TEST REPORT

Report Number: 100246399MPK-002
Project Number: 100246399
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 90
RSS-119 Issue 11
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-002

Equipment Under Test:	GR-5 GNSS Receiver
Trade Name:	Topcon Positioning Systems, Inc.
Part No.:	01-090901-21
Serial No.:	718-PP001
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 90, RSS-119 Issue 11 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 and June 02, 2011

We attest to the accuracy of this report:

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

TABLE OF CONTENTS

1.0 Introduction

1.1 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. This test report covers only the UHF radio. A separate test report, report # 100246399MPK-009, covers the Bluetooth radio. In actual use both radios are used simultaneously; therefore, the investigation was performed on the UHF radio when EUT simultaneously transmitting with the Bluetooth radio.

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

The GR-5 GNSS Receiver provides real-time data transmission using spectrum efficient DQPSK, GMSK modulations.

The 01-090901-21 provides half-duplex communication with transmitter output power of 1 W (+30 dBm) in the frequency bands 410-470 MHz for USA; 410-430 MHz and 450-470MHz for Canada with channel spacing of 25 / 12.5 kHz.

For more information about the radios, refer to the attached product description.

Specification of the radio module	
Name of the EUT	GR-5 GNSS Receiver
Rated RF Output Power	1 W
Frequency Ranges, MHz	USA 410-470 Canada 410-430 MHz and 450-470MHz
Type of Modulation	USA 410-470MHz, 12.5kHz: DQPSK, GMSK 410-420MHz, 25kHz: DQPSK, GMSK Canada 410-430 MHz and 450-470MHz, 12.5kHz: DQPSK, GMSK 410-430 MHz and 450-470MHz, 25kHz: DQPSK, GMSK
Channel Bandwidth and Maximum Data Rate	25 kHz at 38.4 kbps 12.5 kHz at 19.2 kbps
Antenna Type & Gain	½ wave flexible cable antenna, 2.5dBi
Detachable Antenna	Yes
External Input	Data
Operating Temperature	From -30^0C to $+60^0$C

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:	June 02, 2011

1.2 Summary of Test Results

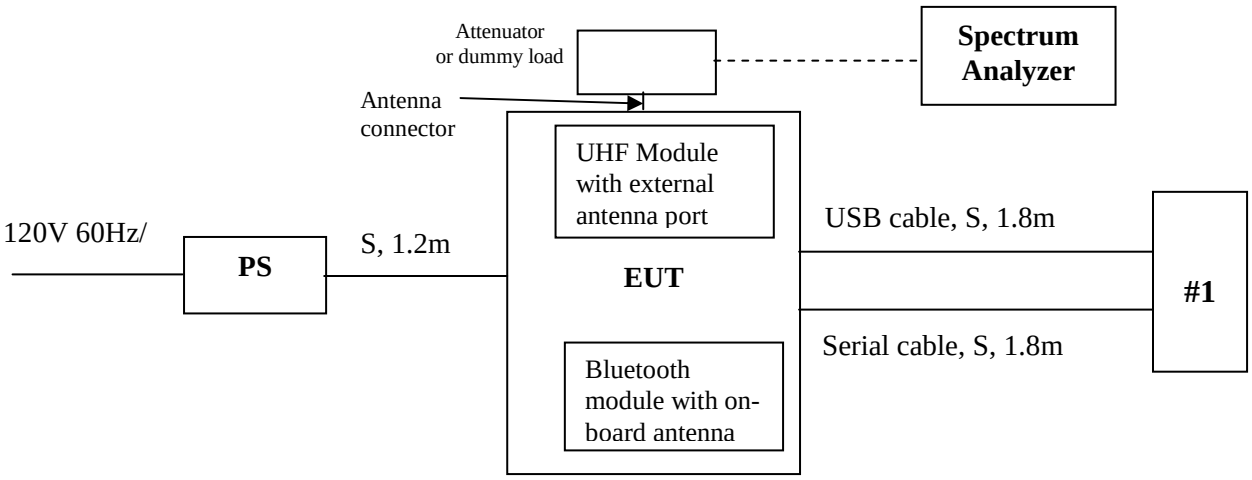
FCC Rule	RSS-119 Rule	Description of Test	Result
2.1046	4.1	RF Power Output	Complies
90.205(h)	-	ERP	Complies
2.1047	-	Modulation Characteristics	Not Applicable
2.1049, 90.209	RSS-GEN	Occupied Bandwidth	Complies
90.210	5.8	Emission Masks	Complies
2.1051, 90.210	5.8	Out of Band Emissions at Antenna Terminals	Complies
2.1053, 90.210	5.8	Spurious Radiation	Complies
2.1055, 90.213	5.3	Frequency Stability vs. Temperature and Voltage	Complies
90.214	5.9	Transient Frequency Behavior	Complies
2.1091	RSS-102	RF Exposure Evaluation	Complies
15.109, 15.111	RSS-GEN	Emissions from the Receiver	Complies
15.109	ICES-003	Radiated Emission from Digital Parts and Receiver	Complies
15.207	RSS-GEN	AC Conducted Emission	Complies

1.3 Test Configuration

1.3.1 Support Equipment

Item #	Description	Model No.	S/N
1	Compaq Laptop	Armada 7400	7933CY570119

1.3.2 Block Diagram of Test Setup



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

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

1.4 Related Submittal(s) Grants

None

2.0 RF Power Output
FCC 2.1046

2.1 Test Procedure

The EUT RF output was connected as shown on the diagram in section 1.3.2. The EUT was setup to transmit continuously the maximum power.

The spectrum analyzer was setup to measure the Average power. The attenuation and cable loss were added to the spectrum analyzer reading by using the OFFSET function.

Measurements were performed at three frequencies (low, middle, and high channels).

2.2 Test Equipment

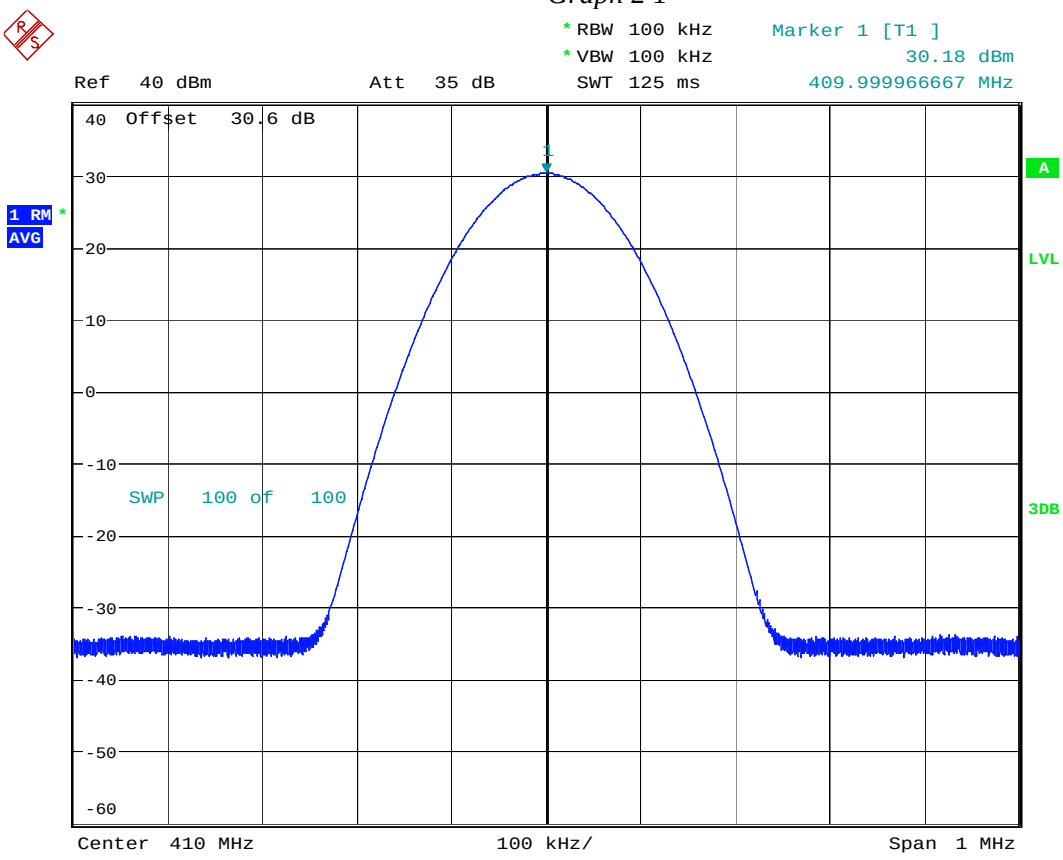
Rohde & Schwarz FSP40 Spectrum Analyzer

2.3 Test Results

Frequency (MHz)	Measured Output Power (dBm)	Measured Output Power (Watt)	Graph
410.0	30.2	1.047	2.1
430.0	30.4	1.096	2.2
450.0	30.0	1.000	2.3
470.0	30.2	1.047	2.4

For more details refer to the attached Graphs.

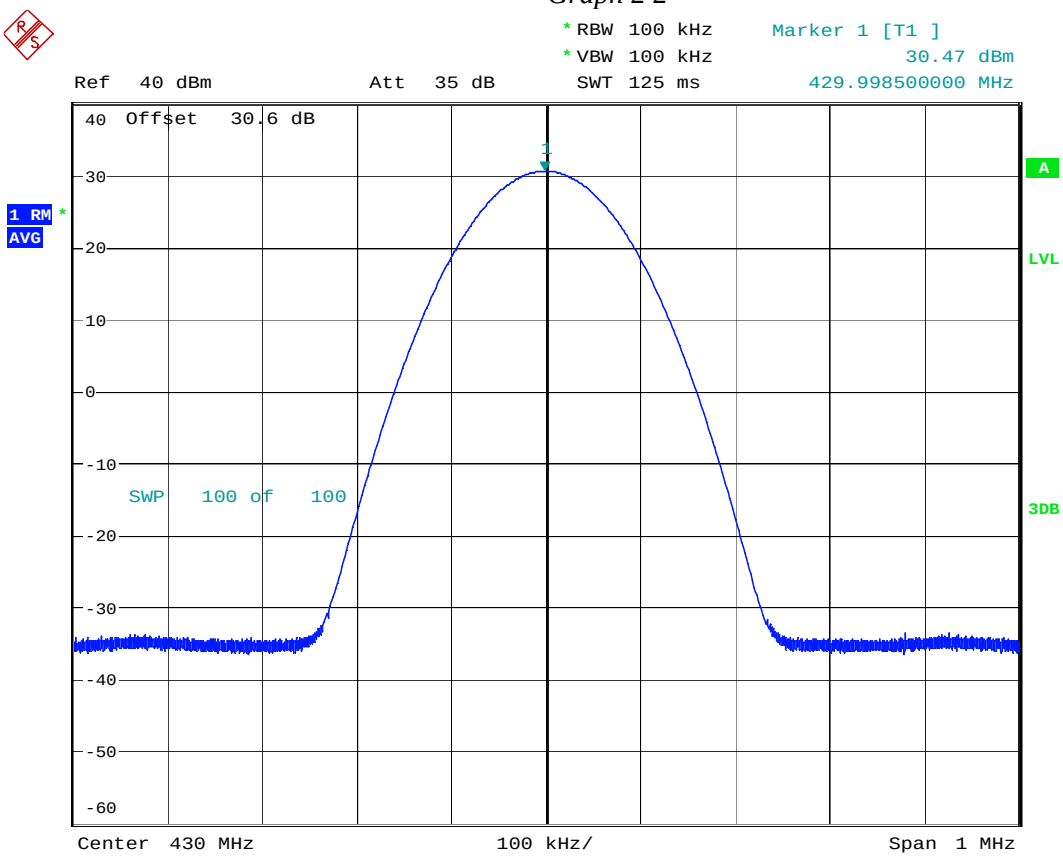
Graph 2 1



Power Output

Date: 22.NOV.2010 10:00:03

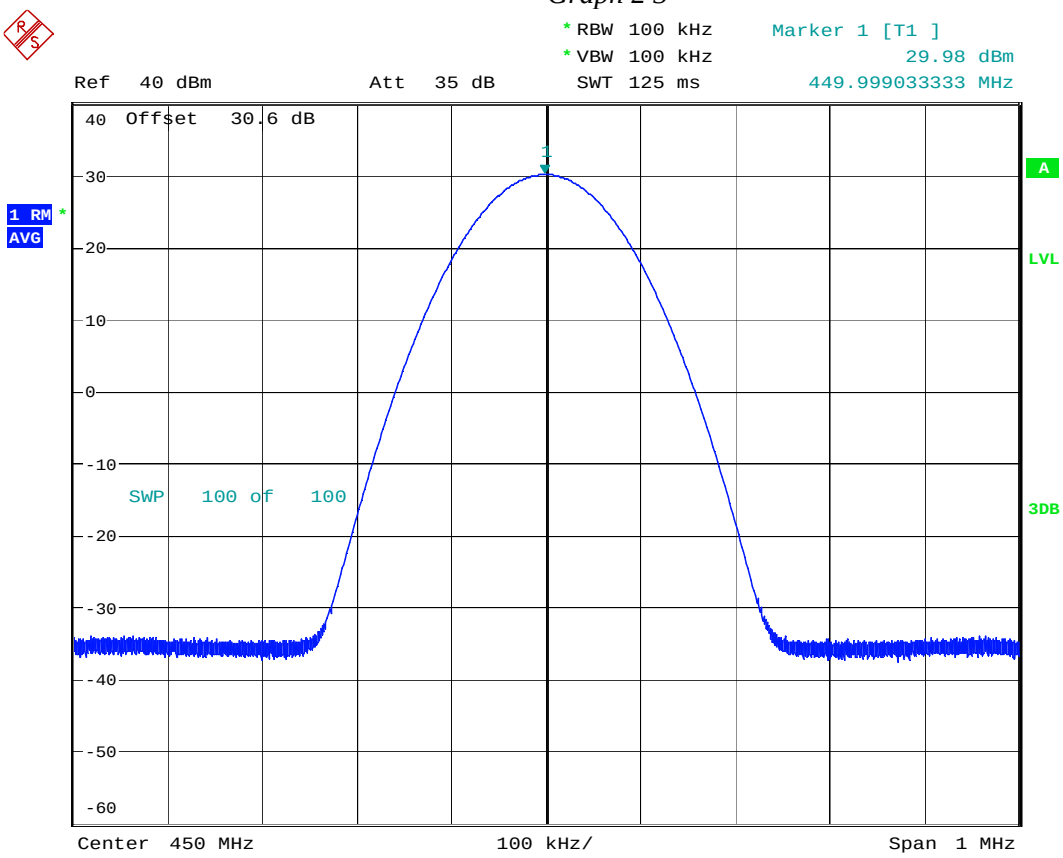
Graph 2 2



Power Output

Date: 22.NOV.2010 09:58:46

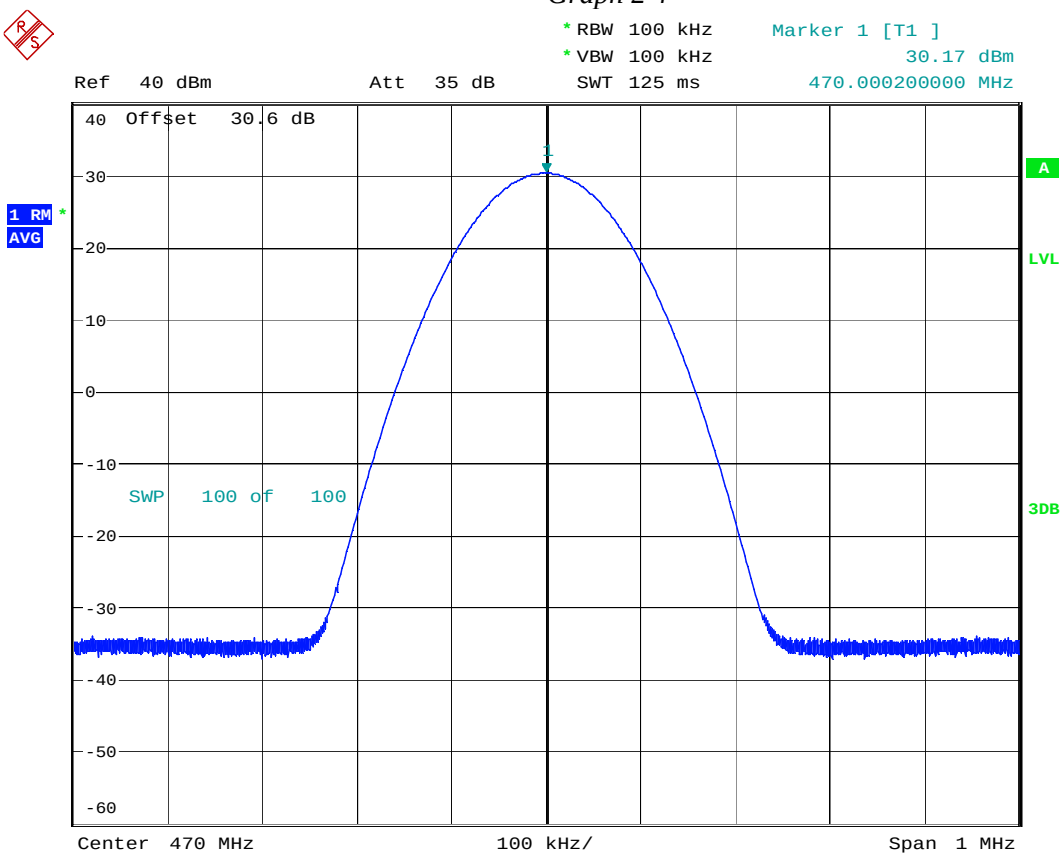
Graph 2 3



Power Output

Date: 22.NOV.2010 10:14:29

Graph 2 4



Power Output

Date: 22.NOV.2010 10:17:29

3.0 Radiated Power

3.1 Requirement

FCC 90.205(h)

The maximum Effective Radiated Power (ERP) is 500 Watts.

3.2 Test Procedure

The ERP was calculated by adding the antenna gain to the output power in dBm.

$ERP = P_{max} + G_{dBd}$

3.3 Test Equipment

None

3.4 Test Results

According to the Installation Guide, a typical 2.5 dBi (0.4 dBd) gain antenna is used with the EUT. Therefore, the calculated peak radiated power is:

ERP = 30.4 + 0.4 = 30.8 dBm (or 1.202 W);
EIRP= 30.4 + 2.5 = 32.9 dBm (or 1.950 W).

Result	**Complies**

4.0 Occupied Bandwidth

FCC 2.1049, 90.209(b)(5)

4.1 Test Procedure

The EUT RF output was connected as shown on the diagram in section 1.3.2. The EUT was setup to transmit the maximum power.

The spectrum analyzer was setup to measure the Occupied Bandwidth (defined as the 99% Power Bandwidth). The Occupied Bandwidth was measured at 450 MHz for all types of modulation and authorized bandwidths.

4.2 Test Equipment

Rohde & Schwarz FSP40 Spectrum Analyzer

4.3 Test Results

The test results are summarized in the following tables and presented on the Graphs 4.1 – 4.4.

