FCC CFR47 PART 15 SUBPART E CERTIFICATION

TEST REPORT

FOR

802.11a/b COMBO WIRELESS LAN MODULE

MODEL NUMBER: PA3233U-1MPC

BRAND NAME: TOSHIBA

FCC ID: CJ6UPA3233WL

REPORT NUMBER: 02U1585-2

ISSUE DATE: NOVEMBER 8, 2002

Prepared for

TOSHIBA CORPORATION DIGITAL MEDIA NETWORK COMPANY
2-9, SUEHIRO-CHO, OME,
TOKYO, 198-8710
JAPAN

Prepared by

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1. TEST RESULT CERTIFICATION

COMPANY NAME: TOSHIBA CORPORATION DIGITAL MEDIA NETWORK COMPANY
2-9, SUEHIRO-CHO, OME
TOKYO, 198-8710 JAPAN

EUT DESCRIPTION: 802.11A/B COMBO WLAN MODULE

MODEL NAME: PA3233U-1MPC

DATE TESTED: OCTOBER 17 – NOVEMBER 6, 2002

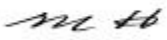
TYPE OF EQUIPMENT	INTENTIONAL RADIATOR
EQUIPMENT TYPE	5.15 – 5.35 GHz TRANSCEIVER *
MEASUREMENT PROCEDURE	ANSI 63.4 / 1992, TIA/EIA 603
PROCEDURE	CERTIFICATION
FCC RULE	CFR 47 PART 15.E

* 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. This report only documents the RF performance of the radio module. AC mains conducted emissions and digital device radiated emissions performance is documented by Toshiba Document Number OFD-H3395 dated October 18, 2002, FCC ID: CJ6PP35ASY, Certification Pending.

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:



MIKE HECKROTTE
CHIEF ENGINEER
COMPLIANCE CERTIFICATION SERVICES

Tested By:

FRANK IBRAHIM
EMC ENGINEER
COMPLIANCE CERTIFICATION SERVICES

2. EUT DESCRIPTION

The Toshiba WLAN module is an 802.11 a/b wireless Spread Spectrum transceiver. It is constructed on a printed circuit card with a Mini PCI interface and is designed to be installed in a host system. This unit provides a power output of +17 dBm (50 mW) in the 5150 – 5350 MHz band. It is designed to use two dual band inverted F film antennas. A single antenna is used for transmit. Both antennas are used for receive diversity. The highest intended antenna gain is 4.8 dBi.

This transceiver 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	NVLAP 200065-0
USA	FCC	3/10 meter Open Area Test Sites to perform FCC Part 15/18 measurements	FC 1300
Japan	VCCI	CISPR 22 Two OATS and one conducted Site	VCCI 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	N 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	N ELA-171
Taiwan	BSMI	CNS 13438	商檢 SL2-IN-E-1012
Canada	Industry Canada	RSS210 Low Power Transmitter and Receiver	Canada 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	8/22/03
Log Periodic Antenna	EMCO	3146	9107-3163	3/30/03
Biconical Antenna	Eaton	94455-1	1197	3/30/03
Spectrum Analyzer	HP	8564E	3943A01643	7/22/03
Preamplifier (1 - 26.5GHz)	HP	8449B	3008A00369	6/30/03
Horn Antenna (1 - 18GHz)	EMCO	3115	6717	1/31/03
Horn Antenna (18 – 26.5GHz)	ARA	MWH 1826/B	6717	1/31/03
High Pass Filter (4.57GHz)	FSY Microwave	FM-4570-9SS	003	N.C.R.
Harmonic Mixer	HP	11970A	3008A04190	10/14/05
Spectrum Analyzer	HP	E4404B	ID 963805	3/25/03
Microwave Detector	Agilent	8474C	2905AO4047	6/4/03
Oscilloscope	HP	54601A	3106A00123	11/6/03

6. SETUP OF EQUIPMENT UNDER TEST

SUPPORT EQUIPMENT

PERIPHERAL SUPPORT EQUIPMENT LIST				
Device Type	Manufacturer	Model	Serial Number	FCC ID
Laptop	Toshiba	PP350U	92036659JU	Prototype / EUT
AC Adapter	Toshiba	PA3083U-1ACA	1336963G	DoC

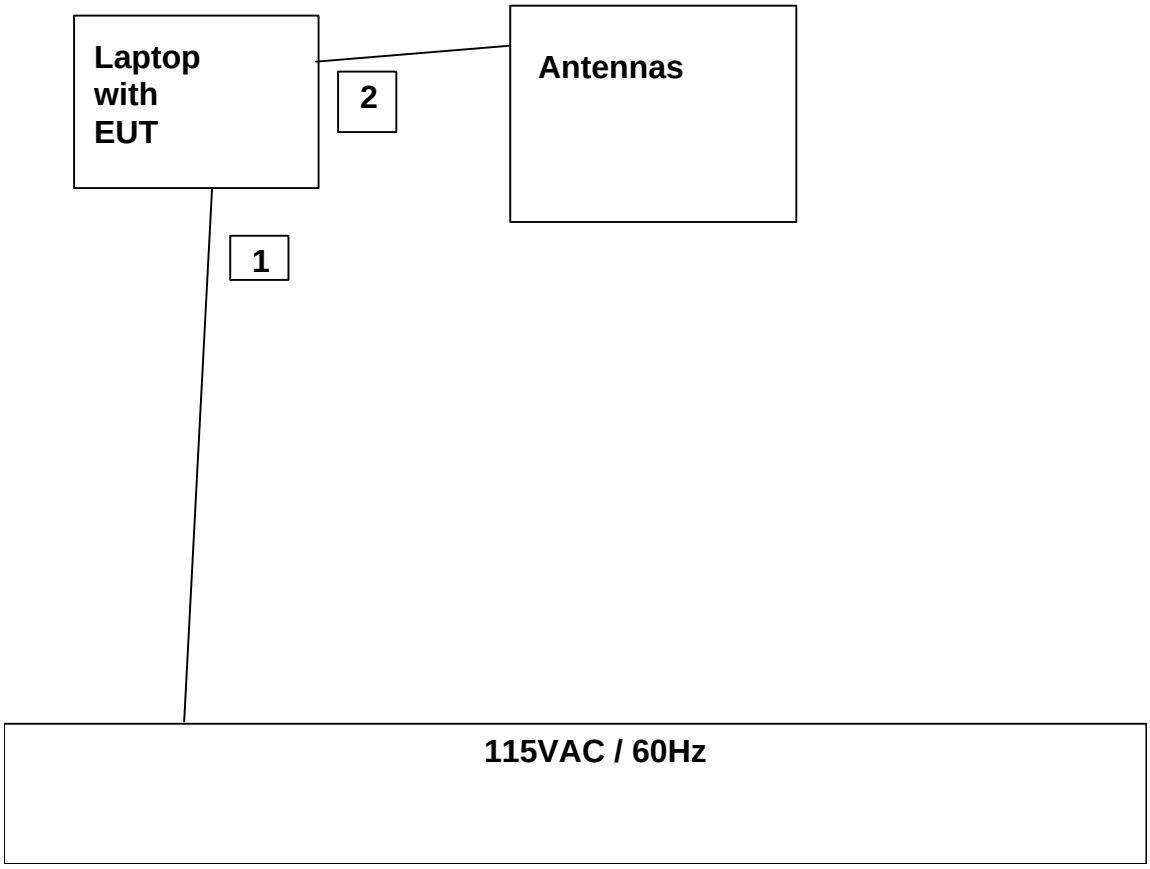
I/O CABLES

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	RF	2	UFL	Shielded	0.3 m	Integrated with Antennas

TEST SETUP

The EUT is installed in the laptop computer via a PCMCIA-to-MiniPCI adapter / extender card.

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	15.85	19.85	17
Middle	5260	15.91	26.91	24
High	5320	15.93	26.93	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	18.6	22.6	17
Middle	5250	18.62	22.62	17
High	5290	18.86	29.82	24

Maximum antenna gain = 4.8 dBi, therefore there is no reduction due to antenna gain.

§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:

4 dBm and 11 dBm. Maximum antenna gain = 4.8 dBi, therefore there is no reduction due to antenna gain.

§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.

§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.

§15.209- RADIATED EMISSION LIMITS

(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.

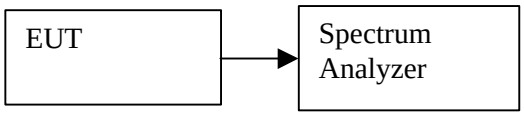
(b) In the emission table above, the tighter limit applies at the band edges.

Frequency Range (MHz)	Field Strength (uV/m at 3 m)	Field Strength (dBuV/m at 3 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:

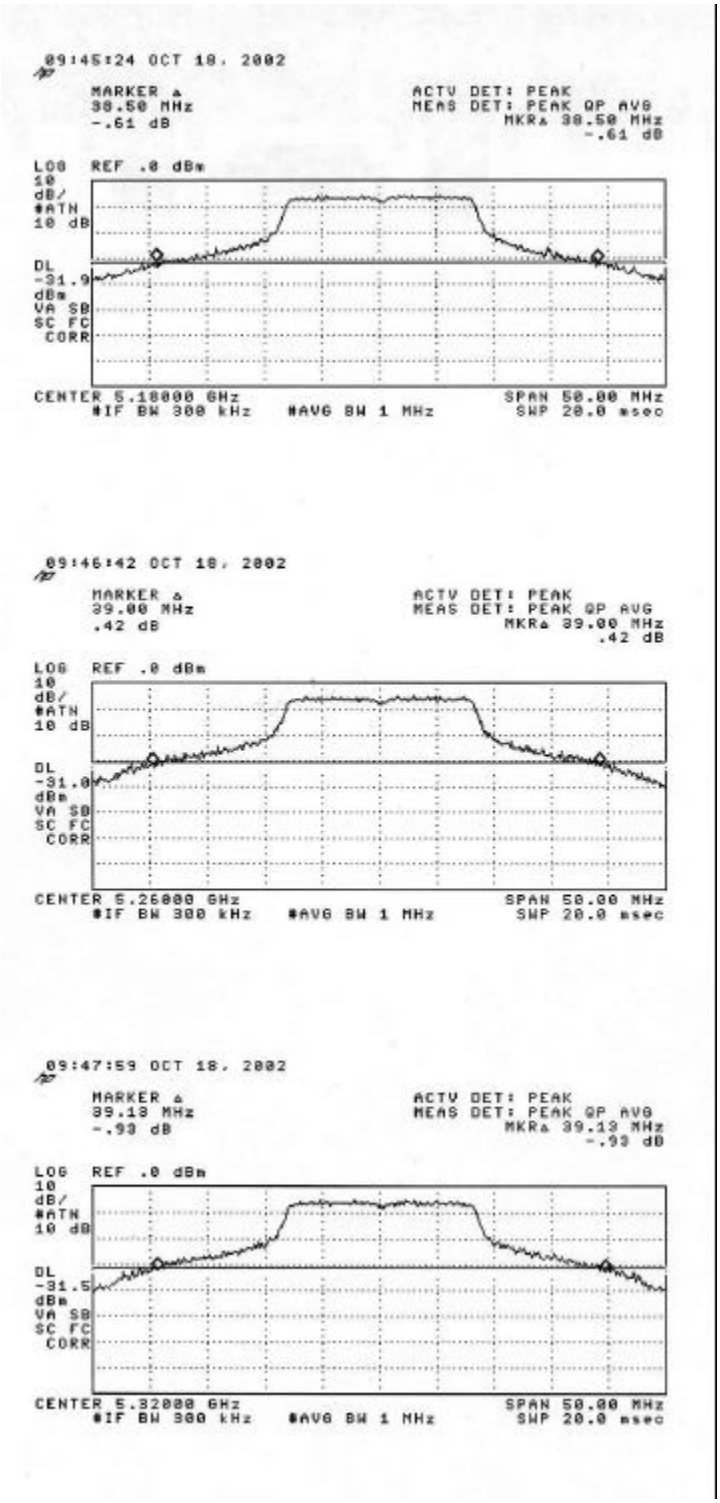
Base Mode

Channel	Frequency (MHz)	B (MHz)	10 Log B (dB)
Low	5180	38.5	15.85
Middle	5260	39	15.91
High	5320	39.13	15.93

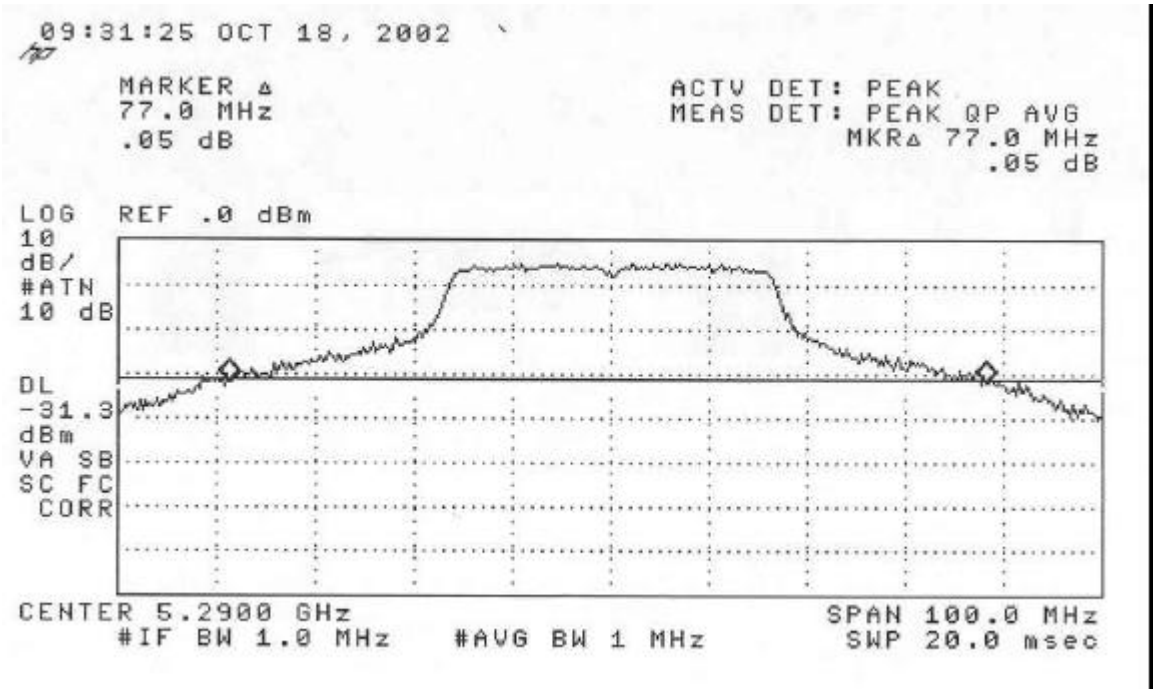
Turbo Mode

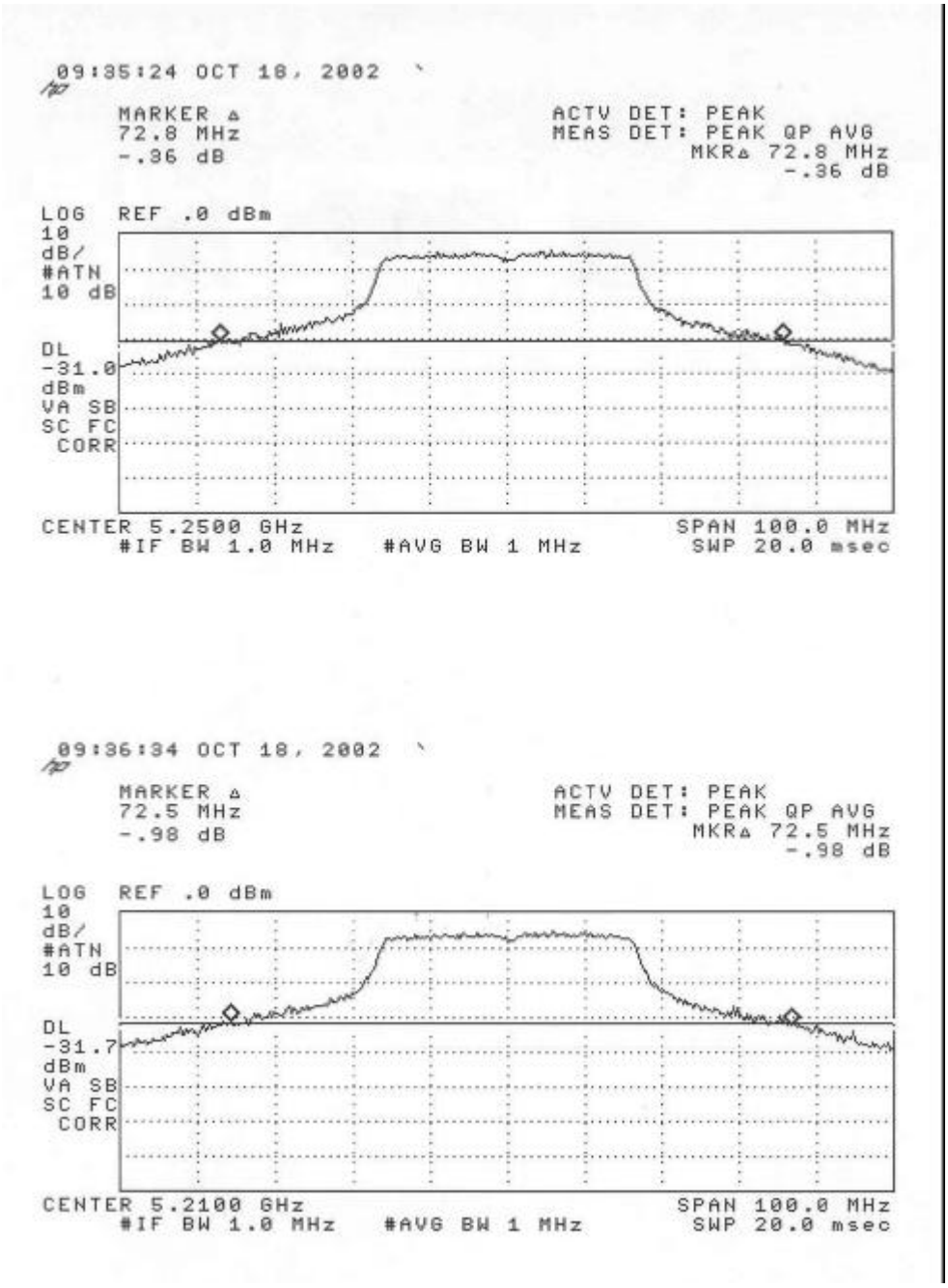
Channel	Frequency (MHz)	B (MHz)	10 Log B (dB)
Low	5210	72.5	18.6
Middle	5250	72.8	18.62
High	5290	77	18.86

EMISSION BANDWIDTH (NORMAL MODE)



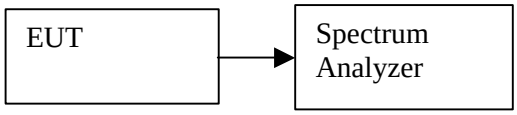
EMISSION BANDWIDTH (TURBO MODE)





8.2. PEAK POWER

TEST SETUP



TEST PROCEDURE

The test is performed in accordance with FCC Public Notice: APPENDIX A Guidelines for Assessing Unlicensed National Information Infrastructure (U-NII) Devices – Part 15, Subpart E, August 2002.

