

Substituting the logarithmic form of power and gain using:

$$P \text{ (mW)} = 10^{(P \text{ (dBm)} / 10)} \text{ and}$$

$$G \text{ (numeric)} = 10^{(G \text{ (dBi)} / 10)}$$

yields

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

where

d = MPE safe distance in cm

P = Power in dBm

G = Antenna Gain in dBi

S = Power Density Limit in mW / cm²

RESULTS

No non-compliance noted:

EUT output power = 19.51 dBm

Antenna Gain = 1.0 dBi

S = 1.0 mW / cm² from 1.1310 Table 1

Substituting these parameters into Equation (1) above,

MPE Safe Distance = 2.99 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. For a transmitter fundamental frequency of 5.35 GHz, this corresponds to +/- 107 kHz.

During band edge testing, it is determined that the smallest margin (along the frequency axis) to the band edge occurred at the upper band edge in the Turbo mode, using average detection, with the antenna vertically polarized. In this configuration, with the transmitter set to the highest channel, the envelope of the modulation sideband intercepted the 54 dBuV/m limit at 5,347.3 MHz. Adding the maximum peak-to-peak deviation due to the crystal (0.214 MHz) yields 5,347.514 MHz, which remains within the authorized band of 5,150 to 5,350 MHz.

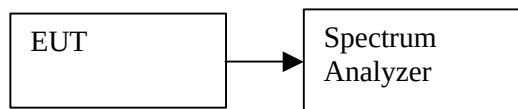
At the lower band edge, the smallest margin (along the frequency axis) occurred in the Base mode, using average detection, with the antenna vertically polarized. In this configuration, with the transmitter set to the lowest channel, the envelope of the modulation sideband intercepted the 54 dBuV/m limit at 5,154 MHz. Subtracting the maximum peak-to-peak deviation due to the crystal (0.214 MHz) yields 5,153.786 MHz, which remains within the authorized band of 5,150 to 5,350 MHz.

8.9. UNDESIRABLE EMISSIONS – CONDUCTED MEASUREMENTS

Conducted RF measurements of the transmitter output were made at the band edges and the adjacent restricted bands.

Also, conducted RF measurements of the transmitter output over the 30 MHz to 26.5 GHz band were made in order 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. For measurements above 1 GHz, the resolution bandwidth is set to 1 MHz. The video bandwidth is set to 1 MHz for peak measurements and 10 Hz for average measurements.

Measurements are made at the lower band edge and the restricted band adjacent to the lower edge of the authorized band, with the transmitter set to the lowest channel.

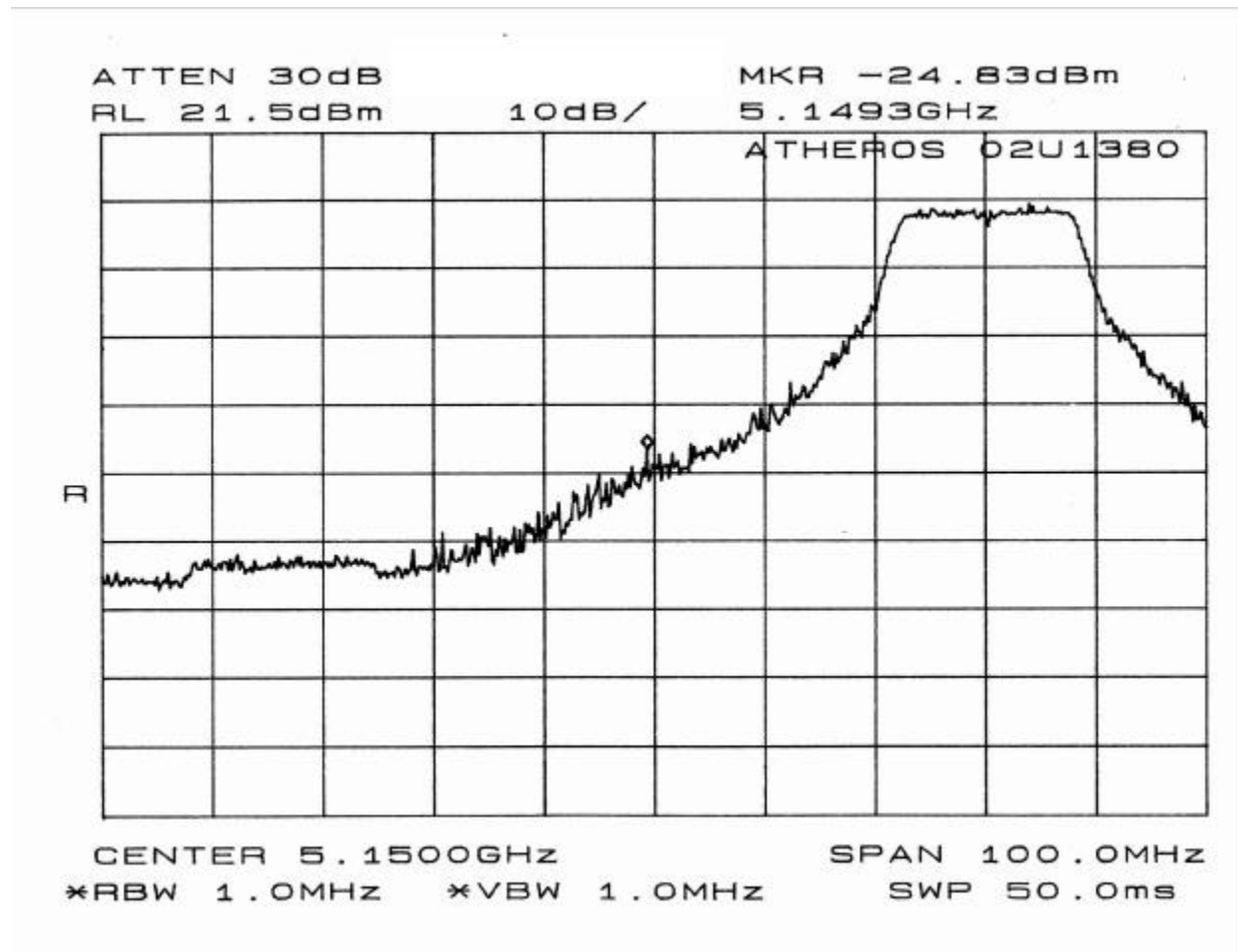
Measurements are made at the upper band edge and the restricted band adjacent to the upper edge of the authorized band, with the transmitter set to the highest channel.

Measurements are made over the 30 MHz to 26.5 GHz range with the transmitter set to the lowest, middle, and highest channels.

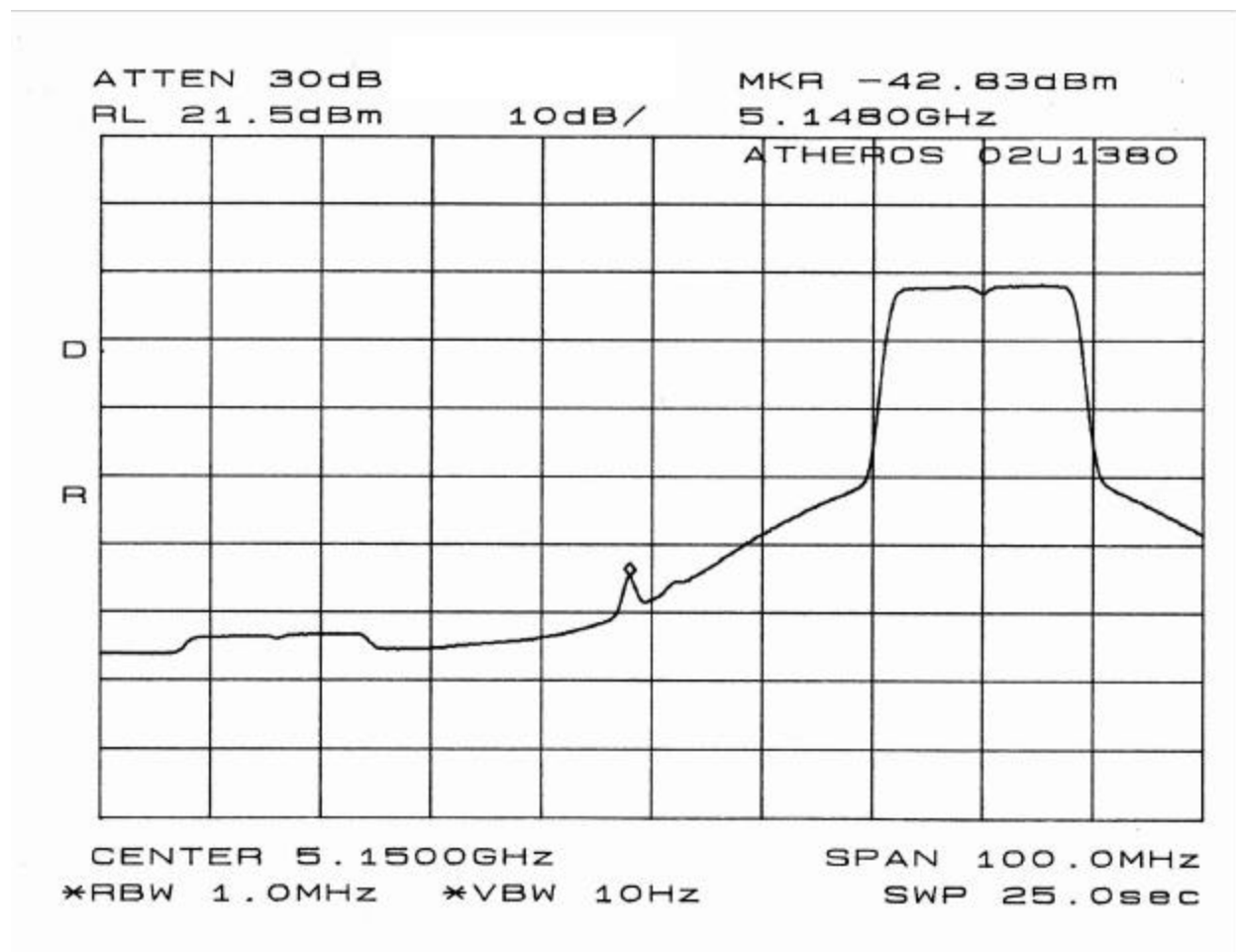
RESULTS

CONDUCTED RF EMISSIONS AT BANDEDGE

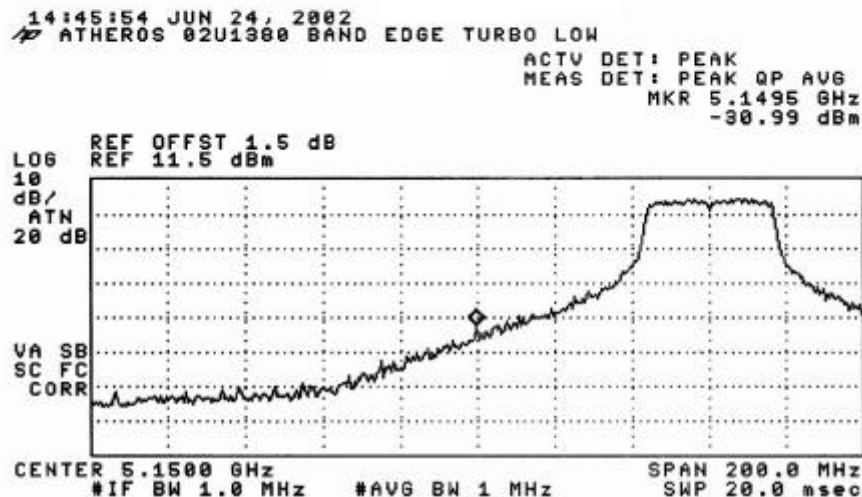
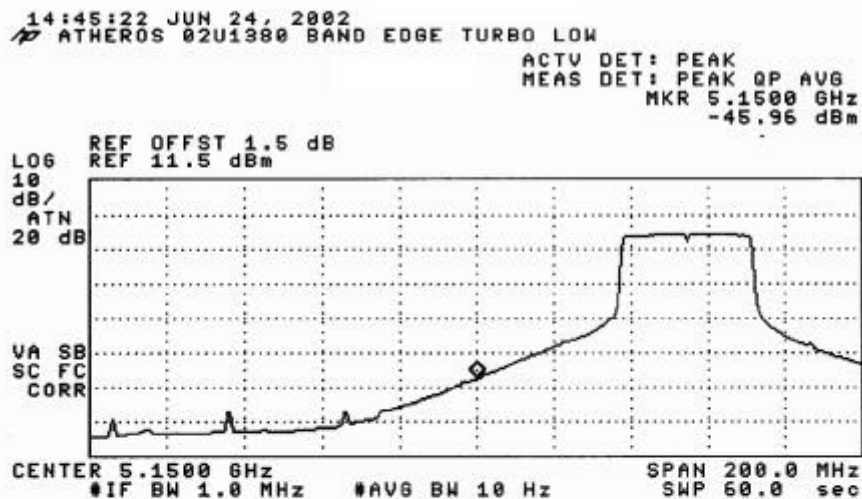
BASE MODE LOW PEAK



