

TEST REPORT

Report Number: 14982436-E2V4

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

Model : A3083 (Parent Model)
A3292, A3293, A3294 (Variant Models)

Brand : APPLE

FCC ID : BCG-E8666A (Parent Model)
BCG-E8667A, BCG-E8668A, BCG-E8683A
(Variant Models)

IC : 579C-E8666A (Parent Model)
579C-E8667A, 579C-E8668A, 579C-E8683A
(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:
2024/07/11

Prepared by:
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REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2024/07/05	Initial Issue	Tony Li
V2	2024/07/08	Address TCB's questions section 6 and 10	Chin Pang
V3	2024/07/10	Address TCB's question on 2 nd level, removed 10dB attenuator and block diagram, fixed 18-6GHz plots	Chin Pang
V4	2024/07/11	Addressed TCB question on Section 6.6 and 10	Tony Li

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1. ATTESTATION OF TEST RESULTS

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

EUT DESCRIPTION: SMART PHONE

MODEL: A3083 (Parent Model)
A3292, A3293, A3294 (Variant Models)

BRAND: APPLE

SERIAL NUMBER: C07GYF0008T0000FDV, C07H4F0015B0000FDT,
C1JQP79DFT, LWQC2DNVTW.

SAMPLE RECEIPT DATE: 2023/12/19.

DATE TESTED: 2023/12/20 – 2024/07/03.

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 can demonstrate 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 considered unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, any agency of the Federal Government, or any agency of the U.S. government.

Approved & Released For
UL Verification Services Inc. By:



Frank Ibrahim
Staff Engineer
Consumer Technology Division
UL Verification Services Inc.

Prepared By:



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

2. TEST SUMMARY

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	Complies	None.
15.247 (b) (3)	RSS-247 5.4 (d)	Output Power	Complies	None.
See Comment		Average power	Reporting purposes only	Per ANSI C63.10, Section 11.9.2.3.2.
15.247 (e)	RSS-247 5.2 (b)	PSD	Complies	None.
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			

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 considered 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
Power Spectral Density	2.466
Time Domain Measurements Using SA	3.39
RF Power Measurement Direct Method Using Power Meter	0.450 (Peak), 1.3 (Ave)
Radio Frequency (Spectrum Analyzer)	141.16 Hz
Occupied Bandwidth	1.2%
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%.

5.4. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \text{Cable} \\ &\text{Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m} \end{aligned}$$

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:

$$\begin{aligned} \text{Final Voltage (dBuV)} &= \text{Measured Voltage (dBuV)} + \text{Cable Loss (dB)} + \text{Limiter Factor (dB)} + \\ &\text{LISN Insertion Loss.} \\ 36.5 \text{ dBuV} + 0 \text{ dB} + 10.1 \text{ dB} + 0 \text{ dB} &= 46.6 \text{ dBuV} \end{aligned}$$

6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The Apple iPhone is a smartphone with cellular GSM, GPRS, EGPRS, WCDMA, LTE, 5G NR1, 5G NR2, 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	Configuration	Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
ANT 4	High Power	2402 - 2480	BLE 1M	20.43	110.41
	Low Power			9.38	8.67
	High Power	2404 - 2478	BLE 2M	20.88	122.46
	Low Power			9.82	9.59
ANT 3	High Power	2402 - 2480	BLE 1M	20.36	108.64
	Low Power			9.37	8.65
	High Power	2404- 2478	BLE 2M	20.80	120.23
	Low Power			9.80	9.55
BF, ANT 4 + ANT 3	High Power	2402 - 2480	BLE 1M	23.32	214.78
	Low Power			7.52	5.65
	High Power	2404- 2478	BLE 2M	23.86	243.22
	Low Power			7.97	6.27

6.3. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) type is IFA type.

The antenna(s) gains, as provided by the manufacturer, are as follows:

Frequency Range (GHz)	ANT 4 (dBi)	ANT 3 (dBi)
2.4	0.0	-2.1

SMA Cable used for RF conducted testing has a loss as follows:

Loss used for Antenna 4 is 2.1 dB

Loss used for Antenna 3 is 2.15 dB

The cables were used for RF antenna port tests that had been offset to the test equipment during testing.

6.4. SOFTWARE AND FIRMWARE

The EUT firmware and software version installed during testing was 22.1.76.242.

6.5. WORST-CASE CONFIGURATION AND MODE

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

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

High Power Beamforming BLE 1Mbps 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/mid/high channel (except the band edge).

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

For 30-1000MHz emissions spurious tests were performed with EUT connected to AC power adapter and set at 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 BLE and 5GHz bands. No noticeable emission was found.

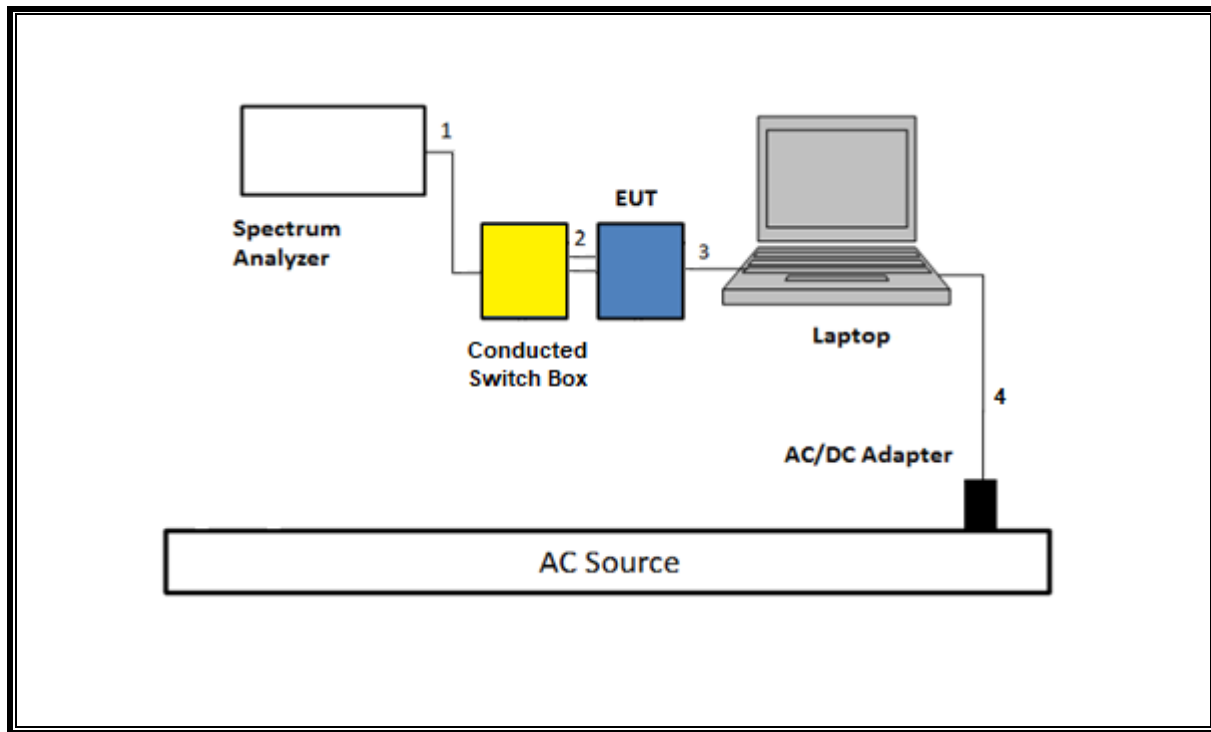
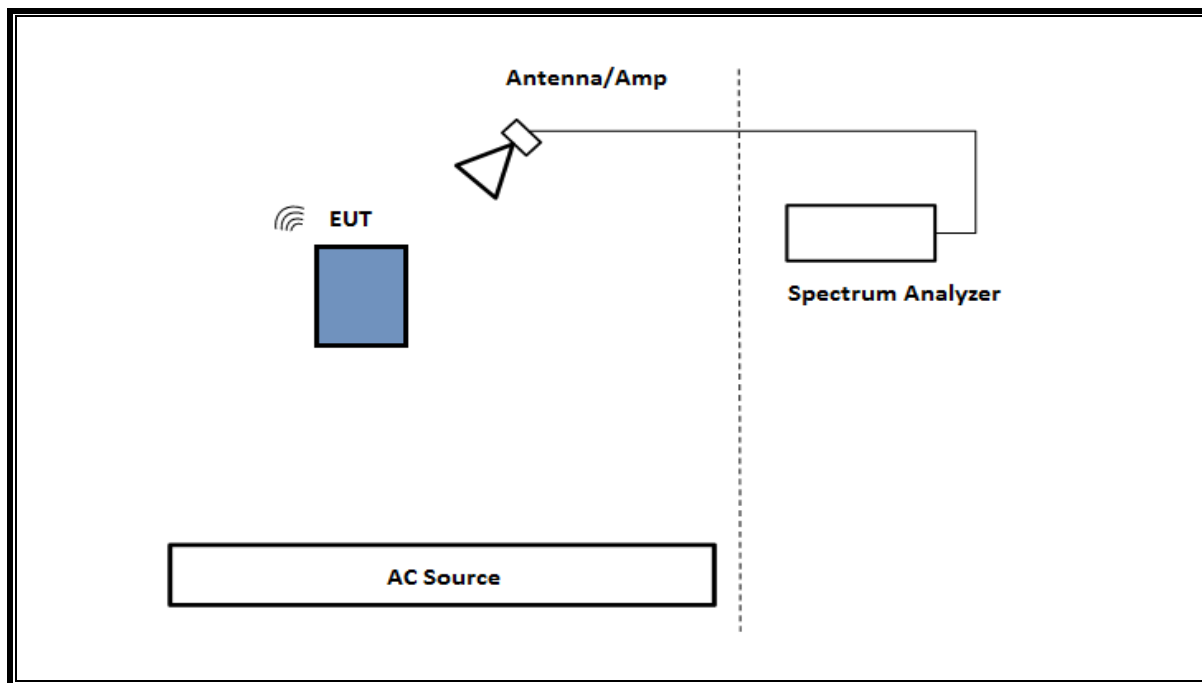
Note: ANT0 and ANT1 indicated in the Radiated test result sections are representative of ANT4 and ANT3, respectively.

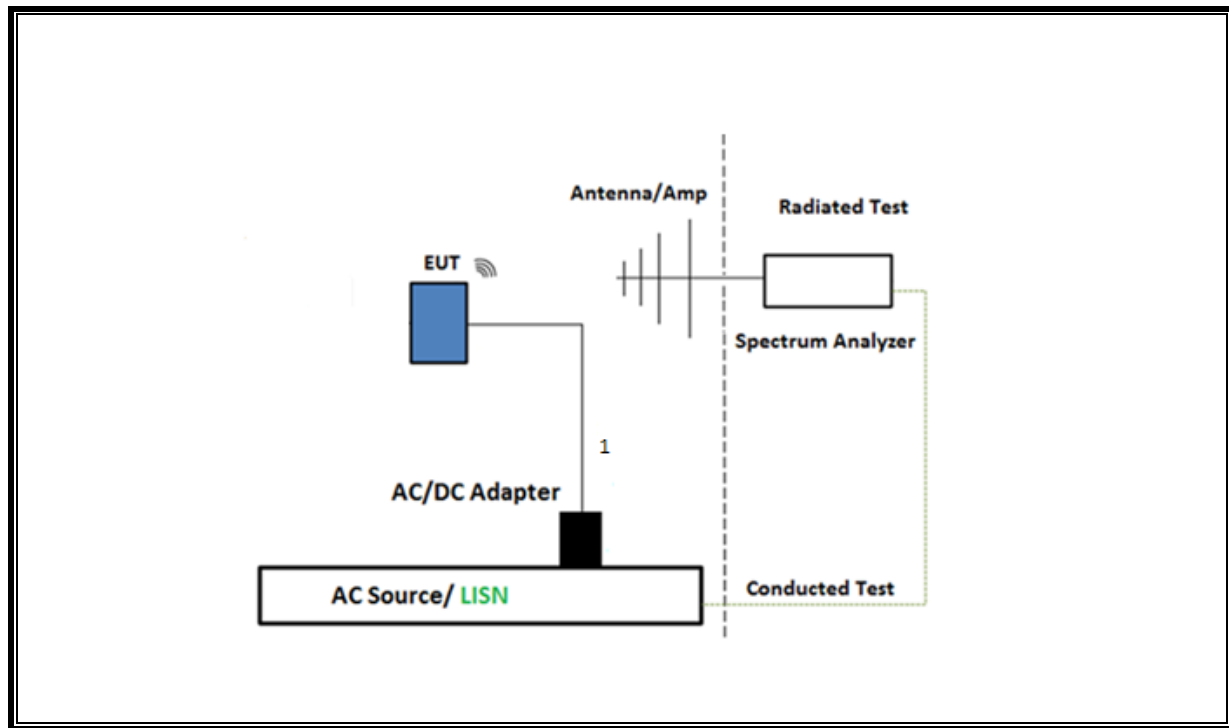
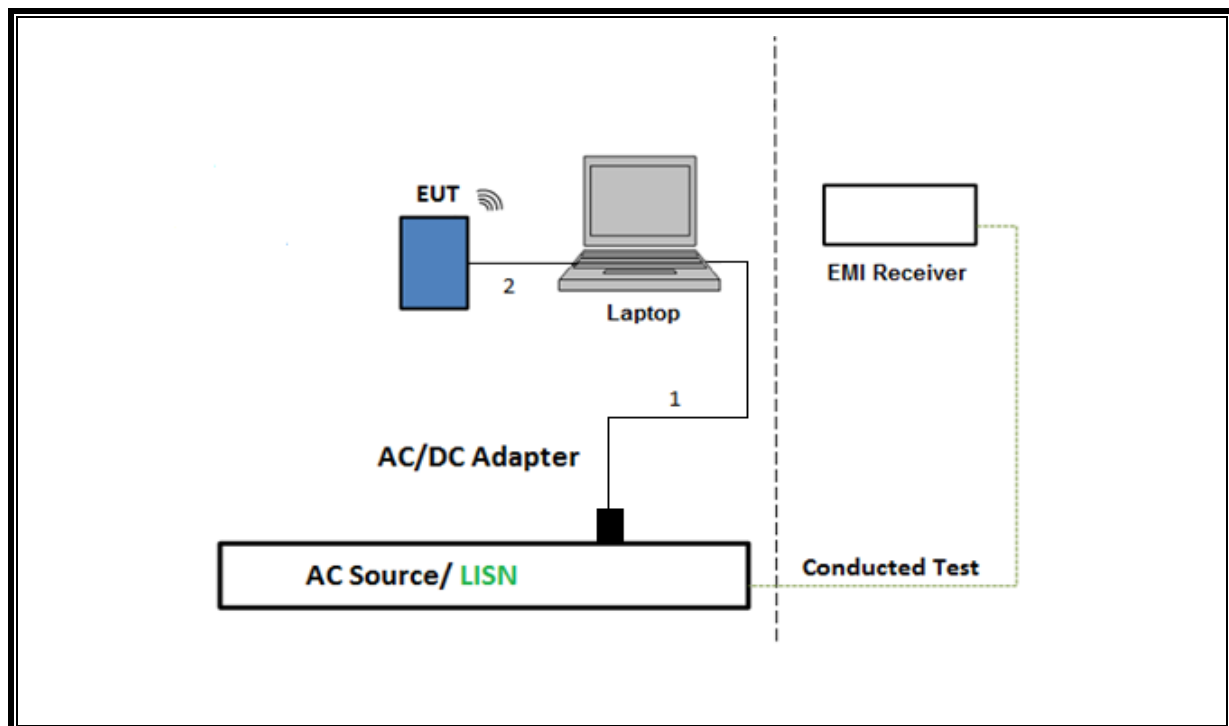
6.6. DESCRIPTION OF TEST SETUP

