TEST REPORT

Report Number. : R14720550-E1a

Applicant : Samsung Electronics Co., Ltd.
129 Samsung-Ro, Yeongtong-Gu
Suwon-Si, Gyeonggi-Do, 16677, Korea

Model : SM-X716B

FCC ID : A3LSMX716B

EUT Description : GSM/WCDMA/LTE/5G NR Tablet + BT/BLE, DTS/UNII a/b/g/n/ac/ax and WPT.

Test Standard(s) : FCC 47 CFR PART 15 SUBPART C: 2023
ISED RSS-247 ISSUE 2: 2017
ISED RSS-GEN ISSUE 5 + A2: 2021

Date Of Issue:
2023-06-09

Prepared by:
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CERT #0751.06

REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2023-05-15	Initial Issue	Charles Moody
V2	2023-05-31	Revised standard versions. Revised antenna nomenclature. Extended calibration dates to end of the due month.	B. Kiewra
V3	2023-06-05	Added gain calculation	B. Kiewra
V4	2023-06-09	Added additional information regarding gain calculation	B. Kiewra

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Samsung Electronics Co., Ltd.
                          129 Samsung-Ro Yeongtong-Gu
                          Suwon-Si, Gyeonggi-Do, 16677, Korea

EUT DESCRIPTION: GSM/WCDMA/LTE/5G NR Tablet + BT/BLE, DTS/UNII
                          a/b/g/n/ac/ax and WPT

MODEL: SM-X716B

SERIAL NUMBER: 5918385, R32W3004BTT, 5918394, 5918392, R32W300404N

SAMPLE RECEIPT DATE: 2023-03-24

DATE TESTED: 2023-04-07 TO 2023-05-11

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
47 CFR Part 15 Subpart C: 2023	Complies
ISED RSS-247 Issue 2: 2017	Complies
ISED RSS-GEN Issue 5 + A2: 2021	Complies

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

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

This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document.

Approved & Released For
UL LLC By: Prepared By:

Michael Antola   Charles Moody
Staff Engineer   Electrical Engineer
Consumer, Medical, and IT Segment   Consumer, Medical, and IT Segment

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2. TEST RESULTS SUMMARY

This report contains data provided by the applicant which can impact the validity of results. UL LLC is only responsible for the validity of results after the integration of the data provided by the customer.

Below is a list of the data provided by the customer:
1)   Antenna gain and type (see section 6.3)
2)   Cable loss (see section 9.4)

FCC Clause	ISED Clause	Requirement	Result	Comment
See Comment		Duty Cycle	Reporting purposes only	ANSI C63.10 Section 11.6.
-	RSS-GEN 6.7	99% OBW	Reporting purposes only	ANSI C63.10 Section 6.9.3.
15.247 (a) (2)	RSS-247 5.2 (a)	6dB BW	Compliant	None.
15.247 (b) (3)	RSS-247 5.4 (d)	Output Power		
15.247 (e)	RSS-247 5.2 (b)	PSD	Compliant	None.
15.247 (d)	RSS-247 5.5	Conducted Spurious Emissions		
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions		
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions		

3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC 47 CFR Part 2, FCC 47 CFR Part 15, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D01 Radiated Test Site v01r01, RSS-GEN Issue 5 + A2, and RSS-247 Issue 2.

4. FACILITIES AND ACCREDITATION

UL LLC is accredited by A2LA, certification #0751.06, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
☒	Building 2800 Suite Perimeter Park Dr. Suite B Morrisville, NC 27560, U.S.A	US0067	27265	825374
☐	Building 12 Laboratory Dr RTP, NC 27709, U.S.A.		2180C	

5. DECISION RULES AND MEASUREMENT UNCERTAINTY

5.1. METROLOGICAL TRACEABILITY

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

5.2. DECISION RULES

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

5.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	U_{Lab}
Radio Frequency (Spectrum Analyzer)	141.2 Hz
Occupied Channel Bandwidth	1.22%
RF output power, conducted	1.3 dB (PK) 0.45 dB (AV)
Power Spectral Density, conducted	2.47 dB
Unwanted Emissions, conducted	1.94 dB
All emissions, radiated	6.01 dB
Conducted Emissions (0.150-30MHz) - LISN	3.40 dB
Temperature	0.57°C
Humidity	3.39%
DC Supply voltages	1.70%

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

5.4. 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

6. EQUIPMENT UNDER TEST

6.1.   EUT DESCRIPTION

The EUT is a GSM/WCDMA/LTE/5G NR tablet + BT/BLE, DTS/UNII a/b/g/n/ac/ax and WPT.
This report covers the emissions from the 2.4 WLAN radio.

6.2. MAXIMUM OUTPUT POWER

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

2.4GHz BAND

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
2Tx			
2412-2472	802.11b	21.91	155.24
2412-2472	802.11g	20.96	124.74
2412-2472	802.11n HT20 CDD	20.78	119.67

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) gain and type, as provided by the manufacturer' are as follows:

The radio utilizes two antennas for diversity, with the following types and maximum gains:

Chain	Designation in Documentation	Type	Maximum Gain (dBi)
0	BT/WiFi 1 Antenna	Metal	0.43
1	BT/WiFi 2 Antenna	Metal	0.64

6.4. SOFTWARE AND FIRMWARE

The EUT hardware installed during testing was REV0.1.

The software version used during testing was X716B.001.

6.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel/mode with highest average output power/PSD as worst-case scenario. This was found to be 11b, 11Mbps, at 2412 MHz.

Band edge was performed with the EUT set to transmit at the measured power on low, high, and all power stepped channels. Radiated emissions between 1GHz and 18GHz was performed with the EUT set to transmit at the highest power on low, middle, and high channels. Band edge and radiated emissions are performed with the EUT set to transmit on the worst-case mode/channel based on average power. For the CCK modulation scheme, this was found to be 11b. For OFDM/OFDMA modulation schemes, this was found to be 11g.

Conducted spurious emissions between 1GHz and 18GHz were performed on low, middle, and high channels with the EUT set to transmit at the highest power.

The fundamental of the EUT was investigated in three orthogonal orientations X,Y,Z, it was determined that Y orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Y orientation.

The EUT was pre-tested in its two configurations; with and without the keyboard attached. As determined through pretesting, without the keyboard was found to be the worst-case configuration. Therefore all final testing was performed without the keyboard attached.

Worst-case data rates as determined through pretesting was found to be:

802.11b mode: 11 Mbps
802.11g mode: 6 Mbps
802.11n HT20mode: MCS0

Based on pretesting, all testing performed in 2Tx mode (NSS=1), where power per chain is equivalent to the 1Tx power on each chain. This allows 2Tx testing to cover all 1Tx testing.

6.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID**
AC Adapter	Samsung	EP-TA800	R37TCCJ49LASEA	-

I/O CABLES

I/O Cable List						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	Charging	1	USB C to USB A	Shielded	<3m	Used to charge the device

TEST SETUP

The EUT is configured to the desired settings prior to testing, using the built-in application on the EUT.

SETUP DIAGRAMS

Please refer to R14720550-EP1 for setup diagrams

7. MEASUREMENT METHOD

On Time and Duty Cycle: ANSI C63.10, Section 11.6 : Zero-Span Spectrum Analyzer Method.

6 dB BW: ANSI C63.10 Subclause -11.8.1

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

Output Power: ANSI C63.10 Subclause -11.9.2.3.2 Method AVGPM-G (Measurement using a gated RF average-reading power meter)

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

Emissions non-restricted frequency bands: ANSI C63.10 Subclause -11.11 and 6.10.4

Emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1 and 6.10.5

General Radiated Spurious Emissions: ANSI C63.10-2013 Section 6.3 to 6.6

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

8. TEST AND MEASUREMENT EQUIPMENT

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

Test Equipment Used - Wireless Conducted Measurement Equipment

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
Conducted Room 1					
SA0027	Spectrum Analyzer	Keysight Technologies	N9030A	2022-05-24	2023-05-31
PWM001 (PRE0136343)	RF Power Meter	Keysight Technologies	N1912A	2022-08-30	2023-08-30
90418	Peak and Avg Power Sensor, 50MHz to 18GHz	Keysight Technologies	N1921A	02/02/2023	2024-02-02
PWS002	Peak and Avg Power Sensor, 50MHz to 18GHz	Keysight Technologies	N1921A	2022-09-27	2023-09-27
HI0091	Environmental Meter	Fisher Scientific	15-077-963	2022-07-20	2023-07-20
SOFTEMI	Antenna Port Software	UL	Version 2022.8.16		
Conducted Room 2					
**SA0025	Spectrum Analyzer	Keysight Technologies	N9030A	2022-05-02	2023-05-31
90411	Spectrum Analyzer	Keysight Technologies	N9030A	2022-08-02	2023-08-02
HI0090	Environmental Meter	Fisher Scientific	15-077-963	2022-07-20	2023-07-20
PWM005	RF Power Meter	Keysight Technologies	N1912A	2022-09-02	2024-09-02
PWS005	Peak and Avg Power Sensor, 50MHz to 18GHz	Keysight Technologies	N1921A	2022-06-15	2023-06-15
SOFTEMI	Antenna Port Software	UL	Version 2022.8.16		
Additional Equipment used					
EMC4366	Bluetooth Tester	Rhode & Schwarz	1153.900.35	-	-
226563	SMA Coaxial 10dB Attenuator 25MHz-18GHz	CentricRF	C18S2-10	2023-02-16	2024-02-16
CBL098	Micro-Coax UTiFLEX Cable Assembly, Low Loss,40Ghz, 39.3", Connectors 2	Carlisle Interconnect Technologies	UFA147A-0-0180-200200	2023-02-17	2024-02-17
CBL101	Micro-Coax UTiFLEX Cable Assembly, Low Loss,40Ghz, 39.3", Connectors 2	Carlisle Interconnect Technologies	UFA147A-0-0180-200200	2023-01-24	2024-01-24
CPL001	Ultra-Wideband Directional Coupler 0.5-18GHz	Mini-Circuits	ZUDC10-183+	2023-02-17	2024-02-17
PWM001 (PRE0136343)	RF Power Meter	Keysight Technologies	N1912A	2022-08-30	2023-08-30
PWS002	Peak and Avg Power Sensor, 50MHz to 18GHz	Keysight Technologies	N1921A	2022-09-27	2023-09-27
90418	Peak and Avg Power Sensor, 50MHz to 18GHz	Keysight Technologies	N1921A	2023-02-02	2024-02-02

NOTE: Testing on this analyzer was performed prior to 2023-05-02, thus while the analyzer was still in calibration.

Test Equipment Used - Line-Conducted Emissions – Voltage (Morrisville – Conducted 1)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
CBL087	Coax cable, RG223, N-male to BNC-male, 20-ft.	Pasternack	PE3W06143-240	2023-04-04	2024-04-04
HI0091	Environmental Meter	Fisher Scientific	15-077-963	2022-07-20	2023-07-20
LISN001	LISN, 50-ohm/50-uH, 2-conductor, 25A	Fischer Custom Com.	FCC-LISN-50-25-2-01-550V	2022-08-01	2023-08-01
LISN003	LISN, 50-ohm/50-uH, 250uH 2-conductor, 25A	Fischer Custom Com.	FCC-LISN-50/250-25-2-01	2022-08-01	2023-08-01
75141	EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESCI 7	2022-08-03	2023-08-03
52859	Transient Limiter, 0.009-100MHz	Electro-Metrics	EM-7600	2023-04-04	2024-04-04
PS216	AC Power Source	Elgar	CW2501M-1 (s/n 1045A04231)	NA	NA
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		
	Miscellaneous (if needed)				
CDECABLE001	ANSI C63.4 1m extension cable.	UL	Per Annex B of ANSI C63.4	2022-09-12	2023-09-12

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville – Chamber 2)

Equip. ID	Description	Manufacturer/Brand	Model Number	Last Cal.	Next Cal.
	0.009-30MHz				
135144	Active Loop Antenna	ETS-Lindgren	6502	2023-01-17	2024-01-17
	30-1000 MHz				
90627	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2022-09-07	2023-09-07
	1-18 GHz				
88761	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2022-09-13	2023-09-13
	18-40 GHz				
204704	Horn Antenna, 18-26.5GHz	Com-Power	AH-626	2022-07-11	2023-07-11
	Gain-Loss Chains				
91975	Gain-loss string: 0.009-30MHz	Various	Various	2022-05-10	2023-05-31
91978	Gain-loss string: 25-1000MHz	Various	Various	2022-05-10	2023-05-31
91977	Gain-loss string: 1-18GHz	Various	Various	2022-05-10	2023-05-31
136042	Gain-loss string: 18-40GHz	Various	Various	2022-05-10	2023-05-31
	Receiver & Software				
SA0026	Spectrum Analyzer	Keysight	N9030A	2022-08-02	2023-08-23
72823	Spectrum Analyzer	Agilent	E4446A	2022-06-08	2023-06-08
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		
	Additional Equipment used				
200540	Environmental Meter	Fisher Scientific	15-077-963 s/n 181474409	2022-10-05	2023-10-05
A45	10dB, DC-18GHz, 5W	Mini-Circuits	BW-N10W5	2022-10-21	2023-10-21

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Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville –
Chamber 1)

