TEST REPORT

Report Number : 14982489-E1V2

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

Model : A3082 (Parent Model)
A3289, A3290, A3291 (Variant Models)

FCC ID : BCG-E8692A (Parent Model)
BCG-E8693A, BCG-E8694A, BCG-E8695A
(Variant Models)

IC : 579C-E8692A (Parent Model)
579C-E8693A, 579C-E8694A, 579C-E8695A
(Variant Models)

EUT Description : SMARTPHONE

Test Standard(s) : FCC 47 CFR PART 15 SUBPART C
ISED RSS-247 ISSUE 3
ISED RSS-GEN ISSUE 5 + A1 + A2

Date Of Issue:
2024/08/08

Prepared by:
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CERT #0751.05

REPORT REVISION HISTORY

Rev.		Issue Date		Revisions		Revised By
V1		2024/08/05		Initial Issue		Chris Xiong
V2		2024/08/08		Address TCB's questions		Chin Pang

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME:	APPLE INC. 11 APPLE PARK WAY CUPERTINO, CA 95014, U.S.A.
EUT DESCRIPTION:	SMARTPHONE
MODEL:	A3082 (Parent Model) A3289, A3290, A3291 (Variant Models)
BRAND:	APPLE
FCC ID:	BCG-E8692A (Parent Model) BCG-E8693A, BCG-E8694A, BCG-E8695A (Variant Models)
IC ID:	579C-E8692A (Parent Model) 579C-E8693A, 579C-E8694A, 579C-E8695A (Variant Models)
SERIAL NUMBER:	C7HH230000G0000HC0, C7HH500000X0000HBX, FJWNV71QMD
SAMPLE RECEIPT DATE:	2024/03/11
DATE TESTED:	2024/03/13 TO 2024/08/08

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart C	Complies
ISED RSS-247 Issue 3	Complies
ISED RSS-GEN Issue 5 + A1 + A2	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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Approved & Released For
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Consumer Technology Division
UL Verification Inc.

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2. TEST SUMMARY

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

3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D01 Radiated Test Site v01r01, KDB 662911, RSS-GEN Issue 5 + A1 + A2, and RSS-247 Issue 3.

4. FACILITIES AND ACCREDITATION

UL Verification Services Inc. is accredited by A2LA, certification #0751.05, 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 1: 47173 Benicia Street, Fremont, CA 94538, USA	US0104	2324A	550739
☐	Building 2: 47266 Benicia Street, Fremont, CA 94538, USA			
☐	Building 3: 843 Auburn Court, Fremont, CA 94538 USA			
☒	Building 4: 47658 Kato Rd, Fremont, CA 94538 USA			
☒	Building 5: 47670 Kato Rd, Fremont, CA 94538 USA			

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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}
Conducted Antenna Port Emission Measurement	1.94 dB
Time Domain Measurements Using SA	3.39 dB
RF Power Measurement Direct Method Using Power Meter	1.30 dB (PK) 0.45 dB (Avg)
Radio Frequency (Spectrum Analyzer)	141.16 Hz
Occupied Bandwidth	1.22%
Carrier Frequency Separation	19.70Hz
Number of Hopping Frequencies	0.00 dB
Worst Case Conducted Disturbance, 9KHz to 0.15 MHz	3.78 dB
Worst Case Conducted Disturbance, 0.15 to 30 MHz	3.40 dB
Worst Case Radiated Disturbance, 9KHz to 30 MHz	2.87 dB
Worst Case Radiated Disturbance, 30 to 1000 MHz	6.01 dB
Worst Case Radiated Disturbance, 1000 to 18000 MHz	4.73 dB
Worst Case Radiated Disturbance, 18000 to 26000 MHz	4.51 dB

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

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6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The Apple iPhone is a smartphone with cellular GSM, GPRS, EGPRS, WCDMA, LTE, 5GNR1, 5GNR2, IEEE 802.11a/b/g/n/ac/ax/be, Bluetooth (BT), Ultra-Wideband (UWB), Global Positioning System (GPS), Near-Field Communication (NFC), Narrow-Band (NB) UNII, 802.15.4, 802.15.4ab-Narrow Band (NB), Wireless Power Transfer (WPT) and Mobile Satellite Service (MSS) technologies. The rechargeable battery is not user accessible. This device is not user-serviceable and requires special tools to disassemble.

6.2. MAXIMUM OUTPUT POWER

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

Antenna	Config	Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
ANT 4	High Power	2402 - 2480	Basic GFSK	19.75	94.41
		2402 - 2480	DQPSK	19.01	79.62
		2402 - 2480	Enhanced 8PSK	19.30	85.11
	Low Power	2402 - 2480	Basic GFSK	11.69	14.76
		2402 - 2480	DQPSK	9.03	8.00
		2402 - 2480	Enhanced 8PSK	9.27	8.45
ANT 3	High Power	2402 - 2480	Basic GFSK	20.22	105.20
		2402 - 2480	DQPSK	19.08	80.91
		2402 - 2480	Enhanced 8PSK	19.25	84.14
	Low Power	2402 - 2480	Basic GFSK	11.10	12.88
		2402 - 2480	DQPSK	9.06	8.05
		2402 - 2480	Enhanced 8PSK	9.29	8.49
Beamforming, ANT 4 + ANT 3	High Power	2402 - 2480	Basic GFSK TxBF	20.16	103.75
		2402 - 2480	DQPSK TxBF	19.05	80.35
		2402 - 2480	Enhanced 8PSK TxBF	19.28	84.72
	Low Power	2402 - 2480	Basic GFSK TxBF	14.40	27.54
		2402 - 2480	DQPSK TxBF	12.05	16.03
		2402 - 2480	Enhanced 8PSK TxBF	12.25	16.79

Note: GFSK, DQPSK, 8PSK Average Power are all investigated. GFSK & 8PSK Powers are the worst case. Testing is based on these modes to show compliance.

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6.3. DESCRIPTION OF AVAILABLE ANTENNAS

Antenna Type is IFA. The antennas' gains, as provided by the manufacturer, are as follows:

Frequency Range (GHz)	ANT 4 (dBi)	ANT 3 (dBi)
2.4	-0.10	-0.60

The SMA cable losses provided by client are as follows and were used for RF antenna port tests that had been offset to the test equipment during testing.

ANT 4 = 2.00 dB
ANT 3 = 2.10 dB

6.4. SOFTWARE AND FIRMWARE

The EUT firmware version installed for testing is 22.1.76.241.

6.5. WORST-CASE CONFIGURATION AND MODE

The EUT was investigated in three orthogonal orientations X, Y and Z on ANT 4 and ANT 3. It was determined that X (Flatbed) was the worst-case orientation for ANT 4, ANT 3 and 2TX Beamforming.

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

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

For below 1GHz emissions spurious tests EUT was connected to AC power adapter and set EUT on X orientation as the worst case; and for above 1GHz, the worst-case configuration reported was tested with EUT only. For AC line conducted emission, test was investigated with AC power adapter and with laptop. For simultaneous transmission of multiple channels in the 2.4GHz BT and 5GHz bands, no noticeable emission was found.

GFSK, DQPSK, 8PSK average power are all investigated. The GFSK & 8PSK powers are the worst case. For average power data, please refer to section 9.8.

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

GFSK Mode : DH5
8PSK Mode : 3-DH5
Beamforming Mode: GFSK (DH5), 8PSK (3-DH5)

For radiated harmonic spurious emissions test, high power beamforming GFSK mode is set to maximum power per chain to cover both SISO and MIMO modes to comply with radiated spurious emissions limits in the restricted bands between 1GHz and 18GHz Low/Middle/High channels.

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6.6. DESCRIPTION OF TEST SETUP

SUPPORT TEST EQUIPMENT				
Description	**Manufacturer**	**Model**	**Serial Number**	**FCC ID/ DoC**
Laptop	Apple	MacBook Pro	C02CWHQ4ML7H	BCGA2251
Laptop AC/DC adapter	Apple	A1718	C4H021107C2PM0WAW	DoC
EUT AC/DC adapter	Apple	A2305	HHY23570SL11PW9A1	DoC

I/O CABLES (RF CONDUCTED TEST)						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	SMA	1	SMA	Shielded	0.75	To spectrum Analyzer
2	Antenna	2	SMA	Un-shielded	0.2	To Conducted Switch Box
3	USB-C	1	USB-C	Shielded	1.0	N/A
4	AC	1	AC	Un-shielded	2	N/A

I/O CABLES (RF RADIATED AND AC LINE CONDUCTED TEST)						
Cable No.	**Port**	**# of Identical Ports**	**Connector Type**	**Cable Type**	**Cable Length (m)**	**Remarks**
1	AC	1	AC	Un-shielded	2	N/A
2	USB	1	USB	Shielded	1	N/A

TEST SETUP

The EUT setup is shown as below. Test software exercised the radio card.

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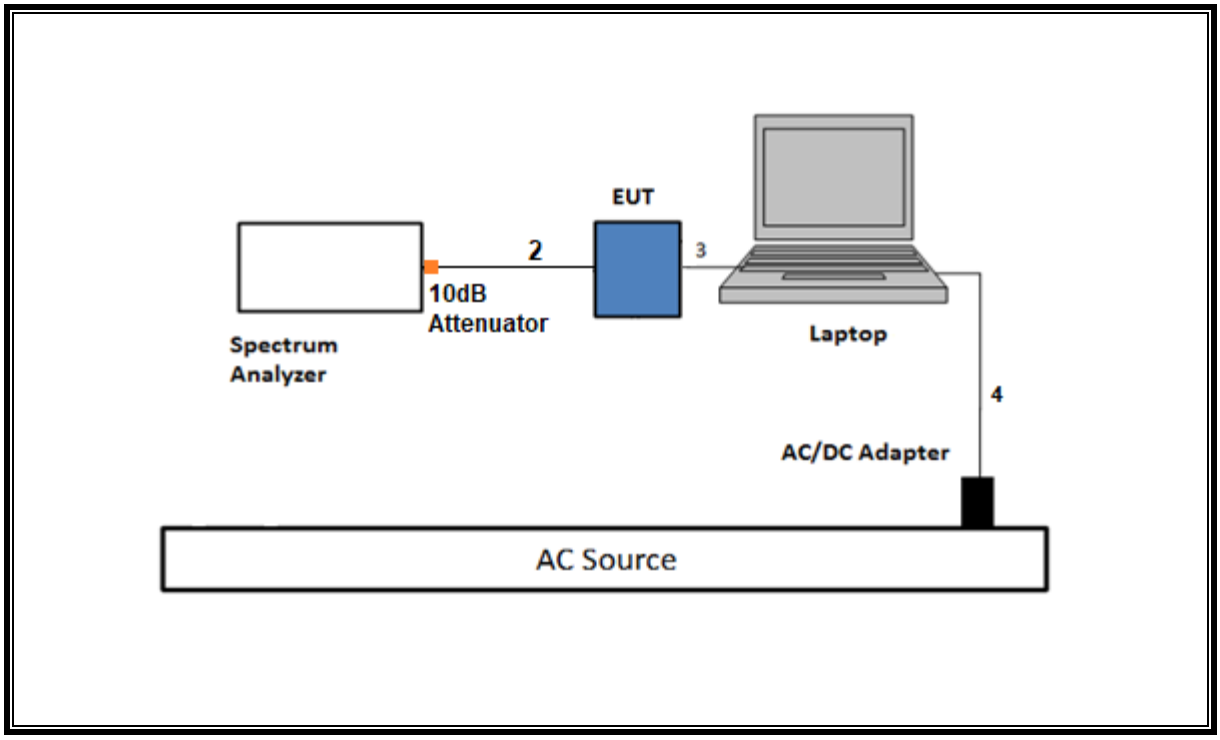
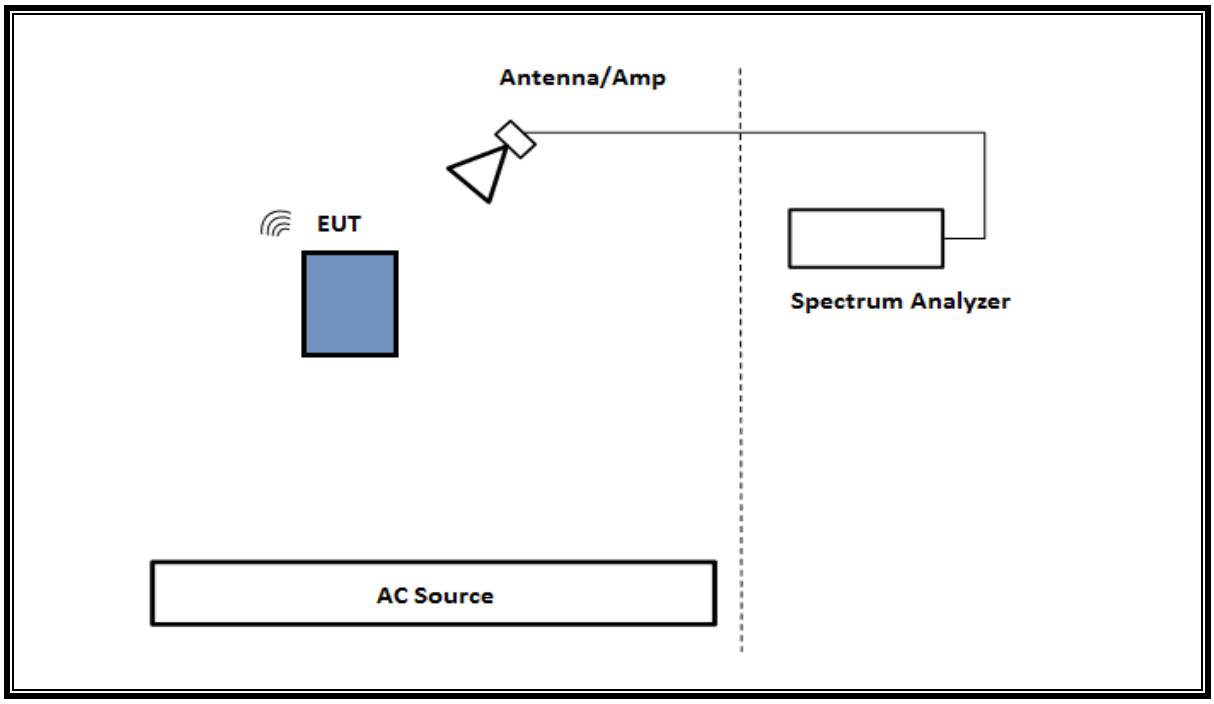
SETUP DIAGRAM FOR CONDUCTED TESTS



