| | | | | |
|---|---|---|---|---|
| **Prüfbericht-Nr.:** *Test report no.:* | **CN22CQQL 001** | **Auftrags-Nr.:** *Order no.:* | 168395327 | **Seite 1 von 23** *Page 1 of 23* |
| **Kunden-Referenz-Nr.:** *Client reference no.:* | N/A | **Auftragsdatum:** *Order date:* | 2022-10-21 | |
| **Auftraggeber:** *Client:* | **Harman International Industries, Inc** 8500 Balboa Blvd, Northridge, California, 91329, United States | | | |
| **Prüfgegenstand:** *Test item:* | BLUETOOTH HEADSET | | | |
| **Bezeichnung / Typ-Nr.:** *Identification / Type no.:* | QUANTUM TWS AIR (Trademark: JBL) | | | |
| **Auftrags-Inhalt:** *Order content:* | Type test | | | |
| ***Prüfgrundlage:*** *Test specification:* | CFR47 FCC Part 15: Subpart C Section 15.247<br>CFR47 FCC Part 15: Subpart C Section 15.207<br>CFR47 FCC Part 15: Subpart C Section 15.209 | | RSS-247 Issue 2 February 2017<br>RSS-Gen Issue 5 March 2019 | |
| **Wareneingangsdatum:** *Date of receipt:* | 2022-10-20 | Refer to photos document | | |
| **Prüfmuster-Nr.:** *Test sample No.:* | A003358854 | | | |
| **Prüfzeitraum:** *Testing period:* | 2022-10-26 – 2022-11-03 | | | |
| **Ort der Prüfung:** *Place of testing:* | TÜV Rheinland (Shenzhen) Co., Ltd. | | | |
| **Prüflaboratorium:** *Testing laboratory:* | TÜV Rheinland (Shenzhen) Co., Ltd. | | | |
| **Prüfergebnis*:** *Test result*:* | Pass | | | |

| | | | |
|---|---|---|---|
| ***geprüft von:*** *tested by:* | X Alex Lan<br>Signed by: Alex Lan | **genehmigt von:** *authorized by:* | X Winnie Hou<br>Signed by: Winnie Hou |
| ***Datum:*** *Date:* 2022-11-11 | | **Ausstellungsdatum:** *Issue date:* 2022-12-07 | |
| **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:** Prüfmuster vollständig und unbeschädigt
*Condition of the test item at delivery:* *Test item complete and undamaged:*

| | | | | | |
|---|---|---|---|---|---|
| * Legende: | 1 = sehr gut | 2 = gut | 3 = befriedigend | 4 = ausreichend | 5 = mangelhalt |
| | P(ass) = entspricht o.g. Prüfgrundlage(n) | | F(ail) = entspricht nicht o.g. Prüfgrundlage(n) | N/A = nicht anwendbar | N/T = nicht getestet |
| *Legend:* | *1 = very good* | *2 = good* | *3 = satisfactory* | *4 = sufficient* | *5 = poor* |
| | *P(ass) = passed a.m. test specifications(s)* | | *F(ail) = failed a.m. test specifications(s)* | *N/A = not applicable* | *N/T = not tested* |





TÜV Rheinland (Shenzhen) Co., Ltd. 1601 R&D Room, 1602-1604, 17-18F, Building 7 Site C, Vanke Cloud City Phase I, Xingke First Street, Xili Street, Xili Community, Nanshan District, Shenzhen 518052, P.R. China
Mail: service@de.tuv.com · Web: www.tuv.com

# *Test Summary*

**5.1.1 ANTENNA REQUIREMENT**
*RESULT: Pass*

**5.1.2 MAXIMUM CONDUCTED OUTPUT POWER**
*RESULT: Pass*

**5.1.3 99% BANDWIDTH**
*RESULT: Pass*

**5.1.4 CONDUCTED SPURIOUS EMISSIONS MEASURED IN 100 KHZ BANDWIDTH**
*RESULT: Pass*

**5.1.5 RADIATED SPURIOUS EMISSION**
*RESULT: Pass*

**5.1.6 20DB BANDWIDTH**
*RESULT: Pass*

**5.1.7 CARRIER FREQUENCY SEPARATION**
*RESULT: Pass*

**5.1.8 FREQUENCY STABILITY**
*RESULT: Pass*

**5.1.9 NUMBER OF HOPPING FREQUENCY**
*RESULT: Pass*

**5.1.10 TIME OF OCCUPANCY**
*RESULT: Pass*

# *Contents*

# 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 basics 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, Technical Description 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 | -10ºC to +45ºC |
| Operating Voltage | DC 3.85, 50mAh, 0.1925Wh via built-in Li-ion cell battery<br>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, π/4DQPSK |
| Antenna Type | PIFA LDS antenna |
| Antenna Gain | -2.21 dBi for left earbud<br>-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<br>-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
   1. Bluetooth transmitting mode (BDR & EDR mode)
      a) Low Channel
      b) Middle Channel
      c) High Channel

B. On, Transmitting on Hopping channel

C. Off

## 3.4 Noise Generating and Noise Suppressing Parts

Refer to Circuit Diagram for further details.

## 3.5 Submitted Documents

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

# 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 or Rating |
|---|---|---|---|
| Laptop | Lenovo | ThinkPad T14 | 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)**

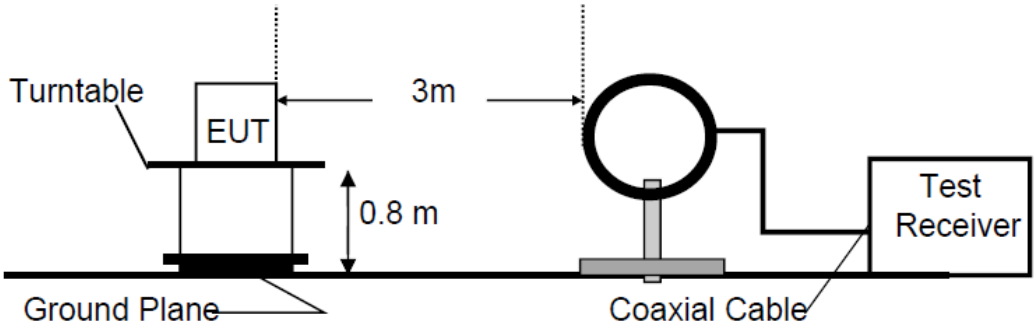



**Diagram of Measurement Configuration for Radiation Test (Below 1GHz)**

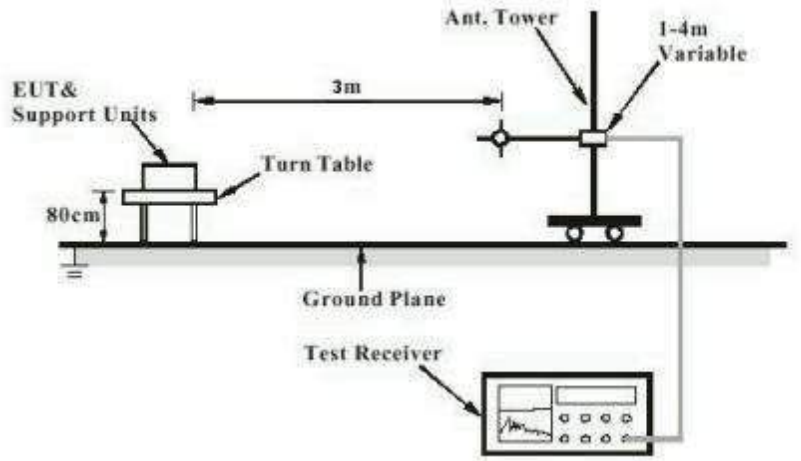



**Diagram of Measurement Configuration for Radiation Test (Above 1GHz)**

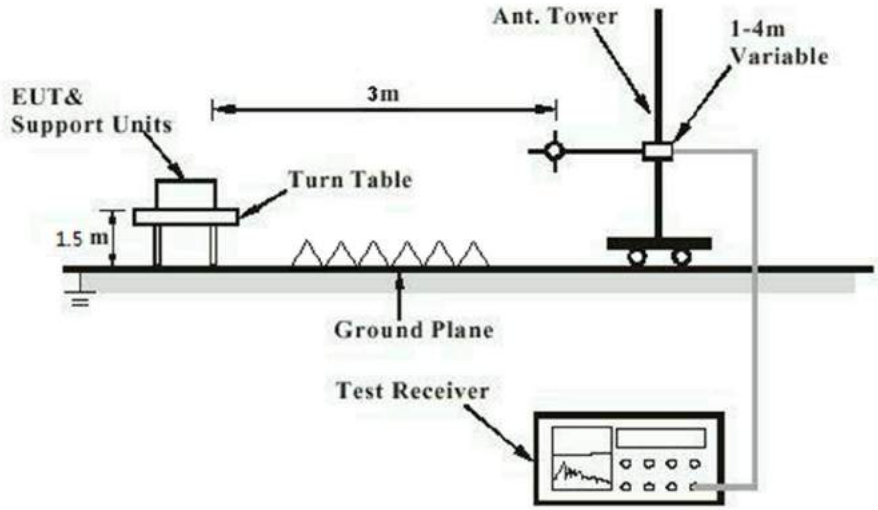
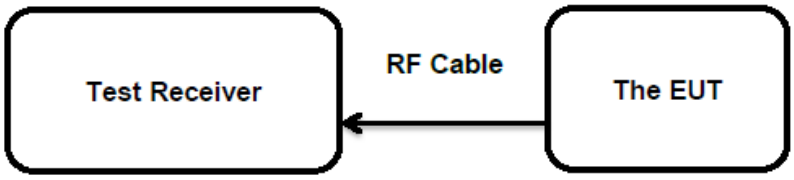


Diagram of Measurement Configuration for Conducted Transmitter Measurement



# 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 8.3

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 Conducted Output Power

**RESULT:** **Pass**

**Test Specification**

| | |
|---|---|
| Test standard | FCC Part 15.247(b)(1)<br>RSS-247 Clause 5.4(b) |
| Basic standard | ANSI C63.10: 2013 |
| Limits | FHSS<0.125W(Maximum peak conducted output power)<br>< 4 W (e.i.r.p.) |
| Kind of test site | Shielded Room |

**Test Setup**

| | |
|---|---|
| Date of testing | 2022-11-01 |
| Input voltage | DC 3.85V |
| Operation mode | A.1 |
| Test channel | Low / Middle / High |
| Ambient temperature | 24.4 ℃ |
| Relative humidity | 61 % |
| Atmospheric pressure | 101 kPa |

**Table 6: Test Result of Maximum Conducted Output Power, left earbud**

| Test Mode | Channel Frequency (MHz) | Measured Peak Output Power | | Limit (W) |
|---|---|---|---|---|
| | | (dBm) | (W) | |
| BDR | 2402 | 10.53 | 0.01130 | < 0.125 |
| | 2441 | 10.19 | 0.01045 | |
| | 2480 | 10.12 | 0.01028 | |
| EDR | 2402 | 10.51 | 0.01125 | < 0.125 |
| | 2441 | 10.33 | 0.01079 | |
| | 2480 | 10.25 | 0.01059 | |

Note: The cable loss is taken into account in results and the maximum e.i.r.p. is 8.32 dBm less than 4W(36dBm).

**Table 7: Test Result of Maximum Conducted Output Power, right earbud**

| Test Mode | Channel Frequency (MHz) | Measured Peak Output Power | | Limit (W) |
|---|---|---|---|---|
| | | (dBm) | (W) | |
| BDR | 2402 | 10.68 | 0.01169 | < 0.125 |
| | 2441 | 10.40 | 0.01096 | |
| | 2480 | 10.27 | 0.01064 | |
| EDR | 2402 | 10.65 | 0.01161 | < 0.125 |
| | 2441 | 10.39 | 0.01094 | |
| | 2480 | 10.25 | 0.01059 | |

Note: The cable loss is taken into account in results and the maximum e.i.r.p. is 6.97 dBm less than 4W(36dBm).

## 5.1.3 99% 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.1 |
| Test channel | : | Low / Middle / High |
| Ambient temperature | : | 24.4 ℃ |
| Relative humidity | : | 61 % |
| Atmospheric pressure | : | 101 kPa |

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

**Table 8: Test Result of 99% Bandwidth, left earbud**

| Test Mode | Channel Frequency (MHz) | Measured 99% Bandwidth (MHz) | Limit |
|---|---|---|---|
| BDR | 2402 | 0.85742 | / |
| | 2441 | 0.86285 | |
| | 2480 | 0.87297 | |
| EDR | 2402 | 1.1869 | / |
| | 2441 | 1.1876 | |
| | 2480 | 1.1829 | |

**Table 9: Test Result of 99% Bandwidth, right earbud**

| Test Mode | Channel Frequency (MHz) | Measured 99% Bandwidth (MHz) | Limit |
|---|---|---|---|
| BDR | 2402 | 0.88557 | / |
| | 2441 | 0.88635 | |
| | 2480 | 0.88033 | |
| EDR | 2402 | 1.1999 | / |
| | 2441 | 1.1988 | |
| | 2480 | 1.2046 | |

Note: The fundamental emissions stay within the allocated band 2400-2483.5MHz.

## 5.1.4 Conducted Spurious Emissions Measured in 100 kHz Bandwidth

**RESULT:** **Pass**

**Test Specification**

| | | |
|---|---|---|
| Test standard | : | FCC Part 15.247(d)<br>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); |
| Kind of test site | : | Shielded Room |

**Test Setup**

| | | |
|---|---|---|
| Date of testing | : | 2022-11-01 |
| Input voltage | : | DC 3.85V |
| Operation mode | : | A.1 |
| Test channel | : | Low / Middle / High |
| Ambient temperature | : | 24.4 ℃ |
| Relative humidity | : | 61 % |
| Atmospheric pressure | : | 101 kPa |

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

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

## 5.1.5 Radiated Spurious Emission

**RESULT:** **Pass**

**Test Specification**

| | | |
|---|---|---|
| Test standard | : | FCC Part 15.247(d) & FCC Part 15.205<br>RSS-247 Clause 3.3 |
| Basic standard | : | ANSI C63.10: 2013 |
| Limits | : | Refer to 15.209(a) of FCC part 15.247(d)<br>RSS-Gen Table 6 & Table 7 |
| Kind of test site | : | 3m Semi-anechoic Chamber |

**Test Setup**

| | | |
|---|---|---|
| Date of testing | : | 2022-11-03 |
| Input voltage | : | DC 3.85V |
| Operation mode | : | A.1 |
| Test channel | : | Low / Middle / High |
| Ambient temperature | : | Refer to test result |
| Relative humidity | : | Refer to test result |
| Atmospheric pressure | : | 101 kPa |

Remark:
During the pretest the EUT was rotated through three orthogonal axes to determine the attitude that maximizes the emissions. After that the EUT was manually handled to find the orientation that has the maximum emission, which is the orientation shown in the test set-up photos.

Testing was carried out within frequency range 9kHz to the tenth harmonics.

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

## 5.1.6 20dB Bandwidth

**RESULT:** **Pass**

**Test Specification**

| | | |
|---|---|---|
| Test standard | : | FCC Part 15.247(a)(1)<br>RSS-247 Clause 5.1(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.1 |
| Test channel | : | Low / Middle / High |
| Ambient temperature | : | 24.4 ℃ |
| Relative humidity | : | 61 % |
| Atmospheric pressure | : | 101 kPa |

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

**Table 10: Test Result of -20dB Bandwidth, Left earbud**

| Test Mode | Channel Frequency (MHz) | 20dB Bandwidth (kHz) | 2/3 of 20dB Bandwidth (kHz) | Limit (MHz) |
|---|---|---|---|---|
| BDR | 2402 | 942 | 628.000 | / |
| | 2441 | 930 | 620.000 | |
| | 2480 | 942 | 628.000 | |
| EDR | 2402 | 1266 | 844.000 | / |
| | 2441 | 1260 | 840.000 | |
| | 2480 | 1275 | 850.000 | |

**Table 11: Test Result of -20dB Bandwidth, Right earbud**

| Test Mode | Channel Frequency (MHz) | 20dB Bandwidth (kHz) | 2/3 of 20dB Bandwidth (kHz) | Limit (MHz) |
|---|---|---|---|---|
| BDR | 2402 | 942 | 628.000 | / |
| | 2441 | 945 | 630.000 | |
| | 2480 | 951 | 634.000 | |
| EDR | 2402 | 1269 | 846.000 | / |
| | 2441 | 1275 | 850.000 | |
| | 2480 | 1269 | 846.000 | |

## 5.1.7 Carrier Frequency Separation

**RESULT:** **Pass**

**Test Specification**

| | | |
|---|---|---|
| Test standard | : | FCC Part 15.247(a)(1)<br>RSS-247 Clause 5.1(b) |
| Basic standard | : | ANSI C63.10: 2013 |
| Limits | : | ≥ 25kHz or 2/3 of 20dB bandwidth, whichever is greater |
| Kind of test site | : | Shielded Room |

**Test Setup**

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

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

**Table 12: Test Result of Carrier Frequency Separation, Left earbud**

| TestMode | Channel | Result[MHz] | Limit[MHz] | Verdict |
|---|---|---|---|---|
| BDR-DH5 | Hop | 0.786 | ≥0.632 | PASS |
| EDR-2DH5 | Hop | 1 | ≥0.848 | PASS |

Note:

The limit is maximum 2/3 of the 20 dB bandwidth: 850KHz.

