



Test Type: Emissions Immunity

Product Type: Wireless module

Product Name/Number: Bose® model 416549 Wireless Module

FCC ID: A94416549
IC: 3232A-416549

Prepared For: *Design Compliance Engineering Department,
Bose Corporation*

Test Results: Pass Fail

Applicable Standards: FCC part 15, RSS210 , RSS-gen and ICES-003

Report Number: EMC.416549.15.20.1

General Comments/Special Test Conditions:

This report relates only to the items tested. This report covers EMC marking requirements for *Enter product and any special modifications or test conditions.*

	Print Name	Signature	Date
Prepared By:	Chad Bell	<i>Chad Bell</i>	1/22/15
Electrical Engineer Review* By:	Bryan Cerqua	<i>Bryan Cerqua</i>	2/20/15

* Since every test result is separately reviewed after its completion, the electrical engineer review indicated above represents a higher level review to ensure this report lists and contains all applicable and appropriate requirements. *If the report carries the "accredited" logo, the reviewer must verify all the tests in this report are covered under the current ISO17025 accreditation. The A2LA-accredited logo must be removed if any of the tests in the report are not performed under the current scope of accreditation. It is the responsibility of the reviewer to ensure the A2LA advertising policy is followed.*



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1.0 Test Report Summary

1.1 Product Information

Description:

Bose® model 416549 is a 2.4Ghz and 5GHz wireless module.

EUT Condition/Setup:

For conducted RF testing the antennas were disconnected and U.fl connectors were soldered to the board. U.fl to SMA cables were used to connect to test equipment. The loss of these cables was accounted for via transducer factors. For radiated measurements the long ribbon cables were used to extend the module as far from the enclosure as possible and the module was tested in 3 orthogonal orientations.

Scope

This report covers EMC requirements as defined by the standards indicated in section 2 of this report.

Test Objective

Verify product meets all applicable EMC requirements.

Results

Product complies with all applicable EMC requirements. All final results represent worst-case emissions and/or immunity.

1.2 Conclusions

The device under test (D.U.T.):

meets all test standards selected in section 2 of this report.

does not meet all test standards selected in section 2 of this report.

Affirmation of Test Results:

	Print Name	Signature	Date
Testing Engineer/Technician	Chad Bell	<i>Chad Bell</i>	1/22/15



2.0 Test Standards

2.1 Emissions:

- Standard
- FCC Part 15B/Canada ICES-003 **Class A** B
- FCC Part 15C
- Canada RSS-210/RSS-310/RSS-GEN
- EN 55013/CISPR-13/AS-NZS CISPR13/GB13837/CNS13439
- EN 55022/CISPR-22/AS-NZS CISPR22 **Class A** B
- EN 55103-1
- EN 61000-3-2/GB17625.1
- EN 61000-3-3/GB17625.2
- EN 61000-6-3
- EN 61000-6-4
- EN 300 220/AS 4268.2
- EN 300 328
- EN 300 440
- EN 301 489

2.2 Immunity:

- Standard
- EN 55020/CISPR-20
- EN 55024/CISPR-24
- EN 55103-2
- EN 61000-4-2
- EN 61000-4-3
- EN 61000-4-4
- EN 61000-4-5
- EN 61000-4-6
- EN 61000-4-8
- EN 61000-4-11
- EN 61000-6-1
- EN 61000-6-2
- EN 301 489

3.0 Environmental Conditions

3.1 Ambient:

- Temperature: 22±4°C
- Humidity: 30-60%RH
- Mains Voltage: 100VAC
- 120VAC
- 230VAC

**EMC TEST REPORT****4.0 Test Results Summary**

FCC part 15	RSS210	RSS-Gen	Test references.	Result / Data section	Test Date
15.15(b)		6.3	There are no user-accessible controls for the adjustment of any transmitter parameters in the device under test.	Complies	N/A
15.27			There are no special devices such as shielded cables or special connectors required for compliance to the applicable standards.	Complies	N/A
15.203			An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The antennas are not accessible by the user.	Complies	N/A
15.205	2.2		The device does not operate in either the US or Canadian restricted bands.	<u>Complies Section 5.9</u>	1/22/2015
15.247 (a)(2)		6.6	6 dB Bandwidth, 99% occupied bandwidth	<u>Complies Section 5.2</u>	12/2/2014
15.247 (b)(3)	A8.4 (2)	6.12	Maximum peak conducted output power	<u>Complies Section 5.6</u>	12/2/2014
15.247(e)			Power Spectral Density	<u>Complies Section 5.3</u>	1/13/2015
15.247(d)	A8.5	6.13	Conducted spurious emissions	<u>Complies Section 5.7</u>	11/25/2014
15.109 15.209		8.9	Radiated emissions < 1GHz	<u>Complies Section 5.8</u>	12/8/2014
15.247(d)		8.9, 8.10	Radiated emissions > 1 GHz, Transmitter harmonics.	<u>Complies Section 5.9</u>	1/22/2015
15.107 15.207		8.8	Conducted emissions, 150kHz–30 MHz	<u>Complies Section 5.10</u>	12/2/2014
		5.2, 7.1	Receiver Spurious emissions	Not applicable only applies to stand-alone receivers	N/A
		6.11, 8.11	Frequency Stability	Not applicable since the occupied bandwidth lies outside the restricted bands and the prohibited TV bands	N/A



5.0 Individual Test Reports and Data

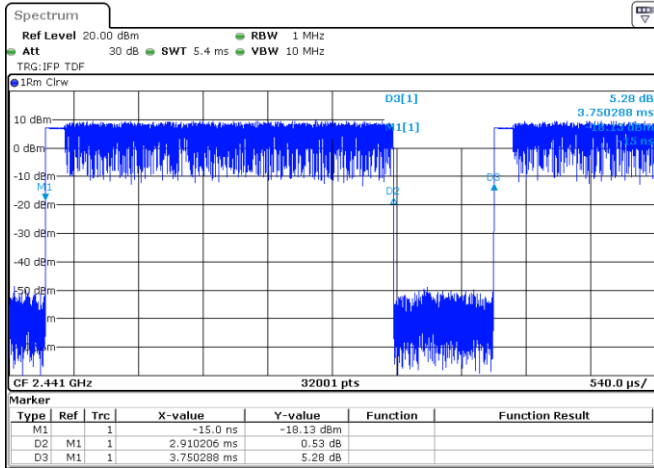
5.1 On time and Duty Cycle

Pulse Width (uS)	Period (us)	Duty Cycle	Duty Cycle Correction Factor
404.28	625.25	0.647	1.894

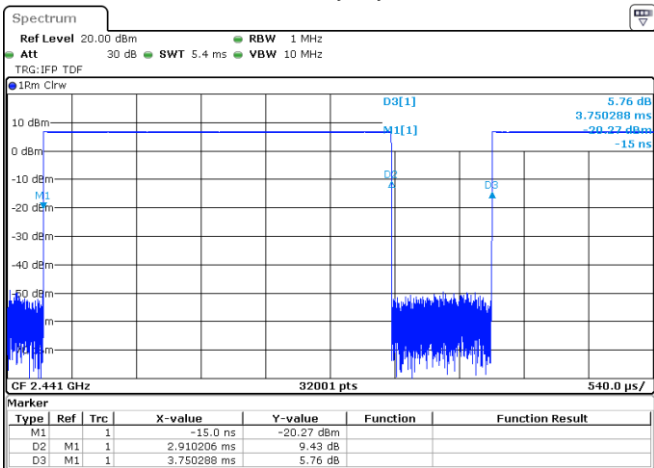
Requirement(s)

There are no limits for this test. It is used to determine the duty cycle correction factor.

