

Test Type: Emissions

Product Type: *Wireless Earbud*

Product Name/Number: *Model 408L*

FCC ID: *A94408L*
IC: *3232A-408L*

Prepared For: *Product Assurance Engineering Department,
Bose Corporation*

Name of manufacturing agency applying for equipment type approval Bose Corporation

Postal Address of manufacturing Agency The Mountain
Framingham MA 01701
USA

Test Results: Pass

Applicable Standards: *FCC 47 CFR PART 15 SUBPART C
ISED RSS-247 ISSUE 2
ISED RSS-GEN ISSUE 5*

Report Number: *EMC.441408.23.167.5*

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:	Bryan Cerqua	<i>Bryan H Cerqua</i>	8/14/2023
Electrical Engineer Review* By:	Kenneth Lee	<i>Kenneth Lee</i>	8/15/2023

* 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.



Certificate # 1514.1

PRODUCT ASSURANCE ENGINEERING COMPLIANCE EMC TEST REPORT



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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Test Report Summary

Product Information:

Description

Truly Wireless In Ear (TWIE) earbud. The bud uses Bluetooth classic (BT) Bluetooth Low Energy (BLE), and Qualcomm High Speed (QHS). The QHS is used for bud-to-bud communications. The role of master/puppet can be changed to best meet radio link conditions during operation. The unit is not supplied with an AC to USB adapter. The antenna is an inverted F with a maximum gain of 0.58 dBi (Left Earbud) and 0.86 dBi (Right Earbud) formed by Laser Direct Sequence on the inside of the top cover of the earbud.

QHS mode is a Qualcomm proprietary FHSS operation mode. The following information was obtained from Qualcomm:

QHS is a proprietary PHY to Qualcomm and may be enabled between Qualcomm devices in either a Bluetooth Classis or Bluetooth LE mode of operation. QHS has 2 MHz channel bandwidth and, therefore, uses 2 MHz channel center spacing for hopping. When enabled on a Bluetooth classic link, QHS uses the adapted hopping kernel used by BR/EDR with the exception that only even channel are allowed in the AFH channel map.

EUT Condition

Product was as built in the factory. For the conducted measurements the antenna was removed, and coaxial cable was installed in its place. Where necessary USB debug wires were added to allow control of the Radio.

Scope:

This report covers EMC requirements. FCC or ISED, FHSS low power transceiver.

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.

Conclusions:

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

[X] meets all test standards on page 1 of this report.

Test Results Summary

TEST NAME	TEST RESULT PASS or N/A	COMMENT(S)
On Time and Duty Cycle	N/A	
99% Occupied Bandwidth	N/A	
20dB Occupied Bandwidth	Pass	
Hopping Frequency Separation	Pass	
Number of Hopping Channels	Pass	
Average Time of Occupancy	Pass	
Output Power	Pass	
Conducted Spurious Emissions	Pass	
RF Conducted Emissions – AC Mains	Pass	
RF Radiated Emissions 30MHz -1GHz	Pass	
Radiated RF Emissions 1-25GHz	Pass	
Radiated Band Edge	Pass	

Environmental Conditions

Ambient:

Temperature: 22±4°C
Humidity: 30-60%RH
Mains Voltage: 120VAC, 5VDC USB

FCC Test Site Accreditation:

Firm Name	Location	Expiration Date	Accreditation	MRA	Designation Number	Contact	Contact Title	Address	PO Box	Mail Stop	City	State	Zip Code	Country	Email	Phone	Fax
Bose Corporation	1 New York Avenue, Framingham, MA	07/31/2024	American Association for Laboratory Accreditation	N/A	US1088	Mr. Cable Best	Quality Manager	Mail Stop 450 The Mountain	N/A	450	Framingham	Massachusetts	01701	United States	Cable_Best@bose.com	1 508 766 6137	508 766 1145

Canadian Test Site Registration:

BOSE CORPORATION 1 New York Avenue Framingham, MA 01701 UNITED STATES Company Number: 3232A Contact: Mario Espinal mario_espinal@bose.com	US0210	RSS-GEN (2019-02-11) RSS-210 (2019-02-11) RSS-247 (2019-02-11) RSS-248 (2021-11-19)	RECOGNIZED UNTIL: 2024-07-31 A2LA ISO/IEC 17025:2017 Expires: 2024-07-31
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RF Conducted Measurements

On Time and Duty Cycle

Project number (Integrity):	408L	Build Phase:	C1.5
Tested by:	Mike Royer	Date:	May 12, 2023
Requirements Standard(s):		Referenced Standard(s):	ANSI C62.10:2013-11.6-b
EUT powered with:	5V USB	Temp / Humidity:	n/a
		Test location:	Braun Room
Test equipment used TN's:	2409		
EUT Serial number(s):	084803M3051E021A1		
EUT Software installed:	1.4.10+g2edc594		
EUT Modification(s):	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.		

Conclusion:

This test is for information only.

Limits:

None; for reporting purposes only.

Procedure:

ANSI C63.10, Section 11.6: Zero-Span Spectrum Analyzer Method.

Equipment Used:

TN	Description	Model	S/N	Manufacturer	Most Recent Calibration	Calibration Due Date
2409	Signal and Spectrum Analyzer	FSV40	101413	Rohde & Schwarz	22-Mar-2023	21-Mar-2024



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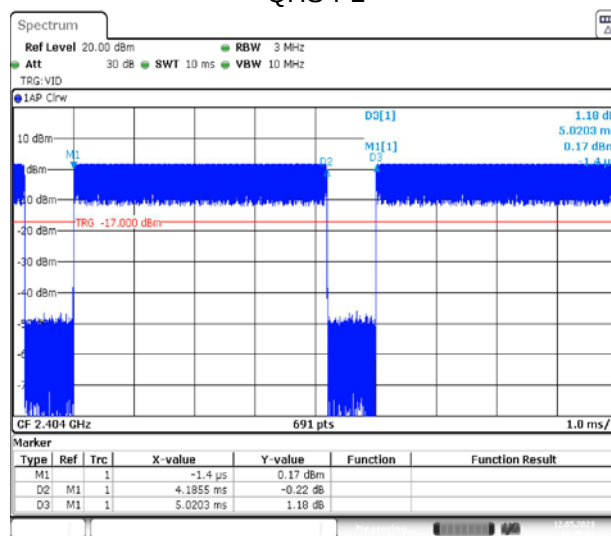


Data Collection:

Duty cycles shown in the table below represent maximum duty cycle in test mode using maximum packet length.

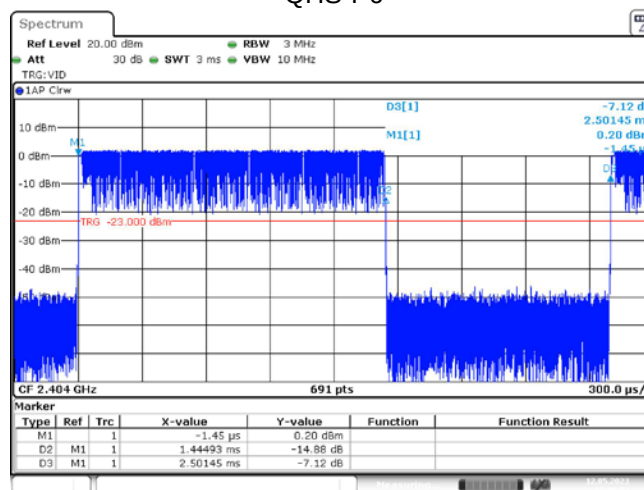
Mode	ON Time (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	1/Ton Hz
QHS-P2	4.186	5.020	0.833	83	239
QHS-P6	1.445	2.502	0.577	58	692

QHS-P2



Date: 12.MAY.2023 17:45:51

QHS-P6



Date: 12.MAY.2023 17:48:02

99% Occupied Bandwidth

Project number (Integrity):	408L	Build Phase:	C1.5
Tested by:	Mike Royer	Date:	May 15, 2023
Requirements Standard(s):		Referenced Standard(s):	ANSI C63.10:2013-6.9.3
EUT powered with:	5V USB	Temp / Humidity:	n/a
		Test location:	Braun Room
Test equipment used TN's:	2409		
EUT Serial number(s):	084803M3051E021A1		
EUT Software installed:	1.4.10+g2edc594		
EUT Modification(s):	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.		

Conclusion:

This test is for information only.

Limits:

None; for reporting purposes only.

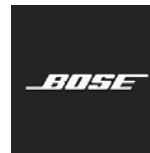
Procedure:

The transmitter output is connected to a spectrum analyzer. The RBW is set to $\geq 1-5\%$ of the 99% Occupied Bandwidth. The VBW is set to $\geq$ RBW.



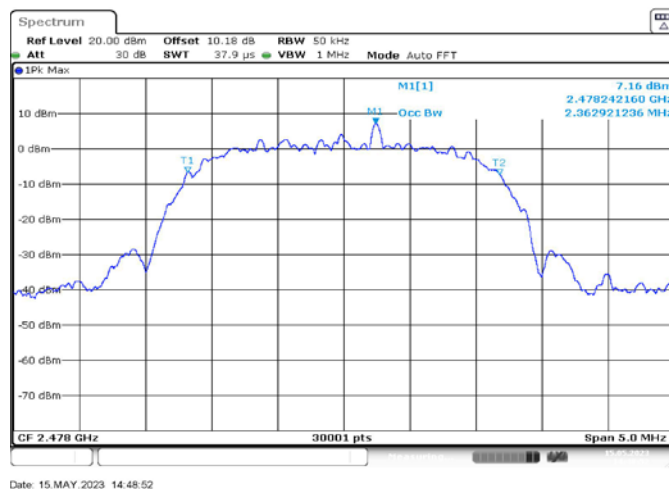
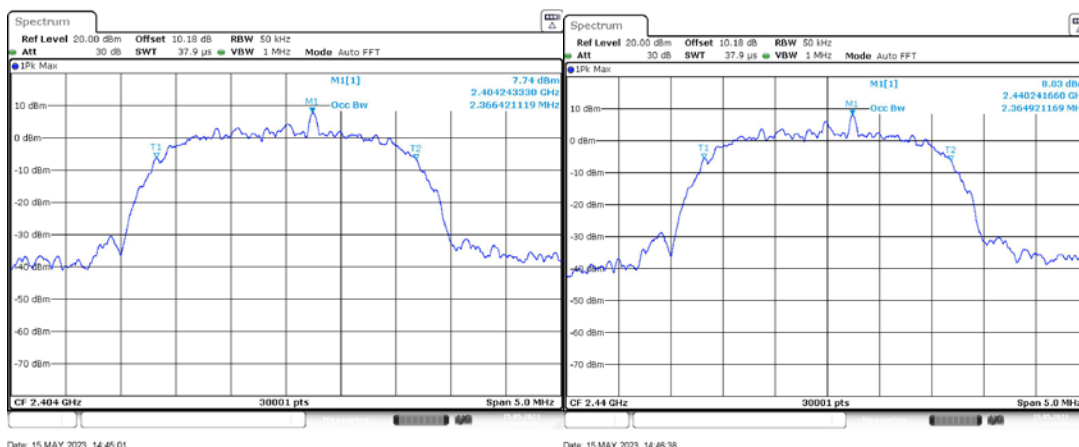
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QHS-P2 Data Collection:

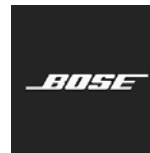
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	2.366
Middle	2440	2.365
High	2478	2.363