**Table 13: Test Result of Carrier Frequency Separation, Right earbud**

| TestMode | Channel | Result[MHz] | Limit[MHz] | Verdict |
|---|---|---|---|---|
| BDR-DH5 | Hop | 0.998 | ≥0.632 | PASS |
| EDR-2DH5 | Hop | 1.012 | ≥0.848 | PASS |

Note:

The limit is maximum 2/3 of the 20 dB bandwidth: 850KHz.

## 5.1.8 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 ℃ |
| Relative humidity | : | 61 % |
| Atmospheric pressure | : | 101 kPa |

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

## 5.1.9 Number of Hopping Frequency

**RESULT:** **Pass**

**Test Specification**

| | | |
|---|---|---|
| Test standard | : | FCC part 15.247(a)(1)(iii)<br>RSS-247 Clause 5.1(d) |
| Basic standard | : | ANSI C63.10: 2013 |
| Limits | : | ≥ 15 non-overlapping channels |
| 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 ℃ |
| Relative humidity | : | 61 % |
| Atmospheric pressure | : | 101 kPa |

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

**Table 14: Test Result of Number of Hopping Frequency**

| Frequency Range | Measured Quantity of Hopping Channel | Limit | Result |
|---|---|---|---|
| 2402 to 2480 MHz | 79 | ≥15 | Pass |

**Table 15: Test Result of Number of Hopping Frequency, Right earbud**

| Frequency Range | Measured Quantity of Hopping Channel | Limit | Result |
|---|---|---|---|
| 2402 to 2480 MHz | 79 | ≥15 | Pass |

## 5.1.10 Time of Occupancy

**RESULT:** **Pass**

**Test Specification**

| | | |
|---|---|---|
| Test standard | : | FCC part 15.247(a)(1)(iii)<br>RSS-247 Clause 5.1(d) |
| Basic standard | : | ANSI C63.10: 2013 |
| Limits | : | < 0.4s |
| Kind of test site | : | Shielded Room |

**Test Setup**

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

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.

# 7 List of Tables

# Appendix B: Test Results of Left earbud

## Appendix B.1: Test Results of 99% Bandwidth

| TestMode | Antenna | Channel | OCB [MHz] | FL[MHz] | FH[MHz] | Limit[MHz] | Verdict |
|---|---|---|---|---|---|---|---|
| DH5 | Ant1 | 2402 | 0.85742 | 2401.5696 | 2402.4270 | --- | --- |
| | | 2441 | 0.86285 | 2440.5606 | 2441.4234 | --- | --- |
| | | 2480 | 0.87297 | 2479.5586 | 2480.4316 | --- | --- |
| 3DH5 | Ant1 | 2402 | 1.1869 | 2401.3949 | 2402.5818 | --- | --- |
| | | 2441 | 1.1876 | 2440.3940 | 2441.5816 | --- | --- |
| | | 2480 | 1.1829 | 2479.3961 | 2480.5790 | --- | --- |

DH5_Ant1_2402


DH5_Ant1_2441

DH5_Ant1_2480


3DH5_Ant1_2402


3DH5_Ant1_2441

| 3DH5_Ant1_2480 |
| --- |
|  |

## Appendix B.2: Test Results of 20dB Bandwidth

| TestMode | Antenna | Channel | 20db EBW[MHz] | FL[MHz] | FH[MHz] | Limit[MHz] | Verdict |
|---|---|---|---|---|---|---|---|
| DH5 | Ant1 | 2402 | 0.942 | 2401.529 | 2402.471 | --- | --- |
| | | 2441 | 0.930 | 2440.544 | 2441.474 | --- | --- |
| | | 2480 | 0.942 | 2479.529 | 2480.471 | --- | --- |
| 3DH5 | Ant1 | 2402 | 1.266 | 2401.349 | 2402.615 | --- | --- |
| | | 2441 | 1.260 | 2440.352 | 2441.612 | --- | --- |
| | | 2480 | 1.275 | 2479.346 | 2480.621 | --- | --- |

DH5_Ant1_2402


DH5_Ant1_2441

DH5_Ant1_2480


3DH5_Ant1_2402


3DH5_Ant1_2441

| 3DH5_Ant1_2480 |
| --- |
|  |

## Appendix B.3: 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 | 2401.994 | 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 (℃) | 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) | 2441 |
|---|---|

**Test result of frequency tolerance of voltage variation**

| Voltage | Test result (MHz) | Deviation Frequency (KHz) | Test result (ppm) | Limit (ppm) |
|---|---|---|---|---|
| DC 3.465V | 2440.990 | -10 | -4.09668 | 10 |
| DC 3.85V | 2440.986 | -14 | -5.73535 | |
| DC 4.235 | 2440.987 | -13 | -5.32569 | |

**Test result of frequency tolerance of temperature variation**

| Temperature (℃) | Test result (KHz) | Deviation Frequency (KHz) | Test result (ppm) | Limit (ppm) |
|---|---|---|---|---|
| -30 | 2440.991 | -9 | -3.68701 | 10 |
| -20 | 2440.995 | -5 | -2.04834 | |
| -10 | 2440.995 | -5 | -2.04834 | |
| 0 | 2440.992 | -8 | -3.27735 | |
| 10 | 2440.993 | -7 | -2.86768 | |
| 20 | 2440.994 | -6 | -2.45801 | |
| 30 | 2440.989 | -11 | -4.50635 | |
| 40 | 2440.987 | -13 | -5.32569 | |
| 50 | 2440.991 | -9 | -3.68701 | |
| 55 | 2440.995 | -5 | -2.04834 | |

| 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 (℃) | 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.4: Test Results of Carrier Frequency Separation

| TestMode | Antenna | Channel | Result[MHz] | Limit[MHz] | Verdict |
|---|---|---|---|---|---|
| DH5 | Ant1 | Hop | 0.786 | ≥0.628 | PASS |
| 3DH5 | Ant1 | Hop | 1 | ≥0.850 | PASS |

DH5_Ant1_Hop


3DH5_Ant1_Hop

## Appendix B.5: Test Results of Number of Hopping Frequencies

| TestMode | Antenna | Channel | Result[Num] | Limit[Num] | Verdict |
|---|---|---|---|---|---|
| DH5 | Ant1 | Hop | 79 | ≥15 | PASS |
| 3DH5 | Ant1 | Hop | 79 | ≥15 | PASS |

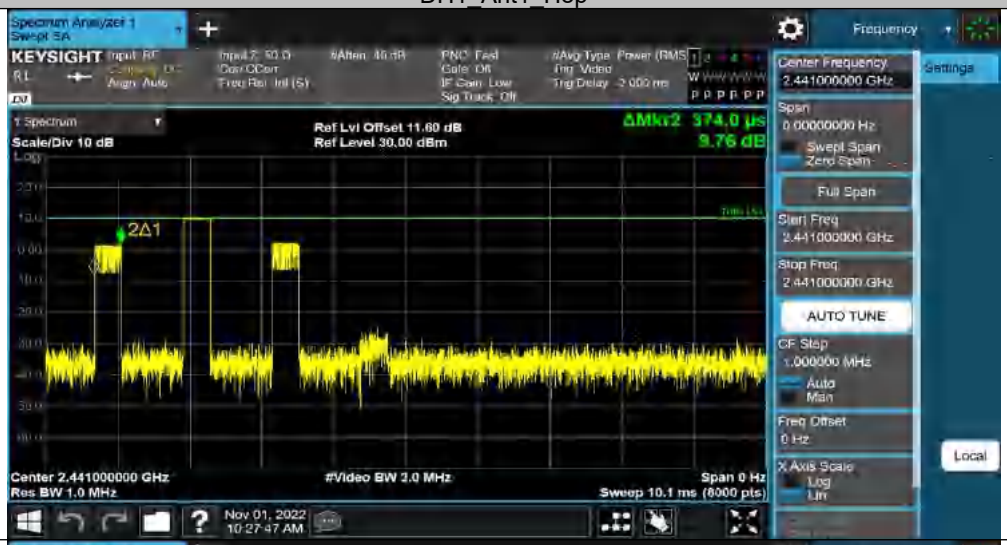
DH5_Ant1_Hop


3DH5_Ant1_Hop

## Appendix B.6: Test Results of Time of Occupancy

| TestMode | Antenna | Channel | BurstWidth [ms] | TotalHops [Num] | Result[s] | Limit[s] | Verdict |
|---|---|---|---|---|---|---|---|
| DH1 | Ant1 | Hop | 0.374 | 319 | 0.119 | ≤0.4 | PASS |
| DH3 | Ant1 | Hop | 1.631 | 159 | 0.259 | ≤0.4 | PASS |
| DH5 | Ant1 | Hop | 2.879 | 107 | 0.308 | ≤0.4 | PASS |
| 3DH1 | Ant1 | Hop | 0.379 | 319 | 0.121 | ≤0.4 | PASS |
| 3DH3 | Ant1 | Hop | 1.630 | 159 | 0.259 | ≤0.4 | PASS |
| 3DH5 | Ant1 | Hop | 2.882 | 107 | 0.308 | ≤0.4 | PASS |

DH1_Ant1_Hop




DH3_Ant1_Hop



DH5_Ant1_Hop


3DH1_Ant1_Hop


3DH3_Ant1_Hop



3DH5_Ant1_Hop


Spectrum Analyzer 1
Swept SA
KEYSIGHT
Frequency
Center Frequency
2.441000000 GHz
Settings
Span
0.00000000 Hz
Swept Span
Zero Span
Full Span
Start Freq
2.441000000 GHz
Stop Freq
2.441000000 GHz
AUTO TUNE
CF Step
510.000 kHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Local
1 Spectrum
Ref Lvl Offset 11.60 dB
Ref Level 30.00 dBm
Scale/Div 10 dB
Log
Center 2.441000000 GHz
Res BW 510 kHz
#Video BW 2.0 MHz
Span 0 Hz
Sweep 31.6 s (30000 pts)
Nov 01, 2022
10:36:26 AM

## Appendix B.7: 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 |
|---|---|---|---|---|---|---|---|
| DH5 | Ant1 | 2402 | Reference | 9.43 | 9.43 | --- | PASS |
| | | | 30~1000 | 9.43 | -48.15 | ≤-10.57 | PASS |
| | | | 1000~26500 | 9.43 | -38.81 | ≤-10.57 | PASS |
| | | 2441 | Reference | 9.30 | 9.30 | --- | PASS |
| | | | 30~1000 | 9.30 | -48.47 | ≤-10.7 | PASS |
| | | | 1000~26500 | 9.30 | -39.36 | ≤-10.7 | PASS |
| | | 2480 | Reference | 8.68 | 8.68 | --- | PASS |
| | | | 30~1000 | 8.68 | -48.53 | ≤-11.32 | PASS |
| | | | 1000~26500 | 8.68 | -39.19 | ≤-11.32 | PASS |
| 3DH5 | Ant1 | 2402 | Reference | 8.21 | 8.21 | --- | PASS |
| | | | 30~1000 | 8.21 | -47.72 | ≤-11.79 | PASS |
| | | | 1000~26500 | 8.21 | -39.06 | ≤-11.79 | PASS |
| | | 2441 | Reference | 5.28 | 5.28 | --- | PASS |
| | | | 30~1000 | 5.28 | -47.31 | ≤-14.72 | PASS |
| | | | 1000~26500 | 5.28 | -39.7 | ≤-14.72 | PASS |
| | | 2480 | Reference | 5.73 | 5.73 | --- | PASS |
| | | | 30~1000 | 5.73 | -47.67 | ≤-14.27 | PASS |
| | | | 1000~26500 | 5.73 | -38.76 | ≤-14.27 | PASS |

DH5_Ant1_2402_0~Reference

DH5_Ant1_2402_30~1000


DH5_Ant1_2402_1000~26500


DH5_Ant1_2441_0~Reference

DH5_Ant1_2441_30~1000


DH5_Ant1_2441_1000~26500


DH5_Ant1_2480_0~Reference

DH5_Ant1_2480_30~1000


DH5_Ant1_2480_1000~26500

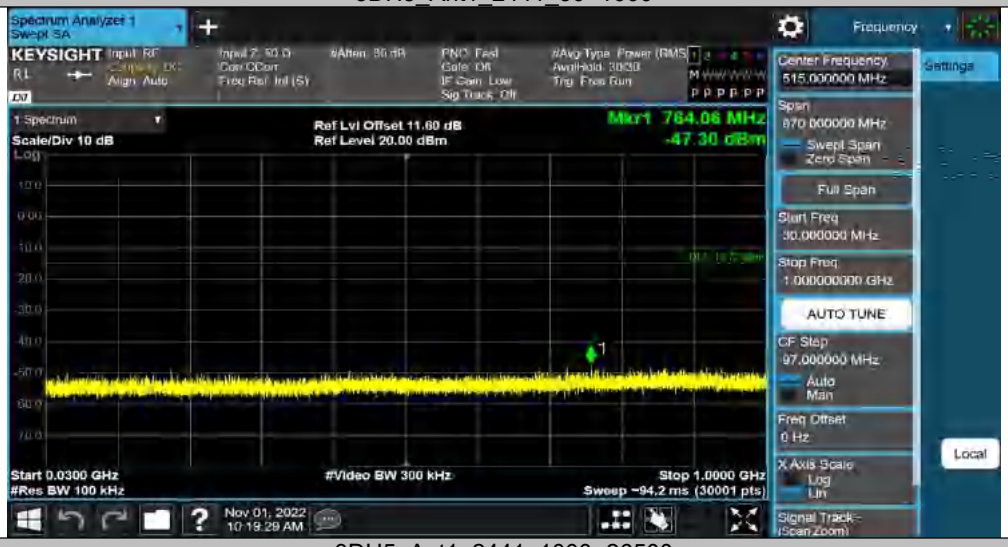

3DH5_Ant1_2402_0~Reference

3DH5_Ant1_2402_30~1000


3DH5_Ant1_2402_1000~26500


3DH5_Ant1_2441_0~Reference

3DH5_Ant1_2441_30~1000




3DH5_Ant1_2441_1000~26500


3DH5_Ant1_2480_0~Reference

3DH5_Ant1_2480_30~1000

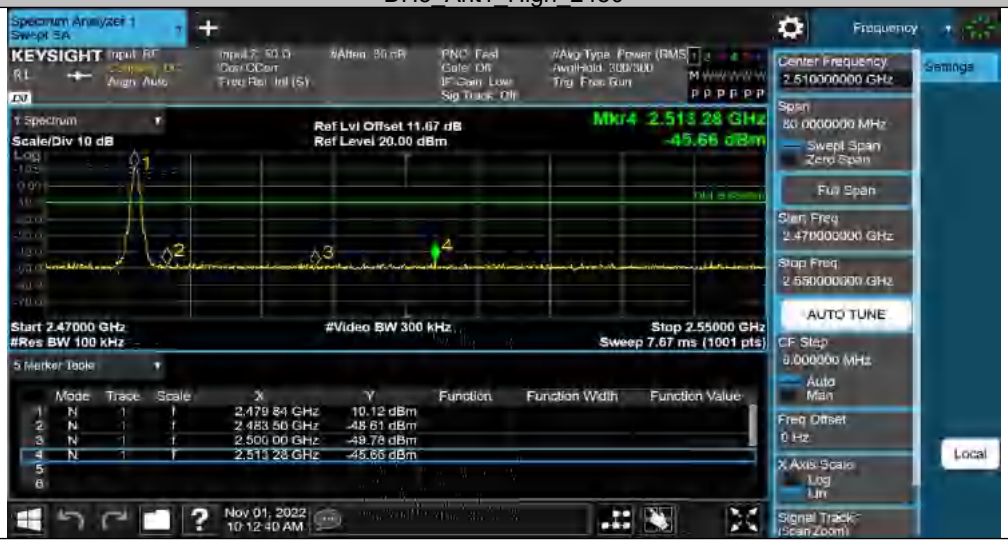

3DH5_Ant1_2480_1000~26500

Band Edge

| TestMode | Antenna | ChName | Channel | RefLevel [dBm] | Result [dBm] | Limit [dBm] | Verdict |
|---|---|---|---|---|---|---|---|
| DH5 | Ant1 | Low | 2402 | 10.49 | -46.38 | ≤-9.51 | PASS |
| | | High | 2480 | 10.12 | -45.66 | ≤-9.88 | PASS |
| | | Low | Hop_2402 | 9.68 | -46.46 | ≤-10.32 | PASS |
| | | High | Hop_2480 | 9.54 | -46.24 | ≤-10.46 | PASS |
| 3DH5 | Ant1 | Low | 2402 | 10.49 | -45.1 | ≤-9.51 | PASS |
| | | High | 2480 | 10.11 | -46.67 | ≤-9.89 | PASS |
| | | Low | Hop_2402 | 8.09 | -46.97 | ≤-11.91 | PASS |
| | | High | Hop_2480 | 6.37 | -45.55 | ≤-13.63 | PASS |