Basic Rate GFSK Duty Cycle Plot



Enhanced Rate 8DPSK Duty Cycle Plot



Test Results Summary

The maximum possible duty cycle is 64.7%.



5.2 6 dB Bandwidth and 99% Bandwidth

6dB Bandwidth Requirements

FCC15.247 (a) (2)

The minimum 6 dB bandwidth shall be at least 500 kHz.

Frequency (MHz)	6dB Bandwidth (kHz)	Minimum Limit (kHz)
2402	0.6610	500
2442	0.6565	500
2480	0.6615	500

Test Results Summary

The minimum 6dB bandwidth is 661 kHz which is greater than the minimum requirement of 500kHz.

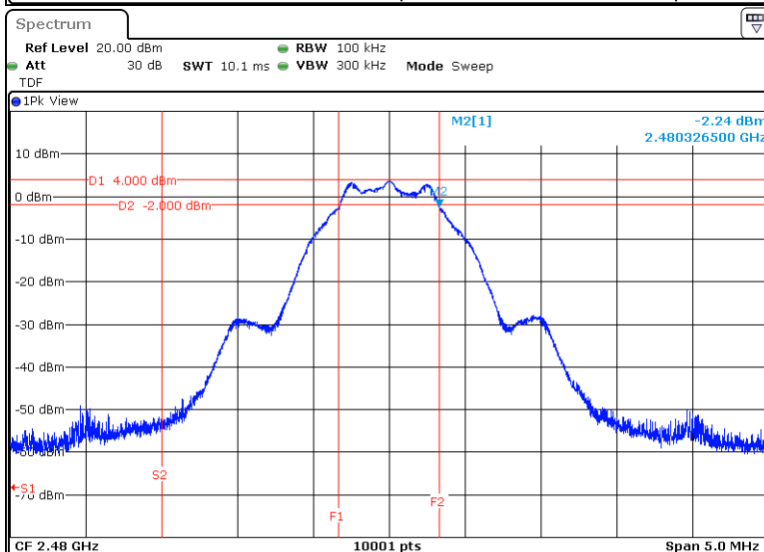
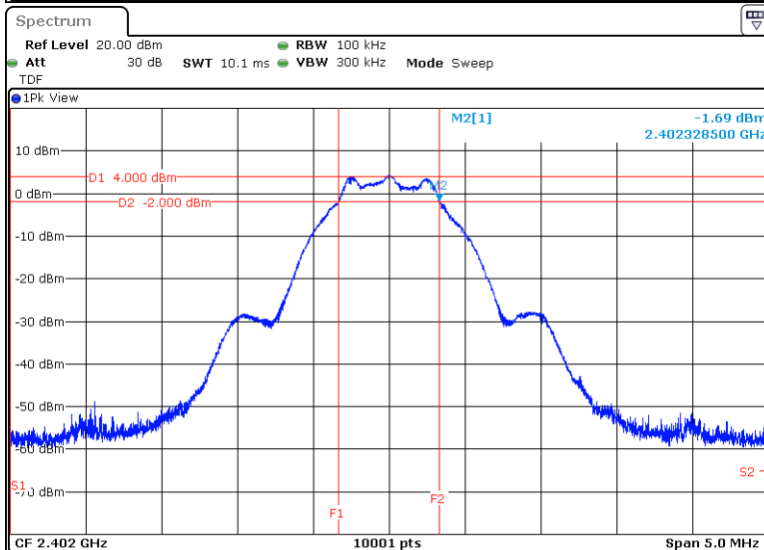
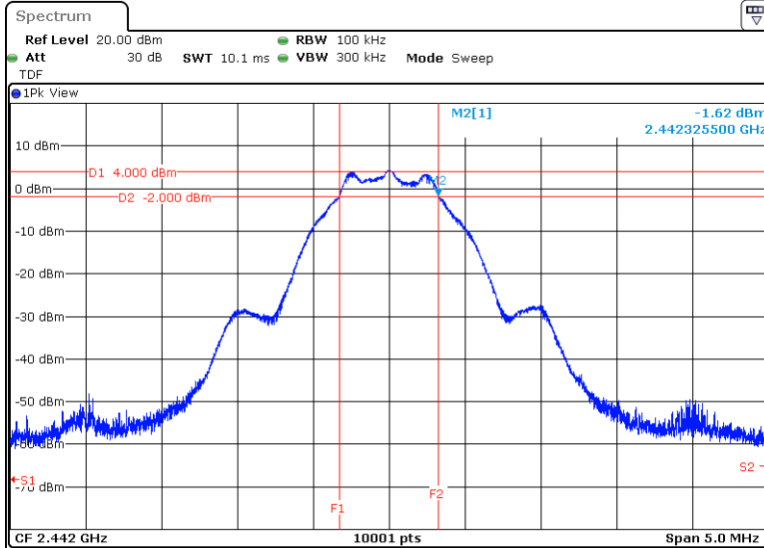
99% Bandwidth Requirements

None; for reporting purposes only.

