



CERTIFICATION TEST REPORT

Report Number. : 12943451-E11V3

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

Model : A2218

FCC ID : BCG-E3308A

IC : 579C-E3308A

EUT Description : Smart Phone

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

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Prepared by:

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NVLAP Lab code: 200065-0

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	8/14/2019	Initial Issue	Chin Pang
V2	8/21/2019	Addressed TCB Feedback on Sections 5.2, 5.3, 5.5, 6, 7, 8, and 9	Tony Li
V3	8/22/2019	Address TCB question on Section 5.5 & 9.2	Chin Pang

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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: G6TYW006N39Y (Conducted), G6TYW03SN39P (Radiated)

DATE TESTED: APRIL 16, 2019 – AUGUST 21, 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.

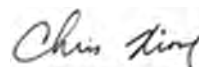
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2. TEST METHODOLOGY

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, KDB 558074 D01 15.247 Meas Guidance v05r02, 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, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

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

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%.

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	Configuration	Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
Antenna 4	High Power	2404 - 2478	HDR4	14.65	29.17
	Low Power			8.60	7.24
	High Power		HDR8	14.98	31.48
	Low Power			8.78	7.55
Antenna 3	High Power	2404 - 2478	HDR4	14.55	28.51
	Low Power			8.89	7.74
	High Power		HDR8	14.93	31.12
	Low Power			8.71	7.43
Antenna 4 + Antenna 3	High Power	2404 - 2478	HDR4	17.84	60.81
	Low Power			11.73	14.89
	High Power		HDR8	17.94	62.23
	Low Power			11.84	15.28

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Range (GHz)	Ant. 4 (Core 0) (dBi)	Ant. 3 (Core 1) (dBi)
2.4	-0.9	-2.3

5.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was v1.29.99992

The test utility software used during testing was QRCT v3.0.264.0.

5.5. WORST-CASE CONFIGURATION AND MODE

The EUT was investigated in three orthogonal orientations X, Y and Z on both Ant 4 (Antenna 4) and Ant 3 (Antenna 4), it was determined that X (Flatbed) orientation was the worst-case orientation for 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 transmits at the channel with the highest output power as worst-case scenario.

For below 1GHz tests were performed with EUT 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.

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The WiFi/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.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
laptop	Apple	A1398	C02PM012G3QD	QDS-BRCM1069
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

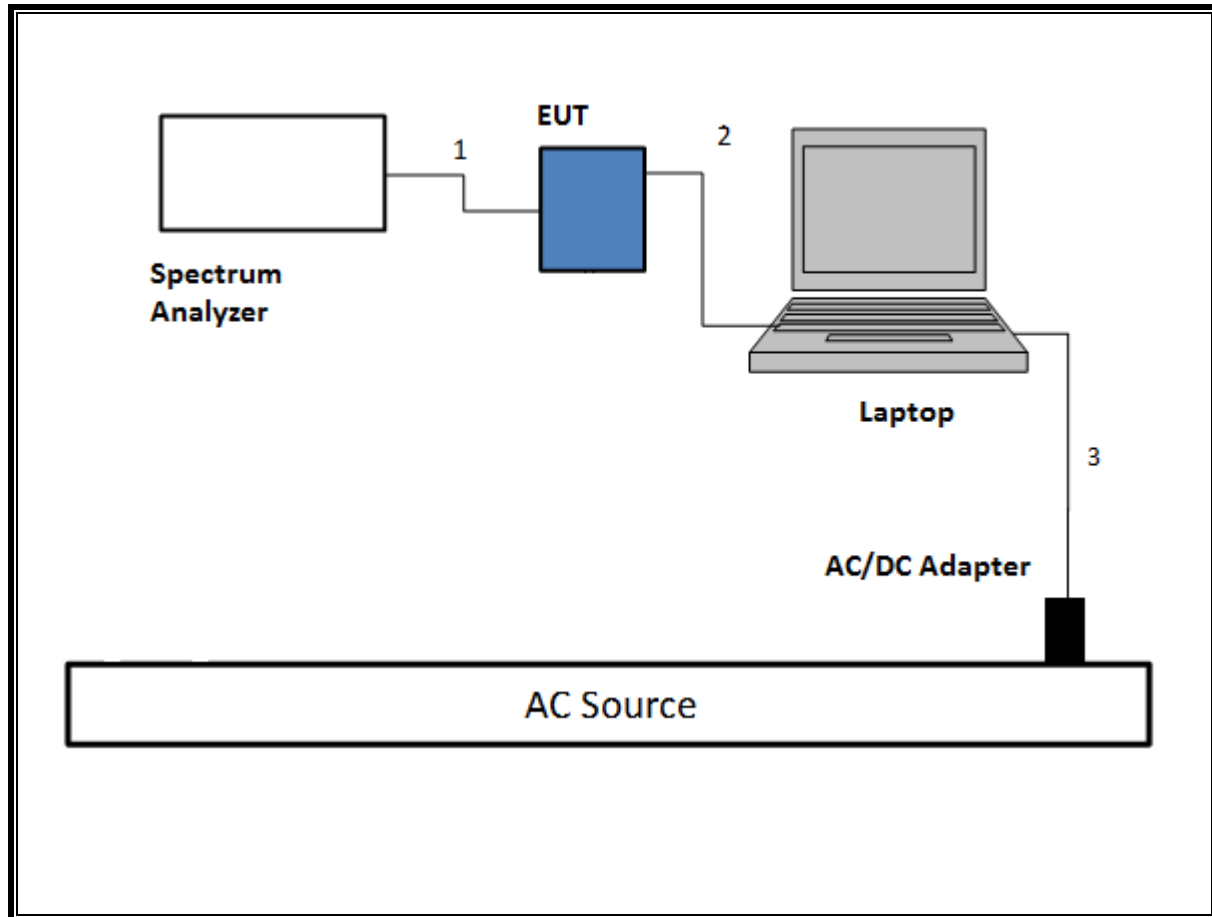
I/O CABLES (BELOW 1GHz AND AC POWER LINE TEST WITH ADAPTER AND LAPTOP)

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

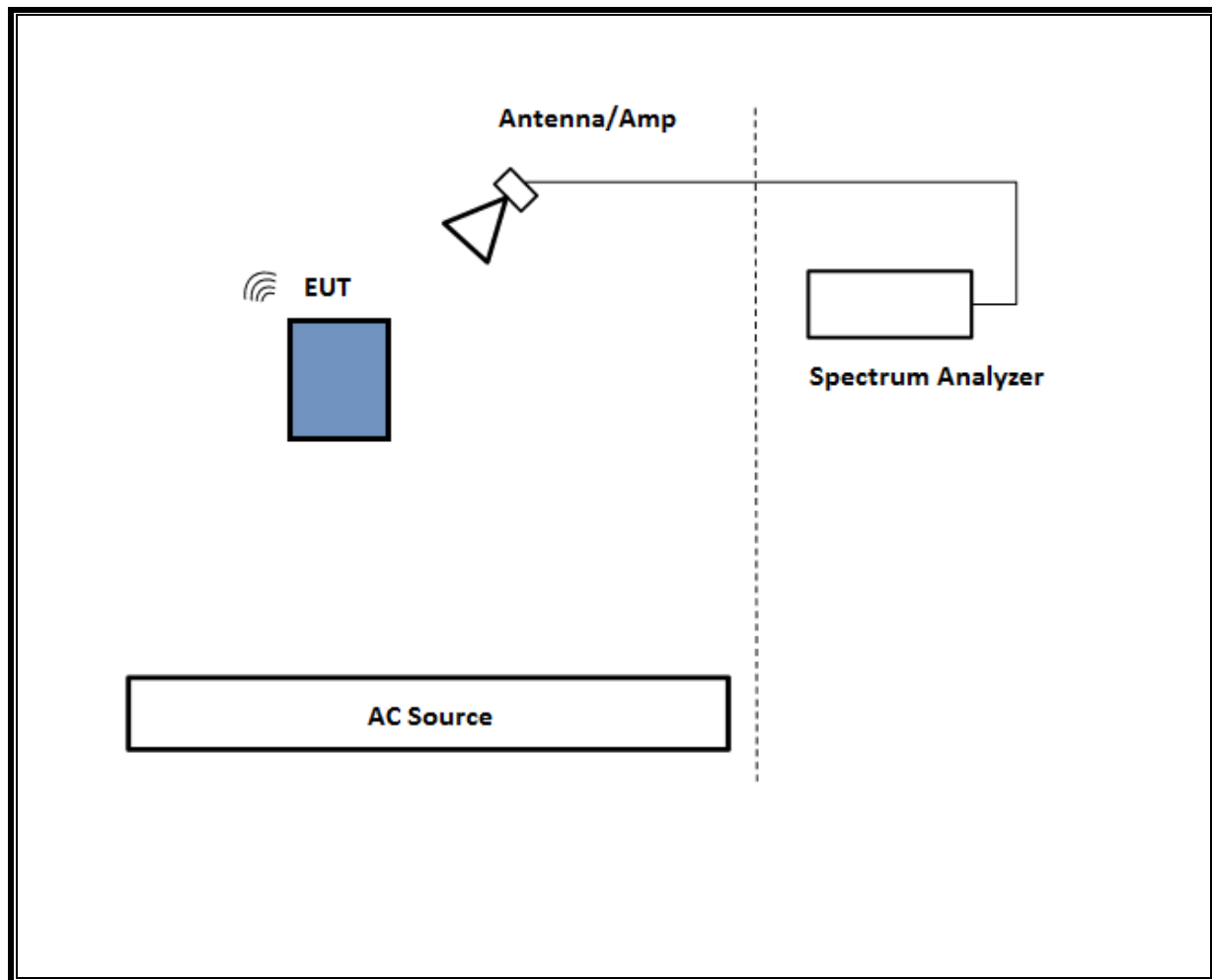
TEST SETUP

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

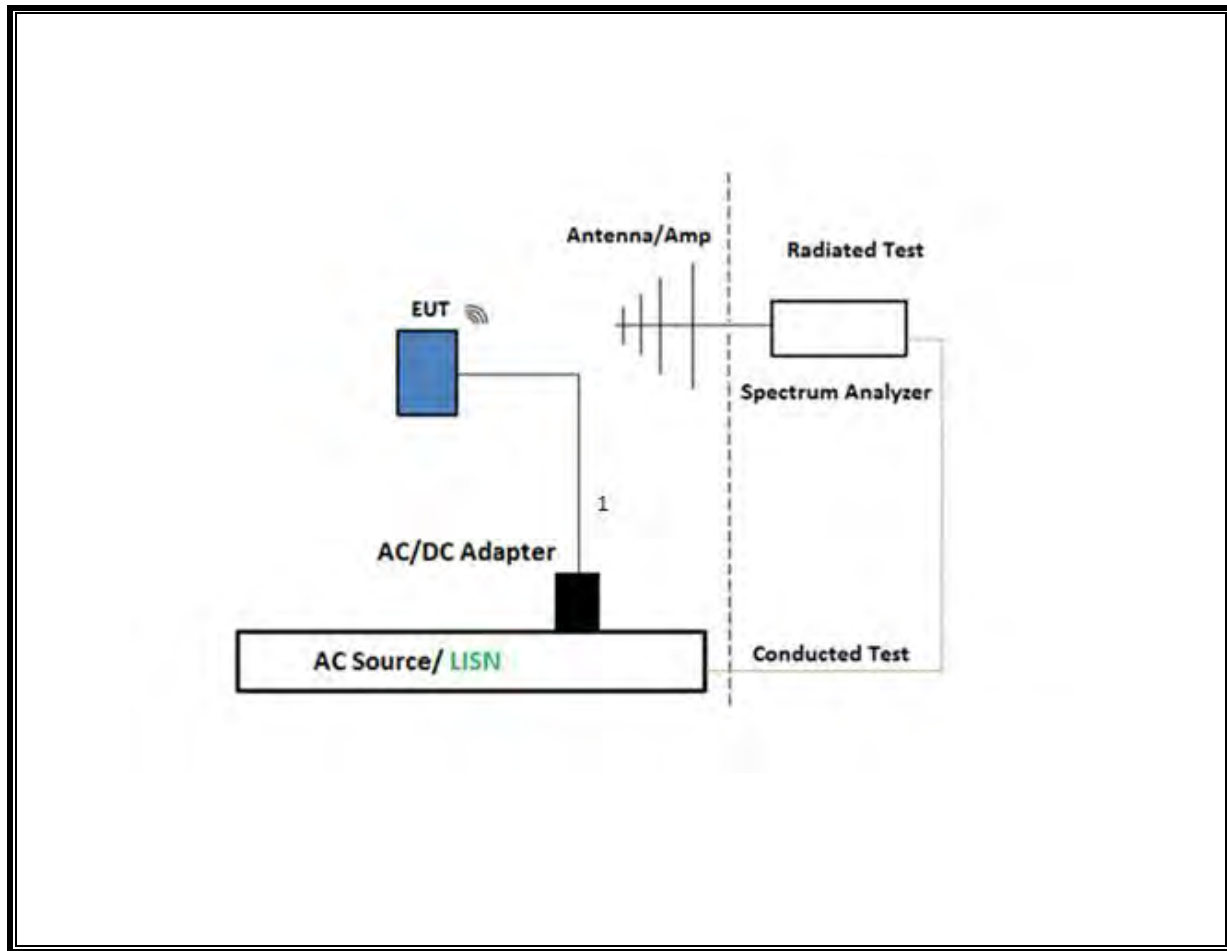
SETUP DIAGRAM FOR CONDUCTED TESTS



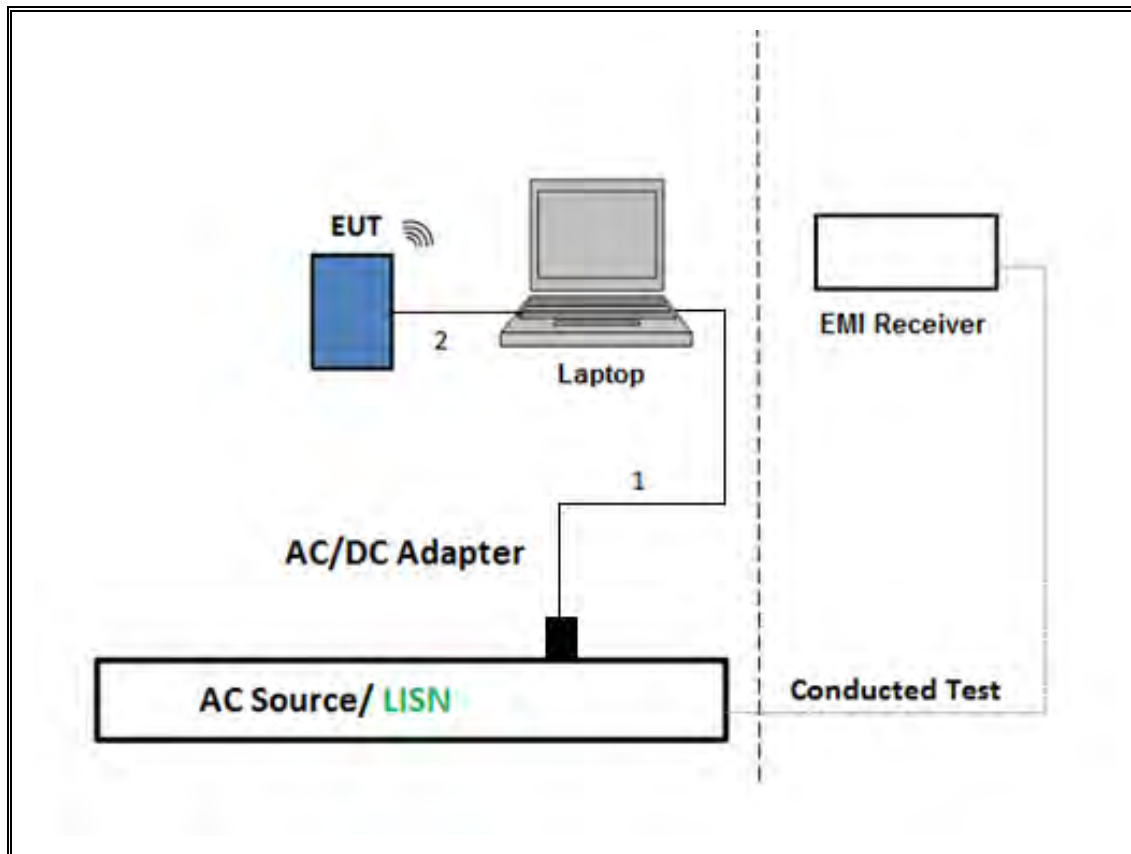
SETUP DIAGRAM FOR RADIATED TESTS Above 1 GHz



SETUP DIAGRAM FOR Below 1GHz and AC LINE CONDUCTED TEST



TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION



6. MEASUREMENT METHOD

On Time and Duty Cycle: KDB 558074 D01 v05r02, Section 6.

6 dB BW: ANSI C63.10 Subclause -11.8.1 RBW \geq DTS BW

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

Output Power: ANSI C63.10 Subclause -11.9.1.3 Method PKPM1 Peak-reading power meter

Output Power: ANSI C63.10 Subclause -11.9.2.3.2 Measurement using gated average power meter

PSD: ANSI C63.10 Subclause -11.10.2 Method PKPSD (peak PSD)

Radiated emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1

Conducted emissions in restricted frequency bands: ANSI C63.10 Subclause -11.12.2

Band-edge: ANSI C63.10 Subclause -11.13.3.2 Integration method -Peak detection

Band-edge: ANSI C63.10 Subclause -11.13.3.3 Integration method -Trace averaging with continuous transmission at full power

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

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

NOTE: All conducted antenna port tests for Beamforming applied the same test procedures as BLE 1Mbps and BLE 2Mbps normal modes

7. 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
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T345	04/20/2020	04/20/2019
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T742	12/15/2019	12/15/2018
*Antenna, Double Ridge Guide Horn Antenna 700MHz to 18GHz	A.H. SYSTEMS, INC.	SAS-571	PRE0190811	07/12/2019	07/12/2018
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	138301	09/15/2019	09/15/2018
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T344	05/07/2020	05/07/2019
*Spectrum Analyzer, PXA 3Hz to 44GHz	Keysight	N9030A-544	T1210	08/06/2019	08/06/2018
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T931	05/11/2020	05/11/2019
*Antenna, Horn 1-18GHz	ETS Lindgren	3117	T120	07/02/2019	07/02/2018
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T491	05/30/2020	05/30/2019
*Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences Corp.	JB3	T900	06/18/2019	06/18/2018
*Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T285	07/06/2019	07/06/2018
*Antenna Horn 18 to 26.5GHz	ARA	MWH-1826/B	T449	06/29/2019	06/29/2018
Pre-Amp 18-26GHz	Agilent Technology	8449B	T404	03/23/2020	03/23/2019
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T342	01/23/2020	01/23/2018
Spectrum Analyzer, PXA, 3Hz to 44GHz	Agilent (Keysight) Technologies	N9030A	T340	01/22/2020	01/22/2018
Spectrum Analyzer, PXA 3Hz to 44GHz	Keysight	N9030A	T1450	01/23/2020	01/23/2019
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	PRE0179367	05/16/2020	05/16/2019
Power Meter, P-series single channel	Keysight	N1912A	T1273	01/30/2020	01/30/2019
Power Sensor	Keysight	N1921A	T1224	02/22/2020	02/22/2019
Antenna, Active Loop 9KHz to 30MHz	ETS-Lindgren	6502	T757	09/25/2019	09/25/2018
AC Line Conducted					
EMI Test Receiver 9KHz-7GHz	Rohde & Schwarz	ESC17	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	06/19/2019	06/19/2018
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.

