



# **TEST REPORT**

**Report Number:** 13131738-E1V1

**Applicant :** APPLE, INC.  
1 APPLE PARK WAY  
CUPERTINO, CA 95014, U.S.A.

**Model :** A2410

**FCC ID :** BCG-E3549A

**IC :** 579C-E3549A

**EUT Description :** SMARTPHONE

**Test Standard(s) :** FCC 47 CFR PART 15 SUBPART C  
ISED RSS-247 ISSUE 2  
ISED RSS-GEN ISSUE 5

**Date of Issue:**  
September 21, 2020

**Prepared by:**  
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## REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	9/21/2020	Initial Issue	Chin Pang

## TABLE OF CONTENTS

<b>REPORT REVISION HISTORY .....</b>	<b>2</b>
<b>TABLE OF CONTENTS .....</b>	<b>3</b>
<b>1. ATTESTATION OF TEST RESULTS .....</b>	<b>4</b>
<b>2. TEST RESULTS SUMMARY .....</b>	<b>5</b>
<b>3. TEST METHODOLOGY .....</b>	<b>5</b>
<b>4. FACILITIES AND ACCREDITATION .....</b>	<b>5</b>
<b>5. DECISION RULES AND MEASUREMENT UNCERTAINTY .....</b>	<b>6</b>
5.1. METROLOGICAL TRACEABILITY .....	6
5.2. DECISION RULES.....	6
5.3. MEASUREMENT UNCERTAINTY.....	6
<b>6. INTRODUCTION OF TEST DATA REUSE.....</b>	<b>7</b>
6.1. EUT DESCRIPTION .....	7
6.2. INTRODUCTION .....	7
6.3. SPOT CHECK VERIFICATION RESULTS SUMMARY .....	7
6.4. REFERENCE DETAIL .....	14
6.5. DESCRIPTION OF AVAILABLE ANTENNAS .....	14
6.6. SOFTWARE AND FIRMWARE.....	14
6.7. WORST-CASE CONFIGURATION AND MODE.....	14
6.8. DESCRIPTION OF TEST SETUP.....	15
<b>7. TEST AND MEASUREMENT EQUIPMENT .....</b>	<b>16</b>
<b>8. MEASUREMENT METHODS .....</b>	<b>16</b>
<b>9. SETUP PHOTOS.....</b>	<b>16</b>
<b>Appendix A – Reference Test Report .....</b>	<b>17</b>

## 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** APPLE, INC.  
1 APPLE PARK WAY  
CUPERTINO, CA 95014, U.S.A.

**EUT DESCRIPTION:** SMARTPHONE

**MODEL:** A2410

**SERIAL NUMBER:** (Original): G6TCQ01TQ897, G6TCV00BQ88T  
(Spot Check): G6TD401A06P9, G6TD401306P3

**DATE TESTED:** AUGUST 15 -31, 2020

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Complies
ISED RSS-247 Issue 2	Complies
ISED RSS-GEN Issue 5	Complies

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For  
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Consumer Technology Division  
UL Verification Services Inc.

Prepared By:



Francisco Guarnero  
Test Engineer  
Consumer Technology Division  
UL Verification Services Inc.

## 2. TEST RESULTS SUMMARY

FCC Clause	ISED Clause	Requirement	Result	Comment
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions	Complies	None.

## 3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 662911, RSS-GEN Issue 5, and RSS-247 Issue 2.

## 4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street	47658 Kato Road
<input type="checkbox"/> Chamber A	<input type="checkbox"/> Chamber D	<input type="checkbox"/> Chamber I
<input type="checkbox"/> Chamber B	<input type="checkbox"/> Chamber E	<input checked="" type="checkbox"/> Chamber J
<input type="checkbox"/> Chamber C	<input type="checkbox"/> Chamber F	<input type="checkbox"/> Chamber K
	<input type="checkbox"/> Chamber G	<input type="checkbox"/> Chamber L
	<input checked="" type="checkbox"/> Chamber H	<input type="checkbox"/> Chamber M

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code: 2324A.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0

## 5. DECISION RULES AND MEASUREMENT UNCERTAINTY

### 5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

### 5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

### 5.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	U <sub>Lab</sub>
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.39 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.07 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	2.52 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	4.88 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.24 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.37 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.17 dB

Uncertainty figures are valid to a confidence level of 95%.

## 6. INTRODUCTION OF TEST DATA REUSE

### 6.1. EUT DESCRIPTION

The Apple iPhone is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, 5G, CDMA, IEEE 802.11a/b/g/n/ac/ax, Bluetooth, Ultra-Wideband, GPS, NFC and WPT. All models support at least one UICC based SIM. The second SIM is either an UICC based p-SIM (physical SIM) or e-SIM (electronic SIM). The device supports a built-in inductive charging transmitter and receiver. The rechargeable battery is not user accessible.

### 6.2. INTRODUCTION

This application for certification is leveraging the data reuse procedures from KDB 484596 D01 based on reference FCC ID: BCG-E3548A, IC: 579C-E3548A to cover variant model BCG-E3549A, 579C-E3549A. The major difference between the parent/reference model and the variant model is the depopulation in the variant model of the mmWave transmitter. All other circuitry and features are identical. The data reuse test plan was approved via manufacturer KDB inquiry.

### 6.3. SPOT CHECK VERIFICATION RESULTS SUMMARY

Spot check verification has been done on device model A2410, FCC ID: BCG-E3549A, IC: 579C-E3549A for radiated spurious and radiated band-edge in accordance with the Test Plan that was approved via KDB inquiry.

BCG-E3549A SPOT CHECK RESULTS										
Technology	Mode	Test Item	Channel	Measured	Original model		Spot check model		Delta (dB)	
					A2342		A2410			
					BCG-E3548A 579C-E3548A		BCG-E3549A 579C-E3549A			
				Frequency	Peak	Ave	Peak	Ave	Peak	Ave
BT	GFSK	RBE	Low	2390.0MHz	49.67	39.21	51.97	38.89	2.3	-0.32
			High	2483.50MHz	51.82	38.18	53.27	39.66	1.45	1.48
		RSE	Mid	10600MHz	52.13	41.57	51.58	38.36	-0.55	-3.21

Comparison of the models, upper deviation is within 3dB range and all tests are under FCC/IC Technical Limits. The test report for FCC ID: BCG-E3548A and IC: 579C-E3548A is therefore being used to support the application for certification for FCC ID: BCG-E3549A and IC: 579C-E3549A.

Note: The output powers were verified on model A2410 to match with model A2342 before radiated emissions spot check was performed.

# SPOT CHECK DATA

## BANDEDGE (LOW CHANNEL)

### HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T662 (dB/m)	Amp/Cbl/Fitr/Pa d (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	40.53	Pk	31.8	-23.8	48.53	-	-	74	-25.47	147	377	H
2	* 2.37196	43.97	Pk	31.8	-23.8	51.97	-	-	74	-22.03	147	377	H
3	* 2.39	30.85	VA1T	31.8	-23.8	38.85	54	-15.15	-	-	147	377	H
4	* 2.36997	30.89	VA1T	31.8	-23.8	36.89	54	-15.11	-	-	147	377	H

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

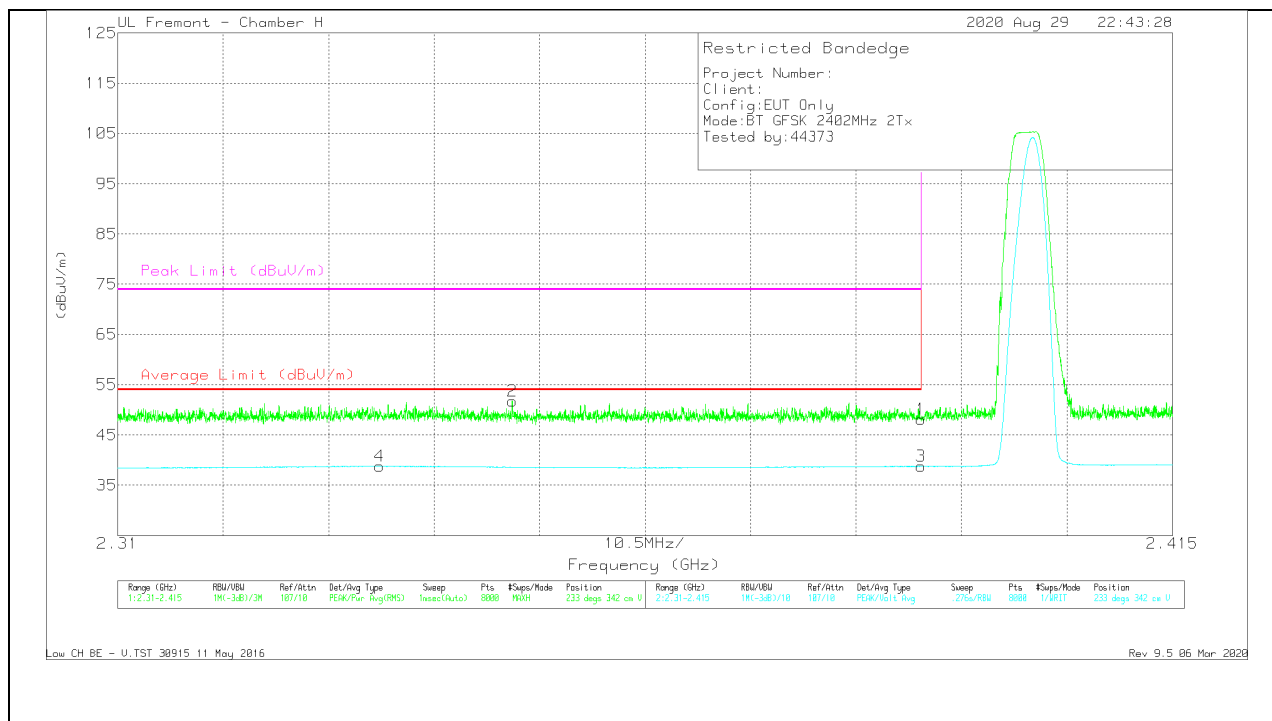
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

Low CH BE - H.TST 30915 11 May 2016

Rev 9.5 06 Mar 2020



## VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T862 (dB/m)	Amp/Cbl/Filtr/Pa d (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degr)	Height (cm)	Polarity
1	* 2.39	40.16	Pk	31.8	-23.8	48.16	-	-	74	-25.84	233	342	V
2	* 2.34928	43.82	Pk	31.8	-23.9	51.72	-	-	74	-22.28	233	342	V
3	* 2.39	30.77	VA1T	31.8	-23.8	38.77	54	-15.23	-	-	233	342	V
4	* 2.3361	30.93	VA1T	31.8	-23.9	38.83	54	-15.17	-	-	233	342	V

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

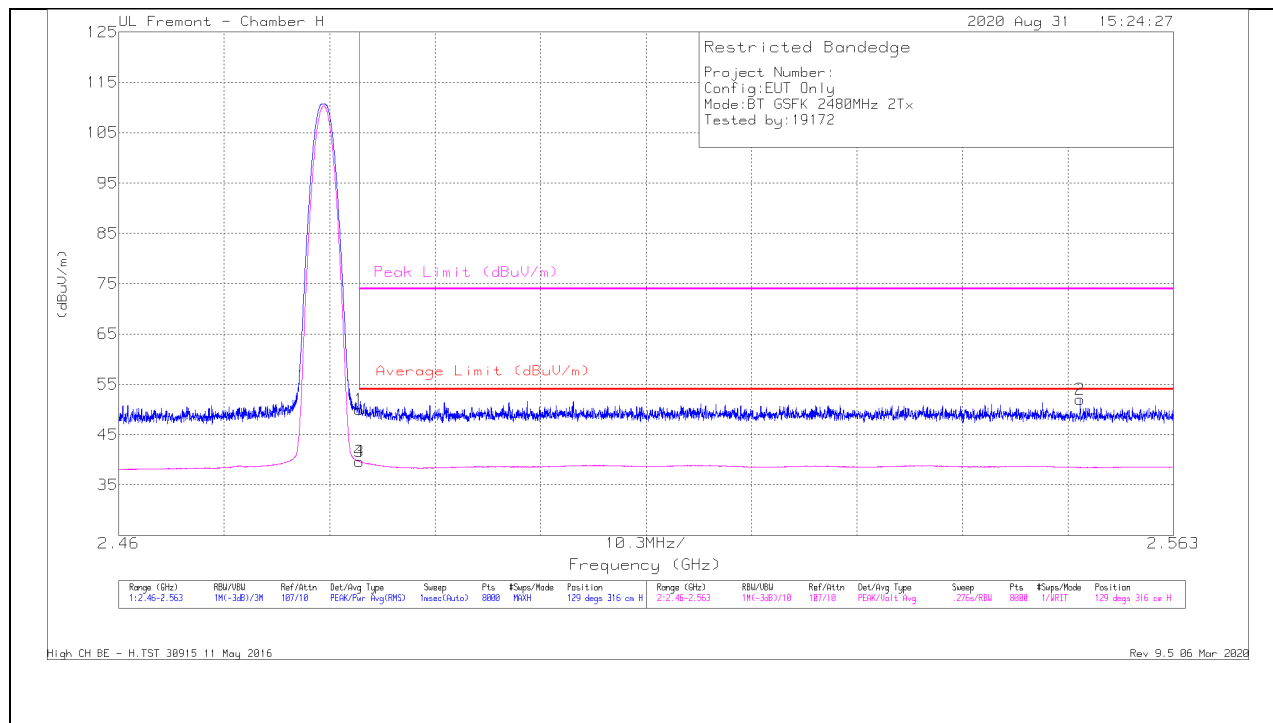
Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

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# **BANDEDGE (HIGH CHANNEL)**

## **HORIZONTAL RESULT**

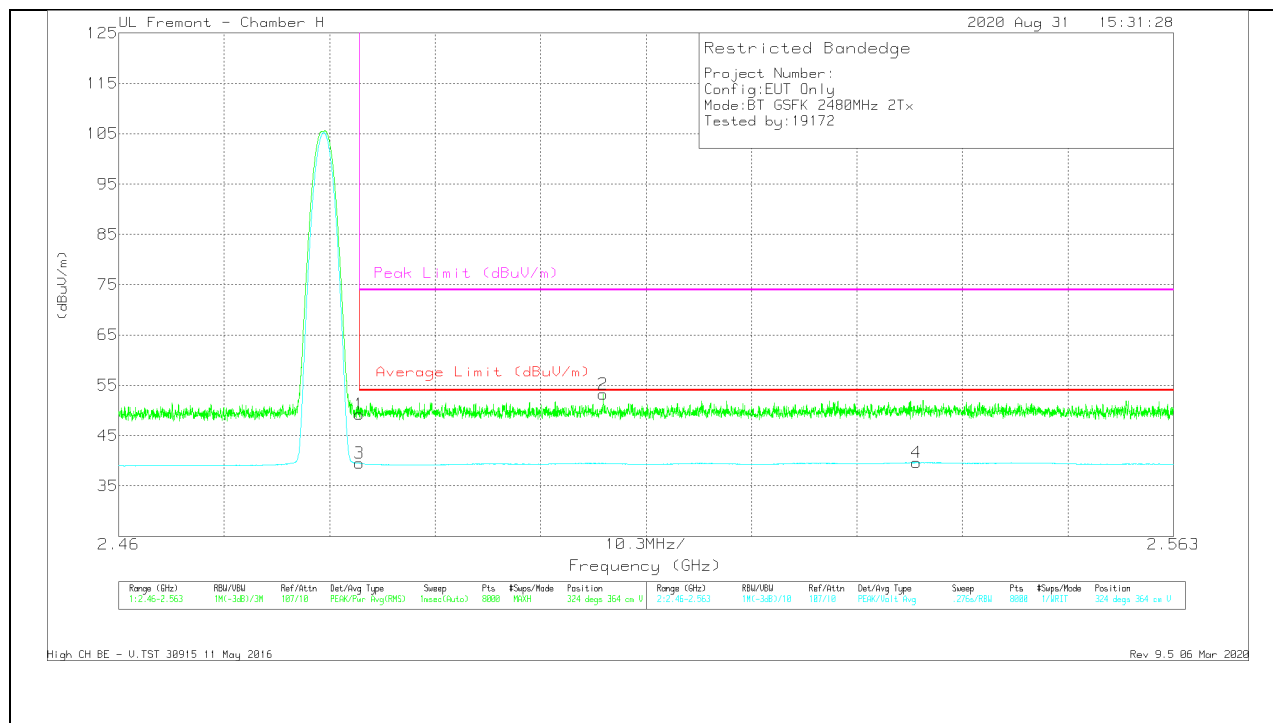


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T862 (dB/m)	Amp/Cbl/Fitr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	41.45	Pk	32.3	-23.7	50.05	-	-	74	-23.95	129	316	H
3	* 2.4835	31.02	VA1T	32.3	-23.7	39.62	54	-14.38	-	-	129	316	H
4	* 2.48351	31.02	VA1T	32.3	-23.7	39.62	54	-14.38	-	-	129	316	H
2	2.55389	43.1	Pk	32.4	-23.5	52	-	-	74	-22	129	316	H

