

TEST REPORT

Report Number: 100387380MPK-001

Project Number: G100387380

Report Date: May 15, 2012

**Testing performed on the
DIG UHF-II Radio Module**

Model: 05-100926-01LF

FCC ID: LCB-100926

IC ID: 6050B-100926

to

FCC Part 15 Subpart C (15.247)

RSS-210 Issue 8

FCC Part 15, Subpart B

Industry Canada ICES-003

for

Topcon Positioning Systems, Inc.

Test Performed by:

Intertek
1365 Adams Court
Menlo Park, CA 94025

Test Authorized by:

Topcon Positioning Systems, Inc.
7449 Southfront Rd
Livermore, CA 94551, USA

Prepared by:


Krishna K Vemuri

Date:

May 15, 2012

Reviewed by:


Bryan Taylor

Date:

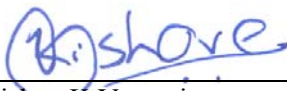
May 15, 2012

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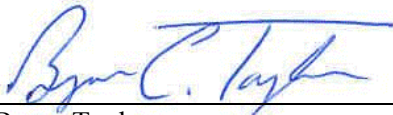
Report No. 100387380MPK-001

Equipment Under Test:	DIG UHF-II Radio Module
Trade Name:	Topcon Positioning Systems, Inc.
Model No.:	05-100926-01LF
FCC ID:	LCB-100926
IC ID:	6050B-100926
Applicant:	Topcon Positioning Systems, Inc.
Contact:	Mr. Leonid Edelman
Address:	7449 Southfront Rd Livermore, CA 94551
Country	USA
Tel. Number:	(925) 245-8406
Fax number:	(925) 460-1318
Email:	Ledelman@topcon.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) RSS-210 Issue 8 FCC Part 15, Subpart B Industry Canada ICES-003
Test Site Location:	ITS – Site 1 1365 Adams Drive Menlo Park, CA 94025
Date of Test:	September 19 to November 22, 2011

We attest to the accuracy of this report:



Krishna K Vemuri
EMC Senior Staff Engineer



Bryan Taylor
EMC Team Leader

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1.0 Introduction

The Equipment Under Test (EUT) is the DIG UHF-II Radio Module, model number 05-100926-01LF, consists of one UHF radio and one Bluetooth radio. This test report covers only the Bluetooth radio. A separate test report, report # 100387380MPK-003, covers the UHF radio. In actual use both radios are used simultaneously; therefore, the investigation was performed on the Bluetooth radio when the EUT was simultaneously transmitting with the UHF radio.

The DIG UHF-II is used for commercial, indoor and outdoor use.

This report is designed to show compliance of the 2.4 GHz transceiver with the requirements of FCC Part 15 Subpart C (15.247) and RSS-210.

1.1 Summary of Tests

TEST	REFERENCE FCC Part 15 Subpart C (15.247)	REFERENCE RSS-210	RESULTS
RF output power	15.247(b)	A8.4	Complies
20-dB Bandwidth	15.247(a)(1)	A8.1(a)	Complies
Channel Separation	15.247(a)(1)	A8.1(b)	Complies
Number of Hopping Channels	15.247(a)(1)	A8.1(d)	Complies
Average Channel Occupancy Time	15.247(a)(1)	A8.1(d)	Complies
Out-of-Band Antenna Conducted Emission	15.247(d)	A8.5	Complies
Transmitter Radiated Emissions	15.247(d), 15.209, 15.205	A8.5, 2.2	Complies
RF Exposure	15.247(i)	RSS-102	Complies
AC Conducted Emission	15.207	RSS-GEN	Complies
Radiated Emission from Digital Parts and Receiver	15.109	ICES-003	Complies
Antenna Requirement	15.203	RSS-GEN	Complies. The EUT does not have an external antenna connector



2.0 General Description

2.1 Product Description

The Equipment Under Test (EUT) is the DIG UHF-II Radio Module, model number 05-100926-01LF, consists of one UHF radio and one Bluetooth radio.

The DIG UHF-II is used for commercial, indoor and outdoor use.

Overview of the EUT

Applicant	Topcon Positioning Systems, Inc. 7449 Southfront Rd Livermore, CA 94551 USA
Manufacturer Name & Address	Topcon Positioning Systems, Inc. 7449 Southfront Rd Livermore, CA 94551 USA
Trade Name & Part No.	05-100926-01LF
FCC Identifier	LCB-100926
IC Identifier	6050B-100926
Use of Product	DIG UHF-II Radio Module
Type of Transmission	Spread Spectrum, Frequency Hopping
Rated RF Output	1 mW
Frequency Range	2402-2480 MHz
Number of Channel(s)	79
Modulation Type	GFSK
Data Rate	1 Mbps
Antenna(s) Gain	4.0 dBi

EUT receive date: September 19 , 2011

EUT receive condition: The prototype version of the EUT was received in good condition with no apparent damage. As declared by the Applicant it is identical to production units.

Test start date: September 19 , 2011

Test completion date: November 22, 2011



2.2 Related Submittal(s) Grants

None.

2.3 Test Methodology

Radiated and AC Line conducted emissions measurements were performed according to the procedures in ANSI C63.4. Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Data Sheet**" of this Application. All other measurements were made in accordance with the procedures described in the FCC Document DA 00-705.

2.4 Test Facility

Then radiated emission test site and conducted measurement facility used to collect the data is 10m semi-anechoic chamber located in Menlo Park, California. This test facility and site measurement data have been fully placed on file with the FCC.

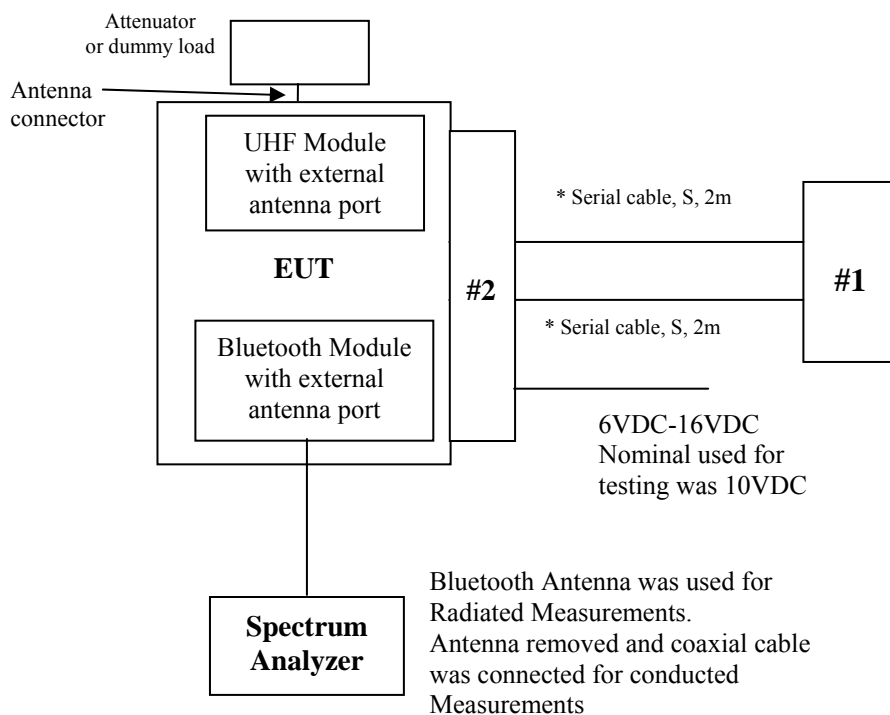
3.0 System Test Configuration

3.1 Support Equipment

Item #	Description	Model No.	Serial No.
1	Compaq Laptop	nc6400	CND7062PVK
2	Topcon Test Board	Not Labeled	Not Labeled

3.2 Block Diagram of Test Setup

The diagram shown below details the interconnection of the EUT and support equipment. For specific layout, refer to the test configuration photograph in the relevant section of this report.



* The DIG UHF-II Radio Module is a radio module intended to be installed in a host and does not contain any serial cables. The serial cables were used for setup purposes only which allowed control of the radio by test software. Radio tests were performed without these cables.

S = Shielded U = Unshielded	F = With Ferrite m = Length in Meters
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3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table. The EUT is attached to peripherals and they are connected and operational (as typical as possible). The EUT is wired to transmit full power. During testing, all cables are manipulated to produce worst-case emissions.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was provided by Topcon.

3.5 Mode of Operation During Test

The EUT was tested in two transmit modes:

1. Hopping mode as in normal use
2. Hopping disabled mode in which the EUT was transmitting at the lowest, middle, and highest channels.

Also, the EUT was tested in Receive mode.

3.6 Modifications Required for Compliance

No modifications were installed by Intertek Testing Services during compliance testing in order to bring the product into compliance.



4.0 Measurement Results

4.1 Conducted Output Power at Antenna Terminals FCC 15.247(b)(1)

Requirements

For systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, the maximum peak output power is 1 watt (30 dBm), for all other systems 0.125 W (21 dBm).

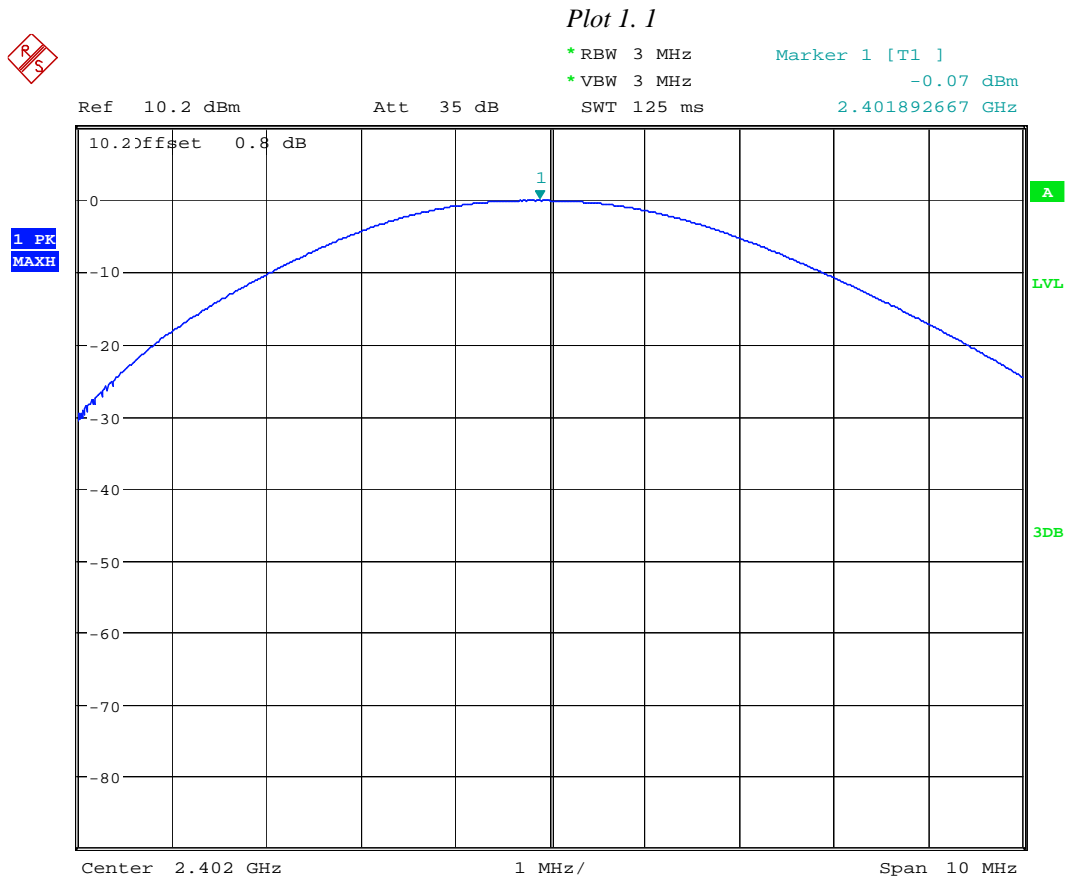
Procedure

The antenna port of the EUT was connected to the input of a spectrum analyzer. Power was read directly and cable loss correction was added to the reading to obtain the power at the EUT antenna terminal.

Test Results

Frequency (MHz)	Output in dBm	Output in mW	Plot number
2402	-0.07	0.984	1.1
2441	-0.78	0.836	1.2
2480	-0.78	0.836	1.3

Notes: 1. Hopping function was disabled during the test.
2. The EUT's antenna has less than 6 dBi gain.

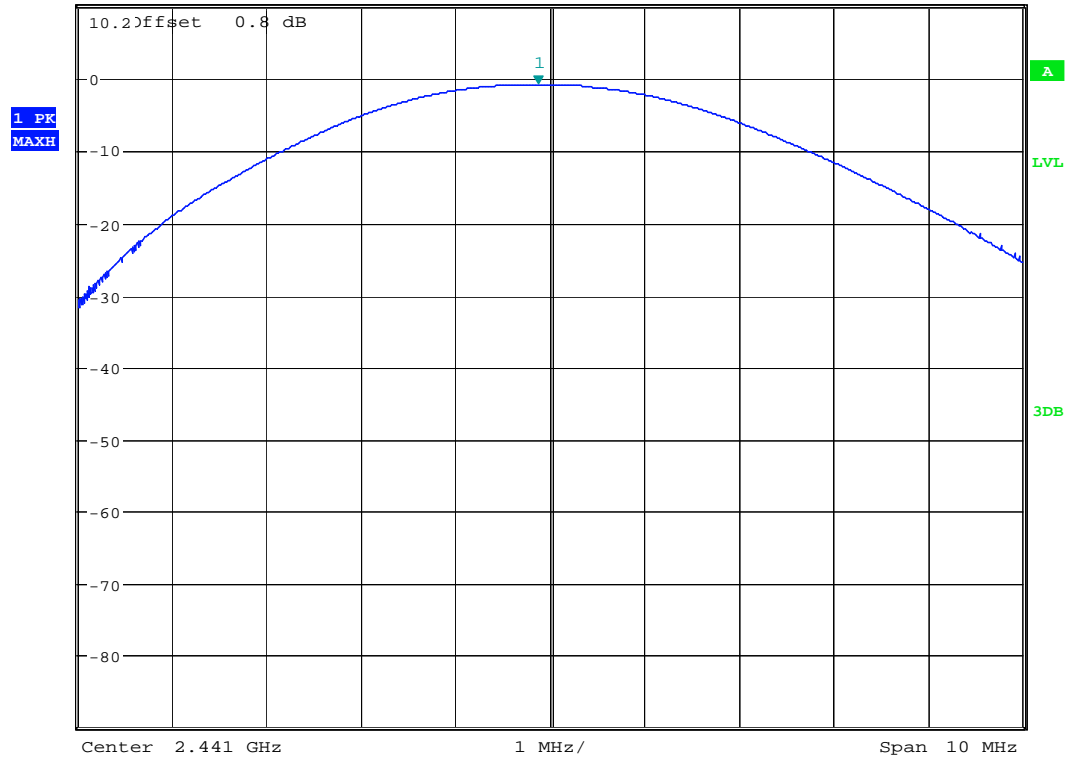


Output power
 Date: 23.SEP.2011 11:37:25



Plot 1. 2

* RBW 3 MHz Marker 1 [T1]
 * VBW 3 MHz -0.78 dBm
 Ref 10.2 dBm Att 35 dB SWT 125 ms 2.440870333 GHz



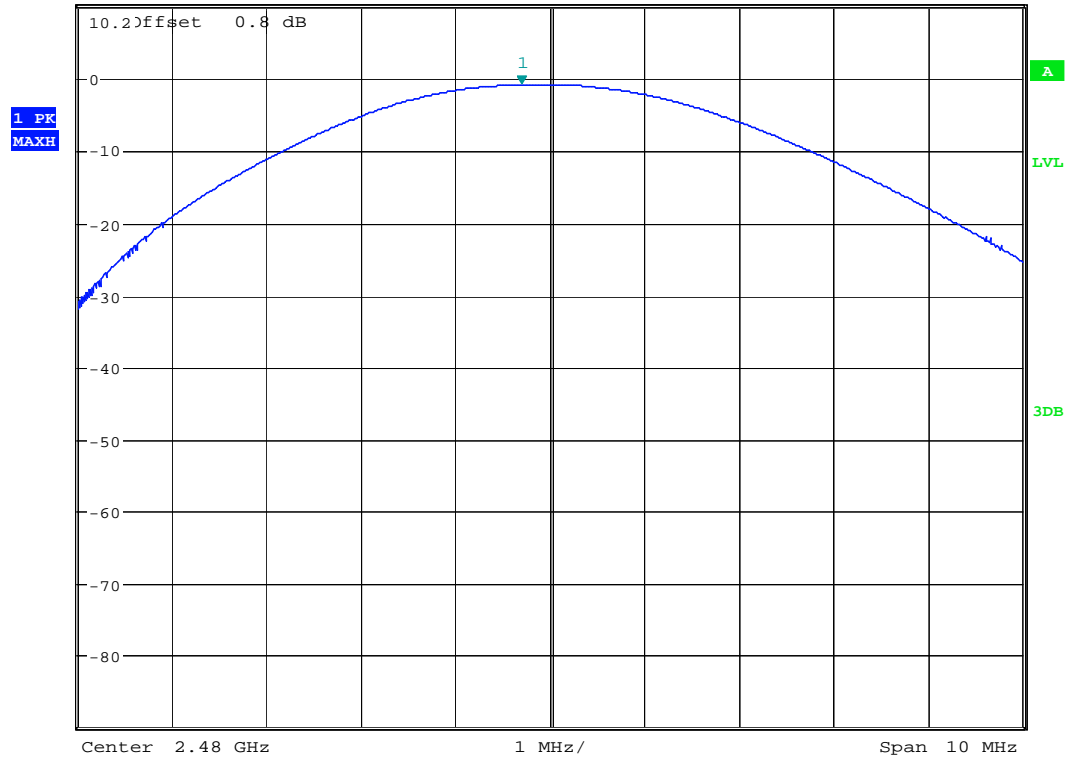
Output power

Date: 23.SEP.2011 11:39:06



Plot 1.3

* RBW 3 MHz Marker 1 [T1]
 * VBW 3 MHz -0.78 dBm
 Ref 10.2 dBm Att 35 dB SWT 125 ms 2.479701000 GHz



Output power

Date: 23.SEP.2011 11:40:03



4.2 Hopping Channel 20-dB Bandwidth FCC 15.247(a)(1)

Procedure

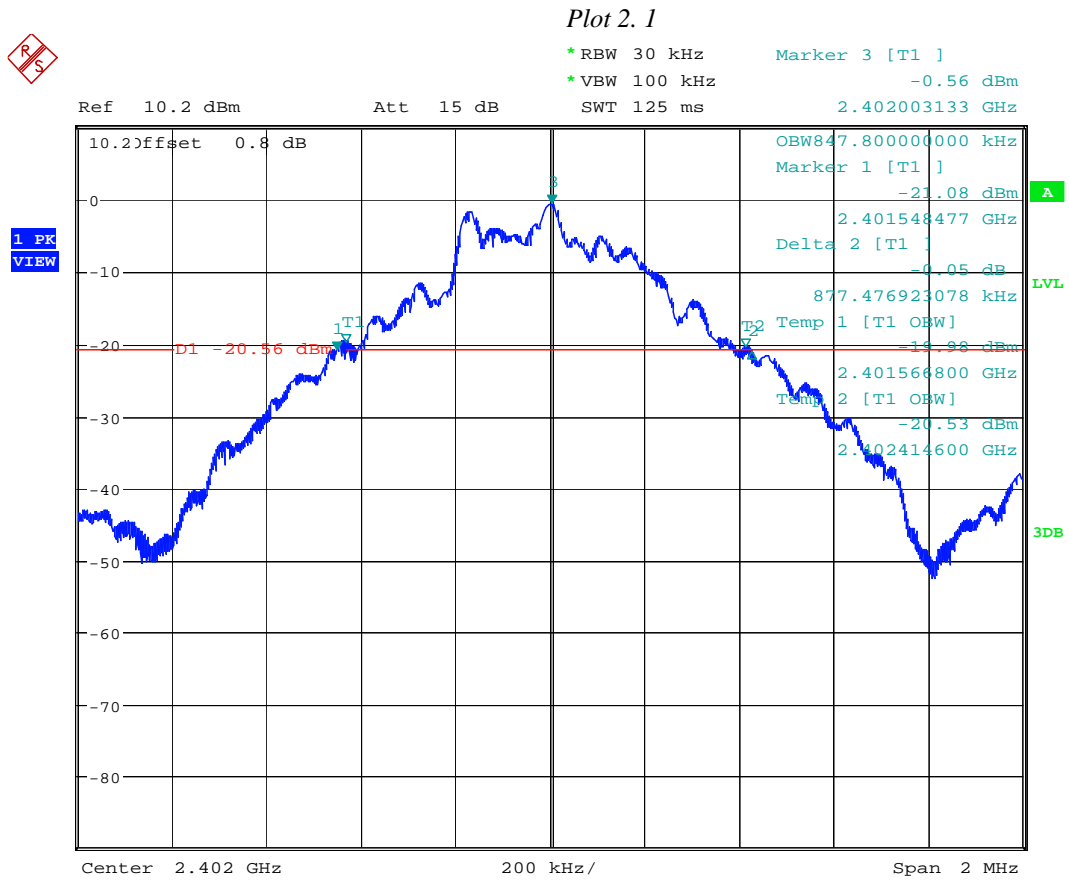
The antenna port of the EUT was connected to the input of a spectrum analyzer. The spectrum analyzer resolution bandwidth was set to approximately 1% of the 20-dB Bandwidth. The 20-dB Bandwidth was measured by using the DELTA MARKER function of the analyzer.

In addition, the occupied bandwidth (99%) was measured.

