



Certificate # 1514.1

PRODUCT ASSURANCE ENGINEERING  
COMPLIANCE  
EMC TEST REPORT



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.441408.23.167.3*

General Comments/Special Test Conditions:  
This report relates only to the items tested.

	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.



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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.*

EUT Condition

*Product was as built in the factory. And 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.*

Bluetest3 Version

*Bluesuite 3.3.12*

Setup (Cables and Accessories)

### Support Equipment List

Description	Manufacturer	Model	Serial Number	FCC ID
AC Adapter	Bose	S008VU0500160	072246Z00802252AE	N/A

Test Objective:

Verify product meets all applicable EMC requirements for the Bluetooth Low Energy mode.

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.



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# Test Results Summary

TEST NAME	TEST RESULT PASS or N/A	COMMENT(S)
On Time and Duty Cycle	N/A	No limits, for information only
99% Occupied Bandwidth	N/A	No limits, for information only
6dB Occupied Bandwidth	Pass	
Output Power	Pass	
Power Spectral Density	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:

Display Exhibits	Display Correspondence	Display Scopes	Firm Name	Location	Accreditation	MRA Designation Number	Expiration Date	Contact Title	Contact	Address	P.O. Box	Mail Stop	City	State	Zip	Country	E-mail Address	Phone Number	Fax Number
		<a href="#">Scopes</a>	<a href="#">Bose Corporation</a>	1 New York Avenue, Framingham, MA	American Association for Laboratory Accreditation	N/A US1088	07/31/2022	Mr. Quality Best	Cable 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:

Organization	CAB identifier	Scope/Recognition Date (yyyy-mm-dd)	Expiration (yyyy-mm-dd)
<b>BOSE CORPORATION</b>  1 New York Avenue Framingham, MA 01701 UNITED STATES  <b>Company Number: 3232A</b>  Contact: Mario Espinal <a href="mailto:mario_espinal@bose.com">mario_espinal@bose.com</a>	US0210	RSS-GEN (2019-02-11)  RSS-210 (2019-02-11) RSS-247 (2019-02-11) RSS-248 (2021-11-19)	<b>RECOGNIZED UNTIL: 2022-07-31</b>  A2LA ISO/IEC 17025:2017 Expires: 2022-07-31



# RF Conducted Measurements

## On Time and Duty Cycle

<b>Model number</b>	408L	<b>Build Phase:</b>	C1.5		
<b>Tested by:</b>	Mike Royer	<b>Date:</b>	May 12, 2023		
<b>Requirements Standard(s):</b>		<b>Referenced Standard(s):</b>	ANSI C63.10-2013		
<b>EUT powered with:</b>	5V USB	<b>Temp / Humidity:</b>	n/a	<b>Test location:</b>	Braun Room
<b>Test equipment used TN's:</b>	2409				
<b>EUT Serial number(s):</b>	084803M3051E021A1				
<b>EUT Software installed:</b>	1.4.10+g2edc594				
<b>EUT Modification(s):</b>	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.

### Data Collection:

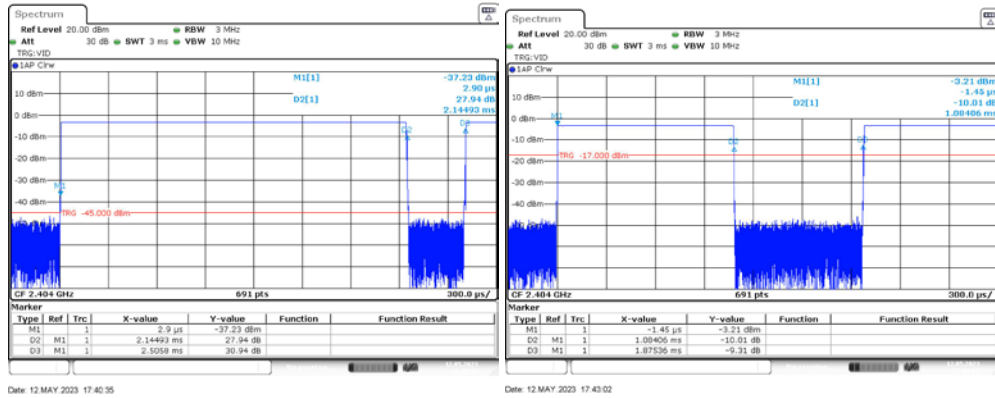
Duty cycles shown in the table below represent maximum duty cycle in test mode using maximum packet length.

Mode	ON Time (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	1/Ton Hz
BLE 1M	2.115	2.506	.844	84	466
BLE 2M	1.084	1.875	.578	58	922



BLE 1M

BLE 2M



## 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



# 99% Occupied Bandwidth

<b>Model number</b>	408L	<b>Build Phase:</b>	C1.5		
<b>Tested by:</b>	Mike Royer	<b>Date:</b>	15 May 2023		
<b>Requirements Standard(s):</b>	CFR 47 Part 15.247	<b>Referenced Standard(s):</b>	ANSI C.63.10-2013 6.9.3		
<b>EUT powered with:</b>	5V USB	<b>Temp / Humidity:</b>	n/a	<b>Test location:</b>	Braun Room
<b>Test equipment used TN's:</b>	2409				
	084803M3051E021A1	084803M3051E021A1			
<b>EUT Software installed:</b>	1.4.10+g2edc594				
<b>EUT Modification(s):</b>	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.				

## Conclusion:

This test is for information only.

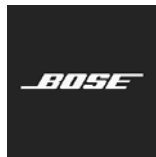
## Limits:

None; for reporting purposes only.



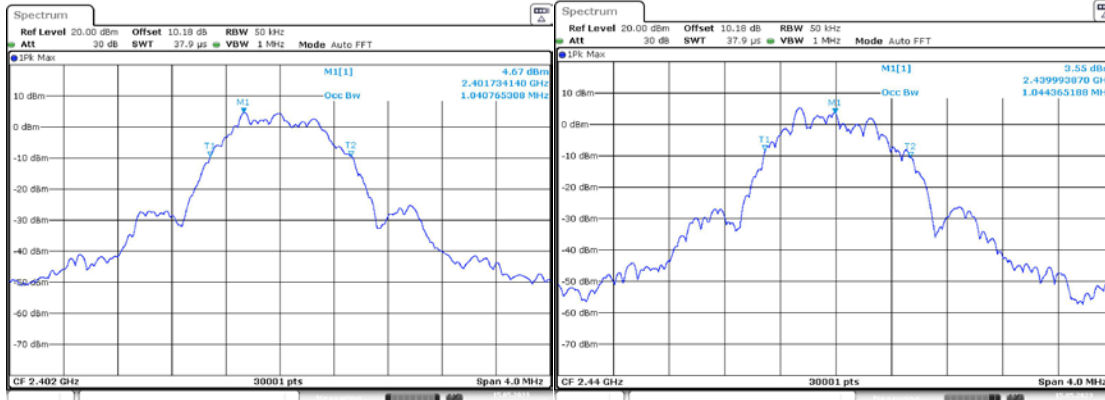
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# DESIGN ASSURANCE ENGINEERING COMPLIANCE EMC TEST REPORT



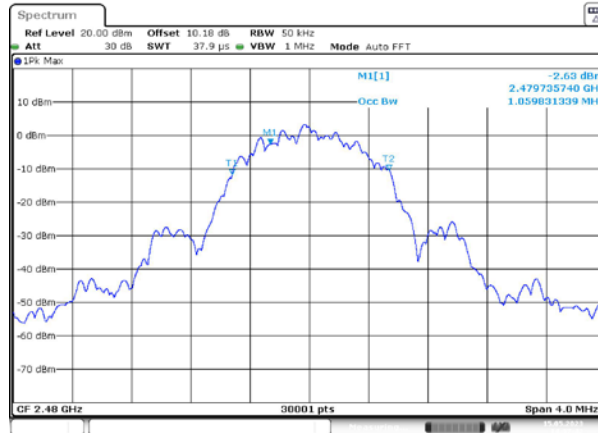
## BLE 1M Data Collection:

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.041
Middle	2441	1.044
High	2480	1.060