8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

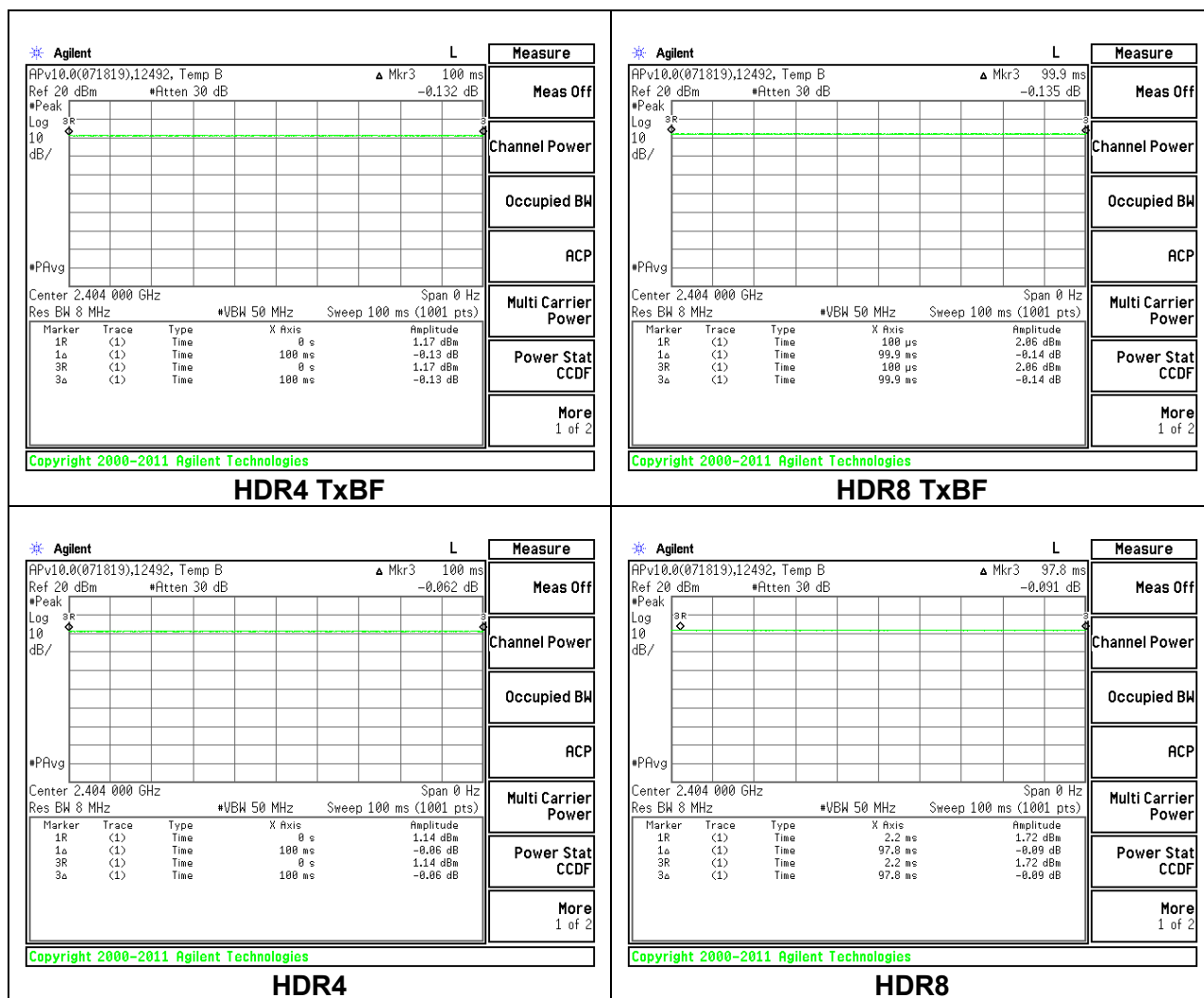
PROCEDURE

KDB 558074 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/B Minimum VBW (kHz)
2.4GHz Band						
HDR4	1.000	1.000	1.000	100.00%	0.00	0.010
HDR4 TxBF	1.000	1.000	1.000	100.00%	0.00	0.010
HDR8 TxBF	0.990	0.990	1.000	100.00%	0.00	0.010
HDR4	1.000	1.000	1.000	100.00%	0.00	0.010
HDR8	0.978	0.978	1.000	100.00%	0.00	0.010

DUTY CYCLE PLOTS



8.2. 99% BANDWIDTH

LIMITS

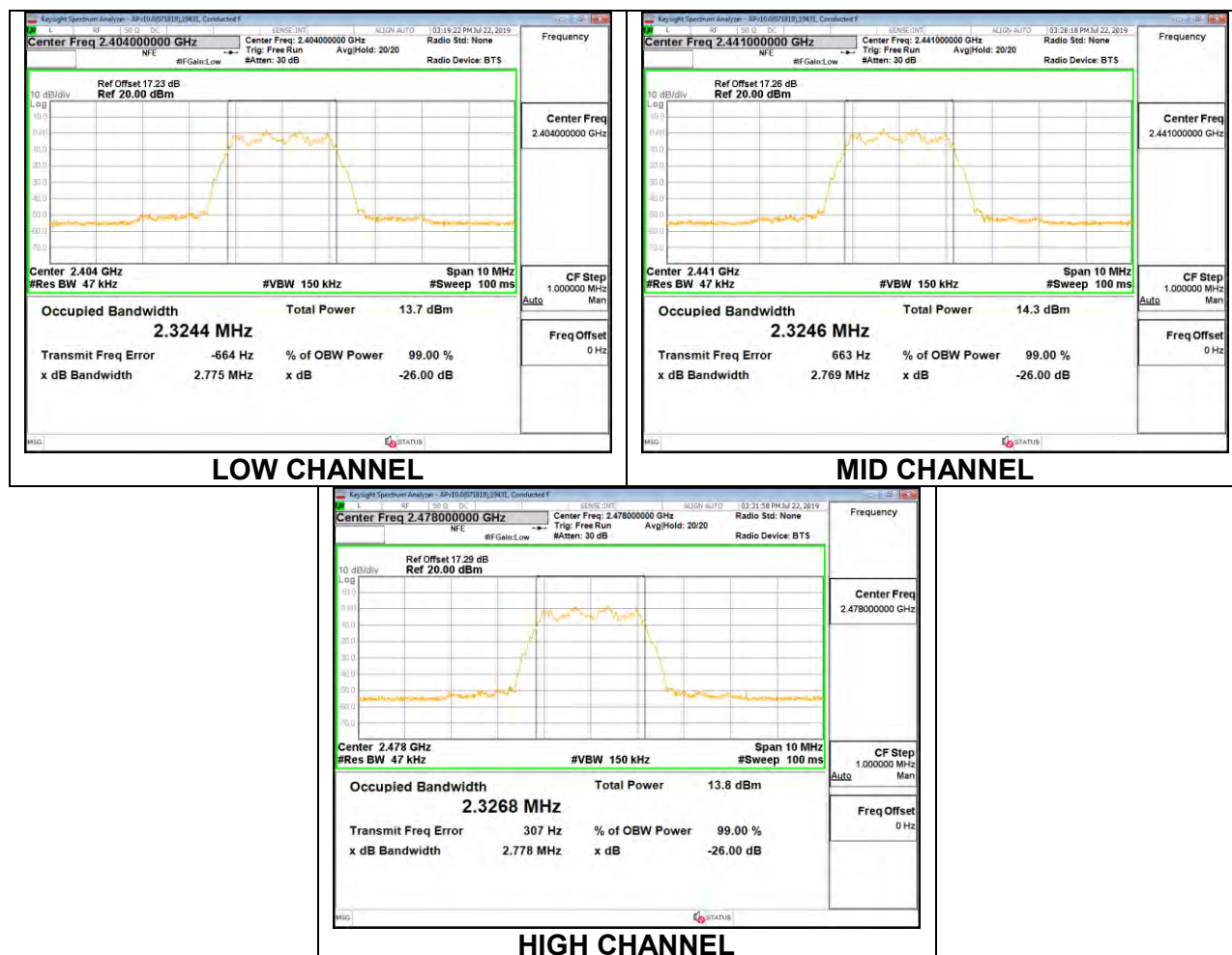
None; for reporting purposes only.

RESULTS

8.2.1. HIGH POWER HDR (HDR4)

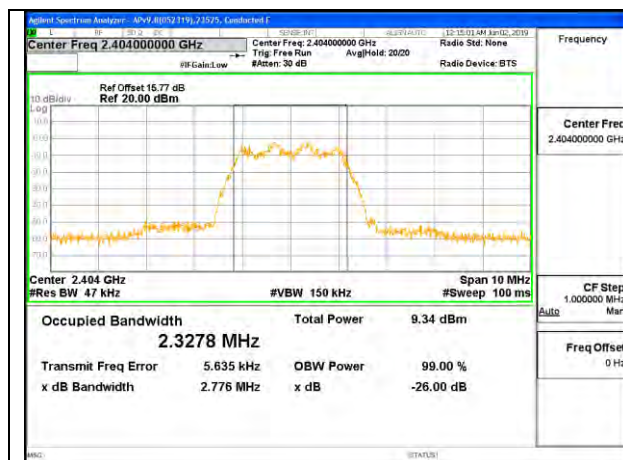
Antenna 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	2.3244
Middle	2441	2.3246
High	2478	2.3268

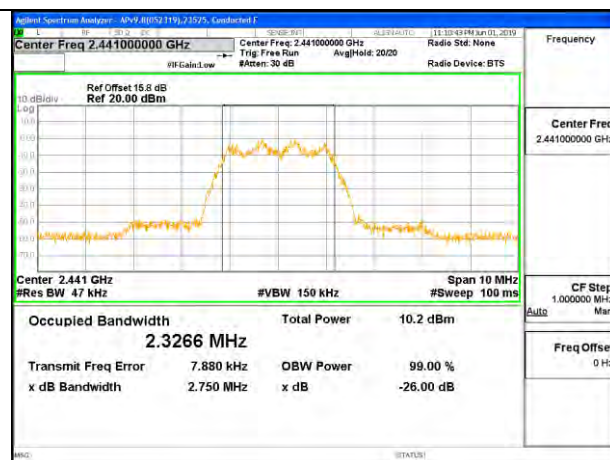


Antenna 3

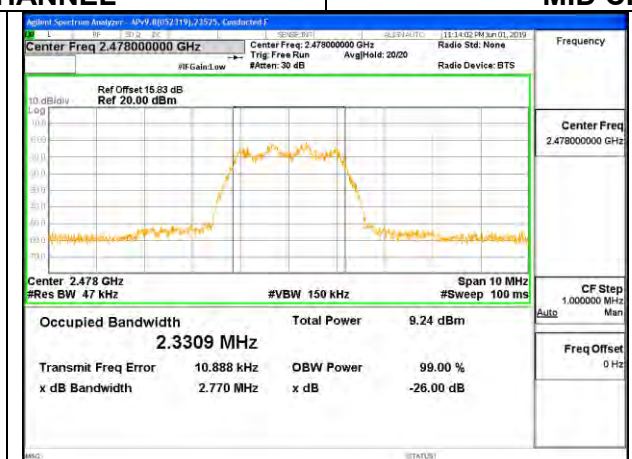
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	2.3278
Middle	2441	2.3266
High	2478	2.3309



LOW CHANNEL



MID CHANNEL

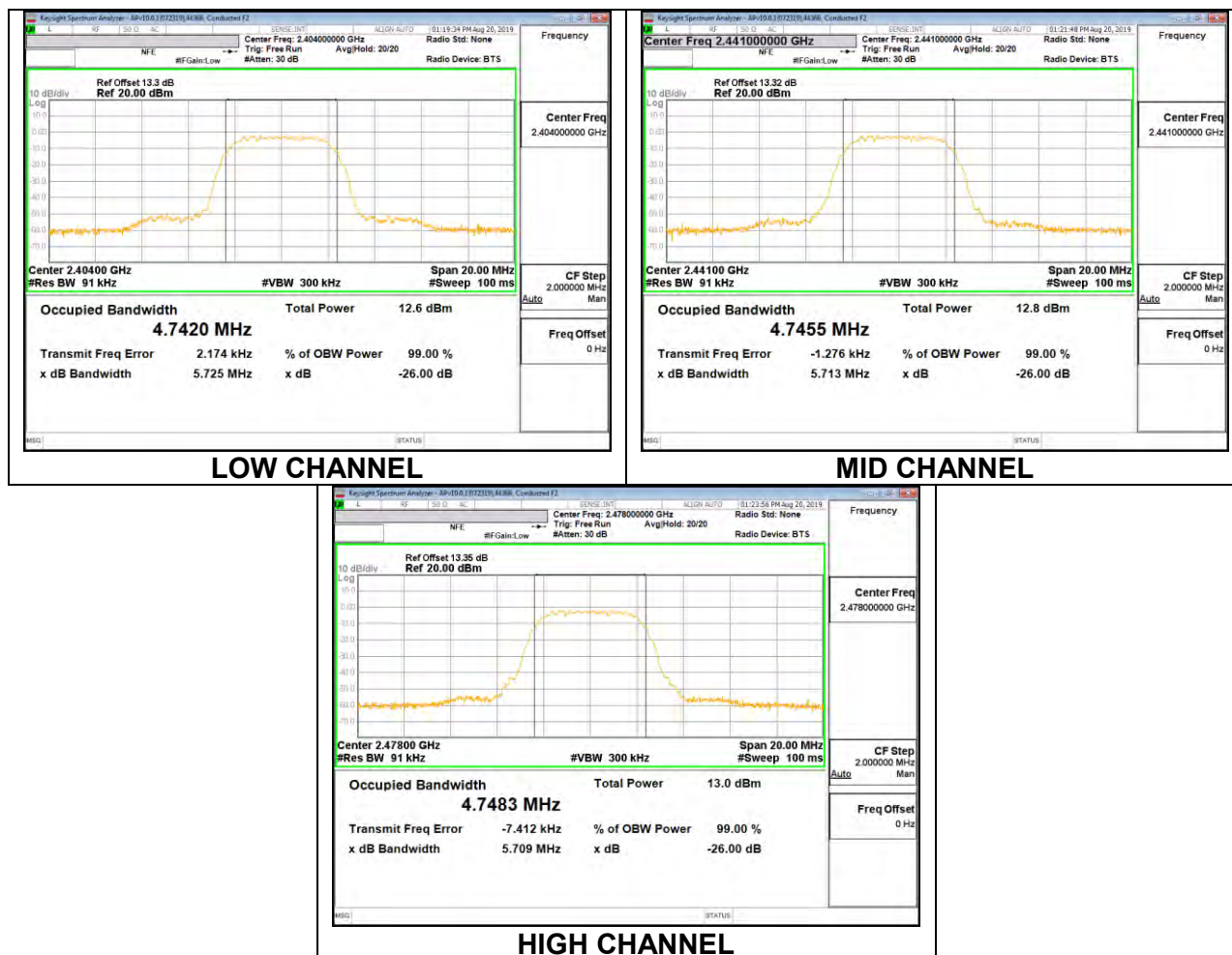


HIGH CHANNEL

8.2.2. HIGH POWER HDR (HDR8)

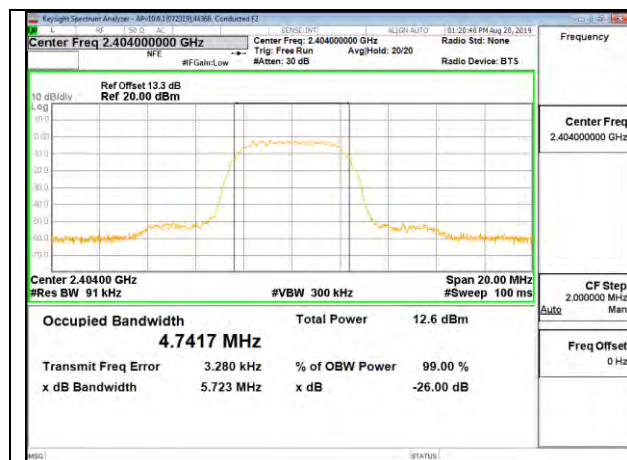
Antenna 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	4.7420
Middle	2441	4.7455
High	2478	4.7483

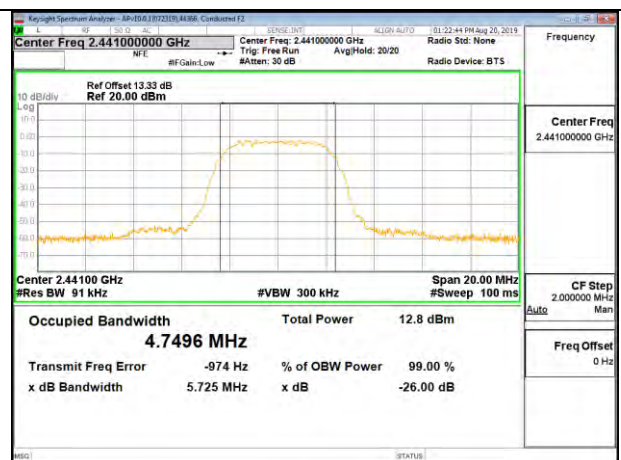


Antenna 3

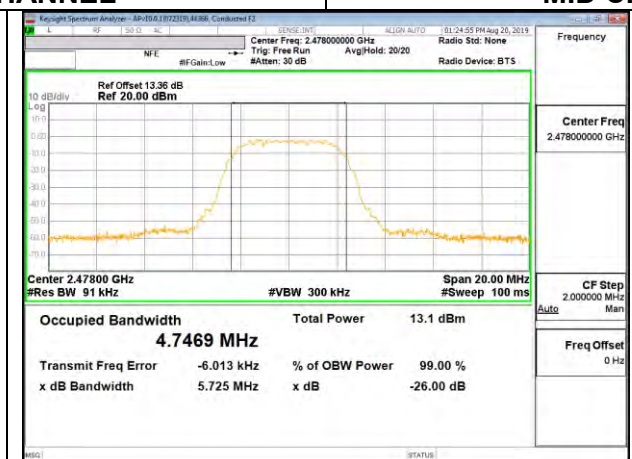
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	4.7417
Middle	2441	4.7496
High	2478	4.7469



LOW CHANNEL



MID CHANNEL

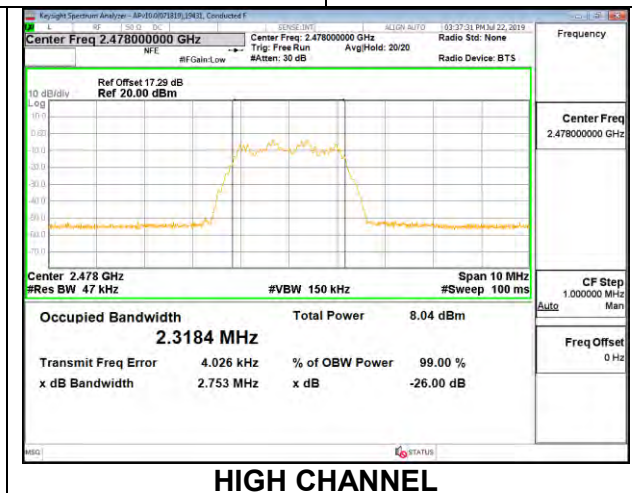
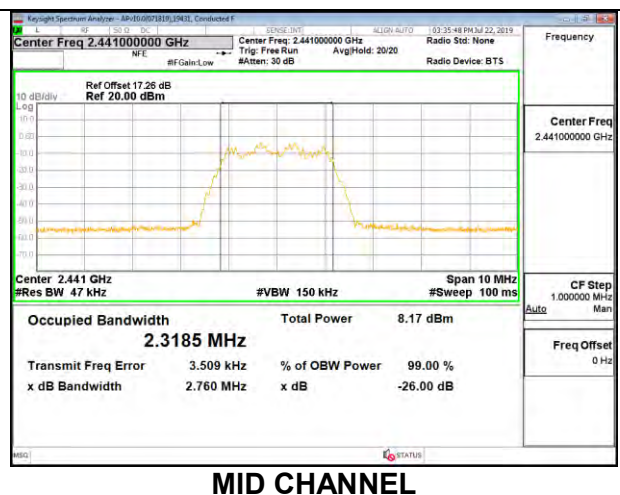
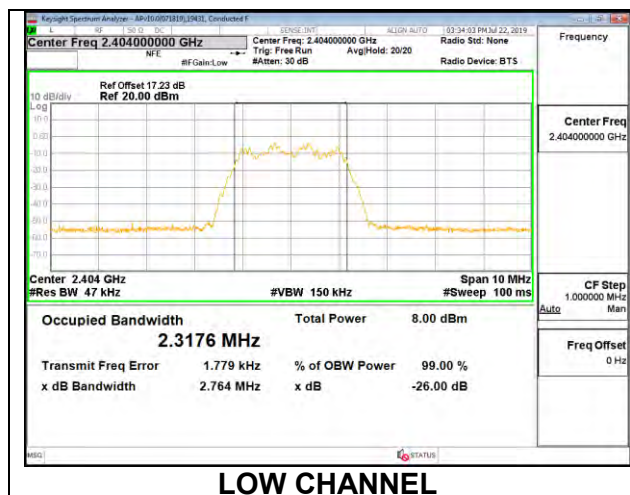


