



FCC 47 CFR PART 15 SUBPART C

TEST REPORT

For

LabQuest2

Model: LQ2-LE

Trade Name: Vernier

Issued to

**Vernier Software & Technology
13979 SW Millikan Way Beaverton, OR 97005**

Issued by

Compliance Certification Services Inc.

**No.11, Wugong 6th Rd., Wugu Dist.,
New Taipei City 24891, Taiwan. (R.O.C.)**

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Issued Date: April 15, 2013



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Revision History

Rev.		Issue Date		Revisions	Effect Page	Revised By
00		April 15, 2013		Initial Issue	ALL	Rachel Wu



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1. TEST RESULT CERTIFICATION

Applicant: Vernier Software & Technology
13979 SW Millikan Way Beaverton, OR 97005

Equipment Under Test: LabQuest2

Trade Name: Vernier

Model: LQ2-LE

Date of Test: February 14, 2012 ~ April 1, 2013

APPLICABLE STANDARDS	
STANDARD	TEST RESULT
FCC 47 CFR Part 15 Subpart C	No non-compliance noted
Deviation from Applicable Standard	
N/A	

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: 2009** 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:

Miller Lee
Section Manager
Compliance Certification Services Inc.

Reviewed by:

Gina Lo
Section Manager
Compliance Certification Services Inc.



2. EUT DESCRIPTION

Product	LabQuest2
Trade Name	Vernier
Model Number	LQ2-LE
Model Discrepancy	N/A
Received Date	March 25, 2013
Power Supply	1. Power Adapter CONDOR / 3A-154WP05 I/P: 100-240V, 50/60Hz, 0.6A O/P: 5V, 2.6A Vernier / SPS-12-002A I/P: 100-240V, 50/60Hz, 0.5A O/P: 5V, 1.5A 2. Battery Rating: 3.7V, 12.21Wh
Frequency Range	2402MHz ~ 2480MHz
Transmit Power	9.25 dBm
Modulation Technique	BLE: GFSK (1Mbps)
Number of Channels	BLE: 40 Channels
Antenna Specification	Gain: 2.35615 dBi
Antenna Designation	PCB Antenna

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: **AUO-LQ2-LE** 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: 2009 and FCC CFR 47 Part 15.207, 15.209, 15.247 and DA00-705.

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 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.



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: LQ2-LE) had been tested under operating condition.

Software 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 and power line conducted emissions below 30MHz, which worst case was in normal link mode only.

The field strength of spurious emission was measured in the following position: EUT stand-up position (Z axis), lie-down position (X, Y axis) with slide and closed mode. The worst emission was found in lie-down position (X axis) with closed mode and the worst case was recorded.

BT 4.0

Tested Channel	Frequency (MHz)	Axis
Low	2402	X
Mid	2440	X
High	2480	X



4 INSTRUMENT CALIBRATION

4.1 MEASURING 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.

4.2 MEASUREMENT EQUIPMENT USED

Equipment Used for Emissions Measurement

Remark: Each piece of equipment is scheduled for calibration once a year and Loop Antenna is scheduled for calibration once three years.

Conducted Emissions Test Site				
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Power Meter	Anritsu	ML2495A	1012009	06/05/2013
Power Sensor	Anritsu	MA2411B	0917072	06/05/2013

3M Chamber Test Site				
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
Spectrum Analyzer	Agilent	E4446A	US42510268	11/06/2013
EMI Test Receiver	R&S	ESCI	100064	02/28/2014
Pre-Amplifier	Mini-Circuits	ZFL-1000LN	SF350700823	01/12/2014
Pre-Amplifier	MITEQ	AFS44-00102650-42-10P-44	1415367	11/19/2013
Bilog Antenna	Sunol Sciences	JB3	A030105	10/02/2013
Horn Antenna	EMCO	3117	00055165	02/13/2014
Horn Antenna	EMCO	3116	2487	10/10/2013
Loop Antenna	EMCO	6502	8905/2356	06/10/2013
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
Site NSA	CCS	N/A	N/A	12/22/2013
Test S/W	EZ-EMC (CCS-3A1RE)			

Conducted Emission room # A				
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
EMI Test Receiver	R&S	ESCI	101203	09/13/2013
LISN	R&S	ESH3-Z5	848773/014	12/10/2013
ISN	FCC	FCC-TLISN-T8-02-09	101131	09/05/2013
Coaxial Cable	Commate	CFD300-NL	NA	12/06/2013
Test S/W	CCS-3A1-CE			



4.3 MEASUREMENT UNCERTAINTY

PARAMETER	UNCERTAINTY
Powerline Conducted Emission	+/- 1.2159
3M Semi Anechoic Chamber / 30M~200M	+/- 4.0138
3M Semi Anechoic Chamber / 200M~1000M	+/- 3.9483
3M Semi Anechoic Chamber / 1G~8G	+/- 2.5975
3M Semi Anechoic Chamber / 8G~18G	+/- 2.6112
3M Semi Anechoic Chamber / 18G~26G	+/- 2.7389
3M Semi Anechoic Chamber / 26G~40G	+/- 2.9683

Remark: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.



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 Dist., New Taipei City 24891, Taiwan. (R.O.C.)

Tel: 886-2-2299-9720 / Fax: 886-2-2298-4045

☐ No.81-1, Lane 210, Bade 2nd Rd., Lujhu Township, Taoyuan County 33841, 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 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	FCC	3M Semi Anechoic Chamber (FCC MRA: TW1039) to perform FCC Part 15 measurements	 FCC MRA: TW1039
Taiwan	TAF	LP0002, RTTE01, FCC Method-47 CFR Part 15 Subpart C, D, E, RSS-210, RSS-310 IDA TS SRD, AS/NZS 4268, AS/NZS 4771, TS 12.1 & 12.2, ETSI EN 300 440-1, ETSI EN 300 440-2, ETSI EN 300 328, ETSI EN 300 220-1, ETSI EN 300 220-2, ETSI EN 301 893, ETSI EN 301 489-1/3/7/17 FCC OET Bulletin 65 + Supplement C, EN 50360, EN 50361, EN 50371, RSS 102, EN 50383, EN 50385, EN 50392, IEC 62209, CNS 14958-1, CNS 14959 FCC Method -47 CFR Part 15 Subpart B IEC / EN 61000-3-2, IEC / EN 61000-3-3, IEC / EN 61000-4-2/3/4/5/6/8/11	
Canada	Industry Canada	3M Semi Anechoic Chamber (IC 2324G-1 / IC 2324G-2) to perform	 IC 2324G-1 IC 2324G-2

* No part of this report may be used to claim or imply product endorsement by A2LA or any agency of the US Government.



6 SETUP OF EQUIPMENT UNDER TEST

6.1 SETUP CONFIGURATION OF EUT

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

6.2 SUPPORT EQUIPMENT

No	Device Type	Brand	Model	Series No.	FCC ID	Data Cable	Power Cord
1.	Notebook PC	HP	dv6-1332TX	CNF9491GLJ	PD9112BNHU	N/A	AC I/P: Unshielded, 1.8m DC O/P: Unshielded, 1.8m with a core
2.	Stainless Steel Temperature Probe	TMP-BTA	N/A	N/A	Vernier	Unshielded, 1m	N/A
3.	Stainless Steel Temperature Probe	TMP-BTA	N/A	N/A	Vernier	Unshielded, 1m	N/A
4.	PH Sensor	PH-BTA	N/A	N/A	Vernier	Unshielded, 1m	N/A
5.	Motion Detector	MD-BTD	N/A	N/A	Vernier	Unshielded, 1m	N/A
6.	Motion Detector	MD-BTD	N/A	N/A	Vernier	Unshielded, 1m	N/A
7.	Earphone	Labtec	Axis-301	N/A	FCC DoC	Unshielded, 1.8m	N/A
8.	SD Card	SANDISK	N/A	N/A	N/A	N/A	N/A
9.	Notebook PC (Remote)	HP	dv6-1332TX	CNF9491GM9	PD9112BNHU	N/A	AC I/P: Unshielded, 1.8m DC O/P: Unshielded, 1.8m with a core
10.	GPS Simulator (Remote)	HWAJEAT	GPS-101	EN001	N/A	N/A	N/A
11.	Wireless Pre-N Router (MIMO) (Remote)	BELKIN	F5D8230-4	N/A	SA3-AGN0901AP0100	N/A	AC I/P: Unshielded, 1.8m DC O/P: Unshielded, 1.8m with a core

Remark:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.



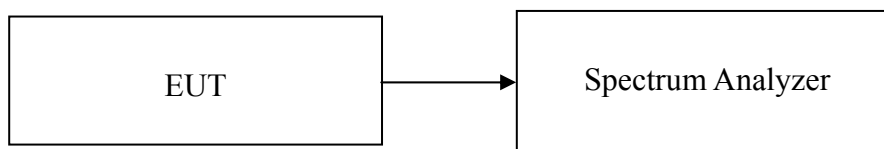
7 FCC PART 15.247 REQUIREMENTS

7.1 6DB BANDWIDTH

LIMIT

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Configuration



TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. Set the RBW = 1% of the emission bandwidth, VBW $\geq 3 \times$ RBW, Detector = Peak, Trace mode = max hold, Sweep = auto couple. Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6dB relative to the maximum level measured in the fundamental emission.

