

Test Report # TR 317406 FHSS TX A

Equipment Under Test: Human Headphone (Left)

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

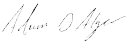
Prepared for: Human Inc.
Attn: Jingping Ma
3100 Airport Way 25-512
Seattle, WA 98134

Report Issued by: Zach Wilson, EMC Engineer

Signature: 

Date: 3/18/2019

Report Reviewed by: Adam Alger, Quality Manager

Signature: 

Date: 3/18/2019

Report Constructed by: Zach Wilson, EMC Engineer

Signature: 

Date: 2/5/2019

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Company: Human Inc.	Page 1 of 43	Name: Human Headphones (Left)
Report: TR 317406 FHSS TX A		Model: 1701
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 43	Name: Human Headphones (Left)
Report: TR 317406 FHSS TX A		Model: 1701
Job: C-2951		Serial: 7406, 7354

1 TEST REPORT SUMMARY

During **1/2/19-3/13/19** the Equipment Under Test (EUT), **Human Headphones (Left)**, 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 (Left)
Model Number	1701
Serial Number	7406, 7354
FCC ID	2ARJG-1701

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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Report: TR 317406 FHSS TX A		Model: 1701
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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

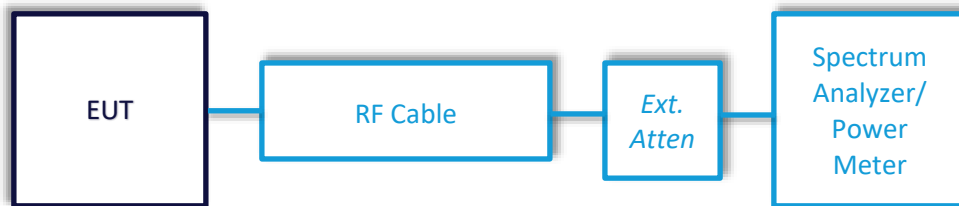
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	1x10 ⁻⁷	0.55x10 ⁻⁷
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply 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	1/23/2019
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 15.247 (a)(1)
Method	ANSI C63.10 Section 7.8.2

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.

Highest Measured Output Power = 4.6 dBm = 2.9mW

Test Parameters

Frequency	2402, 2403 MHz
RBW	300 kHz
VBW	1 MHz
Radio Mode	Bluetooth Hopping, GFSK/EDR2/EDR3
Detector	Max peak hold with peak detector
EUT Power	3.7VDC

Instrumentation



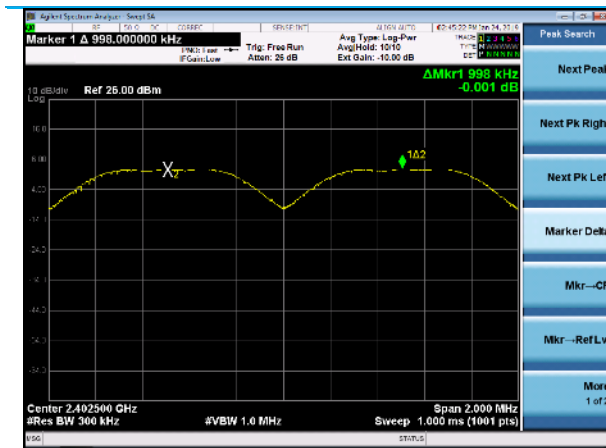
Date : 11-Jan-2019 Test : NFMI Cond. Tx (Left) Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

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	998
EDR3	1006

Plots



Separation, GFSK



Separation, EDR2



Separation, EDR3

5.1.2 Number of Hopping Frequencies

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/23/2019
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 15.247 (a)(1)
Method	ANSI C63.10 Section 7.8.3

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 : NFMI Cond. Tx (Left) Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

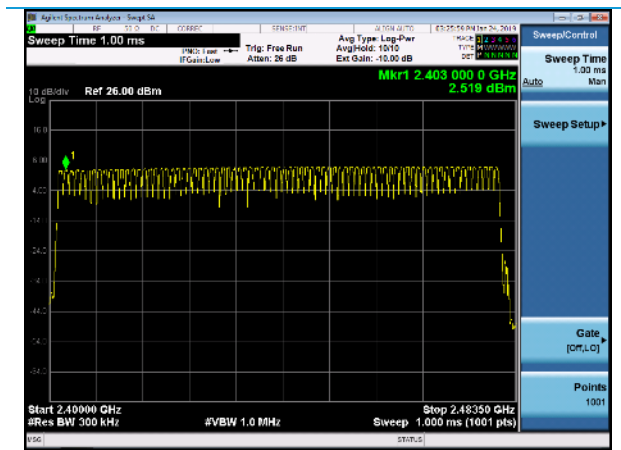
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification

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	1/23/2019
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 15.247 (a)(1)
Method	ANSI C63.10 Section 7.8.4

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 : NFMI Cond. Tx (Left) Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

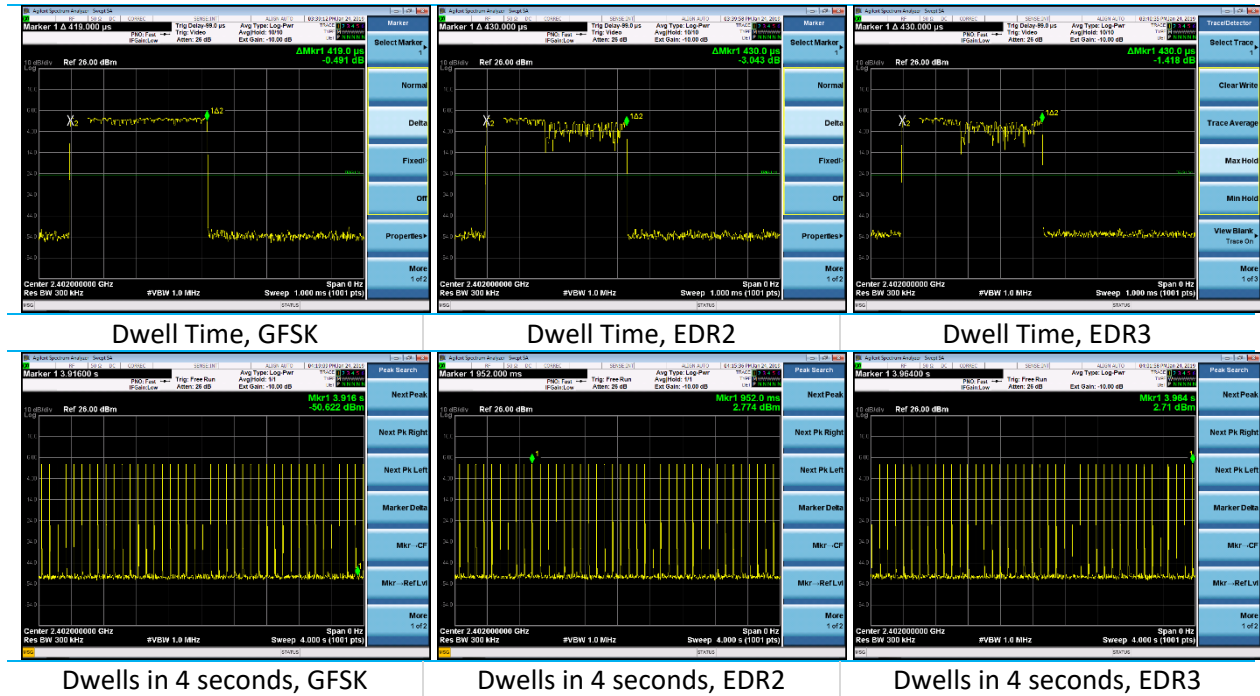
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification

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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	1/23/2019 and 3/13/2019
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 2.1049
Method	ANSI C63.10 Section 6.9.2 and 6.9.3

Test Parameters

Frequency	2402, 2440, 2480 MHz
RBW	15 kHz
VBW	47 kHz
Radio Mode	Bluetooth Continuous Transmit
Detector	Max peak hold with peak detector
EUT Power	3.7VDC

Instrumentation



Date : 13-Mar-2019 Test : Conducted Radio (Left FHSS) 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

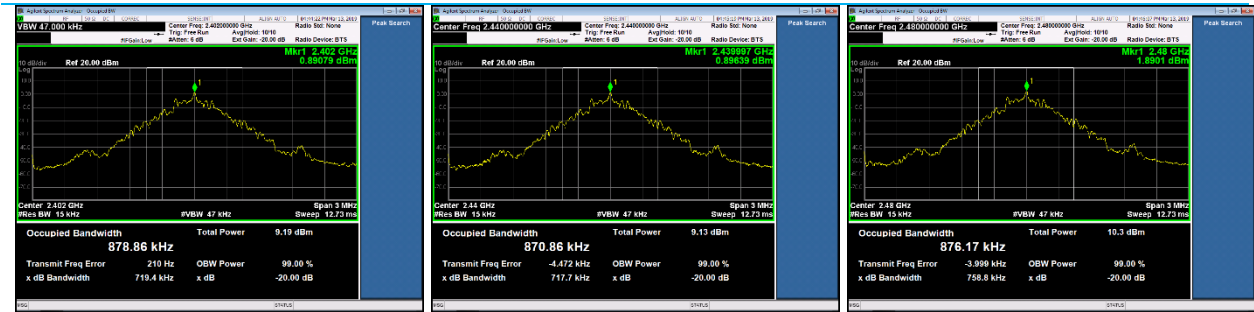
Tables

GFSK		
Transmit Fundamental (MHz)	20dB BW (kHz)	99% BW (kHz)
2402	719.4	878.9
2440	717.7	870.9
2480	758.8	876.2