Test Results

Frequency (MHz)	20-dB channel bandwidth (MHz)	Plot
2402	0.8775	2.1
2441	0.8686	2.2
2480	0.8686	2.3

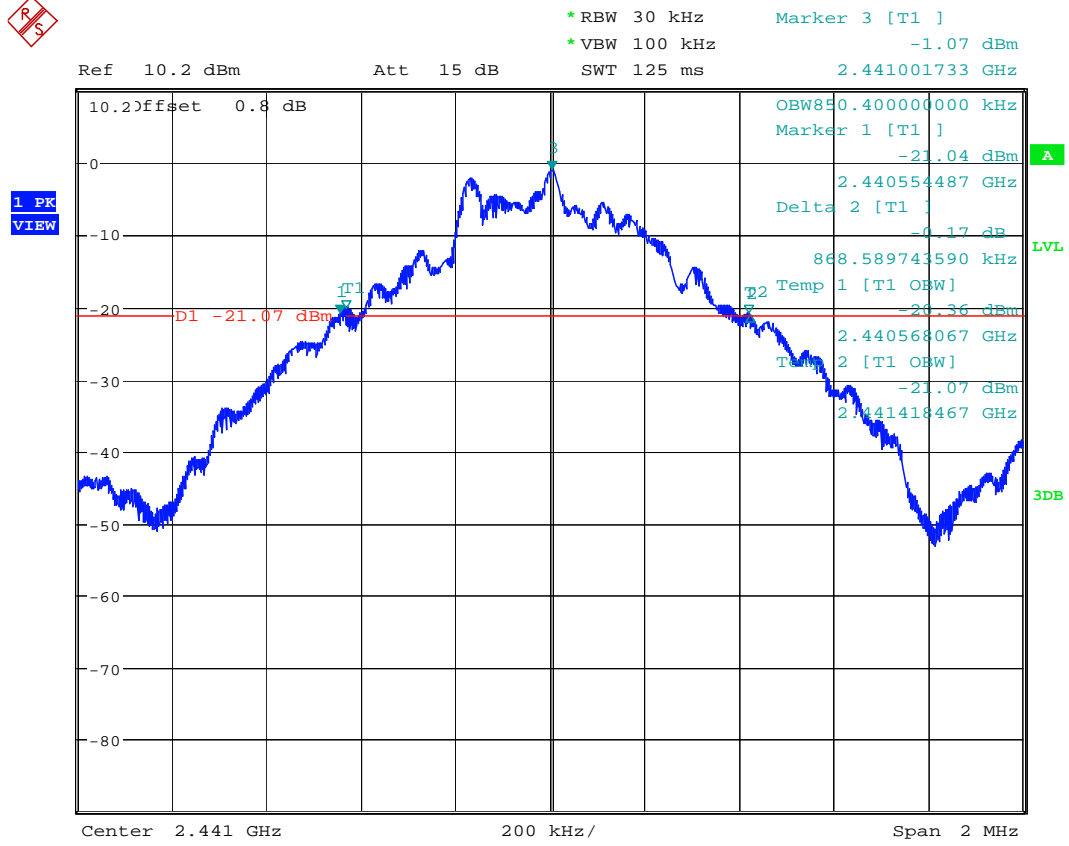
Frequency (MHz)	99% Occupied bandwidth (MHz)	Plot
2402	0.8478	2.1
2441	0.8504	2.2
2480	0.8503	2.3



20-dB bandwidth and Occupied bandwidth
 Date: 23.SEP.2011 11:56:39



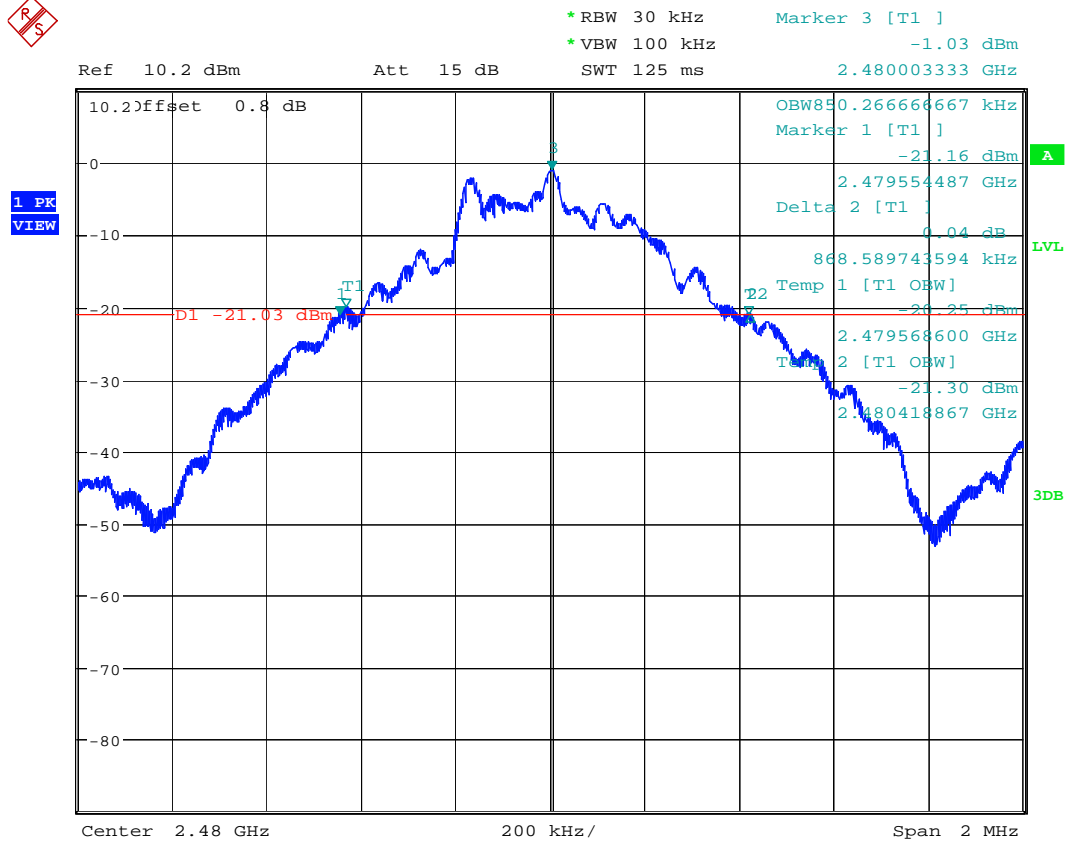
Plot 2. 2



20-dB bandwidth and Occupied bandwidth
Date: 23.SEP.2011 12:02:39



Plot 2.3



20-dB bandwidth and Occupied bandwidth
 Date: 23.SEP.2011 12:07:58



4.3 Carrier Frequency Separation FCC Ref: 15.247(a)(1)

Requirement

Systems shall 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.

Procedure

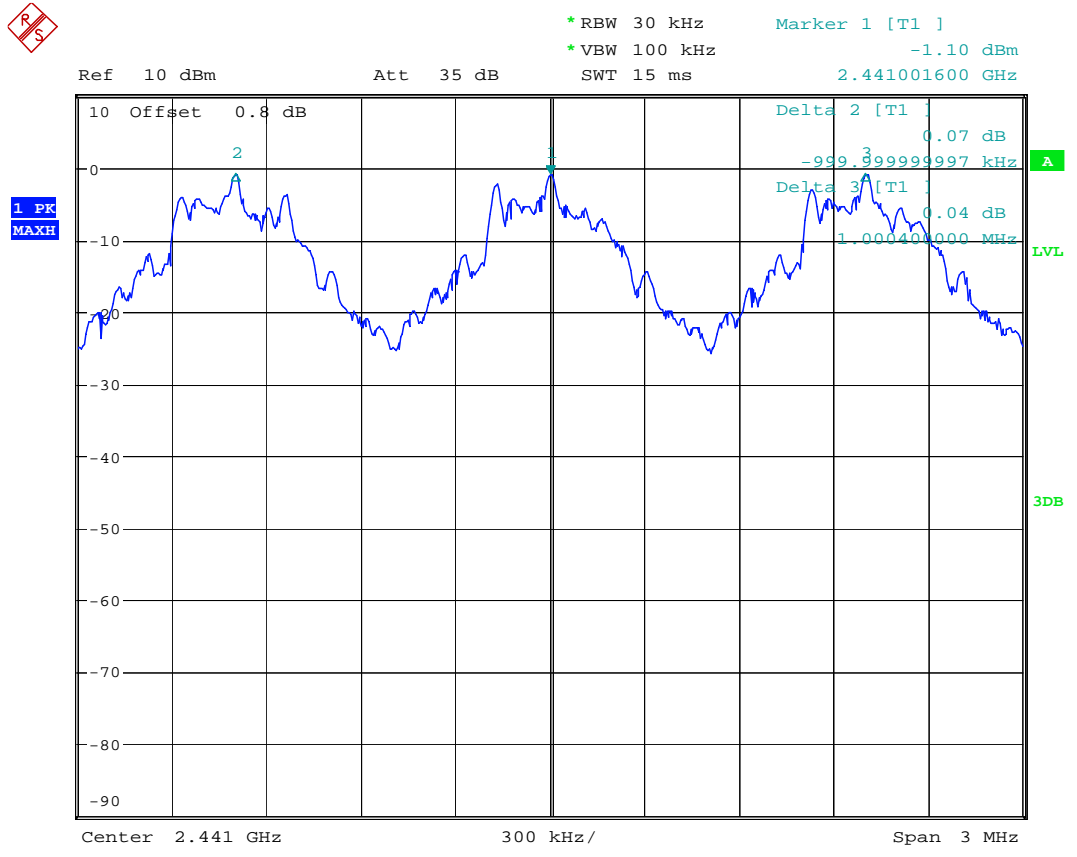
Using the DELTA MARKER function of the analyzer, the frequency separation between two adjacent channels was measured and compared against the limit.

Test Results

Refer to the attached spectrum analyzer plot # 3.1 for the test result.
The channel separation is 1.0004MHz.



Plot 3.1



Carrier frequency separation
 Date: 23.SEP.2011 12:35:56



4.4 Number of Hopping Channels
FCC Ref: 15.247(a)(1)(iii)

Requirement

Systems operating in the 2400-2483.5 MHz band shall use at least 15 hopping channels.

Procedure

With the analyzer set to MAX HOLD, readings were taken for 2 - 3 minutes. The channel peaks were recorded and compared to the minimum number of channels required in the regulation.

Test Results

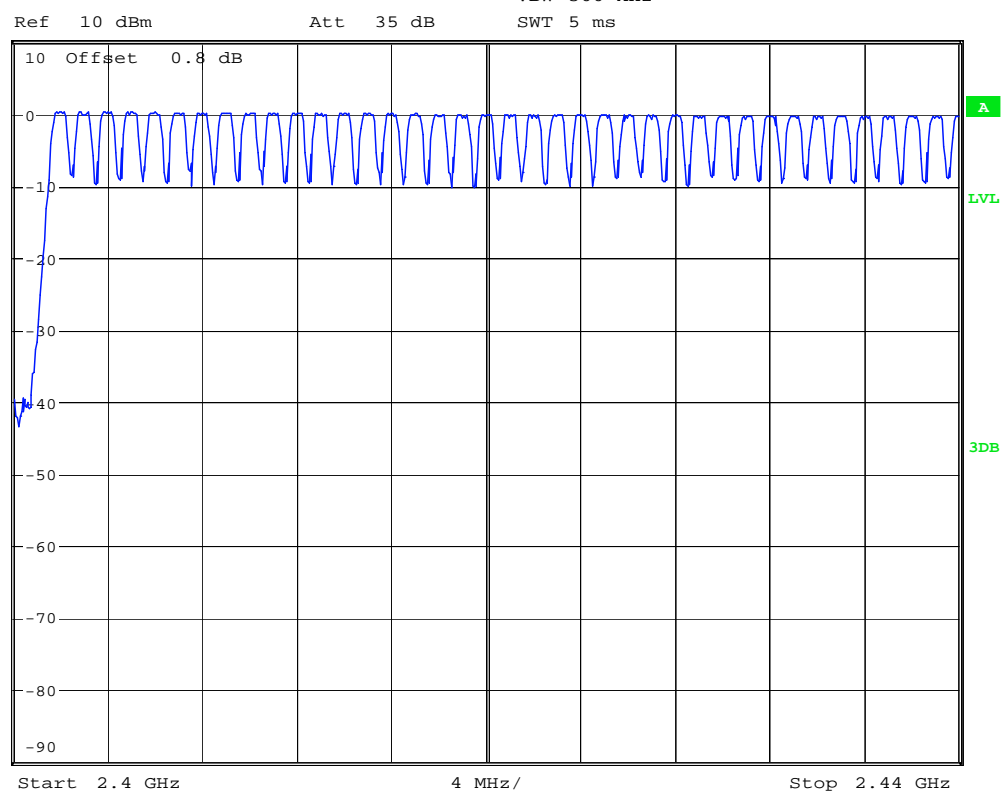
Number of hopping channels	79
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Refer to attached spectrum analyzer plots 4.1 – 4.2.



Plot 4. 1

* RBW 300 kHz
* VBW 300 kHz

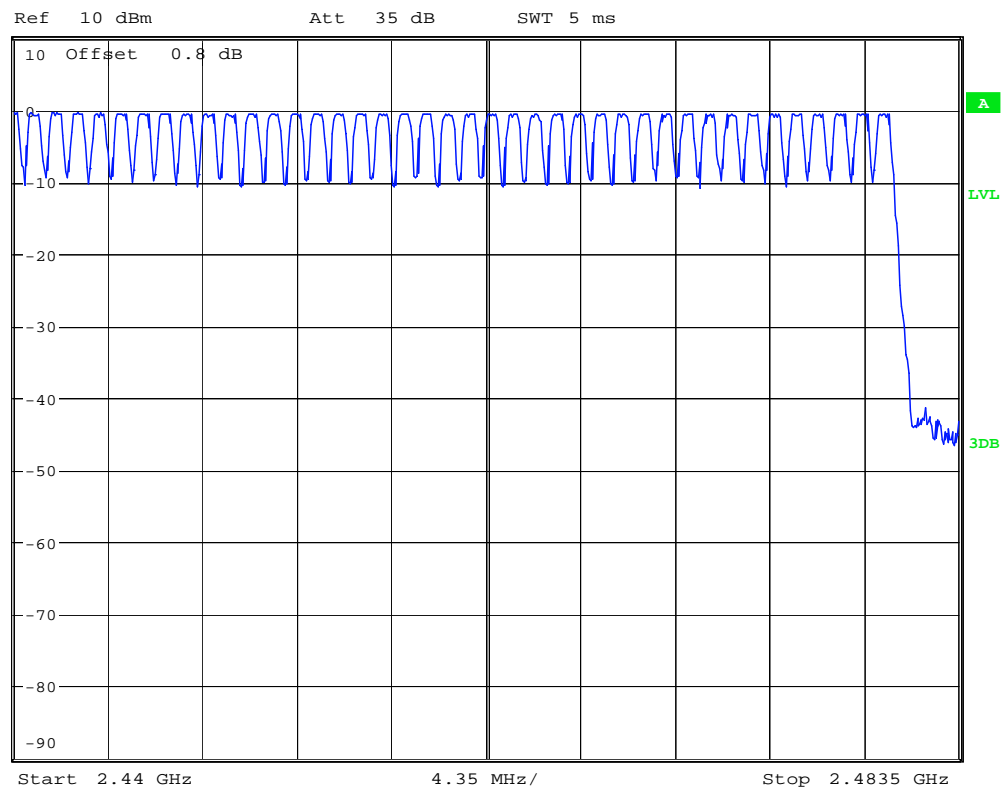


Number of hopping channels
Date: 23.SEP.2011 12:44:36



Plot 4. 2

* RBW 300 kHz
* VBW 300 kHz



Number of hopping channels
Date: 23.SEP.2011 12:47:46



4.5 Average Channel Occupancy Time FCC 15.247(a)(1)

Requirement

For systems operating in the 2400-2483.5 MHz band, the average time of occupancy on any channel shall not be greater than 0.4 second within a period of 0.4 second multiplied by the number of hopping channels employed.

Procedure

The spectrum analyzer center frequency was set to one of the known hopping channels, the SPAN was set to ZERO SPANS, and the TRIGGER was set to VIDEO. The time duration of the transmission was measured with the MARKER DELTA function.

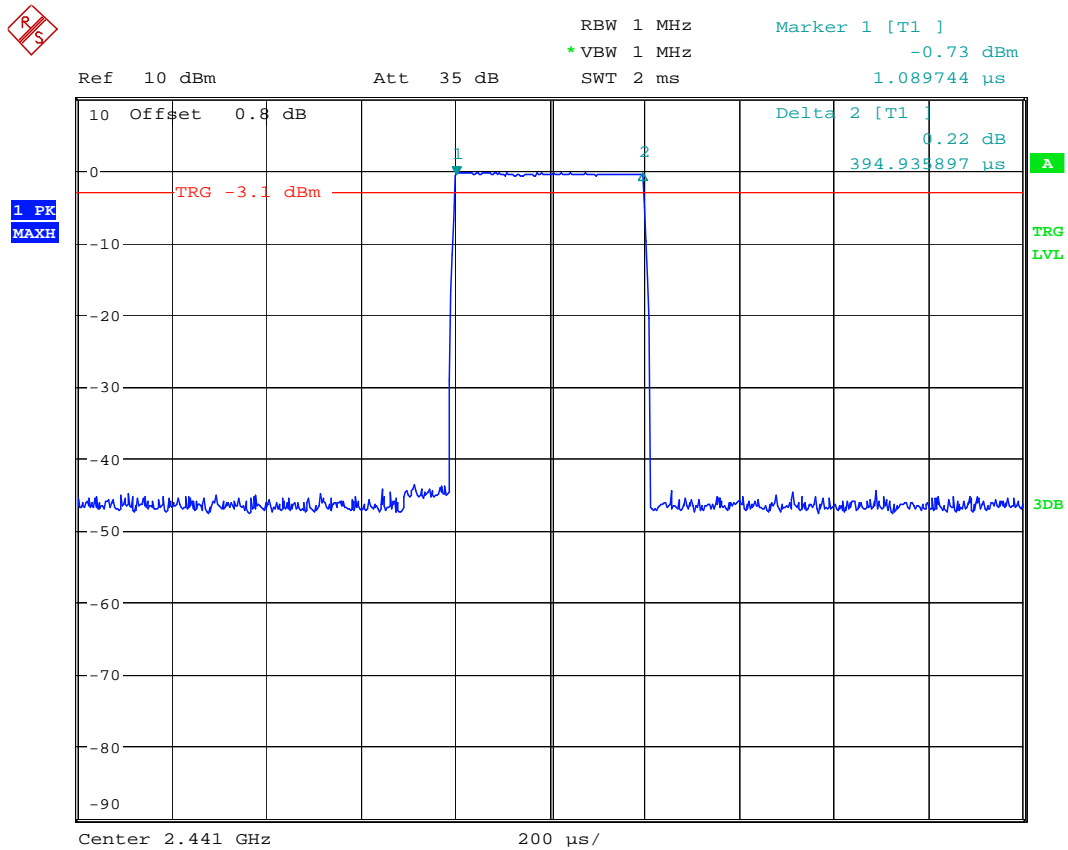
Since the radio employed 79 hopping channels, the Occupancy Time was calculated for the period of $0.4 * 79 = 31.6$ sec.

Test Results

Occupancy Time = $0.000395 * 32 * 10 = 0.126$ sec.

Refer to attached spectrum analyzer plots 5.1 - 5.2.

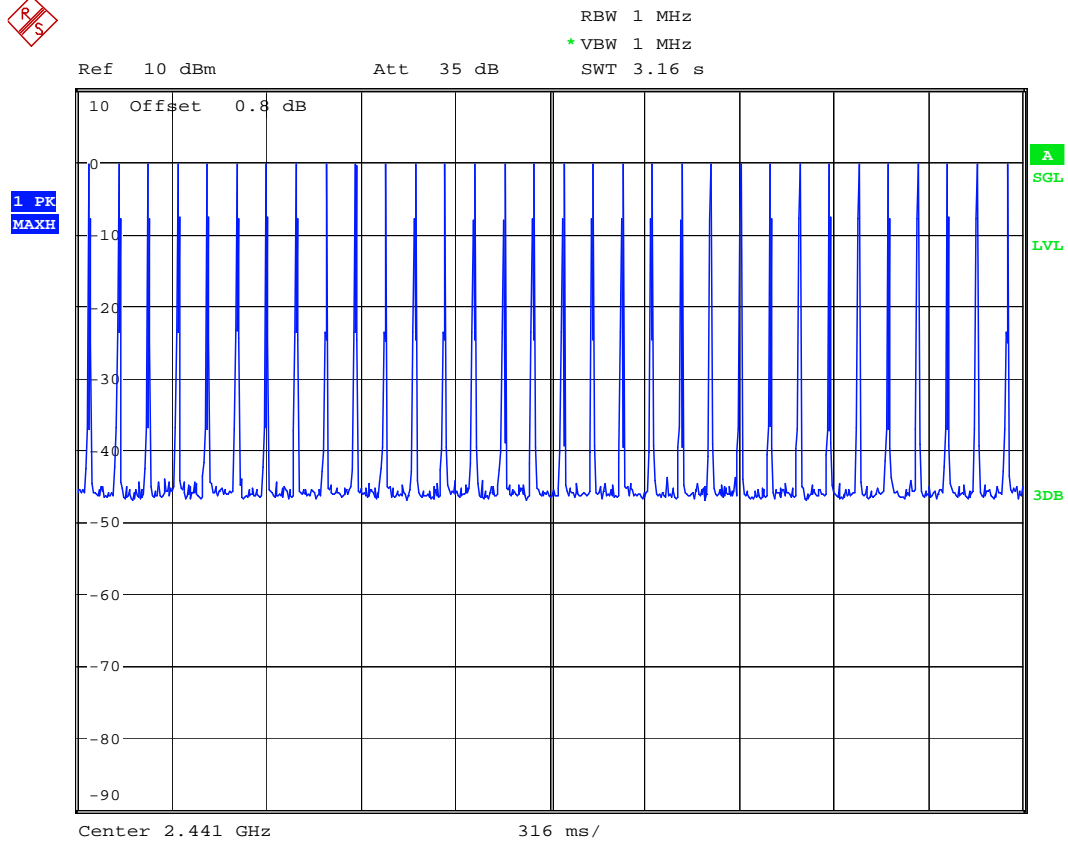
Plot 5.1



Dwell time

Date: 23.SEP.2011 12:54:39

Plot 5.2



Dwell time

Date: 23.SEP.2011 12:57:49



4.6 Out-of-Band Conducted Emissions FCC 15.247(d)

Requirement

In any 100 kHz bandwidths outside the EUT pass-band, the RF power shall be at least 20dB (peak) or 30 dB (average) below that of the maximum in-band 100 kHz emissions.