TEST RESULTS

No non-compliance noted

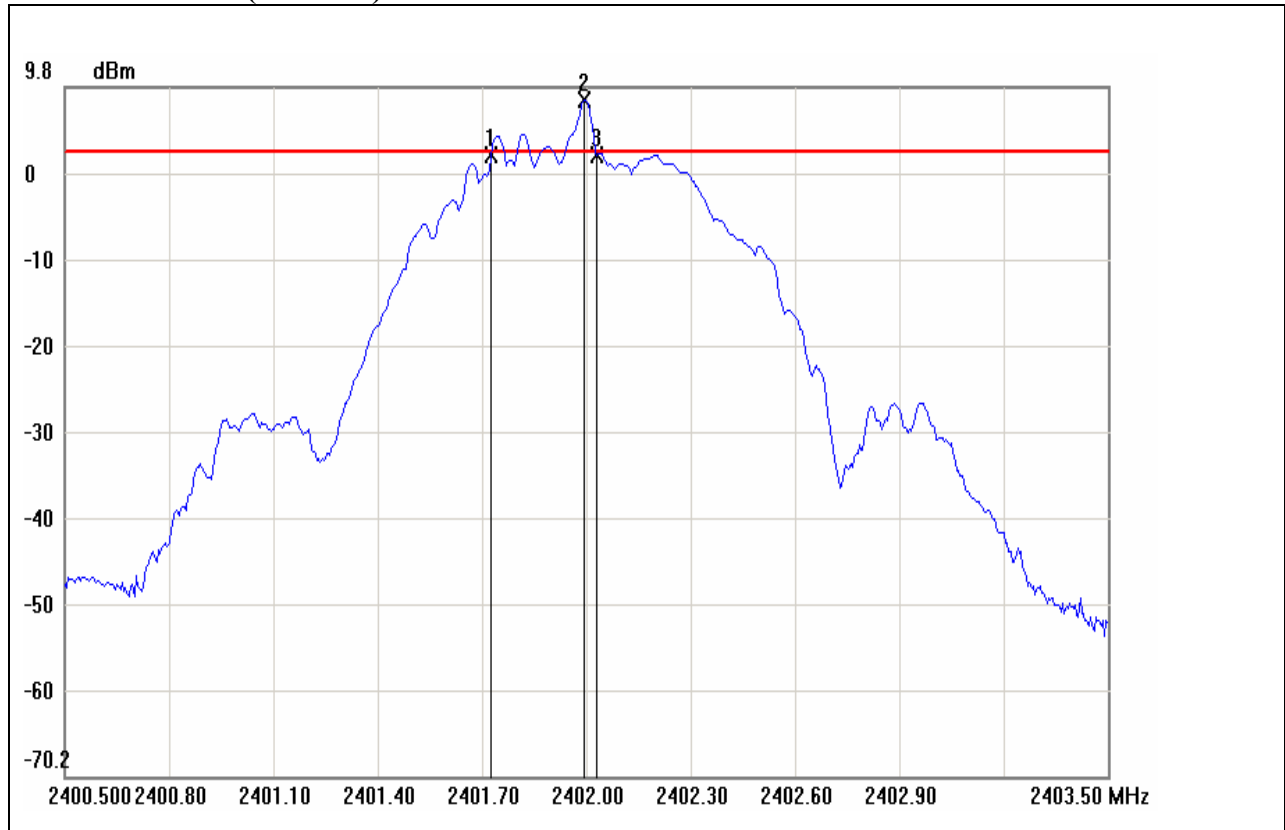
Test Data

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Limit (kHz)	Test Result
Low	2402	0.305	>500	PASS
Mid	2440	0.3		PASS
High	2480	0.31		PASS



Test Plot

6dB Bandwidth (CH Low)

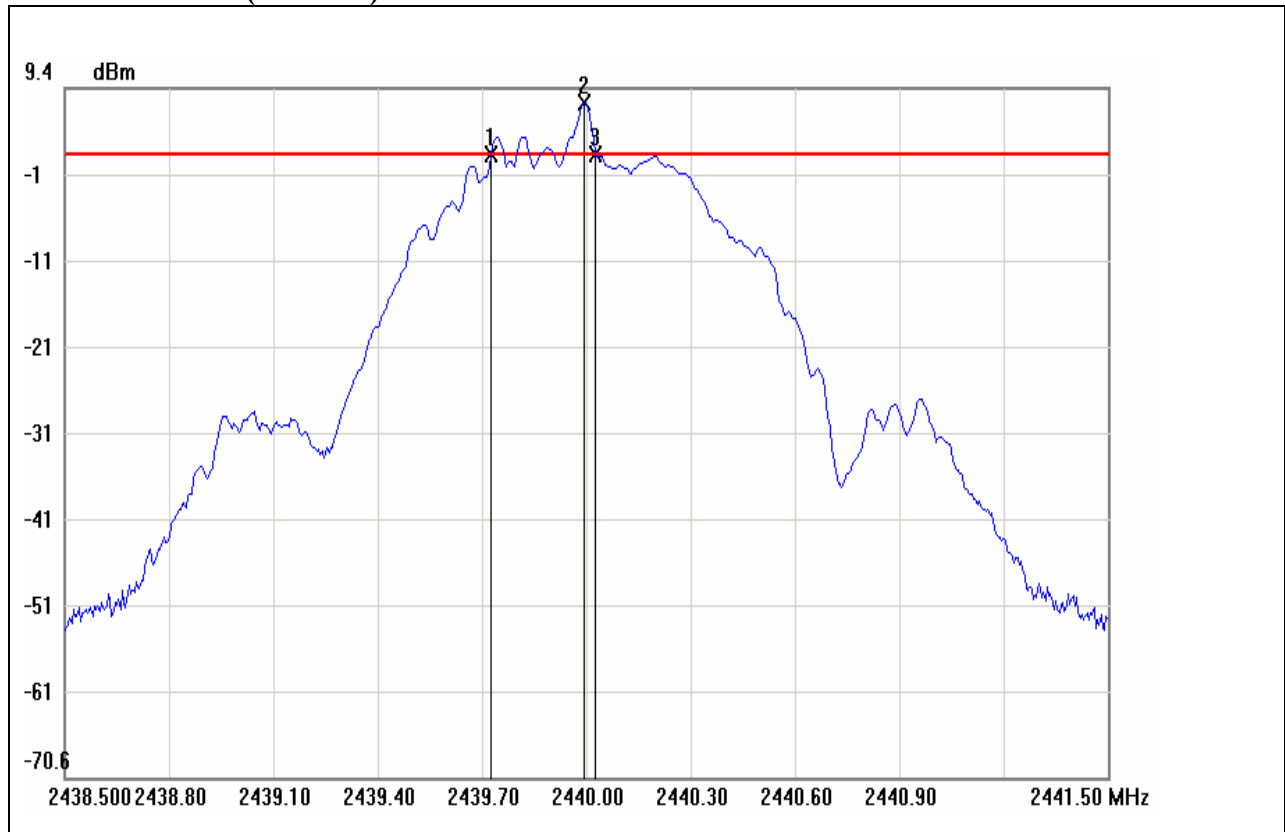


No.	Frequency(MHz)	Result(dBm)	Limit(dBm)	Margin(dBm)
1	2401.7250	2.00	2.25	-0.25
2	2401.9950	8.25	2.25	6.00
3	2402.0300	2.04	2.25	-0.21

No.		Δ Frequency(MHz)	Δ Level(dB)
1	mk3-mk1	0.305	0.04



6dB Bandwidth (CH Mid)

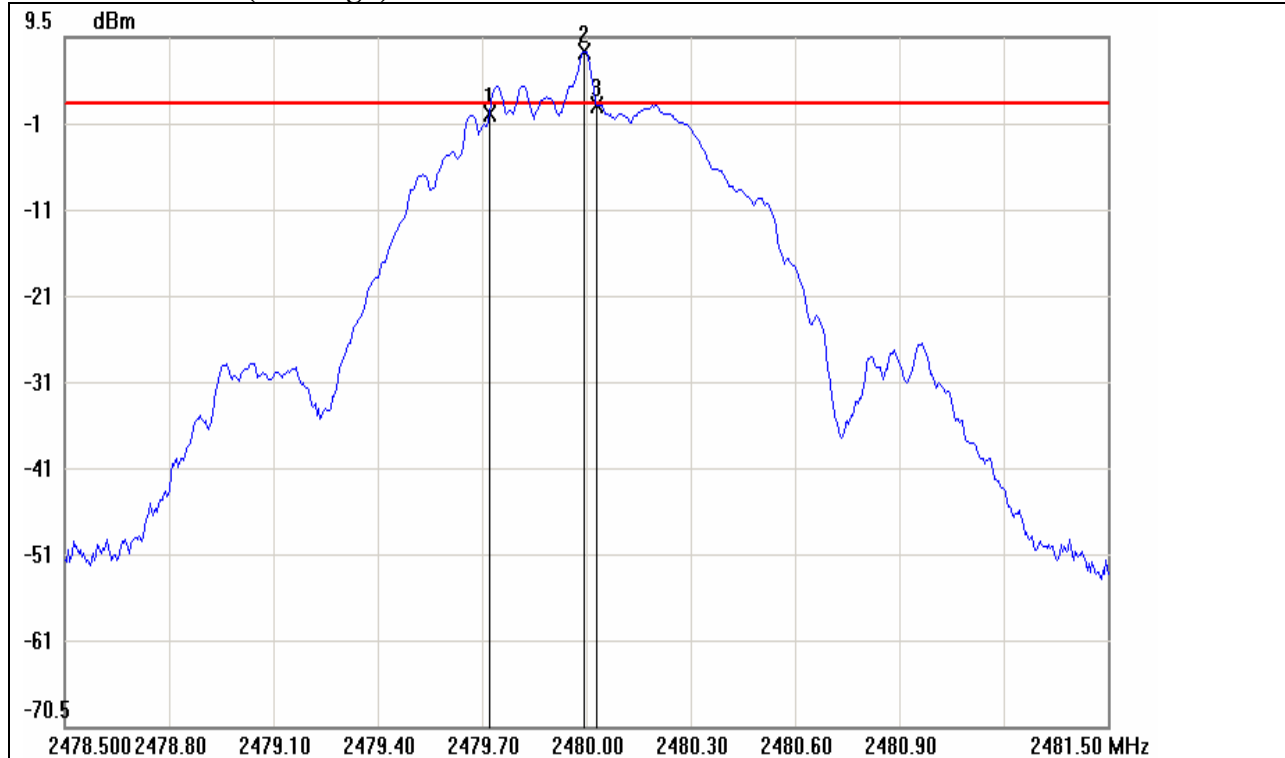


No.	Frequency(MHz)	Result(dBm)	Limit(dBm)	Margin(dBm)
1	2439.7250	1.63	1.65	-0.02
2	2439.9950	7.65	1.65	6.00
3	2440.0250	1.63	1.65	-0.02

No.		Δ Frequency(MHz)	Δ Level(dB)
1	mk3-mk1	0.3	0



6dB Bandwidth (CH High)



No.	Frequency(MHz)	Result(dBm)	Limit(dBm)	Margin(dBm)
1	2479.7200	0.65	1.75	-1.10
2	2479.9950	7.75	1.75	6.00
3	2480.0300	1.52	1.75	-0.23

No.		Δ Frequency(MHz)	Δ Level(dB)
1	mk3-mk1	0.31	0.87



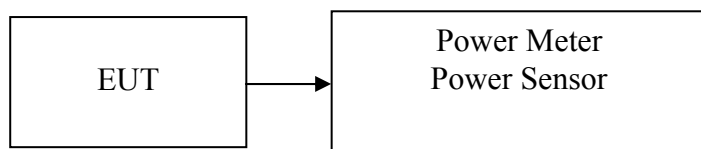
7.2 PEAK POWER

LIMIT

The maximum peak output power of the intentional radiator shall not exceed the following:

1. 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.
2. 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)	Test Result
Low	2402	9.24	0.00839	1	PASS
Mid	2440	9.13	0.00818		PASS
High	2480	9.25	0.00841		PASS

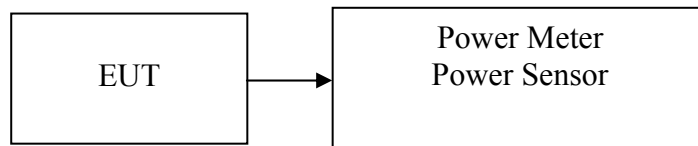


7.3 AVERAGE POWER

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	7.3	0.00537
Mid	2440	7.16	0.00519
High	2480	7.31	0.00538



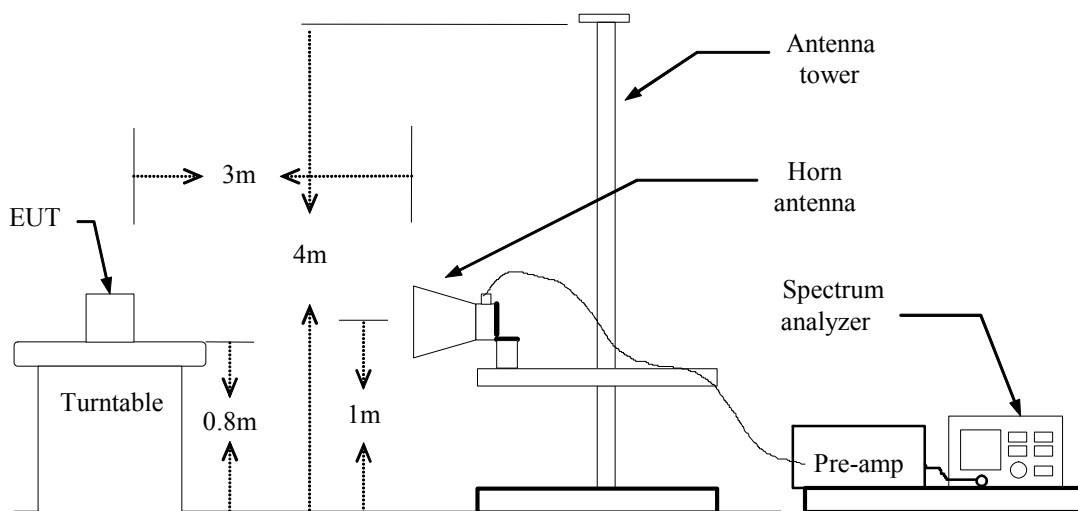
7.4 BAND EDGES MEASUREMENT

LIMIT

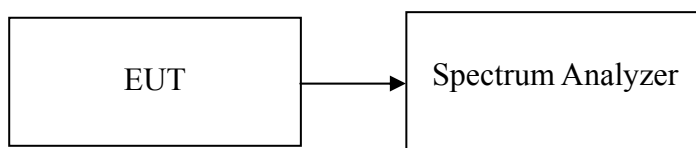
According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains 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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)).

Test Configuration

For Radiated



For Conducted





TEST PROCEDURE

For Radiated

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=1MHz/ VBM=3MHz / Sweep=100ms
 - (b) AVERAGE: RBW=1MHz / VBW=10Hz / Sweep=AUTO
5. Repeat the procedures until all the PEAK and AVERAGE versus POLARIZATION are measured.

For Conducted

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.

TEST RESULTS

Refer to attach spectrum analyzer data chart.



BT 4.0

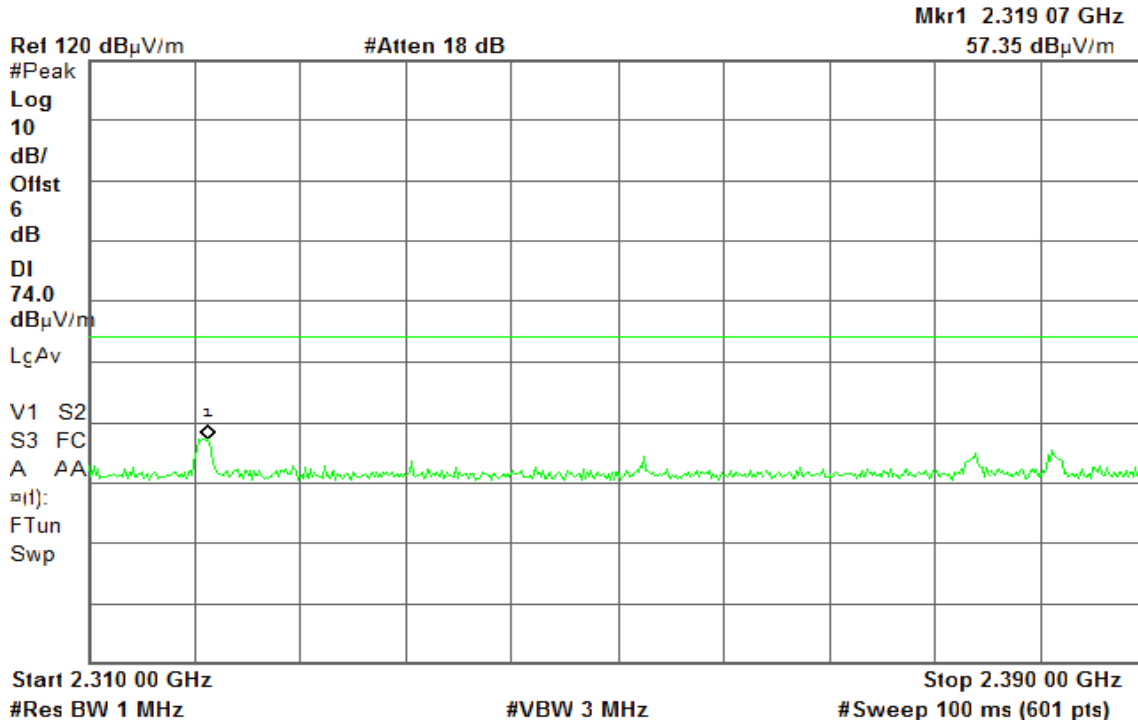
Band Edges (CH Low)

Detector mode: Peak

Polarity: Vertical

Agilent

R T

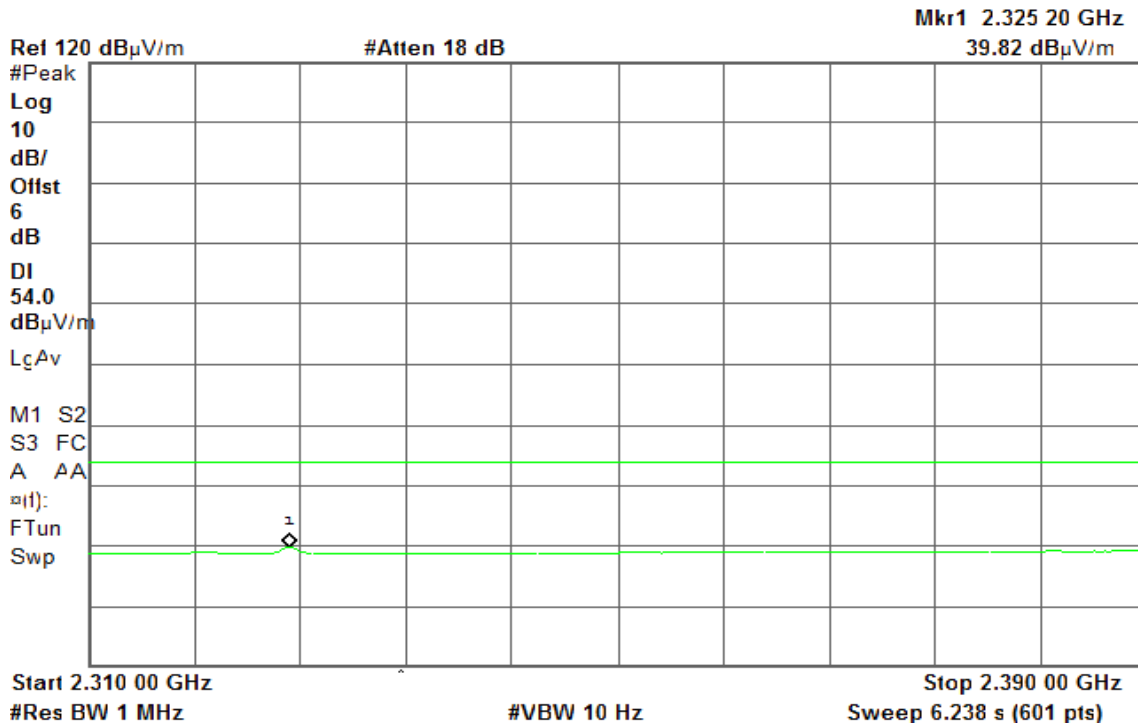


Detector mode: Average

Polarity: Vertical

Agilent

R T





Detector mode: Peak

Polarity: Horizontal

Agilent

R T

Mkr1 2.318 53 GHz

57.35 dB μ V/m

Rel 120 dB μ V/m

#Atten 18 dB

#Peak

Log

10

dB/

Offst

6

dB

DI

74.0

dB μ V/m

L_CAv

V1 S2

S3 FC

A AA

W(f):

FTun

Swp

Start 2.310 00 GHz

Stop 2.390 00 GHz

#Res BW 1 MHz

#VBW 3 MHz

#Sweep 100 ms (601 pts)

Detector mode: Average

Polarity: Horizontal

Agilent

R T

Mkr1 2.325 20 GHz

39.47 dB μ V/m

Rel 120 dB μ V/m

#Atten 18 dB

#Peak

Log

10

dB/

Offst

6

dB

DI

54.0

dB μ V/m

L_CAv

M1 S2

S3 FC

A AA

W(f):

FTun

Swp

Start 2.310 00 GHz

Stop 2.390 00 GHz

#Res BW 1 MHz

#VBW 10 Hz

Sweep 6.238 s (601 pts)



Band Edges (CH High)