DH5_Ant1_Low_2402


DH5_Ant1_High_2480

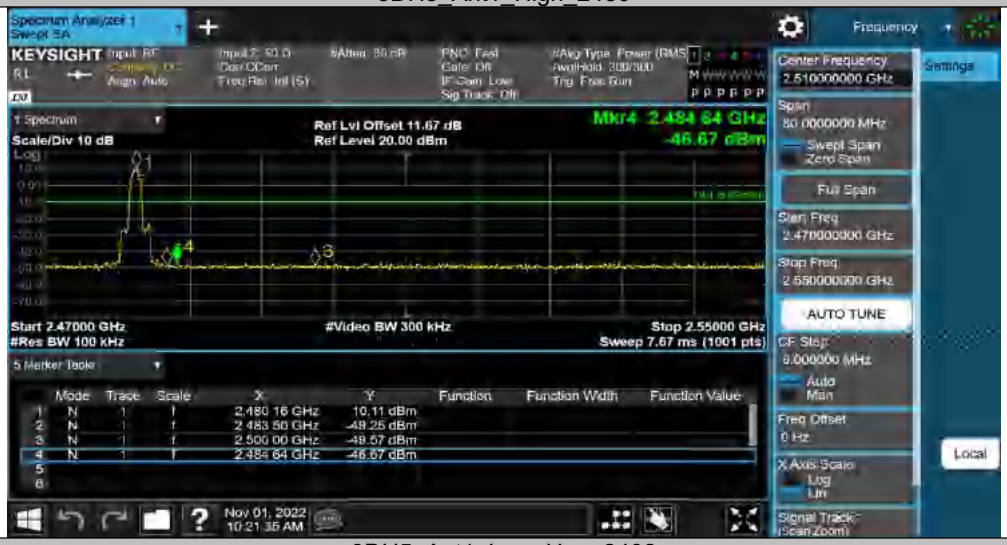


DH5_Ant1_Low_Hop_2402


DH5_Ant1_High_Hop_2480


3DH5_Ant1_Low_2402

3DH5_Ant1_High_2480




3DH5_Ant1_Low_Hop_2402


3DH5_Ant1_High_Hop_2480

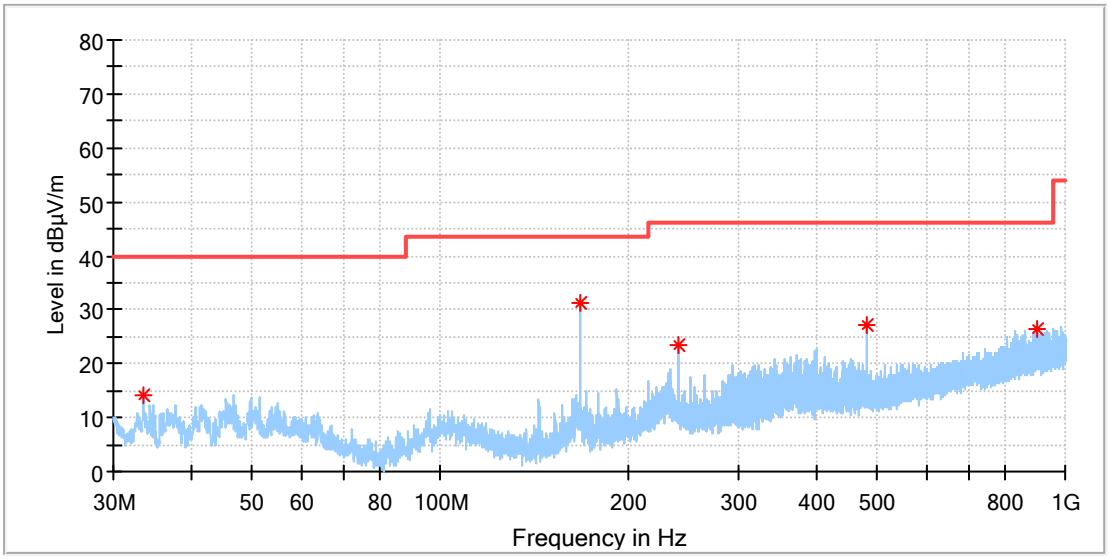
## Appendix B.8: Test Results of Radiated Spurious Emissions

Note: 1. 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. 2. This testing was carried out on different modulations, but only the worst case was presented in this report.

30MHz - 1GHz

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

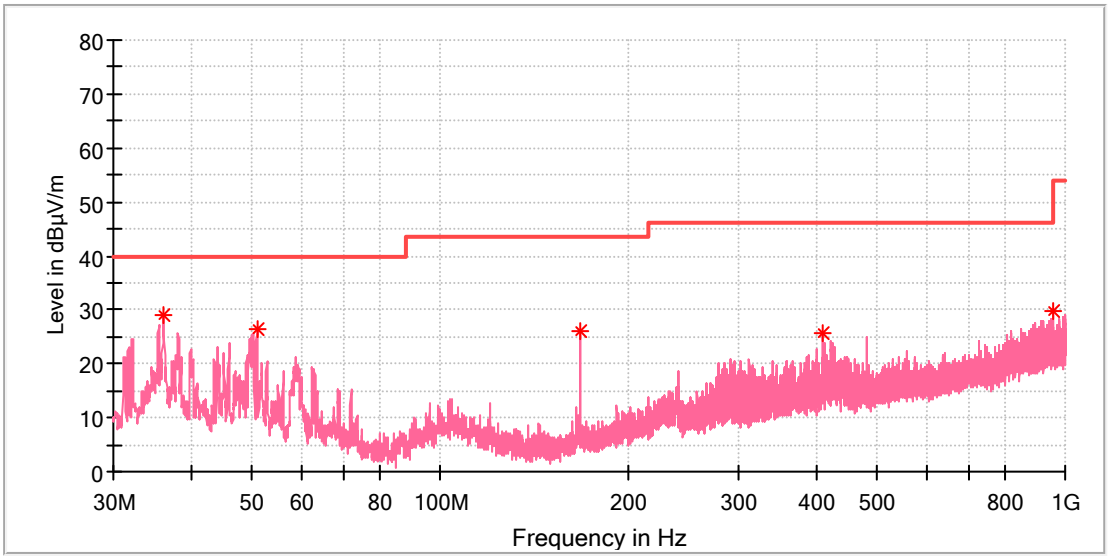



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 33.506923 | 14.30 | 40.00 | 25.70 | 100.0 | H | 248.0 | -22.7 |
| 168.001154 | 31.40 | 43.50 | 12.10 | 100.0 | H | 190.0 | -21.7 |
| 240.005000 | 23.31 | 46.00 | 22.69 | 100.0 | H | 265.0 | -18.0 |
| 480.005385 | 27.08 | 46.00 | 18.92 | 100.0 | H | 290.0 | -12.6 |
| 903.596923 | 26.42 | 46.00 | 19.58 | 100.0 | H | 274.0 | -5.4 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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

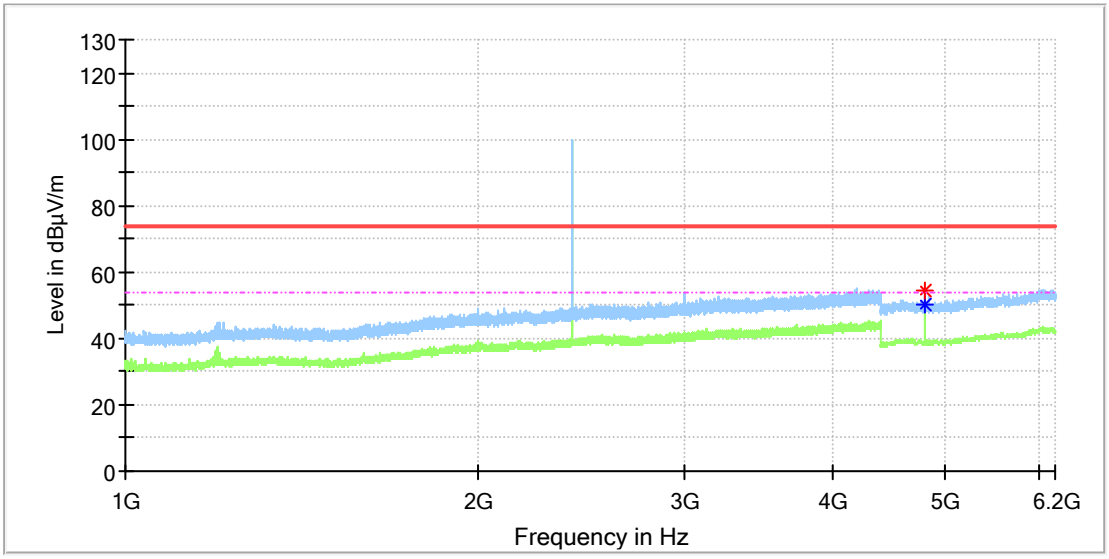
| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 36.081154 | 28.93 | 40.00 | 11.07 | 100.0 | V | 161.0 | -21.8 |
| 50.966923 | 26.60 | 40.00 | 13.40 | 100.0 | V | 323.0 | -18.6 |
| 168.001154 | 25.95 | 43.50 | 17.55 | 100.0 | V | 287.0 | -21.7 |
| 410.575769 | 25.71 | 46.00 | 20.29 | 100.0 | V | 49.0 | -13.9 |
| 957.916923 | 29.76 | 46.00 | 16.24 | 100.0 | V | 323.0 | -4.8 |

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: | BR_DH5_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 |

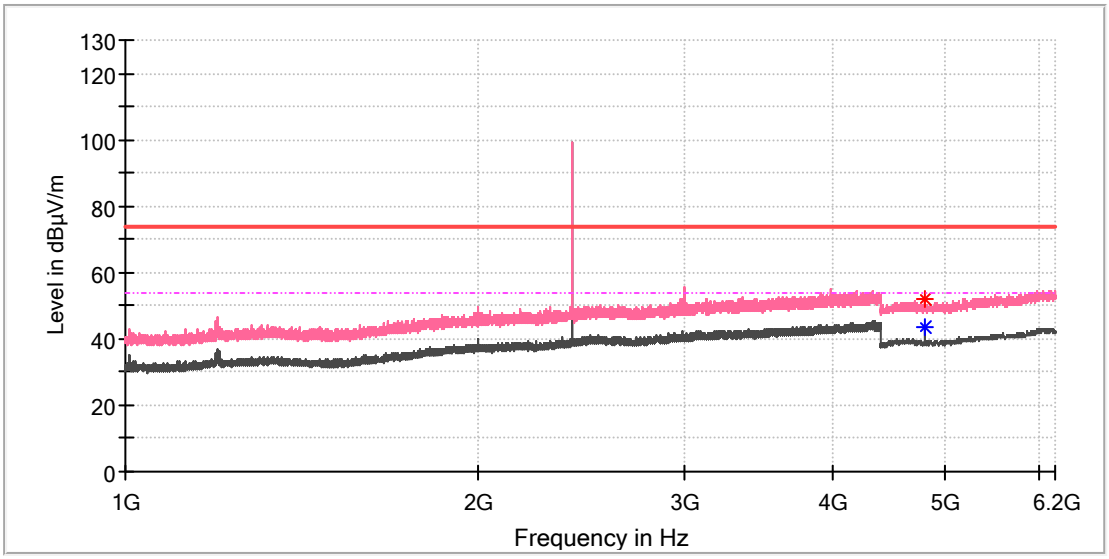



## Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4804.000000 | --- | 50.09 | 54.00 | 3.91 | 100.0 | H | 268.0 | 11.8 |
| 4804.000000 | 54.14 | --- | 74.00 | 19.86 | 100.0 | H | 268.0 | 11.8 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

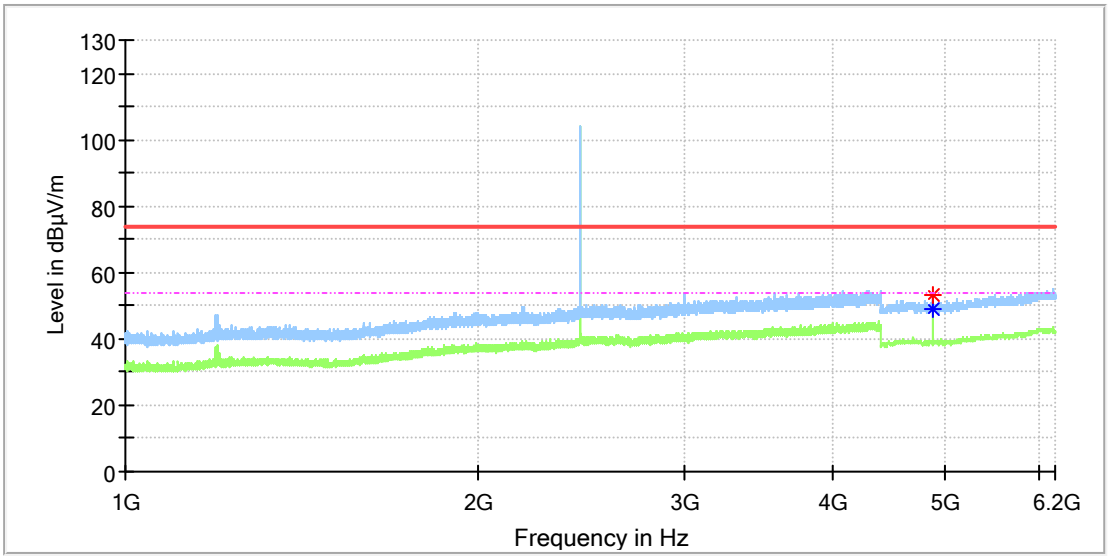



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4804.000000 | 51.87 | --- | 74.00 | 22.13 | 100.0 | V | 258.0 | 11.8 |
| 4804.000000 | --- | 43.29 | 54.00 | 10.71 | 100.0 | V | 258.0 | 11.8 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

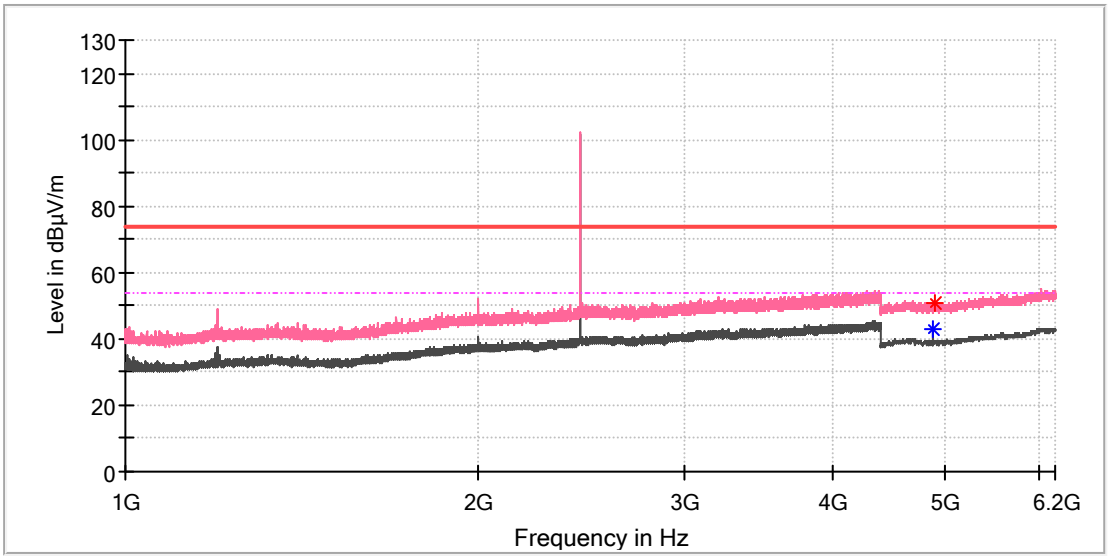



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4881.500000 | 53.01 | --- | 74.00 | 20.99 | 100.0 | H | 275.0 | 11.8 |
| 4882.000000 | --- | 48.92 | 54.00 | 5.08 | 100.0 | H | 282.0 | 11.8 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