Procedure

A spectrum analyzer was connected to the antenna port of the transmitter. Analyzer Resolution Bandwidth was set to 100 kHz. For each channel investigated, the in-band and out-of-band emission measurements were performed. The out-of-band emissions were measured from 30 MHz to 25 GHz.

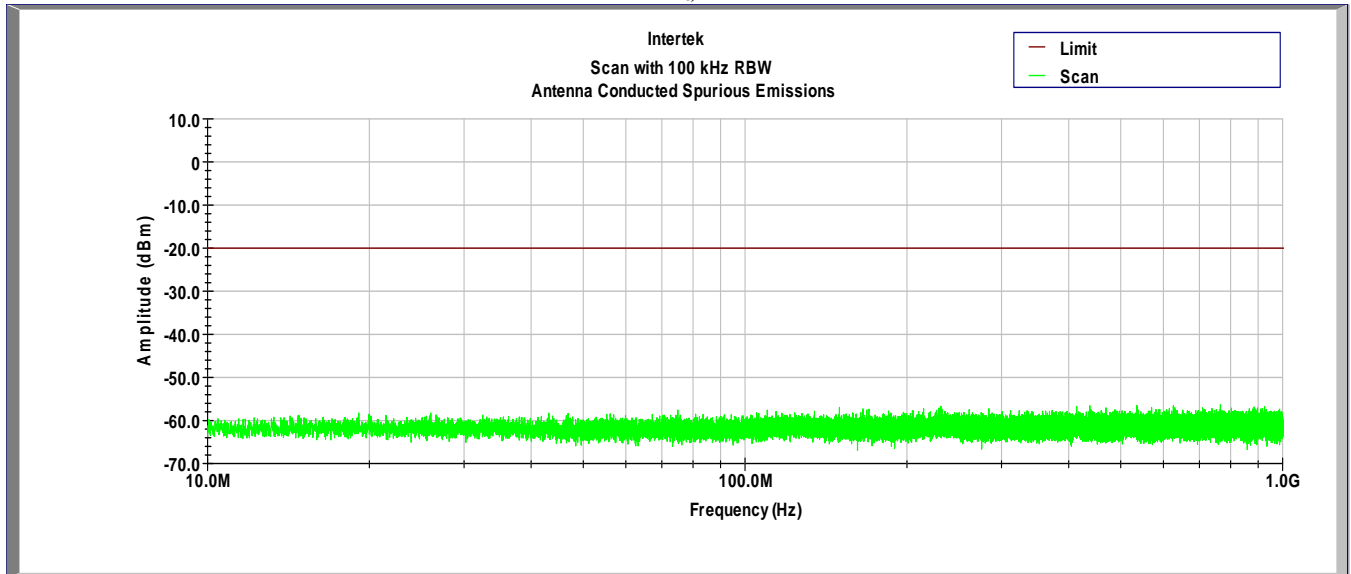
Test Result

Refer to the following plots:

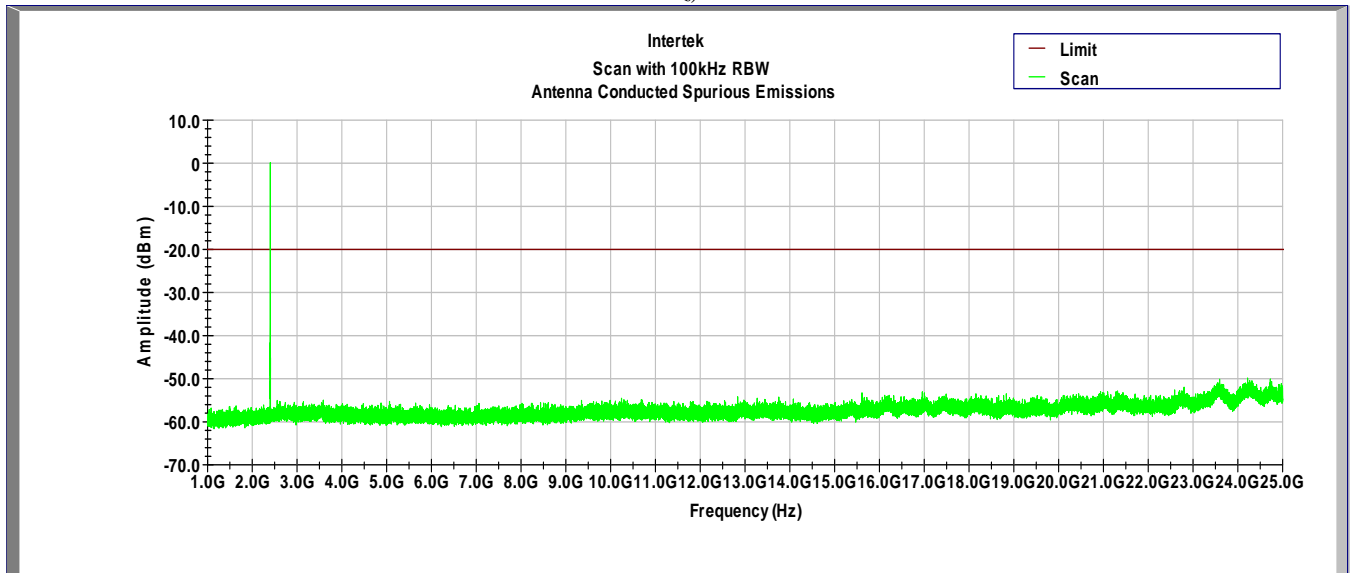
Frequency (MHz)	Channel	Modulation	Description	Plot
2402	1	FHSS	Scan 30 MHz – 1 GHz	6.1
	1	FHSS	Scan 1 GHz – 25 GHz	6.2
	1	FHSS	Emissions on the low band-edge frequency, Hopping mode	6.7
2441	40	FHSS	Scan 30 MHz – 1 GHz	6.3
	40	FHSS	Scan 1 GHz – 25 GHz	6.4
2480	79	FHSS	Scan 30 MHz – 1 GHz	6.5
	79	FHSS	Scan 1 GHz – 25 GHz	6.6
	79	FHSS	Emissions on the high band-edge frequency, Hopping mode	6.8

All out-of-band conducted emissions were attenuated by more than 20 dB.

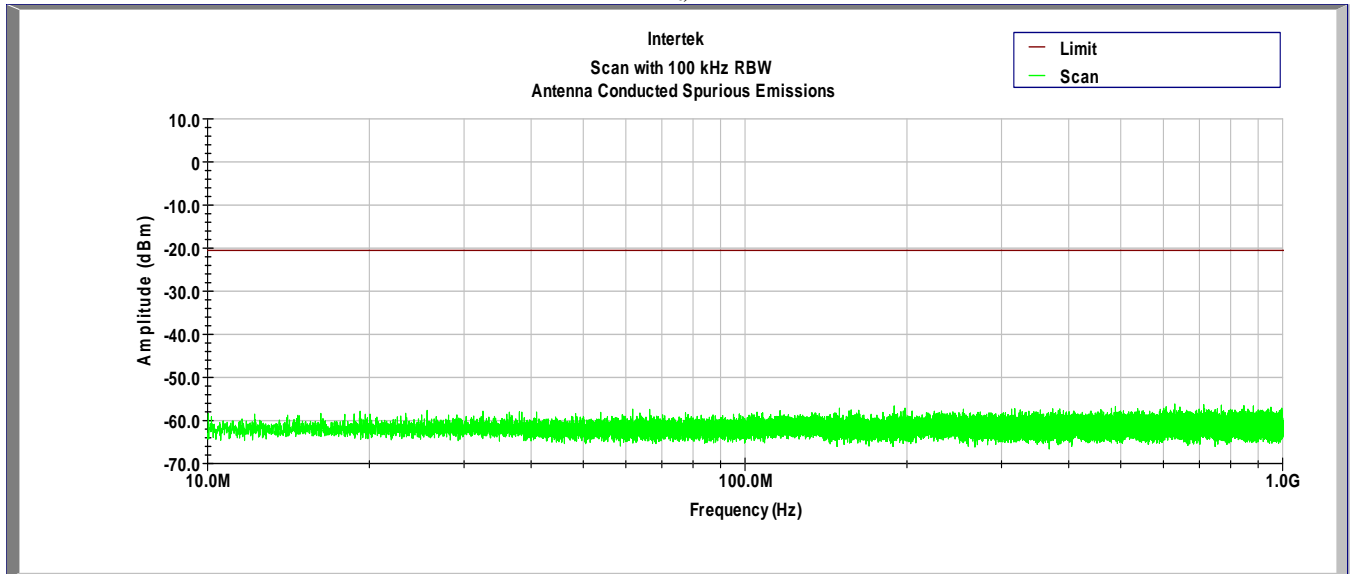
Plot 6.1
Tx @ 2402MHz, Ch1



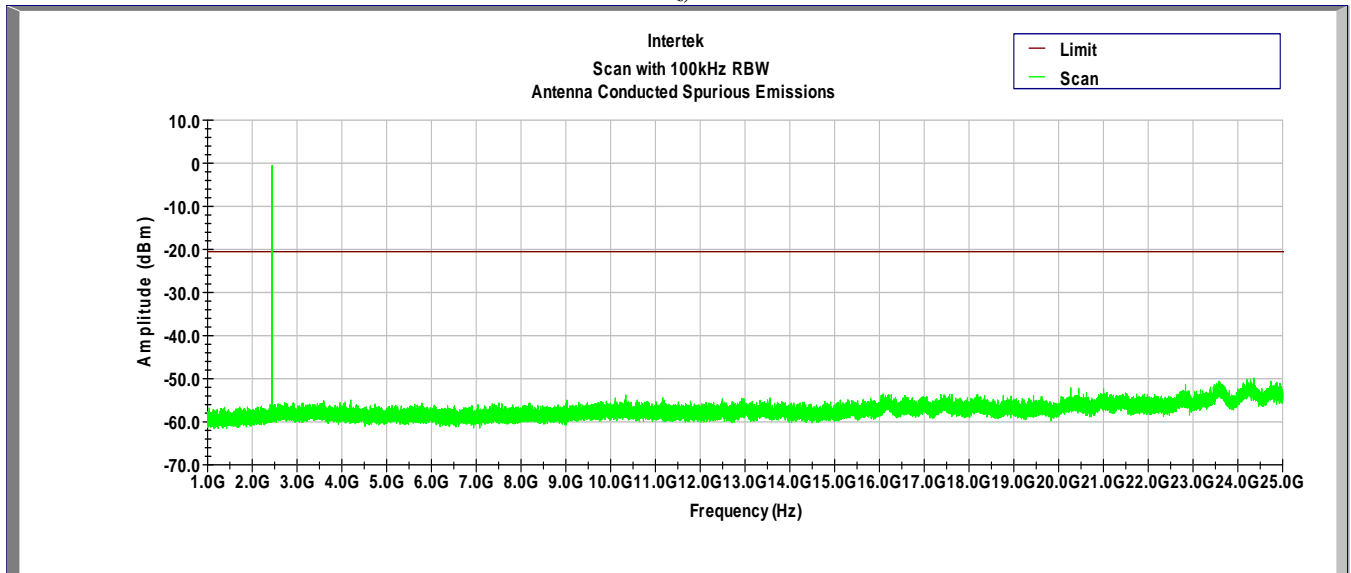
Plot 6.2
Tx @ 2402MHz, Ch1



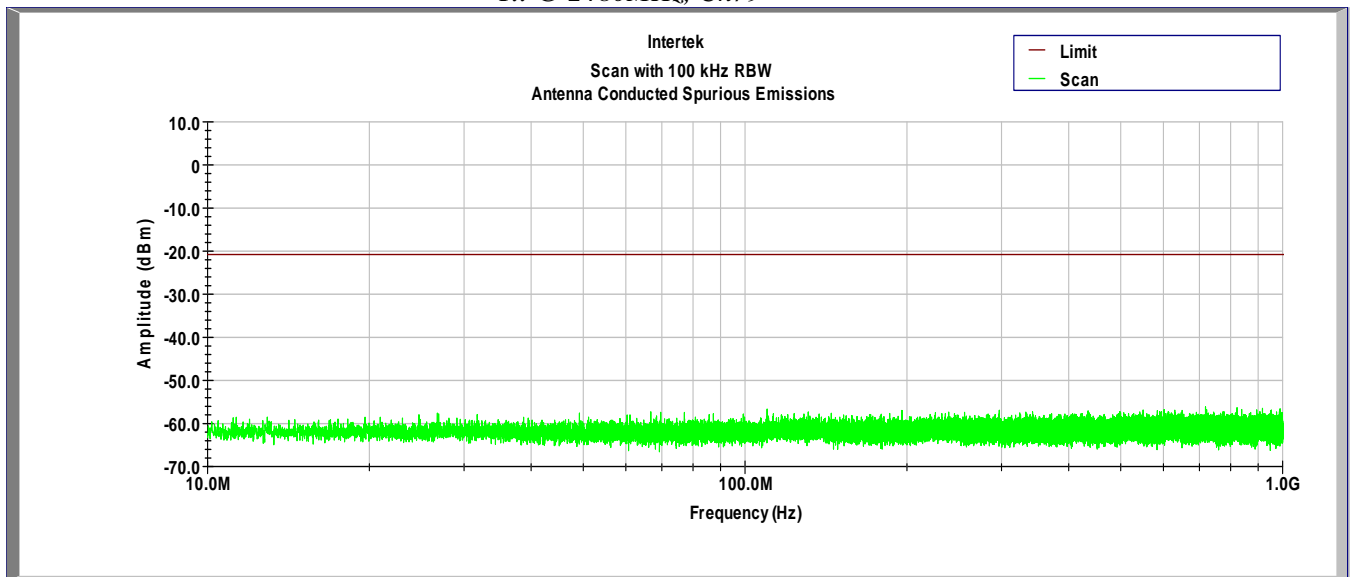
Plot 6.3
Tx @ 2441MHz, Ch40



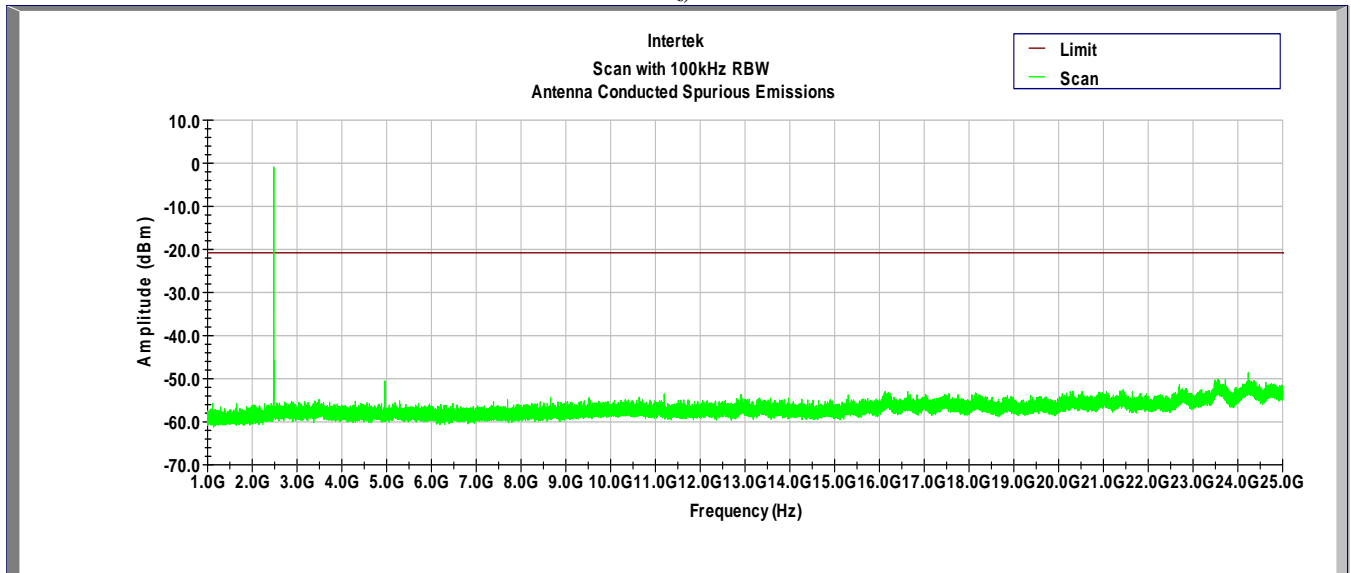
Plot 6.4
Tx @ 2441MHz, Ch40



Plot 6.5
Tx @ 2480MHz, Ch79

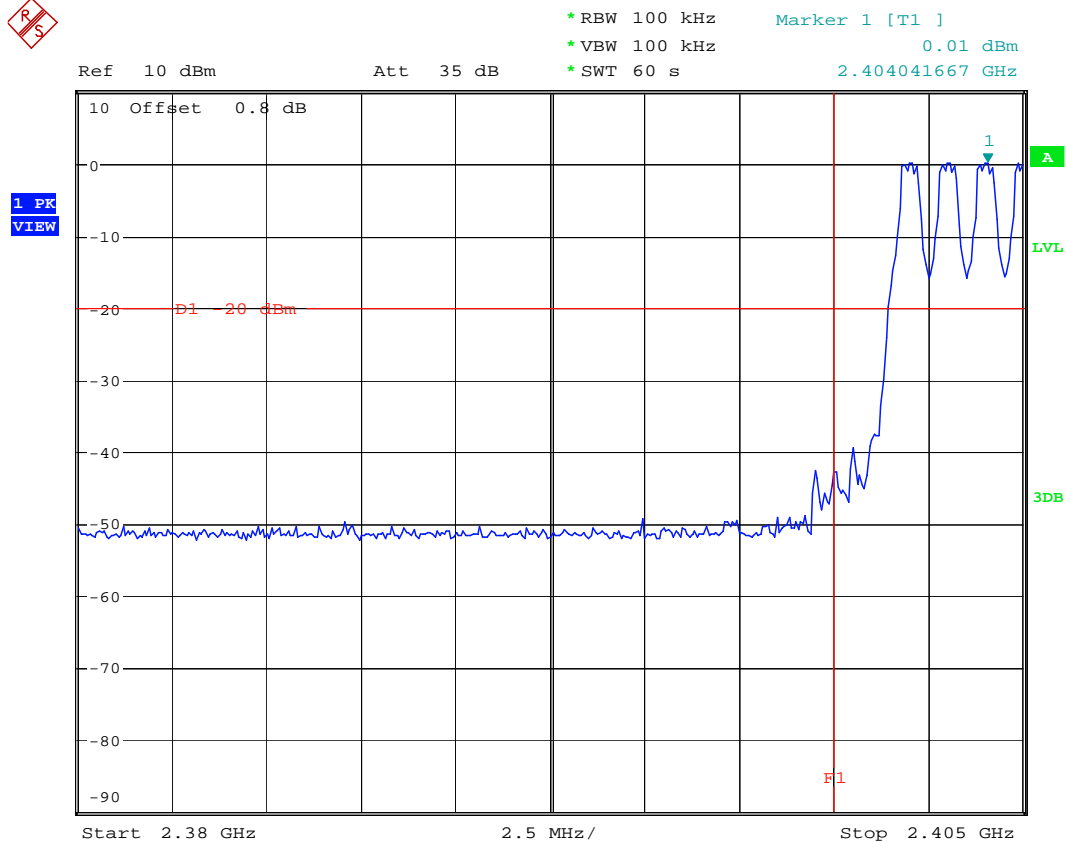


Plot 6.6
Tx @ 2480MHz, Ch79





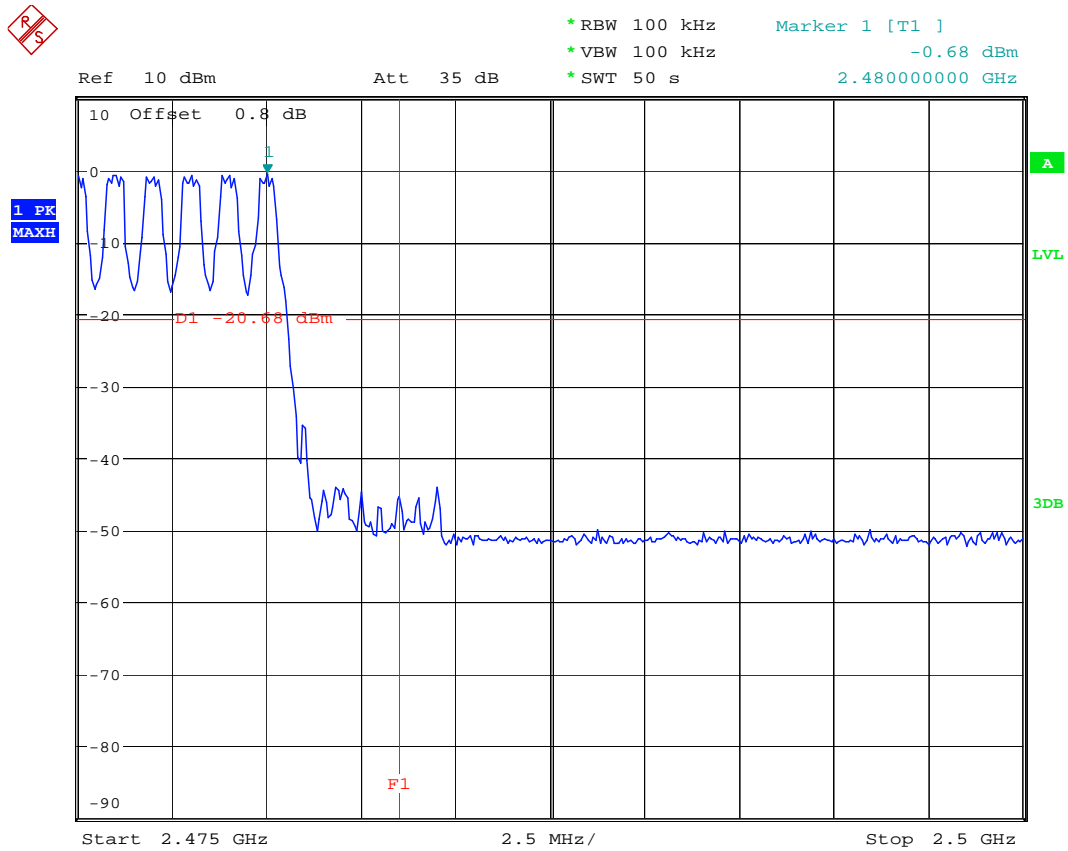
Plot 6.7



Spurious emissions

Date: 23.SEP.2011 13:17:53

Plot 6.8



Spurious emissions

Date: 23.SEP.2011 13:21:59



4.7 Transmitter Radiated Emissions FCC Rule 15.247(d), 15.209, 15.205

Requirement

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

For out of band radiated emissions (except for frequencies in restricted bands), in any 100 kHz bandwidths outside the EUT pass-band, the RF power shall be at least 20dB (peak) or 30 dB (average) below that of the maximum in-band 100 kHz emissions.