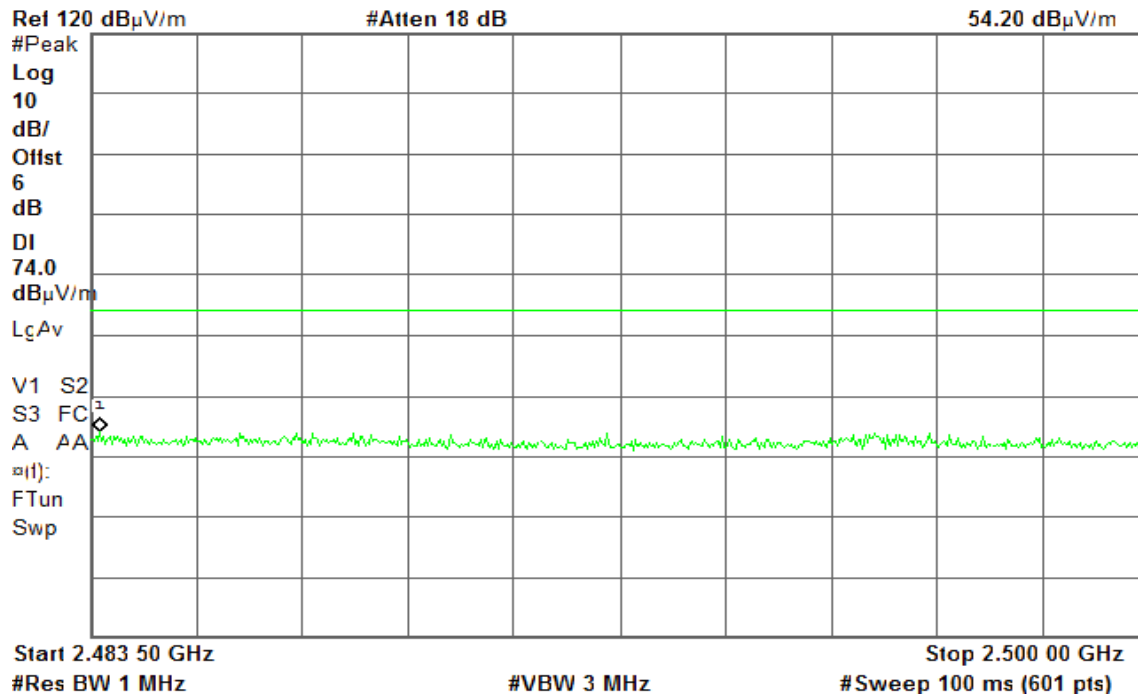
Detector mode: Peak

Polarity: Vertical

Agilent

R T

Mkr1 2.483 64 GHz
54.20 dB μ V/m



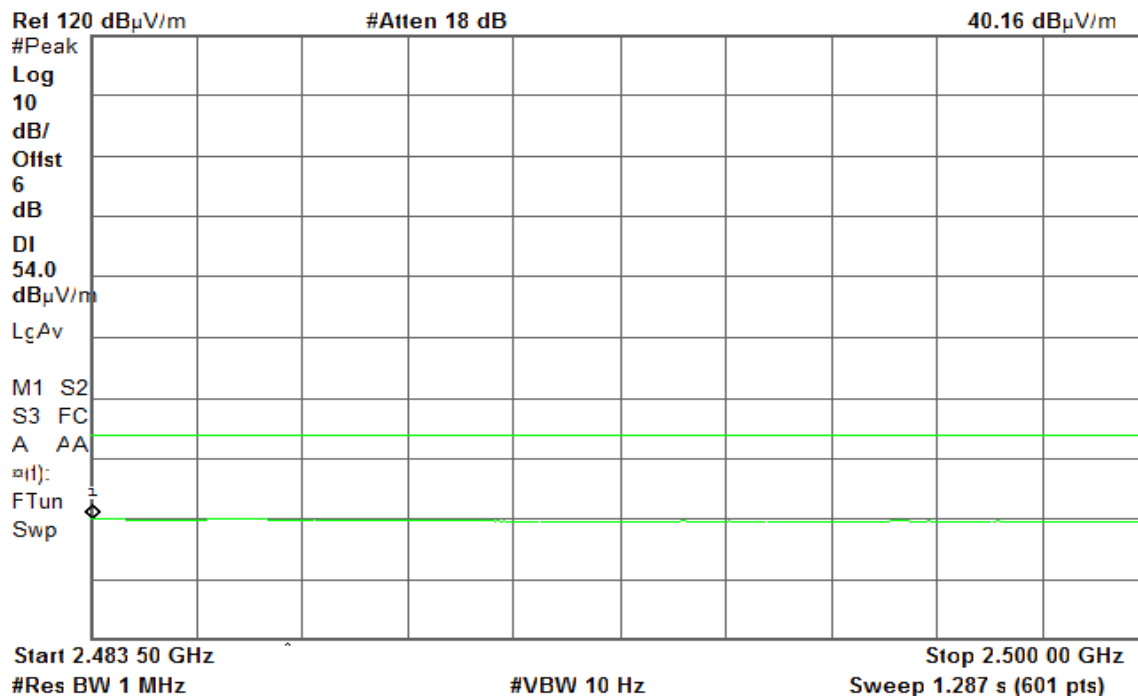
Detector mode: Average

Polarity: Vertical

Agilent

R T

Mkr1 2.483 53 GHz
40.16 dB μ V/m





Detector mode: Peak

Polarity: Horizontal

Agilent

R T

Mkr1 2.486 64 GHz

54.42 dB μ V/mRef 120 dB μ V/m

#Atten 18 dB

#Peak

Log

10

dB/

Offst

6

dB

DI

74.0

dB μ V/m

LcAv

V1 S2

S3 FC

A AA

a(f):

FTun

Swp

Start 2.483 50 GHz

Stop 2.500 00 GHz

#Res BW 1 MHz

#VBW 3 MHz

#Sweep 100 ms (601 pts)

Detector mode: Average

Polarity: Horizontal

Agilent

R T

Mkr1 2.483 53 GHz

39.95 dB μ V/mRef 120 dB μ V/m

#Atten 18 dB

#Peak

Log

10

dB/

Offst

6

dB

DI

54.0

dB μ V/m

LcAv

M1 S2

S3 FC

A AA

a(f):

FTun

Swp

Start 2.483 50 GHz

Stop 2.500 00 GHz

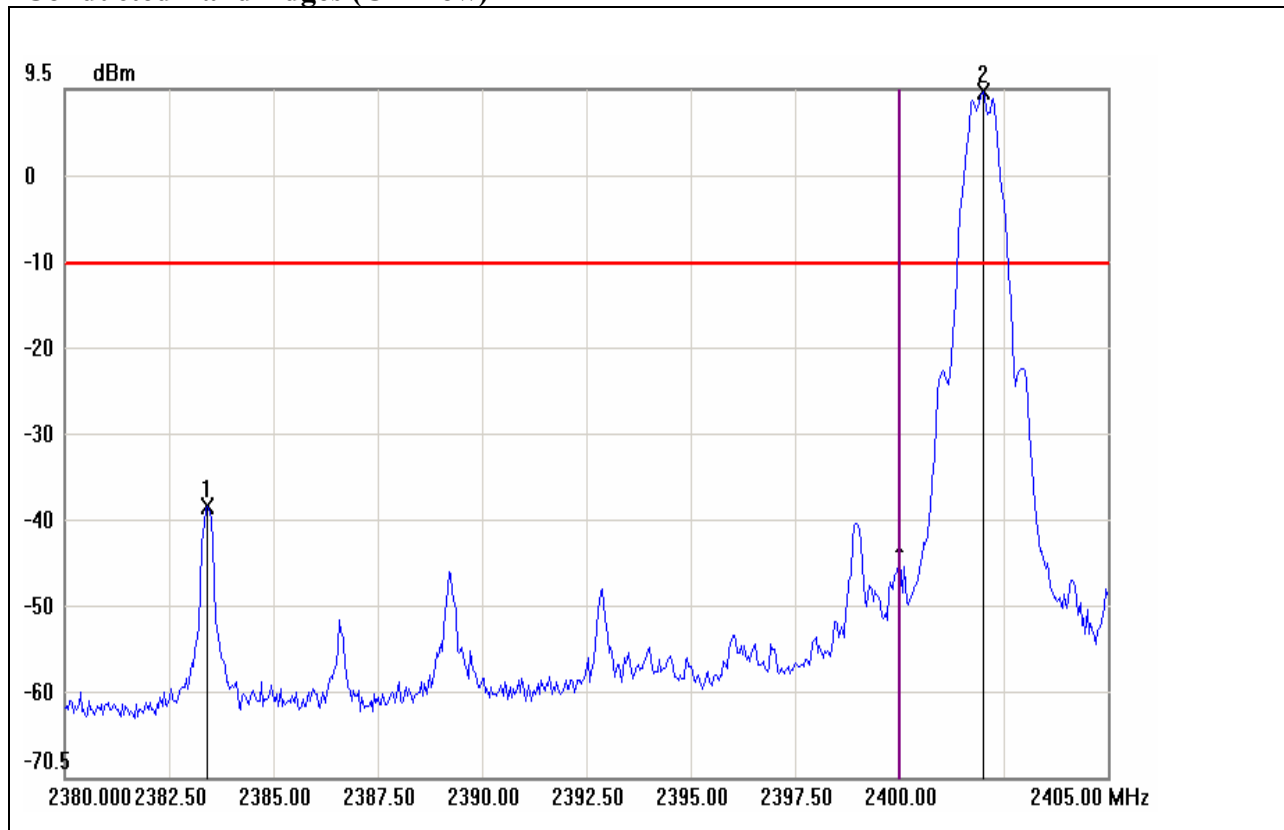
#Res BW 1 MHz

#VBW 10 Hz

Sweep 1.287 s (601 pts)