SETUP DIAGRAM FOR RADIATED TESTS ABOVE 1 GHz



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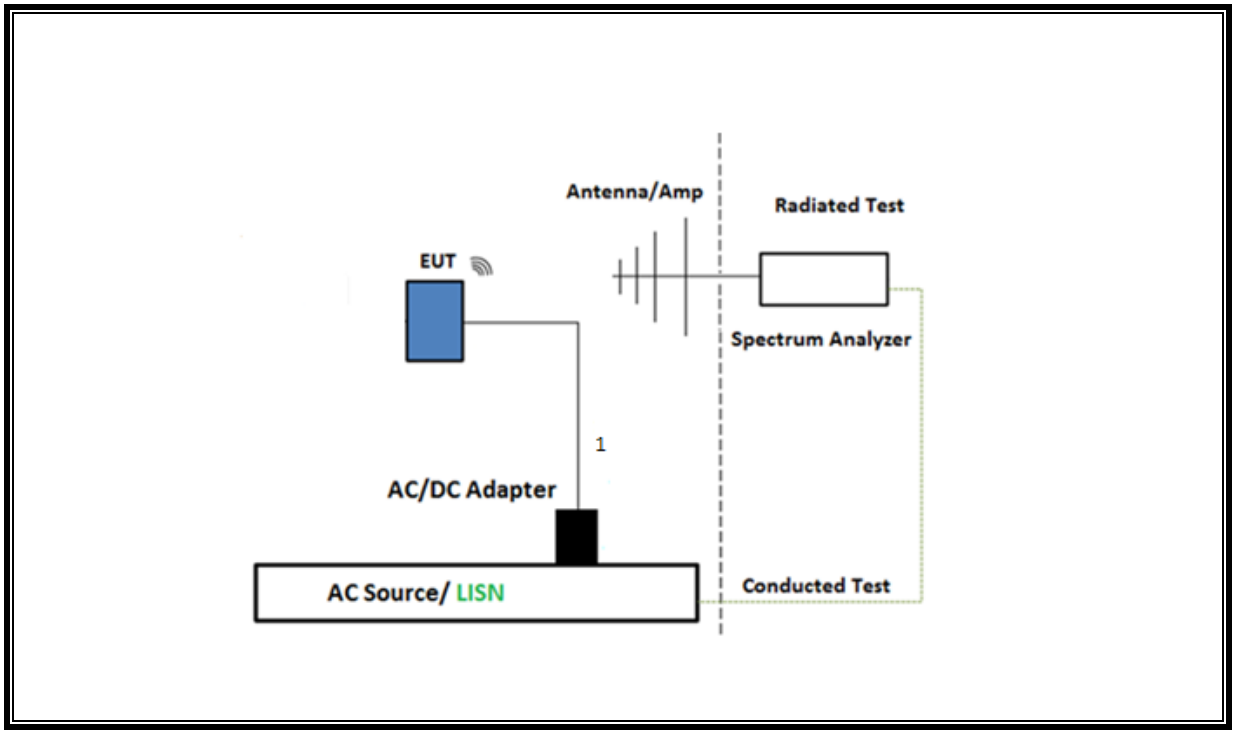
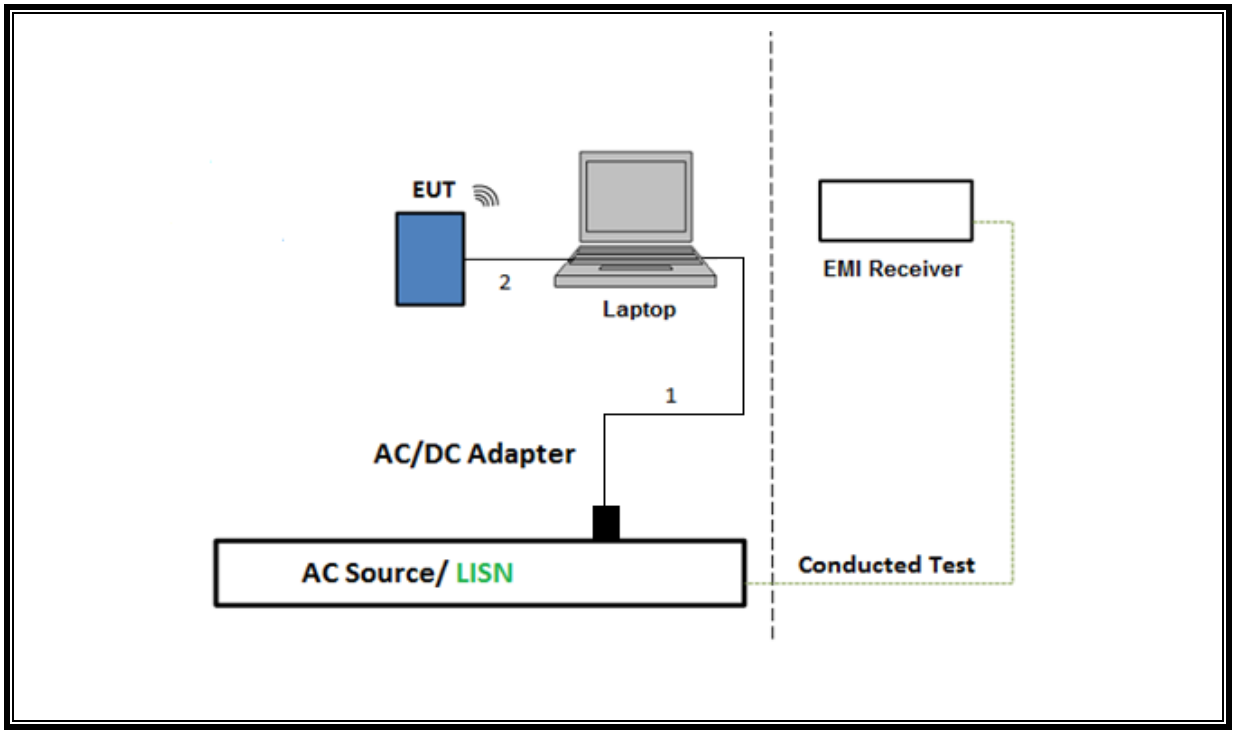
SETUP DIAGRAM FOR BELOW 1GHz and AC LINE CONDUCTED TEST



TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION



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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 Number**	**Cal Due**
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight Technologies Inc	N9030A	125178	2025/01/31
Spectrum Analyzer, PXA, 3Hz to 50GHz w/Ext. Mixer	Keysight Technologies Inc	N9030A	80400	2025/02/28
10dB Fixed Attenuator, 2 Watts Up to 26.5 GHz	Pasternack Enterprises	PE7024-10	236353	2024/08/31
10dB Fixed Attenuator, 2 Watts Up to 26.5 GHz	Pasternack Enterprises	PE7024-10	236355	2024/08/31
Power Meter, P-Series single channel	Keysight Technologies Inc	N1911A	90719	2025/01/31
Power Sensor, P - Series, 50MHz to 18GHz, Wideband	Keysight Technologies Inc	N1921A	90389	2025/01/31
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	169936	2025/02/28
* Antenna, Horn 1-18GHz	ETS-Lindgren	3117	79834	2024/06/30
RF Filter Box, 1-18GHz, 12 Port	UL-FR1	Frankenstein	217255	2024/10/31
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	201499	2025/02/11
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	41112	2024/10/31
RF Filter Box, 1-18GHz, 12 Port	UL-FR1	RATS 2	224478	2025/01/31
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	201500	2025/02/28
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	200784	2025/01/31
RF Filter Box, 1-18GHz, 2x12, 1x8 switches.	UL-FR1	Frankenstein, 2 Amp	235088	2025/04/30
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	201498	2025/02/28
Antenna, Horn 18 to 26.5GHz	A.R.A.	MWH-1826/B	81139	2024/08/31
RF Amplifier Assembly, 18-26.5GHz, 60dB Gain	AMPLICAL	AMP18G26.5-60	220194	2024/07/31
RF Filter Box, 1-18GHz, 17 Ports	UL-FR1	RATS 2	225575	2025/04/17
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	169927	2025/02/28
Antenna, BroadBand Hybrid, 30MHz to 3GHz	Sunol Sciences Corp.	JB3	222008	2024/10/23
Amplifier, 9KHz to 1GHz, 32dB	SONOMA INSTRUMENT	310N	202989	2025/02/28
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	179372	2025/02/28
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	226673	2025/02/28
RF Filter Box, 1-18GHz, 12 Port.	UL-FR1	Frankenstein	231874	2024/08/30
*Antenna, Passive Loop 100KHz - 30MHz	ELECTRO-METRICS	EM-6872	170015	2024/07/31
*Antenna, Passive Loop 30Hz - 1MHz	ELECTRO-METRICS	EM-6871	170013	2024/07/31
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	84797	2024/09/30
RF Filter Box, 1-18GHz, 17 Port.	UL-FR1	RATS 2	226781	2025/04/30
EMI Test Receiver	Rohde & Schwarz	ESW44	223461	2025/02/28

AC LINE CONDUCTED				
Description	**Manufacturer**	**Model**	**ID Number**	**Cal Due**
EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESR	93091	2025/02/28
LISN for Conducted Emissions CISPR-16	FISCHER CUSTOM COMMUNICATIONS	FCC-LISN-50/250-25-2-01-480V	175765	2025/01/31
Transient Limiter	TE	TBFL1	207996	2024/08/31

UL AUTOMATION SOFTWARE			
Radiated Software	UL	UL EMC	Ver 9.5, May 1, 2023
Conducted Software	UL	UL EMC	2024.2.23
AC Line Conducted Software	UL	UL EMC	Ver 9.5, Mar 3, 2023

* Testing was completed before equipment calibration date

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8. MEASUREMENT METHODS

Test Item	Test Method
On Time and Duty Cycle	• ANSI C63.10-2013 Section 11.6
Occupied Bandwidth (20dB)	• ANSI C63.10-2013 Section 6.9.2
Occupied Bandwidth (99%)	• ANSI C63.10-2013 Section 6.9.3
Carrier Frequency Separation	• ANSI C63.10-2013 Section 7.8.2
Number of Hopping Frequencies	• ANSI C63.10-2013 Section 7.8.3
Time of Occupancy (Dwell Time)	• ANSI C63.10-2013 Section 7.8.4
Peak Output Power	• ANSI C63.10-2013 Section 7.8.5
Conducted Spurious Emissions	• ANSI C63.10-2013 Section 7.8.8
Conducted Band-Edge	• ANSI C63.10-2013 Section 6.10.4
Radiated Spurious Emissions Below 30MHz	• ANSI C63.10-2013 Section 6.4 & 13
Radiated Spurious Emissions 30-1000MHz	• ANSI C63.10-2013 Section 6.3, 6.5 & 13
Radiated Spurious Emissions Above 1GHz	• ANSI C63.10-2013 Section 6.3, 6.6 & 13
Radiated Band-Edge	• ANSI C63.10-2013 Section 6.10.5 & 13
AC Power-Line Conducted Emissions	• ANSI C63.10-2013, Section 6.2

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9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

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

ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/T Minimum VBW (kHz)
Bluetooth GFSK	0.0339	0.0339	1.000	100.0%	0.00	0.010
Bluetooth 8PSK	2.1850	2.1850	1.000	100.0%	0.00	0.010

DUTY CYCLE PLOT

BLUETOOTH GFSK

BLUETOOTH 8PSK

Note: DCCF is the same for both SISO MODE and TXBF MODE.

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9.2. 20 dB AND 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

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

Test procedure on beamforming mode is the same as BT basic and EDR mode.

RESULTS

Only High-Power modes result is reported, and it covers all Low Power modes. Only Mid channel plot is reported to show analyzer's settings.

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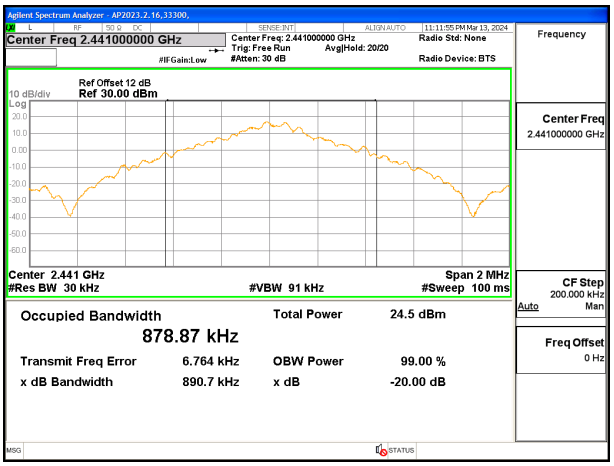
9.2.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

ANT 4

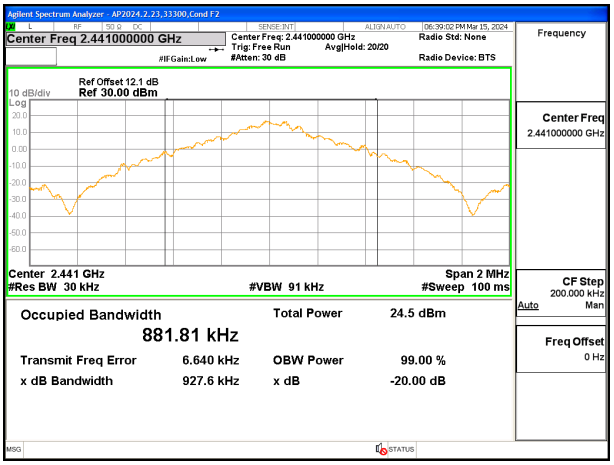
Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	.9226	.87846
Mid	2441	.8907	.87887
High	2480	.8895	.87809



MID CHANNEL

ANT 3

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	.9245	.87918
Mid	2441	.9276	.88181
High	2480	.8910	.88082



MID CHANNEL

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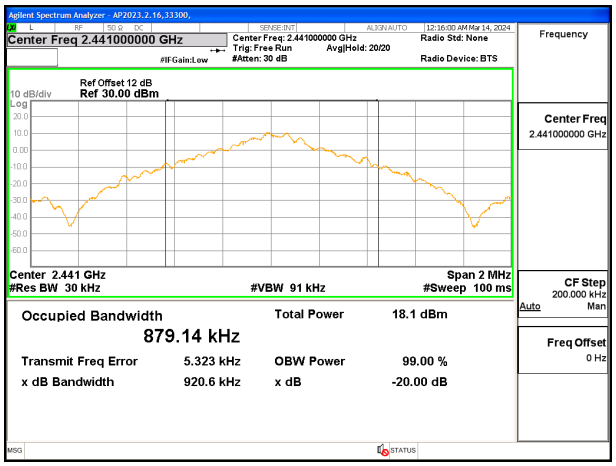
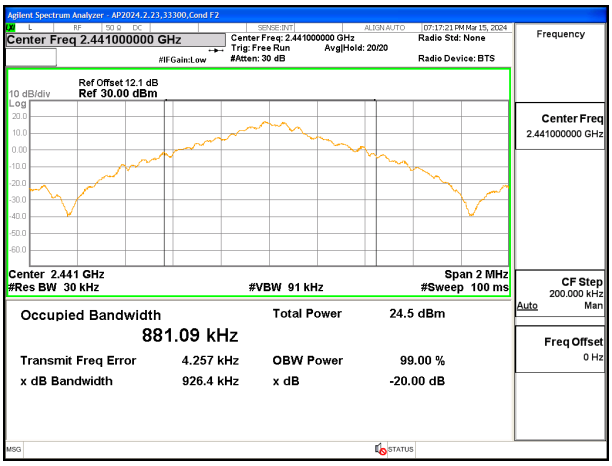
9.2.2. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

Channel	Frequency (MHz)	20dB Bandwidth ANT 4 (MHz)	99% Bandwidth ANT 4 (MHz)	20dB Bandwidth ANT 3 (MHz)	99% Bandwidth ANT 3 (MHz)
Low	2402	.8909	.87696	.9237	.88105
Mid	2441	.9206	.87914	.9264	.88109
High	2480	.8908	.87750	.9240	.87765