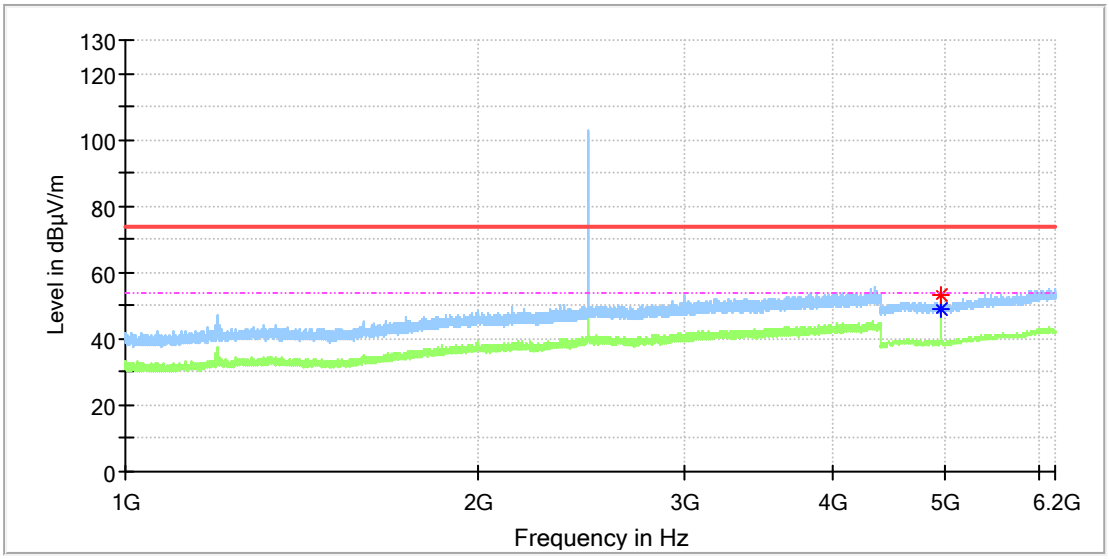



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4882.000000 | --- | 42.66 | 54.00 | 11.34 | 100.0 | V | 271.0 | 11.8 |
| 4890.500000 | 50.75 | --- | 74.00 | 23.25 | 100.0 | V | 123.0 | 11.8 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

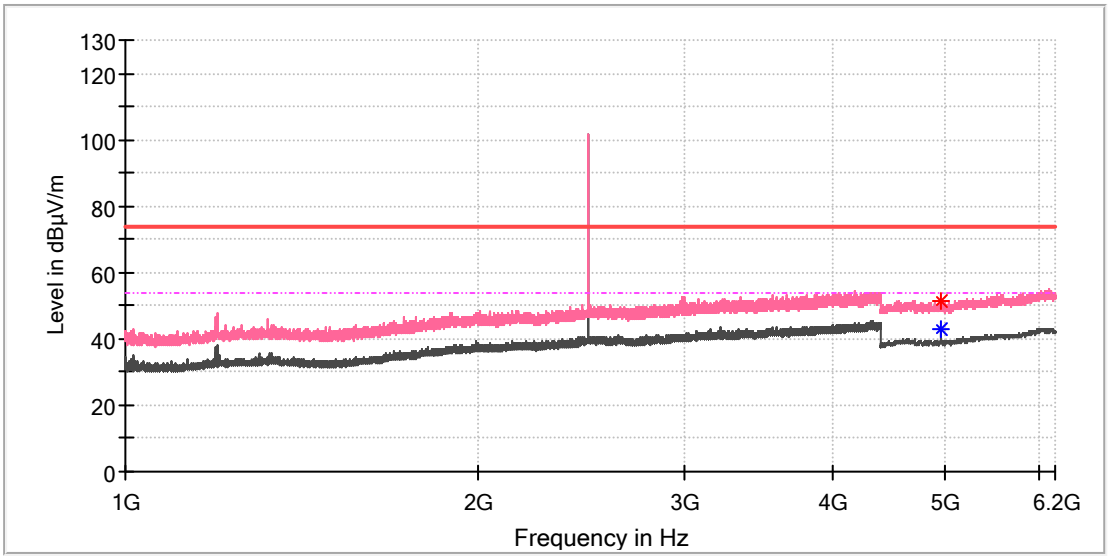



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4960.000000 | 53.22 | --- | 74.00 | 20.78 | 100.0 | H | 282.0 | 11.8 |
| 4960.000000 | --- | 49.00 | 54.00 | 5.00 | 100.0 | H | 282.0 | 11.8 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |



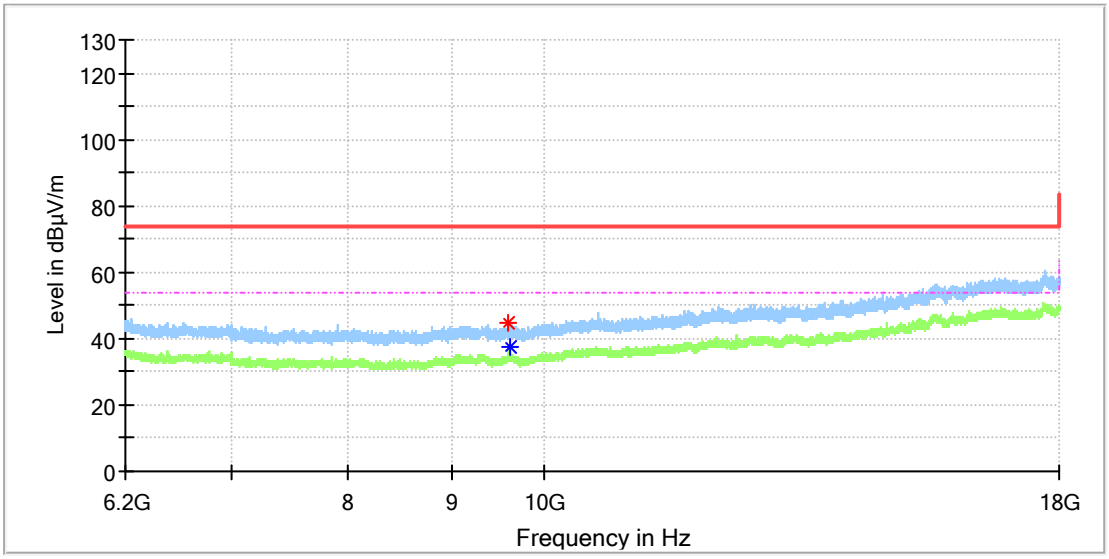

# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4960.000000 | 51.21 | --- | 74.00 | 22.79 | 100.0 | V | 253.0 | 11.8 |
| 4960.000000 | --- | 43.08 | 54.00 | 10.92 | 100.0 | V | 253.0 | 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: | BR_DH5_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 |

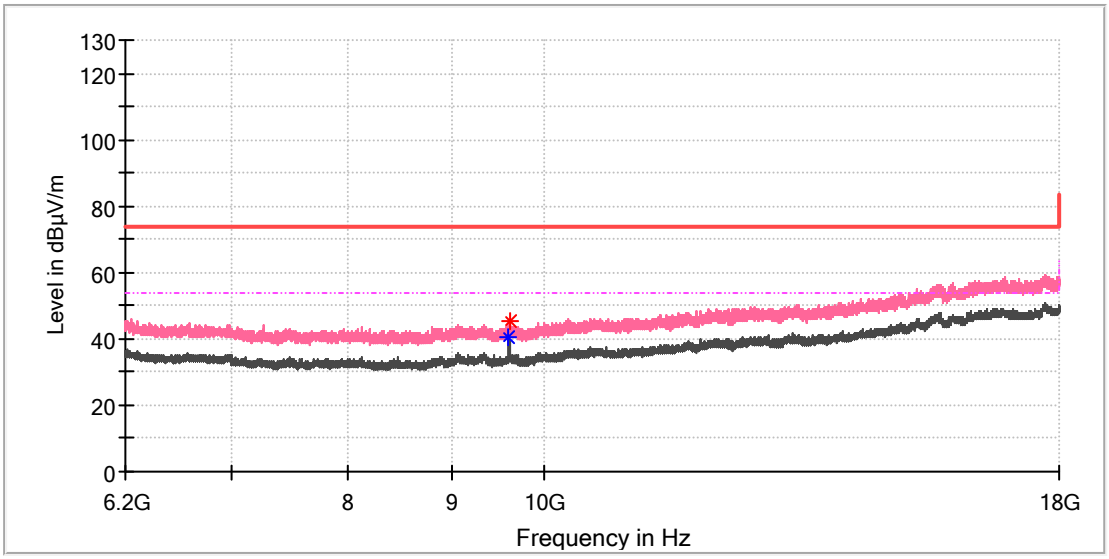



## Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 9598.891667 | 44.58 | --- | 74.00 | 29.42 | 100.0 | H | 278.0 | 10.4 |
| 9607.741667 | --- | 37.66 | 54.00 | 16.34 | 100.0 | H | 31.0 | 10.4 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

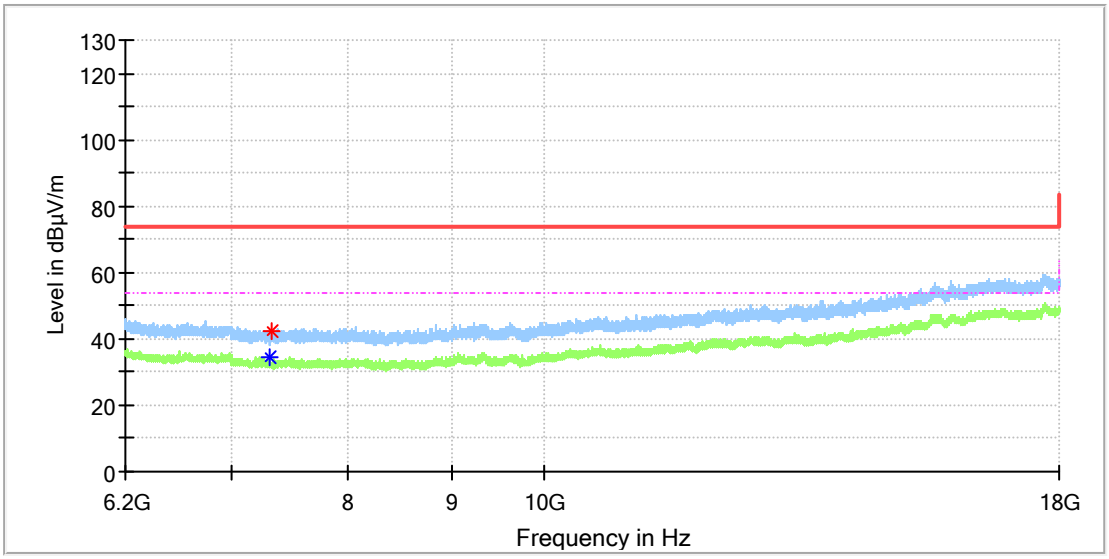



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 9607.250000 | --- | 40.57 | 54.00 | 13.43 | 100.0 | V | 286.0 | 10.4 |
| 9607.741667 | 45.48 | --- | 74.00 | 28.52 | 100.0 | V | 314.0 | 10.4 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

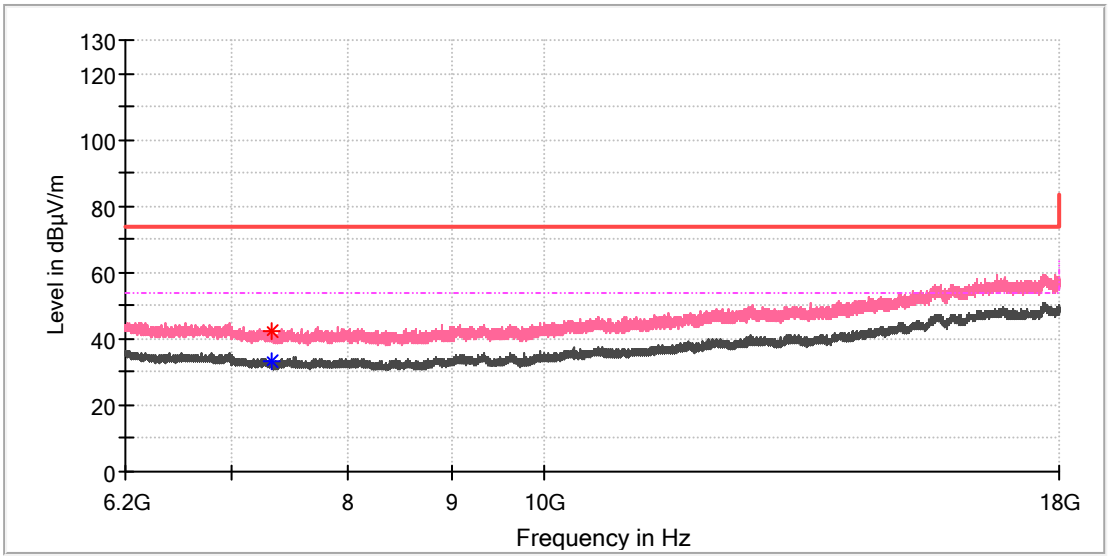



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 7317.066667 | --- | 34.21 | 54.00 | 19.79 | 100.0 | H | 12.0 | 8.2 |
| 7329.358333 | 42.48 | --- | 74.00 | 31.52 | 100.0 | H | 120.0 | 8.1 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

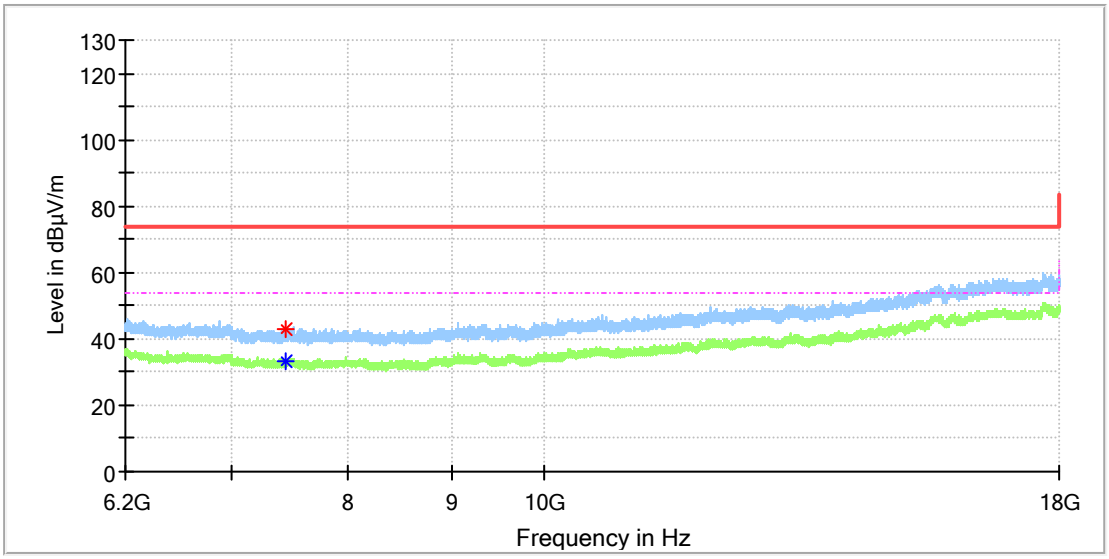



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 7324.933333 | --- | 33.29 | 54.00 | 20.71 | 100.0 | V | 163.0 | 8.2 |
| 7326.900000 | 42.10 | --- | 74.00 | 31.90 | 100.0 | V | 6.0 | 8.1 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

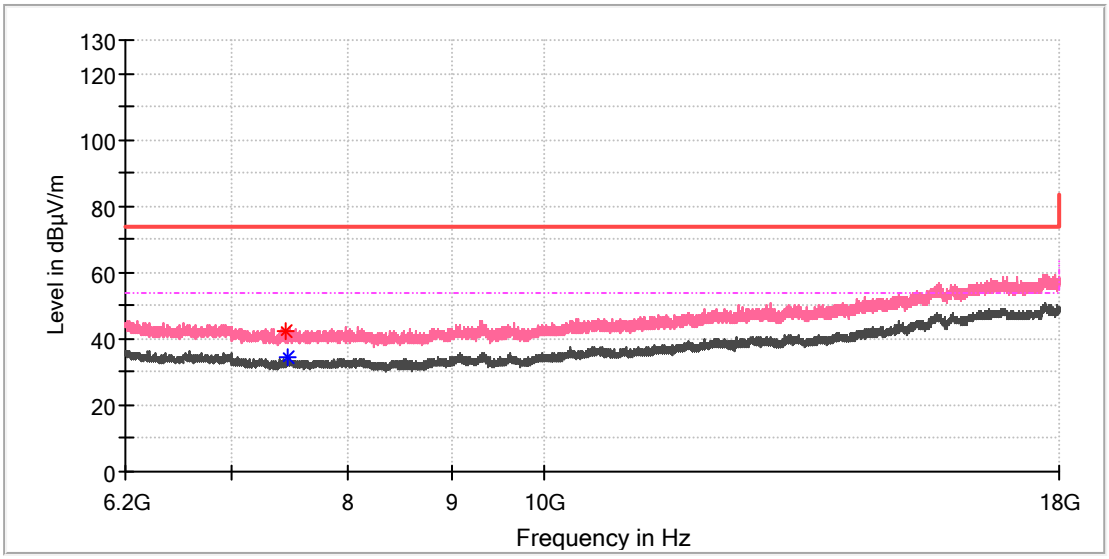



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 7438.016667 | 42.88 | --- | 74.00 | 31.12 | 100.0 | H | 114.0 | 8.4 |
| 7440.475000 | --- | 33.24 | 54.00 | 20.76 | 100.0 | H | 6.0 | 8.4 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |



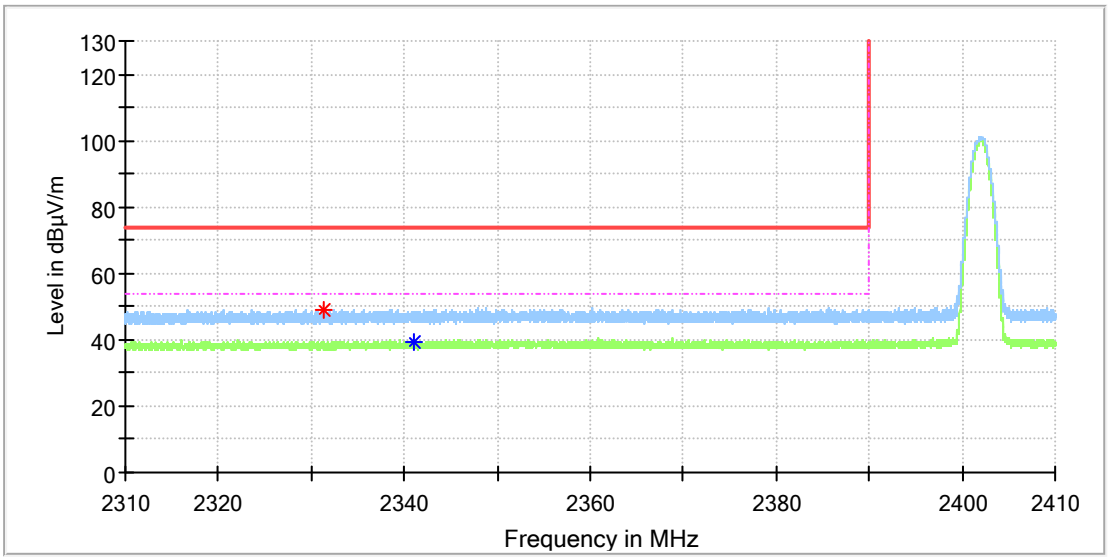

# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 7445.883333 | 42.52 | --- | 74.00 | 31.48 | 100.0 | V | 0.0 | 8.5 |
| 7457.191667 | --- | 34.27 | 54.00 | 19.73 | 100.0 | V | 0.0 | 8.5 |

## Appendix B.9: Test Results of Radiated Emissions in Restricted Bands

## EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

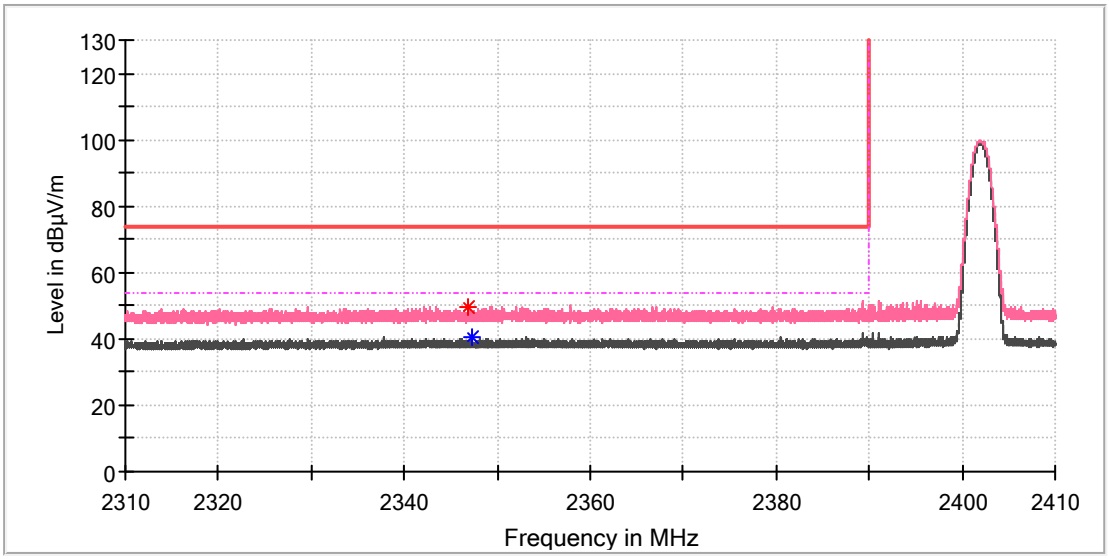



## Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 2331.300000 | 49.20 | --- | 74.00 | 24.80 | 100.0 | H | 220.0 | 6.7 |
| 2341.095000 | --- | 39.53 | 54.00 | 14.47 | 100.0 | H | 164.0 | 6.8 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

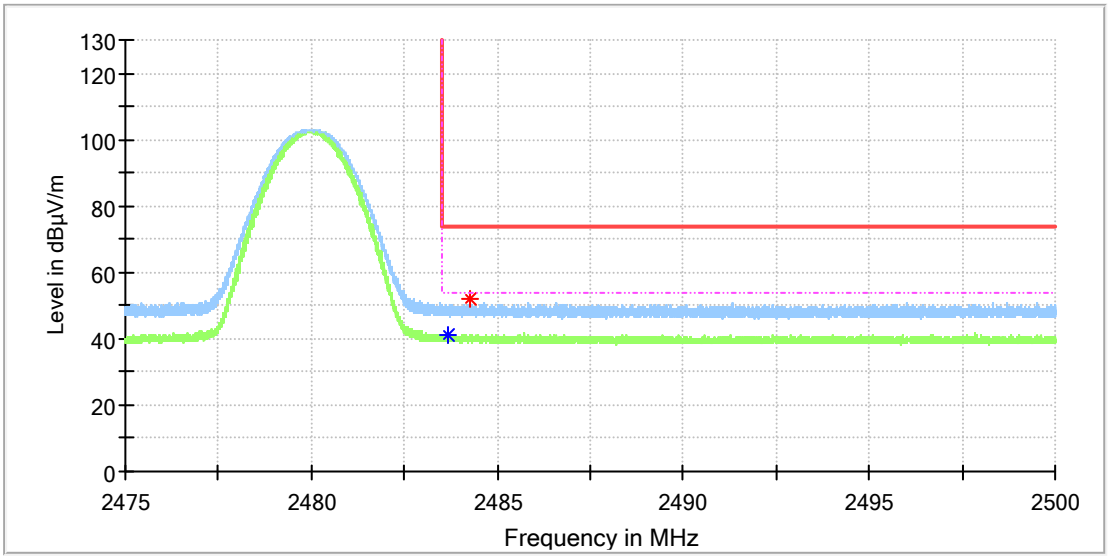



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 2346.890000 | 49.66 | --- | 74.00 | 24.34 | 100.0 | V | 169.0 | 6.9 |
| 2347.285000 | --- | 40.23 | 54.00 | 13.77 | 100.0 | V | 328.0 | 6.9 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

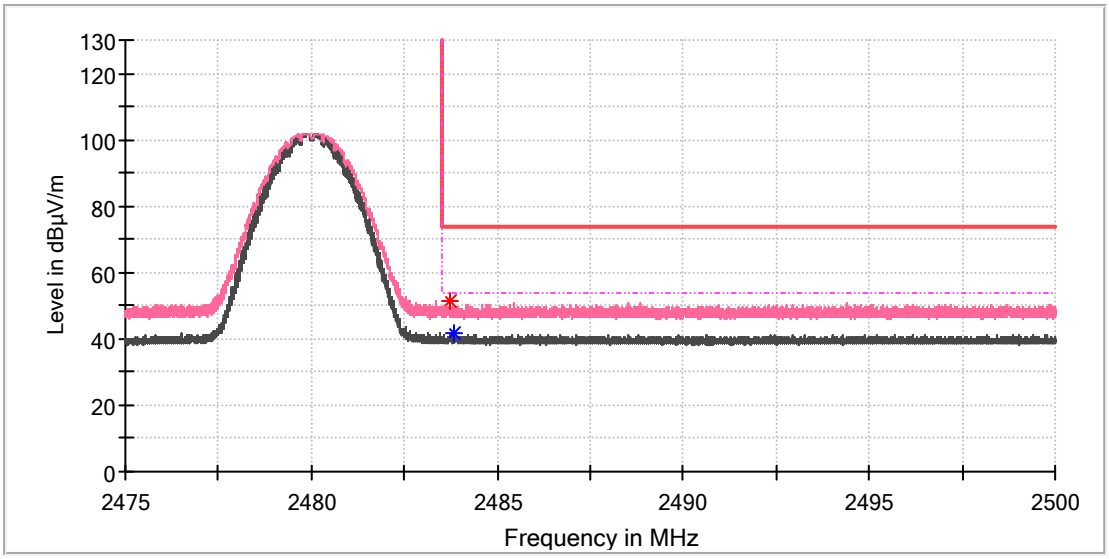



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 2483.686250 | --- | 41.09 | 54.00 | 12.91 | 100.0 | H | 274.0 | 7.4 |
| 2484.292500 | 52.17 | --- | 74.00 | 21.83 | 100.0 | H | 274.0 | 7.4 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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) |
|---|---|---|---|---|---|---|---|---|
| 2483.706250 | 51.16 | --- | 74.00 | 22.84 | 100.0 | V | 217.0 | 7.4 |
| 2483.817500 | --- | 41.44 | 54.00 | 12.56 | 100.0 | V | 217.0 | 7.4 |

# Appendix C: Test Results of right earbud

## Appendix C.1: Test Results of 99% Bandwidth

| TestMode | Antenna | Channel | OCB [MHz] | FL[MHz] | FH[MHz] | Limit[MHz] | Verdict |
|---|---|---|---|---|---|---|---|
| DH5 | Ant1 | 2402 | 0.88557 | 2401.5498 | 2402.4353 | --- | --- |
| | | 2441 | 0.88635 | 2440.5495 | 2441.4359 | --- | --- |
| | | 2480 | 0.88033 | 2479.5534 | 2480.4338 | --- | --- |
| 3DH5 | Ant1 | 2402 | 1.1999 | 2401.3867 | 2402.5866 | --- | --- |
| | | 2441 | 1.1988 | 2440.3858 | 2441.5846 | --- | --- |
| | | 2480 | 1.2046 | 2479.3835 | 2480.5881 | --- | --- |

DH5_Ant1_2402


DH5_Ant1_2441

DH5_Ant1_2480


3DH5_Ant1_2402


3DH5_Ant1_2441

| 3DH5_Ant1_2480 |
| --- |
|  |

## Appendix C.2: Test Results of 20dB Bandwidth

| TestMode | Antenna | Channel | 20db EBW[MHz] | FL[MHz] | FH[MHz] | Limit[MHz] | Verdict |
|---|---|---|---|---|---|---|---|
| DH5 | Ant1 | 2402 | 0.942 | 2401.532 | 2402.474 | --- | --- |
| | | 2441 | 0.945 | 2440.532 | 2441.477 | --- | --- |
| | | 2480 | 0.951 | 2479.526 | 2480.477 | --- | --- |
| 3DH5 | Ant1 | 2402 | 1.269 | 2401.349 | 2402.618 | --- | --- |
| | | 2441 | 1.275 | 2440.343 | 2441.618 | --- | --- |
| | | 2480 | 1.269 | 2479.346 | 2480.615 | --- | --- |

DH5_Ant1_2402


DH5_Ant1_2441

DH5_Ant1_2480


3DH5_Ant1_2402


3DH5_Ant1_2441

| 3DH5_Ant1_2480 |
| --- |
|  |

## Appendix C.3: 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 (℃) | 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) | 2441 |
|---|---|

**Test result of frequency tolerance of voltage variation**

| Voltage | Test result (MHz) | Deviation Frequency (KHz) | Test result (ppm) | Limit (ppm) |
|---|---|---|---|---|
| DC 3.465V | 2440.992 | -8 | -3.27735 | 10 |
| DC 3.85V | 2440.990 | -10 | -4.09668 | |
| DC 4.235 | 2440.986 | -14 | -5.73535 | |

**Test result of frequency tolerance of temperature variation**

| Temperature (℃) | Test result (KHz) | Deviation Frequency (KHz) | Test result (ppm) | Limit (ppm) |
|---|---|---|---|---|
| -30 | 2440.991 | -9 | -3.68701 | 10 |
| -20 | 2440.994 | -6 | -2.45801 | |
| -10 | 2440.994 | -6 | -2.45801 | |
| 0 | 2440.995 | -5 | -2.04834 | |
| 10 | 2440.989 | -11 | -4.50635 | |
| 20 | 2440.990 | -10 | -4.09668 | |
| 30 | 2440.991 | -9 | -3.68701 | |
| 40 | 2440.987 | -13 | -5.32569 | |
| 50 | 2440.991 | -9 | -3.68701 | |
| 55 | 2440.995 | -5 | -2.04834 | |

| 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 (℃) | 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.4: Test Results of Carrier Frequency Separation

| TestMode | Antenna | Channel | Result[MHz] | Limit[MHz] | Verdict |
|---|---|---|---|---|---|
| DH5 | Ant1 | Hop | 0.998 | ≥0.951 | PASS |
| 3DH5 | Ant1 | Hop | 1.012 | ≥0.850 | PASS |

DH5_Ant1_Hop


3DH5_Ant1_Hop

## Appendix C.5: Test Results of Number of Hopping Frequencies

| TestMode | Antenna | Channel | Result[Num] | Limit[Num] | Verdict |
|---|---|---|---|---|---|
| DH5 | Ant1 | Hop | 79 | ≥15 | PASS |
| 3DH5 | Ant1 | Hop | 79 | ≥15 | PASS |

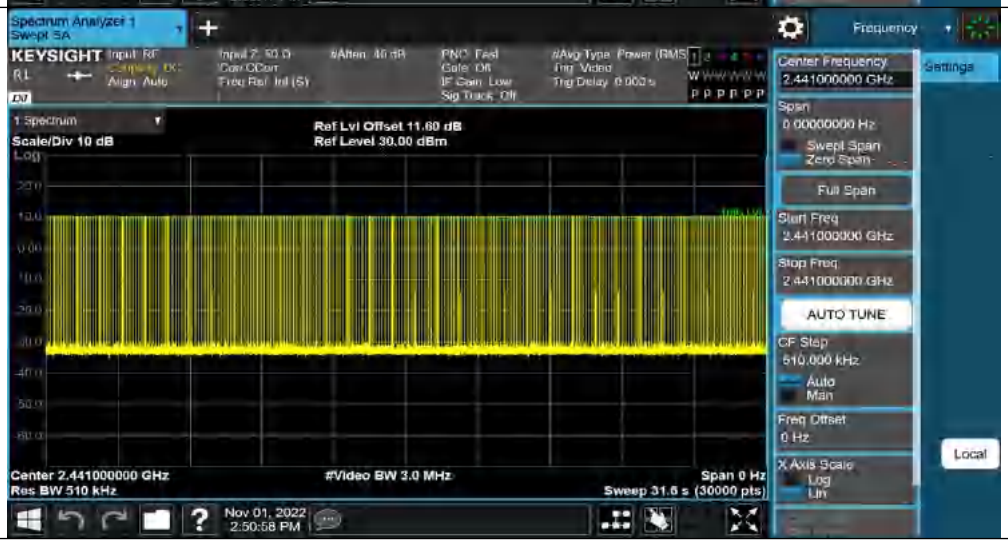
DH5_Ant1_Hop


3DH5_Ant1_Hop

## Appendix C.6: Test Results of Time of Occupancy

| TestMode | Antenna | Channel | BurstWidth [ms] | TotalHops [Num] | Result[s] | Limit[s] | Verdict |
|---|---|---|---|---|---|---|---|
| DH1 | Ant1 | Hop | 0.374 | 319 | 0.119 | ≤0.4 | PASS |
| DH3 | Ant1 | Hop | 1.630 | 159 | 0.259 | ≤0.4 | PASS |
| DH5 | Ant1 | Hop | 2.879 | 107 | 0.308 | ≤0.4 | PASS |
| 3DH1 | Ant1 | Hop | 0.379 | 319 | 0.121 | ≤0.4 | PASS |
| 3DH3 | Ant1 | Hop | 1.631 | 159 | 0.259 | ≤0.4 | PASS |
| 3DH5 | Ant1 | Hop | 2.883 | 107 | 0.308 | ≤0.4 | PASS |