HIGH CHANNEL

8.2.3. LOW POWER HDR (HDR4)

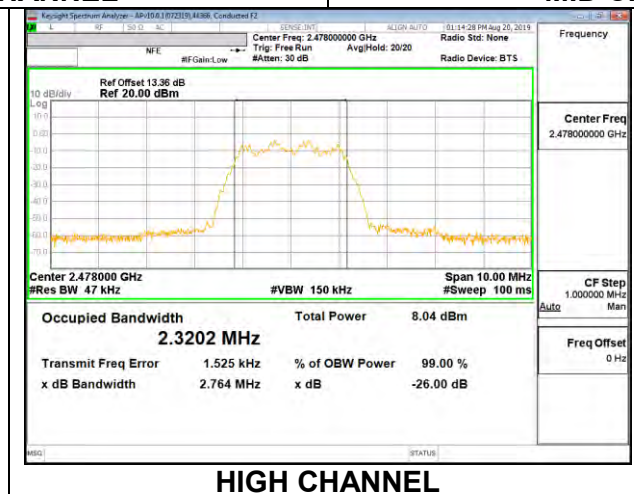
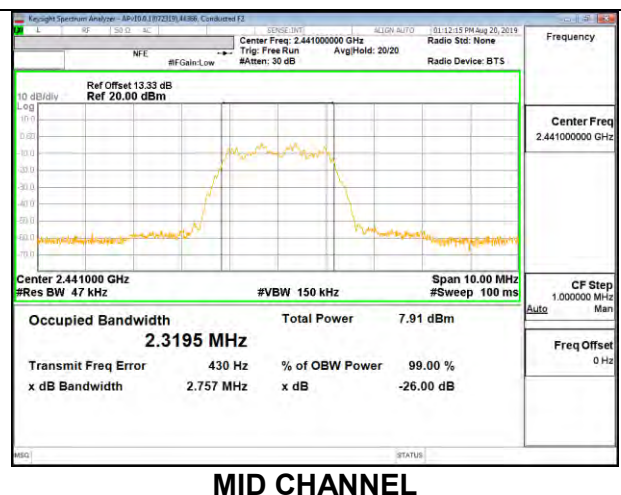
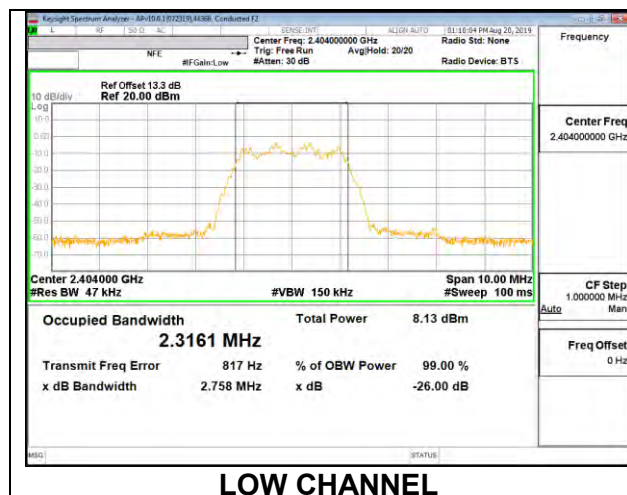
Antenna 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	2.3176
Middle	2441	2.3185
High	2478	2.3184



Antenna 3

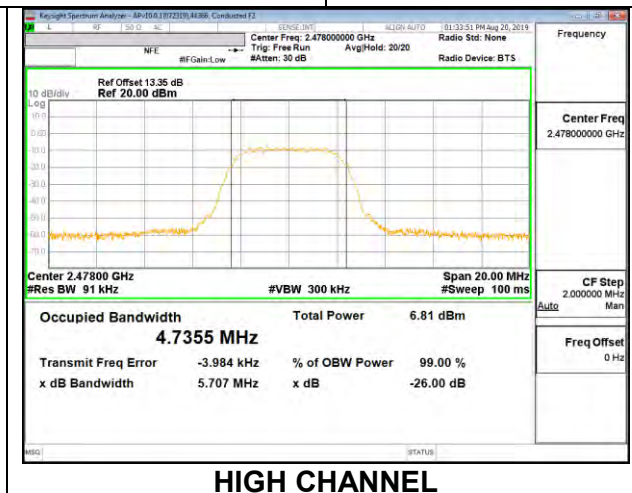
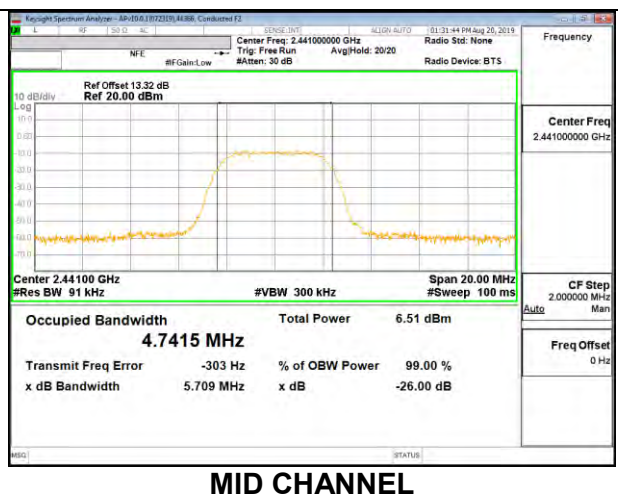
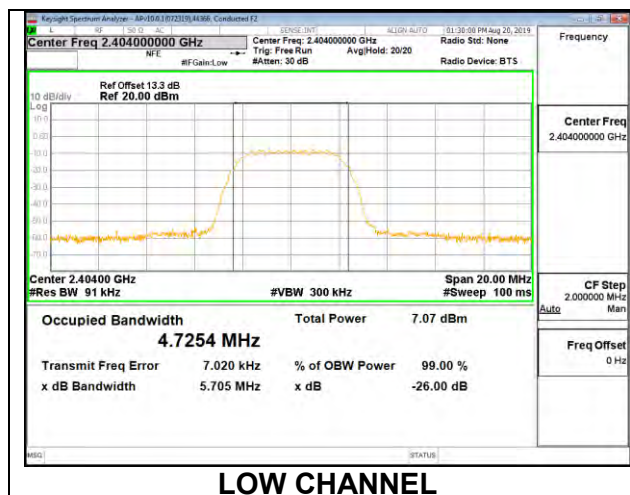
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	2.3161
Middle	2441	2.3195
High	2478	2.3202



8.2.4. LOW POWER HDR (HDR8)

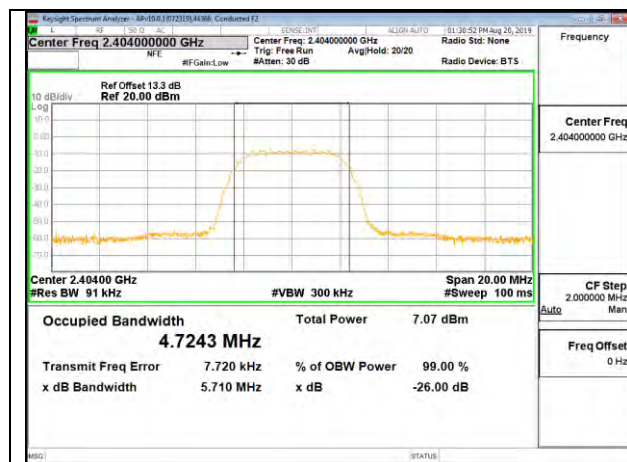
Antenna 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	4.7254
Middle	2441	4.7415
High	2478	4.7355

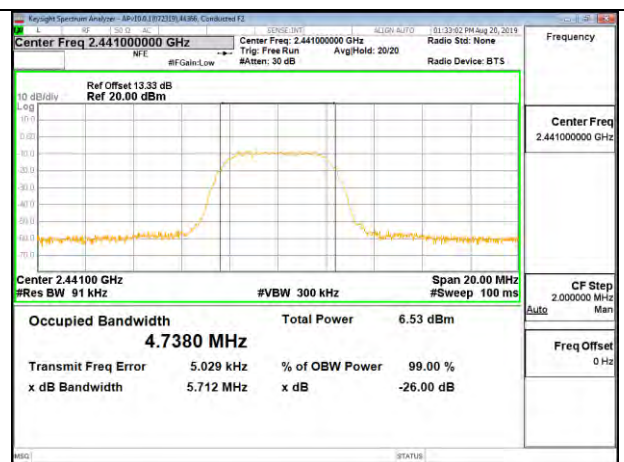


Antenna 3

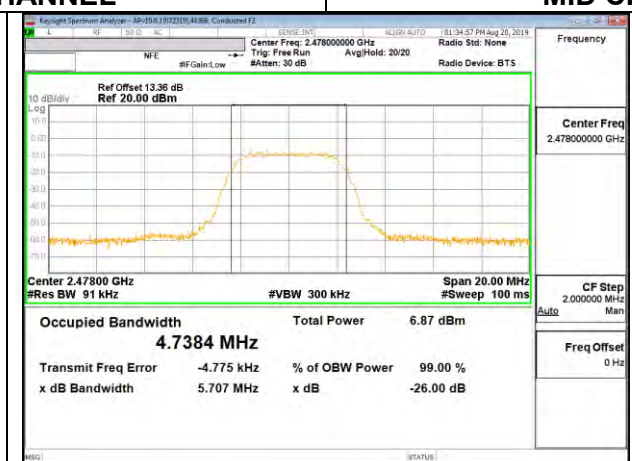
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	4.7243
Middle	2441	4.7380
High	2478	4.7384



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

8.3. BEAMFORMING 99% BANDWIDTH

LIMITS

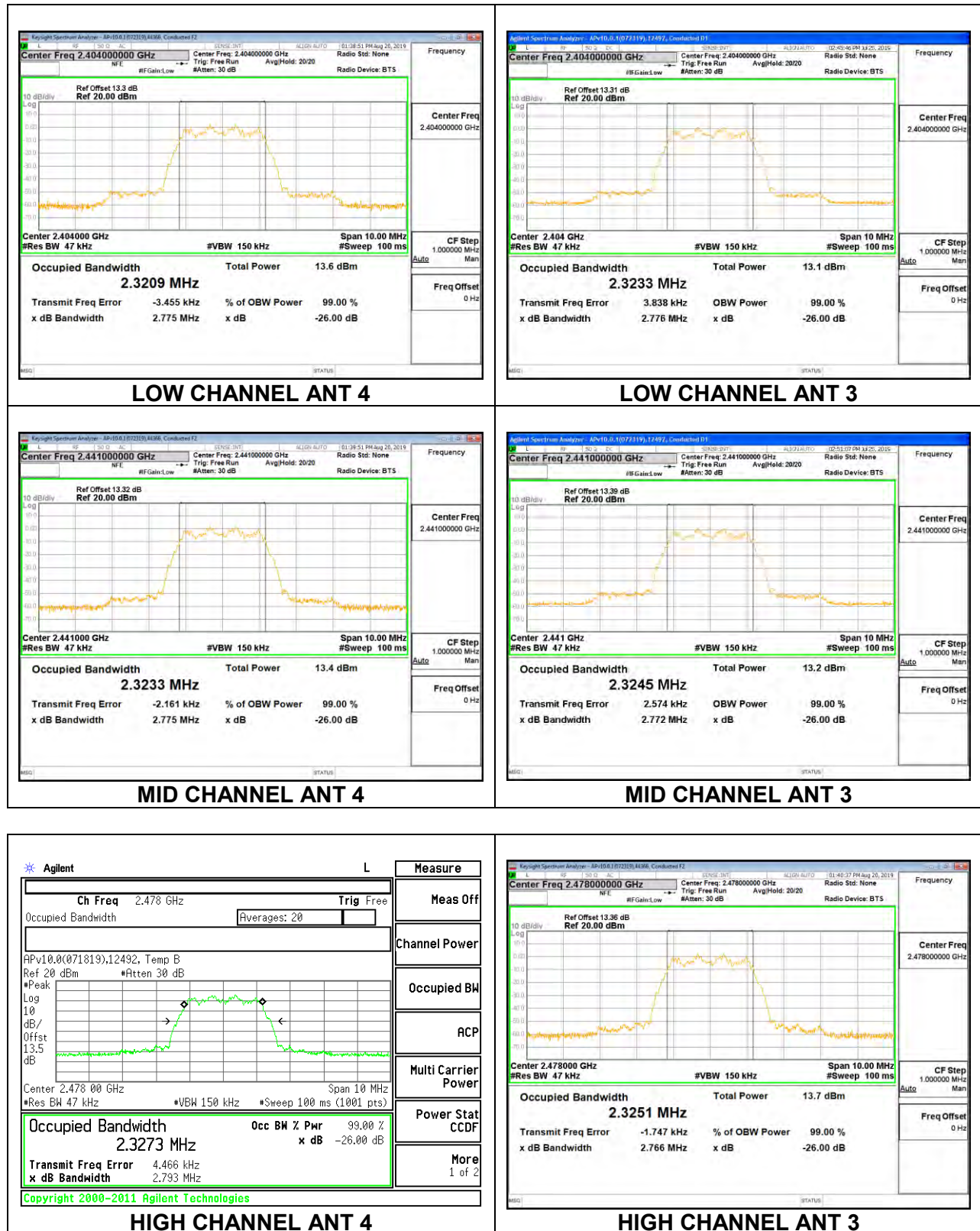
None; for reporting purposes only.

RESULTS

8.3.1. HIGH POWER HDR (HDR4)

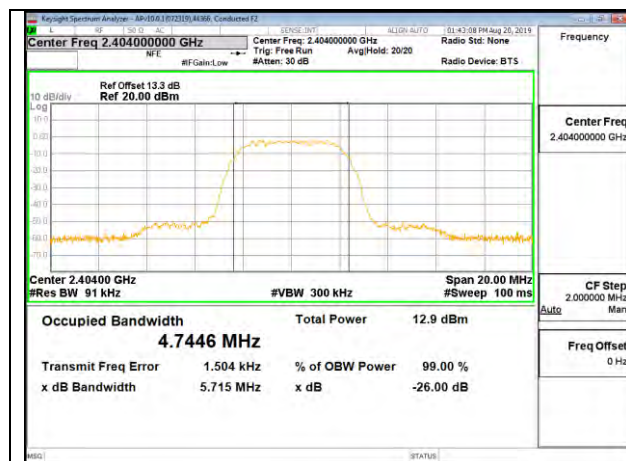
Channel	Frequency (MHz)	99% Bandwidth ANT 4 (MHz)	99% Bandwidth ANT 3 (MHz)
Low	2404	2.3209	2.3233
Mid	2441	2.3233	2.3245
High	2478	2.3273	2.3251

Note: Test procedures and setting on beamforming are same as HDR normal mode



8.3.2. HIGH POWER HDR (HDR8)

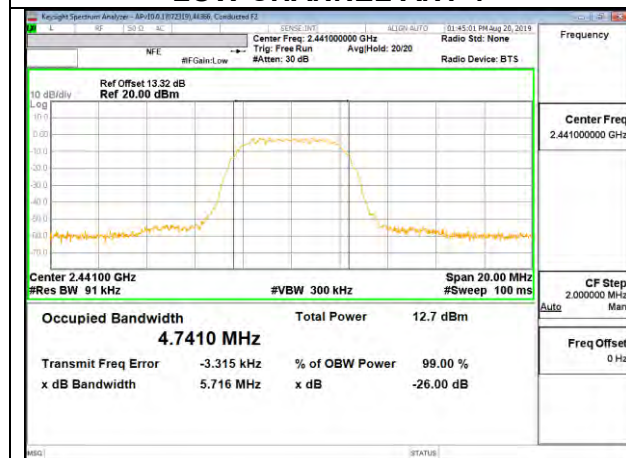
Channel	Frequency (MHz)	99% Bandwidth ANT 4 (MHz)	99% Bandwidth ANT 3 (MHz)
Low	2404	4.7446	4.7432
Mid	2441	4.7410	4.7474
High	2478	4.7474	4.7478



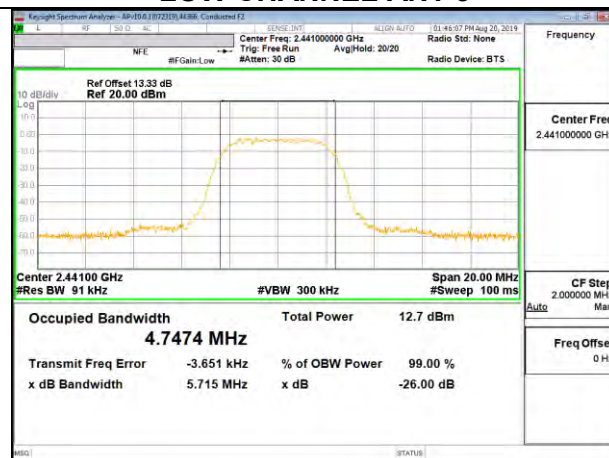
LOW CHANNEL ANT 4



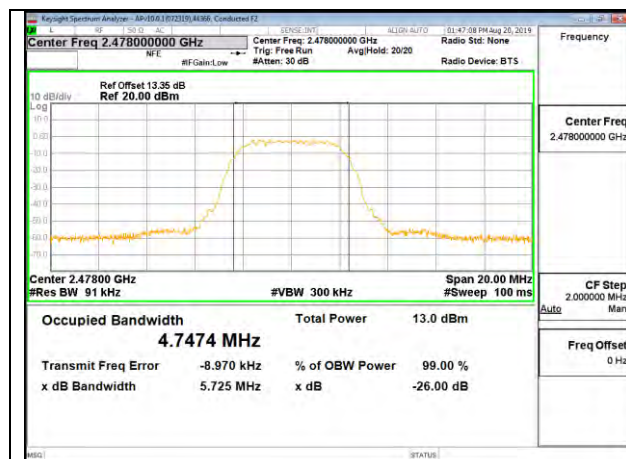
LOW CHANNEL ANT 3



MID CHANNEL ANT 4



MID CHANNEL ANT 3



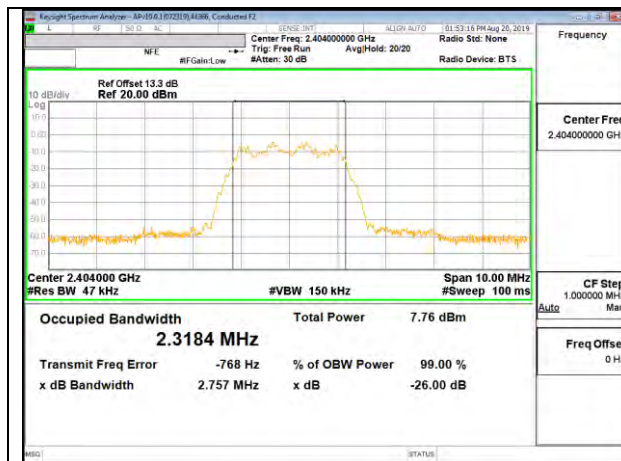
HIGH CHANNEL ANT 4



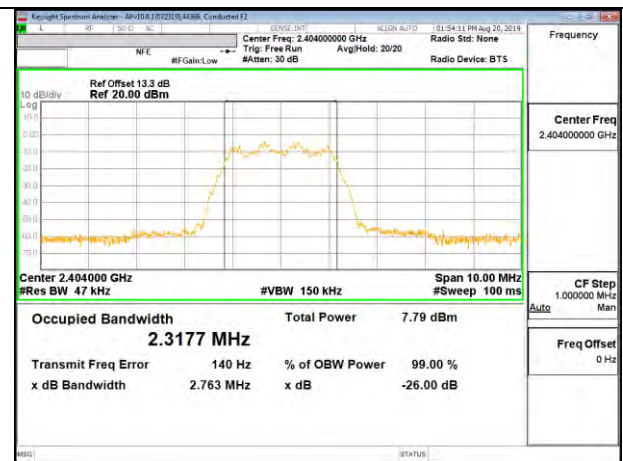
HIGH CHANNEL ANT 3

8.3.3. LOW POWER HDR (HDR4)

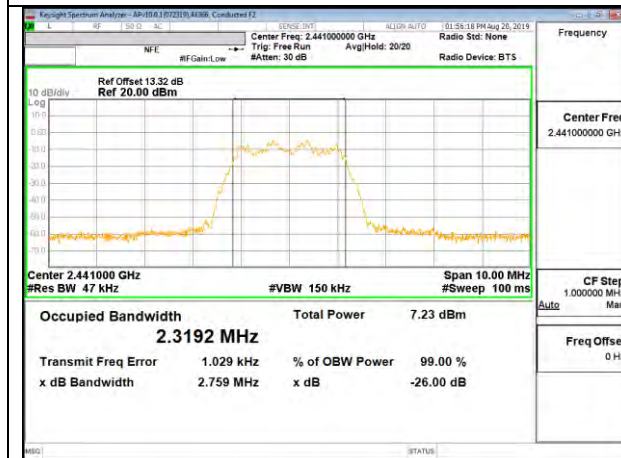
Channel	Frequency (MHz)	99% Bandwidth ANT 4 (MHz)	99% Bandwidth ANT 3 (MHz)
Low	2404	2.3184	2.3177
Mid	2441	2.3192	2.3192
High	2478	2.3193	2.3193



