



Test Report

Date : 2021-12-30
No. : HMD21120027

Page 1 of 90

Applicant : Shenzhen Junlan Electronic Ltd.
No. 277 Pingkui Road, Shijing Community, Pingshan Street, Pingshan
New District, Shenzhen, China

Supplier / Manufacturer : Shenzhen Junlan Electronic Ltd.
No. 277 Pingkui Road, Shijing Community, Pingshan Street, Pingshan
New District, Shenzhen, China

Description of Sample(s) : Submitted sample(s) said to be
Product: Hearth & Hand Bluetooth Radio
Brand Name: Hearth & Hand with Magnolia
Model No.: JC-8105
FCC ID: OKUJC8105

Date Samples Received : 2021-12-14

Date Tested : 2021-12-15 to 2021-12-23

Investigation Requested : Perform Electro Magnetic Interference measurement in accordance
with FCC 47CFR [Codes of Federal Regulations] Part 15 and ANSI
C63.10:2013 for FCC Certification.

Conclusions : The submitted product COMPLIED with the requirements of Federal
Communications Commission [FCC] Rules and Regulations Part 15.
The tests were performed in accordance with the standards described
above and on Section 2.2 in this Test Report.

Remarks : Bluetooth FHSS (GFSK / $\pi/4$ -DQPSK / 8DPSK)
For additional model(s) details, please see page 3.


D. CHAN Kwok Hung, Brian
Authorized Signatory



Test Report

Date : 2021-12-30
No. : HMD21120027

Page 2 of 90

CONTENT:

Cover	Page 1 of 90	
Content	Page 2 of 90	
<u>1.0</u>	<u>General Details</u>	
1.1	Test Laboratory	Page 3 of 90
1.2	Equipment Under Test [EUT] Description of EUT operation	Page 3 of 90
1.3	Date of Order	Page 3 of 90
1.4	Submitted Sample(s)	Page 3 of 90
1.5	Test Duration	Page 3 of 90
1.6	Country of Origin	Page 3 of 90
1.7	RF Module Details	Page 4 of 90
1.8	Antenna Details	Page 4 of 90
1.9	Channel List	Page 4 of 90
<u>2.0</u>	<u>Technical Details</u>	
2.1	Investigations Requested	Page 5 of 90
2.2	Test Standards and Results Summary	Page 6 of 90
2.3	Table for Test Modes	Page 7 of 90
<u>3.0</u>	<u>Test Results</u>	
3.1	Emission	Page 8-85 of 90
<u>Appendix A</u>	List of Measurement Equipment	Page 86 of 90
<u>Appendix B</u>	Photograph(s) of Product	Page 87-90 of 90

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 3 of 90

1.0 General Details

1.1 Test Laboratory

The Hong Kong Standards and Testing Centre Ltd.
EMC Laboratory
10 Dai Wang Street, Taipo Industrial Estate, New Territories, Hong Kong
Telephone: 852 2666 1888
Fax: 852 2664 4353

1.2 Equipment Under Test [EUT]

Description of Sample(s)

Product: Hearth & Hand Bluetooth Radio
Manufacturer: Shenzhen Junlan Electronic Ltd.
No. 277 Pingkui Road, Shijing Community, Pingshan Street,
Pingshan New District, Shenzhen, China
Brand Name: Hearth & Hand with Magnolia
Model Number: JC-8105
Additional Model Number: Grizedale
Rating: 5Vd.c.(power by USB port) /
3.7Vd.c (Li-ion rechargeable battery x1)

The AC/DC adaptor was provided by the lab with following details:

Brand name: WINSTAR, Model no.: N/A, Input: 100-240Va.c. 50/60Hz, Output: 5Vd.c. 2A

1.2.1 Description of EUT Operation

The Equipment Under Test (EUT) is a Hearth & Hand Bluetooth Radio. The transmission signal is digital modulated with channel frequency range 2402-2480MHz. The R.F. signal was modulated by IC; the type of modulation used was frequency hopping spread spectrum Modulation.

1.3 Date of Order

2021-12-14

1.4 Submitted Sample(s):

1 Sample

1.5 Test Duration

2021-12-15 to 2021-12-23

1.6 Country of Origin

China

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 4 of 90

1.7 RF Module Details

Module Model Number: F-6986 V1.1
Module FCC ID: N/A
Module Transmission Type: Bluetooth V4.2 EDR
Modulation: FHSS (GFSK / $\pi/4$ -DQPSK / 8DPSK)
Data Rates:
1Mbps: GFSK
2 MBps: $\pi/4$ -DQPSK
3 MBps: 8DPSK
Frequency Range: 2400-2483.5MHz
Carrier Frequencies: 2402MHz – 2480MHz

Module Specification (specification provided by manufacturer)

1.8 Antenna Details

Antenna Type: PCB antenna
Antenna Gain: 0dBi

1.9 Channel List

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	42	2444
1	2403	43	2445
2	2404	44	2446
3	2405	45	2447
4	2406	46	2448
5	2407	47	2449
6	2408	48	2450
7	2409
8	2410	67	2469
9	2411	68	2470
...	...	69	2471
33	2435	70	2472
34	2436	71	2473
35	2437	72	2474
36	2438	73	2475
37	2439	74	2476
38	2440	75	2477
39	2441	76	2478
40	2442	77	2479
41	2443	78	2480

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Test Report

Date : 2021-12-30
No. : HMD21120027

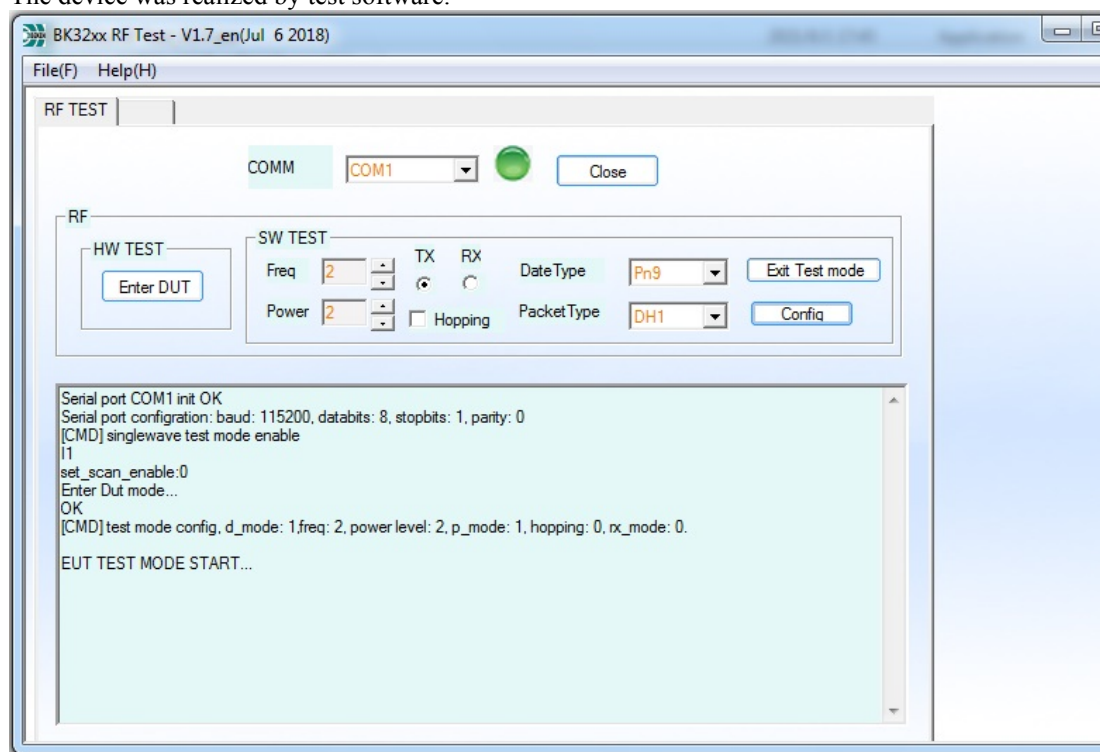
Page 5 of 90

2.0 Technical Details

2.1 Investigations Requested

Perform Electromagnetic Interference measurements in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15 Regulations and ANSI C63.10:2013 for FCC Certification.

The device was realized by test software.





Test Report

Date : 2021-12-30
No. : HMD21120027

Page 6 of 90

2.2 Test Standards and Results Summary Tables

EMISSION Results Summary						
Test Condition	Test Requirement	Test Method	Class / Severity	Test Result		
				Pass	Failed	N/A
Maximum Peak Conducted Output Power	FCC 47CFR 15.247(b)(1)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Radiated Spurious Emissions	FCC 47CFR 15.209, FCC 47CFR 15.205	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
AC Mains Conducted Emissions	FCC 47CFR 15.207	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Conducted Spurious Emissions	FCC 47CFR 15.247(d)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Number of Hopping Frequency	FCC 47CFR 15.247 (b)(1)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20dB Bandwidth	FCC 47CFR 15.247(a)(2)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Hopping Channel Separation	FCC 47CFR 15.247(a)(1)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Band-edge measurement (Radiated)	FCC 47CFR 15.247(d)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Pseudorandom Hopping Algorithm	FCC 47CFR 15.247(a)(1)	N/A	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Time of Occupancy (Dwell Time)	FCC 47CFR 15.247(a)(1)(iii)	ANSI C63.10: 2013	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Antenna requirement	FCC 47CFR 15.203	N/A	N/A	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Note: N/A - Not Applicable

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 7 of 90

2.3 Table for Test Modes

Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate in the table below is the worst case rate with respect to the specific test item.

Investigation has been done on all the possible configurations for searching the worst cases.

The following table is a list of the test modes shown in this test report.

Test Items	Mode	Data Rate
Maximum Peak Conducted Output Power	GFSK / $\pi/4$ -DQPSK / 8DPSK	1MBps / 2MBps/ 3MBps
Hopping Channel Separation	GFSK / $\pi/4$ -DQPSK/ 8DPSK	1MBps / 2MBps/ 3MBps
Number of Hopping Frequency	GFSK / $\pi/4$ -DQPSK/ 8DPSK	1MBps / 2MBp/ 3MBps
Time of Occupancy(Dwell Time)	8DPSK(3DH1/ 3DH3/ 3DH5)	3MBps
Radiated Spurious Emissions	GFSK / $\pi/4$ -DQPSK / 8DPSK	1MBps / 2MBps/ 3MBps
Band-edge compliance of Conducted Emission	GFSK / $\pi/4$ -DQPSK / 8DPSK	1MBps / 2MBps / 3MBps

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 8 of 90

3.0 Test Results

3.1 Emission

3.1.1 Maximum Peak Conducted Output Power

Test Requirement:	FCC 47CFR 15.247(b) (1)
Test Method:	ANSI C63.10: 2013
Test Date:	2021-12-23
Mode of Operation:	Tx mode

Ambient Temperature: 25°C Relative Humidity: 51% Atmospheric Pressure: 101 kPa

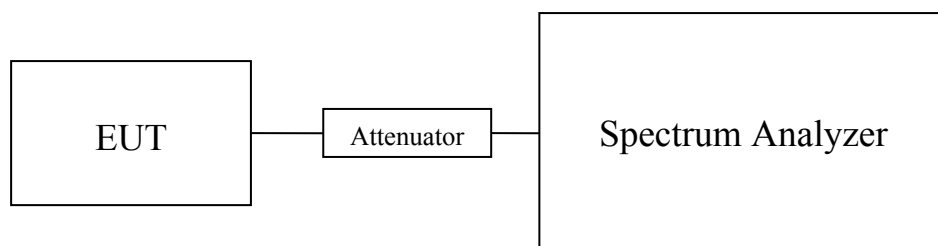
Test Method:

A temporary antenna connector was soldered to the RF output. The RF output of the EUT was connected to the spectrum analyzer. All the attenuation or cable loss will be added to the measured maximum output power. The results are recorded in Watt.

Spectrum Analyzer Setting:

RBW = 3 MHz, VBW= 3MHz, Sweep = Auto, Span: Approximately five times the 20 dB bandwidth
Detector = Peak, Trace = Max. hold

Test Setup:



Note: a temporary antenna connector was soldered to the RF output.



Test Report

Date : 2021-12-30
No. : HMD21120027

Page 9 of 90

Limits for Maximum Peak Conducted Output Power [FCC 47CFR 15.247]:

The maximum peak output power shall not exceeded the following limits:
For frequency hopping systems employing at least 75 hopping channels: 1 Watt
For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 Watts
For Digital Transmission systems in 2400-2483.5 MHz Band: 1 Watt

Results of Bluetooth Communication mode (GFSK) (Fundamental Power): Pass

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2402	0.000928

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2441	0.000928

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2480	0.000905

Results of Bluetooth Communication mode ($\pi/4$ -DQPSK) (Fundamental Power) : Pass

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2402	0.001577

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2441	0.001578

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2480	0.001541

Results of Bluetooth Communication mode (8DPSK) (Fundamental Power) : Pass

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2402	0.001698

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2441	0.001718

Transmitter Frequency (MHz)	Maximum conducted output power (Watt)
2480	0.001682

Calculated measurement uncertainty : 30MHz to 1GHz 1.7dB
1GHz to 18GHz 1.7dB

Remark:

1. All test data for each data rate were verified, but only the worst case was reported.
2. The EUT is programmed to transmit signals continuously for all testing.

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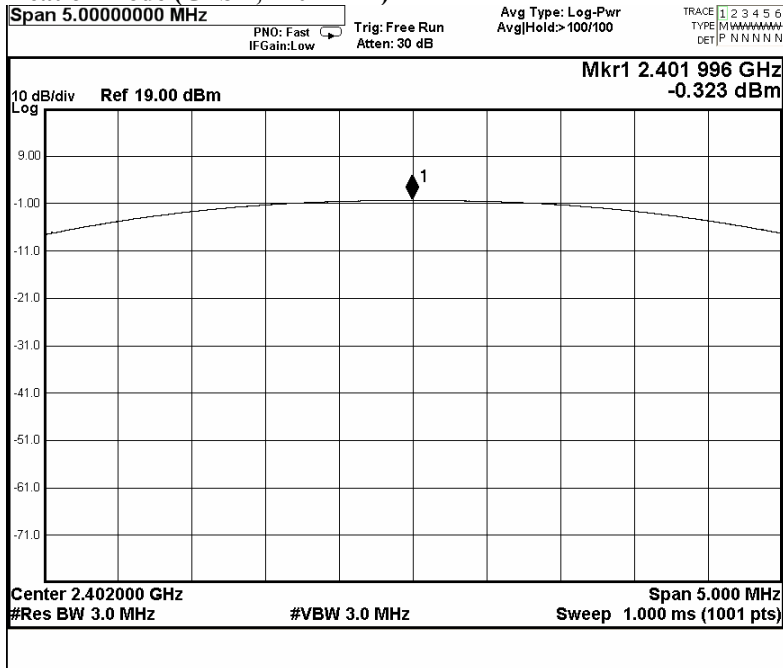
Test Report

Date : 2021-12-30
No. : HMD21120027

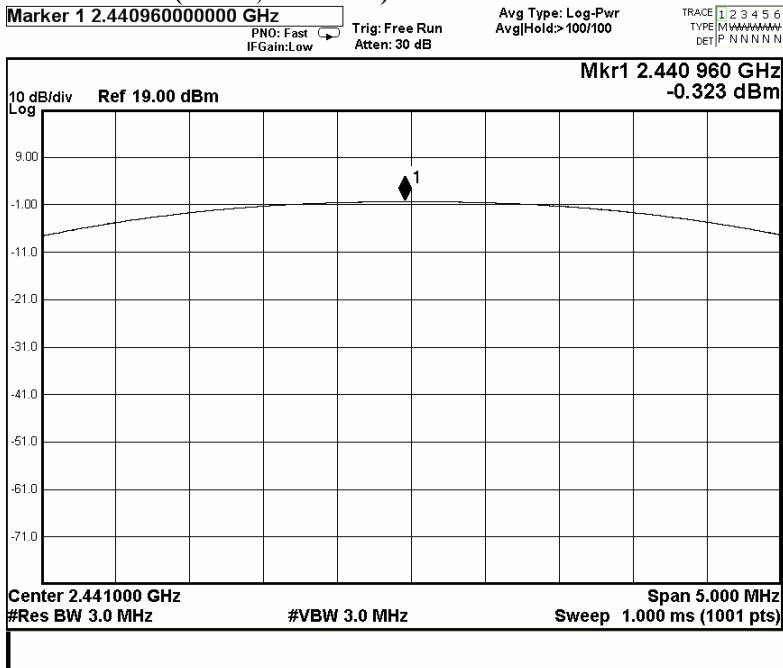
Page 10 of 90

Test plot of Maximum Peak Conducted Output Power:

Bluetooth Communication mode (GFSK, 2402MHz)



Bluetooth Communication mode (GFSK, 2441MHz)



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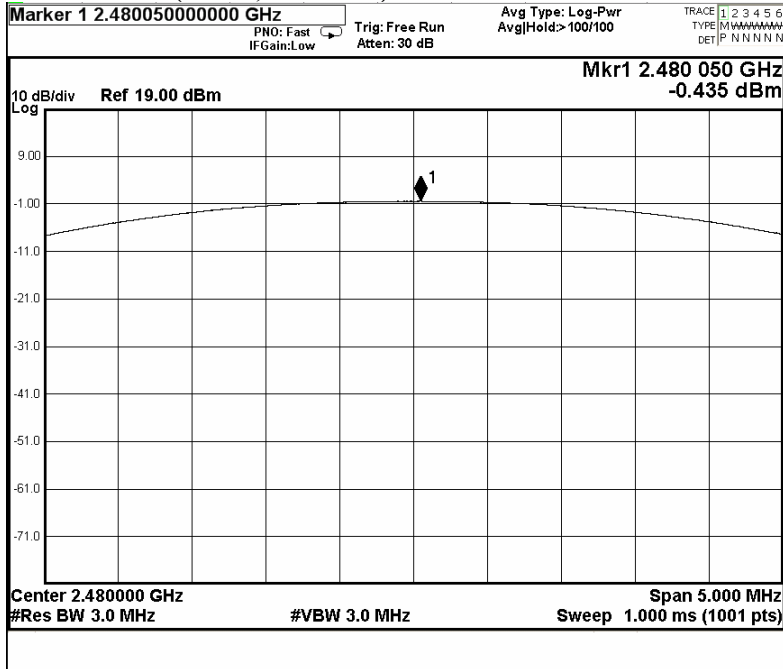


Test Report

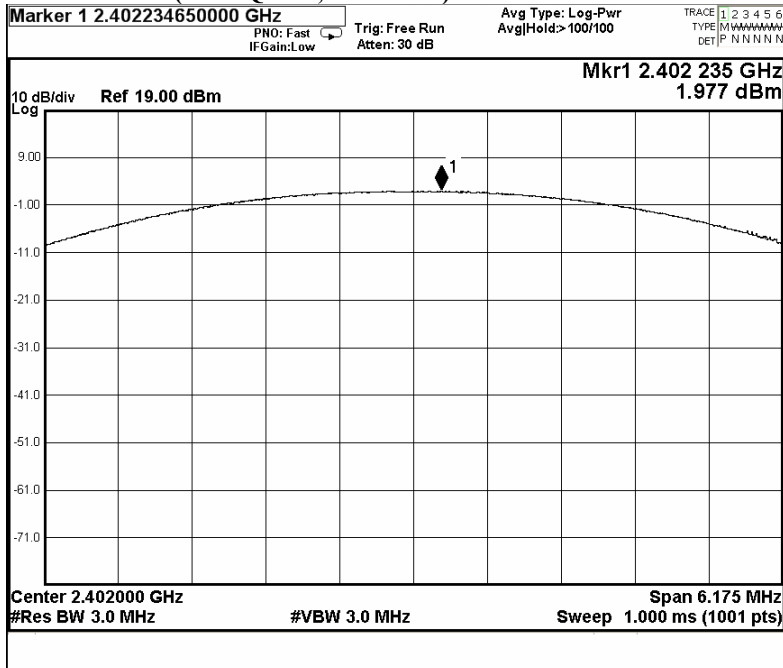
Date : 2021-12-30
No. : HMD21120027

Page 11 of 90

Bluetooth Communication mode (GFSK, 2480MHz)



Bluetooth Communication mode ($\pi/4$ DQPSK, 2402MHz)



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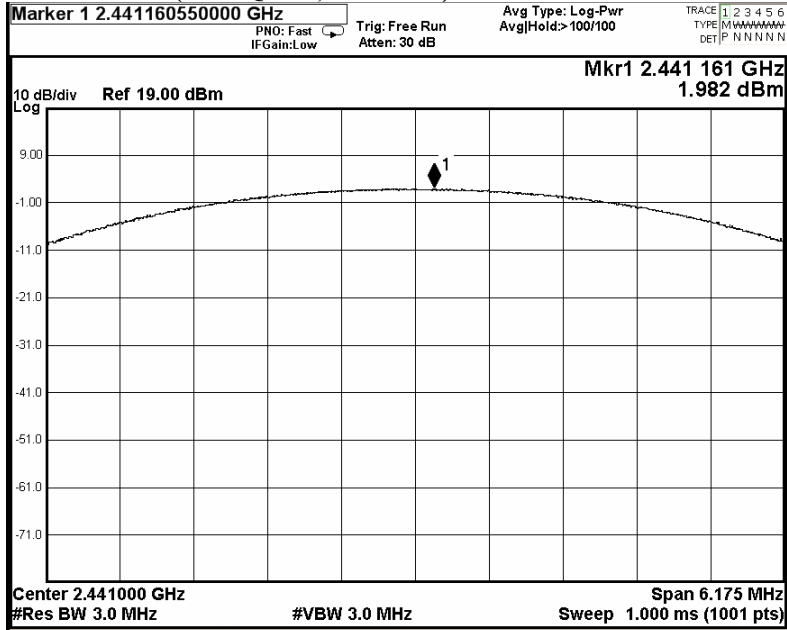


Test Report

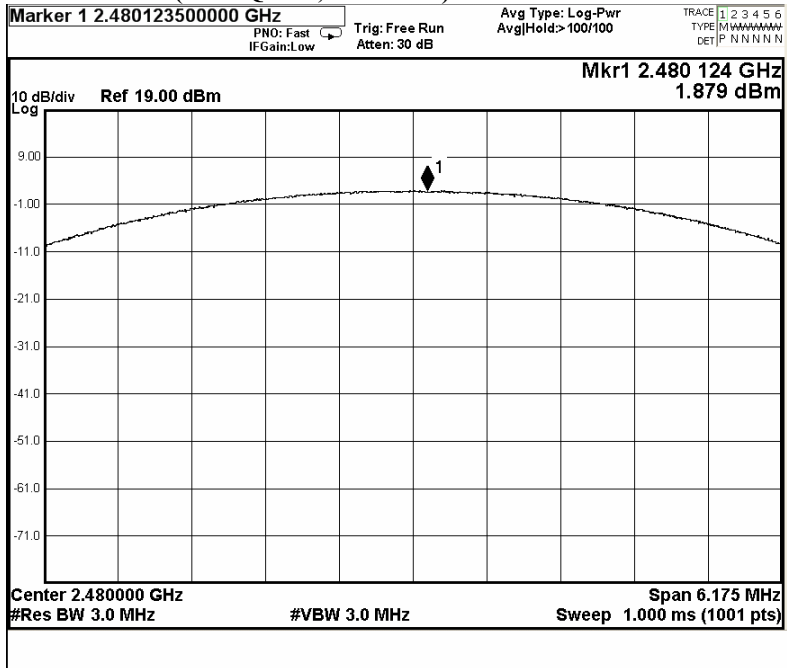
Date : 2021-12-30
No. : HMD21120027

Page 12 of 90

Bluetooth Communication mode ($\pi/4$ DQPSK, 2441MHz)



Bluetooth Communication mode ($\pi/4$ DQPSK, 2480MHz)



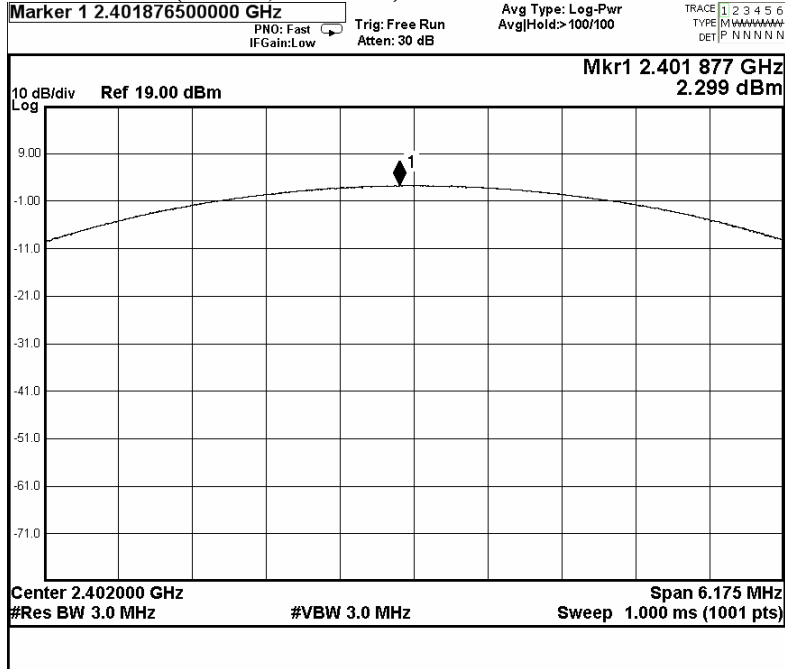


Test Report

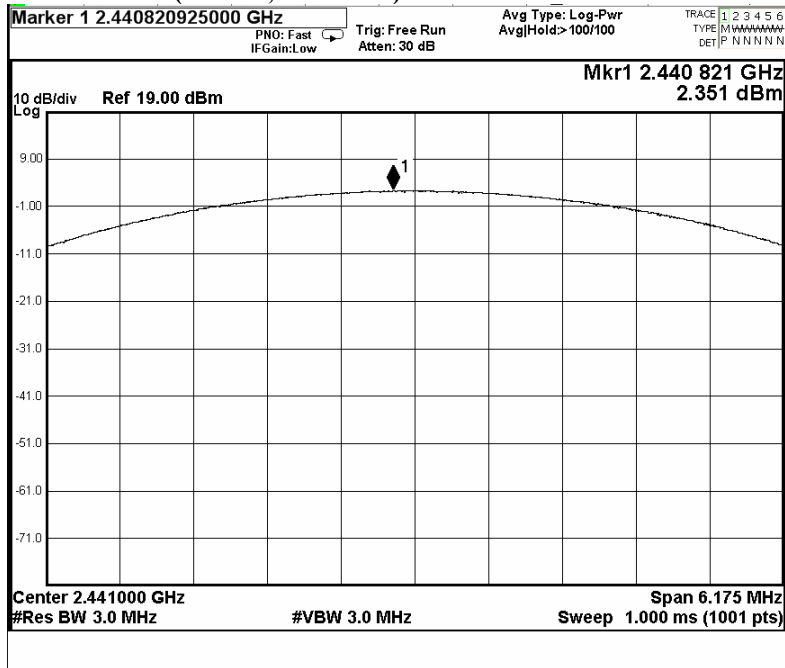
Date : 2021-12-30
No. : HMD21120027

Page 13 of 90

Bluetooth Communication mode (8DPSK, 2402MHz)



Bluetooth Communication mode (8DPSK, 2441MHz)



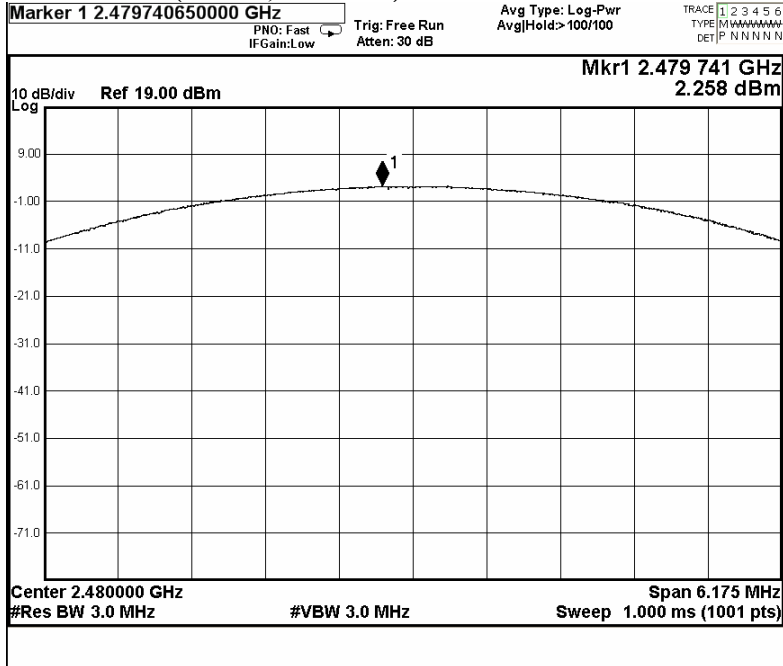


Test Report

Date : 2021-12-30
No. : HMD21120027

Page 14 of 90

Bluetooth Communication mode (8DPSK, 2480MHz)





Test Report

Date : 2021-12-30
No. : HMD21120027

Page 15 of 90

3.1.2 Radiated Spurious Emissions

Test Requirement: FCC 47CFR 15.209
Test Method: ANSI C63.10:2013
Test Date: 2021-12-14 to 2021-12-23
Mode of Operation: Tx mode / Bluetooth play mode (GFSK)

Ambient Temperature: 26.8°C Relative Humidity: 43.9% Atmospheric Pressure: 100.8 kPa

Test Method:

For emission measurements at or below 1 GHz, the sample was placed 0.8m above the ground plane of semi-anechoic Chamber*. For emission measurements above 1 GHz, the sample was placed 1.5m above the ground plane of semi-anechoic Chamber*. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages.