DH1_Ant1_Hop

DH3_Ant1_Hop



DH5_Ant1_Hop


3DH1_Ant1_Hop


| 3DH3_Ant1_Hop |
| --- |
|  |
|  |
| 3DH5_Ant1_Hop |
|  |


KEYSIGHT
Ref Lvl Offset 11.60 dB
Ref Level 30.00 dBm
Scale/Div 10 dB
Center 2.441000000 GHz
Res BW 510 kHz
#Video BW 2.0 MHz
Span 0 Hz
Sweep 31.6 s (30000 pts)
Center Frequency
2.441000000 GHz
Span
0.00000000 Hz
Swept Span
Zero Span
Full Span
Start Freq
2.441000000 GHz
Stop Freq
2.441000000 GHz
AUTO TUNE
CF Step
510.000 kHz
Auto
Man
Freq Offset
0 Hz
X Axis Scale
Log
Lin
Local
Nov 01, 2022
2:58:00 PM

## Appendix C.7: 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 |
|---|---|---|---|---|---|---|---|
| DH5 | Ant1 | 2402 | Reference | 9.97 | 9.97 | --- | PASS |
| | | | 30~1000 | 9.97 | -47.7 | ≤-10.03 | PASS |
| | | | 1000~26500 | 9.97 | -37.54 | ≤-10.03 | PASS |
| | | 2441 | Reference | 9.52 | 9.52 | --- | PASS |
| | | | 30~1000 | 9.52 | -48.62 | ≤-10.48 | PASS |
| | | | 1000~26500 | 9.52 | -39.18 | ≤-10.48 | PASS |
| | | 2480 | Reference | 9.45 | 9.45 | --- | PASS |
| | | | 30~1000 | 9.45 | -48.11 | ≤-10.55 | PASS |
| | | | 1000~26500 | 9.45 | -39.03 | ≤-10.55 | PASS |
| 3DH5 | Ant1 | 2402 | Reference | 6.39 | 6.39 | --- | PASS |
| | | | 30~1000 | 6.39 | -47.45 | ≤-13.61 | PASS |
| | | | 1000~26500 | 6.39 | -39.18 | ≤-13.61 | PASS |
| | | 2441 | Reference | 6.50 | 6.50 | --- | PASS |
| | | | 30~1000 | 6.50 | -48.27 | ≤-13.5 | PASS |
| | | | 1000~26500 | 6.50 | -39.01 | ≤-13.5 | PASS |
| | | 2480 | Reference | 6.04 | 6.04 | --- | PASS |
| | | | 30~1000 | 6.04 | -48.19 | ≤-13.96 | PASS |
| | | | 1000~26500 | 6.04 | -38.87 | ≤-13.96 | PASS |

DH5_Ant1_2402_0~Reference

DH5_Ant1_2402_30~1000


DH5_Ant1_2402_1000~26500


DH5_Ant1_2441_0~Reference

DH5_Ant1_2441_30~1000


DH5_Ant1_2441_1000~26500


DH5_Ant1_2480_0~Reference

DH5_Ant1_2480_30~1000


DH5_Ant1_2480_1000~26500


3DH5_Ant1_2402_0~Reference

3DH5_Ant1_2402_30~1000


3DH5_Ant1_2402_1000~26500

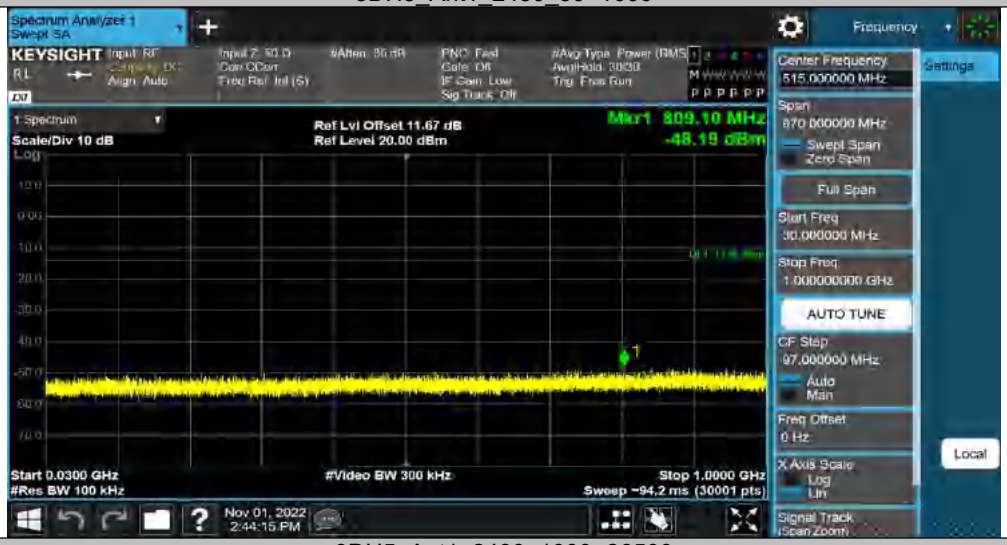

3DH5_Ant1_2441_0~Reference

3DH5_Ant1_2441_30~1000


3DH5_Ant1_2441_1000~26500


3DH5_Ant1_2480_0~Reference

3DH5_Ant1_2480_30~1000

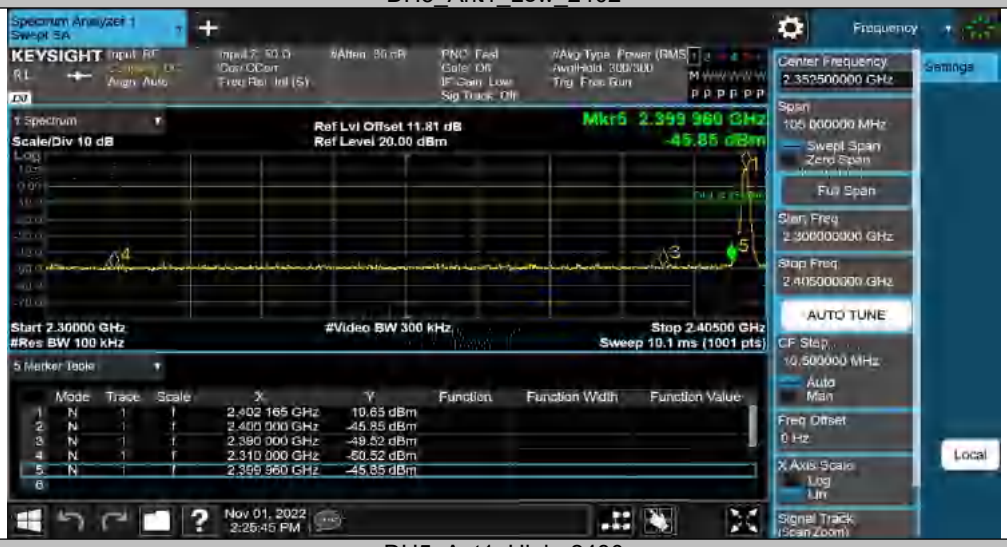



3DH5_Ant1_2480_1000~26500

Band Edge

| TestMode | Antenna | ChName | Channel | RefLevel [dBm] | Result [dBm] | Limit [dBm] | Verdict |
|---|---|---|---|---|---|---|---|
| DH5 | Ant1 | Low | 2402 | 10.65 | -45.85 | ≤-9.35 | PASS |
| | | High | 2480 | 10.16 | -46.47 | ≤-9.85 | PASS |
| | | Low | Hop_2402 | 9.83 | -46.52 | ≤-10.17 | PASS |
| | | High | Hop_2480 | 9.86 | -46.55 | ≤-10.15 | PASS |
| 3DH5 | Ant1 | Low | 2402 | 10.56 | -44 | ≤-9.44 | PASS |
| | | High | 2480 | 10.17 | -46.29 | ≤-9.84 | PASS |
| | | Low | Hop_2402 | 5.87 | -46.56 | ≤-14.13 | PASS |
| | | High | Hop_2480 | 9.78 | -46.59 | ≤-10.22 | PASS |

DH5_Ant1_Low_2402




DH5_Ant1_High_2480

DH5_Ant1_Low_Hop_2402


DH5_Ant1_High_Hop_2480


3DH5_Ant1_Low_2402

3DH5_Ant1_High_2480


3DH5_Ant1_Low_Hop_2402


3DH5_Ant1_High_Hop_2480

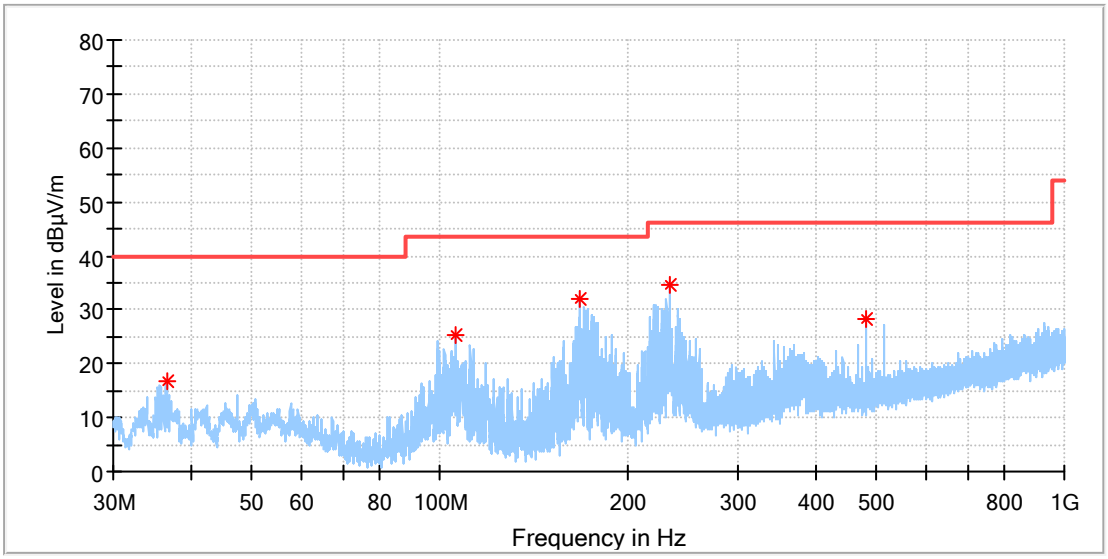
## Appendix C.8: Test Results of Radiated Spurious Emissions

Note: 1. 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. 2. This testing was carried out on different modulations, but only the worst case was presented in this report.

30MHz - 1GHz

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

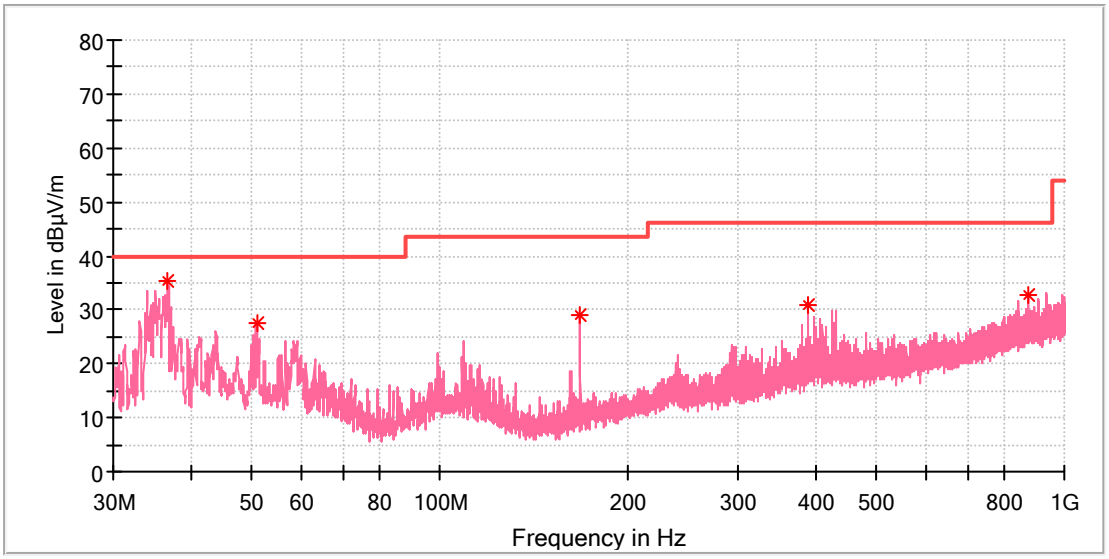



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 36.491539 | 16.67 | 40.00 | 23.33 | 100.0 | H | 212.0 | -21.7 |
| 105.921154 | 25.12 | 43.50 | 18.38 | 100.0 | H | 293.0 | -19.1 |
| 168.001154 | 31.91 | 43.50 | 11.59 | 100.0 | H | 188.0 | -21.7 |
| 233.998462 | 34.72 | 46.00 | 11.28 | 100.0 | H | 212.0 | -18.3 |
| 480.005385 | 28.34 | 46.00 | 17.66 | 100.0 | H | 196.0 | -12.6 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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

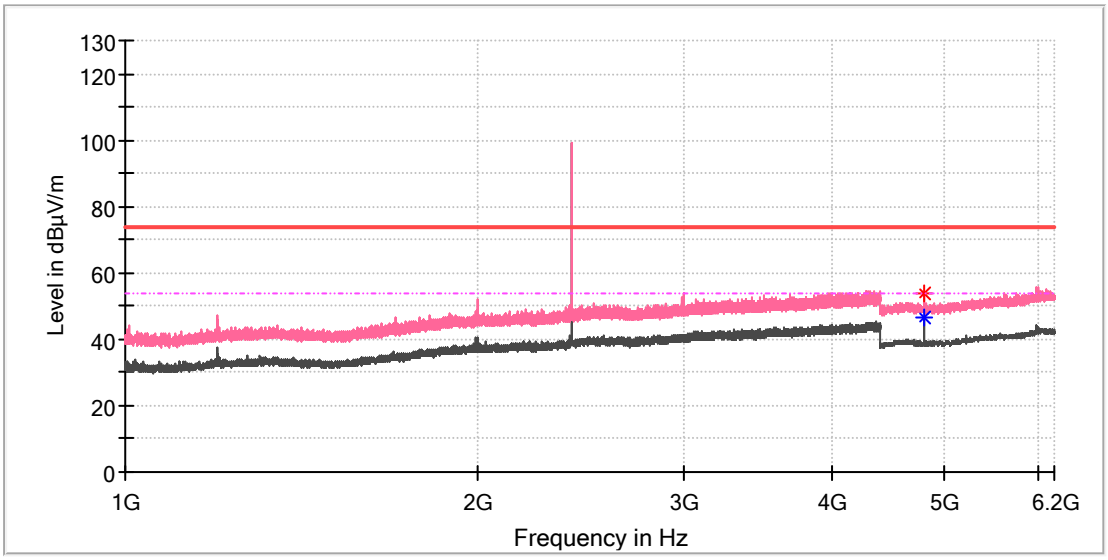
| Frequency (MHz) | MaxPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|
| 36.741500 | 35.26 | 40.00 | 4.74 | 100.0 | V | 223.0 | -21.3 |
| 50.903500 | 27.69 | 40.00 | 12.31 | 100.0 | V | 341.0 | -18.3 |
| 168.031000 | 28.92 | 43.50 | 14.58 | 100.0 | V | 285.0 | -21.3 |
| 389.918500 | 30.76 | 46.00 | 15.24 | 100.0 | V | 171.0 | -13.9 |
| 877.489000 | 32.68 | 46.00 | 13.32 | 100.0 | V | 128.0 | -5.2 |

