TEST REPORT

Report Number: 100343916MPK-001
Project Number: G100343916
Report Date: April 27, 2011

Testing performed on the
X-22 Wireless Excavator System
Model: 5434
FCC ID: LCB-5434
IC ID: 6050B-5434

to

FCC Part 15.247 and RSS-210 Issue 8

for

Topcon Positioning Systems, Inc.

Test Performed by:	Test Authorized by:
Intertek	Topcon Positioning Systems, Inc.
1365 Adams Court	7449 Southfront Rd.
Menlo Park, CA 94025 USA	Livermore, CA 94551 USA

Prepared by: _____ **Date:** April 27, 2011
Edmund Cruz

Reviewed by: _____ **Date:** April 27, 2011
Krishna K Vemuri

Report No. 100343916MPK-001

Equipment Under Test:	X-22 Wireless Excavator System
Trade Name:	Topcon Positioning Systems, Inc.
Model No.:	5434
FCC ID:	LCB-5434
IC ID:	6050B-5434
Applicant:	Topcon Positioning Systems, Inc.
Contact:	Mr. Chuck Haas
Address:	7449 Southfront Rd. Livermore, CA 94551
Country	USA
Tel. Number:	(925) 245-8300
Fax number:	(925) 460-1318
Email	Chuck_Haas@topcon.com
Applicable Regulation:	FCC Part 15, Subpart C and RSS-210 Issue 8
Test Site Location:	ITS – Site 1 1365 Adams Drive Menlo Park, CA 94025
Date of Test:	April 4 to 13, 2011

We attest to the accuracy of this report:

Edmund Cruz	Krishna K Vemuri
Test Engineer	EMC Senior Staff Engineer

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1.0 Introduction

The Equipment Under Test (EUT) is a device with a DTS (Digital Transmission System) transceiver operating in the 2.4GHz frequency band.

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

1.1 Summary of Tests

TEST	REFERENCE FCC 17.247	REFERENCE RSS-210	RESULTS
Output power	15.247(b)(3)	A8.4(4)	Complies
6-dB Bandwidth	15.247(a)(2)	A8.2(a)	Complies
Power Spectral Density	15.247(e)	A8.2(b)	Complies
Out-of-band Antenna Conducted Emission	15.247(d)	A8.5	The EUT has a permanently attached internal antenna. It does not contain an antenna port connector. Instead of Antenna Conducted measurements, Radiated measurements were performed.
Out-of-Band Radiated Emission (except emissions in Restricted Bands)	15.247(d)	A8.5	Complies
Radiated Emission in Restricted Bands	15.247(d), 15.205	2.2	Complies
RF exposure	15.247(i)	RSS-102	Complies
AC Conducted Emission	15.207	RSS-GEN	Not Applicable[1]
Radiated Emission from Digital Parts and receiver	15.109	ICES-003	Complies

[1] EUT does not contain any AC power ports. EUT is battery powered.

2.0 General Description

2.1 Product Description

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
Model Number	5434
FCC Identifier	LCB-5434
IC ID Number	6050B-5434
Rated RF Output (EIRP)	7.24 mW
Frequency Range	2480 MHz
Number of Channel(s)	1
Modulation Type	O-QPSK
Antenna Type and Gain	Internal Chip Antenna, Peak gain = 1.5 dBi Average gain = -2.3 dBi

The system consists of wireless sensors and a wireless coordinator which are mounted on an excavator machine to assist with digging. The wireless sensors are mounted on different parts of the excavator, i.e.:, bucket, boom, control arm, etc. The wireless sensors communicate their position back to the wireless coordinator. The wireless coordinator is connected to a display unit. The display unit is mounted inside the operator's cab and it displays the information from the wireless coordinator.

All wireless devices use the same RF circuit and tilt sensor functionality.

There are three different types of wireless sensors:

1. Tilt (also called Bucket or Boom sensors)
2. Tilt + Compass (the compass sensor has a compass inside which outputs a heading direction to the operator)
3. Tilt + Laser Receiver (the laser receiver has photocells to detect laser strikes)

Production versions of the samples were received on April 4, 2011 in good condition. As declared by the Applicant, it is identical to production units.

Test start date April 4, 2011
Test end date: April 13, 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 guidance document, *Measurement of Digital Transmission Systems Operating under Section 15.247*.

2.4 Test Facility

The 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 and Industry Canada (Site # 2042L-1).

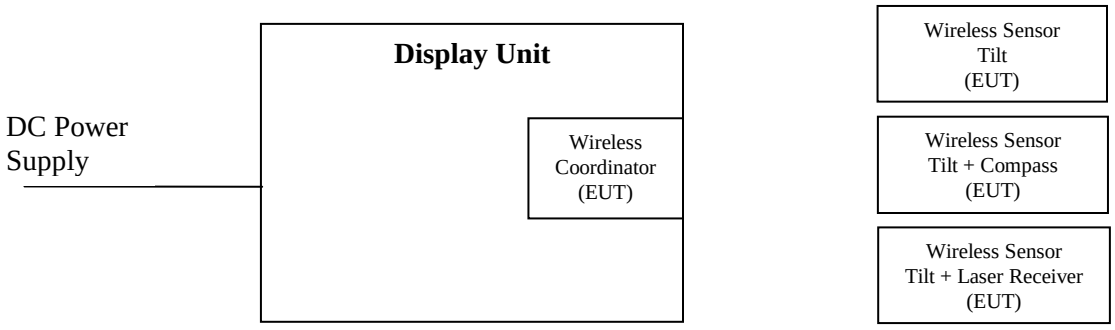
3.0 System Test Configuration

3.1 Support Equipment

Description	Model No.	Serial No.
EXTECH DC Power Supply	EP-3003	D30030012

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.



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

3.3 Justification

For radiated emission measurements the EUT was placed on a non-conductive table. The EUT was configured to transmit full power.

In actual use, the wireless coordinator is powered by a car battery. During tests, the wireless coordinator was powered by a DC power supply to simulate power from a car battery. The batteries in the wireless sensors were fully charged prior to testing.

3.4 Software Exercise Program

None.

3.5 Mode of Operation During Test

The EUT was set to continuously operate at the 2480MHz channel during the tests.

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)(3)

Requirements

For systems operating in the 2400-2483.5 MHz band using digital modulation, the maximum peak output power is 1 watt (30 dBm), the conducted power limit is based on the use of antenna with directional gain that do not exceed 6dBi. If the transmitting antenna of directional gain greater than 6dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated value as in FCC 15.247(b)(4)(i).

Procedure

The EUT has a permanently attached internal antenna. It does not contain an antenna port connector. Instead of Antenna Conducted measurements, Radiated measurements were performed.

The maximum field strength of the fundamental was measured.

The transmitter's peak power was calculated using the following equation:

Where: E = the measured maximum field strength in V/m.

Set the RBW > 6dB bandwidth of the emission or use a peak power meter.

P = (E x d) squared / (30 x G).

G = the numeric gain of the transmitting antenna over an isotropic radiator.

d = the distance in meters from which the field strength was measured.

P = the power in watts for which you are solving.

Test Results

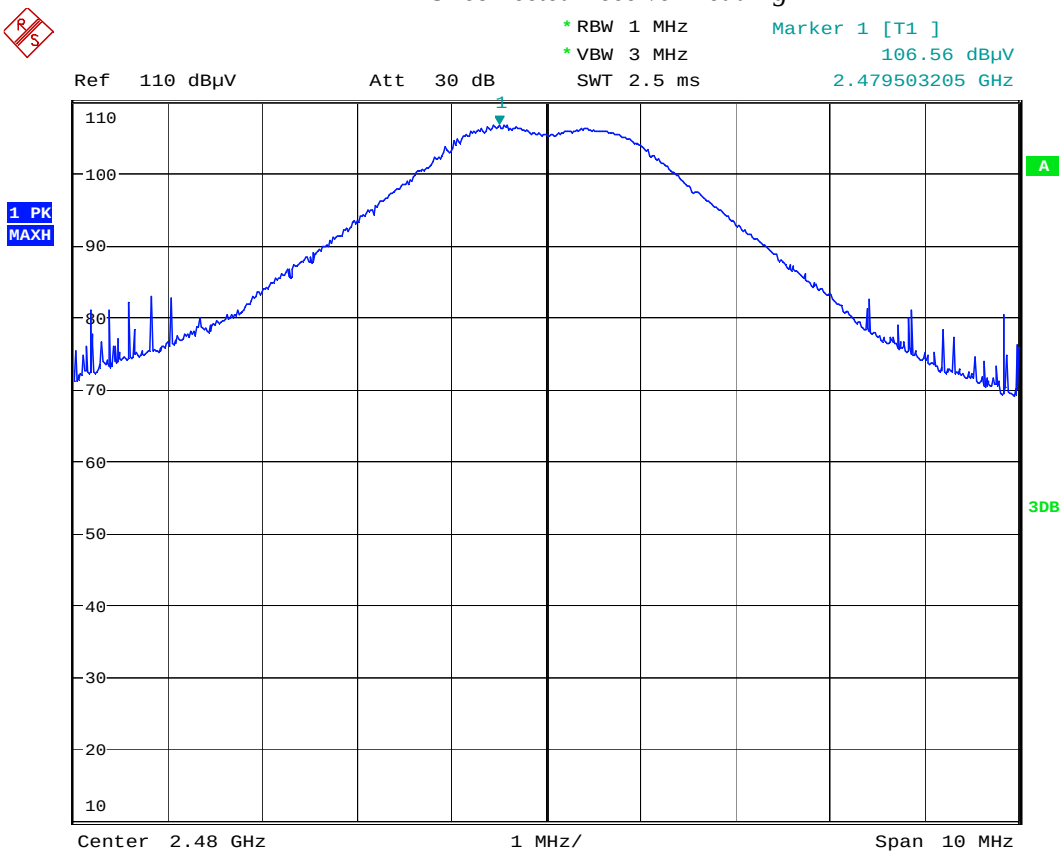
Frequency (MHz)	Output in dBm	Output in mW	Plot number
2480	8.6*	7.2	1.1 to 1.4

*Highest measurement was reported.

Note: The EUT's antenna has less than 6 dBi gain.

Plot 1.1

Uncorrected Receiver Reading



Output Power, Wireless Sensor Coordinator

Date: 4.APR.2011 13:34:50

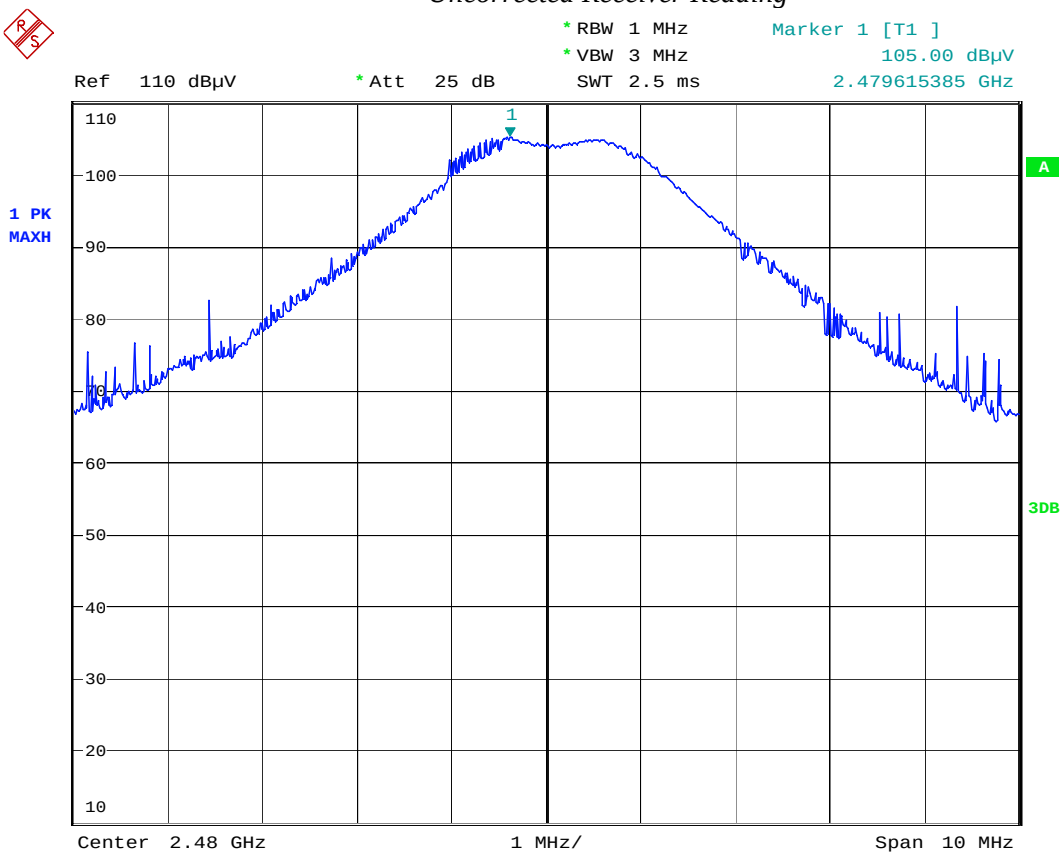
Final Corrected Reading

Frequency	RA	AG	CF	AF	Final Field Strength	EIRP	EIRP
MHz	dB(uV)	dB	dB	dB(1/m)	dB(uV/m)	dBm	mW
2480.0	106.6	35.5	5.5	27.3	103.9	8.6	7.2