LOW CHANNEL ANT 4



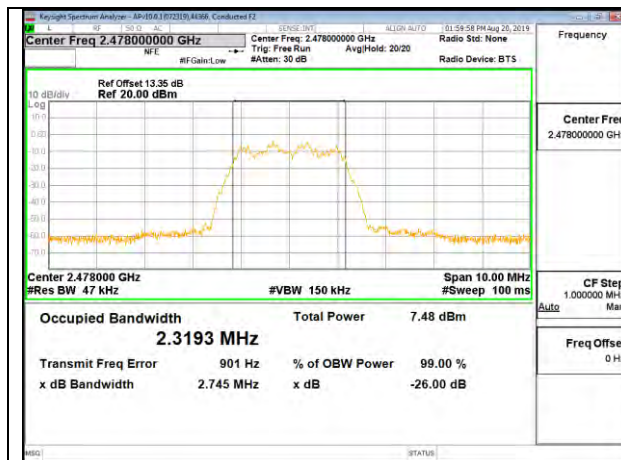
LOW CHANNEL ANT 3



MID CHANNEL ANT 4



MID CHANNEL ANT 3



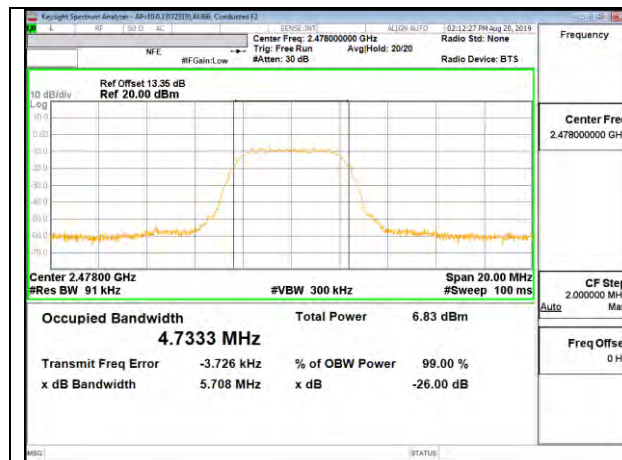
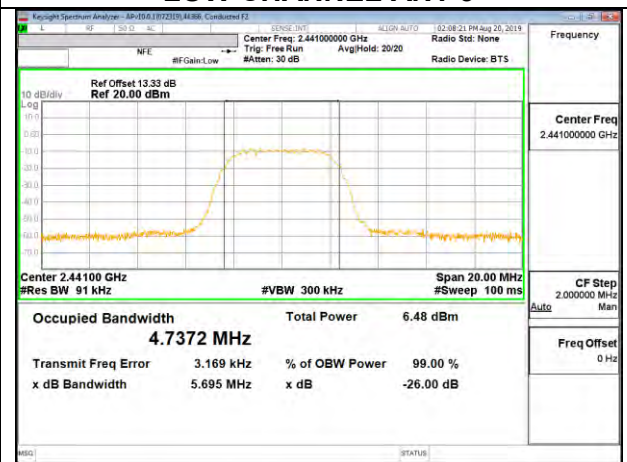
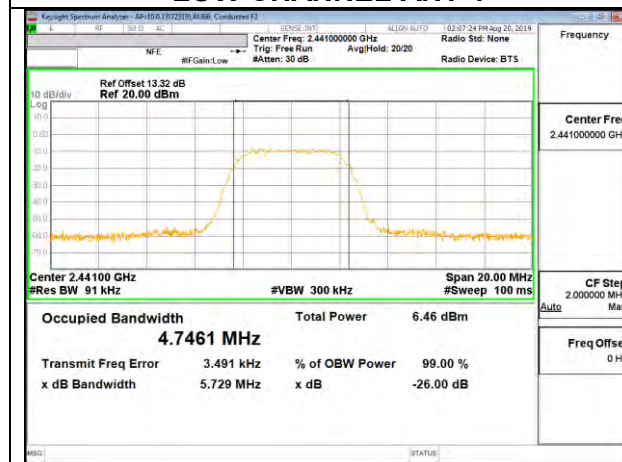
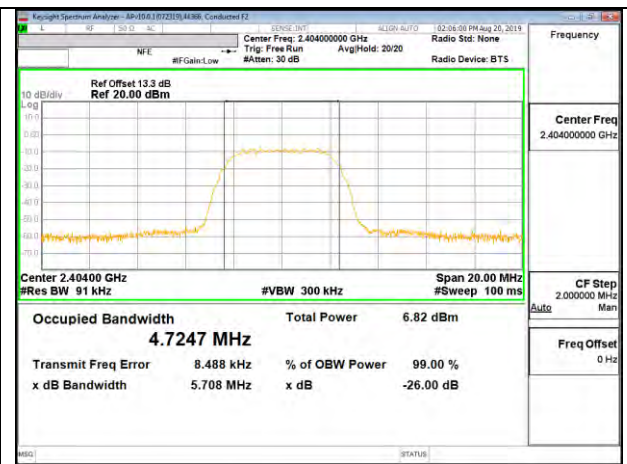
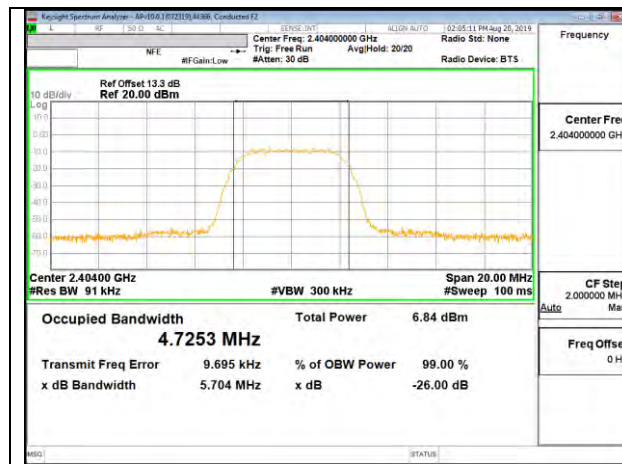
HIGH CHANNEL ANT 4



HIGH CHANNEL ANT 3

8.3.4. LOW POWER HDR (HDR8)

Channel	Frequency (MHz)	99% Bandwidth ANT 4 (MHz)	99% Bandwidth ANT 3 (MHz)
Low	2404	4.7253	4.7247
Mid	2441	4.7461	4.7372
High	2478	4.7333	4.7366



8.4. 6 dB BANDWIDTH

LIMITS

FCC §15.407 (e)

RSS-247 5.2 (a)

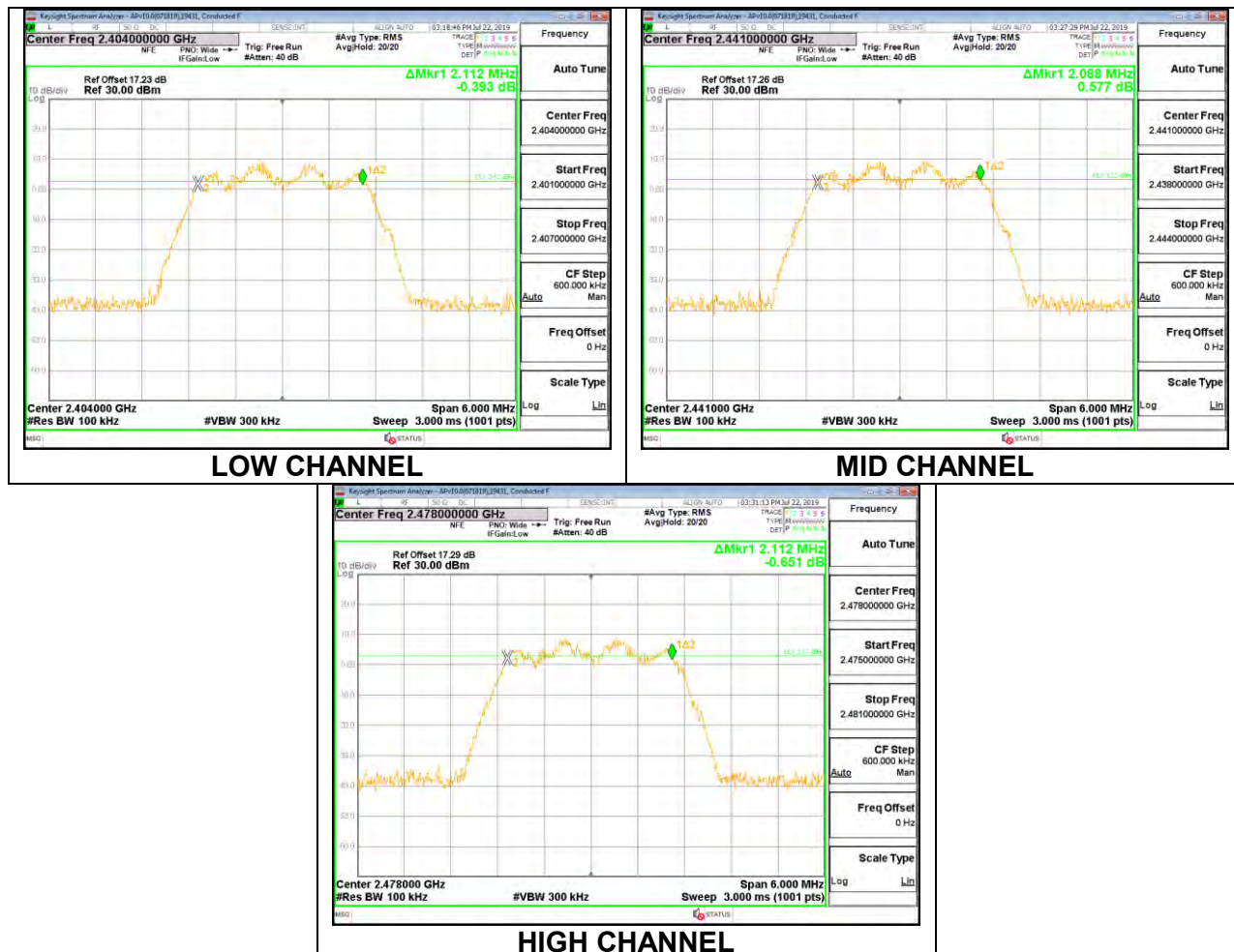
The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS

8.4.1. HIGH POWER HDR (HDR4)

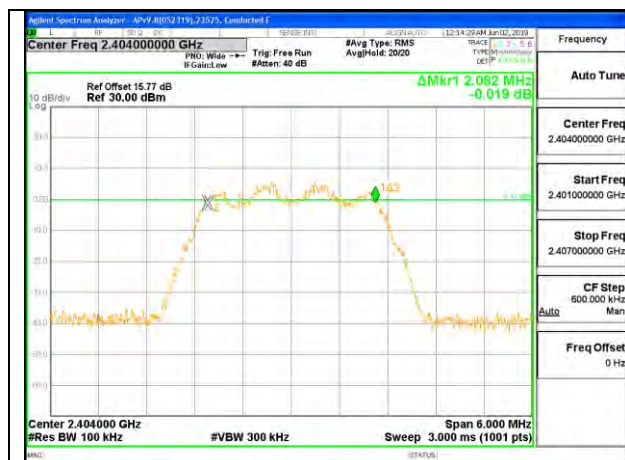
Antenna 4

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2404	2.112	0.5
Middle	2441	2.088	0.5
High	2478	2.112	0.5



Antenna 3

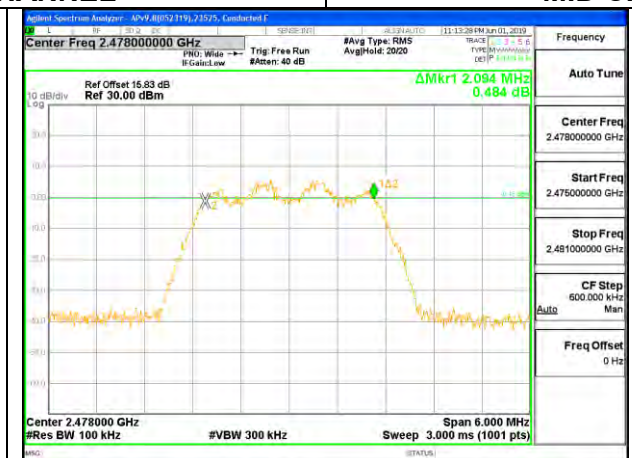
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2404	2.082	0.5
Middle	2441	2.088	0.5
High	2478	2.094	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

8.4.2. HIGH POWER HDR (HDR8)

Antenna 4

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2404	4.128	0.5
Middle	2441	4.002	0.5
High	2478	3.972	0.5



LOW CHANNEL



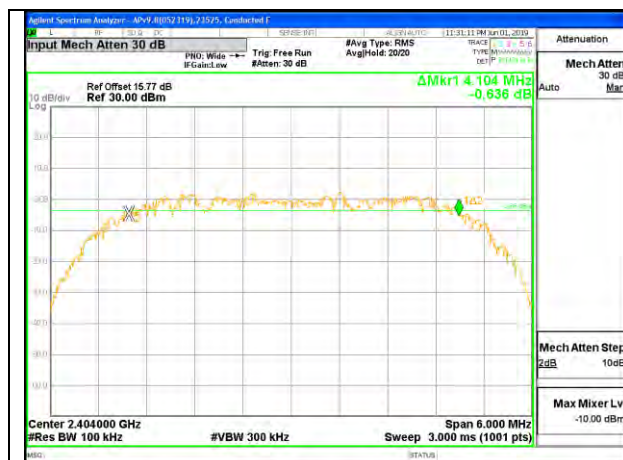
MID CHANNEL



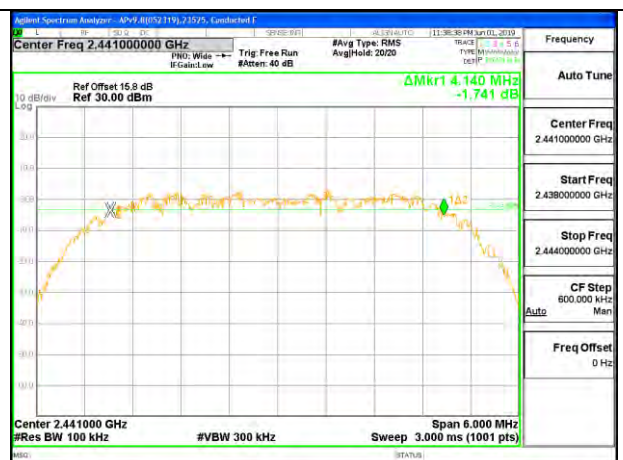
HIGH CHANNEL

Antenna 3

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2404	4.104	0.5
Middle	2441	4.140	0.5
High	2478	4.146	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

8.4.3. LOW POWER HDR (HDR4)

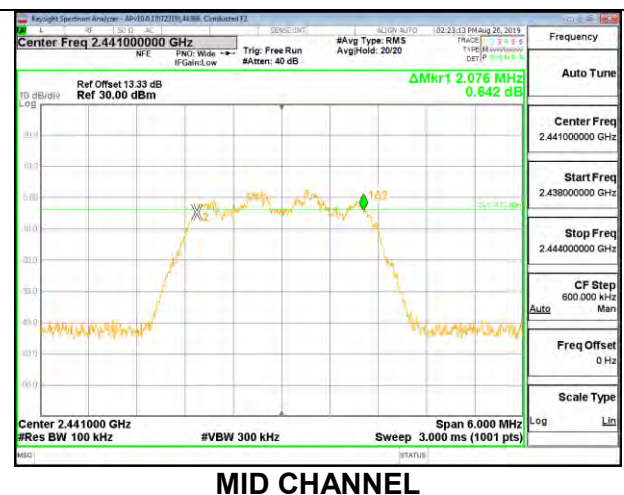
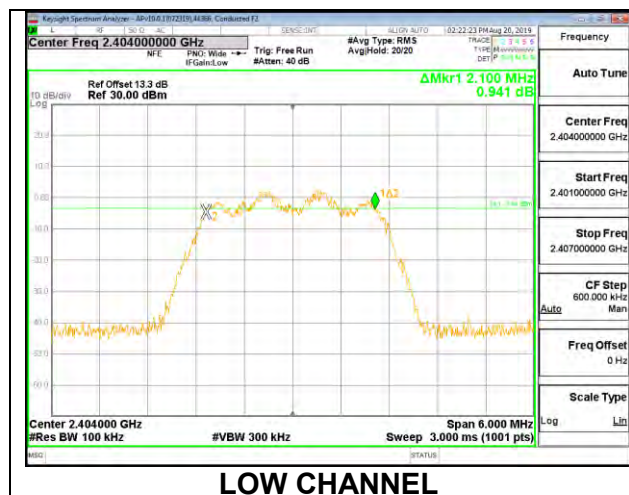
Antenna 4

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2404	2.058	0.5
Middle	2441	2.105	0.5
High	2478	2.094	0.5



Antenna 3

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2404	2.100	0.5
Middle	2441	2.076	0.5
High	2478	2.100	0.5



8.4.4. LOW POWER HDR (HDR8)

Antenna 4

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2404	3.846	0.5
Middle	2441	3.846	0.5
High	2478	3.942	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

Antenna 3

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2404	4.164	0.5
Middle	2441	4.134	0.5
High	2478	4.140	0.5



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

8.5. BEAMFORMING 6 dB BANDWIDTH

LIMITS

FCC §15.407 (e)

RSS-247 5.2 (a)

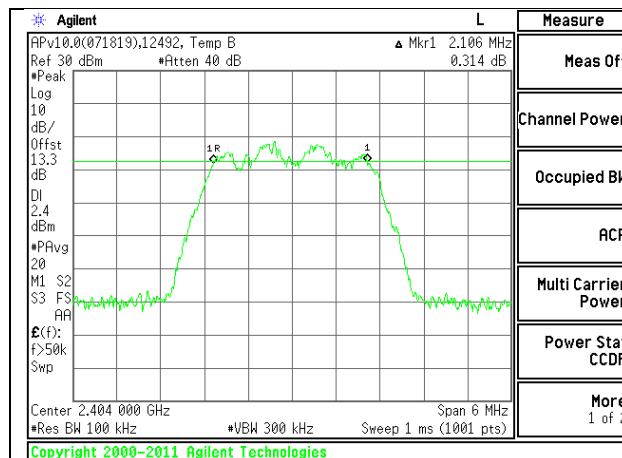
The minimum 6 dB bandwidth shall be at least 500 kHz.

Note: Test procedures and setting on beamforming are same as HDR normal mode

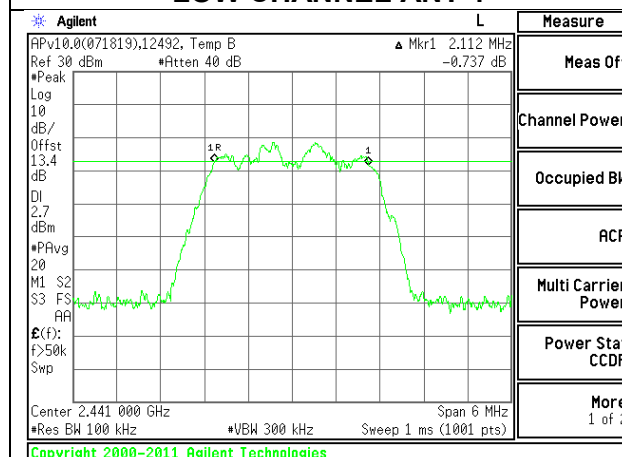
RESULTS

8.5.1. HIGH POWER HDR (HDR4)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
		ANT 4	ANT 3	
Low	2404	2.106	2.106	0.5
Middle	2441	2.112	2.124	0.5
High	2478	2.100	2.112	0.5



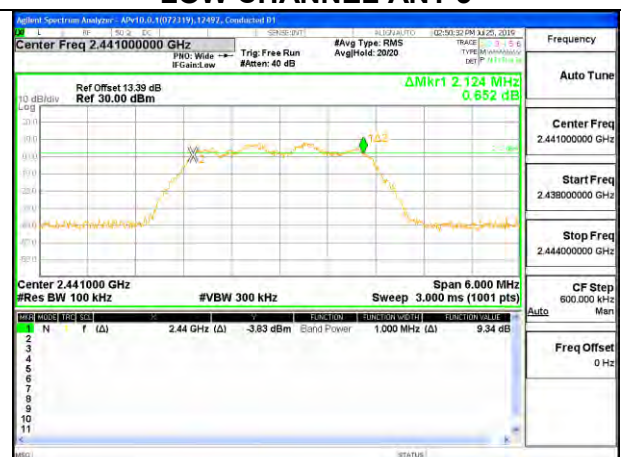
LOW CHANNEL ANT 4



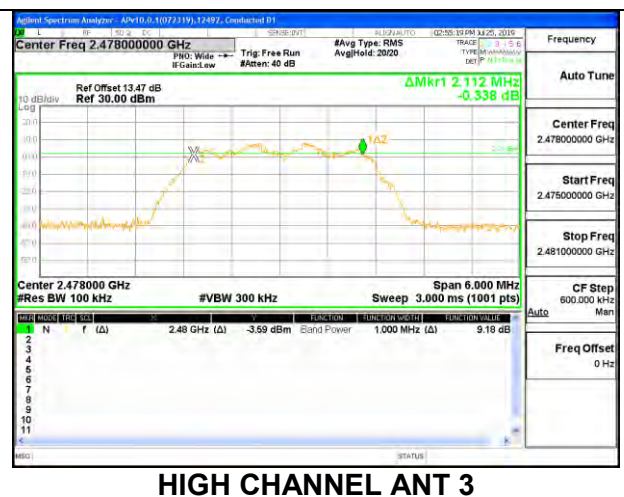
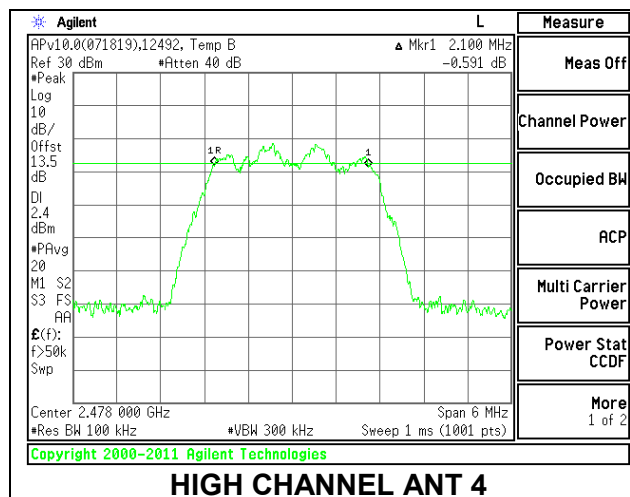
MID CHANNEL ANT 4



