Electromagnetic Compatibility
Test Report

Test Report No: ELM 141106
Issued on: November 14, 2006

Product Name
Wireless System for DPT
"Transmitter" Unit

Tested According to
FCC 47 CFR Part 15.247

Tests Performed for
Elcam Medical
BarAm 13860
Tel: 972-4-6988120/1/2

QualiTech EMC Laboratory
30 Hasivim St,
Petah-Tikva, 49517, Israel
Tel: 972-3-926 8443
Fax: 972-3-928 7490

ACCREDITED
1633.01

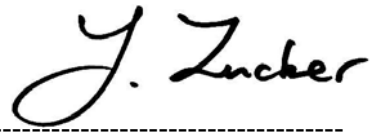
Test personnel

Tests Performed By: ----------

Rami Nataf

Report Prepared By: ----------

Bina Talkar



Report Reviewed By: ----------

Y. Zucker
QA and Lab. Manager
QualiTech EMC Laboratory

ACCREDITED
1633.01

Assessment information:

This report contains an assessment of the EUT against Electromagnetic Compatibility based upon tests carried out on the samples submitted. The results contained in this report relate only to the items tested. Manufactured products will not necessarily give identical results due to production and measurement tolerances. QualiTech, EMC Lab does not assume responsibility for any conclusion and generalization drawn from the test results with regards to other specimens or samples of type of the equipment represented by test item.

The EUT was set up and exercised using the configuration, modes of operation and arrangements defined in this report only.

Modifications:

Modifications made to the EUT

None.

Modifications made to the Test Standard

None.

Summary of Compliance Status

Test Spec. Clause	Test Case	Remarks
§15.247 (a) (1) & RSS-210 section A8.1 (2)	Carrier Frequency Separation	**Pass**
§15.247 (a) (1)(iii) & RSS-210 section A8.1 (3)	Number of Hopping Channels	**Pass**
§15.247 (a) (1)(iii) & RSS-210 section A8.1 (4)	Time Occupancy (Dwell Time)	**Pass**
§15.247 (a) (1) (ii) & RSS-210 section A8.1 (1)	Spectrum Bandwidth of a FHSS system/ Maximum 20dB BW	**Pass**
§15.247 (b) (1) & RSS-210 section A8.4 (2)	Maximum Peak Output Power	**Pass**
§15.247 (d) & RSS-210 section A8.5	Band-Edge compliance of RF Conducted Emission	**Pass**
§15.205 & RSS-210 section A8.5	Radiated Emission, Restricted Bands	**Pass**
§15.247 (d) & RSS-210 section A8.5	Spurious Emission Conducted	**Pass**
§15.247 (d) & RSS-210 section A8.5	Spurious Emission Radiated	**Pass**
§15.109 & ICES-003, RSS-GEN, Section 7.2.3.2	Radiated Emission (receiver)	**Pass**
§15.207 & ICES-003, RSS-GEN, Section 7.2.3.2	Power line Emission	**Pass**
§15.203 & RSS-Gen, Section 7.1.4	Antenna Connector requirement	**Pass**

Table of Content

1. General Description

1.1. Description of the EUT system/test Item:

EUT Description:
The wireless blood pressure transducer system is designed utilizing the Bluetooth class 2, 802.15.1 communications protocol. It eliminates the multi-conductor, fixed length, shielded, reusable cable that typically acts as the interface between the patient's bedside monitor and the disposable transducer. The disposable transducer is simply plugged into the system's remote transmitter unit, which will send its output signal to the system's receiver unit that is affixed to the bedside monitor. The wireless system is designed to operate at varying distances to accommodate typical layouts that exist within hospital operating rooms, critical care units, emergency rooms and catheterization lab suites.

"Transmitter" unit

This unit is connected to 1-5 pressure sensors (DPTs) and wirelessly transmits the pressure readings generated by those DPTs to the monitor unit. Entry of pressure sensors are amplified to the A/D range and transmitted to the "Main Receiver". The "Transmitter" is powered by battery and by external power, and includes charge circuit, power connector and lithium battery.

The Bluetooth **"Transmitter" unit** was tested and investigated with maximum transmitted power. All data rates were investigated and worst-case rates were selected and plotted. PRBS data was transmitted during testing. The transmitter was operated during testing at 100% duty cycle.

2. Method of Measurements

2.1 Conducted Measurements:

The RF output of the transmitter under test was directly connected to the input of the Spectrum analyzer through a specialized antenna connector provided by the manufacturer, and an attenuator as specified. The external attenuator and cable loss were added to the reading. Worst-case results of the various modulation modes (where applicable) were reported.

For carrier frequency separation, number of hopping frequencies, time of occupancy, 20dB BW, peak output power, band edge emissions, and spurious emissions were measured according the guidelines in DA 00-705.

2.2 Radiated Spurious Emissions Measurements in the restricted bands:

For radiated emissions, which fall in the restricted bands the spectrum from 1MHz to 25GHz was investigated following the guidelines in ANSI C63.4-2003, with the transmitter set to the lowest, middle and highest channel frequencies. Measurements were performed with peak detector and repeated averaged with VBW=10Hz.

2.3 Radiated Emission measurements:

During the testing process, the EUT was controlled via dedicated software. The EUT was operated at in receive mode.

Measurements were performed at a 3-meter measurement distance in the semi-anechoic chamber in order to evaluate the radiated electromagnetic interference characteristics of the EUT. The EUT was placed on a non-metallic table/support, 0.8m above the turntable, was configured, arranged and operated in a manner consistent with typical application and load conditions.
An appropriate antenna depending upon the frequency range, per ANSI C63.4-2003 clause 4.1.5 was used. While the turntable was being rotated, the height of the antenna was varied from 1 to 4m for the frequency range of 9kHz to 25GHz. The highest radiated emission was detected by manipulating the system cables to the worst-case position. This process was repeated for both antenna polarizations.
The amplitudes of worst-case emission were measured with the detector modes and resolution bandwidths over various frequency ranges according to the requirements of ANSI C63.4-2003 clause 4.2.

2.4 Power line Emission measurements:

The EUT was placed on a non-conductive table/support 80 cm above the reference ground plane. The EUT was configured in accordance with ANSI C63.4-2003 using a 50µH/50 ohm LISN.

Compliance with the provisions was based on the measurements of the radio frequency voltage between each line and the ground at the power terminal.

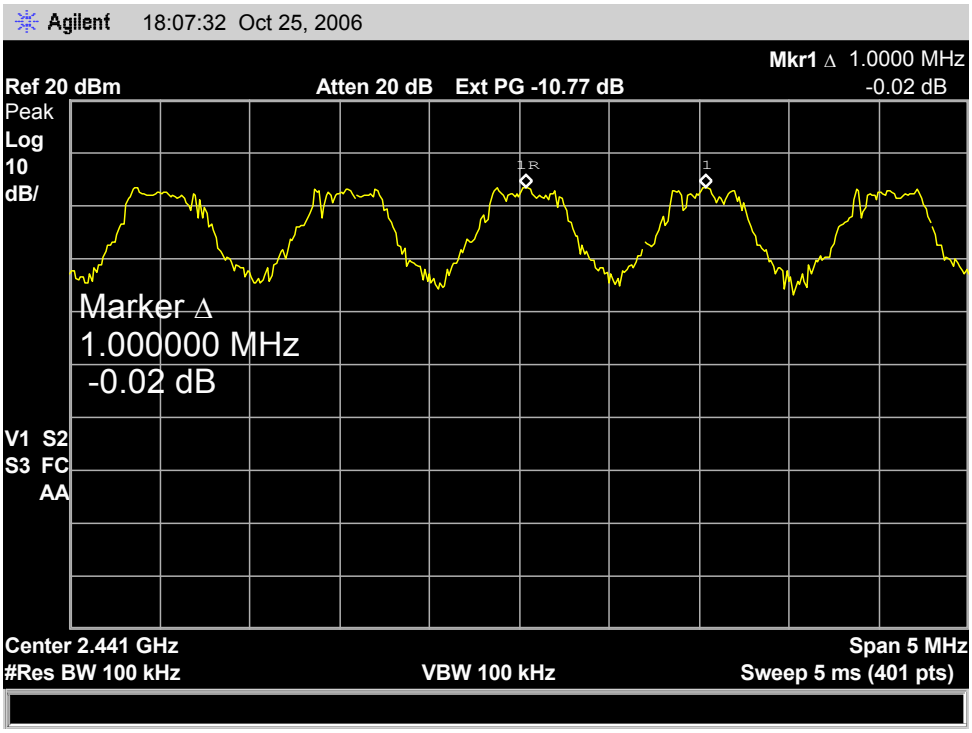
3. Bluetooth: Report of Measurements and examinations

3.1. Carrier Frequency Separation

Reference document:	**47 CFR §15.247 (a) (1) & DA 00-705**		
Test Requirements:	Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW.		
Test setup:	See Sec. 2.1	**Pass**	
Operating conditions:	Under normal test conditions		
Method of testing:	Conducted		
S.A. Settings:	RBW: 100kHz, VBW: 100kHz		
Hopping function:	Enabled		
Environment conditions:	Ambient Temperature: 22°c	Relative Humidity: 48%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	Plot 3.1	

20dB BW [kHz]	2/3 of 20dB BW [kHz]	Carrier separation [kHz]	Result
1070	717	1000	Pass

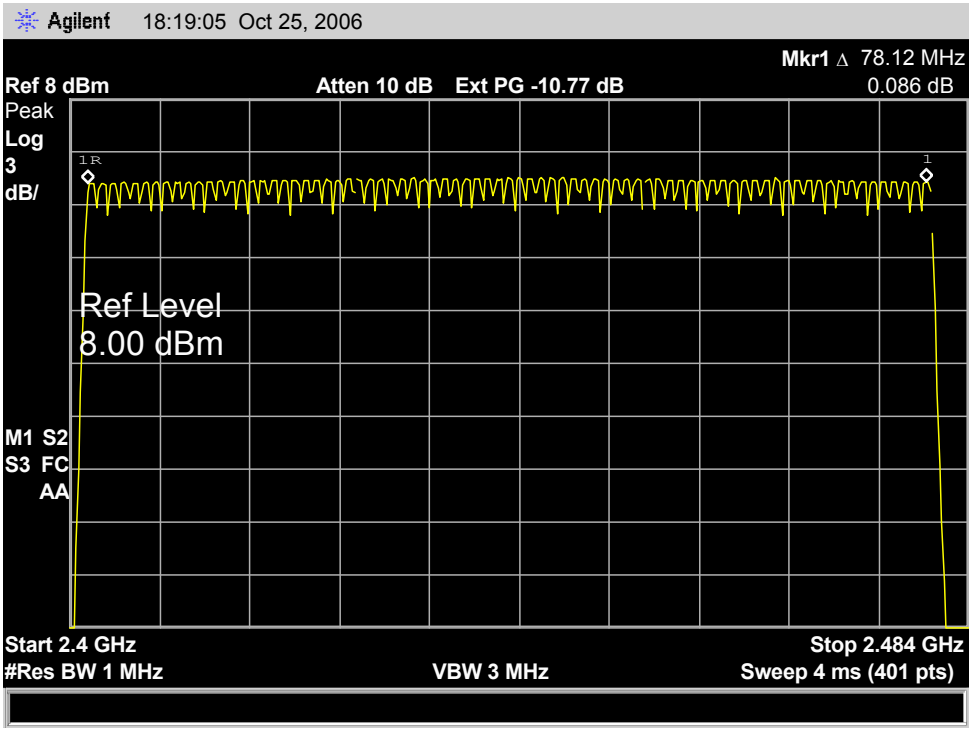
Plot 3.1



3.2. Number of Hopping Channels

Reference document:	**47 CFR §15.247 (a) (1)(iii) & DA 00-705**		
Test Requirements:	Hopping system shall use at least 15 non-overlapping channels.		
Test setup:	See Sec. 2.1	**Pass**	
Operating conditions:	Under normal test conditions		
Method of testing:	Conducted		
S.A. Settings:	RBW: 1MHz, VBW: 3MHz		
Hopping function:	Enabled		
Environment conditions:	Ambient Temperature: 22°c	Relative Humidity: 48%	Atmospheric Pressure: 1011.4 hPa
Test Result:	79 hopping channels	Plot 3.2	

Plot 3.2



3.3. Average Time of Occupancy (Dwell Time)

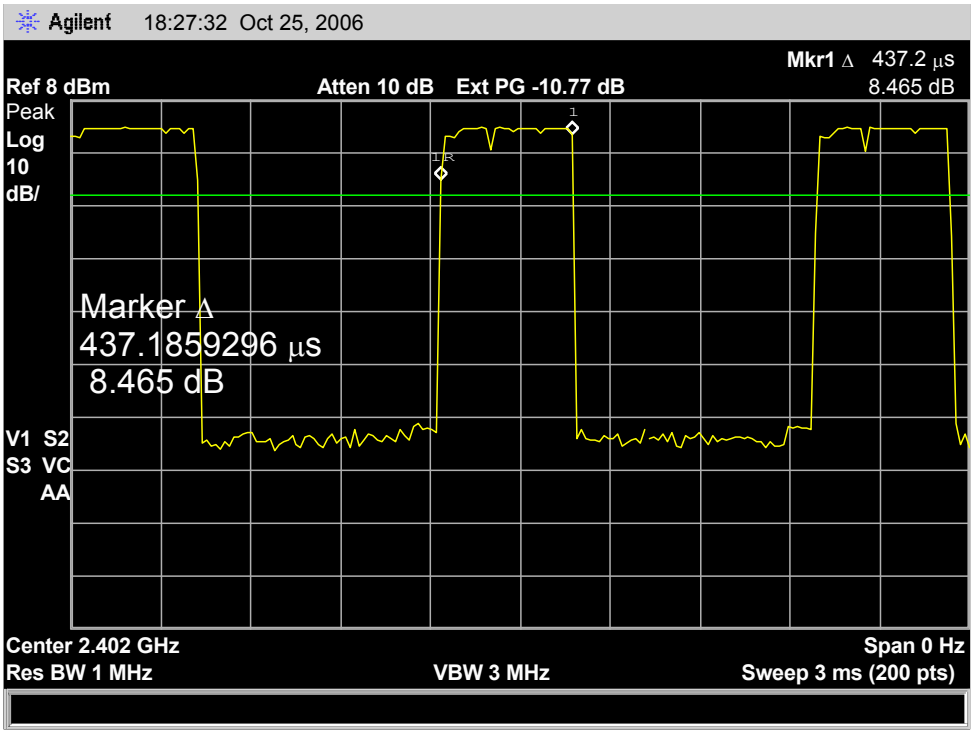
Reference document:	**47 CFR §15.247 (a) (1) (iii) & DA 00-705**		
Test Requirements:	The average time of occupancy on any channel shall not be greater than 0.4seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.		
Test setup:	See Sec. 2.1	**Pass**	
Operating conditions:	Under normal test conditions		
Method of testing:	Conducted		
S.A. Settings:	RBW: 1MHz, VBW: 3MHz, Span:0 centered on hopping channel		
Hopping function:	Disabled		
Environment conditions:	Ambient Temperature: 22°c	Relative Humidity: 48%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 3.3.1– Plot 3.3.3	

Test results:

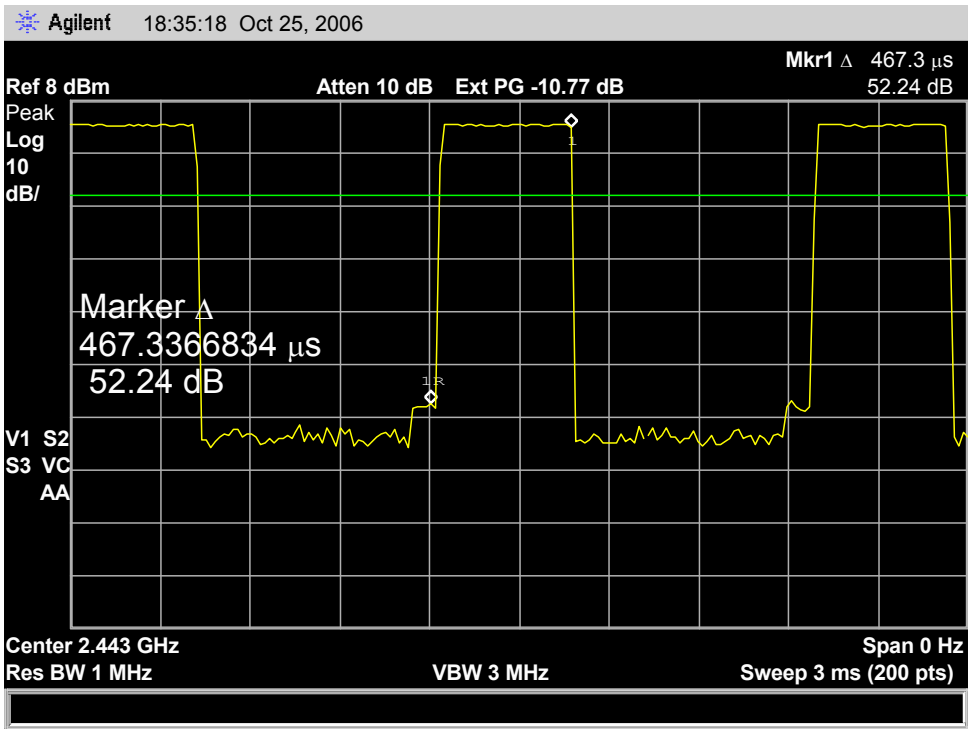
Frequency [GHz]	Time slot length [msec]	Dwell time [Sec]	Limit [Sec]	Result	Reference
2.402	0.4372	0.280	0.4	Pass	Plot 3.3.1
2.443	0.4673	0.300	0.4	Pass	Plot 3.3.2
2.480	0.4523	0.290	0.4	Pass	Plot 3.3.3

Dwell Time = Time Slot Length * Hop Rate/Number of Hopping Channels* Period Time
Period Time= 0.4sec * 79, Hop Rate =1600 1/s

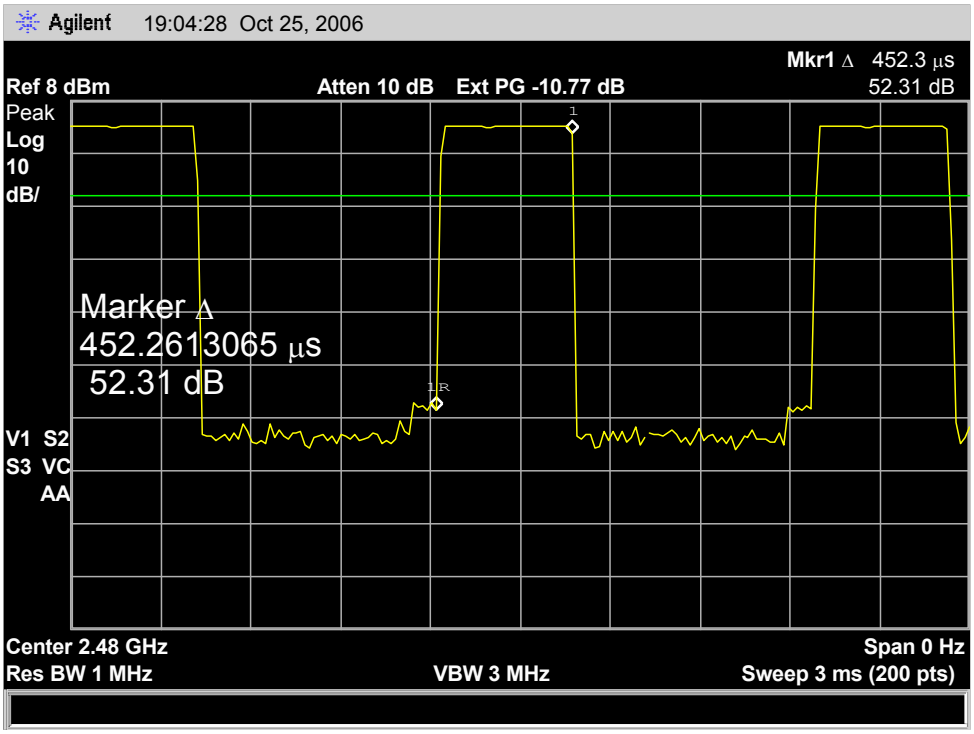
Plot 3.3.1



Plot 3.3.2



Plot 3.3.3


Agilent 19:04:28 Oct 25, 2006
Mkr1 Δ 452.3 µs
52.31 dB
Ref 8 dBm
Atten 10 dB Ext PG -10.77 dB
Peak
Log
10
dB/
Marker Δ
452.2613065 µs
52.31 dB
V1 S2
S3 VC
AA
Center 2.48 GHz
Res BW 1 MHz
VBW 3 MHz
Span 0 Hz
Sweep 3 ms (200 pts)

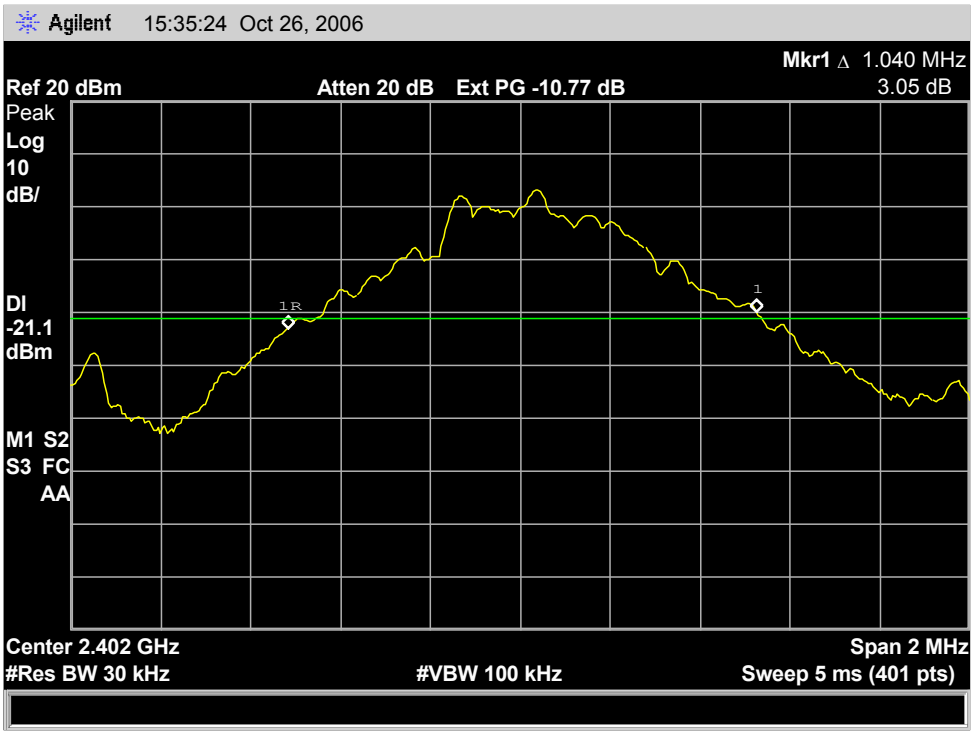
3.4. Maximum 20dB Bandwidth

Reference document:	47 CFR §15.247 (a) (1)(iii) & DA 00-705		
Test Requirements:	Hopping channels carrier frequencies separated by a minimum of 25kHz or 20dB Bandwidth of the hopping channel, whichever is greater.		
Test setup:	See Sec. 2.1	Pass	
Operating conditions:	Under normal test conditions		
Method of testing:	Conducted		
S.A. Settings:	RBW: 30kHz, VBW: 100kHz, Span: 2MHz		
Hopping function:	Disabled		
Environment conditions:	Ambient Temperature: 22°c	Relative Humidity: 48%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 3.4.1 – Plot 3.4.3	

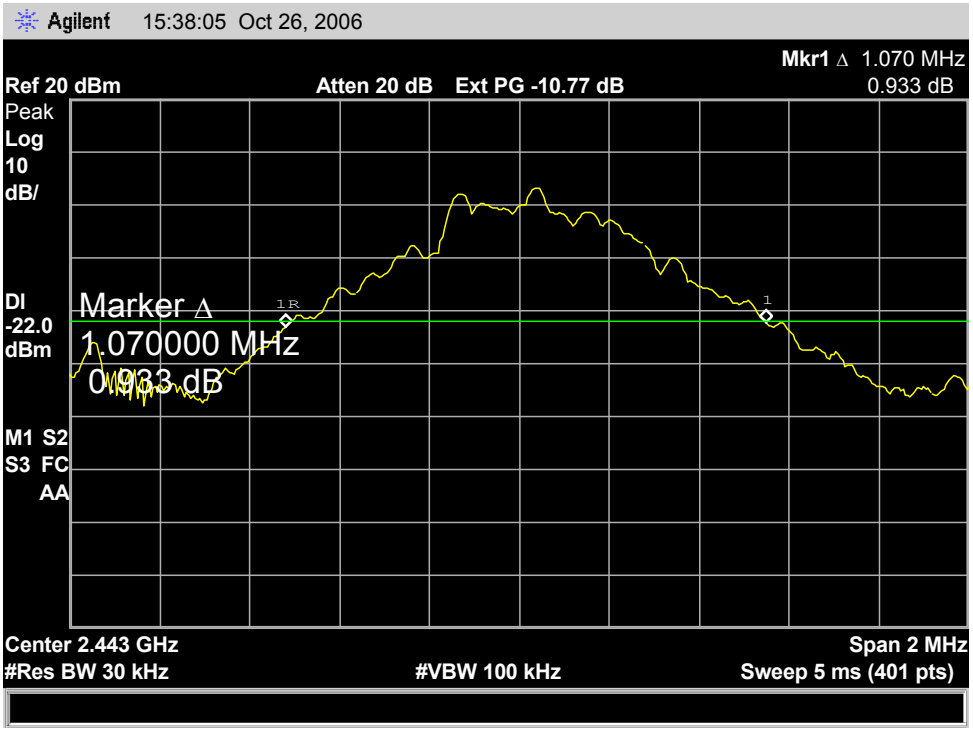
Test results:

Frequency [GHz]	20dB BW [kHz]	Reference
2.402	1040	Plot 3.4.1
2.443	1070	Plot 3.4.2
2.480	1065	Plot 3.4.3

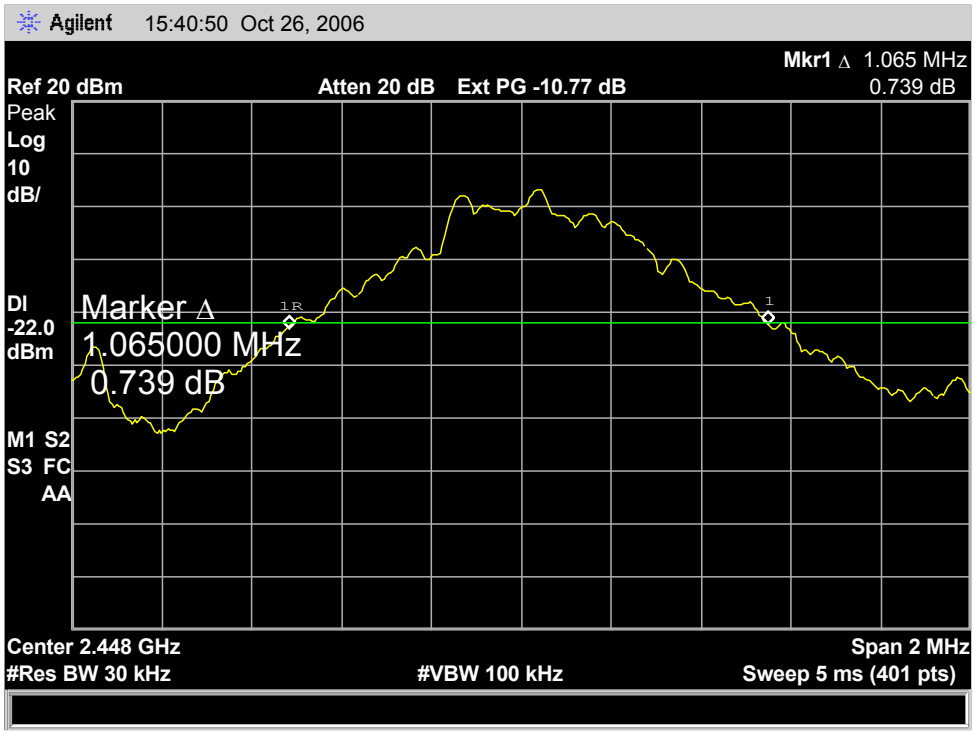
Plot 3.4.1



Plot 3.4.2



Plot 3.4.3


Agilent 15:40:50 Oct 26, 2006
Mkr1 Δ 1.065 MHz
0.739 dB
Ref 20 dBm
Atten 20 dB Ext PG -10.77 dB
Peak
Log
10
dB/
Dl
-22.0
dBm
Marker Δ
1.065000 MHz
0.739 dB
M1 S2
S3 FC
AA
Center 2.448 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 2 MHz
Sweep 5 ms (401 pts)

3.5. Maximum Peak Output Power

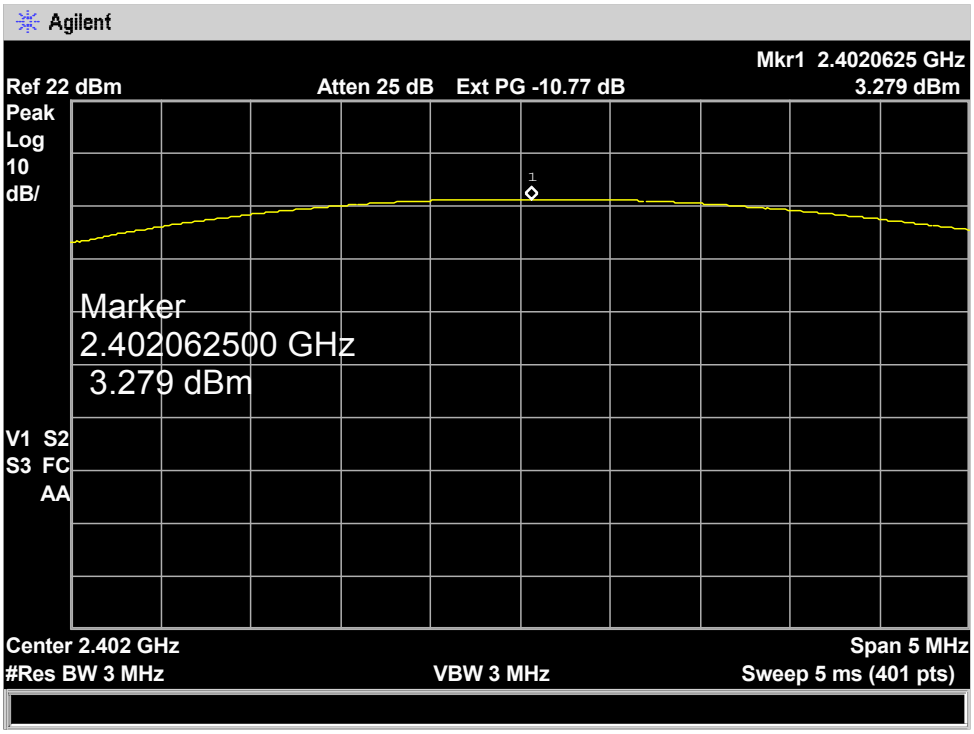
Reference document:	**47 CFR §15.247 (b) (1) & DA 00-705**		
Test Requirements:	The maximum peak output power shall not exceed 1Watt (30dBm)		
Test setup:	See Sec. 2.1	**Pass**	
Operating conditions:	Under normal test conditions		
Method of testing:	Conducted		
S.A. Settings:	RBW: 3MHz, VBW: 3MHz,		
Hopping function:	Disabled		
Environment conditions:	Ambient Temperature: 22°c	Relative Humidity: 48%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 3.5.1 – Plot 3.5.3	

Test results:

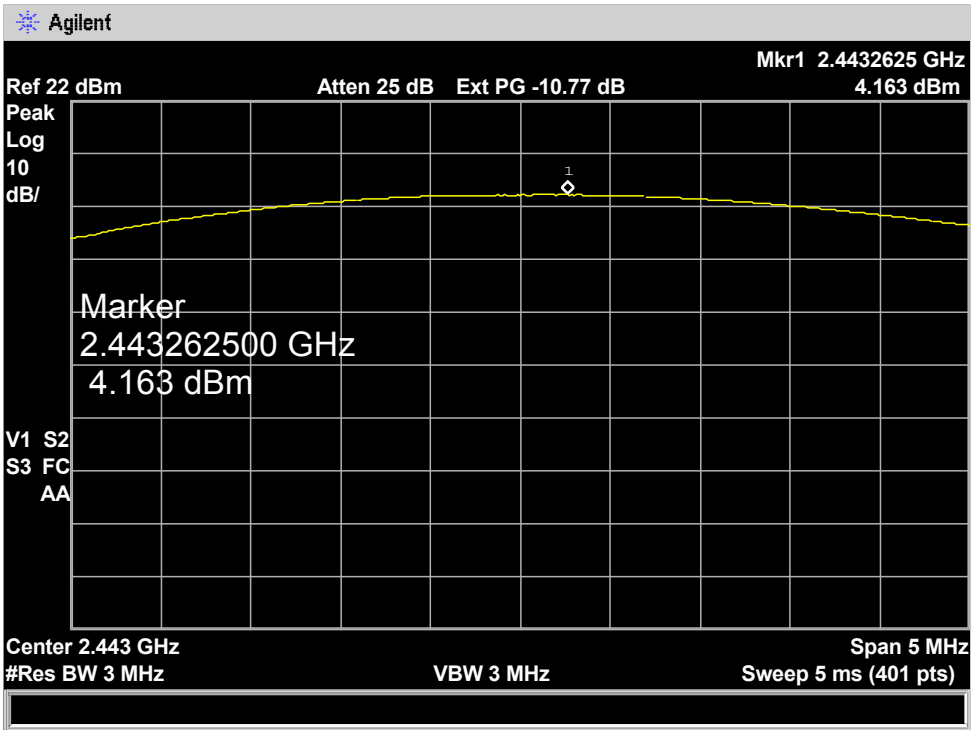
Frequency [GHz]	Max. Peak Output power* [dBm]	Max. Peak Output power* [mW]	Reference	Result
2.402	3.279	2.122	Plot 3.5.1	Pass
2.443	4.163	2.212	Plot 3.5.2	Pass
2.480	4.334	2.214	Plot 3.5.3	Pass

*Corrected for external attenuations

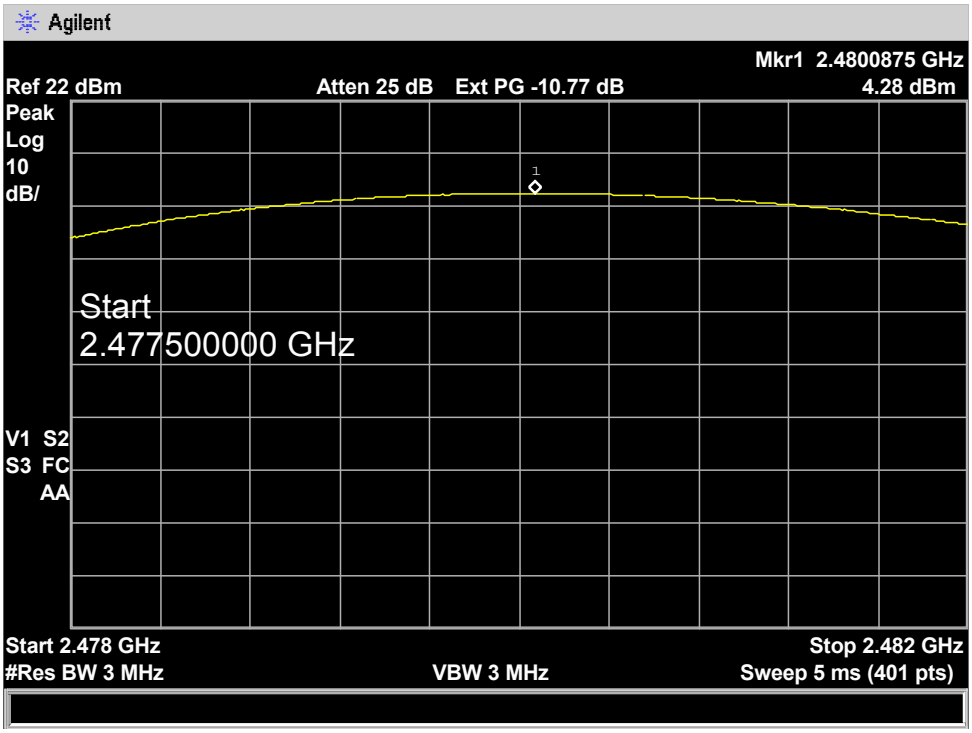
Plot 3.5.1



Plot 3.5.2



Plot 3.5.3


Agilent
Mkr1 2.4800875 GHz
Ref 22 dBm
Atten 25 dB Ext PG -10.77 dB
4.28 dBm
Peak
Log
10
dB/
Start
2.477500000 GHz
V1 S2
S3 FC
AA
Start 2.478 GHz
#Res BW 3 MHz
VBW 3 MHz
Stop 2.482 GHz
Sweep 5 ms (401 pts)

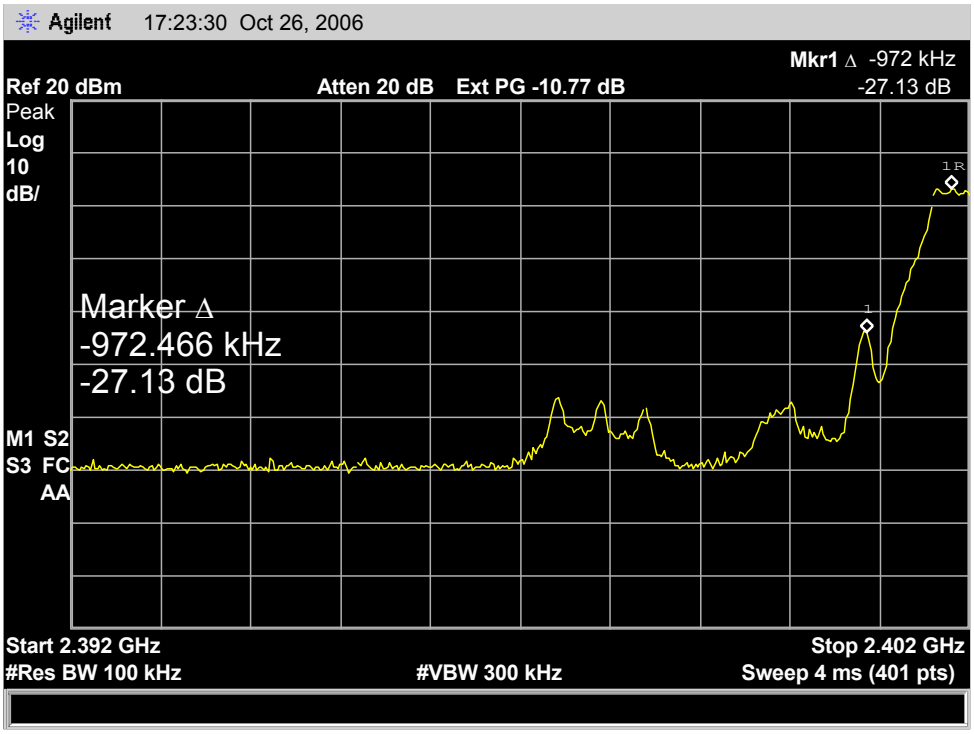
3.6. Band-edge compliance of RF Conducted Emission

Reference document:	**47 CFR §15.247 (d) & DA 00-705**		
Test Requirements and limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum is operating, the radio frequency power that is produced by the intentional radiator shall be **at least 20 dB below** that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a) (See section 15.205(c).		
Test setup:	See Sec. 2.1	**Pass**	
Operating conditions:	Under normal test conditions		
Method of testing:	Conducted		
S.A. Settings:	RBW: 100kHz, VBW: 100kHz		
Hopping function:	Disabled/Enabled		
Environment conditions:	Ambient Temperature: 22°c	Relative Humidity: 48%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 3.6.1 – Plot 3.6.4	

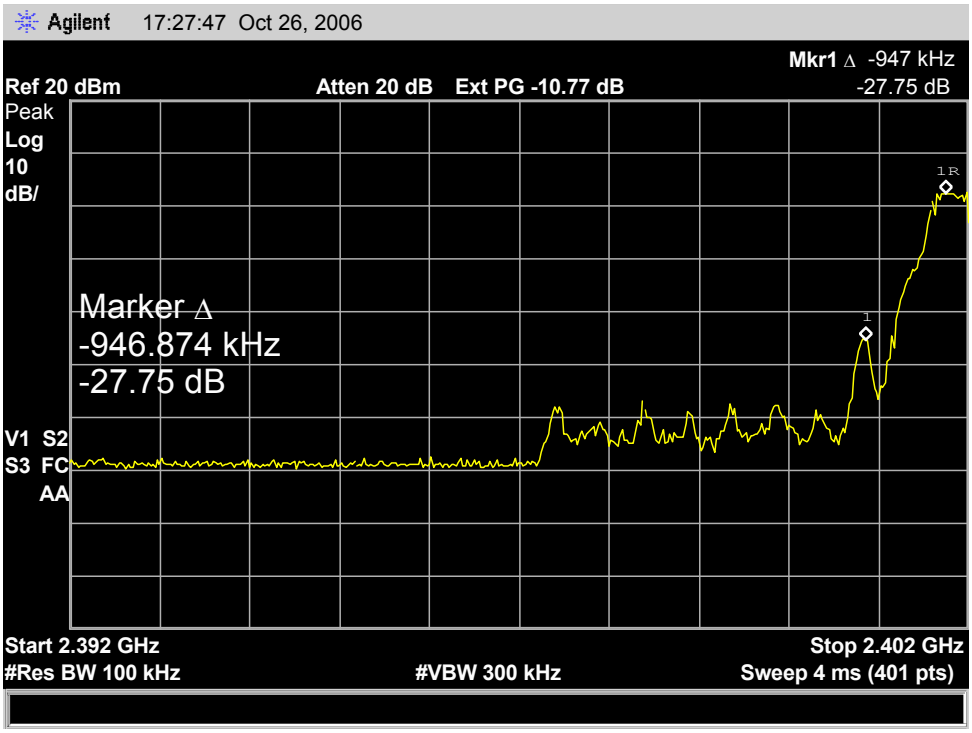
Test results

Activity	Measured emission [dBc]	Limit [dBc]	Reference	Result
Hopping off, lowest frequency	At least –30 dBc	-20	Plot 3.6.1	Pass
Hopping on, lowest frequency	At least –30 dBc	-20	Plot 3.6.2	Pass
Hopping off, highest frequency	At least –30 dBc	-20	Plot 3.6.3	Pass
Hopping on, highest frequency	At least –30 dBc	-20	Plot 3.6.4	Pass

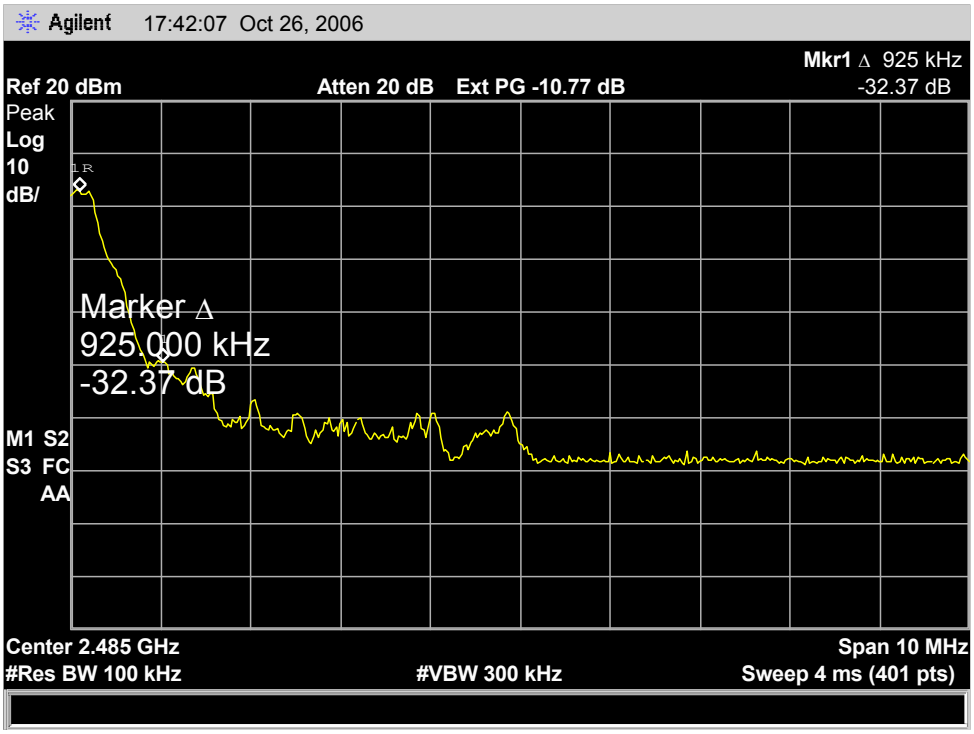
Plot 3.6.1



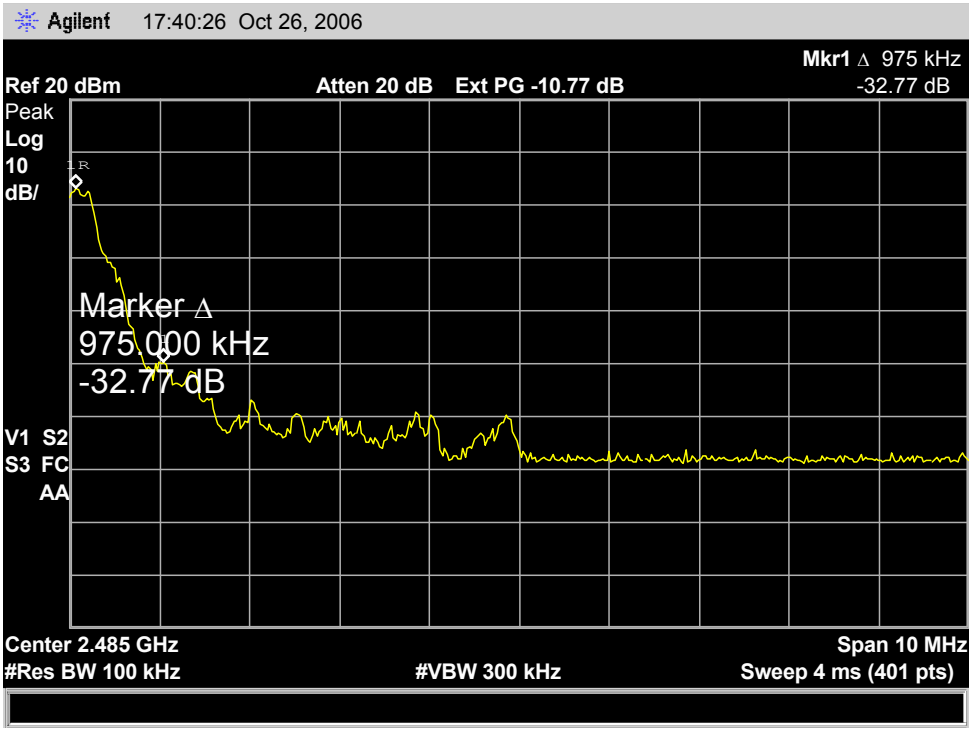
Plot 3.6.2



Plot 3.6.3



Plot 3.6.4



3.7. Spurious RF Conducted Emission

Reference document:	**47 CFR §15.247 (d) & DA 00-705**		
Test Requirements:	In any 100 kHz bandwidth outside the frequency band at least 20 dB below the highest level of the desired power.		
Test setup:	See Sec. 2.1	**Pass**	
Operating conditions:	Under normal test conditions		
Method of testing:	Conducted		
S.A. Settings:	RBW: 100kHz, VBW: 100kHz,		
Hopping function:	Disabled (lowest, middle, and highest)		
Environment conditions:	Ambient Temperature: 22°c	Relative Humidity: 48%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 3.7.1 – Plot 3.7.3	

