TEST REPORT

Report Number: 100246399MPK-009
Project Number: G100246399
Report Date: September 12, 2012

Testing performed on the
GR-5 GNSS Receiver
Model: 01-090901-21
FCC ID: LCB-D90901
IC ID: 6050B-D90901
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:	**Test Authorized by:**
Intertek	Topcon Positioning Systems, Inc.
1365 Adams Court	7400 National Drive
Menlo Park, CA 94025, USA	Livermore, CA 94551, USA

Prepared by: _____ **Date:** September 12, 2012
Krishna K Vemuri, Senior Staff Engineer

Reviewed by: _____ **Date:** September 12, 2012
Yuriy Litvinov, EMC Business Manager

Report No. 100246399MPK-009

Equipment Under Test:	GR-5 GNSS Receiver
Trade Name:	Topcon Positioning Systems, Inc.
Model No.:	01-090901-21
FCC ID:	LCB-D90901
IC ID:	6050B-D90901
Applicant:	Topcon Positioning Systems, Inc.
Contact:	Ferdinand Riodique
Address:	7400 National Drive Livermore, CA 94551
Country	USA
Tel. Number:	(925) 784-9178
Email:	Friodique@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:	October 18 to November 24, 2010

We attest to the accuracy of this report:

Krishna K Vemuri	Yuriy Litvinov
EMC Senior Staff Engineer	EMC Business Manager

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1.0 Introduction

The Equipment Under Test (EUT) is the GR-5 GNSS Receiver, model number 01-090901-21, consisting of one UHF radio and one Bluetooth radio. This test report covers only the Bluetooth radio. A separate test report, report # 100246399MPK-002, 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 GR-5 GNSS Receiver is used are in the fields of GNSS RTK systems, engineering and constructional applications.

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 Receiver	15.109, 15.111	RSS-GEN	Complies
Radiated Emission from Digital Parts	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 GR-5 GNSS Receiver, model number 01-090901-21, consisting of one UHF radio and one Bluetooth radio.

The GR-5 GNSS Receiver is used are in the fields of GNSS RTK systems, engineering and constructional applications

Overview of the EUT

Applicant	Topcon Positioning Systems, Inc. 7400 National Drive Livermore, CA 94551 USA
Manufacturer name & address	Topcon Positioning Systems, Inc. 7400 National Drive Livermore, CA 94551 USA
Trade Name & Part No.	01-090901-21
FCC Identifier	LCB-D90901
IC Identifier	6050B-D90901
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) type & Gain	4.0 dBi

EUT receive date: October 18, 2010
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 the production units.
Test start date: October 18, 2010
Test completion date: November 24, 2010

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 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.

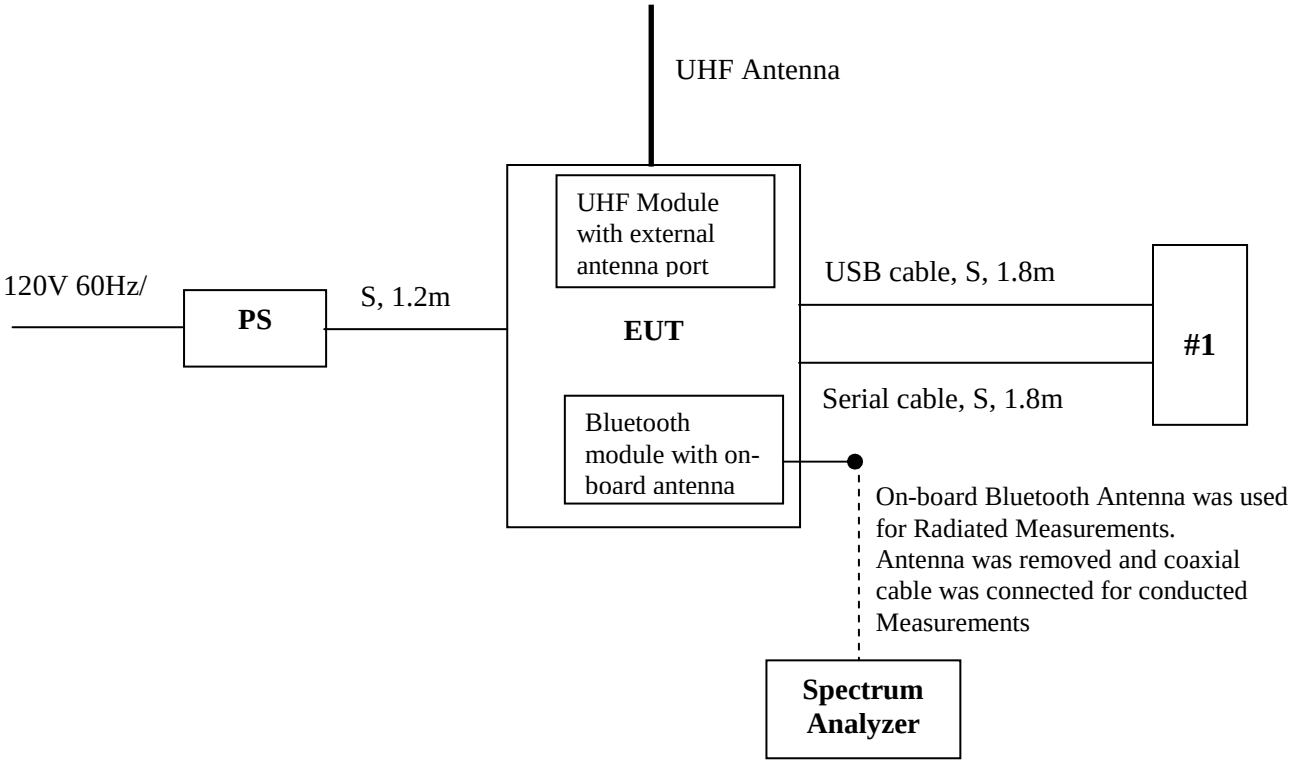
3.0 System Test Configuration

3.1 Support Equipment

Item #	Description	Model No.	Serial No.
1	Compaq Laptop	Compaq nc6400	6A9B901B2U41BM

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.



Power Supply, PHIHONG, Model: PSC30U-120, Serial: P01702775C2

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

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 the Applicant.

3.5 Mode of Operation During Test

The EUT was tested in two 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 (frequencies).

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

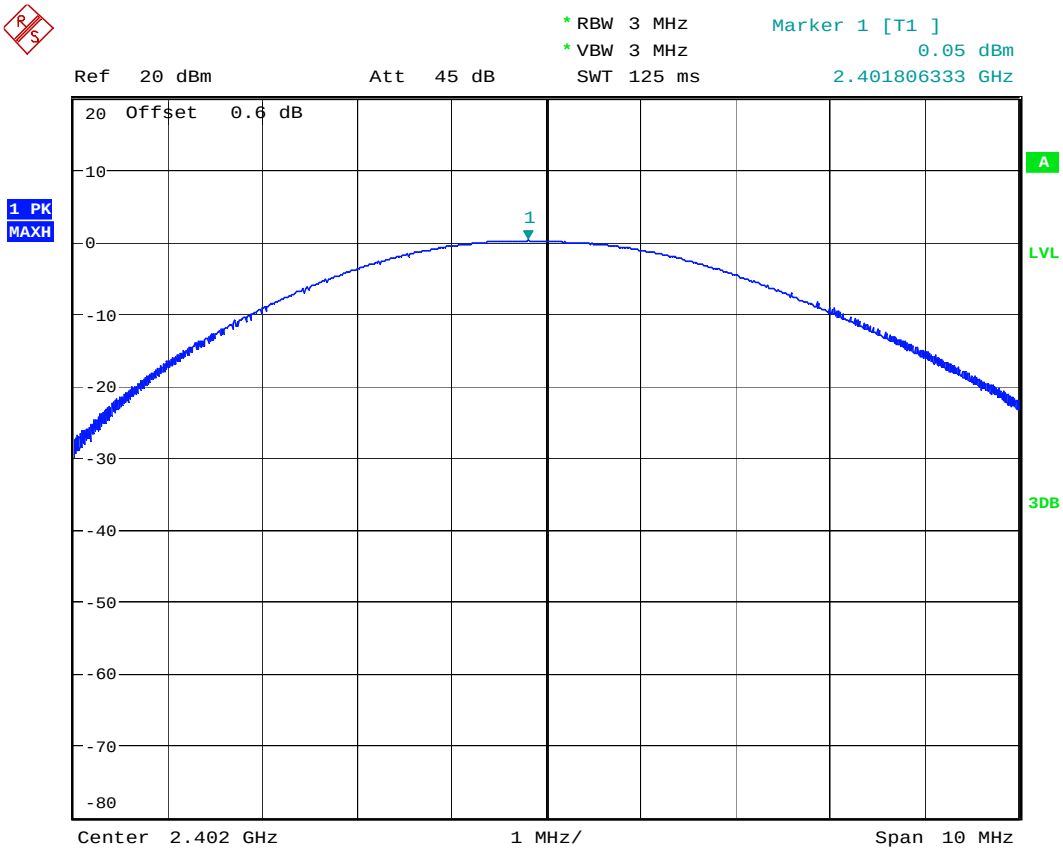
The antenna port of the EUT was connected to the input of a spectrum analyzer. Power was read directly and cable loss correction was added to the reading to obtain the power at the EUT antenna terminal.

Test Results

Frequency (MHz)	Output in dBm	Output in mW	Plot Number
2402	0.05	1.0	1.1
2441	-0.11	0.975	1.2
2480	0.07	1.0	1.3

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

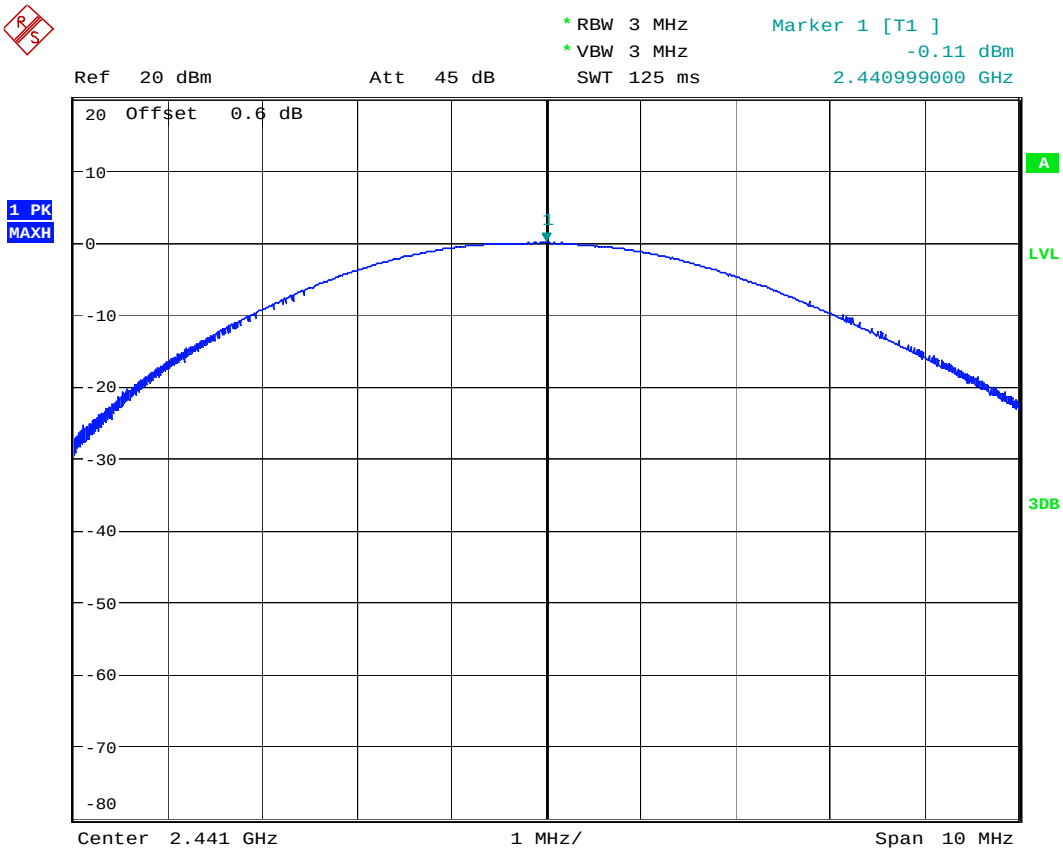
Plot 1.1



Output power

Date: 22.NOV.2010 12:42:32

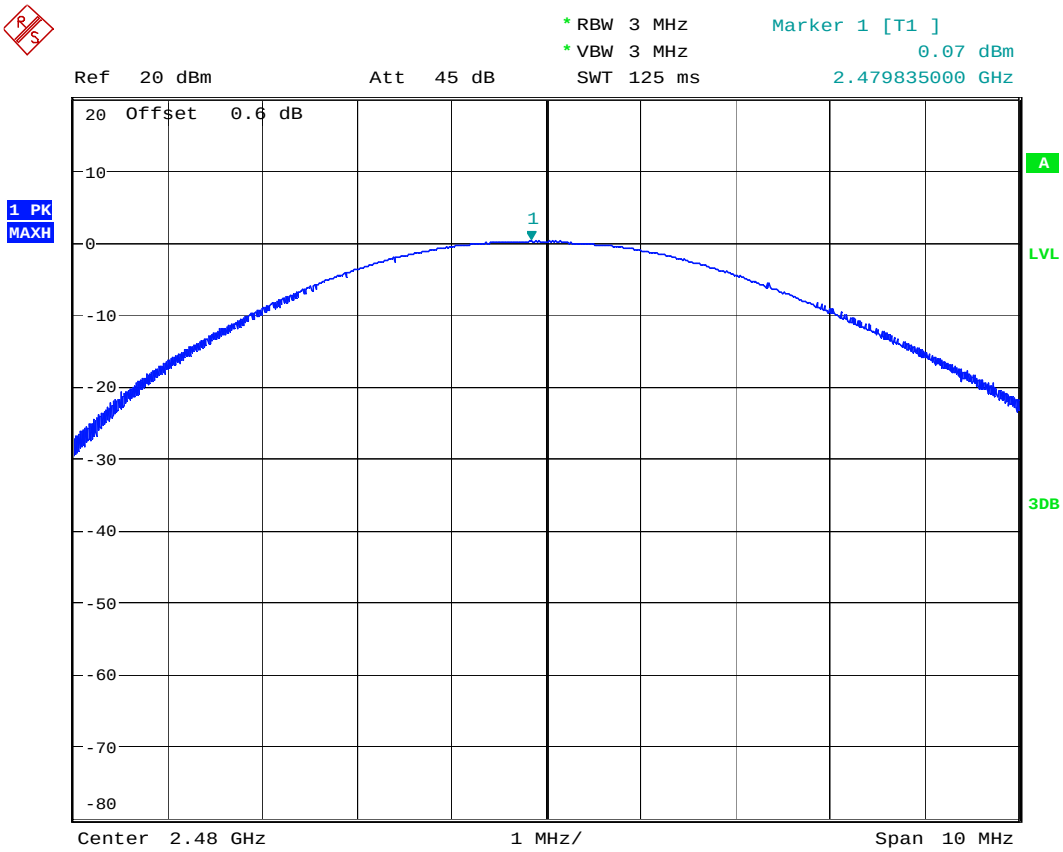
Plot 1.2



Output power

Date: 22.NOV.2010 12:44:28

Plot 1.3



Output power

Date: 22.NOV.2010 12:46:08

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.

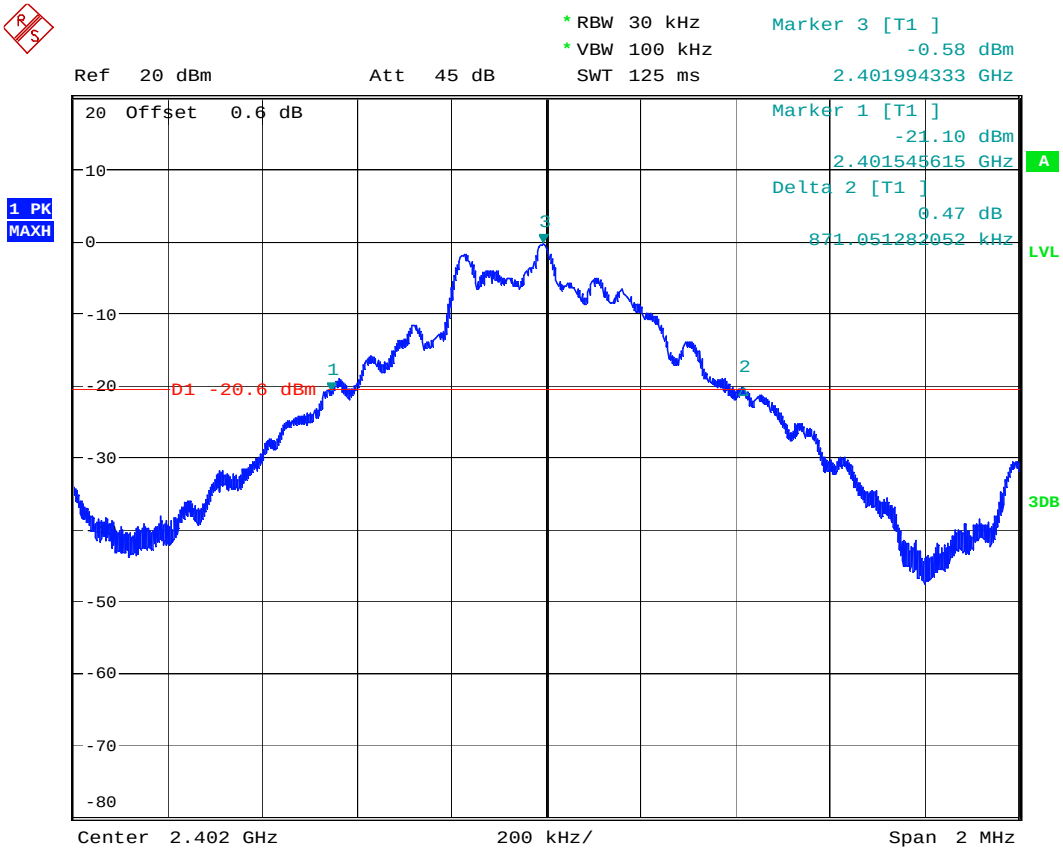
In addition, the occupied bandwidth (99%) was measured.