Equip. ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	1-18 GHz				
206211	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2023-04-06	2024-04-06
	Gain-Loss Chains				
91979	Gain-loss string: 1-18GHz	Various	Various	2022-12-02	2023-12-02
	Receiver & Software				
197954	Spectrum Analyzer	Rohde & Schwarz	ESW44	2023-02-02	2024-02-02
SOFTEMI	EMI Software	UL	Version 9.5 (18 Oct 2021)		
	Additional Equipment used				
200539	Environmental Meter	Fisher Scientific	15-077-963 s/n 18474341	2022-10-05	2023-10-05

9. ANTENNA PORT TEST RESULTS

9.1. 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						
802.11b 2TX	0.8798	0.9821	0.896	89.58	0.96	1.137
802.11g 2TX	1.464	1.571	0.932	93.19	0.61	0.683
802.11n HT20 2TX	1.248	1.354	0.922	92.17	0.71	0.801

DUTY CYCLE PLOTS

DUTY CYCLE 802.11b 2TX MODE

DUTY CYCLE 802.11g 2TX MODE

DUTY CYCLE 802.11nHT20 2TX MODE
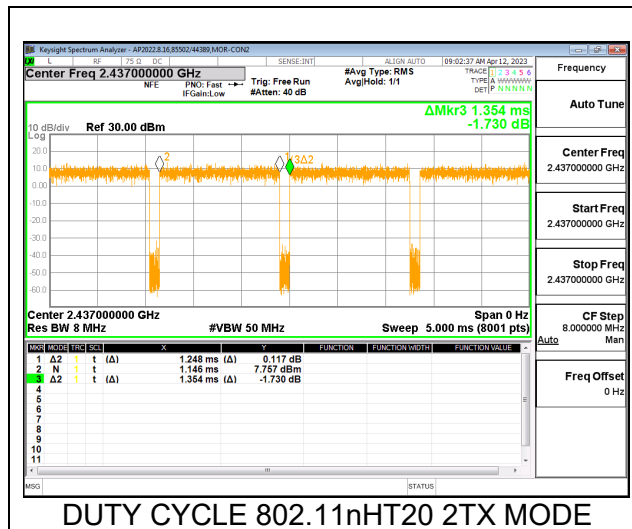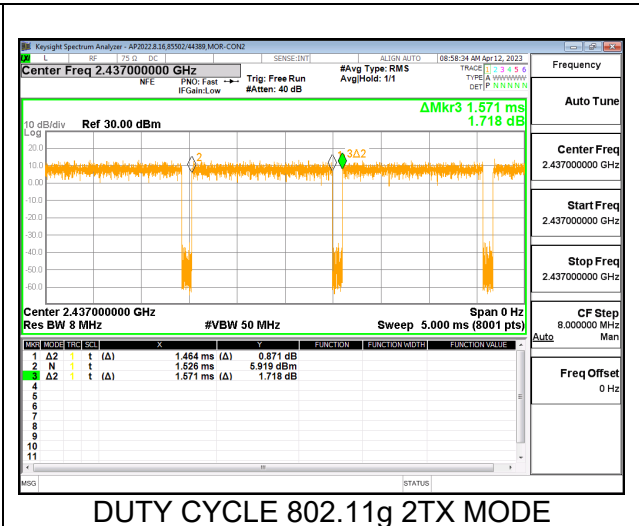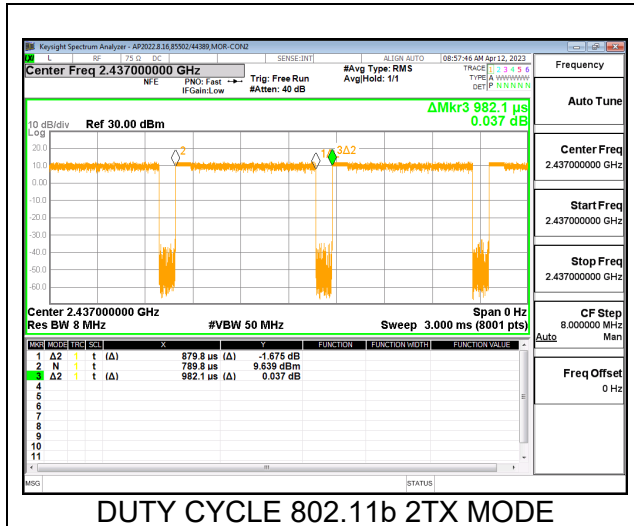
9.2. 99% BANDWIDTH

LIMITS

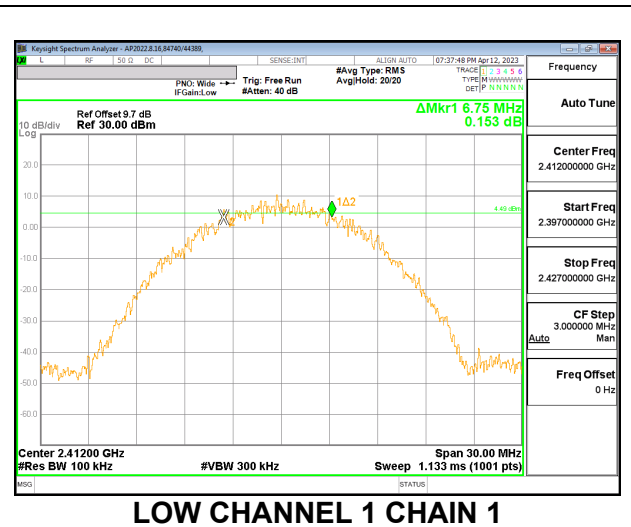None; for reporting purposes only.

RESULTS

9.2.1. 802.11b MODE

2TX Chain 0 + Chain 1 MODE

Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 1 (MHz)
Low 1	2412	13.051	12.927
Mid 6	2437	13.036	13.346
High 13	2472	12.575	12.440

LOW CHANNEL 1

LOW CHANNEL 1 CHAIN 0

LOW CHANNEL 1 CHAIN 1

MID CHANNEL 6

MID CHANNEL 6 CHAIN 0

MID CHANNEL 6 CHAIN 1

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HIGH CHANNEL 13

HIGH CHANNEL 13 CHAIN 0

HIGH CHANNEL 13 CHAIN 1

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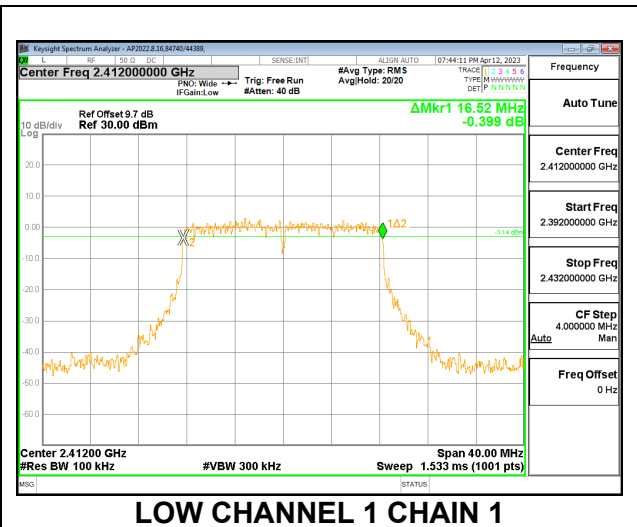*This report shall not be reproduced except in full, without the written approval of UL LLC*
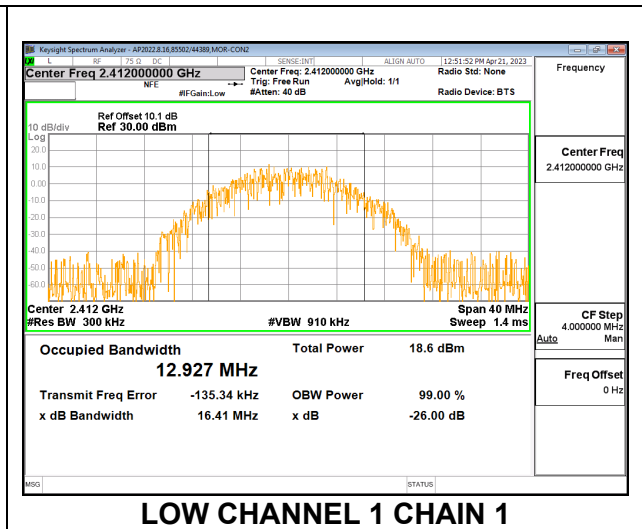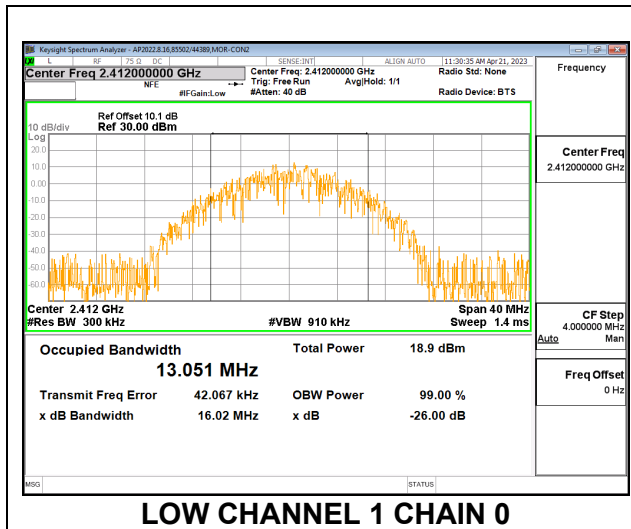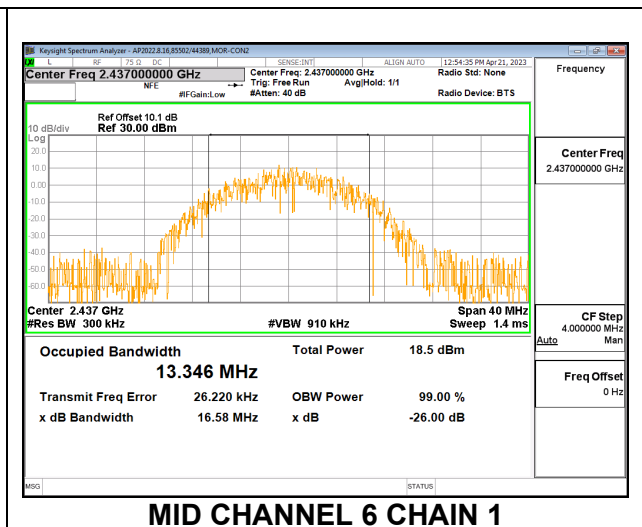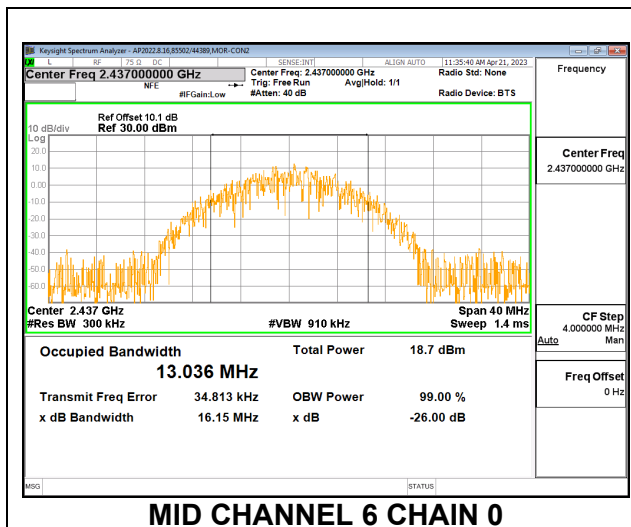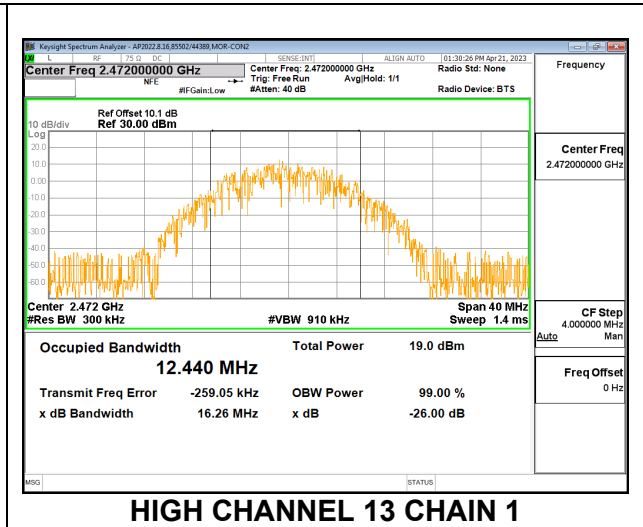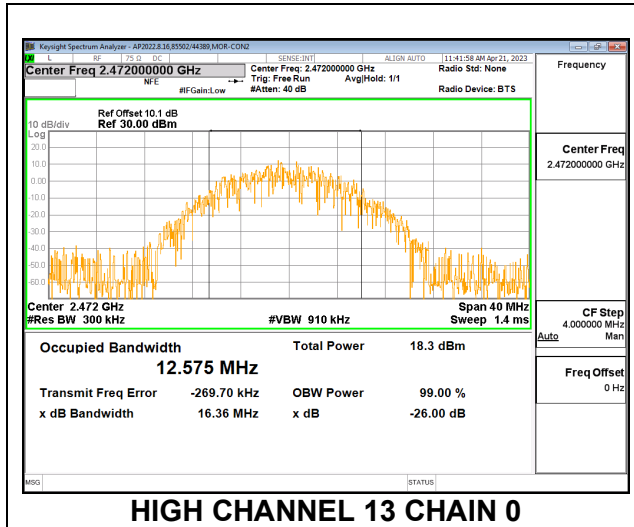
9.2.2. 802.11g MODE