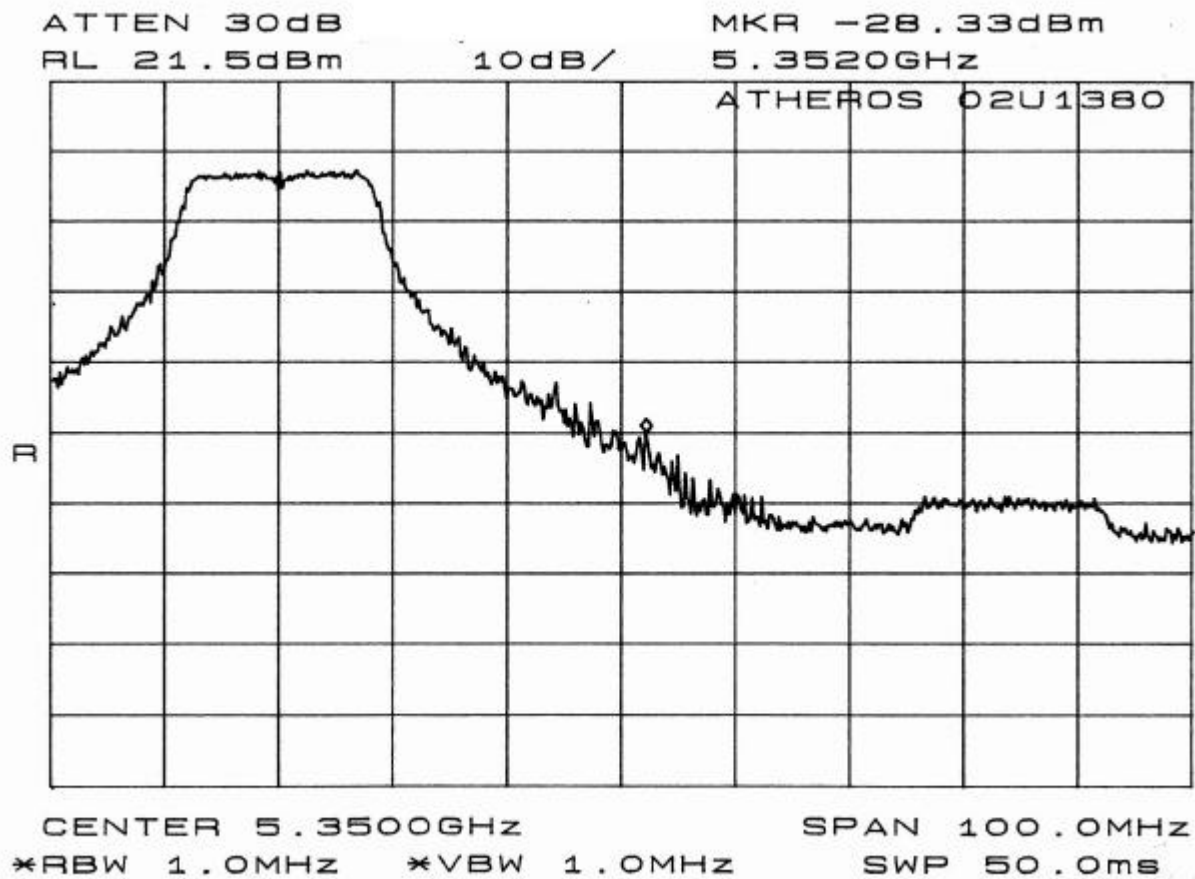
BASE MODE LOW AVERAGE



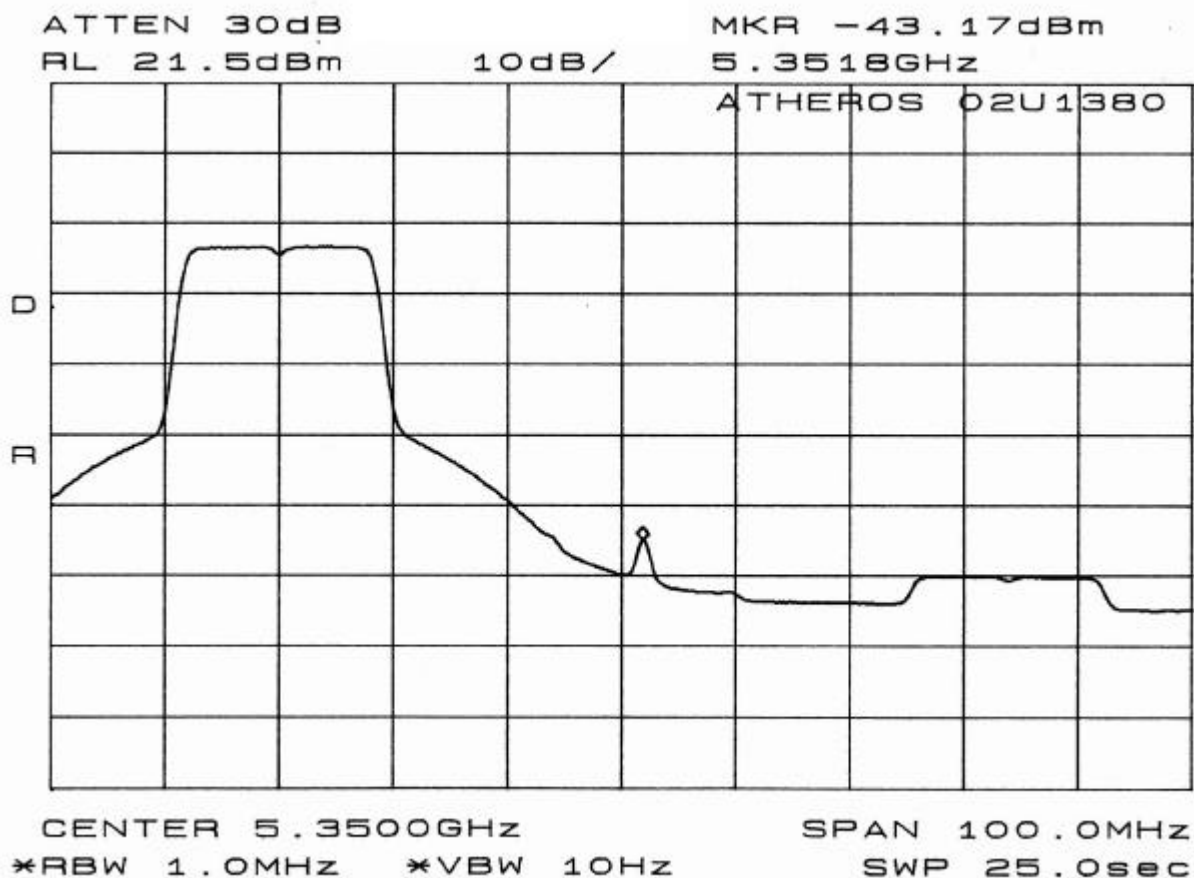
TURBO MODE LOW AVERAGE AND PEAK



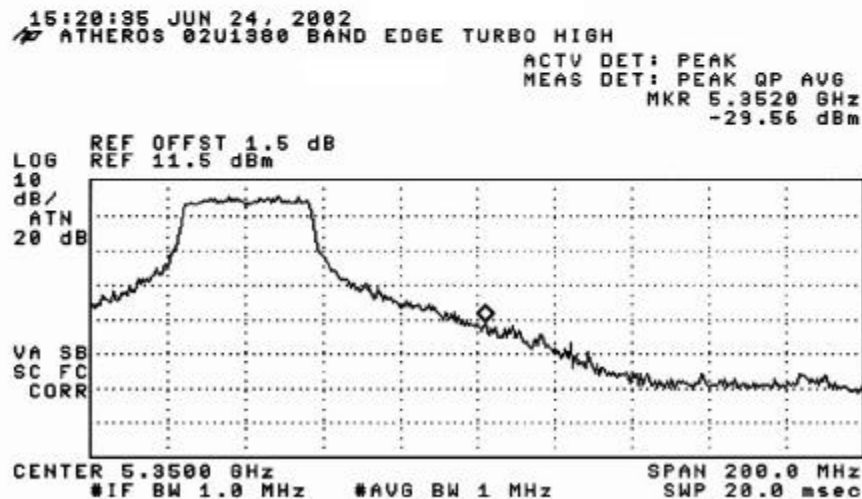
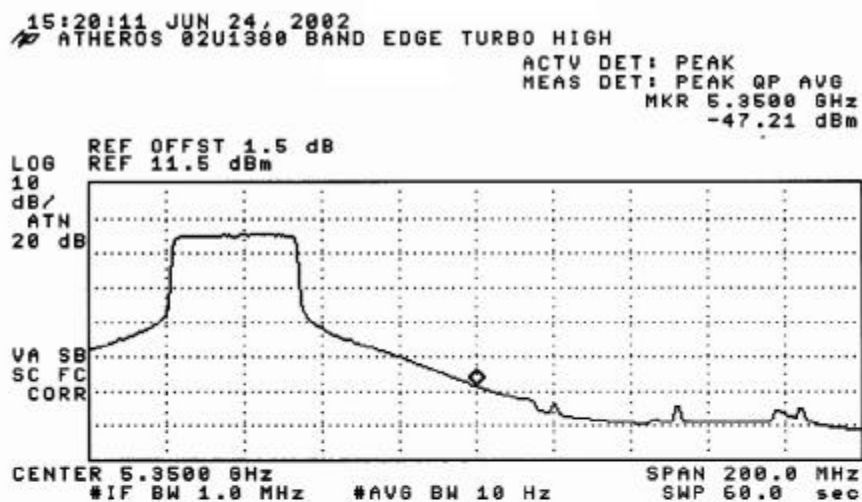
BASE MODE HIGH PEAK



