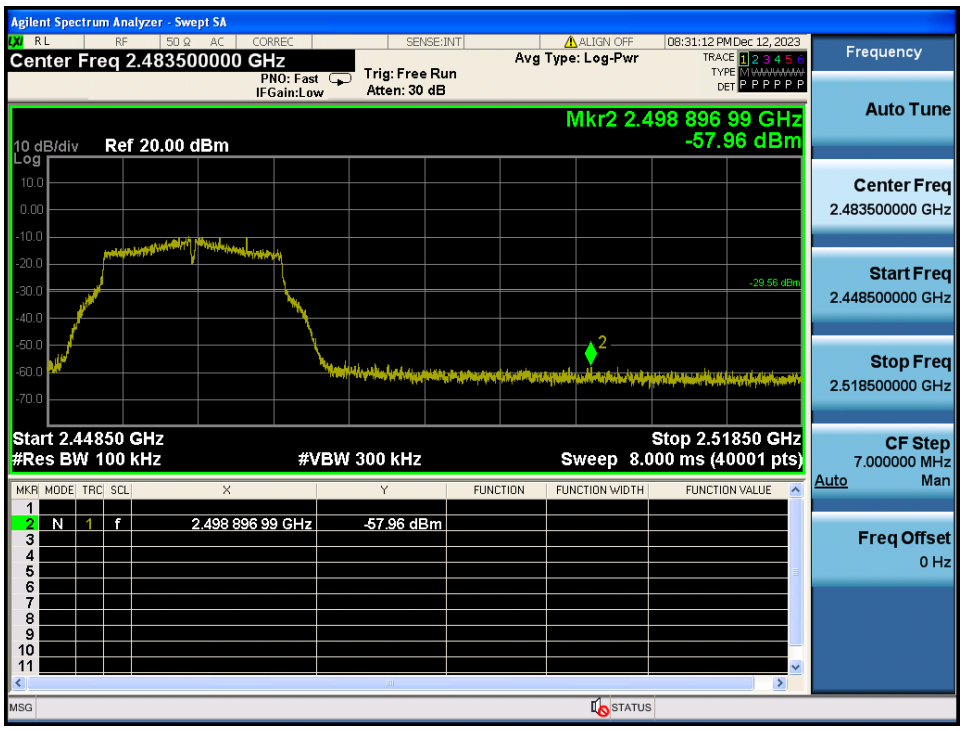
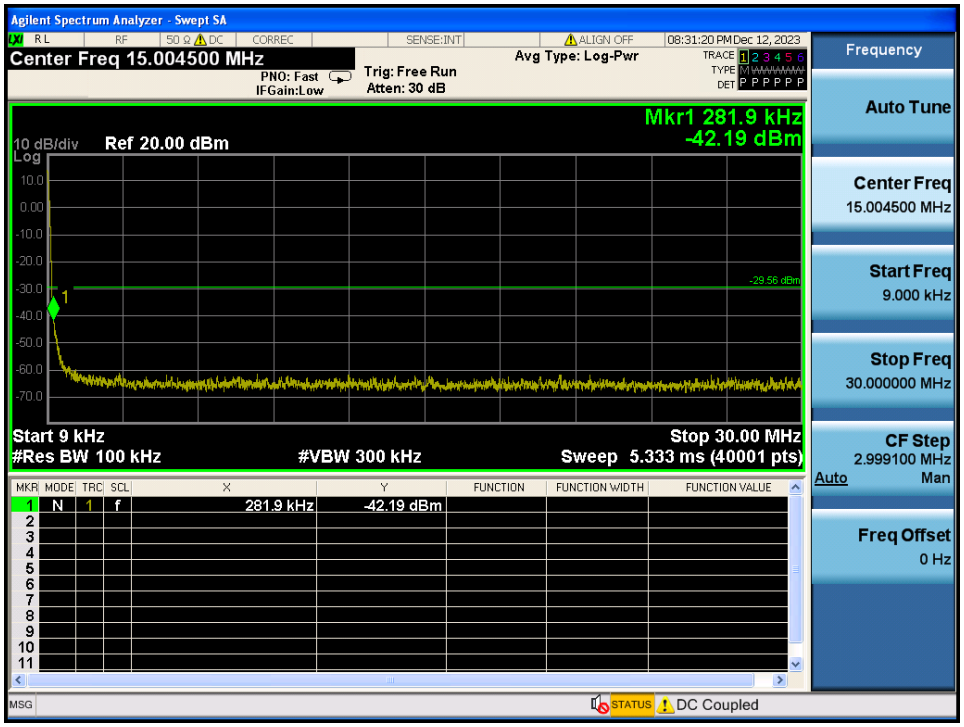
TM 2 & 2 462