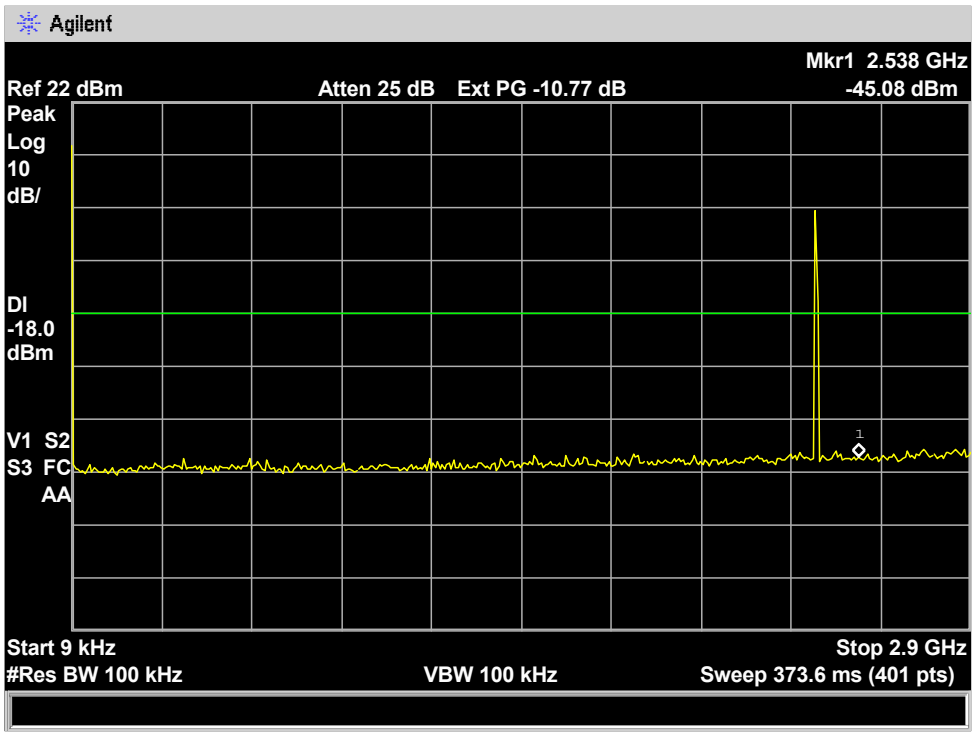
Test results:

Frequency [GHz]	Spurious Frequency [GHz]	Measured [dBc]	Emissions limit	Reference	Result
2.402	-	At least -40dBc	-20dBc	Plot 3.7.1 - Plot 3.7.2	Pass
2.443	-	At least - 40dBc		Plot 3.7.3 - Plot 3.7.4	Pass
2.480	-	At least -40dBc		Plot 3.7.5 - Plot 3.7.6	Pass

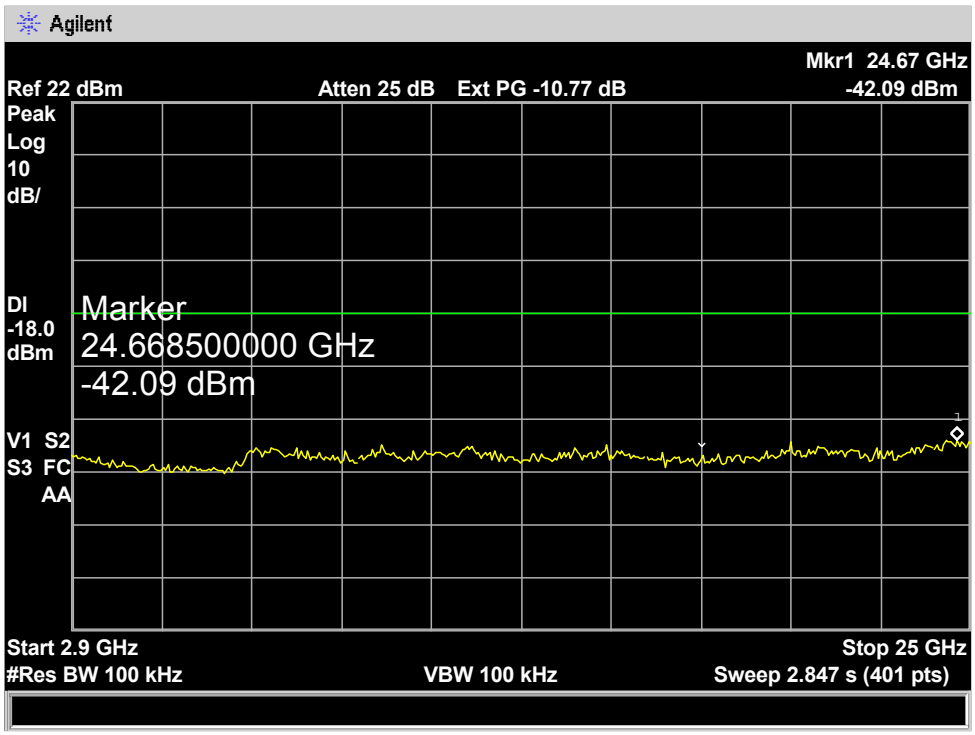
Sec. 3.7 Spurious Emission- Conducted

Low frequency

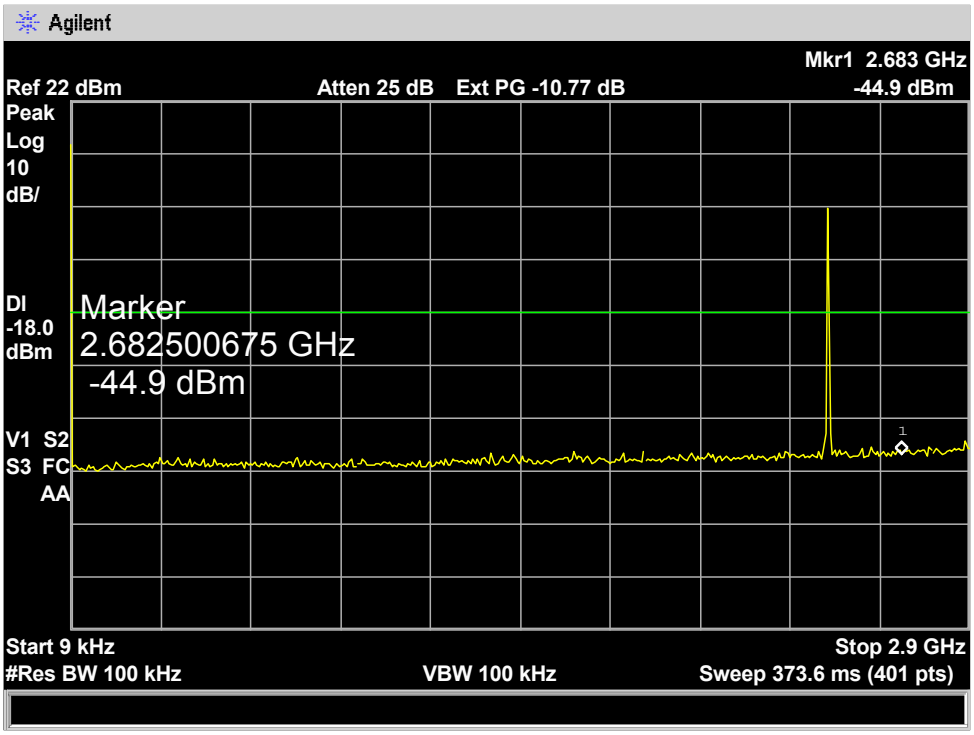
Plot 3.7.1



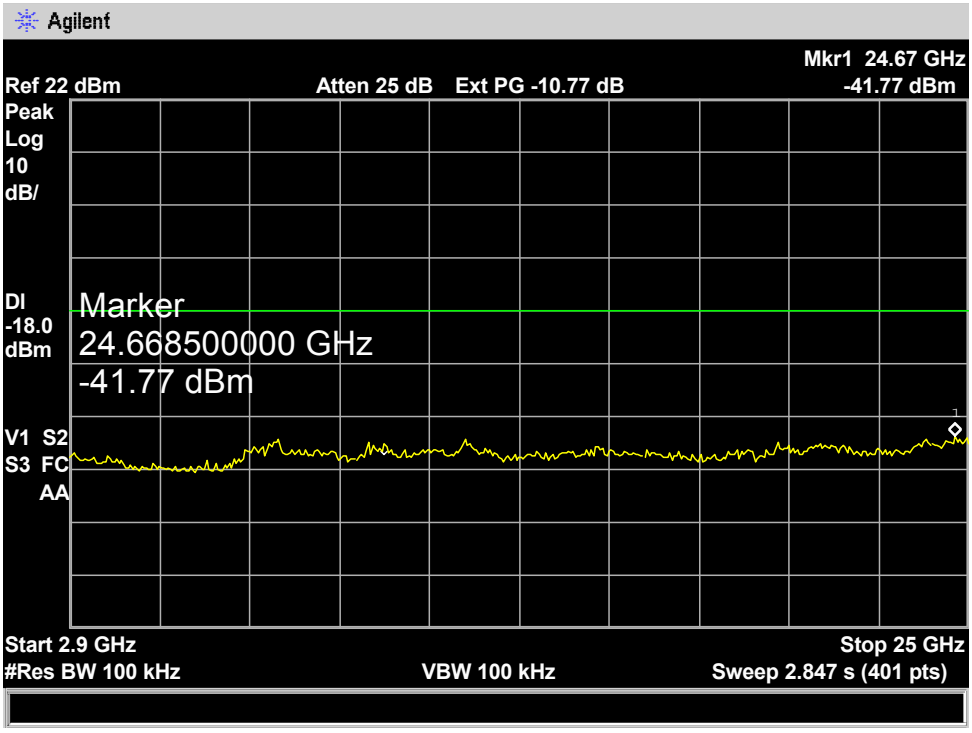
Plot 3.7.2



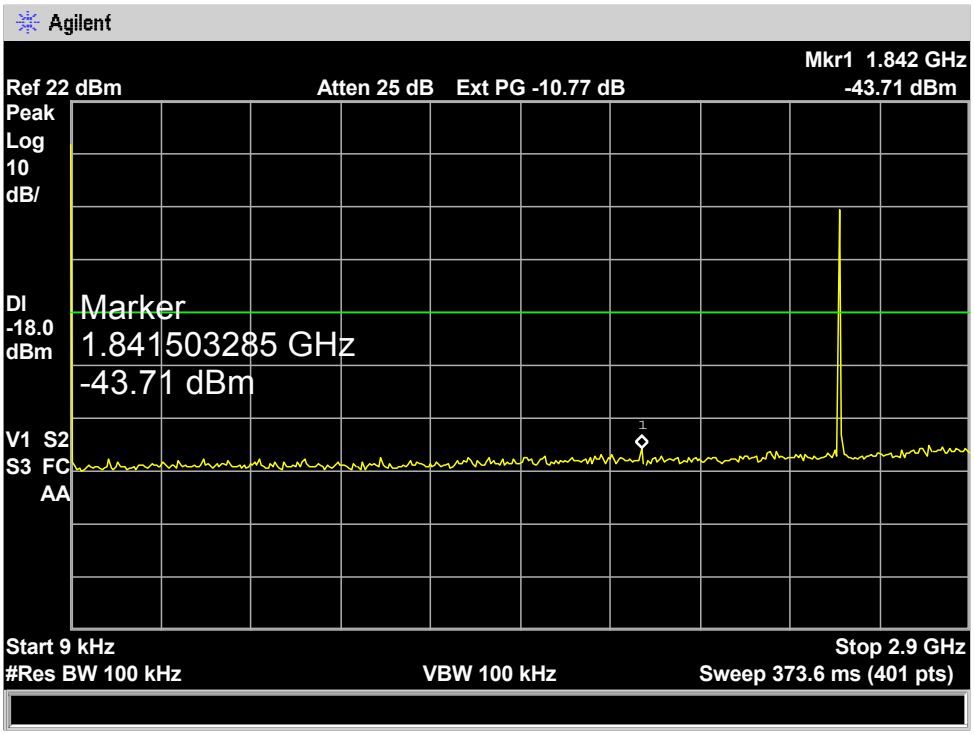
Middle frequency
Plot 3.7.3



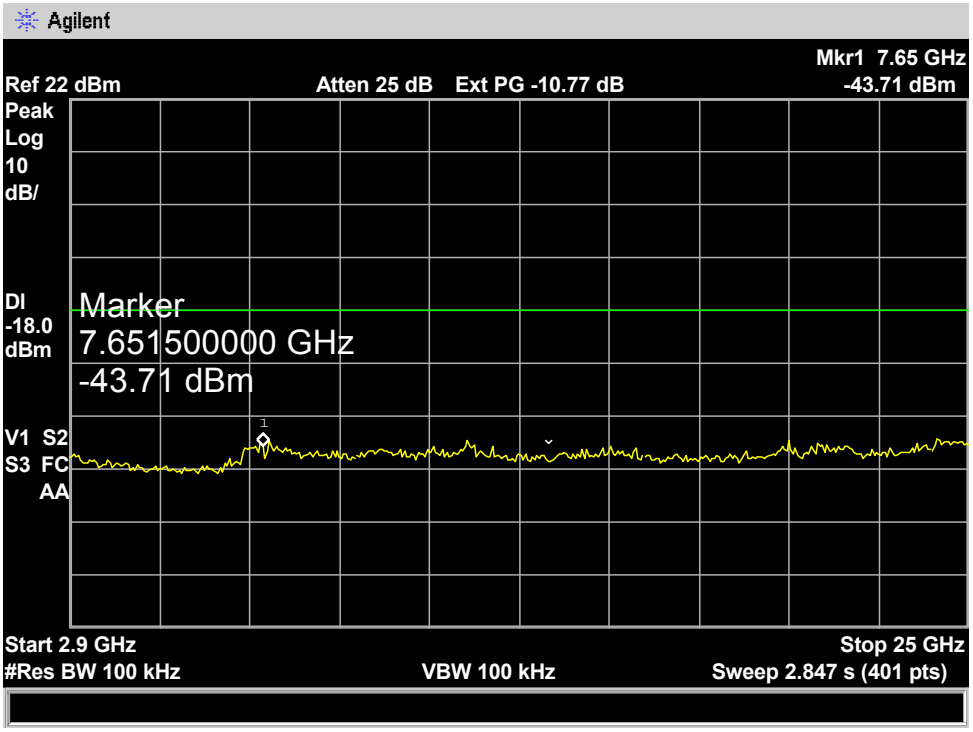
Plot 3.7.4



High frequency
Plot 3.7.5



Plot 3.7.6



3.8. Spurious Radiated Emissions, Restricted Bands

Reference document:	**47 CFR §15.205 & DA 00-705**		
Test Requirements:	Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a) (See section 15.205(c).		
Test setup:	See Sec. 2.2	**Pass**	
Operating conditions:	Under normal test conditions		
Method of testing:	Radiated		
S.A. Settings:	f <1GHz: RBW: 120kHz,VBW: 1MHz f >1GHz: RBW: 1MHz, VBW: 3MHz		
Hopping function:	Disabled		
Environment conditions:	Ambient Temperature: 22°c	Relative Humidity: 48%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plot 3.8.1 – Plot 3.8.12 & Appendix A	

Test results:

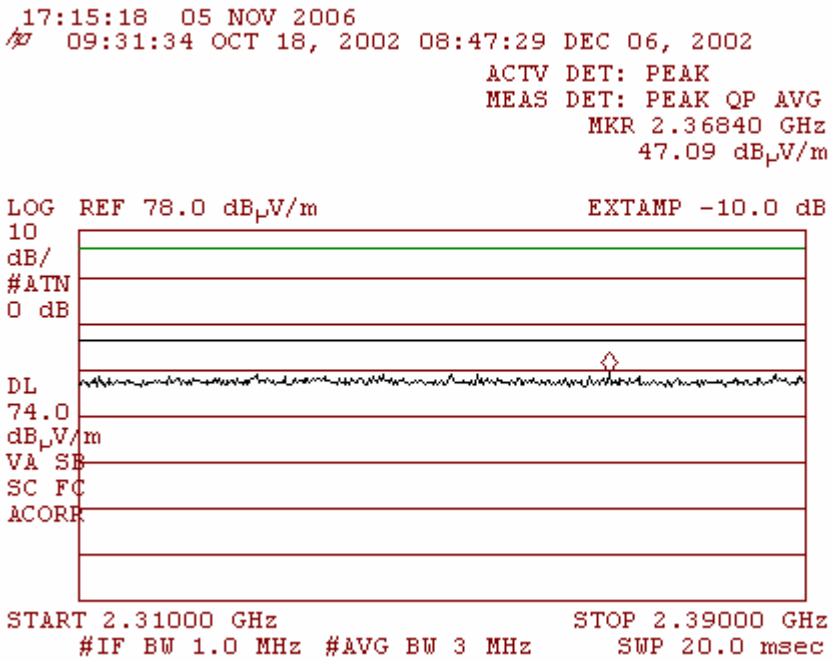
All measurements were done in horizontal and vertical polarizations; the results show the worst case

Lowest channel, 2402 MHz					
Spurious Frequency [MHz]	Detector type	Spurious level [dBµV/m]	Limit [dBµV/m]	Reference Plot	Result
2386.2	Average	32.5	54	Plot 3.8.2	Pass
2368.4	Peak	47.09	74	Plot 3.8.1	Pass
4804	Average	33.57	54	Appendix A Plot 2	Pass
4804	Peak	46.73	74	Appendix A Plot 2	Pass

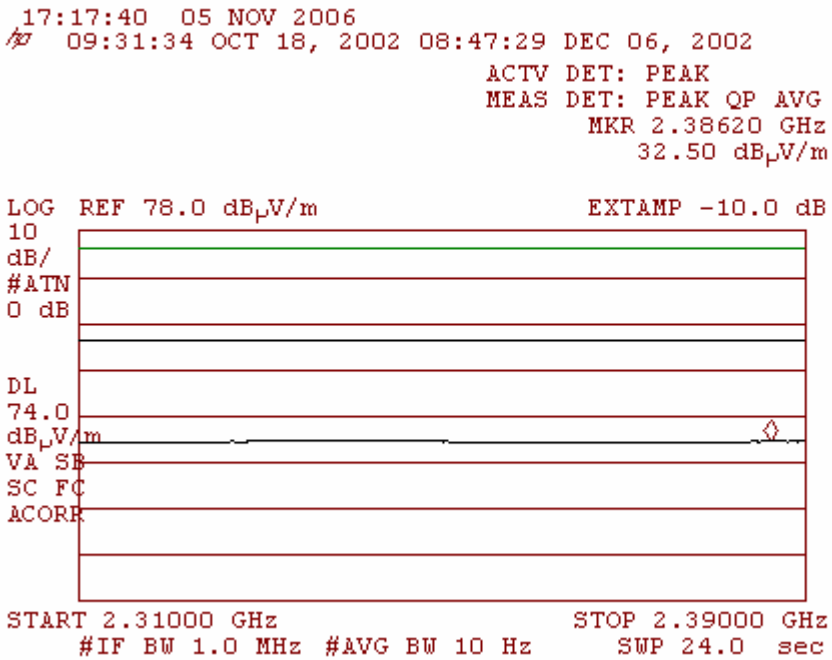
Middle channel, 2443 MHz					
Spurious Frequency [MHz]	Detector type	Spurious level [dBµV/m]	Limit [dBµV/m]	Reference Plot	Result
4886	Average	32.85	54	Appendix A Plot 8	Pass
4886	Peak	45.60	74	Appendix A Plot 8	Pass

Highest channel, 2480 MHz					
Spurious Frequency [MHz]	Detector type	Spurious level [dBµV/m]	Limit [dBµV/m]	Reference Plot	Result
2483.5	Average	35.71	54	Plot 3.8.8	Pass
2484.86	Peak	53.96	74	Plot 3.8.7	Pass
4960	Average	41.89	54	Appendix A Plot 14	Pass
4960	Peak	44.99	74	Appendix A Plot 14	Pass

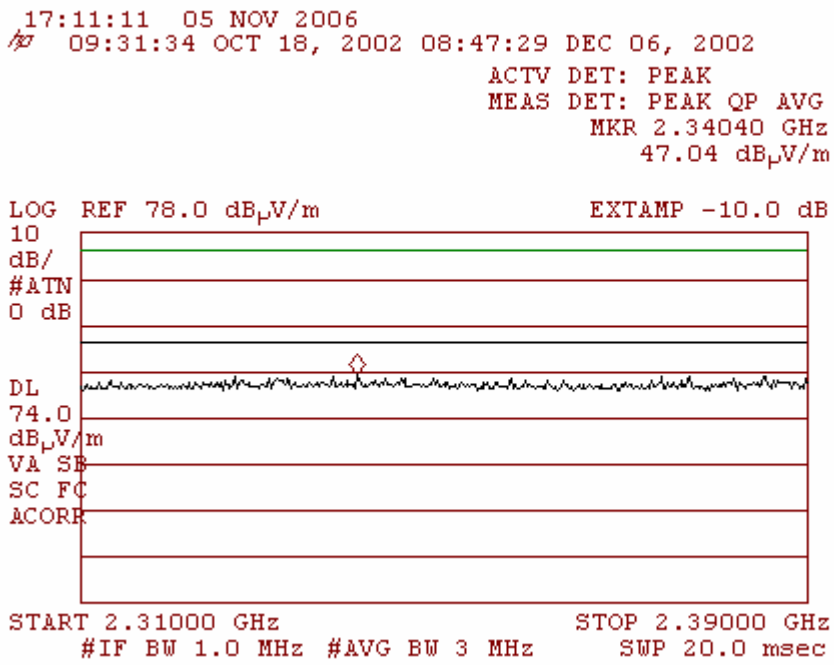
Single mode Lowest Frequency
Vertical Polarization
Peak
Plot 3.8.1



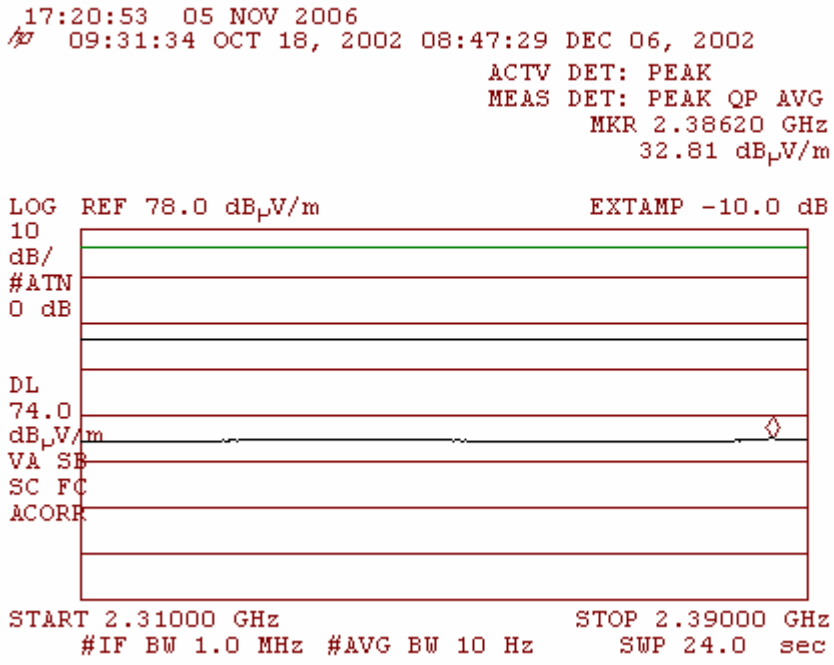
Average
Plot 3.8.2



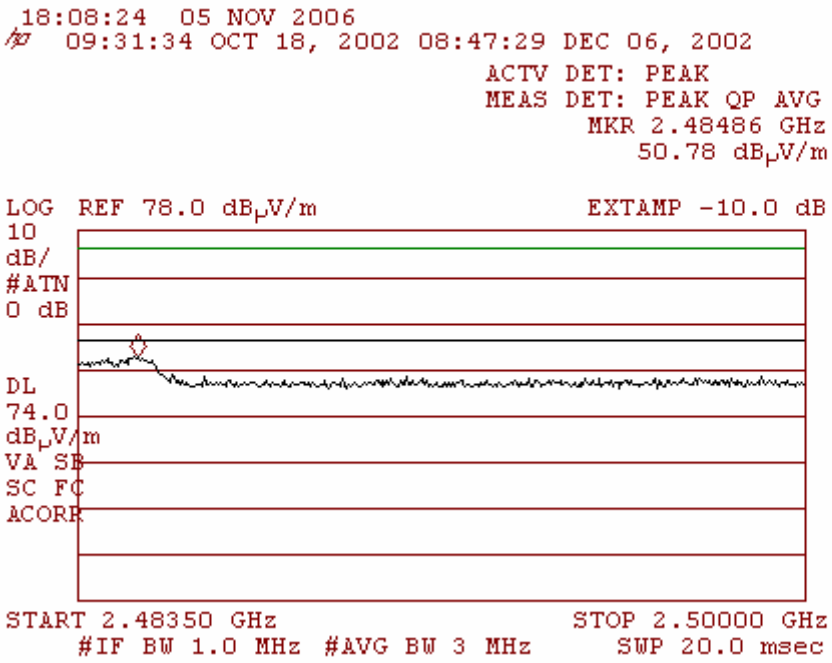
Single mode Lowest Frequency
Horizontal Polarization
Peak
Plot 3.8.3



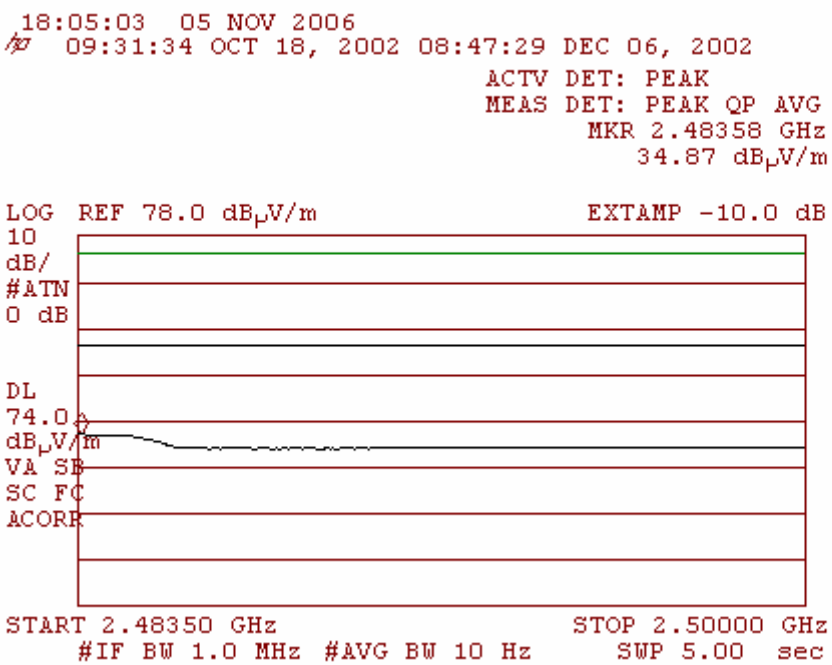
Average
Plot 3.8.4



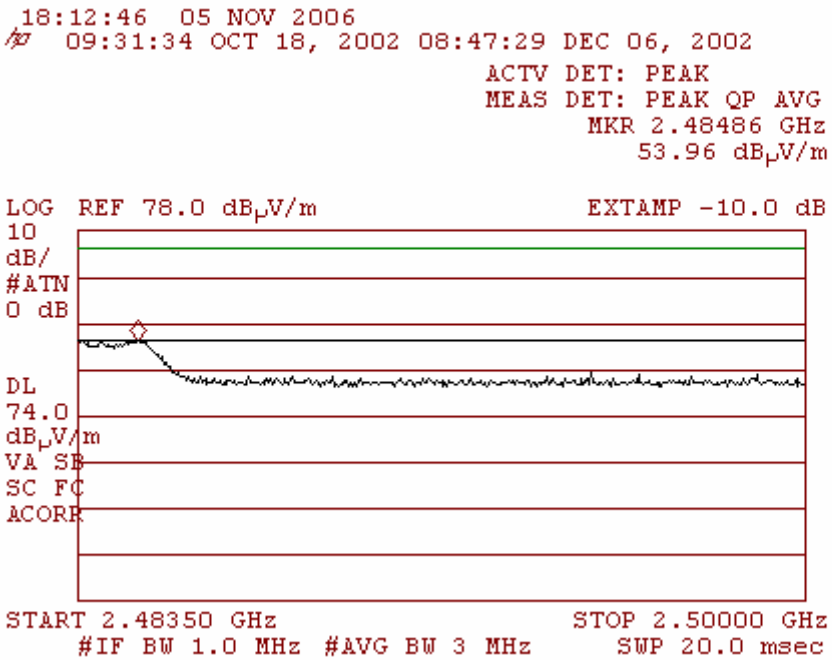
Single mode Highest Frequency
Vertical Polarization
Peak
Plot 3.8.5



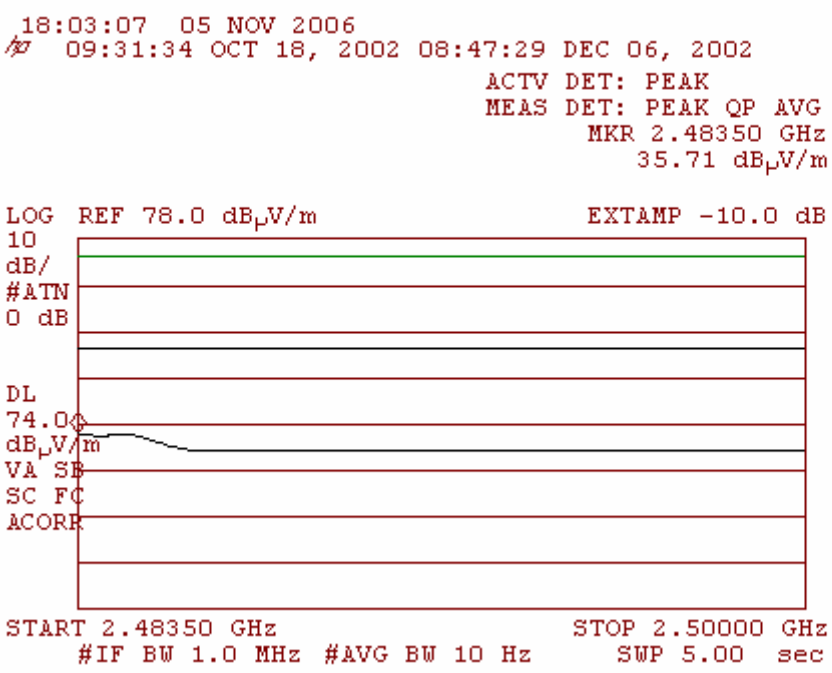
Average
Plot 3.8.6



Single mode Highest Frequency
Horizontal Polarization
Peak
Plot 3.8.7



Average
Plot 3.8.8



4. Unintentional Radiated Emission- (Receive mode)

Reference document:	**47 CFR §15.109**		
Test Requirements:	Emission Level shall not exceed §15.109 limits		
Test setup:	See Sec. 2.3	**Pass**	
Operating conditions:	Under normal test conditions		
Method of testing:	Radiated		
S.A. Settings:	F <1GHz: RBW: 120kHz,VBW: 1MHz F >1GHz: RBW: 1MHz, VBW: 3MHz		
Mode of operation:	Receive		
Environment conditions:	Ambient Temperature: 22°c	Relative Humidity: 48%	Atmospheric Pressure: 1011.4 hPa
Test Result:	All readings were at least 10 db below the limit	Appendix B	

5. Antenna Connector Requirements

Reference document:	**47 CFR §15.203**	
Test Requirements:	An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with provisions of this section.	
Test Result:	The EUT employs a unique I-PEX connector type.	Pass