EDR2		
Transmit Fundamental (MHz)	20dB BW (kHz)	99% BW (kHz)
2402	1192.0	1160.0
2440	1173.0	1156.3
2480	1176.0	1156.8

EDR3		
Transmit Fundamental (MHz)	20dB BW (kHz)	99% BW (kHz)
2402	1184.0	1145.9
2440	1186.0	1145.8
2480	1195.0	1159.9

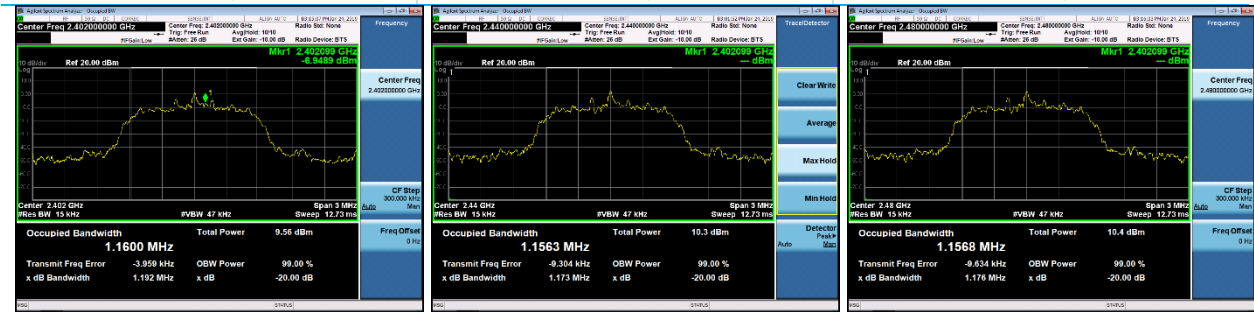
Plots



2402 MHz, GFSK

2440 MHz, GFSK

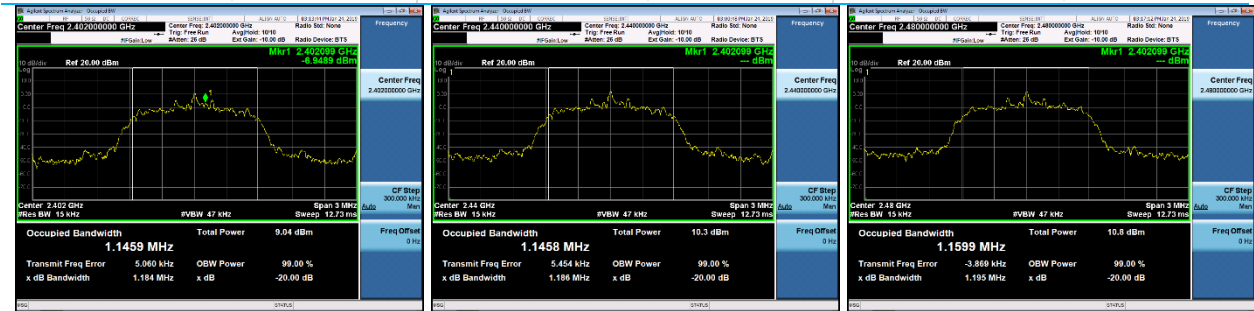
2480 MHz, GFSK



2402 MHz, EDR2

2440 MHz, EDR2

2480 MHz, EDR2



2402 MHz, EDR3

2440 MHz, EDR3

2480 MHz, EDR3

Company: Human Inc.		Name: Human Headphones (Left)
Report: TR 317406 FHSS TX A	Page 17 of 43	Model: 1701
Job: C-2951		Serial: 7406, 7354

5.1.5 Maximum Output Power

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/23/2019
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 15.247 (b)(1)
Method	ANSI C63.10 Section 7.8.5

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



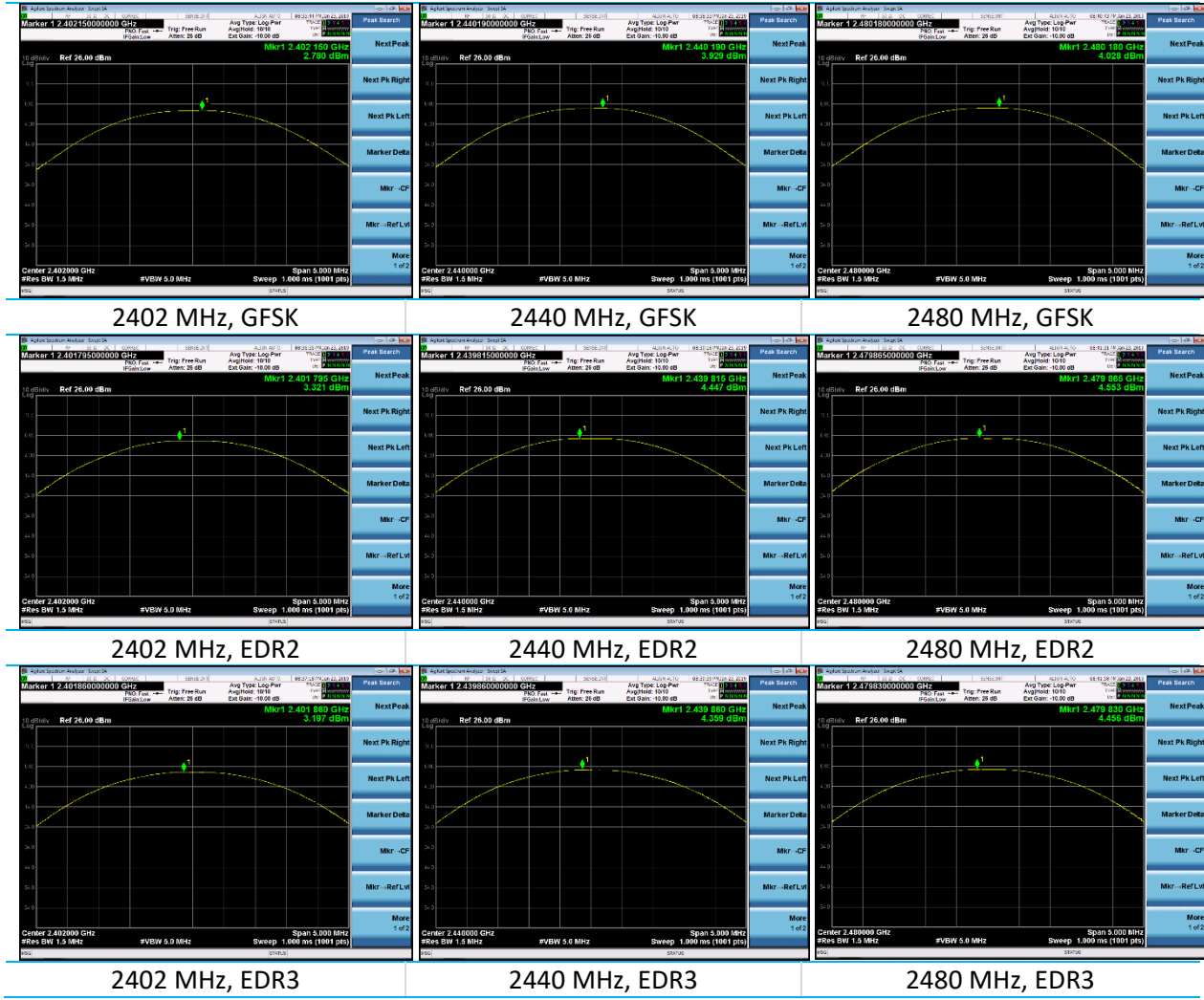
Date : 11-Jan-2019 Test : NFMI Cond. Tx (Left) Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

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

Tables

GFSK				EDR2				EDR3			
Transmit Fundamental (MHz)	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)	Transmit Fundamental (MHz)	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)	Transmit Fundamental (MHz)	Peak Output Power (dBm)	Limit (dBm)	Margin (dB)
2402	2.8	30.0	27.2	2402	3.3	30.0	26.7	2402	3.2	30.0	26.8
2440	3.9	30.0	26.1	2440	4.4	30.0	25.6	2440	4.4	30.0	25.6
2480	4.0	30.0	26.0	2480	4.6	30.0	25.4	2480	4.5	30.0	25.5

Plots



5.1.6 RF Spurious Emissions at the Transmitter Antenna Terminal

Operator	Zach Wilson
QA	Adam Alger
Test Date	1/23/2019 and 3/13/2019
Location	Bench
Temp. / R.H.	21.5°C / 35.4%RH
Requirement	FCC 15.247 (d)
Method	ANSI C63.10 Section 6.7

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.

$$\text{Limit} = 4.6 \text{ dBm} - 20 \text{ dB} = -15.4 \text{ dBm}$$

Test Parameters

Frequency	30 MHz – 25 GHz
RBW	100 kHz
VBW	300 kHz
Radio Mode	Bluetooth Continuous Transmit, Bluetooth Hopping
Detector	Max peak hold with peak detector
EUT Power	3.7VDC
Limit Line Notes	Limit shown at -41.23 dBm is incorrect for spurious and upper band edge plots.