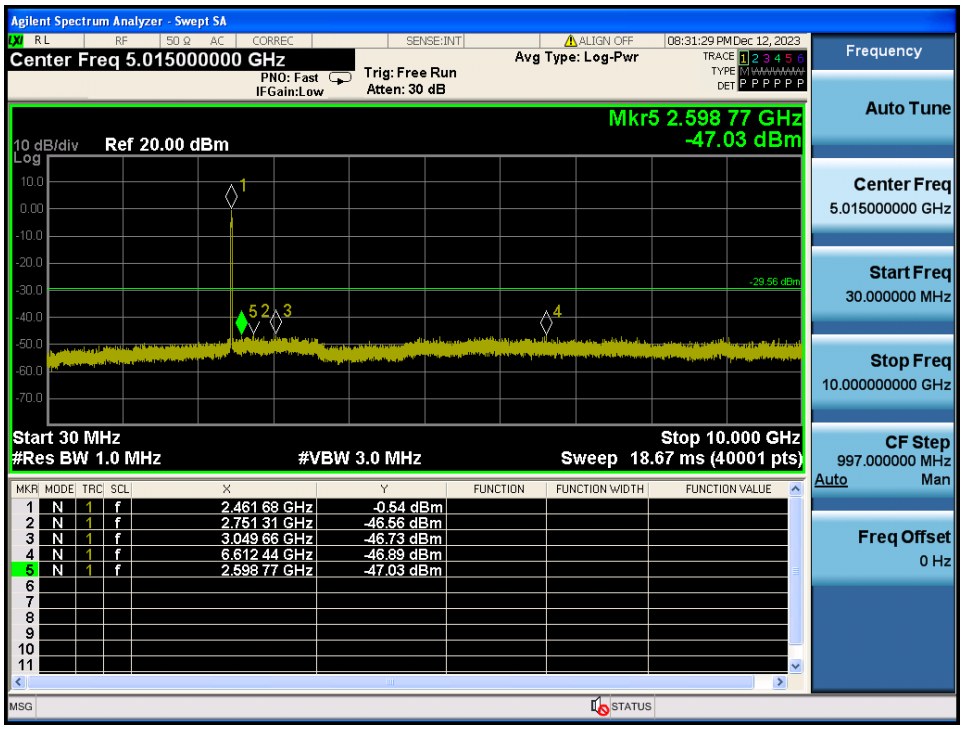
Reference

High Band-edge

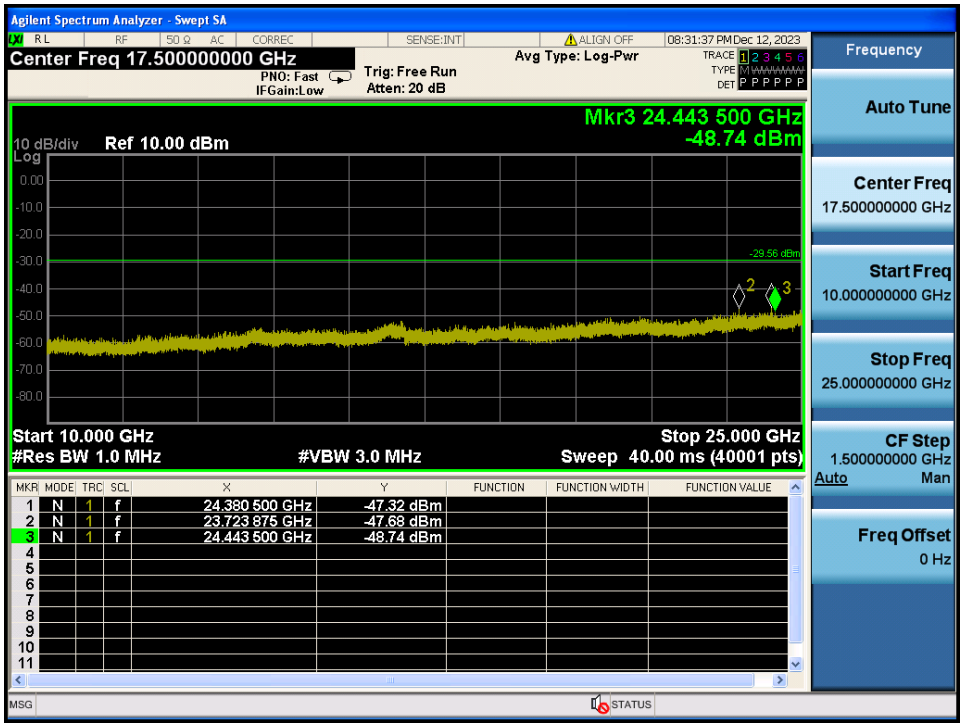


Conducted Spurious Emissions





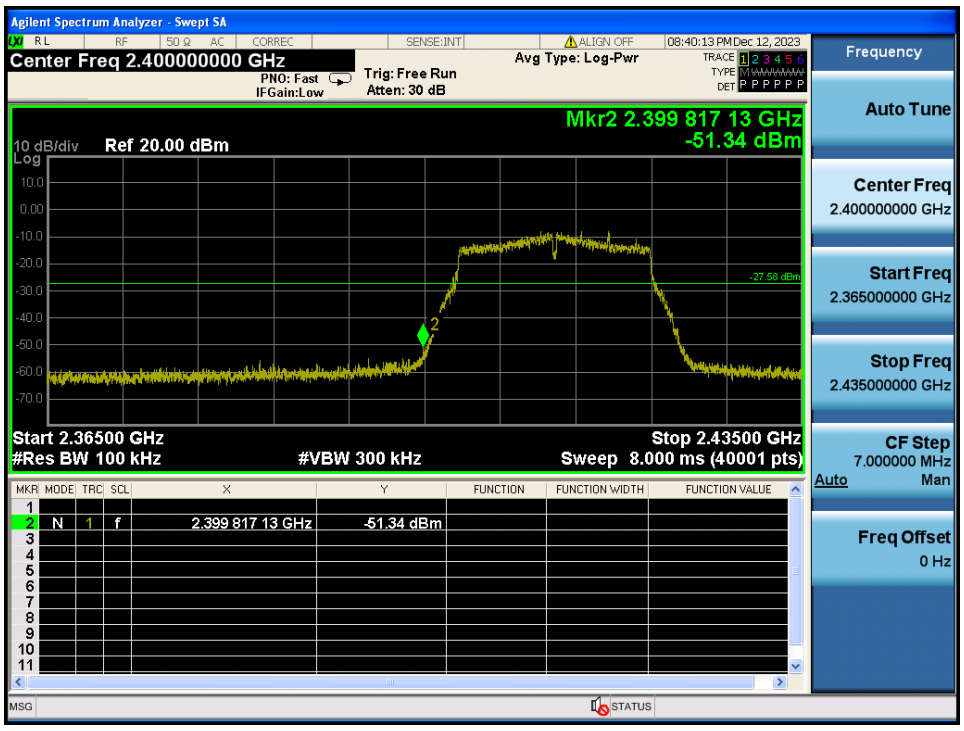
Conducted Spurious Emissions



TM 3 & 2 412

Reference

Low Band-edge



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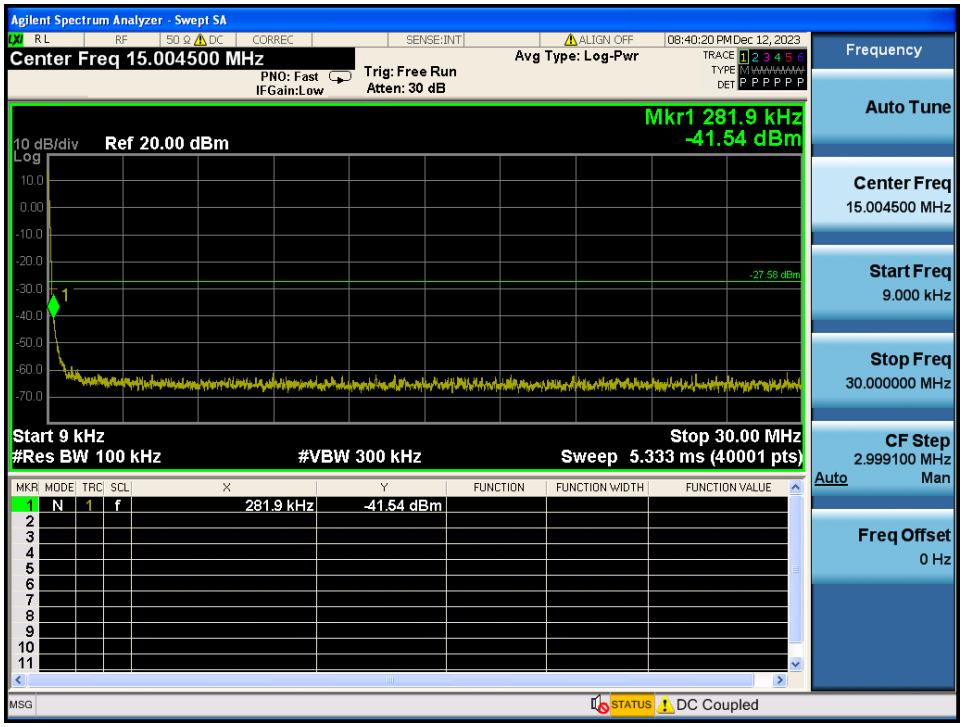
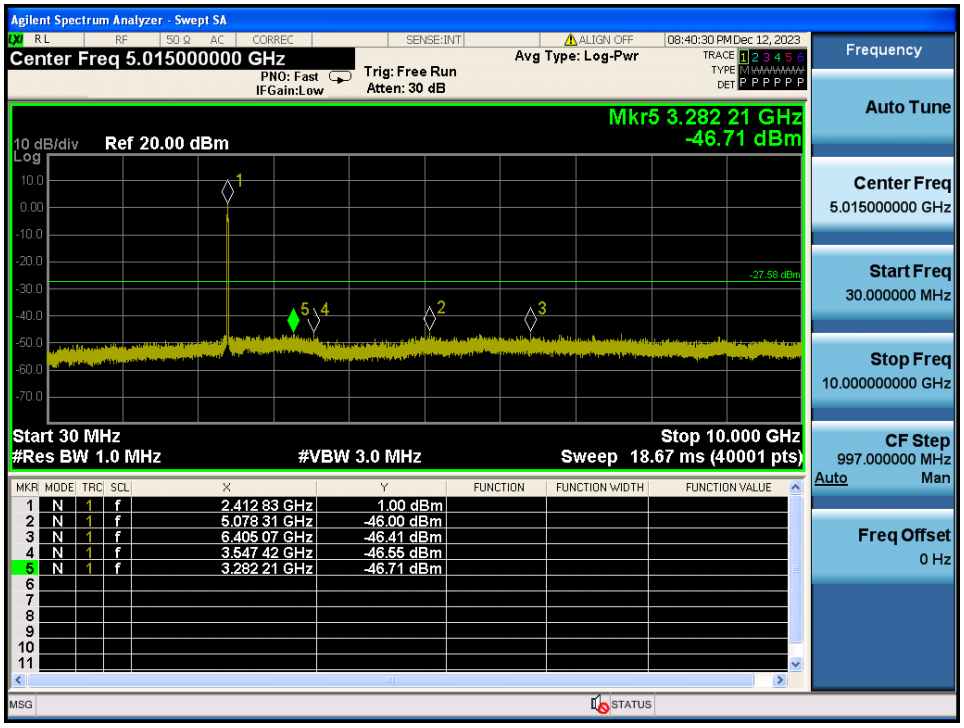
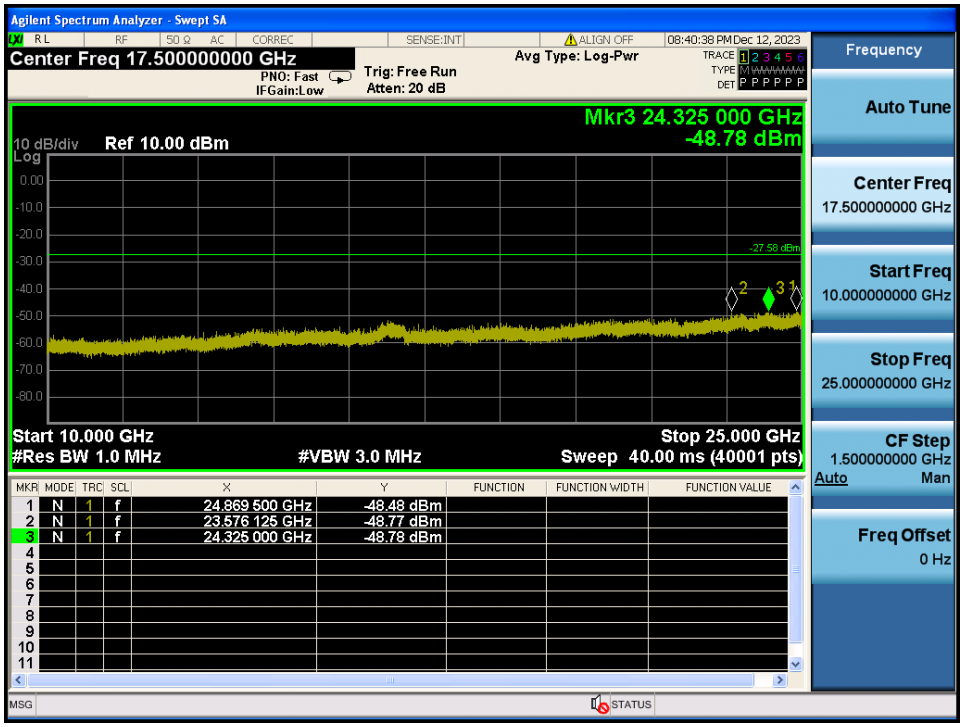