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band  
Pk - Peak detector  
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

High CH BE - H.TST 30915 11 May 2016  
Rev 9.5 06 Mar 2020

## VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T662 (dB/m)	Amp/Cb/Filt/Pa d (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Dogs)	Height (cm)	Polarity
1	* 2.4835	40.7	Pk	32.3	-23.7	49.3	-	-	74	-24.7	324	364	V
3	* 2.4835	30.89	VA1T	32.3	-23.7	39.49	54	-14.51	-	-	324	364	V
2	2.50731	44.37	Pk	32.4	-23.5	53.27	-	-	74	-20.73	324	364	V
4	2.53793	30.66	VA1T	32.4	-23.4	39.66	54	-14.34	-	-	324	364	V

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

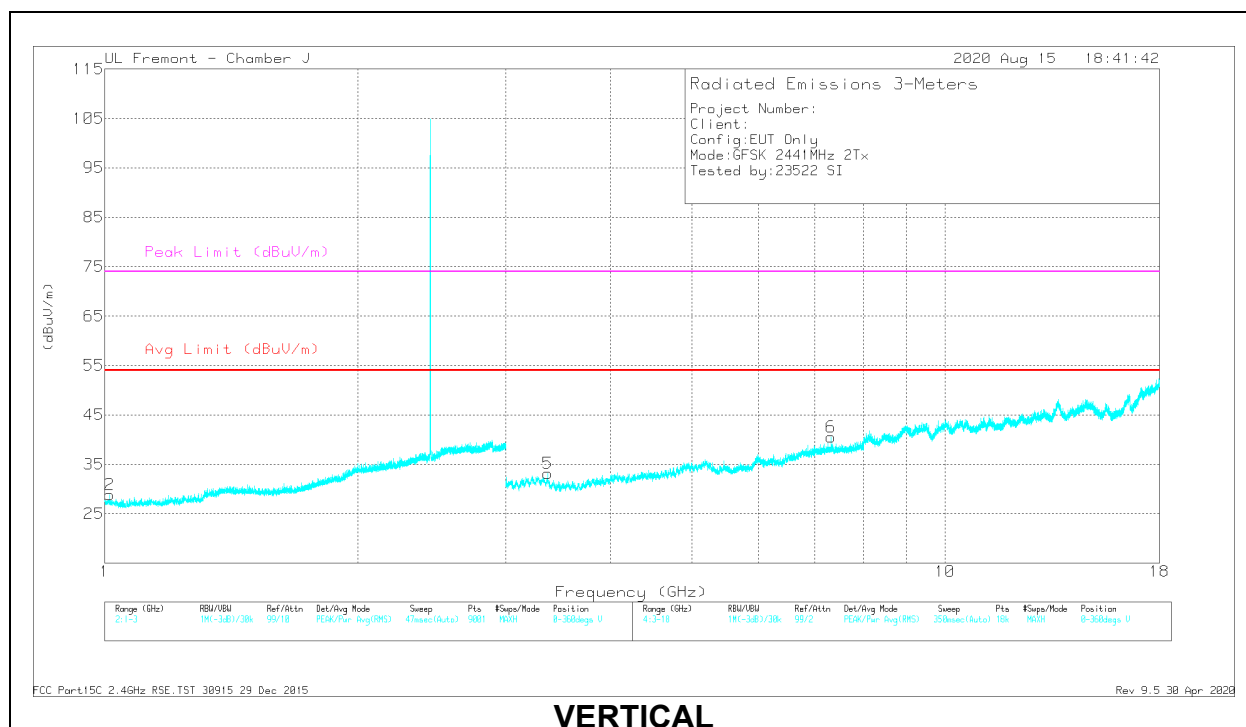
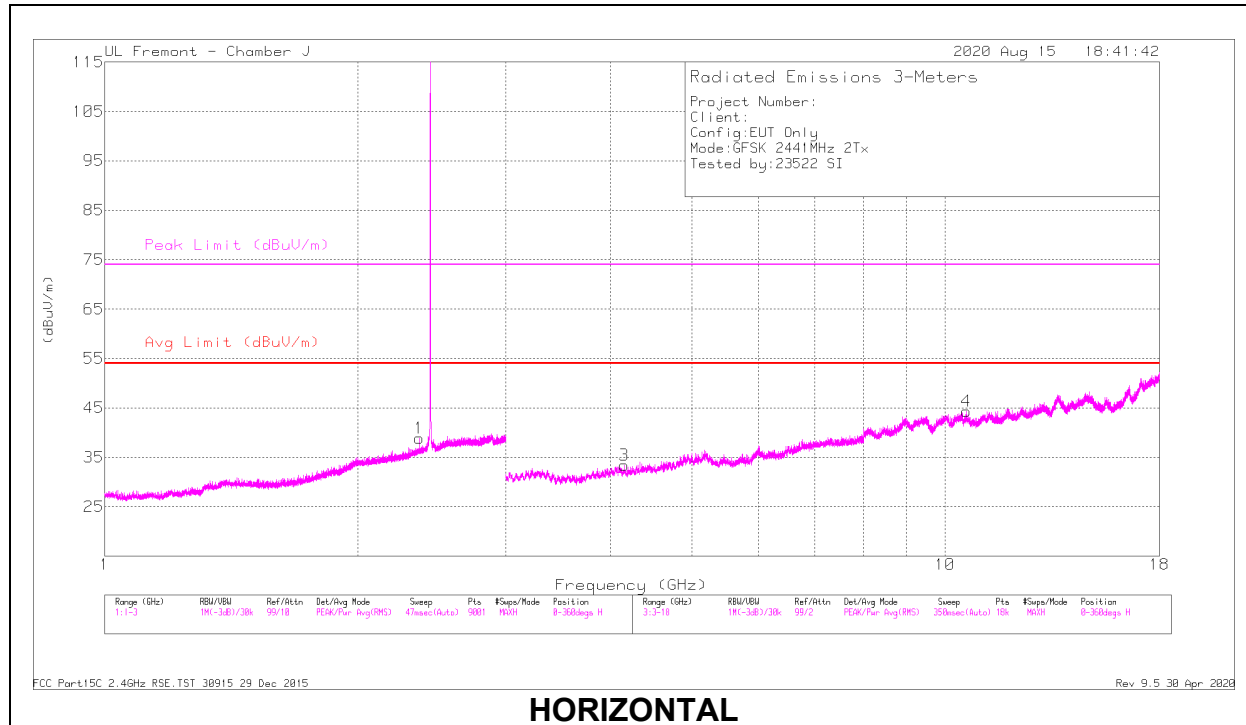
Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

High CH BE - V.TST 30915 11 May 2016  
Rev 9.5 06 Mar 2020

## HARMONICS AND SPURIOUS EMISSIONS

### MID CHANNEL RESULTS



## RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AF T963 (dB/m)	Amp/Cbl/Fitr/P ad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.36881	31.63	PKFH	29	-14.8	45.83	-	-	74	-28.17	76	188	H
	* 2.36858	19.12	VA1T	29	-14.8	33.32	54	-20.68	-	-	76	188	H
2	* 1.01396	31.4	PKFH	23.8	-18.6	36.6	-	-	74	-37.4	327	173	V
	* 1.0124	17.53	VA1T	23.8	-18.6	22.73	54	-31.27	-	-	327	173	V
3	* 4.15133	40.64	PKFH	31.8	-31.3	41.14	-	-	74	-32.86	281	373	H
	* 4.15273	26.89	VA1T	31.8	-31.3	27.39	54	-26.61	-	-	281	373	H
4	* 10.6097	35.48	PKFH	39.5	-23.4	51.58	-	-	74	-22.42	82	190	H
	* 10.6103	22.36	VA1T	39.5	-23.5	38.36	54	-15.64	-	-	82	190	H
5	3.36653	43.22	PKFH	31.2	-33.4	41.02	-	-	-	-	9	141	V
	* 7.32246	37.07	PKFH	37.1	-27.1	47.07	-	-	74	-26.93	226	239	V
6	* 7.32215	23.37	VA1T	37.1	-27.1	33.37	54	-20.63	-	-	226	239	V

\* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

PKFH FHSS/BT RB=100k for Frequencies<1GHz / RB=1MHz for Frequencies>1GHz, VB=3 x RB, Peak

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

#### 6.4. REFERENCE DETAIL

Reference application that contains the reference data which is attached to this report in Appendix A.

Equipment Class	Reference FCC ID & IC	Reference Report	Report Title/Section
DSS	BCG-E3548A 579C-E3548A	13335182-E1	FCC IC_BT Report / All sections

#### 6.5. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Range (GHz)	ANT 4 (dBi)	ANT 3 (dBi)
2.4	0.3	-1.7

#### 6.6. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was 18.1.148.558

#### 6.7. WORST-CASE CONFIGURATION AND MODE

Radiated band edge and spurious emissions from 1GHz to 18GHz were performed based on the Model A2342 worst case with the EUT set at highest power at Low/Middle/High channels.

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The Wi-Fi/Bluetooth radio modules have the same mechanical outline (e.g., the same package dimension and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances.

Baseline testing was performed on the two variants to determine the worst case on all radiated emissions.

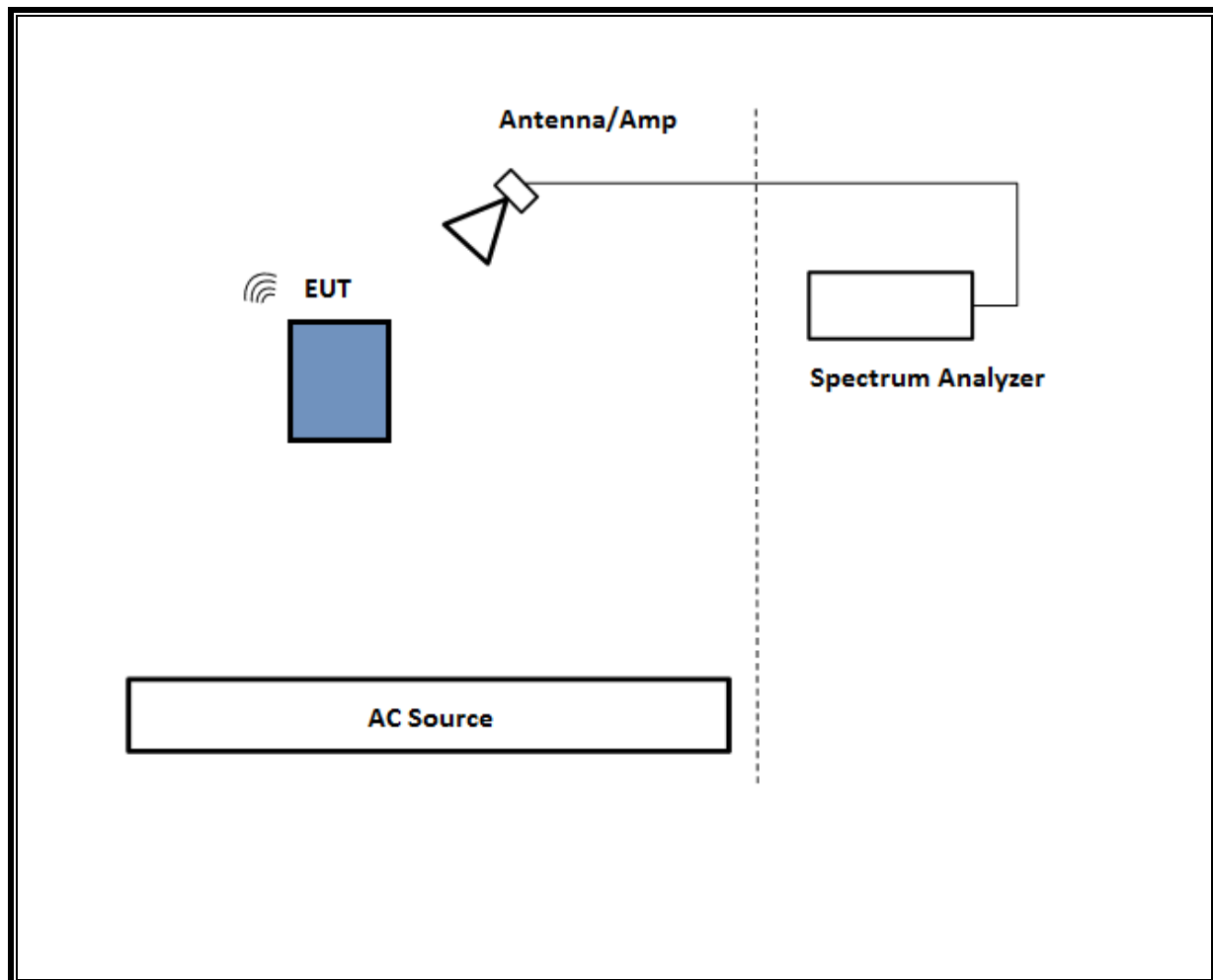
## 6.8. DESCRIPTION OF TEST SETUP

SUPPORT TEST EQUIPMENT						
Description		Manufacturer	Model	Serial Number		FCC ID/ DoC
Laptop		Apple	A1398	C02PM012G3QD		QDS-BRCM1069
Laptop AC/DC adapter		Liteon Technology	PA-1450-BA1	B123		N/A
EUT AC/DC adapter		Apple	A1385	D29325SM03XDHLHC9		N/A
I/O CABLES (RF RADIATED TEST)						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	AC	Un-shielded	2	N/A
2	USB	1	USB	Un-shielded	1	N/A

### TEST SETUP

The EUT is connected to a test laptop during the tests. Test software exercised the radio card.

### SETUP DIAGRAM FOR RADIATED TESTS Above 1 GHz



## 7. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment were utilized for the tests documented in this report:

Description	Manufacturer	Model	ID Num	Cal Due	Last Cal
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T862	08/19/2021	08/19/2020
RF Amplifier, 1-18GHz	MITEQ	AFS42-00101800-25-S-42	PRE0181078	05/06/2021	05/06/2020
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179522	02/20/2021	02/20/2020
Antenna, Double Ridge Guide Horn Antenna 700MHz to 18GHz	A.H. Systems, Inc.	SAS-571	T963	01/25/2021	01/25/2020
*Amplifier, 1 to 18GHz, 35dB	AMPLICAL	AMP1G18-35	T1571	08/20/2021	08/20/2020
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179372	02/22/2021	02/25/2020
Power Meter, P-series single channel	Keysight	N1911A	PRE0177682	01/21/2021	01/21/2020
Power Sensor	Keysight	N1921A	T1226	02/13/2021	02/13/2020

\*Testing is completed before equipment expiration date.

## 8. MEASUREMENT METHODS

Radiated Spurious Emissions Below 30MHz: ANSI C63.10-2013 Section 6.4 & 13

Radiated Spurious Emissions 30-1000MHz: ANSI C63.10-2013 Section 6.3, 6.5 & 13

Radiated Spurious Emissions above 1GHz: ANSI C63.10-2013 Section 6.3, 6.6 & 13

Radiated Band-edge: ANSI C63.10-2013 Section 6.10.5 & 13

## 9. SETUP PHOTOS

Please refer to 13335182-EP1 for setup photos

## END OF TEST REPORT



## **Appendix A – Reference Test Report**

Attached is the test report (13335182-E1) containing the reference data from the parent model as detailed in section 6.4.