2TX Chain 0 + Chain 1 MODE

Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 1 (MHz)
Low 1	2412	16.484	16.385
Mid 6	2437	16.446	16.377
High 13	2472	16.447	16.463

LOW CHANNEL 1
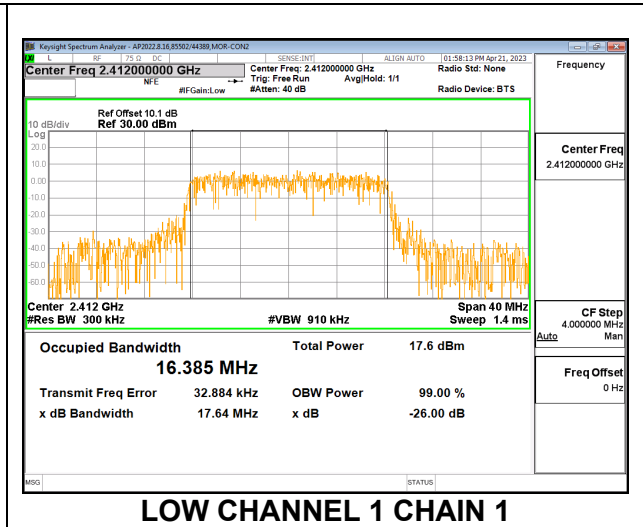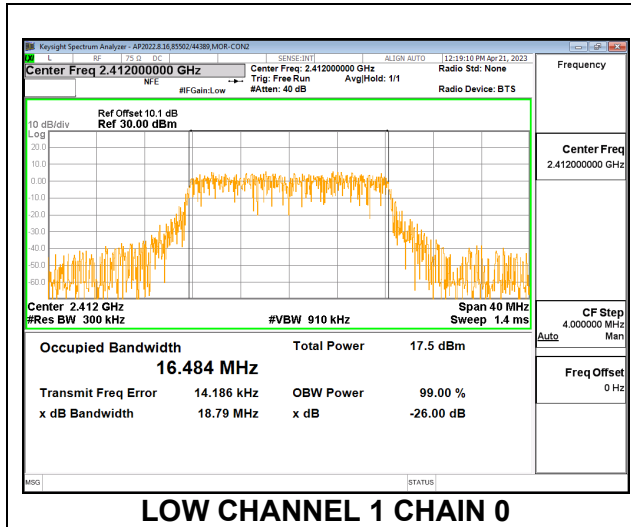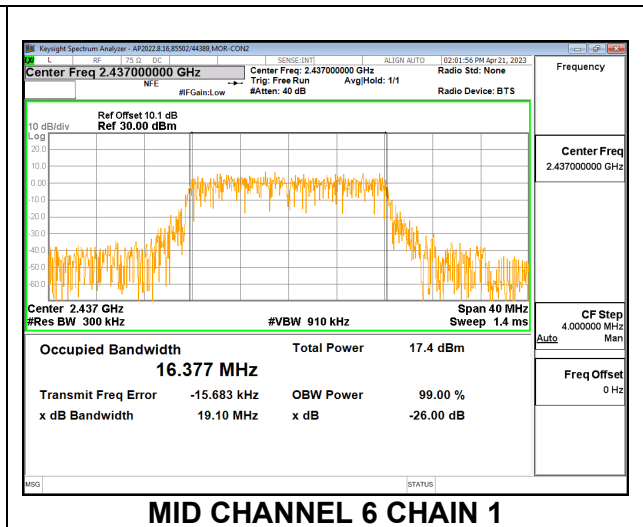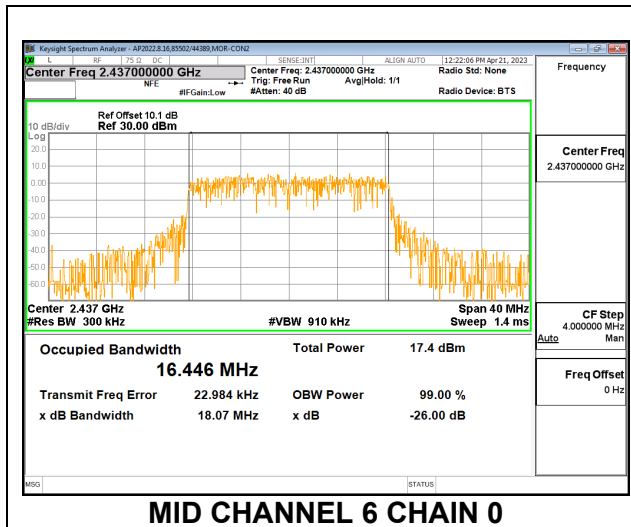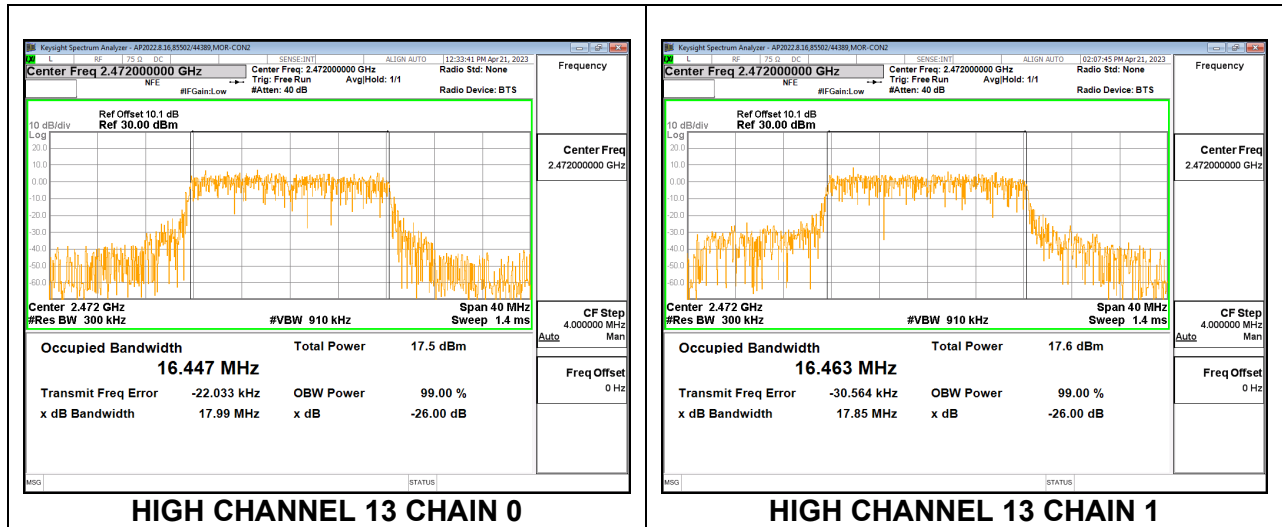
LOW CHANNEL 1 CHAIN 0

LOW CHANNEL 1 CHAIN 1

MID CHANNEL 6

MID CHANNEL 6 CHAIN 0

MID CHANNEL 6 CHAIN 1

HIGH CHANNEL 13

HIGH CHANNEL 13 CHAIN 0	HIGH CHANNEL 13 CHAIN 1

9.2.3. 802.11n HT20 MODE

2TX Chain 0 + Chain 1 MODE

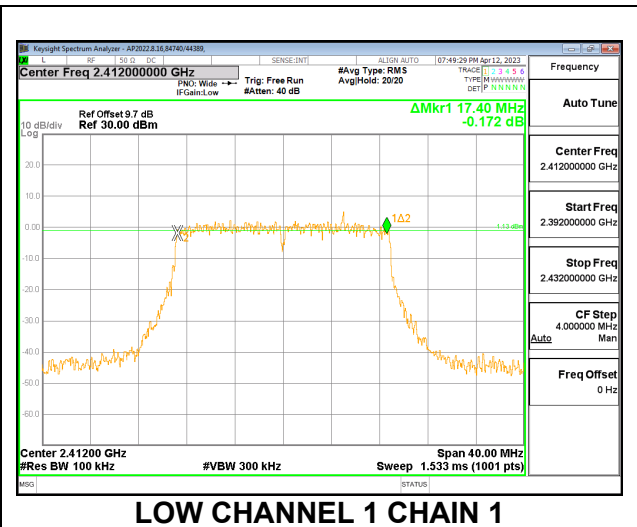| Channel	Frequency (MHz)	99% Bandwidth Chain 0 (MHz)	99% Bandwidth Chain 1 (MHz)
Low 1	2412	17.588	17.633
Mid 6	2437	17.692	17.613
High 13	2472	17.697	17.693

LOW CHANNEL 1
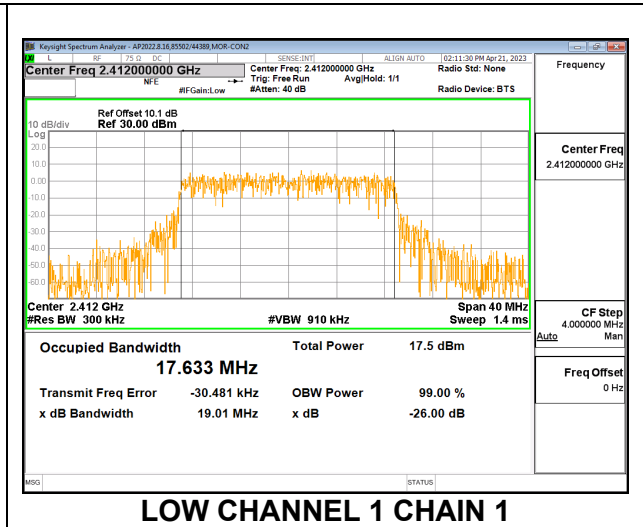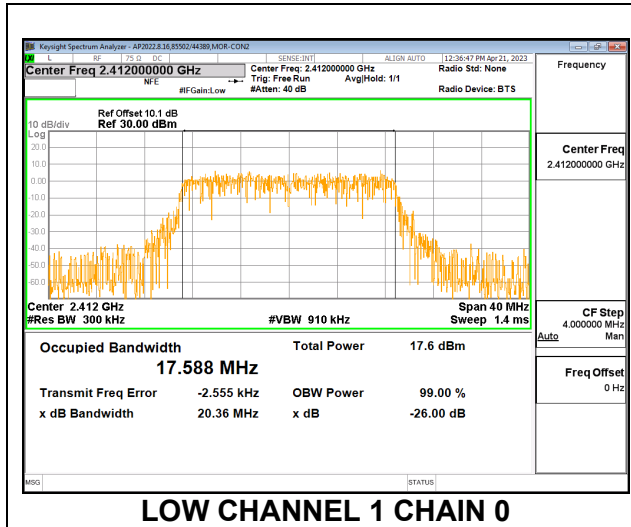
LOW CHANNEL 1 CHAIN 0

