

Test Report # TR317406 DTS TX B

Equipment Under Test: Human Headphones (Right)

Test Date(s): January 2nd – March 13th, 2019

Prepared for: Human Inc.
Attn: Jingping Ma
3100 Airport Way 25-512
Seattle, WA 98134

Report Issued by: Zach Wilson, EMC Engineer

Signature: 

Date: 3/14/2019

Report Reviewed by: Adam Alger, Quality Manager

Signature: 

Date: 03/14/2019

Report Constructed by: Zach Wilson, EMC Engineer

Signature: 

Date: 2/4/2019

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Report: TR317406 DTS TX B		Model: 1702
Job: C-2951		Serial: 7406, 7354

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Laird Technologies Test Services in Review

The Laird Technologies, Inc. laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:



A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2017 with Electrical (EMC) Scope

A2LA Certificate Number: 1255.01

Scope of accreditation includes all test methods listed herein, unless otherwise noted.



Federal Communications Commission (FCC) – USA

Accredited recognition of two 3 meter Semi-Anechoic Chambers

Accredited Test Firm Registration Number: 953492



**Government
of Canada**

Innovation, Science and Economic Development Canada

ISED Site listing of two 3 meter Semi-Anechoic Chambers based on RSS-GEN – Issue 4

File Number: IC 3088A-2

File Number: IC 3088A-3

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1 TEST REPORT SUMMARY

During **1/2/19-3/13/19** the Equipment Under Test (EUT), **Human Headphones (Right)**, as provided by **Human Inc.** was tested to the following requirements of the **Federal Communications Commission**:

Requirement	Description	Specification	Method	Result
FCC: 15.247 (a)(2)	Digital Modulation System 6 dB bandwidth	500 kHz	ANSI C63.10	Compliant
FCC: 2.1049	Occupied Bandwidth	Reported	ANSI C63.10	Reported
FCC: 15.247 (b)(3)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Compliant
FCC: 15.247 (e)	Digital Modulation System Power Spectral Density	8 dBm / 3 kHz	ANSI C63.10	Compliant
FCC: 15.247 (d)	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	ANSI C63.10	Compliant
FCC: 15.247 (d)	Spurious Radiated Emissions in Restricted Bands	FCC 15.209	ANSI C63.10	Compliant
FCC: 2.1055 (d)	Frequency Stability	Reported	ANSI C63.10	Reported
FCC: 15.207	AC Power Line Conducted Emissions	0.150-30 MHz	ANSI C63.10	Compliant

Notice:

The results relate only to the item tested and described in this report. Any modifications made to the equipment under test after the specified test date(s) may invalidate the data herein.

If the resulting measurement margin is seen to be within the uncertainty value, as listed in this report, the possibility exists that this unit may not meet the required limit specification if subsequently tested.

2 CLIENT INFORMATION

Company Name	Human Inc.
Contact Person	Jingping Ma
Address	3100 Airport Way 25-512 Seattle, WA 98134

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	Human Headphones (Right)
Model Number	1702
Serial Number	7406, 7354
FCC ID	2ARJG-1702

2.2 Product Description

Left (model 1701) and right (model 1702) ear headphone units. The unit has two modes of operation; amplify mode when both ears are together and headphone mode when the units are on the user's head. The units use 10.5 MHz NFMI when in headphone mode to communicate with each other and 14.8 MHz NFMI while in amplify mode. The right ear unit receives audio via Bluetooth classic and input commands via BLE. The left ear unit receives OTA updates via BLE/BT.

The units are powered via 3.7 VDC Li-ion batteries. They are charged via a 5-pin charging port connected to a wall wart capable of an input voltage of 100-240 VAC, 50-60 Hz. The antenna for BLE/BT is a custom monopole antenna with a peak gain of 2.5 dBi. The manufacturer declared tune up tolerance is ± 1 dB.

2.3 Modifications Incorporated for Compliance

None noted at time of test

2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

2.5 Programming Information

Two software applications were used to program the radios. Airoha AB152C Lab Test Tool, v2.1.1.15730 and Docklight v2.2.8.

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3 REFERENCES

Publication	Edition	Date
ANSI C63.10	-	2013
CFR Part 1, 2, 15	-	2018

4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k = 2.

References	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

Measurement Type	Configuration	Uncertainty ±
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

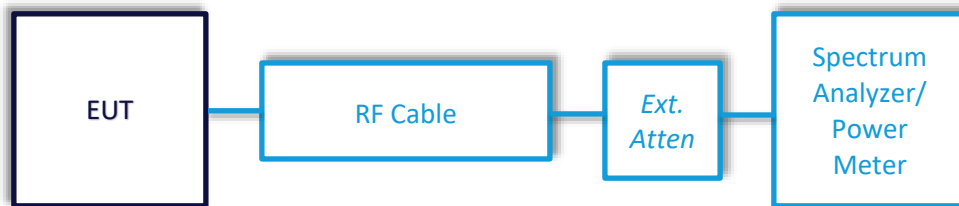
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	1x10 ⁻⁷	0.55x10 ⁻⁷
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 Antenna Port Conducted Emissions

Description of Measurement	<p>The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter.</p> <p>The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.</p>
Example Calculations	<p>Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm)</p> <p>Margin (dB) = Limit (dBm) – Corrected Reading (dBm)</p>

Block Diagram



5.1.1 Antenna Port Conducted Emissions – DTS Bandwidth

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/23/2019
Location	Radio Bench
Temp. / R.H.	21.5°C / 35.4% RH
Requirement	FCC 15.247 (a)(2)
Method	ANSI C63.10 Section 11.8

Test Parameters

Frequency	2402 MHz (Low), 2440 MHz (Mid), 2480 MHz (High)
RBW	100 kHz
VBW	300 kHz
Detector	Max peak hold with peak detector
EUT Mode	BLE Continuous Transmit
EUT Power	Battery @ 3.7 VDC

Instrumentation



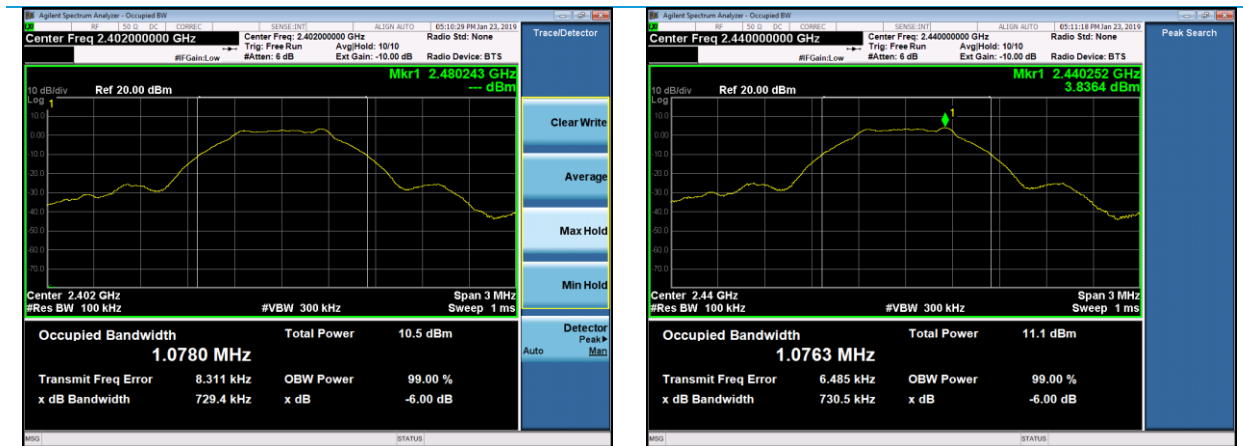
Date : 13-Mar-2019 Test : Conducted Radio (Right DTS) Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification

Table

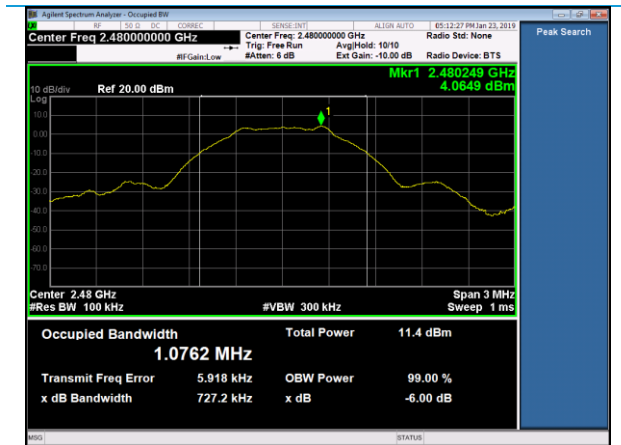
Channel	DTS BW (kHz)	Limit (kHz)	Margin (kHz)
Low	729.4	500.0	229.4
Mid	730.5	500.0	230.5
High	727.2	500.0	227.2

Plots



Low Channel – DTS BW

Mid Channel – DTS BW



High Channel – DTS BW

5.1.2 Antenna Port Conducted Emissions – 99% Occupied Bandwidth

Operator	Zach Wilson
QA	Adam Alger
Test Date	3/13/2019
Location	Radio Bench
Temp. / R.H.	21.5°C / 35.4% RH
Requirement	FCC 2.1049
Method	ANSI C63.10 Section 6.9