MID CHANNEL [ANT 4]



MID CHANNEL [ANT 3]

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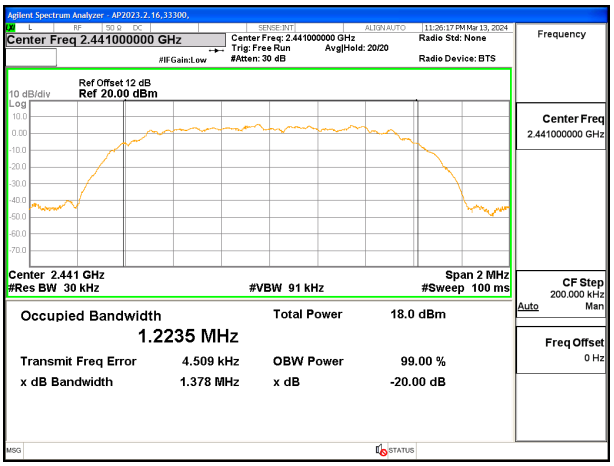
9.2.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

ANT 4

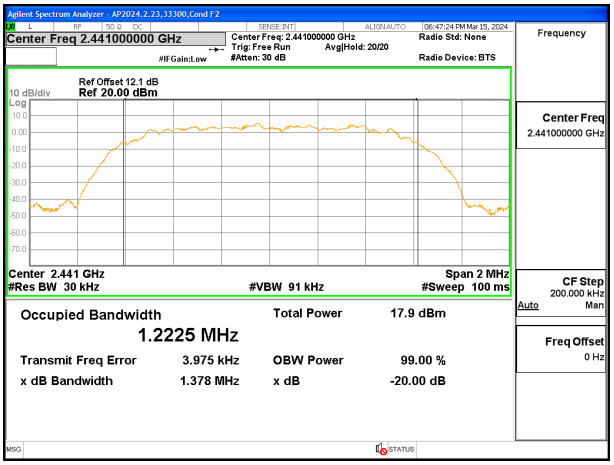
Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.378	1.2226
Mid	2441	1.378	1.2235
High	2480	1.376	1.2230



MID CHANNEL

ANT 3

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.378	1.2234
Mid	2441	1.378	1.2225
High	2480	1.380	1.2236



MID CHANNEL

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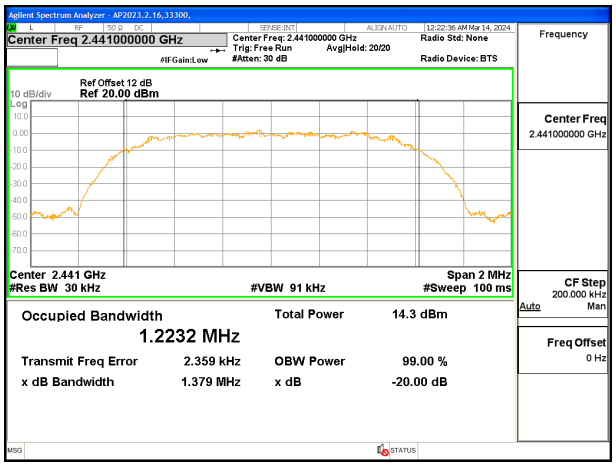
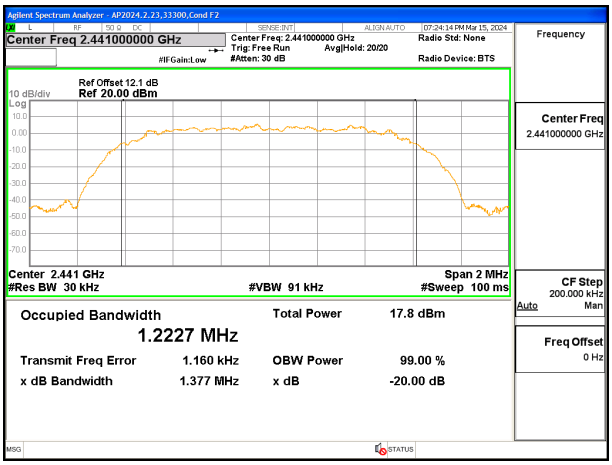
9.2.4. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

Channel	Frequency (MHz)	20dB Bandwidth ANT 4 (MHz)	99% Bandwidth ANT 4 (MHz)	20dB Bandwidth ANT 3 (MHz)	99% Bandwidth ANT 3 (MHz)
Low	2402	1.380	1.2225	1.379	1.2235
Mid	2441	1.379	1.2232	1.377	1.2227
High	2480	1.377	1.2236	1.379	1.2234



MID CHANNEL [ANT 4]



MID CHANNEL [ANT 3]

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9.3. HOPPING FREQUENCY SEPARATION

LIMITS

FCC §15.247 (a) (1)

RSS-247 (5.1) (b)

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

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

TEST PROCEDURE

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

RESULTS

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

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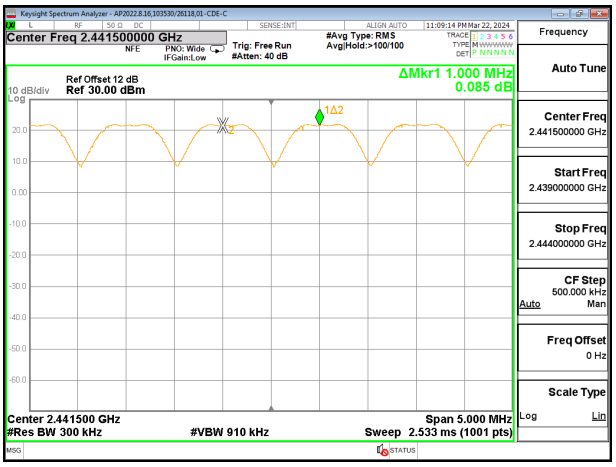
9.3.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

HOPPING FREQUENCY SEPARATION



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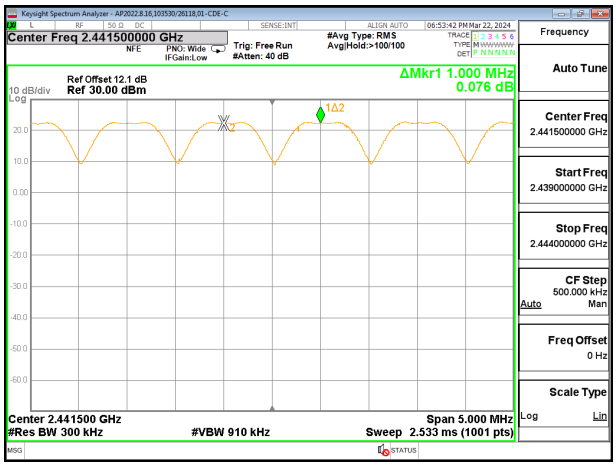

[ANT 3]

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9.4. NUMBER OF HOPPING CHANNELS

LIMITS

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

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

TEST PROCEDURE

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

RESULTS

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

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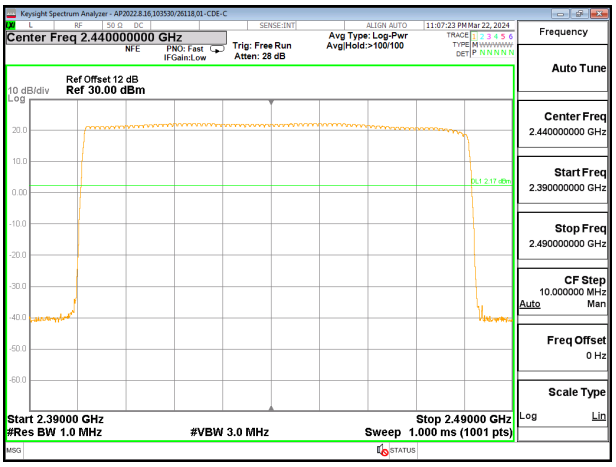
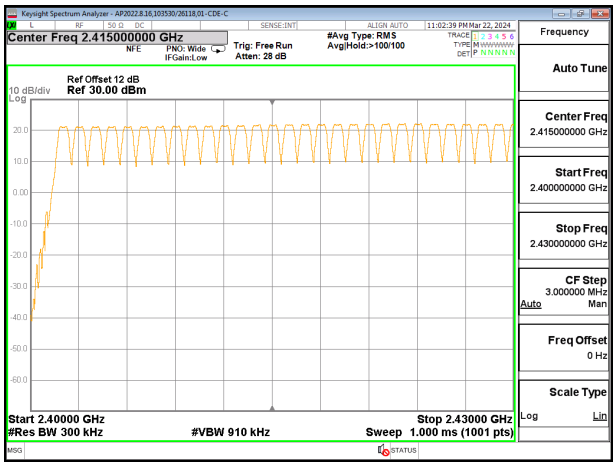
9.5. HIGH POWER BASIC DATA RATE GFSK MODULATION

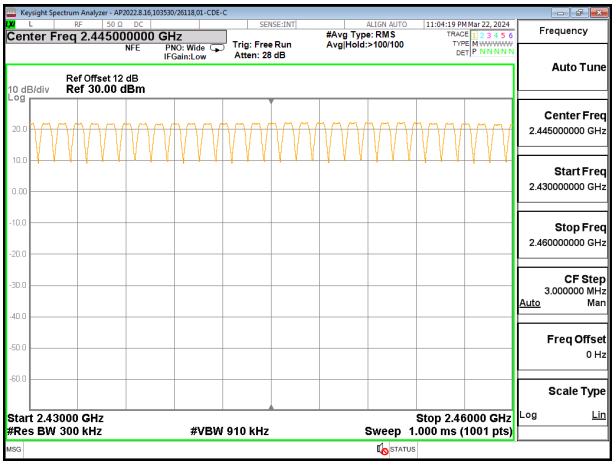
ANT 4



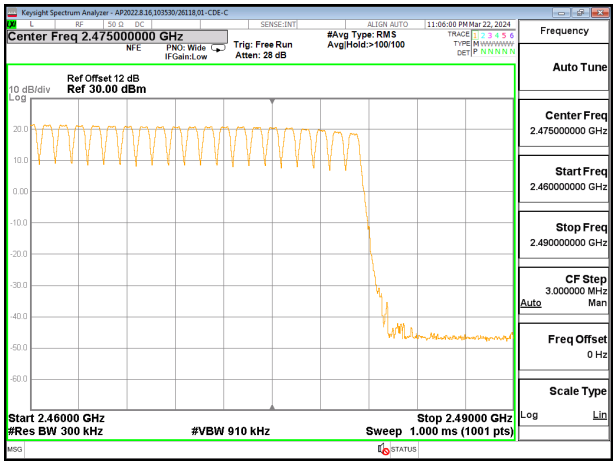
100MHz SPAN



30MHz SPAN, SEGMENT 1 OF 3



30MHz SPAN, SEGMENT 2 OF 3



30MHz SPAN, SEGMENT 3 OF 3

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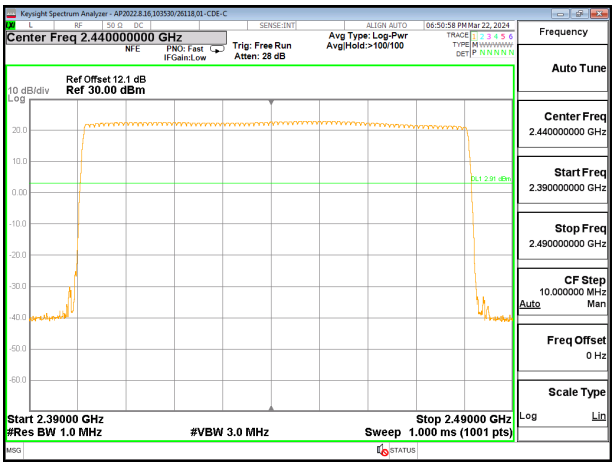
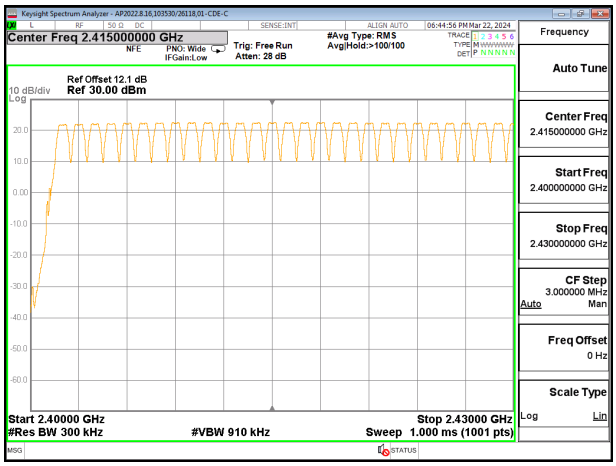
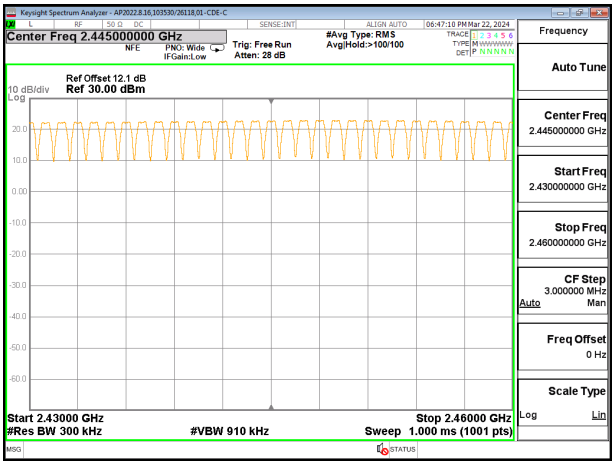
ANT 3



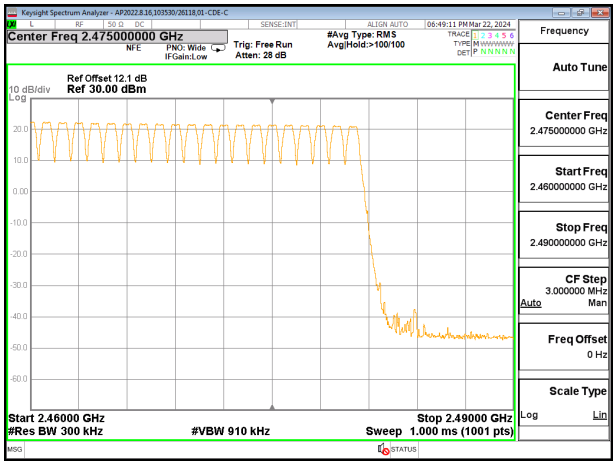
100MHz SPAN



30MHz SPAN, SEGMENT 1 OF 3



30MHz SPAN, SEGMENT 2 OF 3



30MHz SPAN, SEGMENT 3 OF 3

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9.6. AVERAGE TIME OF OCCUPANCY

LIMITS

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

TEST PROCEDURE

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

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

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

RESULTS

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

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9.6.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