LOW CHANNEL 1 CHAIN 1

MID CHANNEL 6

MID CHANNEL 6 CHAIN 0

MID CHANNEL 6 CHAIN 1

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HIGH CHANNEL 13

HIGH CHANNEL 13 CHAIN 0	HIGH CHANNEL 13 CHAIN 1

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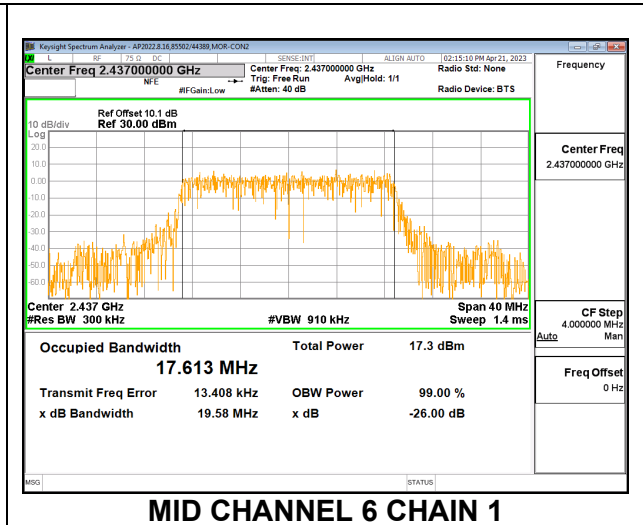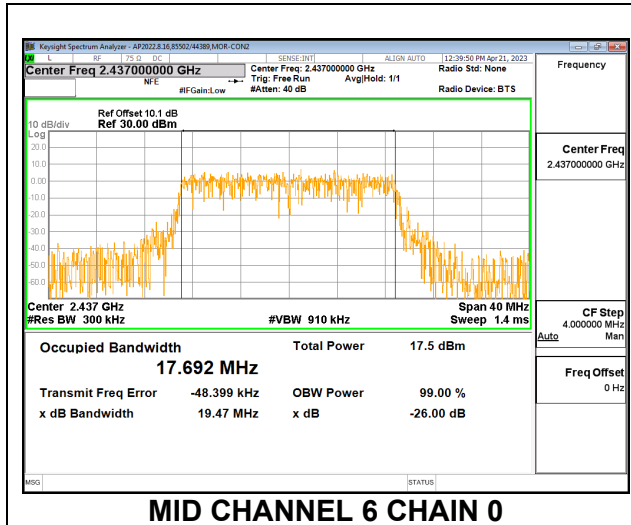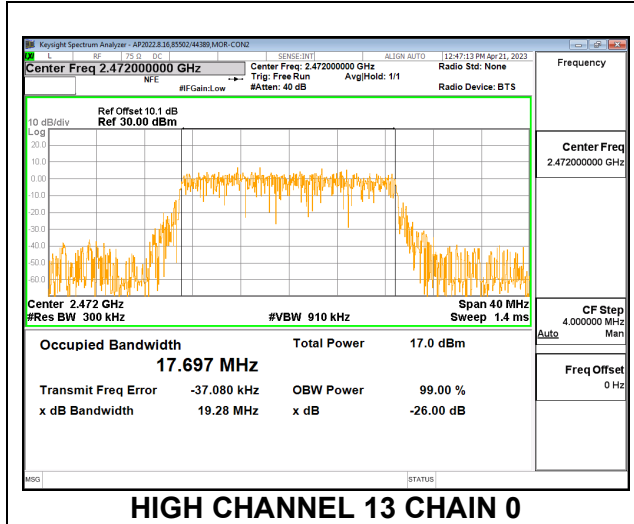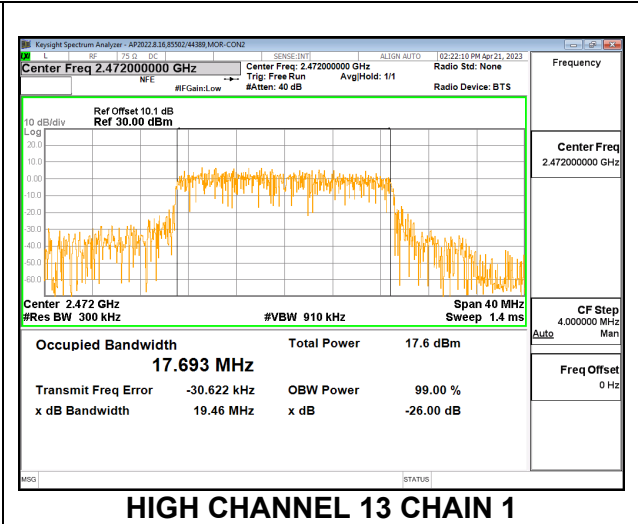
9.3. 6 dB BANDWIDTH

LIMITS

FCC §15.247 (a) (2)
RSS-247 5.2 (a)

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

RESULTS

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9.3.1. 802.11b MODE

2TX Chain 0 + Chain 1 MODE

Channel	Frequency (MHz)	6 dB BW Chain 0 (MHz)	6 dB BW Chain 1 (MHz)	Minimum Limit (MHz)
Low 1	2412	7.20	6.75	0.5
Mid 6	2437	6.81	7.38	0.5
High 13	2472	6.15	7.86	0.5

LOW CHANNEL 1

LOW CHANNEL 1 CHAIN 0

LOW CHANNEL 1 CHAIN 1

MID CHANNEL 6

MID CHANNEL 6 CHAIN 0

MID CHANNEL 6 CHAIN 1

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HIGH CHANNEL 13

HIGH CHANNEL 13 CHAIN 0

HIGH CHANNEL 13 CHAIN 1

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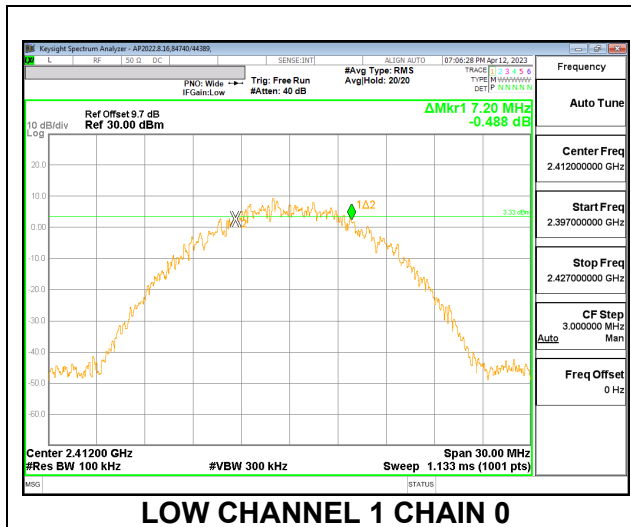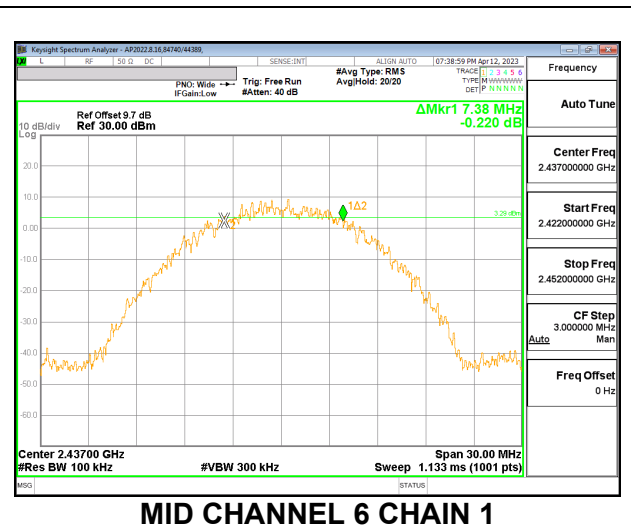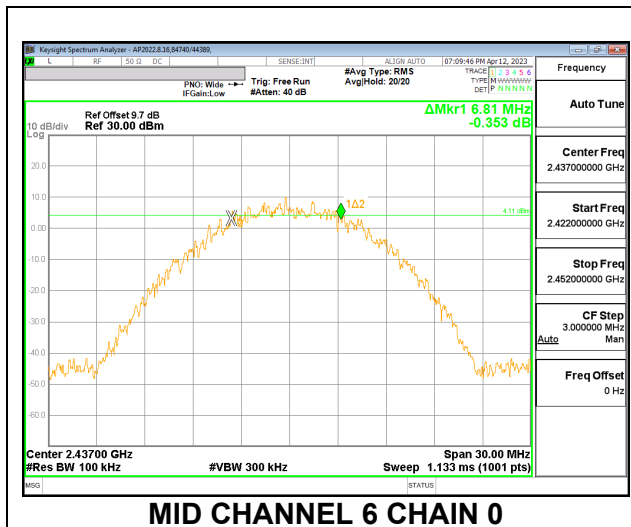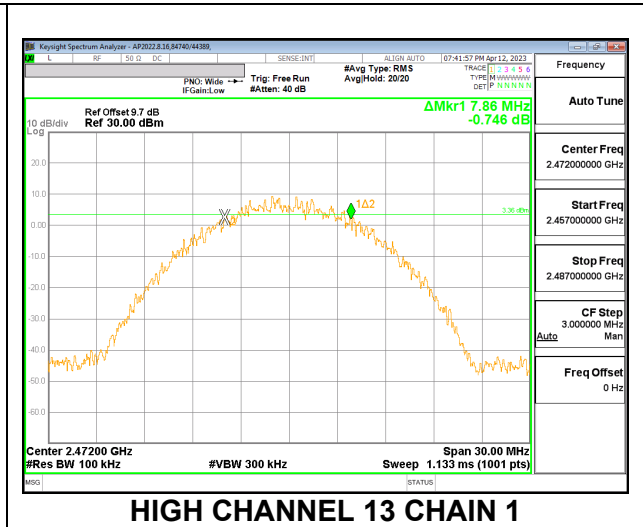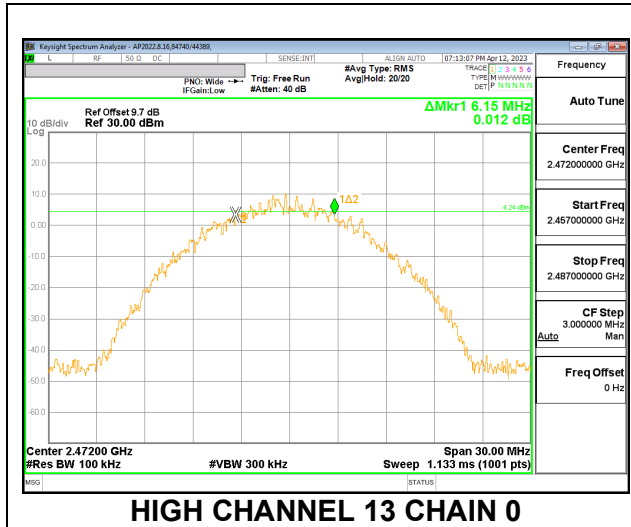
9.3.2. 802.11g MODE

2TX Chain 0 + Chain 1 MODE

Channel	Frequency (MHz)	6 dB BW Chain 0 (MHz)	6 dB BW Chain 1 (MHz)	Minimum Limit (MHz)
Low 1	2412	16.40	16.52	0.5
Mid 6	2437	16.40	16.40	0.5
High 13	2472	15.76	16.52	0.5

LOW CHANNEL 1
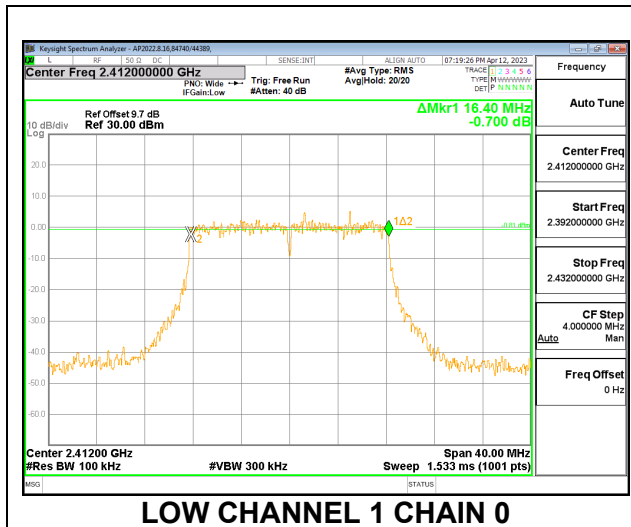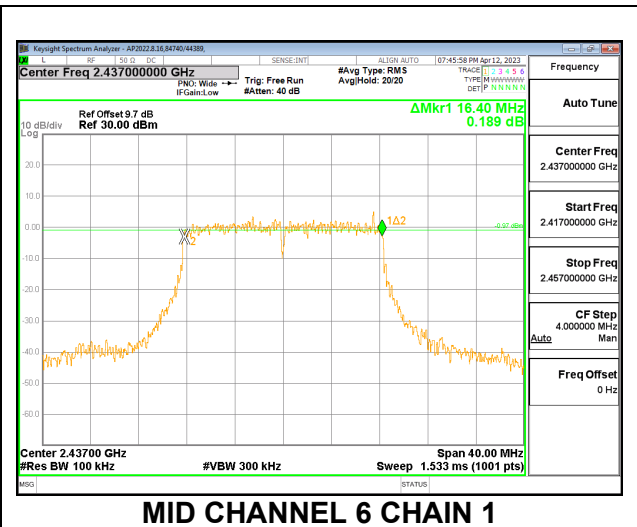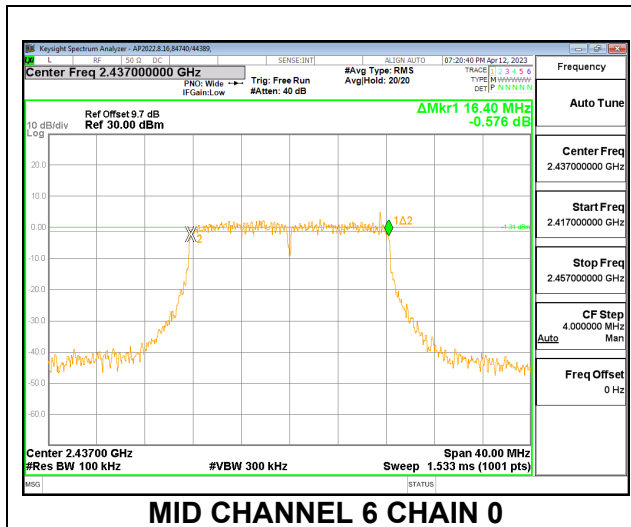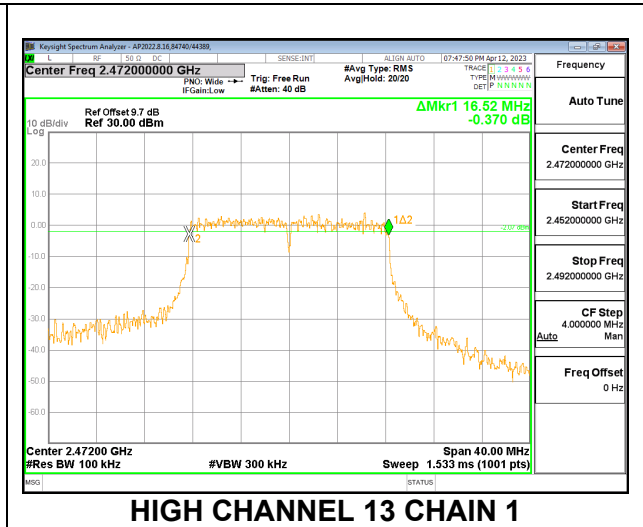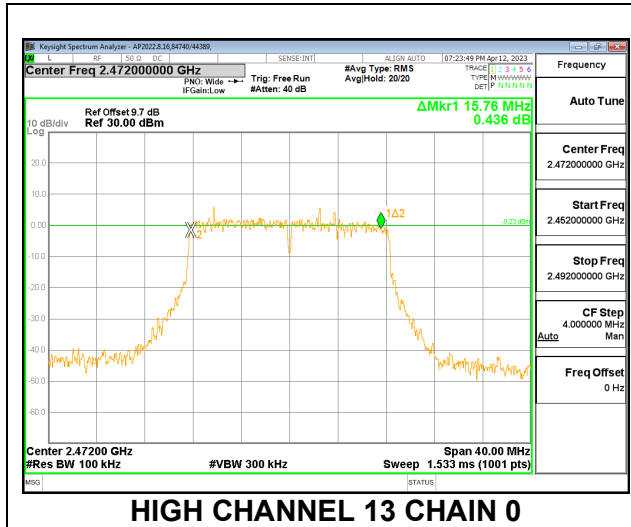
LOW CHANNEL 1 CHAIN 0