RA = Receiver Amplitude
AG = Amplifier Gain
CF = Cable Factor
AF = Antenna Factor

Plot 1.2

Uncorrected Receiver Reading



Output Power, Wireless Tilt Sensor Compass

Date: 4.APR.2011 14:26:46

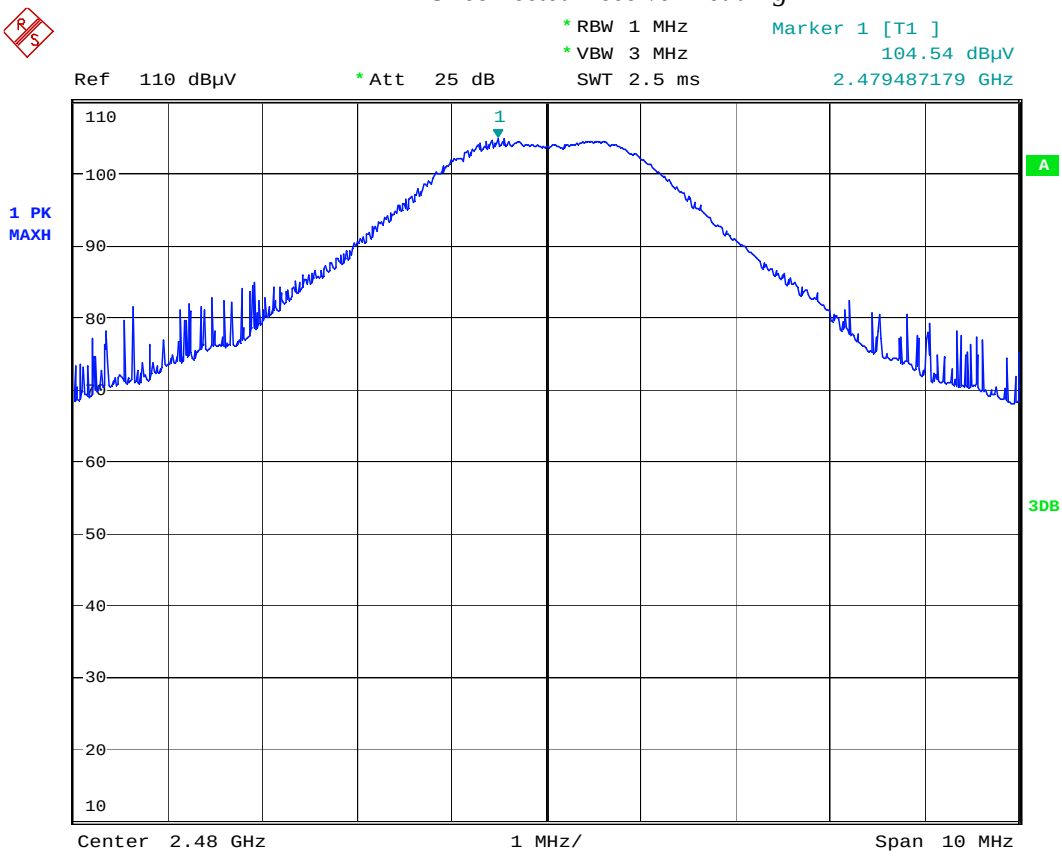
Final Corrected Reading

Frequency	RA	AG	CF	AF	Final Field Strength	EIRP	EIRP
MHz	dB(uV)	dB	dB	dB(1/m)	dB(uV/m)	dBm	mW
2480.0	105.0	35.5	5.5	27.3	102.3	7.0	5.0

RA = Receiver Amplitude
AG = Amplifier Gain
CF = Cable Factor
AF = Antenna Factor

Plot 1.3

Uncorrected Receiver Reading



Output Power, Wireless Tilt Sensor + Receiver

Date: 4.APR.2011 15:06:51

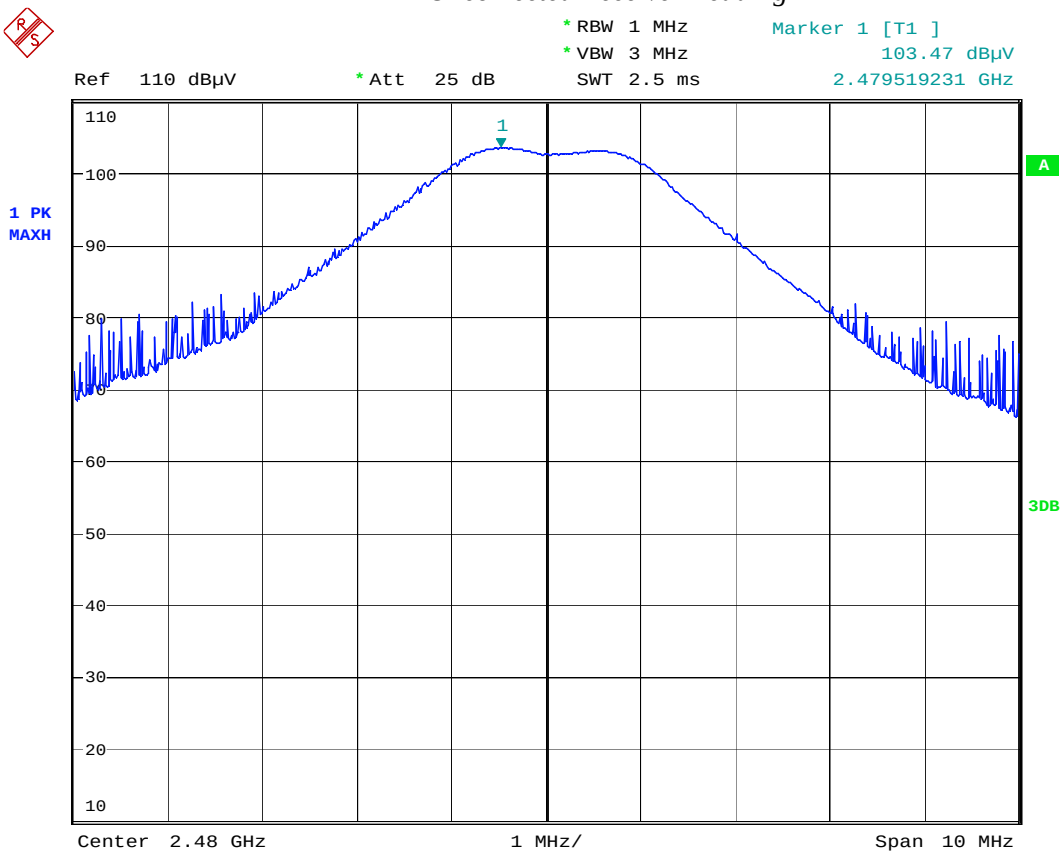
Final Corrected Reading

Frequency	RA	AG	CF	AF	Final Field Strength	EIRP	EIRP
MHz	dB(uV)	dB	dB	dB(1/m)	dB(uV/m)	dBm	mW
2480.0	104.5	35.5	5.5	27.3	101.8	6.5	4.5

RA = Receiver Amplitude
AG = Amplifier Gain
CF = Cable Factor
AF = Antenna Factor

Plot 1.4

Uncorrected Receiver Reading



Output Power, Wireless Tilt Sensor

Date: 4.APR.2011 15:42:33

Final Corrected Reading

Frequency	RA	AG	CF	AF	Final Field Strength	EIRP	EIRP
MHz	dB(uV)	dB	dB	dB(1/m)	dB(uV/m)	dBm	mW
2480.0	103.5	35.5	5.5	27.3	100.8	5.5	3.6

RA = Receiver Amplitude
AG = Amplifier Gain
CF = Cable Factor
AF = Antenna Factor

4.2 6-dB Bandwidth
FCC 15.247(a)(2)

Requirements

For systems operating in the 2400-2483.5 MHz band using digital modulation, the minimum 6-dB Bandwidth shall be at least 500kHz.

Procedure

A measuring antenna was placed in close proximity to the EUT. The spectrum analyzer resolution bandwidth was set to approximately 1% of the total emission bandwidth, VBW>RBW. The 6-dB Bandwidth was measured by using the DELTA MARKER function of the analyzer.

In addition, the Occupied Bandwidth (99%) was measured.

Test Results

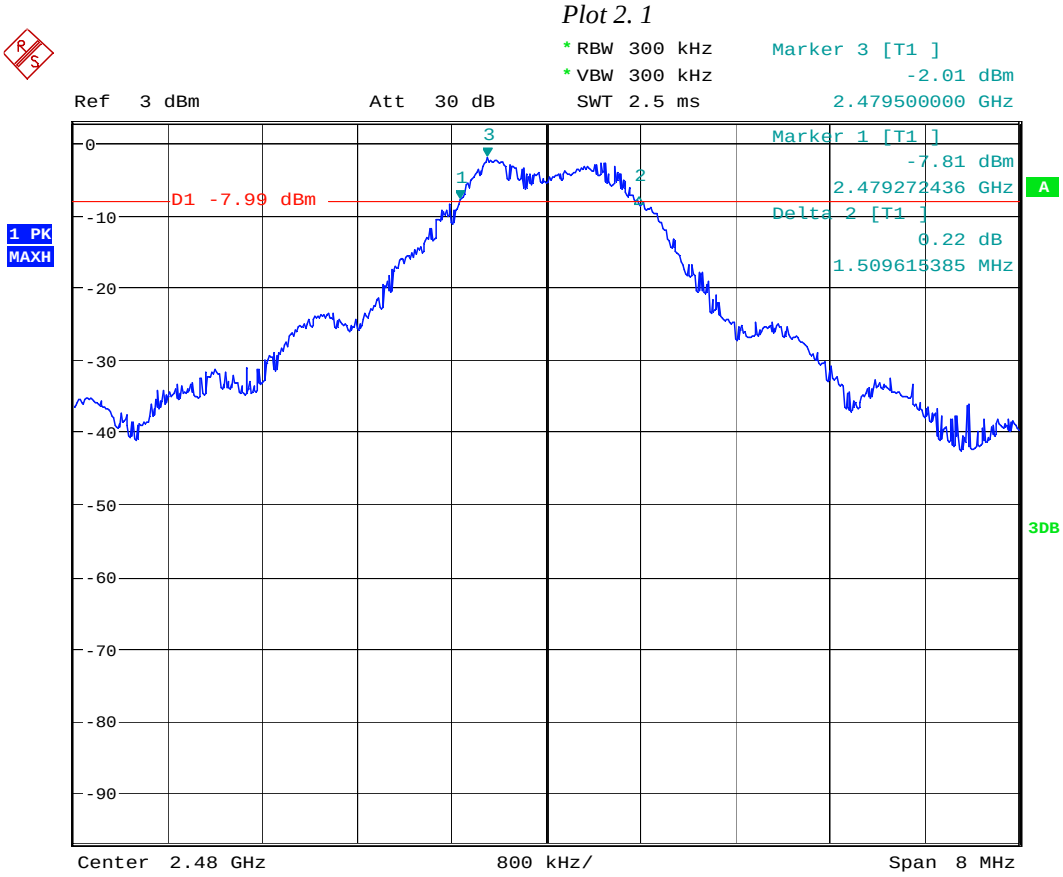
Frequency (MHz)	6-dB Channel Bandwidth (MHz)	Plot
2480	1.615*	2.1, 2.3, 2.5, 2.7

*Highest measurement was reported.

Frequency (MHz)	99% Occupied Bandwidth (MHz)	Plot
2480	2.872*	2.2,2.4,2.6,2.8

*Highest measurement was reported.