Test Parameters

Frequency	2402 MHz (Low), 2440 MHz (Mid), 2480 MHz (High)
RBW	30 kHz
VBW	91 kHz
Detector	Max peak hold with peak detector
EUT Mode	BLE Continuous Transmit
EUT Power	Battery @ 3.7 VDC

Instrumentation



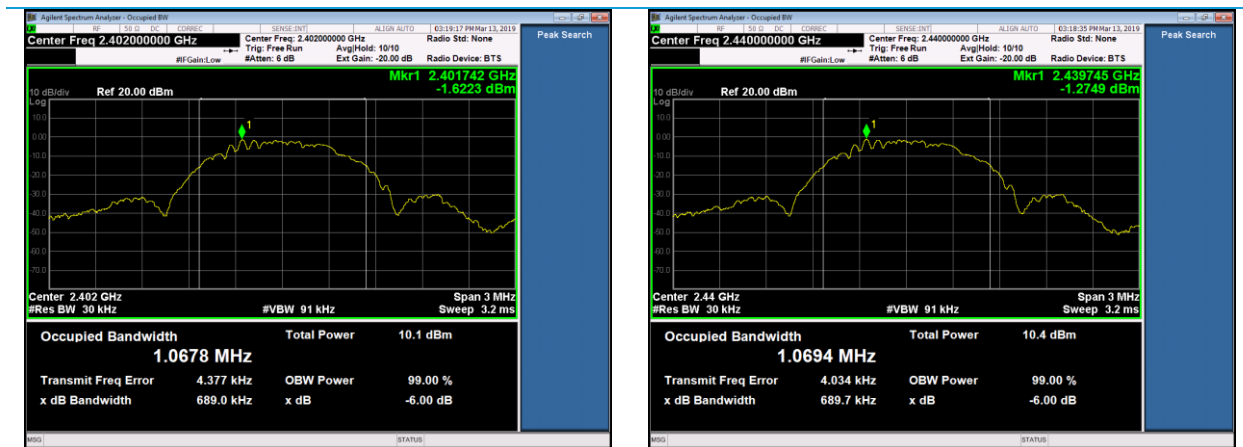
Date: 13-Mar-2019 Test: Conducted Radio (Right DTS) Job: C-2951
 PE: Zach Wilson Customer: Human Inc. Quote: 317406

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification
3	AA 960144	Cable	Gore	EKD01D010720	5800373	11/12/2018	11/12/2019	Active Verification

Table

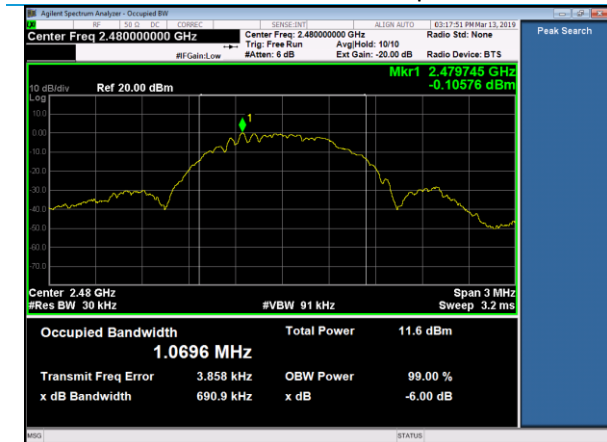
Channel	OBW 99% (kHz)
Low	1067.8
Mid	1069.4
High	1069.6

Plots



Low Channel – 99% Occupied BW

Mid Channel – 99% Occupied BW



High Channel – 99% Occupied BW

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5.1.3 Antenna Port Conducted Emissions – Maximum Conducted Output Power

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/23/2019
Location	Radio Bench
Temp. / R.H.	21.5°C / 35.4% RH
Requirement	FCC 15.247 (b)(3)
Method	ANSI C63.10 Section 11.9.1.1

Test Parameters

Frequency	2402 MHz (Low), 2440 MHz (Mid), 2480 MHz (High)
RBW	1 MHz
VBW	3 MHz
Detector	Max Peak Hold with peak detector
EUT Mode	BLE Continuous Transmit
EUT Power	Battery @ 3.7 VDC

Instrumentation



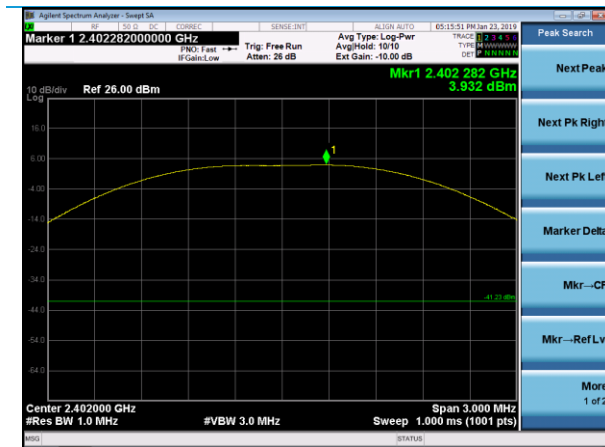
Date : 13-Mar-2019 Test : Conducted Radio (Right DTS) Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification

Table

Channel	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	3.9	30.0	26.1
Mid	4.7	30.0	25.3
High	4.9	30.0	25.1

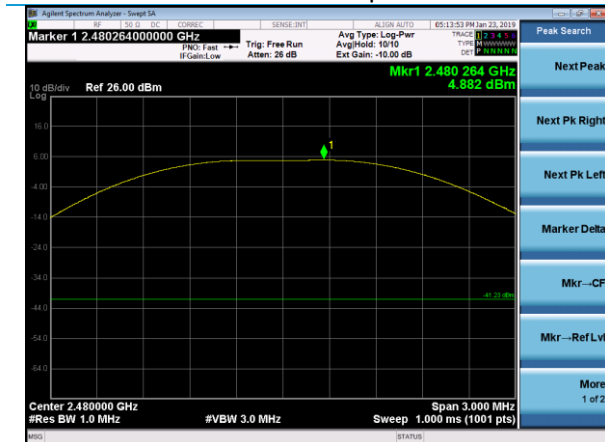
Plots



Low Channel – Output Power



Mid Channel – Output Power



High Channel – Output Power

5.1.4 Antenna Port Conducted Emissions – Digital Modulation System Power Spectral Density

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/23/2019
Location	Radio Bench
Temp. / R.H.	21.5°C / 35.4% RH
Requirement	FCC 15.247 (e)
Method	ANSI C63.10 Section 11.10.2

Test Parameters

Frequency	2402 MHz (Low), 2440 MHz (Mid), 2480 MHz (High)
RBW	100 kHz
VBW	300 kHz
Detector	Max Peak Hold with peak detector
EUT Mode	BLE Continuous Transmit
EUT Power	Battery @ 3.7 VDC

Instrumentation



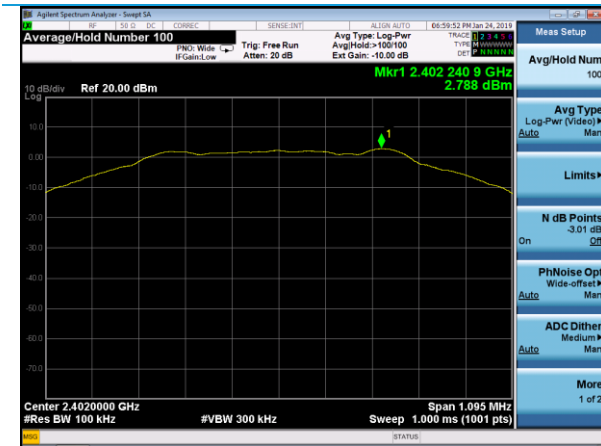
Date : 13-Mar-2019 Test : Conducted Radio (Right DTS) Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification

Table

Channel	Peak PSD (dBm)	Limit (dBm/3kHz)	Margin (dB)
Low	2.8	8.0	5.2
Mid	4.0	8.0	4.0
High	4.2	8.0	3.8

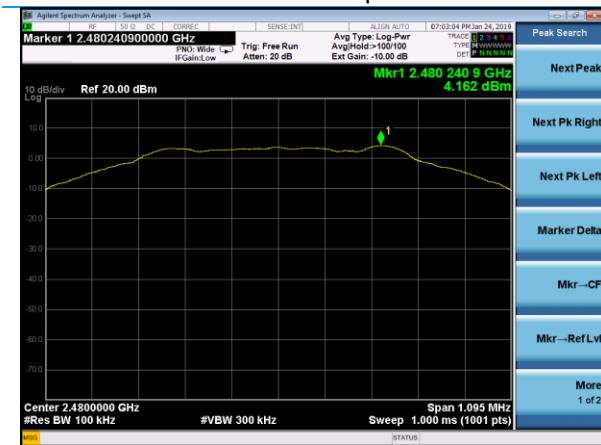
Plots



Low Channel – Output Power



Mid Channel – Output Power



High Channel – Output Power

5.1.5 Antenna Port Conducted Emissions – RF Spurious Emissions at the Transmitter Antenna Terminal

Operator	Zach Wilson
QA	Adam Alger
Test Date	3/13/19
Location	Radio Bench
Temp. / R.H.	21.5°C / 35.4% RH
Requirement	FCC 15.247 (e)
Method	ANSI C63.10 Section 11.11

Test Parameters

Frequency	2402 MHz (Low), 2440 MHz (Mid), 2480 MHz (High)
RBW	100 kHz
VBW	300 kHz
Detector	Max Peak Hold with peak detector
EUT Mode	BLE Continuous Transmit
EUT Power	Battery @ 3.7 VDC
Notes	Reference level plot shown to determine limit of -15.4 dBm. Incorrect limit line shown on plots.

