

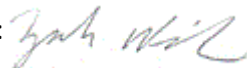
Test Report # TR 317406 FHSS TX B

Equipment Under Test: Human Headphone (Right)

Test Date(s): January 2nd – March 14th, 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: 3/18/2019

Report Reviewed by: Adam Alger, Quality Manager

Signature: 

Date: 3/18/2019

Report Constructed by: Zach Wilson, EMC Engineer

Signature: 

Date: 2/7/2019

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Company: Human Inc.	Page 1 of 40	Name: Human Headphones (Right)
Report: TR 317406 FHSS 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

Company: Human Inc.	Page 3 of 40	Name: Human Headphones (Right)
Report: TR 317406 FHSS TX B		Model: 1702
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1 TEST REPORT SUMMARY

During **1/2/19-3/14/19** 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)(1)	Channel Separation, Number of Hopping frequencies, Time of Occupancy	FHS	ANSI C63.10	Compliant
FCC: 2.1049	Occupied Bandwidth	Reported	ANSI C63.10	Reported
FCC: 15.247 (b)(1)	Maximum Conducted Output Power	30 dBm	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: 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

Client understands the modifications / 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
FCC CFR	-	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

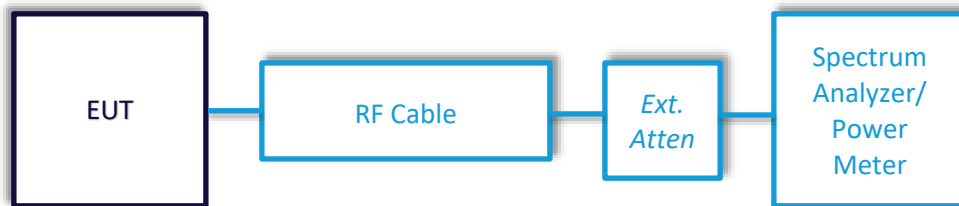
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	1x10 ⁻⁷	0.55x10 ⁻⁷
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply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

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/24/19-1/25/19
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 15.247 (a)(1)
Method	ANSI C63.10

Limits:

Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Test Parameters

Frequency	2402, 2403 MHz
RBW	300 kHz
VBW	1 MHz
Radio Mode	Bluetooth Hopping, GFSK Modulation
Detector	Max peak hold with peak detector
EUT Power	3.7VDC

Instrumentation



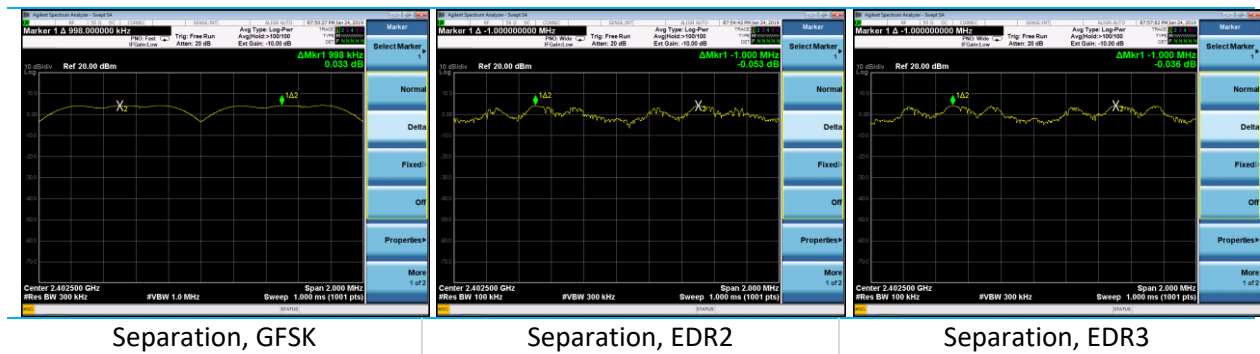
Date: 11-Jan-2019 Test: BT Tx Right Job: C-2951
 PE: Zach Wilson Customer: Human Inc. Quote: 317406

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 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

Modulation	Channel Separation (kHz)
GFSK	998.0
EDR2	1000.0
EDR3	1000.0

Plots



5.1.2 Number of Hopping Frequencies

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/24/19-1/25/19
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 15.247 (a)(1)
Method	ANSI C63.10

Limits:

(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

Test Parameters

Frequency	Hopping 2402-2480 MHz
RBW	300 kHz
VBW	1 MHz
Radio Mode	Bluetooth Hopping, GFSK Modulation
Detector	Max peak hold with peak detector
EUT Power	3.7VDC

Instrumentation



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

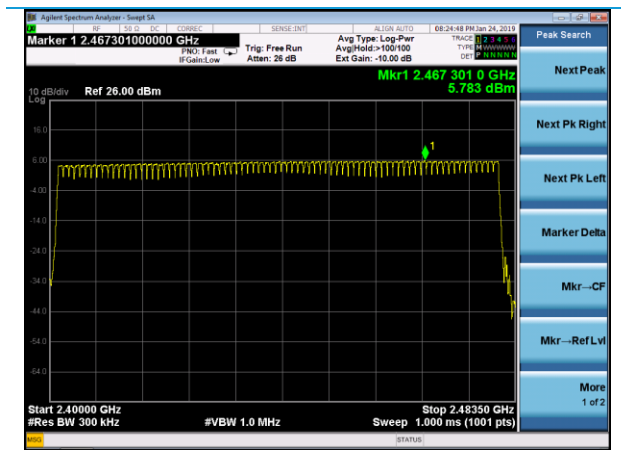
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification

Table

Number of Hopping Frequencies

79

Plots



Number of Hopping Frequencies, Hopping GFSK

5.1.3 Time of Occupancy

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/24/19-1/25/19
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 15.247 (a)(1)
Method	ANSI C63.10

Limits:

(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test Parameters

Frequency	Hopping 2402 MHz
RBW	300 kHz
VBW	1 MHz
Radio Mode	Bluetooth Hopping, GFSK Modulation
Detector	Max peak hold with peak detector
EUT Power	3.7VDC

Instrumentation



Date: 11-Jan-2019

Test: BT Tx Right

Job: C-2951

PE: Zach Wilson

Customer: Human Inc.

Quote: 317406

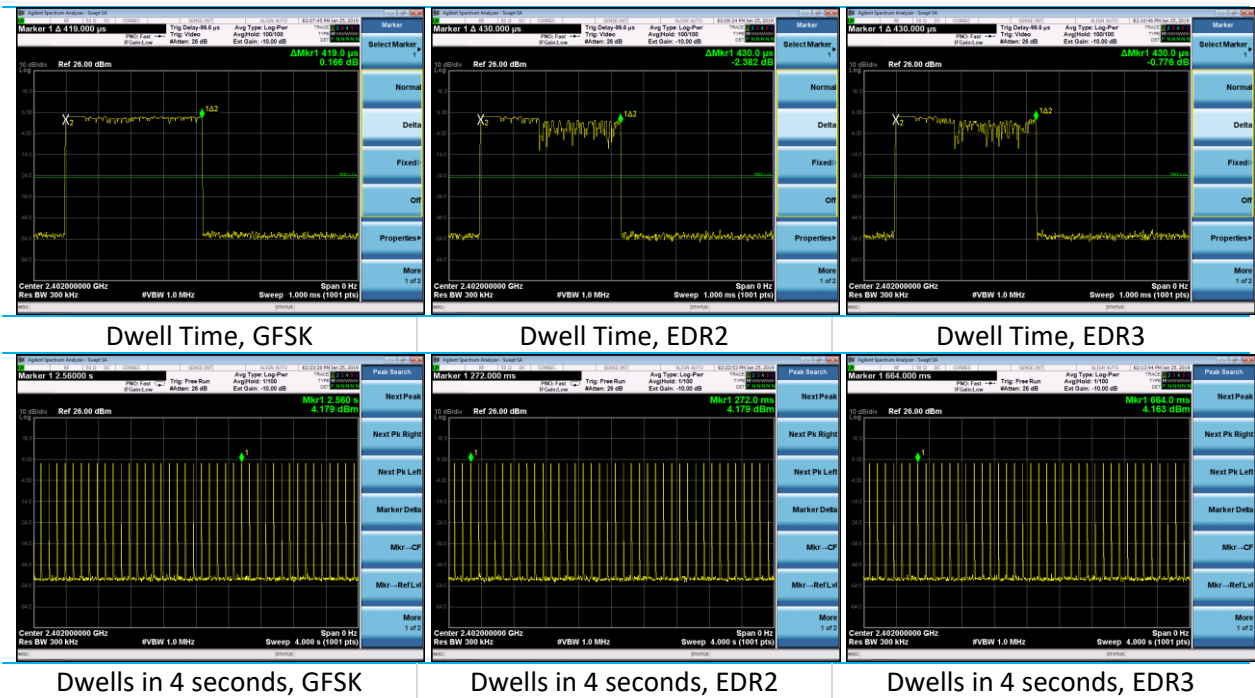
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification

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Table

Mode	Number of hops in 4s	Extrapolated # of hops in 32s	Dwell Time (us)	Average Time of Occupancy Reading (ms)	Average Time of Occupancy Limit (ms)	Margin (ms)
GFSK	40.0	320.0	419.0	134.1	400.0	265.9
EDR2	40.0	320.0	430.0	137.6	400.0	262.4
EDR3	40.0	320.0	430.0	137.6	400.0	262.4

Plots



5.1.4 Occupied Bandwidth

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/24/19-1/25/19
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 2.1049
Method	ANSI C63.10

Test Parameters

Frequency	2402, 2440, 2480 MHz
RBW	30 kHz
VBW	100 kHz
Radio Mode	Bluetooth Continuous Transmit
Detector	Max peak hold with peak detector
EUT Power	3.7VDC

Instrumentation



Date: 11-Jan-2019 Test: BT Tx 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 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

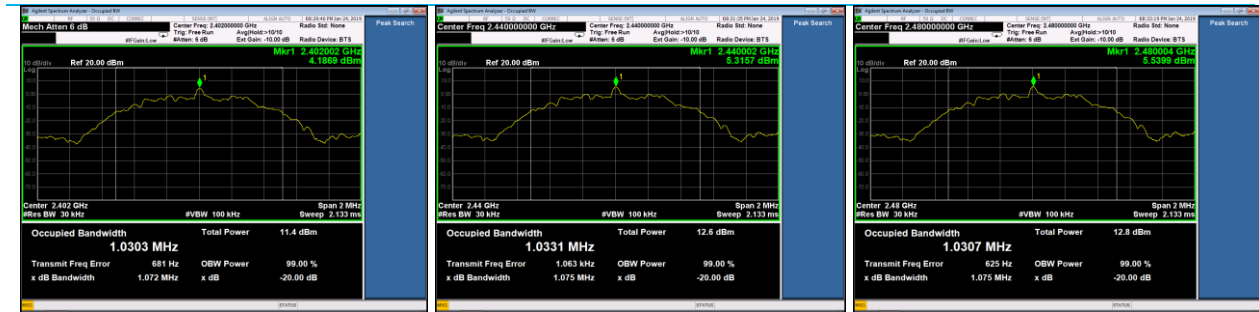
Table

GFSK		
Fundamental Frequency (MHz)	20dB BW (kHz)	99% BW (kHz)
2402	1072.0	1030.3
2440	1075.0	1033.1
2480	1075.0	1030.7

EDR2		
Fundamental Frequency (MHz)	20dB BW (kHz)	99% BW (kHz)
2402	1244.0	1172.4
2440	1240.0	1172.2
2480	1245.0	1175.1

EDR3		
Fundamental Frequency (MHz)	20dB BW (kHz)	99% BW (kHz)
2402	1214.0	1153.2
2440	1215.0	1156.0
2480	1245.0	1157.6

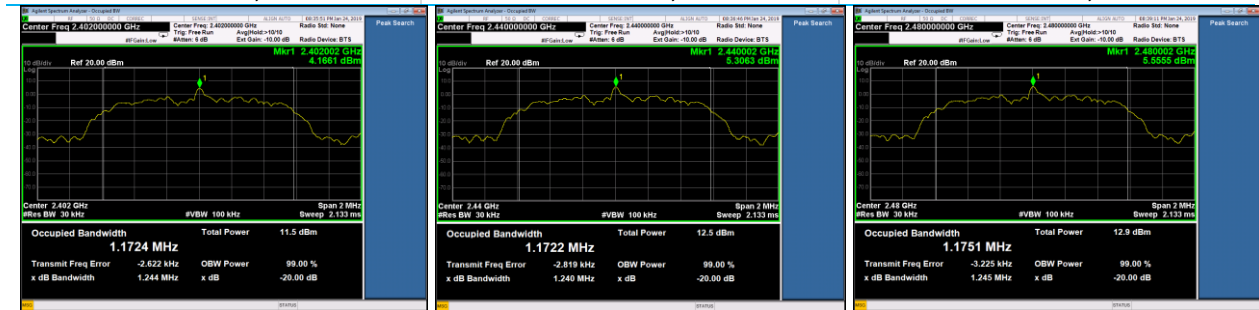
Plots



BT 2402 MHz, GFSK

BT 2440 MHz, GFSK

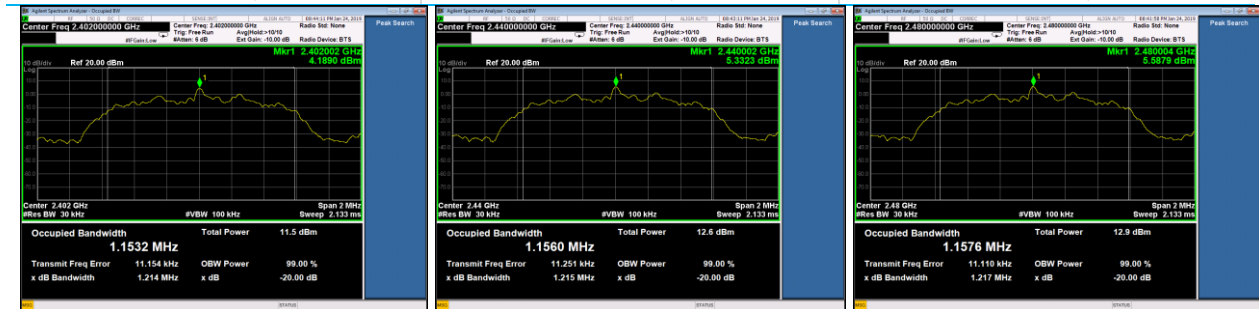
BT 2480 MHz, GFSK



BT 2402 MHz, EDR2

BT 2440 MHz, EDR2

BT 2480 MHz, EDR3



BT 2402 MHz, EDR3

BT 2440 MHz, EDR3

BT 2480 MHz, EDR3

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Report: TR 317406 FHSS TX B		Model: 1702
Job: C-2951		Serial: 7406, 7354

5.1.5 Maximum Output Power

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/24/19-1/25/19
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 15.247 (b)(1)
Method	ANSI C63.10

Limits:

(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

Test Parameters

Frequency	2402, 2440, 2480 MHz
RBW	1 MHz
VBW	3 MHz
Radio Mode	Bluetooth Continuous Transmit
Detector	Max peak hold with peak detector
EUT Power	3.7VDC
Example Calculation	Limit (dBm) = $10\log_{10}[\text{Limit (mW)}]$

Instrumentation



Date: 11-Jan-2019 Test: BT Tx 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 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

