CERTIFICATION TEST REPORT

Report Number. : 12943451-E1V2

Applicant	:	APPLE, INC. 1 APPLE PARK WAY CUPERTINO, CA 95014, U.S.A.
Model	:	A2218
FCC ID	:	BCG-E3308A
IC	:	579C-E3308A
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:
August 26, 2019

Prepared by:
UL Verification Services Inc.
47173 Benicia Street
Fremont, CA 94538 U.S.A.
TEL: (510) 319-4000
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NVLAP Lab code: 200065-0

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	8/19/2019	Initial Issue	Chin Pang
V2	8/21/2019	Address TCB Questions	Joe Vang

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UL VERIFICATION SERVICES INC.
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1. ATTESTATION OF TEST RESULTS

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

EUT DESCRIPTION: SMARTPHONE

MODEL: A2218

SERIAL NUMBER: Radiated & Conducted
G6TYW036N39T, G6TYW03BN39T, G6TYW02HN39M, G6TYW009N39M

DATE TESTED: JUNE 1, 2019 – AUGUST 14, 2019

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
UL Verification Services Inc. By:

Chin Pang
Senior Engineer
Consumer Technology Division
UL Verification Services Inc.

Prepared By:

Tony Li
Test Engineer
Consumer Technology Division
UL Verification Services Inc.

2. 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, RSS-GEN Issue 5, KDB 558074 D01v05r02 and RSS-247 Issue 2.

3. 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
☒ Chamber A (ISED:2324B-1)	☒ Chamber D (ISED:22541-1)	☐ Chamber I (ISED:2324A-5)
☒ Chamber B (ISED:2324B-2)	☒ Chamber E (ISED:22541-2)	☐ Chamber J (ISED:2324A-6)
☐ Chamber C (ISED:2324B-3)	☒ Chamber F (ISED:22541-3)	☒ Chamber K (ISED:2324A-1)
	☒ Chamber G (ISED:22541-4)	☐ Chamber L (ISED:2324A-3)
	☒ Chamber H (ISED:22541-5)	

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

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

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4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:
Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)
36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:
Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.
36.5 dBuV + 0 dB +10.1 dB+ 0 dB = 46.6 dBuV

4.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.84 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.65 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%.

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5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

The Apple iPhone is a smartphone with multimedia functions (music, application support, and video), cellular GSM, GPRS, EGPRS, UMTS, LTE, TD-SCDMA, CDMA, IEEE 802.11a/b/g/n/ac/ax, Bluetooth, Ultra-Wide band, GPS and NFC. All models support at least one UICC based SIM. The second SIM, if present, is either UICC based pSIM (physical SIM) or e-SIM (electronic SIM). The device has a built-in inductive charging receiver. The rechargeable battery is also not user accessible.

5.2. 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)
Antenna 4	High Power	2402 - 2480	Basic GFSK	17.29	53.58
		2402 - 2480	QPSK	18.10	64.57
		2402 - 2480	Enhanced 8PSK	18.39	69.02
	Low Power	2402 - 2480	Basic GFSK	12.74	18.79
		2402 - 2480	QPSK	11.05	12.74
		2402 - 2480	Enhanced 8PSK	11.31	13.52
Antenna 3	High Power	2402 - 2480	Basic GFSK	19.78	95.06
		2402 - 2480	QPSK	18.07	64.12
		2402 - 2480	Enhanced 8PSK	18.45	69.98
	Low Power	2402 - 2480	Basic GFSK	12.77	18.92
		2402 - 2480	DQPSK	10.99	12.56
		2402 - 2480	Enhanced 8PSK	11.38	13.74
Beamforming (Antenna 4 + Antenna 3)	High Power	2402 - 2480	Basic GFSK TxBF	20.25	105.93
		2402 - 2480	QPSK TxBF	20.04	100.93
		2402 - 2480	Enhanced 8PSK TxBF	20.34	108.14
	Low Power	2402 - 2480	Basic GFSK TxBF	15.76	37.67
		2402 - 2480	QPSK TxBF	14.07	25.53
		2402 - 2480	Enhanced 8PSK TxBF	14.34	27.16

5.4. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Range (GHz)	Ant. 4 (dBi)	Ant. 3 (dBi)
2.4	-0.9	-2.3

5.5. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was BT FW Version: 17.1.140.1283.

5.6. 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 both Ant 4, Ant 3, and 2TX Beamforming.

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 30MHz, below 1GHz, 18-26GHz and power line conducted emissions were performed with the EUT transmitting at the channel with the highest output power as worst-case scenario.

For below 1GHz tests, EUT was connected to AC power adapter as the worst case; and for above 1GHz tests, the worst-case configuration reported was with EUT only. There was no emission found below 30MHz within 20dB of the limit. 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 new 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 8.7.

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

GFSK mode: DH5
8PSK mode: 3-DH5
BFTX, DH5
BFTX, 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.

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5.7. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
Laptop	Apple	A1502	HRP003436	QDS-BRCM1080
Laptop AC/DC adapter	Liteon Technology	PA-1450-BA1	B123	NA
EUT AC Adapter	Apple	A1385	D29325SM03XDHLHC9	NA

I/O CABLES

I/O Cable List						
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	N/A
3	AC	1	AC	Un-shielded	2	N/A

I/O CABLES (BELOW 1GHz AND AC POWER LINE TEST WITH ADAPTER AND LAPTOP)

I/O Cable List						
Cable No	**Port**	**# of identical**	**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.

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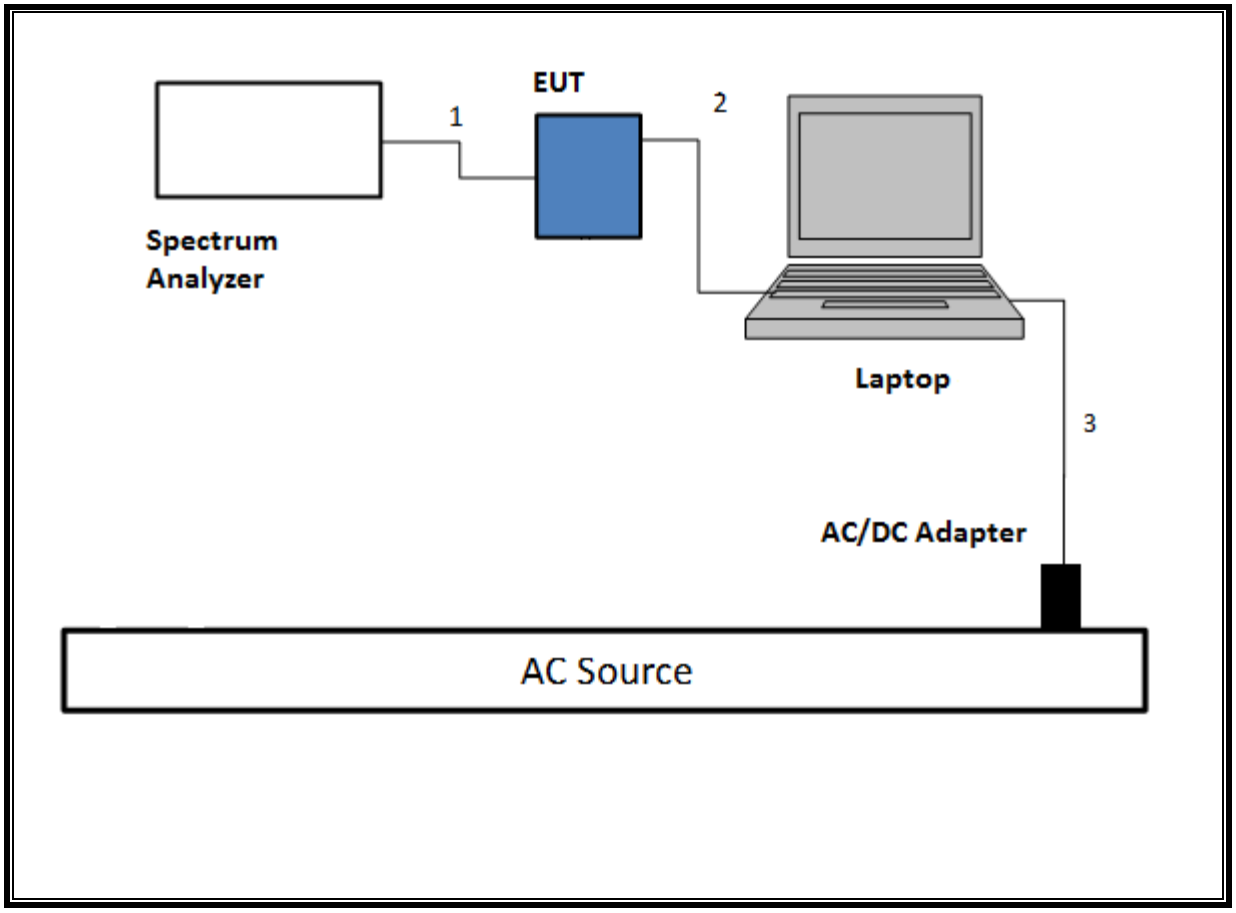
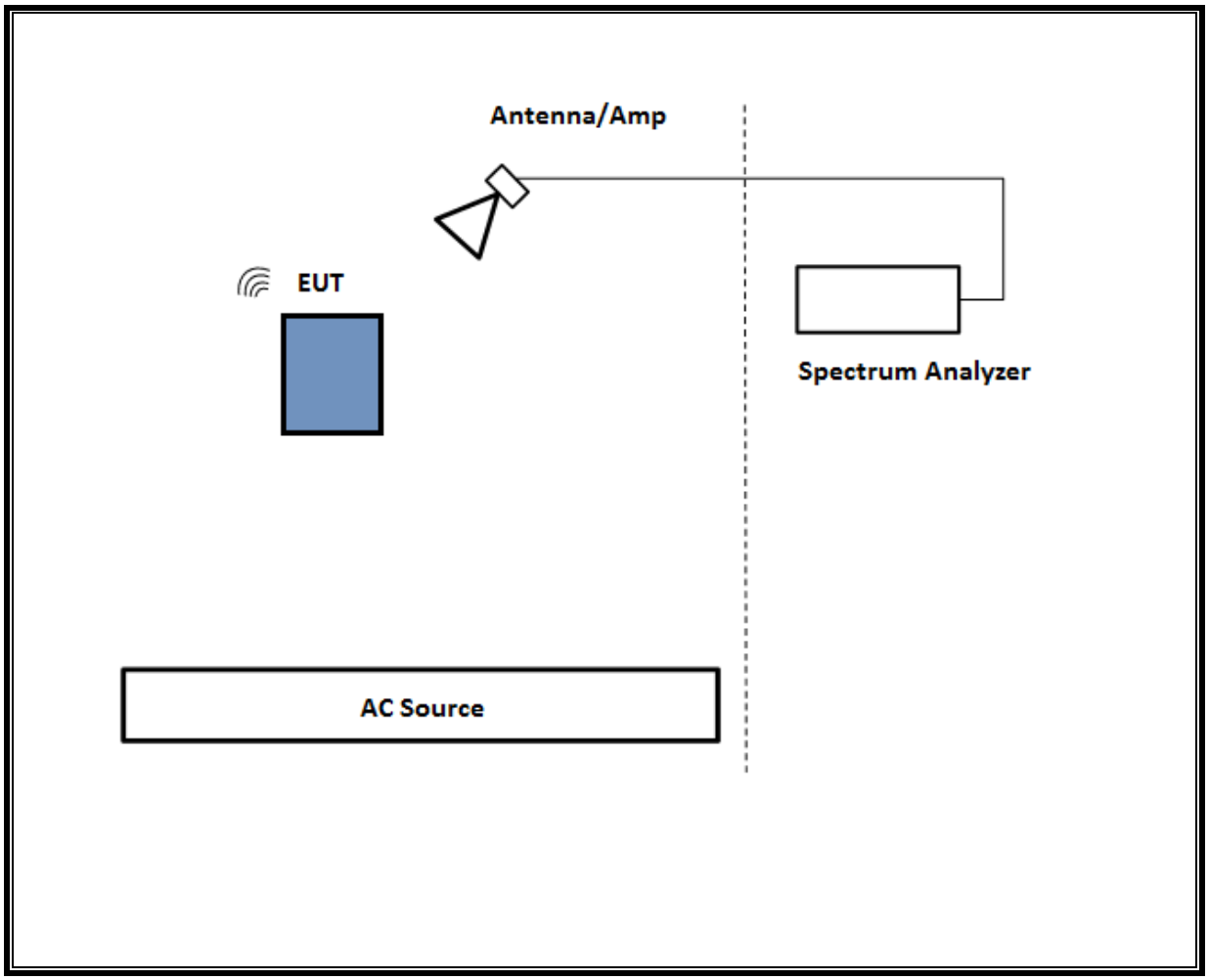
SETUP DIAGRAM FOR CONDUCTED TESTS



SETUP DIAGRAM FOR RADIATED TESTS Above 1GHz



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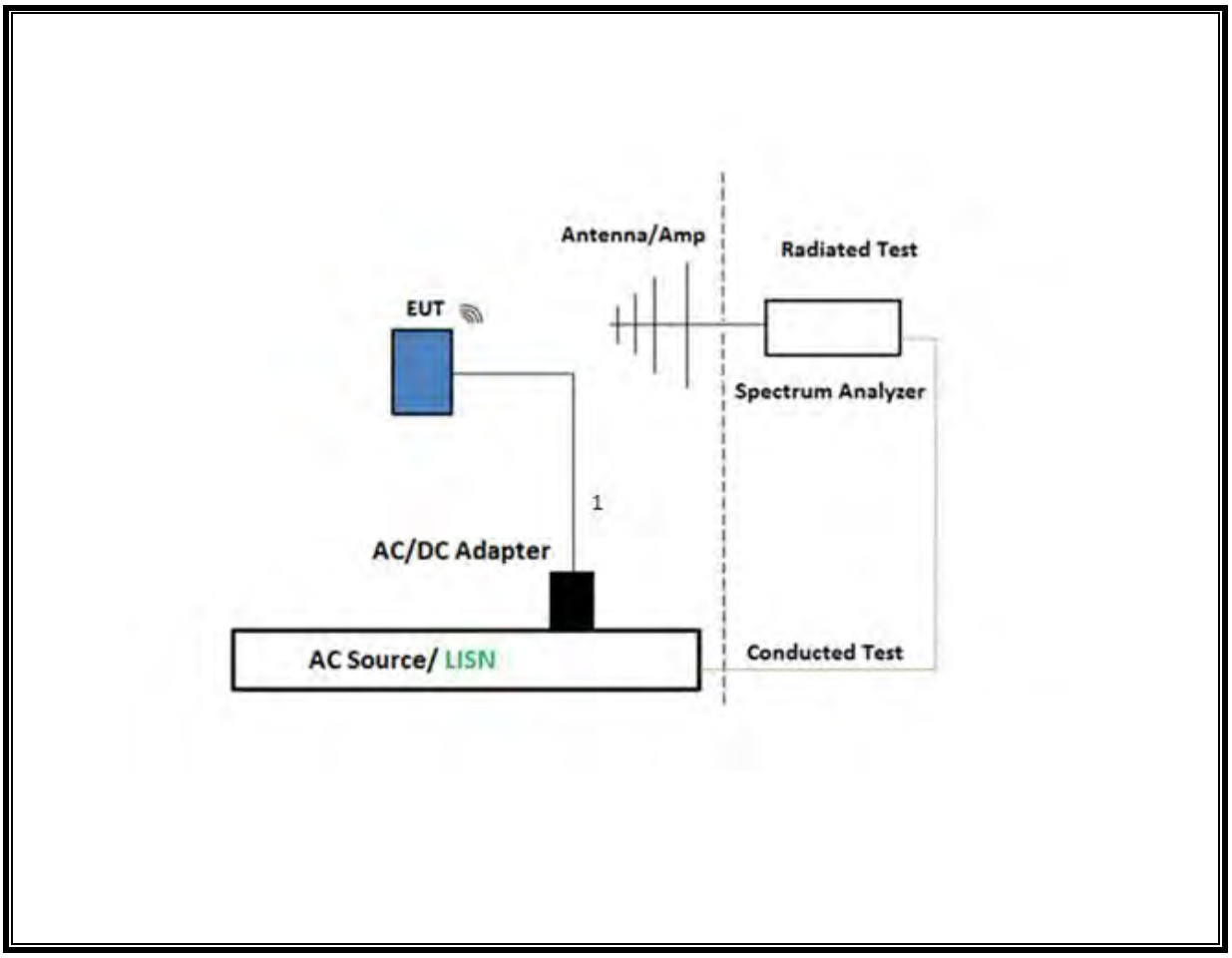
SETUP DIAGRAM FOR BELOW 1GHz and AC LINE CONDUCTED TEST



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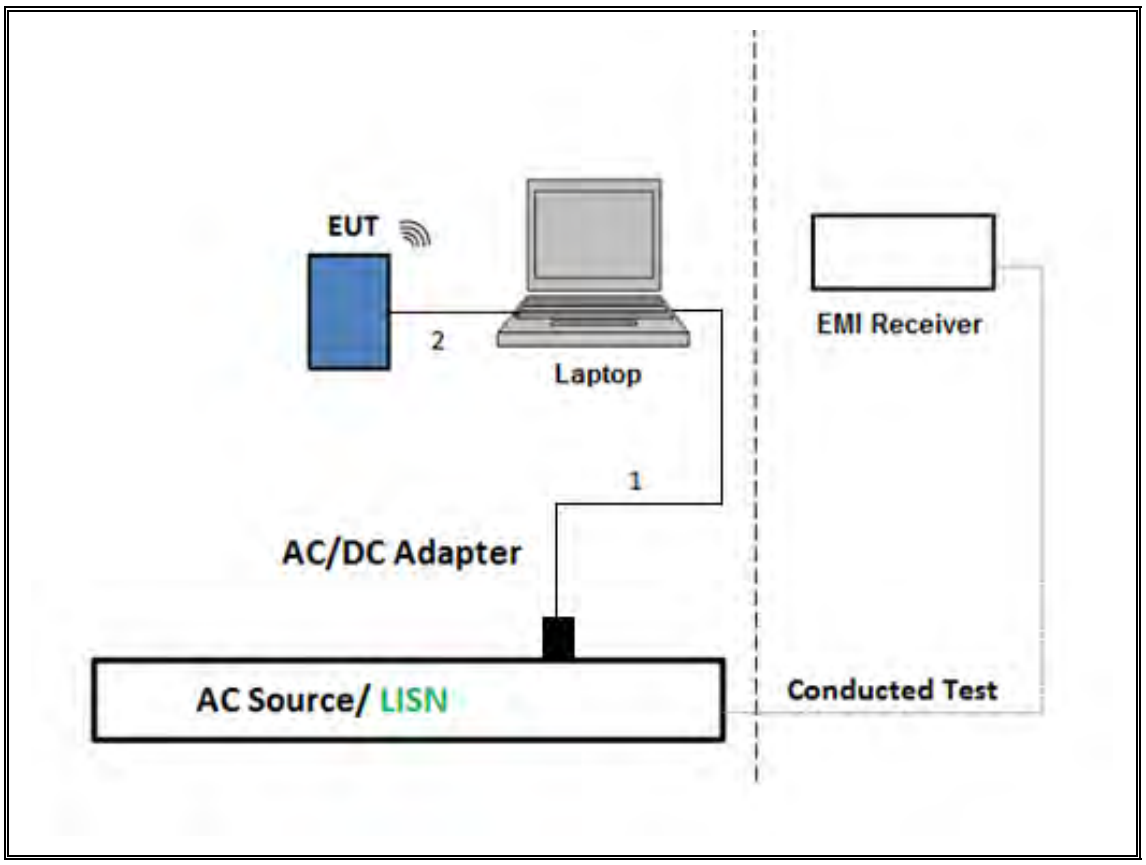
TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION



6.TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was 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	Agilent (Keysight) Technologies	N9030A	T908	01/23/2020	01/23/2019
Horn Antenna 1-18GHz	ETS-Lindgren	3117	T136	06/14/2020	06/14/2019
Horn Antenna 1-18GHz	ETS-Lindgren	3117	T345	04/20/2020	04/25/2019
Amplifier, 10KHz to 1GHz, 32dB	Sonoma Instrument Co.	310N	T15	10/20/2019	10/20/2018
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T712	02/26/2020	02/26/2019
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	138301	09/15/2019	09/15/2018
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T120	05/10/2020	05/10/2019
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T491	05/30/2020	05/30/2019
Antenna, Active Loop 9KHz to 30MHz	ETS-Lindgren	6502	T1616	10/18/2019	10/18/2018
*Hybrid Antenna, 30-3Ghz	SunAR rf Motion	JB3	PRE0181574	08/01/2019	08/01/2018
*Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826/B	T447	06/16/2019	06/16/2018
Amplifier, 1 - 18GHz	Miteq	AFS42-00101800-25-S-42	T1165	02/02/2020	02/02/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T340	01/22/2020	01/22/2019
Amplifier, 1 - 18GHz	Miteq	AFS42-00101800-25-S-42	T1567	01/26/2020	01/26/2019
Pre-Amp 18-26GHz	Agilent Technology	8449B	T404	03/23/2020	03/23/2019
Power Meter, P-series single channel	Agilent (Keysight) Technologies	N1911A	T227	10/29/2019	10/29/2018
Filter, HPF 3GHz	Micro-Tronics	HPM17543	T1014	01/26/2020	01/26/2019
Power Sensor	Power Sensor	Keysight	T1226	02/06/2020	02/06/2019
AC Line Conducted					
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	T1436	02/14/2020	02/14/2019
Power Cable, Line Conducted Emissions	UL	PG1	T861	08/31/2019	08/31/2018
LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	01/24/2020	01/24/2019
UL AUTOMATION SOFTWARE					
Radiated Software	UL	UL EMC	Ver 9.5, April 26, 2016		
Conducted Software	UL	UL EMC	Ver 5.4, October 13, 2016		
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015		

*Testing is completed before equipment expiration date

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7. 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

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

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

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

AC Power-line conducted emissions: ANSI C63.10-2013, Section 6.2.