Instrumentation



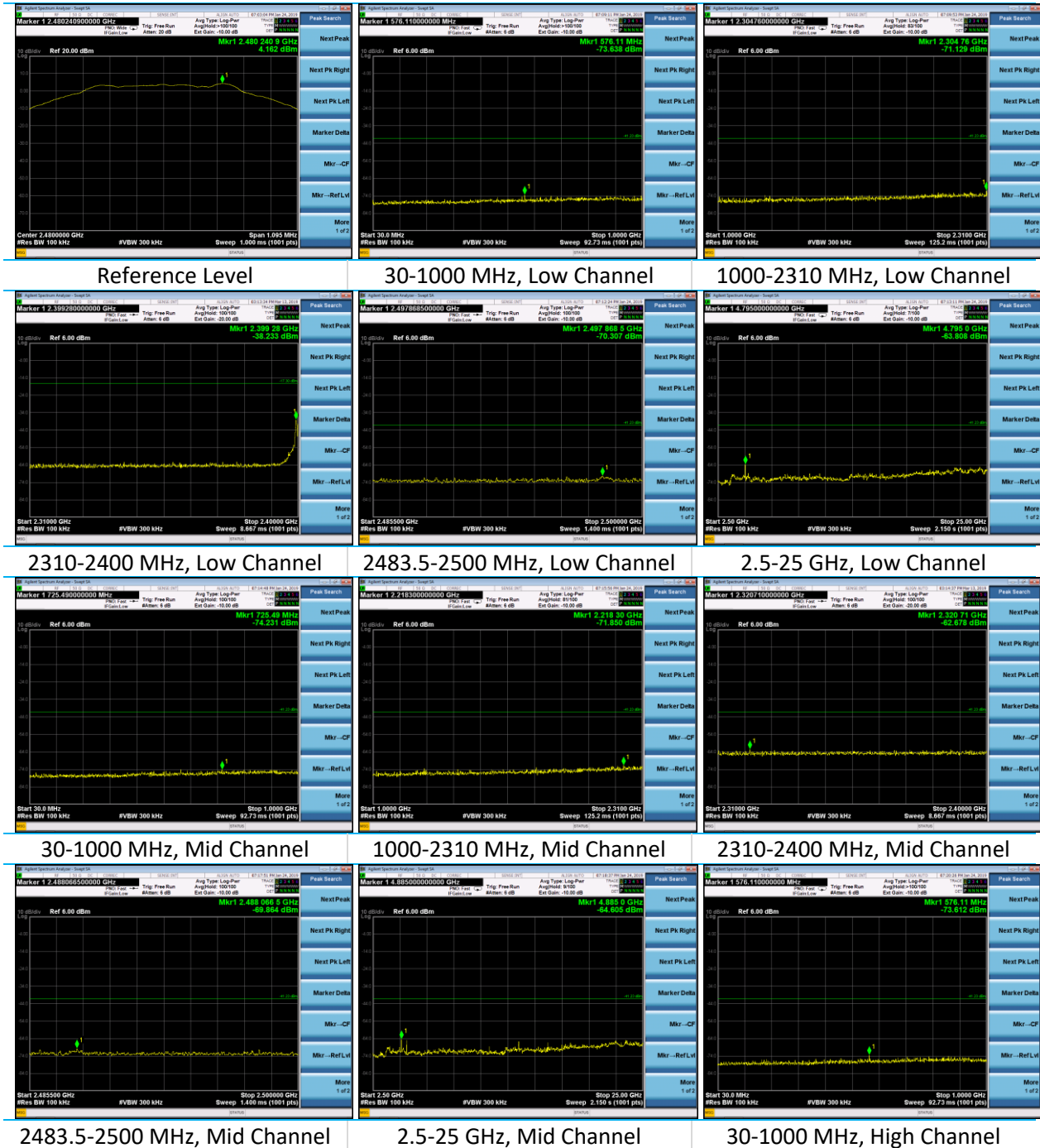
Date: 13-Mar-2019 Test: Conducted Radio (Right DTS) Job: C-2951
 PE: Zach Wilson Customer: Human Inc. Quote: 317406

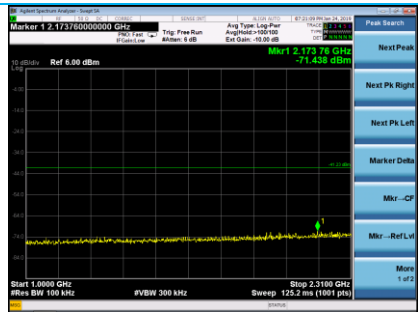
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification
3	AA 960144	Cable	Gore	EKD01D010720	5800373	11/12/2018	11/12/2019	Active Verification

Table

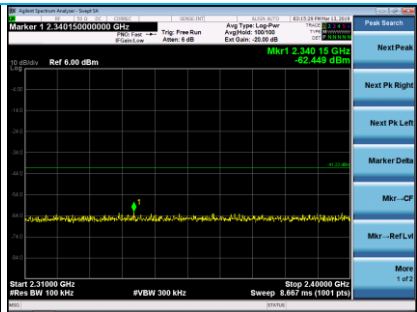
Frequency (MHz)	Channel	Peak Reading (dBm)	Peak Limit (dBm)	Peak Margin (dBm)
2399.3	Low	-38.2	-15.4	22.8
4885.0	Mid	-64.6	-15.4	49.2
2485.5	High	-58.5	-15.4	43.1

Plots





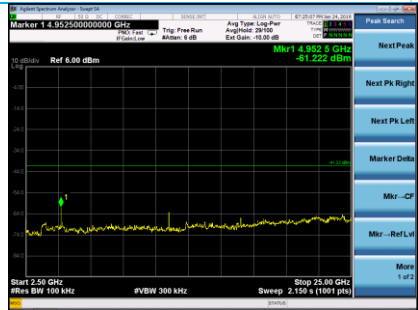
1000-2310 MHz, High Channel



2310-2400 MHz, High Channel



2483.5-2500 MHz, High Channel



2.5-25 GHz, High Channel

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Name: Human Headphones (Right)
Model: 1702
Serial: 7406, 7354

5.1.6 Antenna Port Conducted Emissions – Frequency Stability (Voltage Variation)

Operator	Anthony Smith
QA	Zach Wilson
Test Date	1/25/2019
Location	Radio Bench
Temp. / R.H.	21.5°C / 35.4% RH
Requirement	FCC 2.1055 (d)
Method	ANSI C63.10 Section 6.8

Test Parameters

Frequency	2402 MHz (Low), 2440 MHz (Mid), 2480 MHz (High)
RBW	100 kHz
VBW	300 kHz
Detector	Max Peak Hold with peak detector
EUT Mode	BLE Continuous Transmit
EUT Environment	Varied Voltage $\pm 15\%$ from 3.7 VDC for Voltage Variation.

Instrumentation



Date : 13-Mar-2019 Test : Conducted Radio (Right DTS) Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification

Table

Channel	Voltage (DC)	Frequency (Hz)	Variance (Hz)
High	3.7	2479994788	0
High	4.3	2480001262	-6474
High	3.2	2480004296	-9508
Low	3.2	2402000202	-1892
Low	3.7	2401998310	0
Low	4.3	2402001358	-3048
Mid	3.7	2439997380	0
Mid	4.3	2440001280	-3900
Mid	3.2	2440004316	-6936

5.1.7 Antenna Port Conducted Emissions – Frequency Stability (Ambient Temperature)

Operator	Anthony Smith
QA	Zach Wilson
Test Date	1/25/2019
Location	Radio Bench
Temp. / R.H.	21.5°C / 35.4% RH
Requirement	FCC 2.1055 (d)
Method	ANSI C63.10 Section 6.8

Test Parameters

Frequency	2402 MHz (Low), 2440 MHz (Mid), 2480 MHz (High)
RBW	100 kHz
VBW	300 kHz
Detector	Max Peak Hold with peak detector
EUT Mode	BLE Continuous Transmit
EUT Environment	Temperature varied from -20°C to 50°C for Ambient Temperature.