SUPPORT TEST EQUIPMENT						
Description		Manufacturer	Model	Serial Number	FCC ID/ DoC	
Laptop		Apple	Macbook Pro	C02VD7SAHV22	BCGA1708	
Laptop AC/DC adapter		Liteon Technology	A1424	NSW25679	DoC	
EUT AC/DC adapter		Apple	A1720	C3D8417A7R93KVPA8	DoC	
Conducted Switch Box		UL	n/a	208281	N/A	
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.

SETUP DIAGRAM FOR CONDUCTED TESTS**SETUP DIAGRAM FOR RADIATED TESTS Above 1 GHz (1 to 26 GHz)**

SETUP DIAGRAM FOR Below 1GHz (30-1000MHz) and AC LINE CONDUCTED TEST**TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION**

7. MEASUREMENT METHOD

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

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

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

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

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

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

Radiated emissions restricted frequency bands: ANSI C63.10 Subclause -11.12.1 & Clause 13

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

Band-edge: ANSI C63.10 Subclause -11.13.3.2 & Clause 13: Integration method -Peak detection.

Band-edge: ANSI C63.10 Subclause -11.13.3.3 & Clause 13: Integration method -Trace averaging with continuous transmission at full power.

Radiated Band-edge: ANSI C63.10-2013 Section 6.10.5 & 13

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

Radiated emissions non-restricted frequency bands ANSI C63.10 Subclause -11.11 & Clause 13

Radiated Spurious Emissions Below 30MHz: ANSI C63.10-2013 Section 6.4 & 13

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

8. TEST AND MEASUREMENT EQUIPMENT

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

Description	Manufacturer	Model	ID Num	Cal Due	Last Cal
*Antenna, Horn 1-18GHz	ETS-Lindgren	3117	206808	2024/03/31	2023/03/31
*RF Filter Box, 1-18GHz	UL-FR1	NA	PRE0183207	2024/03/31	2023/03/31
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	223461	2024/08/29	2023/08/29
Antenna, BroadBand Hybrid 30 MHz - 3 GHz	SUNOL SCIENCES CORP.	JB3	230634	2025/01/31	2024/01/31
Link File, @3m, 9kHz- 1000MHz Hybrid Path Loss	UL-FR1	Port 0 Factors	232001	2025/02/28	2024/02/28
Antenna, Horn 18 to 26.5GHz	A.R.A	MWH-1826/B	81139	2024/08/31	2023/08/31
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	201501	2024/11/30	2023/11/30
RF Amplifier Assembly, 18- 26.5GHz, 60dB Gain	AMPLICAL	AMP18G26.5- 60	171583	2025/03/31	2024/03/31
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	81887	2025/03/31	2024/03/31
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	201499	2025/02/11	2024/02/11
RF Filter Box, 1-18GHz, 17 Ports	UL-FR1	RATS 2	225474	2025/04/30	2024/04/30
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	200784	2025/01/31	2024/01/31
RF Filter Box, 1-18GHz, 12 Port	UL-FR1	Frankenstein	216812	2025/01/30	2024/01/30
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	201497	2025/02/28	2024/02/28
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	230299	2025/01/31	2024/01/31
RF Filter Box, 1-18GHz, 17 Ports	UL-FR1	RATS 2	225575	2025/04/27	2024/04/27
EMI TEST RECEIVER	Rohde & Schwarz	ESW44	230548	2025/02/28	2024/02/28
Power Meter, P-series single channel	Keysight Technologies Inc	N1911A	90731	2025/01/31	2024/01/31
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Keysight Technologies Inc	N1921A	80120	2025/01/31	2024/01/31
Power Meter, P-series single channel	Keysight Technologies Inc	N1911A	90719	2025/01/31	2024/01/31
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Keysight Technologies Inc	N1921A	90389	2025/01/31	2024/01/31
10dB Fixed Attenuator	Pasternack Enterprises	PE7087-10	178557	Verified Before Use	
10dB Fixed Attenuator	Pasternack Enterprises	PE7087-10	178558	Verified Before Use	
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight Technologies Inc	N9030A	80397	2025/01/31	2024/01/31
Spectrum Analyzer, PXA, 3Hz to 50GHz w/Ext. Mixer	Keysight Technologies Inc	N9030A	80400	2025/02/02	2024/02/02
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight Technologies Inc	N9030A	125178	2025/01/31	2024/01/31
*Conducted Switch Box	N/A	CSB	208281	2024/04/30	2023/04/30
Conducted Switch Box	N/A	CSB	208281	2025/05/08	2024/05/08
Antenna, Passive Loop 30Hz to 1MHz	Electro-Metrics	EM-6871	170013	2024/07/31	2023/07/31
Antenna, Passive Loop 100KHz - 30MHz	ELECTRO-METRICS	EM-6872	170015	2024/07/31	2023/07/31

AC Line Conducted					
Description	Manufacturer	Model	ID Num	Cal Due	Last Cal
EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESR	93091	2025/02/28	2024/02/28
LISN for Conducted Emissions CISPR-16	FISCHER CUSTOM COMMUNICATIONS	FCC-LISN- 50/250-25-2-01- 480V	175765	2025/01/31	2024/01/31
Transient Limiter	TE	TBFL1	207996	2024/08/31	2023/08/31
UL AUTOMATION SOFTWARE					
Radiated Software	UL	UL EMC	Ver 9.5, May 1, 2023		
Conducted Software	UL	UL EMC	2023.2.23		
AC Line Conducted Software	UL	UL EMC	Ver 9.5, Mar 3, 2023		

*Testing was completed before equipment calibration date

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						
BLE, 1Mbps	0.040	0.040	1.000	100.00%	0.00	0.010
BLE, 2Mbps	0.080	0.080	1.000	100.00%	0.00	0.010

Note: DCCF for 2TX mode is the same as that of 1TX mode.

DUTY CYCLE PLOTS



9.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

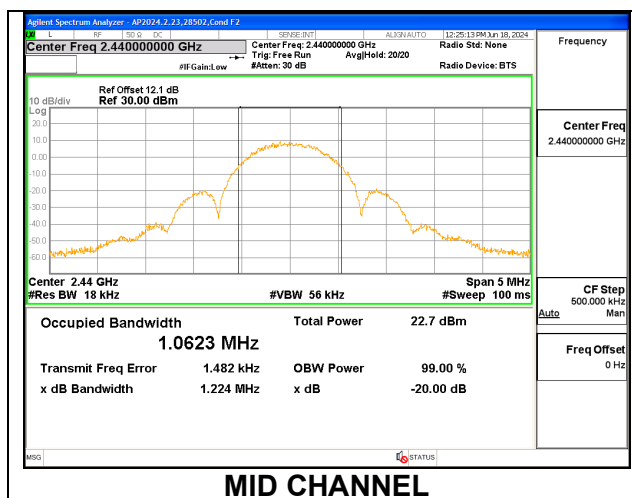
RESULTS

Only High-Power modes result is reported, it covers all Low Power modes. Only Mid channel plot is reported to show setting parameter complies with testing method/procedure.

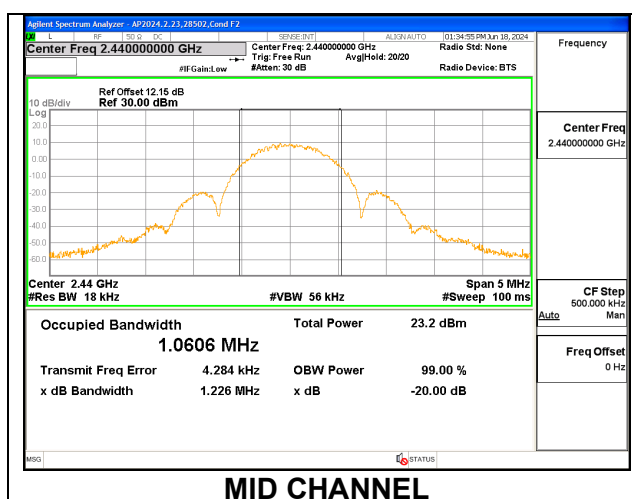
9.2.1. HIGH POWER BLE (1Mbps)

ANT 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0619
Middle	2440	1.0623
High	2480	1.0606

**ANT 3**

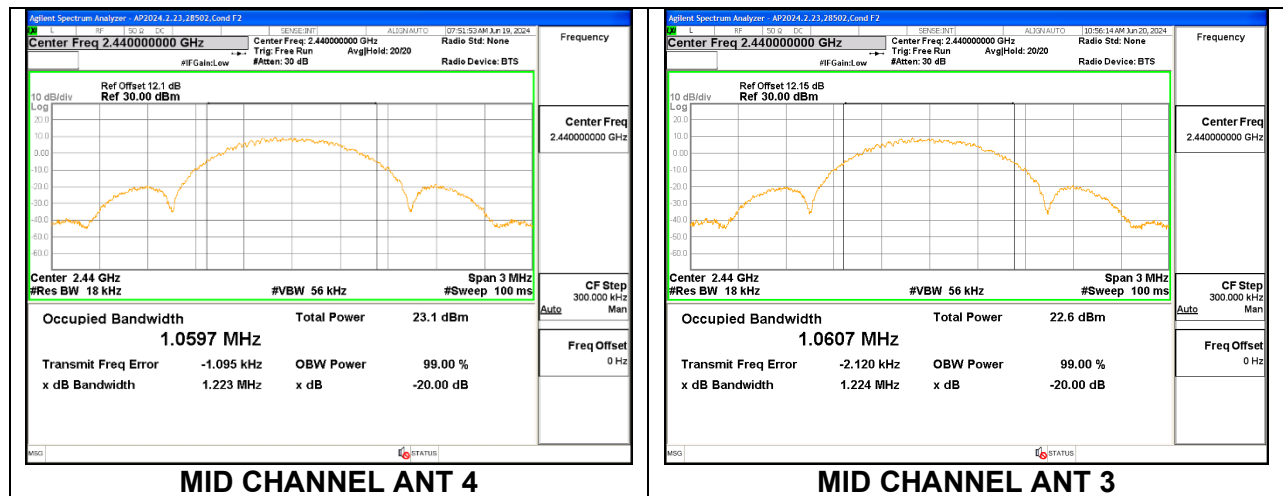
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2402	1.0590
Middle	2440	1.0606
High	2480	1.0604



9.2.2. HIGH POWER BLE TXBF (1Mbps)

Channel	Frequency (MHz)	99% Bandwidth ANT 4 (MHz)	99% Bandwidth ANT 3 (MHz)
Low	2402	1.0603	1.0603
Mid	2440	1.0597	1.0607
High	2480	1.0607	1.0583

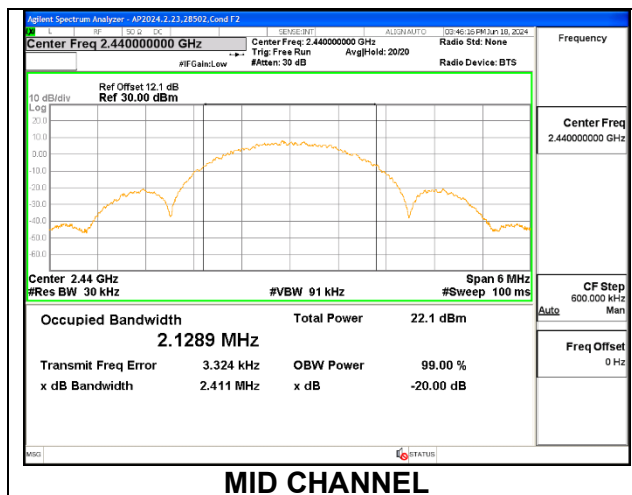
Note: Test procedures and setting are same as BLE normal mode.



