TEST REPORT

Report Number: 100586460MIN-001
Project Number: G100586460

Testing performed on the
CAT0000433

FCC ID: PQMASTOP2
Industry Canada ID: 4071-ASTOP2

to
47 CFR Part 15. 247:2010
RSS- 210, Issue 8, 2010
47 CFR, Part 15:2009, §15.107 and §15.109, Class B
ICES-003, Issue 4:2004
AS/NZS 4268:2008

For
Benchmark Electronics, Inc.

Test Performed by:	Test Authorized by:
Intertek Testing Services NA, Inc.	Benchmark Electronics, Inc.
7250 Hudson Blvd., Suite 100	3535 Technology Drive
Oakdale, MN 55128 USA	Rochester, MN 55901, USA

Prepared by: Richard Blonigen — Date: February 29, 2012

Reviewed by: Norman Shpilsher — Date: February 29, 2012

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1.0 GENERAL DESCRIPTION

Model:	CAT0000433
Type of EUT:	Remote Autonomous Stop
Serial Number:	00002-12F (continuous transmitting sample) 00003-12F (normal operating mode sample)
FCC ID:	PQMASTOP2
Industry Canada ID:	4071-ASTOP2
Related Submittal(s) Grants:	None
Company:	Benchmark Electronics, Inc.
Customer:	Mr. Joeseph Hlavka
Address:	3535 Technology Drive Rochester, MN 55901, USA
Phone:	(507) 535-4265
Fax:	(507) 535-4828
e-mail:	Joseph.hlavka@bench.com
Test Standards:	☒ 47 CFR, Part 15:2010, §15.247 ☒ RSS–210, Issue 8, 2010 ☒ RSS-Gen, Issue 3, 2010 ☒ 47 CFR, Part 15:2010, §15.107 and §15.109, Class B ☒ ICES-003, Issue 4:2004 ☒ AS/NZS 4268:2008
Type of radio:	☒ Stand -alone ☐ Module ☐ Hybrid
Date Sample Submitted:	January 3, 2012
Test Work Started:	January 3, 2012
Test Work Completed:	January 4, 2012
Test Sample Conditions:	☐ Damaged ☐Poor (Usable) ☒ Good

1.1 Product Description; Test Facility

Product Description:	919MHz Transceiver
Transmitter Type:	☐ FHSS ☒ Digital Modulation ☐ WiFi ☐ Blue Tooth
Operating Frequency Range(s):	919MHz
Number of Channels:	1
Modulation:	2-FSK
Emission Designator:	570KFIDBN
Antenna(s) Info:	Integral Antenna Antenna Gain: -1dBi
Antenna Installation:	☐ User ☐ Professional ☒ Factory
Transmitter power configuration:	☐ Internal battery ☐ External power source ☒ 100-240VAC ☐ 230VAC ☐ 400VAC ☐ VDC ☐ Other: 0.4 Amp. ☒ 50/60Hz ☐ 60Hz
Special Test Arrangement:	None
Test Facility Accreditation:	A2LA (Certificate No. 1427.01)
Test Methodology:	Measurements performed according to the procedures in ANSI C63.10-2009 and FCC DTS Measurement Guide

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 919MHz transmitting frequency

Cables:

No.	Type	Length	Designation	Note
1	2-wire unshielded	2m	AC	

Support equipment/Services:

No.	Item	Description
1	none	

General notes:

1. S/N 00003-12F was used for transmitting portion of testing and S/N 00002-12F was used for standby portion of testing.
2. Power Supply MW170KB0503B01 was used during testing as EUT can operate in AC charging mode or battery mode. AC charging mode was determined to be worst case.

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)

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	Antenna conducted spurious emissions	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 / RSS-Gen	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

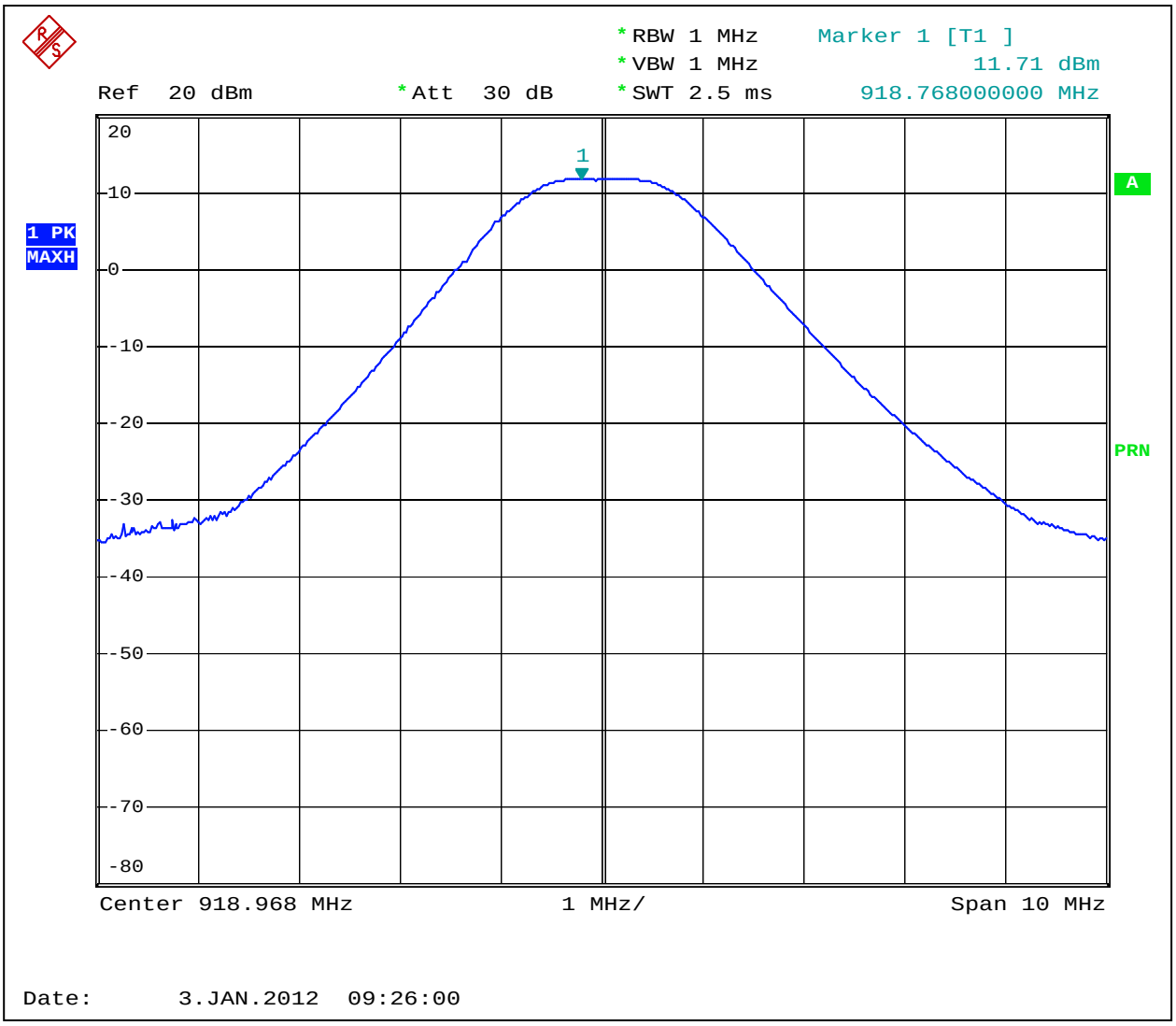
Test location: ☐ OATS ☒ Anechoic Chamber ☐ Other

Test result: **Pass**

Max. Margin: 17.99 dB below the limits

Power Output:	**Conducted**					
Frequency Range:	☒ 902-928MHz ☐ 2400-2483.5MHz ☐ 5725-5850MHz					
	Measured power dBm	**Attenuaton dB**	**Power at Antenna dBm**	**Limit dBm**	**Limit Reduction dB**	**Margin dB**
919 MHz	11.71	0.3	12.01	30.00	0	-17.99
RBW:	☒ 1MHz ☐ 3MHz ☐ 10MHz					
VBW:	☒ 1MHz ☐ 3MHz ☐ 10MHz					
Antenna Gain:	☒ < 6dBi ☐ >6dBi and = dBi, Output power reduction = dB					

Notes:


*RBW 1 MHz
*VBW 1 MHz
*SWT 2.5 ms
Marker 1 [T1]
11.71 dBm
918.768000000 MHz
Ref 20 dBm
*Att 30 dB
1 PK
MAXH
A
PRN
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Center 918.968 MHz
1 MHz/
Span 10 MHz
Date: 3.JAN.2012 09:26:00