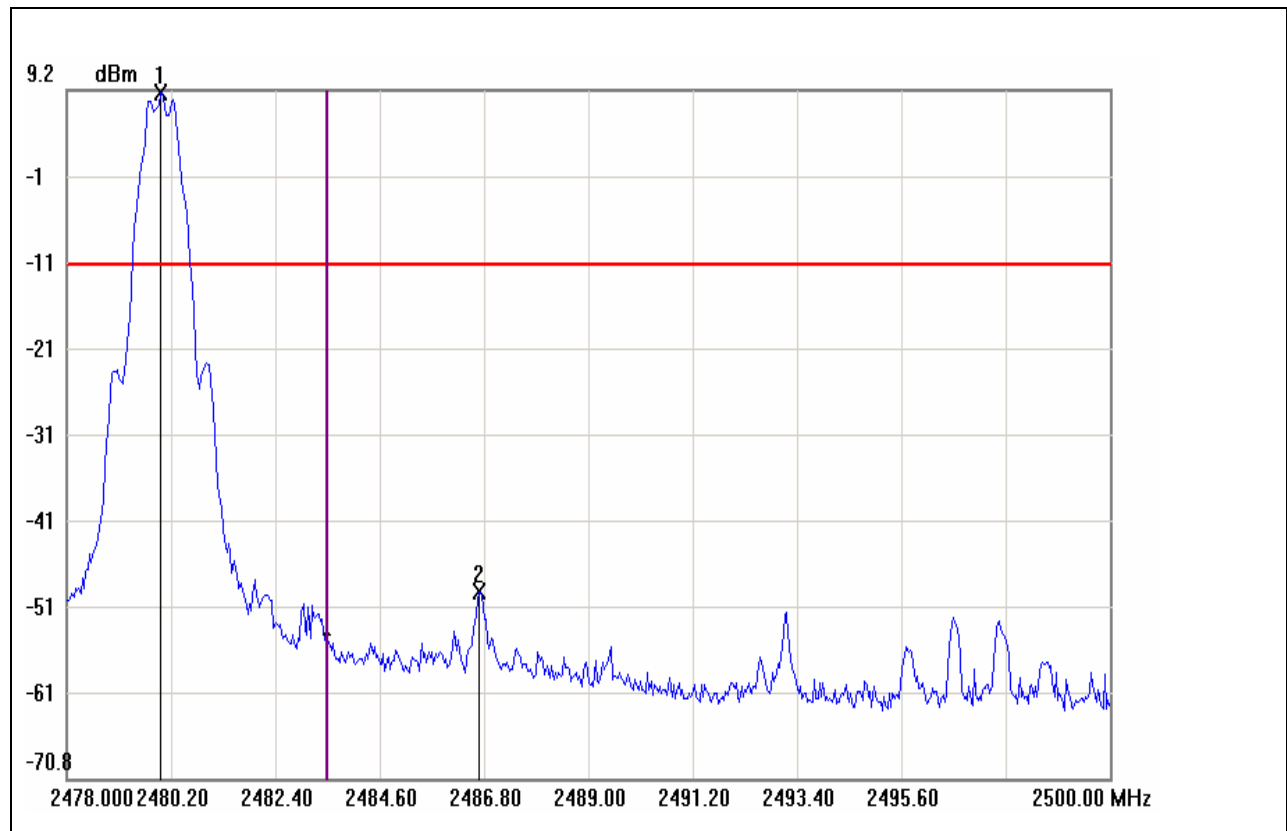
Conducted Band Edges (CH Low)



No.	Frequency(MHz)	Result(dBm)	Limit(dBm)	Margin(dBm)
1	2383.4167	-38.95	-10.79	-28.16
2	2402.0000	9.21	-10.79	20.00



Conducted Band Edges (CH High)



No.	Frequency(MHz)	Result(dBm)	Limit(dBm)	Margin(dBm)
1	2479.9800	8.79	-11.21	20.00
2	2486.6900	-49.13	-11.21	-37.92

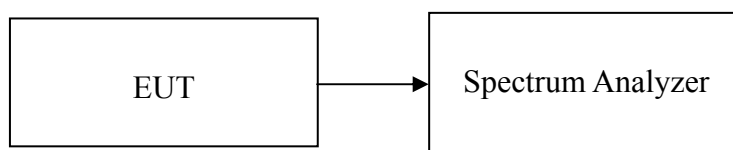


7.5 PEAK POWER SPECTRAL DENSITY

LIMIT

1. According to §15.247(e), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.
2. According to §15.247(f), the digital modulation operation of the hybrid system, with the frequency hopping turned off, shall comply with the power density requirements of paragraph (d) of this section.

Test Configuration



TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. Set the RBW = 100 kHz, VBW $\geq$ 300 kHz, span to 1.5 times the DTS bandwidth, Detector = peak, Trace mode= max hold, Sweep = auto couple. Allow trace to fully stabilize. Use the peak marker function to determine the maximum amplitude level within the RBW.

TEST RESULTS

No non-compliance noted

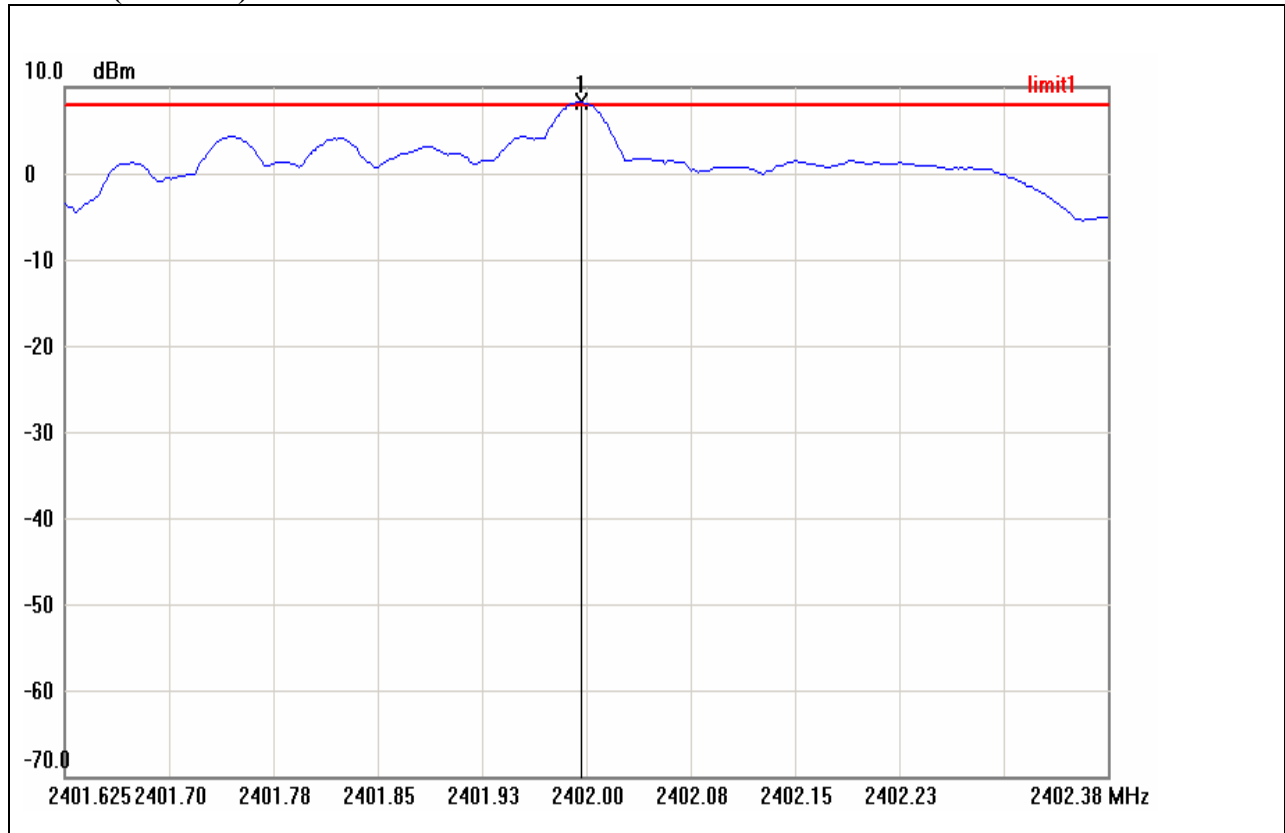
Test Data

Channel	Frequency (MHz)	PPSD (dBm)	Limit (dBm)	Result
Low	2402	8.29	8.00	PASS
Mid	2440	7.87		PASS
High	2480	7.95		PASS



Test Plot

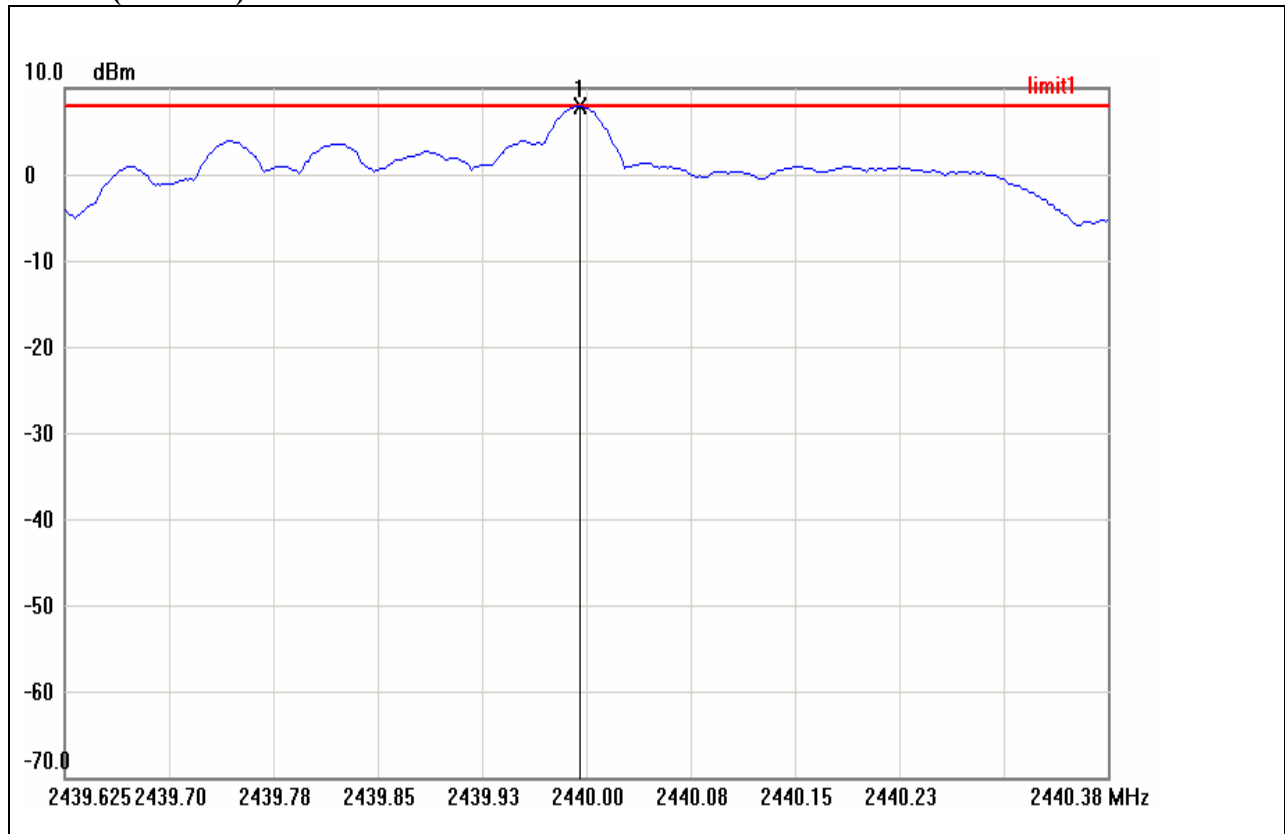
PPSD (CH Low)