1GHz - 6.2GHz

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

## UT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

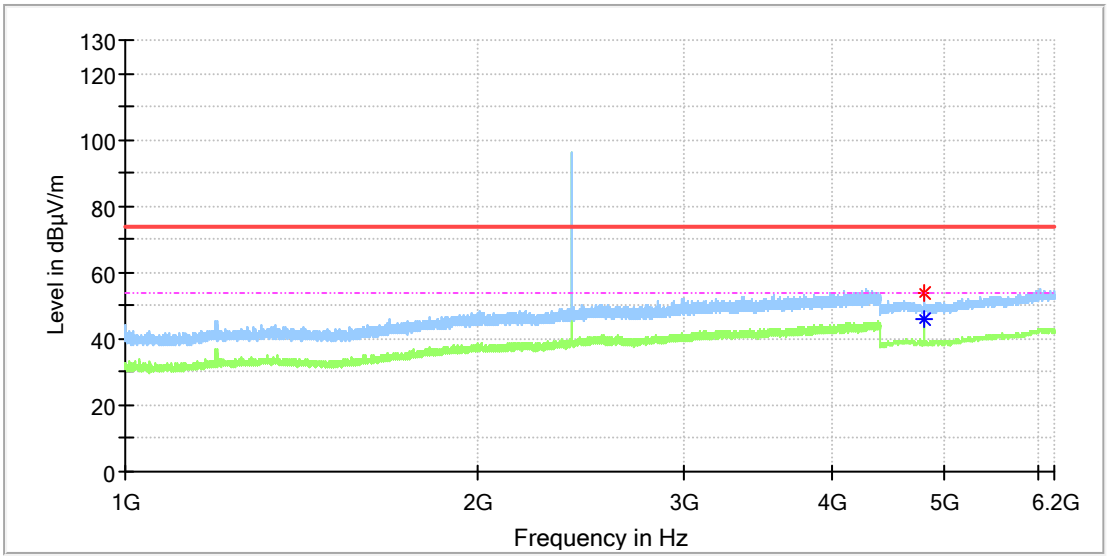



## Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4803.500000 | 53.59 | --- | 74.00 | 20.41 | 100.0 | V | 51.0 | 11.8 |
| 4804.000000 | --- | 46.53 | 54.00 | 7.47 | 100.0 | V | 45.0 | 11.8 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

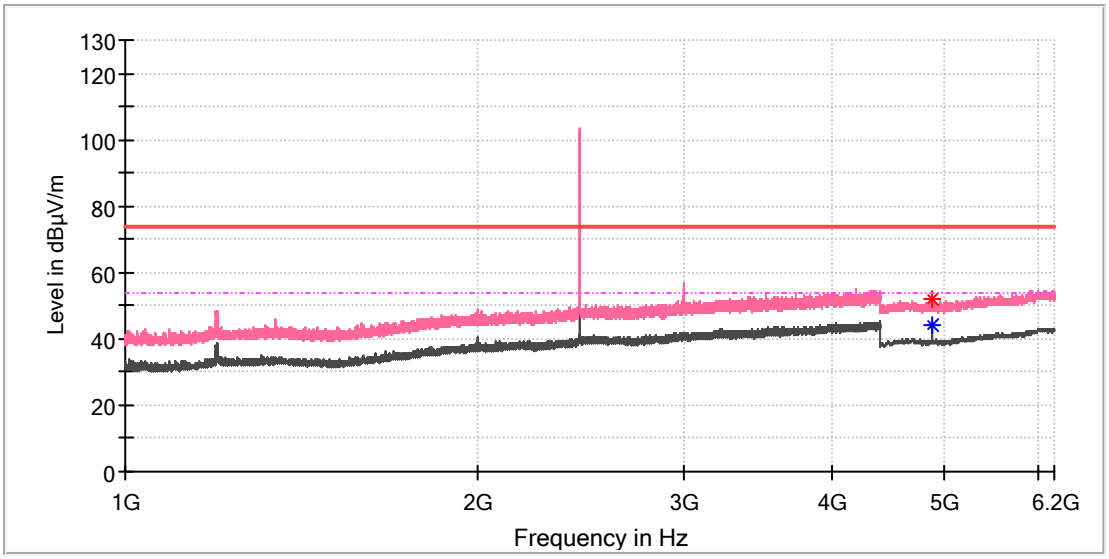



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4804.000000 | 53.59 | --- | 74.00 | 20.41 | 100.0 | H | 25.0 | 11.8 |
| 4804.000000 | --- | 45.73 | 54.00 | 8.27 | 100.0 | H | 25.0 | 11.8 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

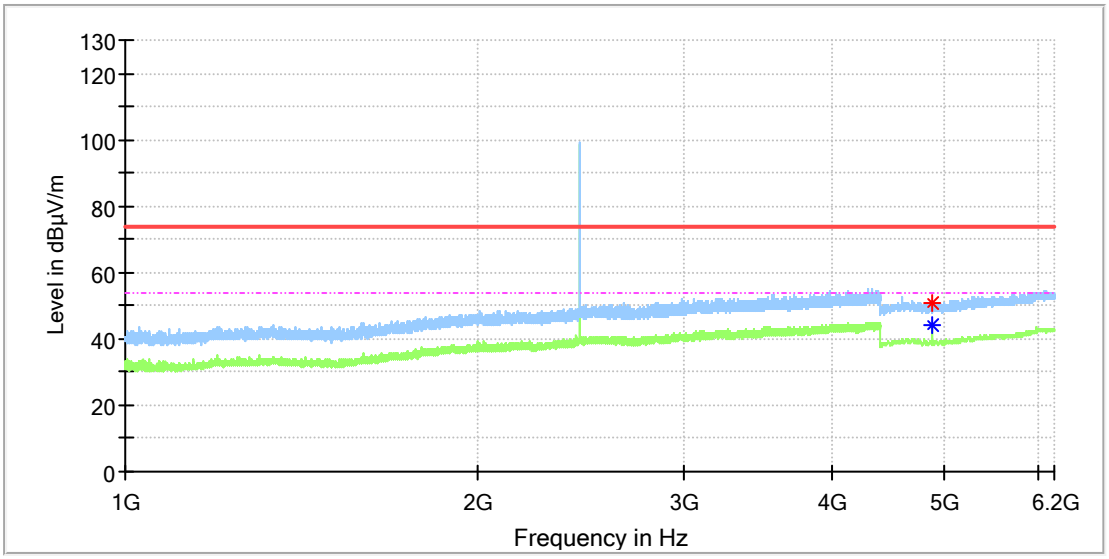



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4882.000000 | 51.85 | --- | 74.00 | 22.15 | 100.0 | V | 49.0 | 11.8 |
| 4882.000000 | --- | 44.43 | 54.00 | 9.57 | 100.0 | V | 49.0 | 11.8 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

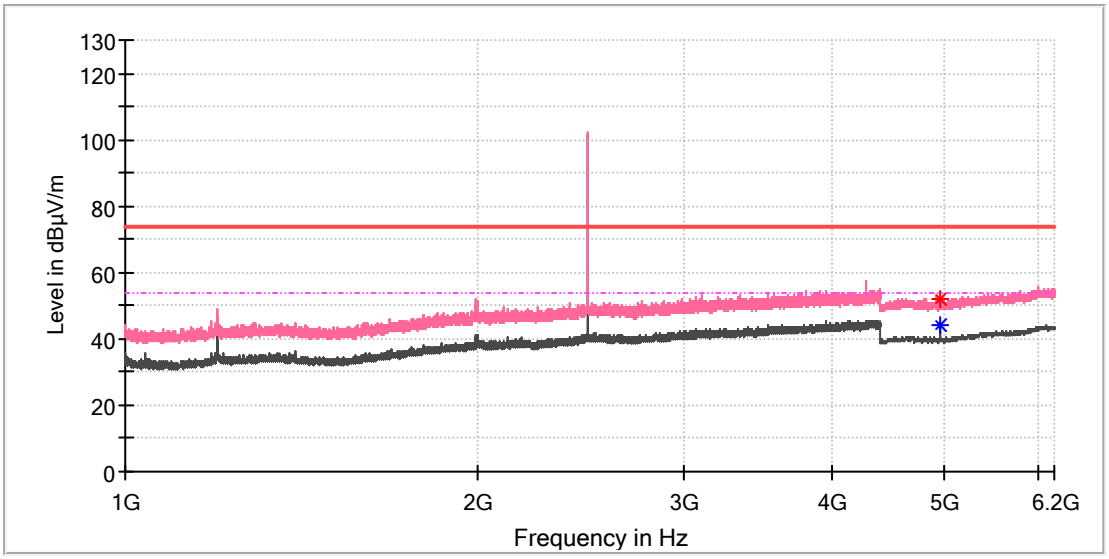



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4881.500000 | 51.00 | --- | 74.00 | 23.00 | 100.0 | H | 315.0 | 11.8 |
| 4882.000000 | --- | 44.19 | 54.00 | 9.81 | 100.0 | H | 165.0 | 11.8 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

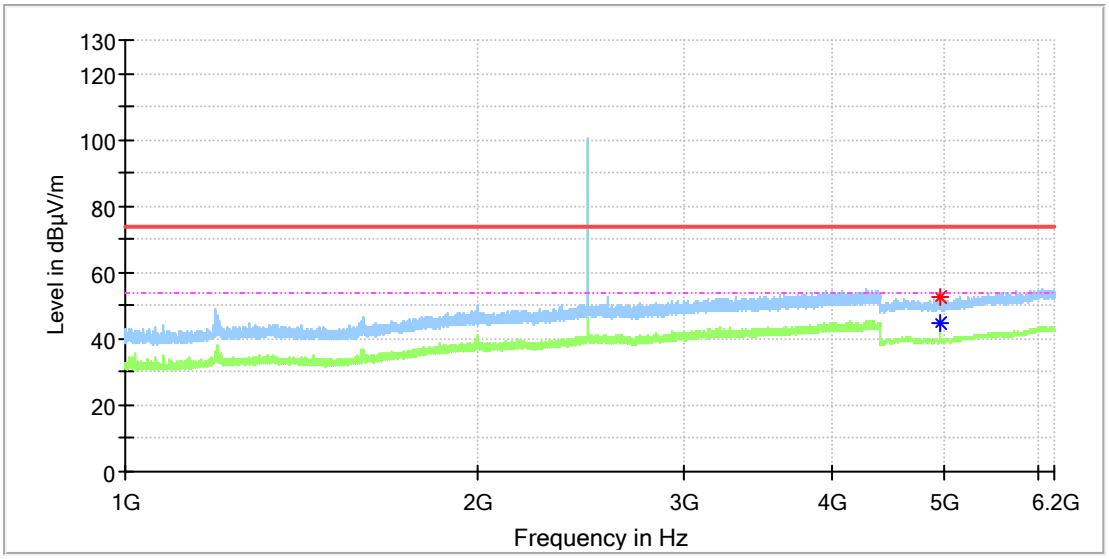



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4960.000000 | 52.04 | --- | 74.00 | 21.96 | 100.0 | V | 57.0 | 11.8 |
| 4960.000000 | --- | 43.91 | 54.00 | 10.09 | 100.0 | V | 57.0 | 11.8 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |



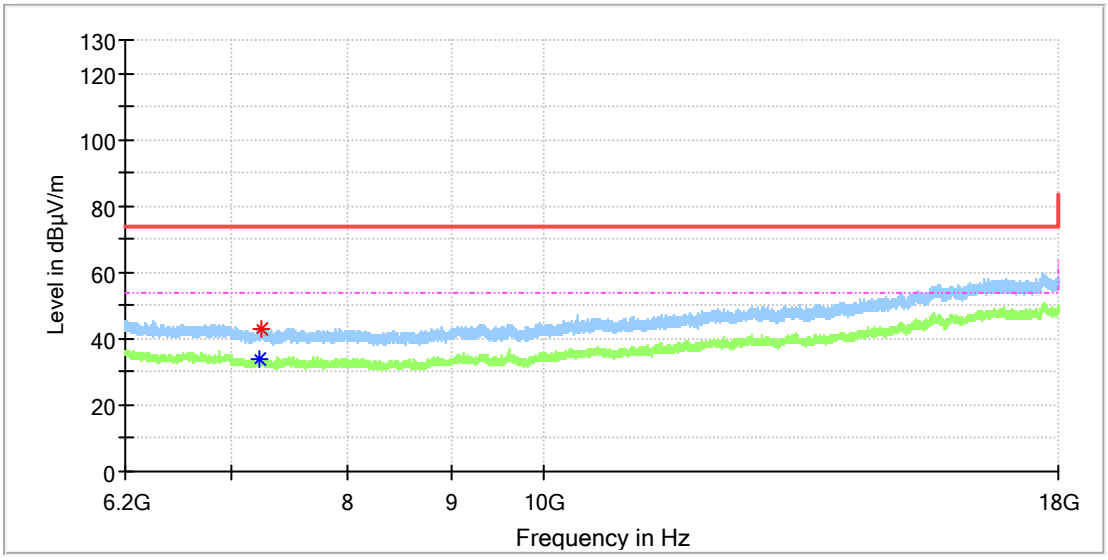

# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 4959.500000 | 52.57 | --- | 74.00 | 21.43 | 100.0 | H | 348.0 | 11.8 |
| 4959.500000 | --- | 44.45 | 54.00 | 9.55 | 100.0 | H | 348.0 | 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: | BR_DH5_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 |

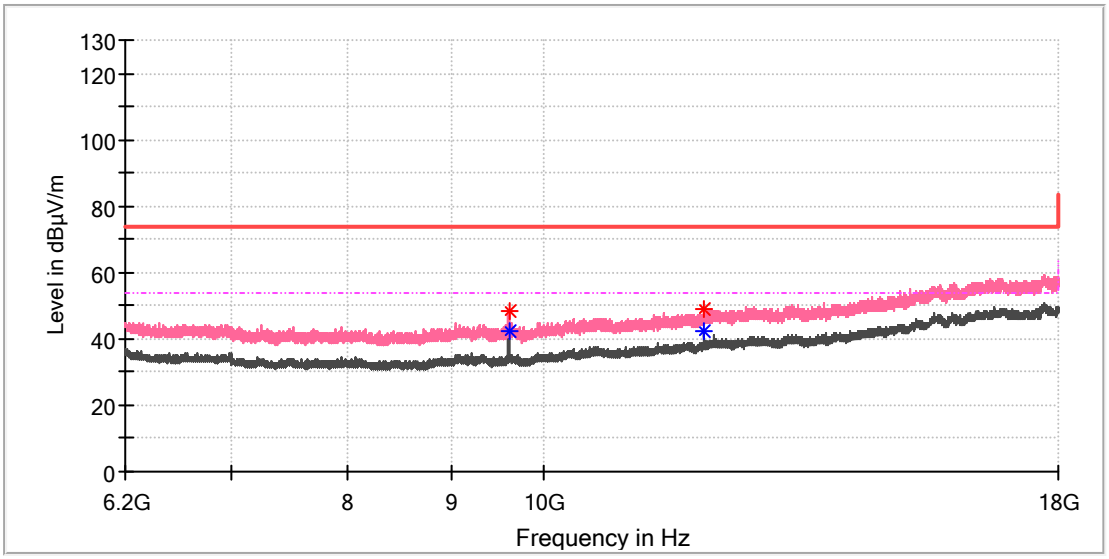



## Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 7233.975000 | --- | 33.77 | 54.00 | 20.23 | 100.0 | H | 77.0 | 8.6 |
| 7243.316667 | 42.75 | --- | 74.00 | 31.25 | 100.0 | H | 16.0 | 8.6 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

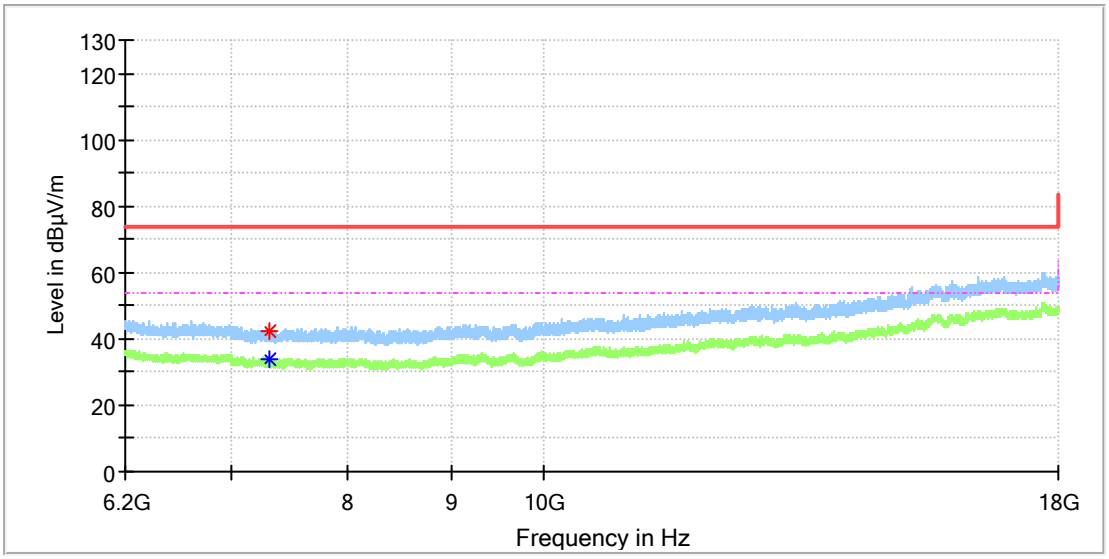



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 9607.741667 | --- | 42.53 | 54.00 | 11.47 | 100.0 | V | 356.0 | 10.4 |
| 9608.725000 | 48.67 | --- | 74.00 | 25.33 | 100.0 | V | 356.0 | 10.4 |
| 12010.516667 | 48.70 | --- | 74.00 | 25.30 | 100.0 | V | 346.0 | 14.0 |
| 12010.516667 | --- | 42.47 | 54.00 | 11.53 | 100.0 | V | 346.0 | 14.0 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

