Electromagnetic Emission

FCC MEASUREMENT REPORT

CERTIFICATION OF COMPLIANCE

FCC Part 15 Certification Measurement

PRODUCT	:	GPS Tracking Terminal
MODEL/Serial No.	:	GPS-250MVK / Proto type
BRAND NAME	:	GRTelecom
FCC ID	:	ZR4GPS-250MVK
APPLICANT	:	GR Telecom Co., Ltd. 9F, Samwoo Building, 6136 Taepyeong-Dong, Soojeong-Gu, Seongnam-Si, Kyeonggi-Do, Korea Attn.: Johnson Lim
MANUFACTURER	:	GR Telecom Co., Ltd. 9F, Samwoo Building, 6136 Taepyeong-Dong, Soojeong-Gu, Seongnam-Si, Kyeonggi-Do, Korea
TYPE OF MODULATION	:	CDMA
FREQUENCY RANGE	:	22H: 824 MHz-849 MHz 24E: 1850 MHz-1909 MHz
RF Output Power	:	824-849Mhz: 23.22dBm(ERP) 1850-1909Mhz: 24.700dBm(EiRP)
Eimmssion Designator	:	1M32F9W
Frequency Tolerance	:	±2.5 ppm
ANTENNA TYPE	:	Stubby Antenna
RULE PART(S)	:	FCC Part 15 & 22H & 24E
FCC PROCEDURE	:	ANSI C63.4-2009 / TIA-603-C-2004
TEST REPORT No.	:	ET110720.01
DATES OF TEST	:	July 03 to July 20, 2011
REPORT ISSUE DATE	:	July 20, 2011
TEST LABORATORY	:	ETL Inc. (FCC Designation Number : KR0022)

The GPS Tracking Terminal, Model GPS-250MVK has been tested in accordance with the measurement procedures specified in ANSI C63.4-2009 at the ETL Test Laboratory and has been shown to be complied with the electromagnetic radiated emission limits specified in FCC Rule Part15 & 22H & 24E.

I attest to the accuracy of data. All measurement herein was performed by me or was made under my supervision and is correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Prepared by:	Reviewed by:
Jeong Hwan, Pyo (Test Engineer)	Yo Han, Park (Chief Engineer)
July 20, 2011	July 20, 2011

ETL Inc.
#371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea
Tel: 82-2-858-0786 Fax: 82-2-858-0788

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FCC MEASUREMENT REPORT

Scope – *Measurement and determination of electromagnetic emission (EME) of radio frequency devices including intentional radiators and/or unintentional radiators for compliance with the technical rules and regulations of the U.S Federal Communications Commission(FCC)*

General Information

Applicant Name	**: GR Telecom Co., Ltd.**
Address	**: 9F, Samwoo Building, 6136 Taepyeong-Dong, Soojeong-Gu, Seongnam-Si, Kyeonggi-Do, Korea**
Attention	**: Johnson Lim**

- **EUT Type** : GPS Tracking terminal
- **Model Number** : GPS-250MVK
- **S/N** : Proto type
- **Freq. Range** : 22H: 824 MHz to 849 MHz
  24E: 1 850 MHz to 1 909 MHz
- **Modulation Technique** : CDMA
- **Air Data Rate** : -
- **Antenna Type** : Stubby Antenna
- **FCC Rule Part(s)** : FCC Part 15 & 22H & 24E
- **Test Procedure** : ANSI C63.4-2009 / TIA-603-C-2004
- **Place of Tests** : ETL Inc. Testing Lab.
  Radiated Emission test;
  #499-1, Sagot-ri, Seosin-myeon, Hwaseong-si, Gyeonggi-do, 445-882, Korea

  Conducted Emission test;
  ETL Inc. Testing Lab.
  371-51, Gasan-dong, Geumcheon-gu, Seoul, 153-803, Korea

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1. INTRODUCTION

The measurement test for radiated and conducted emission test was conducted at the ETL Inc. The site is constructed in conformance with the requirements of the ANSI C63.4-2009 and CISPR Publication 16. The ETL has site descriptions on file with the FCC for 3 m and 10 m site configurations. Detailed description of test facility was found to be in compliance with FCC Rules according to the ANSI C63.4-2009 and registered to the Federal Communications Commission (FCC Designation Number : KR0022).

The measurement procedure described in American National Standard for Method of Measurement of Radio-Noise Emission from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (ANSI C63.4-2009) was used in determining radiated and conducted emissions from the GR Telecom Co., Ltd. Model: GPS-250MVK

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2. PRODUCT INFORMATION

Environment Specification

Relative Humidity: 5 % R.H. ~ 95 % R.H.
Storage Temperature: -40 ℃ ~ 80 ℃
Operation Temperature: -20 ℃ ~ 60 ℃
Vibration Stability: 1.5 G peak 5 Hz to 500 Hz

Hardware Specification

CDMA Protocol: CDMA 2000 1xRTT
Power Consumption: 12 V/320 mA, 24 V/160 mA / (Tx Max Power)
IF Receiving Chip: RFR6000/RFL6000
IF Transfer Chip: RFT6100
Main Chipset: Qualcomm MSM6050
GPS Chipset: Sirf III
Interface: USB

RF Specification

Transmitting Part
Maximum RF Output Power: 23 dBm ~ 27 dBm
Frequency Range: 824 MHz ~ 849 MHz & 1 850 MHz ~ 1 909 MHz
Modulation method: QPSK
Channel spacing: 1.23 MHz
Occupied bandwidth: Within 1.32 MHz
Frequency conversion method: Baseband to RF direct conversion (Zero IF)
Waveform quality: Above 0.944

Receiving Part
Frequency Range: 869 MHz ~ 894 MHz & 1 931 MHz ~ 1 990 MHz
Frequency conversion method: RF to Baseband direct conversion (Zero IF)
Channel spacing: 1.23 MHz
Modulation method: QPSK
Receiving sensitivity range: Below -104 dBm (FER = 0.5 %)
GPS Sensitivity: -155 dBm min

GPS Part
Receiver Type: L1 Frequency (1 575.42 MHz), C/A Code, 20-Channel
Max Up-date Rate: 1 sec
Accuracy (SA off): Position < 10 m 3D RMS
3D Tracking Sensitivity: -155 dBm at the Receiver Input (Typical)
Re-acquisition Sensitivity: -153 dBm at the Receiver Input (Typical)
Operational Limit: Altitude < 18 000 m (60 000 ft.)
Velocity < 515 m/s (1 000 knots)
Time to First Fix (TTFF): Cold Start 60 sec (Typical)
Warm Start 40 sec (Typical)
Hot Start 1 sec (Typical)
Re-acquisition Time: 3 sec
Protocol: NMEA 9 600 bps

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3. DESCRIPTION OF TESTS

3.1 Conducted Emission Measurement

Conducted emissions measurements were made in accordance with section 11, "Measurement of Information Technology Equipment" of ANSI C63.4-2009. The measurement were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to a Spectrum Analyzer or a Field Intensity Meter. The measurements were made with the detector set for "Peak" amplitude within a bandwidth of 10 kHz or for "quasi-peak" within a bandwidth of 9 kHz.

The line-conducted emission test is conducted inside a shielded anechoic chamber room with 1.0 m x 1.5 m x 0.8 m wooden table, which is placed 40 cm away from the vertical wall, and 1.5 m away from the sidewall of the chamber room. Two LISNs are bonded to the shielded room. The EUT is powered from the PMM LISN and the support equipment is powered from the LISN. Power to the LISNs is filtered by a noise cut power line filters. All electrical cables are shielded by braided tinned steel tubing with inner ϕ 1.2 cm. If the EUT is a DC-powered device, power will be derived from the source power supply it normally will be powered from and these supply lines will be connected to the LISN. All interconnecting cables more than 1.0 m were shortened by non-inductive bundling (serpentine fashion) to a 1m length. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the Spectrum Analyzer to determine the frequency producing the max. Emission from the EUT. The frequency producing the max. Level was reexamined using the detector function set to the CISPR Quasi-Peak mode by manual, after scanned by automatic Peak mode from 0.15 MHz to 30 MHz. The bandwidth of the Spectrum Analyzer was set to 9 kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Each emission was maximized by switching power lines, varying the mode of operation or resolution, clock or data exchange speed, if applicable, whichever determined the worst-case emission. Each emission reported was calibrated using self-calibrating mode.

Photographs of the worst-case emission can be seen in photographs of conducted emission test setup.

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3.2 Radiated Emission Measurement

Preliminary measurements were made at indoors 3-meter semi EMC Anechoic Chamber using broadband antennas, broadband amplifier, and spectrum analyzer to determine the emission frequencies producing the maximum EME.

Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configurations, mode of operation, turntable azimuth with respect to the antenna were noted for each frequency found. The spectrum was scanned from 30 MHz to 1 000 MHz using bi-log antenna and above 1 000 MHz, linearly polarized double ridge horn antennas were used. Above 1 GHz, linearly polarized double ridge horn antennas were used. The measurements were performed with three frequencies, which were selected as bottom, middle, and top frequency in the operating band. Emission level from the EUT with various configurations was examined on the spectrum analyzer connected with the RF amplifier and plotted graphically. Final measurements were made outdoors open site at 3-meter test range using biconical and log periodic, Horn antenna. The output from the antenna was connected, via a preselector or a preamplifier, to the input of the EMI Measuring Receiver and Spectrum analyzer (for above 25 GHz). The detector function was set to the quasi-peak or peak mode as appropriate. The measurement bandwidth on the Field strength receiver was set to at least 120 kHz (1MHz for measurement above 1 GHz), with all post-detector filtering no less than 10 times the measurement bandwidth. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition.

Each frequency found during preliminary measurement was examined and investigated as the same set up and configuration which produced the maximum emission The EUT, support equipment and interconnecting cables were configured to the set-up producing the maximum emission for the frequency and were placed on top of a 0.8 m high non-metallic 1.0 m x 1.5 m table. The turntable containing the system was rotated and the antenna height was varied 1 to 4 meters and stopped at the azimuth or height producing the maximum emission.

Varying the mode of operating frequencies of the EUT maximized each emission. The system was tested in all the three orthogonal planes and changing the polarity of the antenna. The worst-case emissions are recorded in the data tables. If necessary, the radiated emission measurement could be performed at a closer distance to ensure higher accuracy and the results were extrapolated to the specified distance using an inverse linear distance extrapolation factor (20 dB/decade) as per section 15.31(f).

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4. TEST CONDITION

4.1 Test Configuration

The device was configured for testing in a typical fashion (as a customer would normally use it). During the tests, the EUT and the supported equipments were installed to meet FCC requirement and operated in a manner, which tends to maximize its emission level in a typical application.

Radiated Emission Test

Preliminary radiated emission tests were conducted using the procedure in ANSI C63.4/2009 Clause 8.3.1.1 to determine the worst operating condition. Final radiated emission tests were measured at 3-meter open field test site. To complete the test configuration required by the FCC, the EUT was tested in all three orthogonal planes.

4.2 EUT operation

EUT was tested according to the operation modes provided by the specifications given by the manufacturer, and reported the worst emissions.

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5. TEST RESULTS

5.1 Summary of Test Results

The measurement results were obtained with the EUT tested in the conditions described in this report. Detailed measurement data and plots showing the maximum emission of the EUT are reported.

FCC Rule	Description of Test	Result
§2.1046,	Conducted Output Power	Pass
§22.913(a), §24.232	Radiated Output Power	Pass
§2.1049 §22.917 §22.905 §24.238	Occupied Bandwidth	Pass
§2.1051 §22.917 §24.238(a)	Spurious Emission at Antenna Terminals	Pass
§2.1053 §22.917(a)(b) §24.238(a)(b)	Field Strength of Spurious Radiation(Transmit mode)	Pass
§2.1055(a), §2.1055(d), §22.355, §24.235	Frequency Stability	Pass
§15.109	Radiated Emissions(Receive mode)	Pass
§15.107	Conducted Emissions	N/A

The data collected shows that the product complies with technical requirements of the Part 22H & 24E of the FCC Rules.

Note: Modification to EUT

The device tested is not modified anything, mechanical or circuits to improve EMI status during a measurement. No EMI suppression device(s) was added and/or modified.

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5.2 Conducted Output Power

EUT	GPS Tracking Terminal / GPS-250MVK
Test Date	July 17, 2011
Operating Condition	Continues TX
Environment Condition	25 °C/58 % R.H.
Result	Passed

5.2.1 Definition

The conducted carrier power output rating for a transmitter is the power available at the output terminals of the transmitter when the output terminals are connected to the standard transmitter load.

5.2.2 Specification

FCC Rules Part 2, Section 2.1046

5.2.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.1

5.2.4 Measurement Set-Up

Fig-1

5.2.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	GPS-250MVK	GR Telecom
Attenuator	SA18N25WA	FAIRVIEW MICROWAVE INC.
Spectrum analyzer	N9020A	Agilent
Spectrum analyzer	FSP13SE	Rohde & Schwarz

5.2.6 Test Procedure

① Connect the equipment as Fig-1.
② Measure the transmitter output power.
③ RBW 100kHz, VBW 300kHz, Channel Power Mode

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5.2.7 Test Result

Cellular CDMA

Carrier Channel	Frequency (MHz)	Measured Average Output Power (dBm)	Measured Average Output Power (W)	Limit (dBm)	Margin (dB)
Low	824.64	25.14	0.327	38.45	13.31
Mid	837.00	25.16	0.328	38.45	13.29
High	848.37	25.12	0.325	38.45	13.33

PCS CDMA

Carrier Channel	Frequency (MHz)	Measured Average Output Power (dBm)	Measured Average Output Power (W)	Limit (dBm)	Margin
Low	1 851.25	25.33	0.341	33.00	7.67
Mid	1 880.00	25.39	0.344	33.00	7.61
High	1 906.25	25.36	0.344	33.00	7.64

5.2.8 Plot of RF Power Output

Frequency	RF Power Output
824.64 MHz	

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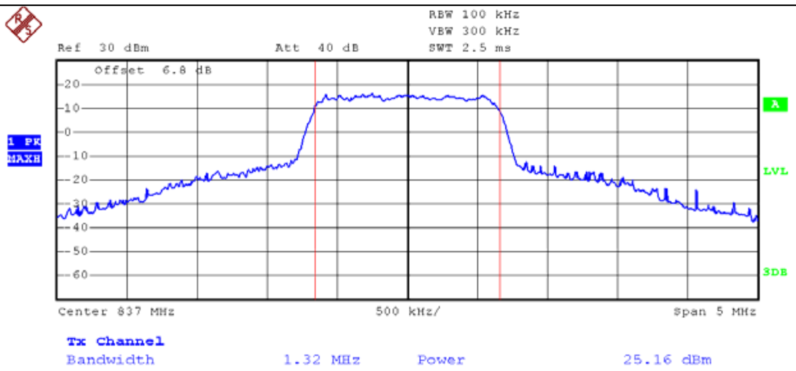
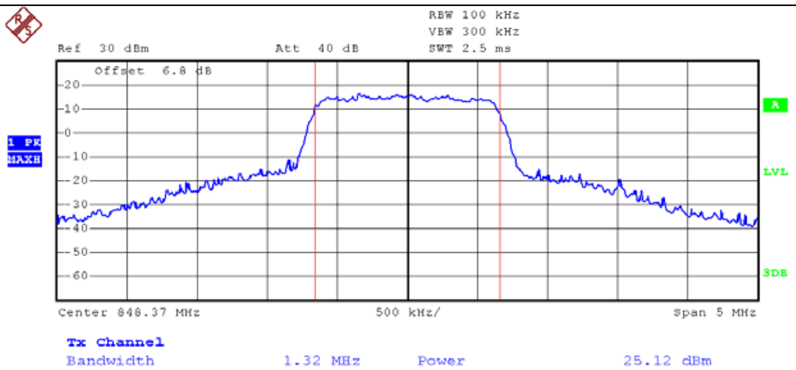
Frequency	RF Power Output
837.00 MHz	
848.37 MHz	

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Frequency	RF Power Output
1 851.25 MHz	
1 880.00 MHz	

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Frequency	RF Power Output
1 906.25 MHz	

5.3 Radiated Output Power

EUT	GPS Tracking Terminal / GPS-250MVK
Test Date	July 17, 2011
Operating Condition	Continues TX
Environment Condition	25 °C/58 % R.H.
Result	Passed

5.3.1 Definition

The conducted carrier power output rating for a transmitter is the power available at the output terminals of the transmitter when the output terminals are connected to the standard transmitter load.

