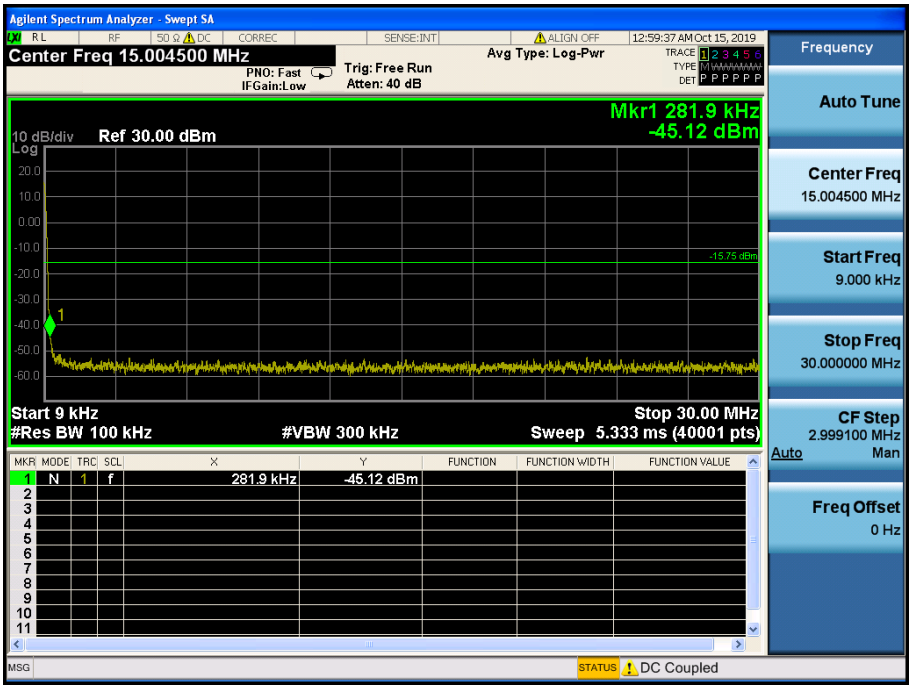
TM 2 & ANT 2 & 2437

Reference

Conducted Spurious Emissions



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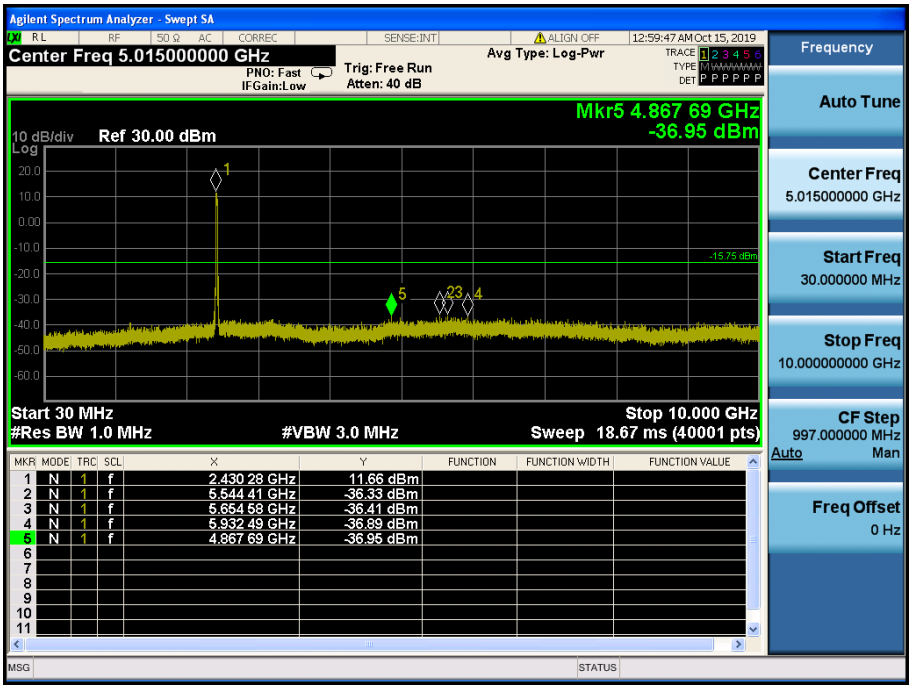
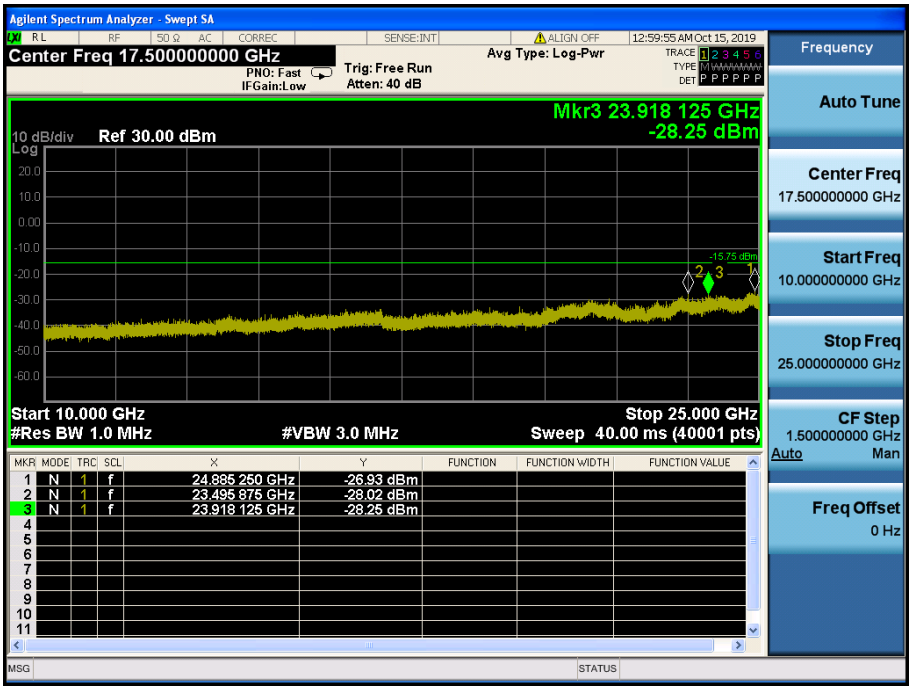
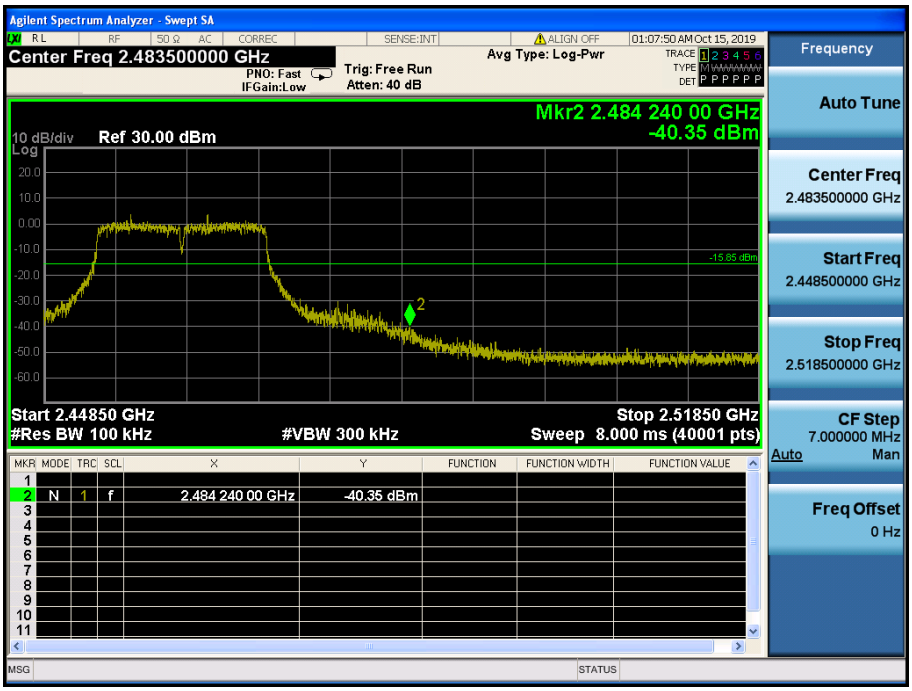




TM 2 & ANT 2 & 2462

Reference

High Band-edge



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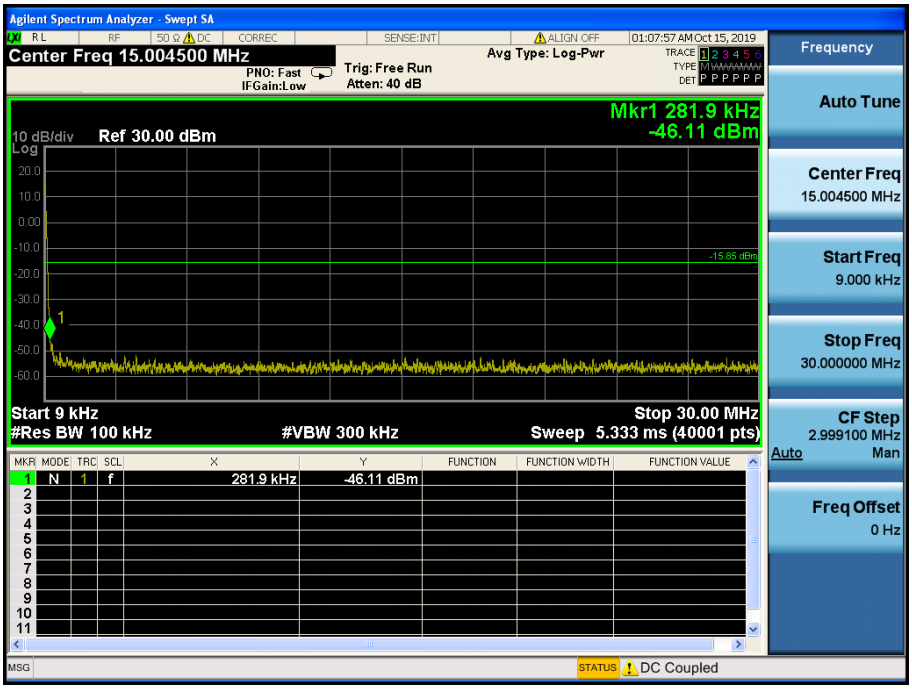