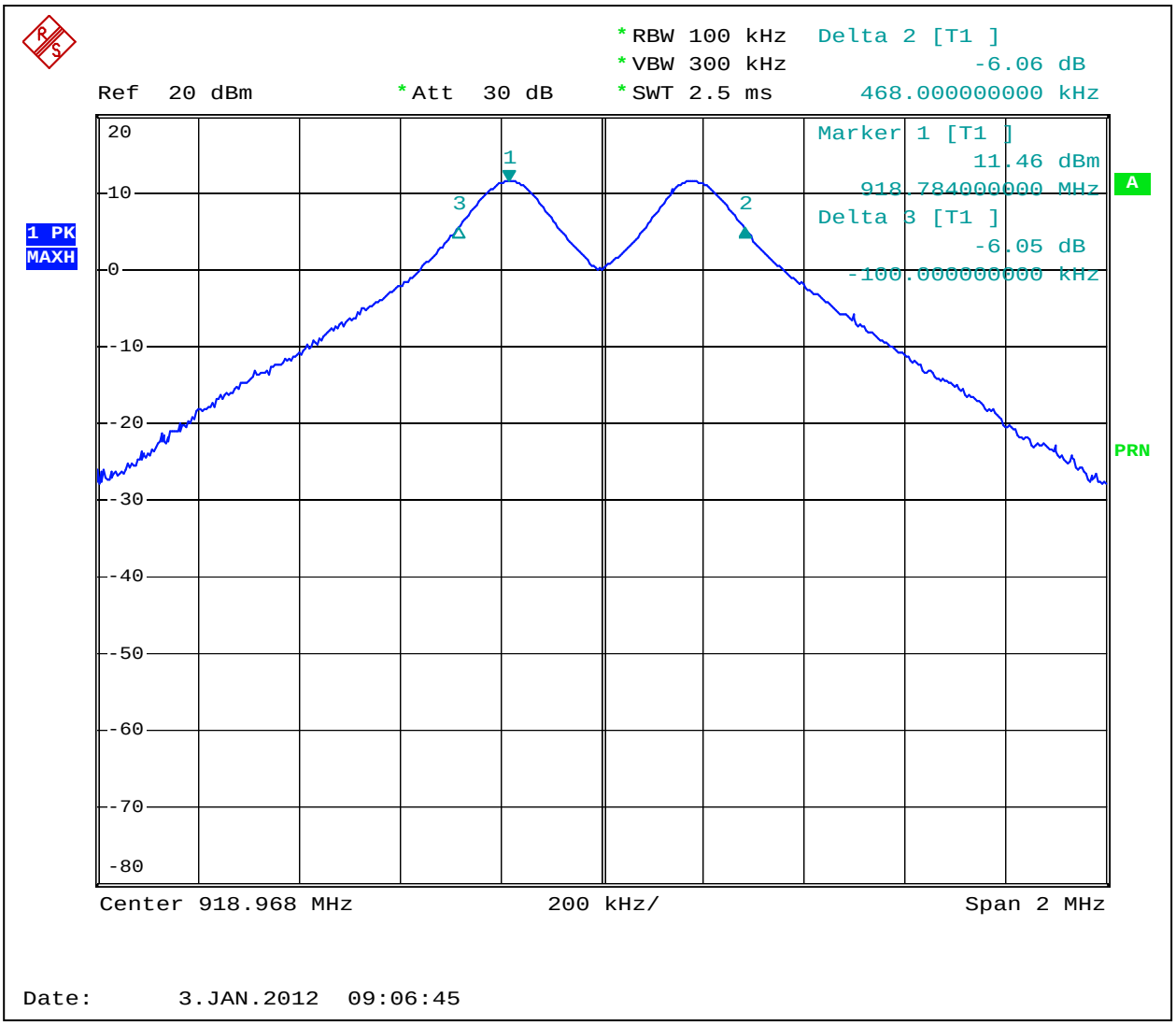
Graph 3.1.1

3.2 6dB bandwidth of the digital modulation

919MHz Channel kHz	Minimum Bandwidth kHz	Result
568	500	**Pass**

RBW:	☒ 100kHz	☐ other	kHz
VBW:	☐ 100kHz	☒ 300kHz	☐ other kHz

Notes:

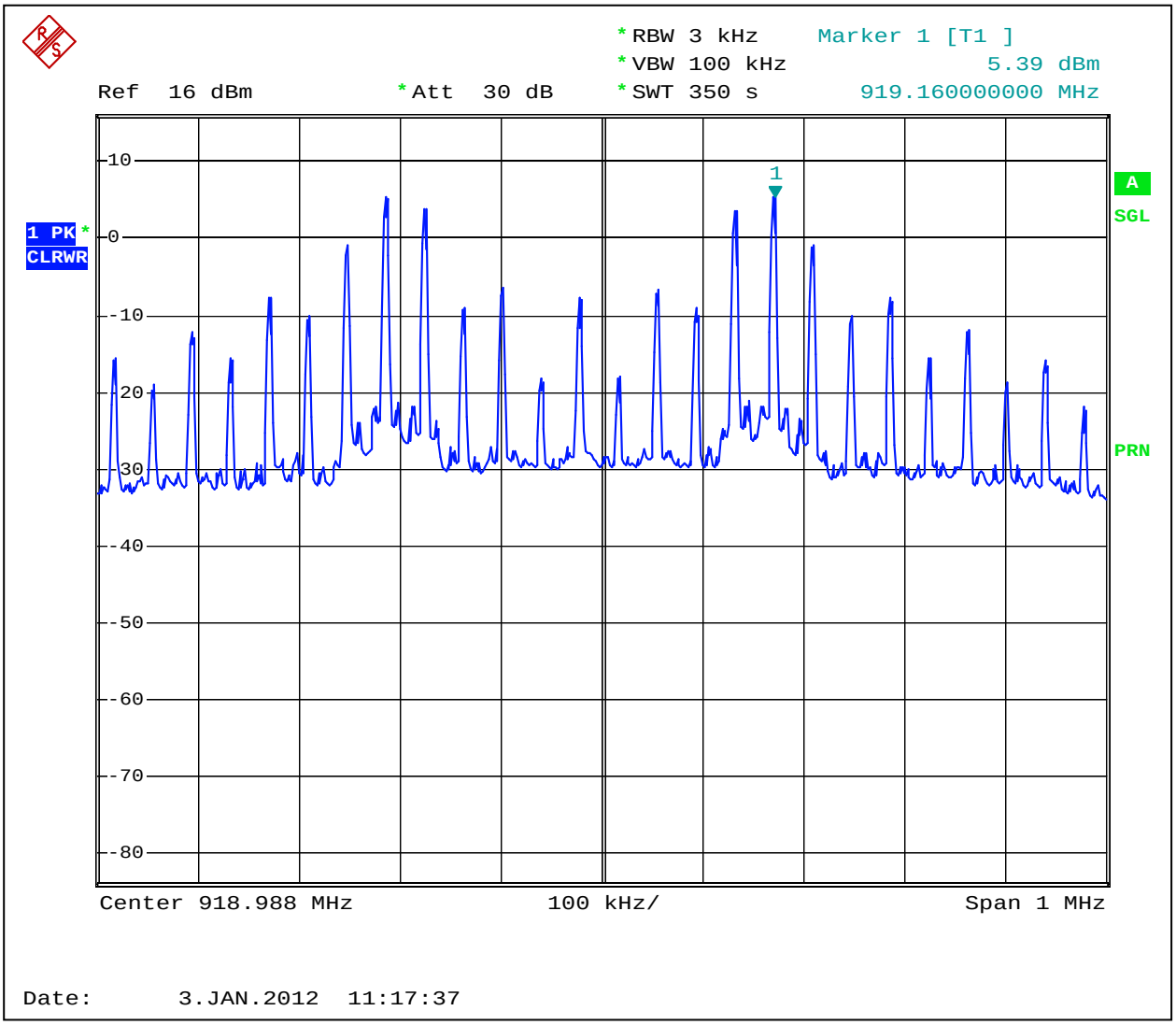

*RBW 100 kHz
*VBW 300 kHz
Ref 20 dBm
*Att 30 dB
*SWT 2.5 ms
Delta 2 [T1]
-6.06 dB
468.000000000 kHz
Marker 1 [T1]
11.46 dBm
918.784000000 MHz
Delta 3 [T1]
-6.05 dB
-100.000000000 kHz
1 PK
MAXH
A
PRN
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Center 918.968 MHz
200 kHz/
Span 2 MHz
Date: 3.JAN.2012 09:06:45

Graph 3.2.1

3.3 Power spectral density

Power Output:	☒ Conducted ☐ Radiated			
	Measured Density dBm	**Power Spectral Density dBm**	**Limit dBm**	**Margin dB**
919MHz Channel	5.39	5.69	8	-2.31
Analyzer Settings:	☒ RBW=3KHz ☒ VBW=100KHz ☒ Span=1MHz ☒ Sweep=350sec			
Antenna Gain:	☐ < 6dBi and = dBi ☐ >6dBi and = dBi, limit reduction = dB			

Notes: The Power Spectral Density was calculated adding the cable/attenuator loss of 0.3 dB from the measured density value.