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8. ANTENNA PORT TEST RESULTS

8.1. 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

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	1.00	1.00	1.000	100.0%	0.00	0.010
Bluetooth 8PSK	1.00	1.00	1.000	100.0%	0.00	0.010
Bluetooth GFSK TxBF	1.00	1.00	1.000	100.0%	0.00	0.010
Bluetooth 8PSK TxBF	1.00	1.00	1.000	100.0%	0.00	0.010

Note: Low power duty cycle is same as high power

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DUTY CYCLE PLOTS

BLUETOOTH GFSK

BLUETOOTH 8PSK

BLUETOOTH TxBF GFSK

BLUETOOTH TxBF 8PSK

8.2. 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 ≥ 1% of the 20 dB bandwidth. The VBW is set to ≥ RBW. The sweep time is coupled.

RESULTS

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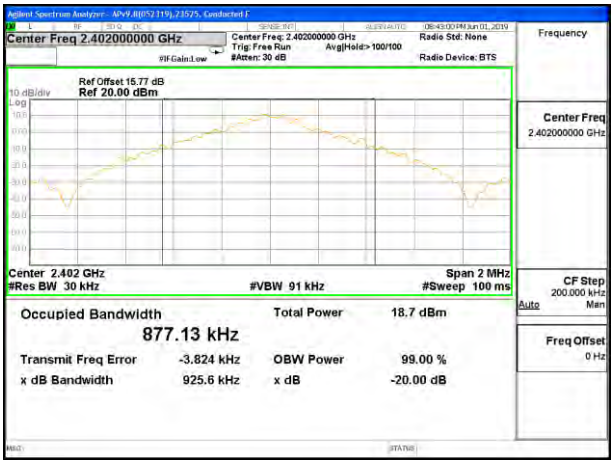
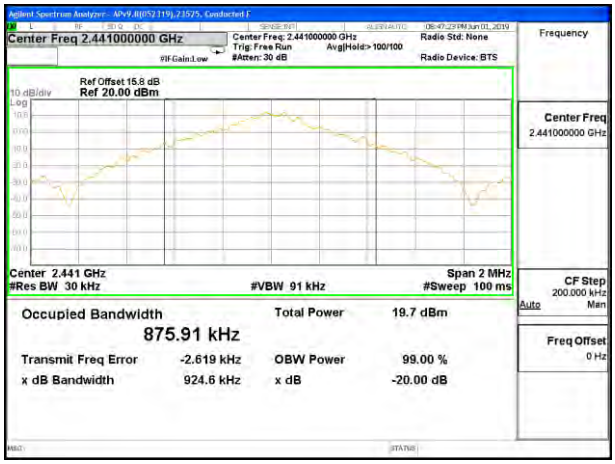
8.2.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

Antenna 3

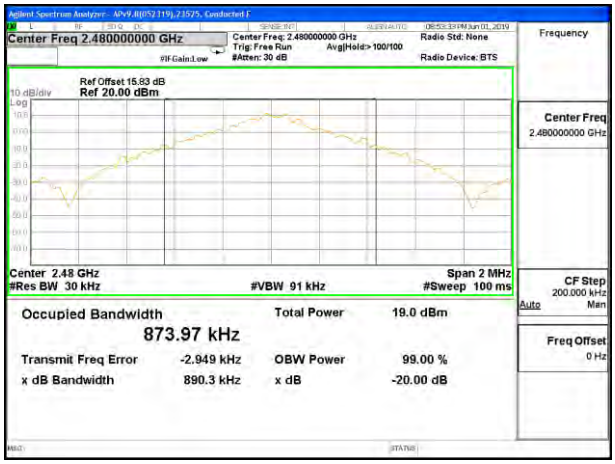
Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	0.926	0.8771
Mid	2441	0.925	0.8759
High	2480	0.890	0.8740



LOW CHANNEL



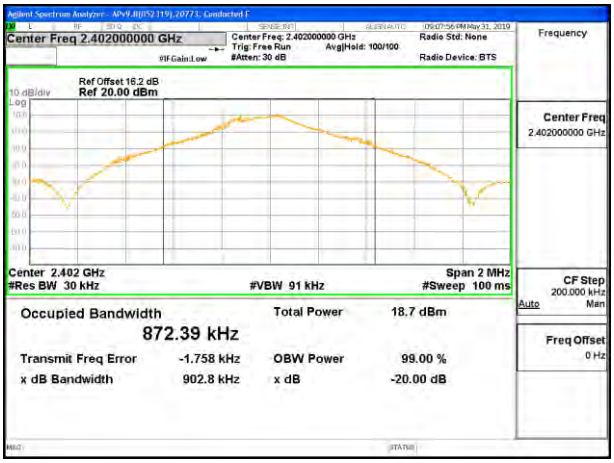
MID CHANNEL



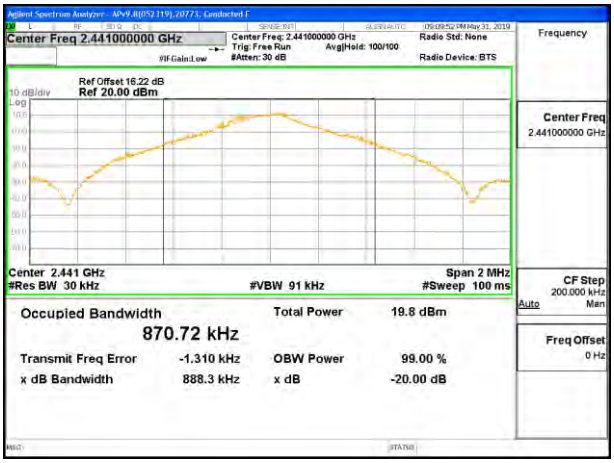
HIGH CHANNEL

Antenna 4

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	0.903	0.8724
Mid	2441	0.888	0.8707
High	2480	0.885	0.8704



LOW CHANNEL



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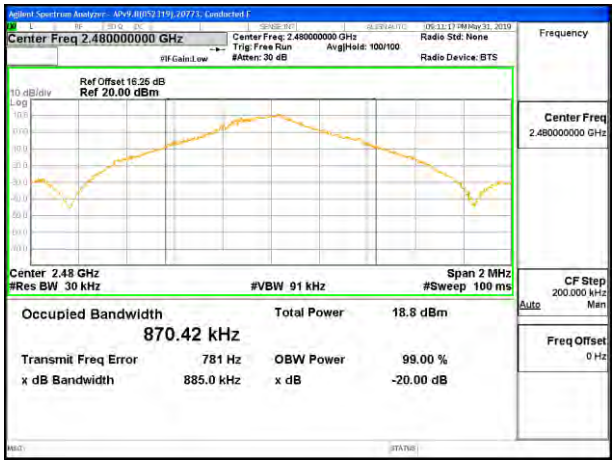
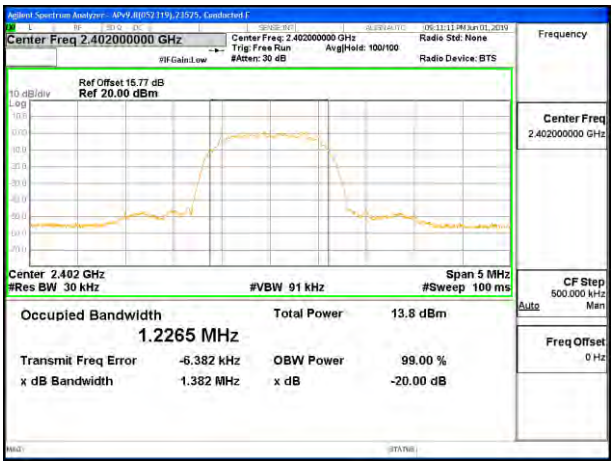


HIGH CHANNEL

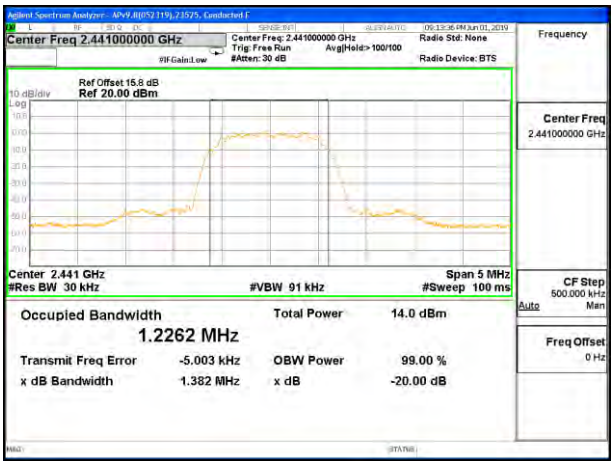
8.2.2. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

Antenna 3

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.382	1.2265
Mid	2441	1.382	1.2262
High	2480	1.382	1.2262



LOW CHANNEL



MID CHANNEL

HIGH CHANNEL

Antenna 4

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.367	1.2186
Mid	2441	1.383	1.2172
High	2480	1.387	1.2204

LOW CHANNEL

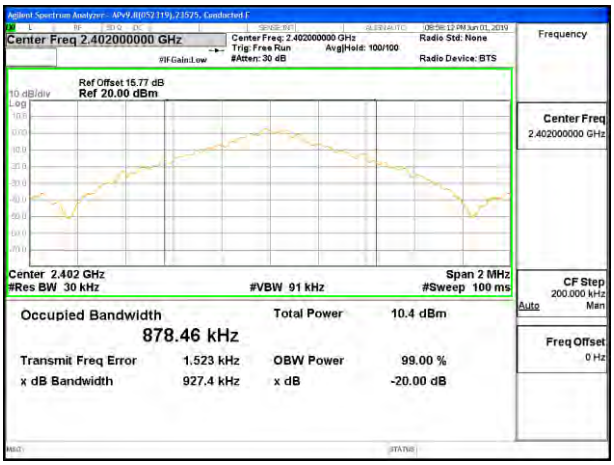
MID CHANNEL

HIGH CHANNEL

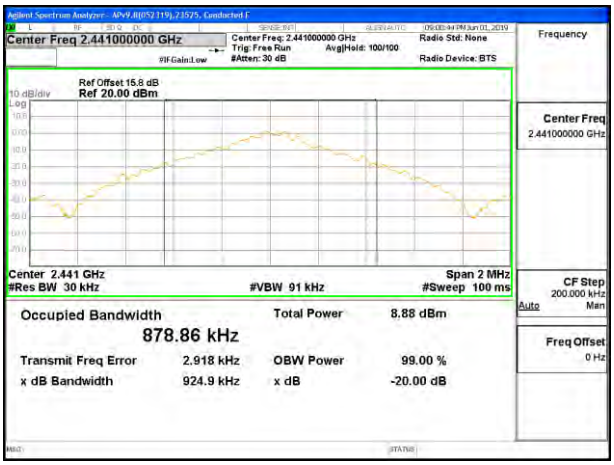
8.2.3. LOW POWER BASIC DATA RATE GFSK MODULATION

Antenna 3

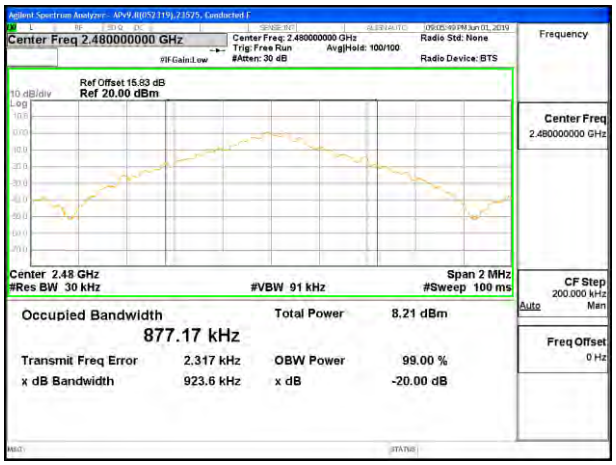
Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	0.927	0.8785
Mid	2441	0.925	0.8789
High	2480	0.924	0.8772



LOW CHANNEL



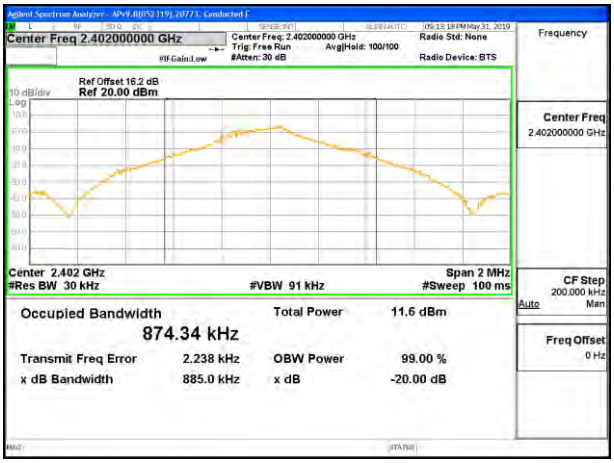
MID CHANNEL



HIGH CHANNEL

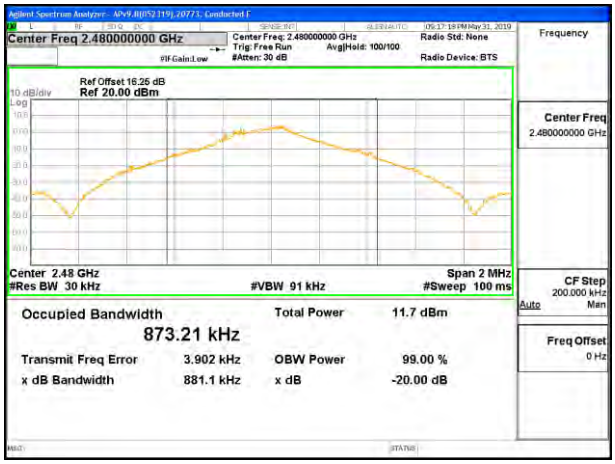
Antenna 4

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	0.885	0.8743
Mid	2441	0.919	0.8736
High	2480	0.881	0.8732



LOW CHANNEL

MID CHANNEL

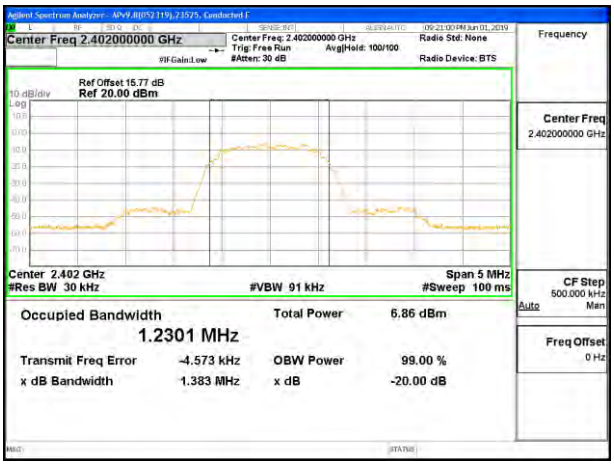


HIGH CHANNEL

8.2.4. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

Antenna 3

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.383	1.2301
Mid	2441	1.382	1.2266
High	2480	1.382	1.2262



LOW CHANNEL

MID CHANNEL

HIGH CHANNEL

Antenna 4

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.372	1.2192
Mid	2441	1.369	1.2184
High	2480	1.389	1.2228

LOW CHANNEL

MID CHANNEL

HIGH CHANNEL

8.3. 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 hoping 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.