ANT 4

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal Mode					
DH1	0.380	31	0.118	0.4	-0.282
DH3	1.634	17	0.278	0.4	-0.122
DH5	2.876	7	0.201	0.4	-0.199
DH Packet	**Pulse Width (sec)**	**Number of Pulses in 0.8 seconds**	**Average Time of Occupancy (sec)**	**Limit (sec)**	**Margin (sec)**
GFSK AFH Mode					
DH1	0.380	8	0.029	0.4	-0.371
DH3	1.634	4	0.069	0.4	-0.331
DH5	2.876	2	0.050	0.4	-0.350

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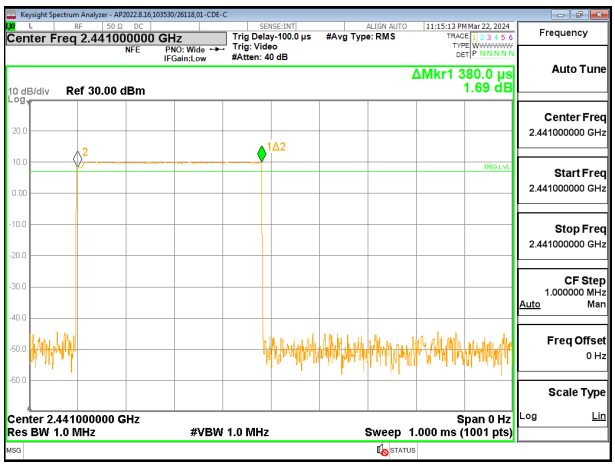
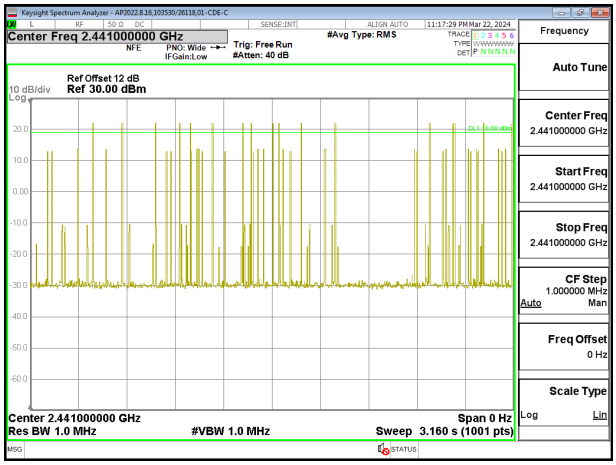


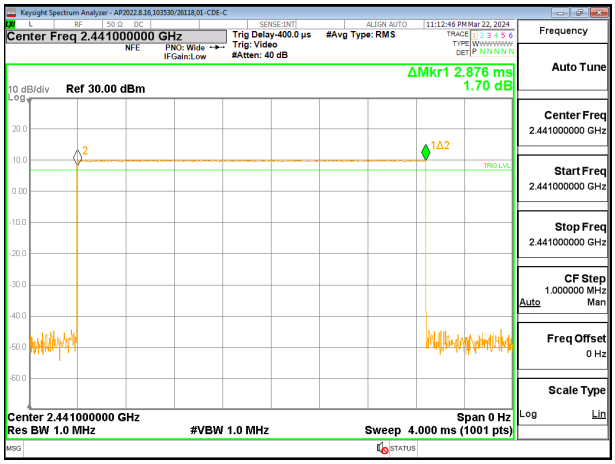
PULSE WIDTH – DH1

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1

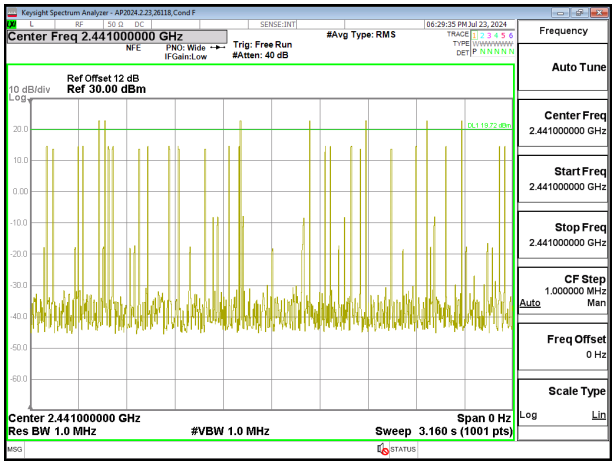
PULSE WIDTH – DH3



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3



PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5

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ANT 3

DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal Mode					
DH1	0.380	31	0.118	0.4	-0.282
DH3	1.632	17	0.277	0.4	-0.123
DH5	2.872	7	0.201	0.4	-0.199
DH Packet	**Pulse Width (sec)**	**Number of Pulses in 0.8 seconds**	**Average Time of Occupancy (sec)**	**Limit (sec)**	**Margin (sec)**
GFSK AFH Mode					
DH1	0.380	7.75	0.029	0.4	-0.371
DH3	1.632	4.25	0.069	0.4	-0.331
DH5	2.872	1.75	0.050	0.4	-0.350

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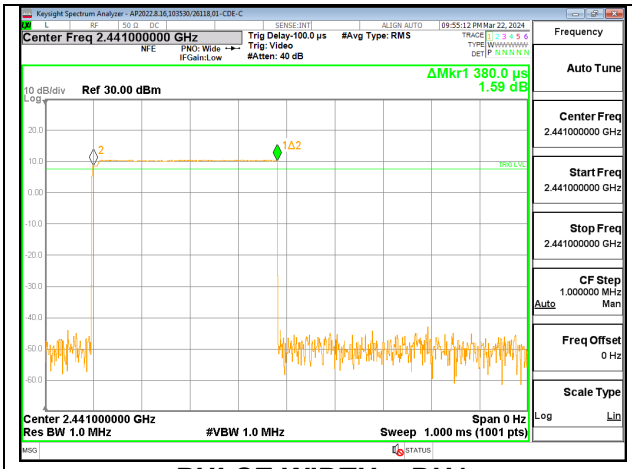
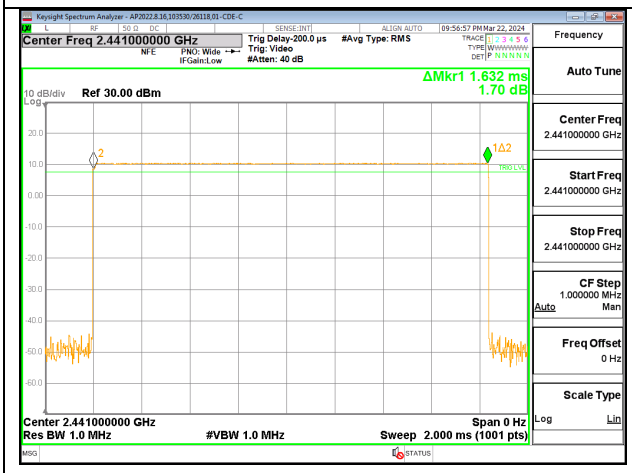
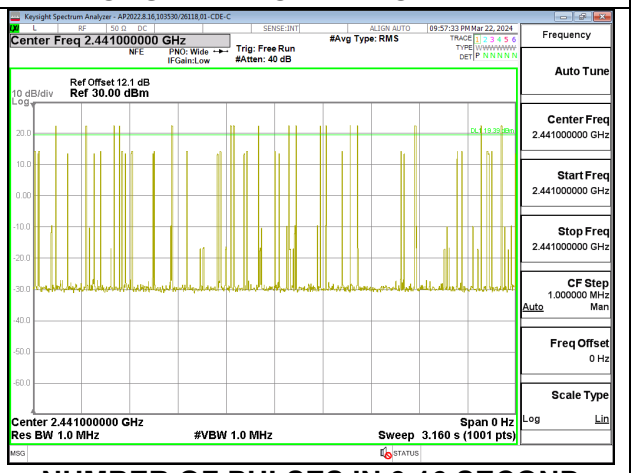


PULSE WIDTH – DH1

NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1

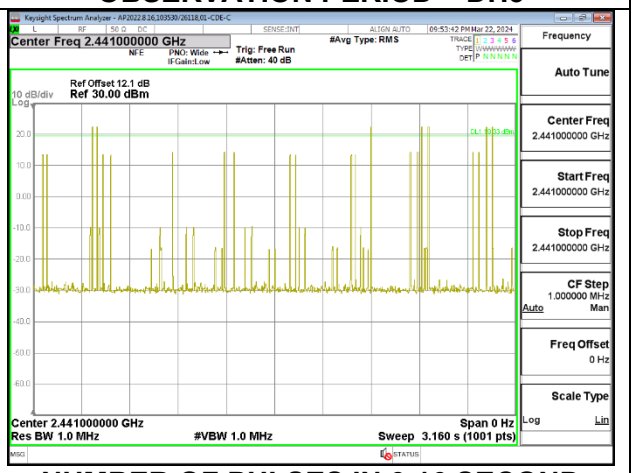


PULSE WIDTH – DH3



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3

PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5

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9.7. OUTPUT POWER

LIMITS

§15.247 (b) (1)

RSS-247 (5.4) (b)

The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts

TEST PROCEDURE

Measurements were performed using a power meter with wideband peak power sensor.

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

DIRECTIONAL ANTENNA GAIN

For 1 TX:
There is only one transmitter output therefore the directional gain is equal to the antenna gain.

For 2 TX:
Tx chains are correlated for power due to the device supporting Beamforming. The directional gains are as follows:

Band (GHz)	ANT 4 Gain (dBi)	ANT 3 Gain (dBi)	Uncorrelated Directional Gain (dBi)	Correlated Directional Gain (dBi)
2.4	-0.10	-0.60	-0.34	2.66

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DIRECTIONAL GAIN CALCULATION:

ANSI C63.10-2013 section 14.4.3

Uncorrelated Directional Gain $$= 10 * \mathrm{LOG}\left[\frac{10^{\frac{\mathrm{ANT4}}{10}} + 10^{\frac{\mathrm{ANT3}}{10}}}{2}\right]$$

Correlated Directional Gain $$= 10 * \mathrm{LOG}\left[\frac{\left(10^{\frac{\mathrm{ANT4}}{20}} + 10^{\frac{\mathrm{ANT3}}{20}}\right)^2}{2}\right]$$

Sample Calculation:

ANT 4 = -0.10 dBi
ANT 3 = -0.60 dBi

Uncorrelated Directional Gain $$= 10 * \mathrm{LOG}\left[\frac{10^{\frac{-0.10}{10}} + 10^{\frac{-0.60}{10}}}{2}\right] = -0.34\ \mathrm{dBi}$$

Correlated Directional Gain $$= 10 * \mathrm{LOG}\left[\frac{\left(10^{\frac{-0.10}{20}} + 10^{\frac{-0.60}{20}}\right)^2}{2}\right] = 2.66\ \mathrm{dBi}$$

RESULTS

Tested By:	26118
Date:	2024/05/07 2024/07/01 2024/07/17

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9.7.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Limit (dBm)	Margin ANT 4 (dB)	Margin ANT 3 (dB)
Low	2402	19.65	20.14	21	-1.35	-0.86
Middle	2441	19.75	20.22		-1.25	-0.78
High	2480	19.62	20.20		-1.38	-0.80

9.7.2. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	17.09	17.06	20.09	21	-0.91
Middle	2441	17.17	17.13	20.16		-0.84
High	2480	17.11	17.17	20.15		-0.85

9.7.3. HIGH POWER ENHANCED DATA RATE QPSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Limit (dBm)	Margin ANT 4 (dB)	Margin ANT 3 (dB)
Low	2402	18.98	19.03	21	-2.02	-1.97
Middle	2441	19.01	19.08		-1.99	-1.92
High	2480	18.98	19.01		-2.02	-1.99

9.7.4. HIGH POWER ENHANCED DATA RATE TXBF QPSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	16.02	15.91	18.98	21	-2.02
Middle	2441	16.02	16.06	19.05		-1.95
High	2480	16.06	16.02	19.05		-1.95

9.7.5. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Limit (dBm)	Margin ANT 4 (dB)	Margin ANT 3 (dB)
Low	2402	19.30	19.23	21	-1.70	-1.77
Middle	2441	19.24	19.25		-1.76	-1.75
High	2480	19.18	19.22		-1.82	-1.78

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9.7.6. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	16.28	16.20	19.25	21	-1.75
Middle	2441	16.24	16.29	19.28		-1.72
High	2480	16.28	16.18	19.24		-1.76

9.7.7. LOW POWER BASIC DATA RATE GFSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Limit (dBm)	Margin ANT 4 (dB)	Margin ANT 3 (dB)
Low	2402	11.63	11.06	21	-9.37	-9.94
Middle	2441	11.69	11.10		-9.31	-9.90
High	2480	11.67	11.07		-9.33	-9.93

9.7.8. LOW POWER BASIC DATA RATE TXBF GFSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	11.63	11.09	14.38	21.00	-6.62
Middle	2441	11.60	11.13	14.38		-6.62
High	2480	11.65	11.12	14.40		-6.60

9.7.9. LOW POWER ENHANCED DATA RATE QPSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Limit (dBm)	Margin ANT 4 (dB)	Margin ANT 3 (dB)
Low	2402	9.03	8.98	21.00	-11.97	-12.02
Middle	2441	8.97	9.06		-12.03	-11.94
High	2480	9.00	9.01		-12.00	-11.99

9.7.10. LOW POWER ENHANCED DATA RATE TXBF QPSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	9.05	9.01	12.04	21.00	-8.96
Middle	2441	8.97	9.10	12.05		-8.95
High	2480	9.00	8.97	12.00		-9.00

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9.7.11. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Limit (dBm)	Margin ANT 4 (dB)	Margin ANT 3 (dB)
Low	2402	9.26	9.15	21.00	-11.74	-11.85
Middle	2441	9.27	9.29		-11.73	-11.71
High	2480	9.19	9.25		-11.81	-11.75

9.7.12. LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	9.20	9.28	12.25	21.00	-8.75
Middle	2441	9.22	9.23	12.24		-8.76
High	2480	9.19	9.17	12.19		-8.81

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9.8. AVERAGE POWER

LIMITS

None; for reporting purposes only

TEST PROCEDURE

Measurements were performed using a power meter with wideband average power sensor.

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

RESULTS

Tested By:	26118
Date:	2024/05/07 2024/07/01 2024/07/17

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9.8.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)
Low	2402	19.31	19.79
Middle	2441	19.39	19.87
High	2480	19.27	19.85

9.8.2. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)	Total Power (dBm)
Low	2402	16.73	16.71	19.73
Middle	2441	16.82	16.77	19.81
High	2480	16.75	16.82	19.80

9.8.3. HIGH POWER ENHANCED DATA RATE QPSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)
Low	2402	16.26	16.31
Middle	2441	16.29	16.36
High	2480	16.25	16.28

9.8.4. HIGH POWER ENHANCED DATA RATE TXBF QPSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)	Total Power (dBm)
Low	2402	13.32	13.21	16.28
Middle	2441	13.31	13.35	16.34
High	2480	13.35	13.32	16.35

9.8.5. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)
Low	2402	16.38	16.32
Middle	2441	16.32	16.35
High	2480	16.28	16.31

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9.8.6. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)	Total Power (dBm)
Low	2402	13.38	13.29	16.35
Middle	2441	13.33	13.38	16.37
High	2480	13.37	13.28	16.34

9.8.7. LOW POWER BASIC DATA RATE GFSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)
Low	2402	11.28	10.71
Middle	2441	11.35	10.76
High	2480	11.33	10.72

9.8.8. LOW POWER BASIC DATA RATE TXBF GFSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)	Total Power (dBm)
Low	2402	11.29	10.75	14.04
Middle	2441	11.25	10.78	14.03
High	2480	11.30	10.77	14.05

9.8.9. LOW POWER ENHANCED DATA RATE QPSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)
Low	2402	6.33	6.27
Middle	2441	6.26	6.34
High	2480	6.28	6.31

9.8.10. LOW POWER ENHANCED DATA RATE TXBF QPSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)	Total Power (dBm)
Low	2402	6.35	6.30	9.34
Middle	2441	6.26	6.38	9.33
High	2480	6.28	6.25	9.28

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9.8.11. LOW POWER ENHANCED DATA RATE 8PSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)
Low	2402	6.35	6.24
Middle	2441	6.36	6.38
High	2480	6.27	6.33

9.8.12. LOW POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)	Total Power (dBm)
Low	2402	6.28	6.37	9.34
Middle	2441	6.31	6.31	9.32
High	2480	6.29	6.25	9.28

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9.9. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

RSS-247 5.5

Limit = -20 dBc

TEST PROCEDURE

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

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

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

Note: Test procedure on Beamforming mode is same as BT BDR and EDR mode.