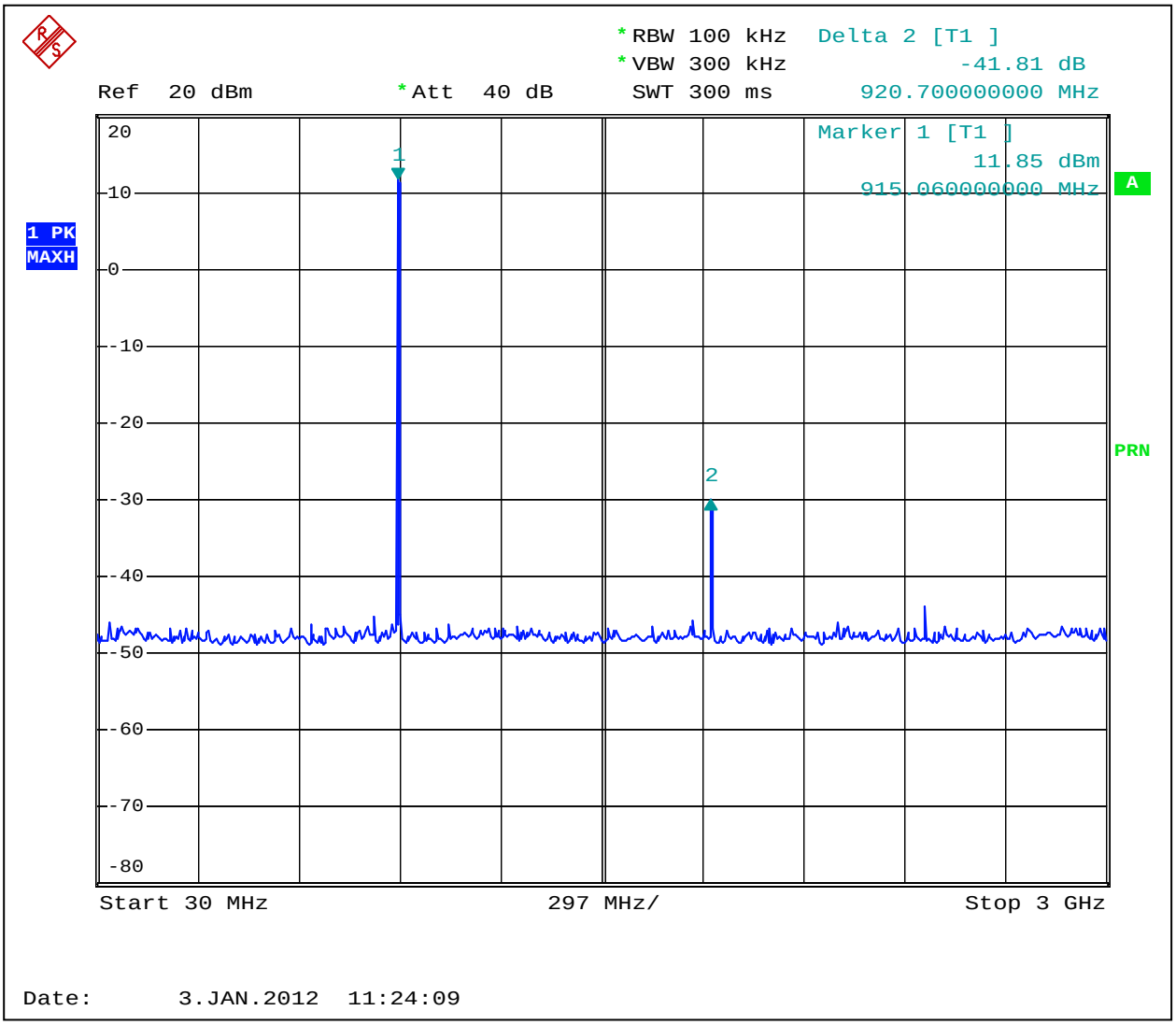

*RBW 3 kHz
*VBW 100 kHz
*SWT 350 s
Marker 1 [T1]
5.39 dBm
919.160000000 MHz
Ref 16 dBm
*Att 30 dB
1 PK *
CLRWR
A
SGL
PRN
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Center 918.988 MHz
100 kHz/
Span 1 MHz
Date: 3.JAN.2012 11:17:37

Graph 3.3.1

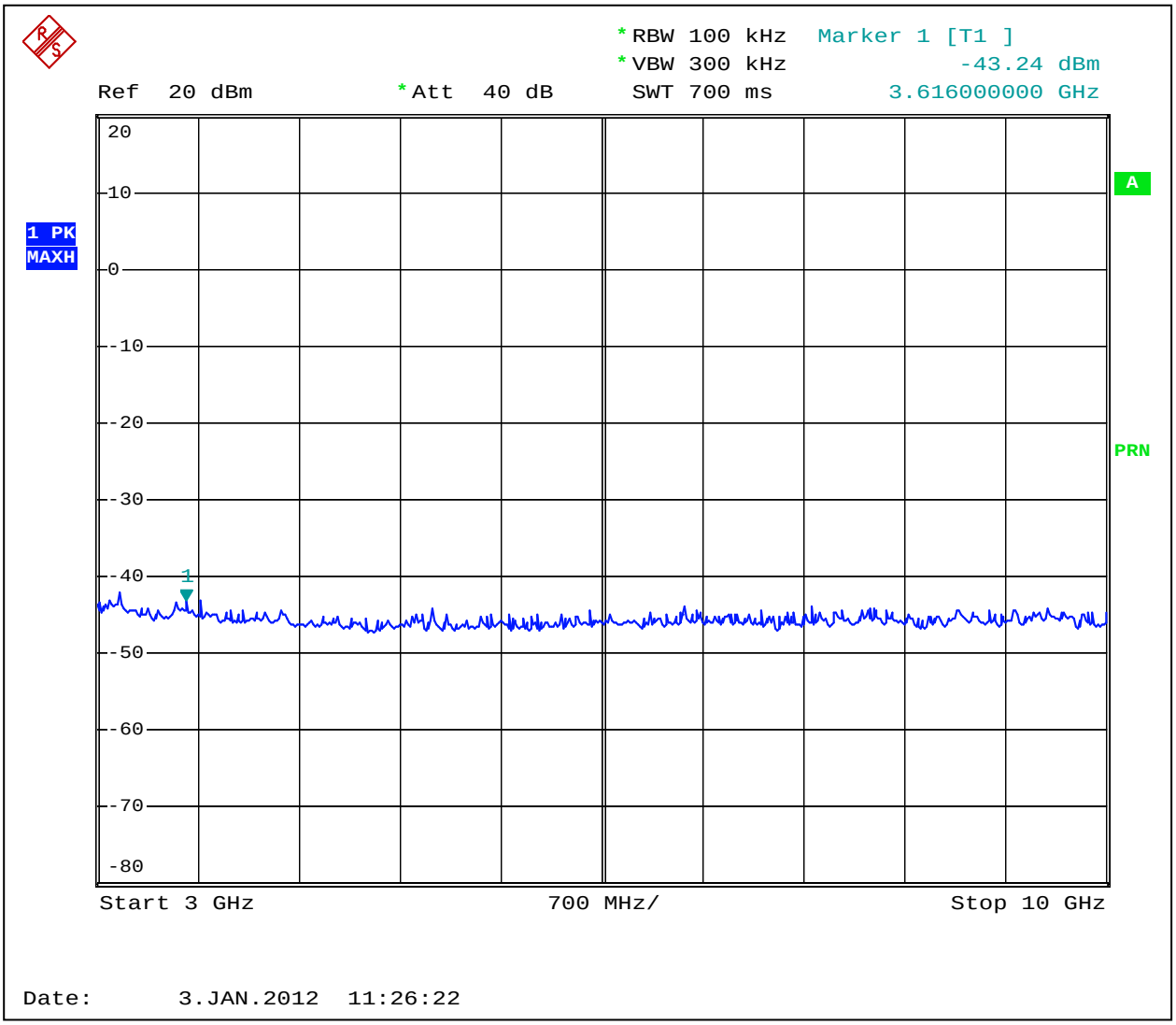
3.4 Antenna conducted spurious emissions

	Minimum Measured Attenuation dB	Minimum Allowed Attenuation dB	Margin dB
919 MHz Channel	41.21	20	-21.21
Analyzer Settings:	☒ RBW=100KHz		
Minimum Allowed Attenuation:	☒ 20dB ☐ 30dB (for digital systems with conducted power measured using RMS averaging over a time interval)		