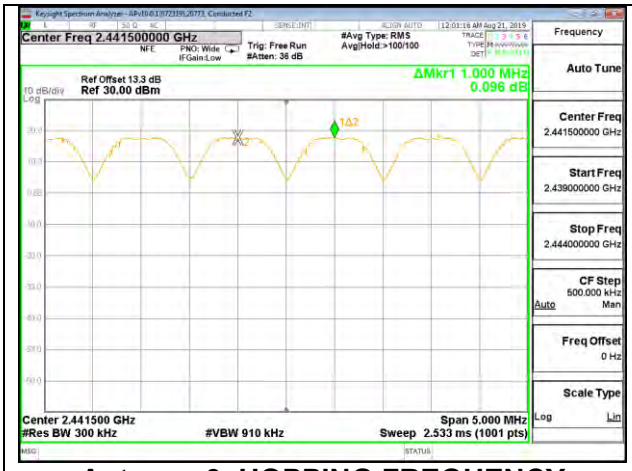
TEST PROCEDURE

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

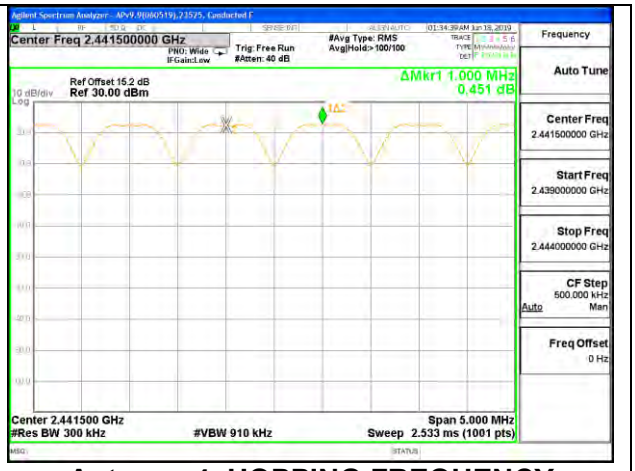
RESULTS

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

8.3.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

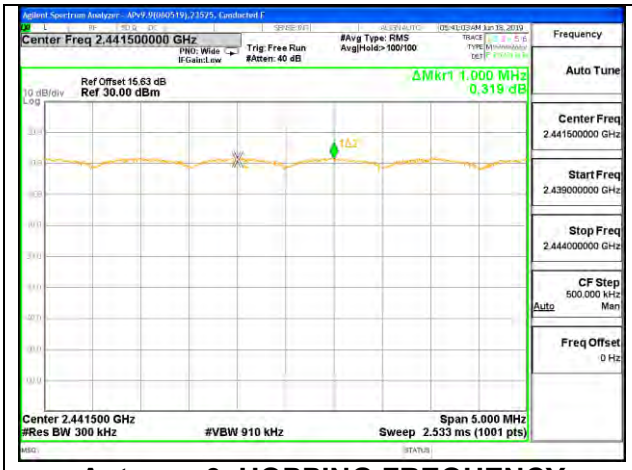


Antenna 3, HOPPING FREQUENCY SEPARATION

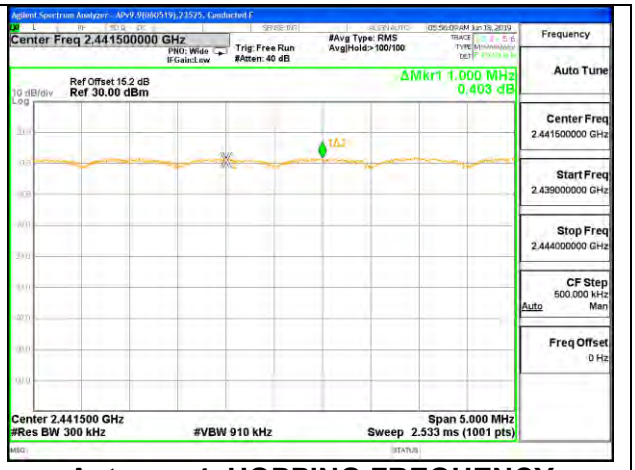


Antenna 4, HOPPING FREQUENCY SEPARATION

8.3.2. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

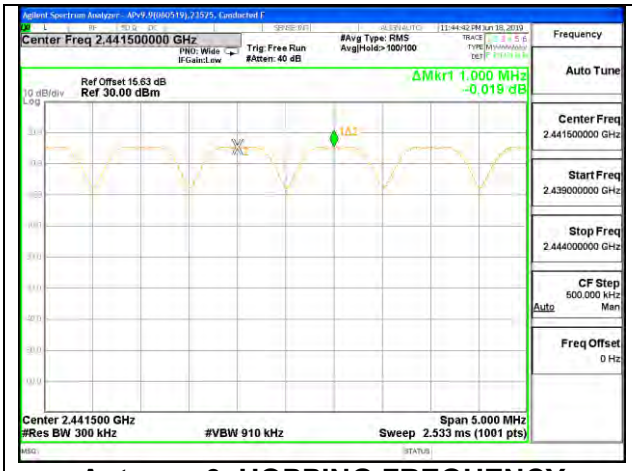


Antenna 3, HOPPING FREQUENCY SEPARATION

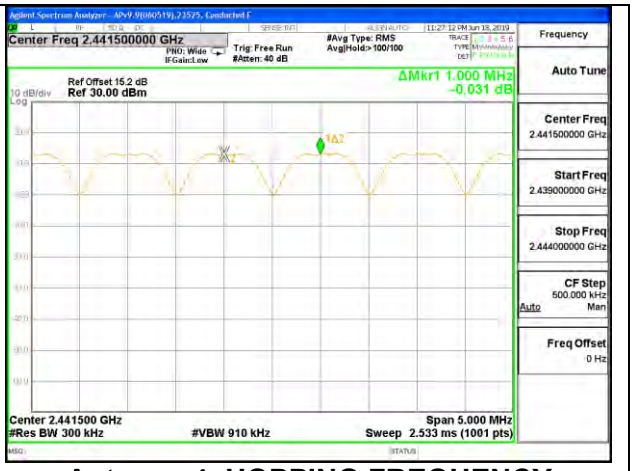


Antenna 4, HOPPING FREQUENCY SEPARATION

8.3.3. LOW POWER BASIC DATA RATE GFSK MODULATION

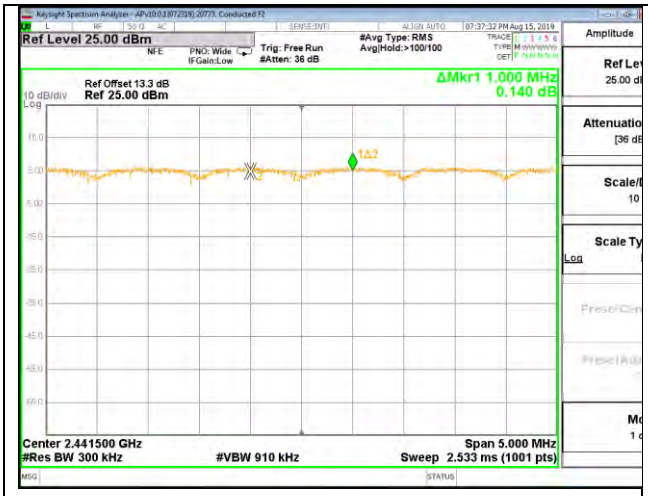


Antenna 3, HOPPING FREQUENCY SEPARATION

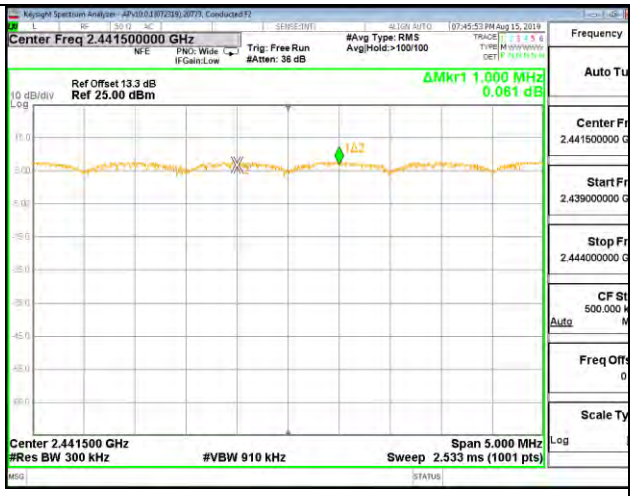


Antenna 4, HOPPING FREQUENCY SEPARATION

8.3.4. LOW POWER ENHANCED DATA RATE 8PSK MODULATION



Antenna 3, HOPPING FREQUENCY SEPARATION



Antenna 4, HOPPING FREQUENCY SEPARATION

8.4. 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.

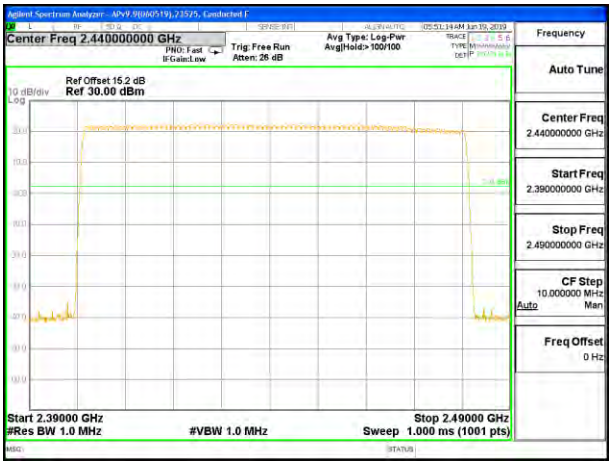
RESULTS

Normal Mode: All Channels Observed

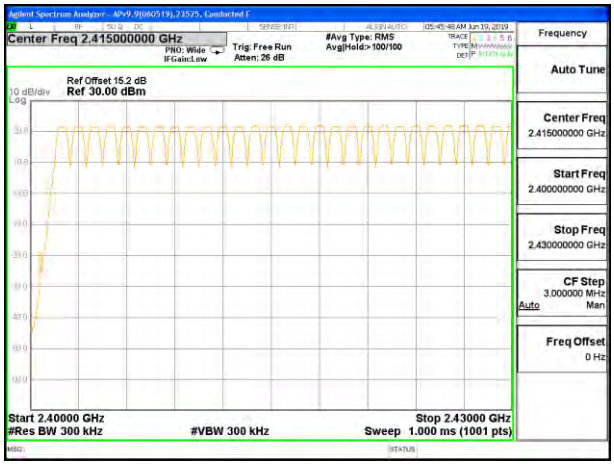
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