RESULTS

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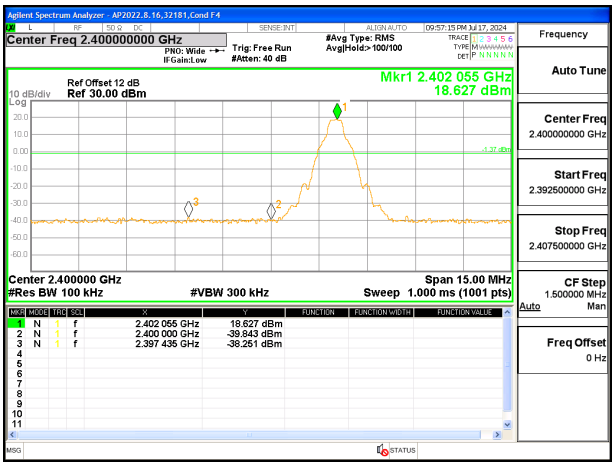
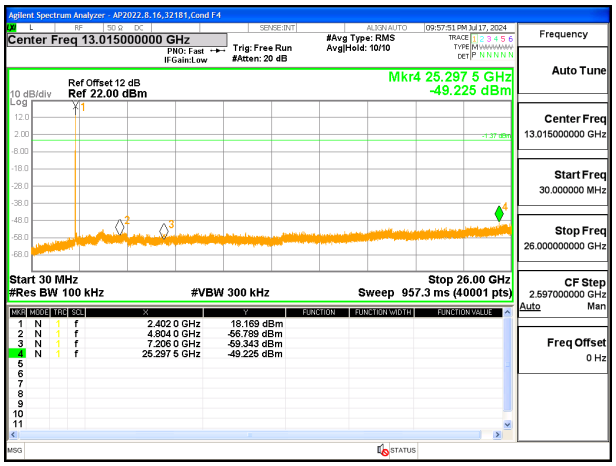
9.9.1. HIGH POWER BASIC DATA RATE GFSK MODULATION

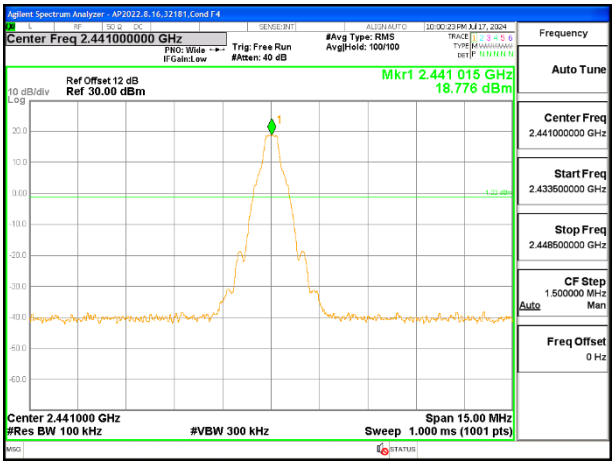
ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



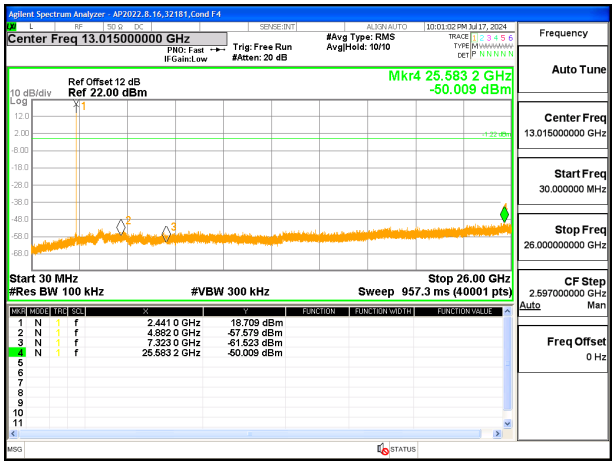
LOW CHANNEL BANDEDGE



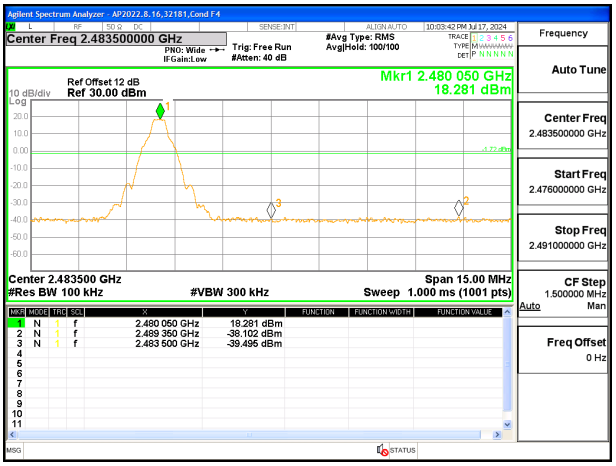
LOW CHANNEL OUT-OF-BAND



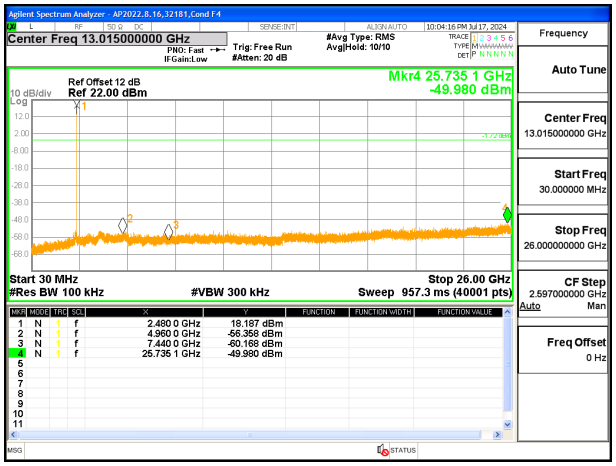
MID CHANNEL REFERENCE LEVEL



MID CHANNEL OUT-OF-BAND



HIGH CHANNEL BANDEDGE



HIGH CHANNEL OUT-OF-BAND

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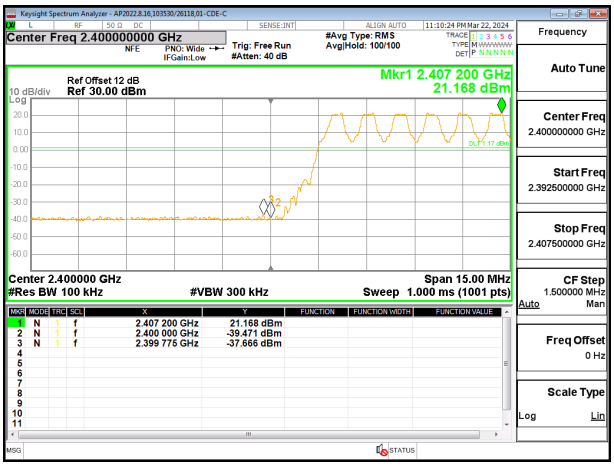
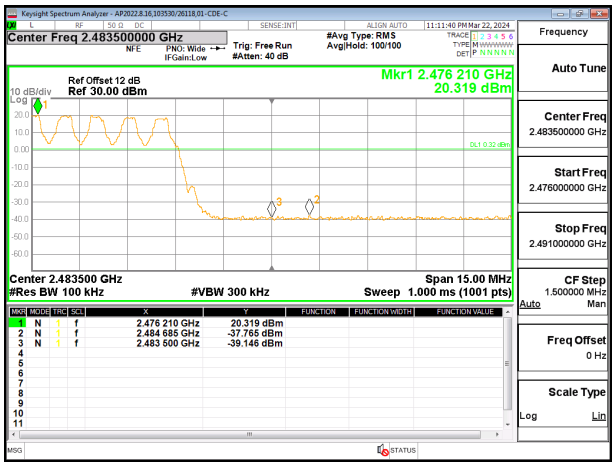
ANT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



LOW BANDEDGE



HIGH BANDEDGE

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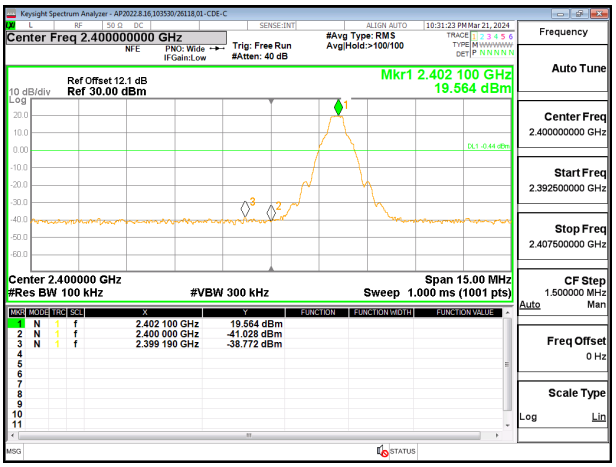
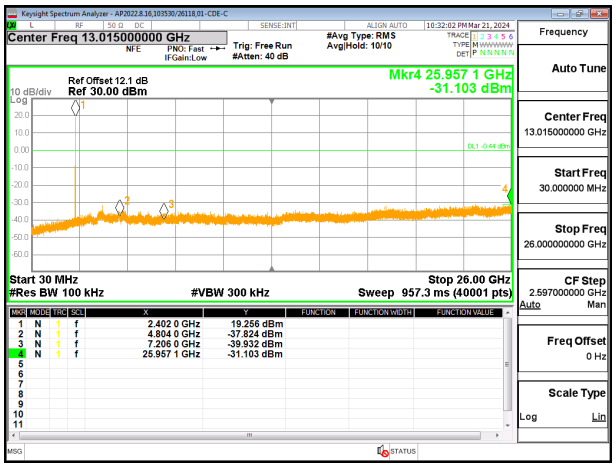
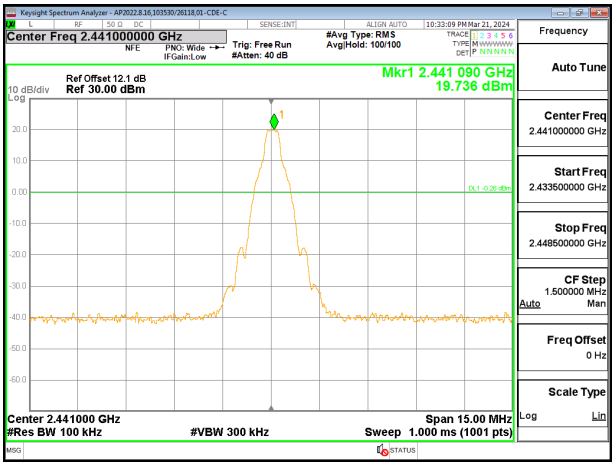
ANT 3 SPURIOUS EMISSIONS, NON-HOPPING



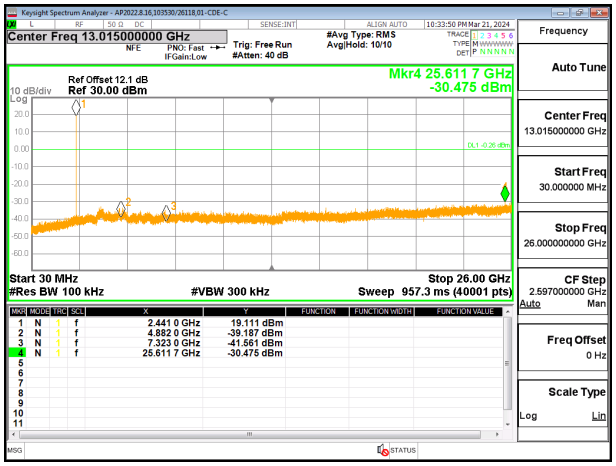
LOW CHANNEL BANDEDGE



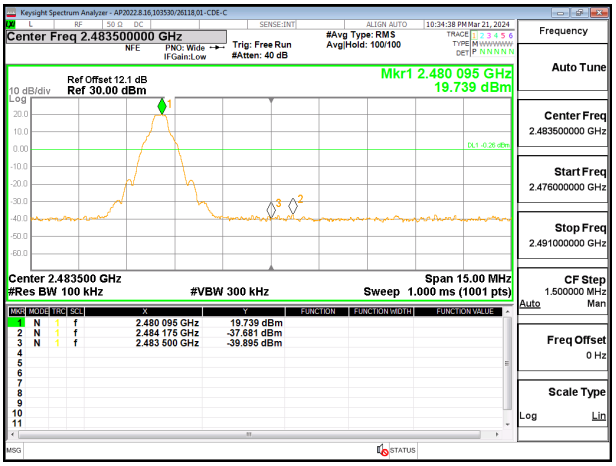
LOW CHANNEL OUT-OF-BAND



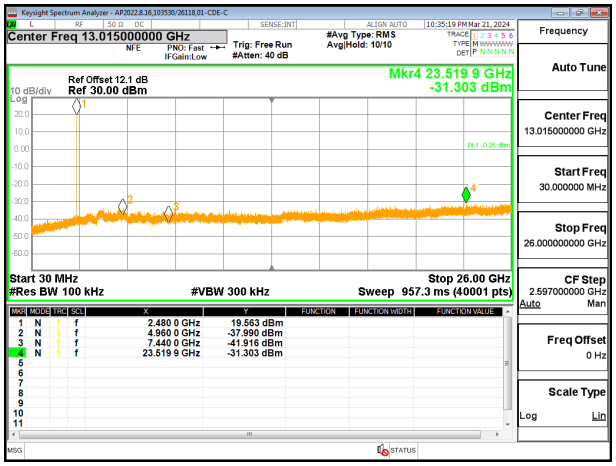
MID CHANNEL REFERENCE LEVEL



MID CHANNEL OUT-OF-BAND



HIGH CHANNEL BANDEDGE



HIGH CHANNEL OUT-OF-BAND

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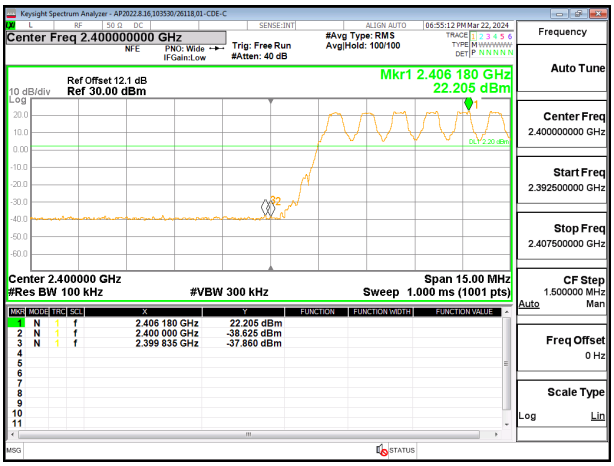
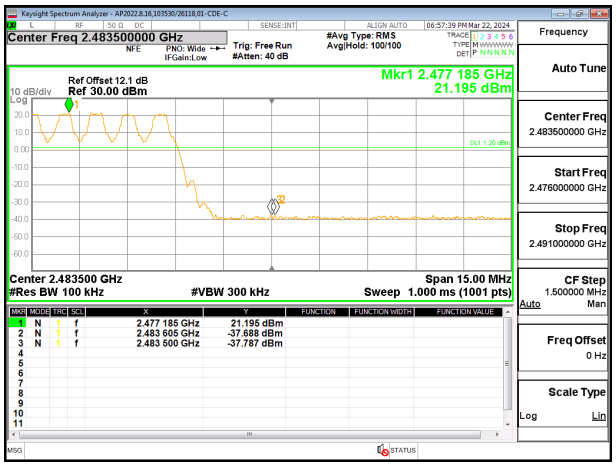
ANT 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