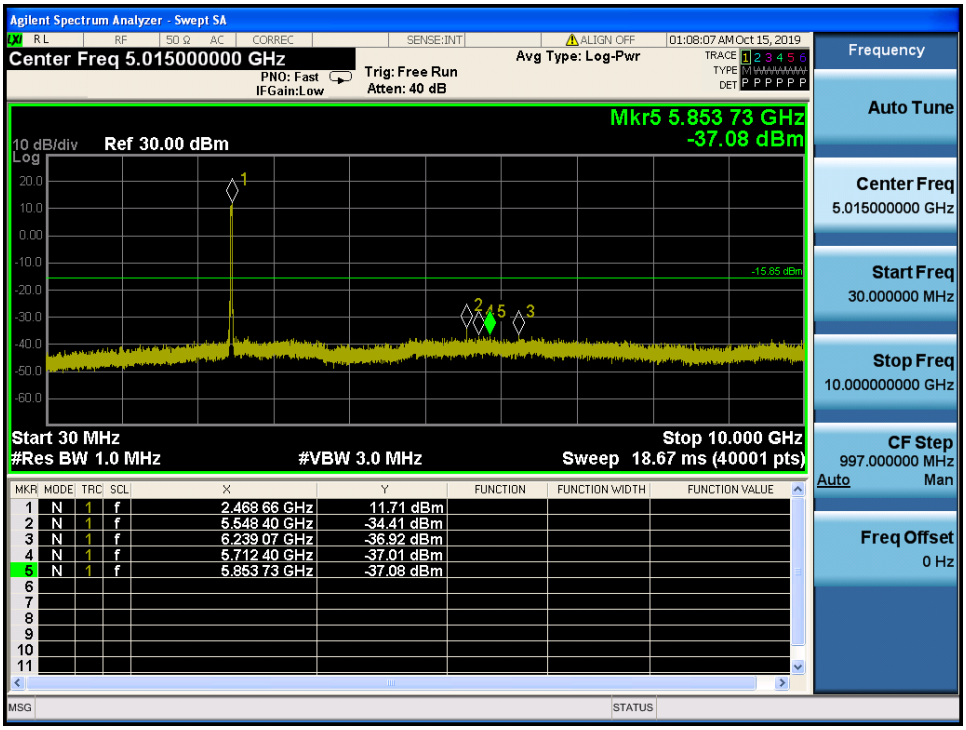

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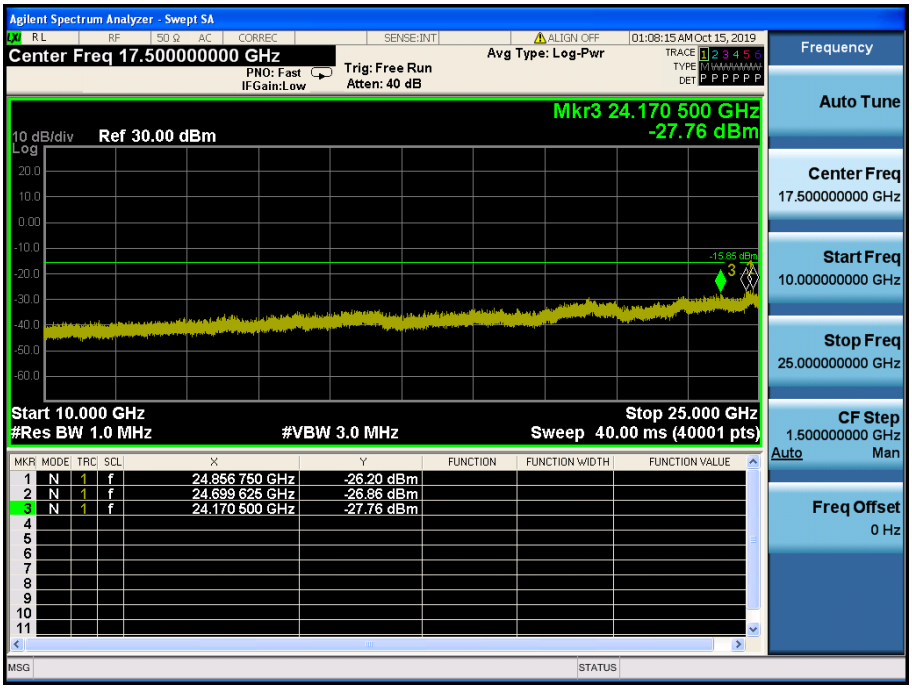
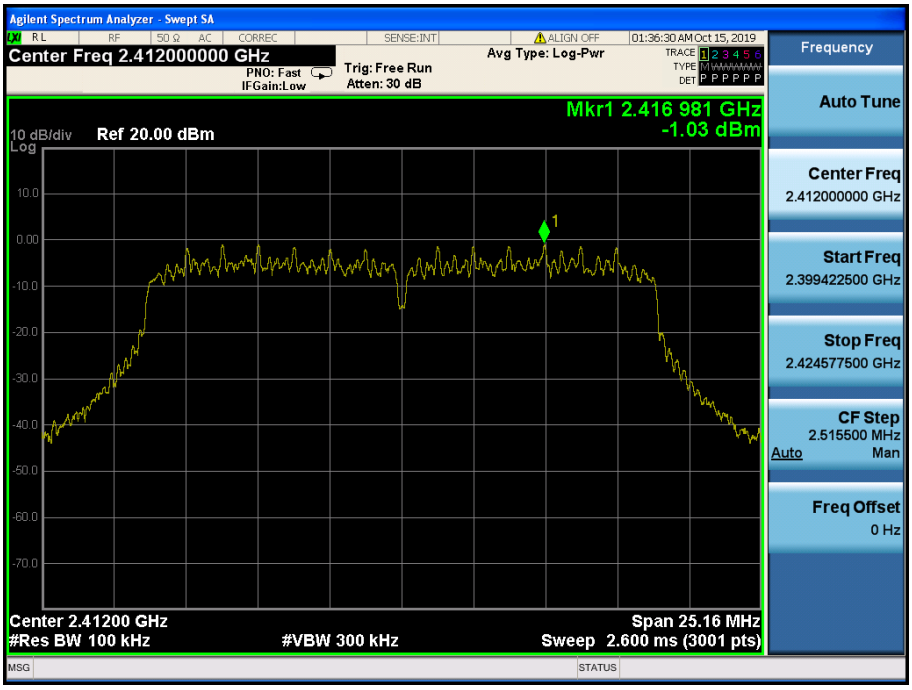
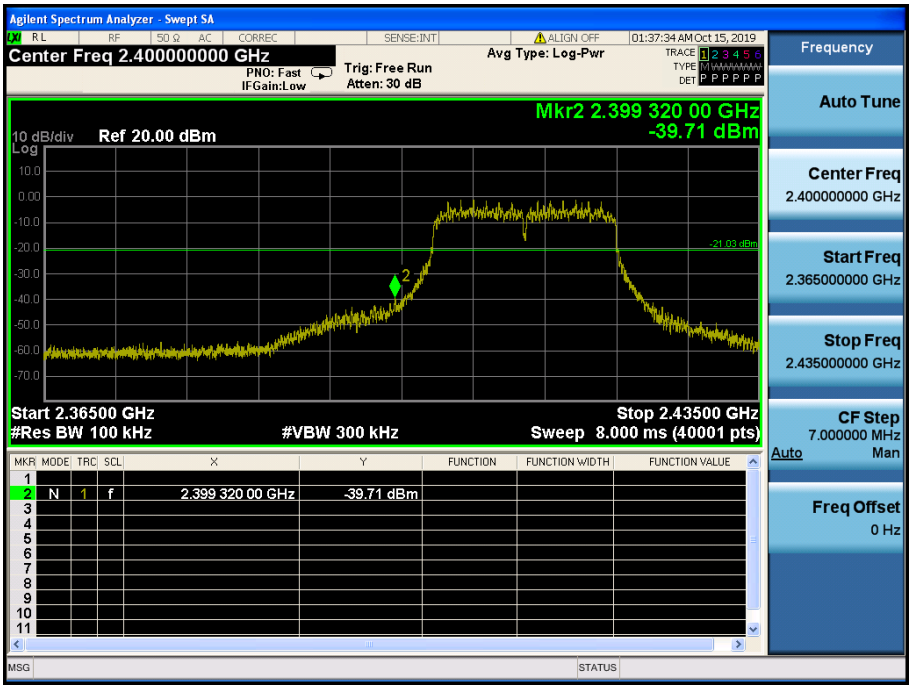


TM 3 & ANT 2 & 2412

Reference



Low Band-edge



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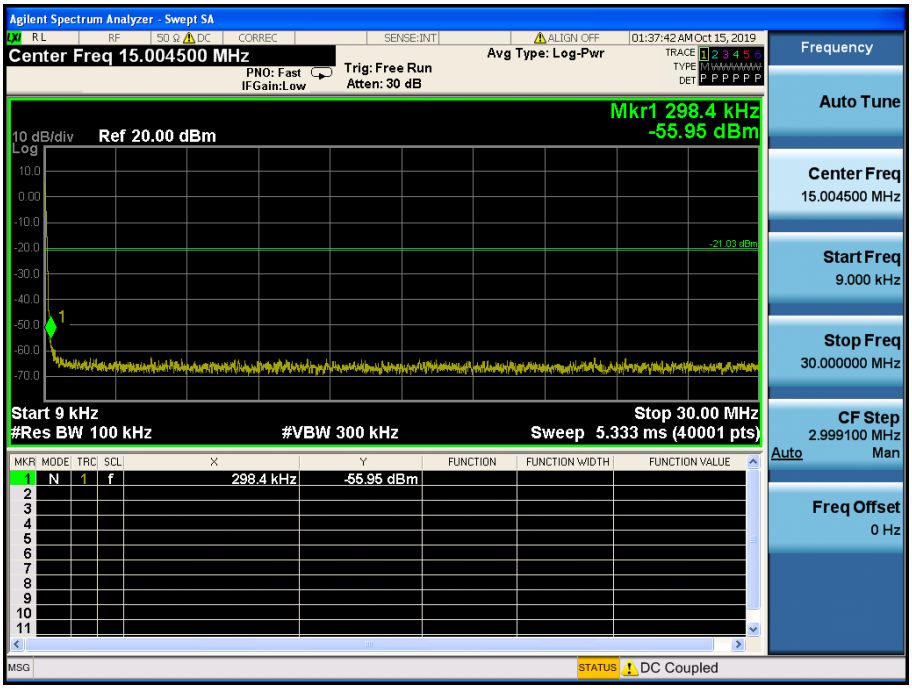

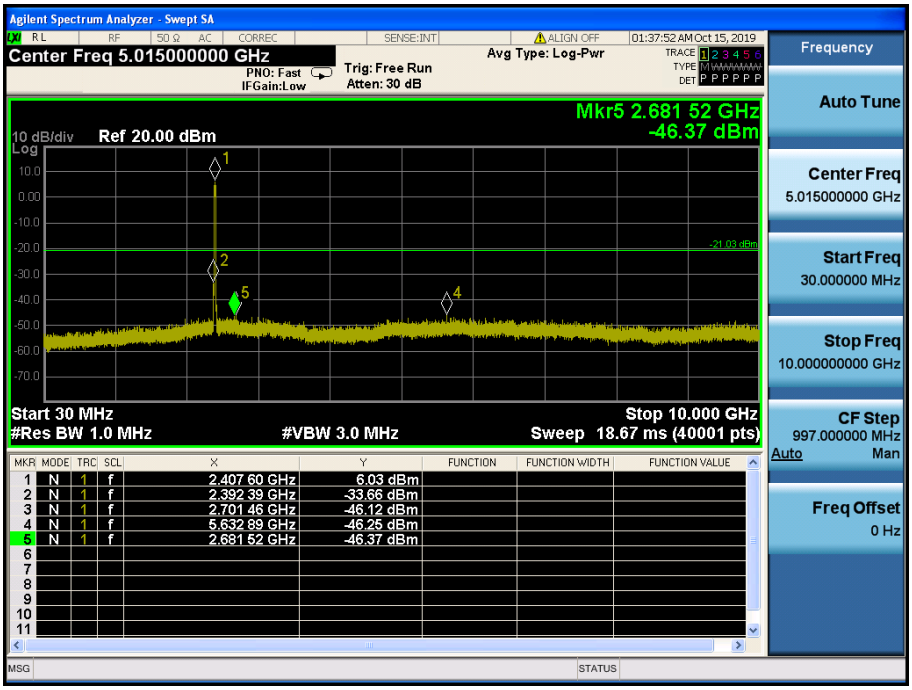

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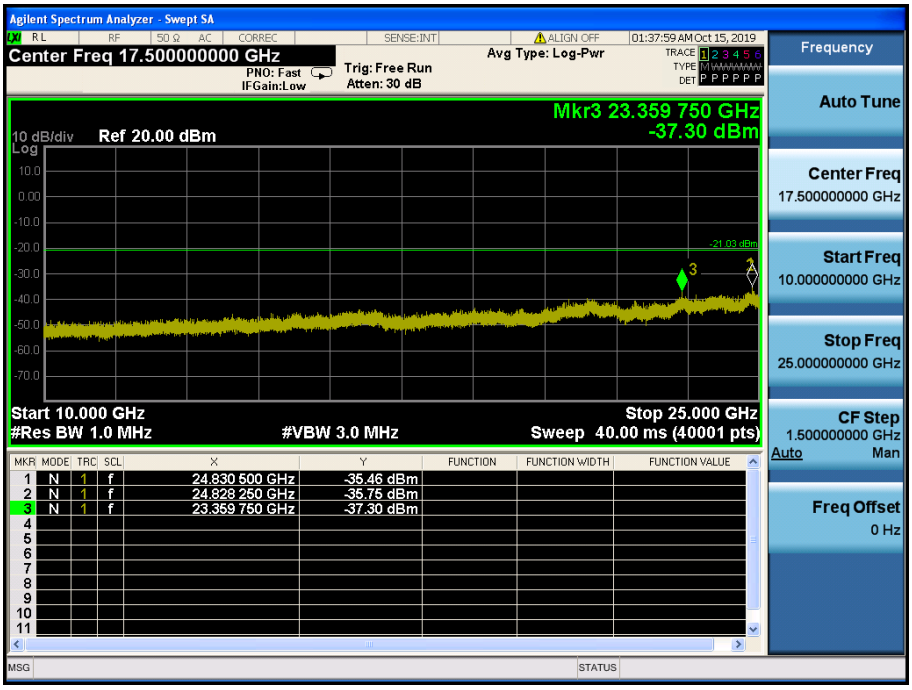
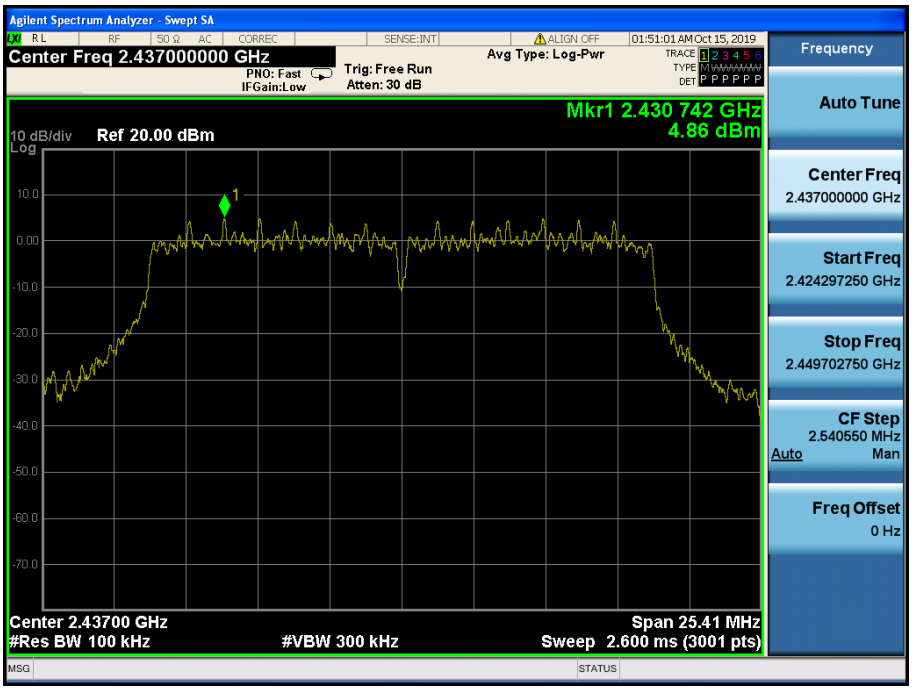


TM 3 & ANT 2 & 2437

Reference



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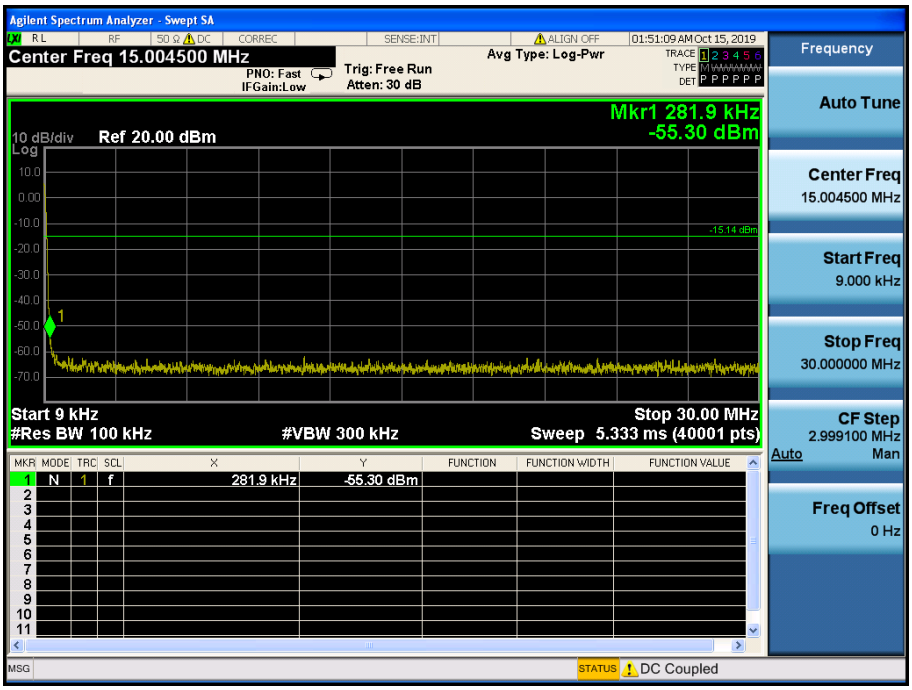