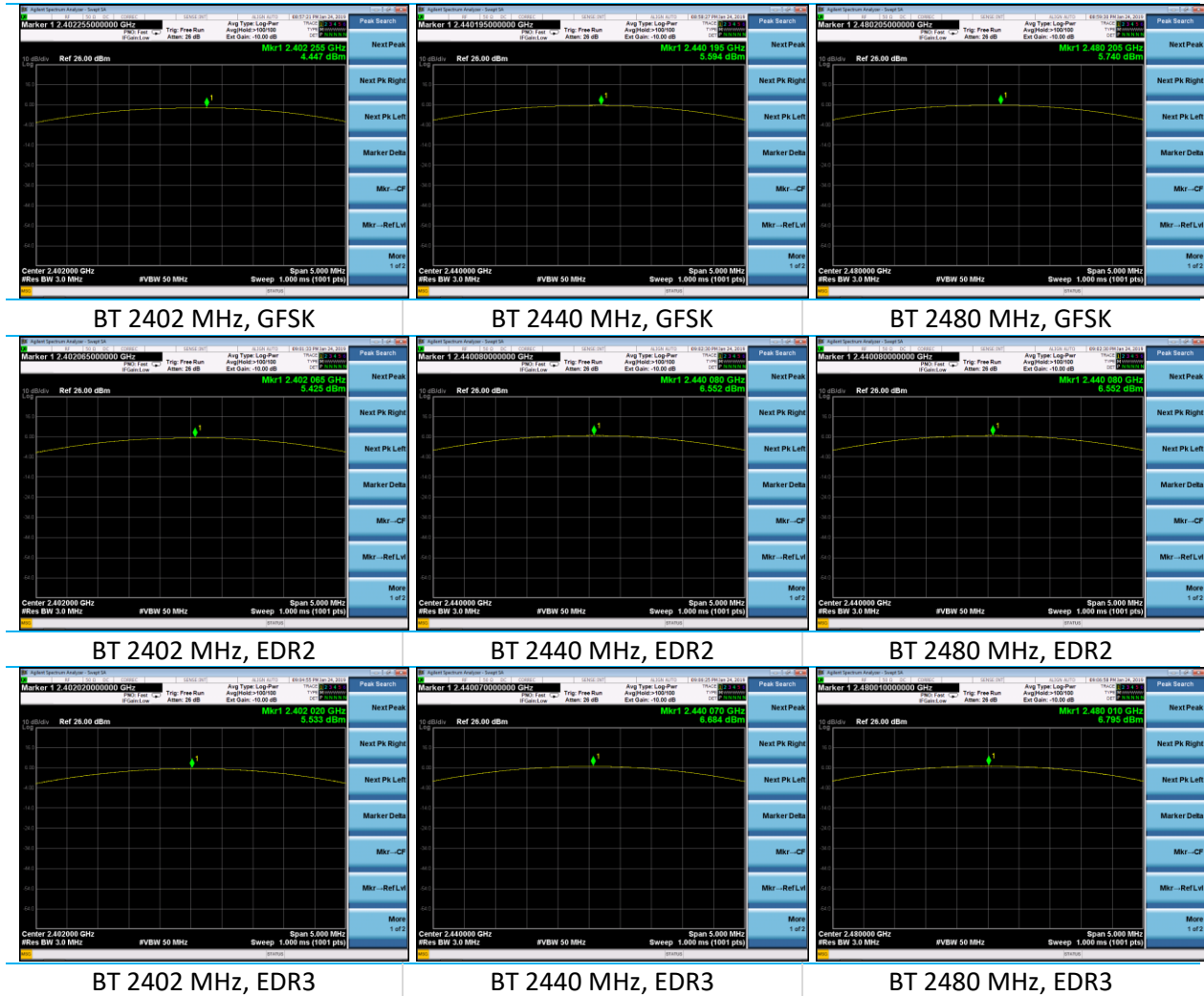
Table

GFSK			
Transmit Fundamental (MHz)	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
2402	4.4	30.0	25.6
2440	5.6	30.0	24.4
2480	5.7	30.0	24.3

EDR2			
Transmit Fundamental (MHz)	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
2402	5.4	30.0	24.6
2440	6.6	30.0	23.4
2480	6.7	30.0	23.3

EDR3			
Transmit Fundamental (MHz)	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
2402	5.5	30.0	24.5
2440	6.7	30.0	23.3
2480	6.8	30.0	23.2

Plots



5.1.6 RF Spurious Emissions at the Transmitter Antenna Terminal

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/24/19-3/15/19
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 15.247 (d)
Method	ANSI C63.10 Sections 7.8.8, 6.10

Limits:

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

Limit = 6.8 dBm – 20 dB = -13.2 dBm

Test Parameters

Frequency	30 MHz – 25 GHz
RBW	100 kHz
VBW	300 kHz
Radio Mode	Bluetooth Continuous Transmit Low/Mid/High, Bluetooth Hopping
Detector	Max peak hold with peak detector
EUT Power	3.7VDC
Limit Line Notes	Limit line shown is incorrect except for band edges.

Instrumentation



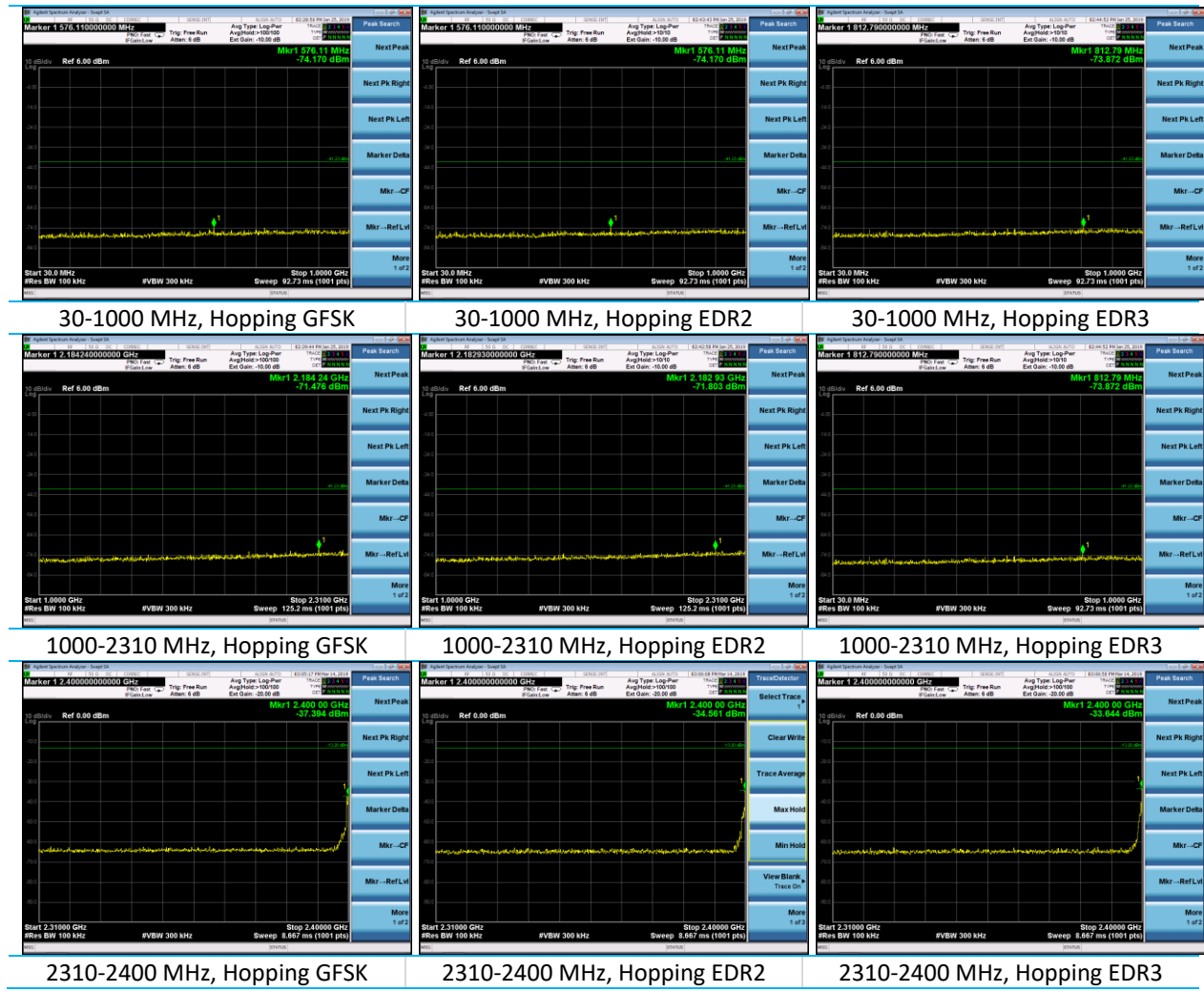
Date: 11-Jan-2019 Test: BT Tx Right Job: C-2951
 PE: Zach Wilson Customer: Human Inc. Quote: 317406

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 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

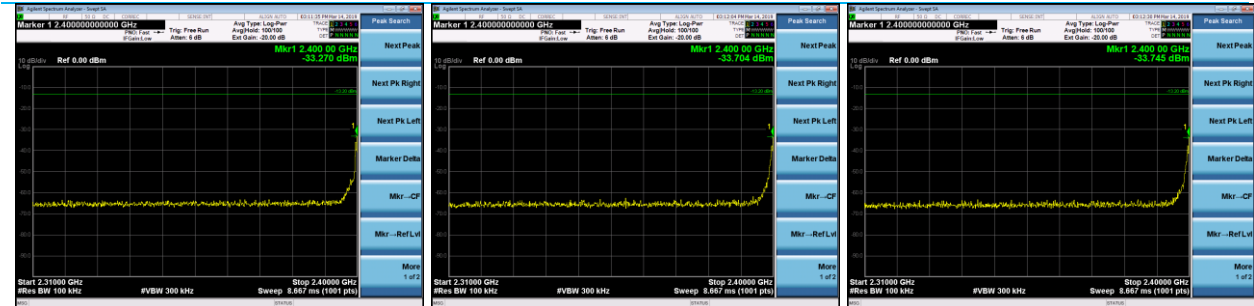
Table

Data Rate	Fundamental Frequency (MHz)	Frequency (MHz)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)
EDR3	Hopping	2400.0	-33.6	-13.2	20.4
GFSK	2402	2400.0	-33.3	-13.2	20.1
EDR2	2402	2400.0	-33.7	-13.2	20.5

