TEST REPORT

Report Number: 100387380MPK-003
Project Number: G100387380
May 15, 2012

Testing performed on the
DIG UHF-II Radio Module
Model: 05-100926-01LF
FCC ID: LCB-100926
IC ID: 6050B-100926
to

FCC Part 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	7449 Southfront Rd
Menlo Park, CA 94025 USA	Livermore, CA 94551, USA

Prepared by: _____ **Date:** May 15, 2012
Krishna K Vemuri

Reviewed by: _____ **Date:** May 15, 2012
Bryan Taylor

Report No. 100387380MPK-003

Equipment Under Test:	DIG UHF-II Radio Module
Trade Name:	Topcon Positioning Systems, Inc.
Part No.:	05-100926-01LF
Serial No.:	EMCProto1
FCC ID:	LCB-100926
IC ID:	6050B-100926
Applicant:	Topcon Positioning Systems, Inc.
Contact:	Mr. Leonid Edelman
Address:	7449 Southfront Rd Livermore, CA 94551
Country	USA
Tel. number:	(925) 245-8406
Fax number:	(925) 460-1318
Email:	Ledelman@topcon.com
Applicable Regulation:	FCC Part 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:	September 19 to November 22, 2011

We attest to the accuracy of this report:

Krishna K Vemuri	Bryan Taylor
EMC Senior Staff Engineer	EMC Team Leader

TABLE OF CONTENTS

1.0 Introduction

1.1 Product Description

The Equipment Under Test (EUT) is the DIG UHF-II Radio Module, model number 05-100926-01LF, consists of one UHF radio and one Bluetooth radio. This test report covers only the UHF radio. A separate test report, report # 100387380MPK-001, 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 DIG UHF-II is used for commercial, indoor and outdoor use.

The DIG UHF-II Radio Module provides real-time data transmission using spectrum efficient 4FSK/GFSK modulations.

The 05-100926-01LF provides half-duplex communication with transmitter output power of 1 W (+30 dBm) in the frequency bands 406.1-470 MHz for USA; 406.1-430 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	
Type	DIG UHF-II Radio Module
Rated RF Output Power	1 W
Frequency Ranges, MHz	USA 406.1-470 Canada 406.1-430 MHz and 450-470MHz
Type of Modulation	USA 406.1-470MHz, 12.5kHz: 4FSK/GFSK 406.1-420MHz, 25kHz: 4FSK/GFSK Canada 406.1-430 MHz and 450-470MHz, 12.5kHz: 4FSK/GFSK 406.1-430 MHz and 450-470MHz, 25kHz: 4FSK/GFSK
Channel Bandwidth and Maximum Data Rate	25 kHz at 38.4 kbps 12.5 kHz at 19.2 kbps
Antenna Type & Gain	½ Wave Dipole, 2.5dBi
Detachable Antenna	Yes
External Input	Data
Operating Temperature	From -30^0C to $+60^0$C

EUT receive date:	September 19 , 2011
EUT receive condition:	The prototype version of the EUT was received in good condition with no apparent damage. As declared by the Applicant it is identical to the production units.
Test start date:	September 19 , 2011
Test completion date:	November 22, 2011

1.2 Summary of Test Results

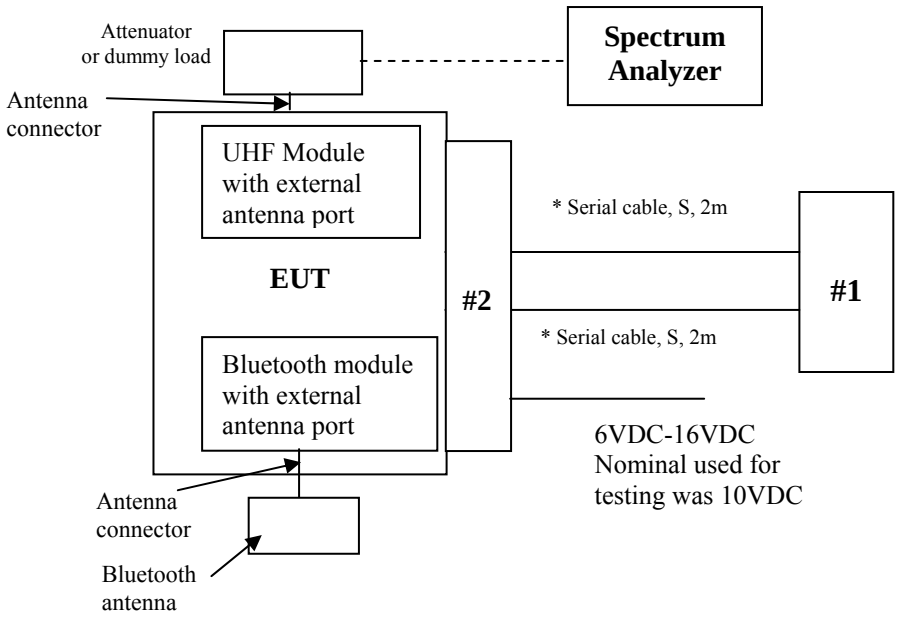
FCC Rule	RSS-119 Rule	Description of Test	Result
2.1046	4.1	RF Power Output	Complies
90.205(h)	-	ERP	Complies
2.1047	-	Modulation Characteristics	Not Applicable
2.1049, 90.209	RSS-GEN	Occupied Bandwidth	Complies
90.210	5.8	Emission Masks	Complies
2.1051, 90.210	5.8	Out of Band Emissions at Antenna Terminals	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	nc6400	CND7062PVK
2	Topcon Test Board	Not Labeled	Not Labeled

1.3.2 Block Diagram of Test Setup



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

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

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 report 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 OFFSET function.

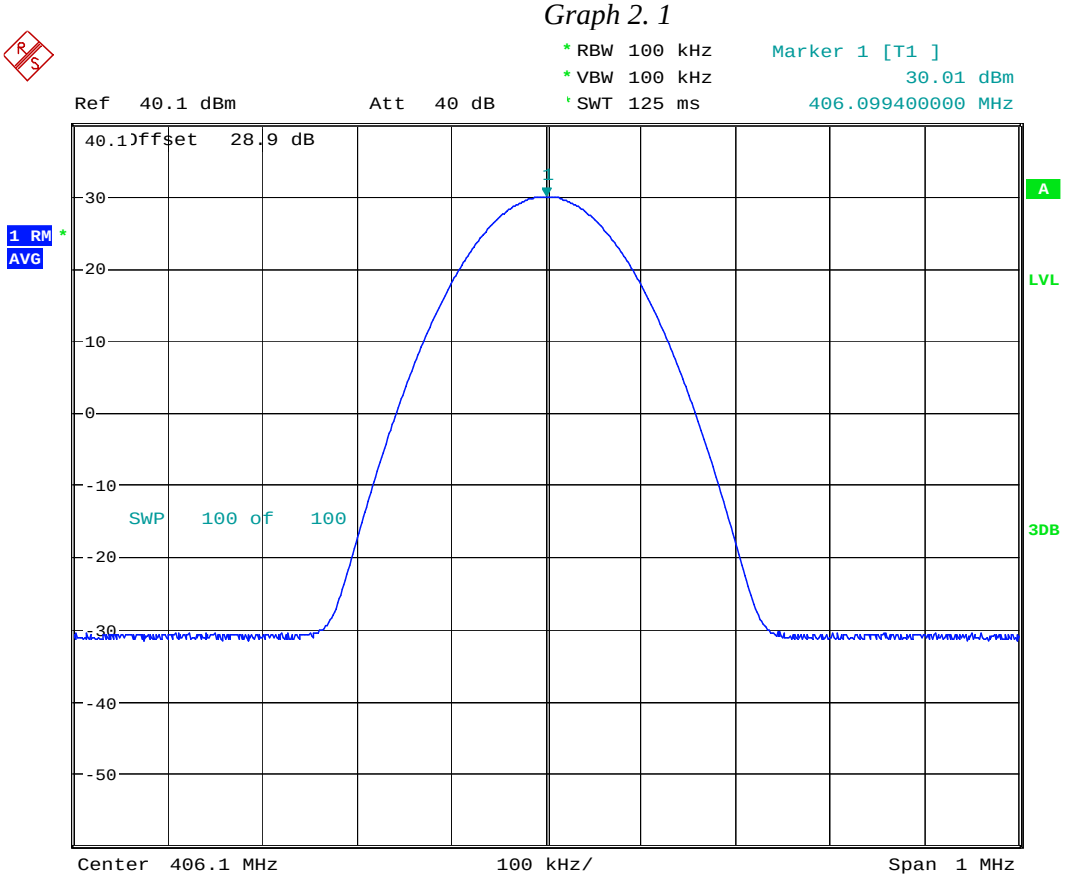
Measurements were performed at 406.1MHz, 430MHz, 450MHz and 470MHz frequencies (low, middle, and high channels).

2.2 Test Results

Frequency (MHz)	Measured Output Power (dBm)	Measured Output Power (Watt)	Graph
406.1	30.0	1.000	2.1
430.0	30.3	1.072	2.2
450.0	29.9	0.977	2.3
470.0	30.4	1.096	2.4

Refer to the attached Graphs.

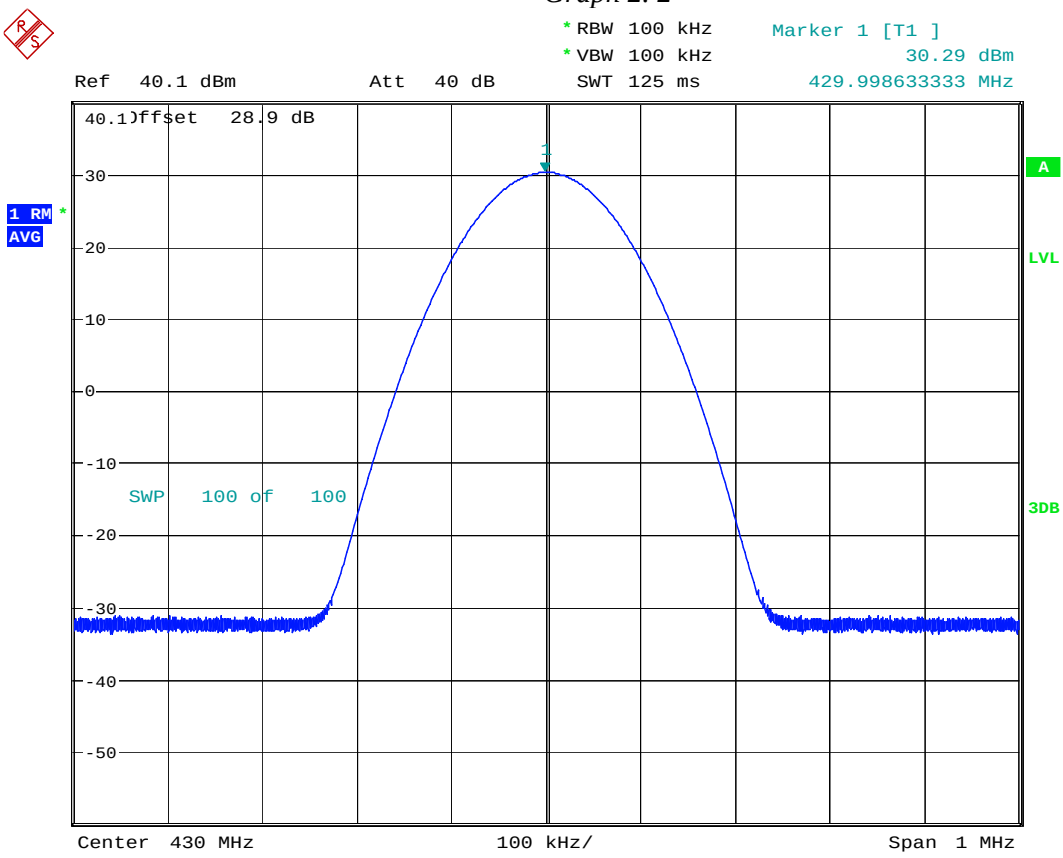
Graph 2. 1



Power output

Date: 20.SEP.2011 15:57:16

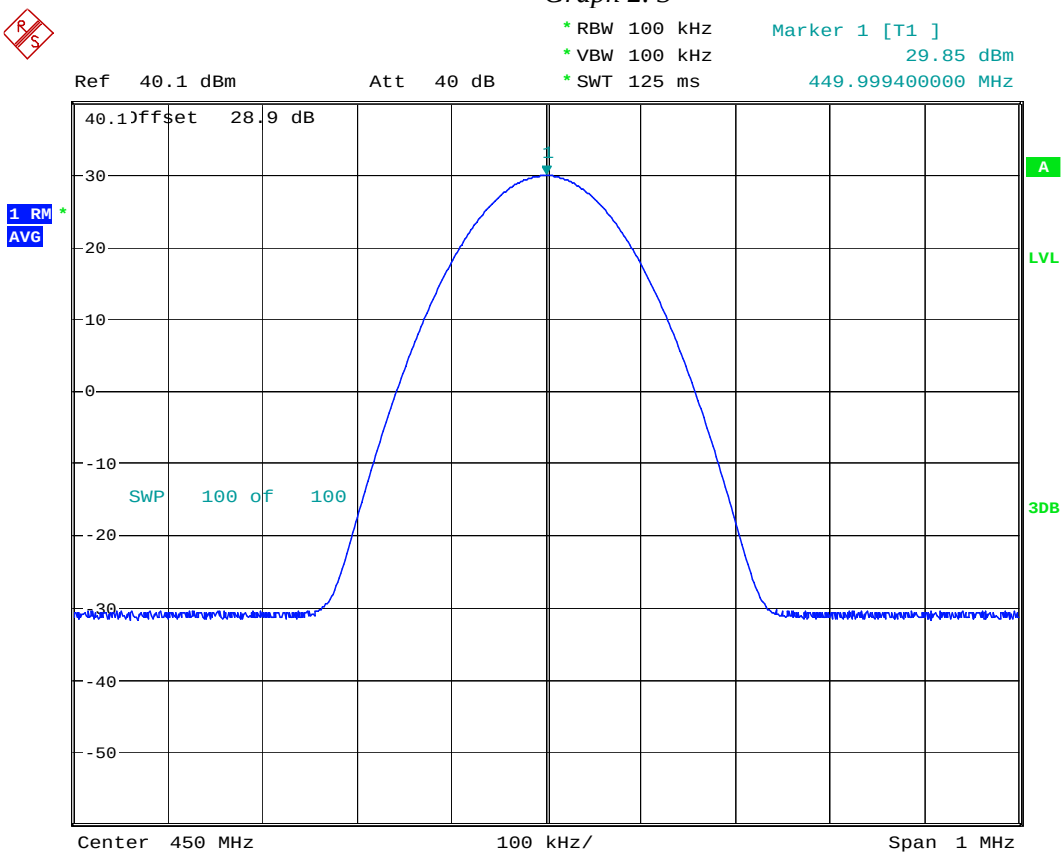
Graph 2. 2



Power output

Date: 22.SEP.2011 15:22:56

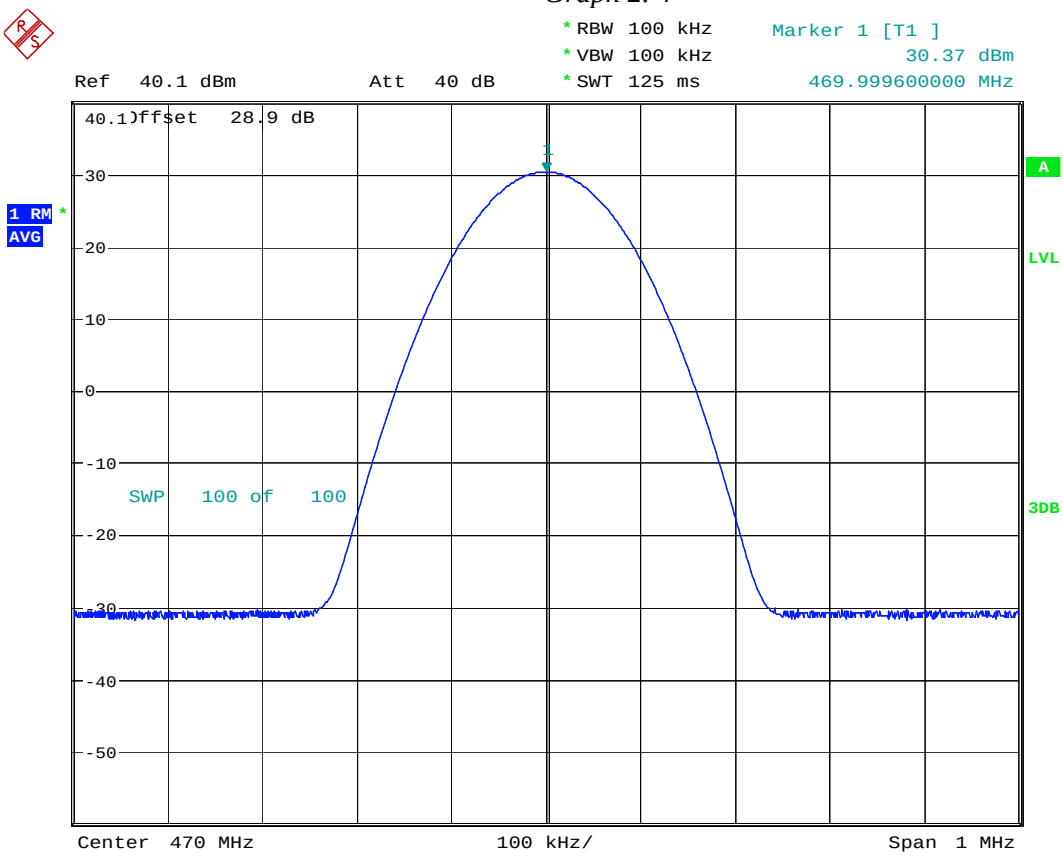
Graph 2. 3



Power output

Date: 20.SEP.2011 15:59:41

Graph 2. 4



Power output

Date: 20.SEP.2011 16:00:59

3.0 Radiated Power

FCC 90.205(h)

3.1 Requirement

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 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 report 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 406.1MHz and 470MHz for all types of modulation and authorized bandwidths.

4.2 Test Results

The test results are summarized in the following tables and presented on the Graphs 4.1 – 4.8.

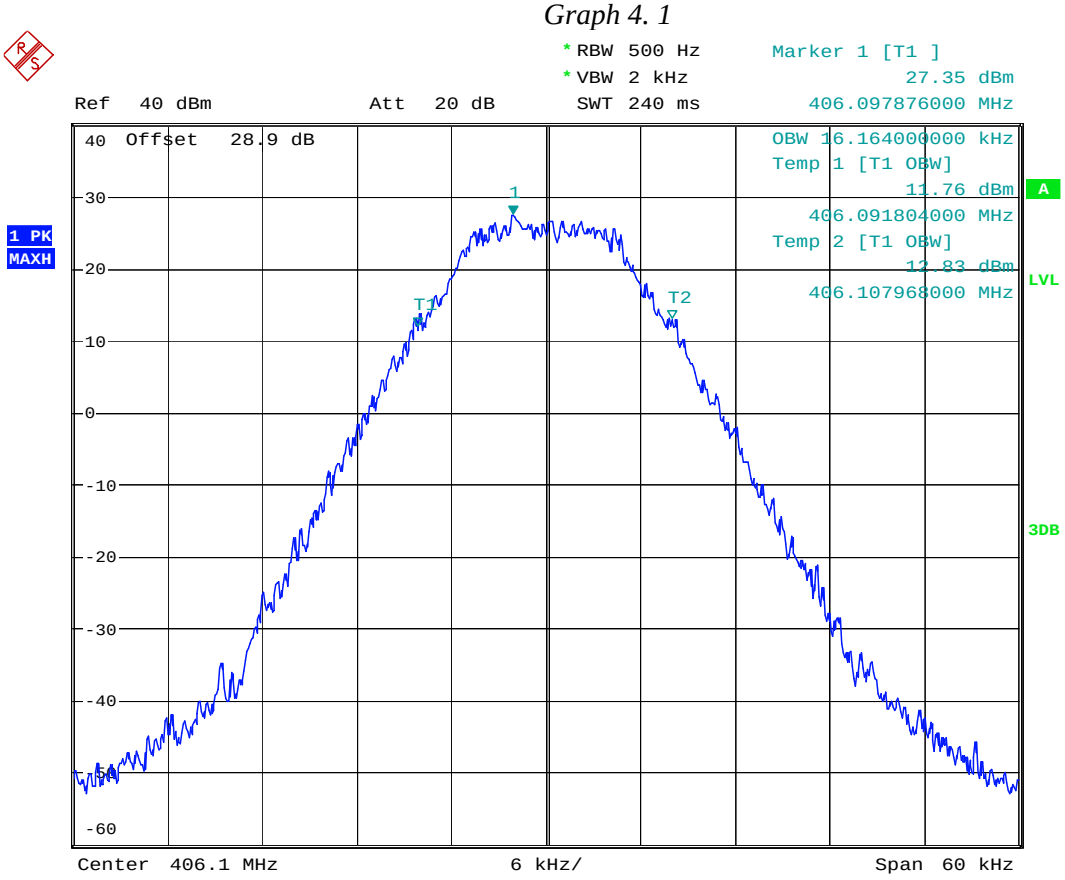
The following Emission Designators describe the emission type:

16K16F1D
10K63F1D
6K47F1D
4K85F1D

Frequency (MHz)	Modulation	Channel Bandwidth (kHz)	Authorized Bandwidth (kHz)	Measured Occupied Bandwidth (kHz)	Graph
406.1	4FSK	25.0	20.0	16.16	4.1
	GFSK			10.61	4.4
470	4FSK	25.0	20.0	15.84	4.2
	GFSK			10.63	4.3
406.1	4FSK	12.5	11.25	6.47	4.5
	GFSK			4.85	4.8
470	4FSK	12.5	11.25	6.29	4.6
	GFSK			4.81	4.7

Refer to the attached Graphs.