Procedure

Radiated emission measurements were performed from 30 MHz to 25,000 MHz. Spectrum Analyzer Resolution Bandwidth is 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz for frequencies above 1000 MHz.

The EUT is placed on a non-conductive table. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables were manipulated to produce worst case emissions. The signal is maximized through rotation of the turntable. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance.

Data is included for the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included.



Field Strength Calculation

For measurements made at 10 meters distance

The field strength is calculated by adding the Antenna Factor and Cable Factor to from the measured reading, followed by subtracting the Amplifier Gain (if any) and Distance Correction Factor (if any). The basic equation with a sample calculation is as follows:

The field strength is calculated by adding the Antenna Factor and Cable Factor and the Distance Correction Factor; and subtracting the Amplifier Gain from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG + DCF$$

Where FS = Field Strength in dB(μ V/m)

RA = Receiver Amplitude (including preamplifier) in dB(μ V)

AF = Antenna Factor in dB(1/m)

CF = Cable Attenuation Factor in dB

AG = Amplifier Gain in dB

DCF = Distance Correction Factor in dB for measurements made at 10 meters distance

Assume a receiver reading of 52.5 dB(μ V) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB and Distance Correction Factor (for measurements made at 10 meters distance) of 10.5 dB is subtracted, giving field strength of 22 dB(μ V/m). This value in dB(μ V/m) was converted to its corresponding level in μ V/m.

RA = 52.5 dB(μ V)

AF = 7.4 dB(1/m)

CF = 1.6 dB

AG = 29.0 dB

DCF = 10.5 dB

FS = 52.5+7.4+1.6-29.0+10.5 = 43 dB(μ V/m).

Level in μ V/m = Common Antilogarithm [(43 dB μ V/m)/20] = 141.3 μ V/m.

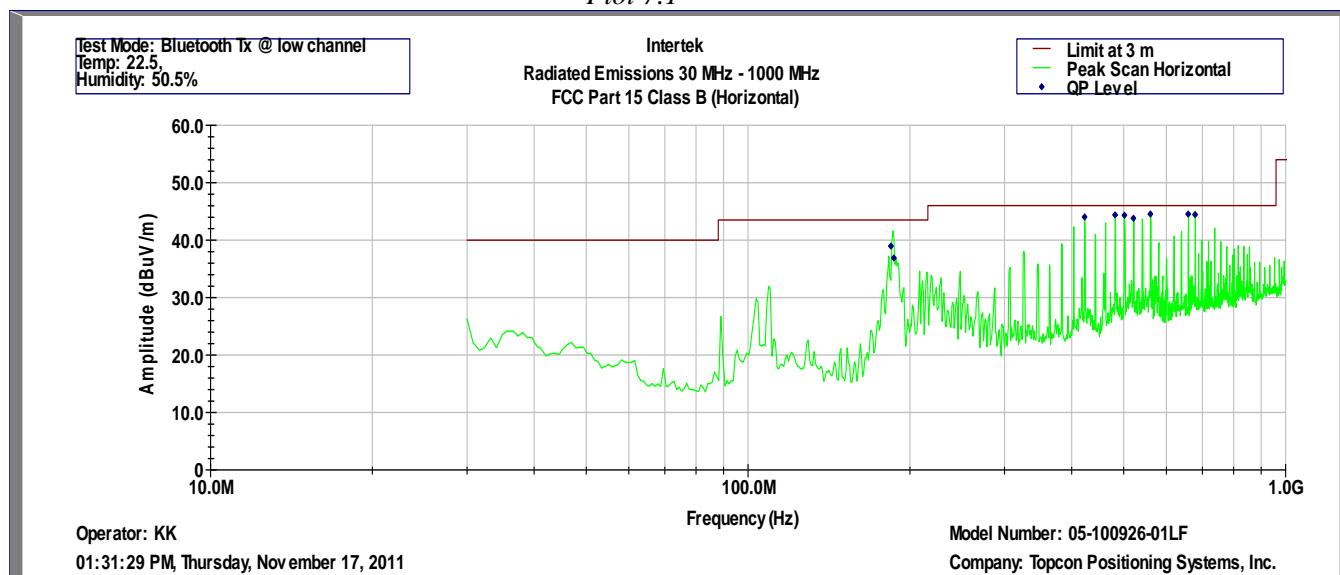
For measurements made at 3 meters distance

The field strength is calculated by following the example above for measurements made at 10 meters distance except the Distance Correction Factor in dB is not applied.

Test Results

The data on the following pages list the significant emission frequencies, the limit and the margin of compliance. The radiated emissions in the restricted bands are presented on the following plots 7.1 – 7.18. The EUT passed by 1.4 dB.

Plot 7.1



Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Horizontal)

Model Number: 05-100926-01LF

Operator: KK
17-Nov-11

Company: Topcon Positioning Systems, Inc.

Frequency	Quasi Pk FS	Limit@3m	Margin	RA	CF	AG	DCF	AF
Hz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB	dB(1/m)
1.84E+08	39.0	43.5	-4.5	49.2	1.6	31.9	10.5	9.6
1.87E+08	36.9	43.5	-6.6	47.1	1.6	31.9	10.5	9.6
4.23E+08	44.0	46.0	-2.0	46.4	2.4	31.9	10.5	16.6
4.82E+08	44.4	46.0	-1.6	46.0	2.6	31.9	10.5	17.2
5.01E+08	44.3	46.0	-1.7	46.4	2.6	31.9	10.5	16.7
5.21E+08	43.8	46.0	-2.2	45.4	2.7	32.0	10.5	17.2
5.60E+08	44.5	46.0	-1.5	45.0	2.8	32.0	10.5	18.2
6.59E+08	44.5	46.0	-1.5	44.1	3.0	32.1	10.5	19.0
6.78E+08	44.4	46.0	-1.6	43.3	3.1	32.1	10.5	19.7

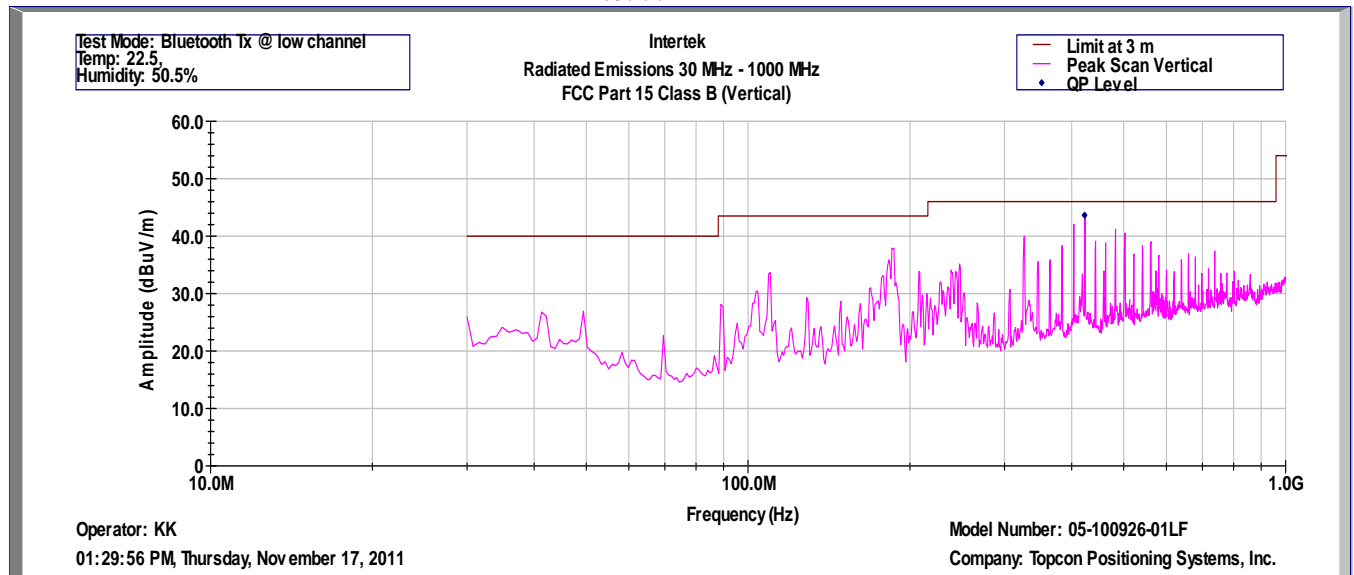
Test Mode: Bluetooth Tx @ low channel

Temp: 22.5C

Humidity: 50.5%

Notes: Measurements made at 10 meters distance.

Plot 7.2



Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Vertical)

Model Number: 05-100926-01LF

Operator: KK
17-Nov-11

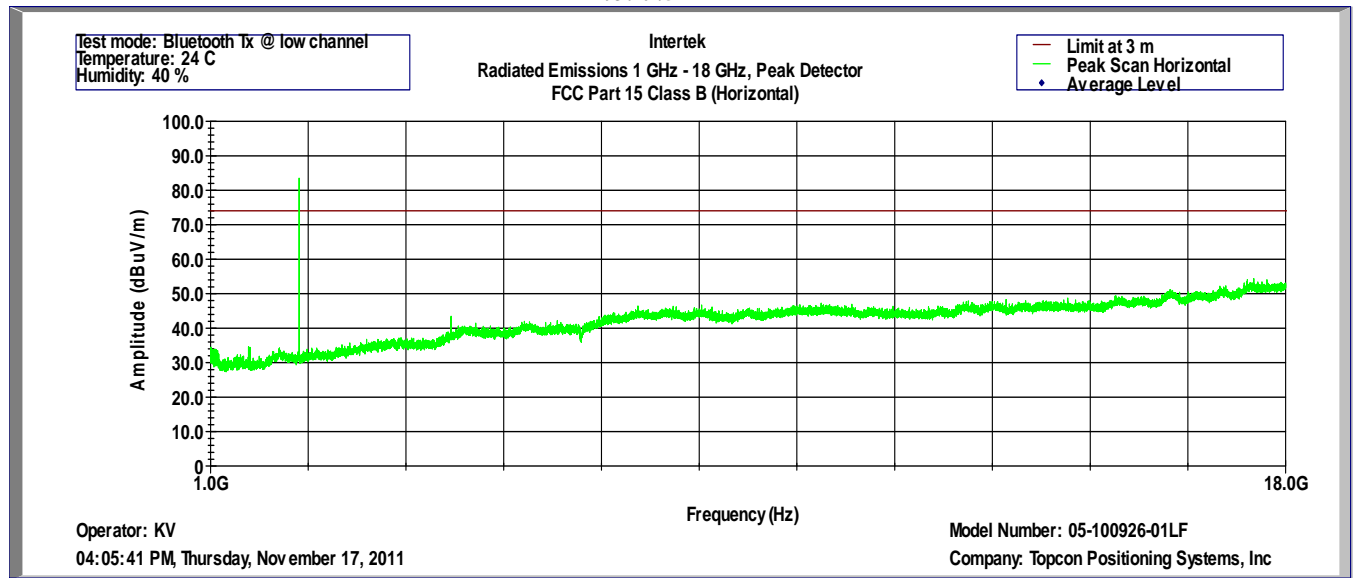
Company: Topcon Positioning Systems, Inc.

Frequency	Quasi Pk FS	Limit@3m	Margin	RA	Cable	AG	DCF	AF
Hz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB	dB(1/m)
4.23E+08	43.6	46.0	-2.4	46.0	2.4	31.9	10.5	16.6

Test Mode: Bluetooth Tx @ low channel
Temp: 22.5C
Humidity: 50.5%

Notes: Measurements made at 10 meters distance.

Plot 7.3



Intertek Testing Services
Radiated Emissions 1 GHz - 18 GHz, Peak Detector
FCC Part 15 Class B (Horizontal)
Operator: KV
17-Nov-11
Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

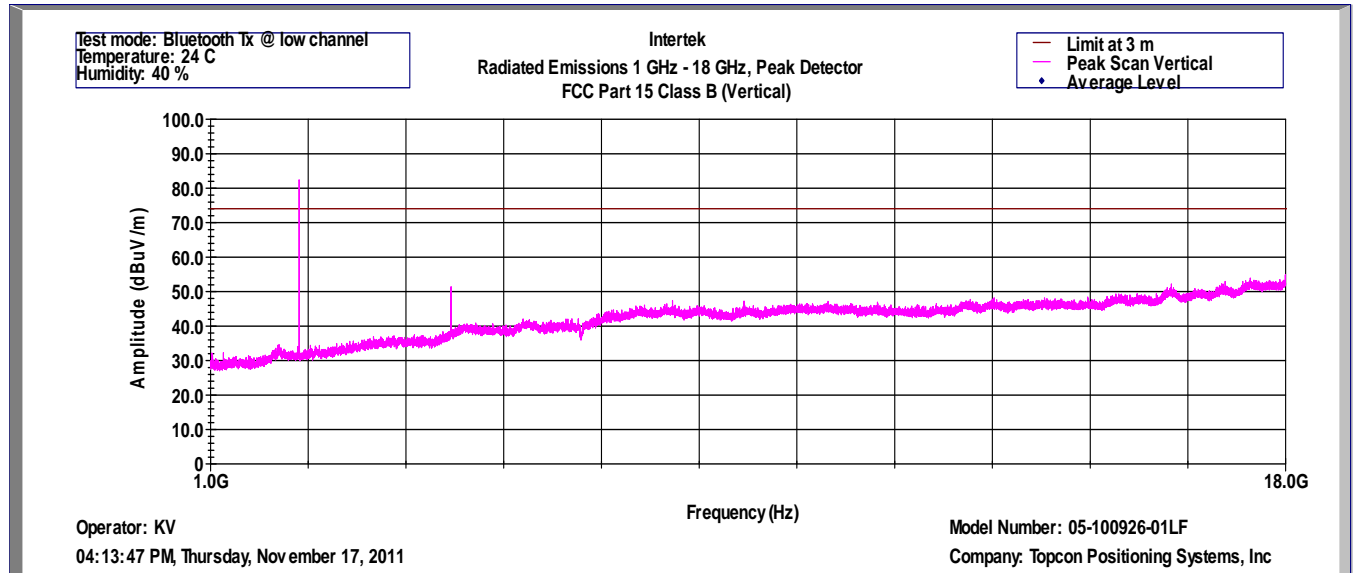
Frequency (Hz)	Pk Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Cable (dB)	Preamp (dB)	AF dB(1/m)
4.8040E+09	43.4	74.0	-30.6	37.2	8.4	35.0	32.8

Test mode: Bluetooth Tx @ low channel
Temperature: 24 C
Humidity: 40 %

Notes: Measurements made at 3 meters distance.

No emissions were detected above the noise floor which was at least 10 dB below the limit in the range of 18GHz – 25GHz.

Plot 7.4



Intertek Testing Services

Radiated Emissions 1 GHz - 18 GHz, Peak Detector

FCC Part 15 Class B (Vertical)

Operator: KV
 17-Nov-11

Model Number: 05-100926-01LF
 Company: Topcon Positioning Systems, Inc.

Frequency (Hz)	Pk Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Cable (dB)	Preamplifier (dB)	AF dB(1/m)
4.8040E+09	51.4	74.0	-22.6	45.2	8.4	35.0	32.8

Test mode: Bluetooth Tx @ low channel
 Temperature: 24 C
 Humidity: 40 %

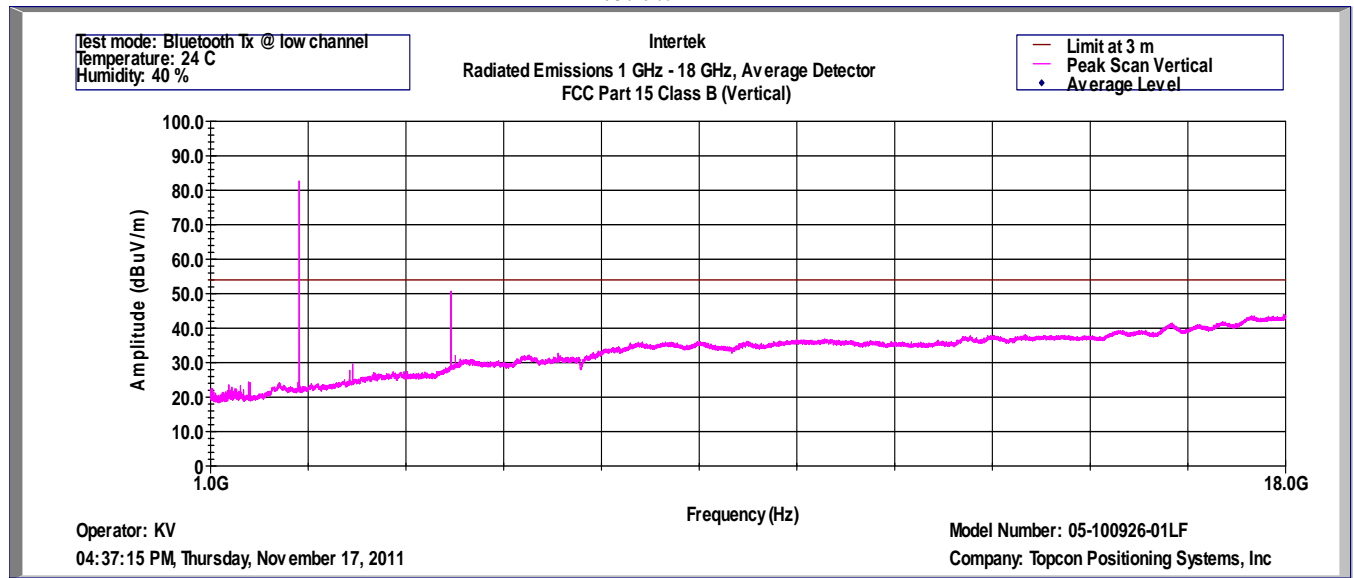
Measurement at the Bandedge

Frequency (Hz)	Pk Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Cable (dB)	Preamplifier (dB)	AF dB(1/m)
2.3900+09	35.7	74.0	-38.3	39.1	4.4	35.6	27.8

Notes: Measurements made at 3 meters distance.

No emissions were detected above the noise floor which was at least 10 dB below the limit in the range of 18GHz – 25GHz.

Plot 7.5



Intertek Testing Services
Radiated Emissions 1 GHz - 18 GHz, Average Detector
FCC Part 15 Class B (Vertical)

Operator: KV
17-Nov-11

Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

Frequency (Hz)	Av Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Duty Cycle* (dB)	Cable (dB)	Preamp (dB)	AF dB(1/m)
4.8040E+0 9	40.8	54.0	-13.2	44.5	9.9	8.4	35.0	32.8

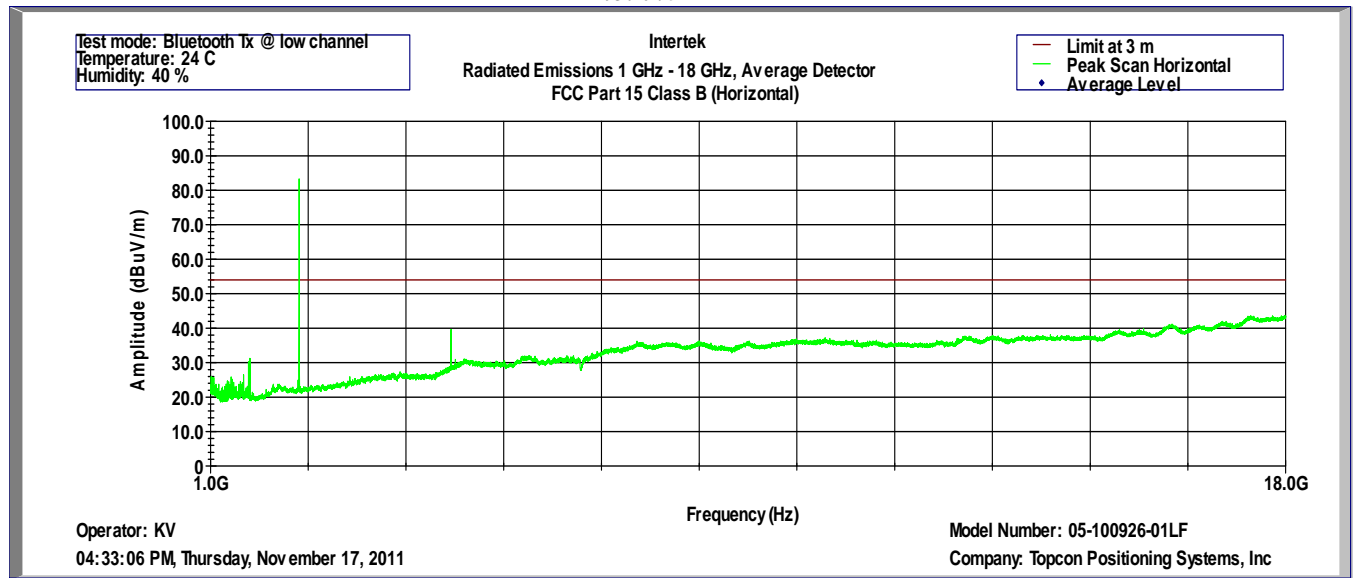
Test mode: Bluetooth Tx @ low channel
Temperature: 24 C
Humidity: 40 %

Notes: Measurements made at 3 meters distance.