# **TEST REPORT**

**Report Number:** 13335182-E1V2

**Applicant :** APPLE, INC.  
1 APPLE PARK WAY  
CUPERTINO, CA 95014, U.S.A.

**Model :** A2342

**FCC ID :** BCG-E3548A

**IC :** 579C-E3548A

**EUT Description :** SMARTPHONE

**Test Standard(s) :** FCC 47 CFR PART 15 SUBPART C  
ISED RSS-247 ISSUE 2  
ISED RSS-GEN ISSUE 5

**Date of Issue:**  
September 25, 2020

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## REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	9/21/2020	Initial Issue	Chin Pang
V2	9/25/2020	Address TCB's Questions	Chin Pang

## TABLE OF CONTENTS

<b>REPORT REVISION HISTORY .....</b>	<b>2</b>
<b>TABLE OF CONTENTS .....</b>	<b>3</b>
<b>1. ATTESTATION OF TEST RESULTS .....</b>	<b>6</b>
<b>2. TEST RESULTS SUMMARY .....</b>	<b>7</b>
<b>3. TEST METHODOLOGY .....</b>	<b>7</b>
<b>4. FACILITIES AND ACCREDITATION .....</b>	<b>7</b>
<b>5. DECISION RULES AND MEASUREMENT UNCERTAINTY .....</b>	<b>8</b>
5.1. METROLOGICAL TRACEABILITY .....	8
5.2. DECISION RULES.....	8
5.3. MEASUREMENT UNCERTAINTY.....	8
<b>6. EQUIPMENT UNDER TEST .....</b>	<b>9</b>
6.1. EUT DESCRIPTION .....	9
6.2. MAXIMUM OUTPUT POWER.....	9
6.3. DESCRIPTION OF AVAILABLE ANTENNAS .....	10
6.4. SOFTWARE AND FIRMWARE.....	10
6.5. WORST-CASE CONFIGURATION AND MODE.....	10
6.6. DESCRIPTION OF TEST SETUP.....	11
<b>7. TEST AND MEASUREMENT EQUIPMENT .....</b>	<b>16</b>
<b>8. MEASUREMENT METHODS .....</b>	<b>17</b>
<b>9. ANTENNA PORT TEST RESULTS .....</b>	<b>18</b>
9.1. ON TIME AND DUTY CYCLE.....	18
9.2. 20 dB AND 99% BANDWIDTH .....	20
9.2.1. HIGH POWER BASIC DATA RATE GFSK MODULATION.....	21
9.2.2. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION.....	22
9.2.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION .....	23
9.2.4. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION .....	24
9.3. HOPPING FREQUENCY SEPARATION .....	25
9.3.1. HIGH POWER BASIC DATA RATE GFSK MODULATION.....	26
9.4. NUMBER OF HOPPING CHANNELS.....	27
9.4.1. HIGH POWER BASIC DATA RATE GFSK MODULATION.....	28
9.5. AVERAGE TIME OF OCCUPANCY.....	30
9.5.1. HIGH POWER BASIC DATA RATE GFSK MODULATION.....	31

<b>9.6. OUTPUT POWER.....</b>	<b>35</b>
9.6.1. HIGH POWER BASIC DATA RATE GFSK MODULATION.....	36
9.6.2. HIGH POWER ENHANCED DATA RATE QPSK MODULATION .....	36
9.6.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION .....	37
9.6.4. LOW POWER BASIC DATA RATE GFSK MODULATION.....	37
9.6.5. LOW POWER ENHANCED DATA RATE QPSK MODULATION .....	38
9.6.6. LOW POWER ENHANCED DATA RATE 8PSK MODULATION .....	38
9.6.7. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION.....	39
9.6.8. HIGH POWER ENHANCED DATA RATE TXBF QPSK MODULATION .....	39
9.6.9. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION .....	39
9.6.10. LOW POWER BASIC DATA RATE TXBF GFSK MODULATION .....	40
9.6.11. LOW POWER ENHANCED DATA RATE TXBF QPSK MODULATION.....	40
9.6.12. LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION .....	40
<b>9.7. AVERAGE POWER.....</b>	<b>41</b>
9.7.1. HIGH POWER BASIC DATA RATE GFSK MODULATION.....	42
9.7.2. HIGH POWER ENHANCED DATA RATE QPSK MODULATION .....	42
9.7.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION .....	43
9.7.4. LOW POWER BASIC DATA RATE GFSK MODULATION.....	43
9.7.5. LOW POWER ENHANCED DATA RATE QPSK MODULATION .....	44
9.7.6. LOW POWER ENHANCED DATA RATE 8PSK MODULATION .....	44
9.7.7. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION.....	45
9.7.8. HIGH POWER ENHANCED RATE TXBF QPSK MODULATION.....	45
9.7.9. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION .....	45
9.7.10. LOW POWER BASIC DATA RATE TXBF GFSK MODULATION .....	46
9.7.11. LOW POWER ENHANCED DATA RATE TXBF QPSK MODULATION.....	46
9.7.12. LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION .....	46
<b>9.8. CONDUCTED SPURIOUS EMISSIONS.....</b>	<b>47</b>
9.8.1. HIGH POWER BASIC DATA RATE GFSK MODULATION.....	48
9.8.2. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION.....	52
9.8.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION .....	56
9.8.4. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION .....	60
9.8.5. LOW POWER BASIC DATA RATE GFSK MODULATION.....	64
9.8.6. LOW POWER BASIC DATA RATE TXBF GFSK MODULATION.....	68
9.8.7. LOW POWER ENHANCED DATA RATE 8PSK MODULATION .....	72
9.8.8. LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION .....	76
<b>10. RADIATED TEST RESULTS .....</b>	<b>80</b>
<b>10.1. TRANSMITTER ABOVE 1 GHz.....</b>	<b>82</b>
10.1.1. HIGH POWER BASIC DATA RATE GFSK MODULATION .....	82
10.1.2. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION.....	90
10.1.3. LOW POWER BASIC DATA RATE GFSK MODULATION .....	98
10.1.4. LOW POWER ENHANCED DATA RATE 8PSK MODULATION .....	106
10.1.5. HIGH POWER BASIC DATA RATE TX BF GFSK MODULATION .....	114
10.1.6. HIGH POWER BASIC DATA RATE TXBF 8PSK MODULATION.....	118
10.1.7. LOW POWER BASIC DATA RATE TXBF GFSK MODULATION .....	122
10.1.8. LOW POWER BASIC DATA RATE TXBF 8PSK MODULATION.....	126
10.1.9. HIGH POWER HARMONICS AND SPURIOUS TXBF GFSK MODULATION	130
<b>10.2. WORST CASE BELOW 1 GHZ.....</b>	<b>136</b>
<b>10.3. WORST CASE 18-26 GHZ.....</b>	<b>138</b>

<b>11.</b>	<b>AC POWER LINE CONDUCTED EMISSIONS .....</b>	<b>140</b>
11.1.	AC Power Line With Laptop.....	141
11.2.	AC Power Line With AC/DC Adapter.....	143
<b>12.</b>	<b>SETUP PHOTOS .....</b>	<b>145</b>

## 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** APPLE, INC.  
1 APPLE PARK WAY  
CUPERTINO, CA 95014, U.S.A.

**EUT DESCRIPTION:** SMARTPHONE

**MODEL:** A2342

**SERIAL NUMBER:** G6TCQ01TQ897, G6TCQ02KQ897

**DATE TESTED:** MAY 07, 2020 – SEPTEMBER 02, 2020

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Complies
ISED RSS-247 Issue 2	Complies
ISED RSS-GEN Issue 5	Complies

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

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Senior Engineer  
Consumer Technology Division  
UL Verification Services Inc.

Prepared By:



Francisco Guarnero  
Test Engineer  
Consumer Technology Division  
UL Verification Services Inc.

## 2. TEST RESULTS SUMMARY

FCC Clause	ISED Clause	Requirement	Result	Comment
See Comment		Duty Cycle	Reporting purposes only	Per ANSI C63.10, Section 11.6.
See Comment	RSS-GEN 6.7	20dB BW/99% OBW	Reporting purposes only	ANSI C63.10 Sections 6.9.2 and 6.9.3
15.247 (a)(1)	RSS-247 (5.1) (b)	Hopping Frequency Separation	Complies	None.
15.247 (a)(1)(iii)	RSS-247 (5.1) (d)	Number of Hopping Channels	Complies	None.
15.247 (a)(1)(iii)	RSS-247 (5.1) (d)	Average Time of Occupancy	Complies	None.
15.247 (b)(1)	RSS-247 (5.4) (b)	Output Power	Complies	None.
See Comment		Average Power	Reporting purposes only	Per ANSI C63.10, Section 11.9.2.3.2.
15.247 (d)	RSS-247 (5.5)	Conducted Spurious Emissions	Complies	None.
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions	Complies	None.
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	Complies	None.

## 3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 662911, RSS-GEN Issue 5, and RSS-247 Issue 2.

## 4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street	47658 Kato Rd.
<input type="checkbox"/> Chamber A (IC:2324B-1)	<input type="checkbox"/> Chamber D (IC:22541-1)	<input checked="" type="checkbox"/> Chamber I (IC: 2324A-5)
<input type="checkbox"/> Chamber B (IC:2324B-2)	<input checked="" type="checkbox"/> Chamber E (IC:22541-2)	<input checked="" type="checkbox"/> Chamber J (IC: 2324A-6)
<input type="checkbox"/> Chamber C (IC:2324B-3)	<input type="checkbox"/> Chamber F (IC:22541-3)	<input type="checkbox"/> Chamber K (IC: 2324A-1)
	<input type="checkbox"/> Chamber G (IC:22541-4)	<input type="checkbox"/> Chamber L (IC: 2324A-3)
	<input checked="" type="checkbox"/> Chamber H (IC:22541-5)	<input type="checkbox"/> Chamber M (IC: 2324A-2)

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code: 2324A.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0



## 5. DECISION RULES AND MEASUREMENT UNCERTAINTY

### 5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

### 5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

### 5.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	U <sub>Lab</sub>
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.39 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.07 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	2.52 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	4.88 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.24 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.37 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.17 dB

Uncertainty figures are valid to a confidence level of 95%.

## 6. EQUIPMENT UNDER TEST

### 6.1. EUT DESCRIPTION

The Apple iPhone is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, 5G, CDMA, IEEE 802.11a/b/g/n/ac/ax, Bluetooth, Ultra-Wideband, GPS, NFC and WPT. All models support at least one UICC based SIM. The second SIM is either an UICC based p-SIM (physical SIM) or e-SIM (electronic SIM). The device supports a built-in inductive charging transmitter and receiver. The rechargeable battery is not user accessible.

### 6.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

Antenna	Config	Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
Ant 4	High Power	2402 - 2480	Basic GFSK	20.14	103.28
		2402 - 2480	QPSK	18.44	69.82
		2402 - 2480	Enhanced 8PSK	18.80	75.86
	Low Power	2402 - 2480	Basic GFSK	12.59	18.16
		2402 - 2480	QPSK	11.21	13.21
		2402 - 2480	Enhanced 8PSK	11.72	14.86
Ant 3	High Power	2402 - 2480	Basic GFSK	20.11	102.57
		2402 - 2480	QPSK	18.29	67.45
		2402 - 2480	Enhanced 8PSK	18.72	74.47
	Low Power	2402 - 2480	Basic GFSK	12.80	19.05
		2402 - 2480	QPSK	11.11	12.91
		2402 - 2480	Enhanced 8PSK	11.72	14.86
BF, Ant 4 + Ant 3	High Power	2402 - 2480	Basic GFSK TxBF	20.13	103.04
		2402 - 2480	QPSK TxBF	20.35	108.39
		2402 - 2480	Enhanced 8PSK TxBF	20.72	118.03
	Low Power	2402 - 2480	Basic GFSK TxBF	15.78	37.84
		2402 - 2480	QPSK TxBF	14.38	27.42
		2402 - 2480	Enhanced 8PSK TxBF	14.79	30.13

Note: GFSK, DQPSK, 8PSK average Power are all investigated, The GFSK & 8PSK Power are the worst case. Testing is based on these modes to showing compliance. For average power data please refer to section 9.7.

### 6.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Range (GHz)	ANTENNA 4 (dBi)	ANTENNA 3 (dBi)
2.4	0.3	-1.7

### 6.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was 18.1.148.558

### 6.5. WORST-CASE CONFIGURATION AND MODE

The EUT was investigated in three orthogonal orientations X, Y and Z on ANTENNA 4 (Core 0) and ANTENNA 3 (Core 1). It was determined that X (Flatbed) orientation was the worst-case orientation for ANTENNA 4 and 2TX BF, and Y (Landscape) was the worst case for ANTENNA 3.

Radiated band edge, harmonic, and spurious emissions from 1GHz to 18GHz were performed with the EUT set to transmit at highest power on Low/Middle/High channels.

Radiated emissions below 1GHz, 18-26GHz and power line conducted emissions were performed with the EUT transmits at the channel with the highest output power as worst-case scenario. There were no emissions found below 30MHz within 20dB of the limit.

For below 1GHz tests EUT was connected to AC power adapter as the worst case; and for above 1GHz, the worst-case configuration reported was tested with EUT only.. For AC line conducted emission, test was investigated with AC power adapter and with laptop.

For simultaneous transmission of multiple channels in the 2.4GHz BT and 5GHz bands, No noticeable emission was found.

GFSK, DQPSK, 8PSK average power are all investigated, The GFSK & 8PSK power are the worst case. For average power data please refer to section 9.7.

Worst-case data rates as provided by the client were:

GFSK mode: DH5

8PSK mode: 3-DH5

Beamforming : GFSK, DH5, 8PSK, 3-DH5

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The Wi-Fi/Bluetooth radio modules have the same mechanical outline (e.g., the same package dimension and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances.

Baseline testing was performed on the two variants to determine the worst case on all conducted power and radiated emissions.

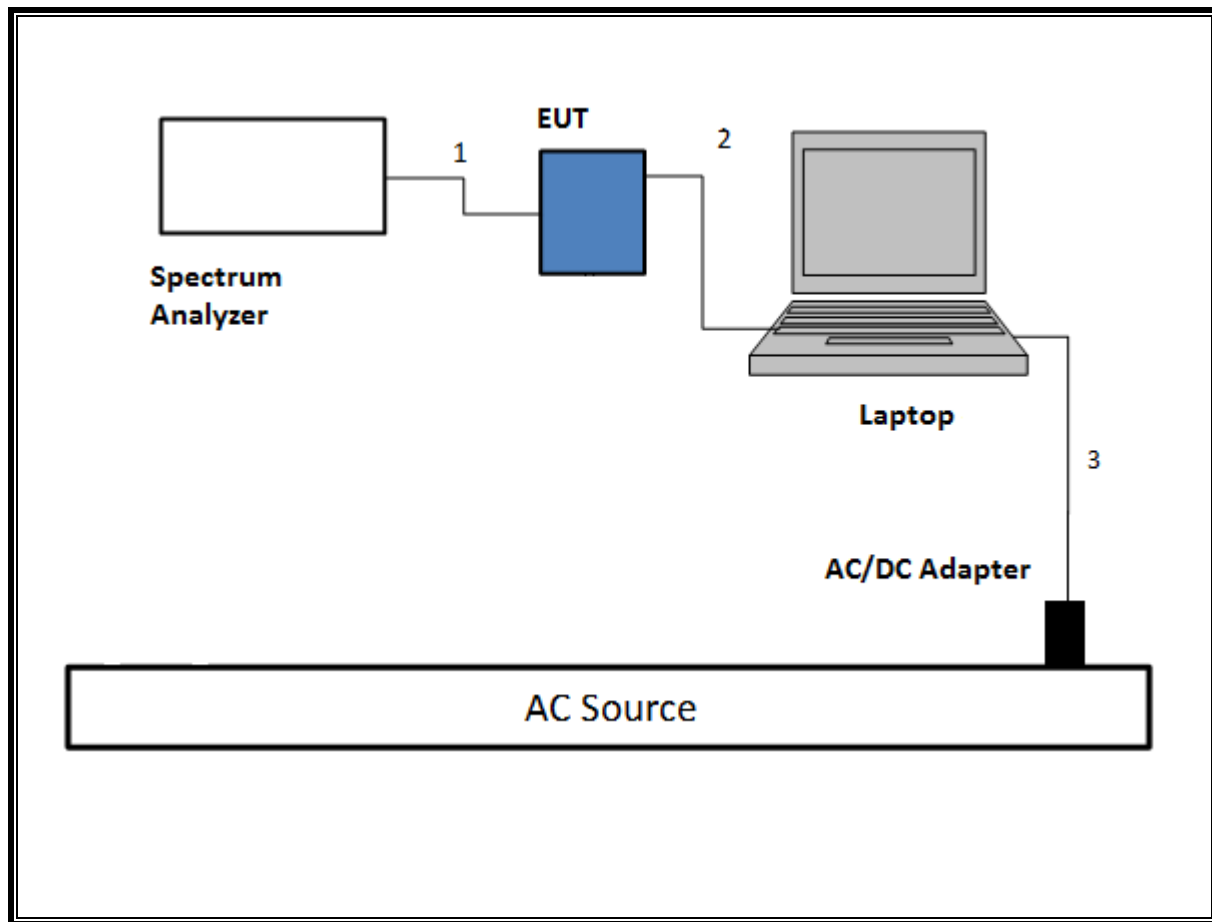
## 6.6. DESCRIPTION OF TEST SETUP

SUPPORT TEST EQUIPMENT						
Description		Manufacturer	Model	Serial Number		FCC ID/ DoC
Laptop		Apple	A1398	C02PM012G3QD		QDS-BRCM1069
Laptop AC/DC adapter		Liteon Technology	PA-1450-BA1	B123		N/A
EUT AC/DC adapter		Apple	A1385	D29325SM03XDHLHC9		N/A
I/O CABLES (RF CONDUCTED TEST)						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Antenna	1	SMA	Un-shielded	0.2	To spectrum Analyzer
2	USB	1	USB	Shielded	1.0	N/A
3	AC	1	AC	Un-shielded	2	N/A
I/O CABLES (RF RADIATED TEST)						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	AC	1	AC	Un-shielded	2	N/A
2	USB	1	USB	Un-shielded	1	N/A