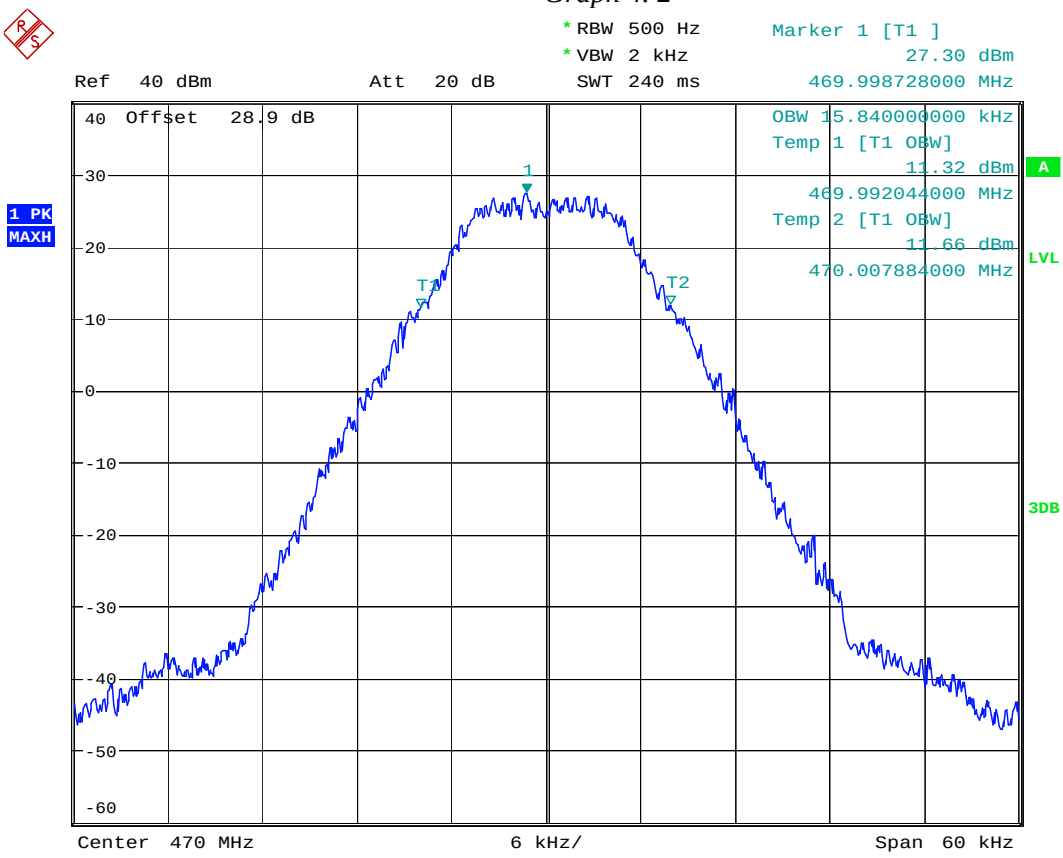
Graph 4. 1



Occupied bandwidth, 20kHz authorized bandwidth, 4FSK

Date: 20.SEP.2011 16:22:45

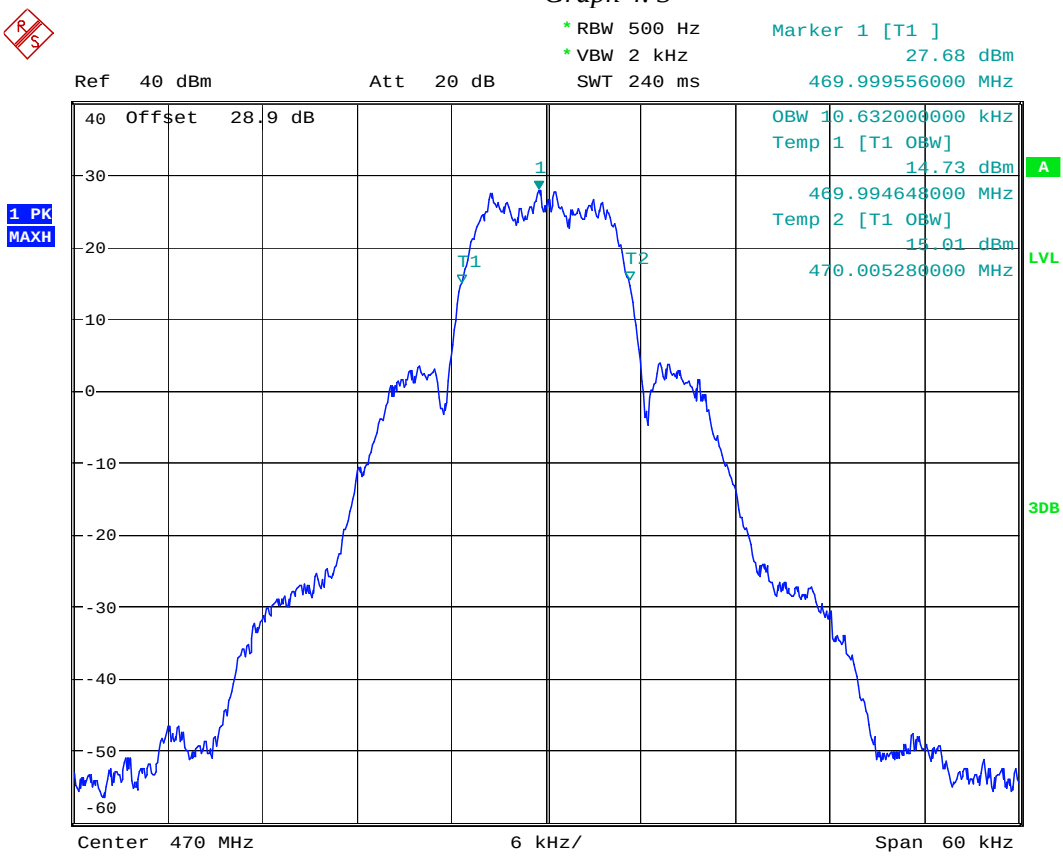
Graph 4. 2



Occupied bandwidth, 20kHz authorized bandwidth, 4FSK

Date: 20.SEP.2011 16:26:10

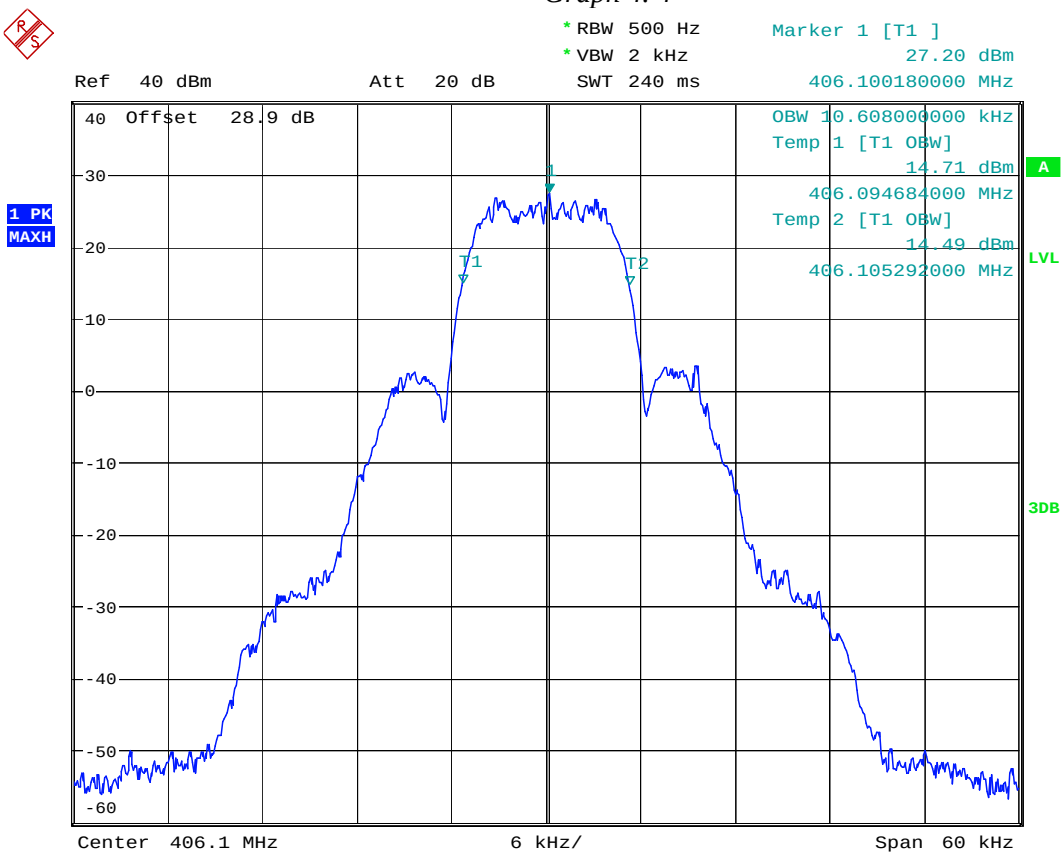
Graph 4. 3



Occupied bandwidth, 20kHz authorized bandwidth, GFSK

Date: 20.SEP.2011 16:30:36

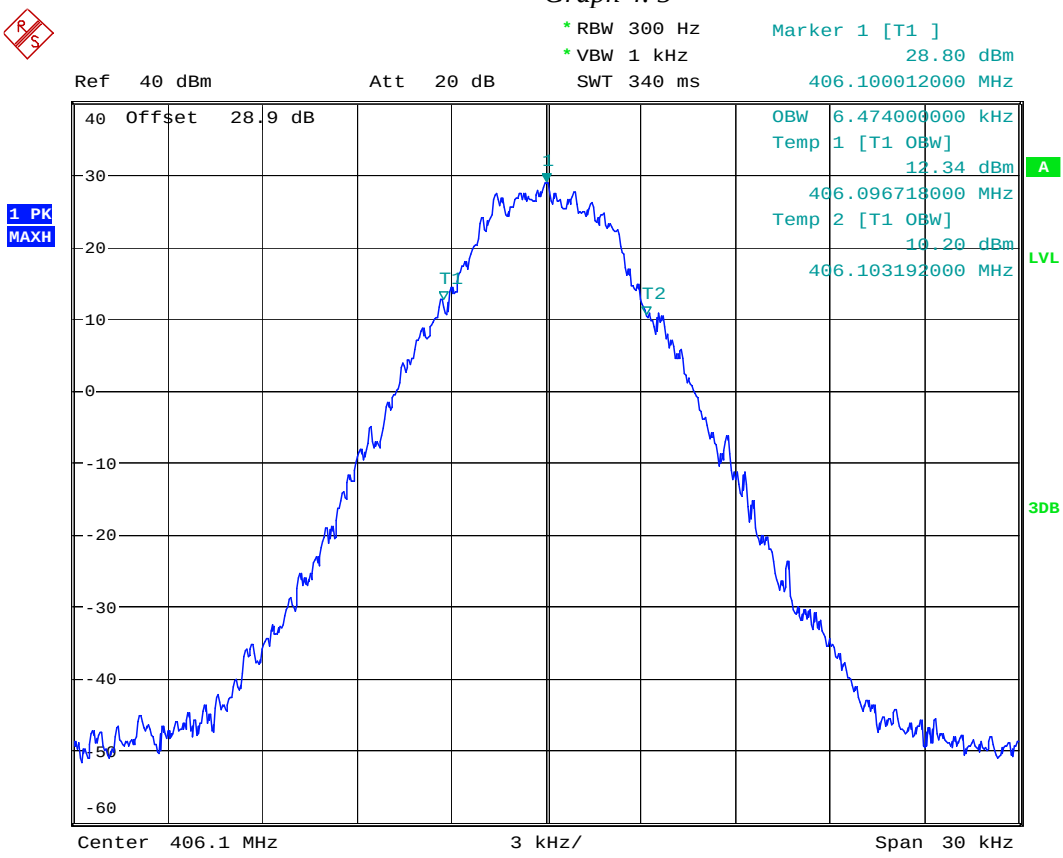
Graph 4. 4



Occupied bandwidth, 20kHz authorized bandwidth, GFSK

Date: 20.SEP.2011 16:32:58

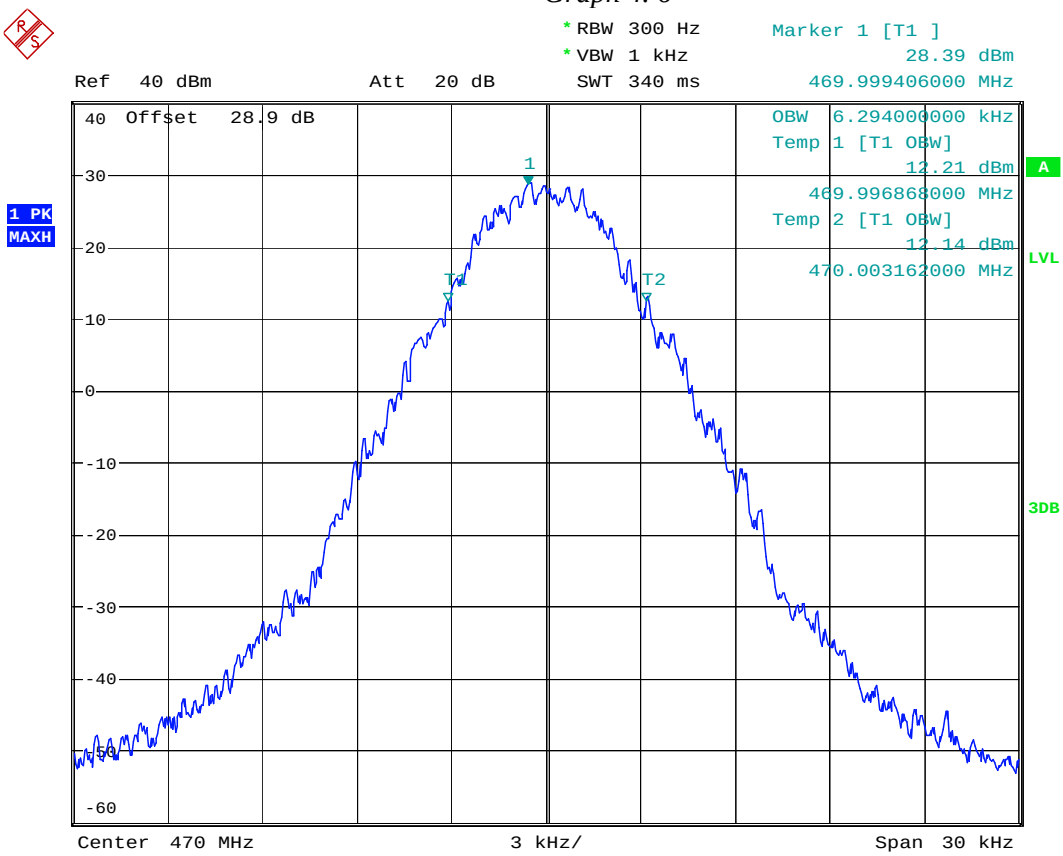
Graph 4. 5



Occupied bandwidth, 11.25kHz authorized bandwidth, 4FSK

Date: 20.SEP.2011 16:38:47

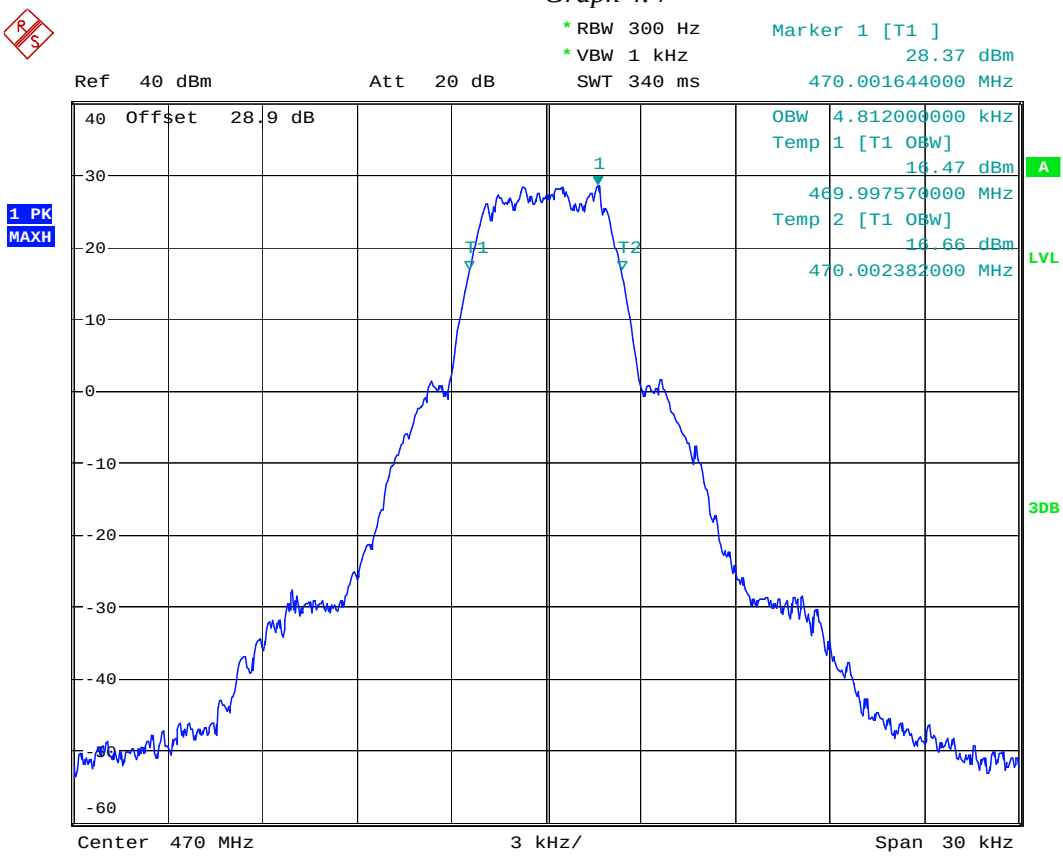
Graph 4. 6



Occupied bandwidth, 11.25kHz authorized bandwidth, 4FSK

Date: 20.SEP.2011 16:39:43

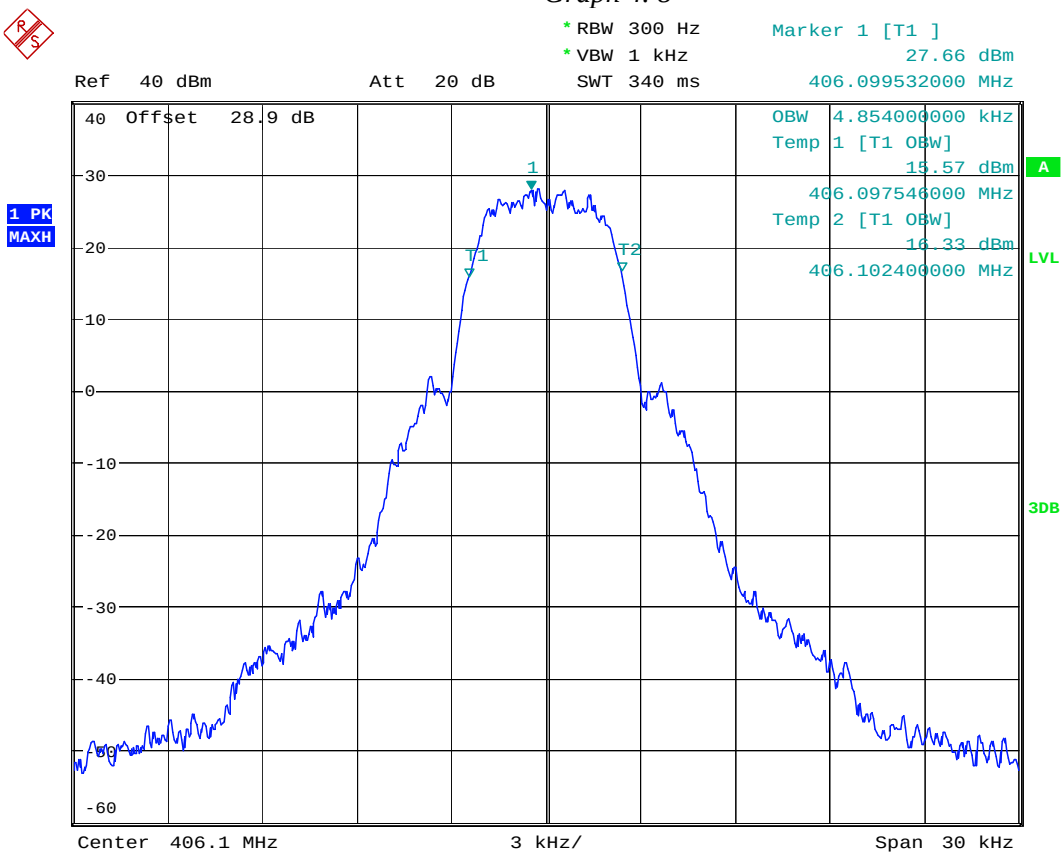
Graph 4. 7



Occupied bandwidth, 11.25kHz authorized bandwidth, GFSK

Date: 20.SEP.2011 16:44:05

Graph 4. 8



Occupied bandwidth, 11.25kHz authorized bandwidth, GFSK

Date: 20.SEP.2011 16:45:09

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 report section 1.3.2. The EUT was setup to transmit the maximum power.

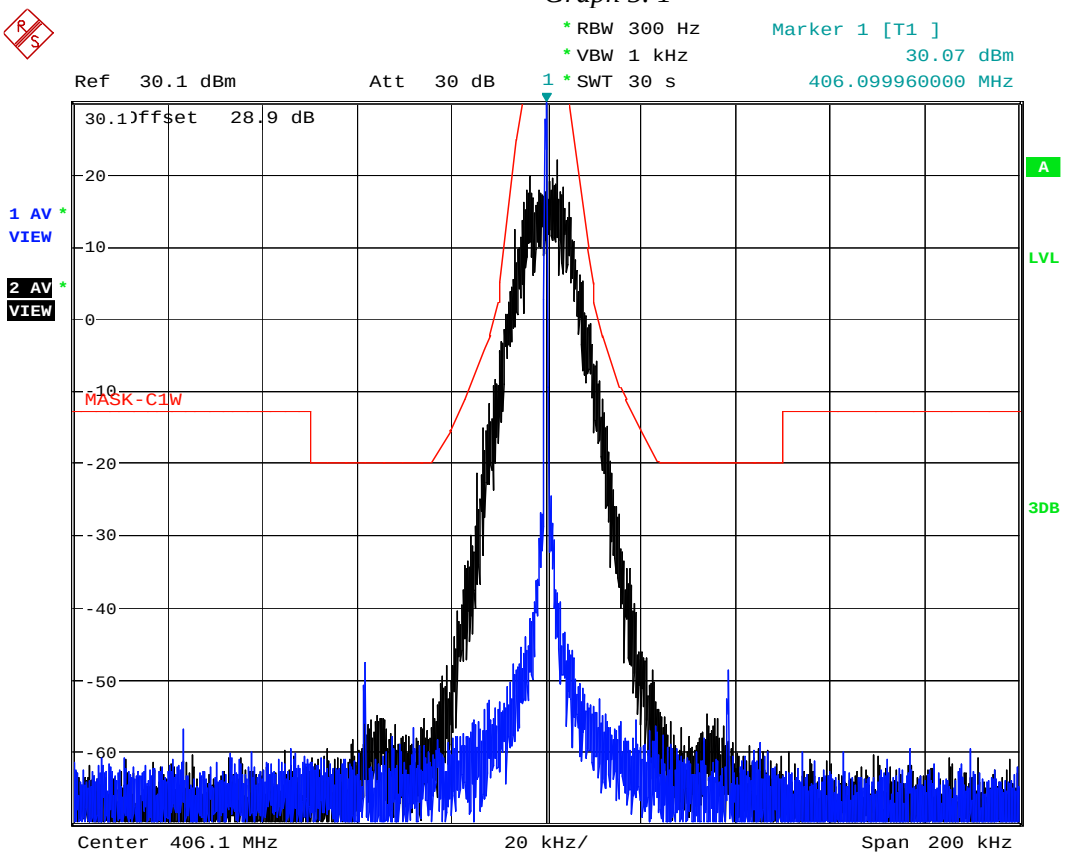
The spectrum analyzer was setup to measure the Emission at frequencies ± 100 kHz from the fundamental frequency – for Mask C, ± 31.25 kHz – for Mask D, ± 22.5 kHz – for Mask E. The peak detector is used for these measurements.

The Emission Mask was measured at 406.1MHz and 470MHz for all types of modulation.

5.3 Test Results

Complies with Emission Mask Requirements. Refer to the attached Graphs: 5.1 – 5.8.