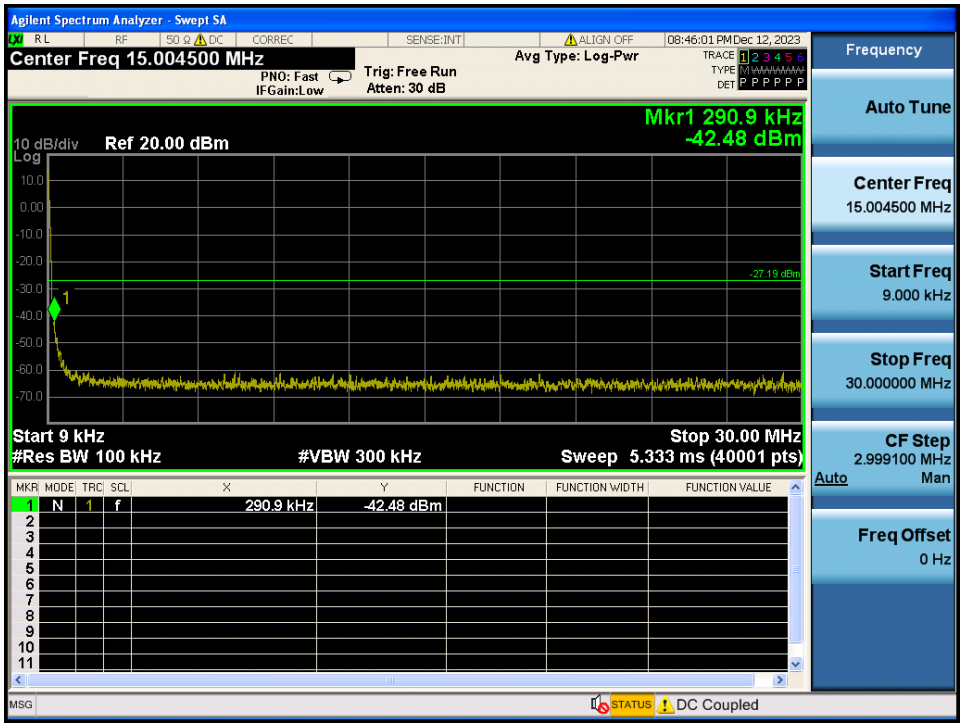
Conducted Spurious Emissions



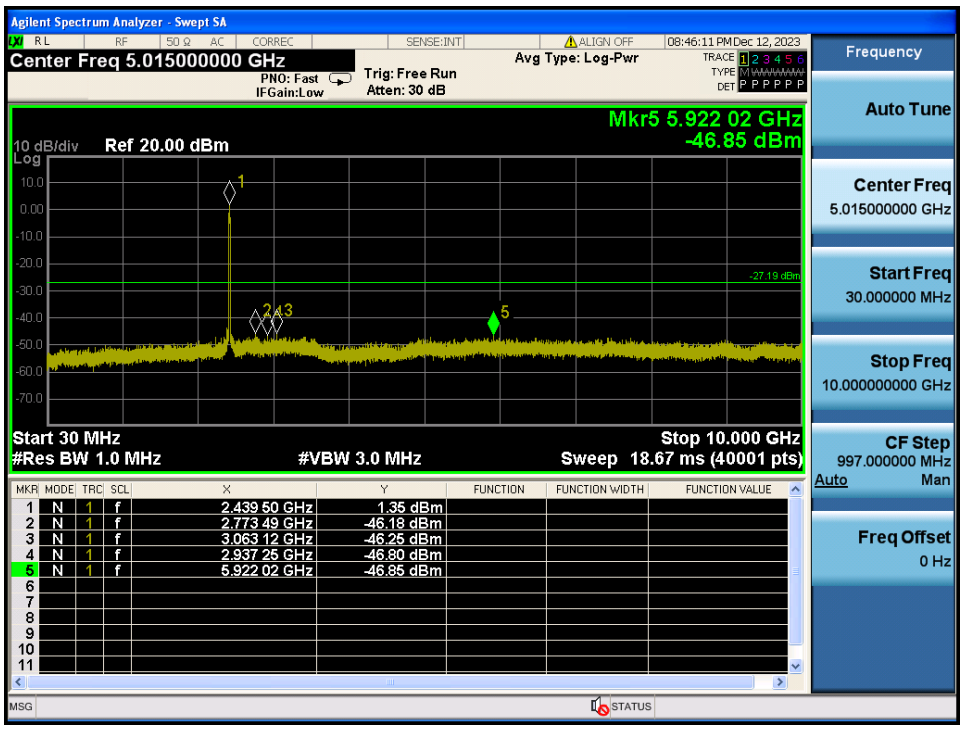
TM 3 & 2 437

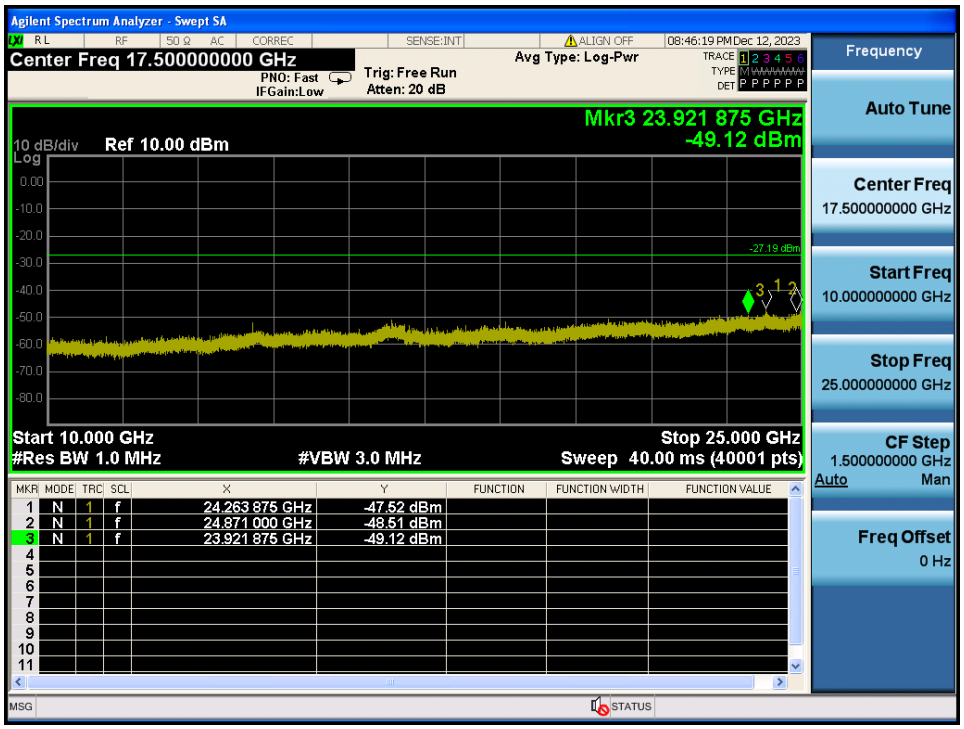
Reference

Conducted Spurious Emissions



Conducted Spurious Emissions

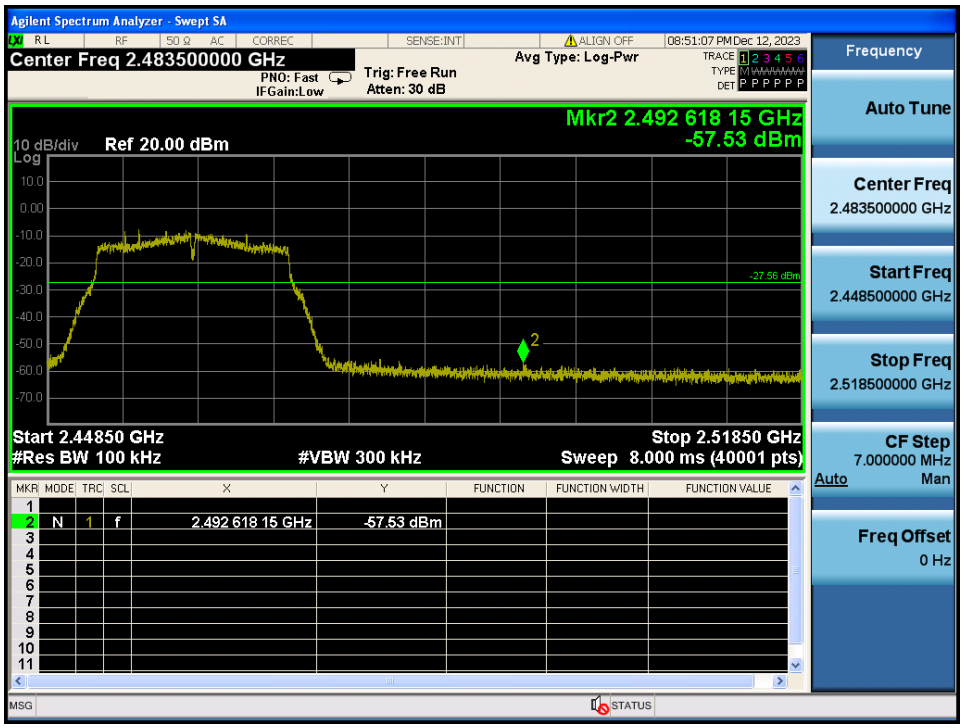




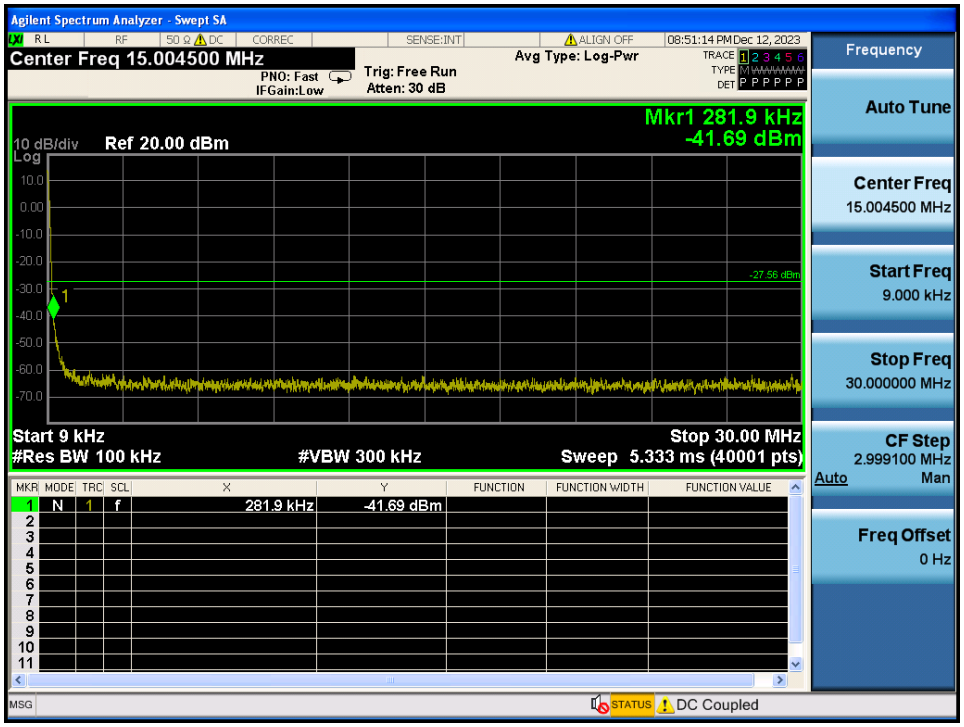
TM 3 & 2 462

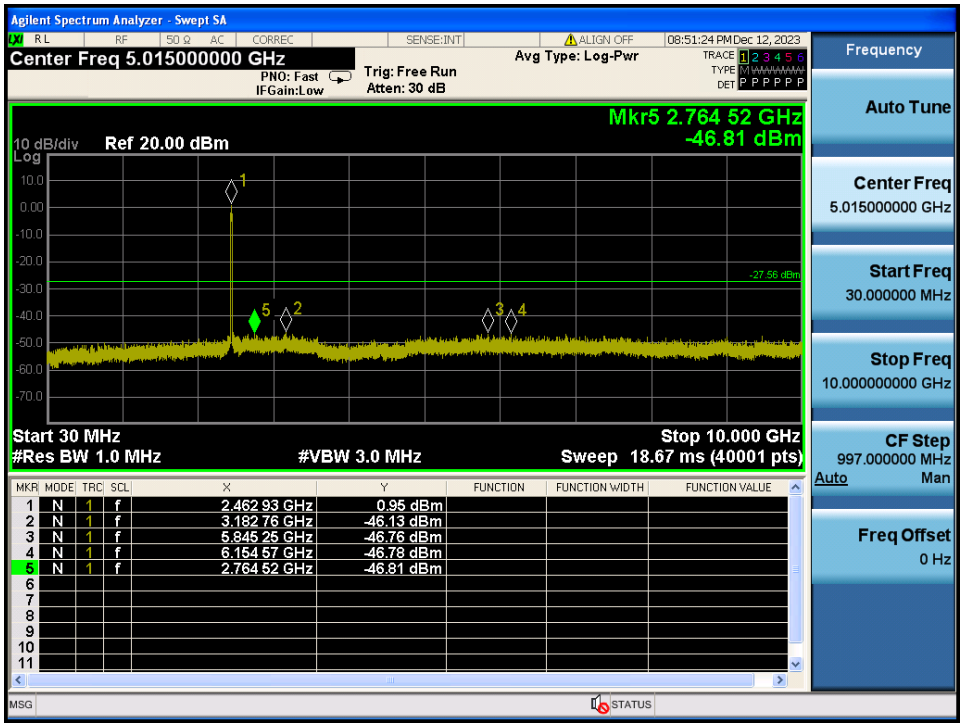
Reference

High Band-edge

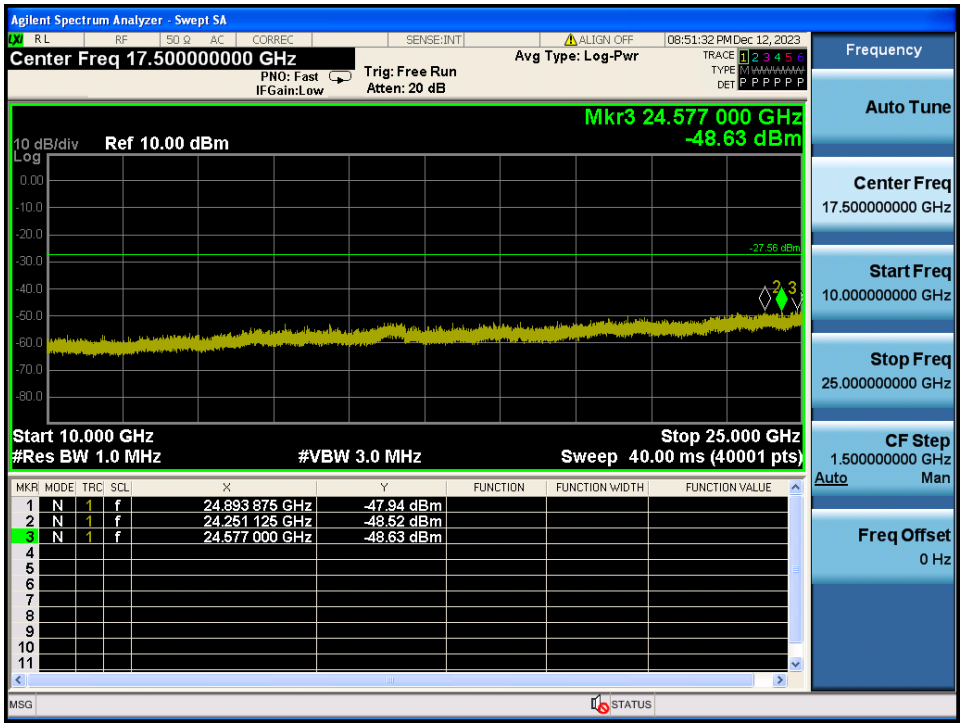


Conducted Spurious Emissions





Conducted Spurious Emissions



5.5. Unwanted Emissions (Radiated)

▣ **Test Requirements and limit,**

Part 15.247(d), Part 15.205, Part 15.209

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of Part 15.247 the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

- Part 15.209: General requirement

Frequency (MHz)	FCC Limit (uV/m)	Measurement Distance (m)
0.009 – 0.490	2 400 / F (kHz)	300
0.490 – 1.705	24 000 / F (kHz)	30
1.705 – 30.0	30	30

Frequency (MHz)	FCC Limit (uV/m)	Measurement Distance (m)
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

- Part 15.205(a): Restricted band of operation

MHz	MHz	MHz	MHz	GHz	GHz
0.009 ~ 0.110	8.414 25 ~ 8.414 75	108 ~ 121.94	1 300 ~ 1 427	4.5 ~ 5.15	14.47 ~ 14.5
0.495 ~ 0.505	12.29 ~ 12.293	123 ~ 138	1 435 ~ 1 626.5	5.35 ~ 5.46	15.35 ~ 16.2
2.173 5 ~ 2.190 5	12.519 75 ~ 12.520 25	149.9 ~ 150.05	1 645.5 ~ 1 646.5	7.25 ~ 7.75	17.7 ~ 21.4
4.125 ~ 4.128	12.576 75 ~ 12.577 25	156.524 75 ~ 156.525 25	1 660 ~ 1 710	8.025 ~ 8.5	22.01 ~ 23.12
4.177 25 ~ 4.177 75	13.36 ~ 13.41	156.7 ~ 156.9	1 718.8 ~ 1 722.2	9.0 ~ 9.2	23.6 ~ 24.0
4.207 25 ~ 4.207 75	16.42 ~ 16.423	162.012 5 ~ 167.17	2 200 ~ 2 300	9.3 ~ 9.5	31.2 ~ 31.8
6.215 ~ 6.218	16.694 75 ~ 16.695 25	167.72 ~ 173.2	2 310 ~ 2 390	10.6 ~ 12.7	36.43 ~ 36.5
6.267 75 ~ 6.268 25	16.804 25 ~ 16.804 75	240 ~ 285	2 483.5 ~ 2 500	13.25 ~ 13.4	Above 38.6
6.311 75 ~ 6.312 25	25.5 ~ 25.67	322 ~ 335.4	2 655 ~ 2 900		
8.291 ~ 8.294	37.5 ~ 38.25	399.90 ~ 410	3 260 ~ 3 267		
8.362 ~ 8.366	73 ~ 74.6	608 ~ 614	3 332 ~ 3 339		
8.376 25 ~ 8.386 75	74.8 ~ 75.2	960 ~ 1 240	3 345.8 ~ 3 358		
			3 600 ~ 4 400		

5.5.1. Test Setup

Refer to the APPENDIX I.

5.5.2. Test Procedures

1. The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.

Note: Measurement Instrument Setting for Radiated Emission Measurements.

- **KDB558074 D01v05r02 - Section 8.6**
- **ANSI C63.10-2013 – Section 11.12**

1. Frequency Range Below 1 GHz

RBW = 100 or 120 kHz, VBW = 3 x RBW, Detector = Peak or Quasi Peak

2. Frequency Range > 1 GHz

Peak Measurement > 1 GHz

RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Sweep time = Auto, Trace mode = Max Hold until the trace stabilizes

Average Measurement > 1 GHz

1. RBW = 1 MHz (unless otherwise specified).
2. VBW ≥ 3 x RBW.
3. Detector = RMS (Number of points ≥ 2 x Span / RBW)
4. Averaging type = power (i.e., RMS).
5. Sweep time = auto.
6. Perform a trace average of at least 100 traces.
7. A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:
   1) If power averaging (RMS) mode was used in step 4, then the applicable correction factor is 10 log(1 / D), where D is the duty cycle.
   2) If linear voltage averaging mode was used in step 4, then the applicable correction factor is 20 log(1 / D), where D is the duty cycle.
   3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

Duty Cycle Correction factor

Test Mode	Date rate	T_{on}(ms)	T_{on+off} (ms)	D = T_{on} / (T_{on+off})	DCCF = 10 log(1/D) (dB)
TM 1	11 Mbps	1.207	1.302	0.927 0	0.33
TM 2	6 Mbps	2.064	2.167	0.952 5	0.21