LOW BANDEDGE



HIGH BANDEDGE

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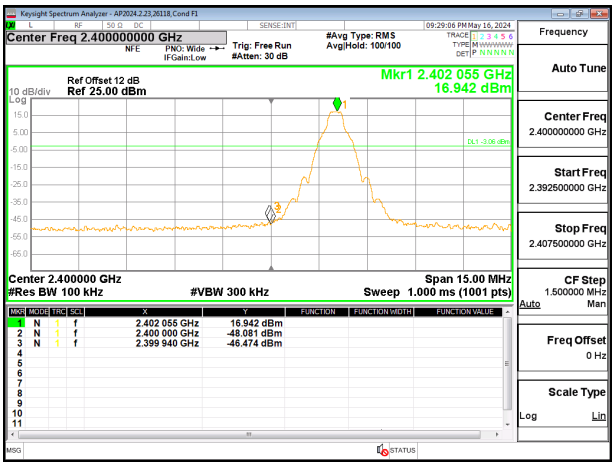
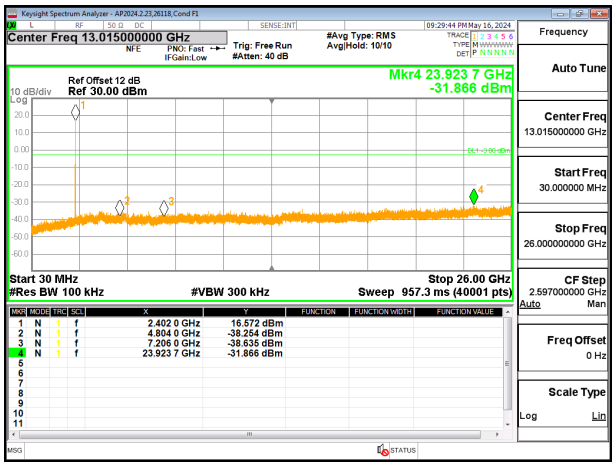
9.9.2. HIGH POWER BASIC DATA RATE TXBF GFSK MODULATION

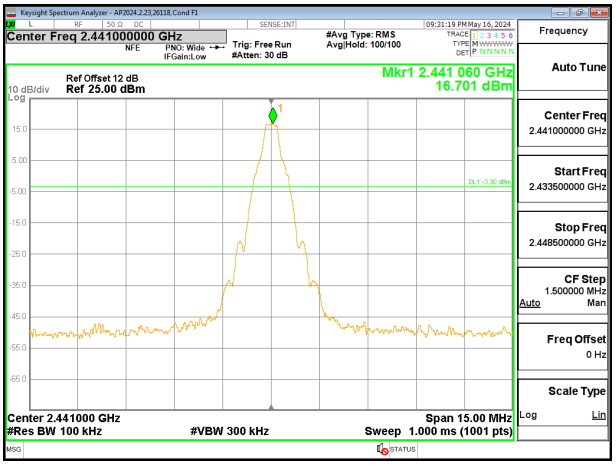
ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



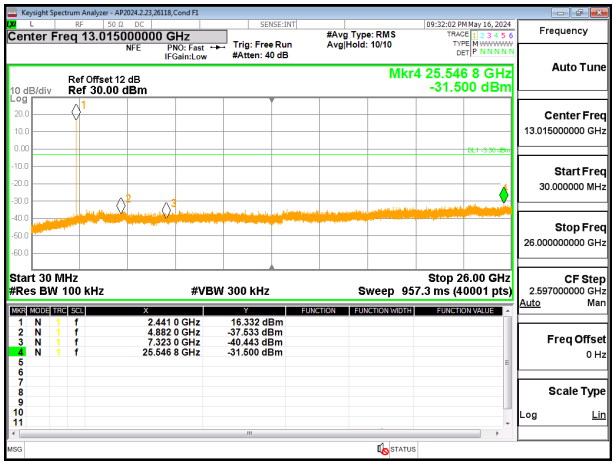
LOW CHANNEL BANDEDGE



LOW CHANNEL OUT-OF-BAND



MID CHANNEL REFERENCE LEVEL



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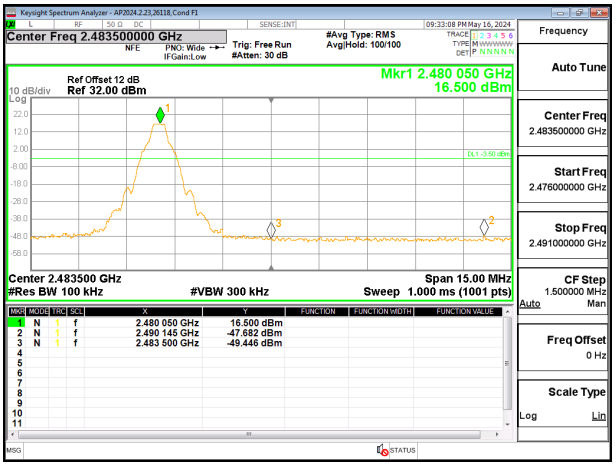
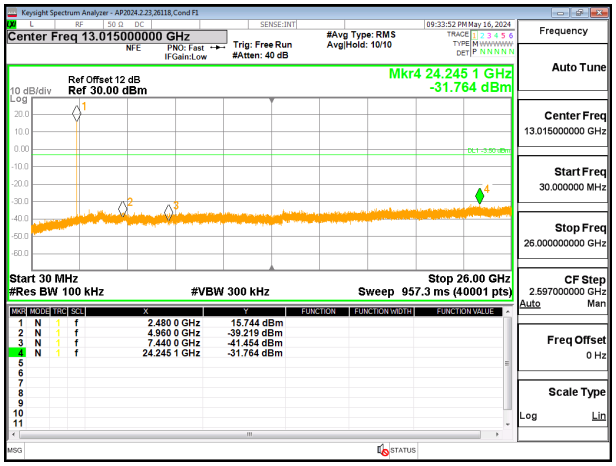


HIGH CHANNEL BANDEDGE



HIGH CHANNEL OUT-OF-BAND

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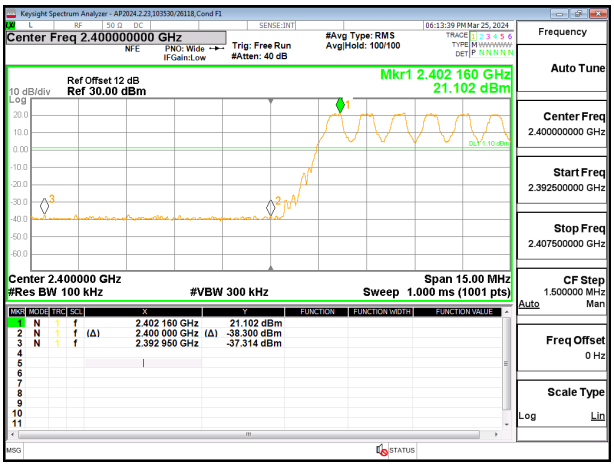
ANT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



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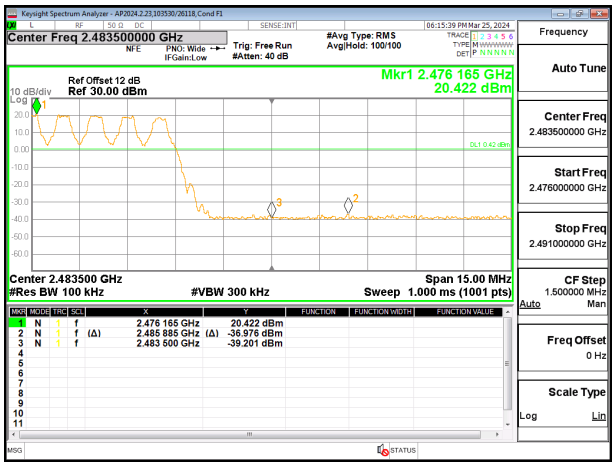

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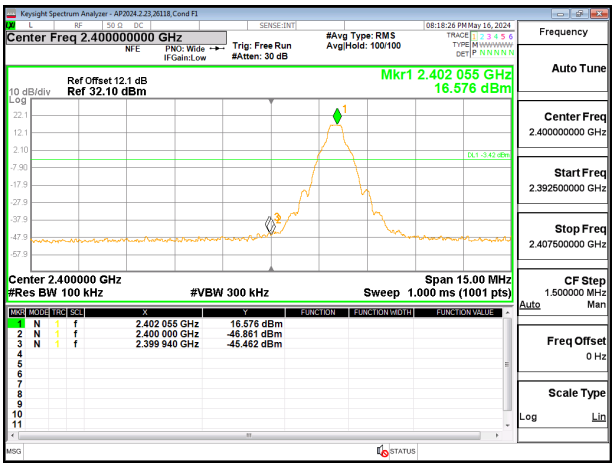
ANT 3 SPURIOUS EMISSIONS, NON-HOPPING



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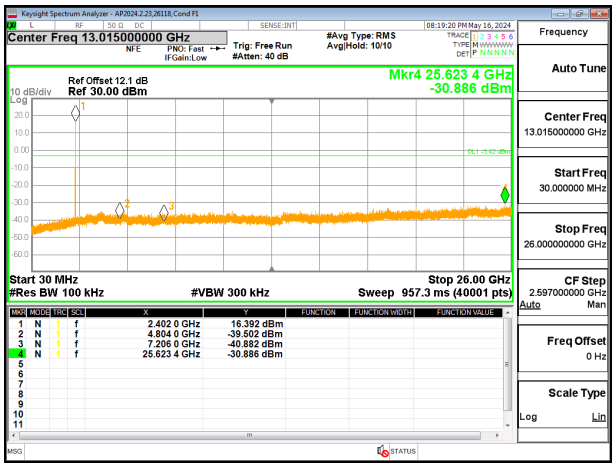
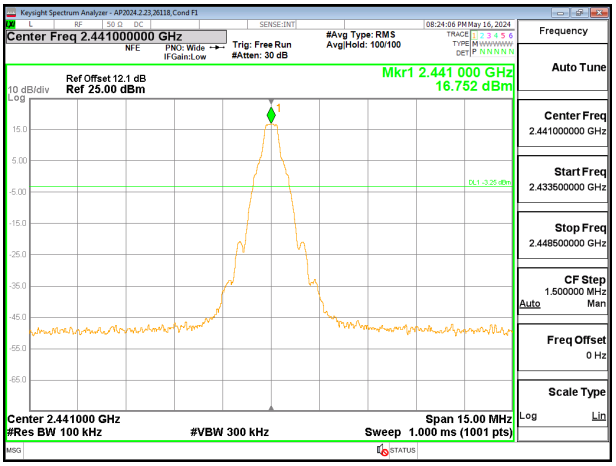
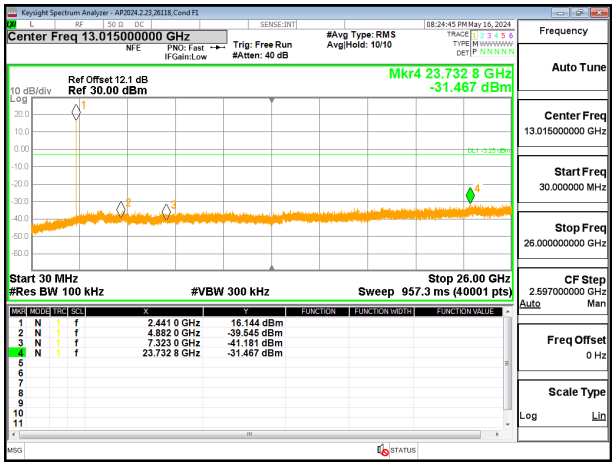


LOW CHANNEL OUT-OF-BAND



MID CHANNEL REFERENCE LEVEL



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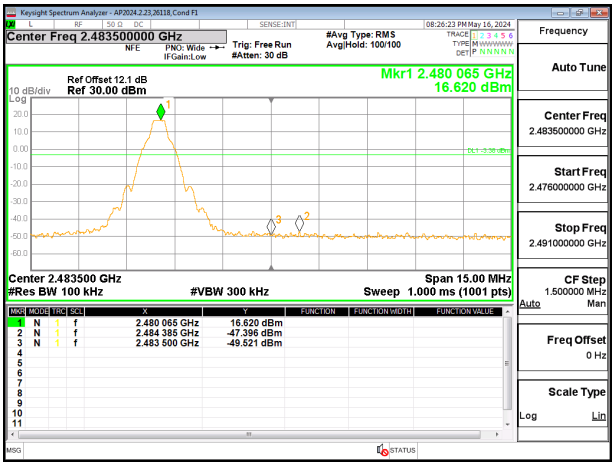

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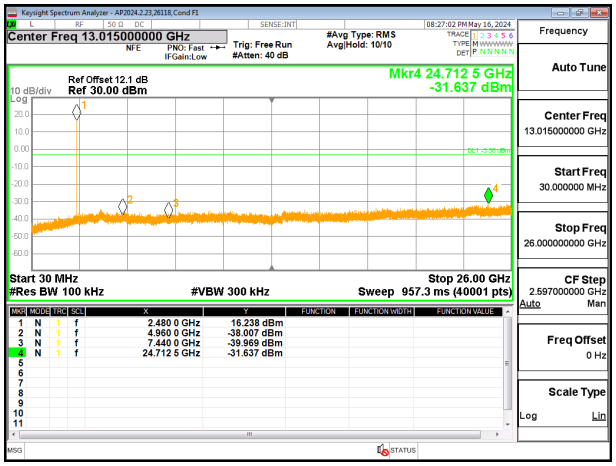