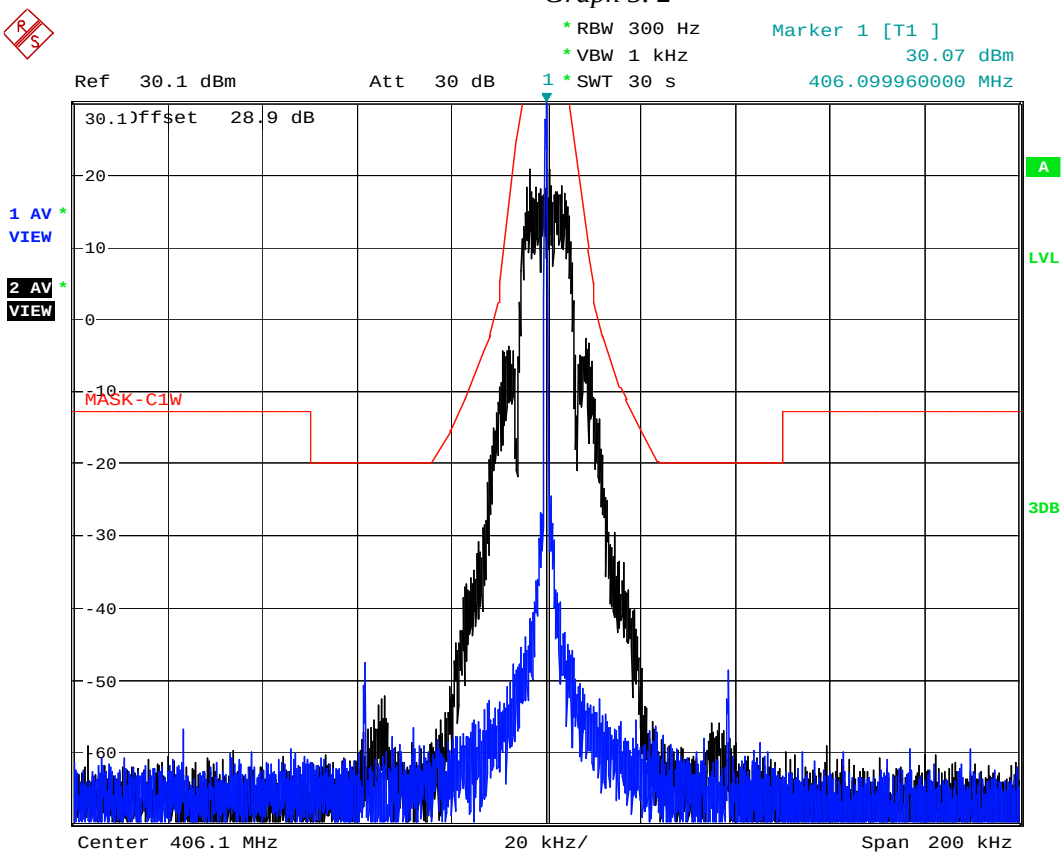
Graph 5. 1



Emission Mask, 25kHz ch spacing, 4FSK

Date: 20.SEP.2011 18:02:17

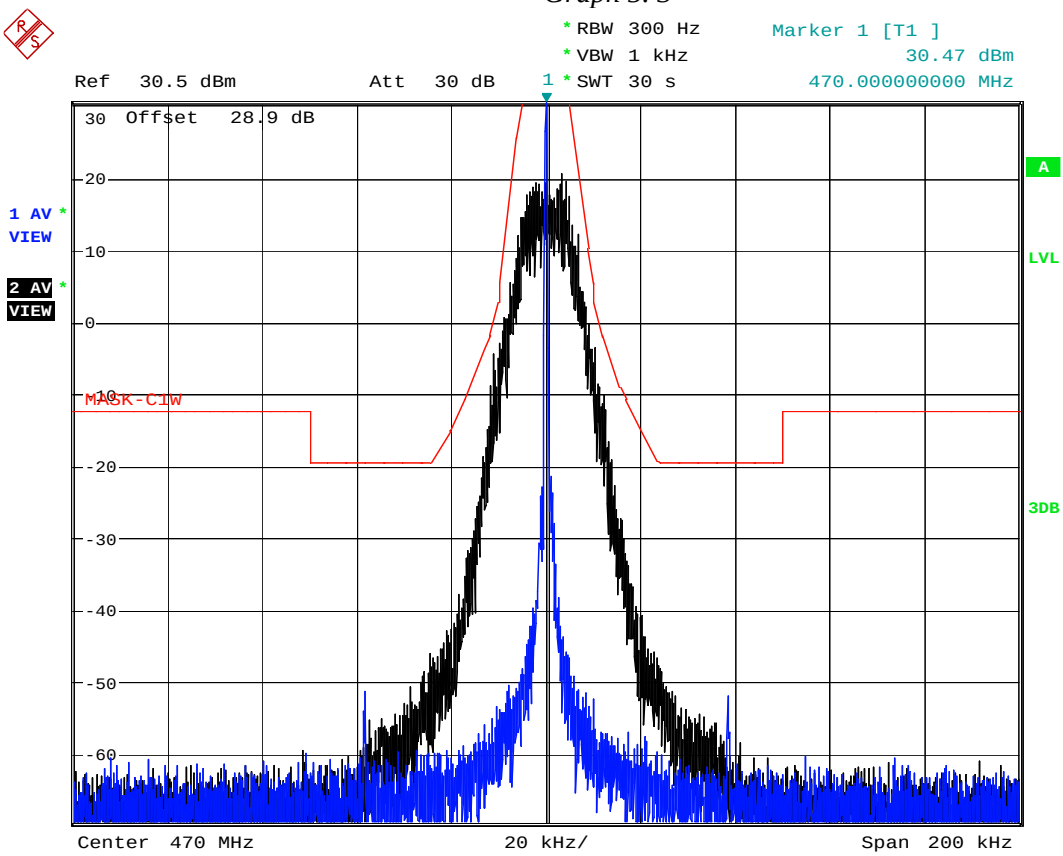
Graph 5. 2



Emission Mask, 25kHz ch spacing, GFSK

Date: 20.SEP.2011 18:56:13

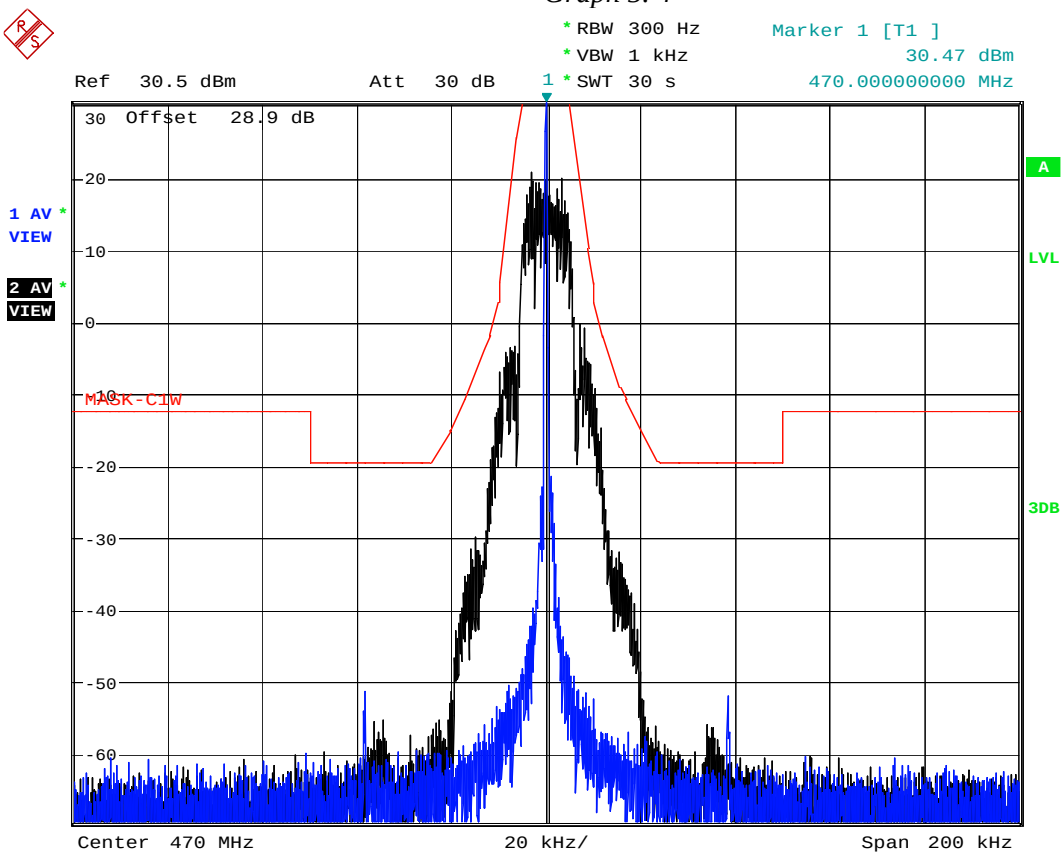
Graph 5. 3



Emission Mask, 25kHz ch spacing, 4FSK

Date: 21.SEP.2011 10:28:27

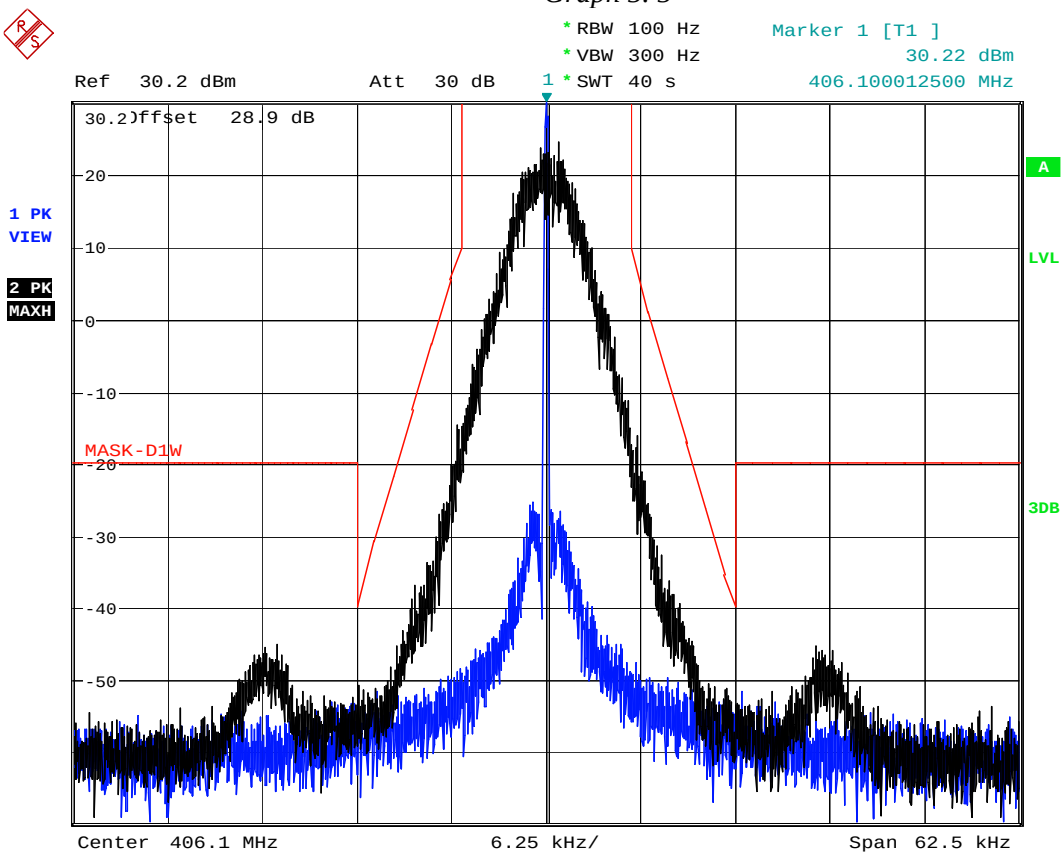
Graph 5. 4



Emission Mask, 25kHz ch spacing, GFSK

Date: 21.SEP.2011 10:30:27

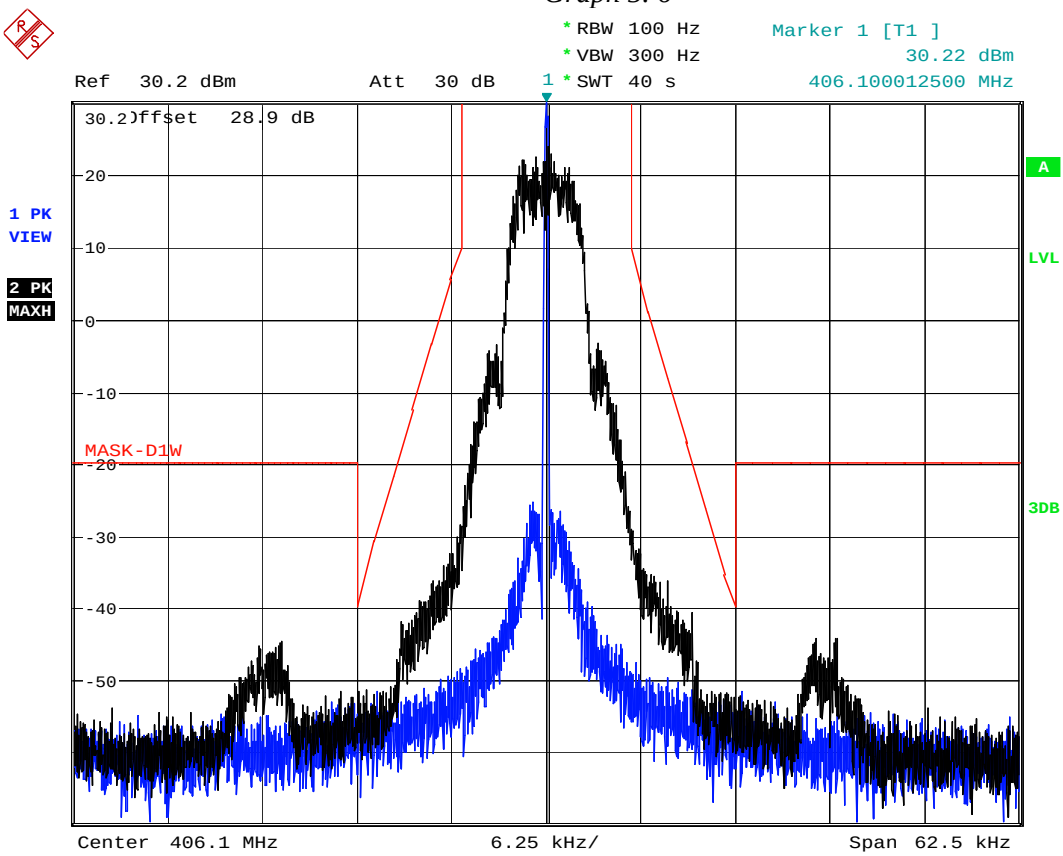
Graph 5. 5



Emission Mask, 12.5kHz ch spacing, 4FSK

Date: 21.SEP.2011 10:49:04

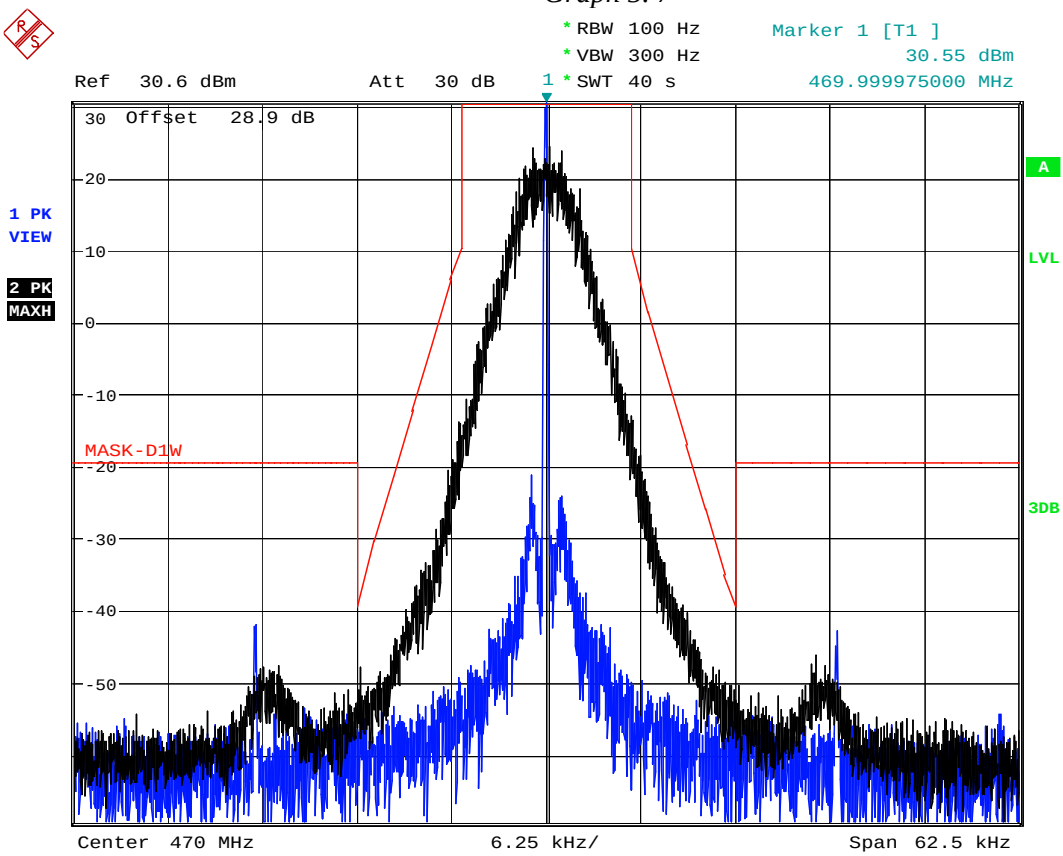
Graph 5. 6



Emission Mask, 12.5kHz ch spacing, GFSK

Date: 21.SEP.2011 10:51:33

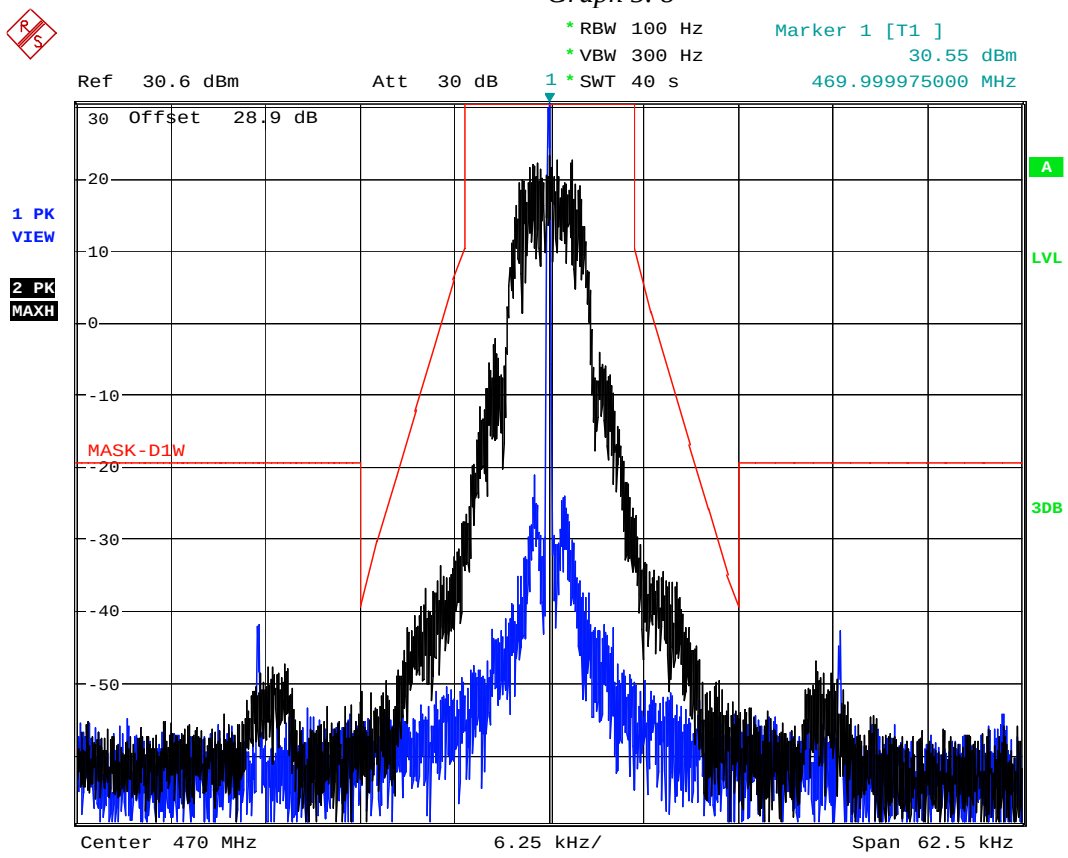
Graph 5. 7



Emission Mask, 12.5kHz ch spacing, 4FSK

Date: 21.SEP.2011 11:05:11

Graph 5. 8



Emission Mask, 12.5kHz ch spacing, GFSK

Date: 21.SEP.2011 11:07:06

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 report section 1.3.2. The EUT was setup to transmit the maximum power.

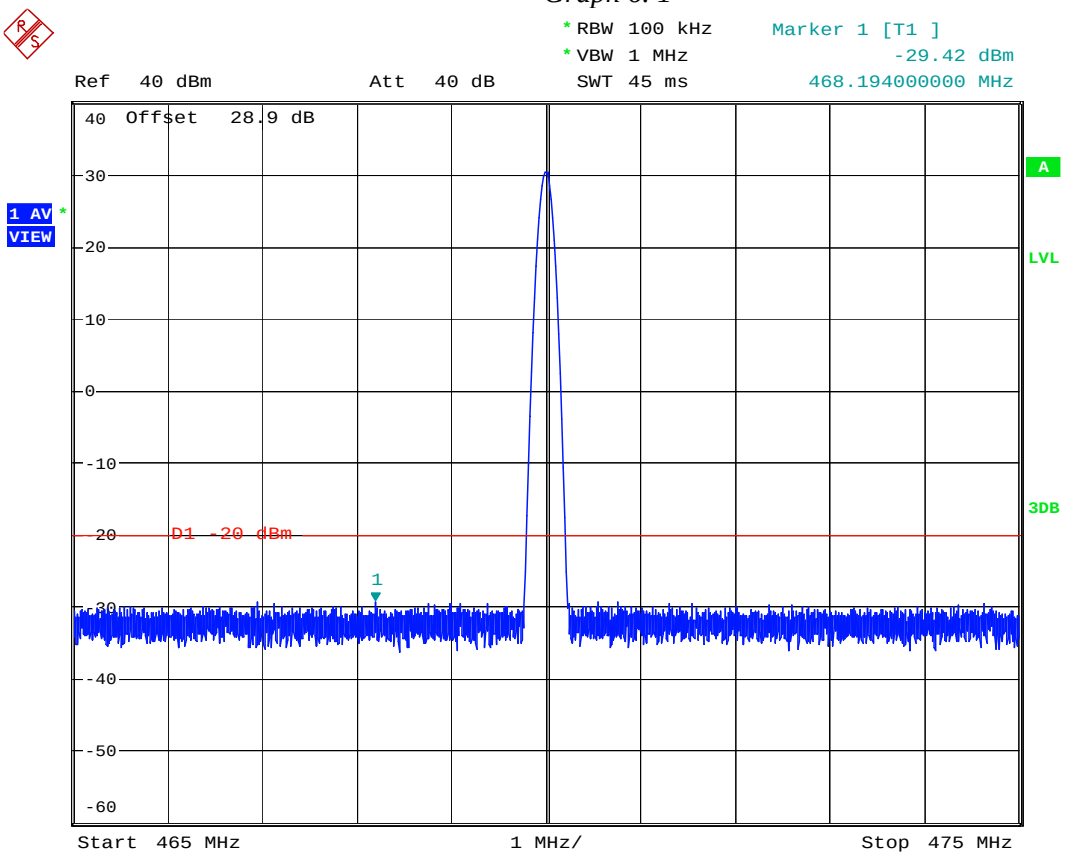
For measurements at frequencies below 1 GHz, the spectrum analyzer resolution bandwidth was set to 10 kHz. For measurements at frequencies above 1 GHz, the spectrum analyzer resolution bandwidth was set to 1 MHz. Average detector is used for these measurements.

