



FCC 47 CFR PART 15 SUBPART C

TEST REPORT

For

Bluetooth Laser Mouse

Model: BA7; BA9; BAA; BAJ; BAK

Trade Name: ACROX

Issued to

**Acrox Technologies Co., Ltd.
8F, No. 437, Rui Guang Rd., Nei Hu Dist., Taipei 114, Taiwan, R.O.C.**

Issued by

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Revision History

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	July 20, 2009	Initial Issue	ALL	Celine Chou



TABLE OF CONTENTS

1. TEST RESULT CERTIFICATION	4
2. EUT DESCRIPTION.....	5
3. TEST METHODOLOGY.....	6
3.1 EUT CONFIGURATION	6
3.2 EUT EXERCISE	6
3.3 GENERAL TEST PROCEDURES.....	6
3.4 FCC PART 15.205 RESTRICTED BANDS OF OPERATIONS.....	7
3.5 DESCRIPTION OF TEST MODES.....	7
4. INSTRUMENT CALIBRATION	8
4.1 MEASUREMENT EQUIPMENT USED	8
4.2 MEASUREMENT UNCERTAINTY	9
5. FACILITIES AND ACCREDITATIONS	10
5.1 FACILITIES	10
5.2 EQUIPMENT	10
5.3 TABLE OF ACCREDITATIONS AND LISTINGS	11
6. SETUP OF EQUIPMENT UNDER TEST	12
6.1 SETUP CONFIGURATION OF EUT	12
6.2 SUPPORT EQUIPMENT.....	12
7. FCC PART 15.247 REQUIREMENTS	13
7.1 20dB BANDWIDTH	13
7.2 PEAK POWER	16
7.3 AVERAGE POWER	17
7.4 BAND EDGES MEASUREMENT	18
7.5 FREQUENCY SEPARATION.....	23
7.6 NUMBER OF HOPPING FREQUENCY.....	25
7.7 TIME OF OCCUPANCY (DWELL TIME).....	27
7.8 SPURIOUS EMISSIONS	38
7.9 POWERLINE CONDUCTED EMISSIONS.....	49
APPENDIX I RADIO FREQUENCY EXPOSURE	50
APPENDIX II PHOTOGRAPHS OF TEST SETUP	54



1. TEST RESULT CERTIFICATION

Applicant: **Acrox Technologies Co., Ltd.**
8F, No. 437, Rui Guang Rd., Nei Hu Dist.,
Taipei 114, Taiwan, R.O.C.

Manufacturer: **Acrox Technologies Co., Ltd.**
8F, No. 437, Rui Guang Rd., Nei Hu Dist.,
Taipei 114, Taiwan, R.O.C.

Equipment Under Test: Bluetooth Laser Mouse

Trade Name: ACROX

Model: BA7; BA9; BAA; BAJ; BAK

Date of Test: July 16 ~ 17, 2009

APPLICABLE STANDARDS	
STANDARD	TEST RESULT
FCC 47 CFR Part 15 Subpart C	No non-compliance noted

We hereby certify that:

The above equipment was tested by Compliance Certification Services Inc. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.4: 2003 and the energy emitted by the sample EUT tested as described in this report is in compliance with the requirements of FCC Rules Part 15.207, 15.209, 15.247.

The test results of this report relate only to the tested sample EUT identified in this report.

Approved by:

David Wang
Director

Reviewed by:

Ethan Huang
Section Manager



2. EUT DESCRIPTION

Product	Bluetooth Laser Mouse
Trade Name	ACROX
Model Number	BA7; BA9; BAA; BAJ; BAK
Model Discrepancy	All the model numbers are identical just for marketing purpose only
EUT Power Rating	3VDC
Operating Frequency Range	2402 ~ 2480 MHz
Transmit Power	0.81dBm (1.21mW)
Modulation Technique	FHSS (GFSK)
Transmit Data Rate	1Mbps
Number of Channels	79 Channels
Antenna Specification	PCB Antenna / Gain: -1.55dBi

Remark:

1. The sample selected for test was production product and was provided by manufacturer.
2. This submittal(s) (test report) is intended for FCC ID: **PRDLABTNAMU03** filing to comply with Section 15.207, 15.209 and 15.247 of the FCC Part 15, Subpart C Rules.



3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.4: 2003 and FCC CFR 47 2.1046, 2.1047, 2.1049, 2.1051, 2.1053, 2.1055, 2.1057, 15.207, 15.209 and 15.247.

3.1 EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

3.2 EUT EXERCISE

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements.

According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

3.3 GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 13.1.4.1 of ANSI C63.4: 2003 Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the maximum emissions, exploratory radiated emission measurements were made according to the requirements in Section 13.1.4.1 of ANSI C63.4: 2003.



3.4 FCC PART 15.205 RESTRICTED BANDS OF OPERATIONS

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
¹ 0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 -	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.52525	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	156.7 - 156.9	3260 - 3267	23.6 - 24.0
12.29 - 12.293	162.0125 - 167.17	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	167.72 - 173.2	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	240 - 285	3600 - 4400	(²)
13.36 - 13.41	322 - 335.4		

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

² Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

3.5 DESCRIPTION OF TEST MODES

The EUT (model: BA7) had been tested under operating condition.

Test program used to control the EUT for staying in continuous transmitting mode was programmed.

After verification, all tests were carried out with the worst case test modes as shown below except radiated spurious emission below 1GHz, which worst case was in normal link mode only.

Channel Low (2402MHz), Mid (2441MHz) and High (2480MHz) were chosen for full testing.



4. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

4.1 MEASUREMENT EQUIPMENT USED

Equipment Used for Emissions Measurement

Remark: Each piece of equipment is scheduled for calibration once a year.

Conducted Emissions Test Site				
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	Agilnet	E4446A	MY48250064	10/28/2009
Spectrum Analyzer	R&S	FSEB	825829/011	10/29/2009
Power Meter	Agilnet	E4416A	GB41291611	04/03/2010

3M Chamber Test Site				
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	Agilnet	E4446A	MY48250064	10/28/2009
Spectrum Analyzer	R&S	FSEB	825829/011	10/29/2009
Pre-Amplifier	HP	8447D	2944A06530	12/31/2009
Pre-Amplifier	HP	8449B	3008A01738	04/17/2010
EMI Test Receiver	SCHAFFNER	SCR 3501	436	01/21/2010
Loop Antenna	EMCO	6502	2356	05/28/2010
Bilog Antenna	SCHWAZBECK	VULB9160	3084	09/08/2009
Horn Antenna	EMCO	3115	00022250	05/08/2010
Turn Table	CCS	CC-T-1F	N/A	N.C.R
Antenna Tower	CCS	CC-A-1F	N/A	N.C.R
Controller	CCS	CC-C-1F	N/A	N.C.R
Test S/W	LabVIEW 6.1 (Wugu Chamber EMI Test V1_4.5.3)			

Remark: The measurement uncertainty is less than +/-4.0235dB (30MHz ~ 1GHz), +/-3.0958dB (Above 1GHz) which is evaluated as per the NAMAS NIS 81 and CISPR/A/291/CDV.

Powerline Conducted Emissions Test Site #3				
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
EMI Test Receiver	R&S	ESCS30	845552/030	05/18/2010
LISN	R&S	ENV216	100074	12/09/2009
LISN	FCC	FCC-LISN-50/ 250-16-2-07	06013	10/12/2009
Test S/W	CCS-3A1-CE-Luchu			

Remark: The measurement uncertainty is less than +/- 1.7806dB, which is evaluated as per the NAMAS NIS 81 and CISPR/A/291/CDV.



4.2 MEASUREMENT UNCERTAINTY

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated in accordance with TR 100 028-1 [2] and shall correspond to an expansion factor (coverage factor) $k = 1,96$ or $k = 2$ (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).

Table 6 is based on such expansion factors.

Table 6: Maximum measurement uncertainty

Parameter	Uncertainty
RF frequency	$\pm 1 \cdot 10^{-5}$
Total RF power conducted	$\pm 1,5$ dB
RF power density, conducted	± 3 dB
Spurious emissions, conducted	± 3 dB
All emissions, radiated	± 6 dB
Humidity	± 5 %
Temperature	$\pm 1^{\circ}\text{C}$
DC and low frequency voltages	$\pm 3\%$



5. FACILITIES AND ACCREDITATIONS

5.1 FACILITIES

All measurement facilities used to collect the measurement data are located at

- No.199, Chunghsen Road, Hsintien City, Taipei Hsien, Taiwan, R.O.C.
Tel: 886-2-2217-0894 / Fax: 886-2-2217-1029

- No.11, Wugong 6th Rd., Wugu Industrial Park, Taipei Hsien 248, Taiwan
Tel: 886-2-2299-9720 / Fax: 886-2-2298-4045

- No. 81-1, Lane 210, Pa-De 2nd Rd., Luchu Hsiang, Taoyuan Shien, (338) Taiwan, R.O.C.
Tel: 886-3-324-0332 / Fax: 886-3-324-5235

The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4: 2003 and CISPR Publication 22.

5.2 EQUIPMENT





Radiated emissions are measured with one or more of the following types of linearly polarized antennas: tuned dipole, biconical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.

Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers.

Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

5.3 TABLE OF ACCREDITATIONS AND LISTINGS

Country	Agency	Scope of Accreditation	Logo
USA	A2LA	CFR 47, FCC Part15/18, CISPR 22, EN 55022, ICES-003, AS/NZS CISPR 22, VCCI V-3, EN 55011, CISPR 11, IEC/EN 61000-4-2/3/4/5/6/8/11, EN 61000-6-1/2/3/4, EN 55024, CISPR 24, AS/NZS CISPR 24, AS/NZS 61000.6.2, EN 55014-1/-2, ETSI EN 300 386 v1.3.2/v1.3.3, IEC/EN 61000-3-2, AS/NZS 61000.3.2, IEC/EN 61000-3-3, AS/NZS 61000.3.3	 ACCREDITED No. 0824-01
USA	FCC MRA	3/10 meter Open Area Test Sites to perform FCC Part 15/18 measurements	
Japan	VCCI	3/10 meter Open Area Test Sites and conducted test sites to perform radiated/conducted measurements	VCCI R-2882/2541/2798/725/1868 C-402/747/912 T-321/325
Taiwan	TAF	EN 55014-1, CISPR 14, CNS 13781-1, EN 55013, CISPR 13, CNS 13439, EN 55011, CISPR 11, CNS 13803, PLMN09, IS2045-0, LP0002 FCC Part 27/90, Part 15B/C/D/E, RSS-192/193/210/310 ETSI EN 300 328/ 300 220-1/ 300 220-2/ 301 893/ 301 489-01/ 301 489-03/ 301 489-07 / 301 489-17/ 300 440-1/ 300 440-2 AS/NZS 4268, AS/NZS 4771 CISPR 22, EN 55022, CNS 13438, AS/NZS CISPR 22, VCCI, IEC/EN 61000-4-2/3/4/5/6/8/11, CNS 14676-2/3/4/5/6/8, CNS 14934-2/3, CNS 13783-1, CNS 13439, CNS 13803	 IAC-MRA TAF Testing Laboratory 0363
Taiwan	BSMI	CNS 13438, CNS 13783-1, CNS 13439, CNS 14115	SL2-IS-E-0014 / IN-E-0014 /A1-E-0014 /R1-E-0014 /R2-E-0014 /L1-E-0014
Canada	Industry Canada	RSS212, Issue 1	 IC 2324C-3 IC 2324C-5

Note: No part of this report may be used to claim or imply product endorsement by A2LA, TAF or other government agency.



6. SETUP OF EQUIPMENT UNDER TEST

6.1 SETUP CONFIGURATION OF EUT

See test photographs attached in Appendix 1 for the actual connections between EUT and support equipment.

6.2 SUPPORT EQUIPMENT

For Radiated Emission and Conduction Emission							
No.	Device Type	Brand	Model	Series No.	FCC ID	Data Cable	Power Cord
1.	Test jig	N/A	N/A	N/A	N/A	RS232 Cable: Unshielded, 1.8m	N/A

For Powerline Conducted Emission							
No.	Device Type	Brand	Model	Series No.	FCC ID	Data Cable	Power Cord
1.	Notebook Computer	IBM	1706-A78	LV-L1870 06/09	FCC DOC	N/A	AC I/P: Unshielded, 1.8m DC O/P: Unshielded, 1.8m with a core
2	LCD Monitor	DELL	2407WFPb	CN-0FC255-46633 -675-22TJS	FCC DoC	D-SUB Cable: Shielded, 1.8m with two cores	Unshielded, 1.8m
3	Test jig	N/A	N/A	N/A	N/A	N/A	N/A

Remark: Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.



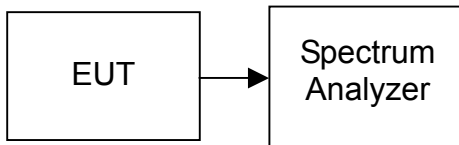
7. FCC PART 15.247 REQUIREMENTS

7.1 20dB BANDWIDTH

LIMIT

None; for reporting purposes only.

TEST CONFIGURATION



TEST PROCEDURE

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set the spectrum analyzer as RBW=30kHz, VBW = 100kHz, Span = 3MHz, Sweep = auto.
4. Mark the peak frequency and 20dB (upper and lower) frequency.
5. Repeat until all the rest channels are investigated.

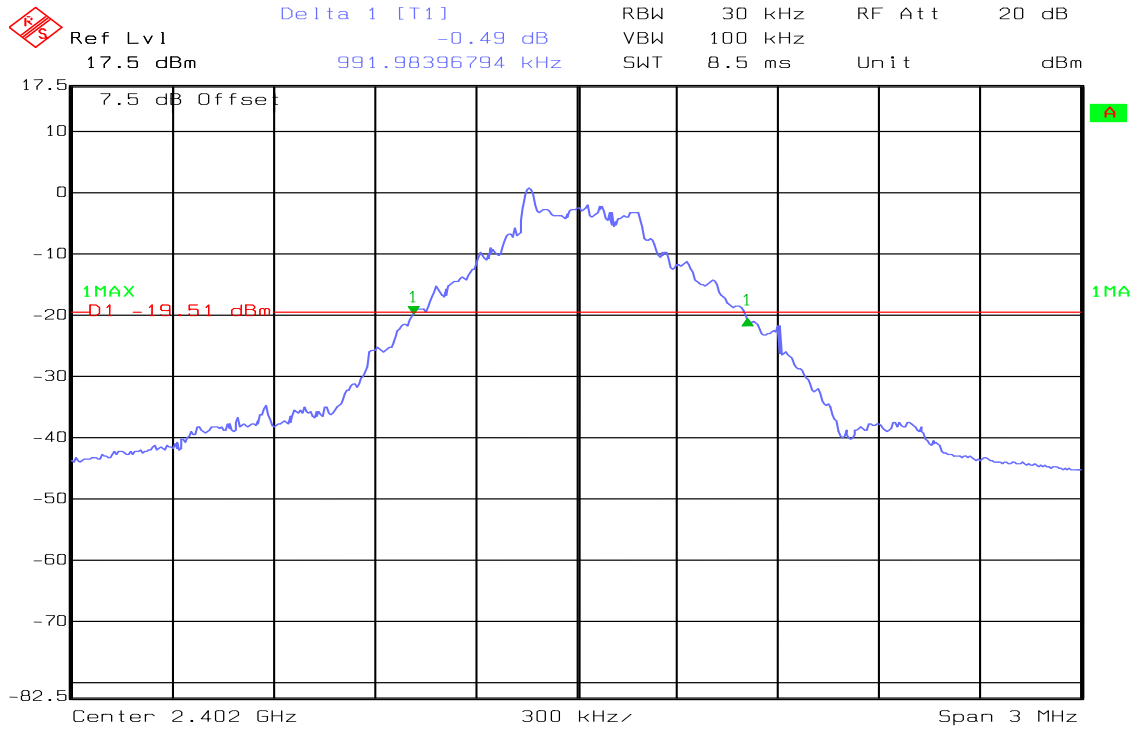
TEST RESULTS

No non-compliance noted



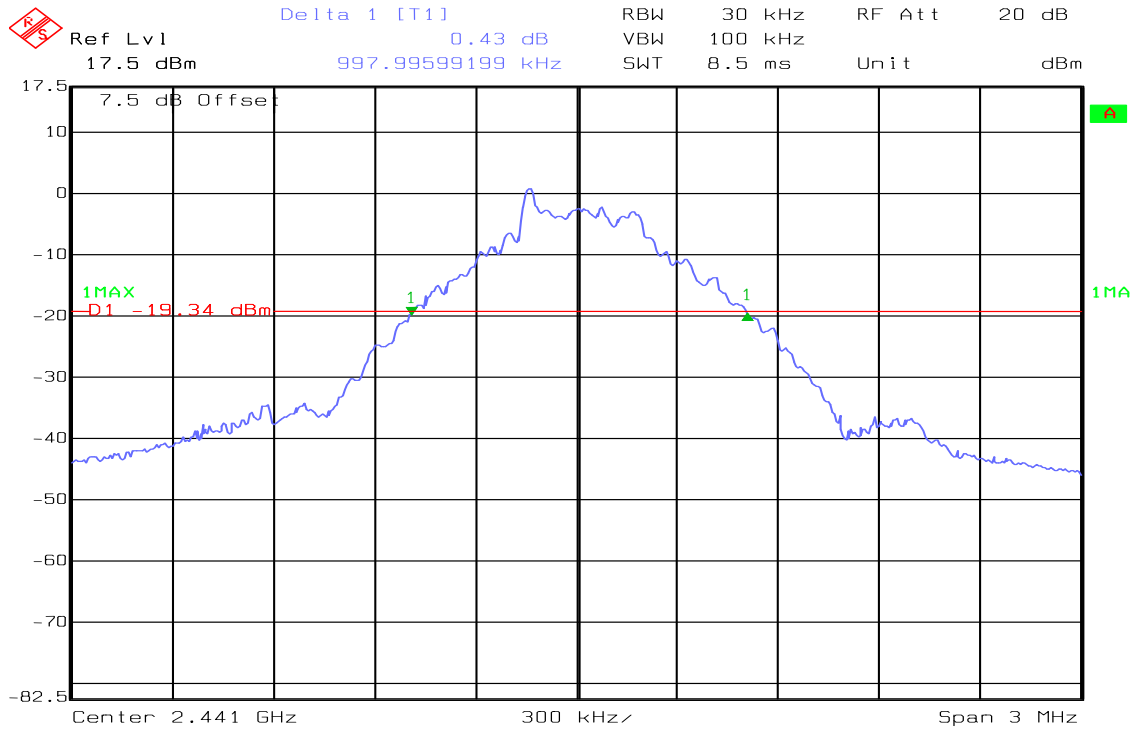
Test Plot

20dB Bandwidth (CH Low)