BASE MODE HIGH AVERAGE

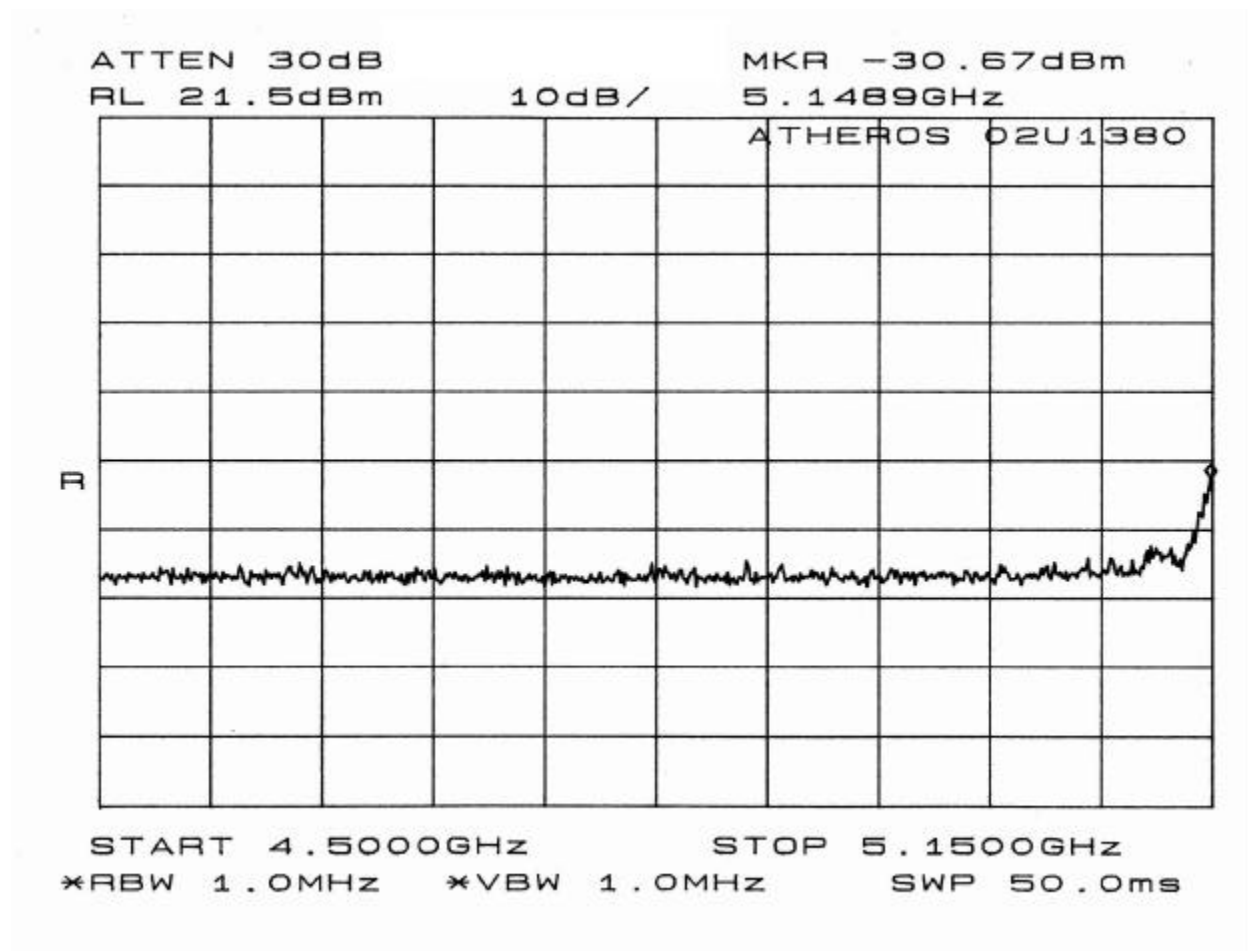


TURBO MODE HIGH AVERAGE AND PEAK

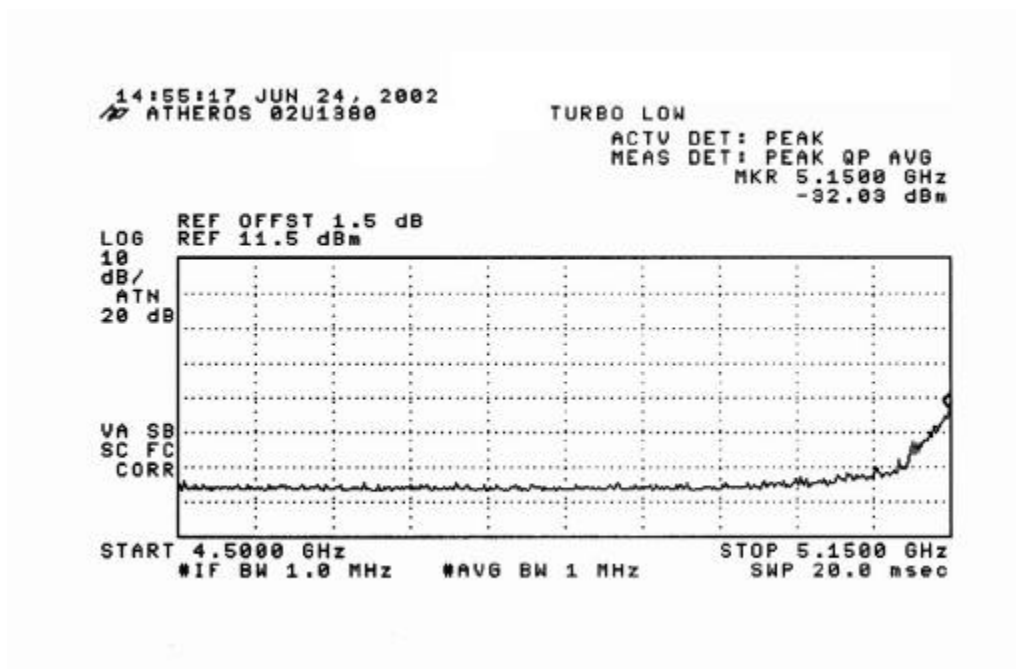


CONDUCTED RF EMISSIONS OVER ADJACENT RESTRICTED BANDS

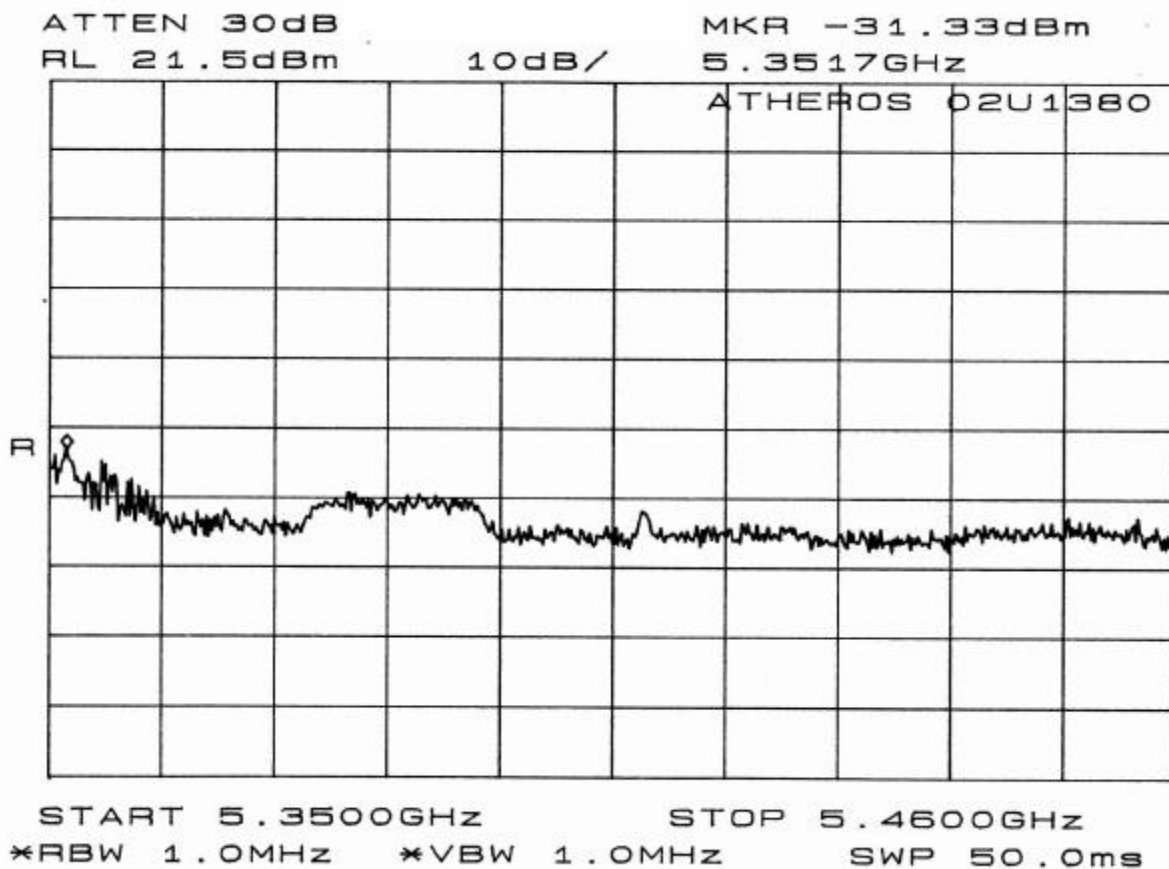
BASE MODE LOW



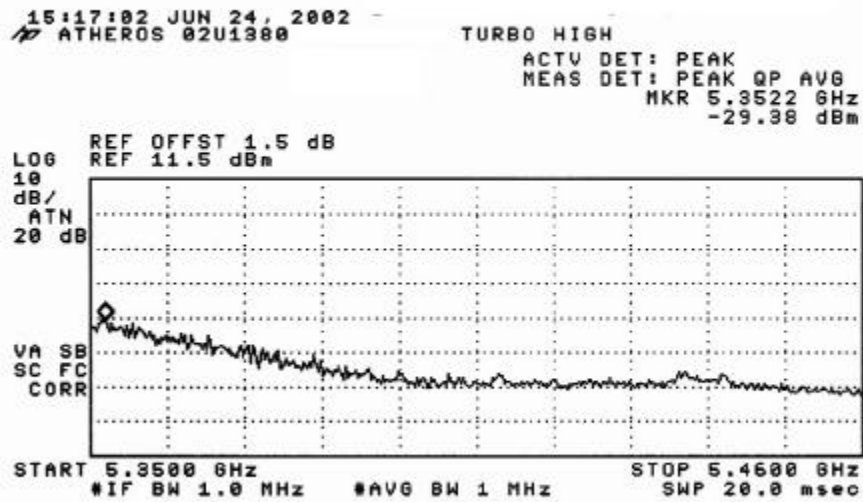
TURBO MODE LOW



BASE MODE HIGH