5.3.2 Specification

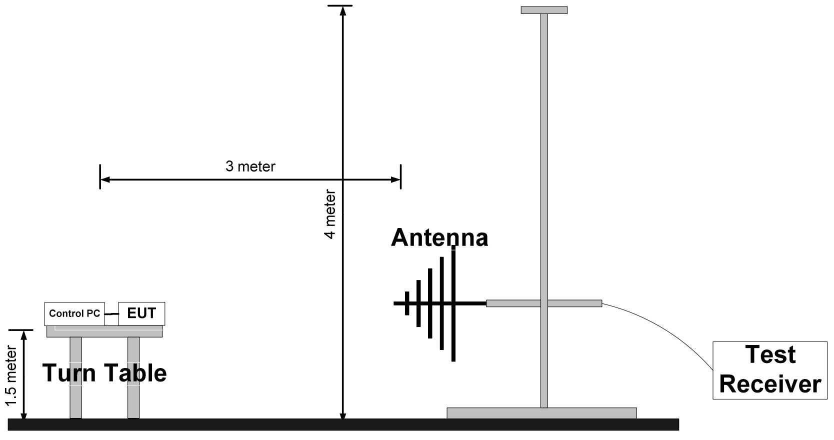
FCC Rules Part 22, Section 22.913(a)
FCC Rules Part 24, Section 24.232

5.3.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.1

5.6.4 Measurement Set-Up

Step 1. Measurement of Field Strength (Fig-4.1)



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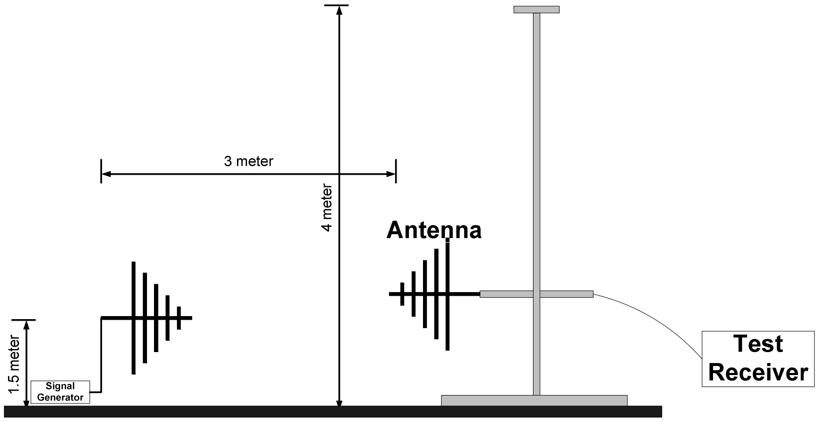
Step 2. Measurement of ERP (Fig-4.2)



5.6.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	GPS-250MVK	GR Telecom
Receiver	ESVN 30	ROHDE & SCHWARZ
Receiver	ESPI	ROHDE & SCHWARZ
Signal Generator	GT9000	GIGATRONICS
Bilog Antenna	VULB 9160	SCHWARZBECK
Bilog Antenna	VULB 9161	SCHWARZBECK
Horn Antenna	BBHA 9120	SCHWARZBECK
Horn Antenna	BBHA9120	SCHWARZBECK

5.6.6 Test Procedure

① X, Y, Z axis, tested carried out to find the maximum condition.
② Maximum conditions: Z-Axis
③ As a result of the Z axis write a report.

5.6.7 Test Procedure

① Connect the equipment as Fig-4-1.
② Place the transmitter to be tested on the turntable in the standard test site
③ The transmitter is transmitting into a nonradiating load that is placed on the turntable. The RF cable to this load should be of minimum length. For transmitters with integral antennas, the tests are to be run with the unit operating into the integral antenna.
④ For each spurious measurement the test antenna should be adjusted to the correct length for the frequency involved. This length may be determined from a calibration ruler supplied with the equipment. Measurements shall be made from the lowest radio frequency generated in the equipment to the tenth harmonic of the carrier, except for the region close to the carrier equal to ± the test bandwidth.
⑤ Key the transmitter.

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⑥ For each spurious frequency, raise and lower the test antenna from 1 m to 4 m to obtain a maximum reading on the spectrum analyzer with the test antenna at horizontal polarity. Then the turntable should be rotated 360° to determine the maximum reading. Repeat this procedure to obtain the highest possible reading. Record this maximum reading.

⑦ Repeat step ⑥ for each spurious frequency with the test antenna polarized vertically.

⑧ Reconnect the equipment as Fig-4.2.

⑨ Remove the transmitter and replace it with a substitution antenna (the antenna should be half-wavelength for each frequency involved). The center of the substitution antenna should be approximately at the same location as the center of the transmitter. At the lower frequencies, where the substitution antenna is very long, this will be impossible to achieve when the antenna is polarized vertically. In such case the lower end of the antenna should be 0.3 m above the ground.

⑩ Feed the substitution antenna at the transmitter end with a signal generator connected to the antenna by means of a nonradiating cable. With the antennas at both ends horizontally polarized, and with the signal generator tuned to a particular spurious frequency, raise and lower the test antenna to obtain a maximum reading at the spectrum analyzer. Adjust the level of the signal generator output until the previously recorded maximum reading for this set of conditions is obtained. This should be done carefully repeating the adjustment of the test antenna and generator output.

⑪ Repeat step ⑩ with both antennas vertically polarized for each spurious frequency.

⑫ Calculate power in dBm into a reference ideal half-wave dipole antenna by reducing the readings obtained in steps ⑩ and ⑪ by the power loss in the cable between the generator and the antenna, and further corrected for the gain of the substitution antenna used relative to an ideal half-wave dipole antenna by the following formula :

ERP = S.G Output (dBm) + Antenna Gain (dBd) – Cable Loss(dB)
EIRP = S.G Output (dBm) + Antenna Gain (dBi) – Cable Loss(dB)

5.3.7 Test Result

Cellular CDMA

EUT MODE	Measured Frequency(Mhz)	Antenna Polarization (V/H)	SPA Reading (dBuV)	Signal Generator Level (dBm)	Cable Loss (dB)	Antenna Gain(dBd)	Limit (dBm)	ERP (dBm)
Cellular CDMA	824.64	H	117.25	23.23	-3.7	3.6	38.45	23.22
	837.00	H	116.91	22.87	-3.7	3.6	38.45	22.86
	848.37	H	116.54	22.55	-3.7	3.6	38.45	22.54

PCS CDMA

Band/Channel	Measured Frequency(Mhz)	Antenna Polarization (V/H)	SPA Reading (dBuV)	Signal Generator Level (dBm)	Cable Loss (dB)	Antenna Gain(dBi)	Limit (dBm)	EIRP (dBm)
PCS CDMA	1851.25	H	111.22	18.42	-5.3	10.4	33.00	23.52
	1880.00	H	111.56	18.89	-5.3	10.4	33.00	23.99
	1906.25	H	112.04	19.60	-5.3	10.4	33.00	24.70

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5.4 Occupied Bandwidth

EUT	GPS Tracking Terminal / GPS-250MVK
Test Date	July 17, 2011
Operating Condition	Continues TX
Environment Condition	25 °C/58 % R.H.
Result	Passed

5.4.1 Definition

The transmitter sideband spectrum denotes the sideband power produced at a discrete frequency separation from the carrier up to the test bandwidth due to all sources of unwanted noise within the transmitter in a modulated condition.

5.4.2 Specification

FCC Rules Part 2, Section 2.1049
FCC Rules Part 22, Section 22.905
FCC Rules Part 24, Section 24.238

5.4.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.11

5.4.4 Measurement Set-Up

Fig-2

5.4.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	GPS-250MVK	GR Telecom
Attenuator	SA18N25WA	FAIRVIEW MICROWAVE INC.
Spectrum analyzer	N9020A	Agilent
Spectrum analyzer	FSP13SE	Rohde & Schwarz

5.3.6 Test Procedure

① Connect the equipment as Fig-2.
② The test shall be performed using the modulation of the EUT.

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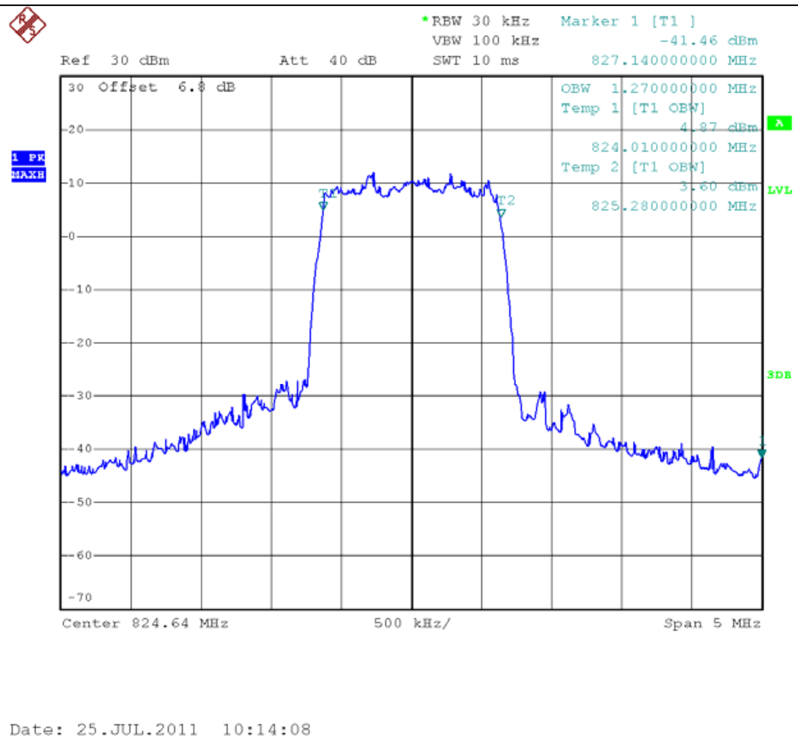
5.4.7 Test Result

CDMA 824 MHz - 849 MHz		
Carrier Channel	Frequency (MHz)	Occupied Bandwidth (kHz)
Low	824.64	1 270
Mid	837.00	1 280
High	848.37	1 280

PCS 1 850 MHz - 1 910 MHz		
Carrier Channel	Frequency (MHz)	Occupied Bandwidth (kHz)
Low	1 851.25	1 270
Mid	1 880.00	1 280
High	1 906.25	1 280

5.4.8 Plot of Occupied Bandwidth

Frequency	Occupied Bandwidth
824.64 MHz	

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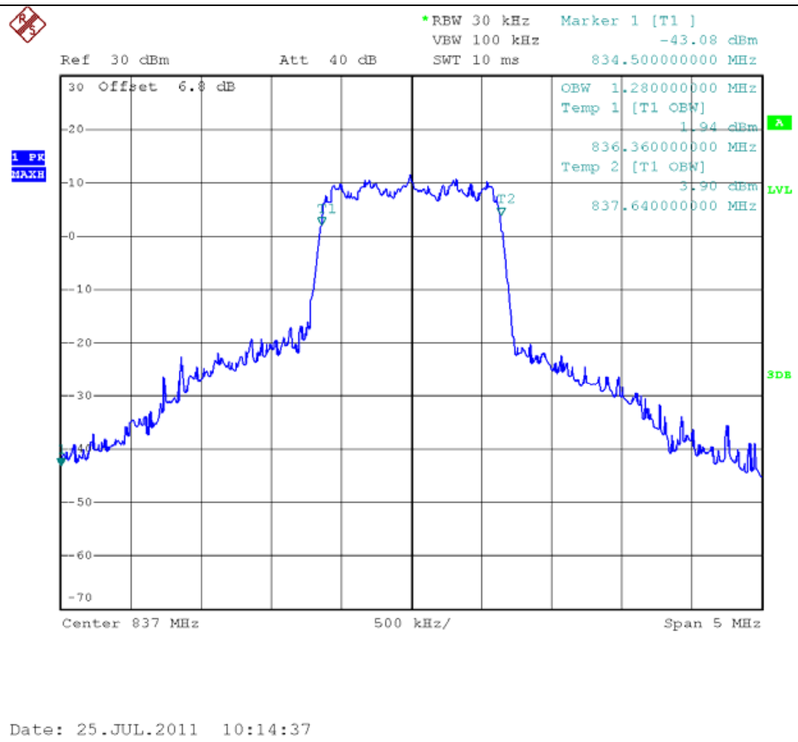
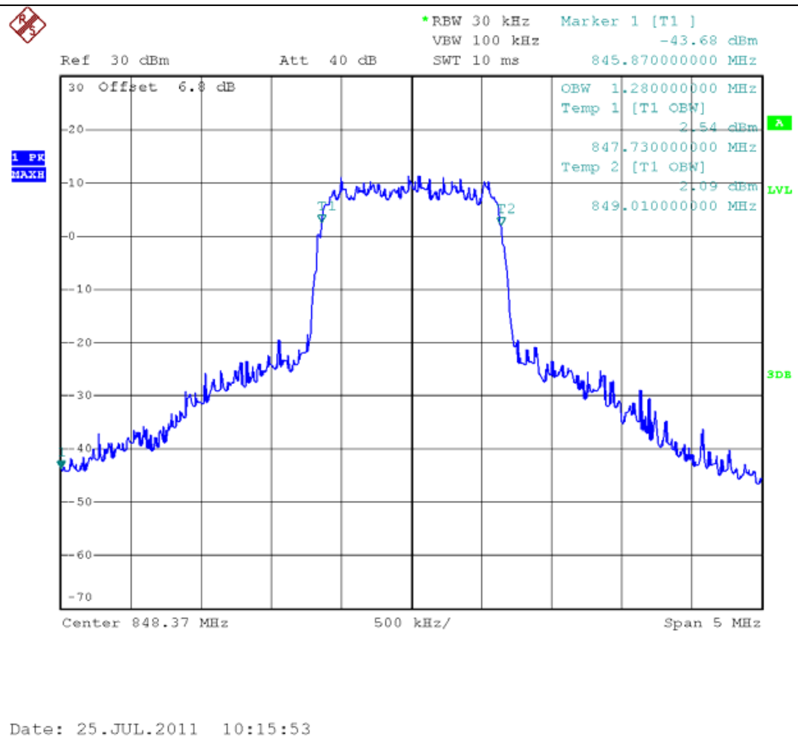
Frequency	Occupied Bandwidth
837.00 MHz	
848.37 MHz	