Date: 17.JUL.2009 09:24:53

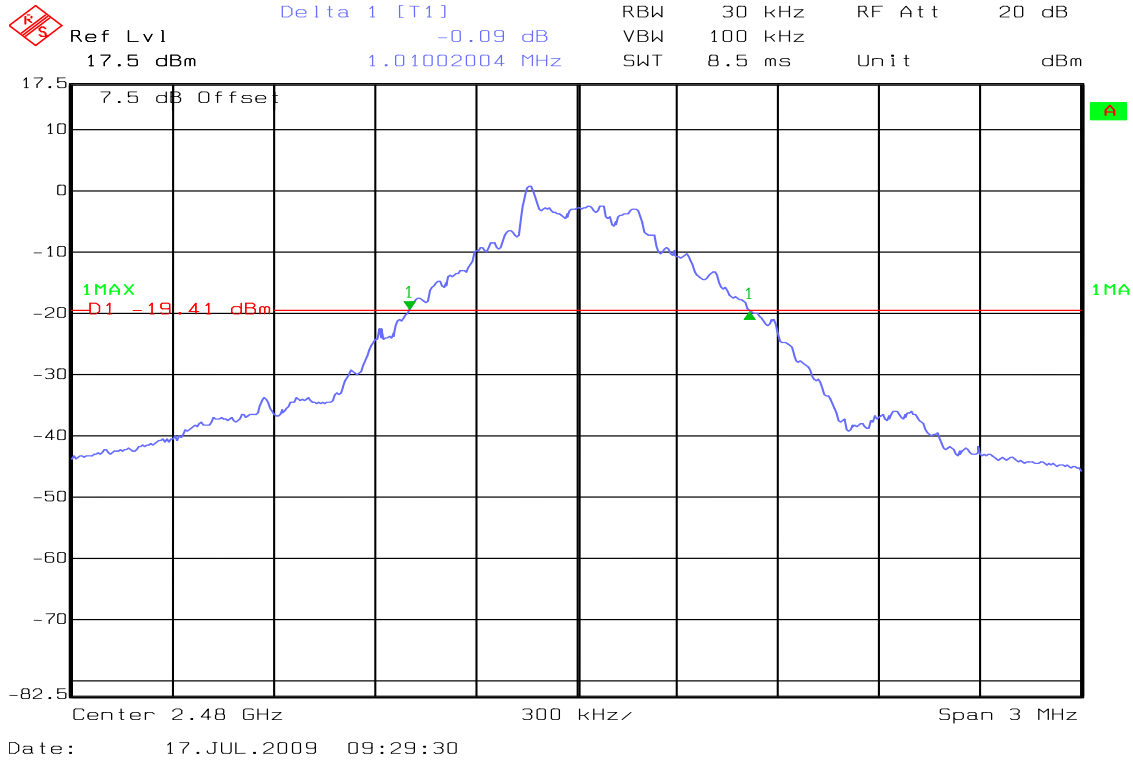
20dB Bandwidth (CH Mid)



Date: 17.JUL.2009 09:26:29



20dB Bandwidth (CH High)





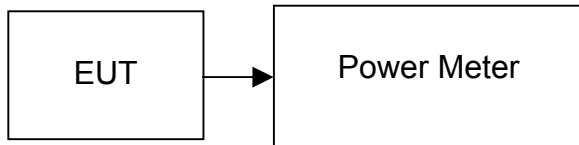
7.2 PEAK POWER

LIMIT

According to §15.247, the maximum peak output power of the intentional radiator shall not exceed the following:

1. According to §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
2. According to §15.247(b)(3), for systems using digital modulation in the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz: 1 watt.
3. According to §15.247(b) (4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

TEST CONFIGURATION



TEST PROCEDURE

The transmitter output is connected to the Power Meter. The Power Meter is set to the peak power detection.

TEST RESULTS

No non-compliance noted

TEST DATA

Channel	Frequency (MHz)	Output Power (dBm)	Output Power (W)	Limit (W)	Result
Low	2402	0.58	0.00114	0.125	PASS
Mid	2441	0.81	0.00121		PASS
High	2480	0.76	0.00119		PASS

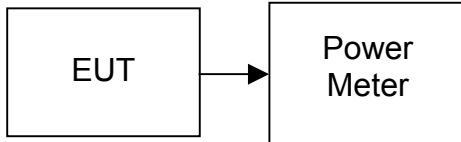


7.3 AVERAGE POWER

LIMIT

None; for reporting purposes only.

TEST CONFIGURATION



TEST PROCEDURE

The transmitter output is connected to the Power meter. The Power Meter is set to the average power detection.

TEST RESULTS

No non-compliance noted

TEST DATA

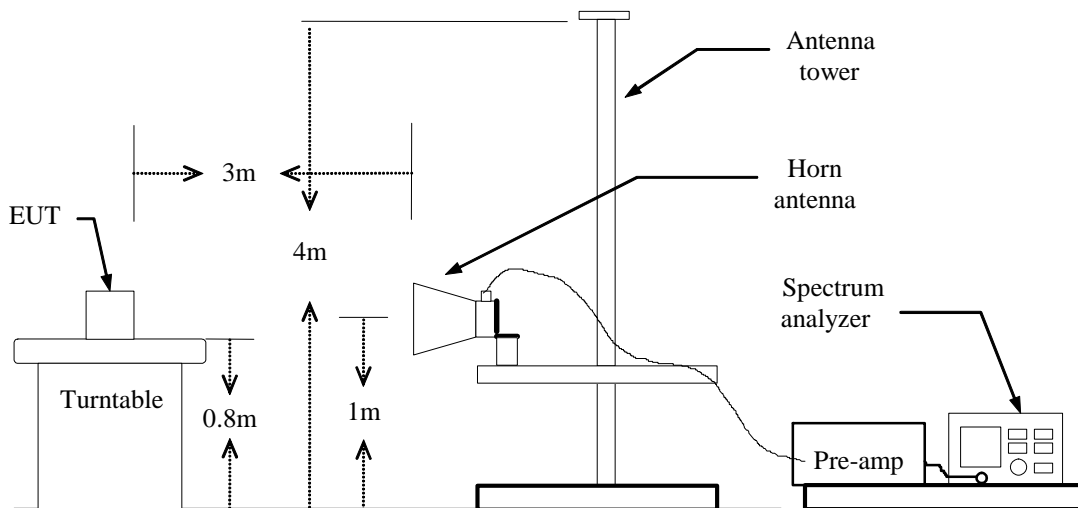
Channel	Frequency (MHz)	Output Power (dBm)	Output Power (W)
Low	2402	-1.28	0.00074
Mid	2441	-1.29	0.00074
High	2480	-1.35	0.00073

7.4 BAND EDGES MEASUREMENT

LIMIT

According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

TEST CONFIGURATION



TEST PROCEDURE

1. The EUT is placed on a turntable, which is 0.8m above the ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emission.
4. Set the spectrum analyzer in the following setting in order to capture the lower and upper band-edges of the emission:
 - (a) PEAK: RBW=VBW=1MHz / Sweep=AUTO
 - (b) AVERAGE: RBW=1MHz / VBW=10Hz / Sweep=AUTO
5. Repeat the procedures until all the PEAK and AVERAGE versus POLARIZATION are measured.

TEST RESULTS

No non-compliance noted

TEST DATA

Refer to attach spectrum analyzer data chart.



Band Edges (CH Low)

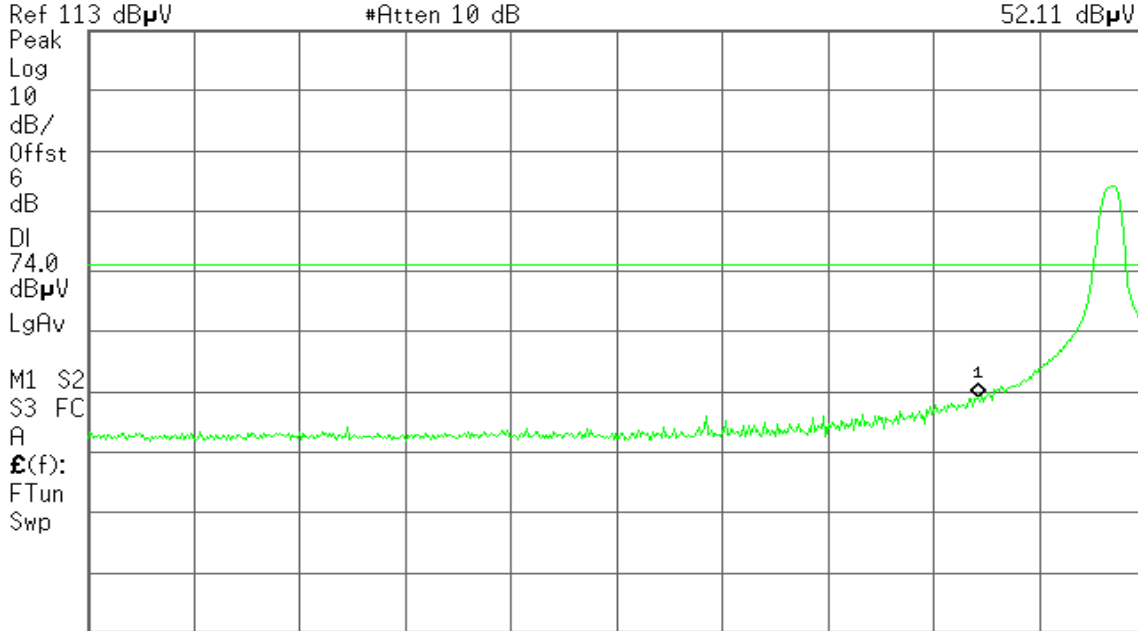
Detector mode: Peak

Polarity: Vertical

Agilent 17:13:28 Jul 16, 2009

R T

Mkr1 2.390 00 GHz
52.11 dB μ V



Detector mode: Average

Polarity: Vertical

Agilent 17:14:17 Jul 16, 2009

R T

Mkr1 2.390 00 GHz
33.18 dB μ V





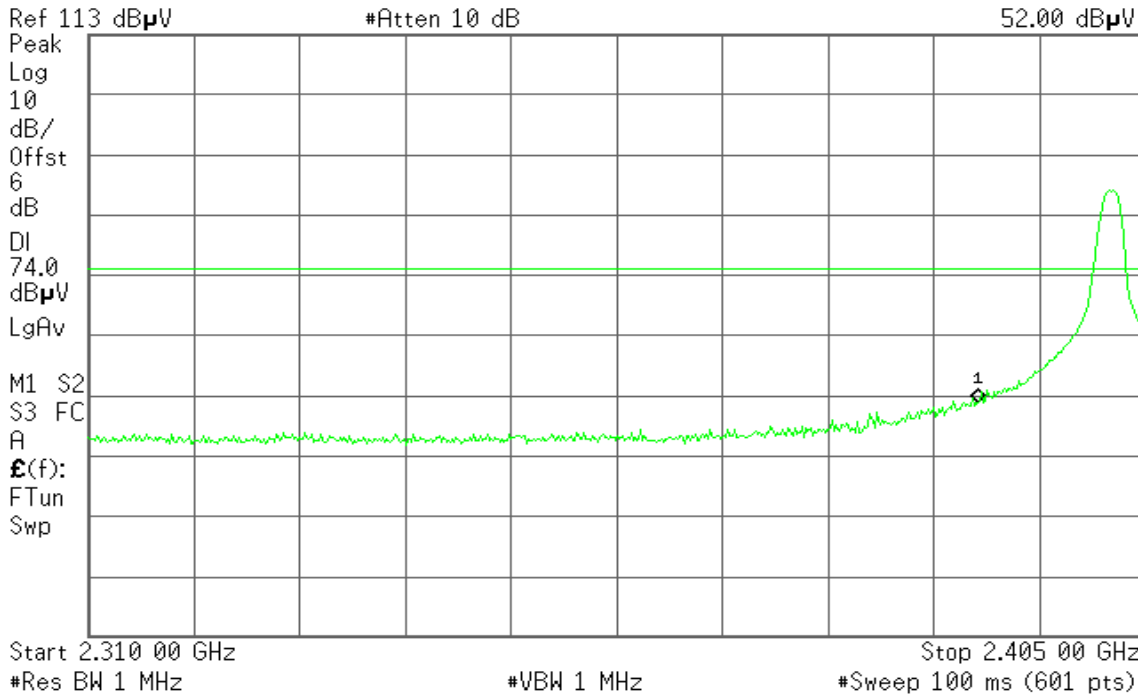
Detector mode: Peak

Polarity: Horizontal

Agilent 17:10:25 Jul 16, 2009

R T

Mkr1 2.390 00 GHz
52.00 dB μ V



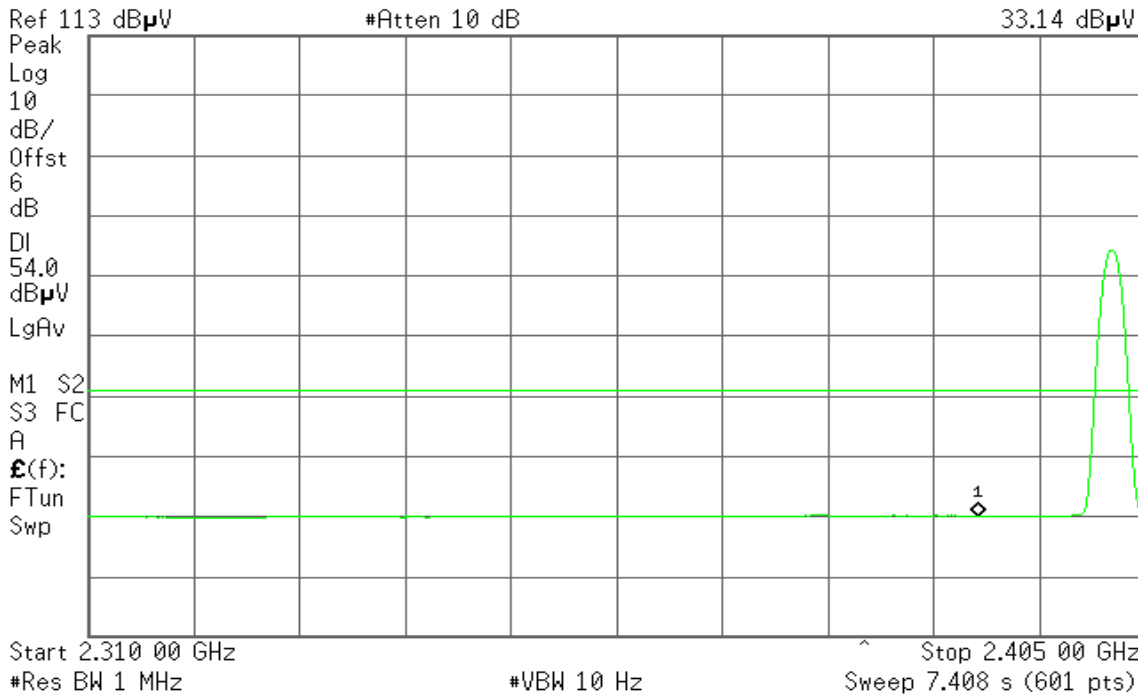
Detector mode: Average

Polarity: Horizontal

Agilent 17:11:08 Jul 16, 2009

R T

Mkr1 2.390 00 GHz
33.14 dB μ V





Band Edges (CH High)

