

Prüfbericht-Nr.: <i>Test report no.:</i>	CN22CQQL 002	Auftrags-Nr.: <i>Order no.:</i>	168395327	Seite 1 von 21 <i>Page 1 of 21</i>
Kunden-Referenz-Nr.: <i>Client reference no.:</i>	N/A	Auftragsdatum: <i>Order date:</i>	2022-10-21	
Auftraggeber: <i>Client:</i>	Harman International Industries, Inc 8500 Balboa Blvd, Northridge, California, 91329, United States			
Prüfgegenstand: <i>Test item:</i>	BLUETOOTH HEADSET			
Bezeichnung / Typ-Nr.: <i>Identification / Type no.:</i>	QUANTUM TWS AIR (Trademark: JBL)			
Auftrags-Inhalt: <i>Order content:</i>	FCC and IC approval			
Prüfgrundlage: <i>Test specification:</i>	CFR47 FCC Part 15: Subpart C Section 15.247 CFR47 FCC Part 15: Subpart C Section 15.207 CFR47 FCC Part 15: Subpart C Section 15.209 RSS-247 Issue 2 February 2017 RSS-Gen Issue 5 February 2021			
Wareneingangsdatum: <i>Date of receipt:</i>	2022-10-20	Please refer to photo documents		
Prüfmuster-Nr.: <i>Test sample No.:</i>	A003358854			
Prüfzeitraum: <i>Testing period:</i>	2022-10-26 – 2022-11-03			
Ort der Prüfung: <i>Place of testing:</i>	TÜV Rheinland (Shenzhen) Co., Ltd.			
Prüflaboratorium: <i>Testing laboratory:</i>	TÜV Rheinland (Shenzhen) Co., Ltd.			
Prüfergebnis*: <i>Test result*:</i>	Pass			
geprüft von: <i>tested by:</i>			genehmigt von: <i>authorized by:</i>	
Datum: <i>Date:</i> 2022-11-11	Signed by: Alex Lan		Ausstellungsdatum: <i>Issue date:</i> 2022-12-07	Signed by: Winnie Hou
Stellung / Position	Assistant Project Manager		Stellung / Position	Department Manager
Sonstiges / Other:	FCC ID: APIJBLQTWSAIR IC: 6132A-JBLQTWSAIR HVIN: QTWSAIRL, QTWSAIRR			
Zustand des Prüfgegenstandes bei Anlieferung: <i>Condition of the test item at delivery:</i>	Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged:</i>			
* Legende:	1 = sehr gut P(ass) = entspricht o.g. Prüfgrundlage(n) Legend: 1 = very good P(ass) = passed a.m. test specifications(s)	2 = gut F(ail) = entspricht nicht o.g. Prüfgrundlage(n) 2 = good 3 = satisfactory F(ail) = failed a.m. test specifications(s)	3 = befriedigend N/A = nicht anwendbar 4 = sufficient N/A = not applicable	4 = ausreichend N/T = nicht getestet 5 = mangelhaft N/T = not tested
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. <i>This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i>				

V05

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Test Summary

5.1.1 ANTENNA REQUIREMENT

RESULT: Pass

5.1.2 MAXIMUM PEAK CONDUCTED OUTPUT POWER

RESULT: Pass

5.1.3 CONDUCTED POWER SPECTRAL DENSITY

RESULT: Pass

5.1.4 99%dB BANDWIDTH

RESULT: Pass

5.1.5 6dB BANDWIDTH

RESULT: Pass

5.1.6 FREQUENCY STABILITY

RESULT: Pass

5.1.7 CONDUCTED SPURIOUS EMISSIONS MEASURED IN 100 KHz BANDWIDTH

RESULT: Pass

5.1.8 RADIATED SPURIOUS EMISSION

RESULT: Pass

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1 General Remarks

1.1 Complementary Materials

All attachments are integral parts of this test report. This applies especially to the following appendix:

Appendix A: Photographs of the Test Set-up

Appendix B: Test Results of left earbud.

Appendix B: Test Results of right earbud.

2 Test Sites

2.1 Test Facilities

TÜV Rheinland (Shenzhen) Co., Ltd.

No. 362 Huanguan Road Middle, Longhua District, Shenzhen 518110, People's Republic of China

FCC Registration No.: 694916

IC Registration No.: 25069 and the CAB identifier is CN0078.

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Radio Spectrum				
Description	Manufacturer	Model	Serial No.	Calibrated until
EXA Signal Analyzer, Multi-touch	Keysight	N9010B	MY60241175	2023-09-27
MXG X-Series RF Vector Signal Generator	Keysight	N5182B	MY61250137	2023-09-27
EXG X-Series Microwave Analog Signal Generator	Keysight	N5173B	MY61250141	2023-09-27
DC Power Supply	Keysight	E3642A	MY61276100	2023-09-27
Wireless Connectivity Tester	R&S	CMW270	102505	2023-09-27
Power Control Unit	Tonscend	JS0806-4ADC	N/A	2023-09-27
Automation Control Unit	Tonscend	JS0806-2	21C8060396	2023-09-27
Test Software	Tonscend	JS1120-3	N/A	N/A
Control PC	Lenovo	TianYi510S-071MB	YLX23JMF	N/A
Radiated Spurious Emissions				
Description	Manufacturer	Model	Serial No.	Calibrated until
EMI Test Receiver	R&S	ESR 7	102021	2023-08-02
Signal Analyzer	R&S	FSV 40	101439	2023-08-01
System Controller Interface	R&S	SCI-100	S10010038	N/A
Filterbank	R&S	Wlan	100759	2023-08-01
OSP	R&S	OSP 120	102040	N/A
Pre-amplifier	R&S	SCU08F1	08320031	2023-08-02
Amplifier	R&S	SCU-18F	180070	2023-08-02
Amplifier	R&S	SCU40A	100475	2023-08-02
Trilog Broadband Antenna (30 MHz - 7 GHz)	Schwarzbeck	VULB 9162	193	2024-08-06
Double-Ridged Antenna (1 -18 GHz)	ETS-LINDGREN	3117	00218717	2024-08-06
Wideband Ridged Horn Antenna (18-40 GHz)	Steatite	QMS-00880	19067	2022-09-08
Active Loop Antenna	Schwarzbeck	FMZB 1513	302	2024-08-06
Test software	R&S	EMC32 (V10.60.10)	N/A	N/A
Control PC	Dell	OptiPlex 7050	36NV9P2	N/A
3m Semi-Anechoic Chamber	Albatross	SAC-3m	APC17151-SAC	2024-06-22

2.3 Traceability

All measurement equipment calibrations are traceable to NIM (National Institute of Metrology) or where calibration is performed in other countries, to equivalent nationally recognized standards organizations.

2.4 Calibration

Equipment requiring calibration is calibrated periodically by the manufacturer or according to manufacturer's specifications. Additionally all equipment is verified for proper performance on a regular basis using in house standards or comparisons.

2.5 Measurement Uncertainty

The estimated combined standard uncertainty for radiated emissions and conducted emissions measurements as below table.

Parameter	Uncertainty (k=2)
Occupied Channel Bandwidth	± 2.08 %
RF output power, conducted	± 0.99 dB
RF power density, conducted	± 0.99 dB
Unwanted Emissions, conducted	± 0.89 dB
All emissions, radiated	± 4.17 dB
Conducted Emission, (9kHz to 150kHz)/(150kHz to 30MHz)	± 3.70 dB / ± 3.30 dB

2.6 Location of Original Data

The original copies of all test data taken during actual testing were attached at Appendix A & B & C of this report and delivered to the applicant. A copy has been retained in the TÜV Rheinland (Shenzhen) file for certification follow-up purposes.

2.7 Status of Facility Used for Testing

The TÜV Rheinland (Shenzhen) Co., Ltd. Test facility located at No. 362 Huanguan Road Middle, Longhua District, Shenzhen 518110, People's Republic of China. is listed on the US Federal Communications Commission list of facilities approved to perform measurements.

3 General Product Information

3.1 Product Function and Intended Use

The EUTs are Bluetooth earbuds, which supports Bluetooth dual mode technology.

There is no difference except the PCB layout of left and right earbuds.

For details refer to the User Manual and Circuit Diagram.

3.2 Ratings and System Details

Table 2: Technical Specification of EUT

General Information of EUT	Value
Kind of Equipment	BLUETOOTH HEADSET
Type Designation	QUANTUM TWS AIR
Trademark	JBL
FCC ID	APIJBLQTWSAIR
IC	6132A-JBLQTWSAIR
HVIN	QTWSAIRL, QTWSAIRR
Extreme Temperature Range	-10°C to +45°C
Operating Voltage	DC 3.85, 50mAh, 0.1925Wh via built-in Li-ion cell battery DC 5V, 100mA via charging case for charging
Technical Specification of Classical Bluetooth	
Bluetooth Core Version	Bluetooth 5.2
Operating Frequency band	2402 ~ 2480 MHz
Channel Number	79 channels
Channel separation	1MHz
Modulation	GFSK, $\pi/4$ DQPSK
Antenna Type	PIFA LDS antenna
Antenna Gain	-2.21 dBi for left earbud -3.71 dBi for right earbud
Technical Specification of Bluetooth Low Energy	
Bluetooth Core Version	Bluetooth 5.2
Operating Frequency band	2402 ~ 2480 MHz
Channel Number	40 channels
Channel separation	2MHz
Data rate	1Mbps, 2Mbps
Modulation	GFSK
Antenna Type	PIFA LDS antenna
Antenna Gain	-2.21 dBi for left earbud -3.71 dBi for right earbud

Table 3: RF Channel and Frequency of Classic Bluetooth

RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)
00	2402.00	20	2422.00	40	2442.00	60	2462.00
01	2403.00	21	2423.00	41	2443.00	61	2463.00
02	2404.00	22	2424.00	42	2444.00	62	2464.00
03	2405.00	23	2425.00	43	2445.00	63	2465.00
04	2406.00	24	2426.00	44	2446.00	64	2466.00
05	2407.00	25	2427.00	45	2447.00	65	2467.00
06	2408.00	26	2428.00	46	2448.00	66	2468.00
07	2409.00	27	2429.00	47	2449.00	67	2469.00
08	2410.00	28	2430.00	48	2450.00	68	2470.00
09	2411.00	29	2431.00	49	2451.00	69	2471.00
10	2412.00	30	2432.00	50	2452.00	70	2472.00
11	2413.00	31	2433.00	51	2453.00	71	2473.00
12	2414.00	32	2434.00	52	2454.00	72	2474.00
13	2415.00	33	2435.00	53	2455.00	73	2475.00
14	2416.00	34	2436.00	54	2456.00	74	2476.00
15	2417.00	35	2437.00	55	2457.00	75	2477.00
16	2418.00	36	2438.00	56	2458.00	76	2478.00
17	2419.00	37	2439.00	57	2459.00	77	2479.00
18	2420.00	38	2440.00	58	2460.00	78	2480.00
19	2421.00	39	2441.00	59	2461.00	--	--

Table 4: RF Channel and Frequency of Bluetooth Low Energy

RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)	RF Channel	Frequency (MHz)
00	2402.00	10	2422.00	20	2442.00	30	2462.00
01	2404.00	11	2424.00	21	2444.00	31	2464.00
02	2406.00	12	2426.00	22	2446.00	32	2466.00
03	2408.00	13	2428.00	23	2448.00	33	2468.00
04	2410.00	14	2430.00	24	2450.00	34	2470.00
05	2412.00	15	2432.00	25	2452.00	35	2472.00
06	2414.00	16	2434.00	26	2454.00	36	2474.00
07	2416.00	17	2436.00	27	2456.00	37	2476.00
08	2418.00	18	2438.00	28	2458.00	38	2478.00
09	2420.00	19	2440.00	29	2460.00	39	2480.00

3.3 Independent Operation Modes

The basic operation modes are:

- A. On, Bluetooth LE transmitting mode
 - 1. Low channel
 - 2. Middle channel
 - 3. High channel
- B. On, Charging with normal operating
- C. Off

3.4 Noise Generating and Noise Suppressing Parts

Refer to Circuit Diagram for further details.

3.5 Submitted Documents

- | | |
|----------------------------------|------------------|
| - Application Form | - Photo Document |
| - Block Diagram | - Schematics |
| - FCC/IC Label and Location Info | - User Manual |
| - Operation Description | |

4 Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

Radio Spectrum: The equipment under test (EUT) was configured at its highest power output in order to measure its highest possible radiation and conducted level. The test modes were adapted accordingly in reference to the instructions for use.

Emission: The equipment under test (EUT) was configured to measure its highest possible radiation level. The test modes were adapted accordingly in reference to the instructions for use.

4.2 Test Operation and Test Software

Test operation refers to test setup in chapter 5. All testing were performed according to the procedures in ANSI C63.10: 2013.

According to clause 3.1, all test items were applied on model QUANTUM TWS AIR with left & right earbuds.

4.3 Special Accessories and Auxiliary Equipment

Table 5: List of Accessories and Auxiliary Equipment

Description	Manufacturer	Model	S/N
Laptop	Lenovo	ThinkPad X240	10Q67059

4.4 Countermeasures to Achieve EMC Compliance

The test sample which has been tested contained the noise suppression parts as described in the Technical Construction File (TCF).

No additional measures were employed to achieve compliance.

4.5 Test Setup Diagram

Diagram of Measurement Configuration for Radiation Test (Below 30MHz)

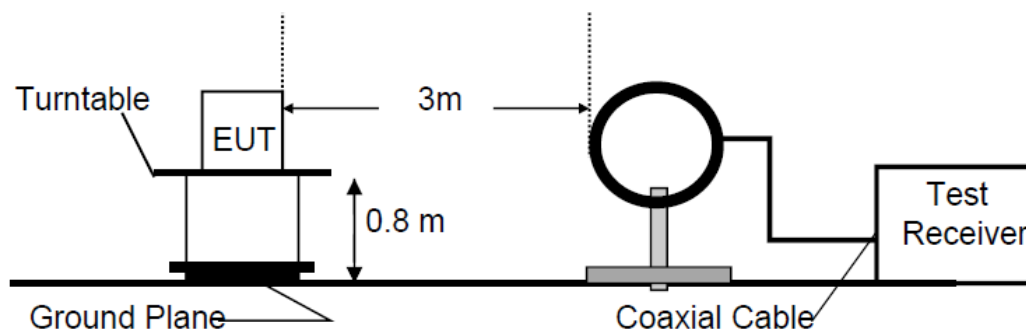


Diagram of Measurement Configuration for Radiation Test (Below 1GHz)

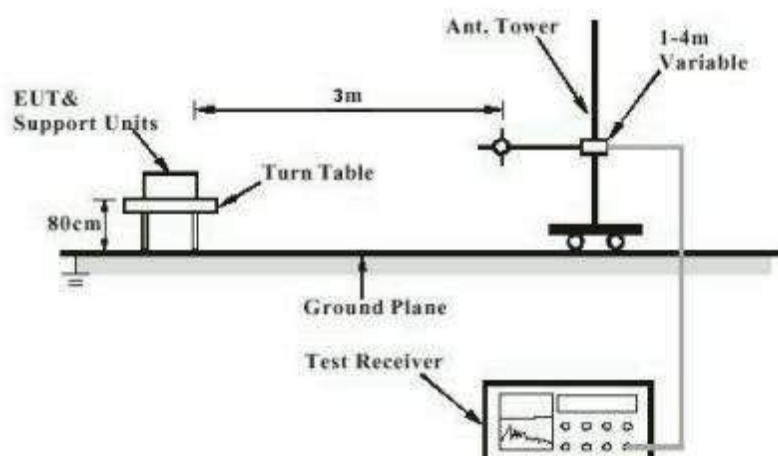


Diagram of Measurement Configuration for Radiation Test (Above 1GHz)

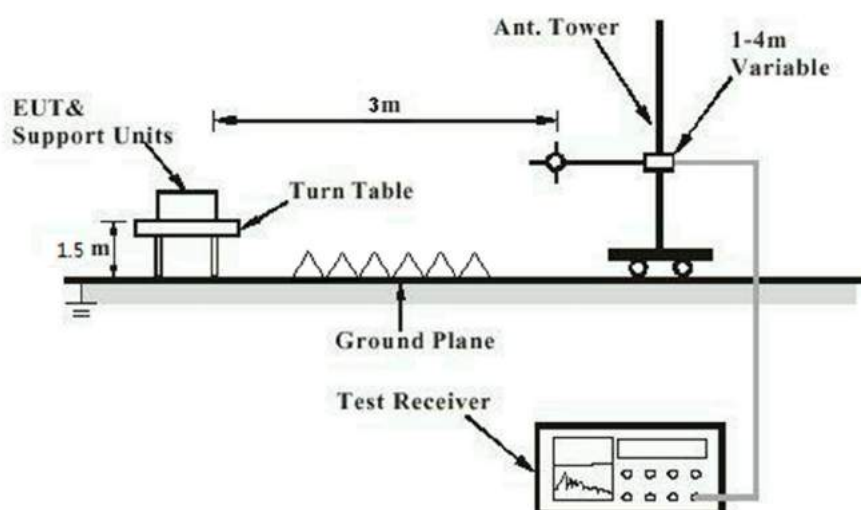
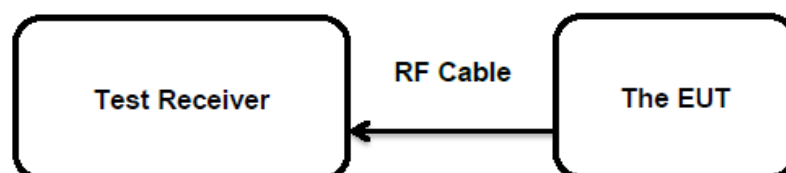


Diagram of Measurement Configuration for Conducted Transmitter Measurement



5 Test Results

5.1 Transmitter Requirement & Test Suites

5.1.1 Antenna Requirement

RESULT:

Pass

Test Specification

Test standard	:	FCC Part 15.247(b)(4) and Part 15.203
	:	RSS-Gen Clause 6.7
Limit	:	the use of antennas with directional gains that do not exceed 6 dBi

According to the manufacturer declared, the EUT has one integral antenna, the directional gain of antennas are -2.21 dBi for left earbud & -3.71 dBi for right earbud , and the antenna connector is designed with permanent attachment and no consideration of replacement. Therefore the EUT is considered sufficient to comply with the provision.

Refer to EUT Photo for further details.