The transmitter output is initially connected to a microwave detector and oscilloscope to measure the pulse duration, T.

Normal mode pulse duration = 3.14 msec.
Normal mode pulse duration = 1.57 msec.

The automatic analyzer settings yield a sweep time of 50 msec. Sweep time > T and EBW > largest available RBW, therefore Method # 3 is used.

RESULTS

No non-compliance noted:

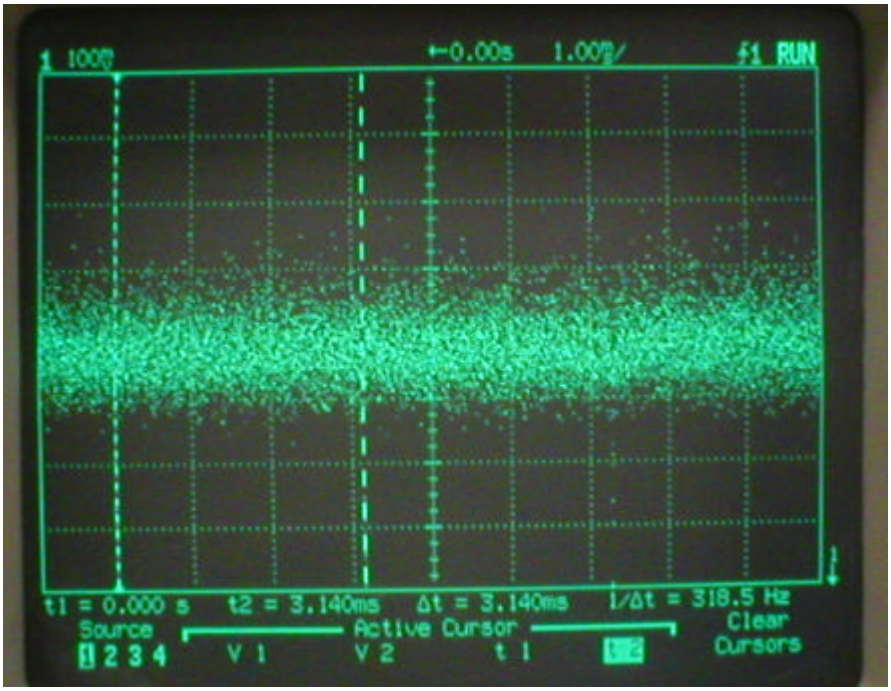
Base Mode

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin dB
Low	5180	14.6	17	-2.4
Middle	5260	16.8	24	-7.2
High	5320	14.9	24	-9.1

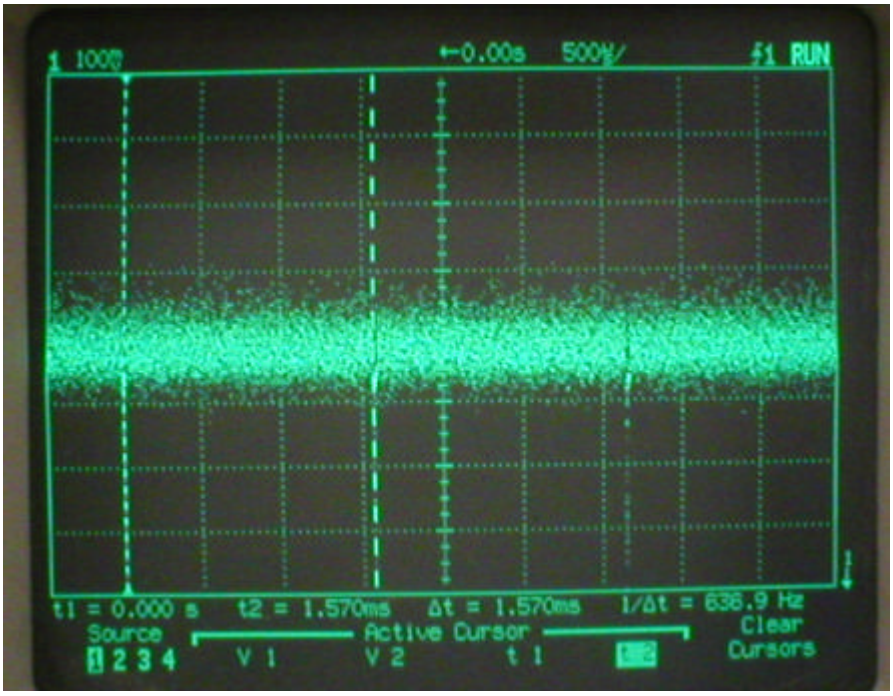
Turbo Mode

Channel	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	Margin dB
Low	5210	16.8	17	-0.2
Middle	5250	16.6	17	-0.4
High	5290	17	24	-7.0

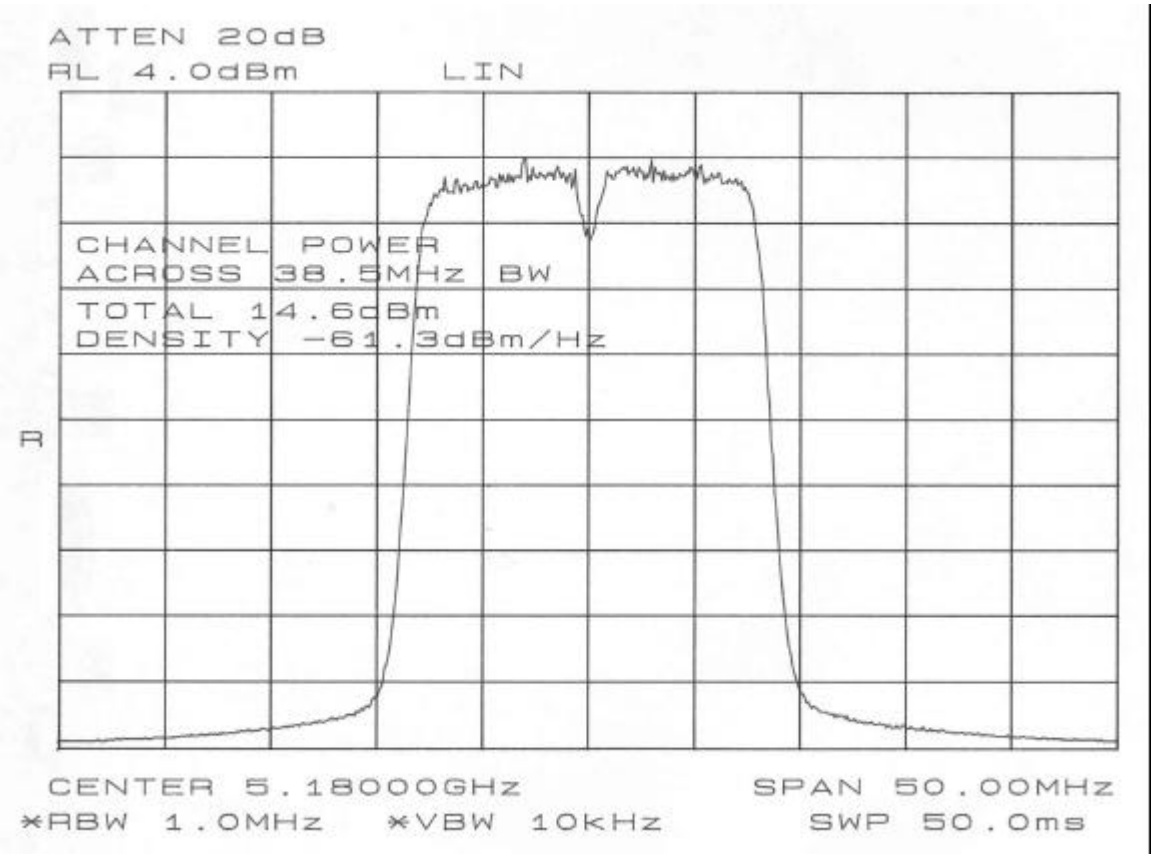
PULSE DURATION (NORMAL MODE)

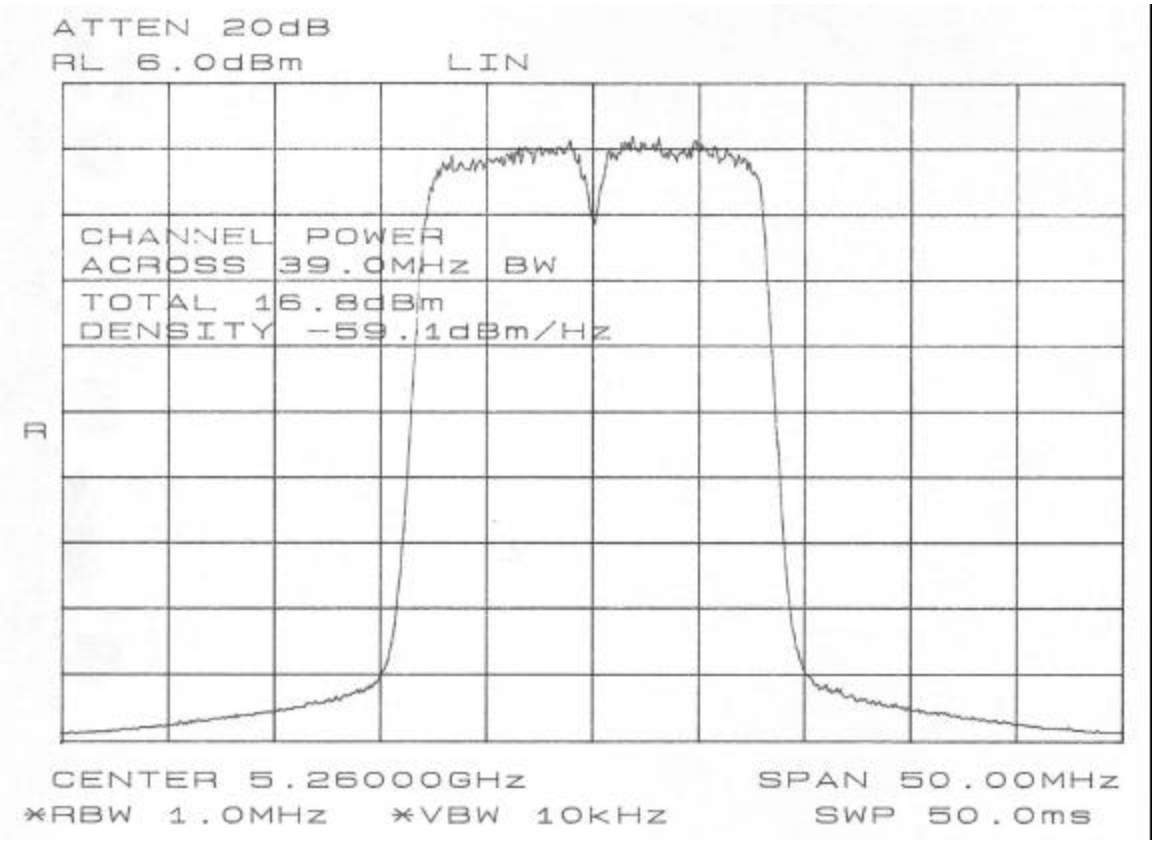


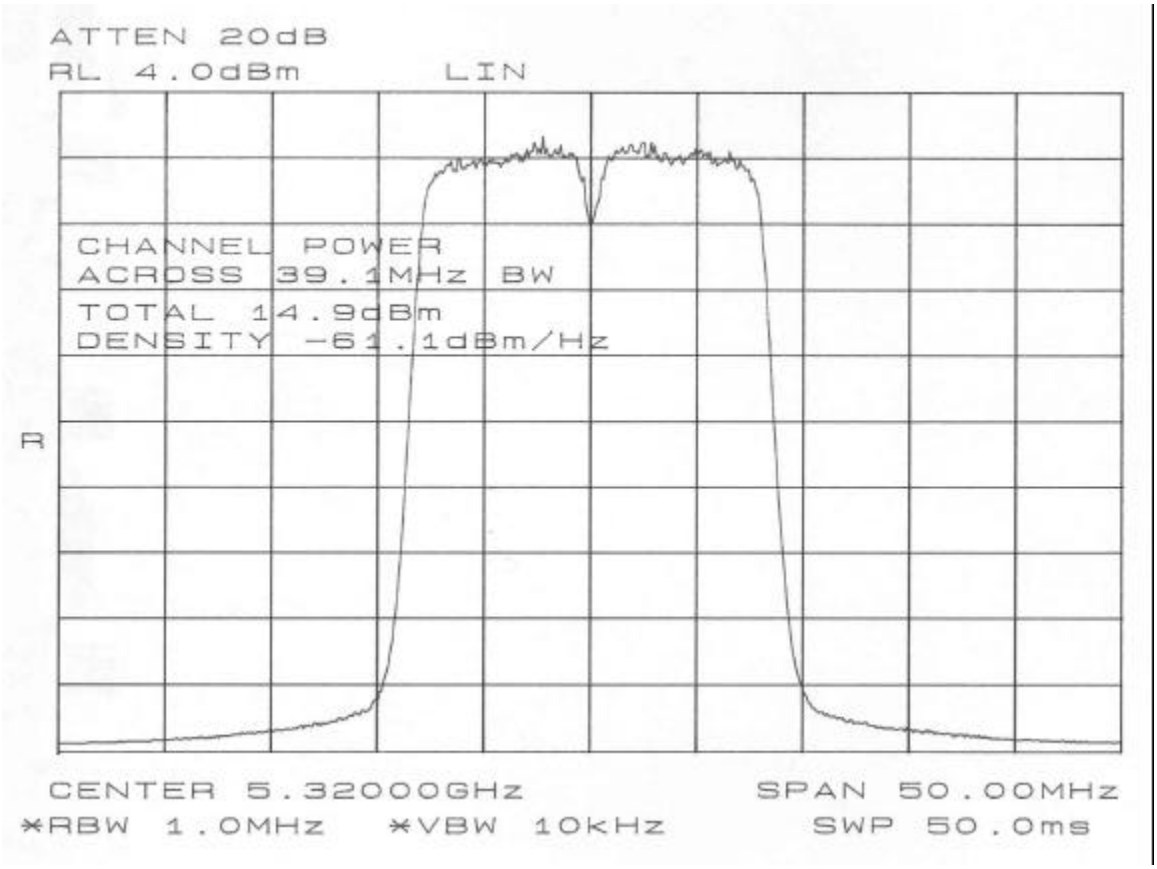
PULSE DURATION (TURBO MODE)



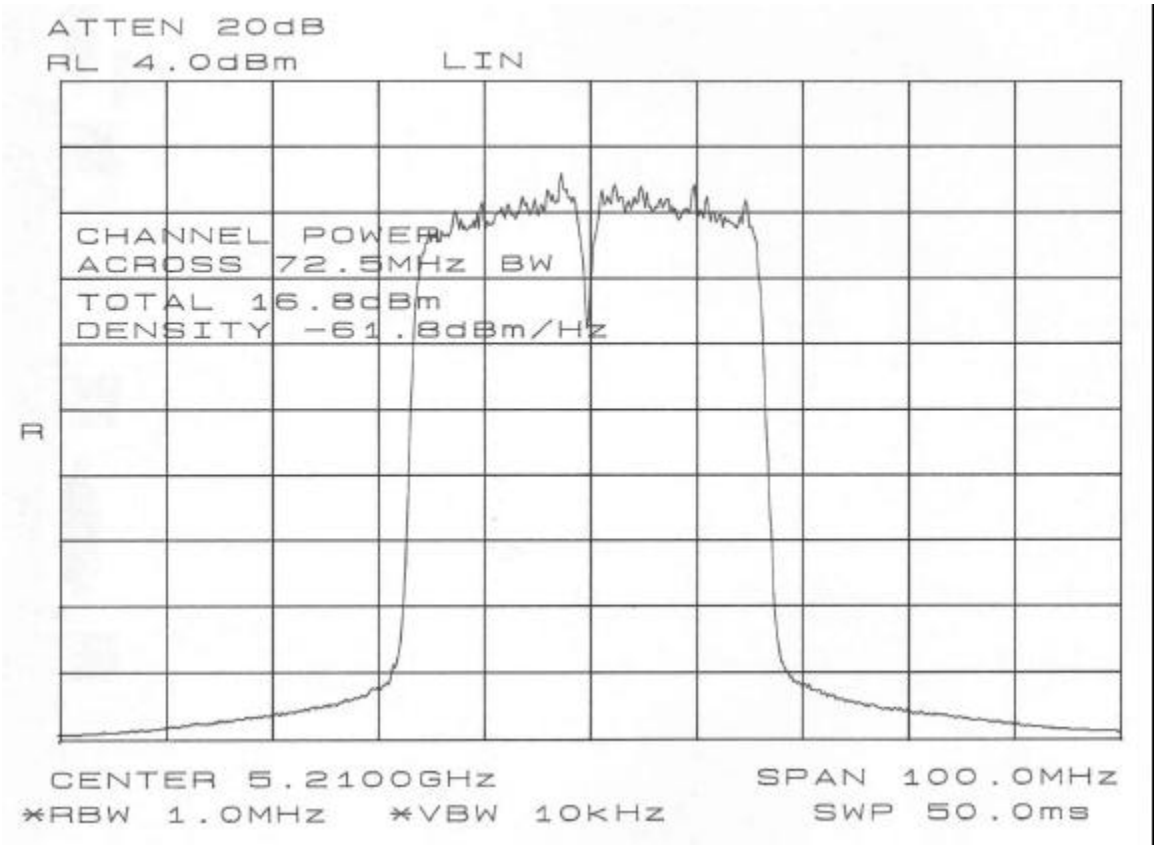
PEAK POWER (NORMAL MODE)