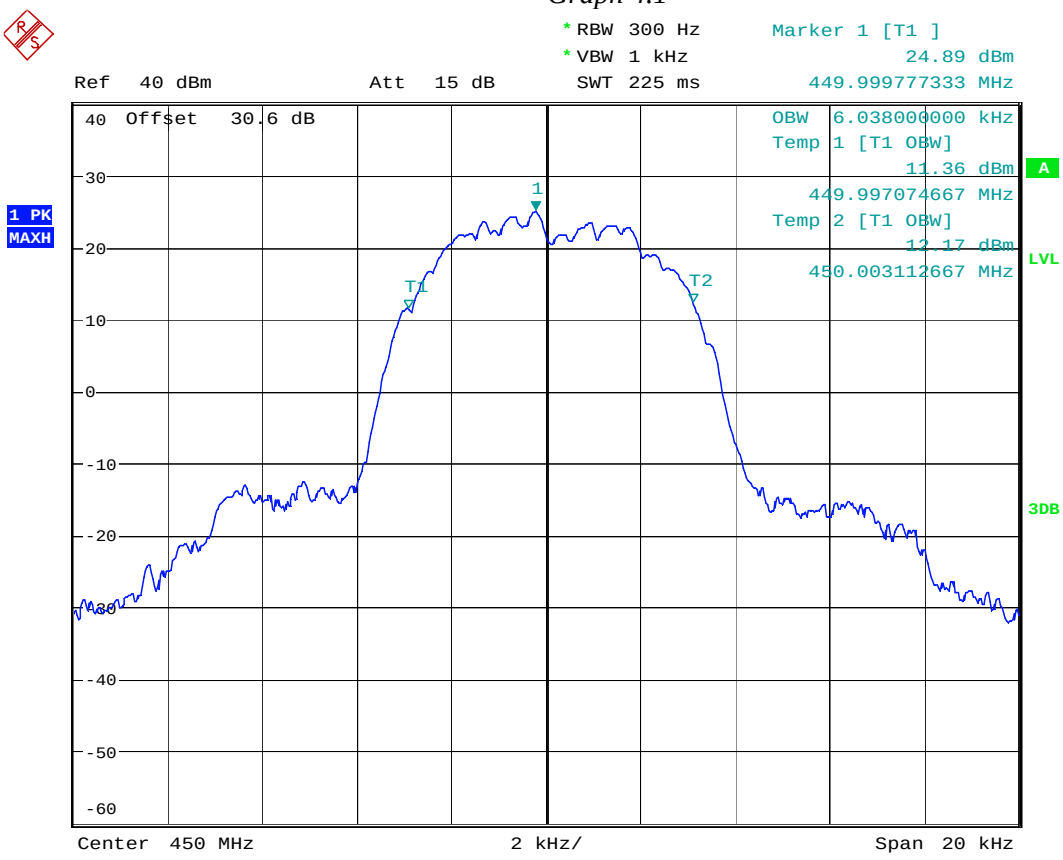
The following Emission Designators are described the emission type:

6K04G1D
6K03F1D
12K00G1D
12K01F1D

Frequency (MHz)	Modulation	Channel Bandwidth (kHz)	Authorized Bandwidth (kHz)	Measured Occupied Bandwidth (kHz)	Graph
450	DQPSK	12.5	11.25	6.04	4.1
	GMSK			6.03	4.2
450	DQPSK	25.0	20.0	12.0	4.3
	GMSK			12.01	4.4

For more details refer to the attached Graphs.

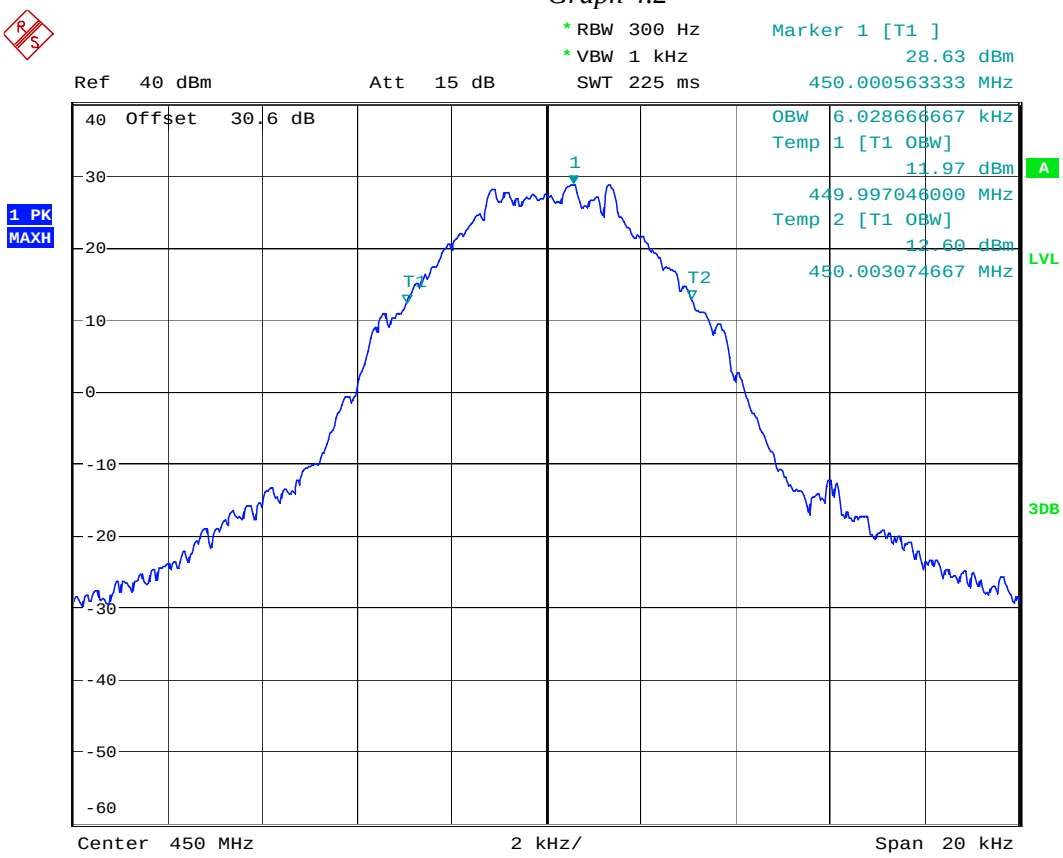
Graph 4.1



Occupied bandwidth, 11.25kHz authorized bandwidth, DQPSK

Date: 5.NOV.2010 09:58:02

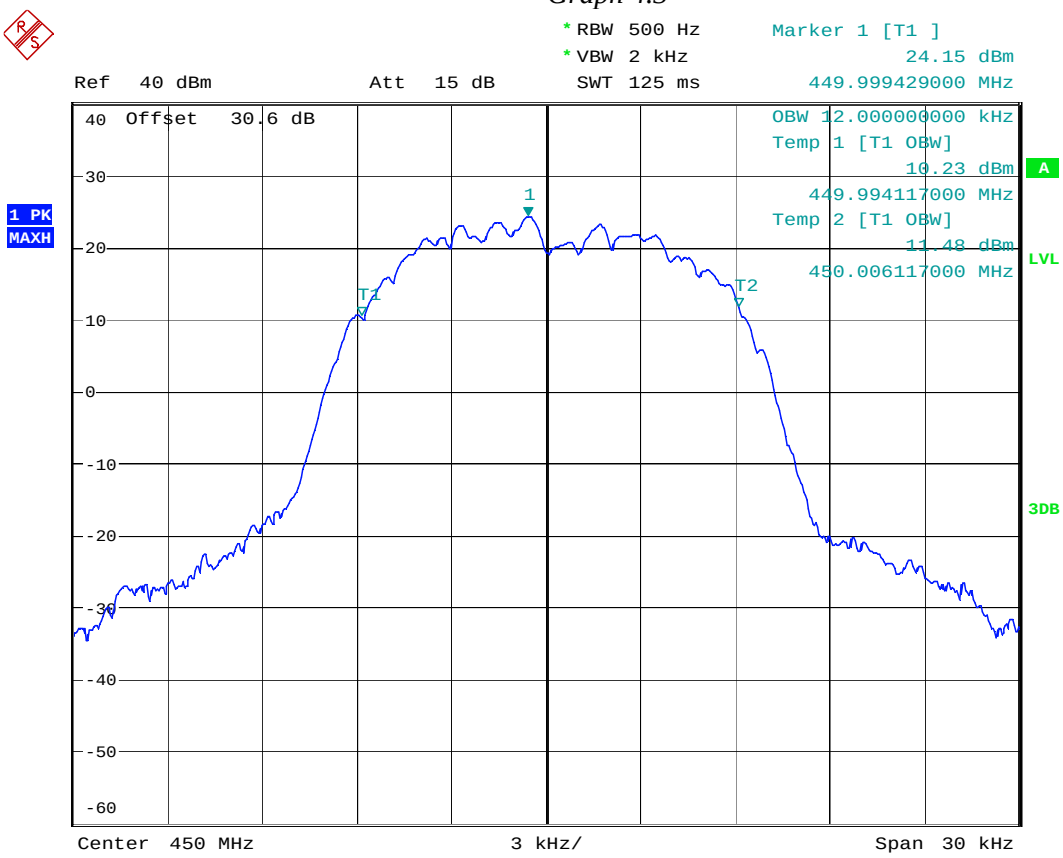
Graph 4.2



Occupied bandwidth, 11.25kHz authorized bandwidth, GMSK

Date: 5.NOV.2010 10:04:47

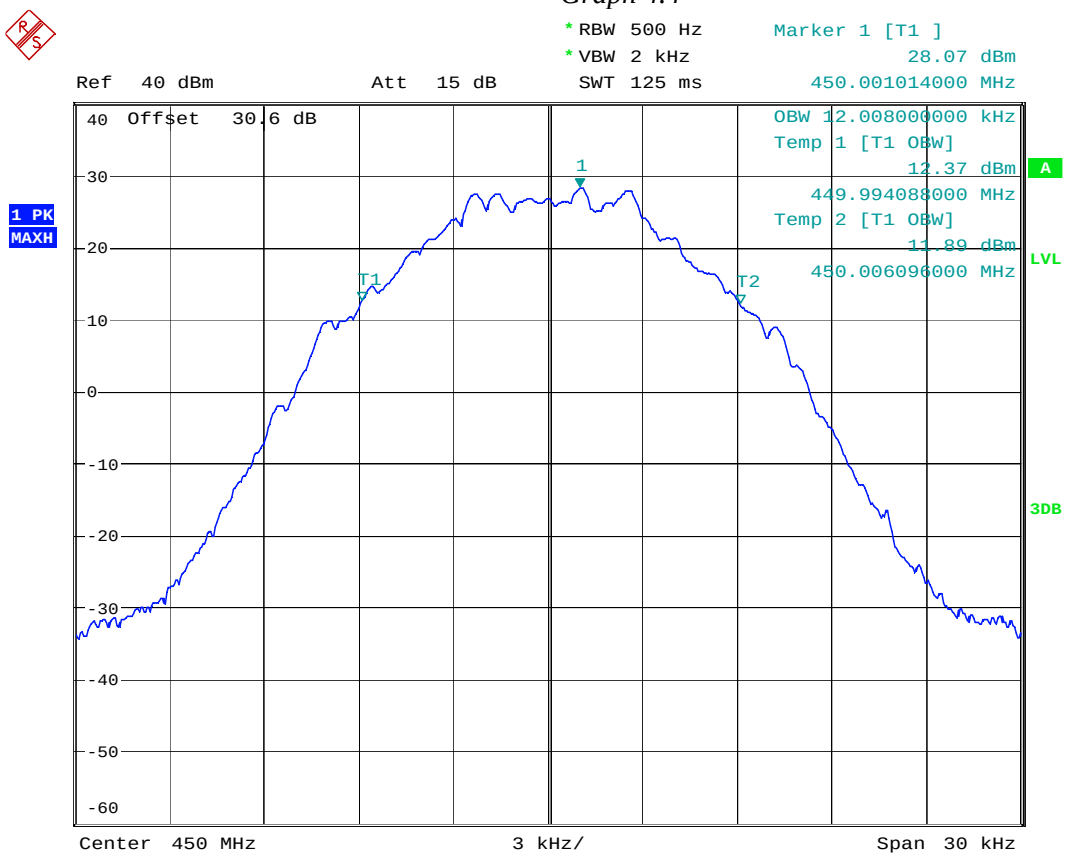
Graph 4.3



Occupied bandwidth, 20kHz authorized bandwidth, DQPSK

Date: 5.NOV.2010 10:09:15

Graph 4.4



Occupied bandwidth, 20kHz authorized bandwidth, GMSK

Date: 5.NOV.2010 10:16:14

4

5.0 Emission Mask

FCC 90.210

5.1 Requirement

Equipment designed to operate with a 25 kHz channel bandwidth must meet the requirements of Emission Mask C (for equipment without audio low pass filter).

Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D.

5.2 Test Procedure

The EUT RF output was connected as shown on the diagram in section 1.3.2. The EUT was setup to transmit the maximum power.

The spectrum analyzer was setup to measure the Emission at frequencies ± 100 kHz from the fundamental frequency – for Mask C, ± 31.25 kHz – for Mask D, ± 22.5 kHz – for Mask E. The peak detector is used for these measurements.

The Emission Mask was measured at 410 MHz and 450 MHz for all types of modulation.

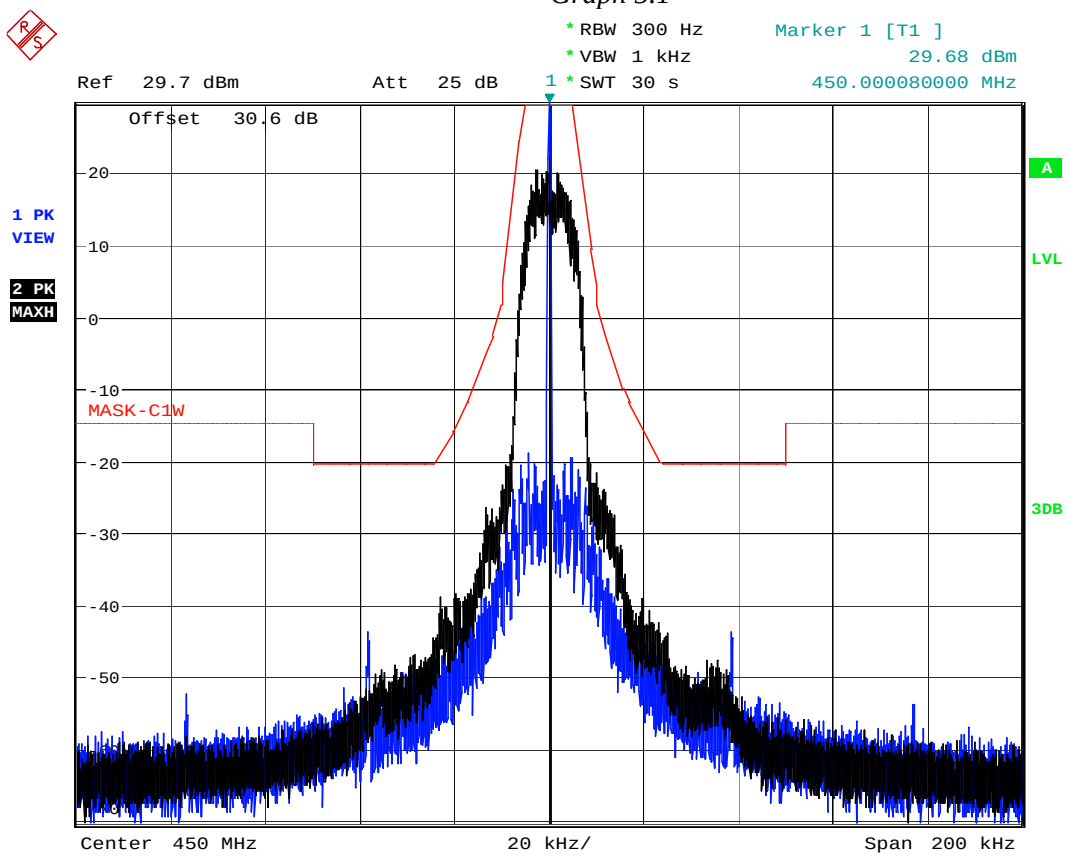
5.3 Test Equipment

Rohde & Schwarz FSP40 Spectrum Analyzer

5.4 Test Results

Complies with Emission Mask Requirements. For more details refer to the attached Graphs: 5.1 – 5.8.

