

# **CERTIFICATION TEST REPORT**

**Report Number. :** 12204512-E1V3

- Applicant : APPLE, INC. 1 APPLE PARK WAY CUPERTINO, CA 95014, U.S.A.
  - Model : A2101
  - FCC ID : BCG-E3234A
    - IC : 579C-E3234A
- 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 10, 2018

Prepared by: UL Verification Services Inc. 47173 Benicia Street Fremont, CA 94538, U.S.A. TEL: (510) 771-1000 FAX: (510) 661-0888



NVLAP LAB CODE 200065-0

# **REPORT REVISION HISTORY**

Rev.	lssue Date	Revisions	Revised By
V1	8/2/2018	Initial Issue	Francisco Guarnero
V2	8/09/2018	Address TCB's Questions	Chin Pang
V3	8/10/18	Address TCB's Questions	Tri Pham

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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:	A2101
SERIAL NUMBER:	C39WK00GK3VQ
DATE TESTED:	MARCH 15, 2018 – JULY 17, 2018

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. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. 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:

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# 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, 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, 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
Chamber A (ISED:2324B-1)	Chamber D (ISED:22541-1)
Chamber B (ISED:2324B-2)	Chamber E (ISED:22541-2)
Chamber C (ISED:2324B-3)	Chamber F (ISED:22541-3)
	Chamber G (ISED:22541-4)
	Chamber H (ISED:22541-5)

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers A through C are covered under ISED company address code 2324B with site numbers 2324B -1 through 2324B-3, respectively. Chambers D through H are covered under ISED company address code 22541 with site numbers 22541 -1 through 22541-5, respectively.

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at <u>NVLAP Lab Search</u>.

# 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

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

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### 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	3.15 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	5.36 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.32 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.45 dB
Worst Case Radiated Disturbance, 26000 to 40000 MHz	5.24 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, Bluetooth, GPS and NFC. All models support at least one UICC based SIM. The second SIM is either UICC based, electronic SIM (e-SIM), or second SIM is not present. The device has a built-in inductive charging receiver which is not user accessible. The rechargeable battery is not user accessible.

### 5.2. MAXIMUM OUTPUT POWER

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

Antenna	Config	Config Frequency Range Mode		Output Power	Output Power
		(MHz)		(dBm)	(mW)
		2402 - 2480	Basic GFSK	18.13	65.01
	High Power	2402 - 2480	DQPSK	20.15	103.51
Ant 4		2402 - 2480	Enhanced 8PSK	20.22	105.20
AIIL 4		2402 - 2480	Basic GFSK	11.32	13.55
	Low Power	2402 - 2480	DQPSK	10.10	10.23
		2402 - 2480	Enhanced 8PSK	10.12	10.28
		2402 - 2480	Basic GFSK	20.20	104.71
	High Power	2402 - 2480	DQPSK	20.18	104.23
A m+ 2		2402 - 2480	Enhanced 8PSK	20.24	105.68
Ant 3	Low Power	2402 - 2480	Basic GFSK	11.23	13.27
		2402 - 2480	DQPSK	10.20	10.47
		2402 - 2480	Enhanced 8PSK	10.23	10.54

# 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Range	Ant. 4	Ant. 3	
(GHz)	(dBi)	(dBi)	
2.4	-2.3	-4.8	

# 5.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was BT FW: 16.1.98.

### 5.5. WORST-CASE CONFIGURATION AND MODE

The EUT was investigated in three orthogonal orientations X, Y and Z on Ant 3 (Antenna 3) and Ant 4 (Antenna 4), it was determined that Y (Landscape) orientation was the worst-case orientation for Ant 4 and Z (Portrait) for Ant 3.

Radiated band edge, harmonic, and spurious emissions from 1GHz to 18GHz were performed with the EUT was 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 transmits 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, the worst-case configuration reported was tested with EUT only. There were no emissions 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

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.

Bluetooth RF output path is switched when the power exceeds 11dBm. Measurements were made therefore at the maximum power setting (with amplifier switched in) and also at the 11dBm power level (amplifier switched out), and they are the high power and low power modes documented in this report respectively.

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### 5.6. DESCRIPTION OF TEST SETUP

#### SUPPORT EQUIPMENT

Support Equipment List							
Description Manufacturer Model Serial Number FCC ID							
laptop	Apple	Macbook Pro	C02P41RZG086	FCC DoC			
Laptop AC/DC adapter	Liteon Technology	PA-1450-BA1	B123	NA			
EUT AC Adapter	Apple	A1385	D292365CDYADHLHC3	NA			

#### I/O CABLES (CONDUCTED TEST)

	I/O Cable List								
Cable	Cable         Port         # of identical         Connector         Cable Type         Cable					Remarks			
No		ports	Туре		Length (m)				
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 (RADIATED ABOVE 1 GHZ)

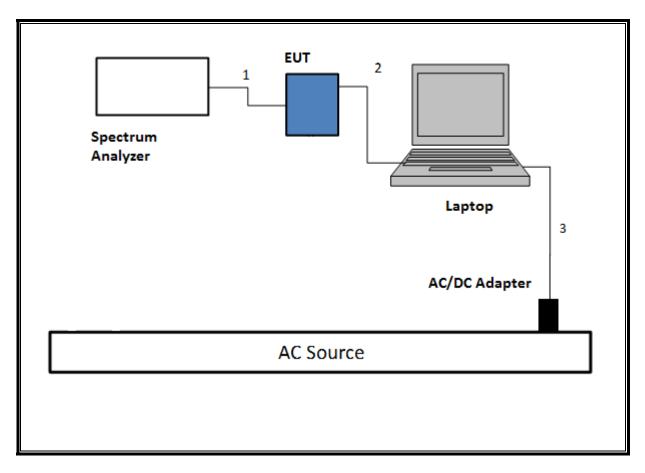
I/O Cable List								
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks		
None U	None Used							

#### 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	

The EUT was tested connected to a host Laptop via USB cable adapter and spectrum analyzer to antenna port. Test software exercised the EUT.

#### SETUP DIAGRAM

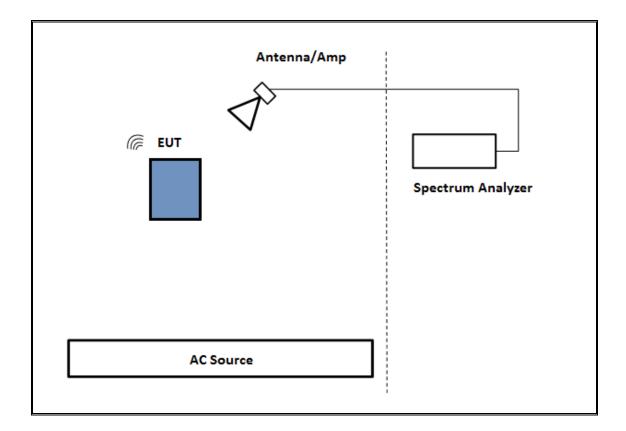


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#### TEST SETUP- RADIATED-ABOVE 1 GHZ

The EUT was powered by Battery. Test software exercised the EUT.

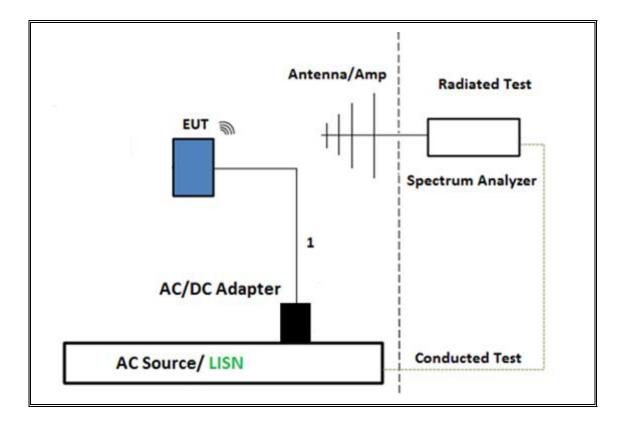
#### SETUP DIAGRAM



#### TEST SETUP- BELOW 1GHZ & AC LINE CONDUCTED TESTS

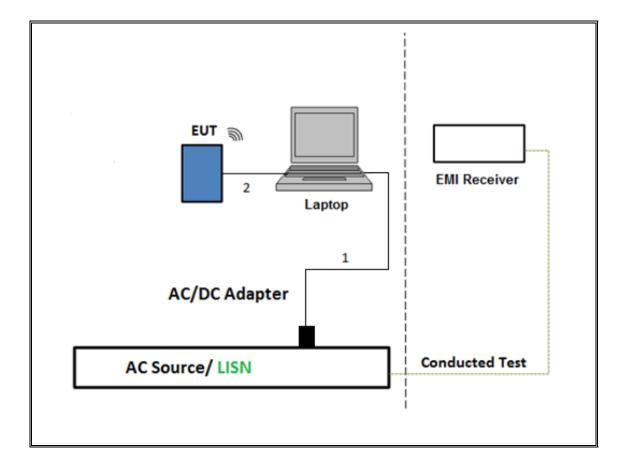
The EUT was powered by AC cord. Test software exercised the EUT.