Instrumentation



Date: 13-Mar-2019 Test: Conducted Radio (Right DTS) Job: C-2951
 PE: Zach Wilson Customer: Human Inc. Quote: 317406

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification

Table

Channel	Temperature (°C)	Frequency (Hz)	Variance (Hz)
Low	20	2401998316	0
Low	50	2401986491	11825
Low	-20	2402008352	10036
Mid	20	2401998346	0
Mid	50	2401988781	9565
Mid	-20	2402001366	3020
High	20	2402009910	0
High	50	2401998362	11548
High	-20	2402016683	6773

5.2 Radiated Emissions

<p>Description of Measurement</p>	<p>The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna.</p> <p>The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values.</p> <p>The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.</p>
<p>Example Calculations</p>	<p>Measurement (dBμV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBμV/m)</p> <p>Margin (dB) = Limit (dBμV/m) - Corrected Reading (dBμV/m)</p> <p>Example at 4000 MHz: Reading = 40 dBμV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBμV/m Average Limit = 20 log (500) = 54 dBμV/m Margin = 54 dBμV/m - 50.8 dBμV/m = 3.2 dB</p>

Block Diagram



5.2.1 Spurious Emissions 30-2310 MHz

Operator	Jon Dilley
QA	Shane Dock
Test Date	1/15/19
Location	Chambers 5
Temp. / R.H.	23.3°C / 34.6%RH
Requirement	FCC 15.247, 15.209
Method	ANSI C63.10 Sections 6.5 and 11.12

Limits:

Frequency (MHz)	Quasi Peak (dB μ V/m)	Average (dB μ V/m)	Peak (dB μ V/m)
30-88	40	-	-
88-216	43.5	-	-
216-960	46	-	-
960-1000	54	-	-
1000-25000	-	54	74

Test Parameters

Frequency	30-2310 MHz
Distance	3m
RBW	< 1 GHz: 120 kHz > 1 GHz : 1 MHz
VBW	< 1 GHz: 1.2 MHz > 1 GHz: 3 MHz
Detector	Max peak hold for all plots. Quasi peak detector for under 1 GHz. Average and peak detectors for over 1 GHz.
EUT Mode	BLE Continuous Tx, Low/High Channels.
EUT Configuration	EUT on charger deemed worst case configuration. NFMI @ 14.8 MHz.
Data Note	All emissions under 1 GHz found to be more than 10 dB under limit and/or not a function of the radio. BLE disabled mode plots taken for comparison.

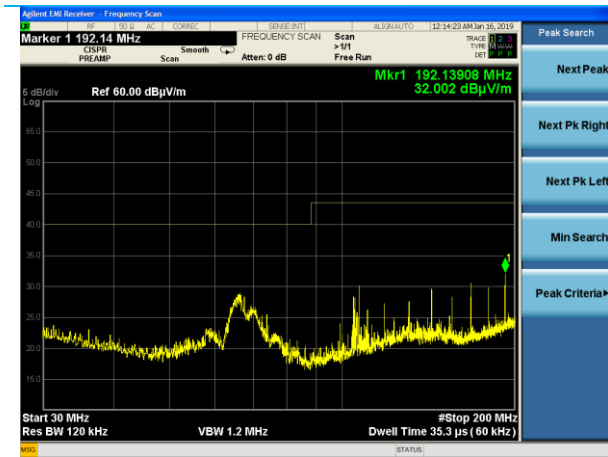
Instrumentation



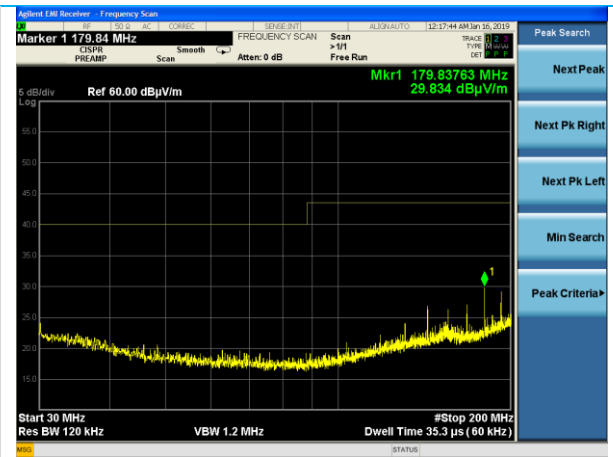
Date : 13-Mar-2019 Test : RE Tx (Right DTS) Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : Q317406

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960163	Antenna - Log Periodic	A.H. Systems, Inc	SAS-512-2	500	1/30/2018	1/30/2019	Active Calibration
2	AA 960128	Antenna - Biconical	ETS Lindgren	3110B	00062899	5/16/2018	5/16/2019	Active Calibration
3	EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	4/24/2018	4/24/2019	Active Calibration
4	AA 960081	Antenna - Double Ridge Horn	EMCO	3115	6907	4/16/2018	4/16/2019	Active Calibration

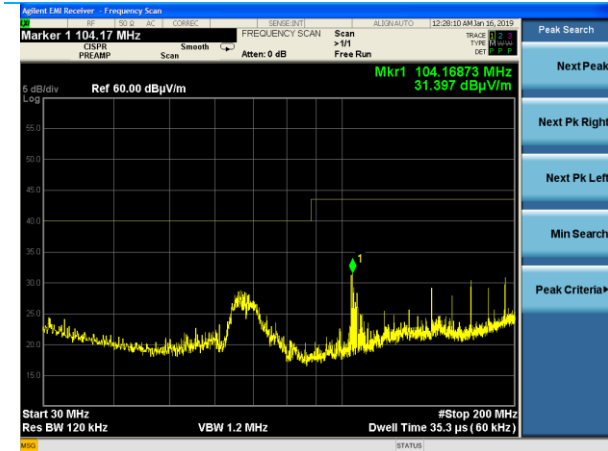
Plots



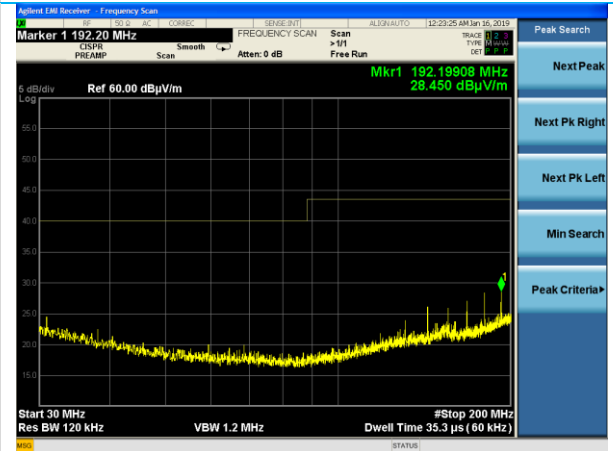
30-200 MHz, Vertical Polarity, BLE Disabled



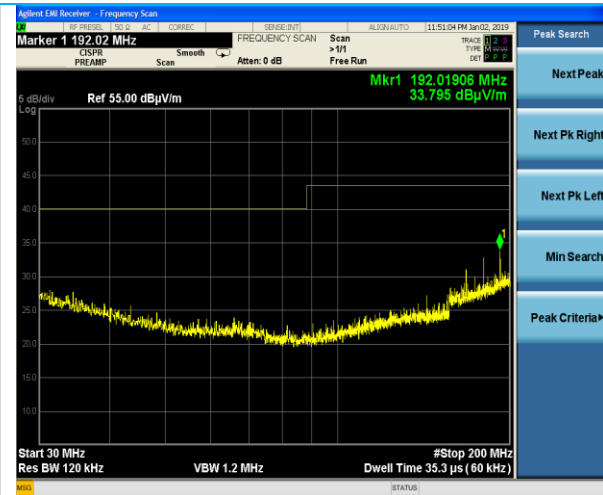
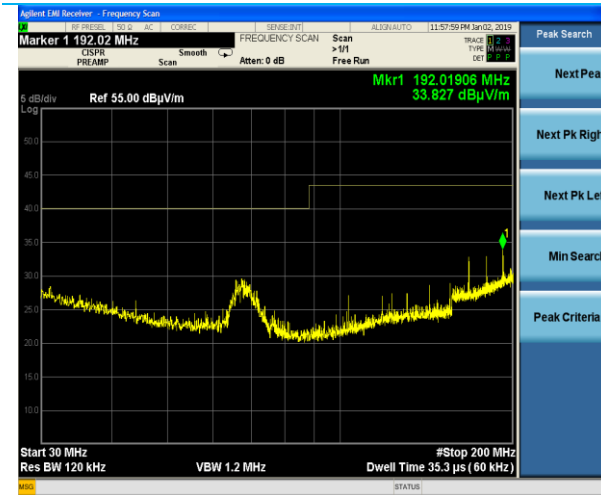
30-200 MHz, Horizontal Polarity, BLE Disabled



30-200 MHz, Vertical Polarity, BLE High

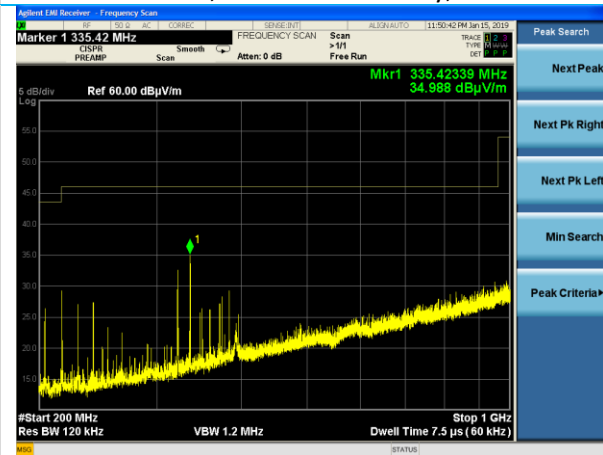
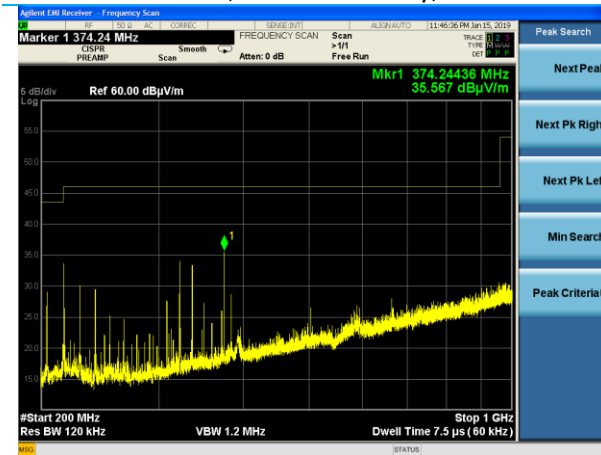