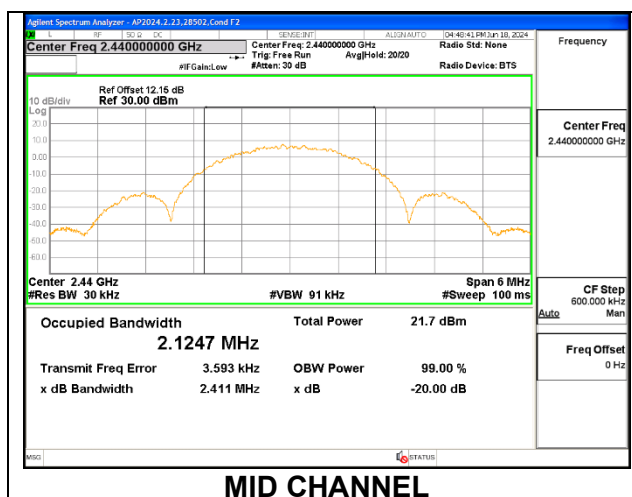
9.2.3. HIGH POWER BLE (2Mbps)

ANT 4

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	2.1286
Middle	2440	2.1289
High	2478	2.1258

**ANT 3**

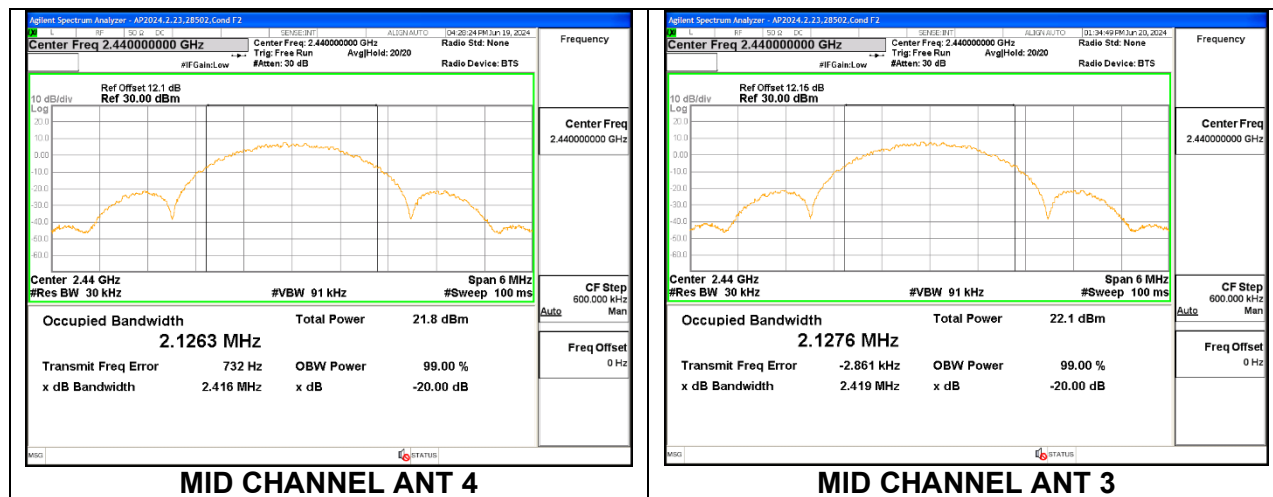
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	2404	2.1255
Middle	2440	2.1247
High	2478	2.1255



9.2.4. HIGH POWER BLE TXBF (2Mbps)

Channel	Frequency (MHz)	99% Bandwidth ANT 4 (MHz)	99% Bandwidth ANT 3 (MHz)
Low	2404	2.1266	2.1251
Mid	2440	2.1263	2.1276
High	2478	2.1247	2.1257

Note: Test procedures and setting are same as BLE normal mode.



9.3. 6 dB BANDWIDTH

LIMITS

FCC §15.407 (e)

RSS-247 5.2 (a)

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

RESULTS

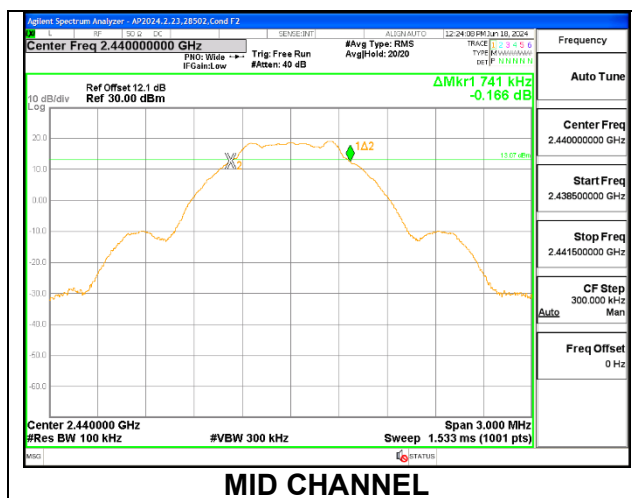
The 6dB bandwidth was measured for the narrowest bandwidth mode, High Power 1Mbps, to demonstrate compliance with the minimum required bandwidth of 500 kHz. Other modes were not tested as their bandwidth is greater than the High Power 1Mbps mode, as demonstrated by the 99% bandwidth measurements performed on all modes.

Only Mid channel plot is reported to show setting parameter complies with testing method/procedure.

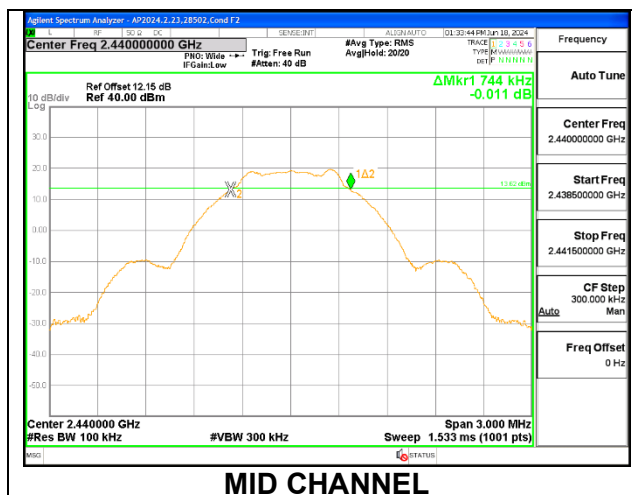
9.3.1. HIGH POWER BLE (1Mbps)

ANT 4

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.744	0.5
Middle	2440	0.741	0.5
High	2480	0.732	0.5

**ANT 3**

Channel	Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum Limit (MHz)
Low	2402	0.729	0.5
Middle	2440	0.744	0.5
High	2480	0.744	0.5



9.4. OUTPUT POWER

LIMITS

FCC §15.247 (b) (3)

RSS-247 5.4 (d)

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

TEST PROCEDURE

Measurements were performed using a wideband RF power meter.

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 2TX:

Tx chains are correlated for power and PSD due to the device supporting Beamforming mode. The directional gains are as follows:

Band (GHz)	ANT 4 Antenna Gain (dBi)	ANT 3 Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)	Correlated Chains Directional Gain (dBi)
2.4	0.00	-2.10	-0.92	2.02

DIRECTIONAL GAIN CALCULATION:

ANSI C63.10-2013 section 14.4.3

Uncorrelated directional gain= $10 \cdot \log((10^{(Ant1/10)} + 10^{(Ant2/10)})/2)$

Correlated directional Gain= $10 \cdot \log(((10^{(Ant1/20)} + 10^{(Ant2/20)})^2)/2)$

Sample Calculation:

Ant4=0.0, Ant3=-2.1

Uncorrelated Antenna gain= $10 \log[(10^{(0/10)} + 10^{(-2.1/10)})/2] = -0.92 \text{ dBi}$

Correlated Antenna gain= $10 \log[(10^{(0/20)} + 10^{(-2.1/20)})^2/2] = 2.02 \text{ dBi}$

RESULTS

9.4.1. HIGH POWER BLE (1Mbps)**ANT 4**

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	20.35	30	-9.65
Middle	2440	20.30	30	-9.70
High	2480	20.43	30	-9.57

ANT 3

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	20.32	30	-9.68
Middle	2440	20.29	30	-9.71
High	2480	20.36	30	-9.64

9.4.2. HIGH POWER BLE TXBF (1Mbps)**ANT 4 + ANT 3**

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	20.30	20.31	23.32	30	-6.68
Middle	2440	20.37	20.22	23.31	30	-6.69
High	2480	20.30	20.29	23.31	30	-6.69

9.4.3. HIGH POWER BLE (2Mbps)

ANT 4

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	20.79	30	-9.21
Middle	2440	20.88	30	-9.12
High	2478	20.81	30	-9.19

ANT 3

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	20.80	30	-9.20
Middle	2440	20.69	30	-9.31
High	2478	20.80	30	-9.20

9.4.4. HIGH POWER BLE TXBF (2Mbps)

ANT 4 + ANT 3

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2404	20.83	20.84	23.85	30	-6.15
Middle	2440	20.83	20.86	23.86	30	-6.14
High	2478	20.82	20.84	23.84	30	-6.16

9.4.5. LOW POWER BLE (1Mbps)

ANT 4

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	9.32	30	-20.68
Middle	2440	9.38	30	-20.62
High	2480	9.37	30	-20.63

ANT 3

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2402	9.32	30	-20.68
Middle	2440	9.34	30	-20.66
High	2480	9.37	30	-20.63

9.4.6. LOW POWER BLE TXBF (1Mbps)

ANT 4 + ANT 3

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	3.37	5.39	7.51	30	-22.49
Middle	2440	3.41	5.39	7.52	30	-22.48
High	2480	3.36	5.35	7.48	30	-22.52

9.4.7. LOW POWER BLE (2Mbps)**ANT 4**

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	9.76	30	-20.24
Middle	2440	9.64	30	-20.36
High	2478	9.82	30	-20.18

ANT 3

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Peak Power Reading (dBm)	Limit (dBm)	Margin (dB)
Low	2404	9.80	30	-20.20
Middle	2440	9.72	30	-20.28
High	2478	9.68	30	-20.32

9.4.8. LOW POWER BLE TXBF (2Mbps)**ANT 4 + ANT 3**

Tested By:	28502
Date:	6/21/2024

Channel	Frequency (MHz)	Output Power ANT 4 (dBm)	Output Power ANT 3 (dBm)	Total Power (dBm)	Limit (dBm)	Margin (dB)
Low	2404	3.76	5.74	7.87	30	-22.13
Middle	2440	3.85	5.84	7.97	30	-22.03
High	2478	3.79	5.88	7.97	30	-22.03

9.5. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

Measurements were performed using a wideband RF power meter.