5.1.2 Maximum Peak Conducted Output Power

RESULT:
Pass
Test Specification

Test standard	: FCC Part 15.247(b)(3)
	: RSS-247 Clause 5.4(d)
Basic standard	: ANSI C63.10: 2013
Limits	: < 1 Watt (Maximum Conducted Peak Power)
	: e.i.r.p. <4W
Kind of test site	: Shielded Room

Test Setup

Date of testing	: 2022-11-01
Input voltage	: DC 3.85V
Operation mode	: A
Test channel	: Low / Middle / High
Ambient temperature	: 24.4 °C
Relative humidity	: 61 %
Atmospheric pressure	: 101 kPa

For details refer to following test result.

Table 6: Test Result of Maximum Peak Conducted Output Power, Left earbud

Data Rate	Test Channel (MHz)	Measured Peak Power		Limit (W)
		(dBm)	(W)	
1 Mbps	2402	10.45	0.0111	< 1.0
	2440	10.35	0.0108	
	2480	10.25	0.0106	
2 Mbps	2402	10.52	0.0113	
	2440	10.41	0.0110	
	2480	10.23	0.0105	
Maximum Measured Value		10.52	0.0113	

Note: The cable loss is taken into account in results and the maximum e.i.r.p. is 8.21 dBm less than 4W (36 dBm).

Table 7: Test Result of Maximum Peak Conducted Output Power, Right earbud

Data Rate	Test Channel (MHz)	Measured Peak Power		Limit (W)
		(dBm)	(W)	
1 Mbps	2402	10.69	0.0117	< 1.0
	2440	10.48	0.0112	
	2480	10.26	0.0106	
2 Mbps	2402	10.63	0.0116	
	2440	10.46	0.0111	
	2480	10.23	0.0105	
Maximum Measured Value		10.69	0.0117	

Note: The cable loss is taken into account in results and the maximum e.i.r.p. is 6.98 dBm less than 4W (36 dBm).

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5.1.3 Conducted Power Spectral Density

RESULT:**Pass****Test Specification**

Test standard	:	FCC Part 15.247(e) RSS-247 Clause 5.2(b)
Basic standard	:	ANSI C63.10: 2013
Limits	:	8 dBm / 3kHz
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2022-11-01
Input voltage	:	DC 3.85V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.4 °C
Relative humidity	:	61 %
Atmospheric pressure	:	101 kPa

For the measurement records, refer to the appendix B&C.

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5.1.4 99%dB Bandwidth

RESULT:

Pass

Test Specification

Test standard	: RSS-Gen clause 6.7
Basic standard	: ANSI C63.10: 2013
Kind of test site	: Shielded Room

Test Setup

Date of testing	: 2022-11-01
Input voltage	: DC 3.85V
Operation mode	: A
Test channel	: Low / Middle / High
Ambient temperature	: 24.4 °C
Relative humidity	: 61 %
Atmospheric pressure	: 101 kPa

For the measurement records, refer to the appendix B&C.

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5.1.5 6dB Bandwidth

RESULT:**Pass****Test Specification**

Test standard	:	FCC Part 15.247(a)(2)
	:	RSS-247 Clause 5.2(a)
Basic standard	:	ANSI C63.10: 2013
Kind of test site	:	Shielded Room

Test Setup

Date of testing	:	2022-11-01
Input voltage	:	DC 3.85V
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	24.4 °C
Relative humidity	:	61 %
Atmospheric pressure	:	101 kPa

For the measurement records, refer to the appendix B&C.

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5.1.6 Frequency stability

RESULT:**Pass****Test Specification**

Test standard	: RSS-247 Clause 8.11
Basic standard	: ANSI C63.10: 2013
Limits	: within at least the central 80% of its permitted operating frequency band (2400-2483.5MHz)
Kind of test site	: Shielded Room

Test Setup

Date of testing	: 2022-11-01
Input voltage	: DC 3.85V
Operation mode	: B
Ambient temperature	: 24.4 °C
Relative humidity	: 61 %
Atmospheric pressure	: 101 kPa

For the measurement records, refer to the appendix B & C

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5.1.7 Conducted Spurious Emissions Measured in 100 kHz Bandwidth**RESULT:****Pass****Test Specification**

Test standard	: FCC Part 15.247(d) RSS-247 Clause 5.5
Basic standard	: ANSI C63.10: 2013
Limits	: 20dB (below that in the 100kHz bandwidth within the band that contains the highest level of the desired power); In addition, radiated emissions which fall in the restricted bands, must also comply with the radiated emission limits specified in 15.209(a)
Kind of test site	: Shielded Room

Test Setup

Date of testing	: 2022-11-01
Input voltage	: DC 3.85V
Operation mode	: A
Test channel	: Low / Middle / High
Ambient temperature	: 24.4 °C
Relative humidity	: 61 %
Atmospheric pressure	: 101 kPa

Test results of 100kHz Bandwidth of Frequency Band Edge by Conducted method refer to test plots, and compliance is achieved as well.

For the measurement records, refer to the appendix B&C.

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5.1.8 Radiated Spurious Emission

RESULT:**Pass****Test Specification**

Test standard	:	FCC Part 15.247(d) & FCC Part 15.205 RSS-247 Clause 3.3 & 5.5
Basic standard	:	ANSI C63.10: 2013
Limits	:	Refer to 15.209(a) of FCC part 15.247(d) RSS-Gen Table 4 & Table 5
Kind of test site	:	3m Semi-anechoic Chamber

Test Setup

Date of testing	:	2022-08-22
Input voltage	:	DC 5V by USB cable
Operation mode	:	A
Test channel	:	Low / Middle / High
Ambient temperature	:	Refer to test result
Relative humidity	:	Refer to test result
Atmospheric pressure	:	101 kPa

Remark:

Testing was carried out within frequency range 9kHz to the tenth harmonics. Only the worst case spurious emissions configuration of the each mode were reported.

For the measurement records, refer to the appendix B&C.

6 Photographs of the Test Set-Up

For photographs of the test set-up, refer to the appendix A.

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Appendix B: Test Results of left earbud

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Appendix B.1: Test Results of Conducted Power Spectral Density

TestMode	Antenna	Channel	Result[dBm/3-100kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-4.99	≤8.00	PASS
		2440	-4.98	≤8.00	PASS
		2480	-5.18	≤8.00	PASS
BLE_2M	Ant1	2402	-7.06	≤8.00	PASS
		2440	-7.08	≤8.00	PASS
		2480	-7.27	≤8.00	PASS

BLE 1M Ant1 2402



BLE 1M Ant1 2440



BLE 1M Ant1 2480



BLE 2M Ant1 2402



BLE 2M Ant1 2440





Appendix B.2: Test Results of 6dB Bandwidth

TestMode	Antenna	Channel	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.704	2401.644	2402.348	0.5	PASS
		2440	0.688	2439.644	2440.332	0.5	PASS
		2480	0.708	2479.636	2480.344	0.5	PASS
BLE_2M	Ant1	2402	1.280	2401.328	2402.608	0.5	PASS
		2440	1.204	2439.376	2440.580	0.5	PASS
		2480	1.232	2479.348	2480.580	0.5	PASS

BLE_1M_Ant1_2402



BLE_1M_Ant1_2440



BLE 1M Ant1 2480



BLE 2M Ant1 2402



BLE 2M Ant1 2440





Appendix B.3: Test Results of 99% Bandwidth

TestMode	Antenna	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.0424	2401.4836	2402.5260	---	---
		2440	1.0407	2439.4853	2440.5260	---	---
		2480	1.0331	2479.4825	2480.5156	---	---
BLE_2M	Ant1	2402	2.0819	2400.9732	2403.0551	---	---
		2440	2.0605	2438.9855	2441.0460	---	---
		2480	2.0855	2478.9705	2481.0560	---	---

BLE_1M Ant1 2402



BLE_1M Ant1 2440



BLE 1M Ant1 2480



BLE 2M Ant1 2402



BLE 2M Ant1 2440





Appendix B.4: Test Results of Frequency stability

Test Channel (MHz)	2402
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Test result of frequency tolerance of voltage variation

Voltage	Test result (MHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
DC 3.465V	2401.994	6	2.497918	10
DC 3.85V	2401.990	10	4.163197	
DC 4.235	2401.988	12	4.995837	

Test result of frequency tolerance of temperature variation

Temperature (°C)	Test result (KHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
-30	2401.986	14	5.828476	10
-20	2401.990	10	4.163197	
-10	2401.994	6	2.497918	
0	2401.985	10	4.163197	
10	2401.993	7	2.914238	
20	2401.990	10	4.163197	
30	2401.988	12	4.995837	
40	2401.994	6	2.497918	
50	2401.995	5	2.081599	
55	2401.994	6	2.497918	

Test Channel (MHz)	2440
-----------------------	------

Test result of frequency tolerance of voltage variation

Voltage	Test result (MHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
DC 3.465V	2439.990	-10	-4.09836	10
DC 3.85V	2439.995	-5	-2.04918	
DC 4.235	2439.987	-13	-5.32787	

Test result of frequency tolerance of temperature variation

Temperature (°C)	Test result (KHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
-30	2439.993	-7	-2.86885	10
-20	2439.997	-3	-1.22951	
-10	2439.994	-6	-2.45902	
0	2439.989	-11	-4.5082	
10	2439.986	-14	-5.7377	
20	2439.990	-10	-4.09836	
30	2439.989	-11	-4.5082	
40	2439.985	-15	-6.14754	
50	2439.985	-15	-6.14754	
55	2439.988	-12	-4.91803	

Test Channel (MHz)	2480
--------------------	------

Test result of frequency tolerance of voltage variation

Voltage	Test result (MHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
DC 3.465V	2479.988	-10	-4.03226	10
DC 3.85V	2479.990	-8	-3.22581	
DC 4.235	2479.992	-8	-3.22581	

Test result of frequency tolerance of temperature variation

Temperature (°C)	Test result (KHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
-30	2479.985	-15	-6.04839	10
-20	2479.987	-13	-5.24194	
-10	2479.991	-9	-3.62903	
0	2479.990	-10	-4.03226	
10	2479.992	-8	-3.22581	
20	2479.995	-5	-2.01613	
30	2479.996	-4	-1.6129	
40	2479.992	-8	-3.22581	
50	2479.993	-7	-2.82258	
55	2479.991	-9	-3.62903	

Appendix B.5: Test Results of Conducted Spurious Emissions Measured in 100 kHz Bandwidth

Conducted Spurious Emission

TestMode	Antenna	Channel	FreqRange [MHz]	RefLevel [dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	2402	Reference	9.33	9.33	---	PASS
			30~1000	9.33	-48.02	≤-10.67	PASS
			1000~26500	9.33	-38.8	≤-10.67	PASS
		2440	Reference	9.30	9.30	---	PASS
			30~1000	9.30	-47.84	≤-10.7	PASS
			1000~26500	9.30	-39.23	≤-10.7	PASS
		2480	Reference	9.13	9.13	---	PASS
			30~1000	9.13	-47.32	≤-10.87	PASS
			1000~26500	9.13	-38.17	≤-10.87	PASS
BLE_2M	Ant1	2402	Reference	7.55	7.55	---	PASS
			30~1000	7.55	-47.77	≤-12.45	PASS
			1000~26500	7.55	-39.25	≤-12.45	PASS
		2440	Reference	8.19	8.19	---	PASS
			30~1000	8.19	-46.74	≤-11.81	PASS
			1000~26500	8.19	-39.36	≤-11.81	PASS
		2480	Reference	5.68	5.68	---	PASS
			30~1000	5.68	-48.63	≤-14.32	PASS
			1000~26500	5.68	-38.84	≤-14.32	PASS



BLE_1M_Ant1_2402_30~1000



BLE_1M_Ant1_2402_1000~26500



BLE_1M_Ant1_2440_0~Reference



BLE_1M_Ant1_2440_30~1000



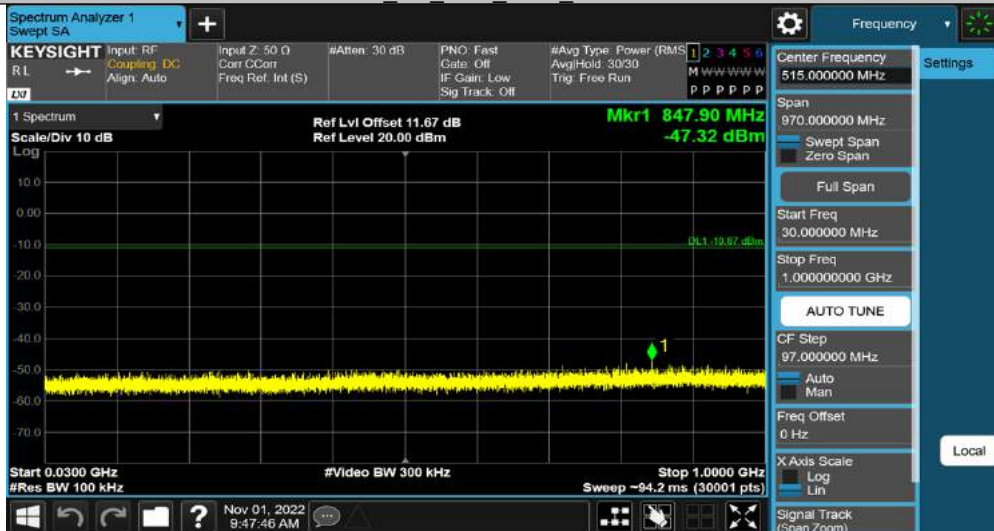
BLE_1M_Ant1_2440_1000~26500



BLE_1M_Ant1_2480_0~Reference



BLE 1M_Ant1_2480_30~1000



BLE 1M_Ant1_2480_1000~26500



BLE 2M_Ant1_2402_0~Reference



BLE_2M_Ant1_2402_30~1000



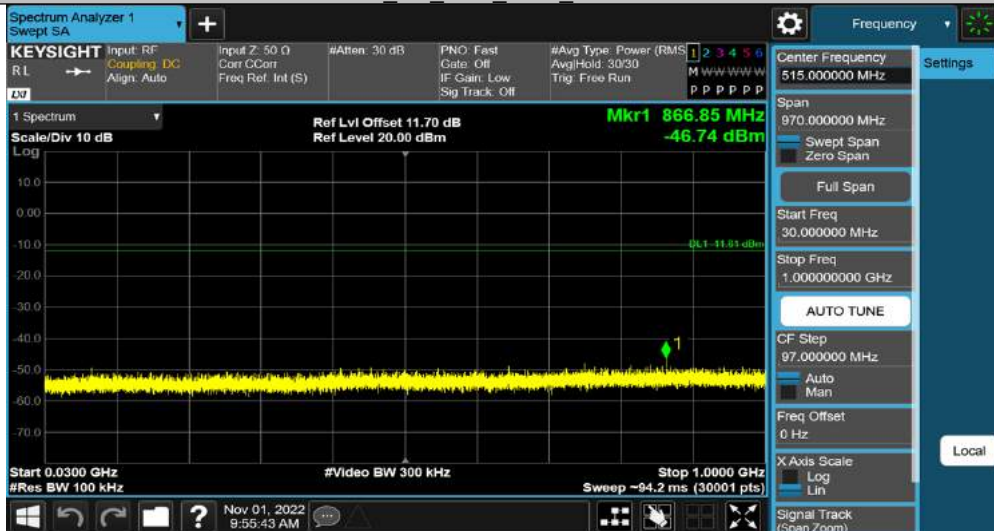
BLE_2M_Ant1_2402_1000~26500



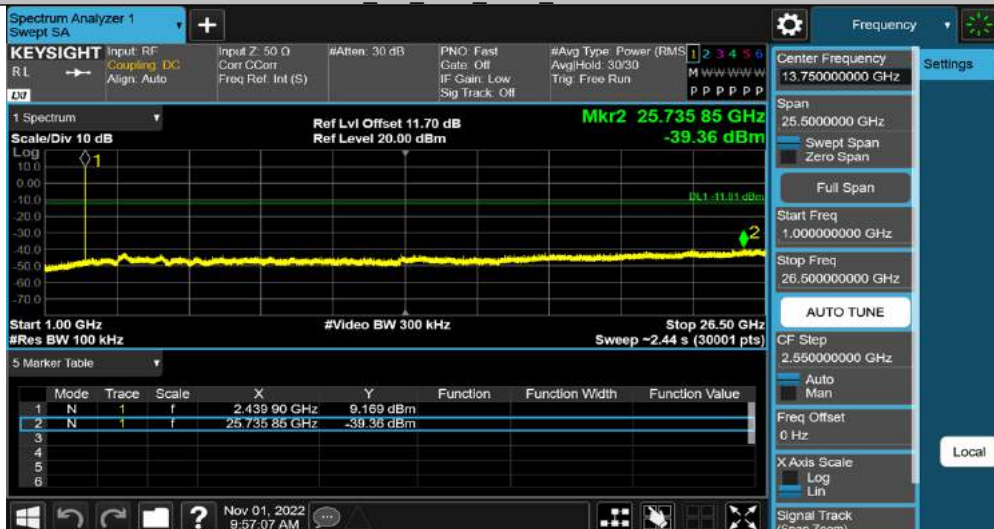
BLE_2M_Ant1_2440_0~Reference



BLE_2M_Ant1_2440_30~1000



BLE_2M_Ant1_2440_1000~26500



BLE_2M_Ant1_2480_0~Reference



BLE_2M_Ant1_2480_30~1000



BLE_2M_Ant1_2480_1000~26500



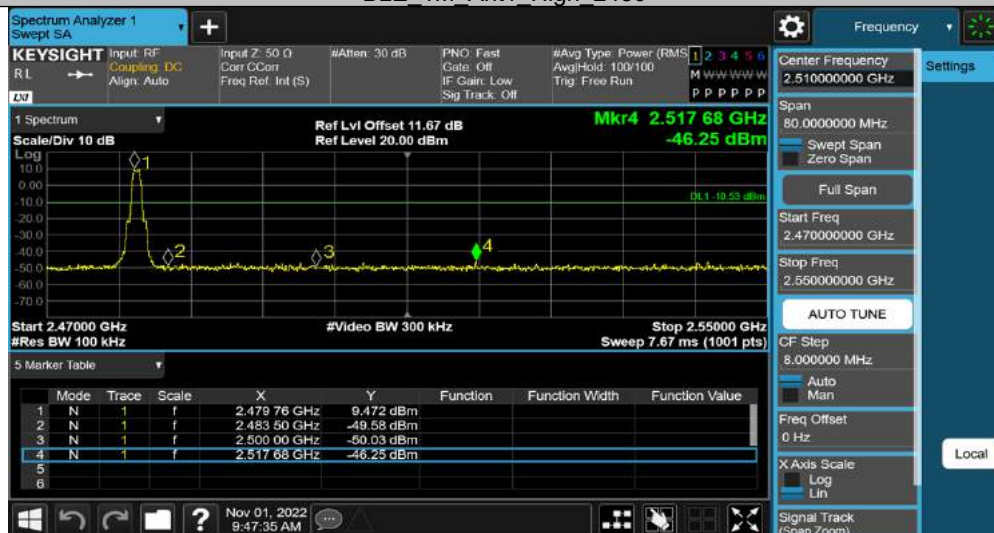
Band Edge

TestMode	Antenna	ChName	Channel	RefLevel[dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	Low	2402	9.72	-46.35	≤-10.29	PASS
		High	2480	9.47	-46.25	≤-10.53	PASS
BLE_2M	Ant1	Low	2402	7.31	-22.06	≤-12.69	PASS
		High	2480	8.19	-46.84	≤-11.81	PASS