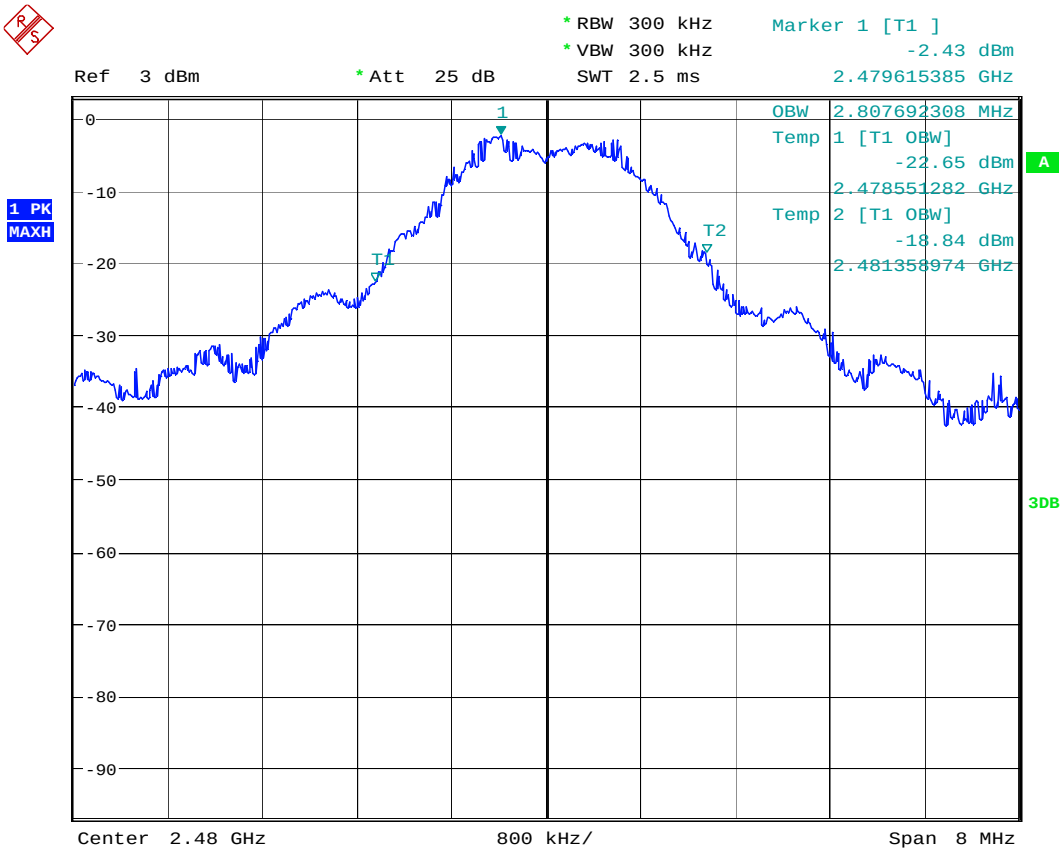
Plot 2. 1



6dB Bandwidth, Wireless Sensor Coordinator

Date: 4.APR.2011 13:46:14

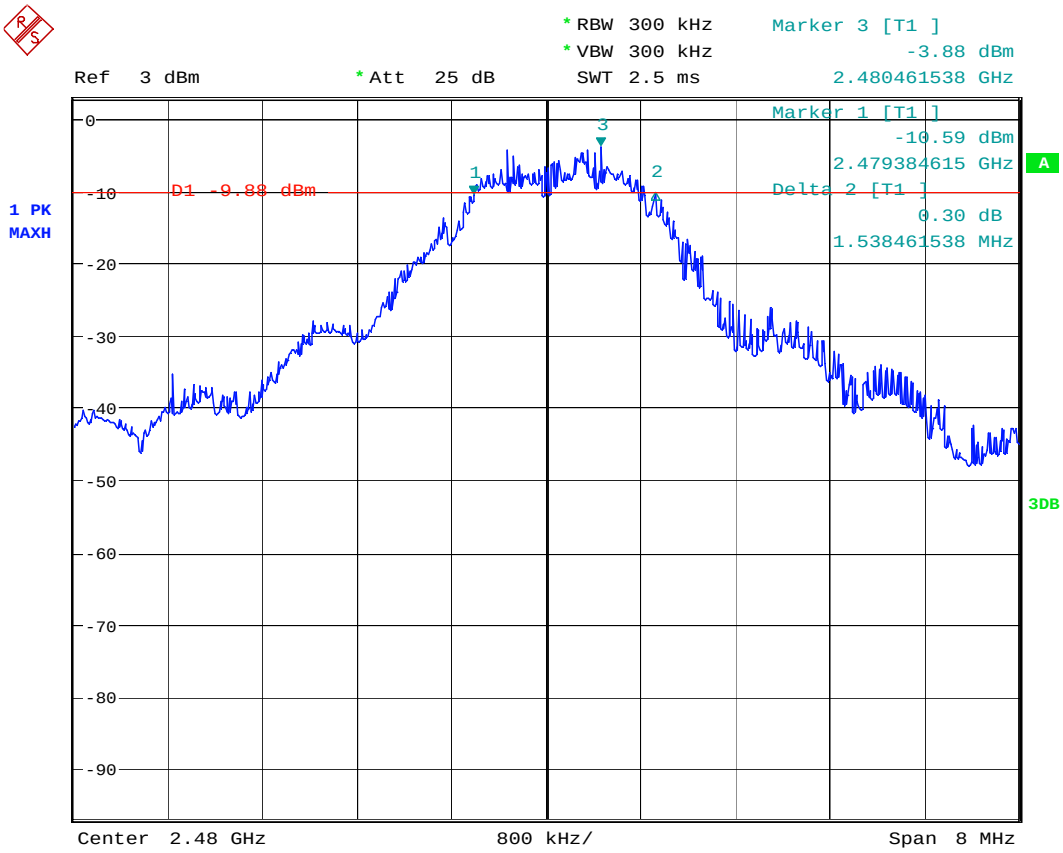
Plot 2. 2



99% Bandwidth, Wireless Sensor Coordinator

Date: 4.APR.2011 13:58:10

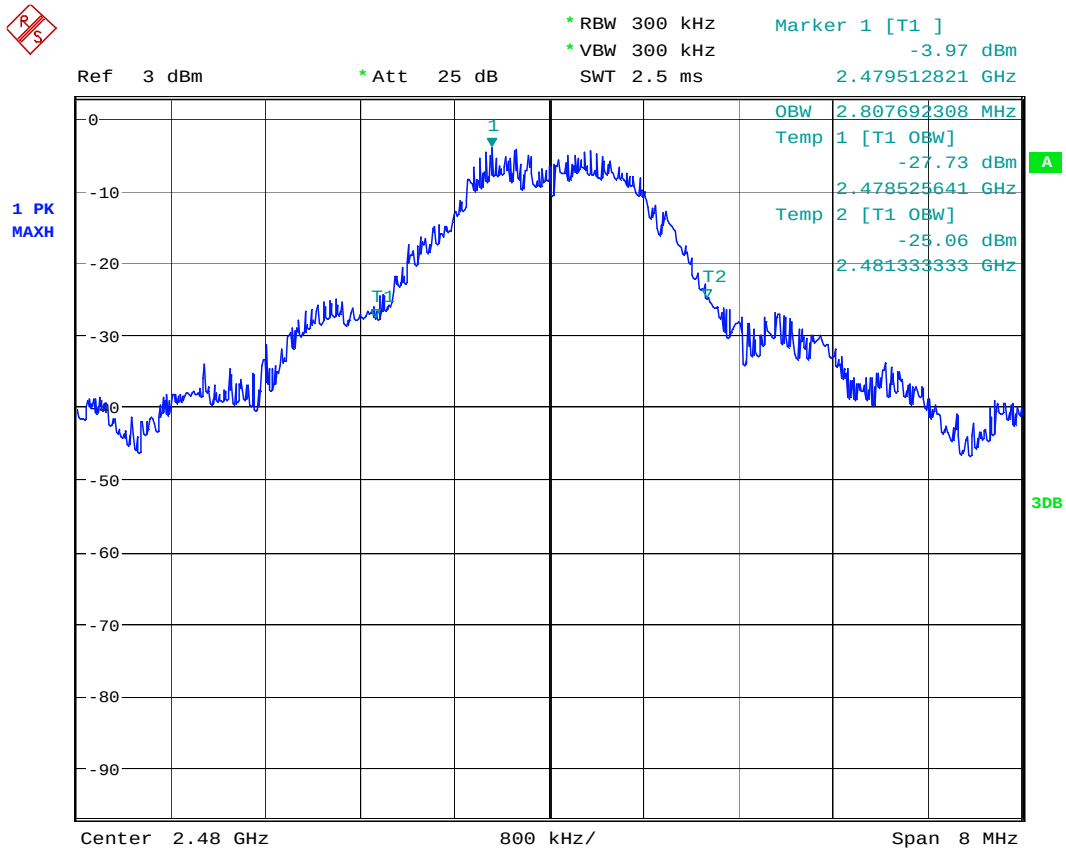
Plot 2. 3



6dB Bandwidth, Wireless Tilt Sensor Compass

Date: 4.APR.2011 14:38:20

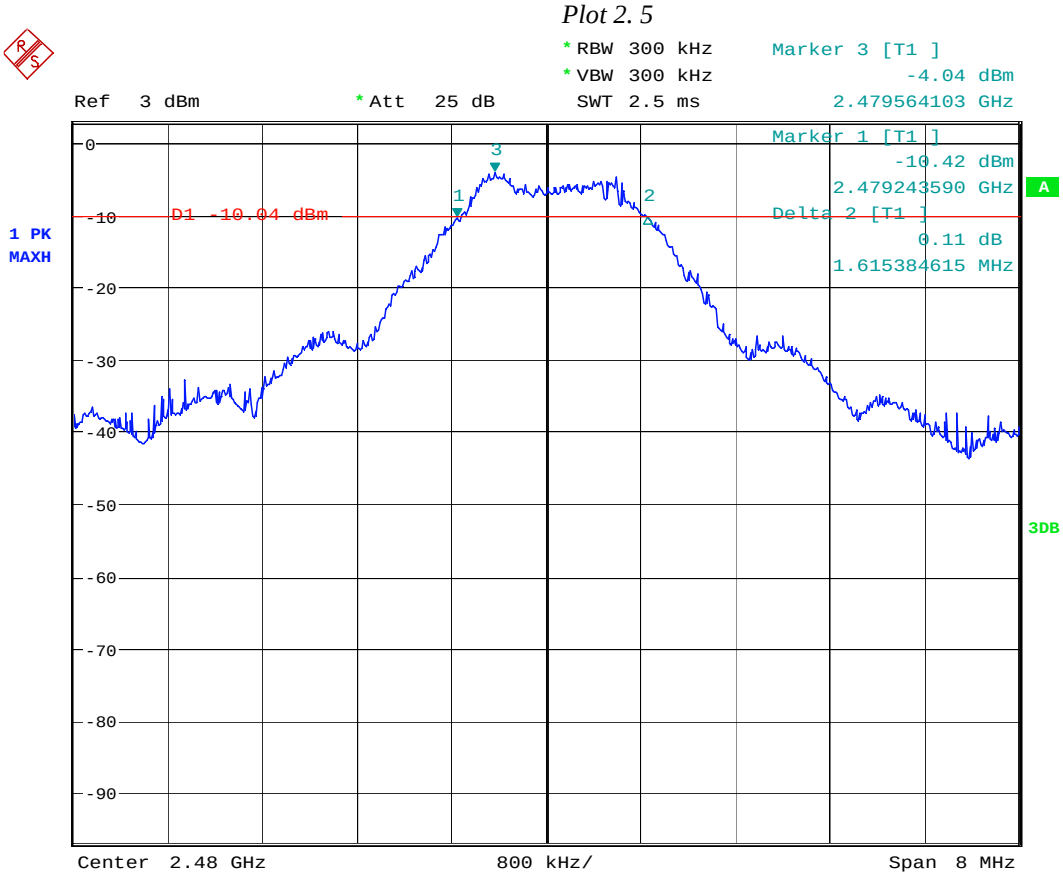
Plot 2. 4



99% Bandwidth, Wireless Tilt Sensor Compass

Date: 4.APR.2011 14:42:31

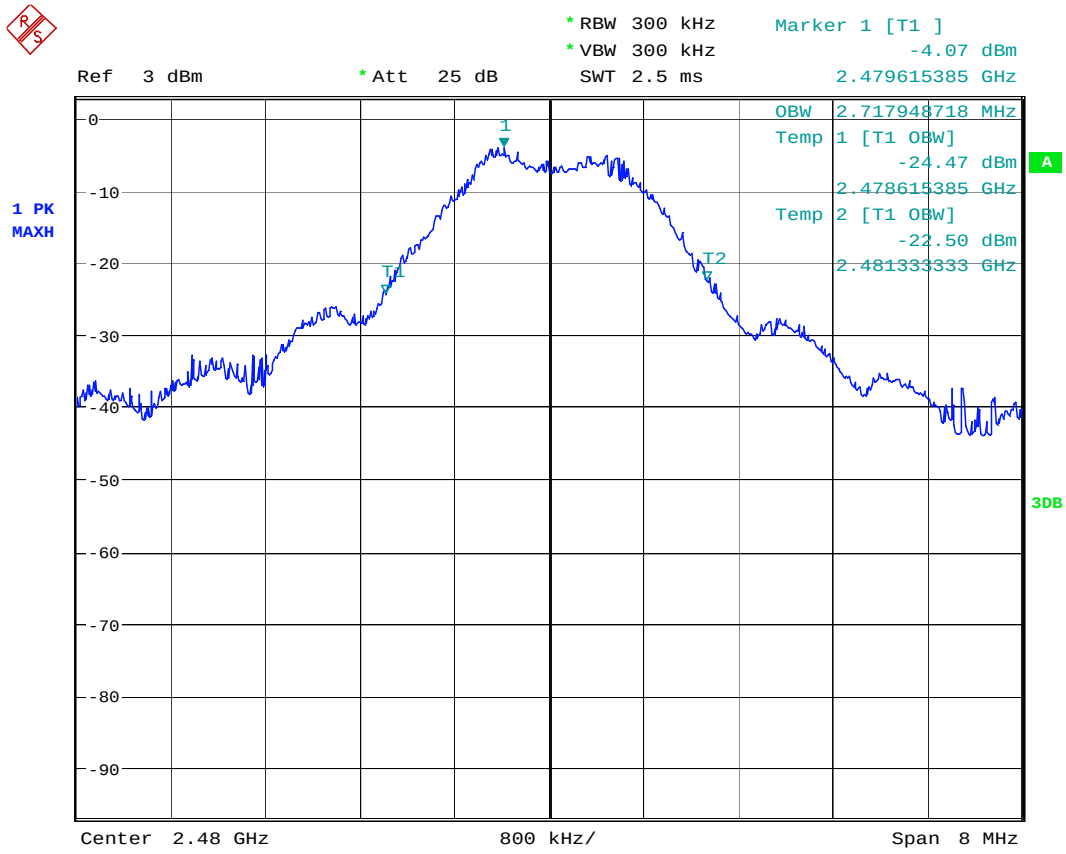
Plot 2. 5



6dB Bandwidth, Wireless Tilt Sensor + Receiver

Date: 4.APR.2011 15:13:33

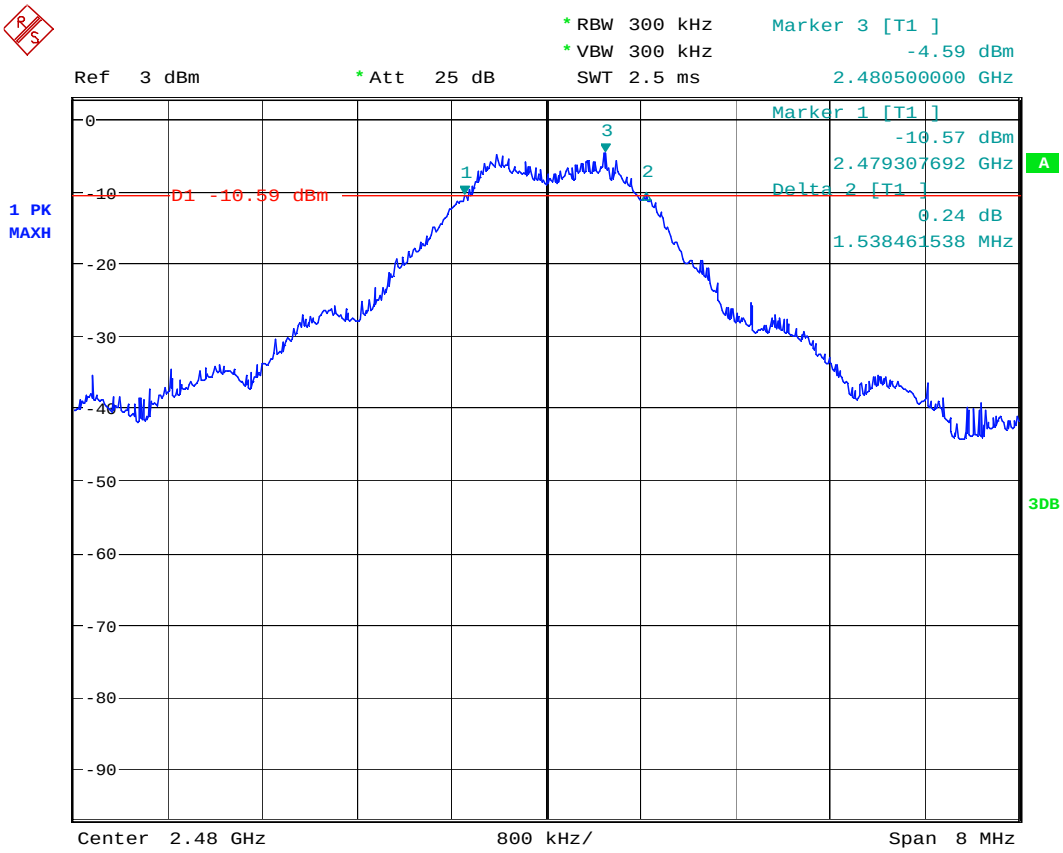
Plot 2. 6



99% Bandwidth, Wireless Tilt Sensor + Receiver

Date: 4.APR.2011 15:18:41

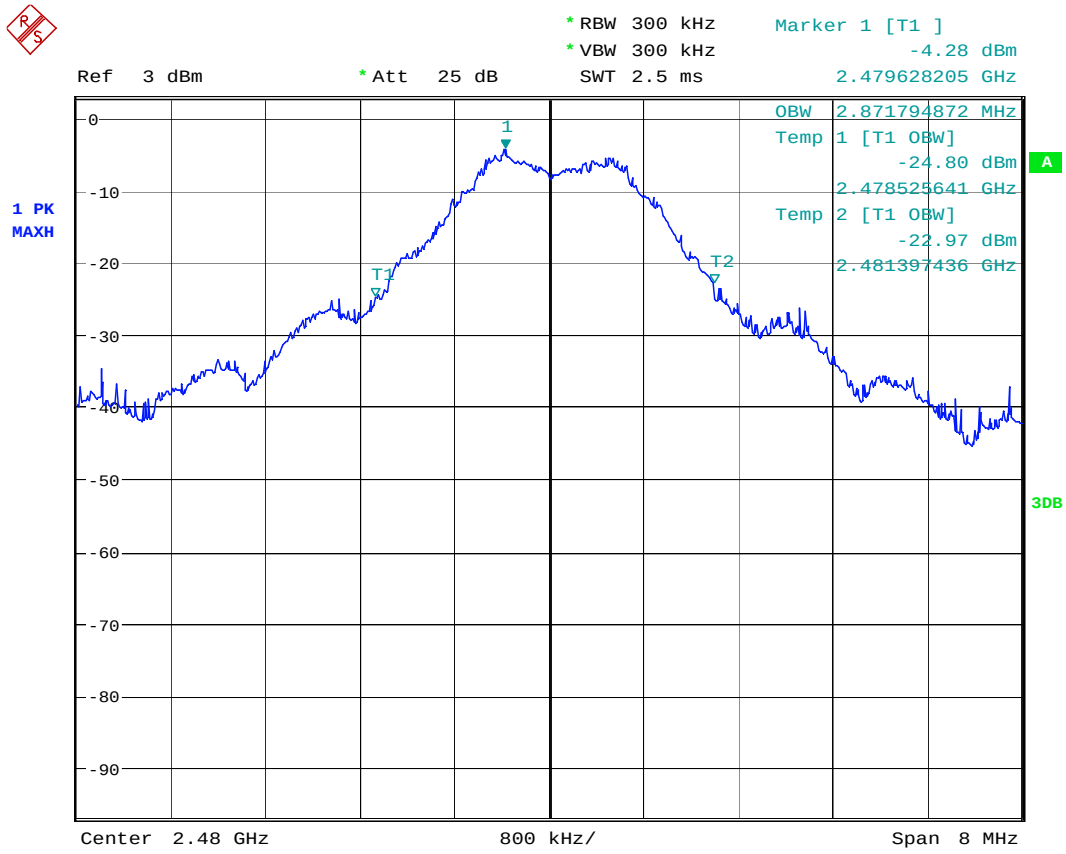
Plot 2. 7



6dB Bandwidth, Wireless Tilt Sensor

Date: 4.APR.2011 15:46:21

Plot 2. 8



99% Bandwidth, Wireless Tilt Sensor

Date: 4.APR.2011 15:48:53

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

Requirement

In any 100 kHz bandwidth outside the EUT pass-band, the RF power shall be at least 20 dB below that of the maximum in-band 100 kHz emission.

Procedure

The EUT has a permanently attached internal antenna. It does not contain an antenna port connector. Instead of Antenna Conducted measurements, Radiated measurements were performed. The out-of-band emissions were measured from 30 MHz to 25 GHz.

Test Result