Frequency (MHz)	99% Bandwidth (kHz)
2402	1.0306
2442	1.0314
2480	1.0348

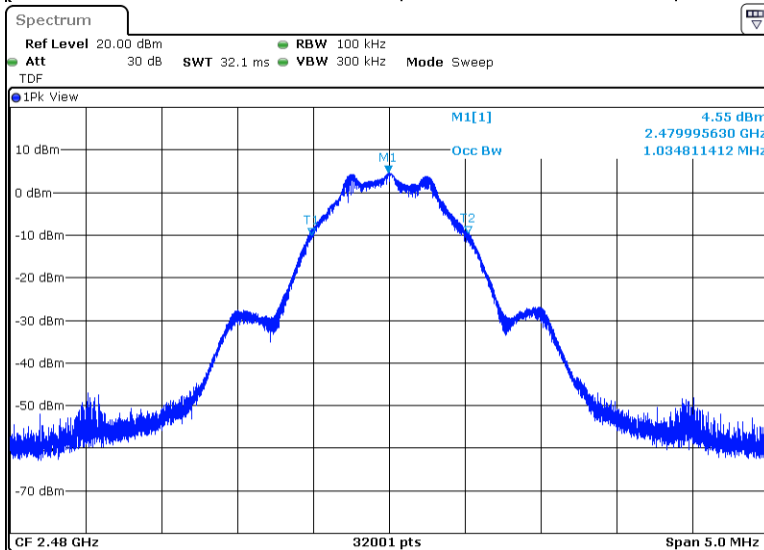
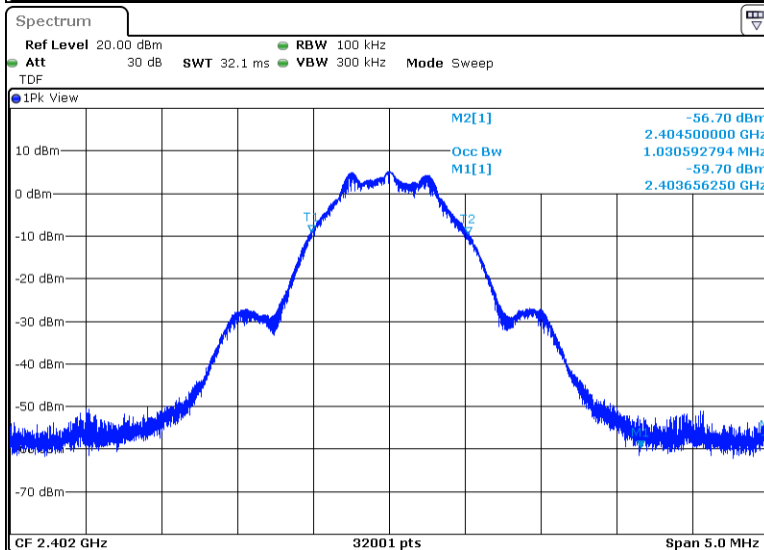
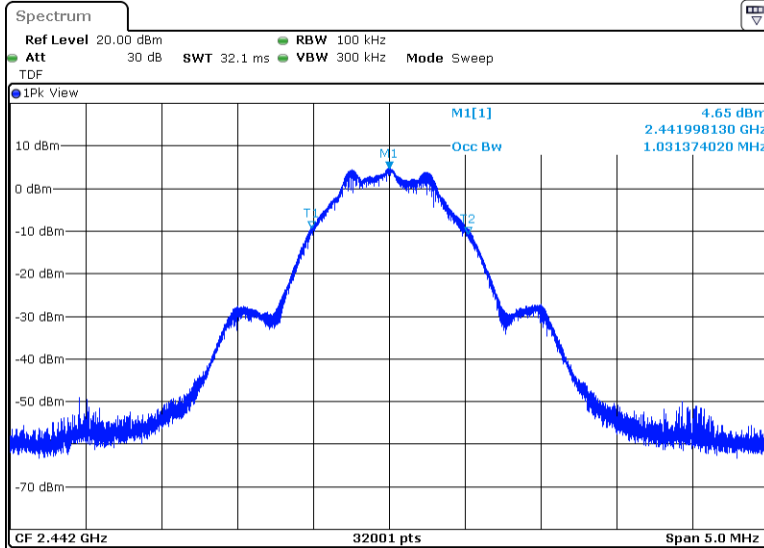


Representative 6dB Bandwidth Plots





Representative 99% Bandwidth Plots





5.3 Output power

Requirement(s)

FCC 15.247 (b) (1)

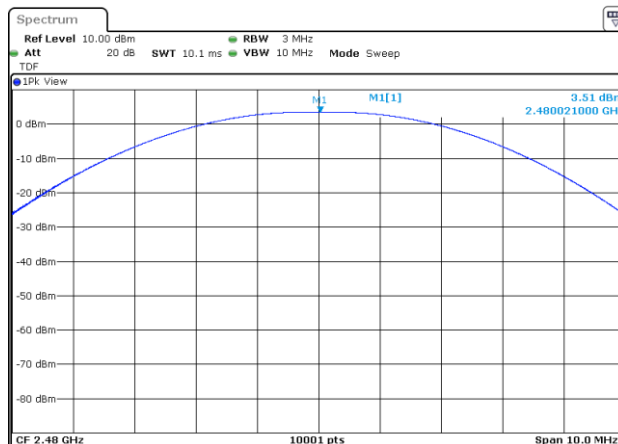
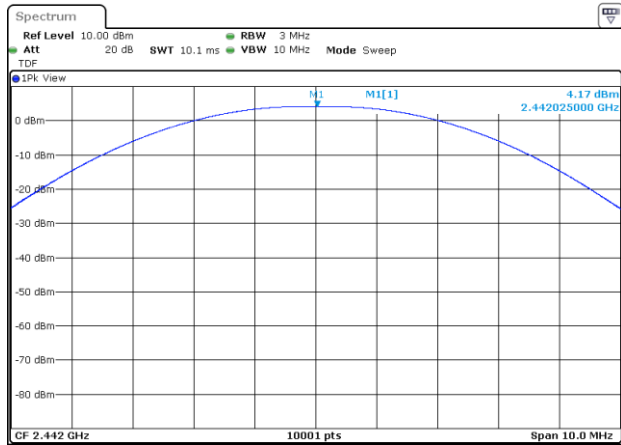
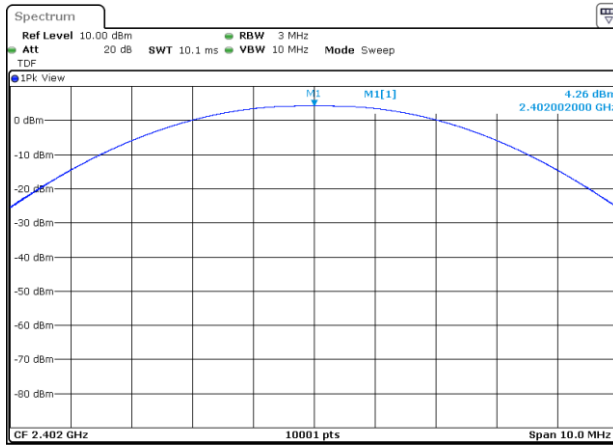
The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm.

Test Method

Measure per KDB 558074 v03r02 section 9.1.1 RBW ≥ DTS bandwidth

Test Results

Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
2402	4.26	30	25.74
2442	4.17	30	25.83
2480	3.51	30	26.49



Test Results Summary

The highest recorded peak output power was 4.26dBm which passes by 25.74dB.



5.4 Conducted Spurious Emissions

Requirement(s)

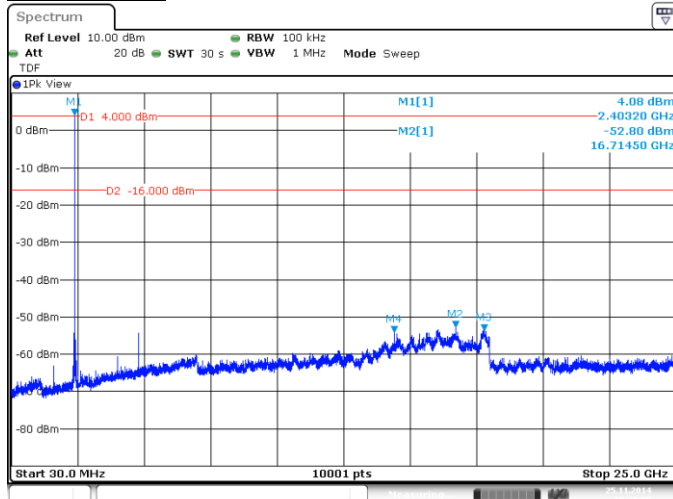
FCC 15.247 (d) and IC RSS-210 A8.5

If the maximum peak conducted output power procedure was used to demonstrate compliance, then the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).