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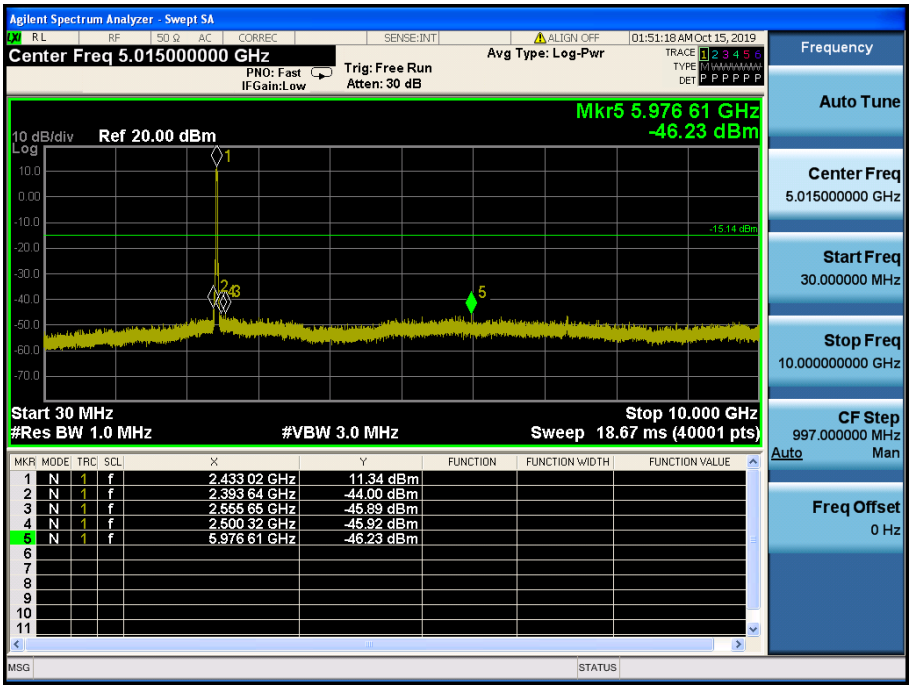
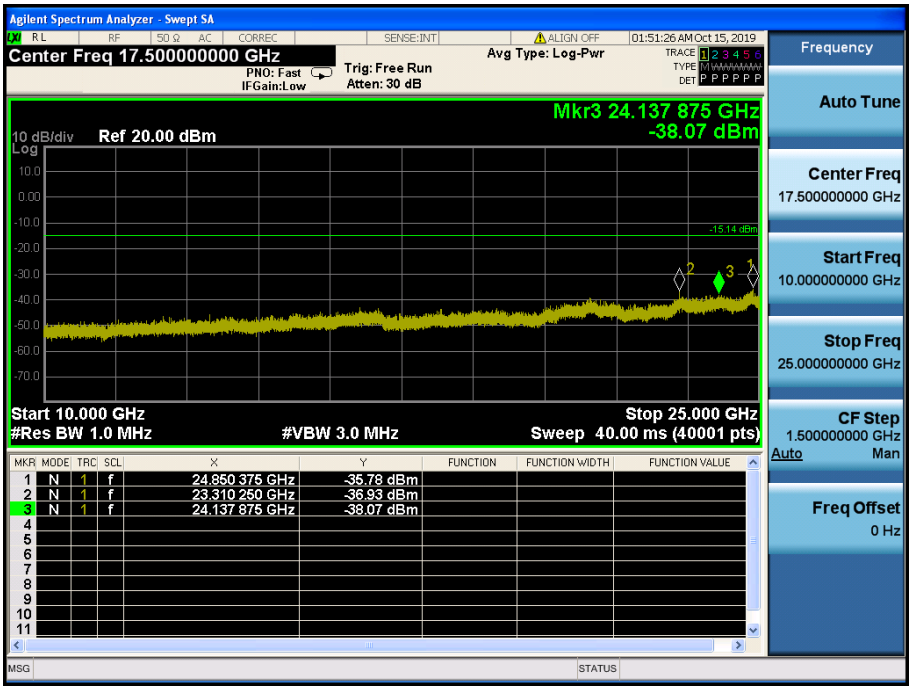
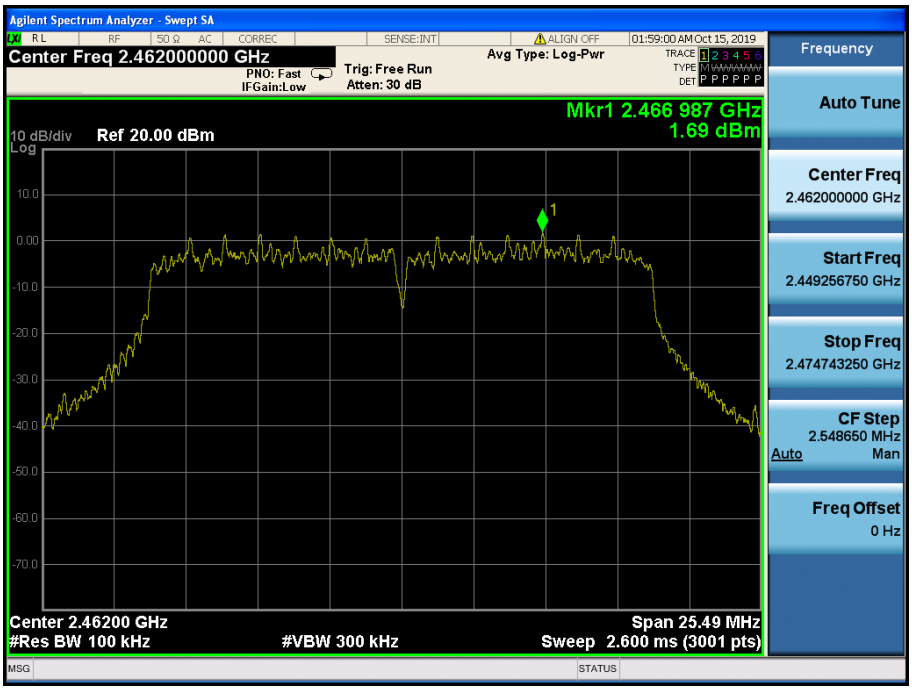


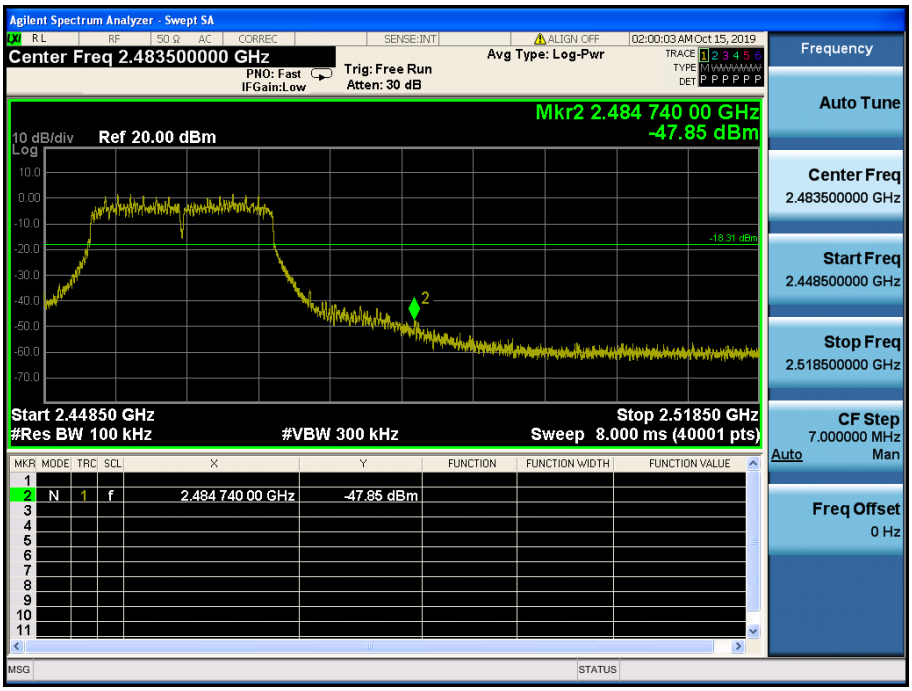


TM 3 & ANT 2 & 2462

Reference



High Band-edge



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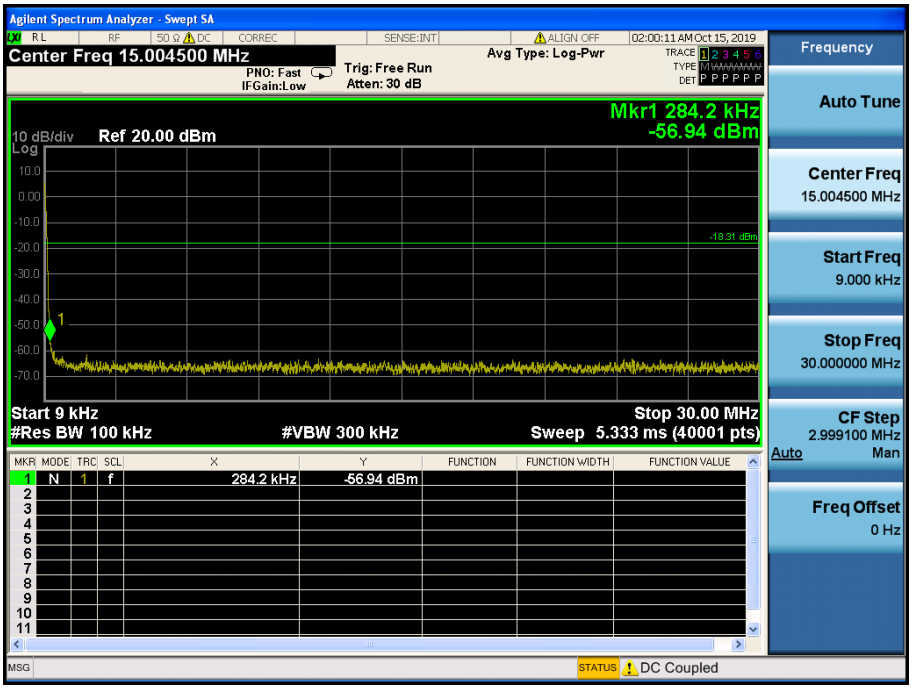

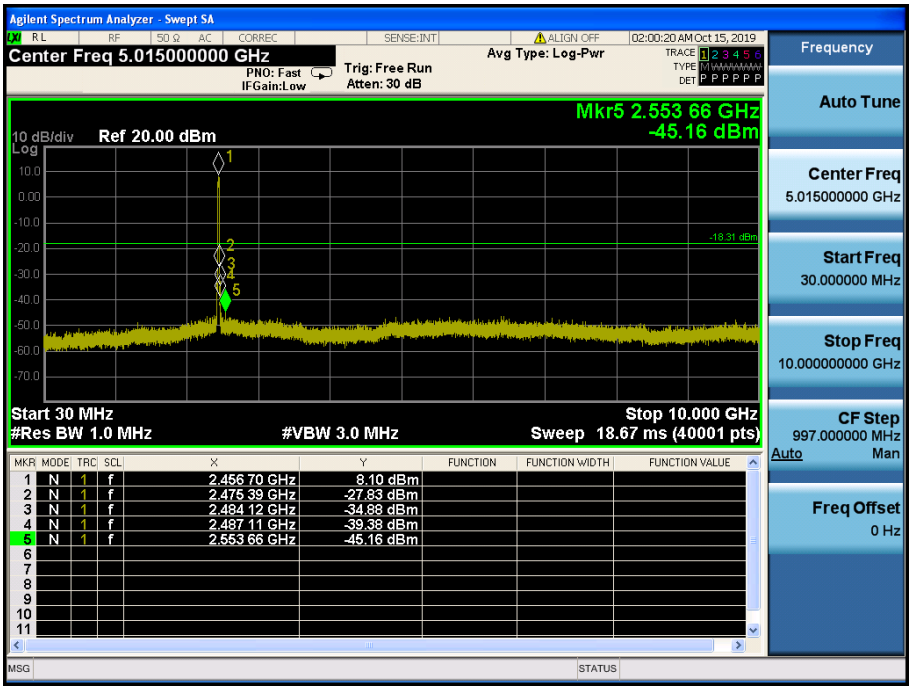

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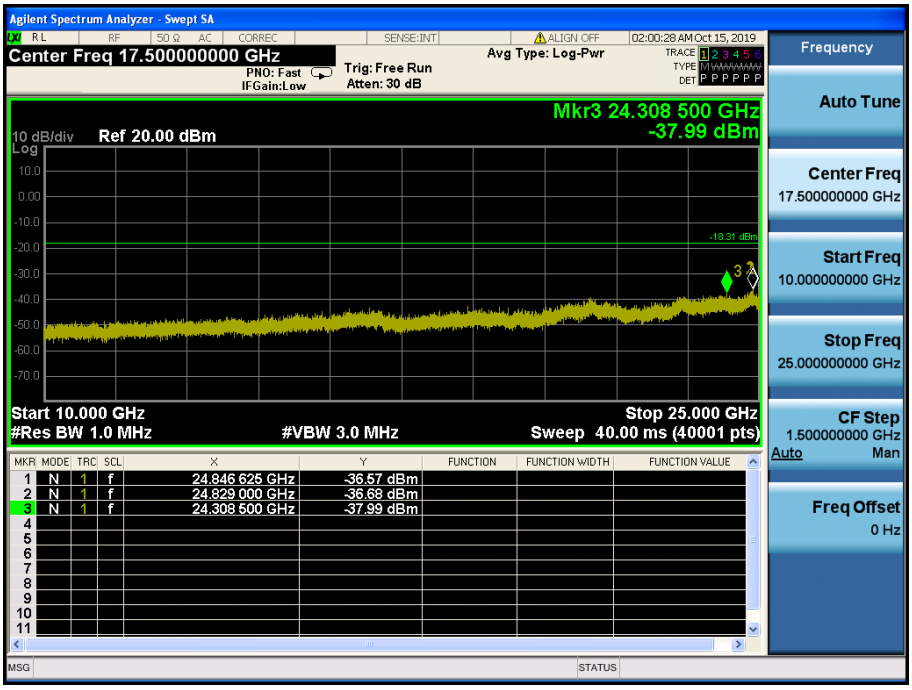