No.	Frequency(MHz)	Result(dBm)	Limit(dBm)	Margin(dBm)
1	2401.9963	8.29	8.00	0.29



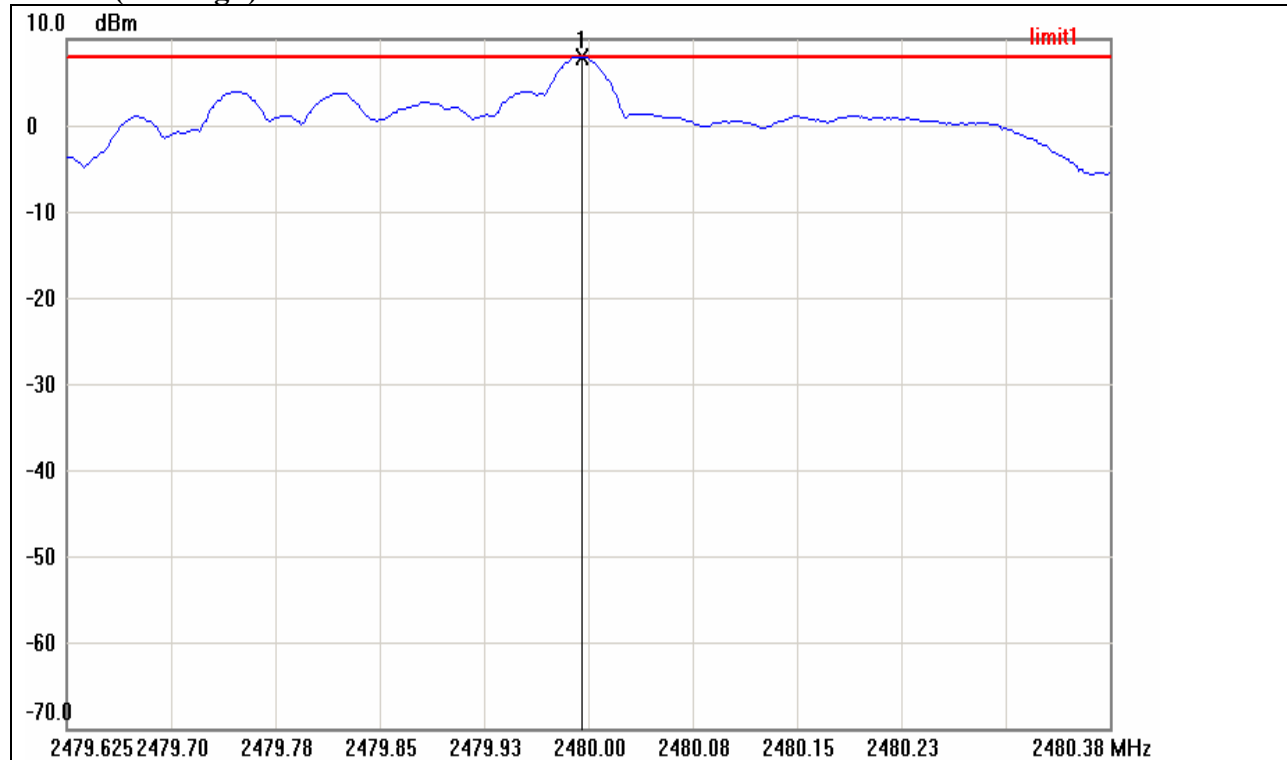
PPSD (CH Mid)



No.	Frequency(MHz)	Result(dBm)	Limit(dBm)	Margin(dBm)
1	2439.9950	7.87	8.00	-0.13



PPSD (CH High)



No.	Frequency(MHz)	Result(dBm)	Limit(dBm)	Margin(dBm)
1	2479.9950	7.95	8.00	-0.05



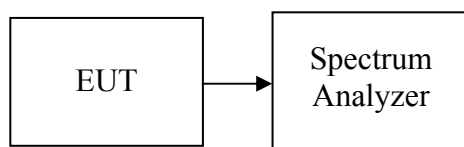
7.6 SPURIOUS EMISSIONS

7.6.1 Conducted Measurement

LIMIT

According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum 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. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in 15.209(a) (see Section 15.205(c)).

Test Configuration



TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. Set the RBW=100 kHz and VBW= 300 kHz. Investigate the frequency from 30 MHz to 26 GHz with L, M and H channels separately.

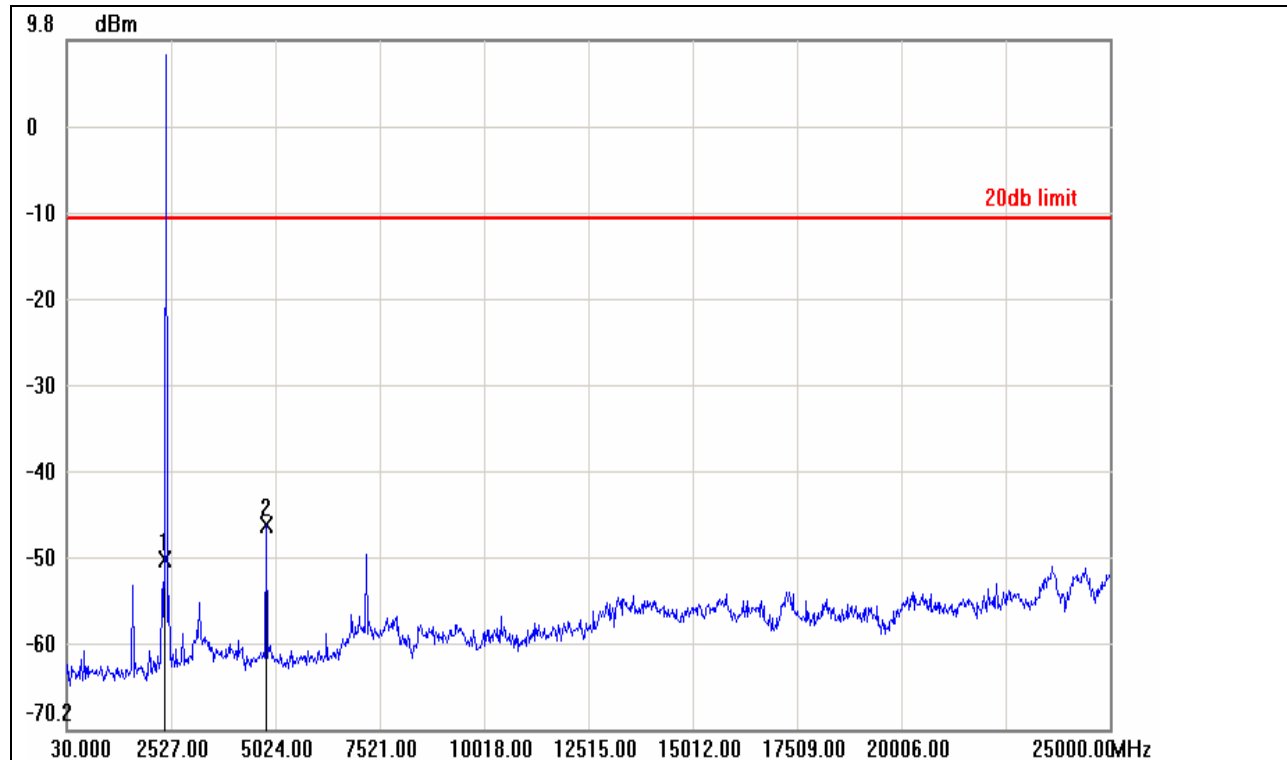
TEST RESULTS

No non-compliance noted.



Test Plot

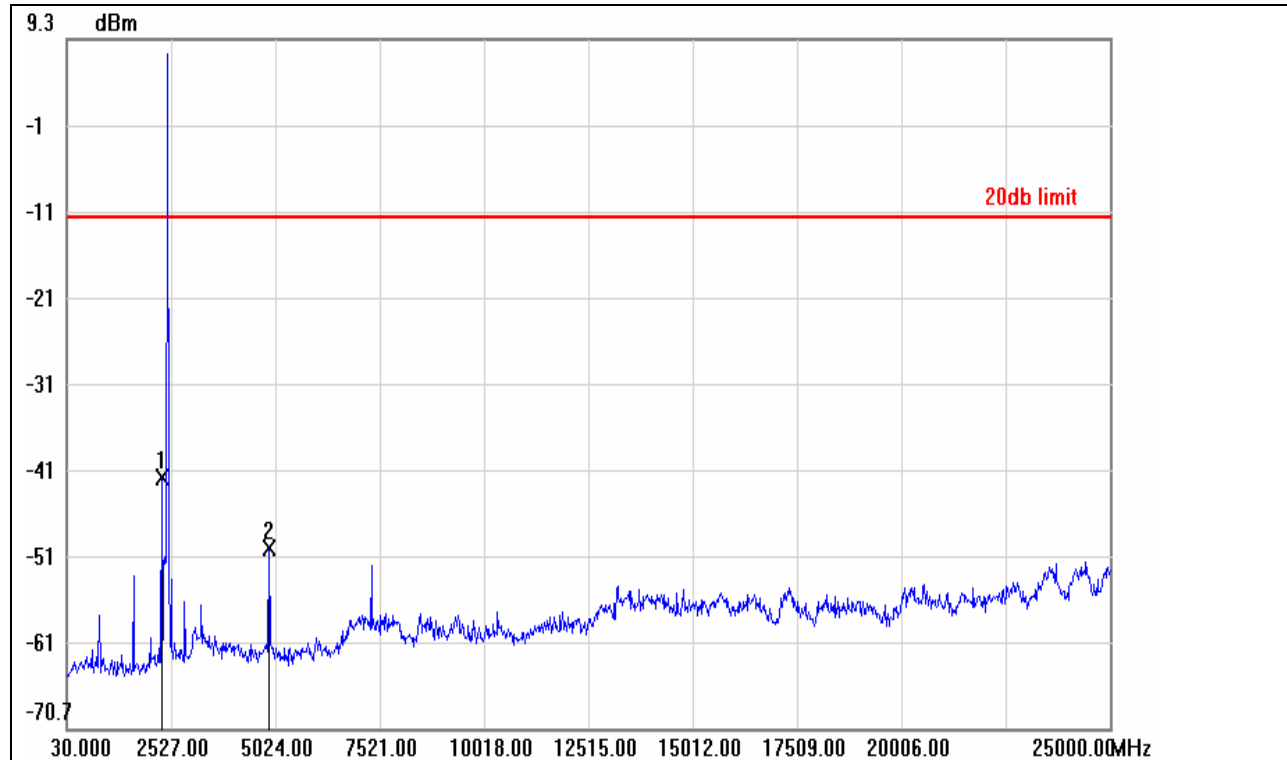
CH Low



No.	Frequency(MHz)	Result(dBm)	Limit(dBm)	Margin(dBm)
1	2377.1800	-50.39	-10.76	-39.63
2	4799.2700	-46.45	-10.76	-35.69