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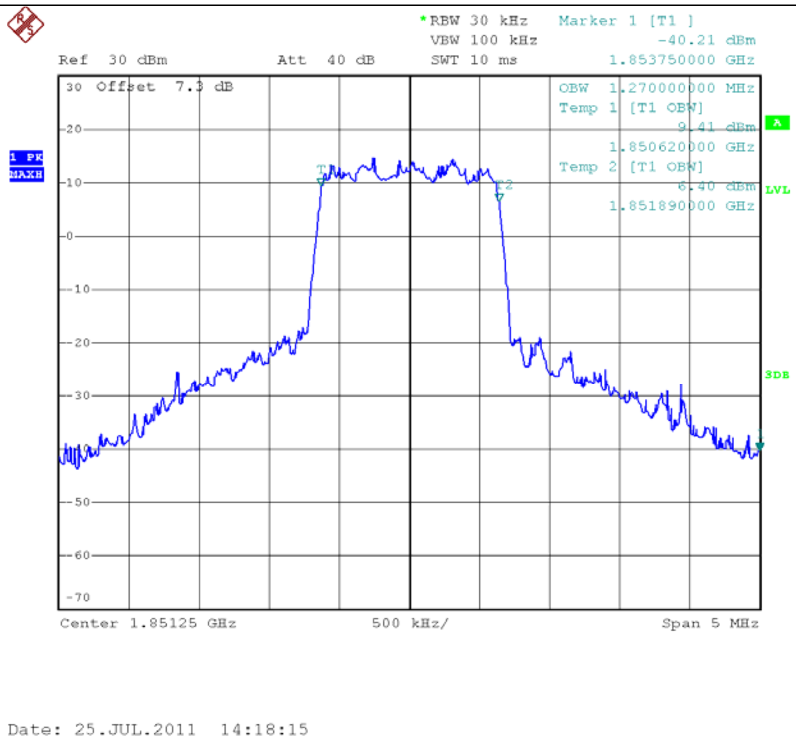
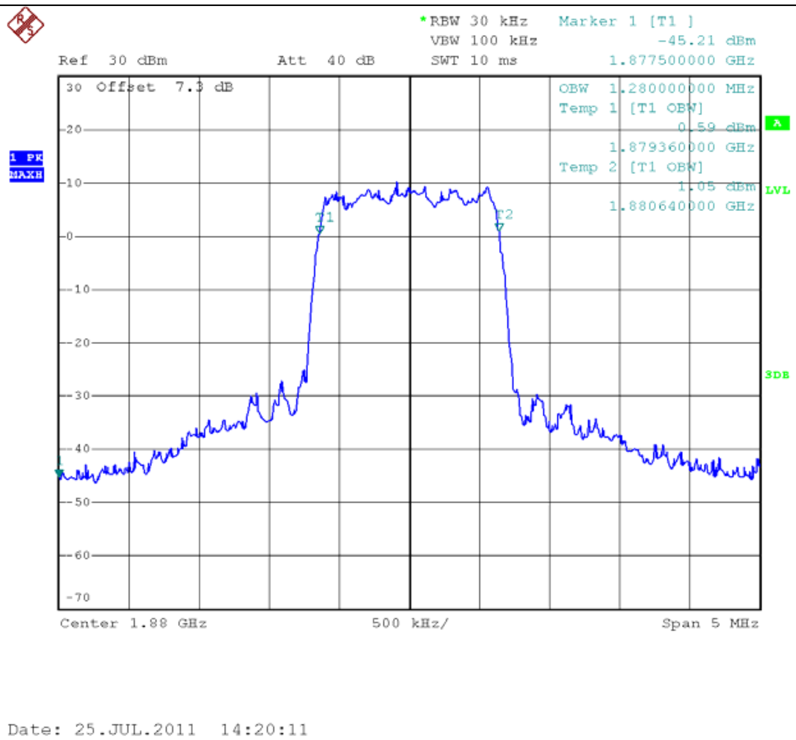
Frequency	Occupied Bandwidth
1 851.25 MHz	
1 880.00 MHz	

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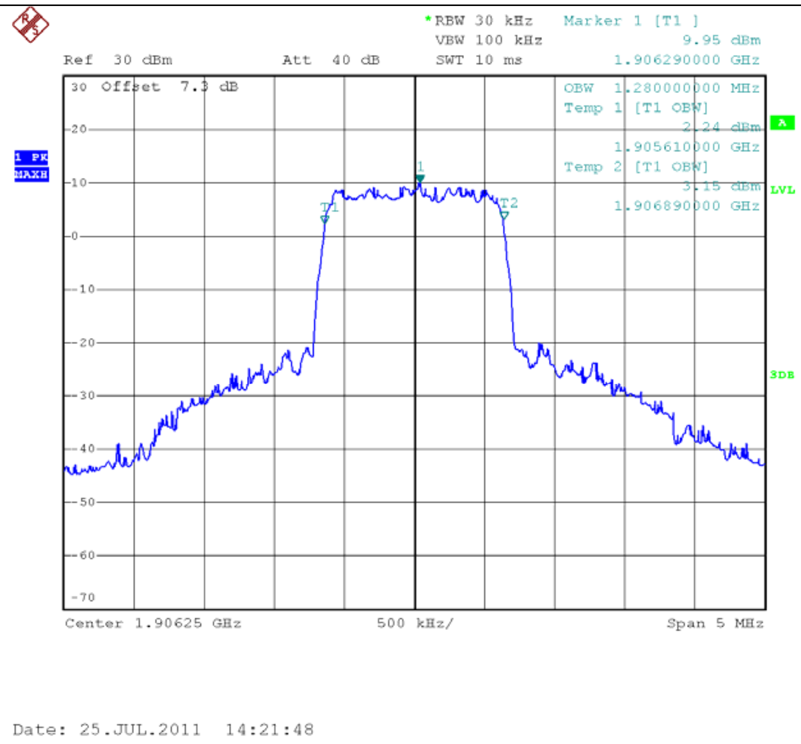
Frequency	Occupied Bandwidth
1 906.25 MHz	

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5.5 Spurious Emission at Antenna Terminals

EUT	GPS Tracking Terminal / GPS-250MVK
Test Date	July 17, 2011
Operating Condition	Continues TX
Environment Condition	25 °C/58 % R.H.
Result	Passed

5.5.1 Definition

Conducted spurious emissions are emissions at the antenna terminals on a frequency or frequencies that are outside a band sufficient to ensure transmission of information of required quality for the class of communication desired.

5.5.2 Specification

FCC Rules Part 2, Section 2.1051
FCC Rules Part 22, Section 22.917
FCC Rules Part 24, Section 24.238(a)

5.5.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.13

5.5.4 Measurement Set-Up

Fig-3

5.5.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	GPS-250MVK	GR Telecom
Attenuator	SA18N25WA	FAIRVIEW MICROWAVE INC.
Spectrum analyzer	N9020A	Agilent
Spectrum analyzer	FSP13SE	Rohde & Schwarz

5.5.6 Test Procedure

① Connect the equipment as Fig-3.
② Set the center frequency of the spectrum analyzer to the assigned transmitter frequency, key the transmitter, and set the level of the carrier to the full scale reference line.
③ Measure the spurious emission.
③ 30-1000MHz RBW 100 kHz, VBW 300 kHz, Max Hold, 1Ghz above RBW 1 MHz, VBW 3 MHz

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5.5.7 Limit

① 824 MHz ~ 849 MHz / “43 + 10log(P) dBc = -13 dBm”
② 1850 MHz ~ 1909 MHz / “43 + 10log(P) dBc = -13 dBm”

5.5.8 Test Result

Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	1649.28	-44.09	-13.0	31.09
	2473.92	-44.37	-13.0	31.37
Middle	1674.00	-41.83	-13.0	28.83
	2511.00	-44.56	-13.0	31.56
High	1696.74	-45.06	-13.0	32.06
	2548.11	-43.09	-13.0	30.09

Channel	Frequency (MHz)	Measured Value (dBm)	Limit (dBm)	Margin (dB)
Low	111.48	-47.97	-13.0	34.97
	3702.50	-54.67	-13.0	41.67
	5553.75	-55.56	-13.0	42.56
Middle	140.58	-45.45	-13.0	32.45
	3760.00	-57.36	-13.0	44.36
	5640.00	-64.60	-13.0	51.60
High	167.74	-46.99	-13.0	33.99
	3812.50	-56.61	-13.0	43.61
	5718.75	-65.19	-13.0	52.19

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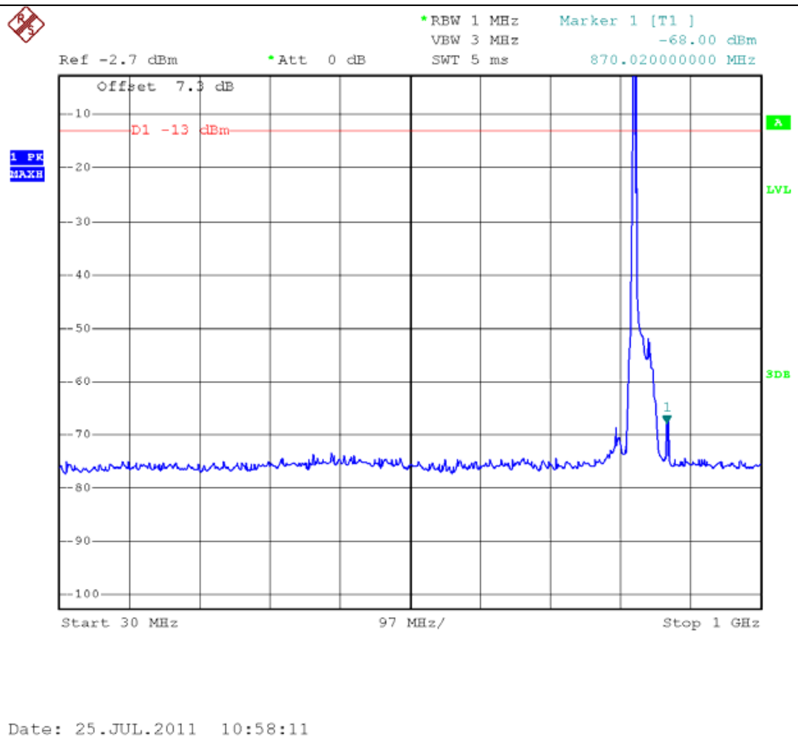
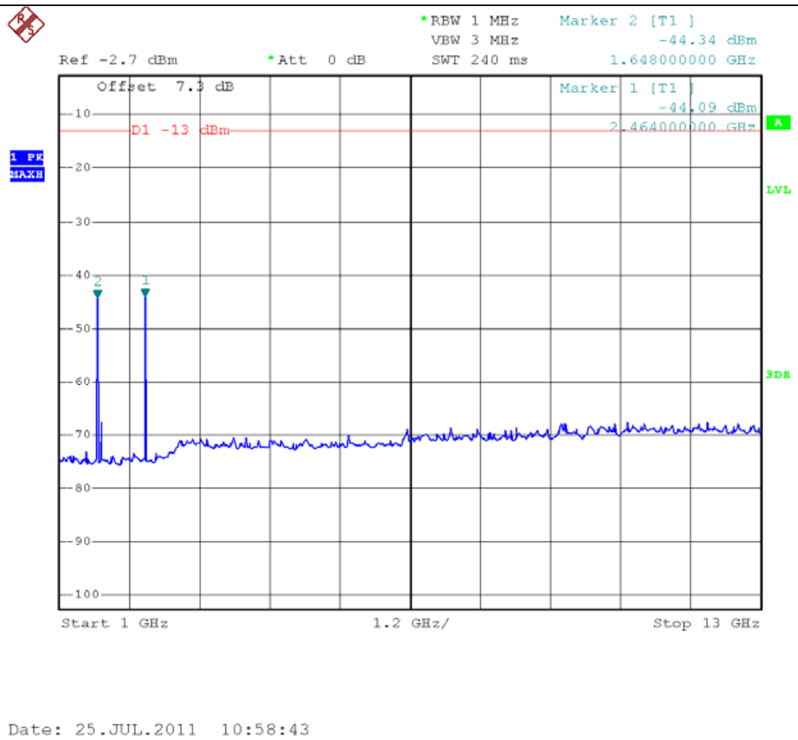
5.5.9 Plot of Spurious Emission at Antenna Terminals