TM 4 & ANT 2 & 2422

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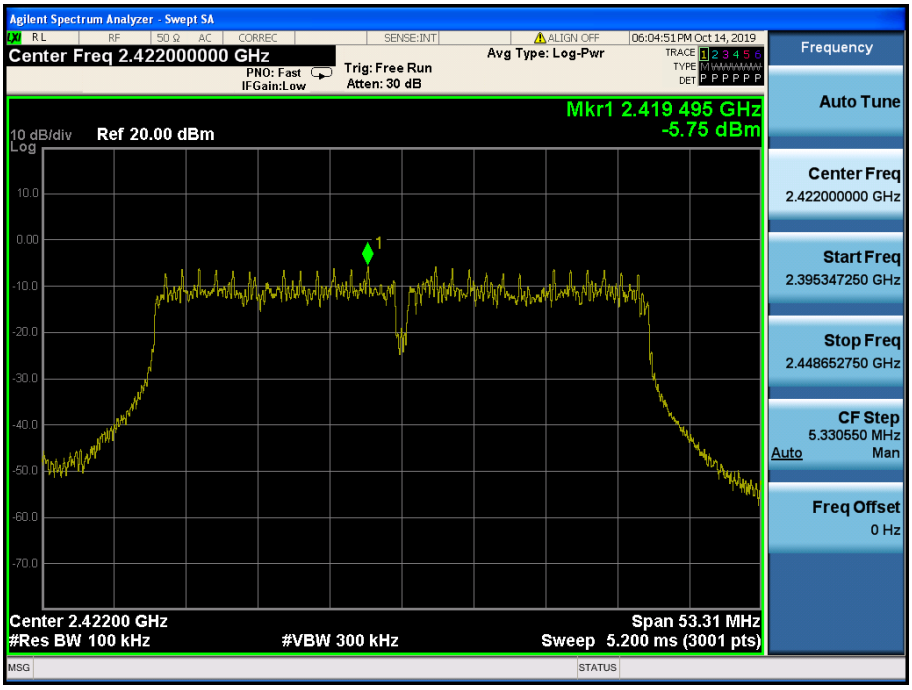
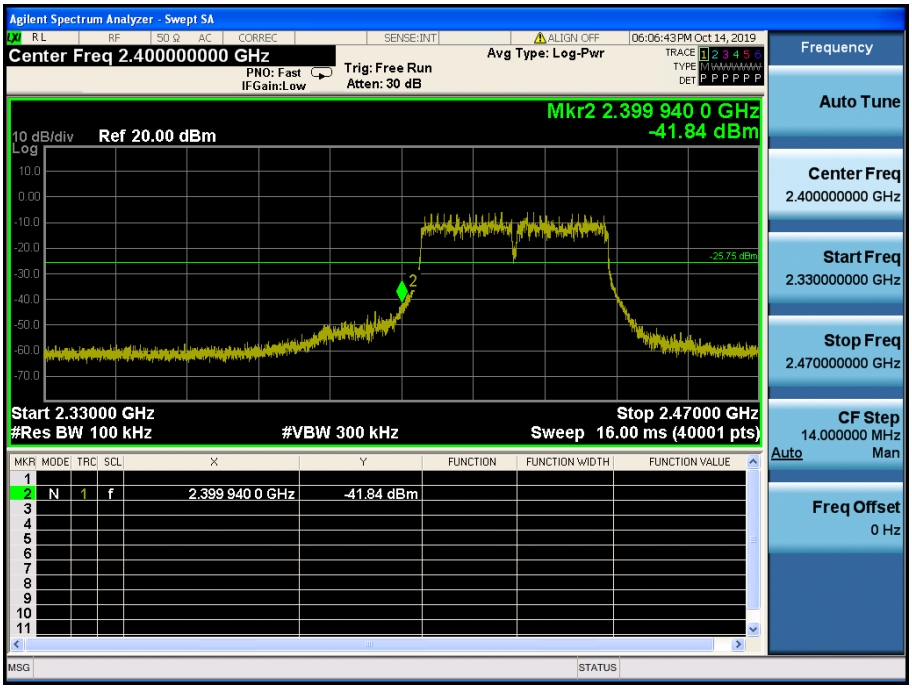


Low Band-edge



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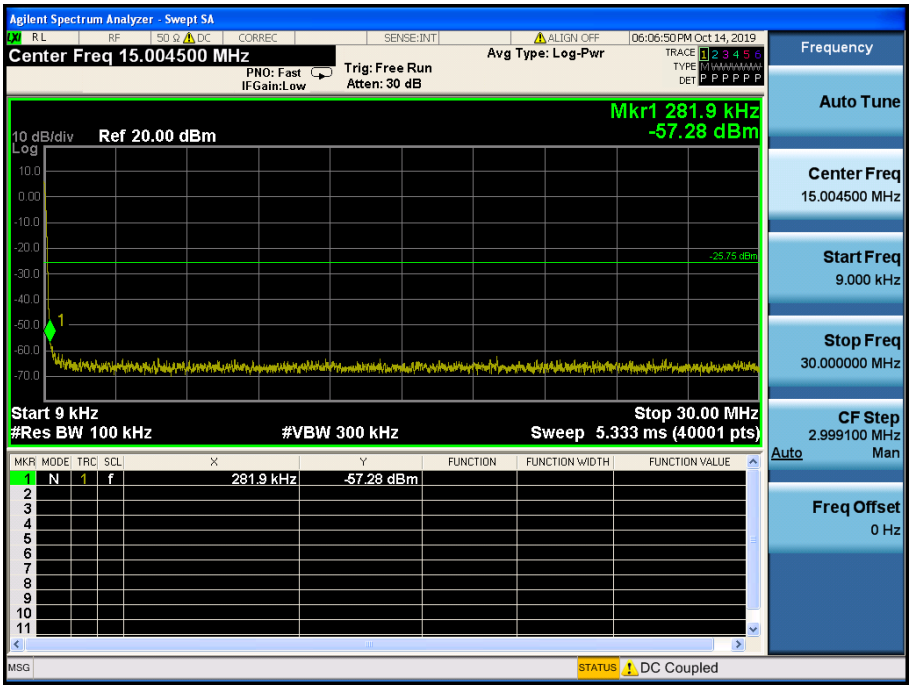

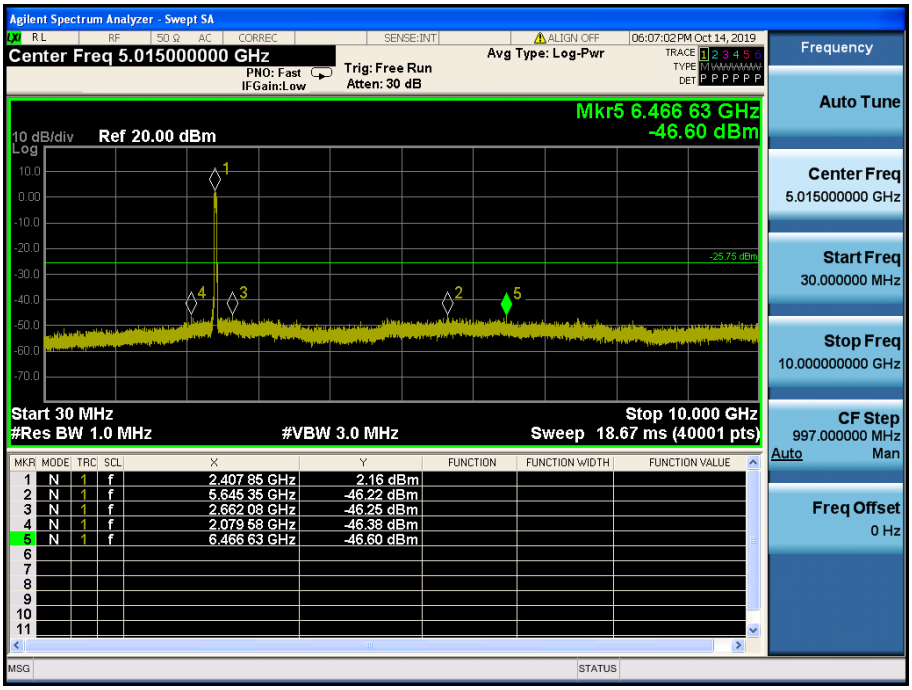

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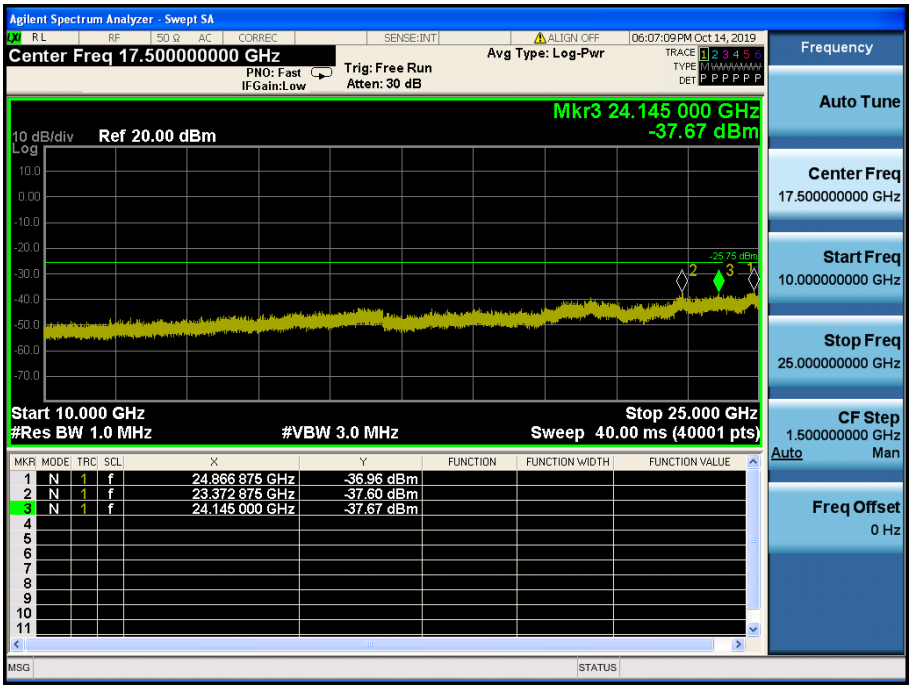
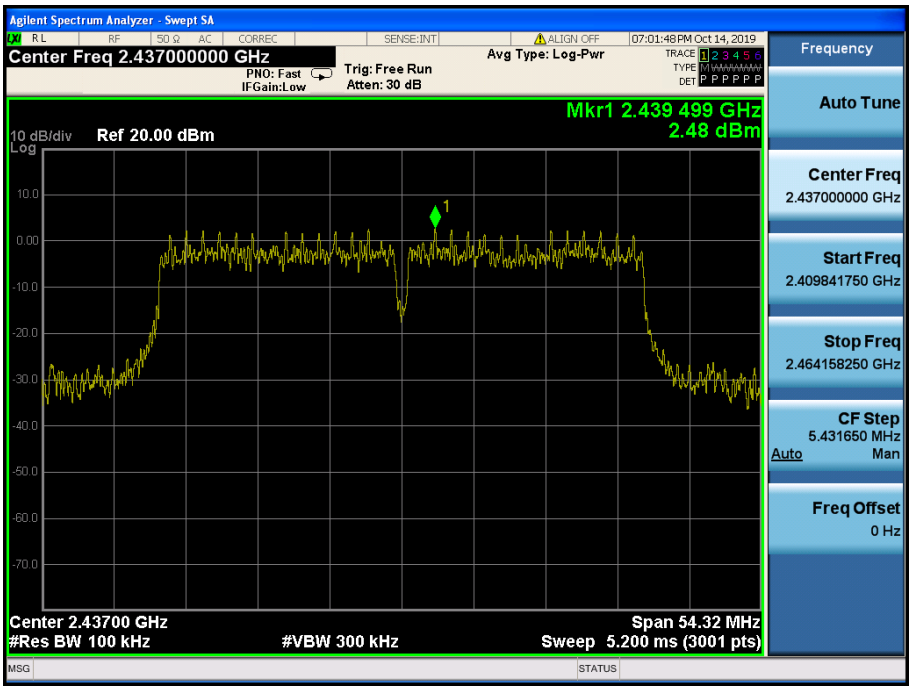


TM 4 & ANT 2 & 2437

Reference



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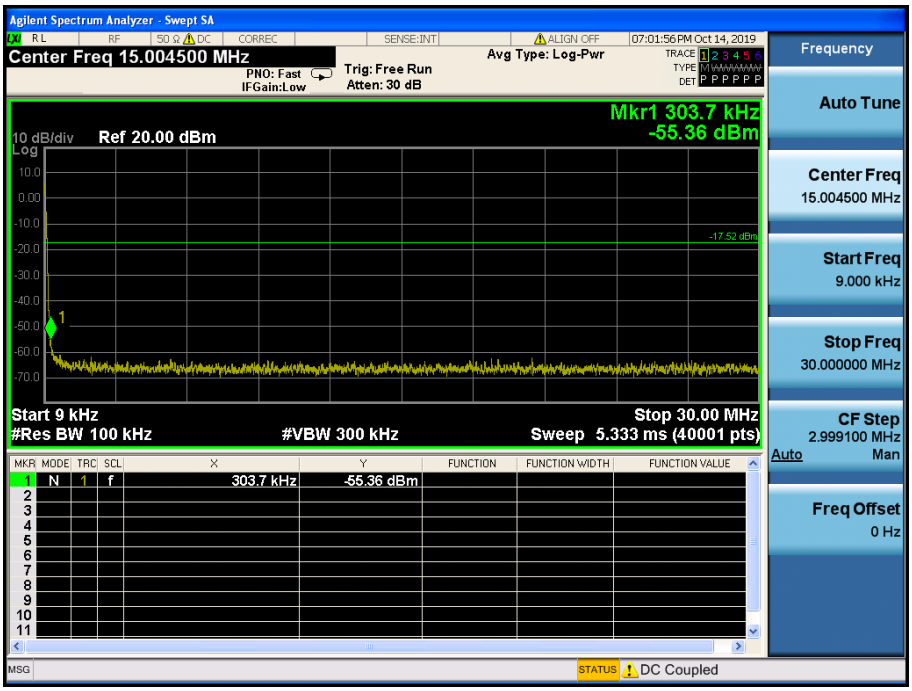