Date: 15 MAY 2023 14:34:16

Date: 15 MAY 2023 14:36:23

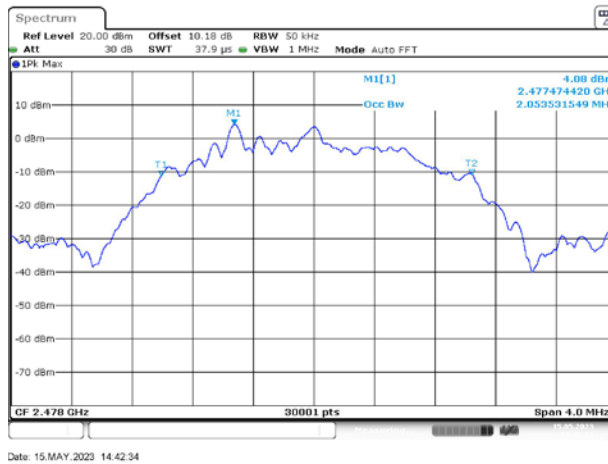
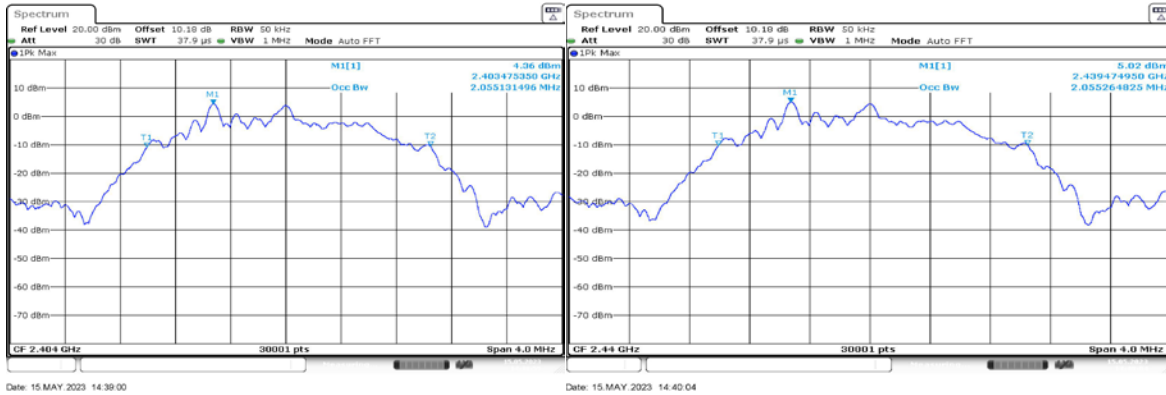


Date: 15 MAY 2023 14:37:42



# BLE 2M Data Collection:

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	2.050
Middle	2441	2.054
High	2478	2.050



# 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



# 6dB Occupied Bandwidth

<b>Model</b>	408L	<b>Build Phase:</b>	C1.5		
<b>Tested by:</b>	Mike Royer	<b>Date:</b>	May 19, 2023		
<b>Requirements Standard(s):</b>	FCC §15.247 (a) (2) RSS-247 5.2 (a)	<b>Referenced Standard(s):</b>	ANSI 63.10:2013 - 11.8		
<b>EUT powered with:</b>	5V USB	<b>Temp / Humidity:</b>	n/a	<b>Test location:</b>	Braun Room
<b>Test equipment used TN's:</b>	2409				
<b>EUT Serial number(s):</b>	084803M3051E021A1				
<b>EUT Software installed:</b>	1.4.10+g2edc594				
<b>EUT Modification(s):</b>	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.				

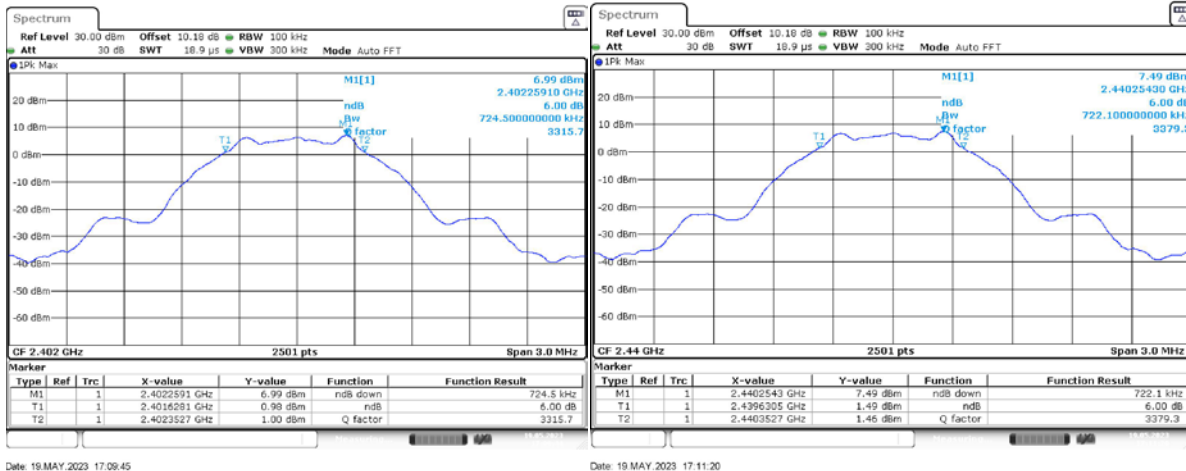
## Conclusion:

The lowest recorded 6dB bandwidth measured was 719 kHz which is more than the required minimum of 500 kHz by 219 kHz.

# Data Collection:

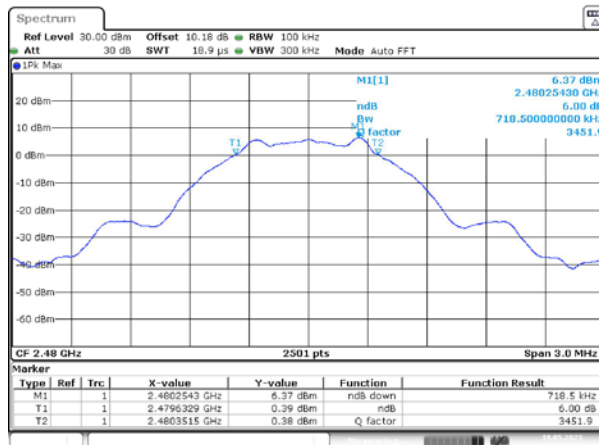
DTS Bandwidth Summary Table (BLE)						
Channel	Frequency MHz	Mode	DTS BW kHz	Limit kHz	Margin kHz	Result
Low	2402	BLE 1M	725	500	225	Pass
Middle	2440	BLE 1M	722	500	222	Pass
High	2480	BLE 1M	719	500	219	Pass
Low	2404	BLE 2M	1269	500	726	Pass
Middle	2440	BLE 2M	1269	500	769	Pass
High	2478	BLE 2M	1268	500	768	Pass

BLE 1M



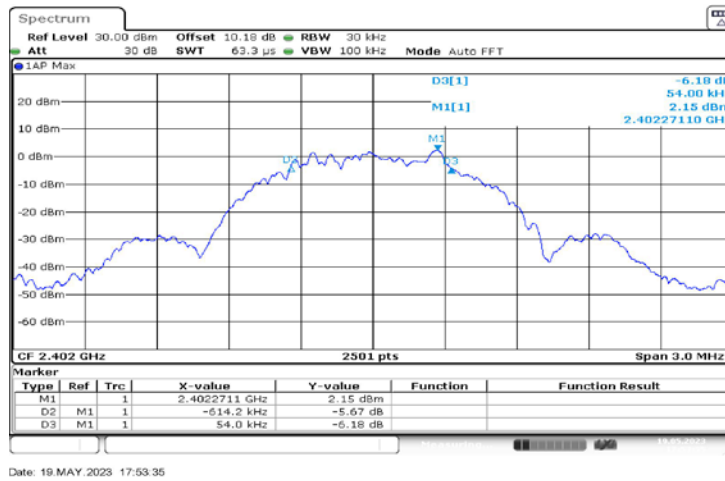
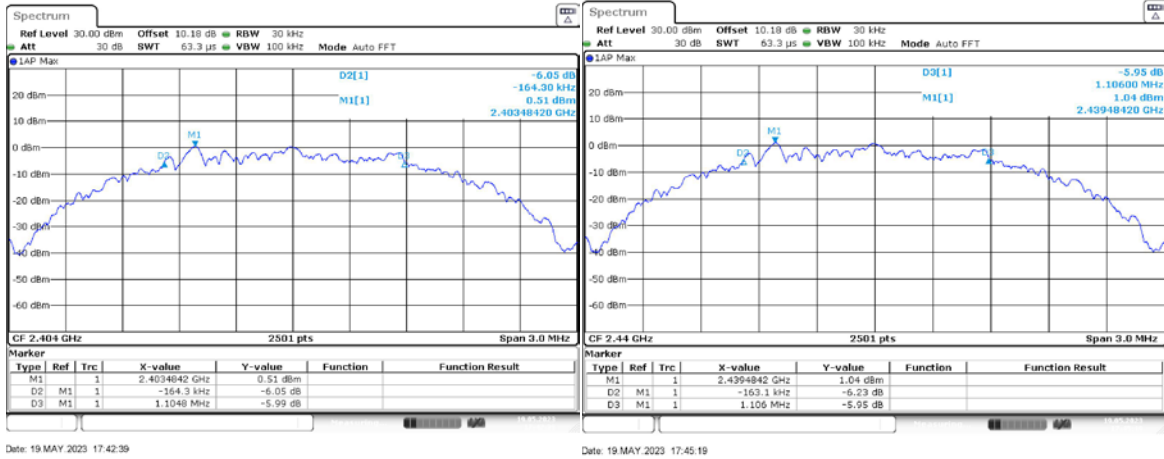
Date: 19.MAY.2023 17:09:45

Date: 19.MAY.2023 17:11:20



Date: 19.MAY.2023 17:12:19

BLE 2M



Limits:

FCC §15.247 (a) (2)

RSS-247 5.2 (a)

ANSI 63.10:2013 – 11.8

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

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



# Output Power

<b>Model number</b>	408L	<b>Build Phase:</b>	C1.5		
<b>Tested by:</b>	Mike Royer	<b>Date:</b>	17 May, 2023		
<b>Requirements Standard(s):</b>	FCC §15.247 (b) (3) RSS-247 5.4 (d)	<b>Referenced Standard(s):</b>	ANSI C63.10-2013 11.9.1.1		
<b>EUT powered with:</b>	5V USB	<b>Temp / Humidity:</b>	n/a	<b>Test location:</b>	Braun Room
<b>Test equipment used TN's:</b>	2409				
<b>EUT Serial number(s):</b>	084803M3051E021A1				
<b>EUT Software installed:</b>	1.4.10+g2edc594				
<b>EUT Modification(s):</b>	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.				