LOW CHANNEL ANT 3



MID CHANNEL ANT 3

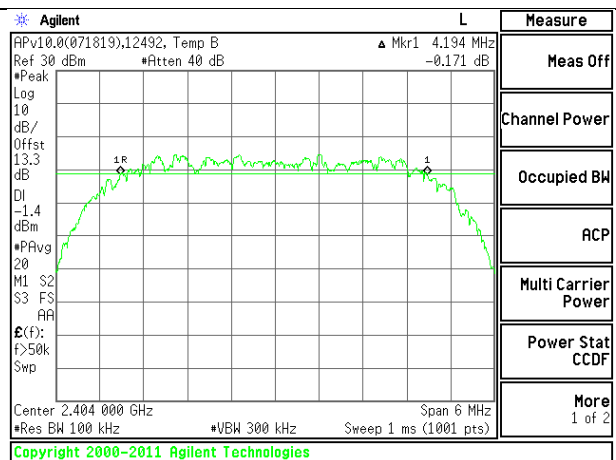


8.5.2. HIGH POWER HDR (HDR8)

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
		ANT 4	ANT 3	
Low	2404	4.092	4.194	0.5
Middle	2441	4.092	4.176	0.5
High	2478	4.098	4.115	0.5



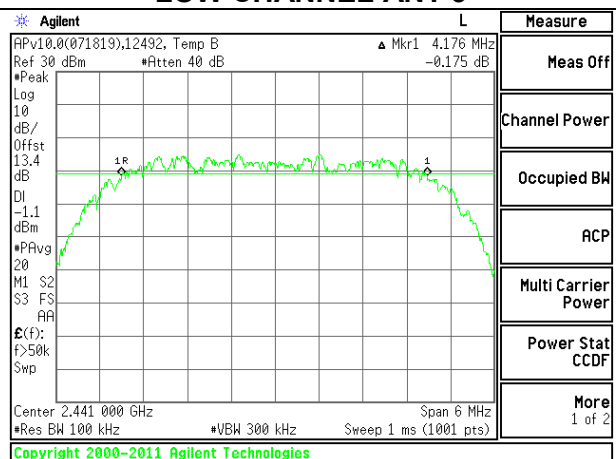
LOW CHANNEL ANT 4



LOW CHANNEL ANT 3



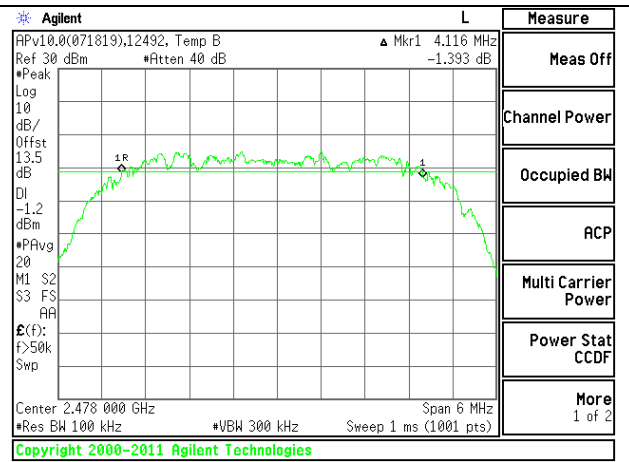
MID CHANNEL ANT 4



MID CHANNEL ANT 3



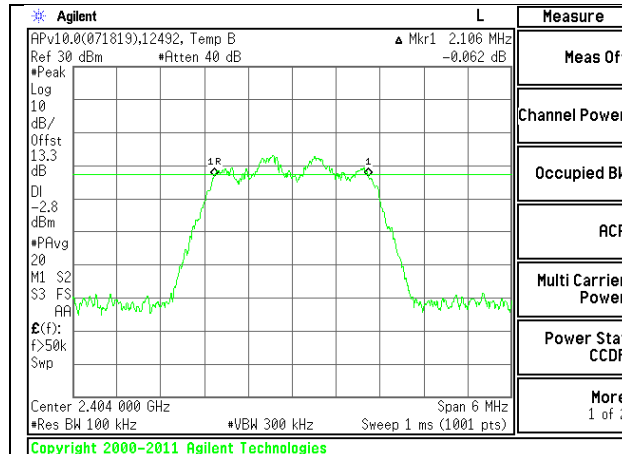
HIGH CHANNEL ANT 4



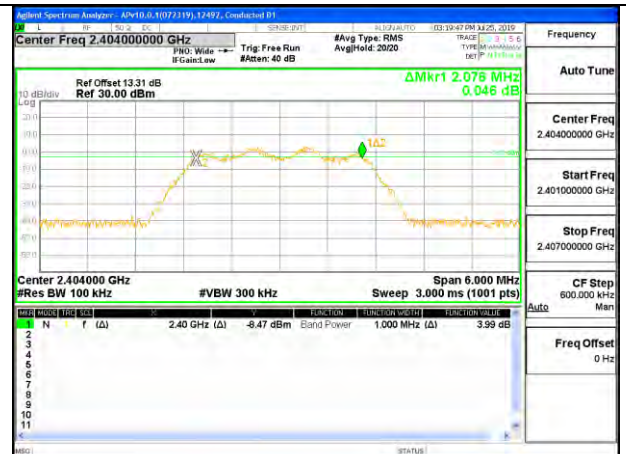
HIGH CHANNEL ANT 3

8.5.3. LOW POWER HDR (HDR4)

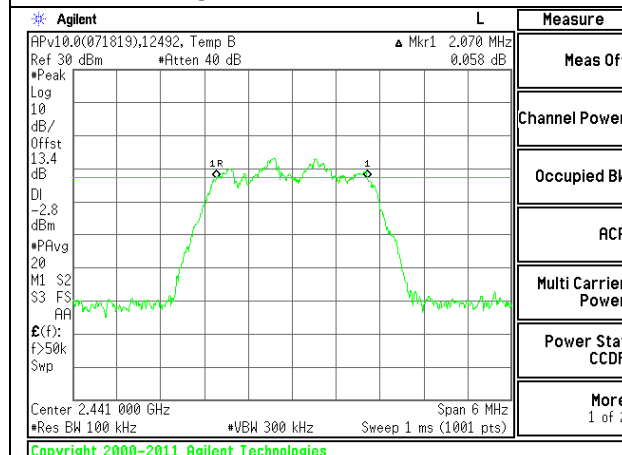
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
		ANT 4	ANT 3	
Low	2404	2.106	2.076	0.5
Middle	2441	2.070	2.070	0.5
High	2478	2.088	2.100	0.5



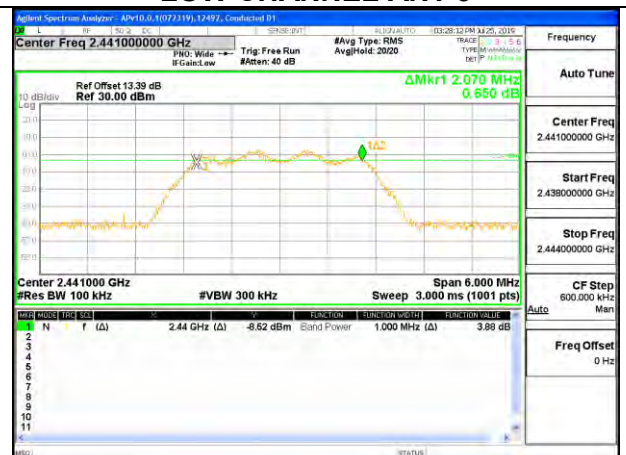
LOW CHANNEL ANT 4



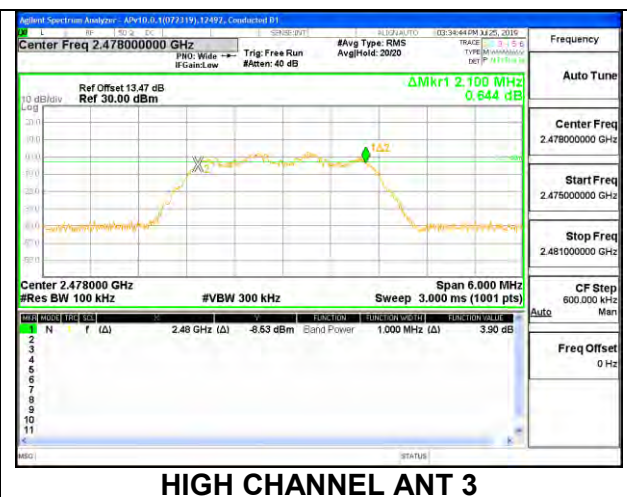
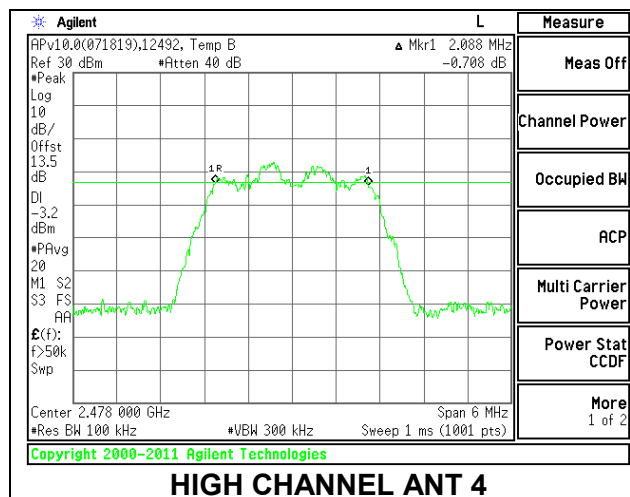
LOW CHANNEL ANT 3



MID CHANNEL ANT 4

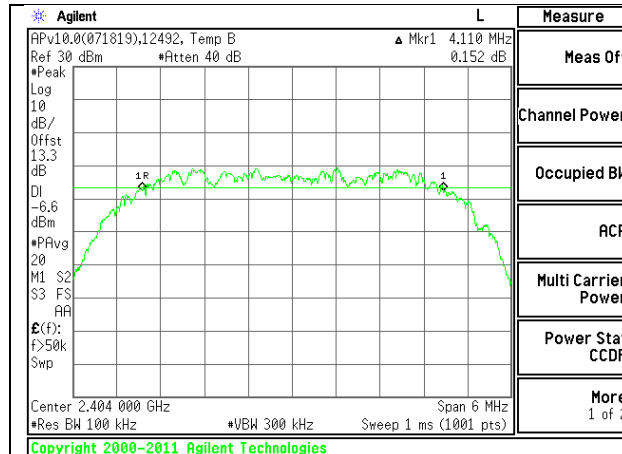


MID CHANNEL ANT 3



8.5.4. LOW POWER HDR (HDR8)

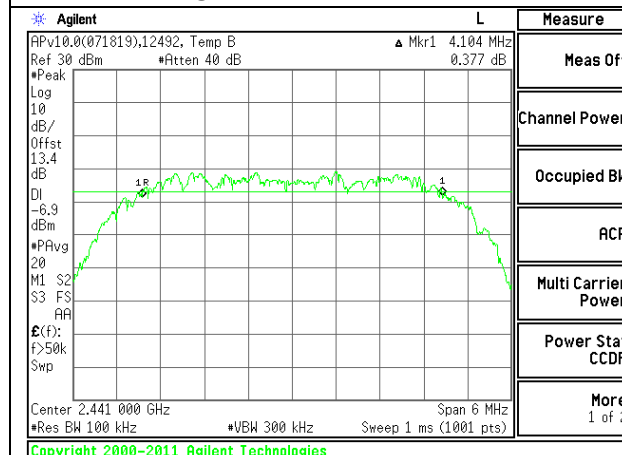
Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
		ANT 4	ANT 3	
Low	2404	4.110	4.158	0.5
Middle	2441	4.104	4.134	0.5
High	2478	4.116	4.152	0.5



LOW CHANNEL ANT 4



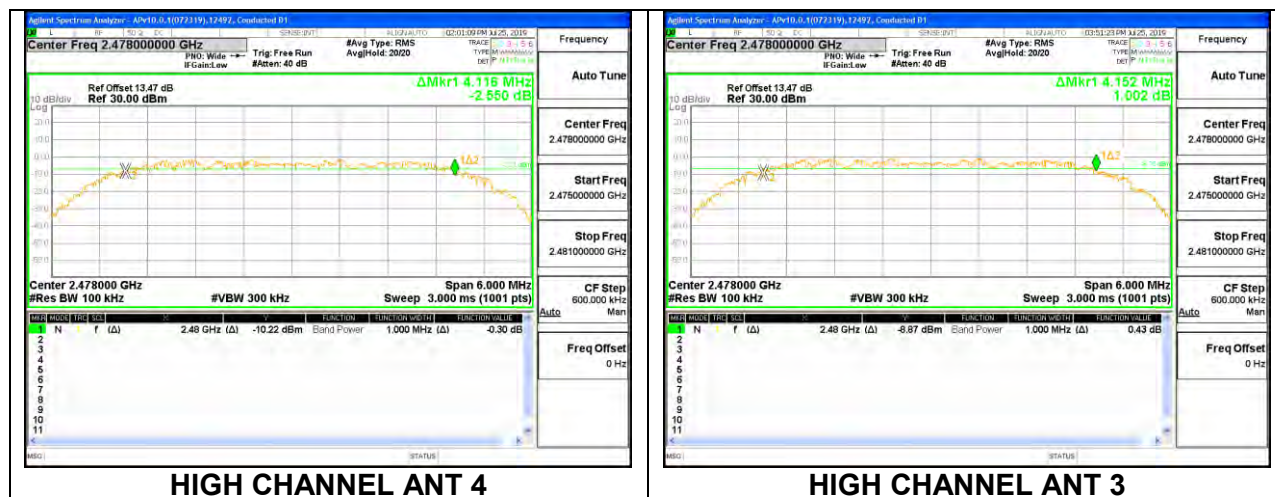
LOW CHANNEL ANT 3



MID CHANNEL ANT 4



MID CHANNEL ANT 3



8.6. OUTPUT POWER

LIMITS

FCC §15.247 (b) (3)

RSS-247 5.4 (d)

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

TEST PROCEDURE

The transmitter output is connected to a 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

8.6.1. HIGH POWER HDR (HDR4)

Antenna 4

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	14.52	30	-15.480
Middle	2441	14.65	30	-15.350
High	2478	14.54	30	-15.460

Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	14.53	30	-15.470
Middle	2441	14.55	30	-15.450
High	2478	14.44	30	-15.560

8.6.2. HIGH POWER HDR (HDR8)

Antenna 4

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	14.56	30	-15.440
Middle	2441	14.98	30	-15.020
High	2478	14.87	30	-15.130

Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	14.78	30	-15.220
Middle	2441	14.93	30	-15.070
High	2478	14.81	30	-15.190

8.6.3. LOW POWER HDR (HDR4)

Antenna 4

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	8.51	30	-21.490
Middle	2441	8.49	30	-21.510
High	2478	8.60	30	-21.400

Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	8.62	30	-21.380
Middle	2441	8.65	30	-21.350
High	2478	8.89	30	-21.110

8.6.4. LOW POWER HDR (HDR8)

Antenna 4

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	8.49	30	-21.510
Middle	2441	8.56	30	-21.440
High	2478	8.78	30	-21.220

Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	8.36	30	-21.640
Middle	2441	8.49	30	-21.510
High	2478	8.71	30	-21.290

8.7. BEAMFORMING OUTPUT POWER

8.7.1. HIGH POWER HDR (HDR4)

Antenna 4 + Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power Antenna 4 (dBm)	Output Power Antenna 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2404	14.58	14.67	17.64	30	-12.36
Middle	2441	14.97	14.69	17.84	30	-12.16
High	2478	14.82	14.59	17.72	30	-12.28

8.7.2. HIGH POWER HDR (HDR8)

Antenna 4 + Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power Antenna 4 (dBm)	Output Power Antenna 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2404	14.69	14.88	17.80	30	-12.20
Middle	2441	14.89	14.97	17.94	30	-12.06
High	2478	14.74	14.93	17.85	30	-12.15

Note: Test procedures and setting on beamforming are same as HDR normal mode

8.7.3. LOW POWER HDR (HDR4)

Antenna 4 + Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power Antenna 4 (dBm)	Output Power Antenna 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2404	8.69	8.75	11.73	30	-18.27
Middle	2441	8.64	8.64	11.65	30	-18.35
High	2478	8.52	8.59	11.57	30	-18.43

8.7.4. LOW POWER HDR (HDR8)

Antenna 4 + Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Output Power Antenna 4 (dBm)	Output Power Antenna 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2404	8.75	8.61	11.69	30	-18.31
Middle	2441	8.93	8.73	11.84	30	-18.16
High	2478	8.71	8.68	11.71	30	-18.29

Note: Test procedures and setting on beamforming are same as HDR normal mode

8.8. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

The transmitter output is connected to a 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

8.8.1. HIGH POWER HDR (HDR4)

Antenna 4

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	11.92
Middle	2441	11.95
High	2478	11.93

Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	11.91
Middle	2441	11.94
High	2478	11.89

8.8.2. HIGH POWER HDR (HDR8)

Antenna 4

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	11.89
Middle	2441	11.96
High	2478	11.94

Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	11.92
Middle	2441	11.98
High	2478	11.94

8.8.3. LOW POWER HDR (HDR4)

Antenna 4

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	6.45
Middle	2441	6.44
High	2478	6.47

Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	6.41
Middle	2441	6.46
High	2478	6.48

8.8.4. LOW POWER HDR (HDR8)

Antenna 4

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	6.43
Middle	2441	6.45
High	2478	6.47

Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	6.39
Middle	2441	6.43
High	2478	6.48

8.9. BEAMFORMING AVERAGE POWER

8.9.1. HIGH POWER HDR (HDR4)

Antenna 4 + Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Average Power Antenna 4 (dBm)	Average Power Antenna 3 (dBm)	Total Power (dBm)
Low	2404	11.88	11.95	14.93
Middle	2441	11.97	11.96	14.98
High	2478	11.94	11.92	14.94

8.9.2. HIGH POWER HDR (HDR8)

Antenna 4 + Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Average Power Antenna 4 (dBm)	Average Power Antenna 3 (dBm)	Total Power (dBm)
Low	2404	11.89	11.88	14.90
Middle	2441	11.93	11.96	14.96
High	2478	11.9	11.93	14.93

Note: Test procedures and setting on beamforming are same as HDR normal mode

8.9.3. LOW POWER HDR (HDR4)

Antenna 4 + Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Average Power Antenna 4 (dBm)	Average Power Antenna 3 (dBm)	Total Power (dBm)
Low	2404	6.49	6.48	9.50
Middle	2441	6.47	6.44	9.47
High	2478	6.41	6.39	9.41

8.9.4. LOW POWER HDR (HDR8)

Antenna 4 + Antenna 3

Tested By:	12492
Date:	7/24/2019

Channel	Frequency (MHz)	Average Power Antenna 4 (dBm)	Average Power Antenna 3 (dBm)	Total Power (dBm)
Low	2404	6.42	6.44	9.44
Middle	2441	6.45	6.46	9.47
High	2478	6.40	6.48	9.45

8.10. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

RSS-247 (5.2) (b)