LOW CHANNEL 1 CHAIN 1

MID CHANNEL 6

MID CHANNEL 6 CHAIN 0

MID CHANNEL 6 CHAIN 1

HIGH CHANNEL 13

HIGH CHANNEL 13 CHAIN 0

HIGH CHANNEL 13 CHAIN 1

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9.3.3. 802.11n HT20 MODE

2TX Chain 0 + Chain 1 MODE

Channel	Frequency (MHz)	6 dB BW Chain 0 (MHz)	6 dB BW Chain 1 (MHz)	Minimum Limit (MHz)
Low 1	2412	17.76	17.40	0.5
Mid 6	2437	17.24	17.76	0.5
High 13	2472	17.68	17.64	0.5

LOW CHANNEL 1

LOW CHANNEL 1 CHAIN 0

LOW CHANNEL 1 CHAIN 1

MID CHANNEL 6

MID CHANNEL 6 CHAIN 0

MID CHANNEL 6 CHAIN 1

HIGH CHANNEL 13

HIGH CHANNEL 13 CHAIN 0

HIGH CHANNEL 13 CHAIN 1

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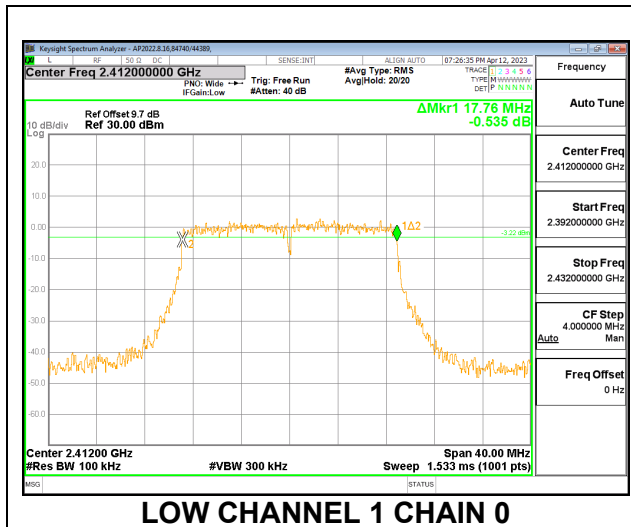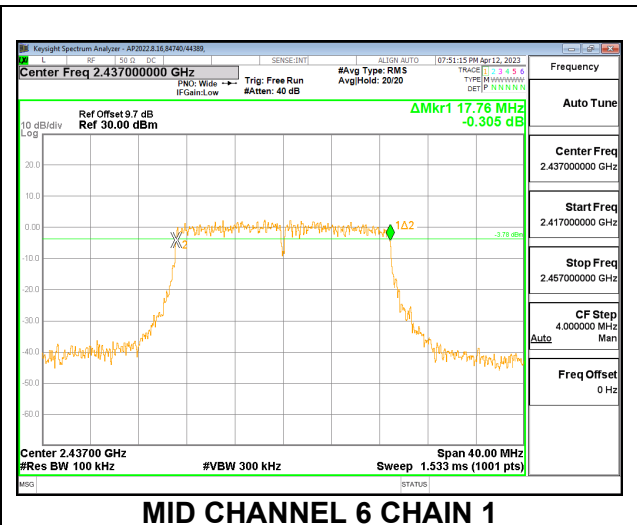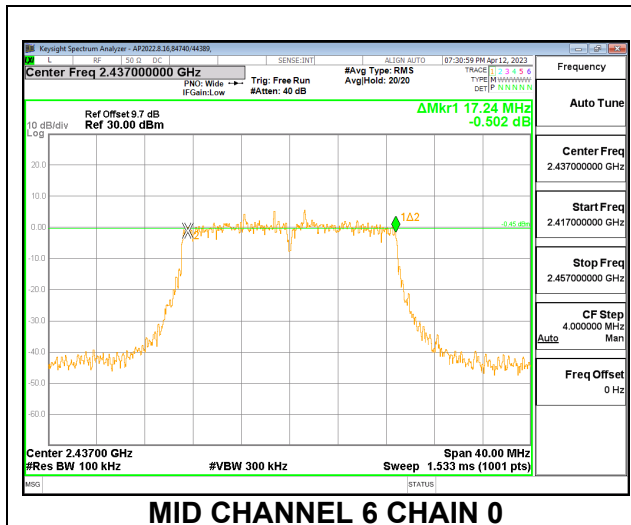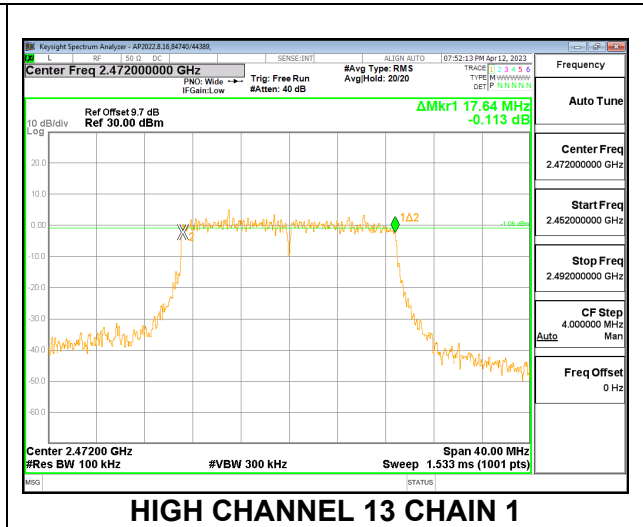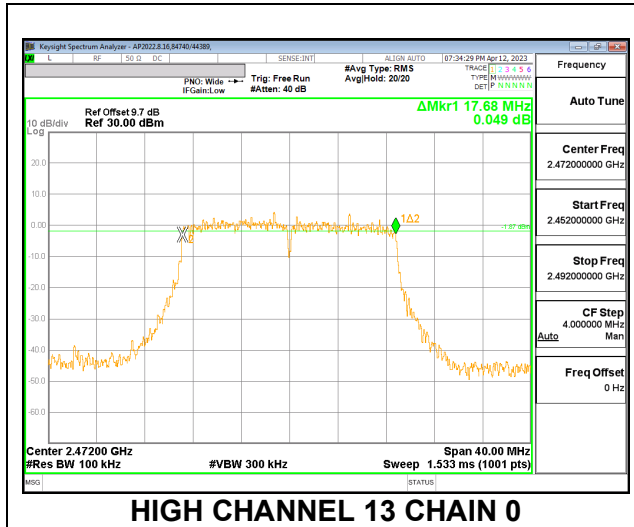
9.4. OUTPUT POWER

LIMITS

FCC §15.247 (b) (3)
RSS-247 5.4 (d)

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt, based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

TEST PROCEDURE

The transmitter output is connected to a gated average power meter.

The cable assembly insertion loss of 9.70 dB (including 9.28 dB pad and 0.42 dB EUT cable) for Chain 0 and 10.14 dB (including 9.72 dB pad and 0.42 dB EUT cable) for Chain 1, was entered as an offset in the power meter to allow for a peak reading of power.

DIRECTIONAL ANTENNA GAIN

For 2 TX:

Tx chains are uncorrelated for power and correlated for PSD due to the device supporting CDD in all MIMO modes. The directional gains are as follows:

Band (GHz)	Chain 0 Antenna Gain (dBi)	Chain 1 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)	Correlated Chains Directional Gain (dBi)
2.4	0.43	0.64	0.54	3.55

Directional gains for MIMO operations were determined using KDB662911 D01 Section F (2)(d)(i) and (ii) for unequal antenna gains, with equal transmit powers. The directional gains are calculated using the formulas for uncorrelated and correlated transmissions across the two transmit antennas.

(i) Correlated gain = $10\log((10^{G1/20} + 10^{G2/20})^2 / N_{Ant})$
(ii) Uncorrelated gain = $10\log((10^{G1/10} + 10^{G2/10}) / N_{Ant})$

Sample calculation, using 2 antennas:
Correlated gain = $10\log(10^{0.43/20} + 10^{0.64/20})^2/2) = 3.55$dBi
Uncorrelated gain = $10\log(10^{0.43/10} + 10^{0.64/10})/2) = 0.54$dBi

RESULTS

9.4.1. 802.11b MODE

2TX Chain 0 + Chain 1 CDD MODE

Test Engineer:	84740/44389, 85502/44389
Test Date:	2023-04-07 TO 2023-04-11

	(MHz)	Gain (dBi)	Power Limit (dBm)	EIRP Limit (dBm)	Power (dBm)
Low 1	2412	0.54	30.00	36	30.00
Mid 6	2437	0.54	30.00	36	30.00
High 11	2462	0.54	30.00	36	30.00
High 12	2467	0.54	30.00	36	30.00
High 13	2472	0.54	30.00	36	30.00

Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low 1	2412	18.84	18.96	21.91	30.00	-8.09
Mid 6	2437	18.64	18.73	21.70	30.00	-8.30
High 11	2462	18.59	18.89	21.75	30.00	-8.25
High 12	2467	1.61	2.81	5.26	30.00	-24.74
High 13	2472	-1.26	-0.26	2.28	30.00	-27.72

9.4.2. 802.11g MODE

2TX Chain 0 + Chain 1 CDD MODE

Test Engineer:	84740/44389, 85502/44389
Test Date:	2023-04-07 TO 2023-04-11

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC/ISED Power Limit (dBm)	ISED EIRP Limit (dBm)	Max Power (dBm)
Low 1	2412	0.54	30.00	36	30.00
Mid 6	2437	0.54	30.00	36	30.00
High 10	2457	0.54	30.00	36	30.00
High 11	2462	0.54	30.00	36	30.00
High 12	2467	0.54	30.00	36	30.00
High 13	2472	0.54	30.00	36	30.00

Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low 1	2412	17.98	17.92	20.96	30.00	-9.04
Mid 6	2437	17.61	17.64	20.64	30.00	-9.36
High 10	2457	17.43	17.73	20.59	30.00	-9.41
High 11	2462	16.16	16.45	19.32	30.00	-10.68
High 12	2467	1.77	2.60	5.22	30.00	-24.78
High 13	2472	-1.10	-0.07	2.46	30.00	-27.54

9.4.3. 802.11n HT20 MODE

2TX Chain 0 + Chain 1 CDD MODE

Test Engineer:	84740/44389, 85502/44389
Test Date:	2023-04-07 TO 2023-04-11

Limits

Channel	Frequency (MHz)	Directional Gain (dBi)	FCC/ISED Power Limit (dBm)	ISED EIRP Limit (dBm)	Max Power (dBm)
Low 1	2412	0.54	30.00	36	30.00
Mid 6	2437	0.54	30.00	36	30.00
High 11	2462	0.54	30.00	36	30.00
High 12	2467	0.54	30.00	36	30.00
High 13	2472	0.54	30.00	36	30.00

Results

Channel	Frequency (MHz)	Chain 0 Meas Power (dBm)	Chain 1 Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Margin (dB)
Low 1	2412	17.76	17.77	20.78	30.00	-9.22
Mid 6	2437	17.65	17.66	20.67	30.00	-9.33
High 11	2462	17.49	17.52	20.52	30.00	-9.48
High 12	2467	1.47	2.75	5.17	30.00	-24.83
High 13	2472	-1.32	-0.38	2.19	30.00	-27.81

9.5. 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.