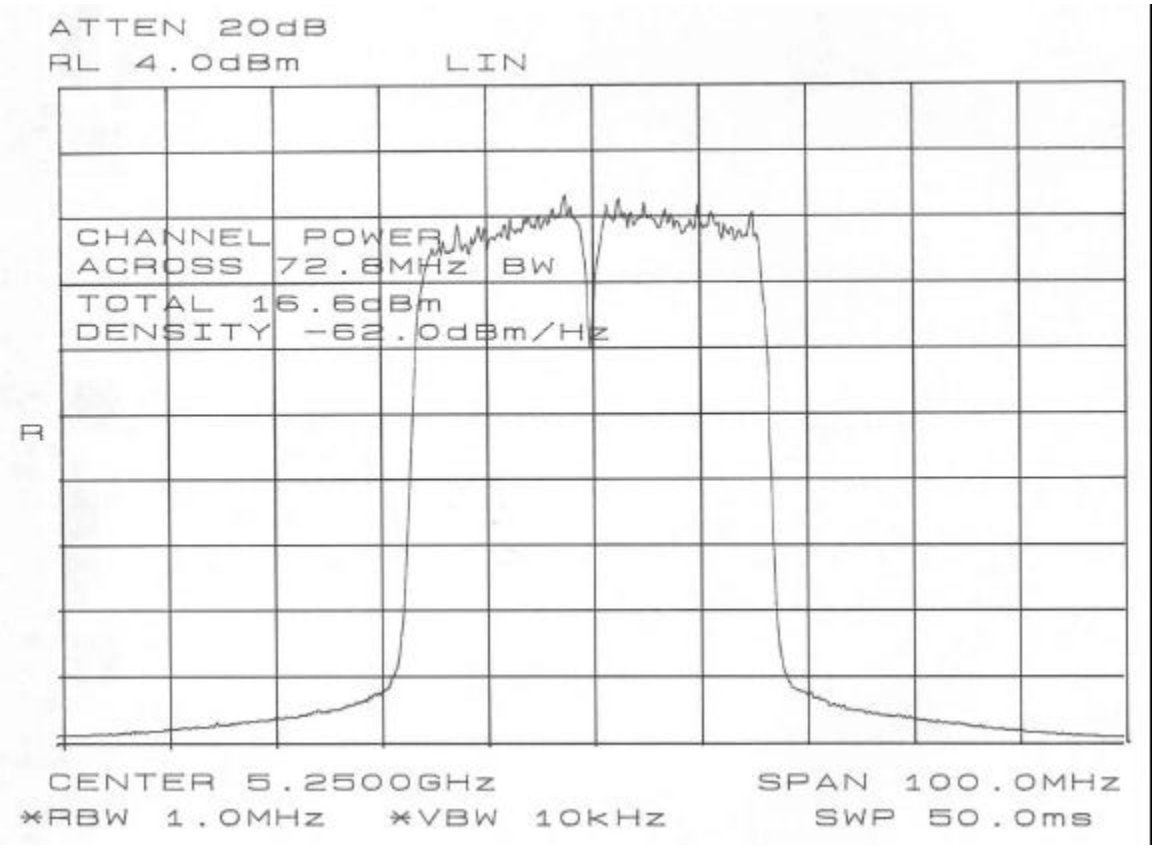


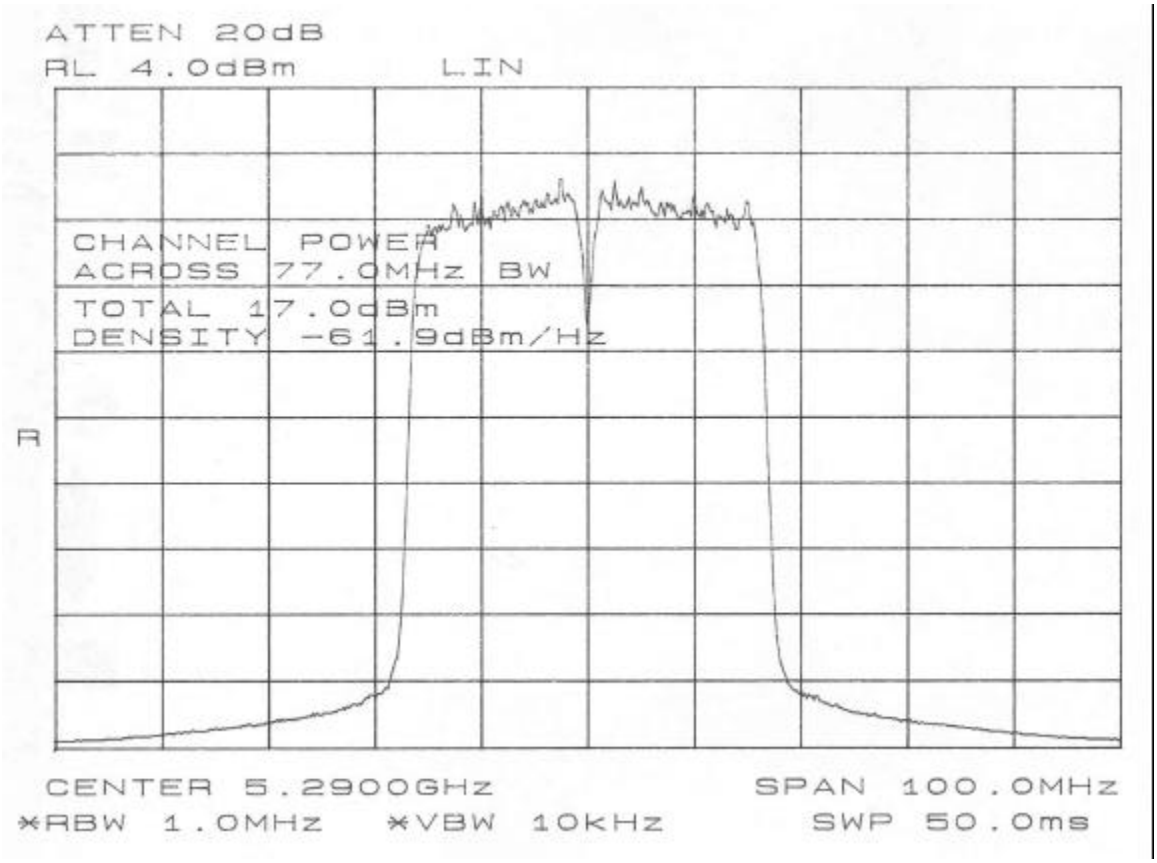




PEAK POWER (TURBO MODE)

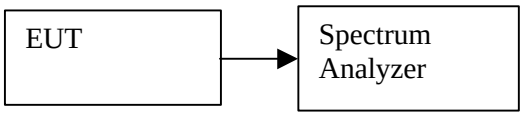






8.3. PEAK POWER SPECTRAL DENSITY

TEST SETUP



TEST PROCEDURE

The test is performed in accordance with FCC Public Notice: APPENDIX A Guidelines for Assessing Unlicensed National Information Infrastructure (U-NII) Devices – Part 15, Subpart E, August 2002, Method 2.

RESULTS

No non-compliance noted:

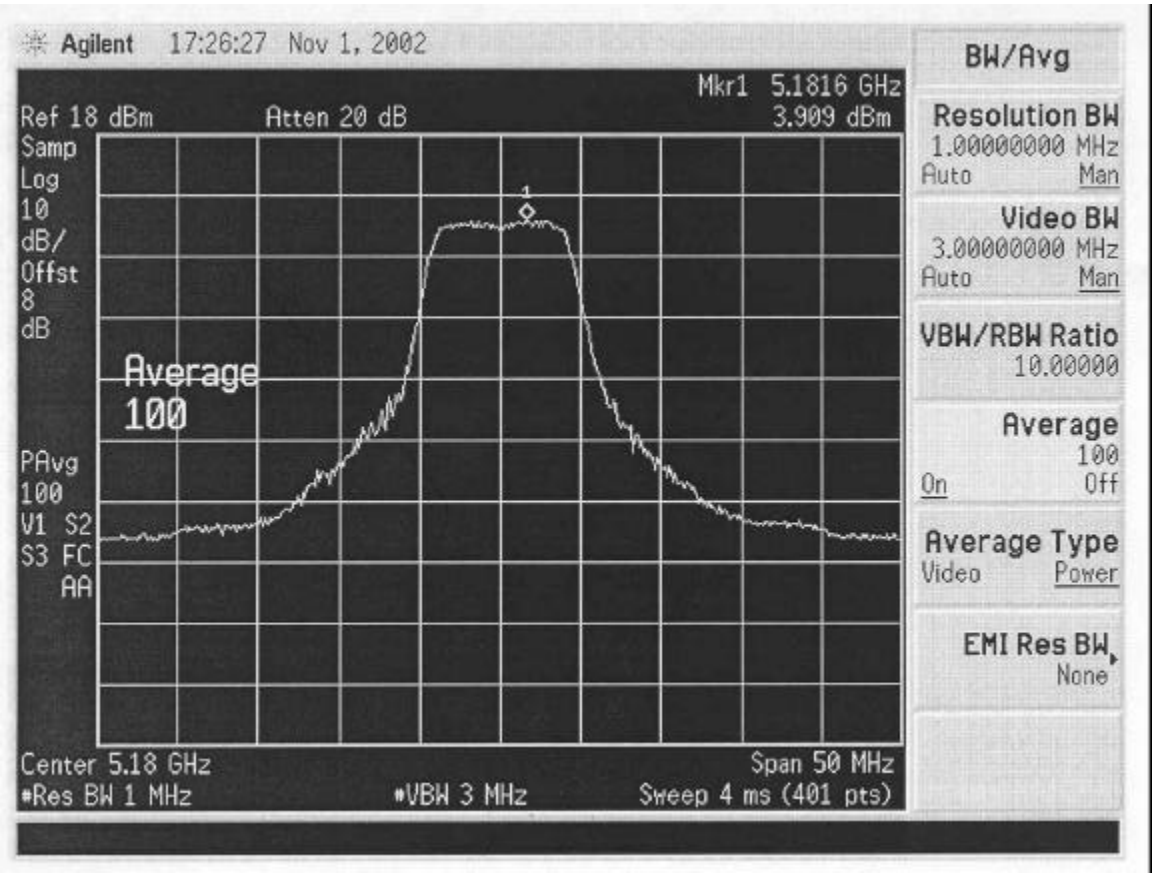
Base Mode

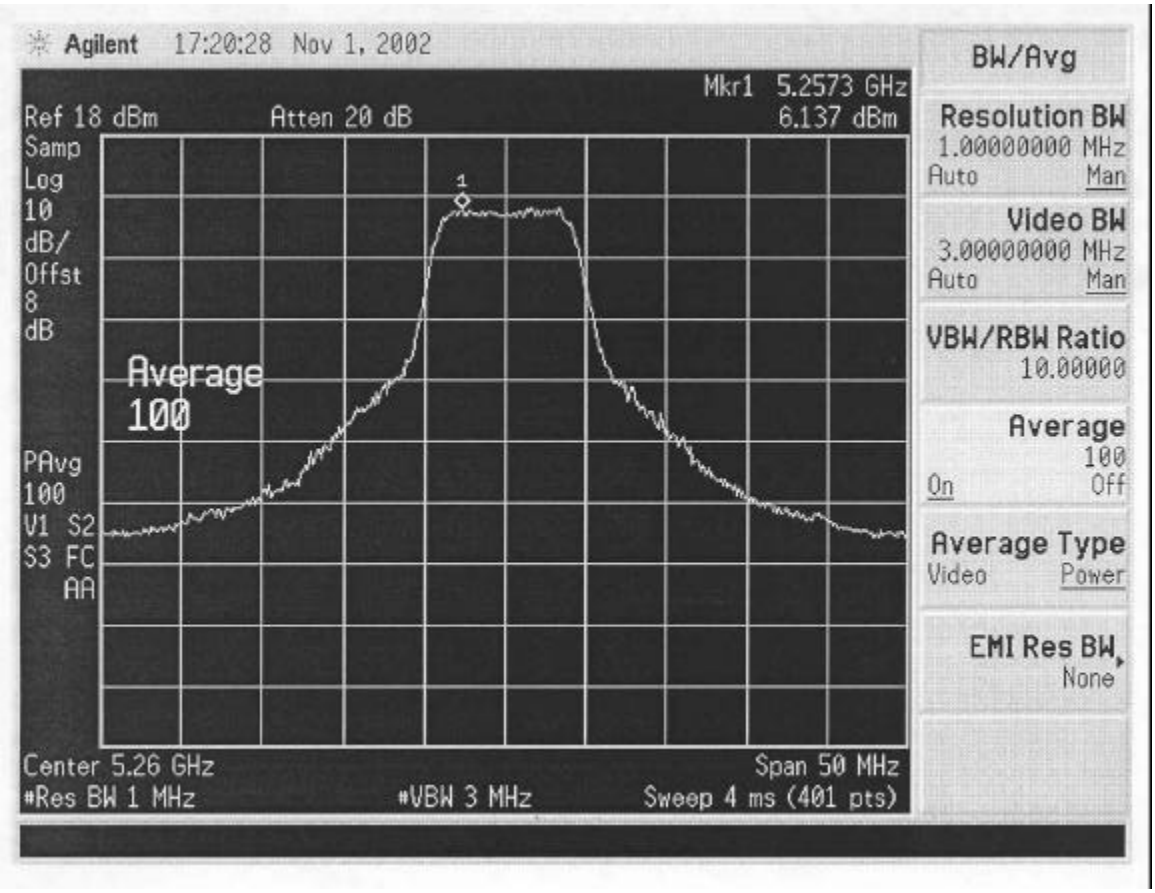
Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin dB
Low	5180	3.909	4	-0.091
Middle	5260	6.137	11	-4.863
High	5320	5.289	11	-5.711

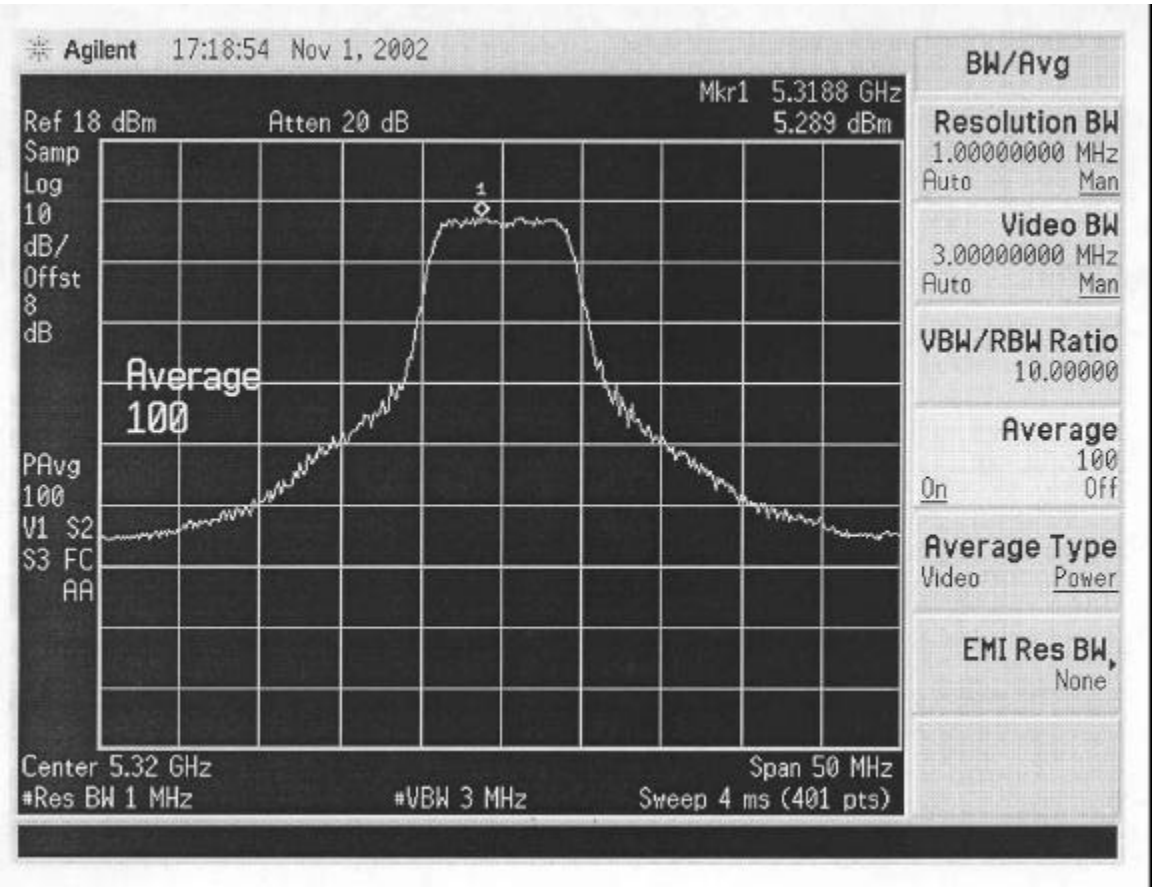
Turbo Mode

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Margin dB
Low	5210	1.241	4	-2.759
Middle	5250	0.042	4	-3.958
High	5290	0.623	11	-10.38

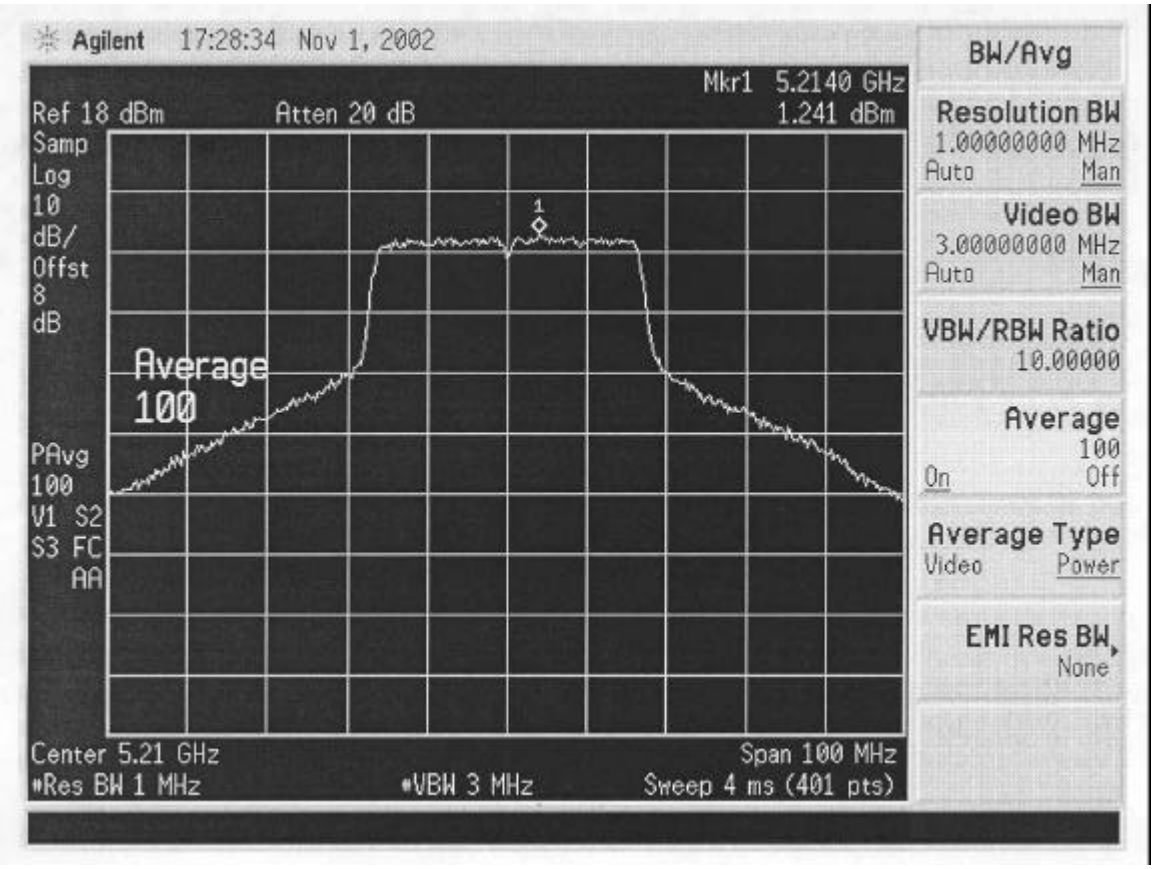
PPSD (NORMAL MODE)