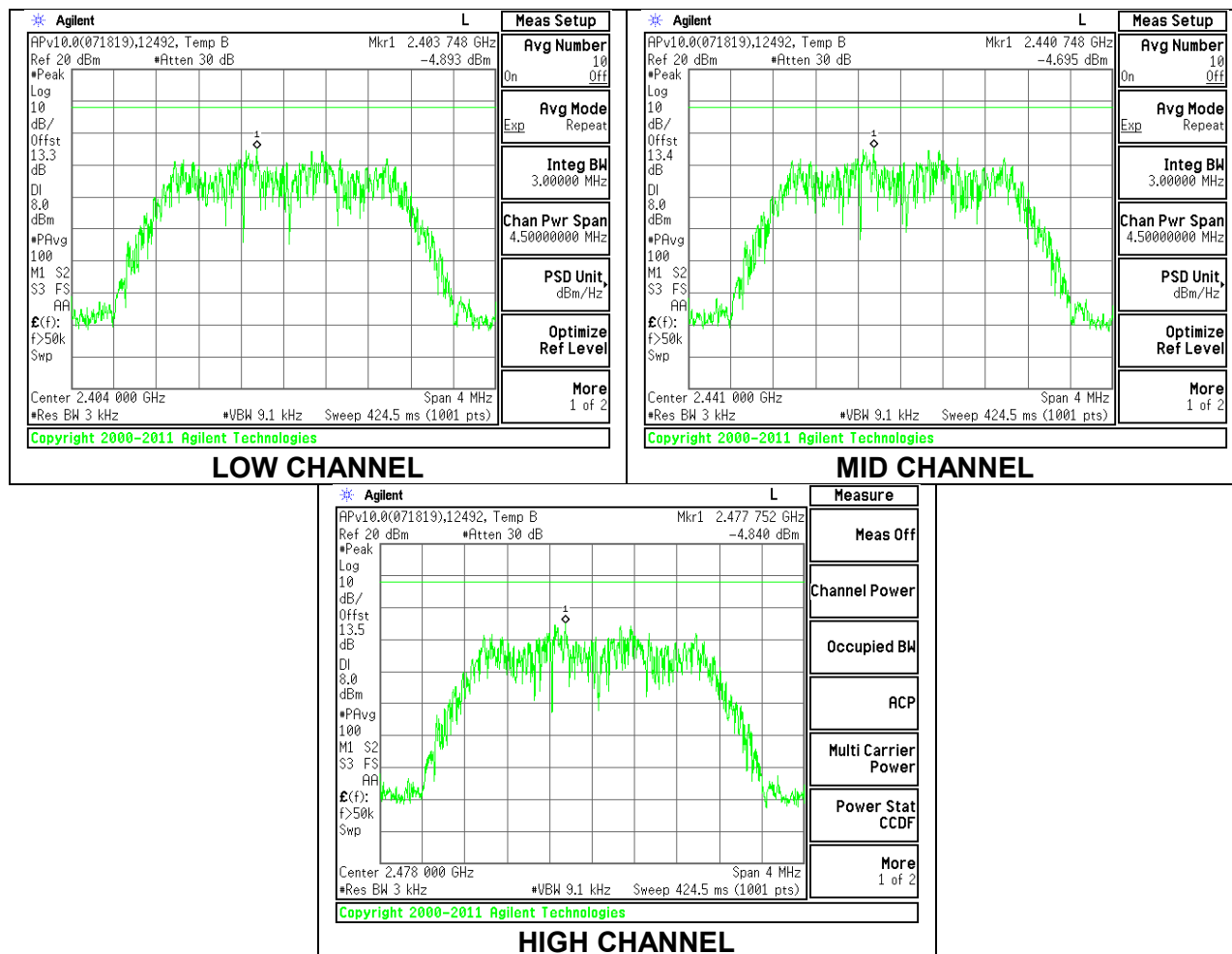
The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS

8.10.1. HIGH POWER HDR (HDR4)

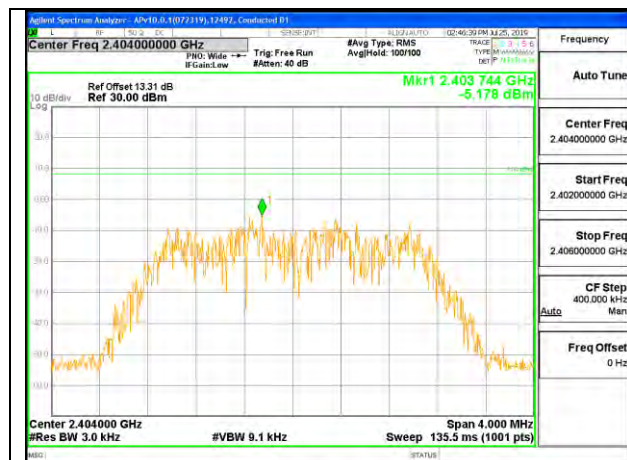
Antenna 4

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2404	-4.893	8	-12.89
Middle	2441	-4.695	8	-12.70
High	2478	-4.840	8	-12.84

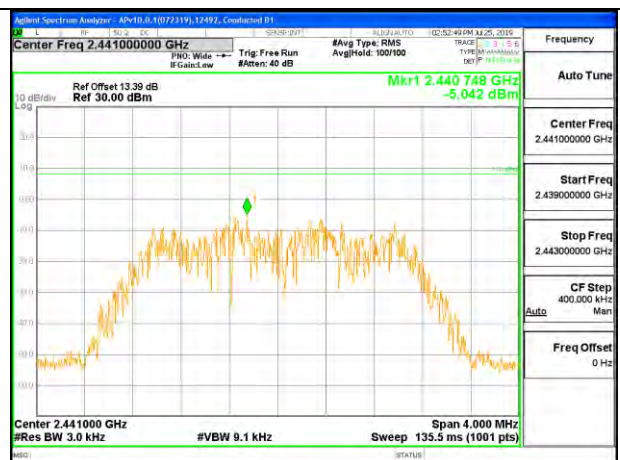


Antenna 3

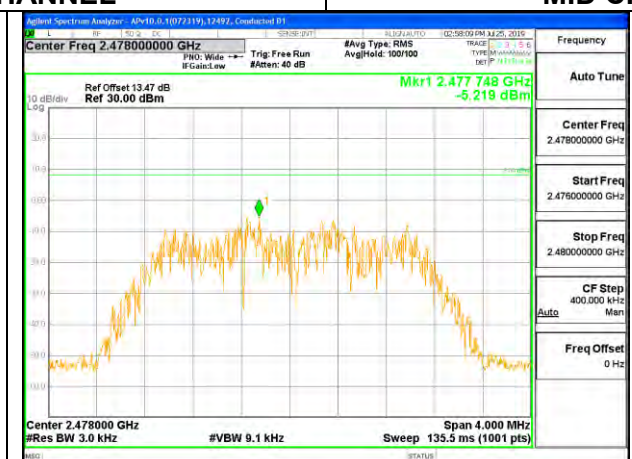
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2404	-5.178	8	-13.18
Middle	2441	-5.042	8	-13.04
High	2478	-5.219	8	-13.22



LOW CHANNEL



MID CHANNEL

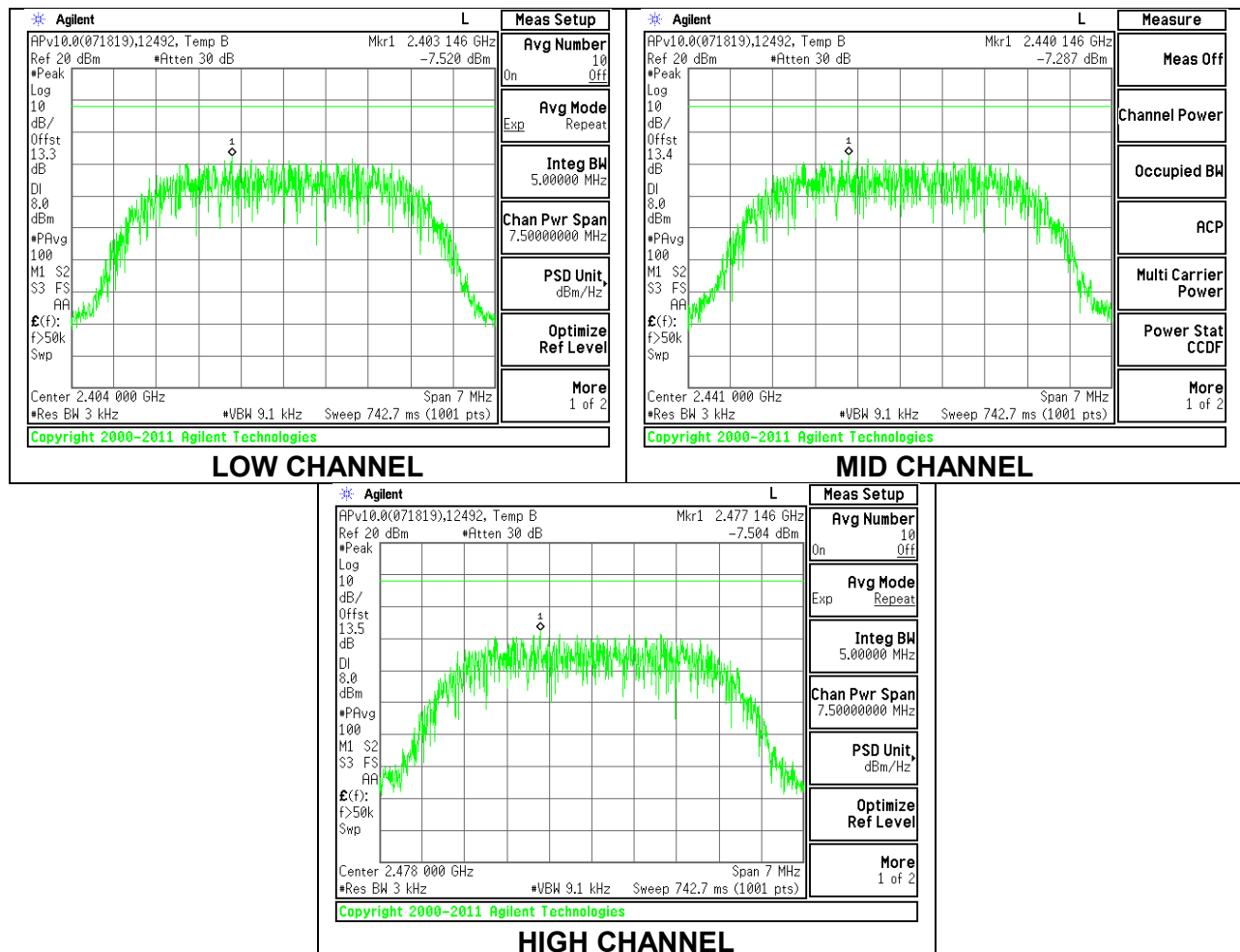


HIGH CHANNEL

8.10.2. HIGH POWER HDR (HDR8)

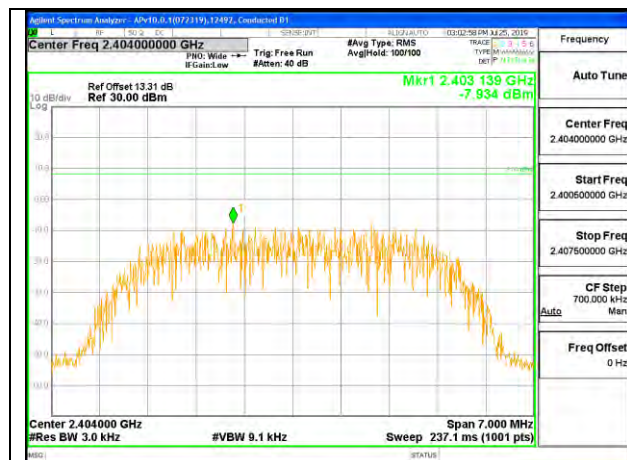
Antenna 4

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2404	-7.520	8	-15.52
Middle	2441	-7.287	8	-15.29
High	2478	-7.504	8	-15.50

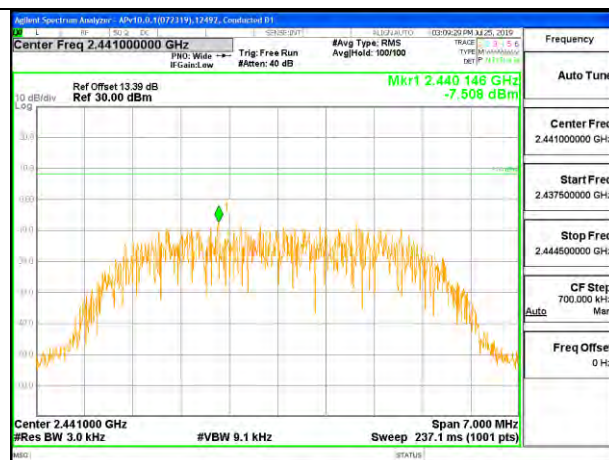


Antenna 3

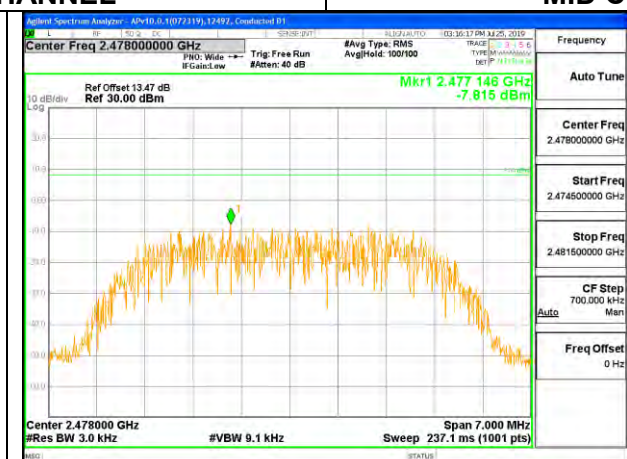
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2404	-7.934	8	-15.93
Middle	2441	-7.508	8	-15.51
High	2478	-7.815	8	-15.82



LOW CHANNEL



MID CHANNEL

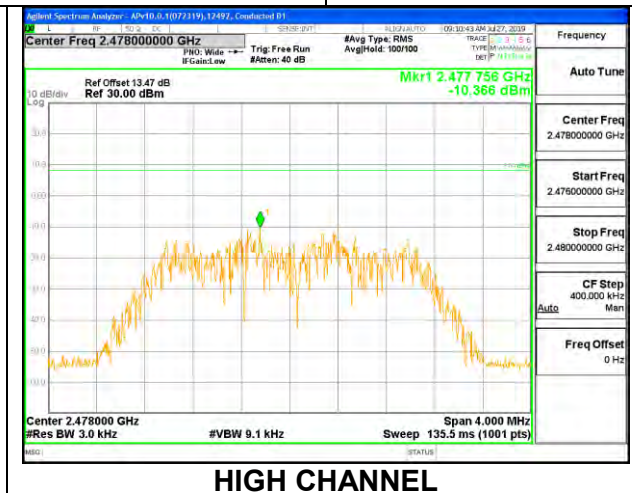
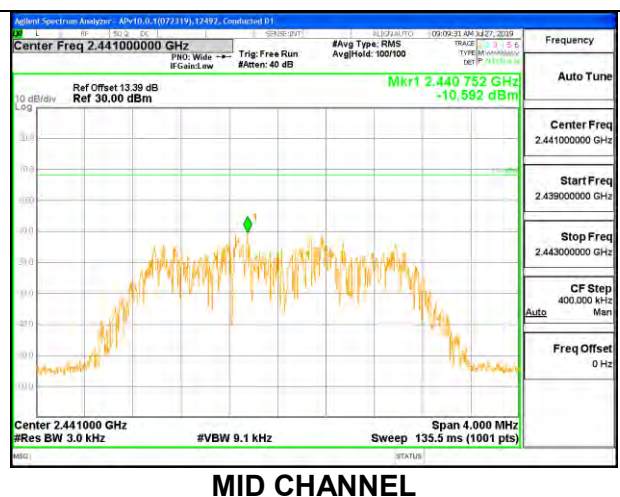
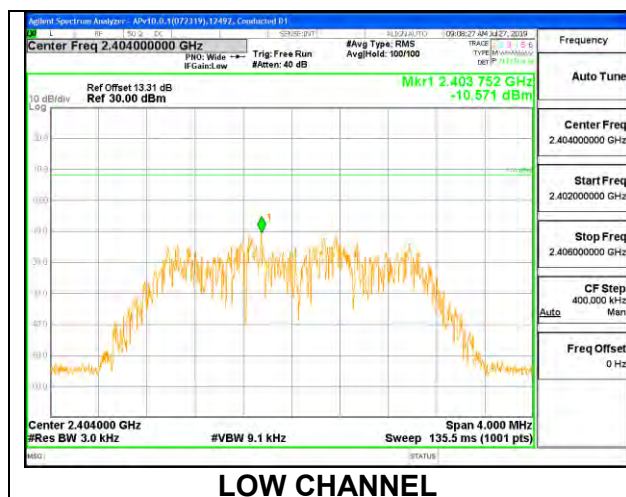


HIGH CHANNEL

8.10.3. LOW POWER HDR (HDR4)

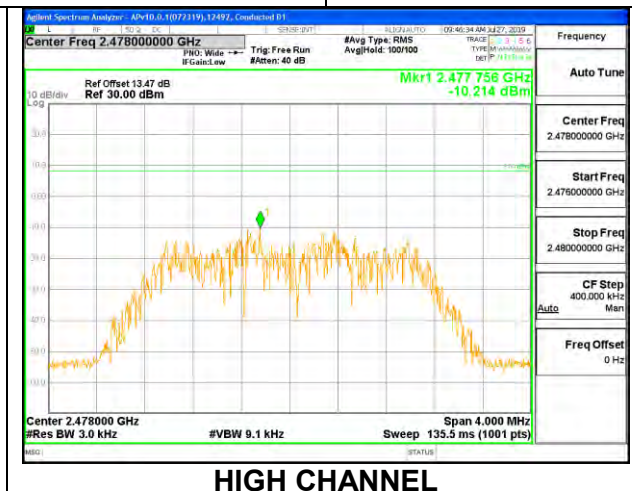
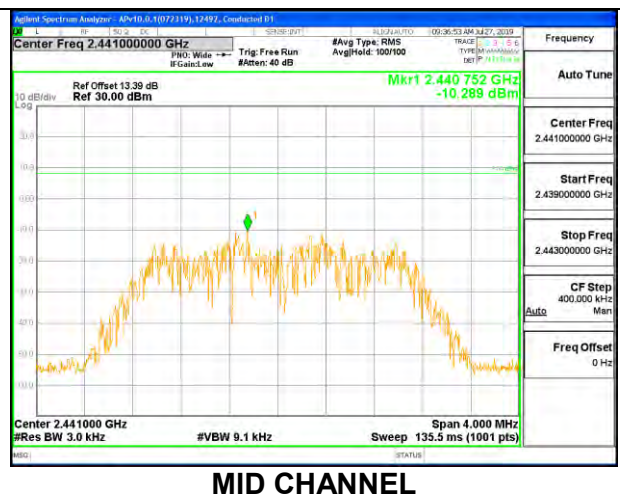
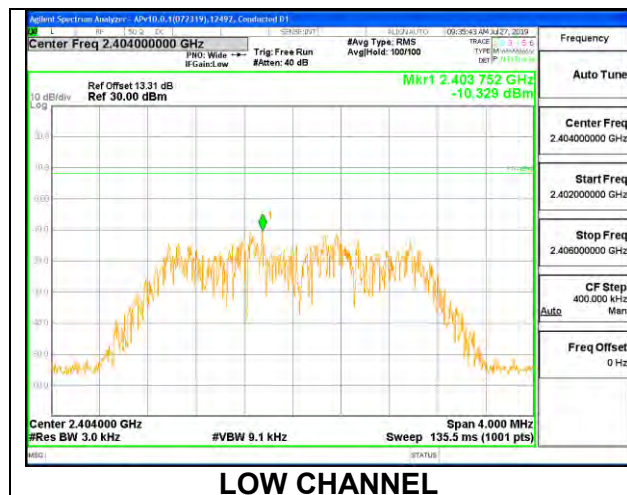
Antenna 4

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2404	-10.571	8	-18.57
Middle	2441	-10.592	8	-18.59
High	2478	-10.366	8	-18.37



Antenna 3

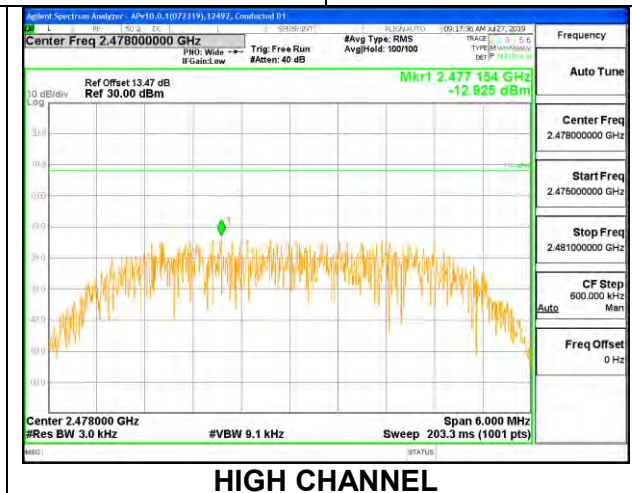
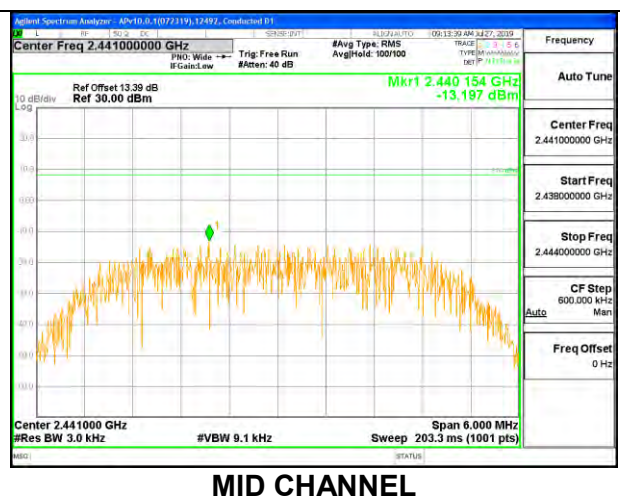
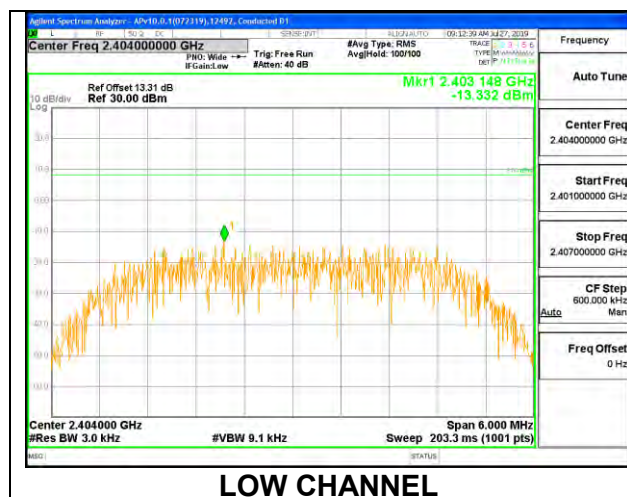
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2404	-10.329	8	-18.33
Middle	2441	-10.289	8	-18.29
High	2478	-10.214	8	-18.21