Frequency	Spurious Emission at Antenna Terminals
824.64 MHz	
824.64 MHz	

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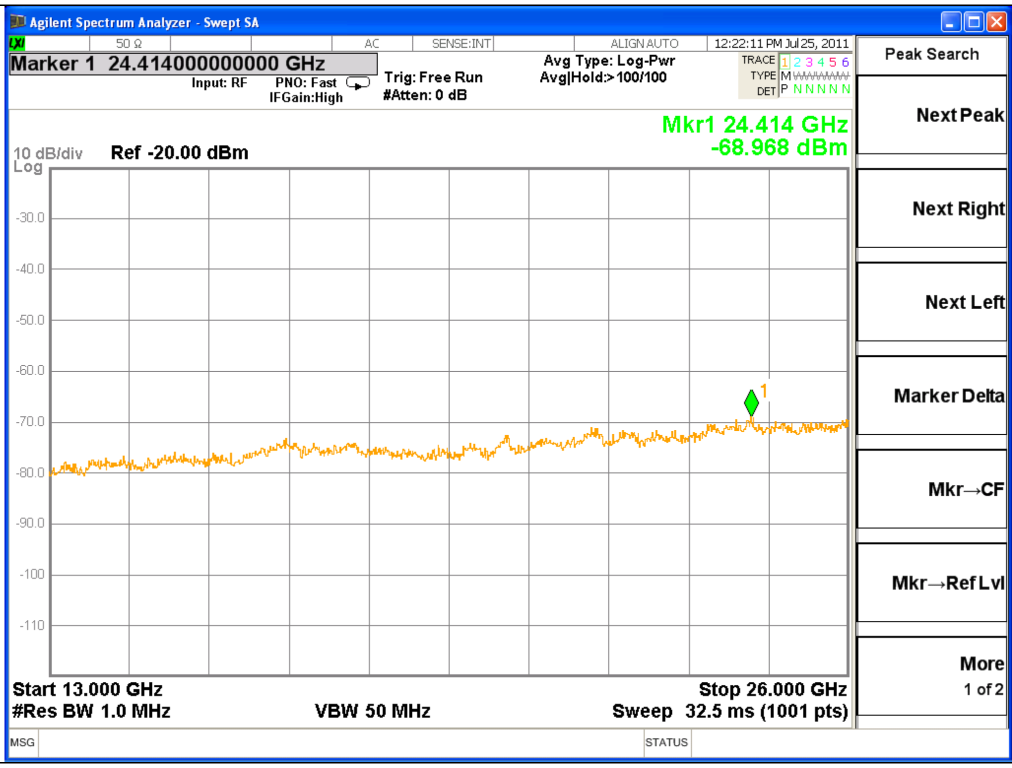
<tr><th>Frequency</th><th>Spurious Emission at Antenna Terminals</th></tr>
<tr><td>824.64 MHz</td><td>
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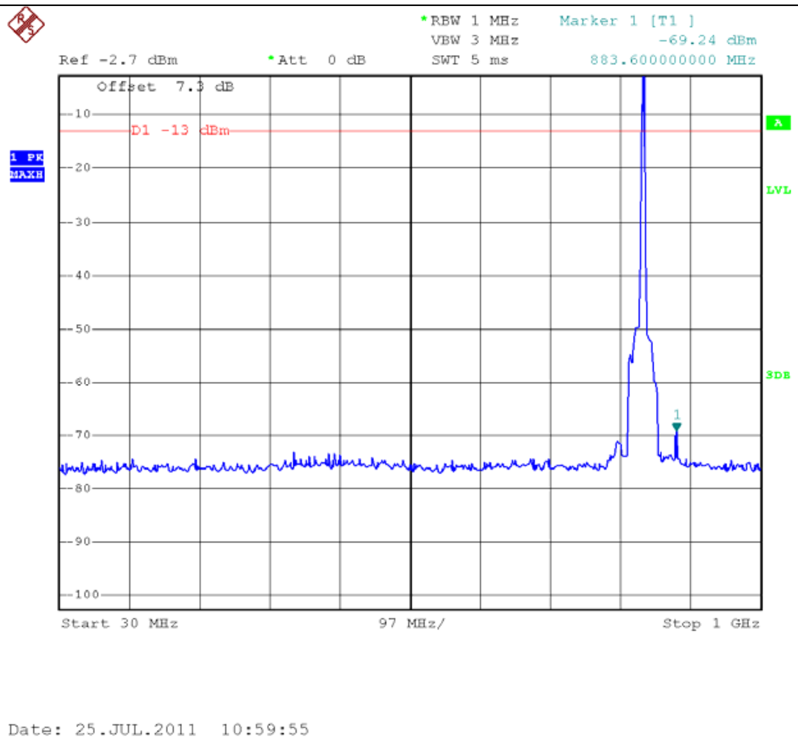
<tr><td>837.00 MHz</td><td>
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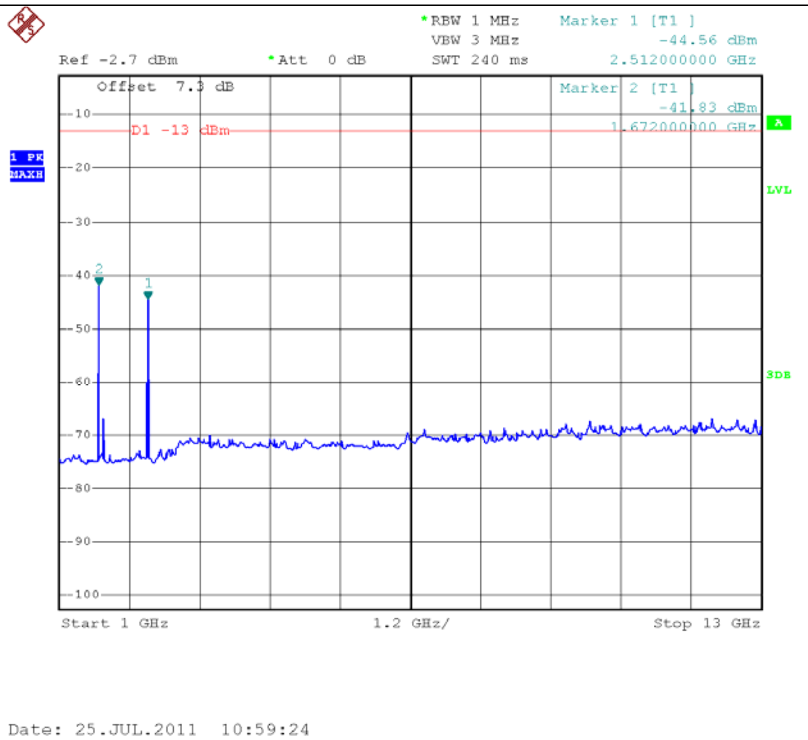
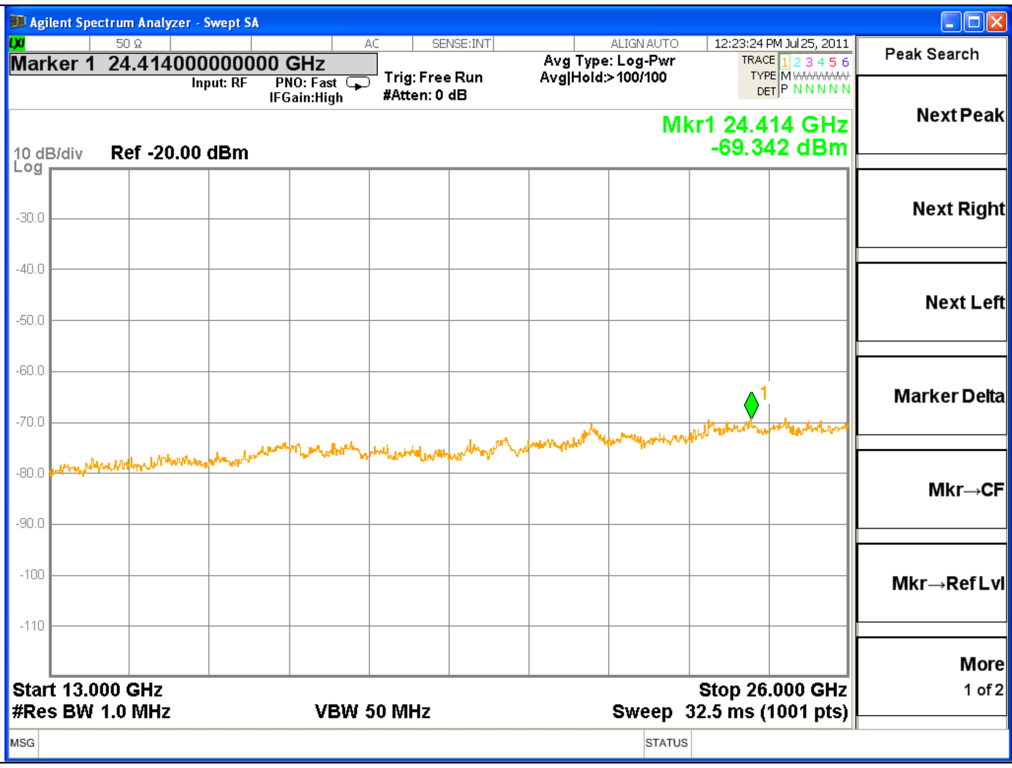
Frequency	Spurious Emission at Antenna Terminals
837.00 MHz	
837.00 MHz	

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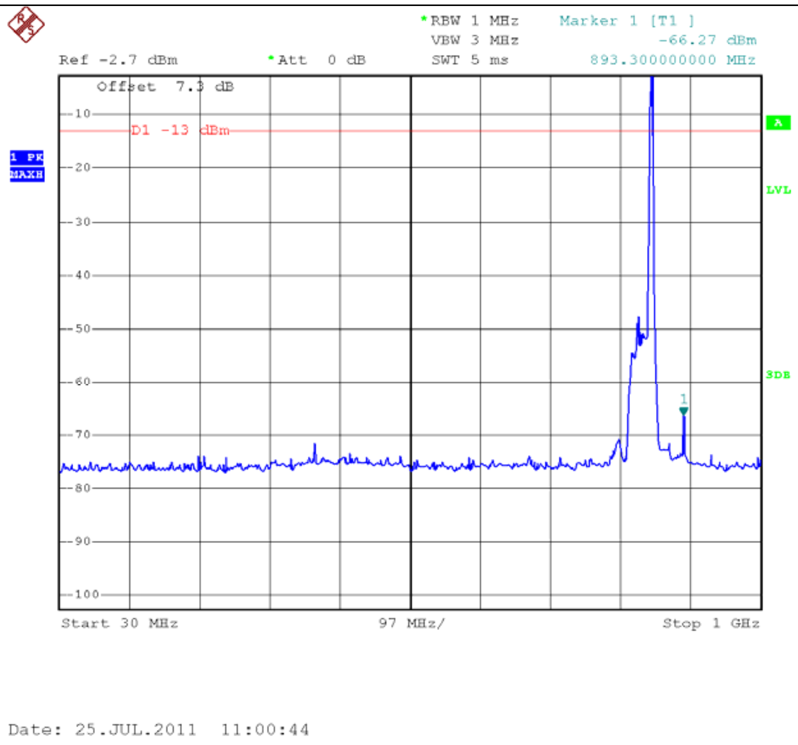
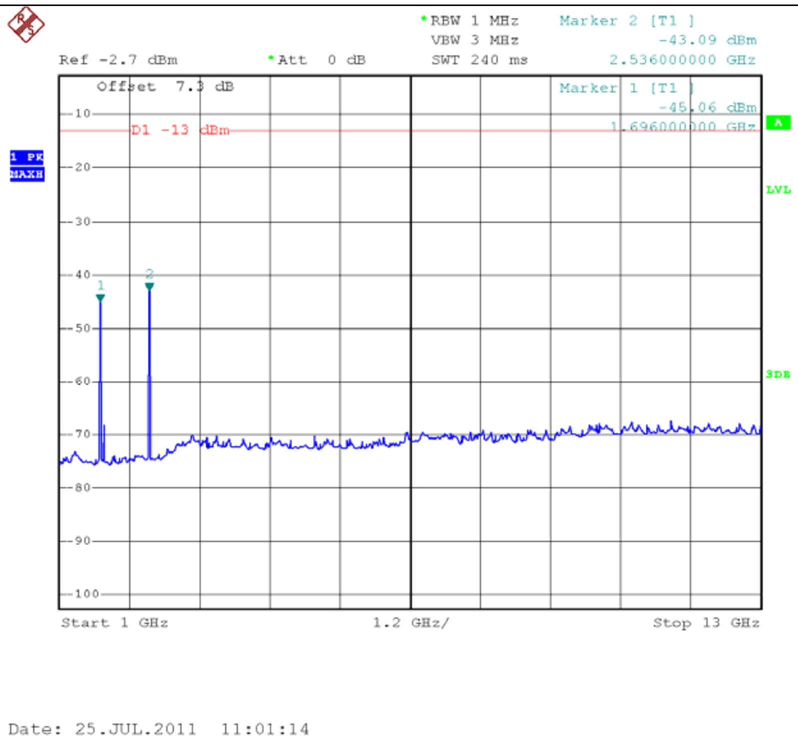
Frequency	Spurious Emission at Antenna Terminals
848.37 MHz	
848.37 MHz	