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

9.5.1. HIGH POWER BLE (1Mbps)**ANT 4**

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	19.89
Middle	2440	19.85
High	2480	19.97

ANT 3

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	19.94
Middle	2440	19.91
High	2480	19.96

9.5.2. HIGH POWER BLE TXBF (1Mbps)**ANT 4 + ANT 3**

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)	Total Power (dBm)
Low	2402	19.87	19.93	22.91
Middle	2440	19.93	19.83	22.89
High	2480	19.91	19.86	22.90

9.5.3. HIGH POWER BLE (2Mbps)**ANT 4**

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	19.92
Middle	2440	19.97
High	2478	19.93

ANT 3

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	19.87
Middle	2440	19.83
High	2478	19.95

9.5.4. HIGH POWER BLE TXBF (2Mbps)**ANT 4 + ANT 3**

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)	Total Power (dBm)
Low	2404	19.93	19.95	22.95
Middle	2440	19.92	19.97	22.96
High	2478	19.91	19.96	22.95

9.5.5. LOW POWER BLE (1Mbps)**ANT 4**

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	8.87
Middle	2440	8.93
High	2480	8.92

ANT 3

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	AV power (dBm)
Low	2402	8.91
Middle	2440	8.93
High	2480	8.95

9.5.6. LOW POWER BLE TXBF (1Mbps)**ANT 4 + ANT 3**

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)	Total Power (dBm)
Low	2402	2.92	4.95	7.06
Middle	2440	2.96	4.95	7.08
High	2480	2.92	4.90	7.03

9.5.7. LOW POWER BLE (2Mbps)**ANT 4**

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	8.89
Middle	2440	8.76
High	2478	8.96

ANT 3

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	AV power (dBm)
Low	2404	8.92
Middle	2440	8.85
High	2478	8.80

9.5.8. LOW POWER BLE TXBF (2Mbps)**ANT 4 + ANT 3**

Tested By:	28502
Date:	6/20/2024

Channel	Frequency (MHz)	Average Power ANT 4 (dBm)	Average Power ANT 3 (dBm)	Total Power (dBm)
Low	2404	2.86	4.85	6.98
Middle	2440	2.97	4.94	7.08
High	2478	2.91	4.97	7.07

9.6. POWER SPECTRAL DENSITY

LIMITS

FCC §15.247 (e)

RSS-247 (5.2) (b)

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

RESULTS

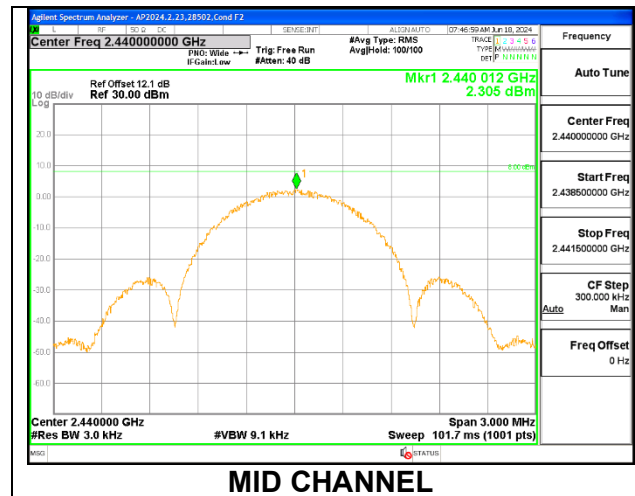
Only Mid channel plot is reported to show setting parameter complies with testing method/procedure.

Only High-Power modes result is reported, it covers all Low Power modes.

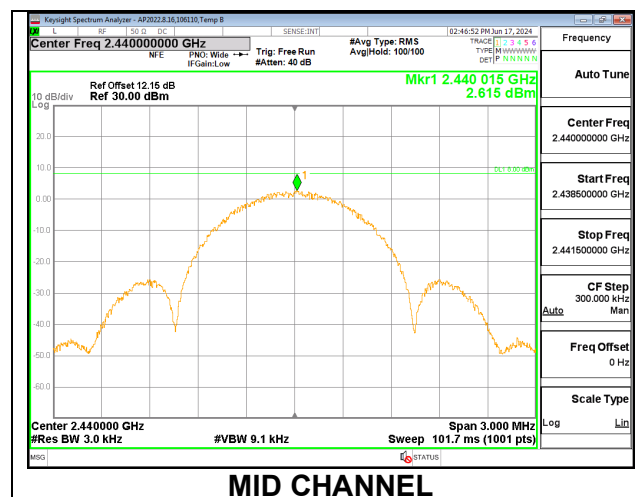
9.6.1. HIGH POWER BLE (1Mbps)

ANT 4

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	2.556	8	-5.44
Middle	2440	2.305	8	-5.70
High	2480	2.740	8	-5.26

**ANT 3**

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2402	2.398	8	-5.60
Middle	2440	2.615	8	-5.39
High	2480	2.654	8	-5.35



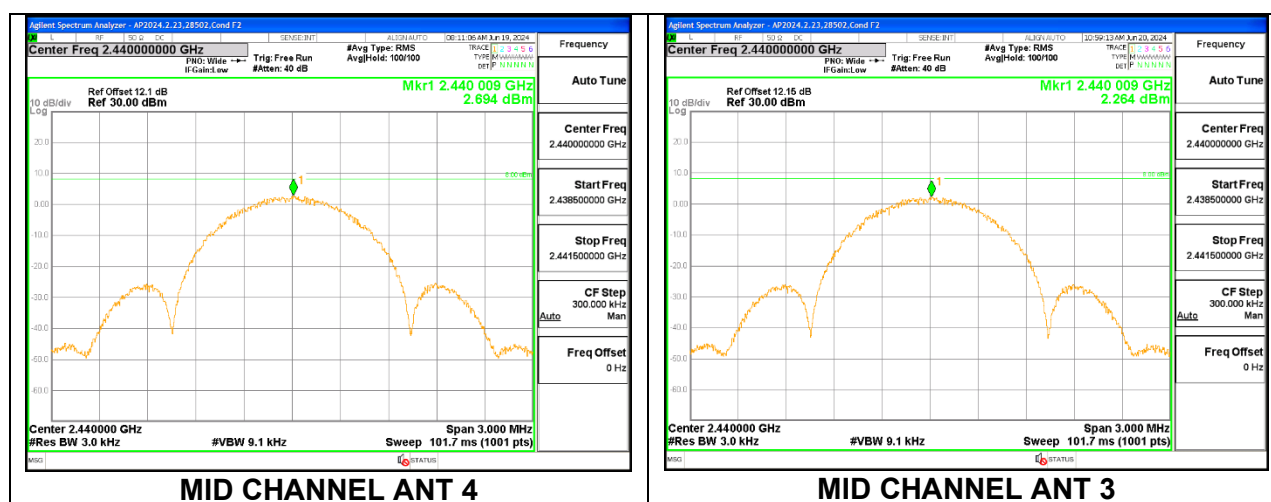
9.6.2. HIGH POWER BLE TXBF (1Mbps)

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

Channel	Frequency (MHz)	ANT 4 Meas (dBm/ 3kHz)	ANT 3 Meas (dBm/ 3kHz)	Total Corr'd PSD (dBm/ 3kHz)	Limit (dBm/ 3kHz)	Margin (dB)
Low	2402	2.249	2.563	5.42	8.0	-2.6
Mid	2440	2.694	2.264	5.49	8.0	-2.5
Hjigh	2480	2.546	2.284	5.43	8.0	-2.6

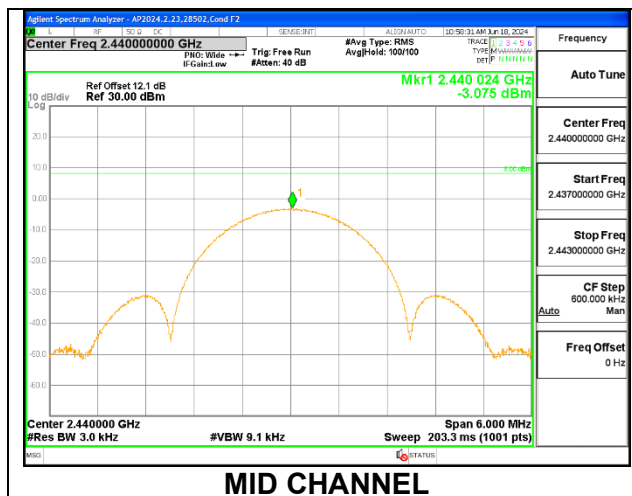
Note: Test procedures and setting are same as BLE normal mode.



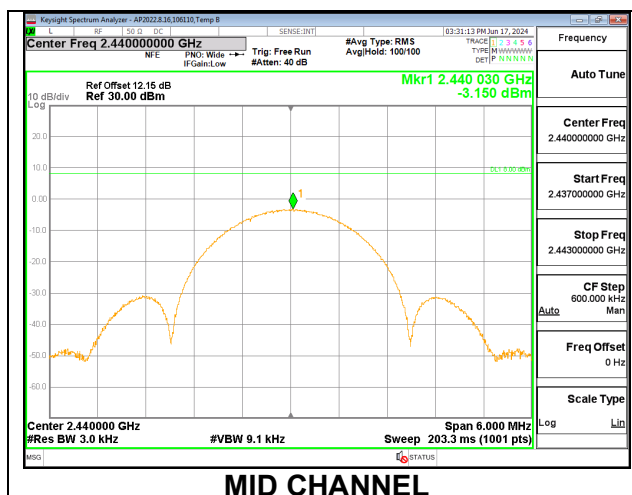
9.6.3. HIGH POWER BLE (2Mbps)

ANT 4

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2404	-2.829	8	-10.83
Middle	2440	-3.075	8	-11.08
High	2478	-3.026	8	-11.03

**ANT 3**

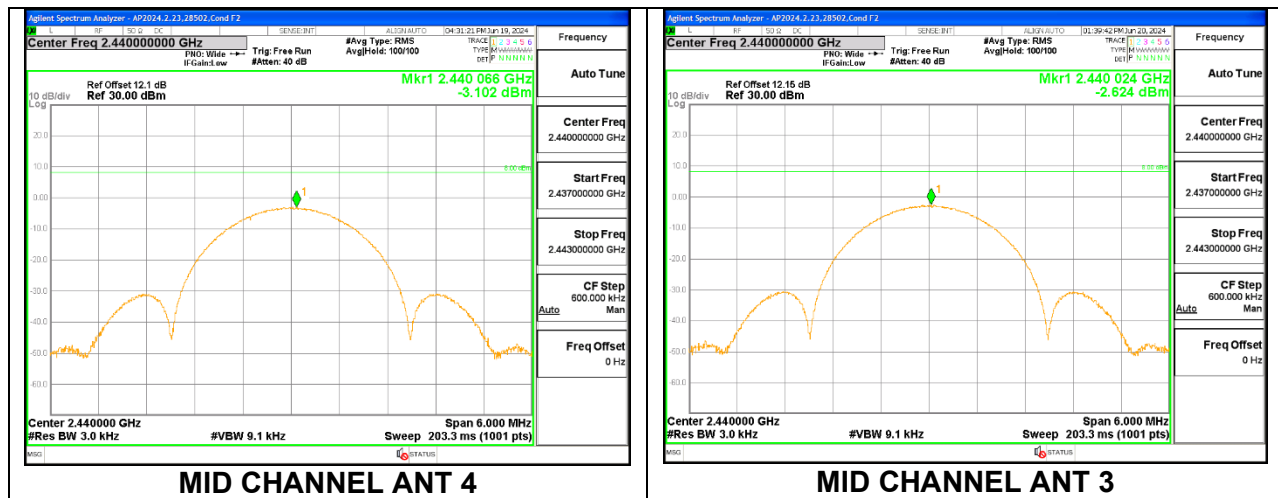
Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Margin (dB)
Low	2404	-3.152	8	-11.15
Middle	2440	-3.150	8	-11.15
High	2478	-2.950	8	-10.95



9.6.4. HIGH POWER BLE TXBF (2Mbps)

Duty Cycle CF (dB)		0.00		Included in Calculations of Corr'd PSD		
PSD Results						
Channel	Frequency	ANT 4 Meas	ANT 3 Meas	Total Corr'd PSD	Limit	Margin
	(MHz)	(dBm/3kHz)	(dBm/3kHz)	(dBm/3kHz)	(dBm/3kHz)	(dB)
Low	2404	-3.125	-3.132	-0.12	8.0	-8.1
Mid	2440	-3.102	-2.624	0.15	8.0	-7.8
Hjigh	2478	-3.157	-2.942	-0.04	8.0	-8.0

Note: Test procedures and setting are same as BLE normal mode.



9.7. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

RSS-247 5.5

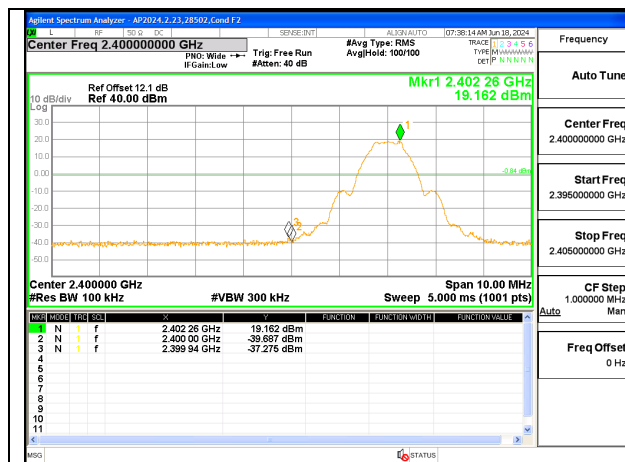
Output power was measured based on the use of a peak measurement; therefore, the required attenuation is 20 dBc.

Note: Test procedures and setting are same as BLE normal mode.