8.10.4. LOW POWER HDR (HDR8)

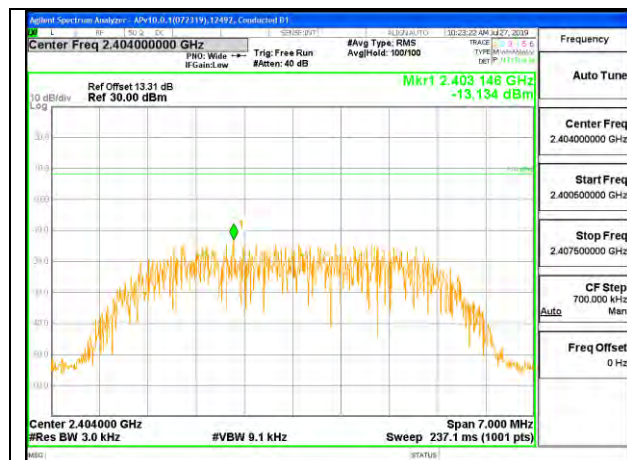
Antenna 4

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2404	-13.332	8	-21.33
Middle	2441	-13.197	8	-21.20
High	2478	-12.925	8	-20.93

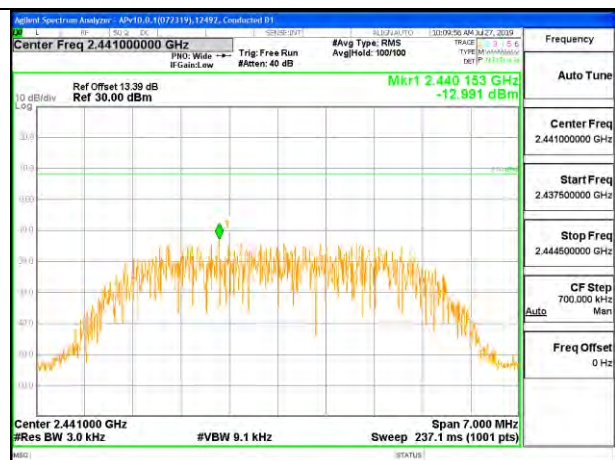


Antenna 3

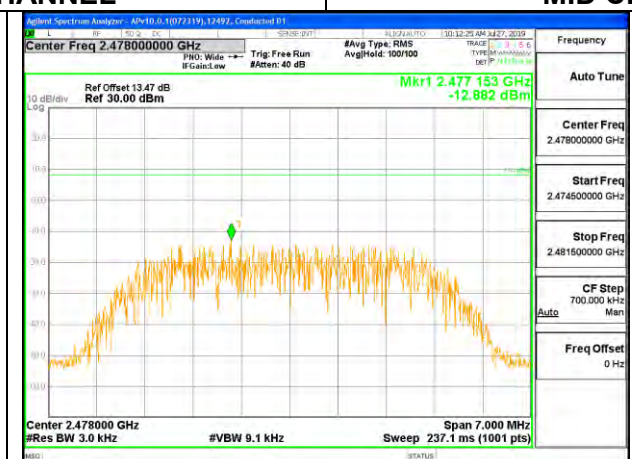
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2404	-13.134	8	-21.13
Middle	2441	-12.991	8	-20.99
High	2478	-12.882	8	-20.88



LOW CHANNEL



MID CHANNEL



HIGH CHANNEL

8.11. BEAMFORMING POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

RSS-247 (5.2) (b)

The power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Note: Test procedures and setting on beamforming are same as HDR normal mode

RESULTS

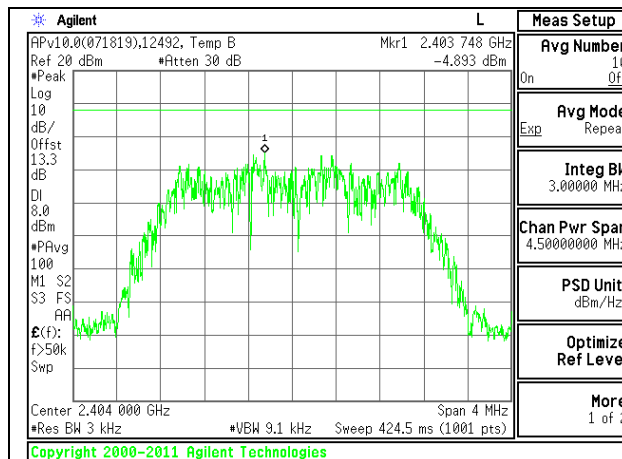
8.11.1. HIGH POWER HDR (HDR4)

Antenna 4 + Antenna 3

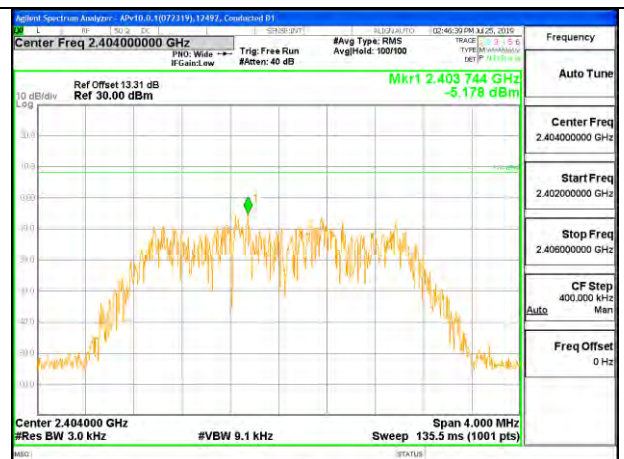
Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD
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PSD Results

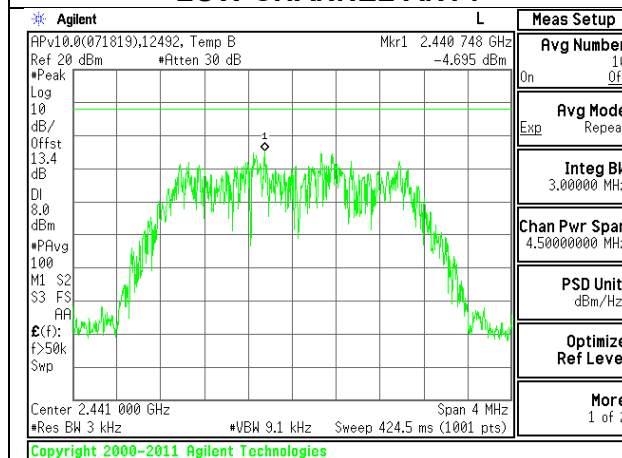
Channel	Frequency (MHz)	Ant 4 Meas (dBm/ 3kHz)	Ant 3 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low	2404	-4.893	-5.178	-2.02	8.0	-10.0
Mid	2441	-4.695	-5.042	-1.85	8.0	-9.9
High	2478	-4.840	-5.219	-2.02	8.0	-10.0



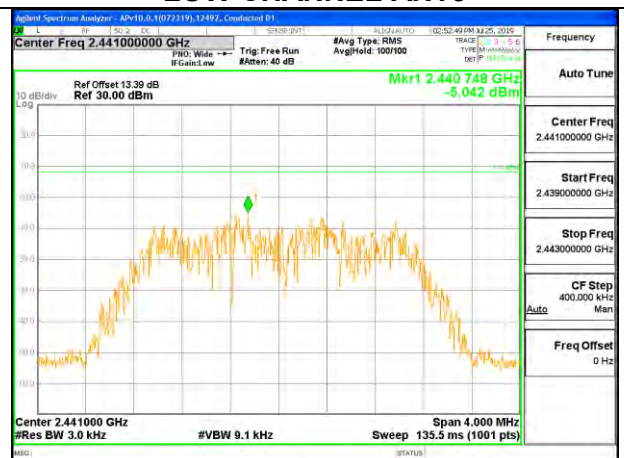
LOW CHANNEL ANT4



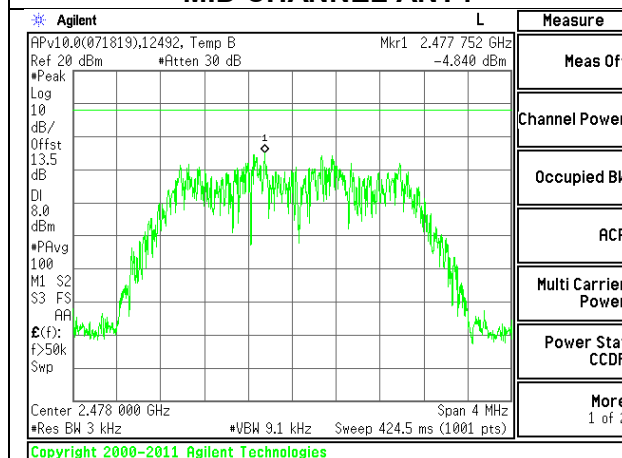
LOW CHANNEL ANT3



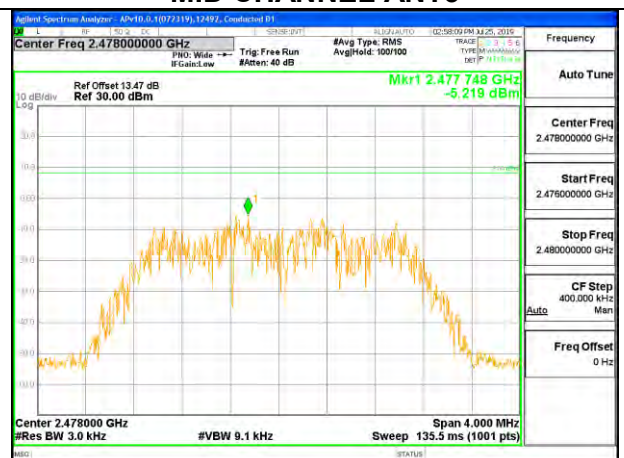
MID CHANNEL ANT4



MID CHANNEL ANT3



HIGH CHANNEL ANT4



HIGH CHANNEL ANT3

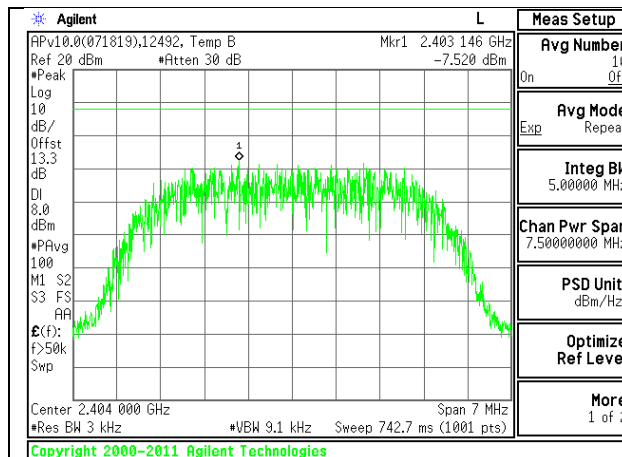
8.11.2. HIGH POWER HDR (HDR8)

Antenna 4 + Antenna 3

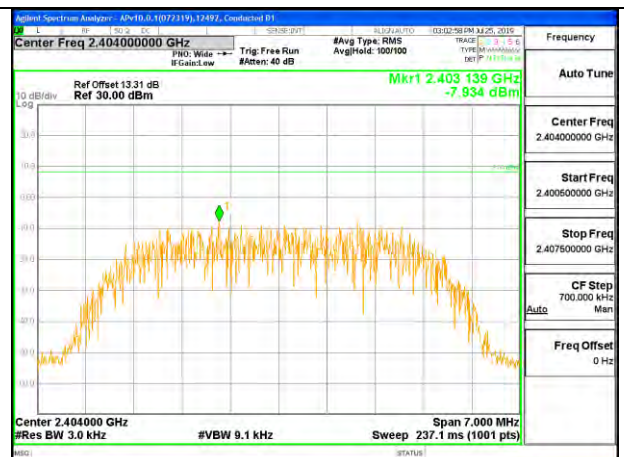
Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD
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PSD Results

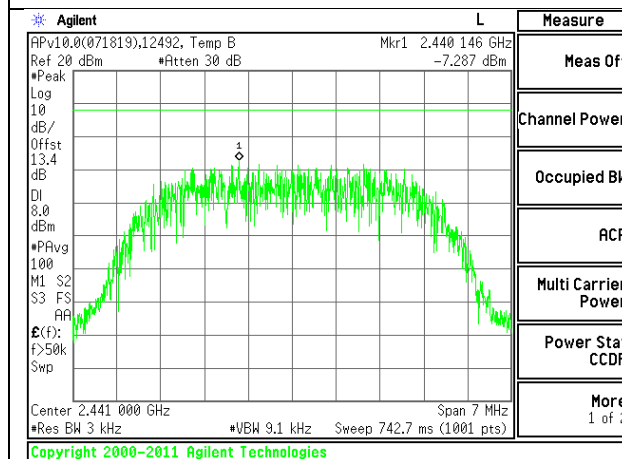
Channel	Frequency (MHz)	Ant 4 Meas (dBm/ 3kHz)	Ant 3 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low	2404	-7.520	-7.934	-4.71	8.0	-12.7
Mid	2441	-7.287	-7.508	-4.39	8.0	-12.4
High	2478	-7.504	-7.815	-4.65	8.0	-12.6



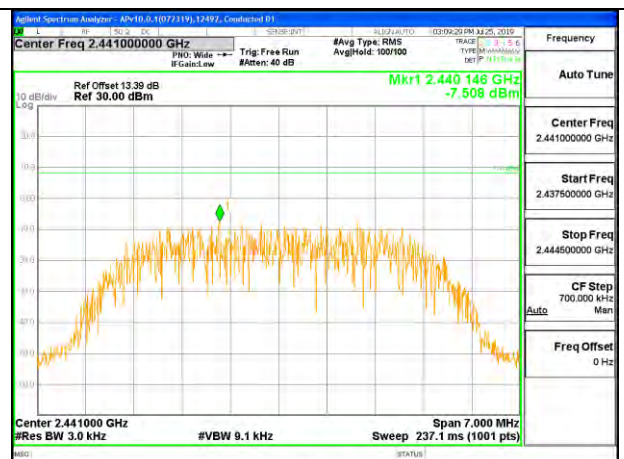
LOW CHANNEL ANT4



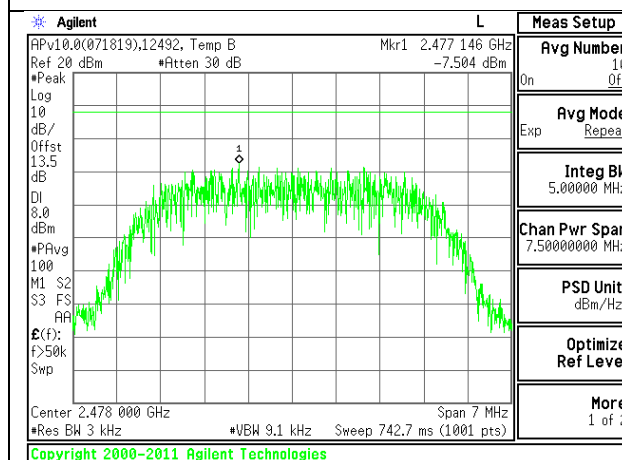
LOW CHANNEL ANT3



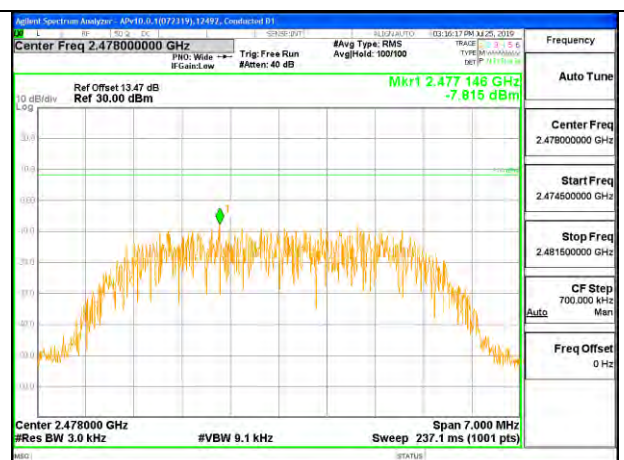
MID CHANNEL ANT4



MID CHANNEL ANT3



HIGH CHANNEL ANT4



HIGH CHANNEL ANT3

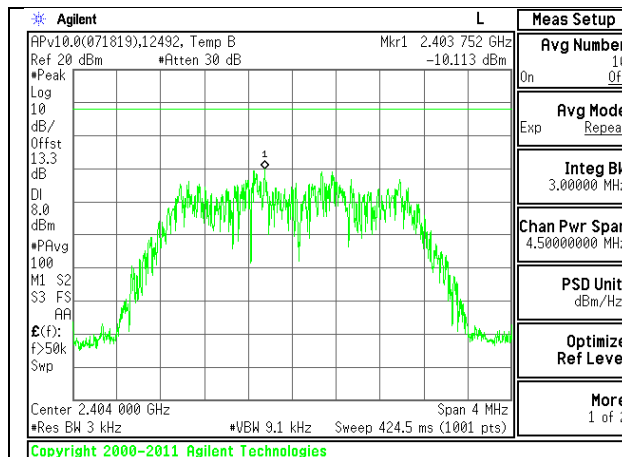
8.11.3. LOW POWER HDR (HDR4)

Antenna 4 + Antenna 3

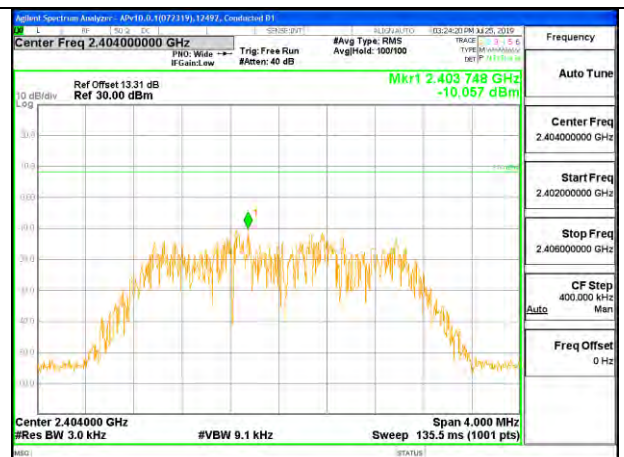
Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD
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PSD Results

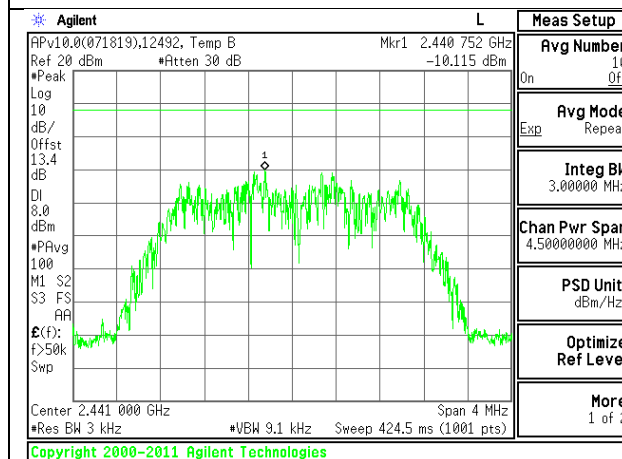
Channel	Frequency (MHz)	Ant 4 Meas (dBm/ 3kHz)	Ant 3 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low	2404	-10.113	-10.057	-7.07	8.0	-15.1
Mid	2441	-10.115	-10.463	-7.28	8.0	-15.3
High	2478	-10.473	-10.451	-7.45	8.0	-15.5