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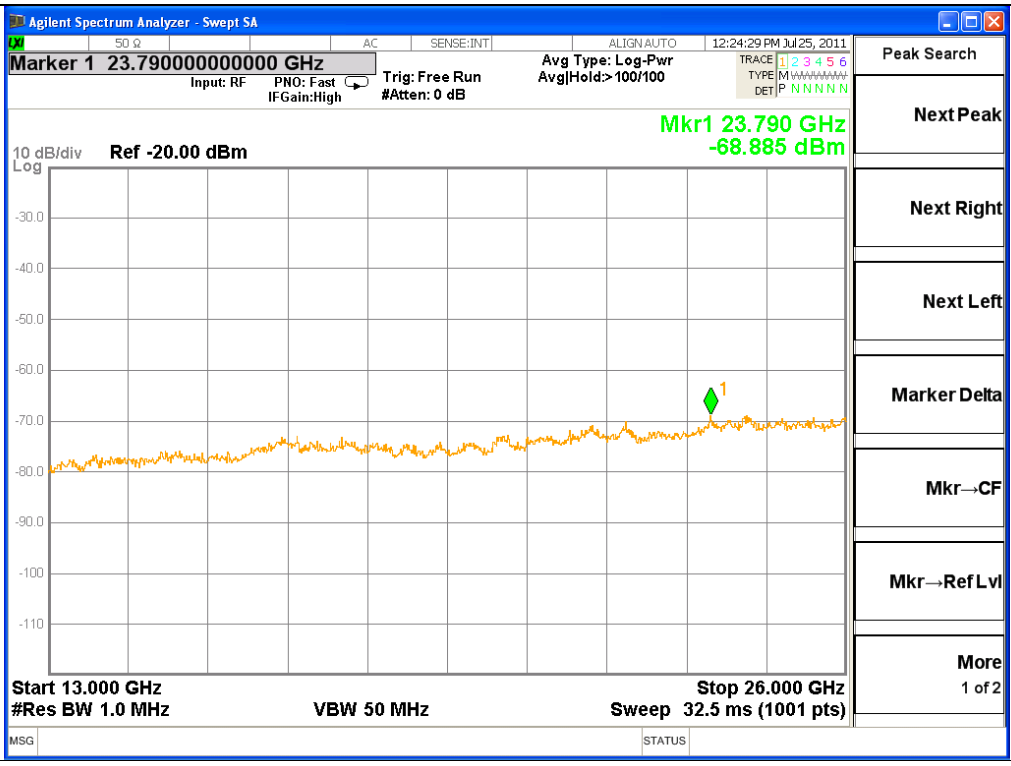
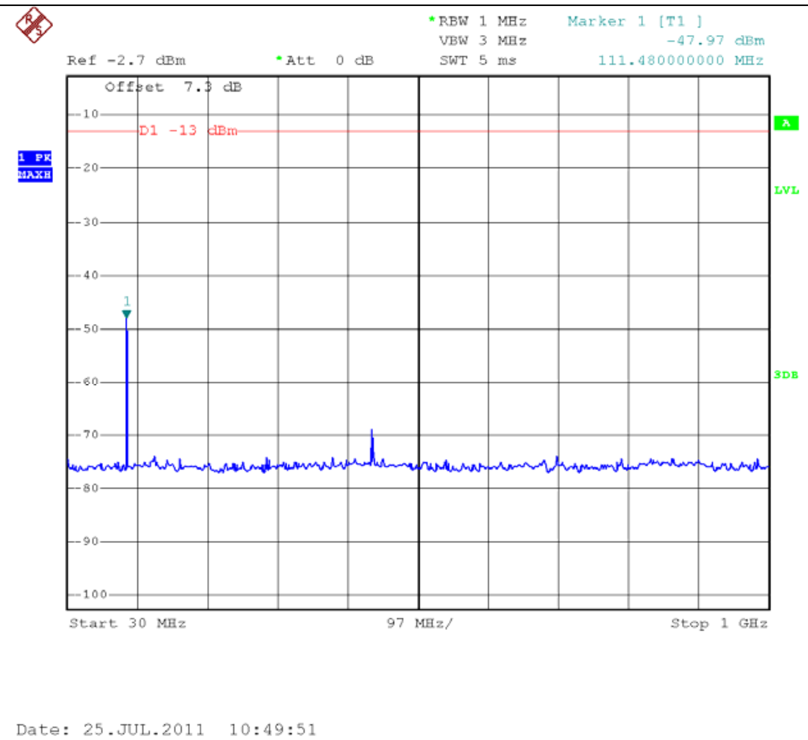
Frequency	Spurious Emission at Antenna Terminals
848.37 MHz	
1 851.25 MHz	

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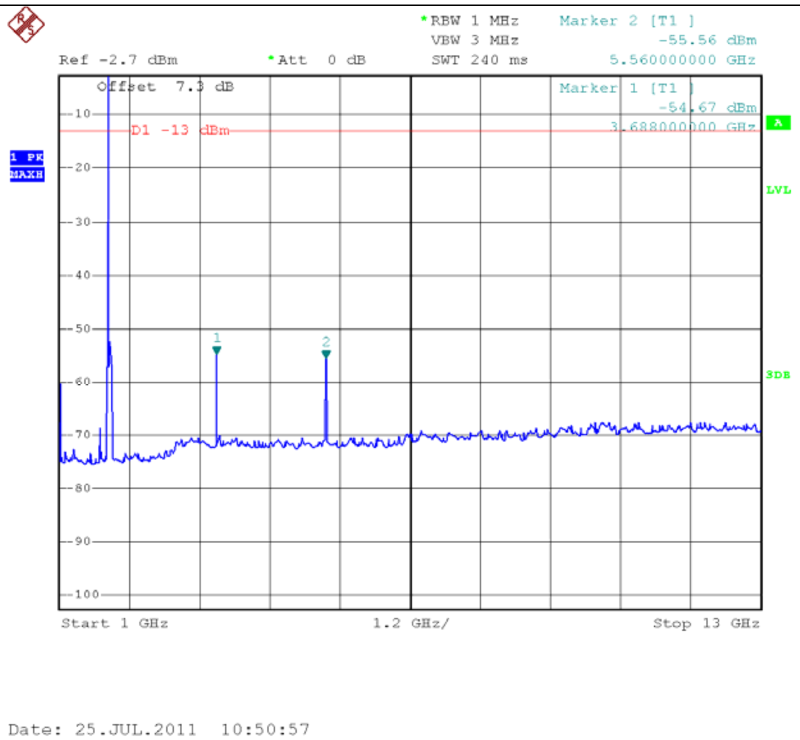
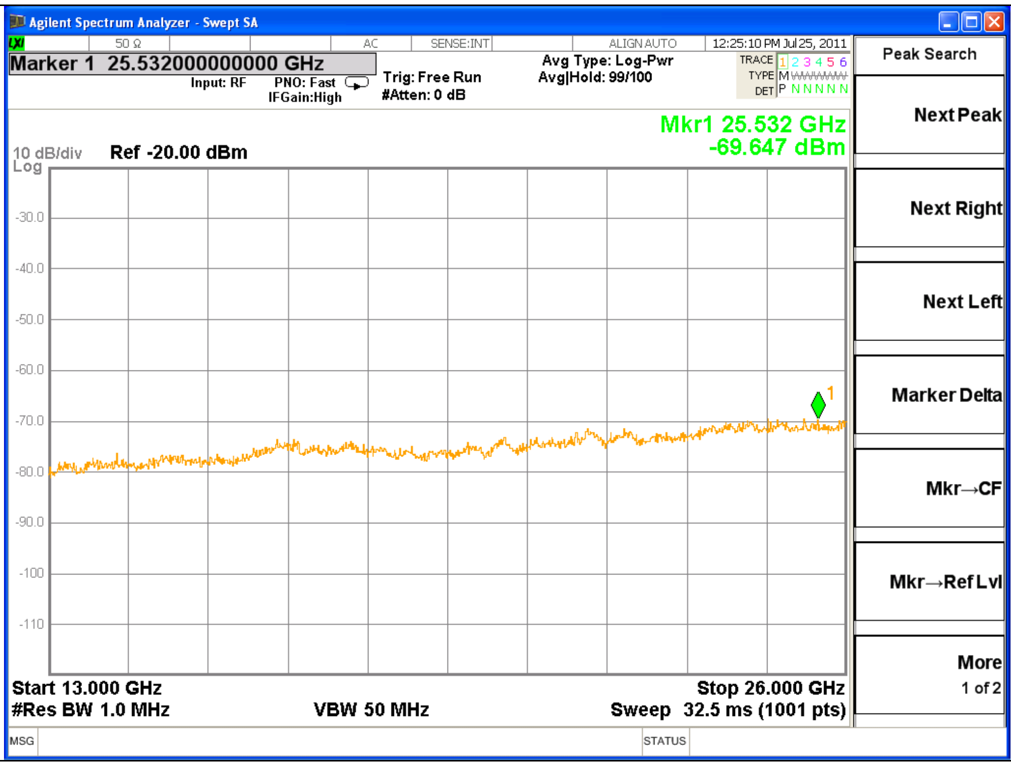
Frequency	Spurious Emission at Antenna Terminals
1 851.25 MHz	
1 851.25 MHz	

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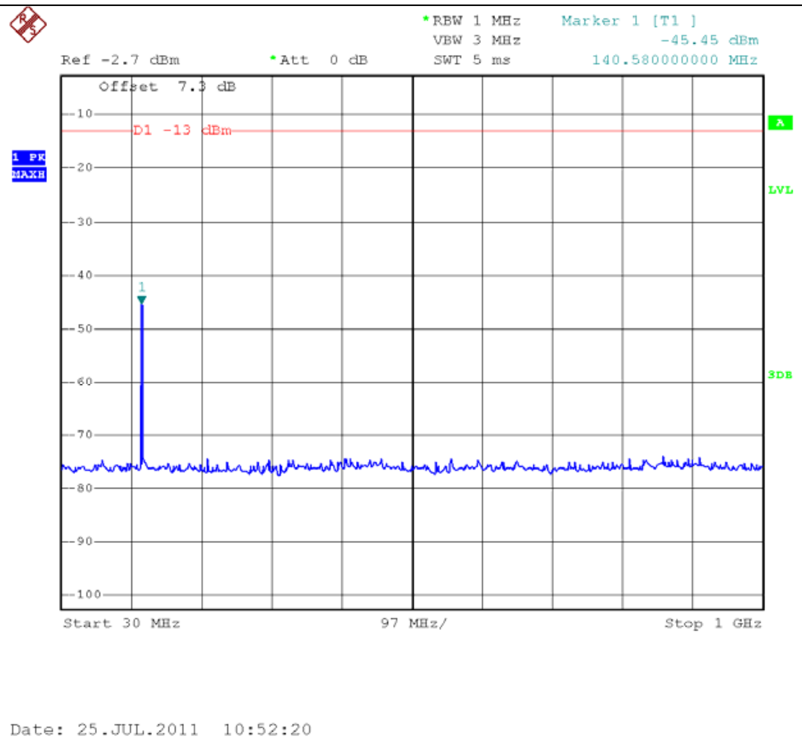
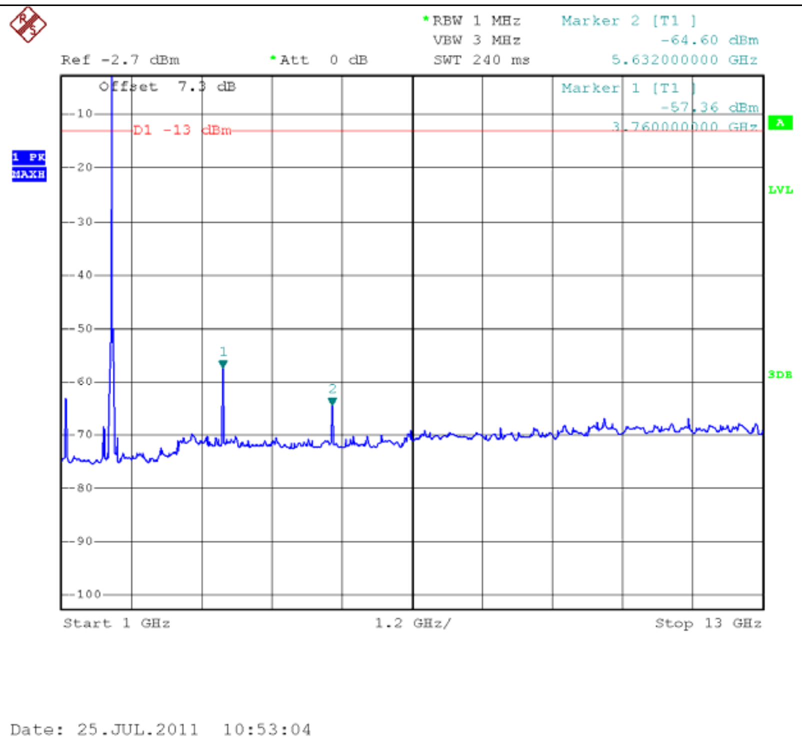
Frequency	Spurious Emission at Antenna Terminals
1 880.00 MHz	
1 880.00 MHz	

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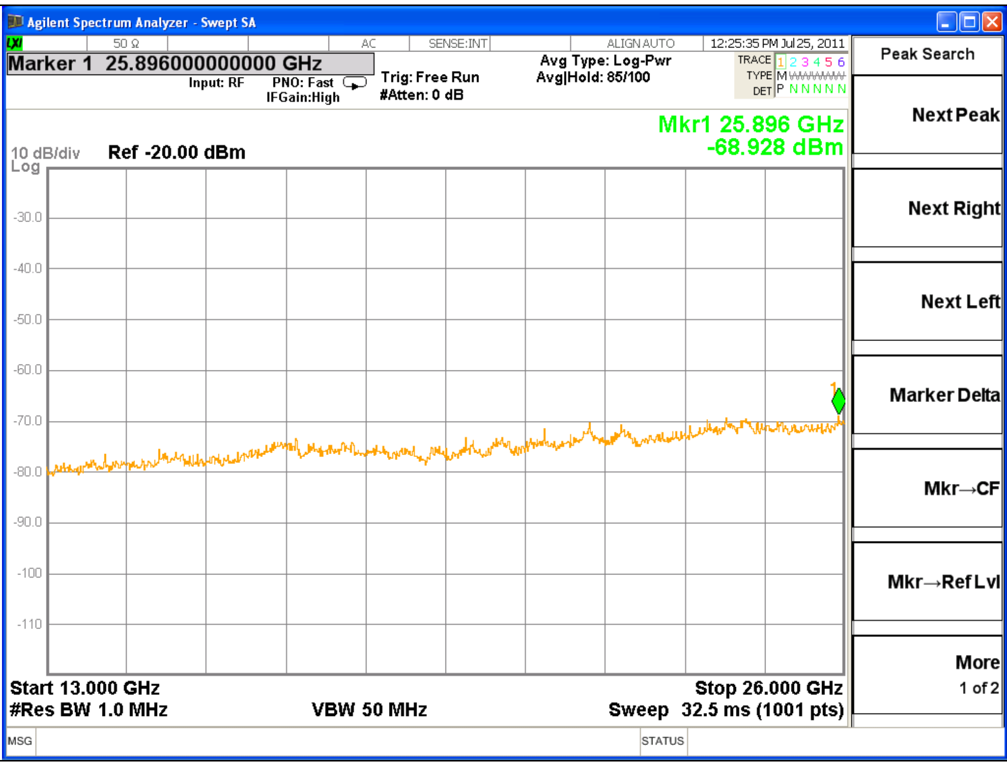
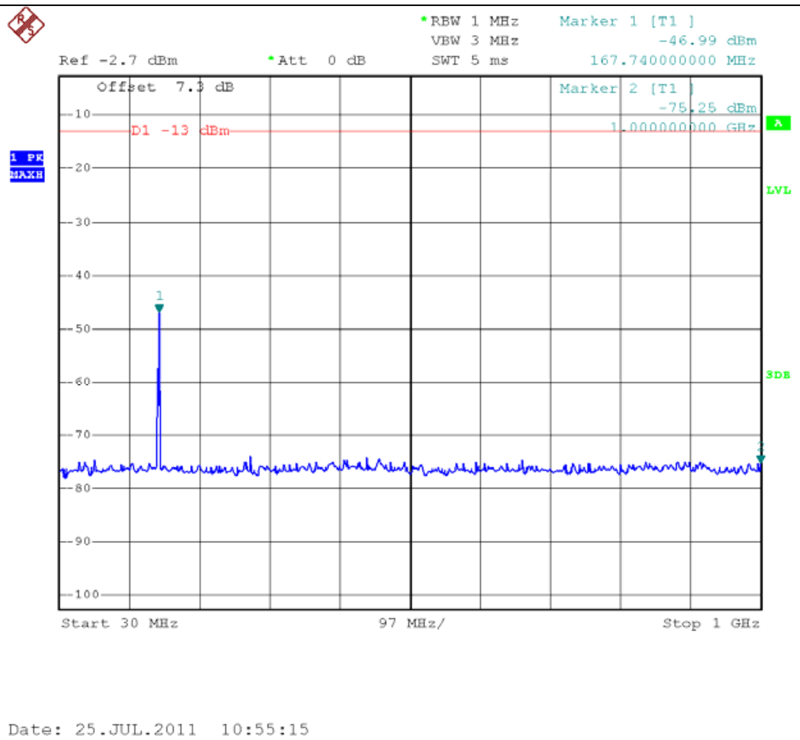
Frequency	Spurious Emission at Antenna Terminals
1 880.00 MHz	
1 906.25 MHz	