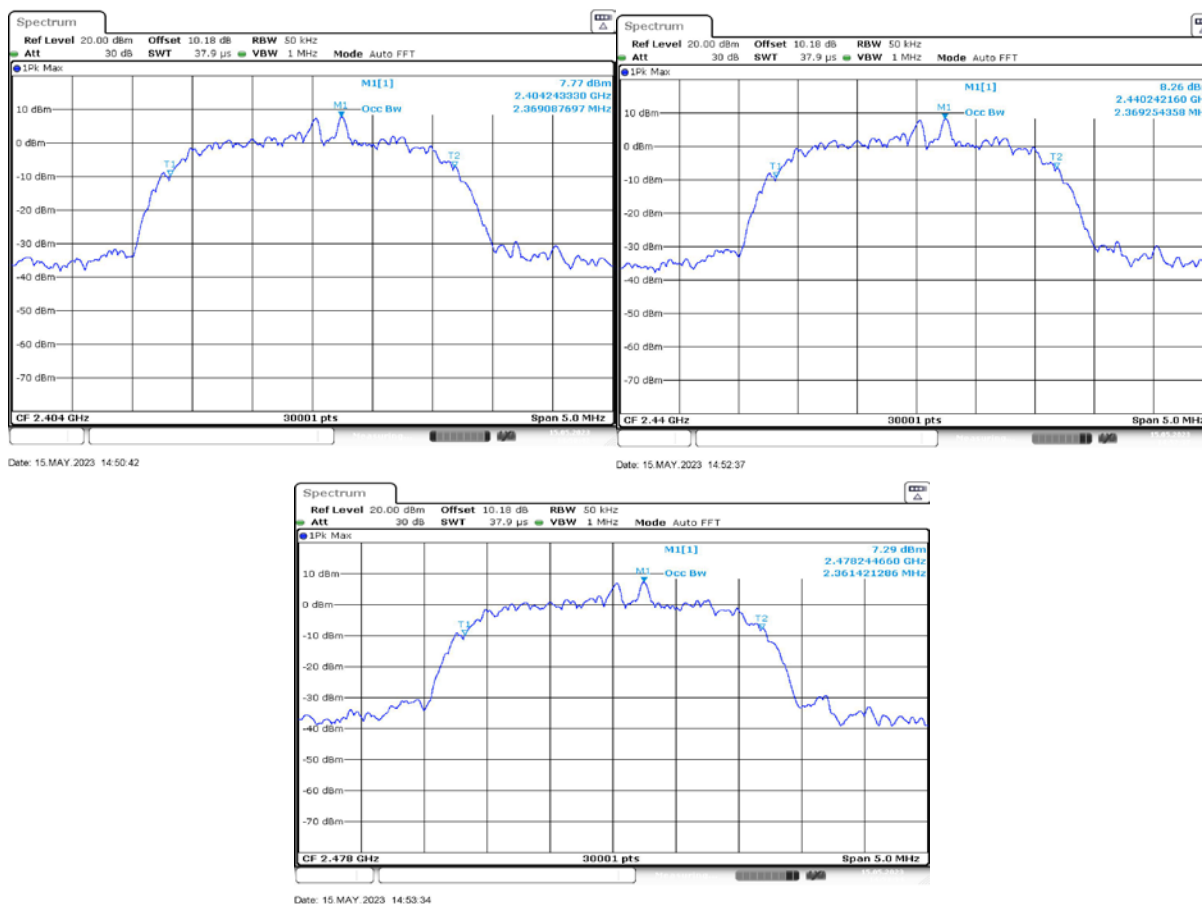
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QHS-P6 Data Collection:

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	2.369
Middle	2440	2.369
High	2478	2.361



Equipment Used:

TN	Description	Model	S/N	Manufacturer	Most Recent Calibration	Calibration Due Date
2409	Signal and Spectrum Analyzer	FSV40	101413	Rohde & Schwarz	22-Mar-2023	21-Mar-2024

20dB Occupied Bandwidth

Project number (Integrity):	408L	Build Phase:	C1.5			
Tested by:	Mike Royer		Date:	May 12, 2023		
Requirements Standard(s):	FCC §15.247 (2) RSS-247 5.1 (a)		Referenced Standard(s):		ANSI 63.10:2013 - 6.9.2	
EUT powered with:	5V USB	Temp / Humidity:	n/a	Test location:	Braun Room	
Test equipment used TN's:	2409					
EUT Serial number(s):	084803M3051E021A1					
EUT Software installed:	1.4.10+g2edc594					
EUT Modification(s):	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.					

Conclusion:

This test is for information only.

Limits:

None; for reporting purposes only.

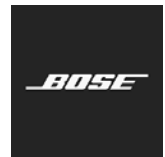
Procedure:

The transmitter output is connected to a spectrum analyzer. The RBW is set to $\geq 1-5\%$ of the 20dB bandwidth. The VBW is set to $\geq$ RBW.



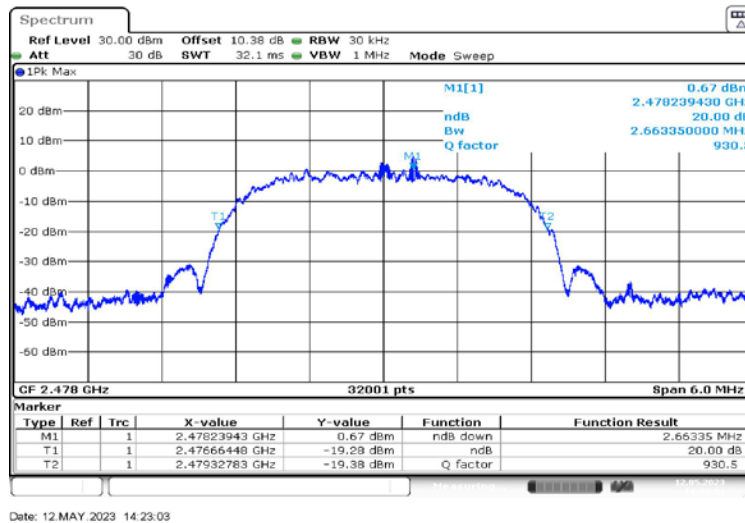
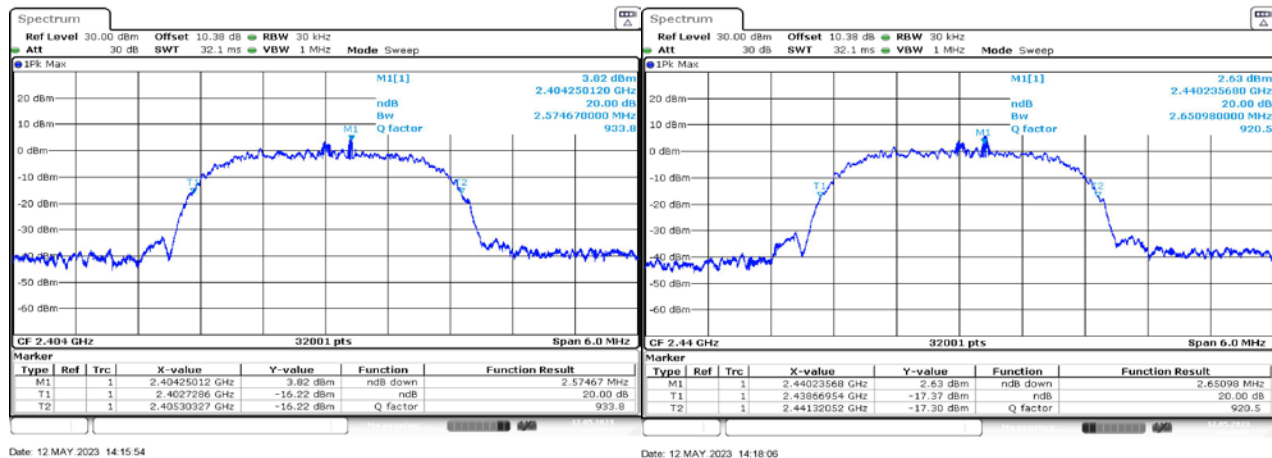
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QHS-P2 Data Collection:

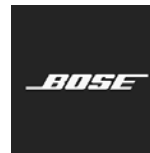
Setting	BW MHz
Low	2.575
Mid	2.651
High	2.663





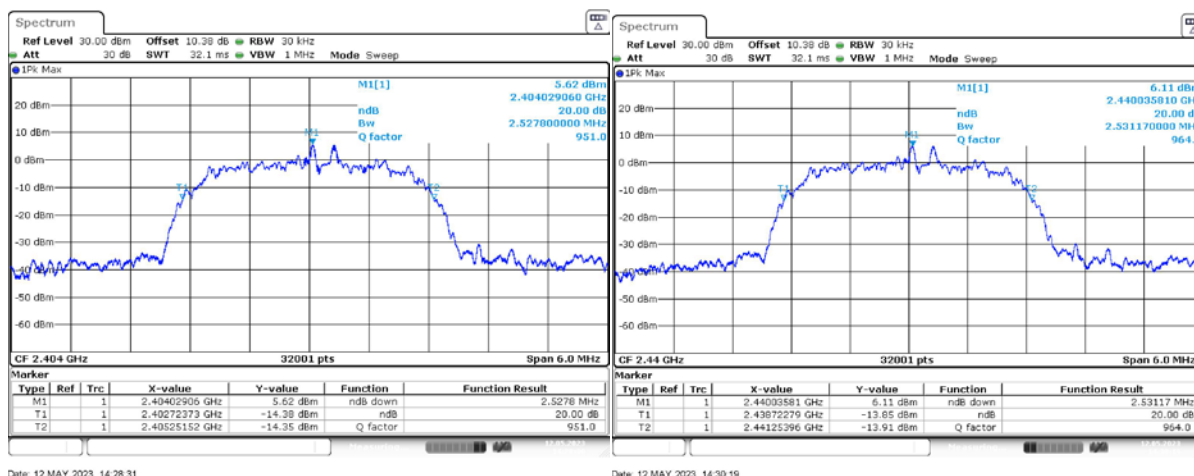
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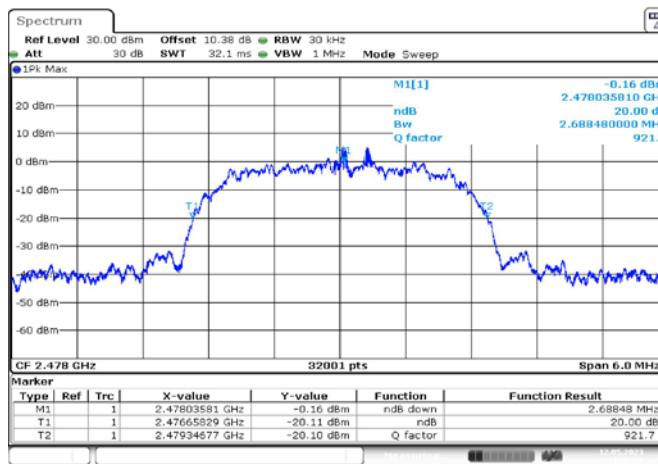
QHS-P6 Data Collection:

Channel	Frequency (MHz)	20dB Bandwidth (MHz)
Low	2402	2.528
Middle	2441	2.531
High	2480	2.688



Date: 12 MAY 2023 14:28:31

Date: 12 MAY 2023 14:30:19



Date: 12 MAY 2023 14:42:19

Equipment Used:

TN	Description	Model	S/N	Manufacturer	Most Recent Calibration	Calibration Due Date
2409	Signal and Spectrum Analyzer	FSV40	101413	Rohde & Schwarz	22-Mar-2023	21-Mar-2024

Hopping Frequency Separation

Project number (Integrity):	408L	Build Phase:	C1.5		
Tested by:	Mike Royer		Date:	May 15, 2023	
Requirements Standard(s):	FCC 15.247 (a) (1), RSS-247 5.1 (b)		Referenced Standard(s):	ANSI C63.10-2013 7.8.2	
EUT powered with:	5V USB	Temp / Humidity:	n/a	Test location:	Braun room
Test equipment used TN's:	2409				
EUT Serial number(s):	084803M3051E021A1				
EUT Software installed:	1.4.10+g2edc594				
EUT Modification(s):	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.				