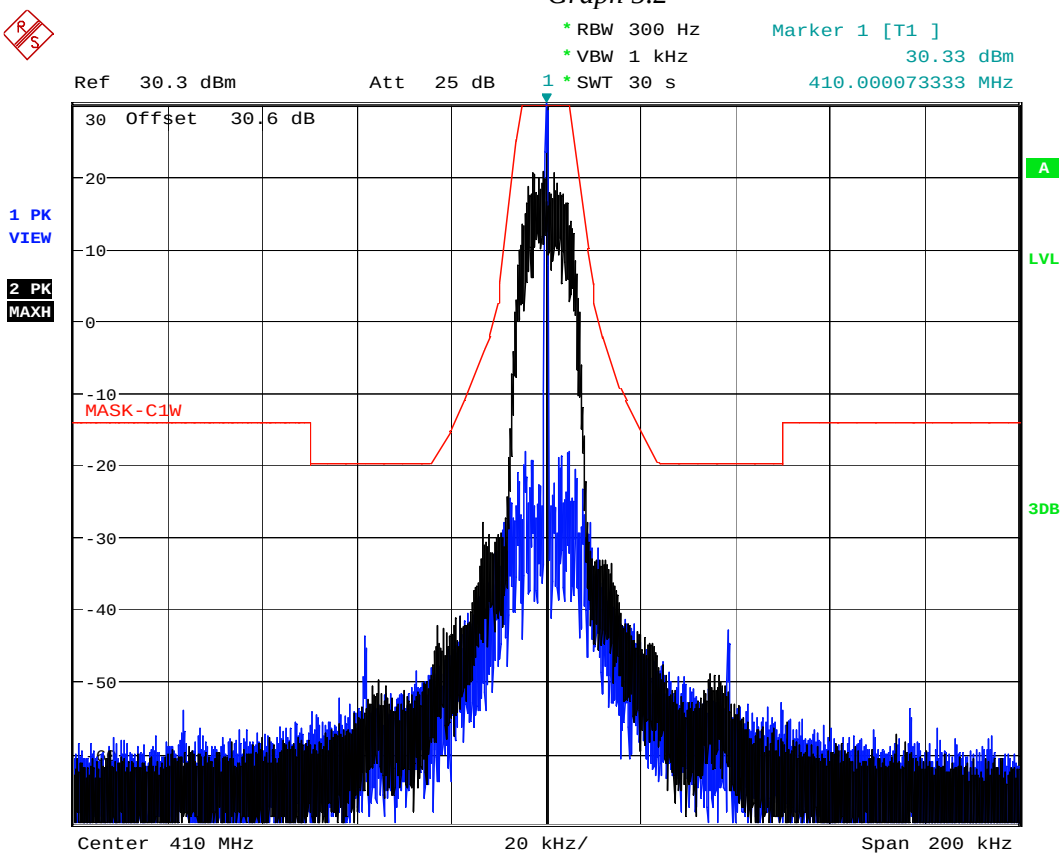
Graph 5.1



Emission Mask, 25kHz ch. spacing, DQPSK

Date: 11.NOV.2010 18:10:23

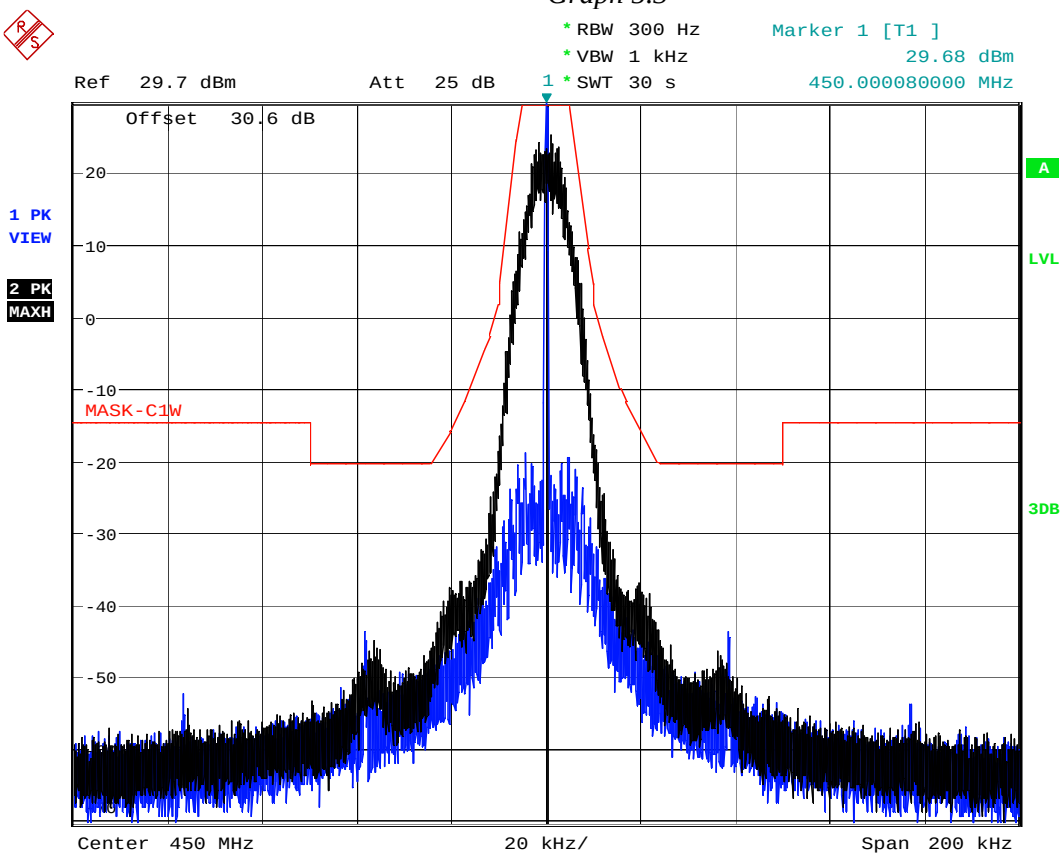
Graph 5.2



Emission Mask, 25kHz ch. spacing, DQPSK

Date: 12.NOV.2010 12:07:27

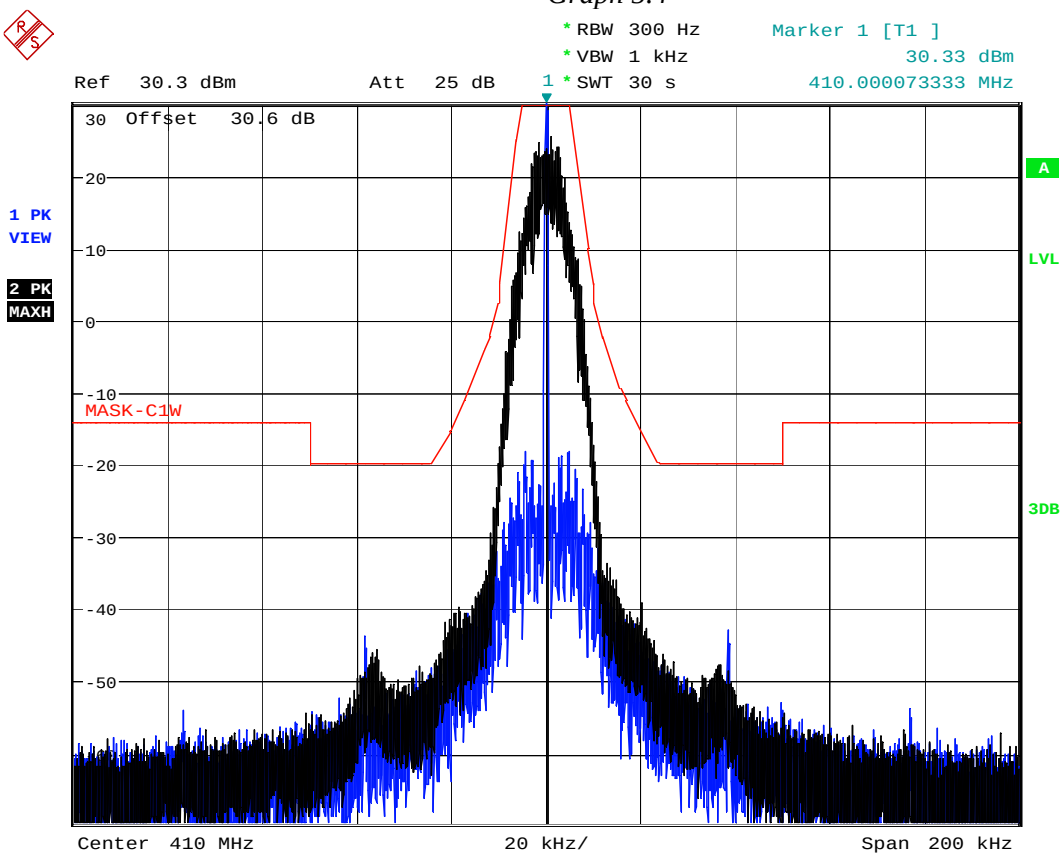
Graph 5.3



Emission Mask, 25kHz ch. spacing, GMSK

Date: 11.NOV.2010 18:15:14

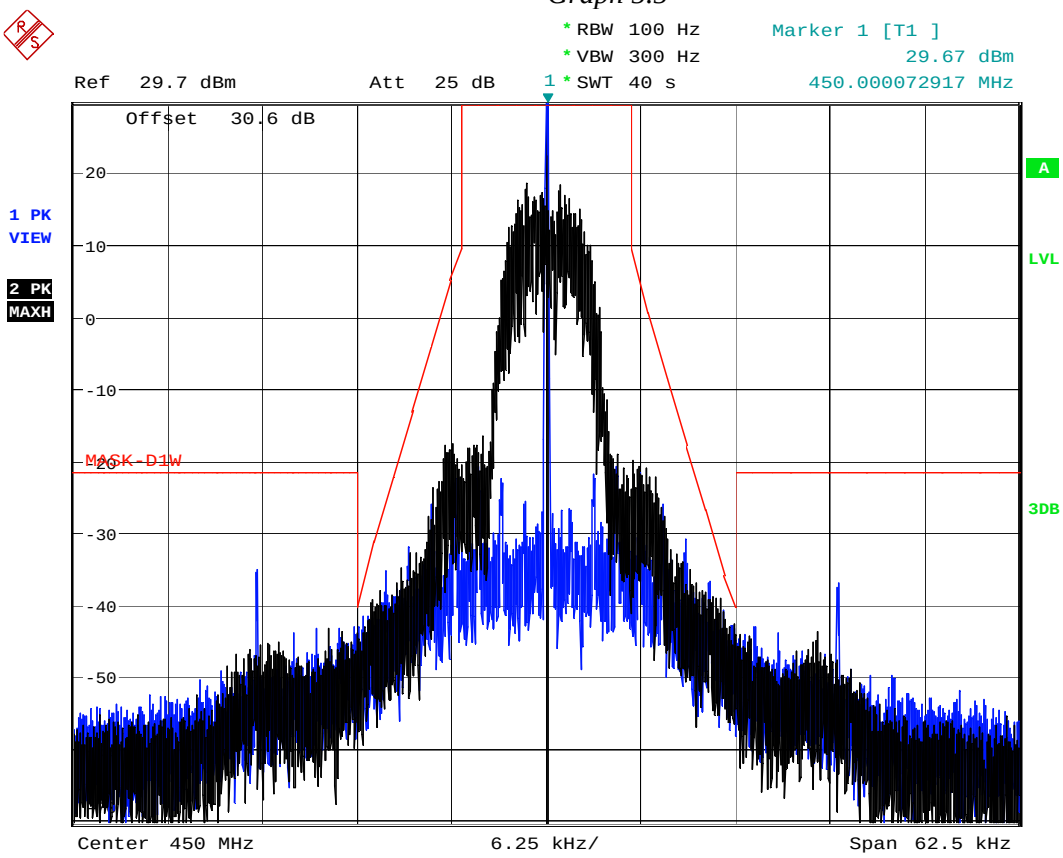
Graph 5.4



Emission Mask, 25kHz ch. spacing, GMSK

Date: 12.NOV.2010 12:09:21

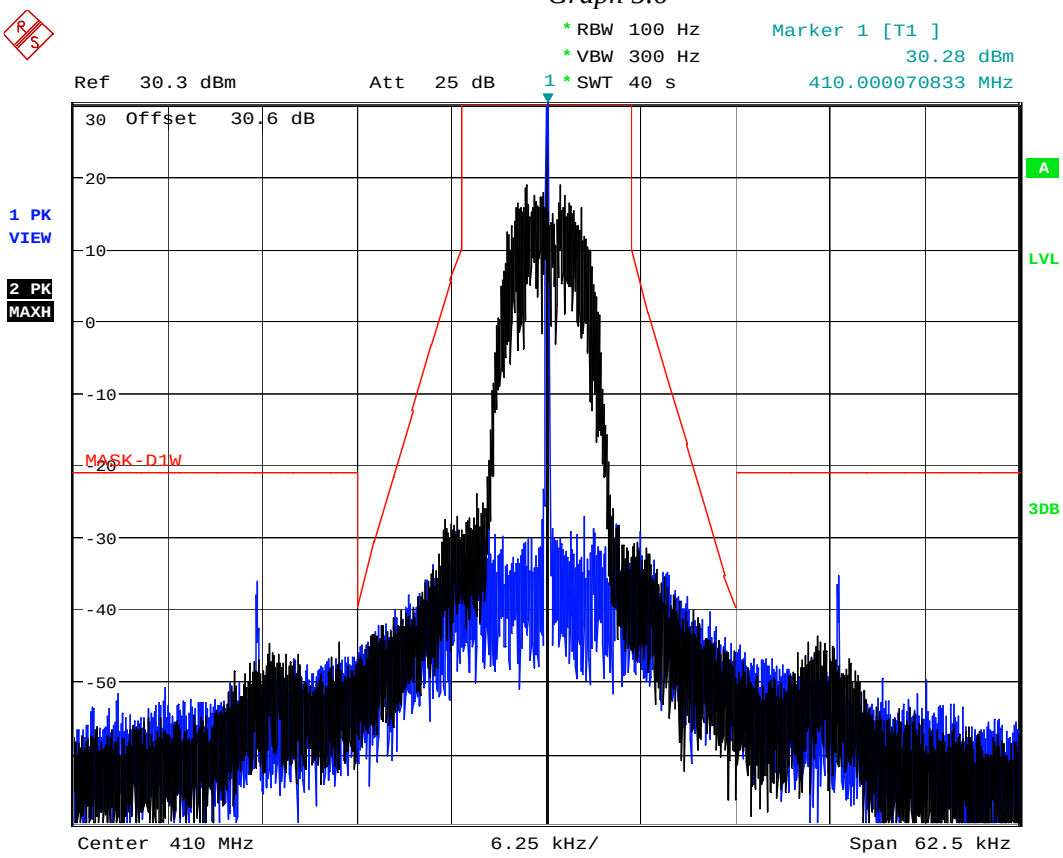
Graph 5.5



Emission Mask, 12.5kHz ch. spacing, DQPSK

Date: 11.NOV.2010 18:36:40

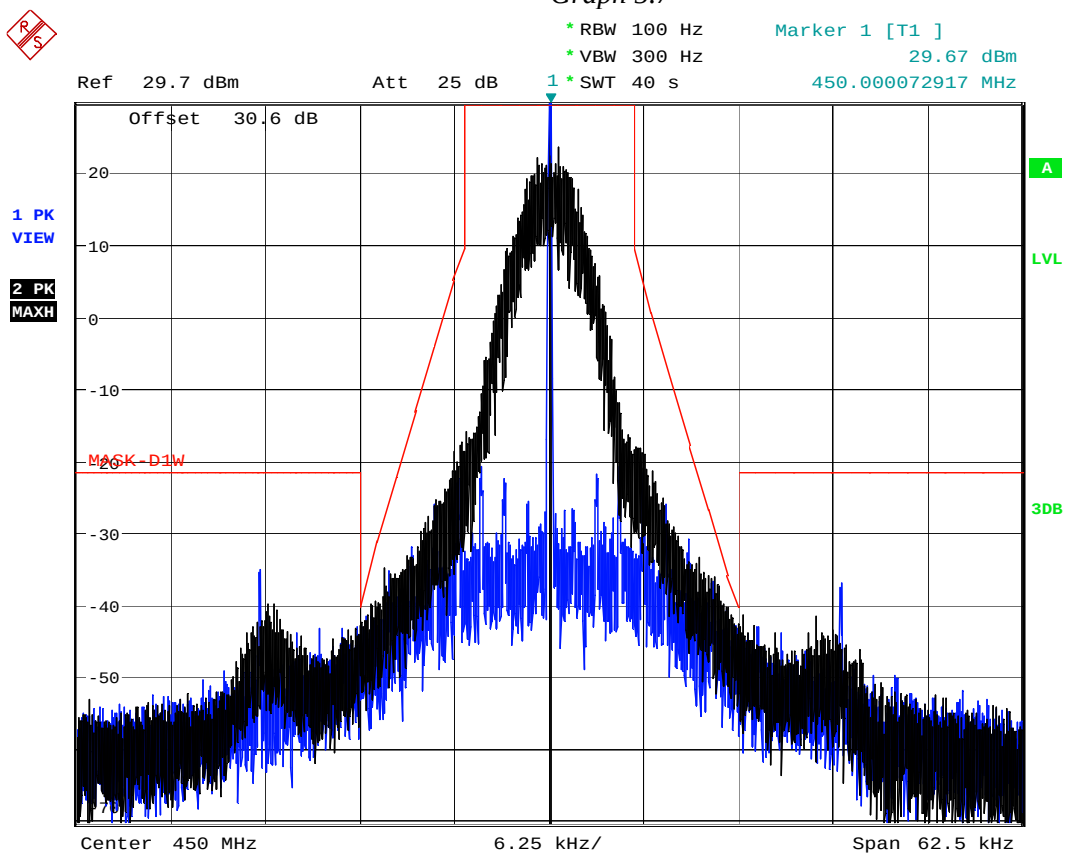
Graph 5.6



Emission Mask, 12.5kHz ch. spacing, DQPSK

Date: 12.NOV.2010 12:17:52

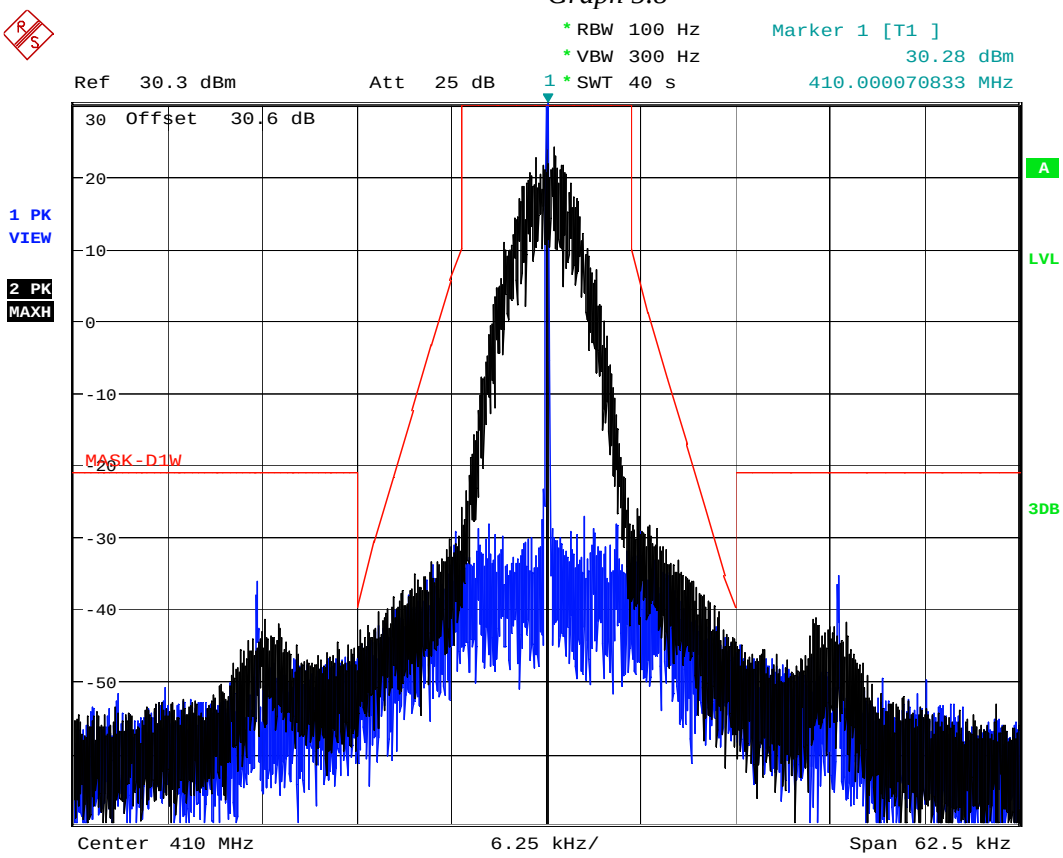
Graph 5.7



Emission Mask, 12.5kHz ch. spacing, GMSK

Date: 11.NOV.2010 18:31:17

Graph 5.8



Emission Mask, 12.5kHz ch. spacing, GMSK

Date: 12.NOV.2010 12:20:08

6.0 Spurious Emissions at Antenna Terminals

FCC 2.1051, 90.210

6.1 Requirement

Emission Mask C

The power of any emissions must be attenuated below the unmodulated carrier output power (P) on any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: at least (43 + 10 log P) dB.

Note: That corresponds to the level of -13 dBm for any out-of-band and spurious emissions.

Emission Mask D

The power of any emissions must be attenuated below the unmodulated carrier output power (P) on any frequency removed from the center of the authorized bandwidth by more than 12.5 kHz:
at least (50 + 10 log P) dB or 70 dB, whichever is lesser attenuation.

Note: Attenuation of (50 + 10 log P) dB corresponds to the level of -20 dBm for any out-of-band and spurious emissions.

6.2 Test Procedure

The EUT RF output was connected as shown on the diagram in section 1.3.2. The EUT was setup to transmit the maximum power.

For measurements at frequencies below 1 GHz, the spectrum analyzer resolution bandwidth was set to 10 kHz. For measurements at frequencies above 1 GHz, the spectrum analyzer resolution bandwidth was set to 1 MHz. Average detector is used for these measurements.

Sufficient scans were taken to show the spurious emissions up to 10th harmonic.