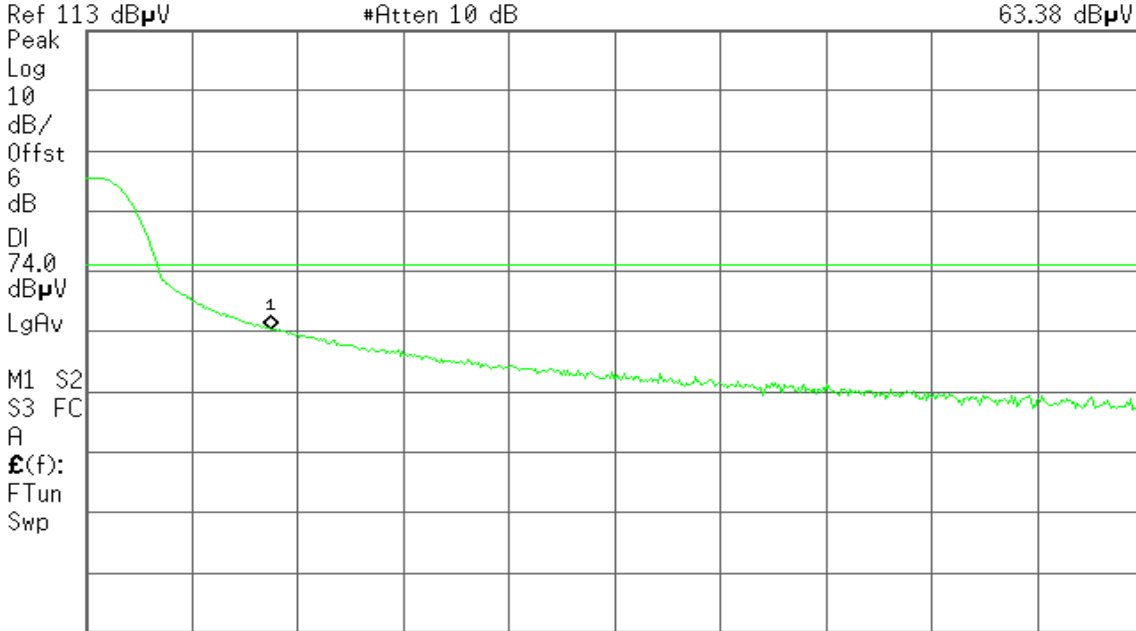
Detector mode: Peak

Polarity: Vertical

Agilent 17:01:57 Jul 16, 2009

R T

Mkr1 2.483 50 GHz
63.38 dB μ V



Start 2.480 00 GHz #Res BW 1 MHz #Atten 10 dB #VBW 1 MHz Stop 2.500 00 GHz #Sweep 100 ms (601 pts)

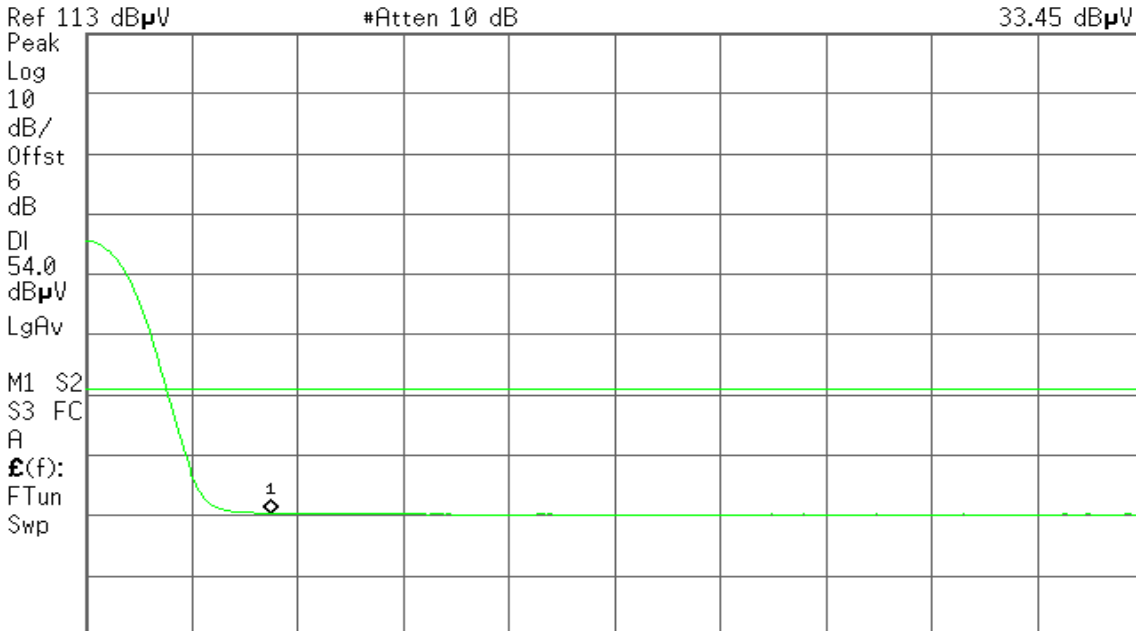
Detector mode: Average

Polarity: Vertical

Agilent 17:02:22 Jul 16, 2009

R T

Mkr1 2.483 50 GHz
33.45 dB μ V



Start 2.480 00 GHz #Res BW 1 MHz #Atten 10 dB #VBW 10 Hz Stop 2.500 00 GHz Sweep 1.56 s (601 pts)

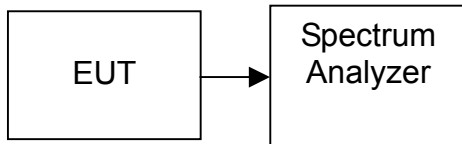


7.5 FREQUENCY SEPARATION

LIMIT

1. According to §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

TEST CONFIGURATION



TEST PROCEDURE

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = middle of hopping channel.
4. Set the spectrum analyzer as RBW = 30kHz, VBW = 100kHz, Span = 3MHz, Sweep = auto.
5. Max hold, mark 3 peaks of hopping channel and record the 3 peaks frequency.

TEST RESULTS

No non-compliance noted

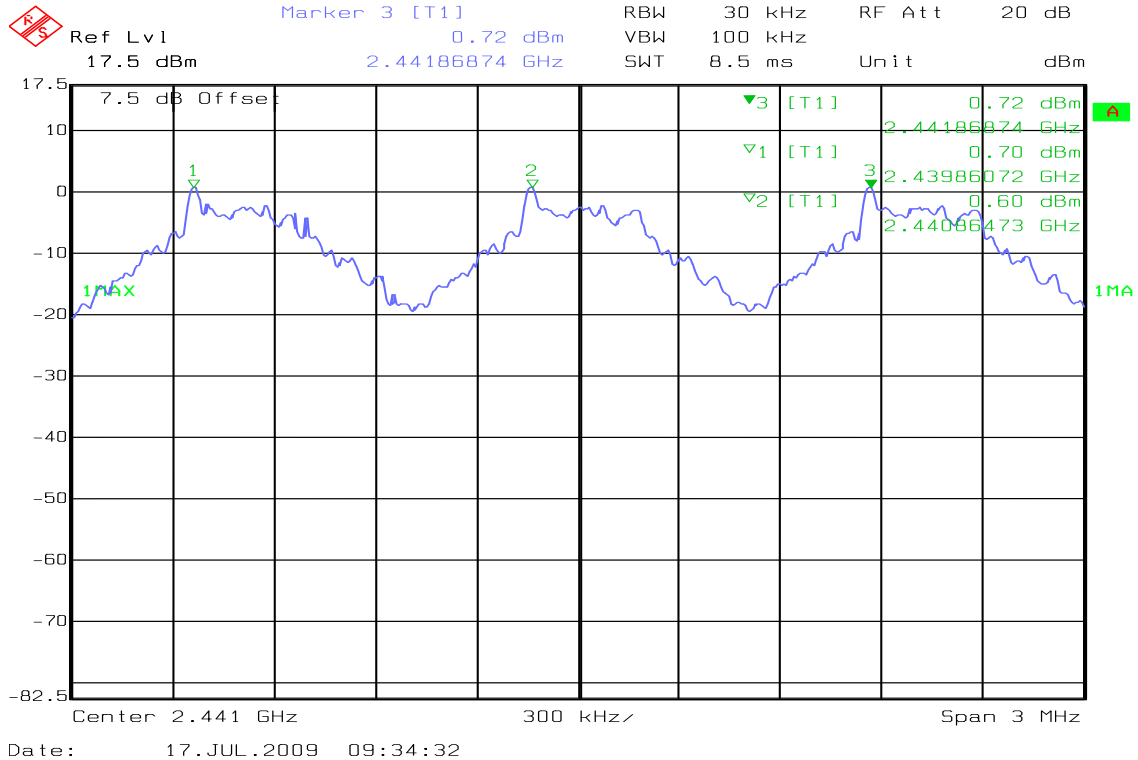
TEST DATA

Channel Separation (MHz)	two-thirds of the 20 dB bandwidth (kHz)	Channel Separation Limit	Result
1.00	673	> 20dB Bandwidth	Pass



Test Plot

Measurement of Channel Separation



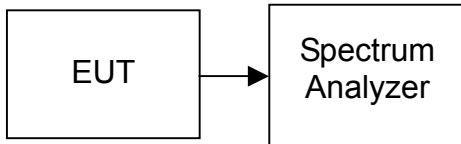


7.6 NUMBER OF HOPPING FREQUENCY

LIMIT

According to §15.247(a)(1)(ii), Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands shall use at least 75 hopping frequencies.

TEST CONFIGURATION



TEST PROCEDURE

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set spectrum analyzer Start=2400MHz, Stop = 2441.5MHz, Sweep = auto and Start=2441.5MHz, Stop = 2483.5MHz, Sweep = auto.
4. Set the spectrum analyzer as RBW, VBW=500kHz.
5. Max hold, view and count how many channel in the band.

TEST RESULTS

No non-compliance noted

TEST DATA

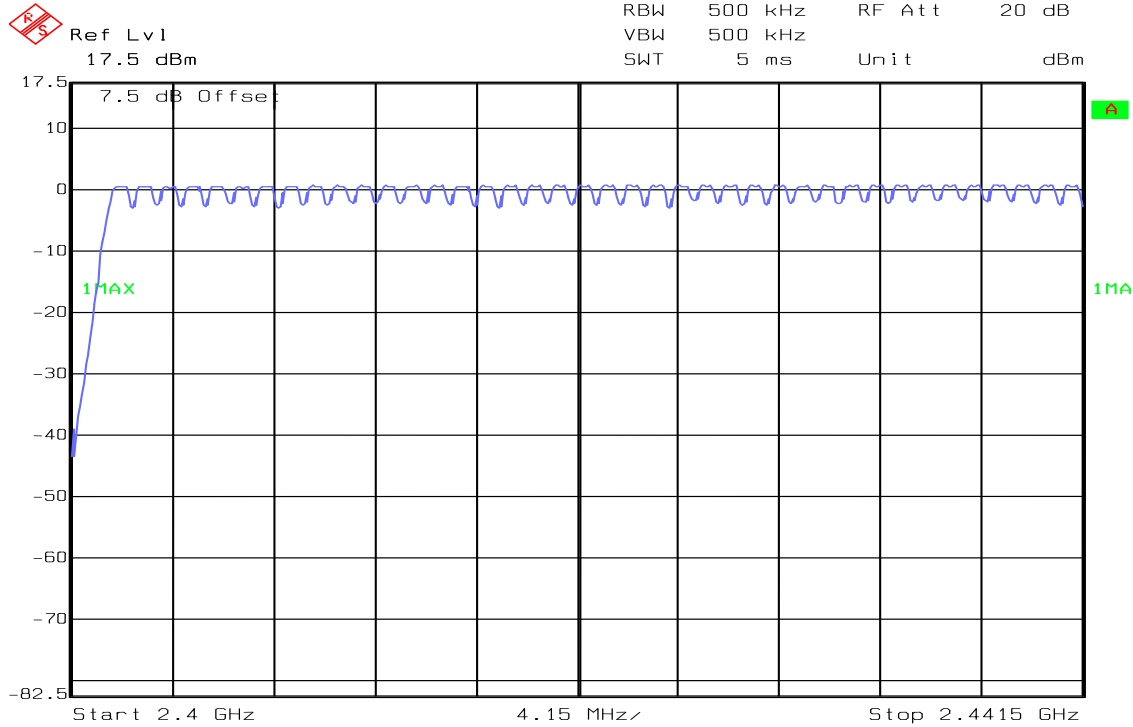
Result (No. of CH)	Limit (No. of CH)	Result
79	>15	PASS



Test Plot

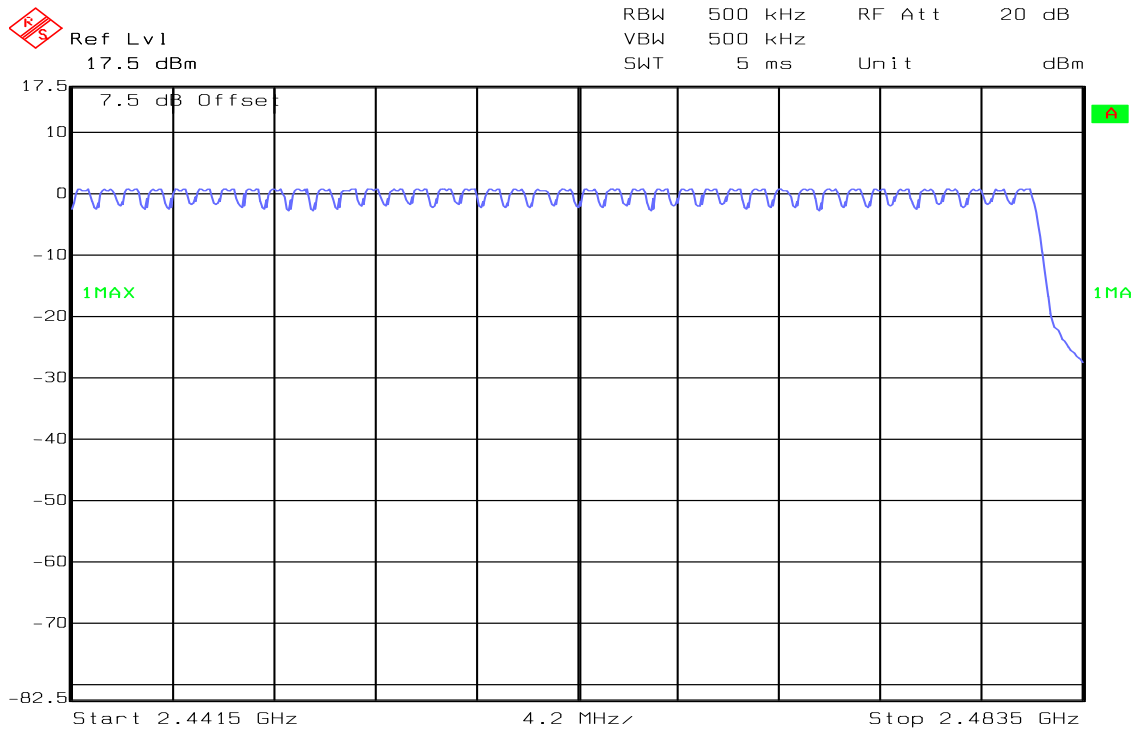
Channel Number

2.4 GHz – 2.4415 GHz



Date: 17.JUL.2009 10:26:10

2.4415 GHz – 2.4835 GHz



Date: 17.JUL.2009 10:27:17

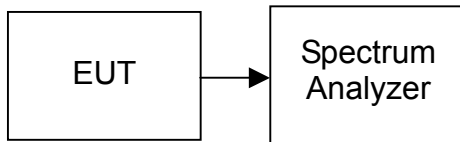


7.7 TIME OF OCCUPANCY (DWELL TIME)

LIMIT

According to §15.247(a)(1)(iii), Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands. The average time of occupancy on any channels shall not greater than 0.4 s within a period 0.4 s multiplied by the number of hopping channels employed.

TEST CONFIGURATION



TEST PROCEDURE

1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW, VBW=1MHz, Span = 0Hz, Sweep = auto.
5. Repeat above procedures until all frequency measured were complete.