### SETUP DIAGRAM



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TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION



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# 6. TEST AND MEASUREMENT EQUIPMENT

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

Description	Manufacturer	Model	ID Num	Cal Due	
*Antenna, Horn 1-18GHz	ETS Lindgren	3117	T136	06/26/2018	
*Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	T477	07/07/2018	
*Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T286	06/02/2018	
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S- 42	T740	12/30/2018	
Spectrum Analyzer, PXA 3Hz to 44GHz	Keysight	N9030A	T340	12/15/2018	
*Antenna, Horn 1-18GHz	ETS Lindgren	3117	T120	07/02/2019	
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S- 42	T491	05/19/2019	
*Antenna, Horn 1-18GHz	ETS Lindgren	3117	T344	04/20/2018	
*Amplifier, 1 to 18GHz, 35dB	Amplical	AMP1G18-35	T1569	05/31/2018	
Spectrum Analyzer, PSA, 3Hz to 44GHz	Agilent (Keysight) Technologies	E4446A	T177	04/12/2019	
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T119	04/03/2019	
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S- 42	T742	12/04/2018	
*Antenna Horn 18 to 26.5GHz	ARA	MWH-1826/B	T449	06/12/2018	
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T1454	01/08/2019	
Pre-Amp 18-26GHz	Agilent Technology	8449B	T404	07/23/2018	
Power Meter, P-series single channel	Keysight	N1912A	T1272	05/01/2019	
Power Sensor	Keysight	N1921A	T1226	08/30/2018	
Antenna, Active Loop 9KHz to 30MHz	ETS-Lindgren	6502	T757	09/14/2018	
	AC Line	Conducted			
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	T1436	01/25/2019	
Power Cable, Line Conducted Emissions	UL	PG1	T861	08/31/2018	
*LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/15/2018	
	UL AUTOMAT	TION SOFTWARE			
Radiated Software	UL	UL EMC		pril 26, 2016	
Conducted Software	UL	UL EMC	Ver 5.4, October 13, 2016		
AC Line Conducted Software	UL	UL EMC	Ver 9.5, M	lay 26, 2015	

Note: \*Testing is completed before equipment expiration date.

### 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 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

#### <u>LIMITS</u>

None; for reporting purposes only.

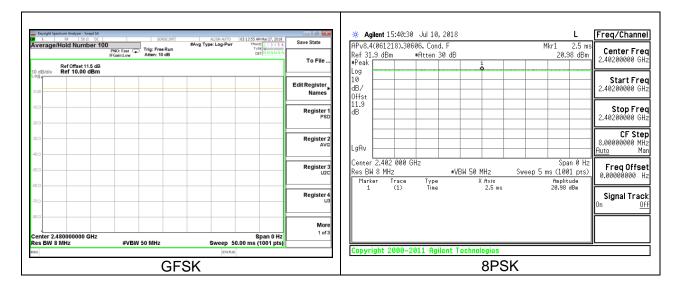
#### PROCEDURE

KDB 789033 Zero-Span Spectrum Analyzer Method.

#### **ON TIME AND DUTY CYCLE RESULTS**

Mode	ON Time	Period	Duty Cycle	Duty	Duty Cycle	1/T
	В		х	Cycle	<b>Correction Factor</b>	Minimum VBW
	(msec)	(msec)	(linear)	(%)	(dB)	(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

#### DUTY CYCLE PLOTS



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### 8.2. 20 dB AND 99% BANDWIDTH

#### LIMITS

None; for reporting purposes only.

#### TEST PROCEDURE

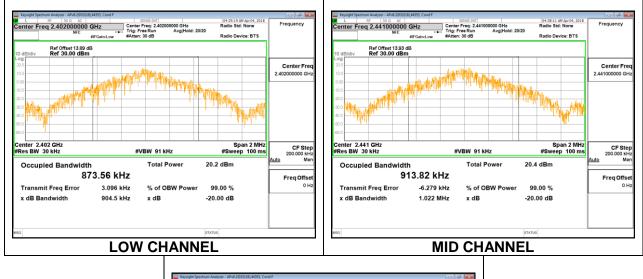
The transmitter output is connected to a spectrum analyzer. The RBW is set to  $\geq$  1% of the 20 dB bandwidth. The VBW is set to  $\geq$  RBW. The sweep time is coupled.

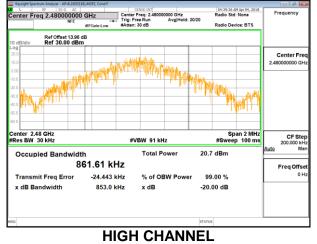
#### **RESULTS**

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

#### Antenna 4

Channel	Frequency	20dB Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2402	0.905	0.874
Mid	2441	1.022	0.914
High	2480	0.853	0.862



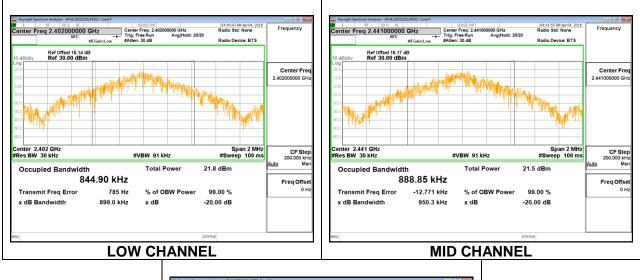


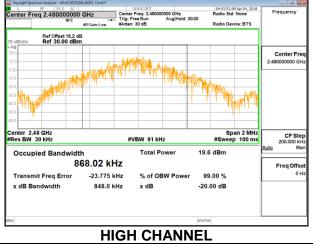
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#### Antenna 3

Channel	Frequency	20dB Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2402	0.899	0.845
Mid	2441	0.950	0.889
High	2480	0.848	0.868



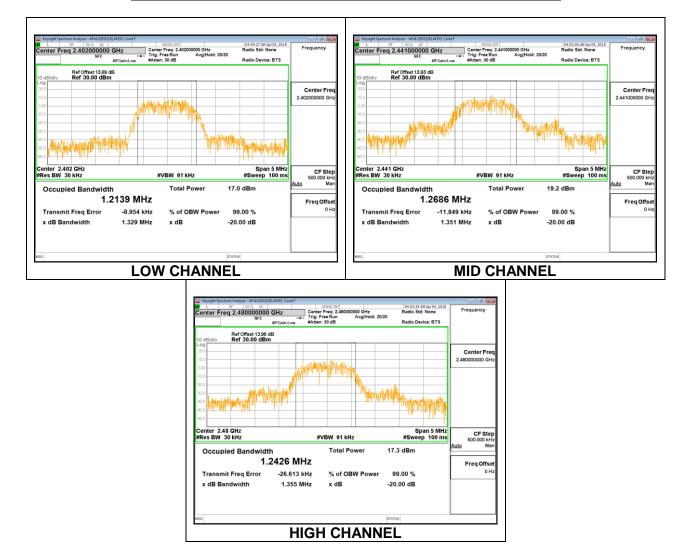


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### 8.2.2. HIGH POWER ENCHANCED DATA RATE 8PSK MODULATION

#### Antenna 4

Channel	Frequency	20dB Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2402	1.329	1.214
Mid	2441	1.351	1.269
High	2480	1.355	1.243

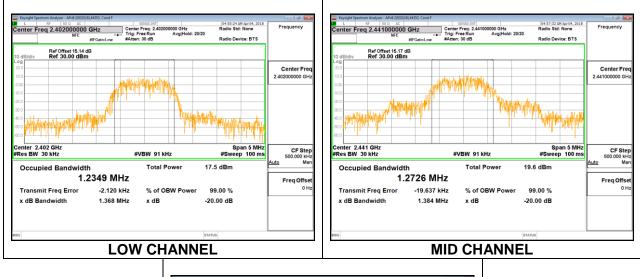


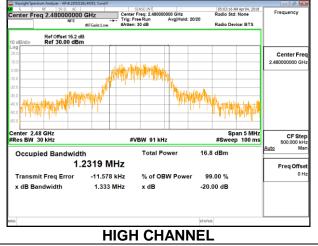
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#### Antenna 3