Conclusion:

Hopping frequencies are separated by 2 MHz which is more than the required minimum of 25kHz and more than 2/3 of the 20dB bandwidth of the hopping channel which would be 1.8 MHz.

Limits:

FCC §15.247 (a) (1)

RSS-247 (5.1) (b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB 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.

Equipment Used:

TN	Description	Model	S/N	Manufacturer	Most Recent Calibration	Calibration Due Date
2409	Signal and Spectrum Analyzer	FSV40	101413	Rohde & Schwarz	22-Mar-2023	21-Mar-2024

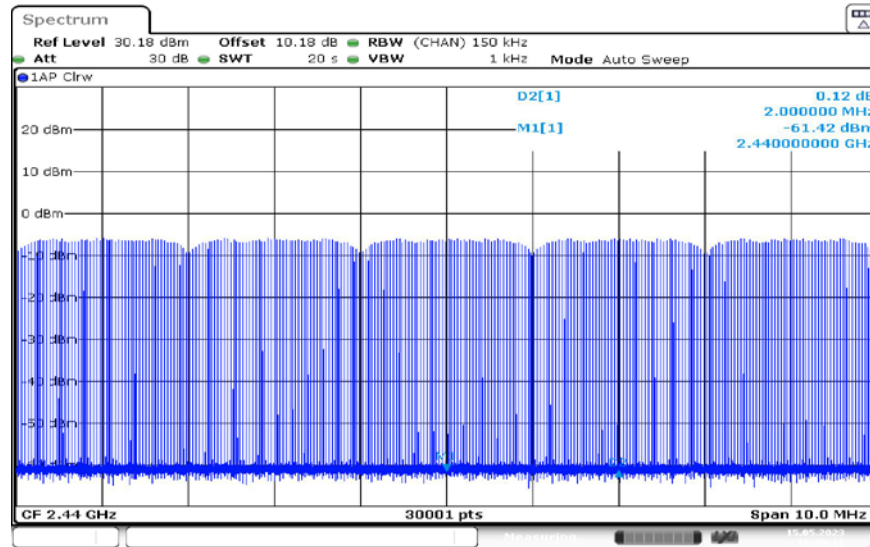


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Data Collection:



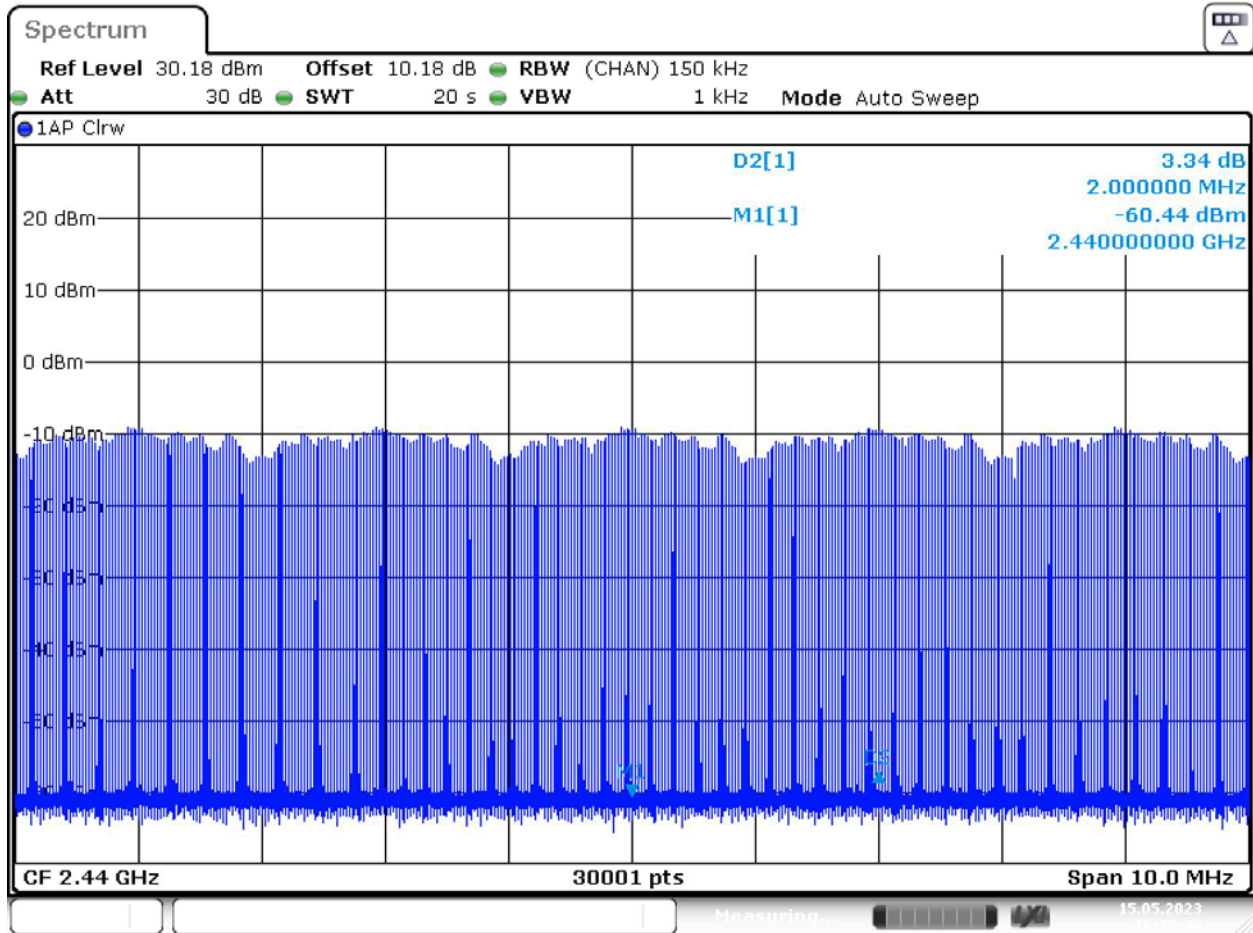
Date: 15.MAY.2023 16:39:11

QHS-P2 hopping



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Date: 15.MAY.2023 16:39:49

QHS-P6 hopping

Note: slight dips in the profile are visible every 2 divisions.

Number of Hopping Channels

Project number (Integrity):	408L	Build Phase:	C1.5		
Tested by:	Mike Royer	Date:	May 15, 2023		
Requirements Standard(s):	FCC 15.247 (a) (1) (iii) RSS-247 5.1 (d)		Referenced Standard(s):		ANSI C63.10-2013 7.8.3
EUT powered with:	5V USB	Temp / Humidity:	n/a	Test location:	Braun Room
Test equipment used TN's:	2409				
EUT Serial number(s):	084803M3051E021A1				
EUT Software installed:	1.4.10+g2edc594				
EUT Modification(s):	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.				

Conclusion:

Bose Model 408L uses 79 hopping channels in normal operation and always uses at least 20, both of which are more than the required 15.

Limits:

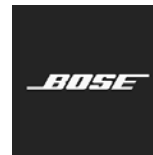
FCC 15.247 (a) (1) (iii), RSS-247 5.1 (d)

Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels.

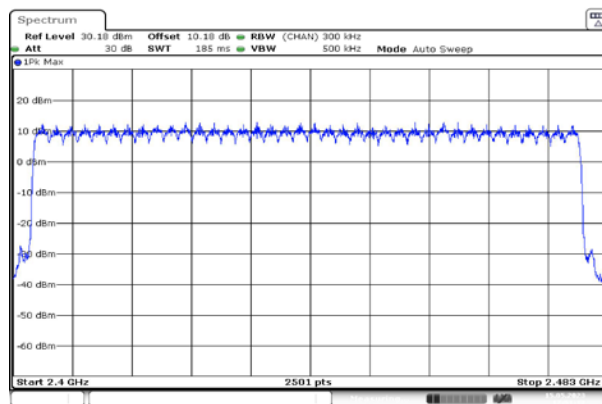


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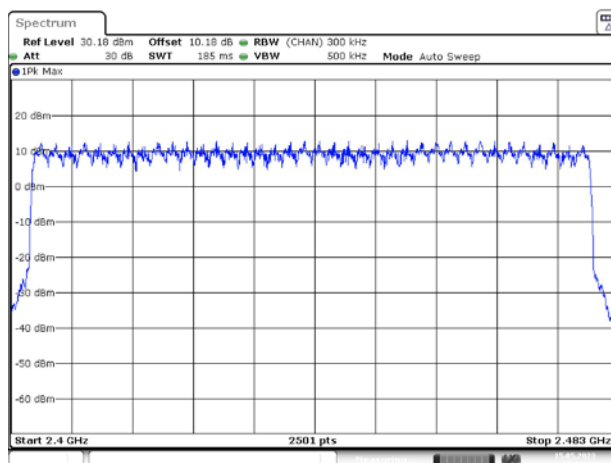


Data Collection:



Date: 15.MAY.2023 17:51:12

38 hopping Channels QHS-P2



Date: 15.MAY.2023 17:48:44

38 hopping Channels QHS-P6

Equipment Used:

TN	Description	Model	S/N	Manufacturer	Most Recent Calibration	Calibration Due Date
2409	Signal and Spectrum Analyzer	FSV40	101413	Rohde & Schwarz	22-Mar-2023	21-Mar-2024

Average Time of Occupancy

Project number (Integrity):	408L	Build Phase:	C1.5		
Tested by:	Mike Royer		Date:	May 22, 2023	
Requirements Standard(s):	FCC 15.247 (a) (1) (iii) RSS-247 5.1 (d)		Referenced Standard(s):		ANSI C63.10-2013 7.8.4
EUT powered with:	5V USB	Temp / Humidity:	n/a	Test location:	Braun Room
Test equipment used TN's:	2409				
EUT Serial number(s):	084803M3051E021A1				
EUT Software installed:	1.4.10+g2edc594				
EUT Modification(s):	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.				

Conclusion:

The highest time of occupancy in any mode is 276 mS which meets the 400mS limit by 124mS.

Limit:

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Observation time = (38 hopping channels) * 400 mS = 15.2 seconds.

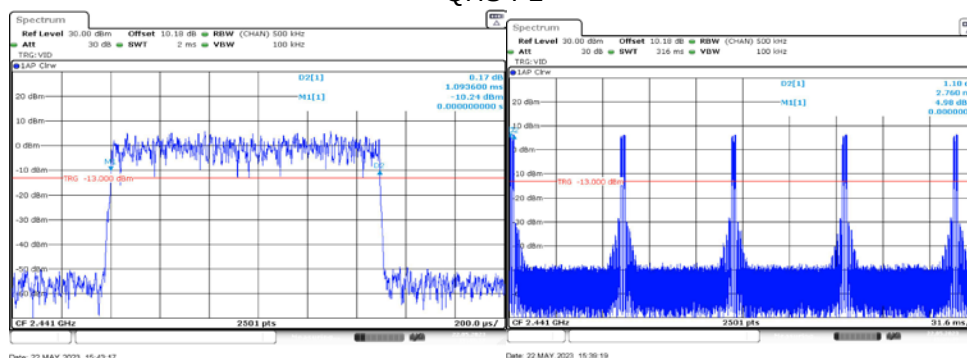
Set the observation time to 316ms and count the pulses.

