TEST REPORT

Report Number: 100027828MIN-002
Project Number: G100027828

Testing performed on the
Wireless HART Adapter

FCC ID: X89-WA1101
Industry Canada ID: 8879A-WA1101

to
47 CFR Part 15. 247:2009
RSS- 210, Issue 7, 2007

For
MACTek Corporation

Test Performed by:	Test Authorized by:
Intertek Testing Services NA, Inc.	MACTek Corporation
7250 Hudson Blvd., Suite 100	7380 Stoneham Road
Oakdale, MN 55128	Gates Mills, OH 44040

Prepared by: _____ Date: April 27, 2010
Uri Spector

Reviewed by: _____ Date: April 27, 2010
Norman Shpilsher

TABLE OF CONTENTS

1.0 GENERAL DESCRIPTION

Model:	Wireless HART
Type of EUT:	Bullet Wireless HART adapter
Serial Number:	N/A
FCC ID:	X89-WA1101
Industry Canada ID:	8879A-WA1101
Related Submittal(s) Grants:	None
Company:	MACTek Corporation
Customer:	Mr. Thomas Holmes
Address:	MACTek Corp. 7380 Stoneham Road Gates Mills, OH 44040
Phone:	(440) 423-0955
Fax:	
e-mail:	
Test Standards:	☒ 47 CFR, Part 15:2009, §15.247 ☒ RSS–210, Issue 7, 2007 ☒ RSS-Gen, Issue 2, 2007 ☒ 47 CFR, Part 15:2009, §15.107 and §15.109, Class B ☐ Other
Type of radio:	☒ Stand -alone ☐ Module ☐ Hybrid
Date Sample Submitted:	March 31, 2010
Test Work Started:	March 31, 2010
Test Work Completed:	April 26, 2010
Test Sample Conditions:	☐ Damaged ☐Poor (Usable) ☒ Good

1.1 Product Description; Test Facility

Product Description:	2.4 – 2.4835GHz Transceiver
Transmitter Type:	☐ FHSS ☒ Digital Modulation ☐ WiFi ☐ Blue Tooth
Operating Frequency Range(s):	Range From 2400 to 24835 MHz
Number of Channels:	16
Modulation:	OQPSJ
Emission Designator:	1M53G7D
Antenna(s) Info:	Antenna Type: Omni directional Gain: 2dBi Connector Type: Solder direct to circuit board (The EUT does not have antenna port connector, therefore no measurements were performed at antenna port)
Antenna Installation:	☐ User ☐ Professional ☒ Factory
Transmitter power configuration:	☐ Internal battery ☒ External power source ☐ 120VAC ☐ 230VAC ☐ 400VAC ☒ 7-32VDC ☐ Other: Amp. ☐ 50Hz ☐ 60Hz
Special Test Arrangement:	As a hand-held device the EUT was rotated through three orthogonal axes to determine and tested with the maximum emissions
Test Facility Accreditation:	A2LA (Certificate No. 1427.01)
Test Methodology:	Measurements performed according to the procedures in ANSI C63.4-2003 and FCC Public Notice DA 00-705

1.2 EUT Configuration

The equipment under test was operated during the measurement under the following conditions:

☐ - Standby
☒ - Continuous transmissions (modulated signal)
☒ - Continuous transmissions (un-modulated signal)
☐ - Continuous receiving
☐ - Test program (customer specific)
☐ -

Operating modes of the EUT:

No.	Description
1	Test was performed at low channel 0, middle channel 7, and upper channel 15. During testing the EUT was powered at 9VDC.

Cables:

No.	Type	Length	Designation	Note
1	HART communication cable	7ft.	USB Interface for HART network	

Support equipment/Services:

No.	Item	Description
1	Acer Aspire One laptop	Local PC
2	Viator HART interface	USB HART interface to control EUT
3	Topward Electric Instruments Co., LTD TPS-4000	Dual Tracking Power Supply

1.3 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

☒ **Normal**

Temperature:	+15 to +35 ° C
Humidity:	20-75 %
Atmospheric pressure:	86-106 kPa

☐ **Extreme**

☐ **Temperature:**	-20 to +50 ° C
☐ **Supply voltage:**	85% to +115%

1.4 Measurement uncertainty

The expanded uncertainty (k = 2) for radiated measurements has been determined to be:
±4 dB at 10m and ±5.4 dB at 3m
The expanded uncertainty (k = 2) for conducted measurements at antenna terminal has been determined to be:
±1.0 dB
The expanded uncertainty (k = 2) for line conducted measurements has been determined to be:
±2.6 dB

1.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured emissions reading on the EMI Receiver.
The basic equation with a sample calculation is as follows:
FS = RA + AF + CF - AG

Where: FS = Field Strength in dB(μV/m)
RA = Receiver Amplitude in dB(μV)
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB(m^{-1})
AG = Amplifier Gain in dB

Assume a receiver reading of 48.1 dB(μV) is obtained. The antenna factor of 7.4 dB(m^{-1}) and cable factor of 1.6 dB is added and amplifier gain of 16.0 dB is subtracted giving field strength of 41.1 dB(μV/m).

RA = 48.1 dB(μV)
AF = 7.4 dB(m^{-1})
CF = 1.6 dB
AG = 16.0 dB
FS = RA + AF + CF - AG
FS = 48.1 + 7.4 + 1.6 – 16.0
FS = 41.1 dB(μV/m)

General notes:

2.0 TEST SUMMARY

Referring to the performance criteria and the operating mode during the tests specified in this report, the equipment complies with the requirements according to the following standards.

TEST SPECIFICATION	TEST PARAMETERS	RESULT
15.247(b), (c) / RSS-210 A8.4	Maximum peak output power	Pass
15.247(a) / RSS-210 A8.2	6dB bandwidth of the digital modulation system	Pass
15.247/(e) / RSS-210 A8.2	Power spectral density	Pass
15.247(d) / RSS-210 A8.5	Radiated spurious emissions	Pass
15.247(i) / RSS- Gen 5.5	RF Exposure Compliance	Pass
15.207 / RSS-Gen 7.2.2	Transmitter Power Line conducted emissions	Pass
15.109 / ICES-003	Receiver/digital device radiated emissions	Pass
15.107 / ICES-003	Digital device conducted emissions	Pass

3.0 TEST CONDITIONS AND RESULTS

3.1 Maximum peak output power

Test location: ☐ OATS ☒ Anechoic Chamber ☐ Other

Test result: **Pass**

Max. Margin: 31.3dB below the limits

Power Output: Distance:	**Radiated** ☒ **3m** ☐ **10m**				
Frequency Range:	☐ 902-928MHz ☒ 2400-2483.5MHz ☐ 5725-5850MHz				
Low Frequency 2404.2MHz	**Measured field dBµV/m**	**Tx Peak Power dBm**	**Limit dBm**	**Limit Reduction dB**	**Margin dB**
Vertical Antenna	101.9	4.6	30	0	-25.4
Horizontal Antenna					
Middle Frequency 2439MHz					
Vertical Antenna	98.3	1.1	30	0	-28.9
Horizontal Antenna					
Upper Frequency 2478.62MHz					
Vertical Antenna	95.9	-1.3	30	0	-31.3
Horizontal Antenna					
RBW:	☐ 1MHz ☐ 3MHz ☒ 10MHz				
VBW:	☐ 1MHz ☐ 3MHz ☒ 10MHz				
Antenna Gain:	☒ < 6dBi and = 2 dBi ☐ >6dBi and = dBi, Output power reduction = dB				

Notes: The Maximum Peak Output Power was calculated from equitation $P=(E \times d)^2/30G$, where P is the power in watts; E is the measured field strength in V/m; d is the measurement distance and = 3m; G is the numerical antenna gain of the transmitter

Date:	April 2, 2010	**Result:** **Pass**
Standard:	FCC Part 15.247	
Tested by:	Uri Spector	
Test Point:	Emissions at Fundamental	
Operation mode:	See Page 5	
Note:	Table shows worst-case emissions	

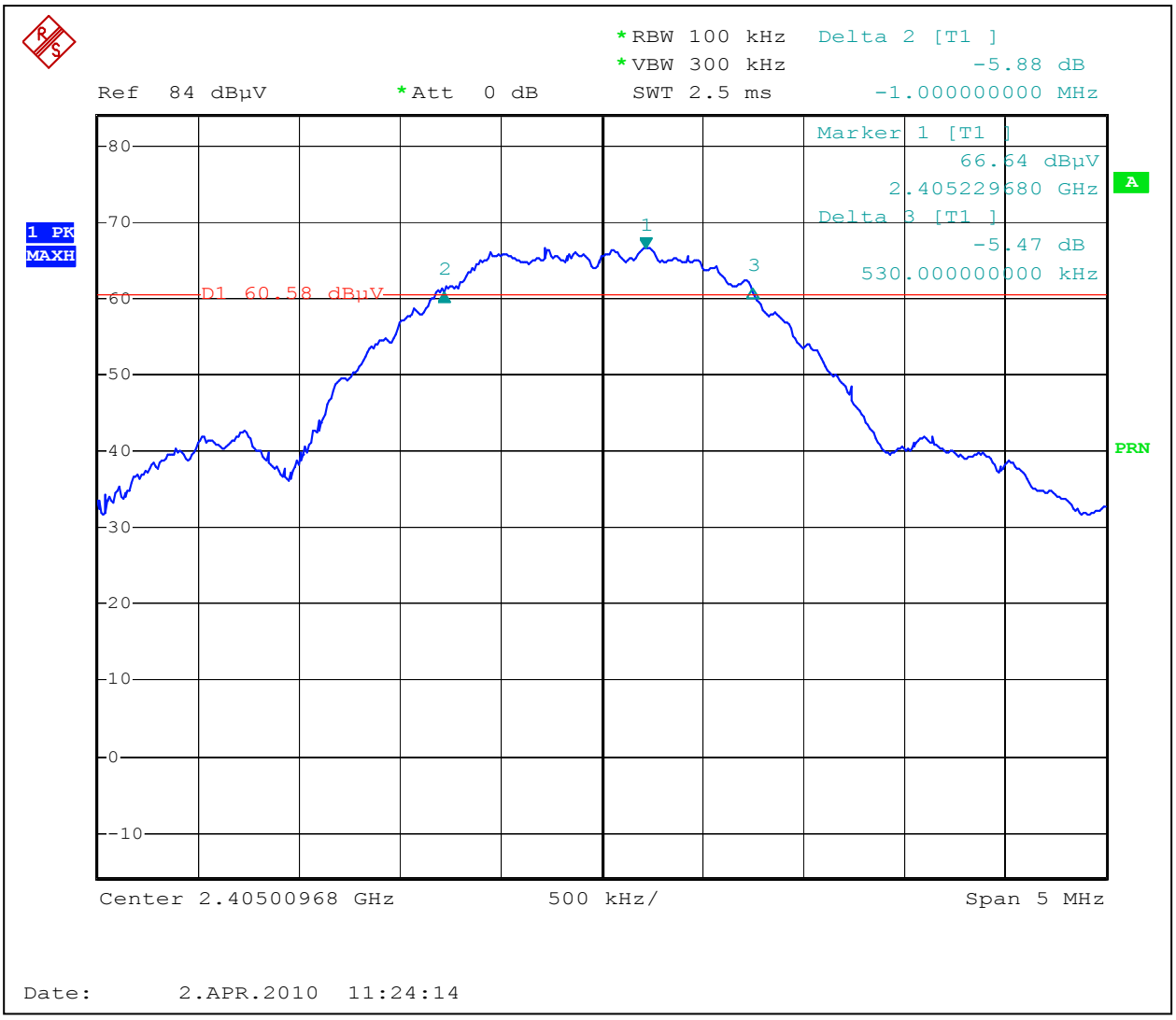
Table 3.1.1

Frequency	Antenna		Ant. CF	Cable loss	Pre-amp	Peak Reading	Total @ 3m	Limit	Margin	Comments
MHz	Polarity	Hts(cm)	dB1/m	dB	Gain (dB)	dBµV	dBµV/m	dBµV/m	dB	
2404.20	V	100	27.9	3.5	0.0	70.5	101.9	N/A	N/A	
2439.00	V	100	28.0	3.6	0.0	66.8	98.3	N/A	N/A	
2478.62	V	100	28.1	3.6	0.0	64.2	95.9	N/A	N/A	