Test Results

Frequency (MHz)	20-dB channel Bandwidth (MHz)	Plot
2402	0.871	2.1
2441	0.863	2.2
2480	0.861	2.3

Frequency (MHz)	Occupied Bandwidth (MHz)	Plot
2402	0.856	2.4
2441	0.831	2.5
2480	0.836	2.6

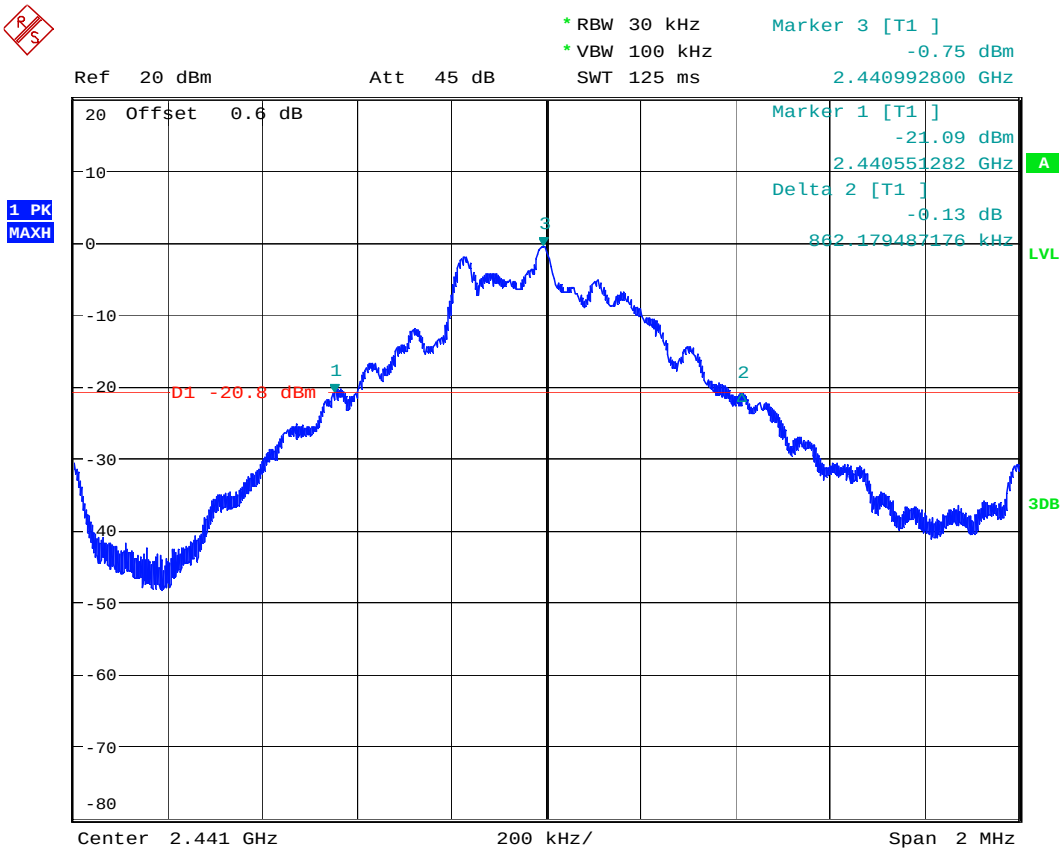
Plot 2.1



20-dB Bandwidth

Date: 22.NOV.2010 14:17:55

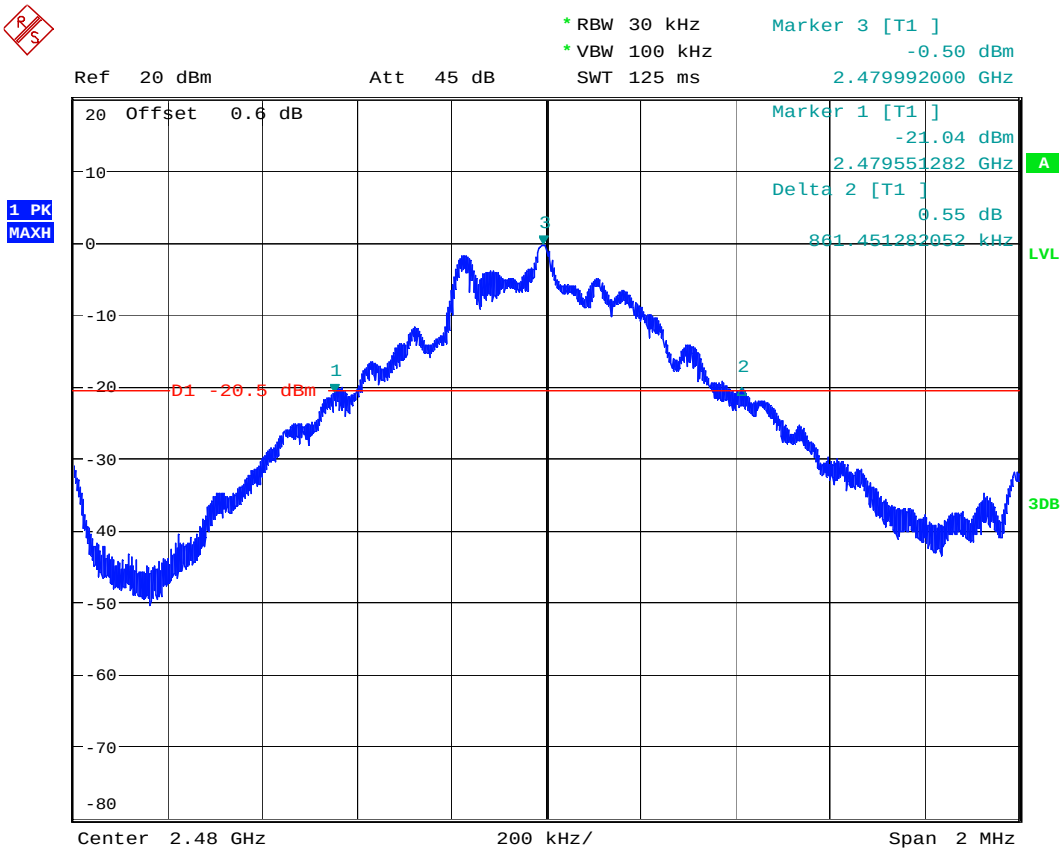
Plot 2.2



20-dB Bandwidth

Date: 22.NOV.2010 14:22:55

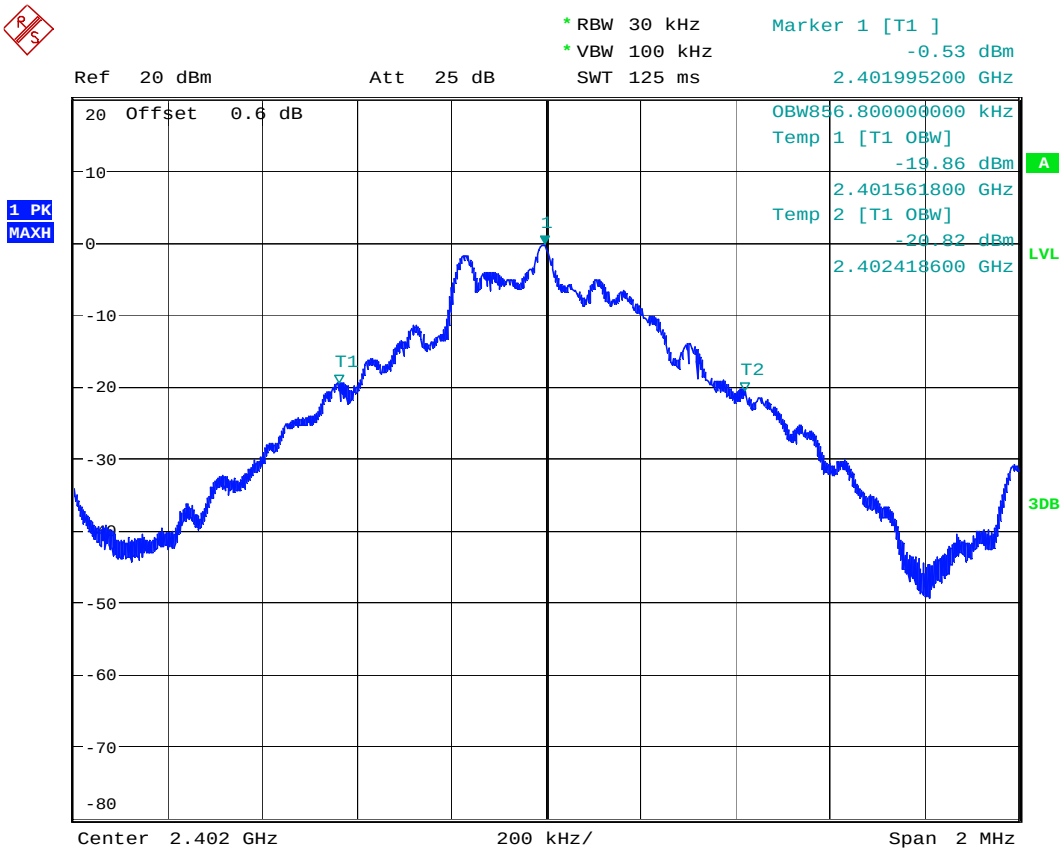
Plot 2.3



20-dB Bandwidth

Date: 22.NOV.2010 14:25:26

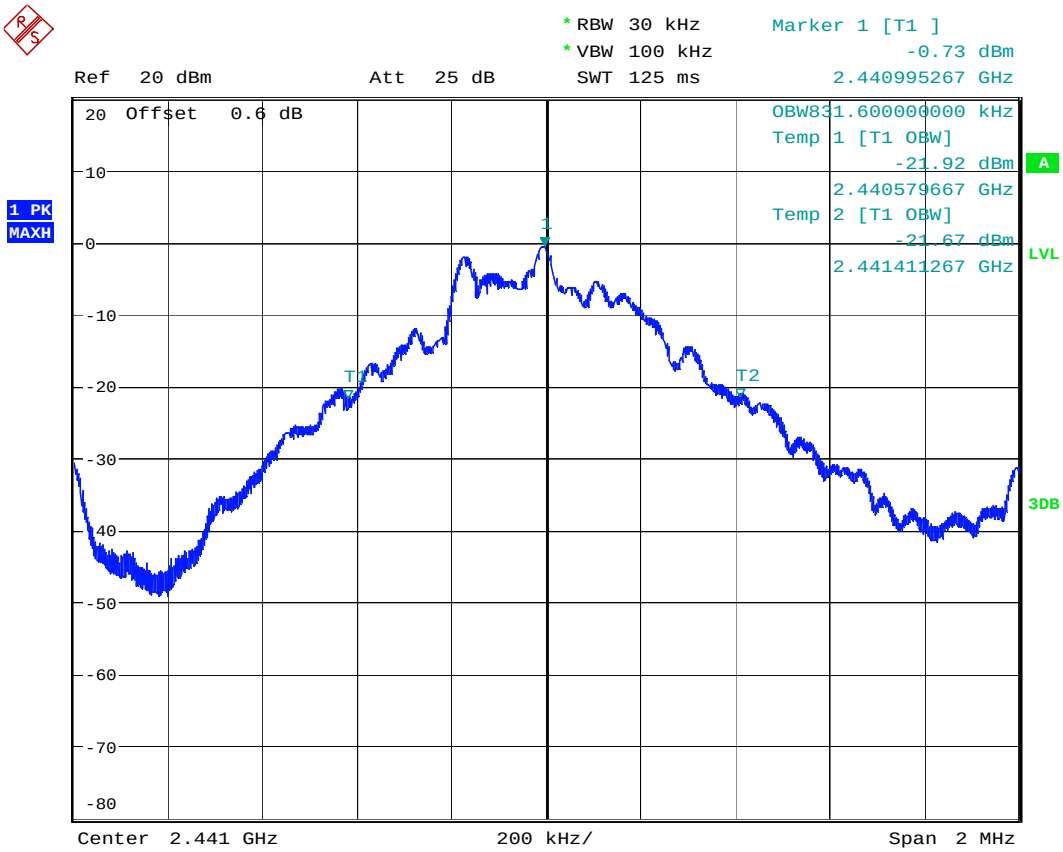
Plot 2.4



Occupied Bandwidth

Date: 22.NOV.2010 13:11:46

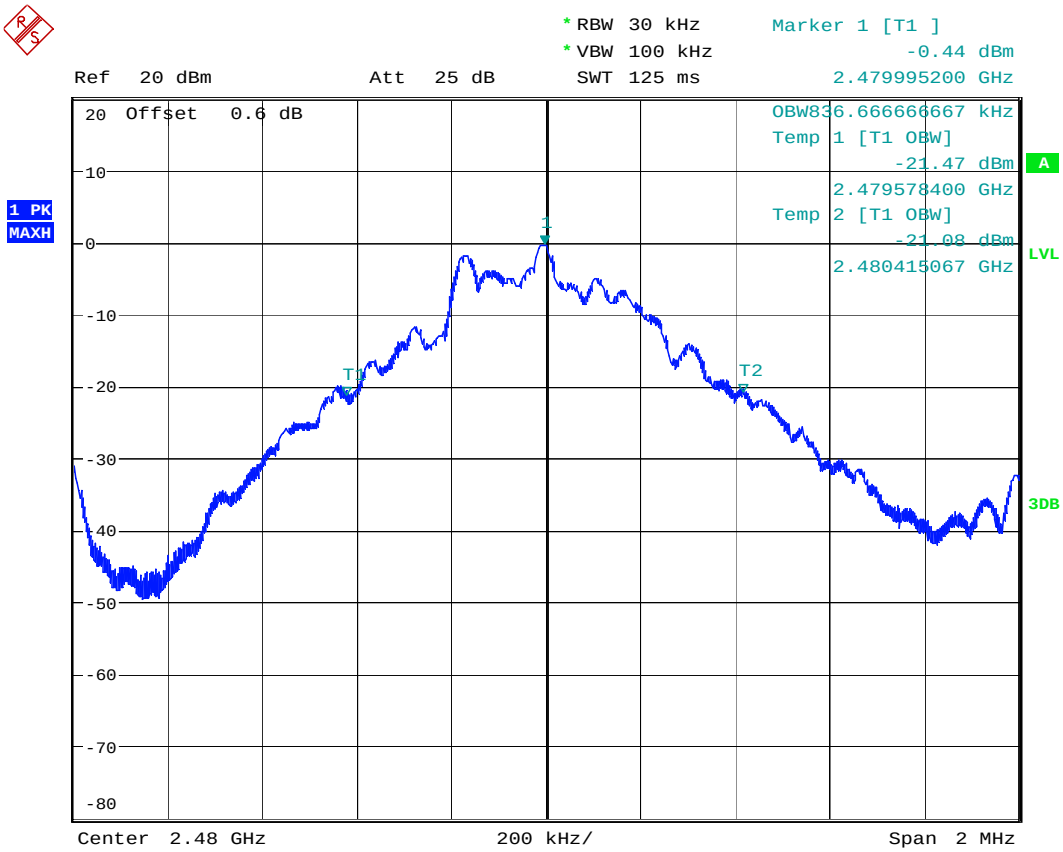
Plot 2.5



Occupied Bandwidth

Date: 22.NOV.2010 13:06:33

Plot 2.6



Occupied Bandwidth

Date: 22.NOV.2010 13:02:24

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.

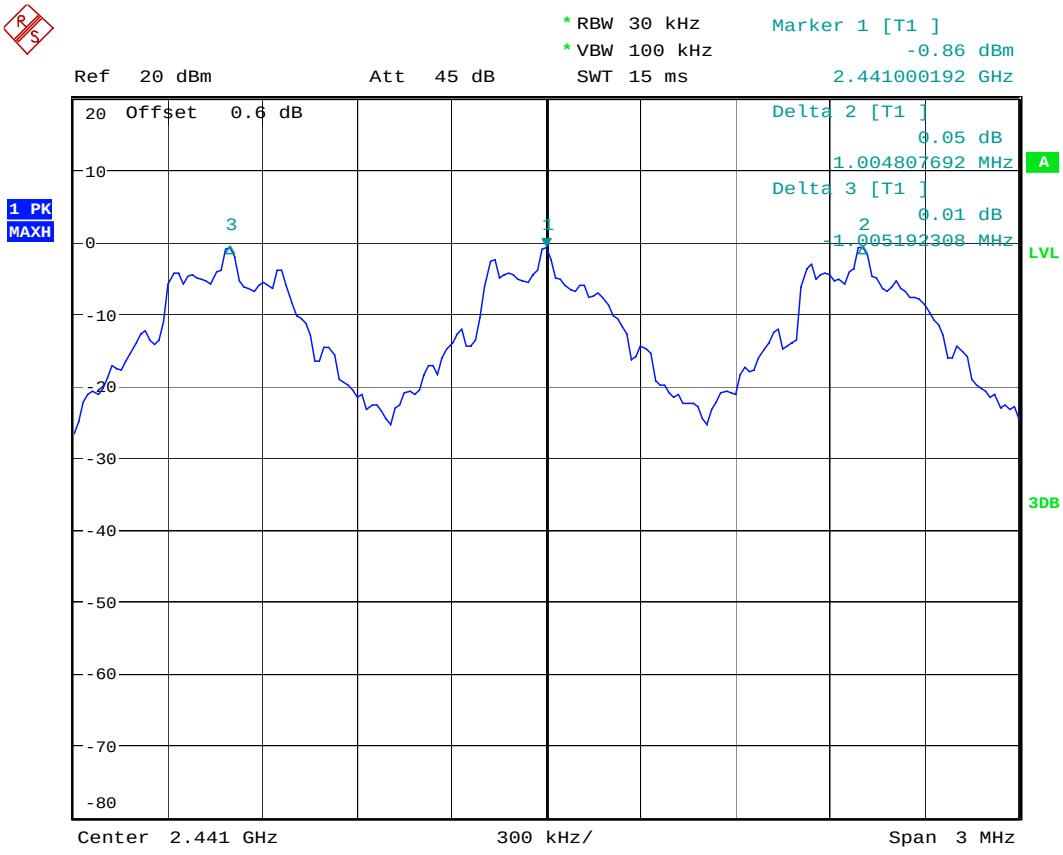
Procedure

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

Test Results

Please refer to the attached spectrum analyzer plot # 3.1 for the test result.
The channel separation is 1.005MHz.