Multiply number of pulses in 316ms by (15.2/0.316) = 48.1.

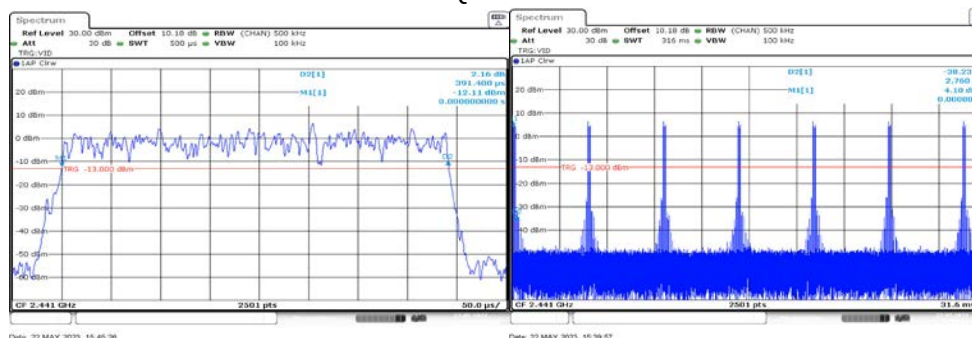
Data Collection:

Channel	Frequency (MHz)	Mode	Pulse Width (mS)	Number of pulses in 316ms	Number of pulses in 15.2s (X 48.1)	Time of occupancy (Pulse Width X Number of pulses) (mS)	Limit (mS)	Margin (mS)	Result
Middle	2440	QHS-P2	1.094	5	240.5	263.1	400	136.9	Pass
Middle	2440	QHS-P6	0.391	7	336.7	131.6	400	268.4	Pass

QHS-P2



QHS-P6



Equipment Used:

TN	Description	Model	S/N	Manufacturer	Most Recent Calibration	Calibration Due Date
2409	Spectrum Analyzer	FSV40	101413	Rohde & Schwarz	22-Mar-2023	21-Mar-2024

Output Power

Project number (Integrity):	408L	Build Phase:	C1.5		
Tested by:	Mike Royer		Date:	May 16, 2023	
Requirements Standard(s):	FCC 15.247 (b) (3) RSS-247 5.4 (b)		Referenced Standard(s):	ANSI 63.10:2013 – 7.8.5	
EUT powered with:	5V USB	Temp / Humidity:	n/a	Test location:	Braun Room
Test equipment used TN's:	2409				
EUT Serial number(s):	084803M3051E021A1				
EUT Software installed:	1.4.10+g2edc594				
EUT Modification(s):	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.				

Conclusion:

The unit passes output power by 8.46 dB for QHS-P2 mode and 8.40 dB for QHS-P6 mode.

Limits:

FCC §15.247 (b) (1)

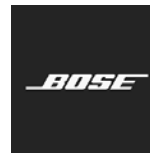
RSS-247 5.4 (b)

The device maintains a minimum of 20 hopping channels. The limit is 21 dBm.



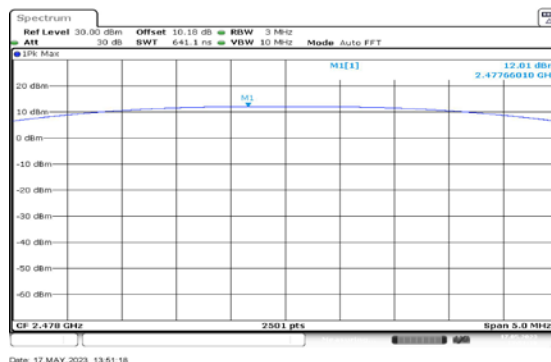
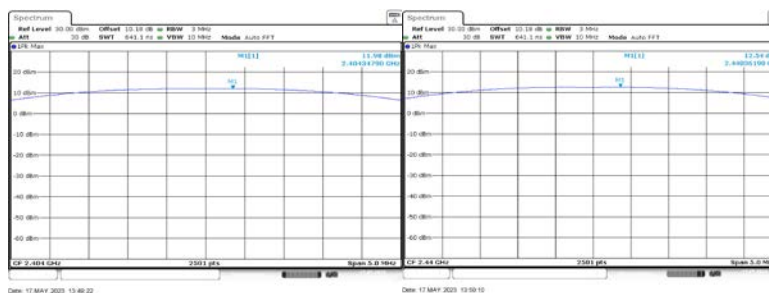
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QHS-P2 Data Collection:

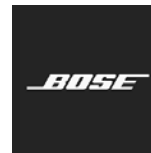
Channel	Frequency (MHz)	Output Power (dBm)	Limit (dB)	Margin (dB)	Result
Low	2404	11.98	21	9.02	Pass
Middle	2440	12.54	21	8.46	Pass
High	2478	12.01	21	8.99	Pass





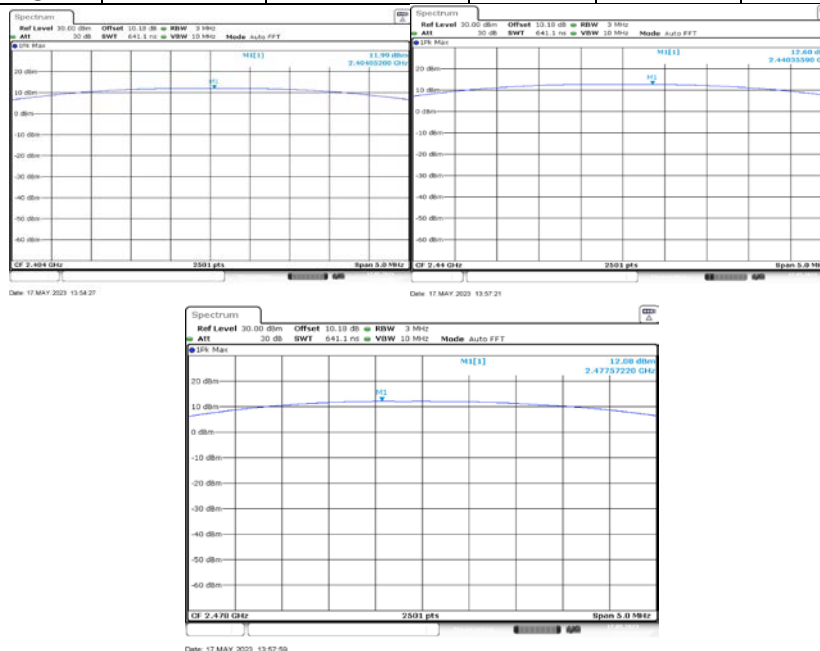
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PRODUCT ASSURANCE ENGINEERING COMPLIANCE EMC TEST REPORT



QHS-P6Data Collection:

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dB)	Margin (dB)	Result
Low	2404	11.99	21	9.01	Pass
Middle	2440	12.60	21	8.40	Pass
High	2478	12.08	21	8.92	Pass



Equipment Used:

TN	Description	Model	S/N	Manufacturer	Most Recent Calibration	Calibration Due Date
2409	Signal and Spectrum Analyzer	FSV40	101413	Rohde & Schwarz	22-Mar-2023	21-Mar-2024

Conducted Spurious Emissions

Project number (Integrity):	408L	Build Phase:	C1.5		
Tested by:	Mike Royer		Date:	May 23, 2023	
Requirements Standard(s):	FCC §15.247 (d) RSS-247 5.5		Referenced Standard(s):		ANSI 63.10 (7.8.8)
EUT powered with:	5V USB	Temp / Humidity:	n/a	Test location:	Braun Room
Test equipment used TN's:	2409				
EUT Serial number(s):	084803M3051E021A1				
EUT Software installed:	1.4.10+g2edc594				
EUT Modification(s):	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.				

Conclusion:

The Bose Model 408L passes Conducted Spurious Emissions by more than 10dB.

Limits

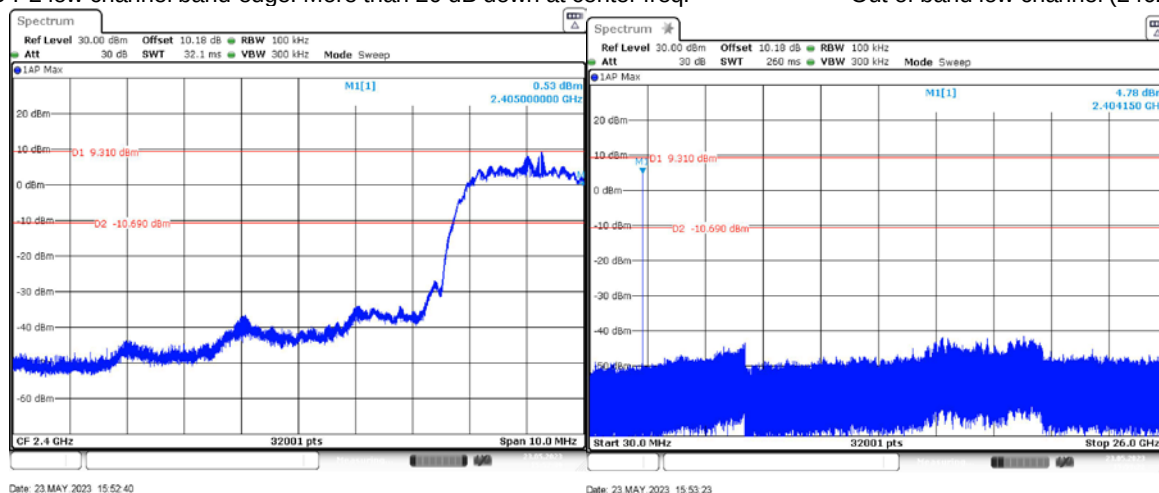
FCC §15.247 (d), RSS-247 5.5

Output power was measured based on the use of a peak measurement; therefore, the required attenuation is 20 dB.

Data Collection:

QHS-P2 low channel band-edge. More than 20 dB down at center freq.