Refer to the radiated emissions test data located in report section 4.5.

The attenuation of emissions outside the EUT pass-band is more than 20 dB.

4.4 Power Spectral Density
FCC 15.247 (e)

Requirement

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna should not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

Procedure

The EUT has a permanently attached internal antenna. It does not contain an antenna port connector. Instead of Antenna Conducted measurements, Radiated measurements were performed.

(A) Tune the analyzer to the highest point of the maximized fundamental emission.
Reset the analyzer to a RBW = 3 kHz, VBW > RBW, span = 300 kHz, sweep = 100 sec.

(B) From the peak level obtained in (A), derive the field strength, E, by applying the appropriate antenna factor, cable loss, pre-amp gain, etc.

The transmitter's peak power was calculated using the following equation:

Where: E = the measured maximum field strength in V/m.

Set the RBW > 6dB bandwidth of the emission or use a peak power meter.

P = (E x d) squared / (30 x G)

G = the numeric gain of the transmitting antenna over an isotropic radiator.

d = the distance in meters from which the field strength was measured.

P = the power in watts for which you are solving.

Test Result

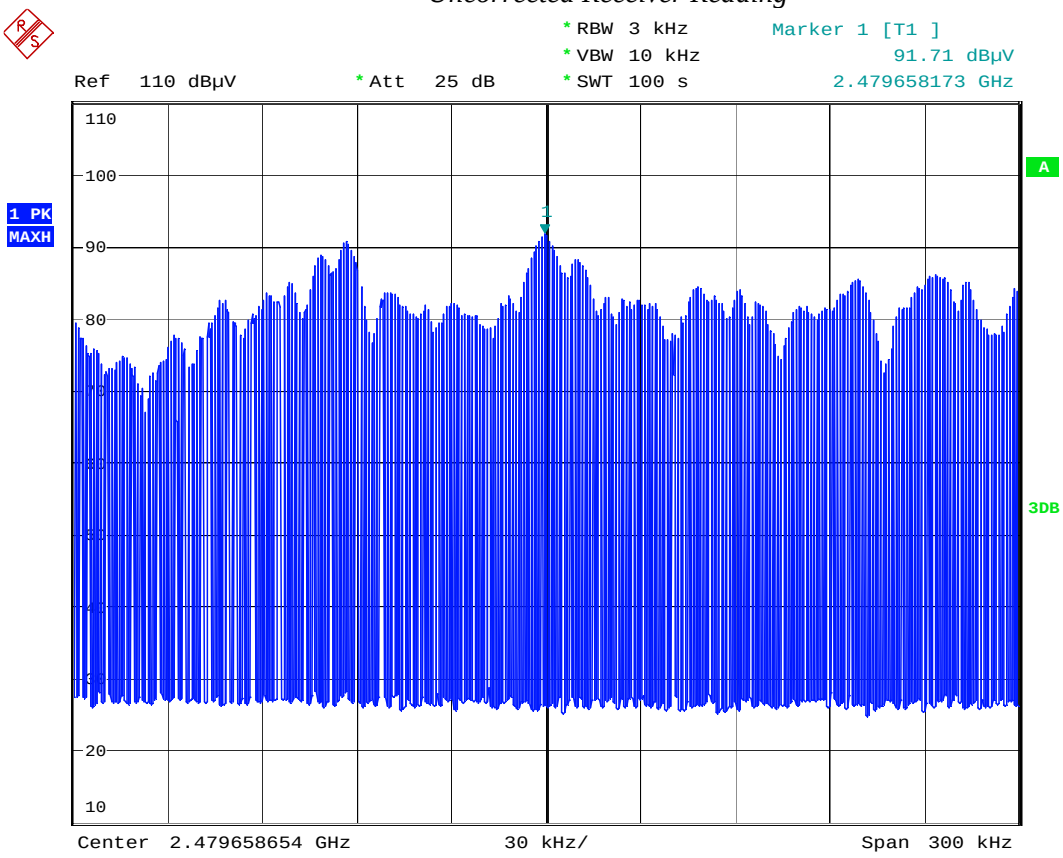
Refer to the following plots for the test result:

Frequency (MHz)	Power Spectral Density (dBm)	Plot
2480	-7.8*	4.1 to 4.4

*Highest measurement was reported.