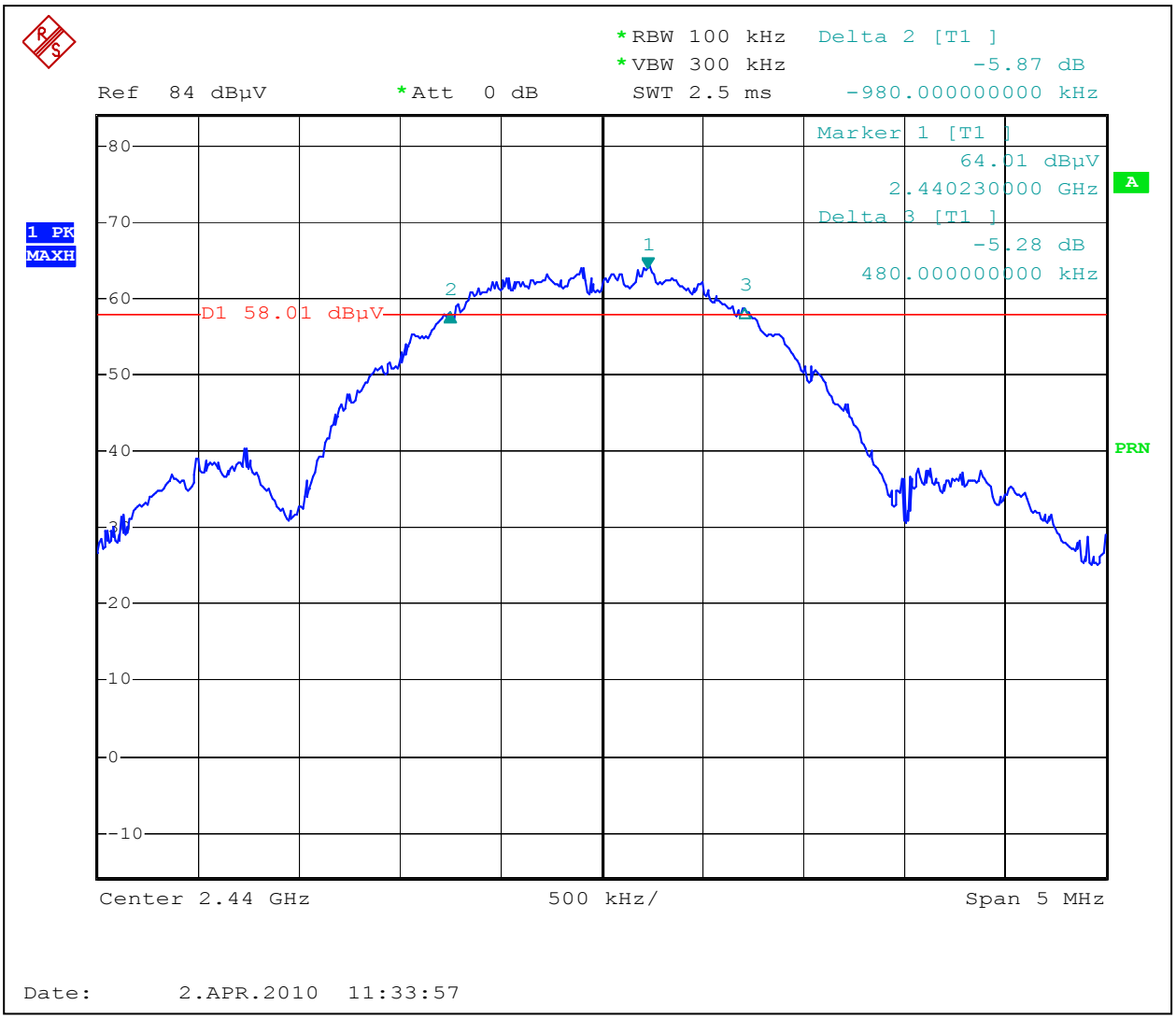
3.2 6dB bandwidth of the digital modulation

Low Frequency Channel kHz	Middle Frequency Channel kHz	Upper Frequency Channel kHz	Minimum Bandwidth kHz	Result
1530	1460	1490	500	**Pass**
RBW: **VBW:**	☒ 100kHz ☐ other kHz ☐ 100kHz ☒ 300kHz ☐ other kHz			

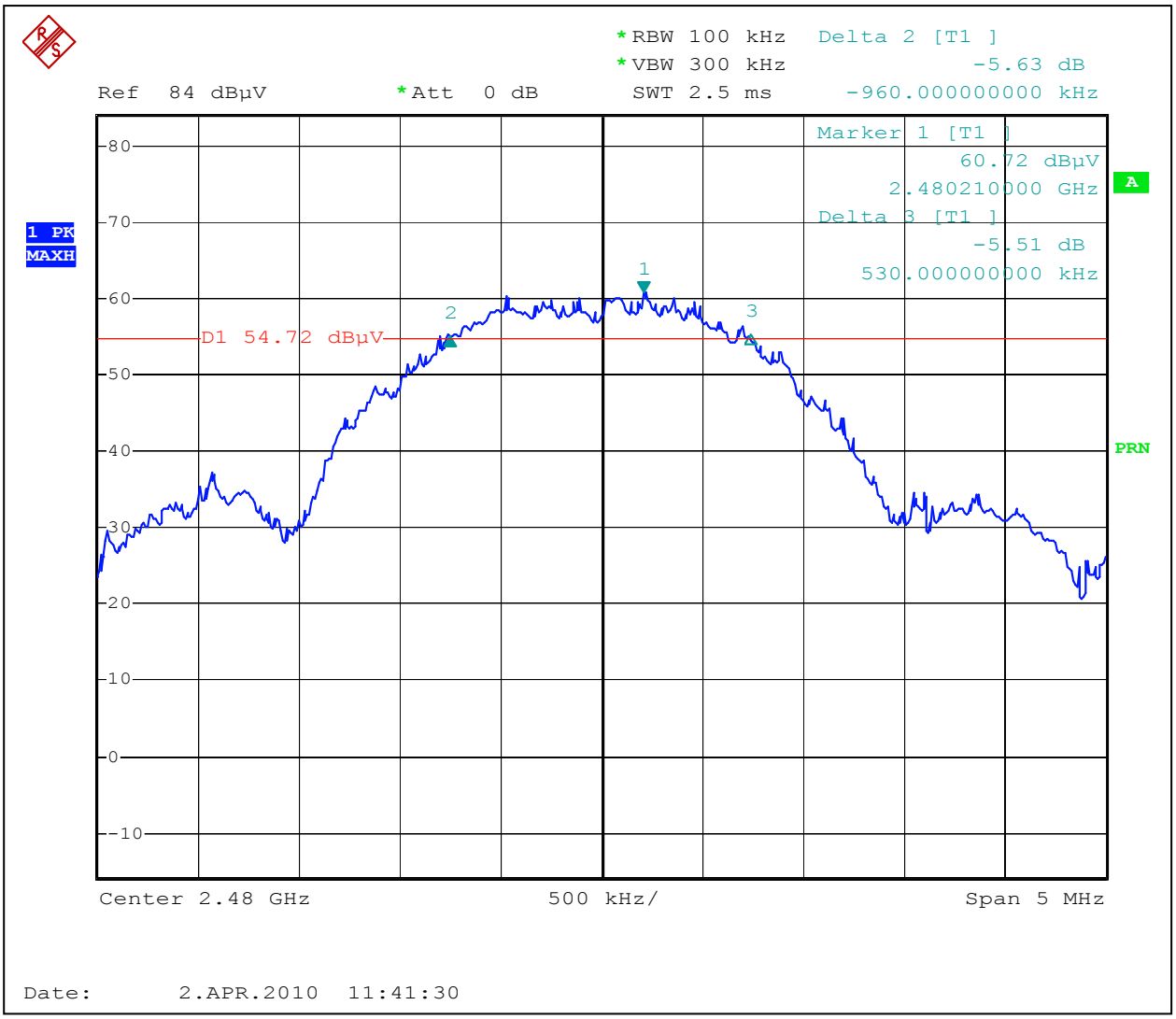
Notes: Graphs 3.2.1 to 3.2.3 show the 6dB bandwidth


*RBW 100 kHz
*VBW 300 kHz
Ref 84 dBµV
*Att 0 dB
SWT 2.5 ms
Delta 2 [T1]
-5.88 dB
-1.000000000 MHz
Marker 1 [T1]
66.64 dBµV
2.405229680 GHz
Delta 3 [T1]
-5.47 dB
530.000000000 kHz
1 PK
MAXH
A
PRN
D1 60.58 dBµV
80
70
60
50
40
30
20
10
0
-10
Center 2.40500968 GHz
500 kHz/
Span 5 MHz
Date: 2.APR.2010 11:24:14

Graph 3.2.1


*RBW 100 kHz
*VBW 300 kHz
Ref 84 dBµV
*Att 0 dB
SWT 2.5 ms
Delta 2 [T1]
-5.87 dB
-980.000000000 kHz
Marker 1 [T1]
64.01 dBµV
2.440230000 GHz
Delta 3 [T1]
-5.28 dB
480.000000000 kHz
1 PK
MAXH
A
PRN
D1 58.01 dBµV
80
70
60
50
40
20
10
0
-10
Center 2.44 GHz
500 kHz/
Span 5 MHz
Date: 2.APR.2010 11:33:57

Graph 3.2.2


*RBW 100 kHz
*VBW 300 kHz
Ref 84 dBµV
*Att 0 dB
SWT 2.5 ms
Delta 2 [T1]
-5.63 dB
-960.000000000 kHz
Marker 1 [T1]
60.72 dBµV
2.480210000 GHz
Delta 3 [T1]
-5.51 dB
530.000000000 kHz
1 PK
MAXH
A
PRN
D1 54.72 dBµV
80
70
60
50
40
30
20
10
0
-10
Center 2.48 GHz
500 kHz/
Span 5 MHz
Date: 2.APR.2010 11:41:30

Graph 3.2.3

3.3 Power spectral density

Power Output:	☐ Conducted ☒ Radiated			
	Measured Density dBµV/m	**Power Spectral Density dBm**	**Limit dBm**	**Margin dB**
Low Frequency Channel	90.2	-7.0	8	-15.0
Middle Frequency Channel	89.9	-7.3	8	-15.3
Upper Frequency Channel	82.5	-14.7	8	-22.7
Analyzer Settings:	☒ RBW=3KHz ☒ VBW=10KHz ☒ Span=300KHz ☐ Sweep=100sec			
Antenna Gain:	☒ < 6dBi and = 2 dBi ☐ >6dBi and = dBi, limit reduction = dB			

Notes: The Maximum Peak Output Power was calculated from equitation $P=(E \times d)^2/30G$, where P is the power in watts; E is the measured field strength in V/m; d is the measurement distance and = 3m; G is the numerical antenna gain of the transmitter

Table 3.3.1

Frequency	Antenna		Ant. CF	Cable loss	Pre-amp	Peak Reading	Total @ 3m	Limit	Margin	Comments
MHz	Polarity	Hts(cm)	dB1/m	dB	Gain (dB)	dBµV	dBµV/m	dBµV/m	dB	
2404.20	V	100	27.9	3.5	0.0	58.7	90.2	N/A	N/A	
2439.00	V	100	28.0	3.6	0.0	58.3	89.9	N/A	N/A	
2478.62	V	100	28.1	3.6	0.0	50.8	82.5	N/A	N/A	