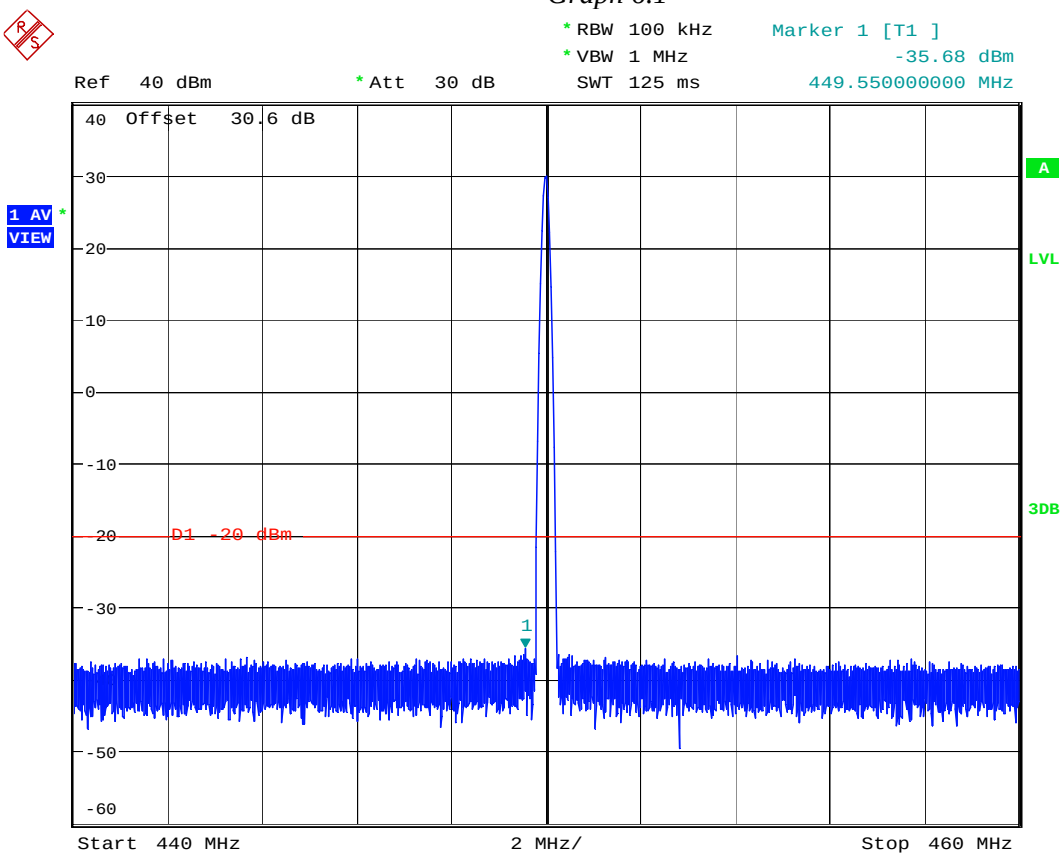
6.3 Test Equipment

Rohde & Schwarz FSP40 Spectrum Analyzer

6.4 Test Results

Complies	Refer to the following Graphs

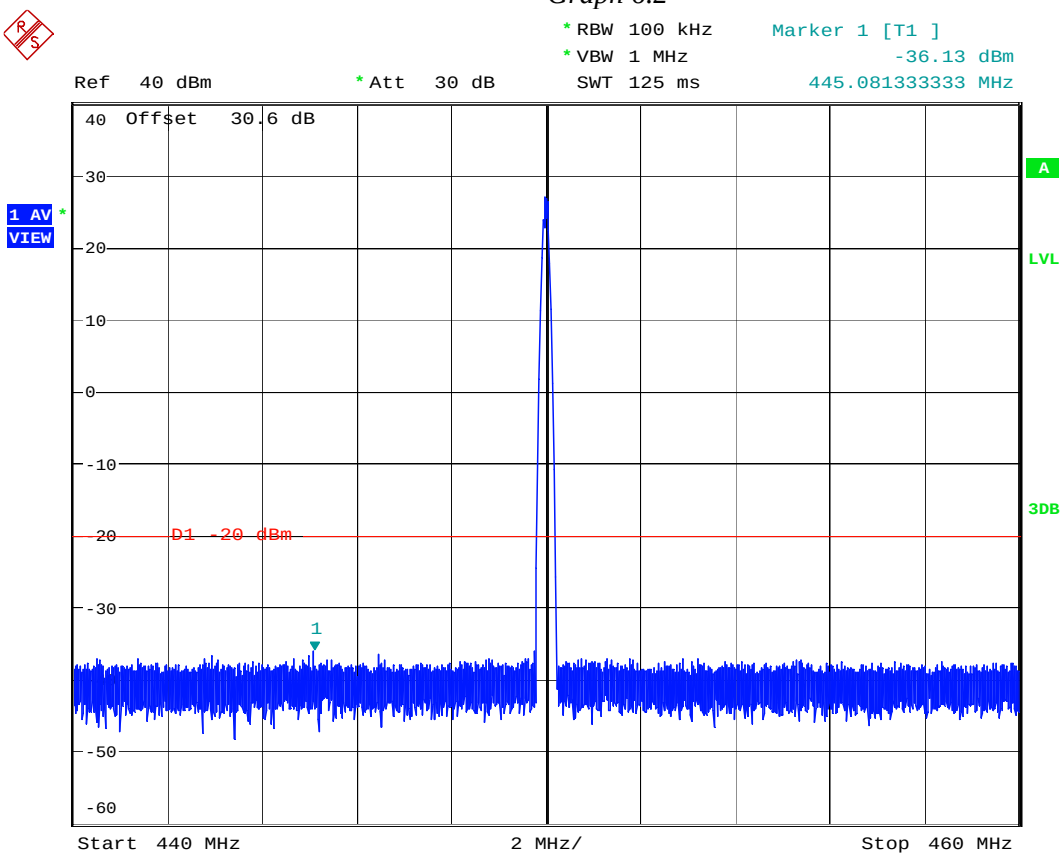
Graph 6.1



Conducted Spurious, 450MHz, Unmodulated

Date: 22.NOV.2010 10:36:40

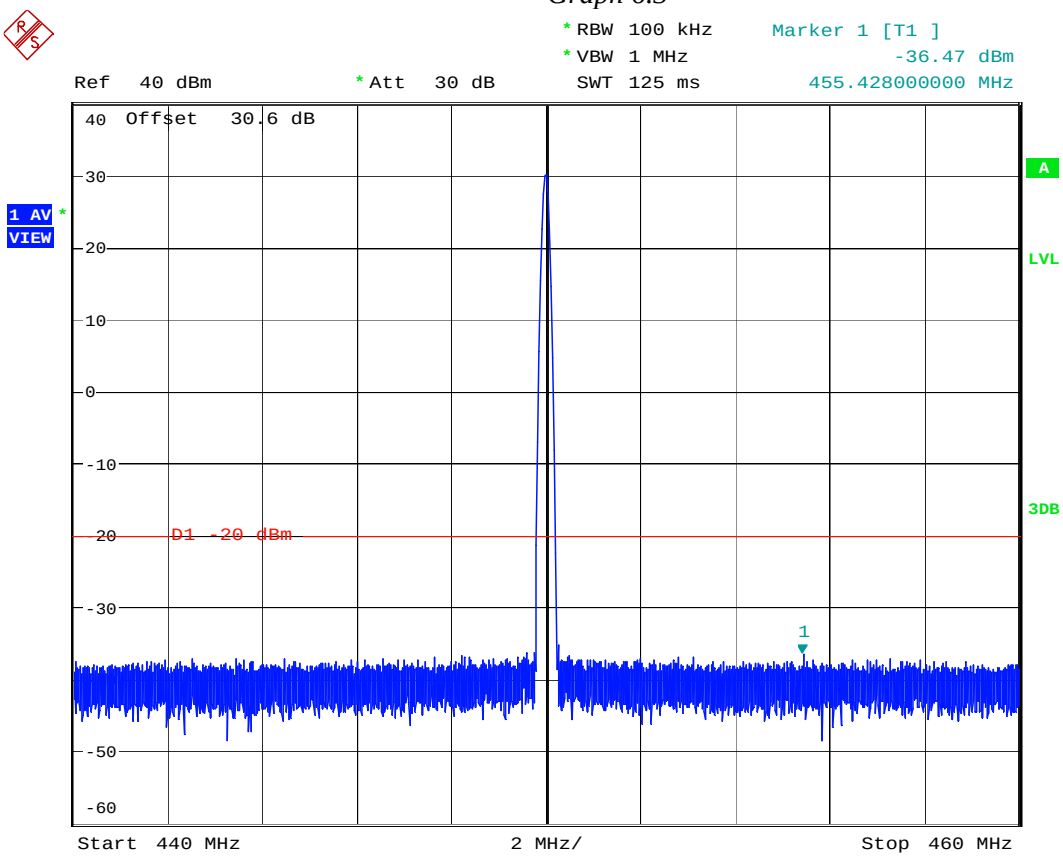
Graph 6.2



Conducted Spurious, 450MHz, DQPSK

Date: 22.NOV.2010 10:38:35

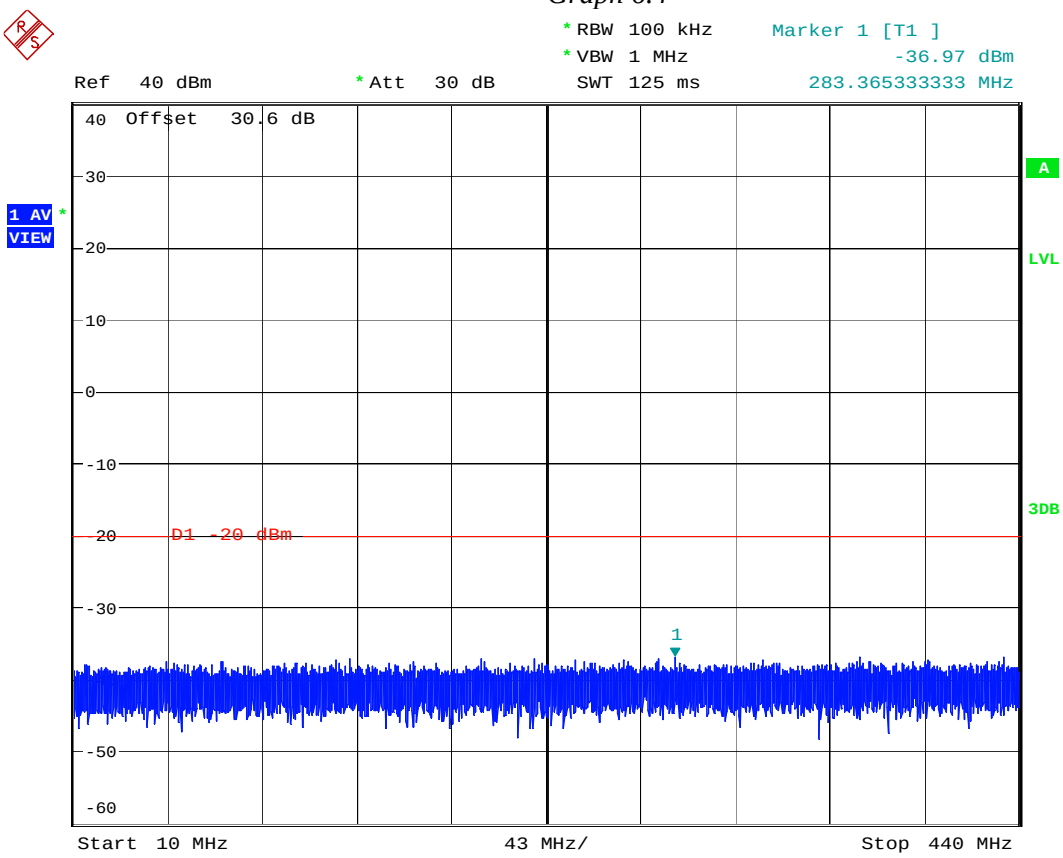
Graph 6.3



Conducted Spurious, 450MHz, GMSK

Date: 22.NOV.2010 10:41:17

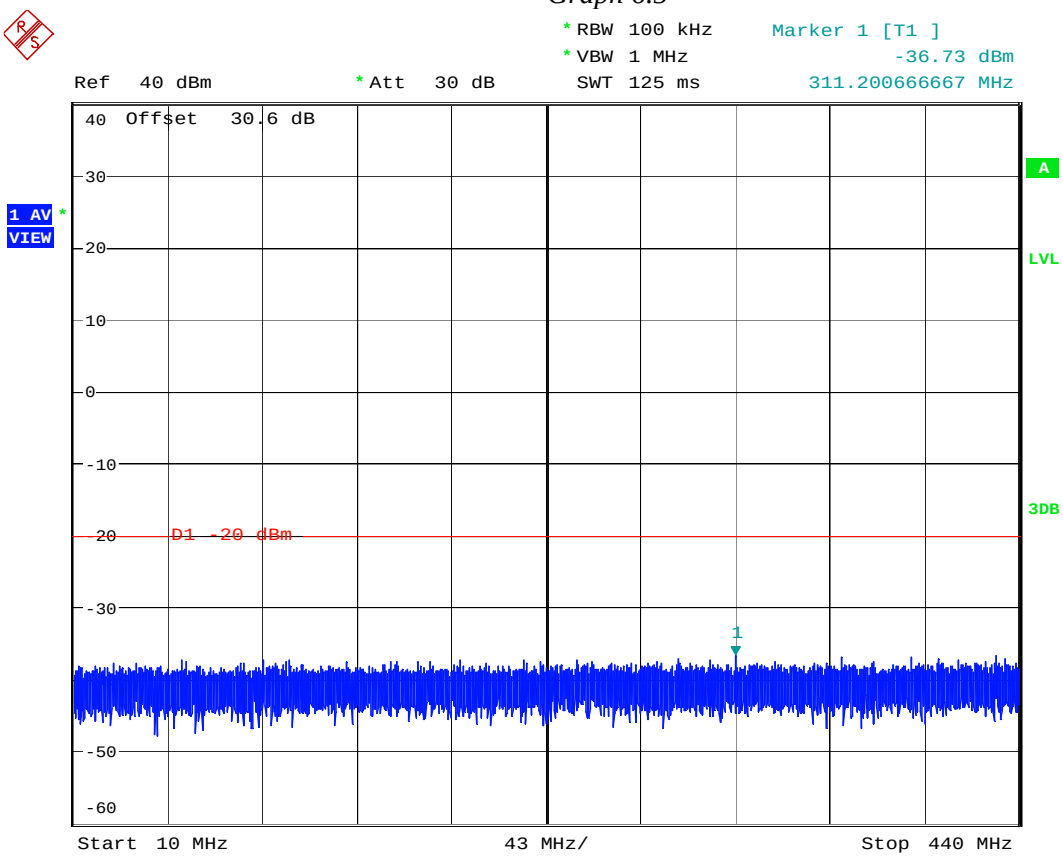
Graph 6.4



Conducted Spurious, 450MHz, DQPSK

Date: 22.NOV.2010 10:45:04

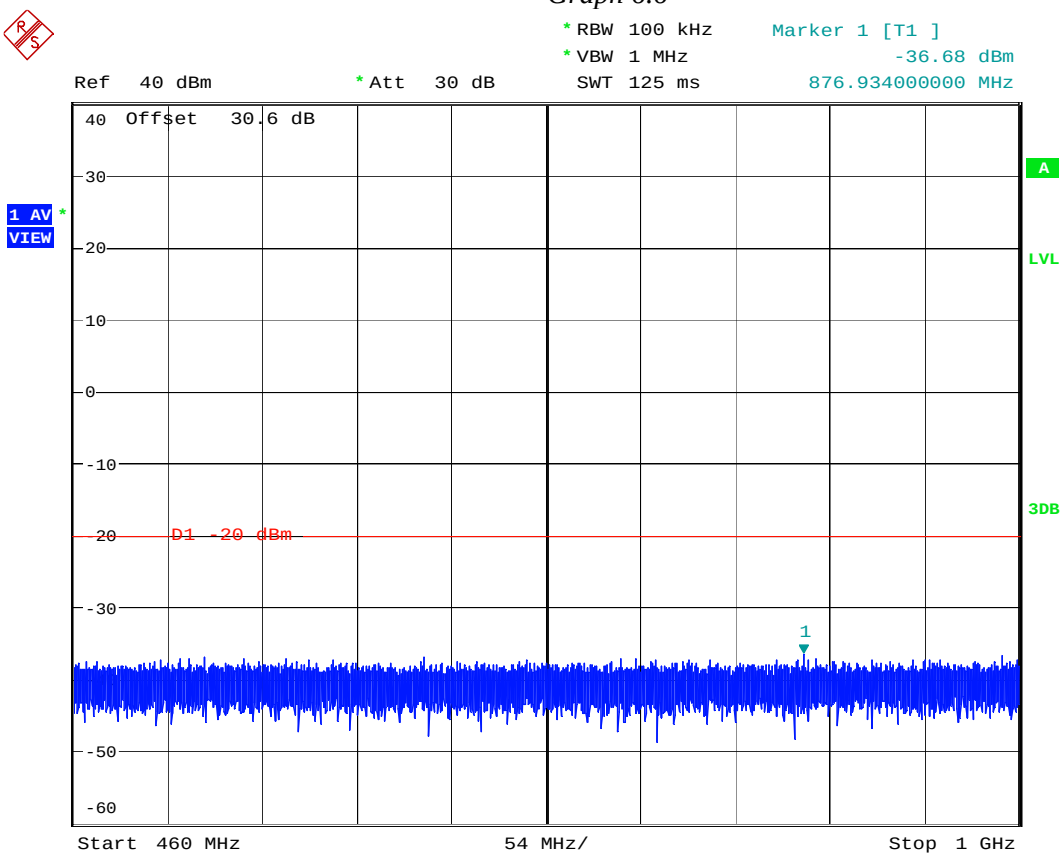
Graph 6.5



Conducted Spurious, 450MHz, GMSK

Date: 22.NOV.2010 10:46:06

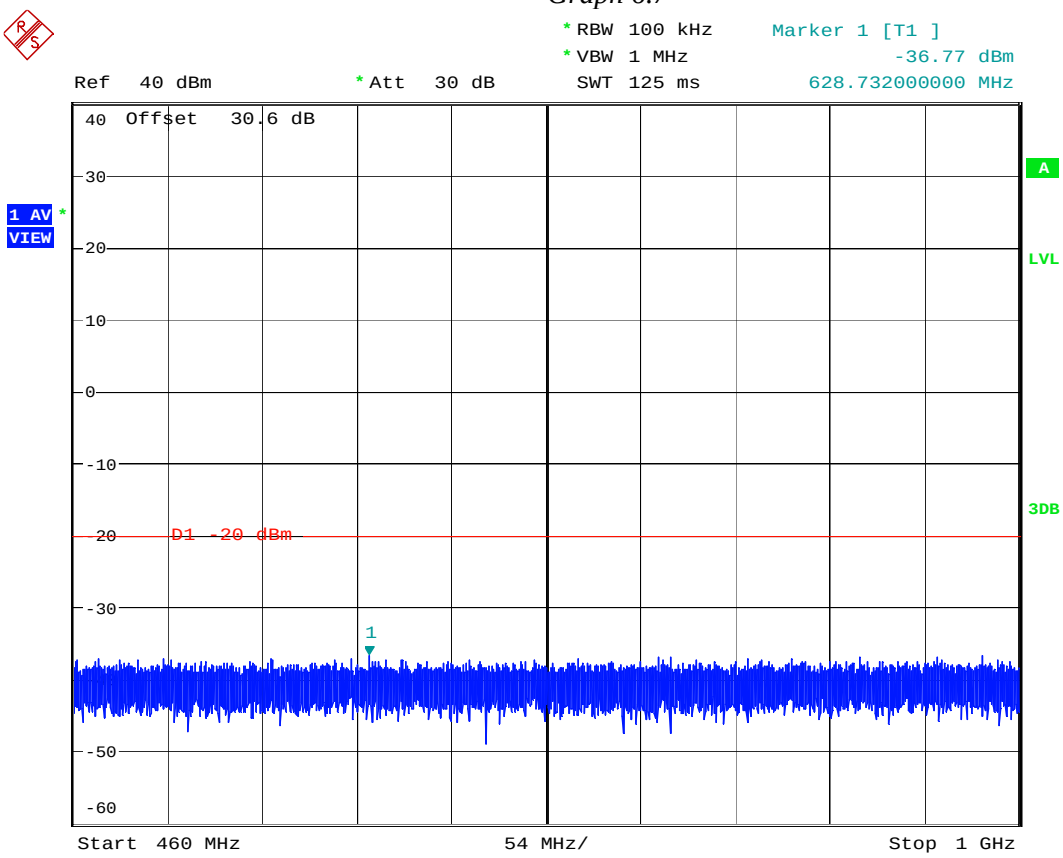
Graph 6.6



Conducted Spurious, 450MHz, GMSK

Date: 22.NOV.2010 10:47:30

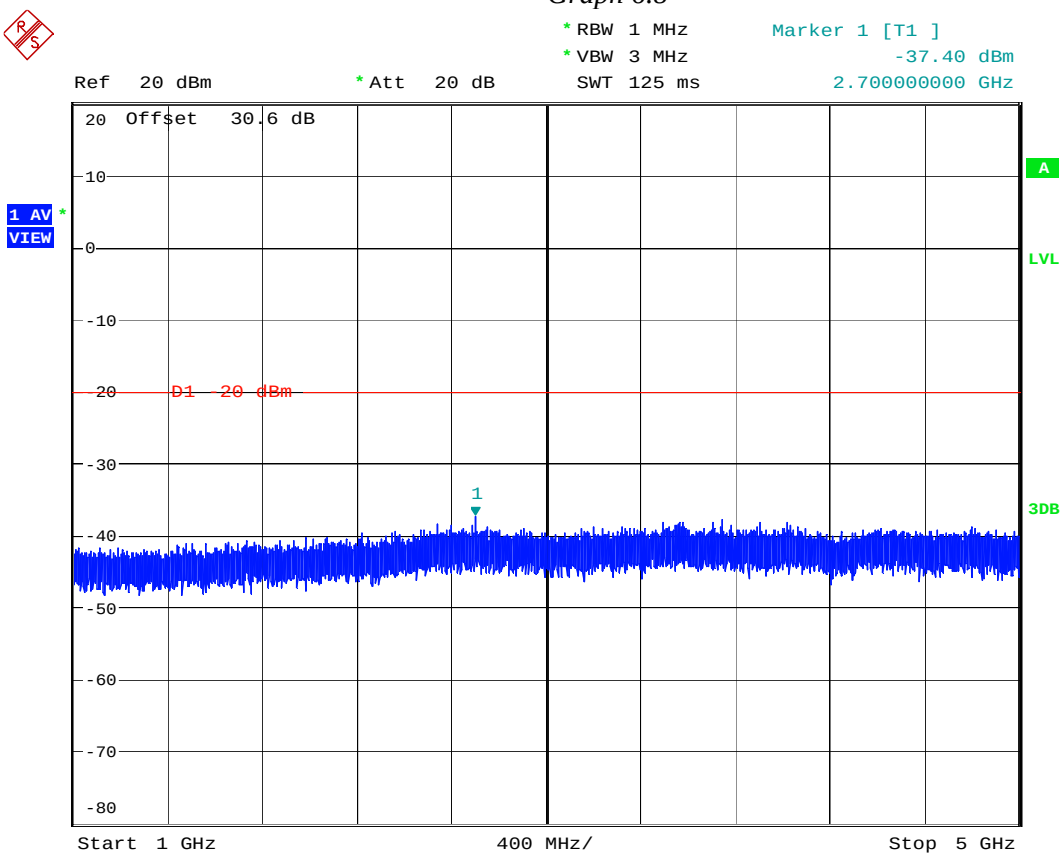
Graph 6.7



Conducted Spurious, 450MHz, DQPSK

Date: 22.NOV.2010 10:48:35

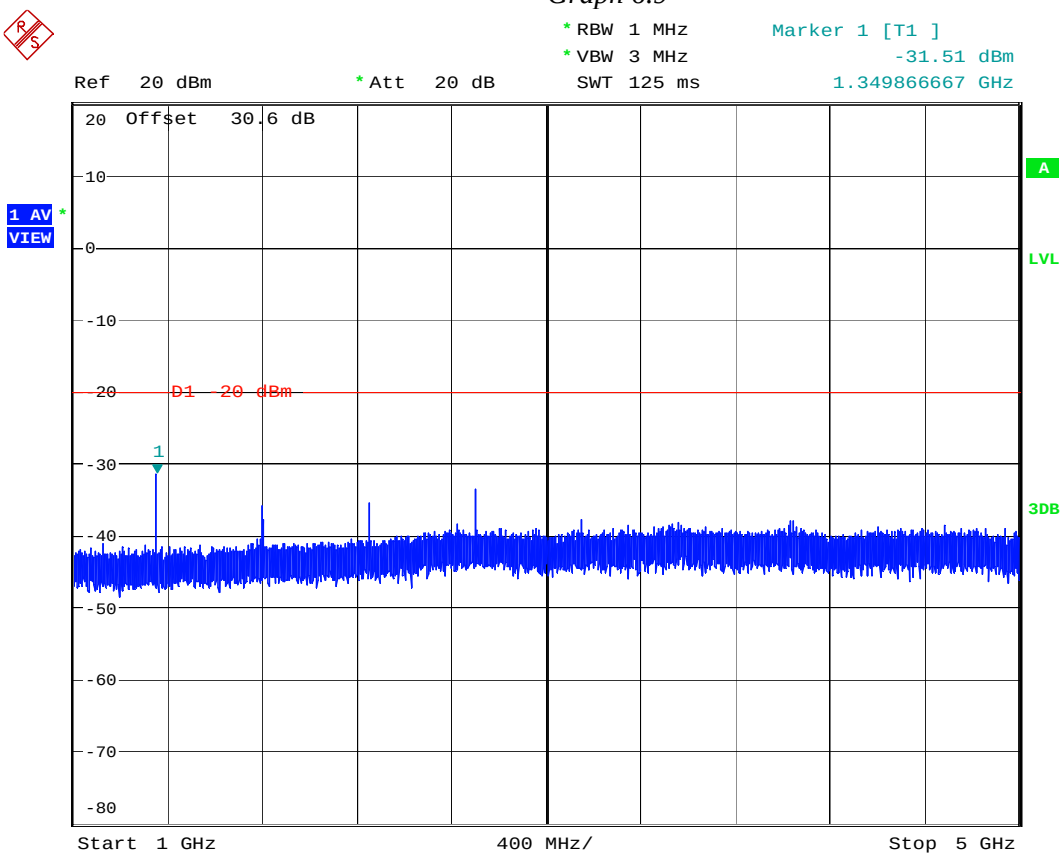
Graph 6.8



Conducted Spurious, 450MHz, DQPSK

Date: 22.NOV.2010 10:54:59

Graph 6.9



Conducted Spurious, 450MHz, GMSK

Date: 22.NOV.2010 10:53:44

7.0 Spurious Radiation

FCC 2.1053, 90.210

7.1 Requirement

The mean power of emissions must be attenuated below the mean power of the unmodulated carrier (P) on any frequency outside the frequency band by at least (50 + 10 log P) dB or 70 dB, whichever is lesser attenuation.

Note: Attenuation of (50 + 10 log P) dB corresponds to the level of -20 dBm for any out-of-band and spurious emissions.

7.2 Test Procedure

Radiated emissions are taken at 3 meters for frequencies above 1 GHz and at 10 meters for frequencies below 1 GHz. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT.

The frequency range up to 10th harmonic was investigated. The worst case of emissions was reported.

For spurious emissions attenuation, the substitution method was used. The EUT was substituted by a reference antenna (half-wave dipole - below 1 GHz, or Horn antenna - above 1GHz), connected to a signal generator. The signal generator output level ($\mathbf{V_g}$ in dBm) was adjusted to obtain the same reading as from EUT. The ERP at the spurious emissions frequency was calculated as follows.

$$ERP_{(dBm)} = \mathbf{V_g + G_{(dBd)}}$$