30-200 MHz, Horizontal Polarity, BLE High



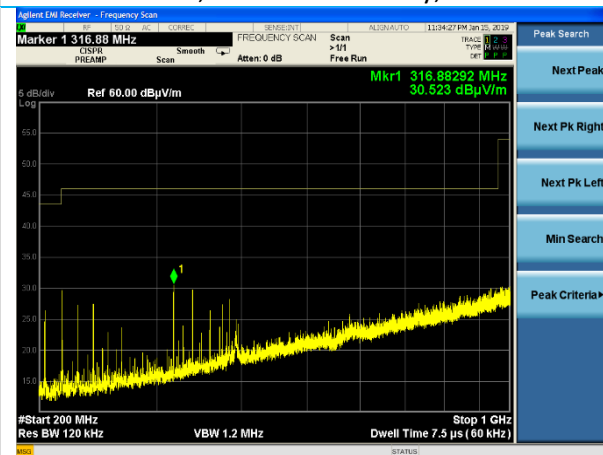
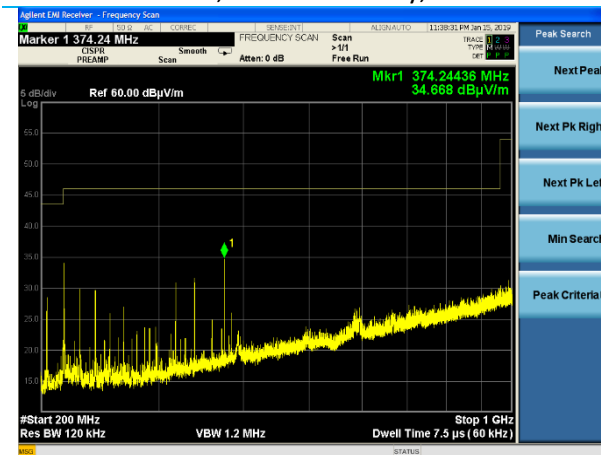
30-200 MHz, Vertical Polarity, BLE Low

30-200 MHz, Horizontal Polarity, BLE Low



200-1000 MHz, Vertical Polarity, BLE Disabled

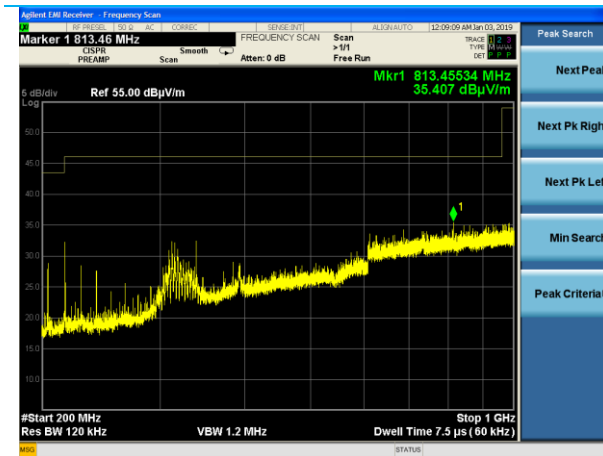
200-1000 MHz, Horizontal Polarity, BLE Disabled



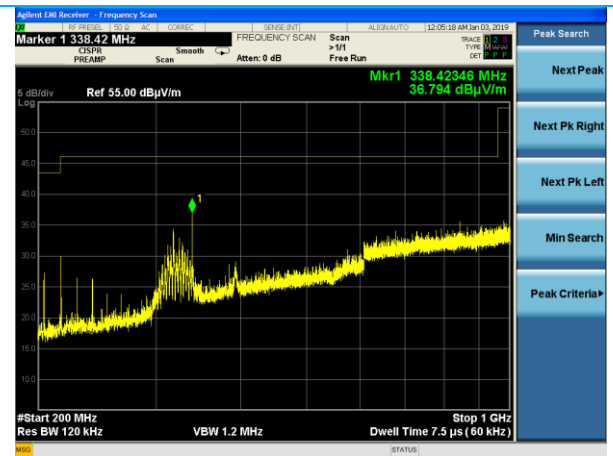
200-1000 MHz, Vertical Polarity, BLE High

200-1000 MHz, Horizontal Polarity, BLE High

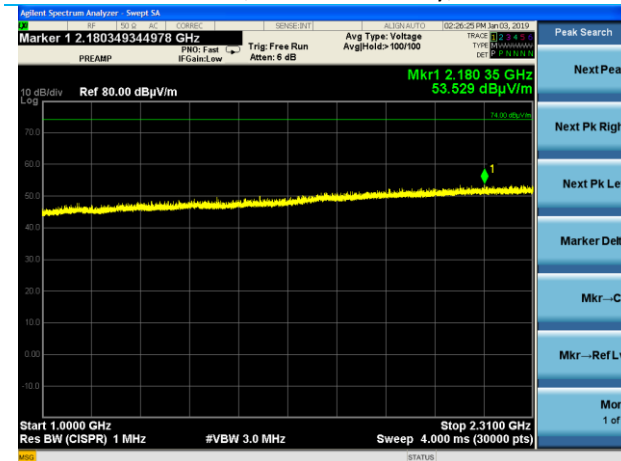
Company: Human Inc.	Page 28 of 41	Name: Human Headphones (Right)
Report: TR317406 DTS TX B		Model: 1702
Job: C-2951		Serial: 7406, 7354



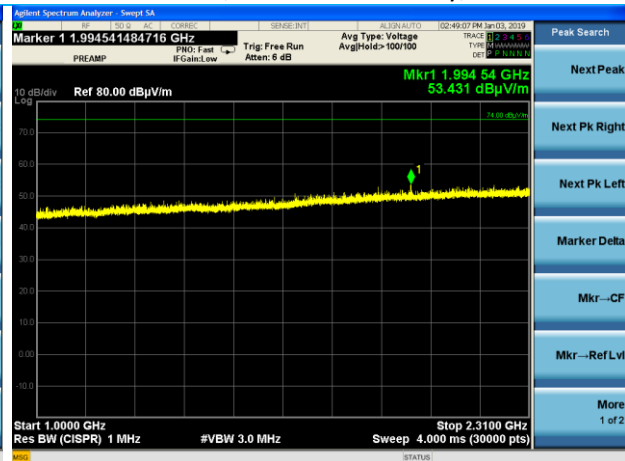
200-1000 MHz, Vertical Polarity, BLE Low



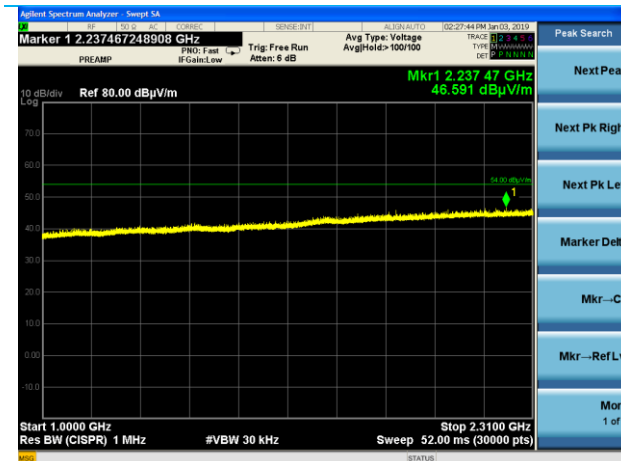
200-1000 MHz, Horizontal Polarity, BLE Low



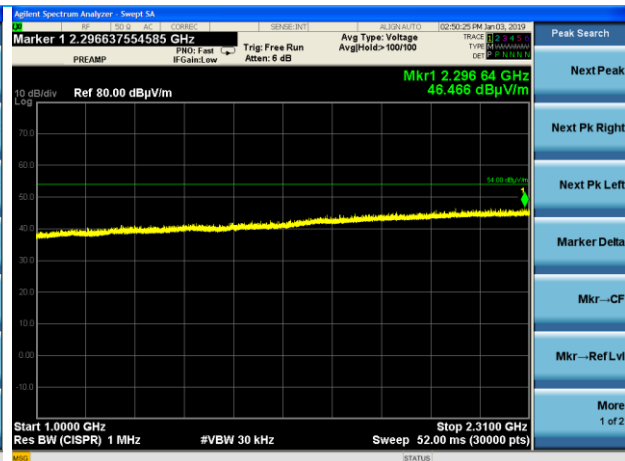
1000-2310 MHz, Vertical Polarity, BLE Low, Peak Plot



1000-2310 MHz, Vertical Polarity, BLE High, Peak Plot



1000-2310 MHz, Vertical Polarity, BLE Low, Average Plot with Reduced VBW



1000-2310 MHz, Vertical Polarity, BLE High, Average Plot with Reduced VBW

Company: Human Inc.	Page 29 of 41	Name: Human Headphones (Right)
Report: TR317406 DTS TX B		Model: 1702
Job: C-2951		Serial: 7406, 7354

5.2.2 Band Edge

Operator	Anthony Smith
QA	Zach Wilson
Test Date	1/3/2019
Location	Chambers 5
Temp. / R.H.	22.9°C / 22.6%RH
Requirement	FCC 15.247, 15.209
Method	ANSI C63.10 Sections 6.6 and 11.2

Limits:

Frequency (MHz)	Average (dB μ V/m)	Peak (dB μ V/m)
2310-2390	54	74
2483.5-2500	54	74

Test Parameters

Frequency	2310-2390 & 2483.5-2500 MHz
Distance	3m
RBW	1 MHz
VBW	Peak: 3 MHz Average: 10 Hz
Detector	Max peak hold for all plots. Average and peak detectors for measurements.
EUT Mode	BLE Continuous Tx, Low/High Channels. 100% duty cycle.
EUT Configuration	Vertical EUT position deemed worst case by peaking of the fundamental emission.
Note	Vertical Antenna polarity deemed worst case by peaking of the fundamental emission.