Plot 3.1



Carrier frequency separation

Date: 22.NOV.2010 15:32:32

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

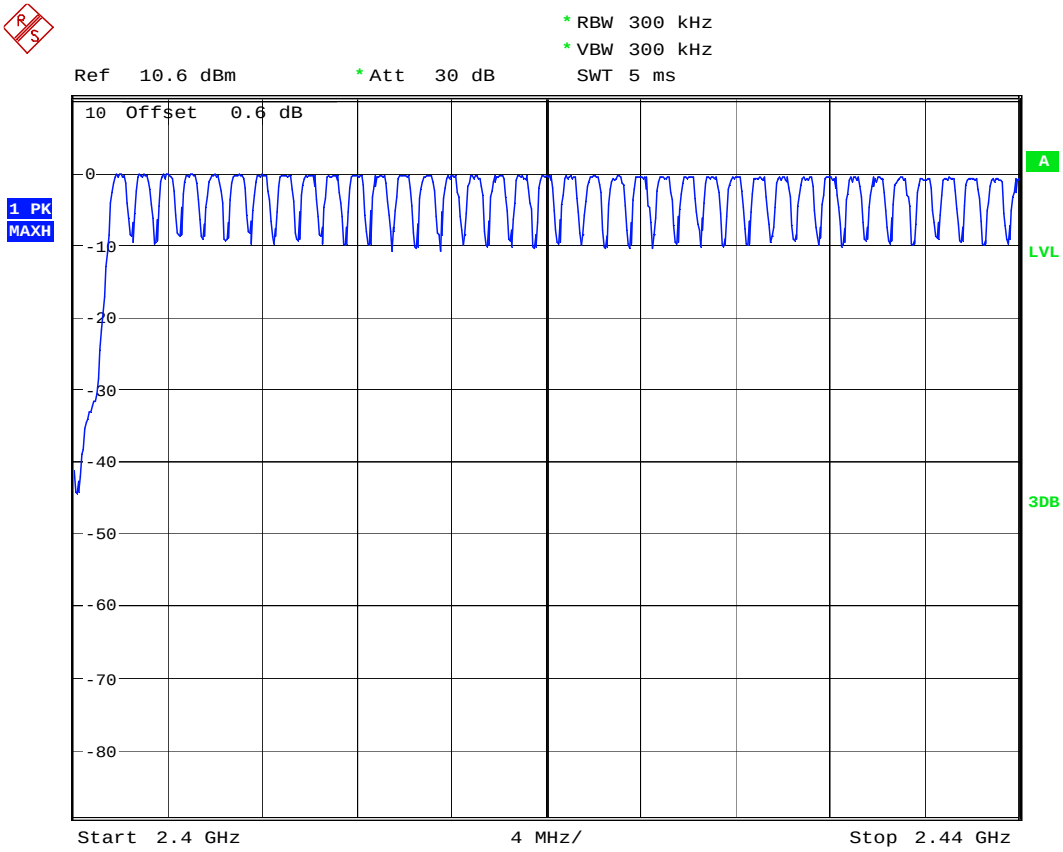
With the analyzer set to MAX HOLD, readings were taken for 2 - 3 minutes. The channel peaks were recorded and compared to the minimum number of channels required in the regulation.

Test Results

Number of hopping channels	79

Refer to attached spectrum analyzer charts: Plots 4.1 – 4.2

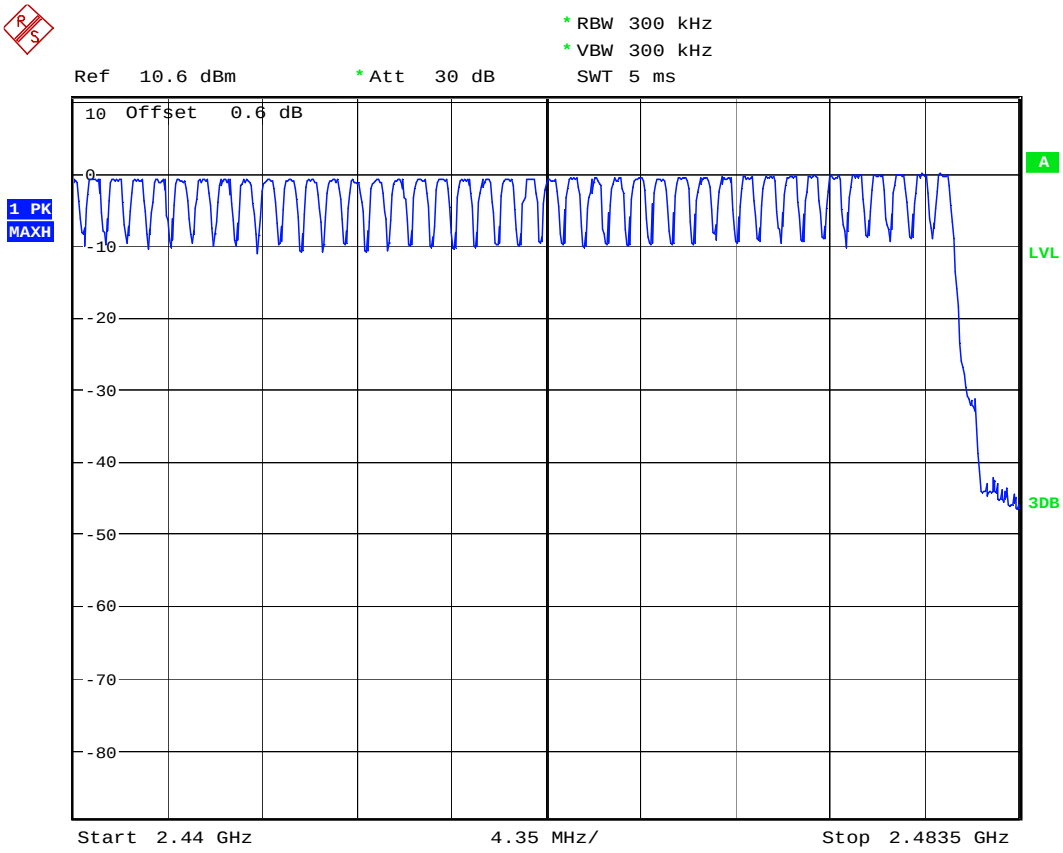
Plot 4.1



Number of hopping channels

Date: 23.NOV.2010 10:04:01

Plot 4.2



Number of hopping channels

Date: 23.NOV.2010 10:05:50

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 so captured was measured with the MARKER DELTA function.

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

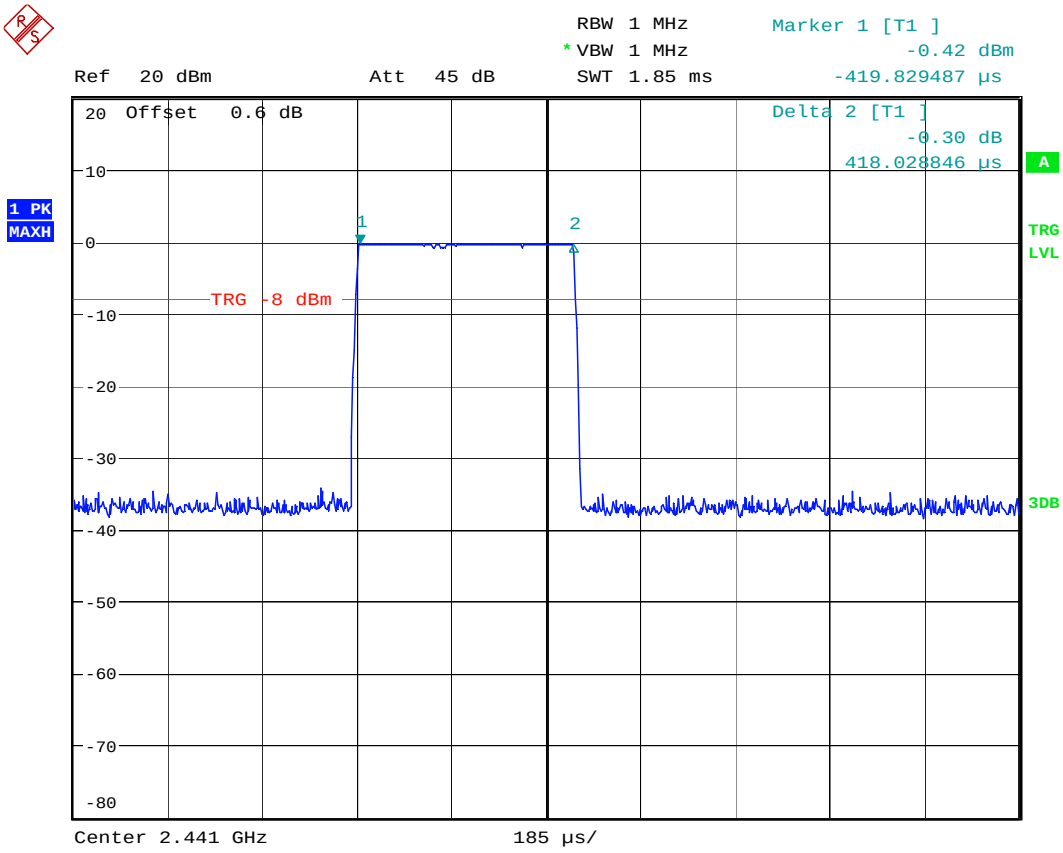
Test Results

Occupancy Time (see plots 5.1 and 5.2)

0.000419* 32 *10 = 0.134 sec.

Refer to attached spectrum analyzer plots 5.1-5.2 for details.

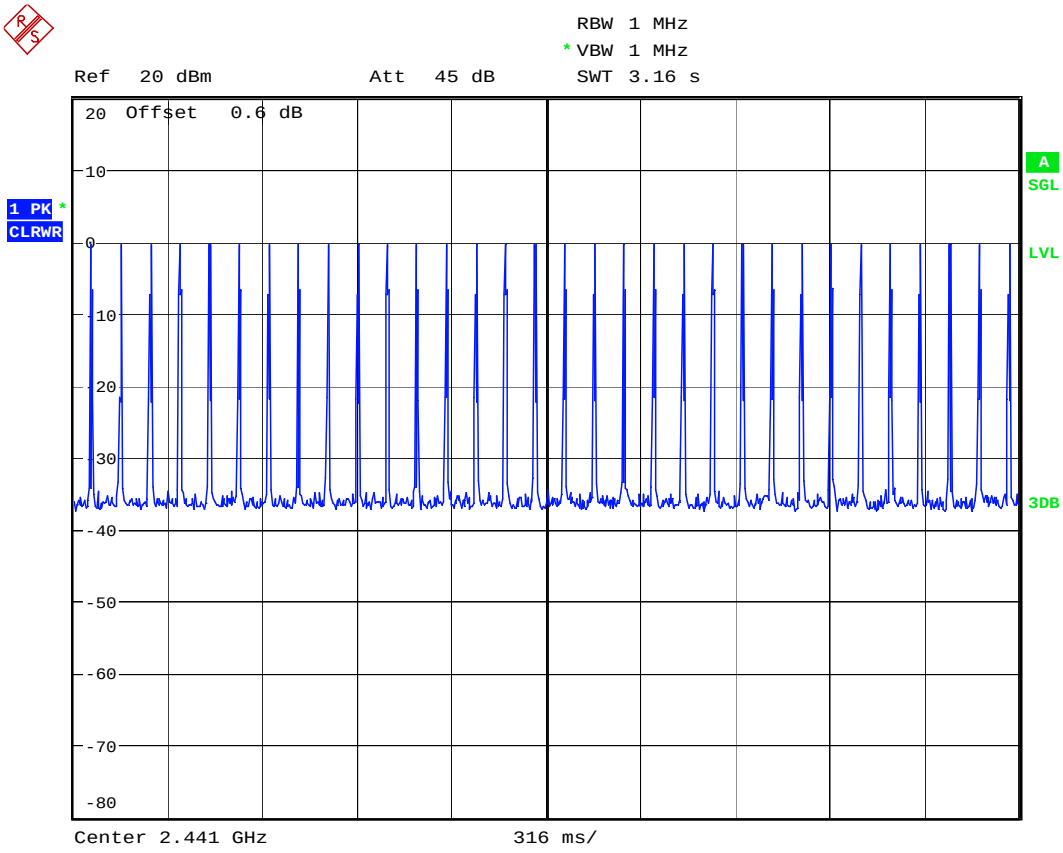
Plot 5.1



Dwell time

Date: 22.NOV.2010 15:47:27

Plot 5.2



Dwell time

Date: 22.NOV.2010 16:00:23

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.

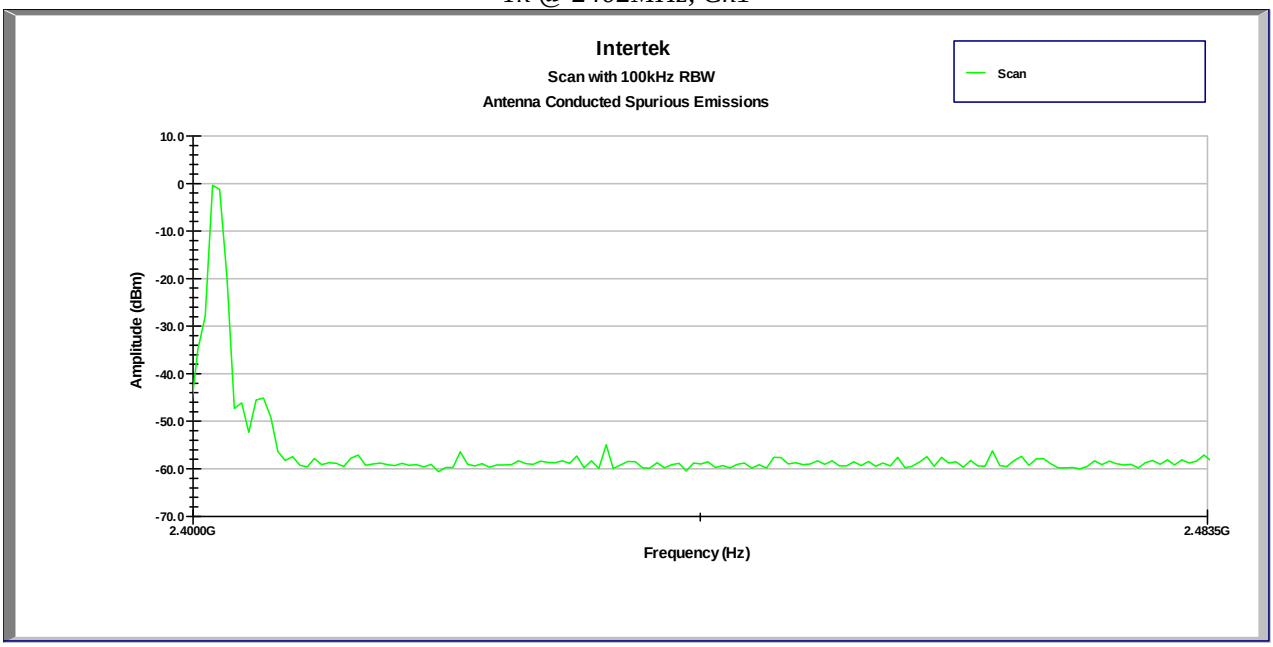
Test Result

Refer to the following plots for the test result:

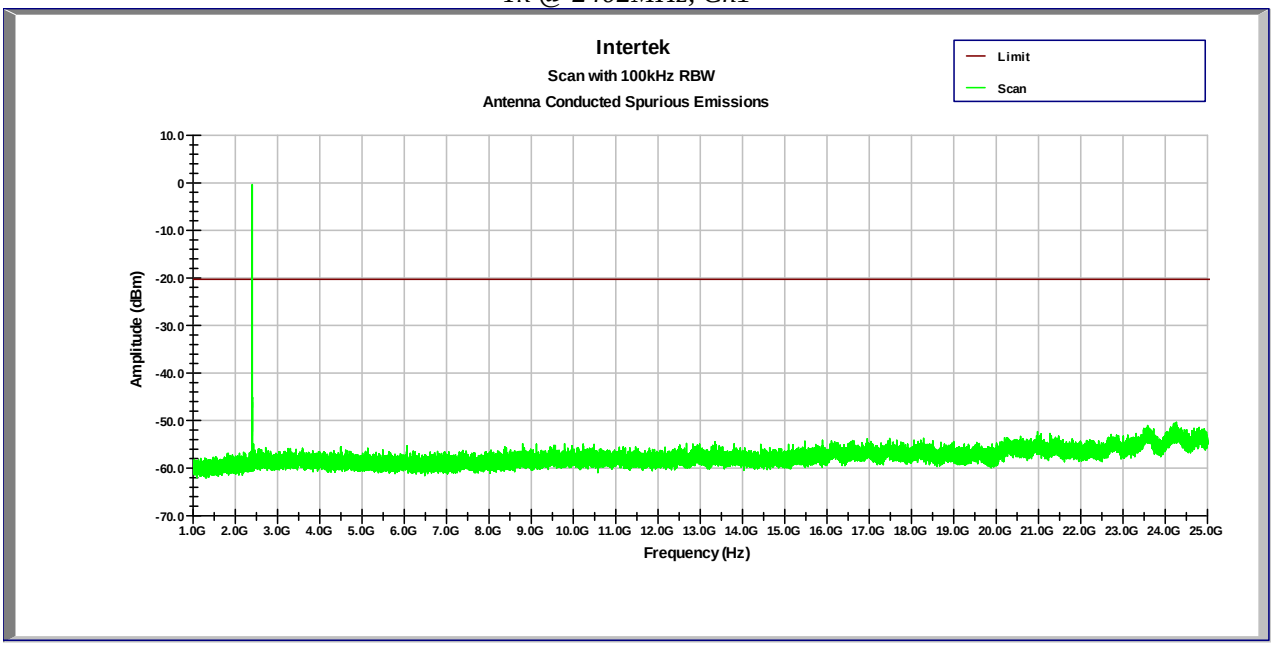
Frequency (MHz)	Channel	Modulation	Description	Plot
2402	1	FHSS	In-band Emissions	4.1
	1	FHSS	Scan 30 MHz – 25 GHz	4.2, 4.3
	1	FHSS	Emissions on the low band-edge frequency, Hopping mode	4.10
2441	40	FHSS	In-band Emissions	4.4
	40	FHSS	Scan 30 MHz – 25 GHz	4.5, 4.6
2480	79	FHSS	In-band Emissions	4.7
	79	FHSS	Scan 30 MHz – 25 GHz	4.8, 4.9
	79	FHSS	Emissions on the high band-edge frequency, Hopping mode	4.11

The attenuation is more than 20 dB.