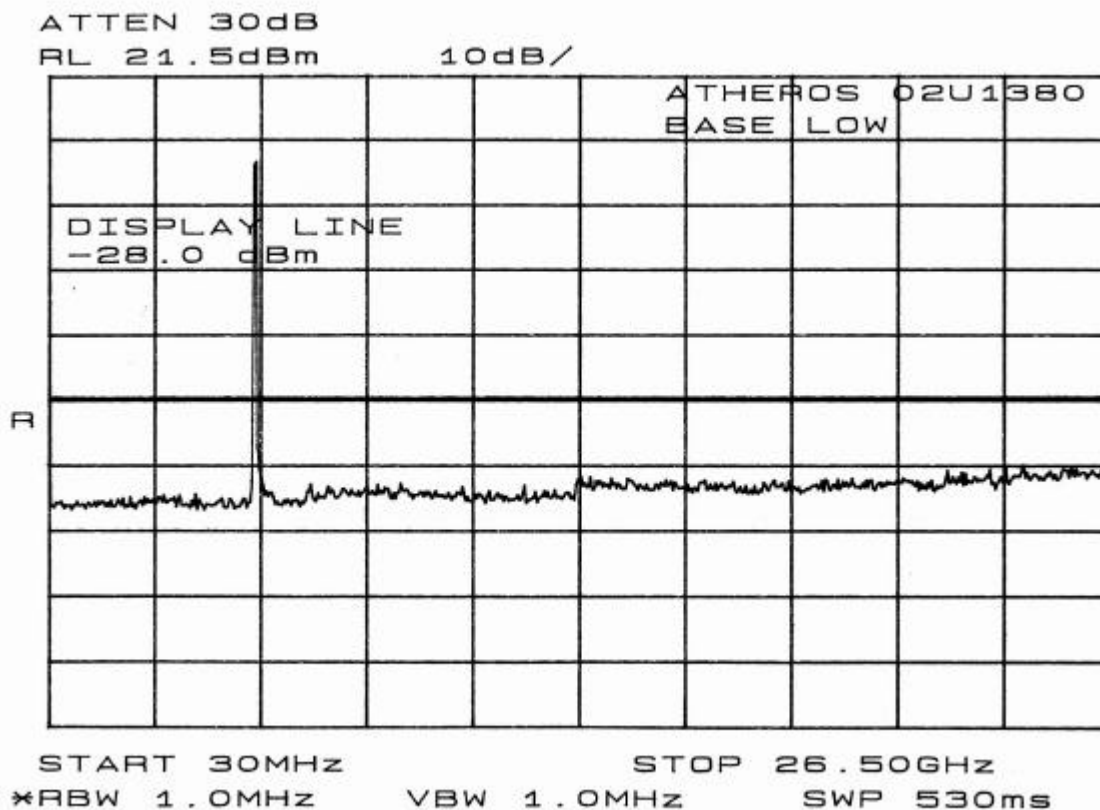


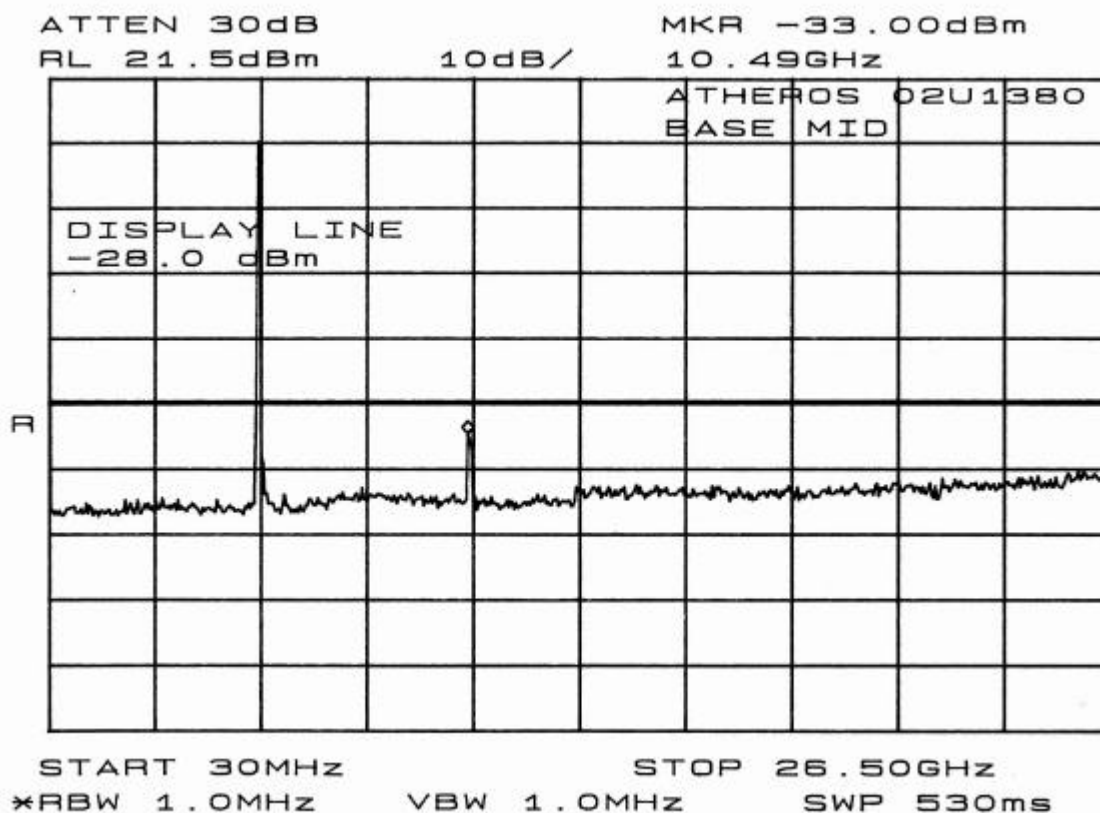
TURBO MODE HIGH

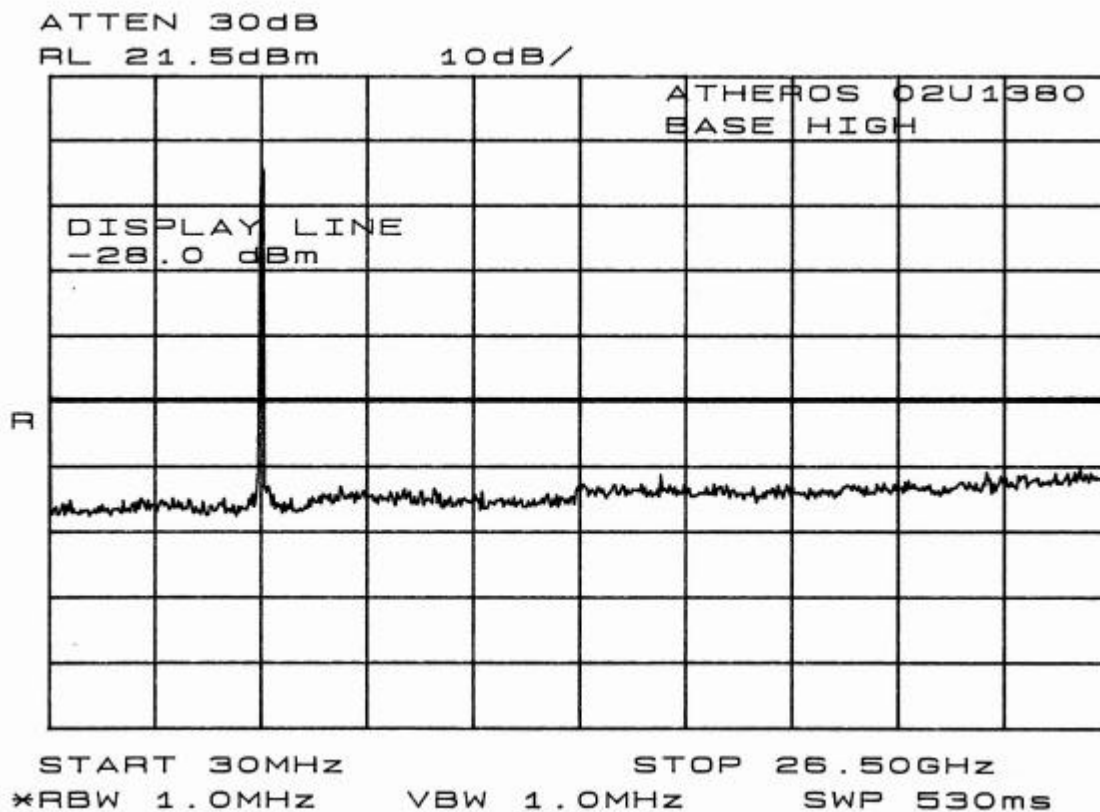


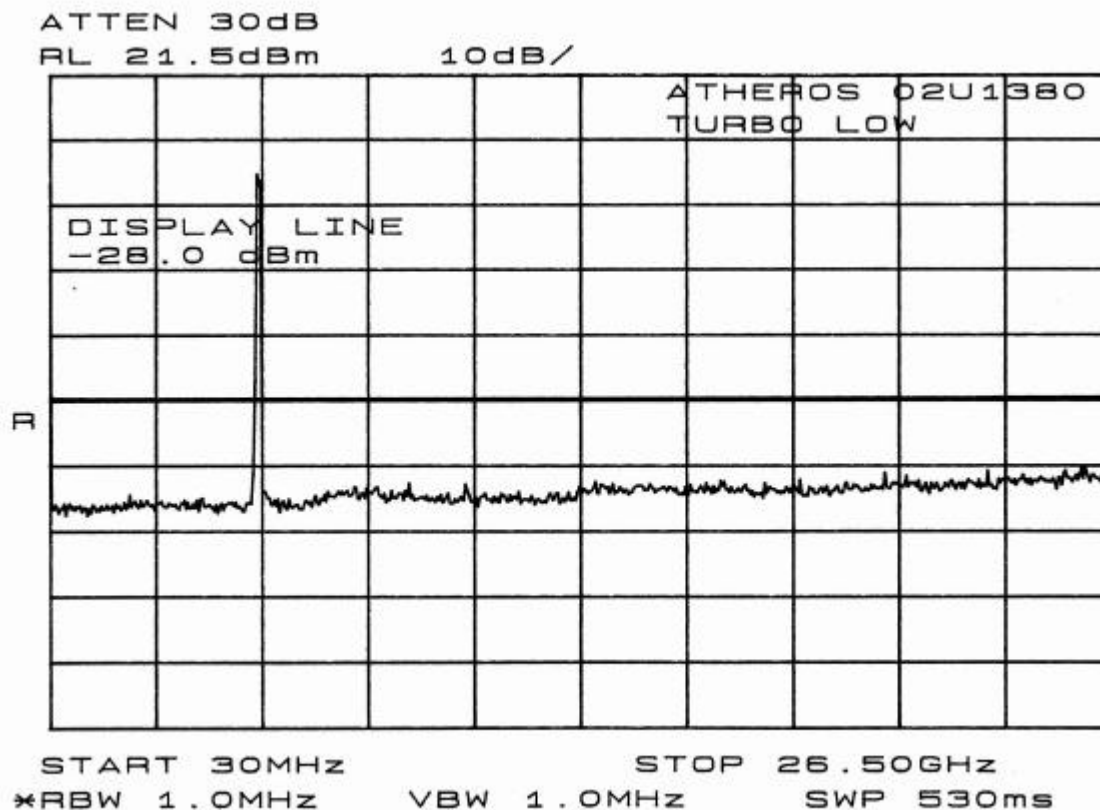
CONDUCTED RF SPURIOUS EMISSIONS

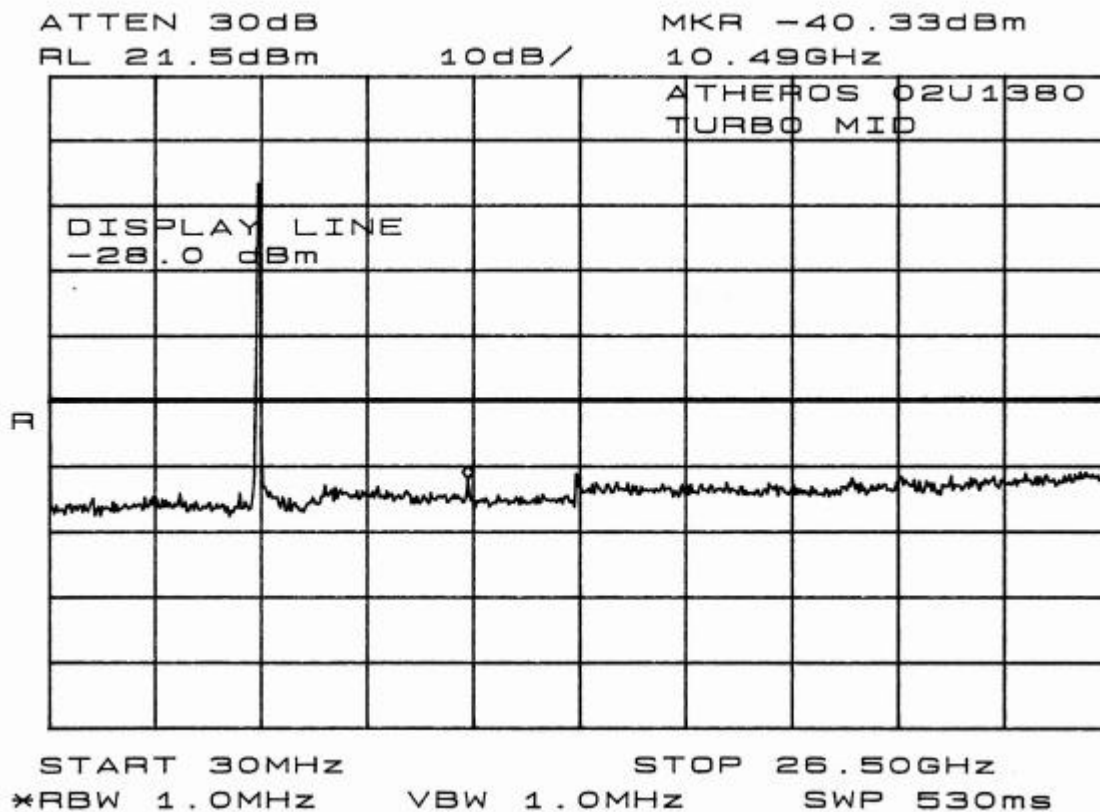
NOTE: Peak measurements are compared to the average limit corrected for antenna gain.