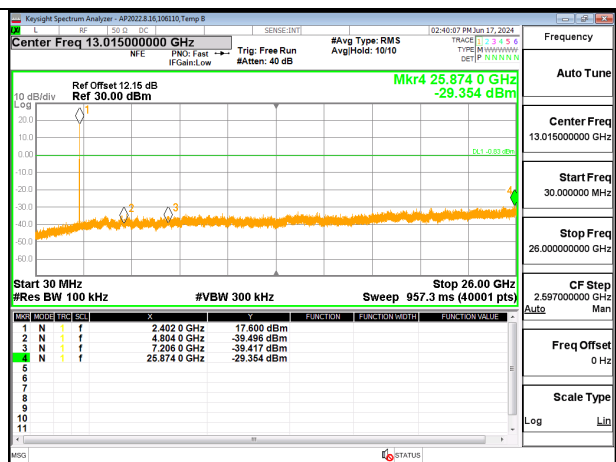
RESULTS

9.7.1. HIGH POWER BLE (1Mbps)

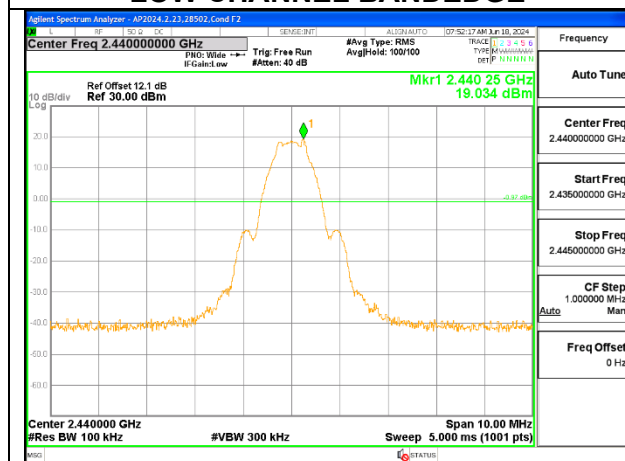
ANT 4



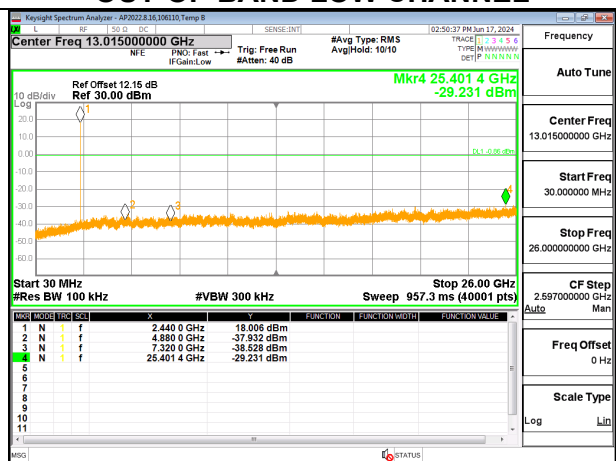
LOW CHANNEL BANDEDGE



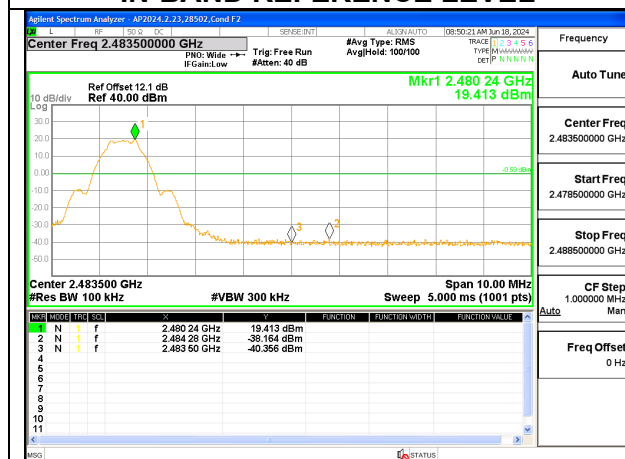
OUT-OF-BAND LOW CHANNEL



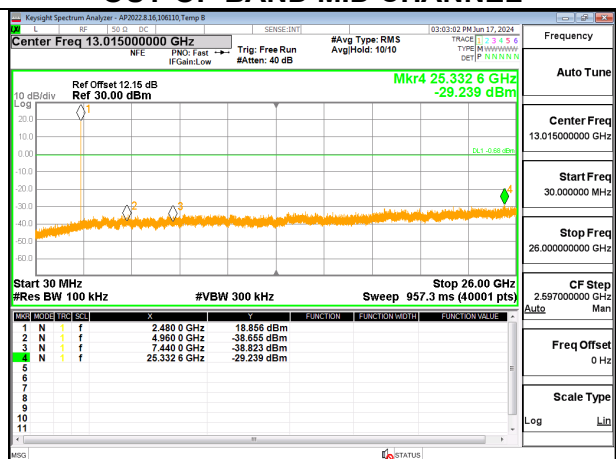
IN-BAND REFERENCE LEVEL



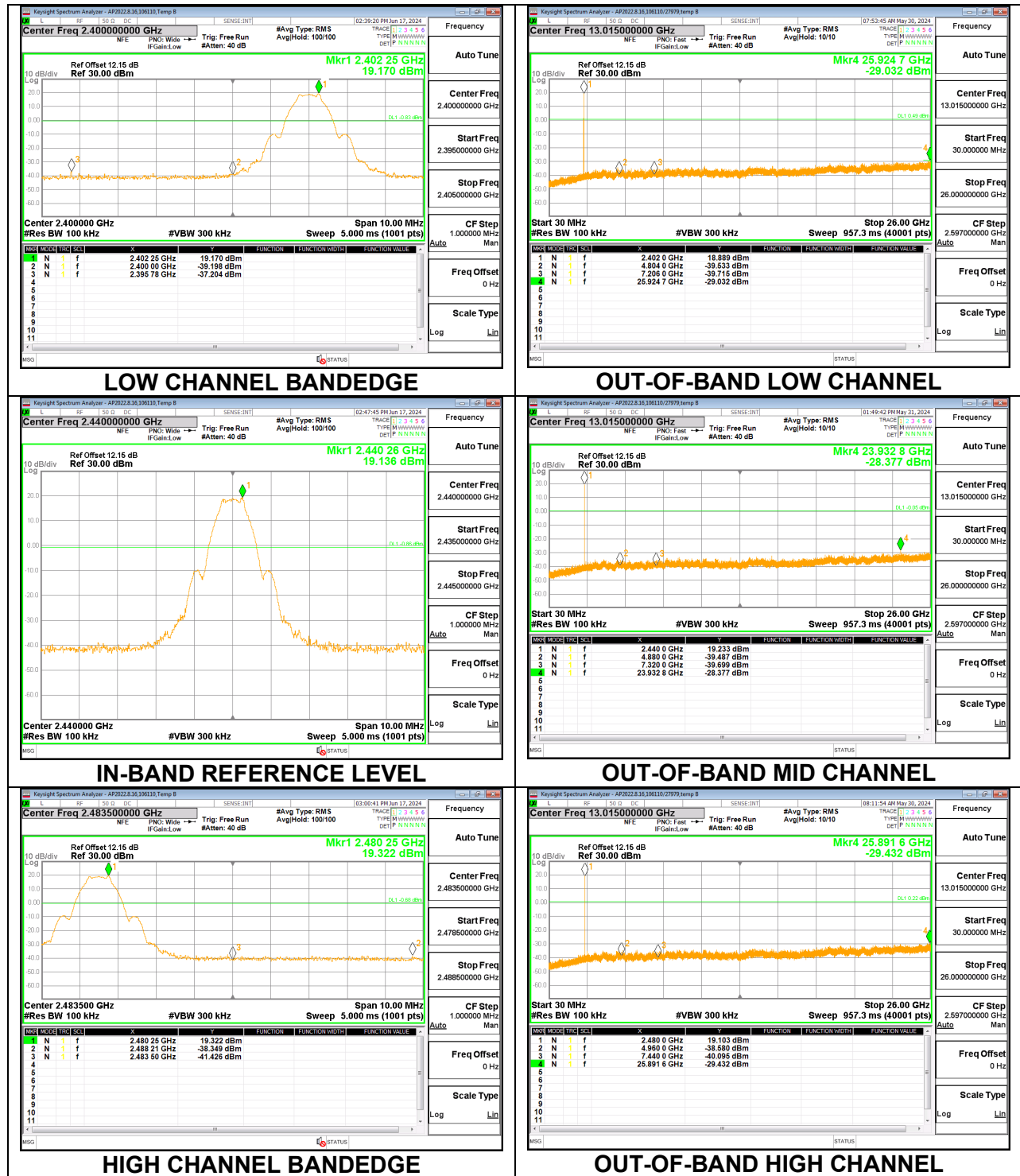
OUT-OF-BAND MID CHANNEL



HIGH CHANNEL BANDEDGE

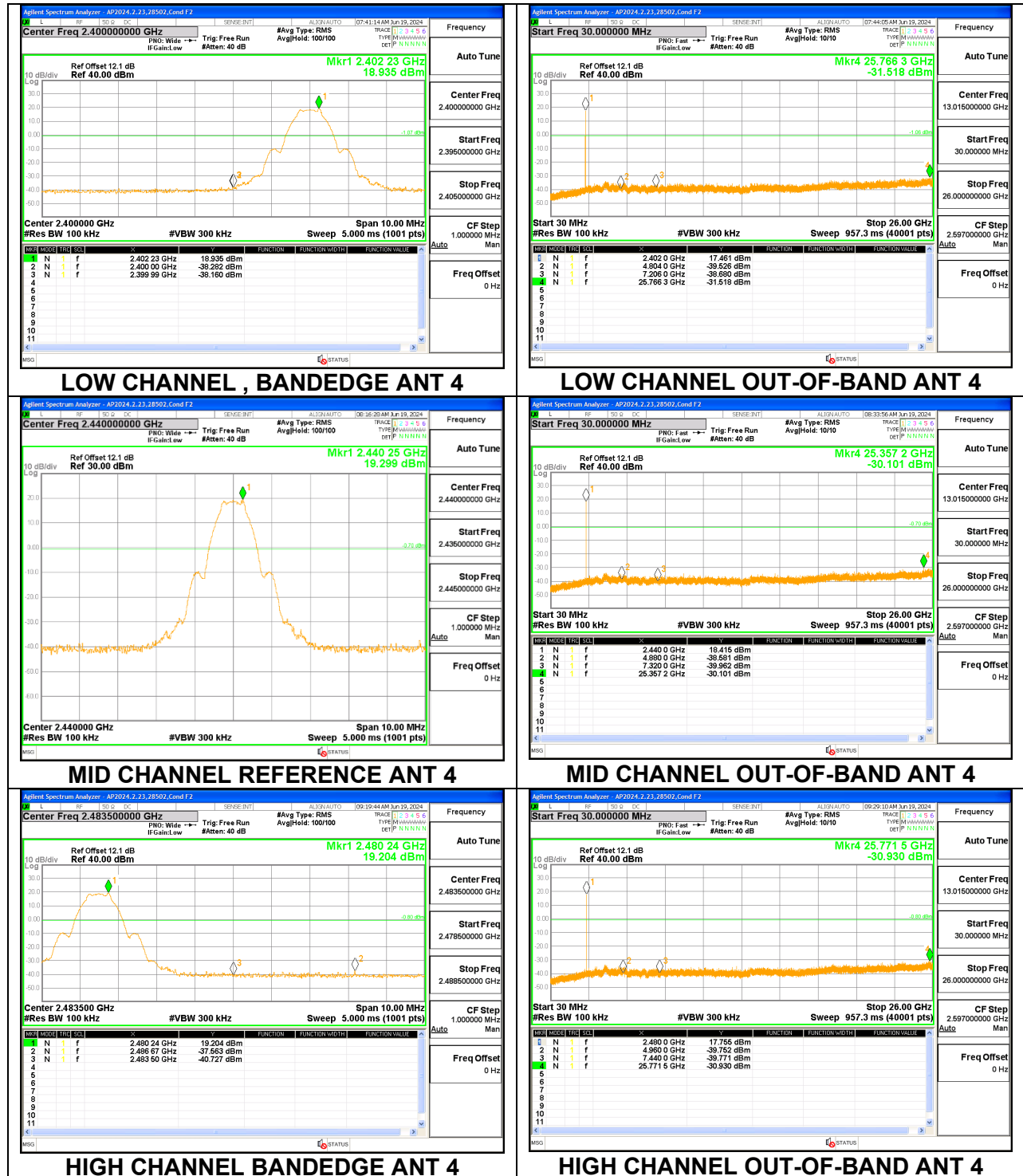


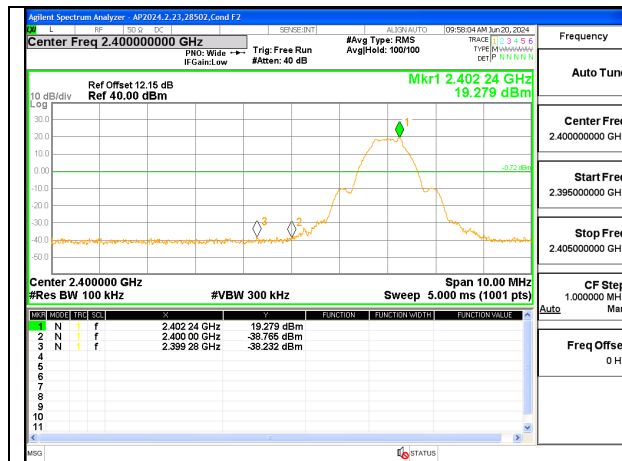
OUT-OF-BAND HIGH CHANNEL

ANT 3

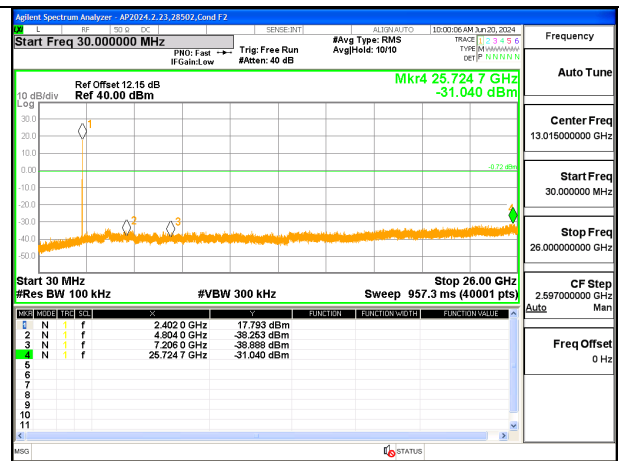
9.7.2. HIGH POWER BLE TXBF (1Mbps)

Note: Test procedures and setting are same as BLE normal mode.