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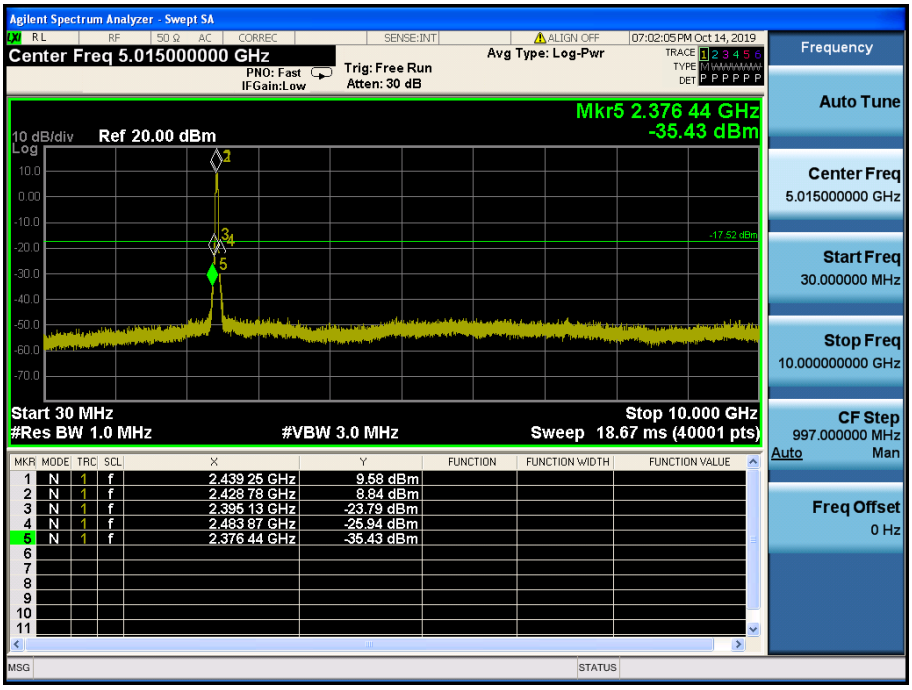
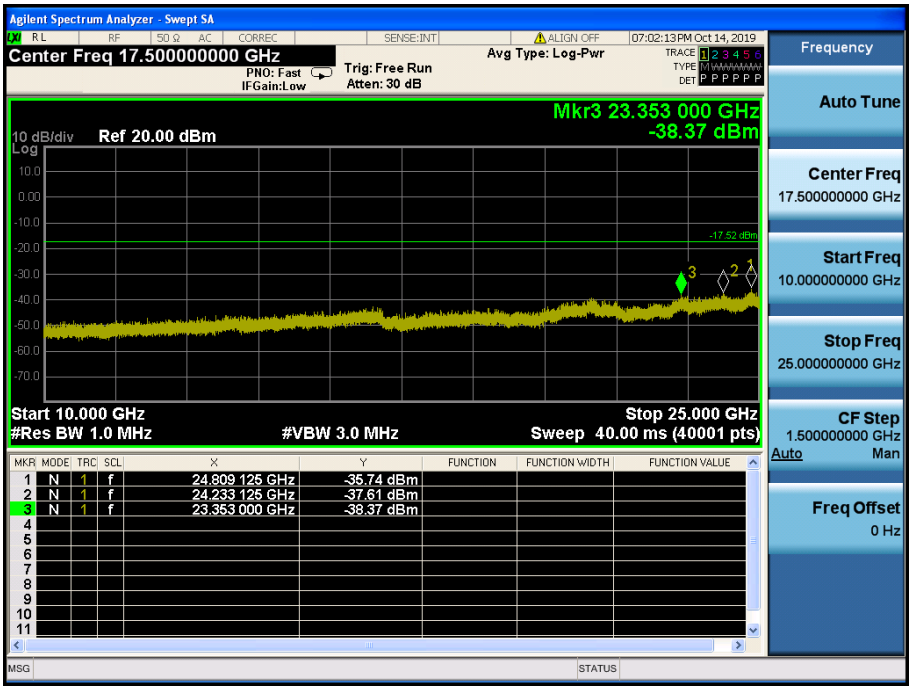
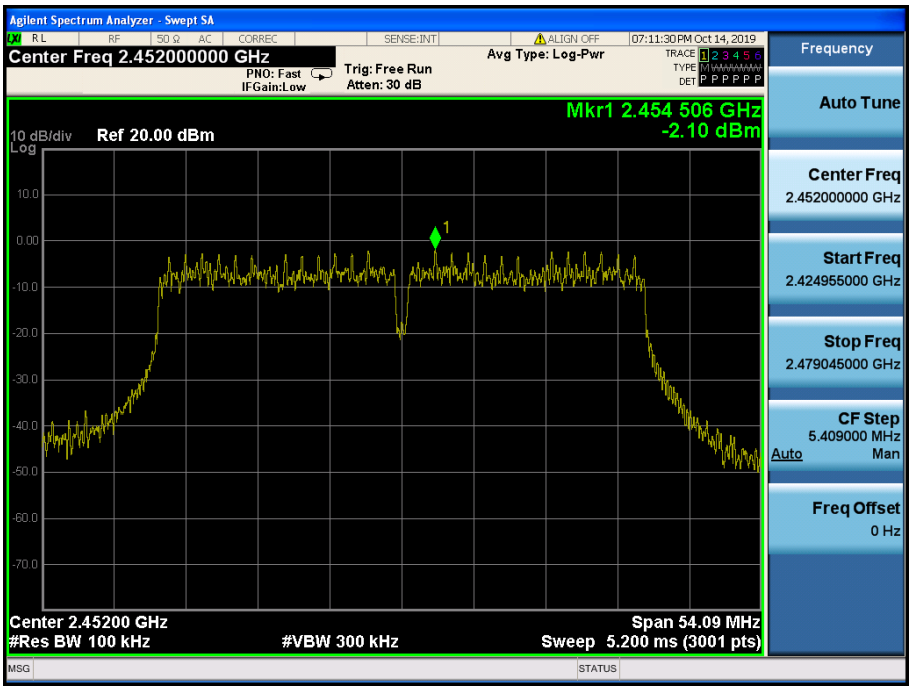


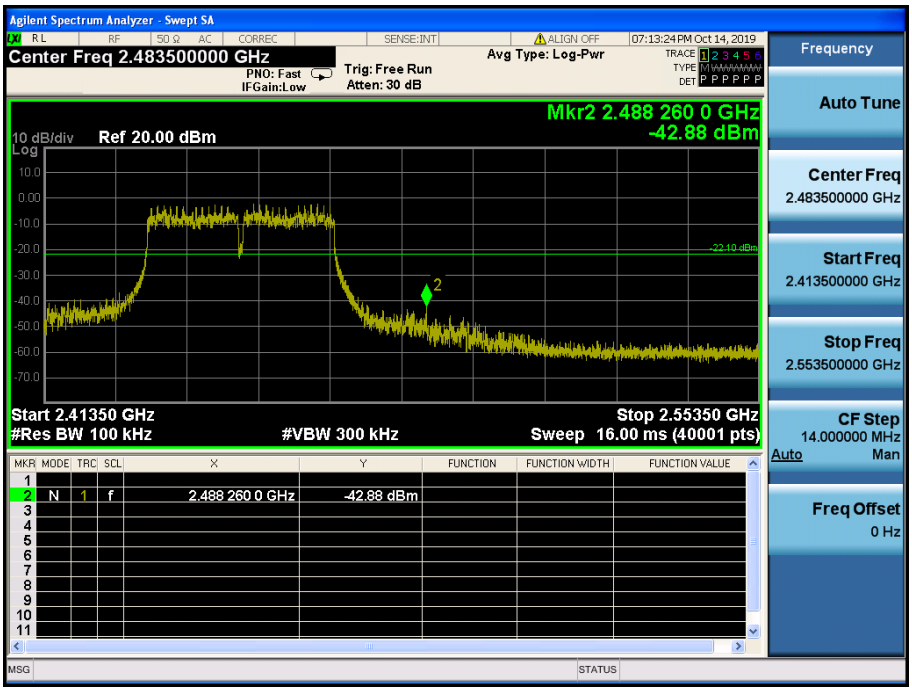


TM 4 & ANT 2 & 2452

Reference



High Band-edge



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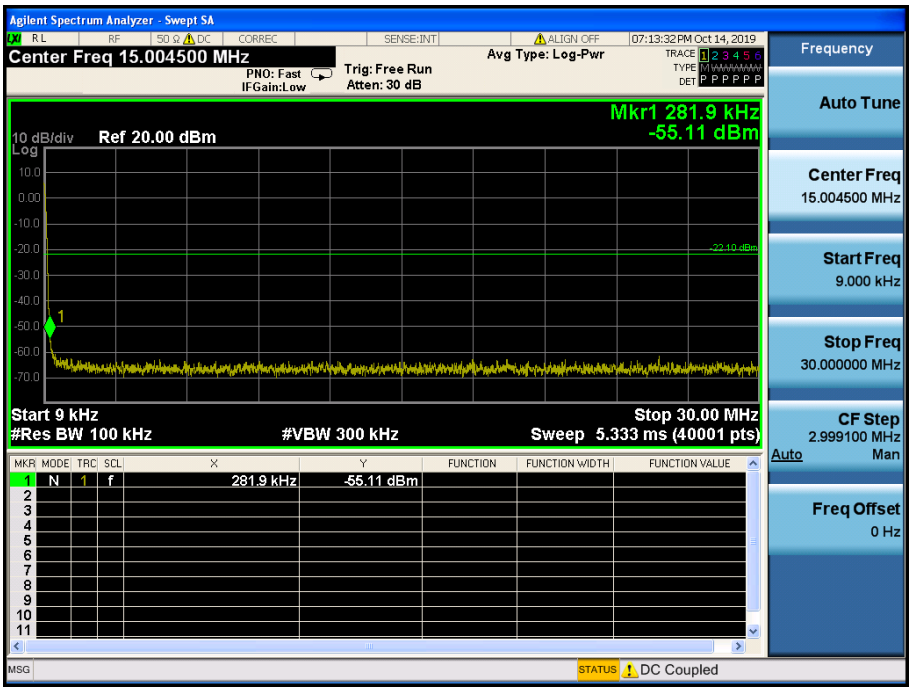

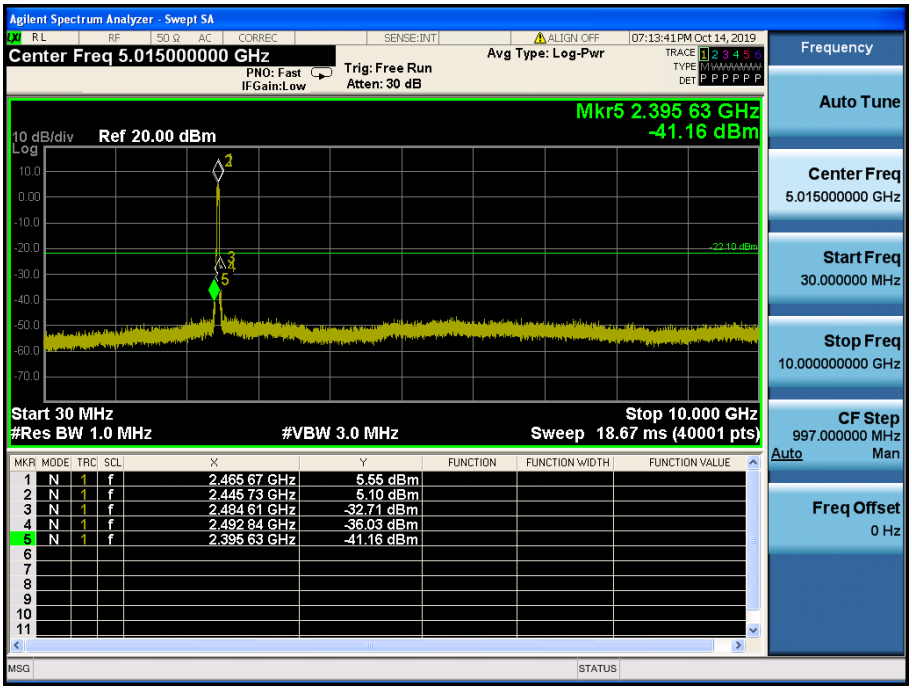

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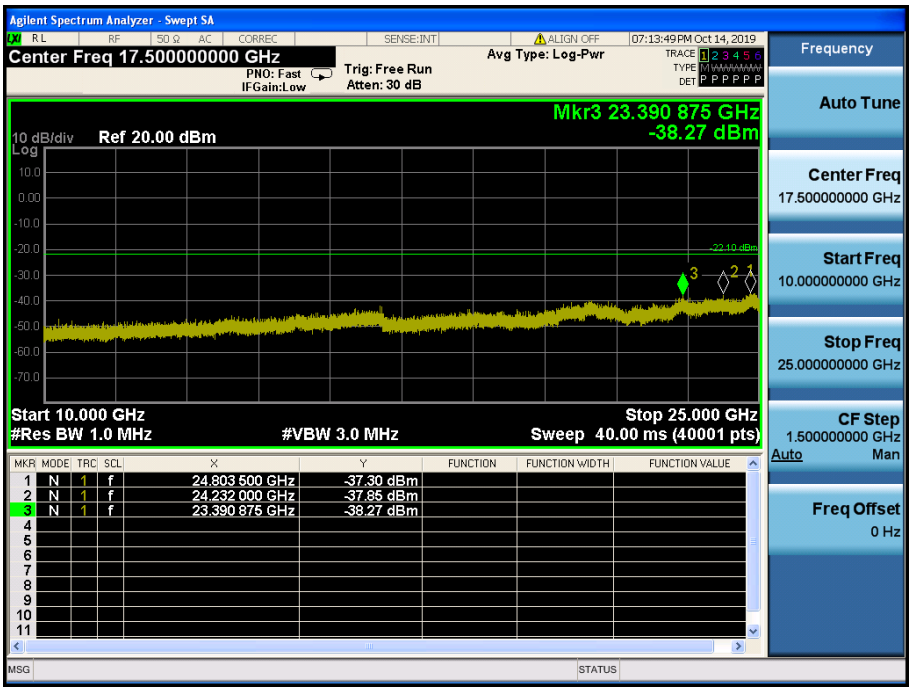
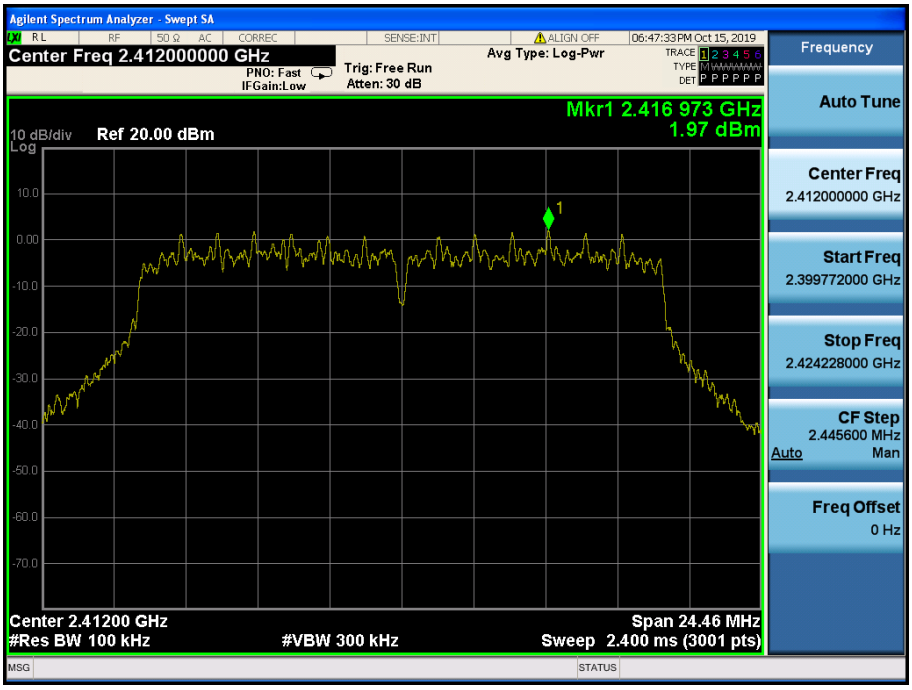
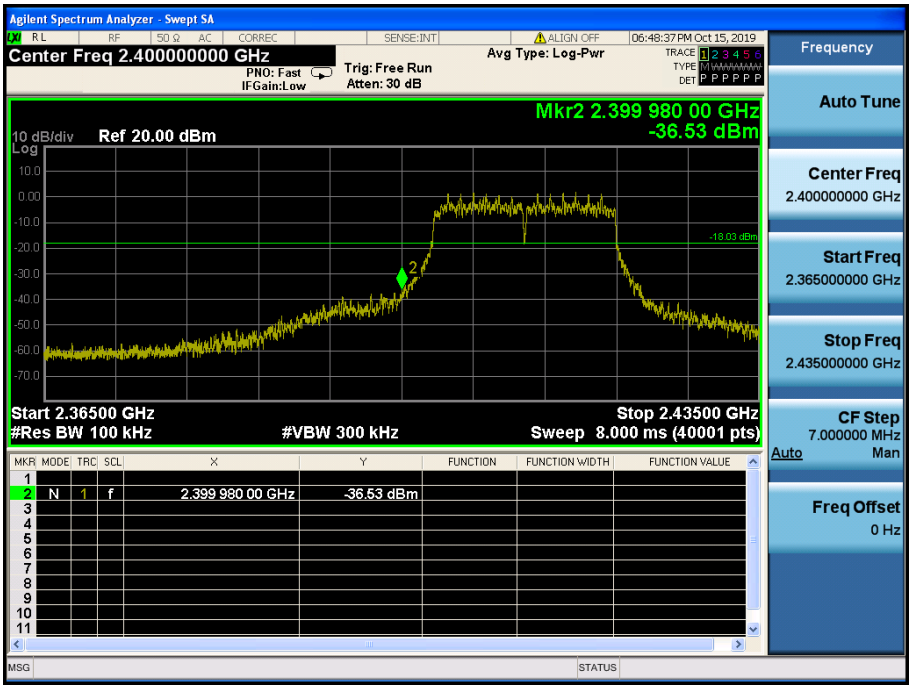


