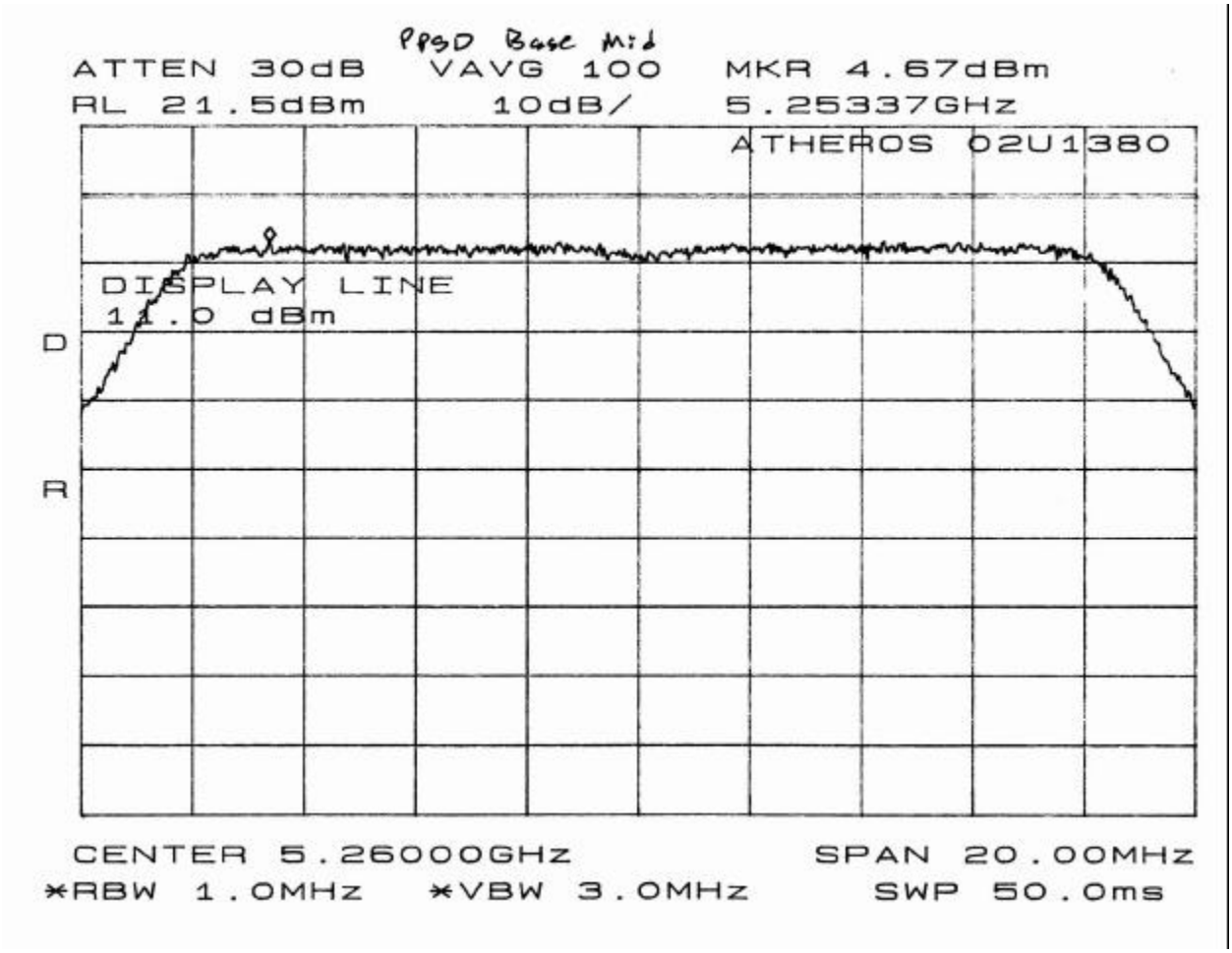
Base Mode

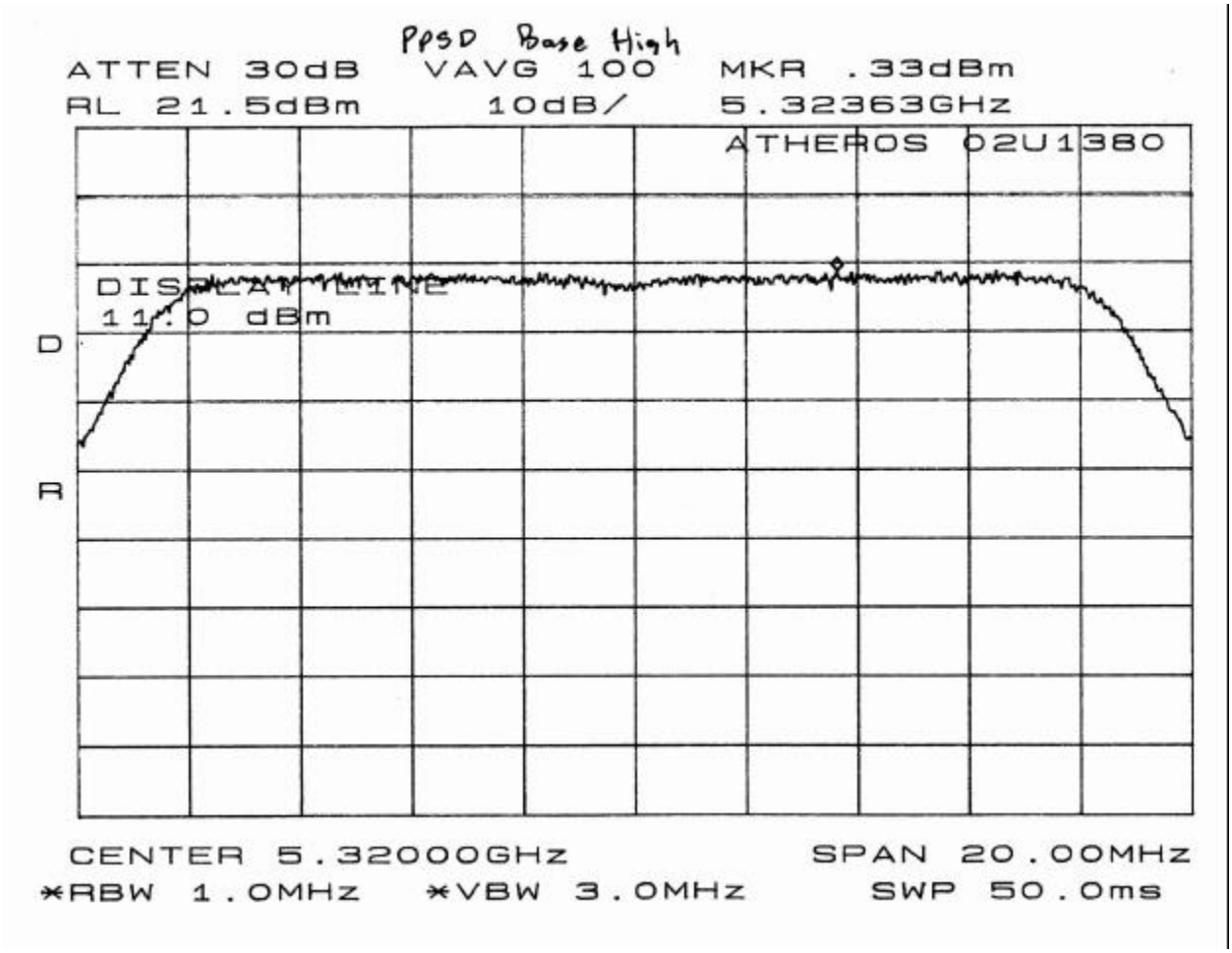
Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin dB
Low	5180	2.33	4	-1.67
Middle	5260	4.67	11	-6.33
High	5320	0.33	11	-10.67