Notes:


*RBW 100 kHz
*VBW 300 kHz
SWT 300 ms
Delta 2 [T1]
-41.81 dB
920.700000000 MHz
Ref 20 dBm
*Att 40 dB
Marker 1 [T1]
11.85 dBm
915.060000000 MHz
1 PK
MAXH
A
PRN
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start 30 MHz
297 MHz/
Stop 3 GHz
Date: 3.JAN.2012 11:24:09

Graph 3.4.1


*RBW 100 kHz
*VBW 300 kHz
Ref 20 dBm
*Att 40 dB
SWT 700 ms
Marker 1 [T1]
-43.24 dBm
3.616000000 GHz
1 PK
MAXH
A
PRN
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1
Start 3 GHz
700 MHz/
Stop 10 GHz
Date: 3.JAN.2012 11:26:22

Graph 3.4.2

3.5 Radiated spurious emissions

Test location: ☐ OATS ☒ Anechoic Chamber ☐ Other

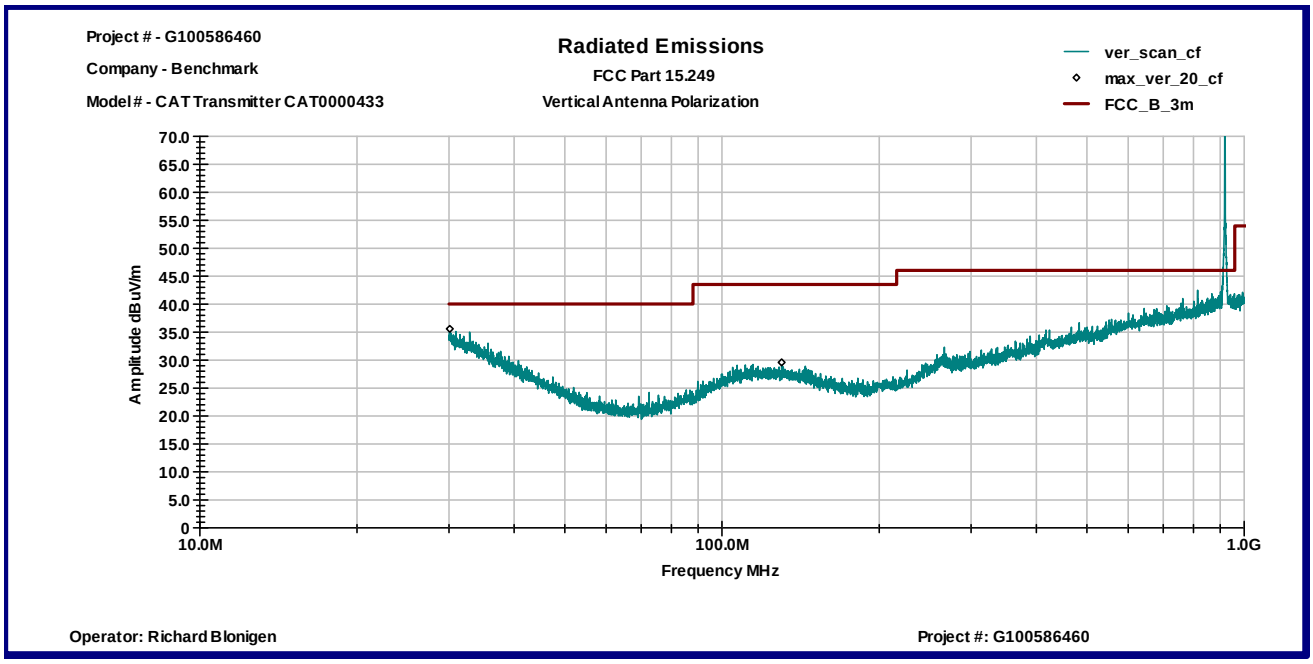
Test result: **Pass**

Max. Margin: 4.4 dB below the limits

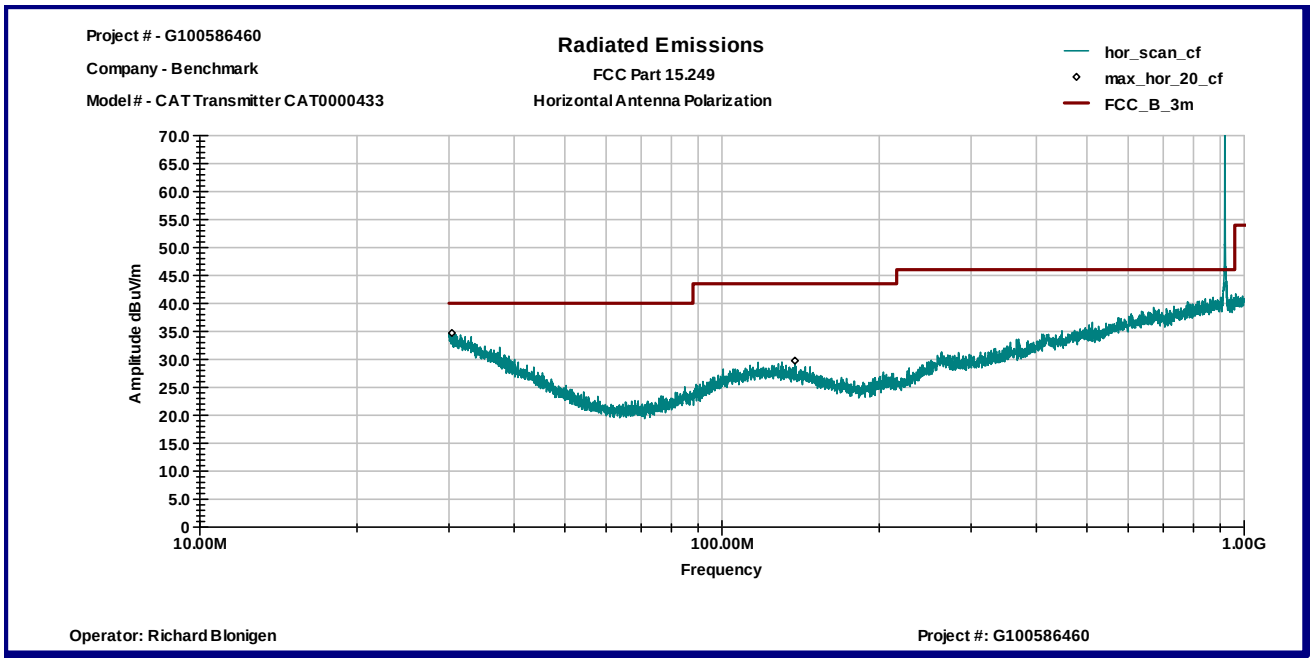
Date:	January 3, 2012	**Result:** **Pass**
Standard:	FCC part 15.247(d)	
Tested by:	Richard Blonigen / Simon Khazon	
Test Point:	919MHz channel	
Operation mode:	See Page 5	
Note:	Frequencies in unrestricted band were removed from graph	

Table 3.5.1

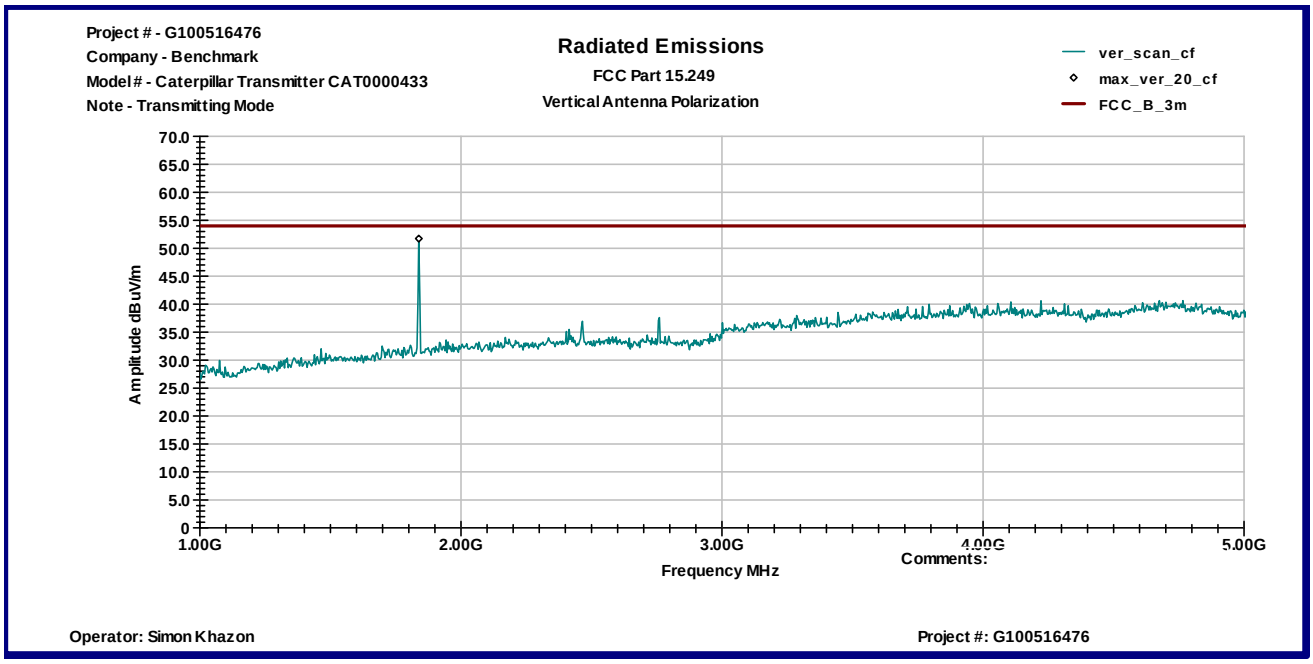
Frequency MHz	Antenna Polarity	Peak Reading dBµV	Total C.F. dB1/m	Pre-Amp. Gain (dB)	Total at 3m dBµV/m	Limit dBµV/m	Margin dB
30.117 MHz	V	15.3	20.3	0.0	35.6	40.0	-4.4
130.12 MHz	V	15.8	13.8	0.0	29.6	43.5	-13.9
6.4288 GHz	V	48.9	39.2	42.0	46.0	54.0	-8.0
9.1936 GHz	V	45.3	43.6	40.5	48.4	54.0	-5.6
30.397 MHz	H	14.6	20.1	0.0	34.7	40.0	-5.3
137.96 MHz	H	16.3	13.5	0.0	29.8	43.5	-13.8
9.8668 GHz	H	43.8	44.3	41.2	46.9	54.0	-7.1