3.4 Radiated spurious emissions

Test location: ☐ OATS ☒ Anechoic Chamber ☐ Other

Test result: **Pass**

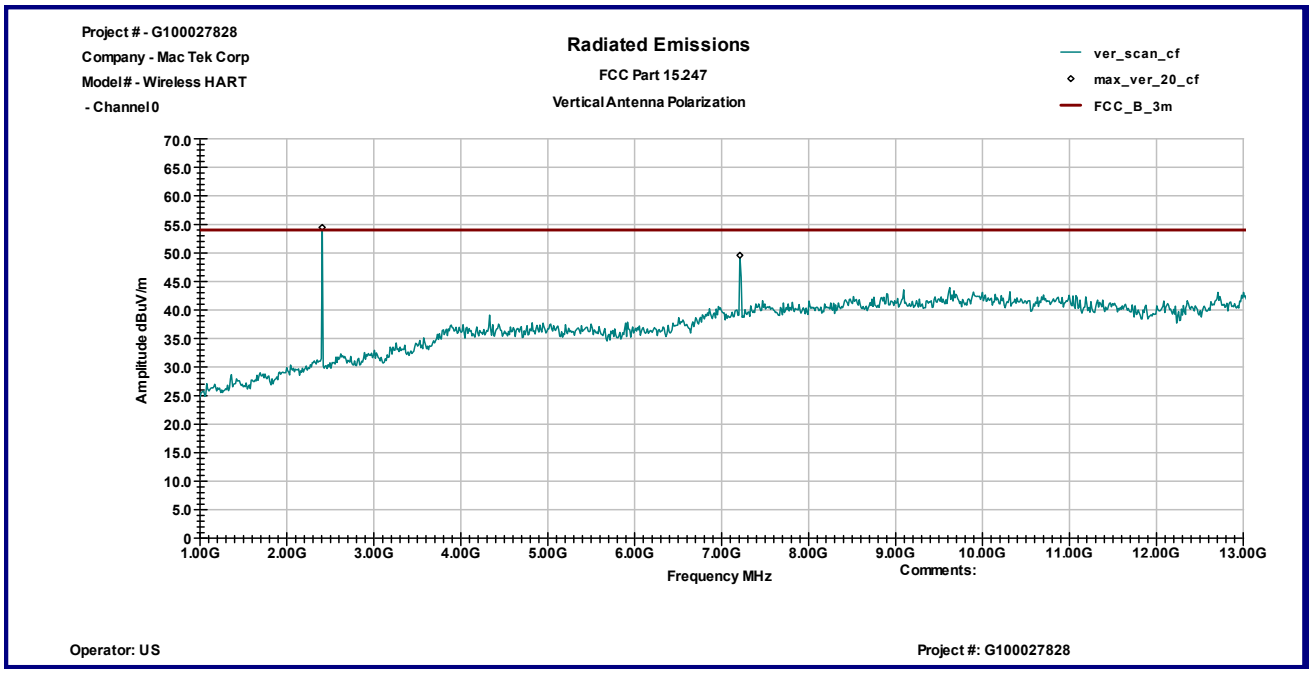
Max. Margin: 4.4dB below the limits

Notes: No radiated spurious emissions related to the transmitter were detected in the frequency range 30-1000MHz. The table 3.4.1 and Graphs 3.4.1-3.4.12 show the 2nd and 3rd harmonics in restricted band of operation per FCC 15.205. Fundamental frequency was excluded from the table.
No emissions were detected above ambient at 4th and above harmonics.
Graph 3.4.13 shows band edge compliance at 2400MHz
Graph 3.4.14 shows band edge compliance at 2483.5MHz

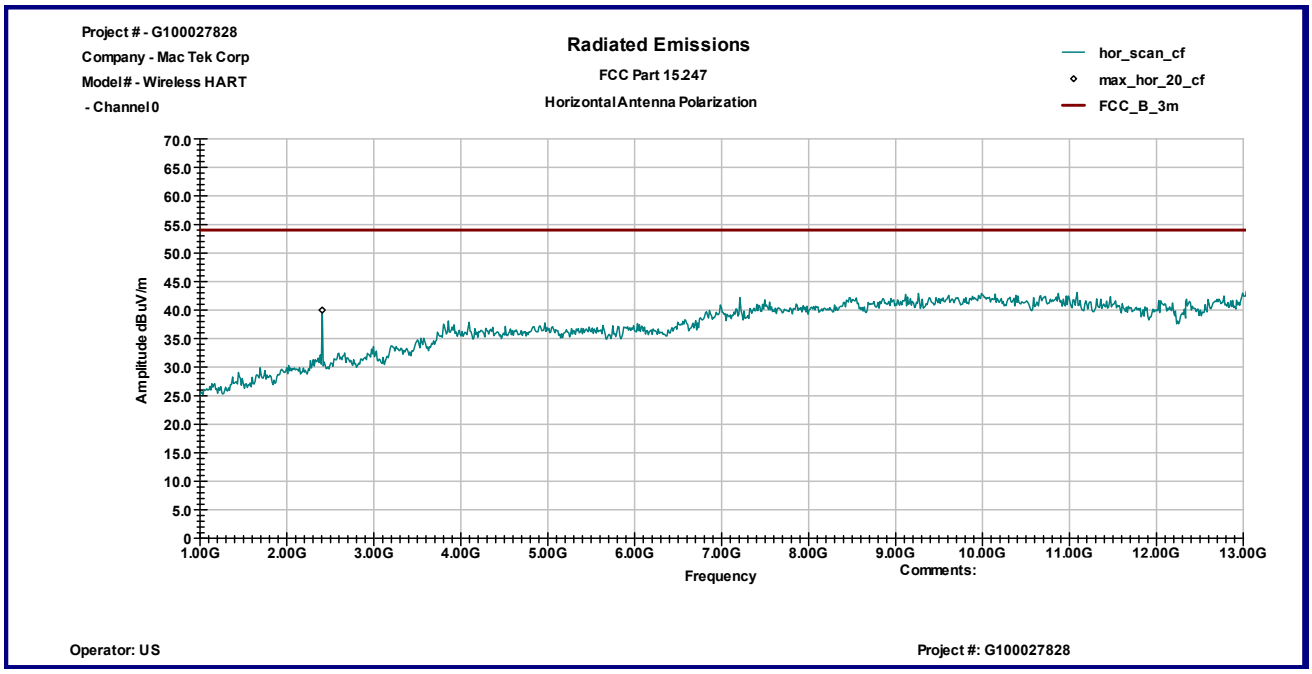
Date:	April 1, 2010	**Result:** **Pass**
Standard:	FCC part 15.247(d)	
Tested by:	Uri Spector	
Test Point:	Enclosure with Antenna	
Operation mode:	See Page 5	
Note:		

Table 3.4.1

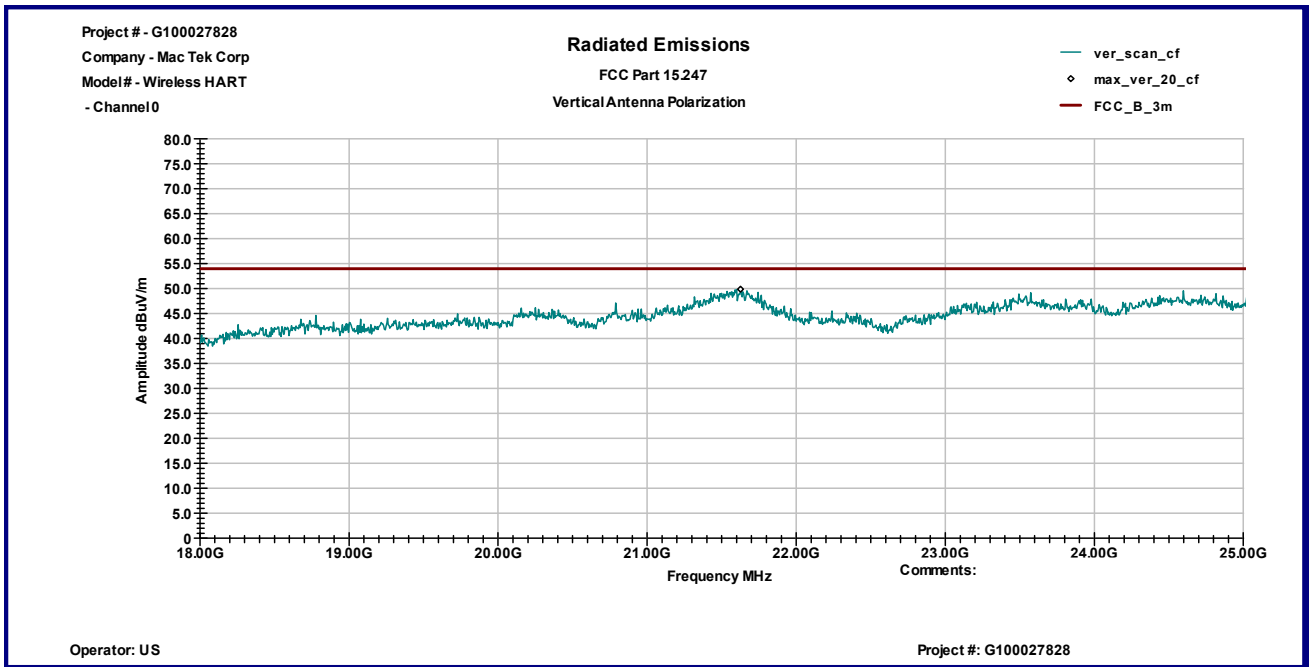
Frequency MHz	Antenna Polarity	Peak Reading dBµV	Total C.F. dB1/m	Pre-Amp. Gain (dB)	Total at 3m dBµV/m	AVG Limit dBµV/m	Margin dB
		Channel 0					
7.2107 GHz	V	49.0	42.0	41.4	49.6	54.0	-4.4
		Channel 7					
4.8873 GHz	V	45.7	38.1	41.8	42.1	54.0	-11.9
7.324 GHz	V	45.3	42.3	41.2	46.4	54.0	-7.6
		Channel 15					
4.9667 GHz	V	48.4	38.2	41.6	45.0	54.0	-9.0
7.4373 GHz	V	45.4	42.6	41.0	47.0	54.0	-7.0