* Semi-Anechoic chamber located on the G/F of The Hong Kong Standards and Testing Centre Ltd. with a metal ground plane filed with the FCC pursuant to section 2.948 of the FCC rules, with Registration Number: 607756.

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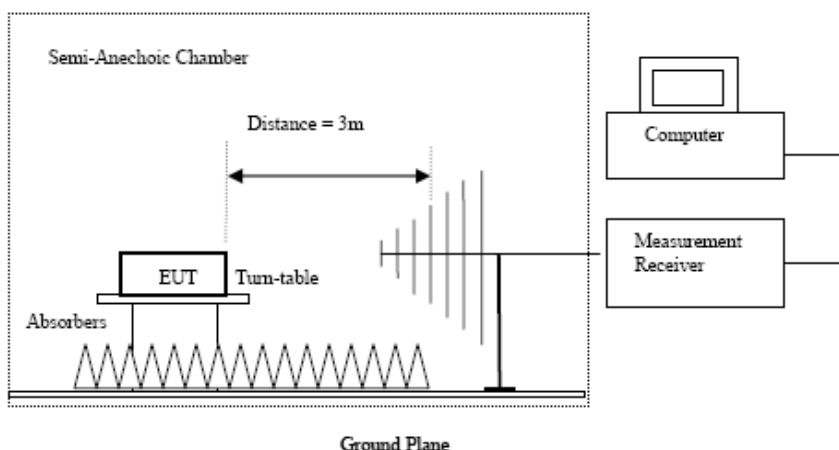
Date : 2021-12-30
No. : HMD21120027

Page 16 of 90

Spectrum Analyzer Setting:

9KHz – 30MHz (Pk & Av)	RBW: 10kHz VBW: 30kHz Sweep: Auto Span: Fully capture the emissions being measured Trace: Max. hold
30MHz – 1GHz (QP)	RBW: 120kHz VBW: 120kHz Sweep: Auto Span: Fully capture the emissions being measured Trace: Max. hold
Above 1GHz (Pk)	RBW: 1MHz VBW: 1MHz Sweep: Auto Span: Fully capture the emissions being measured Trace: Max. hold
Above 1GHz (Av)	RBW: 1MHz VBW: 10Hz Sweep: Auto Span: Fully capture the emissions being measured Trace: Max. hold

Test Setup:



- Absorbers placed on top of the ground plane are for measurements above 1000MHz only.
- Measurements between 30MHz to 1000MHz made with Bi-log antennas, above 1000MHz horn antennas are used, 9kHz to 30MHz loop antennas are used.

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Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 17 of 90

Limits for Radiated Emissions FCC 47 CFR 15.247 Class B):

Frequency Range [MHz]	Quasi-Peak Limits [μV/m]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above960	500

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Result of Tx mode (2402.0 MHz) (GFSK) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2402.0 MHz) (GFSK) (Above 1GHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBμV	Correction Factor dB/m	Field Strength dBμV/m	Limit @3m dBμV/m	Margin dB	E-Field Polarity
4804.0	61.3	0.82	62.1	74.0	11.9	Vertical
4804.0	58.9	0.52	59.4	74.0	14.6	Horizontal
7206.0	49.3	7	56.3	74.0	17.7	Vertical
7206.0	49.4	6.5	55.9	74.0	18.1	Horizontal
9608.0	47.2	8.5	55.7	74.0	18.4	Vertical
9608.0	46.9	8.3	55.2	74.0	18.8	Horizontal
12010.0	44.9	10.9	55.8	74.0	18.2	Vertical
12010.0	45.3	10.8	56.1	74.0	18.0	Horizontal

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Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 18 of 90

Field Strength of Spurious Emissions						
Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4804.0	41.8	0.8	42.6	54.0	11.4	Vertical
4804.0	40.6	0.5	41.2	54.0	12.8	Horizontal
7206.0	31.6	7.0	38.6	54.0	15.4	Vertical
7206.0	31.7	6.5	38.2	54.0	15.8	Horizontal
9608.0	29.7	8.5	38.2	54.0	15.8	Vertical
9608.0	30.1	8.3	38.4	54.0	15.6	Horizontal
12010.0	27.9	10.9	38.8	54.0	15.2	Vertical
12010.0	28.2	10.8	39.04	54.0	15.0	Horizontal

Result of Tx mode (2441.0 MHz) (GFSK) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2441.0 MHz) (GFSK) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4882.0	61.4	0.8	62.2	74.0	11.8	Vertical
4882.0	59.5	0.5	60.0	74.0	14.0	Horizontal
7223.0	49.3	7.0	56.3	74.0	17.8	Vertical
7223.0	50.6	6.5	57.1	74.0	16.9	Horizontal
9764.0	47.4	8.5	55.9	74.0	18.1	Vertical
9764.0	47.0	8.3	55.3	74.0	18.7	Horizontal
12205.0	45.2	10.9	56.1	74.0	17.9	Vertical
12205.0	45.1	10.8	55.9	74.0	18.1	Horizontal

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Test Report

Date : 2021-12-30

Page 19 of 90

No. : HMD21120027

Field Strength of Spurious Emissions						
Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dB	E-Field Polarity
4882.0	42.2	0.8	43.0	54.0	11.0	Vertical
4882.0	40.7	0.52	41.3	54.0	12.7	Horizontal
7323.0	32.4	7	39.4	54.0	14.6	Vertical
7323.0	33.3	6.5	39.8	54.0	14.2	Horizontal
9764.0	30.9	8.5	39.4	54.0	14.7	Vertical
9764.0	30.8	8.3	39.1	54.0	15.0	Horizontal
12205.0	28.3	10.9	39.2	54.0	14.8	Vertical
12205.0	28.3	10.8	39.1	54.0	15.0	Horizontal

Result of Tx mode (2480.0 MHz) (GFSK) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2480.0 MHz) (GFSK) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4960.0	61.5	0.8	62.3	74.0	11.7	Vertical
4960.0	60.5	0.5	61.1	74.0	13.0	Horizontal
7440.0	50.8	7.0	57.8	74.0	16.2	Vertical
7440.0	51.8	6.5	58.3	74.0	15.8	Horizontal
9920.0	47.3	8.5	55.8	74.0	18.2	Vertical
9920.0	47.2	8.3	55.5	74.0	18.5	Horizontal
12400.0	45.2	10.9	56.1	74.0	18.0	Vertical
12400.0	45.1	10.8	55.9	74.0	18.1	Horizontal

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Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 20 of 90

Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4960.0	41.2	0.8	42.0	54.0	12.0	Vertical
4960.0	40.6	0.5	41.1	54.0	12.9	Horizontal
7440.0	33.6	7.0	40.6	54.0	13.4	Vertical
7440.0	34.7	6.5	41.2	54.0	12.8	Horizontal
9920.0	30.9	8.5	39.4	54.0	14.6	Vertical
9920.0	31.0	8.3	39.3	54.0	14.7	Horizontal
12400.0	28.3	10.9	39.2	54.0	14.8	Vertical
12400.0	28.7	10.8	39.5	54.0	14.5	Horizontal

Result of Tx mode (2402.0 MHz) ($\pi/4$ -DQPSK) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2402.0 MHz) ($\pi/4$ -DQPSK) (Above 1GHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4804.0	61.5	0.82	62.4	74.0	11.6	Vertical
4804.0	61.3	0.52	61.8	74.0	12.2	Horizontal
7206.0	50.3	7	57.3	74.0	16.7	Vertical
7206.0	51.8	6.5	58.3	74.0	15.7	Horizontal
9608.0	47.2	8.5	55.7	74.0	18.3	Vertical
9608.0	47.3	8.3	55.6	74.0	18.4	Horizontal
12010.0	45.4	10.9	56.3	74.0	17.8	Vertical
12010.0	45.3	10.8	56.1	74.0	18.0	Horizontal

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Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 21 of 90

Field Strength of Spurious Emissions						
Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4804.0	41.5	0.8	42.3	54.0	11.7	Vertical
4804.0	41.7	0.5	42.2	54.0	11.8	Horizontal
7206.0	34.4	7.0	41.4	54.0	12.6	Vertical
7206.0	34.9	6.5	41.4	54.0	12.6	Horizontal
9608.0	31.1	8.5	39.6	54.0	14.4	Vertical
9608.0	31.0	8.3	39.3	54.0	14.7	Horizontal
12010.0	29.2	10.9	40.1	54.0	13.9	Vertical
12010.0	29.3	10.8	40.11	54.0	13.9	Horizontal

Result of Tx mode (2441.0 MHz) ($\pi/4$ -DQPSK) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2441.0 MHz) ($\pi/4$ -DQPSK) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4882.0	61.6	0.8	62.5	74.0	11.5	Vertical
4882.0	61.6	0.5	62.1	74.0	11.9	Horizontal
7223.0	50.3	7.0	57.3	74.0	16.8	Vertical
7223.0	50.6	6.5	57.1	74.0	16.9	Horizontal
9764.0	47.3	8.5	55.8	74.0	18.2	Vertical
9764.0	47.4	8.3	55.7	74.0	18.3	Horizontal
12205.0	45.3	10.9	56.2	74.0	17.8	Vertical
12205.0	45.4	10.8	56.2	74.0	17.8	Horizontal

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 22 of 90

Field Strength of Spurious Emissions						
Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dB	E-Field Polarity
4882.0	41.8	0.8	42.6	54.0	11.4	Vertical
4882.0	41.8	0.52	42.3	54.0	11.7	Horizontal
7323.0	33.3	7	40.3	54.0	13.7	Vertical
7323.0	34.1	6.5	40.6	54.0	13.4	Horizontal
9764.0	30.6	8.5	39.1	54.0	15.0	Vertical
9764.0	30.9	8.3	39.2	54.0	14.8	Horizontal
12205.0	29.7	10.9	40.6	54.0	13.4	Vertical
12205.0	29.5	10.8	40.3	54.0	13.7	Horizontal

Result of Tx mode (2480.0 MHz) ($\pi/4$ -DQPSK) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2480.0 MHz) ($\pi/4$ -DQPSK) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4960.0	61.5	0.8	62.3	74.0	11.7	Vertical
4960.0	60.9	0.5	61.4	74.0	12.6	Horizontal
7440.0	50.6	7.0	57.6	74.0	16.4	Vertical
7440.0	50.8	6.5	57.3	74.0	16.8	Horizontal
9920.0	47.1	8.5	55.6	74.0	18.4	Vertical
9920.0	46.75	8.3	55.1	74.0	19.0	Horizontal
12400.0	45.3	10.9	56.2	74.0	17.8	Vertical
12400.0	45.3	10.8	56.1	74.0	17.9	Horizontal

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Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 23 of 90

Field Strength of Spurious Emissions						
Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4960.0	41.1	0.8	41.9	54.0	12.1	Vertical
4960.0	41.5	0.5	42.0	54.0	12.0	Horizontal
7440.0	33.4	7.0	40.4	54.0	13.6	Vertical
7440.0	35.1	6.5	41.6	54.0	12.4	Horizontal
9920.0	30.7	8.5	39.2	54.0	14.8	Vertical
9920.0	30.8	8.3	39.1	54.0	14.9	Horizontal
12400.0	29.1	10.9	40.0	54.0	14.0	Vertical
12400.0	29.5	10.8	40.3	54.0	13.7	Horizontal

Result of Tx mode (2402.0 MHz) (8DPSK) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2402.0 MHz) (8DPSK) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4804.0	61.0	0.82	61.9	74.0	12.2	Vertical
4804.0	61.7	0.52	62.3	74.0	11.7	Horizontal
7206.0	50.3	7	57.3	74.0	16.7	Vertical
7206.0	50.4	6.5	56.9	74.0	17.1	Horizontal
9608.0	47.2	8.5	55.7	74.0	18.3	Vertical
9608.0	46.8	8.3	55.1	74.0	18.9	Horizontal
12010.0	45.2	10.9	56.1	74.0	17.9	Vertical
12010.0	45.5	10.8	56.3	74.0	17.8	Horizontal

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 24 of 90

Field Strength of Spurious Emissions						
Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4804.0	40.6	0.8	41.4	54.0	12.6	Vertical
4804.0	40.9	0.5	41.4	54.0	12.6	Horizontal
7206.0	33.2	7.0	40.2	54.0	13.8	Vertical
7206.0	33.0	6.5	39.5	54.0	14.6	Horizontal
9608.0	31.2	8.5	39.7	54.0	14.4	Vertical
9608.0	31.0	8.3	39.3	54.0	14.7	Horizontal
12010.0	29.1	10.9	40.0	54.0	14.0	Vertical
12010.0	29.4	10.8	40.16	54.0	13.8	Horizontal

Result of Tx mode (2441.0 MHz) (8DPSK) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2441.0 MHz) (8DPSK) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4882.0	61.4	0.8	62.2	74.0	11.8	Vertical
4882.0	61.5	0.5	62.0	74.0	12.0	Horizontal
7223.0	50.3	7.0	57.3	74.0	16.7	Vertical
7223.0	50.7	6.5	57.2	74.0	16.8	Horizontal
9764.0	47.1	8.5	55.6	74.0	18.4	Vertical
9764.0	46.9	8.3	55.2	74.0	18.9	Horizontal
12205.0	45.2	10.9	56.1	74.0	18.0	Vertical
12205.0	45.5	10.8	56.3	74.0	17.7	Horizontal

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 25 of 90

Field Strength of Spurious Emissions						
Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dB	E-Field Polarity
4882.0	41.4	0.8	42.2	54.0	11.8	Vertical
4882.0	40.9	0.52	41.5	54.0	12.5	Horizontal
7323.0	33.6	7	40.6	54.0	13.4	Vertical
7323.0	33.8	6.5	40.3	54.0	13.7	Horizontal
9764.0	30.6	8.5	39.1	54.0	15.0	Vertical
9764.0	30.6	8.3	38.9	54.0	15.1	Horizontal
12205.0	29.2	10.9	40.1	54.0	13.9	Vertical
12205.0	29.5	10.8	40.3	54.0	13.7	Horizontal

Result of Tx mode (2480.0 MHz) (8FPSK) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the FCC Limits						

Result of Tx mode (2480.0 MHz) (8DPSK) (Above 1GHz): Pass

Field Strength of Spurious Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4960.0	61.3	0.8	62.1	74.0	11.9	Vertical
4960.0	61.2	0.5	61.7	74.0	12.3	Horizontal
7440.0	51.2	7.0	58.2	74.0	15.8	Vertical
7440.0	50.8	6.5	57.3	74.0	16.7	Horizontal
9920.0	47.3	8.5	55.8	74.0	18.3	Vertical
9920.0	47.37	8.3	55.7	74.0	18.3	Horizontal
12400.0	45.4	10.9	56.3	74.0	17.7	Vertical
12400.0	45.3	10.8	56.1	74.0	17.9	Horizontal

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 26 of 90

Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
4960.0	41.2	0.8	42.1	54.0	12.0	Vertical
4960.0	40.6	0.5	41.2	54.0	12.8	Horizontal
7440.0	33.6	7.0	40.6	54.0	13.4	Vertical
7440.0	33.6	6.5	40.1	54.0	13.9	Horizontal
9920.0	30.7	8.5	39.2	54.0	14.8	Vertical
9920.0	31.4	8.3	39.7	54.0	14.3	Horizontal
12400.0	29.2	10.9	40.1	54.0	13.9	Vertical
12400.0	29.3	10.8	40.1	54.0	13.9	Horizontal

Remarks:

No additional spurious emissions found between lowest internal used/generated frequency and 30 MHz

* Denotes restricted band of operation.

Measurements were made using a peak detector. Any emission less than 1000MHz and falling within the restricted bands of FCC Rules Part 15 Section 15.205 and the limits of FCC Rules Part 15 Section 15.209 were applied.

Correction Factor included Antenna Factor and Cable Attenuation.

Calculated measurement uncertainty
(9kHz-30MHz): 2.0dB
(30MHz -1GHz): 4.9dB
(1GHz -6GHz): 4.02dB
(6GHz -26.5GHz): 4.03dB

Emissions in the vertical and horizontal polarizations have been investigated and the worst-case test results are recorded in this report.

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 27 of 90

Radiated Emissions Measurement:

Limit :

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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)).

Result: RF Radiated Emissions (Lowest)-GFSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2390.0	50.1	-4.8	45.3	74.0	28.7	Vertical
2390.0	48.8	-4.7	44.1	74.0	29.9	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2390.0	43.2	-4.8	38.4	54.0	15.6	Vertical
2390.0	42.7	-4.7	38.0	54.0	16.1	Horizontal

Result: RF Radiated Emissions (Highest) -GFSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2483.5	51.3	-4.8	46.5	74.0	27.5	Vertical
2483.5	52.8	-4.7	48.1	74.0	25.9	Horizontal

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Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 28 of 90

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2483.5	43.6	-4.8	38.8	54.0	15.2	Vertical
2483.5	43.3	-4.7	38.6	54.0	15.4	Horizontal

Result: RF Radiated Emissions (Lowest)- $\pi/4$ -DQPSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2390.0	48.8	-4.8	44.0	74.0	30.0	Vertical
2390.0	49.6	-4.7	44.9	74.0	29.2	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2390.0	42.7	-4.8	37.9	54.0	16.1	Vertical
2390.0	43.1	-4.7	38.4	54.0	15.6	Horizontal

Result: RF Radiated Emissions (Highest) - $\pi/4$ -DQPSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2483.5	53.1	-4.8	48.3	74.0	25.7	Vertical
2483.5	52.2	-4.7	47.5	74.0	26.5	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2483.5	43.7	-4.8	38.9	54.0	15.1	Vertical
2483.5	43.0	-4.7	38.3	54.0	15.7	Horizontal



Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 29 of 90

Result: RF Radiated Emissions (Lowest)- 8DPSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2390.0	49.7	-4.8	44.9	74.0	29.1	Vertical
2390.0	48.3	-4.7	43.6	74.0	30.4	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2390.0	43.4	-4.8	38.6	54.0	15.4	Vertical
2390.0	42.8	-4.7	38.1	54.0	16.0	Horizontal

Result: RF Radiated Emissions (Highest) -8DPSK

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2483.5	52.6	-4.8	47.8	74.0	26.2	Vertical
2483.5	53.3	-4.7	48.6	74.0	25.4	Horizontal

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dB μ V	Correction Factor dB/m	Field Strength dB μ V/m	Limit @3m dB μ V/m	Margin dB	E-Field Polarity
2483.5	43.5	-4.8	38.7	54.0	15.3	Vertical
2483.5	44.1	-4.7	39.4	54.0	14.6	Horizontal



Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 30 of 90

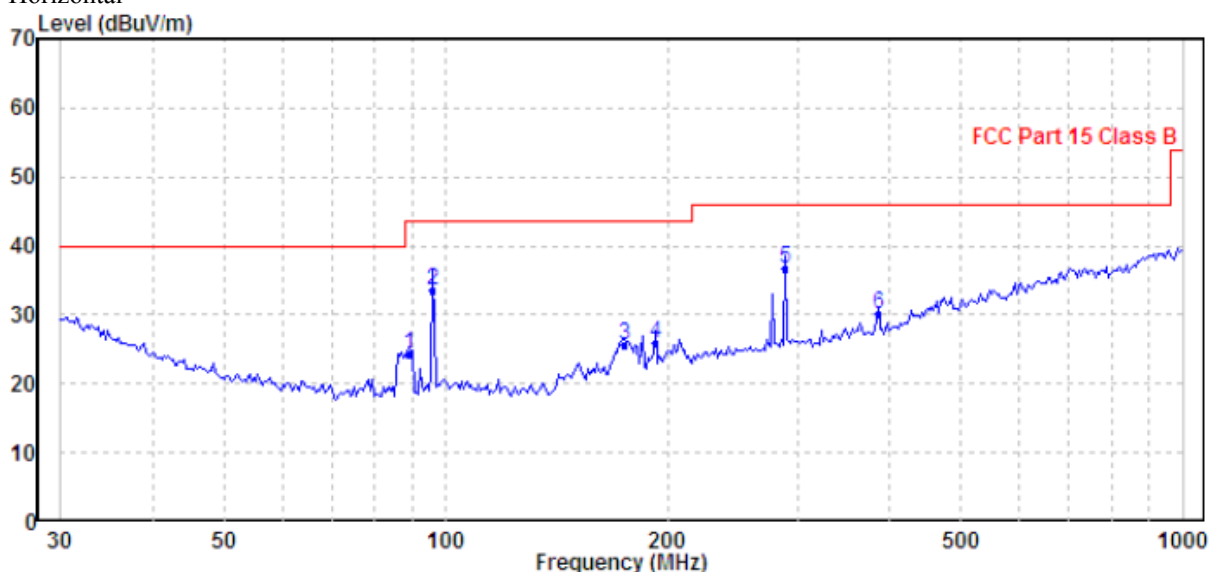
Limits for Radiated Emissions FCC 47 CFR 15.247 Class B]:

Frequency Range	Quasi-Peak Limits
[MHz]	[μ V/m]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above960	500

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Results of Charging+ Bluetooth mode (GFSK 2402.0 MHz) (30MHz – 1GHz): Pass

Horizontal



Ambient Temperature: 22.6C
 Relative Humidity : 49.2%

	Limit	Over			
Freq	Level	Line	Limit	Remark	Pol/Phase
MHz	dBuV/m	dBuV/m	dB		
1	88.964	24.21	43.50	-19.29 QP	Horizontal
2	96.099	33.49	43.50	-10.01 QP	Horizontal
3	174.424	25.50	43.50	-18.00 QP	Horizontal
4	192.419	25.82	43.50	-17.68 QP	Horizontal
5	289.002	36.81	46.00	-9.19 QP	Horizontal
6	385.281	30.09	46.00	-15.91 QP	Horizontal

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Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 31 of 90

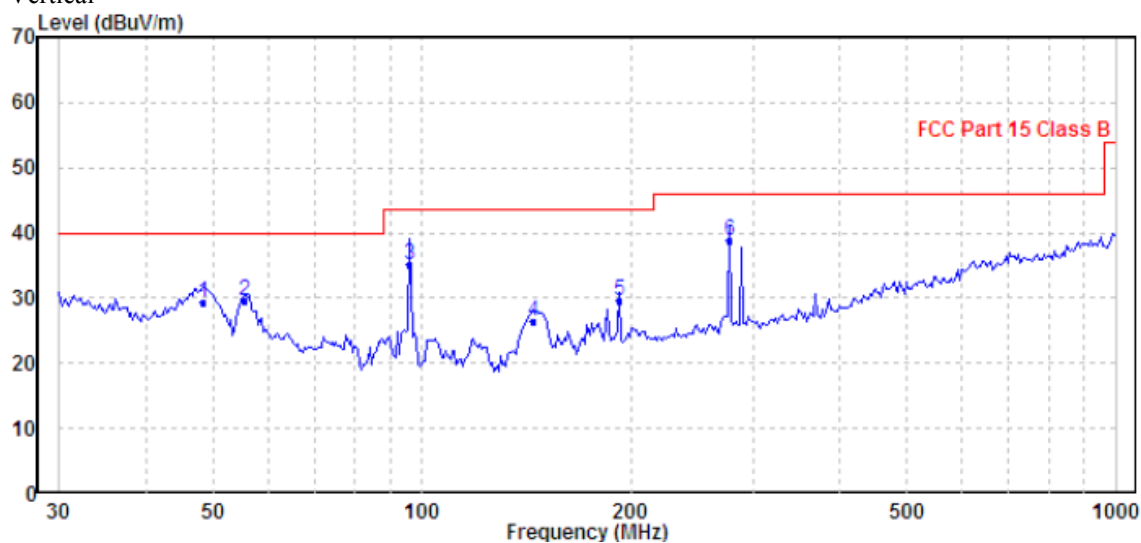
Limits for Radiated Emissions FCC 47 CFR 15.247 Class B]:

Frequency Range [MHz]	Quasi-Peak Limits [μV/m]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above960	500

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Results of Charging+ Bluetooth mode (GFSK 2402.0 MHz) (30MHz – 1GHz): Pass

Vertical



Ambient Temperature: 22.6C
 Relative Humidity : 49.2%

	Freq	Level	Limit	Over	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB		
1	48.332	29.38	40.00	-10.62	QP	Vertical
2	55.609	29.58	40.00	-10.42	QP	Vertical
3	96.099	35.06	43.50	-8.44	QP	Vertical
4	144.335	26.47	43.50	-17.03	QP	Vertical
5	192.419	29.70	43.50	-13.80	QP	Vertical
6	277.094	38.94	46.00	-7.06	QP	Vertical

Remarks: Calculated measurement uncertainty (30MHz – 1GHz): 4.9dB

Emissions in the vertical and horizontal polarizations have been investigated and the worst-case test results are recorded in this report.

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 32 of 90

3.1.3 AC Mains Conducted Emissions (0.15MHz to 30MHz)

Test Requirement:	FCC 47CFR 15.207
Test Method:	ANSI C63.10:2013
Test Date:	2021-12-15
Mode of Operation:	Bluetooth mode
Test Voltage:	120Va.c. 60Hz

Ambient Temperature: 25°C Relative Humidity: 51% Atmospheric Pressure: 101 kPa

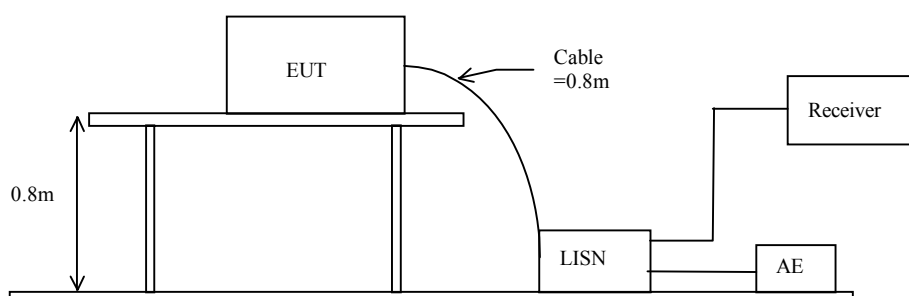
Test Method:

The test was performed in accordance with ANSI C63.10:2013, with the following: an initial measurement was performed in peak and average detection mode on the live line, any emissions recorded within 30dB of the relevant limit line were re-measured using quasi-peak and average detection on the live and neutral lines with the worst case recorded in the table of results.