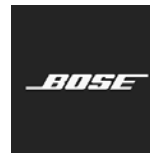
Out of band low channel (2402MHz)



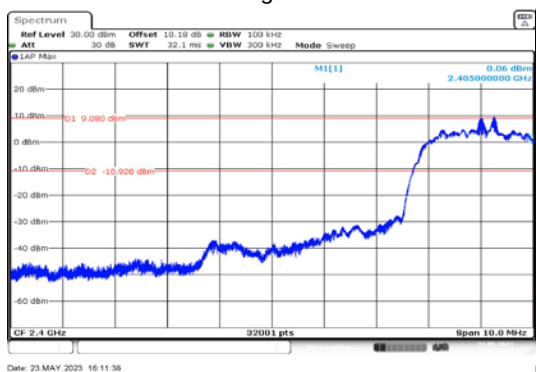


Certificate # 1514.1

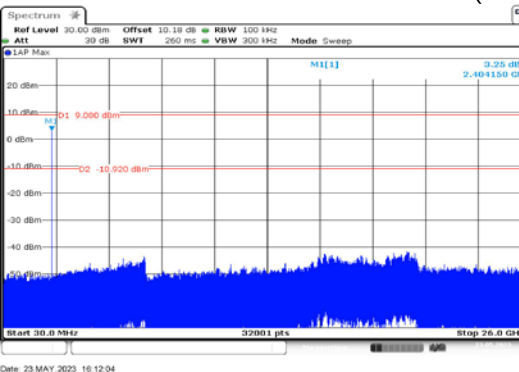
PRODUCT ASSURANCE ENGINEERING COMPLIANCE EMC TEST REPORT



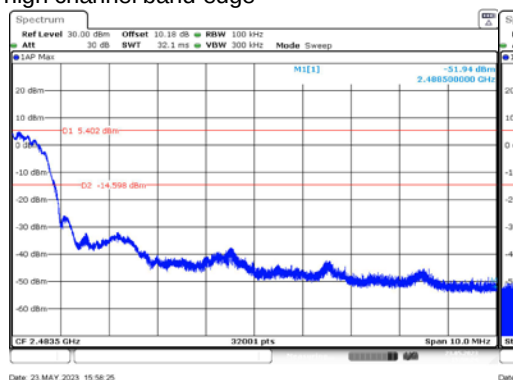
QHS-P6 low channel band-edge



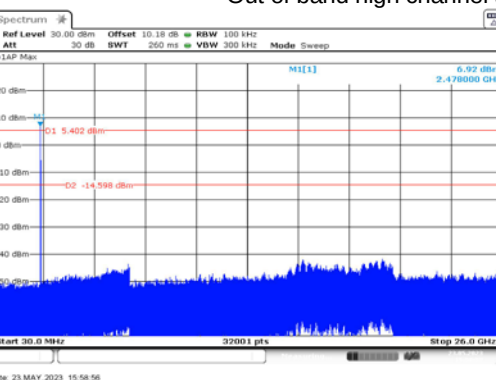
Out of band low channel (2404MHz)



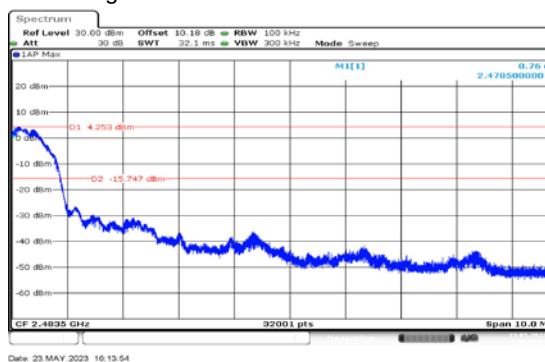
QHS-P2 high channel band-edge



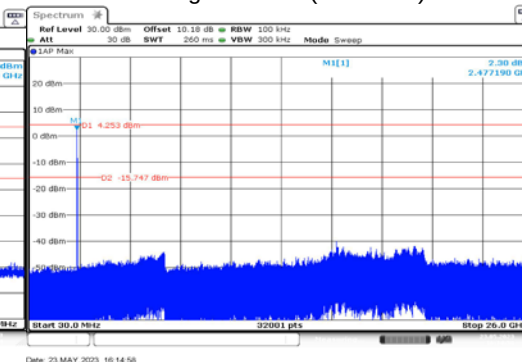
Out of band high channel (2480MHz)



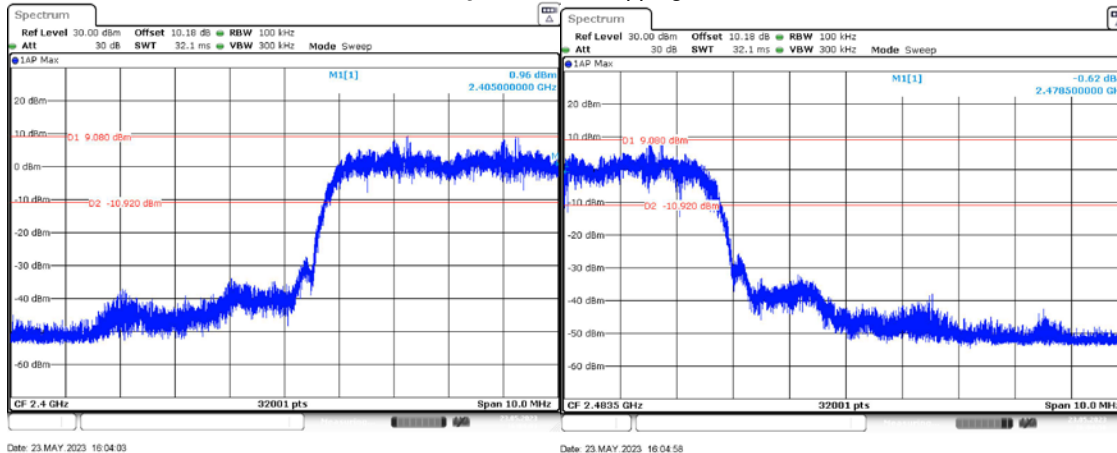
QHS-P6 high channel band-edge



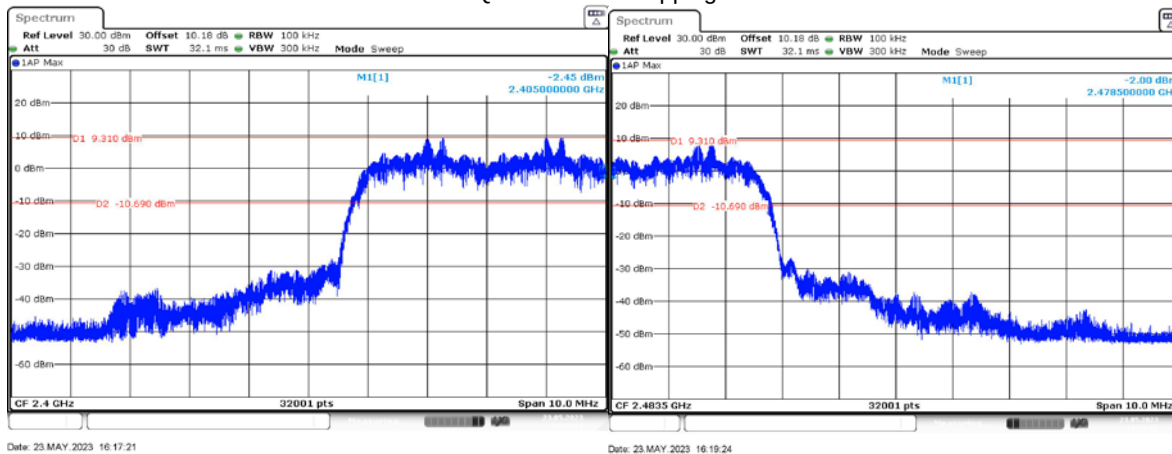
Out of band high channel (2478MHz)



QHS-2 While hopping



QHS-P6 While hopping



Equipment Used:

TN	Description	Model	S/N	Manufacturer	Most Recent Calibration	Calibration Due Date
2409	Signal and Spectrum Analyzer	FSV40	101413	Rohde & Schwarz	21-Mar-2023	22-Mar-2024

RF Radiated Emissions 30MHz -1GHz

Test Information:

Project number (Integrity):		Build Phase:	Pre-C1		
Tested by:	M. Mehrmann		Date:	8+9 February 2023	
Requirements Standard(s):	FCC §15.247 (d) and RSS-247 section 5.5		Referenced Standard(s):	ANSI C63.10 6.5	
EUT powered with:		Temp / Humidity:		Test location:	Maxwell House
Test equipment used TN's:	644,2319,1541,2077,1277-22				
EUT Serial number(s):	Left: 084803M3003B005A Right: 084803M3003B004A				
EUT Software installed:	0.0.19 diag code				
EUT Modification(s):	None				

Objective/Summary/Conclusion:

Passes FCC 15.247 and RSS-247 Section 5.5 requirements with a worst-case passing margin of 16.0 dB at 700 MHz.

Additional EUT Information:

The EUT was tested in a 3m Semi Anechoic Chamber on an insulating turntable 80 cm high.

The device was scanned in three orthogonal axis and no signals were detected.

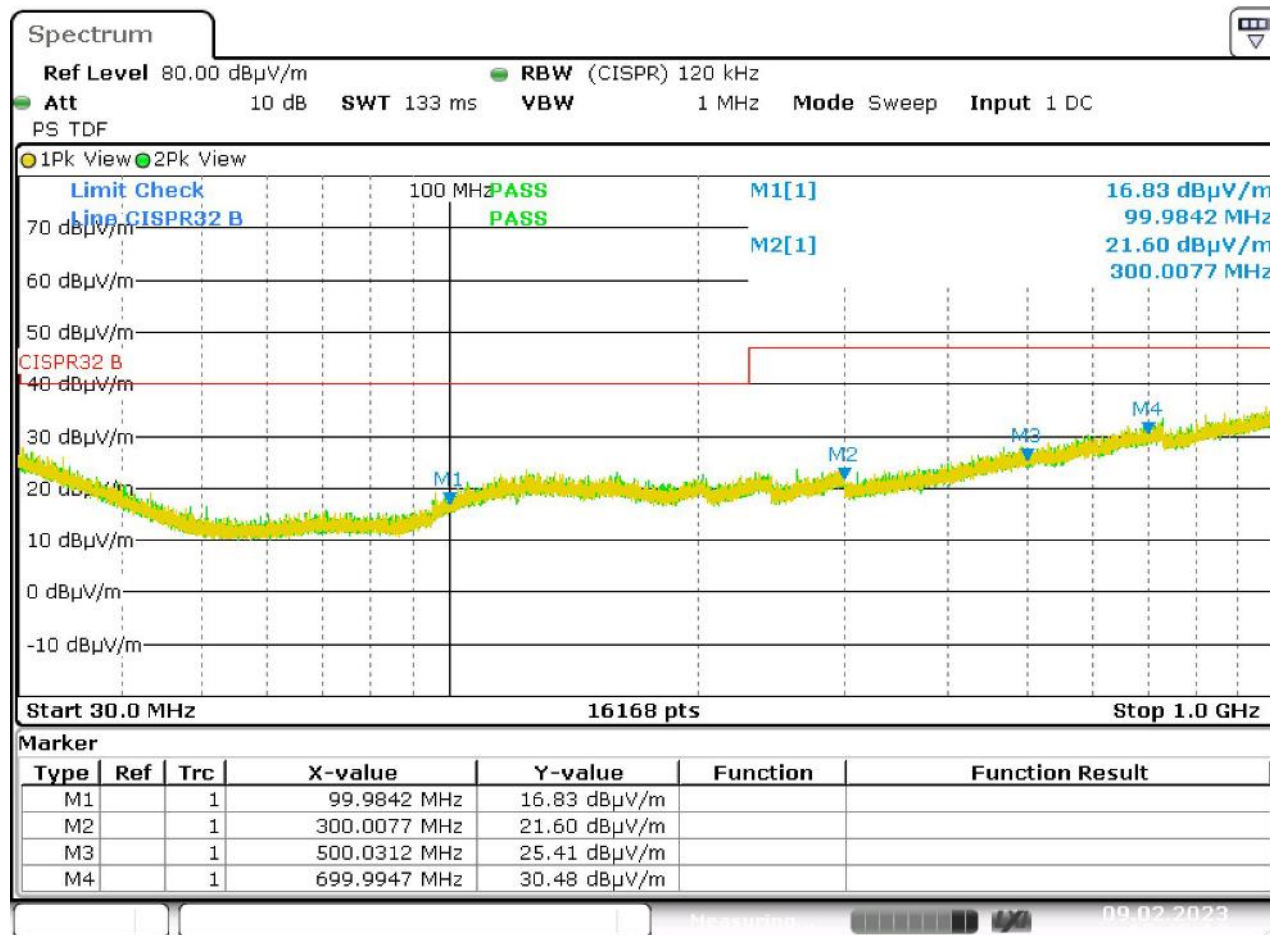
Test Setup Details:

EUT Emissions levels contained within this report are calculated on the following basis:

Radiated Emission Level (dBμV/m) = EMI Receiver Reading (dBμV) + Antenna Correction Factor (dB/m) – Preamplifier Gain (dB) + Cable Loss (dB)

Data Collection:

EUT S/N:	Left bud	Power applied:		Plot#	1
EUT Mods:					
EUT Setup:					
Comments:	Position X				

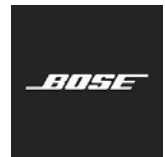


Date: 9.FEB.2023 13:49:10

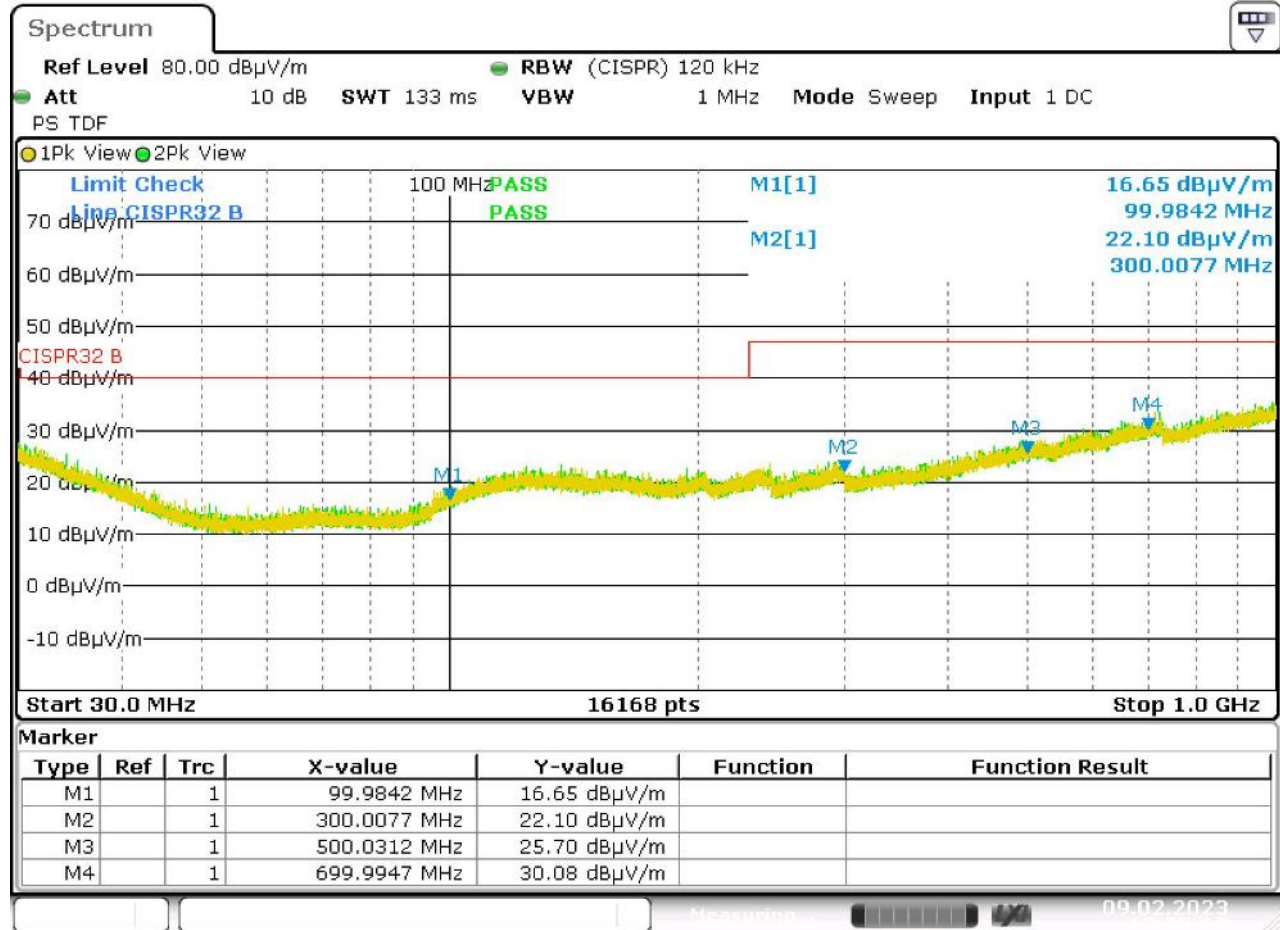


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EUT S/N:	Left bud	Power applied:		Plot#	2
EUT Mods:					
EUT Setup:					
Comments:	Position Y				

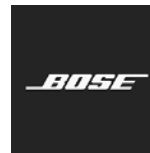


Date: 9.FEB.2023 13:58:19

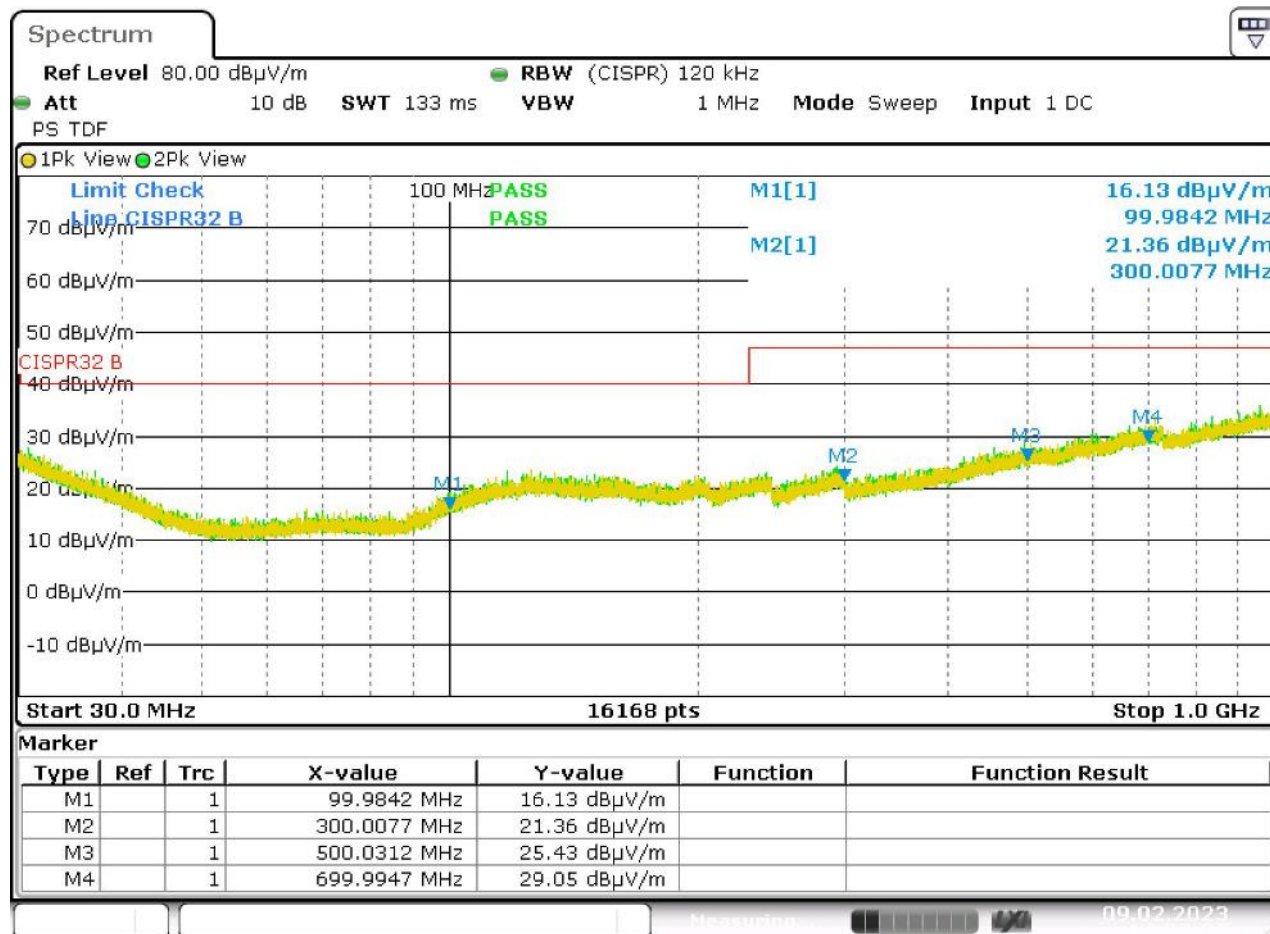


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EUT S/N:	Left bud	Power applied:		Plot#	3
EUT Mods:					
EUT Setup:					
Comments:	Position Z				



Date: 9.FEB.2023 14:07:37



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Limits:

Standard	Freq Range (MHz)	Limits (dBuV QP ¹)			Comments
		Class A		Class B	Measurements above 1 GHz are made using average and peak detectors.
		10 m	3 m ²	3 m	
FCC §15.247 (d) RSS-247 Section 5.5	30-88	39	49	40	Mains cables draped to floor, not bundled. *For measurements above 1 GHz, peak limits must also be met that are 20 dB higher than average limits.
	88-216	43.5	53.5	43.5	
	216-960	46.5	56.5	46	
	>960	49.5*	59.5*	54*	
bandwidth and Detector Settings:					
Freq. Range (MHz)	RBW (kHz)	VBW (kHz)	Detector		
30 – 1000	120	>300	QP		
> 1000	1000	>1000	Pk and AVG		

Equipment Used:

TN	Description	Model	S/N	Manufacturer	Most Recent Calibration	Calibration Due Date	Most Recent Verification	Verification Due Date
1541	Antenna 30MHz - 6GHz	JB6	A050807	Sunol Sciences Corp	14-Dec-2021	14-Dec-2023		
3062	RF Cable 10MHz-18GHz, low loss LL142 coax, 26 feet, "N" connectors	SCE18110505-312	N/A	Fairview Microwave[2]			01-Sep-2022	01-Sep-2023
2077	Maxwell House RE Pre-amp (20MHz-3GHz)	N/A	N/A	Bose Corporation			01-Sep-2022	01-Sep-2023
2319	EMI Test Receiver	ESR26	101276	Rohde & Schwarz	29-Mar-2023	28-Mar-2024		

Uncertainty:

Uncertainty Budget				
Title:	Radiated RF Emissions (30MHz-1GHz)			
Source of Uncertainty	Value units:± dB	Distribution	Divisor	Uncertainty (± dB)
Receiver - absolute level	0.3	Rect.	1.73	0.17
Receiver - frequency response	0.8	Rect.	1.73	0.46
Receiver - attenuator switching	0.2	Rect.	1.73	0.12
Receiver - bandwidth switching	0.2	Rect.	1.73	0.12
Receiver - display	0.5	Rect.	1.73	0.29
Antenna factor	0.8	Norm.	2.00	0.38
Antenna directivity	1.0	Norm.	2.00	0.50
Preamplifier correction factor	0.5	Norm.	2.00	0.25
Cable correction factor	0.5	Norm.	2.00	0.25
Site imperfection - NSA	4.0	Triang.	2.45	1.63
Test table impact	1.1	Rect.	1.73	0.64
Combined uncertainty (RSS):				1.98
Coverage factor (2 sigma):				2.00
Extended uncertainty (95% confidence):				3.97

Radiated Spurious Emissions 1-25GHz

Project number (Integrity):	408L	Build Phase:	C1.5		
Tested by:	Mike Royer		Date:	June 12, 2023	
Requirements Standard(s):	FCC §15.247 (d) RSS-247 Section 5.5		Referenced Standard(s):		ANSI C63.10-2013
					6.3 – 6.6
					6.10.5 RBE
					4.1.4.2.3 Reduced video BW method for average.
EUT powered with:	Battery	Temp / Humidity:	N/A	Test location:	Marconi Manor
Test equipment used TN's:	1663,3685,2349,2602,2414				
EUT Serial number(s):	Left	084803M3051D038A1			
	Right	084808M3051D019A1			
EUT Software installed:	0.4.10				
EUT Modification(s):	USB Debug wires were attached to the earbud to allow control of the radio.				