TEST RESULTS

No non-compliance noted



TEST DATA

DH 1

CH Low: $0.54 * (1600/2)/79 * 31.6 = 172.80$ (ms)

CH Mid: $0.54 * (1600/2)/79 * 31.6 = 172.80$ (ms)

CH High: $0.54 * (1600/2)/79 * 31.6 = 172.80$ (ms)

CH	Pulse Time (ms)	Total of Dwell (ms)	Period Time (s)	Limit (ms)	Result
Low	0.54	172.80	31.60	400.00	PASS
Mid	0.54	172.80	31.60		PASS
High	0.54	172.80	31.60		PASS

DH 3

CH Low: $1.78 * (1600/4)/79 * 31.6 = 284.80$ (ms)

CH Mid: $1.76 * (1600/4)/79 * 31.6 = 281.60$ (ms)

CH High: $1.78 * (1600/4)/79 * 31.6 = 284.80$ (ms)

CH	Pulse Time (ms)	Total of Dwell (ms)	Period Time (s)	Limit (ms)	Result
Low	1.78	284.80	31.60	400.00	PASS
Mid	1.76	281.60	31.60		PASS
High	1.78	284.80	31.60		PASS

DH 5

CH Low: $3.05 * (1600/6)/79 * 31.6 = 325.33$ (ms)

CH Mid: $3.05 * (1600/6)/79 * 31.6 = 325.33$ (ms)

CH High: $3.03 * (1600/6)/79 * 31.6 = 323.20$ (ms)

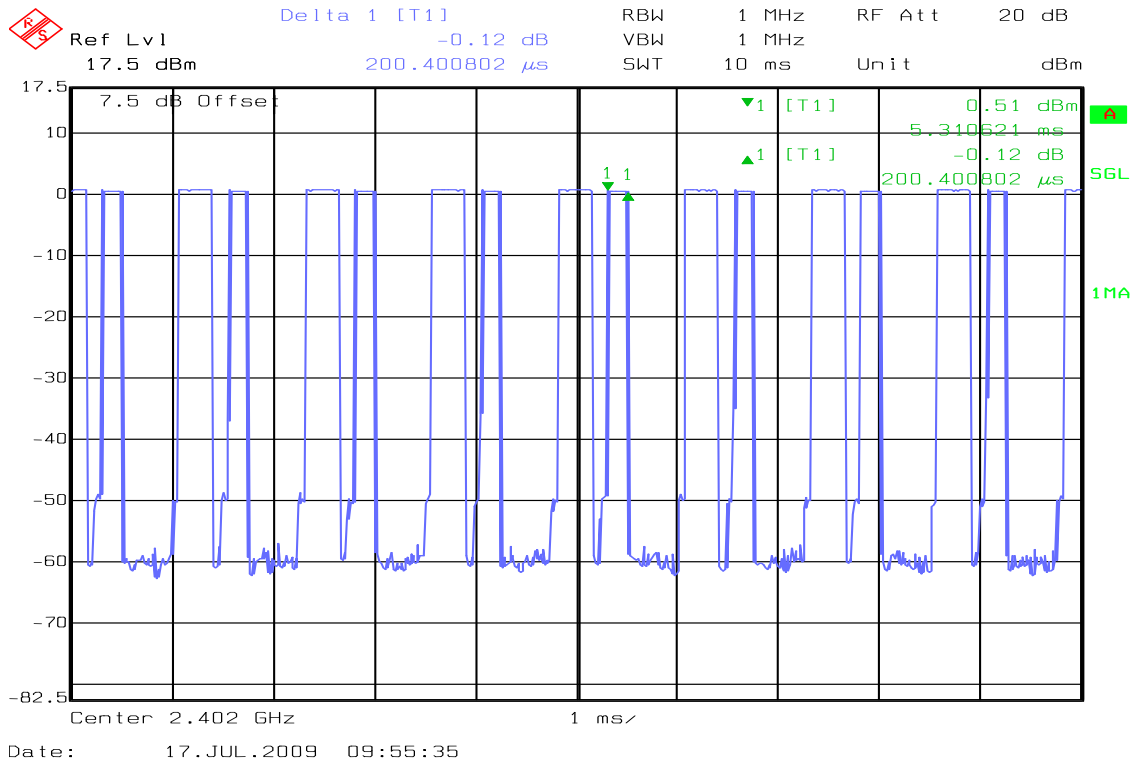
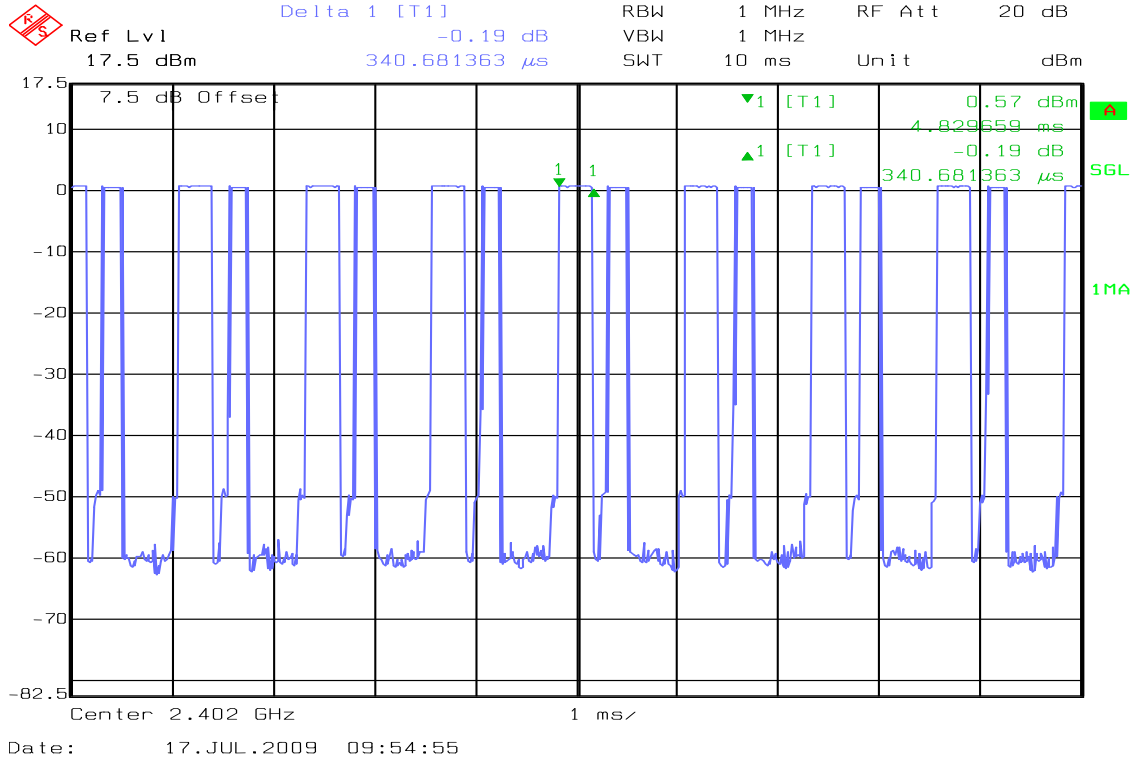
CH	Pulse Time (ms)	Total of Dwell (ms)	Period Time (s)	Limit (ms)	Result
Low	3.05	325.33	31.60	400.00	PASS
Mid	3.05	325.33	31.60		PASS
High	3.03	323.20	31.60		PASS



Test Plot

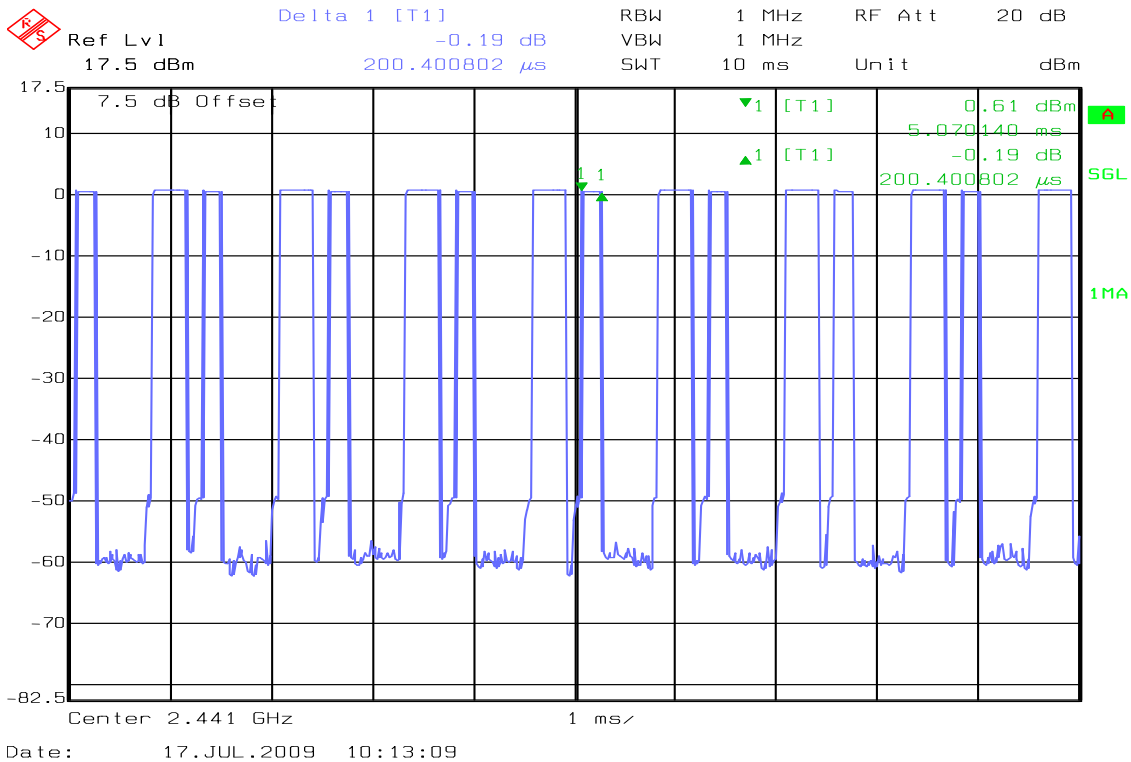
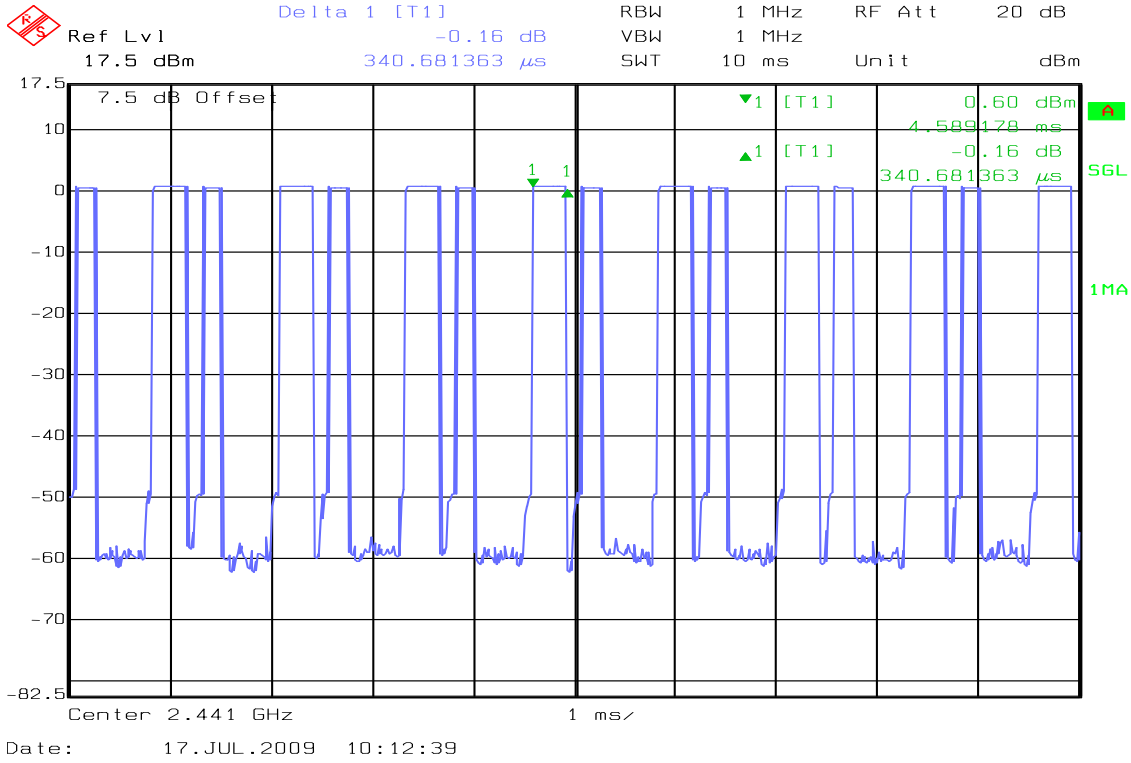
DH 1

(CH Low)



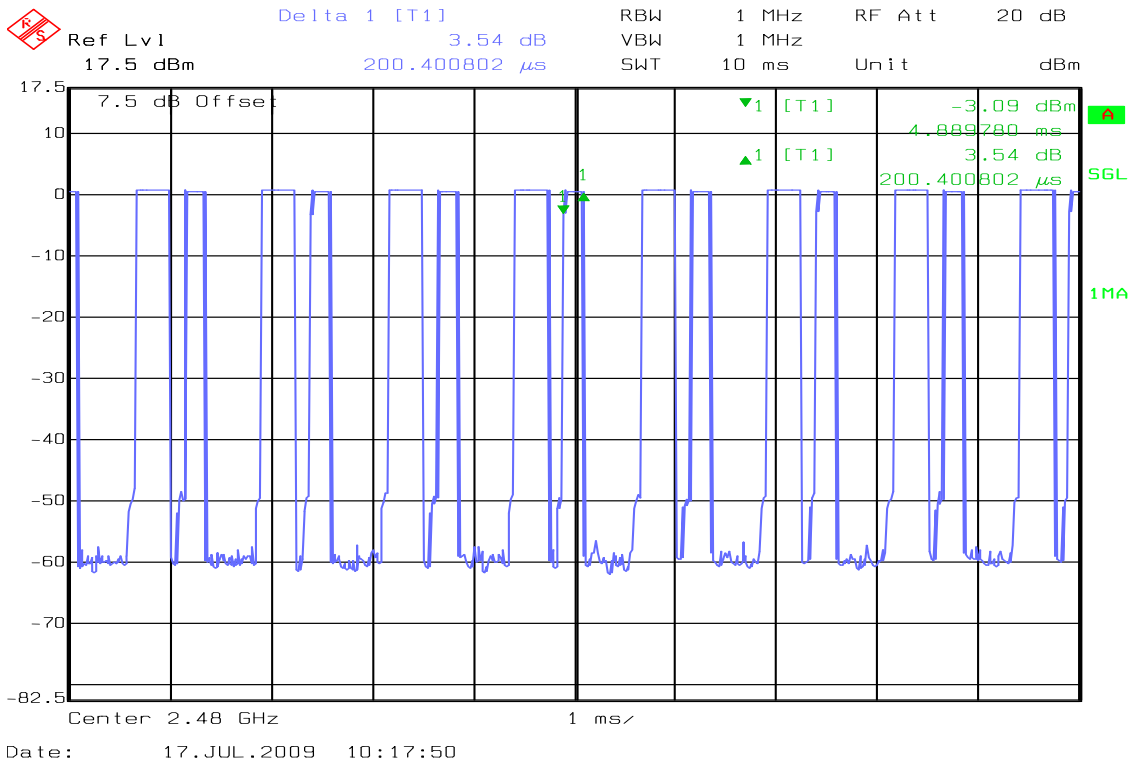
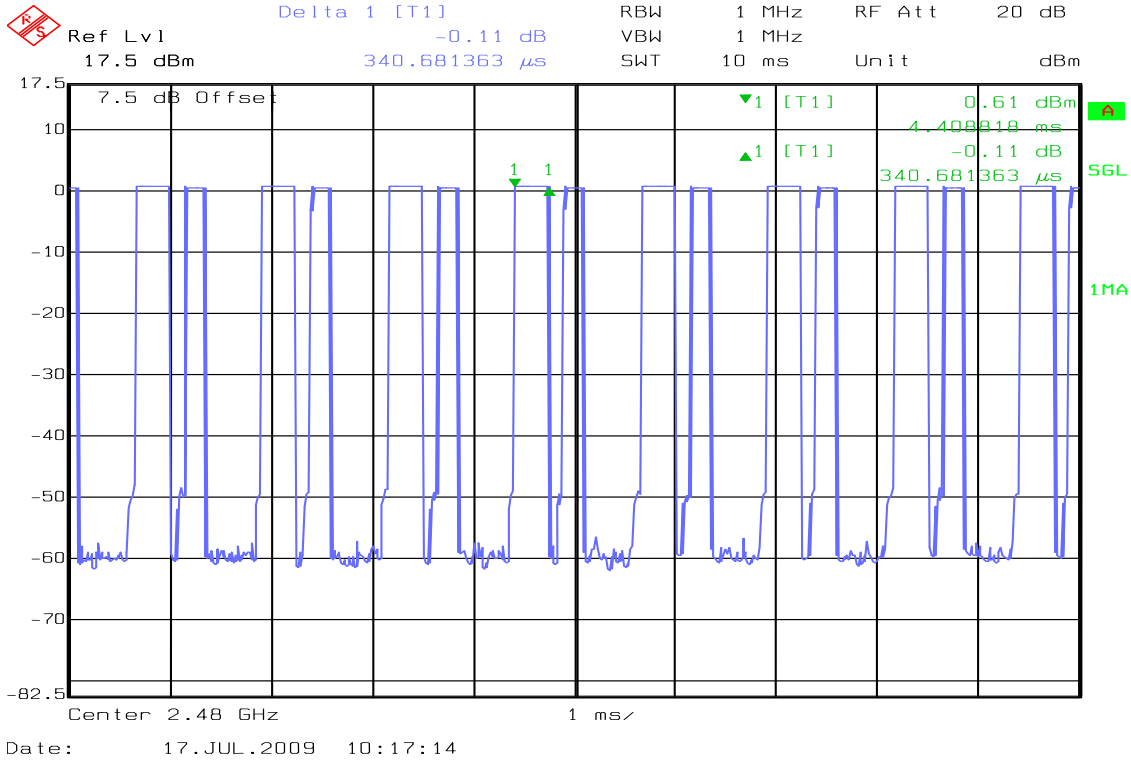


(CH Mid)