Receiver Setting:

Bandw. = 9 kHz, Meas. Time= 10.0 ms, Step Width = 5.0kHz
 Detector = MaxPeak and CISPR AV

Test Setup:



Limits for Conducted Emissions (FCC 47 CFR 15.207):

Frequency Range [MHz]	Quasi-Peak Limits [dBμV]	Average [dBμV]
0.15-0.5	66 to 56*	56 to 46*
0.5-5.0	56	46
5.0-30.0	60	50

* Decreases with the logarithm of the frequency.

Remarks:

Calculated measurement uncertainty (0.15MHz – 30MHz): 3.25dB

-*- Emission(s) that is far below the corresponding limit line.



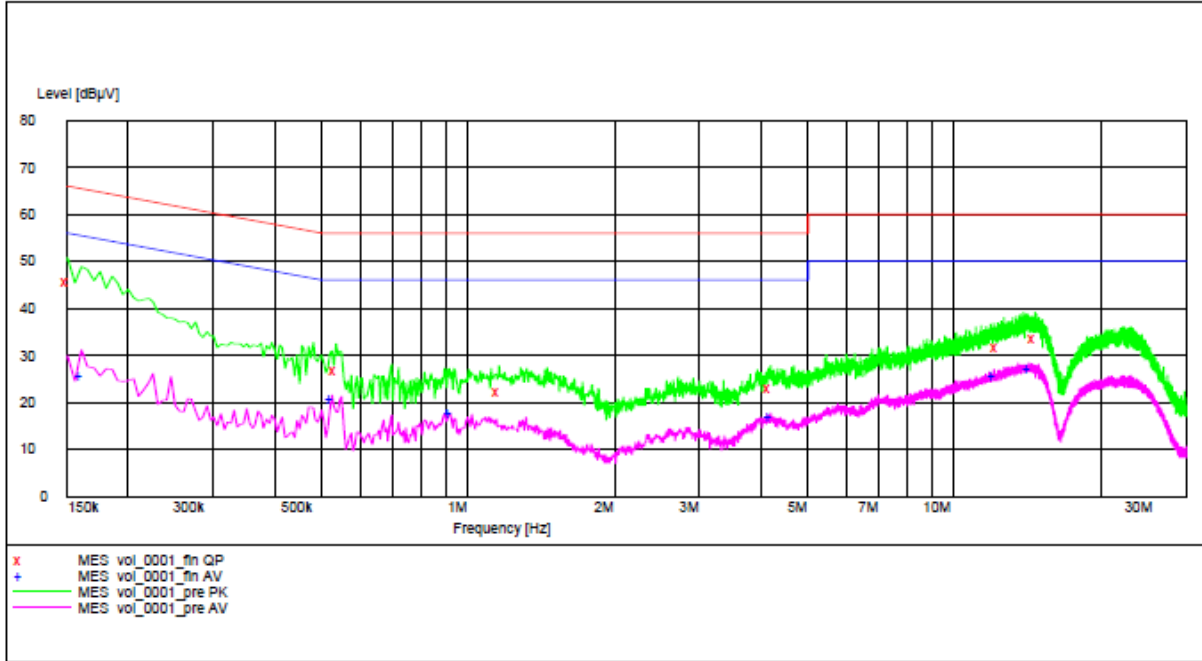
Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 33 of 90

Results of Charging+ Bluetooth mode (L): PASS

Please refer to the following diagram for individual results.



MEASUREMENT RESULT: "vol_0001_fin QP"

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.150000	45.80	9.7	66	20.2	L1	GND
0.535000	26.80	9.7	56	29.2	L1	GND
1.160000	22.20	9.7	56	33.8	L1	GND
4.195000	23.10	9.8	56	32.9	L1	GND
12.295000	31.60	10.1	60	28.4	L1	GND
14.675000	33.50	10.2	60	26.5	L1	GND

MEASUREMENT RESULT: "vol_0001_fin AV"

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.160000	25.70	9.7	56	29.7	L1	GND
0.525000	20.90	9.7	46	25.1	L1	GND
0.920000	17.60	9.7	46	28.4	L1	GND
4.195000	16.80	9.8	46	29.2	L1	GND
12.110000	25.50	10.1	50	24.5	L1	GND
14.255000	27.30	10.2	50	22.7	L1	GND

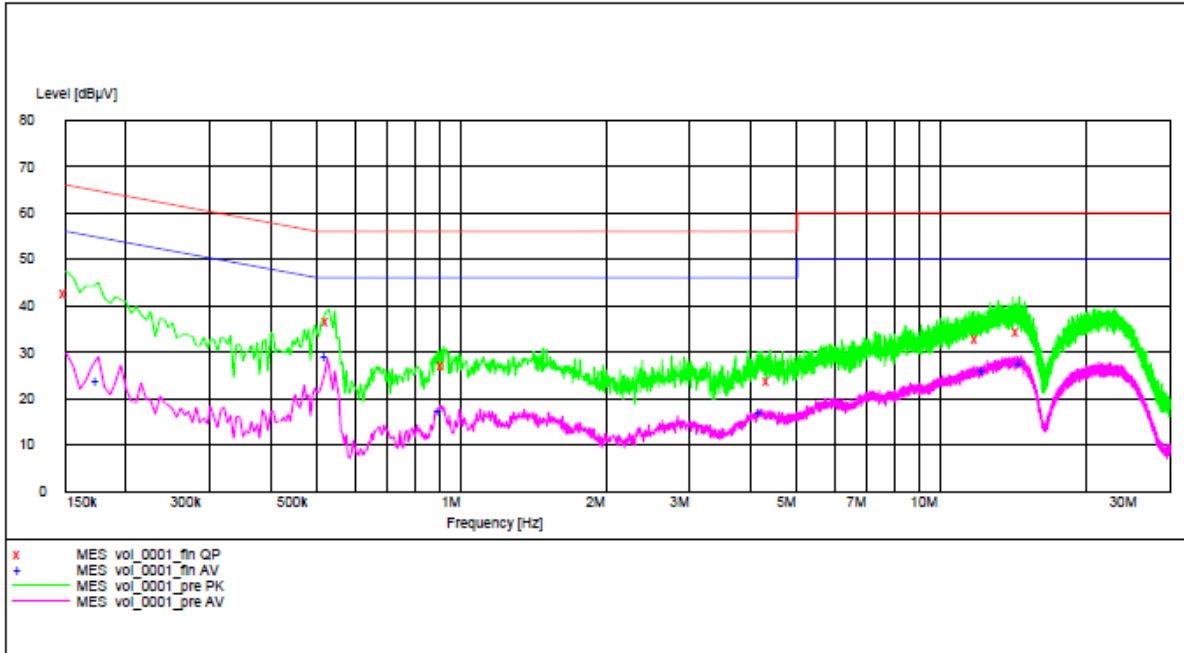
Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 34 of 90

Results of Charging+ Bluetooth mode (N): PASS

Please refer to the following diagram for individual results.



MEASUREMENT RESULT: "vol_0001_fin_QP"

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.150000	42.80	9.7	66	23.2	N	GND
0.530000	36.60	9.7	56	19.4	N	GND
0.920000	27.30	9.7	56	28.7	N	GND
4.400000	23.80	9.8	56	32.2	N	GND
11.965000	32.70	10.1	60	27.3	N	GND
14.565000	34.50	10.2	60	25.5	N	GND

MEASUREMENT RESULT: "vol_0001_fin_AV"

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Line	PE
0.175000	23.60	9.7	55	31.1	N	GND
0.525000	28.90	9.7	46	17.1	N	GND
0.905000	17.40	9.7	46	28.6	N	GND
4.215000	16.80	9.8	46	29.2	N	GND
12.305000	26.00	10.1	50	24.0	N	GND
14.715000	27.40	10.2	50	22.6	N	GND



Test Report

Date : 2021-12-30
No. : HMD21120027

Page 35 of 90

3.1.4 Number of Hopping Frequency

Ambient Temperature: 25°C Relative Humidity: 51% Atmospheric Pressure: 101 kPa

Limit of Number of Hopping Frequency

Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels

Test Method:

The RF output of the EUT was connected to the spectrum analyzer by a low loss cable.

Spectrum Analyzer Setting:

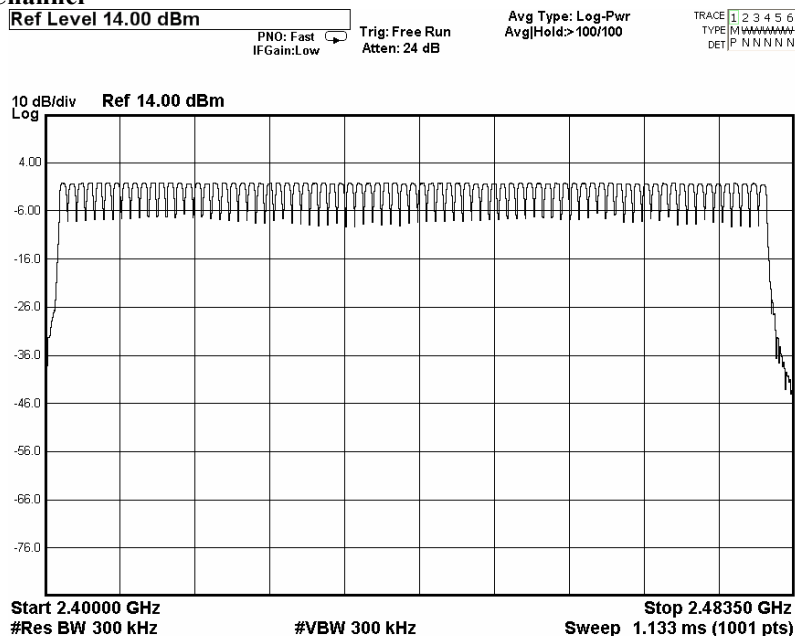
RBW = 300kHz, VBW ≥ RBW, Sweep = Auto, Span = the frequency band of operation
Detector = Peak, Trace = Max. hold

Test Setup:

As Test Setup of clause 3.1.1 in this test report.

Measurement Data:

GFSK: 79 of 79 Channel



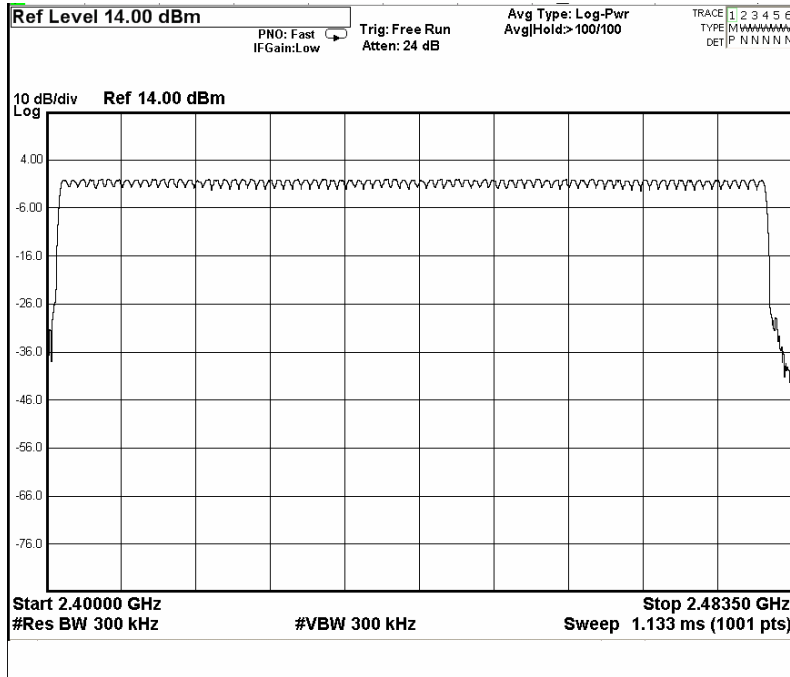


Test Report

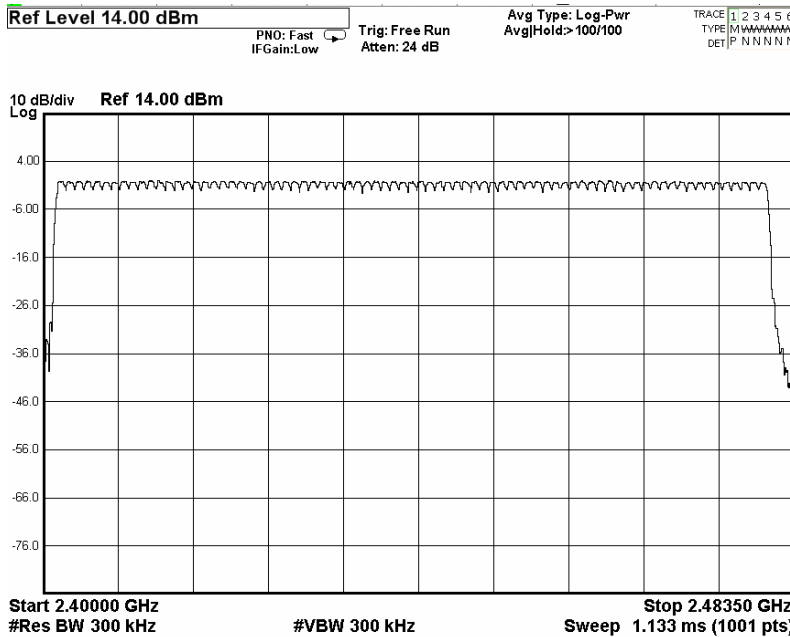
Date : 2021-12-30
No. : HMD21120027

Page 36 of 90

$\pi/4$ -DQPSK: 79 of 79 Channel



8DPSK: 79 of 79 Channel



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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 37 of 90

3.1.5 20dB Bandwidth

Test Requirement: FCC 47CFR 15.247(a)(1)
Test Method: ANSI C63.10:2013
Test Date: 2021-12-21
Mode of Operation: Tx mode

Ambient Temperature: 25°C Relative Humidity: 51% Atmospheric Pressure: 101 kPa

Remark:

The result has been done on all the possible configurations for searching the worst cases.

Test Method:

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency. Once the reference level is established, the equipment is conditioned with typical modulating signal to produce the worst-case (i.e. the widest) bandwidth.

Spectrum Analyzer Setting:

RBW = 30kHz, VBW \geq RBW, Sweep = Auto, Span = two times and five times the OBW
Detector = Peak, Trace = Max. hold

Test Setup:

As Test Setup of clause 3.1.1 in this test report.

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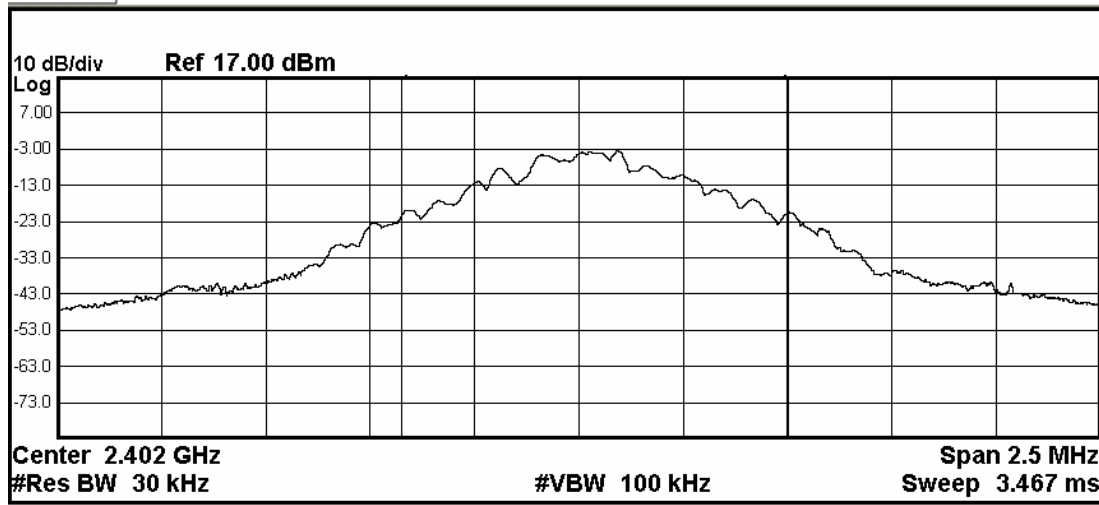
Date : 2021-12-30
 No. : HMD21120027

Page 38 of 90

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2402	1.027	Within 2400-2483.5

(Lowest Operating Frequency) - (GFSK)

Span 2.5000 MHz Center Freq: 2.402000000 GHz Radio Std: None
 #IFGain:Low Trig: Free Run Avg|Hold:>10/10 Radio Device: BTS
 #Atten: 10 dB



Occupied Bandwidth	Total Power	5.49 dBm
921.13 kHz		
Transmit Freq Error	40.495 kHz	OBW Power
x dB Bandwidth	1.027 MHz	99.00 %
	x dB	-20.00 dB



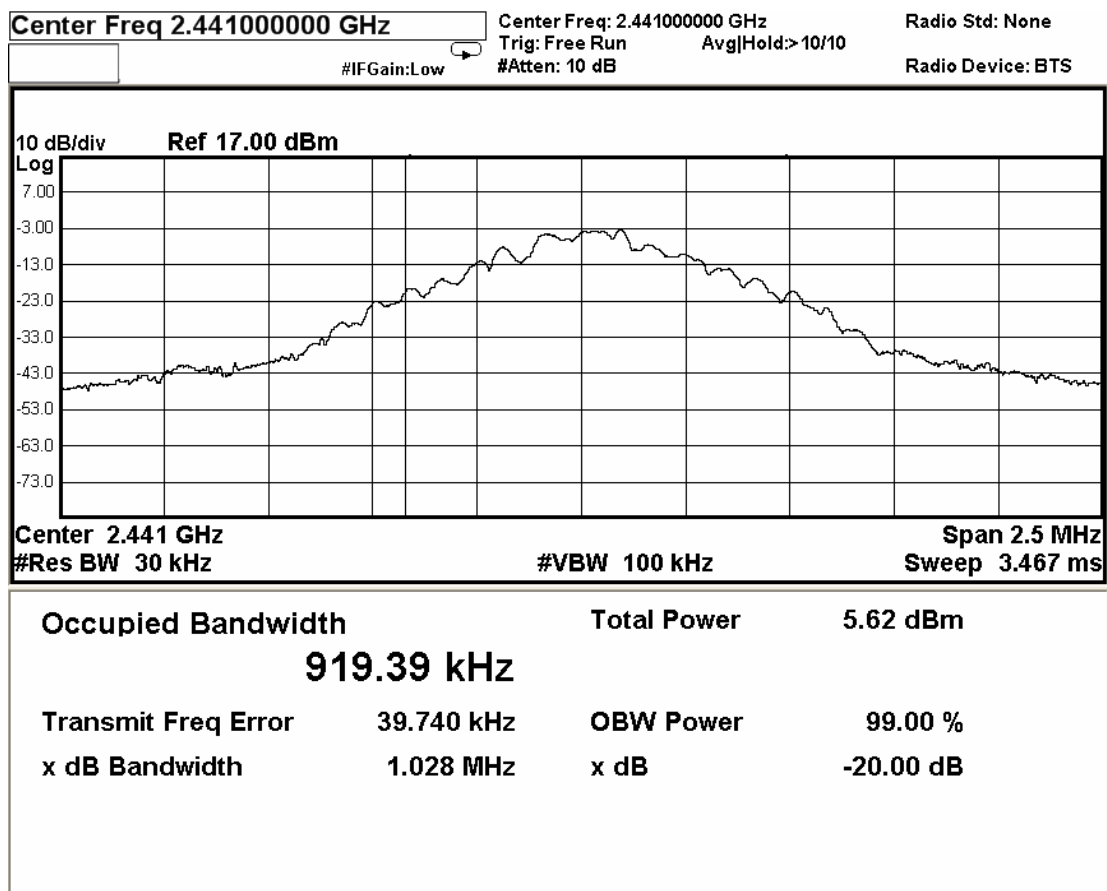
Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 39 of 90

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	1.028	Within 2400-2483.5

(Middle Operating Frequency) - (GFSK)





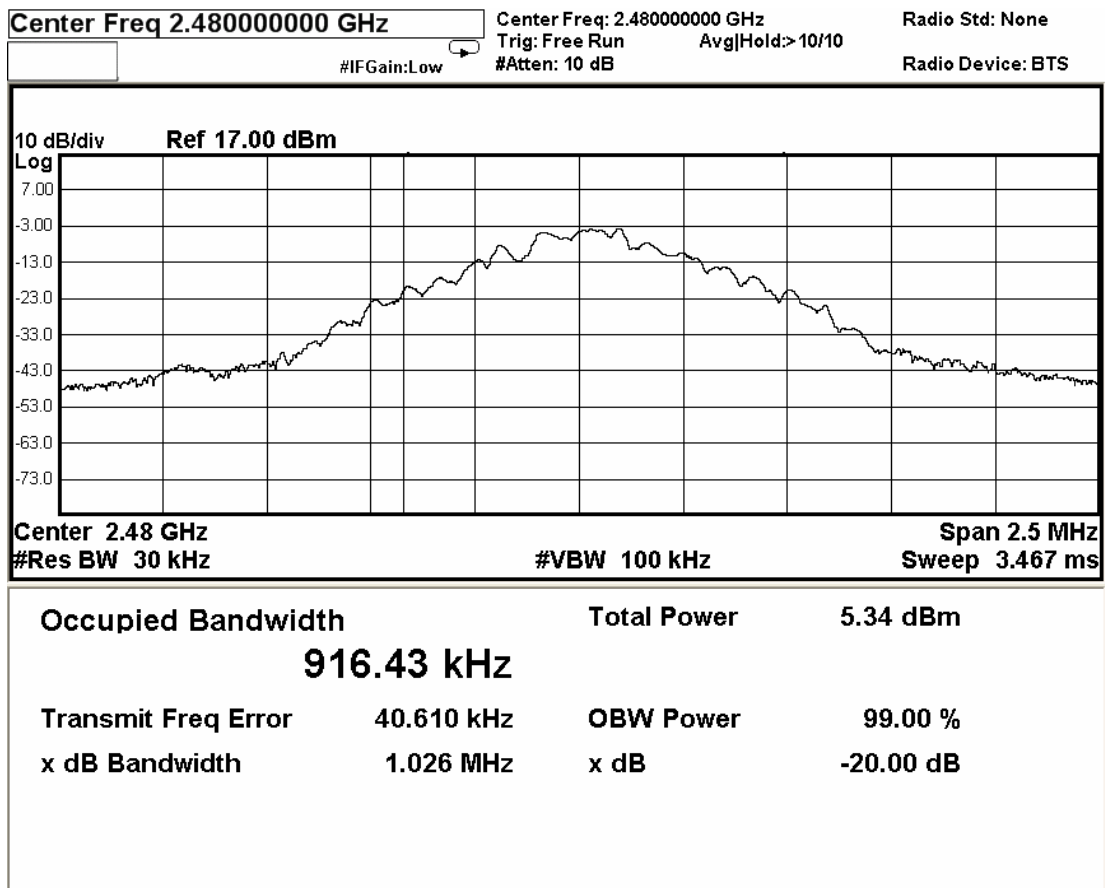
Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 40 of 90

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	1.026	Within 2400-2483.5

(Highest Operating Frequency) - (GFSK)





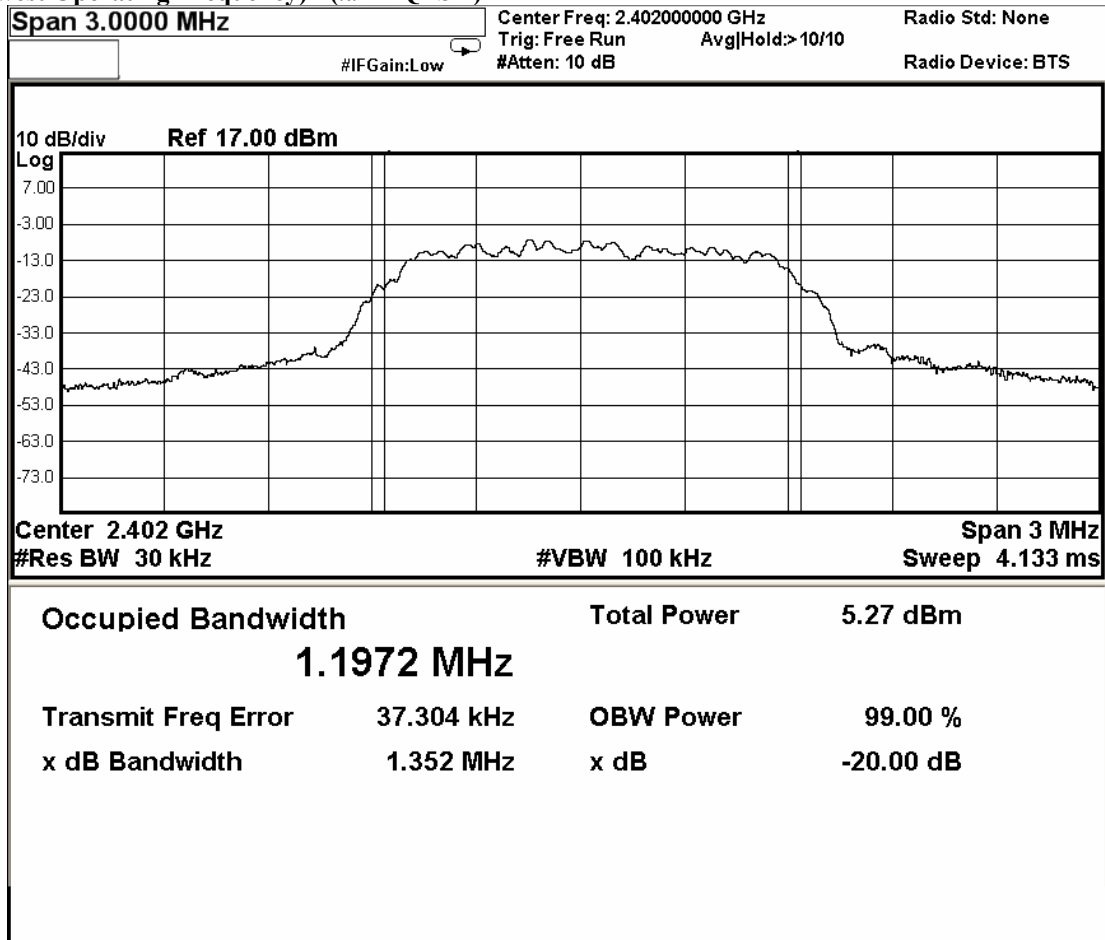
Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 41 of 90

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2402	1.352	Within 2400-2483.5

(Lowest Operating Frequency) - ($\pi/4$ DQPSK)