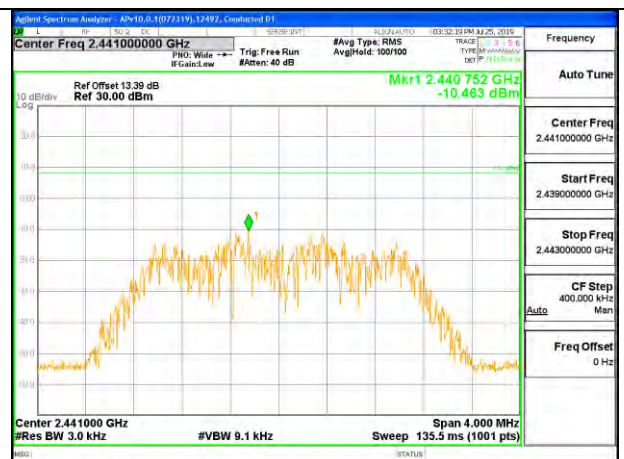
LOW CHANNEL ANT4



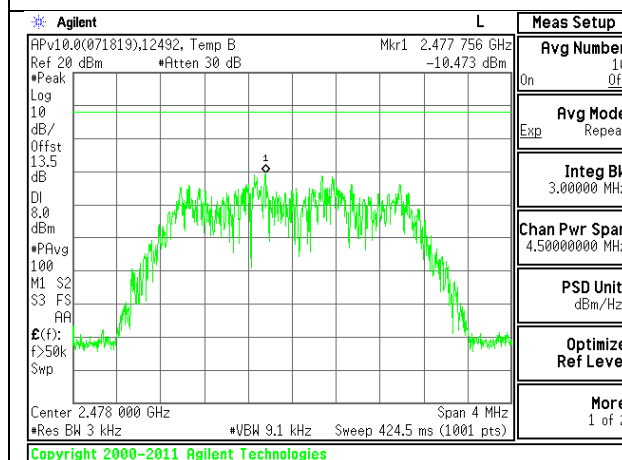
LOW CHANNEL ANT3



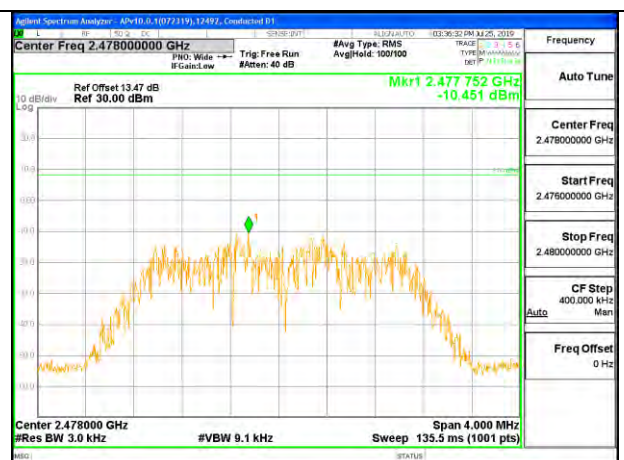
MID CHANNEL ANT4



MID CHANNEL ANT3



HIGH CHANNEL ANT4



HIGH CHANNEL ANT3

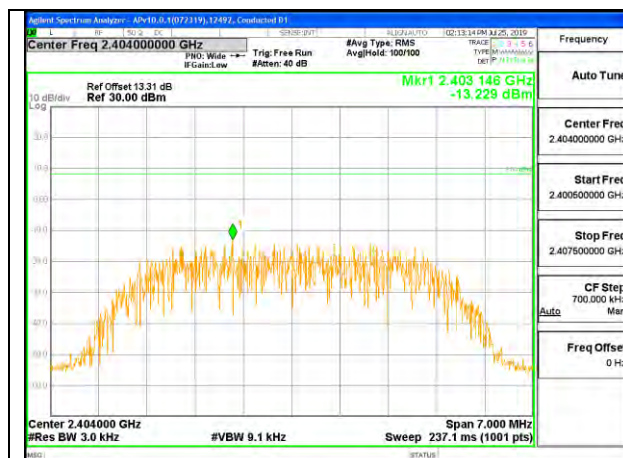
8.11.4. LOW POWER HDR (HDR8)

Antenna 4 + Antenna 3

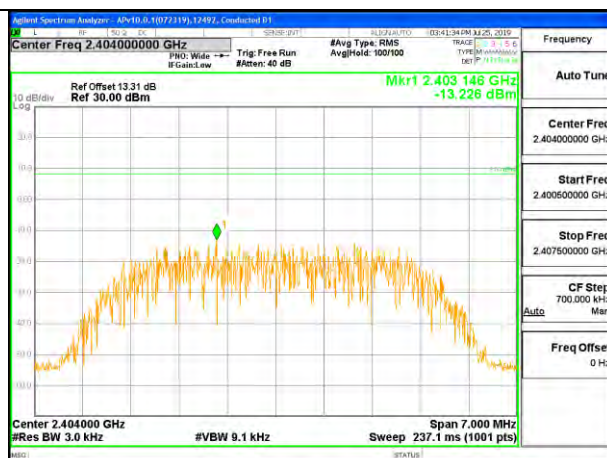
Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD
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PSD Results

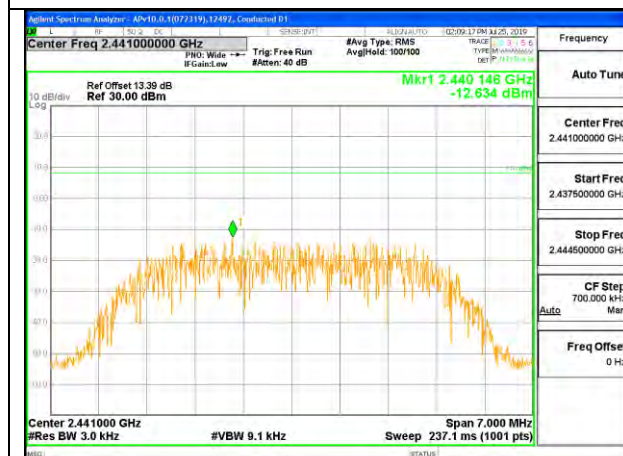
Channel	Frequency (MHz)	Ant 4 Meas (dBm/ 3kHz)	Ant 3 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low	2404	-13.229	-13.226	-10.22	8.0	-18.2
Mid	2441	-12.634	-13.060	-9.83	8.0	-17.8
High	2478	-13.441	-12.941	-10.17	8.0	-18.2



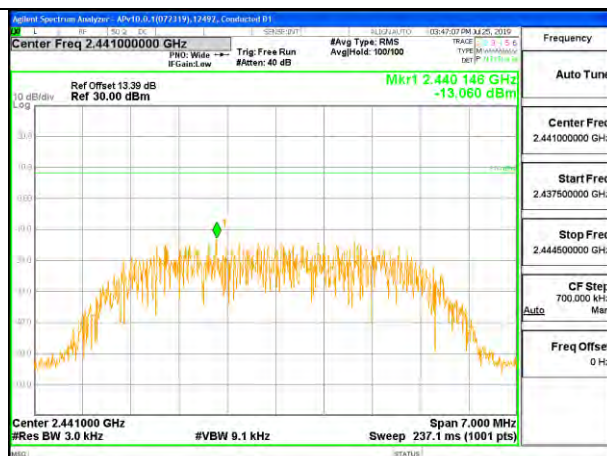
LOW CHANNEL ANT4



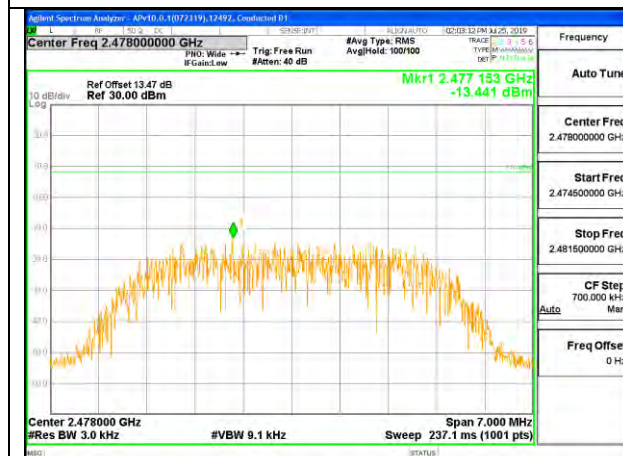
LOW CHANNEL ANT4



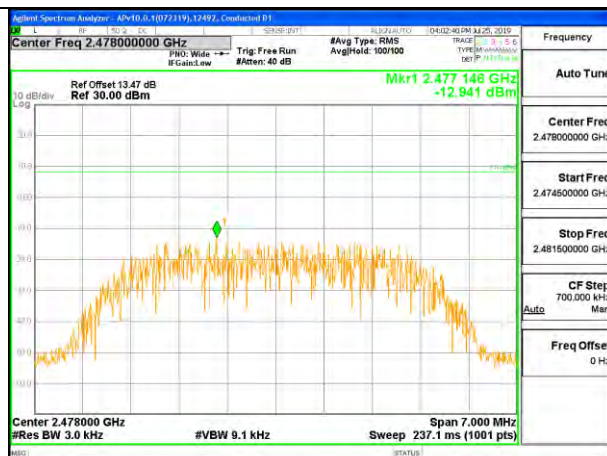
MID CHANNEL ANT4



MID CHANNEL ANT4



HIGH CHANNEL ANT4



HIGH CHANNEL ANT4

8.12. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

RSS-247 5.5

Output power was measured based on the use of a peak measurement, therefore the required attenuation is 20 dB.

RESULTS

8.12.1. HIGH POWER HDR (HDR4)

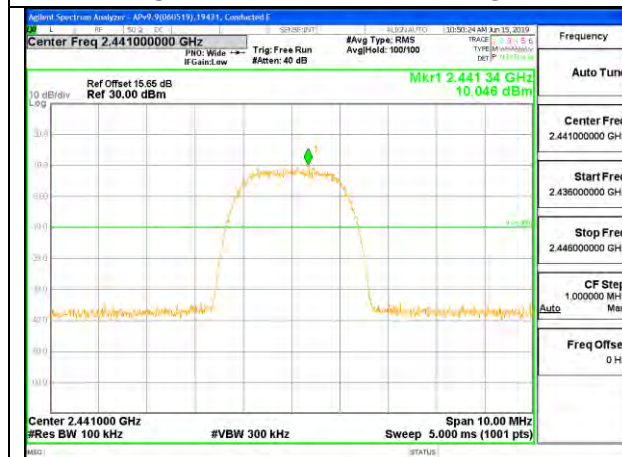
Antenna 4



LOW CHANNEL BANDEDGE



OUT-OF-BAND LOW CHANNEL



IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

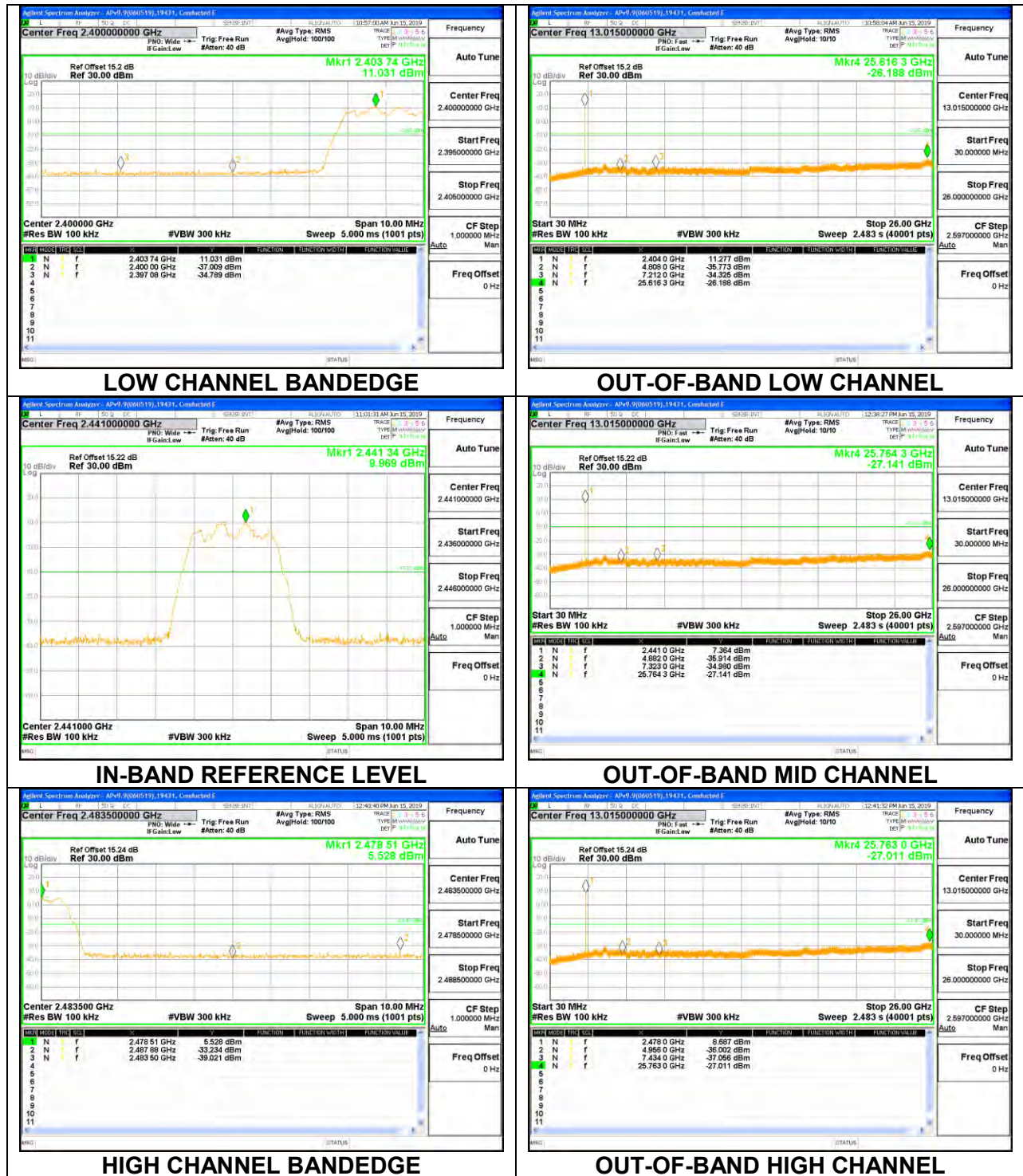


HIGH CHANNEL BANDEDGE



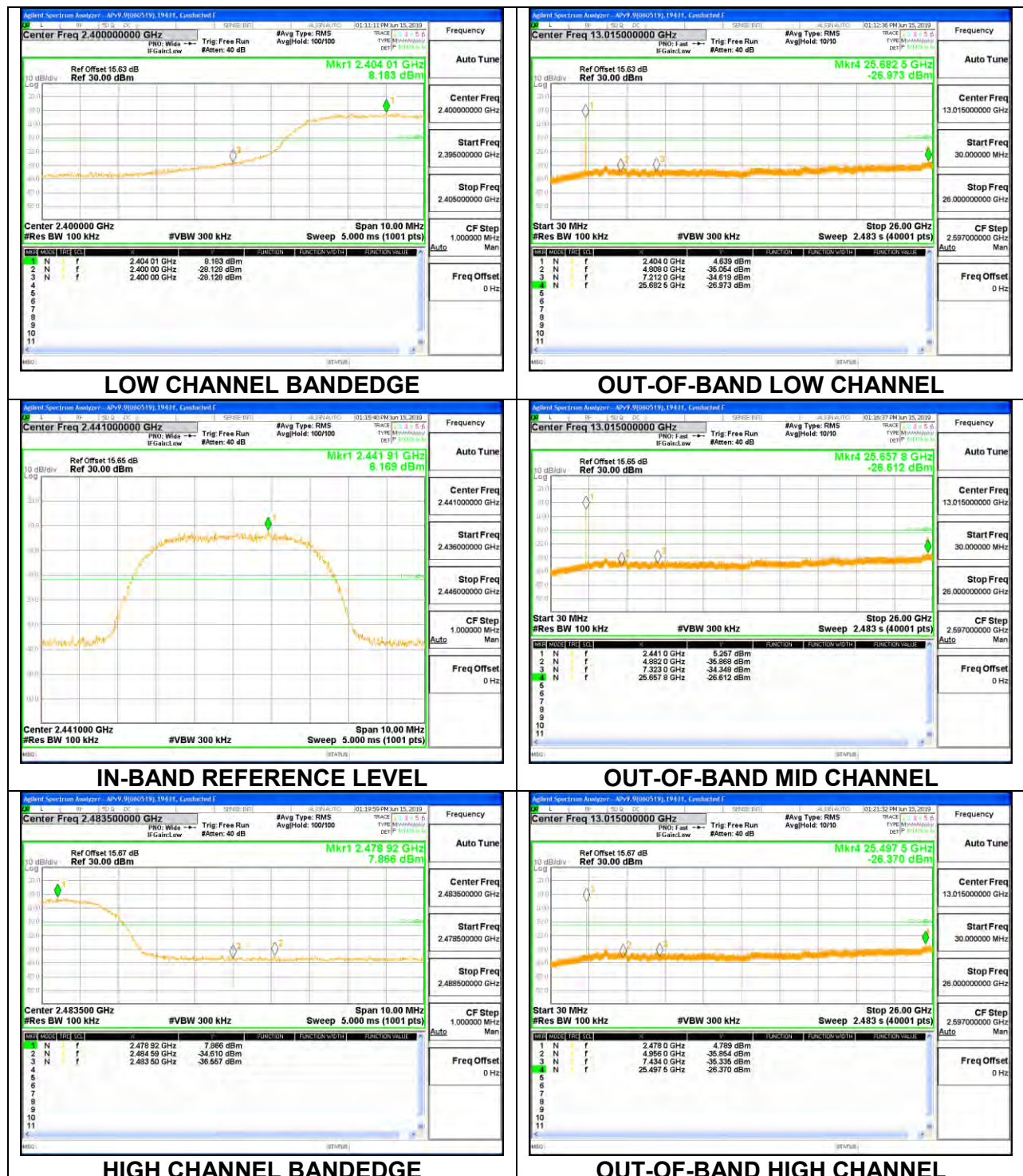
OUT-OF-BAND HIGH CHANNEL

Antenna 3



8.12.2. HIGH POWER HDR (HDR8)

Antenna 4



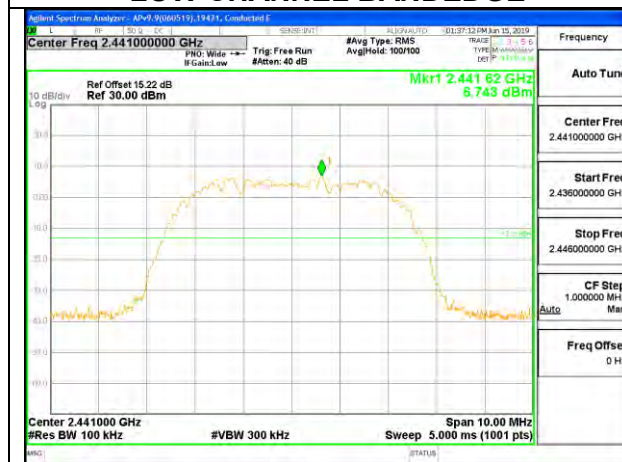
Antenna 3



LOW CHANNEL BANDEDGE



OUT-OF-BAND LOW CHANNEL



IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE



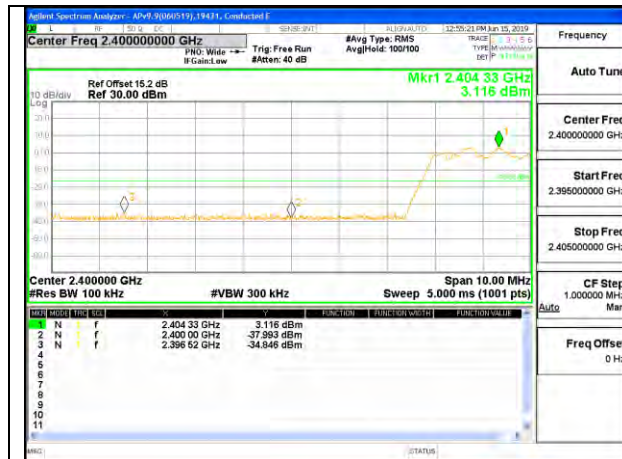
OUT-OF-BAND HIGH CHANNEL

8.12.3. LOW POWER HDR (HDR4)

Antenna 4



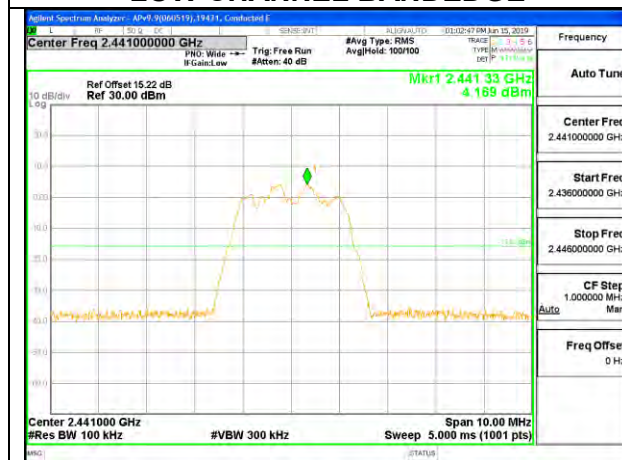
Antenna 3



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