TM 3	MCS 0	1.920	2.023	0.949 1	0.23

Note1: Where, T= Transmission duration / D= Duty cycle

Note2: Please refer to the appendix II for duty cycle plots.

5.5.3. Test Results

- **Test Notes**

1. The radiated emissions were investigated 9 kHz to 25 GHz. And no other spurious and harmonic emissions were found below listed frequencies.
2. Information of Distance Correction Factor
   For finding emissions, measurements may be performed at a distance closer than that specified in the regulations.
   In this case, the distance factor is applied to the result.
   - Calculation of distance correction factor
   At frequencies below 30 MHz = 40 log(tested distance / specified distance)
   At frequencies at or above 30 MHz = 20 log(tested distance / specified distance)
   When distance factor is “N/A”, the measurements were performed at the specified distance and distance factor is not applied.
3. Sample Calculation.
   Margin = Limit – Result / Result = Reading + TF+ DCCF + DCF / TF = AF + CL + HL + AL – AG
   Where, TF = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain, HL = High pass filter Loss, AL = Attenuator Loss,
   DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor

Radiated Emissions data(9 kHz ~ 25 GHz) : TM 1

Tested Frequency (MHz)	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin(dB)
2 412	2 388.04	V	X	PK	50.68	4.47	N/A	N/A	55.15	74.00	18.85
	2 387.65	V	X	AV	39.73	4.47	N/A	N/A	44.53	54.00	9.47
	4 824.71	V	X	PK	50.44	1.61	N/A	N/A	52.05	74.00	21.95
	4 825.10	V	X	AV	39.64	1.61	N/A	N/A	41.58	54.00	12.42
2 437	4 874.64	V	X	PK	50.49	2.06	N/A	N/A	52.06	74.00	21.94
	4 874.26	V	X	AV	39.88	2.06	0.33	N/A	41.76	54.00	12.24
2 462	2 488.71	V	X	PK	50.33	5.08	N/A	N/A	55.41	74.00	18.59
	2 488.01	V	X	AV	40.24	5.07	0.33	N/A	45.64	54.00	8.36
	4 922.68	V	X	PK	49.59	2.24	N/A	N/A	51.83	74.00	22.17
	4 922.67	V	X	AV	39.12	2.24	0.33	N/A	41.69	54.00	12.31

Radiated Emissions data(9 kHz ~ 25 GHz) : TM 2

Tested Frequency (MHz)	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin(dB)
2 412	2 389.23	V	X	PK	50.02	4.48	N/A	N/A	54.50	74.00	19.50
	2 389.78	V	X	AV	40.16	4.48	0.21	N/A	44.85	54.00	9.15
	4 824.79	V	X	PK	50.47	1.61	N/A	N/A	52.08	74.00	21.92
	4 824.04	V	X	AV	39.60	1.61	0.21	N/A	41.42	54.00	12.58
2 437	4 874.35	V	X	PK	49.78	1.55	N/A	N/A	51.33	74.00	22.67
	4 874.25	V	X	AV	39.85	1.55	0.21	N/A	41.61	54.00	12.39
2 462	2 486.90	V	X	PK	51.29	5.05	N/A	N/A	56.34	74.00	17.66
	2 486.45	V	X	AV	40.06	5.04	0.21	N/A	45.31	54.00	8.69
	4 922.97	V	X	PK	49.99	2.24	N/A	N/A	52.23	74.00	21.77
	4 922.54	V	X	AV	39.13	2.24	0.21	N/A	41.58	54.00	12.42

Radiated Emissions data(9 kHz ~ 25 GHz) : TM 3

Tested Frequency (MHz)	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin(dB)
2 412	2 387.69	V	X	PK	50.15	4.47	N/A	N/A	54.62	74.00	19.38
	2 387.10	V	X	AV	40.14	4.47	0.23	N/A	44.84	54.00	9.16
	4 823.18	V	X	PK	50.67	1.61	N/A	N/A	52.28	74.00	21.72
	4 822.76	V	X	AV	39.66	1.61	0.23	N/A	41.50	54.00	12.50
2 437	4 873.37	V	X	PK	50.48	1.54	N/A	N/A	52.02	74.00	21.98
	4 873.76	V	X	AV	39.87	1.54	0.23	N/A	41.64	54.00	12.36
2 462	2 492.01	V	X	PK	50.75	5.15	N/A	N/A	55.90	74.00	18.10
	2 491.34	V	X	AV	40.47	5.14	0.23	N/A	45.84	54.00	8.16
	4 923.75	V	X	PK	50.25	2.25	N/A	N/A	52.50	74.00	21.50
	4 923.37	V	X	AV	38.93	2.25	0.23	N/A	41.41	54.00	12.59

5.6. AC Power-Line Conducted Emissions

▣ **Test Requirements and limit, Part 15.207**

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 uH/50 ohm line impedance stabilization network (LISN).

Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequency ranges.