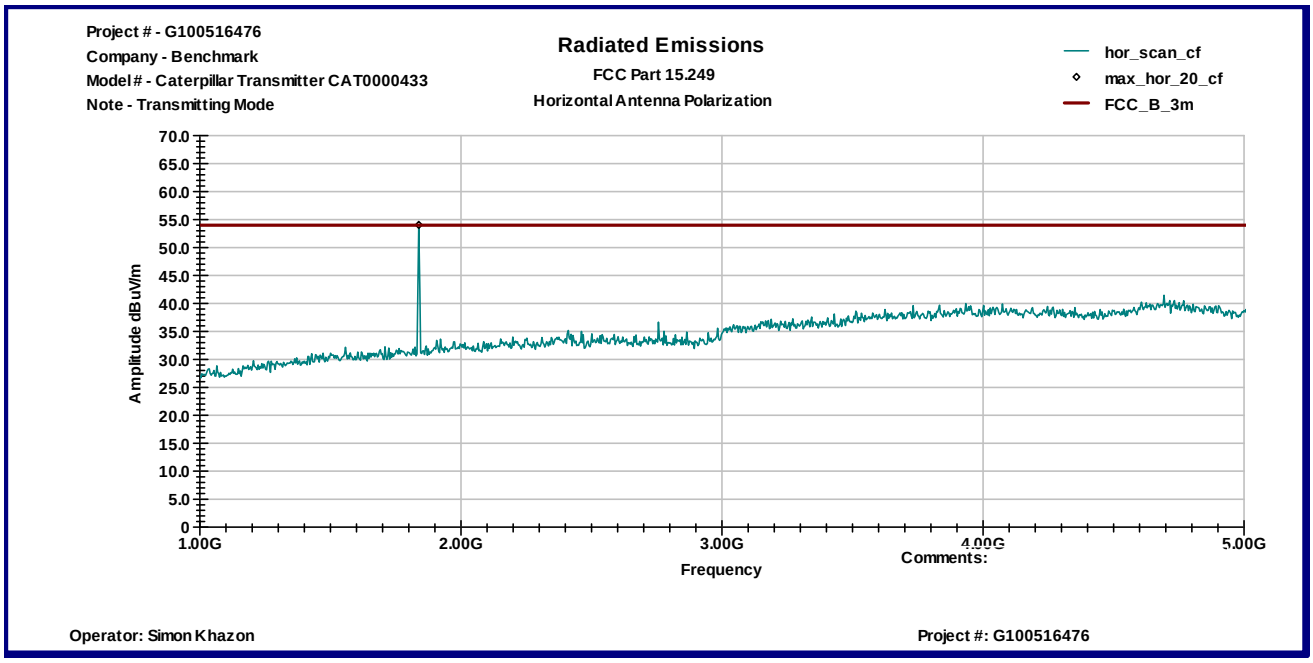
Graph 3.5.1



Graph 3.5.2



Graph 3.5.3



Graph 3.5.4

3.6 RF Exposure Compliance

The maximum measured antenna conducted power, P is 12 dBm

The antenna gain, G is -1dBi

The maximum EIRP power = P + G
ERP = 12+ -1= 11dBm, or 0.013W

The limits for Maximum Permissible Exposure (MPE) for transmitter operating at 902-928MHz, MPE is 919/1500 = 0.6mW/cm^2, or 6W/m^2

The Power Density, S is related to EIRP with the equation:
S = EIRP / 4πD^2, where D is the safe separation distance and = 0.2m, or 20cm
S = 13mW / 4π20^2,
S = 0.003mW/cm^2, or below the Maximum Permissible Exposure (MPE) of 0.6mW/cm^2

3.7 Transmitter power line conducted emissions

Test location: ☐ OATS ☒ Anechoic Chamber ☐ Other

Test result: **Pass**

Frequency range: 0.15MHz-30MHz

Max. Emissions margin: 4.5 dB below the limits

Notes:

Date:	January 3, 2012	**Result:** **Pass**
Standard:	FCC 15.207	
Tested by:	Simon Khazon	
Test Point:	Power Line	
Operation mode:	See Page 5	
Note:	None	