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

6.3 Test Results

Complies	Refer to the following Graphs

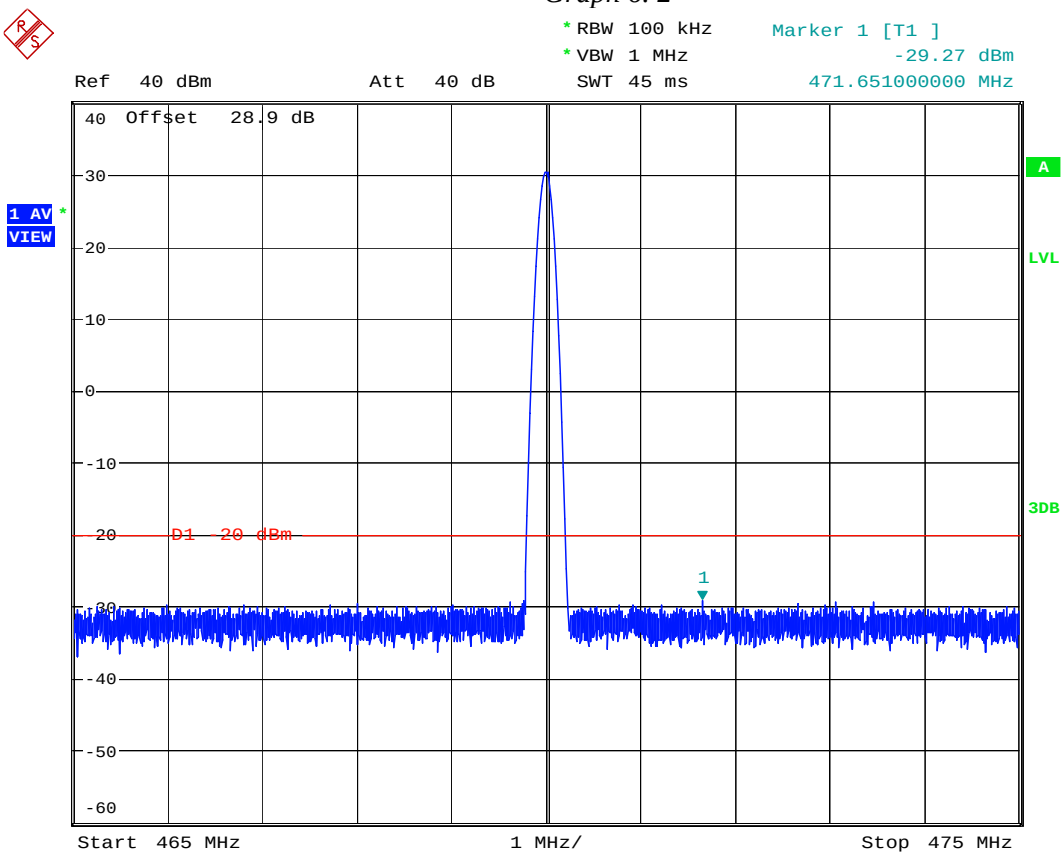
Graph 6. 1



Conducted Spurious, 470MHz, Unmodulated

Date: 21.SEP.2011 11:39:44

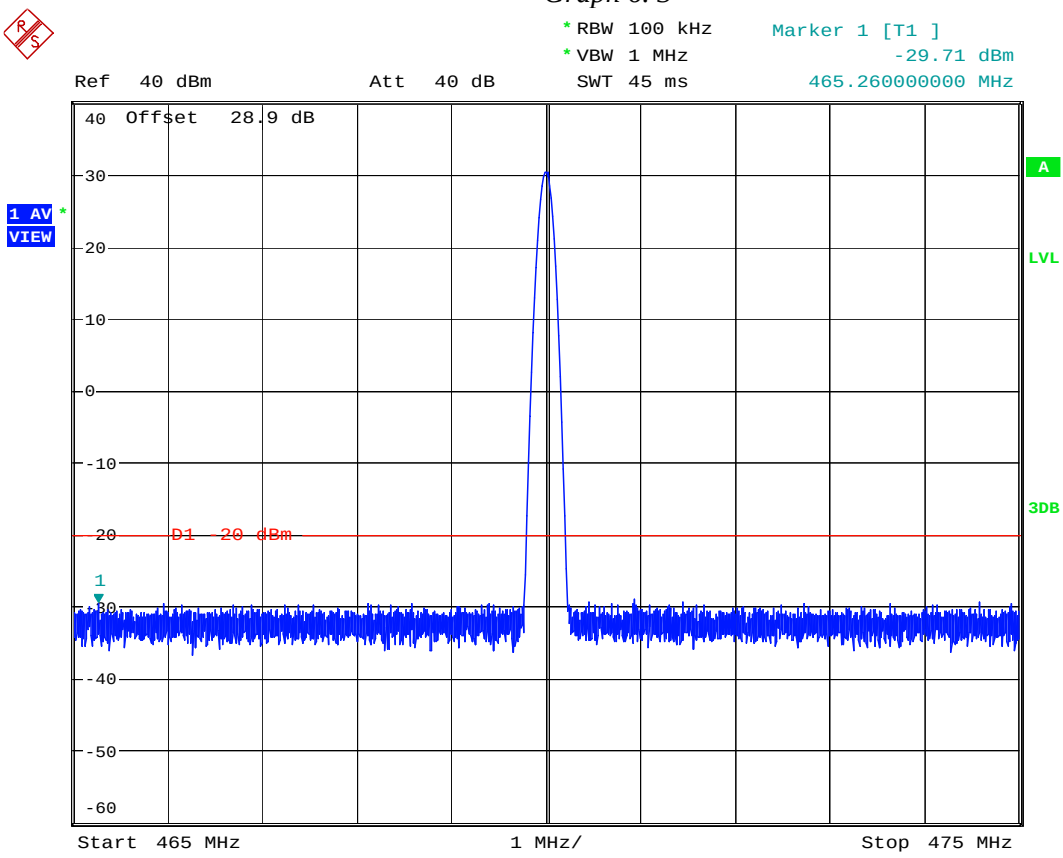
Graph 6. 2



Conducted Spurious, 470MHz, GFSK

Date: 21.SEP.2011 11:42:43

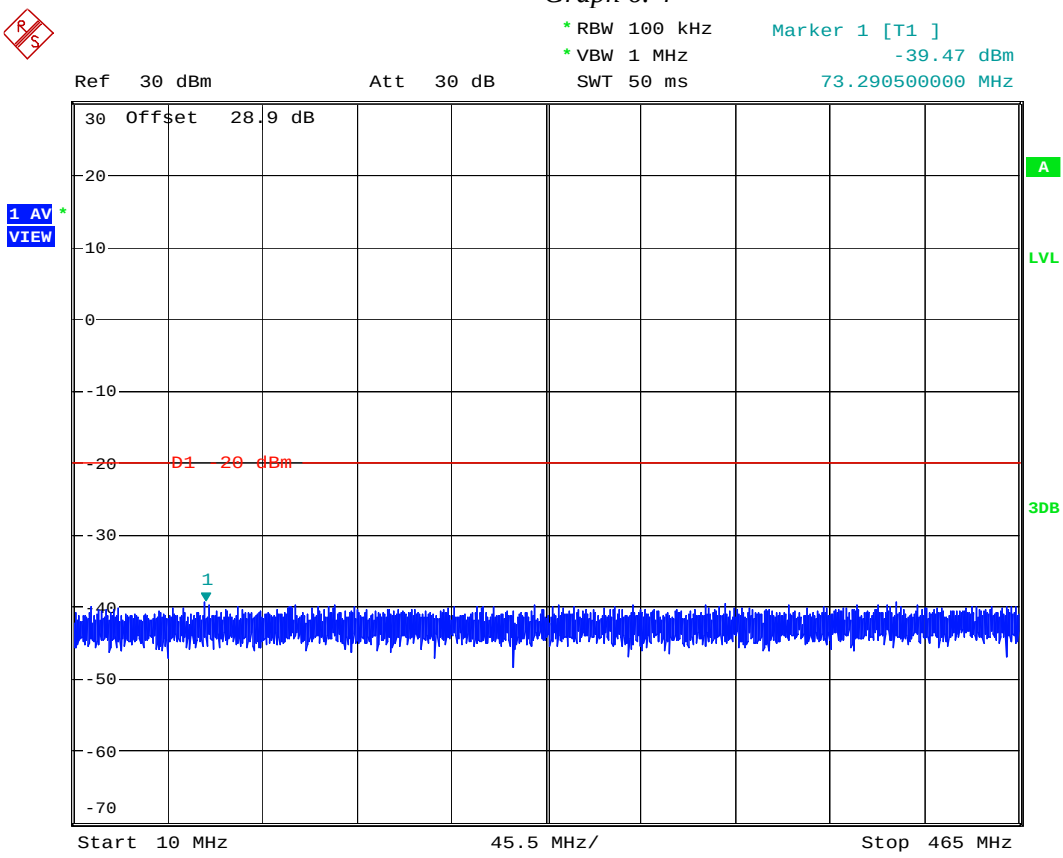
Graph 6. 3



Conducted Spurious, 470MHz, 4FSK

Date: 21.SEP.2011 11:43:44

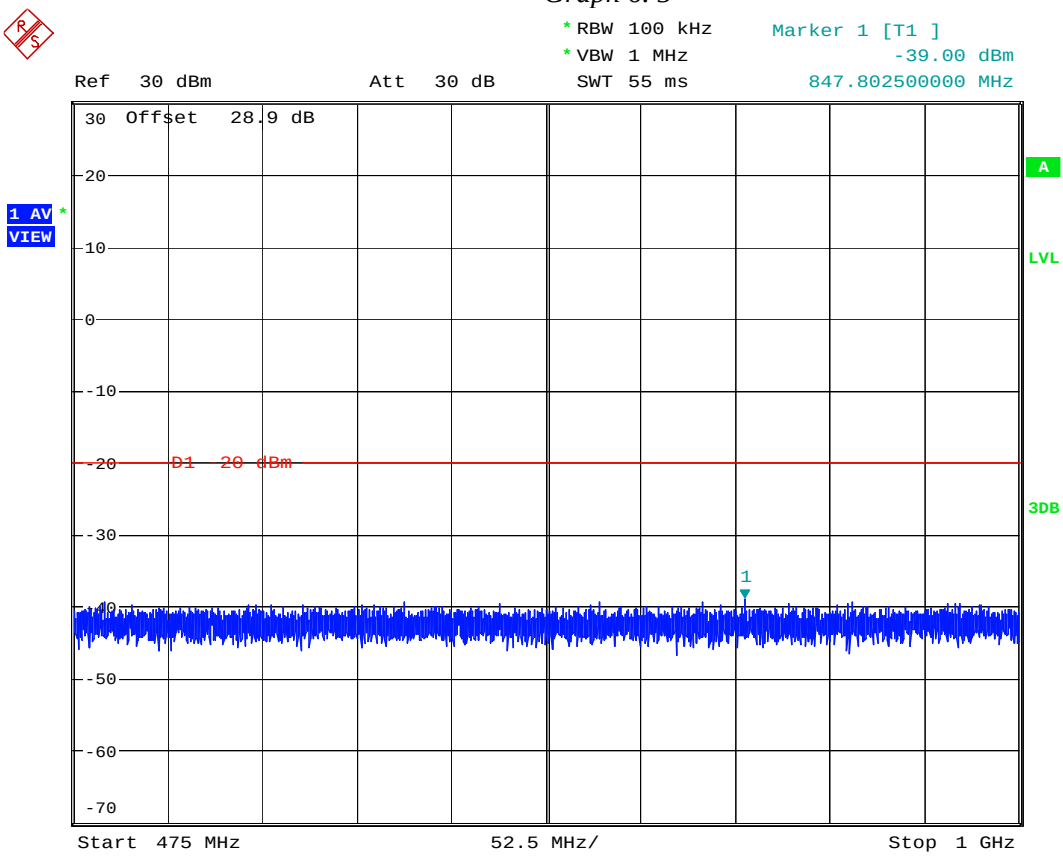
Graph 6. 4



Conducted Spurious, 470MHz, 4FSK

Date: 21.SEP.2011 12:01:22

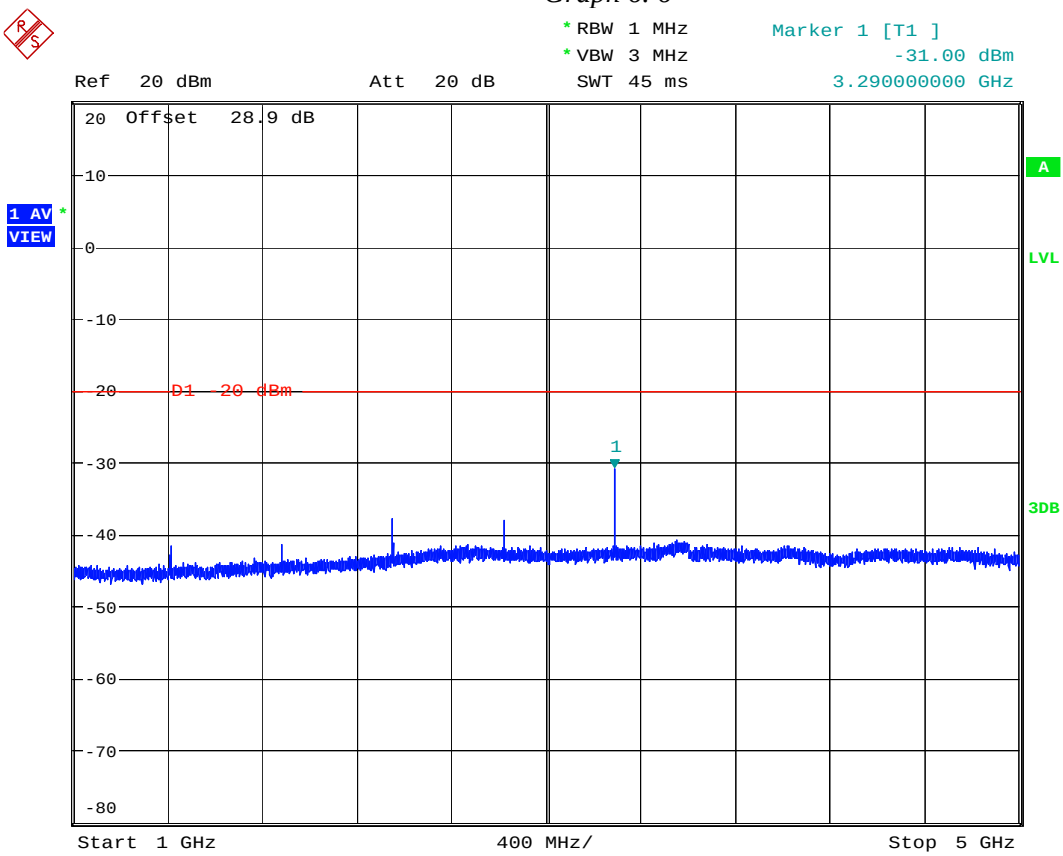
Graph 6. 5



Conducted Spurious, 470MHz, 4FSK

Date: 21.SEP.2011 12:03:23

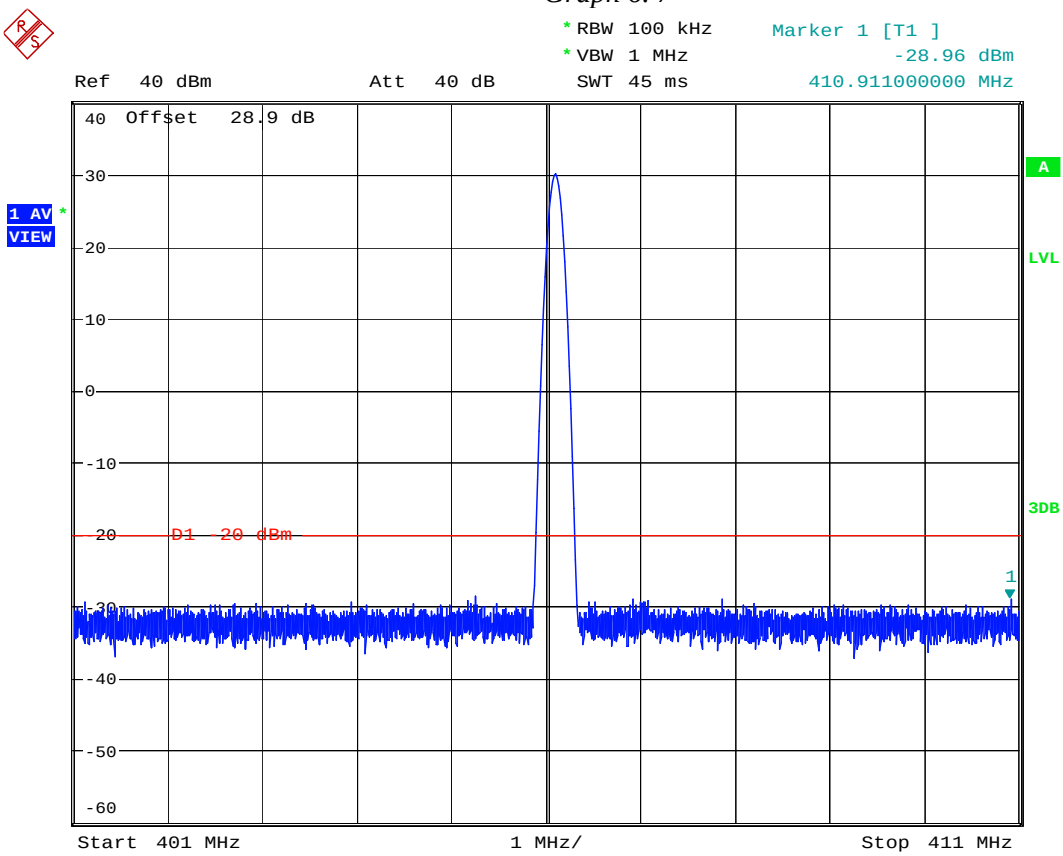
Graph 6. 6



Conducted Spurious, 470MHz, 4FSK

Date: 21.SEP.2011 12:06:59

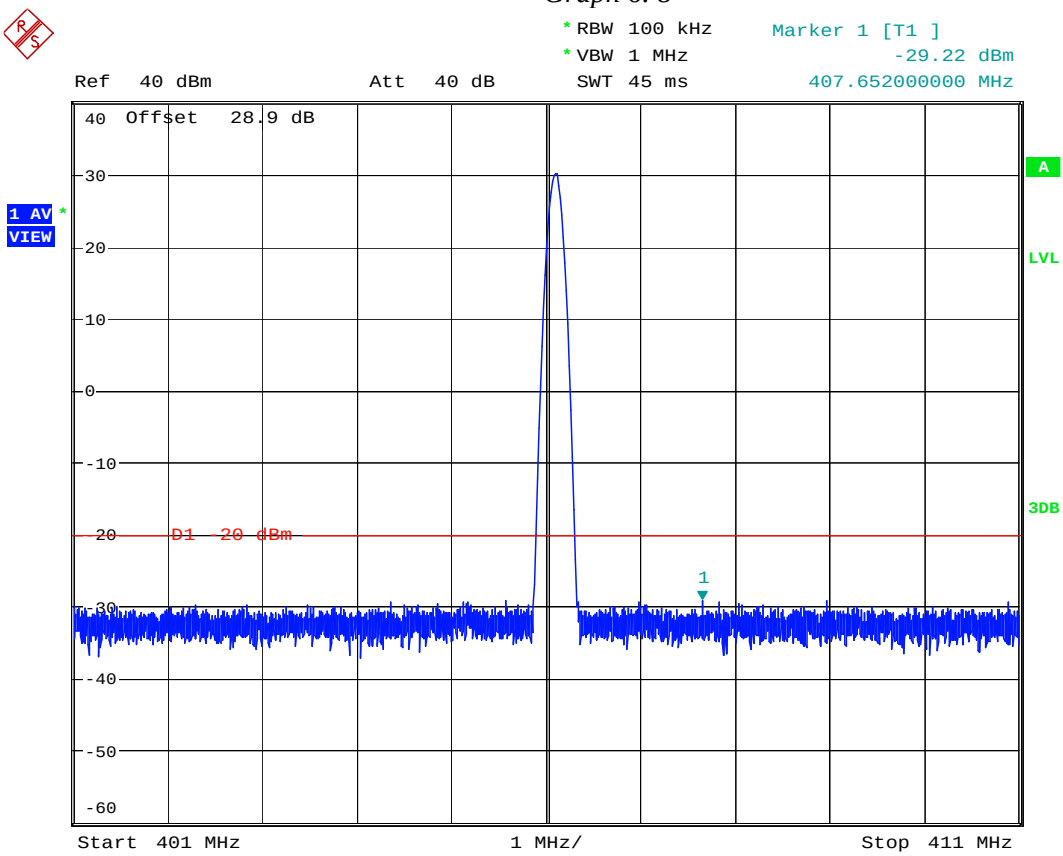
Graph 6. 7



Conducted Spurious, 406.1MHz, Unmodulated

Date: 21.SEP.2011 11:34:27

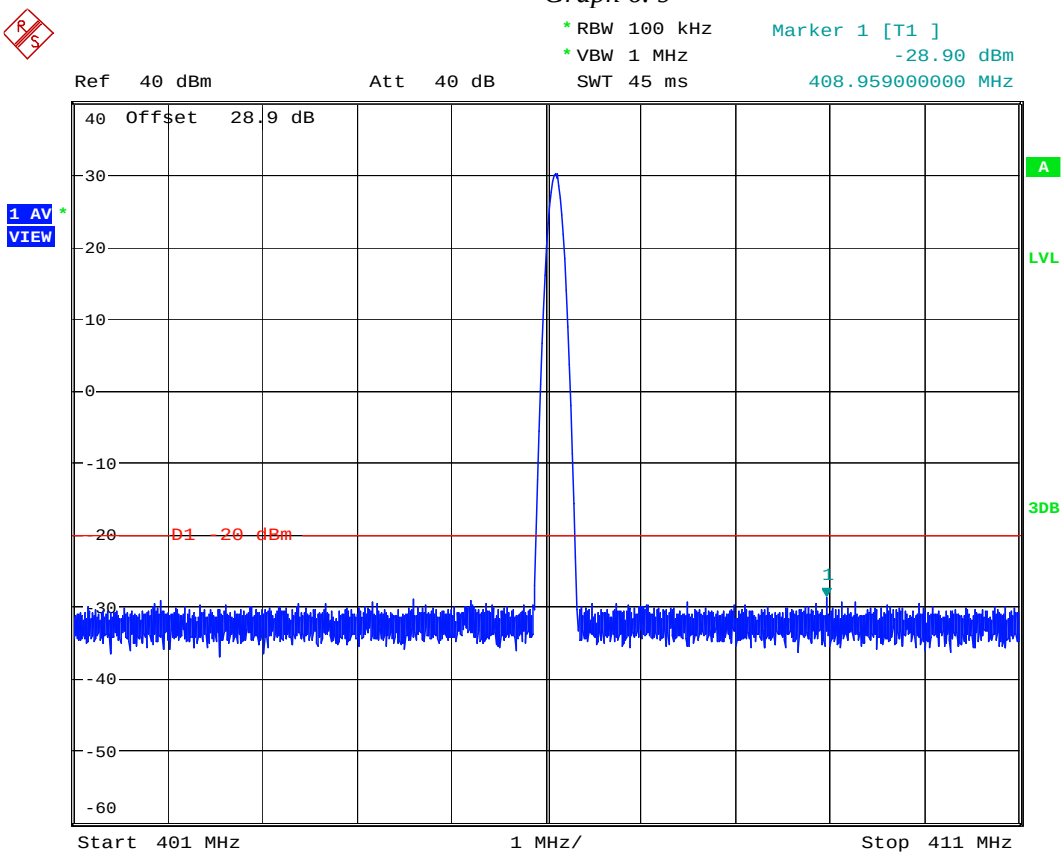
Graph 6. 8



Conducted Spurious, 406.1MHz, GFSK

Date: 21.SEP.2011 11:36:26

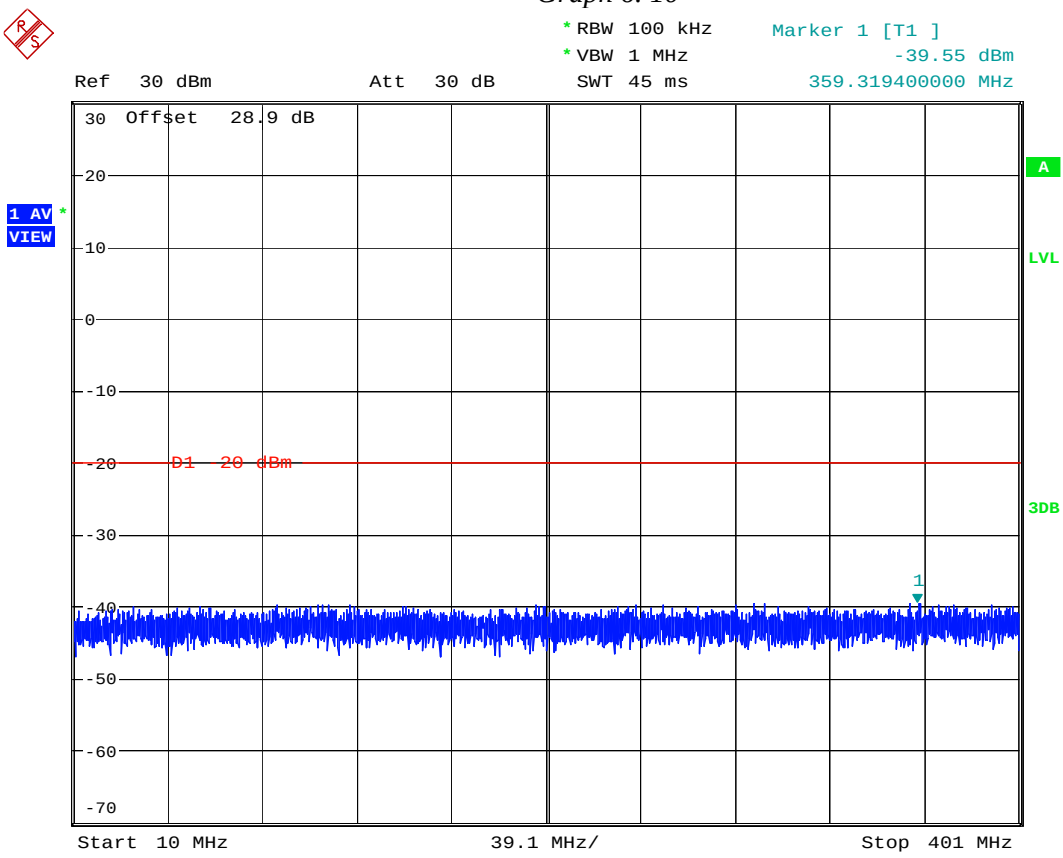
Graph 6. 9



Conducted Spurious, 406.1MHz, 4FSK

Date: 21.SEP.2011 11:37:27

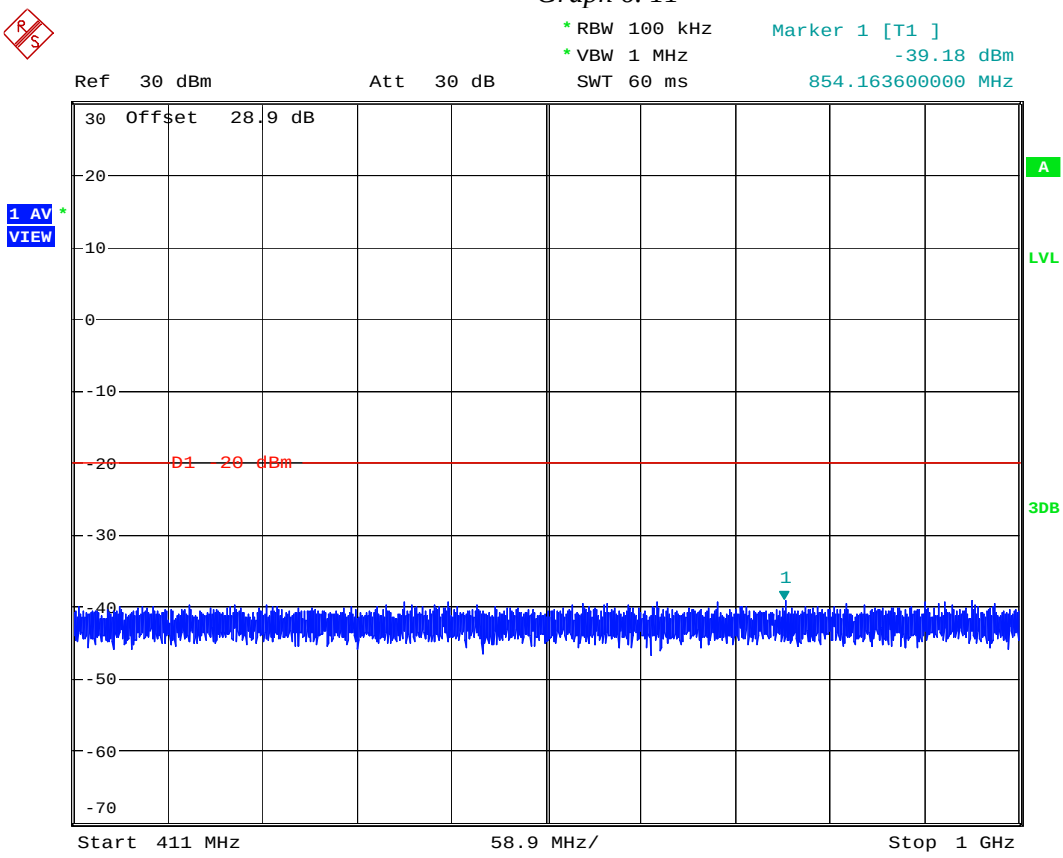
Graph 6. 10



Conducted Spurious, 406.1MHz, 4FSK

Date: 21.SEP.2011 12:15:49

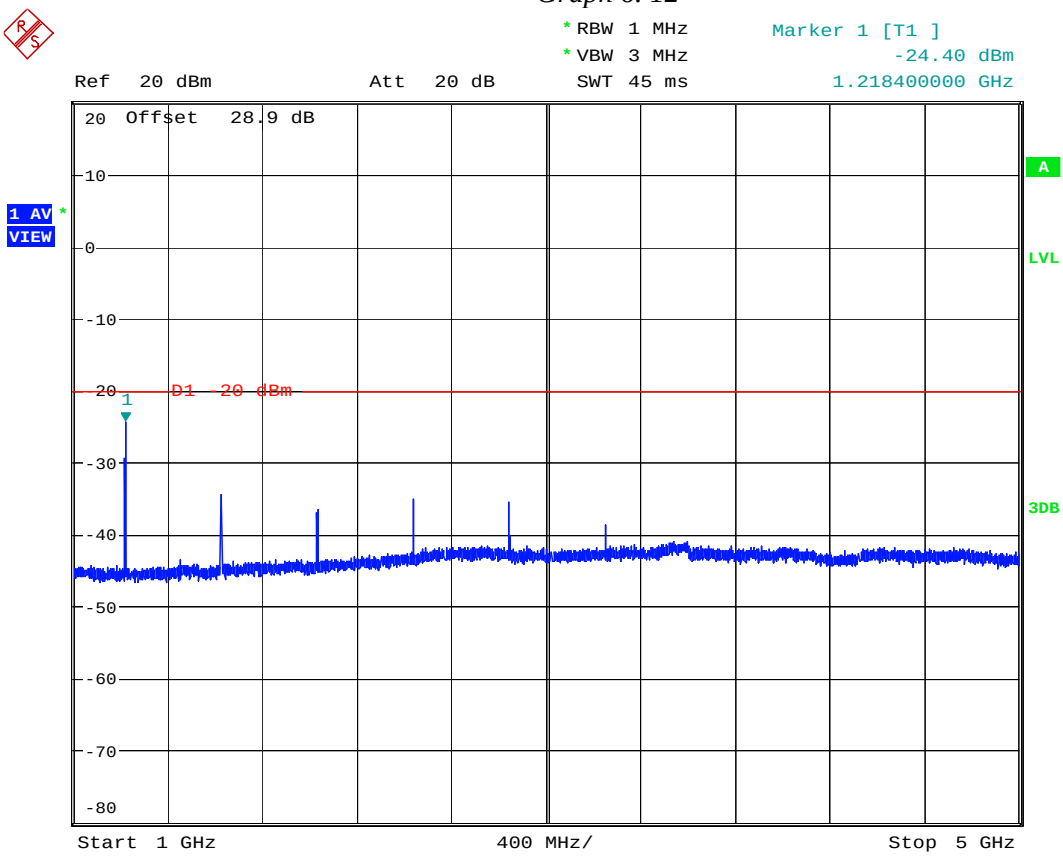
Graph 6. 11



Conducted Spurious, 406.1MHz, 4FSK

Date: 21.SEP.2011 12:17:25

Graph 6. 12



Conducted Spurious, 406.1MHz, 4FSK

Date: 21.SEP.2011 12:13:18

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.

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

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

7.3 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 406.1 MHz					
186.0	52.8	-54.7	-54.7	-20.0	-34.7
190.9	52.8	-54.7	-54.7	-20.0	-34.7
346.1	48.2	-53.8	-53.8	-20.0	-33.8
462.5	47.7	-52.0	-52.0	-20.0	-32.0
812.2	41.9	-52.9	-52.9	-20.0	-32.9
1218.3	48.2	-61.8	-56.8	-20.0	-36.8
1624.4	45.7	-65.0	-58.1	-20.0	-38.1
2030.5	44.8	-61.3	-55.6	-20.0	-35.6
2436.6	51.7	-57.0	-49.1	-20.0	-29.1
2842.7	50.8	-57.1	-48.7	-20.0	-28.7
3248.8	45.7	-60.4	-52.0	-20.0	-32.0
3654.9	44.5	-59.6	-51.3	-20.0	-31.3
4061.0	40.2	-62.5	-54.3	-20.0	-34.3
4467.1	37.2	-66.0	-56.7	-20.0	-36.7
4873.2	37.0	-63.2	-54.2	-20.0	-34.2
Tx 430 MHz					
191.7	53.8	-53.7	-53.7	-20.0	-33.7
346.9	48.3	-53.6	-53.6	-20.0	-33.6
462.5	46.3	-53.3	-53.3	-20.0	-33.3
718.7	42.7	-53.1	-53.1	-20.0	-33.1
860.0	43.1	-50.2	-50.2	-20.0	-30.2