The spurious emissions attenuation is the difference between ERP at the fundamental frequency (see section 3) and at the spurious emissions frequency.

7.3 Test Equipment

Roberts Antenna
EMCO 3115 Horn Antennas
Rohde & Schwarz FSP40 Spectrum Analyzer
Low Pass Filter
Preamplifiers

7.4 Test Results

Spurious Radiated Emissions

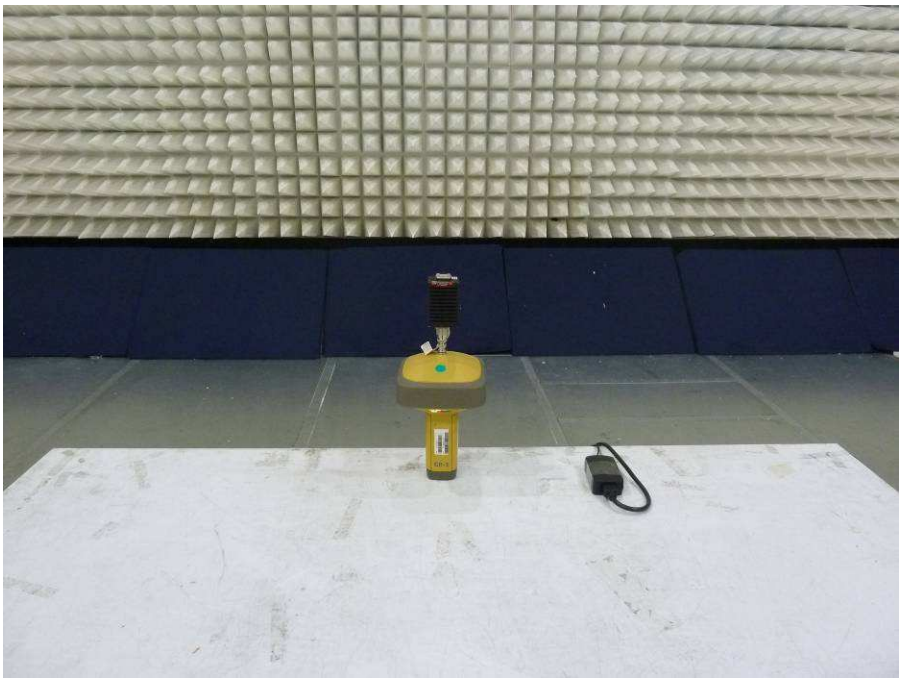
Frequency	SA Reading (from EUT)	Signal Generator Output required to have the same SA Reading as from EUT	ERP*	ERP Limit	ERP Margin
MHz	**dB(µV)**	**V_g dBm**	**dBm**	**dBm**	**dB**
Tx 450.0 MHz					
900.0	27.7	-54.2	-54.2	-20.0	-34.2
1350.0	36.6	-72.4	-67.0	-20.0	-47.0
1399.4	37.8	-71.1	-65.5	-20.0	-45.5
1800.0	33.4	-77.1	-69.3	-20.0	-49.3
1909.0	44.5	-64.2	-56.9	-20.0	-36.9
2250.0	34.3	-73.1	-65.6	-20.0	-45.6
2455.8	36.6	-71.4	-63.2	-20.0	-43.2
2471.5	38.6	-69.2	-61.0	-20.0	-41.0
2700.0	52.5	-54.0	-46.0	-20.0	-26.0
3150.0	42.2	-63.1	-54.7	-20.0	-34.7
3600.0	32.2	-71.9	-63.4	-20.0	-43.4
4050.0	34.1	-67.7	-59.3	-20.0	-39.3
4500.0	30.0	-70.9	-61.7	-20.0	-41.7

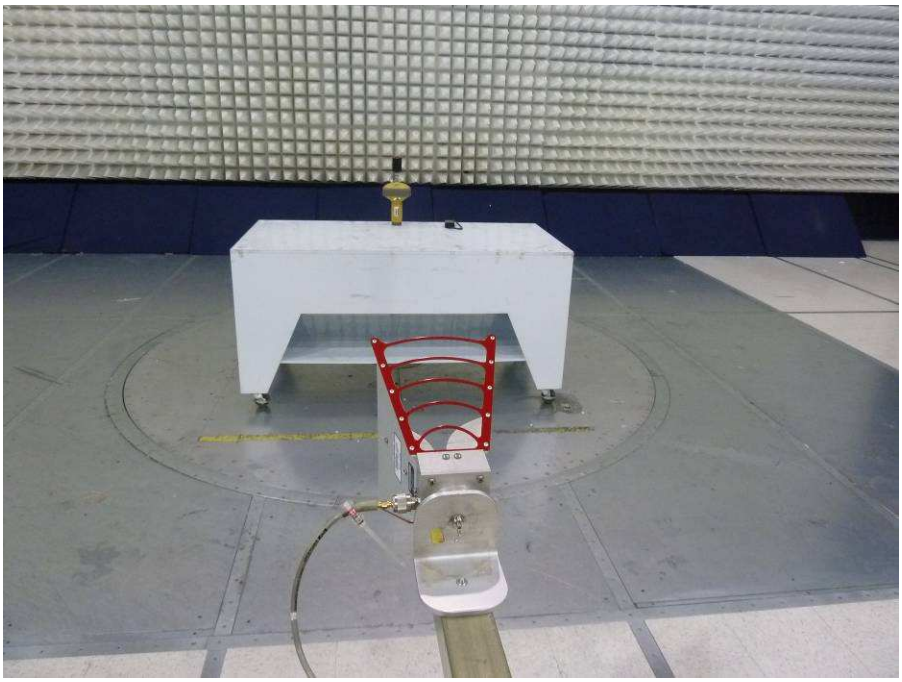
* ERP is calculated as: $ERP_{(dBm)} = \mathbf{V_{g(dBm)} + G_{(dBd)}}$

All other emissions not reported are more than 10 dB below the limit.

Result	Complies

7.5 Test Setup Photographs





8.0 Transient Frequency Behavior

FCC 90.214

8.1 Requirement

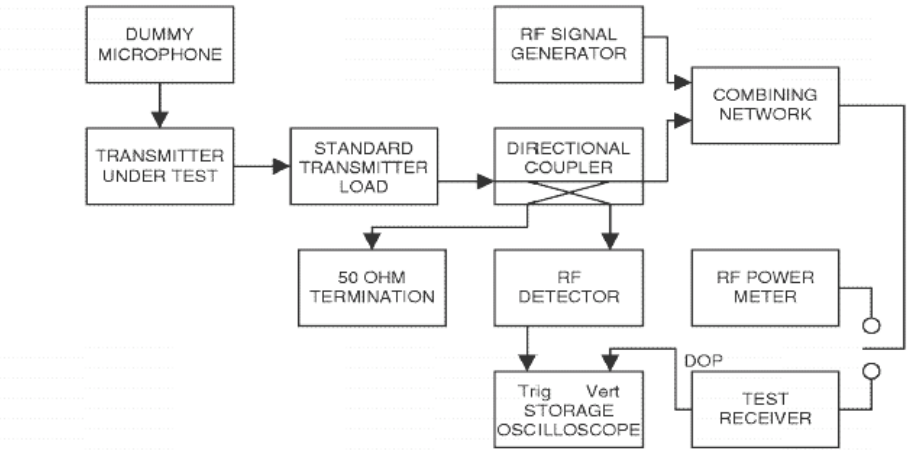
Time interval	Maximum frequency difference	Time
Transient Frequency Behavior for equipment designed to operate on 25 kHz channels		
t1 *	±25 kHz	10 ms
t2	±12.5 kHz	25 ms
t3 *	±25 kHz	10 ms
Transient Frequency Behavior for equipment designed to operate on 12.5 kHz channels		
t1 *	±12.5 kHz	10 ms
t2	±6.25 kHz	25 ms
t3 *	±12.5 kHz	10 ms

ton is the instant when a 1 kHz test signal is completely suppressed
t1 is time period immediately following **t**on
t2 is time period immediately following **t**1
t3 is time period from the instant when the transmitter is turned off until **t**off
toff is the instant when the 1 kHz test signal start to rise

* If the transmitter carrier output power rating is 6 Watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

8.2 Test Procedure

Test was performed according to the block diagram below.

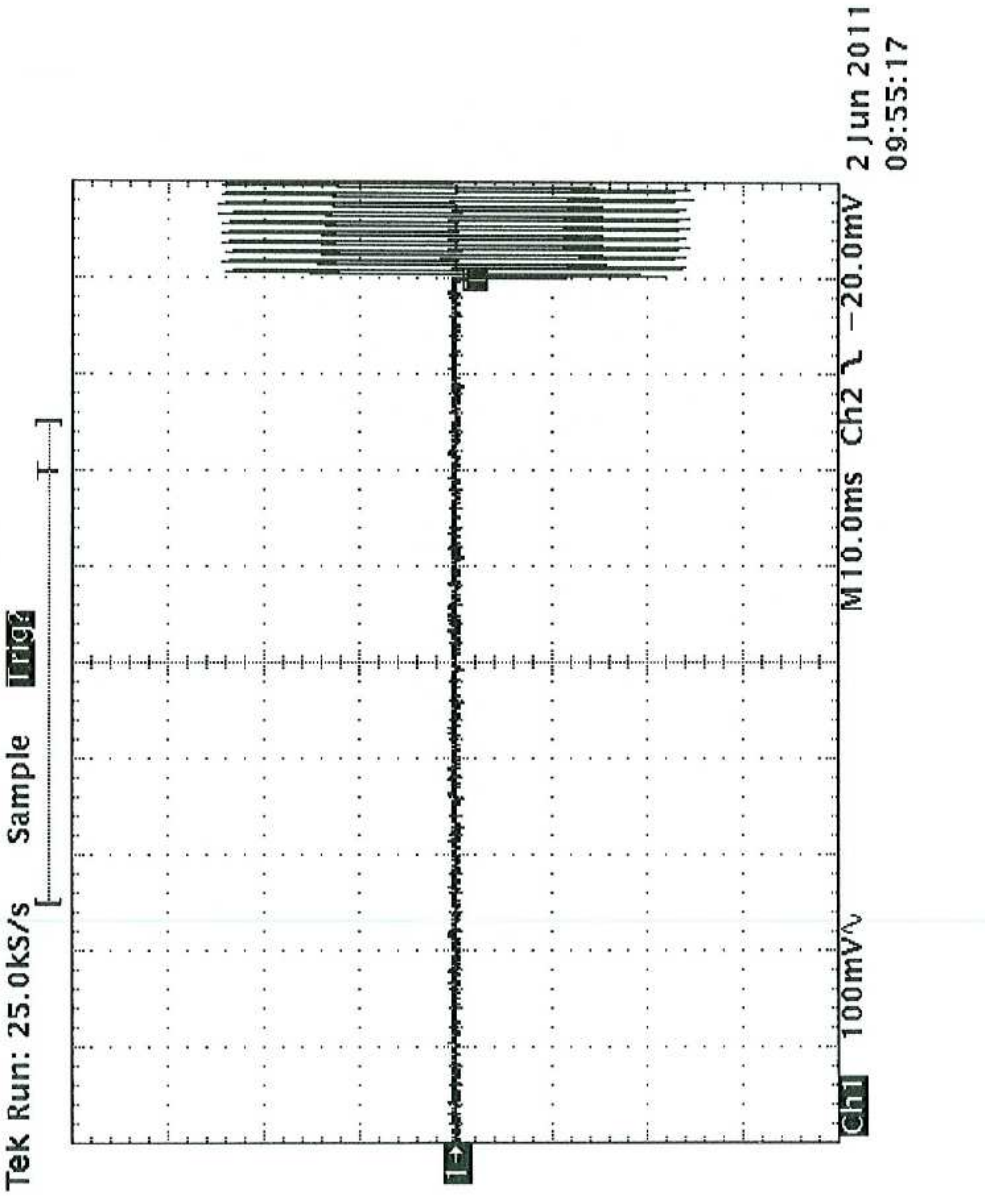


8.3 Test Results

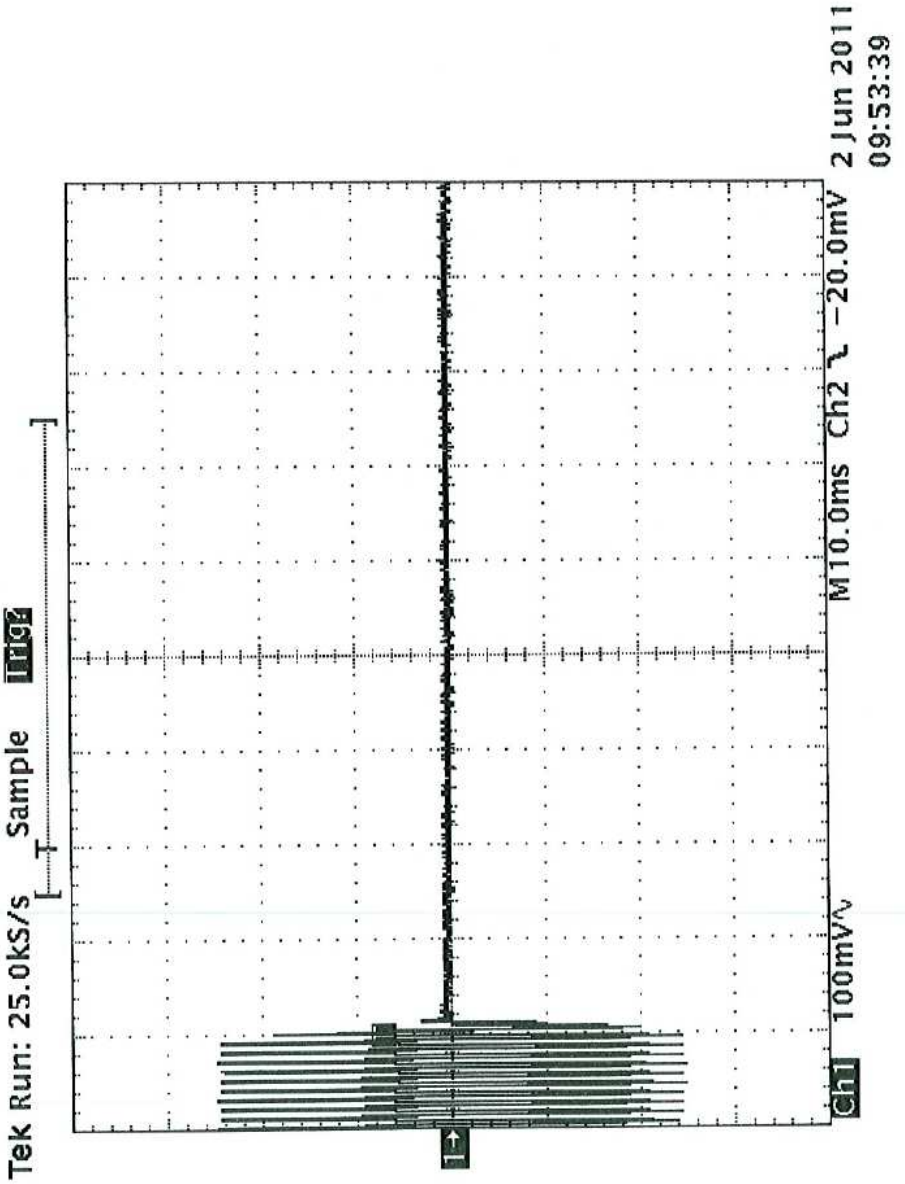
For more details refer to the attached Graphs