6. Power line Emission measurements

Reference document:	**47 CFR §15.107**		
Test Requirements:	The radio frequency voltage that is conducted back onto the AC power line shall not exceed the limits specified in §15.107 &§15.207		
Test setup:	See Sec. 2.4	**Pass**	
Operating conditions:	Under normal test conditions		
Method of testing:	Conducted		
S.A. Settings:	f <30MHz: RBW: 9kHz, VBW:30kHz		
Environment conditions:	Ambient Temperature: 21°c	Relative Humidity: 54%	Atmospheric Pressure: 1011.4 hPa
Test Result:	See below	See Plots 6.1 – 6.2	

Test Results:

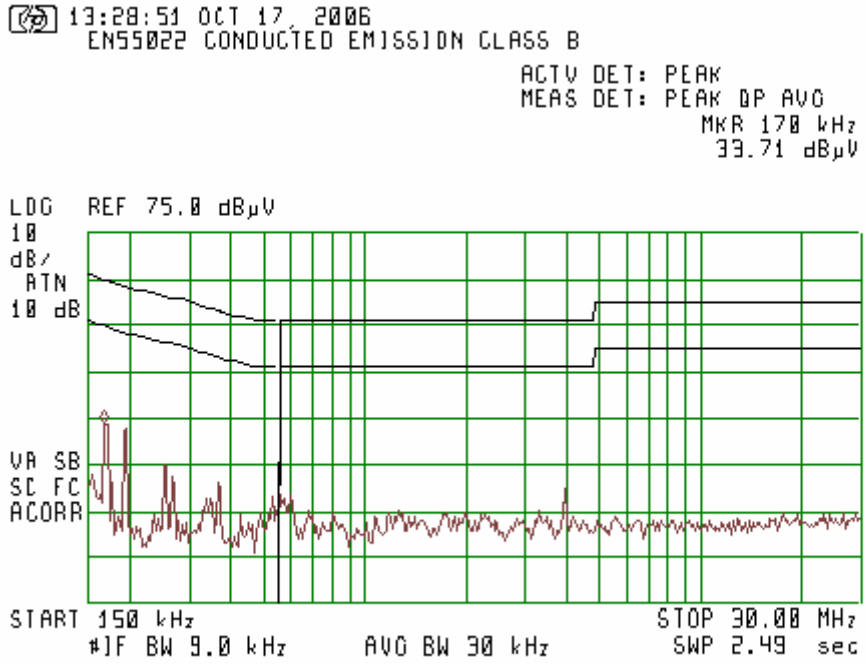
"Phase" Lead, 110 VAC

Frequency [MHz]	Measured Result [dBµV]		Class B Limits [dBµV]		Margin [dB]		Pass/Fail
	QP	AVR	QP	AVR	QP	AVR	
0.168246	32.7	16.7	65.05	55.05	-32.35	-38.35	Pass
0.186786	29.9	13.5	64.18	54.18	-34.28	-40.68	Pass
0.206845	27.7	11.4	63.33	53.33	-35.63	-41.93	Pass
0.241788	25.6	11.1	62.03	52.03	-36.43	-40.93	Pass
0.351594	17.8	8.8	58.92	48.92	-41.12	-40.12	Pass
0.629704	19	14.5	56.00	46.00	-37.00	-31.50	Pass

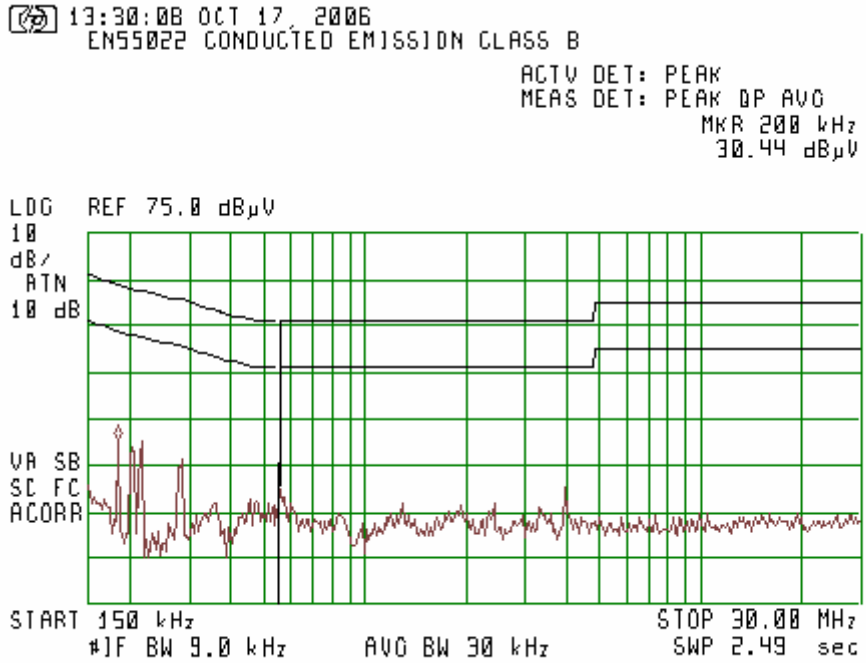
"Neutral" Lead, 110 VAC

Frequency [MHz]	Measured Result [dBµV]		Class B Limits [dBµV]		Margin [dB]		Pass/Fail
	QP	AVR	QP	AVR	QP	AVR	
0.168246	32.4	16.6	65.05	55.05	-32.65	-38.45	Pass
0.186786	30.4	14.9	64.18	54.18	-33.78	-39.28	Pass
0.206845	27.6	9.4	63.33	53.33	-35.73	-43.93	Pass
0.241788	24	8	62.03	52.03	-38.03	-44.03	Pass
0.351594	18.1	8.7	58.92	48.92	-40.82	-40.22	Pass
0.629704	18.9	14	56.00	46.00	-37.10	-32.00	Pass

Plot 6.1
Power Supply port
150kHz – 30MHz
"Phase" Lead



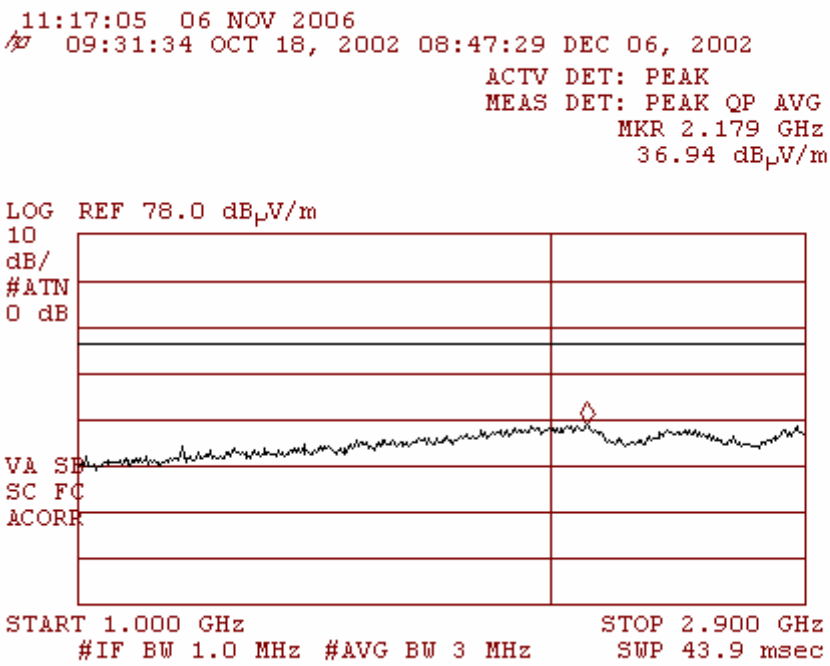
Plot 6.2
Power Supply port
150kHz – 30MHz
"Neutral" Lead



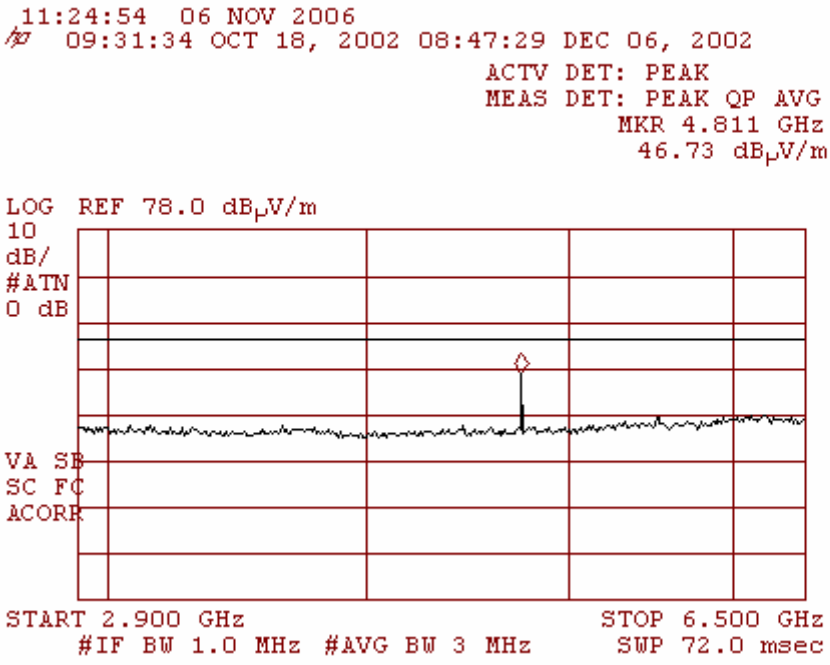
7. Appendix

Appendix A: Spurious emissions test plots

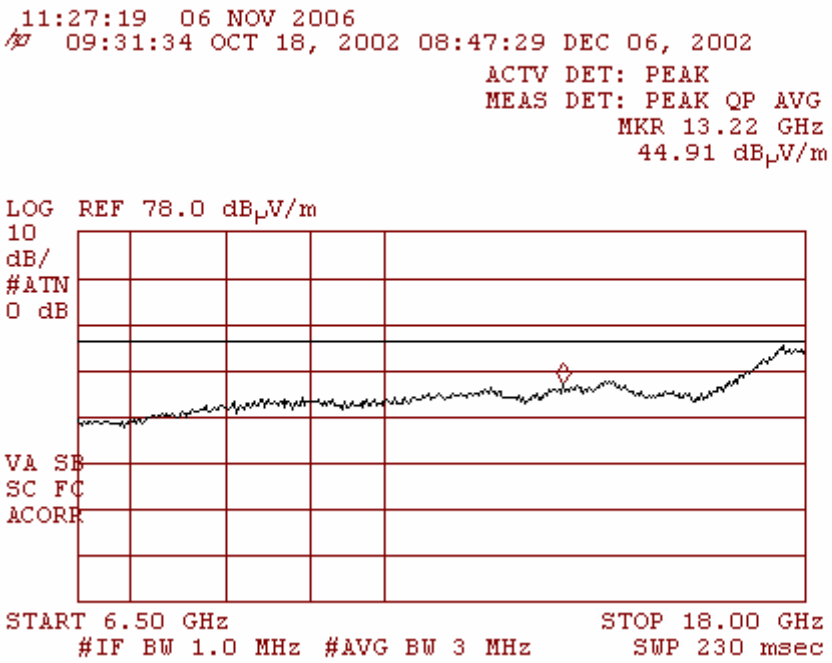
Bluetooth (2402 MHz)
Lowest frequency
Horizontal & Vertical Polarization
Plot 1



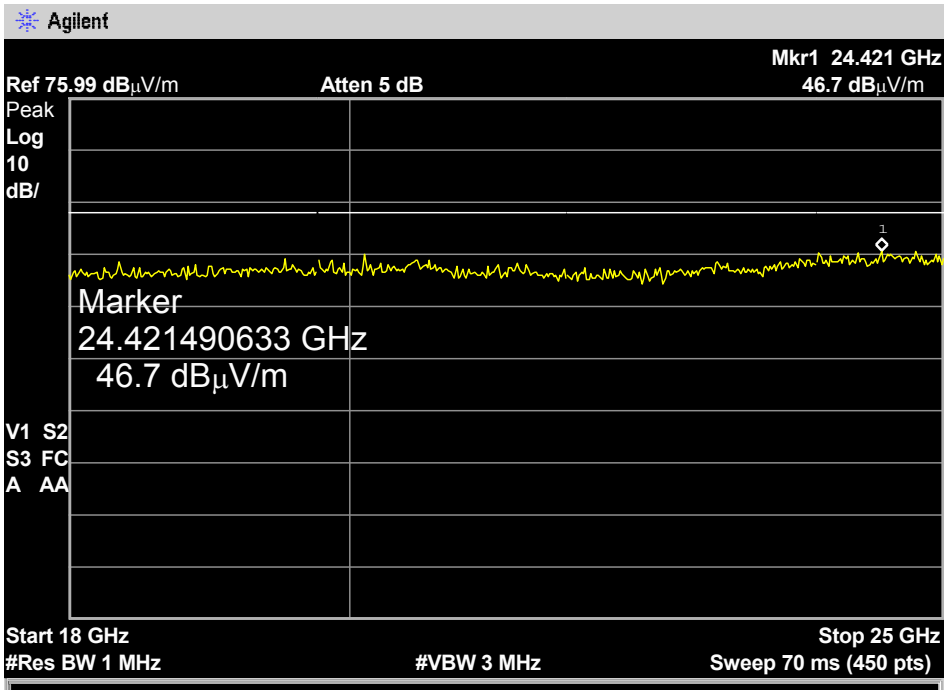
Horizontal & Vertical Polarization
Plot 2



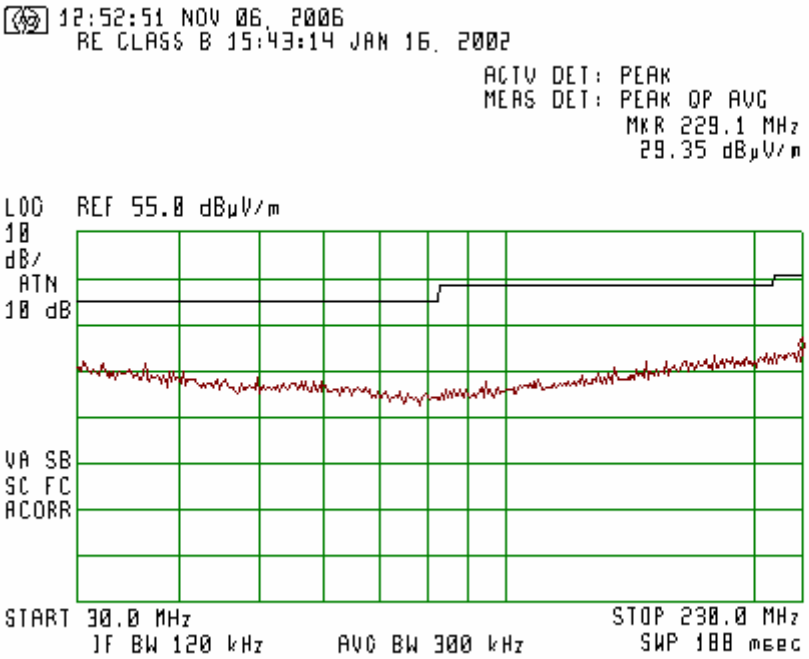
Horizontal & Vertical Polarization
Plot 3



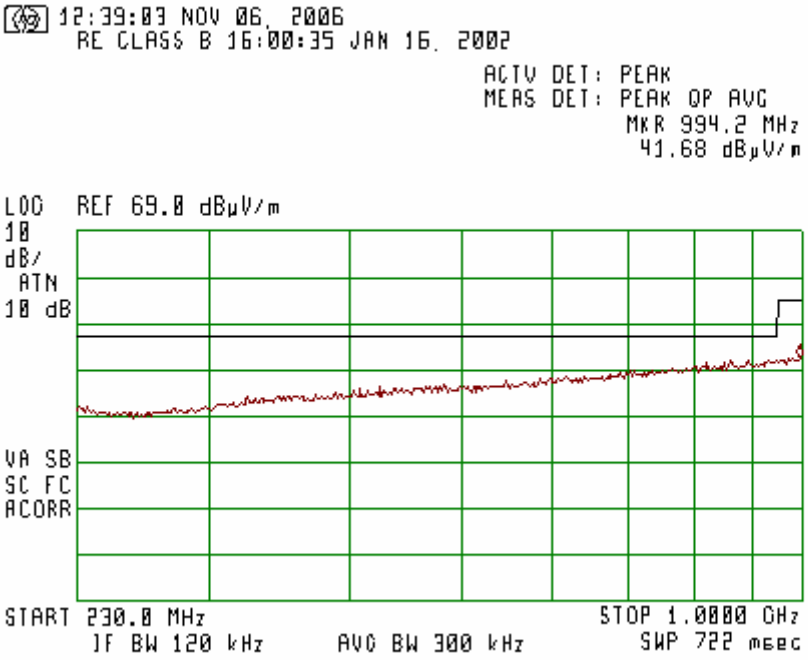
Horizontal & Vertical Polarization
Plot 4