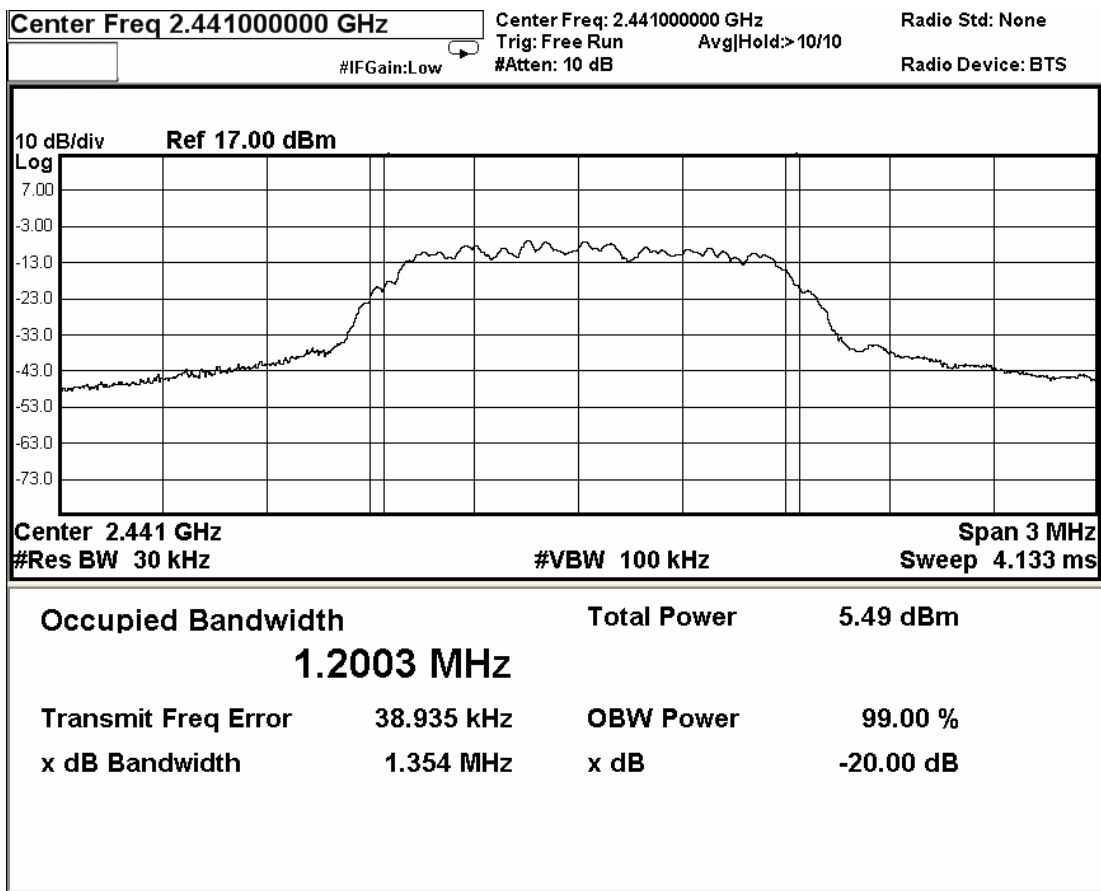
Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 42 of 90

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	1.354	Within 2400-2483.5

(Middle Operating Frequency) - ($\pi/4$ DQPSK)





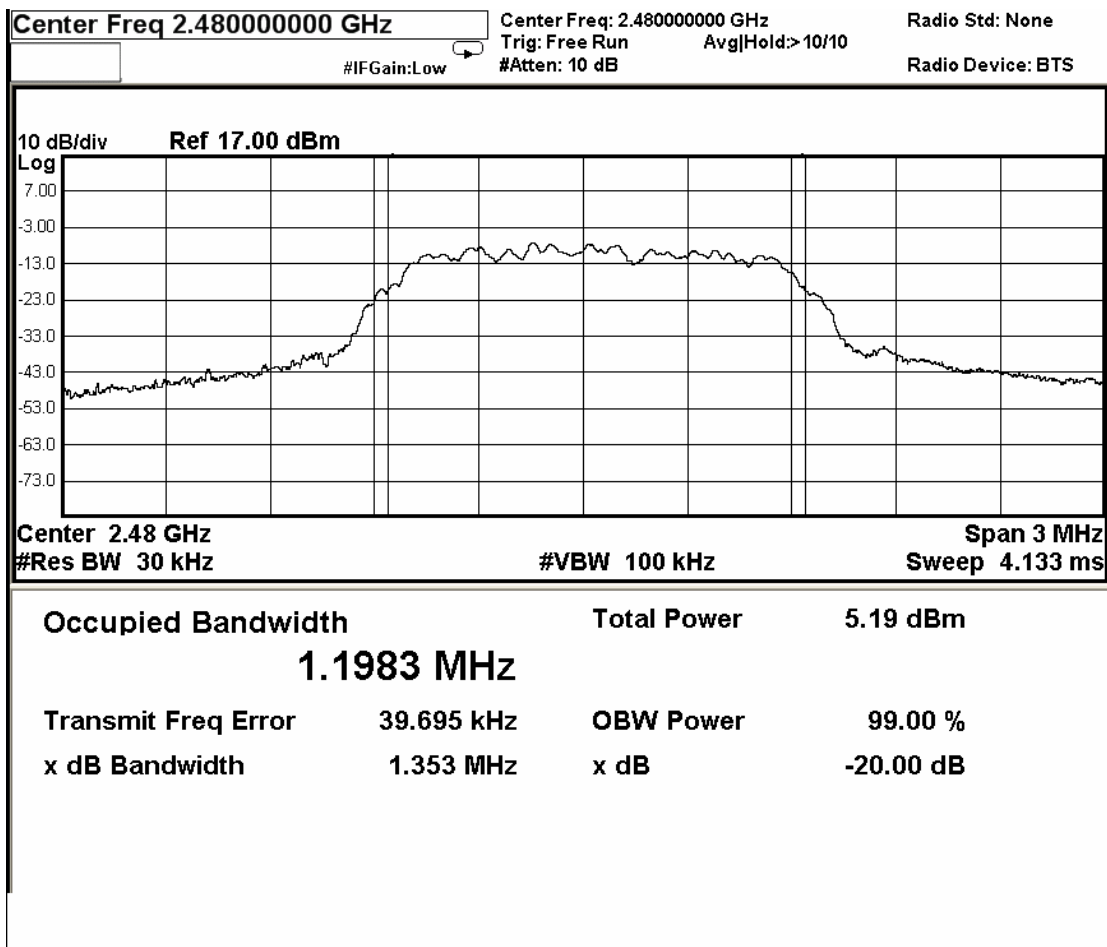
Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 43 of 90

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	1.353	Within 2400-2483.5

(Highest Operating Frequency) - ($\pi/4$ DQPSK)





Test Report

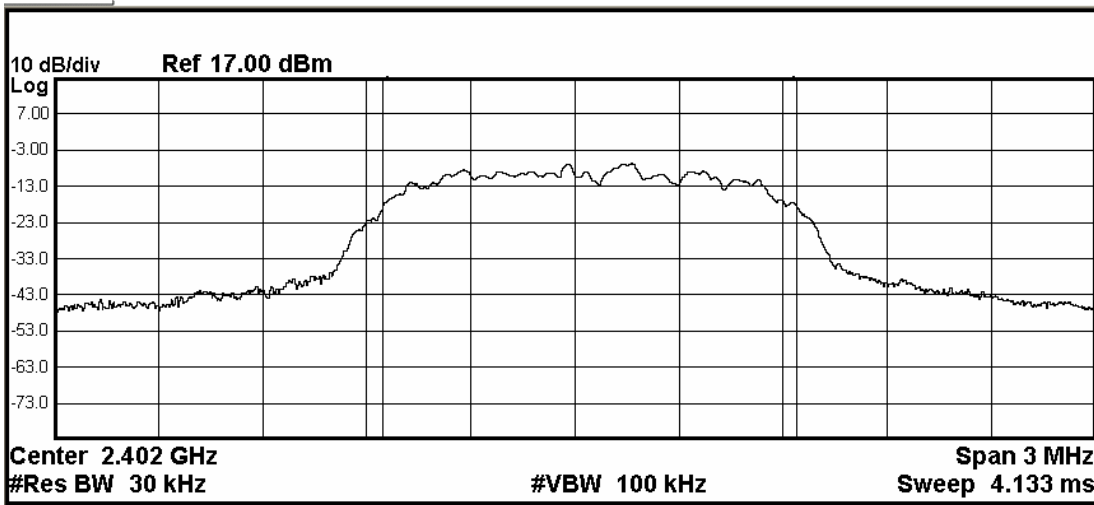
Date : 2021-12-30
 No. : HMD21120027

Page 44 of 90

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2402	1.345	Within 2400-2483.5

(Lowest Operating Frequency) - (8DPSK)

Center Freq **2.40200000 GHz** Center Freq: 2.40200000 GHz Radio Std: None
 Trig: Free Run Avg|Hold:>10/10
 #IFGain:Low #Atten: 10 dB Radio Device: BTS



Occupied Bandwidth	Total Power	5.31 dBm
1.1924 MHz		
Transmit Freq Error	43.687 kHz	OBW Power
x dB Bandwidth	1.345 MHz	99.00 %
	x dB	-20.00 dB



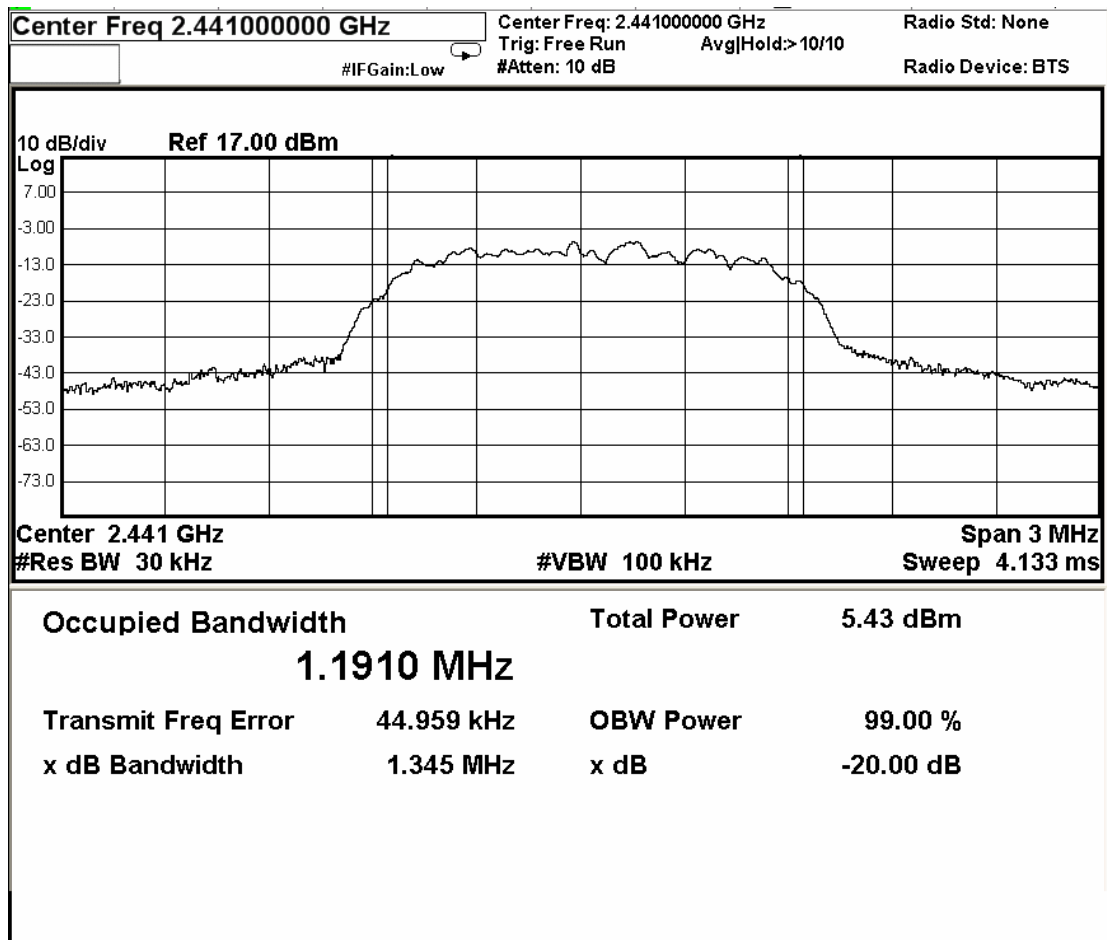
Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 45 of 90

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2441	1.345	Within 2400-2483.5

(Middle Operating Frequency) - (8DPSK)





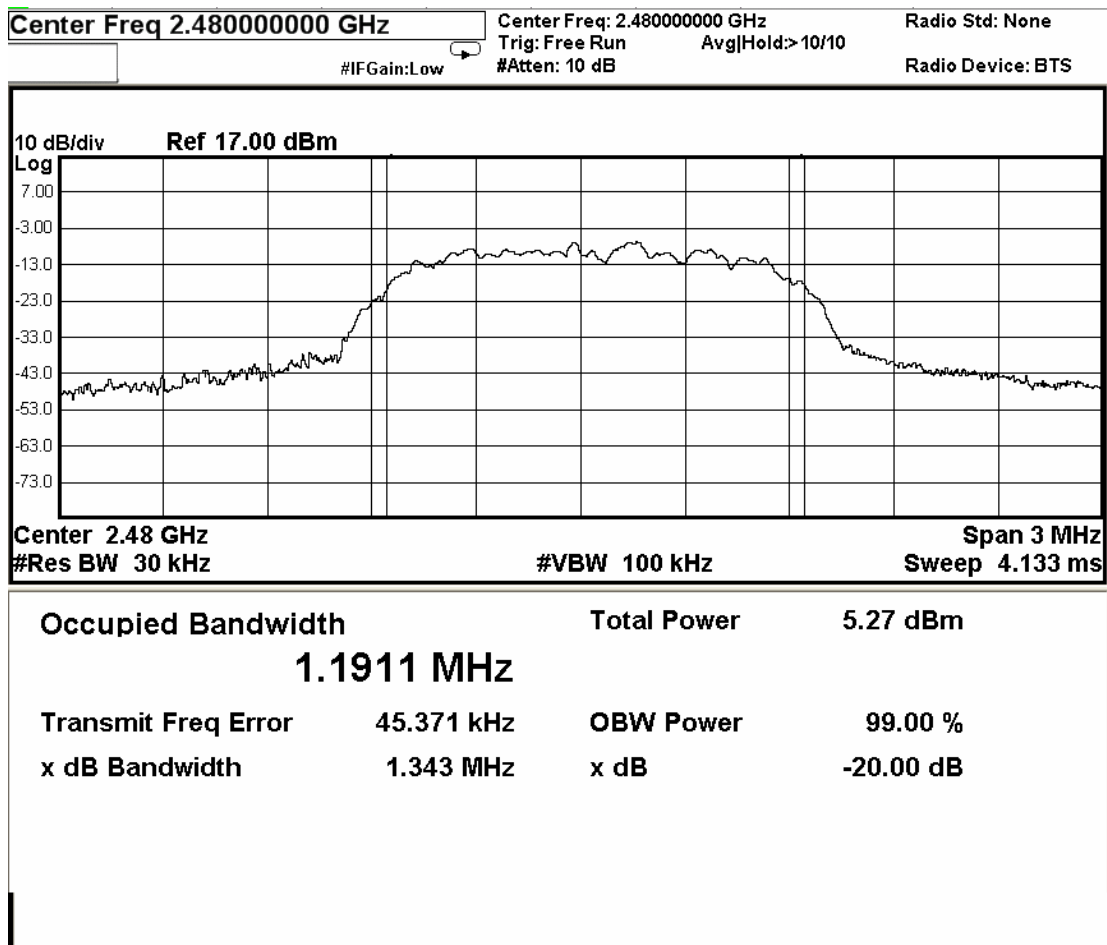
Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 46 of 90

Fundamental Frequency [MHz]	20dB Bandwidth [MHz]	FCC Limits [MHz]
2480	1.343	Within 2400-2483.5

(Highest Operating Frequency) - (8DPSK)





Test Report

Date : 2021-12-30
No. : HMD21120027

Page 47 of 90

3.1.6 Hopping Channel Separation

Ambient Temperature: 25°C

Relative Humidity: 51%

Atmospheric Pressure: 101 kPa

Requirements:

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.

Spectrum Analyzer Setting:

RBW = 300kHz, VBW \geq RBW, Sweep = Auto,
Span = Wide enough to capture the peaks of two adjacent channels
Detector = Peak, Trace = Max. hold

Limit:

The measured maximum bandwidth * 2/3 = 1.354MHz * 2/3 = 902.67kHz

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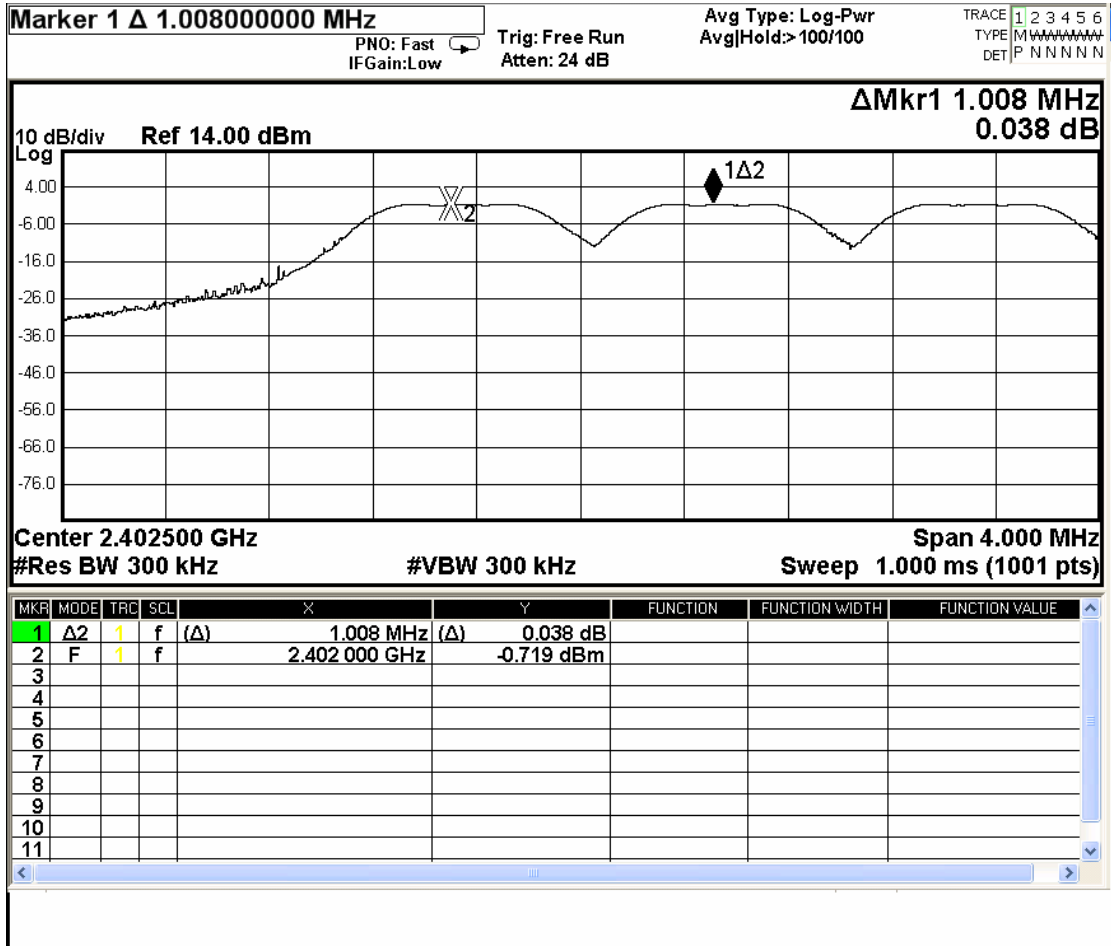


Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 48 of 90

Channel separation = 1MHz (>902.67kHz) (Lowest) (GFSK)



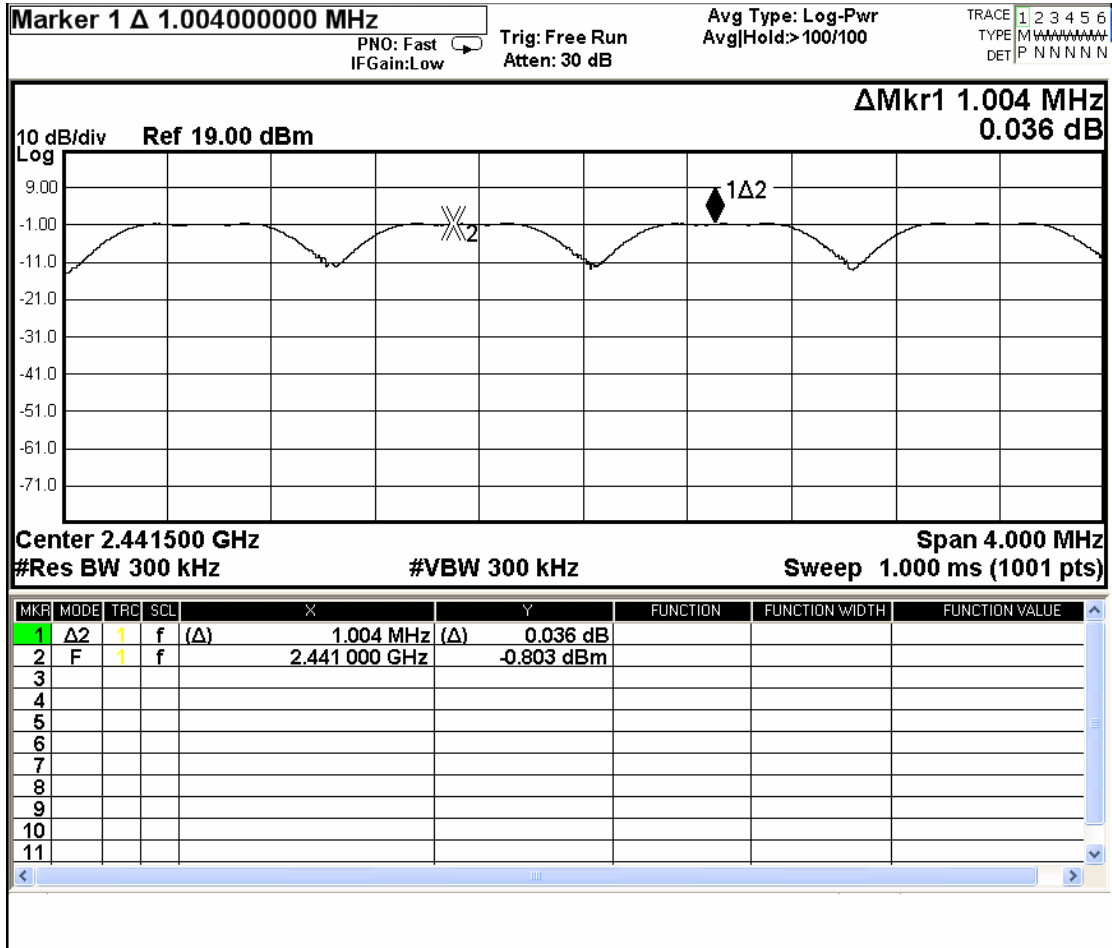


Test Report

Date : 2021-12-30
No. : HMD21120027

Page 49 of 90

Channel separation = 1MHz (>902.67kHz) (Mid) (GFSK)





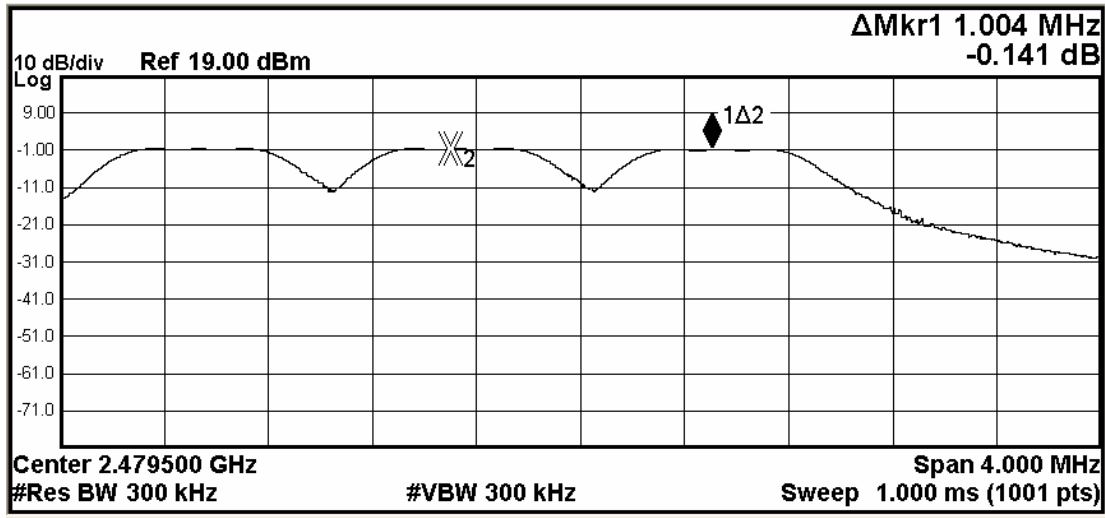
Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 50 of 90

Channel separation = 1MHz (>902.67kHz) (Highest) (GFSK)

Marker 1 1.004000000 MHz Avg Type: Log-Pwr
AvgHold:>100/100
 PNO: Fast Trig: Free Run
 IFGain:Low Atten: 30 dB



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	Δ2	1	f	1.004 MHz (Δ)	-0.141 dB			
2	F	1	f	2.479 000 GHz	-0.693 dBm			
3								
4								
5								
6								
7								
8								
9								
10								
11								

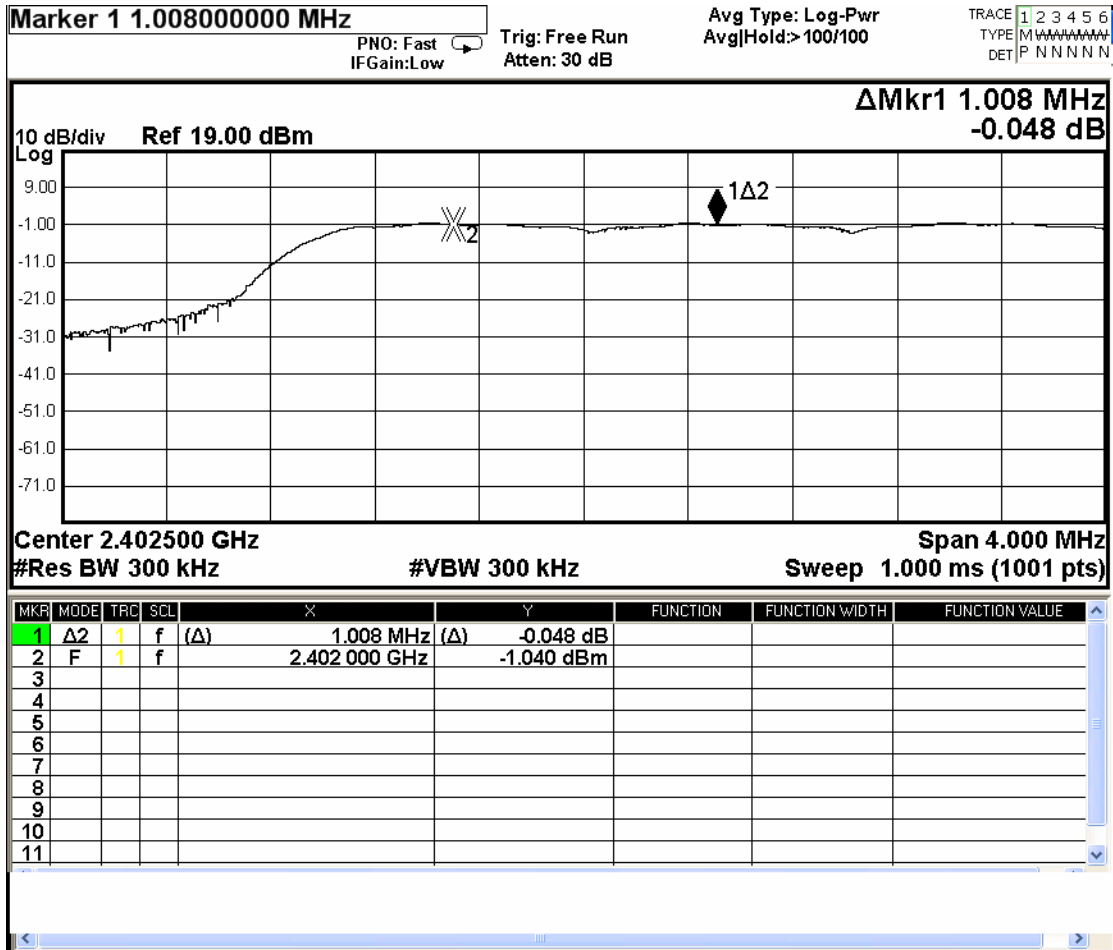


Test Report

Date : 2021-12-30
No. : HMD21120027

Page 51 of 90

Channel separation = 1MHz (>902.67kHz) (Lowest) ($\pi/4$ DQPSK)