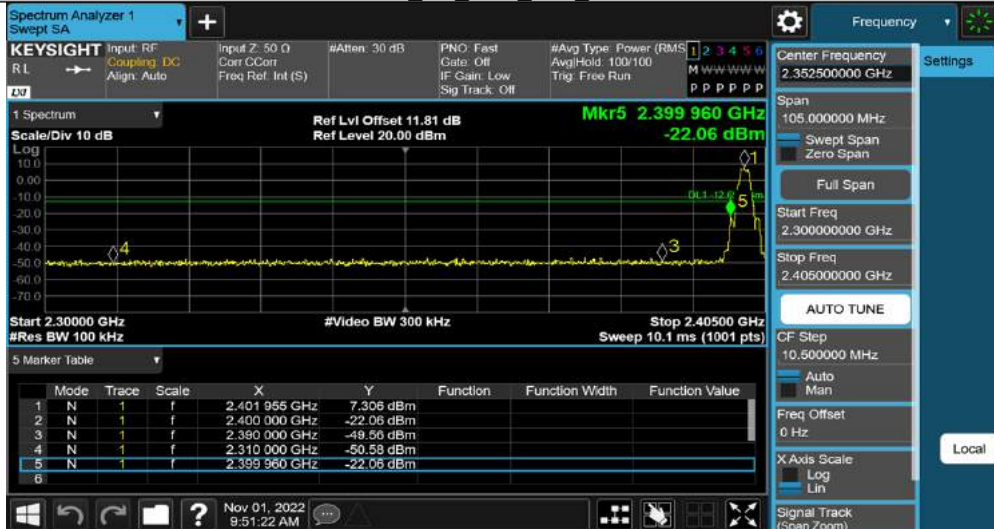
BLE 1M Ant1 Low 2402



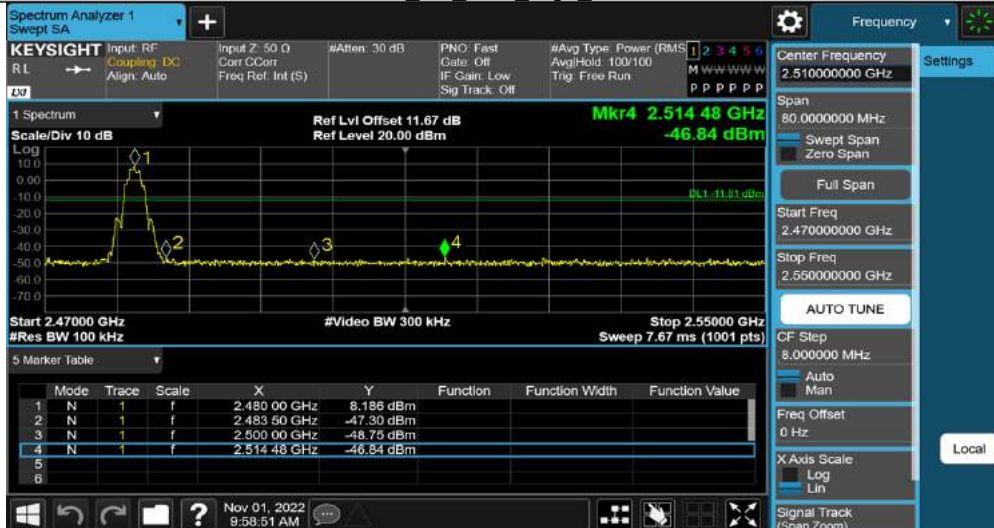
BLE 1M Ant1 High 2480



BLE 2M Ant1 Low 2402



BLE 2M Ant1 High 2480



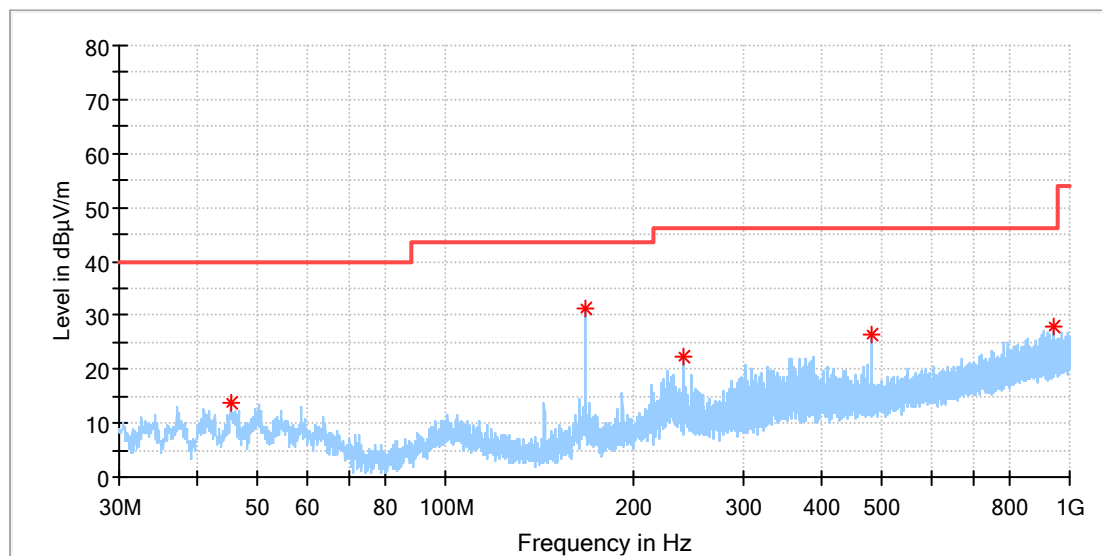
Appendix B.6: Test Results of Radiated Spurious Emissions

Note:

- 1) This testing was carried out on different modulations, but only the worst case was presented in this report.
 - 2) Testing was carried out within frequency range 9kHz to the tenth harmonics. The measurement results below 30MHz and 18GHz - 26.5GHz were greater than 20dB below the limit, so only the radiated spurious emissions from 30MHz to 18GHz were reported.
- 30 MHz to 1GHz

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

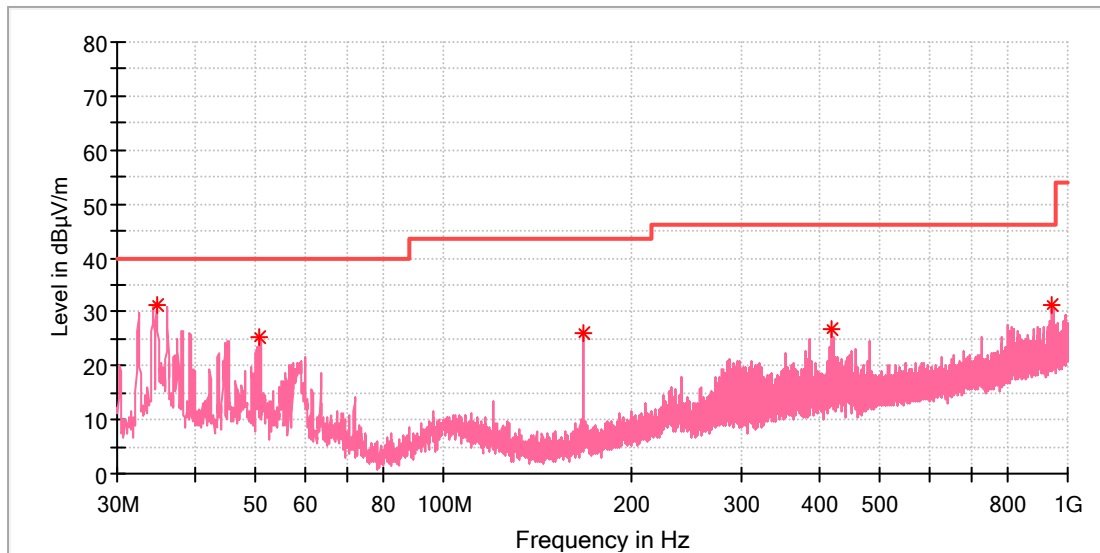


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
45.258846	13.83	40.00	26.17	100.0	H	226.0	-19.1
168.001154	31.43	43.50	12.07	100.0	H	193.0	-21.7
240.005000	22.46	46.00	23.54	100.0	H	273.0	-18.0
480.005385	26.29	46.00	19.71	100.0	H	281.0	-12.6
945.978462	27.74	46.00	18.26	100.0	H	8.0	-4.9

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical_Freqs

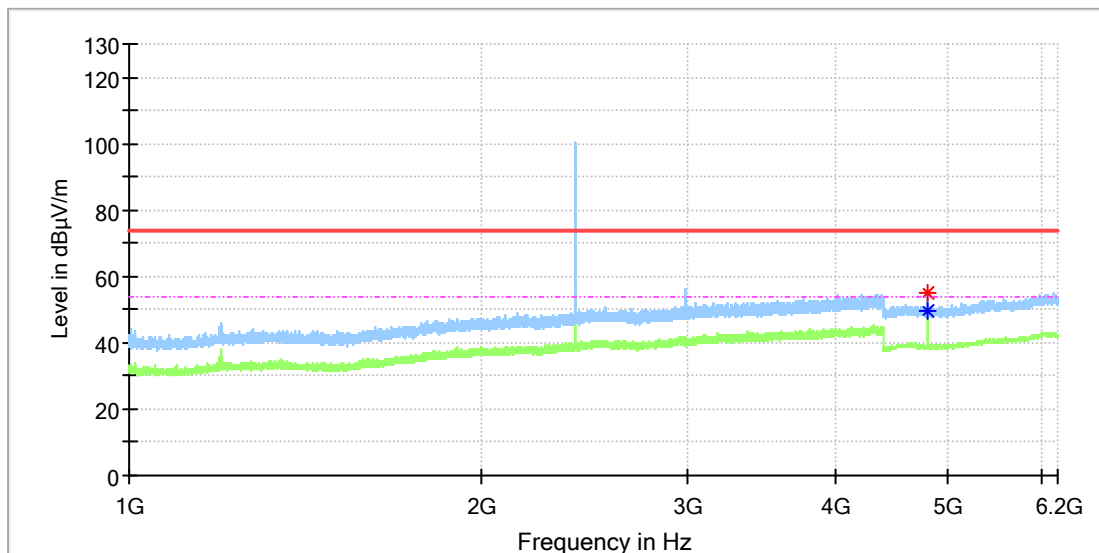
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
34.700769	31.26	40.00	8.74	100.0	V	54.0	-22.3
50.855000	25.23	40.00	14.77	100.0	V	328.0	-18.6
168.001154	26.23	43.50	17.27	100.0	V	285.0	-21.7
419.455000	26.92	46.00	19.08	100.0	V	69.0	-13.7
939.822692	31.08	46.00	14.92	100.0	V	185.0	-5.0

1GHz-6.2GHz

Note: The highest waveform in the figure is Bluetooth Fundamental.

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

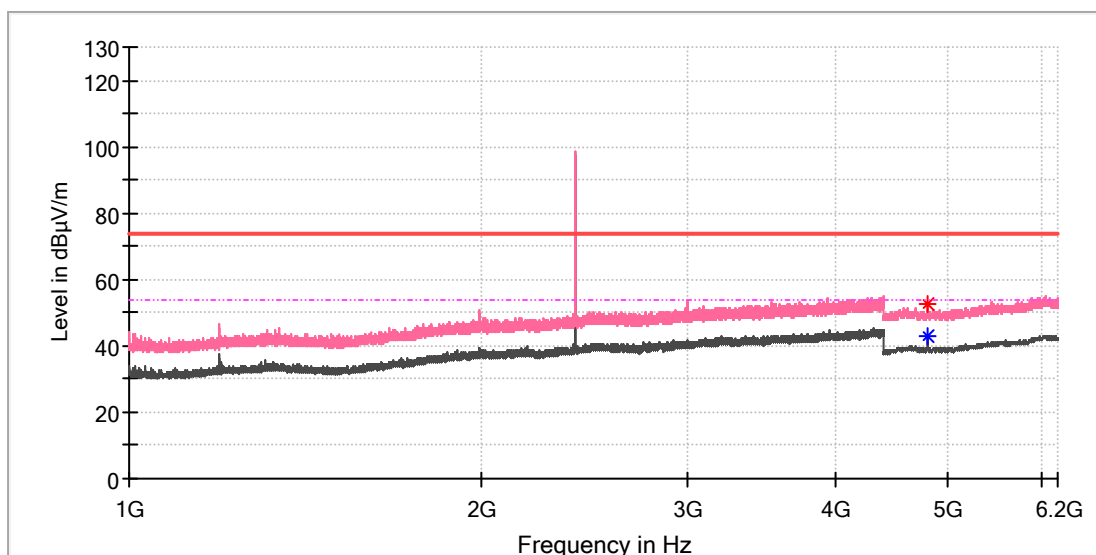


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4803.500000	55.01	---	74.00	18.99	100.0	H	277.0	11.8
4804.000000	---	49.77	54.00	4.23	100.0	H	269.0	11.8

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

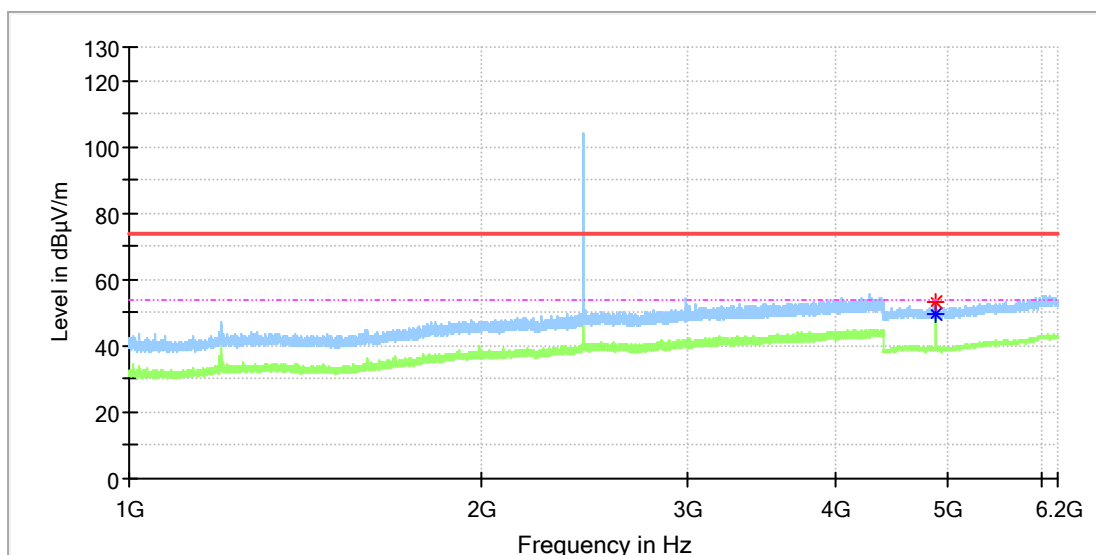


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4804.000000	52.48	---	74.00	21.52	100.0	V	261.0	11.8
4804.000000	---	43.20	54.00	10.80	100.0	V	261.0	11.8

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

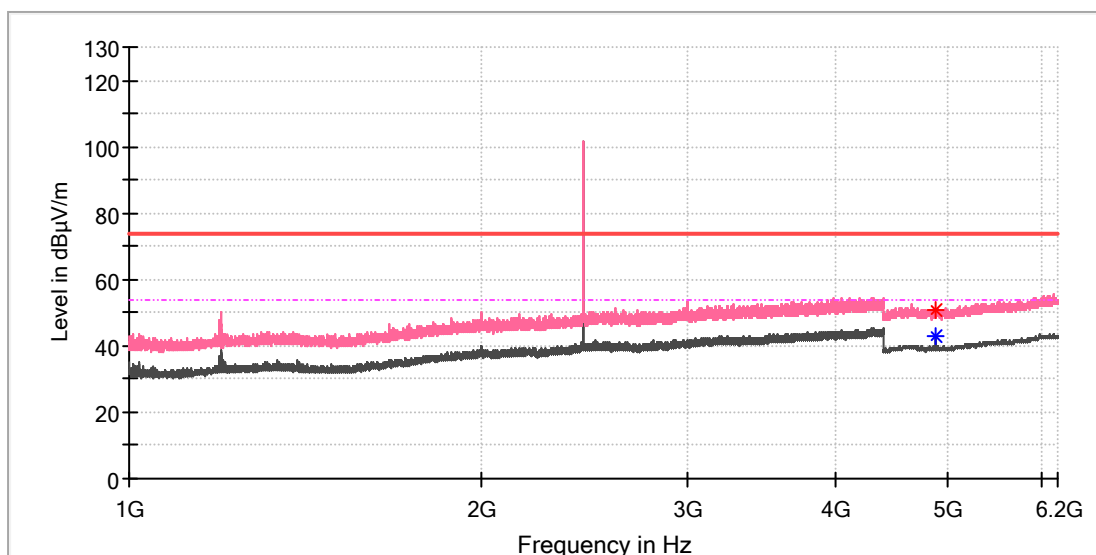


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4880.000000	53.33	---	74.00	20.67	100.0	H	273.0	11.8
4880.000000	---	49.39	54.00	4.61	100.0	H	273.0	11.8