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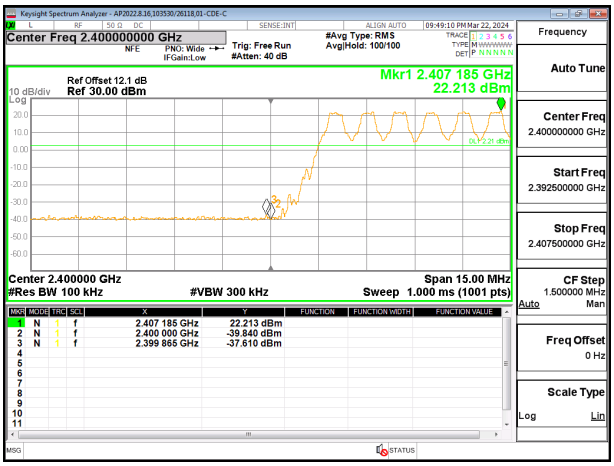
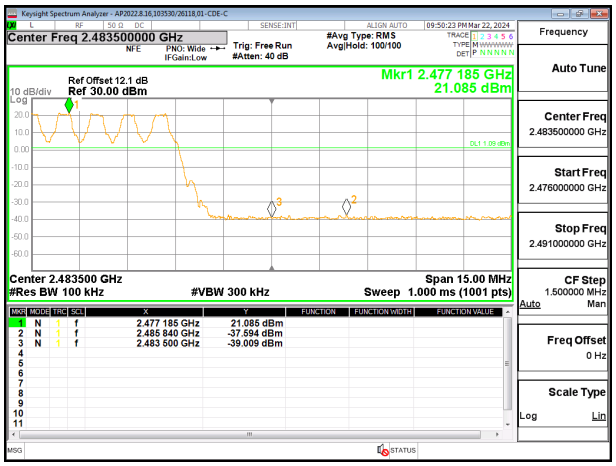
ANT 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



LOW BANDEDGE



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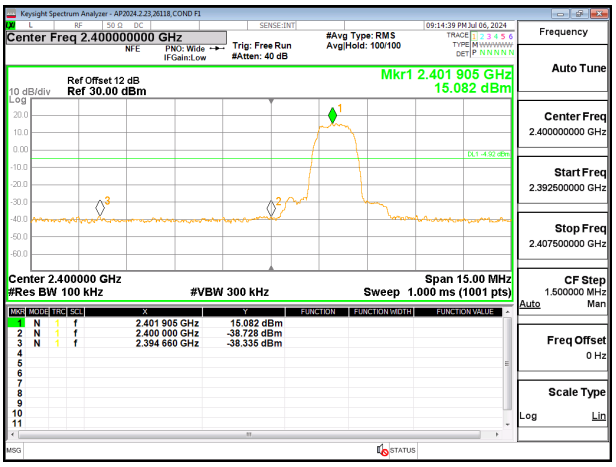
9.9.3. HIGH POWER ENHANCED DATA RATE 8PSK MODULATION

ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



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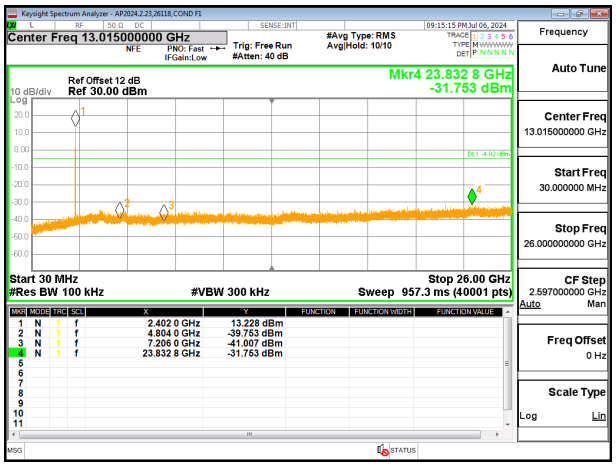

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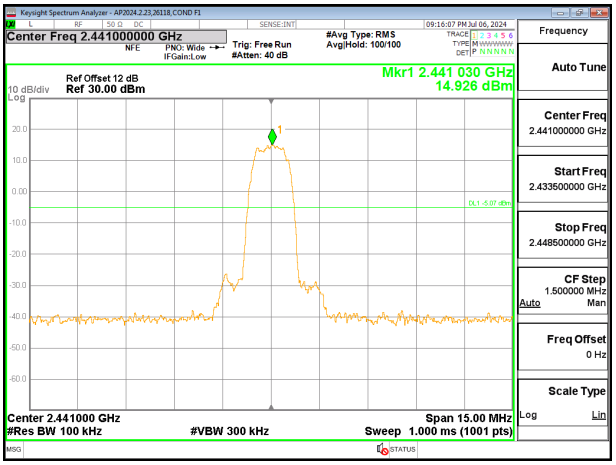
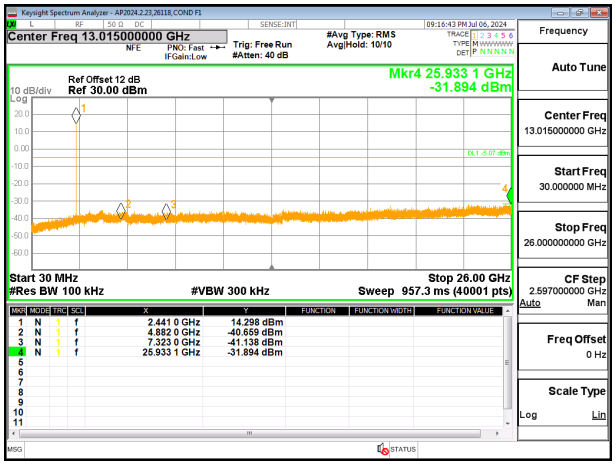


MID CHANNEL REFERENCE LEVEL



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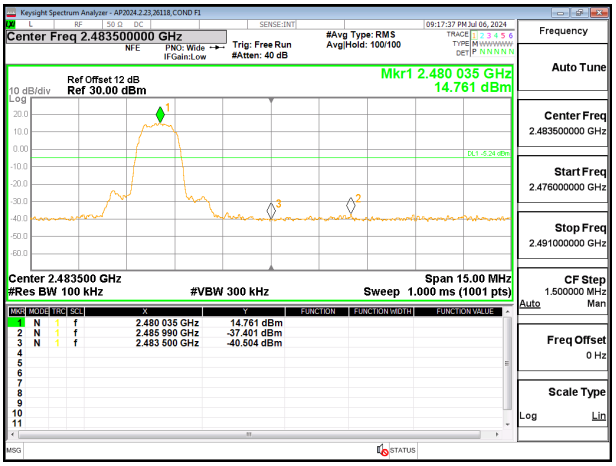
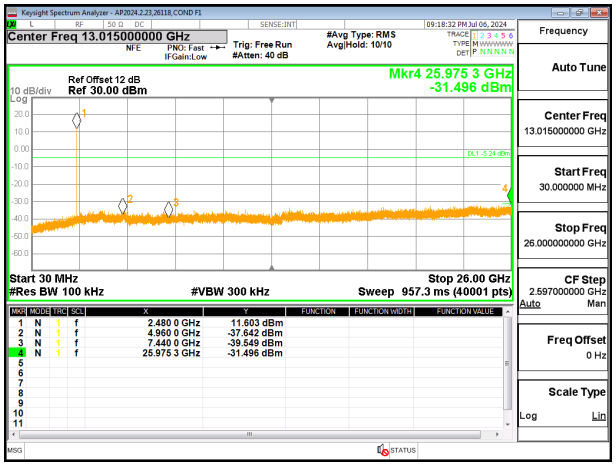


HIGH CHANNEL BANDEDGE



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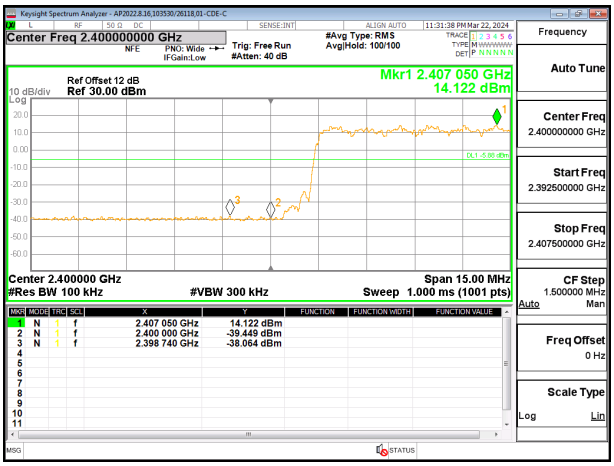
ANT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



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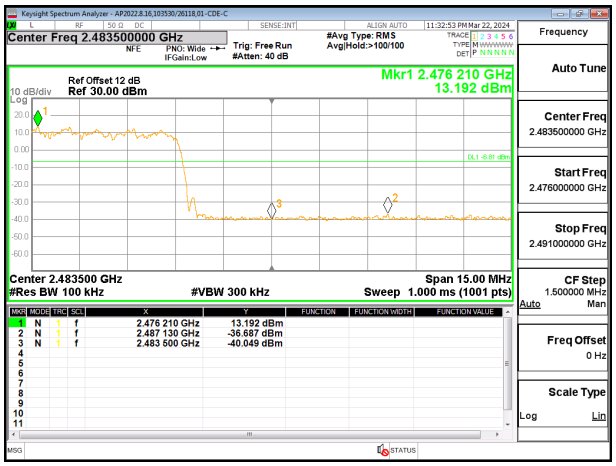

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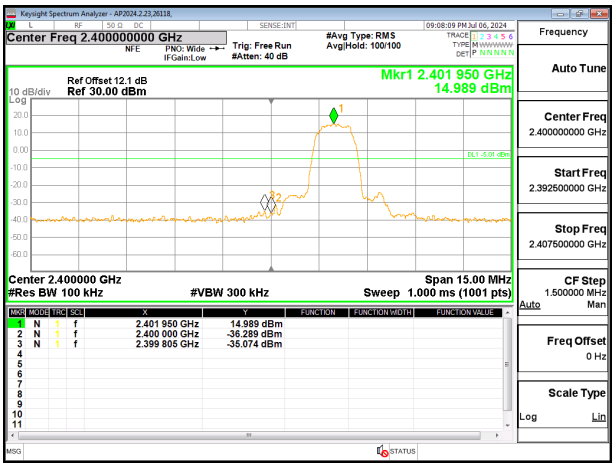
ANT 3 SPURIOUS EMISSIONS, NON-HOPPING



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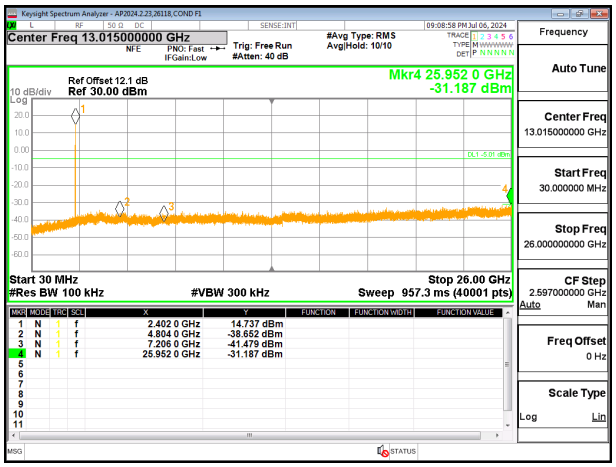

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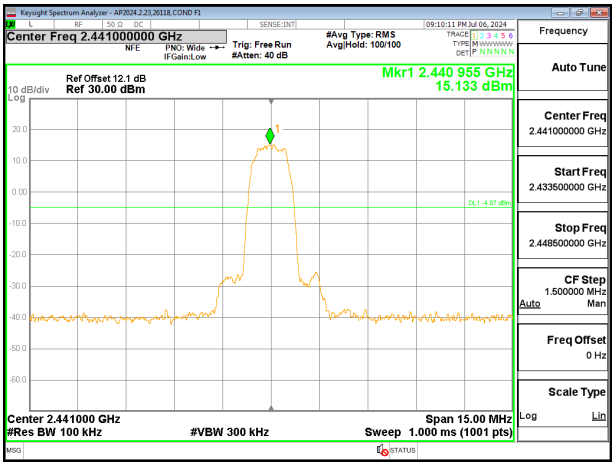
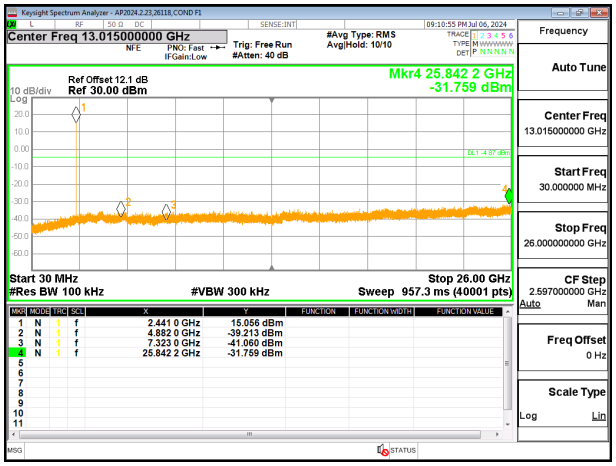


MID CHANNEL REFERENCE LEVEL



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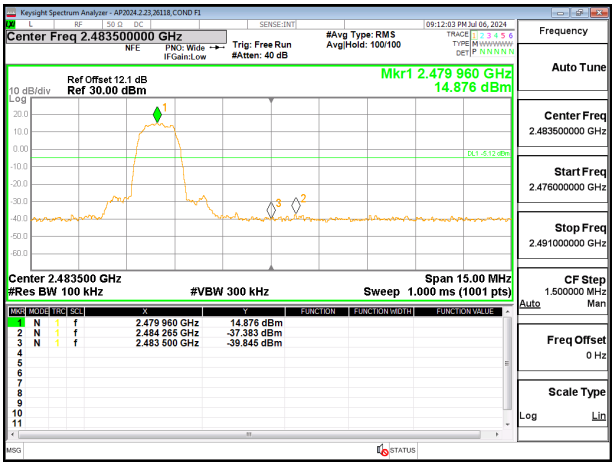

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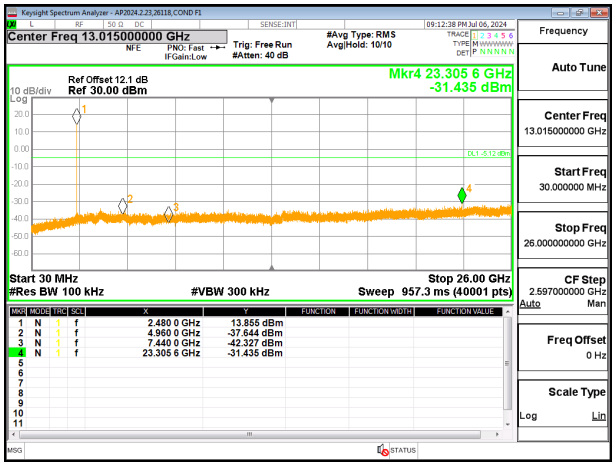