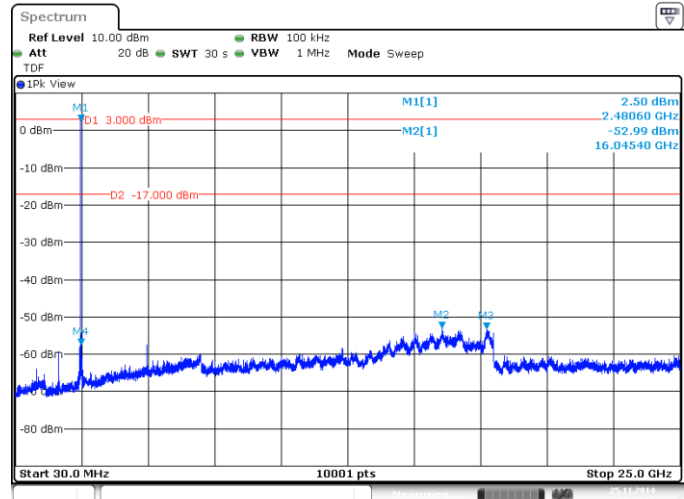
Test Method

Measure per KDB 558074 v03r02 section 11.0

Test Results



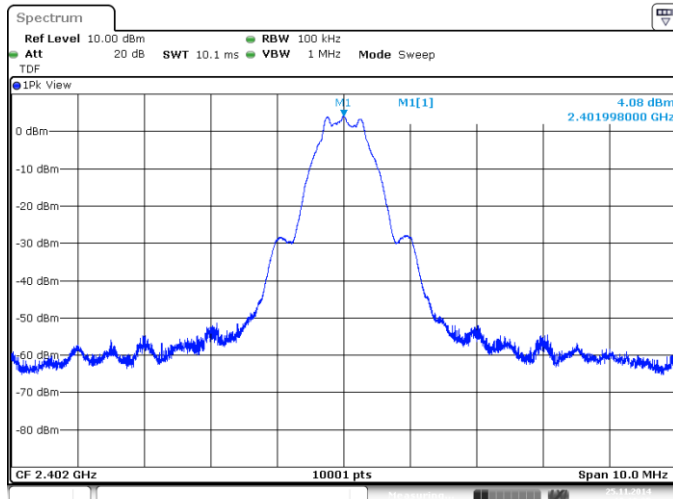
T26 FCC247 Spur 30 to 25000MHz 2402 BLE
Date: 25.NOV.2014 19:21:00



T28 FCC247 Spur 30 to 25000MHz 2480 BLE
Date: 25.NOV.2014 19:24:51

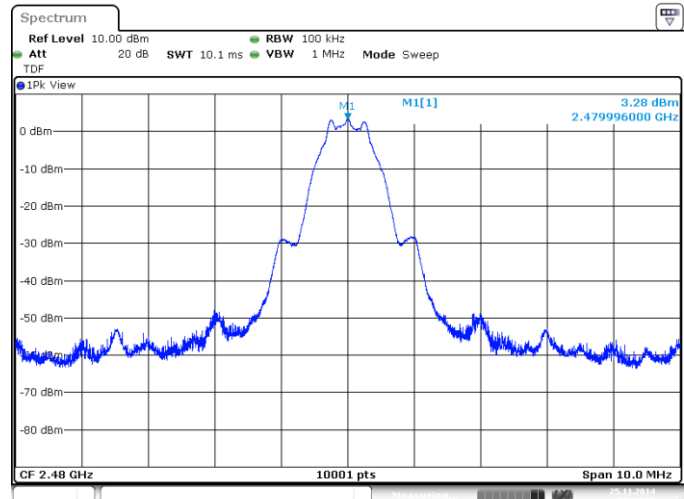
Low Channel spurious

High Channel spurious



T25 FCC247 Find Peak2402 2402 BLE
Date: 25.NOV.2014 19:18:25

Spurious lower band edge



T27 FCC247 Find Peak2480 2480 BLE
Date: 25.NOV.2014 19:22:16

Spurious upper band edge

Results Summary

All emissions outside of the 2.4-2.4835GHz band are more than the required 20dB below the fundamental.



5.5 Power Spectral Density

Requirement(s)

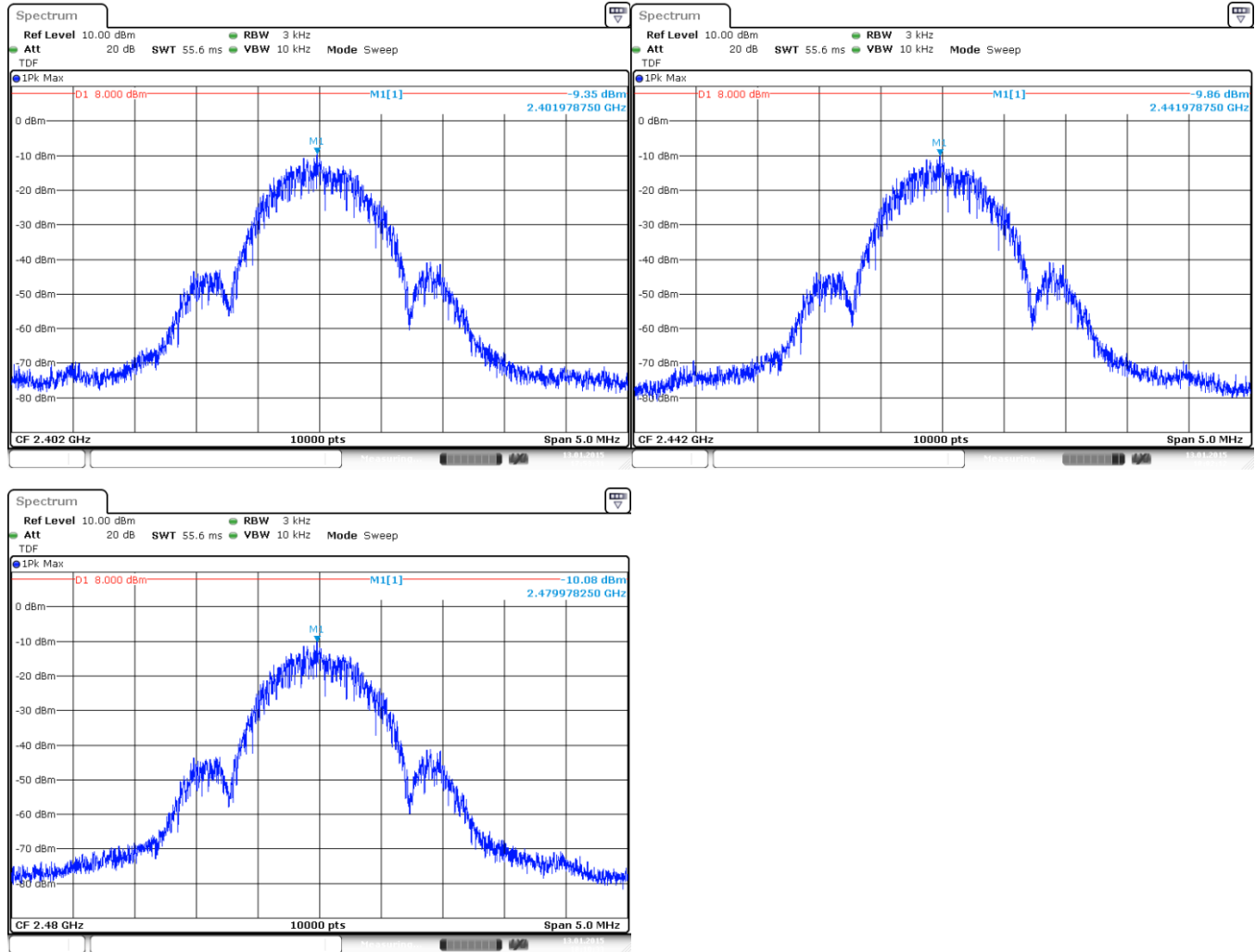
FCC 15.247 (e)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Test Method

KDB 558074 D01 v03r02 using 10.2 Method PKPSD (peak PSD)

Test Results



Results Summary

The worst case result was -9.35dBm which passes the 8dBm limit by 17.35dB.