Plot 4. 1

Uncorrected Receiver Reading



Power Density, Wireless Sensor Coordinator

Date: 4.APR.2011 14:08:55

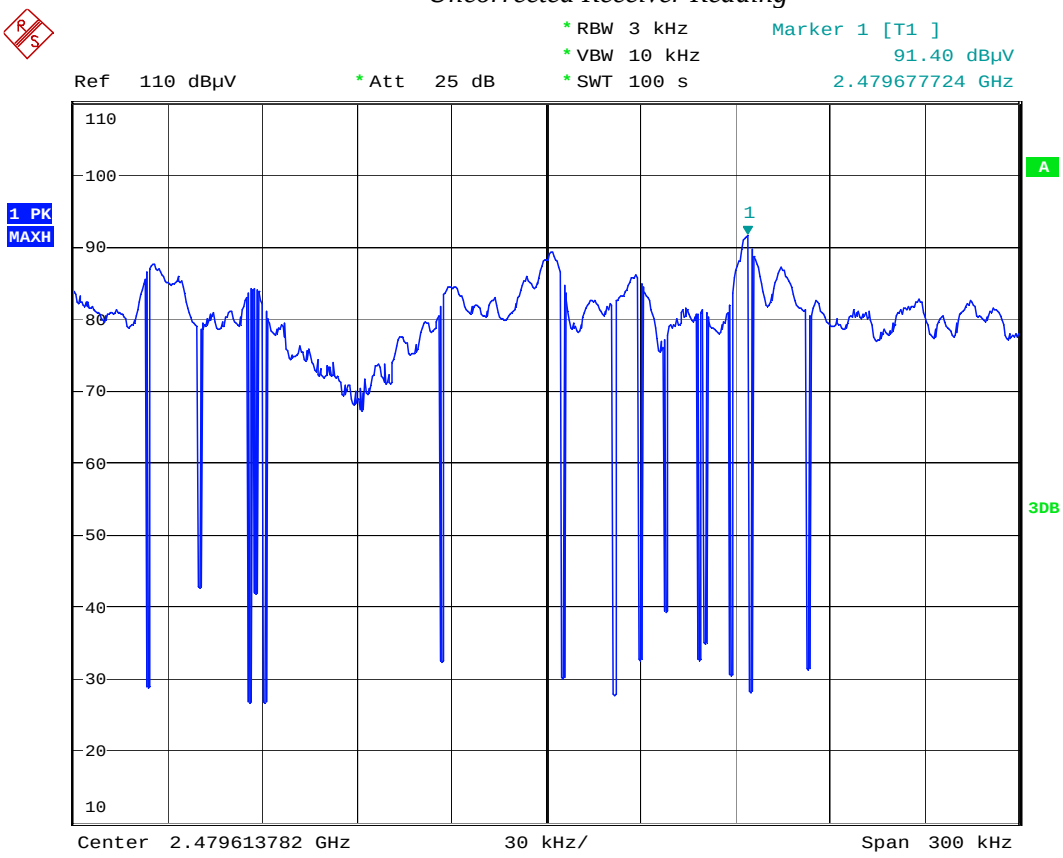
Final Corrected Reading

Frequency	RA	AG	CF	AF	Final Field Strength	EIRP	EIRP
MHz	dB(uV)	dB	dB	dB(1/m)	dB(uV/m)	dBm	mW
2480.0	91.7	35.5	5.5	27.3	89.0	-6.3	0.23

RA = Receiver Amplitude
AG = Amplifier Gain
CF = Cable Factor
AF = Antenna Factor

Plot 4. 2

Uncorrected Receiver Reading



Power Density, Wireless Tilt Sensor Compass

Date: 4.APR.2011 14:56:29

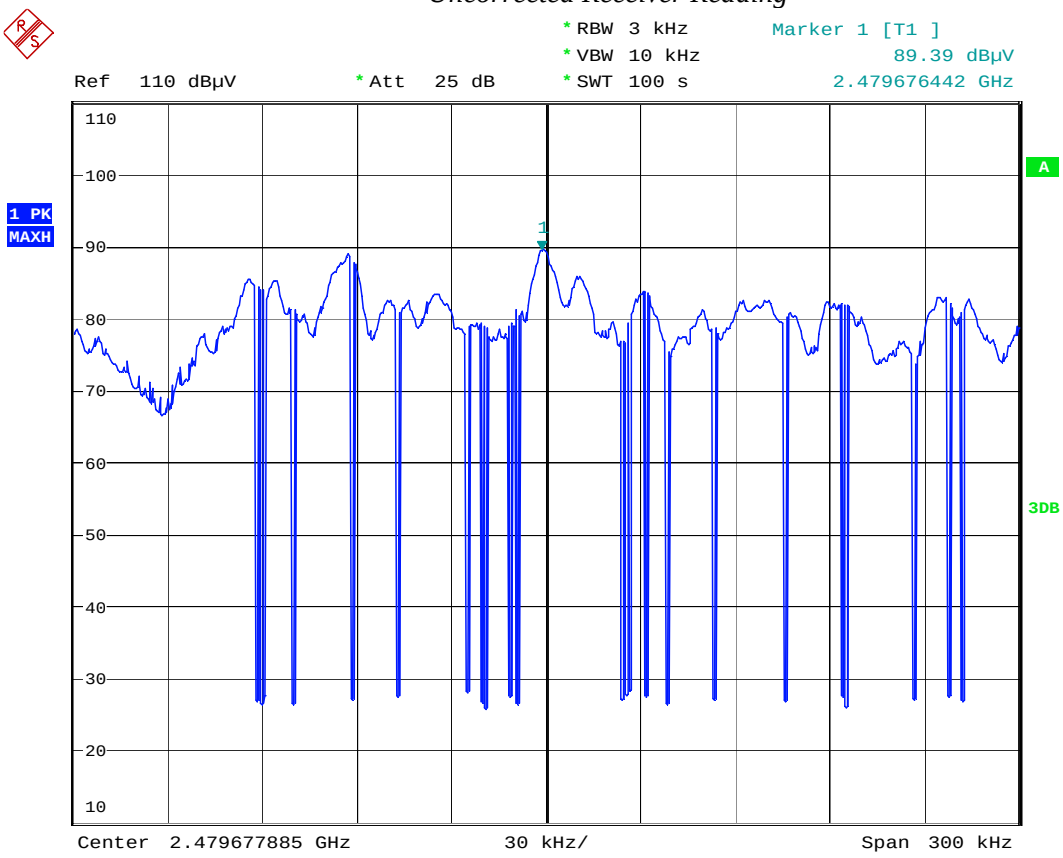
Final Corrected Reading

Frequency	RA	AG	CF	AF	Final Field Strength	EIRP	EIRP
MHz	dB(uV)	dB	dB	dB(1/m)	dB(uV/m)	dBm	mW
2480.0	91.4	35.5	5.5	27.3	88.7	-6.6	0.22

RA = Receiver Amplitude
AG = Amplifier Gain
CF = Cable Factor
AF = Antenna Factor

Plot 4. 3

Uncorrected Receiver Reading



Power Density, Wireless Tilt Sensor + Receiver

Date: 4.APR.2011 15:29:26

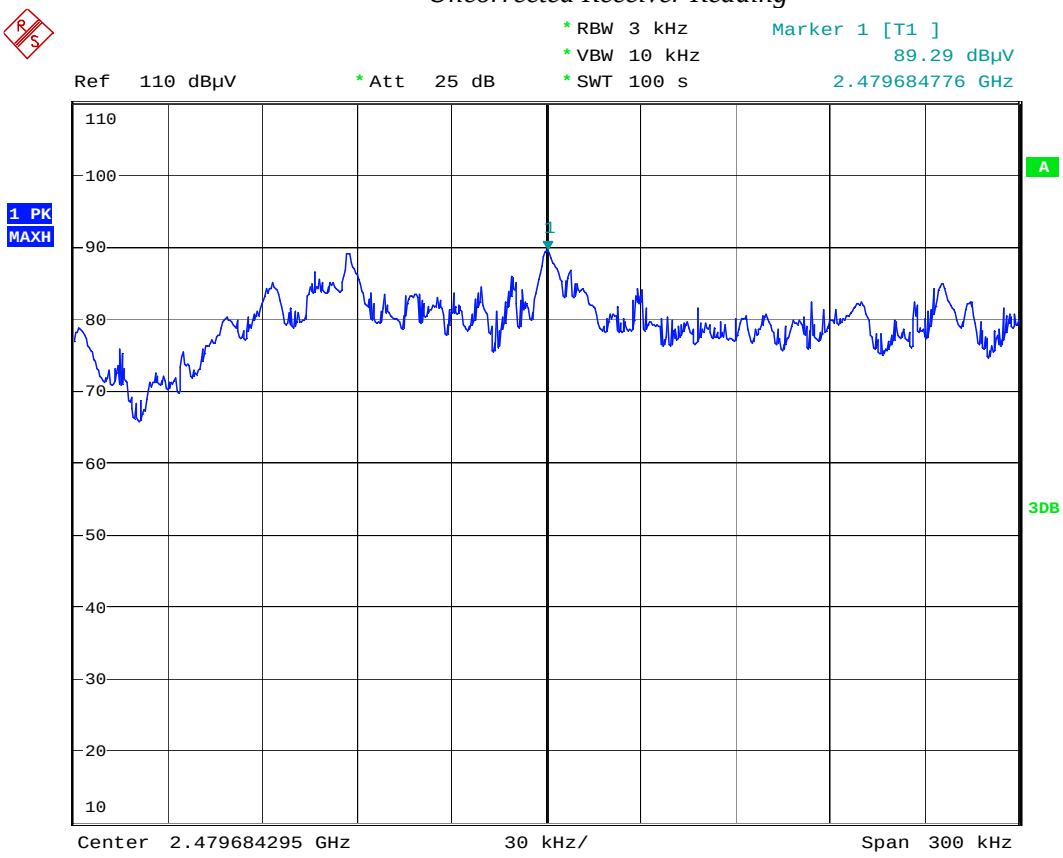
Final Corrected Reading

Frequency	RA	AG	CF	AF	Final Field Strength	EIRP	EIRP
MHz	dB(uV)	dB	dB	dB(1/m)	dB(uV/m)	dBm	mW
2480.0	89.4	35.5	5.5	27.3	86.7	-8.6	0.14

RA = Receiver Amplitude
AG = Amplifier Gain
CF = Cable Factor
AF = Antenna Factor

Plot 4. 4

Uncorrected Receiver Reading



Power Density, Wireless Tilt Sensor

Date: 4.APR.2011 15:57:03

Final Corrected Reading

Frequency	RA	AG	CF	AF	Final Field Strength	EIRP	EIRP
MHz	dB(uV)	dB	dB	dB(1/m)	dB(uV/m)	dBm	mW
2480.0	89.3	35.5	5.5	27.3	86.6	-8.7	0.13

RA = Receiver Amplitude
AG = Amplifier Gain
CF = Cable Factor
AF = Antenna Factor

4.5 Transmitter Radiated Emissions
FCC 15.247 (d), 15.205, 15.209

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. 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 of 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(µV/m)
RA = Receiver Amplitude (including preamplifier) in dB(µV)
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

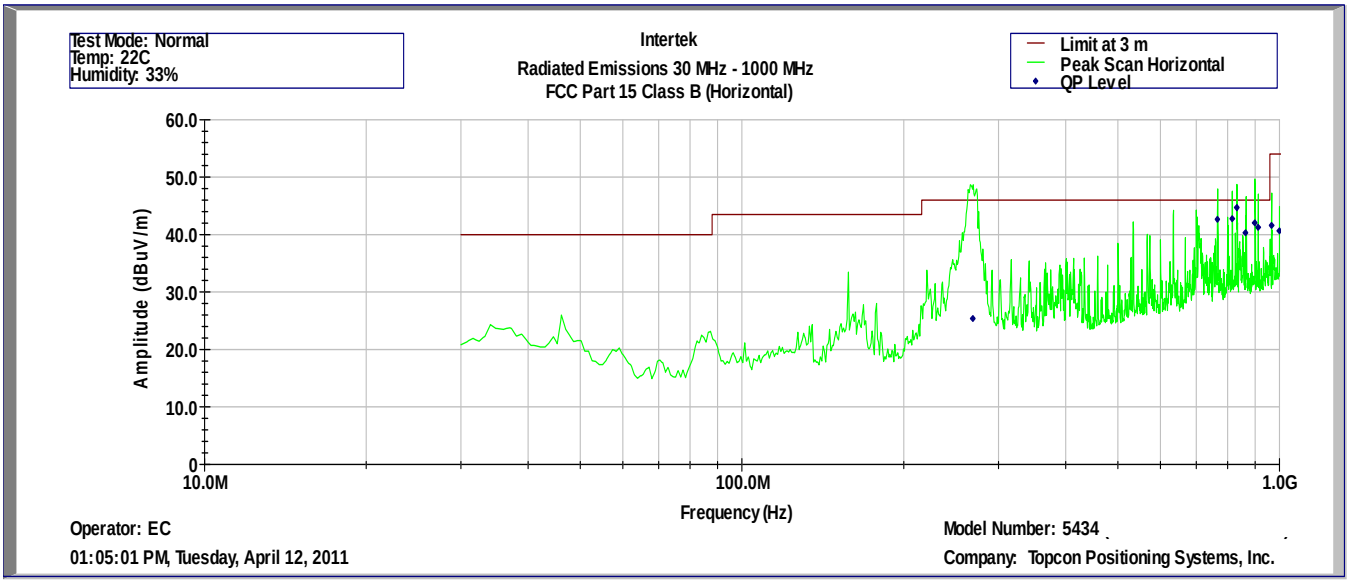
Assume a receiver reading of 52.5 dB(µV) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB and Distance Correction Factor (for measurements made at 10 meters distance) of 10.5 dB is subtracted, giving field strength of 22 dB(µV/m). This value in dB(µV/m) was converted to its corresponding level in µV/m.
RA = 52.5 dB(µV)
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(µV/m).
Level in µV/m = Common Antilogarithm [(43 dBµV/m)/20] = 141.3 µV/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.

Result

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 5.1 – 5.8. The EUT passed by 1.1 dB.