Conclusion:

The Bose model 408L passes radiated emissions from 1-25GHz.

The peak emissions maximum is below the average limit in all cases.

1-18 GHz, the maximum emission was 53.1 dBuV/m peak, noise floor. The limit is 54 dBuV/m and the margin is 0.9 dB.

18-25 GHz. The maximum emission was 62.1. The limit is 74 dBuV/m, and the margin is 11.9 dB.

Procedure:

Per 558074 D01 15.247 Meas Guidance v05r02:

Each mode tested was measured at all 10 Harmonics, at the low, middle, and high transmit frequencies.

EUT was taped to a bamboo skewer and stuck into the test support at 150cm above the floor. From there the table was rotated and the antenna scanned up down and horizontal and vertical polarizations.

A notch filter was used to block the fundamental emission from overloading the measurement equipment including the pre-amplifier and the spectrum analyzer.

The duty cycle used is shown in the table on page 6.

Limit calculation:

The E field in the far field observes the inverse square law. So that the difference in field strength difference in decibels is;

$$20 \log \left(\frac{D1}{D2} \right) = 20 \log 10 = 20$$

Peak limit of 74 becomes 94 dBuV at 30cm.

Average limit of 54 becomes 74 dBuV at 30cm.



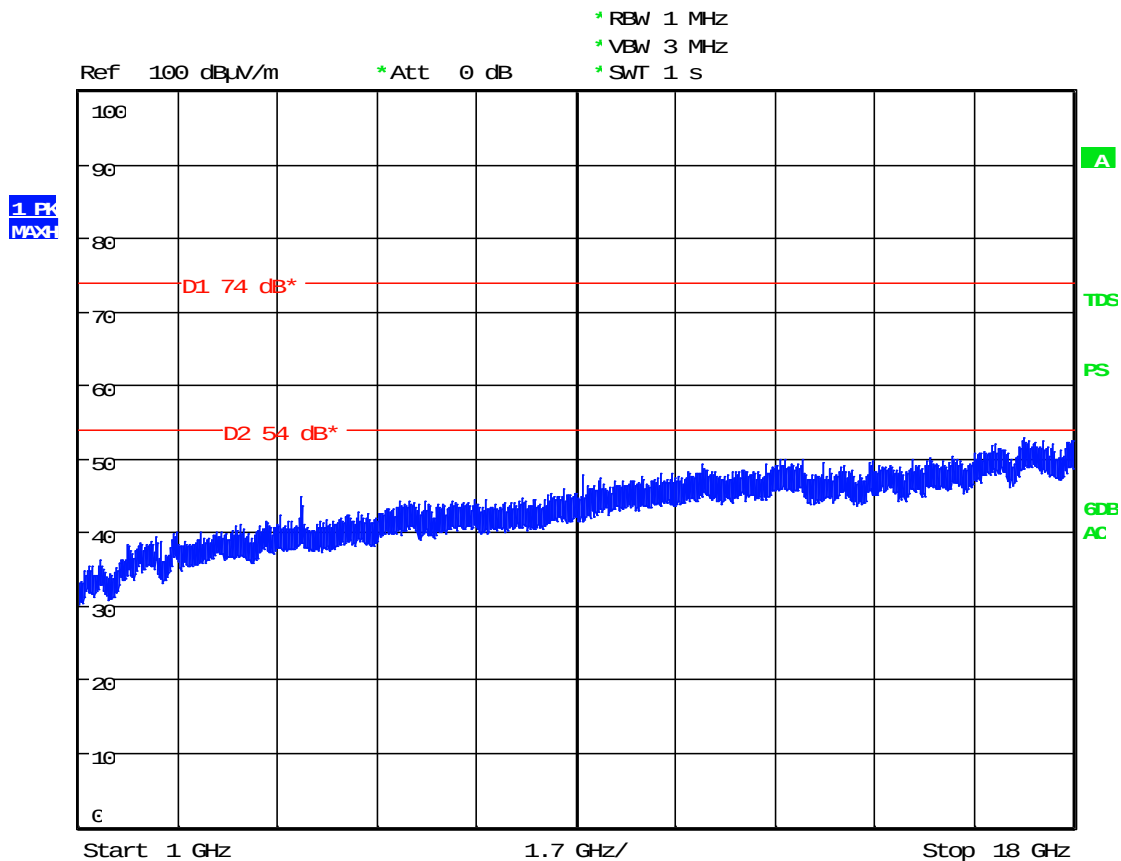
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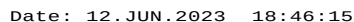


Data Collection:

EUT S/N:	Left	Power applied:	Battery		Plot#	1
EUT Mods:	None					
EUT Setup:	QHS P2 Low channel					
Comments:	2.4 GHz band reject filter included to suppress the fundamental.					



Date: 12. JUN. 2023 15:05:01



FCC 15.247d and RSS-247 Section 5.5 @ 3 Meters

MK #	Emission Frequency (MHz)	Measured Amplitude (dBµV/m) QP/AVG*	Measured Amplitude (dBµV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBµV/m) QP/AVG*	Limit (dBµV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	4808	35.60	46.10	54.0	74.0	18.4	27.9	0	V	1.50	Signal Maximized
2	7212	31.40	44.80	54.0	74.0	22.6	29.2	0	H	1.50	Noise floor
3	9617	37.90	49.80	54.0	74.0	16.1	24.2	0	H	1.50	Signal Maximized
4	12020	35.30	48.20	54.0	74.0	18.7	25.8	0	V	1.50	Noise floor
5	14424	34.80	48.10	54.0	74.0	19.2	25.9	0	H	1.50	Noise floor
6	16828	38.20	51.30	54.0	74.0	15.8	22.7	0	V	1.50	Noise floor

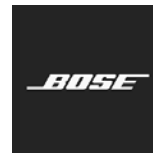
FCC 15.247d and RSS-247 Section 5.5 @ 30 cm

MK #	Emission Frequency (MHz)	Measured Amplitude (dBµV/m) QP/AVG*	Measured Amplitude (dBµV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBµV/m) QP/AVG*	Limit (dBµV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	19232	42.80	55.80	74.0	94.0	31.2	38.2				Noise floor
2	21636	40.80	54.80	74.0	94.0	33.2	39.2				Noise floor
3	24040	43.00	57.20	74.0	94.0	31.0	36.8				Noise floor



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EUT S/N:	Left	Power applied:	Battery		Plot#	2
EUT Mods:						
EUT Setup:	QHS P2 Mid channel					
Comments:						

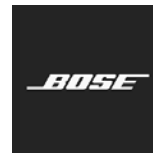
FCC 15.247d and RSS-247 Section 5.5 @ 3 Meters											
MK #	Emission Frequency (MHz)	Measured Amplitude (dBμV/m) QP/AVG*	Measured Amplitude (dBμV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBμV/m) QP/AVG*	Limit (dBμV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	4880	34.90	46.00	54.0	74.0	19.1	28.0	0	V	1.50	Signal Maximized
2	7320	31.90	44.80	54.0	74.0	22.1	29.2	0	H	1.50	Noise floor
3	9761	38.30	50.40	54.0	74.0	15.7	23.6	0	H	1.50	Signal Maximized
4	12198	38.00	51.20	54.0	74.0	16.0	22.8	0	H	1.50	Signal Maximized
5	14640	36.10	49.60	54.0	74.0	17.9	24.4	0	V	1.50	Noise floor
6	17080	38.80	52.20	54.0	74.0	15.2	21.8	0	H	1.50	Noise floor

FCC 15.247d and RSS-247 Section 5.5 @ 30 cm											
MK #	Emission Frequency (MHz)	Measured Amplitude (dBμV/m) QP/AVG*	Measured Amplitude (dBμV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBμV/m) QP/AVG*	Limit (dBμV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	19520	40.90	53.80	74.0	94.0	33.1	40.2	0	H	1.50	Noise floor
2	21960	40.20	53.60	74.0	94.0	33.6	40.3	0	H	1.50	Noise floor
3	24400	40.40	53.70	74.0	94.0	33.6	40.3	0	H	1.50	Noise floor



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EUT S/N:	Left	Power applied:	Battery		Plot#	3
EUT Mods:						
EUT Setup:	QHS P2 High channel					
Comments:						

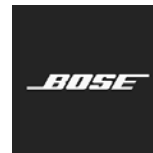
FCC 15.247d and RSS-247 Section 5.5 @ 3 Meters											
MK #	Emission Frequency (MHz)	Measured Amplitude (dBμV/m) QP/AVG*	Measured Amplitude (dBμV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBμV/m) QP/AVG*	Limit (dBμV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	4956	34.10	45.10	54.0	74.0	19.9	28.9	0	V	1.50	Signal Maximized
2	7434	32.20	46.30	54.0	74.0	21.8	27.7	0	H	1.50	Noise floor
3	9913	41.10	51.50	54.0	74.0	12.9	22.5	0	H	1.50	Signal Maximized
4	12388	36.70	49.80	54.0	74.0	17.3	24.2	0	H	1.50	Signal Maximized
5	14868	36.90	50.30	54.0	74.0	17.1	23.7	0	V	1.50	Noise floor
6	17346	39.50	53.10	54.0	74.0	14.5	20.9	0	H	1.50	Noise floor

FCC 15.247d and RSS-247 Section 5.5 @ 30 cm											
MK #	Emission Frequency (MHz)	Measured Amplitude (dBμV/m) QP/AVG*	Measured Amplitude (dBμV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBμV/m) QP/AVG*	Limit (dBμV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	19824	41.00	54.70	74.0	94.0	33.0	39.3				Noise floor
2	22302	40.60	55.10	74.0	94.0	33.4	38.9				Noise floor
3	24780	40.40	53.70	74.0	94.0	33.6	40.3				Noise floor



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DESIGN ASSURANCE ENGINEERING COMPLIANCE EMC TEST REPORT



EUT S/N:	Left	Power applied:	Battery		Plot#	4
EUT Mods:						
EUT Setup:	QHS P6 Low channel					
Comments:						

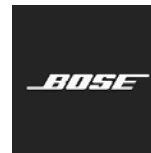
FCC 15.247d and RSS-247 Section 5.5 @ 3 Meters											
MK #	Emission Frequency (MHz)	Measured Amplitude (dBμV/m) QP/AVG*	Measured Amplitude (dBμV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBμV/m) QP/AVG*	Limit (dBμV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	4808	34.60	46.10	54.0	74.0	19.4	27.9	0	V	1.50	Signal Maximized
2	7212	31.50	44.90	54.0	74.0	22.5	29.1	0	H	1.50	Noise floor
3	9616	37.20	50.00	54.0	74.0	16.8	24.0	0	V	1.50	Signal Maximized
4	12020	35.40	48.70	54.0	74.0	18.6	25.3	0	H	1.50	Noise floor
5	12020	35.40	48.70	54.0	74.0	18.6	25.3	0	V	1.50	Noise floor
6	16828	38.20	51.30	54.0	74.0	15.8	22.7	0	H	1.50	Noise floor