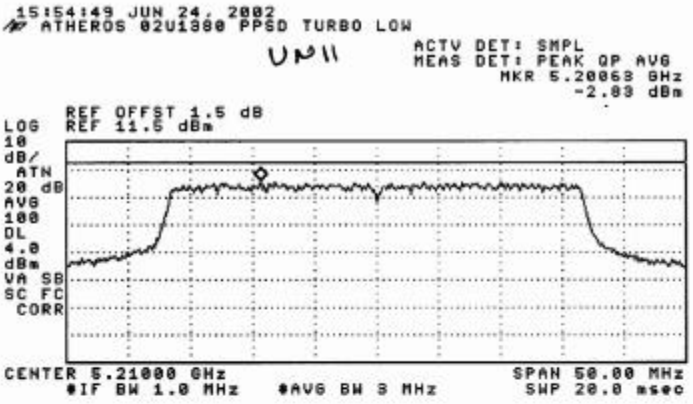
Turbo Mode

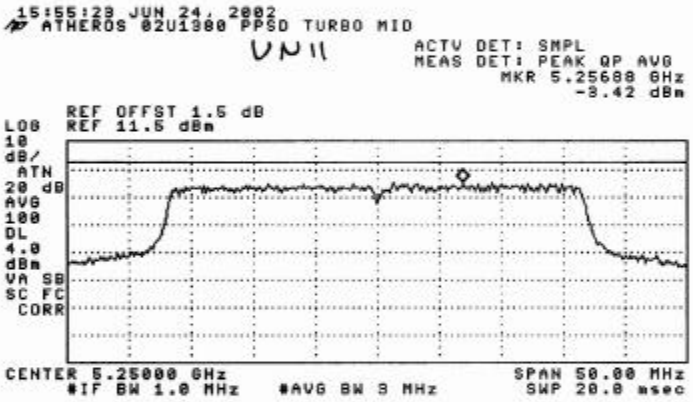
Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin dB
Low	5210	-2.83	4	-6.83
Middle	5250	-3.42	4	-7.42
High	5290	-2.39	11	-13.39

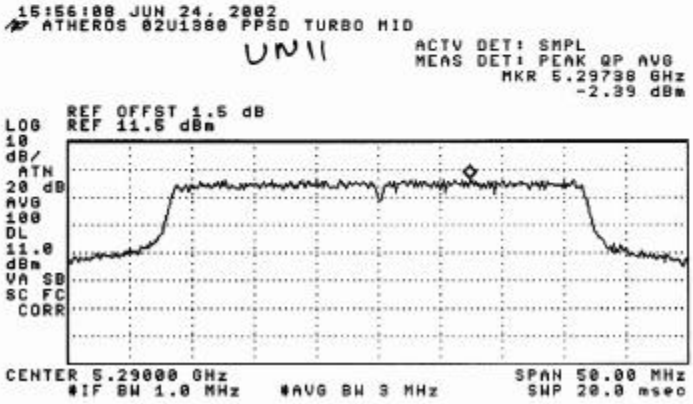






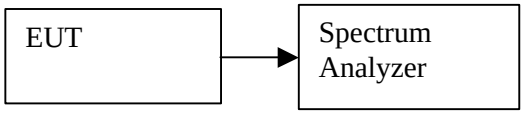






8.4. PEAK EXCURSION

TEST SETUP



TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. The resolution bandwidth is set to and maintained at 1 MHz. First the video bandwidth is set to 1 MHz, Trace A is set to Max Hold, then to View. Then the video bandwidth is readjusted to 30 kHz, and the signal under this measurement condition is captured in Trace B.

The difference between the traces is investigated. The marker is placed at the frequency which shows the largest difference. The amplitude delta between the traces at this frequency is the peak excursion.