Plot 5.1



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

Operator: EC
12-Apr-11

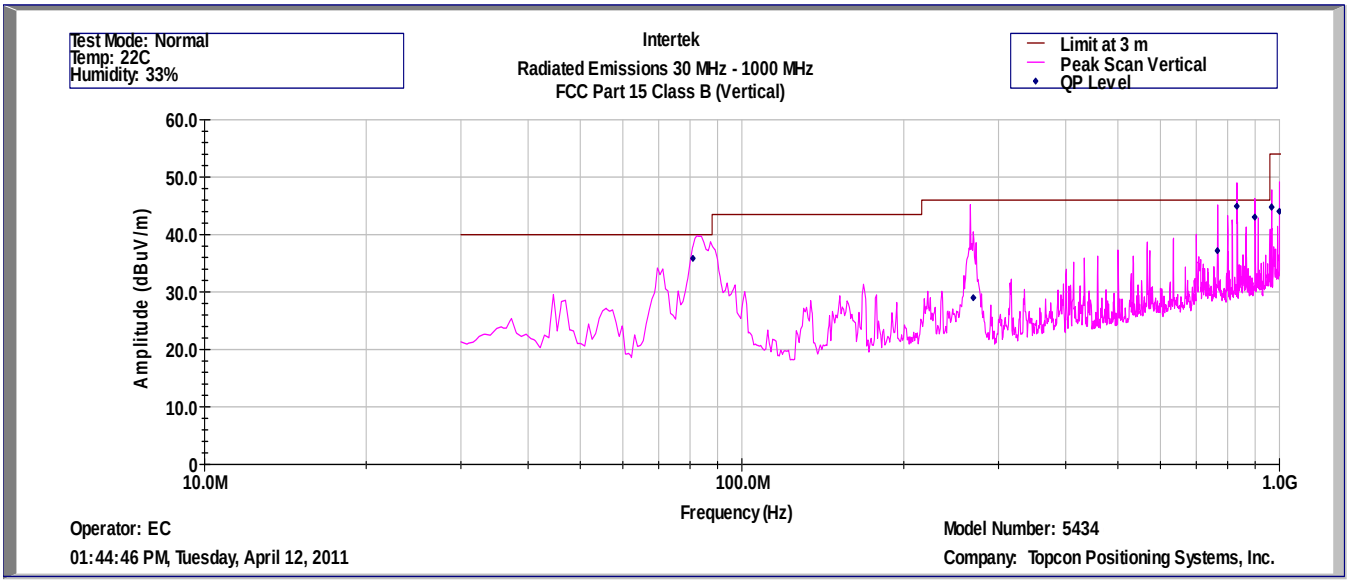
Model Number: 5434 (Sensors & Coordinator)
Company: Topcon Positioning Systems, Inc.

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)
2.69E+08	25.4	46.0	-20.6	31.6	1.9	31.8	10.5	13.2
7.66E+08	42.6	46.0	-3.4	40.2	3.3	32.0	10.5	20.6
8.16E+08	42.8	46.0	-3.2	40.1	3.4	31.9	10.5	20.7
8.33E+08	44.7	46.0	-1.3	41.9	3.4	31.9	10.5	20.7
8.64E+08	40.3	46.0	-5.7	36.7	3.5	31.7	10.5	21.4
8.99E+08	42.0	46.0	-4.0	38.1	3.6	31.6	10.5	21.5
9.12E+08	41.2	46.0	-4.8	36.8	3.6	31.5	10.5	21.8
9.66E+08	41.6	54.0	-12.4	36.7	3.7	31.1	10.5	21.8
9.99E+08	40.7	54.0	-13.3	34.1	3.8	30.9	10.5	23.2

Test Mode: Normal
Temp: 22C
Humidity: 33%

Note: All 3 wireless sensors and the wireless coordinator were placed on the test table and measured at the same time.

Plot 5. 2



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

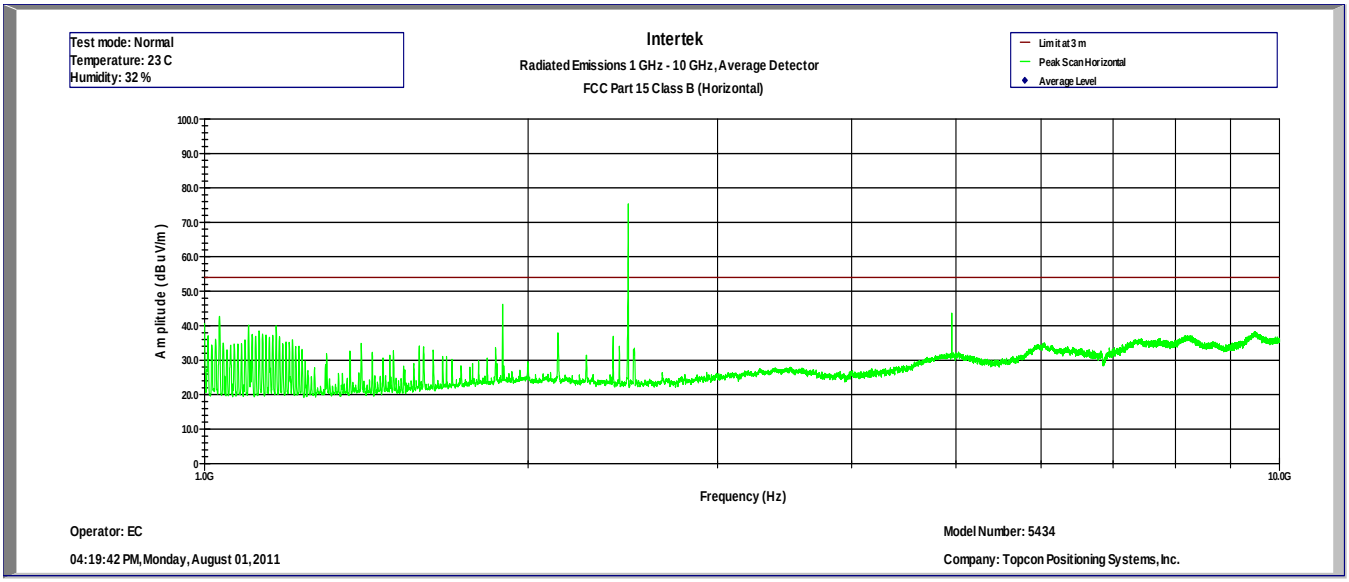
Operator: EC
12-Apr-11

Model Number: 5434 (Sensors & Coordinator)
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)
8.10E+07	35.9	40.0	-4.1	49.4	1.0	32.1	10.5	7.0
2.69E+08	29.0	46.0	-17.0	35.2	1.9	31.8	10.5	13.2
7.66E+08	37.2	46.0	-8.8	34.8	3.3	32.0	10.5	20.6
8.33E+08	44.9	46.0	-1.1	42.1	3.4	31.9	10.5	20.7
8.99E+08	43.0	46.0	-3.0	39.1	3.6	31.6	10.5	21.5
9.66E+08	44.8	54.0	-9.2	39.9	3.7	31.1	10.5	21.8
9.99E+08	44.0	54.0	-10.0	37.5	3.8	30.9	10.5	23.1

Test Mode: Normal
Temp: 22C
Humidity: 33%

Plot 5. 3



Intertek Testing Services
Radiated Emissions 1 GHz - 10 GHz, Average Detector
FCC Part 15 Class B (Horizontal)

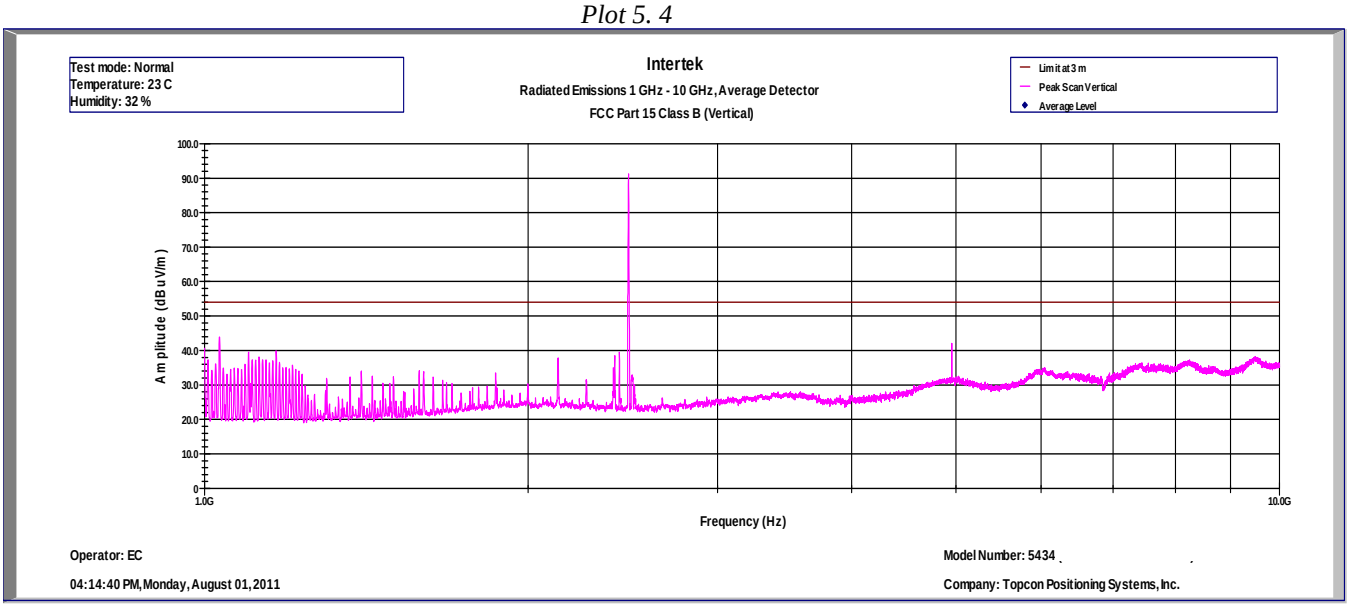
Operator: EC
1-Aug-11

Model Number: 5434 (Sensors & Coordinator)
Company: Topcon Positioning Systems, Inc.

Frequency (Hz)	Av Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Cable (dB)	Preamp (dB)	AF dB(1/m)
1.744E+10	38.6	54.0	-15.4	21.5	10.7	35.2	41.6

Test mode: Normal
Temperature: 23 C
Humidity: 32 %

Plot 5. 4



Intertek Testing Services
Radiated Emissions 1 GHz - 10 GHz, Average Detector
FCC Part 15 Class B (Vertical)

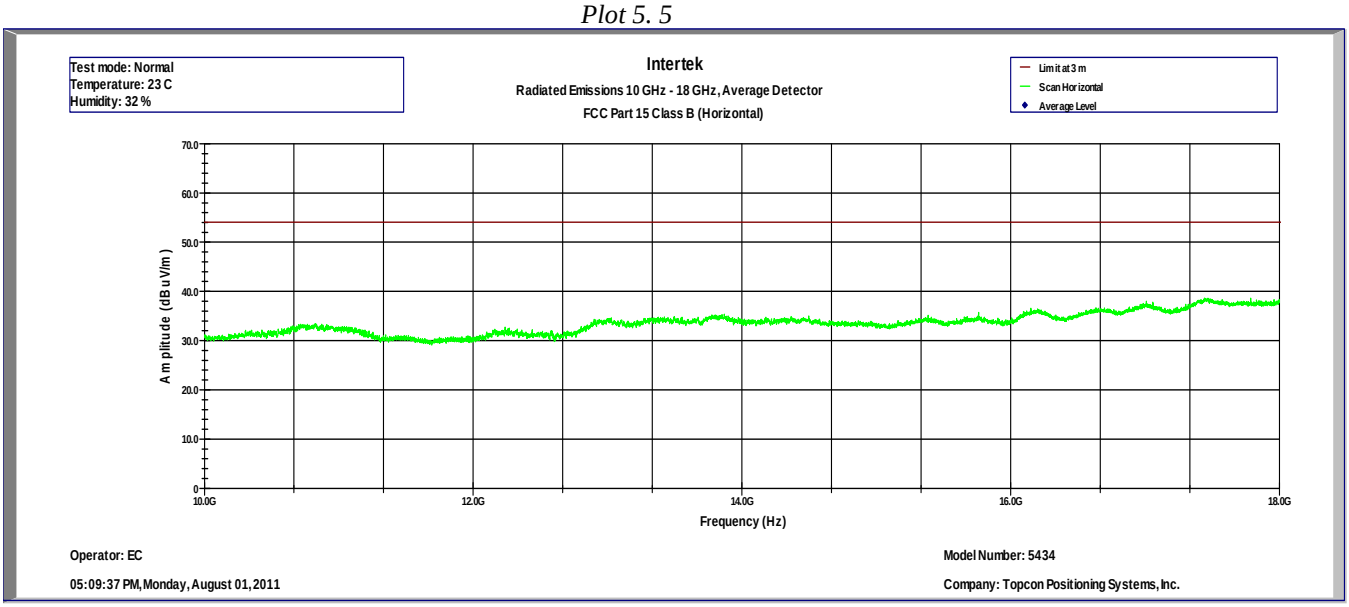
Operator: EC
1-Aug-11

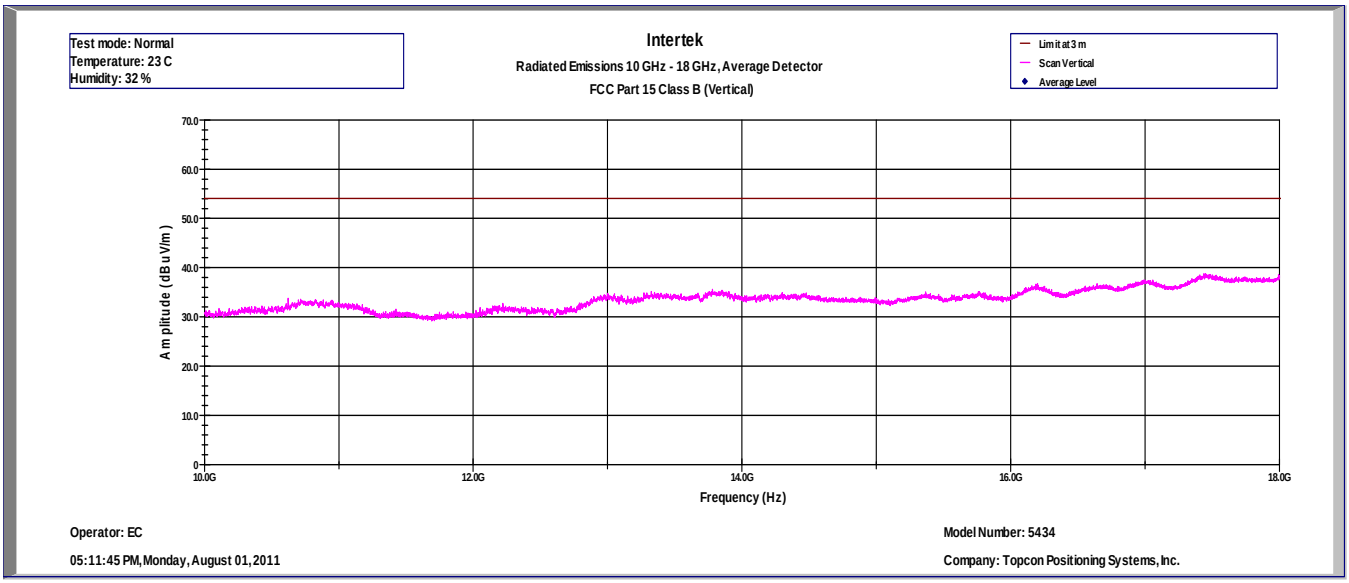
Model Number: 5434 (Sensors & Coordinator)
Company: Topcon Positioning Systems, Inc.