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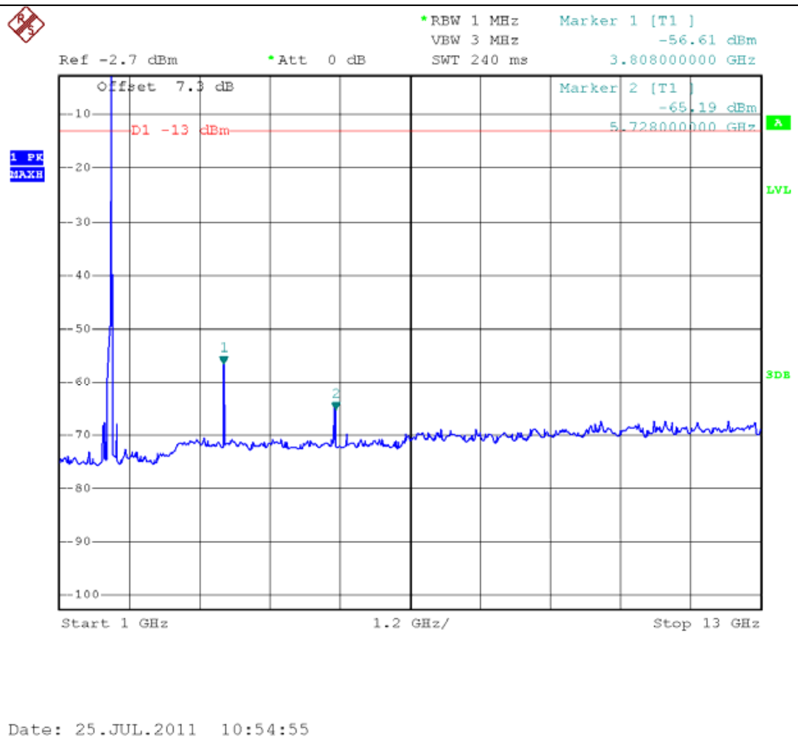
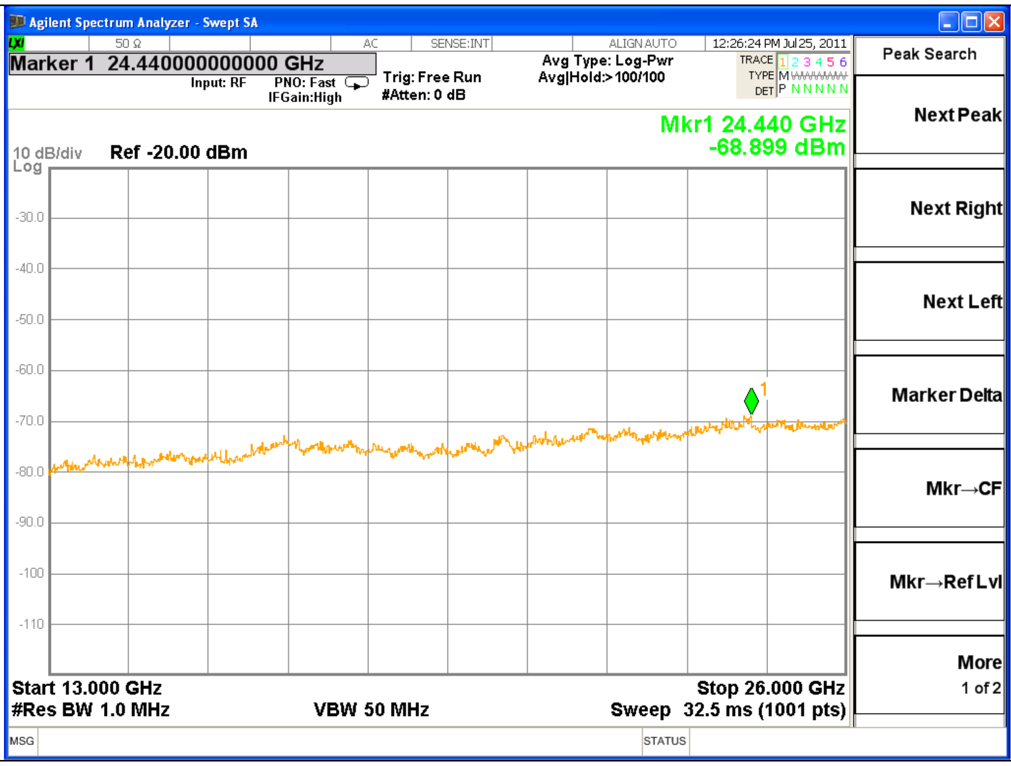
Frequency	Spurious Emission at Antenna Terminals
1 906.25 MHz	
1 906.25 MHz	

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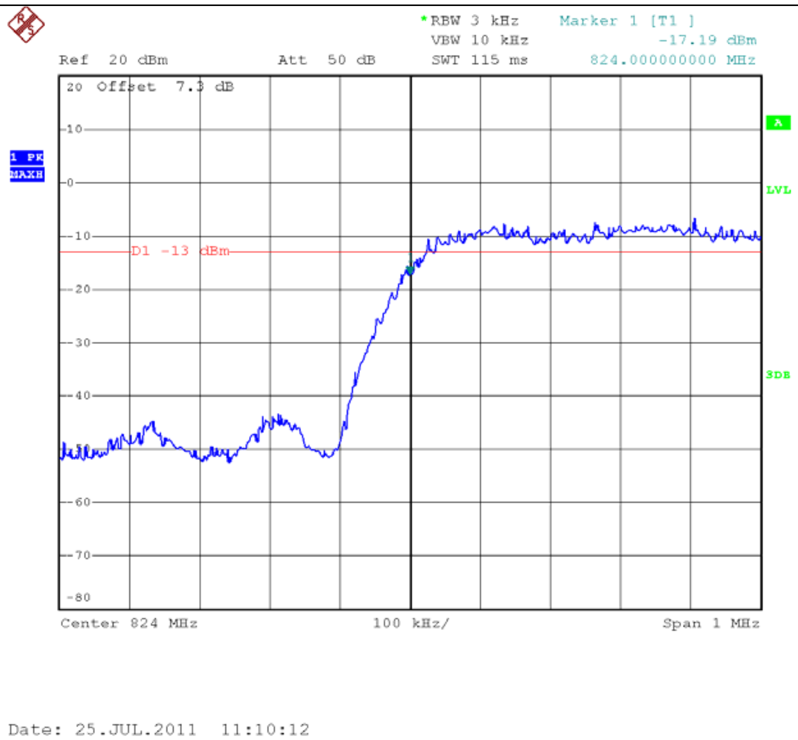
<table>
<tr><th>Frequency</th><th>Out of band emission</th></tr>
<tr><td>824.00 MHz</td><td>


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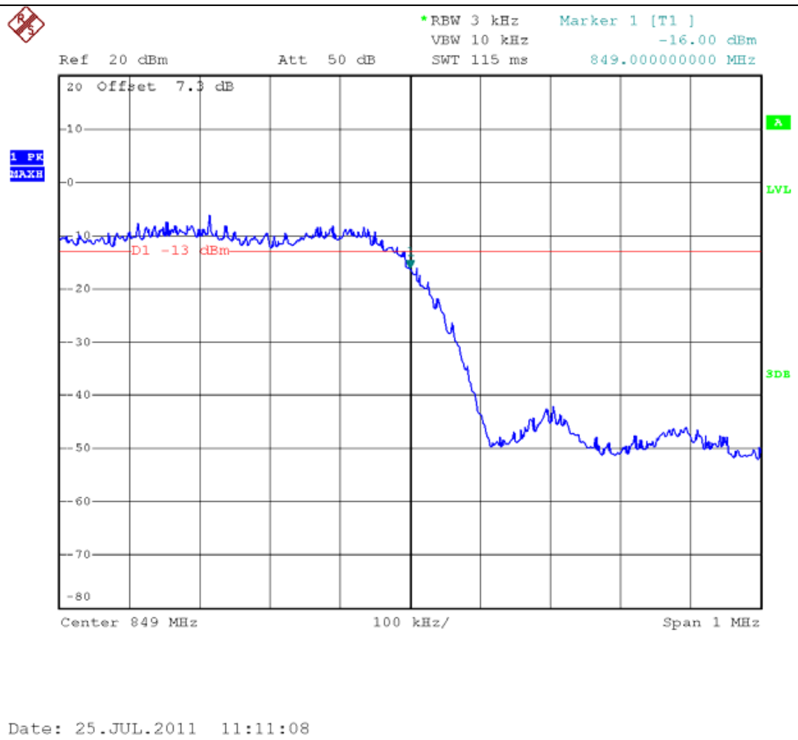
<tr><td>849.00 MHz</td><td>


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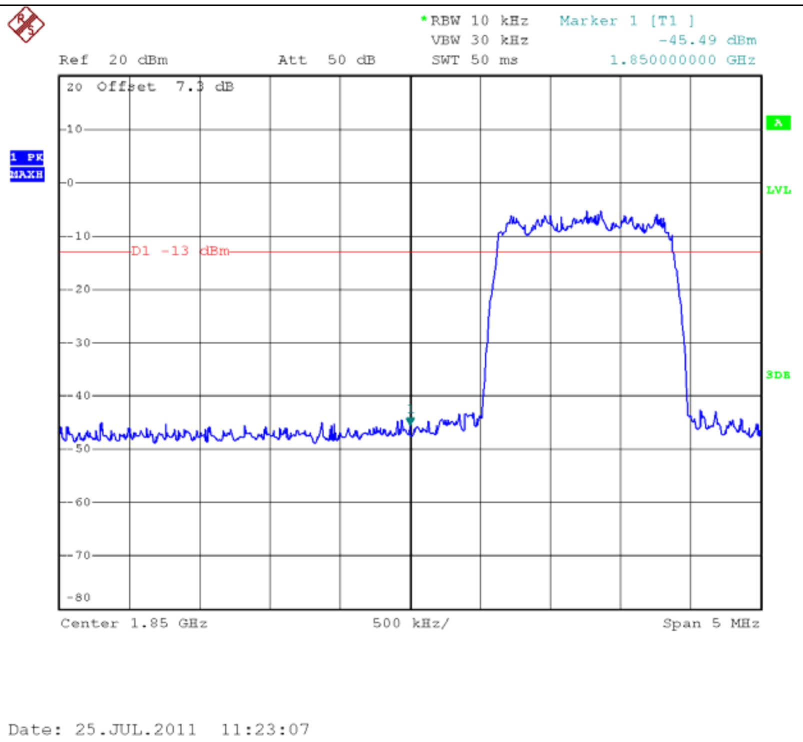
<tr><th>Frequency</th><th>Out of band emission</th></tr>
<tr><td>1 851.00 MHz</td><td>
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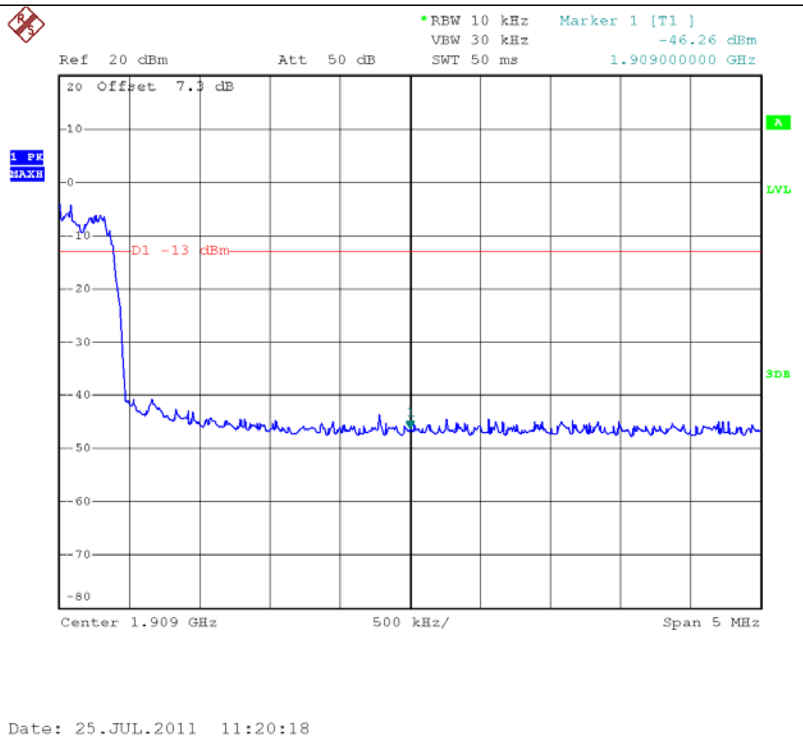
<tr><td>1 909.00 MHz</td><td>
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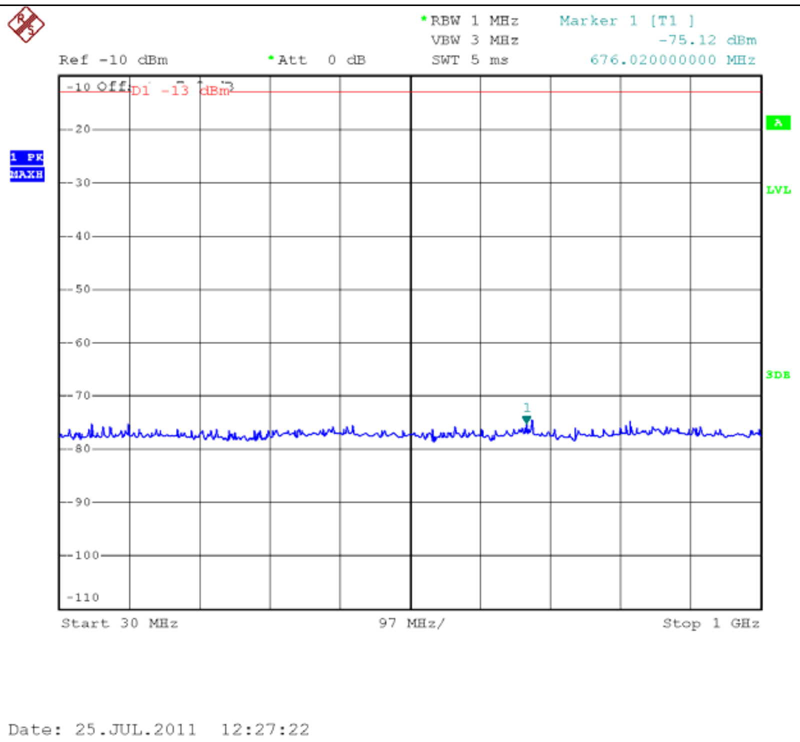
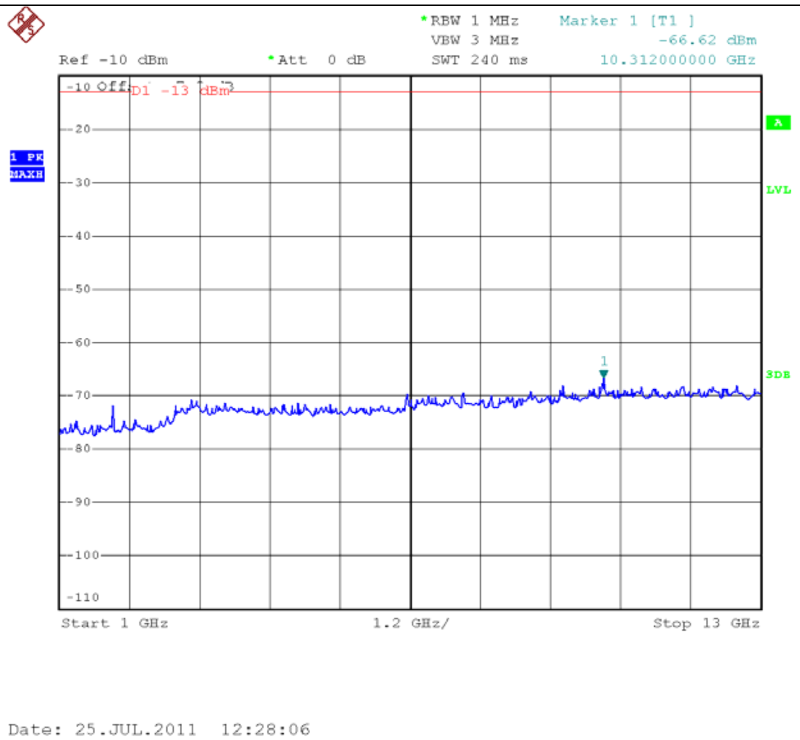
Frequency	Spurious Emission at Antenna Terminals(Receive mode)
Worst-case Mode	