## Conclusion:

The Bose Model 408L passes output power by 22.29 dB.

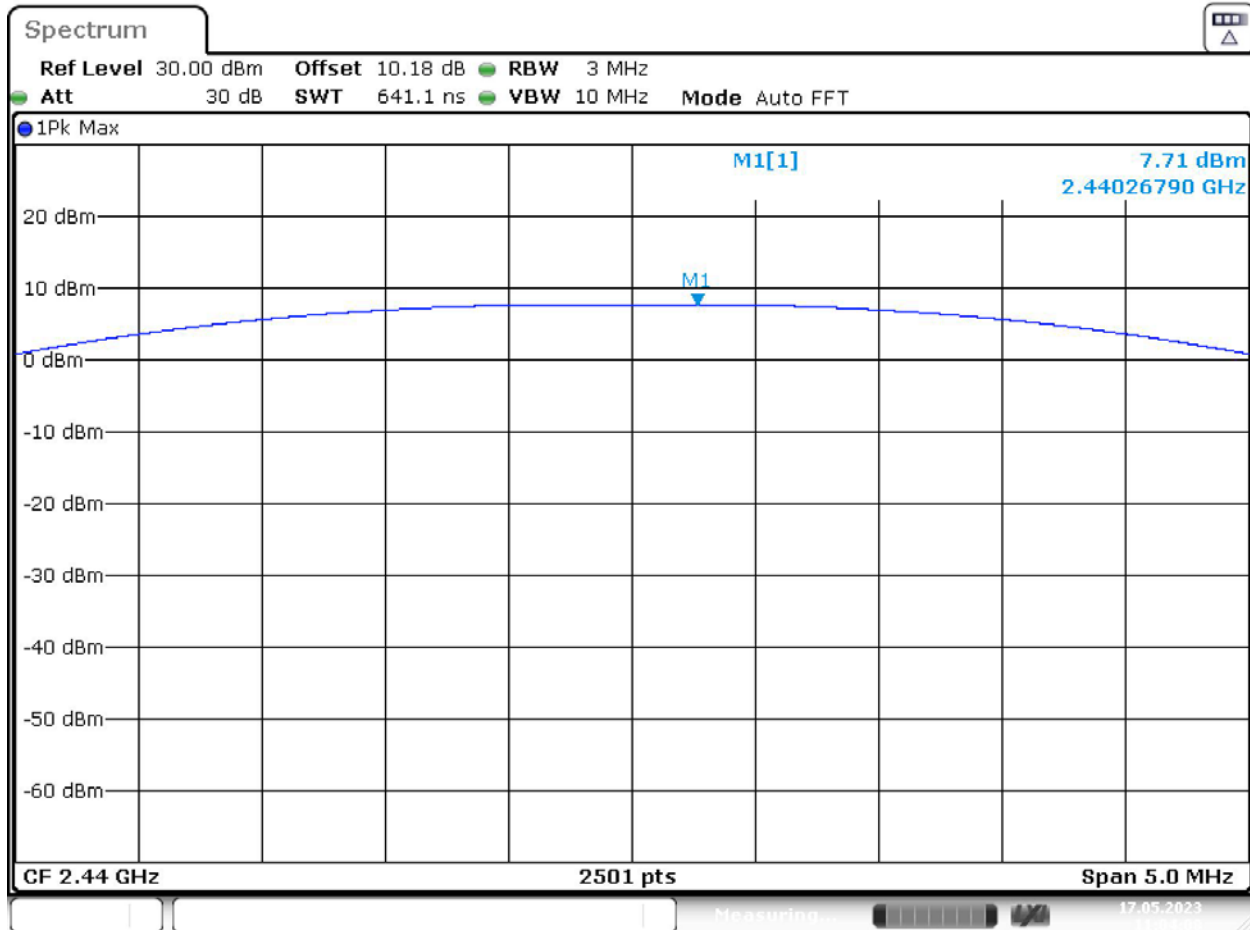
Method from ANSI C63.10-2013 section 11.9.1.1 was used.

Cable loss was accounted for in the Spectrum Analyzer offset.

# Data Collection:

Output Power Summary Table							
Channel	Frequency	Mode	Output Power dBm	Directional Gain dBi	Limit	Margin	Result
Low	2402	BLE 1M	7.27	1	30	22.73	Pass
Middle	2440	BLE 1M	7.71	1	30	22.29	Pass
High	2480	BLE 1M	6.47	1	30	23.53	Pass
Low	2404	BLE 2M	6.96	1	30	23.04	Pass
Middle	2440	BLE 2M	7.48	1	30	22.52	Pass
High	2478	BLE 2M	6.72	1	30	23.28	Pass

Example Plot, Mid, BLE 1M



Date: 17.MAY.2023 11:04:08



## Limits:

FCC §15.247 (b) (3)

RSS-247 5.4 (d)

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

## 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



# Power Spectral Density

<b>Model Number</b>	408L	<b>Build Phase:</b>	C1.5		
<b>Tested by:</b>	Mike Royer	<b>Date:</b>	May 17, 2023		
<b>Requirements Standard(s):</b>	FCC §15.247 (e) RSS-247 (5.2) (b)	<b>Referenced Standard(s):</b>	ANSI 63.10 (11.10.2)		
<b>EUT powered with:</b>	5V USB	<b>Temp / Humidity:</b>	n/a	<b>Test location:</b>	Braun Room
<b>Test equipment used TN's:</b>	2409				
<b>EUT Serial number(s):</b>	084803M3051E021A1				
<b>EUT Software installed:</b>	1.4.10+g2edc594				
<b>EUT Modification(s):</b>	Product was tested as built except the antenna was disconnected and a coaxial cable was installed.				

## Conclusion:

The Bose Model 408L passes spectral density by 0.65 dB.

Test method is ANSI C63.10-2013 (11.10.2)

The cable loss is accounted for in the Spectrum Analyzer offset. The earbud is set to transmit continuously, duty cycle = 100%.

## Limits:

FCC §15.247 (e)

RSS-247 (5.2) (b)

ANSI 63.10 (11.10.2)

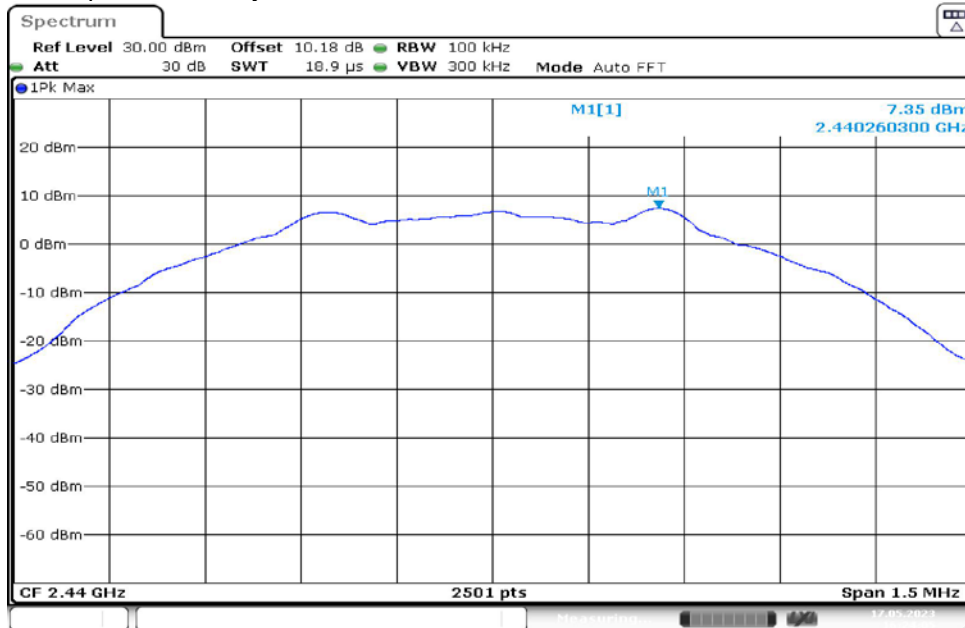
The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.



## Data Collection:

Mode	Channel	Frequency MHz	Max reading from SA dBm	Limit dBm	Margin dB	Result
BLE 1M	Low	2402	6.79	8	1.21	Pass
BLE 1M	Middle	2440	7.35	8	0.65	Pass
BLE 1M	High	2480	6.32	8	1.68	Pass
BLE 2M	Low	2404	6.56	8	1.44	Pass
BLE 2M	Middle	2440	7.16	8	0.84	Pass
BLE 2M	High	2478	6.37	8	1.63	Pass

BLE 1M Mid channel Power Spectral Density measurement.