No emissions were detected above the noise floor which was at least 10 dB below the limit in the range of 18GHz – 25GHz.

* See Appendix A for Duty Cycle measurement.

Plot 7.6



Intertek Testing Services

Radiated Emissions 1 GHz - 18 GHz, Average Detector

FCC Part 15 Class B (Horizontal)

Operator: KV

17-Nov-11

Model Number: 05-100926-01LF

Company: Topcon Positioning Systems, Inc.

Frequency (Hz)	Av Level (dBUV/m)	Limit@3m (dBUV/m)	Margin (dB)	Raw (dBUV)	Duty cycle* (dB)	Cable (dB)	Preamplifier (dB)	AF dB(1/m)
4.8040E+09	29.7	54.0	-24.3	33.4	9.9	8.4	35.0	32.8

Test mode: Bluetooth Tx @ low channel

Temperature: 24 C

Humidity: 40 %

Measurement at the Bandedge

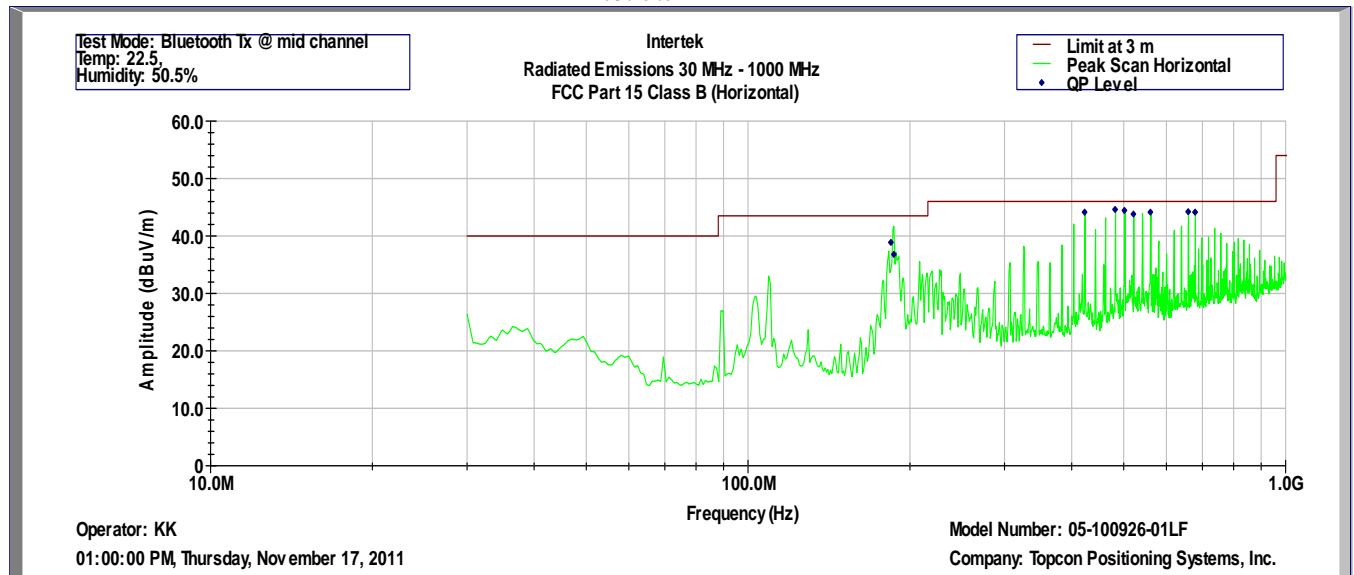
Frequency (Hz)	Av Level (dBUV/m)	Limit@3m (dBUV/m)	Margin (dB)	Raw (dBUV)	Cable (dB)	Preamplifier (dB)	AF dB(1/m)
2.3900+09	24.4	54.0	-29.6	27.8	4.4	35.6	27.8

Notes: Measurements made at 3 meters distance.

No emissions were detected above the noise floor which was at least 10 dB below the limit in the range of 18GHz – 25GHz.

* See Appendix A for Duty Cycle measurement.

Plot 7.7



Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Horizontal)

Model Number: 05-100926-01LF

Operator: KK
17-Nov-11

Company: Topcon Positioning Systems, Inc.

Frequency Hz	Quasi Pk FS dB(uV/m)	Limit@3m dB(uV/m)	Margin dB	RA dB(uV)	CF dB	AG dB	DCF dB	AF dB(1/m)
1.84E+08	38.9	43.5	-4.6	49.1	1.6	31.9	10.5	9.6
1.87E+08	36.8	43.5	-6.7	47.0	1.6	31.9	10.5	9.6
4.23E+08	44.1	46.0	-1.9	46.5	2.4	31.9	10.5	16.6
4.82E+08	44.6	46.0	-1.4	46.2	2.6	31.9	10.5	17.2
5.01E+08	44.4	46.0	-1.6	46.5	2.6	31.9	10.5	16.7
5.21E+08	43.8	46.0	-2.2	45.4	2.7	32.0	10.5	17.2
5.60E+08	44.1	46.0	-1.9	44.6	2.8	32.0	10.5	18.2
6.59E+08	44.2	46.0	-1.8	43.8	3.0	32.1	10.5	19.0
6.78E+08	44.1	46.0	-1.9	43.0	3.1	32.1	10.5	19.7

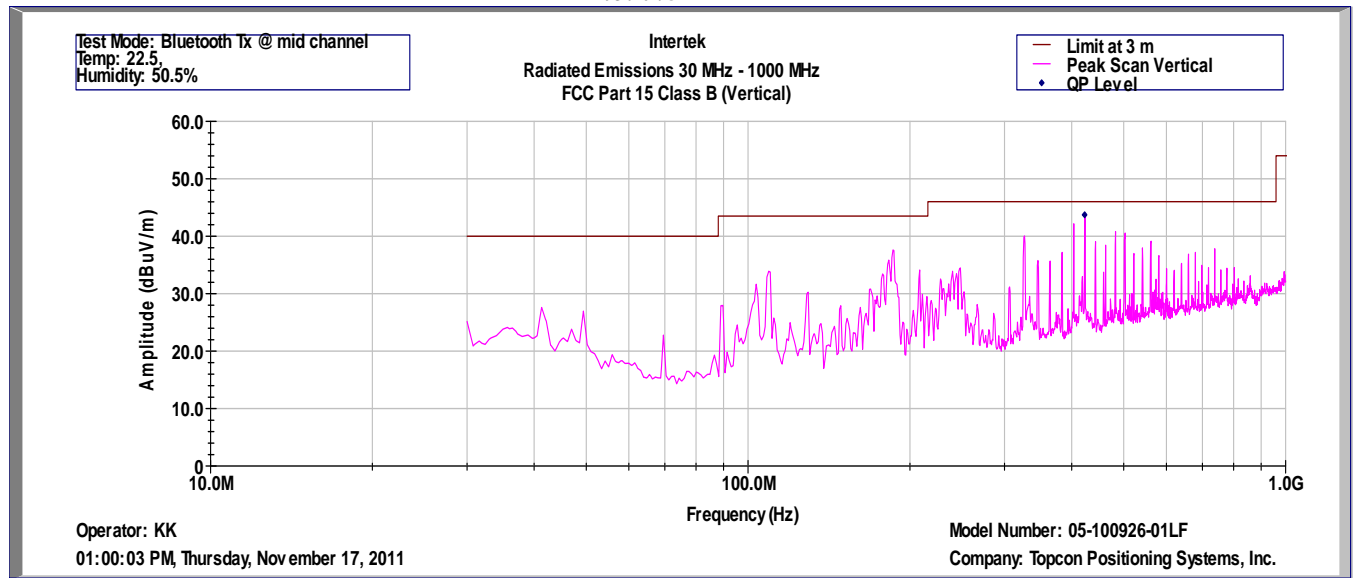
Test Mode: Bluetooth Tx @ mid channel

Temp: 22.5,

Humidity: 50.5%

Notes: Measurements made at 10 meters distance.

Plot 7.8



Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Vertical)

Model Number: 05-100926-01LF

Operator: KK
17-Nov-11

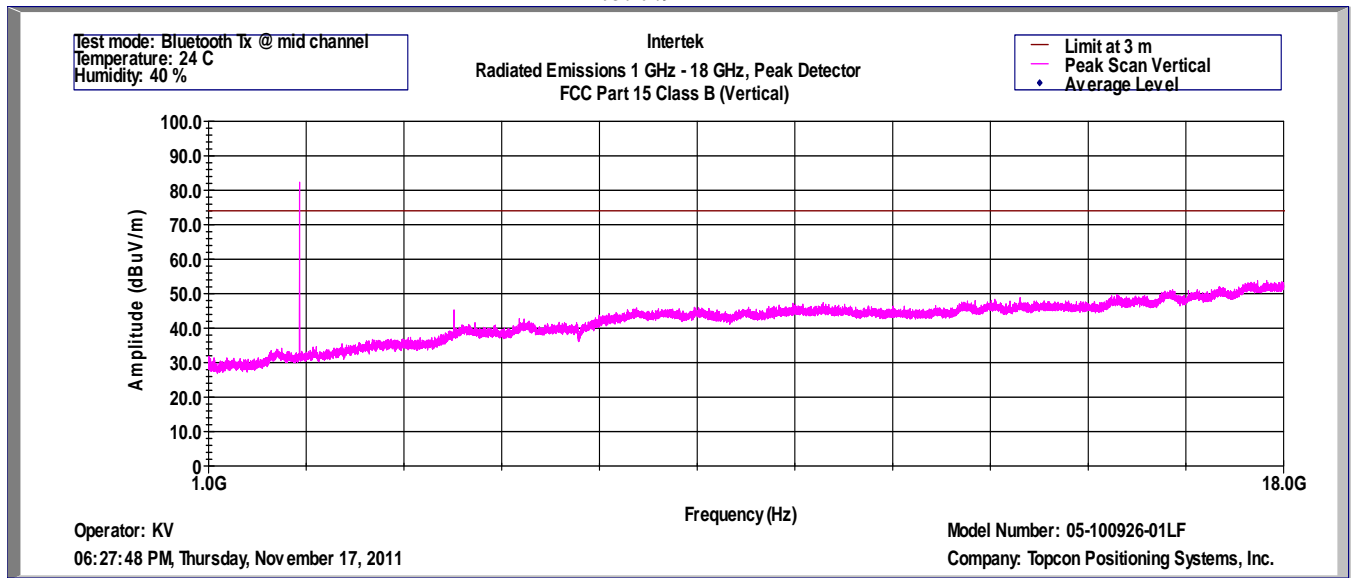
Company: Topcon Positioning Systems, Inc.

Frequency	Quasi Pk FS	Limit@3m	Margin	RA	Cable	AG	DCF	AF
Hz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB	dB(1/m)
4.23E+08	43.7	46.0	-2.3	46.1	2.4	31.9	10.5	16.6

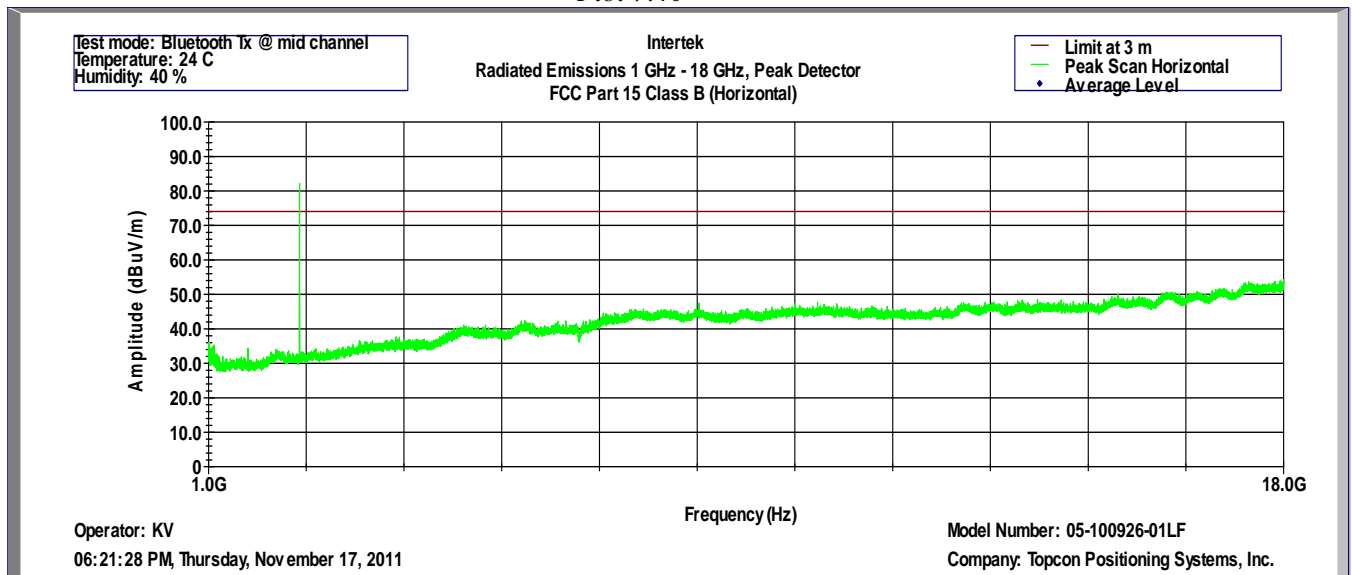
Test Mode: Bluetooth Tx @ mid channel
Temp: 22.5,
Humidity: 50.5%

Notes: Measurements made at 10 meters distance.

Plot 7.9



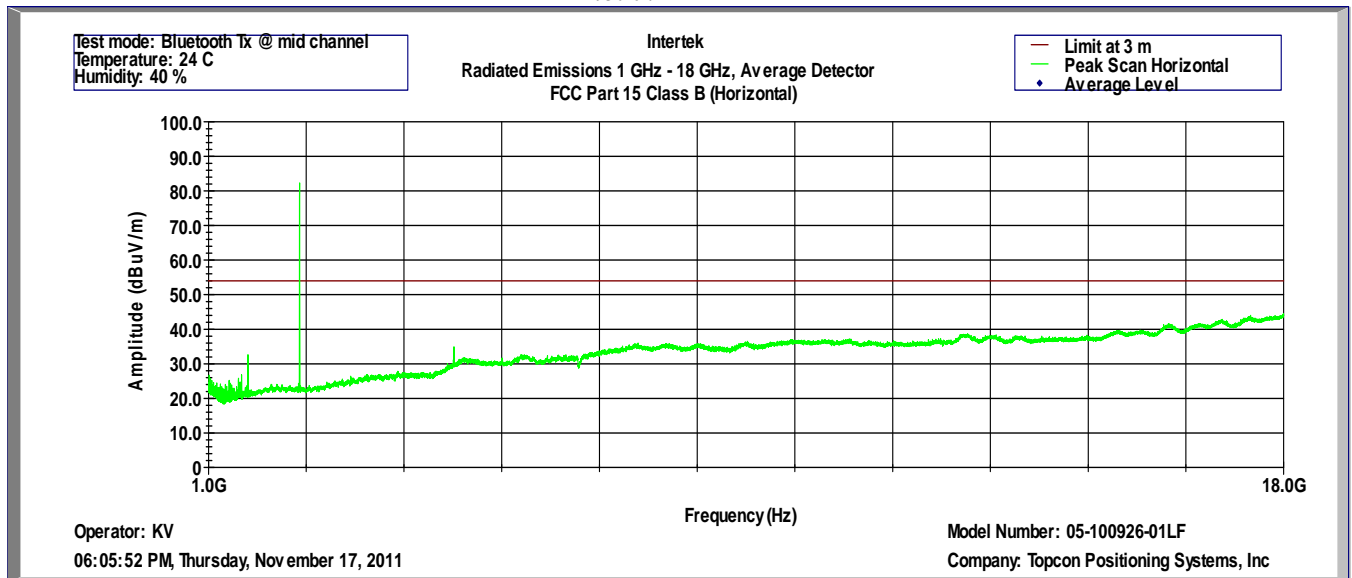
Plot 7.40



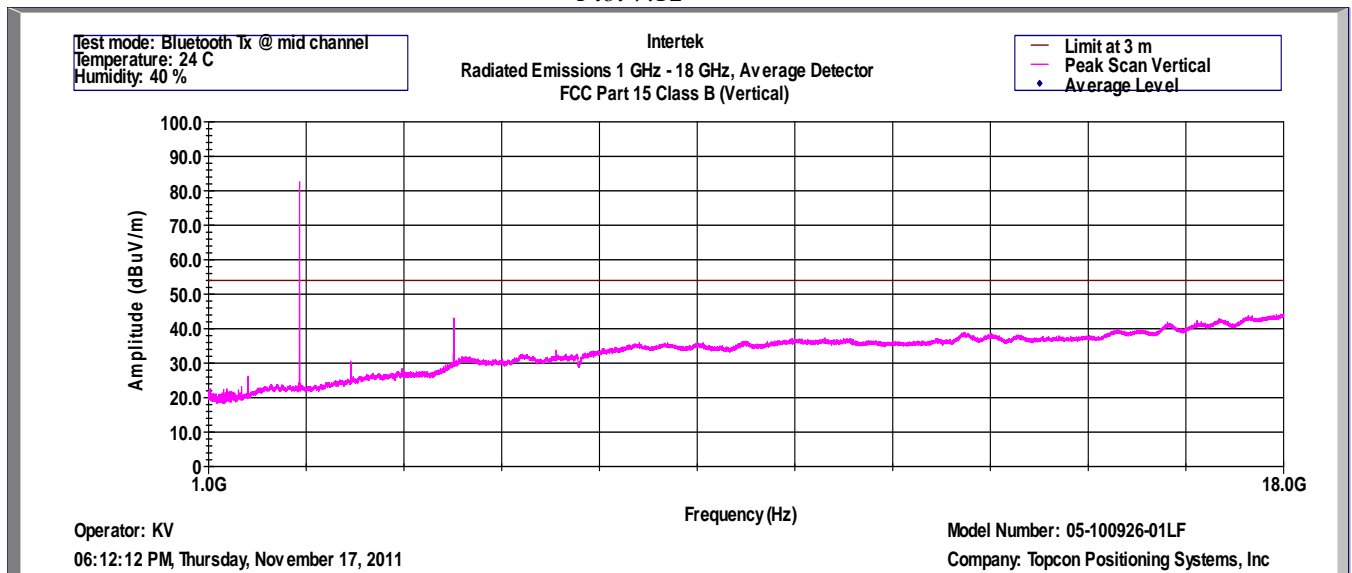
Notes: Measurements made at 3 meters distance.

No emissions were detected above the noise floor which was at least 10 dB below the limit in the range of 18GHz – 25GHz.

Plot 7.11



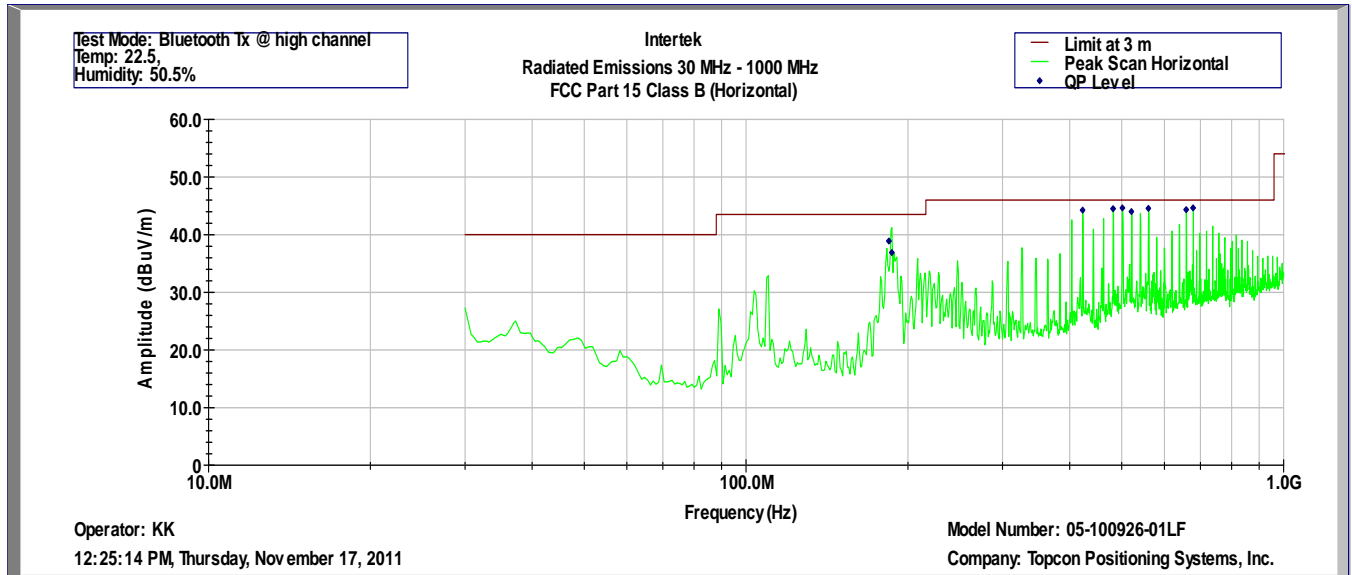
Plot 7.12



Notes: Measurements made at 3 meters distance.

No emissions were detected above the noise floor which was at least 10 dB below the limit in the range of 18GHz – 25GHz.