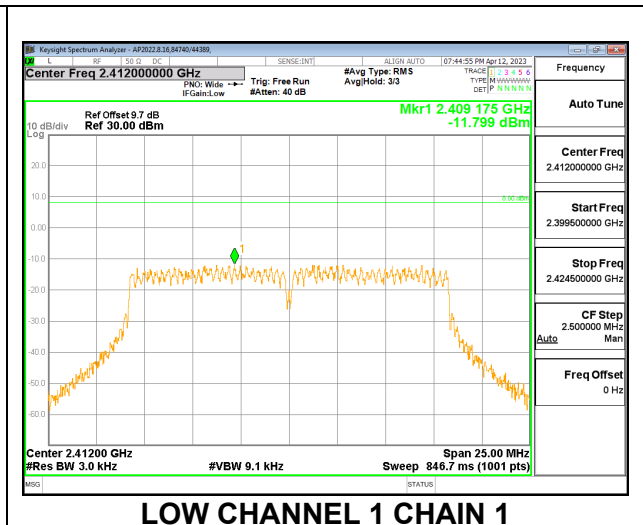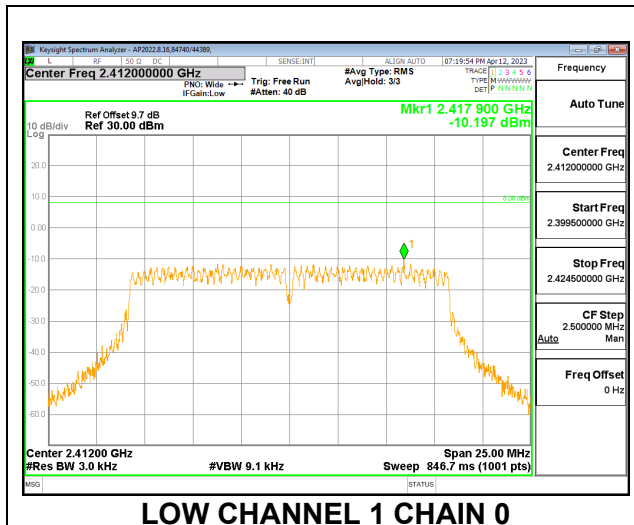NOTE: All PSD was done at the mid channel power.
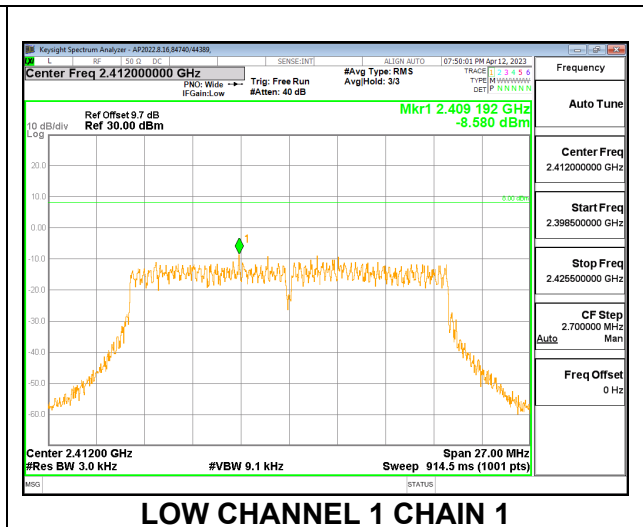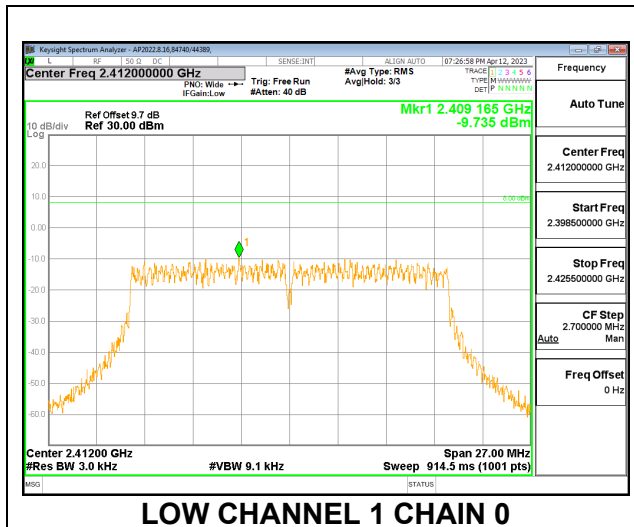
RESULTS

9.5.1. 802.11b MODE

2TX Chain 0 + Chain 1 CDD MODE

PSD Results

Channel	Frequency (MHz)	Chain 0 Meas (dBm/ 3kHz)	Chain 1 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low 1	2412	-4.200	-3.676	-0.92	8.0	-8.9
Mid 6	2437	-4.169	-4.192	-1.17	8.0	-9.2
High 13	2472	-4.199	-4.259	-1.22	8.0	-9.2

LOW CHANNEL 1

LOW CHANNEL 1 CHAIN 0   **LOW CHANNEL 1 CHAIN 1**

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MID CHANNEL 6

MID CHANNEL 6 CHAIN 0

MID CHANNEL 6 CHAIN 1

HIGH CHANNEL 13

HIGH CHANNEL 13 CHAIN 0

HIGH CHANNEL 13 CHAIN 1

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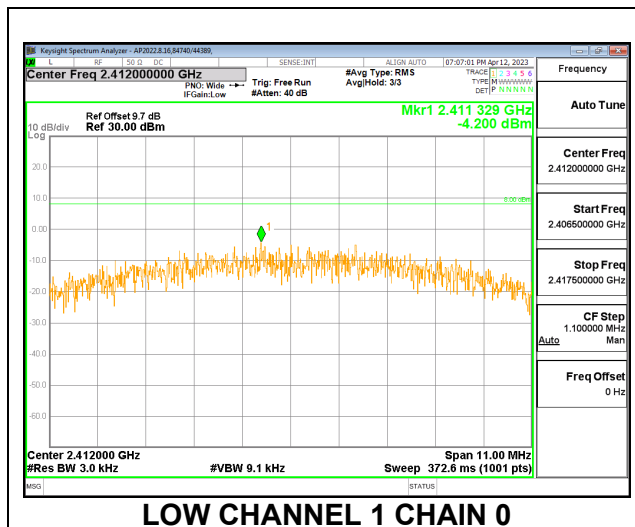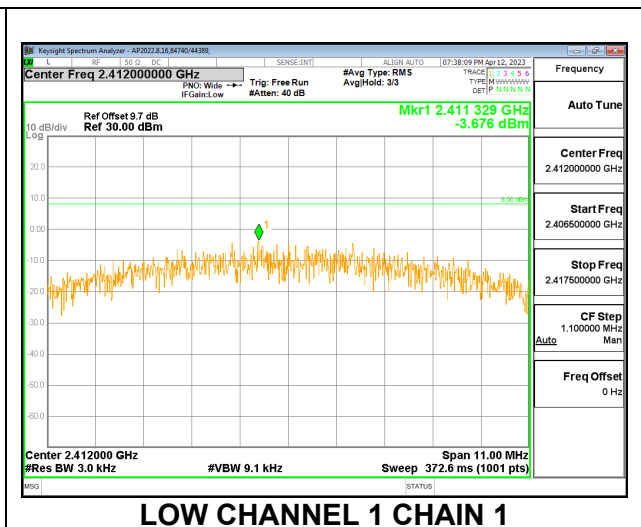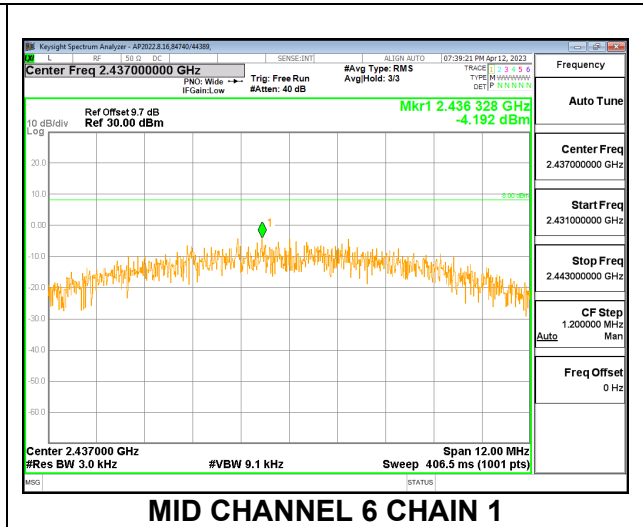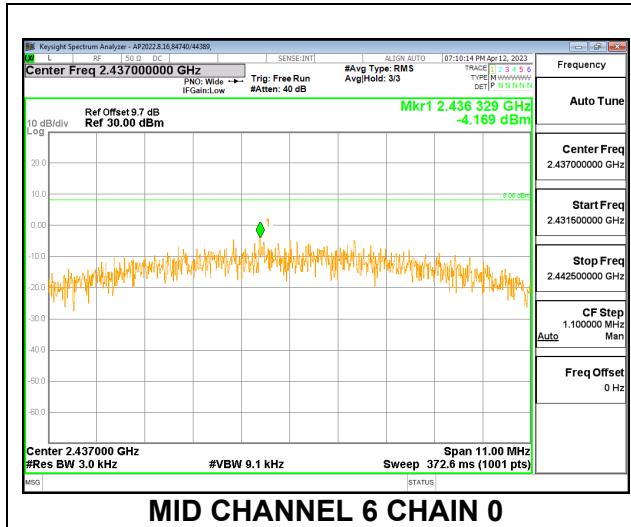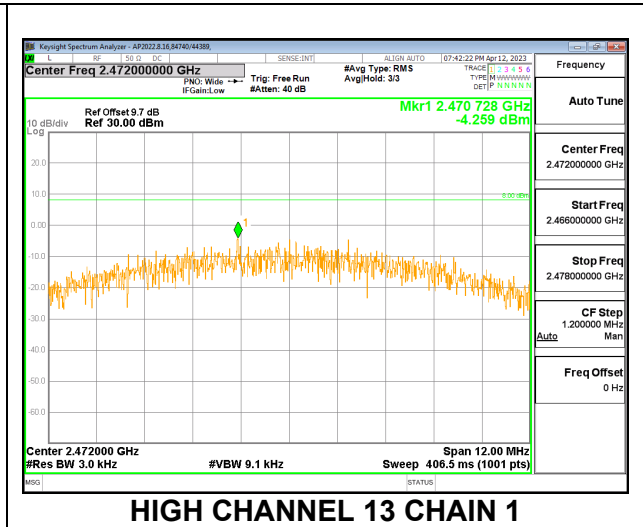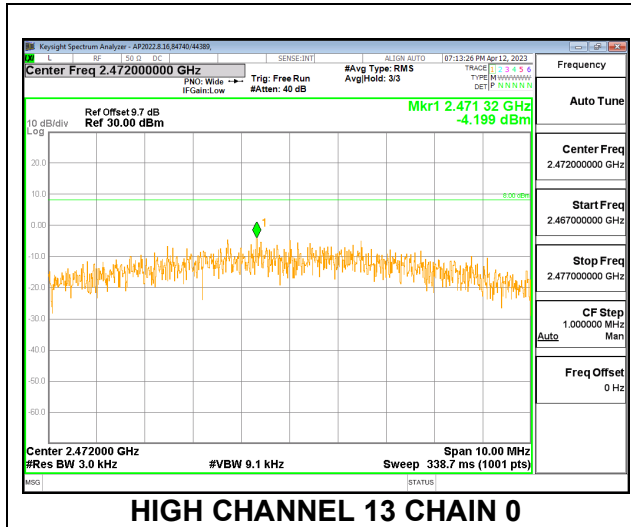
9.5.2. 802.11g MODE

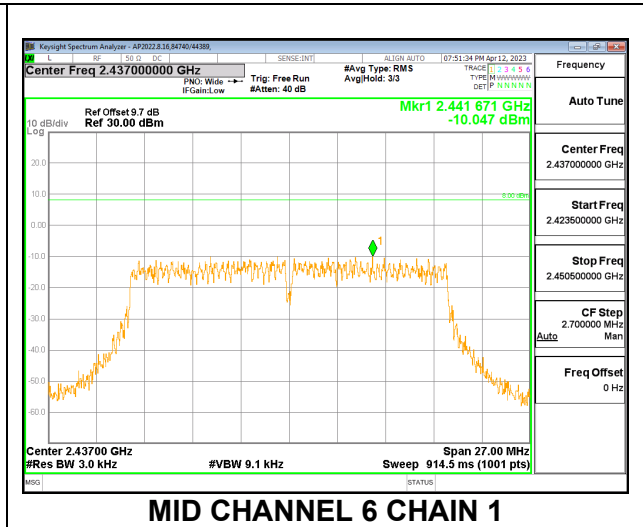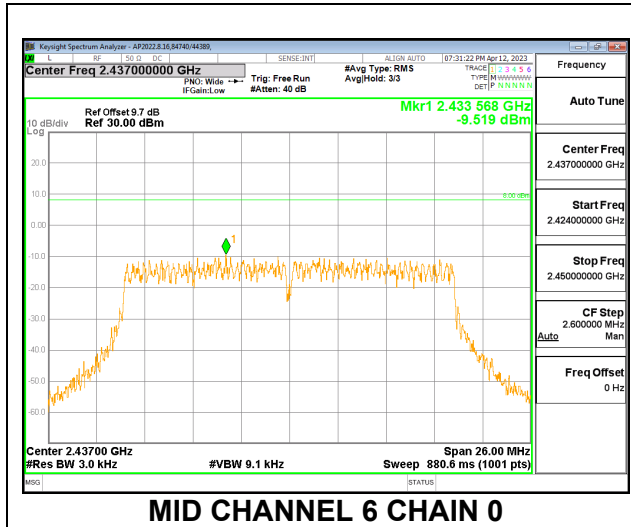**2TX Chain 0 + Chain 1 CDD MODE**

PSD Results

Channel	Frequency (MHz)	Chain 0 Meas (dBm/3kHz)	Chain 1 Meas (dBm/3kHz)	Total Corr'd PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low 1	2412	-10.197	-11.799	-7.91	8.0	-15.9
Mid 6	2437	-11.617	-11.406	-8.50	8.0	-16.5
High 13	2472	-10.571	-10.245	-7.39	8.0	-15.4