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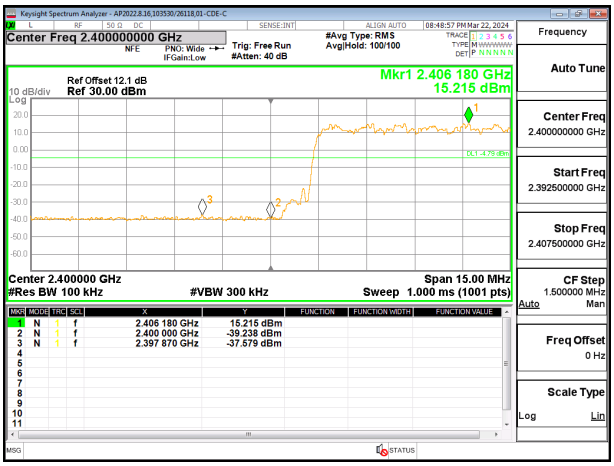
ANT 3 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



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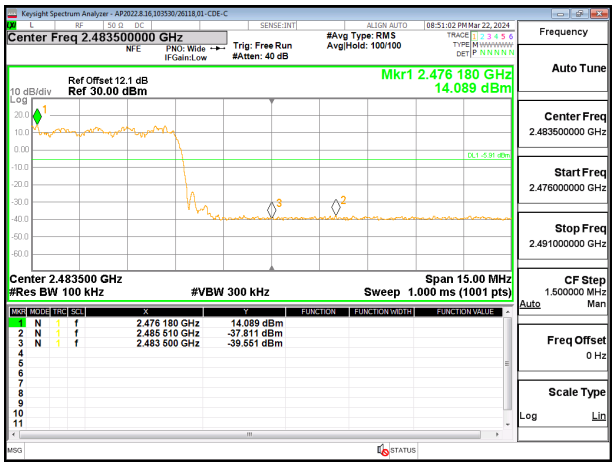

HIGH BANDEDGE

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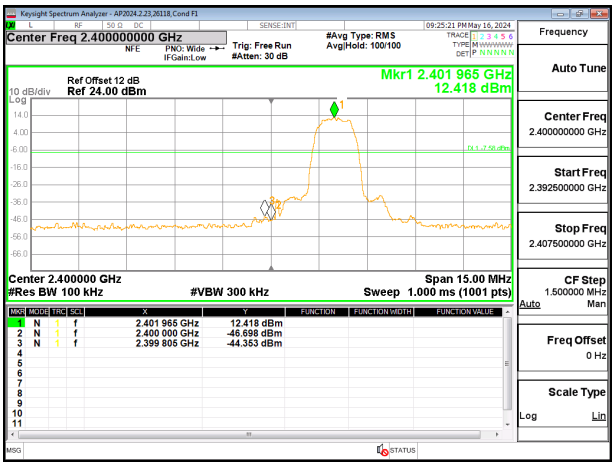
9.9.4. HIGH POWER ENHANCED DATA RATE TXBF 8PSK MODULATION

ANT 4 SPURIOUS EMISSIONS, NON-HOPPING



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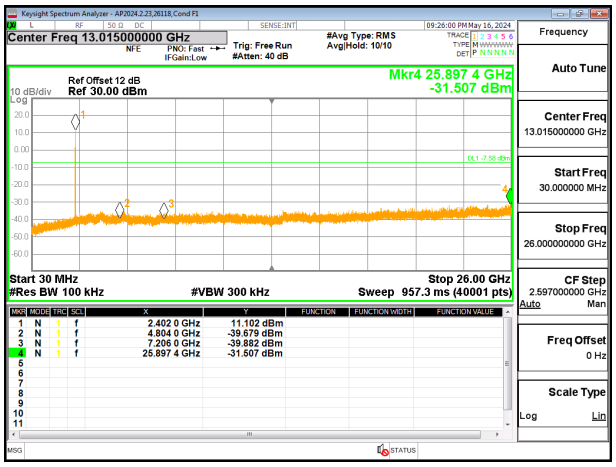

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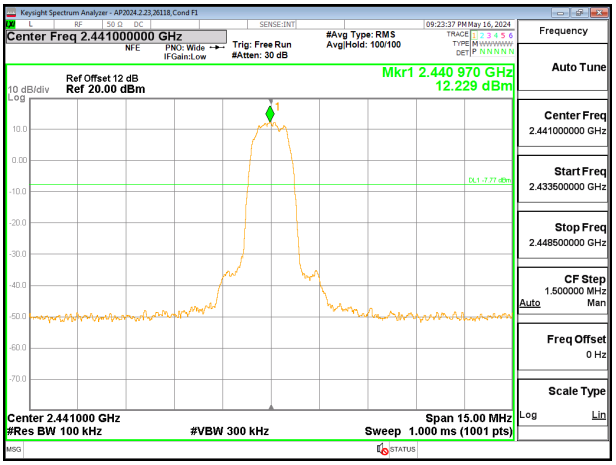
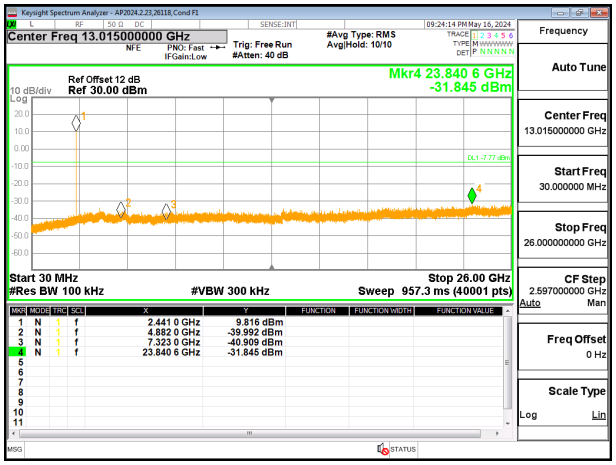


MID CHANNEL REFERENCE LEVEL



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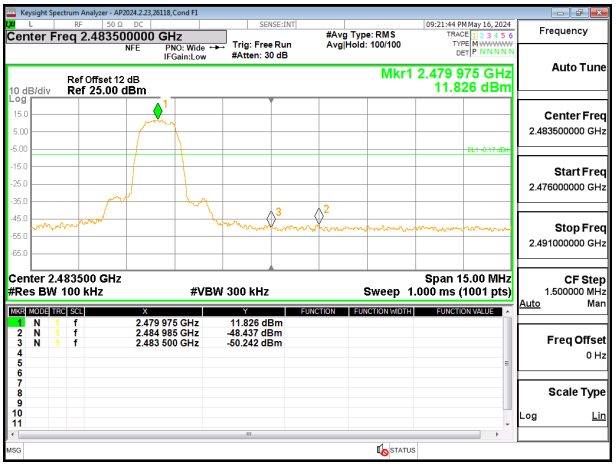

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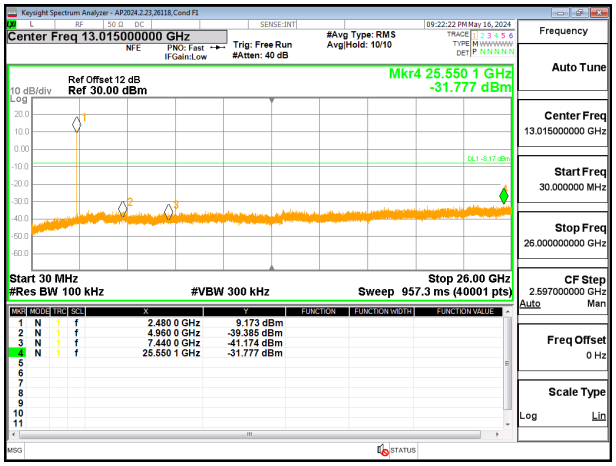

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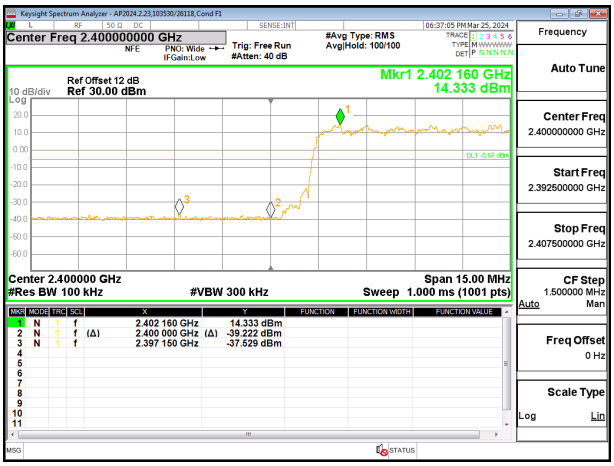
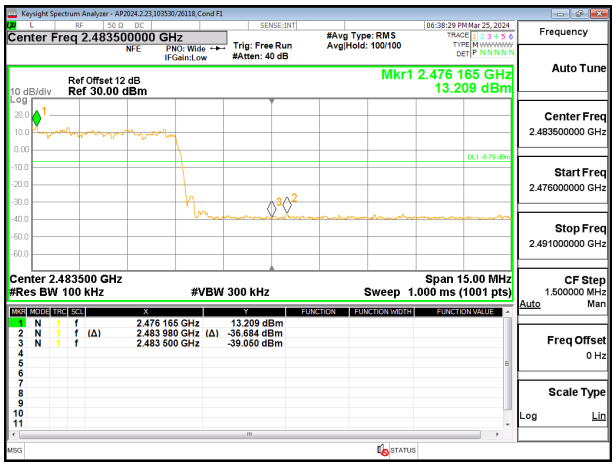
ANT 4 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



LOW BANDEDGE



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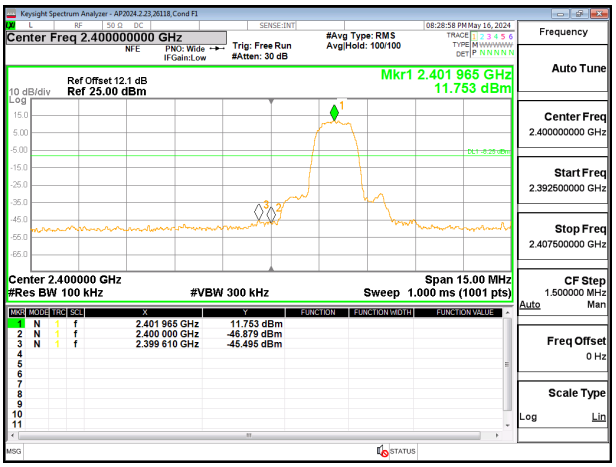
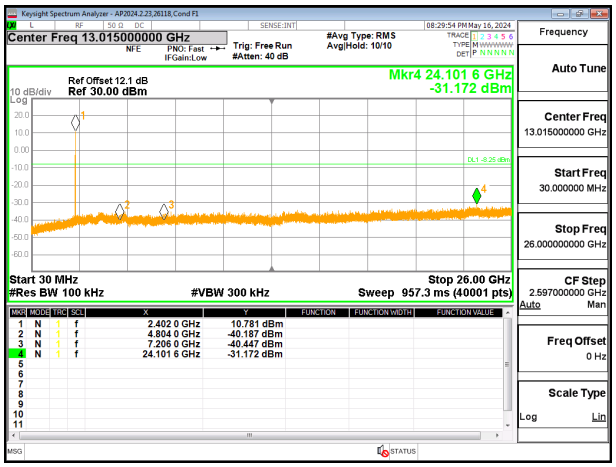
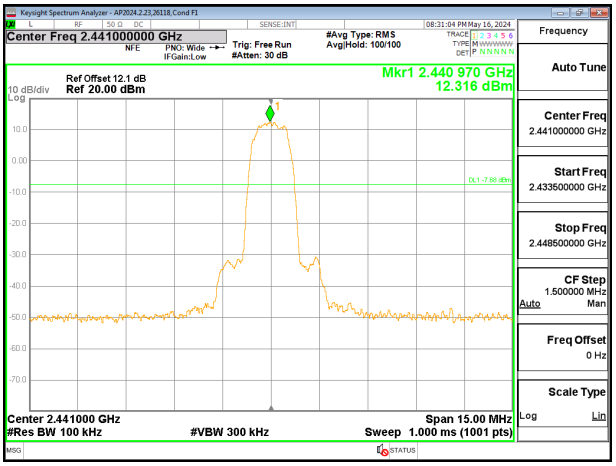
ANT 3 SPURIOUS EMISSIONS, NON-HOPPING



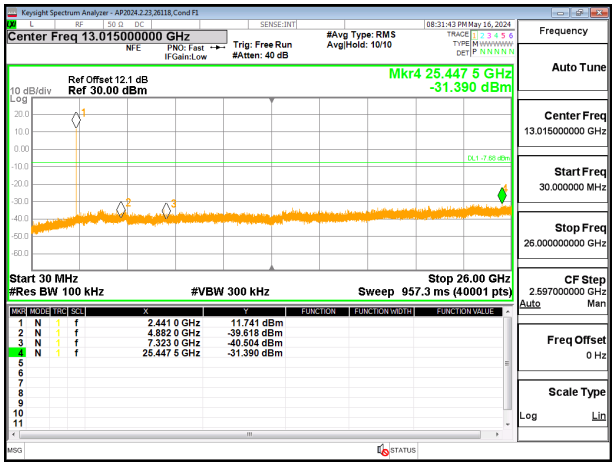
LOW CHANNEL BANDEDGE



LOW CHANNEL OUT-OF-BAND



MID CHANNEL REFERENCE LEVEL



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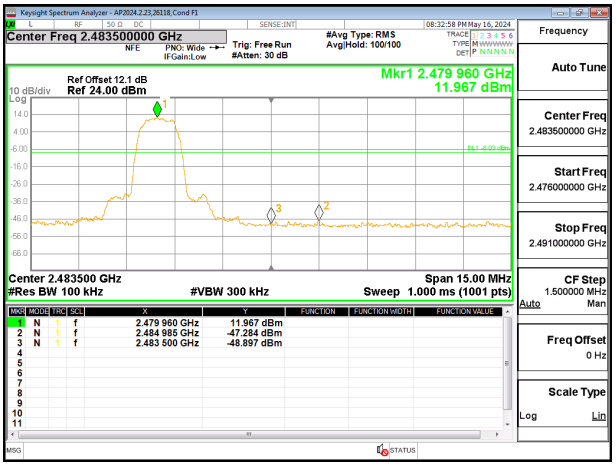
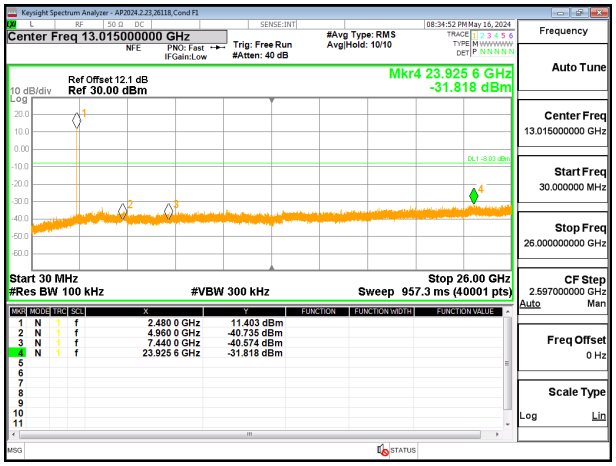


HIGH CHANNEL BANDEDGE



HIGH CHANNEL OUT-OF-BAND

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