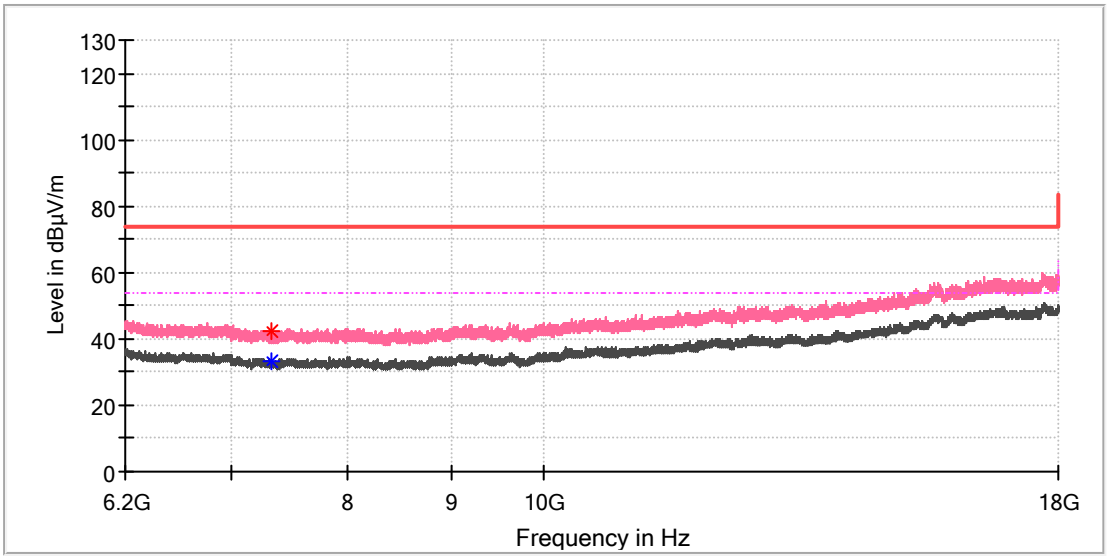



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 7304.775000 | --- | 33.71 | 54.00 | 20.29 | 100.0 | H | 203.0 | 8.3 |
| 7310.675000 | 42.40 | --- | 74.00 | 31.60 | 100.0 | H | 203.0 | 8.2 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

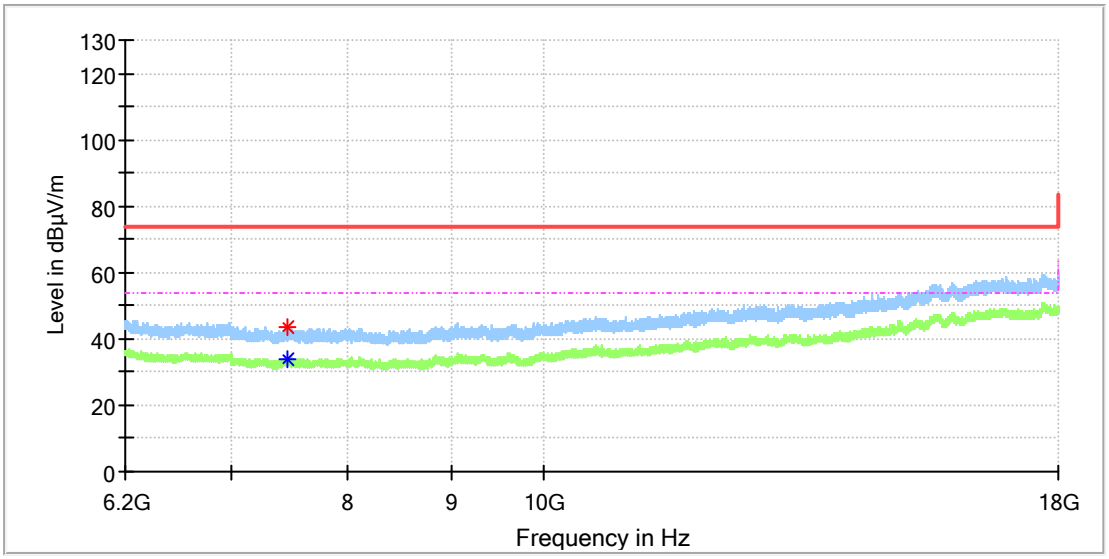



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 7322.475000 | --- | 33.48 | 54.00 | 20.52 | 100.0 | V | 251.0 | 8.2 |
| 7328.375000 | 42.13 | --- | 74.00 | 31.87 | 100.0 | V | 166.0 | 8.1 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

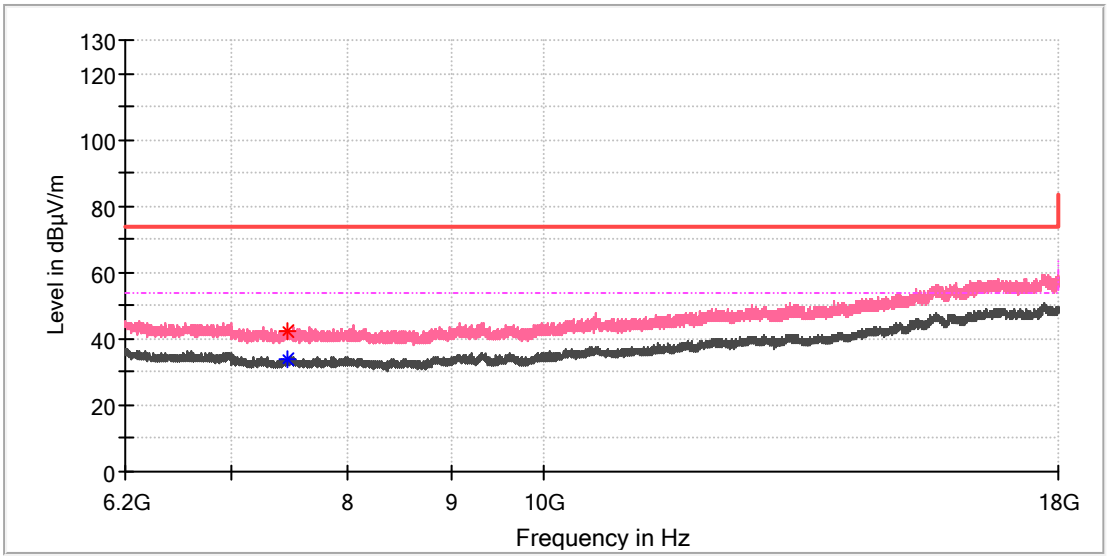



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 7459.650000 | --- | 33.84 | 54.00 | 20.16 | 100.0 | H | 316.0 | 8.5 |
| 7465.550000 | 43.38 | --- | 74.00 | 30.62 | 100.0 | H | 344.0 | 8.6 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |



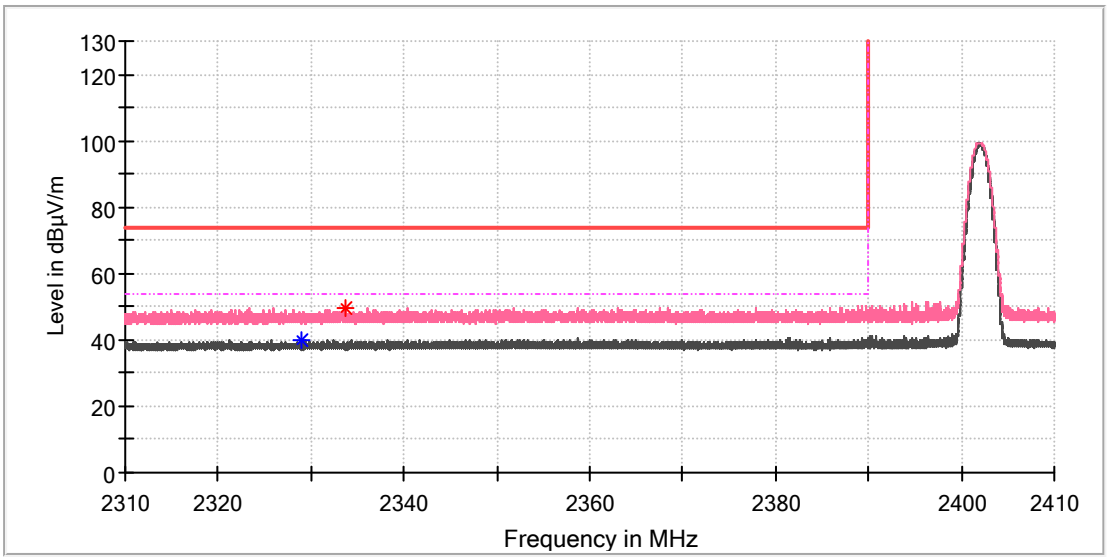

# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 7454.733333 | 42.31 | --- | 74.00 | 31.69 | 100.0 | V | 1.0 | 8.5 |
| 7456.700000 | --- | 34.16 | 54.00 | 19.84 | 100.0 | V | 152.0 | 8.5 |

## Appendix C.9: Test Results of Radiated Emissions in Restricted Bands

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

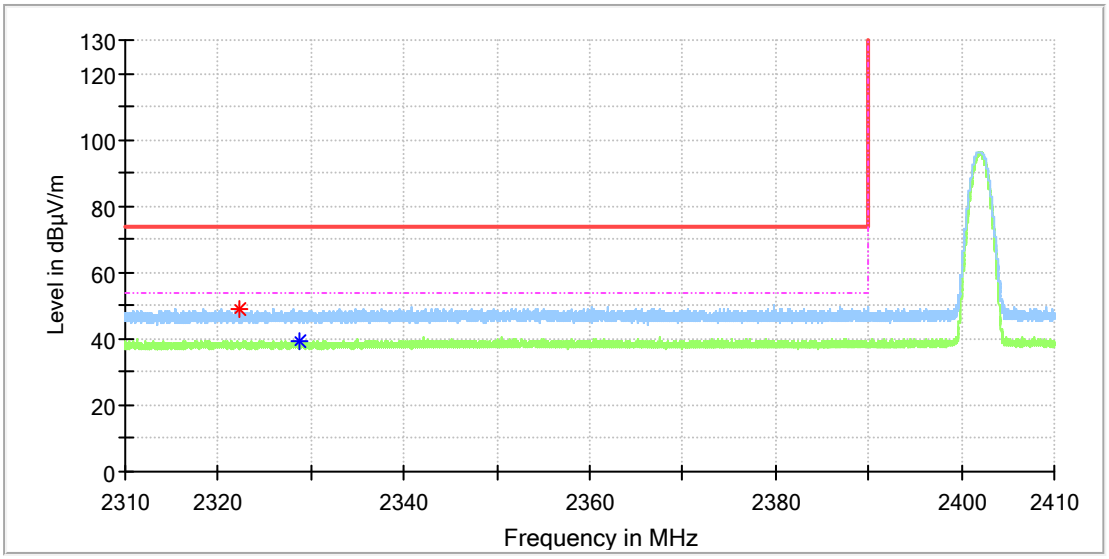



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 2328.985000 | --- | 39.82 | 54.00 | 14.18 | 100.0 | V | 91.0 | 6.7 |
| 2333.680000 | 49.71 | --- | 74.00 | 24.29 | 100.0 | V | 267.0 | 6.7 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

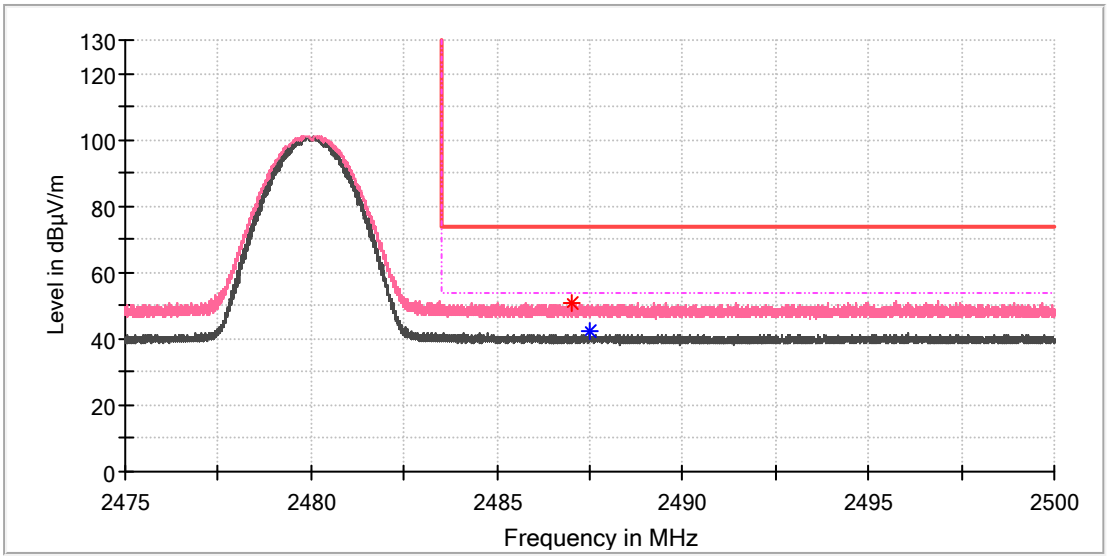



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 2322.240000 | 48.83 | --- | 74.00 | 25.17 | 100.0 | H | 189.0 | 6.6 |
| 2328.745000 | --- | 39.59 | 54.00 | 14.41 | 100.0 | H | 166.0 | 6.7 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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 |

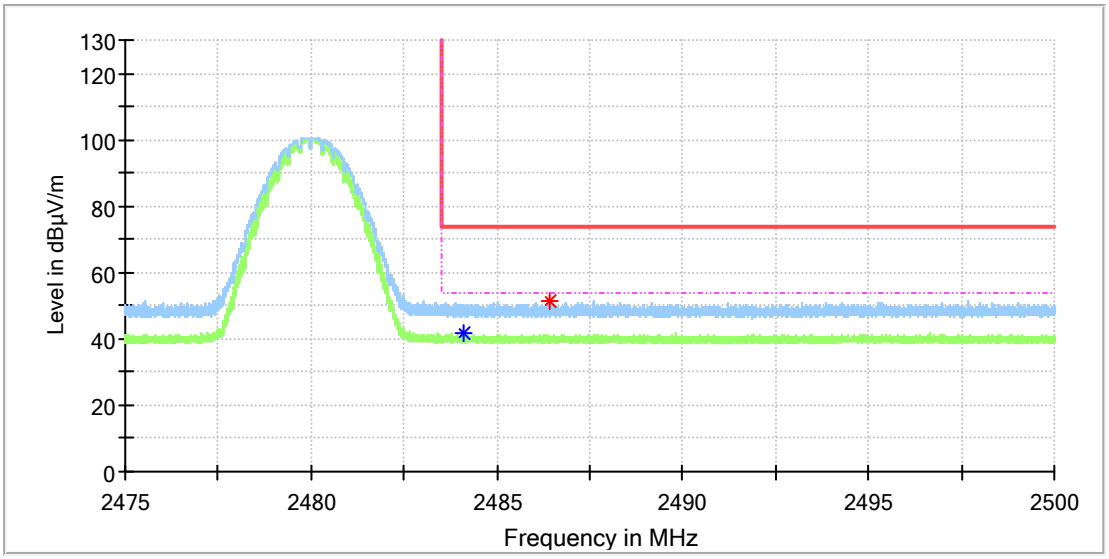



# Critical_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|
| 2487.035000 | 51.00 | --- | 74.00 | 23.00 | 100.0 | V | 0.0 | 7.4 |
| 2487.482500 | --- | 42.21 | 54.00 | 11.79 | 100.0 | V | 82.0 | 7.4 |

# EUT Information

| | |
|---|---|
| EUT Name: | BLUETOOTH HEADSET |
| Model: | QUANTUM TWS AIR |
| Test Mode: | BR_DH5_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) |
|---|---|---|---|---|---|---|---|---|
| 2484.126250 | --- | 41.85 | 54.00 | 12.15 | 100.0 | H | 76.0 | 7.4 |
| 2486.398750 | 51.14 | --- | 74.00 | 22.86 | 100.0 | H | 5.0 | 7.4 |