8.4.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

Antenna 3

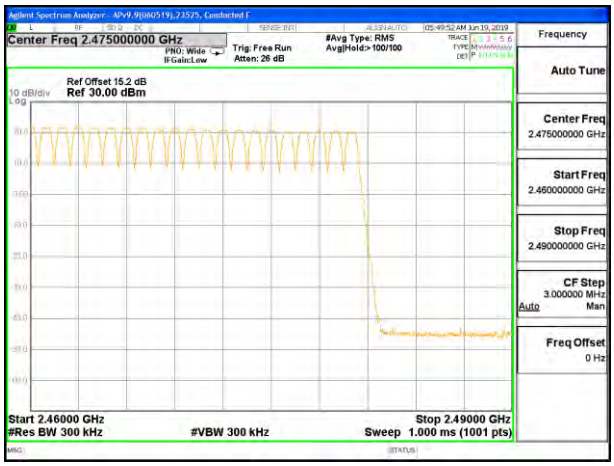


100MHz SPAN



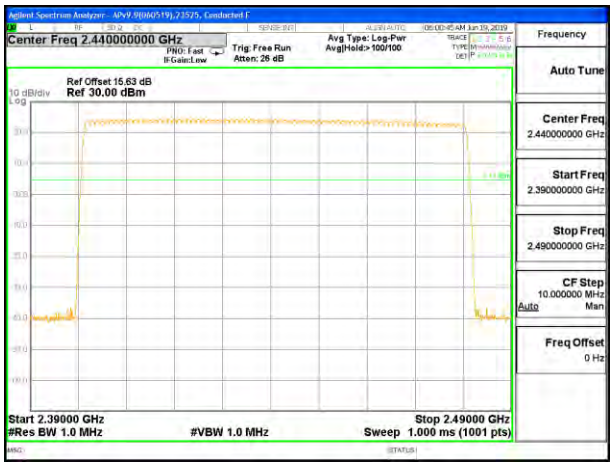
30MHz SPAN, SEGMENT 1 OF 3

30MHz SPAN, SEGMENT 2 OF 3

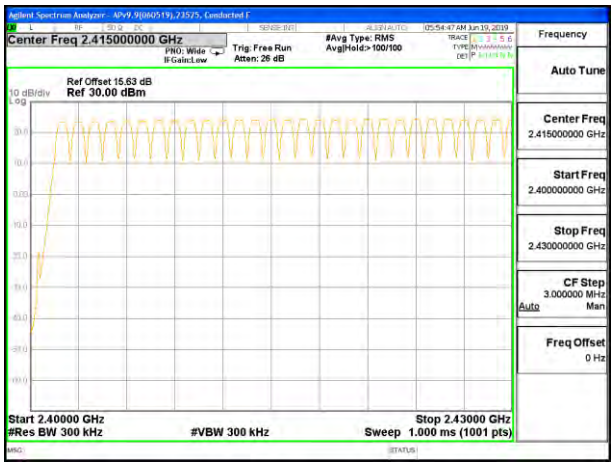


30MHz SPAN, SEGMENT 3 OF 3

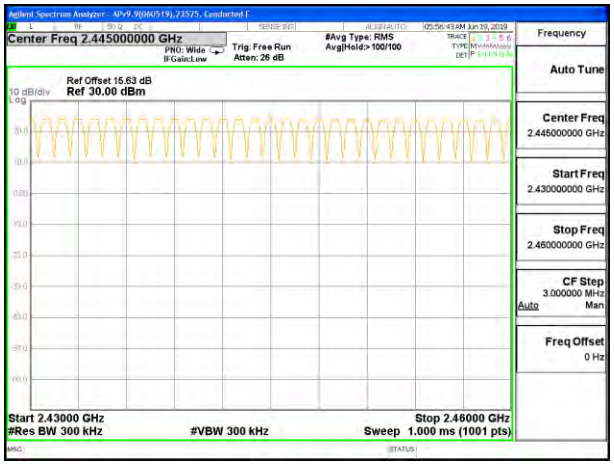
Antenna 4



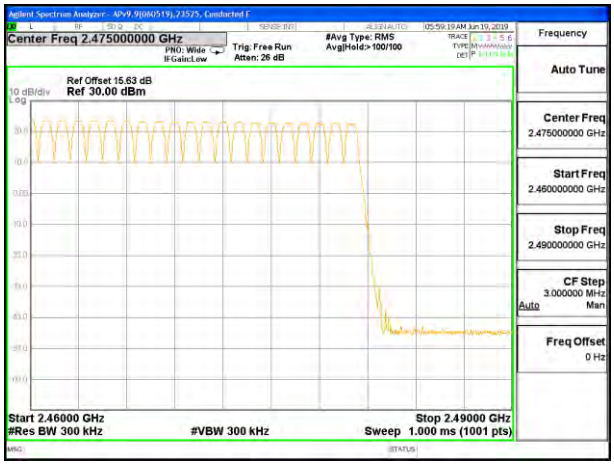
100MHz SPAN



30MHz SPAN, SEGMENT 1 OF 3



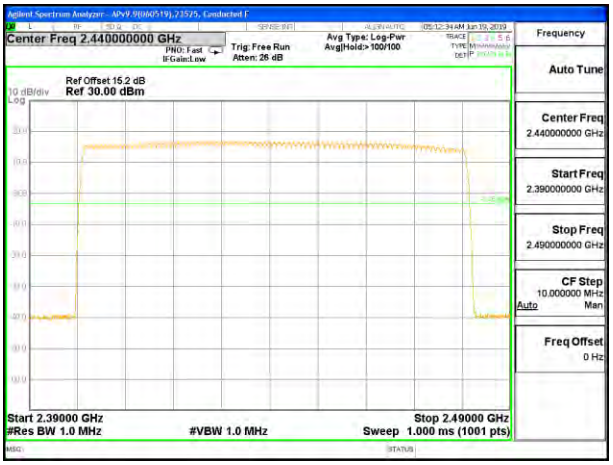
30MHz SPAN, SEGMENT 2 OF 3



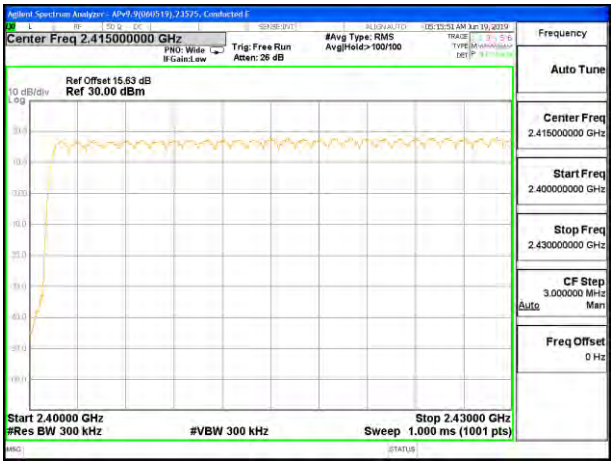
30MHz SPAN, SEGMENT 3 OF 3

8.4.2. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

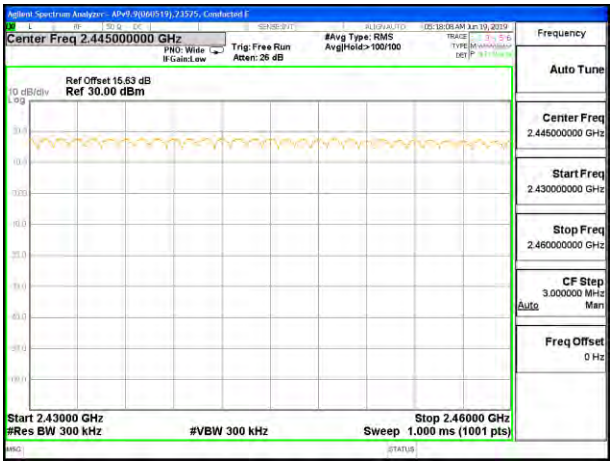
Antenna 3



100MHz SPAN



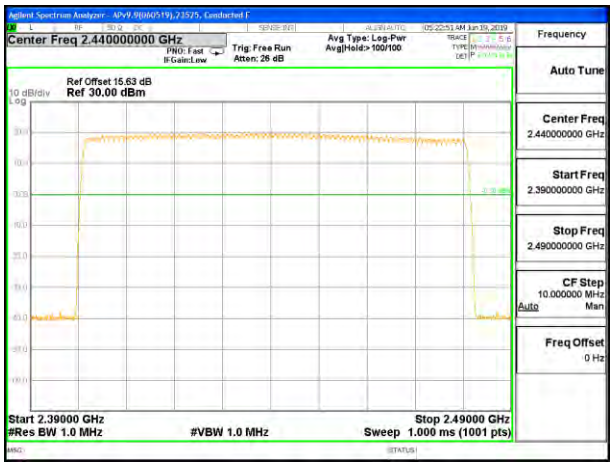
30MHz SPAN, SEGMENT 1 OF 3



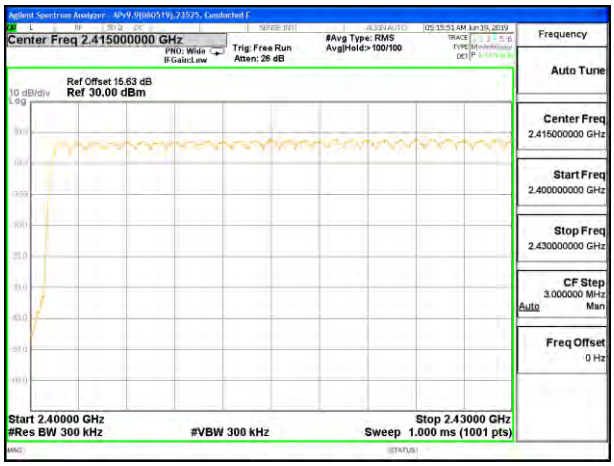
30MHz SPAN, SEGMENT 2 OF 3

30MHz SPAN, SEGMENT 3 OF 3

Antenna 4



100MHz SPAN



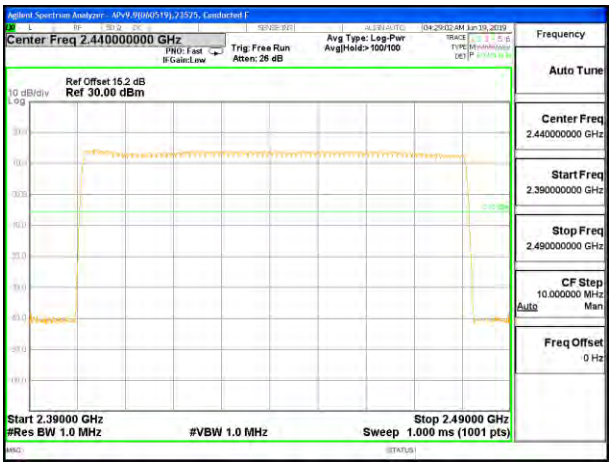
30MHz SPAN, SEGMENT 1 OF 3

30MHz SPAN, SEGMENT 2 OF 3

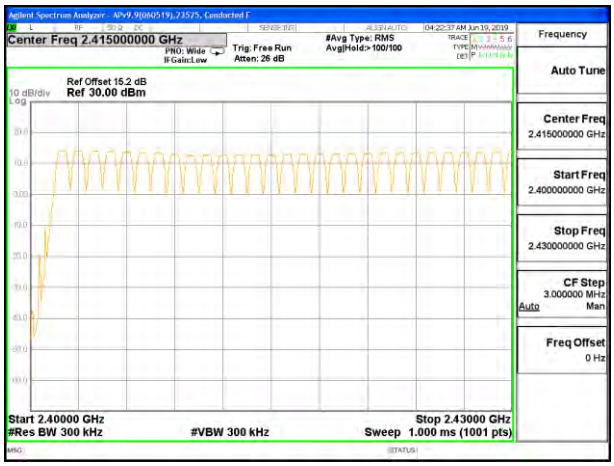
30MHz SPAN, SEGMENT 3 OF 3

8.4.3. LOW POWER BASIC DATA RATE GFSK MODULATION

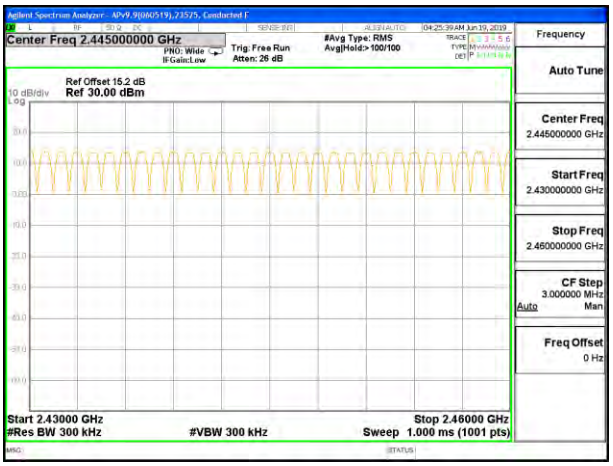
Antenna 3



100MHz SPAN



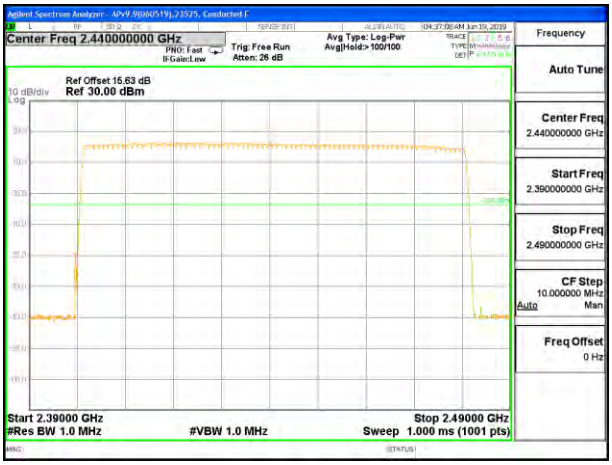
30MHz SPAN, SEGMENT 1 OF 3



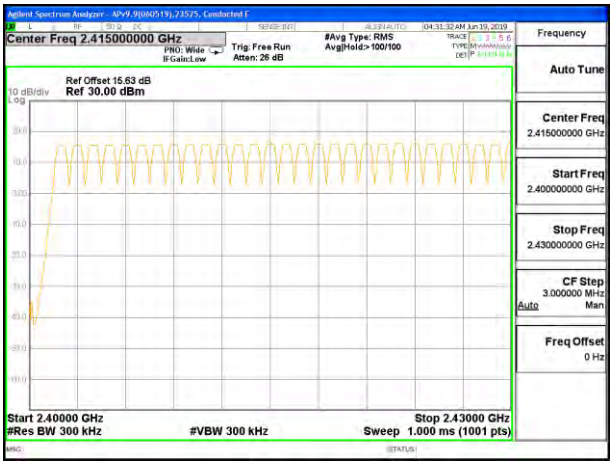
30MHz SPAN, SEGMENT 2 OF 3

30MHz SPAN, SEGMENT 3 OF 3

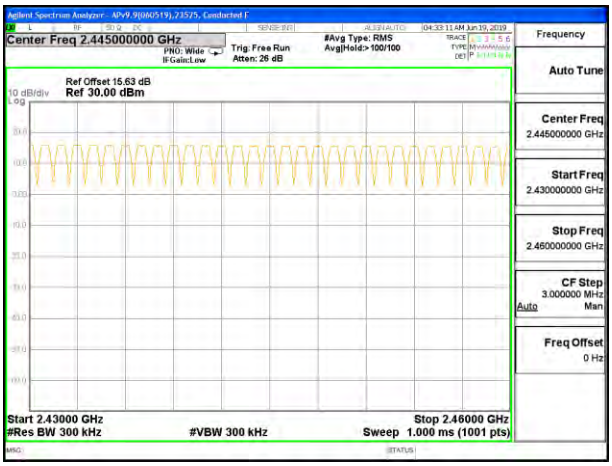
Antenna 4



100MHz SPAN



30MHz SPAN, SEGMENT 1 OF 3

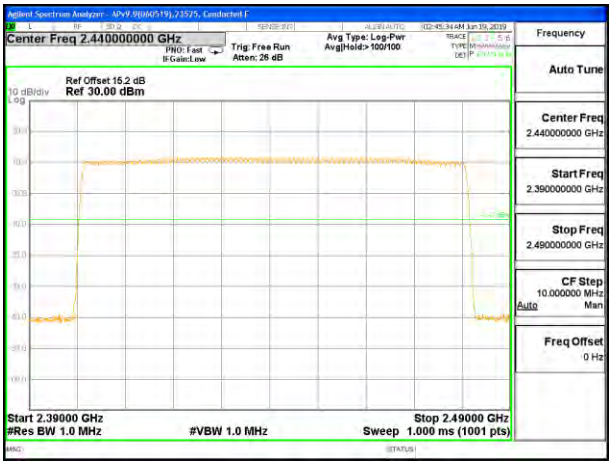


30MHz SPAN, SEGMENT 2 OF 3

30MHz SPAN, SEGMENT 3 OF 3

8.4.4. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

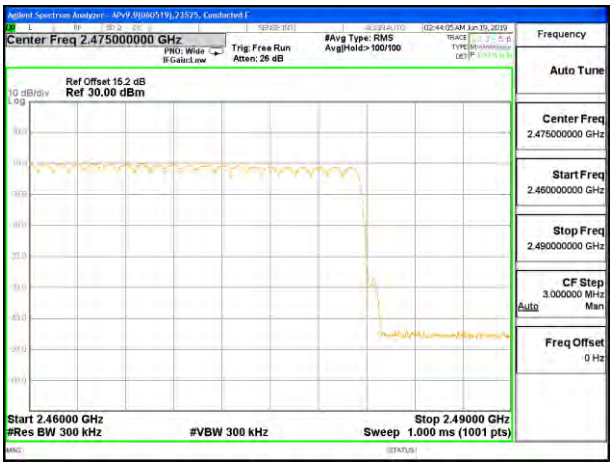
Antenna 3



100MHz SPAN

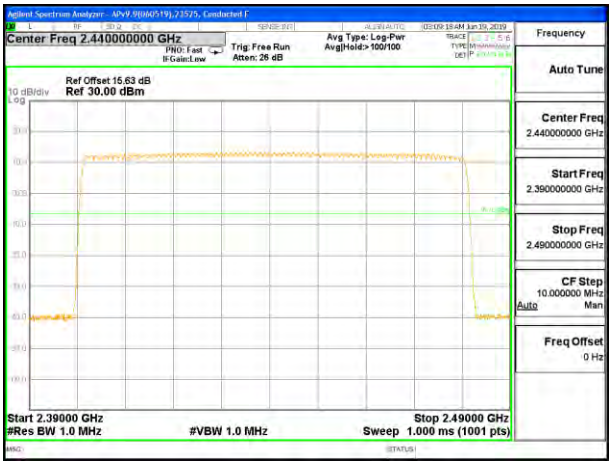
30MHz SPAN, SEGMENT 1 OF 3

30MHz SPAN, SEGMENT 2 OF 3



30MHz SPAN, SEGMENT 3 OF 3

Antenna 4



100MHz SPAN

30MHz SPAN, SEGMENT 1 OF 3

30MHz SPAN, SEGMENT 2 OF 3

30MHz SPAN, SEGMENT 3 OF 3

8.5. 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 * (# of pulses in 3.16 s) * 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 * (# of pulses in 0.8 s) * pulse width.

RESULTS

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

8.5.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

Antenna 3

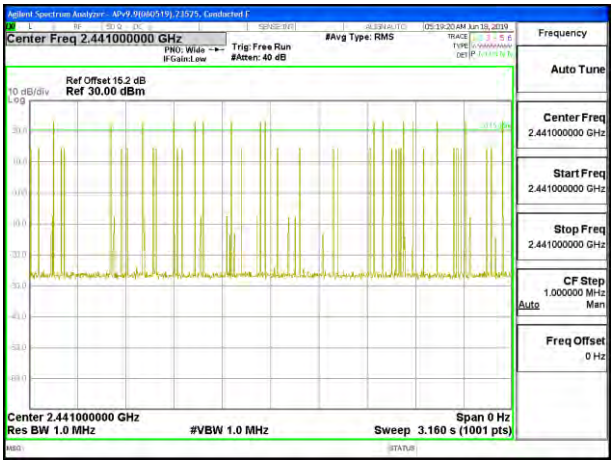
DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal Mode					
DH1	0.381	32	0.1219	0.4	-0.2781
DH3	1.638	16	0.2621	0.4	-0.1379
DH5	2.884	6	0.1730	0.4	-0.2270
DH Packet	Pulse Width (sec)	Number of Pulses in 0.8 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK AFH Mode					
DH1	0.381	8	0.03048	0.4	-0.3695
DH3	1.638	4	0.06552	0.4	-0.3345
DH5	2.884	1.5	0.04326	0.4	-0.3567

PULSE WIDTH – DH1

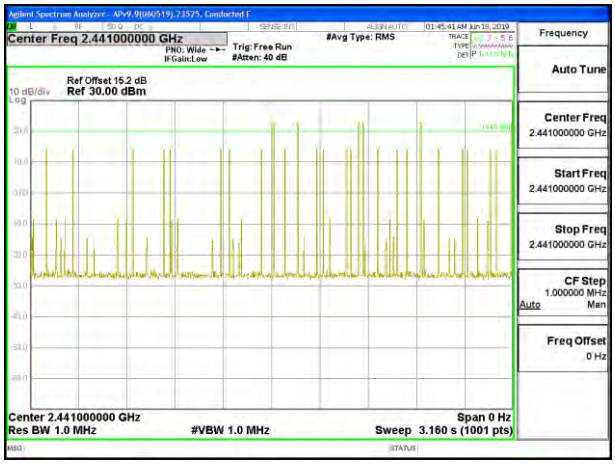
PULSE WIDTH – DH3

PULSE WIDTH – DH5

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3

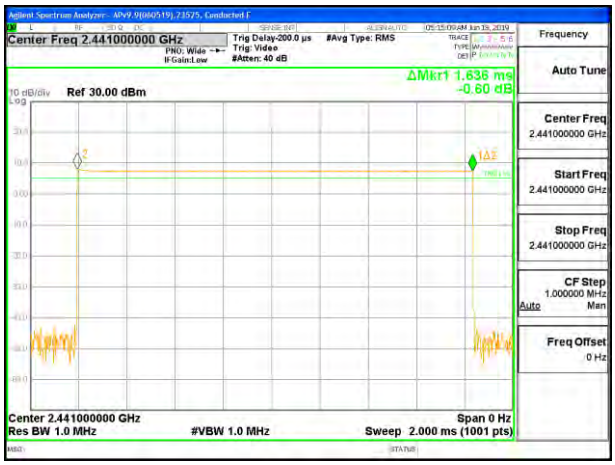


NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5

Antenna 4

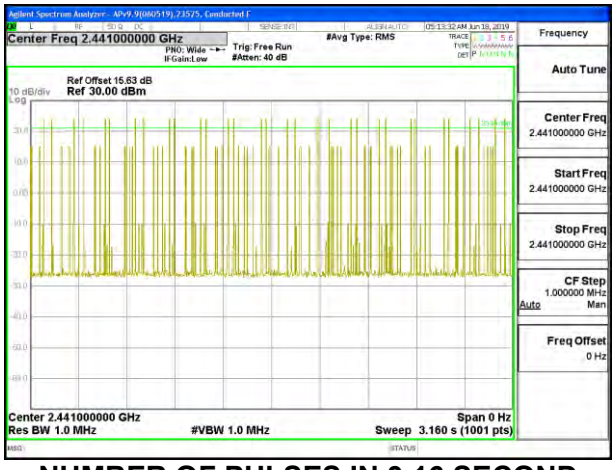
DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal Mode					
DH1	0.381	32	0.1219	0.4	-0.2781
DH3	1.636	17	0.2781	0.4	-0.1219
DH5	2.884	7	0.2019	0.4	-0.1981
DH Packet	Pulse Width (sec)	Number of Pulses in 0.8 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK AFH Mode					
DH1	0.381	8	0.03048	0.4	-0.3695
DH3	1.636	4.25	0.06953	0.4	-0.3305
DH5	2.884	1.75	0.05047	0.4	-0.3495

PULSE WIDTH – DH1

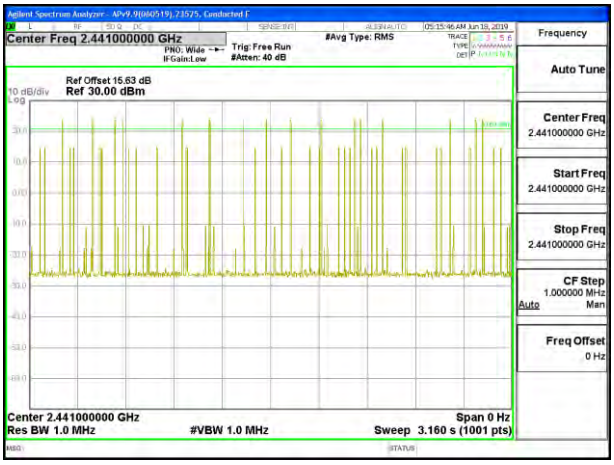


PULSE WIDTH – DH3

PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3

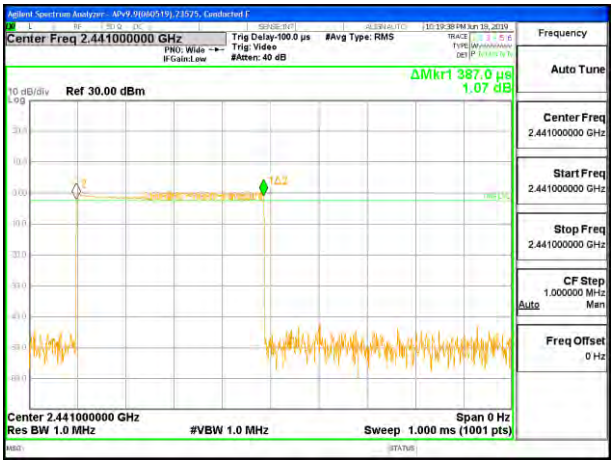
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5

8.5.2. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

Antenna 3

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
8PSK Normal Mode					
3DH1	0.387	32	0.12384	0.4	-0.27616
3DH3	1.638	17	0.27846	0.4	-0.12154
3DH5	2.888	4	0.11552	0.4	-0.28448

Note: for AFH(8PSK) mode, please refer to the results of AFH(GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate demonstrates compliance with channel occupancy when AFH is employed.



PULSE WIDTH – 3DH1

PULSE WIDTH – 3DH3

PULSE WIDTH – 3DH5

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH1

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH3

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH5

Antenna 4

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
8PSK Normal Mode					
3DH1	0.387	32	0.12384	0.4	-0.27616
3DH3	1.638	17	0.27846	0.4	-0.12154
3DH5	2.888	7	0.20216	0.4	-0.19784

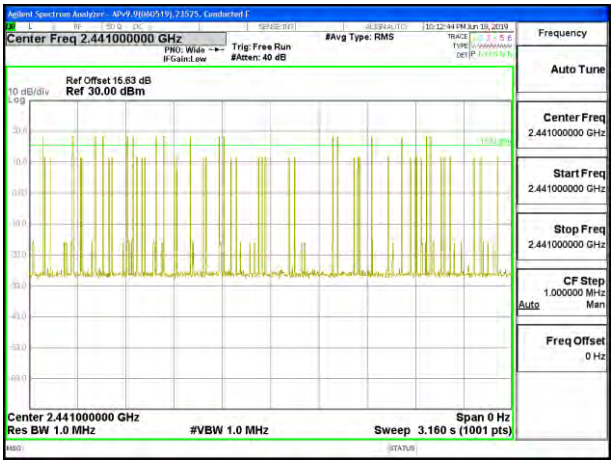
Note: for AFH(8PSK) mode, please refer to the results of AFH(GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate demonstrates compliance with channel occupancy when AFH is employed.

PULSE WIDTH – 3DH1

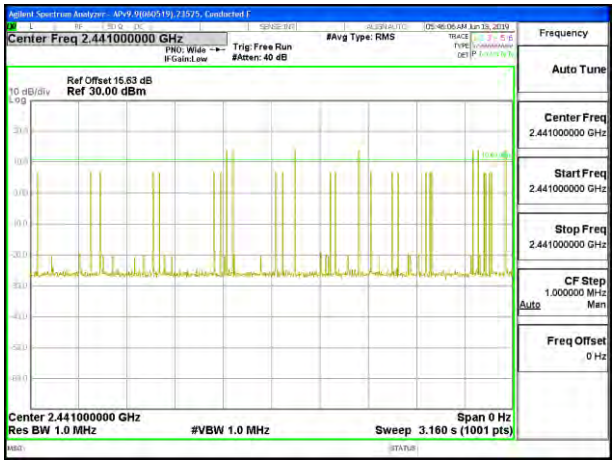
PULSE WIDTH – 3DH3

PULSE WIDTH – 3DH5

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH1



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH3



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH5

8.5.3. LOW POWER BASIC DATA RATE GFSK MODULATION

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	0.381	32	0.1219	0.4	-0.2781
DH3	1.638	17	0.2785	0.4	-0.1215
DH5	2.888	6	0.1733	0.4	-0.2267
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	0.381	8	0.03048	0.4	-0.3695
DH3	1.638	4.25	0.06962	0.4	-0.3304
DH5	2.888	1.5	0.04332	0.4	-0.3567

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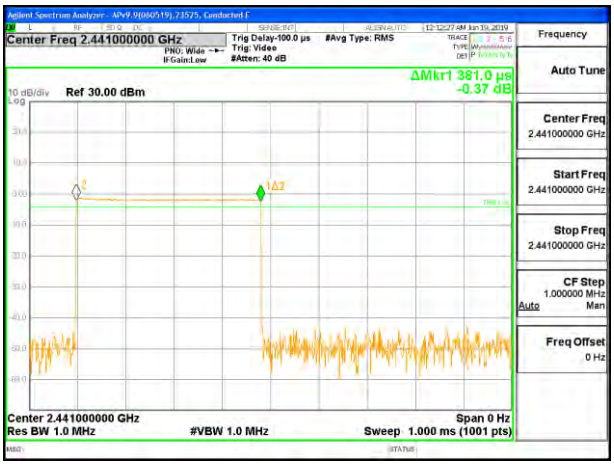


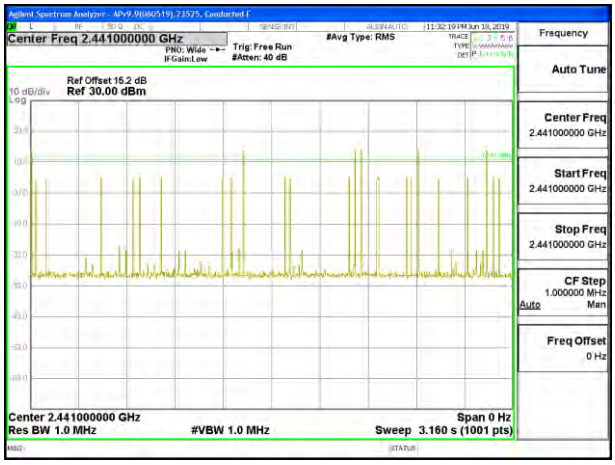
PULSE WIDTH – DH1

PULSE WIDTH – DH3

PULSE WIDTH – DH5

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1

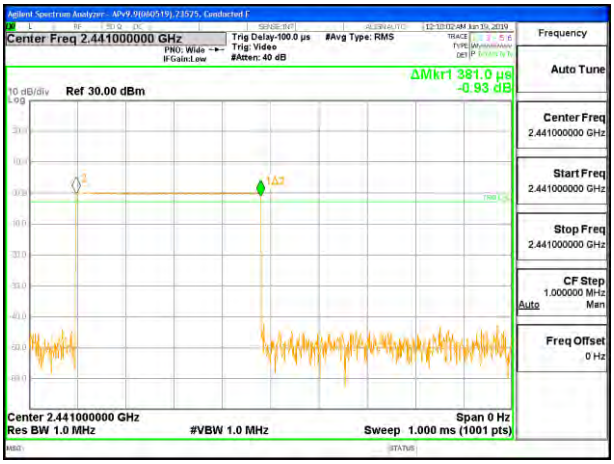
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5

Antenna 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	0.381	31	0.1181	0.4	-0.2819
DH3	1.638	17	0.2785	0.4	-0.1215
DH5	2.884	5	0.1442	0.4	-0.2558
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	0.381	7.75	0.02953	0.4	-0.3705
DH3	1.638	4.25	0.06962	0.4	-0.3304
DH5	2.884	1.25	0.03605	0.4	-0.3640



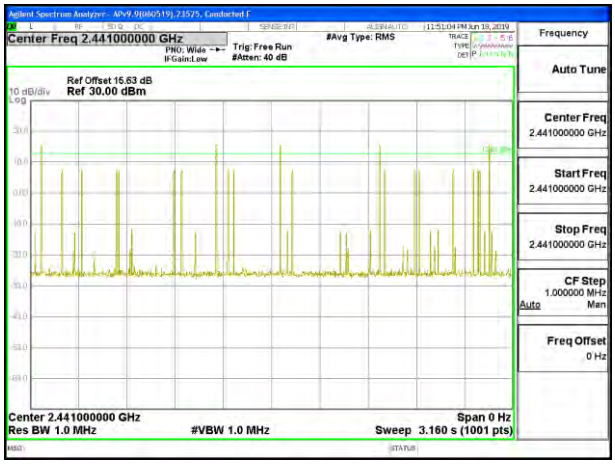
PULSE WIDTH – DH1

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



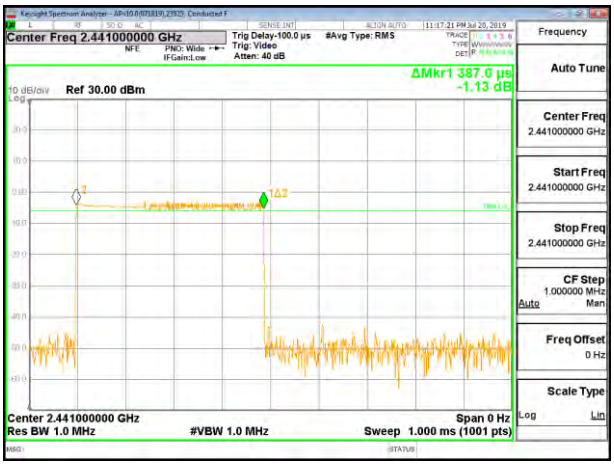
NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5

8.5.4. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

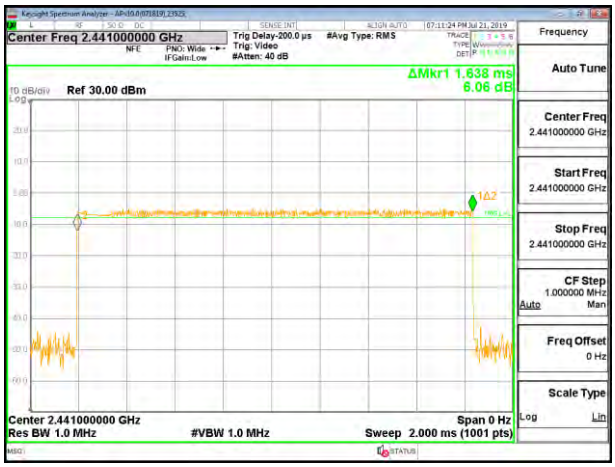
Antenna 3

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
8PSK Normal Mode					
3DH1	0.387	32	0.12384	0.4	-0.2762
3DH3	1.638	18	0.29484	0.4	-0.1052
3DH5	2.888	5	0.14440	0.4	-0.2556

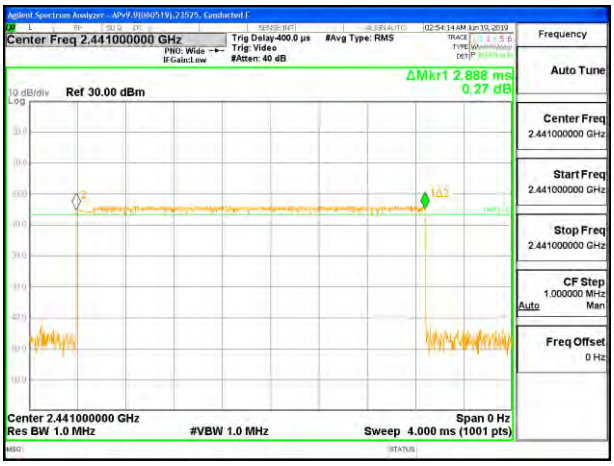
Note: for AFH(8PSK) mode, please refer to the results of AFH(GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate demonstrates compliance with channel occupancy when AFH is employed.