1290.0	53.1	-56.4	-51.4	-20.0	-31.4
1720.0	49.2	-61.8	-54.4	-20.0	-34.4
2150.0	49.9	-56.2	-50.2	-20.0	-30.2
2580.0	62.5	-45.3	-37.4	-20.0	-17.4
3010.0	51.1	-56.1	-47.7	-20.0	-27.7
3440.0	48.7	-56.1	-47.9	-20.0	-27.9
3870.0	42.4	-60.5	-52.4	-20.0	-32.4
4300.0	42.7	-60.5	-51.5	-20.0	-31.5
4730.0	37.6	-63.4	-54.5	-20.0	-34.5

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

All other emissions not reported are more than 20 dB below the limit.

Spurious Radiated Emissions

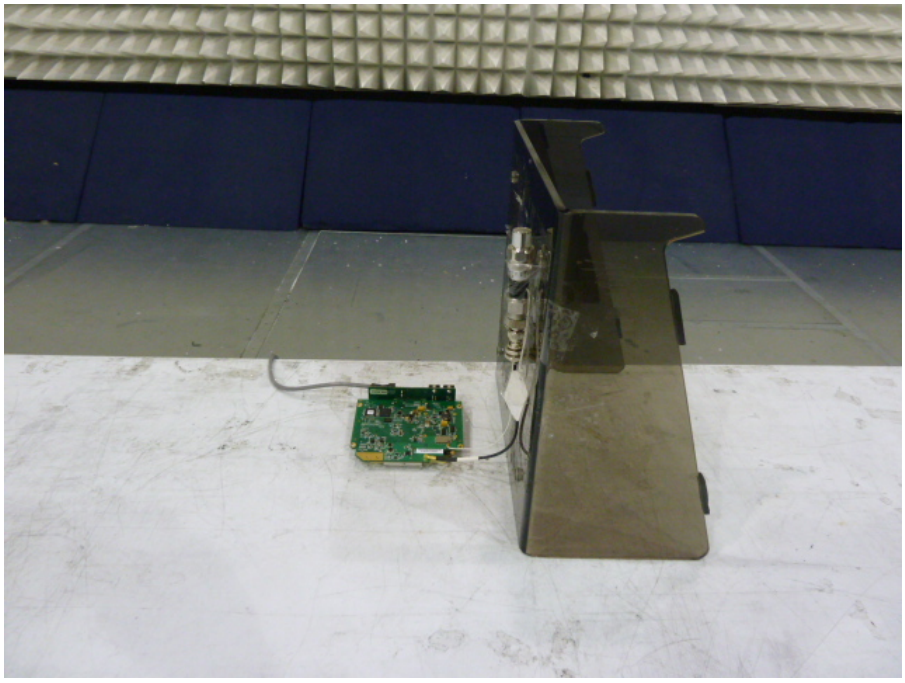
Frequency	SA Reading (from EUT)	Signal Generator Output required to have the same SA Reading as from EUT	ERP*	ERP Limit	ERP Margin
MHz	**dB(µV)**	**V_g dBm**	**dBm**	**dBm**	**dB**
Tx 450 MHz					
191.7	52.4	-55.1	-55.1	-20.0	-35.1
346.9	48.7	-53.2	-53.2	-20.0	-33.2
462.5	45.5	-54.2	-54.2	-20.0	-34.2
679.1	42.6	-53.6	-53.6	-20.0	-33.6
900.0	39.4	-54.2	-54.2	-20.0	-34.2
1350.0	54.5	-54.8	-49.6	-20.0	-29.6
1800.0	47.3	-63.3	-55.9	-20.0	-35.9
2250.0	50.5	-57.2	-50.2	-20.0	-30.2
2700.0	54.1	-53.4	-45.4	-20.0	-25.4
3150.0	50.5	-55.9	-47.5	-20.0	-27.5
3600.0	47.5	-56.8	-48.5	-20.0	-28.5
4050.0	43.4	-59.3	-51.1	-20.0	-31.1
4500.0	40.2	-63.0	-53.7	-20.0	-33.7
4950.0	36.2	-57.9	-48.8	-20.0	-28.8
Tx 470 MHz					
191.7	49.8	-57.6	-57.6	-20.0	-37.6
197.3	50.0	-57.4	-57.4	-20.0	-37.4
463.3	41.2	-58.4	-58.4	-20.0	-38.4
477.0	40.6	-58.4	-58.4	-20.0	-38.4
940.0	40.3	-52.4	-52.4	-20.0	-32.4
1410.0	56.3	-53.1	-47.7	-20.0	-27.7
1880.0	45.3	-64.7	-57.4	-20.0	-37.4
2350.0	52.6	-56.0	-48.3	-20.0	-28.3
2820.0	54.8	-53.0	-44.7	-20.0	-24.7
3290.0	58.7	-47.1	-38.8	-20.0	-18.8
3760.0	48.7	-54.8	-46.6	-20.0	-26.6
4230.0	40.4	-62.4	-53.7	-20.0	-33.7
4700.0	41.0	-60.2	-51.3	-20.0	-31.3

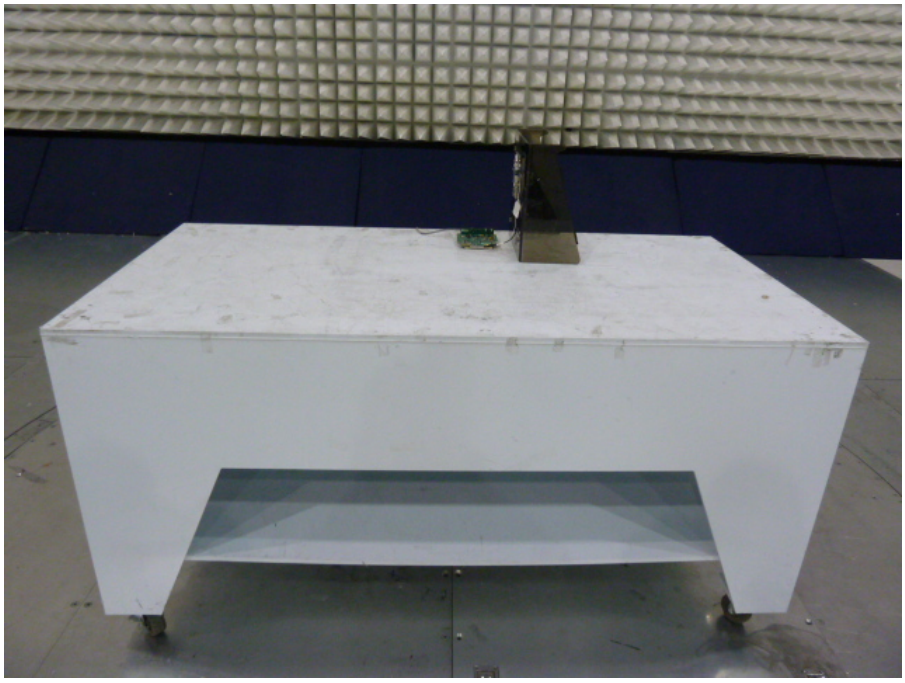
* ERP is calculated as: $ERP_{(dBm)} = V_{g(dBm)} + G_{(dBd)}$

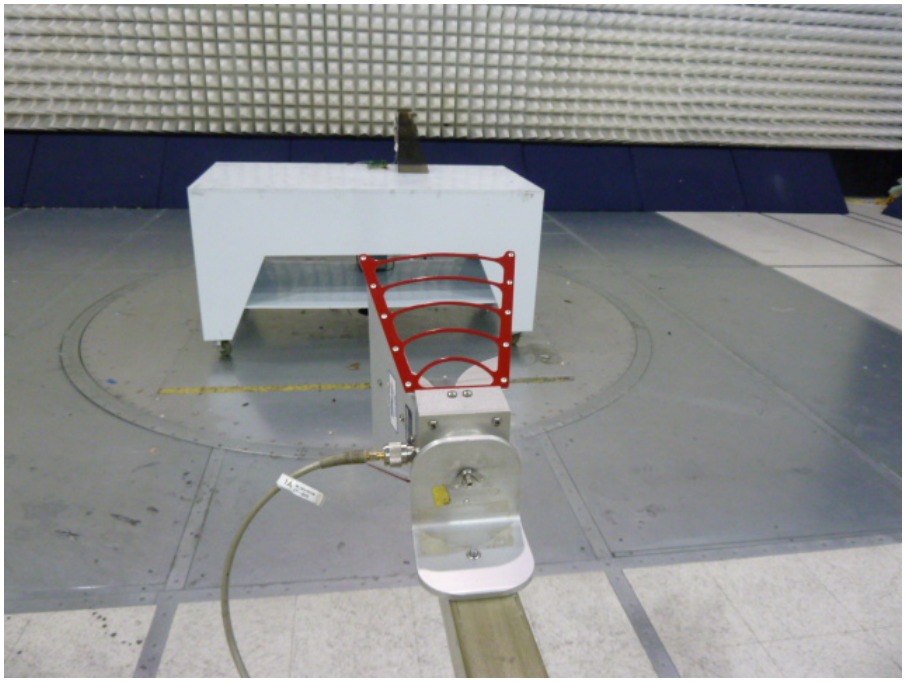
All other emissions not reported are more than 20 dB below the limit

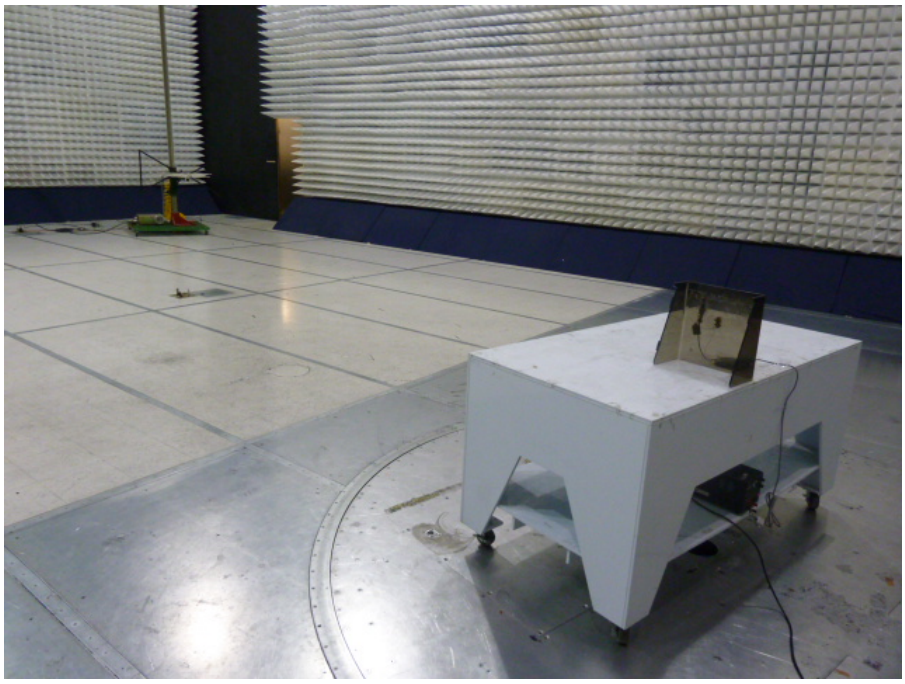
Result	Complies

Test Setup Photographs









8.0 Transient Frequency Behavior

FCC 90.214

8.1 Requirement

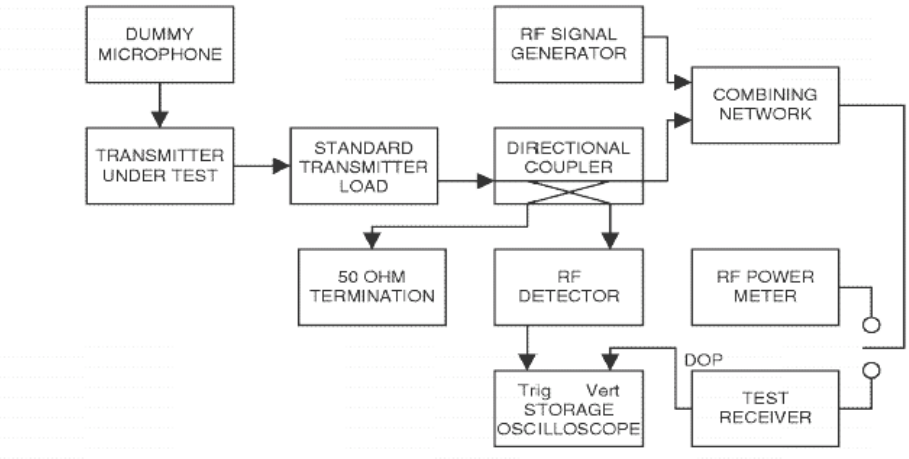
Time interval	Maximum frequency difference	Time
Transient Frequency Behavior for equipment designed to operate on 25 kHz channels		
t1 *	±25 kHz	10 ms
t2	±12.5 kHz	25 ms
t3 *	±25 kHz	10 ms
Transient Frequency Behavior for equipment designed to operate on 12.5 kHz channels		
t1 *	±12.5 kHz	10 ms
t2	±6.25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