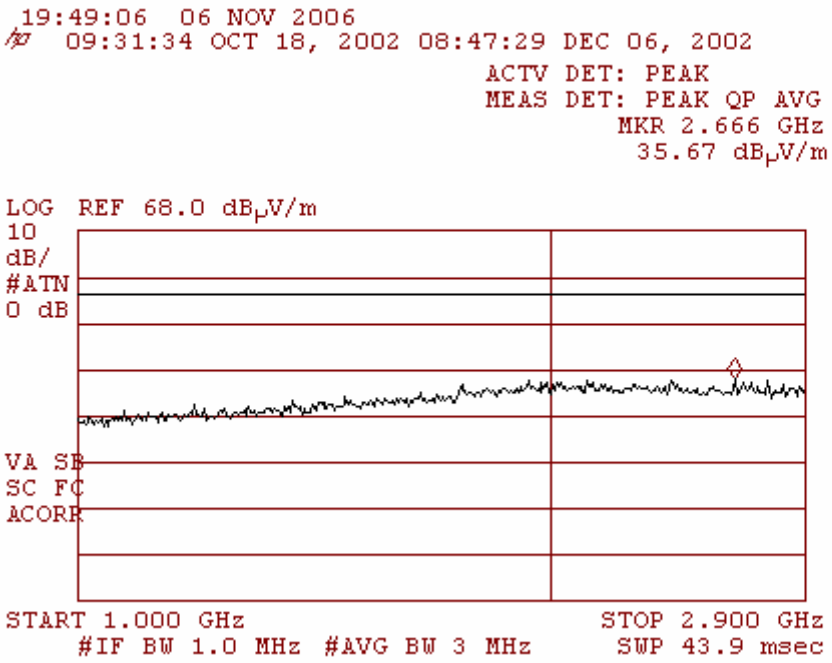
Horizontal & Vertical Polarization
Plot 5



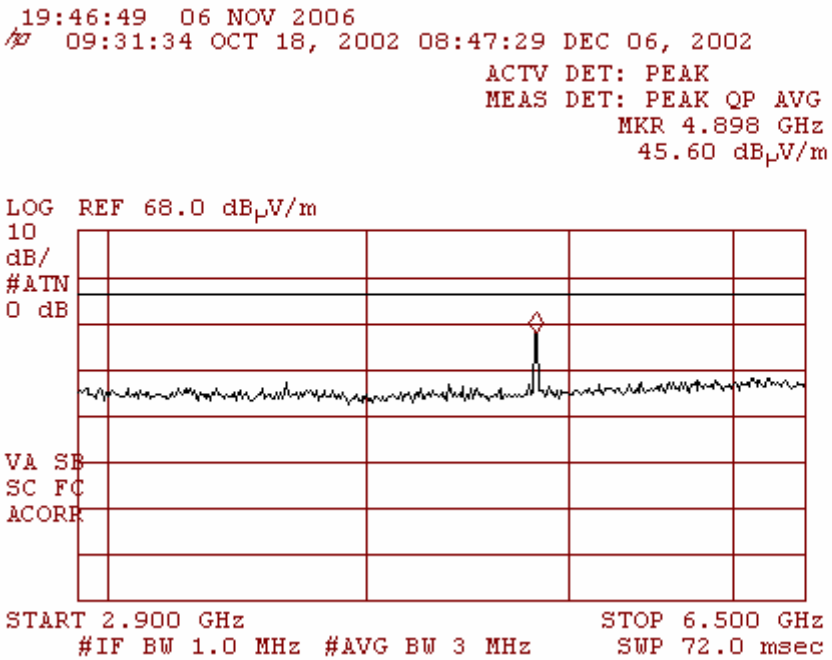
Horizontal & Vertical Polarization
Plot 6



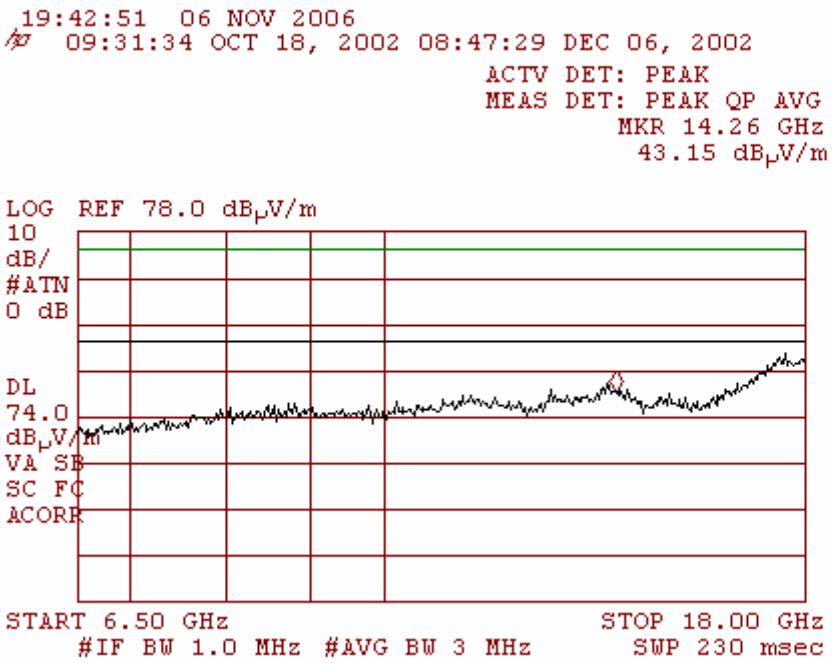
Bluetooth (2443 MHz)
Middle frequency
Horizontal & Vertical Polarization
Plot 7



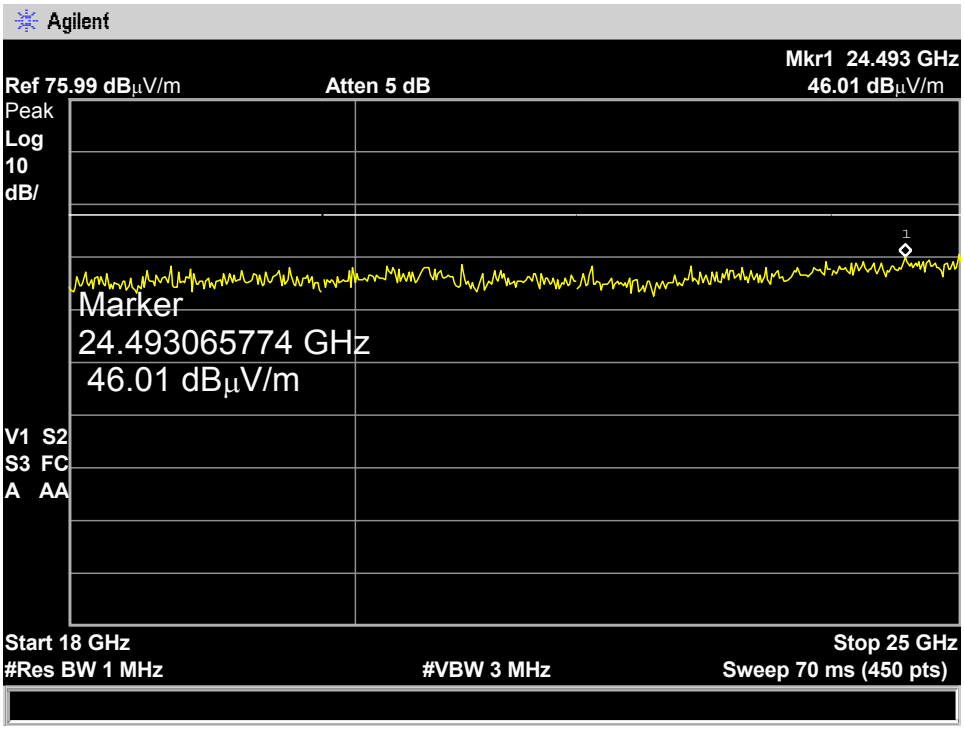
Horizontal & Vertical Polarization
Plot 8



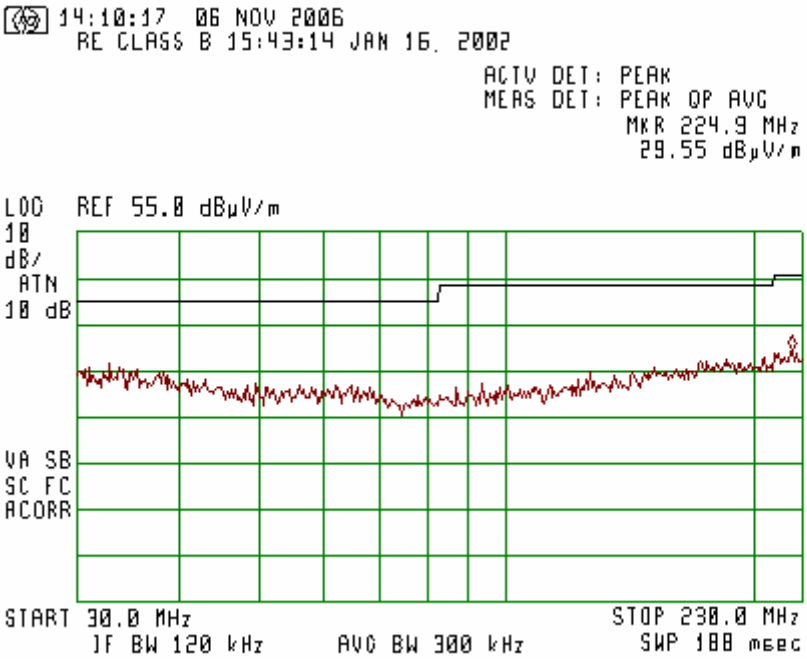
Horizontal & Vertical Polarization
Plot 9



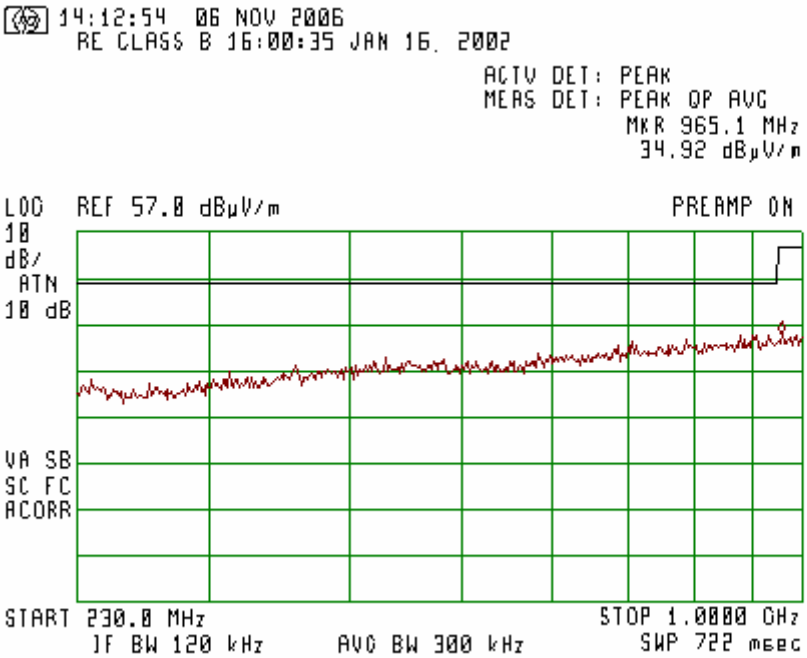
Horizontal & Vertical Polarization
Plot 10



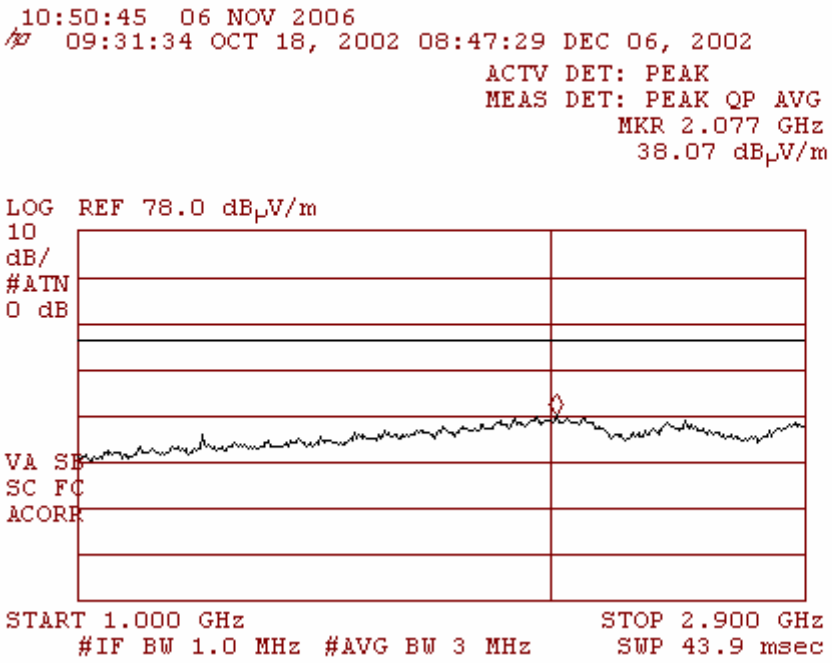
Horizontal & Vertical Polarization
Plot 11



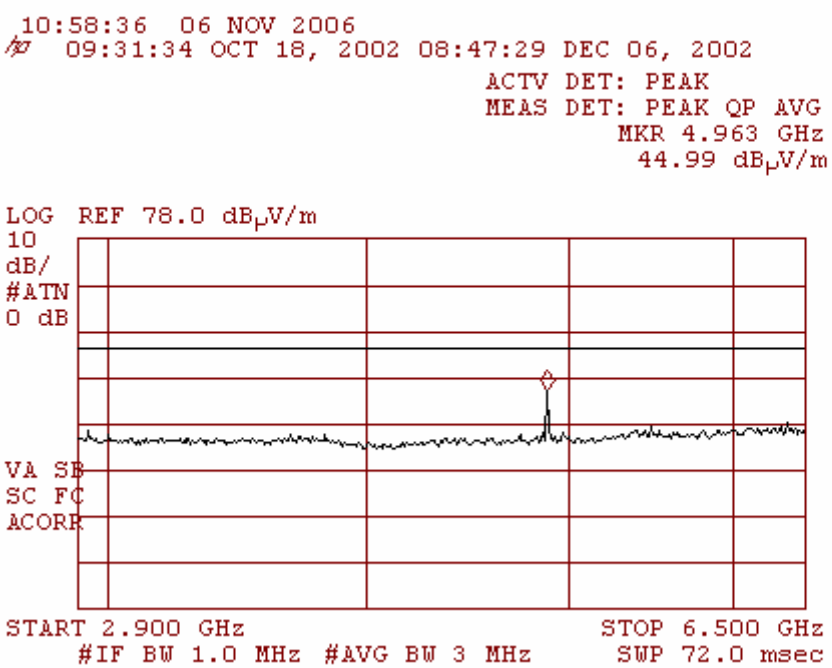
Horizontal & Vertical Polarization
Plot 12