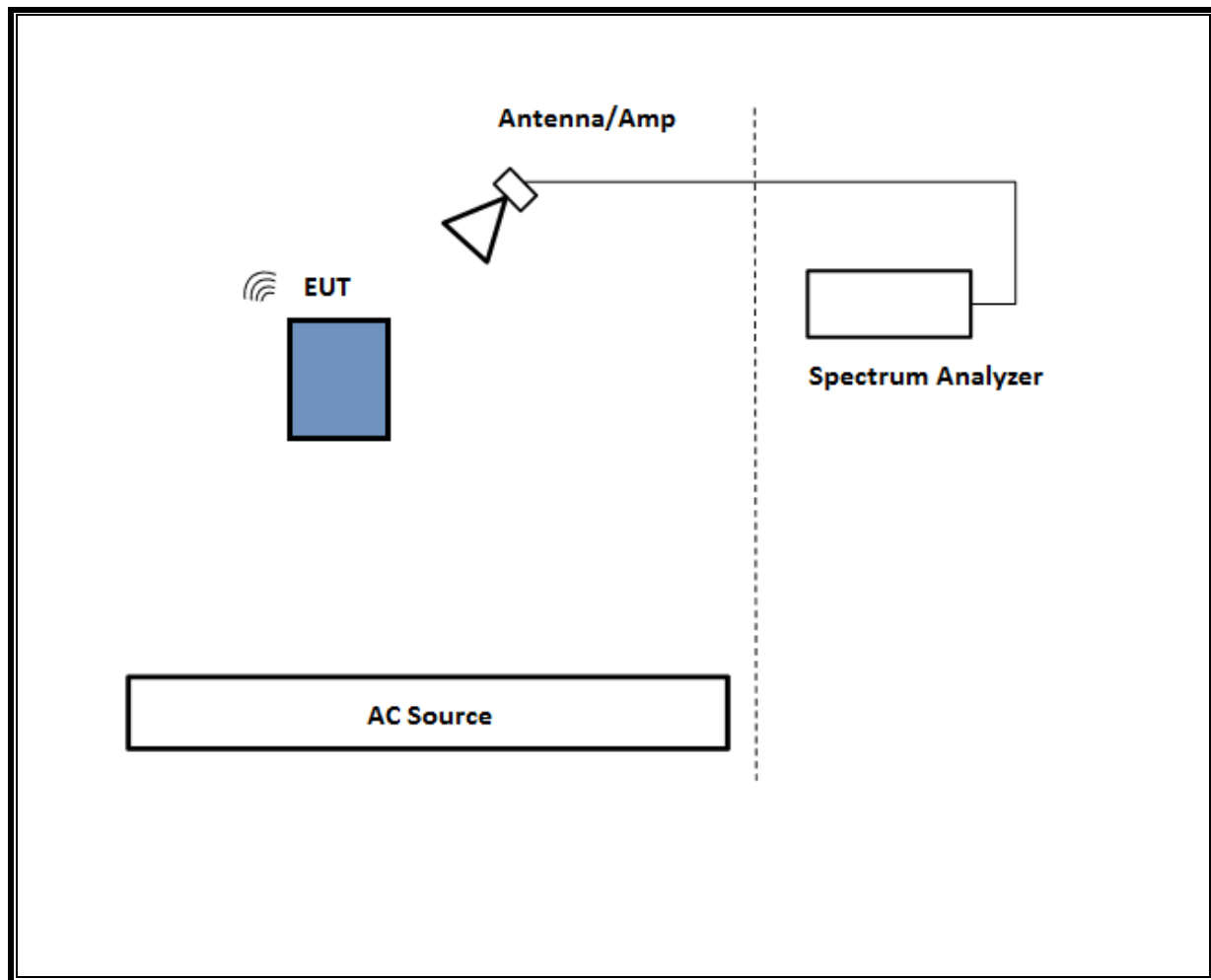
### TEST SETUP

The EUT is connected to a test laptop during the tests. Test software exercised the radio card.

**SETUP DIAGRAM FOR CONDUCTED TESTS**

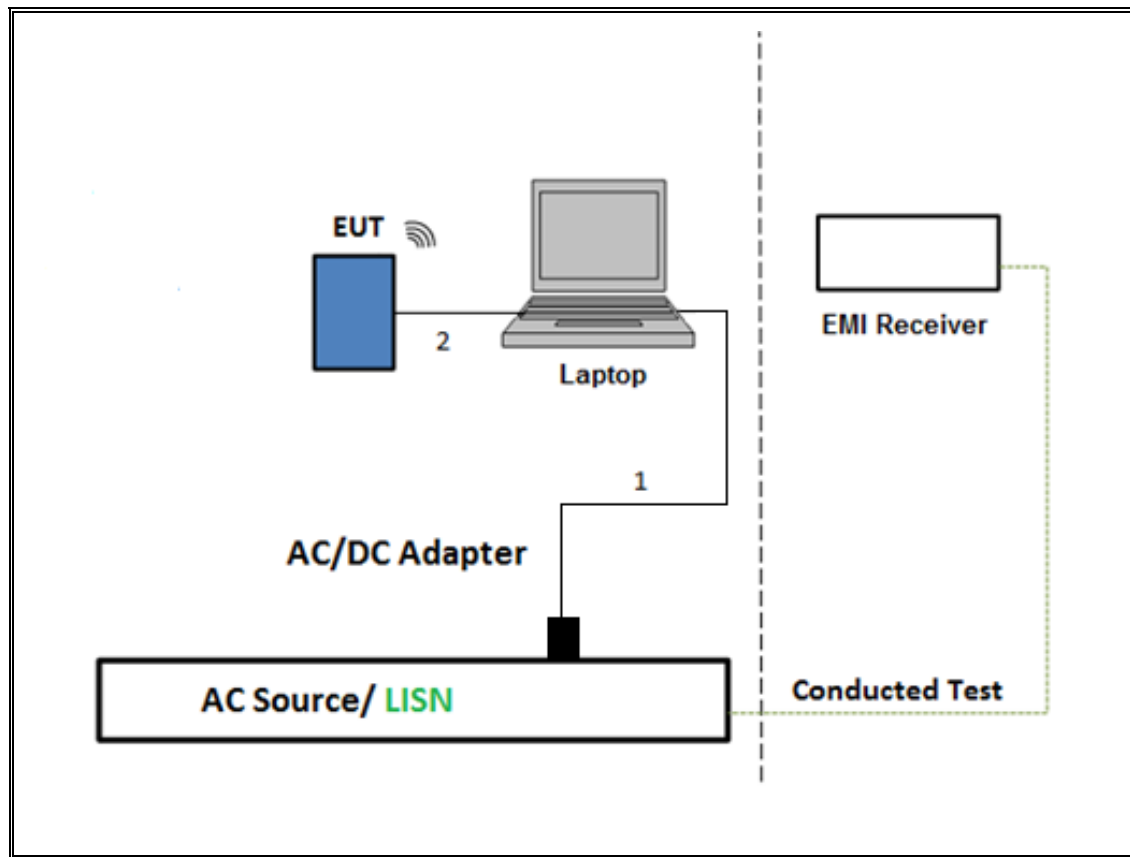


**SETUP DIAGRAM FOR RADIATED TESTS Above 1 GHz**



The diagram illustrates an EMC test setup. On the left, an **AC Source/ LISN** (green text) is connected to an **AC/DC Adapter**. The adapter is connected to an **EUT** (blue box) via a cable labeled **1**. The EUT has a wireless signal icon. A vertical dashed line separates the **Conducted Test** area (left) from the **Radiated Test** area (right). In the **Conducted Test** area, the **AC Source/ LISN** is connected to the **AC/DC Adapter**. In the **Radiated Test** area, an **Antenna/Amp** is connected to a **Spectrum Analyzer** (white box). The **Spectrum Analyzer** is also connected to the **EUT** via a cable. The **Antenna/Amp** is connected to the **EUT** via a cable.

**TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION**





## 7. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment were utilized for the tests documented in this report:

TEST EQUIPMENT LIST					
Description	Manufacturer	Model	ID Num	Cal Due	Last Cal
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight Technologies Inc	N9030A	T1466	01/23/2021	01/23/2020
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences Corp.	JB1	T130	08/04/2021	08/04/2020
Amplifier, 9KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310	T285	07/22/2021	07/22/2020
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight Technologies Inc	N9030A-544	T1210	01/21/2021	01/21/2020
*Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T863	11/01/2020	11/01/2019
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T862	08/19/2021	08/19/2020
Amplifier, 1 - 18GHz	MITEQ	AFS42-00101800-25-S-42	T1567	01/24/2021	01/24/2020
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179522	02/20/2021	02/20/2020
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T346	07/20/2021	07/20/2020
RF Amplifier, 1-18GHz	MITEQ	AFS42-00101800-25-S-42	171460	05/06/2021	05/06/2020
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179372	02/25/2021	02/25/2020
Antenna, Double Ridge Guide Horn Antenna 700MHz to 18GHz	A.H. Systems, Inc.	SAS-571	T963	01/25/2021	01/25/2020
Amplifier, 1 to 18GHz, 35dB	AMPLICAL	AMP1G18-35	T1571	08/20/2021	08/20/2020
Antenna Horn, 18 to 26GHz	ARA	SWH-28	T125	04/17/2021	04/17/2020
Pre-Amp 18-26GHz	Agilent Technology	8449B	T404	04/08/2021	04/08/2020
Antenna, Active Loop 9KHz to 30MHz	ETS-Lindgren	6502	T757	10/01/2020	10/01/2019
Power Meter, P-series single channel	Keysight	N1911A	PRE0177682	01/21/2021	01/21/2020
Power Sensor	Keysight	N1921A	T1226	02/13/2021	02/13/2020
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight Technologies Inc	N9030A	T339	01/21/2021	01/21/2020

AC Line Conducted					
Description	Manufacturer	Model	ID Num	Cal Due	Last Cal
*EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESR	T1436	02/20/2021	02/20/2020
Power Cable, Line Conducted Emissions	UL	PR1	T861	10/27/2020	10/27/2019
LISN for Conducted Emissions CISPR-16	FISCHER CUSTOM COMMUNICATIONS	FCC-LISN-50/250-25-2-01	PRE0186446	01/23/2021	01/23/2020
UL AUTOMATION SOFTWARE					
Radiated Software	UL	UL EMC	Ver 9.5, Apr 30, 2020		
Conducted Software	UL	UL EMC	2020.2.26		
AC Line Conducted Software	UL	UL EMC	Ver 9.5, February 21, 2020		

\*Testing is completed before equipment expiration date.

## 8. MEASUREMENT METHODS

On Time and Duty Cycle: ANSI C63.10-2013 Section 11.6

Occupied BW (20dB): ANSI C63.10-2013 Section 6.9.2

Occupied BW (99%): ANSI C63.10-2013 Section 6.9.3

Carrier Frequency Separation: ANSI C63.10-2013 Section 7.8.2

Number of Hopping Frequencies: ANSI C63.10-2013 Section 7.8.3

Time of Occupancy (Dwell Time): ANSI C63.10-2013 Section 7.8.4

Peak Output Power: ANSI C63.10-2013 Section 7.8.5

Conducted Spurious Emissions: ANSI C63.10-2013 Section 7.8.8

Conducted Band-Edge: ANSI C63.10-2013 Section 6.10.4

Radiated Spurious Emissions Below 30MHz: ANSI C63.10-2013 Section 6.4 & 13

Radiated Spurious Emissions 30-1000MHz: ANSI C63.10-2013 Section 6.3, 6.5 & 13

Radiated Spurious Emissions above 1GHz: ANSI C63.10-2013 Section 6.3, 6.6 & 13

Radiated Band-edge: ANSI C63.10-2013 Section 6.10.5 & section 13

AC Power Line Conducted Emissions: ANSI C63.10-2013, Section 6.2.

## 9. ANTENNA PORT TEST RESULTS

### 9.1. ON TIME AND DUTY CYCLE

#### LIMITS

None; for reporting purposes only.

#### PROCEDURE

ANSI C63.10, Section 11.6: Zero-Span Spectrum Analyzer Method.

#### ON TIME AND DUTY CYCLE RESULTS – On Time & Period are not 100ms. See plots

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/T Minimum VBW (kHz)
Bluetooth GFSK	24.9	24.9	1.000	100.0	0.00	0.010
Bluetooth 8PSK	23.0	23.0	1.000	100.0	0.00	0.010
Bluetooth GFSK TxBF	24.7	24.7	1.000	100.0	0.00	0.010
Bluetooth 8PSK TxBF	27.9	27.9	1.000	100.0	0.00	0.010

Note: Low power duty cycle is same as high power

## DUTY CYCLE PLOTS



## **9.2. 20 dB AND 99% BANDWIDTH**

### **LIMITS**

None; for reporting purposes only.

### **TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The RBW is set to  $\geq 1\%$  of the 20 dB bandwidth. The VBW is set to 3x RBW. The sweep time is coupled.

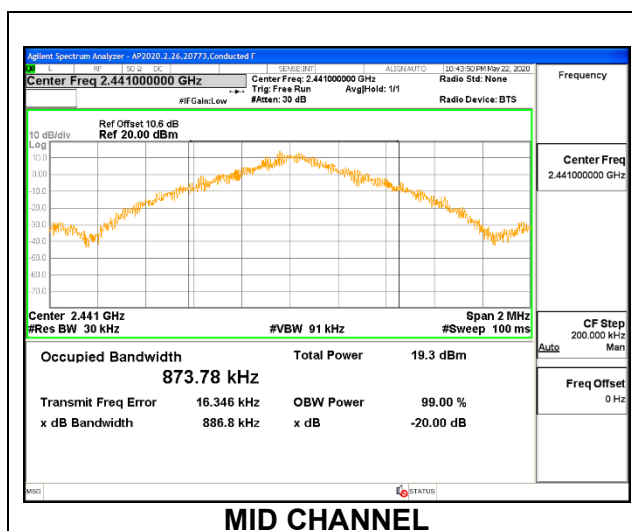
### **RESULTS**

Only High Power modes result is reported, it covers all Low Power modes. Only Mid channel plot is reported to show setting parameter complies with testing method/procedure.