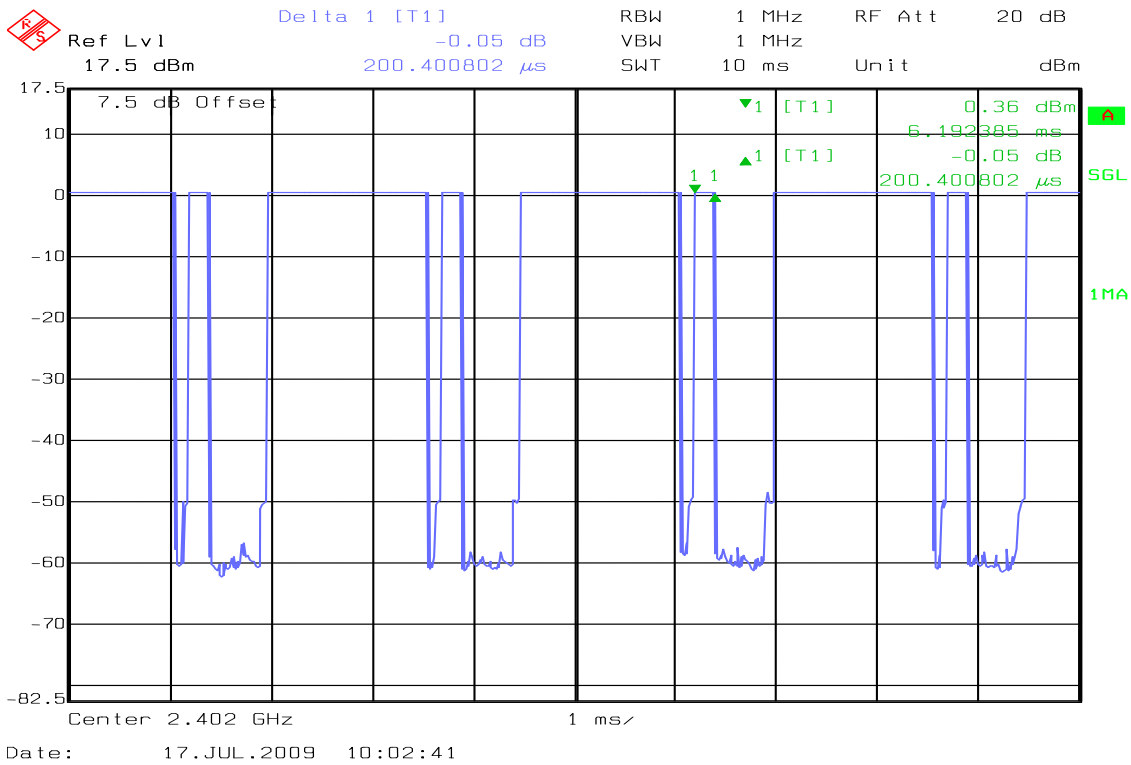
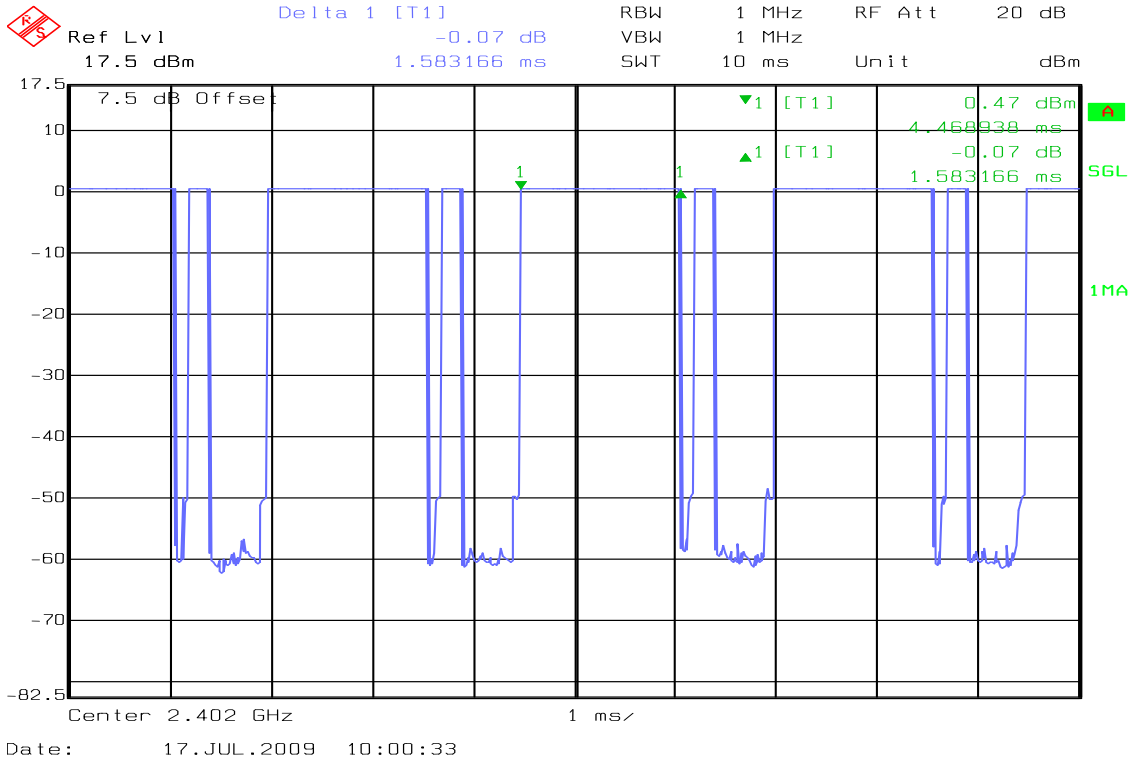
(CH High)





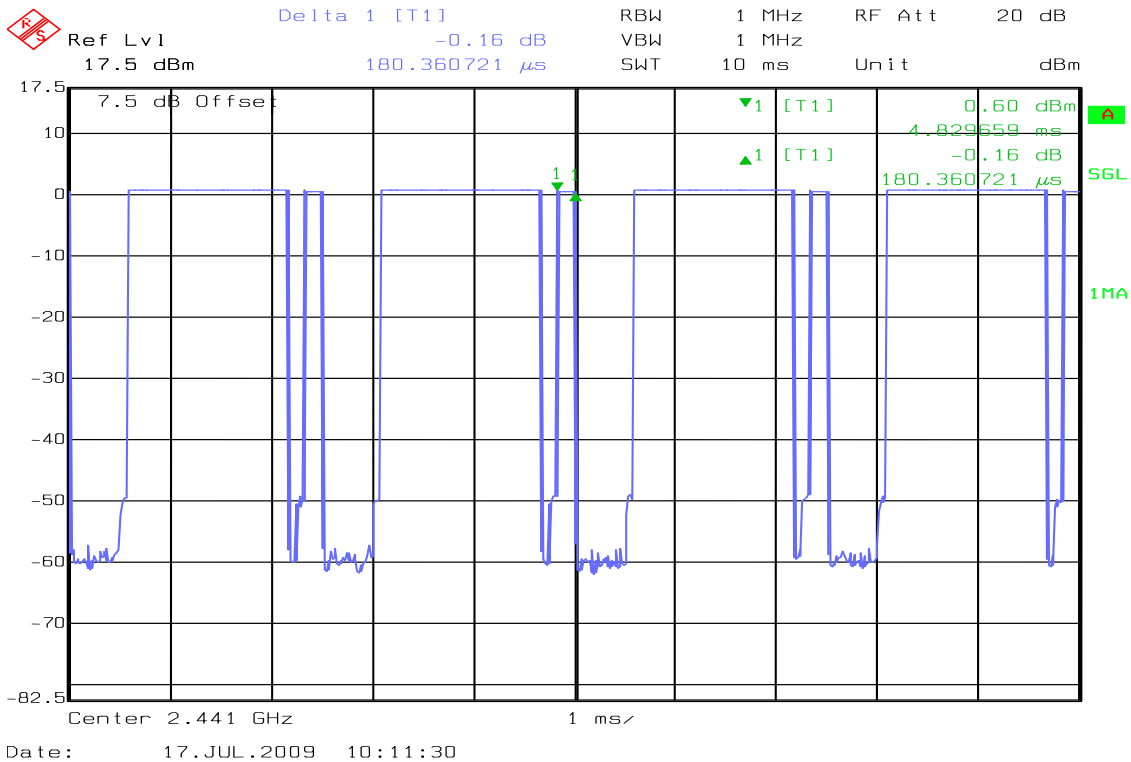
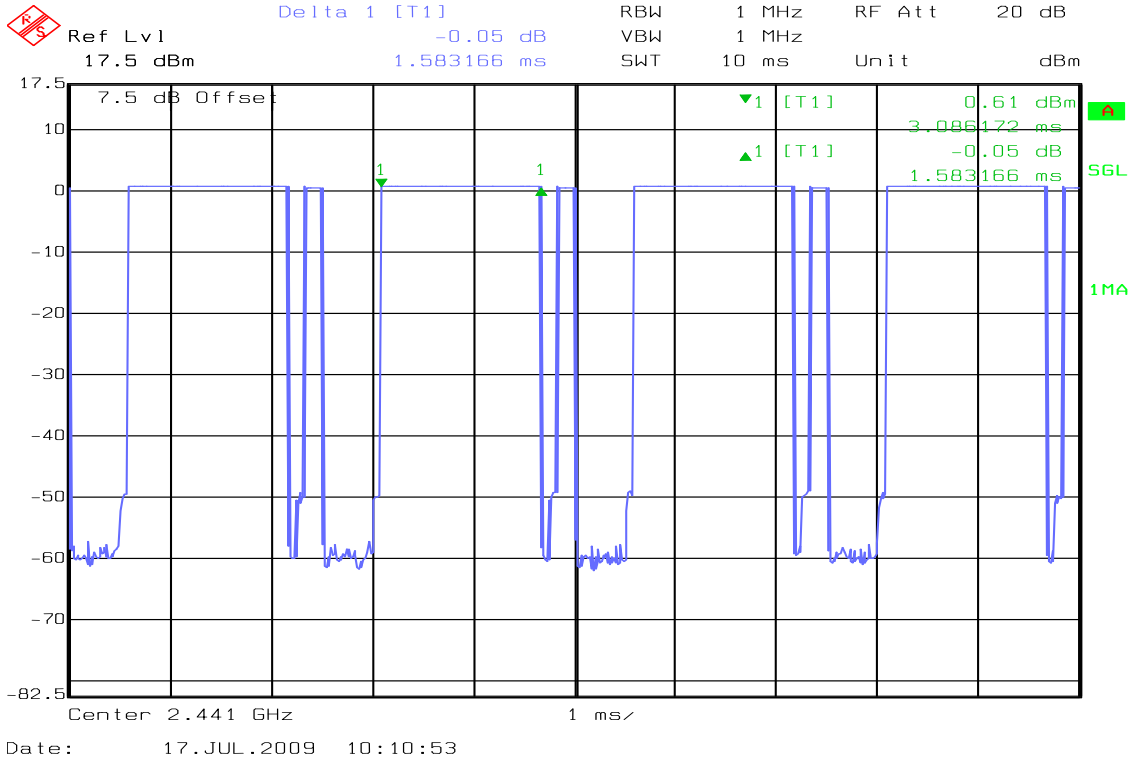
DH 3

(CH Low)



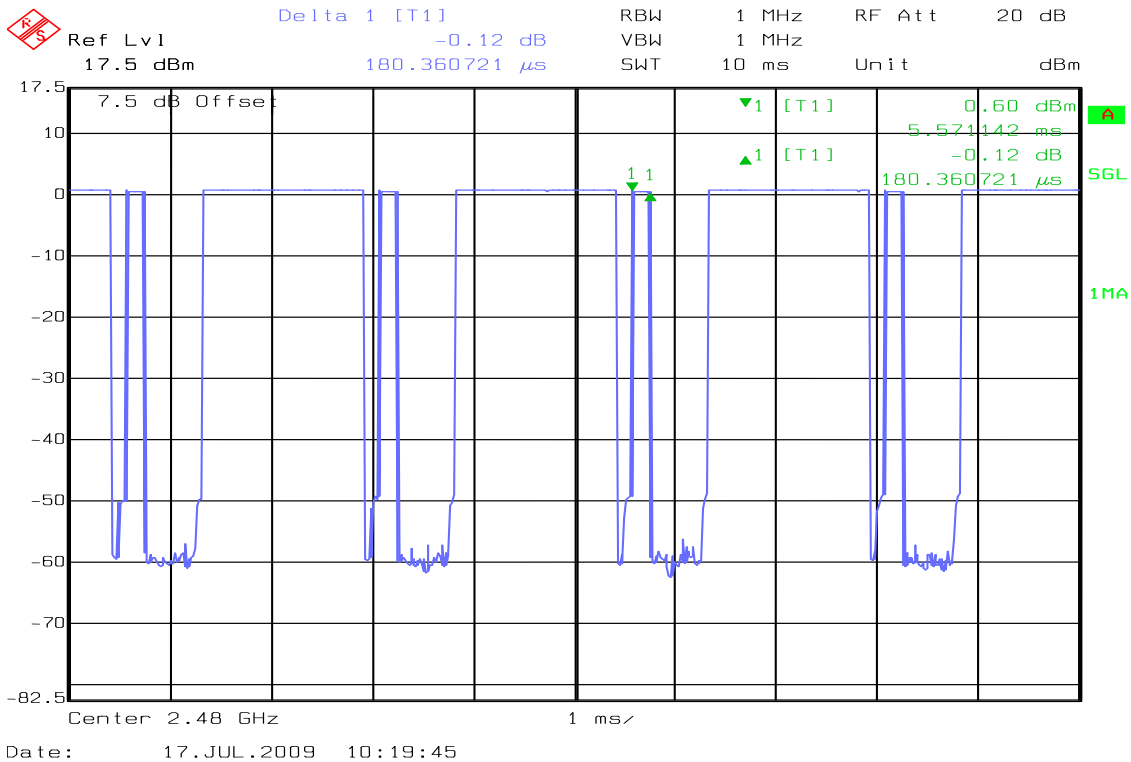
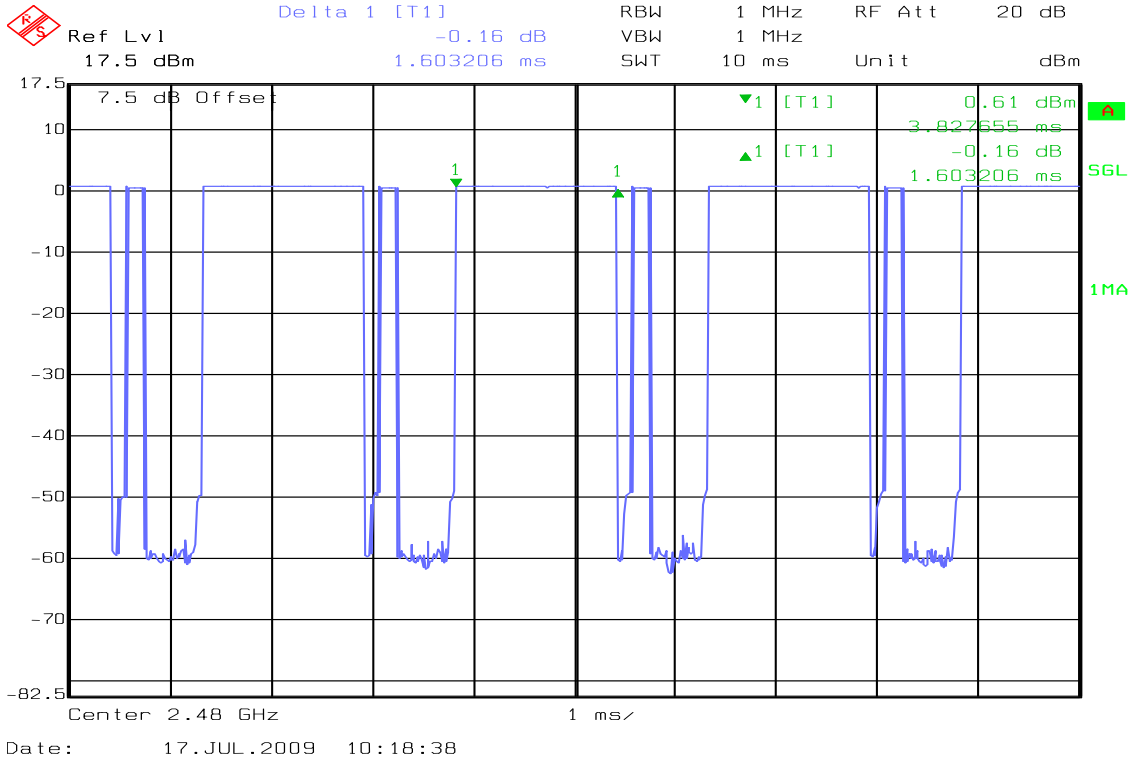


(CH Mid)