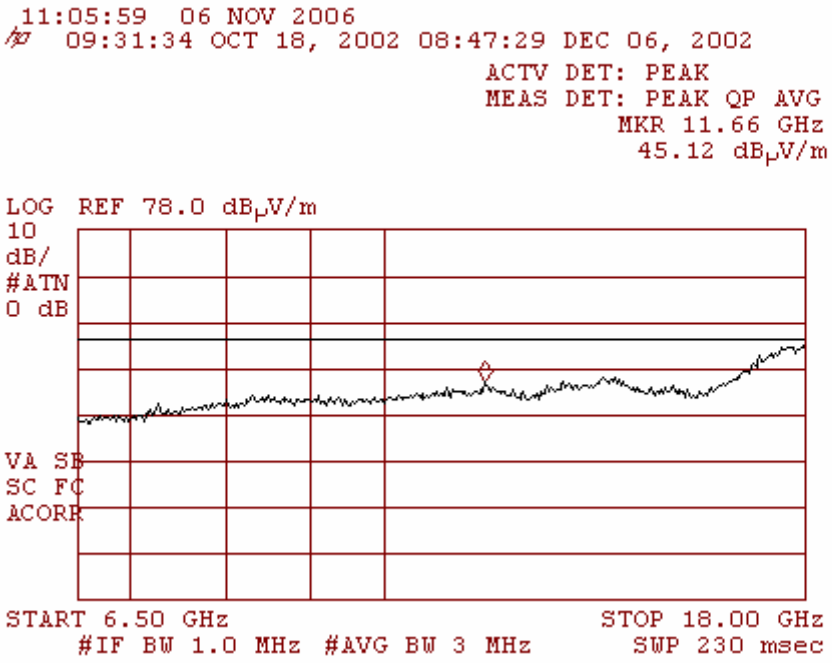
Bluetooth (2480 MHz)
Highest frequency
Horizontal & Vertical Polarization
Plot 13



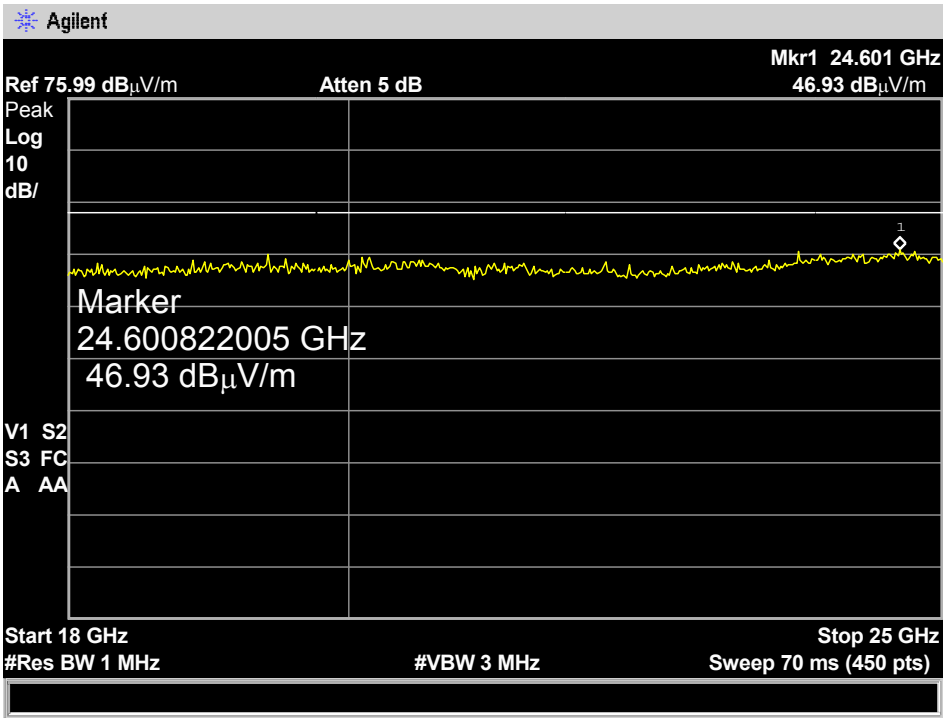
Horizontal & Vertical Polarization
Plot 14



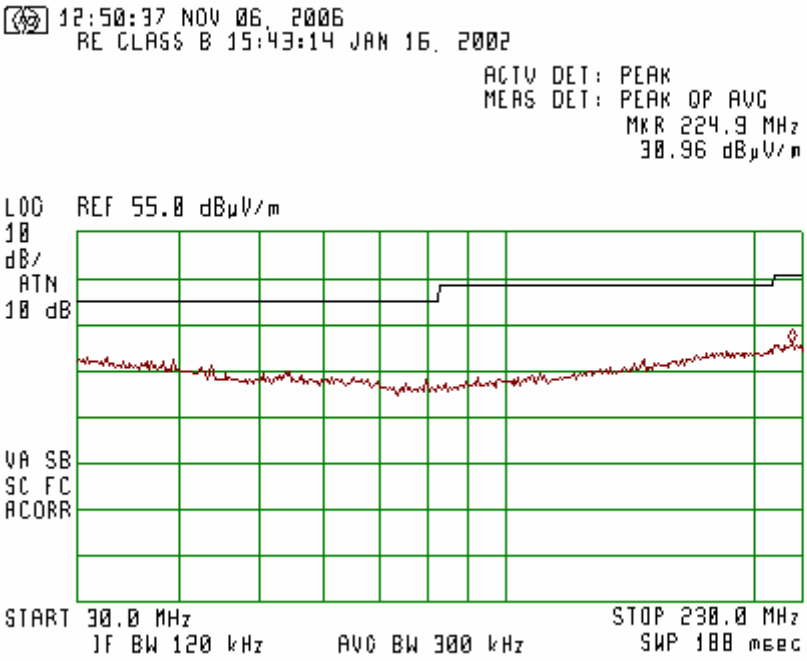
Horizontal & Vertical Polarization
Plot 15



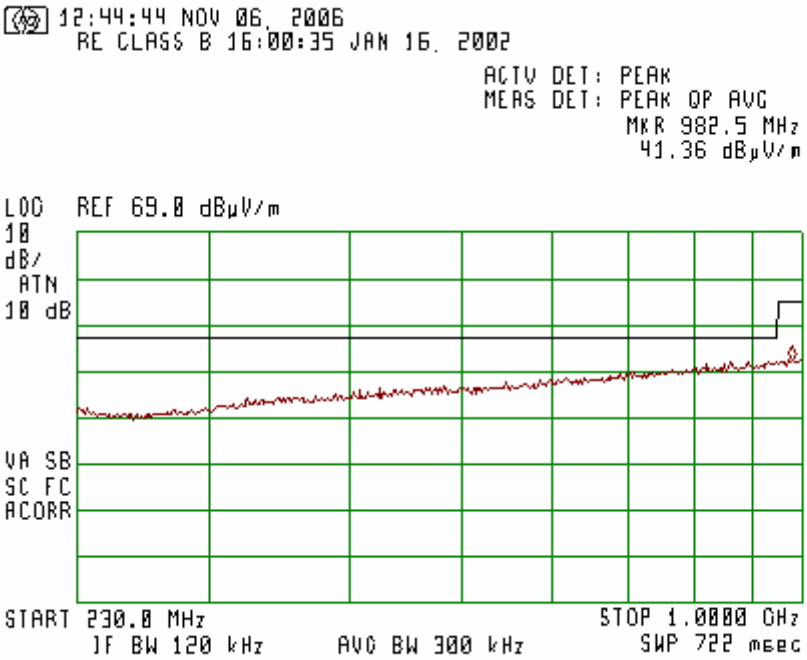
Horizontal & Vertical Polarization
Plot 16



Horizontal & Vertical Polarization
Plot 17

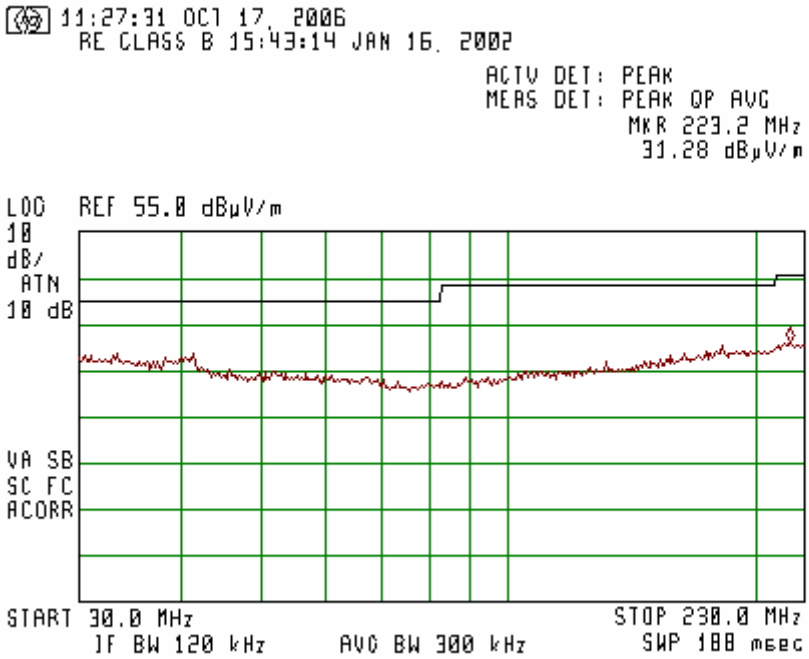


Horizontal & Vertical Polarization
Plot 18

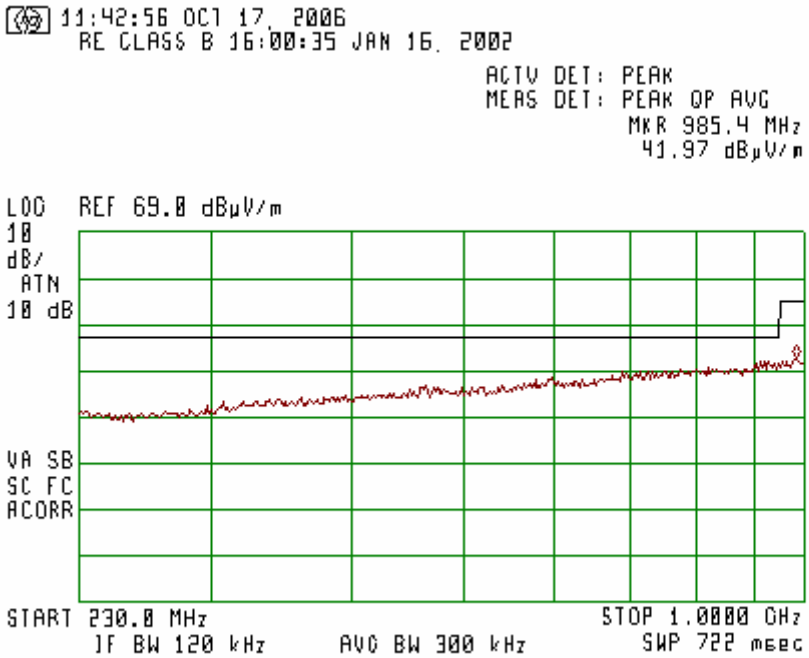


Appendix B: Receive Mode test plots

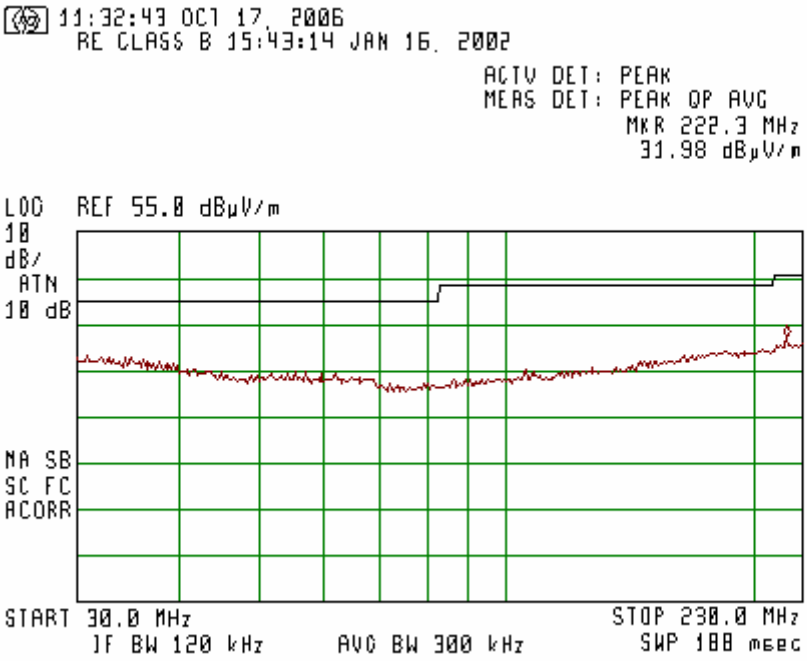
Horizontal Polarization
Plot 1



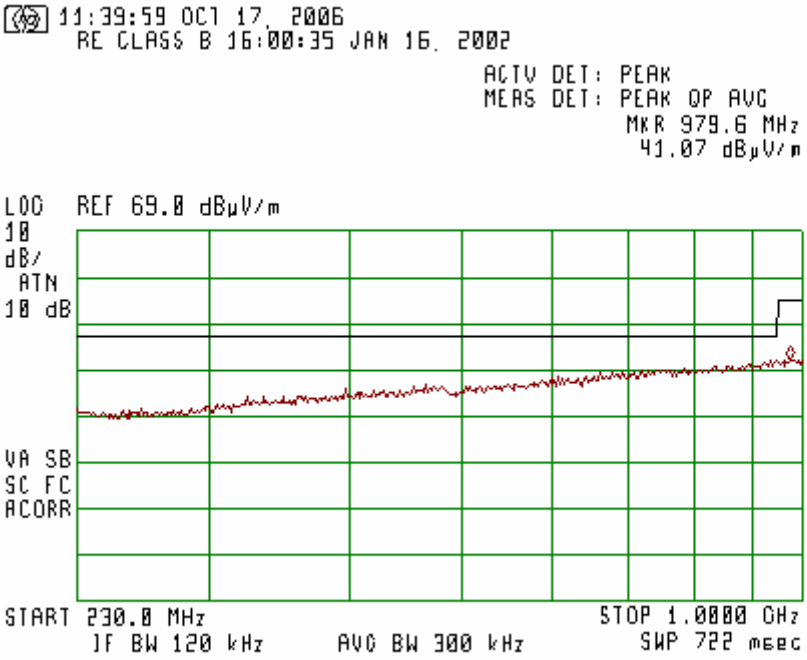
Vertical Polarization
Plot 2



Horizontal Polarization
Plot 3



Vertical Polarization
Plot 4



Appendix C: List of Measuring Equipment used:

Equipment	Manufacturer/ Model	Serial Number	Due date
CISPR16 EMI Receiver	HP8546A	3710A00392	30.06.2007
Spectrum Analyzer 9kHz ÷ 22 GHz	HP 8593EM	3536A00131	30.06.2007
Spectrum Analyzer 100 Hz ÷ 26.5 GHz	Agilent E7405A	US41160436	30.06.2007
LNA Amplifier 1 GHz ÷ 18 GHz	AMP – 5D-010180-30-10P-GW	618653	01.01.2008
Dual Ridged Guide Ant.1-18 GHz	EMCO 3115	9602-4677	01.01.2008
Turn table	HD100	100/693	-
Antenna Mast	HD 100	100/693	-
Biconical 20 –200 MHz	Schwarzbeck VHBB9124	9124/0255	30.06.2007
Log-Periodic 200 – 1000 MHz	Schwarzbeck VUSLP9111	VUSLP9111184	30.06.2007
Pre-Amplifier	MiTeq, AMF-5F-18002650-30-10P	945372	01.01.2008
LISN	Fischer 50/250-25-2	-	30.06.2007
Transient Limiter	HP11947A	-	30.06.2007
Notch Filter	Micro-Tronics BRM50702-05	0001	01.01.2008
Antenna 15G-40 GHz	Schwarzbeck BBHA 9170	BBHA9170214	01.01.2008
High pass Filter	Wainwright WHK 1.2/15G-10EF	3	30.06.2007
High pass Filter	Wainwright WHK2.4/18G-10EF	1	30.06.2007
Oven	Tenneg Ten	10.158-5	30.06.2007
LISN	Fischer 50/250-25-2	-	30.06.2007
Transient Limiter	HP11947A	-	30.06.2007

End of the Test Report