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

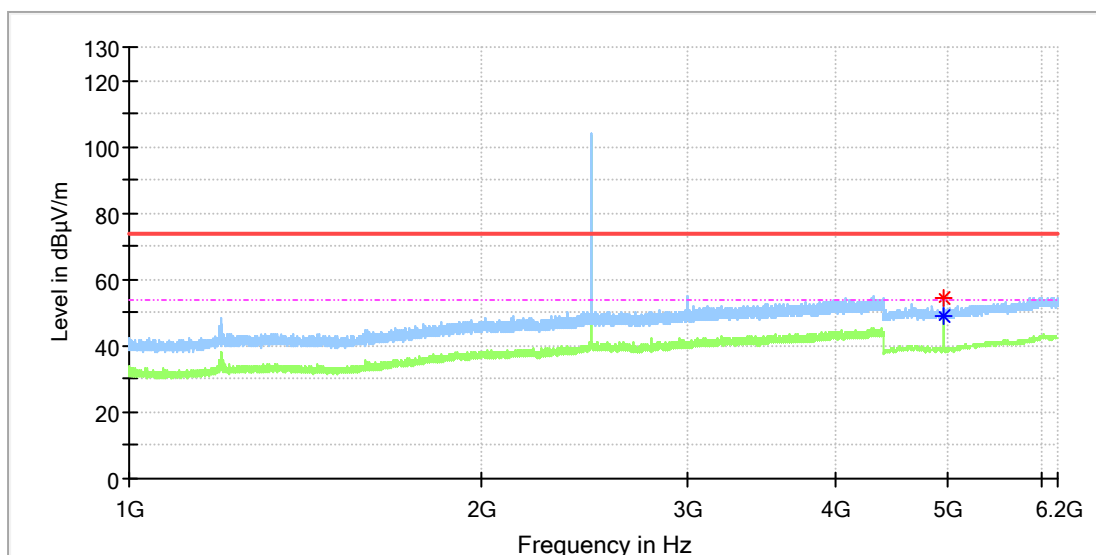


Critical_Freqs

Frequency (MHz)	MaxPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4868.500000	50.71	---	74.00	23.29	100.0	V	106.0	11.8
4880.000000	---	43.17	54.00	10.83	100.0	V	267.0	11.8

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

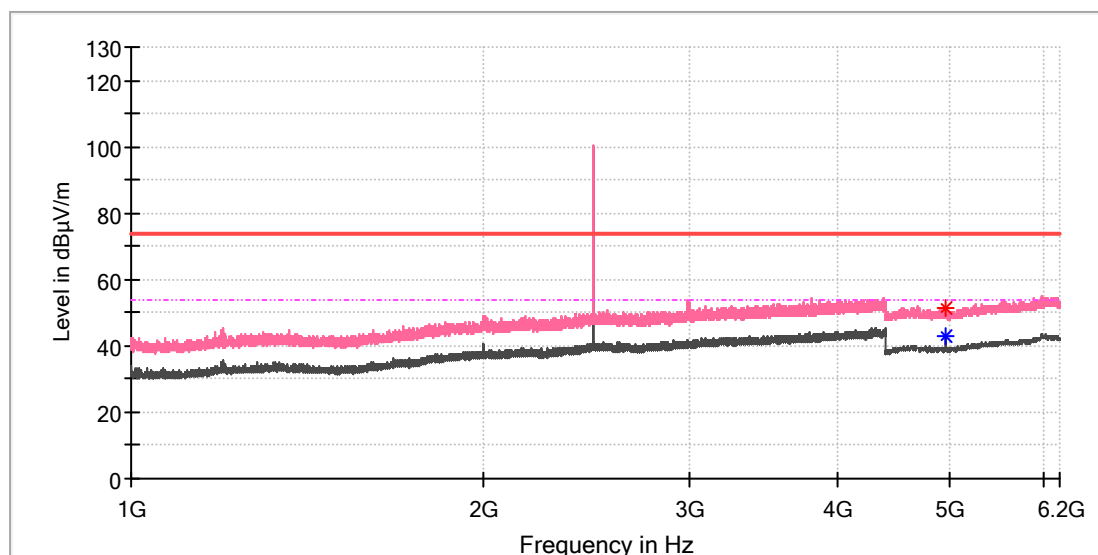


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4960.000000	54.53	---	74.00	19.47	100.0	H	282.0	11.8
4960.000000	---	48.91	54.00	5.09	100.0	H	282.0	11.8

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical_Freqs

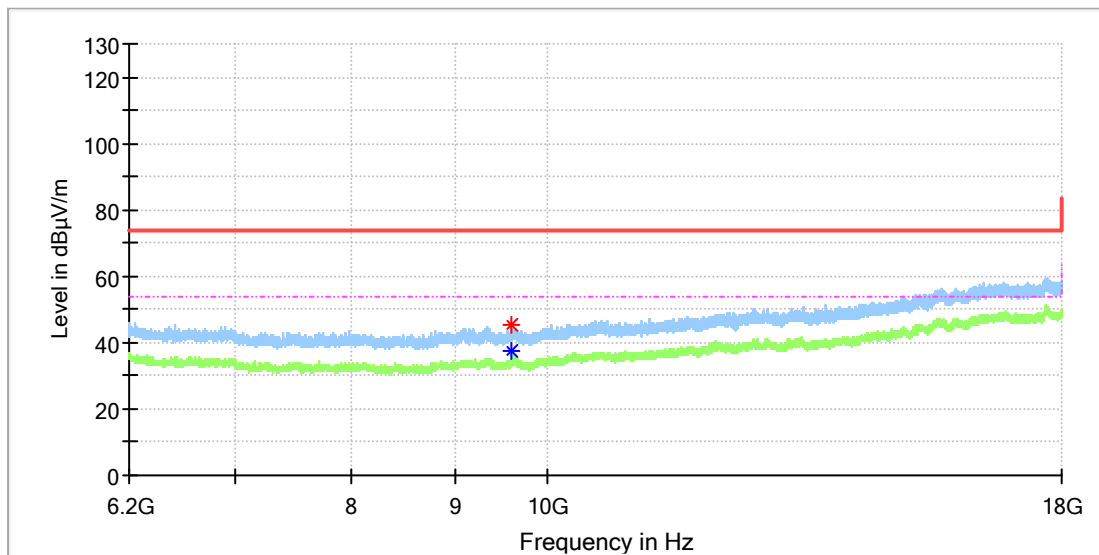
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4957.000000	51.58	---	74.00	22.42	100.0	V	303.0	11.8
4960.000000	---	42.97	54.00	11.03	100.0	V	261.0	11.8

6.2GHz-18GHz

Note: The highest waveform in the figure is Bluetooth harmonic.

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

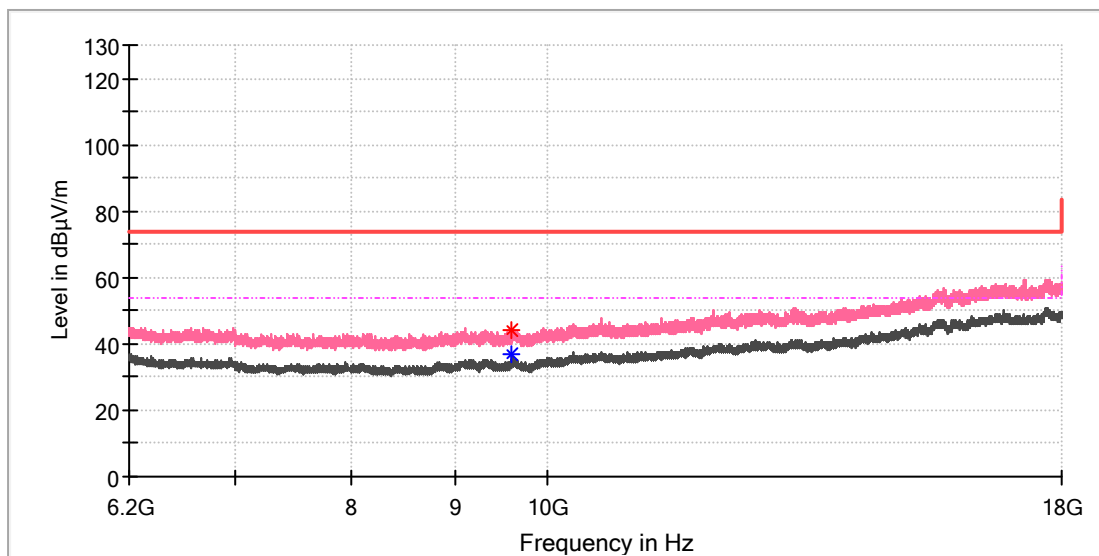


Critical Freqs

Frequency (MHz)	MaxPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9606.758333	45.30	---	74.00	28.70	100.0	H	5.0	10.4
9607.250000	---	37.63	54.00	16.37	100.0	H	354.0	10.4

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

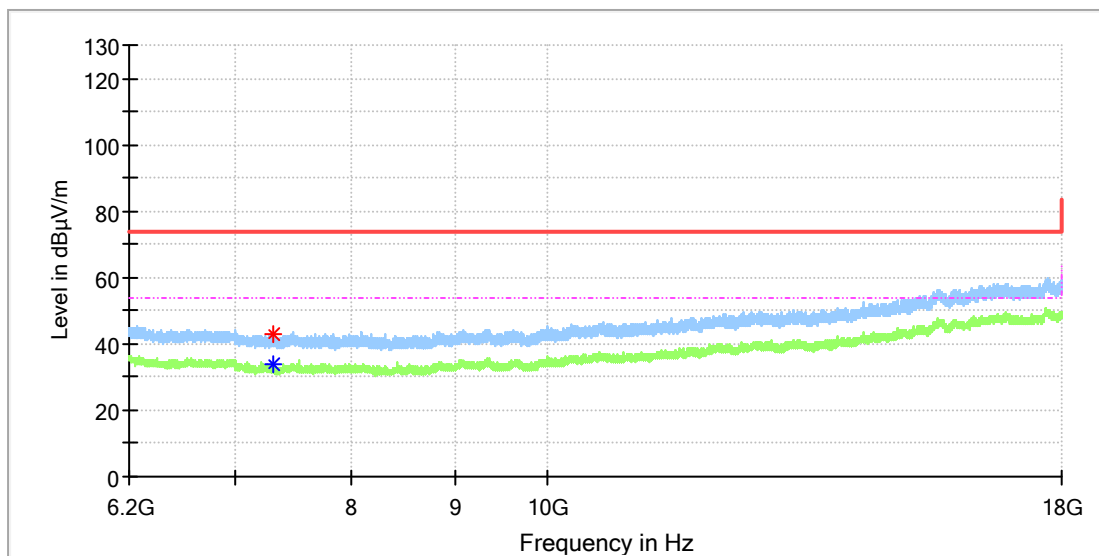


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9595.941667	44.40	---	74.00	29.60	100.0	V	23.0	10.3
9607.250000	---	37.15	54.00	16.85	100.0	V	327.0	10.4

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

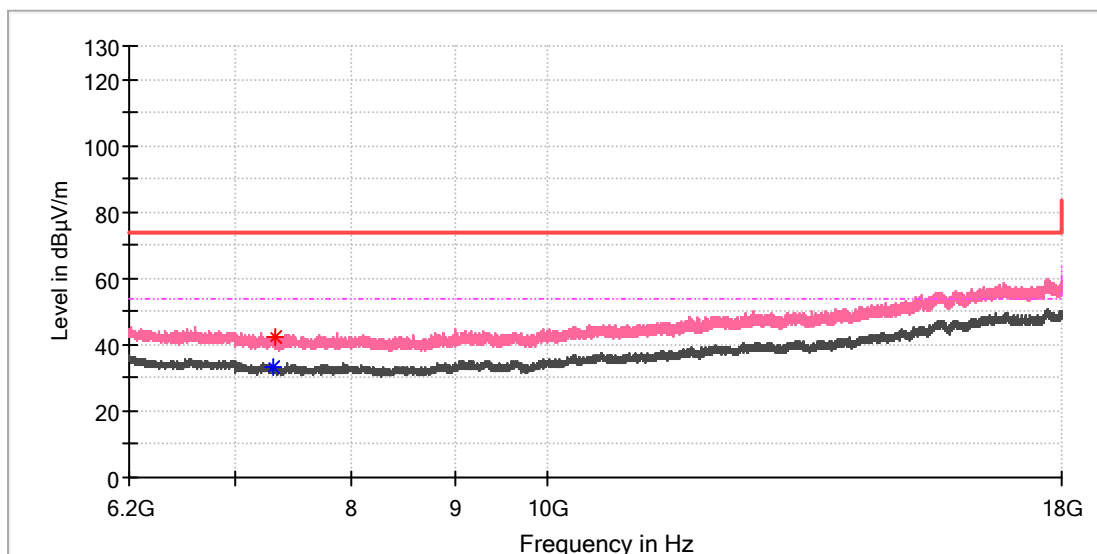


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7301.825000	42.96	---	74.00	31.04	100.0	H	276.0	8.3
7305.758333	---	33.74	54.00	20.26	100.0	H	263.0	8.3

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

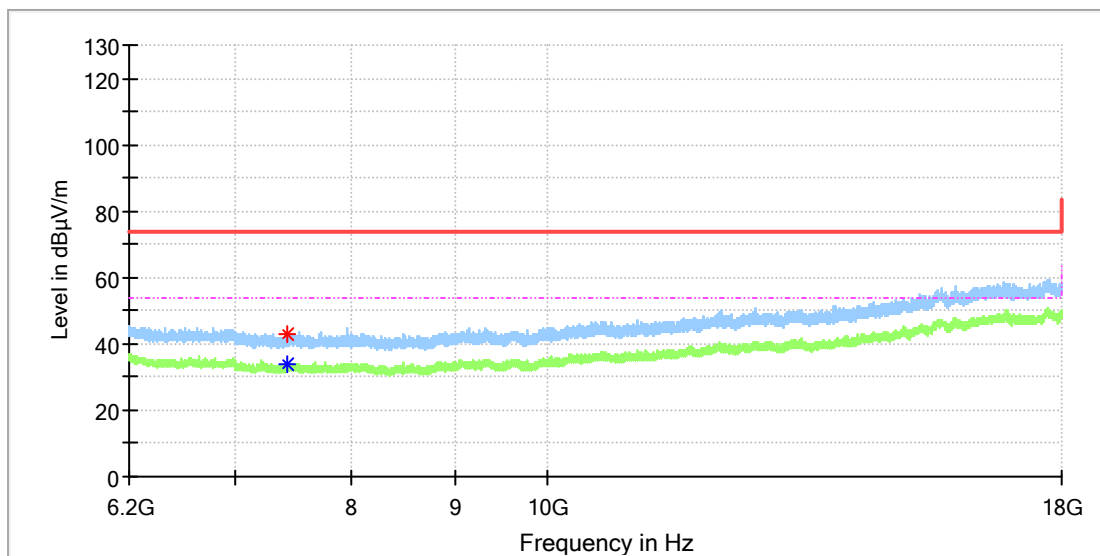


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7313.133333	---	33.55	54.00	20.45	100.0	V	146.0	8.2
7331.325000	42.35	---	74.00	31.65	100.0	V	208.0	8.1

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

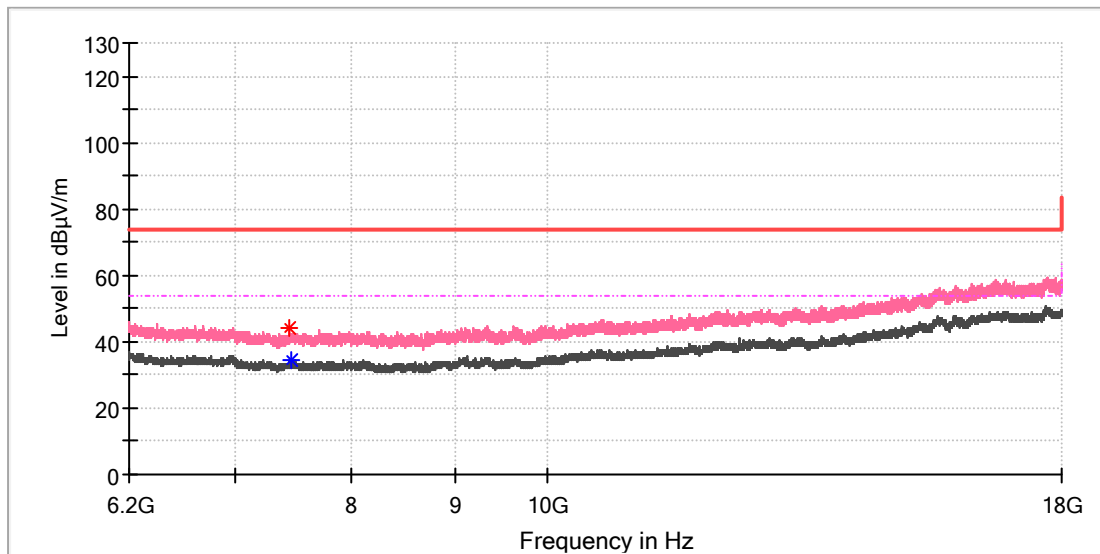


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7422.775000	43.17	---	74.00	30.83	100.0	H	103.0	8.4
7426.708333	---	33.70	54.00	20.30	100.0	H	1.0	8.4

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



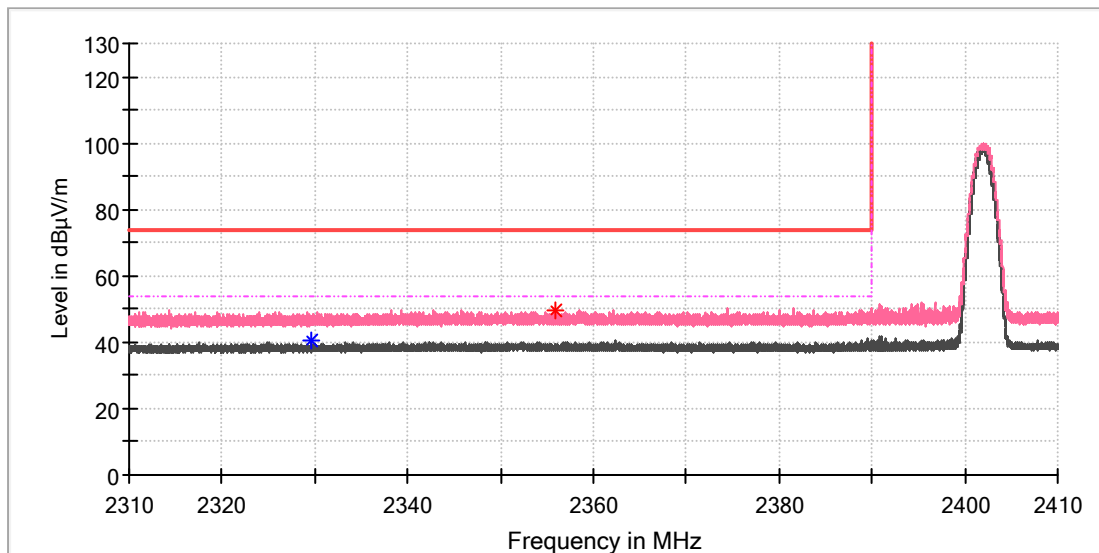
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7439.491667	44.20	---	74.00	29.80	100.0	V	0.0	8.4
7467.025000	---	34.41	54.00	19.59	100.0	V	34.0	8.6