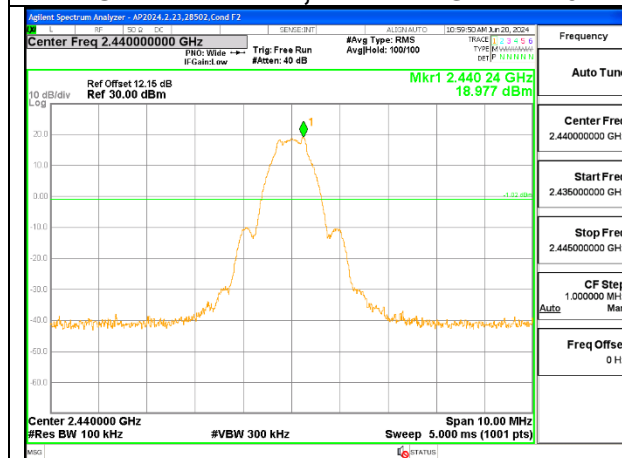




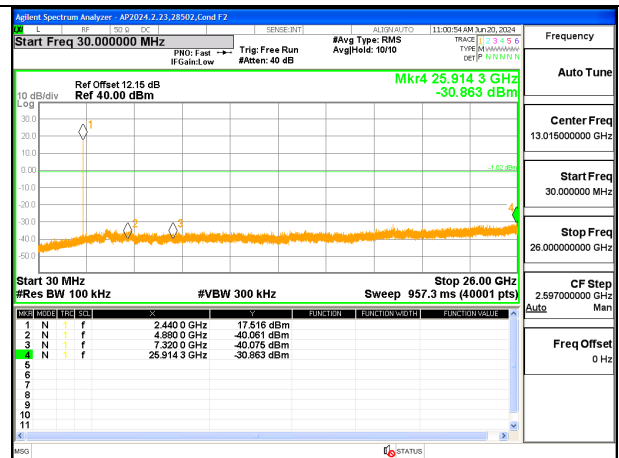
LOW CHANNEL , BANEDGE ANT 3



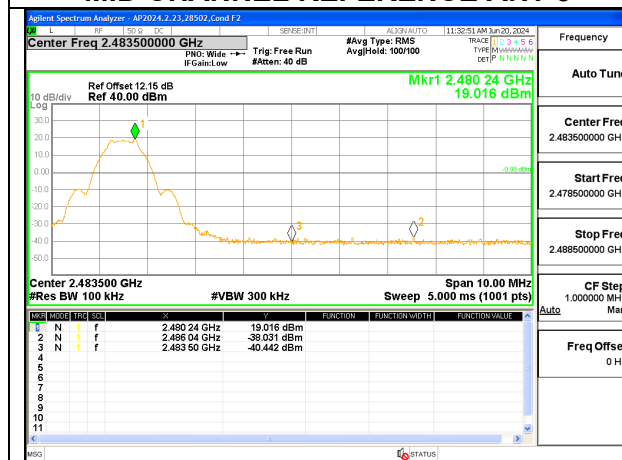
LOW CHANNEL OUT-OF-BAND ANT 3



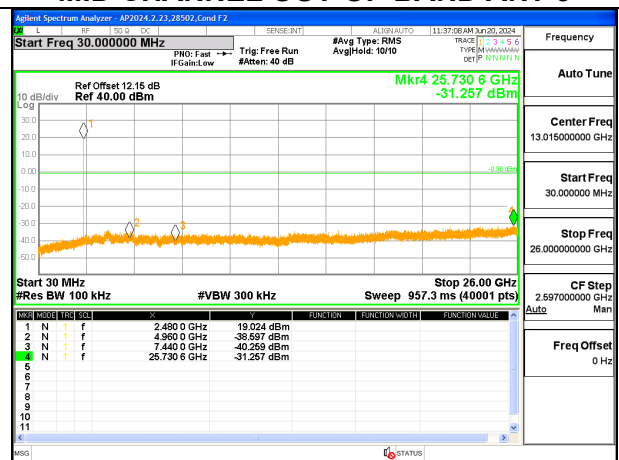
MID CHANNEL REFERENCE ANT 3



MID CHANNEL OUT-OF-BAND ANT 3



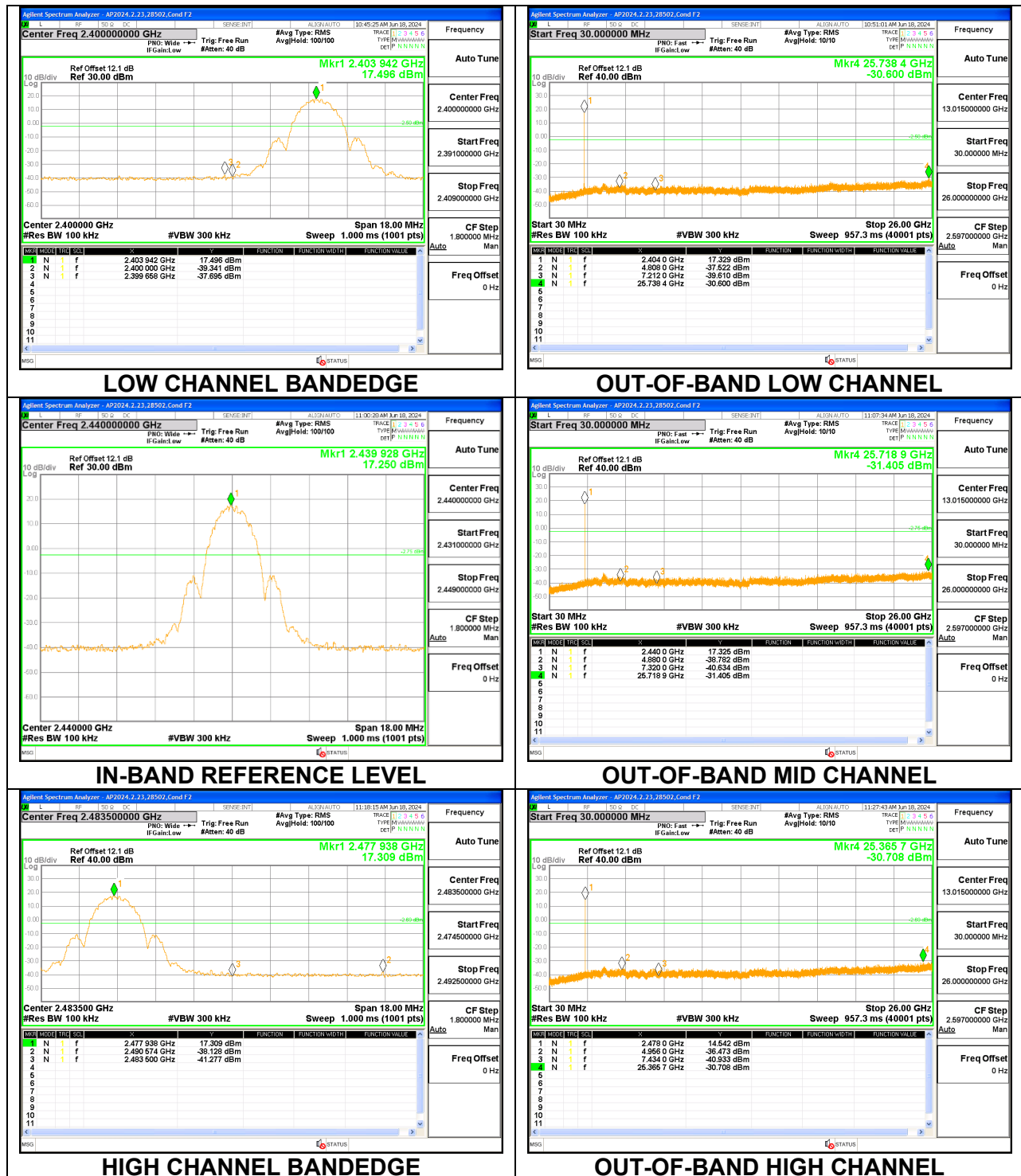
HIGH CHANNEL REFERENCE ANT 3