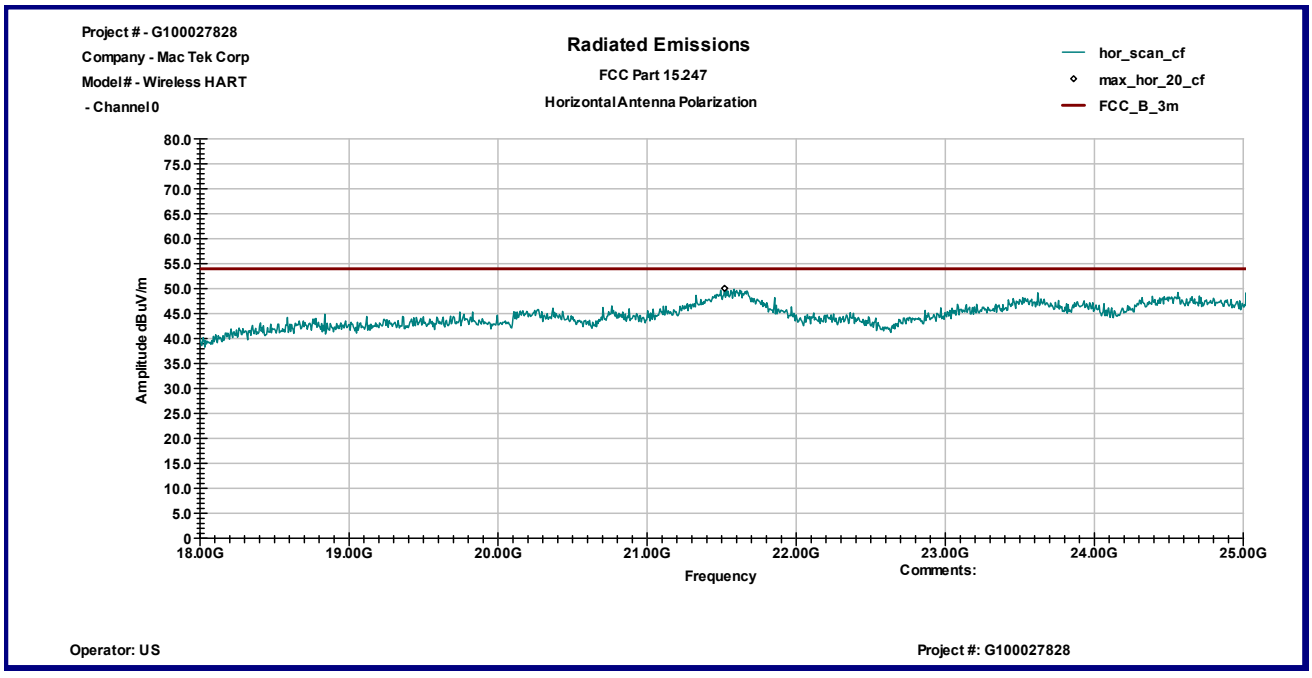
Graph 3.4.1



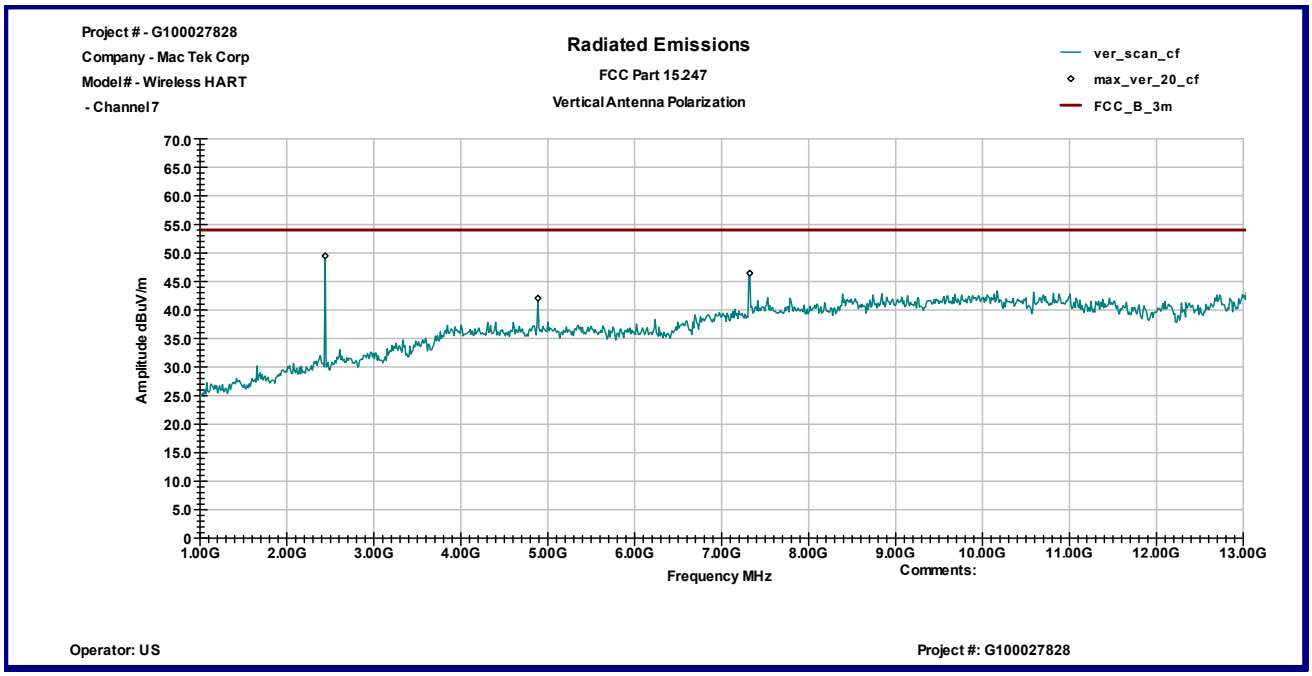
Graph 3.4.2



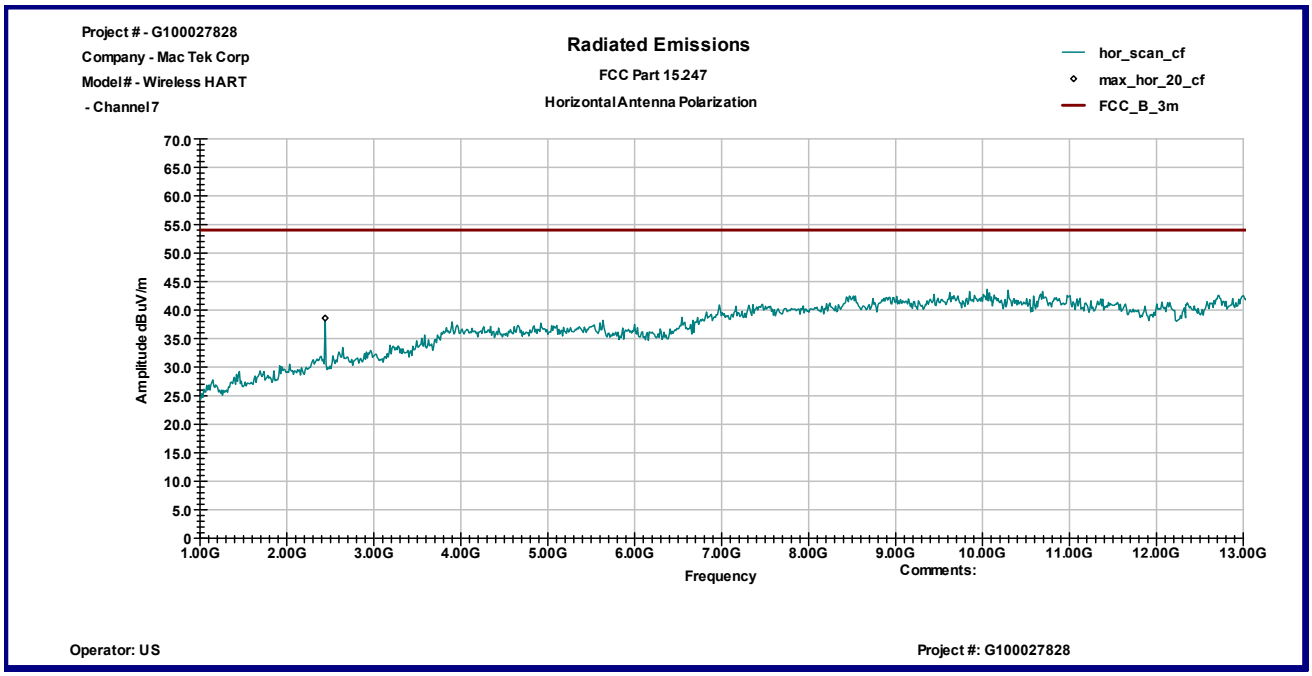
Graph 3.4.3



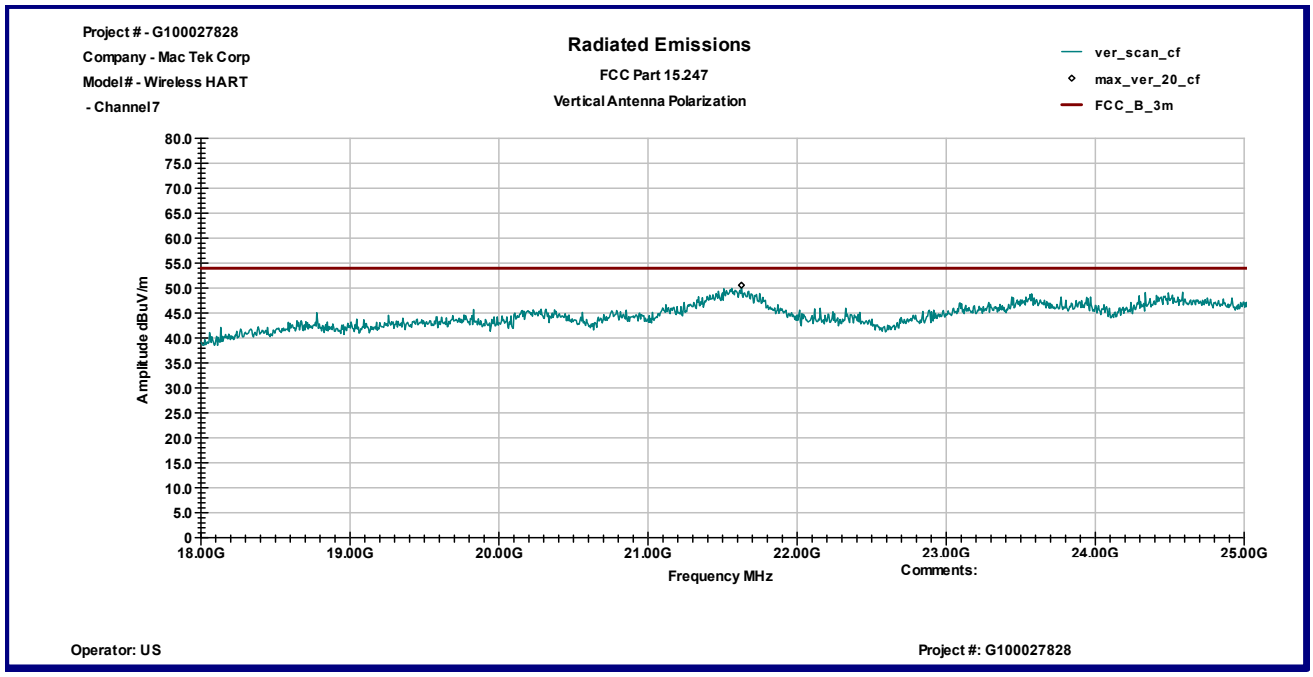
Graph 3.4.4



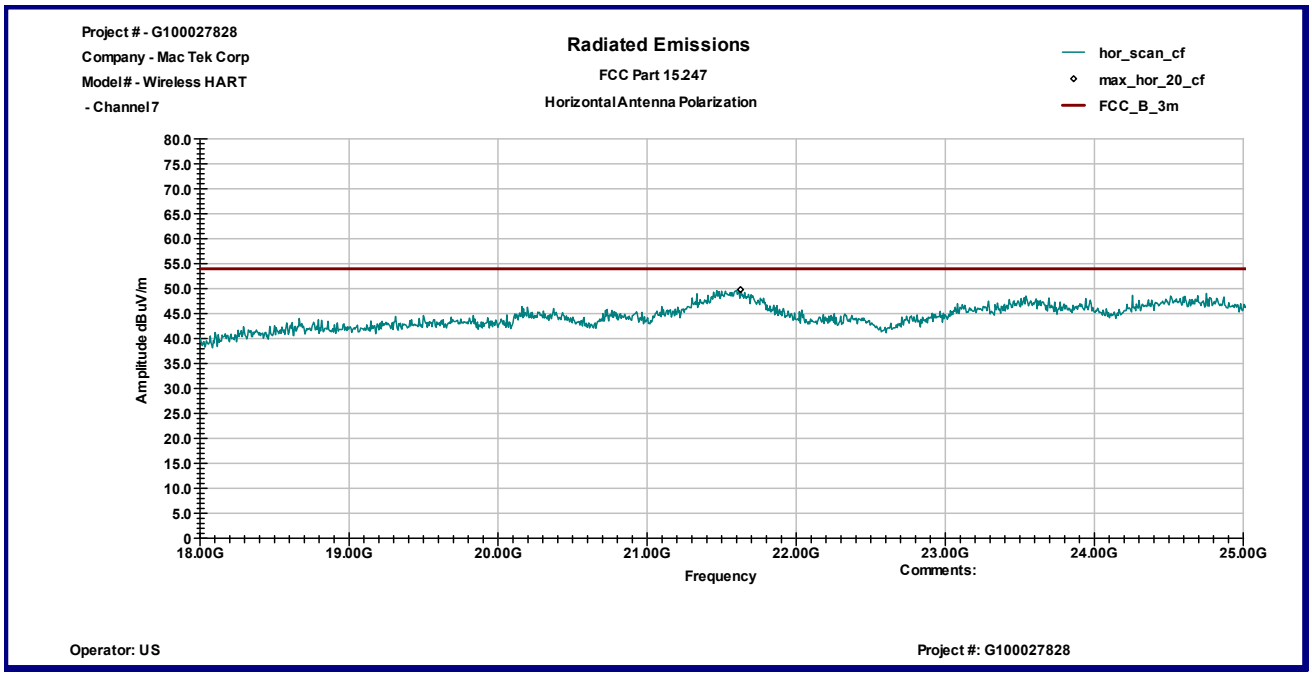
Graph 3.4.5



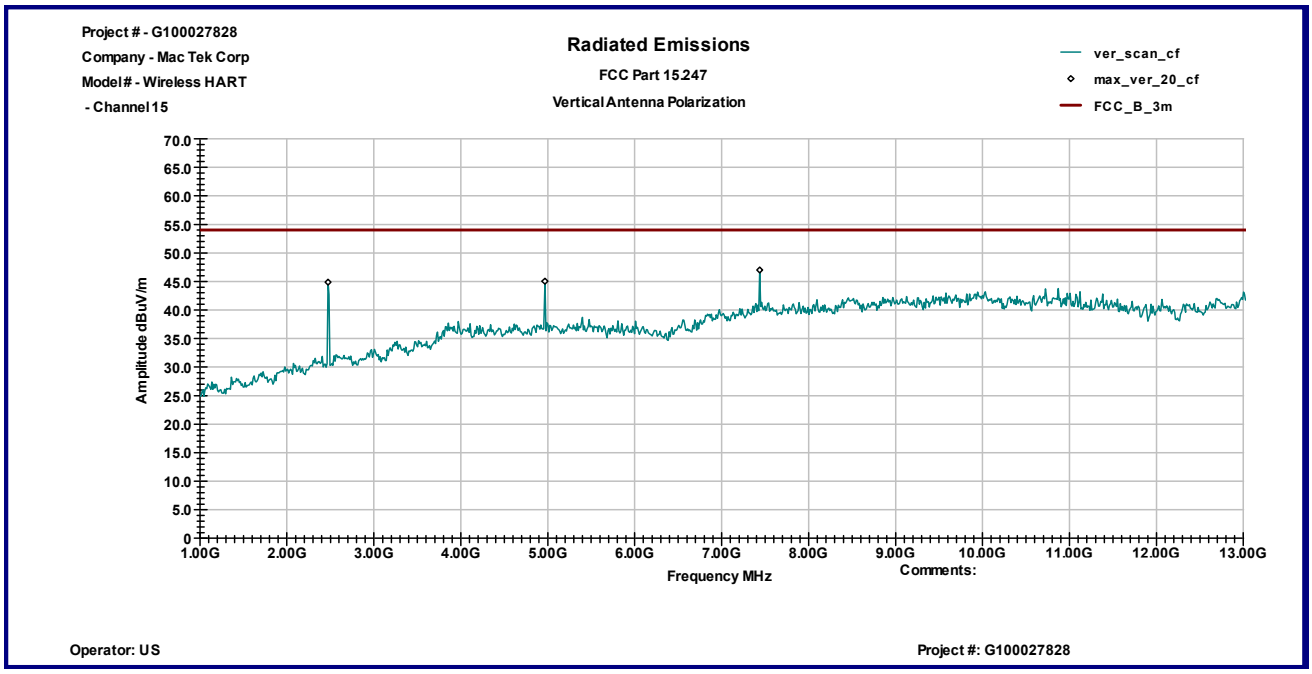
Graph 3.4.6



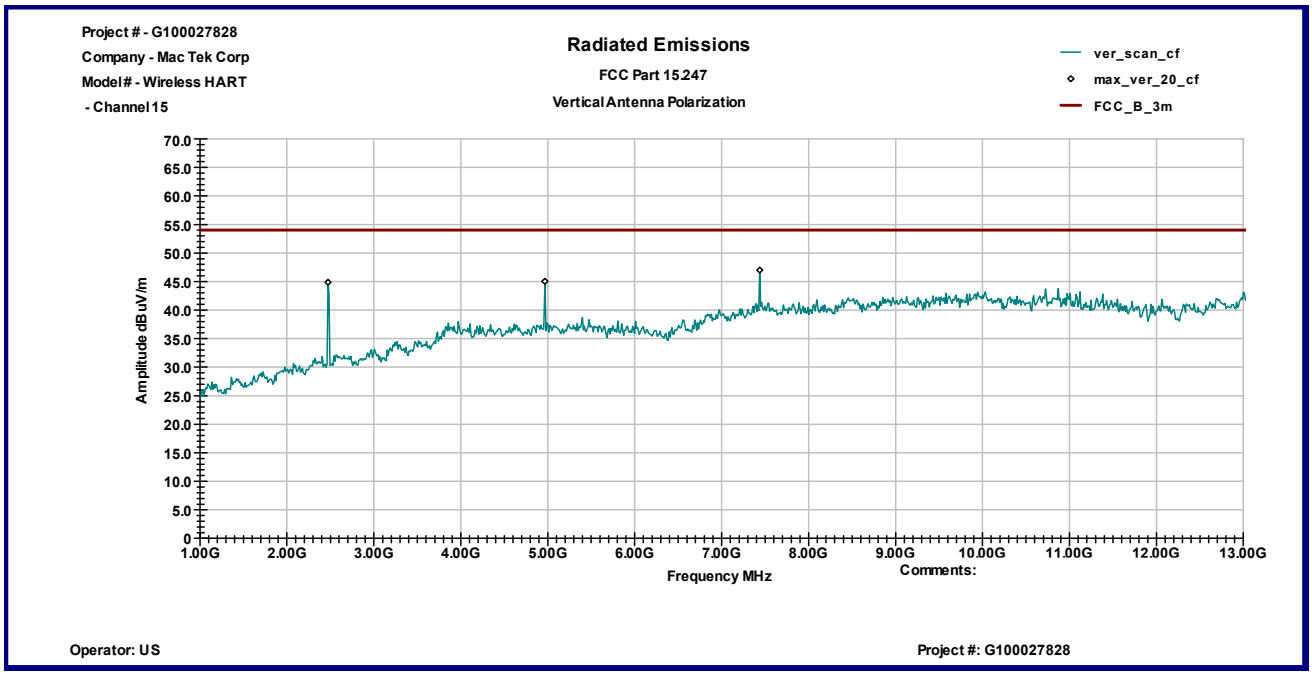
Graph 3.4.7



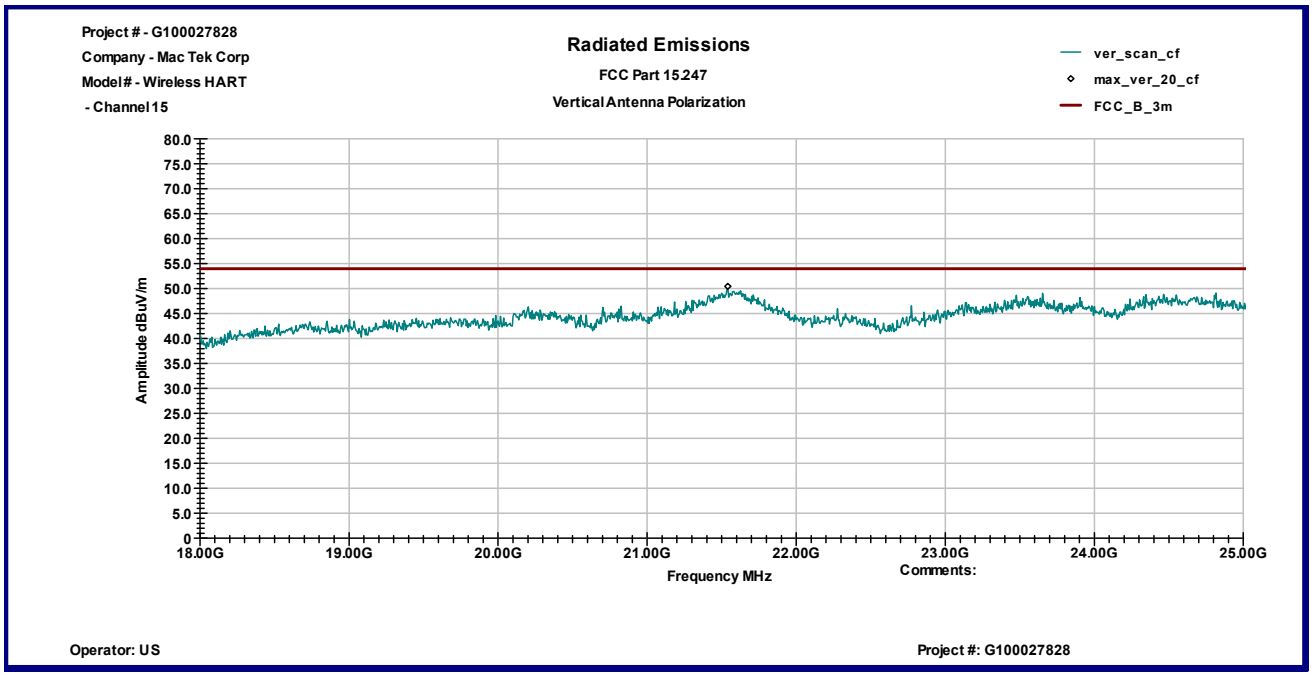
Graph 3.4.8



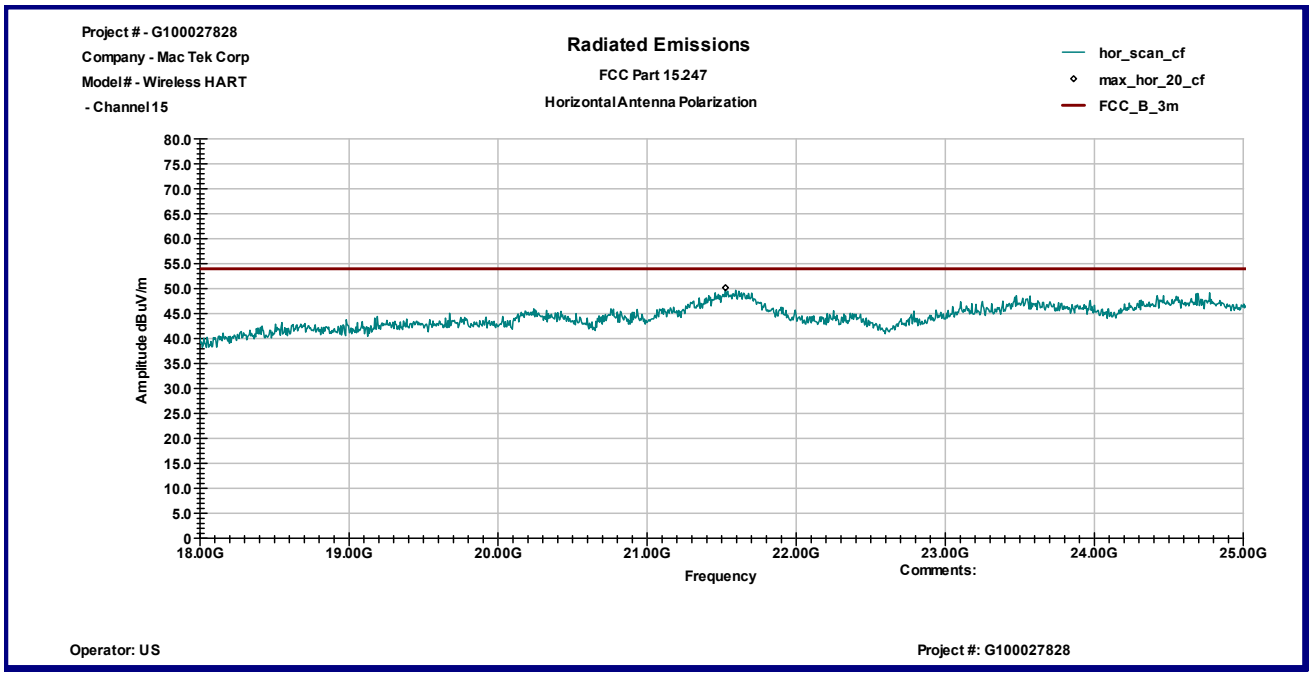
Graph 3.4.9



Graph 3.4.10

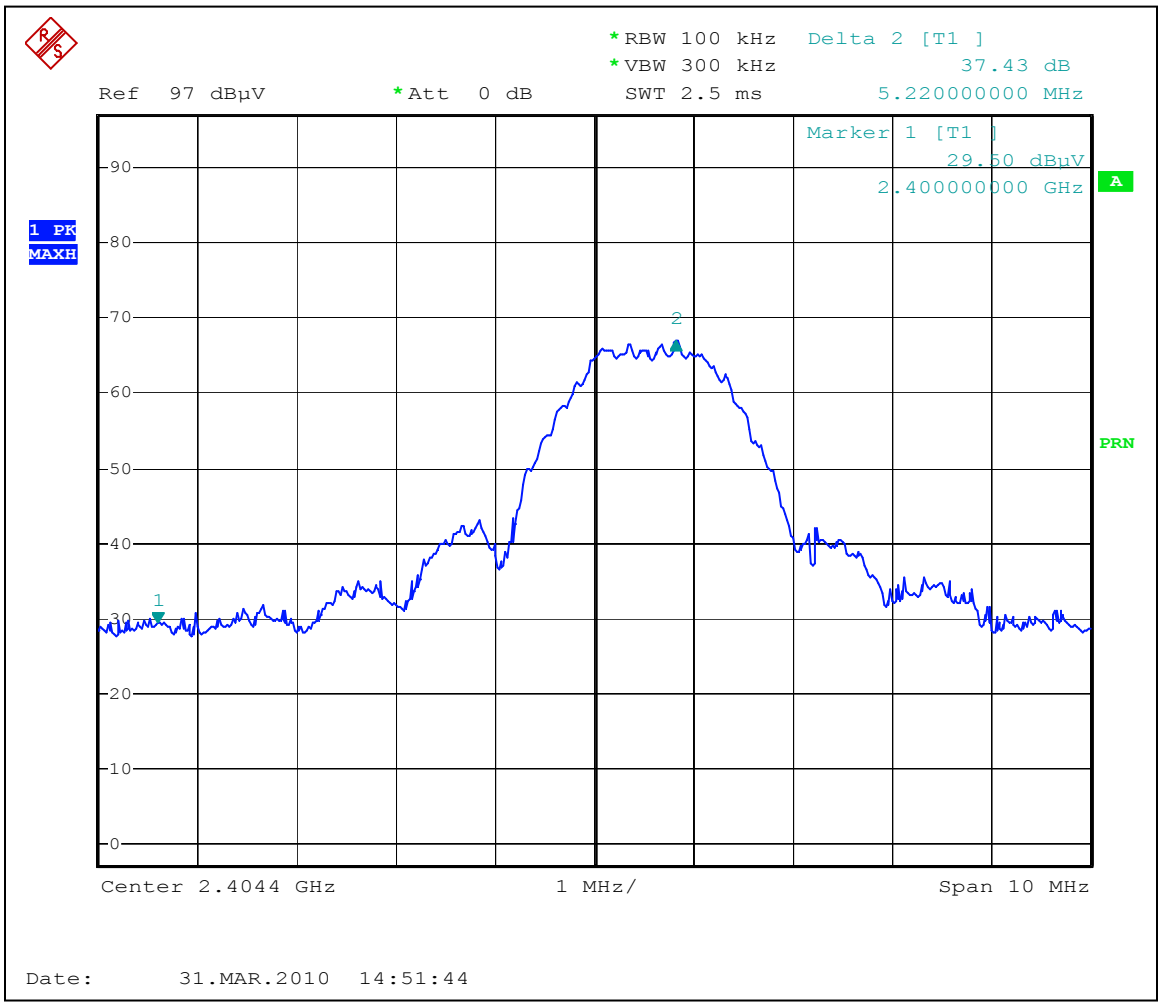


Graph 3.4.11

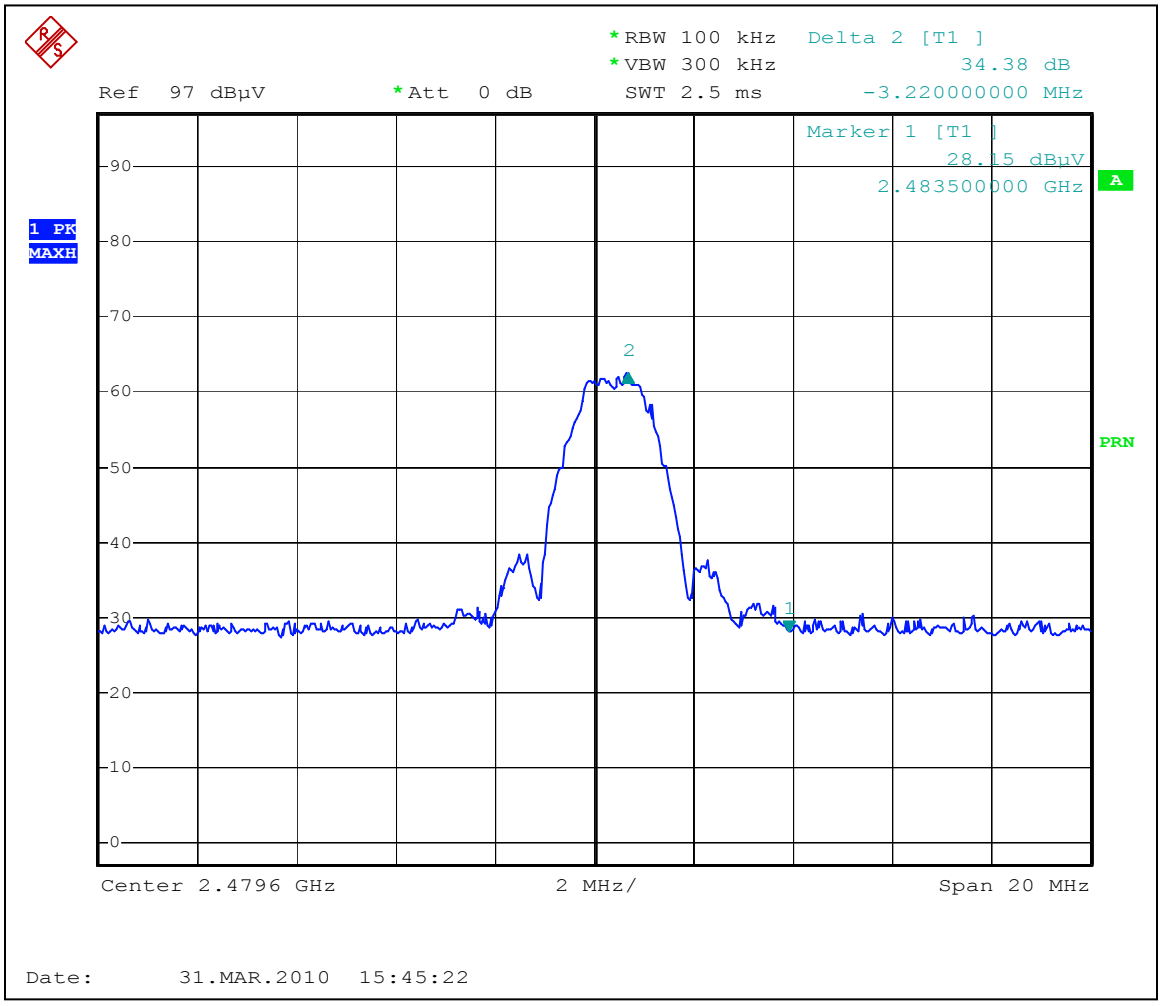


Graph 3.4.12

Bandedge Compliance



Graph 3.4.13


*RBW 100 kHz
*VBW 300 kHz
Ref 97 dBµV
*Att 0 dB
SWT 2.5 ms