## 9.2.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

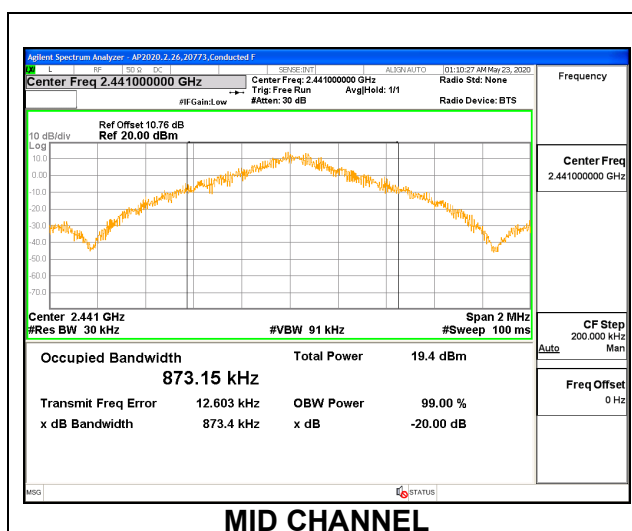
### Antenna 4

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	0.874	0.875
Mid	2441	0.887	0.874
High	2480	0.921	0.875



### Antenna 3

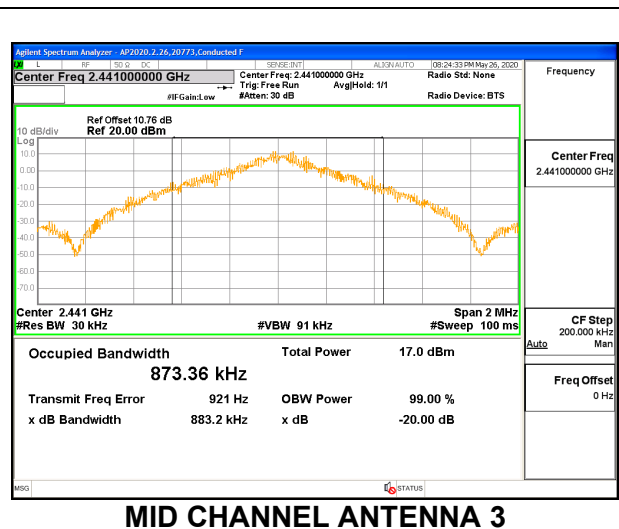
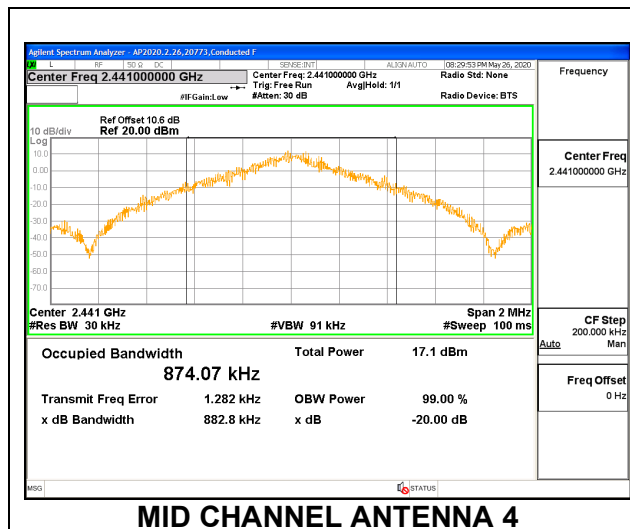
Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	0.927	0.874
Mid	2441	0.873	0.873
High	2480	0.873	0.873



## 9.2.2. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

### 2TX Antenna 4 + Antenna 3 TxBF MODE

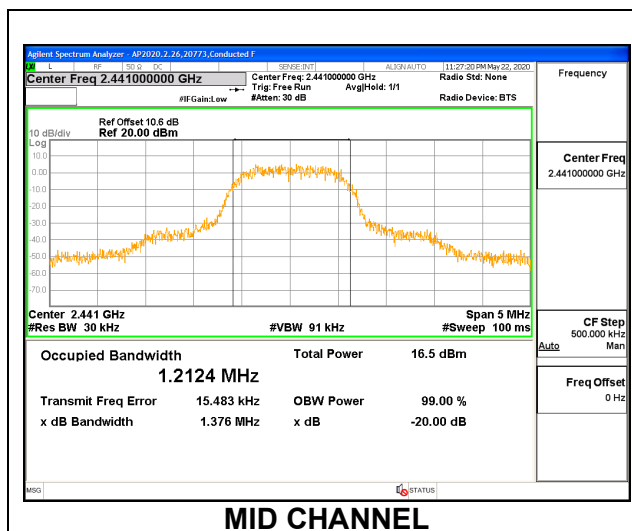
Channel	Frequency (MHz)	20dB Bandwidth Antenna 4 (MHz)	99% Bandwidth Antenna 4 (MHz)	20dB Bandwidth Antenna 3 (MHz)	99% Bandwidth Antenna 3 (MHz)
Low	2402	0.883	0.874	0.873	0.874
Mid	2441	0.883	0.874	0.883	0.873
High	2480	0.928	0.872	0.917	0.873



### 9.2.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

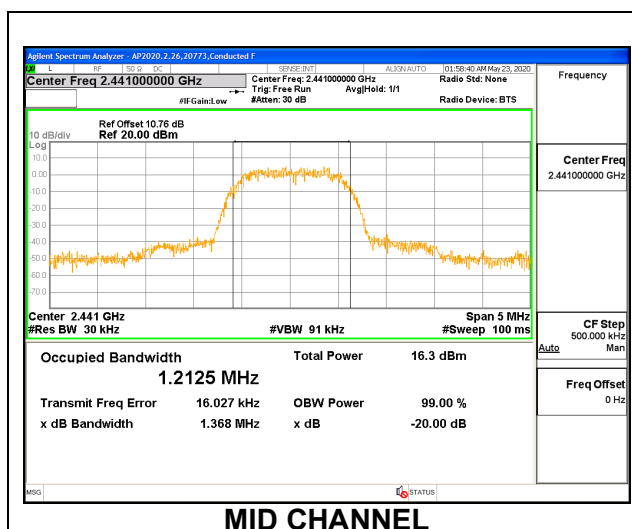
#### Antenna 4

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.341	1.215
Mid	2441	1.376	1.212
High	2480	1.364	1.218



#### Antenna 3

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.370	1.215
Mid	2441	1.368	1.213
High	2480	1.373	1.220

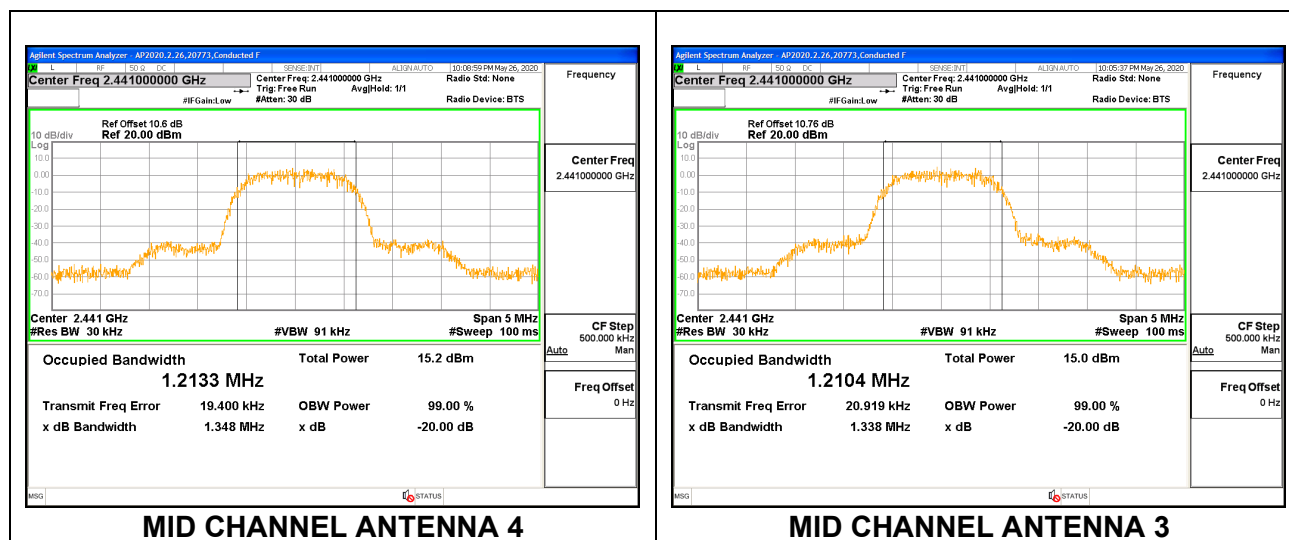




## 9.2.4. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

### 2TX Antenna 4 + Antenna 3 TxBF MODE

Channel	Frequency (MHz)	20dB Bandwidth Antenna 4 (MHz)	99% Bandwidth Antenna 4 (MHz)	20dB Bandwidth Antenna 3 (MHz)	99% Bandwidth Antenna 3 (MHz)
Low	2402	1.337	1.210	1.352	1.215
Mid	2441	1.348	1.213	1.338	1.210
High	2480	1.355	1.225	1.355	1.216



### **9.3. HOPPING FREQUENCY SEPARATION**

#### **LIMITS**

FCC §15.247 (a) (1)

RSS-247 (5.1) (b)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

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

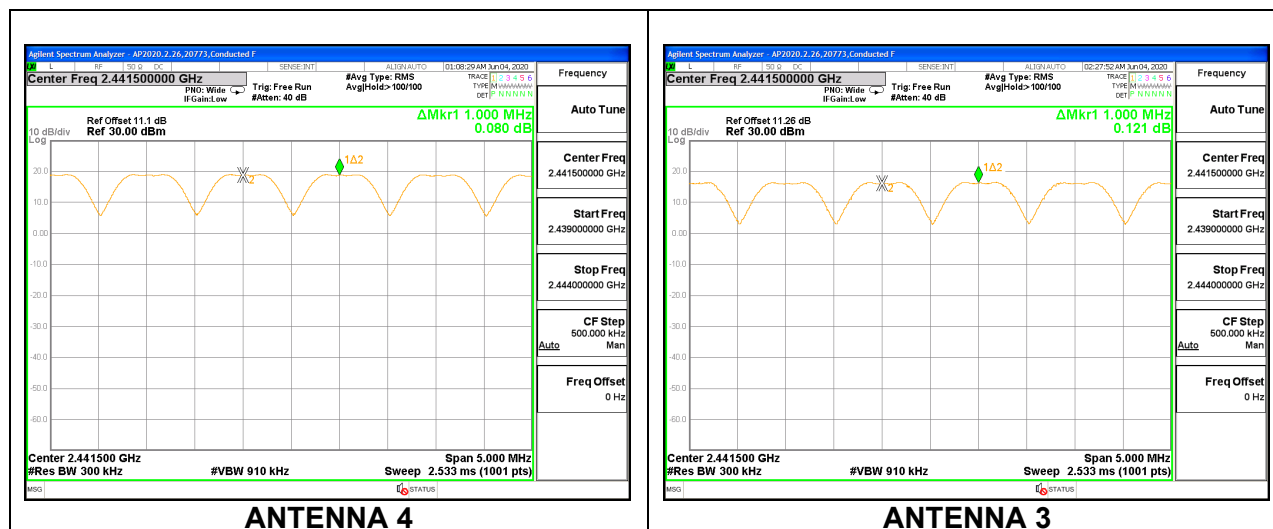
#### **TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to VBW = 3x RBW. The sweep time is coupled.

#### **RESULTS**

Only High Power GFSK mode result is reported since EDR (QPSK/8PSK) has exact same channel plan.

### 9.3.1. HIGH POWER BASIC DATA RATE GFSK MODULATION



## **9.4. NUMBER OF HOPPING CHANNELS**

### **LIMITS**

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

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

### **TEST PROCEDURE**

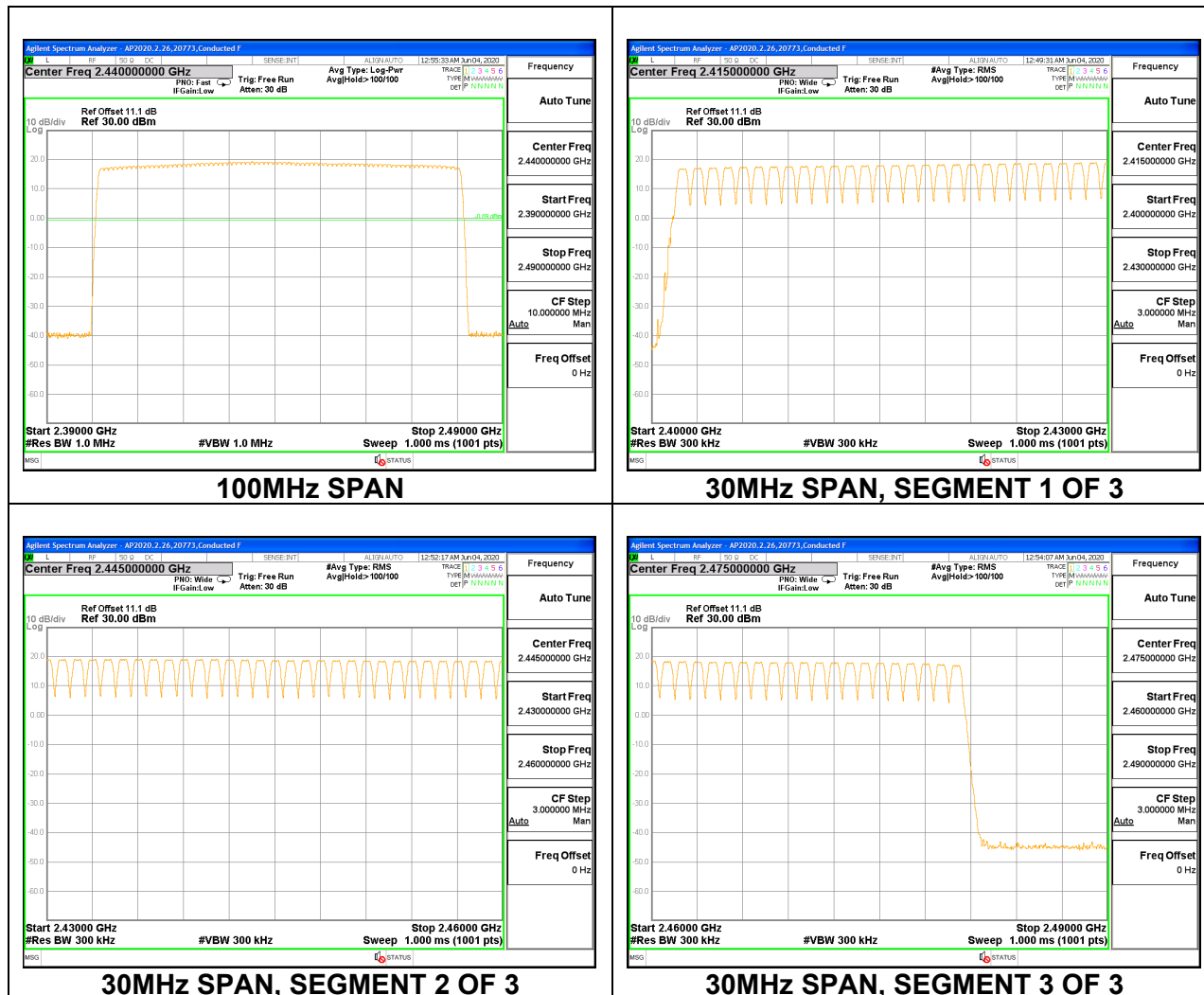
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

### **RESULTS**

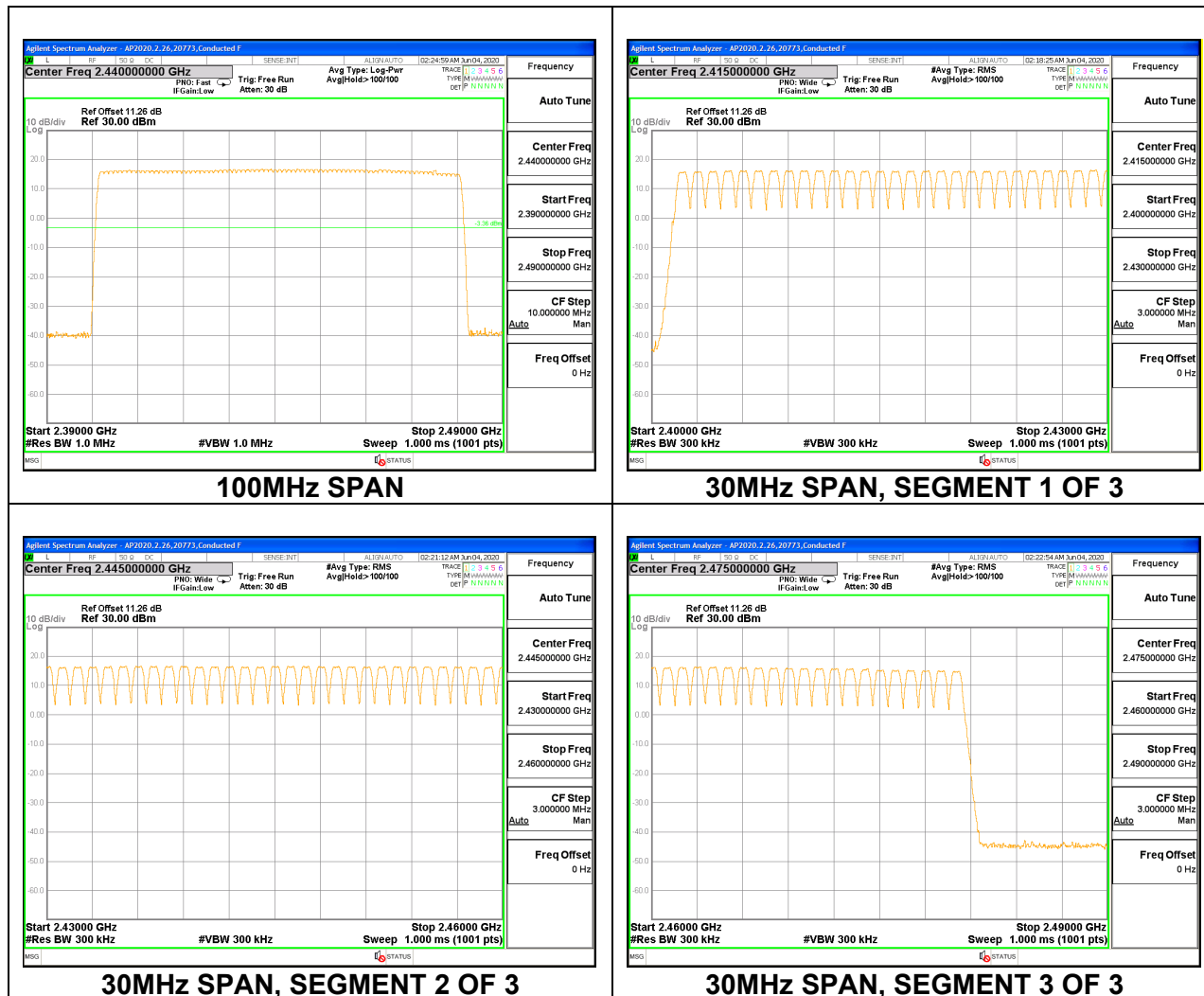
Normal Mode: 79 Channels Observed. Only High Power GFSK mode result is reported since EDR (QPSK/8PSK) has exact same channel plan.