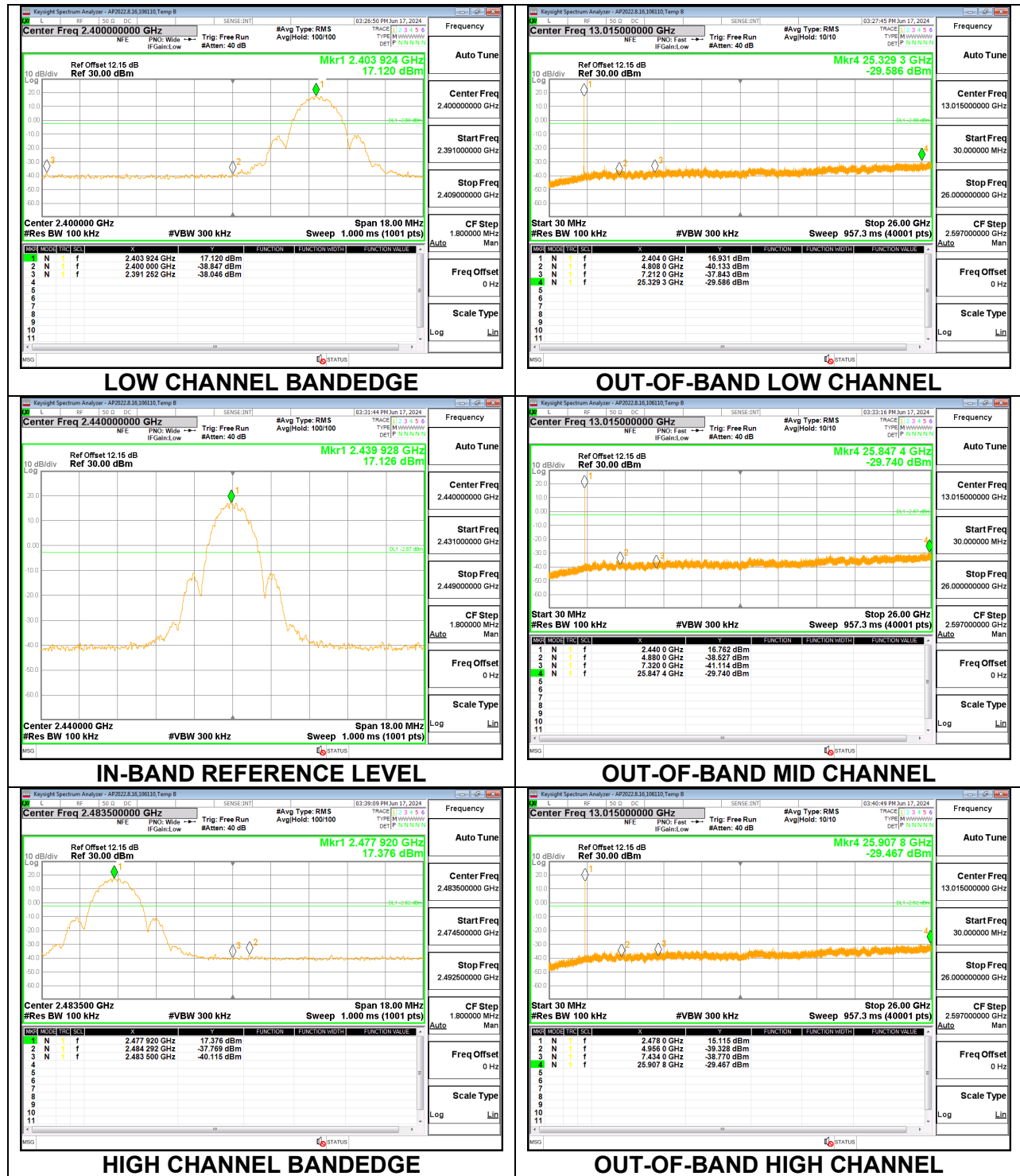


HIGH CHANNEL OUT-OF-BAND ANT 3

9.7.3. HIGH POWER BLE (2Mbps)

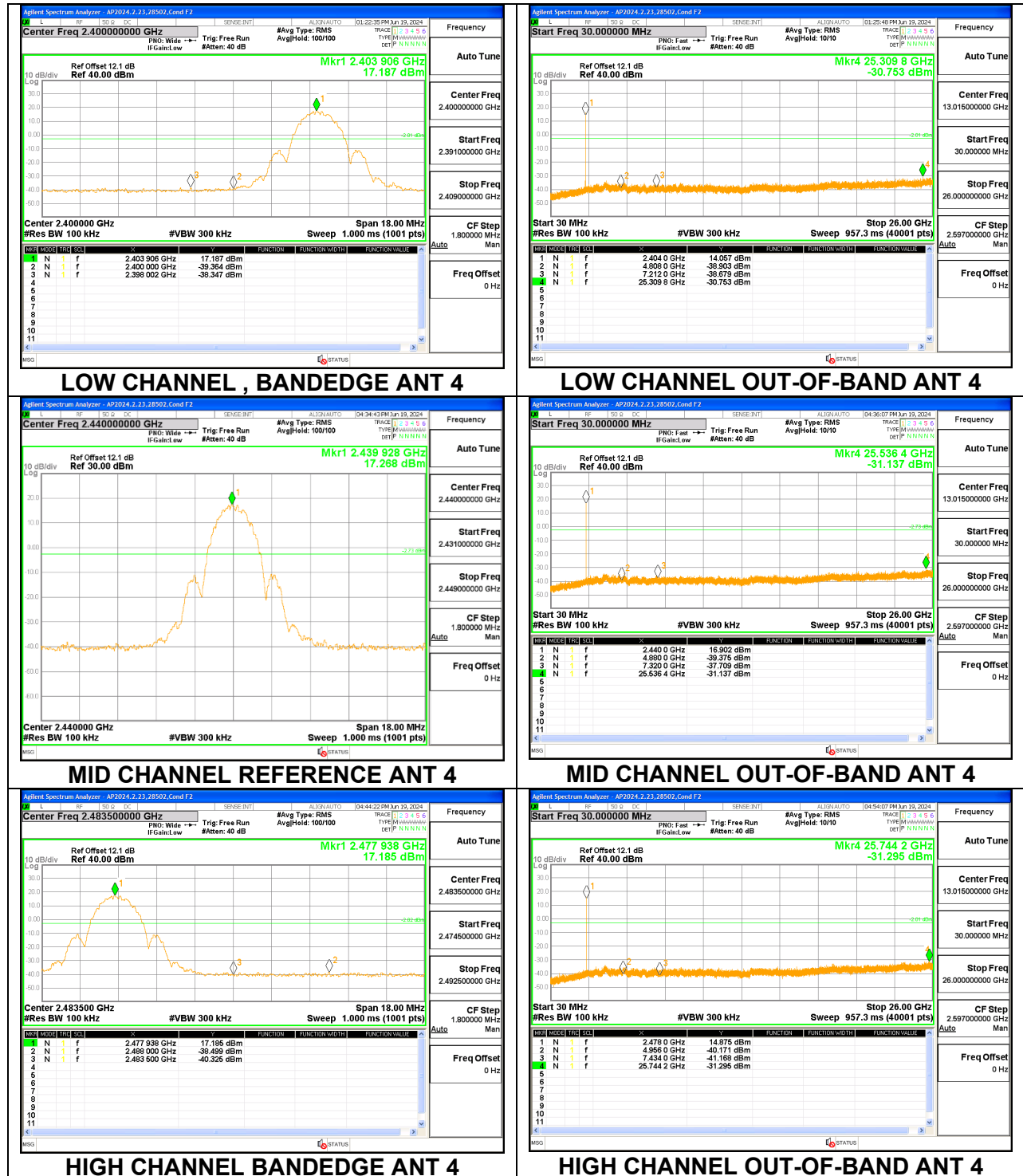
ANT 4

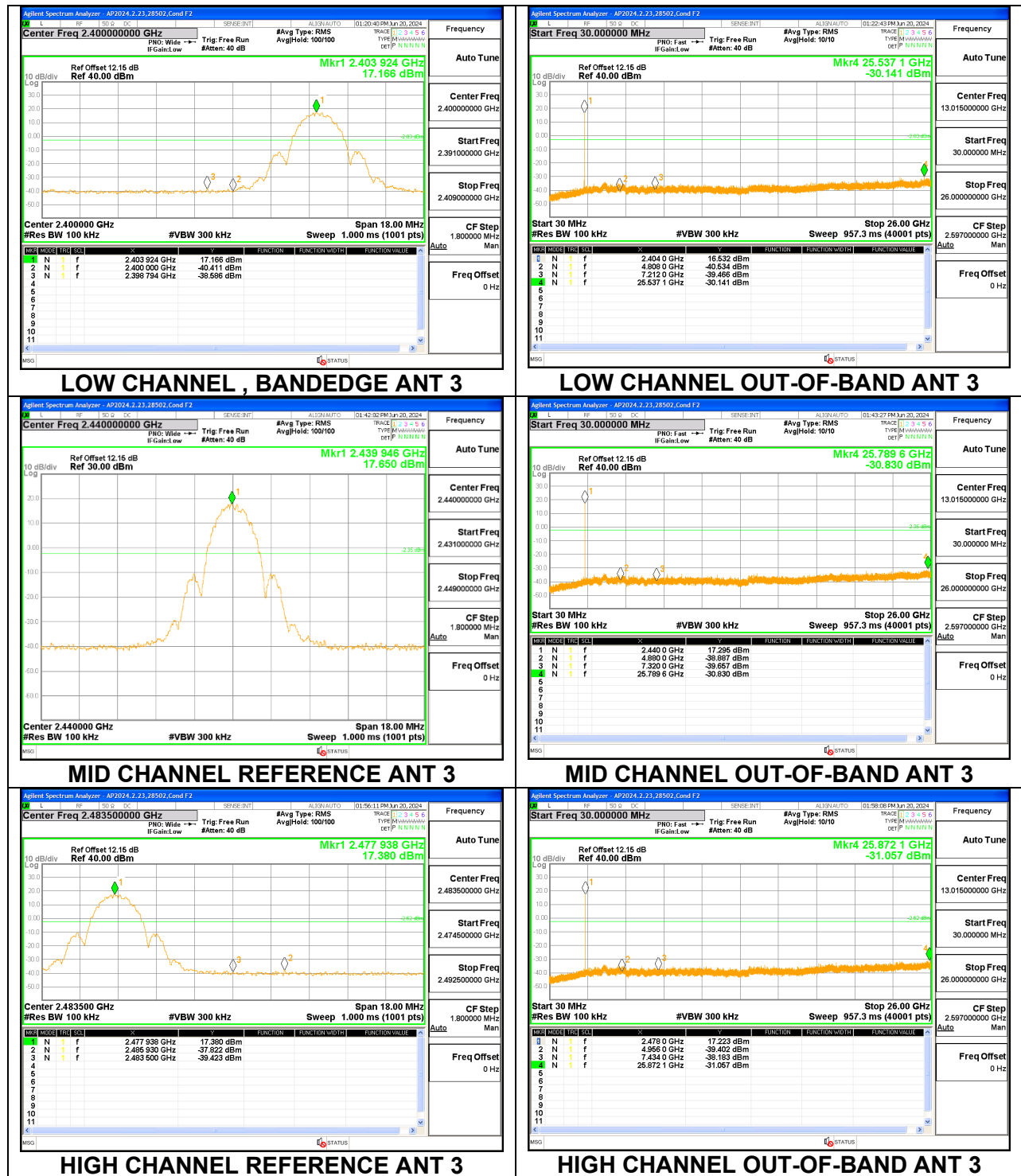


ANT 3

9.7.4. HIGH POWER BLE TXBF (2Mbps)

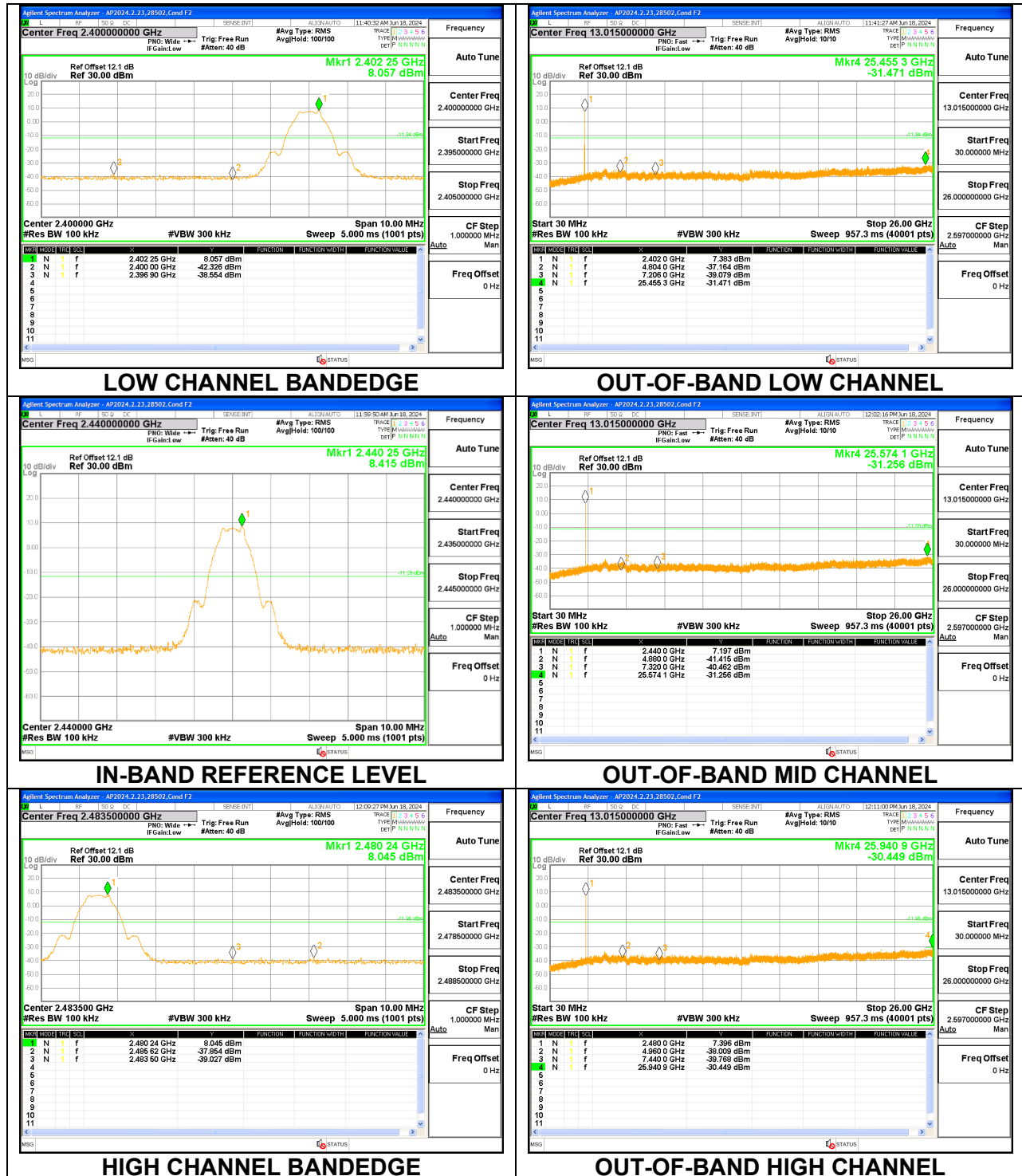
Note: Test procedures and setting are same as BLE normal mode.