Instrumentation



Date: 11-Jan-2018 Test: RE Tx (Right DTS) Job: C-2951
 PE: Zach Wilson Customer: Human Inc. Quote: 317406

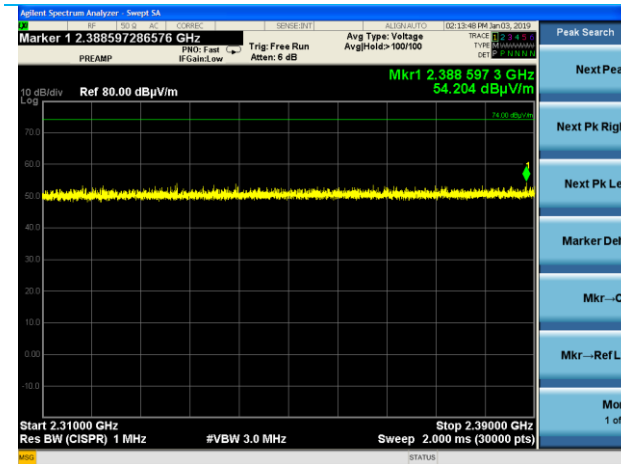
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	4/24/2018	4/24/2019	Active Calibration
2	AA 960081	Antenna - Double Ridge Horn	EMCO	3115	6907	4/16/2018	4/16/2019	Active Calibration

Data

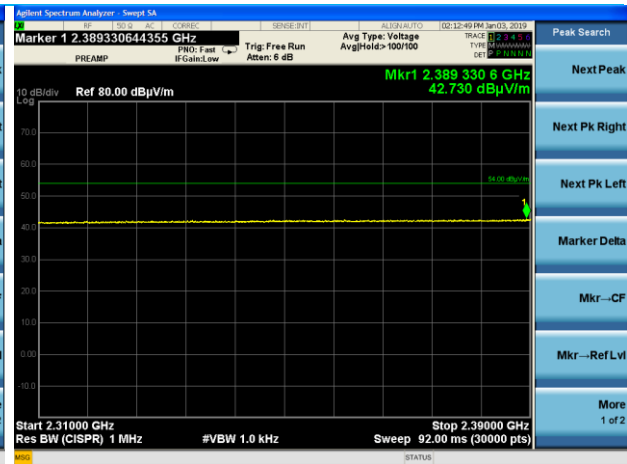
Frequency (MHz)	Height (cm)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)	Antenna Polarity
2388.6	142.0	128.5	54.2	74.0	19.8	Vertical
2483.5	142.0	128.5	56.5	74.0	17.5	Vertical

Frequency (MHz)	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)	Antenna Polarity
2389.3	142.0	128.5	42.7	54.0	11.3	Vertical
2483.5	142.0	128.5	48.1	54.0	5.9	Vertical

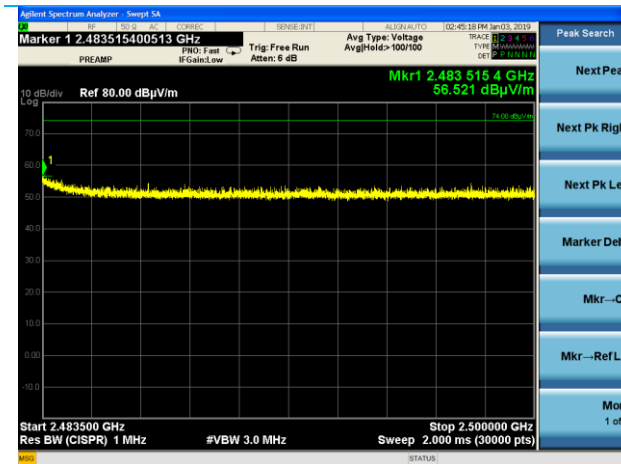
Plots



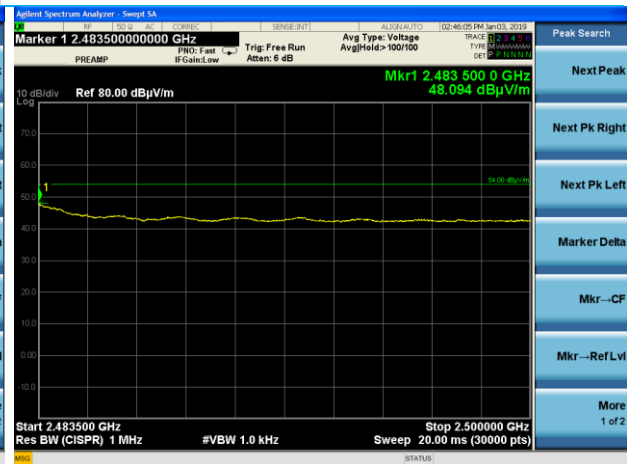
2310-2390 MHz, Peak Plot, BLE Low Channel



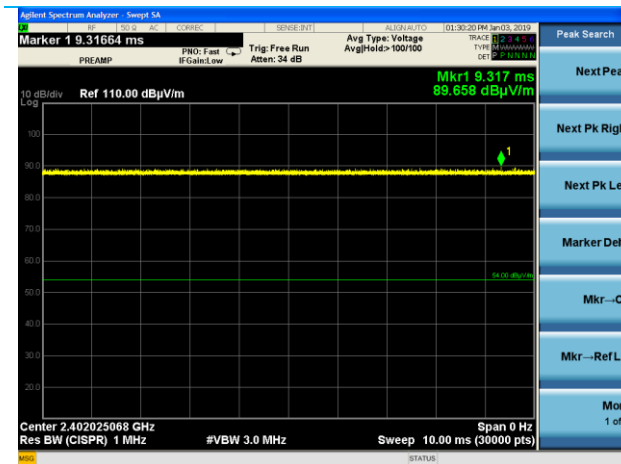
2310-2390 MHz, Average Plot, BLE Low Channel, Reduced VBW



2483.5-2500 MHz, Peak Plot, BLE High Channel



2483.5-2500 MHz, Average Plot, BLE High Channel, Reduced VBW



Duty Cycle of Fundamental, 100%

5.2.3 Spurious Emission 2.5-25 GHz

Operator	Jon Dilley and Anthony Smith
QA	Shane Dock and Zach Wilson
Test Date	1/3/2019 and 1/7/2019
Location	Chambers 5
Temp. / R.H.	21.0°C / 30.0%RH
Requirement	FCC 15.247, 15.209
Method	ANSI C63.10 Sections 6.6 and 11.2

Limits:

Frequency (MHz)	Average (dB μ V/m)	Peak (dB μ V/m)
2500-25000	54	74

Test Parameters

Frequency	2.5 – 25 GHz
Distance	3m
RBW	1 MHz
VBW	Peak: 3 MHz Average: 10 Hz
Detector	Max peak hold for all plots. Average and peak detectors for measurements.
EUT Mode	BLE Continuous Tx, Low/High Channels. 100% duty cycle.
EUT Configuration	Vertical, Flat, and On Charger
Note	For 4-18 GHz harmonics the plot shown is of the worst-case orientation per harmonic in restricted band of operation. The 2 nd harmonic is the only emission in a restricted band.

Instrumentation



Date : 11-Jan-2019

Test : RE Tx (BLE Right) Harmonics

Job : C-2951

PE : Zach Wilson

Customer : Human Inc.