## 9.4.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

### Antenna 4



### Antenna 3



## **9.5. AVERAGE TIME OF OCCUPANCY**

### **LIMITS**

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

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 PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

The average time of occupancy in the specified 3.16 second period (79 channels \* 0.4 s) is equal to  $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{pulse width}$ .

For AFH mode, the average time of occupancy in the specified 8 second period (20 channels \* 0.4 seconds) is equal to  $10 * (\# \text{ of pulses in } 0.8 \text{ s}) * \text{pulse width}$ .

### **RESULTS**

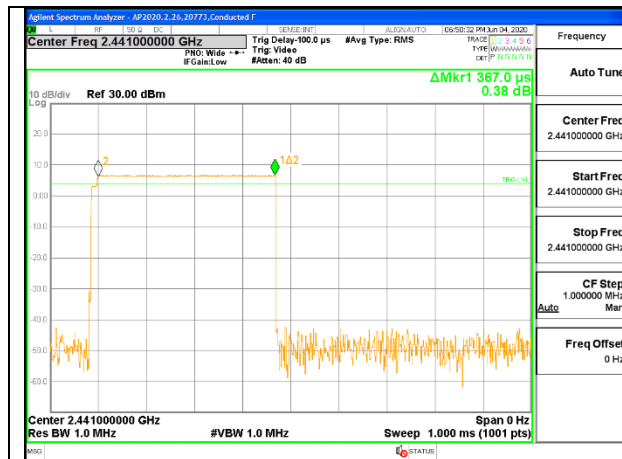
Only High Power GFSK mode result is reported since EDR (QPSK/8PSK) has exact same timing.

## 9.5.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

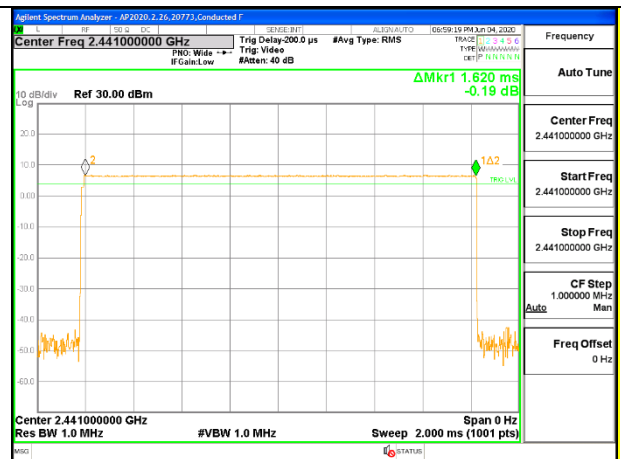
### Antenna 4

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal Mode					
DH1	0.367	31	0.1138	0.4	-0.2862
DH3	1.62	16	0.2592	0.4	-0.1408
DH5	2.864	6	0.1718	0.4	-0.2282
DH Packet	Pulse Width (sec)	Number of Pulses in 0.8 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK AFH Mode					
DH1	0.367	7.75	0.02844	0.4	-0.3716
DH3	1.62	4	0.06480	0.4	-0.3352
DH5	2.864	1.5	0.04296	0.4	-0.3570

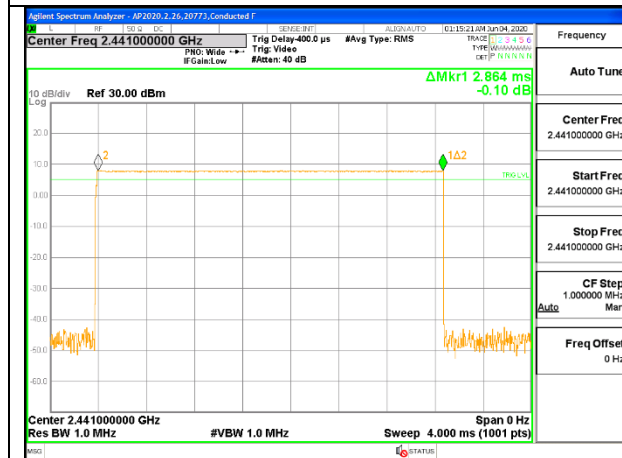




PULSE WIDTH - DH1



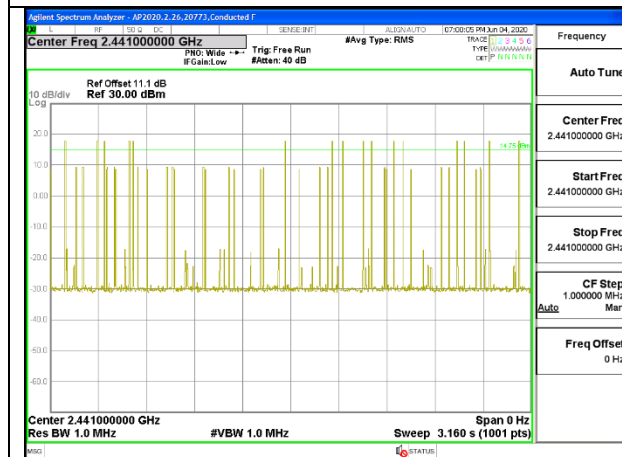
PULSE WIDTH - DH3



PULSE WIDTH - DH5



NUMBER OF PULSES IN 3.16 SECOND  
OBSERVATION PERIOD - DH1



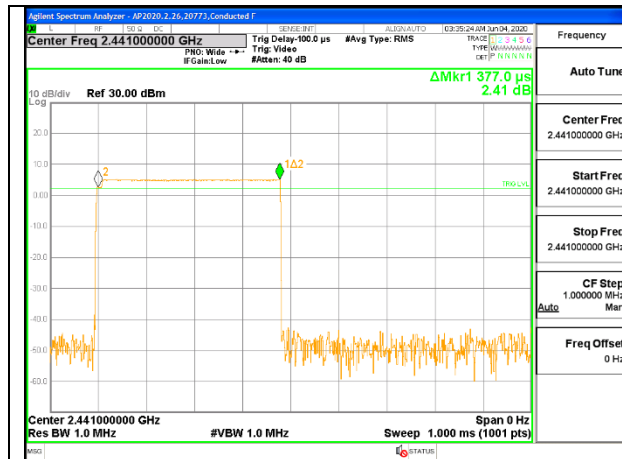
NUMBER OF PULSES IN 3.16 SECOND  
OBSERVATION PERIOD - DH3



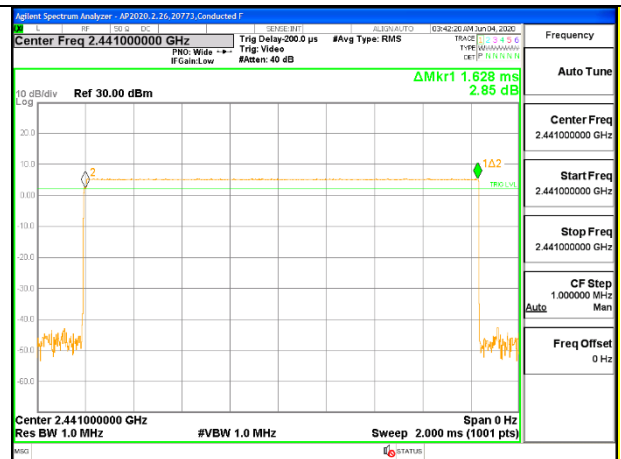
NUMBER OF PULSES IN 3.16 SECOND  
OBSERVATION PERIOD - DH5

**Antenna 3**

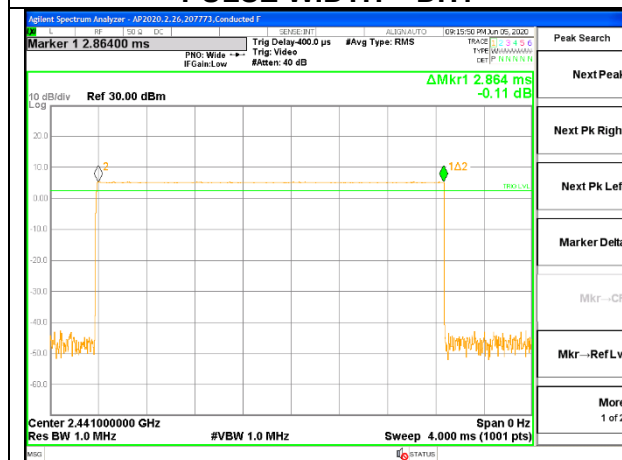
DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal Mode					
DH1	0.377	32	0.1206	0.4	-0.2794
DH3	1.628	15	0.2442	0.4	-0.1558
DH5	2.864	7	0.2005	0.4	-0.1995
DH Packet	Pulse Width (sec)	Number of Pulses in 0.8 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK AFH Mode					
DH1	0.377	8	0.03016	0.4	-0.3698
DH3	1.628	3.75	0.06105	0.4	-0.3390
DH5	2.864	1.75	0.05012	0.4	-0.3499



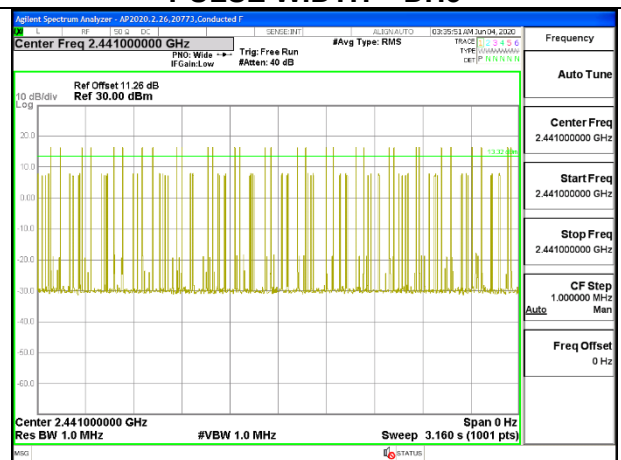
PULSE WIDTH - DH1



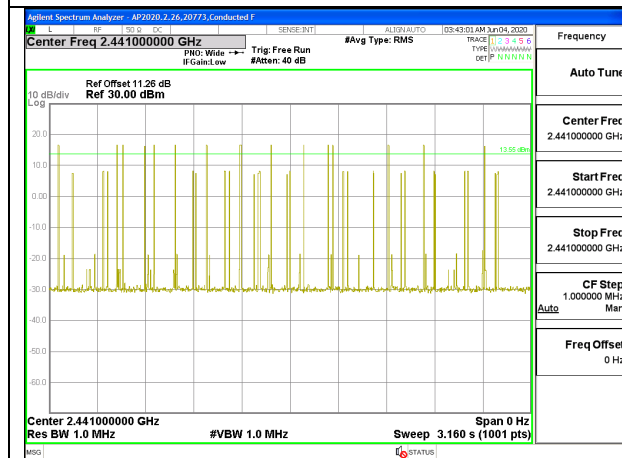
PULSE WIDTH - DH3



PULSE WIDTH - DH5



NUMBER OF PULSES IN 3.16 SECOND  
OBSERVATION PERIOD - DH1



NUMBER OF PULSES IN 3.16 SECOND  
OBSERVATION PERIOD - DH3



NUMBER OF PULSES IN 3.16 SECOND  
OBSERVATION PERIOD - DH5

## 9.6. OUTPUT POWER

### LIMITS

§15.247 (b) (1)

RSS-247 (5.4) (b)

The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm. 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.

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 PROCEDURE

Measurements perform using a wideband RF power meter.

The power output was measured on the EUT antenna port using SMA cable with 10dB attenuator connected to a power meter via wideband peak power sensor. Peak output power was read directly from power meter

### DIRECTIONAL ANTENNA GAIN

For 1 TX:

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

For 2 TX:

Tx chains are correlated for power due to the device supporting Beamforming. The directional gains are as follows:

Band (GHz)	ANT 4 Antenna Gain (dBi)	ANT 3 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)	Correlated Chains Directional Gain (dBi)
2.4	0.30	-1.70	-0.59	2.37

### RESULTS

## 9.6.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

### Antenna 4

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	20.12	21	-0.88
Middle	2441	20.14	21	-0.86
High	2480	20.09	21	-0.91

### Antenna 3

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	20.01	21	-0.99
Middle	2441	20.11	21	-0.89
High	2480	20.05	21	-0.95

## 9.6.2. HIGH POWER ENHANCED DATA RATE QPSK MODULATION

### Antenna 4

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	18.02	21	-2.98
Middle	2441	18.44	21	-2.56
High	2480	18.21	21	-2.79

### Antenna 3

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	18.20	21	-2.8
Middle	2441	18.29	21	-2.71
High	2480	18.23	21	-2.77

### 9.6.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

#### Antenna 4

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	18.64	21	-2.36
Middle	2441	18.8	21	-2.2
High	2480	18.72	21	-2.28

#### Antenna 3

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	18.66	21	-2.34
Middle	2441	18.72	21	-2.28
High	2480	18.40	21	-2.6

### 9.6.4. LOW POWER BASIC DATA RATE GFSK MODULATION

#### Antenna 4

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.41	21	-8.59
Middle	2441	12.59	21	-8.41
High	2480	12.51	21	-8.49

#### Antenna 3

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.62	21	-8.38
Middle	2441	12.80	21	-8.2
High	2480	12.66	21	-8.34

## 9.6.5. LOW POWER ENHANCED DATA RATE QPSK MODULATION

### Antenna 4

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.02	21	-9.98
Middle	2441	11.21	21	-9.79
High	2480	11.09	21	-9.91

### Antenna 3

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.02	21	-9.98
Middle	2441	11.11	21	-9.89
High	2480	11.08	21	-9.92

## 9.6.6. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

### Antenna 4

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.71	21	-9.29
Middle	2441	11.69	21	-9.31
High	2480	11.72	21	-9.28

### Antenna 3

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.59	21	-9.41
Middle	2441	11.72	21	-9.28
High	2480	11.59	21	-9.41

## 9.6.7. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power Antenna 4 (dBm)	Output Power Antenna 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	17.00	17.03	20.03	21	-0.97
Middle	2441	17.12	17.11	20.13	21	-0.87
High	2480	17.07	17.09	20.09	21	-0.91

## 9.6.8. HIGH POWER ENHANCED DATA RATE TXBF QPSK MODULATION

### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power Antenna 4 (dBm)	Output Power Antenna 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	17.39	17.22	20.32	21	-0.68
Middle	2441	17.44	17.24	20.35	21	-0.65
High	2480	17.34	17.3	20.33	21	-0.67

## 9.6.9. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power Antenna 4 (dBm)	Output Power Antenna 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	17.72	17.59	20.67	21	-0.33
Middle	2441	17.74	17.68	20.72	21	-0.28
High	2480	17.62	17.65	20.65	21	-0.35



## 9.6.10. LOW POWER BASIC DATA RATE TXBF GFSK MODULATION

### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power Antenna 4 (dBm)	Output Power Antenna 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.72	12.70	15.72	21	-5.28
Middle	2441	12.75	12.79	15.78	21	-5.22
High	2480	12.67	12.71	15.70	21	-5.30

## 9.6.11. LOW POWER ENHANCED DATA RATE TXBF QPSK MODULATION

### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power Antenna 4 (dBm)	Output Power Antenna 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.25	11.28	14.28	21	-6.72
Middle	2441	11.35	11.39	14.38	21	-6.62
High	2480	11.33	11.26	14.31	21	-6.69

## 9.6.12. LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date:	9/2/2020

Channel	Frequency (MHz)	Output Power Antenna 4 (dBm)	Output Power Antenna 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.71	11.72	14.73	21	-6.27
Middle	2441	11.76	11.79	14.79	21	-6.21
High	2480	11.68	11.65	14.68	21	-6.32

## **9.7. AVERAGE POWER**

### **LIMITS**

None; for reporting purposes only

### **TEST PROCEDURE**

Measurements perform using a wideband gated RF power meter.

The power output was measured on the EUT antenna port using SMA cable with 10dB attenuator connected to a power meter via wideband average power sensor. Gated average output power was read directly from power meter.