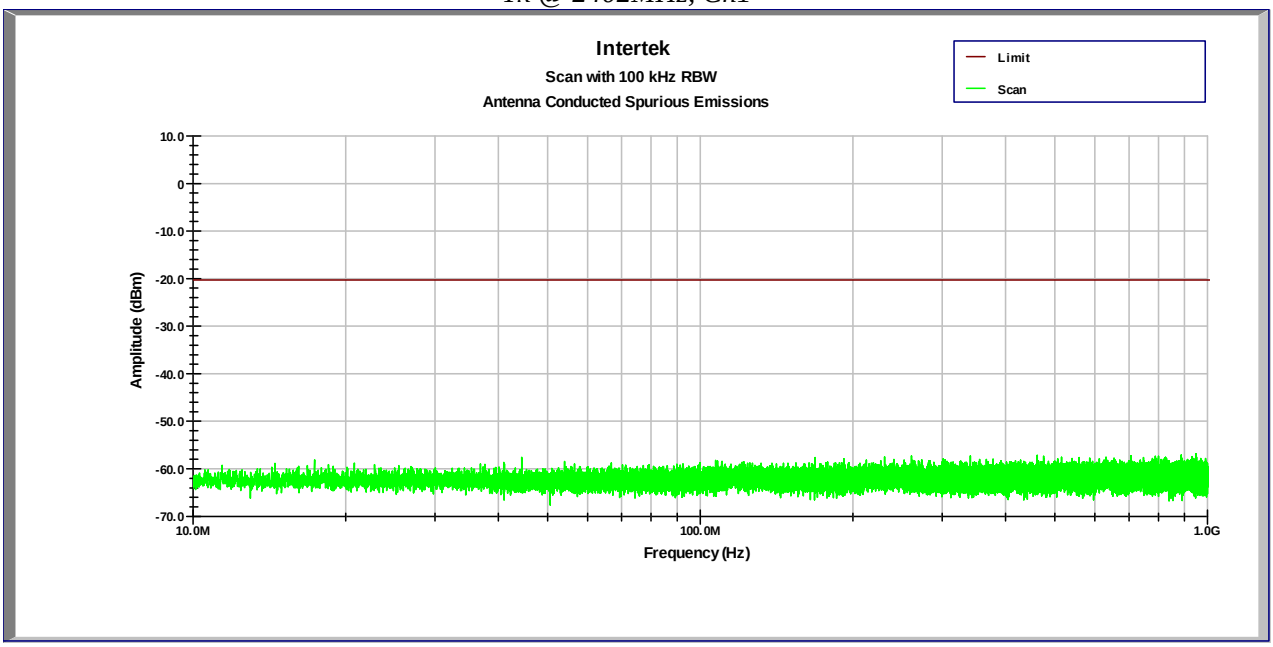
Plot 6.1
Tx @ 2402MHz, Ch1



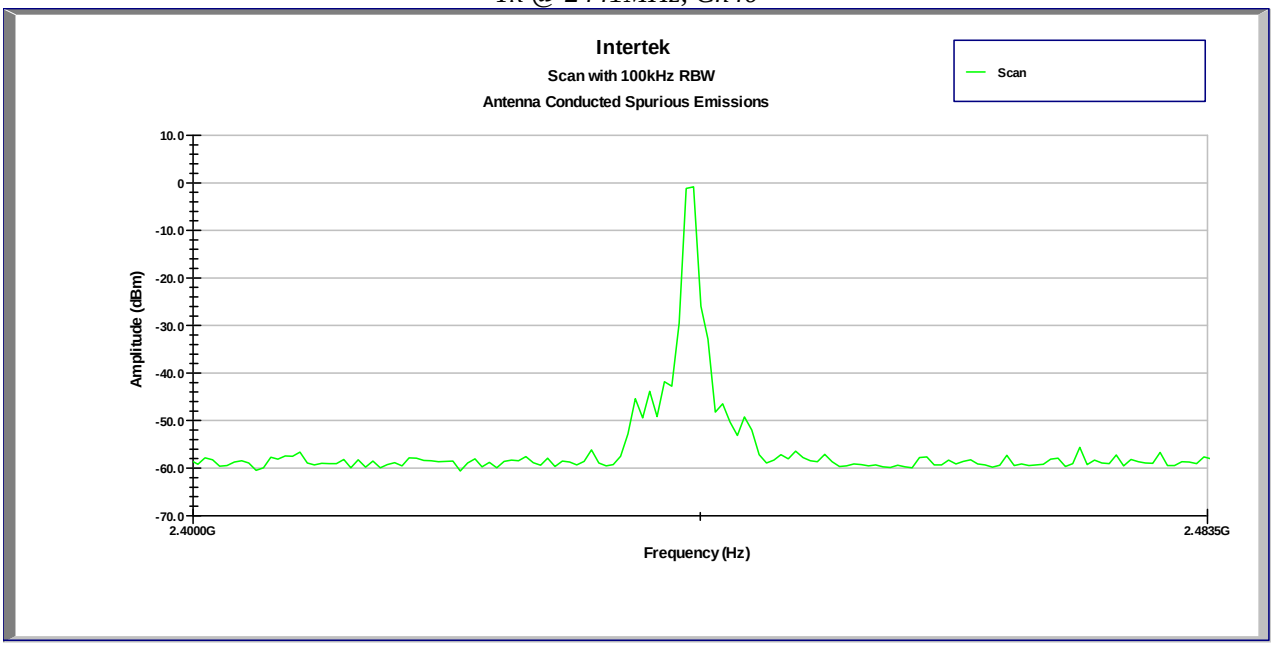
Plot 6.2
Tx @ 2402MHz, Ch1



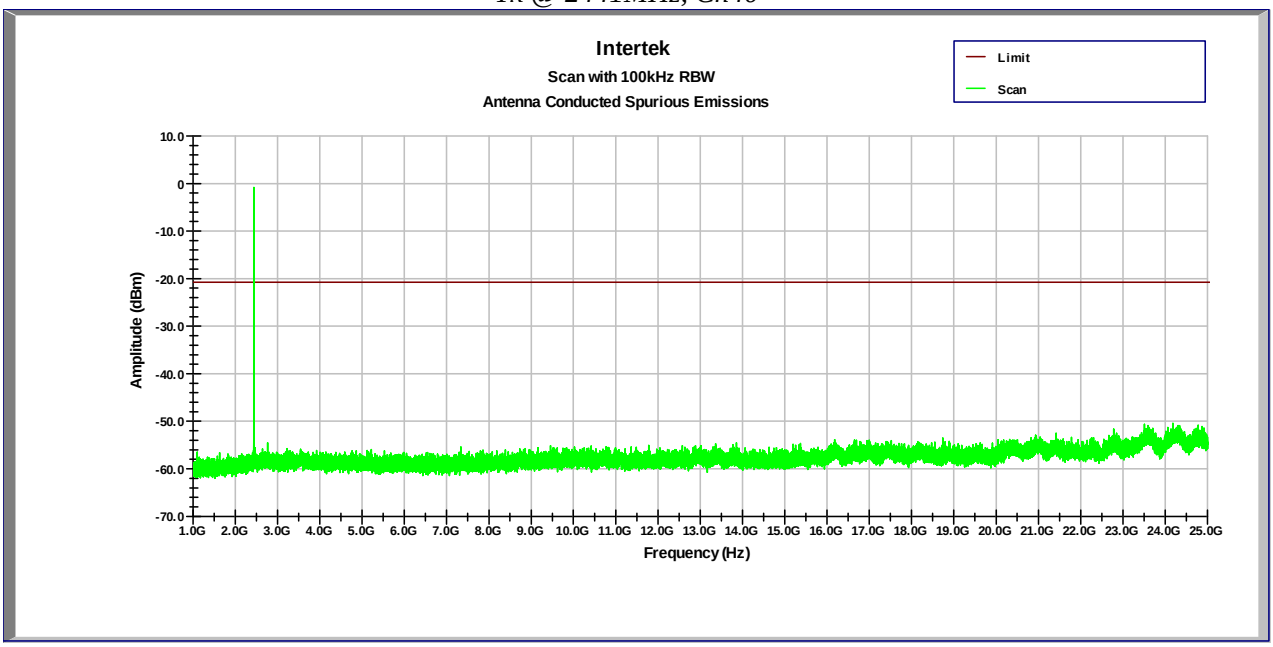
Plot 6.3
Tx @ 2402MHz, Ch1



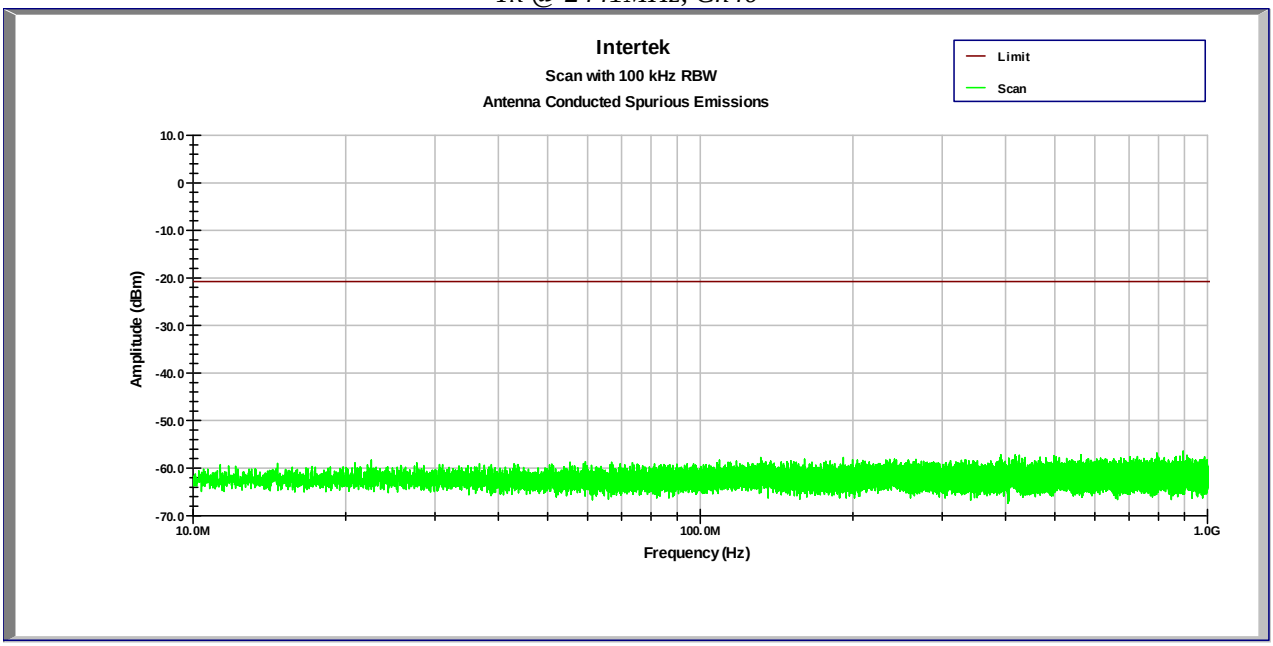
Plot 6.4
Tx @ 2441MHz, Ch40



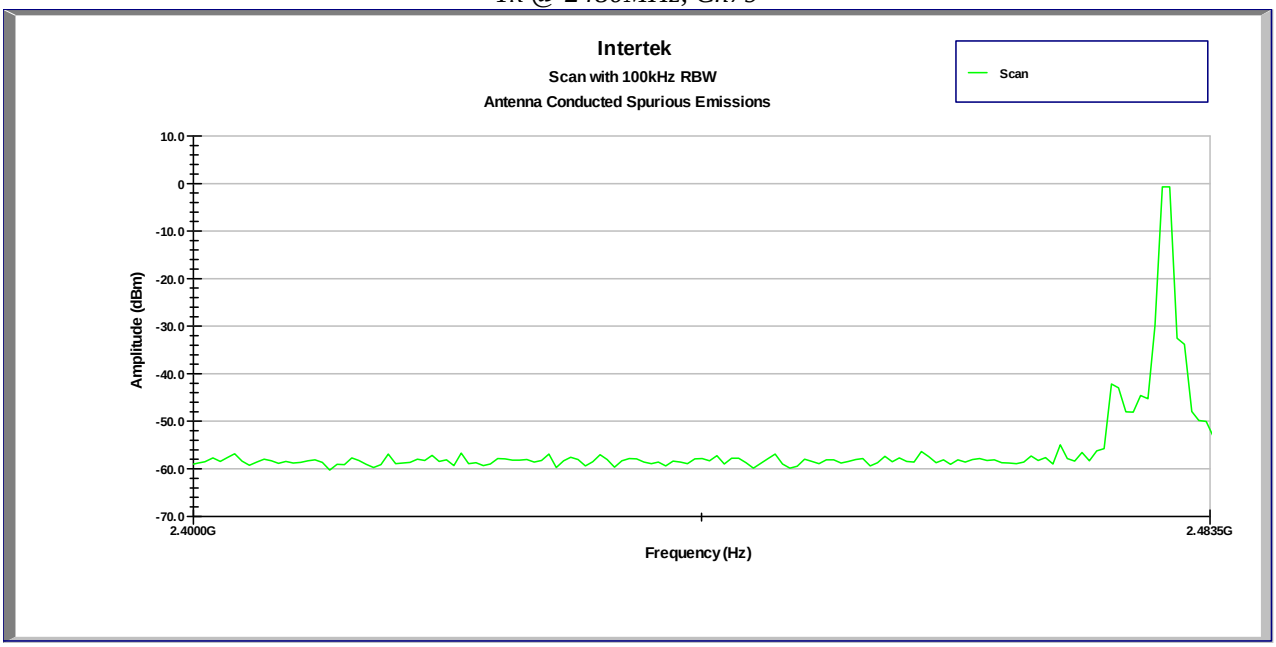
Plot 6.5
Tx @ 2441MHz, Ch40



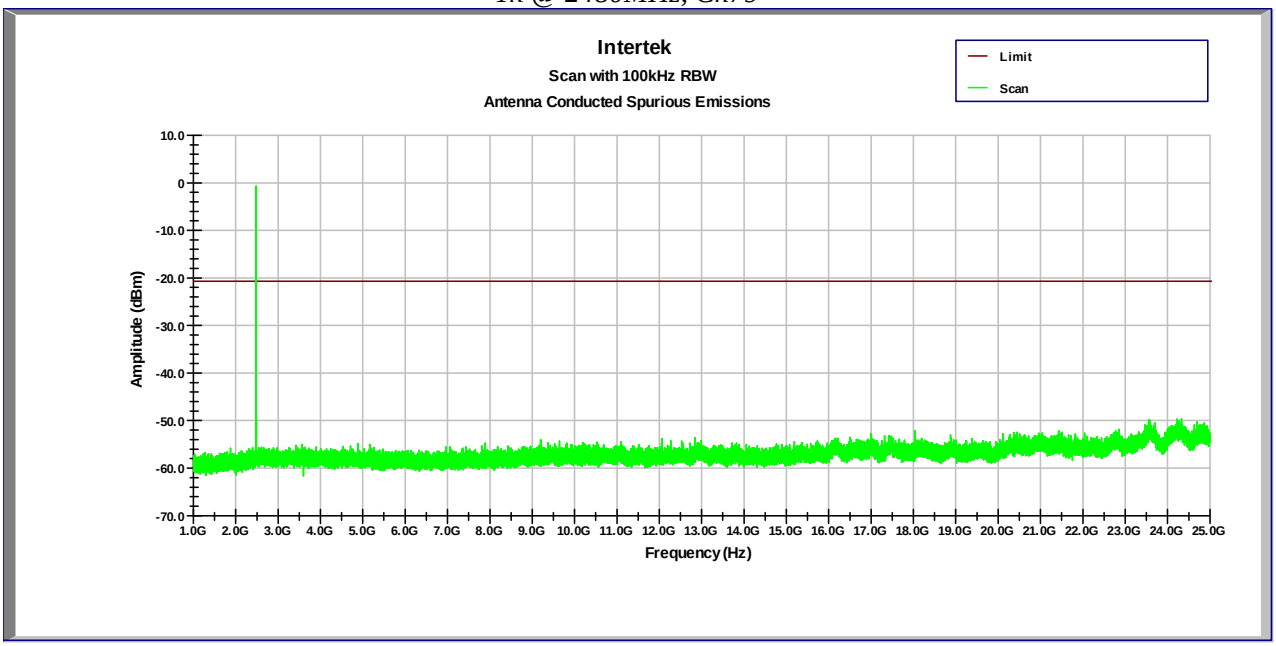
Plot 6.6
Tx @ 2441MHz, Ch40



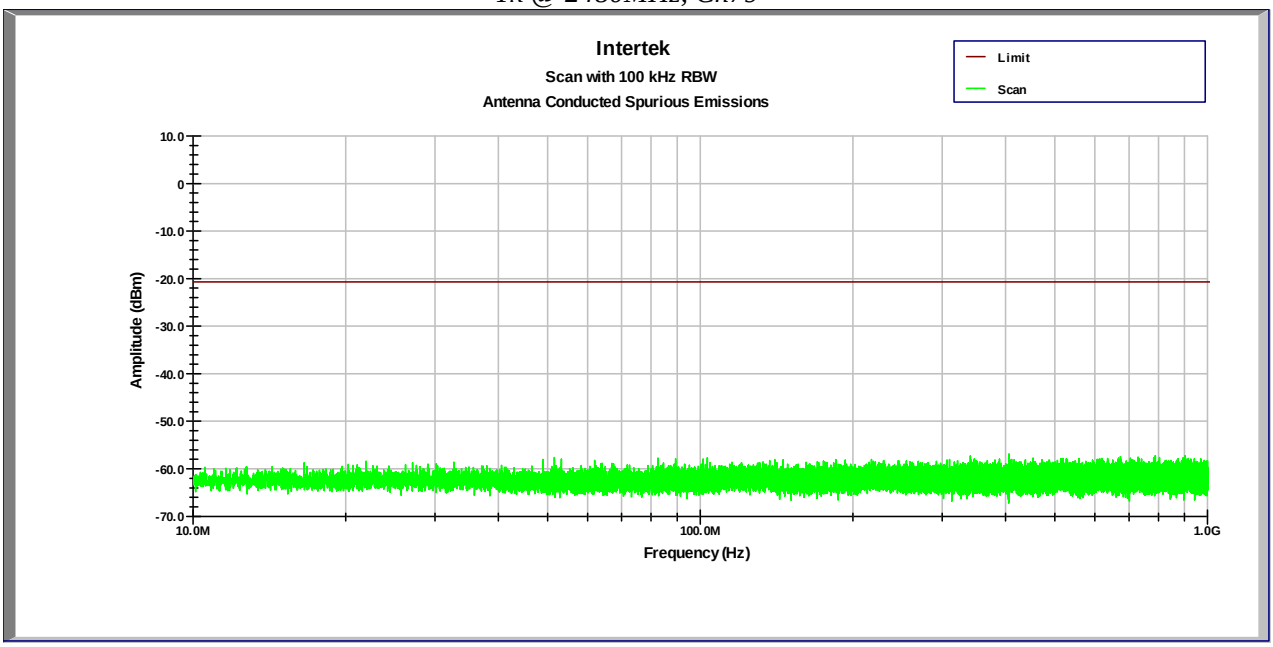
Plot 6.7
Tx @ 2480MHz, Ch79



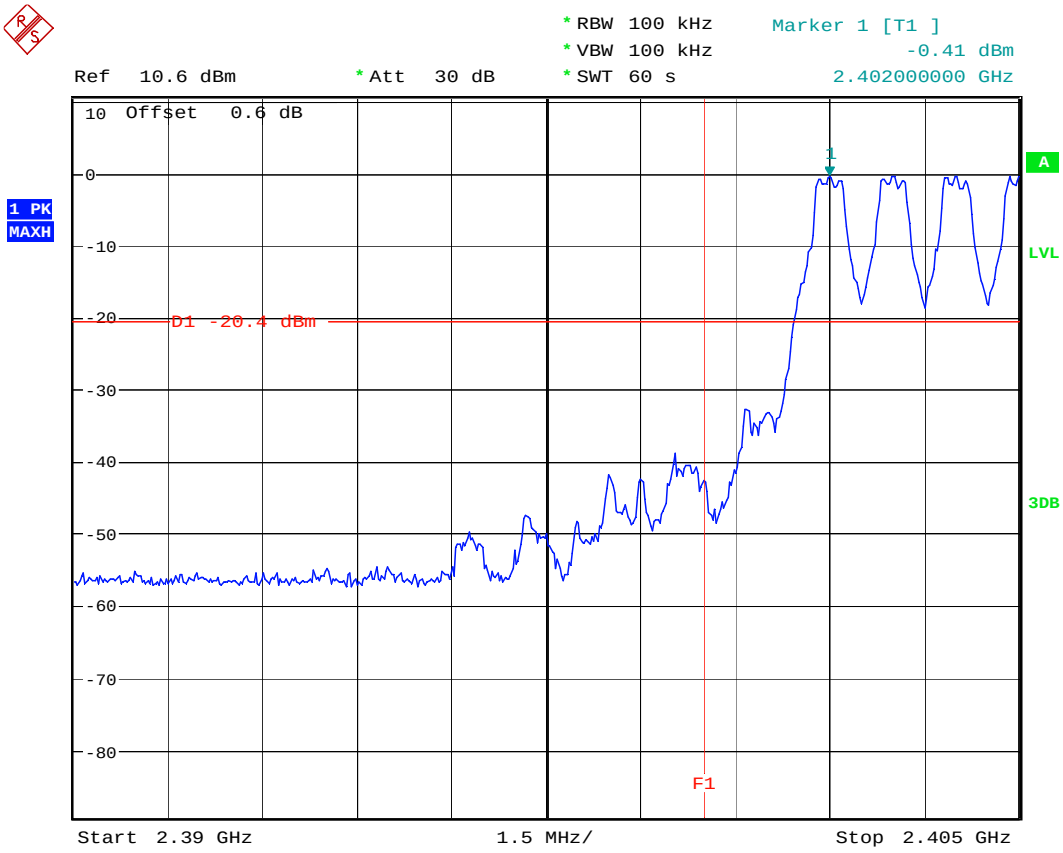
Plot 6.8
Tx @ 2480MHz, Ch79



Plot 6.9
Tx @ 2480MHz, Ch79



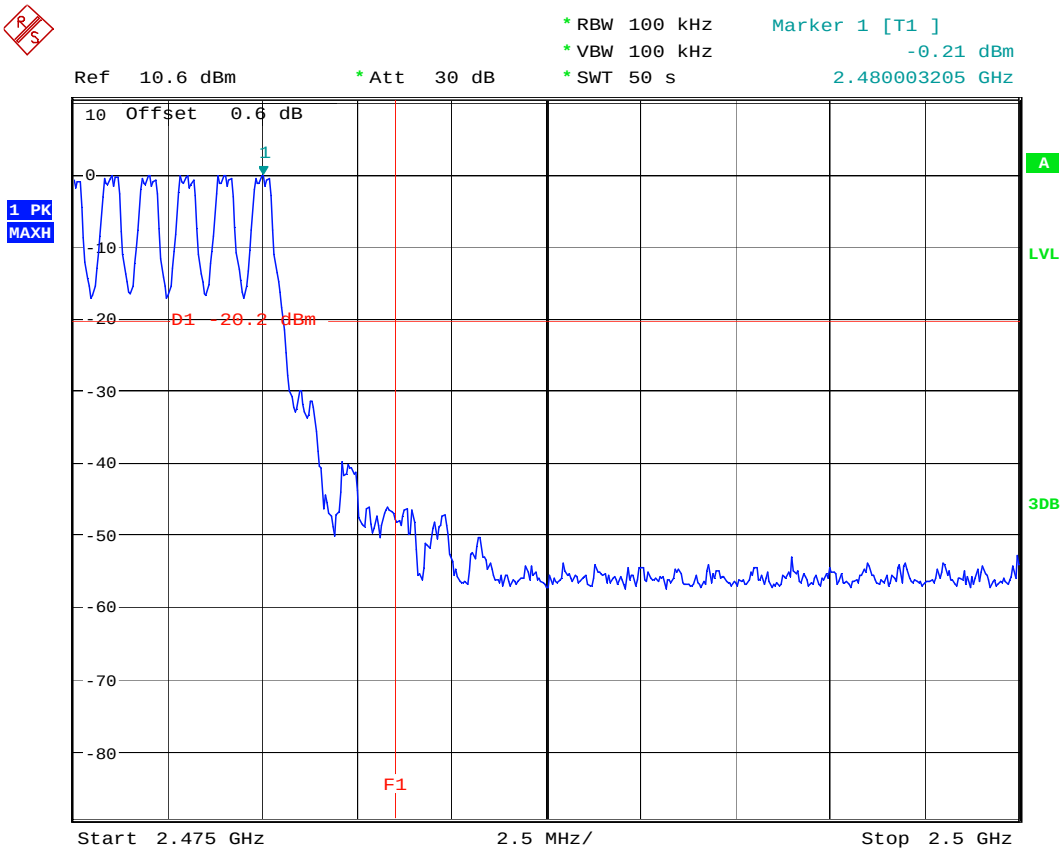