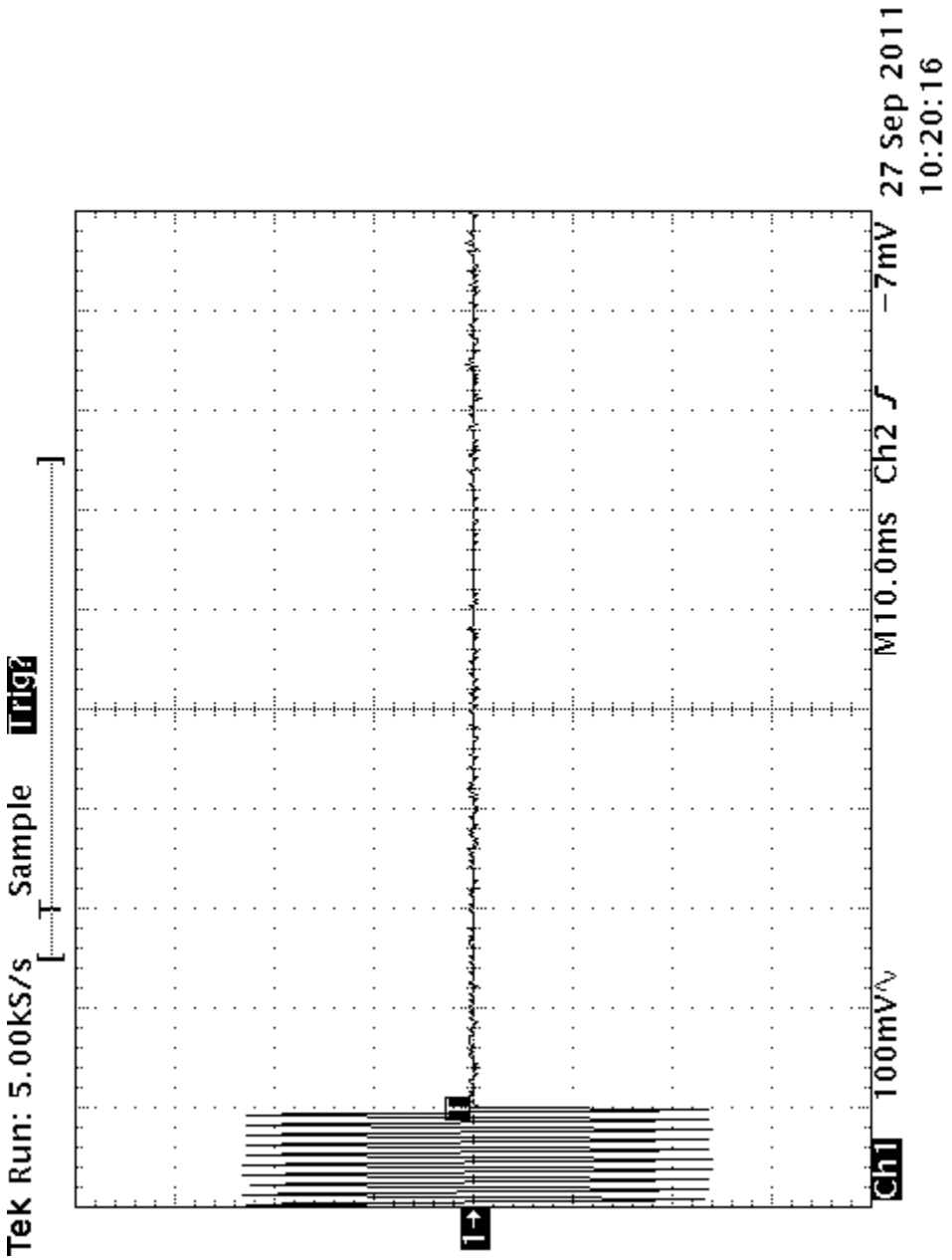


8.3 Test Results

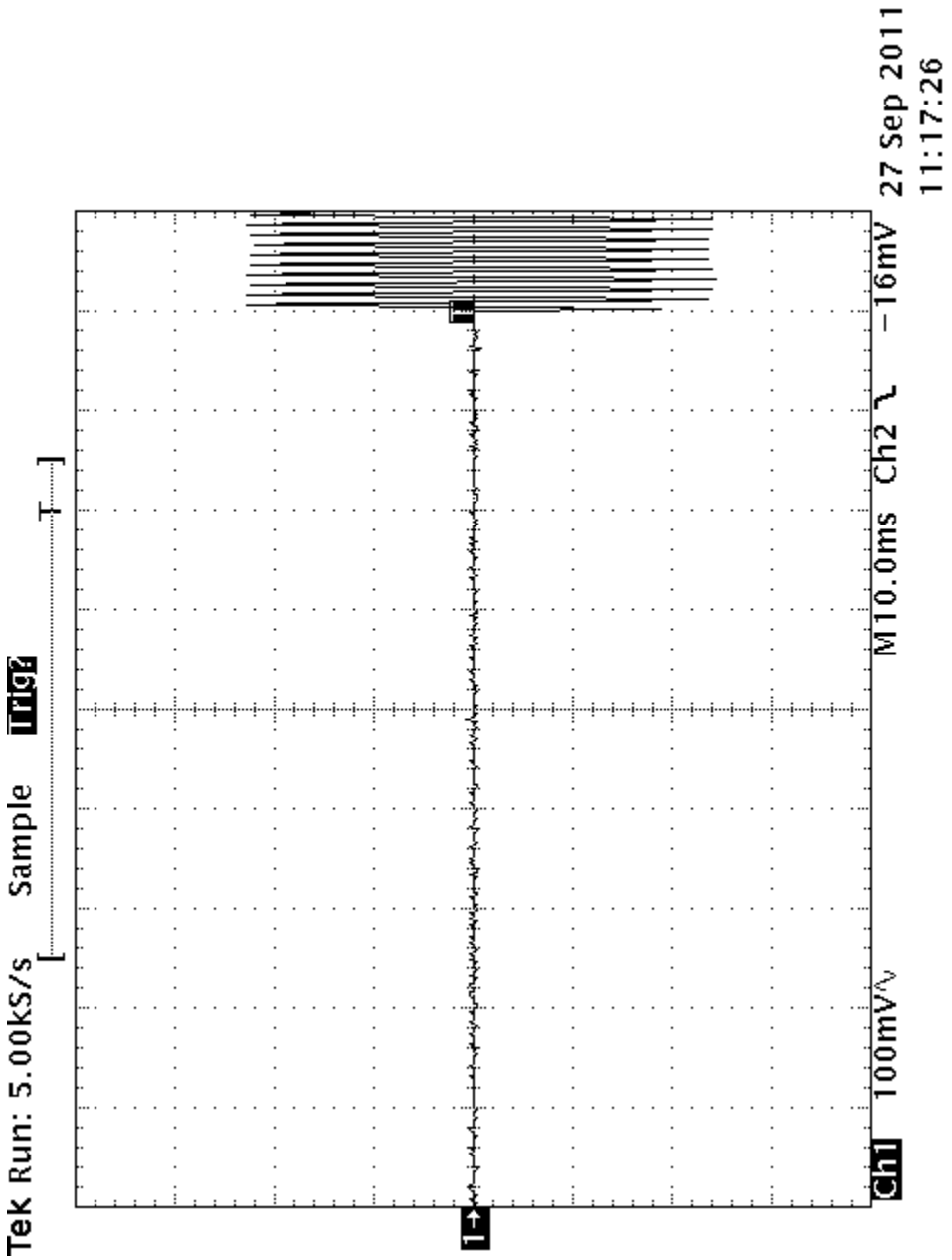
Result	Complies

Refer to the attached Graphs

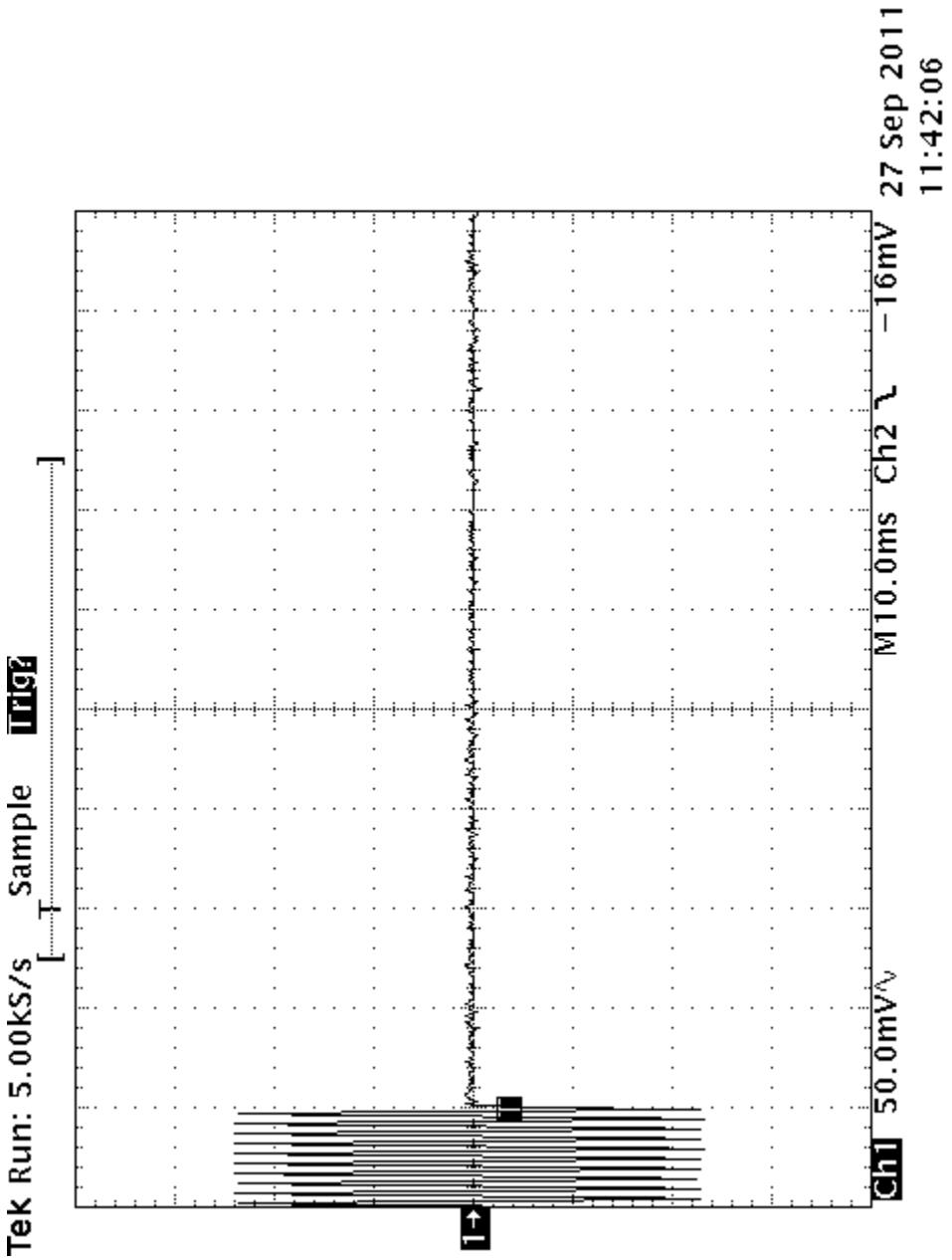
406.1 MHz, 25 kHz spacing



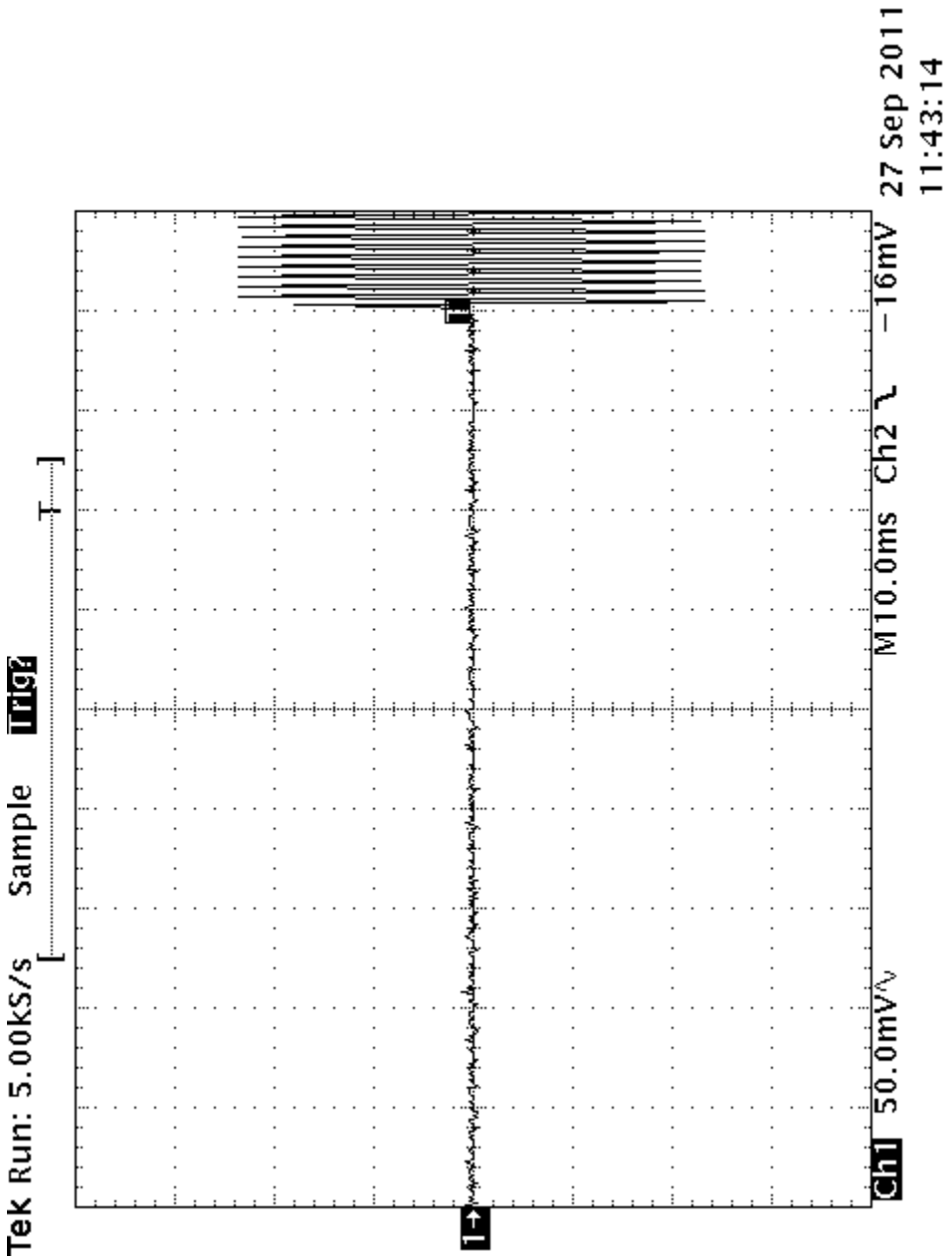
406.1 MHz, 25 kHz spacing



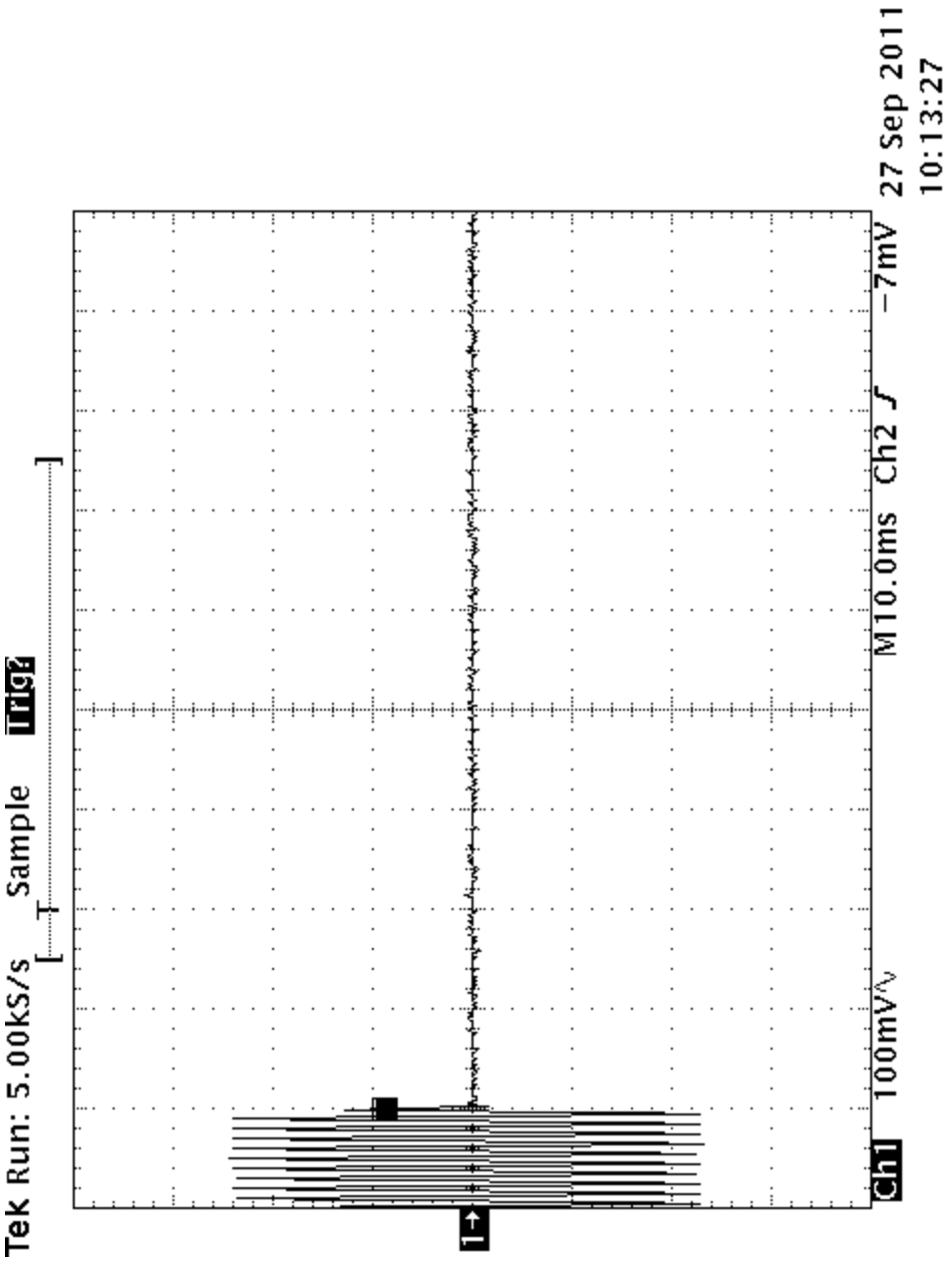
406.1 MHz, 12.5 kHz spacing



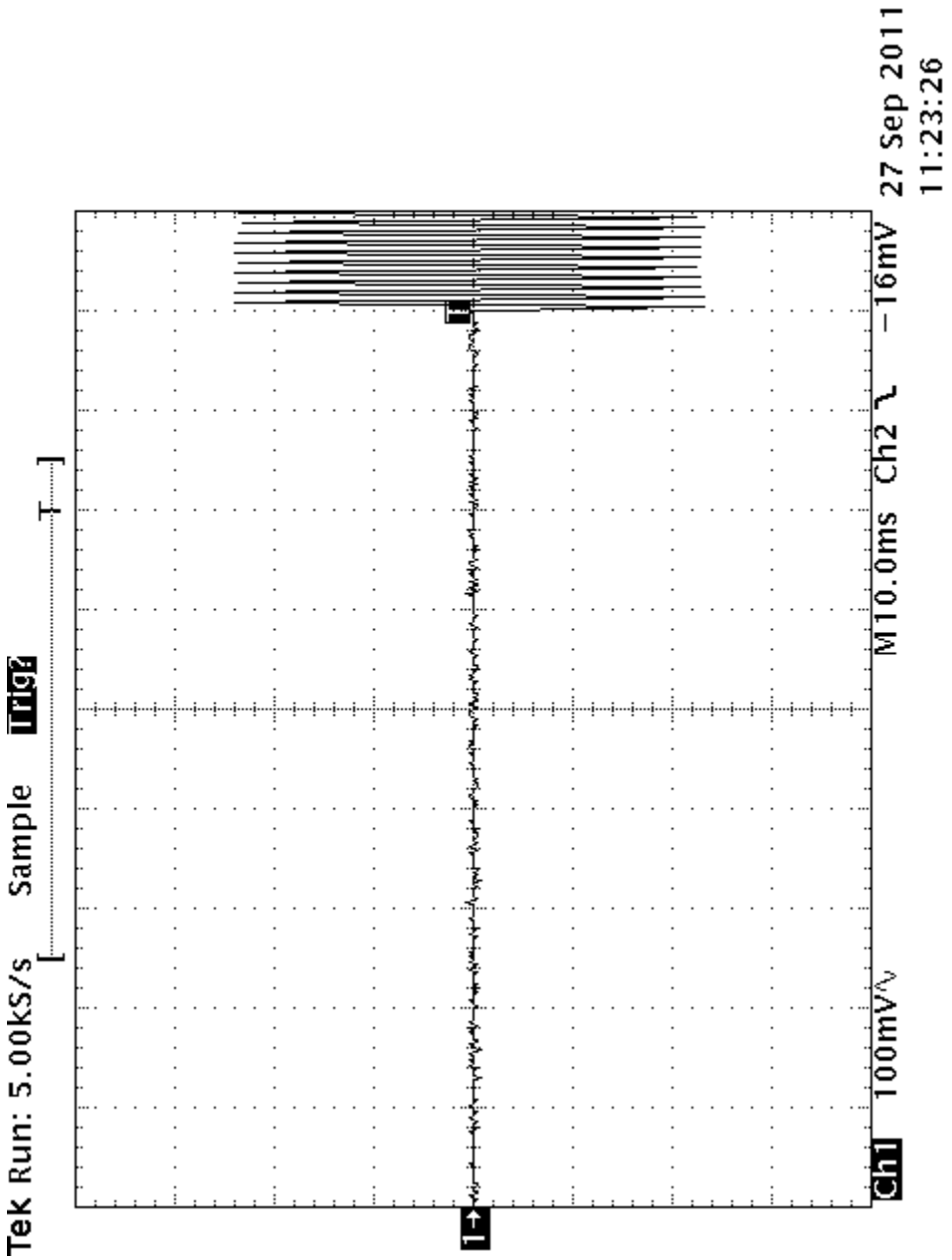
406.1 MHz, 12.5 kHz spacing



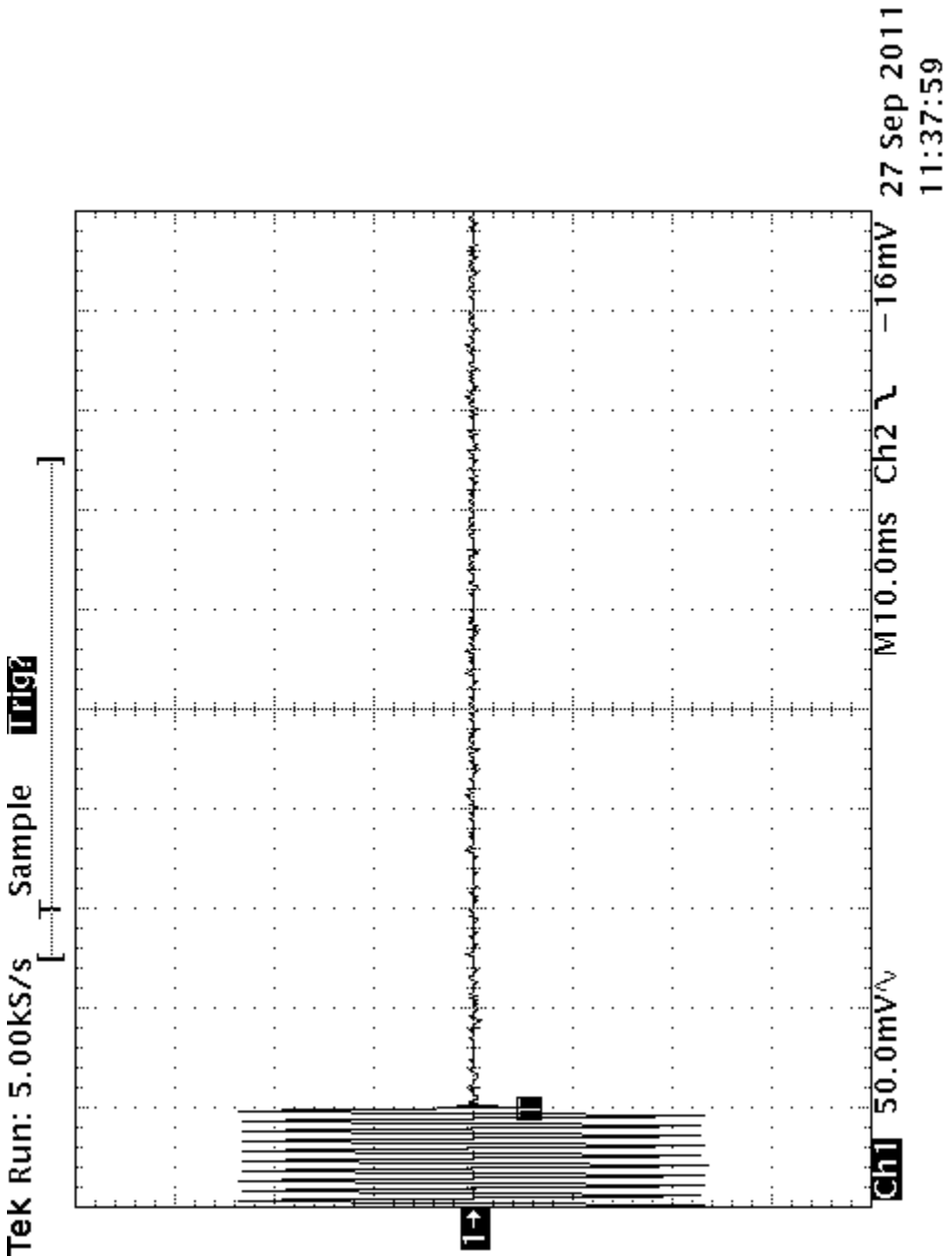
470 MHz, 25 kHz spacing



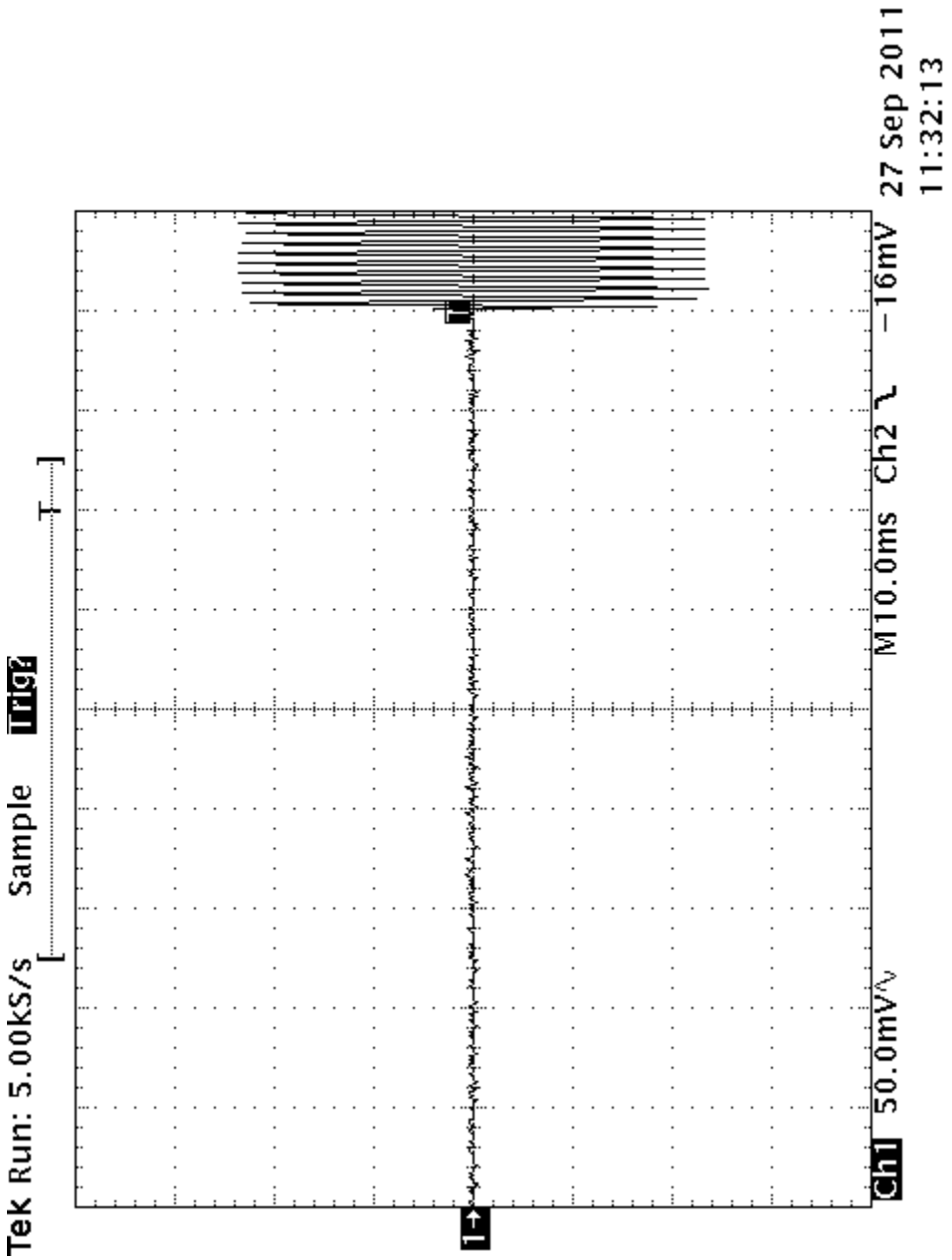
470 MHz, 25 kHz spacing



470 MHz, 12.5 kHz spacing



470 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.