Channel	Frequency	20dB Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2402	1.368	1.235
Mid	2441	1.384	1.273
High	2480	1.333	1.232



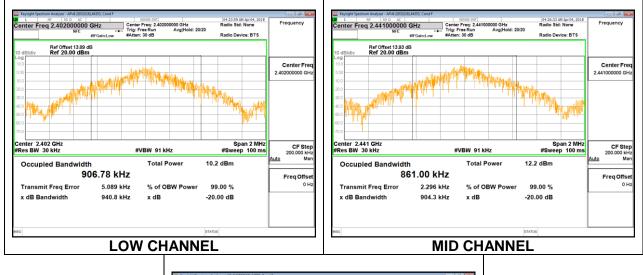


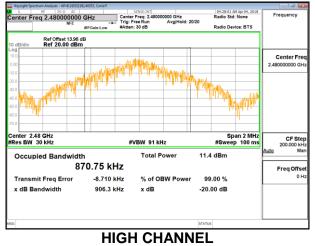
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# 8.2.3. LOW POWER BASIC DATA RATE GFSK MODULATION

#### Antenna 4

Channel	Frequency	20dB Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2402	0.941	0.907
Mid	2441	0.904	0.861
High	2480	0.906	0.871



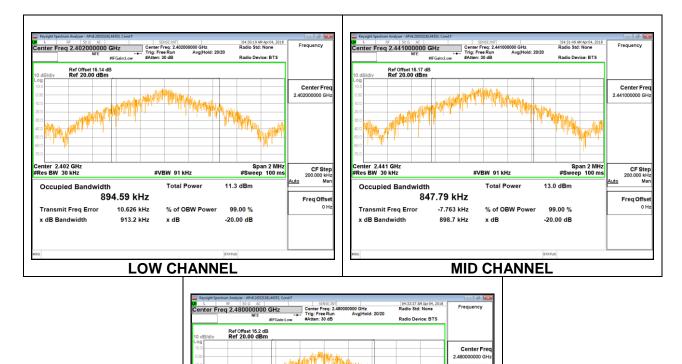


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### REPORT NO: 12204512-E1V3 FCC ID: BCG-E3234A

#### Antenna 3

Channel	Frequency	20dB Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2402	0.913	0.895
Mid	2441	0.899	0.848
High	2480	0.905	0.852



#VBW 91 kHz

x dB

**HIGH CHANNEL** 

Total Power

% of OBW Power

Span 2 MHz

#54

9.92 dBm

99.00 %

-20.00 dB

CF Ste 200.000 k⊦

Freq Offse

enter 2.48 GHz Res BW 30 kHz

Occupied Bandwidth

Transmit Freq Error

x dB Bandwidth

852.01 kHz

-7.424 kHz

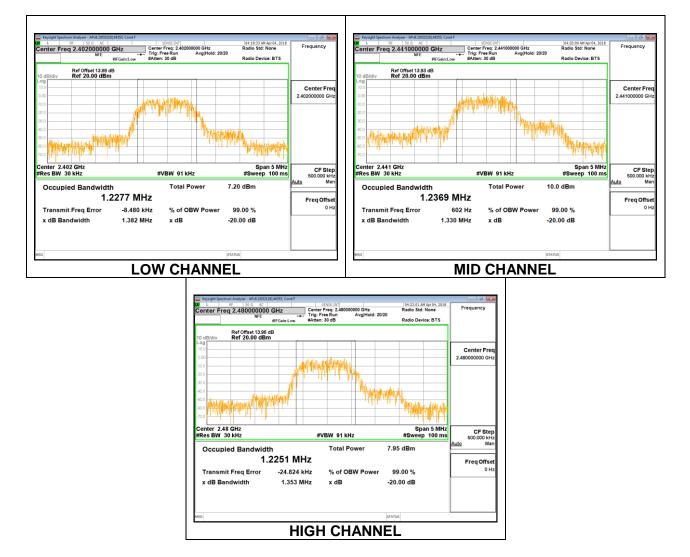
904.6 kHz

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# 8.2.4. LOW POWER ENCHANCED DATA RATE 8PSK MODULATION

#### Antenna 4

Channel	Frequency	20dB Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2402	1.382	1.228
Mid	2441	1.33	1.237
High	2480	1.353	1.225



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### REPORT NO: 12204512-E1V3 FCC ID: BCG-E3234A

### DATE: 8/10/2018 IC: 579C-E3234A

#### Antenna 3

Channel	Frequency	20dB Bandwidth	99% Bandwidth
	(MHz)	(MHz)	(MHz)
Low	2402	1.332	1.189
Mid	2441	1.346	1.237
High	2480	1.354	1.25



#VBW 91 kHz

x dB

**HIGH CHANNEL** 

Total Power

% of OBW Power

Span 5 MHz #Sweep 100 ms

6.23 dBm

99.00 %

-20.00 dB

CF Stej 500.000 kH

Freq Offse

110

1.2504 MHz

-17.852 kHz

1.354 MHz

Center 2.48 GHz Res BW 30 kHz

Occupied Bandwidth

Transmit Freq Error

x dB Bandwidth

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### 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

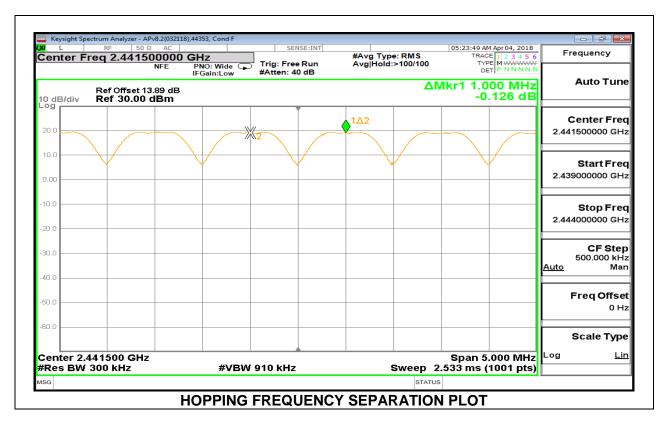
The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to 910 kHz. The sweep time is coupled.

#### **RESULTS**

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

#### Antenna 4



#### Antenna 3

XI L	pectrum Analyzer - A RF 50			SENSE:INT		05:47:33 AM Apr 04, 2018	
Center I	Freq 2.4415	NFE P	Hz NO: Wide 😱 Gain:Low	Trig: Free Run #Atten: 40 dB	#Avg Type: RMS Avg Hold:>100/100	TRACE 1 2 3 4 5 6 TYPE MWWWW DET P NNNN	N
10 dB/div	Ref Offset 1 Ref 30.00				1	Mkr1 1.000 MHz -0.364 dB	
20.0					1Δ2		Center Fred 2.441500000 GHz
10.0	$\backslash$						
0.00				¥			Start Fred 2.439000000 GHz
-10.0							<b>Stop Fred</b> 2.444000000 GHz
-20.0							CF Step 500.000 kHz Auto Mar
-40.0							-
-50.0							Freq Offset 0 Hz
-60.0							Scale Type
	.441500 GH: ∛ 300 kHz	Z	#VBW	910 kHz	Sweep	Span 5.000 MHz 2.533 ms (1001 pts)	
ISG					STA	TUS	

# 8.3.2. HIGH POWER ENCHANCED DATA RATE 8PSK MODULATION

#### Antenna 4

XI L		50 Ω AC		SENSE:INT		06:57:45 AM Apr 04, 2018	Frequency
Center F	r <b>eq 2.4</b> 4	1500000 NEF	PNO: Wide	Trig: Free Run	#Avg Type: RMS Avg Hold:>100/100	TRACE 1 2 3 4 5 6 TYPE M WWWWW	
		NFE	IFGain:Low	#Atten: 40 dB		DET P NNNN	
10 dB/div	Ref Offse Ref 30.0	et 13.89 dB 00 dBm			Δ	Mkr1 1.000 MHz -0.694 dB	Auto Tune
					1Δ2		Center Fred
20.0 ctomput	why and the second	المعاليات ومولك	Mond the market of the	2 Mary Wards whom	when a the bar of any the hours		2.441500000 GHz
10.0							Start Fred
0.00							2.439000000 GHz
-10.0							Stop Fred
-20.0							2.444000000 GH:
-30.0							CF Step 500.000 kHz Auto Mar
-40.0							
-50.0							Freq Offset 0 Hz
-60.0							Scale Type
Center 2.4		Hz				Span 5.000 MHz	Log <u>Lir</u>
#Res BW	300 kHz		#VBW	910 kHz	Sweep	2.533 ms (1001 pts)	