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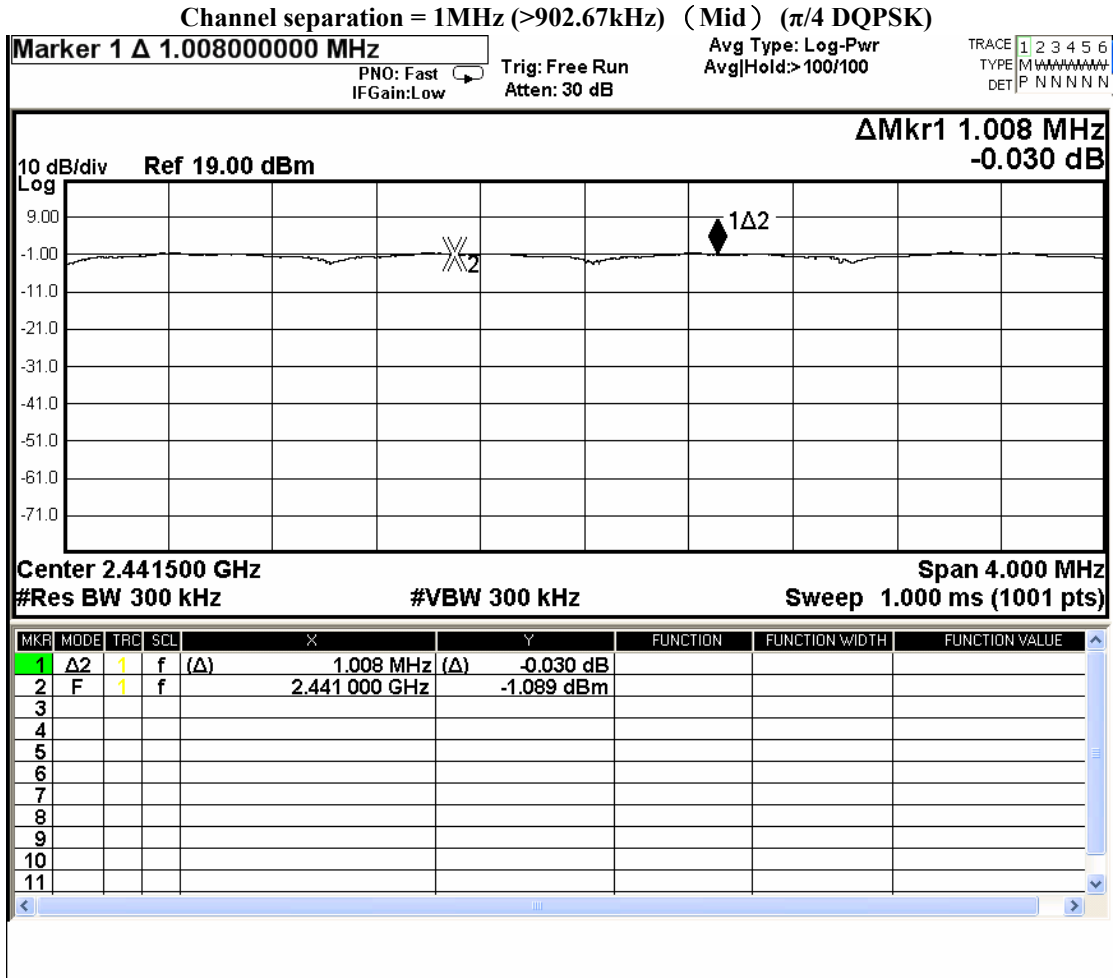
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Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 52 of 90



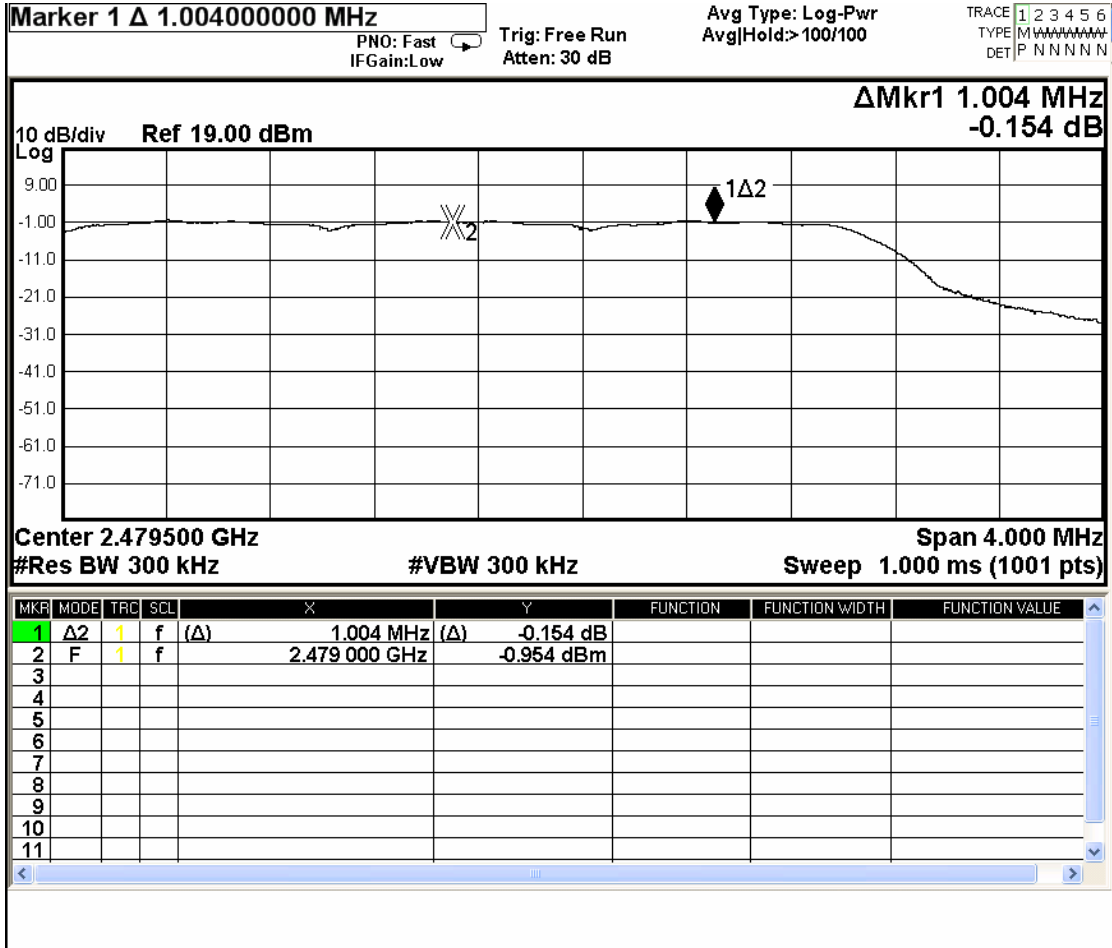


Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 53 of 90

Channel separation = 1MHz (>902.67kHz) (Highest) ($\pi/4$ DQPSK)



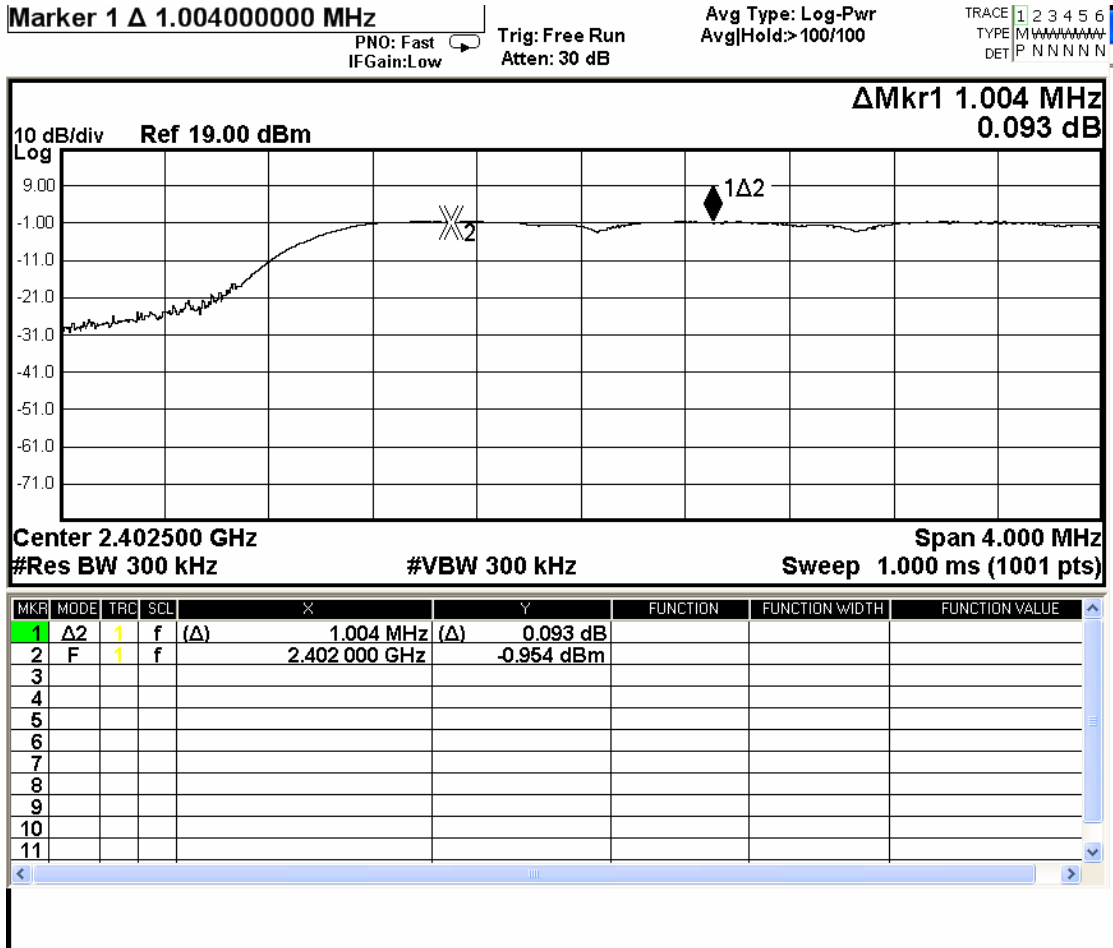


Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 54 of 90

Channel separation = 1MHz (>902.67kHz) (Lowest) (8DPSK)

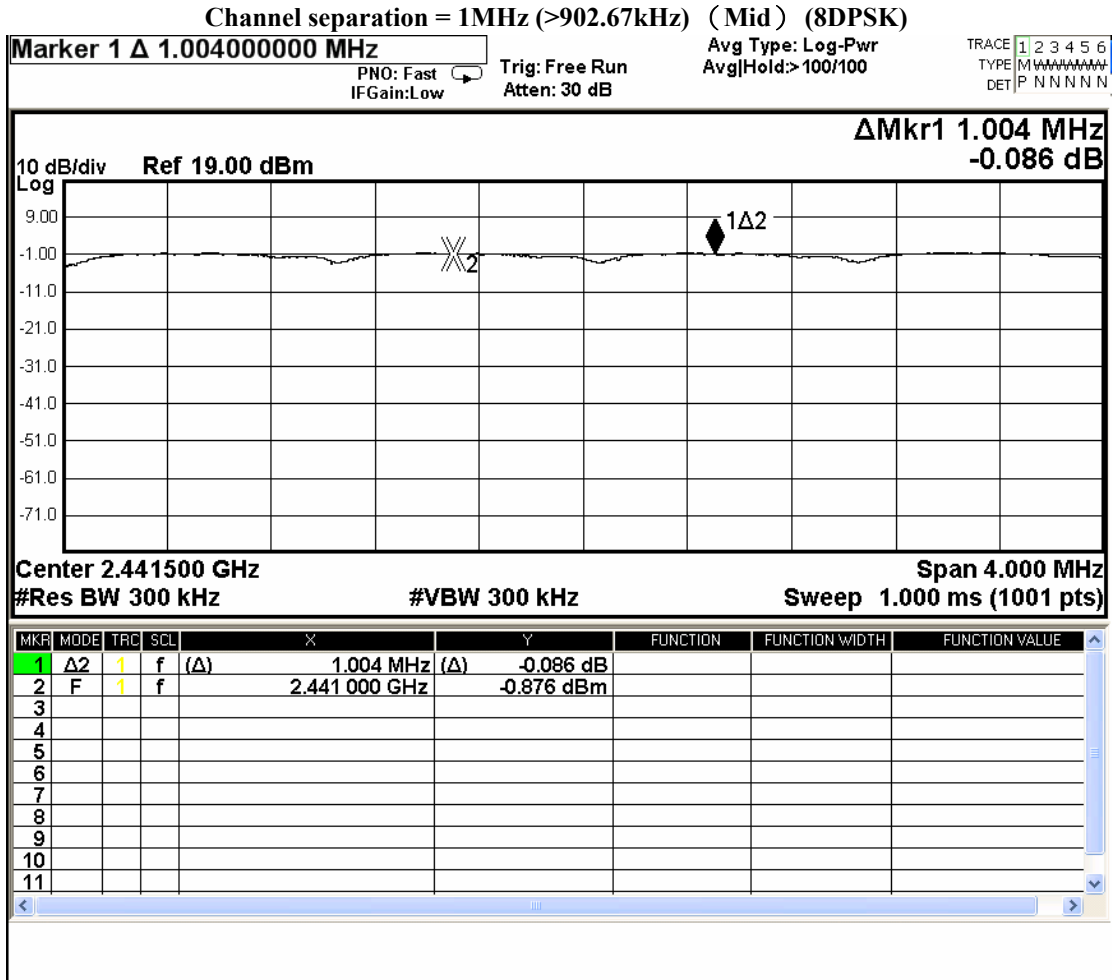




Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 55 of 90

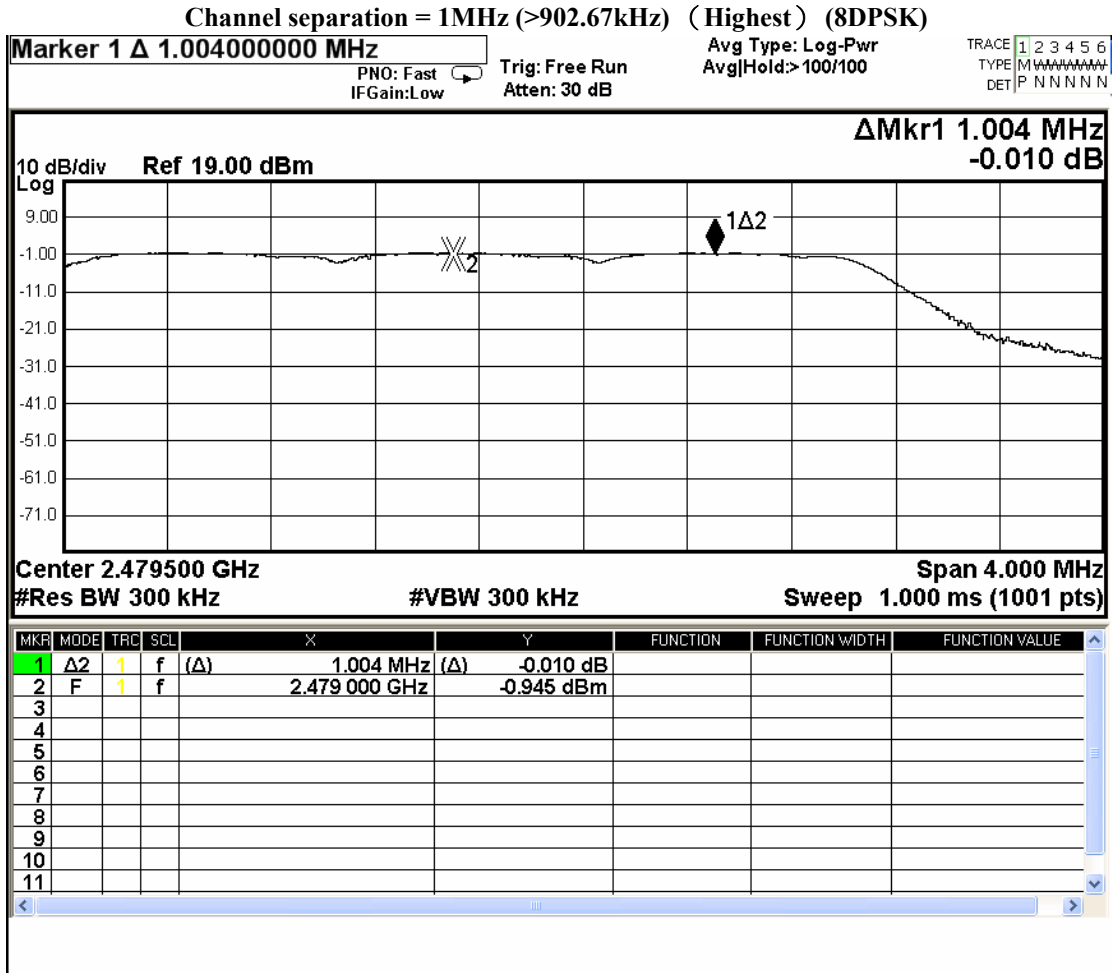




Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 56 of 90





Test Report

Date : 2021-12-30
No. : HMD21120027

Page 57 of 90

3.1.7 Band-edge Compliance of RF Conducted Emissions Measurement:

Ambient Temperature: 25°C Relative Humidity: 51% Atmospheric Pressure: 101 kPa

Limit :

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. Attenuation below the general limits specified in Section 15.209(a) is not required.

According to the test method DA 00-705.

Spectrum Analyzer Setting:

RBW = 100kHz, VBW= 300kHz, Sweep = Coupled,

Span = Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.

Detector = Peak, Trace = Max. hold

Remark: Emissions under the fixed frequency mode and hopping mode have been investigated, the worst-case measurement results were recorded in the test report

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Test Report

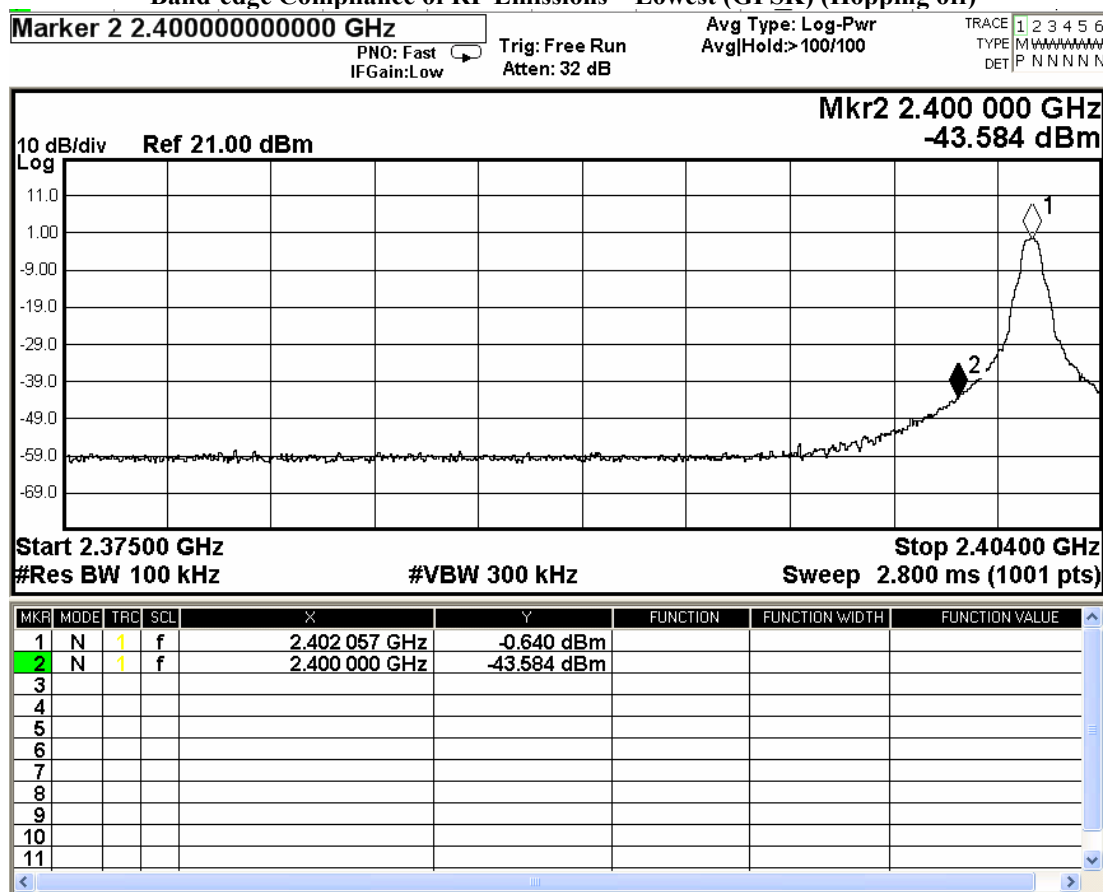
Date : 2021-12-30
 No. : HMD21120027

Page 58 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range	Reference level	Limit	The highest conducted band edge emission	Result
[MHz]	[dBm]	[dBm]	[dBm]	
2400 – Lowest Fundamental (2402)	-0.640	-20.640	-43.584	PASS

Band-edge Compliance of RF Emissions – Lowest (GFSK) (Hopping off)





Test Report

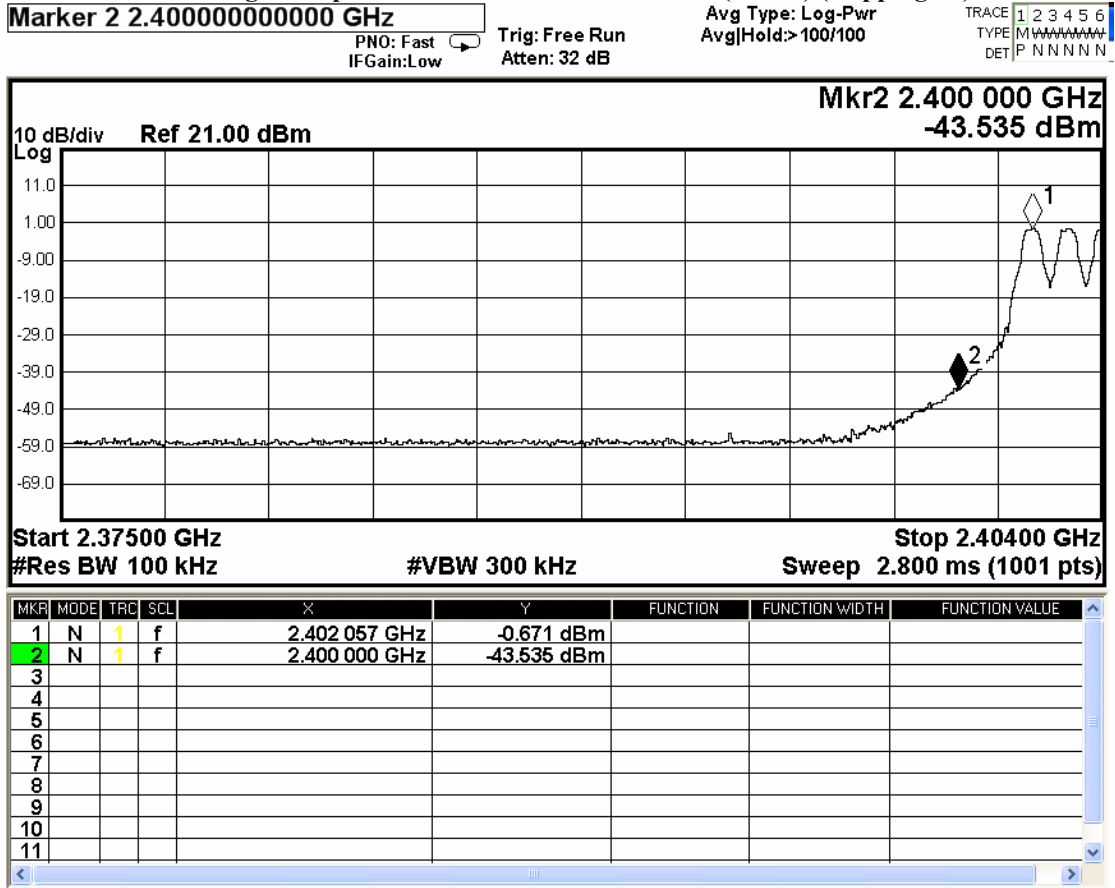
Date : 2021-12-30
 No. : HMD21120027

Page 59 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range	Reference level	Limit	The highest conducted band edge emission	Result
[MHz]	[dBμV]	[dBμV]	[dBμV]	
2400 – Lowest Fundamental (2402)	-0.671	-20.671	-43.535	PASS

Band-edge Compliance of RF Emissions – Lowest (GFSK) (Hopping on)





Test Report

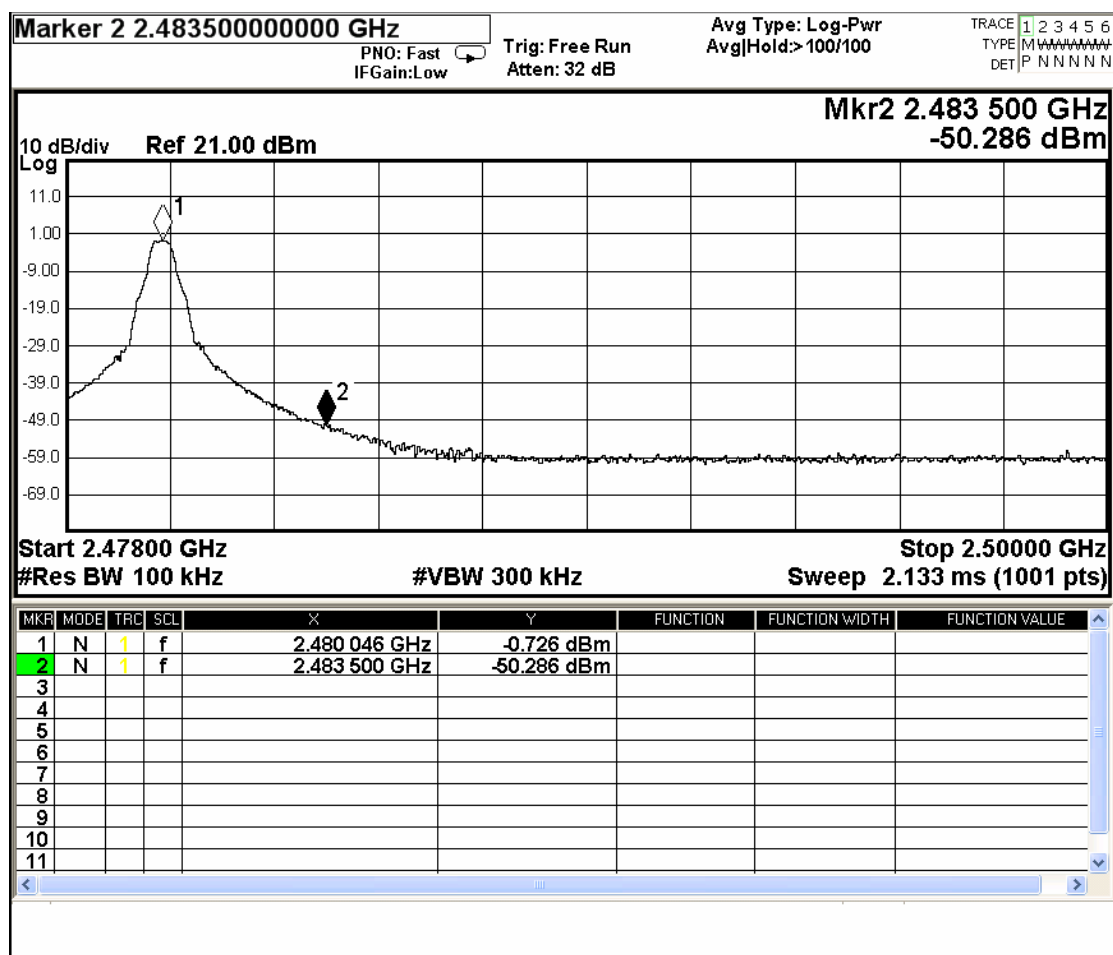
Date : 2021-12-30
 No. : HMD21120027

Page 60 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Reference level [dBμV]	Limit [dBμV]	The highest conducted band edge emission [dBμV]	Result
2483.5 - Highest Fundamental (2480)	-0.726	-20.726	-50.286	PASS