5.6 Radiated Emissions below 1GHz

Requirement(s)

FCC 15.205 and 15.209

Frequency MHz	Limit in uV/m @ 3m Quasi-peak	Limit in dBuV/m @3m Quasi-peak
30 – 88	100	40
88 - 216	150	43.5
216-960	200	46
Above 960	500*	54*

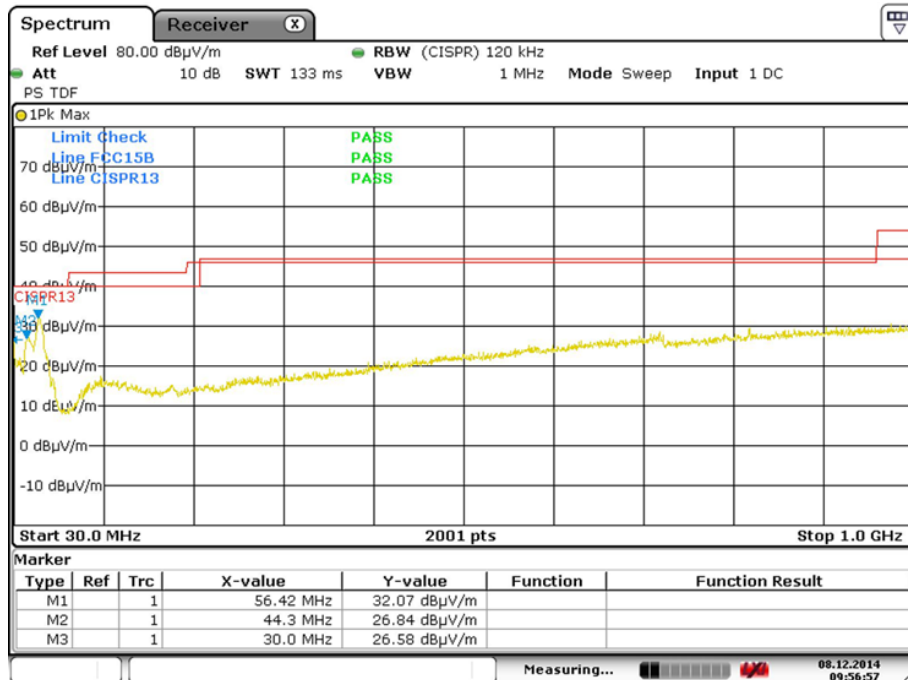
Test setup details

The EUT was placed on an 80 cm high table and configured for worst case emissions based on previous testing. EUT was maximized in 3 orthogonal planes for radiated spurious emissions; plots shown represent worst case orientation.

Photos of the orientations are included in the Test Setup Photos document.

Test Results

FCC 15B Class B Product (Residential) @ 3 Meters									
Emission Frequency (MHz)	Measured Amplitude (dBuV/m) QP/AVG*	Measured Amplitude (dBuV/m) Peak	FCC 15B				Table Azimuth (0° closest to ant)	Receiving Antenna	
			Limit (dBuV/m) QP/AVG*	Limit (dBuV/m) Peak	Margin (dB) QP/AVG*	Margin (dB) Peak		Pol (H/V)	Height (Meters)
30.000	23.00	29.00	40.0	N/A	17.0	N/A	330	V	1.0
46.240	25.20	28.30	40.0	N/A	14.8	N/A	146	V	1.0
57.390	29.60	32.80	40.0	N/A	10.4	N/A	280	V	1.0



Test Results Summary

Worst case emission is passing Class B by 10.4dB.



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5.7 Radiated Emissions above 1GHz

Requirement(s)

FCC 15.205 and 15.209

Frequency MHz	Limit in uV/m @ 3m Quasi-peak	Limit in dBµV/m @3m Quasi-peak
30 – 88	100	40
88 - 216	150	43.5
216-960	200	46
Above 960	500*	54*

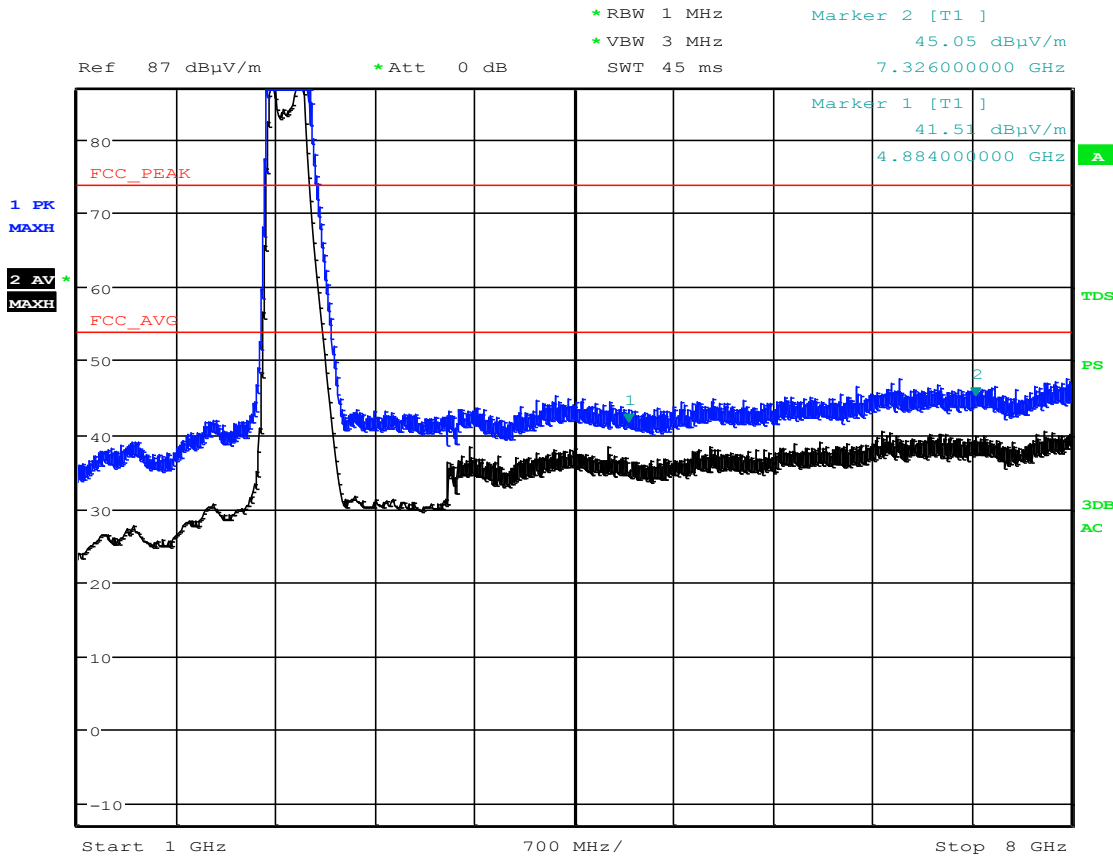
Test setup details

The EUT was placed on an 80 cm high table and configured for worst case emissions based on previous testing. EUT was maximized in 3 orthogonal planes for radiated spurious emissions; plots shown represent worst case orientation.