Quote : 317406

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960081	Antenna - Double Ridge Horn	EMCO	3115	6907	4/16/2018	4/16/2019	Active Calibration
2	AA 960171	Cable	A.H. Systems, Inc	SAC-26G-6	386	11/12/2018	11/12/2019	Active Verification
3	AA 960154	Filter - High Pass 2.4 GHz	KwM	HPF-L-14186	7272-02	4/25/2018	4/25/2019	Active Calibration
4	EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/24/2018	4/24/2019	Active Calibration
5	AA 960174	Antenna - Small Horn	ETS Lindgren	3116C-PA	00206880	5/15/2018	5/15/2019	Active Calibration
6	EE 960096	Antenna - Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	40201429	4/16/2018	4/16/2019	Active Calibration

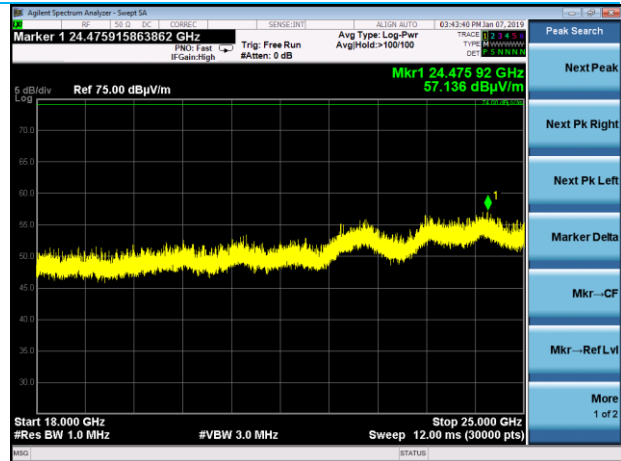
Data

Channel	Emissions Frequency (MHz)	Height (cm)	Azimuth (degrees)	Peak Reading (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dB)	Average Reading (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)	Orientation	Polarity
Low	4804	100.0	319.8	46.1	74.0	27.9	37.5	54.0	16.5	Vertical	Vertical
Low	4804	103.0	80.8	45.3	74.0	28.7	36.8	54.0	17.2	Vertical	Horizontal
Low	4804	130.0	214.5	46.9	74.0	27.1	39.8	54.0	14.2	Flat	Horizontal
Low	4804	100.0	348.0	46.6	74.0	27.4	38.4	54.0	15.6	Flat	Vertical
Low	4804	112.3	43.5	47.9	74.0	26.1	40.7	54.0	13.3	On Charger	Vertical
Low	4804	100.0	34.8	45.6	74.0	28.4	39.2	54.0	14.8	On Charger	Horizontal
Mid	4880	111.1	40.0	46.4	74.0	27.6	39.0	54.0	15.0	On Charger	Vertical
High	4960	139.0	43.5	44.5	74.0	29.5	36.4	54.0	17.6	On Charger	Vertical

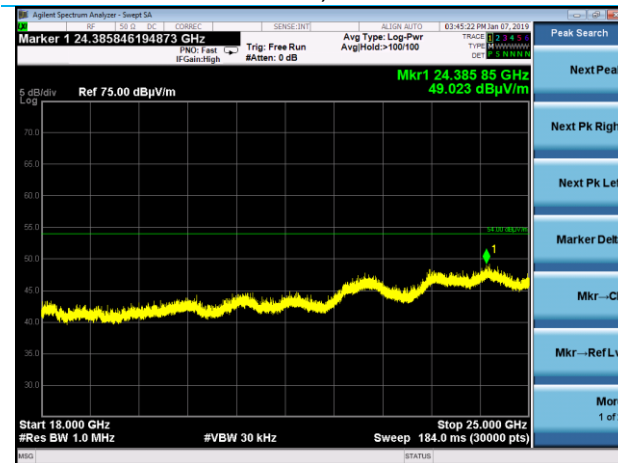
Plots



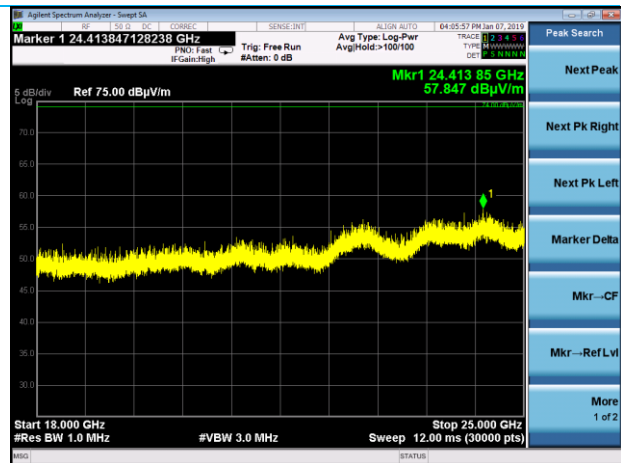
4-18 GHz, Horizontal Antenna, Vertical EUT, BLE Low Channel, Reduced VBW



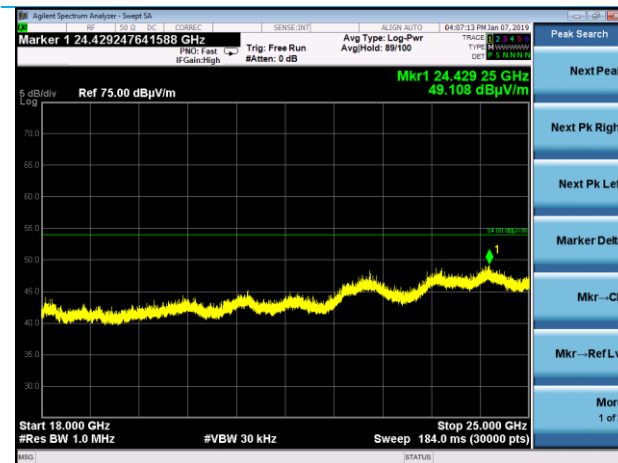
18-25 GHz, Peak Noise Floor at VBW = 3MHz



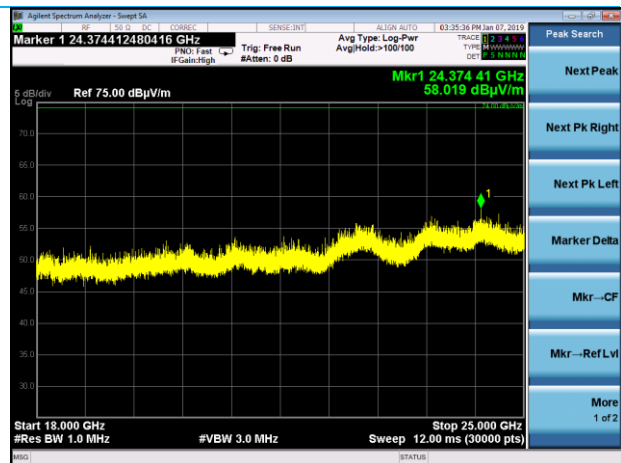
18-25 GHz, Average Noise Floor at VBW - 30 kHz



18-25 GHz, EUT Vertical, Antenna Vertical, BLE Tx High Peak Plot

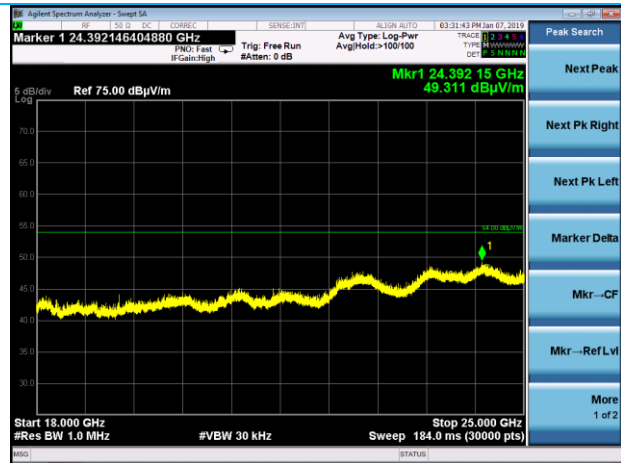


18-25 GHz, EUT Vertical, Antenna Vertical, BLE Tx High Average Plot, Reduced VBW

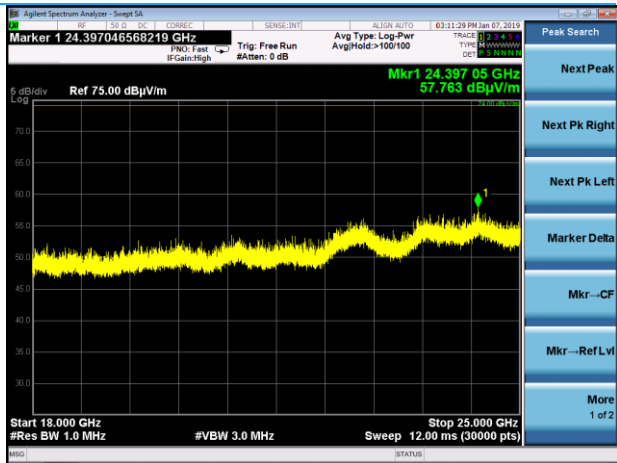


18-25 GHz, EUT Vertical, Antenna Horizontal, BLE Tx Low, Peak Plot

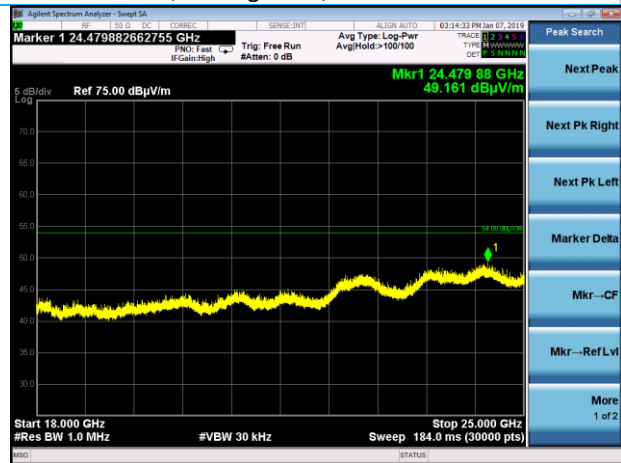
Company: Human Inc.	Page 35 of 41	Name: Human Headphones (Right)
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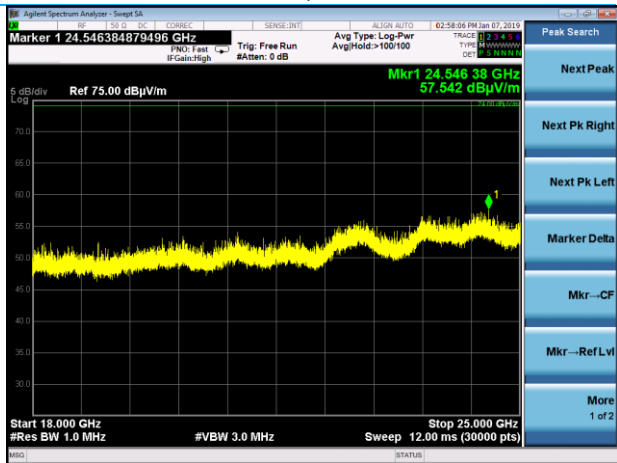
18-25 GHz, EUT Vertical, Antenna Horizontal, BLE Tx Low, Average Plot, Reduced VBW