Plots



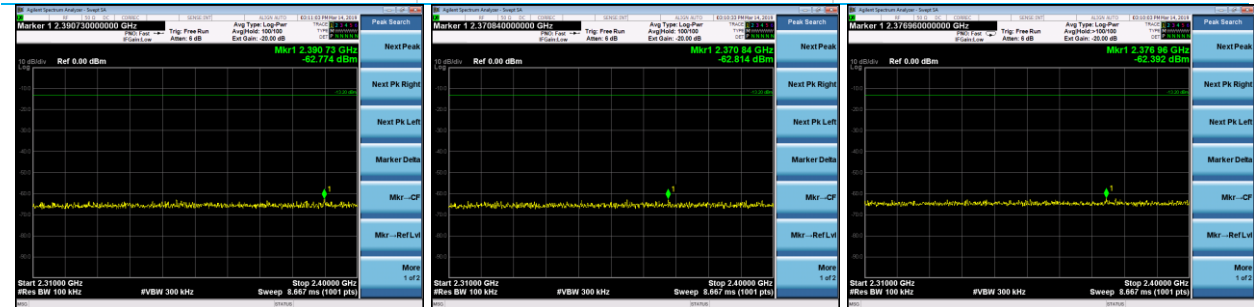
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2310-2400 MHz, BT 2402 MHz,
GFSK

2310-2400 MHz, BT 2402 MHz,
EDR2

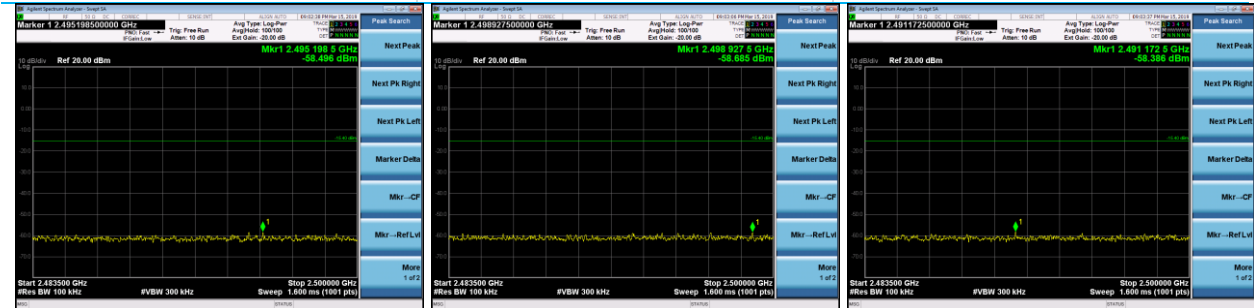
2310-2400 MHz, BT 2402 MHz,
EDR3



2310-2400 MHz, BT 2480 MHz,
GFSK

2310-2400 MHz, BT 2480 MHz,
EDR2

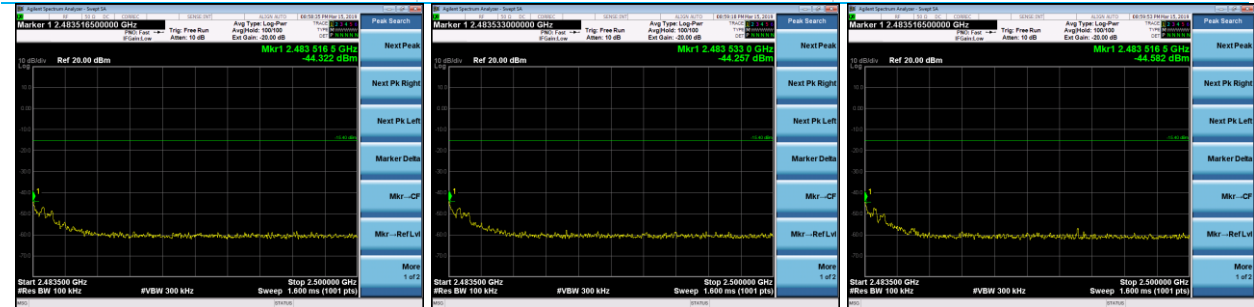
2310-2400 MHz, BT 2480 MHz,
EDR3



2483.5-2500 MHz, BT 2402 MHz,
GFSK

2483.5-2500 MHz, BT 2402 MHz,
EDR2

2483.5-2500 MHz, BT 2402 MHz,
EDR3

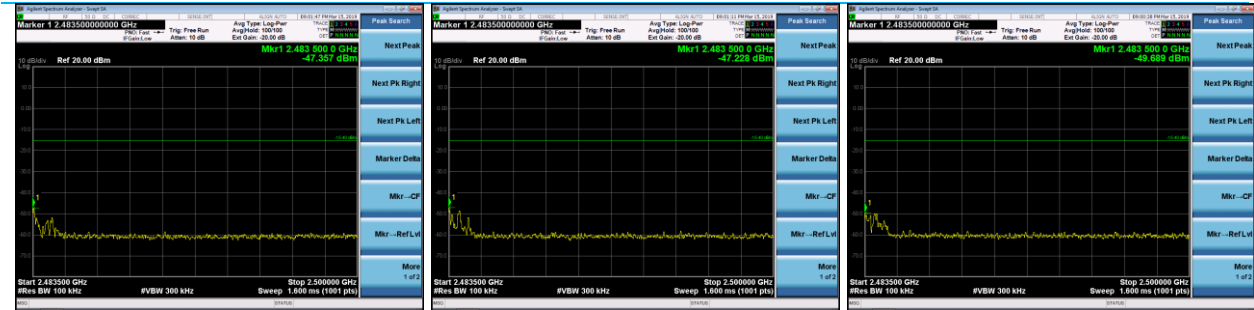


2483.5-2500 MHz, BT 2480 MHz,
GFSK

2483.5-2500 MHz, BT 2480 MHz,
EDR2

2483.5-2500 MHz, BT 2480 MHz,
EDR3

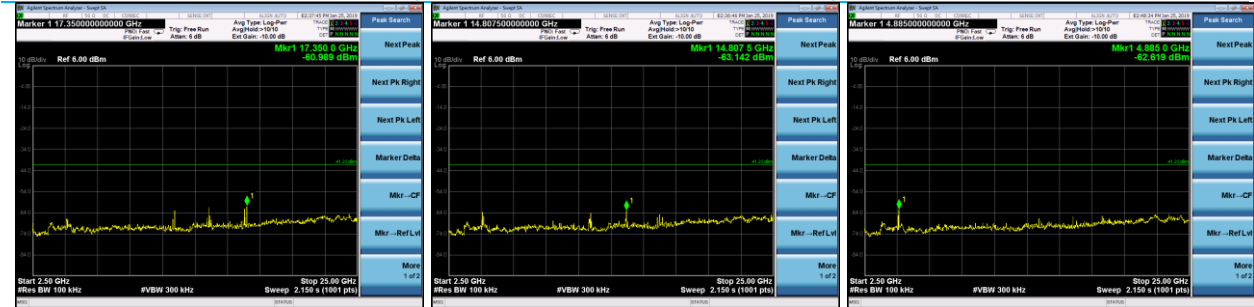
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Job: C-2951		Serial: 7406, 7354



2483.5-2500 MHz, BT Hopping, GFSK

2483.5-2500 MHz, BT Hopping EDR2

2483.5-2500 MHz, BT Hopping EDR3



2.5-25 GHz, Hopping GFSK

2.5-25 GHz, Hopping EDR2

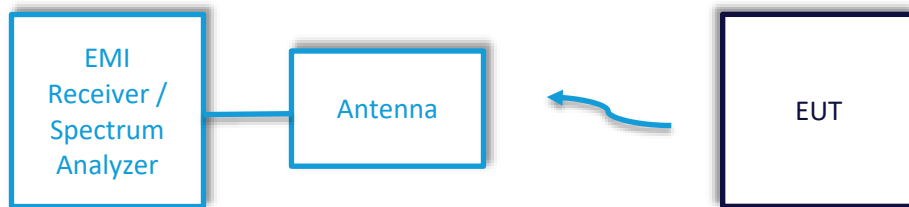
2.5-25 GHz, Hopping EDR3

Company: Human Inc.	Page 23 of 40	Name: Human Headphones (Right)
Report: TR 317406 FHSS TX B		Model: 1702
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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	1/2/19-1/3/19
Location	Chamber 5
Temp. / R.H.	23.6°C / 30.5%RH
Requirement	FCC 15.247, 15.209
Method	ANSI C63.10

Limits:

Frequency (MHz)	Quasi Peak (dBμV/m)	Average (dBμV/m)	Peak (dBμV/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. Above 1 GHz Average measurements use a max peak hold with a VBW of 10 Hz. Above 1 GHz peak measurements use a max peak hold with a VBW of 3 MHz.
EUT Mode	BT Continuous Tx, Low/Mid/High channels.
EUT Configuration	EUT on charger deemed worst case configuration. Worst case shown based on margin.
Data Note	All emissions under 1 GHz found to be more than 10 dB under limit and/or not a function of the radio. BT disabled mode plots taken for comparison.