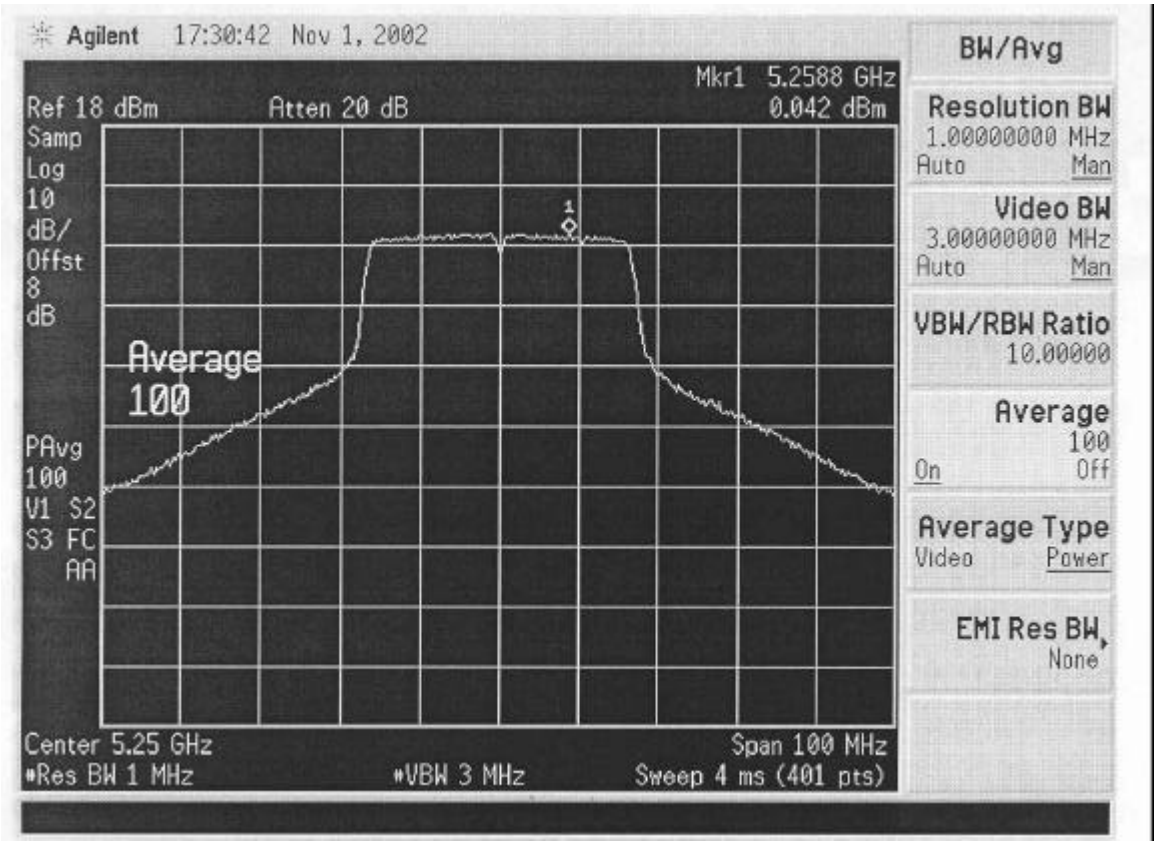


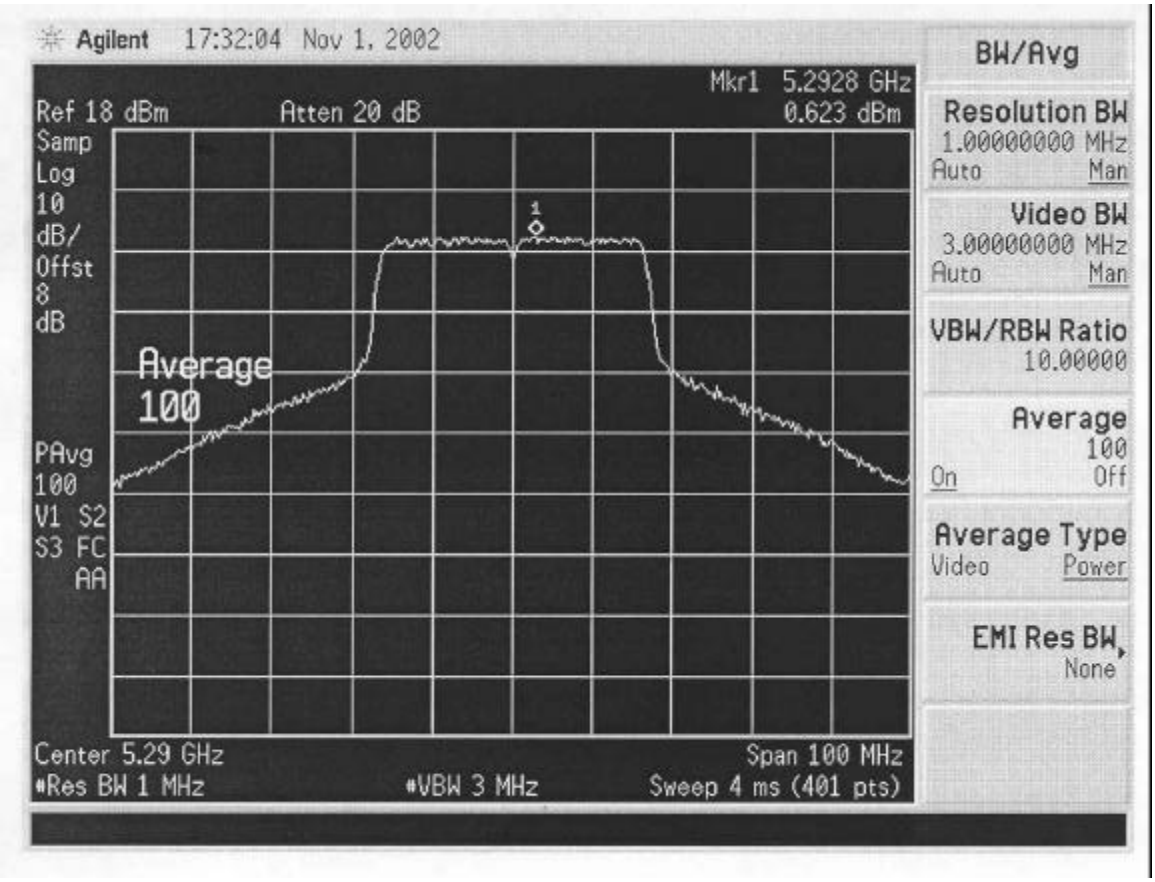




PPSD (TURBO MODE)

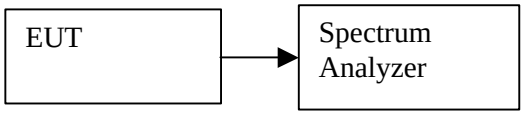






8.4. PEAK EXCURSION

TEST SETUP



TEST PROCEDURE

The test is performed in accordance with FCC Public Notice: APPENDIX A Guidelines for Assessing Unlicensed National Information Infrastructure (U-NII) Devices – Part 15, Subpart E, August 2002.

Since Method # 3 was used for peak power measurements, Method # 3 is used for the second PPSD trace.

RESULTS

No non-compliance noted:

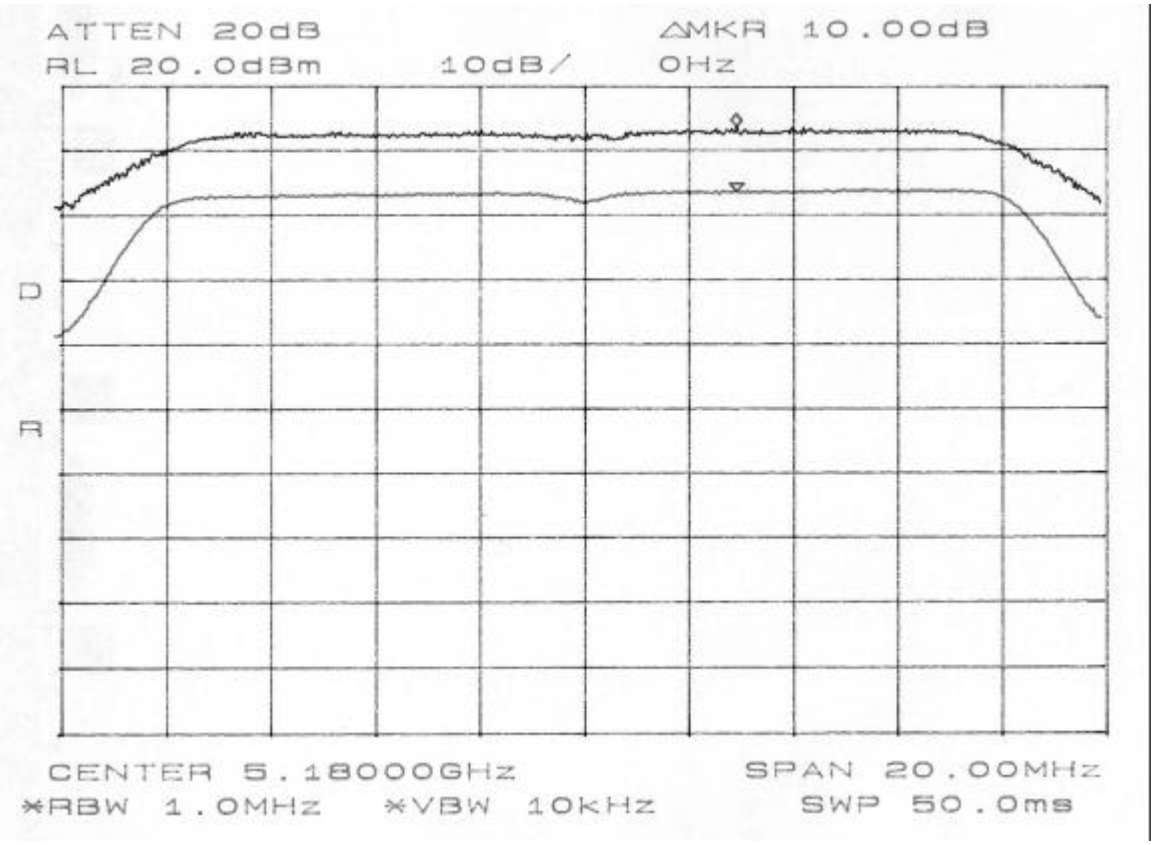
Base Mode

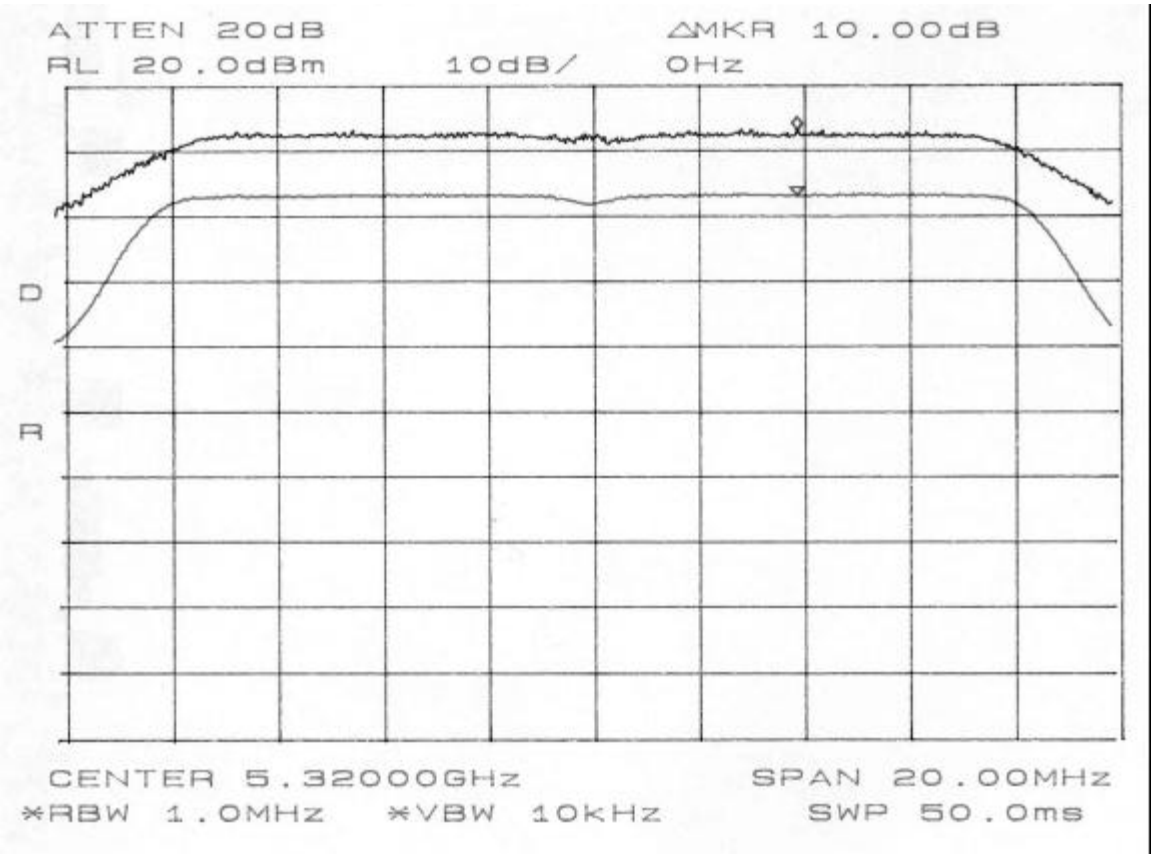
Channel	Frequency (MHz)	Peak Excursion (dB)	Limit (dB)	Margin dB
Low	5180	10.0	13	-3.0
Middle	5260	10.17	13	-2.83
High	5320	10.0	13	-3.0

Turbo Mode

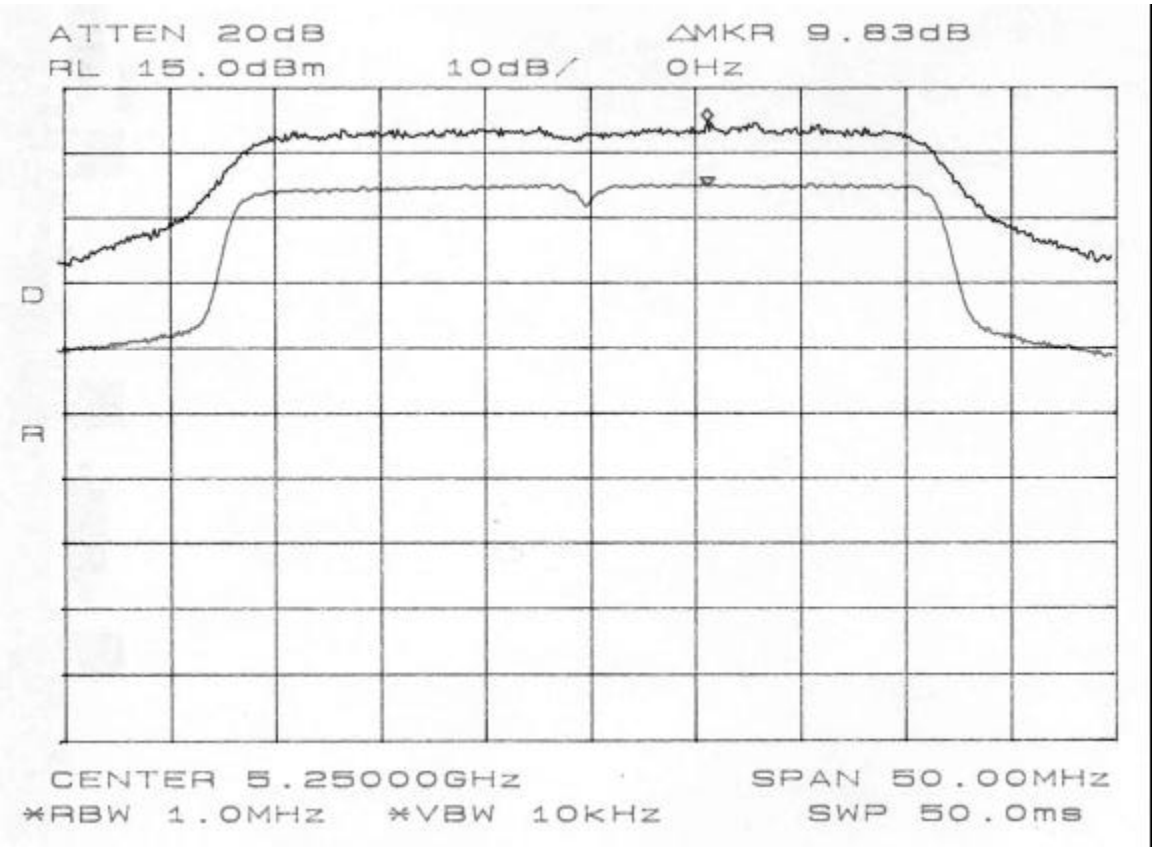
Channel	Frequency (MHz)	Peak Excursion (dB)	Limit (dB)	Margin dB
Low	5210	9.67	13	-3.33
Middle	5250	9.83	13	-3.17
High	5290	9.5	13	-3.5