Instrumentation



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

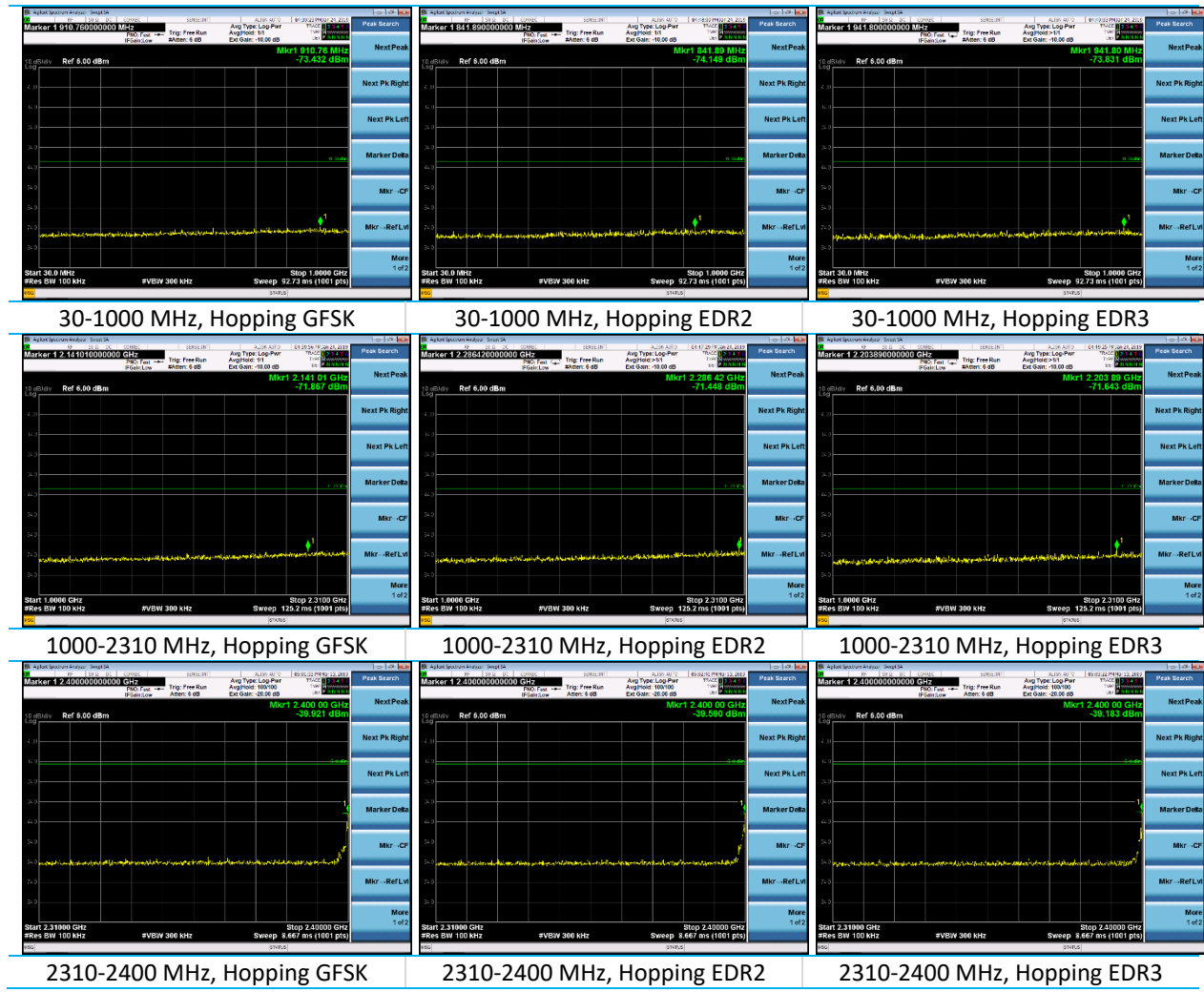
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Analyzer - Spectrum	Agilent	N9010A	MY53400296	4/25/2018	4/25/2019	Active Calibration
2	AA 960143	Cable	Gore	EKD01D01048.0	5546519	11/12/2018	11/12/2019	Active Verification
3	AA 960144	Cable	Gore	EKD01D010720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

Table

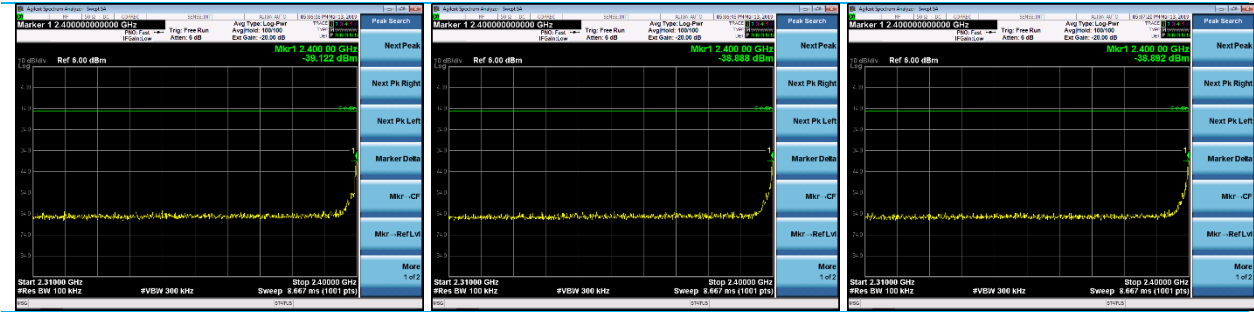
Transmit Fundamental (MHz)	Modulation	Frequency (MHz)	Peak Reading (dBm)	Limit (dBm)	Margin (dB)
Hopping	GFSK	2400.0	-39.9	-15.4	24.5
Hopping	EDR2	2400.0	-39.6	-15.4	24.2
Hopping	EDR3	2400.0	-39.2	-15.4	23.8
2402.0	GFSK	2400.0	-39.1	-15.4	23.7



Plots



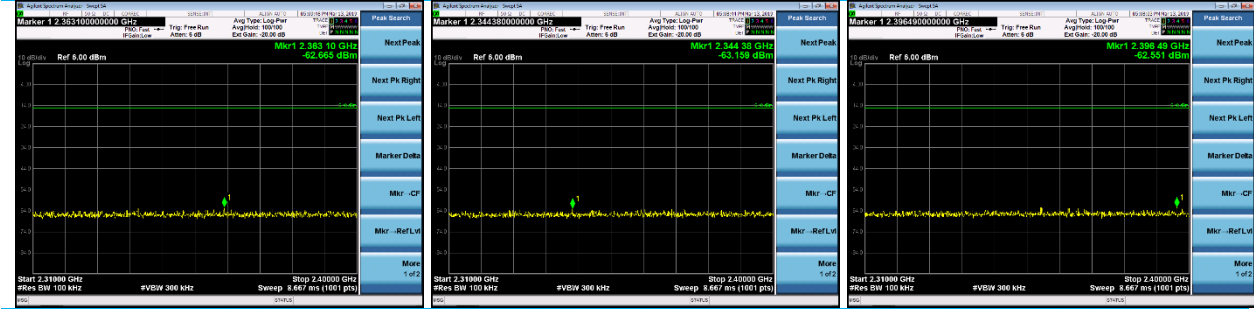
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Job: C-2951		Serial: 7406, 7354