Instrumentation



Date: 11-Jan-2019 Test: BT Tx 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	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	3110E	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

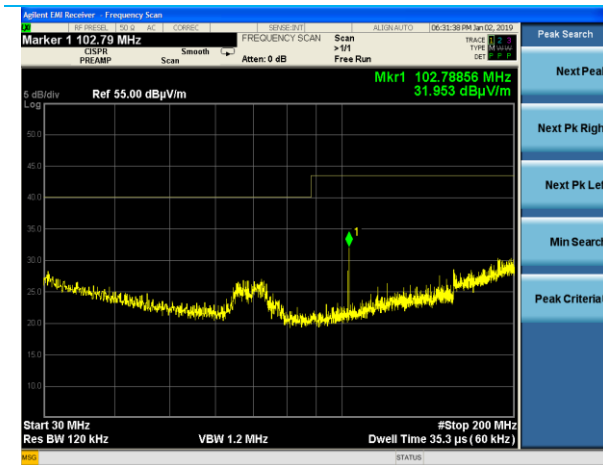
Data

Frequency (MHz)	Channel	Azimuth (degrees)	Height (cm)	Antenna Polarity	Quasi-Peak Measurement (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Margin (dB)
66.8	Low	0.0	100.0	Vertical	21.5	40.0	18.5
192.0	High	98.5	171.8	Horizontal	30.7	43.5	12.8
216.6	Disabled ^{Note 1}	0.0	100.0	Vertical	28.8	46.0	17.2
322.6	High	260.0	100.0	Horizontal	22.4	46.0	23.7
384.0	Low	180.0	100.0	Vertical	26.7	46.0	19.3
322.6	Low	260.0	100.0	Horizontal	23.7	46.0	22.3
338.6	Mid	253.8	100.0	Horizontal	34.6	46.0	11.5

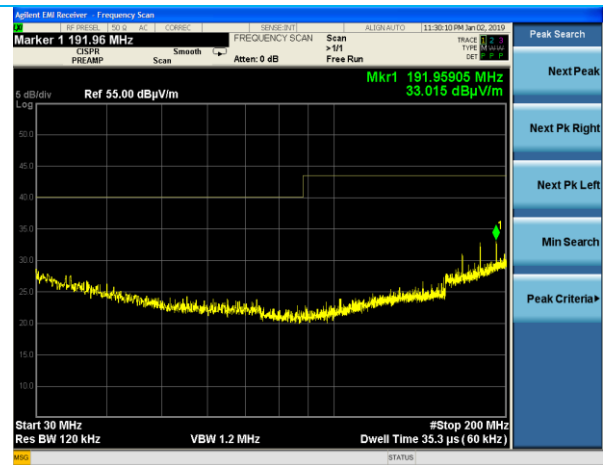
Note:

1. Emission remains, even when transmitter was disabled.

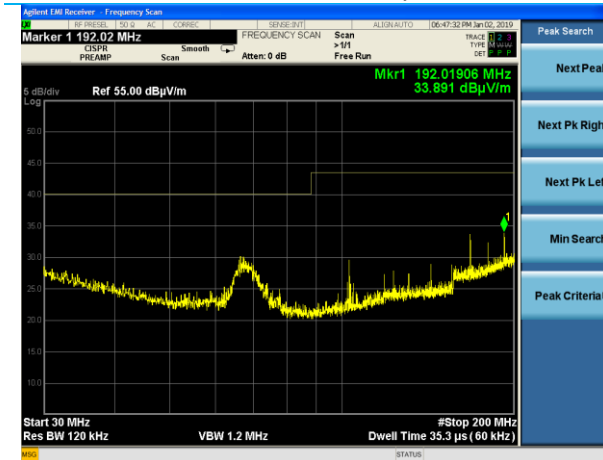
Plots



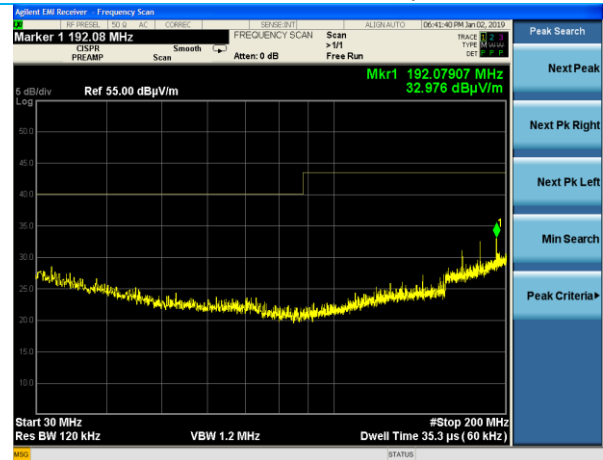
30-200 MHz, Vertical Polarity, BT Disabled



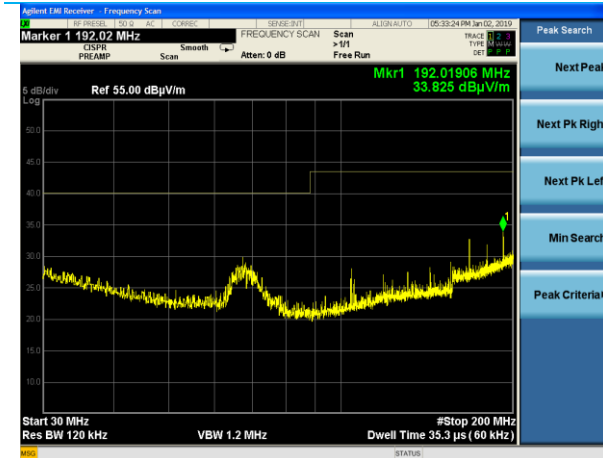
30-200 MHz, Horizontal Polarity, BT Disabled



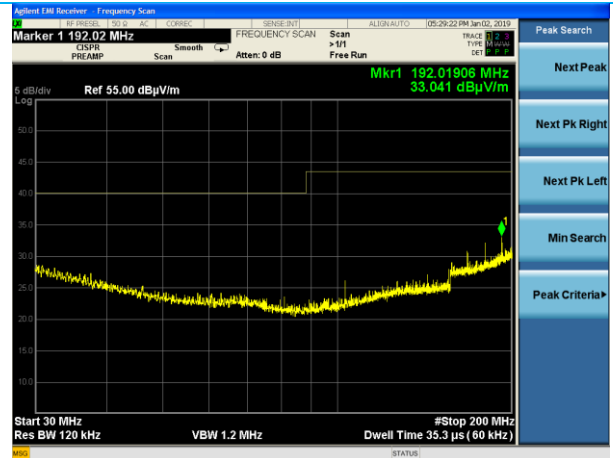
30-200 MHz, Vertical Polarity, BT 2480



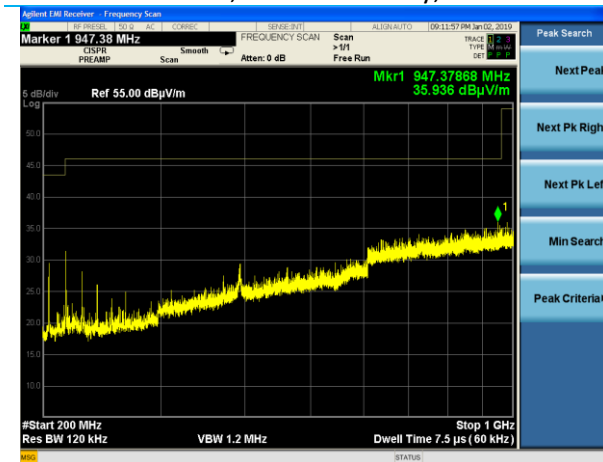
30-200 MHz, Horizontal Polarity, BT 2480