TM 5 & ANT 2 & 2412

Reference



Low Band-edge



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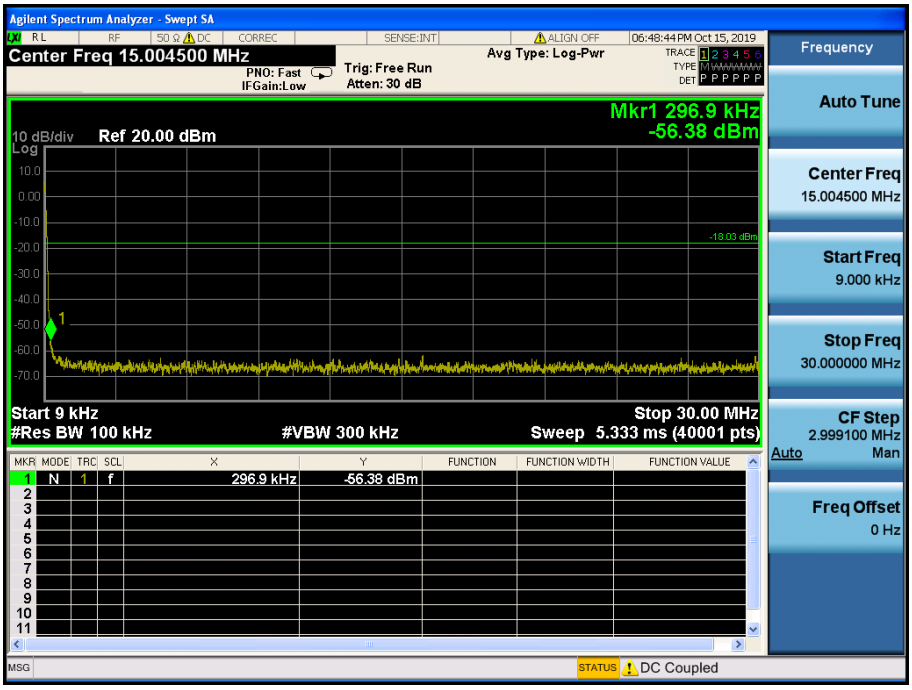

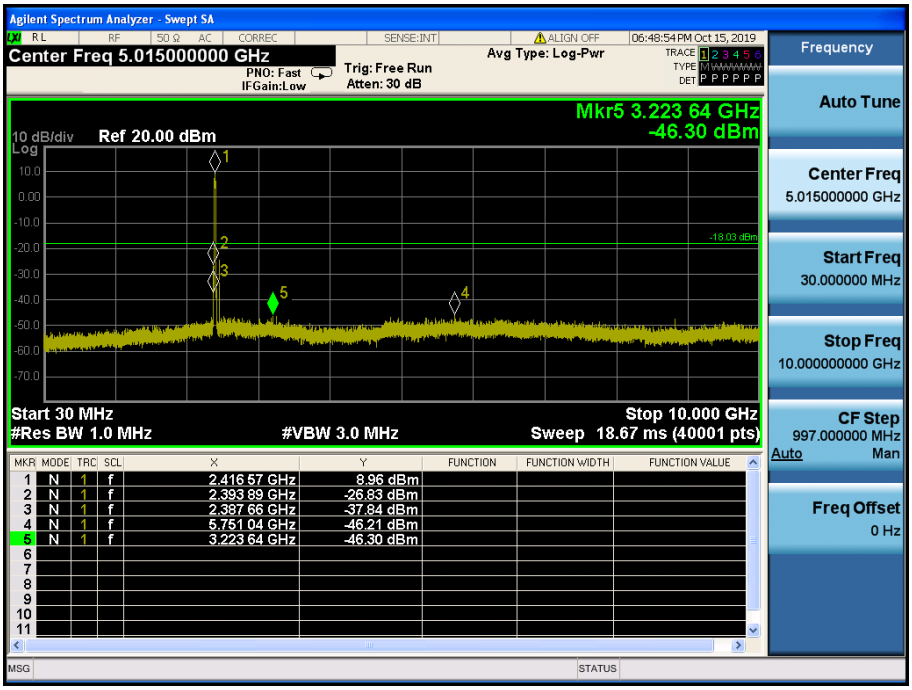

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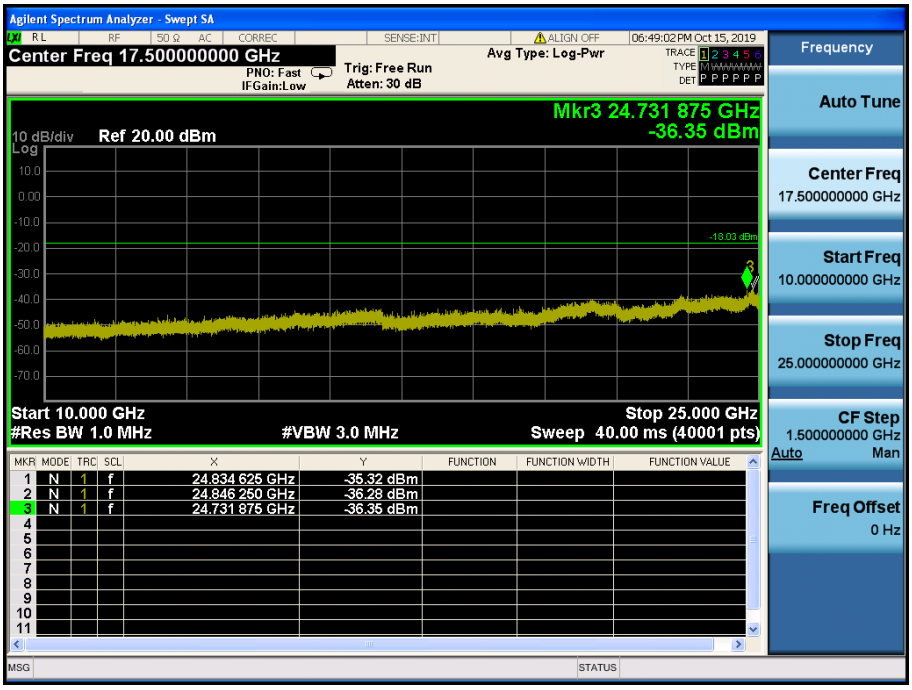
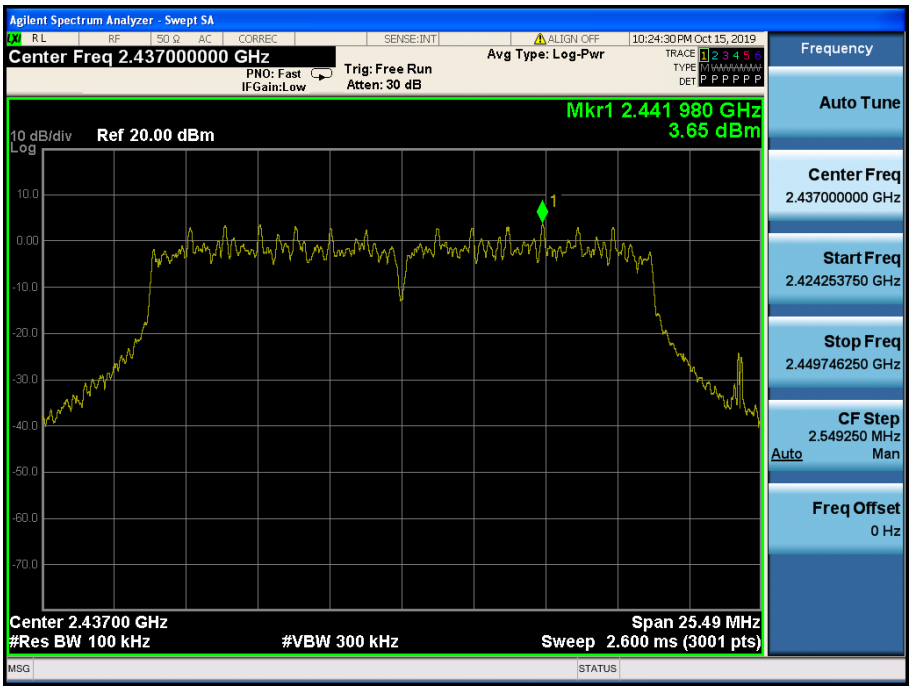


TM 5 & ANT 2 & 2437

Reference



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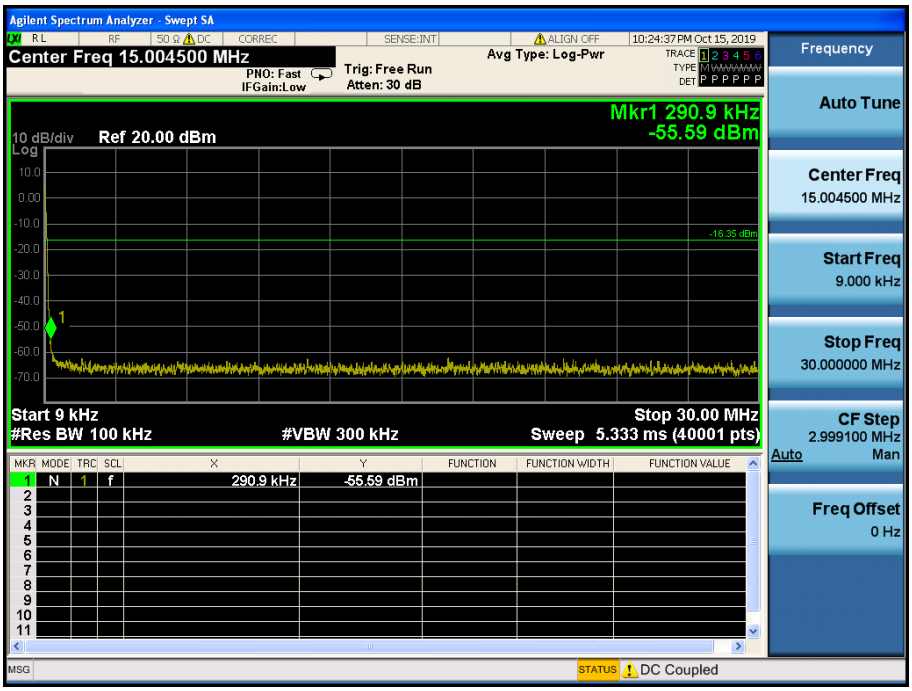