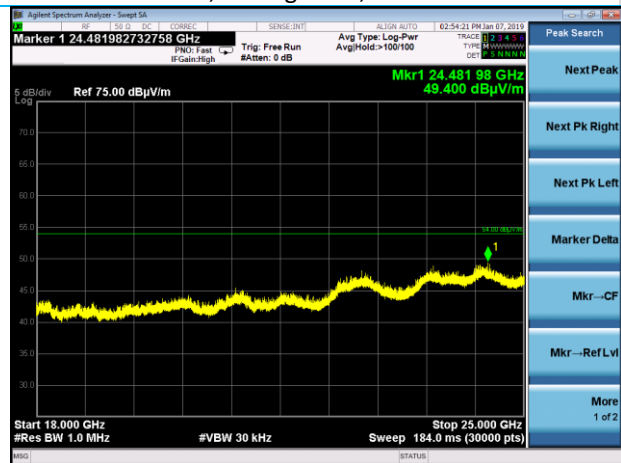
18-25 GHz, EUT On Charger, Antenna Horizontal, BLE Tx Low, Peak Plot



18-25 GHz, EUT On Charge, Antenna Horizontal, BLE Tx Low, Average Plot, Reduced VBW



18-25 GHz, EUT Flat, Antenna Horizontal, BLE Tx Low, Peak Plot



18-25 GHz, EUT Flat, Antenna Horizontal, BLE Tx Low, Average Plot, Reduced VBW

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Report: TR317406 DTS TX B		Model: 1702
Job: C-2951		Serial: 7406, 7354

5.3 AC Mains Conducted Emissions

A line impedance stabilization network (LISN) or artificial mains network (AMN) allows the emissions of the power supply conductors to be measured while isolating the EUT from the supply mains.

Description of Measurement

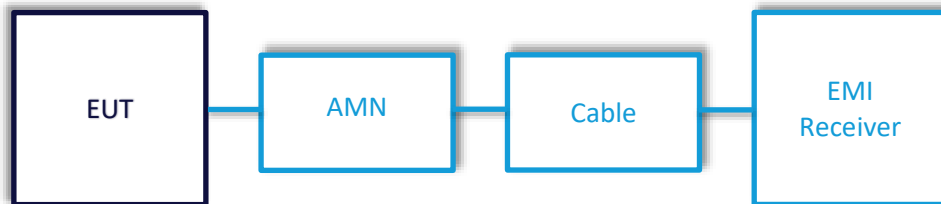
The AMN, cable, and other necessary measurement system correction factors are loaded onto the EMI receiver when the measurements are performed. The data is gathered and reported as the corrected values.

Maximum emissions are determined with a peak max hold trace then measurements at a selection of the highest points are made with quasi-peak and average detectors. Results are recorded and compared to limit for each line. (e.g. line and neutral)

Example Calculations

Measurement (dBμV) + Cable factor (dB) + Other (dB) = Corrected Reading (dBμV)
 Margin (dB) = Limit (dBμV) - Corrected Reading (dBμV)

Block Diagram



5.3.1 AC Mains Conducted Emissions

Operator	Jon Dilley
QA	Shane Dock
Test Date	1/22/2019
Location	Bench
Temp. / R.H.	21.7°C / 33.5%RH
Requirement	FCC 15.207
Method	ANSI C63.10 Section 6.2

Limits:

Frequency (MHz)	Quasi-peak (dBμV)	Average (dBμV)
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

Test Parameters

Frequency	0.150-30 MHz
Distance	80 cm from HCP, 40 cm for VCP
RBW	9 kHz
VBW	90 kHz
EUT Mode	BLE Continuous Tx, Low/Mid/High Channels. Worst case with respect to the margin shown.
EUT Power	Powered via the charging stand, stand powered via 120VAC/60Hz
Detectors	Max peak hold for plots. Average and quasi-peak detectors for final measurements.

Instrumentation



Date : 11-Jan-2019 Test : CE (Right) Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

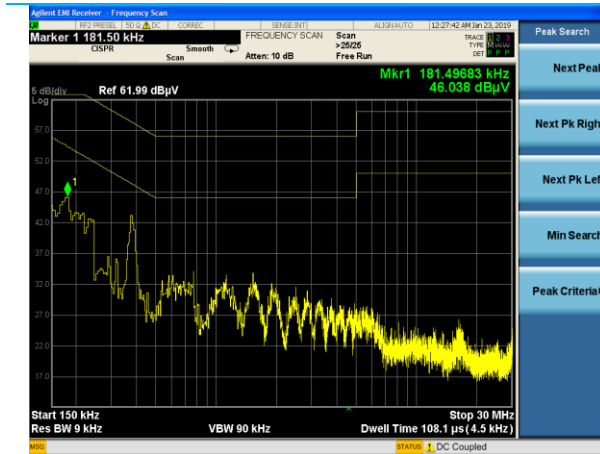
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	Analyzer - EMI Receiver	Agilent	N9038A	MY51210148	4/24/2018	4/24/2019	Active Calibration
2	EE 960162	LISN	COM-POWER	LI-215A	191969	4/23/2018	4/23/2019	Active Calibration

Table

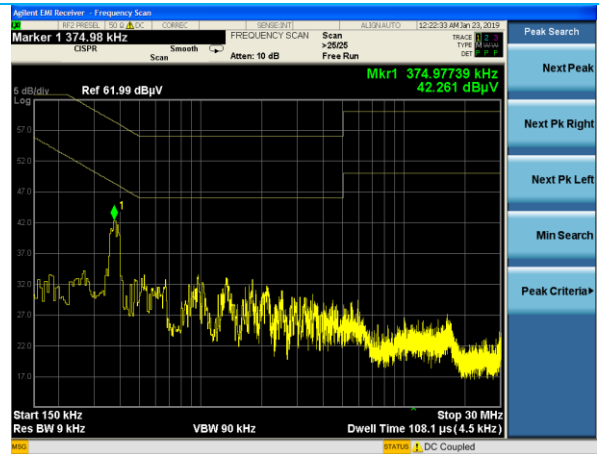
BLE Low Channel							
Line	Frequency (MHz)	Quasi-Peak Reading (dBµV)	Quasi-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)
2	0.383	39.6	58.2	18.6	25.5	48.2	22.7
2	1.552	27.8	56.0	28.2	16.6	46.0	29.4
2	16.293	21.8	60.0	38.2	13.3	50.0	36.8
1	0.383	40.7	58.2	17.5	30.3	48.2	17.9
1	0.159	42.6	65.5	22.9	32.7	55.5	22.9
1	1.586	28.3	56.0	27.7	19.1	46.0	26.9

BLE High Channel							
Line	Frequency (MHz)	Quasi-Peak Reading (dBµV)	Quasi-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)
1	0.383	39.2	58.2	19.0	28.8	48.2	19.4
1	0.154	42.8	65.8	22.9	32.6	55.8	23.1
1	1.554	28.1	56.0	27.9	18.1	46.0	27.9
2	0.379	38.6	58.3	19.7	25.0	48.3	23.3
2	1.099	27.3	56.0	28.7	16.5	46.0	29.5
2	1.964	26.4	56.0	29.6	15.2	46.0	30.8

Plots



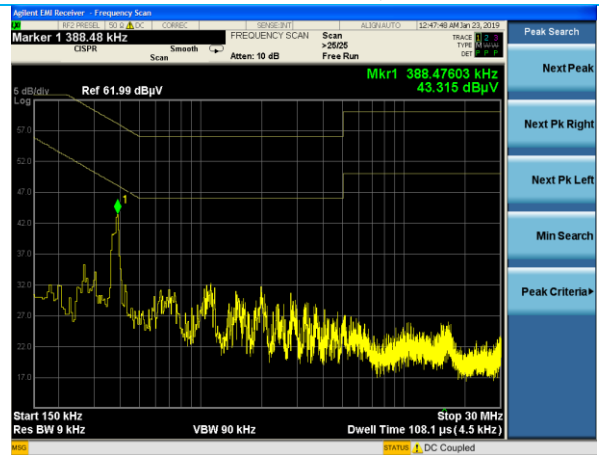
BLE Tx Low Channel, Line 1



BLE Tx Low Channel, Line 2



BLE Tx High Channel, Line 1



BLE Tx High Channel, Line 2

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Job: C-2951		Serial: 7406, 7354

6 REVISION HISTORY

Version	Date	Notes	Person
v0.0	2-4-19	Initial Draft	Zach Wilson
v0.1	3-13-19	Revised Draft	Zach Wilson
v0.2	3-13-19	Updated instrumentation sheets	Zach Wilson
v0.3	3-13-19	Revised	Zach Wilson

END OF REPORT