Photos of the orientations are included in the Test Setup Photos document.

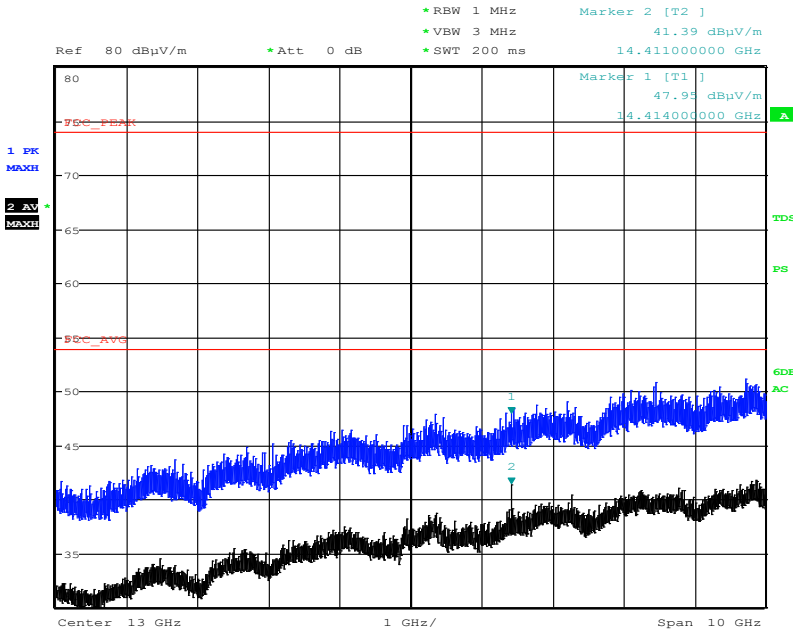


Test Results

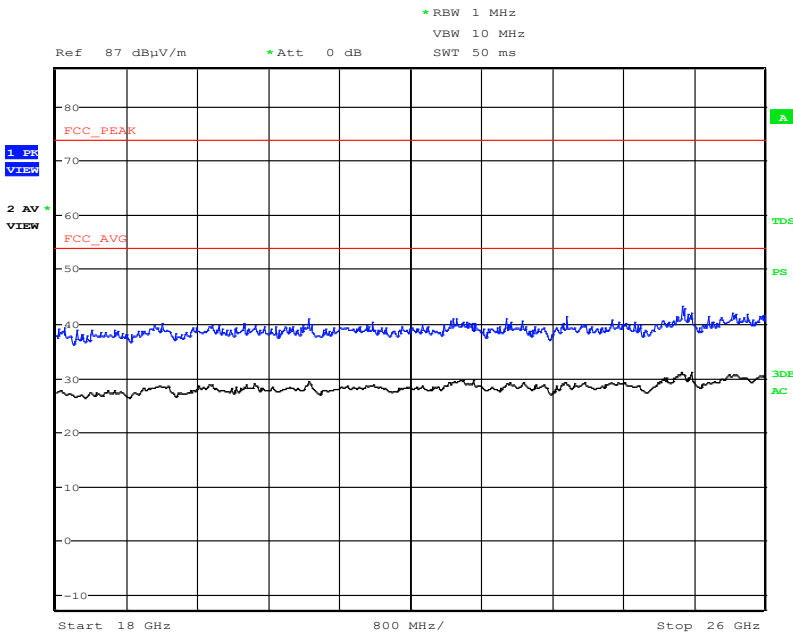


Date: 3.DEC.2014 12:03:16

Max-Hold Peak Pre-scan, 1 - 8GHz, 3 orthogonal axes measured representative plot shown. The spike above the limit is due to the correction factor for the 2.4GHz band reject filter, this will be examined more closely during band-edge measurements. Trace shows Horizontal and Vertical polarity. There are no emissions within 10dB of the limit line.



Max-Hold Peak Pre-scan, 8-18GHz, 3 orthogonal axes measured representative plot shown. Trace shows Horizontal and Vertical polarity. There are no emissions within 10dB of the limit line.



Max-Hold Peak Pre-scan, 18-26GHz, Analyzer was on max hold through all 3 orientations. Trace shows Horizontal and Vertical polarity.

There are no emissions within 10dB of the limit.

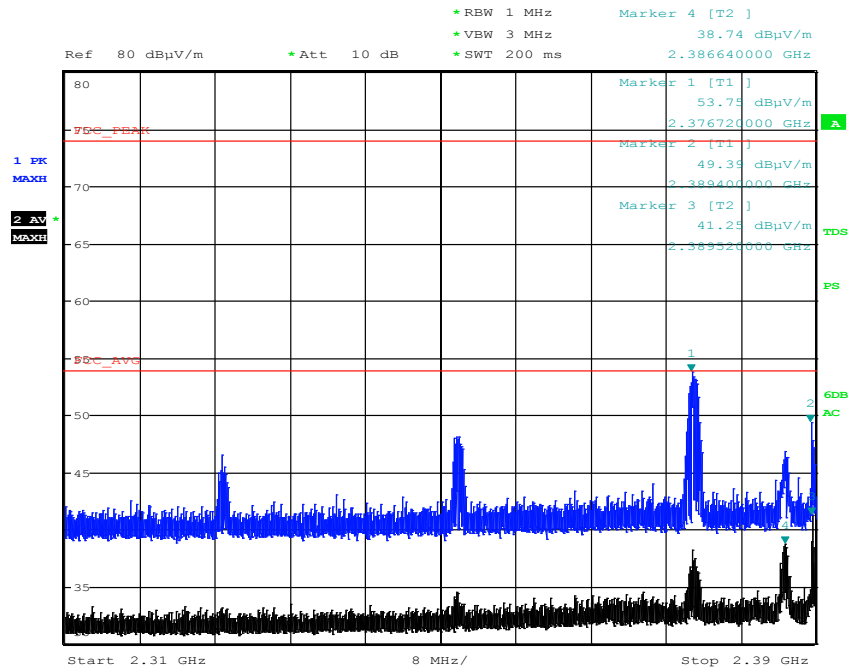
Test Results Summary

Bose® model 416549 Wireless Module passes radiated emissions above 1GHz since there were not any emissions observed during the pre-scan that were within 10dB of the limit