Plot 7.13



Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Horizontal)

Model Number: 05-100926-01LF

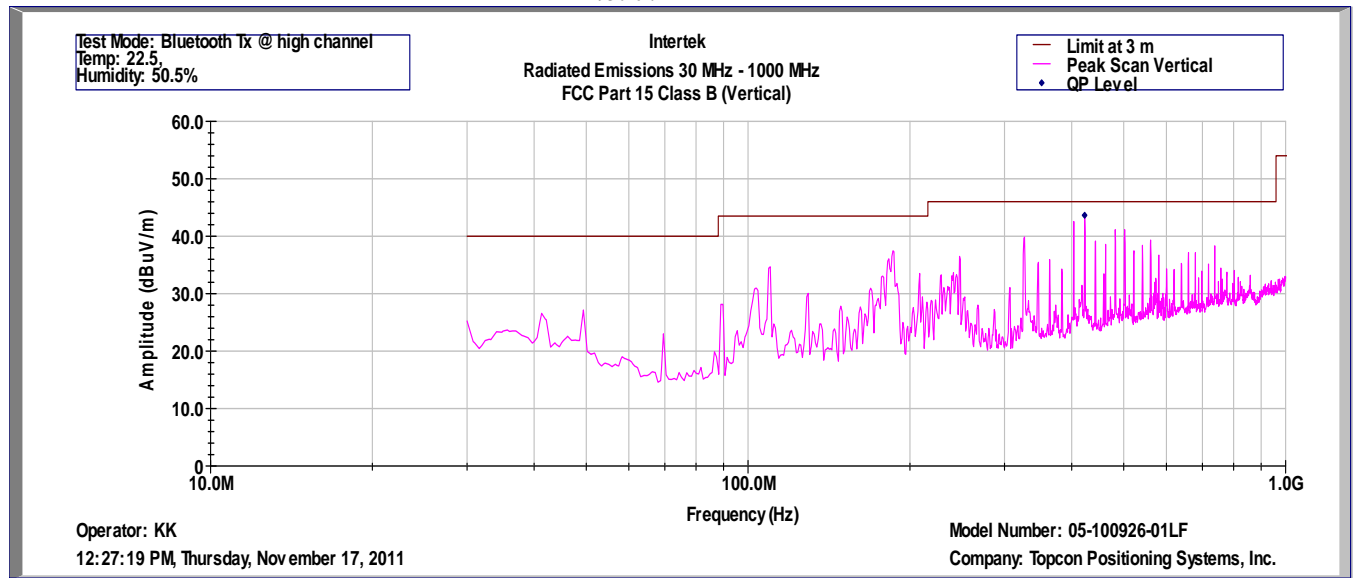
Operator: KK
17-Nov-11

Company: Topcon Positioning Systems, Inc.

Frequency Hz	Quasi Pk FS dB(uV/m)	Limit@3m dB(uV/m)	Margin dB	RA dB(uV)	CF dB	AG dB	DCF dB	AF dB(1/m)
1.84E+08	38.9	43.5	-4.6	49.1	1.6	31.9	10.5	9.6
1.87E+08	36.9	43.5	-6.6	47.1	1.6	31.9	10.5	9.6
4.23E+08	44.2	46.0	-1.8	46.6	2.4	31.9	10.5	16.6
4.82E+08	44.5	46.0	-1.5	46.1	2.6	31.9	10.5	17.2
5.01E+08	44.6	46.0	-1.4	46.7	2.6	31.9	10.5	16.7
5.21E+08	44.0	46.0	-2.0	45.6	2.7	32.0	10.5	17.2
5.60E+08	44.5	46.0	-1.5	45.0	2.8	32.0	10.5	18.2
6.59E+08	44.3	46.0	-1.7	43.9	3.0	32.1	10.5	19.0
6.78E+08	44.6	46.0	-1.4	43.5	3.1	32.1	10.5	19.7

Test Mode: Bluetooth Tx @ high channel
Temp: 22.5,
Humidity: 50.5%
Notes: Measurements made at 10 meters distance.

Plot 7.14



Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Vertical)

Model Number: 05-100926-01LF

Operator: KK
17-Nov-11

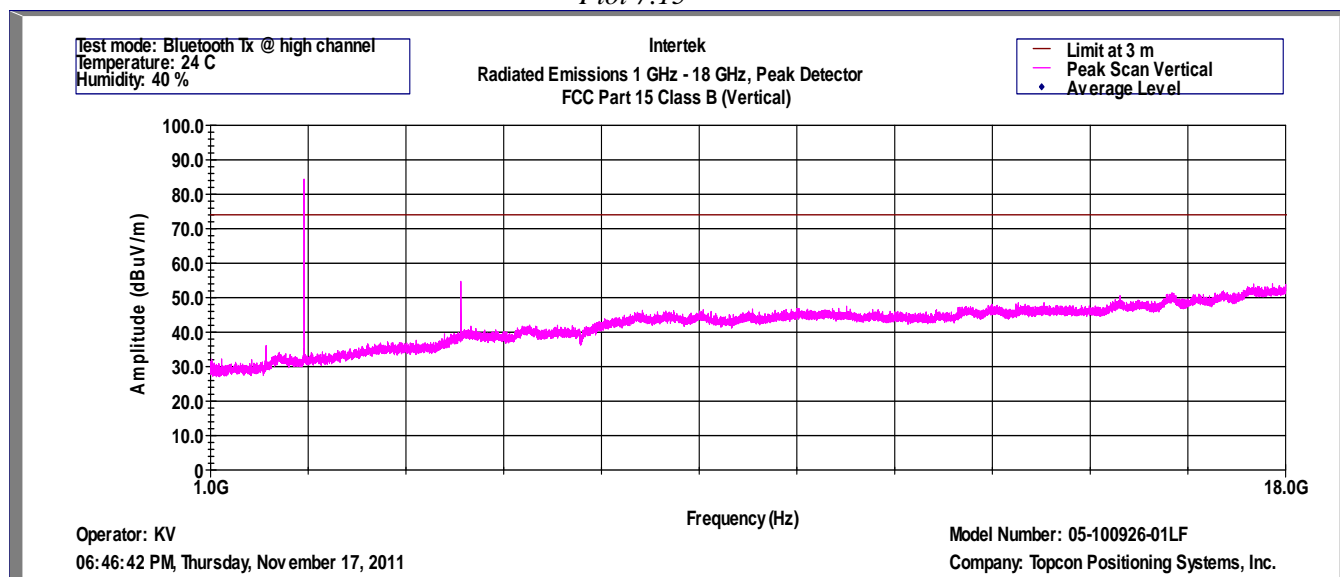
Company: Topcon Positioning Systems, Inc.

Frequency	Quasi Pk FS	Limit@3m	Margin	RA	Cable	AG	DCF	AF
Hz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB	dB(1/m)
4.23E+08	43.6	46.0	-2.4	46.0	2.4	31.9	10.5	16.6

Test Mode: Bluetooth Tx @ high channel
Temp: 22.5,
Humidity: 50.5%
Notes: Measurements made at 10 meters distance.



Plot 7.15



Intertek Testing Services
Radiated Emissions 1 GHz - 18 GHz, Peak Detector
FCC Part 15 Class B (Vertical)

Operator: KV
17-Nov-11

Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

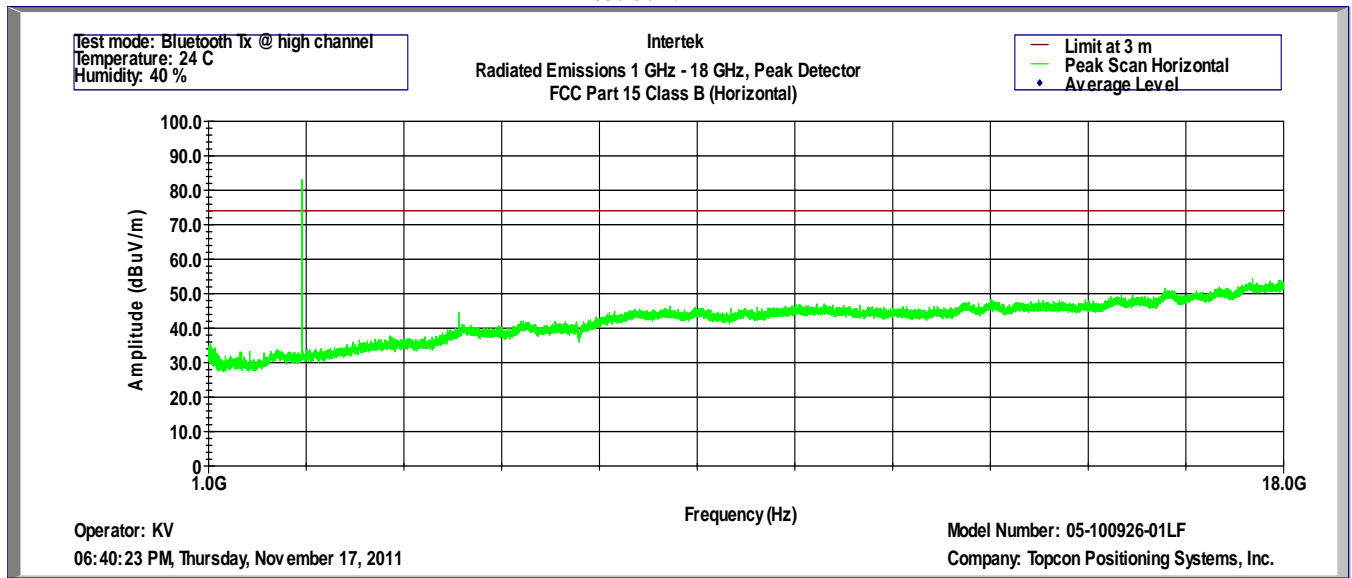
Frequency (Hz)	Pk Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Cable (dB)	Preamp (dB)	AF dB(1/m)
4.9600E+09	54.7	74.0	-19.3	46.5	10.2	34.9	33.0

Test mode: Bluetooth Tx @ high channel
Temperature: 24 C
Humidity: 40 %

Notes: Measurements made at 3 meters distance.

No emissions were detected above the noise floor which was at least 10 dB below the limit in the range of 18GHz – 25GHz.

Plot 7.16



Intertek Testing Services
Radiated Emissions 1 GHz - 18 GHz, Peak Detector
FCC Part 15 Class B (Horizontal)

Operator: KV
17-Nov-11

Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

Frequency (Hz)	Pk Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Cable (dB)	Preamp (dB)	AF dB(1/m)
4.9600E+09	44.5	74.0	-29.5	36.3	10.2	34.9	32.9

Test mode: Bluetooth Tx @ high channel
Temperature: 24 C
Humidity: 40 %

Measurement at the Bandedge

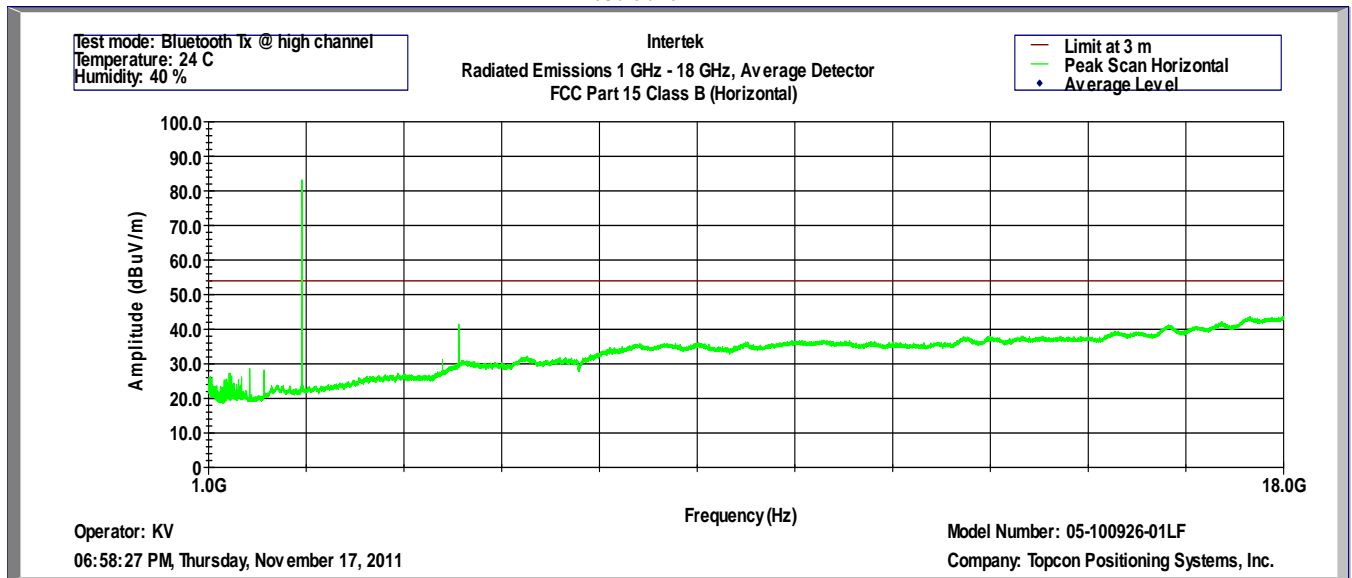
Frequency (Hz)	Pk Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Cable (dB)	Preamp (dB)	AF dB(1/m)
2.4835+09	38.7	74.0	-35.3	41.8	4.5	35.7	28.1

Notes: Measurements made at 3 meters distance.

No emissions were detected above the noise floor which was at least 10 dB below the limit in the range of 18GHz – 25GHz.



Plot 7.17



Intertek Testing Services
Radiated Emissions 1 GHz - 18 GHz, Average Detector
FCC Part 15 Class B (Horizontal)
Operator: KV
17-Nov-11
Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

Frequency	Av Level	Limit@3m	Margin	Raw	Duty cycle*	Cable	Preamp	AF
(Hz)	(dBuV/m)	(dBuV/m)	(dB)	(dBuV)	dB	(dB)	(dB)	dB(1/m)
4.9600E+09	31.5	54.0	-22.5	33.2	9.9	10.2	34.9	32.9

Test mode: Bluetooth Tx @ high channel

Temperature: 24 C

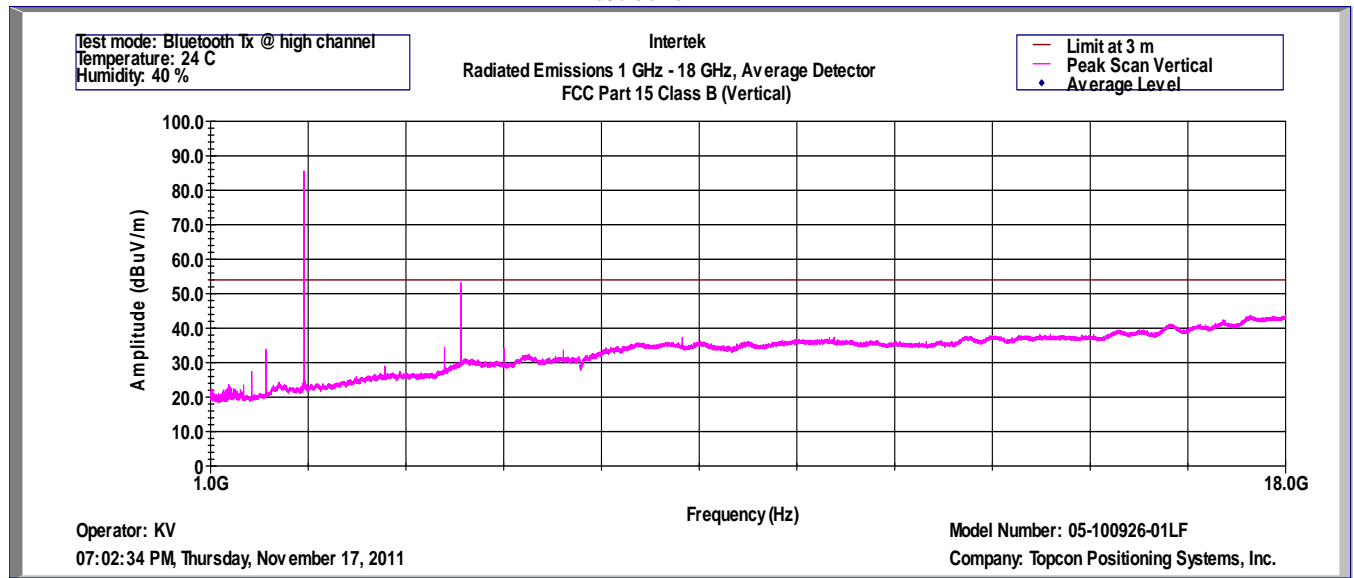
Humidity: 40 %

Notes: Measurements made at 3 meters distance.

No emissions were detected above the noise floor which was at least 10 dB below the limit in the range of 18GHz – 25GHz.

* See Appendix A for Duty Cycle measurement

Plot 7.18



Intertek Testing Services
Radiated Emissions 1 GHz - 18 GHz, Average Detector
FCC Part 15 Class B (Vertical)

Operator: KV
17-Nov-11

Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

Frequency (Hz)	Av Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Duty cycle* dB	Cable (dB)	Preamp (dB)	AF dB(1/m)
4.9600E+09	43.3	54.0	-10.7	44.9	9.9	10.2	34.9	33.0

Test mode: Bluetooth Tx @ high channel
Temperature: 24 C
Humidity: 40 %

Measurement at the Bandedge

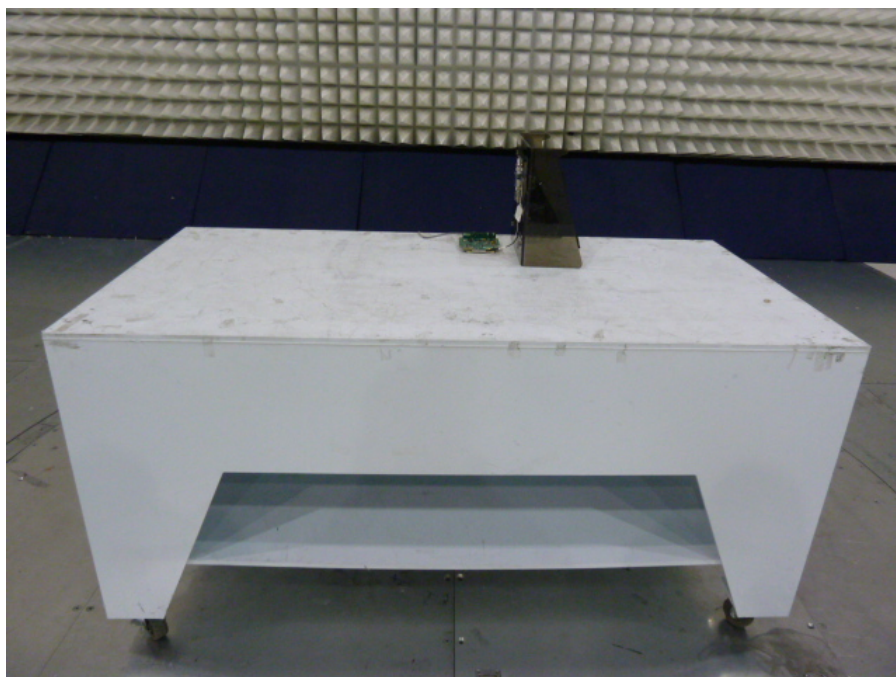
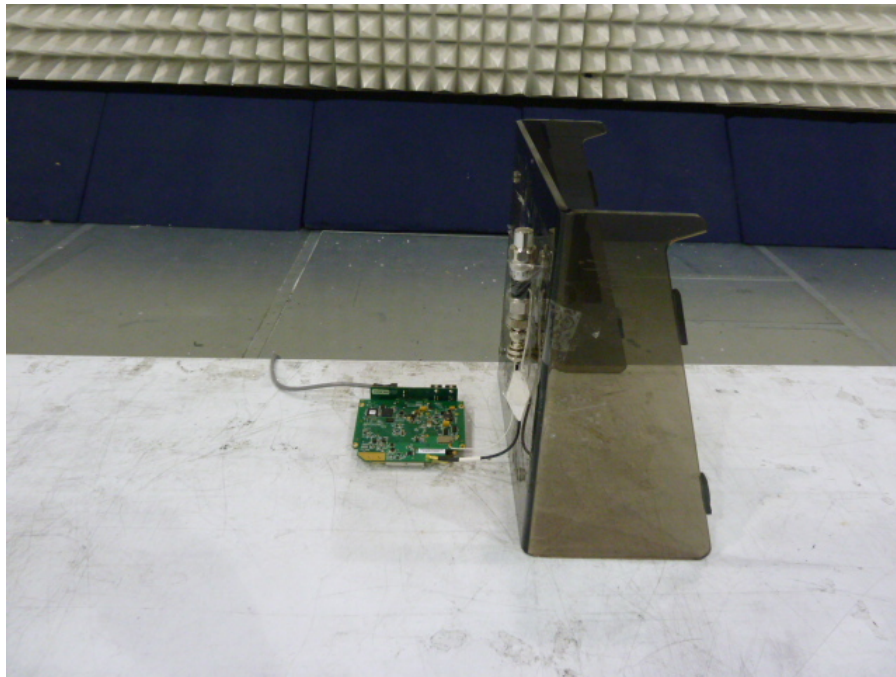
Frequency (Hz)	Av Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Cable (dB)	Preamp (dB)	AF dB(1/m)
2.4835+09	38.1	54.0	-15.9	41.2	4.5	35.7	28.1

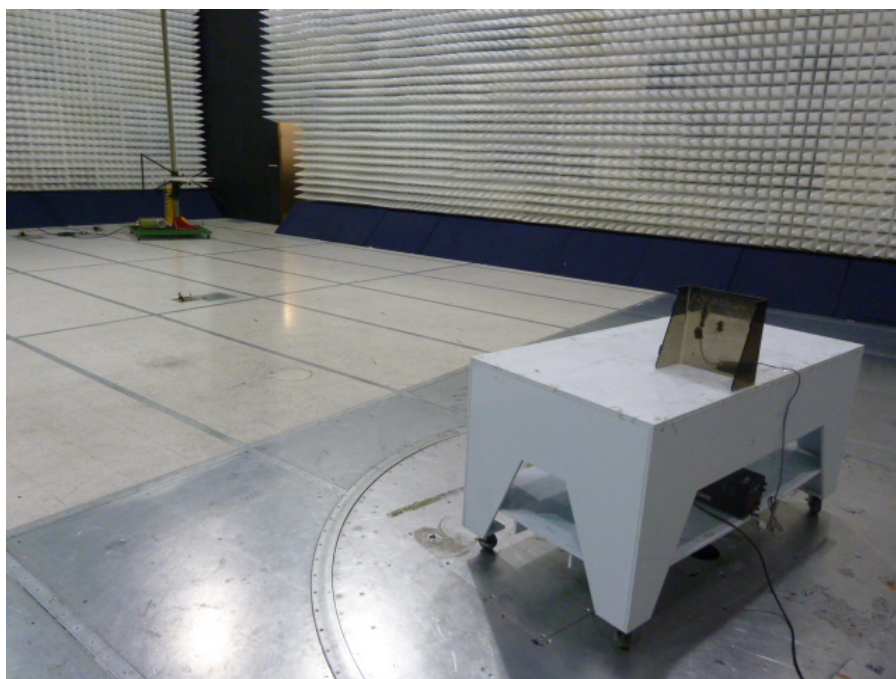
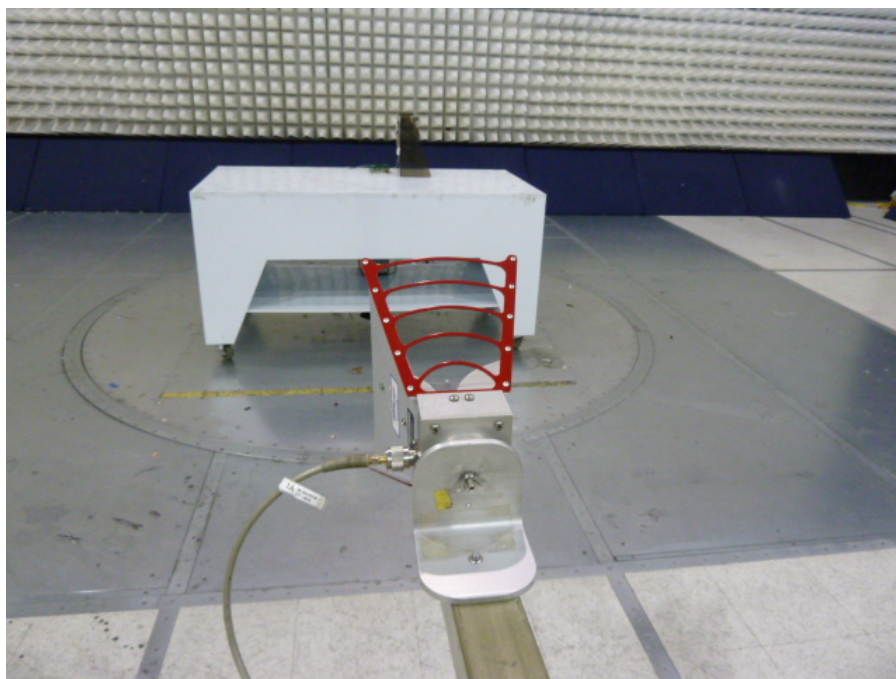
Notes: Measurements made at 3 meters distance.