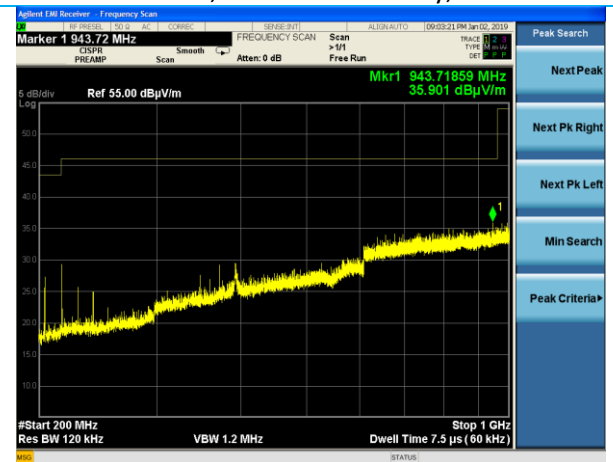
30-200 MHz, Vertical Polarity, BT 2402



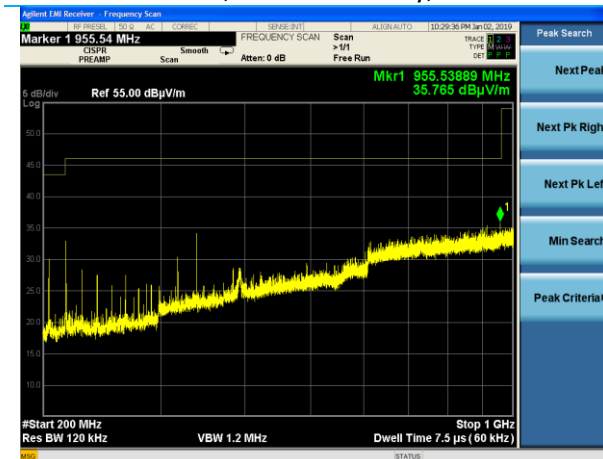
30-200 MHz, Horizontal Polarity, BT 2402



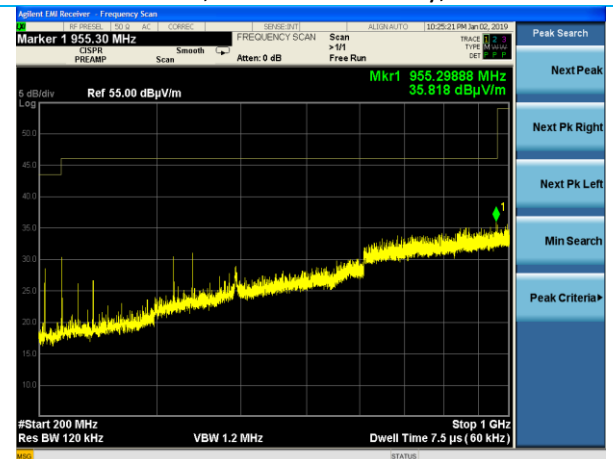
200-1000 MHz, Vertical Polarity, BT Disabled



200-1000 MHz, Horizontal Polarity, BT Disabled

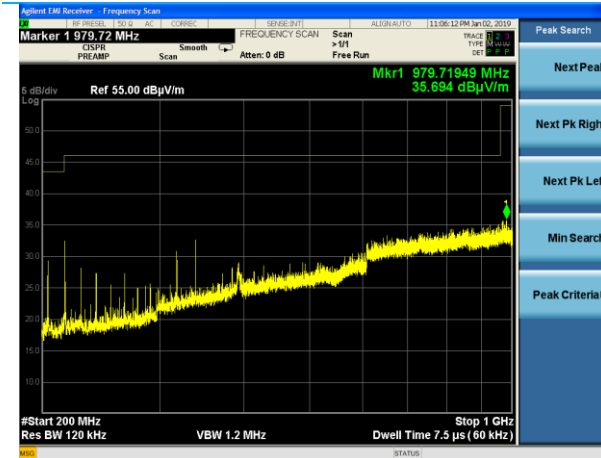


200-1000 MHz, Vertical Polarity, BT 2480

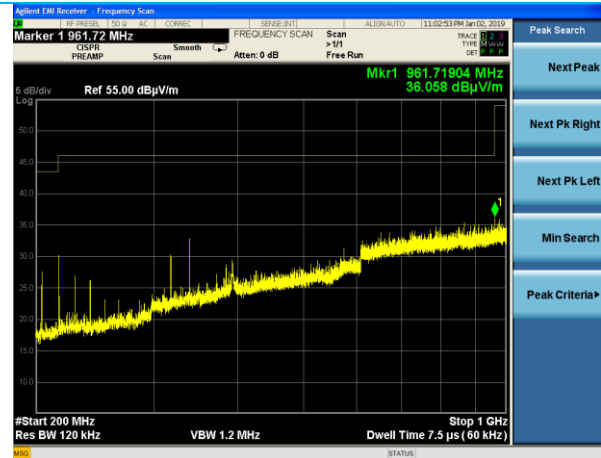


200-1000 MHz, Horizontal Polarity, BT 2480

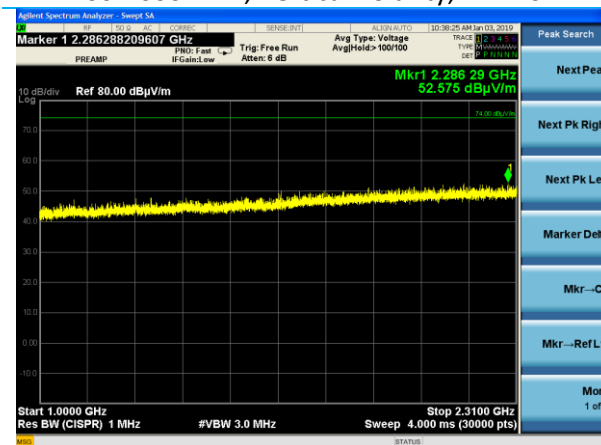
Company: Human Inc.	Page 28 of 40	Name: Human Headphones (Right)
Report: TR 317406 FHSS TX B		Model: 1702
Job: C-2951		Serial: 7406, 7354



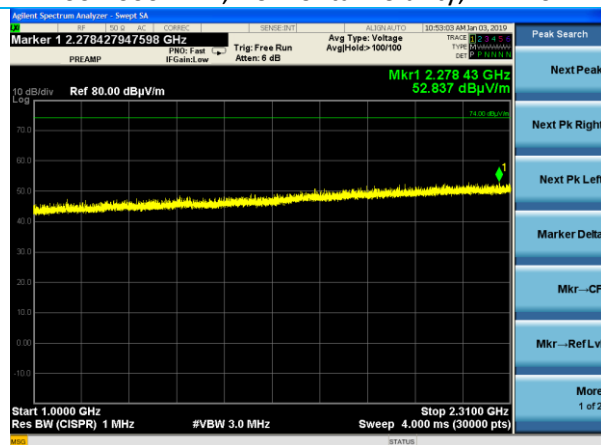
200-1000 MHz, Vertical Polarity, BT 2402



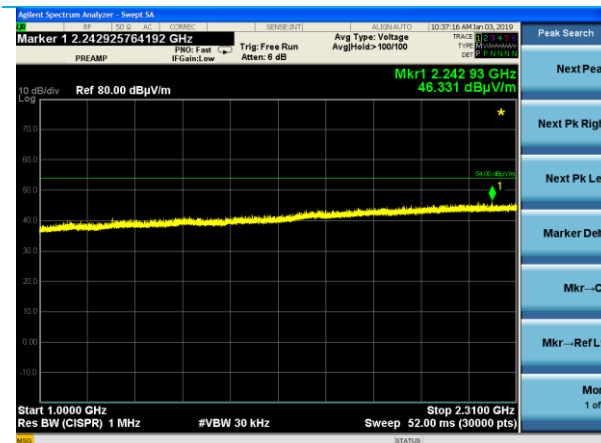
200-1000 MHz, Horizontal Polarity, BT 2402