Delta 2 [T1]
34.38 dB
-3.220000000 MHz
Marker 1 [T1]
28.15 dBµV
2.483500000 GHz
1 PK
MAXH
A
PRN
90
80
70
60
50
40
30
20
10
0
Center 2.4796 GHz
2 MHz/
Span 20 MHz
Date: 31.MAR.2010 15:45:22

Graph 3.4.14

3.5 RF Exposure Compliance

The maximum measured power, P is 4.6dBm

The antenna gain, G is 2dBi

The maximum EIRP power = P + G
ERP = 4.6+ 2= 6.6dBm, or 0.00457W

The limits for Maximum Permissible Exposure (MPE) for transmitter operating at 2.4Hz, MPE is $1mW/cm^2$, or $10W/m^2$

The Power Density is related to EIRP with the equation:
$S = EIRP / 4\pi D^2$, or $10 = 0.00457 / 4\pi D^2$,

The minimum safe separation distance, D = 0.6cm, which is below 20cm

3.6 Transmitter power line conducted emissions

Test location: ☐ OATS ☒ Anechoic Chamber ☐ Other

Test result: **Pass**

Frequency range: 0.15MHz-30MHz

Max. Emissions margin: 18.1dB below the limits

Notes: None

Date:	April 26, 2010	**Result:** **Pass**
Standard:	FCC Part 15.207	
Tested by:	Uri Spector	
Test Point:	Line 1, Line 2	
Operation mode:	Transmitting mode	
Note:		

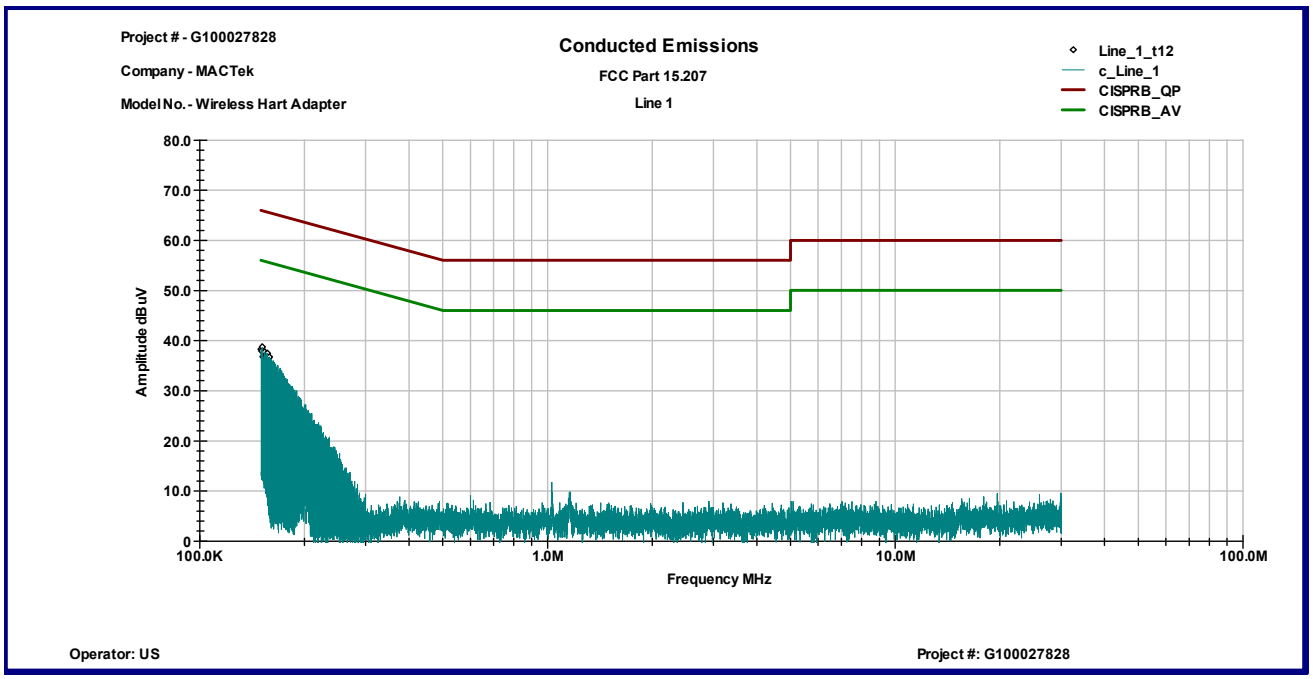
Table 3.6.1

Line 1

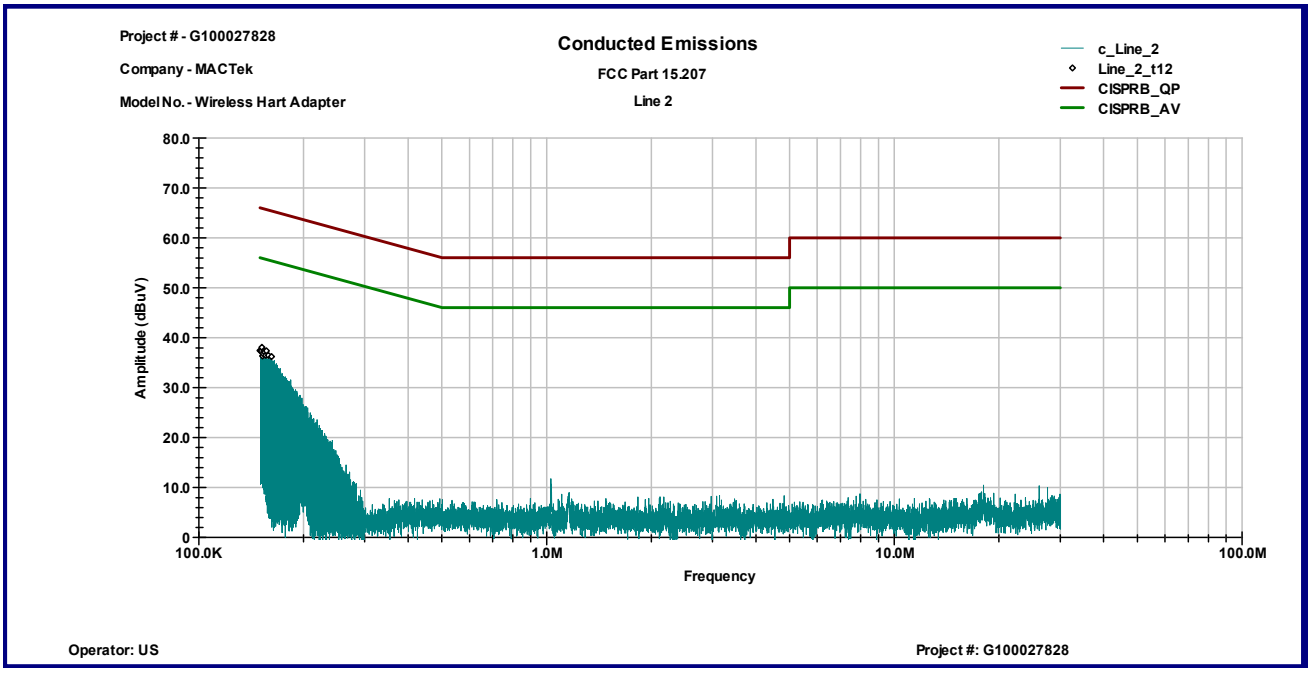
Frequency	Peak dBµV	QP Limit dBµV	AVG Limit dBµV	QP Margin dB	AVG Margin dB
150.08 KHz	38.3	66.0	56.0	-27.8	-17.8
152.02 KHz	36.8	65.9	55.9	-29.1	-19.1
153.96 KHz	37.7	65.8	55.8	-28.1	-18.1
158.54 KHz	36.7	65.5	55.5	-28.8	-18.8
600.00 KHz	9.0	56.0	46.0	-47.0	-37.0
1.027 MHz	11.7	56.0	46.0	-44.3	-34.3