Result	Complies

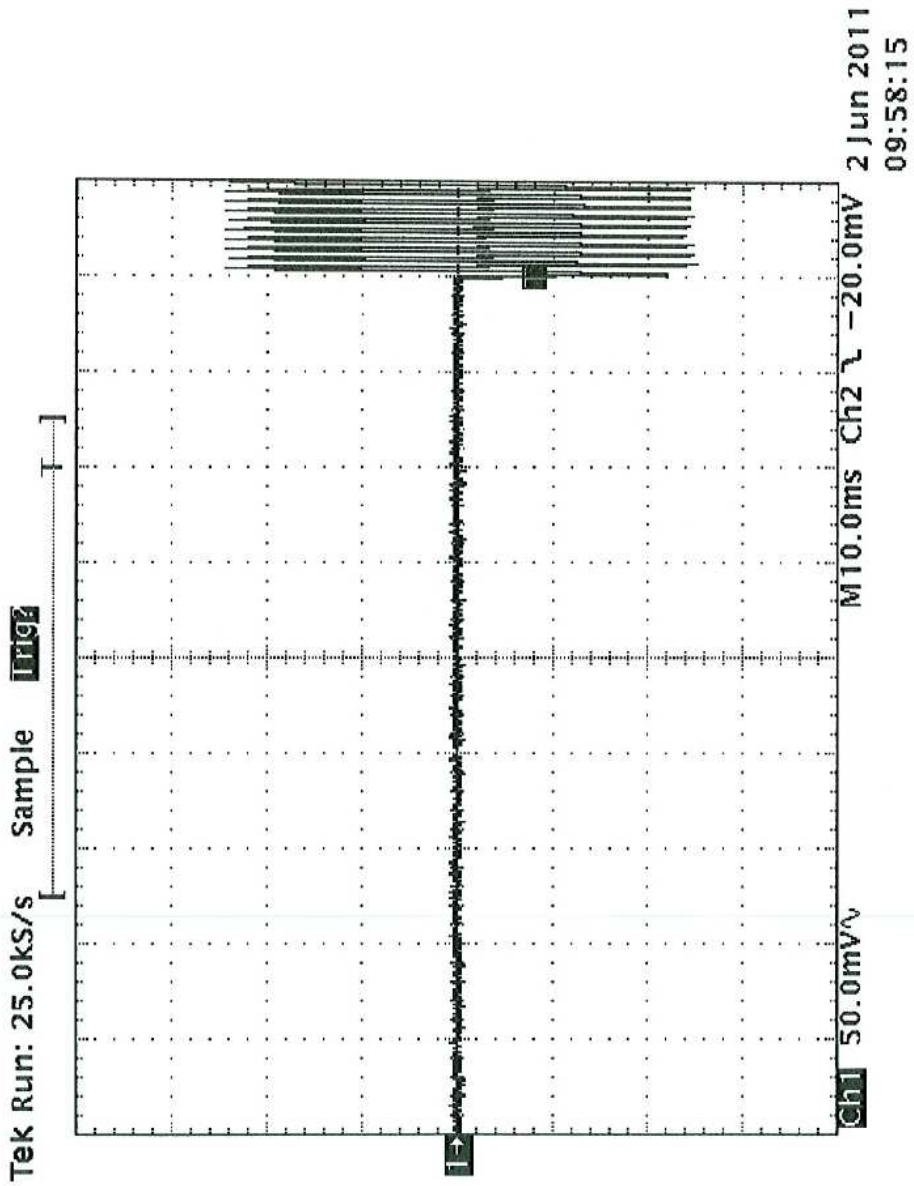
410 MHz, 25 kHz spacing



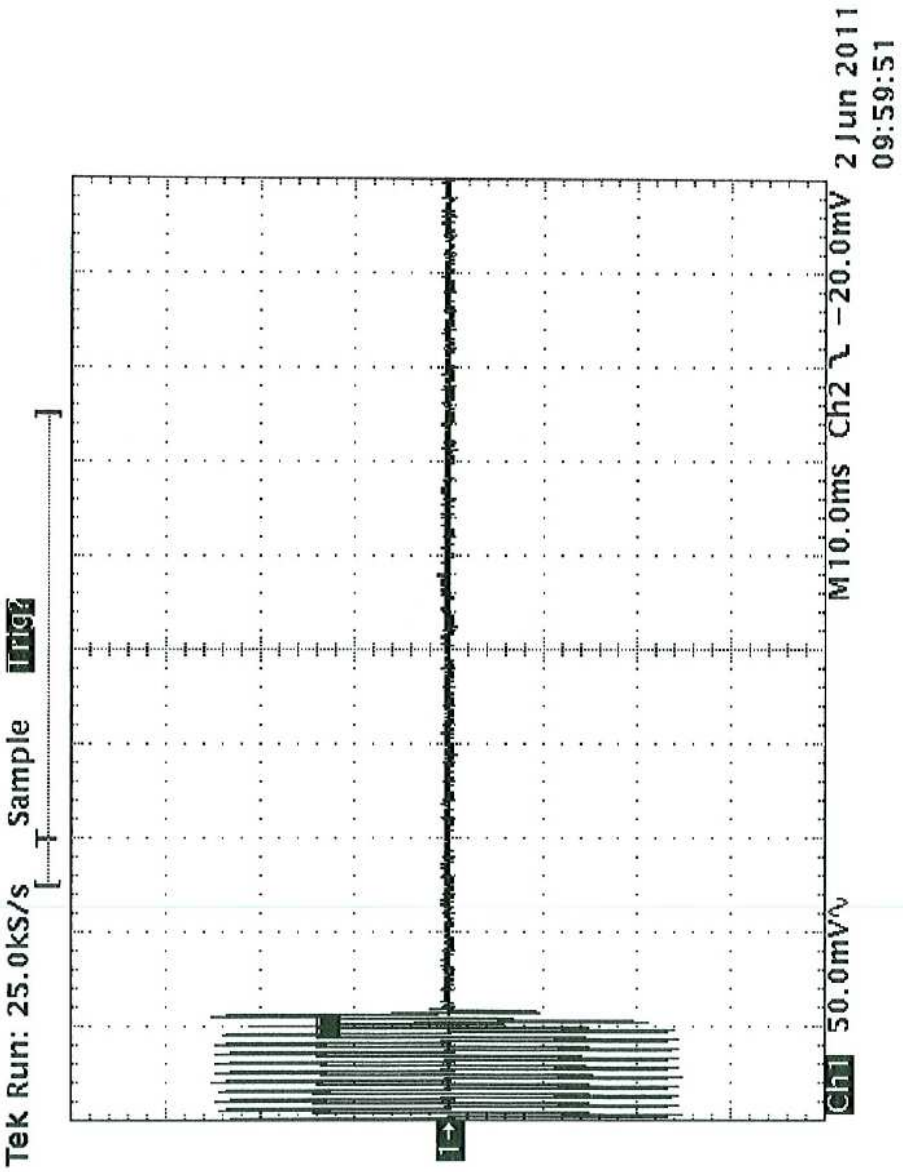
410 MHz, 25 kHz spacing



450 MHz, 12.5 kHz spacing



450 MHz, 12.5 kHz spacing



9.0 Frequency Stability vs Temperature and Voltage

FCC 2.1055, 90.213

9.1 Requirement

In the 421–512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

Note: according to RSS-119, the frequency stability for mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 0.5 ppm.

9.2 Test Procedure

The EUT was placed inside the temperature chamber. The RF power output was connected to frequency counter. The EUT was setup to transmit the maximum power.

After the temperature stabilized for approximately 20 minutes, the transmitting frequency was measured by the frequency counter and recorded.

At the room temperature, the frequency was measured when the EUT was powered with the nominal voltage and with 85% and 115% of the nominal voltage.

9.3 Test Equipment

Temperature Chamber
Spectrum Analyzer

9.4 Test Results

Nominal frequency: 450 MHz

Temperature (°C)	Maximum Deviation from nominal, Hz	Maximum Deviation from nominal, ppm	Maximum Deviation from frequency at 20°C, ppm
-30	-78.0	0.17	0.21
-20	-56.0	0.12	0.16
-10	-32.0	0.07	0.10
0	-15.0	0.03	0.00
10	-9.0	0.02	0.01
20	9.0	0.02	0.05
30	13.0	0.03	0.06
40	35.0	0.08	0.11
50	53.0	0.12	0.15
60	70.0	0.16	0.19

AC Voltage, V	Maximum deviation from nominal, Hz	Maximum deviation from nominal, ppm
102	-15.0	0.03
120	-15.0	0.03
138	-15.0	0.03

Result	Complies

10.0 Emissions from Receiver

10.1 Radiated emissions from Receiver
FCC 15.109, FCC 15.111(a)

10.1.1 Test Limit

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

10.1.2 Test 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.

10.1.3 Test Results

Result	Complies by 8.1 dB

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.

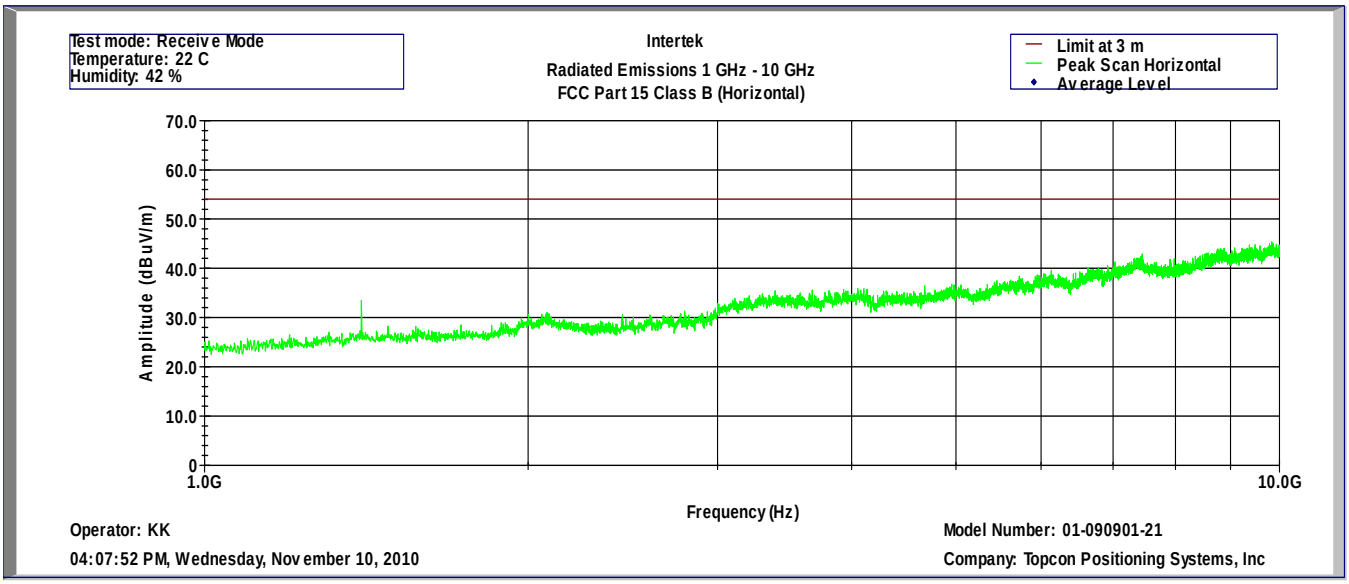
Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (Pk-Horizontal)

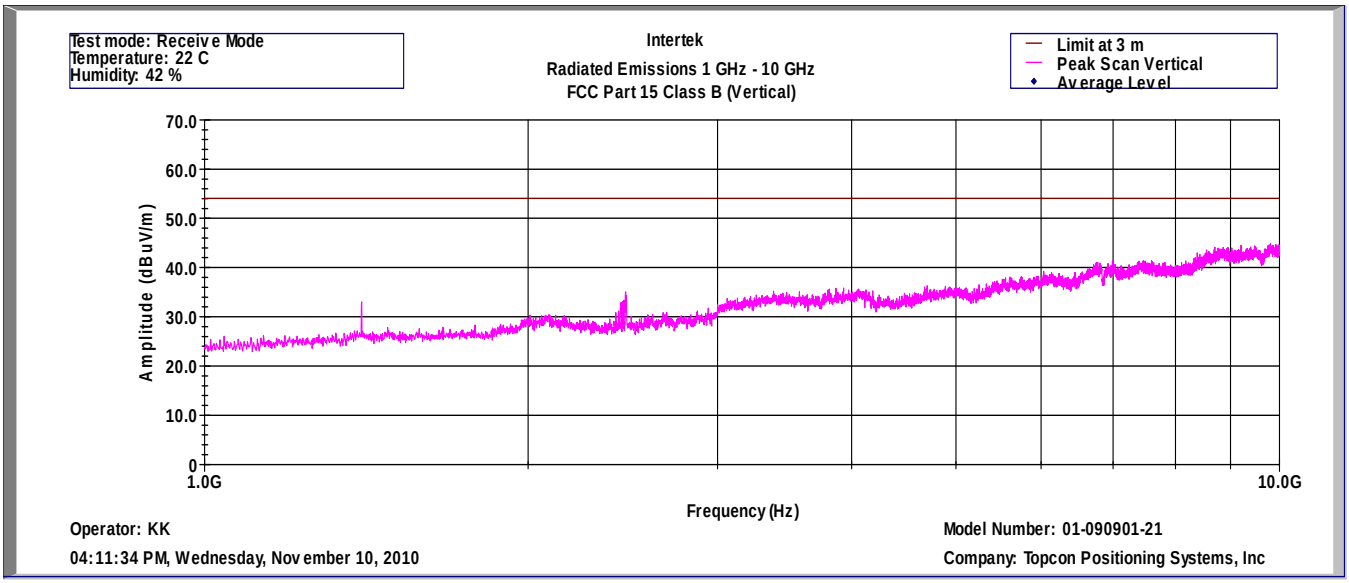
Operator: KK Model Number: 01-090901-21
November 10, 2010 Company: Topcon Positioning Systems, Inc.

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 %

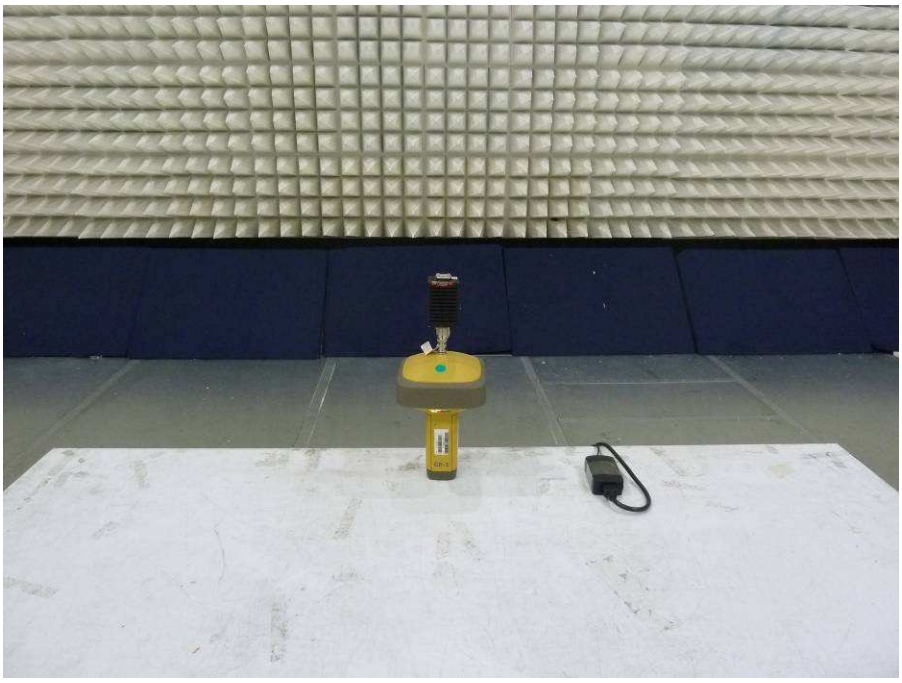
Notes: Measurements made at 10 meters distance.

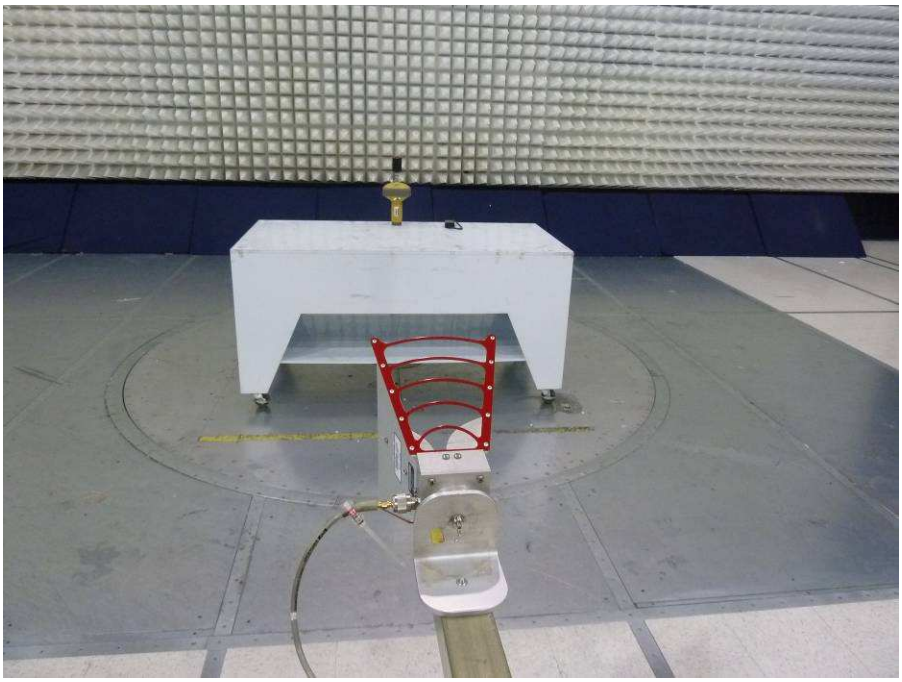




Note: Measurements made at 3 meters distance. Radiated emission measurements were performed up to 25GHz. No other emissions were detected above the noise floor which is at least 10 dB below the limit.