No emissions were detected above the noise floor which was at least 10 dB below the limit in the range of 18GHz – 25GHz.

* See Appendix A for Duty Cycle measurement.

Test Setup Photographs





4.8 AC Line Conducted Emission FCC 15.207

Requirement

Frequency Band MHz	Quasi-Peak	Average
0.15-0.50	66 to 56 Decreases linearly with the logarithm of the frequency	56 to 46 Decreases linearly with the logarithm of the frequency
0.50-5.00	56	46
5.00-30.00	60	50

Note: At the transition frequency the lower limit applies.

Procedure

Measurements are carried out using quasi-peak and average detector receivers in accordance with CISPR 16. An AMN is required to provide a defined impedance at high frequencies across the power feed at the point of measurement of terminal voltage and also to provide isolation of the circuit under test from the ambient noise on the power lines. An AMN as defined in CISPR 16 shall be used.

The EUT is located so that the distance between the boundary of the EUT and the closest surface of the AMN is 0.8m.

Where a flexible mains cord is provided by the manufacturer, this shall be 1m long or if in excess of 1m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4m in length.

The EUT is arranged and connected with cables terminated in accordance with the product specification.

Conducted disturbance is measured between the phase lead and the reference ground, and between the neutral lead and the reference ground. Both measured values are reported.

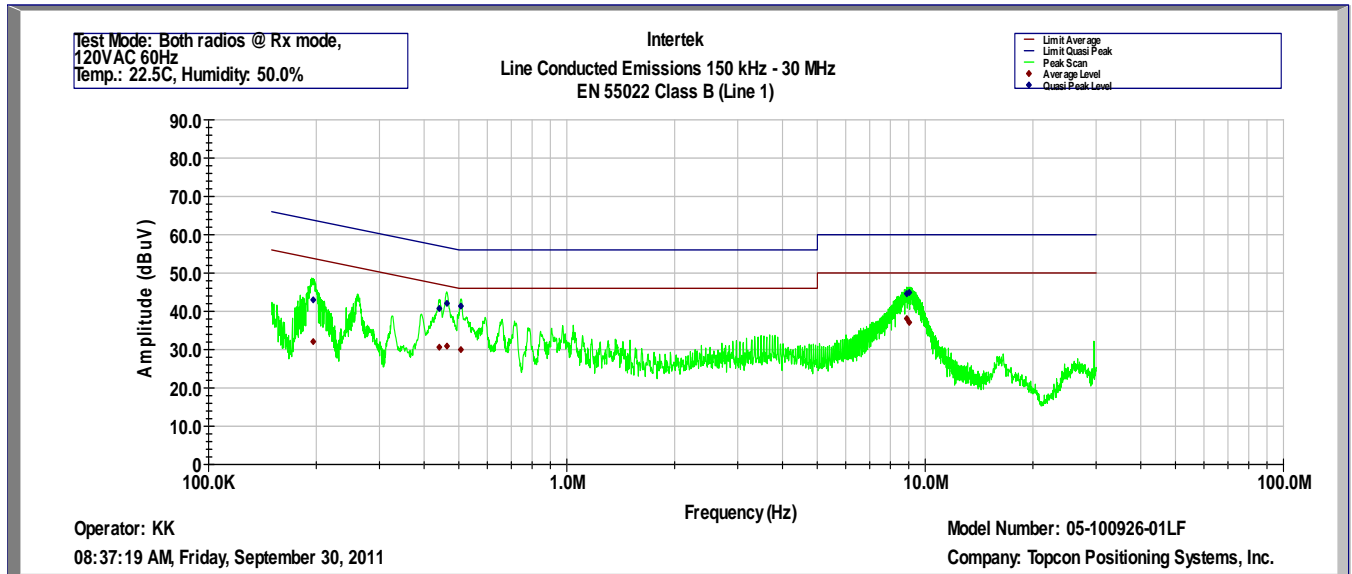
The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground plane not being part of the EUT. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.

Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.4.

Test Results

Conducted Disturbance at AC Mains



Intertek
Line Conducted Emissions 150 kHz - 30 MHz
EN 55022 Class B (Line 1)

Operator: KK
30-Sep-11

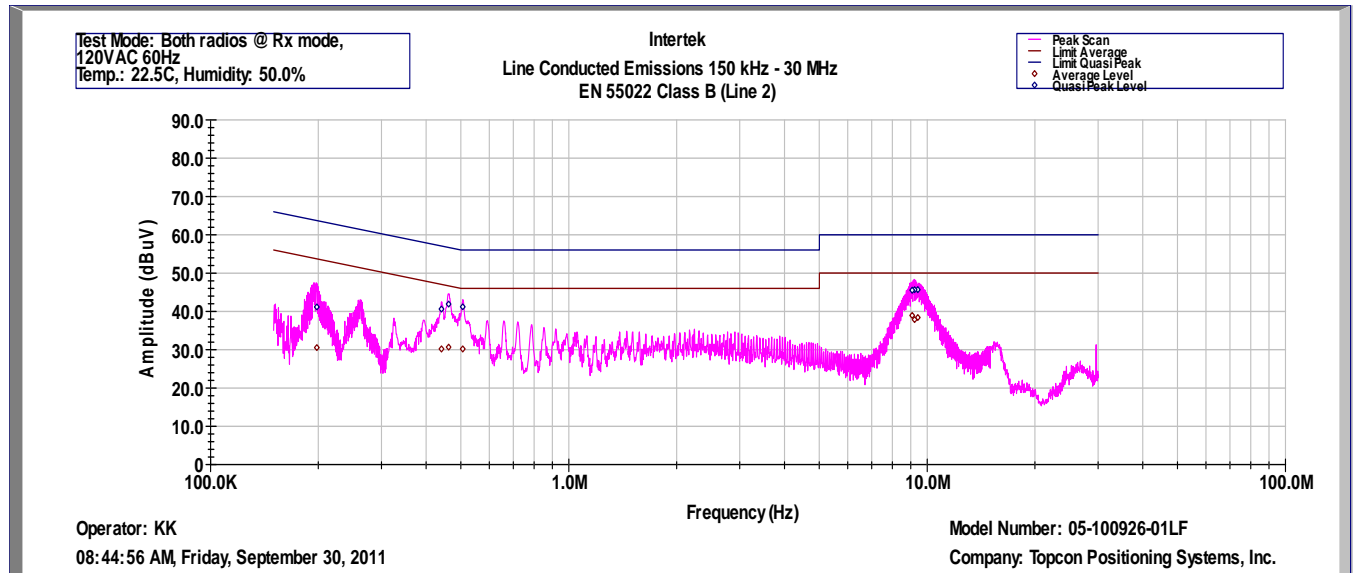
Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
Hz	dBuV	dBuV	dBuV	dBuV	dB	dB
196099	32.1	43.0	54.7	64.7	-22.6	-21.7
440945	30.6	40.7	47.7	57.7	-17.1	-17.0
463078	30.9	42.1	47.1	57.1	-16.2	-15.0
506265	30.0	41.3	46.0	56.0	-16.0	-14.7
8888190	38.1	44.6	50.0	60.0	-11.9	-15.4
9021260	37.1	44.9	50.0	60.0	-12.9	-15.1

Test Mode: Both radios in Rx mode
120VAC 60Hz
Temp.: 22.5C, Humidity: 50.0%

Note: Power Supply used; PHIHONG, Model: PSC30U-120, Serial: P01702775C2

Conducted Disturbance at AC Mains



Intertek
Line Conducted Emissions 150 kHz - 30 MHz
EN 55022 Class B (Line 2)

Operator: KK
30-Sep-11

Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

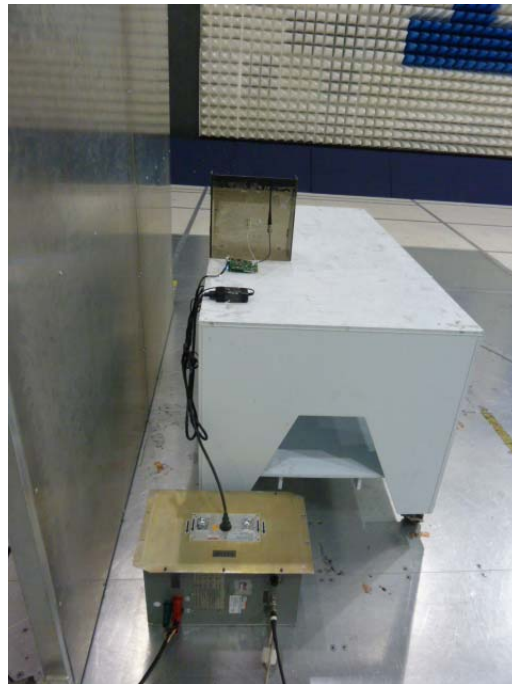
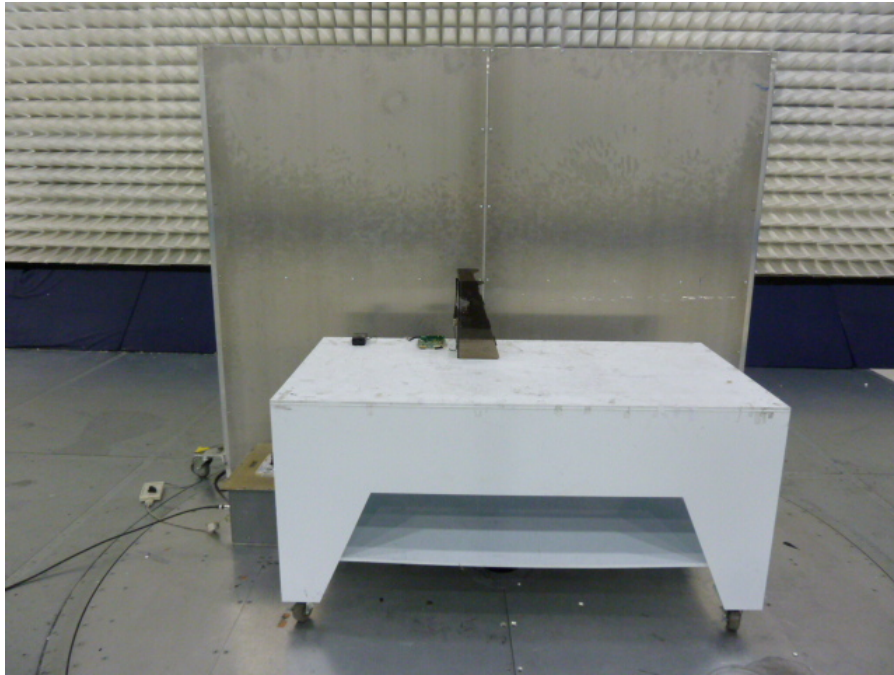
Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
Hz	dBuV	dBuV	dBuV	dBuV	dB	dB
198023	30.5	41.1	54.6	64.6	-24.1	-23.5
441246	30.2	40.6	47.7	57.7	-17.5	-17.1
461968	30.7	41.9	47.1	57.1	-16.4	-15.2
505909	30.2	41.2	46.0	56.0	-15.8	-14.8
9079290	38.9	45.5	50.0	60.0	-11.1	-14.5
9216670	37.8	45.7	50.0	60.0	-12.2	-14.3
9412700	38.4	45.7	50.0	60.0	-11.6	-14.3

Test Mode: Both radios in Rx mode,
120VAC 60Hz
Temp.: 22.5C, Humidity: 50.0%

Note: Power Supply used; PHIHONG, Model: PSC30U-120, Serial: P01702775C2

Results **Complies by 7.7dB**

Test Setup Photographs





4.9 Emissions from Digital Parts and Receiver FCC 15.109

Requirement

Radiated Emission Limits for Class B at 3 meters	
Frequency (MHz)	Quasi-Peak limits, dB (μV/m)
30 to 88	40.0
88 to 216	43.5
216 to 960	46.0
960 and up	54.0

Procedure

Measurements are conducted with a quasi-peak detector instrument in the frequency range of 30 MHz to 1000 MHz and with the average detector instrument in the frequency range above 1000 MHz. The measuring receiver meets the requirements of Section One of CISPR 16 and the measuring antenna correlates to a balanced dipole.

Measurements of the radiated field are made with the antenna located at a distance of 10 meters from the EUT. If the field-strength measurements at 10m cannot be made because of high ambient noise level or for other reasons, measurements of Class B equipment may be made at a closer distance, for example 3m. An inverse proportionality factor of 20 dB per decade should be used to normalize the measured data to the specified distance for determining compliance.

The antenna is adjusted between 1m and 4m in height above the ground plane for maximum meter reading at each test frequency.

The antenna-to-EUT azimuth is varied during the measurement to find the maximum field-strength readings.

The antenna-to-EUT polarization (horizontal and vertical) is varied during the measurements to find the maximum field-strength readings.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for a larger EUT.

Floor standing EUTs are placed on a horizontal metal ground plane and isolated from the ground plane by 3 to 12 mm of insulating material.

Equipment setup for radiated disturbance tests followed the guidelines of ANSI C63.4.

Example Field Strength Calculation

EMC Report for Topcon Positioning Systems, Inc. on the DIG UHF-II Radio Module
File: 100387380MPK-001



For measurements made at 10 meters distance

The field strength is calculated by adding the Antenna Factor and Cable Factor to from the measured reading, followed by subtracting the Amplifier Gain (if any) and Distance Correction Factor (if any). The basic equation with a sample calculation is as follows:

The field strength is calculated by adding the Antenna Factor and Cable Factor and the Distance Correction Factor; and subtracting the Amplifier Gain from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG + DCF$$

Where FS = Field Strength in dB(μ V/m)

RA = Receiver Amplitude (including preamplifier) in dB(μ V)

AF = Antenna Factor in dB(1/m)

CF = Cable Attenuation Factor in dB

AG = Amplifier Gain in dB

DCF = Distance Correction Factor in dB for measurements made at 10 meters distance

Assume a receiver reading of 52.5 dB(μ V) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB and Distance Correction Factor (for measurements made at 10 meters distance) of 10.5 dB is subtracted, giving field strength of 22 dB(μ V/m). This value in dB(μ V/m) was converted to its corresponding level in μ V/m.

RA = 52.5 dB(μ V)

AF = 7.4 dB(1/m)

CF = 1.6 dB

AG = 29.0 dB

DCF = 10.5 dB

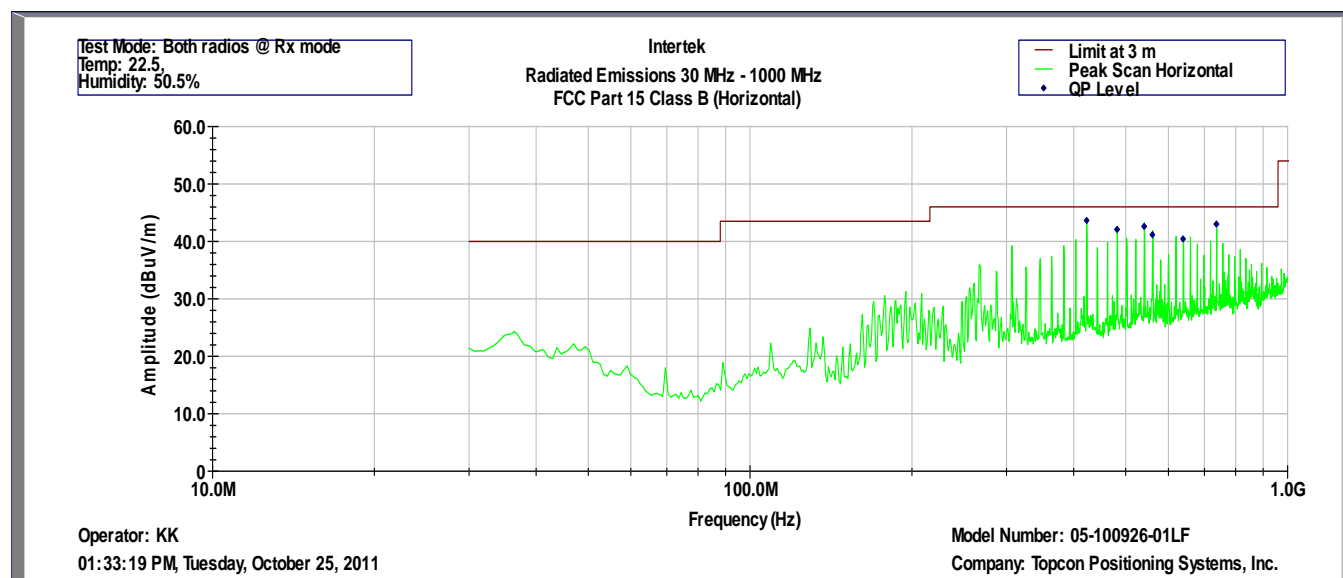
FS = 52.5+7.4+1.6-29.0+10.5 = 43 dB(μ V/m).

Level in μ V/m = Common Antilogarithm [(43 dB μ V/m)/20] = 141.3 μ V/m.

For measurements made at 3 meters distance

The field strength is calculated by following the example above for measurements made at 10 meters distance except the Distance Correction Factor in dB is not applied.