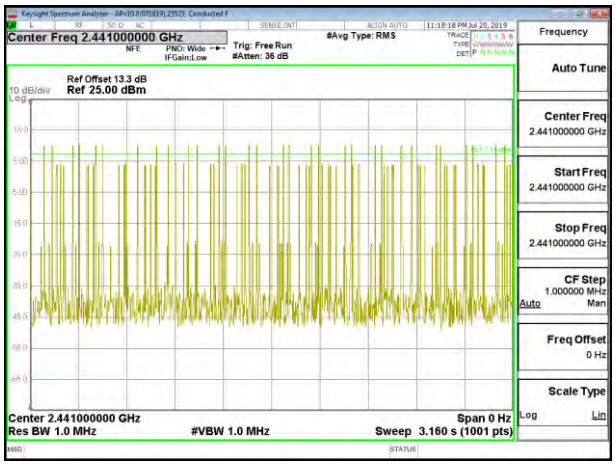
PULSE WIDTH – 3DH1



PULSE WIDTH – 3DH3

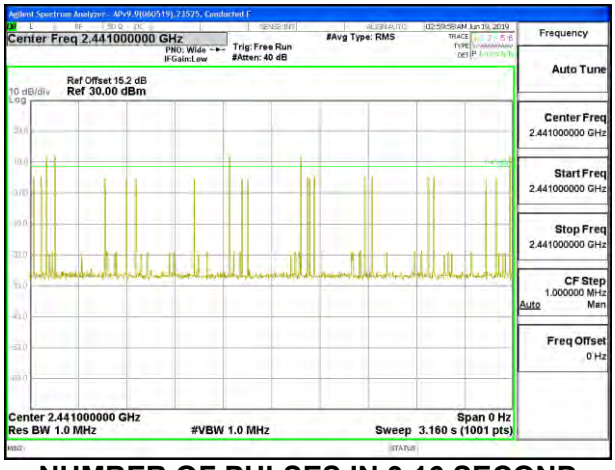


PULSE WIDTH – 3DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH1

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH3



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH5

Antenna 4

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
8PSK Normal Mode					
3DH1	0.387	32	0.12384	0.4	-0.2762
3DH3	1.638	18	0.29484	0.4	-0.1052
3DH5	2.888	5	0.14440	0.4	-0.2556

Note: for AFH(8PSK) mode, please refer to the results of AFH(GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate demonstrates compliance with channel occupancy when AFH is employed.

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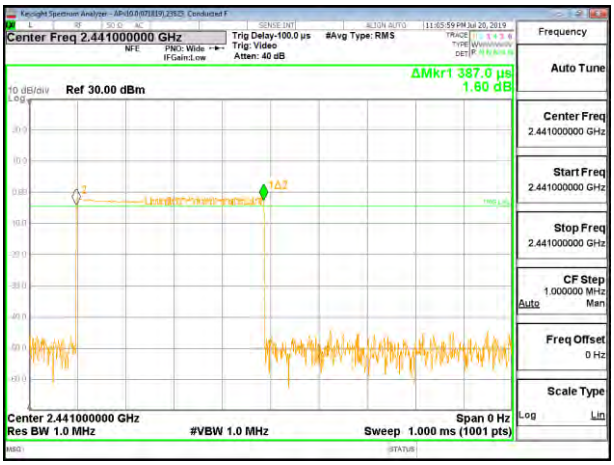
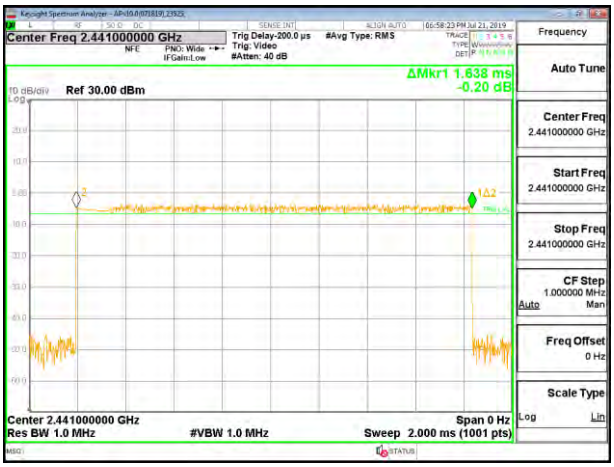
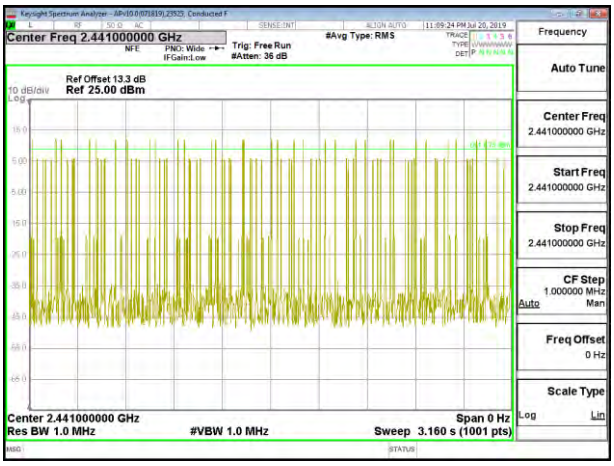


PULSE WIDTH – 3DH1



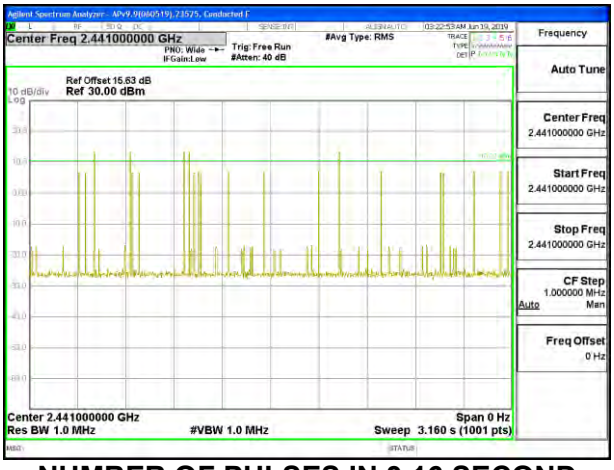
PULSE WIDTH – 3DH3

PULSE WIDTH – 3DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH1

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH3



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – 3DH5

8.6. 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 gated RF power meter.

The cable assembly insertion loss of 10.5 dB (including 10 dB pad and 0.5 dB cable) was entered as an offset in the power meter to allow for a gated peak reading of power.

RESULTS

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8.6.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

Antenna 3

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	19.56	21	-1.44
Middle	2441	19.78	21	-1.22
High	2480	19.73	21	-1.27

Antenna 4

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	17.22	21	-3.78
Middle	2441	17.29	21	-3.71
High	2480	17.24	21	-3.76

8.6.2. HIGH POWER ENHANCED DATA RATE QPSK MODULATION

Antenna 3

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	18.01	21	-2.99
Middle	2441	18.10	21	-2.9
High	2480	18.03	21	-2.97

Antenna 4

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	18.00	21	-3.00
Middle	2441	18.07	21	-2.93
High	2480	18.02	21	-2.98

8.6.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

Antenna 3

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	18.28	21	-2.72
Middle	2441	18.39	21	-2.61
High	2480	18.32	21	-2.68

Antenna 4

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	18.35	21	-2.65
Middle	2441	18.45	21	-2.55
High	2480	18.4	21	-2.6

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8.6.4. LOW POWER BASIC DATA RATE GFSK MODULATION

Antenna 3

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.62	21	-8.38
Middle	2441	12.74	21	-8.26
High	2480	12.66	21	-8.34

Antenna 4

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	12.65	21	-8.35
Middle	2441	12.77	21	-8.23
High	2480	12.69	21	-8.31

8.6.5. LOW POWER ENHANCED DATA RATE QPSK MODULATION

Antenna 3

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.01	21	-9.99
Middle	2441	11.05	21	-9.95
High	2480	11.02	21	-9.98

Antenna 4

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	10.97	21	-10.03
Middle	2441	10.99	21	-10.01
High	2480	10.95	21	-10.05

8.6.6. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

Antenna 3

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.20	21	-9.8
Middle	2441	11.31	21	-9.69
High	2480	11.28	21	-9.72

Antenna 4

Tested By:	50820
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.29	21	-9.71
Middle	2441	11.38	21	-9.62
High	2480	11.27	21	-9.73

8.7. AVERAGE POWER

LIMITS

None; for reporting purposes only

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

The cable assembly insertion loss of 10.5 dB (including 10 dB pad and 0.5 dB cable) was entered as an offset in the power meter to allow for a gated average reading of power.

RESULTS

UL VERIFICATION SERVICES INC.
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8.7.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

Antenna 3

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	16.82
Middle	2441	16.91
High	2480	16.87

Antenna 4

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	19.32
Middle	2441	19.41
High	2480	19.37

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8.7.2. HIGH POWER ENHANCED DATA RATE QPSK MODULATION

Antenna 3

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	15.64
Middle	2441	15.69
High	2480	15.62

Antenna 4

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	15.61
Middle	2441	15.68
High	2480	15.60

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8.7.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

Antenna 3

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	15.84
Middle	2441	15.91
High	2480	15.87

Antenna 4

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	15.83
Middle	2441	15.95
High	2480	15.92

8.7.4. LOW POWER BASIC DATA RATE GFSK MODULATION

Antenna 3

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	12.32
Middle	2441	12.39
High	2480	12.33

Antenna 4

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	12.30
Middle	2441	12.41
High	2480	12.38

8.7.6. LOW POWER ENHANCED DATA RATE QPSK MODULATION

Antenna 3

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.65
Middle	2441	8.68
High	2480	8.60

Antenna 4

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.60
Middle	2441	8.69
High	2480	8.62

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8.7.7. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

Antenna 3

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.84
Middle	2441	8.91
High	2480	8.87

Antenna 4

Tested By:	50820
Date	7/24/2019

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	8.89
Middle	2441	8.98
High	2480	8.93

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

RESULTS

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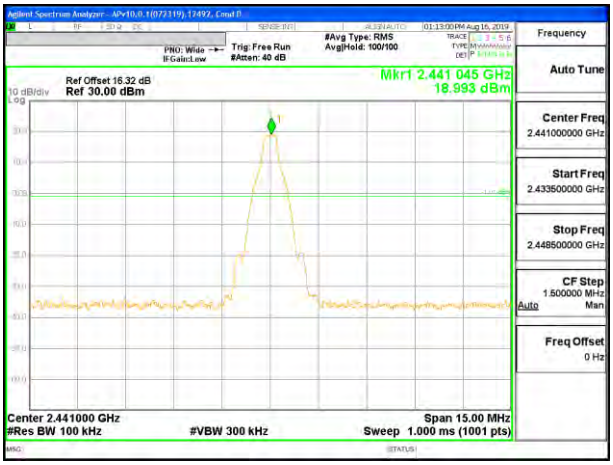
8.8.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

Antenna 3 SPURIOUS EMISSIONS, NON-HOPPING

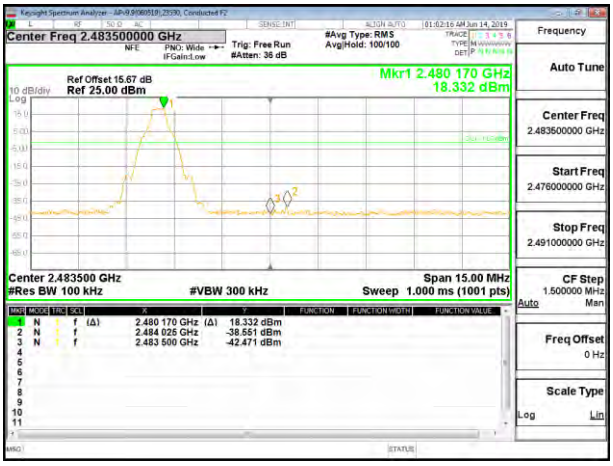
LOW CHANNEL BANDEDGE

OUT-OF-BAND LOW CHANNEL



IN-BAND REFERENCE LEVEL

OUT-OF-BAND MID CHANNEL

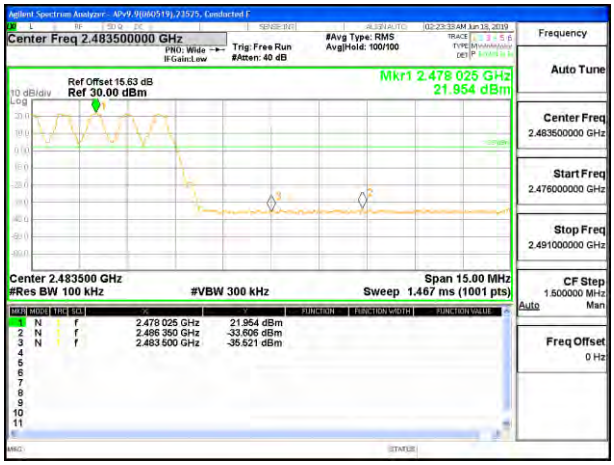


HIGH CHANNEL BANDEDGE

OUT-OF-BAND HIGH CHANNEL

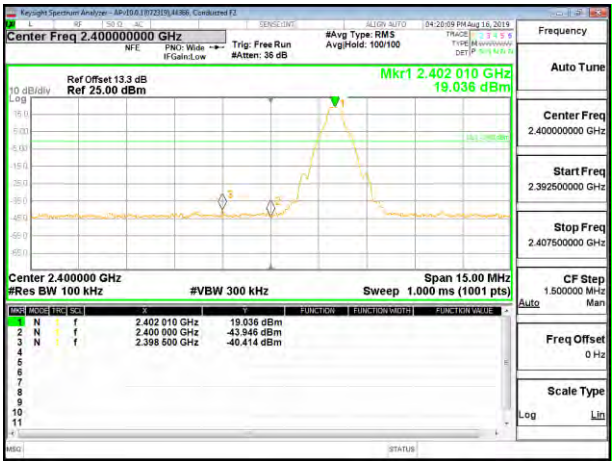
Antenna 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE



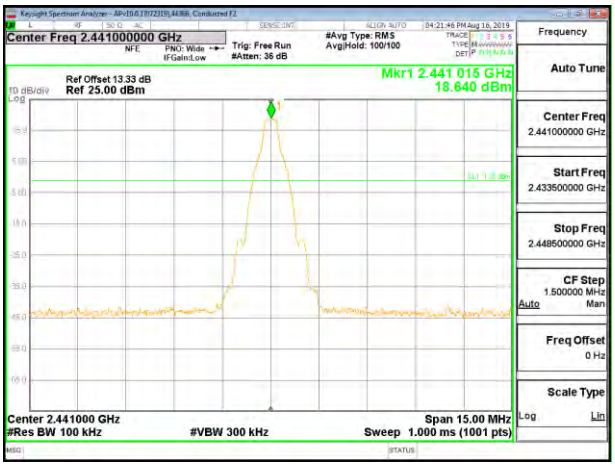
HIGH BANDEDGE

Antenna 4 SPURIOUS EMISSIONS, NON-HOPPING

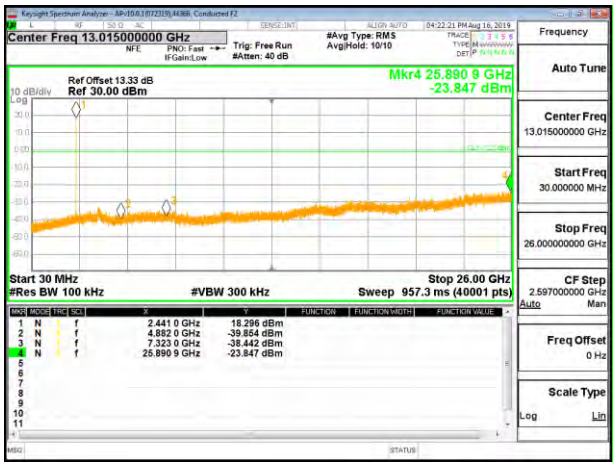


LOW CHANNEL BANDEDGE

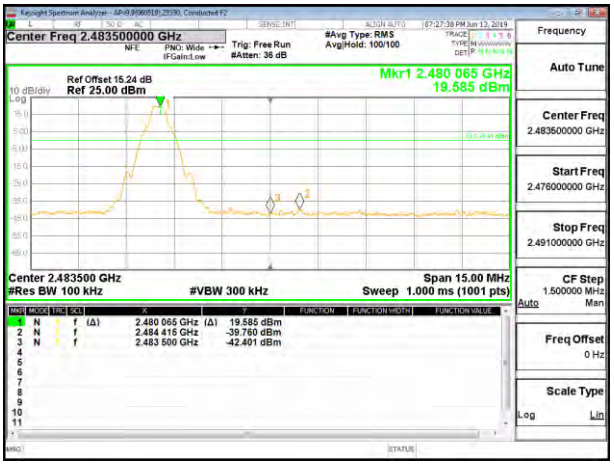
OUT-OF-BAND LOW CHANNEL



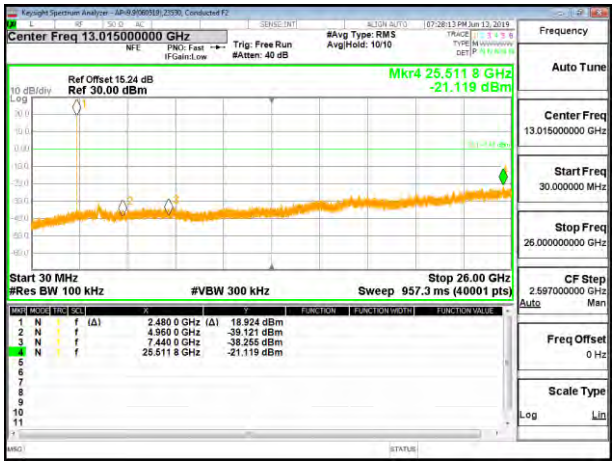
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

Antenna 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE

HIGH BANDEDGE

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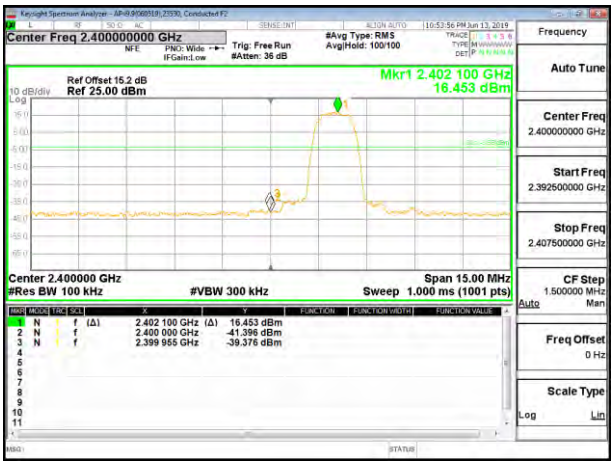
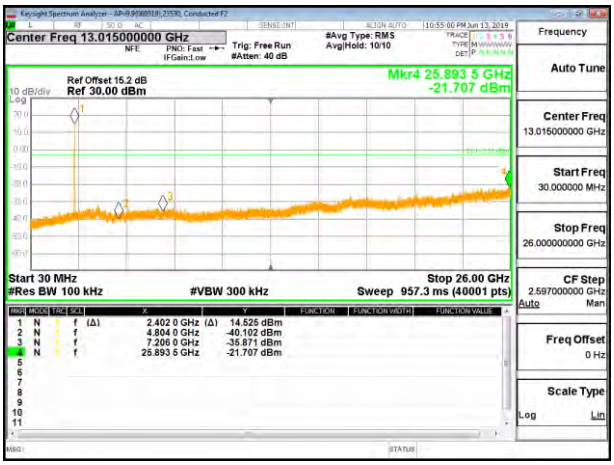
8.8.2. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