10.1.4 Test Setup Photographs





10.2 Receiver Antenna Conducted Emissions
FCC 15.111(a)

10.2.1 Limit

The power at the antenna terminal shall not exceed 2.0 nanowatts (-57 dBm).

10.2.2 Test Procedure

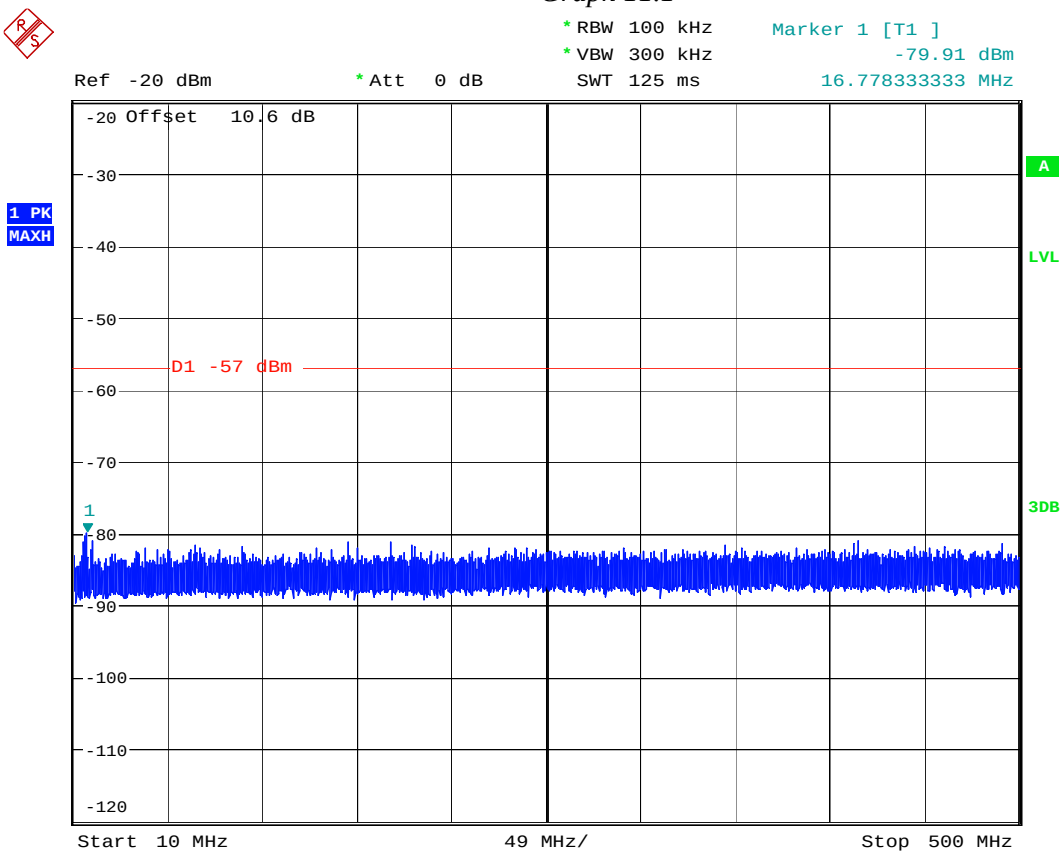
The spectrum analyzer was connected to the RF output of the EUT. The EUT was setup in receiving mode. The test was performed at the tuned frequency of 450 MHz.

10.2.3 Test Results

The test results are presented on the following graphs.

Result	Complies by 10.9 dB

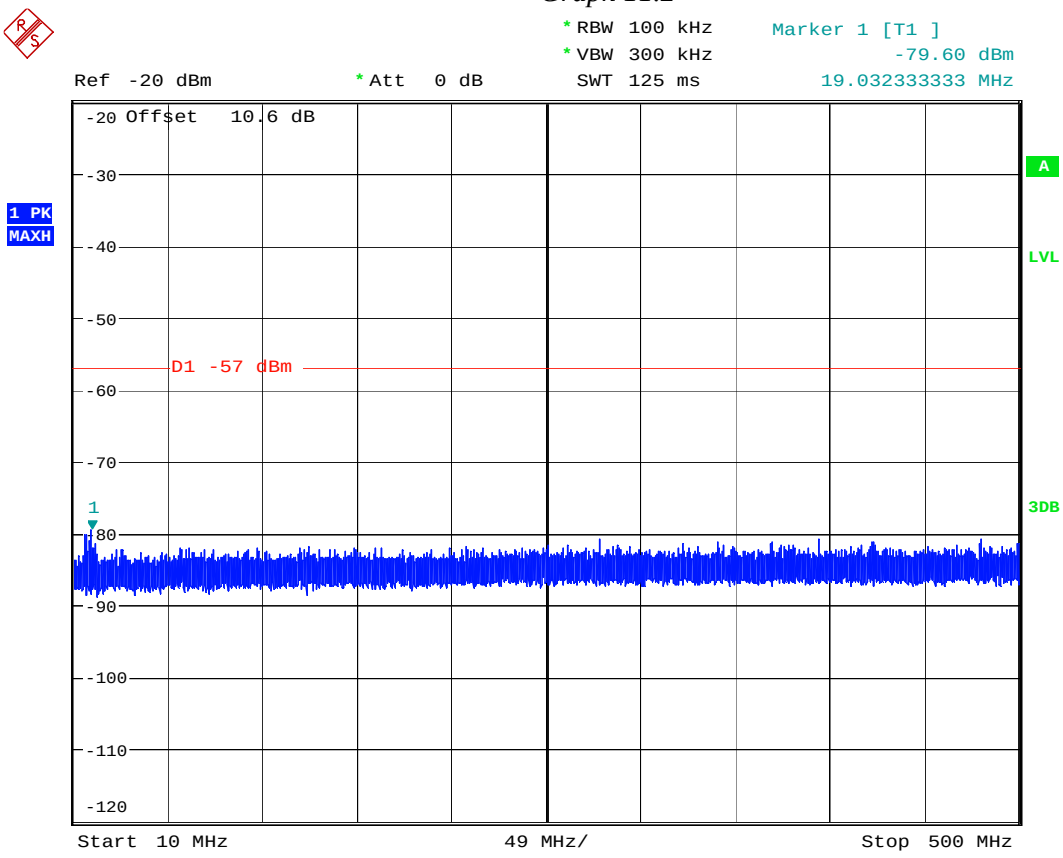
Graph 11.1



Receiver Spurious Conducted, 450MHz, DQPSK

Date: 5.NOV.2010 16:28:28

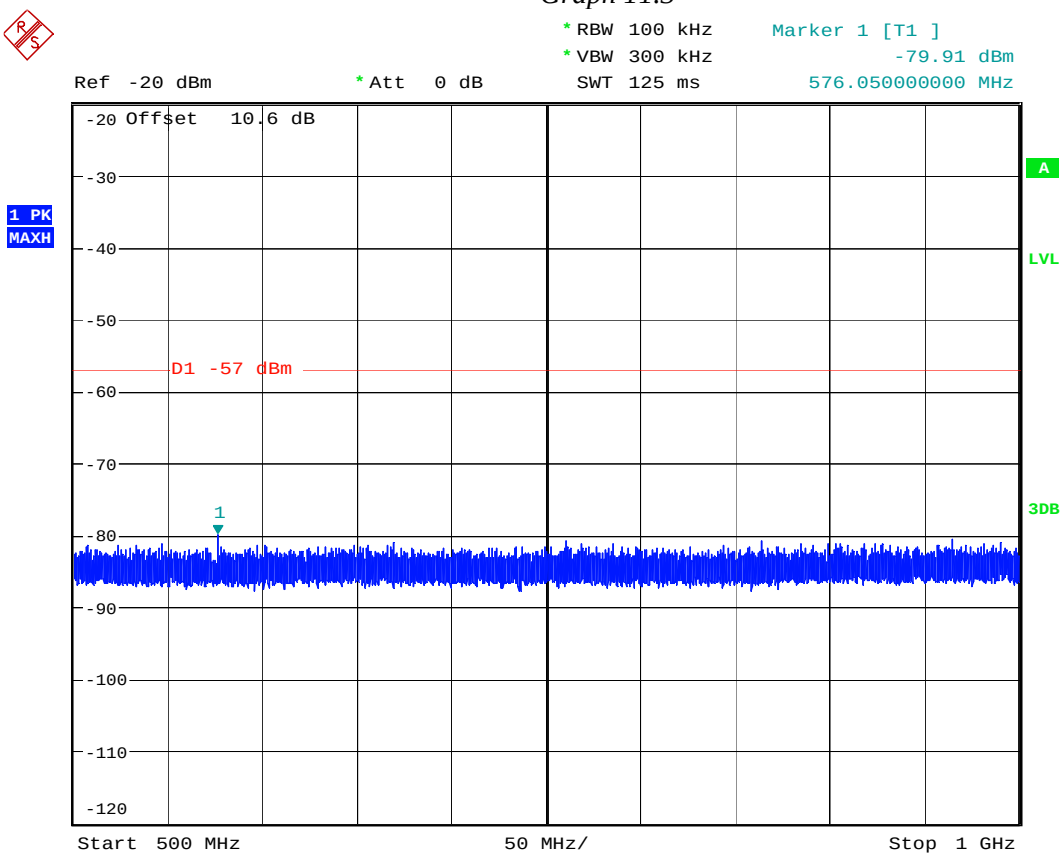
Graph 11.2



Receiver Spurious Conducted, 450MHz, GMSK

Date: 5.NOV.2010 16:19:30

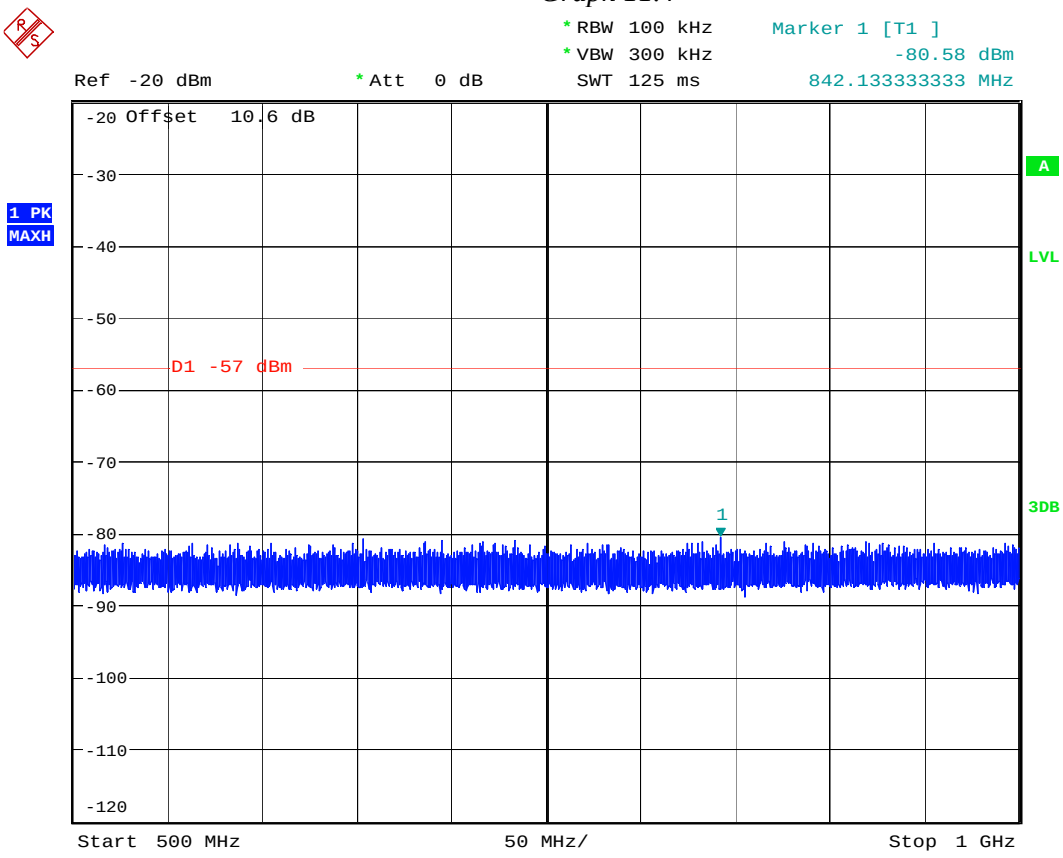
Graph 11.3



Receiver Spurious Conducted, 450MHz, DQPSK

Date: 5.NOV.2010 16:29:43

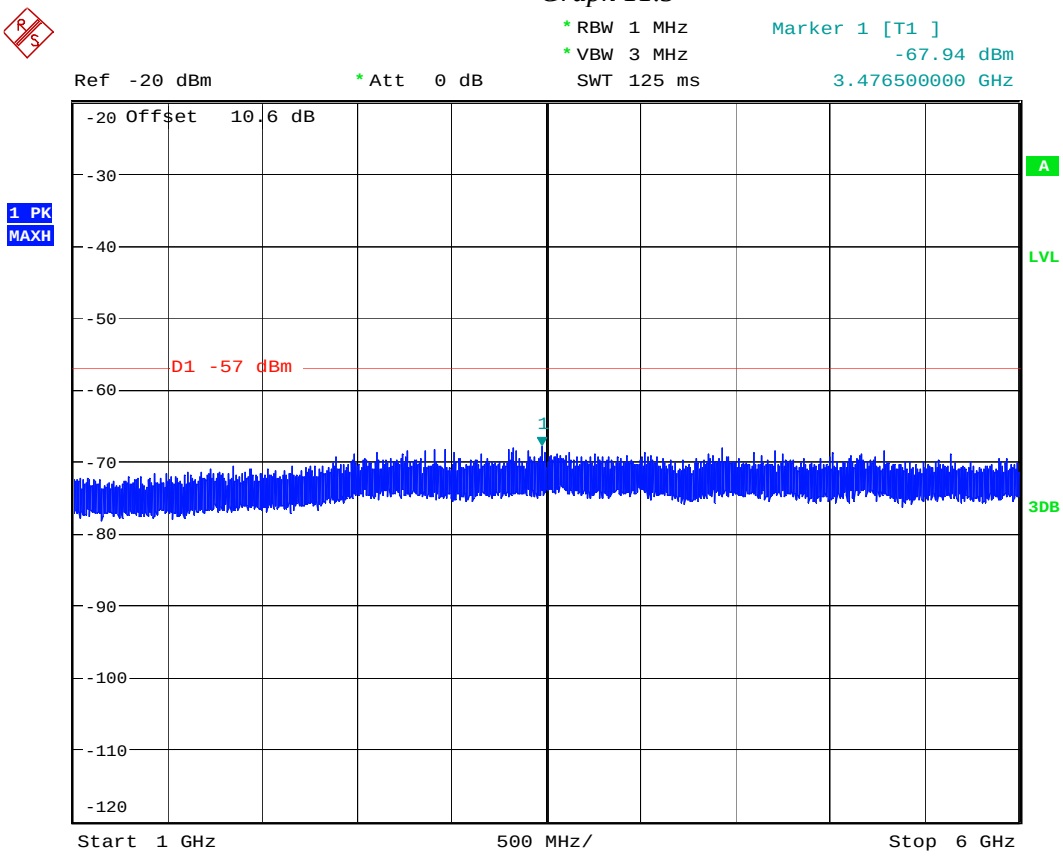
Graph 11.4



Receiver Spurious Conducted, 450MHz, GMSK

Date: 5.NOV.2010 16:20:23

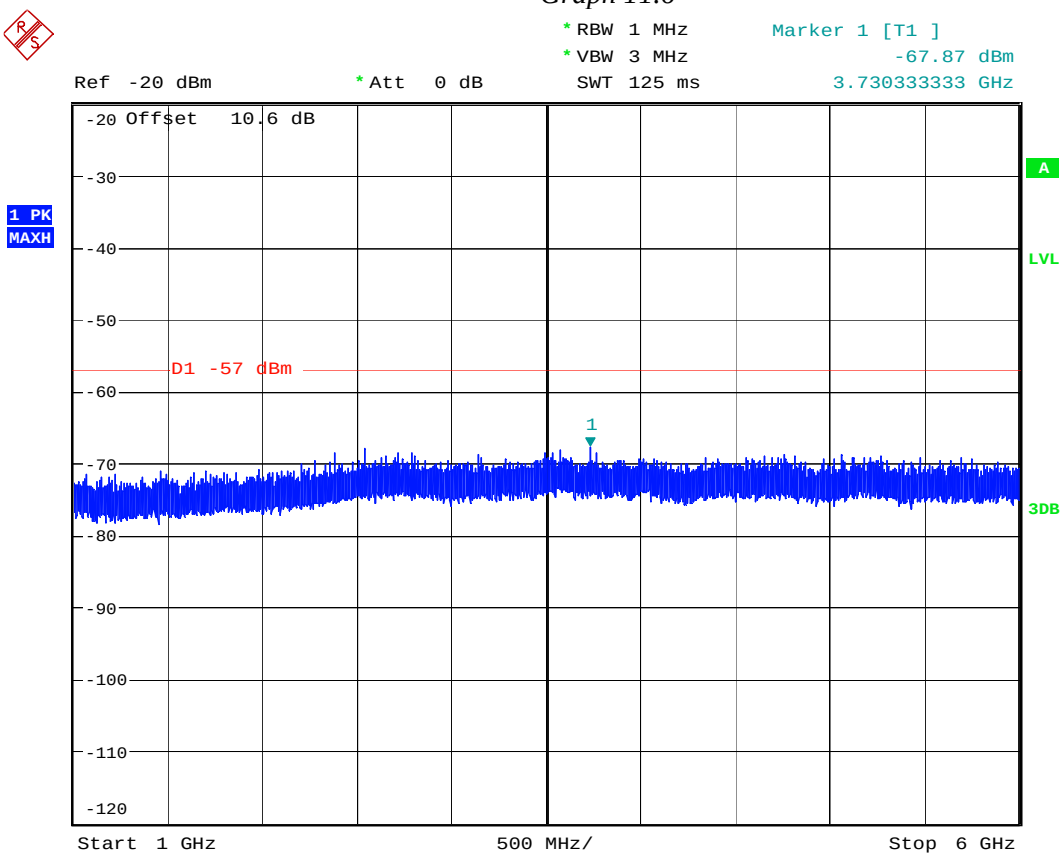
Graph 11.5



Receiver Spurious Conducted, 450MHz, DQPSK

Date: 5.NOV.2010 16:27:26

Graph 11.6



Receiver Spurious Conducted, 450MHz, GMSK

Date: 5.NOV.2010 16:23:04

11.0 Emissions from Digital Parts

11.1 Radiated Emissions
FCC 15.109

11.1.1 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

11.1.2 Test 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.

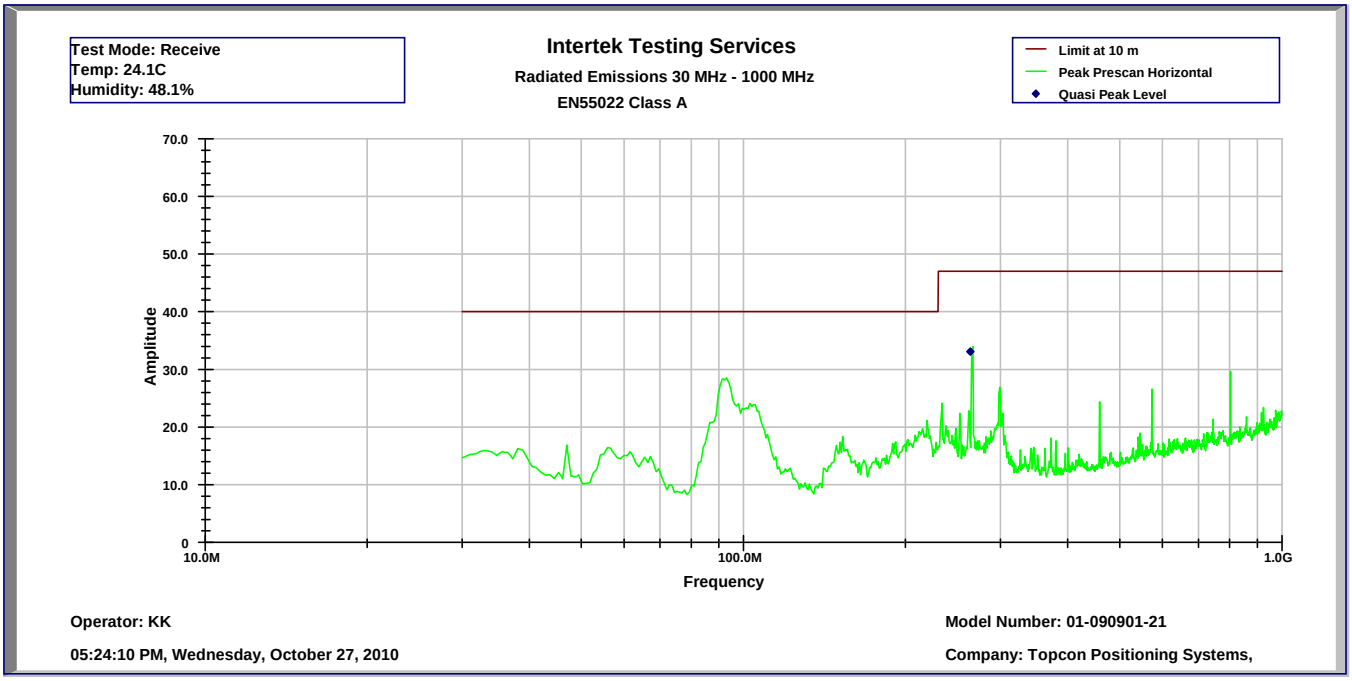
For measurements made at 3 meters distance

The field strength is calculated by following the example above except the Distance Correction Factor in dB is not applied.