FCC 15.247d and RSS-247 Section 5.5 @ 30 cm											
MK #	Emission Frequency (MHz)	Measured Amplitude (dBμV/m) QP/AVG*	Measured Amplitude (dBμV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBμV/m) QP/AVG*	Limit (dBμV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	19232	46.30	59.20	74.0	94.0	27.7	34.8				Noise floor
2	21636	40.70	54.60	74.0	94.0	33.3	39.4				Noise floor
3	24040	42.70	57.50	74.0	94.0	31.3	36.5				Noise floor



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EUT S/N:	Left	Power applied:	Battery		Plot#	5
EUT Mods:						
EUT Setup:	QHS P6 Mid channel					
Comments:						

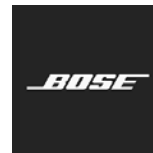
FCC 15.247d and RSS-247 Section 5.5 @ 3 Meters											
MK #	Emission Frequency (MHz)	Measured Amplitude (dBμV/m) QP/AVG*	Measured Amplitude (dBμV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBμV/m) QP/AVG*	Limit (dBμV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	4880	35.20	46.90	54.0	74.0	18.8	27.1	0	V	1.50	Signal Maximized
2	7320	31.90	45.30	54.0	74.0	22.1	28.7	0	H	1.50	Noise floor
3	9760	37.70	50.40	54.0	74.0	16.3	23.6	0	H	1.50	Signal Maximized
4	12200	36.20	49.30	54.0	74.0	17.8	24.7	0	V	1.50	Noise floor
5	14640	36.10	49.80	54.0	74.0	17.9	24.2	0	H	1.50	Noise floor
6	17080	38.80	52.30	54.0	74.0	15.2	21.7	0	V	1.50	Noise floor

FCC 15.247d and RSS-247 Section 5.5 @ 30 cm											
MK #	Emission Frequency (MHz)	Measured Amplitude (dBμV/m) QP/AVG*	Measured Amplitude (dBμV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBμV/m) QP/AVG*	Limit (dBμV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	19520	50.10	62.10	74.0	94.0	23.9	31.9				Noise floor
2	21960	40.70	54.20	74.0	94.0	33.3	39.8				Noise floor
3	24400	41.60	55.60	74.0	94.0	32.4	38.4				Noise floor



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DESIGN ASSURANCE ENGINEERING COMPLIANCE EMC TEST REPORT



EUT S/N:	Left	Power applied:	Battery		Plot#	6
EUT Mods:						
EUT Setup:	QHS P6 High channel					
Comments:						

FCC 15.247d and RSS-247 Section 5.5 @ 3 Meters											
MK #	Emission Frequency (MHz)	Measured Amplitude (dBμV/m) QP/AVG*	Measured Amplitude (dBμV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBμV/m) QP/AVG*	Limit (dBμV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	4956	33.50	45.00	54.0	74.0	20.5	29.0	0	V	1.50	Signal Maximized
2	7434	32.20	45.40	54.0	74.0	21.8	28.6	0	H	1.50	Noise floor
3	9912	35.60	48.40	54.0	74.0	18.4	25.6	0	V	1.50	Signal Maximized
4	12390	34.90	48.50	54.0	74.0	19.1	25.5	0	H	1.50	Noise floor
5	14868	36.90	50.60	54.0	74.0	17.1	23.4	0	V	1.50	Noise floor
6	17346	39.50	52.70	54.0	74.0	14.5	21.3	0	H	1.50	Noise floor

FCC 15.247d and RSS-247 Section 5.5 @ 30 cm											
MK #	Emission Frequency (MHz)	Measured Amplitude (dBμV/m) QP/AVG*	Measured Amplitude (dBμV/m) Peak	FCC 15.247d and RSS-247 Section 5.5				Table Azimuth (0°closest to ant)	Receiving Antenna		*Average detector used for frequencies above 1 GHz. Notes/Mode
				Limit (dBμV/m) QP/AVG*	Limit (dBμV/m) Peak	Margin (dB) QP/AVG	Margin (dB) Peak		Pol (H/V)	Height (Meters)	
1	19824	40.90	54.60	74.0	94.0	33.1	39.4				Noise floor
2	22302	40.40	54.20	74.0	94.0	33.6	39.8				Noise floor
3	24780	40.20	53.90	74.0	94.0	33.8	40.1				Noise floor

Limits:

Standard	Freq Range (MHz)	Limits (dBuV QP ¹)			Comments
		Class A		Class B	
		10 m	3 m	3 m	
FCC 15.247d and RSS-247 Section 5.5	30-88	39	49	40	Measurements above 1 GHz are made using average and peak detectors. Mains cables draped to floor, not bundled. *For measurements above 1 GHz, peak limits must also be met that are 20 dB higher than average limits.
	88-216	43.5	53.5	43.5	
	216-960	46.5	56.5	46	
	>960	49.5*	59.5*	54*	
Bandwidth and Detector Settings:					
Freq. Range (MHz)	RBW (kHz)	VBW (kHz)	Detector		
30 – 1000	120	>300	QP		
> 1000	1000	>1000	Pk and AVG		



Certificate # 1514.1

DESIGN ASSURANCE ENGINEERING COMPLIANCE EMC TEST REPORT



Equipment Used:

TN	Description	Model	S/N	Manufacturer	Most Recent Calibration	Calibration Due Date	Most Recent Verification	Verification Due Date
1663	EMI Test Receiver	ESU40	100098	Rohde & Schwarz	20-Mar-2023	19-Mar-2024		
3685	Marconi Manor 3M mast position RE cable set	3 cables (TN's 2373, 2479, 2357)					28-Mar-2023	27-Mar-2024
2349	Double Ridge Waveguide Horn Antenna 1-18GHz	3117	00152406	ETS Lindgren	24-Feb-2023	23-Feb-2025		
2602	Miteq pre-amp 1-18GHz 35dB	AFS42-01001800-28-10P-42	N/A	Miteq			07-Jul-2022	07-Jul-2023
2414	Band Reject Filter (2.4GHz)	BRM50702-07	003	Micro-Tronics	13-Jan-2015		28-Mar-2023	27-Mar-2024
1757	18GHz-40GHz Preamp	JS4018004000-30-8P-A1	1406279	Miteq			07-Jul-2022	07-Jul-2023
1596	Horn Antenna 18GHz - 26.5GHz	AT4640	309234	Amplifier Research				
2368	RF Cable 30MHz-26.5GHz	TRU-210	TRU-12767-35	TRU Corporation			28-Mar-2023	27-Mar-2024

Uncertainty:

Uncertainty Budget				
Title:	Radiated Emissions (>1GHz)			
Source of Uncertainty	Value units:± dB	Distribution	Divisor	Uncertainty (± dB)
Receiver - absolute level	0.3	Rect.	1.73	0.17
Receiver - frequency response	2.0	Rect.	1.73	1.16
Receiver - attenuator switching	0.2	Rect.	1.73	0.12
Receiver - bandwidth switching	0.2	Rect.	1.73	0.12
Receiver - display	0.5	Rect.	1.73	0.29
Antenna factor	0.4	Norm.	2.00	0.20
Antenna directivity	1.0	Norm.	2.00	0.50
Preamp correction factor	0.5	Norm.	2.00	0.25
Cable correction factor	0.5	Norm.	2.00	0.25
Site imperfection - NSA	3.0	Triang.	2.45	1.22
Test table impact	1.7	Rect.	1.73	0.98
Combined uncertainty (RSS):				2.09
Coverage factor (2 sigma):				2.00
Extended uncertainty (95% confidence):				4.17

Radiated Band Edge

Project number (Integrity):	408L	Build Phase:	C1.5		
Tested by:	Mike Royer		Date:	2 June, 2023	
Requirements Standard(s):	FCC §15.247 (d) RSS -247 Section 5.5		Referenced Standard(s):		ANSI C63.10-2013
EUT powered with:	Battery	Temp / Humidity:	N/A	Test location:	Marconi Manor
Test equipment used TN's:	1663,2929,2349,3685				
EUT Serial number(s):	084803M3051E021A1				
EUT Software installed:	1.4.10+g2edc594				
EUT Modification(s):	USB Debug wires were attached to the earbud to allow control of the radio.				

Conclusion:

The Bose model 408L passes Radiated Band Edge.

Procedure:

The EUT was taped to a bamboo skewer and stuck into the test support at 150cm above the floor. From there the table was rotated and the antenna scanned up down and horizontal and vertical polarizations.

A low gain pre-amp was used to ensure that overloading was avoided. Care was taken in selecting input attenuation and reference level to avoid compression.

For lower band edge measurements, the transmit frequency was 2402 MHz.

For upper band edge measurements, the transmit frequency was 2480 MHz.

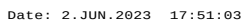
The duty cycle used is shown in the table on page 6.

ANSI C63.10-2013 4.1.4.2.3: Reduced video bandwidth method used for making average measurements for lower and upper adjacent restricted bands



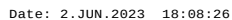
QHS-P2 low channel band edge.

Peak emissions are below the average limit.



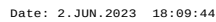
QHS-P2 high channel band edge Peak measurement

Peak emissions are not above the average limit, see next page for reduced video bandwidth method.

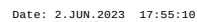




Reduced video bandwidth method. (VBW = 10 kHz > 1/Ton).



Peak emissions are below the average limit.





Limits:

Standard	Freq Range (MHz)	Limits (dBuV QP ¹)			Comments
		Class A		Class B	
		10 m	3 m	3 m	
or RSS-GEN	30-88	39	49	40	Measurements above 1 GHz are made using average and peak detectors. Mains cables draped to floor, not bundled. *For measurements above 1 GHz, peak limits must also be met that are 20 dB higher than average limits.
	88-216	43.5	53.5	43.5	
	216-960	46.5	56.5	46	
	>960	49.5*	59.5*	54*	
CISPR 32			Class A	Class B	Mains cables bundled not draped to floor. *For measurements above 1 GHz, peak limits must also be met that are 20 dB higher than average limits.
			3 m	3 m	
	30-230		50	40	
	230-1000		57	47	
	Freq Range (GHz)				
	1-3		56*	50*	
	3-6		60*	54*	
Bandwidth and Detector Settings:					
Freq. Range (MHz)	RBW (kHz)	VBW (kHz)	Detector		
30 – 1000	120	>300	QP		
> 1000	1000	>1000	Pk and AVG		

Equipment Used:

TN	Description	Model	S/N	Manufacturer	Most Recent Calibration	Calibration Due Date	Most Recent Verification	Verification Due Date
1663	EMI Test Receiver	ESU40	100098	Rohde & Schwarz	20-Mar-2023	19-Mar-2024		
2929	Mini-circuits band-edge pre-amp 300 MHz - 8 GHz 20 dB	ZX60HV-83LN+	N/A	Mini-Circuits			28-Mar-2023	27-Mar-2024
2349	Double Ridge Waveguide Horn Antenna 1-18GHz	3117	00152406	ETS Lindgren	24-Feb-2023	23-Feb-2025		
3685	Marconi Manor 3M mast position RE cable set	3 cables (TN's 2373, 2479, 2357)					28-Mar-2023	27-Mar-2024

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Uncertainty Budget				
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Antenna factor	0.4	Norm.	2.00	0.20
Antenna directivity	1.0	Norm.	2.00	0.50
Preamplifier correction factor	0.5	Norm.	2.00	0.25
Cable correction factor	0.5	Norm.	2.00	0.25
Site imperfection - NSA	3.0	Triang.	2.45	1.22
Test table impact	1.7	Rect.	1.73	0.98
Combined uncertainty (RSS):				2.09
Coverage factor (2 sigma):				2.00
Extended uncertainty (95% confidence):				4.17

End of report