Line 2

Frequency	Peak dBµV	QP Limit dBmV	AVG Limit dBmV	QP Margin dB	AVG Margin dB
150.0 KHz	37.4	66.0	56.0	-28.6	-18.6
152.64 KHz	36.3	65.9	55.9	-29.5	-19.5
153.96 KHz	37.3	65.8	55.8	-28.5	-18.5
156.52 KHz	37.4	65.7	55.7	-28.3	-18.3
161.73 KHz	36.2	65.4	55.4	-29.2	-19.2
1.027 MHz	11.8	56.0	46.0	-44.2	-34.2



Graph 3.6.1



Graph 3.6.2

3.7 Receiver/digital device radiated emissions

Test location: ☐ OATS ☒ Anechoric Chamber

Test distance: ☐ 10 meters ☒ 3 meters

Frequency Range: 30MHz to 12.5GHz (5th Harmonic)

Test result: **Pass**

Max. Emissions margin: 8.2dB below the limits

Notes: The Radiated Emissions test was performed in the Anechoic chamber at 3m measurement distance (see Tables 3.7.1, 3.7.2 and Graphs 3.7.1-3.7.4)

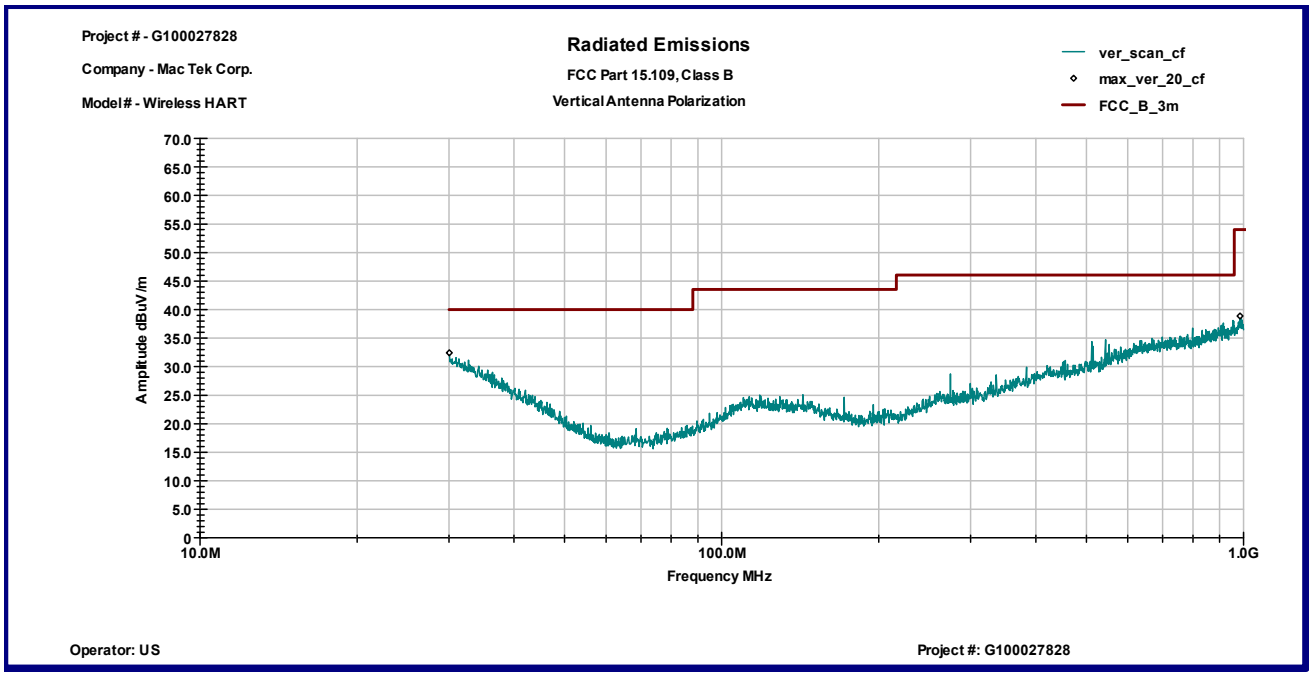
Date:	April 2, 2010	**Result:** **Pass**
Standard:	FCC Part 15.109, Class B	
Tested by:	Uri Spector	
Test Point:	Enclosure	
Operation mode:	Receiving/Stand by mode	
Note:		

Table 3.7.1

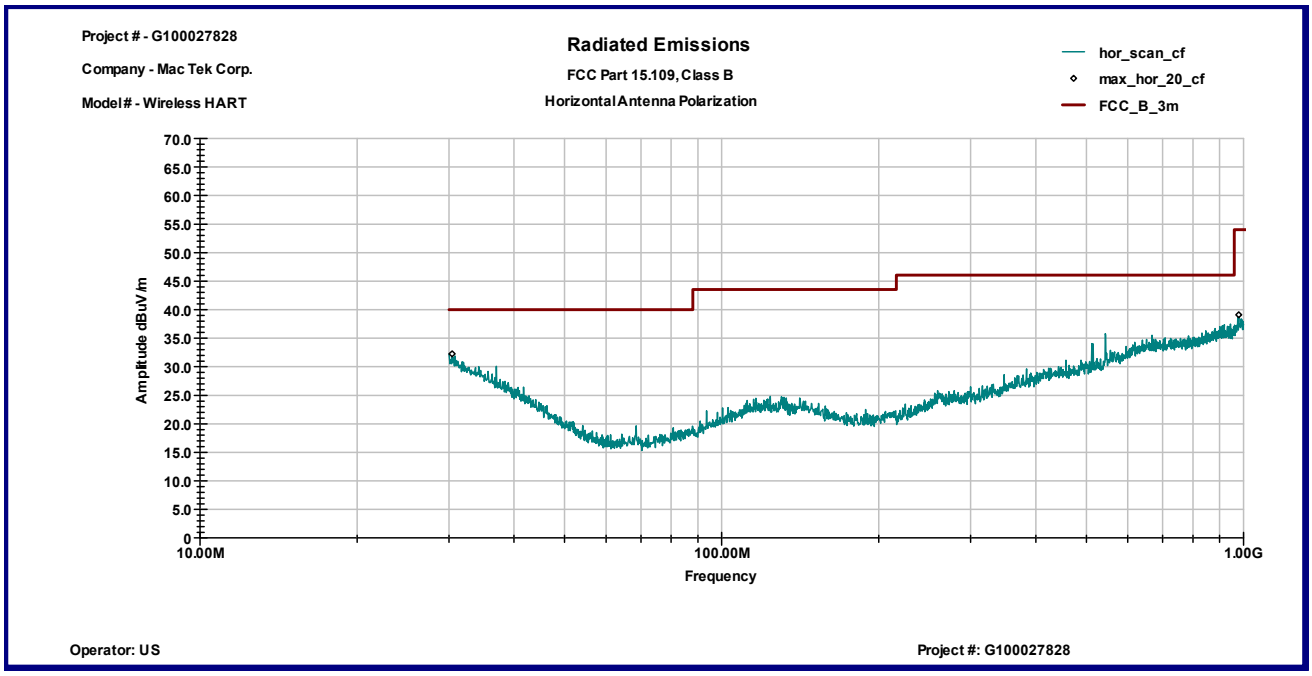
Frequency	Antenna		Ant. CF	Cable loss	Pre-amp	Peak Reading	Total @ 3m	Limit	Margin	Comments
MHz	Polarity	Hts(cm)	dB1/m	dB	Gain (dB)	dBµV	dBµV/m	dBµV/m	dB	
171.71	V	100	10.0	1.4	0.0	13.2	24.6	43.5	-18.9	
274.30	V	100	13.5	1.8	0.0	13.4	28.7	46.0	-17.3	
511.95	V	100	18.2	2.6	0.0	13.6	34.4	46.0	-11.6	
68.50	H	100	6.3	0.8	0.0	12.6	19.7	40.0	-20.3	
511.95	H	100	18.2	2.6	0.0	13.2	34.0	46.0	-12.0	

Table 3.7.2

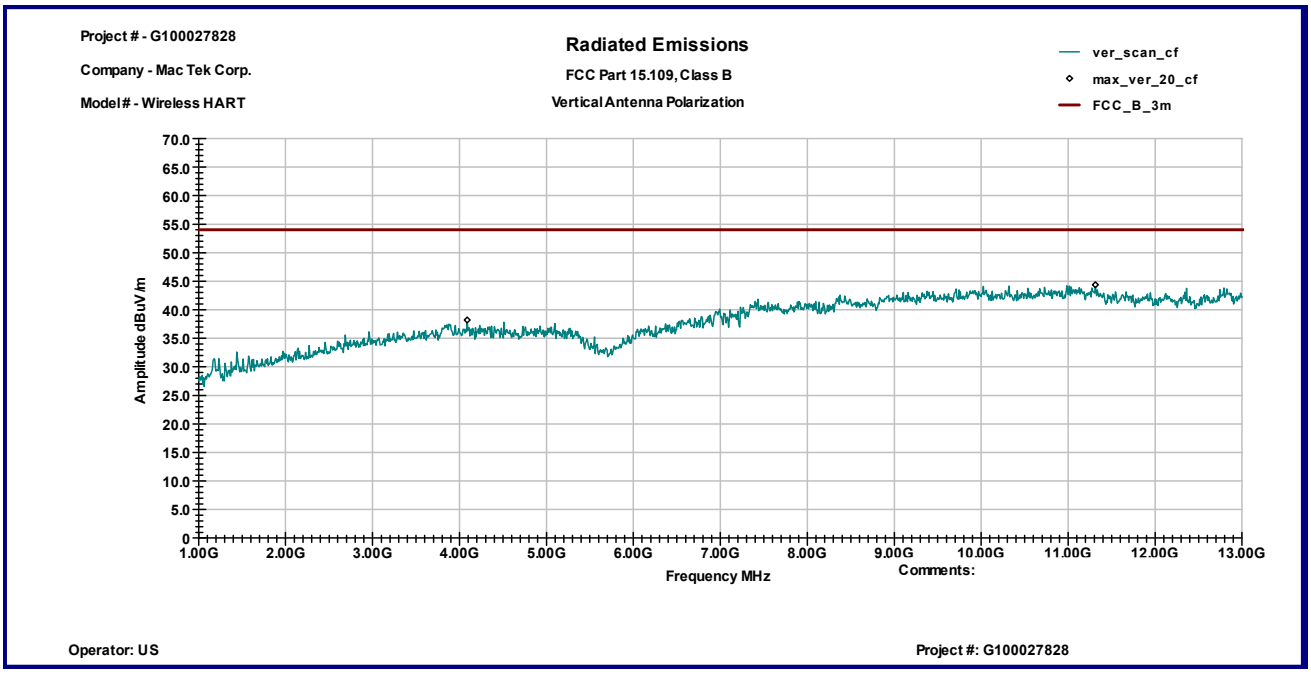
Frequency	Antenna	Peak Reading	Total C.F.	Pre-Amp.	Total at 3m	AVG Limit	Margin
MHz	Polarity	dBµV	dB1/m	Gain (dB)	dBµV/m	dBµV/m	dB
4.088 GHz	V	43.8	37.2	42.8	38.2	54.0	-15.8
11.312 GHz	V	38.2	47.0	40.9	44.4	54.0	-9.6
1.2352 GHz	H	49.4	27.0	42.6	33.8	54.0	-20.2
1.8736 GHz	H	54.7	29.8	43.1	41.4	54.0	-12.6
3.8344 GHz	H	45.9	36.6	43.0	39.5	54.0	-14.5
11.049 GHz	H	39.6	47.3	41.1	45.8	54.0	-8.2