Worst-case Mode	

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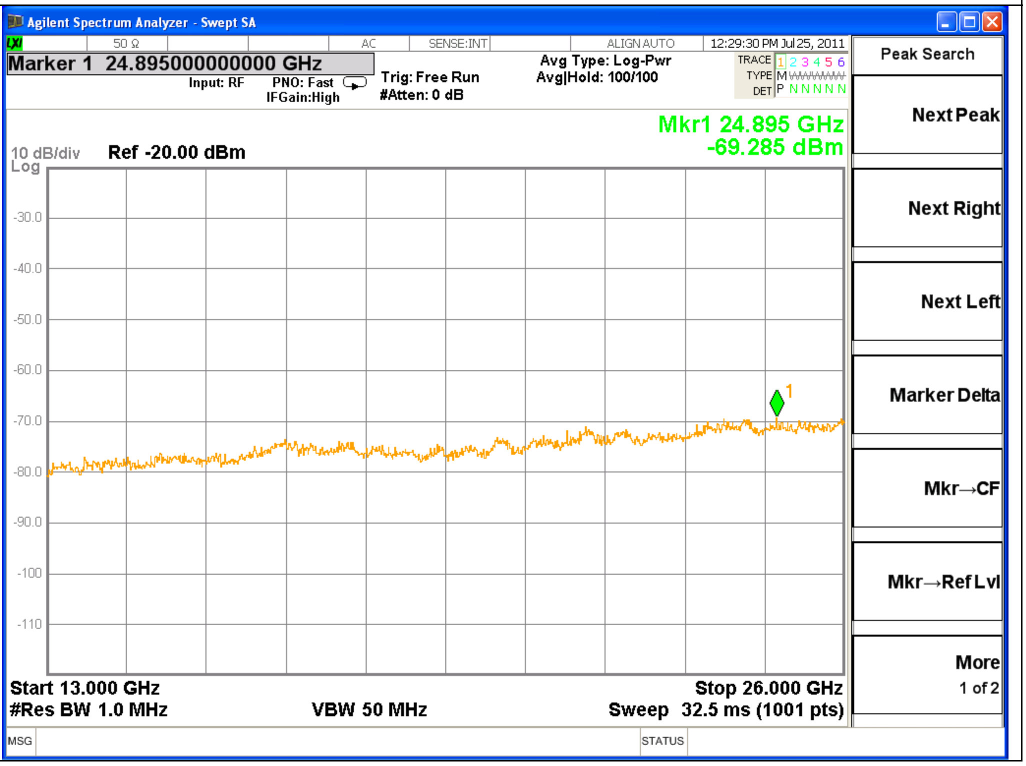
Frequency	Spurious Emission at Antenna Terminals(Receive mode)
Worst-case Mode	

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5.6 Field Strength of Spurious Radiation

EUT	GPS Tracking Terminal / GPS-250MVK
Test Date	July 17, 2011
Operating Condition	Continues TX
Environment Condition	25 °C/58 % R.H.
Result	Passed

5.6.1 Definition

Radiated spurious emissions are emissions from the equipment when transmitting into a nonradiating load on a frequency or frequencies that are outside an occupied band sufficient to ensure transmission of information of required quality for the class of communications desired.

5.6.2 Specification

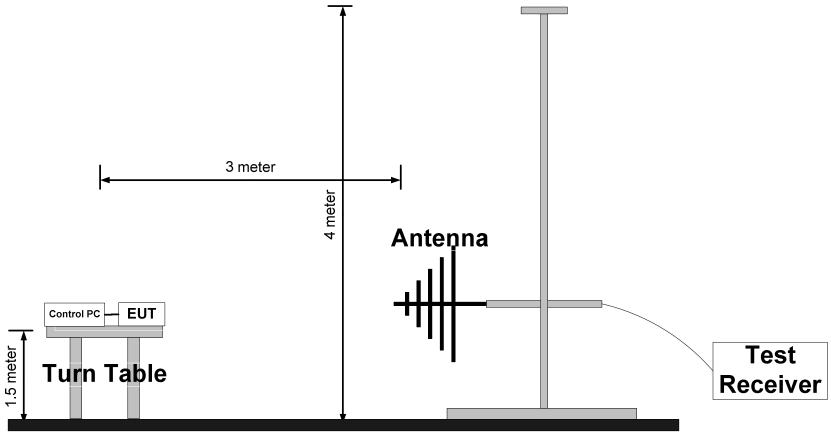
FCC Rules Part 2, Section 2.1053
FCC Rules Part 22, Section 22.917(a)(b)
FCC Rules Part 24, Section 24.238(a)(b)

5.5.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.12

5.6.4 Measurement Set-Up

Step 1. Measurement of Field Strength (Fig-4.1)



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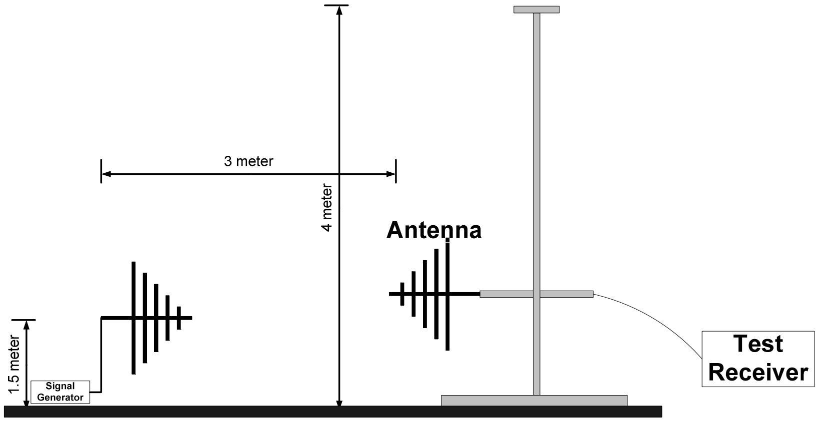
Step 2. Measurement of ERP (Fig-4.2)



5.6.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	GPS-250MVK	GR Telecom
Receiver	ESVN 30	ROHDE & SCHWARZ
Receiver	ESPI	ROHDE & SCHWARZ
Signal Generator	GT9000	GIGATRONICS
Bilog Antenna	VULB 9160	SCHWARZBECK
Bilog Antenna	VULB 9161	SCHWARZBECK
Horn Antenna	BBHA 9120	SCHWARZBECK
Horn Antenna	BBHA9120	SCHWARZBECK

5.6.6 Test Procedure

① X, Y, Z axis, tested carried out to find the maximum condition.
② Maximum conditions: Z-Axis
③ As a result of the Z axis write a report.

5.6.7 Test Procedure

① Connect the equipment as Fig-4-1.
② Place the transmitter to be tested on the turntable in the standard test site
③ The transmitter is transmitting into a nonradiating load that is placed on the turntable. The RF cable to this load should be of minimum length. For transmitters with integral antennas, the tests are to be run with the unit operating into the integral antenna.
④ For each spurious measurement the test antenna should be adjusted to the correct length for the frequency involved. This length may be determined from a calibration ruler supplied with the equipment. Measurements shall be made from the lowest radio frequency generated in the equipment to the tenth harmonic of the carrier, except for the region close to the carrier equal to ± the test bandwidth.
⑤ Key the transmitter.

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⑥ For each spurious frequency, raise and lower the test antenna from 1 m to 4 m to obtain a maximum reading on the spectrum analyzer with the test antenna at horizontal polarity. Then the turntable should be rotated 360° to determine the maximum reading. Repeat this procedure to obtain the highest possible reading. Record this maximum reading.

⑦ Repeat step ⑥ for each spurious frequency with the test antenna polarized vertically.

⑧ Reconnect the equipment as Fig-4.2.

⑨ Remove the transmitter and replace it with a substitution antenna (the antenna should be half-wavelength for each frequency involved). The center of the substitution antenna should be approximately at the same location as the center of the transmitter. At the lower frequencies, where the substitution antenna is very long, this will be impossible to achieve when the antenna is polarized vertically. In such case the lower end of the antenna should be 0.3 m above the ground.

⑩ Feed the substitution antenna at the transmitter end with a signal generator connected to the antenna by means of a nonradiating cable. With the antennas at both ends horizontally polarized, and with the signal generator tuned to a particular spurious frequency, raise and lower the test antenna to obtain a maximum reading at the spectrum analyzer. Adjust the level of the signal generator output until the previously recorded maximum reading for this set of conditions is obtained. This should be done carefully repeating the adjustment of the test antenna and generator output.

⑪ Repeat step ⑩ with both antennas vertically polarized for each spurious frequency.

⑫ Calculate power in dBm into a reference ideal half-wave dipole antenna by reducing the readings obtained in steps ⑩ and ⑪ by the power loss in the cable between the generator and the antenna, and further corrected for the gain of the substitution antenna used relative to an ideal half-wave dipole antenna by the following formula :

Pd (dBm) = Pg (dBm) – cable loss (dB) + antenna gain (dB)

where: **Pd** is the dipole equivalent power and
Pg is the generator output power into the substitution antenna.

5.6.8 Limit

① 824 MHz ~ 849 MHz / “43 + 10log(P) dBc = -13 dBm”
② 1850 MHz ~ 1909 MHz / “43 + 10log(P) dBc = -13 dBm”

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5.6.9 Test Result

Band/Channel	Spurious Frequency(Mhz)	Antenna Polarization (V/H)	SPA Reading (dBuV)	Signal Generator Level (dBm)	Cable Loss (dB)	Antenna Gain(dBi)	Limit (dBm)	Emission Level (dBm)
Cell/824.64	1649.25	H	51.09	-50.24	-5.2	9.4	-13	-46.04
Cell/824.64	2473.90	H	46.04	-52.20	-5.9	10.6	-13	-47.50
Cell/837.00	1673.92	H	50.71	-49.33	-5.2	9.4	-13	-45.13
Cell/837.00	2510.94	H	47.05	-52.20	-6.0	10.6	-13	-47.60
Cell/848.37	1696.70	H	51.56	-48.81	-5.2	9.4	-13	-44.61
Cell/848.37	2545.08	H	45.63	-54.02	-6.0	10.6	-13	-49.42
PCS/1851.25	3702.50	H	48.86	-50.85	-6.8	12.6	-13	-45.05
PCS/1851.25	5553.72	H	43.79	-56.39	-8.4	13.1	-13	-51.69
PCS/1880.00	3759.94	H	47.95	-51.31	-6.9	12.6	-13	-45.61
PCS/1880.00	5639.98	H	43.42	-55.47	-8.5	13.1	-13	-50.87
PCS/1906.25	3812.48	H	48.34	-50.69	-6.9	12.6	-13	-44.99
PCS/1906.25	5718.73	H	44.77	-57.87	-8.5	13.1	-13	-53.27

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5.7 Frequency Stability

EUT	GPS Tracking Terminal / GPS-250MVK
Test Date	July 17, 2011
Operating Condition	Continues TX
Environment Condition	25 °C/58 % R.H.
Result	Passed

5.7.1 Definition

The carrier frequency stability is the ability of the transmitter to maintain an assigned carrier frequency.