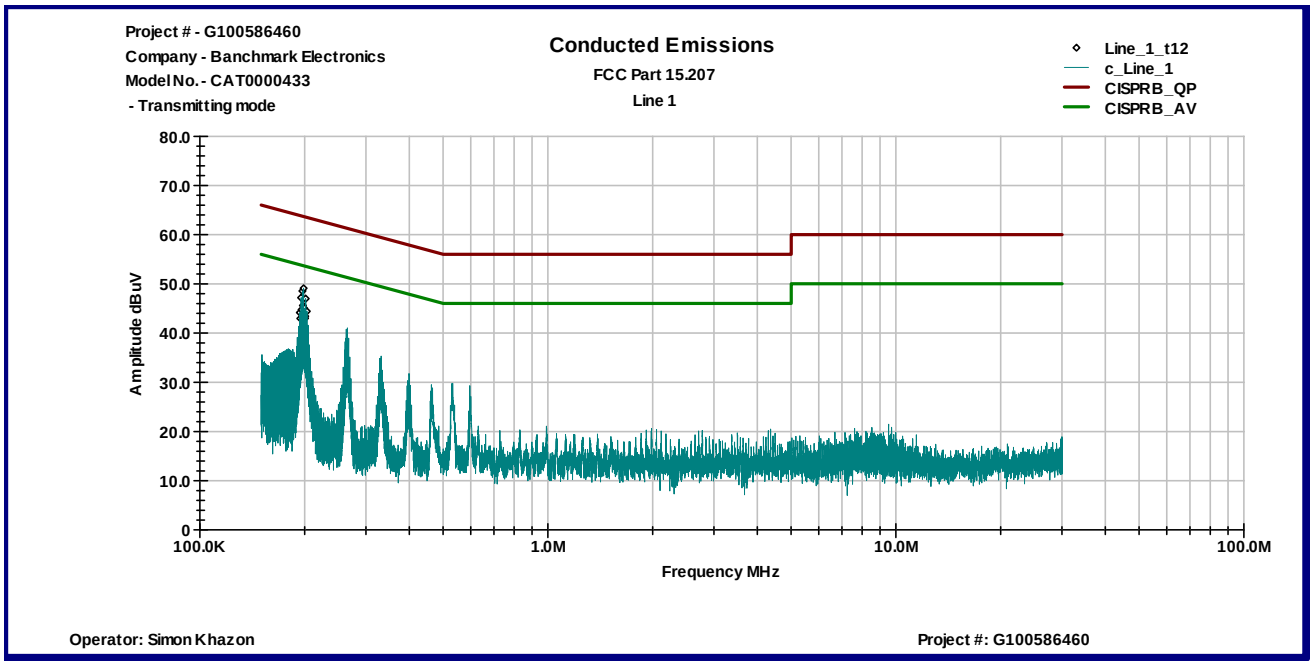
Table 3.7.1

Line 1

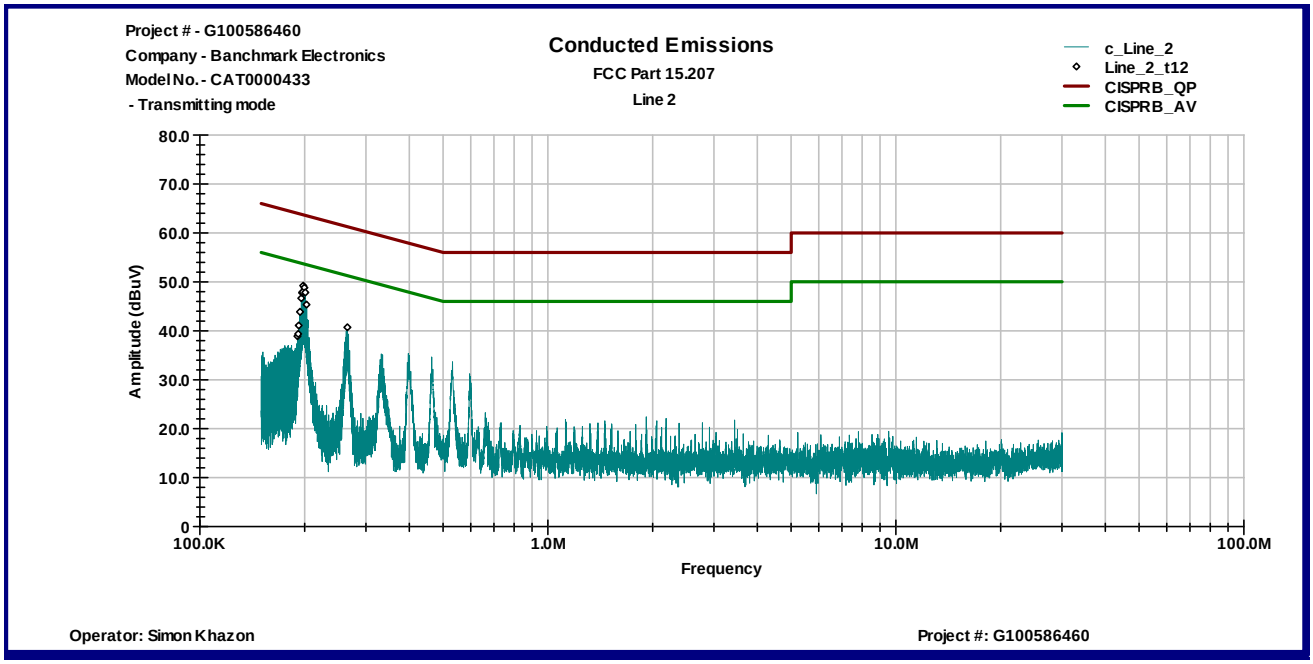
Frequency	Peak dBµV	QP Limit dBµV	AVG Limit dBµV	QP Margin dB	AVG Margin dB
193.73 KHz	44.1	63.9	53.9	-19.7	-9.7
194.41 KHz	43.0	63.9	53.9	-20.9	-10.9
195.39 KHz	47.2	63.8	53.8	-16.6	-6.6
196.08 KHz	44.8	63.8	53.8	-19.0	-9.0
197.05 KHz	48.5	63.7	53.7	-15.2	-5.2
197.74 KHz	45.6	63.7	53.7	-18.1	-8.1
198.62 KHz	49.1	63.7	53.7	-14.6	-4.6
199.3 KHz	45.1	63.6	53.6	-18.6	-8.6
200.48 KHz	43.0	63.6	53.6	-20.6	-10.6
200.67 KHz	43.4	63.6	53.6	-20.2	-10.2
201.36 KHz	47.0	63.6	53.6	-16.6	-6.6
202.92 KHz	44.4	63.5	53.5	-19.1	-9.1

Line 2

Frequency	Peak dBµV	QP Limit dBmV	AVG Limit dBmV	QP Margin dB	AVG Margin dB
190.79 KHz	38.9	64.0	54.0	-25.1	-15.1
191.67 KHz	39.4	64.0	54.0	-24.6	-14.6
192.36 KHz	41.1	63.9	53.9	-22.9	-12.9
194.02 KHz	43.9	63.9	53.9	-20.0	-10.0
195.68 KHz	46.7	63.8	53.8	-17.1	-7.1
196.56 KHz	47.8	63.8	53.8	-16.0	-6.0
197.25 KHz	47.9	63.7	53.7	-15.8	-5.8
198.13 KHz	49.2	63.7	53.7	-14.5	-4.5
199.79 KHz	48.8	63.6	53.6	-14.8	-4.8
200.87 KHz	47.8	63.6	53.6	-15.8	-5.8
202.53 KHz	45.4	63.5	53.5	-18.2	-8.2
265.31 KHz	40.7	61.3	51.3	-20.6	-10.6



Graph 3.7.1



Graph 3.7.2

3.8 Receiver/digital device radiated emissions

Test location: ☐ OATS ☒ Anechoic Chamber

Test distance: ☐ 10 meters ☒ 3 meters

Test result: **Pass**

Frequency range: 30MHz-5000MHz

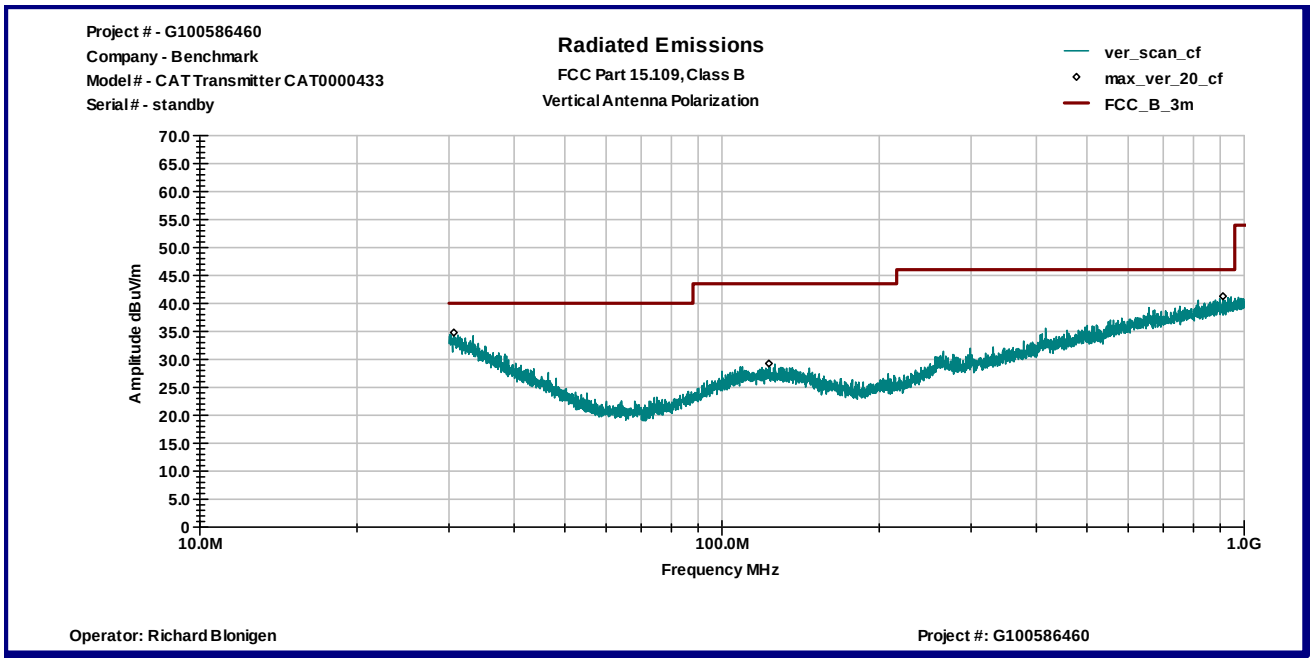
Max. Emissions margin: 4.7 dB below the limits

Notes: The Radiated Emissions test was performed in the Anechoic chamber at 3m measurement distance (see Table 3.11.1 and Graphs 3.11.1 - 3.11.4)