Band-edge Compliance of RF Emissions – Highest (GFSK) (Hopping off)





Test Report

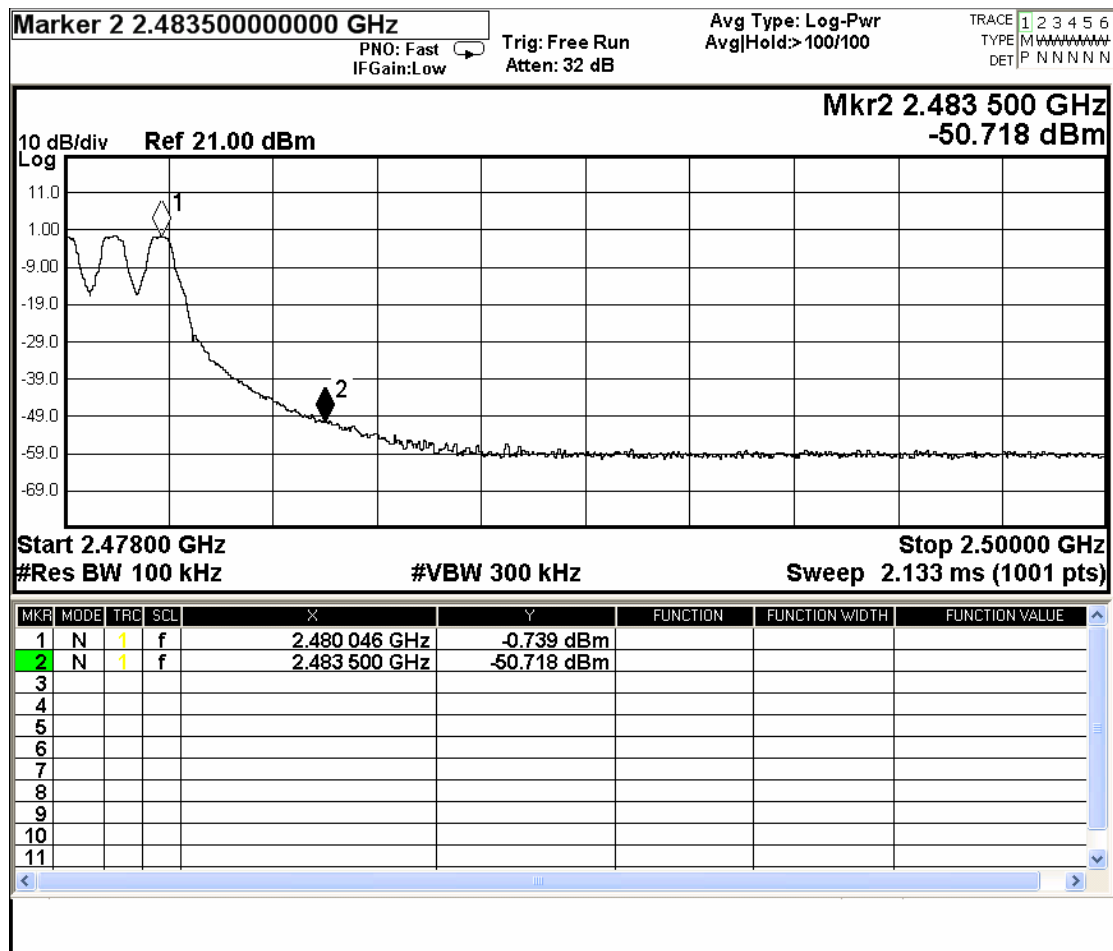
Date : 2021-12-30
No. : HMD21120027

Page 61 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Reference level [dBµV]	Limit [dBµV]	The highest conducted band edge emission [dBµV]	Result
2483.5 - Highest Fundamental (2480)	-0.739	-20.739	-50.718	PASS

Band-edge Compliance of RF Emissions – Highest (GFSK) (Hopping on)





Test Report

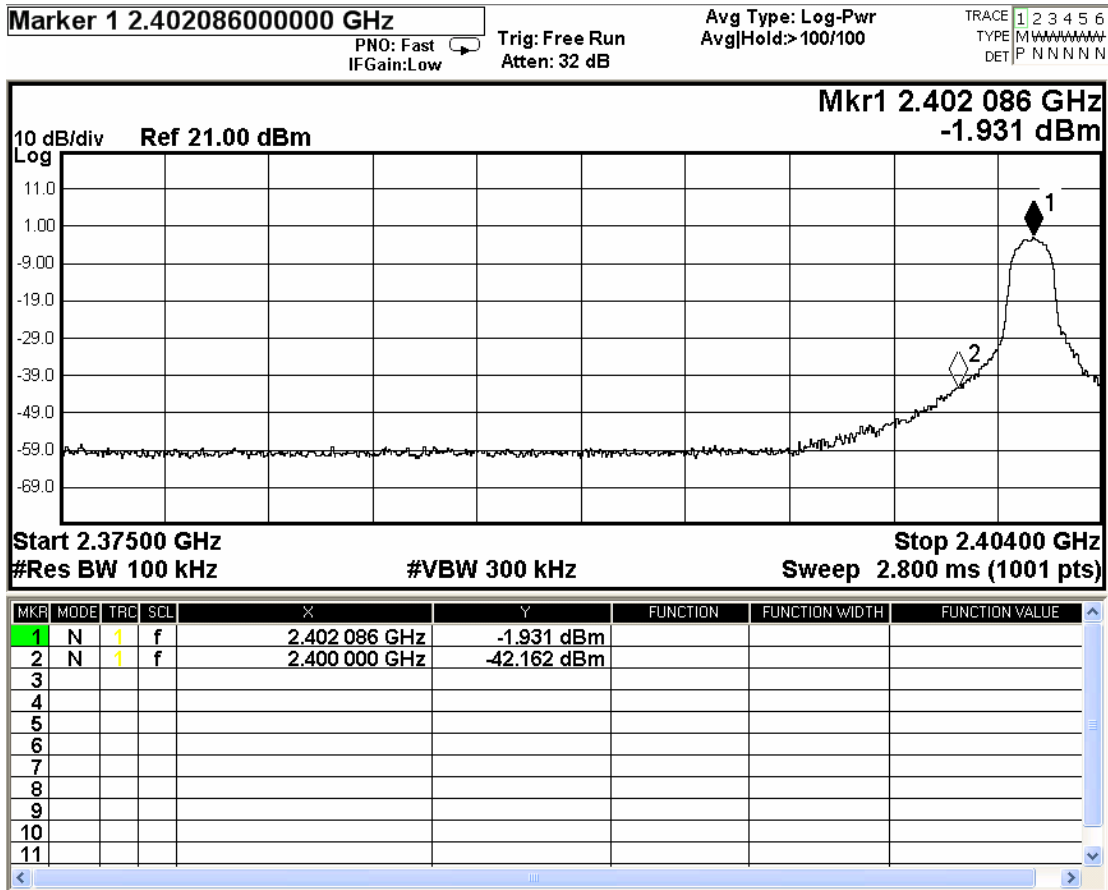
Date : 2021-12-30
 No. : HMD21120027

Page 62 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range	Reference level	Limit	The highest conducted band edge emission	Result
[MHz]	[dBμV]	[dBμV]	[dBμV]	
2400 – Lowest Fundamental (2402)	-1.931	-21.931	-42.162	PASS

Band-edge Compliance of RF Emissions – Lowest ($\pi/4$ DQPSK) (Hopping off)





Test Report

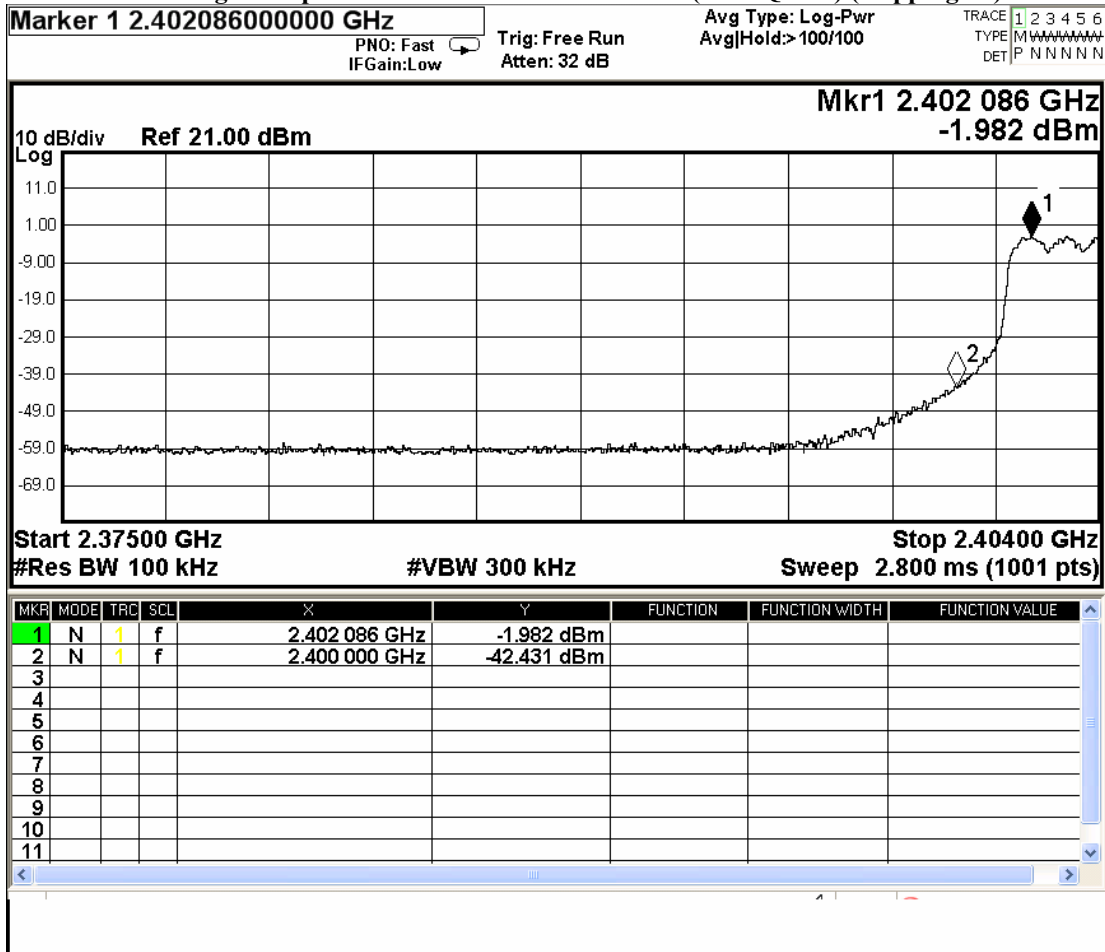
Date : 2021-12-30
 No. : HMD21120027

Page 63 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range	Reference level	Limit	The highest conducted band edge emission	Result
[MHz]	[dBμV]	[dBμV]	[dBμV]	
2400 – Lowest Fundamental (2402)	-1.982	-21.982	-42.431	PASS

Band-edge Compliance of RF Emissions – Lowest ($\pi/4$ DQPSK) (Hopping on)



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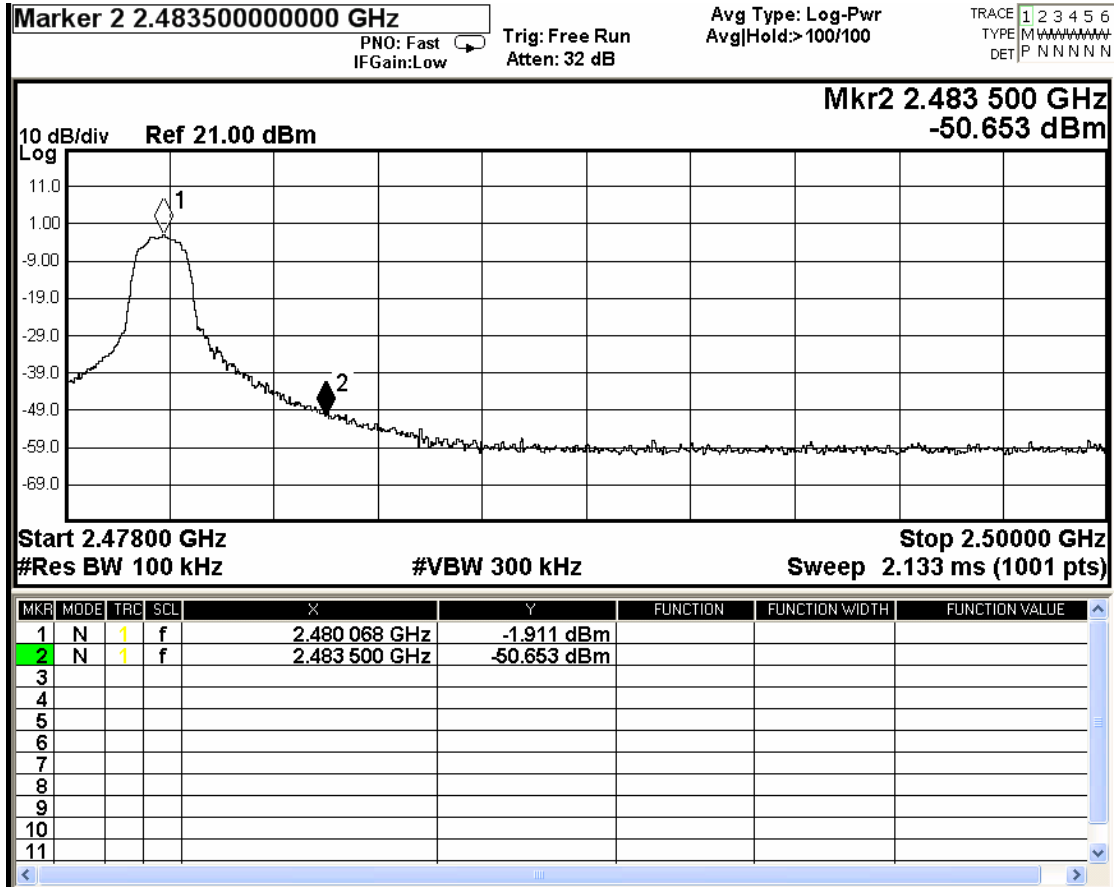
Date : 2021-12-30
 No. : HMD21120027

Page 64 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Reference level [dBμV]	Limit [dBμV]	The highest conducted band edge emission [dBμV]	Result
2483.5 - Highest Fundamental (2480)	-1.911	-21.911	-50.653	PASS

Band-edge Compliance of RF Emissions – Highest ($\pi/4$ DQPSK) (Hopping off)





Test Report

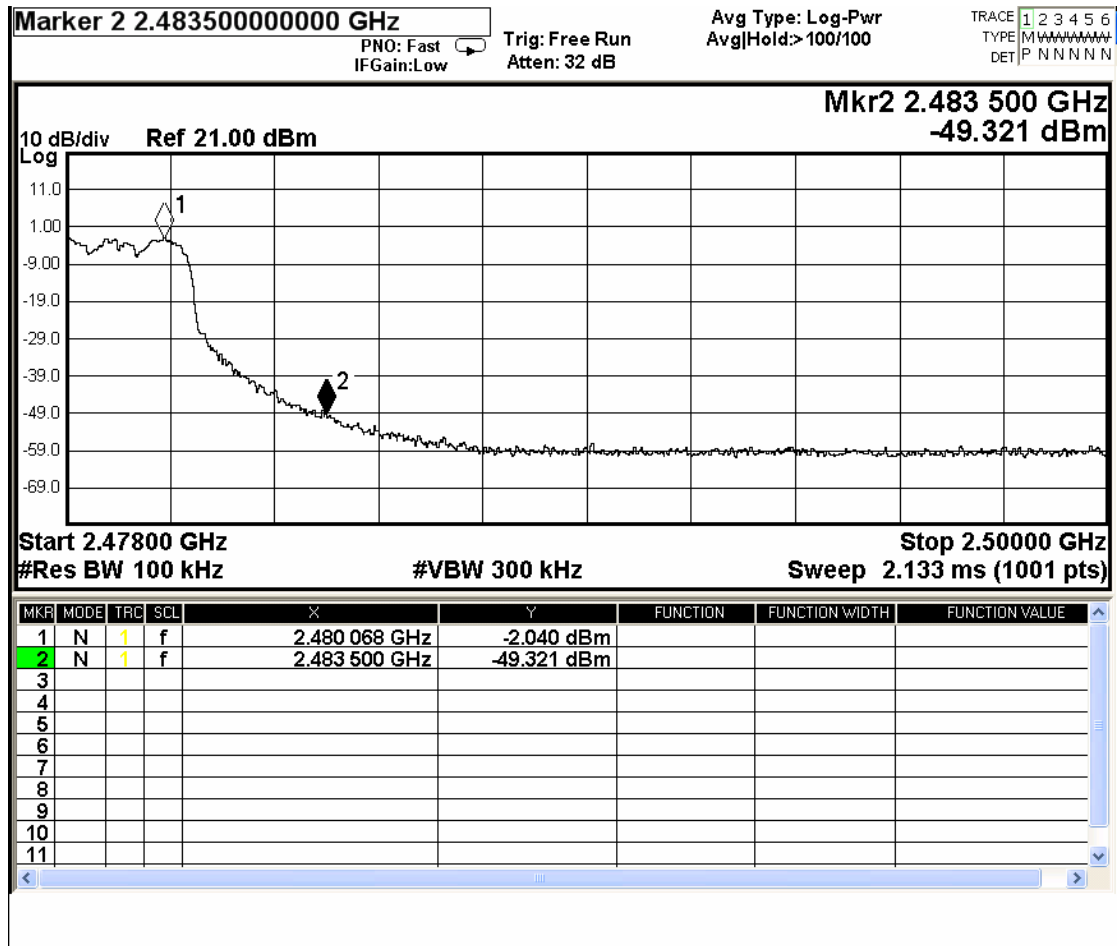
Date : 2021-12-30
 No. : HMD21120027

Page 65 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Reference level [dBμV]	Limit [dBμV]	The highest conducted band edge emission [dBμV]	Result
2483.5 - Highest Fundamental (2480)	-2.040	-22.040	-49.321	PASS

Band-edge Compliance of RF Emissions – Highest ($\pi/4$ DQPSK) (Hopping on)





Test Report

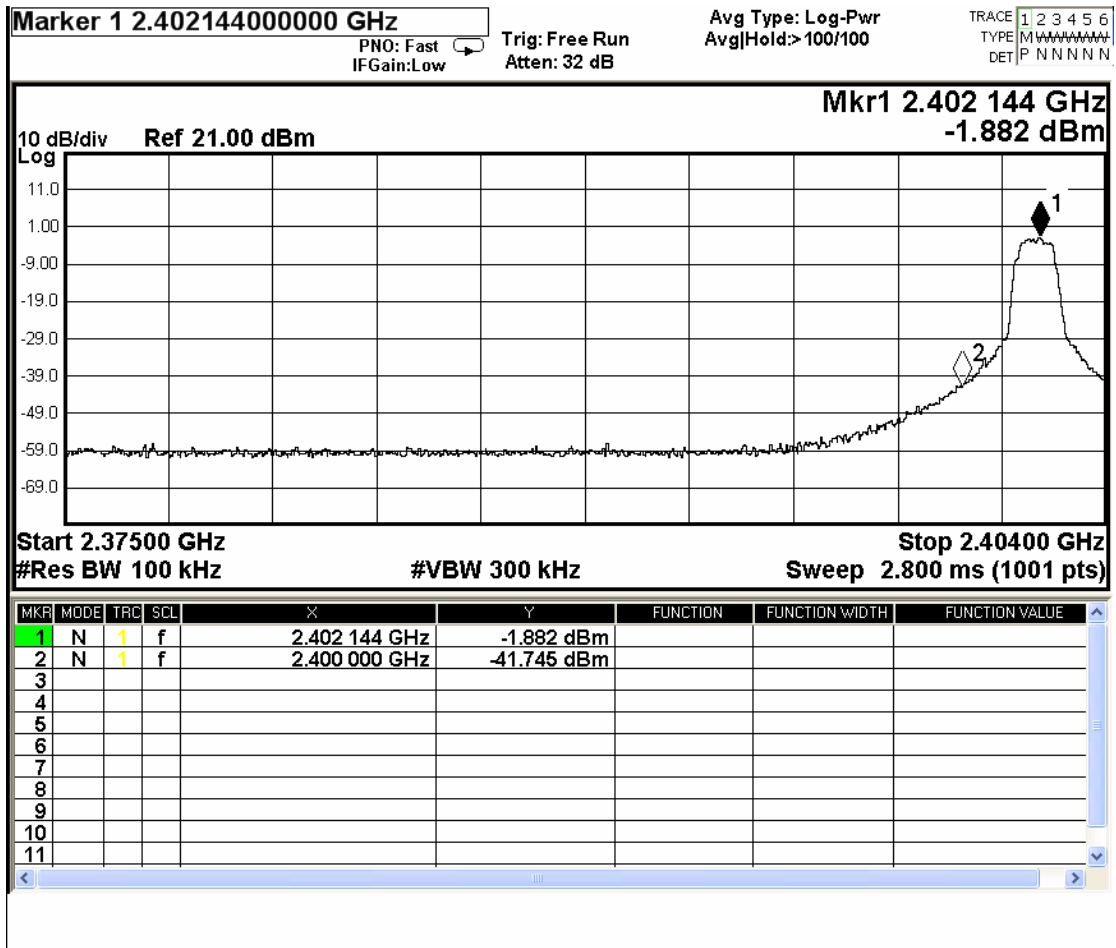
Date : 2021-12-30
 No. : HMD21120027

Page 66 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range	Reference level	Limit	The highest conducted band edge emission	Result
[MHz]	[dBμV]	[dBμV]	[dBμV]	
2400 – Lowest Fundamental (2402)	-1.882	-21.882	-41.745	PASS

Band-edge Compliance of RF Emissions – Lowest (8DPSK) (Hopping off)





Test Report

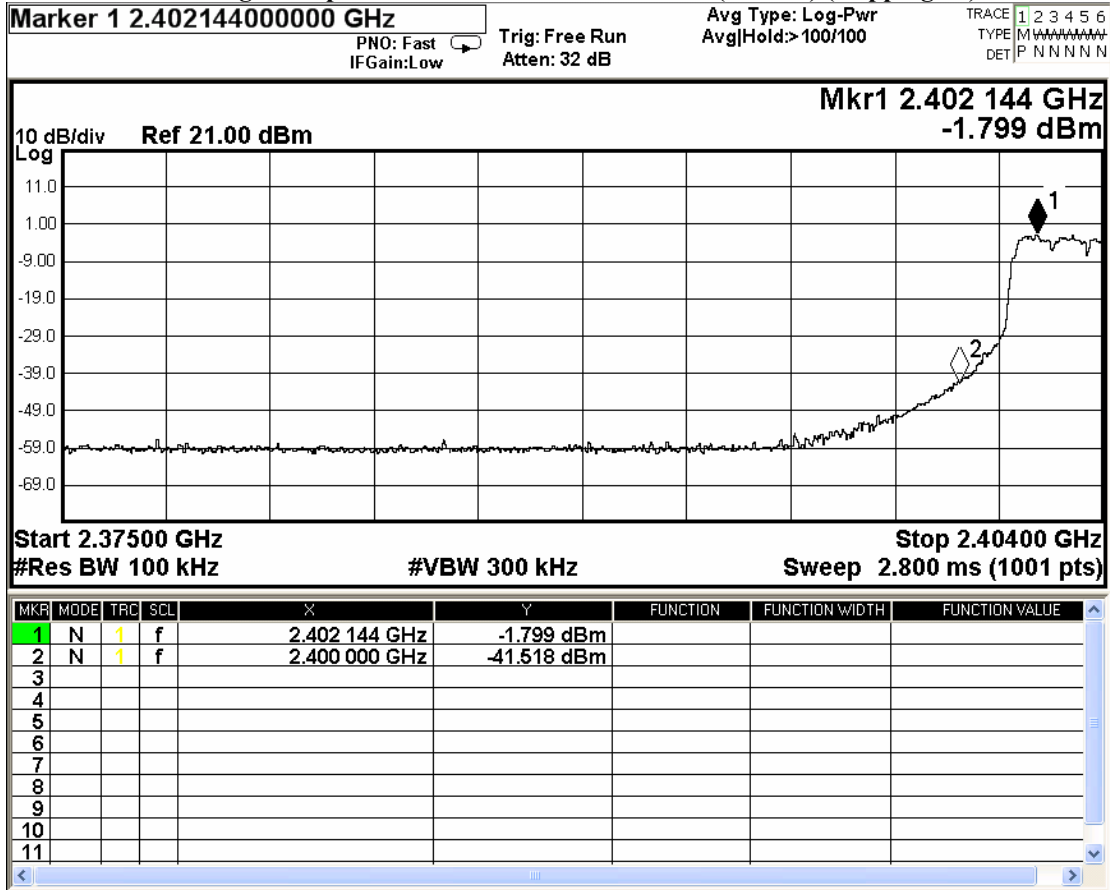
Date : 2021-12-30
 No. : HMD21120027

Page 67 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range	Reference level	Limit	The highest conducted band edge emission	Result
[MHz]	[dBμV]	[dBμV]	[dBμV]	
2400 – Lowest Fundamental (2402)	-1.799	-21.799	-41.518	PASS

Band-edge Compliance of RF Emissions – Lowest (8DPSK) (Hopping on)





Test Report

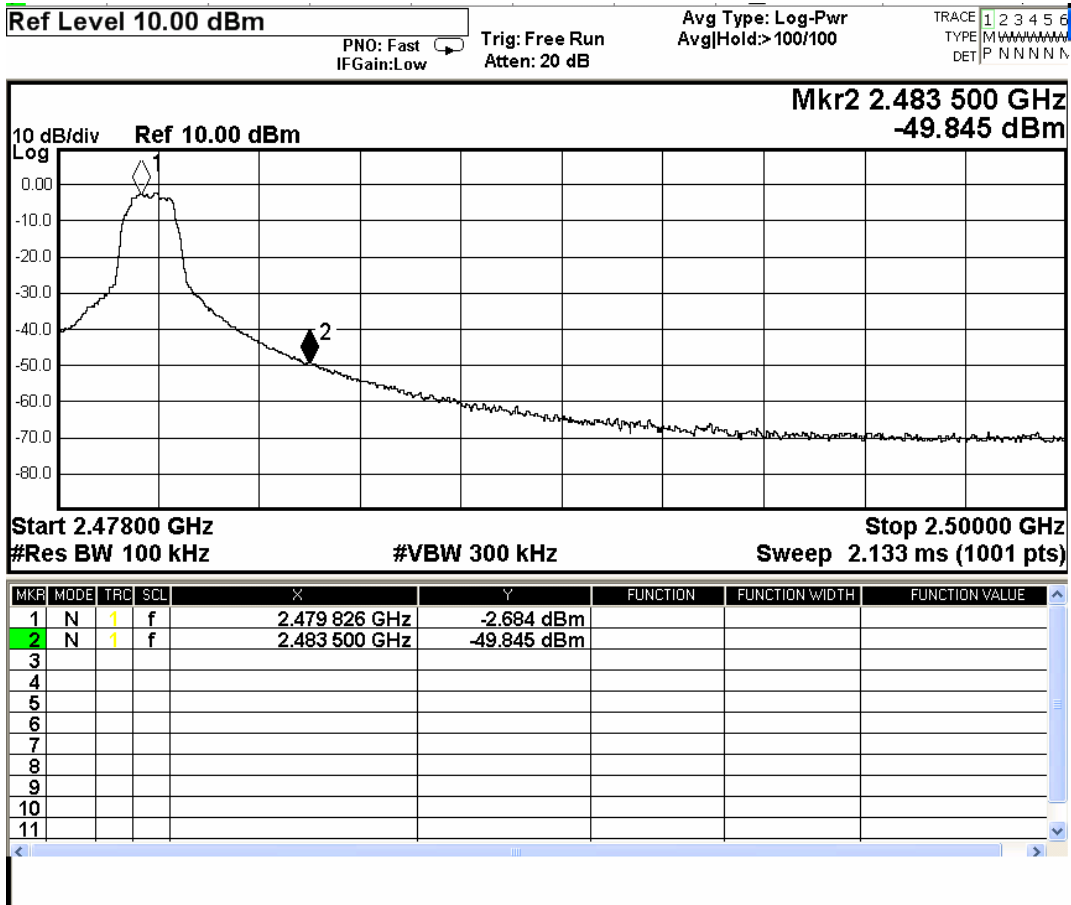
Date : 2021-12-30
 No. : HMD21120027

Page 68 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range	Reference level	Limit	The highest conducted band edge emission	Result
[MHz]	[dBμV]	[dBμV]	[dBμV]	
2483.5 - Highest Fundamental (2480)	-2.684	-22.684	-49.845	PASS