LOW CHANNEL 1

LOW CHANNEL 1 CHAIN 0

LOW CHANNEL 1 CHAIN 1

MID CHANNEL 6

MID CHANNEL 6 CHAIN 0

MID CHANNEL 6 CHAIN 1

HIGH CHANNEL 13

HIGH CHANNEL 13 CHAIN 0

HIGH CHANNEL 13 CHAIN 1

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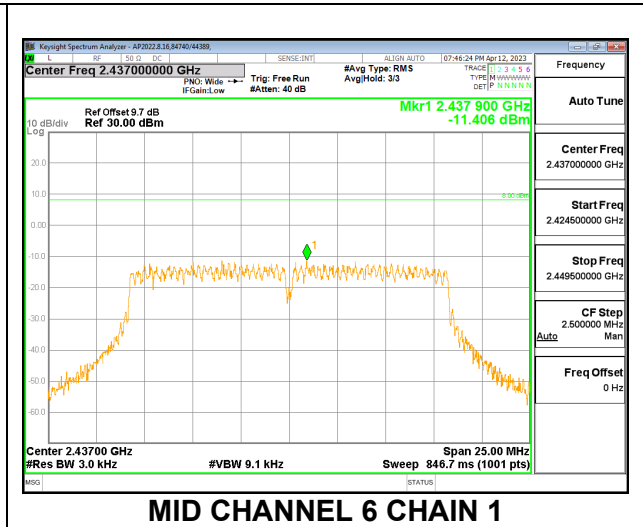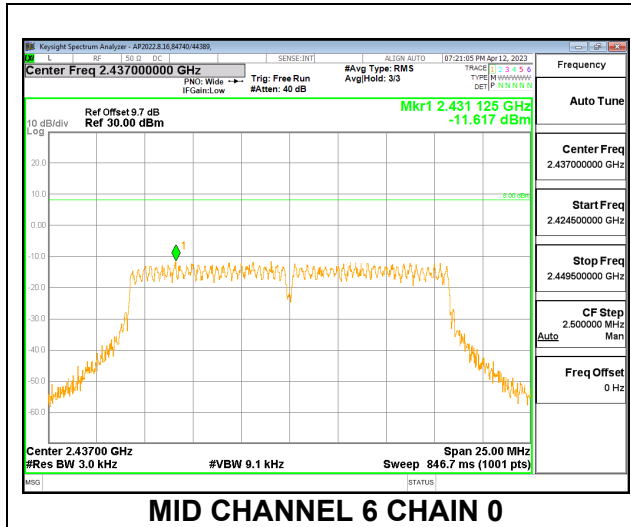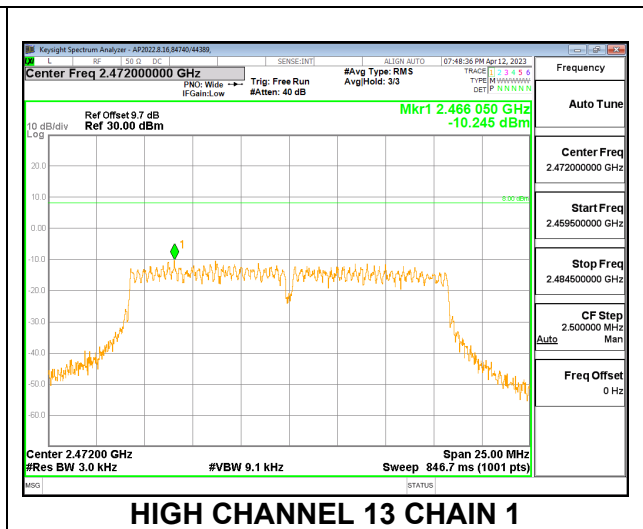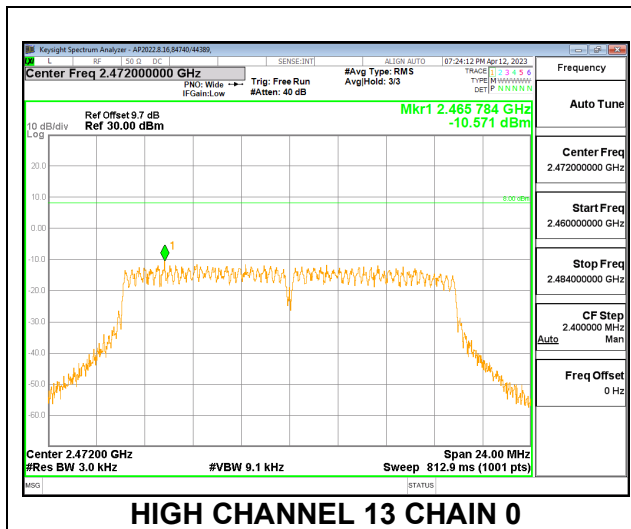
9.5.3. 802.11n HT20 MODE

2TX Chain 0 + Chain 1 CDD MODE

PSD Results

Channel	Frequency (MHz)	Chain 0 Meas (dBm/ 3kHz)	Chain 1 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low 1	2412	-9.735	-8.580	-6.11	8.0	-14.1
Mid 6	2437	-9.519	-10.047	-6.76	8.0	-14.8
High 13	2472	-8.925	-8.376	-5.63	8.0	-13.6

LOW CHANNEL 1

LOW CHANNEL 1 CHAIN 0   **LOW CHANNEL 1 CHAIN 1**

MID CHANNEL 6

MID CHANNEL 6 CHAIN 0

MID CHANNEL 6 CHAIN 1

HIGH CHANNEL 13

HIGH CHANNEL 13 CHAIN 0

HIGH CHANNEL 13 CHAIN 1

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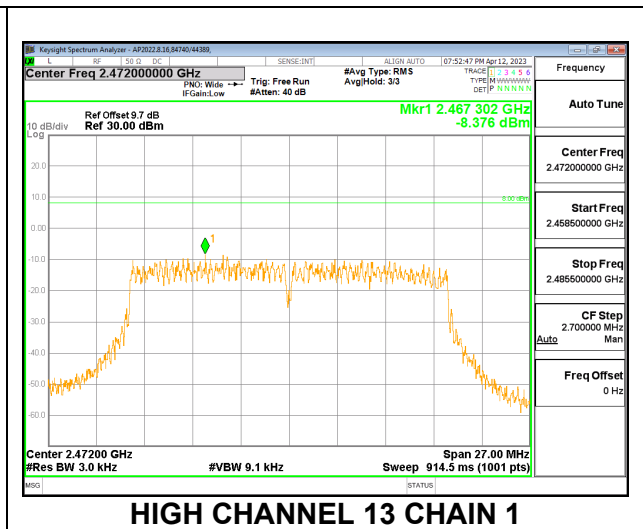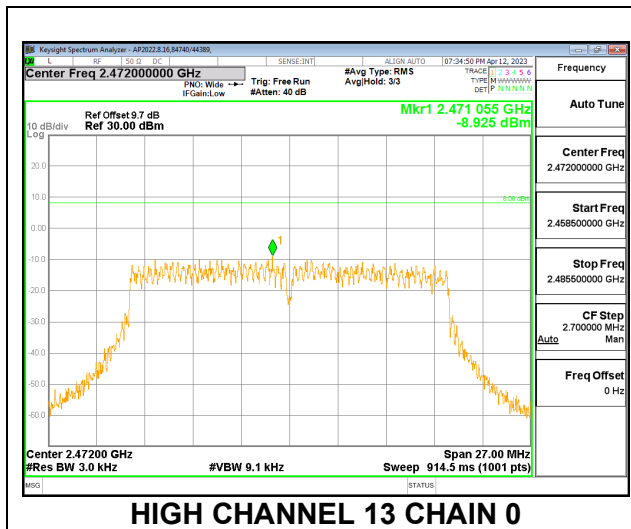
9.6. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)
RSS-247 5.5

Output power was measured based on the use of an average measurement; therefore, the required attenuation is -30 dBc.

RESULTS

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9.6.1. 802.11b MODE
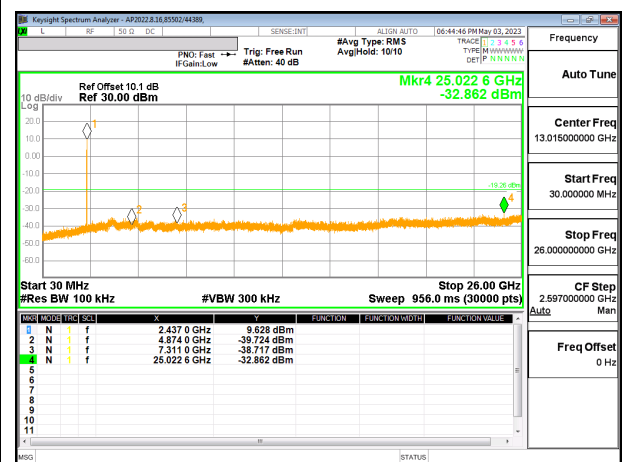
2TX Chain 0 + Chain 1 CDD MODE
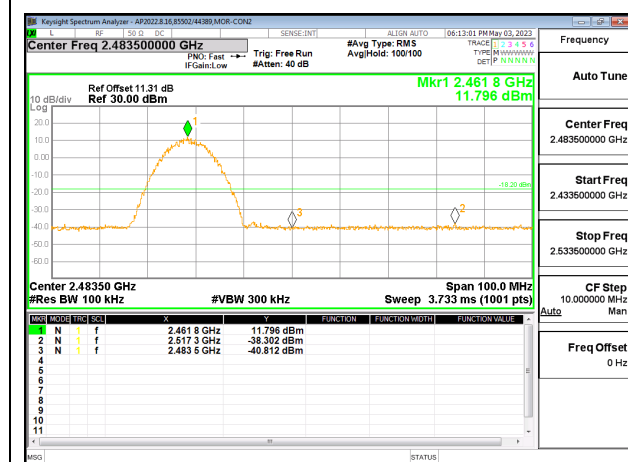

LOW CHANNEL 1 BANDEDGE CHAIN 0

OUT-OF-BAND LOW CHANNEL 1 CHAIN 0

IN-BAND REFERENCE LEVEL CHAIN 0

OUT-OF-BAND MID CHANNEL CHAIN 0

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HIGH CHANNEL 11 BANDEDGE CHAIN 0 | HIGH CHANNEL 12 BANDEDGE CHAIN 0

HIGH CHANNEL 13 BANDEDGE CHAIN 0 | OUT-OF-BAND HIGH CHANNEL 13 CHAIN 0

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LOW CHANNEL 1 BANDEDGE CHAIN 1