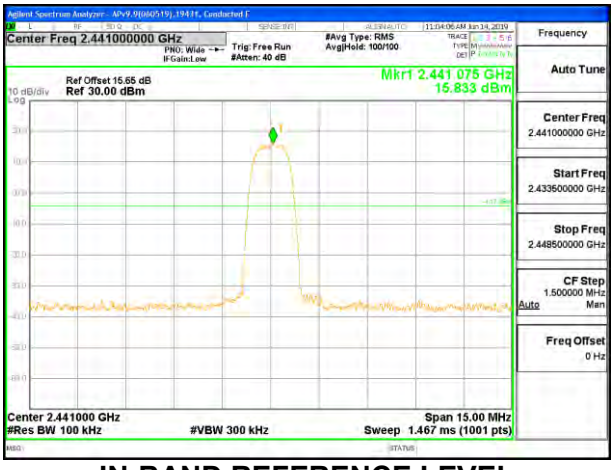
Antenna 3 SPURIOUS EMISSIONS, NON-HOPPING



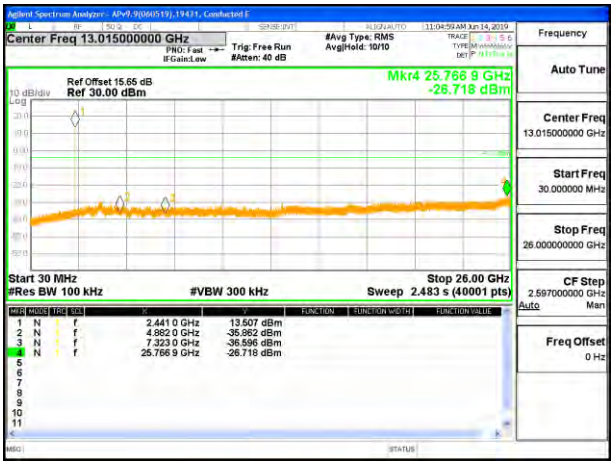
LOW CHANNEL BANDEDGE



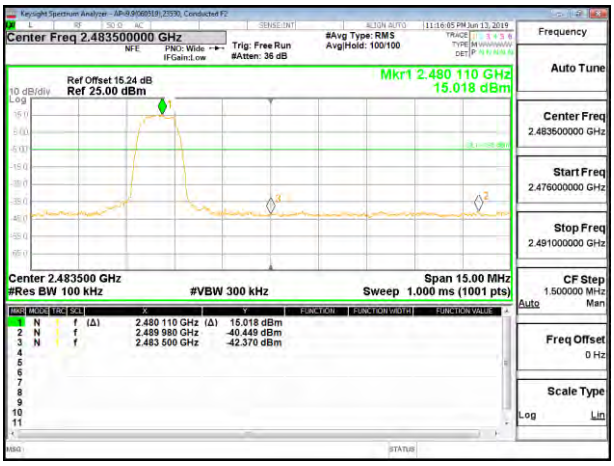
OUT-OF-BAND LOW CHANNEL



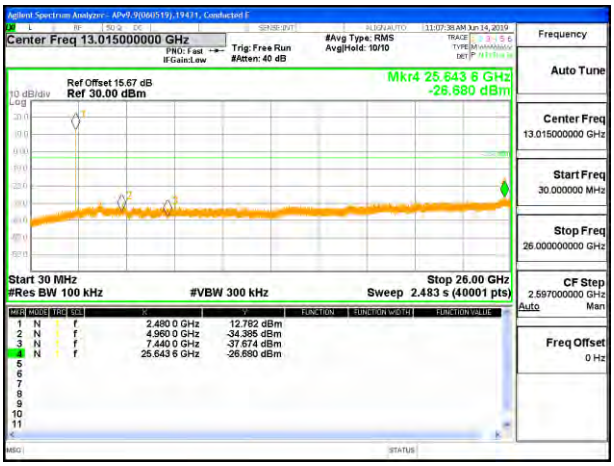
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

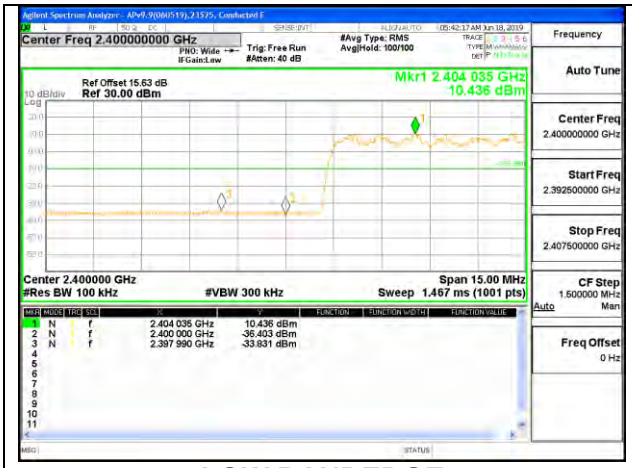


HIGH CHANNEL BANDEDGE

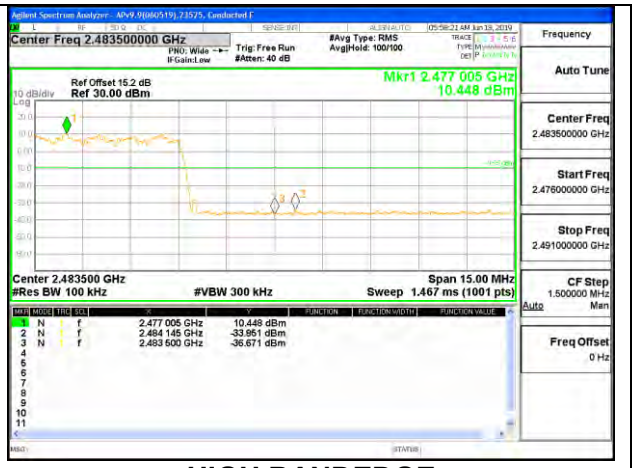


OUT-OF-BAND HIGH CHANNEL

Antenna 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

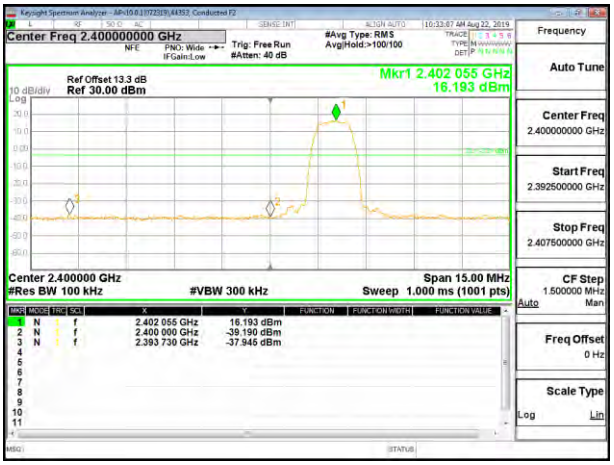


LOW BANDEDGE

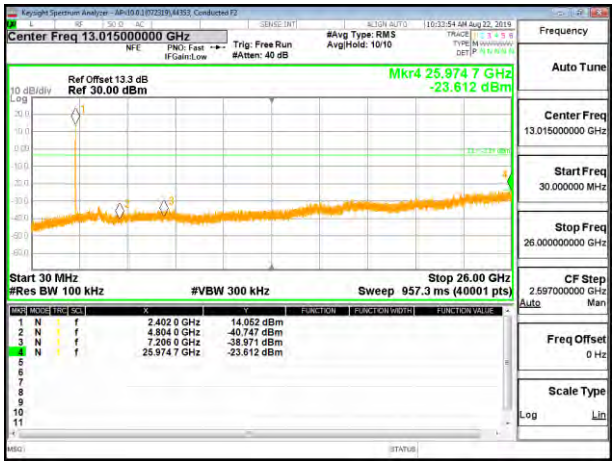


HIGH BANDEDGE

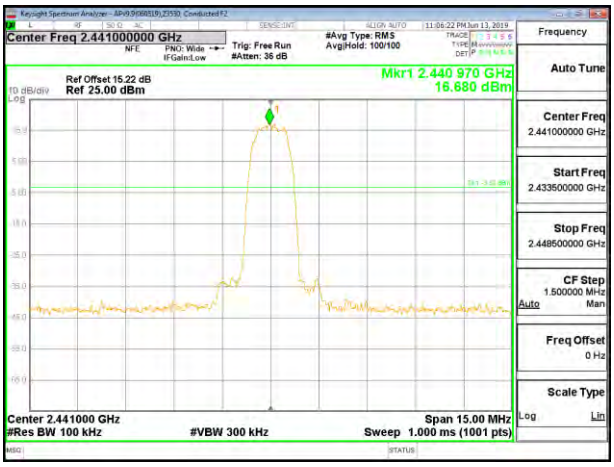
Antenna 4 SPURIOUS EMISSIONS, NON-HOPPING



LOW CHANNEL BANDEDGE

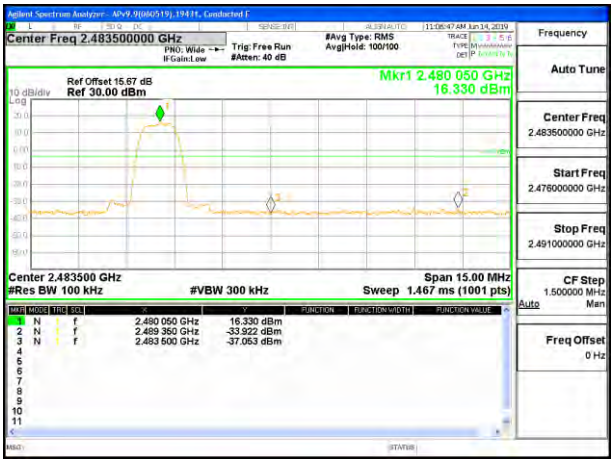


OUT-OF-BAND LOW CHANNEL



IN-BAND REFERENCE LEVEL

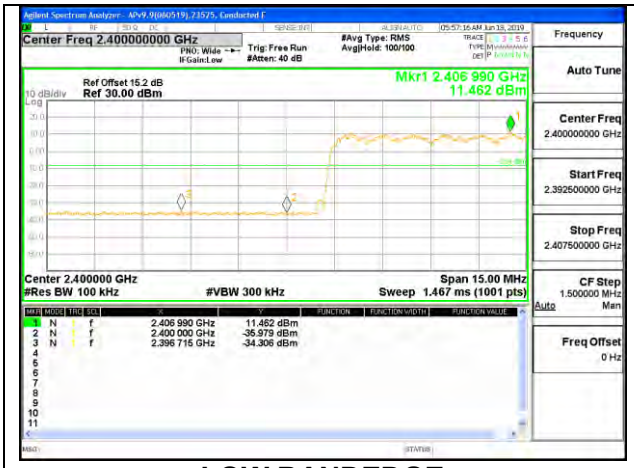
OUT-OF-BAND MID CHANNEL



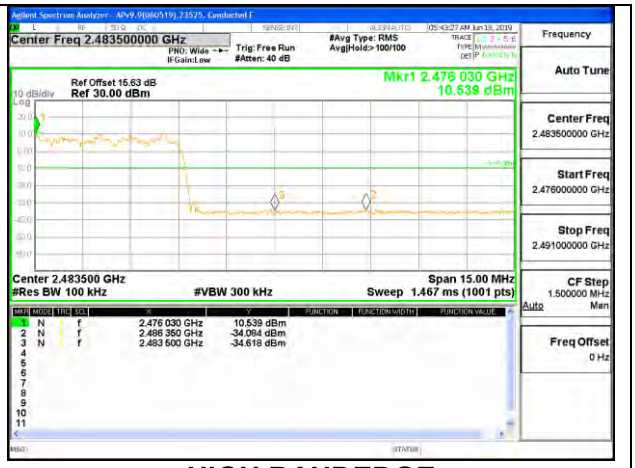
HIGH CHANNEL BANDEDGE

OUT-OF-BAND HIGH CHANNEL

Antenna 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



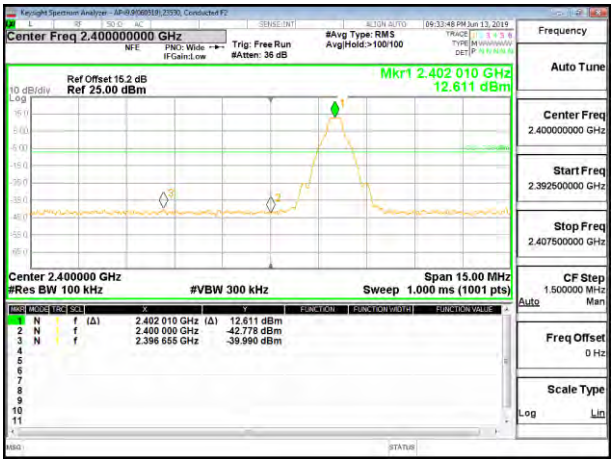
LOW BANDEDGE



HIGH BANDEDGE

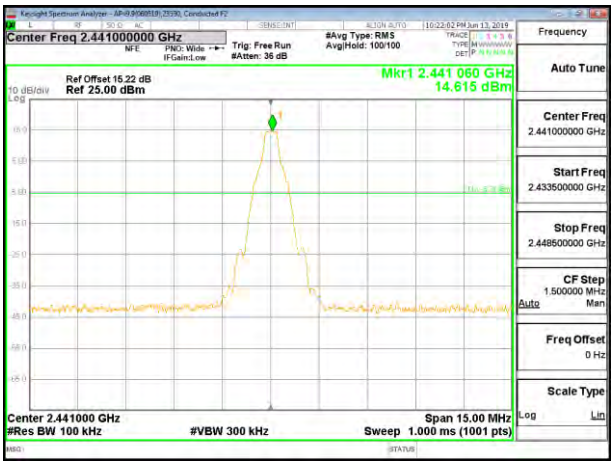
8.8.3. LOW POWER BASIC DATA RATE GFSK MODULATION

Antenna 3 SPURIOUS EMISSIONS, NON-HOPPING



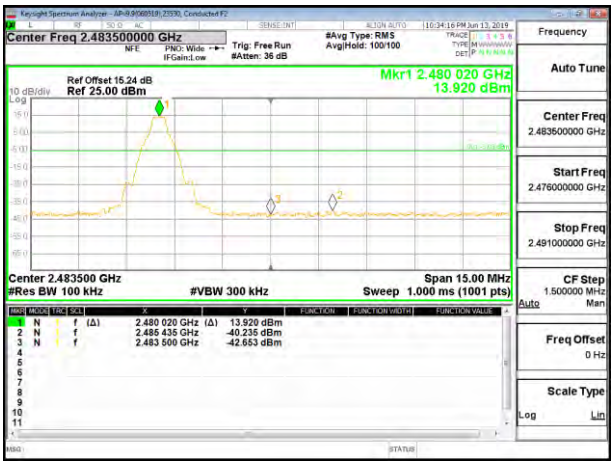
LOW CHANNEL BANDEDGE

OUT-OF-BAND LOW CHANNEL

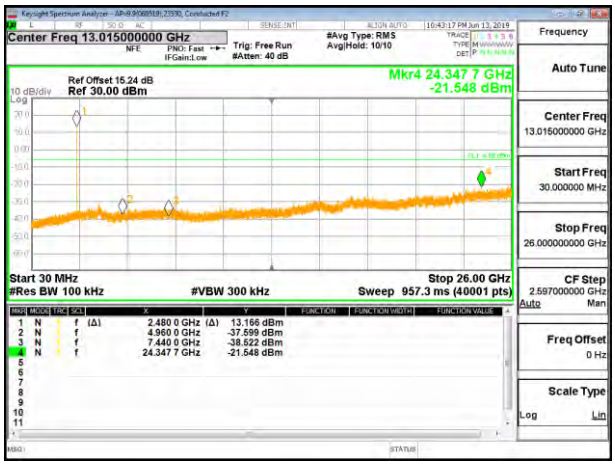


IN-BAND REFERENCE LEVEL

OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

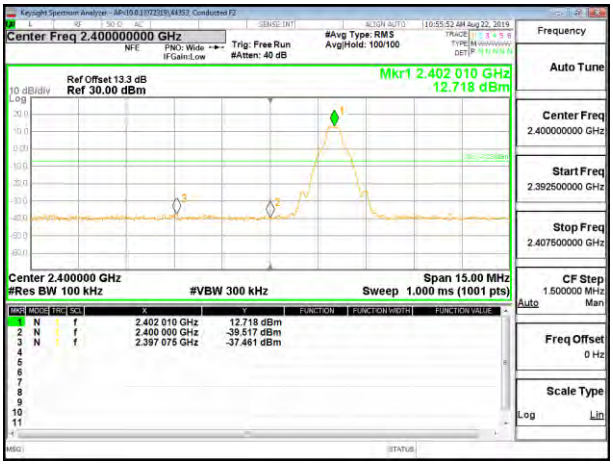
Antenna 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE

HIGH BANDEDGE

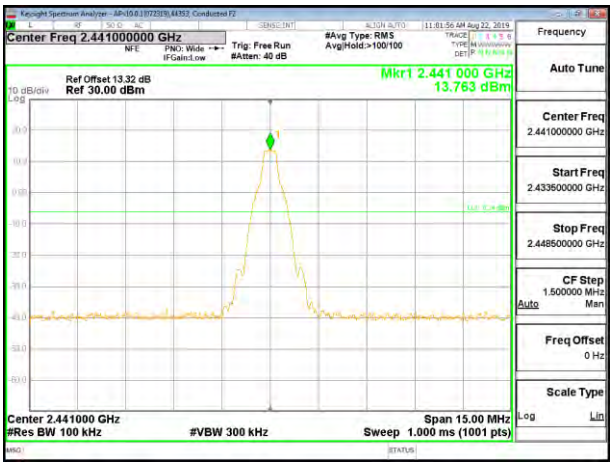
UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

Antenna 4 SPURIOUS EMISSIONS, NON-HOPPING

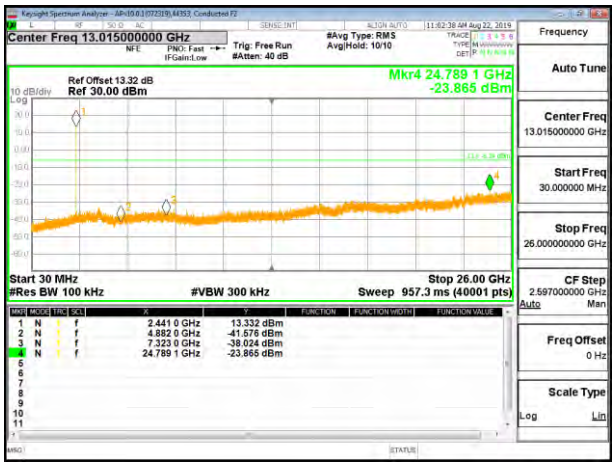


LOW CHANNEL BANDEDGE

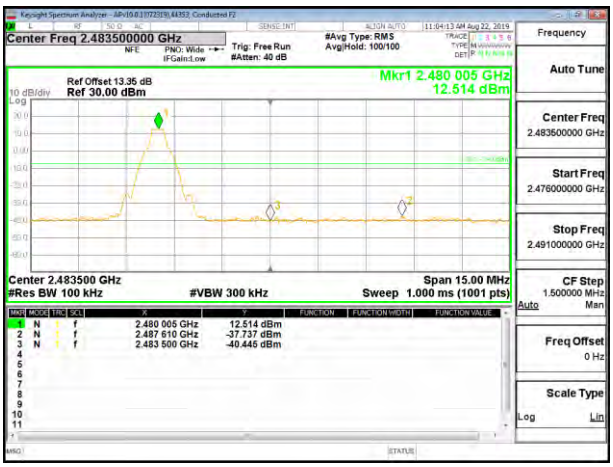
OUT-OF-BAND LOW CHANNEL



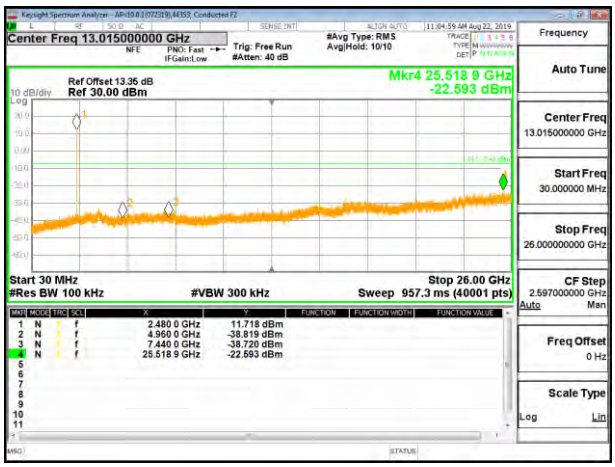
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