RESULTS

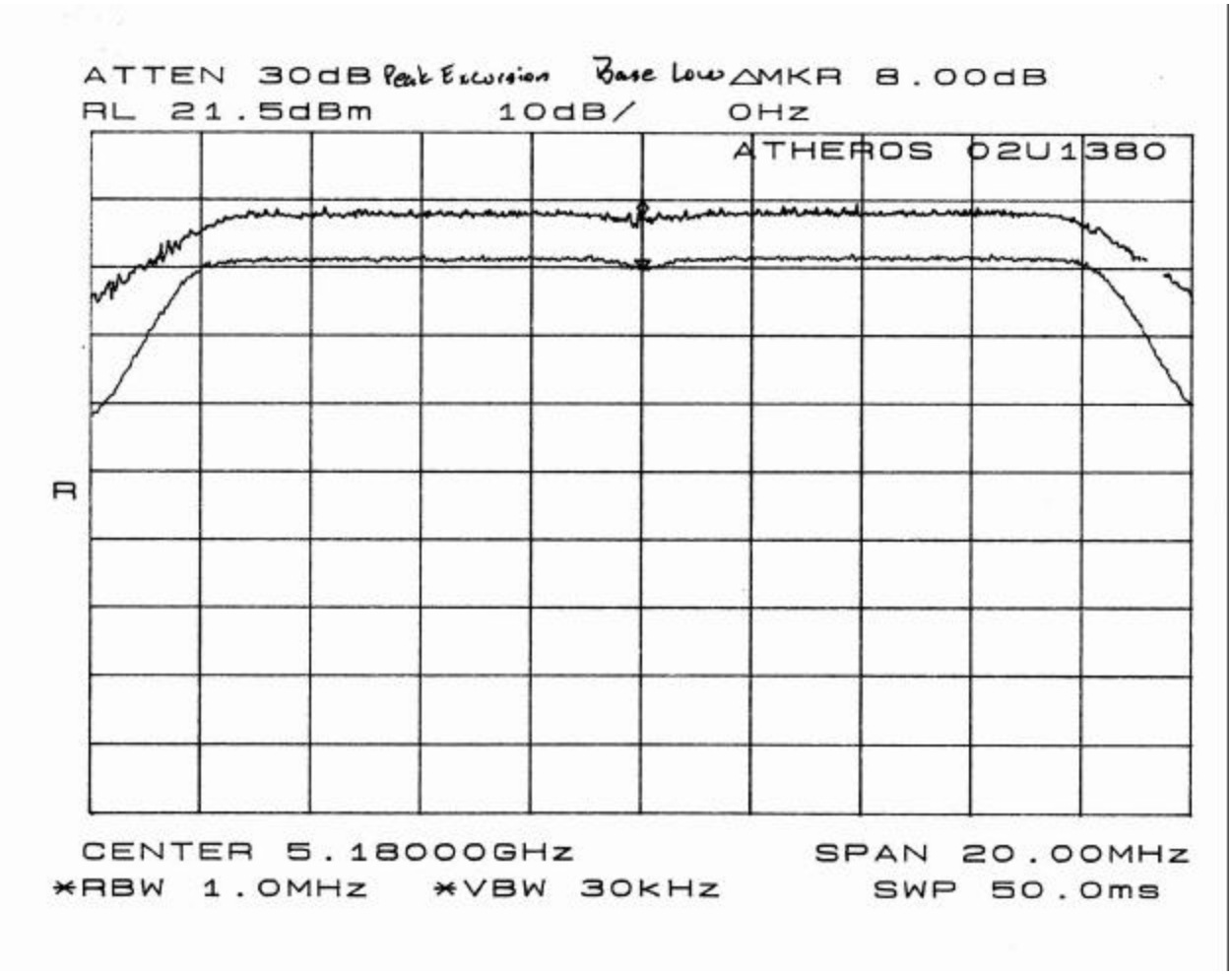
No non-compliance noted:

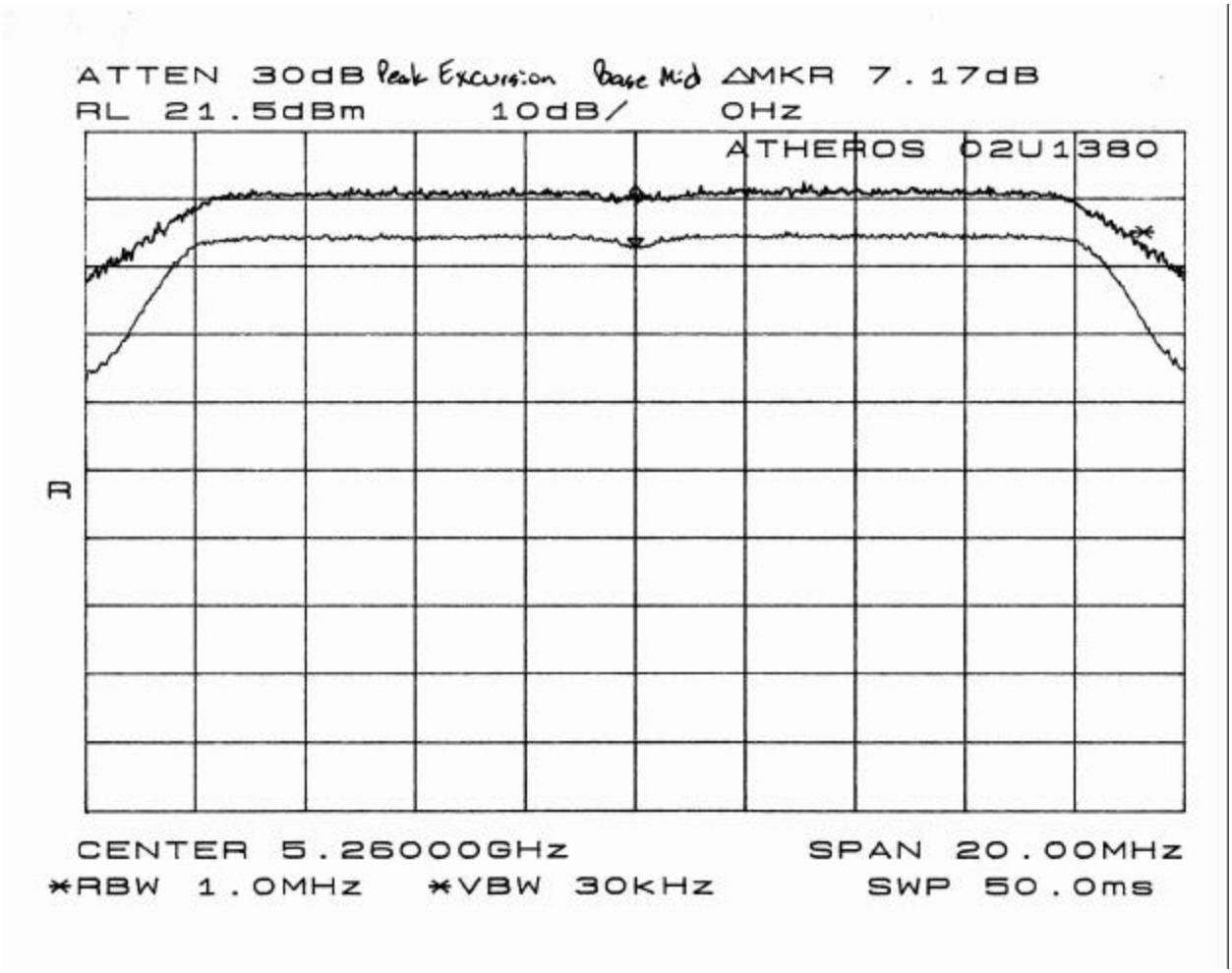
Base Mode

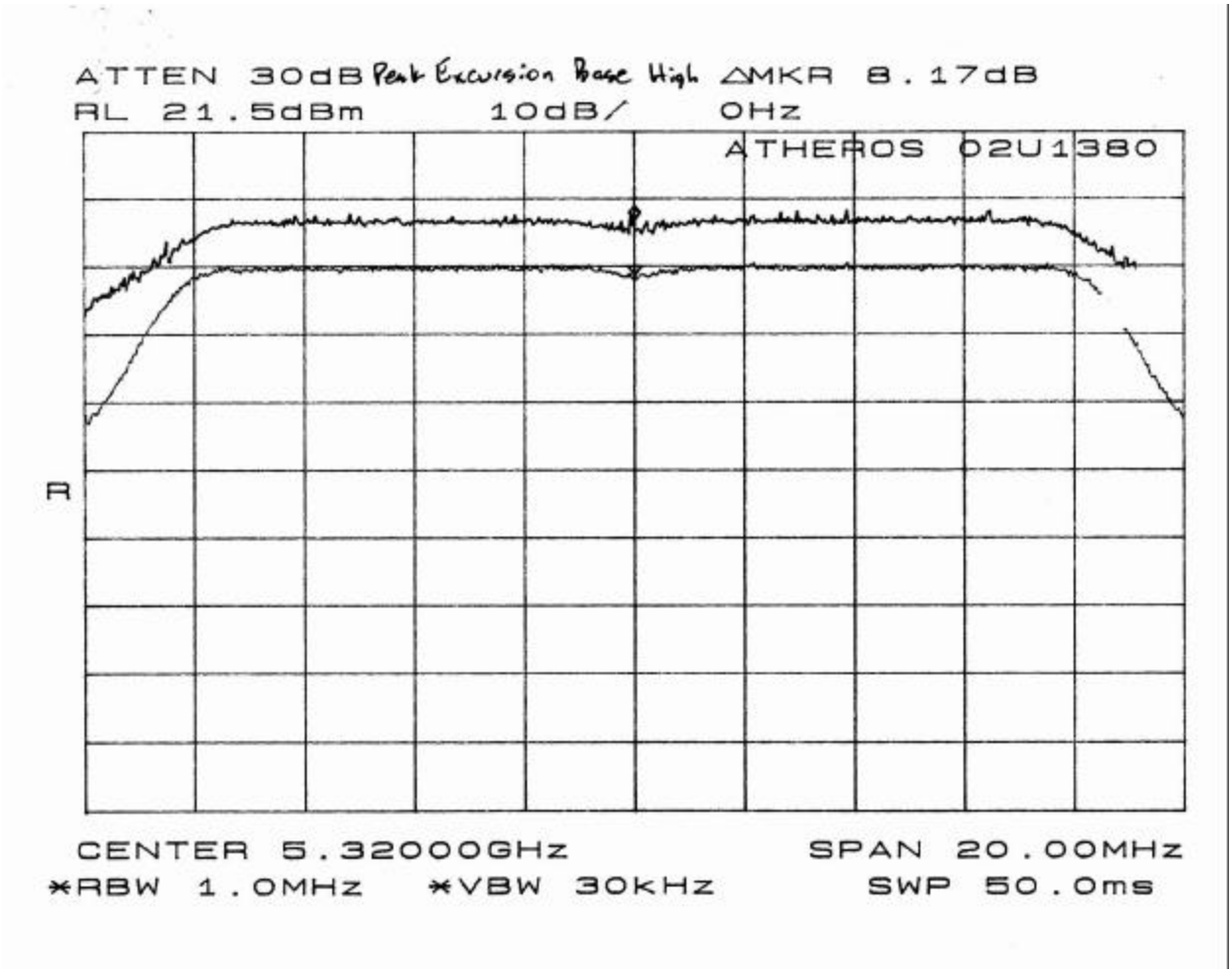
Channel	Frequency (MHz)	Peak Excursion (dB)	Limit (dB)	Margin dB
Low	5180	8.0	13	-5.0
Middle	5260	7.17	13	-5.83
High	5320	8.17	13	-4.83