Plot 6.10



Spurious emissions, Freq 2402MHz

Date: 23.NOV.2010 16:55:30

Plot 6.11



Spurious emissions, Freq 2480MHz

Date: 23.NOV.2010 16:58:21

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(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.

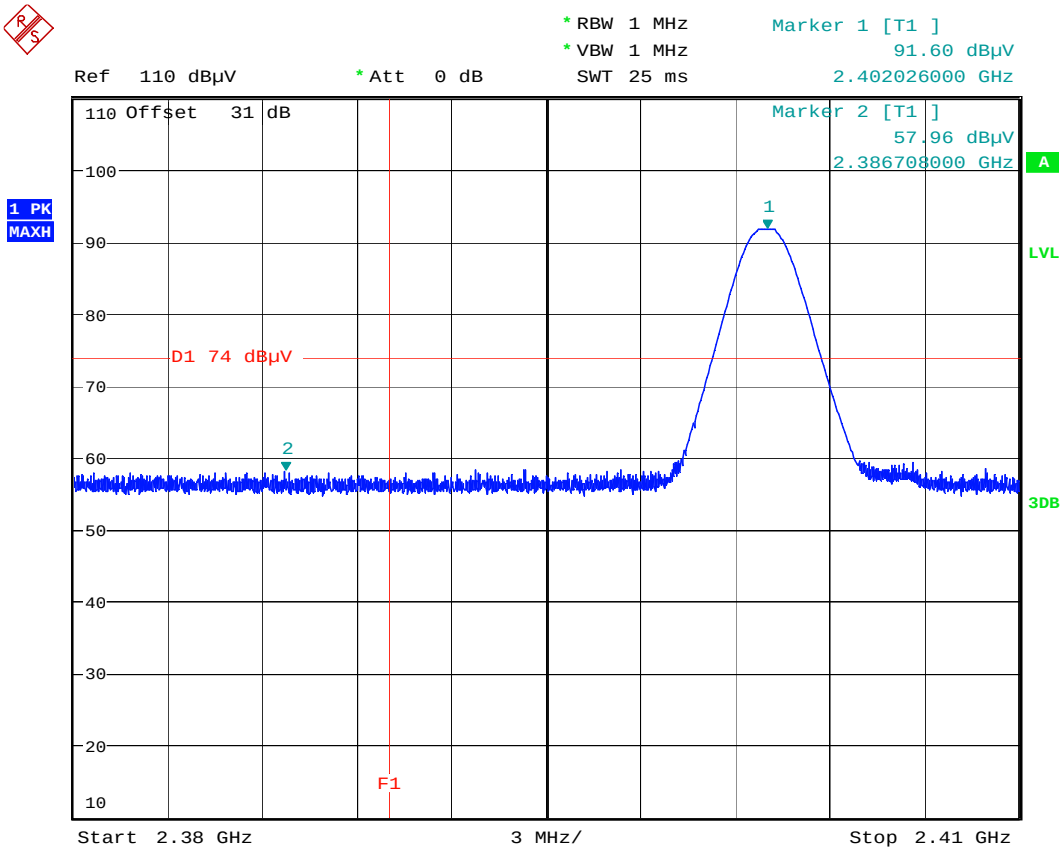
Test Results

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 near the operating band are presented on the following Plots 7.1-7.6. On these plots, the antenna factor and cable loss are included in the OFFSET of the spectrum analyzer reading; therefore, the measurements are the final corrected field strength.

The EUT passed the test by 5.5 dB.