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 Results

Nominal frequency: 406.1 MHz

Temperature (°C)	**Maximum deviation from frequency at 20°C,** Hz	**Maximum deviation from frequency at 20°C,** ppm
-30	105.0	0.26
-20	108.0	0.27
-10	78.0	0.19
0	23.0	0.06
10	11.0	0.03
20	0.0	0.00
30	-34.0	- 0.08
40	-52.0	- 0.13
50	-140.0	- 0.34
60	-149.0	- 0.37

Nominal frequency: 406.1 MHz

DC Voltage, V	**Maximum deviation from nominal,** Hz	**Maximum deviation from nominal,** ppm
6	100.0	0.25
10	100.0	0.25
16	100.0	0.25

Nominal frequency: 470 MHz

Temperature (°C)	**Maximum deviation from frequency at 20°C,** Hz	**Maximum deviation from frequency at 20°C,** ppm
-30	119.0	0.25
-20	121.0	0.26
-10	79.0	0.17
0	27.0	0.06
10	12.0	0.03
20	0.0	0.00
30	-23.0	- 0.05
40	-46.0	- 0.10
50	-163.0	- 0.35
60	-172.0	- 0.37

Nominal frequency: 470 MHz

DC Voltage, V	**Maximum deviation from nominal,** Hz	**Maximum deviation from nominal,** ppm
6	119.0	0.25
10	119.0	0.25
16	119.0	0.25

Result	Complies

10.0 Receiver Antenna Conducted Emissions

FCC 15.111(a)

10.1 Requirement

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

10.2 Test Procedure

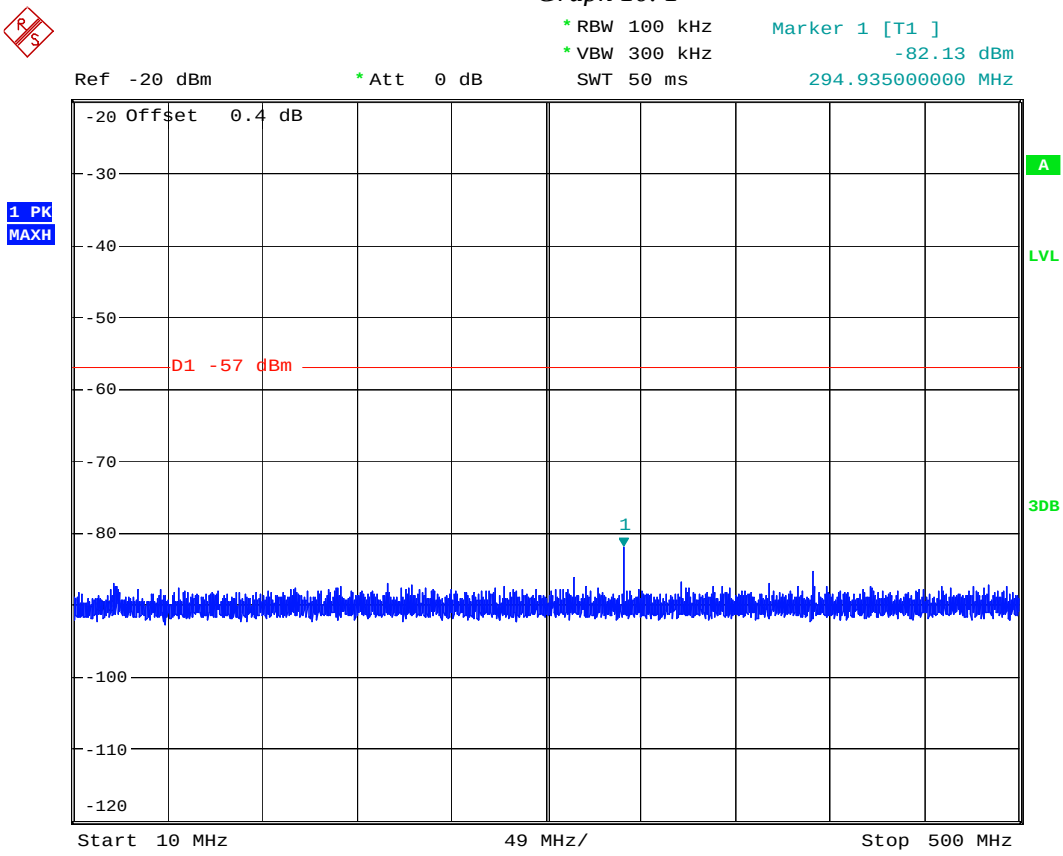
The spectrum analyzer was connected to the RF output of the EUT. The EUT was setup in receiving mode.
Test was performed at tuned frequencies of 406.1 MHz and 470 MHz.

10.3 Test Results

Result	Complies

Refer to the following graphs.

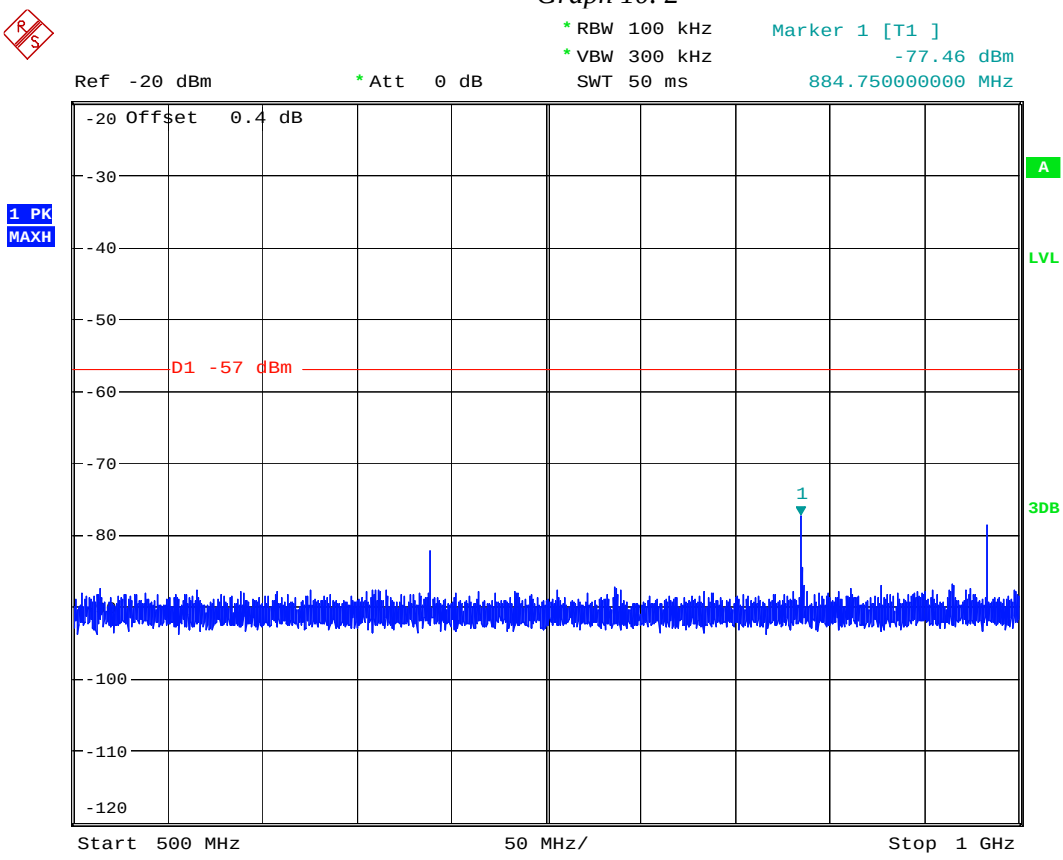
Graph 10. 1



Receiver conducted Spurious, 406.1MHz

Date: 21.SEP.2011 12:25:53

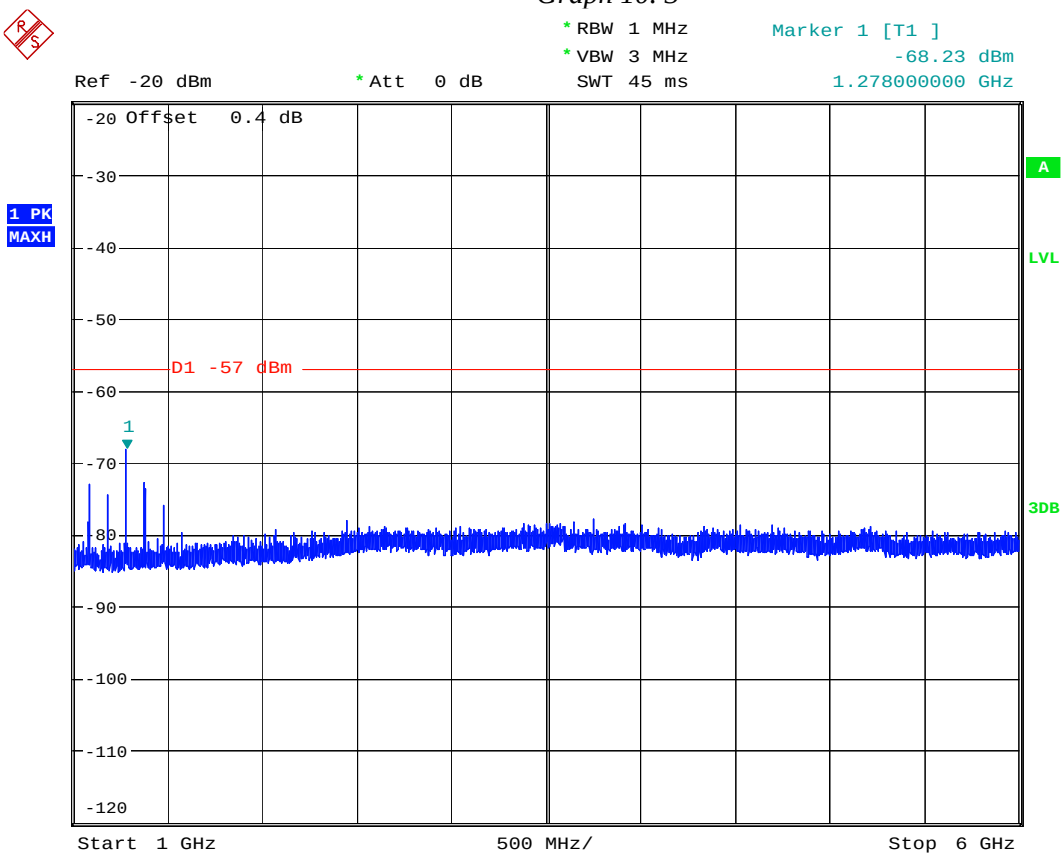
Graph 10. 2



Receiver conducted Spurious, 406.1MHz

Date: 21.SEP.2011 12:26:26

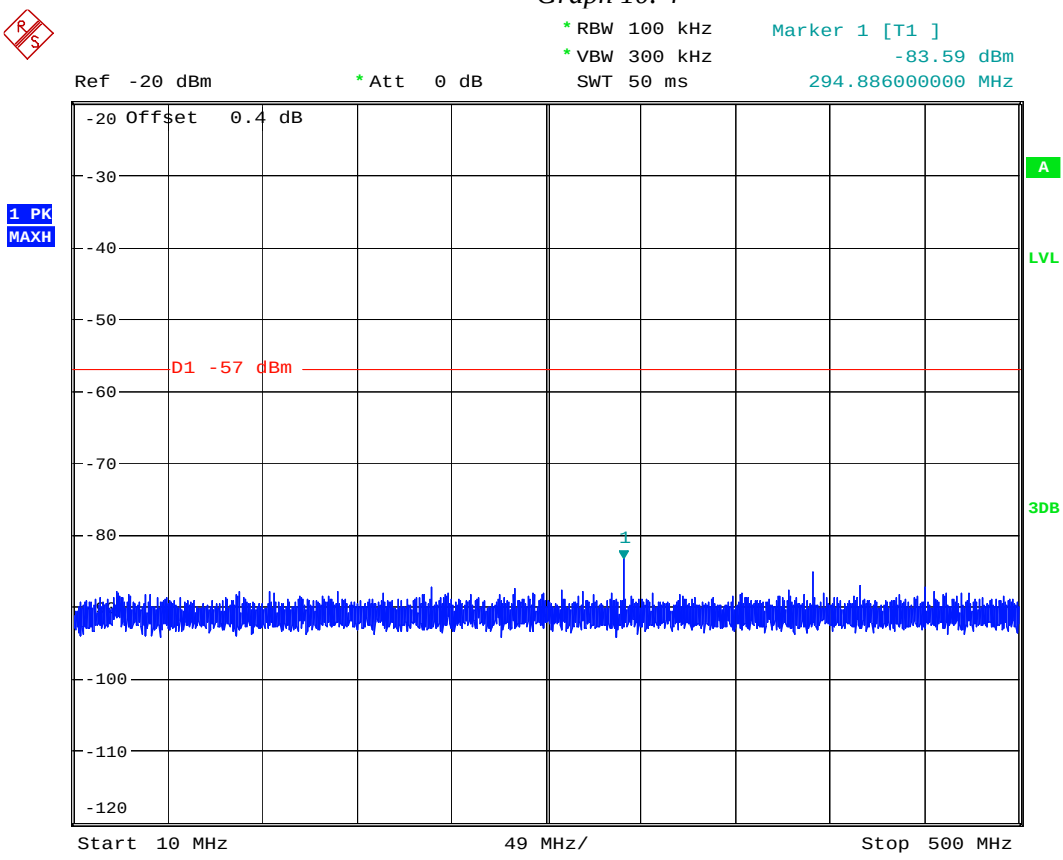
Graph 10. 3



Receiver conducted Spurious, 406.1MHz

Date: 21.SEP.2011 12:27:47

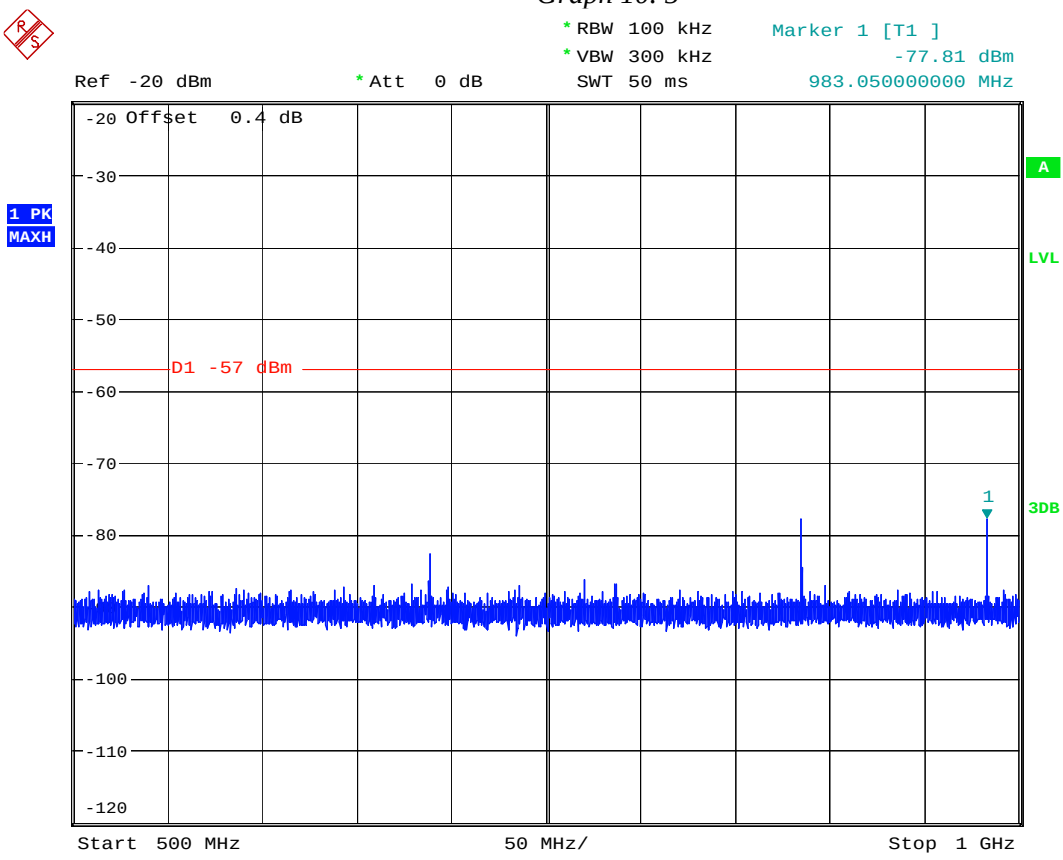
Graph 10. 4



Receiver conducted Spurious, 470MHz

Date: 21.SEP.2011 12:30:31

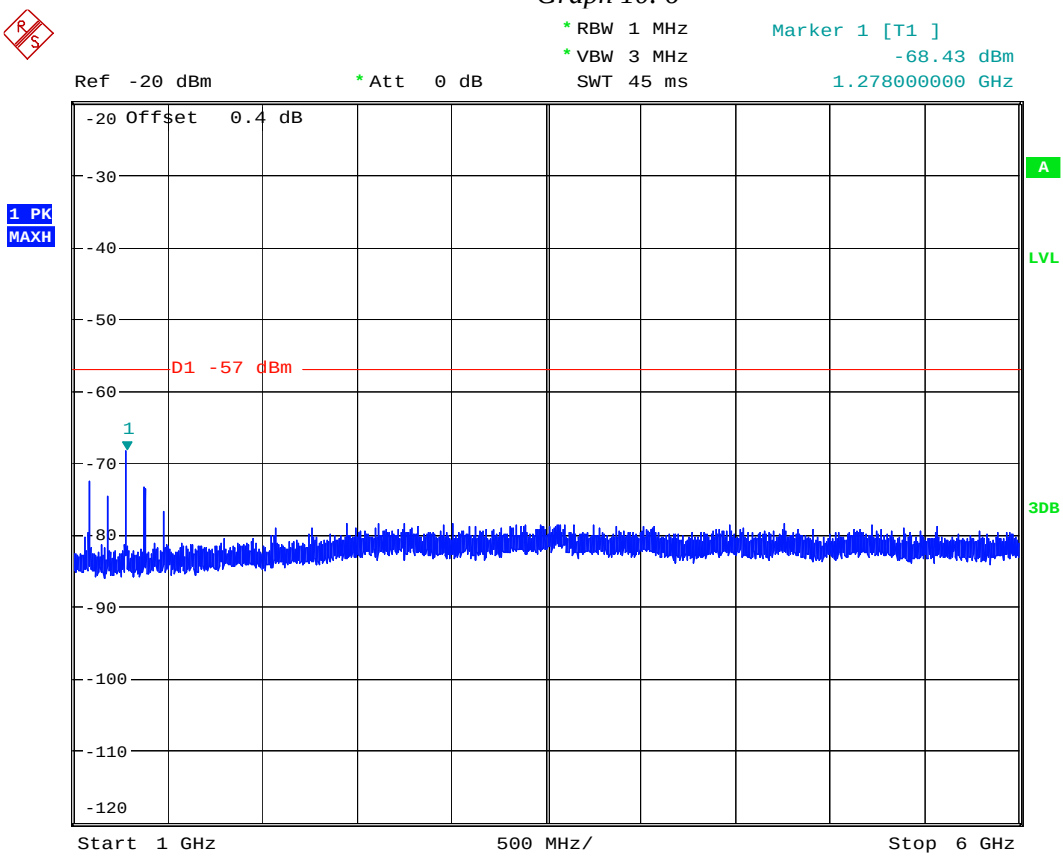
Graph 10. 5



Receiver conducted Spurious, 470MHz

Date: 21.SEP.2011 12:31:01

Graph 10. 6



Receiver conducted Spurious, 470MHz

Date: 21.SEP.2011 12:29:21

11.0 Emissions from Digital Parts and Receiver

11.1 Radiated Emissions
FCC 15.109

11.1.1 Test Limit

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

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

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

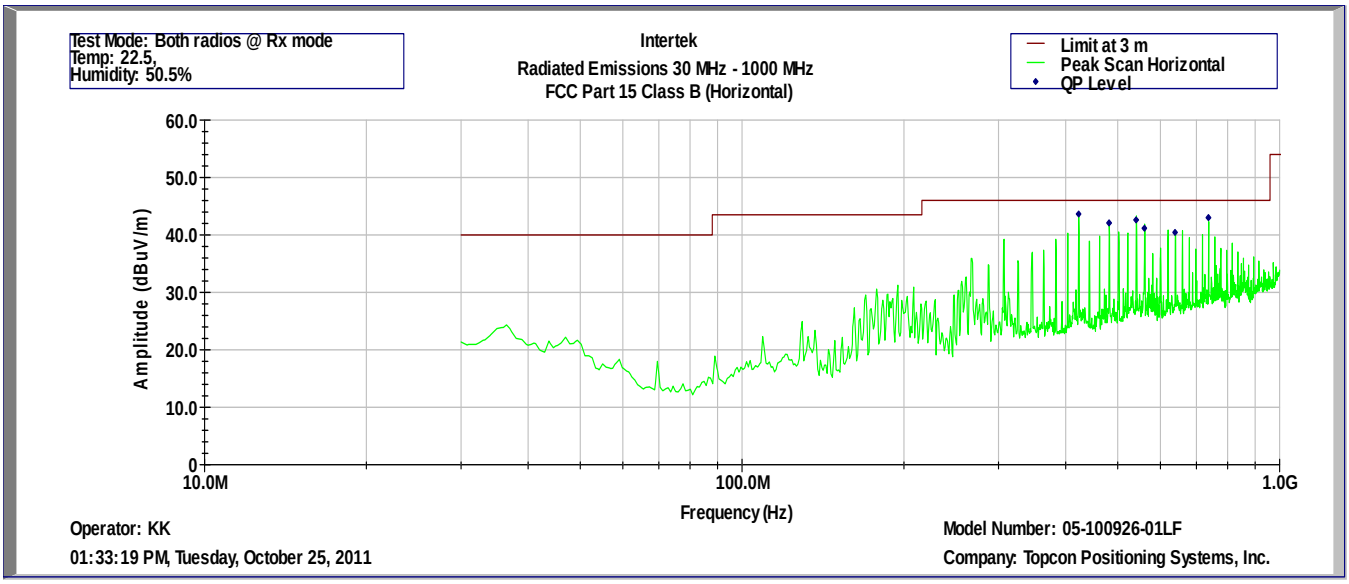
Assume a receiver reading of 52.5 dB(μV) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB and Distance Correction Factor (for measurements made at 10 meters distance) of 10.5 dB is subtracted, giving field strength of 22 dB(μV/m). This value 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 2.4dB



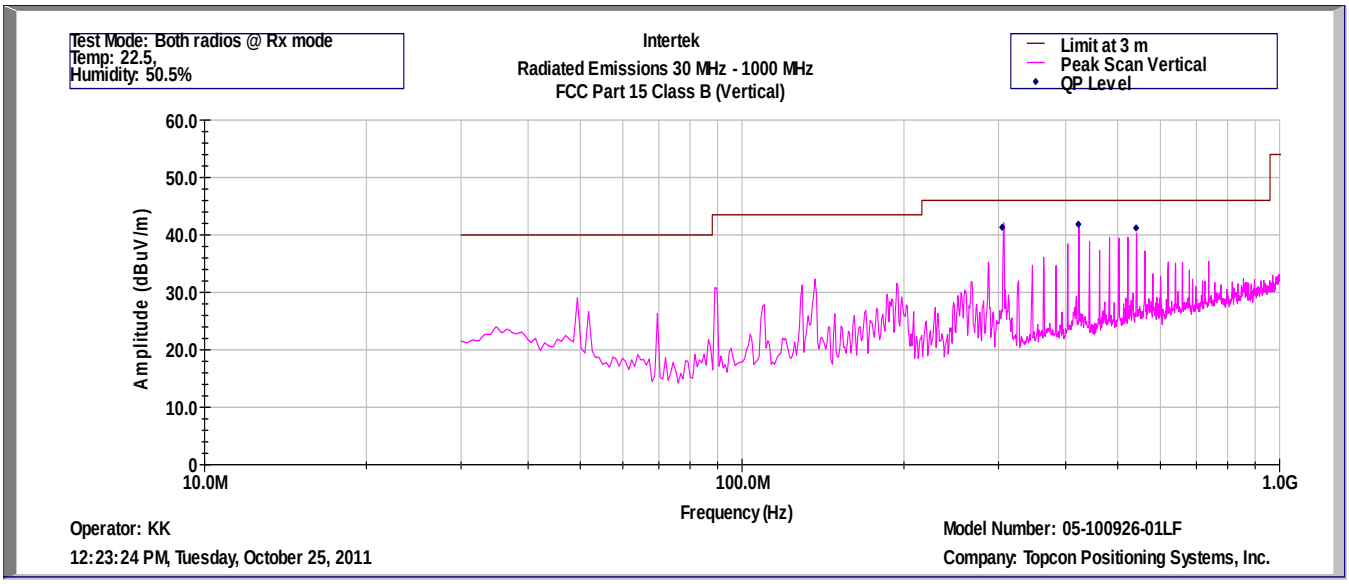
Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Horizontal)