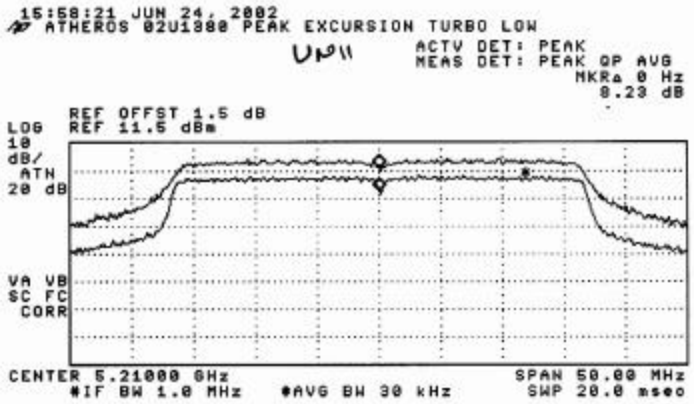
Turbo Mode

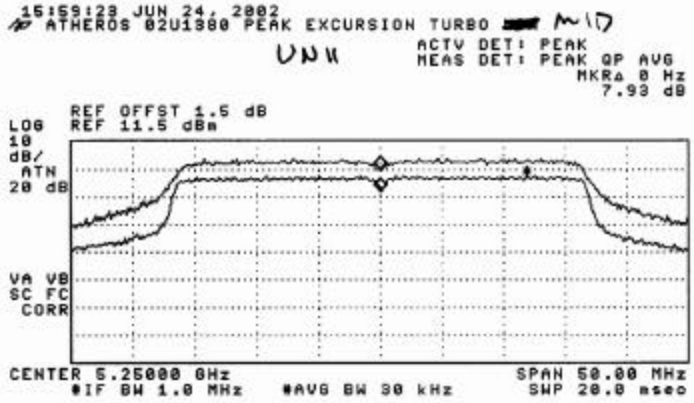
Channel	Frequency (MHz)	Peak Excursion (dB)	Limit (dB)	Margin dB
Low	5210	8.23	13	-4.77
Middle	5250	7.93	13	-5.07
High	5290	8.73	13	-4.27

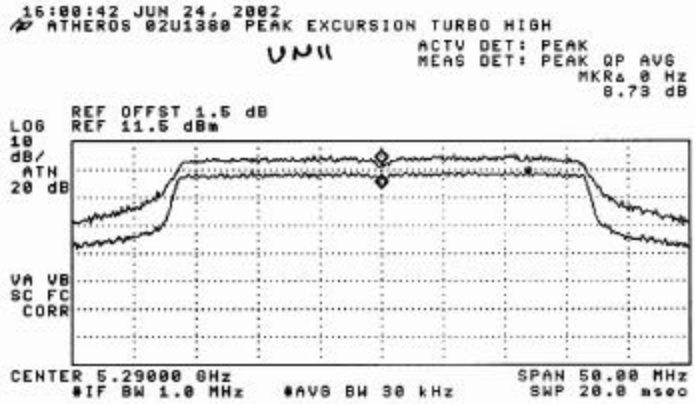












8.5. TRANSMISSION IN THE ABSENCE OF DATA

RESULTS

No non-compliance noted:

Refer to the theory of operation.

8.6. TYPE OF ANTENNA

RESULTS

No non-compliance noted:

The antenna is integral to the device.

8.7. MAXIMUM PERMISSIBLE EXPOSURE

CALCULATIONS

Given

$E = \sqrt{(30 * P * G)} / d$

and

$S = E \wedge 2 / 3770$

where

E = Field Strength in Volts / meter
P = Power in Watts
G = Numeric antenna gain
d = distance in meters
S = Power Density in milliwatts / square centimeter

Combining equations and rearranging the terms to express the distance as a function of the remaining variables yields:

$d = \sqrt{((30 * P * G) / (3770 * S))}$

Changing to units of mW and cm, using:

P (mW) = P (W) / 1000 and

d (cm) =100 * d (m)

yields

$d = 100 * \sqrt{((30 * (P / 1000) * G) / (3770 * S))}$

$d = 0.282 * \sqrt{(P * G / S)}$

where

d = distance in cm
P = Power in mW
G = Numeric antenna gain
S = Power Density in mW / cm^2