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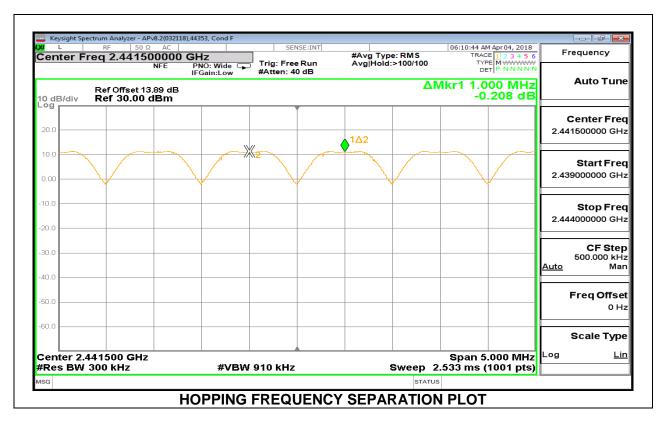
#### Antenna 3

KU L	RF	r - APv8.2(032118),4 50 Ω AC		SENSE:INT		08:46:59 AM Apr 04, 2018	
Cente	r Freq 2.44	NFE	Hz PNO: Wide 🖵 FGain:Low	Trig: Free Run #Atten: 40 dB	#Avg Type: RMS Avg Hold:>100/100	TRACE 1 2 3 4 5 6 TYPE MWWWW DET P NNNN	
10 dB/d		t 15.14 dB 00 dBm			Δ	Mkr1 1.000 MHz 0.354 dB	Auto Tune
				,	1Δ2		Center Fred
20.0	and a second of the second of	and the second se	Constration of the second of the	Same and a second	Martin Martin	and the second state of th	2.441500000 GH;
0.00							<b>Start Fred</b> 2.439000000 GH:
20.0							<b>Stop Fred</b> 2.444000000 GH:
30.0 —							CF Step 500.000 kH: <u>Auto</u> Mar
.40.0							Freq Offsel 0 Hz
60.0							Scale Type
	r 2.441500 G 3W 300 kHz	Hz	#VBW	910 kHz	Sweep	Span 5.000 MHz 2.533 ms (1001 pts)	Log <u>Lir</u>
ISG					STAT	us	

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

#### Antenna 4



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#### Antenna 3

XI L	RF	zer - APv8.2(03211 50 Ω AC		SENSE:INT		06:33:48 AM Apr 04, 2018	
Center	Freq 2.4	41500000 NFE	GHz PNO: Wide ⊂ IFGain:Low	Trig: Free Run #Atten: 40 dB	#Avg Type: RMS Avg Hold:>100/100	TRACE 1 2 3 4 5 6 TYPE MWWWW DET P N N N N N	
10 dB/div		set 15.14 dB ).00 dBm			Δι	4 Mkr1 1.000 MHz -0.371 dB	Auto Tune
20.0					1∆2		Center Fred 2.441500000 GHz
0.00		Allow Arthough		12 Martin		- Ala	Start Fred 2.439000000 GHz
-10.0							<b>Stop Fred</b> 2.444000000 GH;
30.0							CF Step 500.000 kH <u>Auto</u> Mar
.40.0							Freq Offse 0 Ha
60.0							Scale Type
	2.441500 W 300 kH:		#VBW	/ 910 kHz	Sweep 2	Span 5.000 MHz 2.533 ms (1001 pts)	Log <u>Lir</u>
ISG					STATUS	3	

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# 8.3.4. LOW POWER ENCHANCED DATA RATE 8PSK MODULATION

#### Antenna 4

L RF 50     Center Freq 2.441	Ω AC	GHz	SENSE:IN	#Avg Ty	pe: RMS	09:15:14 AM Apr 04, 20 TRACE 1 2 3 4	5 6 Frequency
	NFE	PNO: Wide C IFGain:Low	<sup>I</sup> Trig: Free Run #Atten: 40 dB	Avg Holo	d:>100/100		N N
Ref Offset 10 dB/div Ref 30.00						0.041 d	
			Ť				Center Fred
20.0							2.441500000 GHz
10.0	-1)~1~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	the second with	and and	1Δ2		hannellen and	Start Fred
0.00							2.439000000 GHz
-10.0							Stop Fred
-20.0							2.444000000 GHz
-30.0							CF Step 500.000 kHz Auto Man
-40.0							
-50.0							Freq Offset
-60.0							Scale Type
Center 2.441500 GH #Res BW 300 kHz	z	#VBW	910 kHz		Sweep 2	Span 5.000 Mł .533 ms (1001 pt	

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#### Antenna 3

KI L	RF 5	APv8.2(032118), 0 Ω AC		SENSE:INT		09:39:32 AM Apr 04, 2018	Frequency
Cente	er Freq 2.441	500000 ( NFE	Hz PNO: Wide ♀ IFGain:Low	Trig: Free Run #Atten: 40 dB	#Avg Type: RMS Avg Hold:>100/100	TRACE 1 2 3 4 5 6 TYPE M WWWW DET P N N N N N	
0 dB/d	Ref Offset					/kr1 1.000 MHz -0.749 dB	Auto Tune
20.0 -							Center Free 2.441500000 GH
10.0	- Andrew Contraction of the second	لمدحم ورويه	Martin Martin	2 - warden warden	1∆2	And the second sec	Start Free 2.439000000 GH
10.0 -							Stop Free 2.444000000 GH
30.0 -							CF Stej 500.000 kH <u>Auto</u> Ma
50.0							Freq Offse 0 H
60.0							Scale Type
	r 2.441500 GH BW 300 kHz	lz	#VBW	910 kHz	Sweep 2	Span 5.000 MHz 2.533 ms (1001 pts)	Log <u>Lir</u>
ISG					STATUS	3	

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### 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 nonoverlapping 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.

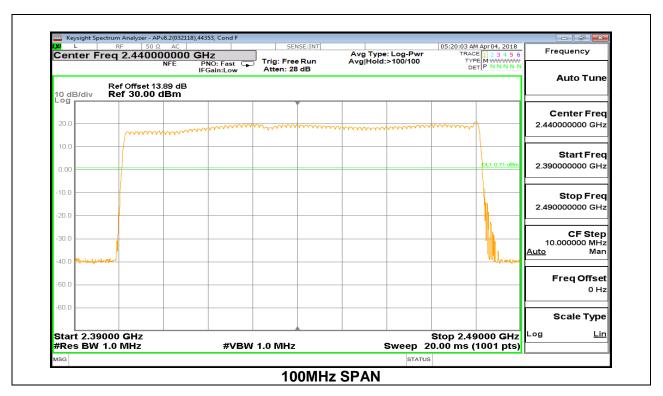
#### **RESULTS**

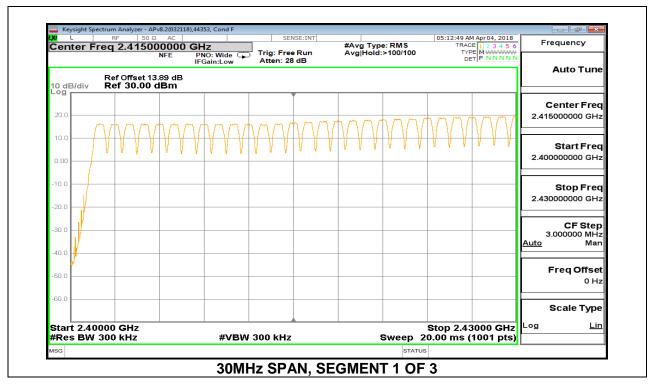
Normal Mode: All Channels Observed

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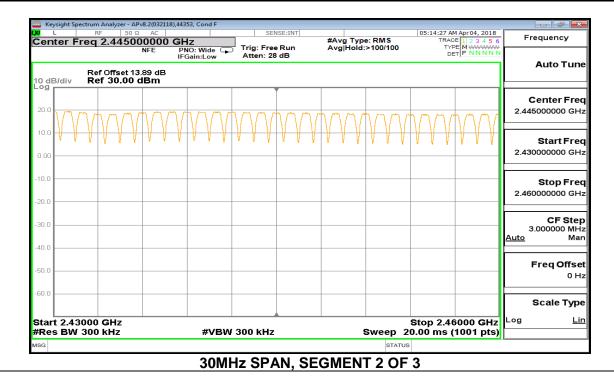
# 8.4.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