Frequency Range (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 ~ 0.5	66 to 56 *	56 to 46 *
0.5 ~ 5.0	56	46
5 ~ 30	60	50

* Decreases with the logarithm of the frequency

5.6.1. Test Setup

NA

5.6.2. Test Procedures

Conducted emissions from the EUT were measured according to the ANSI C63.10-2013.

1. The test procedure is performed in a 6.5 m × 3.5 m × 3.5 m (L × W × H) shielded room. The EUT along with its peripherals were placed on a 1.0 m (W) × 1.5 m (L) and 0.8 m in height wooden table and the EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane.
2. The EUT was connected to power mains through a line impedance stabilization network (LISN) which provides 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room.
3. All peripherals were connected to the second LISN and the chassis ground also bounded to the horizontal ground plane of shielded room.
4. The excess power cable between the EUT and the LISN was bundled. The power cables of peripherals were unbundled. All connecting cables of EUT and peripherals were moved to find the maximum emission.

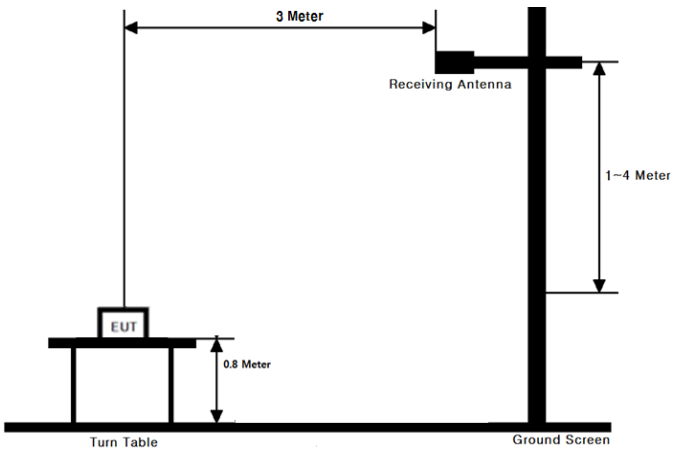
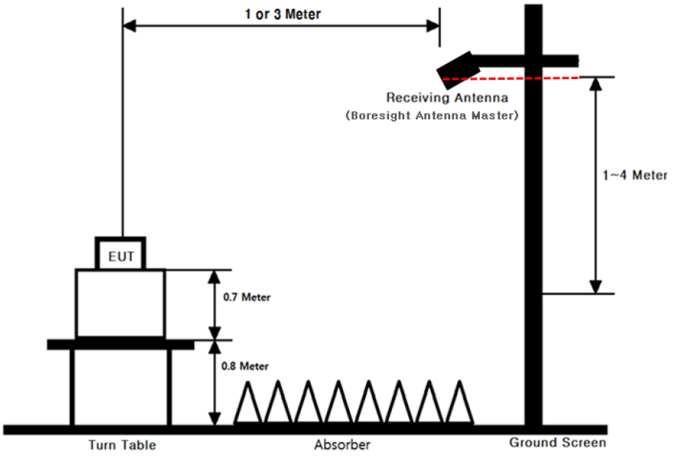
5.6.3. Test Results

NA

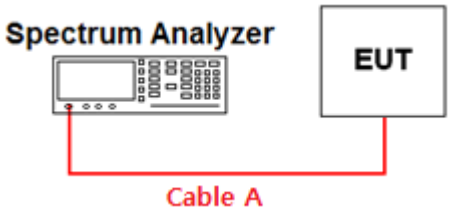
APPENDIX I

Test set up diagrams

- **Radiated Measurement**

Below 1 GHz	Above 1 GHz
	

- **Conducted Measurement**



APPENDIX II

Duty cycle plots

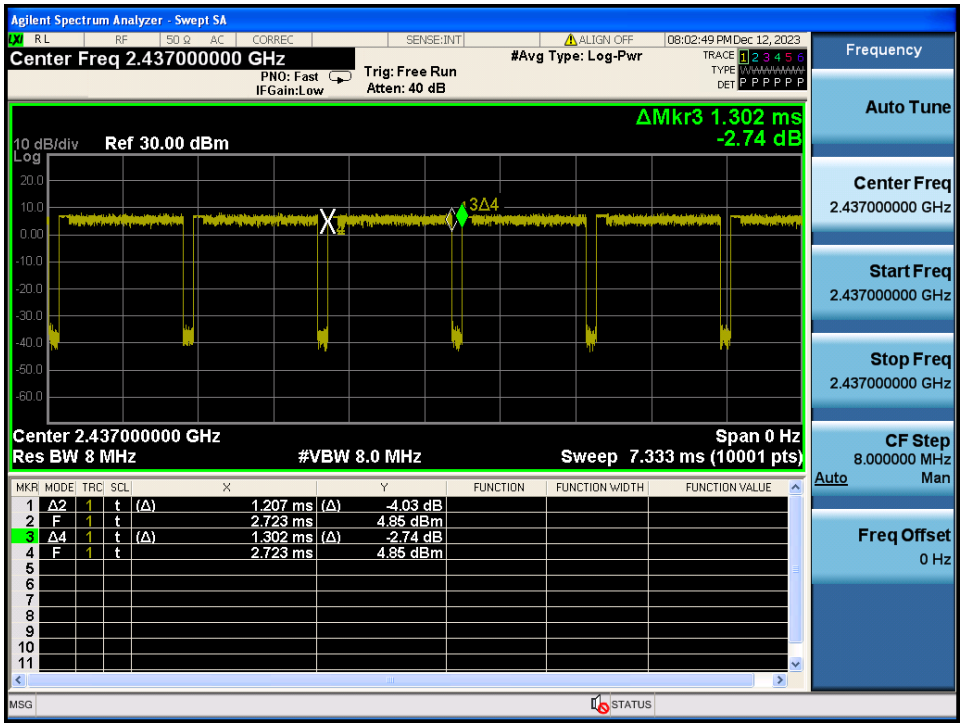
- **Test Procedures**

- KDB558074 D01v05r02 – Section 6

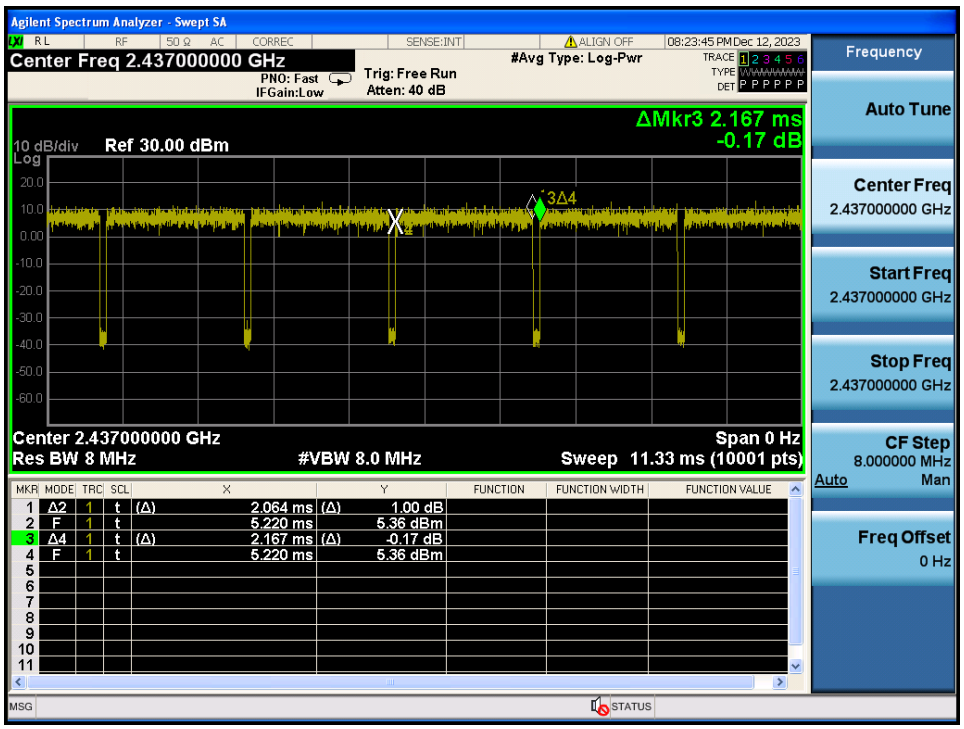
The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average.

The zero-span measurement method shall not be used unless both RBW and VBW are > 50 /T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