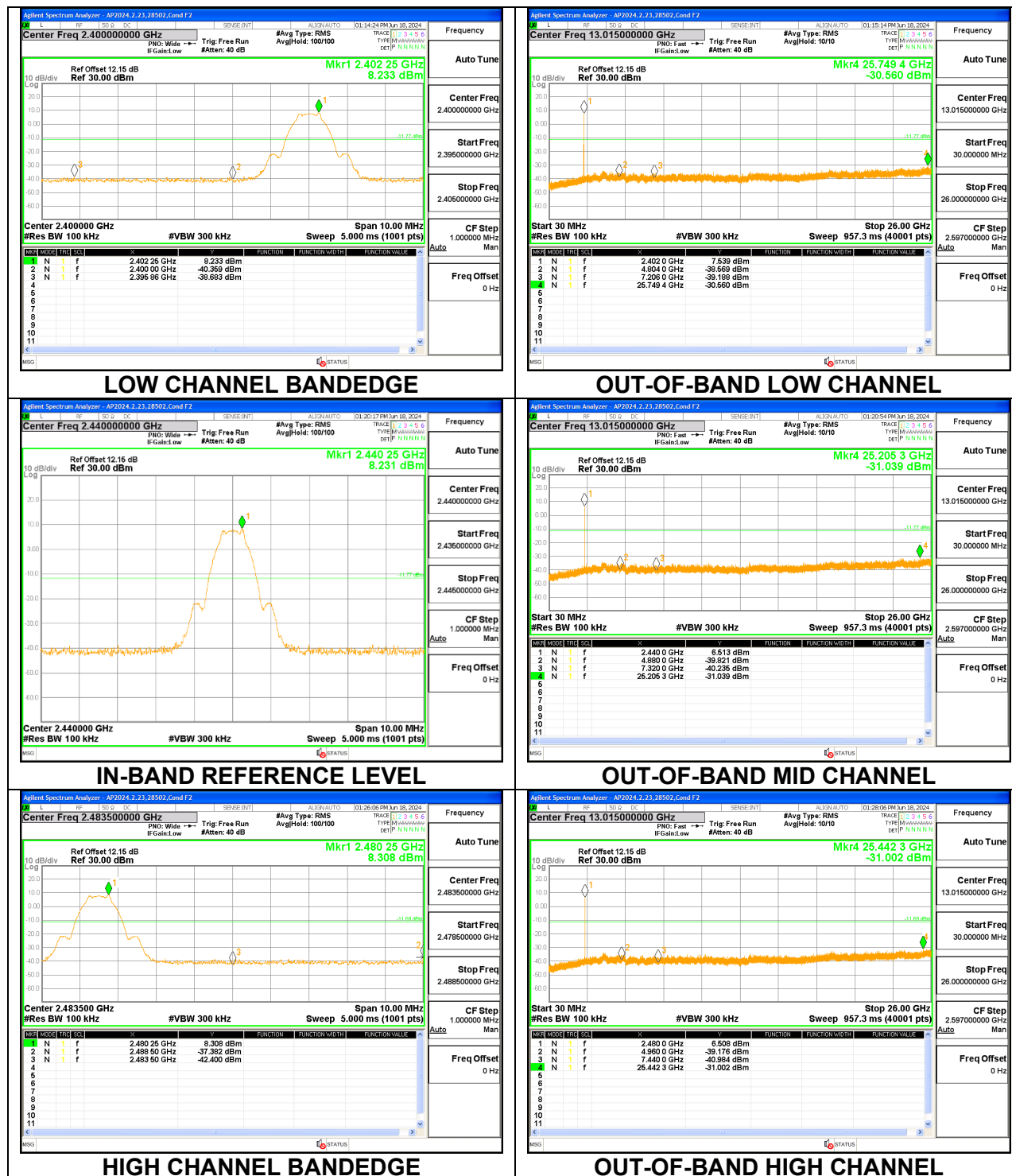




9.7.5. LOW POWER BLE (1Mbps)

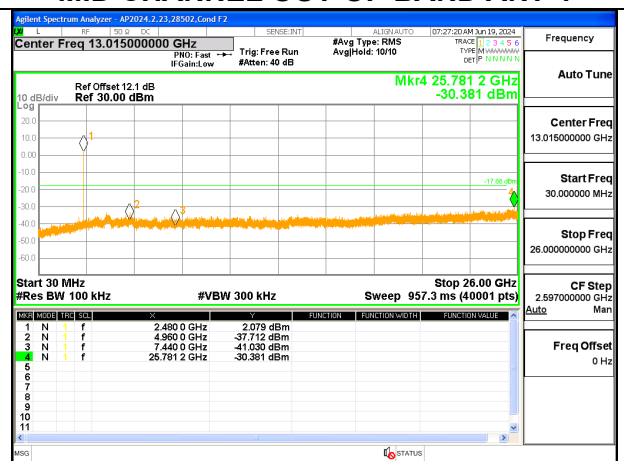
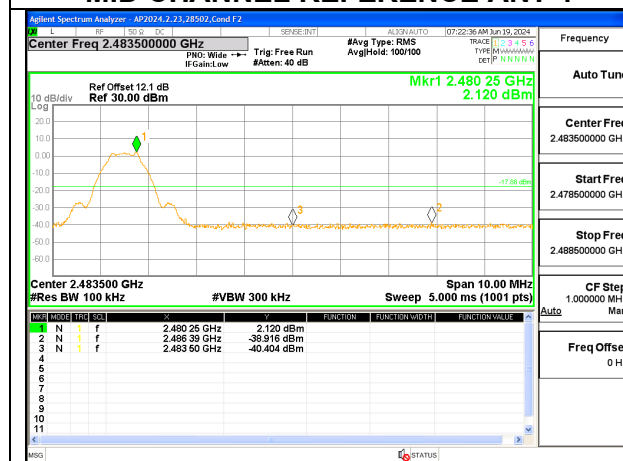
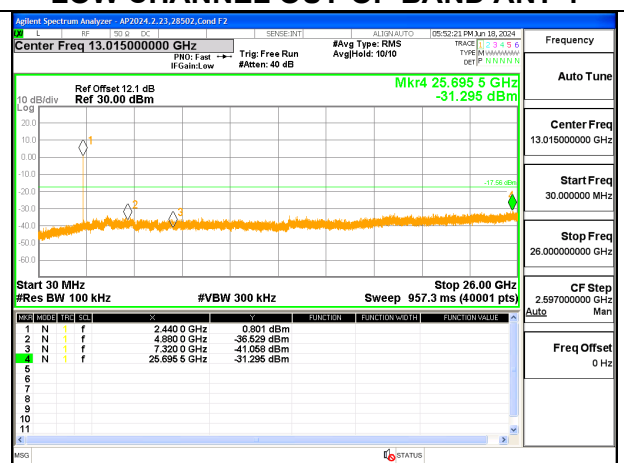
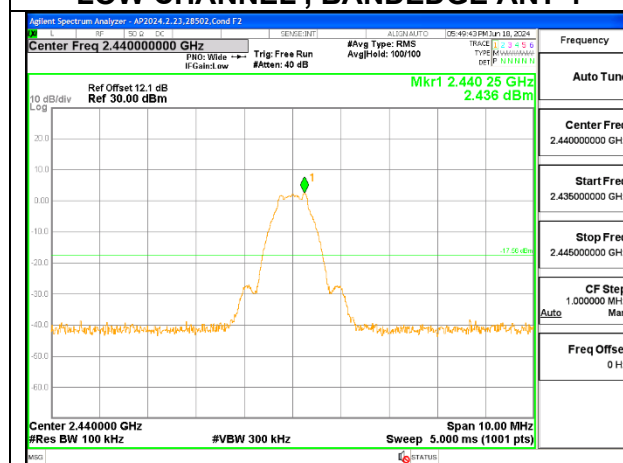
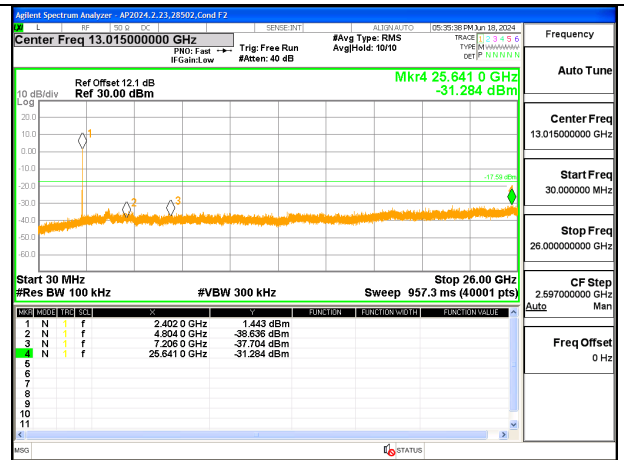
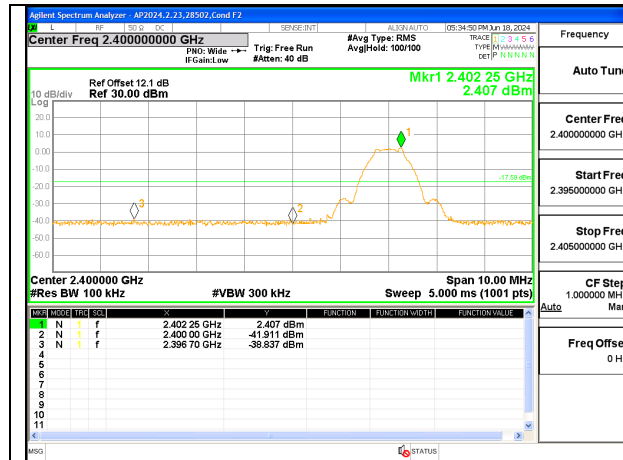
ANT 4

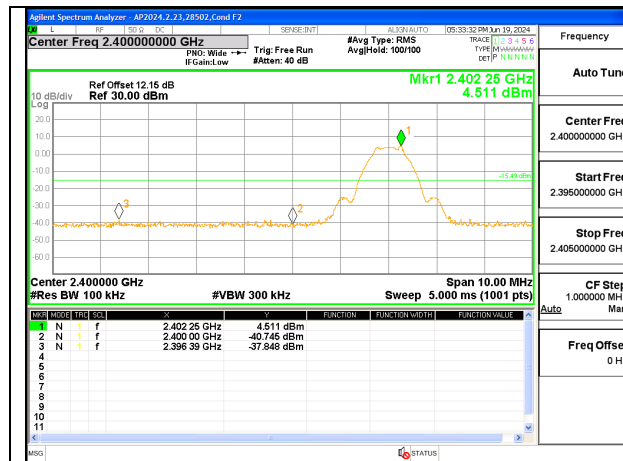


ANT 3

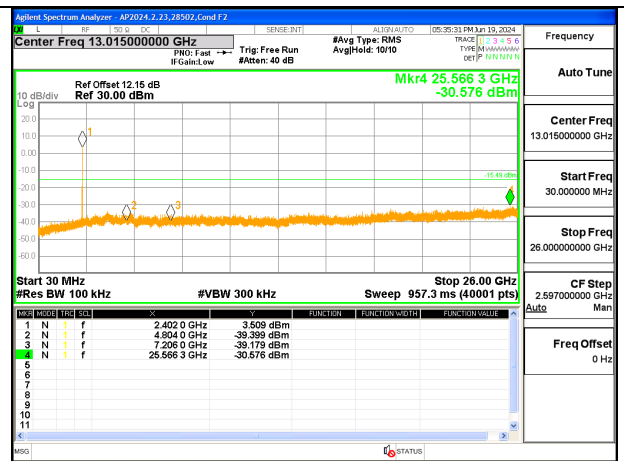
9.7.6. LOW POWER BLE TXBF (1Mbps)

Note: Test procedures and setting are same as BLE normal mode.

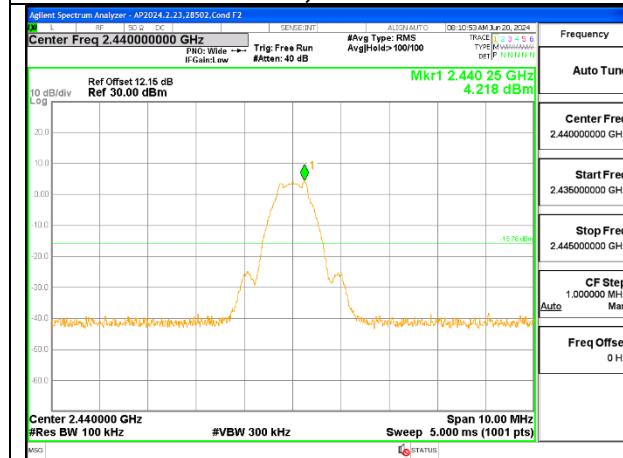




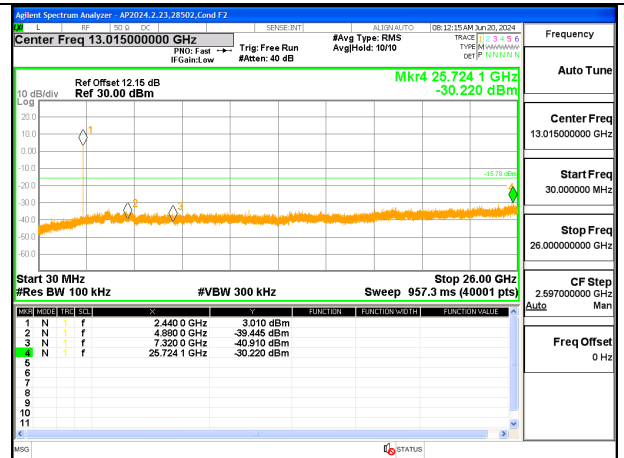
LOW CHANNEL , BANDEDGE ANT 3



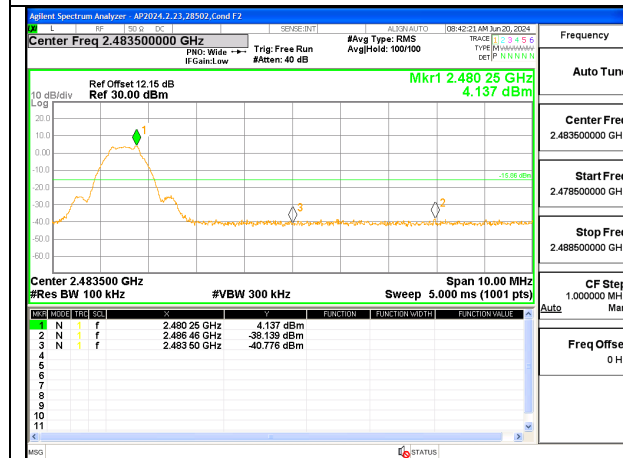
LOW CHANNEL OUT-OF-BAND ANT 3



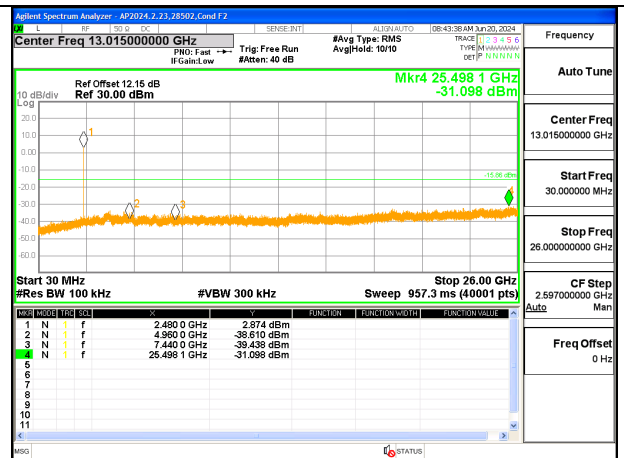
MID CHANNEL REFERENCE ANT 3



MID CHANNEL OUT-OF-BAND ANT 3



HIGH CHANNEL REFERENCE ANT 3



HIGH CHANNEL OUT-OF-BAND ANT 3