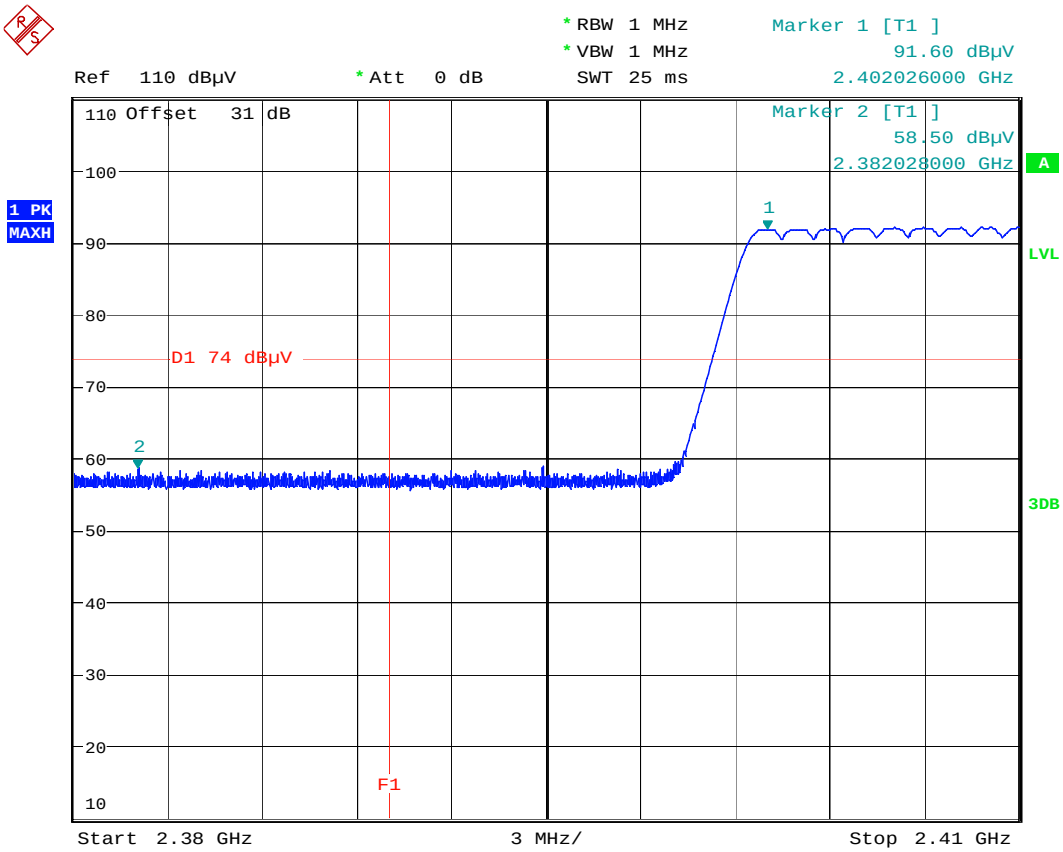
Plot 7.1



Emissions on band-edge frequency, peak, freq 2402MHz

Date: 24.NOV.2010 12:43:55

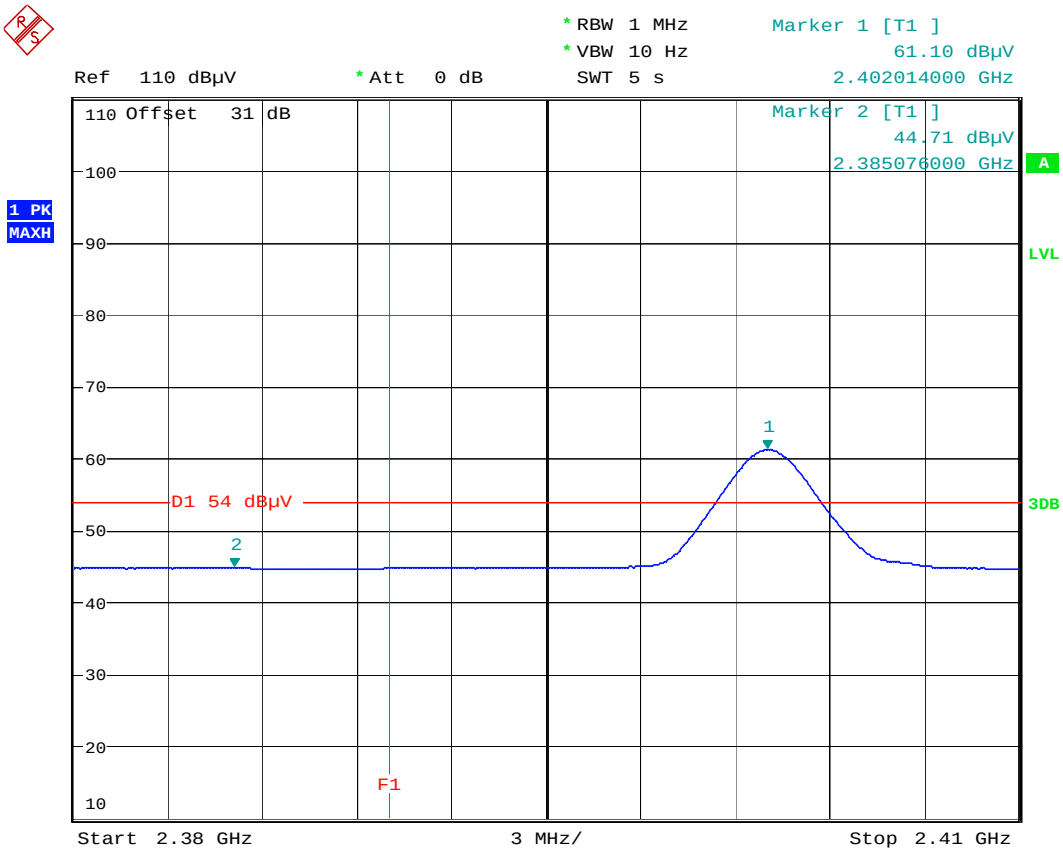
Plot 7.2



Emissions on band-edge frequency, peak, freq 2402MHz

Date: 24.NOV.2010 12:47:52

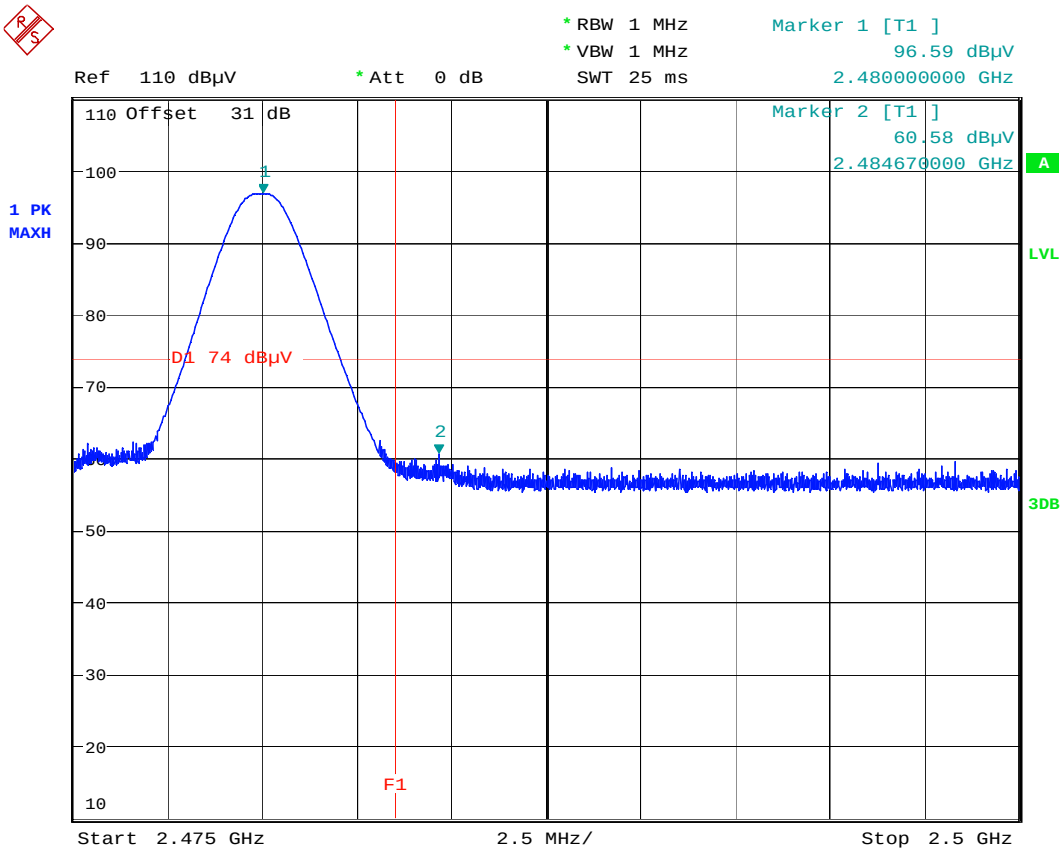
Plot 7.3



Emissions on band-edge frequency, average, freq 2402MHz

Date: 24.NOV.2010 12:50:03

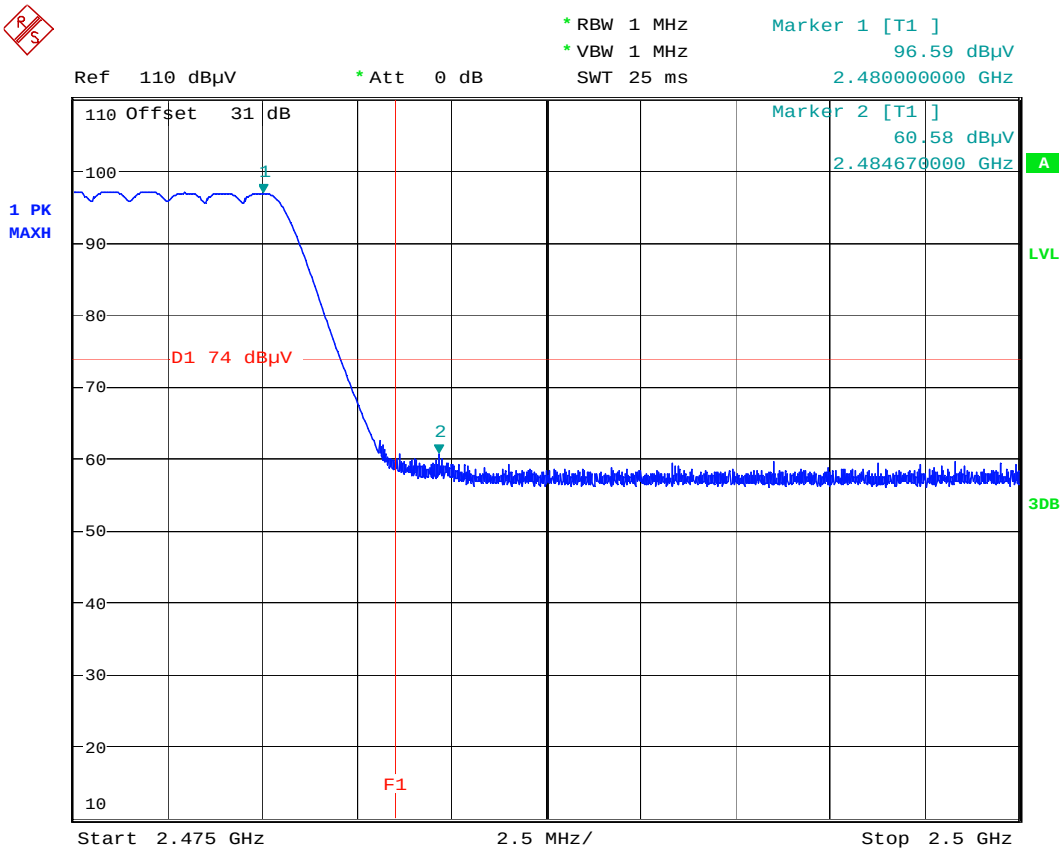
Plot 7.4



Emissions on band-edge frequency, peak, freq 2480MHz

Date: 24.NOV.2010 12:21:47

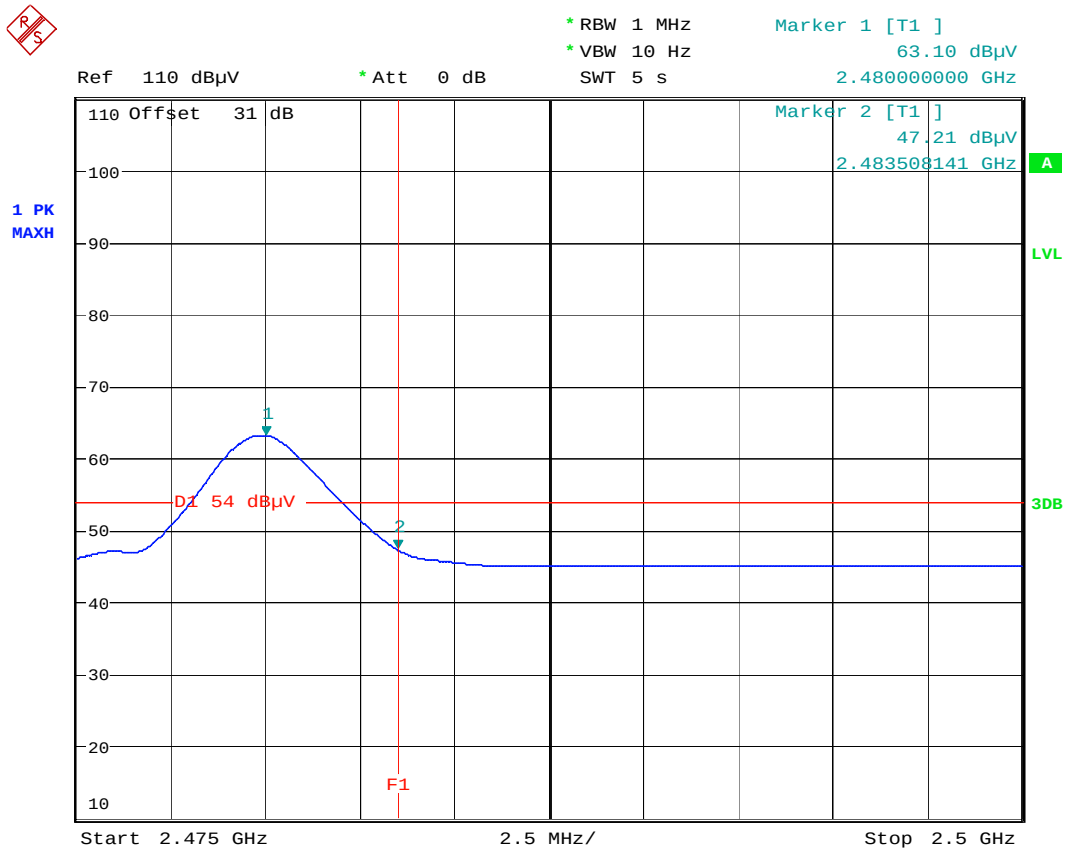
Plot 7.5



Emissions on band-edge frequency, peak, freq 2480MHz

Date: 24.NOV.2010 12:25:29

Plot 7.6



Emissions on band-edge frequency, average, freq 2480MHz

Date: 24.NOV.2010 12:27:57

Radiated Emissions above 1 GHz

Test Result	
FCC Part 15 Subpart C (15.247) Radiated Emission in Restricted Bands	
Temperature: 21C	Topcon Positioning Systems, Inc.
Humidity: 45%	Model: 01-090901-21
Test distance = 3 m	
Test date: November 24, 2010	

Frequency MHz	Detector	SA reading dB(uV)	Correction Factor dB	Ant. Factor dB(1/m)	Field Strength dB(uV/m)	Limit dB(uV/m)	Margin dB
Tx at 2402 MHz							
4804.0	Peak	37.8	-28.6	32.8	42.0	74.0	-32.0
12010.0	Peak	34.7	-24.9	38.6	48.4	74.0	-25.6
4804.0	Aver	23.7	-28.6	32.8	27.9	54.0	-26.1
12010.0	Aver	21.5	-24.9	38.6	35.2	54.0	-18.8
Tx at 2441 MHz							
4882.0	Peak	37.4	-28.3	32.8	41.9	74.0	-32.1
7323.0	Peak	36.1	-26.5	37.5	47.1	74.0	-26.9
12205.0	Peak	35.0	-25.4	38.6	48.2	74.0	-25.8
4882.0	Aver	24.1	-28.3	32.8	28.6	54.0	-25.4
7323.0	Aver	22.4	-26.5	37.5	33.4	54.0	-20.6
12205.0	Aver	22.2	-25.4	38.6	35.4	54.0	-18.6
Tx at 2480 MHz							
4960.0	Peak	37.2	-27.7	32.9	42.4	74.0	-31.6
7440.0	Peak	35.6	-26.3	37.4	46.7	74.0	-27.3
12400.0	Peak	35.9	-25.5	38.6	49.0	74.0	-25.0
4960.0	Aver	23.9	-27.7	32.9	29.1	54.0	-24.9
7440.0	Aver	22.4	-26.3	37.4	33.5	54.0	-20.5
12400.0	Aver	22.5	-25.5	38.6	35.6	54.0	-18.4

a) RBW = 1 MHz, VBW = 1 MHz - for peak measurements
RBW = 1MHz, VBW = 10 Hz - for average measurements
b) Correction Factor: Cable loss + High Pass Filter loss - Pre-amplifier gain
c) FS at 3m = SA reading + Correction Factor + Antenna factor
d) Measurements made at 3 meters distance. Radiated emission measurements were performed up to 25GHz. No other emissions were detected above the noise floor which is at least 10 dB below the limit.

Radiated Emissions below 1 GHz

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

Operator: KK Model Number: 01-090901-21
November 24, 2010 Company: Topcon Positioning Systems, Inc.

Frequency (MHz)	Peak FS dB(uV/m)	Limit@3m dB(uV/m)	Margin dB	RA dB(uV)	CF dB	AG dB	DCF dB	AF dB(1/m)
39.70	24.8	40.0	-15.2	28.9	0.7	31.9	10.5	16.6
168.23	32.7	43.5	-10.8	43.8	1.5	31.9	10.5	8.7
216.73	27.6	46.0	-18.4	36.4	1.7	31.9	10.5	10.9
262.80	28.8	46.0	-17.2	35.2	1.9	31.8	10.5	13.0
287.05	29.5	46.0	-16.5	36.3	2.0	31.9	10.5	12.7
342.02	27.9	46.0	-18.1	32.5	2.2	31.8	10.5	14.5

Test Mode: Normal (Tx/Rx mode)
Temperature: 21 C Humidity : 45 %

Notes: Measurements made at 10 meters distance.

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

Operator: KK Model Number: 01-090901-21
November 24, 2010 Company: Topcon Positioning Systems, Inc.

Frequency (MHz)	Peak FS dB(uV/m)	Limit@3m dB(uV/m)	Margin dB	RA dB(uV)	CF dB	AG dB	DCF dB	AF dB(1/m)
39.70	34.5	40.0	-5.5	39.7	0.7	31.9	10.5	15.4
49.40	26.5	40.0	-13.5	33.7	0.8	31.9	10.5	13.4
69.61	28.5	40.0	-11.5	41.7	1.0	32.1	10.5	7.4
101.13	24.6	43.5	-18.9	34.7	1.2	32.1	10.5	10.3
140.74	30.2	43.5	-13.3	41.9	1.4	31.9	10.5	8.3
174.69	33.3	43.5	-10.2	43.6	1.5	31.9	10.5	9.5
233.70	33.7	46.0	-12.3	41.6	1.8	31.9	10.5	11.7
252.29	33.5	46.0	-12.5	41.0	1.9	31.9	10.5	12.0
287.86	31.6	46.0	-14.4	38.3	2.0	31.9	10.5	12.6
380.82	30.9	46.0	-15.1	34.6	2.3	31.8	10.5	15.3
396.18	29.3	46.0	-16.7	32.0	2.3	31.8	10.5	16.3
501.26	30.4	46.0	-15.6	32.2	2.7	31.9	10.5	17.0

Test Mode: Normal (Tx/Rx mode)
Temperature: 21 C Humidity : 45 %

Notes: Measurements made at 10 meters distance.

4.8 Emissions from Receiver
FCC 15.109, FCC 15.111(a)

Requirement

Radiated Emission Limit for FCC Part 15 Subpart B and ICES 003

Radiated Emission Limits for Class A at 10 meters	
Frequency (MHz)	**Quasi-Peak limits, dB (µV/m)**
30 to 88	39.1
88 to 216	43.5
216 to 960	46.4
960 and up	49.5
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

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 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 (Pk-Vertical)

Operator: KK Model Number: 01-090901-21
November 10, 2010 Company: Topcon Positioning Systems, Inc.

Frequency (MHz)	Peak FS dB(uV/m)	Limit@3m dB(uV/m)	Margin dB	RA dB(uV)	CF dB	AG dB	DCF dB	AF dB(1/m)
39.70	31.9	40.0	-8.1	37.3	0.7	32.1	10.5	15.4
49.40	29.5	40.0	-10.5	36.9	0.8	32.1	10.5	13.4
69.61	28.5	40.0	-11.5	41.7	1.0	32.0	10.5	7.4
89.01	34.1	43.5	-9.4	46.2	1.1	32.0	10.5	8.3
109.22	29.6	43.5	-13.9	38.2	1.2	32.0	10.5	11.7
148.83	28.0	43.5	-15.5	40.5	1.4	32.0	10.5	7.6
169.03	28.8	43.5	-14.7	39.7	1.5	32.0	10.5	9.1
251.48	29.6	46.0	-16.4	37.3	1.9	32.0	10.5	11.9
380.82	29.5	46.0	-16.5	33.3	2.3	32.0	10.5	15.3

Test Mode: Rx mode
Temperature: 21 C Humidity : 45 %

Notes: Measurements made at 10 meters distance.