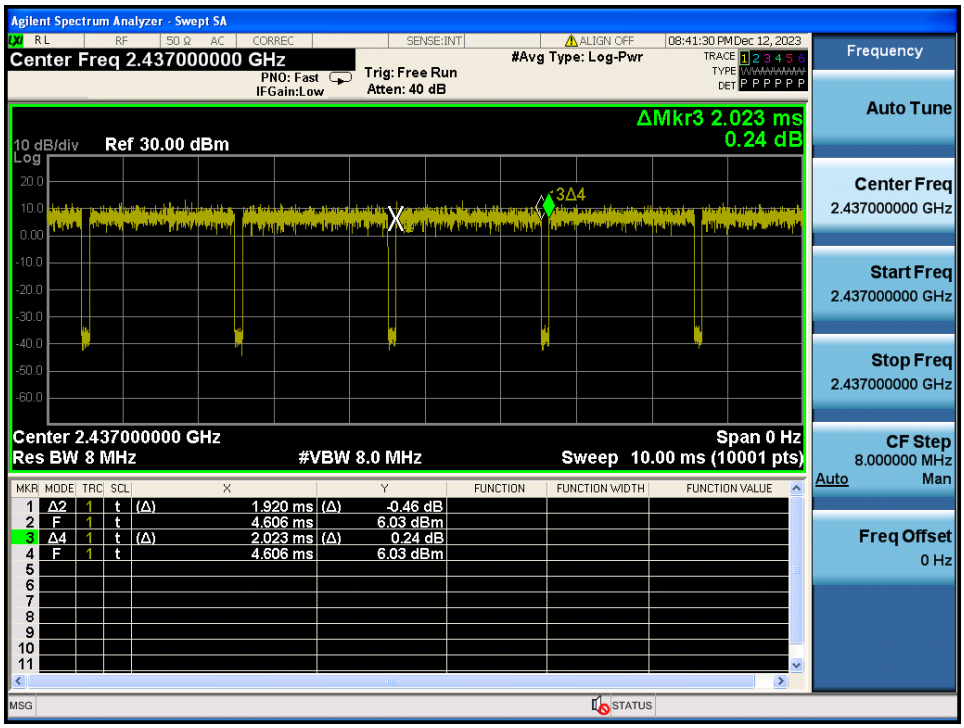
Duty Cycle TM 1 & 2 437 MHz



Duty Cycle TM 2 & 2 437 MHz



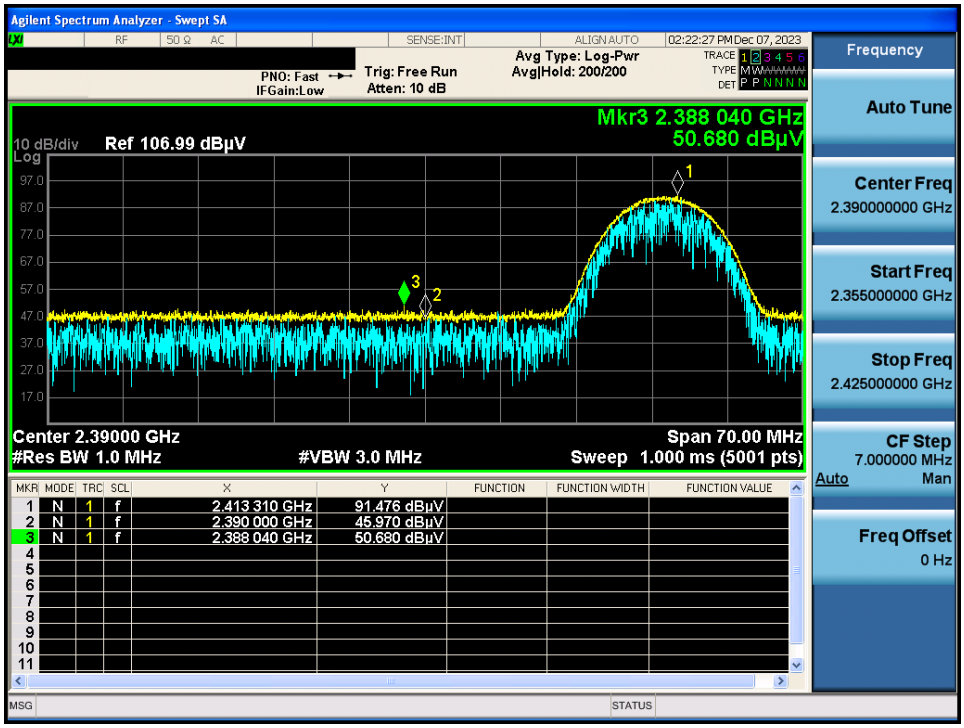
Duty Cycle TM 3 & 2 437 MHz



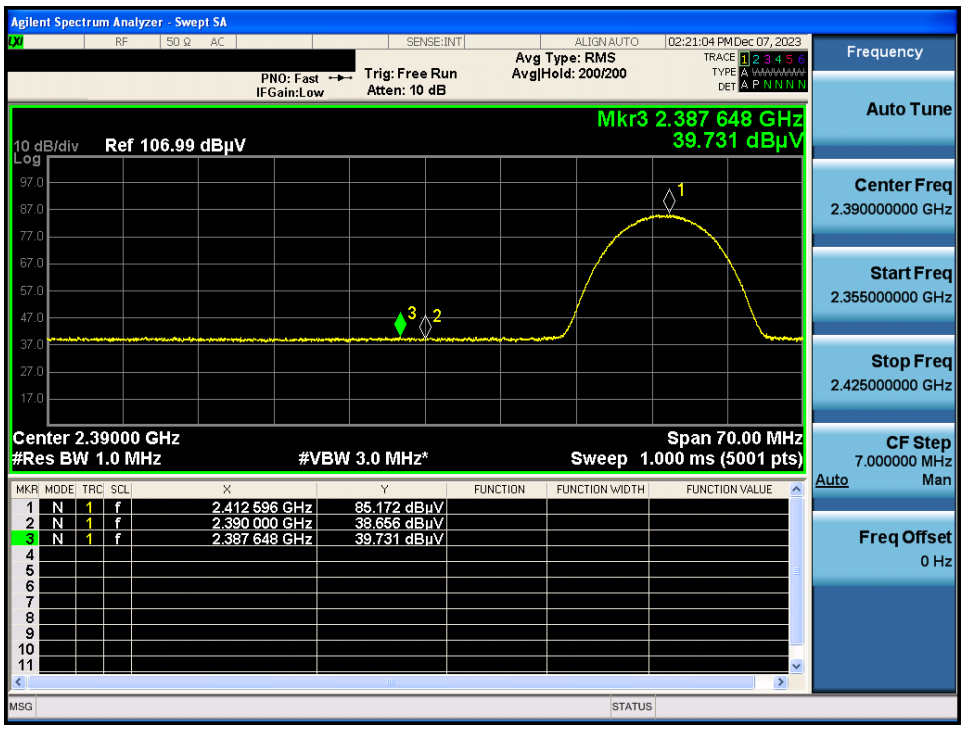
APPENDIX III

Unwanted Emissions (Radiated) Test Plot

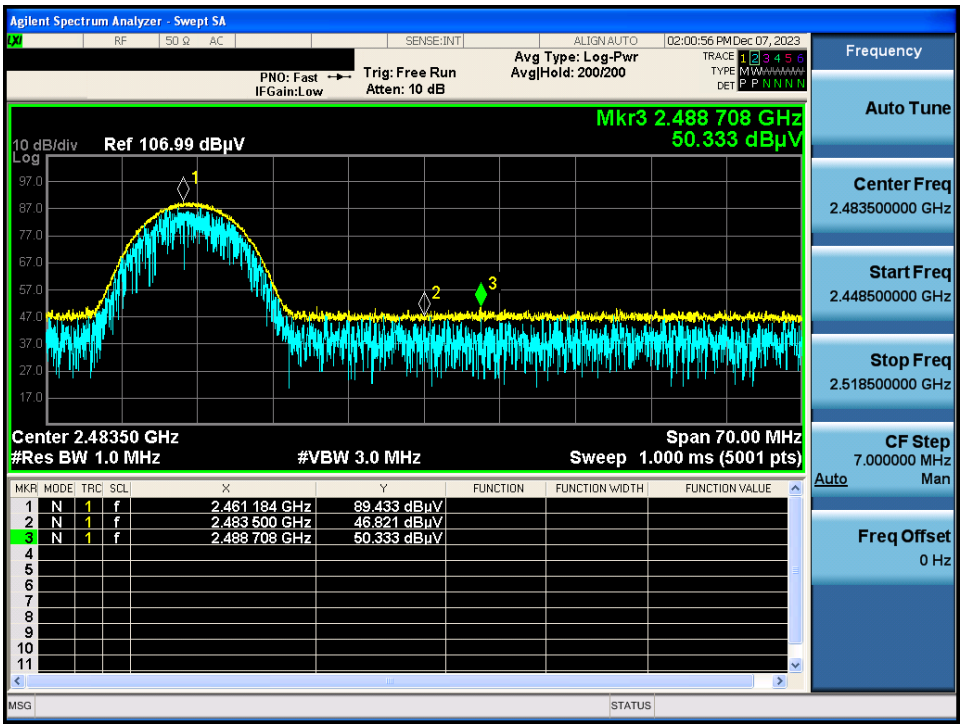
TM 1 & 2 412 & X axis & Ver **Detector Mode : PK**



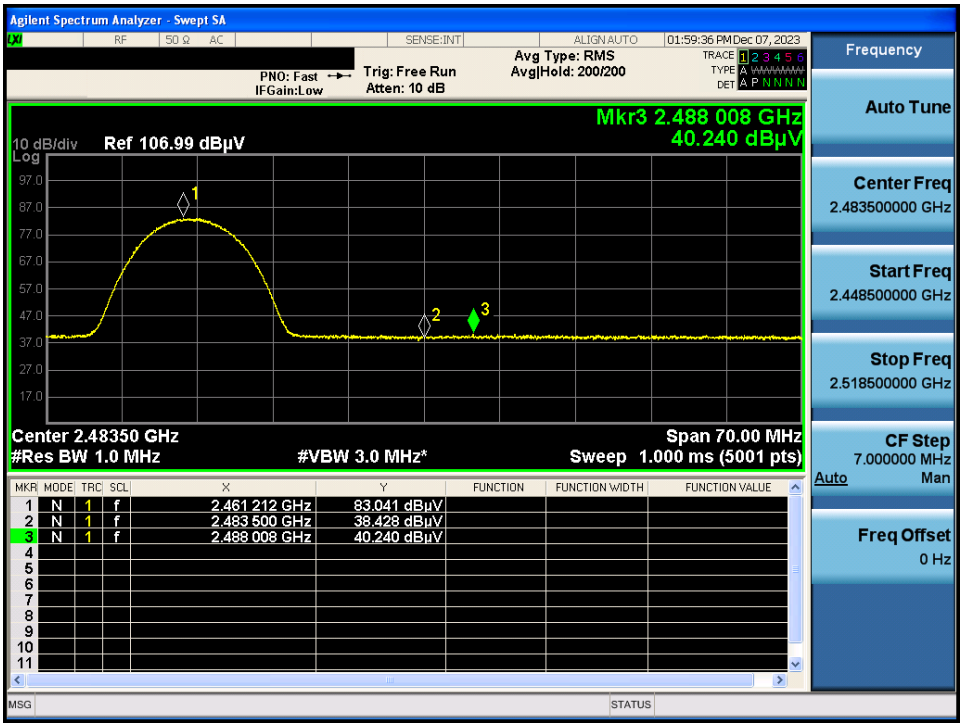
TM 1 & 2 412 & X axis & Ver **Detector Mode : AV**



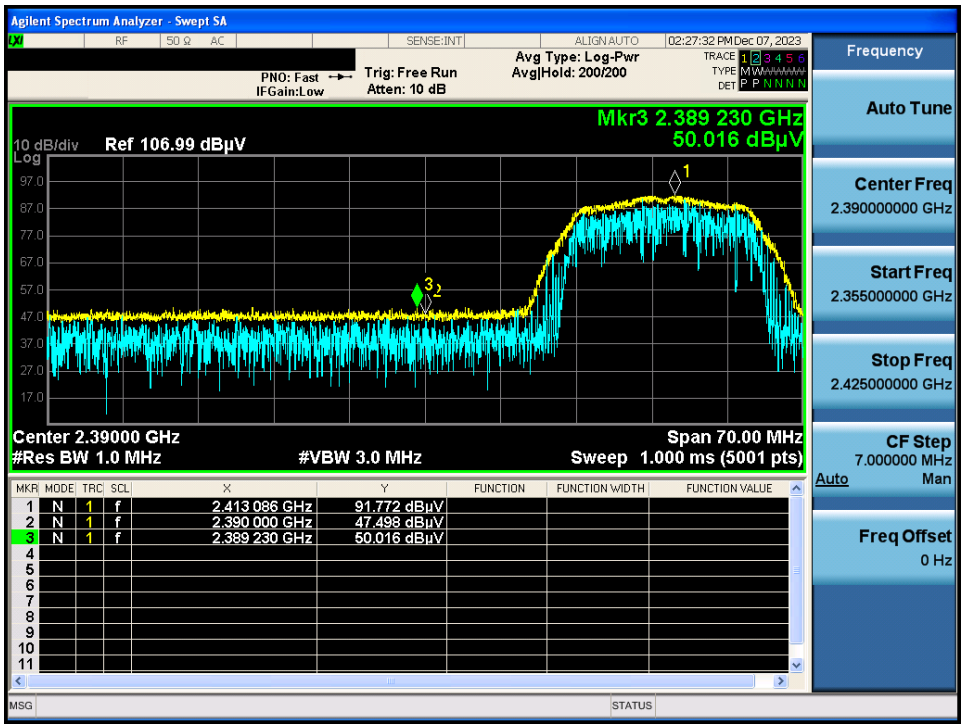
TM 1 & 2 462 & X axis & Ver **Detector Mode : PK**