5.7.2 Specification

FCC Rules Part 2, Section 2.1055
FCC Rules Part 22, Section 22.355
FCC Rules Part 24, Section 24.235

5.7.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.2

5.7.4 Measurement Set-Up

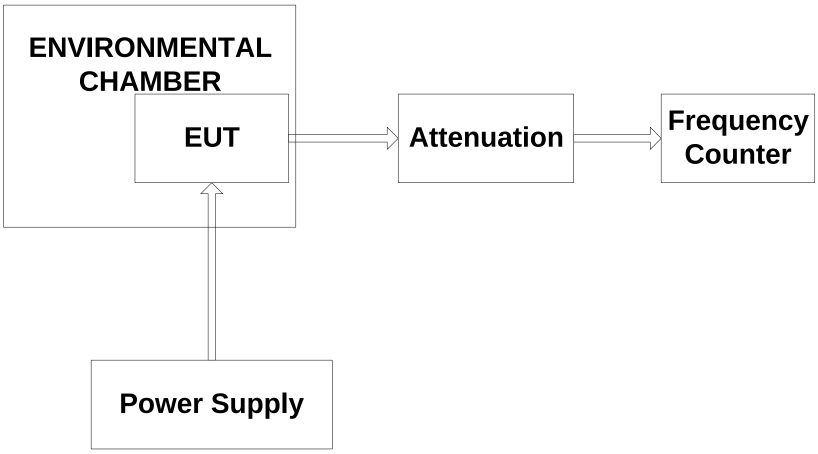

Fig.5

5.7.5 Test Equipment List

Equipment	Model Name	Manufacture
EUT	GPS-250MVK	GR Telecom
Attenuator	SA18N25WA	FAIRVIEW MICROWAVE INC.
Frequency Counter	R5372	ADVENTEST
Environmental Chamber	SJ1013-TH	SEOJIN

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5.7.6 Test Procedure

① Connect the equipment as Fig-5.
② Record the carrier frequency of the transmitter as MCFMHz.
③ Calculate the ppm frequency error.

5.7.7 Limit

2.5 ppm

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5.7.8 Test Result

5.7.8.1 Low Channel (824.64 MHz) / Data Table

Voltage (%)	Power Supply (Vdc)	Temperature (ºC)	Frequency (Hz)	Deviation (ppm)	Limit (ppm)
100 %	12.0	-30	824 640 005.5	0.006 7	2.50
100 %		-20	824 640 006.8	0.008 3	
100 %		-10	824 640 005.1	0.006 2	
100 %		0	824 640 004.2	0.005 1	
100 %		+10	824 640 006.7	0.008 1	
100 %		+20	824 640 004.7	0.005 7	
100 %		+30	824 640 006.1	0.007 4	
100 %		+40	824 640 005.7	0.006 9	
100 %		+50	824 640 006.3	0.007 6	
100 %		+60	824 640 008.0	0.009 7	
High 115 %	13.2	+20	824 640 007.1	0.008 6	
Low 85 %	10.8	+20	824 640 004.9	0.005 9	

5.7.8.2 Middle Channel (837.00 MHz) / Data Table

Voltage (%)	Power Supply (Vdc)	Temperature (ºC)	Frequency (Hz)	Deviation (ppm)	Limit (ppm)
100 %	12.0	-30	837 000 005.4	0.006 5	2.50
100 %		-20	837 000 006.7	0.008 0	
100 %		-10	837 000 005.2	0.006 2	
100 %		0	837 000 003.9	0.004 7	
100 %		+10	837 000 006.4	0.007 7	
100 %		+20	837 000 004.8	0.005 7	
100 %		+30	837 000 005.9	0.007 1	
100 %		+40	837 000 005.5	0.006 6	
100 %		+50	837 000 006.5	0.007 8	
100 %		+60	837 000 007.3	0.008 7	
High 115 %	13.2	+20	837 000 007.2	0.008 6	
Low 85 %	10.8	+20	837 000 005.7	0.006 8	

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5.7.8.3 High Channel (848.37 MHz) / Data Table

Voltage (%)	Power Supply (Vdc)	Temperature (ºC)	Frequency (Hz)	Deviation (ppm)	Limit (ppm)
100 %	12.0	-30	848 370 005.6	0.006 6	2.50
100 %		-20	848 370 006.9	0.008 1	
100 %		-10	848 370 005.2	0.006 1	
100 %		0	848 370 004.1	0.004 8	
100 %		+10	848 370 006.6	0.007 8	
100 %		+20	848 370 004.6	0.005 4	
100 %		+30	848 370 005.8	0.006 8	
100 %		+40	848 370 005.6	0.006 6	
100 %		+50	848 370 006.4	0.007 5	
100 %		+60	848 370 007.7	0.009 1	
High 115 %	13.2	+20	848 370 006.8	0.008 0	
Low 85 %	10.8	+20	848 370 005.4	0.006 4	

5.7.8.4 High Channel (1851.25 MHz) / Data Table

Voltage (%)	Power Supply (Vdc)	Temperature (ºC)	Frequency (Hz)	Deviation (ppm)	Limit (ppm)
100 %	12.0	-30	1 851 250 009.9	0.005 3	2.50
100 %		-20	1 851 250 011.3	0.006 1	
100 %		-10	1 851 250 009.8	0.005 3	
100 %		0	1 851 250 010.5	0.005 7	
100 %		+10	1 851 250 011.2	0.006 0	
100 %		+20	1 851 250 009.5	0.005 1	
100 %		+30	1 851 250 011.7	0.006 3	
100 %		+40	1 851 250 010.8	0.005 8	
100 %		+50	1 851 250 008.9	0.004 8	
100 %		+60	1 851 250 008.2	0.004 4	
High 115 %	13.2	+20	1 851 250 013.7	0.007 4	
Low 85 %	10.8	+20	1 851 250 008.6	0.004 6	

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5.7.8.5 High Channel (1 880.00 MHz) / Data Table

Voltage (%)	Power Supply (Vdc)	Temperature (ºC)	Frequency (Hz)	Deviation (ppm)	Limit (ppm)
100 %	12.0	-30	1 880 000 012.2	0.006 5	2.50
100 %		-20	1 880 000 012.5	0.006 6	
100 %		-10	1 880 000 013.6	0.007 2	
100 %		0	1 880 000 012.1	0.006 4	
100 %		+10	1 880 000 012.4	0.006 6	
100 %		+20	1 880 000 010.6	0.005 6	
100 %		+30	1 880 000 012.8	0.006 8	
100 %		+40	1 880 000 016.1	0.008 6	
100 %		+50	1 880 000 011.9	0.006 3	
100 %		+60	1 880 000 011.3	0.006 0	
High 115 %	13.2	+20	1 880 000 012.2	0.006 5	
Low 85 %	10.8	+20	1 880 000 010.6	0.005 6	

5.7.8.6 High Channel (1 906.25 MHz) / Data Table

Voltage (%)	Power Supply (Vdc)	Temperature (ºC)	Frequency (Hz)	Deviation (ppm)	Limit (ppm)
100 %	12.0	-30	1 906 250 018.1	0.009 5	2.50
100 %		-20	1 906 250 010.9	0.005 7	
100 %		-10	1 906 250 012.7	0.006 7	
100 %		0	1 906 250 011.4	0.006 0	
100 %		+10	1 906 250 013.8	0.007 2	
100 %		+20	1 906 250 013.2	0.006 9	
100 %		+30	1 906 250 013.6	0.007 1	
100 %		+40	1 906 250 013.2	0.006 9	
100 %		+50	1 906 250 014.3	0.007 5	
100 %		+60	1 906 250 014.8	0.007 8	
High 115 %	13.2	+20	1 906 250 011.4	0.006 0	
Low 85 %	10.8	+20	1 906 250 010.3	0.005 4	

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5.8 Field Strength of Spurious Radiation in Receiving Mode

EUT	GPS Tracking Terminal / GPS-250MVK
Test Date	July 17, 2011
Operating Condition	Rx Mode, Tx Mode
Environment Condition	27 °C/71 % R.H.
Result	Passed

5.8.1 Definition

Radiated spurious emissions are emissions from the equipment when transmitting into a nonradiating load on a frequency or frequencies that are outside an occupied band sufficient to ensure transmission of information of required quality for the class of communications desired.

5.8.2 Specification

FCC Rules Part 15, Section 15.209

5.8.3 Method of Measurement

ANSI/TIA-603-C-2004 Section 2.2.12

5.8.4 Measurement Set-Up

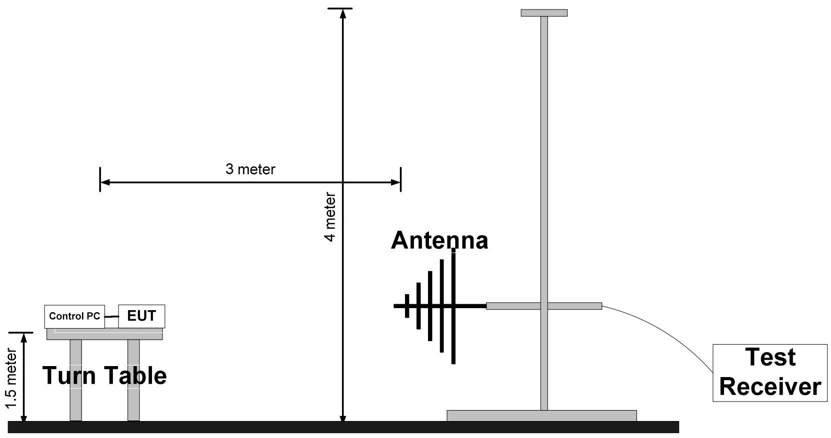

Fig.6

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5.8.5 Test Equipment List

Equipment	Model Name	Manufacture	Serial No	Calibration date	Calibration Deriod(month)
EMI Receiver	ESVN 30	ROHDE & SCHWARZ	832854/010	01. 24. 2011	12
Test Receiver	ESPI	ROHDE & SCHWARZ	100012	01. 25. 2011	12
Bilog Antenna	VULB 9161	SCHWARZBECK	9160-3052	06. 29. 2011	24
Horn Antenna	BBHA 9120 D	SCHWARZBECK	BBHA 9120 D 517	10. 04. 2010	24
Open Site Cable	SUCOTEST 18A	Hubersuhner	8400/18A	N/A	N/A
Antenna Master	JAC-3	DAIL EMC	N/A	N/A	N/A
Antenna Turntable Controller	JAC-2	JAEMC	N/A	N/A	N/A
Chamber Cable	SUCOFLEX 104	Hubersuhner	317392/4	N/A	N/A
Chamber Cable	SUCOFLEX 104	Hubersuhner	323837/4	N/A	N/A
Antenna Master	N/A	AUDIX	N/A	N/A	N/A
Antenna Turntable Controller	ACT	AUDIX	N/A	N/A	N/A

5.8.6 Test Procedure

1. Connect the equipment as Fig-6.

② Place the transmitter to be tested on the turntable in the standard test site

③ The transmitter is transmitting into a nonradiating load that is placed on the turntable. The RF cable to this load should be of minimum length. For transmitters with integral antennas, the tests are to be run with the unit operating into the integral antenna.

④ For each spurious measurement the test antenna should be adjusted to the correct length for the frequency involved. This length may be determined from a calibration ruler supplied with the equipment. Measurements shall be made from the lowest radio frequency generated in the equipment to the tenth harmonic of the carrier, except for the region close to the carrier equal to ± the test bandwidth.

⑤ Key the transmitter.

⑥ For each spurious frequency, raise and lower the test antenna from 1 m to 4m to obtain a maximum reading on the spectrum analyzer with the test antenna at horizontal polarity. Then the turntable should be rotated 360° to determine the maximum reading. Repeat this procedure to obtain the highest possible reading. Record this maximum reading.

⑦ Repeat step ⑥ for each spurious frequency with the test antenna polarized vertically.

5.8.7 Limit

① FCC Rules Part 15, Section 15.109

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5.8.9 Test Result

Receive Mode

Frequency [MHz]	Reading [dB(μV)]	Polarization [*H/**V]	Ant.Factor [dB]	Cable Loss [dB]	Limit [dB(μV/m)]	Emission Level [dB(μV/m)]	Margin [dB]
49.78	22.54	V	12.18	1.60	40.00	36.31	-3.69
54.43	21.36	V	12.21	1.67	40.00	35.24	-4.76
77.14	23.92	V	9.00	1.93	40.00	34.85	-5.15

Notes

1. * H : Horizontal polarization , ** V : Vertical polarization
2. Emission Level = Reading + Antenna factor + Cable loss
3. Margin value = Limit – Emission Level
4. All other emissions not reported were more than 25 Db below the permitted limit.
5. Measurement uncertainty estimated at ± 5.228 dB.
   The measurement uncertainty is given with a confidence of 95.00 % with the coverage factor, *k* = 2.

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List of test equipments used for measurements

The listing below denotes the test equipments utilized for the test(s).

	EQUIPMENT	MODEL	MANUFACTURE	SERIAL NUMBER	Calibration date	Calibration Deriod(month)
1	Receiver	ESVN30	ROHDE & SCHWARZ	832854/010	2011/01/24	12
2	Receiver	ESPI	ROHDE & SCHWARZ	100012	2011/01/25	12
3	Spectrum analyzer	FSP13	ROHDE & SCHWARZ	100278	2011/07/01	12
4	Signal Generator	GT9000	GIGATRONICS	9604010	2010/10/15	12
5	Frequency Counter	R5372	ADVANTEST	41855204	2010/10/14	12
6	Shield Room (7m x 4m x 3m)	N/A	SJEMC	0004	N/A	N/A
7	Turn Table	OSC-30	N/A	BWS-01	N/A	N/A
8	Antenna Master	JAC-3	DAIL EMC	N/A	N/A	N/A
9	Antenna Turntable Controller	JAC-2	JAEMC	N/A	N/A	N/A
10	Temperature & Humidity chanber	SJ1013-TH	SEOJIN	N/A	2010/10/14	12
11	Bilog Antenna	VULB9161	SCHWARZBECK	VULB9161-4067	2010/12/01	24
12	Bilog Antenna	VULB9161	SCHWARZBECK	VULB9161-4068	2010/11/12	24
13	Horn Antenna	BBHA 9120 D	SCHWARZBECK	BBHA 9120 D 517	2010/10/14	24
14	Horn Antenna	BBHA 9120 D	SCHWARZBECK	BBHA 9120 D 474	2010/07/14	24
15	Power Meter	E4418A	HP	GB38272621	2010/10/14	12
16	Power Sensor	E9301B	HP	US40010238	2010/10/14	12
17	Power supply	IPS-30B03DD	INTERACT	42052	2010/10/15	12
18	Bilog Antenna	VULB 9161	SCHWARZBECK	9160-3052	2011/06/29	24
19	Open Site Cable	SUCOTEST 18A	Hubersuhner	8400/18A	N/A	N/A
20	Chamber Cable	SUCOFLEX 104	Hubersuhner	317392/4	N/A	N/A
21	Chamber Cable	SUCOFLEX 104	Hubersuhner	323837/4	N/A	N/A
22	Antenna Master	N/A	AUDIX	N/A	N/A	N/A
23	Antenna Turntable Controller	JAC-2	JAEMC	N/A	N/A	N/A
24	Power Splitter	11667B	HP	50381	2010/10/14	12
24	CDMA Test Set	E8285A	AGILENT	US40332754	2010/10/15	12

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