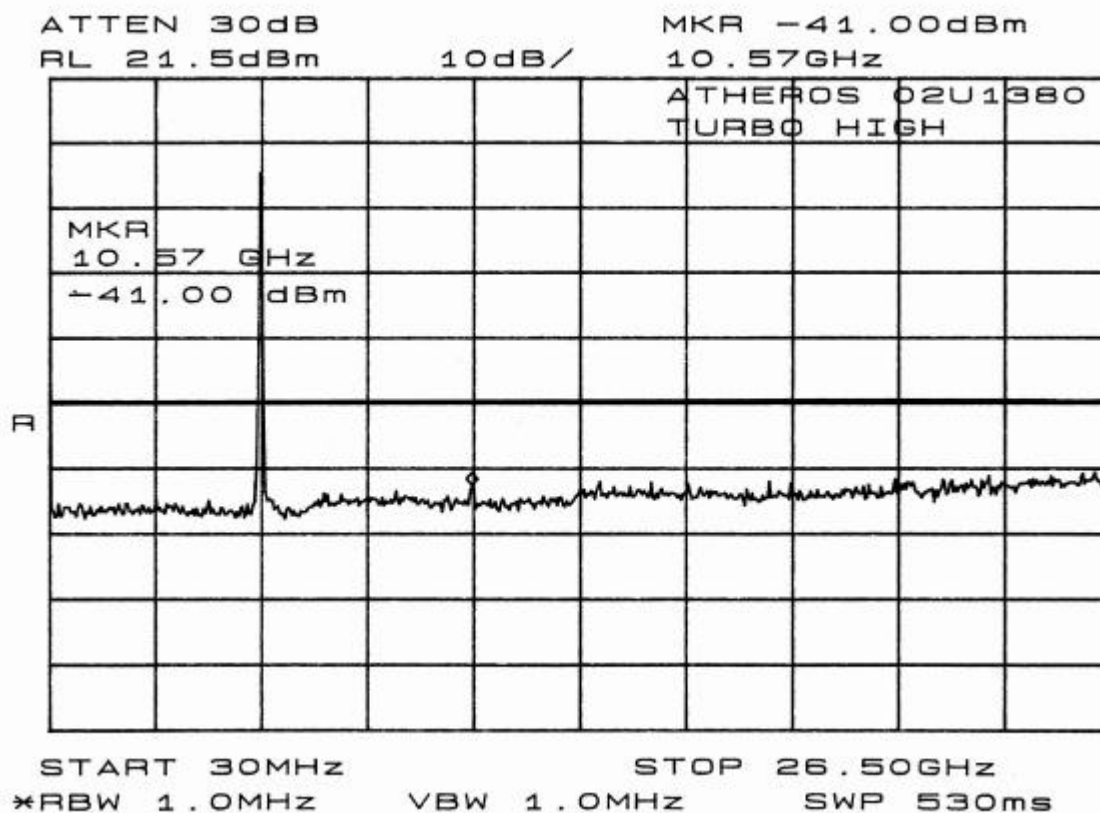












8.10. UNDESIRABLE EMISSIONS – RADIATED MEASUREMENTS

TEST SETUP

For measurements of the EUT as a digital device, the EUT and all other support equipment were placed on a wooden table 80 cm above the ground plane. For measurements of the EUT as a transmitter, the EUT and the laptop were 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 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 measurements above 1 GHz 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.

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 GHz band									
RBW = 1 MHz, peak detection									
26	44.6	33.4	1	-9.5	35.0	19.5	52.96	74	-21.04
RBW = 1 MHz, average detection									
26	32.4	33.4	1	-9.5	35.0	19.5	40.76	54	-13.24
26 to 40 GHz band									
External mixer is used for this band									
Preamplifier is internal to Spectrum Analyzer, with gain factor built into firmware									
Antenna is mounted directly on external mixer, therefore cable = 0 dB									
RBW = 1 MHz, peak detection									
40	39.2	44.5	0.3	-20.0	0.0	0	63.70	74	-10.30
RBW = 1 MHz, average detection									
40	27.2	44.5	0.3	-20.0	0.0	0	51.70	54	-2.30

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:

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

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

$$P \text{ (mW)} = P \text{ (W)} / 1000 \text{ and}$$

$$E \text{ (uV/m)} = E \text{ (V/m)} / 1000000$$

yields

$$\begin{aligned} 10 \log (P * G) &= 10 \log (d^2) + 10 \log (E^2) - 10 \log (30) - 10 \log (10^9) \\ &= 20 \log (d) + 20 \log (E) - 104.77 \end{aligned}$$

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:

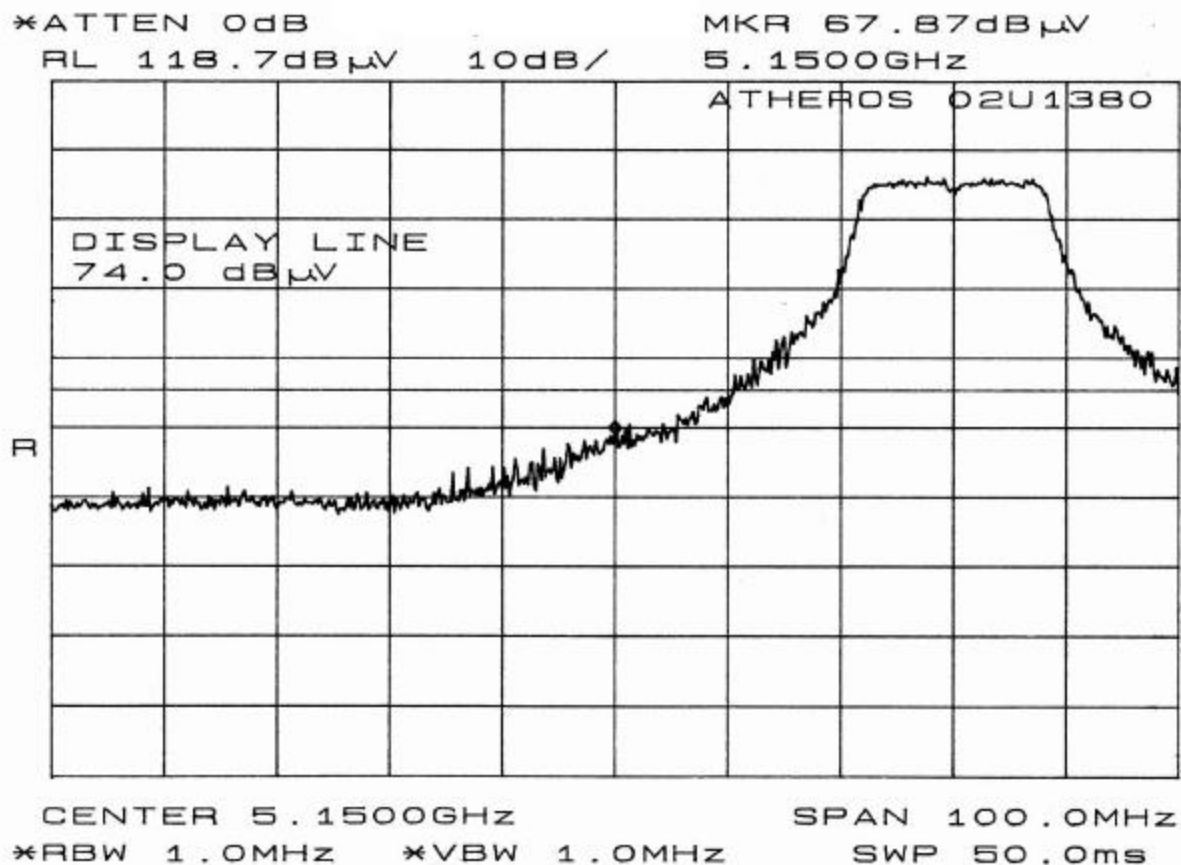
$$\text{EIRP (dBm)} = P * G \text{ (dBm)} = E \text{ (dBuV/m)} - 95.2$$

TEST RESULTS

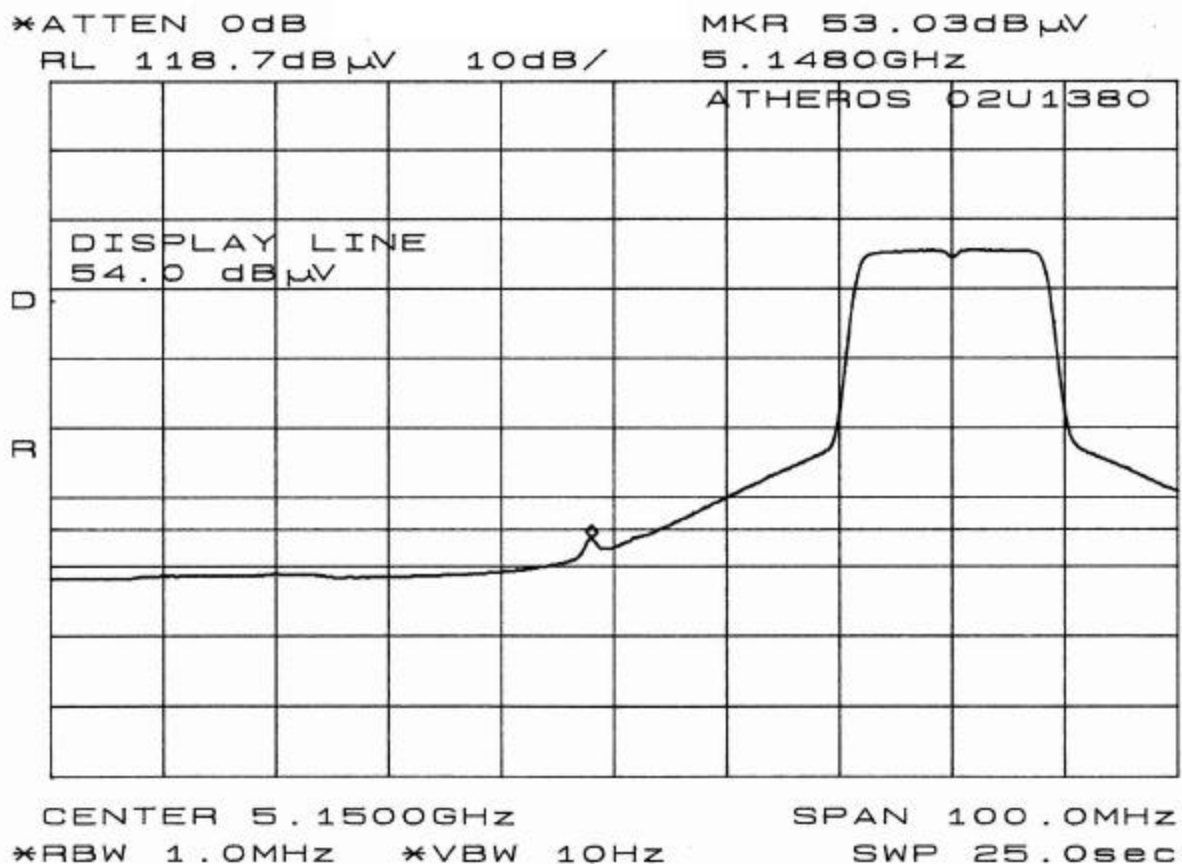
No non-compliance noted:

RADIATED EMISSIONS AT BAND EDGE

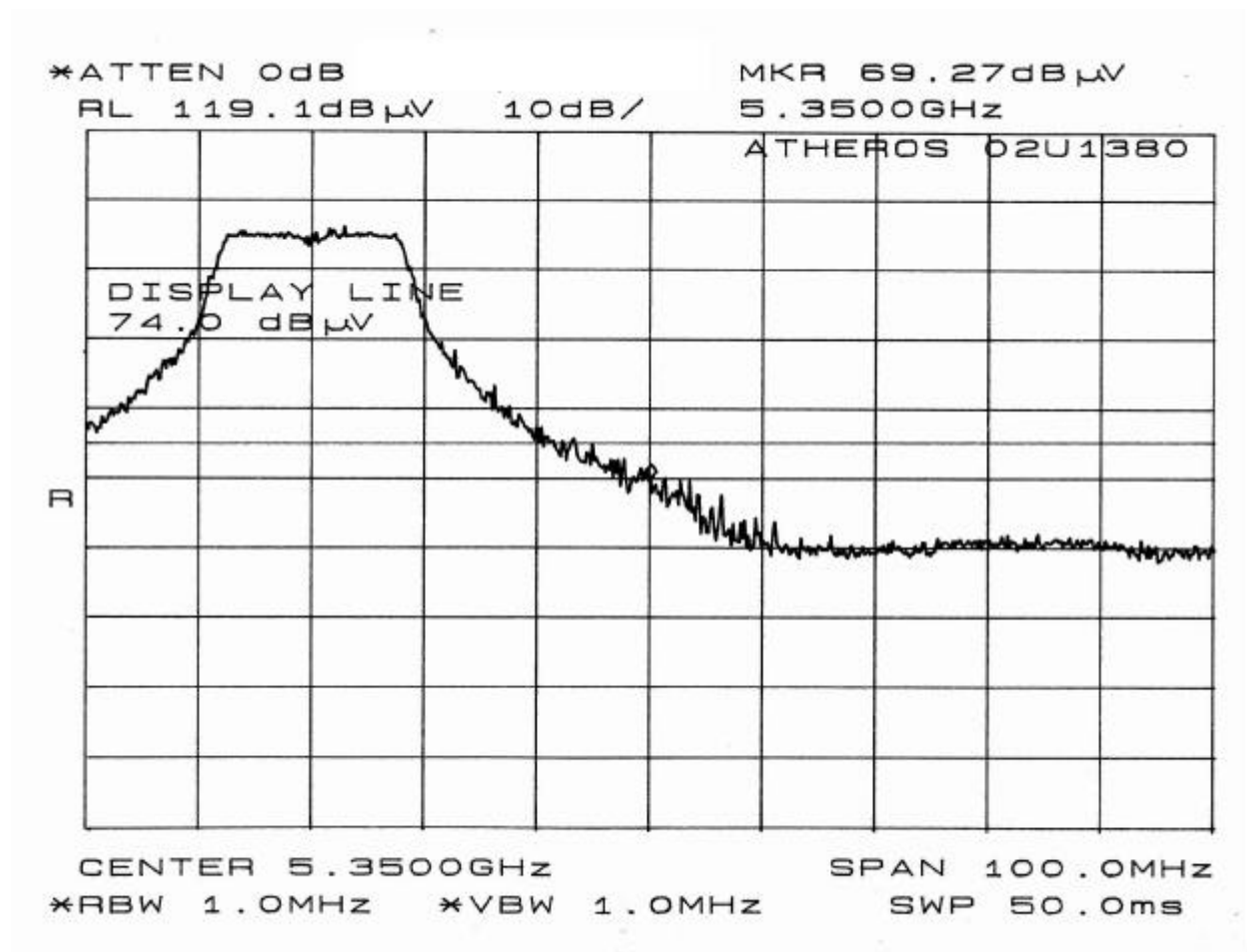
BASE MODE LOW VERTICAL PEAK



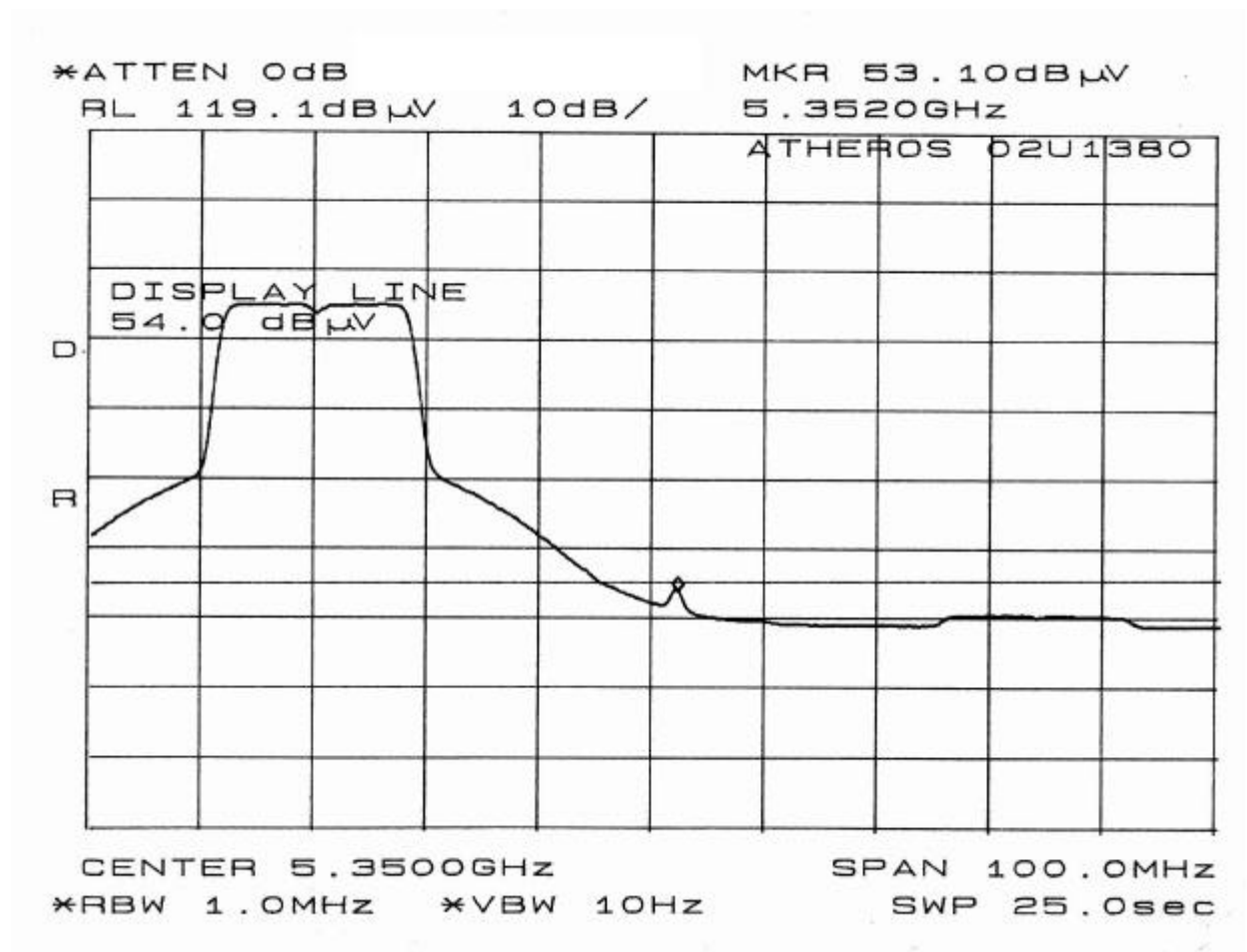
BASE MODE LOW VERTICAL AVERAGE



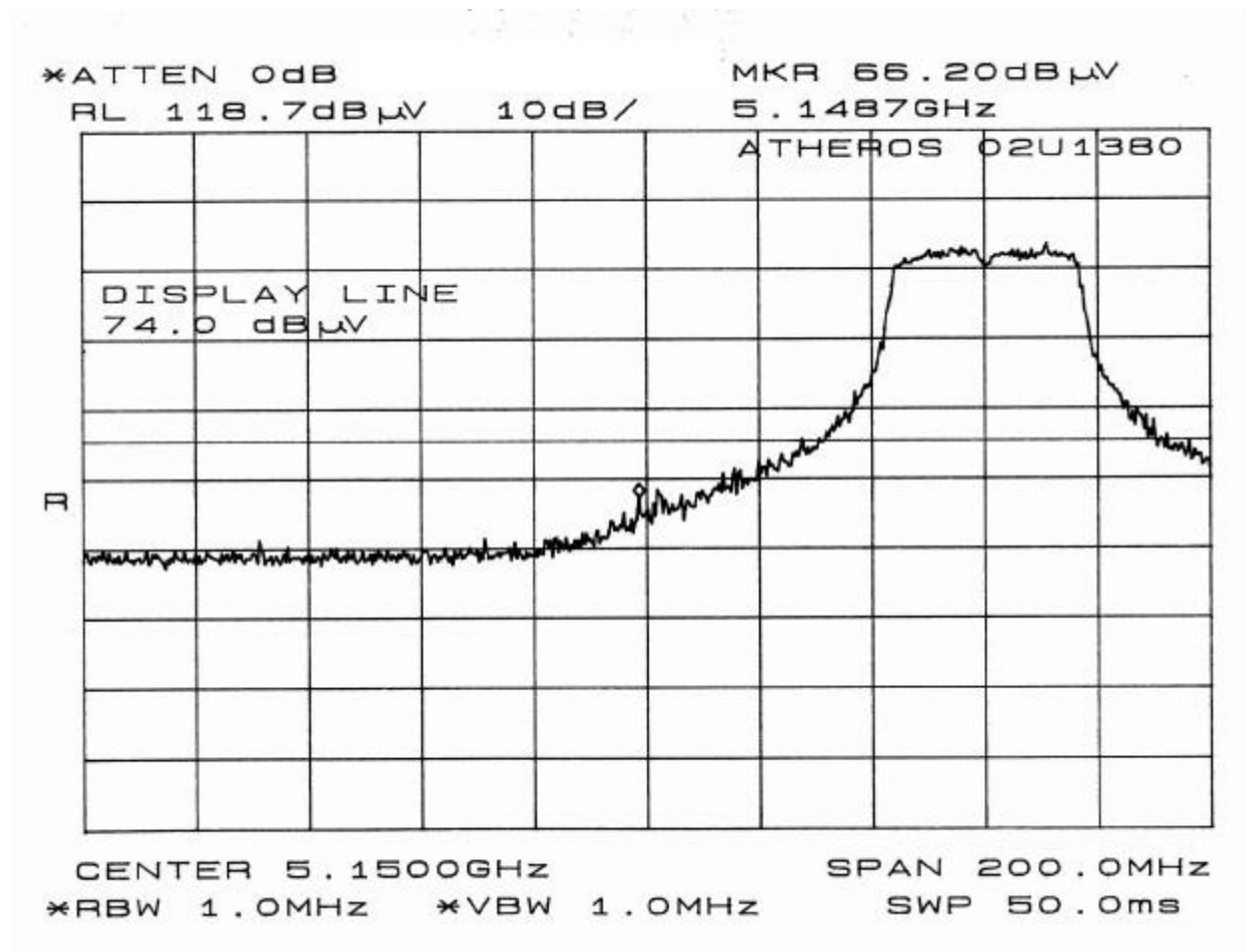
BASE MODE HIGH VERTICAL PEAK



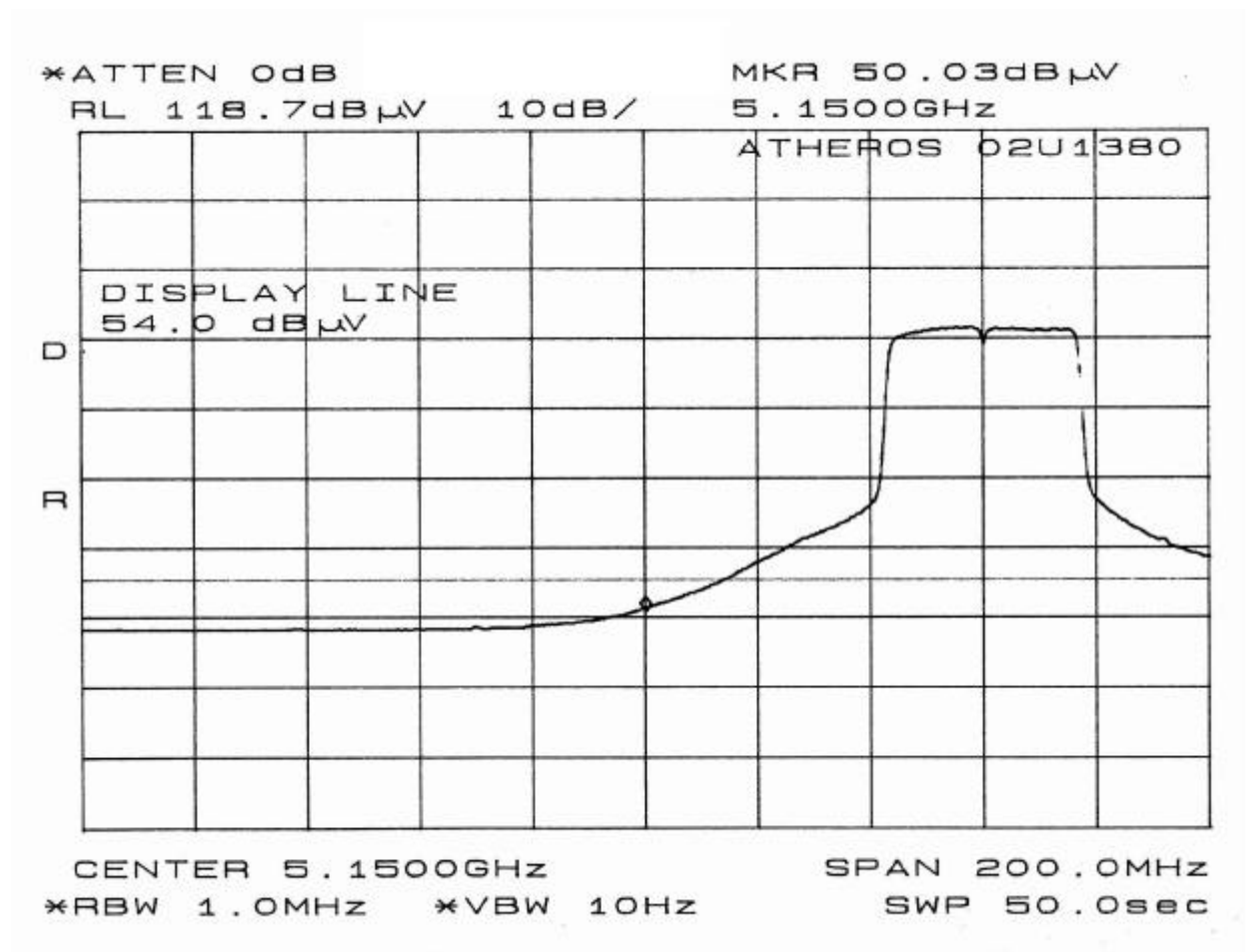
BASE MODE HIGH VERTICAL AVERAGE



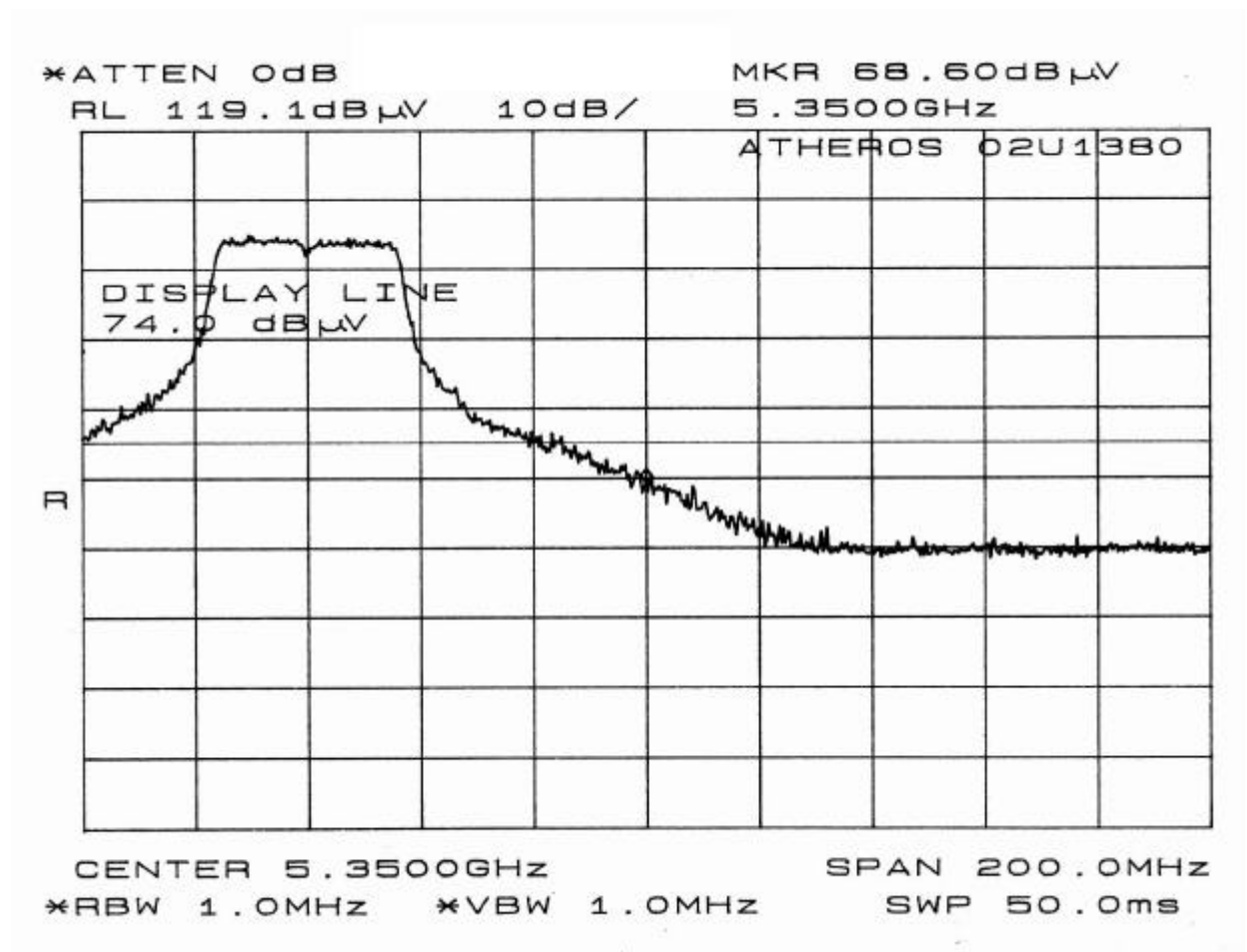
TURBO MODE LOW VERTICAL PEAK



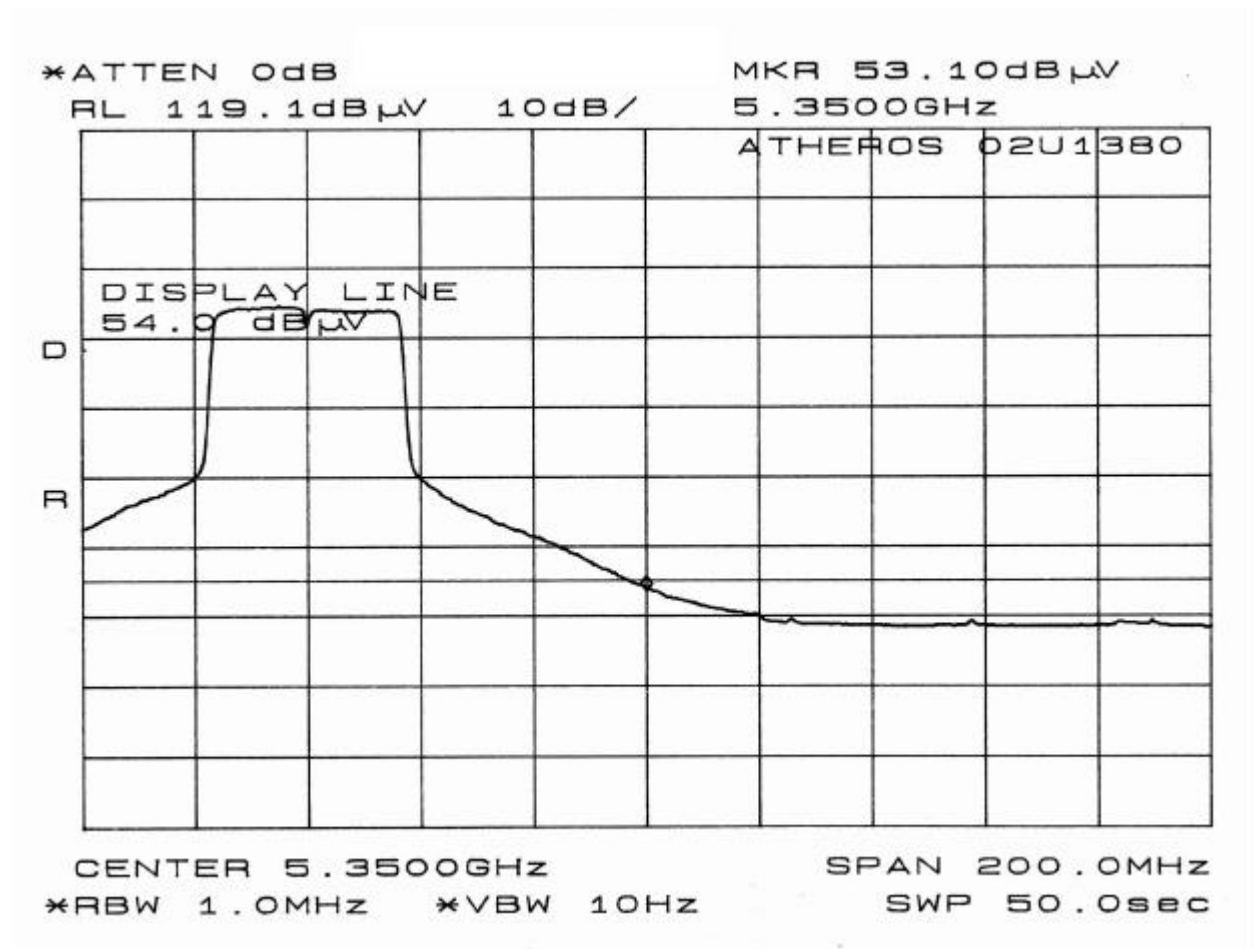
TURBO MODE LOW VERTICAL AVERAGE



TURBO MODE HIGH VERTICAL PEAK



TURBO MODE HIGH VERTICAL AVERAGE



FUNDAMENTAL, HARMONIC AND SPURIOUS RADIATED EMISSIONS

Compliance Certification Services

A-Site

6/28/02 Mike H

Radiated Emissions

Atheros 02U1380

FCC 15.407

Transmitting 11a Base Mode 5.2 Band Low Channel

Specification Distance: 3 m EIRP Conversion Factor: 95.2

Freq GHz	Pol V/H	Det	SA dBuV	AF dB/m	Dist m	Dist dB	Preamp dB	Cable & HPF dB	Field Strength dBuV/m	EIRP dBm	Limit dBuV/m or dBm	Margin dB
Note 1: RBW = 1 MHz.												
Fundamental:												
5.18	V	Peak	76.2	34.5	1	-9.5	0.0	3.7	104.86			
5.18	V	Avg	65.7	34.5	1	-9.5	0.0	3.7	94.36			
5.18	H	Peak	65.4	34.5	1	-9.5	0.0	3.7	94.06			
5.18	H	Avg	54.9	34.5	1	-9.5	0.0	3.7	83.56			
Band Edge:												
5.15	V	Peak	39.2	34.5	1	-9.5	0.0	3.7	67.86		74	-6.14
5.148	V	Avg	24.4	34.5	1	-9.5	0.0	3.7	53.06		54	-0.94
5.149	H	Peak	32.7	34.5	1	-9.5	0.0	3.7	61.36		74	-12.64
5.148	H	Avg	18.9	34.5	1	-9.5	0.0	3.7	47.56		54	-6.44
Harmonics and Spurious:												