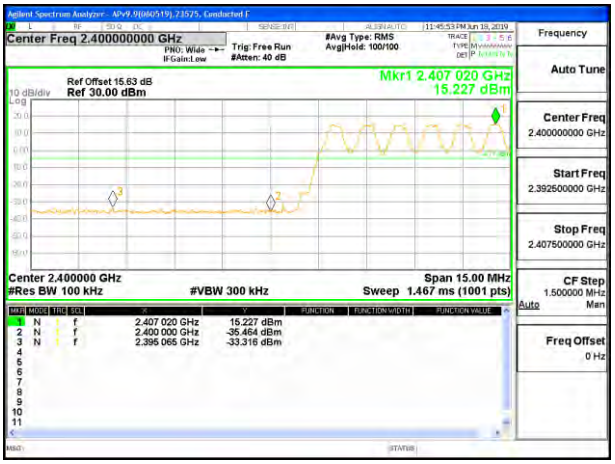
HIGH CHANNEL BANDEDGE



OUT-OF-BAND HIGH CHANNEL

UL VERIFICATION SERVICES INC.
47173 Benicia Street, Fremont, CA 94538; USA TEL:(510) 319-4000 FAX:(510) 661-0888

Antenna 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



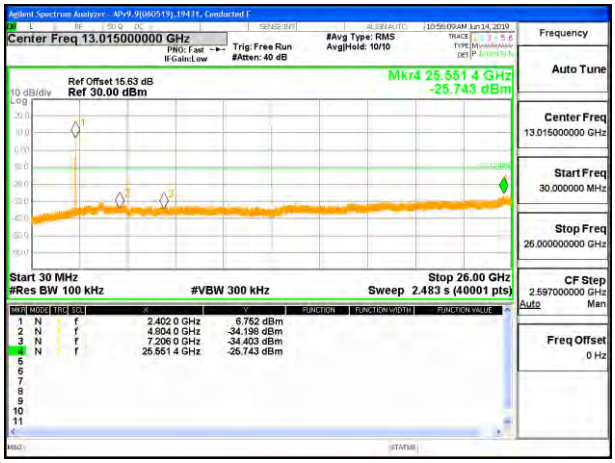
LOW BANDEDGE

HIGH BANDEDGE

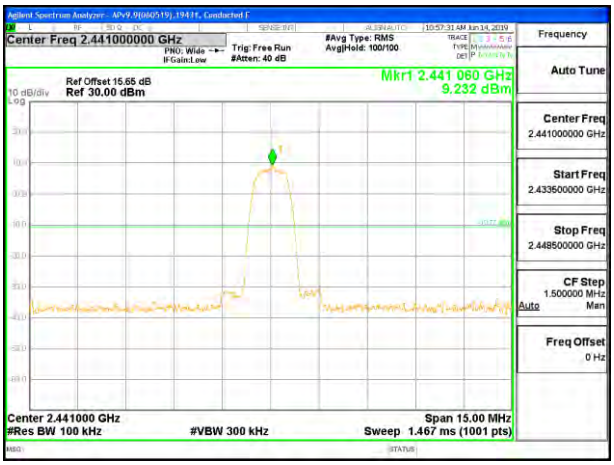
8.8.4. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

Antenna 3 SPURIOUS EMISSIONS, NON-HOPPING

LOW CHANNEL BANDEDGE



OUT-OF-BAND LOW CHANNEL



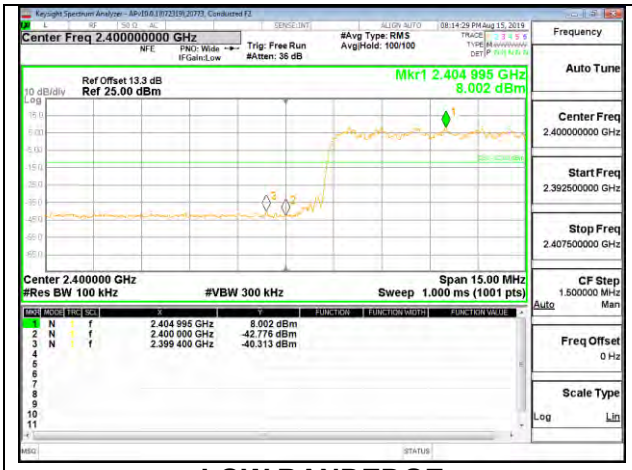
IN-BAND REFERENCE LEVEL

OUT-OF-BAND MID CHANNEL

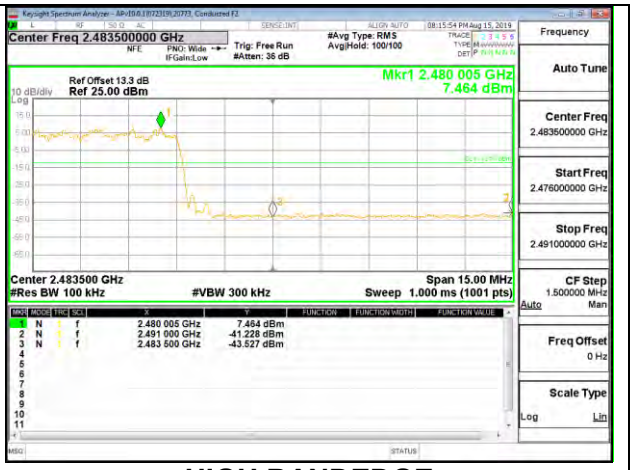
HIGH CHANNEL BANDEDGE

OUT-OF-BAND HIGH CHANNEL

Antenna 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

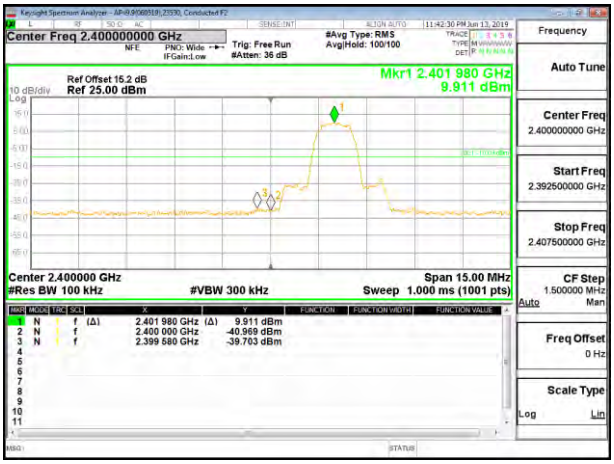


LOW BANDEDGE



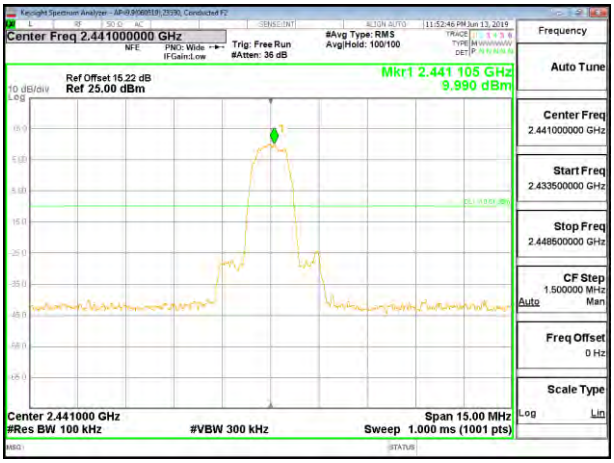
HIGH BANDEDGE

Antenna 4 SPURIOUS EMISSIONS, NON-HOPPING



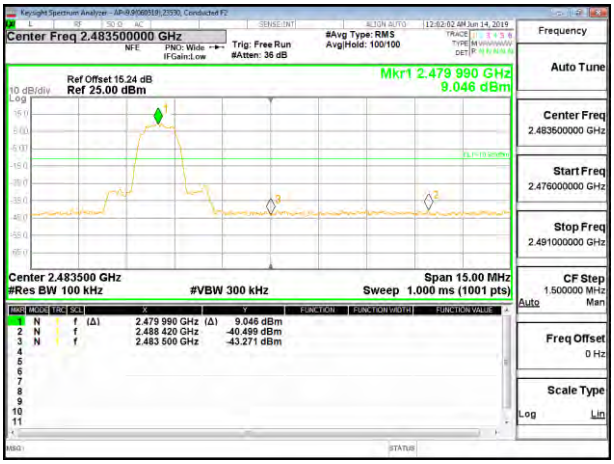
LOW CHANNEL BANDEDGE

OUT-OF-BAND LOW CHANNEL



IN-BAND REFERENCE LEVEL

OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE

OUT-OF-BAND HIGH CHANNEL

Antenna 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

LOW BANDEDGE

HIGH BANDEDGE

8.9. BEAMFORMING, 20dB AND 99% BANDWIDTH

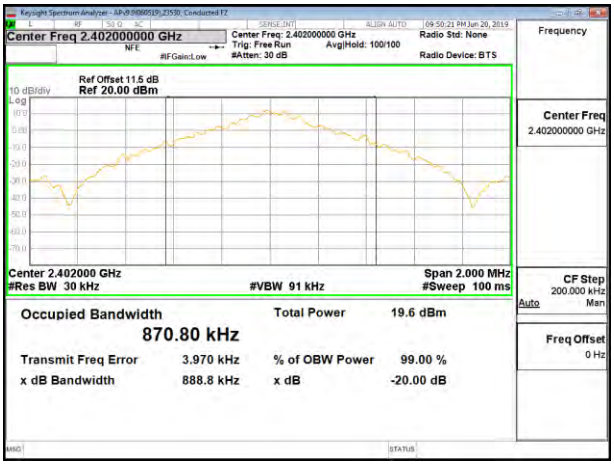
8.9.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

Note: Test procedure on beamforming mode is same as BT basic and EDR mode

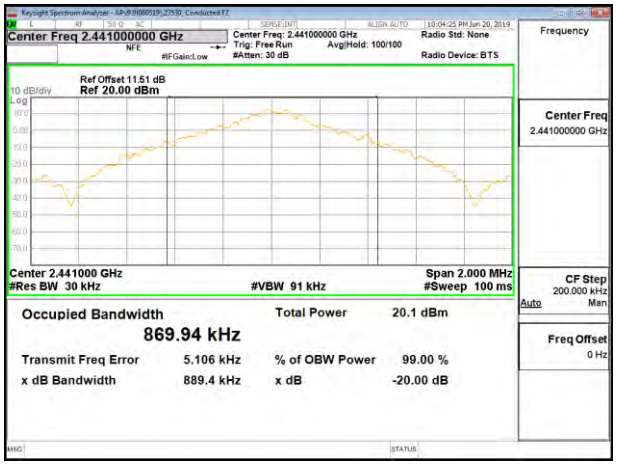
2TX Antenna 3 + Antenna 4 TxBF MODE

Antenna 3

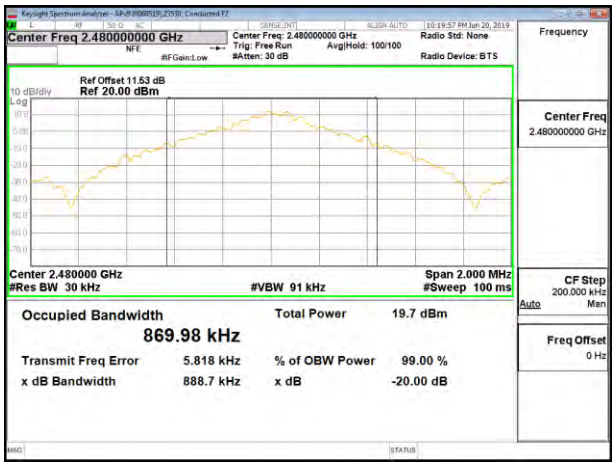
Channel	Frequency (MHz)	20dB Bandwidth Antenna 4 (MHz)	99% Bandwidth Antenna 4 (MHz)
Low	2402	0.8888	0.8708
Mid	2441	0.8894	0.8699
High	2480	0.8887	0.8700



LOW CHANNEL ANTENNA 3



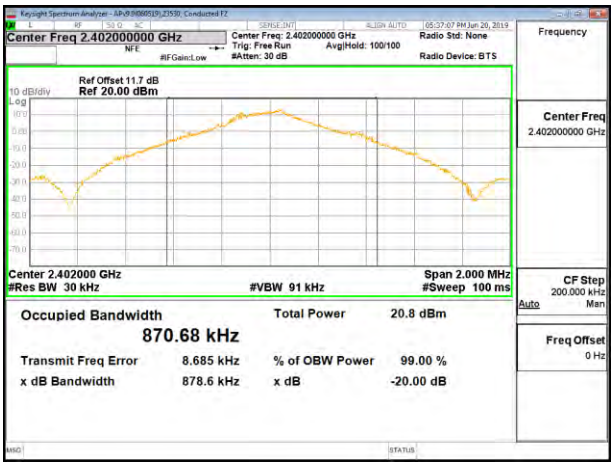
MID CHANNEL ANTENNA 3



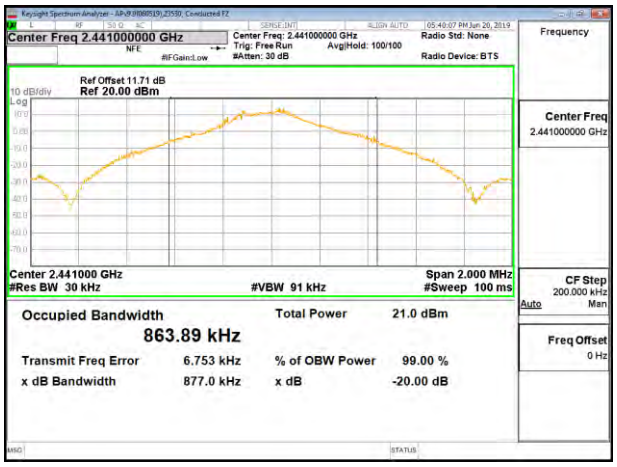
HIGH CHANNEL ANTENNA 3

Antenna 4

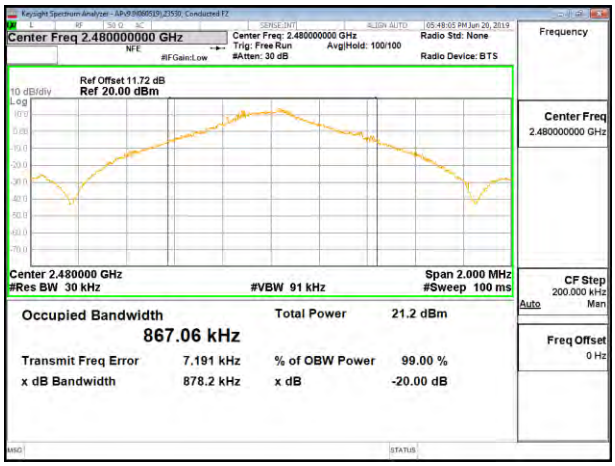
Channel	Frequency (MHz)	20dB Bandwidth Antenna 3 (MHz)	99% Bandwidth Antenna 3 (MHz)
Low	2402	0.8786	0.8707
Mid	2441	0.8770	0.8639
High	2480	0.8782	0.8671



LOW CHANNEL ANTENNA 4



MID CHANNEL ANTENNA 4

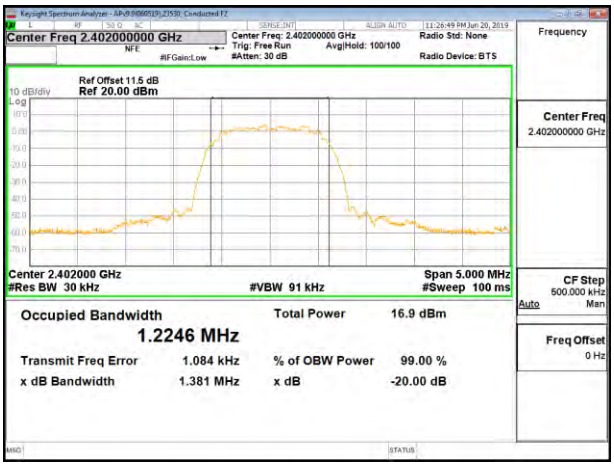


HIGH CHANNEL ANTENNA 4

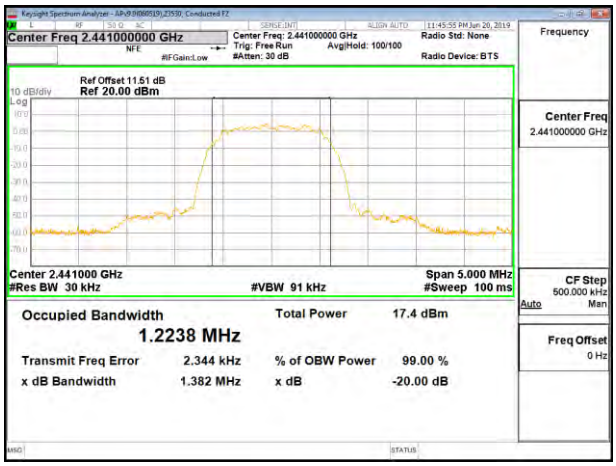
8.9.2. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

Antenna 3

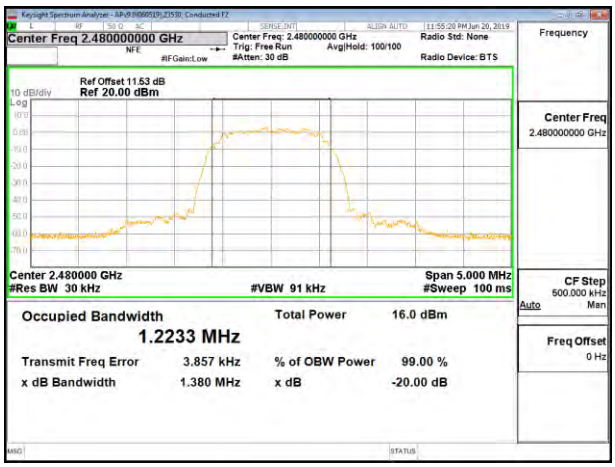
Channel	Frequency (MHz)	20dB Bandwidth Antenna 4 (MHz)	99% Bandwidth Antenna 4 (MHz)
Low	2402	1.3810	1.2246
Mid	2441	1.3820	1.2238
High	2480	1.3800	1.2233



LOW CHANNEL ANTENNA 3



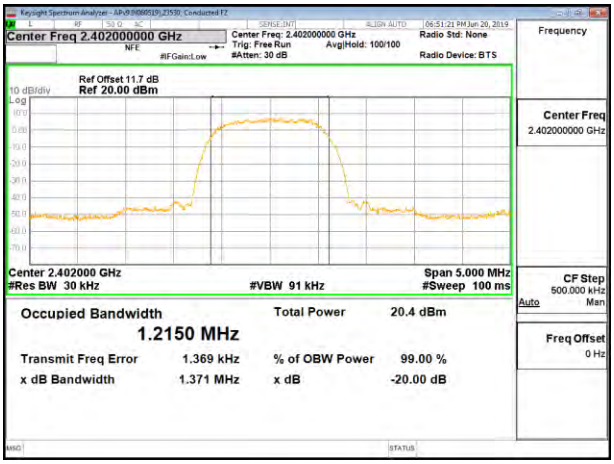
MID CHANNEL ANTENNA 3



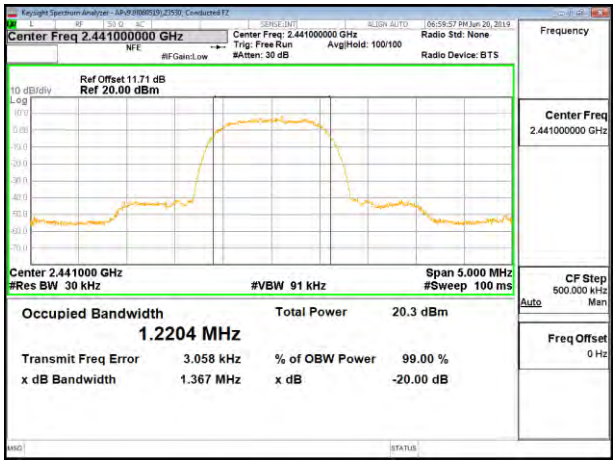
HIGH CHANNEL ANTENNA 3

Antenna 4

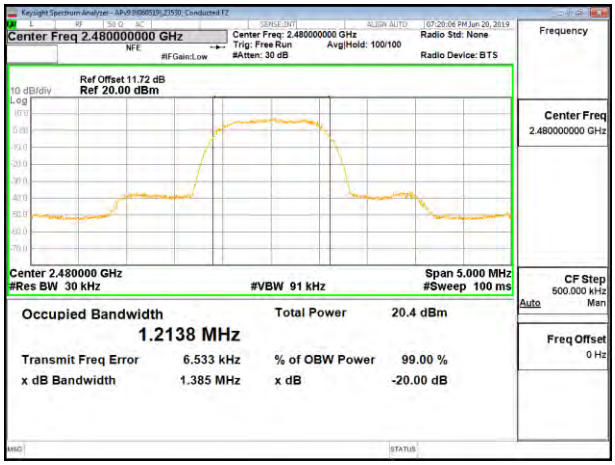
Channel	Frequency (MHz)	20dB Bandwidth Antenna 3 (MHz)	99% Bandwidth Antenna 3 (MHz)
Low	2402	1.3710	1.2150
Mid	2441	1.3670	1.2204
High	2480	1.3580	1.2138