## 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

<b>Model number:</b>	408L	<b>Build Phase:</b>	C1.5		
<b>Tested by:</b>	Mike Royer	<b>Date:</b>	July 19, 2023		
<b>Requirements Standard(s):</b>	FCC §15.247 (d) RSS-247 5.5	<b>Referenced Standard(s):</b>	ANSI 63.10 11.11		
<b>EUT powered with:</b>	5V USB	<b>Temp / Humidity:</b>	n/a	<b>Test location:</b>	Braun Room
<b>Test equipment used TN's:</b>	2409				
<b>EUT Serial number(s):</b>	084803M3051E021A1				
<b>EUT Software installed:</b>	1.4.10+g2edc594				
<b>EUT Modification(s):</b>	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

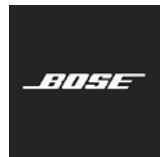
Output power was measured based on the use of a peak measurement; therefore, the required attenuation is 20 dB.

Note: Note that the BLE 2M rate does not support operation on channels 0 and 39 (2402, 2480).



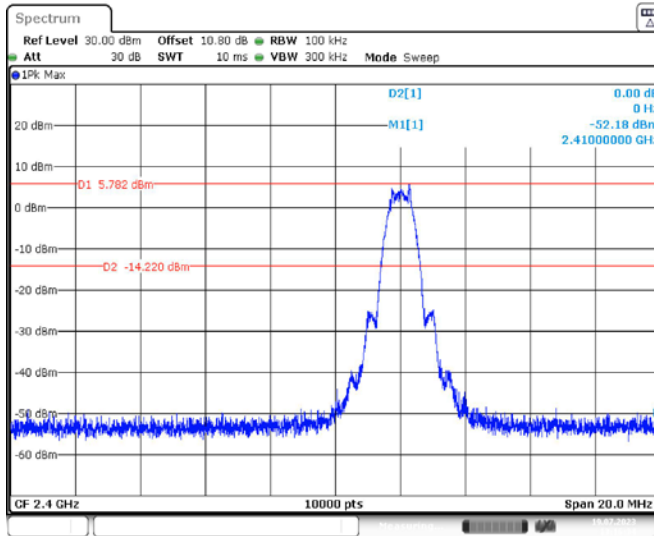
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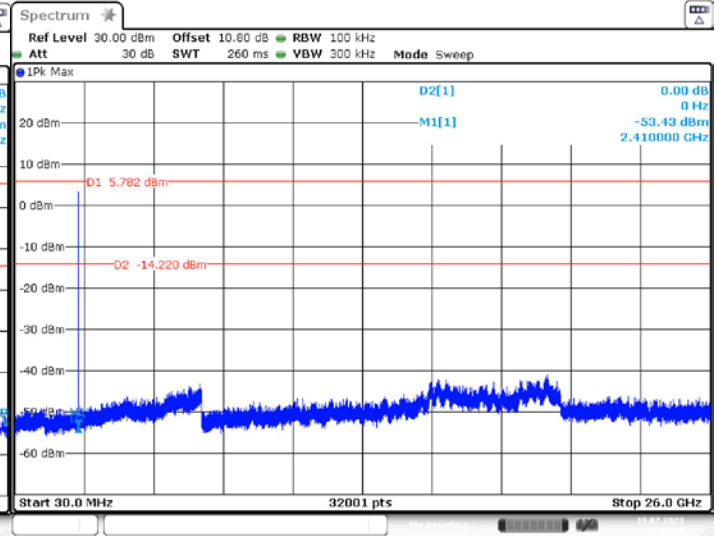
## Data Collection:

### BLE 1M LOW CHANNEL BANDEDGE



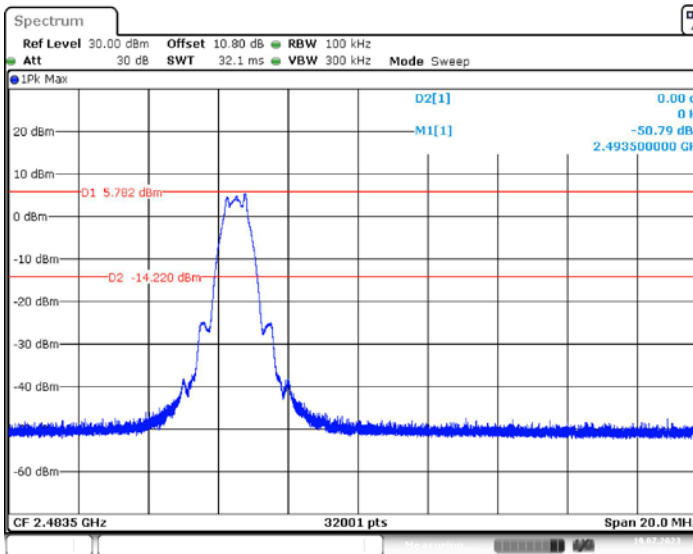
Date: 19 JUL 2023 13:16:35

### OUT-OF-BAND LOW CHANNEL



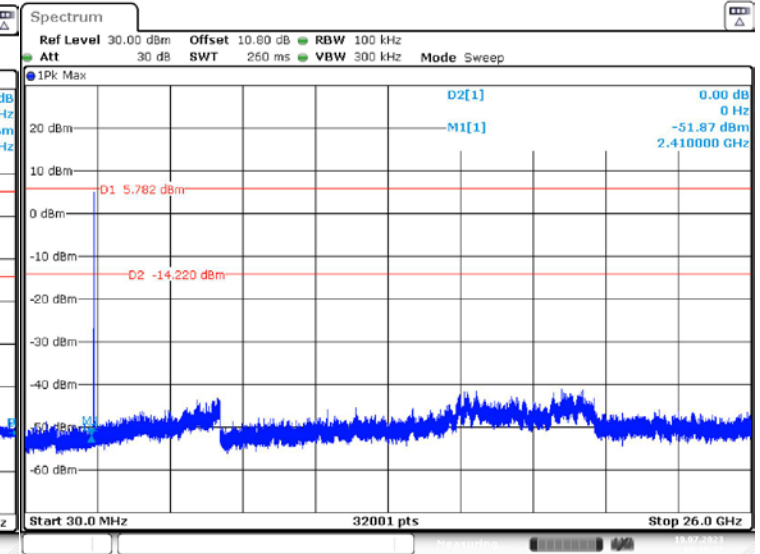
Date: 19 JUL 2023 13:17:54

### BLE 1M HIGH CHANNEL BANDEDGE



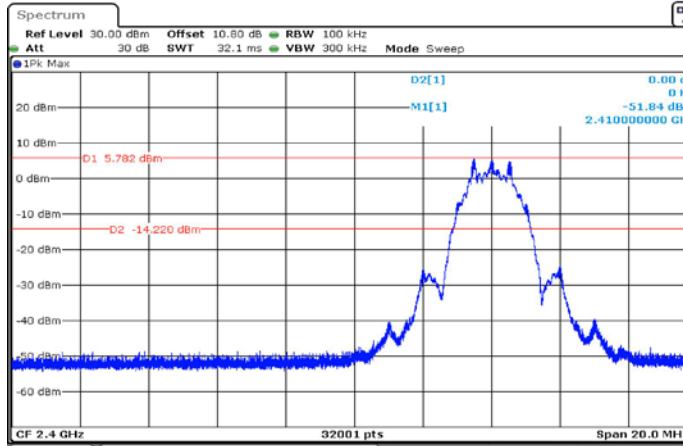
Date: 19 JUL 2023 13:22:49

### OUT-OF-BAND HIGH CHANNEL



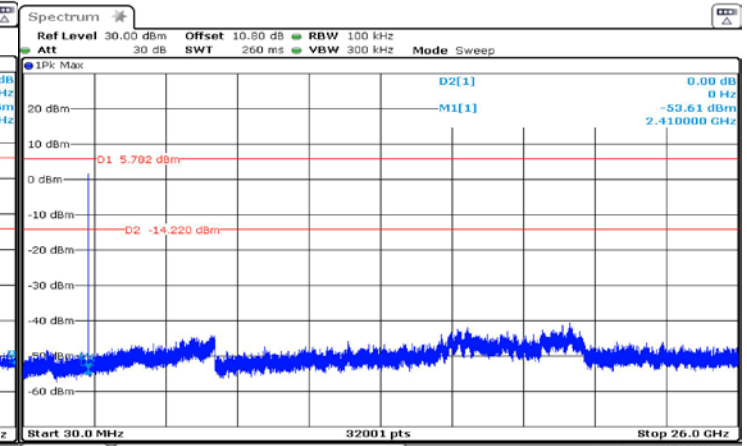
Date: 19 JUL 2023 13:19:13

BLE 2M LOW CHANNEL BANDEDGE



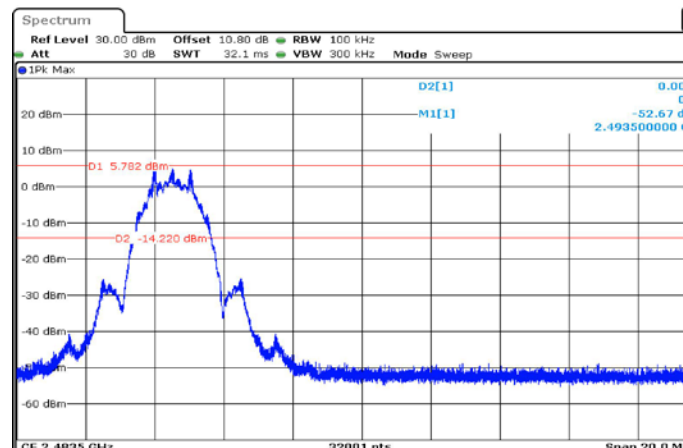
Date: 19 JUL 2023 13:26:01

OUT-OF-BAND LOW CHANNEL



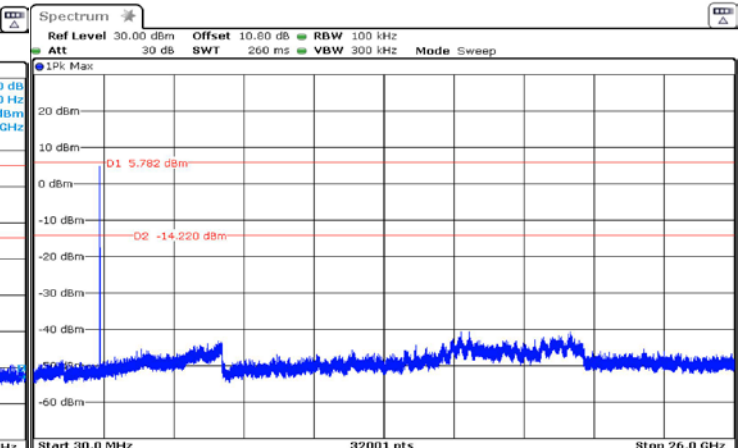
Date: 19 JUL 2023 13:27:51

BLE 2M HIGH CHANNEL BANDEDGE



Date: 19 JUL 2023 13:31:28

OUT-OF-BAND HIGH CHANNEL



Date: 19 JUL 2023 13:33:14

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



# RF Radiated Emissions 30MHz -1GHz

## Test Information:

<b>Project number (Integrity):</b>		<b>Build Phase:</b>	Pre-C1		
<b>Tested by:</b>	M. Mehrmann		<b>Date:</b>	8+9 February 2023	
<b>Requirements Standard(s):</b>	FCC §15.247 (d) and RSS-247 section 5.5		<b>Referenced Standard(s):</b>		
<b>EUT powered with:</b>		<b>Temp / Humidity:</b>		<b>Test location:</b>	Maxwell House
<b>Test equipment used TN's:</b>	644,2319,1541,2077,1277-22				
<b>EUT Serial number(s):</b>	Left: 084803M3003B005A Right: 084803M3003B004A				
<b>EUT Software installed:</b>	0.0.19 diag code				
<b>EUT Modification(s):</b>	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)

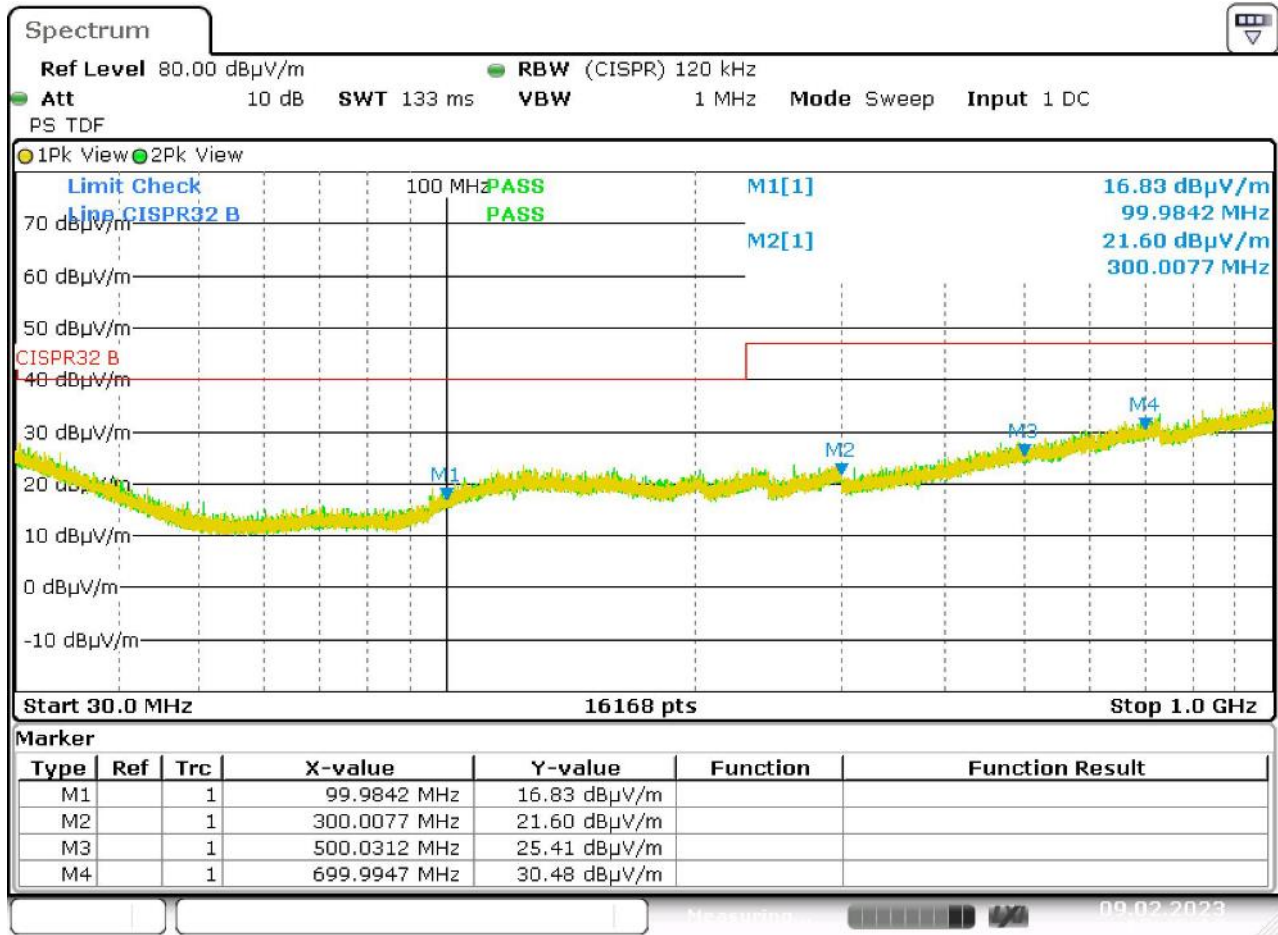


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# Data Collection:

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



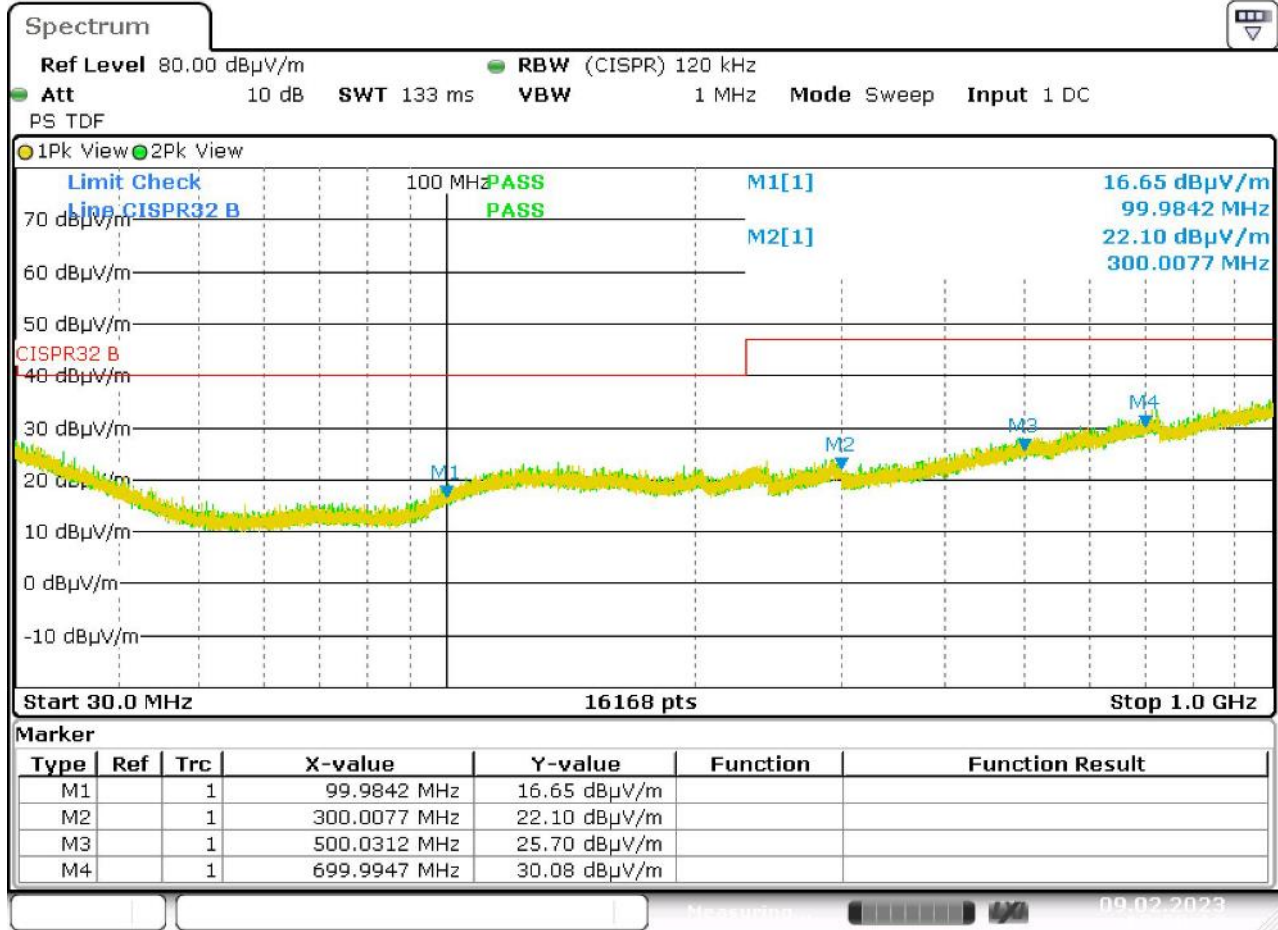
Date: 9.FEB.2023 13:49:10



**PRODUCT ASSURANCE ENGINEERING  
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<b>EUT S/N:</b>	Left bud	<b>Power applied:</b>		<b>Plot#</b>	2
<b>EUT Mods:</b>					
<b>EUT Setup:</b>					
<b>Comments:</b>	Position Y				