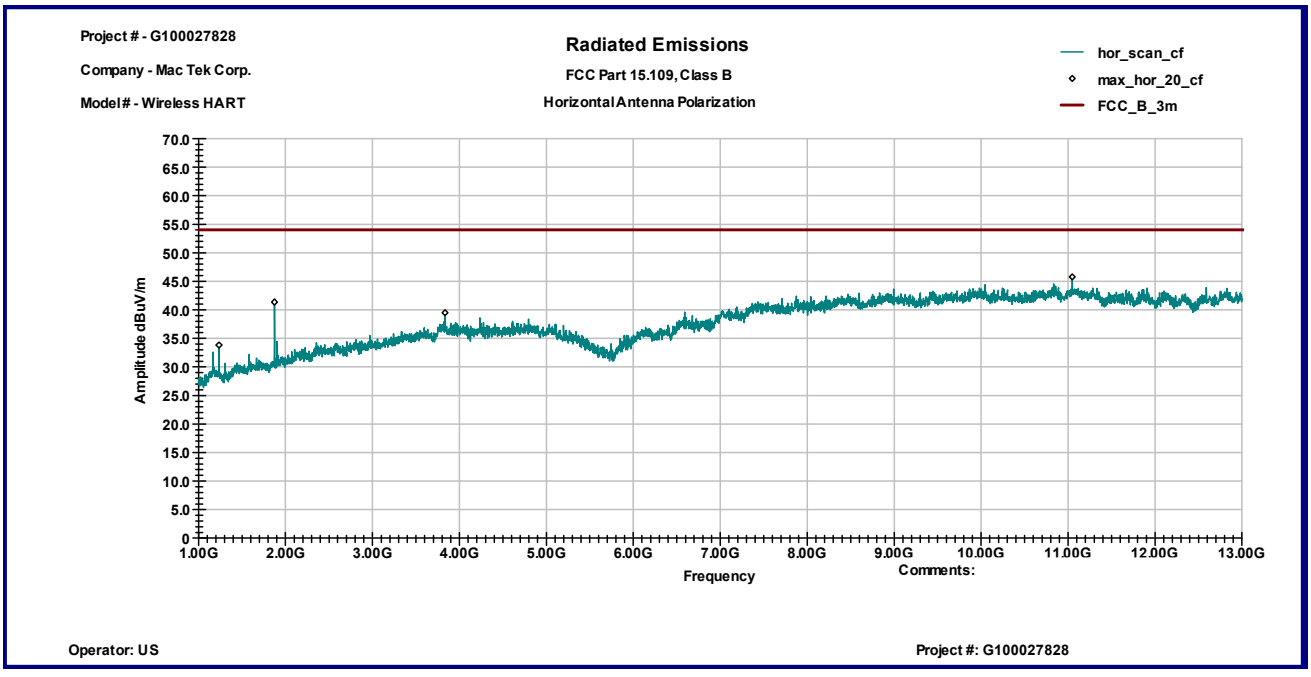
Graph 3.7.1



Graph 3.7.2



Graph 3.7.3



Graph 3.7.4

3.8 Digital device conducted emissions

Test location: ☐ OATS ☒ Anechoic Chamber ☐ Other

Test result: **Pass**

Frequency range: 0.15MHz-30MHz

Max. Emissions margin: 17.5dB below the limits

Notes: None

Date:	April 26, 2010	**Result:** **Pass**
Standard:	FCC Part 15.107, Class B	
Tested by:	Uri Spector	
Test Point:	Line 1 and Line 2	
Operation mode:	Receiving/Stand by mode	
Note:		

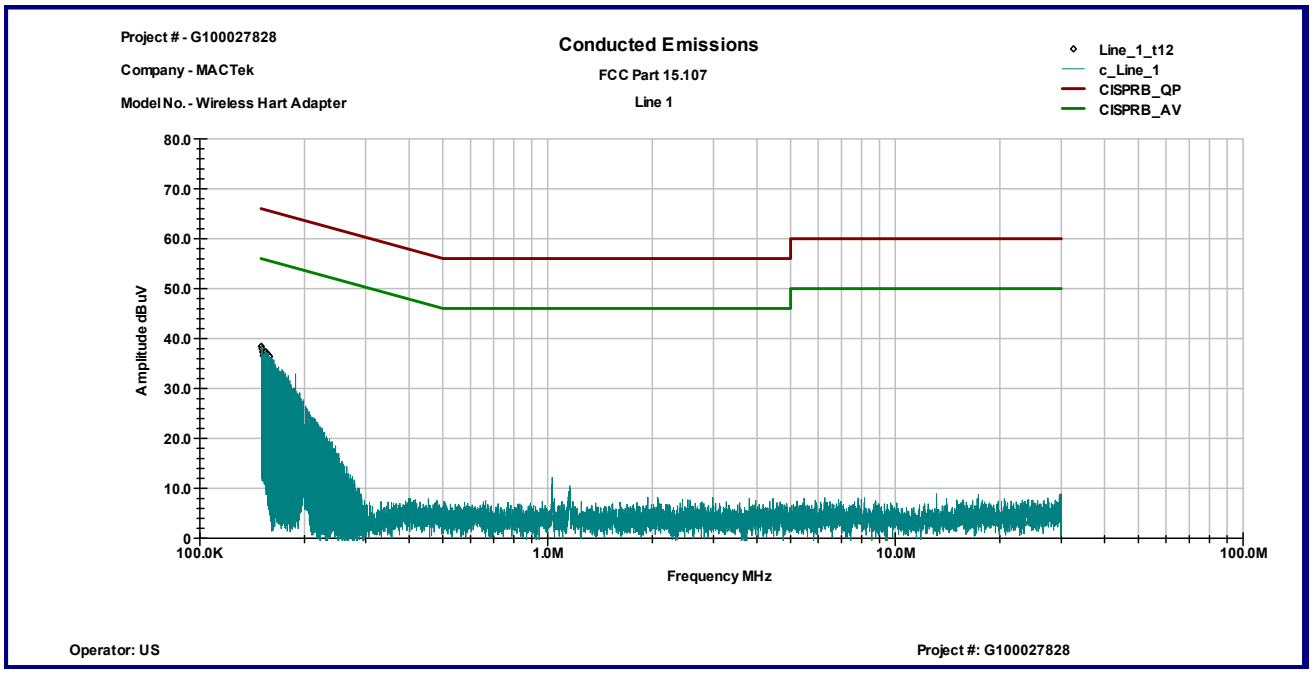
Table 3.8.1

Line 1

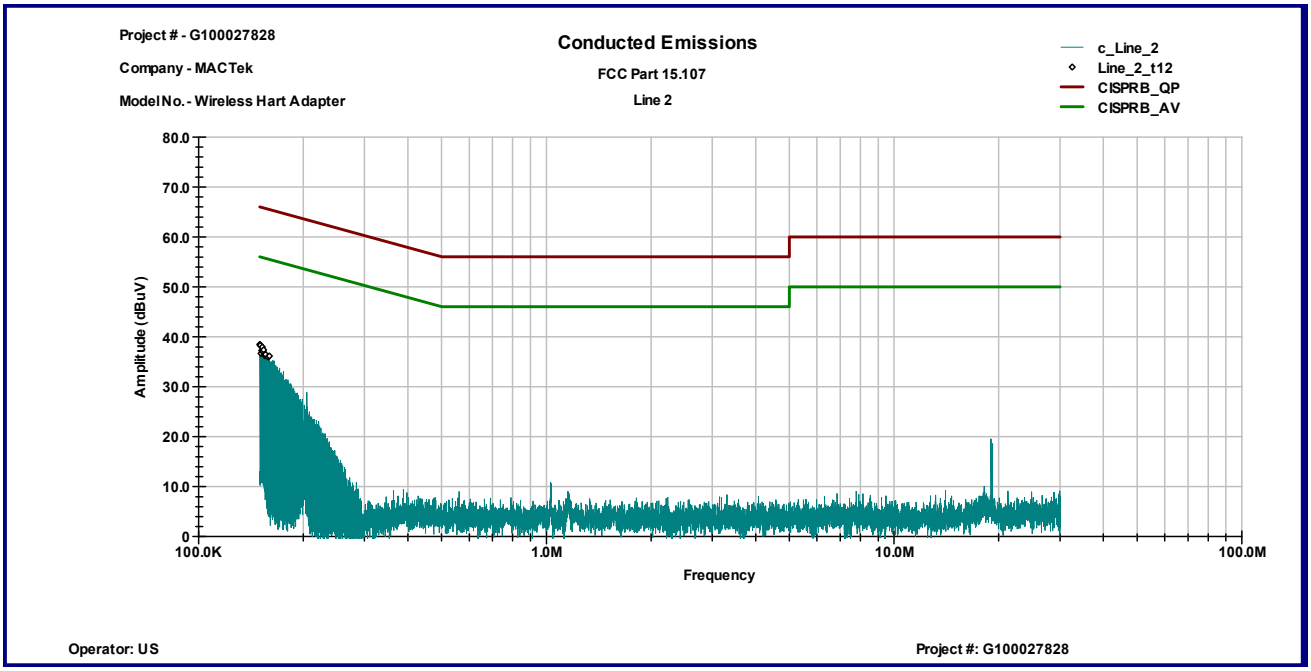
Frequency	Peak dBµV	QP Limit dBµV	AVG Limit dBµV	QP Margin dB	AVG Margin dB
150.23 KHz	38.4	66.0	56.0	-27.6	-17.6
151.55 KHz	37.3	65.9	55.9	-28.6	-18.6
153.5 KHz	37.0	65.8	55.8	-28.8	-18.8
154.82 KHz	37.3	65.7	55.7	-28.4	-18.4
157.46 KHz	36.7	65.6	55.6	-28.9	-18.9
1.031MHz	12.2	56.0	46.0	-43.8	-33.8

Line 2

Frequency	Peak dBµV	QP Limit dBmV	AVG Limit dBmV	QP Margin dB	AVG Margin dB
150.0 KHz	38.5	66.0	56.0	-27.5	-17.5
152.56 KHz	37.9	65.9	55.9	-28.0	-18.0
153.88 KHz	37.4	65.8	55.8	-28.4	-18.4
154.58 KHz	36.4	65.8	55.8	-29.4	-19.4
155.9 KHz	36.5	65.7	55.7	-29.2	-19.2
18.98MHz	19.5	60.0	50.0	-40.5	-30.5



Graph 3.8.1



Graph 3.8.1

4.0 TEST EQUIPMENT

DESCRIPTION	MANUFACTURER	MODEL	SERIAL NO.	INTERTEK ID	CAL DUE	USED
Spectrum Analyzer	R & S	FSP 40	100024	12559	09/10/2010	☒
Spectrum Analyzer	R & S	ESCI	100358	12909	05/18/2010	☒
Bicono-Log Antenna	Schaffner-Chase	CBL 6112 B	2468	14459	09/22/2010	☒
Horn Antenna	EMCO	3115	6579	15580	04/15/2010	☒
LISN	Fischer Custom Communications	FCC-LISN-50-25-2	2014	9665	11/30/2010	☒
Pre-Amplifier	MITEQ	AMF-5D-00501800-28-13P	1402232	172081	08/07/2010	☒
High Pass Filter	Reactel	7HS-4G-S12	0223	015274	VBU	☒
System	TILE! Instrument Control		Ver. 3.4.K.29	15259	VBU	☒