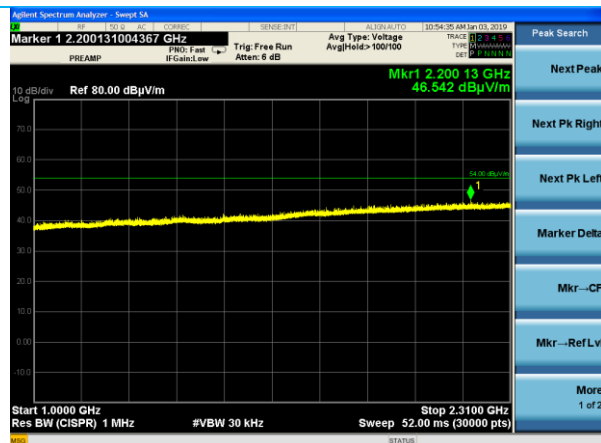
1000-2310 MHz, Vertical Polarity, BT 2402,
Peak Plot



1000-2310 MHz, Vertical Polarity, BT 2480,
Peak Plot



1000-2310 MHz, Vertical Polarity, BT 2402,
Average Plot with Reduced VBW



1000-2310 MHz, Vertical Polarity, BT 2480,
Average Plot with Reduced VBW

Company: Human Inc.	Page 29 of 40	Name: Human Headphones (Right)
Report: TR 317406 FHSS 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	Chamber 5
Temp. / R.H.	23.2°C / 22.0%RH
Requirement	FCC 15.247, 15.209
Method	ANSI C63.10

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 EDR2/EDR3, 3 kHz GFSK
Detector	Max peak hold for all plots. Reduced VBW as shown in table used for final measurements.
EUT Mode	BT Continuous TX, Low/Mid/High and Hopping. 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-2019 Test : BT Tx Right Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

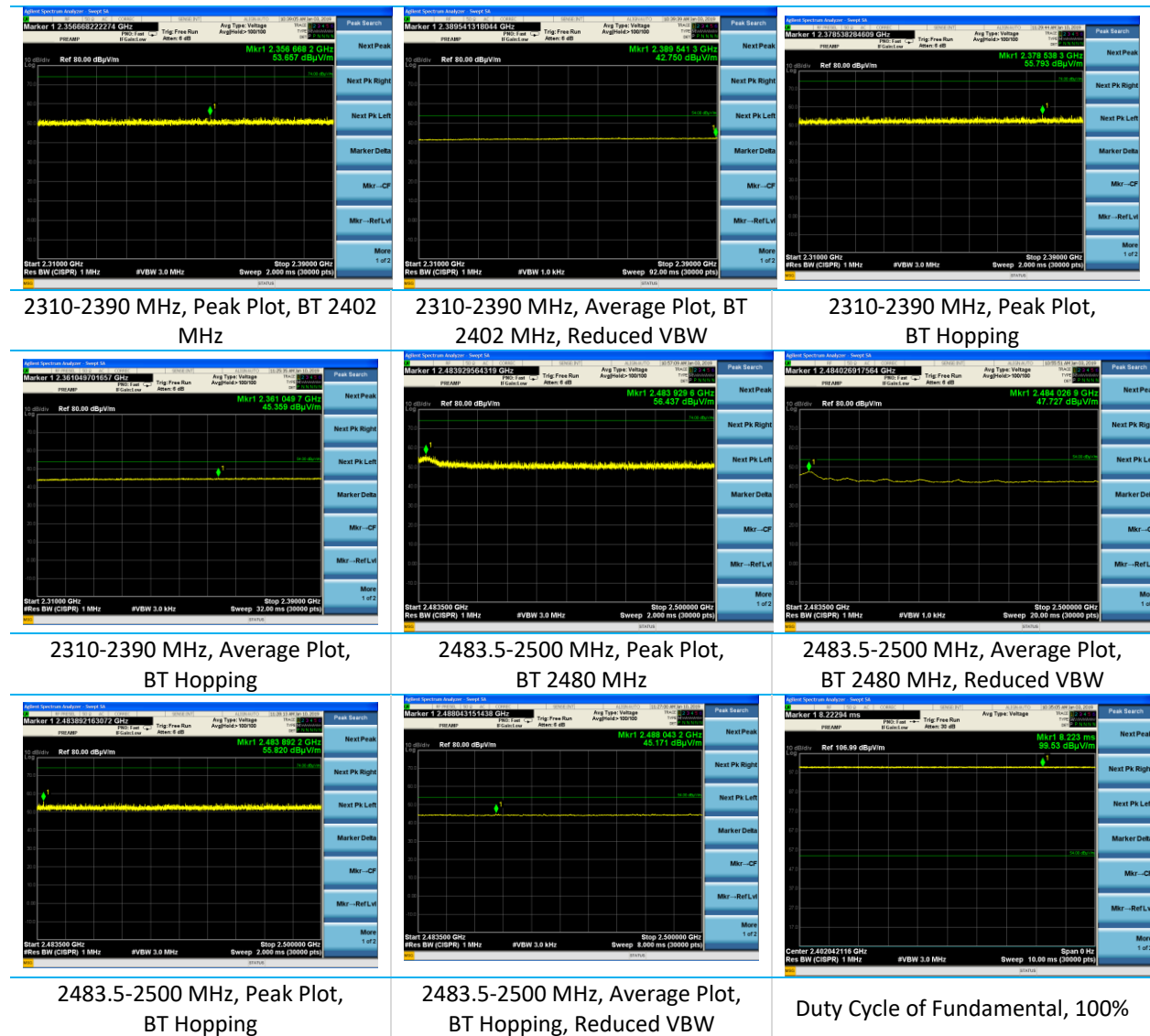
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960088	Analyzer - EMI Receiver	Agilent	N9038A	MY51210138	4/24/2018	4/24/2019	Active Calibration
2	AA 960081	Antenna - Double Ridge Horn	EMCO	3115	6907	4/16/2018	4/16/2019	Active Calibration

Tables

Frequency (MHz)	Height (cm)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)	Antenna Polarity
2356.7	180.0	130.0	53.7	74.0	20.3	Vertical
2483.9	180.0	130.0	56.4	74.0	17.6	Vertical

Frequency (MHz)	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)	Antenna Polarity
2389.5	180.0	130.0	42.8	54.0	11.3	Vertical
2484.0	180.0	130.0	47.7	54.0	6.3	Vertical

Plots



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

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. Reduced VBW as shown in table used for final measurements.
EUT Mode	BT Continuous TX, Low/Mid/High. 100% duty cycle.
EUT Configuration	Vertical, Flat, and On Charger. Vertical EUT deemed worst case.
Note	For 4-18 GHz harmonics the plot shown is of the worst-case orientation per harmonic in restricted band of operation. GFSK modulation shown as worst case.



Instrumentation



Date : 11-Jan-2019 Test : BT Tx 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	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

Table

Channel	Emission Frequency (MHz)	Height (cm)	Azimuth	Peak Reading (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dB)	Average Reading (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)	EUT Orientation	Antenna Polarity
High	4960	101.6	75.3	47.0	74.0	27.0	41.9	54.0	12.1	Vertical	Horizontal
High	4960	163.6	91.3	45.7	74.0	28.3	40.2	54.0	13.8	Vertical	Vertical
High	4960	113.6	264.8	46.5	74.0	27.5	41.7	54.0	12.3	Flat	Vertical
High	4960	105.7	19.0	46.4	74.0	27.6	41.6	54.0	12.4	Flat	Horizontal
High	4960	204.1	139.8	45.3	74.0	28.8	38.6	54.0	15.4	On Charger	Horizontal
High	4960	127.0	44.0	45.3	74.0	28.7	40.4	54.0	13.6	On Charger	Vertical
Low	4804	103.6	82.0	46.7	74.0	27.3	41.1	54.0	12.9	Vertical	Horizontal
Mid	4880	193.3	84.5	46.0	74.0	28.0	41.6	54.0	12.4	Vertical	Horizontal
High	9920	193.6	273.0	56.7	74.0	17.3	53.3	54.0	0.7	Vertical	Horizontal