6.216	V	Peak	58	35.4	1	-9.5	36.5	4.7	52.06	-43.14	-7	-36.14
6.216	V	Avg	55.5	35.4	1	-9.5	36.5	4.7	49.56	-45.64	-27	-18.64
6.216	H	Peak	54.7	35.4	1	-9.5	36.5	4.7	48.76	-46.44	-7	-39.44
6.216	H	Avg	50.8	35.4	1	-9.5	36.5	4.7	44.86	-50.34	-27	-23.34
Note 2: No other non-harmonic spurious emissions were found.												
Note 3: All other harmonic spurious emissions were below system noise floor.												

Compliance Certification Services

A-Site

6/28/02 Mike H

Radiated Emissions

Atheros 02U1380

FCC 15.407

Transmitting 11a Base Mode 5.2 Band Mid Channel

Specification Distance: 3 m EIRP Conversion Factor: 95.2

Freq GHz	Pol V/H	Det	SA dBuV	AF dB/m	Dist m	Dist dB	Preamp dB	Cable & HPF dB	Field Strength dBuV/m	EIRP dBm	Limit dBuV/m or dBm	Margin dB
Note 1: RBW = 1 MHz.												
Fundamental:												
5.26	V	Peak	80.5	34.7	1	-9.5	0.0	3.7	109.36			
5.26	V	Avg	69.7	34.7	1	-9.5	0.0	3.7	98.56			
5.26	H	Peak	69.5	34.7	1	-9.5	0.0	3.7	98.36			
5.26	H	Avg	59.7	34.7	1	-9.5	0.0	3.7	88.56			
Harmonics and Spurious:												
6.312	V	Peak	53.5	35.4	1	-9.5	36.5	4.8	47.66	-47.54	-7	-40.54
6.312	V	Avg	48.8	35.4	1	-9.5	36.5	4.8	42.96	-52.24	-27	-25.24
6.312	H	Peak	52	35.4	1	-9.5	36.5	4.8	46.16	-49.04	-7	-42.04
6.312	H	Avg	46.2	35.4	1	-9.5	36.5	4.8	40.36	-54.84	-27	-27.84
Note 2: No other non-harmonic spurious emissions were found.												
Note 3: All other harmonic spurious emissions were below system noise floor.												