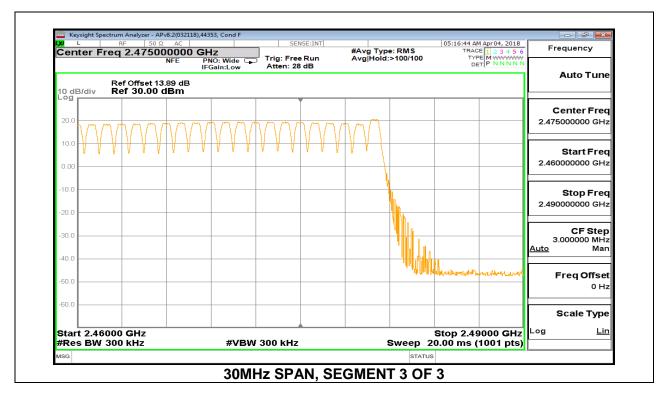
# Antenna 4



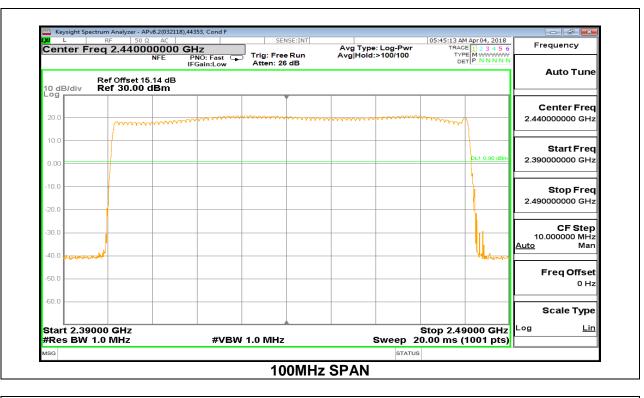


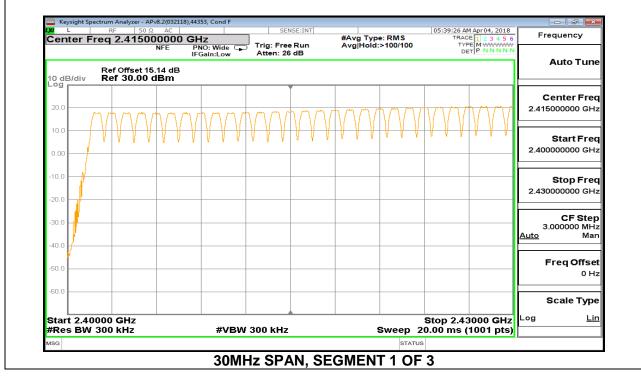
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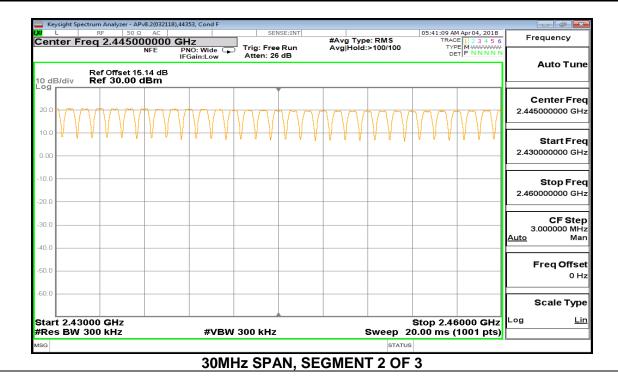


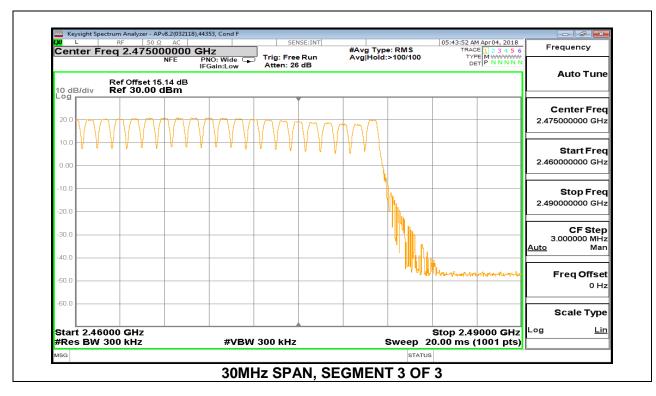
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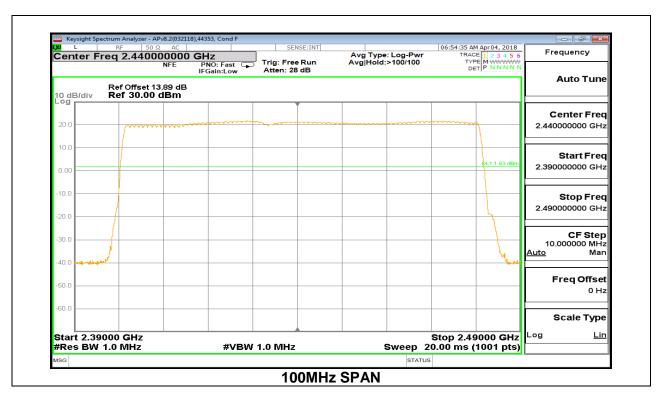