Test Results



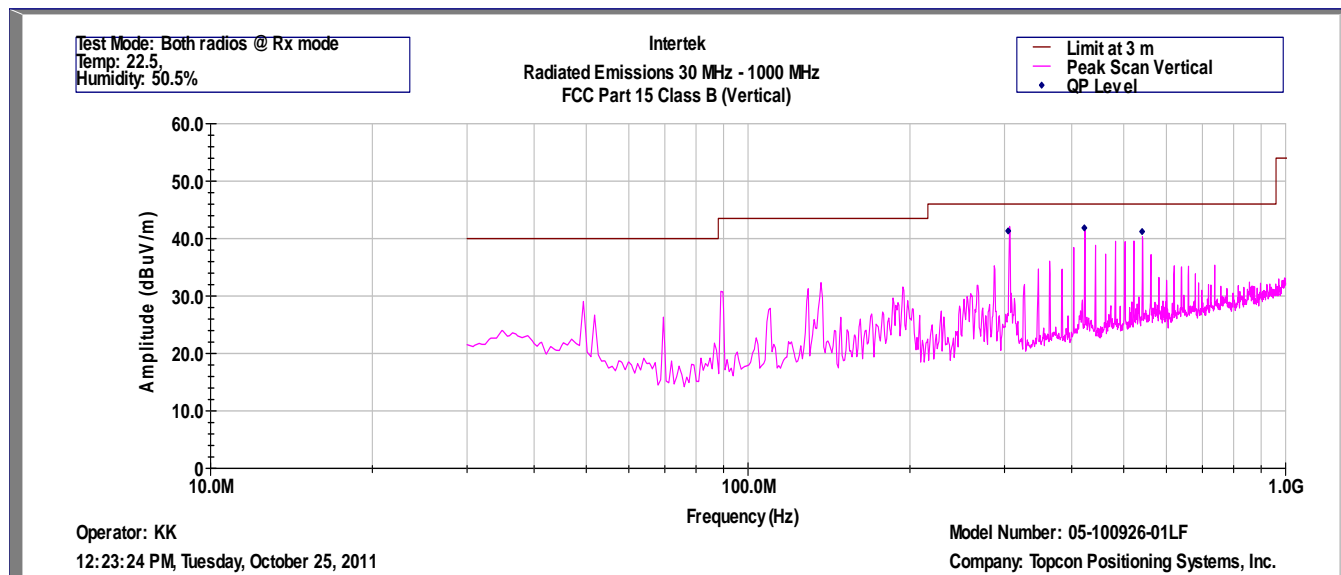
Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Horizontal)

Operator: KK
25-Oct-11

Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

Frequency	Quasi Pk FS	Limit@3m	Margin	RA	CF	AG	DCF	AF
Hz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB	dB(1/m)
4.23E+08	43.6	46.0	-2.4	46.0	2.4	31.9	10.5	16.6
4.82E+08	42.1	46.0	-3.9	43.7	2.6	31.9	10.5	17.2
5.41E+08	42.6	46.0	-3.4	43.4	2.7	32.0	10.5	17.9
5.60E+08	41.1	46.0	-4.9	41.6	2.8	32.0	10.5	18.2
6.39E+08	40.4	46.0	-5.6	39.0	3.0	32.1	10.5	20.0
7.37E+08	43.0	46.0	-3.0	41.0	3.2	32.1	10.5	20.3

Test Mode: Both radios in Rx mode
Temp: 22.5C
Humidity: 50.5%



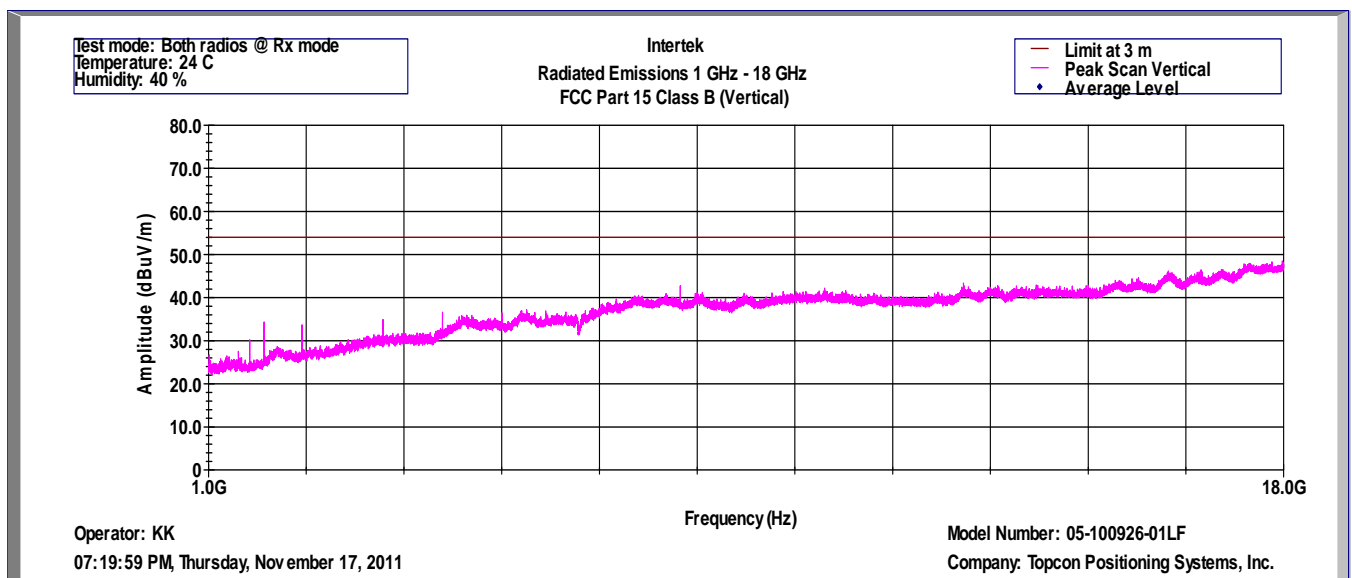
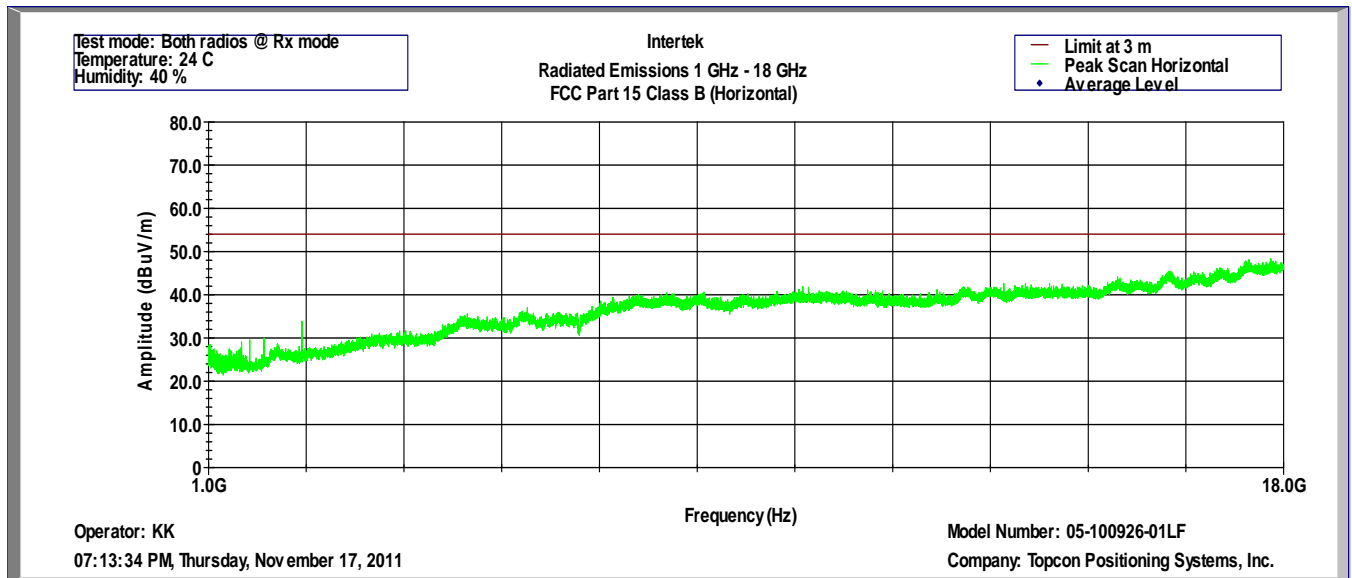
Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Vertical)

Operator: KK
25-Oct-11

Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

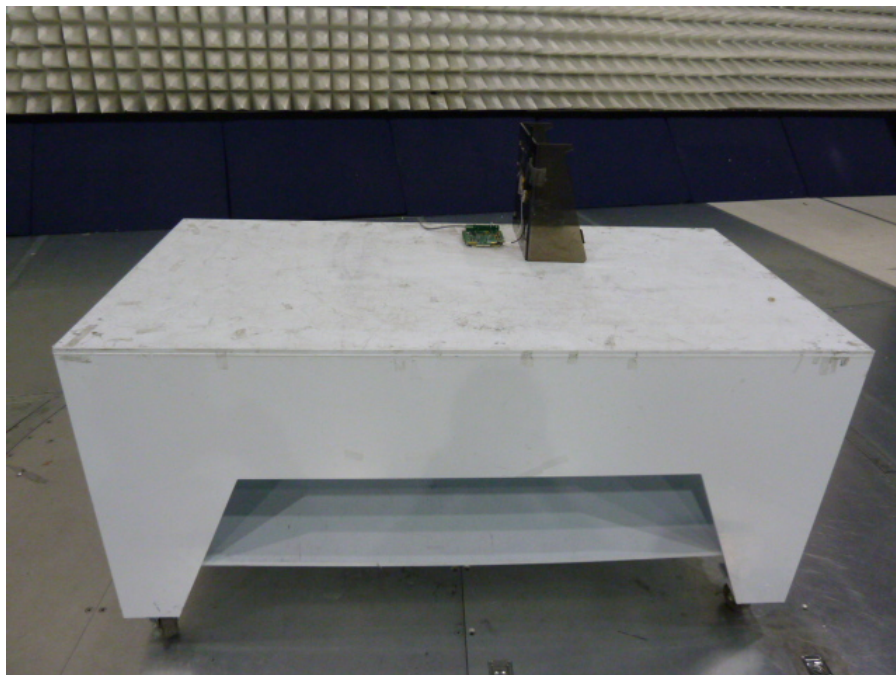
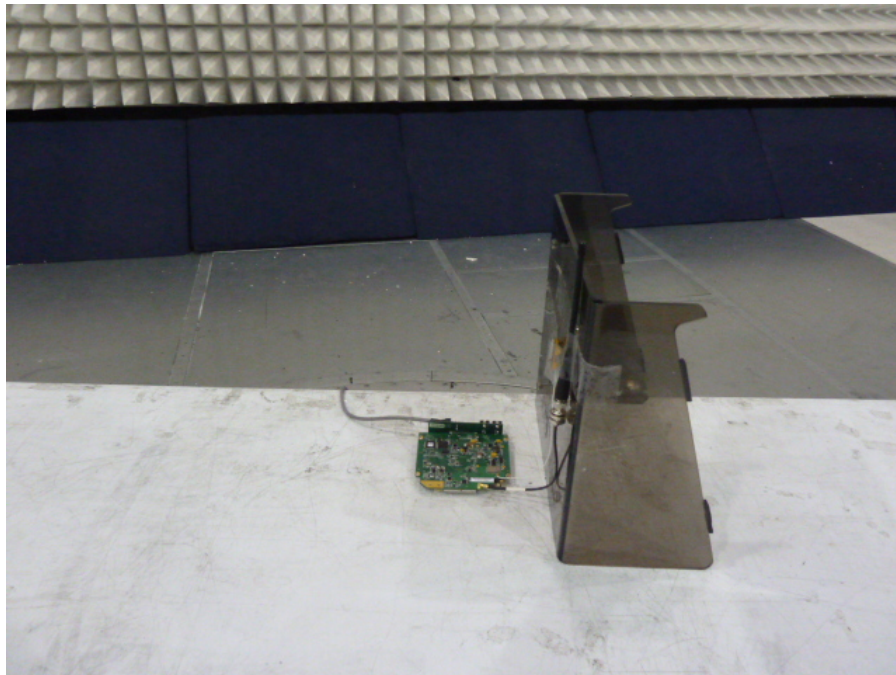
Frequency	Quasi Pk FS	Limit@3m	Margin	RA	Cable	AG	DCF	AF
Hz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB	dB(1/m)
3.05E+08	41.3	46.0	-4.7	47.5	2.0	31.9	10.5	13.2
4.22E+08	41.9	46.0	-4.1	44.2	2.4	31.9	10.5	16.6
5.41E+08	41.2	46.0	-4.8	42.0	2.7	32.0	10.5	17.9

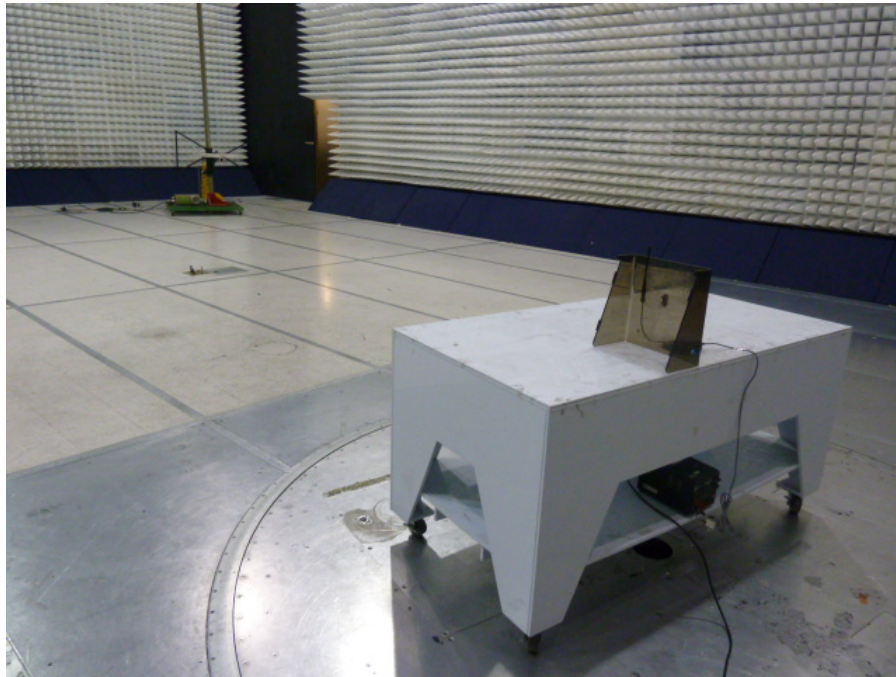
Test Mode: Both radios in Rx mode
Temp: 22.5C
Humidity: 50.5%



Result

Complies by 2.4dB







5.0 RF Exposure Evaluation

FCC 2.1091

Bluetooth Radio:

The EUT is a device used in mobile applications and will be located at least 30 cm from any body part of the user or near by persons.

The maximum conducted power is -0.07dBm (0.984mW); the antenna 4dBi gain; therefore, to comply with the requirements for RF Exposure, the MPE is calculated.

The maximum Peak EIRP calculated is as 3.993dBm or 2.51mW. 2.51mW was the Bluetooth EIRP measured with the EUT simultaneously transmitting with UHF radio.

The Power Density can be calculated using the formula

$$S = \text{EIRP} / 4\pi D^2$$

Where: S is Power Density in W/m²

D is the distance from the antenna.

It is considered that 30cm is the minimum distance that a user can go near the EUT which is installed inside a host.

At 0.3 m, $S = 0.00222 \text{ W/m}^2$, which is below the MPE Limit of 10 W/m^2

A statement that a minimum separation distance of 30 cm between the antenna and persons is included in the User's Manual.

UHF Radio:

The EUT is a wireless device used in a mobile application and will be located at least 30 cm from any body part of the user or nearby persons.

The maximum calculated EIRP is 32.9 dBm (or 1.95 W). 1.95W was the UHF EIRP measured with the EUT simultaneously transmitting with the Bluetooth radio.

Using the formula for the Power Density, $S = \text{EIRP} / 4\pi D^2$, the distance D, where the Maximum Permissible Exposure (MPE) satisfies the FCC 1.1310 limit for General Population/Uncontrolled Exposure, can be calculated as:

$$D \geq \sqrt{(\text{EIRP} / 4\pi S)}$$

According to FCC 1.1310, the MPE Limit at 406 MHz is 2.7 W/m^2 , therefore $D \geq 0.24 \text{ m}$.

A statement that a minimum separation distance of 30 cm between the antenna and persons is included in the User's Manual.



6.0 List of Test Equipment

Measurement equipment used for emission compliance testing utilized the equipment on the following list:

Equipment	Manufacturer	Model/Type	Serial #	Cal Int	Cal Due
RF Filter Section	Hewlett Packard	85460A	3448A00267	12	12/08/11
EMI Receiver	Hewlett Packard	8546A	3710A00373	12	12/08/11
Spectrum Analyzer	Rohde&Schwarz	FSP40	036612004	12	11/09/12
BI-Log Antenna	ARA	LPB-2513/A	1154	12	07/06/12
Pre-Amplifier	Sonoma	310N	185634	12	12/01/11
Pre-Amplifier	Miteq	AMF-4D-001180-24-10P	799159	12	09/01/12
Spectrum Analyzer	Rohde&Schwarz	FSU	200482	12	03/23/12
Horn Antenna	EMCO	3115	00126795	12	11/03/12
Power Meter	Hewlett Packard	EPM-442A	US37480416	12	06/08/12
Signal Generator	Hewlett Packard	8663A	2537A00214	12	04/27/12
Signal Generator	Hewlett Packard	SMR40	100445	12	09/01/12
LISN	FCC	FCC-LISN-50-50-M-H	2012	12	06/28/12

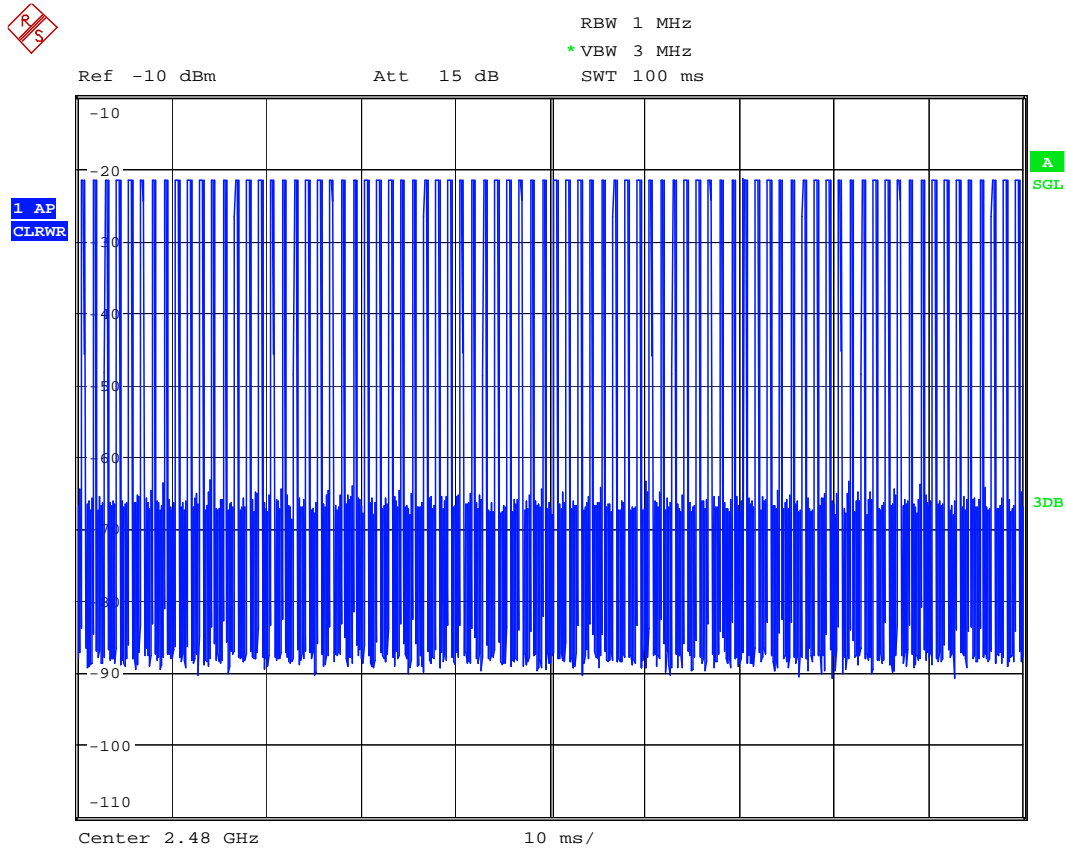


7.0 Document History

Revision/ Job Number	Writer Initials	Date	Change
1.0 / G100387380	KK	May 15, 2012	Original document

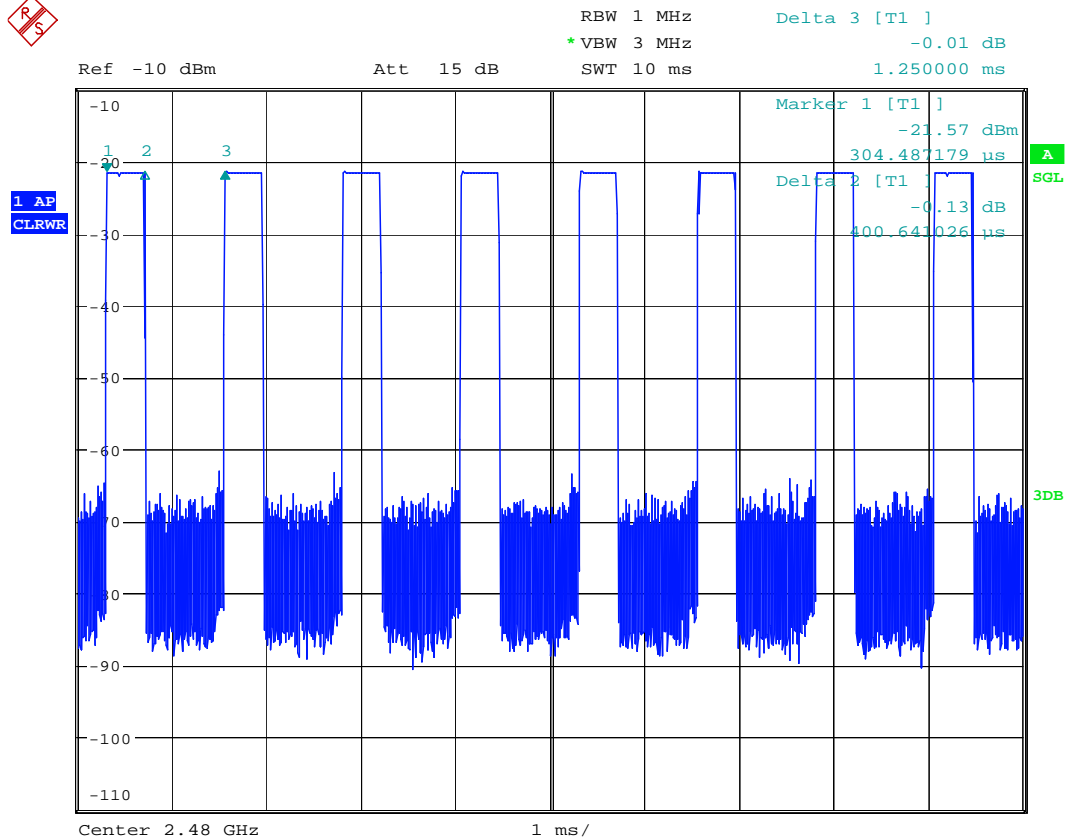


8.0 Appendix A –Graphs for Duty Cycle Measurement



Duty cycle

Date: 22.NOV.2011 10:50:03



Duty cycle

Date: 22.NOV.2011 10:46:26

Duty Cycle Calculation = $20 \log (0.400/1.25) = -9.897\text{dB}$