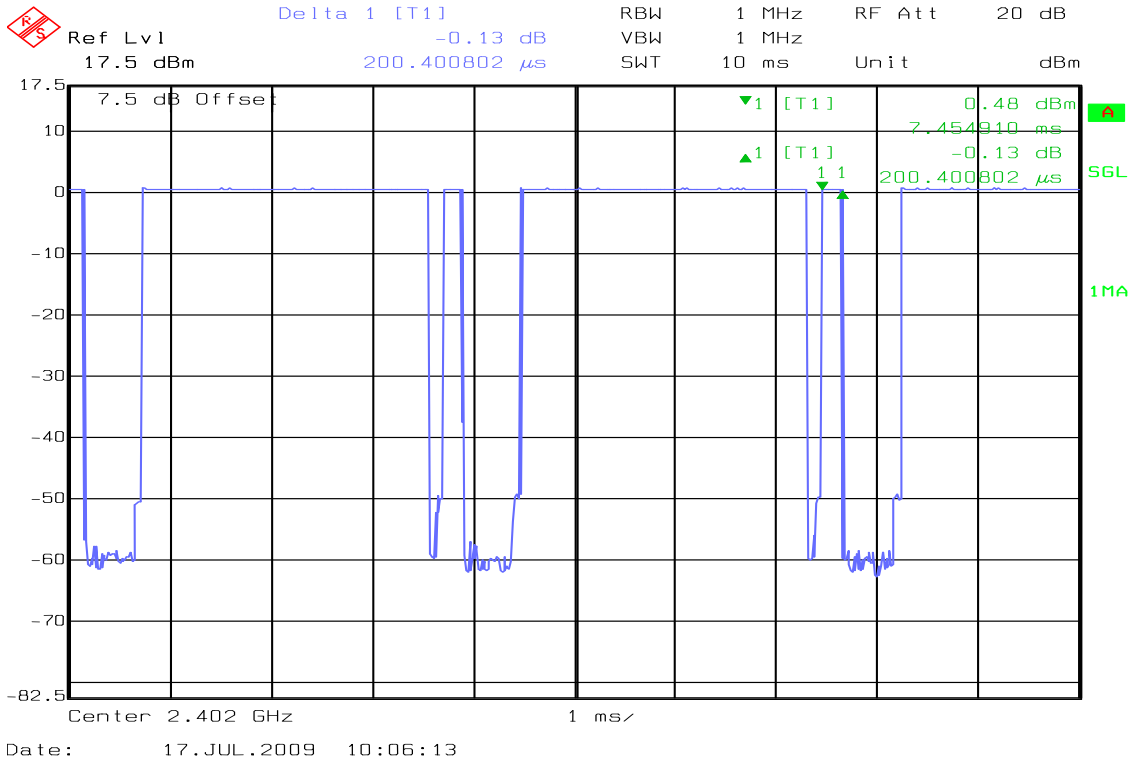
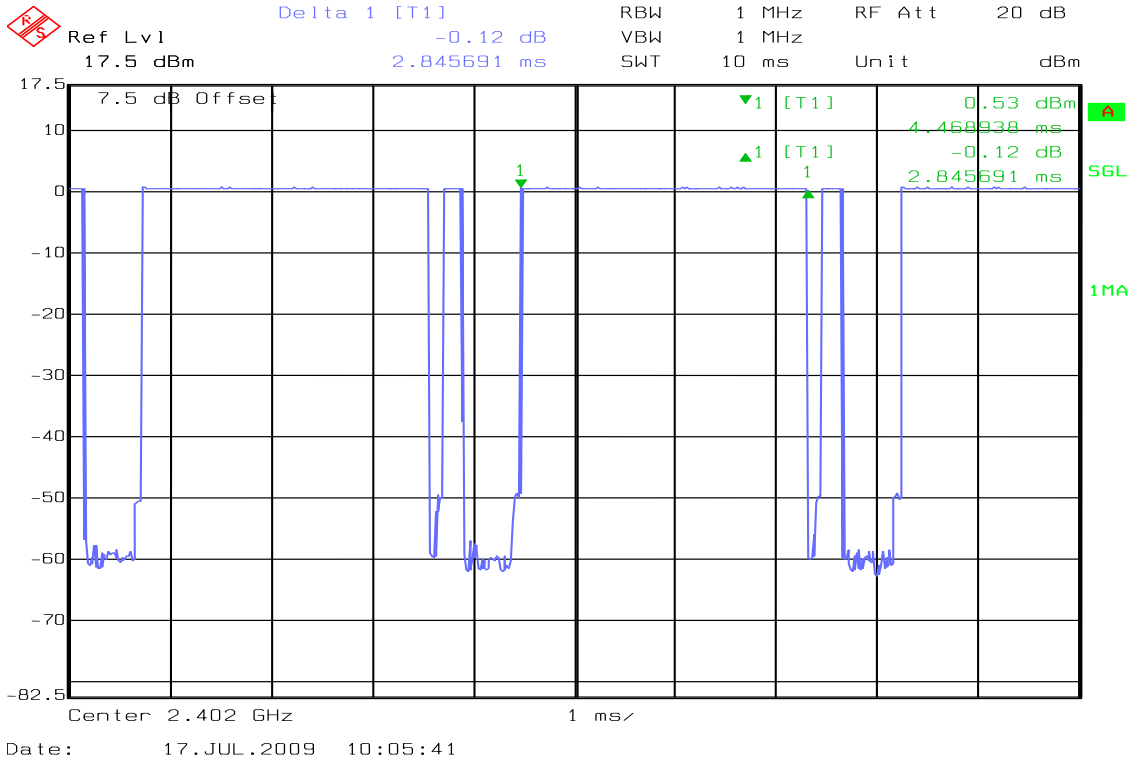
(CH High)





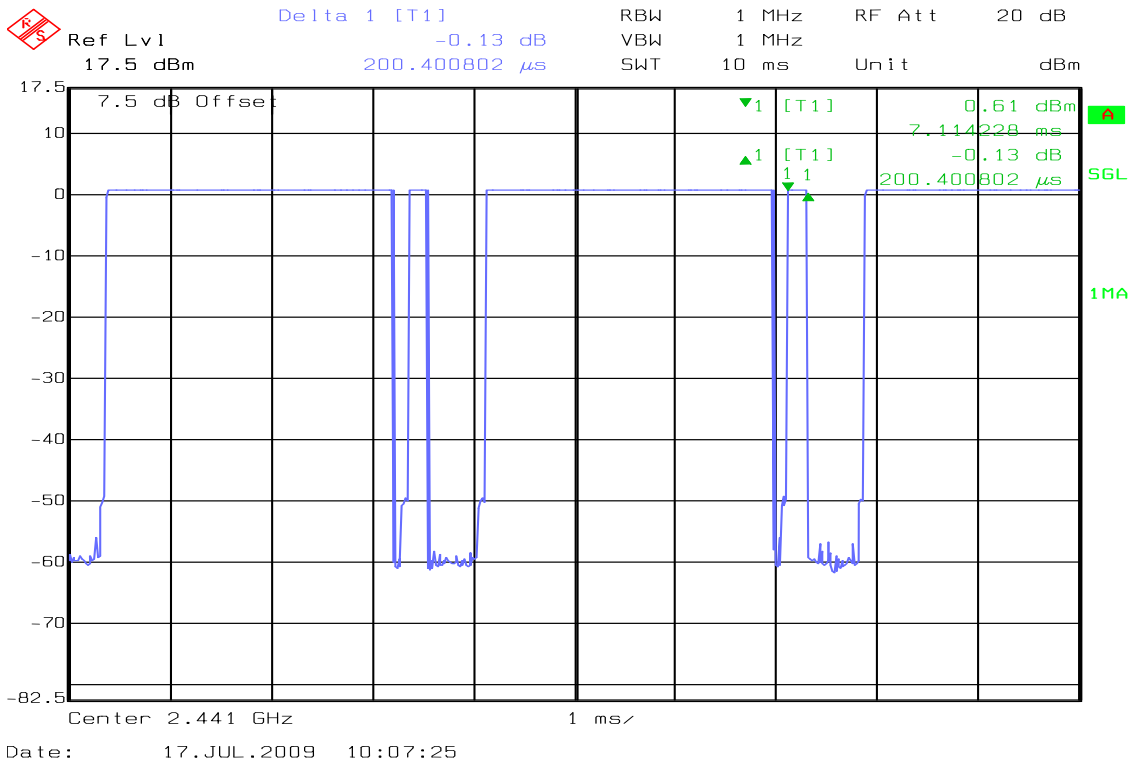
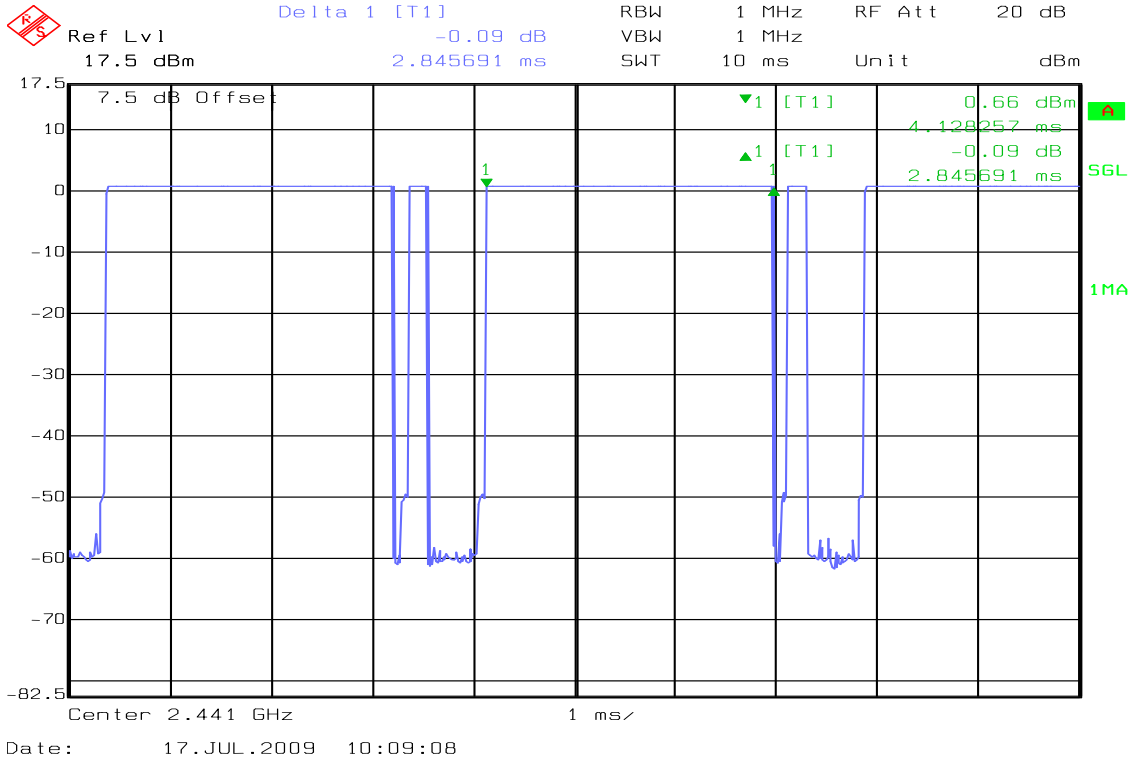
DH 5

(CH Low)



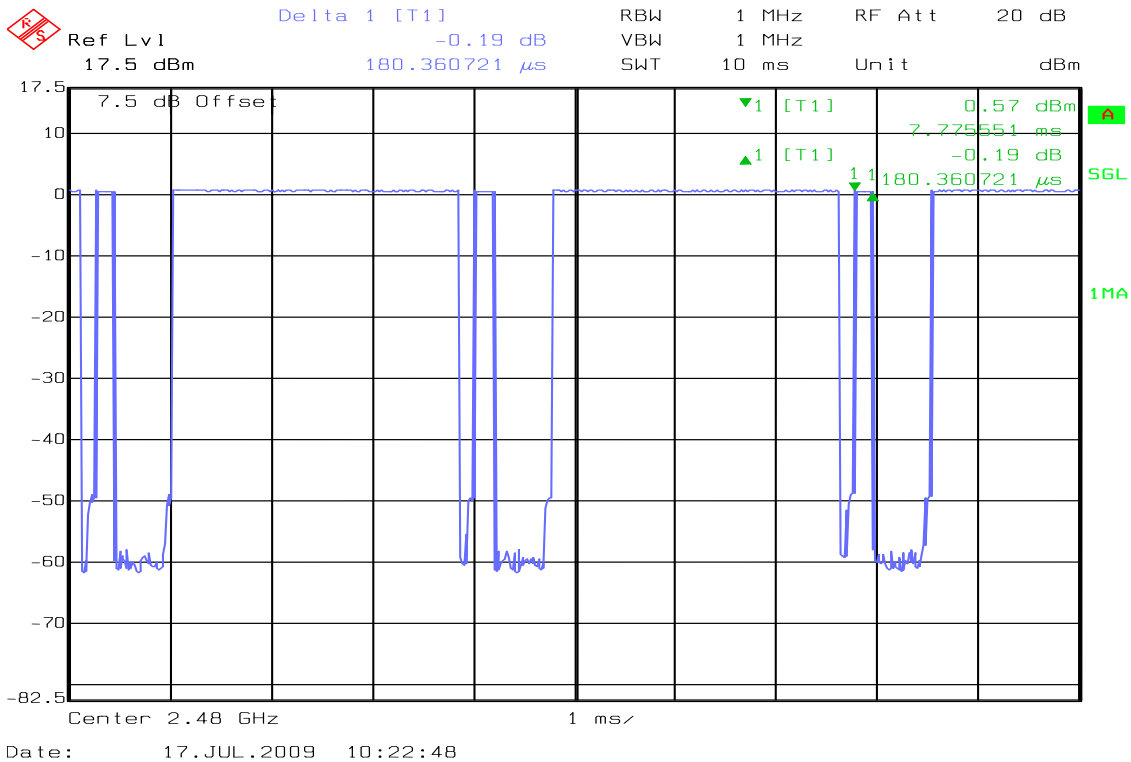
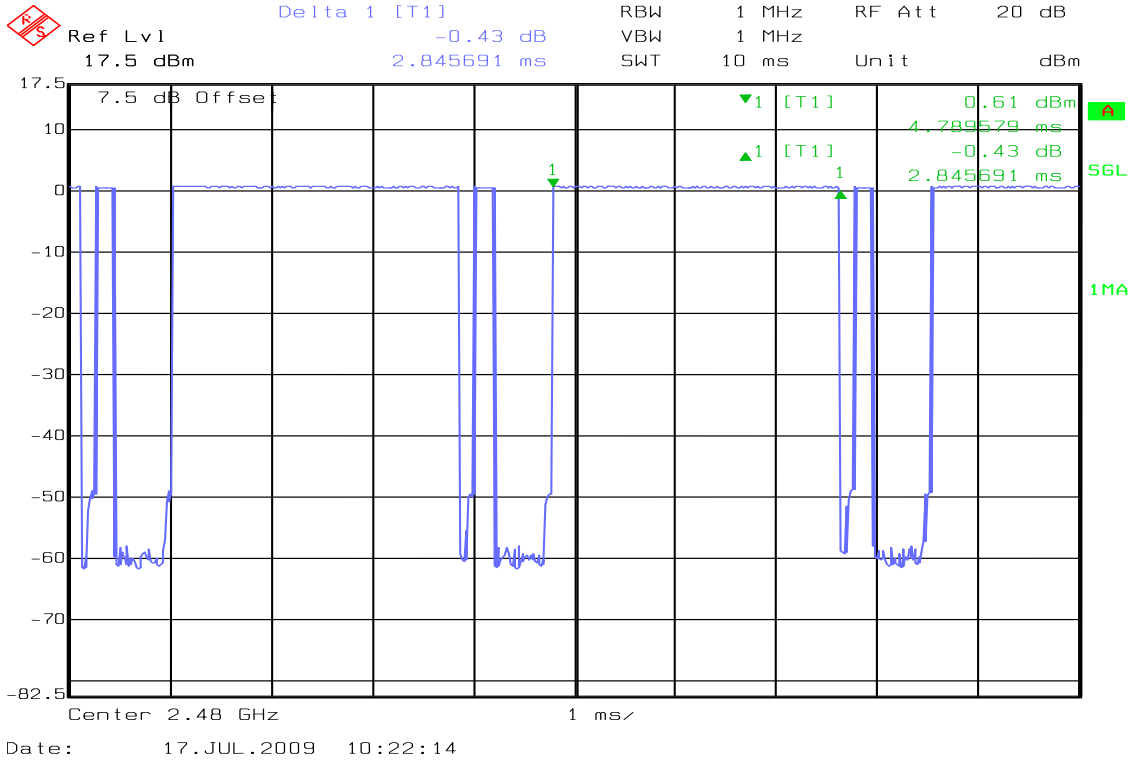


(CH Mid)





(CH High)





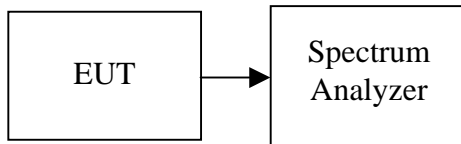
7.8 SPURIOUS EMISSIONS

7.8.1 Conducted Measurement

LIMIT

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

TEST CONFIGURATION



TEST PROCEDURE

Conducted RF measurements of the transmitter output were made to confirm that the EUT antenna port conducted emissions meet the specified limit and to identify any spurious signals that require further investigation or measurements on the radiated emissions site.

The transmitter output is connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 100 kHz.

Measurements are made over the 30MHz to 26GHz range with the transmitter set to the lowest, middle, and highest channels.

TEST RESULTS

No non-compliance noted



TEST DATA

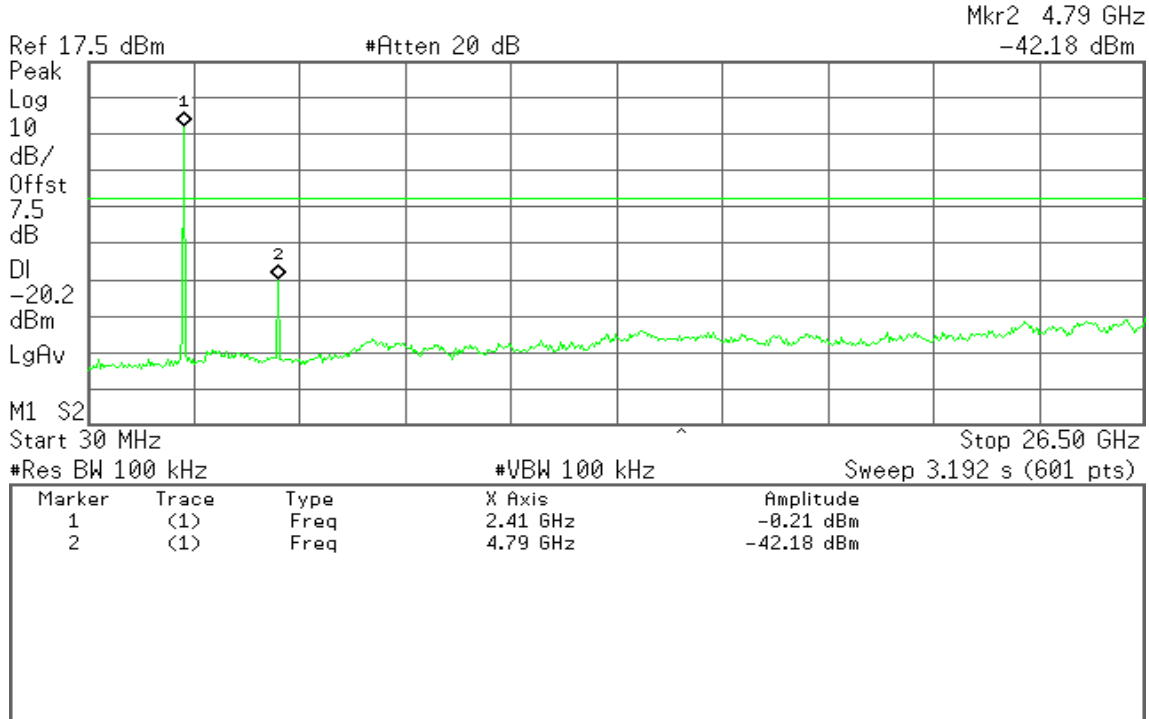
Refer to attach spectrum analyzer data chart.