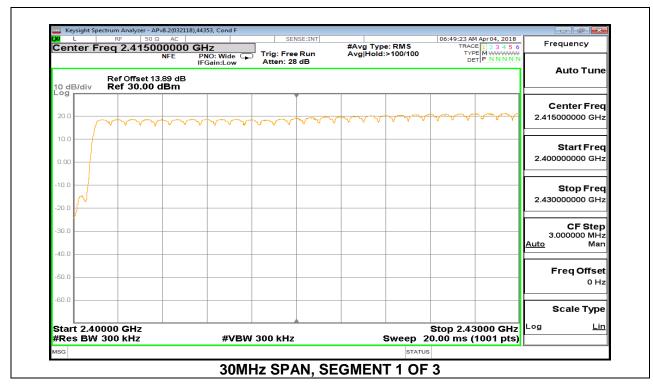


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# 8.4.2. HIGH POWER ENCHANCED DATA RATE 8PSK MODULATION

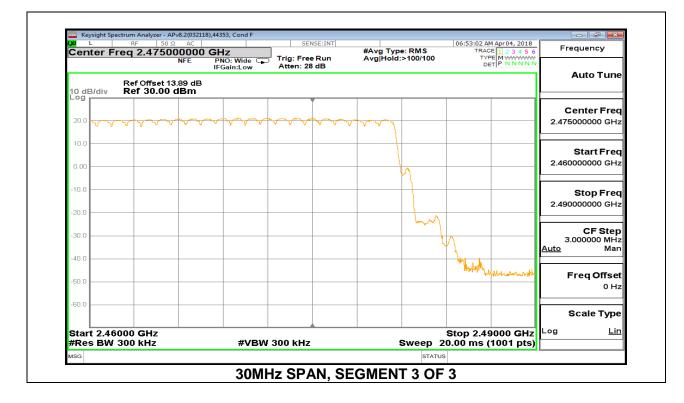
# Antenna 4



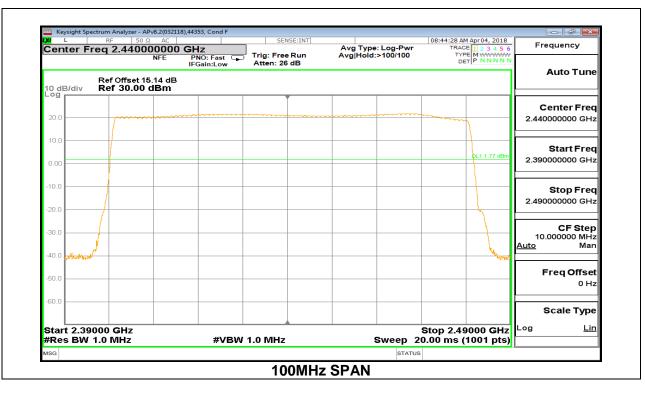


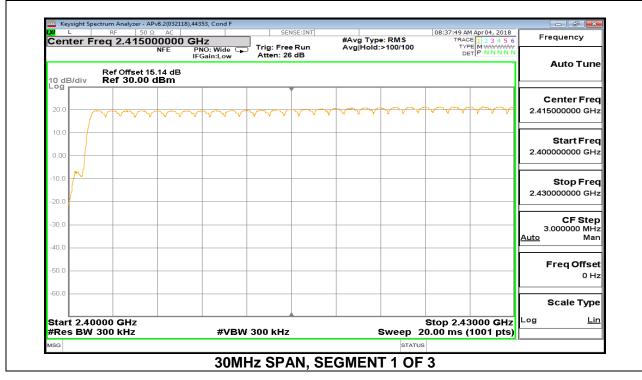
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LXI L	t Spectrum Ana RF	50 Ω	AC		SEN	ISE:INT			06:51:24 AM Apr 04, 2018	
Center	Freq 2.4		FE	Hz PNO: Wide ⊊ IFGain:Low	Trig: Free Atten: 28		#Avg Typ Avg Hold:		TRACE 1 2 3 4 5 6 TYPE M WWWW DET P N N N N N	Frequency
10 dB/di		fset 13.8 0.00 dE								Auto Tune
20.0 V	And A	$\sim$	$\sqrt{-\sqrt{-}}$	<u>~~~~~~~</u>	ᡐ᠆ᡐ᠆ᡐ	~~~~	$\sqrt{\sqrt{2}}$	$\sim \sim \sim$		Center Free 2.445000000 GH
0.00										Start Fre 2.430000000 GH
-10.0										<b>Stop Fre</b> 2.460000000 GH
-30.0										CF Ste 3.000000 MH <u>Auto</u> Ma
-40.0										Freq Offse
-60.0										Scale Type
	43000 GI W 300 KH			#VBW	300 kHz			Sweep 2	Stop 2.46000 GHz 0.00 ms (1001 pts)	Log <u>Li</u> i
MSG								STATUS		



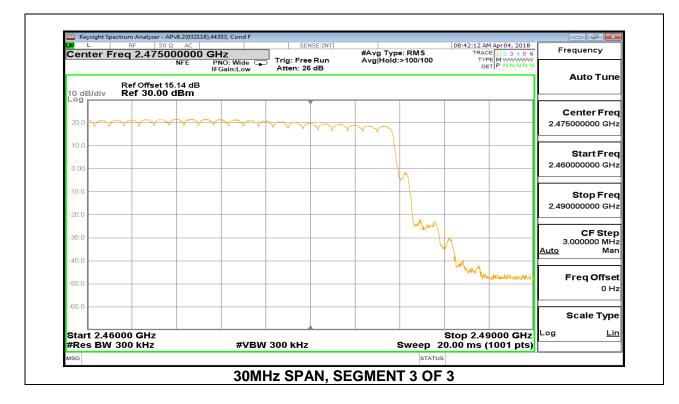
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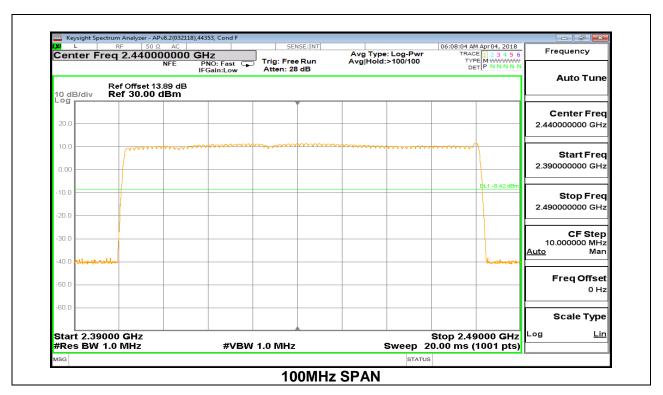
L L		50 Ω AC		SENSE:INT	"A 7 5140	08:39:57 AM Apr 04, 2018	Frequency
Center F	req 2.44	5000000 NFE	GHZ PNO: Wide G IFGain:Low	Trig: Free Run Atten: 26 dB	#Avg Type: RMS Avg Hold:>100/100	TRACE 1 2 3 4 5 6 TYPE M WWWW DET P N N N N N	
10 dB/div	Ref Offse Ref 30.0	t 15.14 dB 00 dBm					Auto Tun
				ľ			Center Fre
20.0							2.445000000 GH
10.0							Start Fre
0.00							2.430000000 GH
-10.0							Stop Fre
-20.0							2.460000000 GH
-30.0							CF Ste 3.000000 MH Auto Ma
-40.0							
-50.0							Freq Offse 0 ⊢
-60.0							Scale Typ
Start 2.43 #Res BW			#VBW	300 kHz	Sweep 2	Stop 2.46000 GHz 0.00 ms (1001 pts)	Log <u>Li</u>
MSG					STATUS		

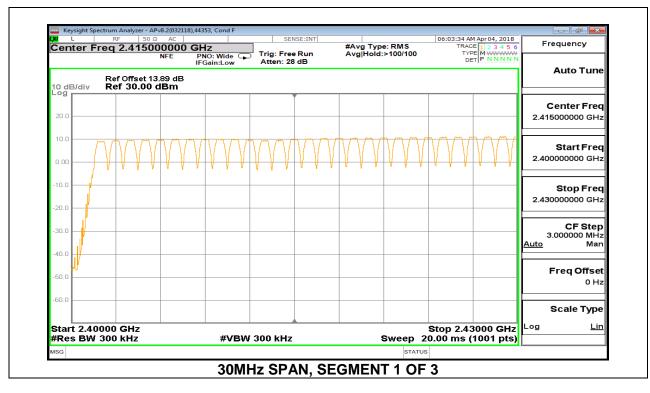


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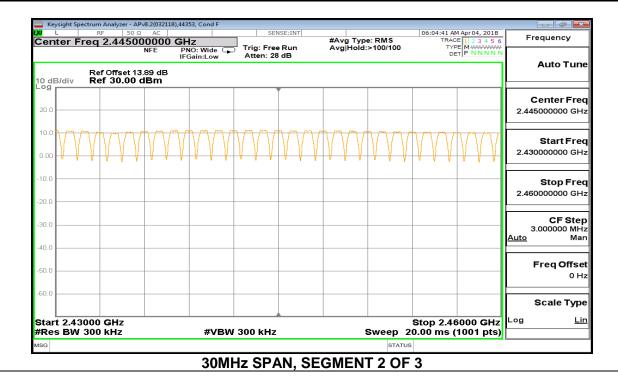
# 8.4.3. LOW POWER BASIC DATA RATE GFSK MODULATION