Appendix B.7: Test Results of Radiated Emissions in Restricted Bands

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

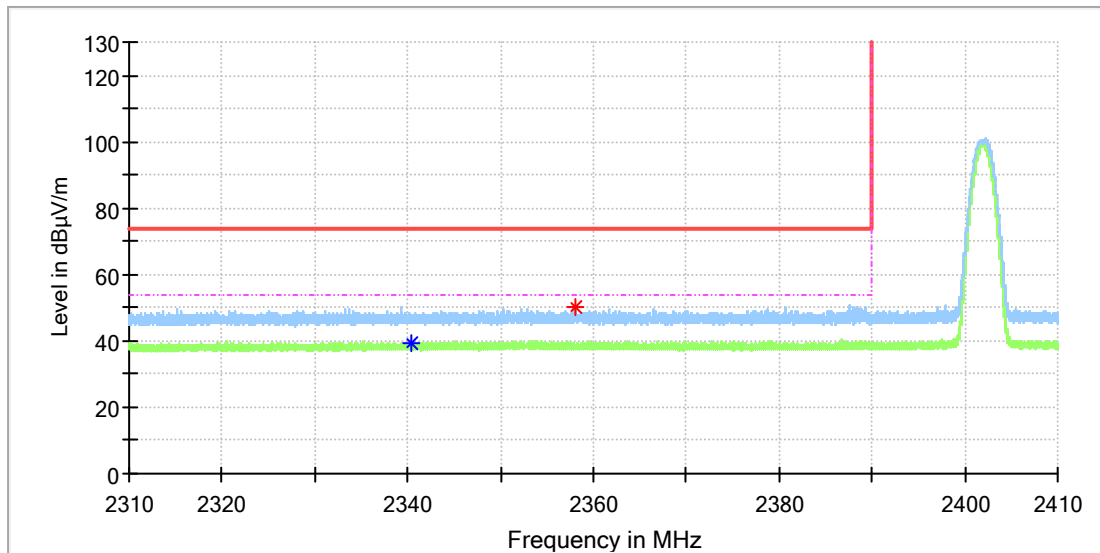


Critical_Freqs

Frequency (MHz)	MaxPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2329.550000	---	40.23	54.00	13.77	100.0	V	248.0	6.7
2355.930000	49.72	---	74.00	24.28	100.0	V	221.0	6.9

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

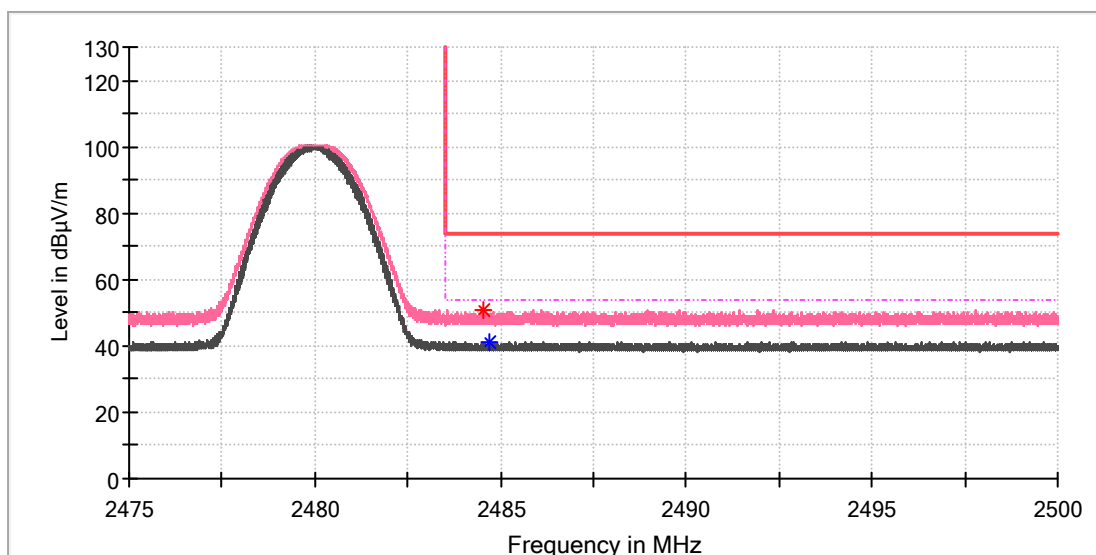


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2340.495000	---	39.53	54.00	14.47	100.0	H	130.0	6.8
2358.010000	50.24	---	74.00	23.76	100.0	H	269.0	6.9

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

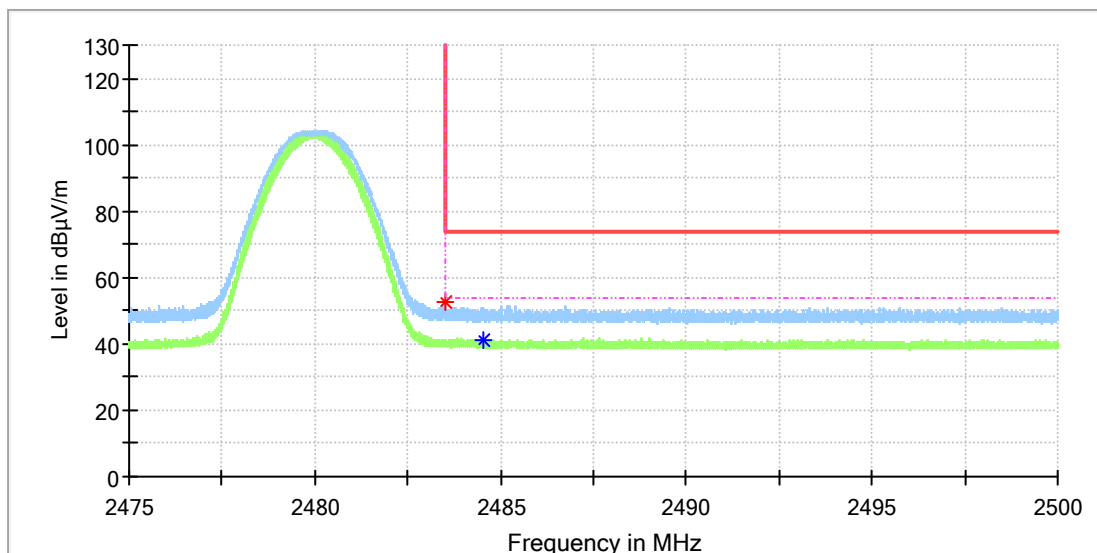


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2484.546250	51.05	---	74.00	22.95	100.0	V	139.0	7.4
2484.695000	---	41.15	54.00	12.85	100.0	V	60.0	7.4

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-005
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2483.523750	52.87	---	74.00	21.13	100.0	H	270.0	7.4
2484.562500	---	41.33	54.00	12.67	100.0	H	208.0	7.4

Appendix C: Test Results of right earbud

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Appendix C.1: Test Results of Conducted Power Spectral Density

TestMode	Antenna	Channel	Result[dBm/3-100kHz]	Limit[dBm/3kHz]	Verdict
BLE_1M	Ant1	2402	-4.65	≤8.00	PASS
		2440	-4.84	≤8.00	PASS
		2480	-5.17	≤8.00	PASS
BLE_2M	Ant1	2402	-6.88	≤8.00	PASS
		2440	-7.02	≤8.00	PASS
		2480	-7.3	≤8.00	PASS

BLE_1M_Ant1_2402



BLE_1M_Ant1_2440



BLE 1M Ant1 2480



BLE 2M Ant1 2402



BLE 2M Ant1 2440





Appendix C.2: Test Results of 6dB Bandwidth

TestMode	Antenna	Channel	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	0.696	2401.636	2402.332	0.5	PASS
		2440	0.684	2439.644	2440.328	0.5	PASS
		2480	0.704	2479.636	2480.340	0.5	PASS
BLE_2M	Ant1	2402	1.200	2401.392	2402.592	0.5	PASS
		2440	1.248	2439.344	2440.592	0.5	PASS
		2480	1.236	2479.340	2480.576	0.5	PASS

BLE_1M Ant1 2402



BLE_1M Ant1 2440



BLE 1M Ant1 2480



BLE 2M Ant1 2402



BLE 2M Ant1 2440





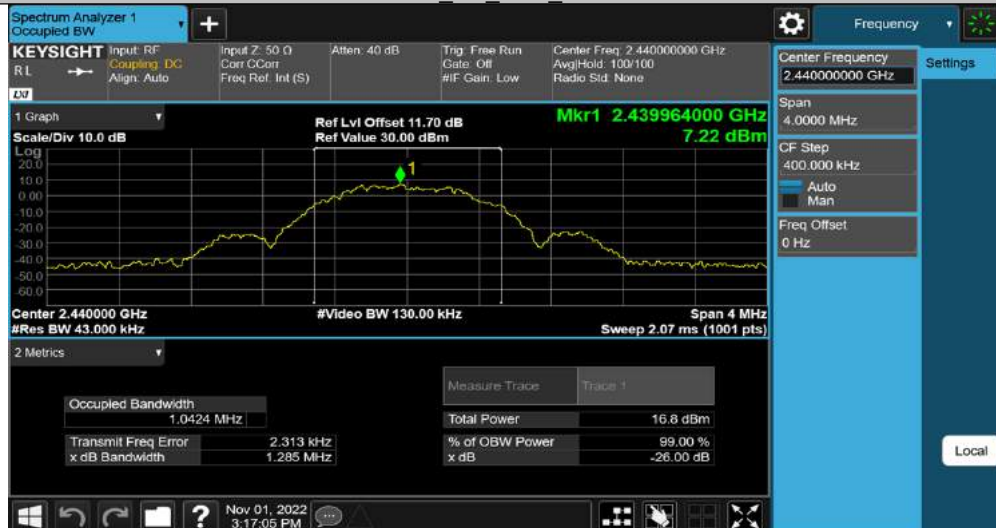
Appendix C.3: Test Results of 99% Bandwidth

TestMode	Antenna	Channel	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
BLE_1M	Ant1	2402	1.0391	2401.4811	2402.5202	---	---
		2440	1.0424	2439.4811	2440.5235	---	---
		2480	1.0438	2479.4801	2480.5239	---	---
BLE_2M	Ant1	2402	2.0673	2400.9789	2403.0462	---	---
		2440	2.0645	2438.9805	2441.0450	---	---
		2480	2.0670	2478.9847	2481.0517	---	---

BLE_1M Ant1 2402



BLE_1M Ant1 2440



BLE 1M Ant1 2480



BLE 2M Ant1 2402



BLE 2M Ant1 2440





Appendix C.4: Test Results of Frequency stability

Test Channel (MHz)	2402
--------------------	------

Test result of frequency tolerance of voltage variation

Voltage	Test result (MHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
DC 3.465V	2401.993	7	2.914238	10
DC 3.85V	2401.990	10	4.163197	
DC 4.235	2401.985	15	6.244796	

Test result of frequency tolerance of temperature variation

Temperature (°C)	Test result (KHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
-30	2401.985	15	6.244796	10
-20	2401.991	9	3.746878	
-10	2401.993	7	2.914238	
0	2401.989	12	4.995837	
10	2401.992	8	3.330558	
20	2401.988	12	4.995837	
30	2401.988	12	4.995837	
40	2401.993	7	2.914238	
50	2401.995	5	2.081599	
55	2401.992	8	3.330558	

Test Channel (MHz)	2440
--------------------	------

Test result of frequency tolerance of voltage variation

Voltage	Test result (MHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
DC 3.465V	2439.992	-8	-3.27869	10
DC 3.85V	2439.995	-5	-2.04918	
DC 4.235	2439.988	-12	-4.91803	

Test result of frequency tolerance of temperature variation

Temperature (°C)	Test result (KHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
-30	2439.993	-7	-2.86885	10
-20	2439.996	-4	-1.63934	
-10	2439.995	-5	-2.04918	
0	2439.990	-10	-4.09836	
10	2439.985	-15	-6.14754	
20	2439.991	-9	-3.68852	
30	2439.989	-11	-4.5082	
40	2439.986	-14	-5.7377	
50	2439.987	-13	-5.32787	
55	2439.988	-12	-4.91803	

Test Channel (MHz)	2480
--------------------	------

Test result of frequency tolerance of voltage variation

Voltage	Test result (MHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
DC 3.465V	2479.998	-5	-2.01613	10
DC 3.85V	2479.995	-8	-3.22581	
DC 4.235	2479.992	-8	-3.22581	

Test result of frequency tolerance of temperature variation

Temperature (°C)	Test result (KHz)	Deviation Frequency (KHz)	Test result (ppm)	Limit (ppm)
-30	2479.988	-12	-4.83871	10
-20	2479.985	-15	-6.04839	
-10	2479.991	-9	-3.62903	
0	2479.990	-10	-4.03226	
10	2479.993	-7	-2.82258	
20	2479.995	-5	-2.01613	
30	2479.996	-4	-1.6129	
40	2479.992	-8	-3.22581	
50	2479.993	-7	-2.82258	
55	2479.995	-5	-2.01613	

Appendix C.5: Test Results of Conducted Spurious Emissions Measured in 100 kHz Bandwidth

Conducted Spurious Emission

TestMode	Antenna	Channel	FreqRange [MHz]	RefLevel [dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	2402	Reference	9.48	9.48	---	PASS
			30~1000	9.48	-46.51	≤-10.52	PASS
			1000~26500	9.48	-38.63	≤-10.52	PASS
		2440	Reference	9.13	9.13	---	PASS
			30~1000	9.13	-48.02	≤-10.87	PASS
			1000~26500	9.13	-38.82	≤-10.87	PASS
		2480	Reference	8.57	8.57	---	PASS
			30~1000	8.57	-48.56	≤-11.43	PASS
			1000~26500	8.57	-38.94	≤-11.43	PASS
BLE_2M	Ant1	2402	Reference	6.30	6.30	---	PASS
			30~1000	6.30	-48.82	≤-13.7	PASS
			1000~26500	6.30	-39.03	≤-13.7	PASS
		2440	Reference	6.22	6.22	---	PASS
			30~1000	6.22	-48.28	≤-13.78	PASS
			1000~26500	6.22	-39.47	≤-13.78	PASS
		2480	Reference	6.68	6.68	---	PASS
			30~1000	6.68	-48.34	≤-13.32	PASS
			1000~26500	6.68	-39.37	≤-13.32	PASS