2310-2400 MHz, 2402 MHz, GFSK

2310-2400 MHz, 2402 MHz, EDR2

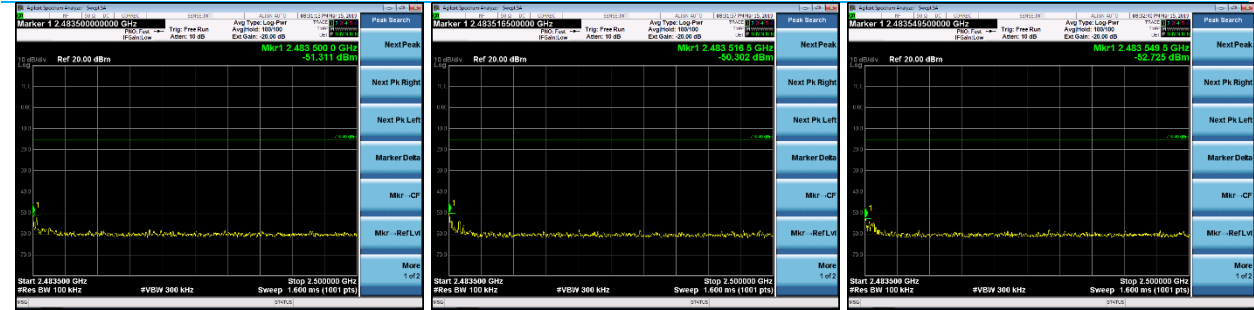
2310-2400 MHz, 2402 MHz, EDR3



2310-2400 MHz, 2480 MHz, GFSK

2310-2400 MHz, 2480 MHz, EDR2

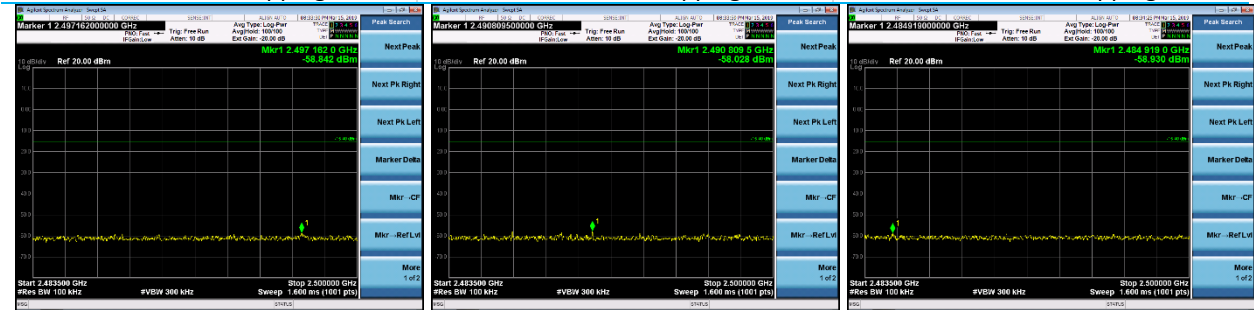
2310-2400 MHz, 2480 MHz, EDR3



2483.5-2500 MHz, Hopping GFSK

2483.5-2500 MHz, Hopping EDR2

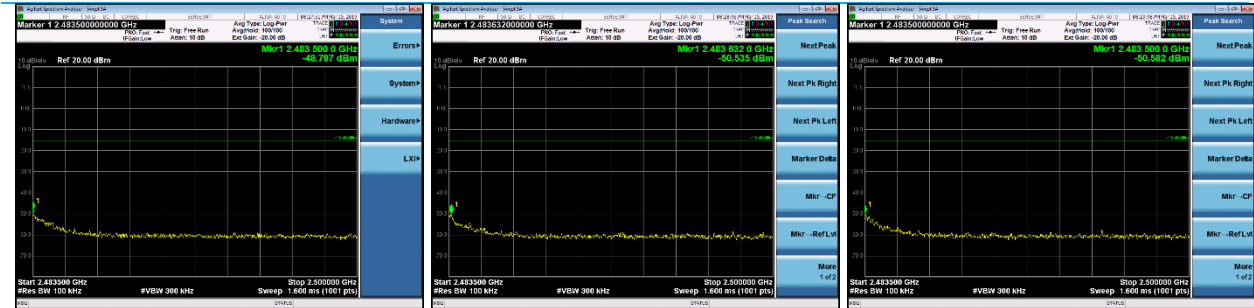
2483.5-2500 MHz, Hopping EDR3



2483.5-2500 MHz, 2402 MHz, GFSK

2483.5-2500 MHz, 2402 MHz, EDR2

2483.5-2500 MHz, 2402 MHz, EDR3



2483.5-2500 MHz, BT 2480 MHz, GFSK

2483.5-2500 MHz, 2480 MHz, EDR2

2483.5-2500 MHz, BT 2480 MHz, EDR3



2.5-25 GHz, Hopping GFSK

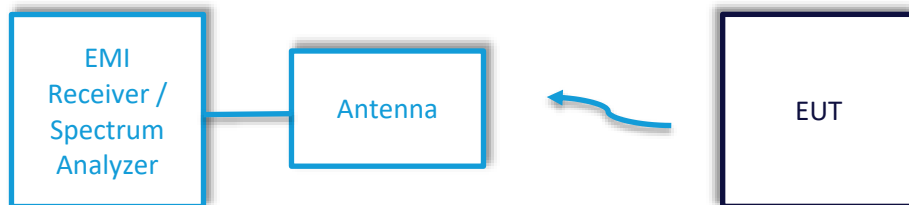
2.5-25 GHz, Hopping EDR2

2.5-25 GHz, Hopping EDR3

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 and Anthony Smith
QA	Shane Dock and Zach Wilson
Test Date	1/3/19, 1/10/19, 1/15/19
Location	Chamber 5
Temp. / R.H.	23.3°C / 34.6%RH
Requirement	FCC 15.247, 15.209
Method	ANSI C63.10

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	-	-
1000-2310	-	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	BT Continuous Tx, Low/Mid/High Channels.
EUT Configuration	EUT on charger deemed worst case configuration.
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



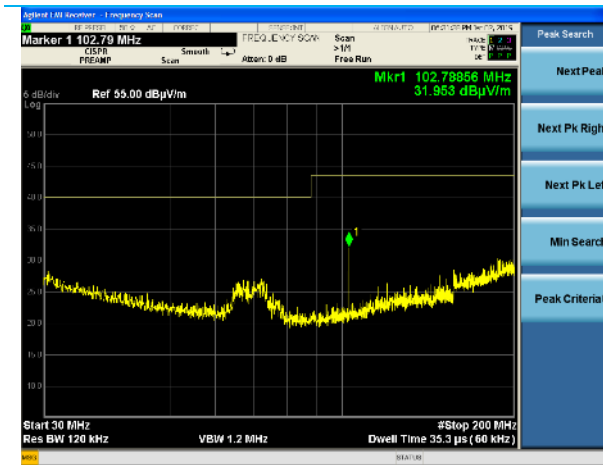
Date: 11-Jan-2019 Test: NFM1 RE Tx (Left) Job: C-2951
 PE: Zach Wilson Customer: Human Inc. Quote: 317406

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	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

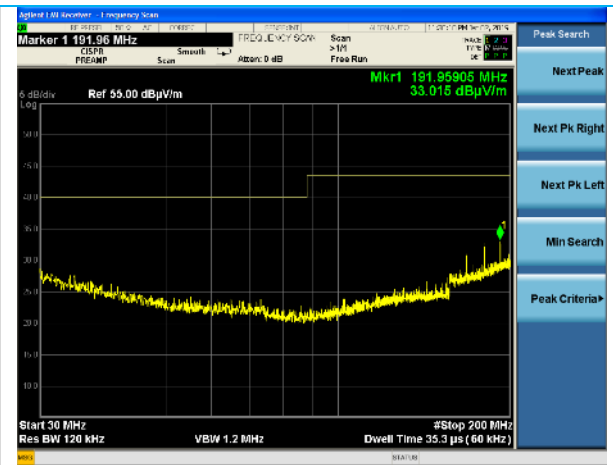
Data

30-1000 MHz, Left Headphone							
Frequency (MHz)	Transmit Fundamental (MHz)	Azimuth (degrees)	Height (cm)	Antenna Polarity	Quasi-Peak Measurement (dBµV/m)	Quasi-Peak Limit (dBµV/m)	Margin (dB)
66.8	2402.0	0.0	100.0	Vertical	21.5	40.0	18.5
192.0	2480.0	98.5	171.8	Horizontal	30.7	43.5	12.8
216.6	N/A	0.0	100.0	Vertical	28.8	46.0	17.2
322.6	2480.0	260.0	100.0	Horizontal	22.4	46.0	23.7
384.0	2402.0	180.0	100.0	Vertical	26.7	46.0	19.3
322.6	2402.0	260.0	100.0	Horizontal	23.7	46.0	22.3

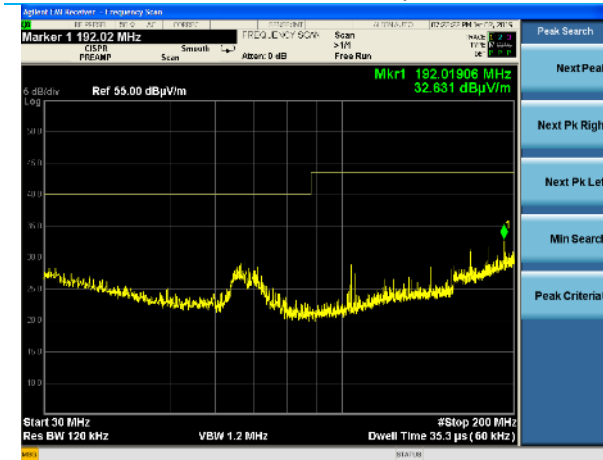
Plots



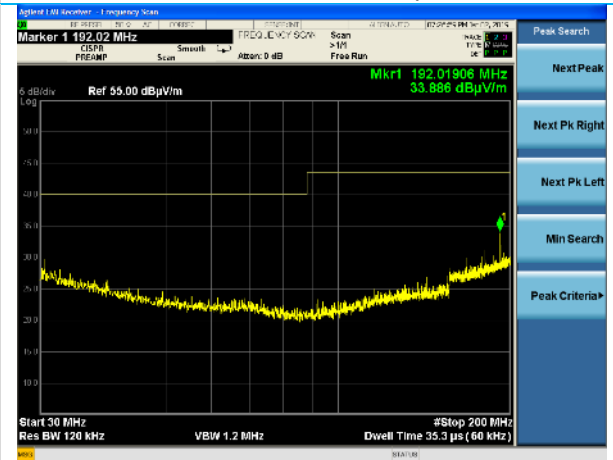
30-200 MHz, Vertical Polarity, BT Disabled