11.1.3 Test Results

Result	Complies by 3.0dB

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

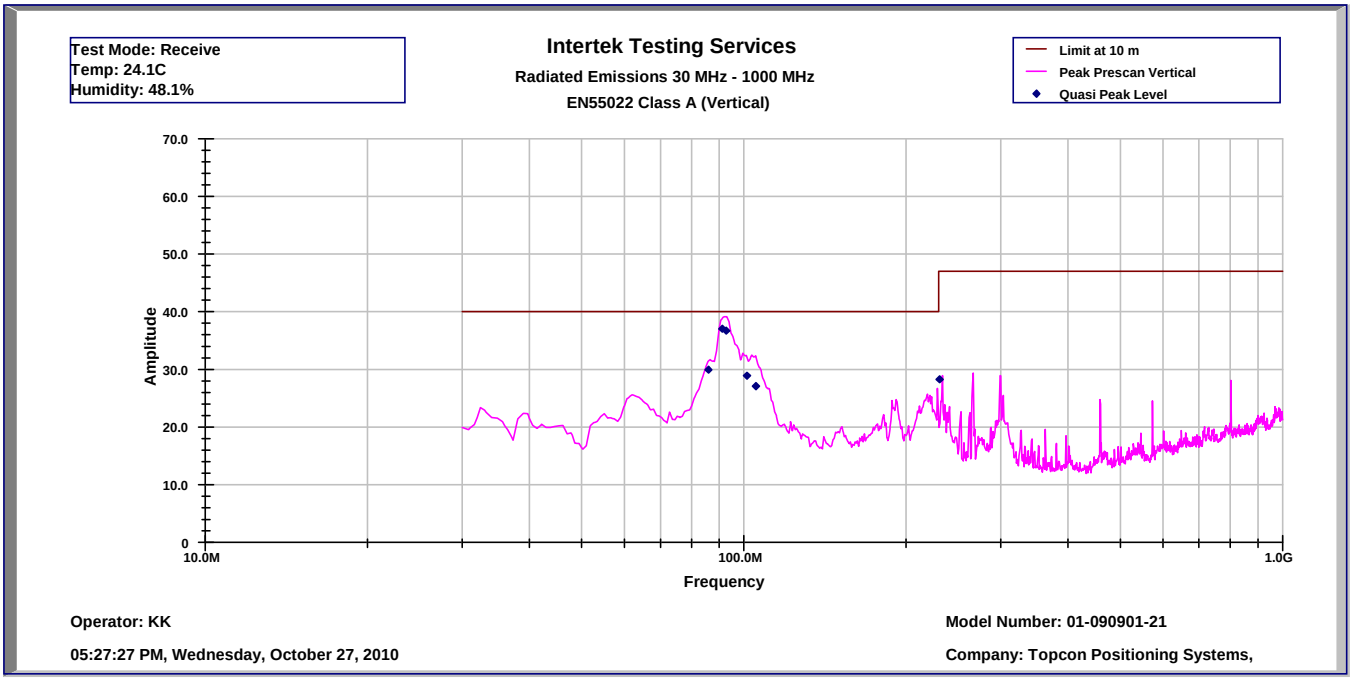
Model Number: 01-090901-21
Company: Topcon Positioning Systems, Inc

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

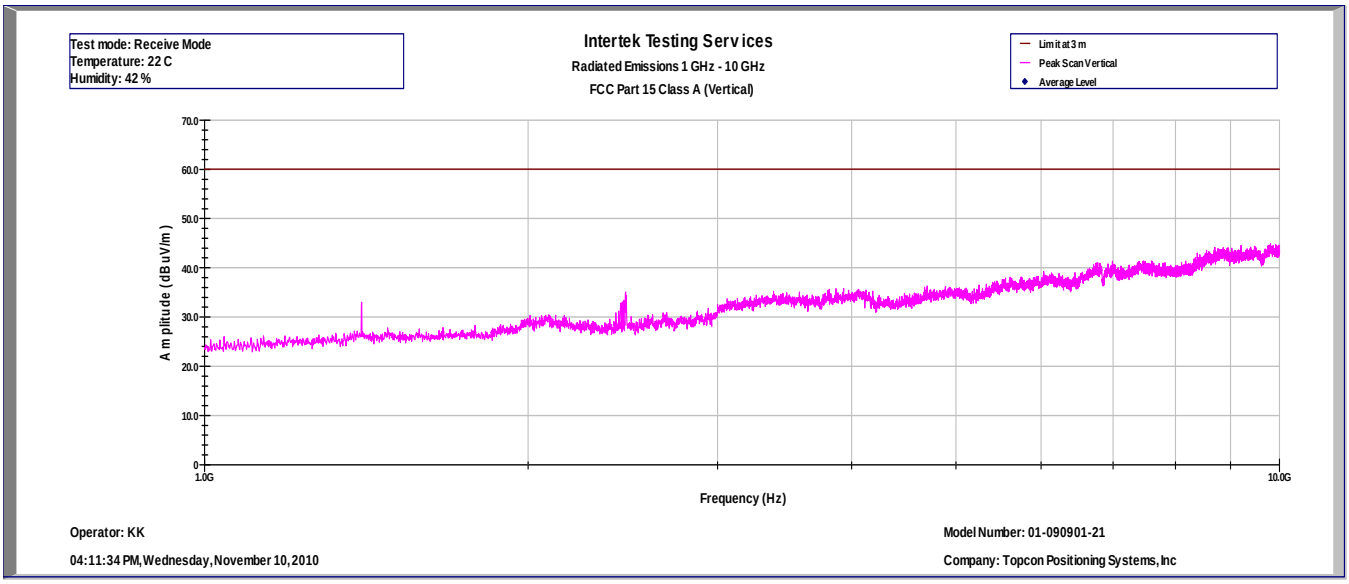
Model Number: 01-090901-21
Company: Topcon Positioning Systems, Inc

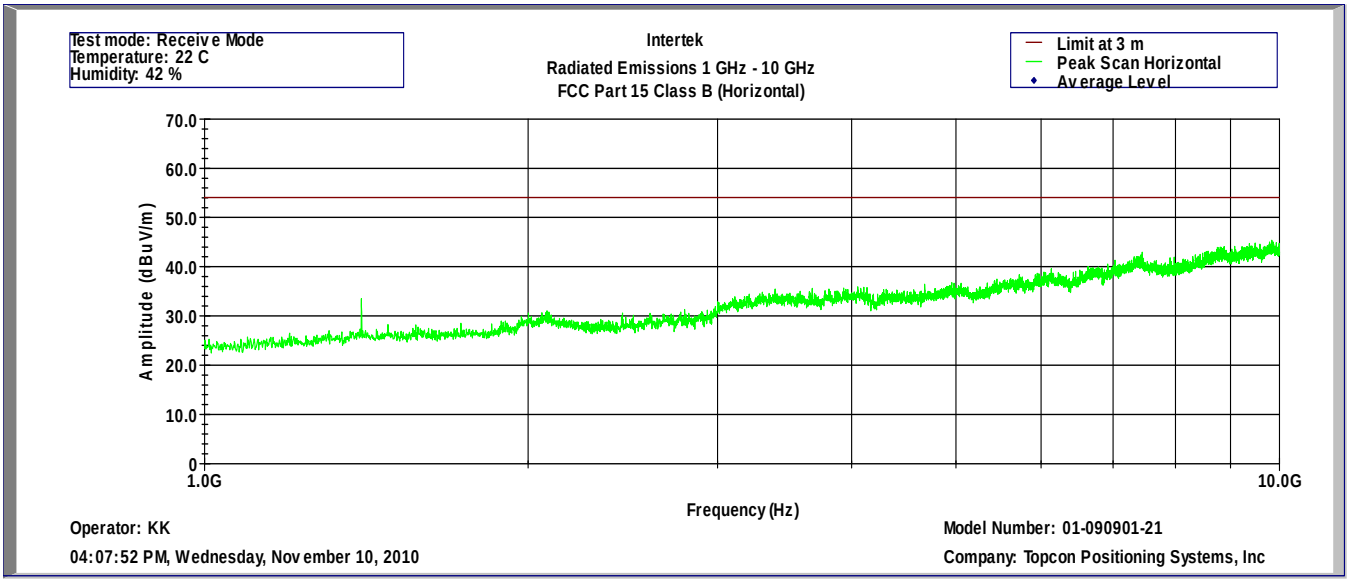
Frequency	Quasi Pk FS	Limit@10m	Margin	RA	AG	AF	CF
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB(1/m)	dB
86.0	29.9	40.0	-10.1	52.9	32.0	8.0	1.1
91.28	37.0	40.0	-3.0	59.5	32.0	8.5	1.1
92.80	36.7	40.0	-3.3	59.0	32.0	8.6	1.1
101.375	28.9	40.0	-11.1	49.3	32.0	10.4	1.2
105.30	27.1	40.0	-12.9	47.1	32.0	10.8	1.2
231.0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

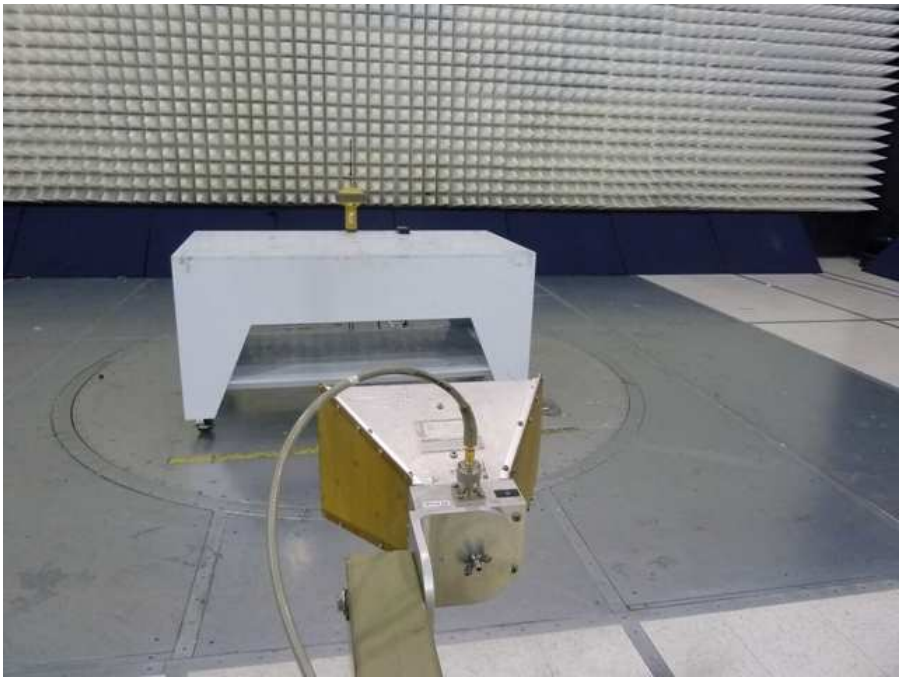
FCC Part 15 Radiated Emissions





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.

11.1.4 Test Setup Photographs



11.2 AC Line Conducted Emission
FCC 15.207

11.2.1 Test Limits

FCC Part 15 Subpart B and ICES 003Limits for Conducted Disturbance at the Mains Ports

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.

11.2.2 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.

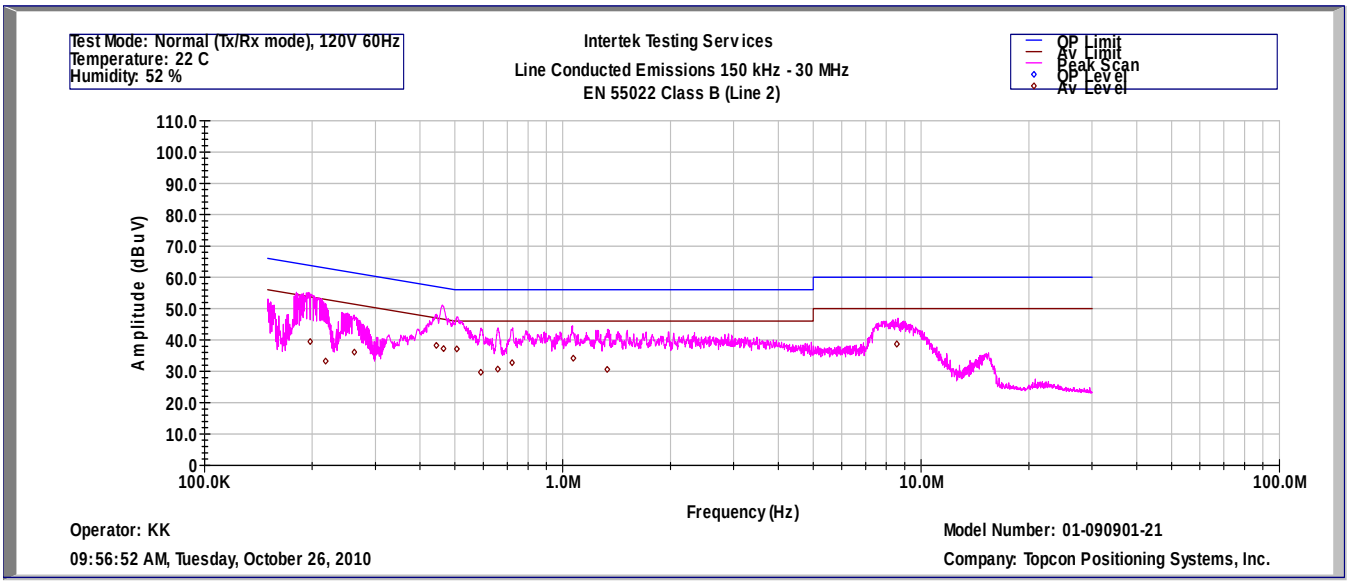
Floor standing EUTs are placed on a horizontal metal ground plane and isolated from the ground plane by 3 to 12 mm of insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

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

11.2.3 Test Result

Results	**Complies** by 5.6 dB

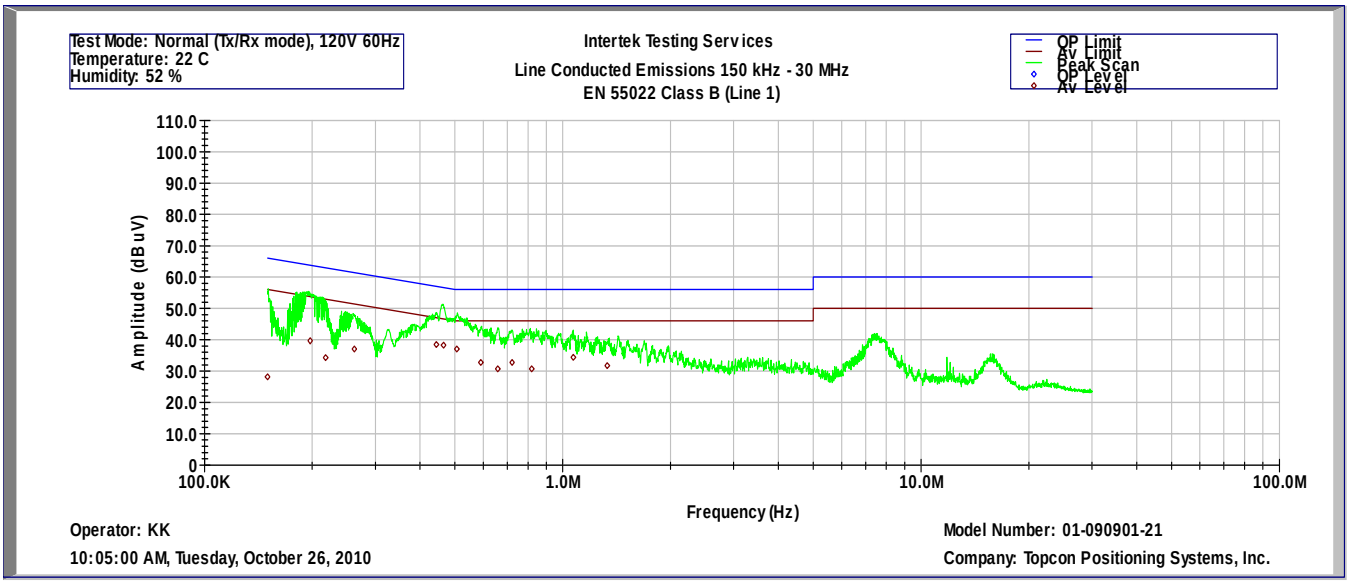
Conducted Disturbance at AC Mains



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 %

11.2.4 Test Setup Photographs

12.0 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.

13.0 List of Test Equipment

Measurement equipment used for 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
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	Sonoma	310N	293620	12	11/02/11
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	9170-3712	12	11/09/11
Horn Antenna	EMCO	3115	00126795	12	10/28/11
Oscilloscope	Tektronix	TDS 680C		12	09/20/11
Power Meter	Hewlett Packard	EPM-442A	US37480416	12	06/03/11
Signal Generator	Hewlett Packard	8663A	2537A00214	12	04/27/12
Signal Generator	Hewlett Packard	SMR40	100445	12	08/27/11

14.0 Document History

Revision/ Job Number	Writer Initials	Date	Change
1.0 / 100246399	KK	September 12, 2012	Original document