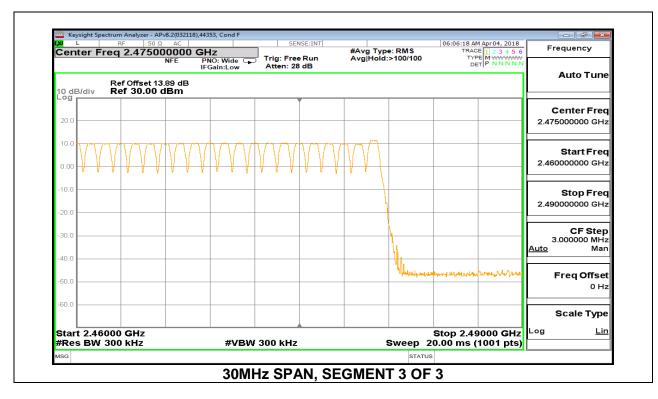
## Antenna 4



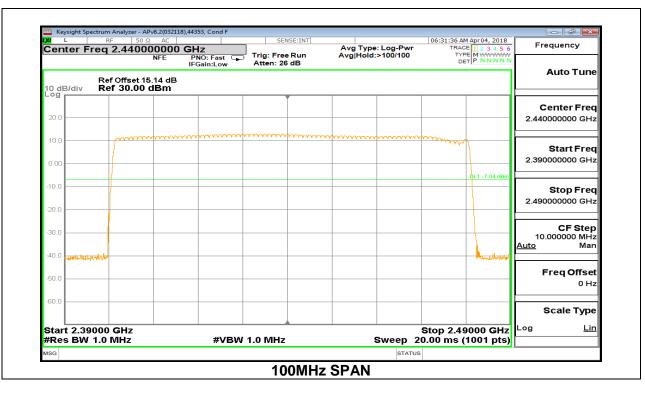


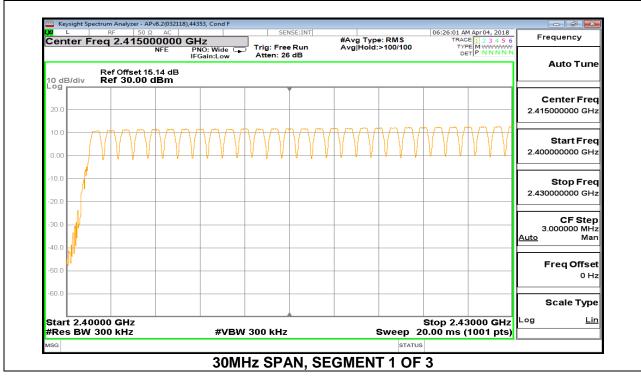
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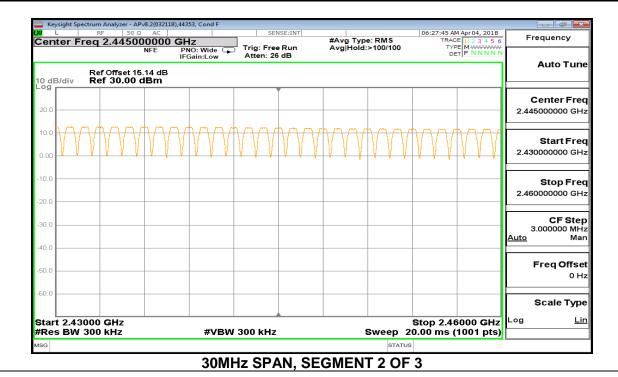


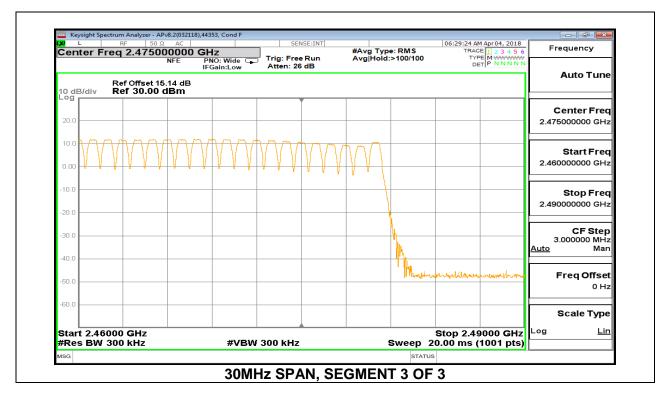
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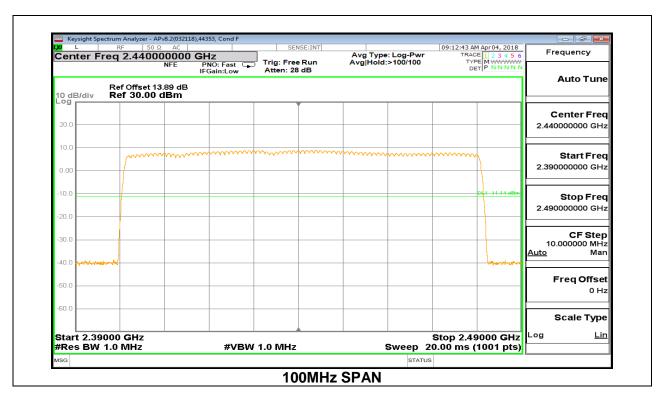


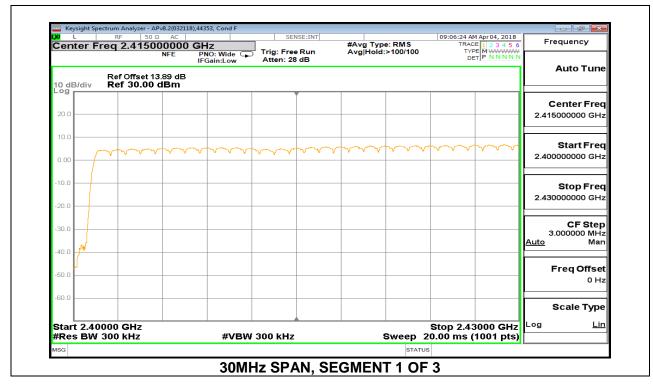


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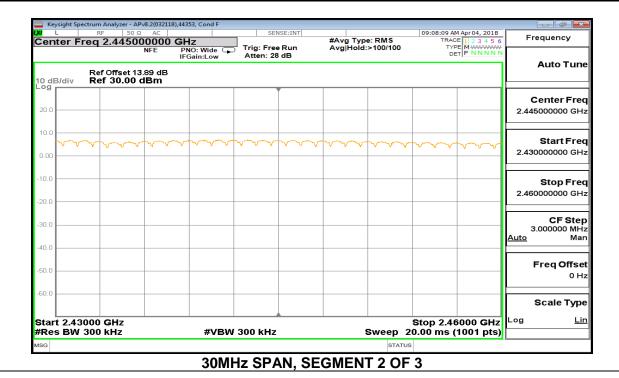
# 8.4.4. LOW POWER ENCHANCED DATA RATE 8PSK MODULATION

## Antenna 4



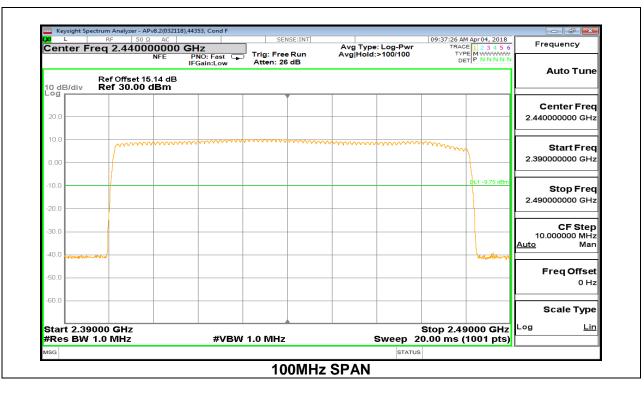


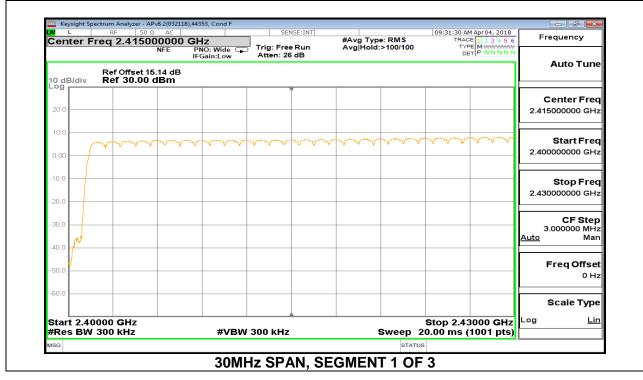
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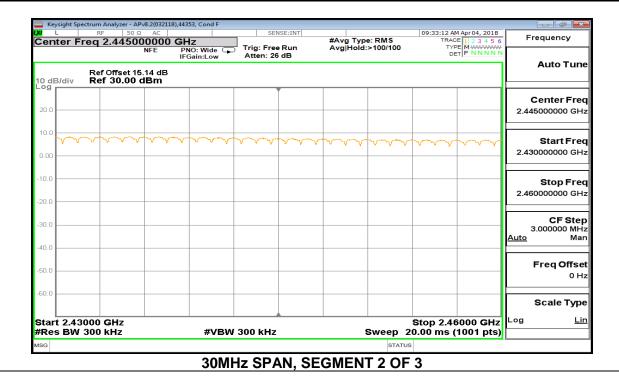
<mark>₩</mark> L RF 50 Center Freq 2.4750	000000 GHz	sense:INT	#Avg Type: RMS Avg Hold:>100/100	09:10:08 AM Apr 04, 2018 TRACE 1 2 3 4 5 6 TYPE M	Frequency
Ref Offset 1 10 dB/div Ref 30.00	IFGain:Low /	Atten: 28 dB		DET PNNNN	Auto Tune
20.0					Center Free 2.475000000 GH
10.0 0.00	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4		v v		Start Free 2.460000000 GH
-10.0					<b>Stop Free</b> 2.490000000 GH
-30.0			4		CF Step 3.000000 MH <u>Auto</u> Mar
-40.0			Juliu and Anna A	- viriansisticuly attaced again	Freq Offse 0 H
-60.0 Start 2.46000 GHz				Stop 2.49000 GHz	Scale Type
#Res BW 300 kHz	#VBW 30	00 kHz	Sweep	20.00 ms (1001 pts)	