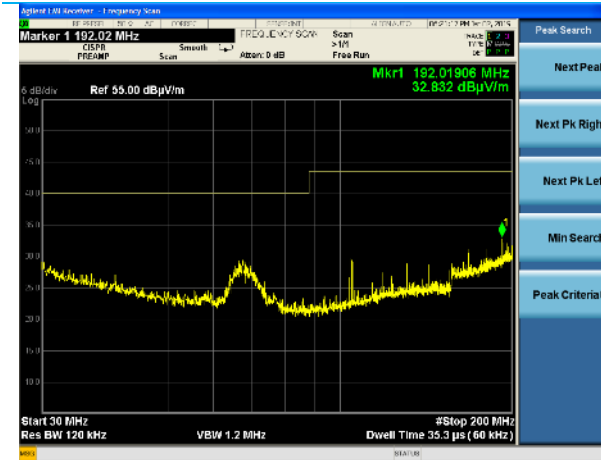
30-200 MHz, Horizontal Polarity, BT Disabled



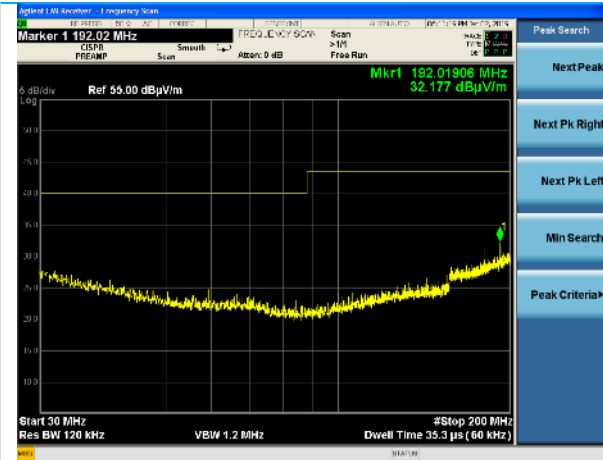
30-200 MHz, Vertical Polarity, BT 2480 MHz



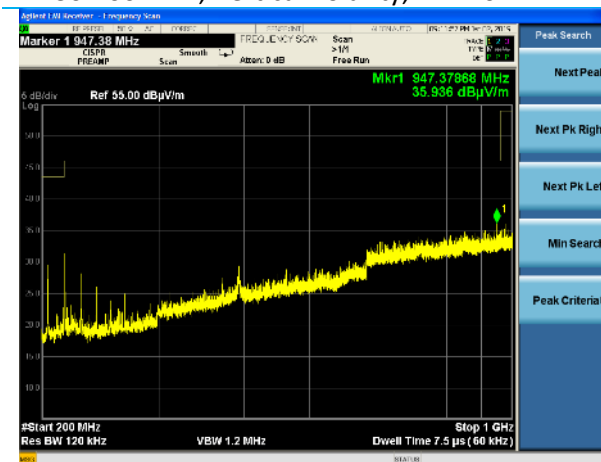
30-200 MHz, Horizontal Polarity, BT 2480 MHz



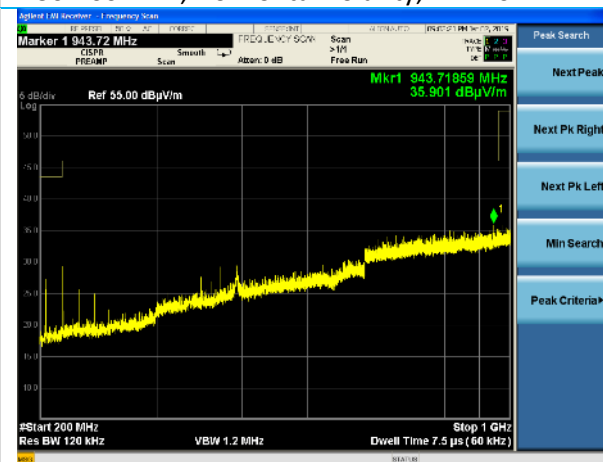
30-200 MHz, Vertical Polarity, BT 2402 MHz



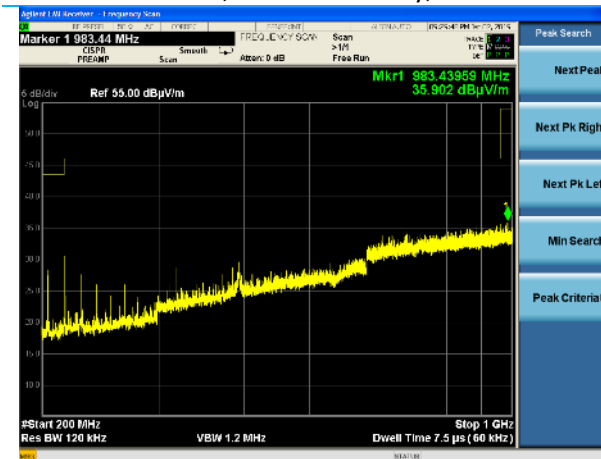
30-200 MHz, Horizontal Polarity, BT 2402 MHz



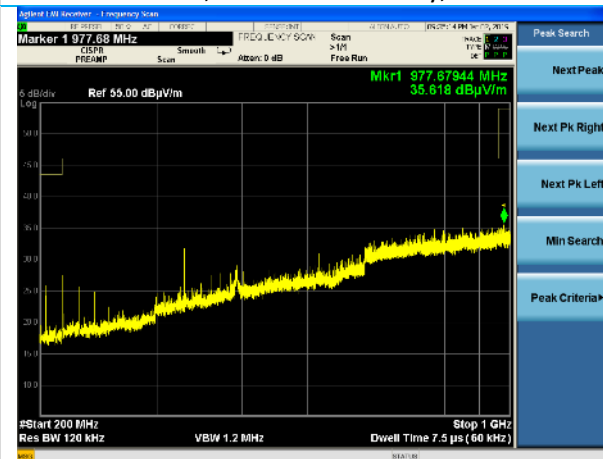
200-1000 MHz, Vertical Polarity, BT Disabled



200-1000 MHz, Horizontal Polarity, BT Disabled

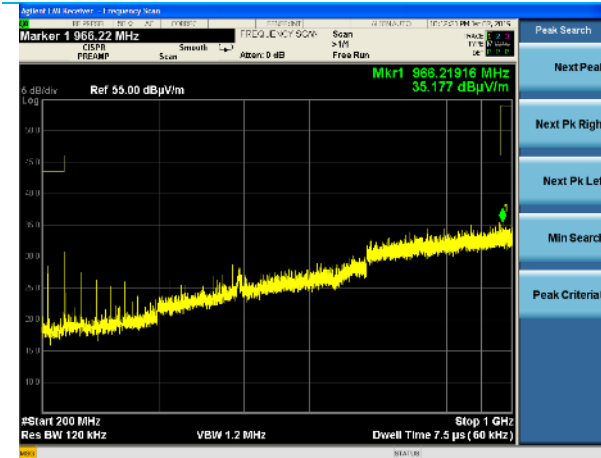


200-1000 MHz, Vertical Polarity, BT 2480 MHz

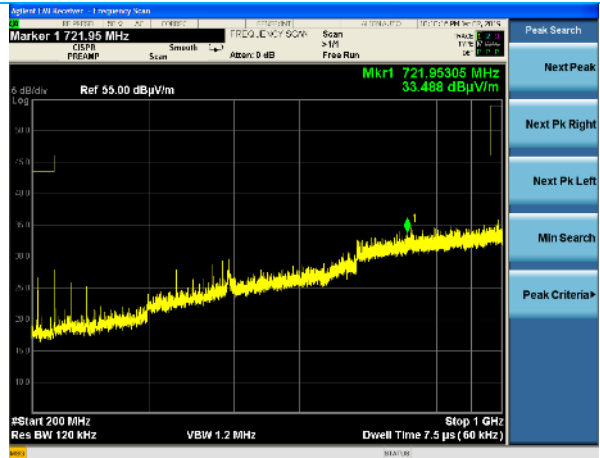


200-1000 MHz, Horizontal Polarity, BT 2480 MHz

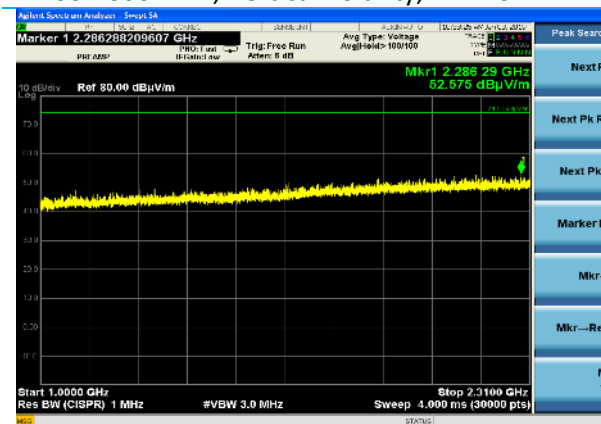
Company: Human Inc.	Page 29 of 43	Name: Human Headphones (Left)
Report: TR 317406 FHSS TX A		Model: 1701
Job: C-2951		Serial: 7406, 7354