Band-edge Compliance of RF Emissions – Highest (8DPSK) (Hopping off)





Test Report

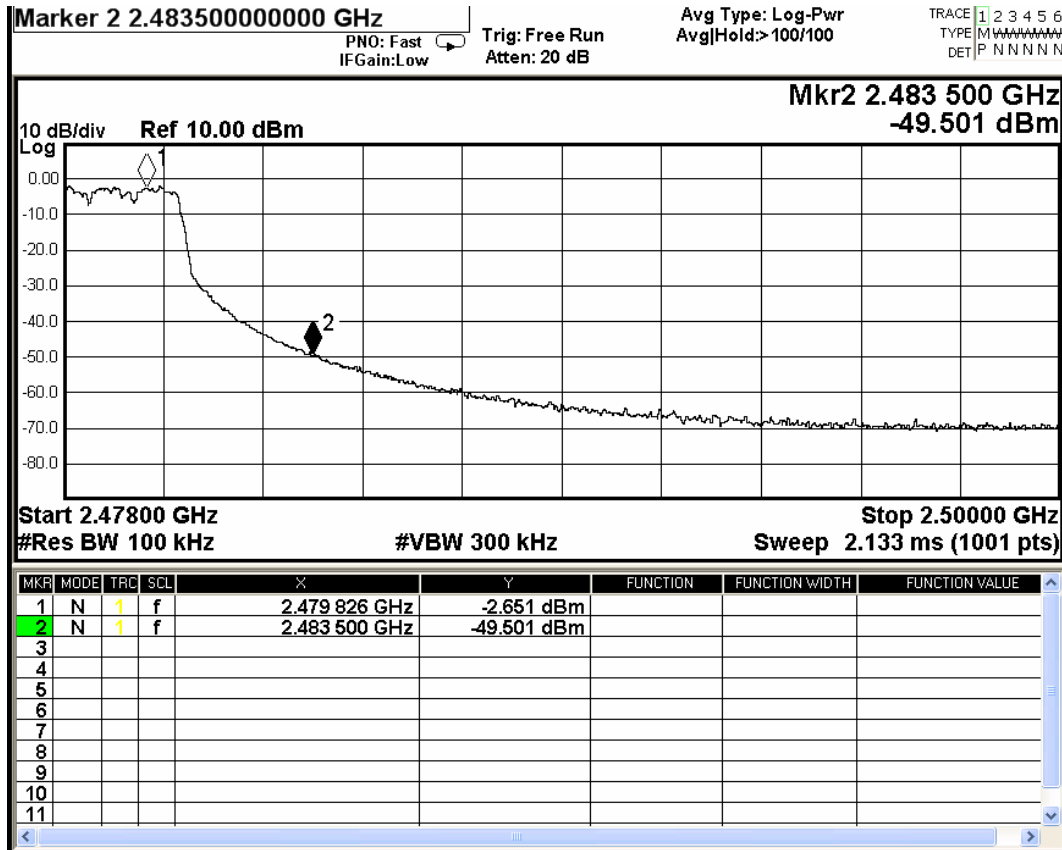
Date : 2021-12-30
 No. : HMD21120027

Page 69 of 90

Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Reference level [dBμV]	Limit [dBμV]	The highest conducted band edge emission [dBμV]	Result
2483.5 - Highest Fundamental (2480)	-2.651	-22.651	-49.501	PASS

Band-edge Compliance of RF Emissions – Highest ($\pi/4$ DQPSK) (Hopping on)





Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 70 of 90

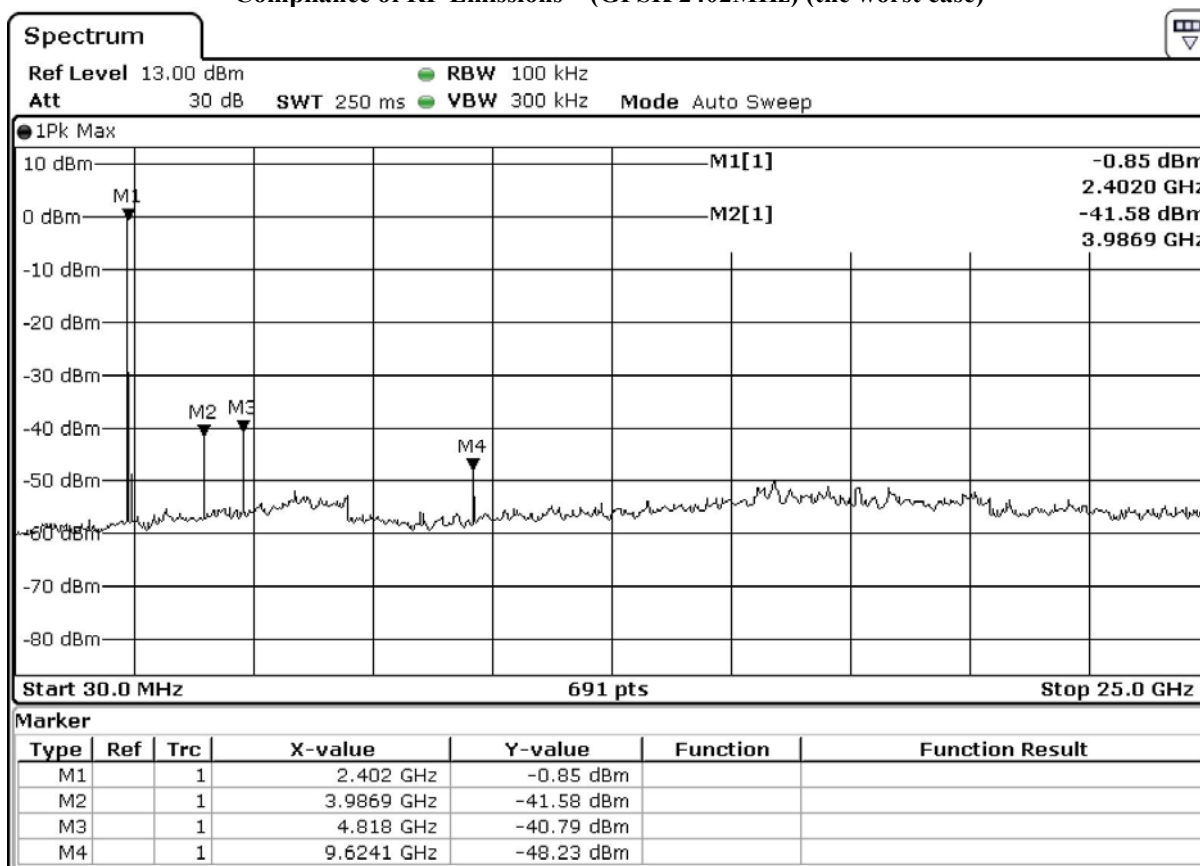
Compliance of RF Conducted Emissions Measurement:

Limit :

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. Attenuation below the general limits specified in Section 15.209(a) is not required.

Remark: Emissions under the fixed frequency mode and hopping mode have been investigated, the worst-case measurement results were recorded in the test report

Compliance of RF Emissions – (GFSK 2402MHz) (the worst case)



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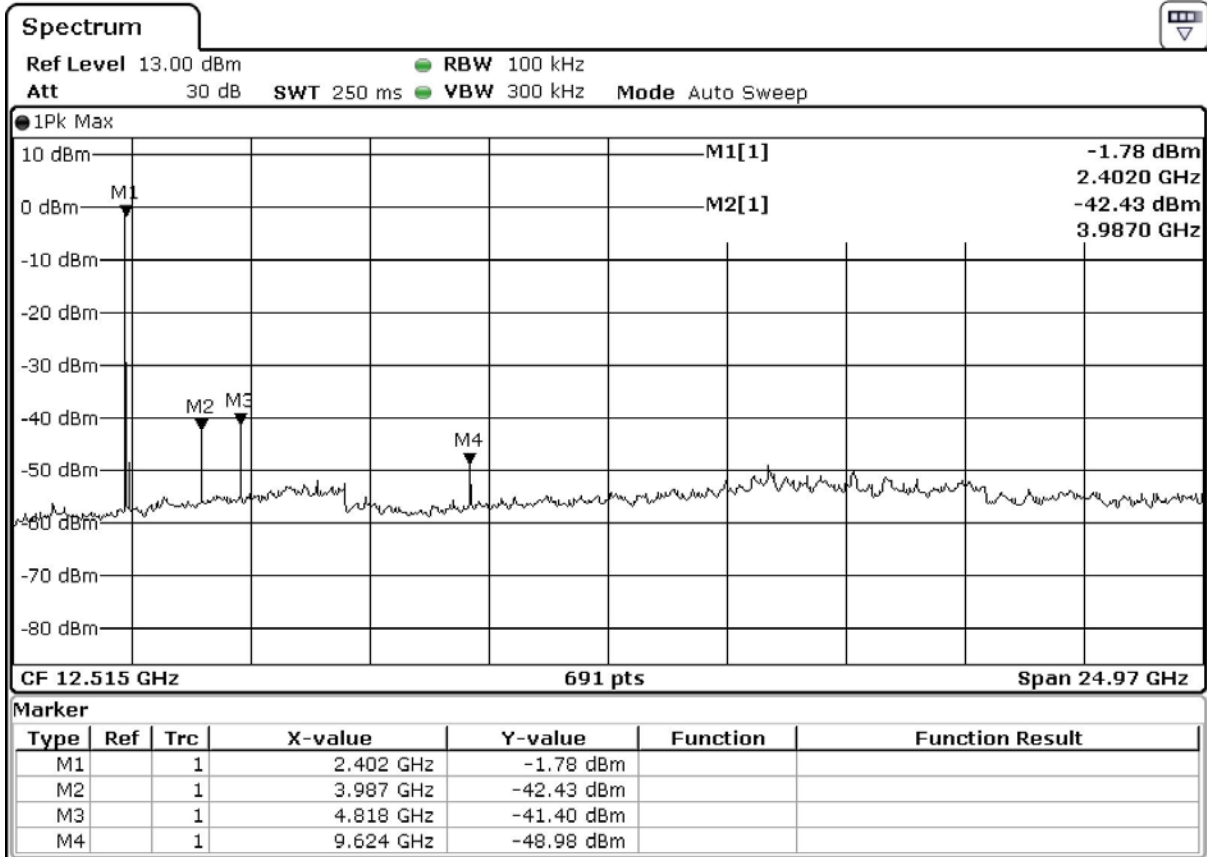


Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 71 of 90

Compliance of RF Emissions – ($\pi/4$ -DQPSK 2402MHz) (the worst case)



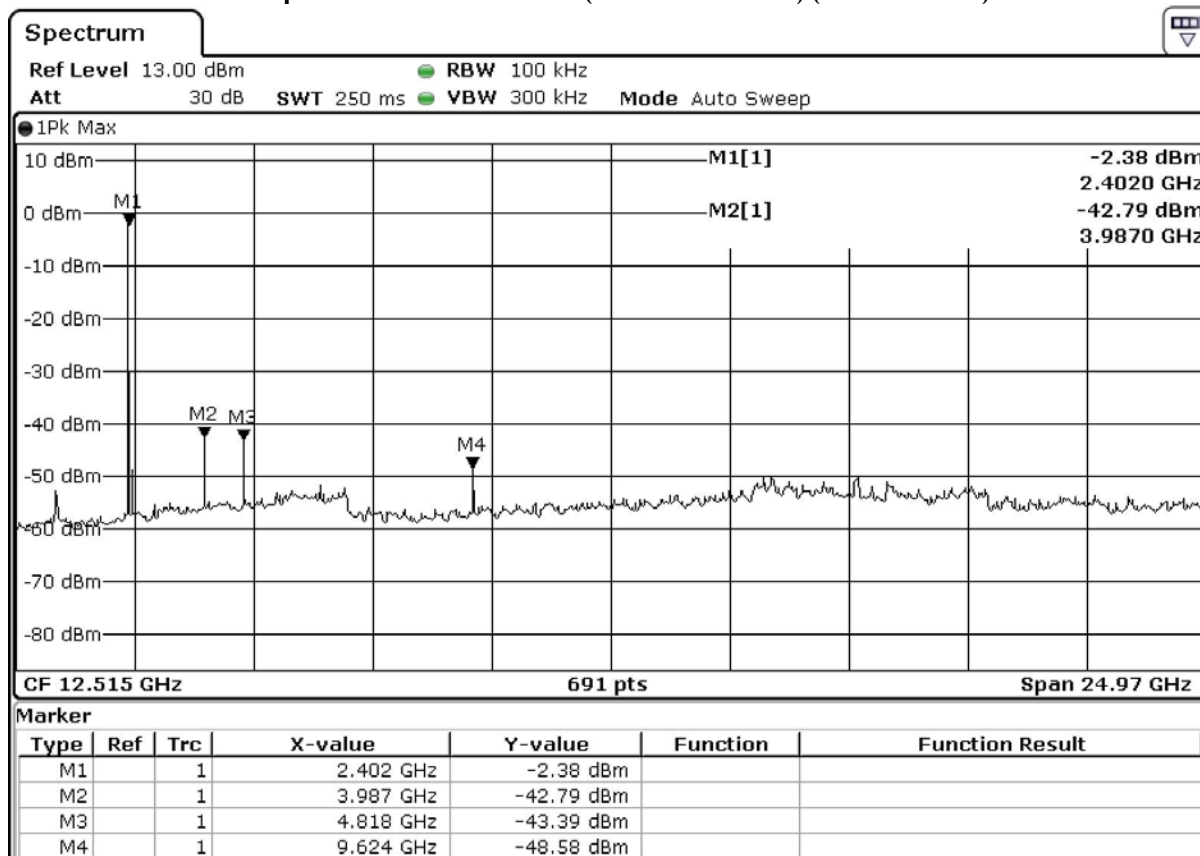


Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 72 of 90

Compliance of RF Emissions – (8DPSK 2402MHz) (the worst case)



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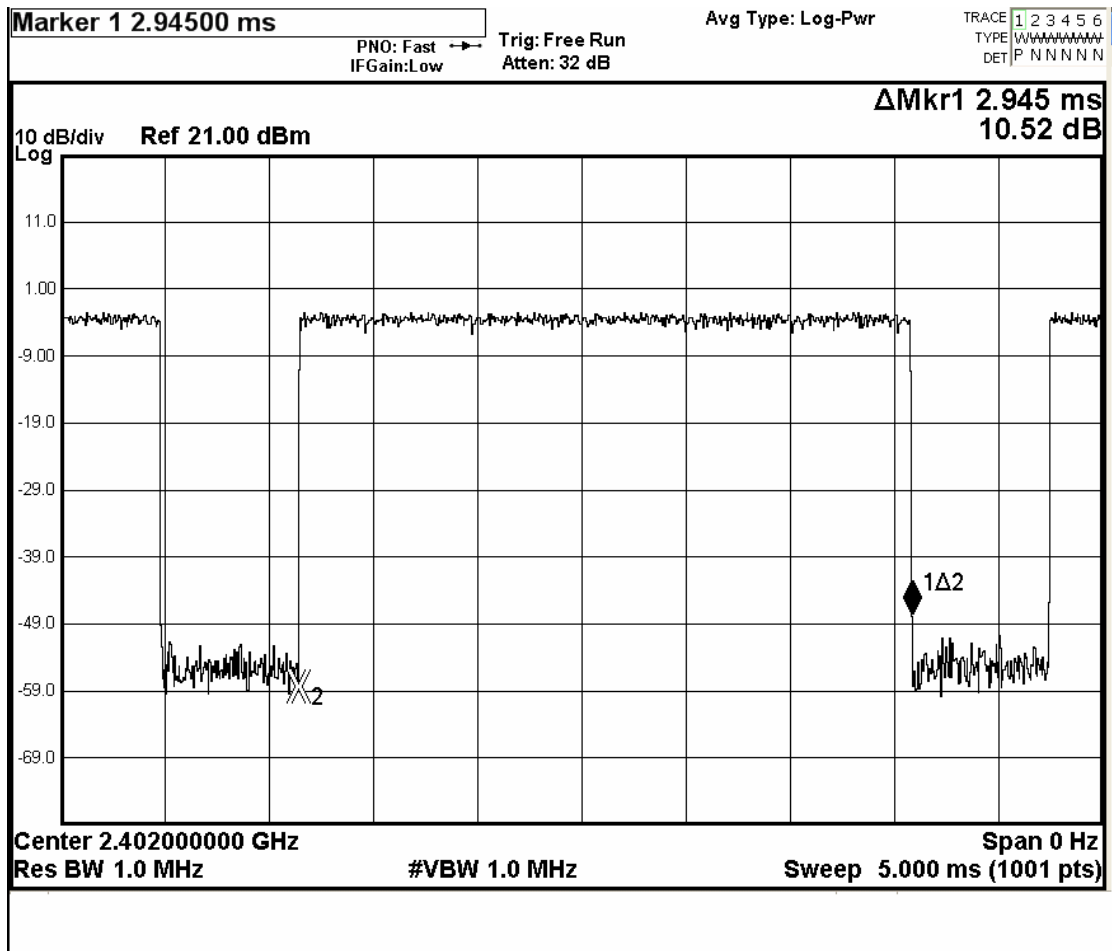
Date : 2021-12-30
No. : HMD21120027

Page 74 of 90

3DH5 Packet:

DH5 Packet permit maximum $1600/79/6 = 3.37$ hops per second in each channel (5 time slots RX, 1 time slot TX). The Dwell time is the time duration of the pulse times $3.37 \times 31.6 = 106.6$ within 31.6 seconds

Fig. A
[Pulse duration of Lowest Channel]



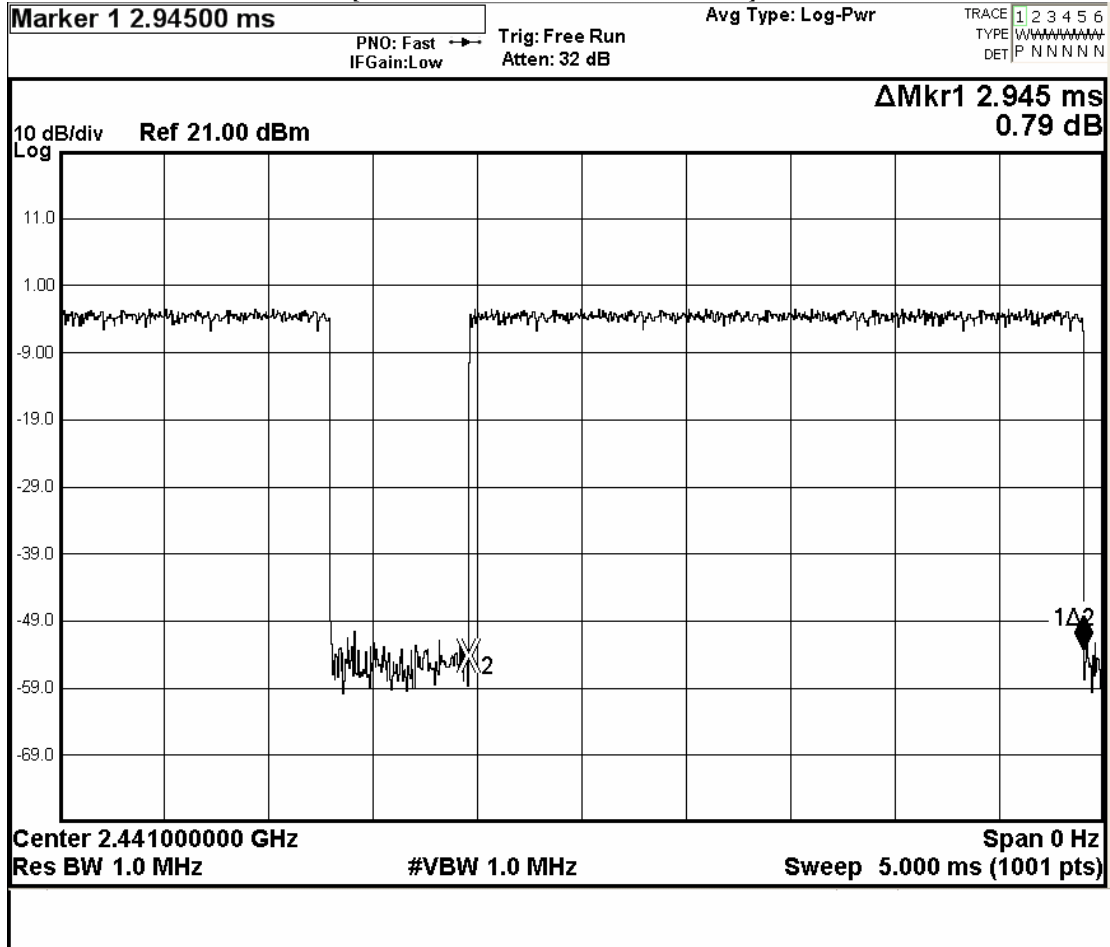


Test Report

Date : 2021-12-30
No. : HMD21120027

Page 75 of 90

Fig. B
[Pulse duration of Middle Channel]



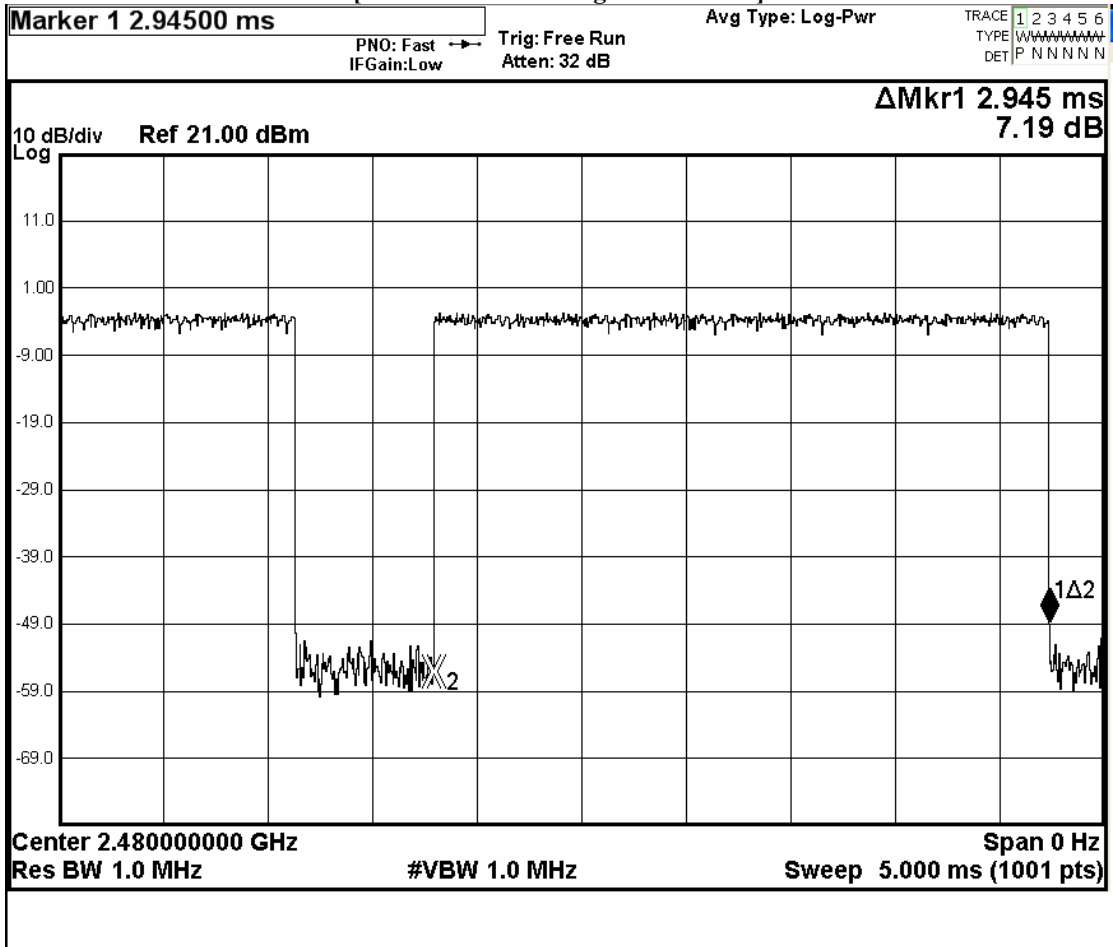


Test Report

Date : 2021-12-30
No. : HMD21120027

Page 76 of 90

Fig. C
[Pulse duration of Highest Channel]



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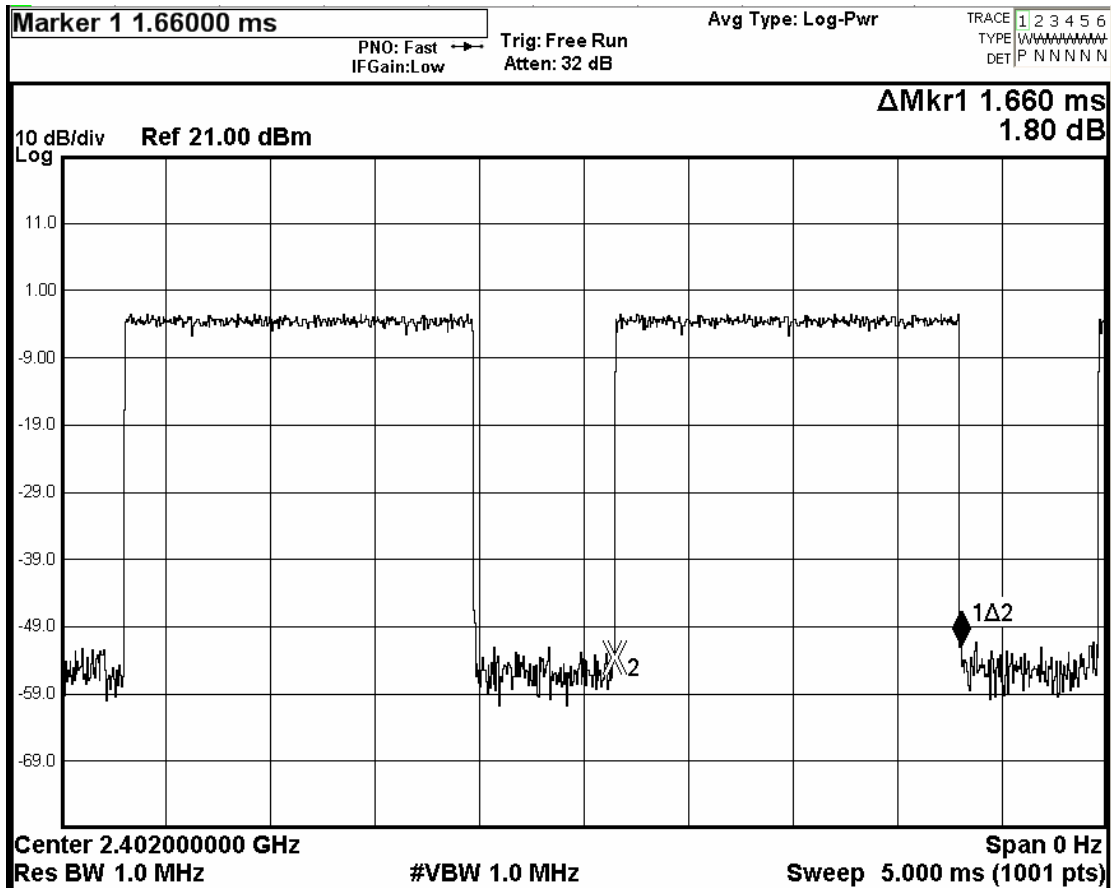
Date : 2021-12-30
No. : HMD21120027