Test Plot

CH Low

Agilent 10:36:10 Jul 17, 2009

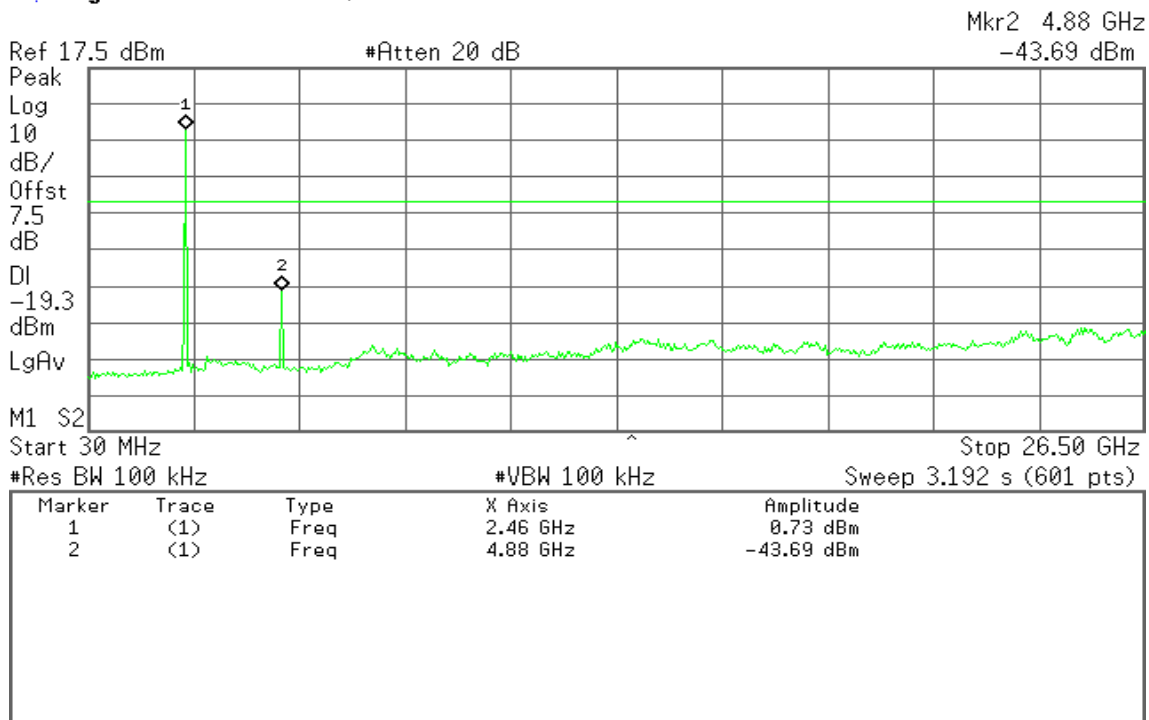
R L



CH Mid

Agilent 10:37:12 Jul 17, 2009

R L

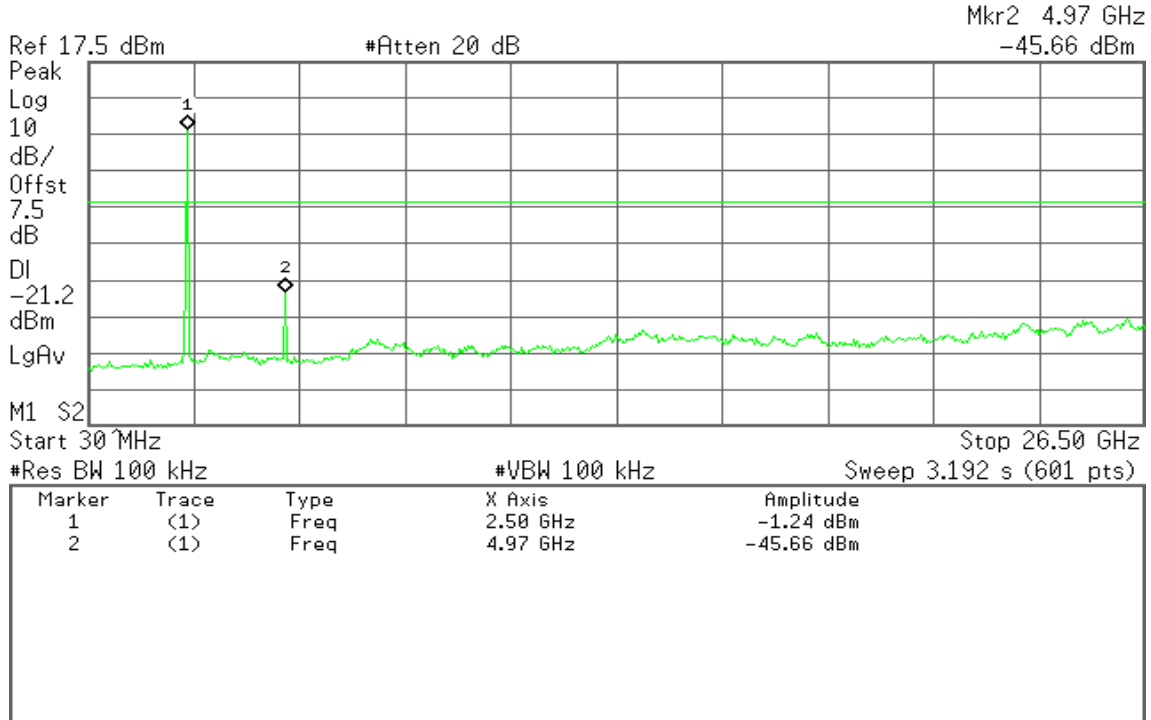




CH High

Agilent 10:39:40 Jul 17, 2009

R L





7.8.2 RADIATED EMISSIONS

LIMIT

1. According to §15.209(a), except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (µV/m)	Measurement Distance (m)
30-88	100*	3
88-216	150*	3
216-960	200*	3
Above 960	500	3

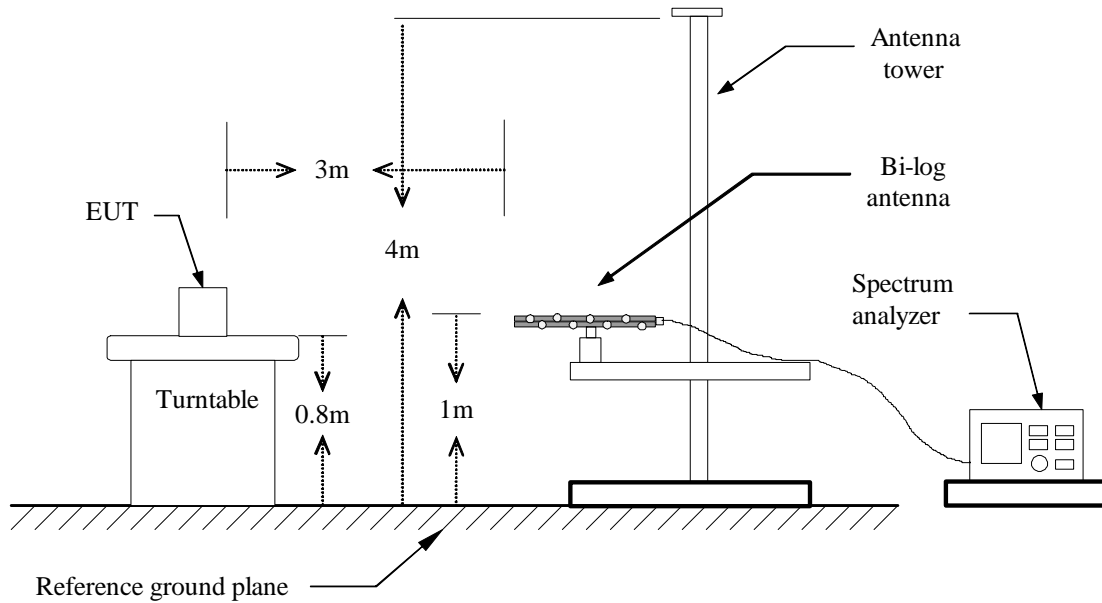
Remark: Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

2. In the emission table above, the tighter limit applies at the band edges.

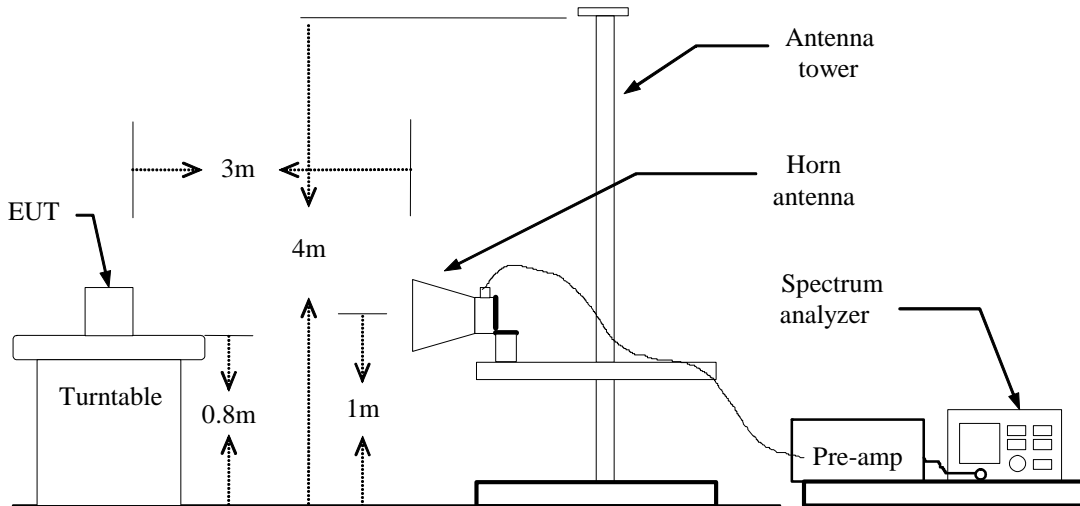
Frequency (Hz)	Field Strength (µV/m at 3-meter)	Field Strength (dBµV/m at 3-meter)
30-88	100	40
88-216	150	43.5
216-960	200	46
Above 960	500	54

TEST CONFIGURATION

Below 1 GHz



Above 1 GHz





TEST PROCEDURE

1. The EUT is placed on a turntable, which is 0.8m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Set the spectrum analyzer in the following setting as:
Below 1GHz:
 RBW=100kHz / VBW=300kHz / Sweep=AUTO
Above 1GHz:
 (a) PEAK: RBW=VBW=1MHz / Sweep=AUTO
 (b) AVERAGE: RBW=1MHz / VBW=10Hz / Sweep=AUTO
7. Repeat above procedures until the measurements for all frequencies are complete.

TEST RESULTS

No non-compliance noted



TEST DATA

Below 1 GHz

Operation Mode: Normal Link

Test Date: July 16, 2009

Temperature: 18°C

Tested by: Alonso Lu

Humidity: 60% RH

Polarity: Ver. / Hor.

Freq. (MHz)	Ant.Pol. H/V	Detector Mode (PK/QP)	Reading (dBUV)	Factor (dB)	Actual FS (dBUV/m)	Limit 3m (dBUV/m)	Safe Margin (dB)
78.6888	V	Peak	45.38	-17.86	27.52	40.00	-12.48
112.4500	V	Peak	51.95	-14.78	37.17	43.50	-6.33
117.3000	V	Peak	49.23	-13.83	35.40	43.50	-8.10
148.8250	V	Peak	50.13	-13.13	37.00	43.50	-6.50
379.2000	V	Peak	47.81	-11.36	36.45	46.00	-9.55
541.6750	V	Peak	39.83	-8.53	31.30	46.00	-14.70
78.5000	H	Peak	44.74	-17.83	26.91	40.00	-13.09
117.3000	H	Peak	44.41	-13.83	30.58	43.50	-12.92
148.8250	H	Peak	43.69	-13.13	30.56	43.50	-12.94
197.3250	H	Peak	48.04	-14.61	33.43	43.50	-10.07
233.7000	H	Peak	44.59	-14.13	30.46	46.00	-15.54
270.0750	H	Peak	42.84	-12.35	30.49	46.00	-15.51
376.7750	H	Peak	45.77	-11.45	34.32	46.00	-11.68

Remark:

1. No emission found between lowest internal used / generated frequency to 30 MHz. (9kHz ~ 30MHz)
2. Measuring frequencies from 9 kHz to the 1GHz.
3. Radiated emissions measured in the measured frequency range were made with an instrument using Quasi-peak detector mode.
4. Data of measurement within this frequency range shown " --- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
5. The IF bandwidth of SPA between 30MHz to 1GHz was 100kHz.



Above 1 GHz

Operation Mode: TX / CH Low

Test Date: July 16, 2009

Temperature: 20°C

Tested by: Alonso Lu

Humidity: 50 % RH

Polarity: Ver. / Hor.

Freq. (MHz)	Ant. Pol H/V	Peak Reading (dBuV)	AV Reading (dBuV)	Ant. / CL CF (dB)	Actual Fs		Peak Limit (dBuV/m)	AV Limit (dBuV/m)	Margin (dB)	Remark
					Peak (dBuV/m)	AV (dBuV/m)				
1203.33	V	47.77	---	-6.06	41.71	---	74.00	54.00	-12.29	Peak
1876.67	V	44.68	---	-2.14	42.55	---	74.00	54.00	-11.45	Peak
2200.00	V	42.50	---	0.59	43.09	---	74.00	54.00	-10.91	Peak
2503.33	V	44.85	---	1.18	46.03	---	74.00	54.00	-7.97	Peak
4800.00	V	41.83	---	7.61	49.44	---	74.00	54.00	-4.56	Peak
5258.33	V	40.36	---	6.71	47.07	---	74.00	54.00	-6.93	Peak
10066.67	V	41.27	---	8.40	49.66	---	74.00	54.00	-4.34	Peak
1570.00	H	44.86	---	-5.73	39.13	---	74.00	54.00	-14.87	Peak
2106.67	H	43.11	---	-1.37	41.74	---	74.00	54.00	-12.26	Peak
2736.67	H	44.22	---	-0.07	44.15	---	74.00	54.00	-9.85	Peak
2843.33	H	43.87	---	0.20	44.07	---	74.00	54.00	-9.93	Peak
4800.00	H	43.37	---	6.71	50.08	---	74.00	54.00	-3.92	Peak
5450.00	H	40.45	---	8.50	48.95	---	74.00	54.00	-5.05	Peak
9350.00	H	40.08	---	7.88	47.96	---	74.00	54.00	-6.04	Peak
11833.33	H	40.08	---	10.71	50.79	---	74.00	54.00	-3.21	Peak

Remark:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Radiated emissions measured in frequency above 1000MHz were made with an instrument using peak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit or as required by the applicant.
4. Data of measurement within this frequency range shown " --- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
5. Measurements above show only up to 6 maximum emissions noted, or would be lesser, with " N/A " remark, if no specific emissions from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.
6. Margin (dB) = Remark result (dBuV/m) – Average limit (dBuV/m).



Operation Mode: TX / CH Mid

Test Date: July 16, 2009

Temperature: 20°C

Tested by: Alonso Lu

Humidity: 50 % RH

Polarity: Ver. / Hor.