BLE_1M_Ant1_2402_30~1000



BLE_1M_Ant1_2402_1000~26500



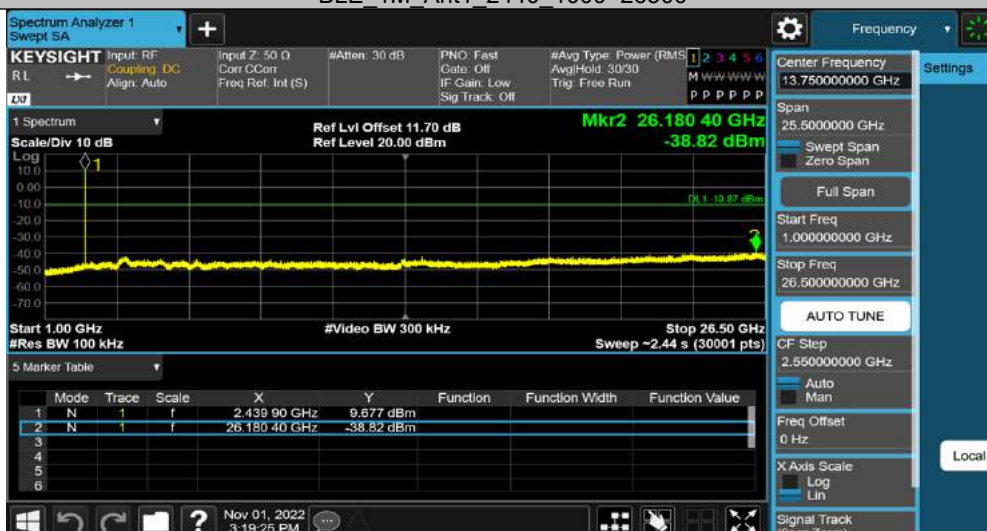
BLE_1M_Ant1_2440_0~Reference



BLE_1M_Ant1_2440_30~1000



BLE_1M_Ant1_2440_1000~26500



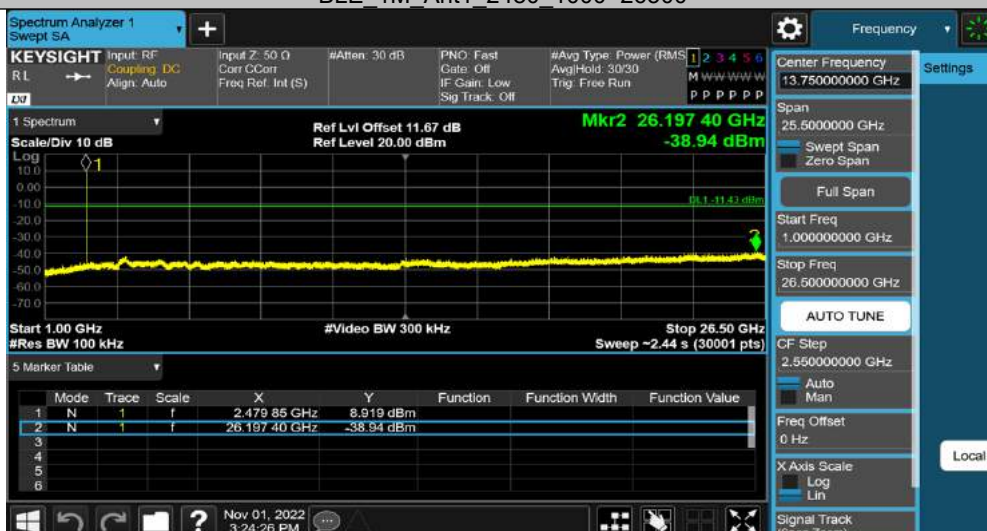
BLE_1M_Ant1_2480_0~Reference



BLE_1M_Ant1_2480_30~1000



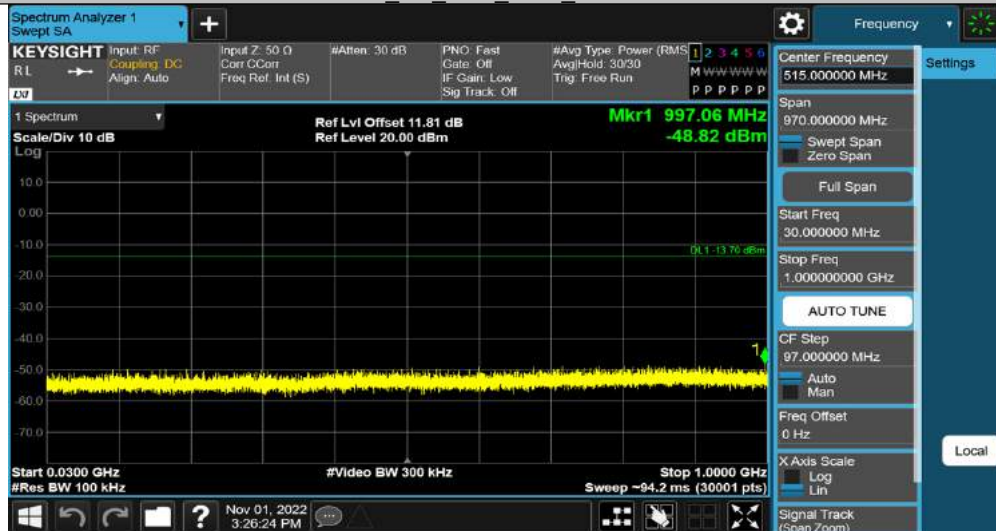
BLE_1M_Ant1_2480_1000~26500



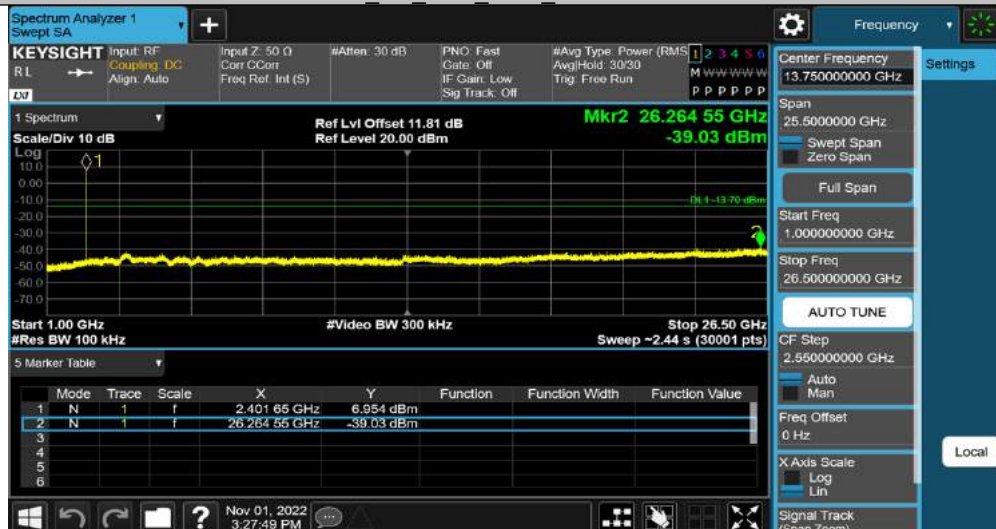
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BLE_2M_Ant1_2402_30~1000



BLE_2M_Ant1_2402_1000~26500



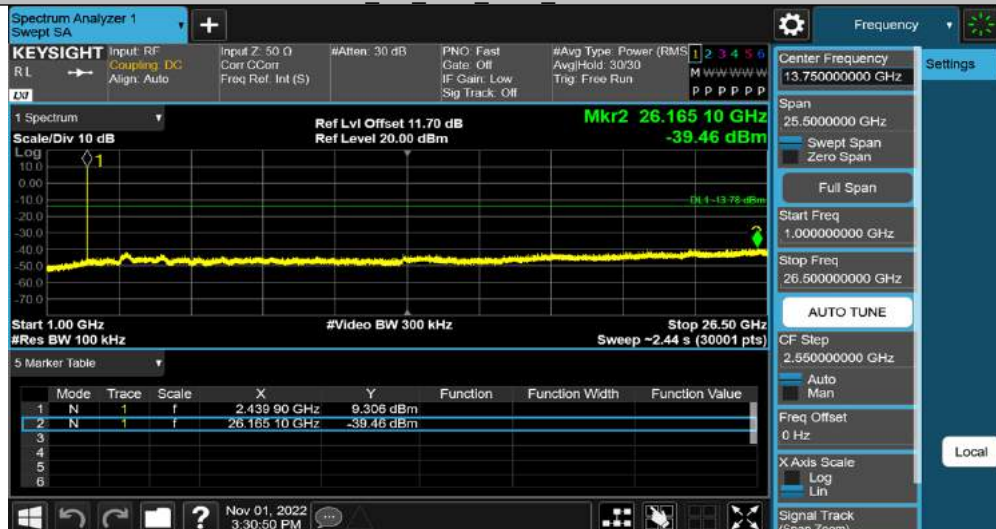
BLE_2M_Ant1_2440_0~Reference



BLE_2M_Ant1_2440_30~1000



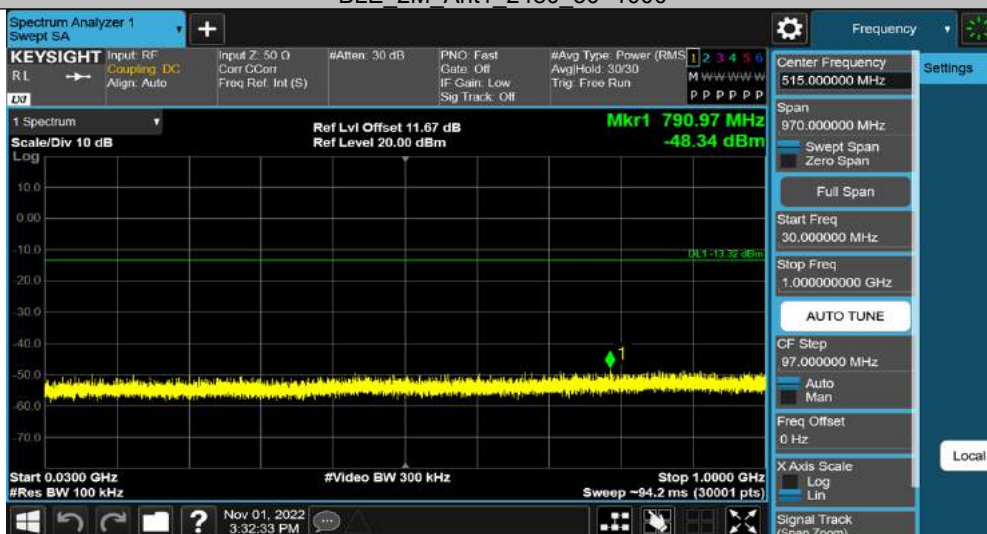
BLE_2M_Ant1_2440_1000~26500



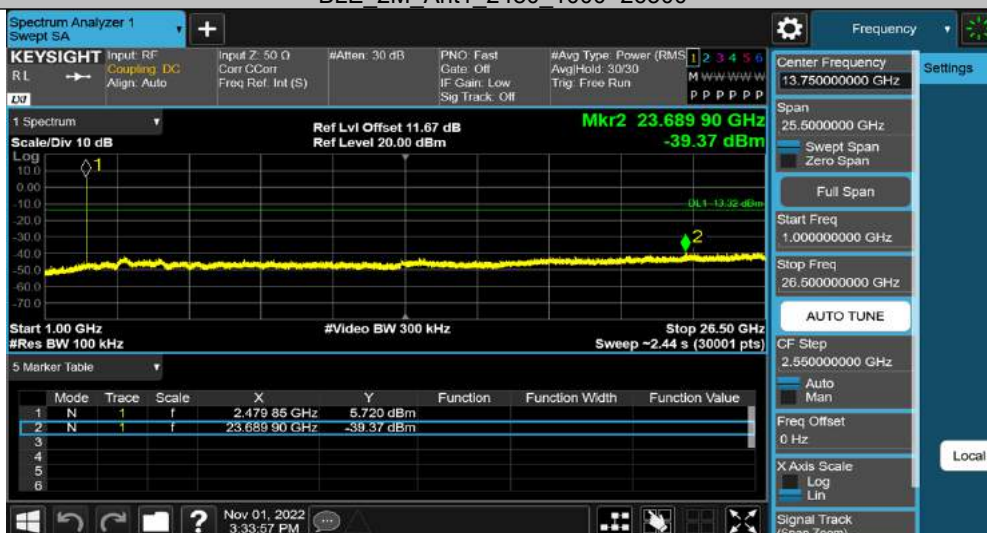
BLE_2M_Ant1_2480_0~Reference



BLE_2M_Ant1_2480_30~1000



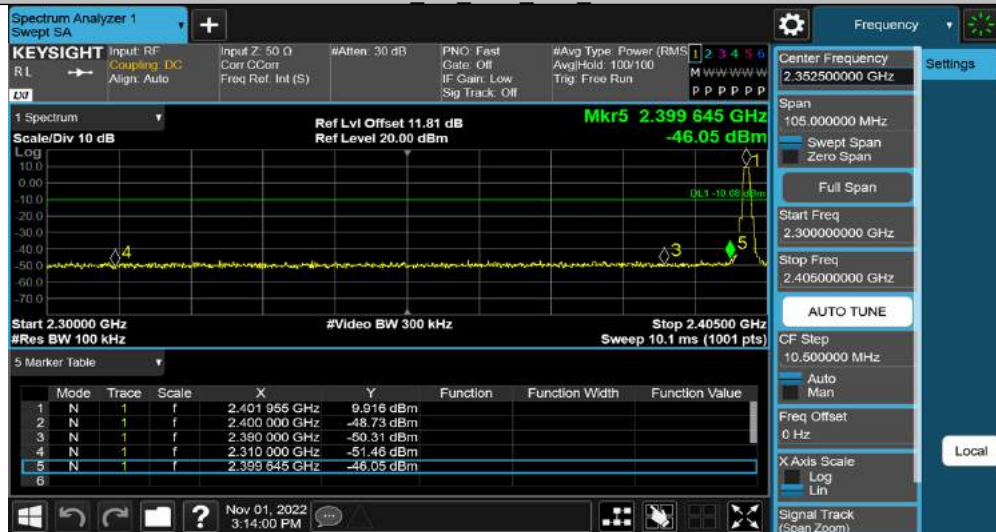
BLE_2M_Ant1_2480_1000~26500



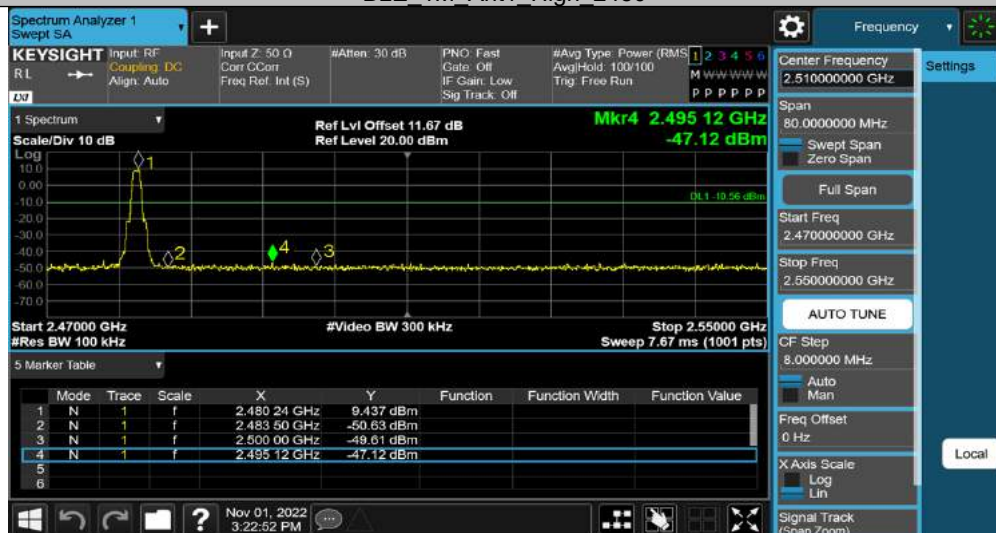
Band Edge

TestMode	Antenna	ChName	Channel	RefLevel[dBm]	Result[dBm]	Limit[dBm]	Verdict
BLE_1M	Ant1	Low	2402	9.92	-46.05	≤-10.08	PASS
		High	2480	9.44	-47.12	≤-10.56	PASS
BLE_2M	Ant1	Low	2402	9.49	-22.62	≤-10.51	PASS
		High	2480	6.94	-47.22	≤-13.06	PASS

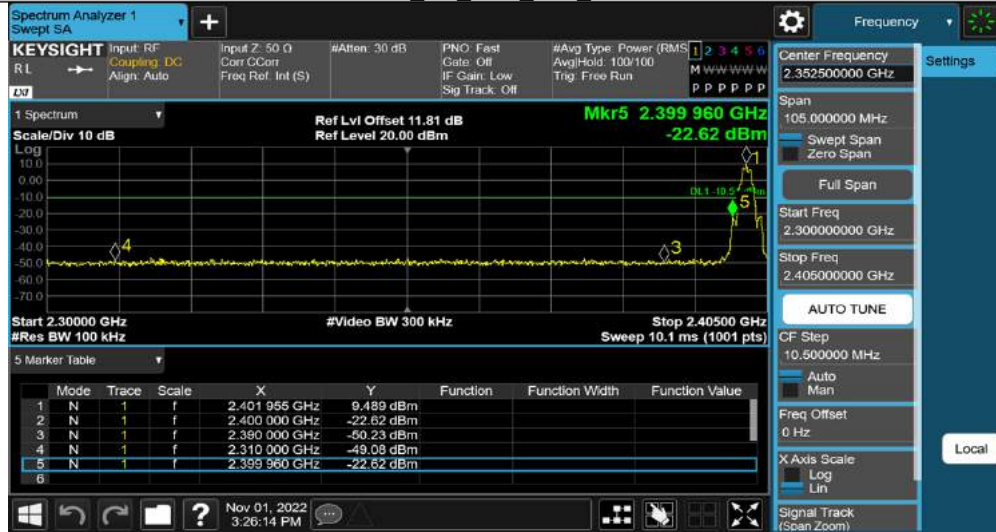
BLE 1M Ant1 Low 2402



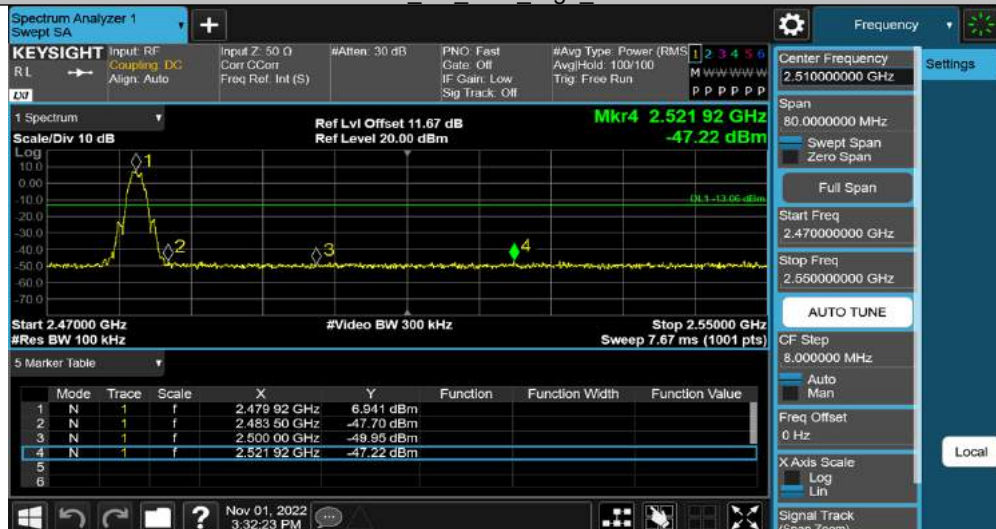
BLE 1M Ant1 High 2480



BLE 2M Ant1 Low 2402



BLE 2M Ant1 High 2480



Appendix C.6: Test Results of Radiated Spurious Emissions

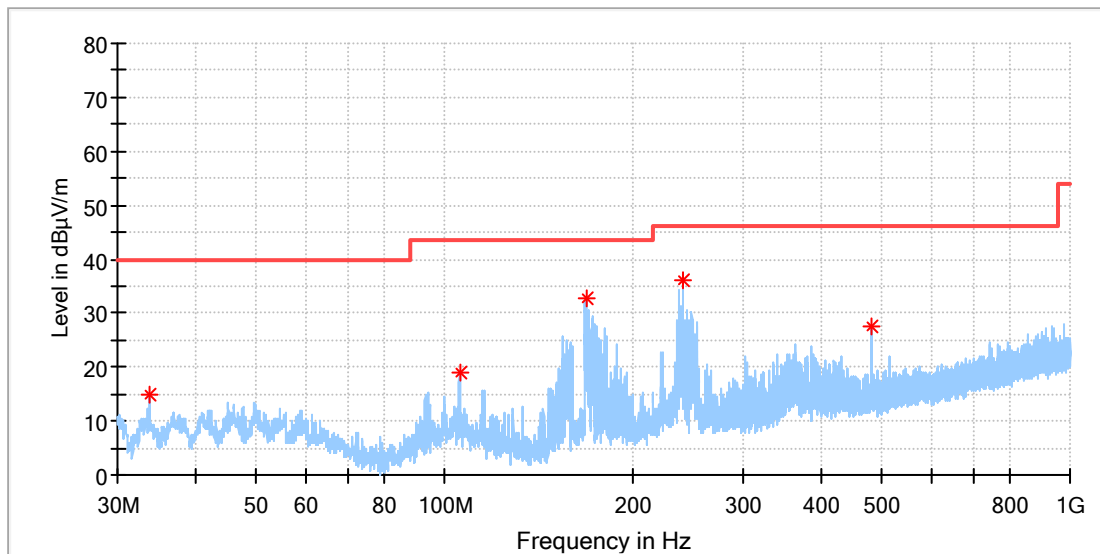
Note:

- 1) This testing was carried out on different modulations, but only the worst case was presented in this report.
- 2) Testing was carried out within frequency range 9kHz to the tenth harmonics. The measurement results below 30MHz and 18GHz - 26.5GHz were greater than 20dB below the limit, so only the radiated spurious emissions from 30MHz to 18GHz were reported.