Page 77 of 90

3DH3 Packet:

DH3 Packet permit maximum $1600/79/4 = 5.06$ hops per second in each channel (3 time slots RX, 1 time slot TX). The Dwell time is the time duration of the pulse times $5.06 \times 31.6 = 160$ within 31.6 seconds

Fig. D
[Pulse duration of Lowest Channel]



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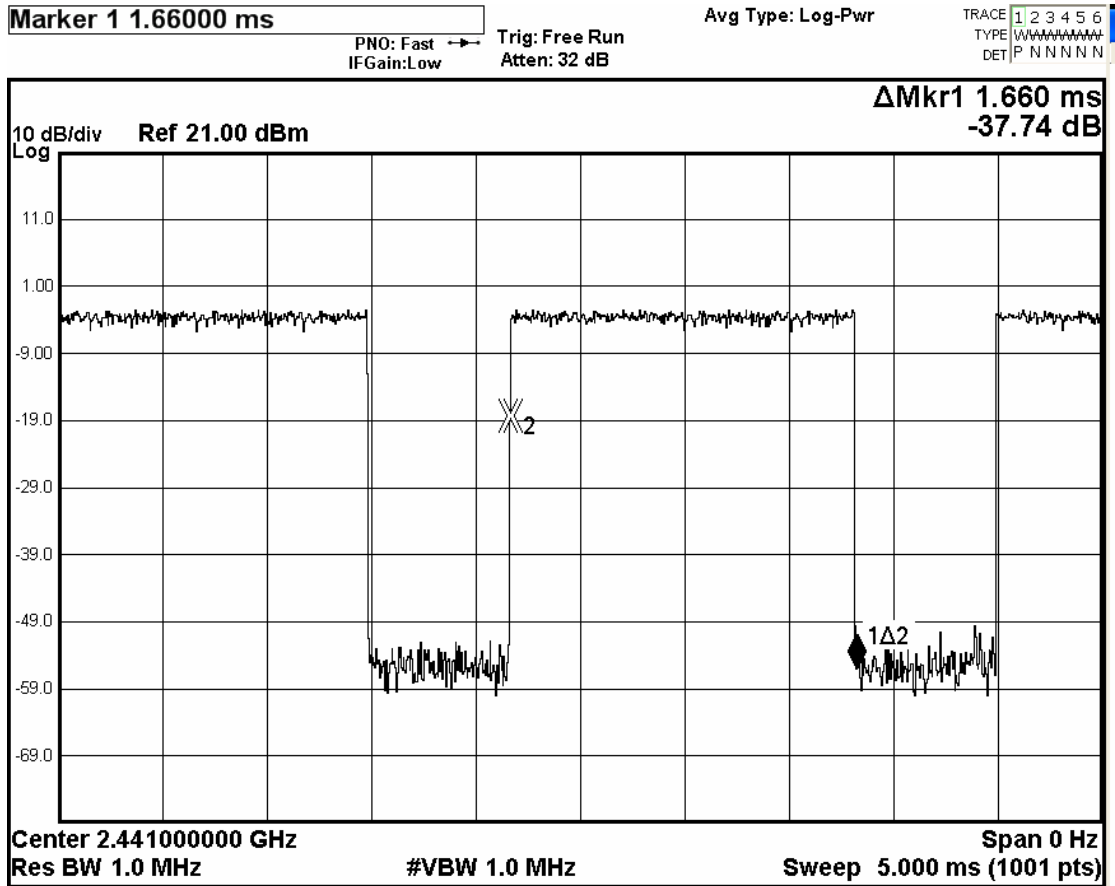


Test Report

Date : 2021-12-30
No. : HMD21120027

Page 78 of 90

Fig. E
[Pulse duration of Middle Channel]



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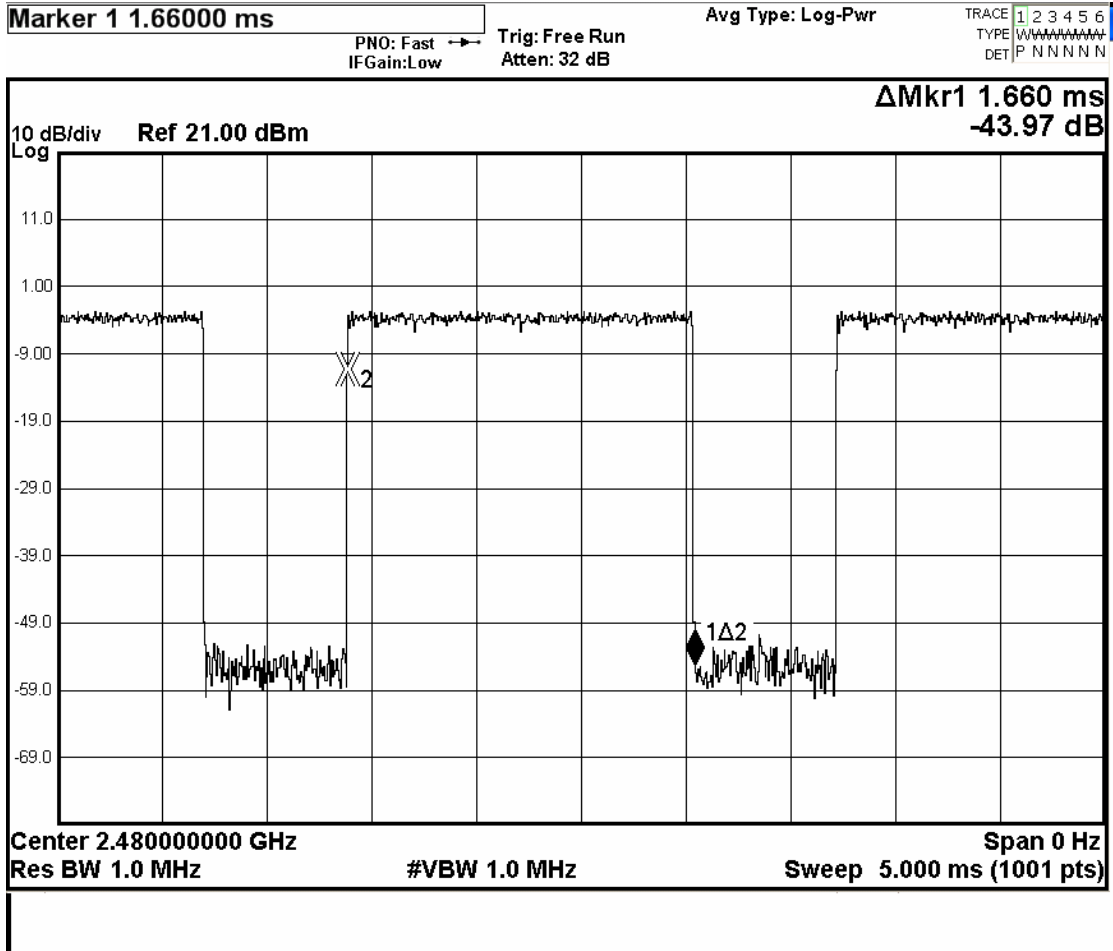


Test Report

Date : 2021-12-30
No. : HMD21120027

Page 79 of 90

Fig. F
[Pulse duration of Highest Channel]



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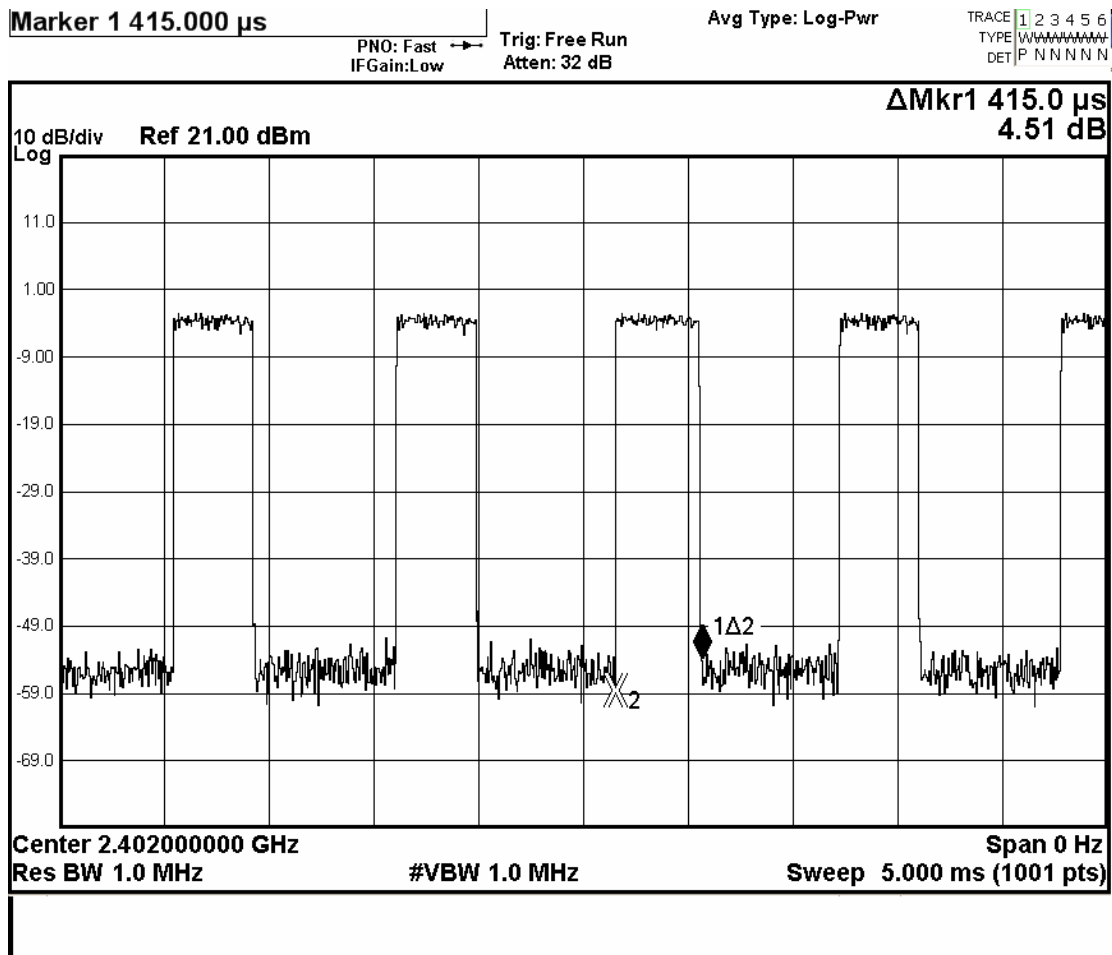
Date : 2021-12-30
No. : HMD21120027

Page 80 of 90

3DH1 Packet:

DH1 Packet permit maximum $1600/79/2 = 10.12$ hops per second in each channel (3 time slots RX, 1 time slot TX). The Dwell time is the time duration of the pulse times $10.12 \times 31.6 = 320$ within 31.6 seconds

Fig. G
[Pulse duration of Lowest Channel]



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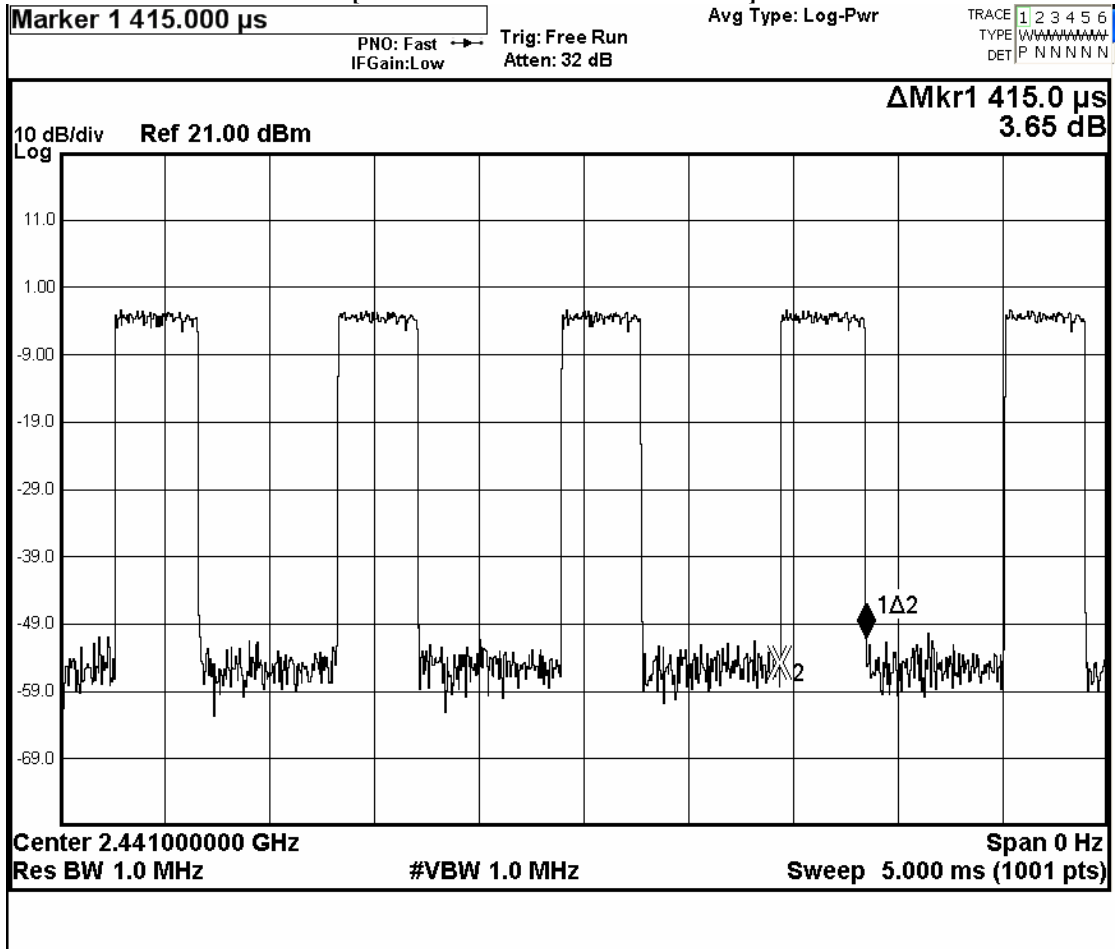


Test Report

Date : 2021-12-30
No. : HMD21120027

Page 81 of 90

Fig. H
[Pulse duration of Middle Channel]



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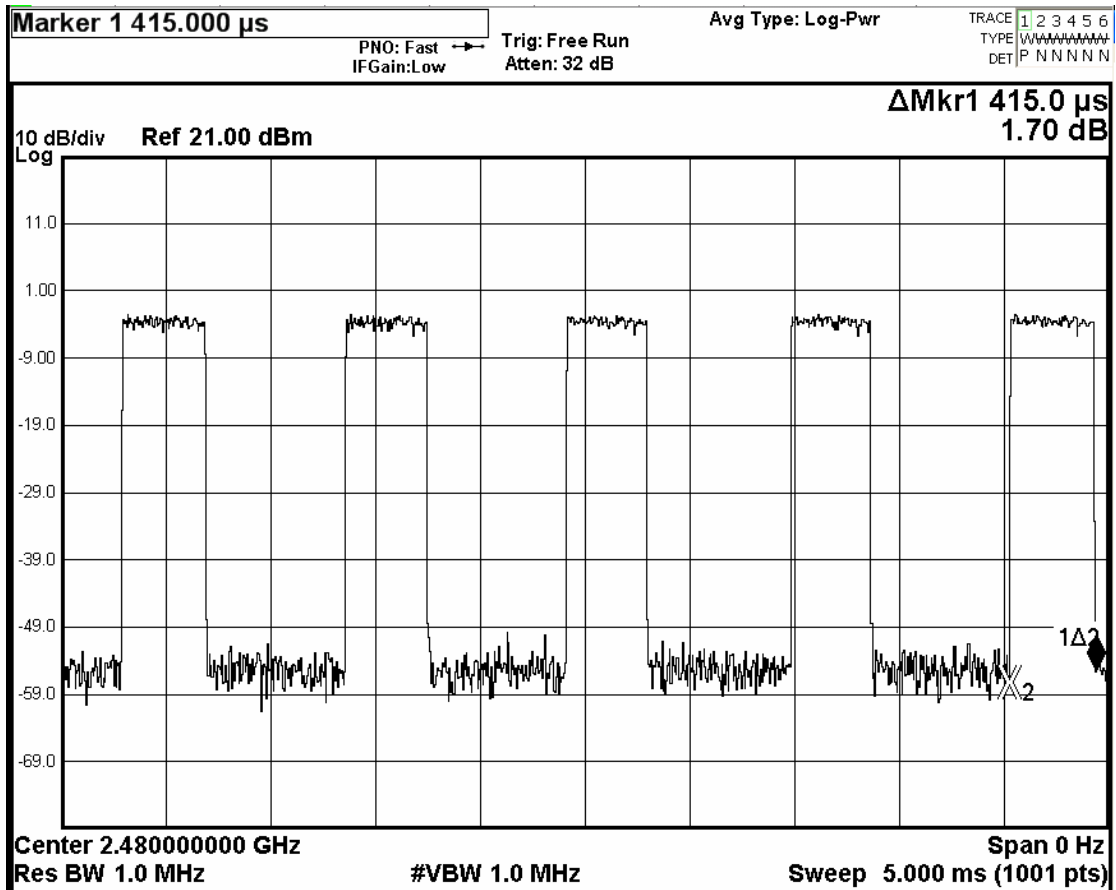


Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 82 of 90

Fig. I
[Pulse duration of Highest Channel]



Time of occupancy (Dwell Time):

Data Packet	Frequency (MHz)	Pulse Duration (ms)	Dwell Time (s)	Limits (s)	Test Results
3DH5	2402	2.945	0.3136	0.400	Complies
3DH5	2441	2.945	0.3136	0.400	Complies
3DH5	2480	2.945	0.3136	0.400	Complies
3DH3	2402	1.660	0.2654	0.400	Complies
3DH3	2441	1.660	0.2654	0.400	Complies
3DH3	2480	1.660	0.2654	0.400	Complies
3DH1	2402	0.415	0.1327	0.400	Complies
3DH1	2441	0.415	0.1327	0.400	Complies
3DH1	2480	0.415	0.1327	0.400	Complies



Test Report

Date : 2021-12-30
No. : HMD21120027

Page 83 of 90

3.1.9 Channel Centre Frequency

Ambient Temperature: 25°C Relative Humidity: 51% Atmospheric Pressure: 101 kPa

Requirements:

Frequency hopping system in the 2400-2483.5MHz band shall use at least 79 (Channel 1 to 79) non-overlapping channels.

The EUT operates in according with the Bluetooth system specification within the 2400 - 2483.5 MHz frequency band.

RF channels for Bluetooth systems are spaced 1 MHz and are ordered in channel number k. In order to comply with out-of-band regulations, a lower frequency guard band of 2.0 MHz and a higher frequency guard band of 3.5MHz is used.

The operating frequencies of each channel are as follows:

First RF channel start from 2400MHz + 2MHz guard band = 2402MHz

Frequency of RF Channel = 2402+k MHz, k = 0,...,78 (Channel separation = 1MHz)

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 84 of 90

3.1.10 Pseudorandom Hopping Algorithm

Ambient Temperature: 25°C

Relative Humidity: 51%

Atmospheric Pressure: 101 kPa

Requirements:

The channel frequencies shall be selected from a pseudorandom ordered list of hopping frequencies. Each frequency must be used equally by the transmitter.

EUT Pseudorandom Hopping Algorithm

The EUT is a Bluetooth device, the Pseudo-random hopping pattern; hopping characteristics and algorithm are based on the Bluetooth specification.

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 85 of 90

3.1.11 Antenna Requirement

Ambient Temperature: 25°C

Relative Humidity: 51%

Atmospheric Pressure: 101 kPa

Test Requirements: § 15.203

Test Specification:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

Test Results:

This is PCB antenna. There is no external antenna, the antenna gain = 0dBi. User is unable to remove or changed the Antenna.

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Test Report

Date : 2021-12-30
 No. : HMD21120027

Page 86 of 90

Appendix A

List of Measurement Equipment

Radiated Emission

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM215	MULTIDEVICE CONTROLLER	EMCO	2090	00024676	N/A	N/A
EM217	ELECTRIC POWERED TURNTABLE	EMCO	2088	00029144	N/A	N/A
EM218	ANECHOIC CHAMBER	ETS-LINDGREN	FACT-3	--	2020/04/20	2022/04/20
EM356	ANTENNA POSITIONING TOWER	ETS-LINDGREN	2171B	00150346	N/A	N/A
EM336	PRECISION CONICAL DIPOLE	SEIBERSDORF LABORATORIES	PCD 3100	6236/M	2020/05/30	2022/05/30
EM229	EMI TEST RECEIVER	R&S	ESIB40	100248	2020/05/13	2022/05/13
EM276	BROADBAND HORN ANTENNA	A-INFOMW	JXTXLB-10180-SF	J2031090903007	2019/03/20	2022/03/29
EM300	PYRAMIDAL STANDARD GAIN HORN ANTENNA	ETS-LINDGREN	3160-09	00130130	2020/04/28	2022/04/28
EM301	PYRAMIDAL STANDARD GAIN HORN ANTENNA	ETS-LINDGREN	3160-10	00130988	2020/04/28	2022/04/28
EM022	LOOP ANTENNA	ETS LINDGREN	6502	00206533	2019/11/30	2022/04/28
EM355	Biconilog Antenna	ETS-Lindgren	3143B	00094856	2020/06/17	2022/06/17
EM200	DUAL CHANNEL POWER METER	R & S	NRVD	100592	2019/10/11	2022/10/11
EM012	PRE-AMPLIFIER	HP	HP8448B	3008A00262	2019/11/08	2022/11/08

Line Conducted

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM119	LISN	R & S	ESH3-Z5	0831.5518.52	2020/06/30	2022/06/30
EM145	EMI TEST RECEIVER	R & S	ESIB7	100072	2020/05/13	2022/05/13
EM179	IMPULSE LIMITER	ROHDE & SCHWARZ	ESH3-Z2	357-8810.52/54	2020/01/13	2022/01/11
EM154	SHIELDING ROOM	SIEMENS MATSUSHITA COMPONENTS	N/A	803-740-057-99A	2017/02/02	2022/02/02
N/A	MEASUREMENT AND EVALUATION SOFTWARE	ROHDE & SCHWARZ	BSIB-K1	V1.20	N/A	N/A

Remarks:-

CM Corrective Maintenance
 N/A Not Applicable
 TBD To Be Determined

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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 87 of 90

Appendix B

Photographs of EUT

View of the product



View of the product



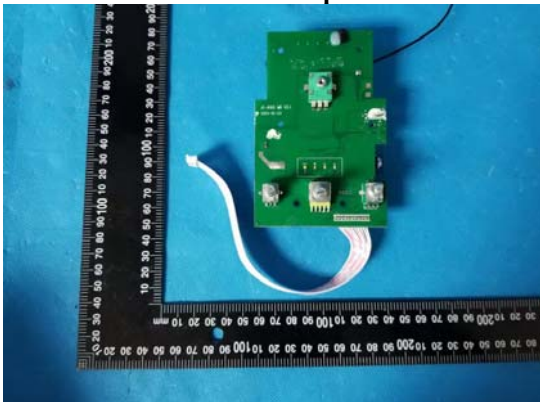
View of the product



Inside View of the product



Inner circuit top view



Inner circuit bottom view



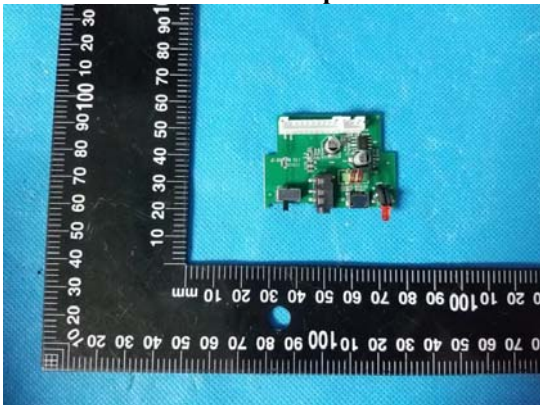
Test Report

Date : 2021-12-30
No. : HMD21120027

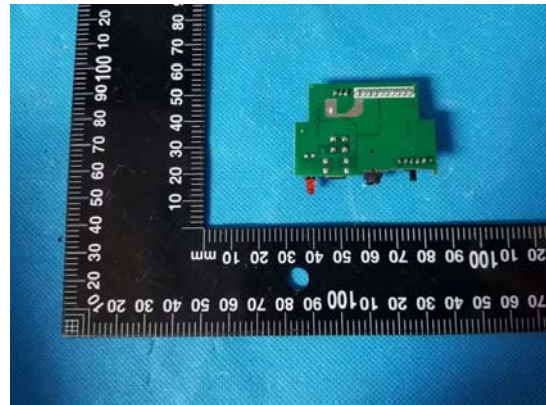
Page 88 of 90

Photographs of EUT

Inner circuit top view



Inner circuit bottom view



Battery View of The Product



Test Report

Date : 2021-12-30
No. : HMD21120027

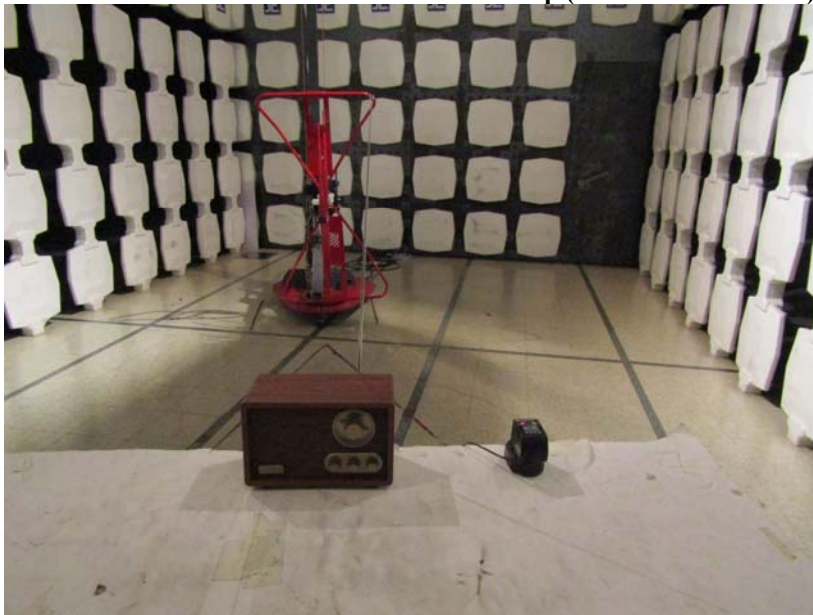
Page 89 of 90

Photographs of EUT

Measurement of Radiated Emission Test Set Up (9kHz – 30MHz)



Measurement of Radiated Emission Test Set Up (30MHz to 1000MHz)



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Test Report

Date : 2021-12-30
No. : HMD21120027

Page 90 of 90

Photographs of EUT

Measurement of Radiated Emission Test Set Up (Above 1000MHz)



Measurement of Conducted Emission Test Set Up



******* End of Test Report *******

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