Frequency (Hz)	Av Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Cable (dB)	Preamp (dB)	AF dB(1/m)
1.745E+10	38.8	54.0	-15.2	21.6	10.7	35.2	41.6

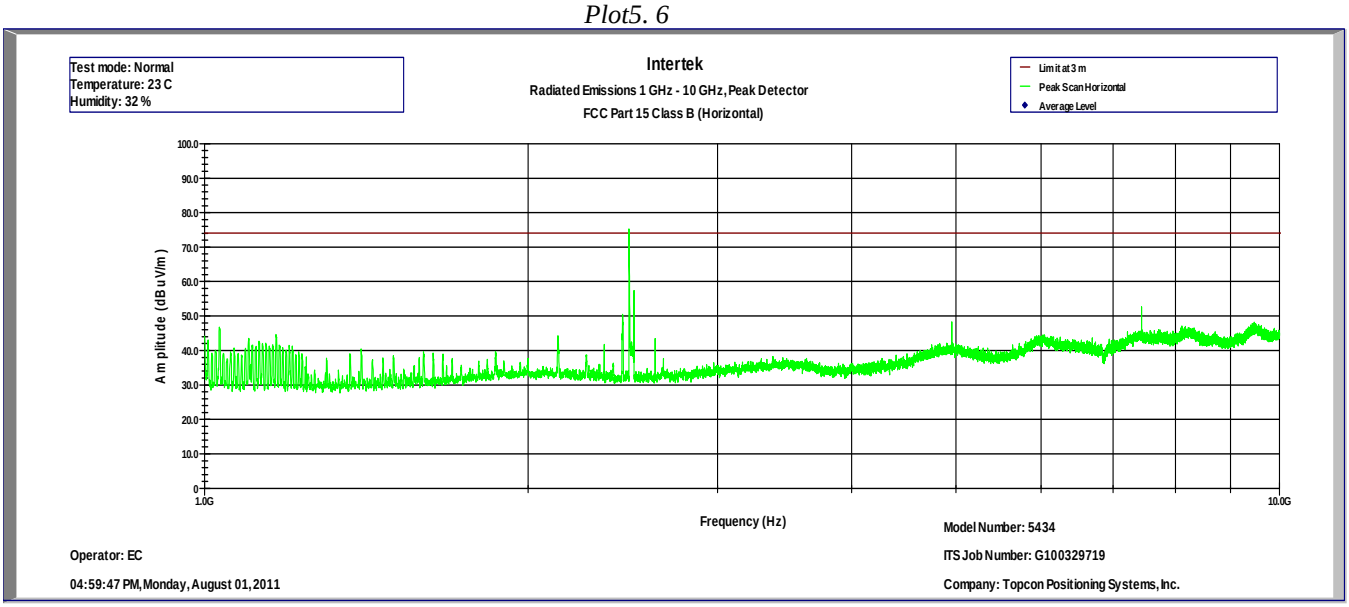
Test mode: Normal
Temperature: 23 C
Humidity: 32 %

Plot 5. 5


Test mode: Normal
Temperature: 23 C
Humidity: 32 %
Intertek
Radiated Emissions 10 GHz - 18 GHz, Average Detector
FCC Part 15 Class B (Horizontal)
Limit at 3 m
Scan Horizontal
Average Level
Amplitude (dBuV/m)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
10.0G
12.0G
14.0G
16.0G
18.0G
Frequency (Hz)
Operator: EC
05:09:37 PM, Monday, August 01, 2011
Model Number: 5434
Company: Topcon Positioning Systems, Inc.


Test mode: Normal
Temperature: 23 C
Humidity: 32 %
Intertek
Radiated Emissions 10 GHz - 18 GHz, Average Detector
FCC Part 15 Class B (Vertical)
Limit at 3 m
Scan Vertical
Average Level
Amplitude (dBuV/m)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
10.0G
12.0G
14.0G
16.0G
18.0G
Frequency (Hz)
Operator: EC
05:11:45 PM, Monday, August 01, 2011
Model Number: 5434
Company: Topcon Positioning Systems, Inc.

Plot5. 6



Intertek Testing Services
Radiated Emissions 1 GHz - 10 GHz, Peak Detector
FCC Part 15 Class B (Horizontal)

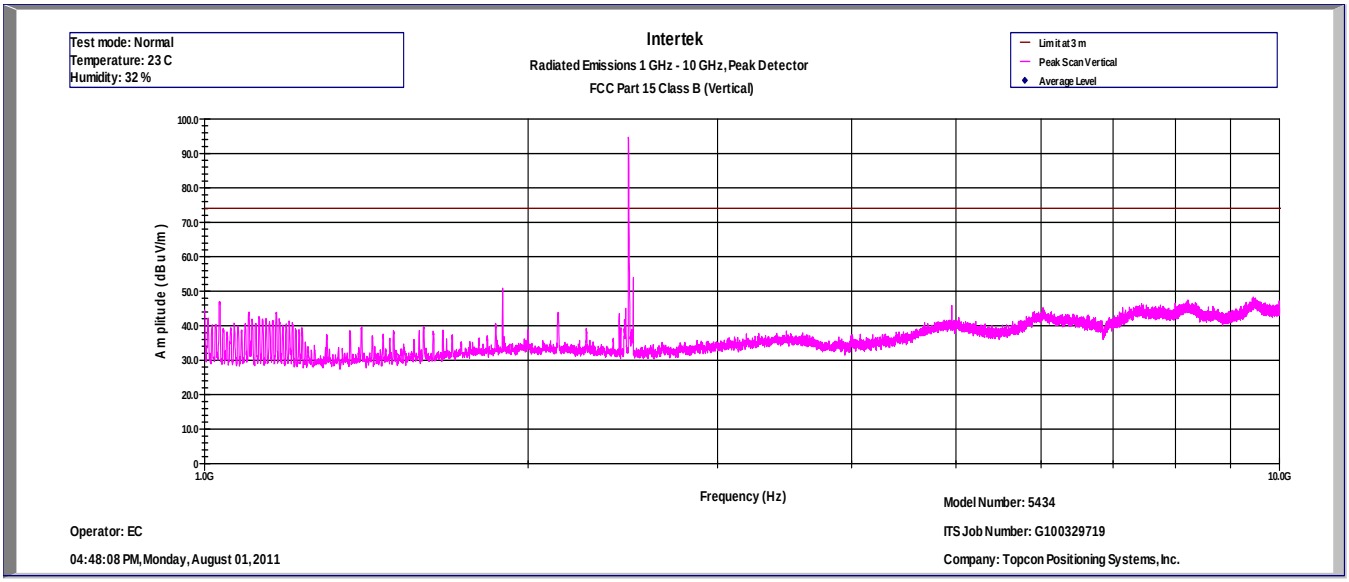
Operator: EC
1-Aug-11

Model Number: 5434 (Sensors & Coordinator)
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)
1.000E+09	44.1	74.0	-29.9	53.2	2.5	35.2	23.6
1.008E+09	43.0	74.0	-31.0	52.0	2.6	35.2	23.6
1.033E+09	46.7	74.0	-27.3	55.6	2.6	35.2	23.7
1.100E+09	43.5	74.0	-30.5	52.0	2.7	35.2	24.0
1.109E+09	41.5	74.0	-32.5	50.0	2.7	35.2	24.0
1.166E+09	44.6	74.0	-29.4	52.7	2.8	35.2	24.2
2.132E+09	44.2	74.0	-29.8	47.0	4.0	35.5	28.6
2.354E+09	41.7	74.0	-32.3	44.6	4.3	35.5	28.3
2.449E+09	50.5	74.0	-23.5	53.3	4.5	35.5	28.2
2.509E+09	57.3	74.0	-16.7	60.1	4.6	35.5	28.1
2.626E+09	43.4	74.0	-30.6	45.9	4.6	35.6	28.5
4.957E+09	48.2	74.0	-25.8	39.4	10.1	34.8	33.5
6.042E+09	44.4	74.0	-29.6	33.2	9.5	34.5	36.2
7.442E+09	52.6	74.0	-21.4	38.6	9.8	33.7	37.9
9.468E+09	48.1	74.0	-25.9	32.1	11.7	34.2	38.5

Test mode: Tx
Temperature: 23 C
Humidity: 32 %

Plot 5. 7



Intertek Testing Services
Radiated Emissions 1 GHz - 10 GHz, Peak Detector
FCC Part 15 Class B (Vertical)