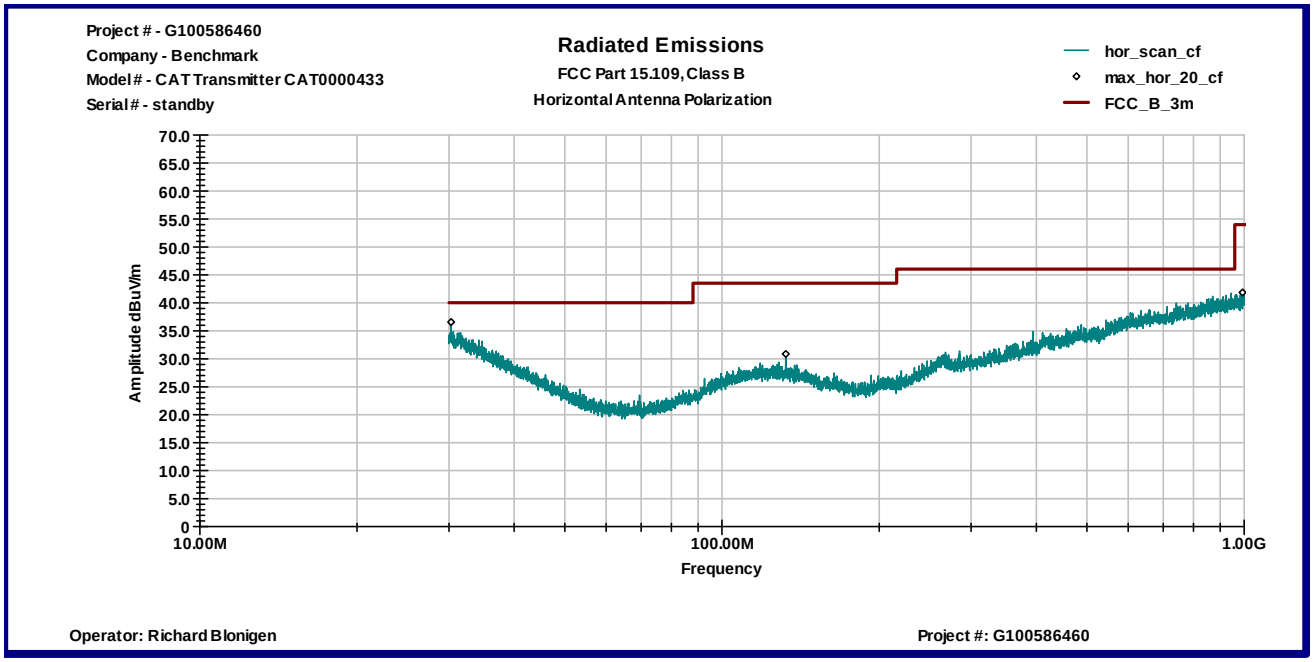
Date:	January 3, 2012	**Result:** **Pass**
Standard:	FCC Part 15.109, Class B	
Tested by:	Richard Blonigen / Simon Khazon	
Test Point:	Enclosure	
Operation mode:	Standby	
Note:	None	

Table 3.8.1

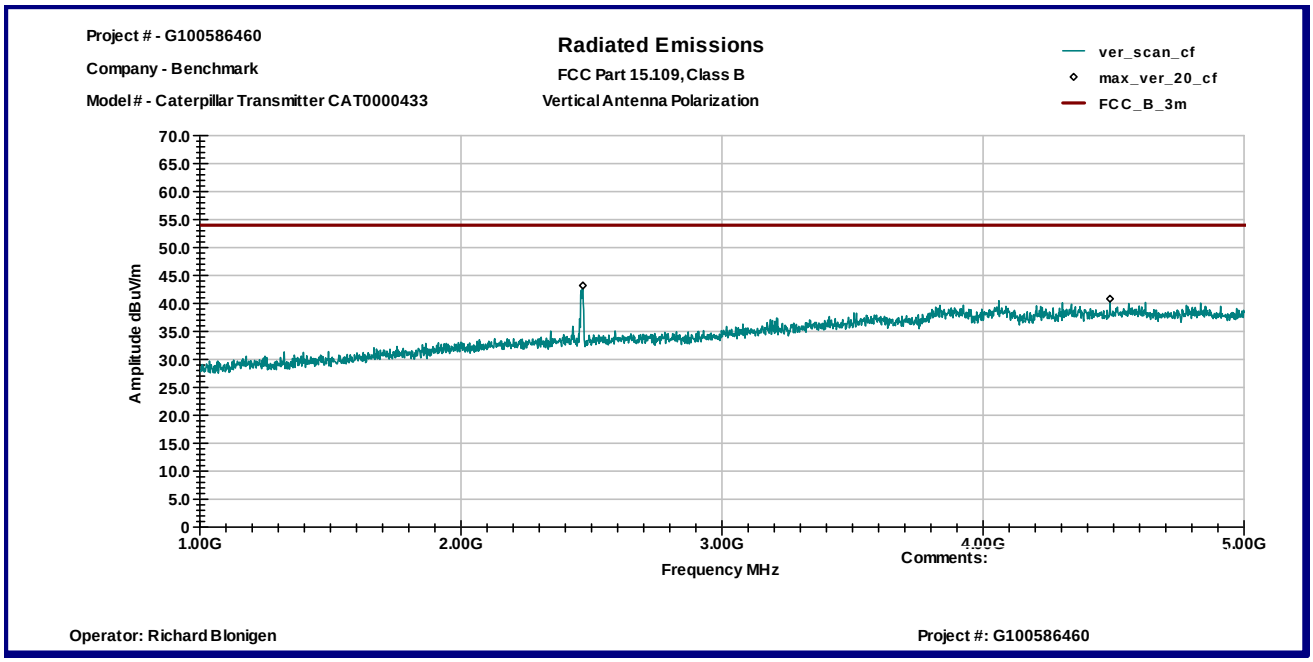
Frequency MHz	Antenna Polarity	Peak Reading dBµV	Total C.F. dB1/m	Pre-Amp. Gain (dB)	Total at 3m dBµV/m	Limit dBµV/m	Margin dB
30.654 MHz	V	14.8	20.0	0.0	34.8	40.0	-5.2
122.98 MHz	V	15.3	14.0	0.0	29.3	43.5	-14.3
910.99 MHz	V	15.8	25.4	0.0	41.3	46.0	-4.7
2.4672 GHz	V	55.0	31.6	43.5	43.2	54.0	-10.8
4.4864 GHz	V	46.3	36.8	42.3	40.8	54.0	-13.2
30.28 MHz	H	14.6	20.2	0.0	34.8	40.0	-5.2
132.47 MHz	H	17.1	13.8	0.0	30.8	43.5	-12.7
993.36 MHz	H	15.5	26.4	0.0	41.8	54.0	-12.1
2.4656 GHz	H	54.1	31.5	43.5	42.1	54.0	-11.9
4.5104 GHz	H	46.1	36.8	42.2	40.6	54.0	-13.4



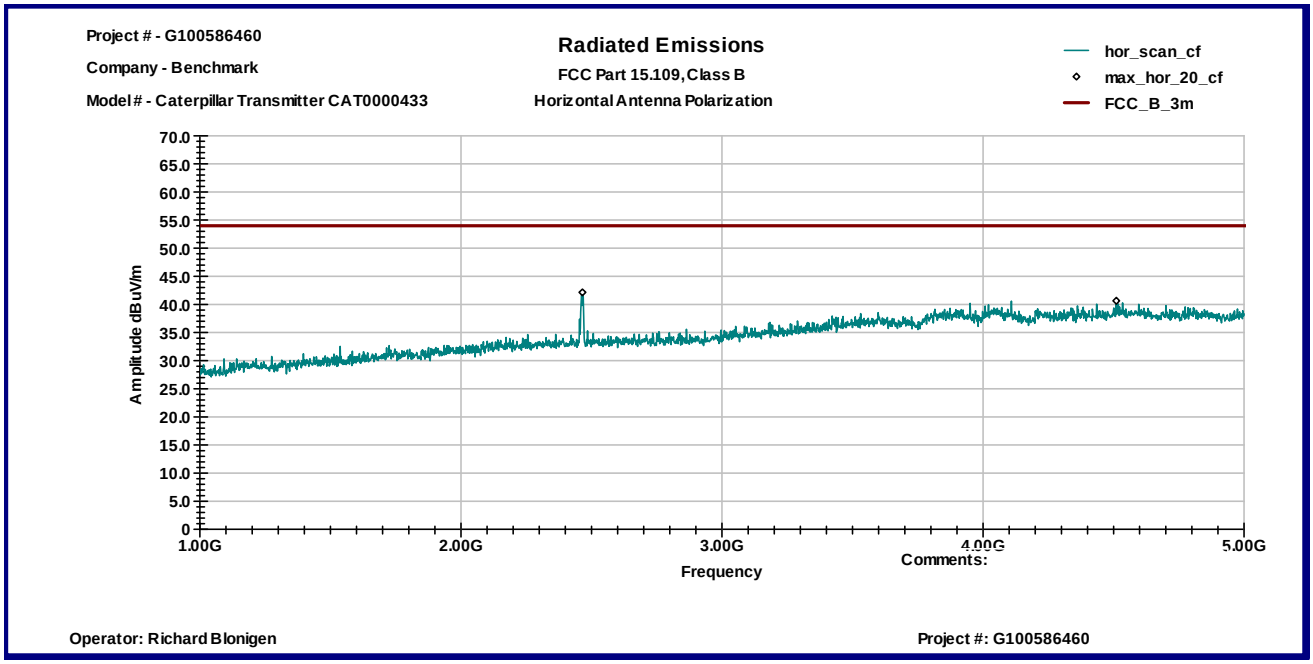
Graph 3.8.1



Graph 3.8.2



Graph 3.8.3



Graph 3.8.4

3.9 Digital device conducted emissions

Test location: ☐ OATS ☒ Anechoic Chamber ☐ Other

Test result: **Pass**

Frequency range: 0.15MHz-30MHz

Max. Emissions margin: 19.3 dB below the limits

Notes:

Date:	January 3, 2012	**Result:** **Pass**
Standard:	FCC 15.107, Class B	
Tested by:	Simon Khazon	
Test Point:	Power Line	
Operation mode:	Standby	
Note:	120VAC 60Hz	

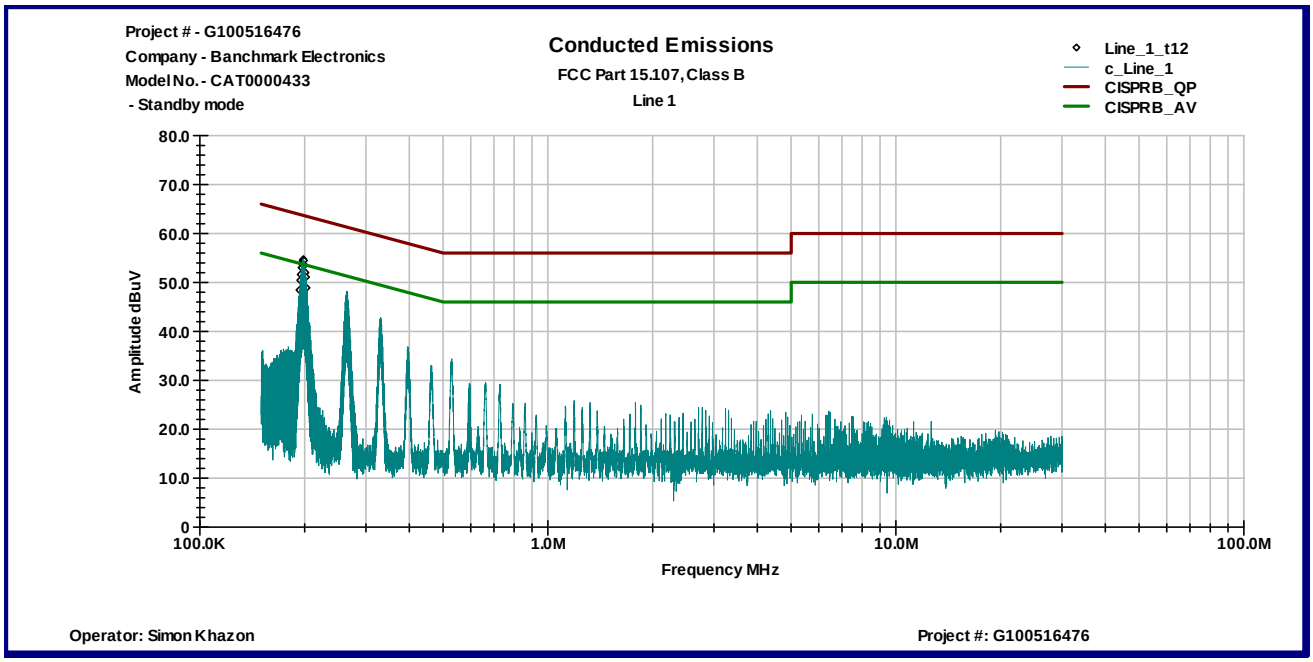
Table 3.9.1

Line 1

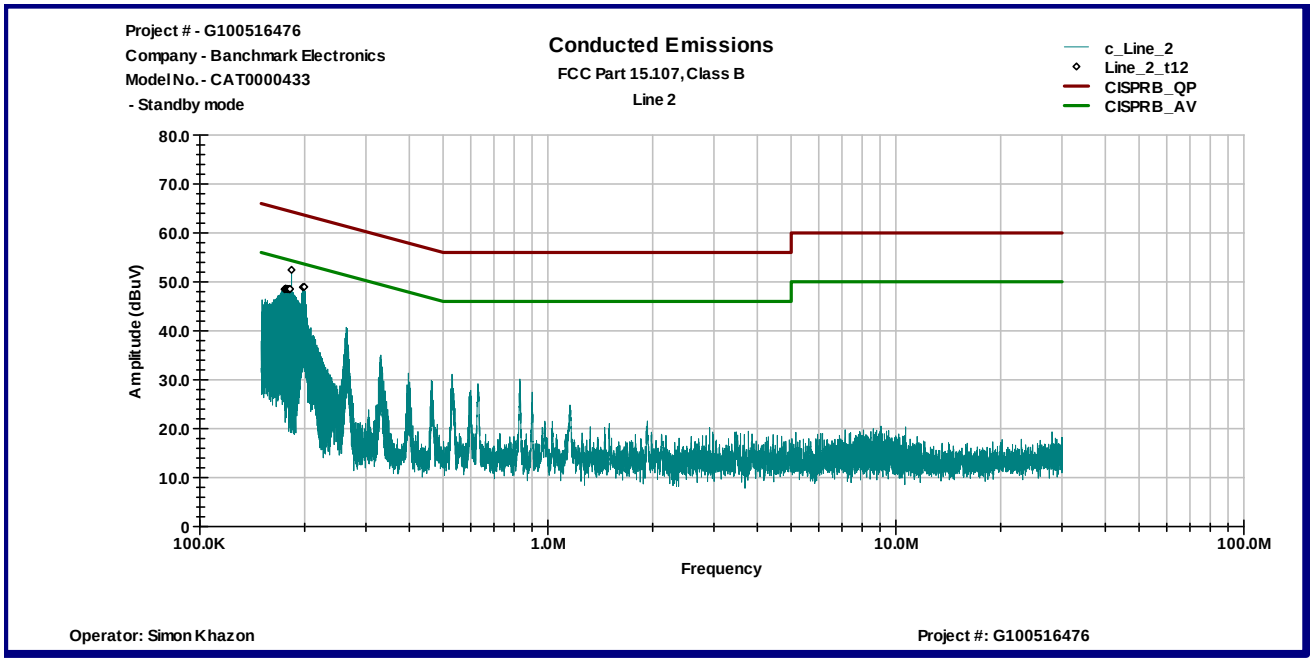
Frequency	QP dBµV	AVG dBµV	QP Limit dBµV	AVG Limit dBµV	QP Margin dB	AVG Margin dB
195.12 KHz	41.7	25.5	63.8	53.8	-22.1	-28.3
197.07 KHz	44.0	27.4	63.7	53.7	-19.8	-26.3
197.17 KHz	44.1	27.5	63.7	53.7	-19.6	-26.2
197.24 KHz	44.1	27.5	63.7	53.7	-19.6	-26.2
199.11 KHz	44.4	27.8	63.7	53.7	-19.3	-25.8
200.5 KHz	43.3	27.0	63.6	53.6	-20.3	-26.6

Line 2

Frequency	QP dBµV	AVG dBµV	QP Limit dBµV	AVG Limit dBµV	QP Margin dB	AVG Margin dB
172.79 KHz	42.3	23.7	64.8	54.8	-22.5	-31.2
174.94 KHz	42.5	22.8	64.7	54.7	-22.3	-32.0
178.13 KHz	43.1	20.3	64.6	54.6	-21.5	-34.3
179.53 KHz	43.3	20.1	64.5	54.5	-21.3	-34.4
197.44 KHz	43.6	25.6	63.7	53.7	-20.1	-28.1
201.12 KHz	42.3	24.7	63.6	53.6	-21.3	-28.9



Graph 3.9.1



Graph 3.9.2

4.0 TEST EQUIPMENT

DESCRIPTION	MANUFACTURER	MODEL	SERIAL NO.	INTERTEK ID	CAL DUE	USED
Spectrum Analyzer	R & S	FSP 40	100024	12559	11/17/2012	☒
Spectrum Analyzer	R & S	ESCI	100358	12909	05/12/2012	☒
Bicono-Log Antenna	Schaffner-Chase	CBL 6112 B	2468	9734	11/08/2012	☒
Horn Antenna	EMCO	3115	9507-4513	9936	04/29/2012	☒
LISN	Fischer Custom Communications	FCC-LISN-2 MOD.SD	316	9945	05/26/2012	☒
Pre-Amplifier	MITEQ	AMF-5D-00501800-28-13P	1402232	172081	10/31/2012	☒
System	TILE! Instrument Control		Ver. 3.4.K.29	15259	VBU	☒