### **RESULTS**

### 9.7.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

#### Antenna 4

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	19.65
Middle	2441	19.77
High	2480	19.69

#### Antenna 3

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	19.62
Middle	2441	19.74
High	2480	19.71

### 9.7.2. HIGH POWER ENHANCED DATA RATE QPSK MODULATION

#### Antenna 4

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	15.41
Middle	2441	15.59
High	2480	15.50

#### Antenna 3

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	15.37
Middle	2441	15.44
High	2480	15.39

### 9.7.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

#### Antenna 4

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	15.62
Middle	2441	15.82
High	2480	15.73

#### Antenna 3

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	15.73
Middle	2441	15.81
High	2480	15.68

### 9.7.4. LOW POWER BASIC DATA RATE GFSK MODULATION

#### Antenna 4

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	12.10
Middle	2441	12.22
High	2480	12.19

#### Antenna 3

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	12.19
Middle	2441	12.39
High	2480	12.35

## 9.7.5. LOW POWER ENHANCED DATA RATE QPSK MODULATION

### Antenna 4

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.48
Middle	2441	8.56
High	2480	8.52

### Antenna 3

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.42
Middle	2441	8.55
High	2480	8.49

## 9.7.6. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

### Antenna 4

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.82
Middle	2441	8.79
High	2480	8.77

### Antenna 3

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.74
Middle	2441	8.88
High	2480	8.71

## 9.7.7. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power Antenna 4 (dBm)	Average Power Antenna 3 (dBm)	Total Average Power (dBm)
Low	2402	16.69	16.74	19.73
Middle	2441	16.82	16.82	19.83
High	2480	16.77	16.80	19.80

## 9.7.8. HIGH POWER ENHANCED RATE TXBF QPSK MODULATION

### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power Antenna 4 (dBm)	Average Power Antenna 3 (dBm)	Total Average Power (dBm)
Low	2402	14.52	14.58	17.56
Middle	2441	14.67	14.64	17.67
High	2480	14.57	14.53	17.56

## 9.7.9. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power Antenna 4 (dBm)	Average Power Antenna 3 (dBm)	Total Average Power (dBm)
Low	2402	14.88	14.75	17.83
Middle	2441	14.89	14.83	17.87
High	2480	14.76	14.82	17.80

### 9.7.10. LOW POWER BASIC DATA RATE TXBF GFSK MODULATION

#### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power Antenna 4 (dBm)	Average Power Antenna 3 (dBm)	Total Average Power (dBm)
Low	2402	12.41	12.39	15.41
Middle	2441	12.43	12.49	15.47
High	2480	12.36	12.41	15.40

### 9.7.11. LOW POWER ENHANCED DATA RATE TXBF QPSK MODULATION

#### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power Antenna 4 (dBm)	Average Power Antenna 3 (dBm)	Total Average Power (dBm)
Low	2402	8.51	8.56	11.55
Middle	2441	8.60	8.62	11.62
High	2480	8.58	8.55	11.58

### 9.7.12. LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

#### 2TX Antenna 4 + Antenna 3 TxBF Mode

Tested By:	39472
Date	9/2/2020

Channel	Frequency (MHz)	Average Power Antenna 4 (dBm)	Average Power Antenna 3 (dBm)	Total Average Power (dBm)
Low	2402	8.72	8.74	11.74
Middle	2441	8.81	8.83	11.83
High	2480	8.70	8.66	11.69

## **9.8. CONDUCTED SPURIOUS EMISSIONS**

### **LIMITS**

FCC §15.247 (d)

RSS-247 5.5

Limit = -20 dBc

### **TEST PROCEDURE**

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

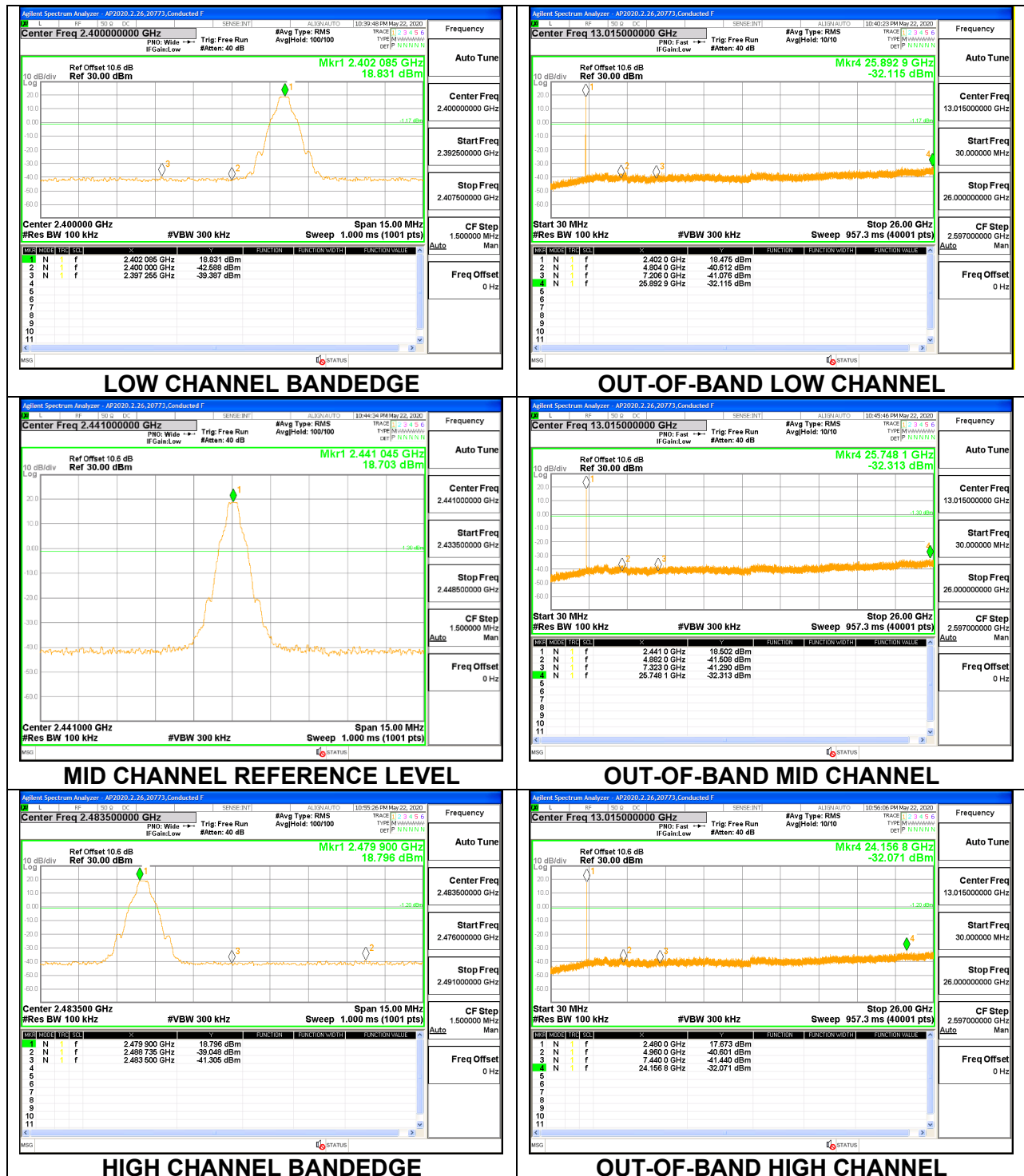
The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

### **RESULTS**

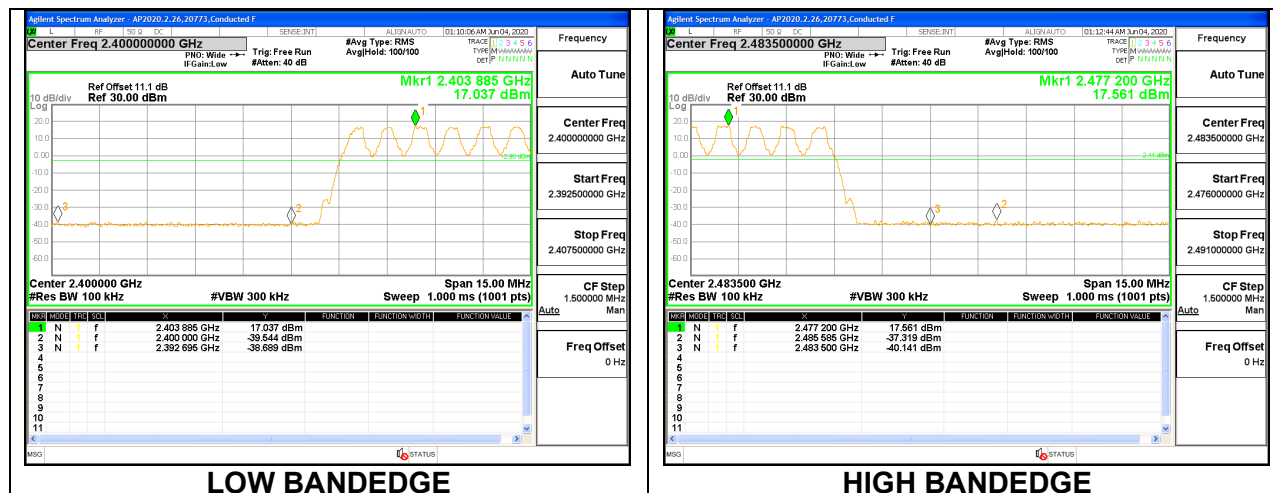


## 9.8.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

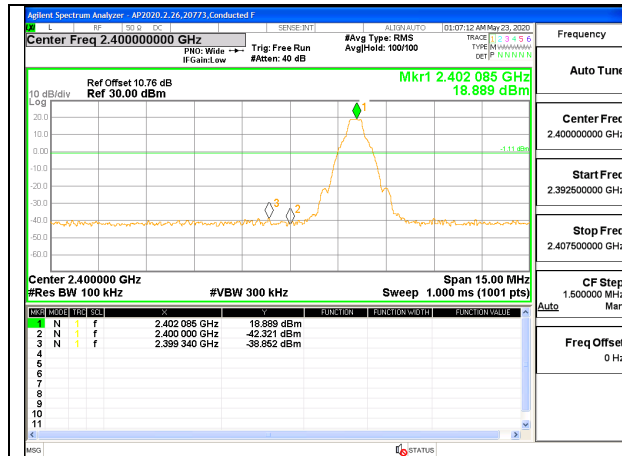
### Antenna 4 SPURIOUS EMISSIONS, NON-HOPPING



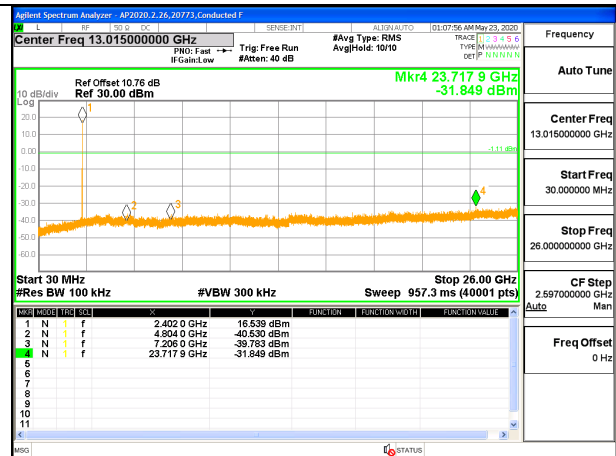
**Antenna 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



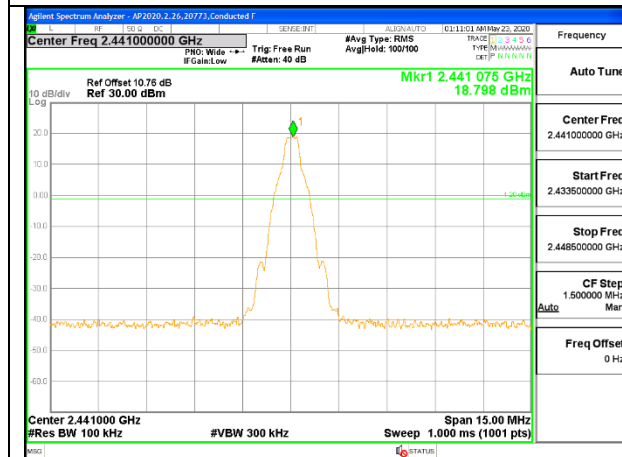
# Antenna 3 SPURIOUS EMISSIONS, NON-HOPPING



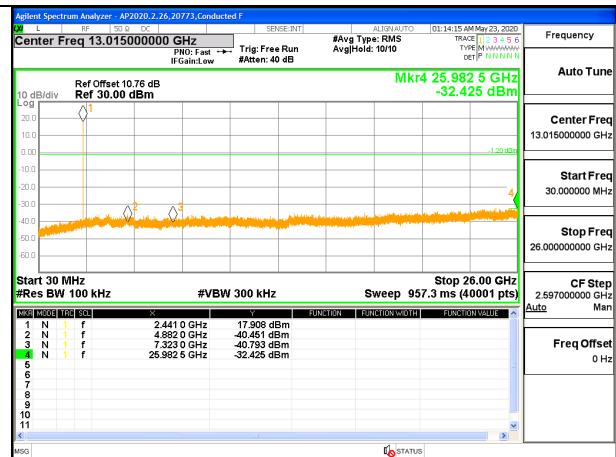
LOW CHANNEL BANDEDGE



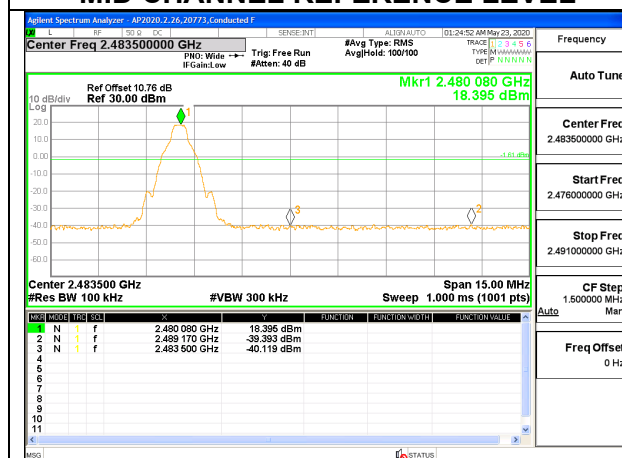
OUT-OF-BAND LOW CHANNEL



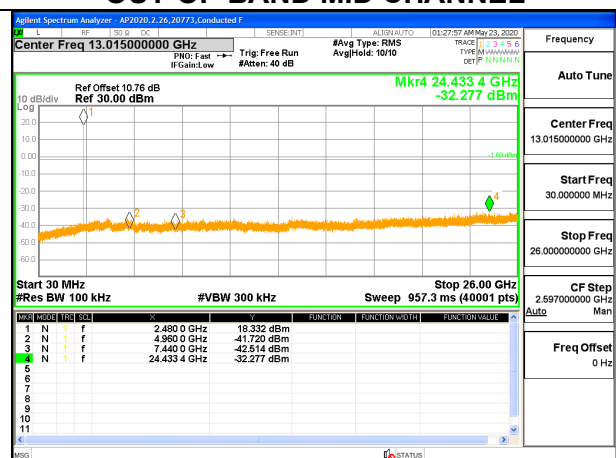
MID CHANNEL REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