Operator: KK
25-Oct-11

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

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

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



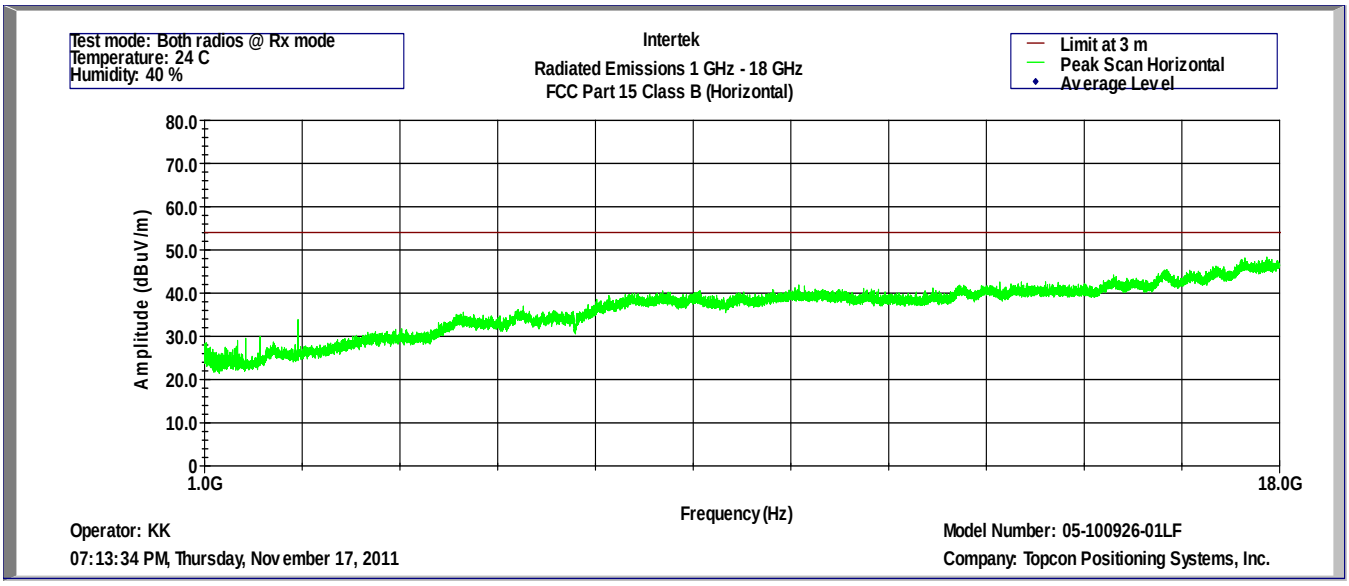
Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Vertical)

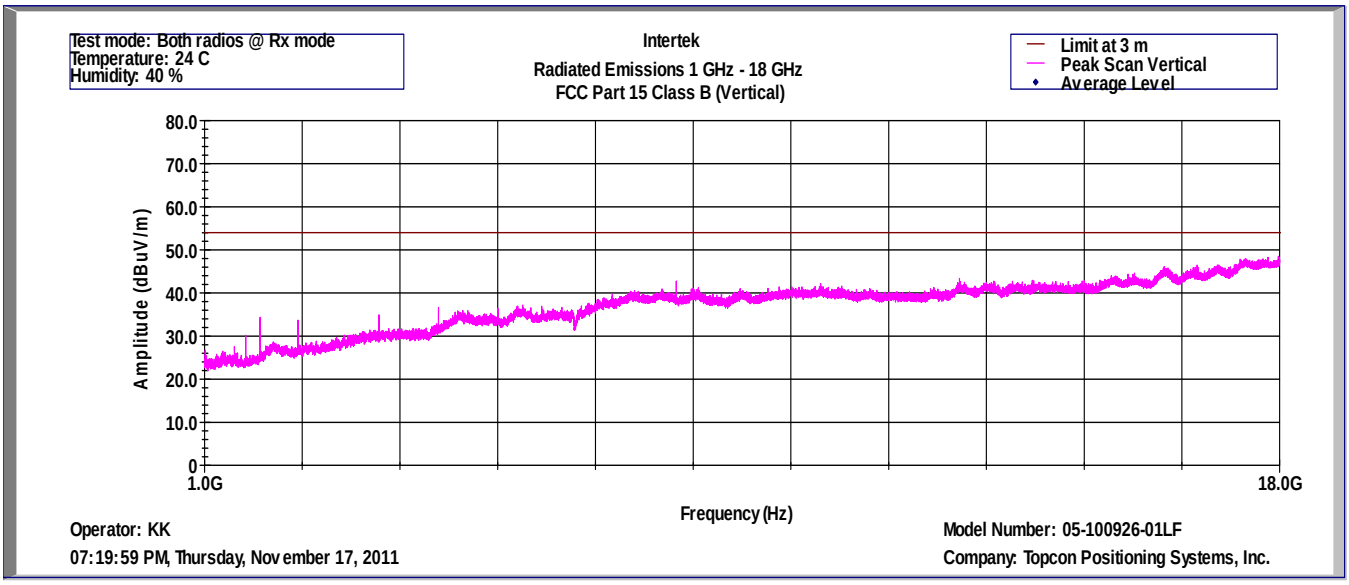
Operator: KK
25-Oct-11

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

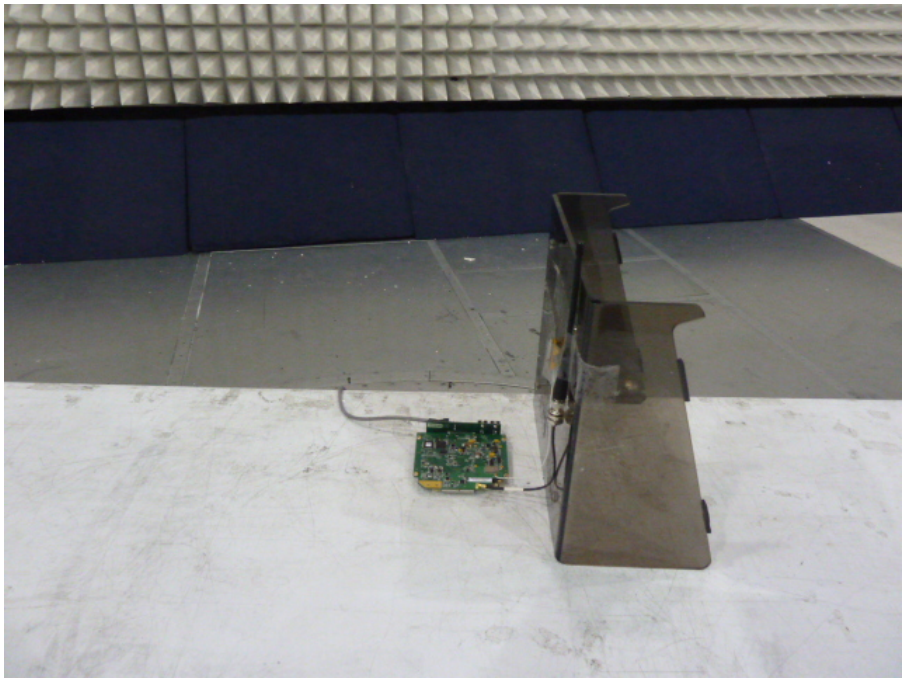
Frequency	Quasi Pk FS	Limit@3m	Margin	RA	Cable	AG	DCF	AF
Hz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB	dB(1/m)
3.05E+08	41.3	46.0	-4.7	47.5	2.0	31.9	10.5	13.2
4.22E+08	41.9	46.0	-4.1	44.2	2.4	31.9	10.5	16.6
5.41E+08	41.2	46.0	-4.8	42.0	2.7	32.0	10.5	17.9

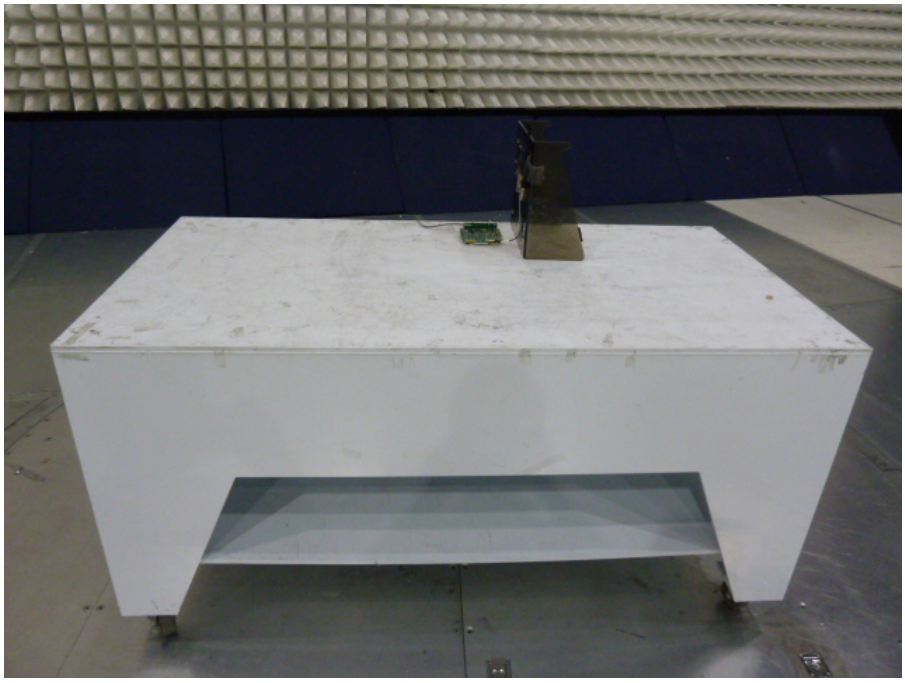
Test Mode: Both radios in Rx mode
Temp: 22.5C
Humidity: 50.5%

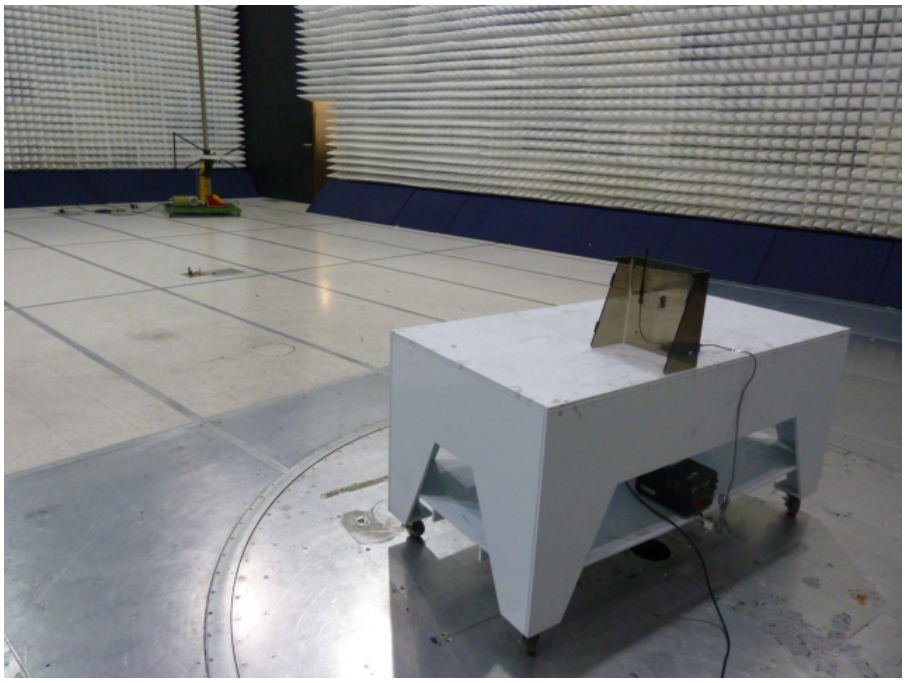

Test mode: Both radios @ Rx mode
Temperature: 24 C
Humidity: 40 %
Intertek
Radiated Emissions 1 GHz - 18 GHz
FCC Part 15 Class B (Horizontal)
Limit at 3 m
Peak Scan Horizontal
Average Level
Amplitude (dBuV/m)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
1.0G
18.0G
Frequency (Hz)
Operator: KK
07:13:34 PM, Thursday, November 17, 2011
Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

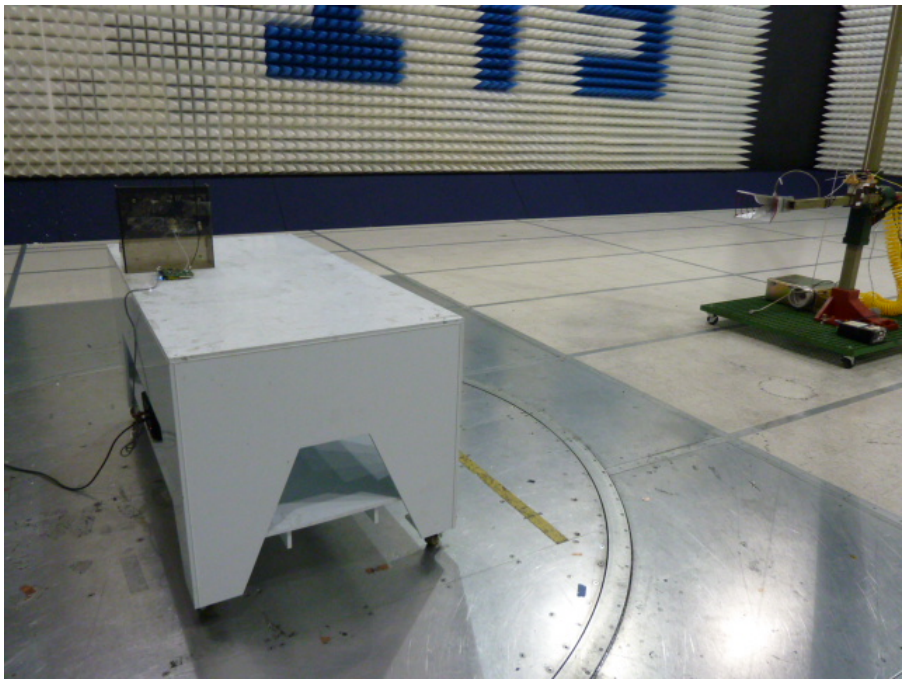

Test mode: Both radios @ Rx mode
Temperature: 24 C
Humidity: 40 %
Intertek
Radiated Emissions 1 GHz - 18 GHz
FCC Part 15 Class B (Vertical)
Limit at 3 m
Peak Scan Vertical
Average Level
Amplitude (dBuV/m)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
1.0G
18.0G
Frequency (Hz)
Operator: KK
07:19:59 PM, Thursday, November 17, 2011
Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

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.

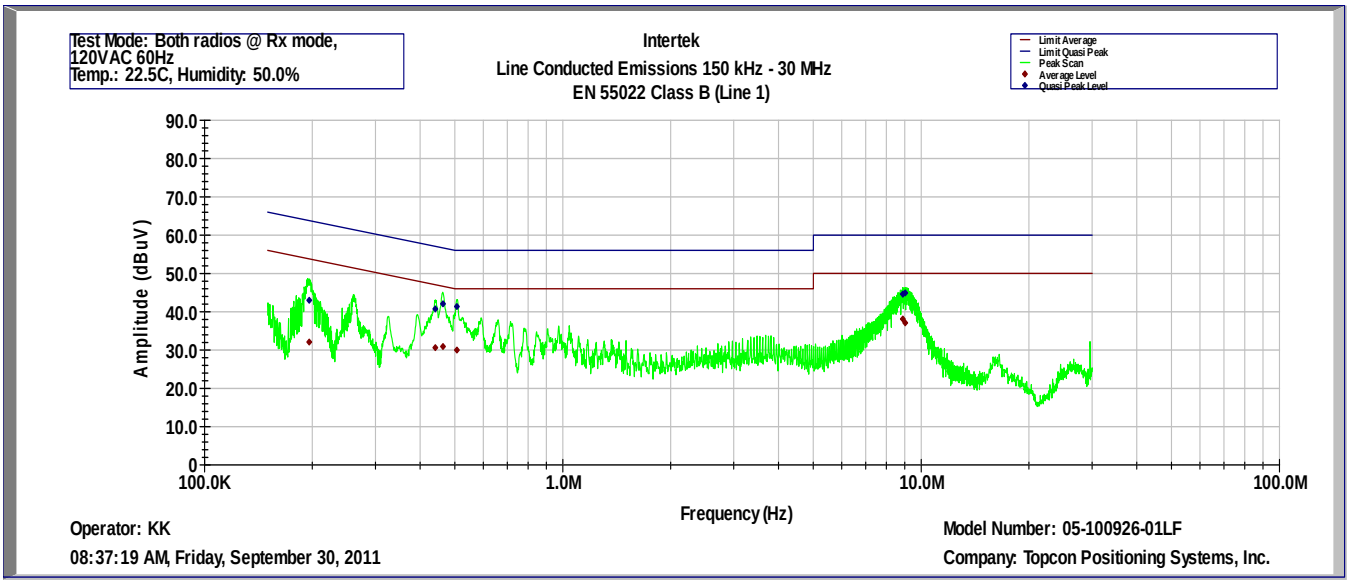
Floor standing EUTs are placed on a horizontal metal ground plane and isolated from the ground plane by 3 to 12 mm of insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

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

11.2.3 Test Result

Results	**Complies** by 7.7dB

Conducted Disturbance at AC Mains



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

Operator: KK
30-Sep-11

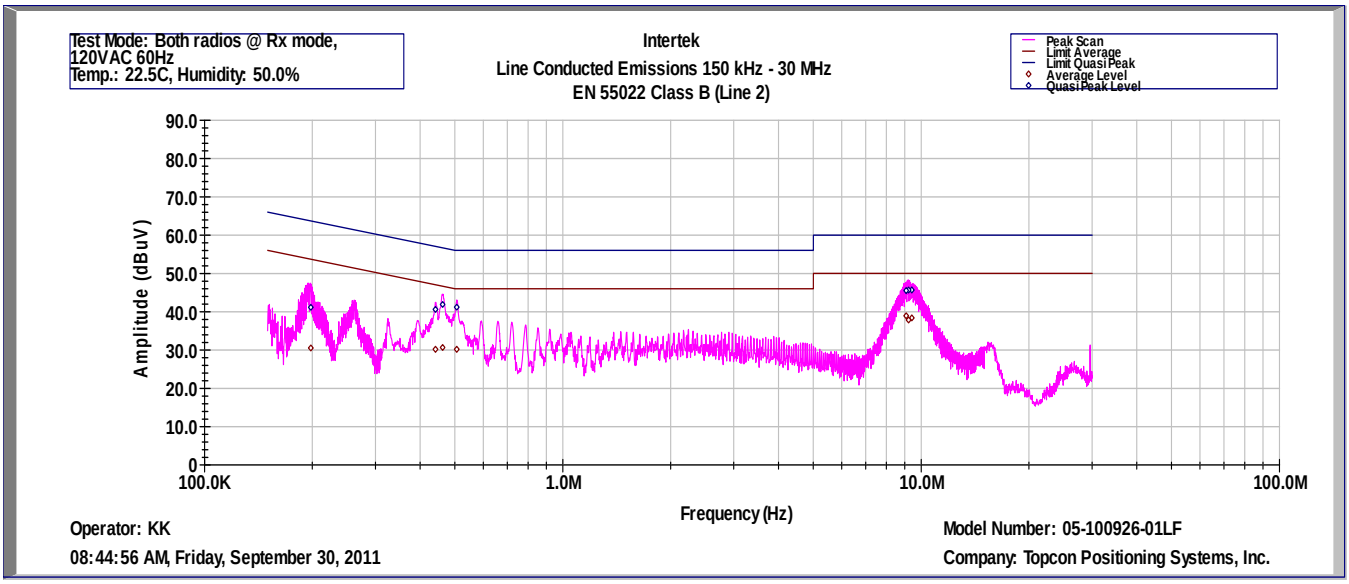
Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

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

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

Note: Power Supply used; PHIHONG, Model: PSC30U-120, Sl. No.P01702775C2

Conducted Disturbance at AC Mains



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

Operator: KK
30-Sep-11

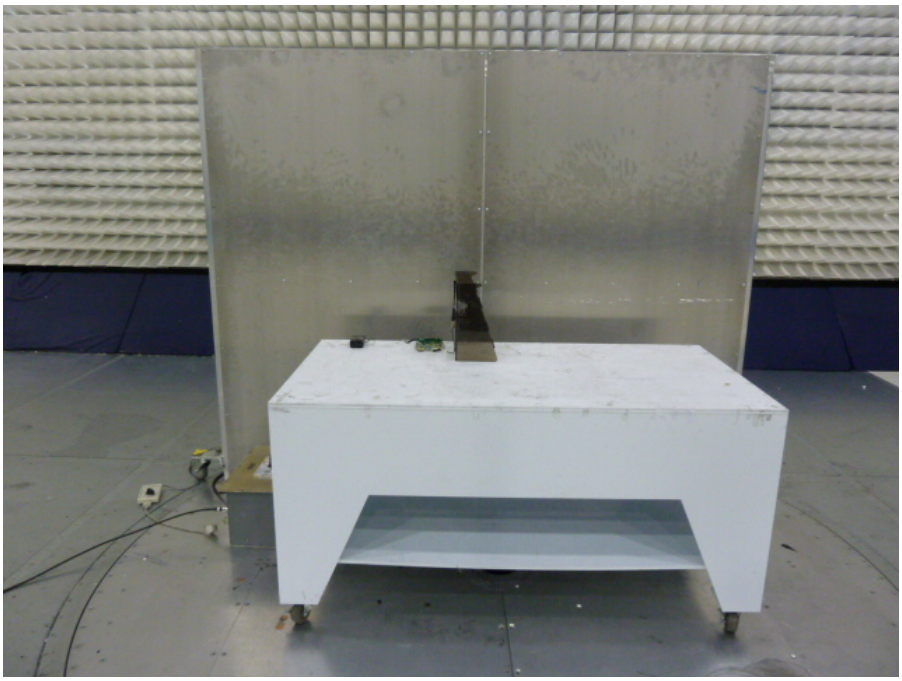
Model Number: 05-100926-01LF
Company: Topcon Positioning Systems, Inc.

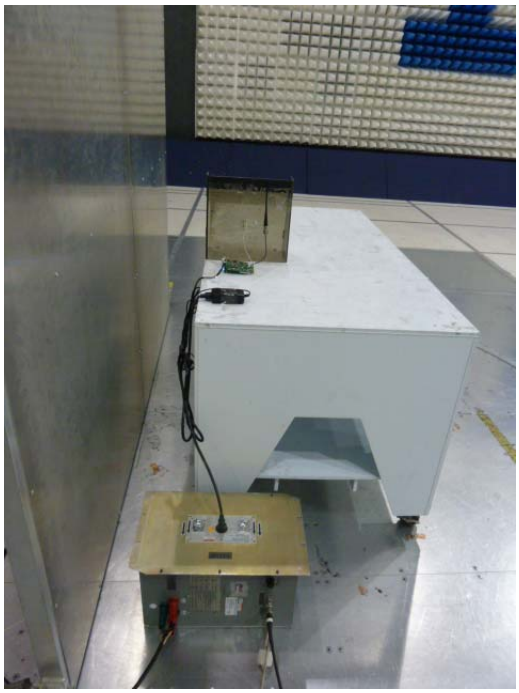
Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
Hz	dBuV	dBuV	dBuV	dBuV	dB	dB
198023	30.5	41.1	54.6	64.6	-24.1	-23.5
441246	30.2	40.6	47.7	57.7	-17.5	-17.1
461968	30.7	41.9	47.1	57.1	-16.4	-15.2
505909	30.2	41.2	46.0	56.0	-15.8	-14.8
9079290	38.9	45.5	50.0	60.0	-11.1	-14.5
9216670	37.8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

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

Note: Power Supply used; PHIHONG, Model: PSC30U-120, Sl. No.P01702775C2

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 406 MHz is 2.7 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 -0.07dBm (0.984mW); the antenna 4dBi gain; therefore, to comply with the requirements for RF Exposure, the MPE is calculated.

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

The Power Density can be calculated using the formula

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

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	12/08/11
EMI Receiver	Hewlett Packard	8546A	3710A00373	12	12/08/11
Spectrum Analyzer	Rohde&Schwarz	FSP40	036612004	12	11/09/12
BI-Log Antenna	ARA	LPB-2513/A	1154	12	07/06/12
Pre-Amplifier	Sonoma	310N	185634	12	12/01/11
Pre-Amplifier	Miteq	AMF-4D-001180-24-10P	799159	12	09/01/12
Spectrum Analyzer	Rohde&Schwarz	FSU	200482	12	03/23/12
Horn Antenna	EMCO	3115	00126795	12	11/03/12
Oscilloscope	Tektronix	TDS 680C	TDS680CB020325	12	09/23/12
Power Meter	Hewlett Packard	EPM-442A	US37480416	12	06/08/12
Signal Generator	Hewlett Packard	8663A	2537A00214	12	04/27/12
Signal Generator	Hewlett Packard	SMR40	100445	12	09/01/12
LISN	FCC	FCC-LISN-50-50-M-H	2012	12	06/28/12

14.0 Document History

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