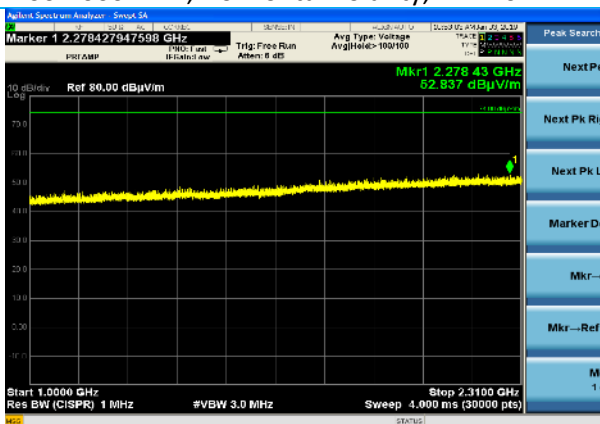
200-1000 MHz, Vertical Polarity, BT 2402 MHz



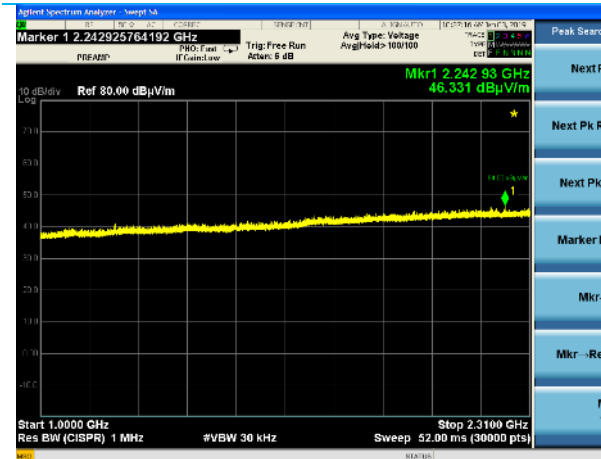
200-1000 MHz, Horizontal Polarity, BT 2402 MHz



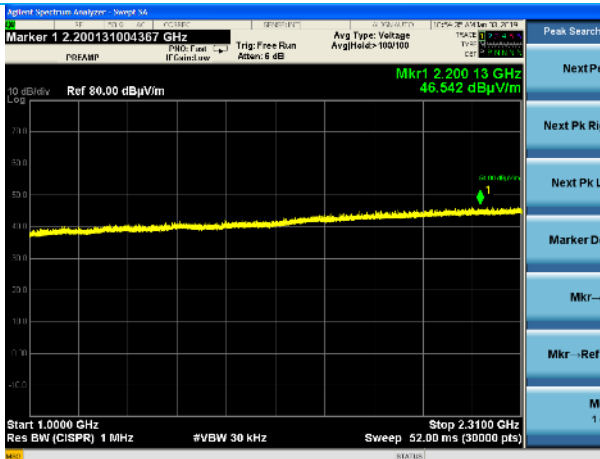
1000-2310 MHz, Vertical Polarity, BT 2402 MHz, Peak Plot



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



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



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

Company: Human Inc.	Page 30 of 43	Name: Human Headphones (Left)
Report: TR 317406 FHSS TX A		Model: 1701
Job: C-2951		Serial: 7406, 7354

5.2.2 Band Edge

Operator	Anthony Smith
QA	Zach Wilson
Test Date	1/3/2019, 1/10/2019
Location	Chamber 5
Temp. / R.H.	22.9°C / 22.6%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
Detector	Max peak hold for all plots. Average and peak detectors for measurements.
EUT Mode	BT Continuous Tx, Low/Mid/High/Hopping 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



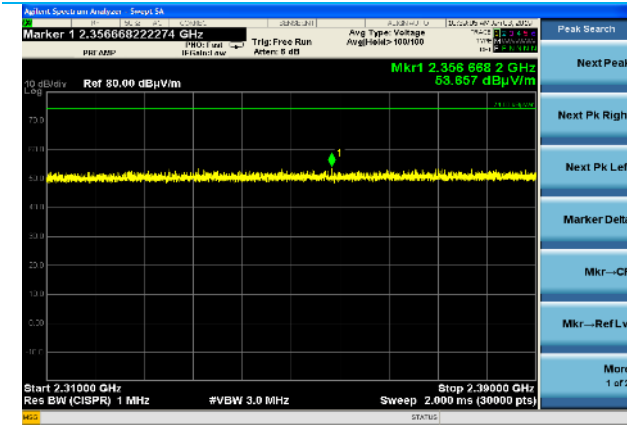
Date : 11-Jan-2019 Test : RE Tx (BLE Left) Job : C-2951
 PE : Zach Wilson Customer : Human Inc. Quote : 317406

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	315	6907	4/16/2018	4/16/2019	Active Calibration

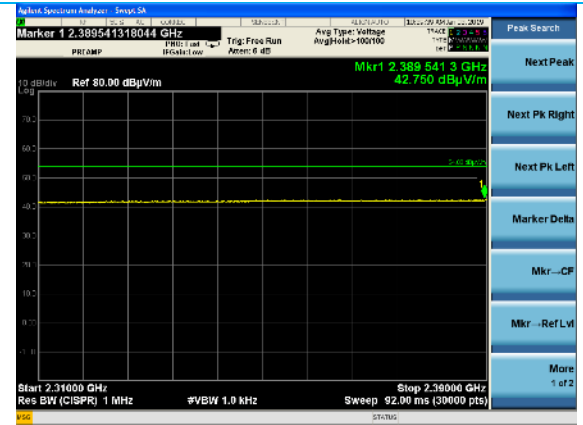
Data

Frequency (MHz)	Height (cm)	Azimuth (degree)	Peak Reading (dBμV/m)	Peak Limit (dBμV/m)	Margin (dB)	Antenna Polarity
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

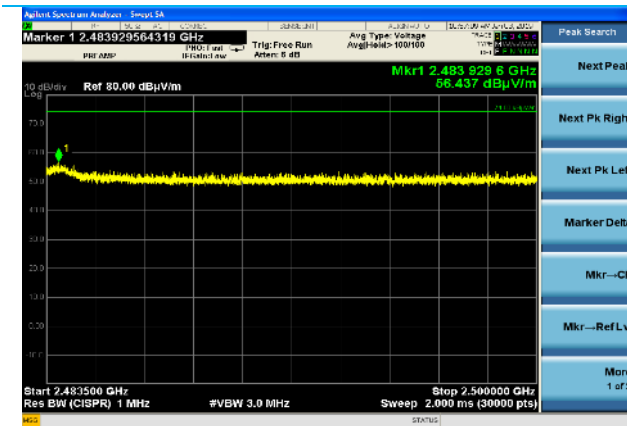
Frequency (MHz)	Height (cm)	Azimuth (degree)	Average Reading (dBμV/m)	Average Limit (dBμV/m)	Margin (dB)	Antenna Polarity
2389.5	180.0	130.0	42.8	54.0	11.3	Vertical
2484.0	180.0	130.0	47.7	54.0	6.3	Vertical



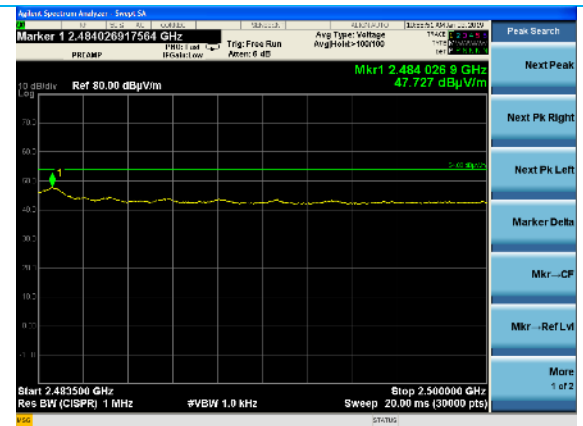
2310-2390 MHz, Peak Plot, BT 2402 MHz



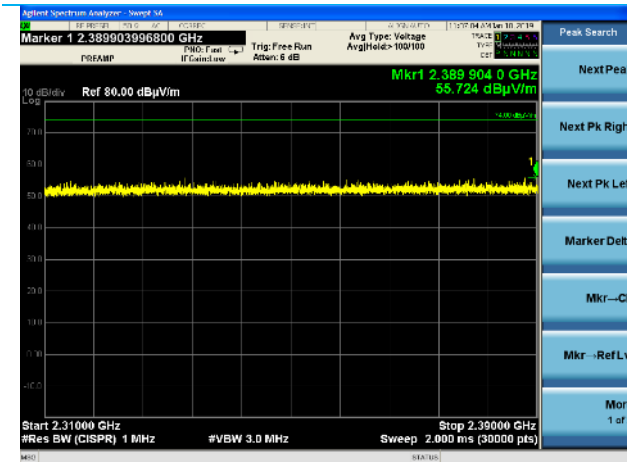
2310-2390 MHz, Average Plot, BT 2402 MHz, Reduced VBW