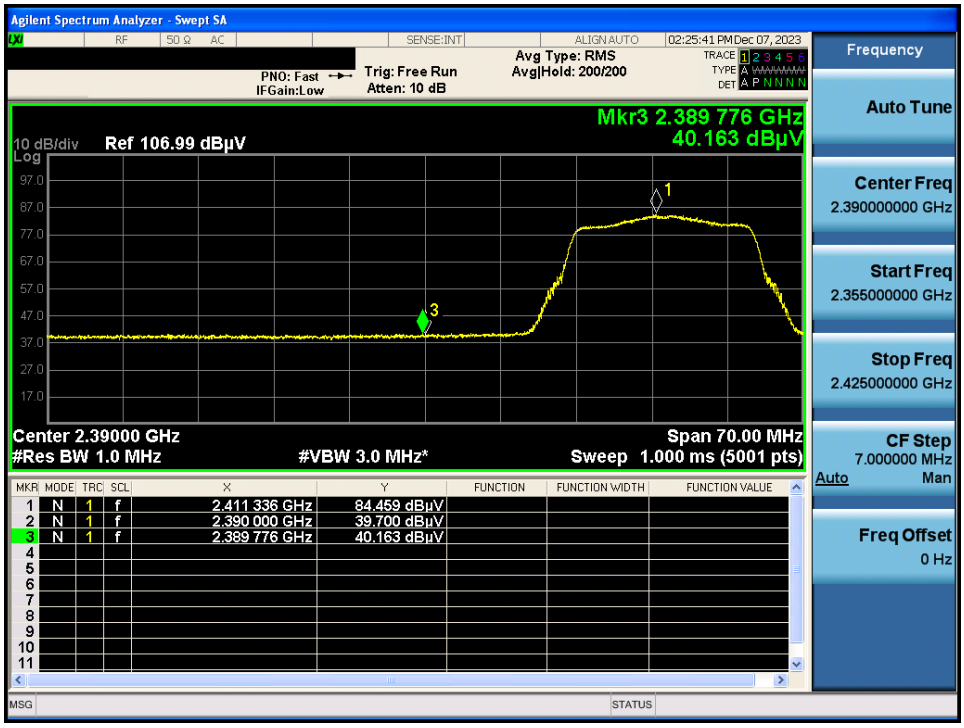
TM 1 & 2 462 & X axis & Ver **Detector Mode : AV**



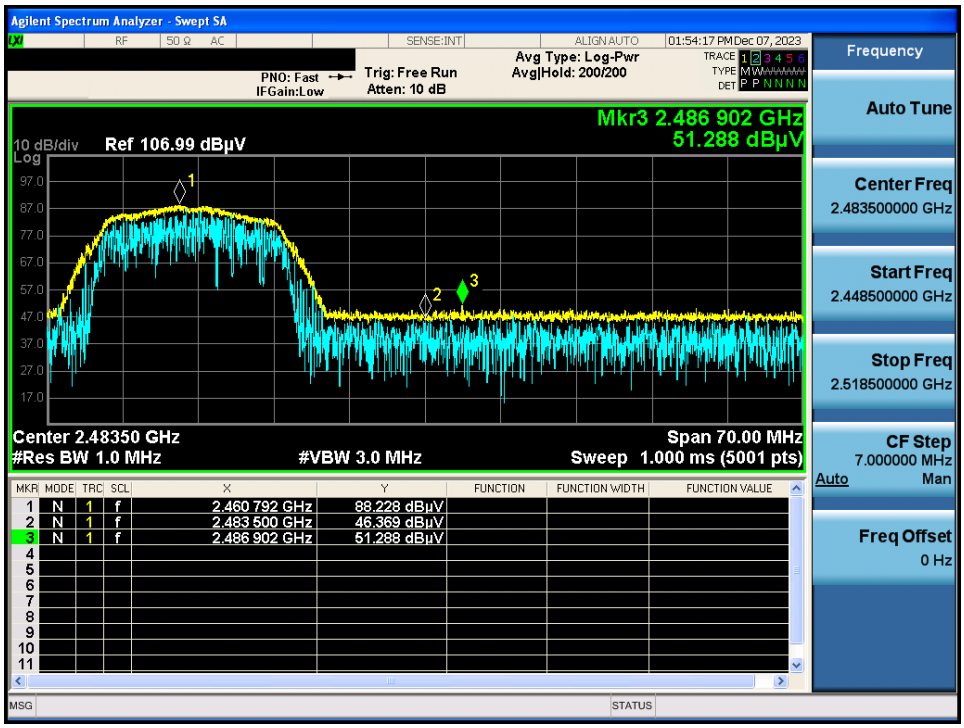
TM 2 & 2 412 & X axis & Ver **Detector Mode : PK**



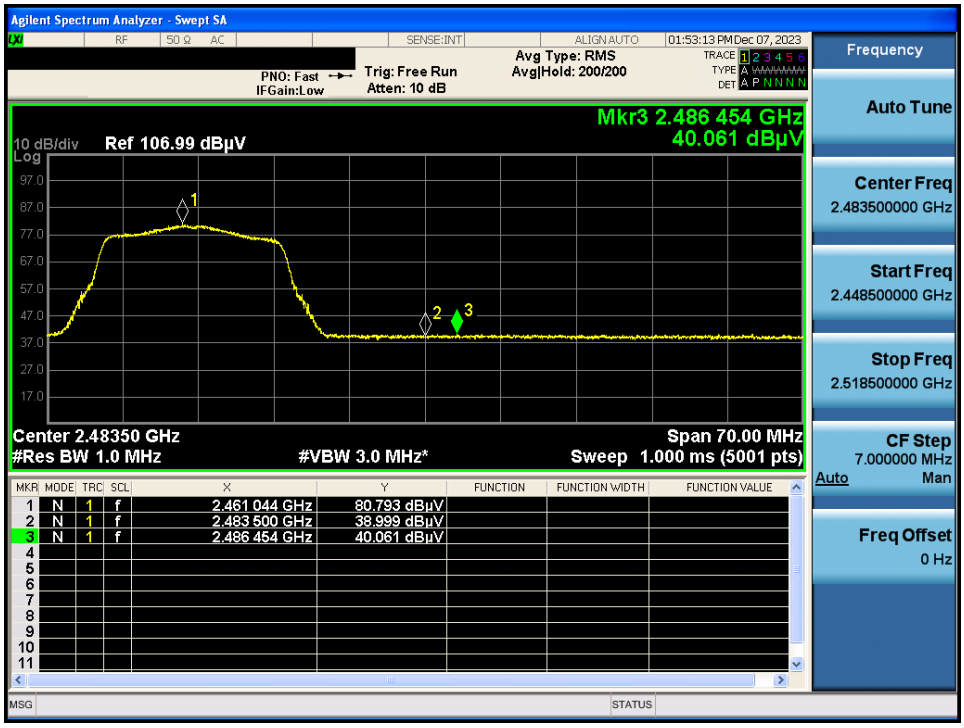
TM 2 & 2 412 & X axis & Ver **Detector Mode : AV**



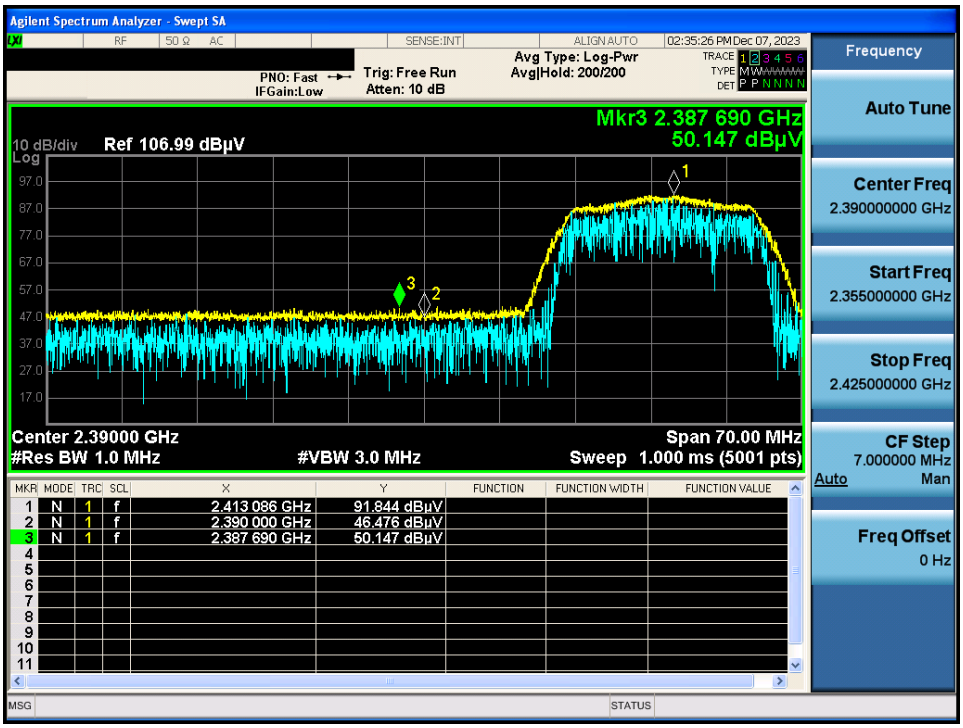
TM 2 & 2 462 & X axis & Ver **Detector Mode : PK**