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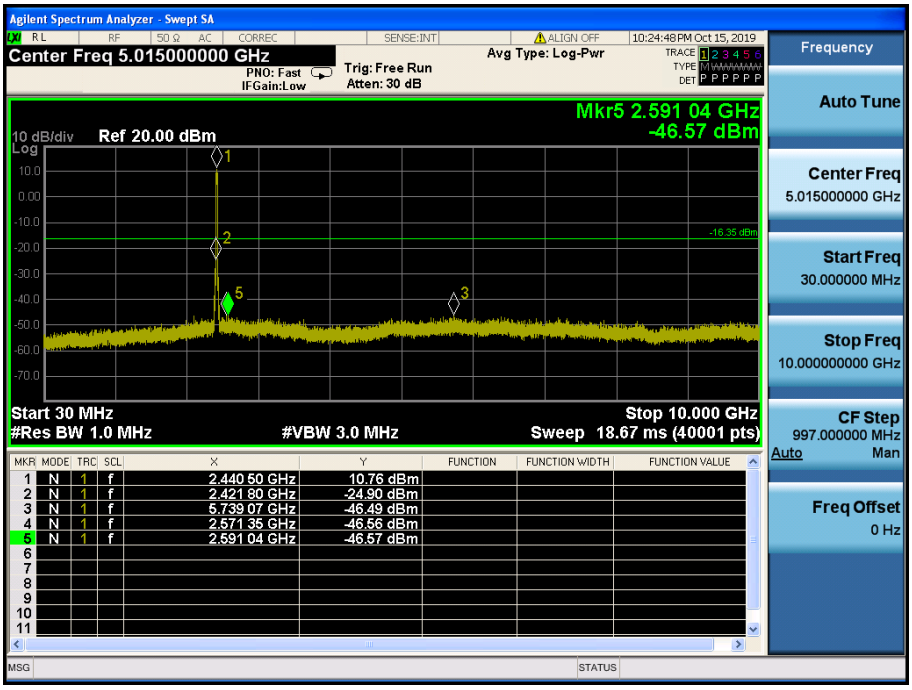
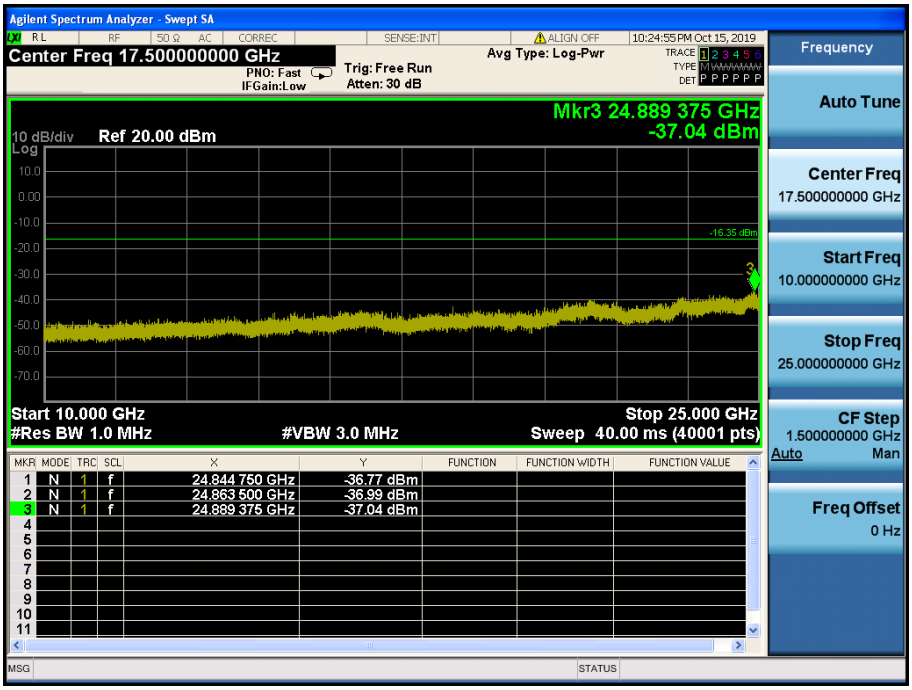
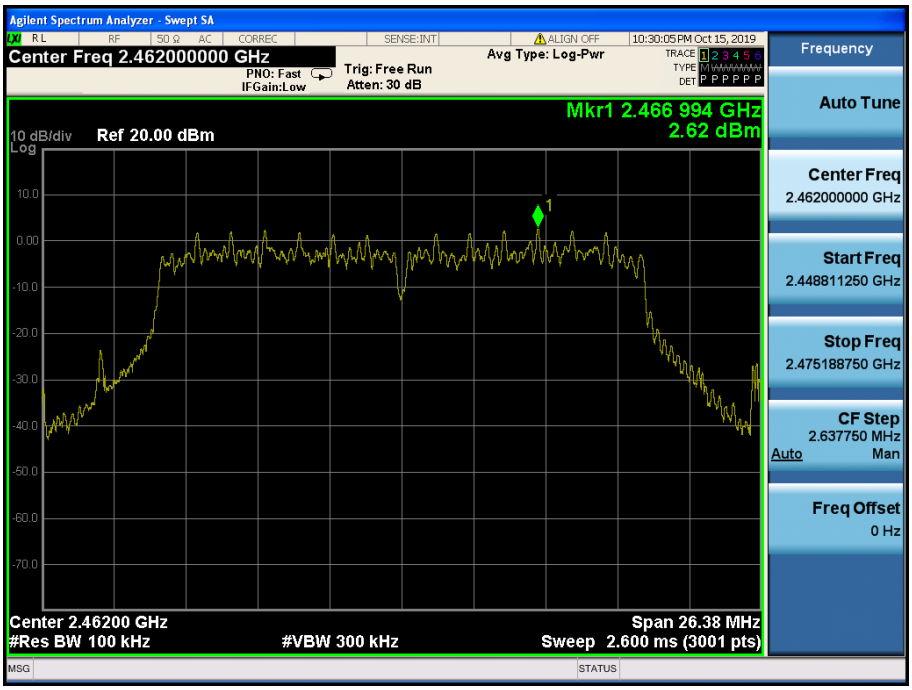


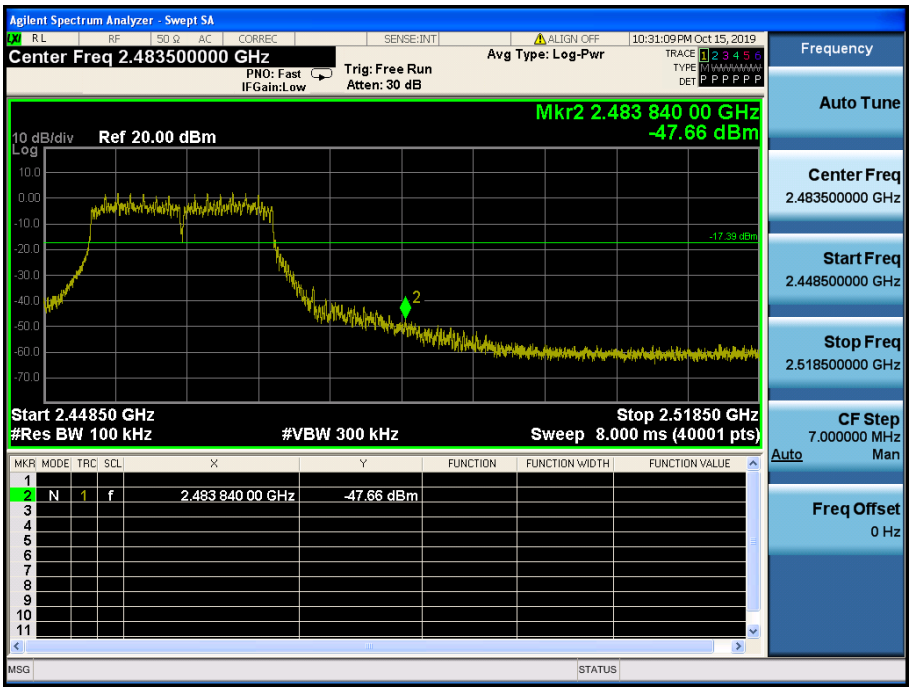


TM 5 & ANT 2 & 2462

Reference



High Band-edge



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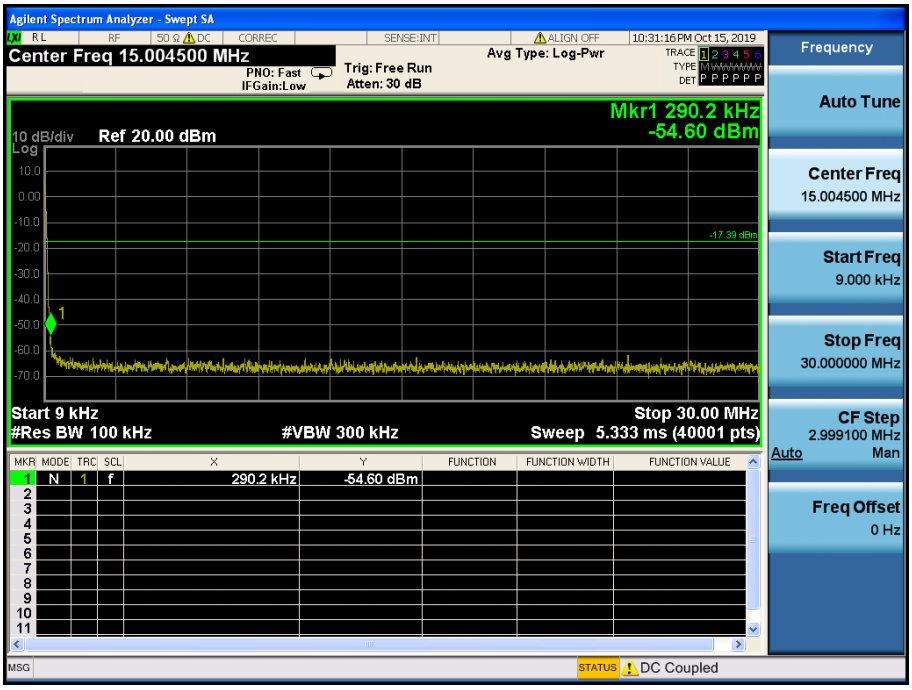
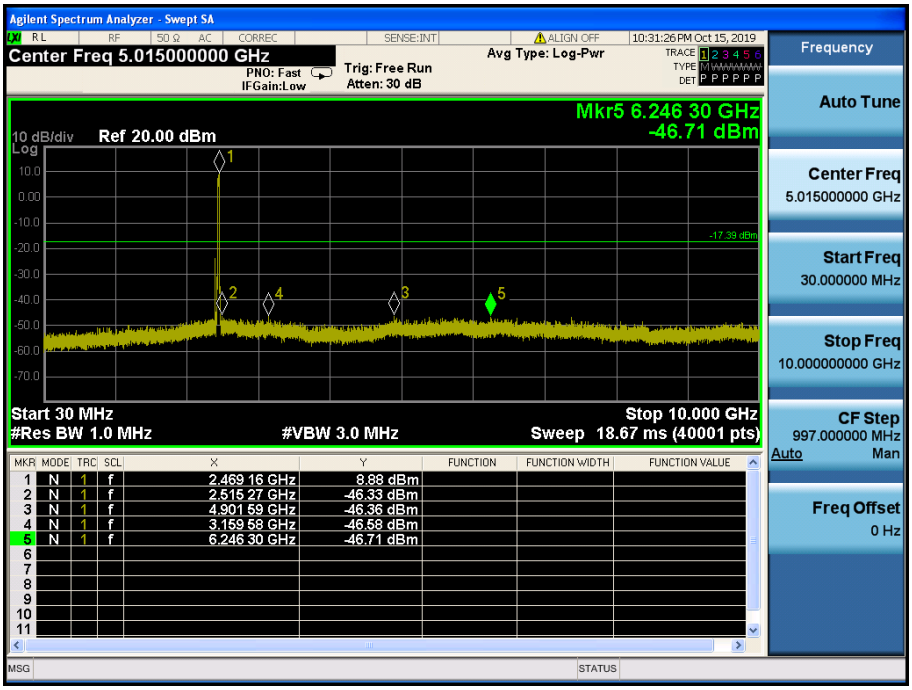
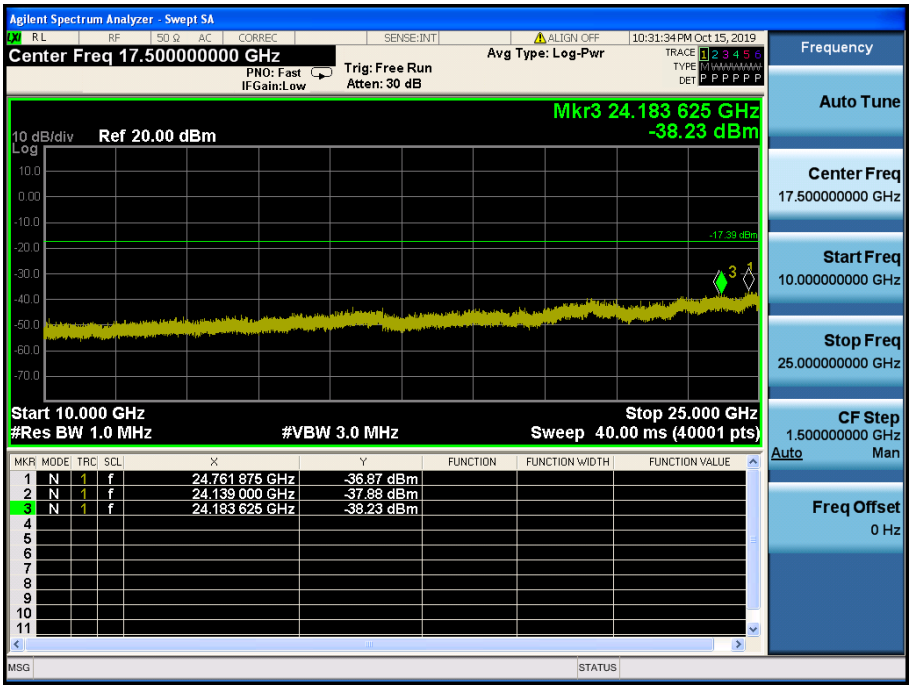