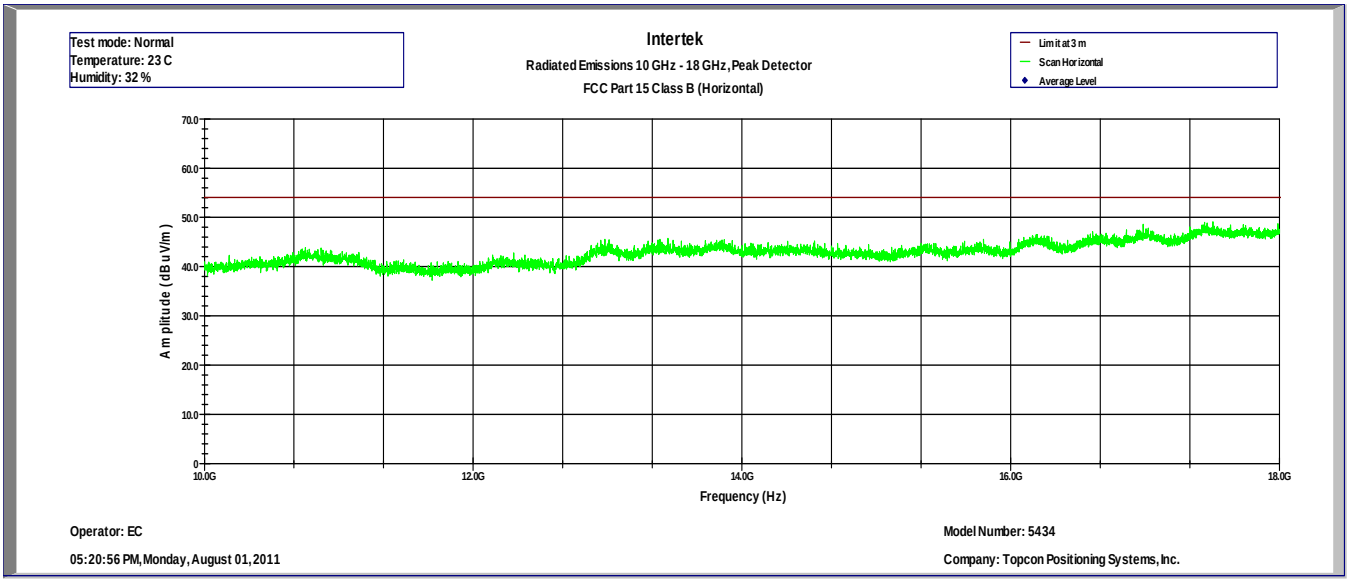
Operator: EC
1-Aug-11

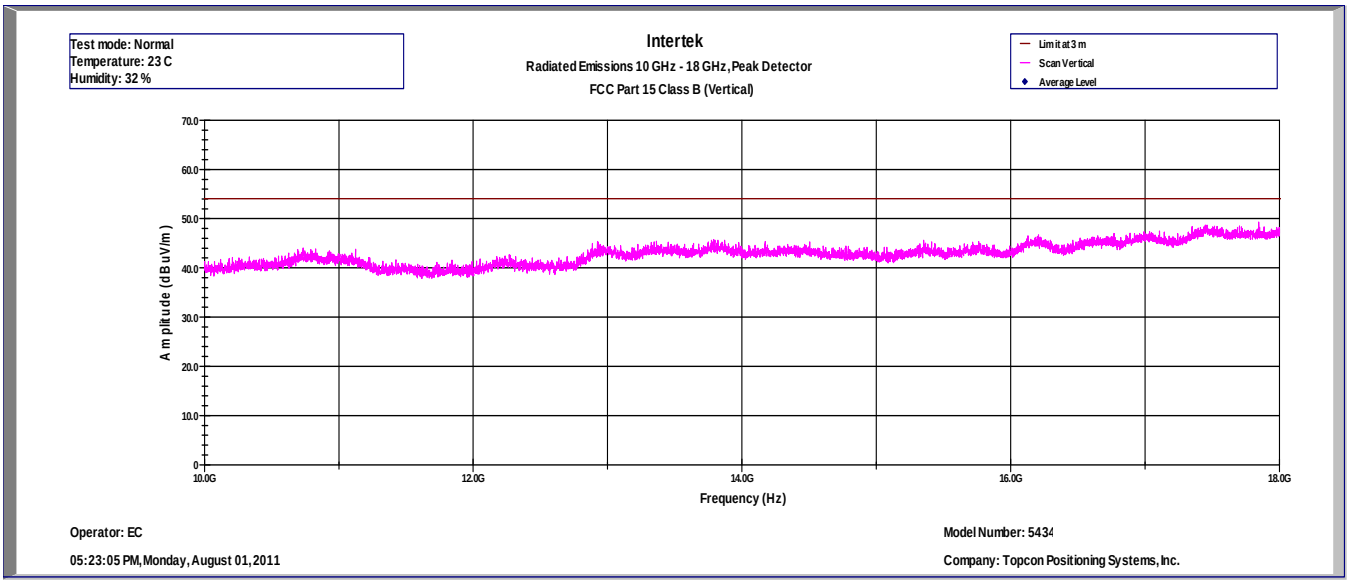
Model Number: 5434 (Sensors & Coordinator)
Company: Topcon Positioning Systems, Inc.

Frequency (MHz)	Pk Level (dBuV/m)	Limit@3m (dBuV/m)	Margin (dB)	Raw (dBuV)	Cable (dB)	Preamp (dB)	AF dB(1/m)
1.001E+09	44.5	74.0	-29.5	53.5	2.6	35.2	23.6
1.033E+09	46.9	74.0	-27.1	55.8	2.6	35.2	23.7
1.101E+09	44.0	74.0	-30.0	52.5	2.7	35.2	24.0
1.167E+09	43.9	74.0	-30.1	52.1	2.8	35.2	24.2
1.174E+09	42.0	74.0	-32.0	50.1	2.9	35.2	24.3
1.894E+09	50.8	74.0	-23.2	54.3	3.8	35.4	28.1
2.135E+09	43.9	74.0	-30.1	46.7	4.0	35.5	28.6
2.431E+09	43.5	74.0	-30.5	46.3	4.4	35.5	28.2
2.465E+09	45.0	74.0	-29.0	47.8	4.5	35.5	28.1
2.505E+09	54.0	74.0	-20.0	56.8	4.6	35.5	28.1
4.957E+09	45.8	74.0	-28.2	37.0	10.1	34.8	33.5
6.024E+09	45.1	74.0	-28.9	33.8	9.6	34.5	36.2
8.219E+09	47.3	74.0	-26.7	32.4	11.3	33.9	37.6
9.454E+09	48.2	74.0	-25.8	32.3	11.7	34.2	38.5

Test mode: Normal
Temperature: 23 C
Humidity: 32 %

Plot 5. 8





Note: No emissions were detected above the noise floor in the range of 18GHz – 25GHz.

4.6 Radiated Emissions from Digital Parts and Receiver
FCC Ref: 15.109

Test Limit

Limits for Electromagnetic Radiated Emissions, FCC Section 15.109(b) and ICES 003*

Frequency (MHz)	**Class A at 10m dB(µV/m)**	**Class B at 3m dB(µV/m)**
30-88	39	40.0
88-216	43.5	43.5
216-960	46.4	46.0
Above 960	49.5	54.0

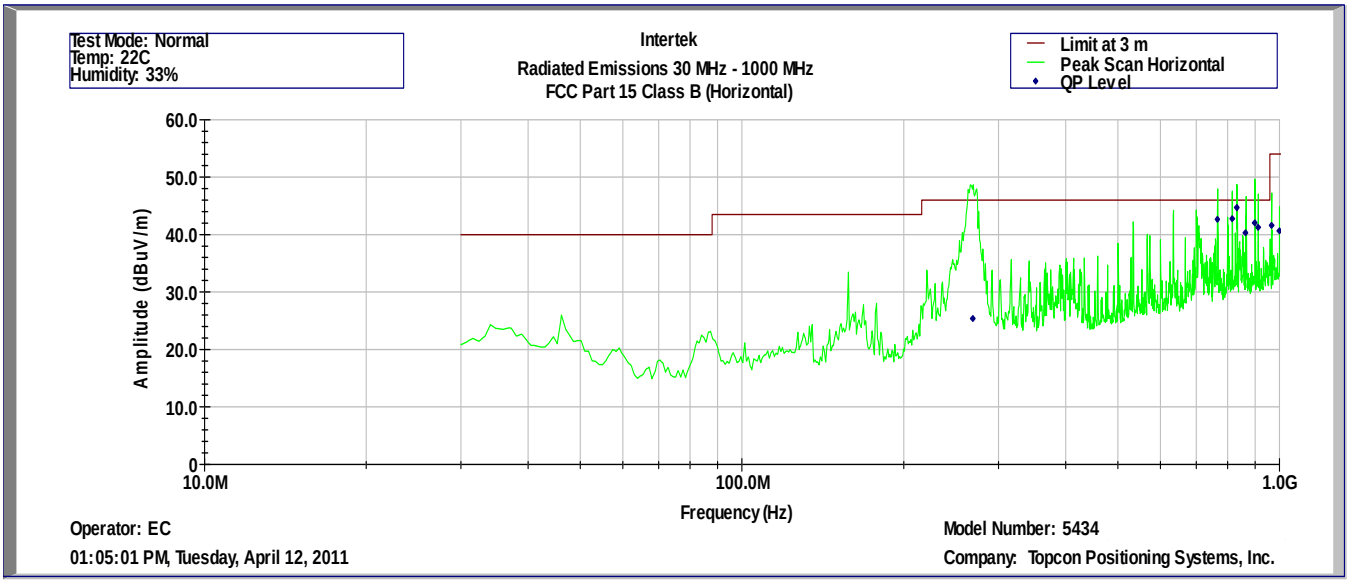
* According to FCC Part 15.109(g) an alternative to the radiated emission limits shown above, digital devices may be shown to comply with the limit of CISPR Pub. 22

Test Results

Radiated emission measurements were performed from 30 MHz to 1000 MHz. The data on the following pages list the significant emission frequencies, the limit and the margin of compliance. The results are presented on the following Plots 6.1 – 6.2.

The EUT passed by 1.1 dB.

Plot 6. 1



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

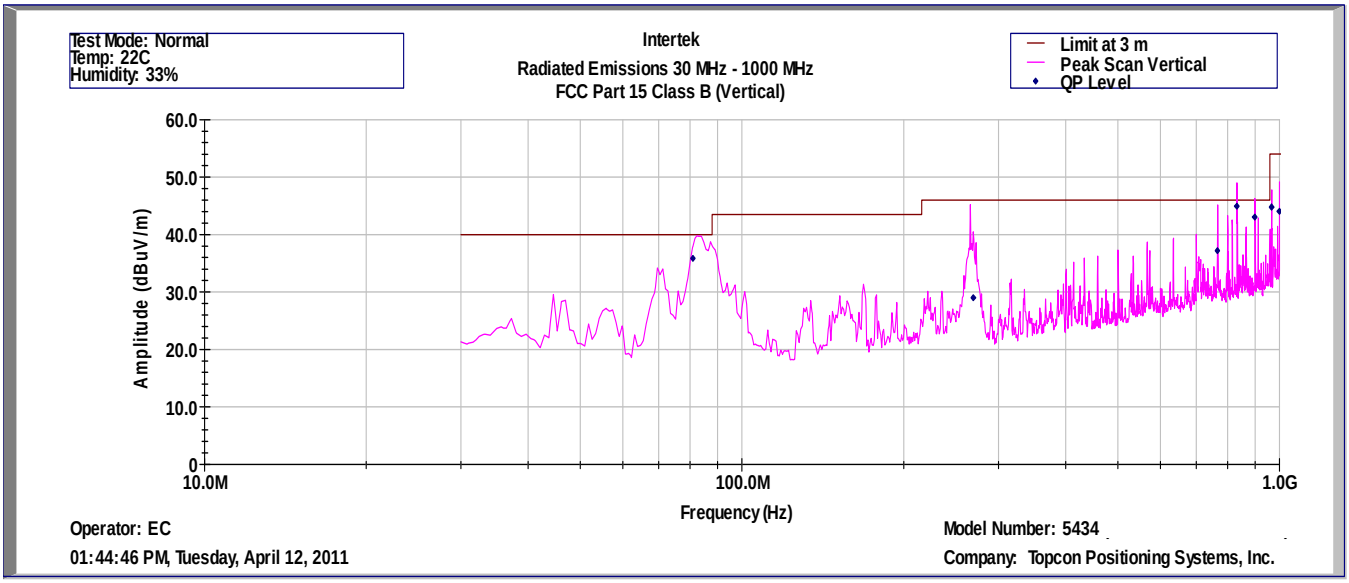
Operator: EC
12-Apr-11

Model Number: 5434 (Sensors & Coordinator)
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)
2.69E+08	25.4	46.0	-20.6	31.6	1.9	31.8	10.5	13.2
7.66E+08	42.6	46.0	-3.4	40.2	3.3	32.0	10.5	20.6
8.16E+08	42.8	46.0	-3.2	40.1	3.4	31.9	10.5	20.7
8.33E+08	44.7	46.0	-1.3	41.9	3.4	31.9	10.5	20.7
8.64E+08	40.3	46.0	-5.7	36.7	3.5	31.7	10.5	21.4
8.99E+08	42.0	46.0	-4.0	38.1	3.6	31.6	10.5	21.5
9.12E+08	41.2	46.0	-4.8	36.8	3.6	31.5	10.5	21.8
9.66E+08	41.6	54.0	-12.4	36.7	3.7	31.1	10.5	21.8
9.99E+08	40.7	54.0	-13.3	34.1	3.8	30.9	10.5	23.2

Test Mode: Normal
Temp: 22C
Humidity: 33%

Plot 6. 2



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

Operator: EC
12-Apr-11

Model Number: 5434 (Sensors & Coordinator)
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)
8.10E+07	35.9	40.0	-4.1	49.4	1.0	32.1	10.5	7.0
2.69E+08	29.0	46.0	-17.0	35.2	1.9	31.8	10.5	13.2
7.66E+08	37.2	46.0	-8.8	34.8	3.3	32.0	10.5	20.6
8.33E+08	44.9	46.0	-1.1	42.1	3.4	31.9	10.5	20.7
8.99E+08	43.0	46.0	-3.0	39.1	3.6	31.6	10.5	21.5
9.66E+08	44.8	54.0	-9.2	39.9	3.7	31.1	10.5	21.8
9.99E+08	44.0	54.0	-10.0	37.5	3.8	30.9	10.5	23.1

Test Mode: Normal
Temp: 22C
Humidity: 33%

4.7 AC Line Conducted Emission
FCC 15.207

Test Limit

Frequency Band MHz	Class B Limit dB (μV)	
	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.

Test 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

Not Applicable. EUT does not contain any AC power ports. EUT is battery powered.

5.0 RF Exposure Evaluation

MPE Evaluation

The EUT is a wireless device used in a mobile application, at least 20 cm from any body part of the user or nearby persons.

The maximum Peak EIRP calculated is 8.6 dBm or 7.24 mW; therefore, to comply with RF Exposure Requirement, the MPE is calculated.

The Power Density can be calculated using the formula

$$S = EIRP/ 4\pi D^2$$

Where: S is Power Density in W/m^2
D is the distance from the antenna.

It is considered that 20 cm is the minimum distance that user can go closest to the EUT.

At 20 cm, $S = 0.014\ W/m^2$, which is below the MPE Limit of $10\ W/m^2$

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	11/04/11
BI-Log Antenna	ARA	LPB-2513/A	1154	12	06/29/11
Pre-Amplifier	Sonoma	310N	185634	12	12/01/11
Pre-Amplifier	Miteq	AMF-4D-001180-24-10P	799159	12	08/05/11
Vector Signal Generator	Rohde&Schwarz	SMU200A	102499	12	04/28/11
Spectrum Analyzer	Rohde&Schwarz	FSU	200482	12	03/23/12
Horn Antenna	EMCO	3115	00126795	12	10/28/11

7.0 Document History

Revision/ Job Number	Writer Initials	Date	Change
1.0 / G100329719	EC	April 27, 2011	Original document