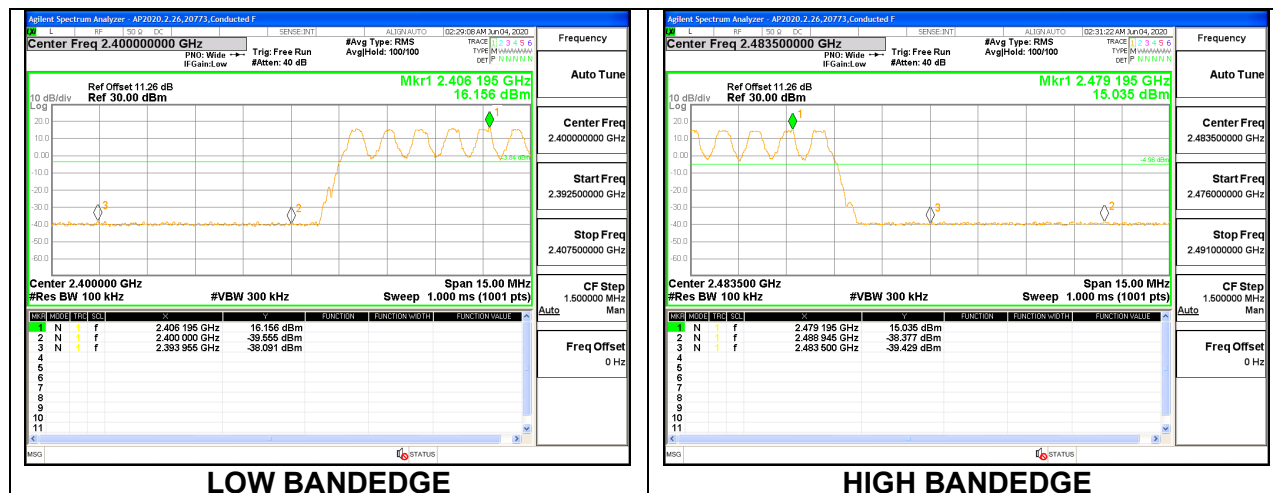


HIGH CHANNEL BANDEDGE



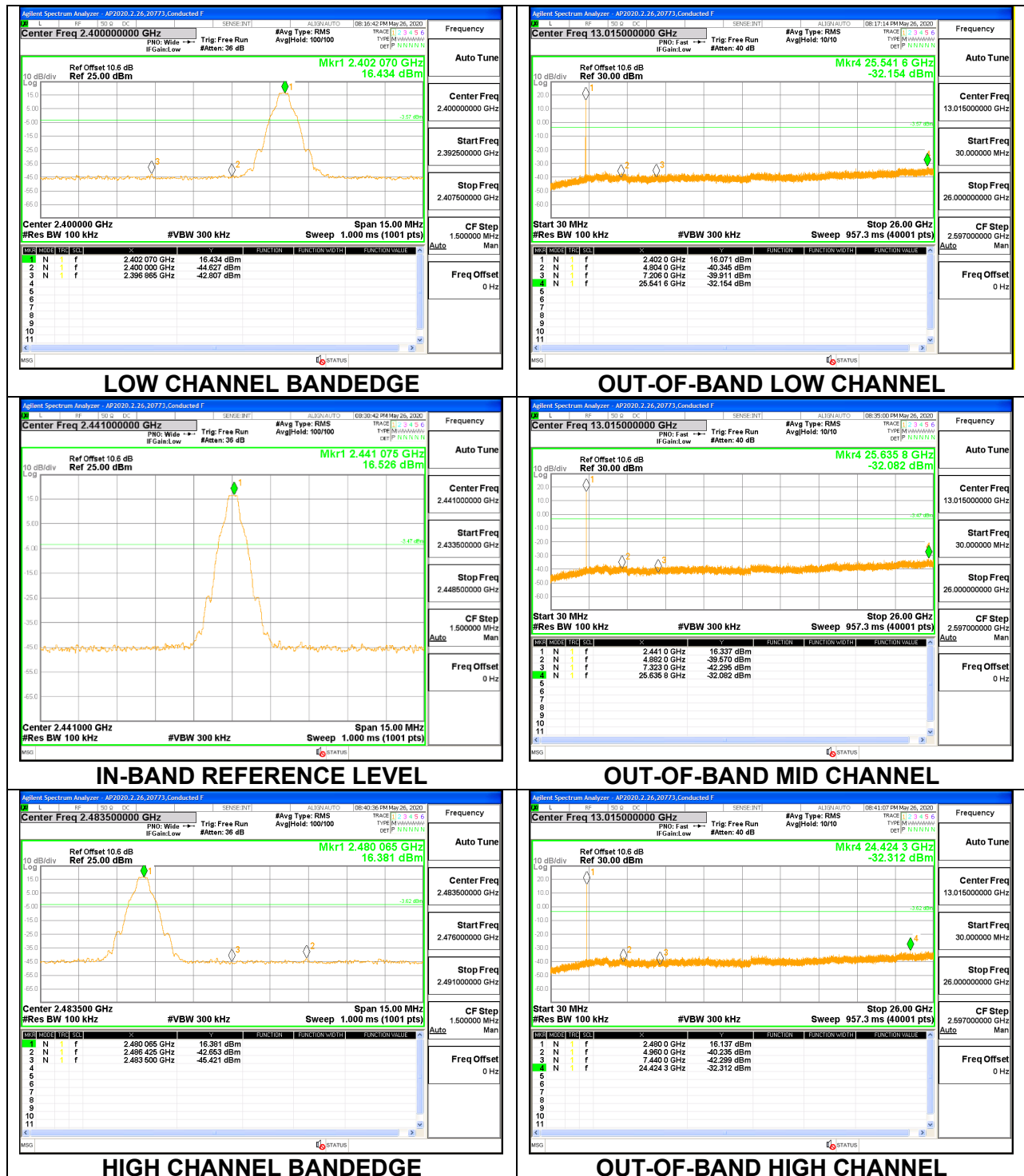
OUT-OF-BAND HIGH CHANNEL

# **Antenna 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**

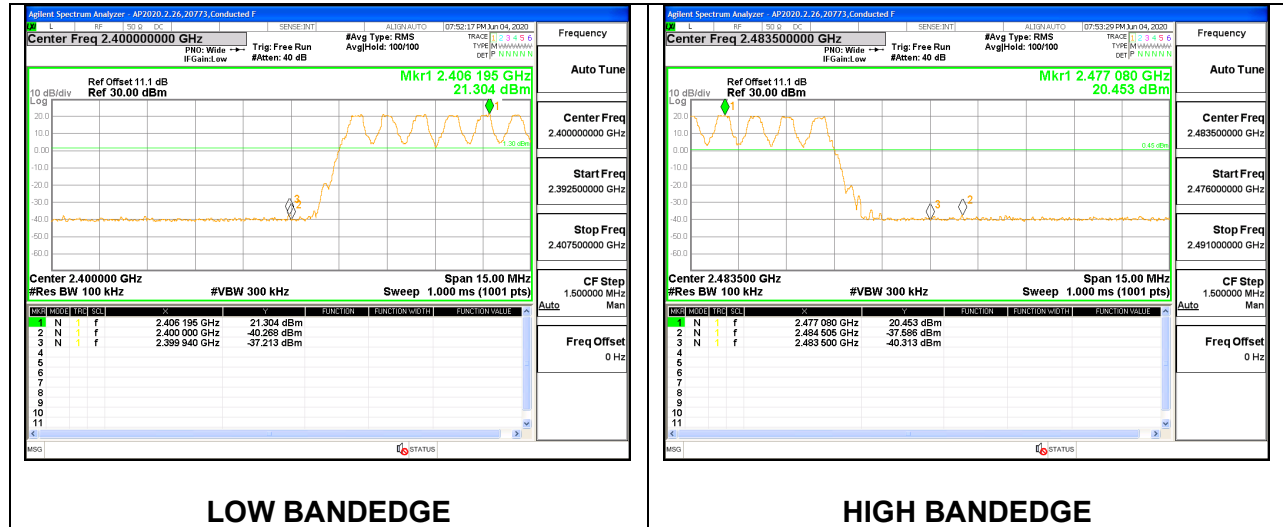


## 9.8.2. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

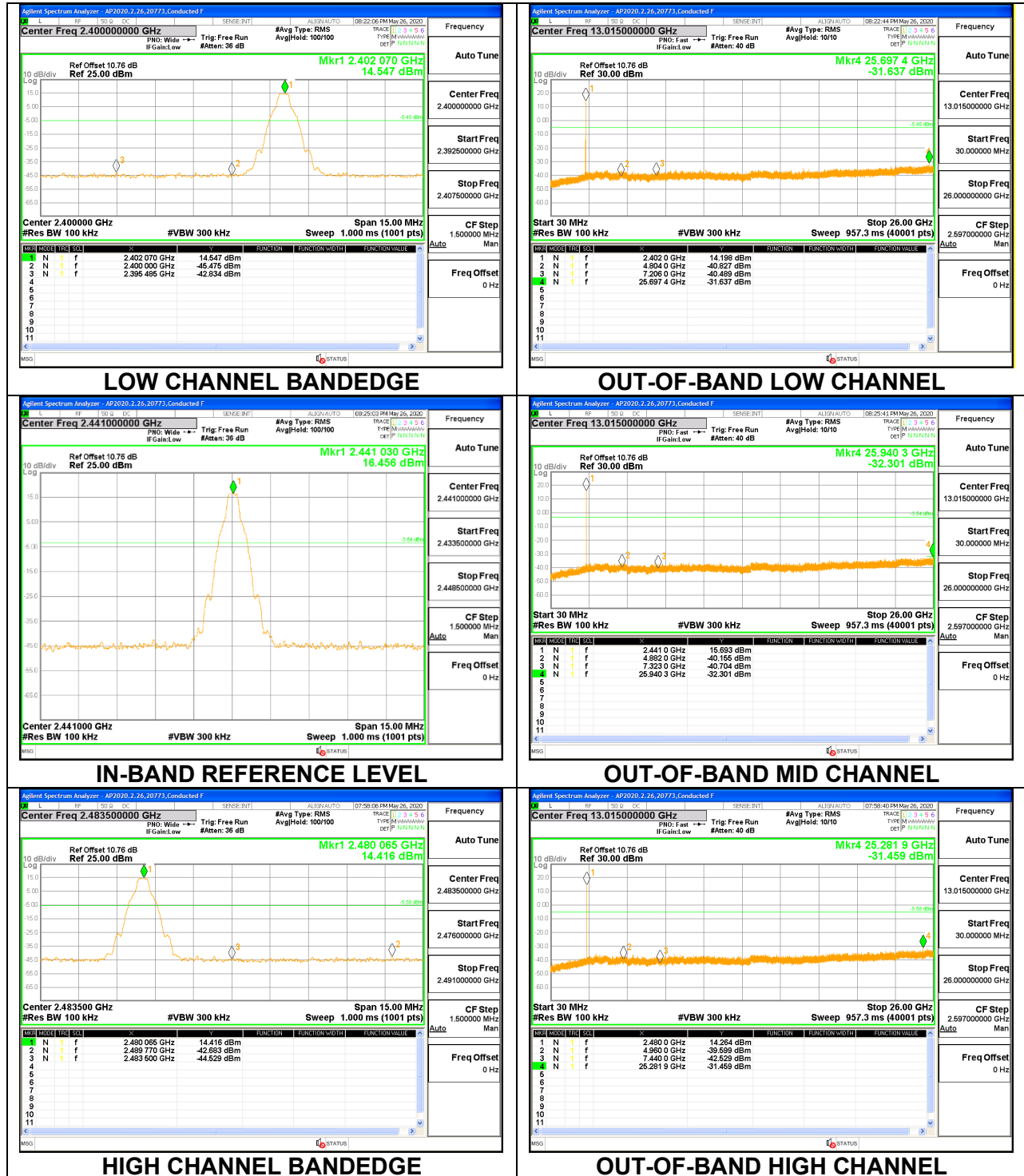
### Antenna 4 SPURIOUS EMISSIONS, NON-HOPPING



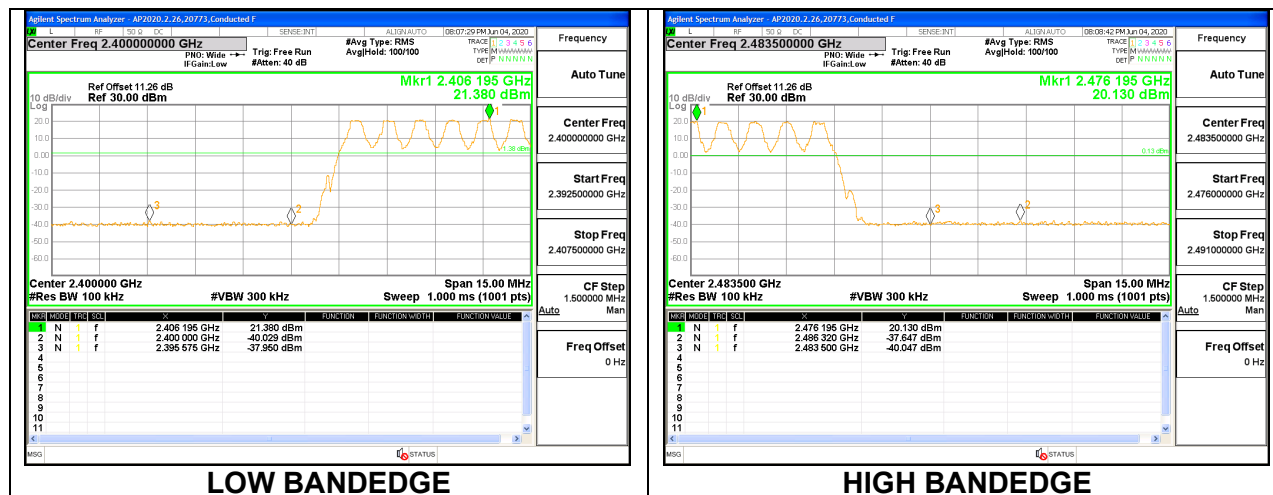
# **Antenna 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**



# Antenna 3 SPURIOUS EMISSIONS, NON-HOPPING



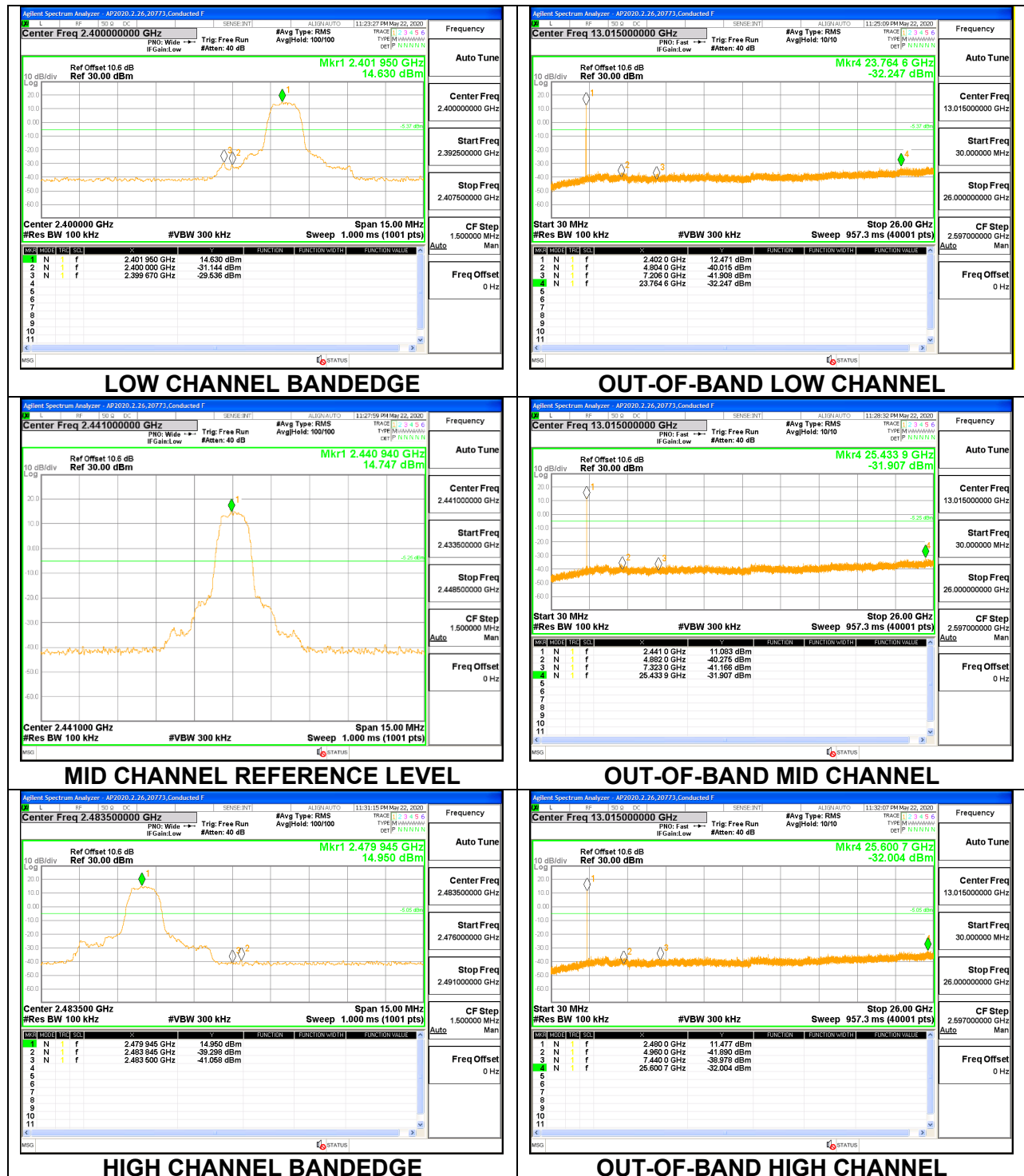
# Antenna 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON





## 9.8.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

### Antenna 4 SPURIOUS EMISSIONS, NON-HOPPING



# **Antenna 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON**