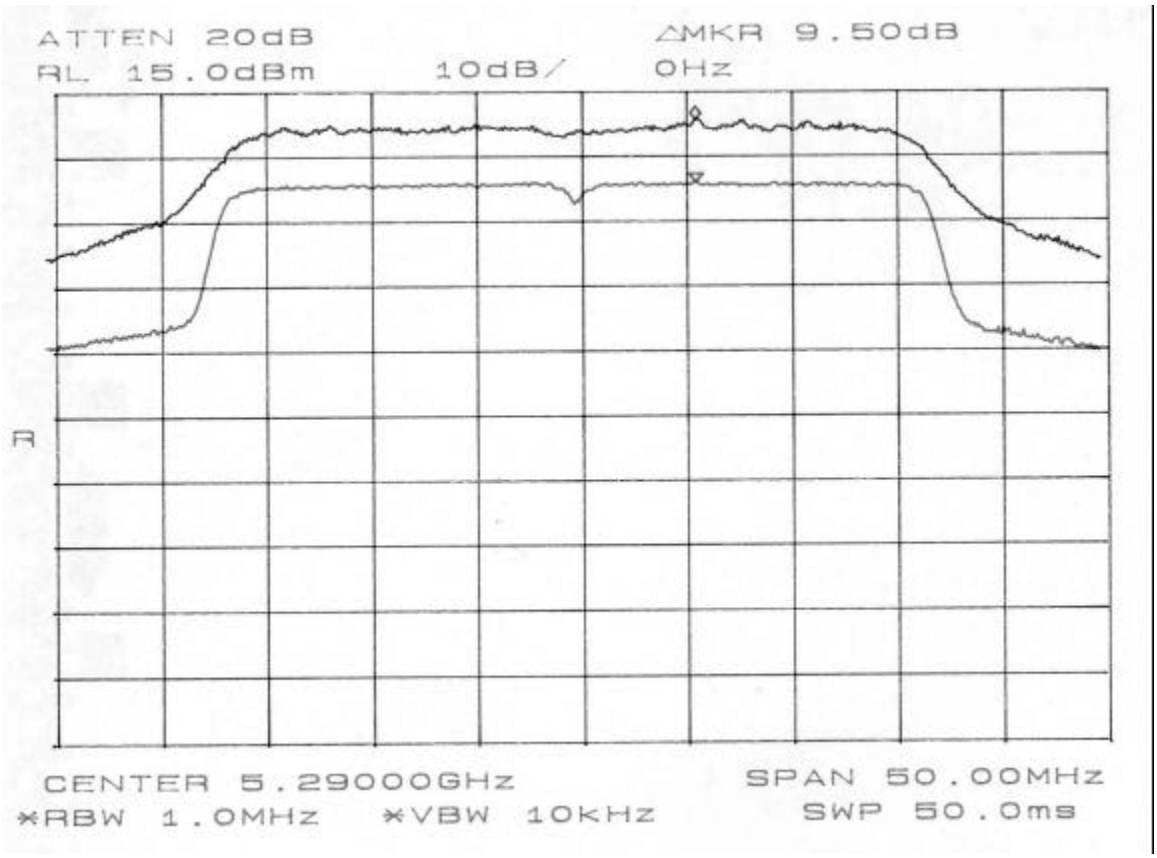
PEAK EXCURSION (NORMAL MODE)





PEAK EXCURSION (TURBO MODE)





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:

Refer to the installation manual.

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

Substituting the logarithmic form of power and gain using:

P (mW) = 10 ^ (P (dBm) / 10) and

G (numeric) = 10 ^ (G (dBi) / 10)

yields

$$d = 0.282 * 10 ^ ((P + G) / 20) / \sqrt{S}$$ Equation (1)

where
d = MPE safe distance in cm
P = Power in dBm
G = Antenna Gain in dBi
S = Power Density Limit in mW / cm^2

RESULTS

No non-compliance noted:

EUT output power = 17.0 dBm
Antenna Gain = 4.8 dBi
S = 1.0 mW / cm^2 from 1.1310 Table 1

Substituting these parameters into Equation (1) above:

MPE Safe Distance = 3.5 cm

NOTE: For mobile or fixed location transmitters, the minimum separation distance is 20 cm, even if calculations indicate that the MPE distance would be less.

8.8. FREQUENCY STABILITY

RESULTS

No non-compliance noted:

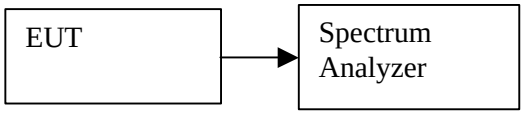
Referring to the theory of operation, the crystal used to set the frequency has a temperature coefficient of +/- 20 ppm over the specified rated temperature range. For a transmitter fundamental frequency of 5.35 GHz, this corresponds to +/- 107 kHz.

An examination of the band edge plots shows that the emission will stay within the authorized band over the entire temperature range.

8.9. UNDESIRABLE EMISSIONS – CONDUCTED MEASUREMENTS

Conducted RF measurements of the transmitter output were made to confirm that the EUT antenna port conducted emissions meet the specified limit and to identify any spurious signals that require further investigation or measurements on the radiated emissions site.

TEST SETUP



TEST PROCEDURE

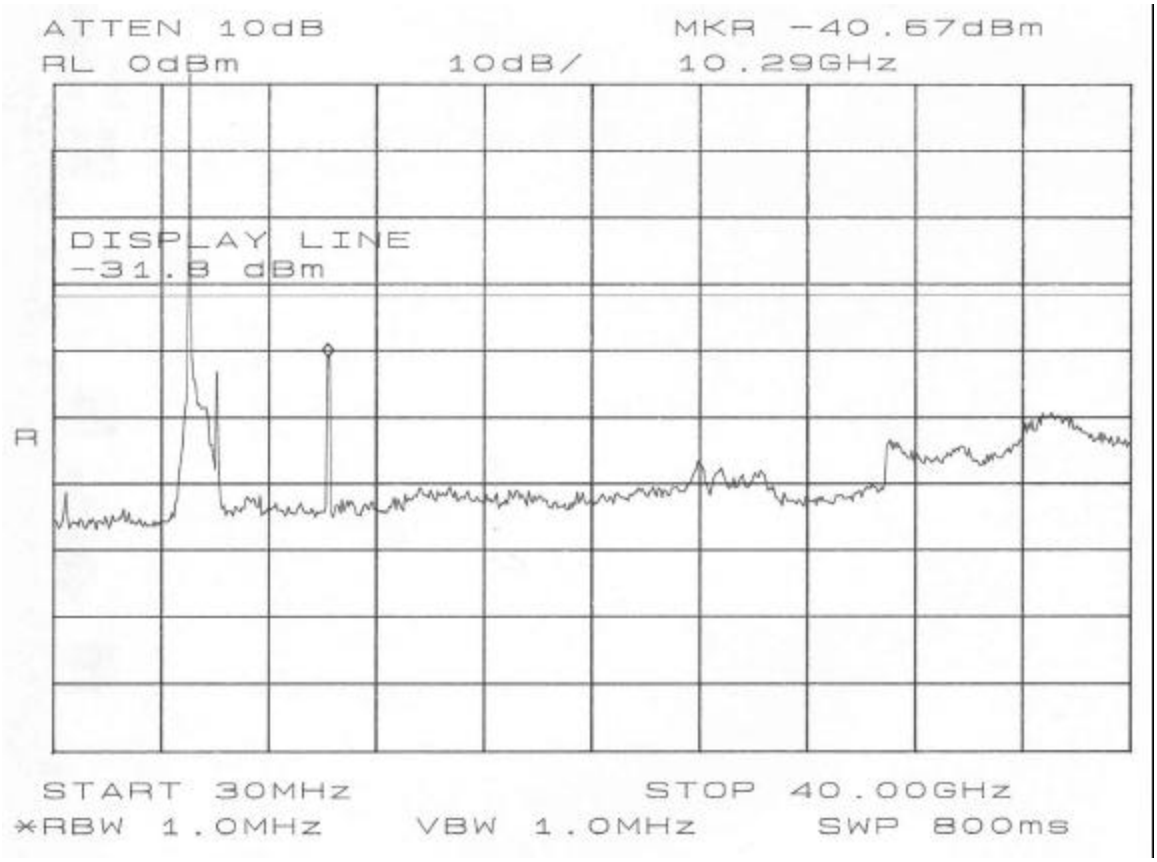
The transmitter output is connected to the spectrum analyzer. The resolution bandwidth is set to 1 MHz. The video bandwidth is set to 1 MHz. Peak detection measurements are compared to the average EIRP limit, adjusted for the maximum antenna gain. If necessary, additional average detection measurements are made.

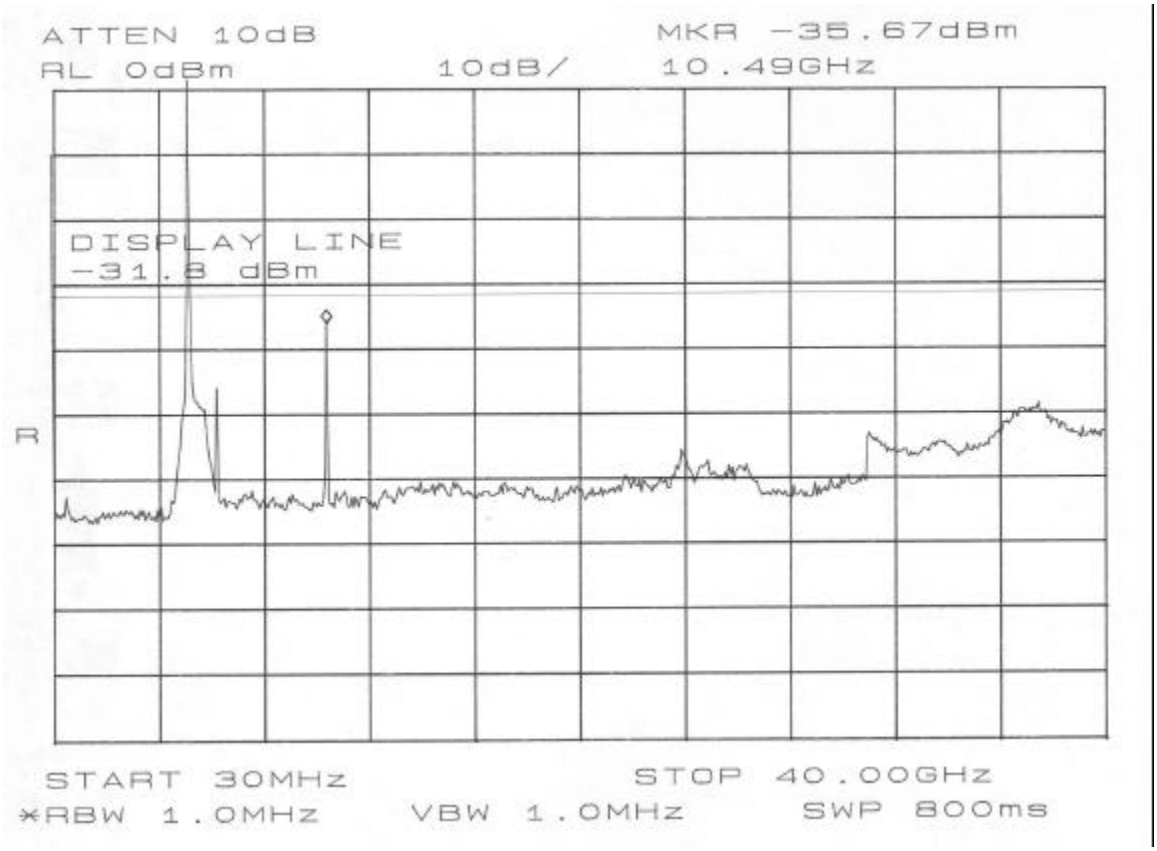
Measurements are made over the 30 MHz to 40 GHz range with the transmitter set to the lowest, middle, and highest channels.

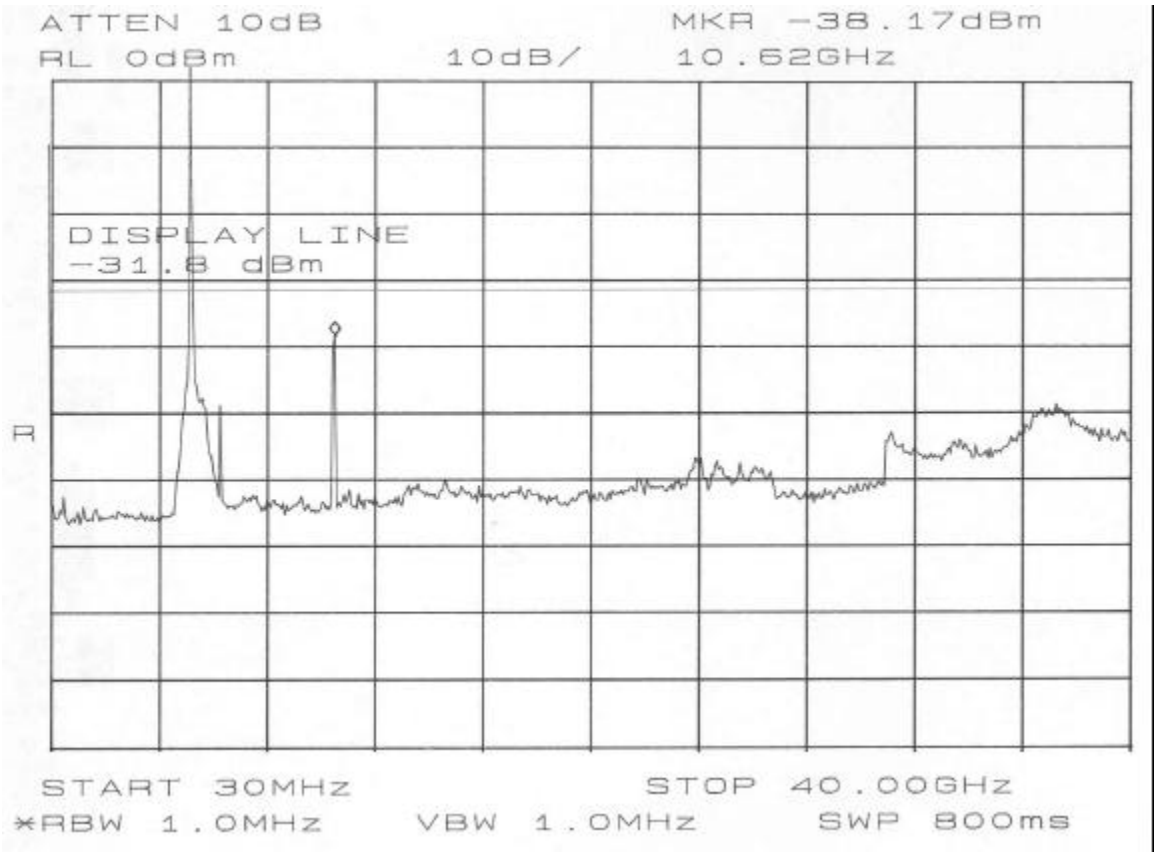
RESULTS

No non-compliance noted:

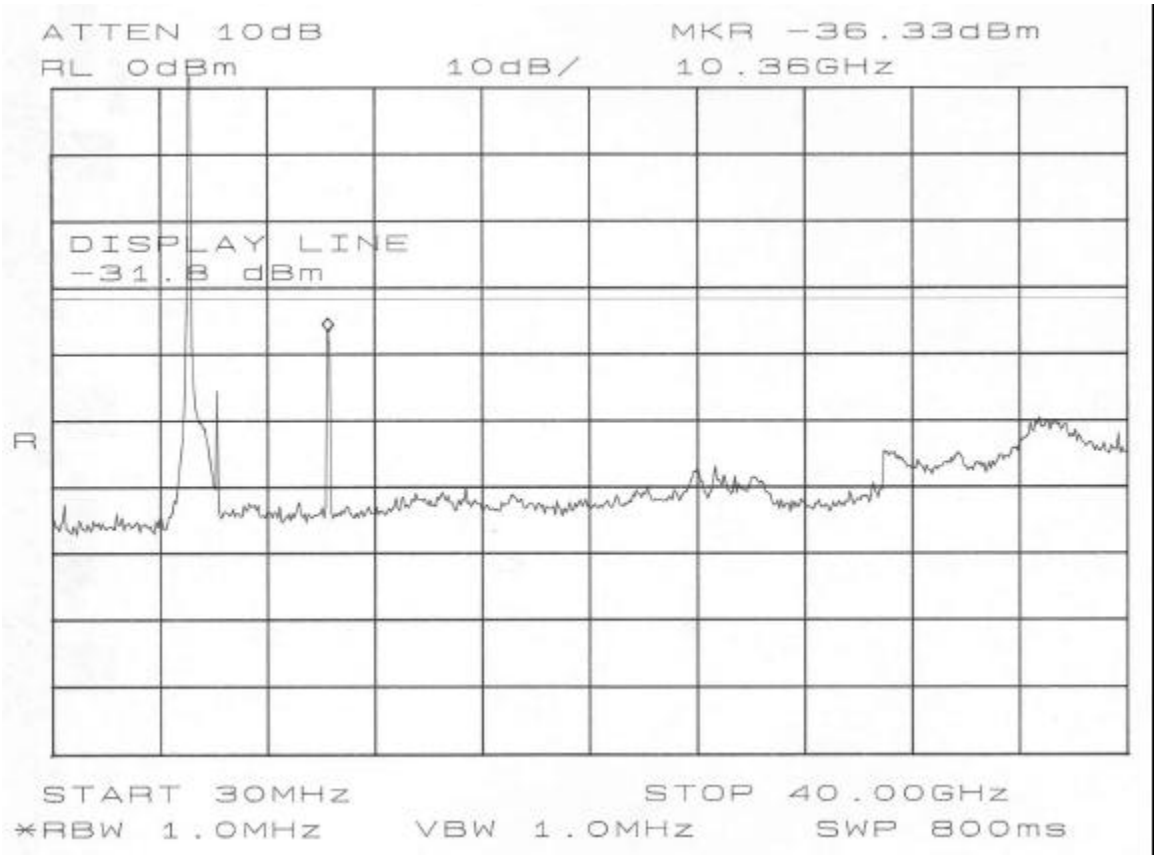
CONDUCTED SPURIOUS (NORMAL MODE)