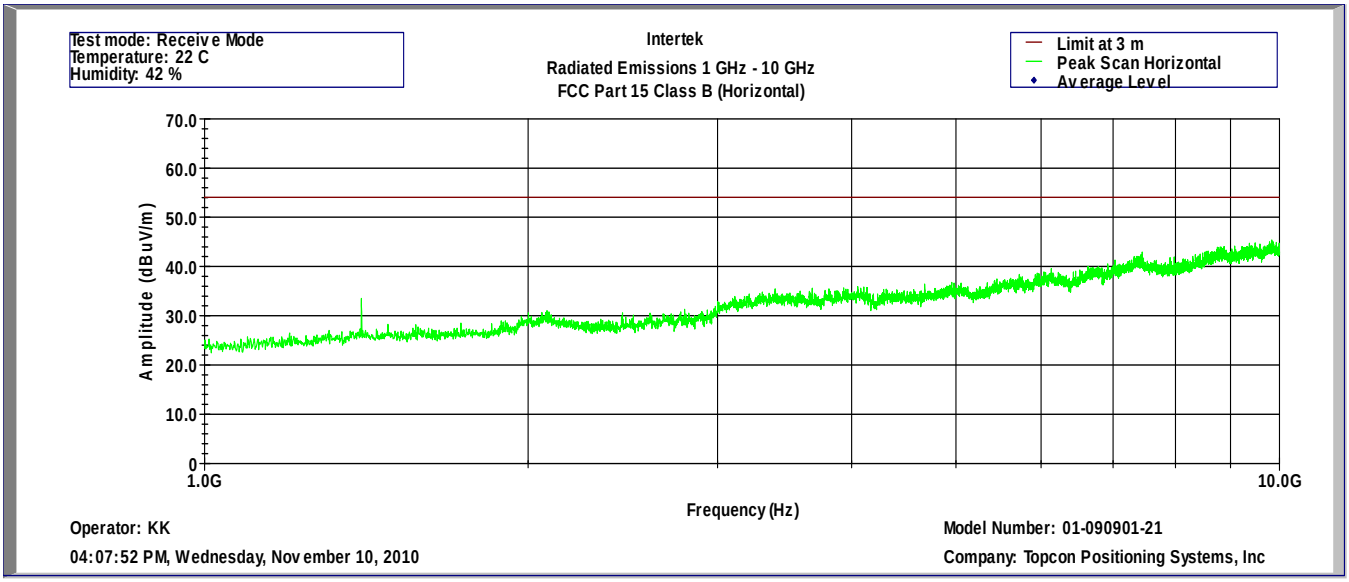
Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (Pk-Horizontal)

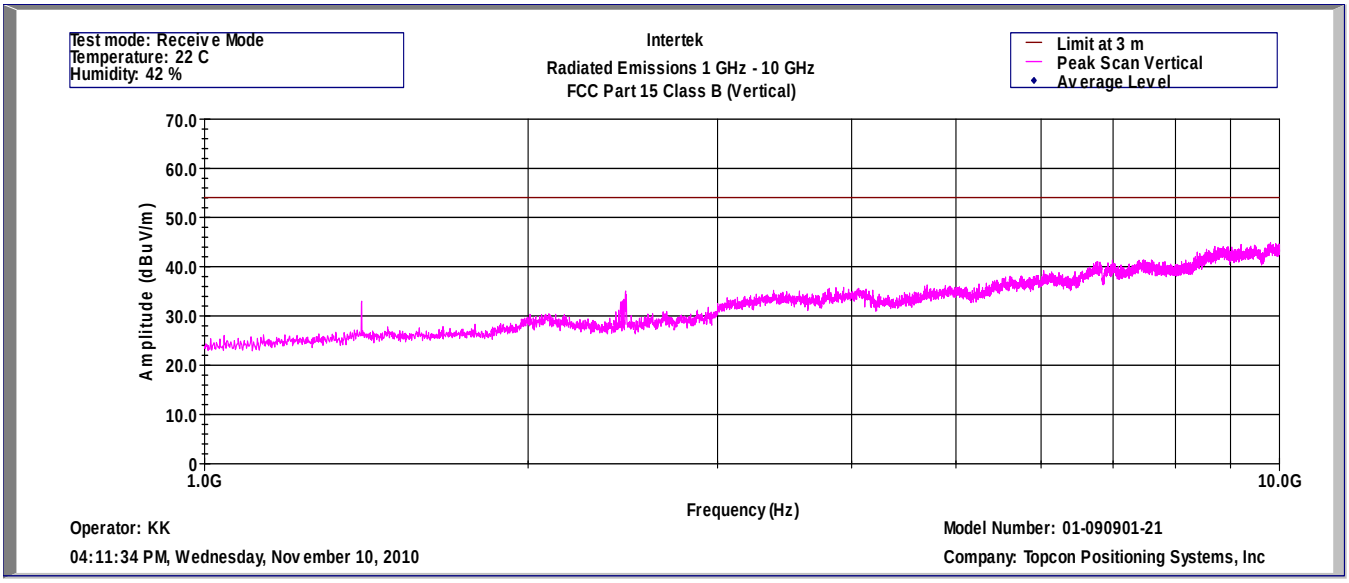
Operator: KK Model Number: 01-090901-21
November 10, 2010 Company: Topcon Positioning Systems, Inc.

Frequency (MHz)	Peak FS dB(uV/m)	Limit@3m dB(uV/m)	Margin dB	RA dB(uV)	CF dB	AG dB	DCF dB	AF dB(1/m)
48.59	24.9	40.0	-15.1	30.9	0.8	32.1	10.5	14.8
89.01	27.3	43.5	-16.2	39.7	1.1	32.0	10.5	8.1
129.43	22.5	43.5	-21.0	31.6	1.3	32.0	10.5	11.1
181.97	27.6	43.5	-15.9	38.2	1.6	32.0	10.5	9.3
250.68	29.4	46.0	-16.6	37.0	1.9	32.0	10.5	12.0
308.88	27.1	46.0	-18.9	33.3	2.1	32.0	10.5	13.2
380.82	30.1	46.0	-15.9	34.4	2.3	32.0	10.5	15.0
974.13	34.0	54.0	-20.0	28.6	3.7	31.0	10.5	22.1

Test Mode: Rx mode
Temperature: 21 C Humidity : 45 %

Notes: Measurements made at 10 meters distance.

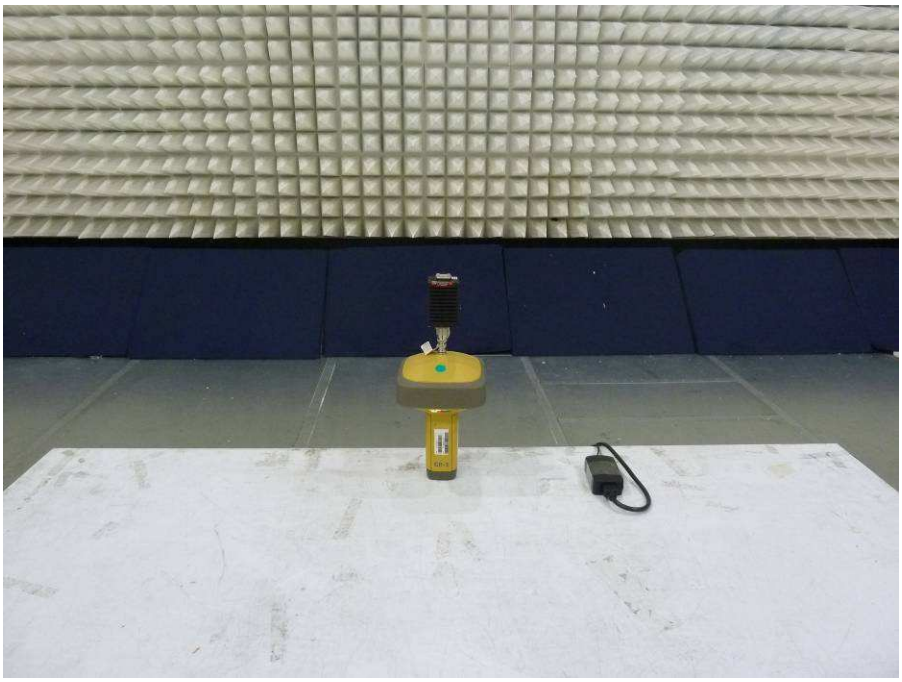


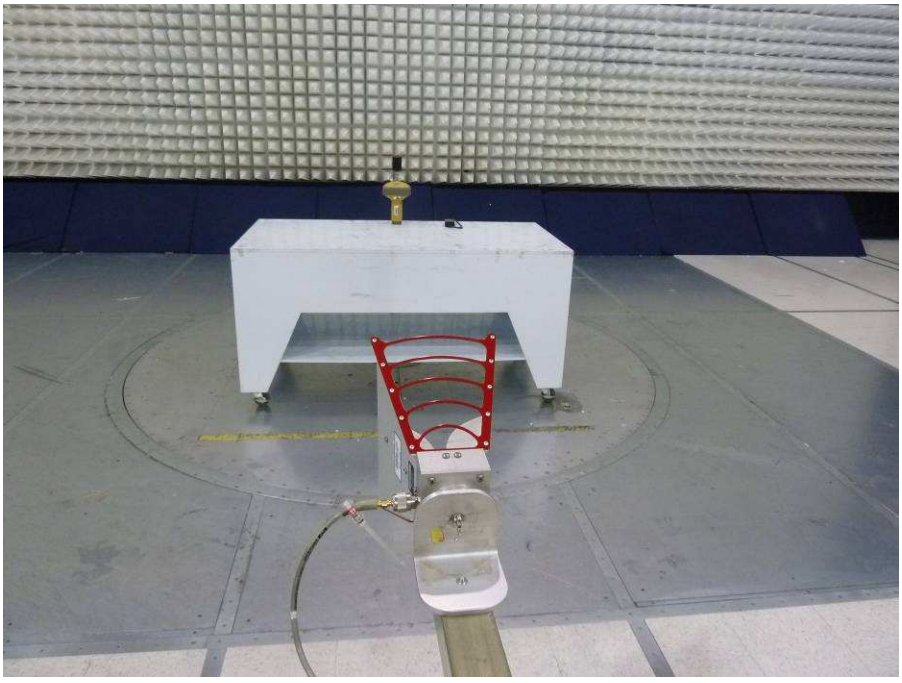


Note: Measurements made at 3 meters distance. Radiated emission measurements were performed up to 25GHz. No other emissions were detected above the noise floor which is at least 10 dB below the limit.

Result	Complies by 8.1 dB

Test Setup Photographs





4.9 Emissions from Digital Parts

4.9.1 Radiated Emissions
FCC 15.109

Requirement

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

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

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

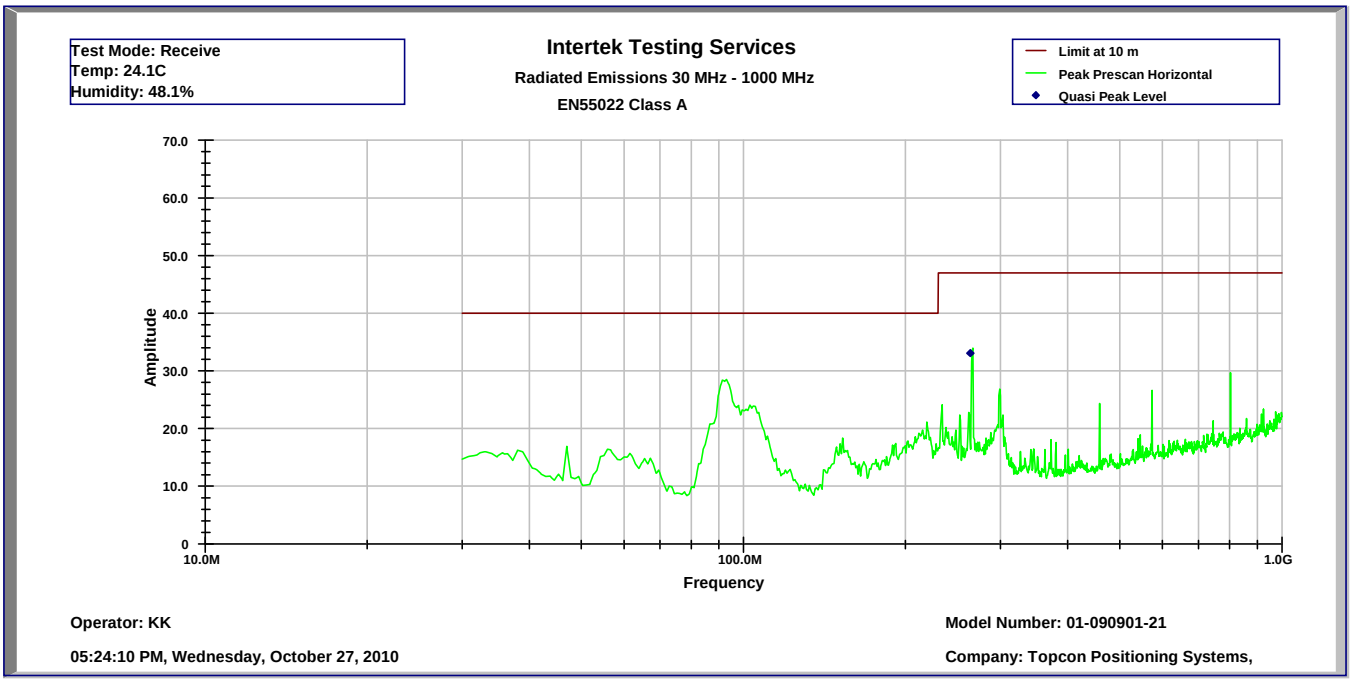
Assume a receiver reading of 52.5 dB(µV) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB and Distance Correction Factor (for measurements made at 10 meters distance) of 10.5 dB is subtracted, giving field strength of 22 dB(µV/m). This value 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 except the Distance Correction Factor in dB is not applied.

Test Results

FCC Part 15 Radiated Emissions



Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
EN 55022 Class A (QP-Horizontal)

Operator: KK
October 27, 2010

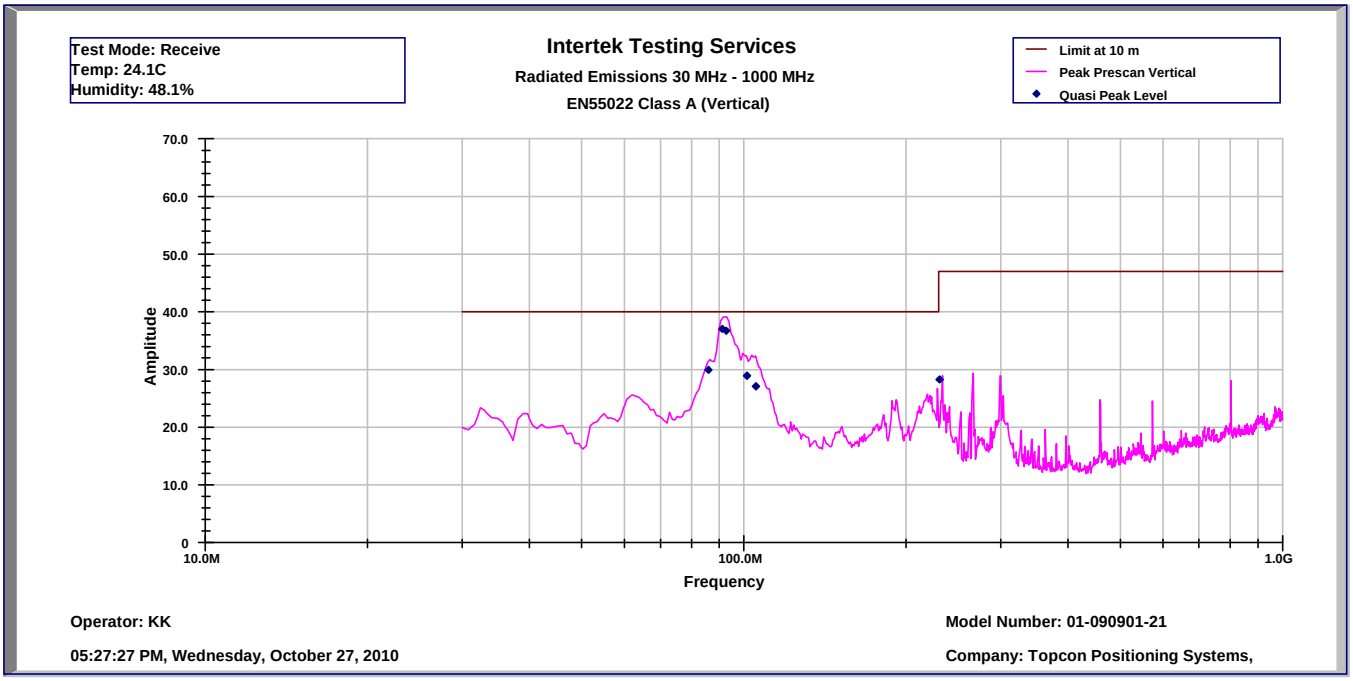
Model Number: 01-090901-21
Company: Topcon Positioning Systems, Inc

Frequency	Quasi Pk FS	Limit@10m	Margin	RA	AG	AF	CF
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB(1/m)	dB
264.0	33.1	47.0	-13.9	50.0	32.0	13.1	1.9

Test Mode: Receive Mode
Temp: 24.1C
Humidity : 48.1%

Notes: Measurements made at 10 meters distance.