LOW CHANNEL ANTENNA 4



LOW CHANNEL ANTENNA 4

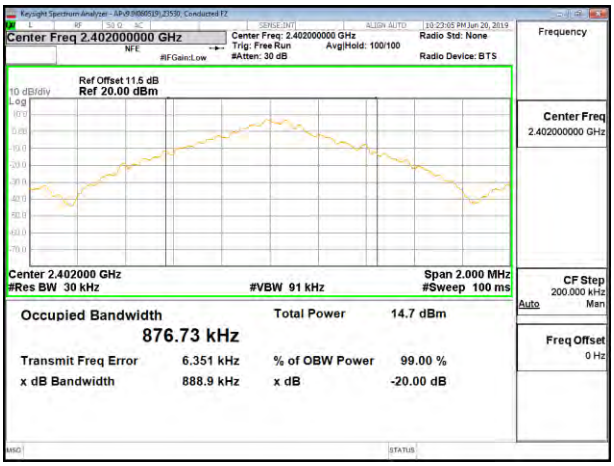


HIGH CHANNEL ANTENNA 4

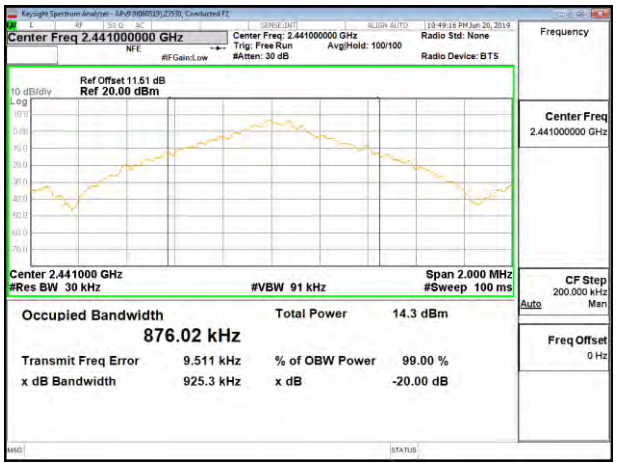
8.9.3. LOW POWER BASIC DATA RATE GFSK MODULATION

Antenna 3

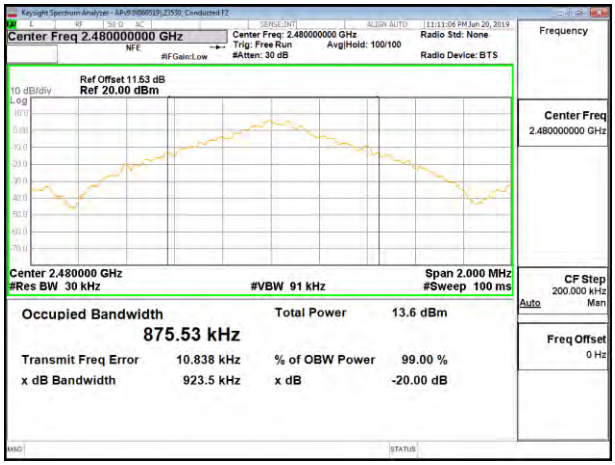
Channel	Frequency (MHz)	20dB Bandwidth Antenna 4 (MHz)	99% Bandwidth Antenna 4 (MHz)
Low	2402	0.8889	0.8767
Mid	2441	0.9253	0.8760
High	2480	0.9235	0.8755



LOW CHANNEL ANTENNA 3



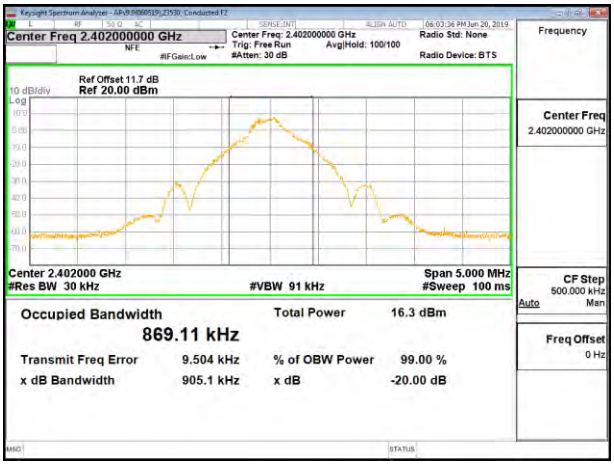
MID CHANNEL ANTENNA 3



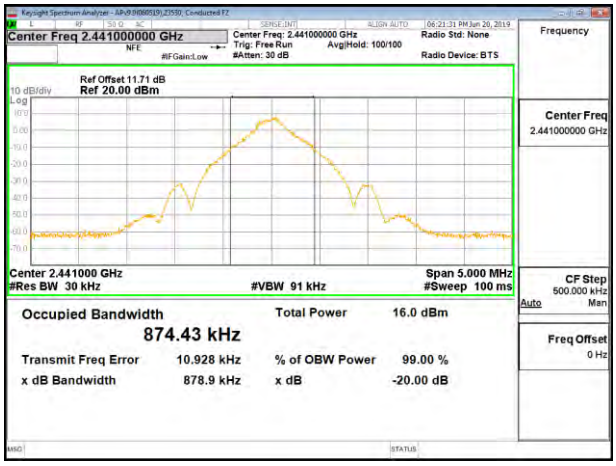
HIGH CHANNEL ANTENNA 3

Antenna 4

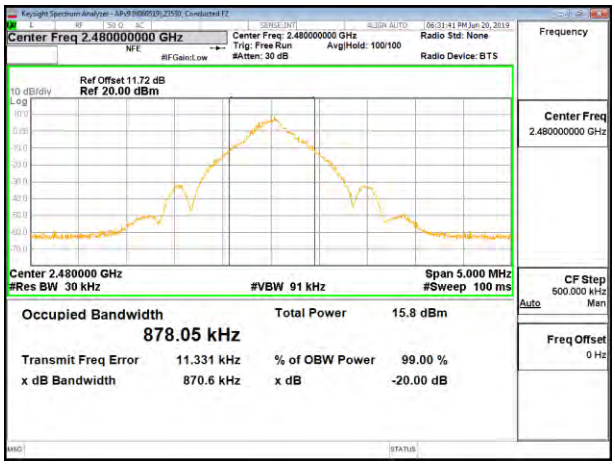
Channel	Frequency (MHz)	20dB Bandwidth Antenna 3 (MHz)	99% Bandwidth Antenna 3 (MHz)
Low	2402	0.9051	0.8691
Mid	2441	0.8789	0.8744
High	2480	0.8706	0.8781



LOW CHANNEL ANTENNA 4



MID CHANNEL ANTENNA 4

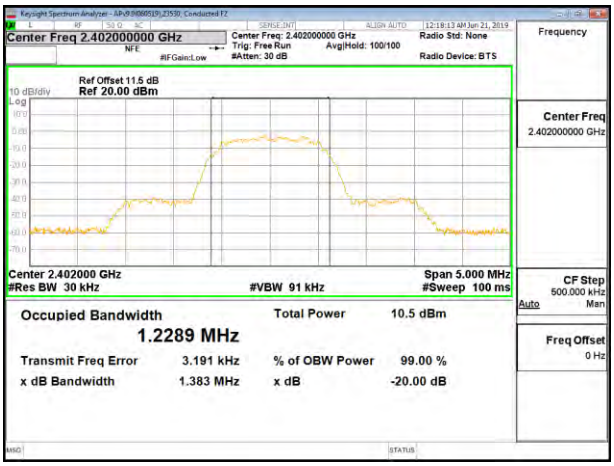


HIGH CHANNEL ANTENNA 4

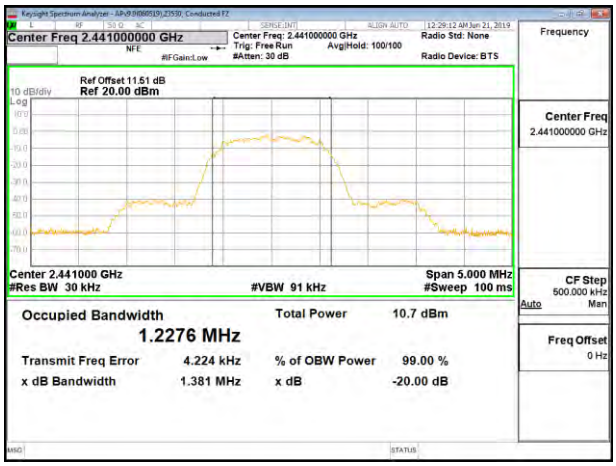
8.9.4. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

Antenna 3

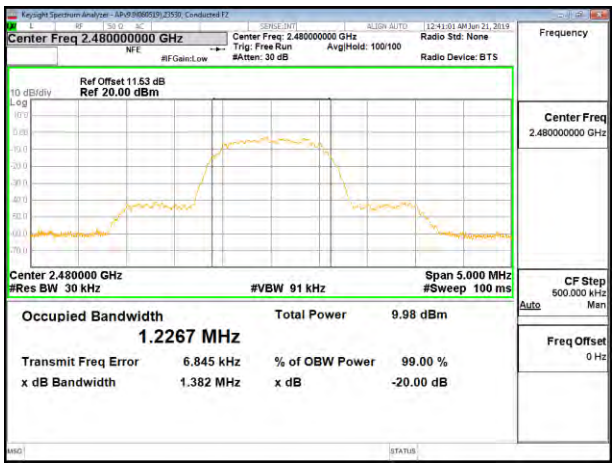
Channel	Frequency (MHz)	20dB Bandwidth Antenna 4 (MHz)	99% Bandwidth Antenna 4 (MHz)
Low	2402	1.3830	1.2289
Mid	2441	1.3810	1.2276
High	2480	1.3820	1.2267



LOW CHANNEL ANTENNA 3



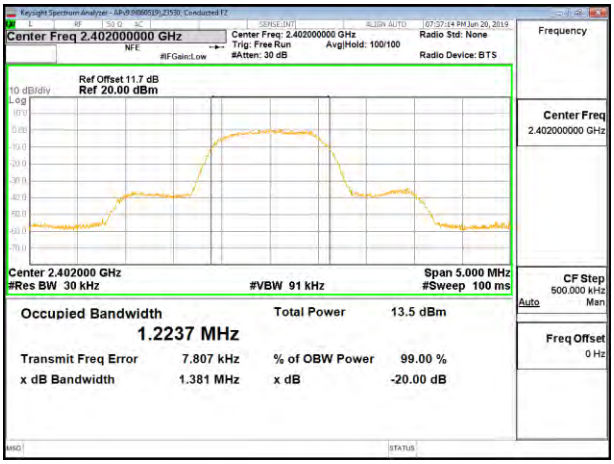
MID CHANNEL ANTENNA 3



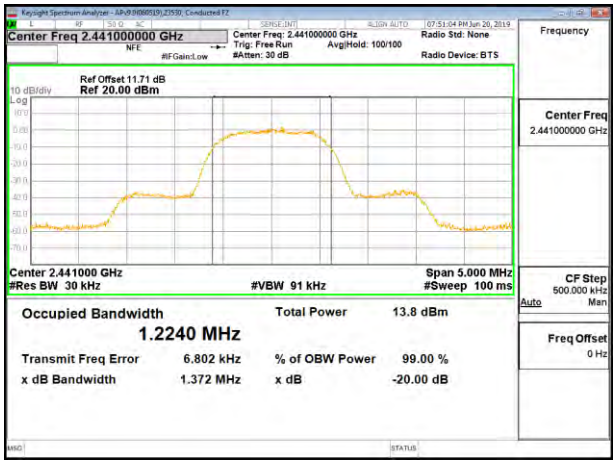
HIGH CHANNEL ANTENNA 3

Antenna 4

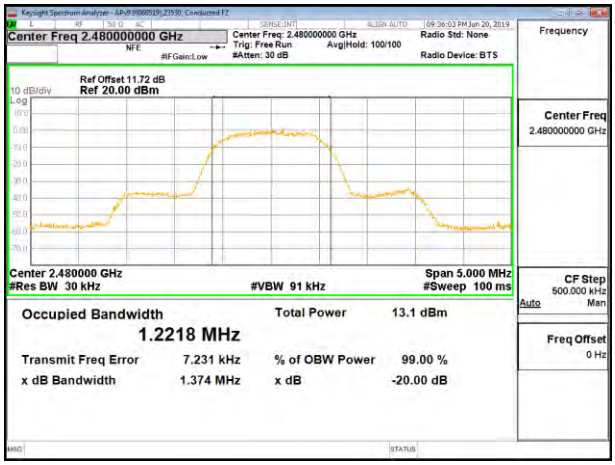
Channel	Frequency (MHz)	20dB Bandwidth Antenna 4 (MHz)	99% Bandwidth Antenna 4 (MHz)
Low	2402	1.3810	1.2237
Mid	2441	1.3720	1.2240
High	2480	1.3740	1.2218



LOW CHANNEL ANTENNA 4



MID CHANNEL ANTENNA 4



HIGH CHANNEL ANTENNA 4

8.10. BEAMFORMING, 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 hoping 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

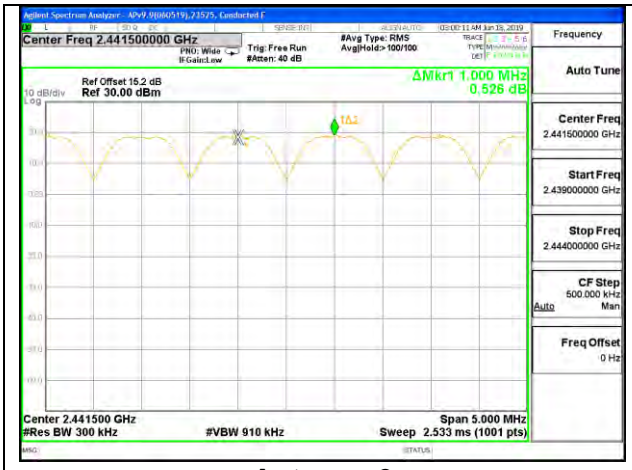
The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to VBW >= RBW. The sweep time is coupled.

Note: Test procedure on beamforming mode is same as BT basic and EDR mode

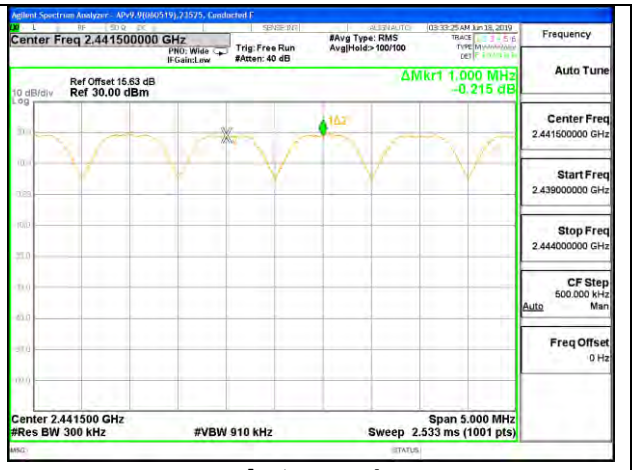
RESULTS

8.10.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

HOPPING FREQUENCY SEPARATION



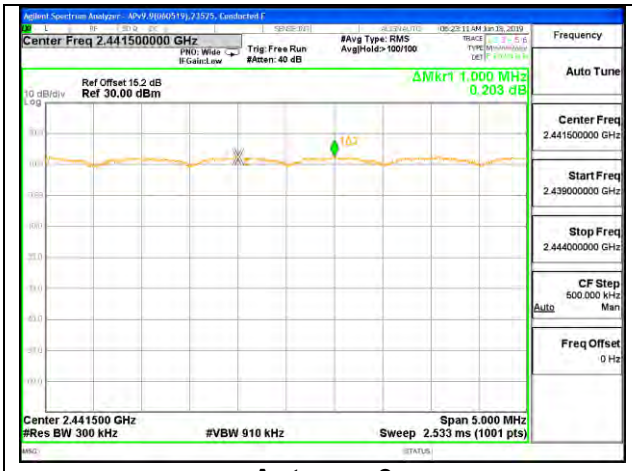
Antenna 3



Antenna 4

8.10.2. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

HOPPING FREQUENCY SEPARATION

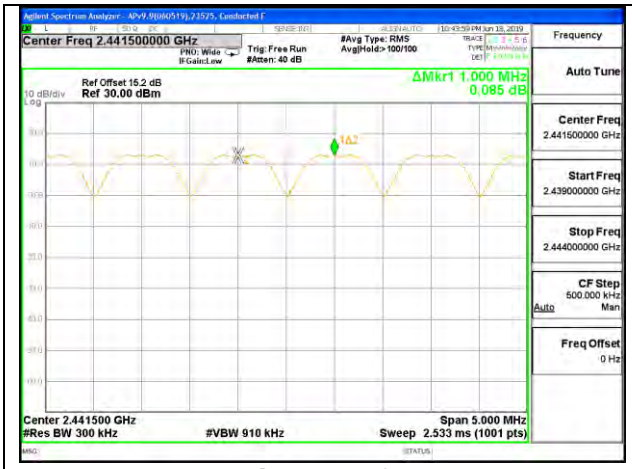


Antenna 3

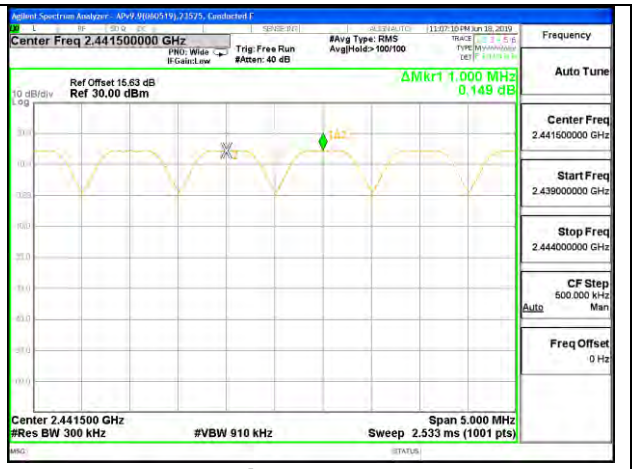
Antenna 4

8.10.3. LOW POWER BASIC DATA RATE GFSK MODULATION

HOPPING FREQUENCY SEPARATION



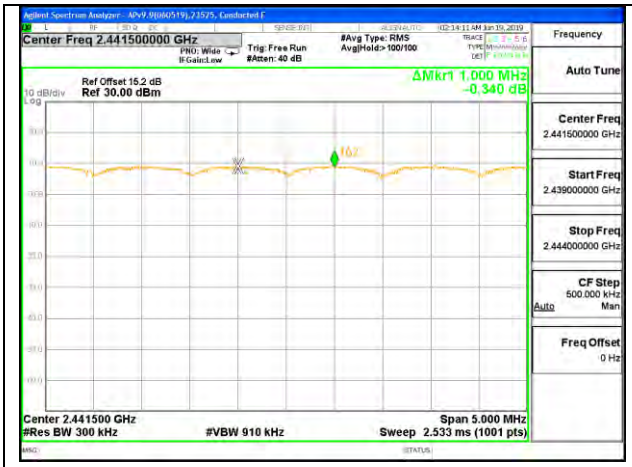
Antenna 3



Antenna 4

8.10.4. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

HOPPING FREQUENCY SEPARATION



Antenna 3

Antenna 4

8.11. BEAMFORMING, 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.

Note: Test procedure on beamforming mode is same as BT basic and EDR mode

RESULTS

Normal Mode: All Channels Observed

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