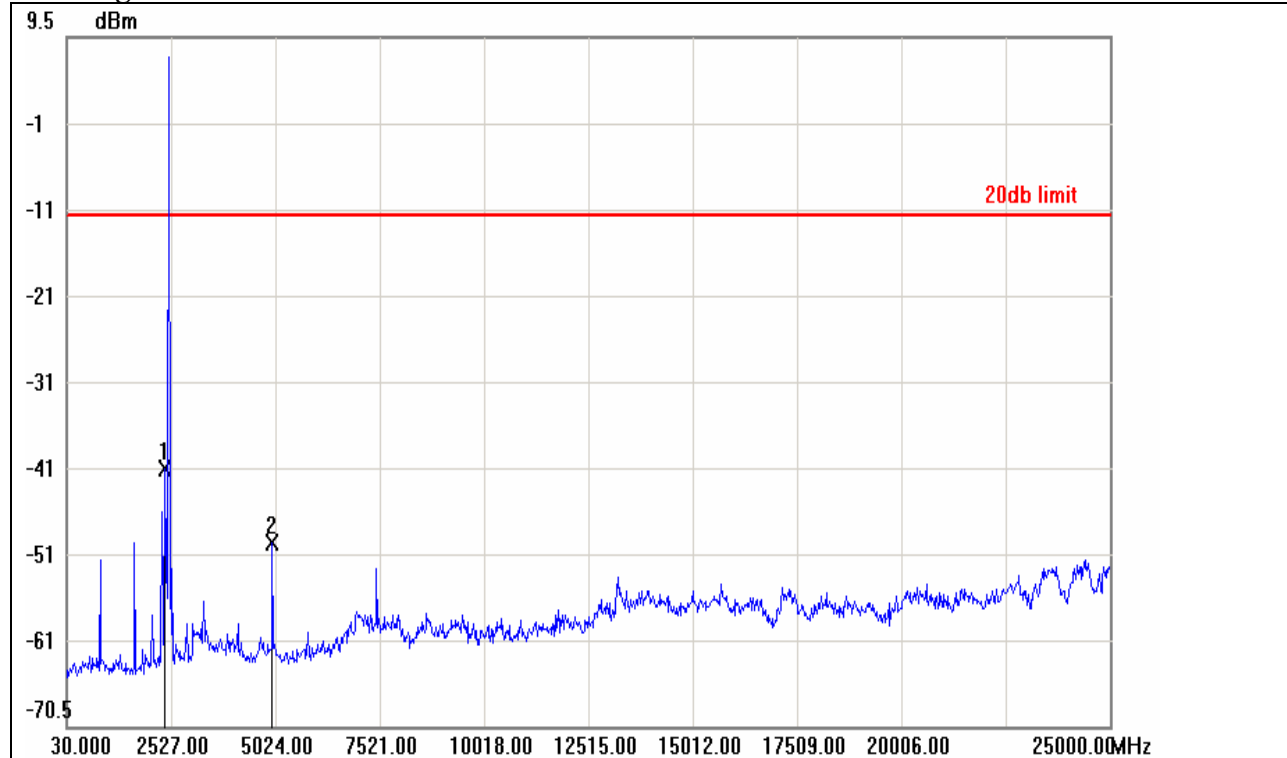
CH Mid



No.	Frequency(MHz)	Result(dBm)	Limit(dBm)	Margin(dBm)
1	2302.2700	-41.64	-11.33	-30.31
2	4874.1800	-49.76	-11.33	-38.43



CH High



No.	Frequency(MHz)	Result(dBm)	Limit(dBm)	Margin(dBm)
1	2377.1800	-40.59	-11.20	-29.39
2	4949.0900	-49.27	-11.20	-38.07



7.6.2 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.

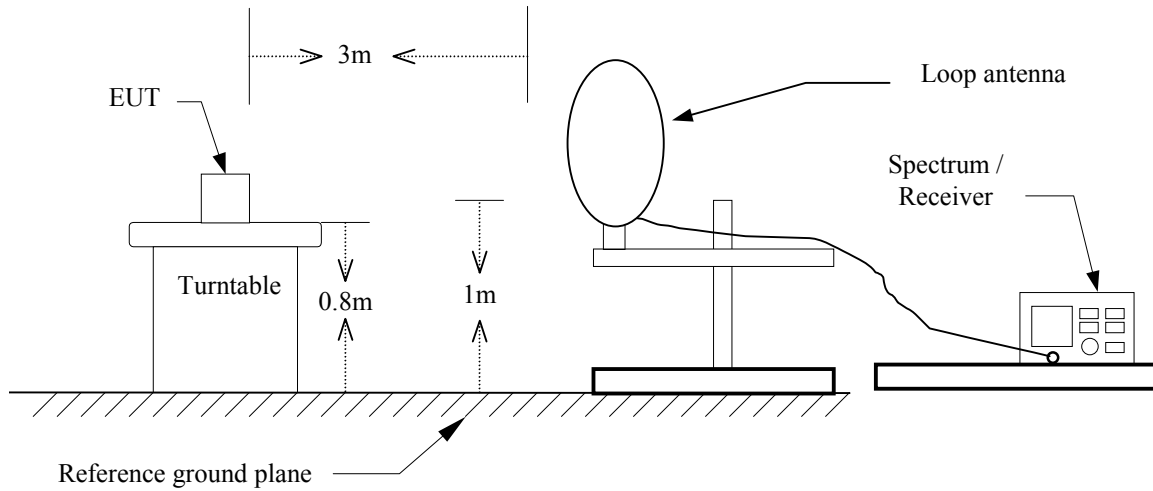
2. In the emission table above, the tighter limit applies at the band edges.

Frequency (MHz)	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

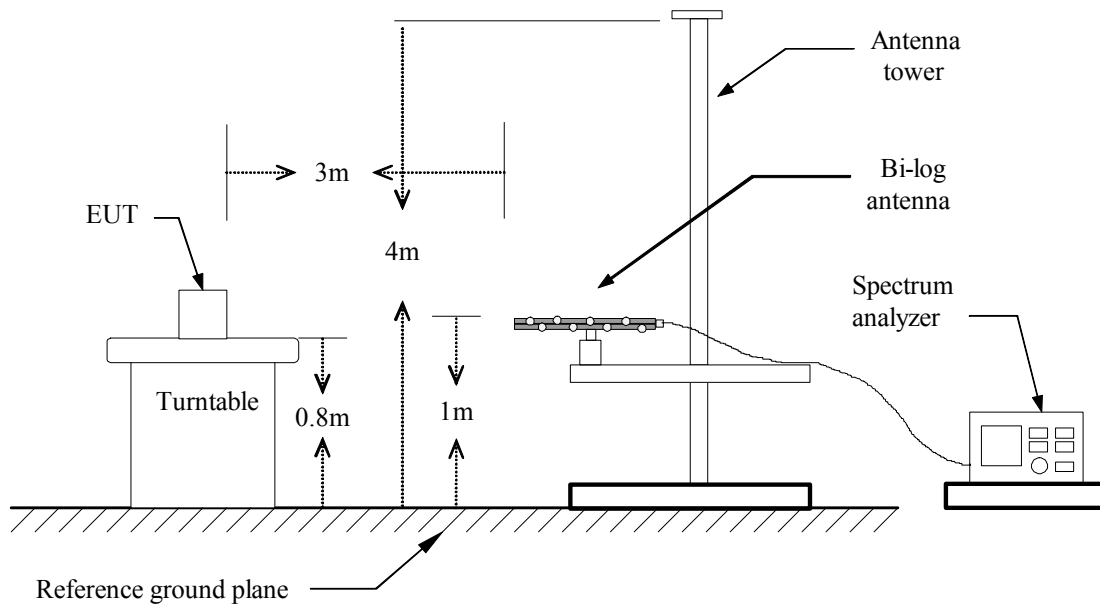


Test Configuration

9kHz ~ 30MHz

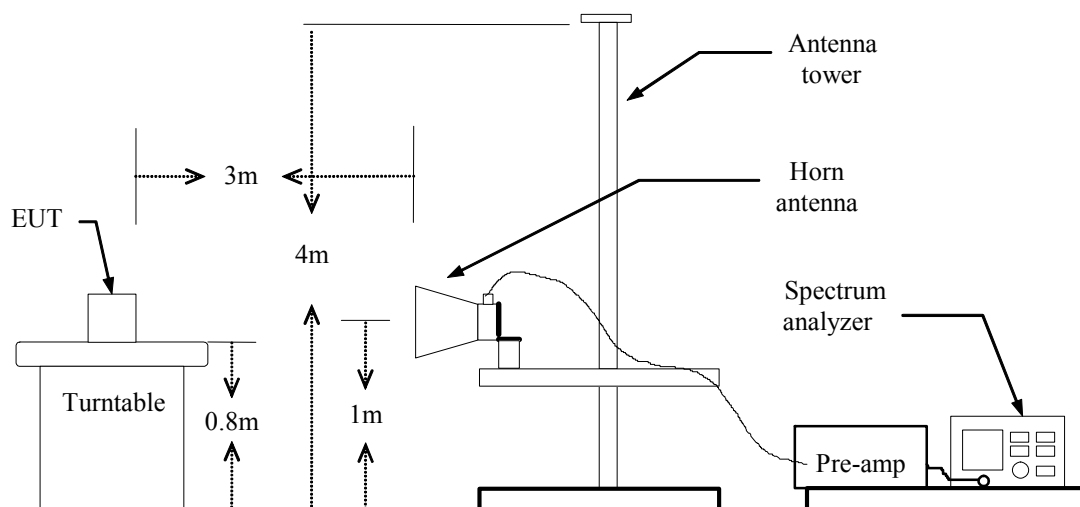


30MHz ~ 1GHz





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.