30 MHz to 1GHz

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

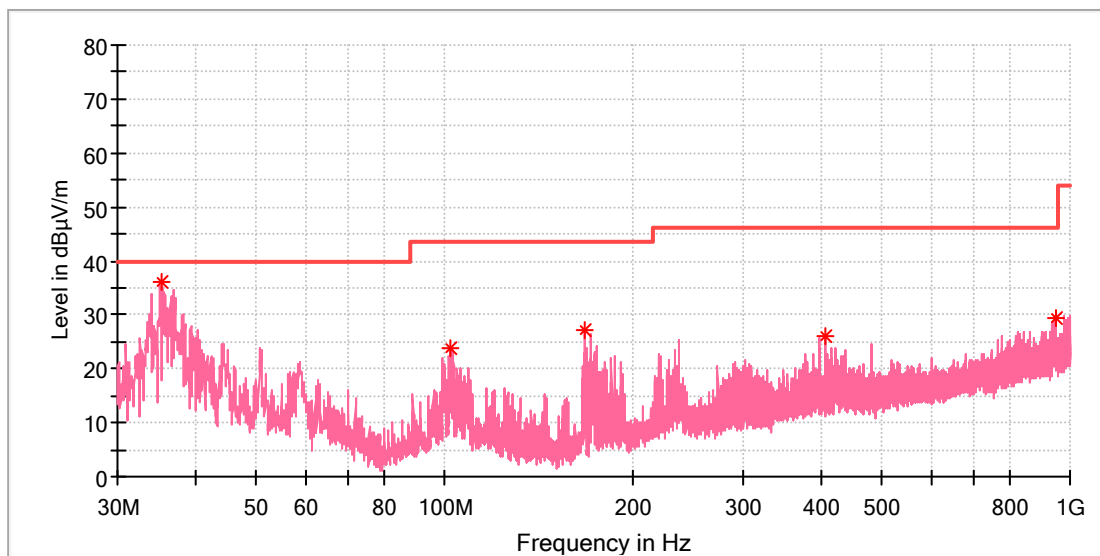


Critical Freqs

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
33.768077	14.75	40.00	25.25	100.0	H	197.0	-22.6
105.622692	19.13	43.50	24.37	100.0	H	113.0	-19.1
168.187692	32.57	43.50	10.93	100.0	H	197.0	-21.7
240.079615	36.11	46.00	9.89	100.0	H	197.0	-18.0
480.005385	27.37	46.00	18.63	100.0	H	204.0	-12.6

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical_Freqs

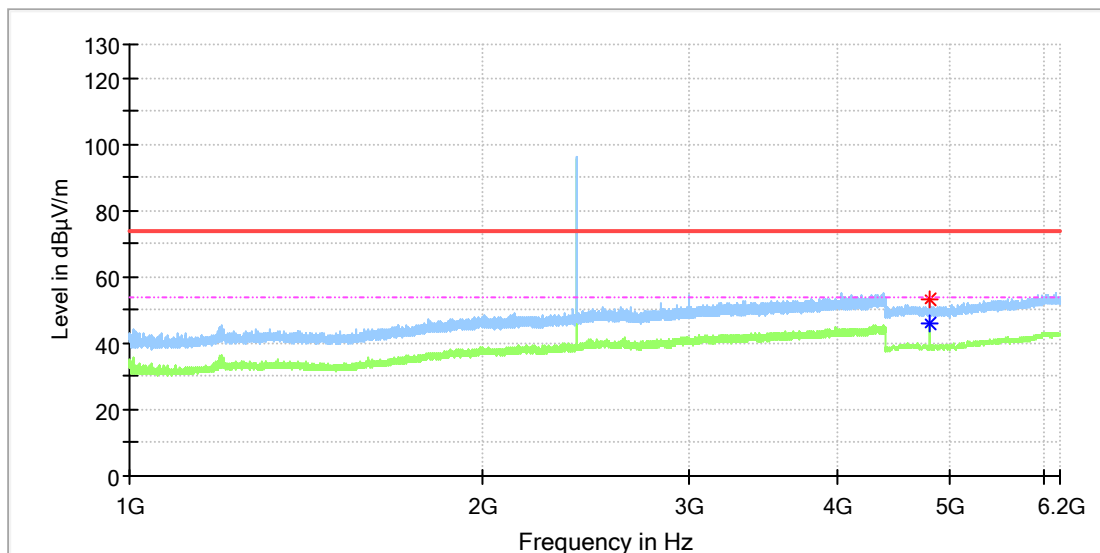
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
35.409615	36.25	40.00	3.75	100.0	V	0.0	-22.1
102.376923	23.66	43.50	19.84	100.0	V	328.0	-19.2
168.001154	27.04	43.50	16.46	100.0	V	292.0	-21.7
405.091539	25.88	46.00	20.12	100.0	V	51.0	-14.0
949.298846	29.32	46.00	16.68	100.0	V	337.0	-4.9

1GHz-6.2GHz

Note: The highest waveform in the figure is Bluetooth Fundamental.

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

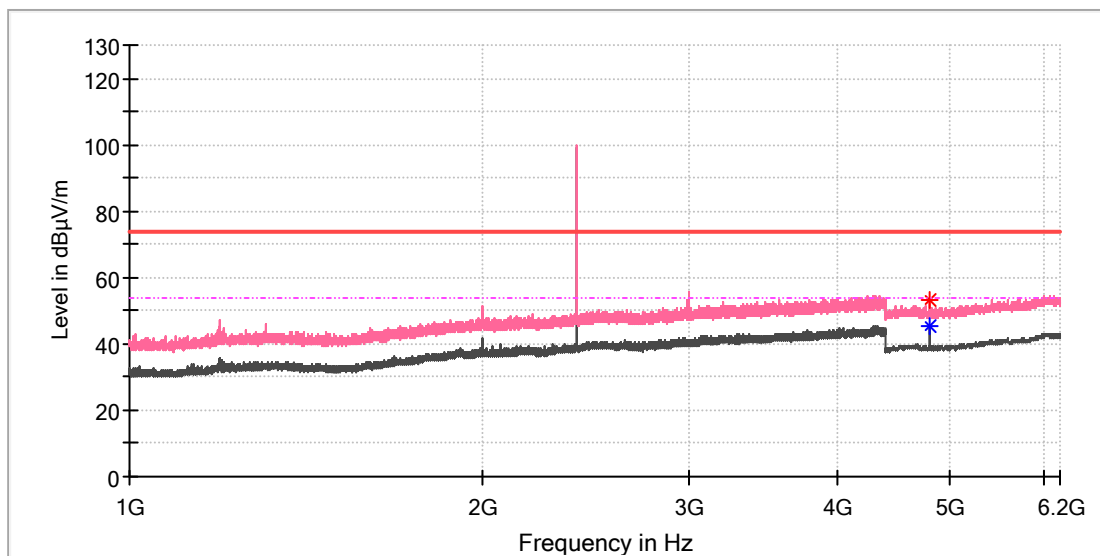


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4803.500000	---	45.68	54.00	8.32	100.0	H	26.0	11.8
4804.000000	53.41	---	74.00	20.59	100.0	H	41.0	11.8

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

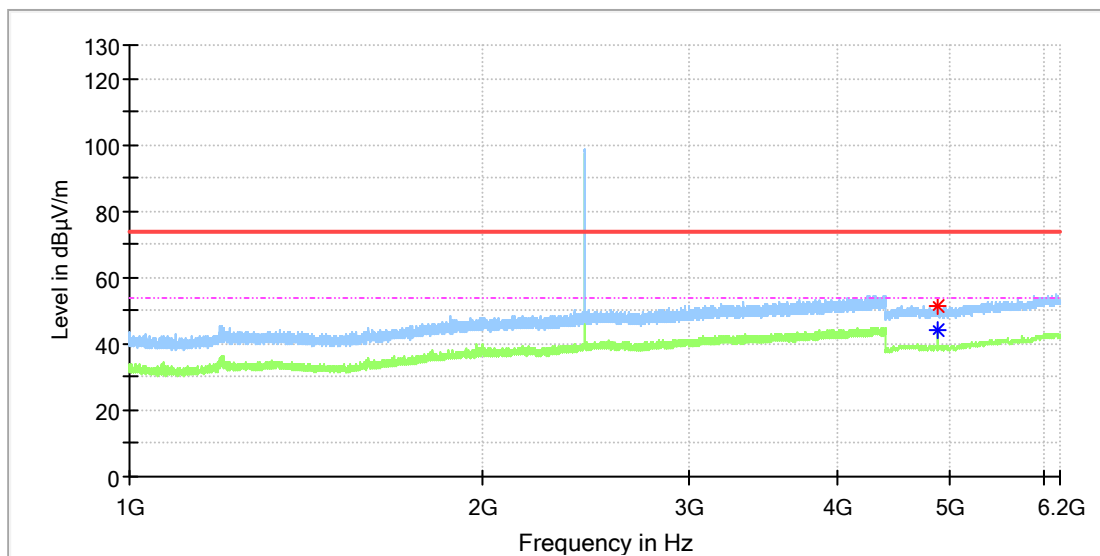


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4803.500000	53.22	---	74.00	20.78	100.0	V	51.0	11.8
4804.000000	---	45.62	54.00	8.38	100.0	V	51.0	11.8

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

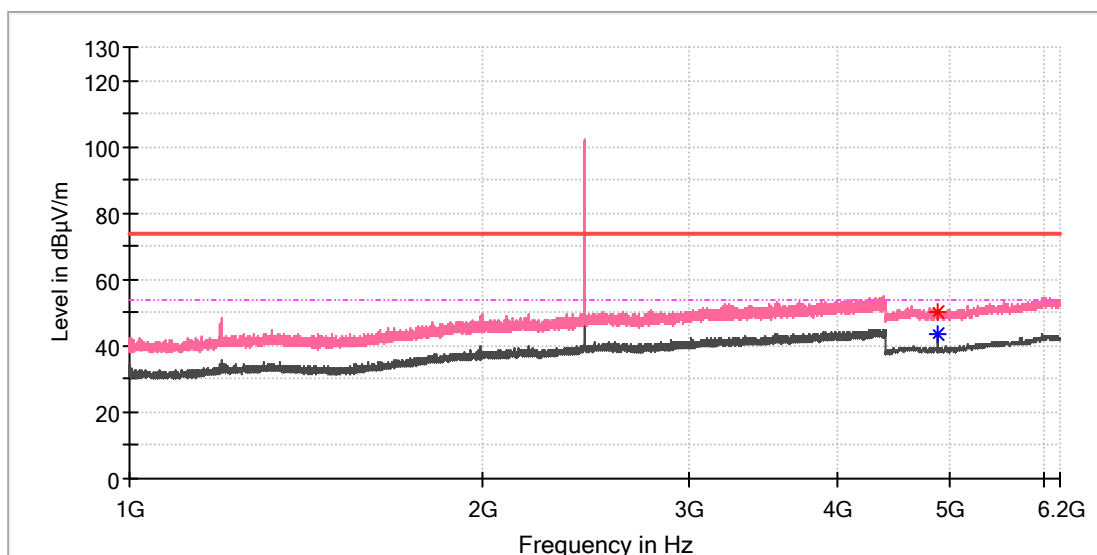


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4879.500000	51.46	---	74.00	22.54	100.0	H	0.0	11.8
4880.000000	---	44.18	54.00	9.82	100.0	H	34.0	11.8

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

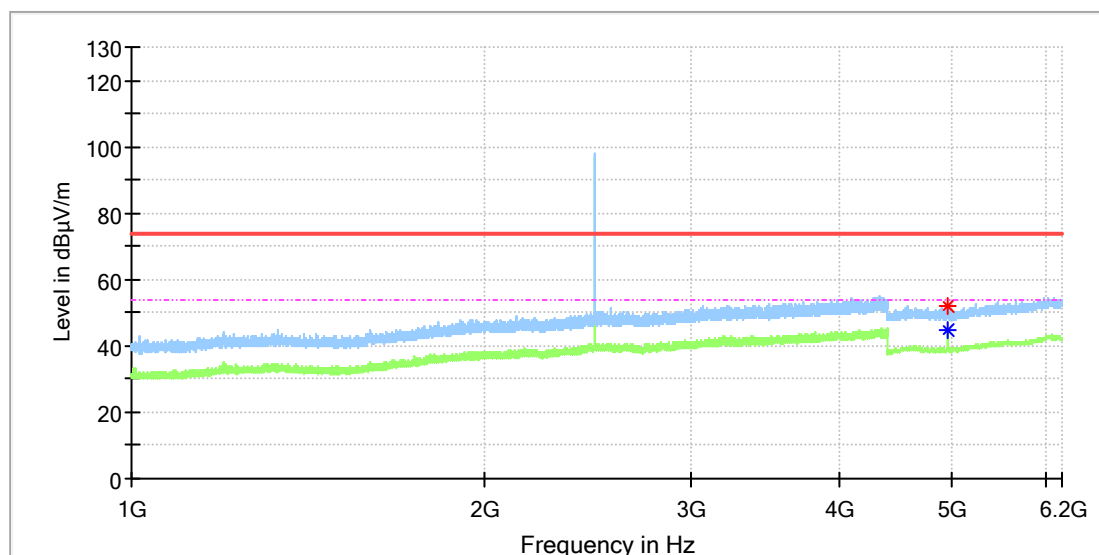


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4879.500000	50.42	---	74.00	23.58	100.0	V	271.0	11.8
4880.000000	---	43.69	54.00	10.31	100.0	V	59.0	11.8

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

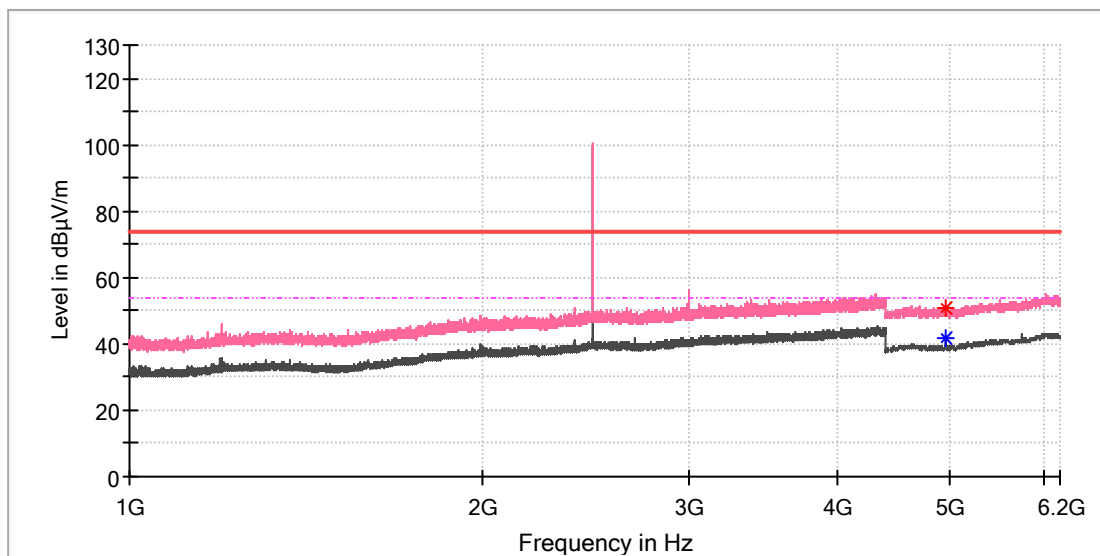


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4960.000000	52.17	---	74.00	21.83	100.0	H	359.0	11.8
4960.000000	---	44.71	54.00	9.29	100.0	H	359.0	11.8

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical_Freqs

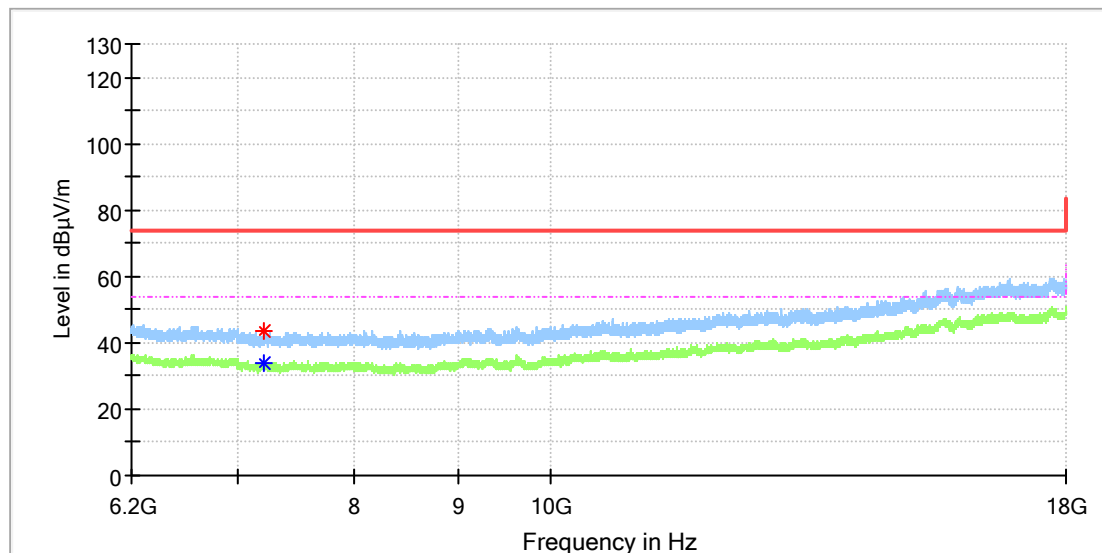
Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
4960.000000	---	41.99	54.00	12.01	100.0	V	65.0	11.8
4964.500000	50.94	---	74.00	23.06	100.0	V	234.0	11.8

6.2GHz-18GHz

Note: The highest waveform in the figure is Bluetooth harmonic.