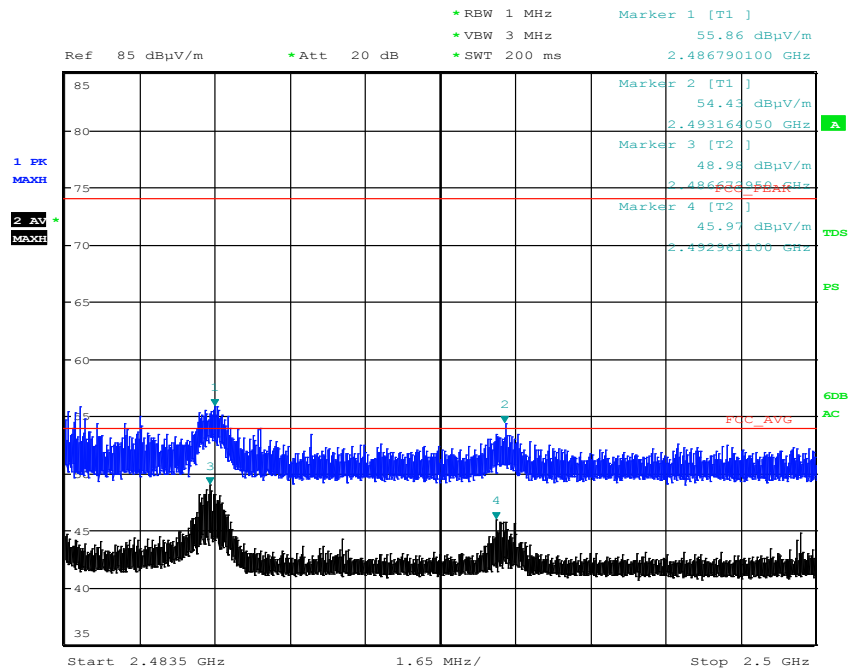


5.7.1 Restricted Band edge

Test Results



Max-Hold Peak Pre-scan, Lower Band Edge (2310-2390MHz), 3 orthogonal axes measured representative plot shown. Trace shows Horizontal and Vertical polarity.



Max-Hold Peak Pre-scan, Upper Band Edge (2483.5-2500MHz), 3 orthogonal axes measured representative plot shown. Trace shows Horizontal and Vertical polarity



FCC 15B Class B Product (Residential) @ 3 Meters									
Emission Frequency (MHz)	Measured Amplitude (dBµV/m) QP/AVG*	Measured Amplitude (dBµV/m) Peak	FCC 15B				Table Azimuth (0° closest to ant)	Receiving Antenna	
			Limit (dBµV/m) QP/AVG*	Limit (dBµV/m) Peak	Margin (dB) QP/AVG*	Margin (dB) Peak		Pol (H/V)	Height (Meters)
2376.864	31.20	58.30	54.0	74.0	22.8	15.7	136.0	H	2.06
2386.640	32.90	51.50	54.0	74.0	21.1	22.5	150.0	H	2.06
2376.864	27.70	49.00	54.0	74.0	26.3	25.0	160.0	H	1.57
2389.480	29.90	49.30	54.0	74.0	24.1	24.7	318.0	V	1.57
2376.864	29.20	54.70	54.0	74.0	24.8	19.3	118.0	H	1.4
2389.480	29.40	50.20	54.0	74.0	24.6	23.8	118.0	H	1.4
2486.673	37.20	53.90	54.0	74.0	16.8	20.1	137	H	1.4
2493.164	33.30	51.10	54.0	74.0	20.7	22.9	137	H	1.4
2486.673	33.00	50.90	54.0	74.0	21.0	23.1	320	V	2.3
2493.164	29.00	44.20	54.0	74.0	25.0	29.8	320	V	2.3
2486.673	31.90	49.90	54.0	74.0	22.1	24.1	133.0	H	1.1
2493.164	28.60	45.90	54.0	74.0	25.4	28.1	133	H	1.1

Test Results Summary

Bose® model 416549 Wireless Module passes radiated emissions in the adjacent restricted bands by 15.7dB at 2376.9MHz



5.8 AC Power Line Conducted Emissions

Requirement(s)

FCC rules part 15.207, RSS 210 section 7.2.4, RSS-Gen section 8.8

Frequency MHz	Limits dB(μV)	
	Quasi-peak	Average
0.15 -0.5	66-56	56-46
0.5 – 1.6	56	46
1.6 – 30	60	50

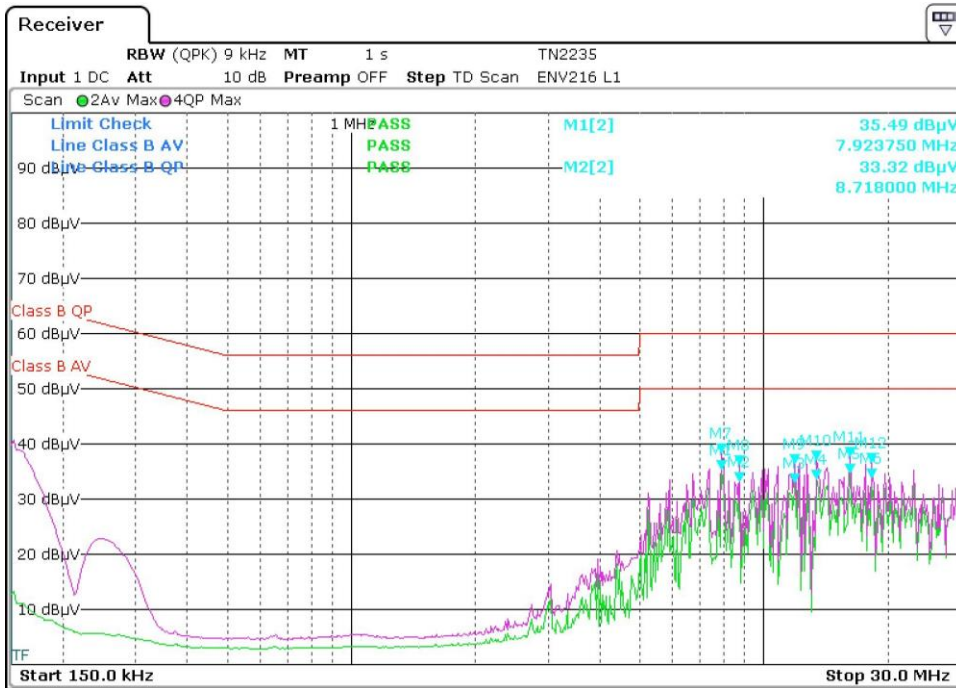
Test Method

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.4.

The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average. Line conducted data is recorded for both Line and Neutral.