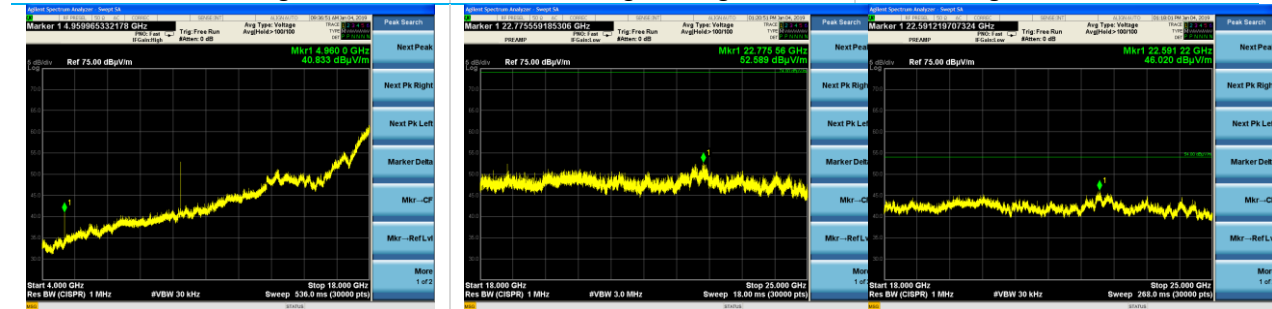
Plots



2.5-4 GHz, Vertical Antenna, Peak, BT High

2.5-4 GHz, Vertical Antenna, Average, BT High

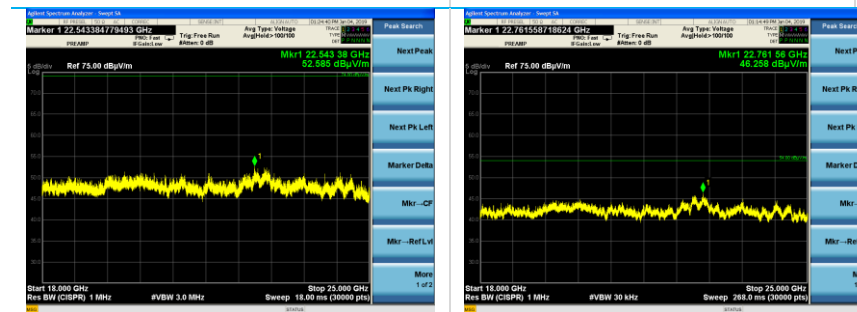
4-18 GHz, Horizontal Antenna, BT High, Reduced VBW



4-18 GHz, Vertical Antenna BT High, Reduced VBW

18-25 GHz, Peak, Horizontal Antenna, BT High

18-25 GHz, Average, Horizontal Antenna, BT High Reduced VBW



18-25 GHz, Peak, Vertical Antenna, BT High

18-25 GHz, Average, Vertical Antenna, BT High Reduced VBW

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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

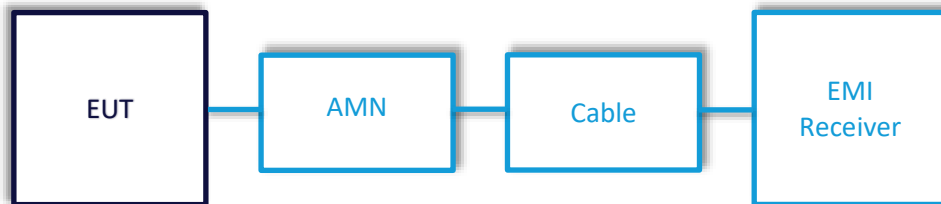
The AMN, Cable, and other necessary measurement system correction factors are loaded onto the EMI receiver when the measurements are performed. The data is gathered and reported as the corrected values.

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.	21.7C/33.5%
Requirement	FCC 15.207
Method	ANSI C63.10

Limits:

Frequency (MHz)	Quasi Peak Limit (dB μ V)	Average Limit (dB μ V)
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	150 kHz – 30 MHz
Distance	80 cm for HGP
RBW	9 kHz
VBW	90 kHz
Detectors	Max peak hold for plot. Quasi peak and average detectors for final measurements.
EUT Mode	BT Continuous Transmit. GFSK modulation. Low/Mid/High Channels.
EUT Power	120VAC/60Hz
Notes	Low and BT 2480 MHz plots shown as worst case with respect to the limit.

Instrumentation



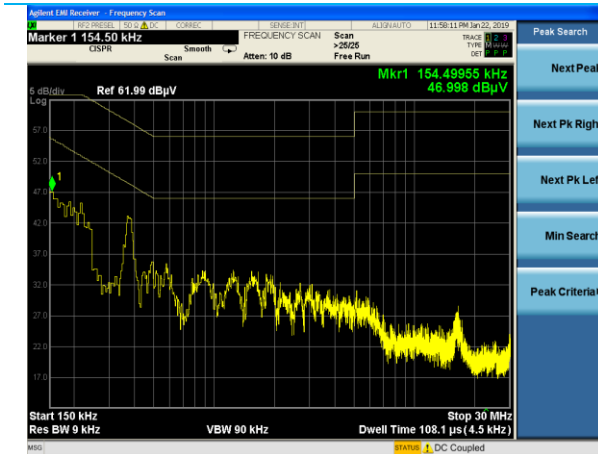
Date : 11-Jan-2019 Test : BT Tx Right Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

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

Line	Transmit Frequency (MHz)	Frequency (MHz)	Q-Peak Reading (dBμV)	Q-Peak Limit (dBμV)	Quasi-Peak Margin (dB)	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)
2	2402	0.383	39.5	58.2	18.7	25.1	48.2	23.1
2	2402	1.189	28.8	56.0	27.2	17.4	46.0	28.6
2	2402	16.140	23.9	60.0	36.2	14.6	50.0	35.4
1	2402	0.374	39.8	58.4	18.6	28.3	48.4	20.1
1	2402	0.150	42.9	66.0	23.1	33.0	56.0	23.0
1	2402	0.590	31.5	56.0	24.5	21.5	46.0	24.5
1	2480	0.374	40.4	58.4	18.0	28.6	48.4	19.8
1	2480	0.154	42.7	65.8	23.1	32.6	55.8	23.2
1	2480	1.410	30.4	56.0	25.6	20.0	46.0	26.0
2	2480	0.379	38.8	58.3	19.5	24.4	48.3	23.9
2	2480	1.977	28.6	56.0	27.4	16.6	46.0	29.4
2	2480	16.716	22.4	60.0	37.6	13.6	50.0	36.4

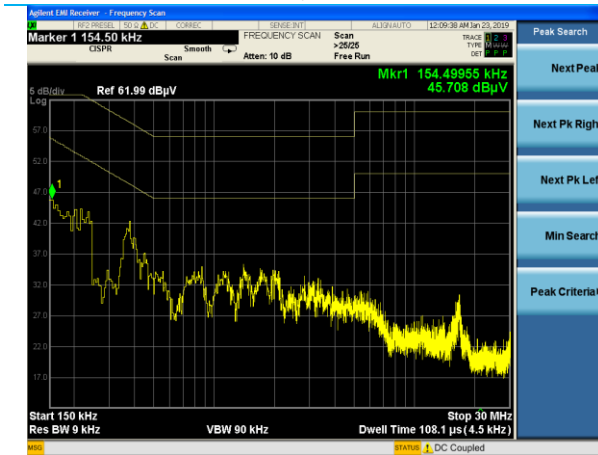
Plots



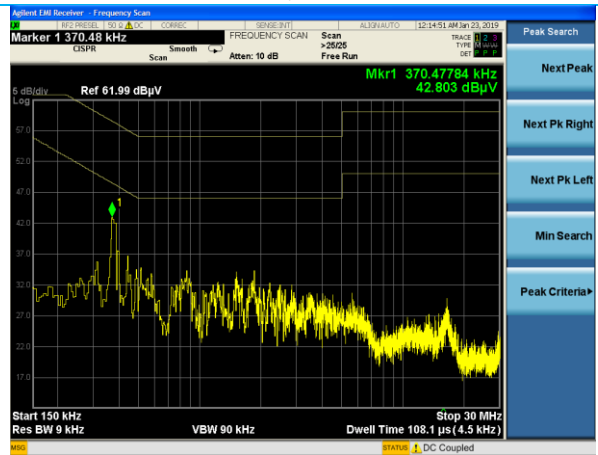
Line 1, BT Low



Line 2, BT Low



Line 1, BT High



Line 2, BT High

Company: Human Inc.	Page 39 of 40	Name: Human Headphones (Right)
Report: TR 317406 FHSS TX B		Model: 1702
Job: C-2951		Serial: 7406, 7354

6 REVISION HISTORY

Version	Date	Notes	Person
v0.0	3-14-19	Initial Draft	Zach Wilson
v0.1	3-15-19	Revised Draft	Zach Wilson
v0.2	3-15-19	Conducted BE redone	Zach Wilson

END OF REPORT