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

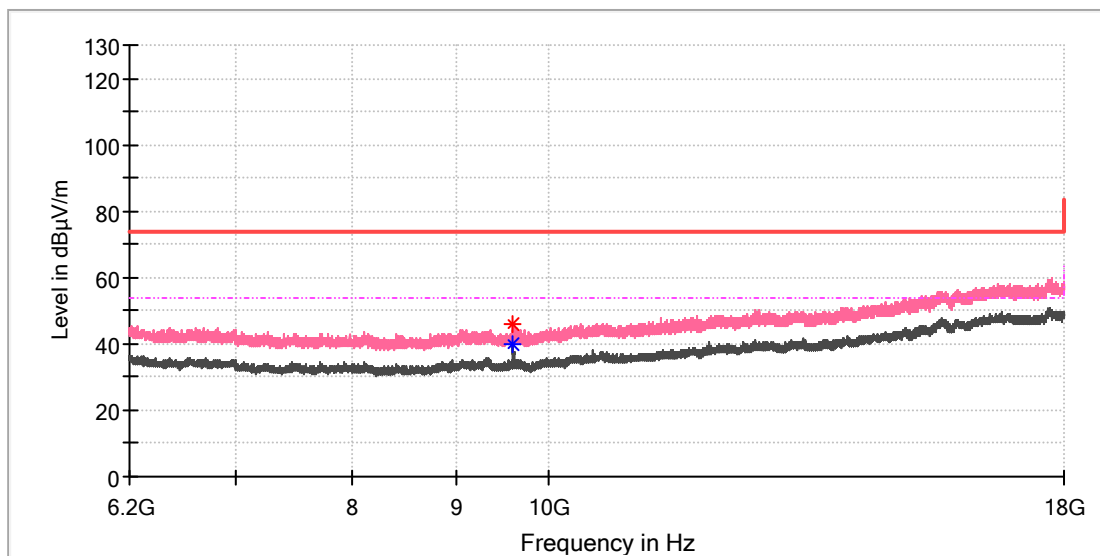


Critical Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7202.508333	---	33.73	54.00	20.27	100.0	H	167.0	8.8
7204.475000	43.32	---	74.00	30.68	100.0	H	0.0	8.8

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

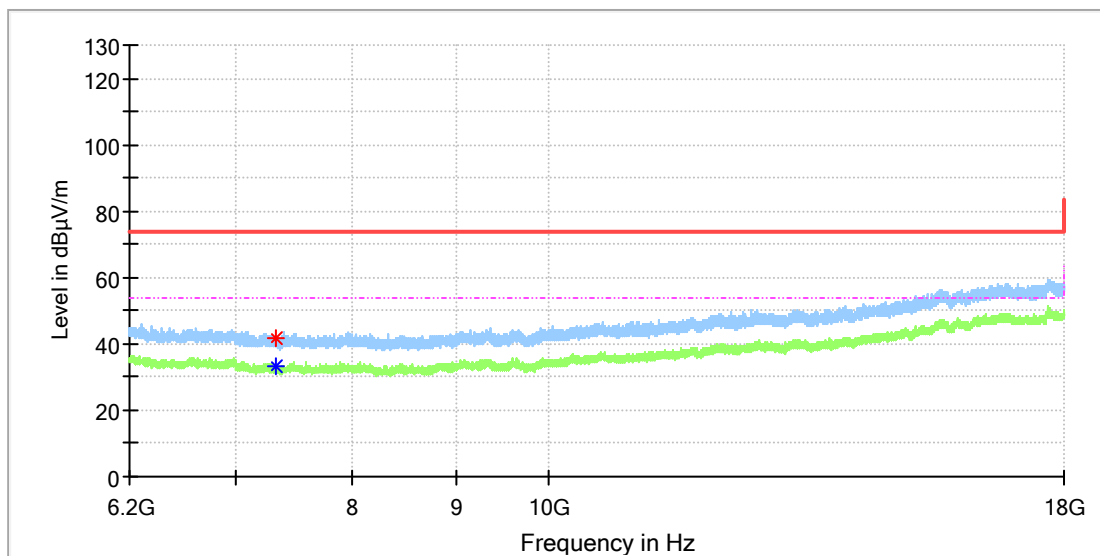


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
9606.758333	---	39.70	54.00	14.30	100.0	V	352.0	10.4
9607.250000	45.86	---	74.00	28.14	100.0	V	352.0	10.4

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

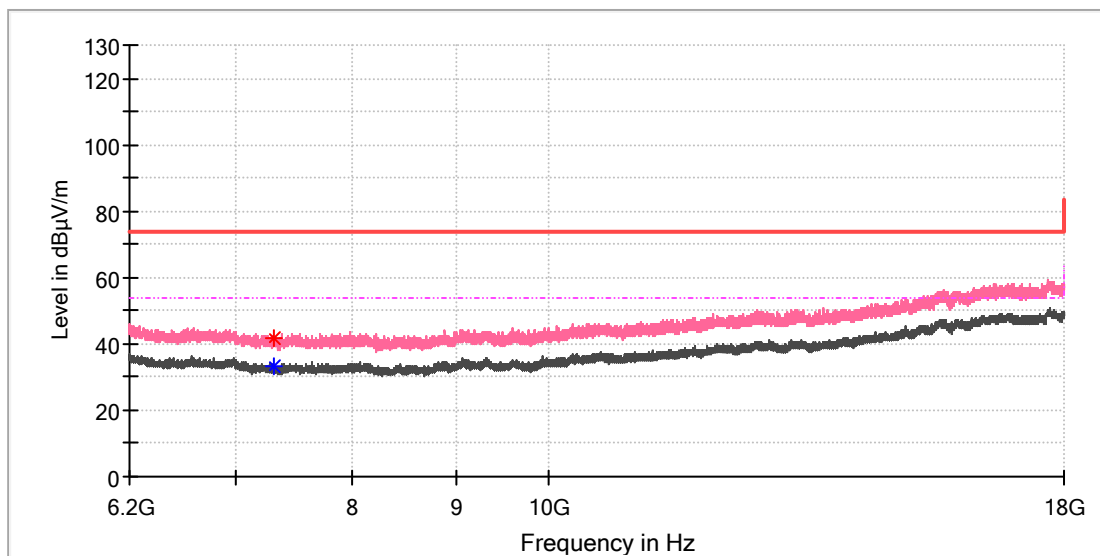


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7322.475000	---	33.08	54.00	20.92	100.0	H	73.0	8.2
7323.950000	42.02	---	74.00	31.98	100.0	H	5.0	8.2

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Mid channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

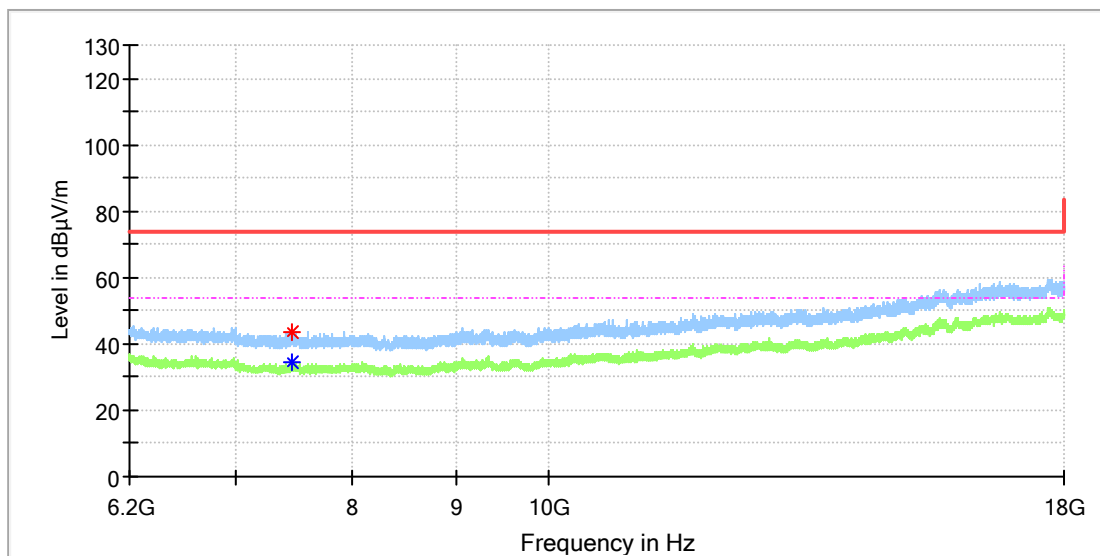


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7306.741667	---	33.30	54.00	20.70	100.0	V	30.0	8.3
7311.658333	41.98	---	74.00	32.02	100.0	V	90.0	8.2

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

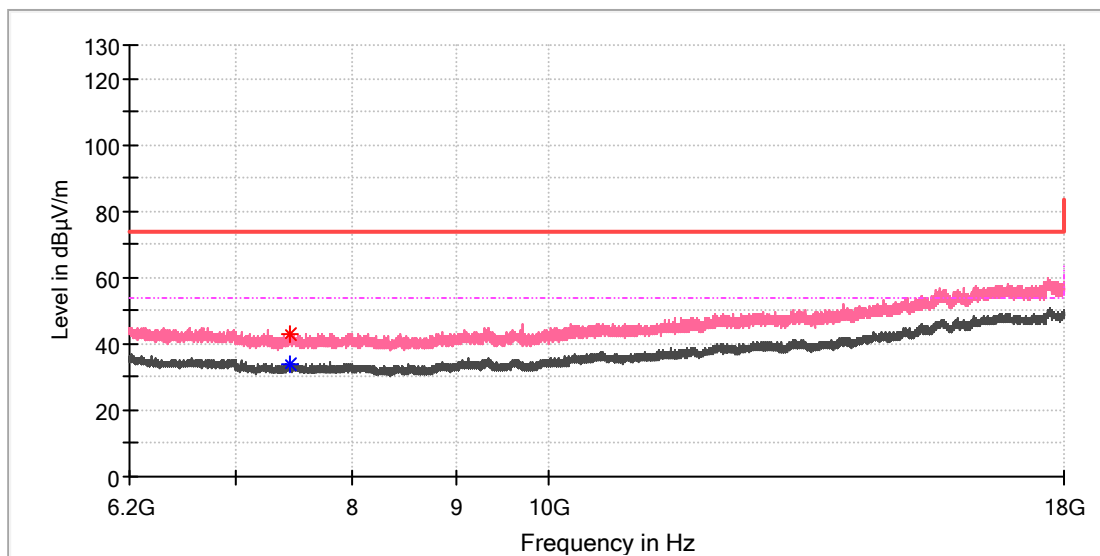


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7464.075000	43.24	---	74.00	30.76	100.0	H	251.0	8.6
7468.500000	---	34.66	54.00	19.34	100.0	H	0.0	8.6

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



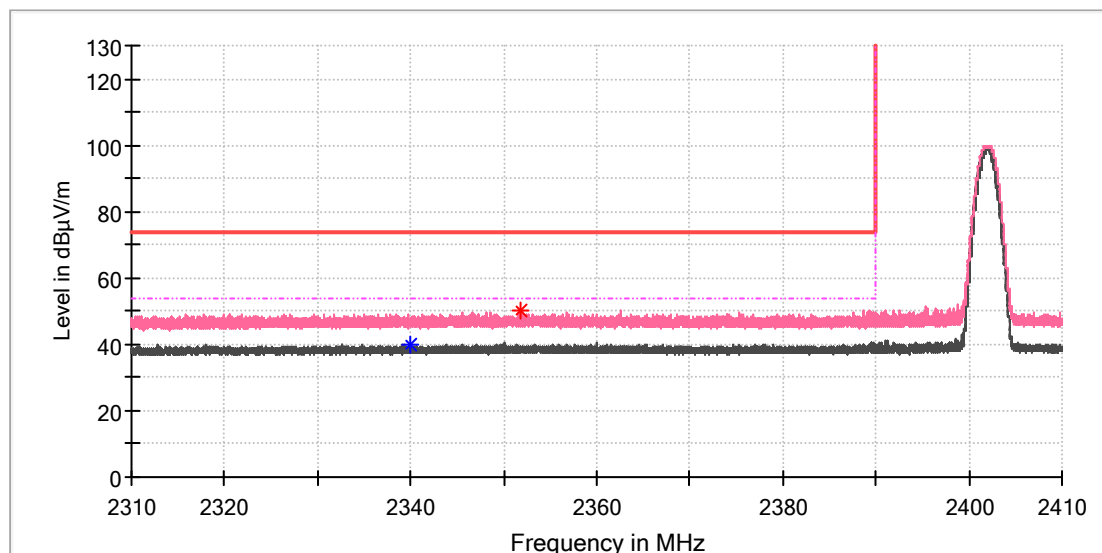
Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
7439.491667	42.66	---	74.00	31.34	100.0	V	0.0	8.4
7440.966667	---	33.68	54.00	20.32	100.0	V	311.0	8.4

Appendix C.7: Test Results of Radiated Emissions in Restricted Bands

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

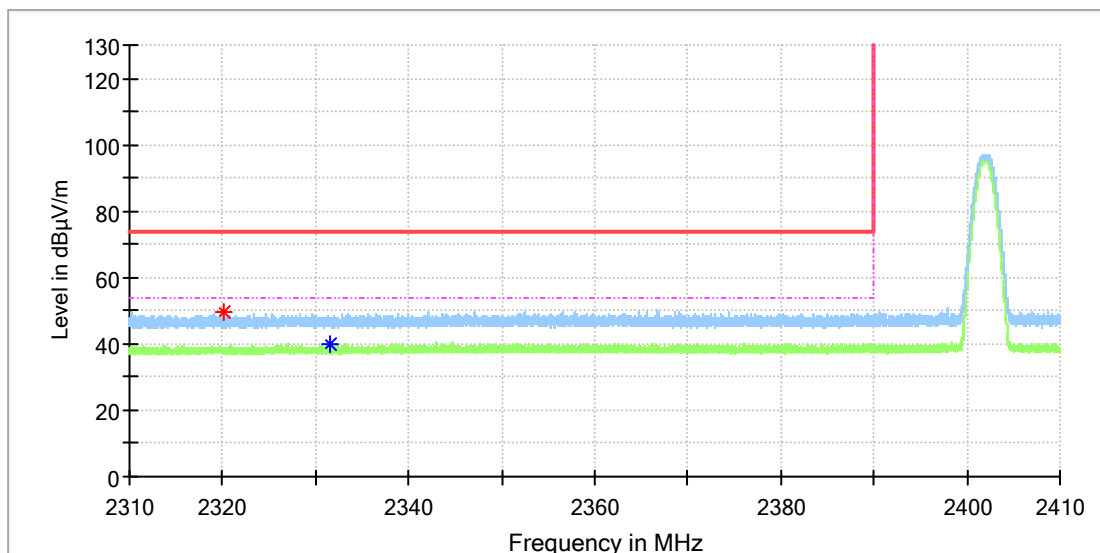


Critical Freqs

Frequency (MHz)	MaxPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2340.040000	---	40.08	54.00	13.92	100.0	V	8.0	6.8
2351.910000	50.14	---	74.00	23.86	100.0	V	41.0	6.9

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_Low channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

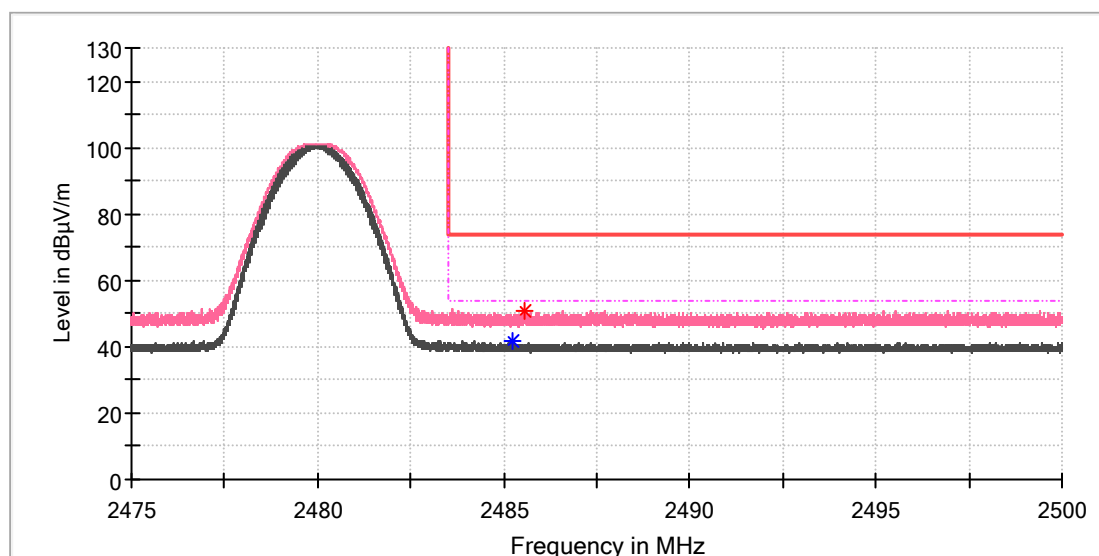


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2320.205000	49.39	---	74.00	24.61	100.0	H	354.0	6.6
2331.445000	---	39.90	54.00	14.10	100.0	H	146.0	6.7

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin

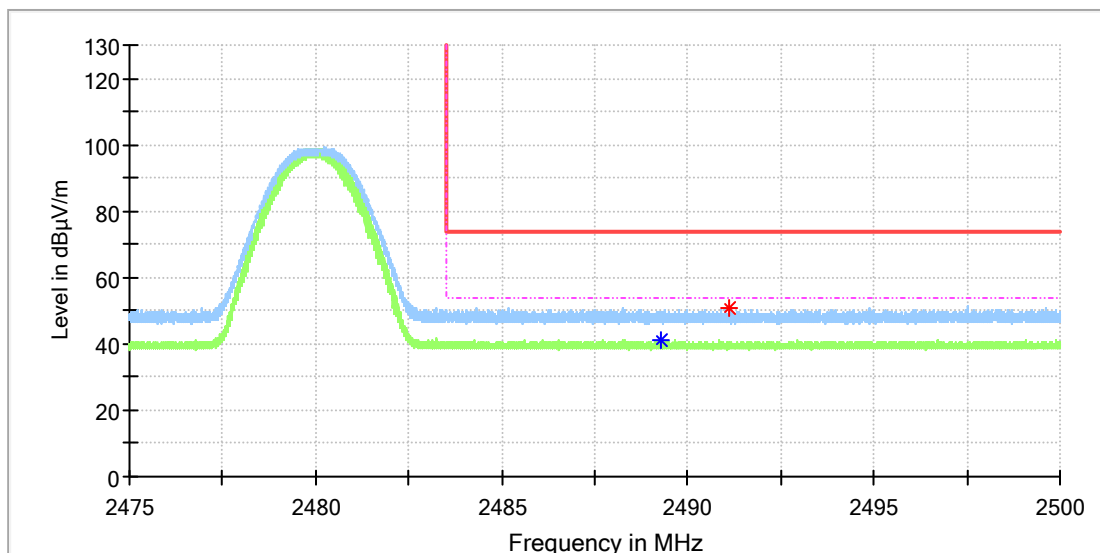


Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2485.263750	---	42.00	54.00	12.00	100.0	V	119.0	7.4
2485.553750	50.99	---	74.00	23.01	100.0	V	329.0	7.4

EUT Information

EUT Name:	BLUETOOTH HEADSET
Model:	QUANTUM TWS AIR
Test Mode:	BLE 1M_High channel
Order No/Sample No:	168395349/A003358854-007
Test Voltage::	Battery
Remark:	Temp 23 Humi:56%
Test Standard:	FCC 15.247
Tested By:	Kei Zhang
Reviewed By:	Terry Yin



Critical_Freqs

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2489.266250	---	40.85	54.00	13.15	100.0	H	1.0	7.4
2491.117500	50.78	---	74.00	23.22	100.0	H	23.0	7.4