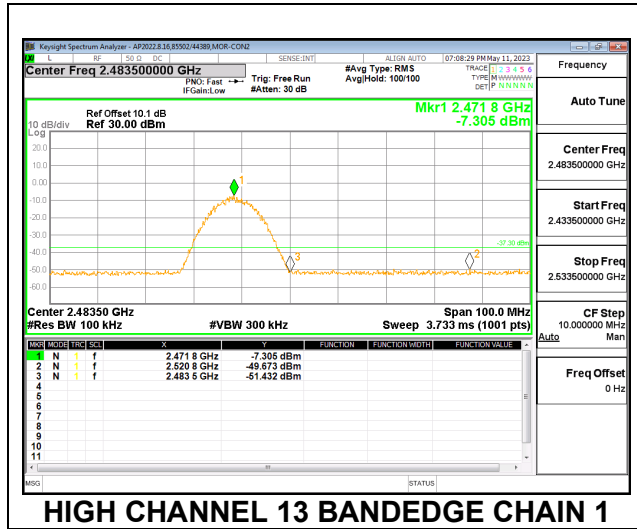**OUT-OF-BAND LOW CHANNEL 1 CHAIN 1**

IN-BAND REFERENCE LEVEL CHAIN 1
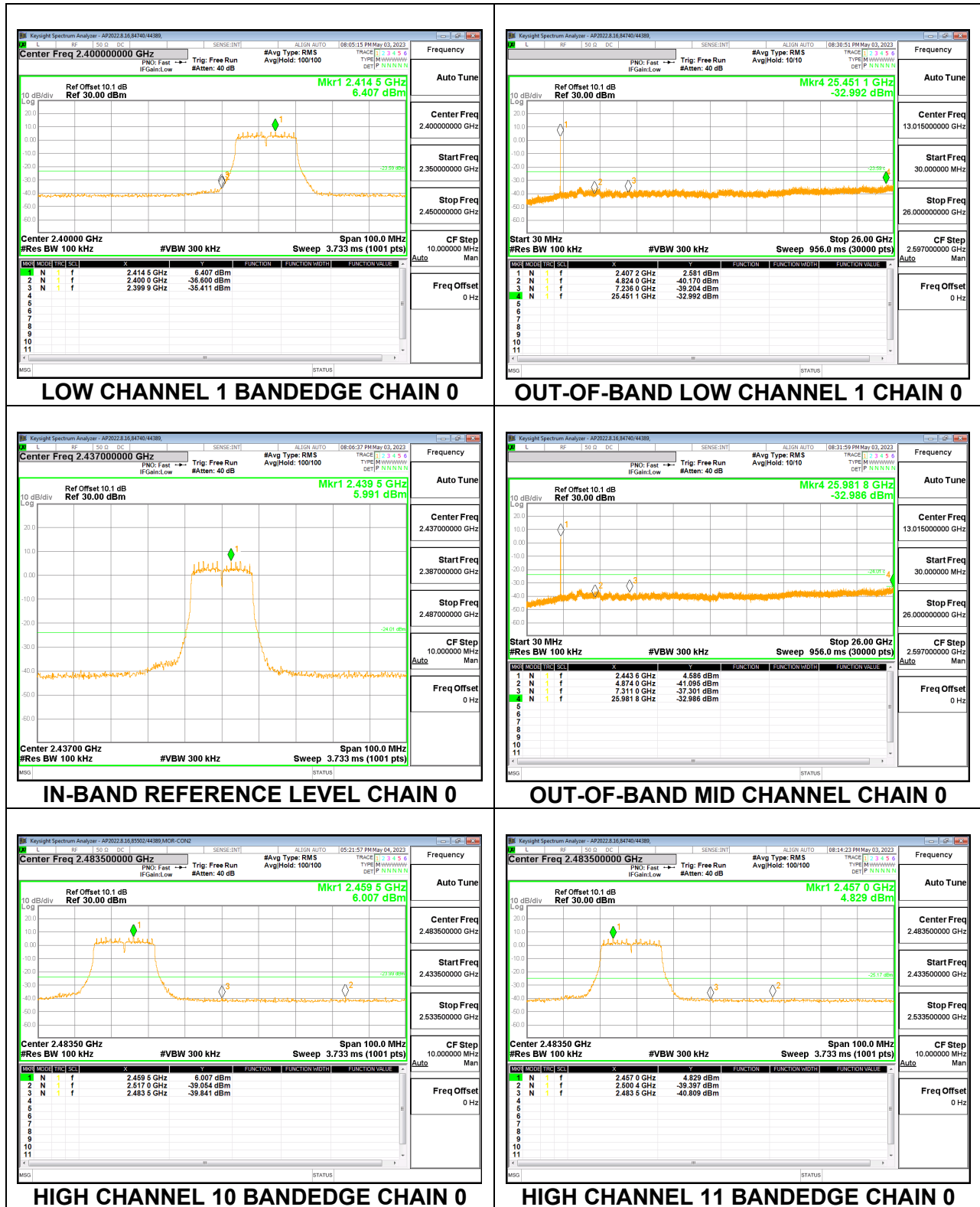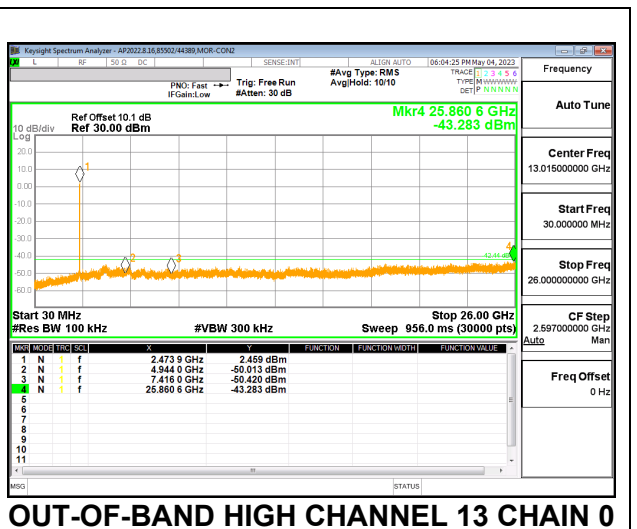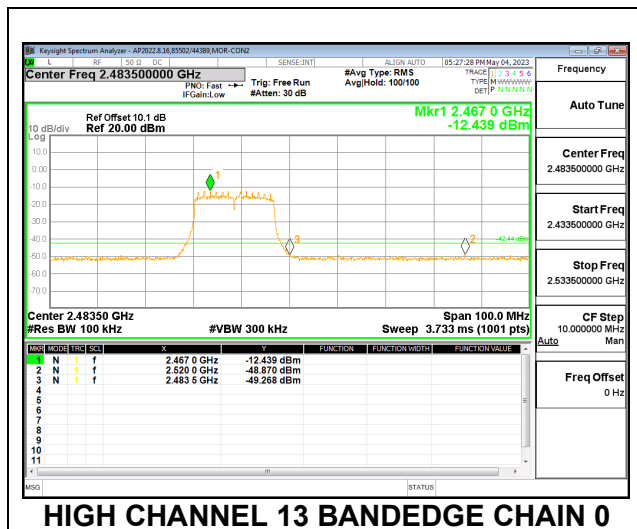

OUT-OF-BAND MID CHANNEL CHAIN 1

HIGH CHANNEL 11 BANDEDGE CHAIN 1

HIGH CHANNEL 12 BANDEDGE CHAIN 1

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HIGH CHANNEL 13 BANDEDGE CHAIN 1

OUT-OF-BAND HIGH CHANNEL 13 CHAIN 1

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9.6.2. 802.11g MODE

2TX Chain 0 + Chain 1 CDD MODE

LOW CHANNEL 1 BANDEDGE CHAIN 0

OUT-OF-BAND LOW CHANNEL 1 CHAIN 0

IN-BAND REFERENCE LEVEL CHAIN 0
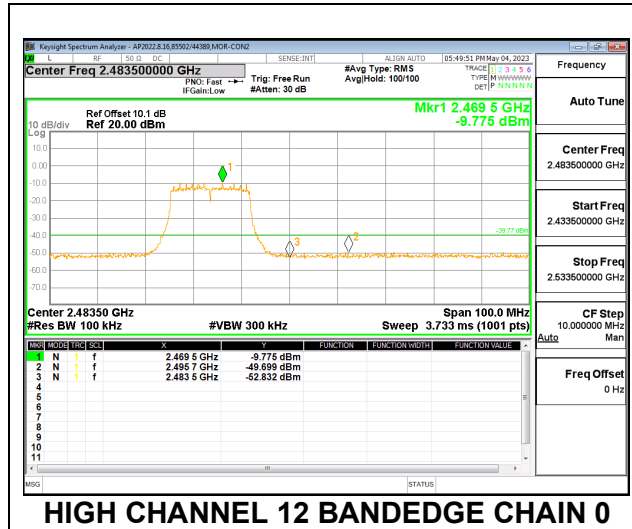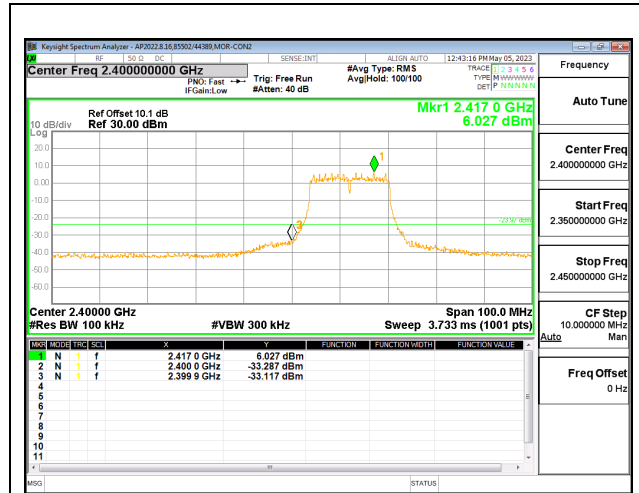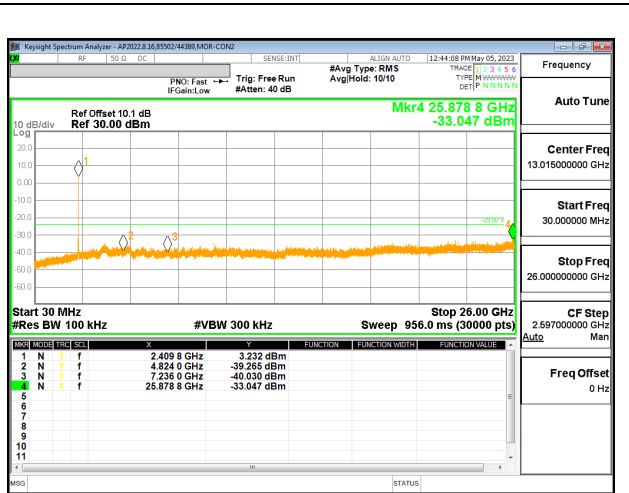

OUT-OF-BAND MID CHANNEL CHAIN 0

HIGH CHANNEL 10 BANDEDGE CHAIN 0

HIGH CHANNEL 11 BANDEDGE CHAIN 0

HIGH CHANNEL 12 BANDEDGE CHAIN 0

HIGH CHANNEL 13 BANDEDGE CHAIN 0

OUT-OF-BAND HIGH CHANNEL 13 CHAIN 0

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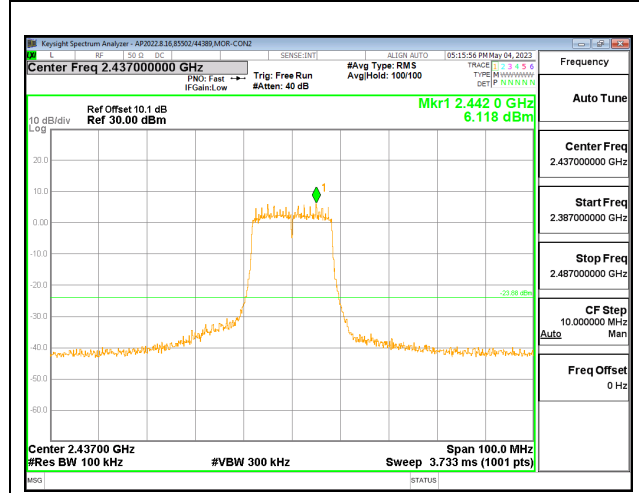*This report shall not be reproduced except in full, without the written approval of UL LLC*
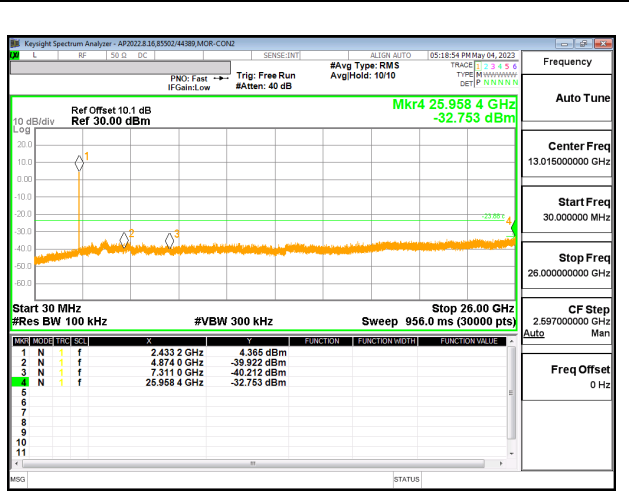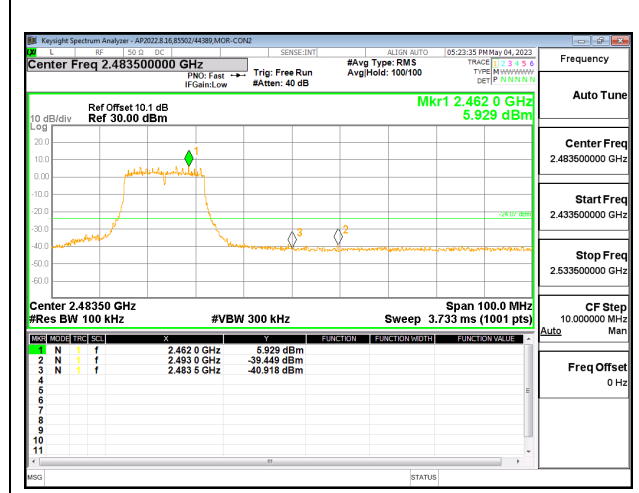
LOW CHANNEL 1 BANDEDGE CHAIN 1

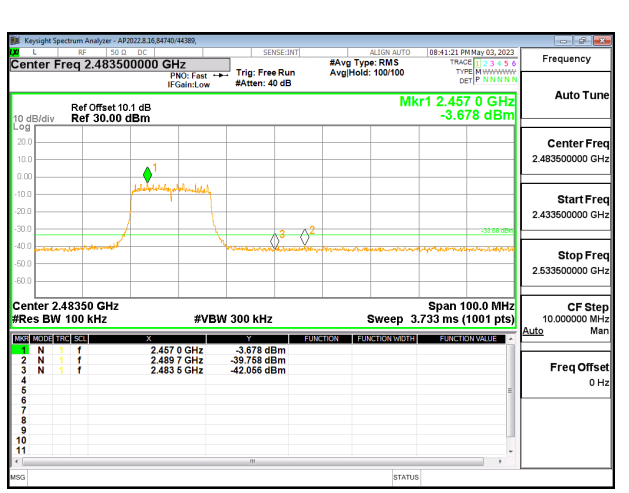**OUT-OF-BAND LOW CHANNEL 1 CHAIN 1**

IN-BAND REFERENCE LEVEL CHAIN 1

OUT-OF-BAND MID CHANNEL CHAIN 1

HIGH CHANNEL 10 BANDEDGE CHAIN 1

HIGH CHANNEL 11 BANDEDGE CHAIN 1

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HIGH CHANNEL 12 BANDEDGE CHAIN 1

HIGH CHANNEL 13 BANDEDGE CHAIN 1

OUT-OF-BAND HIGH CHANNEL 13 CHAIN 1

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