FCC Part 15 Radiated Emissions



Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
EN 55022 Class A (QP-Vertical)

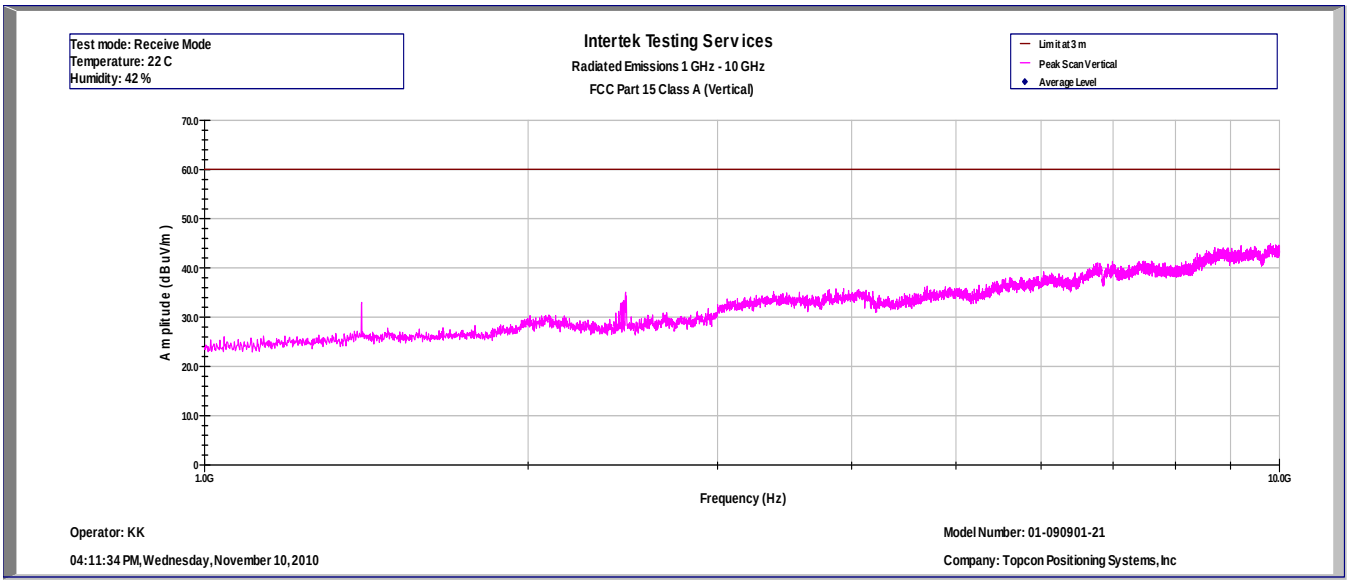
Operator: KK
October 27, 2010

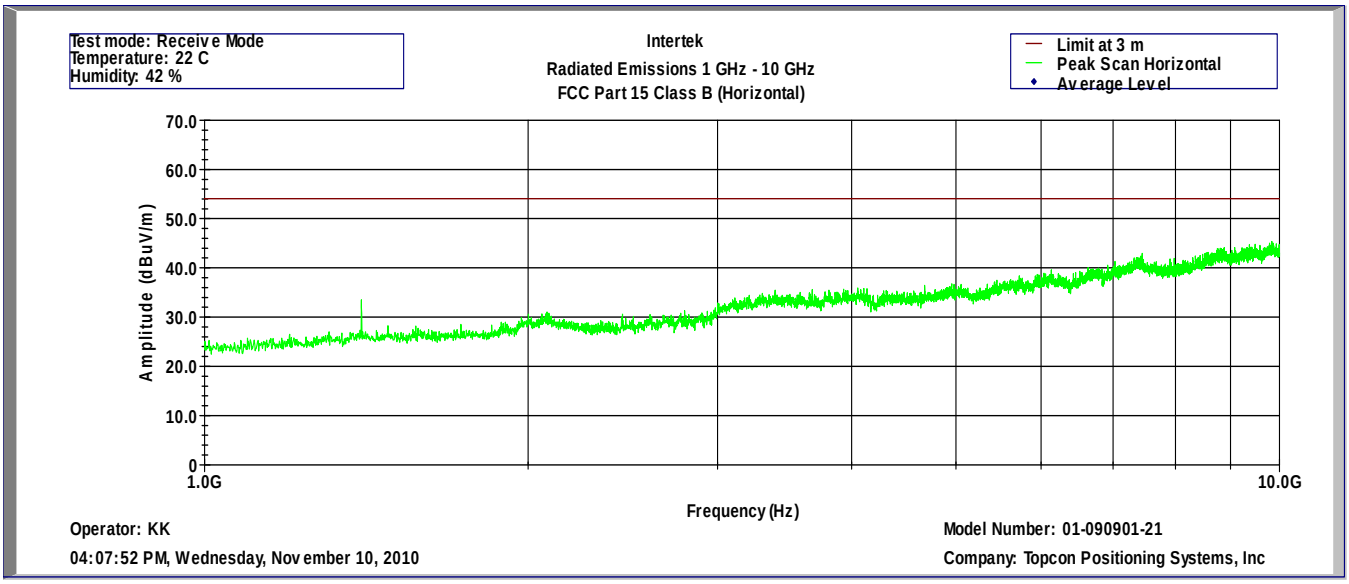
Model Number: 01-090901-21
Company: Topcon Positioning Systems, Inc

Frequency	Quasi Pk FS	Limit@10m	Margin	RA	AG	AF	CF
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB(1/m)	dB
86.0	29.9	40.0	-10.1	52.9	32.0	8.0	1.1
91.28	37.0	40.0	-3.0	59.5	32.0	8.5	1.1
92.80	36.7	40.0	-3.3	59.0	32.0	8.6	1.1
101.375	28.9	40.0	-11.1	49.3	32.0	10.4	1.2
105.30	27.1	40.0	-12.9	47.1	32.0	10.8	1.2
231.0	28.3	47.0	-18.7	46.9	32.0	11.6	1.8

Test Mode: Receive Mode
Temp: 24.1C
Humidity : 48.1%

Notes: Measurements made at 10 meters distance.

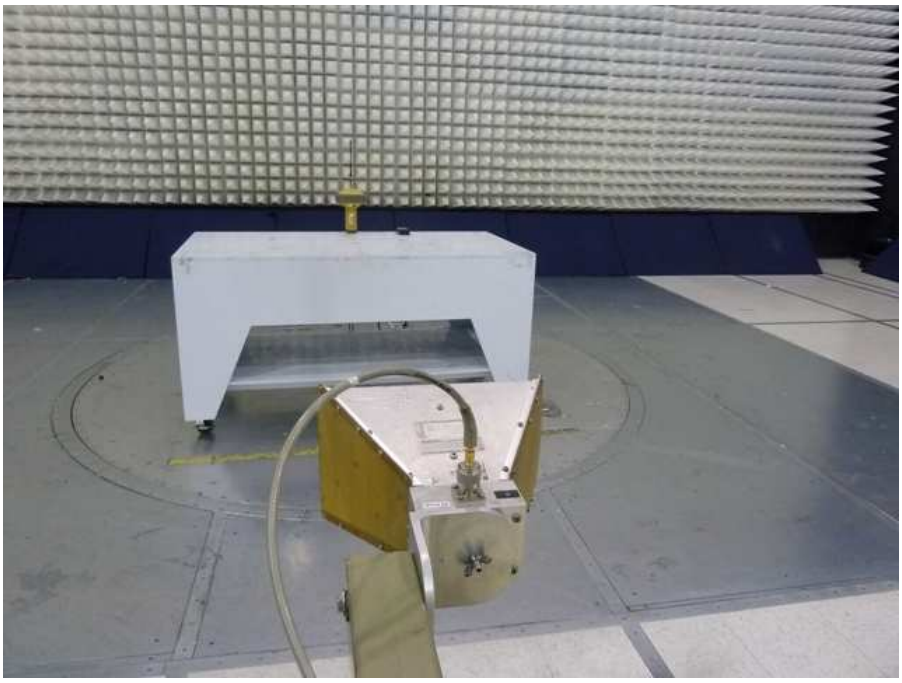




Note: Measurements made at 3 meters distance. Radiated emission measurements were performed up to 25GHz. No other emissions were detected above the noise floor which is at least 10 dB below the limit.

Result	Complies by 3.0dB

Test Setup Photographs



4.9.2 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.

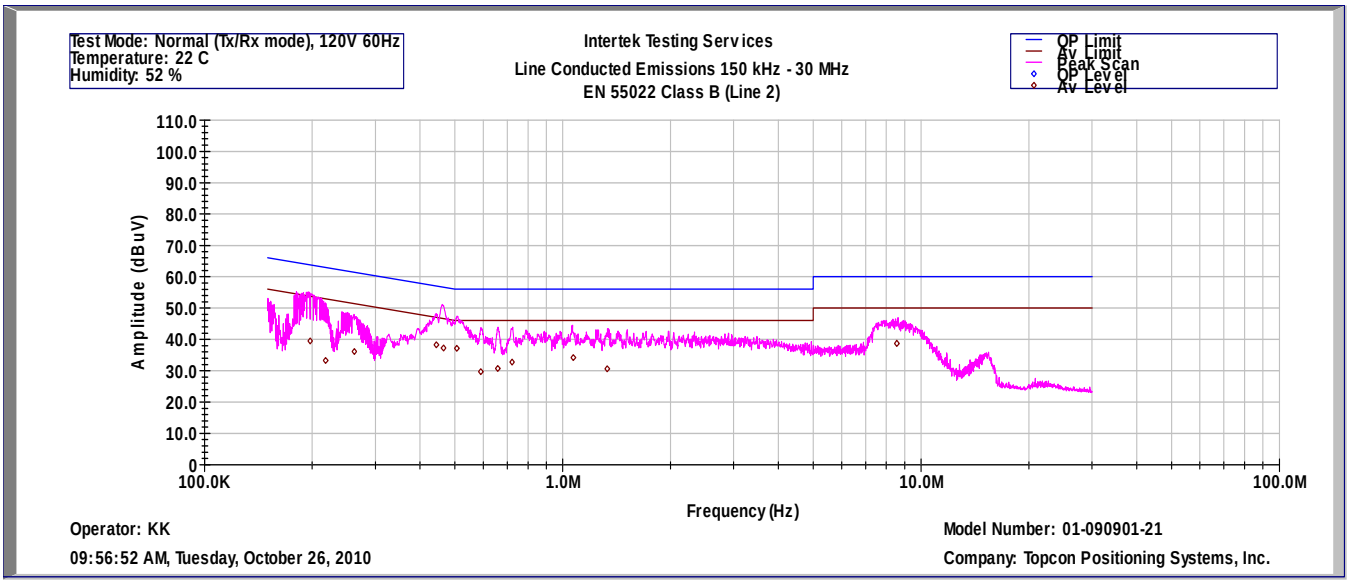
The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground 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

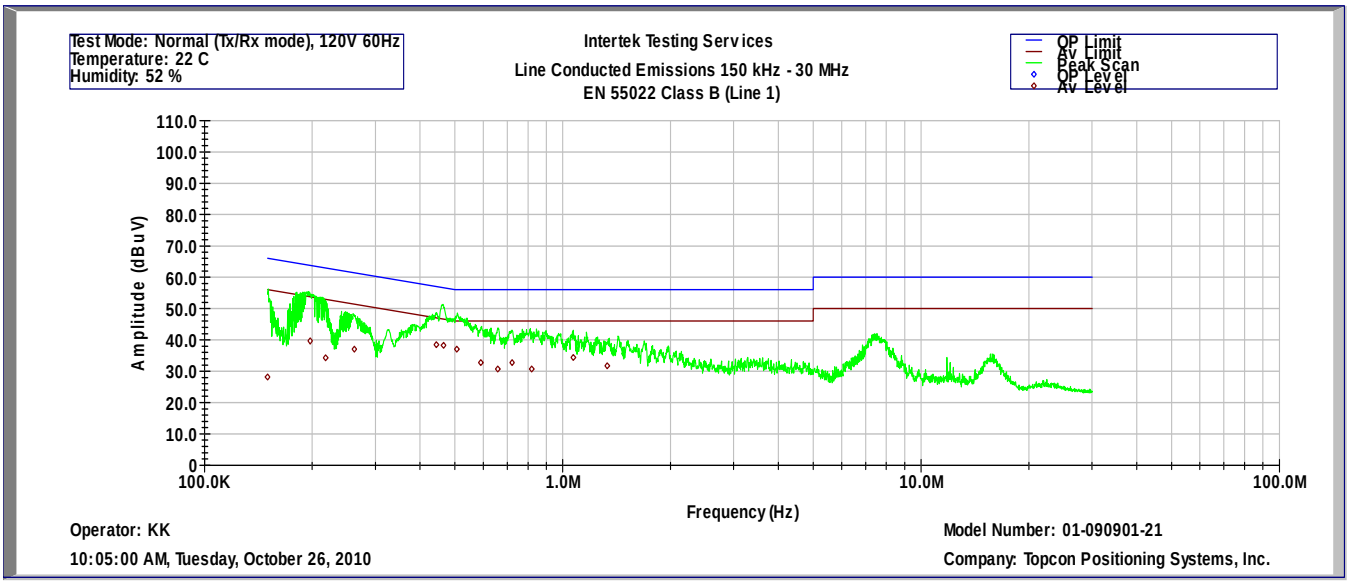
Conducted Disturbance at AC Mains



Intertek	
Line Conducted Emissions 150 kHz - 30 MHz	
EN 55022 Class B (Line 2)	
Operator: KK	Model Number: 01-090901-21
October 26, 2010	Company: Topcon Positioning Systems, Inc.

Frequency Hz	Pk Level (dBuV)	Av Level (dBuV)	Av Limit (dBuV)	QP Limit (dBuV)	Av Margin (dB)	QP Margin (dB)
197300	55.1	39.4	54.6	64.6	-15.2	-9.5
218000	53.2	33.2	54.1	64.1	-20.9	-10.9
262000	48.5	36.1	52.8	62.8	-16.7	-14.3
444000	48.0	38.3	47.6	57.6	-9.3	-9.6
465000	51.1	37.2	47.0	57.0	-9.8	-5.9
506000	47.3	37.1	46.0	56.0	-8.9	-8.7
591000	43.7	29.7	46.0	56.0	-16.3	-12.3
659000	43.8	30.7	46.0	56.0	-15.3	-12.2
722000	43.8	32.7	46.0	56.0	-13.3	-12.2
1070000	44.3	34.1	46.0	56.0	-11.9	-11.7
1330000	43.3	30.6	46.0	56.0	-15.4	-12.7
8556000	47.0	38.7	50.0	60.0	-11.3	-13.0

Test Mode: Normal (Tx/Rx mode), 120V 60Hz
Temperature: 22 C
Humidity: 52 %



Intertek	
Line Conducted Emissions 150 kHz - 30 MHz	
EN 55022 Class B (Line 1)	
Operator: KK	Model Number: 01-090901-21
October 26, 2010	Company: Topcon Positioning Systems, Inc.

Frequency Hz	Pk Level (dBuV)	Av Level (dBuV)	Av Limit (dBuV)	QP Limit (dBuV)	Av Margin (dB)	QP Margin (dB)
150100	55.2	28.1	56.0	66.0	-27.9	-10.8
197300	55.4	39.6	54.6	64.6	-15.0	-9.2
218000	53.5	34.2	54.1	64.1	-19.9	-10.6
262000	48.5	37.1	52.8	62.8	-15.7	-14.3
444000	48.5	38.5	47.6	57.6	-9.1	-9.1
465000	51.4	38.2	47.0	57.0	-8.8	-5.6
506000	48.5	37.0	46.0	56.0	-9.0	-7.5
591000	44.3	32.7	46.0	56.0	-13.3	-11.7
659000	43.7	30.7	46.0	56.0	-15.3	-12.3
722000	43.1	32.7	46.0	56.0	-13.3	-12.9
819000	43.4	30.6	46.0	56.0	-15.4	-12.6
1070000	43.1	34.4	46.0	56.0	-11.6	-12.9
1330000	40.4	31.7	46.0	56.0	-14.3	-15.6

Test Mode: Normal (Tx/Rx mode), 120V 60Hz
Temperature: 22 C
Humidity: 52 %

Results	**Complies** by 5.6 dB

Test Setup Photographs

5.0 RF Exposure Evaluation

FCC 2.1091

UHF Radio:

The EUT is a wireless device used in a mobile application and will be 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 Bluetooth radio.

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

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

According to FCC 1.1310, the MPE Limit at 410 MHz is 2.73 W/m^2, therefore $D \geq 0.24$ m.

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

Bluetooth Radio:

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

The maximum conducted power is 0.0dBm (1mW); the antenna 4dBi gain; therefore, to comply with the requirements for RF Exposure, the MPE is calculated.

The maximum Peak EIRP calculated is as 4.0dBm 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

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

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

It is considered that 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 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.

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	12/04/10
EMI Receiver	Hewlett Packard	8546A	3710A00373	12	12/04/10
Spectrum Analyzer	Rohde&Schwarz	FSP40	036612004	12	11/04/11
Spectrum Analyzer	Rohde&Schwarz	FSU	200482	12	03/18/11
BI-Log Antenna	ARA	LPB-2513/A	1154	12	06/29/11
Horn Antenna	EMCO	3115	00126795	12	10/28/11
Pre-Amplifier	Sonoma	310N	293620	12	11/02/11
Pre-Amplifier	Miteq	AMF-4D-001180-24-10P	799159	12	08/05/11
Power Meter	Hewlett Packard	EPM-442A	US37480416	12	06/03/11
Signal Generator	Hewlett Packard	SMR40	100445	12	08/27/11
LISN	FCC	FCC-LISN-50-50-M-H	2011	12	09/07/11

7.0 Document History

Revision/ Job Number	Writer Initials	Date	Change
1.0 / G100246399	KK	September 12, 2012	Original document