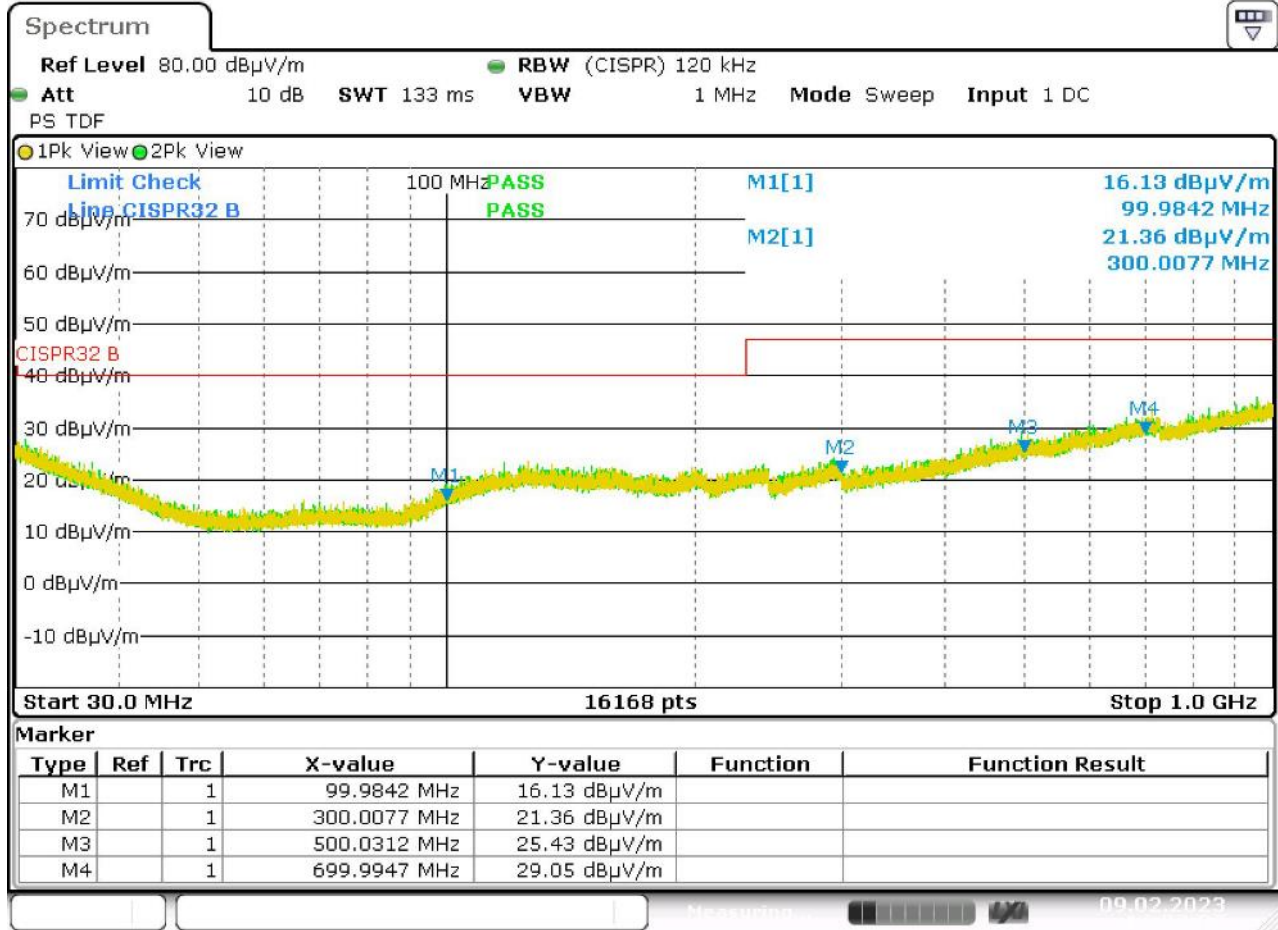
Date: 9.FEB.2023 13:58:19



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



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



## Limits:

Standard	Freq Range (MHz)	Limits (dBuV QP <sup>1</sup> )			Comments
		Class A		Class B	
		10 m	3 m <sup>2</sup>	3 m	
FCC §15.247 (d) 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. <b>*For measurements above 1 GHz, peak limits must also be met that are 20 dB higher than average limits.</b>
	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		



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# 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
Preamp 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):				<b>3.97</b>



# Radiated Spurious Emissions 1-25GHz

<b>Project code name:</b>	Scotty	<b>Marketing name:</b>	QC Earbuds Ultra	<b>Model#:</b>	408L, 408 R
<b>Project number (Integrity):</b>	435911	<b>Build Phase:</b>	C1.5		
<b>Tested by:</b>	M. Royer	<b>Date:</b>	June 7, 2023		
<b>Requirements Standard(s):</b>	FCC part 15.247	<b>Referenced Standard(s):</b>			
<b>EUT powered with:</b>	Battery	<b>Temp / Humidity:</b>	N/A	<b>Test location:</b>	Marconi Manor
<b>Test equipment used TN's:</b>	1663,3685,2349,2602,2414				
<b>EUT Serial number(s):</b>	Left	084803M3051D038A1			
	Right	084808M3051D019A1			
<b>EUT Software installed:</b>	1.4.10				
<b>EUT Modification(s):</b>	The unit had a short USB connection for control of the radio				

## Conclusion:

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

For 1 to 18 GHz, The strongest emission measurement in Peak mode is 51.1 dBuV/m. This meets the average limit of 54 dBuV/m by 2.9 dB.

For 18 to 25 GHz, the strongest emission measurement in Peak mode is 64.5 dBuV/m. This meets the average limit of 74 dBuV/m by 9.5 dB

## Procedure:

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

Pretesting showed that the worst orientation was a vertical position. 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.

The 2.4 GHz band is notched out with a filter to protect the pre-amplifier from overloading.

The duty cycle used is shown in the table on page 5.

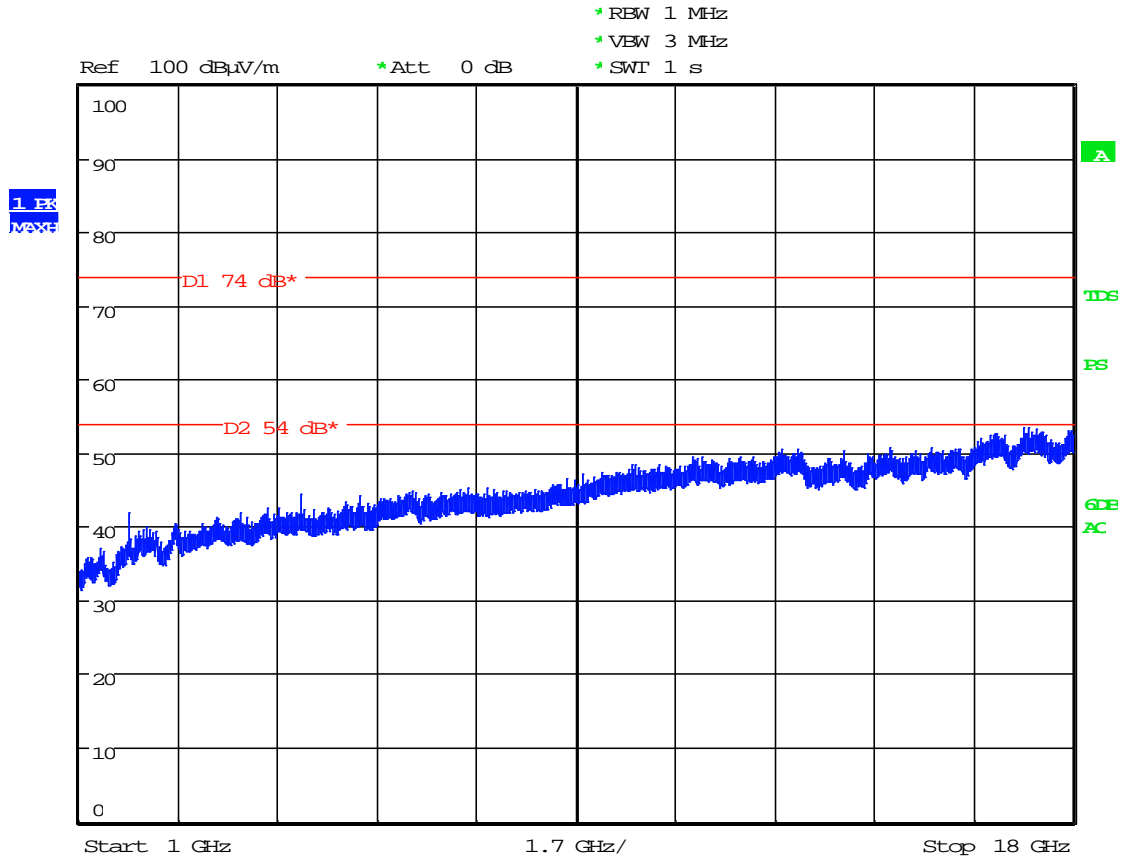


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# Data Collection:

<b>EUT S/N:</b>	Left	<b>Power applied:</b>	Battery		<b>Meas.#</b>	1
<b>EUT Mods:</b>						
<b>EUT Setup:</b>	BLE 1M Low channel 2402 MHz					
<b>Comments:</b>	3m measurement distance(1 to 18 GHz) 30 cm measurement distance(18 to 25 GHz)					

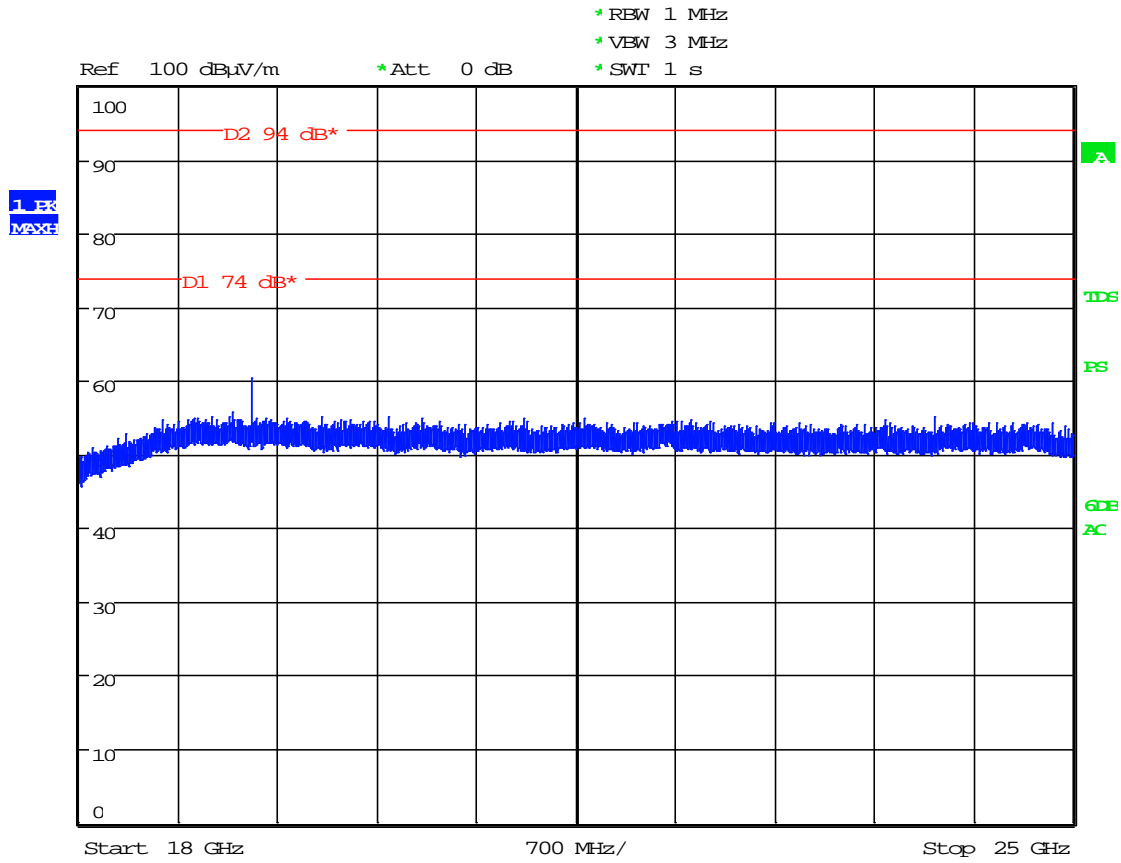


Date: 7.JUN.2023 16:03:40

Measurement Distance 3m



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Date: 14.JUN.2023 17:36:06

Measurement distance 30cm

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;

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

Peak limit of 74 becomes 94 dBuV at 30cm by adding 20 to 74.

Average limit of 54 becomes 74 dBuV at 30cm by adding 20 to 54.



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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	4804	34.80	45.90	54.0	74.0	19.2	28.1	0	V	1.60	Signal Maximized
2	7206	31.40	44.80	54.0	74.0	22.6	29.2	0	H	1.50	Noise floor
3	9607	36.90	49.20	54.0	74.0	17.1	24.8	0	H	1.50	Signal Maximized
4	12010	34.60	48.00	54.0	74.0	19.4	26.0	0	V	1.50	Noise floor
5	14412	34.70	47.80	54.0	74.0	19.3	26.2	0	H	1.50	Noise floor
6	16814	38.30	52.80	54.0	74.0	15.7	21.2	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	19214	48.80	59.70	74.0	94.0	25.2	34.3				Signal Maximized
2	21618	41.00	53.90	74.0	94.0	33.0	40.1				Noise floor
3	24017	46.30	58.40	74.0	94.0	27.7	35.6				Signal Maximized



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<b>EUT S/N:</b>	Left	<b>Power applied:</b>	Battery		<b>Plot#</b>	2
<b>EUT Mods:</b>						
<b>EUT Setup:</b>	BLE 1M Mid channel					
<b>Comments:</b>						

**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	34.60	45.20	54.0	74.0	19.4	28.8	0	V	1.50	Signal Maximized
2	7320	31.90	45.10	54.0	74.0	22.1	28.9	0	H	1.50	Noise floor
3	9759	37.60	49.50	54.0	74.0	16.4	24.5	0	H	1.50	Signal Maximized
4	12200	35.90	49.10	54.0	74.0	18.1	24.9	0	V	1.50	Noise floor
5	14640	36.10	49.30	54.0	74.0	17.9	24.7	0	H	1.50	Noise floor
6	17080	38.80	52.00	54.0	74.0	15.2	22.0	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	19518	52.50	64.20	74.0	94.0	21.5	29.8				Signal Maximized
2	21958	43.50	56.30	74.0	94.0	30.5	37.7				Noise floor
3	24397	49.40	60.50	74.0	94.0	24.6	33.5				Signal Maximized



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<b>EUT S/N:</b>	Left	<b>Power applied:</b>	Battery		<b>Plot#</b>	3
<b>EUT Mods:</b>						
<b>EUT Setup:</b>	BLE 1M High channel					
<b>Comments:</b>						

**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	4960	33.90	44.90	54.0	74.0	20.1	29.1	0	V	1.60	Signal Maximized
2	7440	32.40	45.70	54.0	74.0	21.6	28.3	0	H	1.50	Noise floor
3	9920	36.00	48.80	54.0	74.0	18.0	25.2	0	H	1.50	Signal Maximized
4	12400	35.10	49.00	54.0	74.0	18.9	25.0	0	V	1.50	Noise floor
5	14880	36.80	51.00	54.0	74.0	17.2	23.0	0	H	1.50	Noise floor
6	17360	39.10	52.10	54.0	74.0	14.9	21.9	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	19838	51.90	62.50	74.0	94.0	22.1	31.5				Signal Maximized
2	22320	40.50	53.90	74.0	94.0	33.5	40.1				Noise floor
3	24797	45.20	56.90	74.0	94.0	28.8	37.1				Signal Maximized





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<b>EUT S/N:</b>	Left	<b>Power applied:</b>	Battery		<b>Plot#</b>	4
<b>EUT Mods:</b>						
<b>EUT Setup:</b>	BLE 2M Low channel					
<b>Comments:</b>						

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	4809	33.10	45.40	54.0	74.0	20.9	28.6	0	V	1.60	Signal Maximized
2	7212	31.30	45.40	54.0	74.0	22.7	28.6	0	V	1.60	Noise floor
3	9616	33.50	46.50	54.0	74.0	20.5	27.5	0	H	1.50	Signal Maximized
4	12020	34.80	48.40	54.0	74.0	19.2	25.6	0	V	1.50	Noise floor
5	14424	34.70	47.90	54.0	74.0	19.3	26.1	0	H	1.50	Noise floor
6	16828	38.20	52.20	54.0	74.0	15.8	21.8	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	19228	52.50	63.30	74.0	94.0	21.5	30.7				Signal Maximized
2	21636	40.70	54.20	74.0	94.0	33.3	39.8				Noise floor
3	24035	46.80	58.80	74.0	94.0	27.2	35.2				Signal Maximized



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<b>EUT S/N:</b>	Left	<b>Power applied:</b>	Battery		<b>Plot#</b>	5
<b>EUT Mods:</b>						
<b>EUT Setup:</b>	BLE 2M Mid channel					
<b>Comments:</b>						