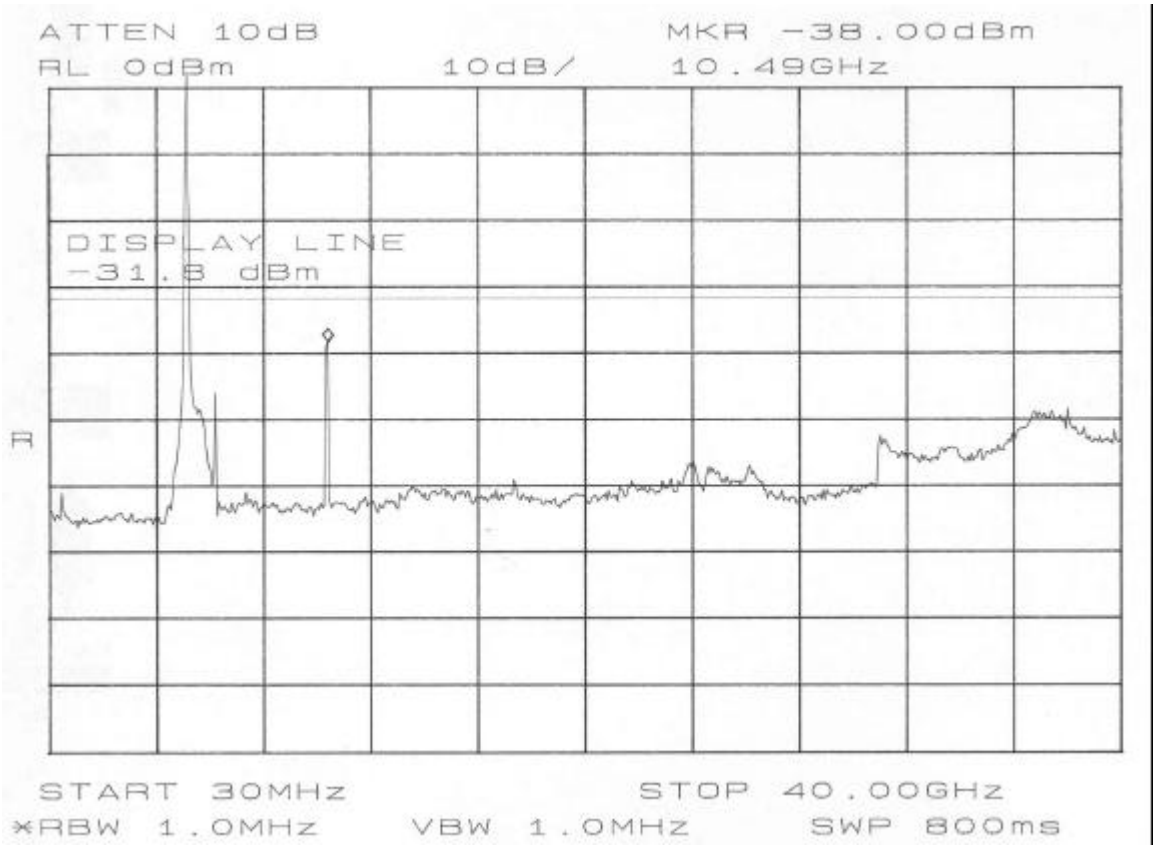


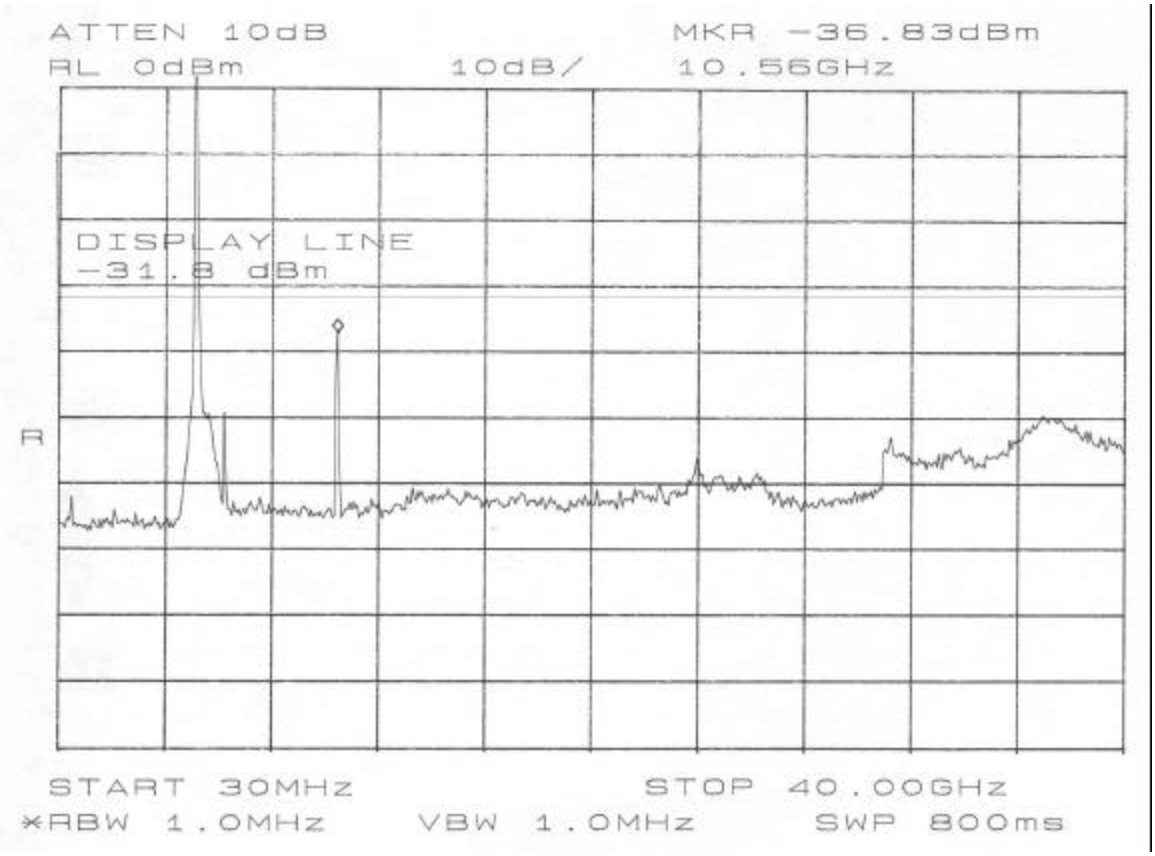




CONDUCTED SPURIOUS (TURBO MODE)







8.10. UNDESIRABLE EMISSIONS – RADIATED MEASUREMENTS

TEST SETUP

The EUT is placed on the wooden table. The antenna to EUT distance is 3 meters for measurements below 1 GHz and 1 meter for measurements above 1 GHz. The EUT is configured in accordance with Section 8 of ANSI C63.4/1992.

The EUT is set to transmit in a continuous mode.

TEST PROCEDURE

For measurements below 1 GHz within restricted bands the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For all other measurements, the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

The spectrum from 30 MHz to 40 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The frequency span is set small enough to easily differentiate between broadcast stations, intermittent ambient signals and EUT emissions. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the suspected signal. Measurements were made with the antenna polarized in both the vertical and the horizontal positions.

SYSTEM NOISE FLOOR FOR HARMONIC AND SPURIOUS MEASUREMENTS

Compliance Certification Services

Worst Case Radiated Emissions System Noise Floor

Each band below corresponds to each horn antenna band
Uses the lowest gain preamplifier; actual preamp used may have higher gain
Uses the longest typical cable configuration; actual cables used may have less loss
Noise floor field strength results are compared to the FCC 15.205 Restricted Band limit

Specification Distance: 3 meters

Freq GHz	SA dBuV	AF dB/m	Distance m	Distance dB	Preamp dB	Cable dB	Field dBuV/m	Limit dBuV/m	Margin dB
1 to 18 GHz band									
RBW = 1 MHz, peak detection									
18	41.9	47.8	1	-9.5	32.6	13.5	61.06	74	-12.94
RBW = 1 MHz, average detection									
18	28.7	47.8	1	-9.5	32.6	13.5	47.86	54	-6.14
18 to 26.5 GHz band									
RBW = 1 MHz, peak detection									
26.5	44.6	33.4	1	-9.5	35.0	19.5	52.96	74	-21.04
RBW = 1 MHz, average detection									
26.5	32.4	33.4	1	-9.5	35.0	19.5	40.76	54	-13.24

SAMPLE CALCULATIONS

Given

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

where

E = Field Strength in Volts / meter
P = Power in watts
G = Numeric antenna gain
d = distance in meters

Rearranging terms yields:

$$P * G = (d * E) \wedge 2 / 30$$

Converting to the logarithmic form and changing to units of mW and uV/m, using:

$$P (mW) = P (W) / 1000 \text{ and}$$
$$E (uV/m) = E (V/m) / 1000000$$

yields

$$10 \log (P * G) = 10 \log (d \wedge 2) + 10 \log (E \wedge 2) - 10 \log (30) - 10 \log (10 \wedge 9)$$
$$= 20 \log (d) + 20 \log (E) - 104.77$$

In this logarithmic form

10 log (P * G) is PG in dBm and
20 log (E) is E in dBuV/m

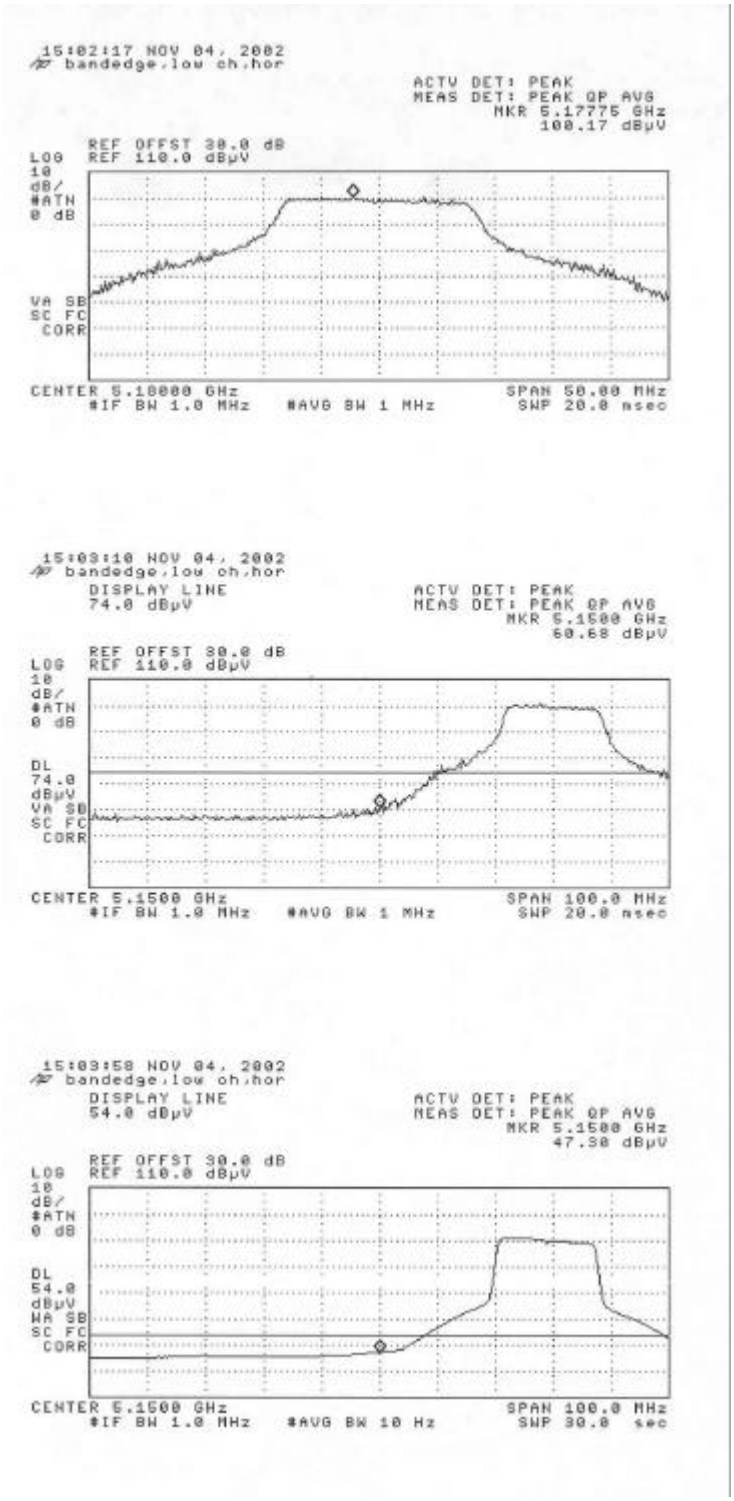
Since EIRP = P * G, then at a specification distance of 3 meters, the EIRP in terms of field strength is:

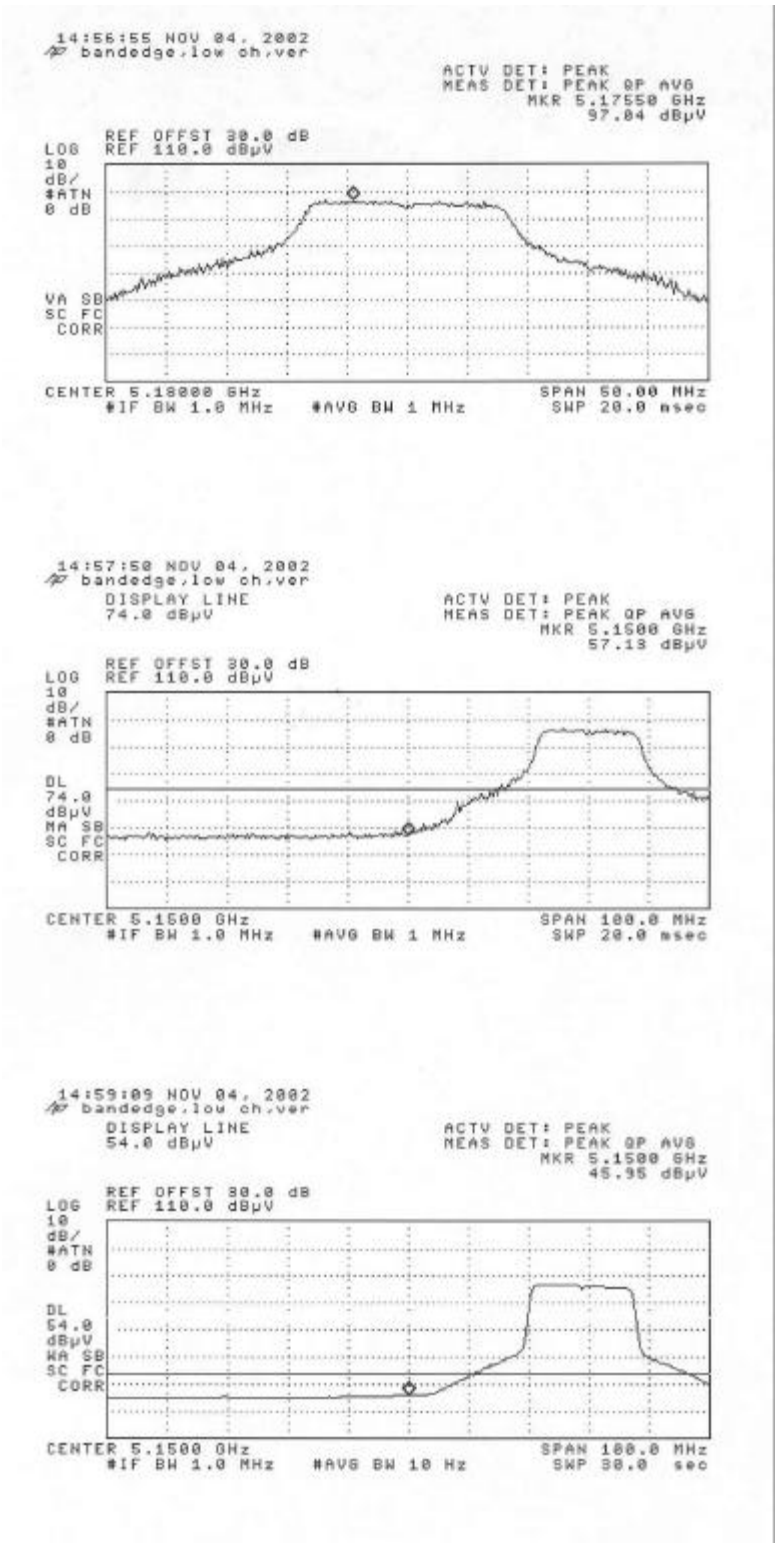
$$EIRP (dBm) = P * G (dBm) = E (dBuV/m) - 95.2$$

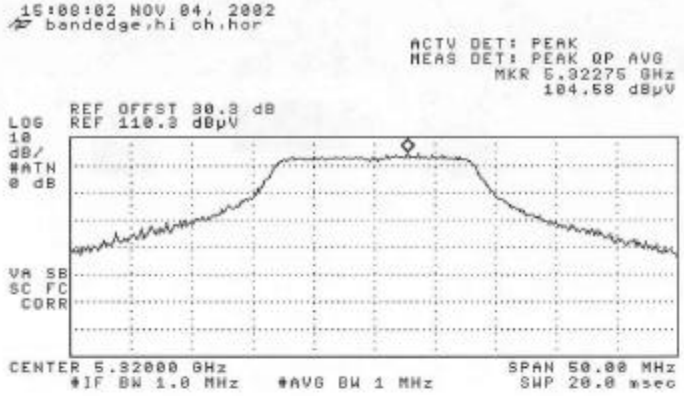
TEST RESULTS

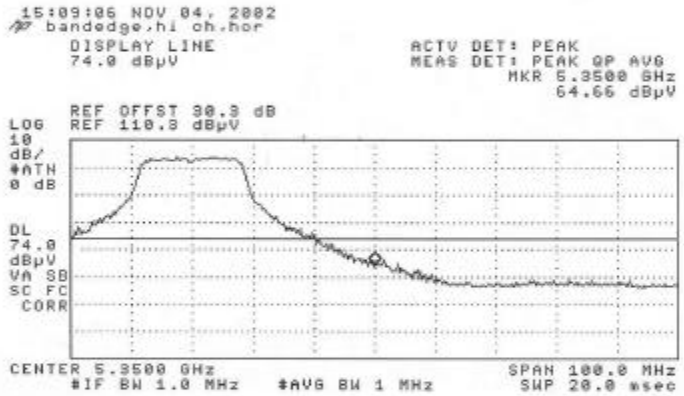
No non-compliance noted:

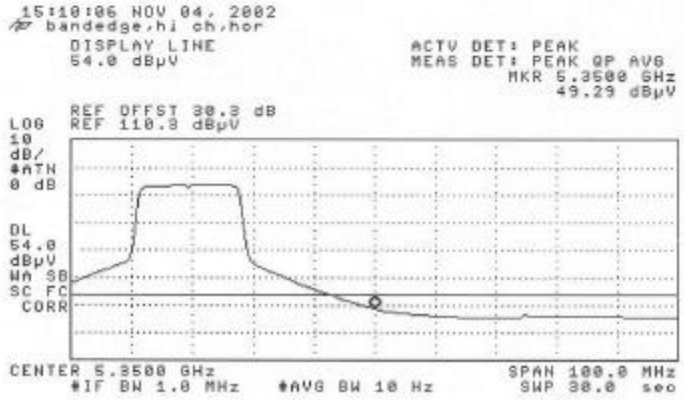
BAND EDGE RADIATED EMISSIONS (NORMAL MODE)

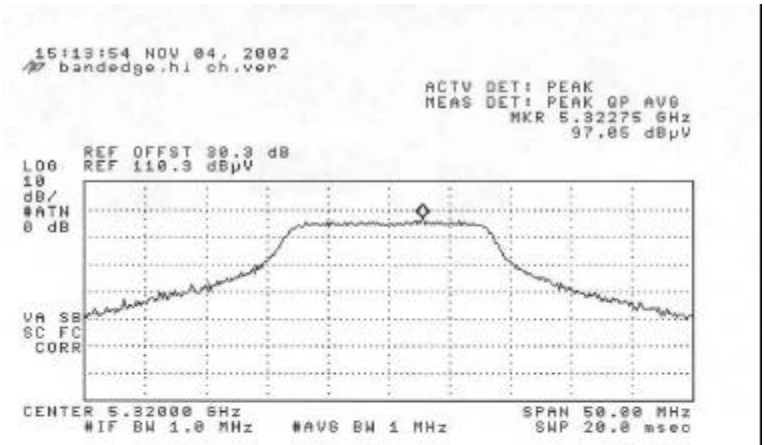


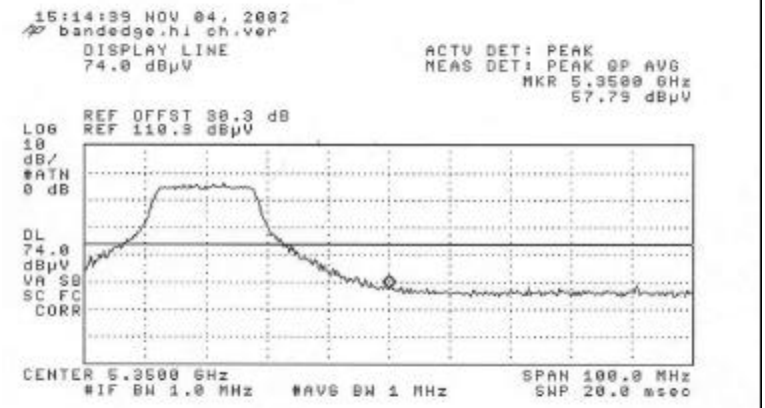


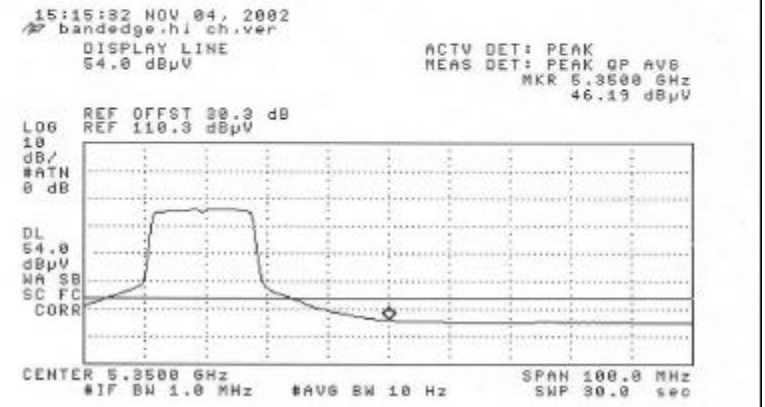




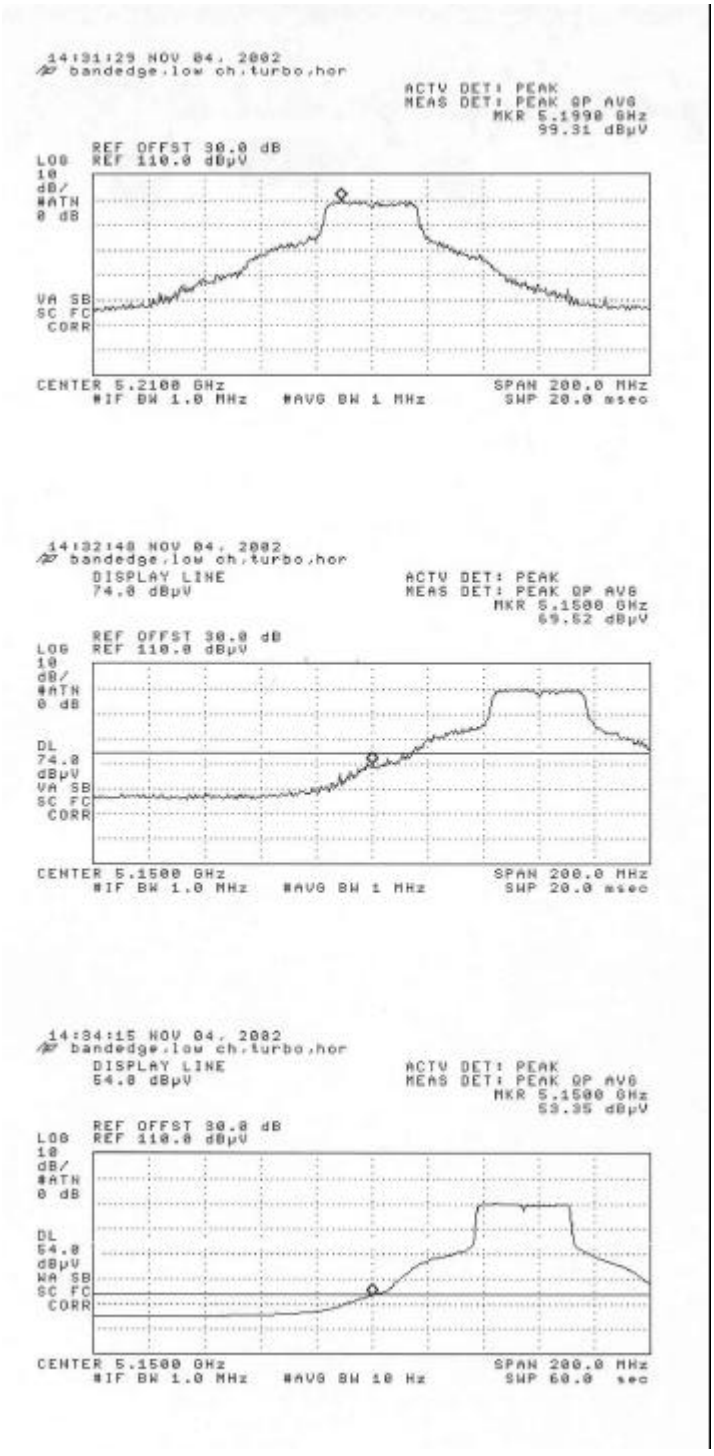


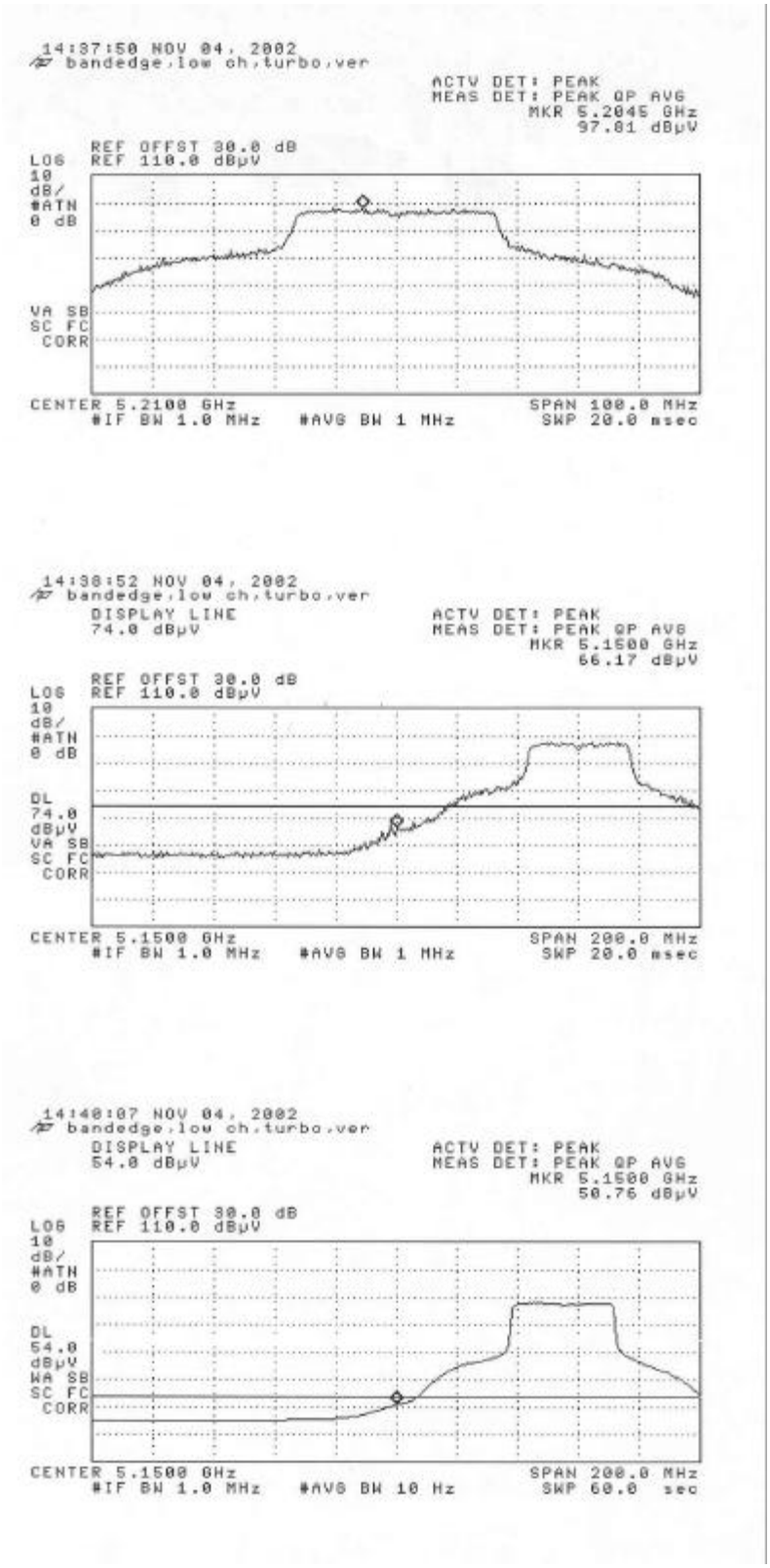


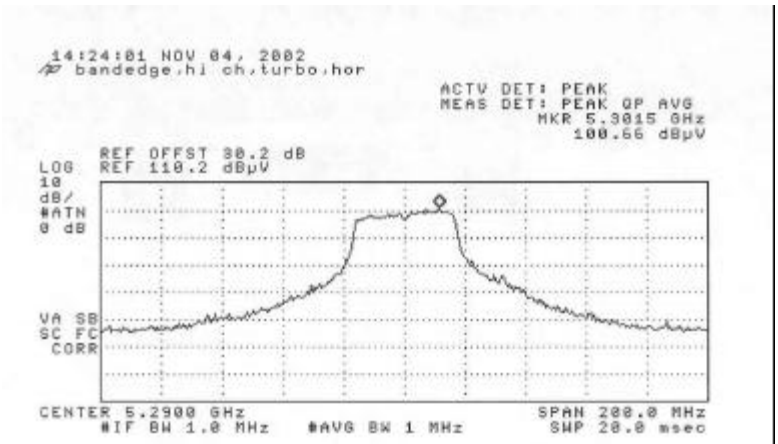


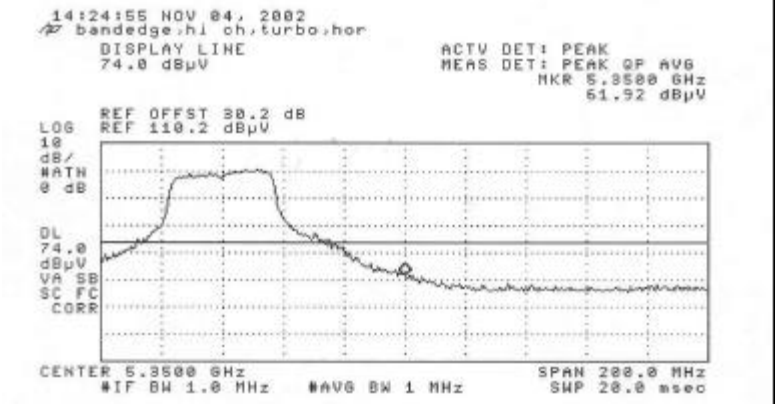


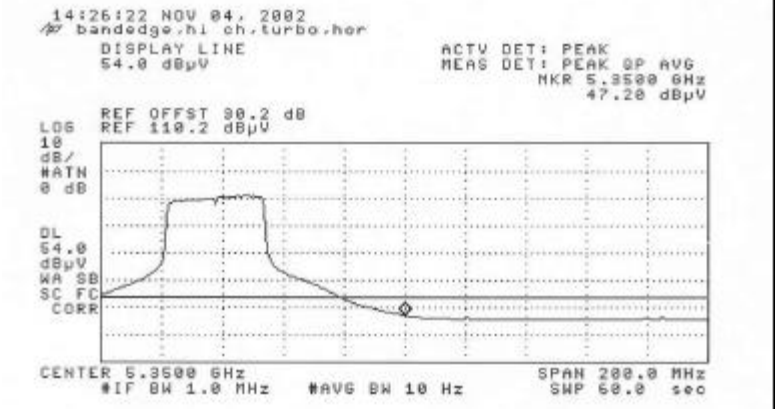
BAND EDGE RADIATED EMISSIONS (TURBO MODE)

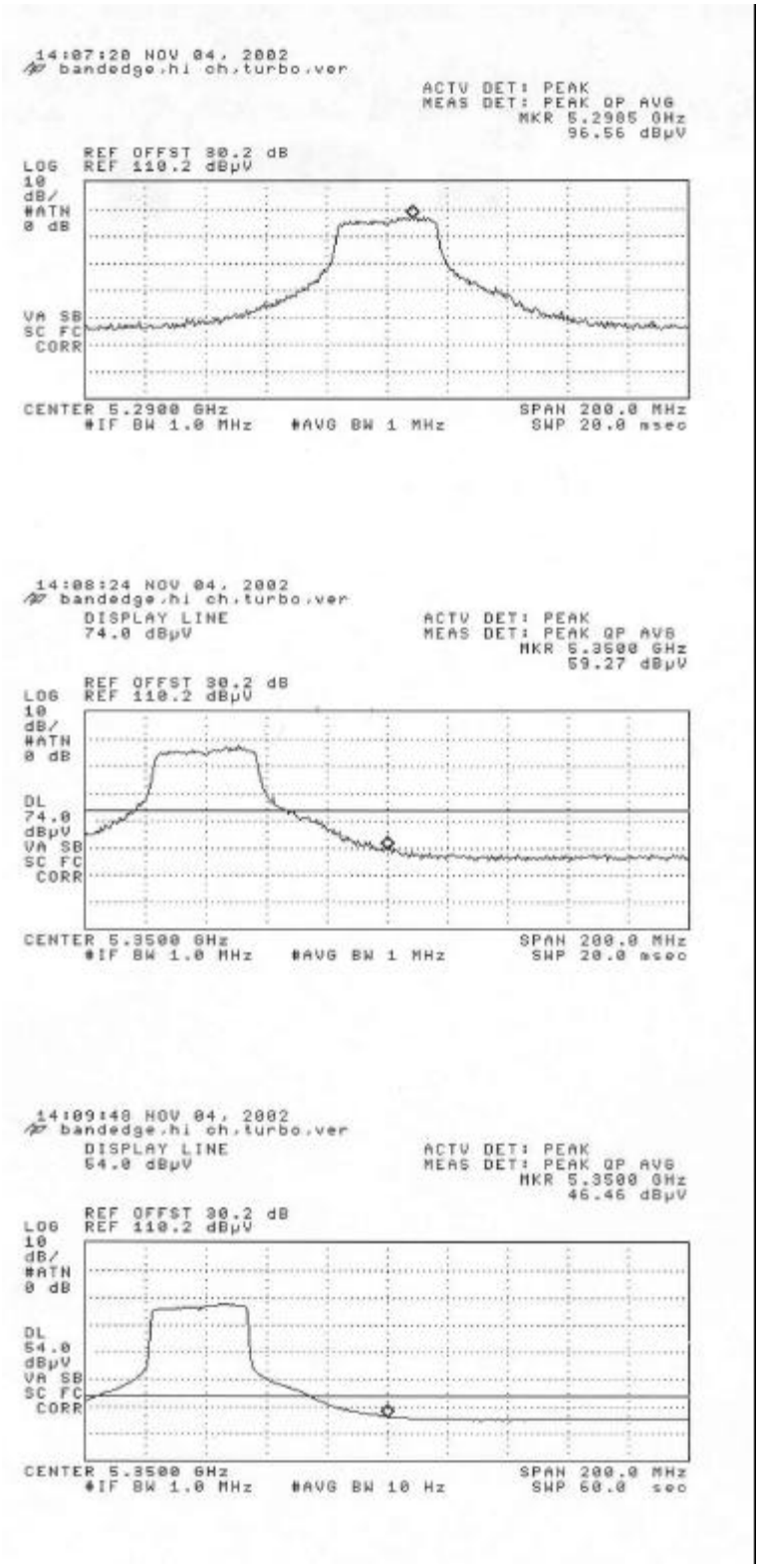












HARMONIC AND SPURIOUS RADIATED EMISSIONS (NORMAL MODE)