Freq. (MHz)	Ant. Pol H/V	Peak Reading (dBuV)	AV Reading (dBuV)	Ant. / CL CF (dB)	Actual Fs		Peak Limit (dBuV/m)	AV Limit (dBuV/m)	Margin (dB)	Remark
					Peak (dBuV/m)	AV (dBuV/m)				
1196.67	V	48.75	---	-6.06	42.69	---	74.00	54.00	-11.31	Peak
1590.00	V	46.86	---	-4.15	42.71	---	74.00	54.00	-11.29	Peak
1863.33	V	45.39	---	-2.08	43.31	---	74.00	54.00	-10.69	Peak
2223.33	V	43.61	---	0.41	44.01	---	74.00	54.00	-9.99	Peak
2476.67	V	47.16	---	0.87	48.03	---	74.00	54.00	-5.97	Peak
2743.33	V	43.34	---	-0.68	42.66	---	74.00	54.00	-11.34	Peak
4116.67	V	40.30	---	5.62	45.92	---	74.00	54.00	-8.08	Peak
4891.67	V	39.26	---	8.03	47.29	---	74.00	54.00	-6.71	Peak
6550.00	V	40.11	---	10.15	50.26	---	74.00	54.00	-3.74	Peak
10283.33	V	39.95	---	8.90	48.86	---	74.00	54.00	-5.14	Peak
11250.00	V	39.41	---	10.40	49.81	---	74.00	54.00	-4.19	Peak
11816.67	V	39.67	---	10.70	50.37	---	74.00	54.00	-3.63	Peak
1590.00	H	44.58	---	-5.46	39.12	---	74.00	54.00	-14.88	Peak
2103.33	H	42.57	---	-1.31	41.26	---	74.00	54.00	-12.74	Peak
2303.33	H	43.68	---	-1.57	42.12	---	74.00	54.00	-11.88	Peak
2493.33	H	45.51	---	-0.62	44.89	---	74.00	54.00	-9.11	Peak
4208.33	H	40.83	---	8.09	48.91	---	74.00	54.00	-5.09	Peak
5091.67	H	40.74	---	8.80	49.54	---	74.00	54.00	-4.46	Peak
10316.67	H	40.31	---	8.98	49.29	---	74.00	54.00	-4.71	Peak
11200.00	H	39.82	---	10.36	50.18	---	74.00	54.00	-3.82	Peak

Remark:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Radiated emissions measured in frequency above 1000MHz were made with an instrument using peak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit or as required by the applicant.
4. Data of measurement within this frequency range shown " --- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
5. Measurements above show only up to 6 maximum emissions noted, or would be lesser, with " N/A " remark, if no specific emissions from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.
6. Margin (dB) = Remark result (dBuV/m) – Average limit (dBuV/m).



Operation Mode: TX / CH High

Test Date: July 16, 2009

Temperature: 20°C

Tested by: Alonso Lu

Humidity: 50 % RH

Polarity: Ver. / Hor.

Freq. (MHz)	Ant. Pol H/V	Peak Reading (dBuV)	AV Reading (dBuV)	Ant. / CL CF (dB)	Actual Fs		Peak Limit (dBuV/m)	AV Limit (dBuV/m)	Margin (dB)	Remark
					Peak (dBuV/m)	AV (dBuV/m)				
1193.33	V	49.19	---	-6.08	43.11	---	74.00	54.00	-10.89	Peak
1753.33	V	43.71	---	-1.96	41.75	---	74.00	54.00	-12.25	Peak
1906.67	V	43.45	---	-2.20	41.24	---	74.00	54.00	-12.76	Peak
2226.67	V	43.75	---	0.38	44.13	---	74.00	54.00	-9.87	Peak
4100.00	V	39.59	---	5.95	45.54	---	74.00	54.00	-8.46	Peak
4900.00	V	39.91	---	8.07	47.98	---	74.00	54.00	-6.02	Peak
6425.00	V	39.73	---	9.34	49.07	---	74.00	54.00	-4.93	Peak
10166.67	V	39.73	---	8.63	48.36	---	74.00	54.00	-5.64	Peak
10983.33	V	38.30	---	10.17	48.47	---	74.00	54.00	-5.53	Peak
11966.67	V	40.31	---	10.75	51.06	---	74.00	54.00	-2.94	Peak
1030.00	H	46.30	---	-7.22	39.08	---	74.00	54.00	-14.92	Peak
2103.33	H	43.19	---	-1.31	41.88	---	74.00	54.00	-12.12	Peak
2343.33	H	43.58	---	-1.39	42.19	---	74.00	54.00	-11.81	Peak
2883.33	H	44.00	---	0.65	44.66	---	74.00	54.00	-9.34	Peak
4108.33	H	41.03	---	8.26	49.29	---	74.00	54.00	-4.71	Peak
5091.67	H	39.72	---	8.80	48.52	---	74.00	54.00	-5.48	Peak
10266.67	H	40.68	---	8.86	49.55	---	74.00	54.00	-4.45	Peak
11316.67	H	39.45	---	10.45	49.91	---	74.00	54.00	-4.09	Peak

Remark:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Radiated emissions measured in frequency above 1000MHz were made with an instrument using peak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit or as required by the applicant.
4. Data of measurement within this frequency range shown " --- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
5. Measurements above show only up to 6 maximum emissions noted, or would be lesser, with " N/A " remark, if no specific emissions from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.
6. Margin (dB) = Remark result (dBuV/m) – Average limit (dBuV/m).



Operation Mode: RX

Test Date: July 16, 2009

Temperature: 20°C

Tested by: Alonso Lu

Humidity: 50 % RH

Polarity: Ver. / Hor.

Freq. (MHz)	Ant. Pol H/V	Peak Reading (dBuV)	AV Reading (dBuV)	Ant. / CL CF (dB)	Actual Fs		Peak Limit (dBuV/m)	AV Limit (dBuV/m)	Margin (dB)	Remark
					Peak (dBuV/m)	AV (dBuV/m)				
1596.67	V	45.78	---	-4.03	41.75	---	74.00	54.00	-12.25	Peak
1726.67	V	43.81	---	-2.04	41.77	---	74.00	54.00	-12.23	Peak
1860.00	V	44.00	---	-2.07	41.93	---	74.00	54.00	-12.07	Peak
2203.33	V	43.41	---	0.56	43.97	---	74.00	54.00	-10.03	Peak
2473.33	V	42.61	---	0.82	43.43	---	74.00	54.00	-10.57	Peak
4108.33	V	40.88	---	5.78	46.67	---	74.00	54.00	-7.33	Peak
4900.00	V	40.37	---	8.07	48.44	---	74.00	54.00	-5.56	Peak
6558.33	V	39.95	---	10.36	50.31	---	74.00	54.00	-3.69	Peak
11066.67	V	39.40	---	10.25	49.65	---	74.00	54.00	-4.35	Peak
11833.33	V	39.78	---	10.71	50.48	---	74.00	54.00	-3.52	Peak
1306.67	H	44.48	---	-7.03	37.45	---	74.00	54.00	-16.55	Peak
2083.33	H	42.37	---	-1.52	40.85	---	74.00	54.00	-13.15	Peak
2443.33	H	44.05	---	-0.90	43.15	---	74.00	54.00	-10.85	Peak
4050.00	H	40.96	---	8.12	49.09	---	74.00	54.00	-4.91	Peak
4183.33	H	41.17	---	8.16	49.33	---	74.00	54.00	-4.67	Peak
5075.00	H	40.25	---	8.68	48.94	---	74.00	54.00	-5.06	Peak
7016.67	H	39.89	---	10.45	50.34	---	74.00	54.00	-3.66	Peak
10316.67	H	40.27	---	8.98	49.25	---	74.00	54.00	-4.75	Peak
11933.33	H	39.65	---	10.74	50.39	---	74.00	54.00	-3.61	Peak

Remark:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Radiated emissions measured in frequency above 1000MHz were made with an instrument using peak/average detector mode.
3. Average test would be performed if the peak result were greater than the average limit or as required by the applicant.
4. Data of measurement within this frequency range shown " --- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
5. Measurements above show only up to 6 maximum emissions noted, or would be lesser, with " N/A " remark, if no specific emissions from the EUT are recorded (ie: margin>20dB from the applicable limit) and considered that's already beyond the background noise floor.
6. Margin (dB) = Remark result (dBuV/m) – Average limit (dBuV/m).



7.9 POWERLINE CONDUCTED EMISSIONS

LIMIT

For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

Frequency Range (MHz)	Limits (dBµV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

TEST CONFIGURATION

See test photographs attached in Appendix 1 for the actual connections between EUT and support equipment.

TEST PROCEDURE

1. The EUT was placed on a table, which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

TEST RESULTS

Not applicable (Since the EUT is powered by battery)



APPENDIX I RADIO FREQUENCY EXPOSURE

LIMIT

According to §15.247(i), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this chapter.

EUT SPECIFICATION

EUT	Bluetooth Laser Mouse
Frequency band (Operating)	<input type="checkbox"/> WLAN: 2.412GHz ~ 2.462GHz <input type="checkbox"/> WLAN: 5.18GHz ~ 5.32GHz / 5.50GHz ~ 5.70GHz <input type="checkbox"/> WLAN: 5.745GHz ~ 5.825GHz <input checked="" type="checkbox"/> Others: <u>Bluetooth: 2.402GHz ~ 2.480GHz</u>
Device category	<input checked="" type="checkbox"/> Portable (<20cm separation) <input type="checkbox"/> Mobile (>20cm separation) <input type="checkbox"/> Others
Exposure classification	<input type="checkbox"/> Occupational/Controlled exposure ($S = 5mW/cm^2$) <input checked="" type="checkbox"/> General Population/Uncontrolled exposure ($S=1mW/cm^2$)
Antenna diversity	<input checked="" type="checkbox"/> Single antenna <input type="checkbox"/> Multiple antennas <input type="checkbox"/> Tx diversity <input type="checkbox"/> Rx diversity <input type="checkbox"/> Tx/Rx diversity
Max. output power	0.81dBm (1.21mW)
Antenna gain (Max)	-1.55dBi (Numeric gain: 1.43)
Evaluation applied	<input type="checkbox"/> MPE Evaluation <input type="checkbox"/> SAR Evaluation <input checked="" type="checkbox"/> N/A
Remark:	
1. The maximum output power is <u>-3.54dBm (0.443mW)</u> at <u>2480MHz</u> (with <u>2.00</u> numeric antenna gain.)	

TEST RESULTS

No non-compliance noted.

(SAR evaluation is not required for the PORTABLE device while its maximum output power is lower than the general population low threshold: $60/f_{(GHz)}=60/2.441=24.58mW$)



APPENDIX II

BLUETOOTH DECLARATION PER FCC 15.247 REQUIREMENTS

1 Output power and channel separation of a Bluetooth device in the different operating modes:

The different operating modes (data-mode, acquisition-mode) of a Bluetooth device don't influence the output power and the channel spacing. There is only one transmitter which is driven by identical input parameters concerning these two parameters. Only a different hopping sequence will be used. For this reason the check of these RF parameters in one op-mode is sufficient.

2 Frequency range of a Bluetooth device:

Hereby we declare that the maximum frequency of this device is: **2402 – 2480 MHz**.

This is according the Bluetooth Core Specification V 1.0B (+ critical errata) for devices which will be operated in the USA.

This was checked during the Bluetooth Qualification tests (Test Case: TRM/CA/04-E).

Other frequency ranges (e.g. for Spain, France, Japan) which are allowed according the Core Specification are **not** supported by this device.

3 Co-ordination of the hopping sequence in data mode to avoid simultaneous occupancy by multiple transmitters:

Bluetooth units which want to communicate with other units must be organized in a structure called piconet. This piconet consist of max. 8 Bluetooth units. One unit is the master the other seven are the slaves. The master co-ordinates frequency occupation in this piconet for all units. As the master hop sequence is derived from it's BD address which is unique for every Bluetooth device, additional masters intending to establish new piconets will always use different hop sequences.

4 Example of a hopping sequence in data mode:

Example of a 79 hopping sequence in data mode:

40, 21, 44, 23, 42, 53, 46, 55, 48, 33, 52, 35, 50, 65, 54, 67,
56, 37, 60, 39, 58, 69, 62, 71, 64, 25, 68, 27, 66, 57, 70, 59,
72, 29, 76, 31, 74, 61, 78, 63, 01, 41, 05, 43, 03, 73, 07, 75,
09, 45, 13, 47, 11, 77, 15, 00, 64, 49, 66, 53, 68, 02, 70, 06,
01, 51, 03, 55, 05, 04

5 Equally average use of frequencies in data mode and behaviour for short transmissions:

The generation of the hopping sequence in connection mode depends essentially on two input values:

1. LAP/UAP of the master of the connection

2. Internal master clock The LAP (lower address part) are the 24 LSB's of the 48 BD_ADDRESS. The BD_ADDRESS is an unambiguous number of every Bluetooth unit. The UAP (upper address part) are the 24 MSB's of the 48 BD_ADDRESS.

The internal clock of a Bluetooth unit is derived from a free running clock which is never adjusted and is never turned off. For synchronisation with other units only offset are used. It has no relation to the time of the day. Its resolution is at least half the RX/TX slot length of 312.5 μ s. The clock has a cycle of about one day (23h30). In most case it is implemented as 28 bit counter. For the deriving of the hopping sequence the entire LAP (24 bits), 4 LSB's (4 bits) (Input 1) and the 27 MSB's of the clock (Input 2) are used.

With this input values different mathematical procedures (permutations, additions, XOR-operations) are performed to generate the sequence. This will be done at the beginning of every new transmission.

Regarding short transmissions the Bluetooth system has the following behaviors:

The first connection between the two devices is established, a hopping sequence was generated. For transmitting the wanted data the complete hopping sequence was not used. The connection ended.

The second connection will be established. A new hopping sequence is generated. Due to the fact that the Bluetooth clock has a different value, because the period between the two transmission is longer (and it cannot be shorter) than the minimum resolution of the clock (312.5 μ s). The hopping sequence will always differ from the first one.



6 Receiver input bandwidth and behaviors for repeated single or multiple packets:

The input bandwidth of the receiver is 1 MHz.

In every connection one Bluetooth device is the master and the other one is the slave.

The master determines the hopping sequence (see chapter 5). The slave follows this sequence. Both devices shift between RX and TX time slot according to the clock of the master.

Additionally the type of connection (e.g. single or multislot packet) is set up at the beginning of the connection. The master adapts its hopping frequency and its TX/RX timing according to the packet type of the connection. Also the slave of the connection will use these settings.

Repeating of a packet has no influence on the hopping sequence. The hopping sequence generated by the master of the connection will be followed in any case. That means, a repeated packet will not be send on the same frequency, it is send on the next frequency of the hopping sequence.

7 Dwell time in data mode

The dwell time of 0.3797s within a 30 second period in data mode is independent from the packet type (packet length). The calculation for a 30 second period is a follows:

Dwell time = time slot length * hop rate / number of hopping channels * 30s

Example for a DH1 packet (with a maximum length of one time slot)

Dwell time = $625 \mu\text{s} * 1600 \text{ 1/s} / 79 * 30\text{s} = 0.3797\text{s}$ (in a 30s period)

For multislot packet the hopping is reduced according to the length of the packet.

Example for a DH5 packet (with a maximum length of five time slots)

Dwell time = $5 * 625 \mu\text{s} * 1600 * 1/5 * 1/s / 79 * 30\text{s} = 0.3797\text{s}$ (in a 30s period)

This is according the Bluetooth Core Specification V 1.0B (+ critical errata) for all Bluetooth devices. There for all Bluetooth devices **comply** with the FCC dwell time requirement in data mode.

This was checked during the Bluetooth Qualification tests.

The Dwell time in hybrid mode is measured and stated in the test report.

8 Channel Separation in hybrid mode

The nominal channel spacing of the Bluetooth system is 1Mhz independent of the operating mode.

The maximum "initial carrier frequency tolerance" which is allowed for Bluetooth is $f_{\text{center}} = 75 \text{ kHz}$.

This was checked during the Bluetooth Qualification tests (Test Case: TRM/CA/07-E) for three frequencies (2402, 2441, 2480 MHz).

Additionally an example for the channel separation is given in the test report

9 Derivation and examples for a hopping sequence in hybrid mode

For the generation of the inquiry and page hop sequences the same procedures as described for the data mode are used (see chapter 5), but this time with different input vectors:

. For the inquiry hop sequence, a predefined fixed address is always used. This results in the same 32 frequencies used by all devices doing an inquiry but every time with a different start frequency and phase in this sequence.

. For the page hop sequence, the device address of the paged unit is used as input vector. This results in the use of a subset of 32 frequencies which is specific for that initial state of the connection establishment between the two units. A page to different devices would result in a different subset of 32 frequencies.

So it is ensured that also in hybrid mode the frequency use equally averaged.

Example of a hopping sequence in inquiry mode:

48, 50, 09, 13, 52, 54, 41, 45, 56, 58, 11, 15, 60, 62, 43, 47, 00, 02, 64, 68, 04, 06, 17, 21, 08, 10, 66, 70, 12, 14, 19, 23

Example of a hopping sequence in paging mode:

08, 57, 68, 70, 51, 02, 42, 40, 04, 61, 44, 46, 63, 14, 50, 48, 16, 65, 52, 54, 67, 18, 58, 56, 20, 53, 60, 62, 55, 06, 66, 64

10 Receiver input bandwidth and synchronisation in hybrid mode:

The receiver input bandwidth is the same as in the data mode (1 MHz). When two Bluetooth devices establish contact for the first time, one device sends an inquiry access code, the other



device is scanning for this inquiry access code. If two devices have been connected previously and want to start a new transmission, a similar procedure takes place. The only difference is, instead of the inquiry access code, an special access code, derived from the BD_ADDRESS of the paged device will be, will be sent by the master of this connection.

Due to the fact that both units have been connected before (in the inquiry procedure) the paging unit has timing and frequency information about the page scan of the paged unit.

For this reason the time to establish the connection is reduced considerable.

11 Spread rate / data rate of the direct sequence signal

The Spread rate / Data rate in inquiry and paging mode can be defined via the access code. The access code is the only criterion for the system to check if there is a valid transmission or not. If you regard the presence of a valid access code as one bit of information, and compare it with the length of the access code of 68 bits, the Spread rate / Data rate will be 68/1.

12 Spurious emission in hybrid mode

The Dwell in hybrid mode is shorter than in data mode. For this reason the spurious emissions average level in data mode is worst case. The spurious emissions peak level is the same for both modes.