**BELOW 1GHZ****Operation Mode:** Normal Link**Test Date:** April 1, 2013**Temperature:** 27°C**Tested by:** Shawn Wu**Humidity:** 53 % RH**Polarity:** Ver. / Hor

Frequency (MHz)	Reading (dBuV)	Correction Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Ant. Pol. (H/V)
31.6167	49.64	-21.64	28.00	40.00	-12.00	peak	V
93.0500	65.94	-33.41	32.53	43.50	-10.97	peak	V
154.4833	56.35	-29.08	27.27	43.50	-16.23	peak	V
215.9167	56.68	-29.84	26.84	43.50	-16.66	peak	V
308.0667	52.37	-27.54	24.83	46.00	-21.17	peak	V
959.5833	43.99	-16.75	27.24	46.00	-18.76	peak	V
30.0000	39.58	-20.45	19.13	40.00	-20.87	peak	H
169.0333	51.72	-29.76	21.96	43.50	-21.54	peak	H
215.9167	53.99	-29.84	24.15	43.50	-19.35	peak	H
246.6333	53.84	-29.70	24.14	46.00	-21.86	peak	H
308.0667	54.75	-27.54	27.21	46.00	-18.79	peak	H
899.7667	47.67	-17.34	30.33	46.00	-15.67	peak	H

Remark:

1. Measuring frequencies from 30 MHz to the 1GHz.
2. Radiated emissions measured in frequency range from 30 MHz to 1000MHz were made with an instrument using Peak/Quasi-peak detector mode.
3. 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.
4. The IF bandwidth of SPA between 30MHz and 1GHz was 100kHz.

**Above 1 GHz****Operation Mode:** TX / GFSK / CH Low**Test Date:** April 1, 2013**Temperature:** 27°C**Tested by:** Shawn Wu**Humidity:** 53 % RH**Polarity:** Ver. / Hor.

Frequency (MHz)	Reading (dBuV)	Correction Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Ant. Pol. (H/V)
2183.333	52.46	-1.08	51.38	74.00	-22.62	peak	V
4800.000	53.94	6.06	60.00	74.00	-14.00	peak	V
4800.000	42.61	6.06	48.67	54.00	-5.33	AVG	V
7208.333	45.59	10.44	56.03	74.00	-17.97	peak	V
7208.333	35.20	10.44	45.64	54.00	-8.36	AVG	V
N/A							
2053.333	53.00	-1.33	51.67	74.00	-22.33	peak	H
4800.000	51.84	6.06	57.90	74.00	-16.10	peak	H
4800.000	42.62	6.06	48.68	54.00	-5.32	AVG	H
7208.333	40.93	10.44	51.37	74.00	-22.63	peak	H
N/A							

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 / GFSK / CH Mid**Test Date:** April 1, 2013**Temperature:** 27°C**Tested by:** Shawn Wu**Humidity:** 53 % RH**Polarity:** Ver. / Hor.

Frequency (MHz)	Reading (dBuV)	Correction Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Ant. Pol. (H/V)
2186.667	52.96	-1.07	51.89	74.00	-22.11	peak	V
4883.333	50.52	6.26	56.78	74.00	-17.22	peak	V
4883.333	41.43	6.26	47.69	54.00	-6.31	AVG	V
7316.667	45.46	10.62	56.08	74.00	-17.92	peak	V
7316.667	35.91	10.62	46.53	54.00	-7.47	AVG	V
N/A							
2293.333	52.81	-0.86	51.95	74.00	-22.05	peak	H
4883.333	50.07	6.26	56.33	74.00	-17.67	peak	H
4883.333	40.86	6.26	47.12	54.00	-6.88	AVG	H
7316.667	42.11	10.62	52.73	74.00	-21.27	peak	H
7316.667	32.91	10.62	43.53	54.00	-10.47	AVG	H
N/A							

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 / GFSK / CH High**Test Date:** April 1, 2013**Temperature:** 27°C**Tested by:** Shawn Wu**Humidity:** 53 % RH**Polarity:** Ver. / Hor.

Frequency (MHz)	Reading (dBuV)	Correction Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark	Ant. Pol. (H/V)
2126.667	52.74	-1.19	51.55	74.00	-22.45	peak	V
4958.333	48.51	6.45	54.96	74.00	-19.04	peak	V
4958.333	39.78	6.45	46.23	54.00	-7.77	AVG	V
7441.667	45.60	10.84	56.44	74.00	-17.56	peak	V
7441.667	33.87	10.84	44.71	54.00	-9.29	AVG	V
N/A							
2243.333	52.77	-0.96	51.81	74.00	-22.19	peak	H
4958.333	48.55	6.45	55.00	74.00	-19.00	peak	H
4958.333	41.22	6.45	47.67	54.00	-6.33	AVG	H
7441.667	44.08	10.84	54.92	74.00	-19.08	peak	H
7441.667	32.81	10.84	43.65	54.00	-10.35	AVG	H
N/A							

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).



7.7 POWERLINE CONDUCTED EMISSIONS

LIMIT

According to §15.207(a), except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that 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 the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency Range (MHz)	Limits (dB μ V)	
	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

Test Configuration

See test photographs attached in Appendix II 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

The initial step in collecting conducted data is a spectrum analyzer peak scan of the measurement range. Significant peaks are then marked as shown on the following data page, and these signals are then quasi-peaked.

Test Data

Operation Mode: Normal Link **Test Date:** February 14, 2012
Temperature: 26°C **Tested by:** Ali Shu
Humidity: 60% RH

Freq. (MHz)	QP Reading (dBuV)	AV Reading (dBuV)	Corr. factor (dB/m)	QP Result (dBuV/m)	AV Result (dBuV/m)	QP Limit (dBuV)	AV Limit (dBuV)	QP Margin (dB)	AV Margin (dB)	Note
0.1942	40.22	27.56	0.09	40.31	27.65	63.85	53.85	-23.54	-26.20	L1
0.2236	35.62	20.40	0.09	35.71	20.49	62.68	52.68	-26.97	-32.19	L1
0.3920	36.64	24.93	0.10	36.74	25.03	58.02	48.02	-21.28	-22.99	L1
0.4712	42.60	31.09	0.10	42.70	31.19	56.49	46.49	-13.79	-15.30	L1
2.0091	46.64	34.96	0.14	46.78	35.10	56.00	46.00	-9.22	-10.90	L1
7.4095	30.92	22.14	0.32	31.24	22.46	60.00	50.00	-28.76	-27.54	L1
0.1900	40.18	31.83	0.09	40.27	31.92	64.04	54.04	-23.77	-22.12	L2
0.4590	46.63	37.95	0.09	46.72	38.04	56.71	46.71	-9.99	-8.67	L2
1.1579	41.53	27.44	0.10	41.63	27.54	56.00	46.00	-14.37	-18.46	L2
2.0220	50.04	39.81	0.12	50.16	39.93	56.00	46.00	-5.84	-6.07	L2
4.8517	37.65	28.19	0.19	37.84	28.38	56.00	46.00	-18.16	-17.62	L2
26.0324	29.69	21.00	0.67	30.36	21.67	60.00	50.00	-29.64	-28.33	L2

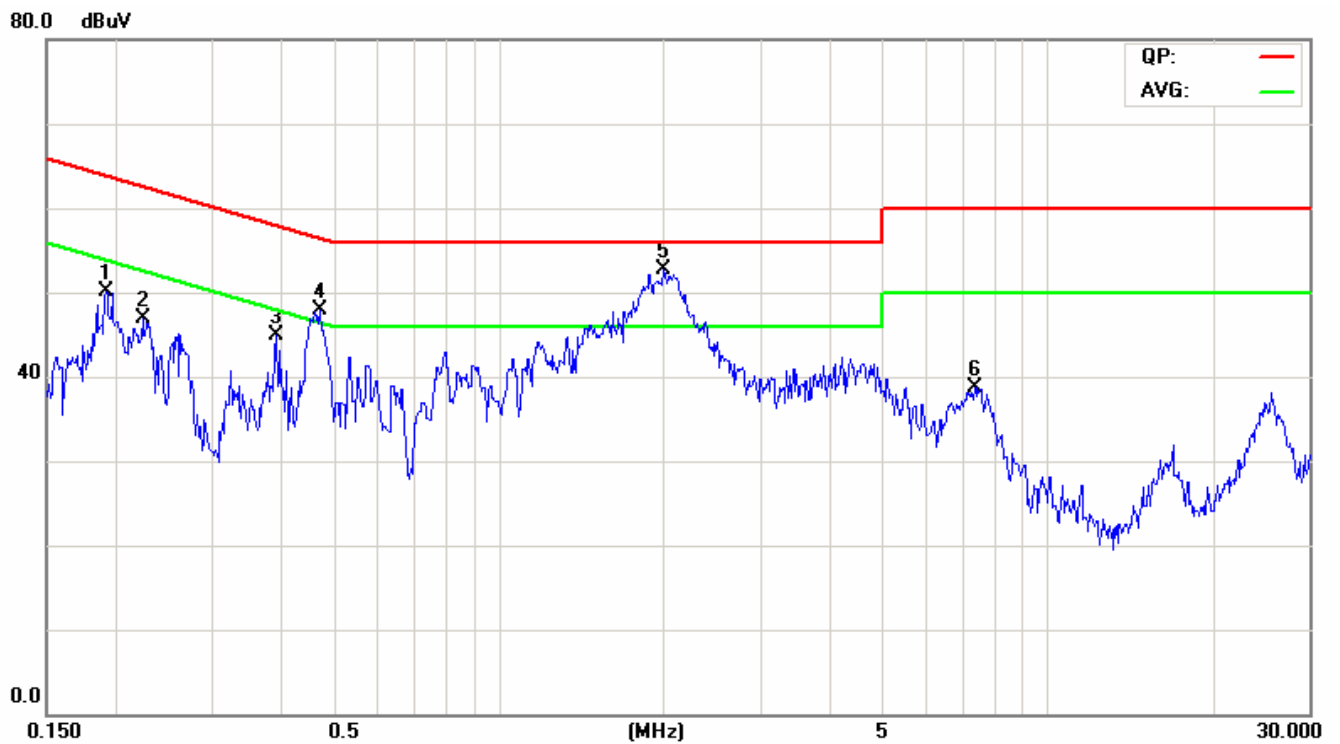
Remark:

1. Measuring frequencies from 0.15 MHz to 30MHz.
2. The emissions measured in frequency range from 0.15 MHz to 30MHz were made with an instrument using Quasi-peak detector and average detector.
3. The IF bandwidth of SPA between 0.15MHz to 30MHz was 10kHz; the IF bandwidth of Test Receiver between 0.15MHz to 30MHz was 9kHz;
4. L1 = Line One (Live Line) / L2 = Line Two (Neutral Line)



Test Plots

Conducted emissions (Line 1)



Conducted emissions (Line 2)