Description of Test:	Radiated Emissions - Out of Band Spurious											
Project Number:	02U1585-1											
Date:	11/05/02											
Test Engineer:	Frank Ibrahim											
Company:	Toshiba											
EUT Description:	802.11 a/b Combo Wireless LAN Module, Card # 5											
Test Configuration:	EUT, Laptop, Mouse, 2 Antennas											
Mode of Operation:	11a Normal Mode, Low Channel (5.18 GHz)											
Specification Distance:	3.0	meters			EIRP Conversion Factor:				95.2	dB		
Actual Distance:	1.0	meters	Cable Length:		15.0	feet						
Freq	**Pol**	**Det**	**SA**	**Dist**	**AF**	**Preamp**	**Filter**	**Cable**	**Field**	**EIRP**	**Limit**	**Margin**
GHz	**V/H**		**dBuV**	**dB**	**dB/m**	**dB**	**dB**	**dB**	**dBuV/m**	**dBm**	**dBm**	**dB**
10.360	V	Peak	59.8	-9.5	39.5	35.7	1.0	8.8	63.9	-31.3	-7.0	-24.3
10.360	V	Avg	46.0	-9.5	39.5	35.7	1.0	8.8	50.1	-45.1	-27.0	-18.1
10.360	H	Peak	46.7	-9.5	39.5	35.7	1.0	8.8	50.7	-44.5	-7.0	-37.5
10.360	H	Avg	35.1	-9.5	39.5	35.7	1.0	8.8	39.2	-56.0	-27.0	-29.0

Description of Test:	Radiated Emissions - Restricted Bands										
Project Number:	02U1585-1										
Date:	11/05/02										
Test Engineer:	Frank Ibrahim										
Company:	Toshiba										
EUT Description:	802.11 a/b Combo Wireless LAN Module, Card # 5										
Test Configuration:	EUT, Laptop, Mouse, 2 Antennas										
Mode of Operation:	11a Normal Mode, Low Channel (5.18 GHz)										
Specification Distance:	3.0	meters									
Actual Distance:	1.0	meters	Cable Length:			15.0	feet				
Freq	**Pol**	**Det**	**SA**	**Dist**	**AF**	**Preamp**	**Filter**	**Cable**	**Field**	**Limit**	**Margin**
GHz	**V/H**		**dBuV**	**dB**	**dB/m**	**dB**	**dB**	**dB**	**dBuV/m**	**dBuV/m**	**dB**
15.540	V	Peak	52.6	-9.5	38.9	38.7	1.0	11.4	55.6	74.0	-18.4
15.540	V	Avg	40.4	-9.5	38.9	38.7	1.0	11.4	43.5	54.0	-10.5

Description of Test:	Radiated Emissions - Out of Band Spurious
Project Number:	02U1585-1
Date:	11/05/02
Test Engineer:	Frank Ibrahim
Company:	Toshiba
EUT Description:	802.11 a/b Combo Wireless LAN Module, Card # 5
Test Configuration:	EUT, Laptop, Mouse, 2 Antennas
Mode of Operation:	11a Normal Mode, Mid Channel (5.26 GHz)

Specification Distance:			3.0	meters		EIRP Conversion Factor:			95.2	dB		
Actual Distance:			1.0	meters	Cable Length:		15.0	feet				
Freq GHz	**Pol V/H**	**Det**	**SA dBuV**	**Dist dB**	**AF dB/m**	**Preamp dB**	**Filter dB**	**Cable dB**	**Field dBuV/m**	**EIRP dBm**	**Limit dBm**	**Margin dB**
10.520	V	Peak	63.4	-9.5	39.2	35.7	1.0	8.9	67.3	-27.9	-7.0	-20.9
10.520	V	Avg	51.7	-9.5	39.2	35.7	1.0	8.9	55.5	-39.7	-27.0	-12.7
10.520	H	Peak	56.3	-9.5	39.2	35.7	1.0	8.9	60.1	-35.1	-7.0	-28.1
10.520	H	Avg	43.3	-9.5	39.2	35.7	1.0	8.9	47.2	-48.0	-27.0	-21.0

Description of Test:	Radiated Emissions - Restricted Bands
Project Number:	02U1585-1
Date:	11/05/02
Test Engineer:	Frank Ibrahim
Company:	Toshiba
EUT Description:	802.11 a/b Combo Wireless LAN Module, Card # 5
Test Configuration:	EUT, Laptop, Mouse, 2 Antennas
Mode of Operation:	11a Normal Mode, Mid Channel (5.26 GHz)

Specification Distance:			3.0	meters								
Actual Distance:			1.0	meters	Cable Length:		15.0	feet				
Freq GHz	**Pol V/H**	**Det**	**SA dBuV**	**Dist dB**	**AF dB/m**	**Preamp dB**	**Filter dB**	**Cable dB**	**Field dBuV/m**	**Limit dBuV/m**	**Margin dB**	
15.780	V	Peak	60.3	-9.5	38.8	38.8	1.0	11.6	63.3	74.0	-10.7	
15.780	V	Avg	47.8	-9.5	38.8	38.8	1.0	11.6	50.9	54.0	-3.1	
15.780	H	Peak	54.6	-9.5	38.8	38.8	1.0	11.6	57.6	74.0	-16.4	
15.780	H	Avg	42.3	-9.5	38.8	38.8	1.0	11.6	45.3	54.0	-8.7	

Description of Test:	Radiated Emissions - Restricted Bands
Project Number:	02U1585-1
Date:	11/05/02
Test Engineer:	Frank Ibrahim
Company:	Toshiba
EUT Description:	802.11 a/b Combo Wireless LAN Module, Card # 5
Test Configuration:	EUT, Laptop, Mouse, 2 Antennas
Mode of Operation:	11a Normal Mode, High Channel (5.32 GHz)

Specification Distance:	3.0	meters			
Actual Distance:	1.0	meters	Cable Length:	15.0	feet

Freq GHz	Pol V/H	Det	SA dBuV	Dist dB	AF dB/m	Preamp dB	Filter dB	Cable dB	Field dBuV/m	Limit dBuV/m	Margin dB
10.640	V	Peak	63.3	-9.5	39.2	35.7	1.0	8.9	67.2	74.0	-6.8
10.640	V	Avg	49.3	-9.5	39.2	35.7	1.0	8.9	53.2	54.0	-0.8
15.960	V	Peak	54.1	-9.5	38.7	38.9	1.0	11.7	57.1	74.0	-16.9
15.960	V	Avg	40.7	-9.5	38.7	38.9	1.0	11.7	43.6	54.0	-10.4

HARMONIC AND SPURIOUS RADIATED EMISSIONS (TURBO MODE)

Description of Test:	Radiated Emissions - Out of Band Spurious
Project Number:	02U1585-1
Date:	11/05/02
Test Engineer:	Frank Ibrahim
Company:	Toshiba
EUT Description:	802.11 a/b Combo Wireless LAN Module, Card # 5
Test Configuration:	EUT, Laptop, Mouse, 2 Antennas
Mode of Operation:	11a Turbo Mode, Low Channel (5.21 GHz)

Specification Distance:			3.0	meters		EIRP Conversion Factor:			95.2	dB			
Actual Distance:			1.0	meters		Cable Length:	15.0	feet					
Freq GHz	**Pol V/H**	**Det**	**SA dBuV**	**Dist dB**	**AF dB/m**	**Preamp dB**	**Filter dB**	**Cable dB**	**Field dBuV/m**	**EIRP dBm**	**Limit dBm**	**Margin dB**	
10.420	V	Peak	57.8	-9.5	39.4	35.7	1.0	8.9	61.7	-33.5	-7.0	-26.5	
10.420	V	Avg	43.6	-9.5	39.4	35.7	1.0	8.9	47.6	-47.6	-27.0	-20.6	
10.420	H	Peak	46.8	-9.5	39.4	35.7	1.0	8.9	50.8	-44.4	-7.0	-37.4	
10.420	H	Avg	36.1	-9.5	39.4	35.7	1.0	8.9	40.1	-55.1	-27.0	-28.1	

Description of Test:	Radiated Emissions - Out of Band Spurious
Project Number:	02U1585-1
Date:	11/05/02
Test Engineer:	Frank Ibrahim
Company:	Toshiba
EUT Description:	802.11 a/b Combo Wireless LAN Module, Card # 5
Test Configuration:	EUT, Laptop, Mouse, 2 Antennas
Mode of Operation:	11a Turbo Mode, Mid Channel (5.25 GHz)

Specification Distance:			3.0	meters		EIRP Conversion Factor:			95.2	dB		
Actual Distance:			1.0	meters	Cable Length:			15.0	feet			
Freq GHz	**Pol V/H**	**Det**	**SA dBuV**	**Dist dB**	**AF dB/m**	**Preamp dB**	**Filter dB**	**Cable dB**	**Field dBuV/m**	**EIRP dBm**	**Limit dBm**	**Margin dB**
10.500	V	Peak	61.0	-9.5	39.2	35.7	1.0	8.9	64.9	-30.3	-7.0	-23.3
10.500	V	Avg	50.0	-9.5	39.2	35.7	1.0	8.9	53.8	-41.4	-27.0	-14.4
10.500	H	Peak	51.4	-9.5	39.2	35.7	1.0	8.9	55.3	-39.9	-7.0	-32.9
10.500	H	Avg	39.7	-9.5	39.2	35.7	1.0	8.9	43.5	-51.7	-27.0	-24.7

Description of Test:	Radiated Emissions - Restricted Bands
Project Number:	02U1585-1
Date:	11/05/02
Test Engineer:	Frank Ibrahim
Company:	Toshiba
EUT Description:	802.11 a/b Combo Wireless LAN Module, Card # 5
Test Configuration:	EUT, Laptop, Mouse, 2 Antennas
Mode of Operation:	11a Turbo Mode, Mid Channel (5.25 GHz)

Specification Distance:			3.0	meters								
Actual Distance:			1.0	meters	Cable Length:			15.0	feet			
Freq GHz	**Pol V/H**	**Det**	**SA dBuV**	**Dist dB**	**AF dB/m**	**Preamp dB**	**Filter dB**	**Cable dB**	**Field dBuV/m**	**Limit dBuV/m**	**Margin dB**	
15.750	V	Peak	55.8	-9.5	38.8	38.8	1.0	11.6	58.8	74.0	-15.2	
15.750	V	Avg	42.9	-9.5	38.8	38.8	1.0	11.6	45.9	54.0	-8.1	

Description of Test:	Radiated Emissions - Out of Band Spurious
Project Number:	02U1585-1
Date:	11/05/02
Test Engineer:	Frank Ibrahim
Company:	Toshiba
EUT Description:	802.11 a/b Combo Wireless LAN Module, Card # 5
Test Configuration:	EUT, Laptop, Mouse, 2 Antennas
Mode of Operation:	11a Turbo Mode, High Channel (5.29 GHz)

Specification Distance:	3.0	meters	EIRP Conversion Factor:	95.2	dB		
Actual Distance:	1.0	meters	Cable Length:	15.0	feet		

Freq GHz	Pol V/H	Det	SA dBuV	Dist dB	AF dB/m	Preamp dB	Filter dB	Cable dB	Field dBuV/m	EIRP dBm	Limit dBm	Margin dB
10.580	V	Peak	60.0	-9.5	39.2	35.7	1.0	8.9	63.8	-31.4	-7.0	-24.4
10.580	V	Avg	48.0	-9.5	39.2	35.7	1.0	8.9	51.8	-43.4	-27.0	-16.4
10.580	H	Peak	55.7	-9.5	39.2	35.7	1.0	8.9	59.6	-35.6	-7.0	-28.6
10.580	H	Avg	42.6	-9.5	39.2	35.7	1.0	8.9	46.4	-48.8	-27.0	-21.8

Description of Test:	Radiated Emissions - Restricted Bands
Project Number:	02U1585-1
Date:	11/05/02
Test Engineer:	Frank Ibrahim
Company:	Toshiba
EUT Description:	802.11 a/b Combo Wireless LAN Module, Card # 5
Test Configuration:	EUT, Laptop, Mouse, 2 Antennas
Mode of Operation:	11a Turbo Mode, High Channel (5.29 GHz)

Specification Distance:	3.0	meters					
Actual Distance:	1.0	meters	Cable Length:	15.0	feet		

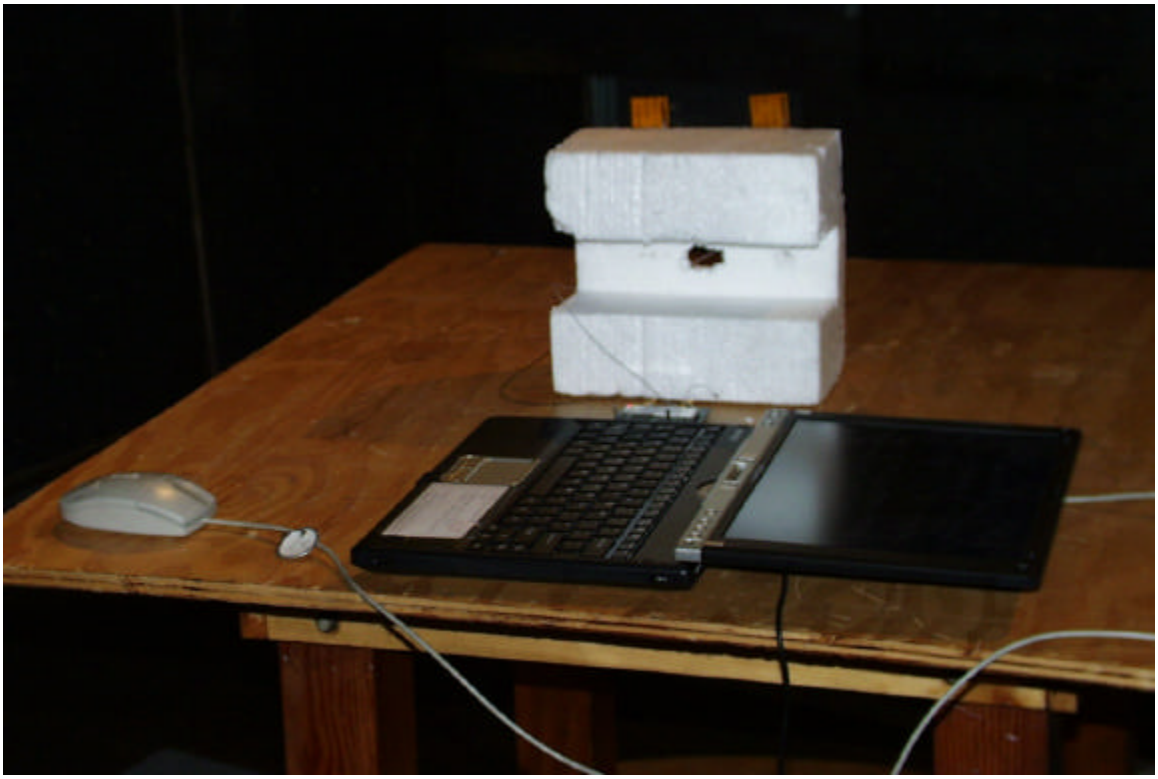
Freq GHz	Pol V/H	Det	SA dBuV	Dist dB	AF dB/m	Preamp dB	Filter dB	Cable dB	Field dBuV/m	Limit dBuV/m	Margin dB
15.750	V	Peak	54.9	-9.5	38.8	38.8	1.0	11.6	57.9	74.0	-16.1
15.750	V	Avg	42.9	-9.5	38.8	38.8	1.0	11.6	45.9	54.0	-8.1
15.750	H	Peak	51.5	-9.5	38.8	38.8	1.0	11.6	54.5	74.0	-19.5
15.750	H	Avg	40.0	-9.5	38.8	38.8	1.0	11.6	43.0	54.0	-11.0

8.11. SETUP PHOTOS

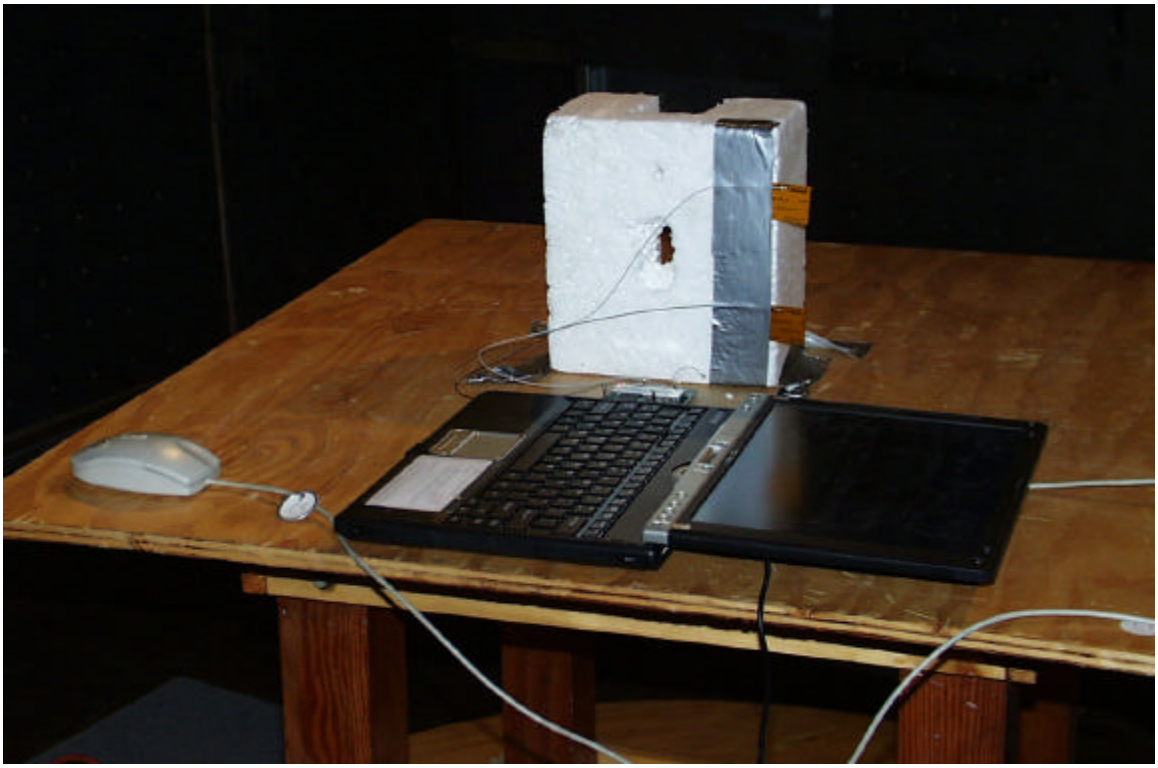
ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP

RADIATED RF MEASUREMENT SETUP: ANTENNA IN X-AXIS ORIENTATION

RADIATED RF MEASUREMENT SETUP: ANTENNA IN Y-AXIS ORIENTATION



RADIATED RF MEASUREMENT SETUP: ANTENNA IN Z-AXIS ORIENTATION



END OF REPORT