Compliance Certification Services

A-Site

6/28/02 Mike H

Radiated Emissions
FCC 15.407

Atheros 02U1380
Transmitting 11a Base Mode 5.2 Band High Channel

Specification Distance: 3 m EIRP Conversion Factor: 95.2

Freq	Pol	Det	SA	AF	Dist	Dist	Preamp	Cable	Field	EIRP	Limit	Margin
GHz	V/H		dBuV	dB/m	m	dB	dB	& HPF dB	Strength dBuV/m	dBm	dBuV/m or dBm	dB
Note 1: RBW = 1 MHz.												
Fundamental:												
5.32	V	Peak	76.2	34.9	1	-9.5	0.0	3.7	105.26			
5.32	V	Avg	65	34.9	1	-9.5	0.0	3.7	94.06			
5.32	H	Peak	66.2	34.9	1	-9.5	0.0	3.7	95.26			
5.32	H	Avg	55.4	34.9	1	-9.5	0.0	3.7	84.46			
Band Edge:												
5.35	V	Peak	40.2	34.9	1	-9.5	0.0	3.7	69.26		74	-4.74
5.352	V	Avg	24	34.9	1	-9.5	0.0	3.7	53.06		54	-0.94
5.35	H	Peak	31.4	34.9	1	-9.5	0.0	3.7	60.46		74	-13.54
5.352	H	Avg	19	34.9	1	-9.5	0.0	3.7	48.06		54	-5.94
Note 2: No other non-harmonic spurious emissions were found.												
Note 3: All other harmonic spurious emissions were below system noise floor.												

Compliance Certification Services

A-Site

6/28/02 Mike H

Radiated Emissions
FCC 15.407

Atheros 02U1380
Transmitting 11a Turbo Mode 5.2 Band Low Channel

Specification Distance: 3 m EIRP Conversion Factor: 95.2

Freq	Pol	Det	SA	AF	Dist	Dist	Preamp	Cable	Field	EIRP	Limit	Margin
GHz	V/H		dBuV	dB/m	m	dB	dB	& HPF dB	Strength dBuV/m	dBm	dBuV/m or dBm	dB
Note 1: RBW = 1 MHz.												
Fundamental:												
5.21	V	Peak	73.7	34.5	1	-9.5	0.0	3.7	102.36			
5.21	V	Avg	61.7	34.5	1	-9.5	0.0	3.7	90.36			
5.21	H	Peak	61.9	34.5	1	-9.5	0.0	3.7	90.56			
5.21	H	Avg	51.5	34.5	1	-9.5	0.0	3.7	80.16			
Band Edge:												
5.149	V	Peak	37.5	34.5	1	-9.5	0.0	3.7	66.16		74	-7.84
5.15	V	Avg	21.4	34.5	1	-9.5	0.0	3.7	50.06		54	-3.94
5.146	H	Peak	31	34.5	1	-9.5	0.0	3.7	59.66		74	-14.34
5.15	H	Avg	18.9	34.5	1	-9.5	0.0	3.7	47.56		54	-6.44
Harmonics and Spurious:												
6.252	V	Peak	54.3	35.4	1	-9.5	36.5	4.7	48.36	-46.84	-7	-39.84
6.252	V	Avg	51	35.4	1	-9.5	36.5	4.7	45.06	-50.14	-27	-23.14
6.252	H	Peak	53.7	35.4	1	-9.5	36.5	4.7	47.76	-47.44	-7	-40.44
6.252	H	Avg	49.2	35.4	1	-9.5	36.5	4.7	43.26	-51.94	-27	-24.94
Note 2: No other non-harmonic spurious emissions were found.												
Note 3: All other harmonic spurious emissions were below system noise floor.												

Compliance Certification Services

A-Site

6/28/02 Mike H

Radiated Emissions
FCC 15.407

Atheros 02U1380
Transmitting 11a Turbo Mode 5.2 Band Mid Channel

Specification Distance: 3 m EIRP Conversion Factor: 95.2

Freq GHz	Pol V/H	Det	SA dBuV	AF dB/m	Dist m	Dist dB	Preamp dB	Cable & HPF dB	Field Strength dBuV/m	EIRP dBm	Limit dBuV/m or dBm	Margin dB
Note 1: RBW = 1 MHz.												
Fundamental:												
5.25	V	Peak	73.5	34.7	1	-9.5	0.0	3.7	102.36			
5.25	V	Avg	63	34.7	1	-9.5	0.0	3.7	91.86			
5.25	H	Peak	63.4	34.7	1	-9.5	0.0	3.7	92.26			
5.25	H	Avg	53.4	34.7	1	-9.5	0.0	3.7	82.26			
Harmonics and Spurious:												
6.3	V	Peak	54.3	35.4	1	-9.5	36.5	4.8	48.46	-46.74	-7	-39.74
6.3	V	Avg	50.8	35.4	1	-9.5	36.5	4.8	44.96	-50.24	-27	-23.24
6.3	H	Peak	52.7	35.4	1	-9.5	36.5	4.8	46.86	-48.34	-7	-41.34
6.3	H	Avg	48.2	35.4	1	-9.5	36.5	4.8	42.36	-52.84	-27	-25.84
Note 2: No other non-harmonic spurious emissions were found.												
Note 3: All other harmonic spurious emissions were below system noise floor.												

Compliance Certification Services

A-Site

6/28/02 Mike H

Radiated Emissions
FCC 15.407

Atheros 02U1380
Transmitting 11a Turbo Mode 5.2 Band High Channel

Specification Distance: 3 m EIRP Conversion Factor: 95.2

Freq GHz	Pol V/H	Det	SA dBuV	AF dB/m	Dist m	Dist dB	Preamp dB	Cable & HPF dB	Field Strength dBuV/m	EIRP dBm	Limit dBuV/m or dBm	Margin dB
Note 1: RBW = 1 MHz.												
Fundamental:												
5.29	V	Peak	75	34.9	1	-9.5	0.0	3.7	104.06			
5.29	V	Avg	64.7	34.9	1	-9.5	0.0	3.7	93.76			
5.29	H	Peak	63.7	34.9	1	-9.5	0.0	3.7	92.76			
5.29	H	Avg	54.2	34.9	1	-9.5	0.0	3.7	83.26			
Band Edge:												
5.35	V	Peak	39.5	34.9	1	-9.5	0.0	3.7	68.56		74	-5.44
5.35	V	Avg	24	34.9	1	-9.5	0.0	3.7	53.06		54	-0.94
5.354	H	Peak	31.2	34.9	1	-9.5	0.0	3.7	60.26		74	-13.74
5.35	H	Avg	19	34.9	1	-9.5	0.0	3.7	48.06		54	-5.94
Harmonics and Spurious:												
6.348	V	Peak	53.7	35.4	1	-9.5	36.5	4.8	47.86	-47.34	-7	-40.34
6.348	V	Avg	50.2	35.4	1	-9.5	36.5	4.8	44.36	-50.84	-27	-23.84
6.348	H	Peak	51	35.4	1	-9.5	36.5	4.8	45.16	-50.04	-7	-43.04
6.348	H	Avg	45.2	35.4	1	-9.5	36.5	4.8	39.36	-55.84	-27	-28.84
Note 2: No other non-harmonic spurious emissions were found.												
Note 3: All other harmonic spurious emissions were below system noise floor.												

DIGITAL DEVICE RADIATED EMISSIONS

						Project #: 02U1380-1 Report #: 020625A1 Date & Time: 06/25/02 6:51 PM Test Engr: Thanh Nguyen					
FCC, VCCI, CISPR, CE, AUSTEL, NZ UL, CSA, TUV, BSMI, DHHS, NVLAP 561F MONTEREY ROAD, SAN JOSE, CA 95037-9001 PHONE: (408) 463-0885 FAX: (408) 463-0888											
Company: ATHEROS COMMUNICATION, INC. EUT Description: 802.11a/b/g Cardbus Test Configuration : EUT plugin the Laptop, Printer, modem Type of Test: FCC Class B Mode of Operation: TX Mode at Lower UNII Mid Channel 5.6GHz											
						<< Main Sheet					

Freq.	Reading	AF	Closs	Pre-amp	Level	Limit	Margin	Pol	Az	Height	Mark
(MHz)	(dBuV)	(dB)	(dB)	(dB)	(dBuV/m)	FCC B	(dB)	(H/V)	(Deg)	(Meter)	(P/Q/A)
401.42	49.10	15.65	3.26	27.82	40.19	46.00	-5.81	3mV	270.00	1.00	P
500.31	46.80	17.97	3.68	28.40	40.05	46.00	-5.95	3mV	270.00	1.00	P
398.52	48.90	15.61	3.24	27.80	39.95	46.00	-6.05	3mV	270.00	1.00	P
400.00	47.20	15.62	3.25	27.81	38.26	46.00	-7.74	3mV	270.00	1.00	P
146.97	44.10	15.93	1.90	27.42	34.51	43.50	-8.99	3mV	180.00	1.00	P
167.22	43.00	16.42	2.02	27.36	34.08	43.50	-9.42	3mV	90.00	1.00	P
6 Worst Data											

Note: Changing the transmitter band, mode or channel does not affect these emissions.

8.11. POWER LINE CONDUCTED EMISSIONS

TEST SETUP

The EUT is placed on a wooden table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane on the floor.

The EUT is set to transmit in a continuous mode.

TEST PROCEDURE

The resolution bandwidth is set to 9 kHz for both peak detection and quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

Line conducted data is recorded for both NEUTRAL and HOT lines.

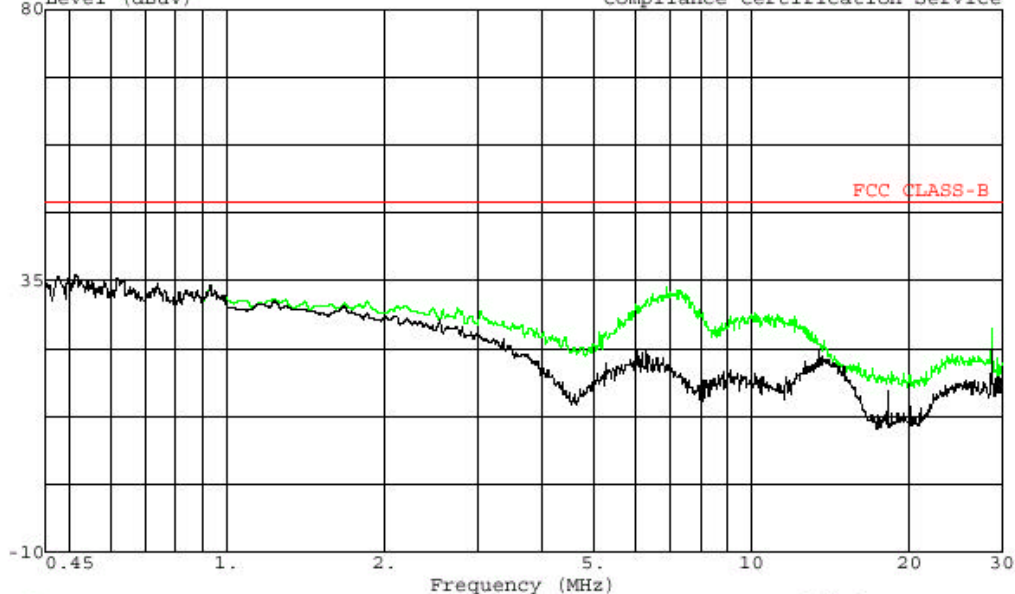
RESULTS

No non-compliance noted:



561F Monterey Road,
San Jose, CA 95037 USA
Tel: (408) 463-0885
Fax: (408) 463-0888

Data#: 8 File#: 02U1380.EMI Date: 06-26-2002 Time: 16:40:33
Level (dBuV) Compliance Certification Service



Trace: 3
Project # : 02U1380-1
Test Engineer: Thanh Nguyen
Company : ATHEROS COMMUNICATIONS, INC.
EUT : 802.11 a/b/g
Model: CB22
Test Config : EUT/laptop/ printer/ mouse
Type of Test : FCC Class B
Mode of Op. : Tx
L1: PK (Green), L2 (Black)
115VAc, 60Hz

Ref Trace:

8.12. SETUP PHOTOS

TRANSMITTER ANTENNA PORT CONDUCTED RF MEASUREMENT SETUP



TRANSMITTER RADIATED RF MEASUREMENT SETUP



DIGITAL DEVICE RADIATED EMISSIONS MEASUREMENT SETUP



POWERLINE CONDUCTED EMISSIONS MEASUREMENT SETUP



END OF REPORT

Page 80 of 80