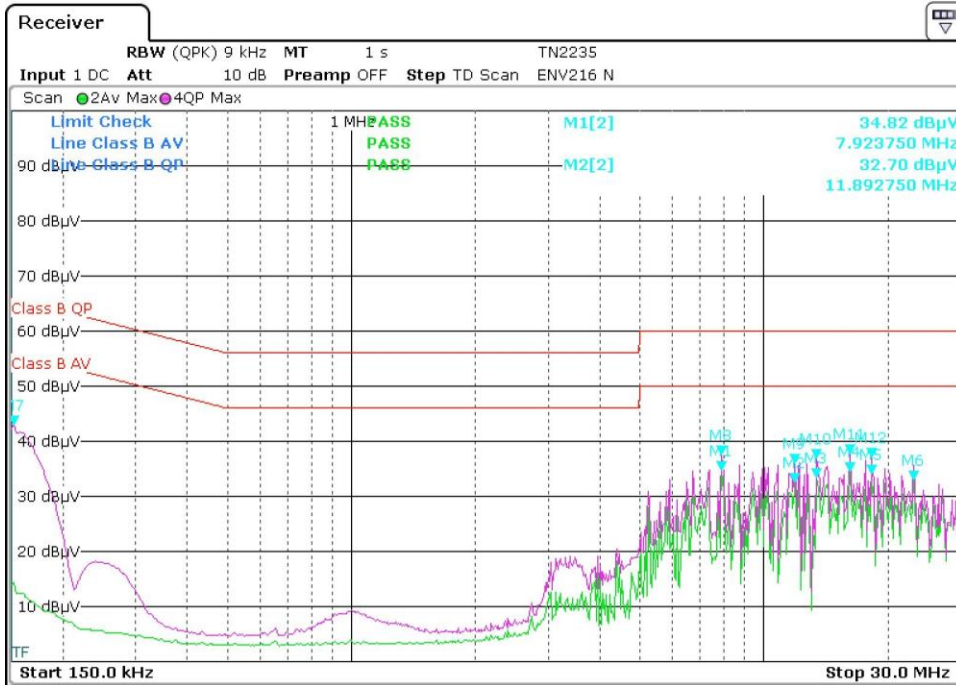
Test Results



Max Hold plot: 150 kHz to 30 MHz, Line – wired, muted, Aux port grounded.
120 V, 60 Hz

Frequency MHz	MEASURED		LIMIT		MARGIN	
	dBµV QP	dBµV AVG	dBµV QP	dBµV AVG	dB QP	dB AVG
7.9238	38.50	35.50	60.0	50.0	21.5	14.5
8.7180	36.30	33.30	60.0	50.0	23.7	16.7
11.8928	36.50	33.10	60.0	50.0	23.5	16.9
13.4205	37.10	33.70	60.0	50.0	22.9	16.3
16.2285	37.80	34.70	60.0	50.0	22.2	15.3
18.2445	36.80	33.80	60.0	50.0	23.2	16.2

Bose® model 416549 Wireless Module **PASSES** FCC conducted emissions limits by 14.5 dB at 7.9238 MHz (AVG measurement) on the Line side.



Max Hold plot: 150 kHz to 30 MHz, Neutral - wired, muted, Aux port grounded.
120 V, 60 Hz

Frequency MHz	MEASURED		LIMIT		MARGIN	
	dBµV QP	dBµV AVG	dBµV QP	dBµV AVG	dB QP	dB AVG
7.9238	37.70	34.80	60.0	50.0	22.3	15.2
11.8928	36.10	32.70	60.0	50.0	23.9	17.3
13.4205	36.80	33.40	60.0	50.0	23.2	16.6
16.2285	37.70	34.60	60.0	50.0	22.3	15.4
18.2445	37.10	34.10	60.0	50.0	22.9	15.9
23.1293	35.70	33.10	60.0	50.0	24.3	16.9

Bose® model 416549 Wireless Module **PASSES** FCC conducted emissions limits by 15.2 dB at 7.9238 MHz (AVG measurement) on the Neutral side.

Test Results Summary

Bose® model 416549 Wireless Module **PASSES** FCC conducted emissions limits by worst case 14.5 dB at 7.9238 MHz (AVG measurement) on the Line side.



6.0 Test Equipment Used

Tracking Number	Description	Model	Manufacturer	Calibration due date	Verification due date	Calibration interval	Verification interval
1620	Comb Generator 1GHz - 10GHz	CGO-5100	Com-Power Corporation	Verify before use	Verify before use	Verify before use	Verify before use
1663	ESU40 EMI Test Receiver	ESU40	Rohde & Schwarz	11-Apr-15	N/A	1 Year	N/A
1672	MITEQ pre-amp 100MHz-20GHz	AFS4-00102000-30-10P-4	Bose Corporation	N/A	13-Nov-15	N/A	1 Year
2241	iPhone 5	16GB	Apple	Verify before use	Verify before use	Verify before use	Verify before use
2342	Band Reject Filter	BRM50702-07	Micro-Tronics	N/A	25-Aug-15	N/A	1 Year
2343	Band Reject Filter	BRM18192	Micro-Tronics	N/A	25-Aug-15	N/A	1 Year
2348	Double Ridge Waveguide Horn Antenna 1-18GHz	3117	ETS Lindgren	16-Oct-15	N/A	1 Year	N/A
2367	RF Cable 30MHz-18GHz	TRU-300	TRU Corporation	N/A	12-Nov-15	N/A	1 Year
2373	RF Cable 30MHz-18GHz - 25 feet "N"	TRU-300	TRU Corporation	N/A	12-Nov-15	N/A	1 Year
2383	RF Cable 30MHz-18GHz - 20 feet, "N" connectors	TRU-300	TRU Corporation	N/A	12-Nov-15	N/A	1 Year
2385	Marconi Manor	3 Meter Semi Anechoic Chamber	AP Americas	N/A	18-Nov-15	N/A	1 Year
728	Microwave Horn Antenna 8GHz - 18GHz	AT4004	Amplifier Research	28-Feb-15	N/A	3 year	N/A
1307	Standard Gain Horn Antenna 18GHz - 26.5GHz	3160-09	EMCO	13-Mar-17	N/A	3 year	N/A
2368	RF Cable 30MHz-26.5GHz	TRU-210	TRU Corporation	12-Nov-15	N/A	1 Year	N/A
2397	MITEQ pre-amp 18-40GHz	TTA1840-35	Miteq	9-Dec-15	N/A	1 Year	N/A



7.0 Measurement Uncertainty

Uncertainty Budget				
Title:		Conducted Emissions		
Source of Uncertainty	Value units: +/-dB	Distribution	Divisor	Uncertainty (± dB)
RF spec anal-level-Ref.	0.6	Rect.	1.73	0.35
RF spec anal-level-Freq resp.	1.0	Rect.	1.73	0.58
RF spec anal-level-Display	0.3	Rect.	1.73	0.17
RF spec anal-level-QP det.	1.0	Rect.	1.73	0.58
Transient limiter loss	0.1	Rect.	1.73	0.06
LISN impedance/loss	0.7	Norm.	2.00	0.35
Combined uncertainty (RSS):				0.97
Coverage factor (2 sigma):				2.00
Extended uncertainty (95% confidence):				1.94

Uncertainty Budget				
Title:		Radiated Emissions		
Source of Uncertainty	Value units: +/-dB	Distribution	Divisor	Uncertainty (± dB)
RF spec anal-level-Ref.	0.6	Rect.	1.73	0.35
RF spec anal-level-Freq resp.	1.0	Rect.	1.73	0.58
RF spec anal-level-Display	0.3	Rect.	1.73	0.17
RF spec anal-level-QP det.	1.0	Rect.	1.73	0.58
Antenna factor	0.9	Norm.	2.00	0.45
Preamp corr. Factor	0.5	Rect.	1.73	0.29
Cable corr. Factor	0.5	Rect.	1.73	0.29
Combined uncertainty (RSS):				1.09
Coverage factor (2 sigma):				2.00
Extended uncertainty (95% confidence):				2.18