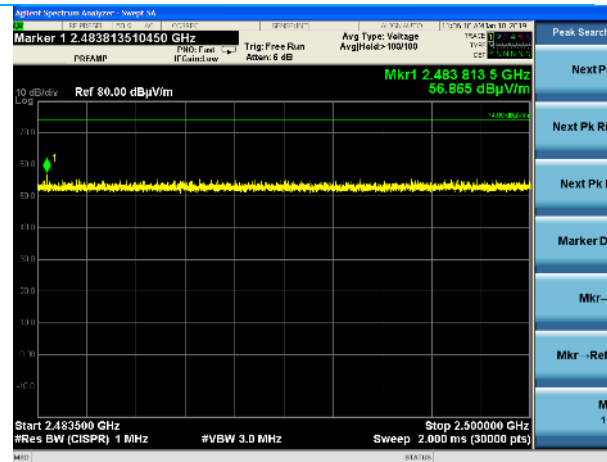
2483.5-2500 MHz, Peak Plot, BT 2480 MHz



2483.5-2500 MHz, Average Plot, BT 2480 MHz, Reduced VBW

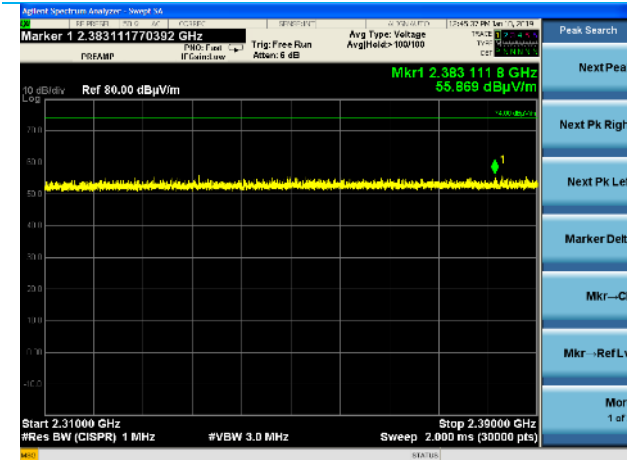


2310-2390 MHz, Peak Plot, BT Hopping GFSK

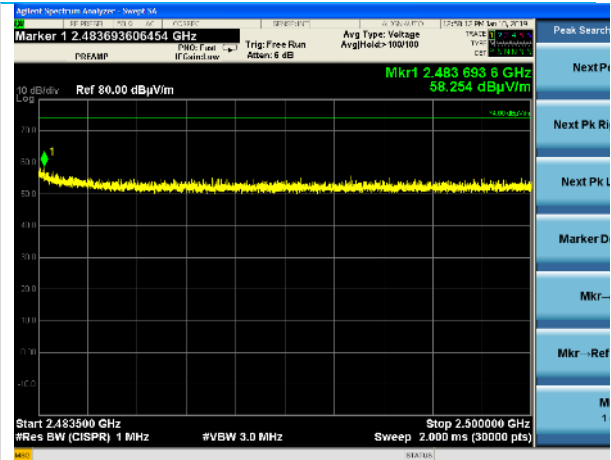


2483.5-2500 MHz, Peak Plot, BT Hopping GFSK

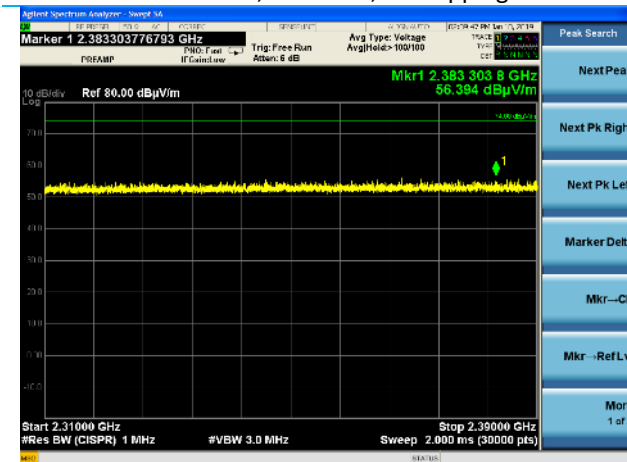
Company: Human Inc.	Page 33 of 43	Name: Human Headphones (Left)
Report: TR 317406 FHSS TX A		Model: 1701
Job: C-2951		Serial: 7406, 7354



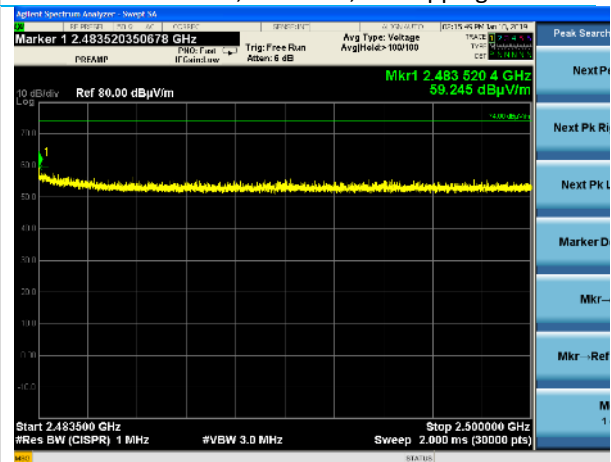
2310-2390 MHz, Peak Plot, BT Hopping EDR2



2483.5-2500 MHz, Peak Plot, BT Hopping EDR2



2310-2390 MHz, Peak Plot, BT Hopping EDR3



2483.5-2500 MHz, Peak Plot, BT Hopping EDR3



Duty Cycle of Fundamental, 100%

Company: Human Inc.	Page 34 of 43	Name: Human Headphones (Left)
Report: TR 317406 FHSS TX A		Model: 1701
Job: C-2951		Serial: 7406, 7354

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. Average and peak detectors for measurements.
EUT Mode	BT Continuous TX, Low/Mid/High, 100% duty cycle.
EUT Configuration	Vertical, Flat, and On Charger
Note	Worst case EUT orientation of flat shown in plots below.

Instrumentation



Date : 11-Jan-2019

Test : RE Tx (BT Left)

Job : C-2951

PE : Zach Wilson

Customer : Human Inc.

Quote : 317406

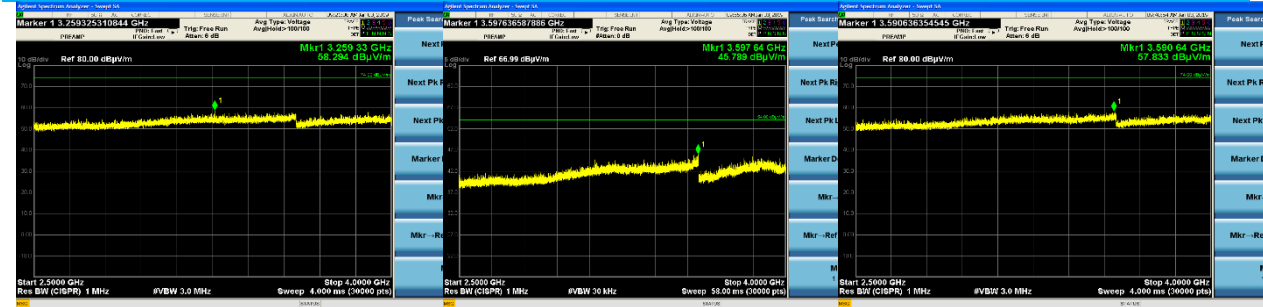
No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	AA 960081	Antenna - Double Ridge Horn	EMCO	3115	6907	4/16/2018	4/16/2019	Active Calibration
2	AA 960171	Cable	A.H. Systems, Inc	SAC-26G-6	386	11/12/2018	11/12/2019	Active Verification
3	AA 960154	Filter - High Pass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

Tables

Frequency (MHz)	Radio Fundamental (MHz)	Height	Azimuth	Peak Reading (dBuV/m)	Peak Limit (dBuV/m)	Peak Margin (dB)	Average Reading (dBuV/m)	Average Limit (dBuV/m)	Average Margin (dB)	Orientation	Polarity
4960.0	2480.0	101.6	75.3	47.0	74.0	27.0	41.9	54.0	12.1	Vertical	Horizontal
4960.0	2480.0	163.6	91.3	45.7	74.0	28.3	40.2	54.0	13.8	Vertical	Vertical
4960.0	2480.0	113.6	264.8	46.5	74.0	27.5	41.7	54.0	12.3	Flat	Vertical
4960.0	2480.0	105.7	19.0	46.4	74.0	27.6	41.6	54.0	12.4	Flat	Horizontal
4960.0	2480.0	204.1	139.8	45.3	74.0	28.8	38.6	54.0	15.4	On Charger	Horizontal
4960.0	2480.0	127.0	44.0	45.3	74.0	28.7	40.4	54.0	13.6	On Charger	Vertical
4804.0	2402.0	103.6	82.0	46.7	74.0	27.3	41.1	54.0	12.9	Vertical	Horizontal
4880.0	2440.0	193.3	84.5	46.0	74.0	28.0	41.6	54.0	12.4	Vertical	Horizontal
9920.0	2480.0	193.6	273.0	56.7	74.0	17.3	53.3	54.0	0.7	Vertical	Horizontal