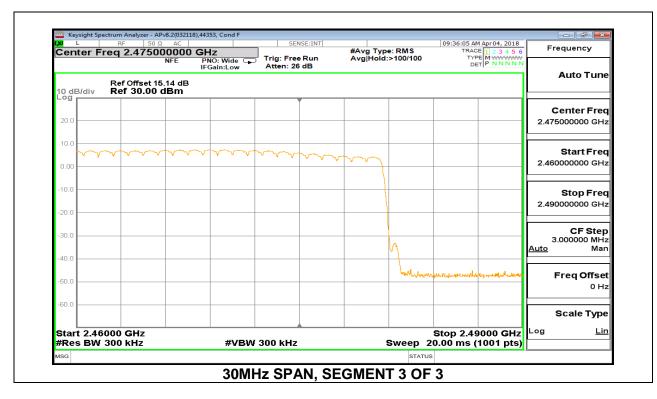
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# 8.5. AVERAGE TIME OF OCCUPANCY

# **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**

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# 8.5.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

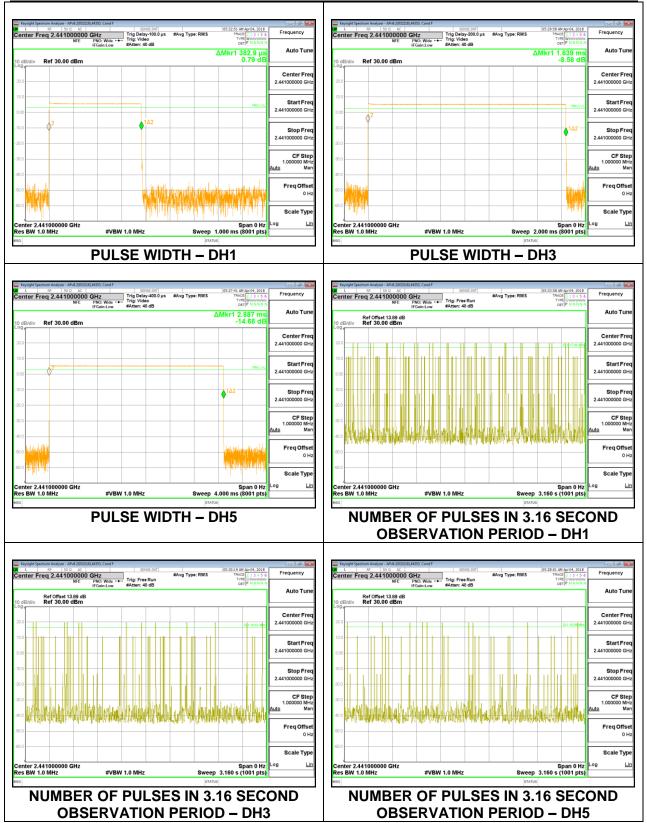
# Antenna 4

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)					
GFSK Norma	GFSK Normal Mode									
DH1	0.383	32	0.1226	0.4	-0.2774					
DH3	1.639	15	0.2459	0.4	-0.1542					
DH5	2.887	10	0.2887	0.4	-0.1113					
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	0.383	8	0.03064	0.4	-0.3694					
DH3	1.639	3.75	0.06146	0.4	-0.3385					
DH5	2.887	2.5	0.07218	0.4	-0.3278					

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## DATE: 8/10/2018 IC: 579C-E3234A

#### REPORT NO: 12204512-E1V3 FCC ID: BCG-E3234A

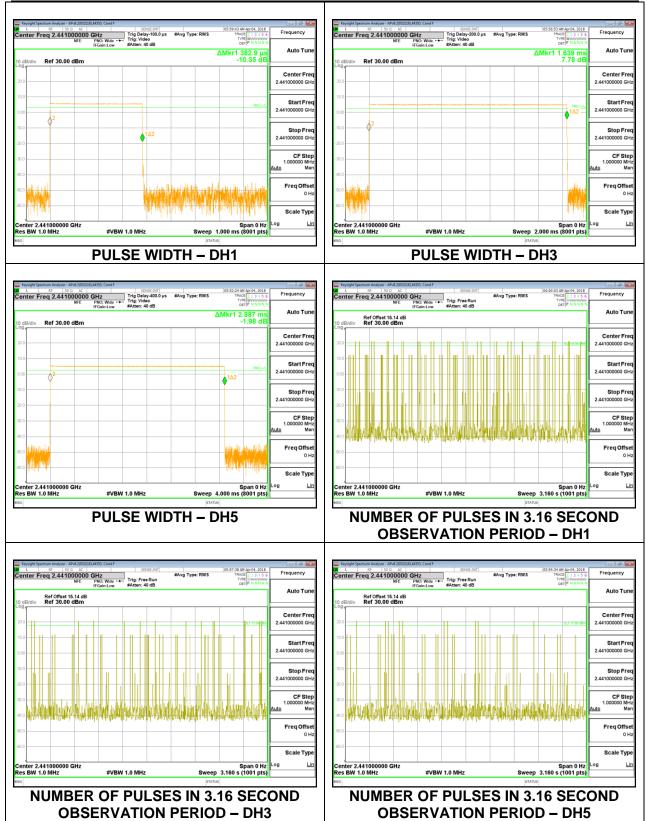


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DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)				
GFSK Normal Mode									
DH1	0.383	32	0.1226	0.4	-0.2774				
DH3	1.639	16	0.2622	0.4	-0.1378				
DH5	2.887	10	0.2887	0.4	-0.1113				
DH Packet	Pulse Width (sec)	Number of Pulses in 0.8 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)				
GFSK AFH Mode									
				<u> </u>	0.0004				
DH1	0.383	8	0.03064	0.4	-0.3694				
DH1 DH3	0.383 1.639	8 4	0.03064 0.06556	0.4	-0.3694 -0.3344				

## DATE: 8/10/2018 IC: 579C-E3234A

#### REPORT NO: 12204512-E1V3 FCC ID: BCG-E3234A



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# 8.5.2. HIGH POWER ENCHANCED DATA RATE 8PSK MODULATION

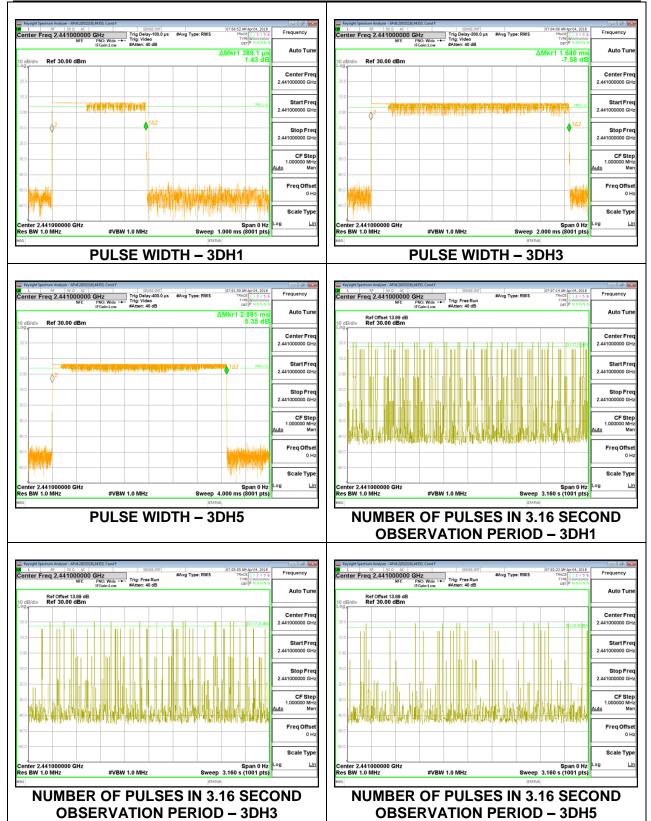
# Antenna 4

DH Packet	Pulse	Number of	Average Time	Limit	Margin			
	Width (msec)	Pulses in 3.16 seconds	of Occupancy (sec)	(sec)	(sec)			
		seconds						
8PSK Normal	8PSK Normal Mode							
3DH1	0.389	32	0.12448	0.4	-0.2755			
3DH3	1.64	13	0.2132	0.4	-0.1868			
3DH5	2.891	12	0.34692	0.4	-0.0531			

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 in section 8.5.1 demonstrates compliance with channel occupancy when AFH is employed.

## DATE: 8/10/2018 IC: 579C-E3234A

#### REPORT NO: 12204512-E1V3 FCC ID: BCG-E3234A



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