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	29.30	43.20	54.0	74.0	24.7	30.8	0	V	1.50	Noise floor
2	7320	31.70	45.40	54.0	74.0	22.3	28.6	0	H	1.50	Noise floor
3	9760	33.20	46.80	54.0	74.0	20.8	27.2	0	H	1.50	Noise floor
4	12200	35.80	49.60	54.0	74.0	18.2	24.4	0	V	1.50	Noise floor
5	14640	36.00	50.30	54.0	74.0	18.0	23.7	0	H	1.50	Noise floor
6	17080	38.80	51.90	54.0	74.0	15.2	22.1	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	19516	53.60	64.50	74.0	94.0	20.4	29.5				Signal Maximized
2	21960	40.90	54.00	74.0	94.0	33.1	40.0				Noise floor
3	24395	45.20	57.00	74.0	94.0	28.8	37.0				Signal Maximized



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<b>EUT S/N:</b>	Left	<b>Power applied:</b>	Battery		<b>Plot#</b>	6
<b>EUT Mods:</b>						
<b>EUT Setup:</b>	BLE 2M High channel					
<b>Comments:</b>						

**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	4957	32.30	44.40	54.0	74.0	21.7	29.6	0	V	1.50	Signal Maximized
2	7434	32.10	46.10	54.0	74.0	21.9	27.9	0	H	1.50	Noise floor
3	9914	36.40	49.20	54.0	74.0	17.6	24.8	0	H	1.50	Signal Maximized
4	12390	35.00	47.80	54.0	74.0	19.0	26.2	0	V	1.50	Noise floor
5	14868	36.80	50.30	54.0	74.0	17.2	23.7	0	H	1.50	Noise floor
6	17346	39.40	52.90	54.0	74.0	14.6	21.1	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	19820	52.80	63.30	74.0	94.0	21.2	30.7				Signal Maximized
2	22302	40.60	53.60	74.0	94.0	33.4	40.4				Noise floor
3	24775	46.10	58.30	74.0	94.0	27.9	35.7				Signal Maximized



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## Limits:

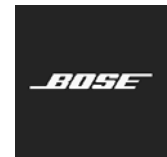
Standard	Freq Range (MHz)	Limits (dBuV QP <sup>1</sup> )			Comments
		Class A		Class B	
		10 m	3 m	3 m	
FCC 15.247d and RSS-247 Section 5.5	30-88	39	49	40	Measurements above 1 GHz are made using average and peak detectors. Mains cables draped to floor, not bundled. <b>*For measurements above 1 GHz, peak limits must also be met that are 20 dB higher than average limits.</b>
	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. <b>*For measurements above 1 GHz, peak limits must also be met that are 20 dB higher than average limits.</b>
			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		
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



PRODUCT ASSURANCE ENGINEERING  
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# 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):				<b>4.17</b>



# Radiated Band Edge

<b>Model Number:</b>	408L	<b>Build Phase:</b>	C1.5		
<b>Tested by:</b>	Mike Royer	<b>Date:</b>	May 24, 2023		
<b>Requirements Standard(s):</b>	CFR47 Part 15.247, RSS-247 Section 5.5	<b>Referenced Standard(s):</b>	ANSI C63.10-2013		
<b>EUT powered with:</b>	Battery	<b>Temp / Humidity:</b>	N/A	<b>Test location:</b>	Marconi Manor
<b>Test equipment used TN's:</b>	1663,2929,2349,3685				
<b>EUT Serial number(s):</b>	084803M3051D038A1				
<b>EUT Software installed:</b>	1.4.10+g2edc594				
<b>EUT Modification(s):</b>	USB Debug wires were attached to the earbud to allow control of the radio.				

## Conclusion:

The Bose model 408L passes Radiated Band Edge.

Note that the BLE 2M rate does not support channels 0 or 39 (2402 MHz, 2478 MHz)

Note that the EUT was placed on a skewer stick and rotated in 3 axes to find the maximum signal strength.

## Procedure:

For BLE 1M lower band edge measurements the transmit frequency was 2402 MHz.

For BLE 1M upper band edge measurements the transmit frequency was 2480 MHz

For BLE 2M lower band edge measurements the transmit frequency was 2404 MHz.

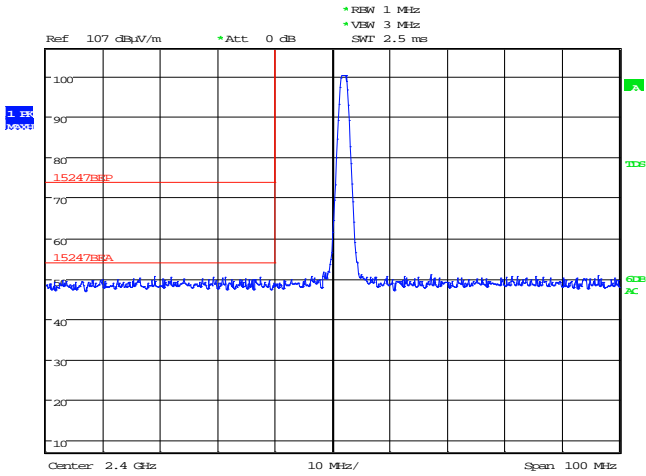
For BLE 2M upper band edge measurements the transmit frequency was 2478 MHz.

The duty cycle used is shown in the table on page 5.

# Data Collection:

Lower Band edge, BLE 1M

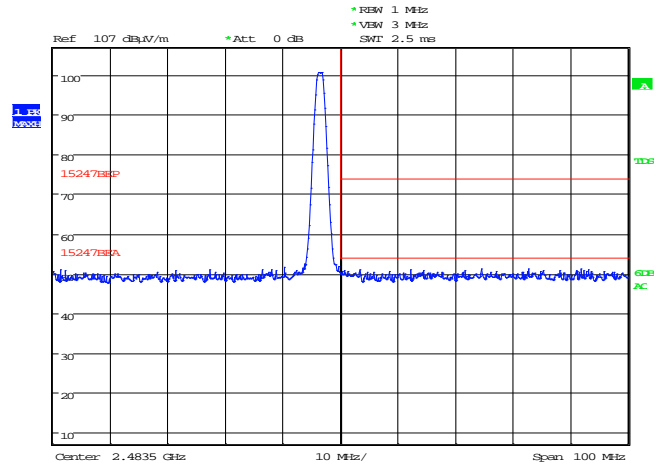
Peak emissions below the average limit.



Date: 24.MAY.2023 19:00:08

Upper Band edge, BLE 1M

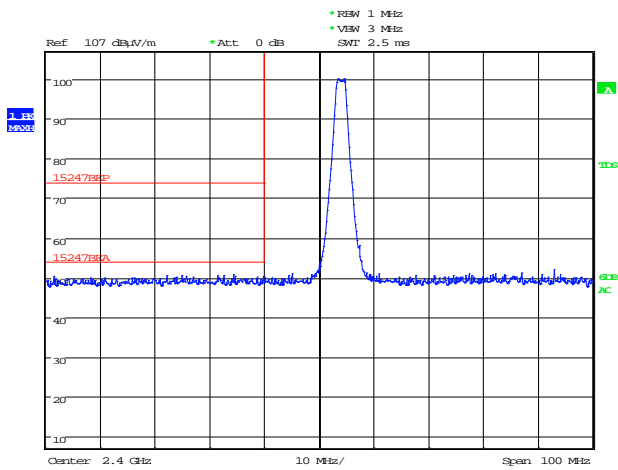
Peak emissions below the average limit.



Date: 24.MAY.2023 19:08:29

Lower Band edge, BLE 2M

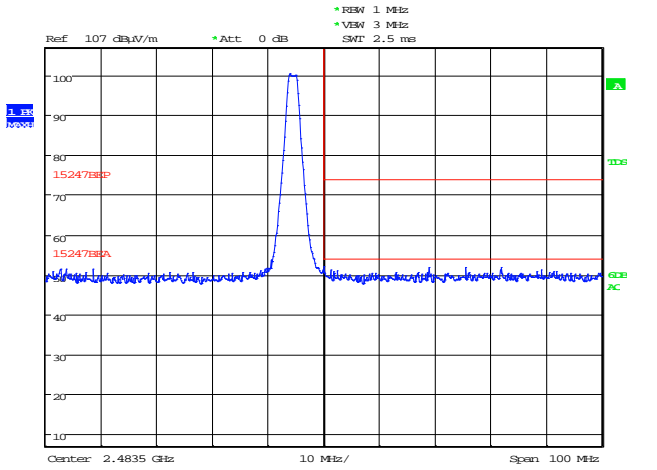
Peak emissions below the average limit.



Date: 24.MAY.2023 19:03:43

Upper Band edge, BLE 2M

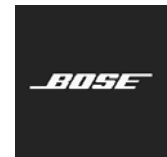
Peak emissions below the average limit.



Date: 24.MAY.2023 19:11:48



**PRODUCT ASSURANCE ENGINEERING  
COMPLIANCE  
EMC TEST REPORT**



## Limits:

Standard	Freq Range (MHz)	Limits (dBuV QP <sup>1</sup> )			Comments
		Class A		Class B	
		10 m	3 m	3 m	
FCC 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. <b>*For measurements above 1 GHz, peak limits must also be met that are 20 dB higher than average limits.</b>
	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. <b>*For measurements above 1 GHz, peak limits must also be met that are 20 dB higher than average limits.</b>
			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



## 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):				<b>4.17</b>

## End of Report