Company: Human Inc.	Page 36 of 43	Name: Human Headphones (Left)
Report: TR 317406 FHSS TX A		Model: 1701
Job: C-2951		Serial: 7406, 7354

Plots



2.5-4 GHz, Peak, Vertical Antenna, 2402 MHz,

2.5-4 GHz, Average, Vertical Antenna, 2402 MHz,

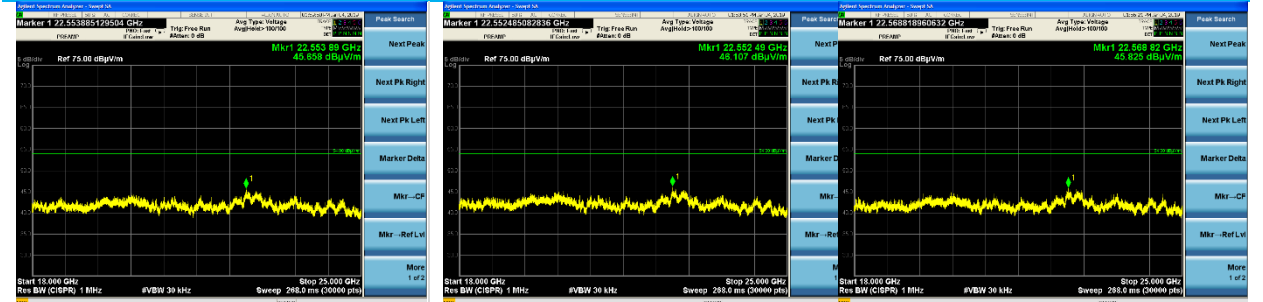
2.5-4 GHz, Peak, Vertical Antenna, 2480 MHz



2.5-4 GHz, Average, Vertical Antenna, 2480 MHz

4-18 GHz, Horizontal Antenna, Reduced VBW, 2480 MHz

4-18 GHz, Vertical Antenna, Reduced VBW, 2480 MHz



18-25 GHz, Noise Floor, Reduced VBW

18-25 GHz, Horizontal Antenna, 2480 MHz, Reduced VBW

18-25 GHz, Vertical Antenna, 2480 MHz, Reduced VBW

Company: Human Inc.	Page 37 of 43	Name: Human Headphones (Left)
Report: TR 317406 FHSS TX A		Model: 1701
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

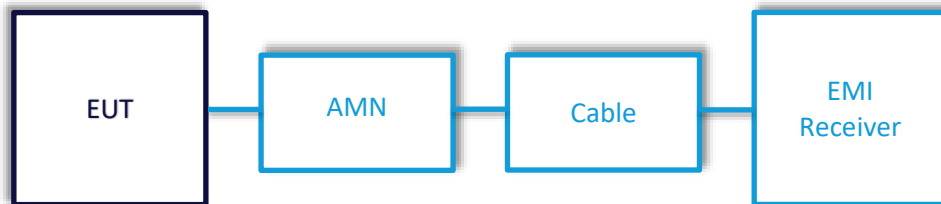
The AMN, cable, and other necessary measurement system correction factors are loaded onto the EMI receiver when the measurements are performed. The data is gathered and reported as the corrected values.

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	80cm for HGP
RBW	9 kHz
VBW	90 kHz
Detectors	Max peak hold for plots. Quasi Peak and Average detectors used for final measurement.
EUT Power	120VAC/60Hz
EUT Mode	BT Tx, Low/Mid/High/Hopping. Mid/Hopping checked but no change in emissions from Low/High.
Notes	Worst case with respect to the limit shown.

Instrumentation



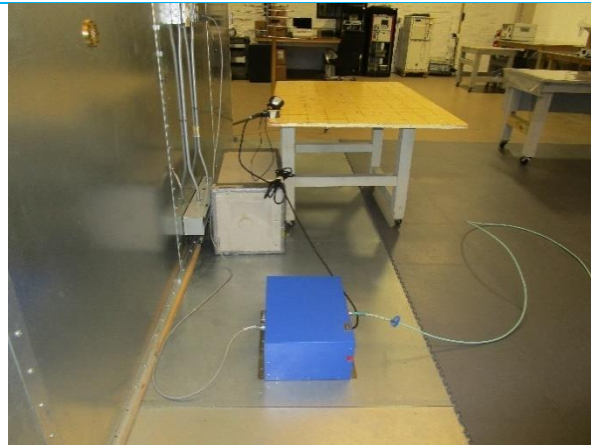
Date: 11-Jan-2019 Test: CE (Left) Job: C-2951
 PE: Zach Wilson Customer: Human Inc. Quote: 317406

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

Setup Photos



Conducted Emission

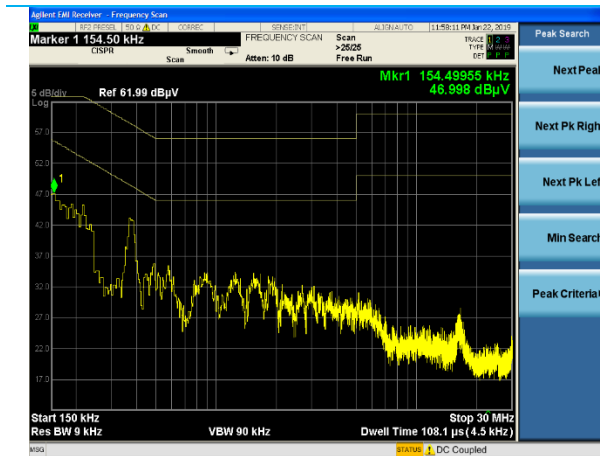


Conducted Emissions

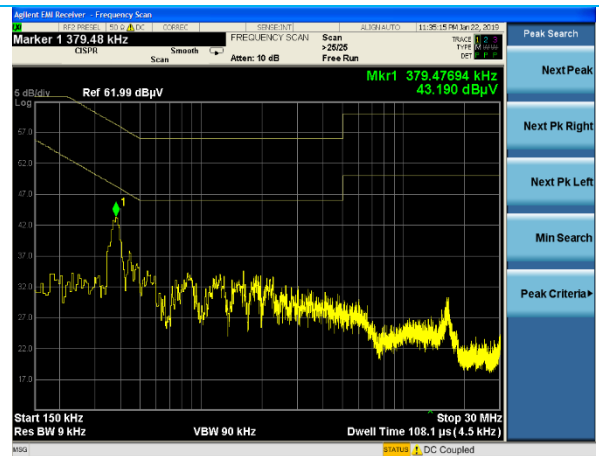
Table

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

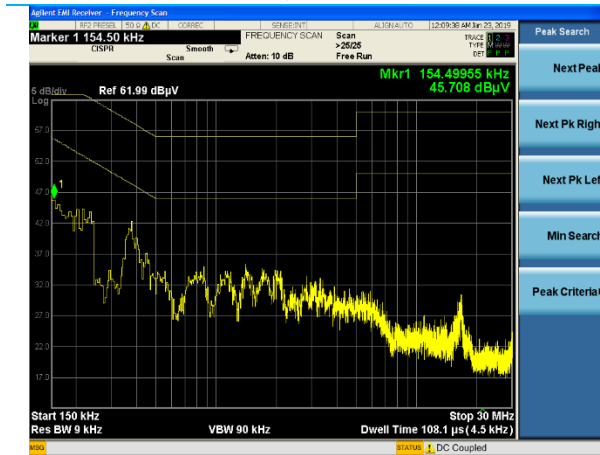
Plots



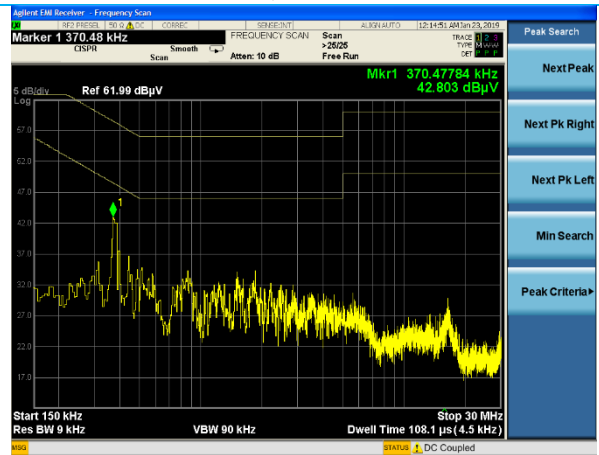
Line 1, 2402 MHz



Line 2, 2402 MHz



Line 1, 2480 MHz



Line 2, 2480 MHz

Company: Human Inc.	Page 42 of 43	Name: Human Headphones (Left)
Report: TR 317406 FHSS TX A		Model: 1701
Job: C-2951		Serial: 7406, 7354

6 REVISION HISTORY

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

END OF REPORT