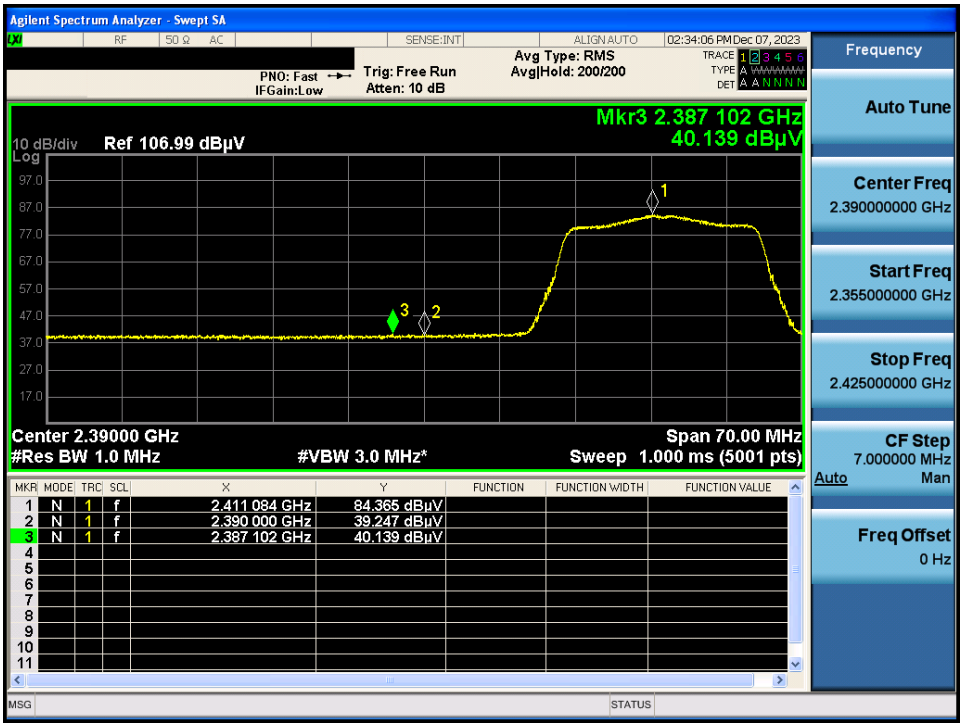
TM 2 & 2 462 & X axis & Ver **Detector Mode : AV**



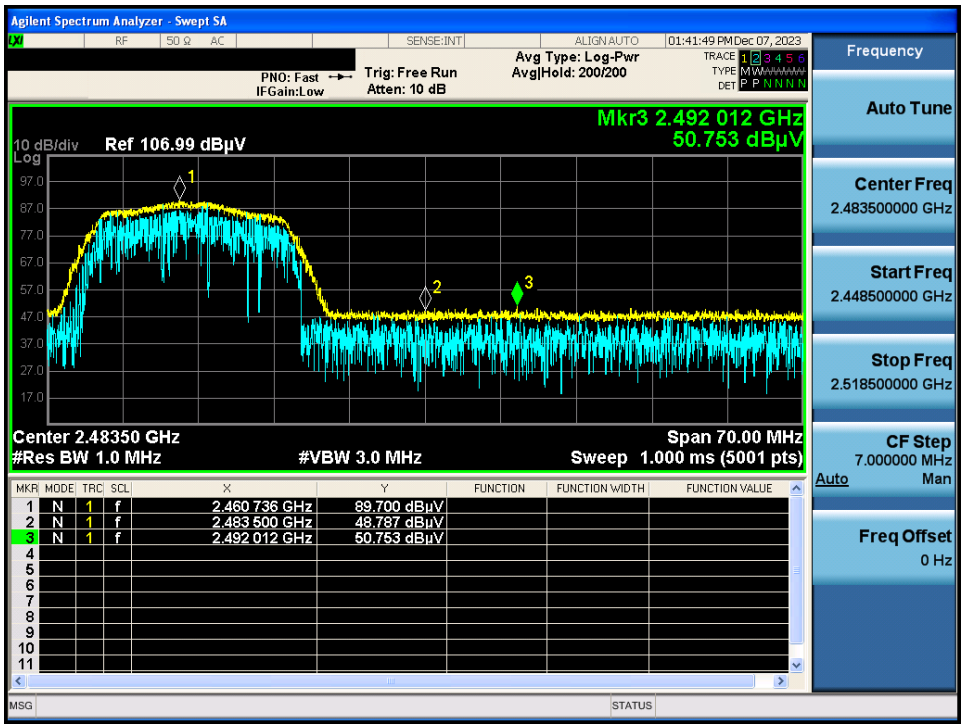
TM 3 & 2 412 & X axis & Ver **Detector Mode : PK**



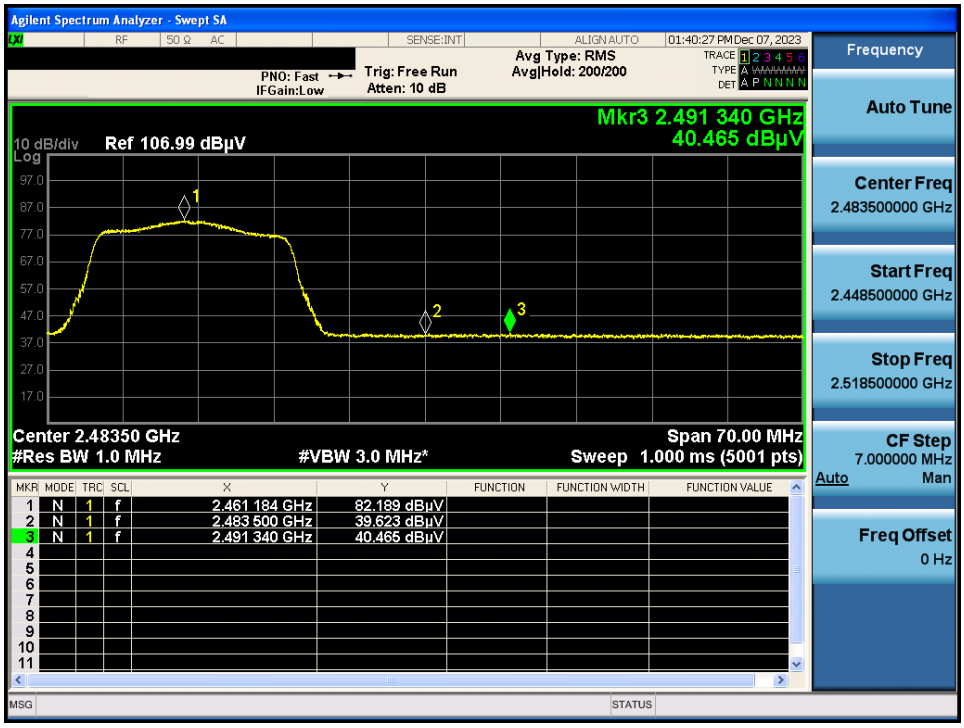
TM 3 & 2 412 & X axis & Ver **Detector Mode : AV**



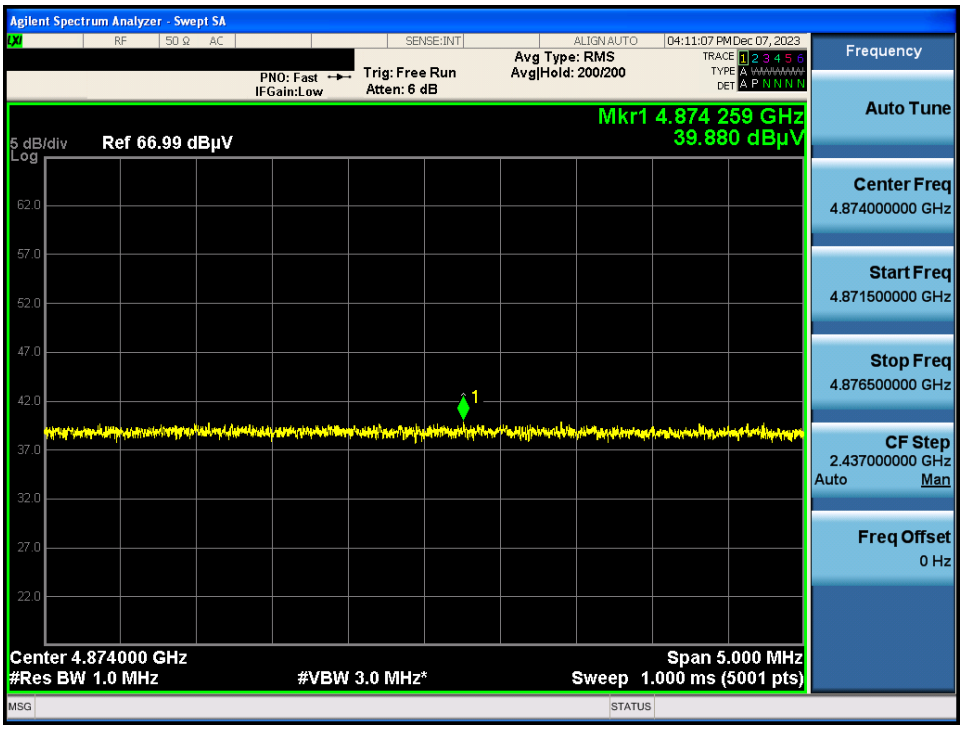
TM 3 & 2 462 & X axis & Ver **Detector Mode : PK**



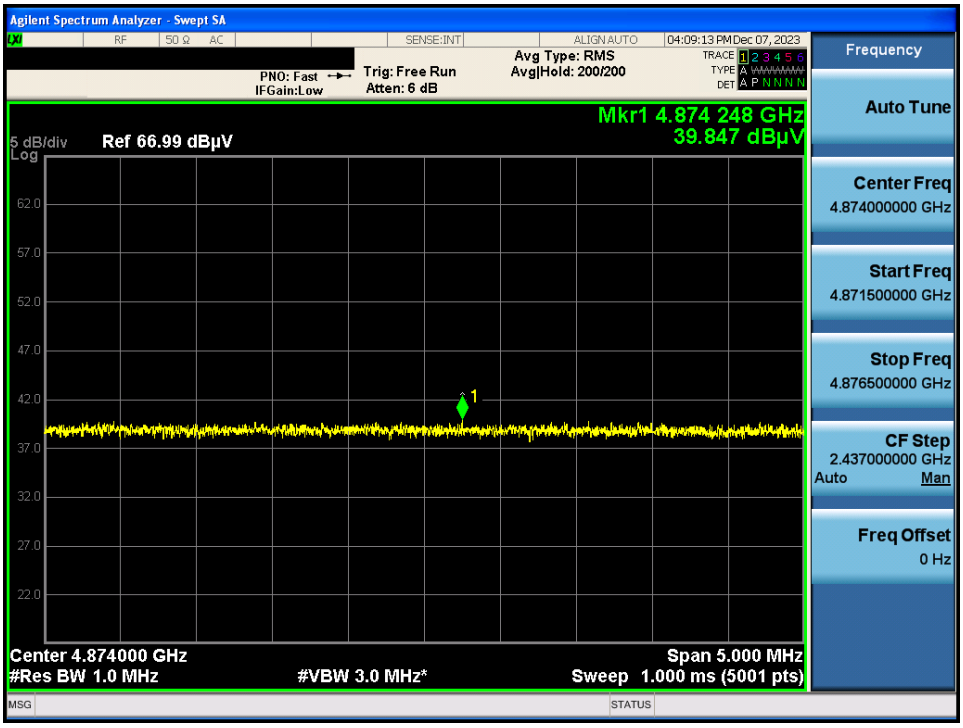
TM 3 & 2 462 & X axis & Ver **Detector Mode : AV**



TM 1 & 2 437 & X axis & Ver **Detector Mode : AV**



TM 2 & 2 437 & X axis & Ver **Detector Mode : AV**



TM 3 & 2 437 & X axis & Ver **Detector Mode : AV**