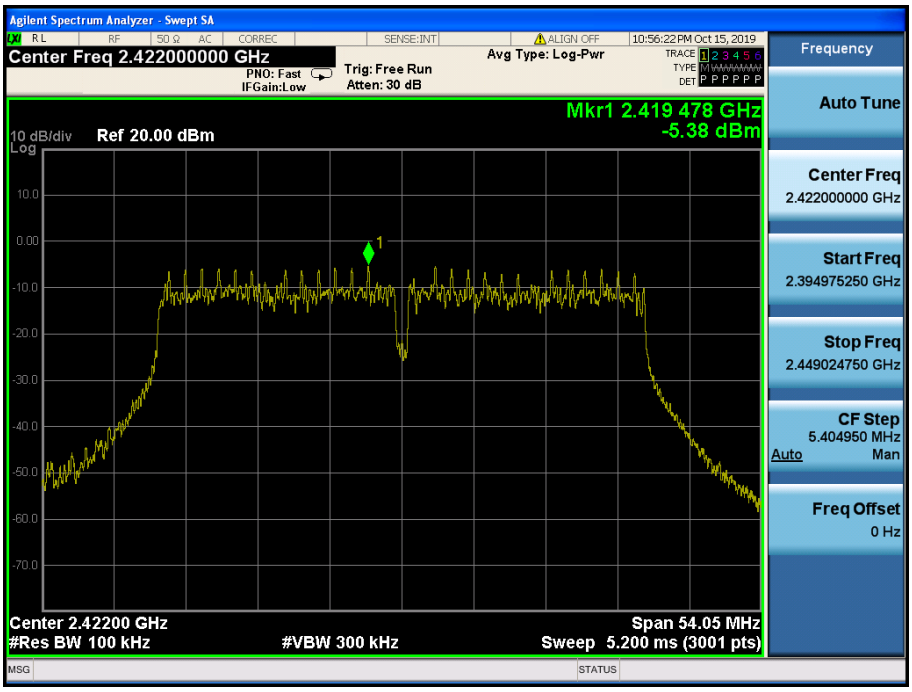


Conducted Spurious Emissions

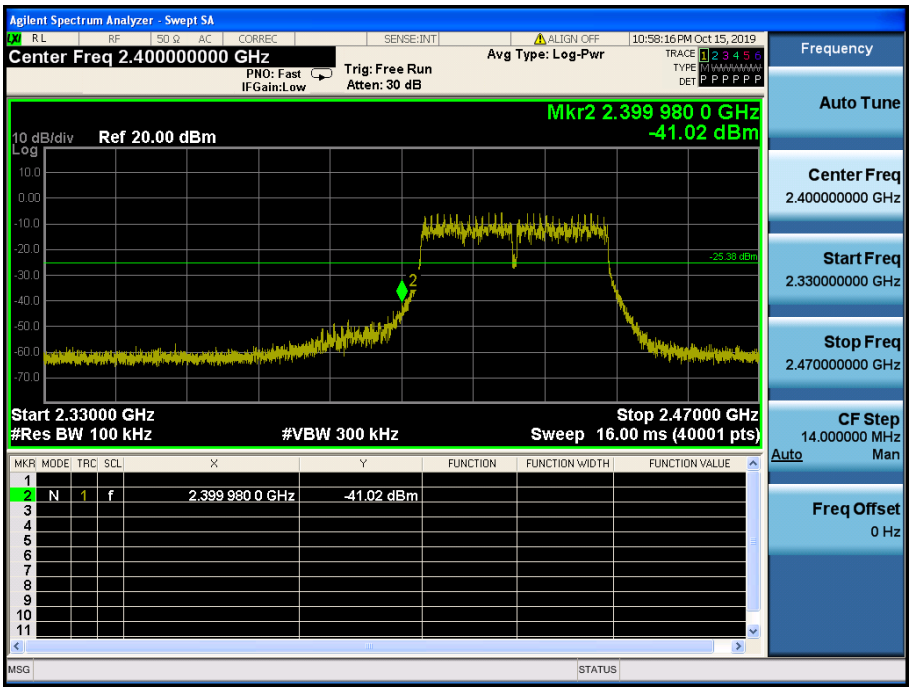


TM 6 & ANT 2 & 2422

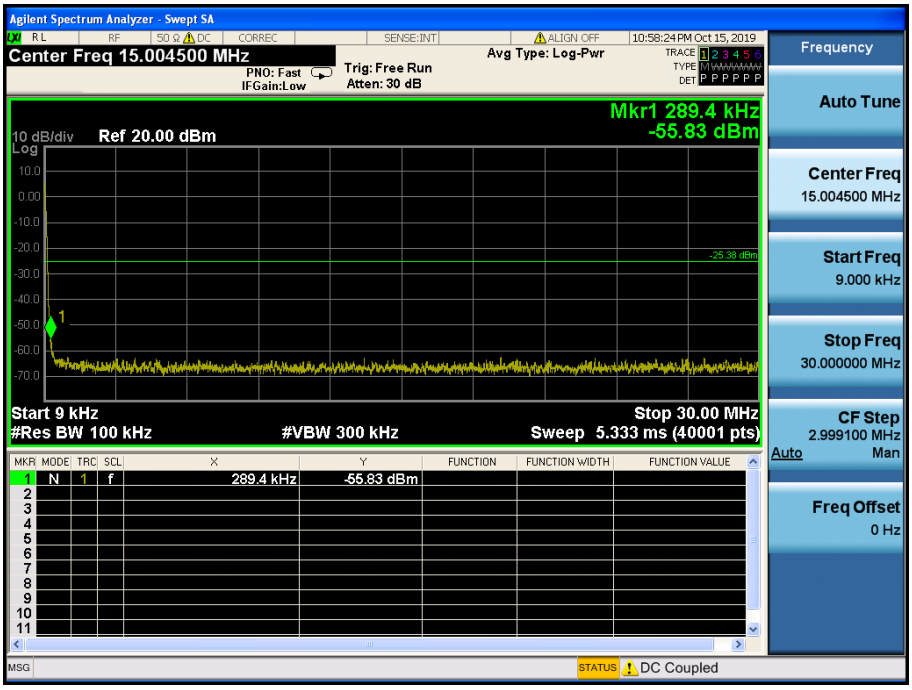
Reference

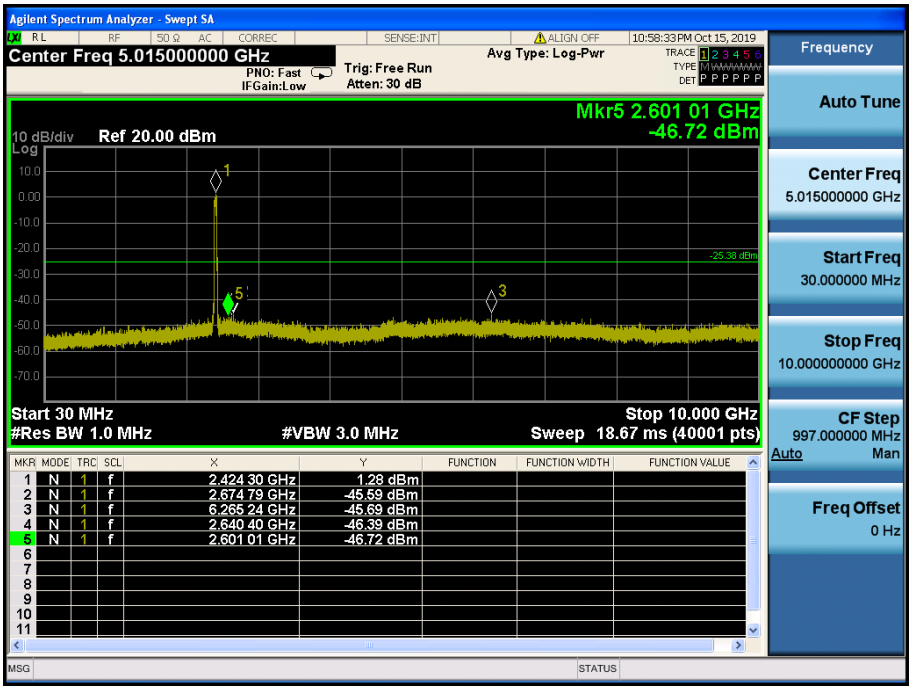


Low Band-edge

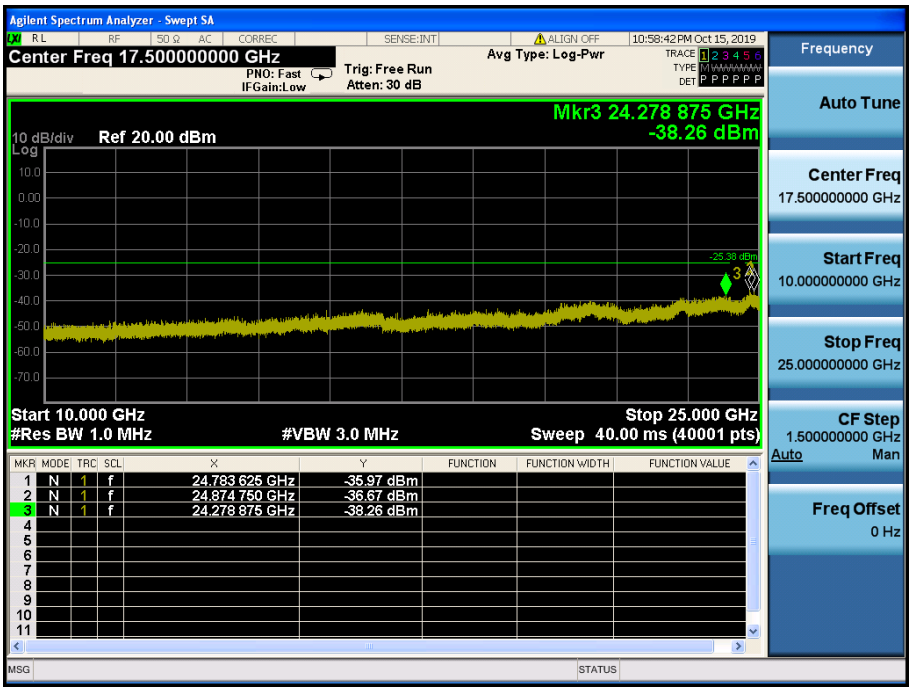


Conducted Spurious Emissions



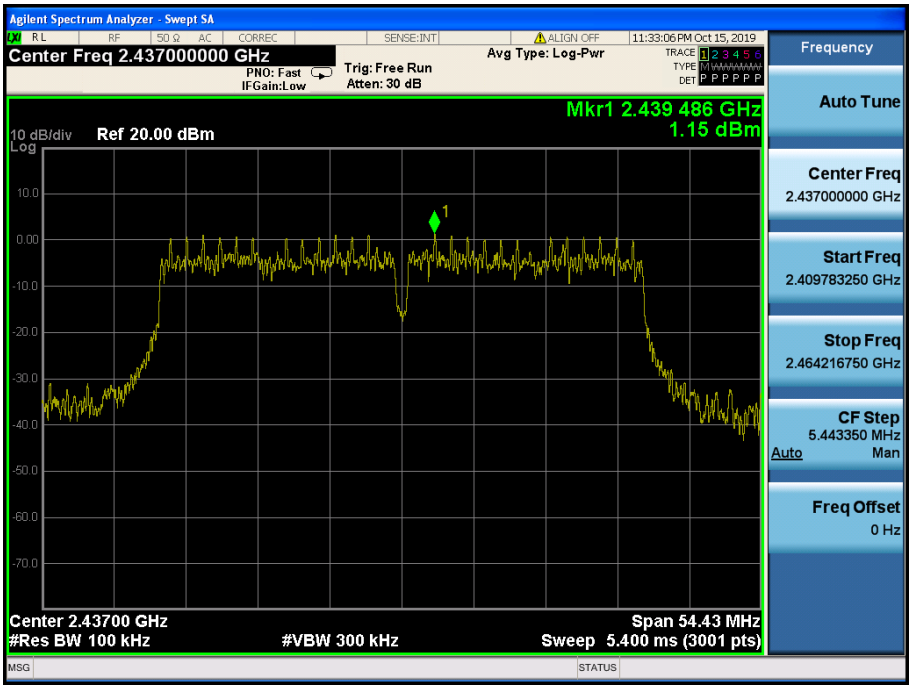


Conducted Spurious Emissions

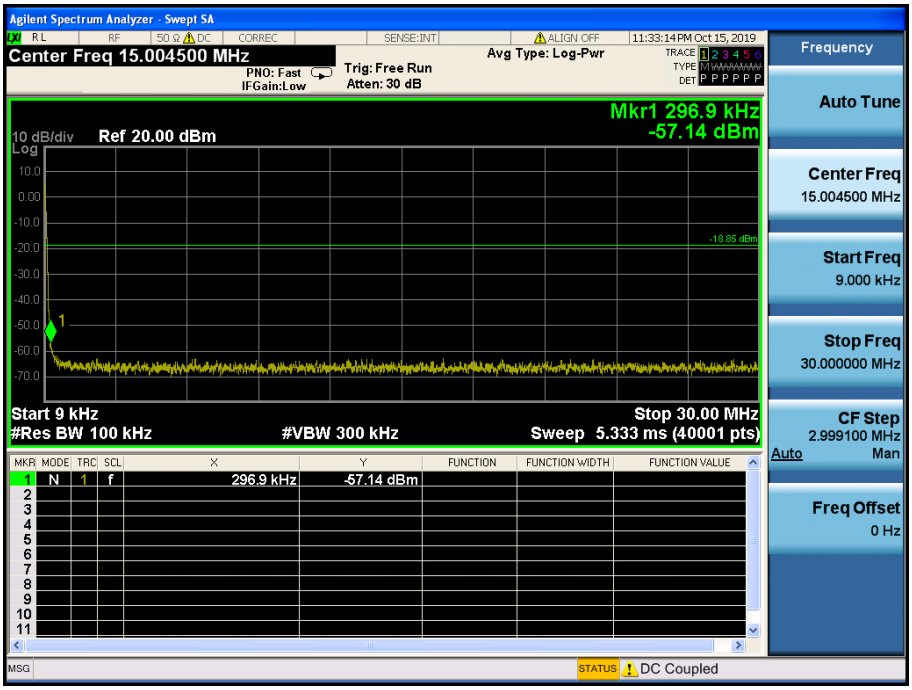


TM 6 & ANT 2 & 2437

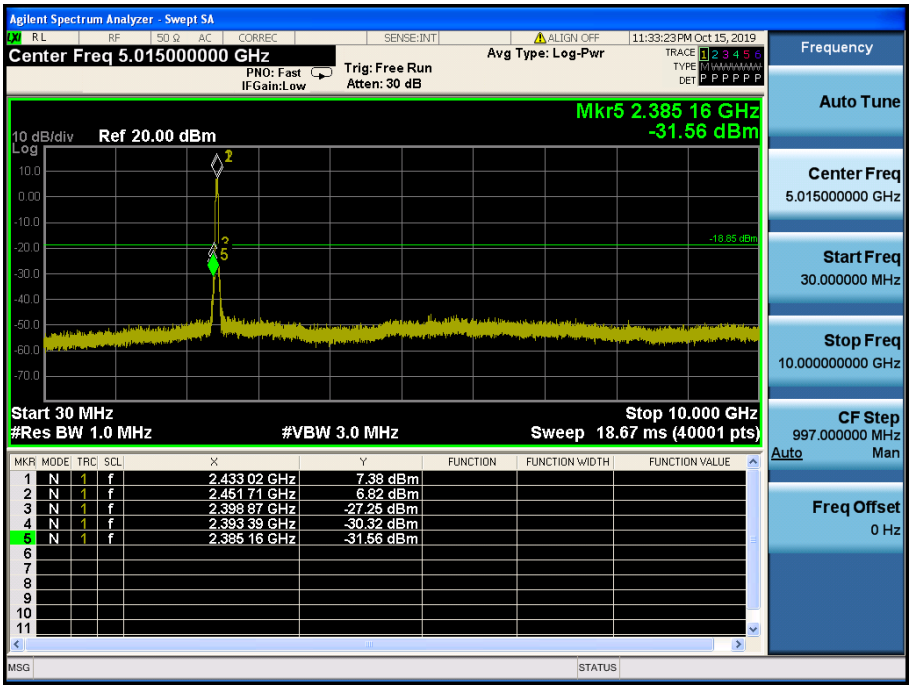
Reference

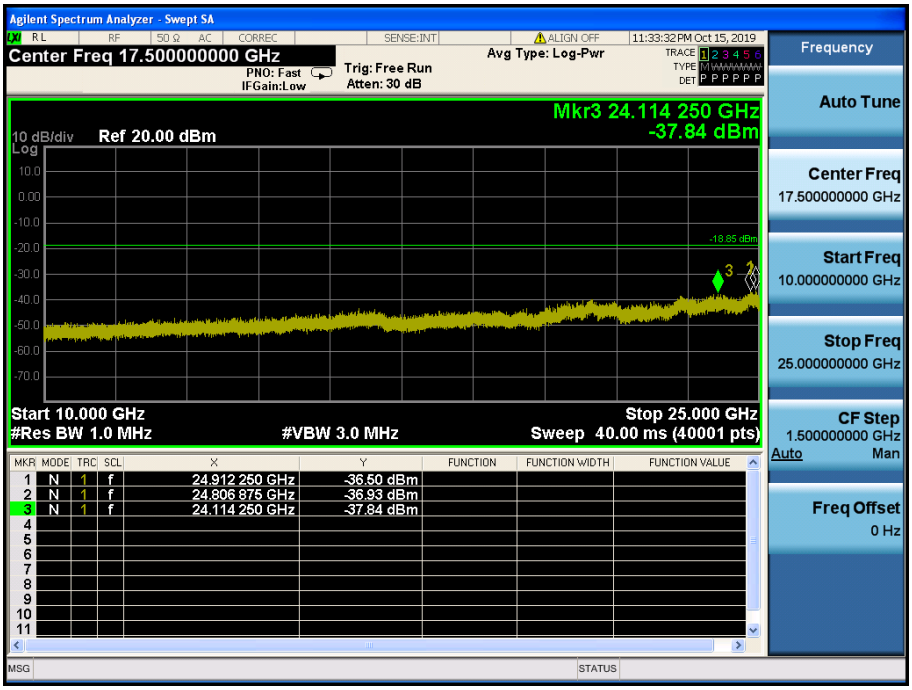


Conducted Spurious Emissions



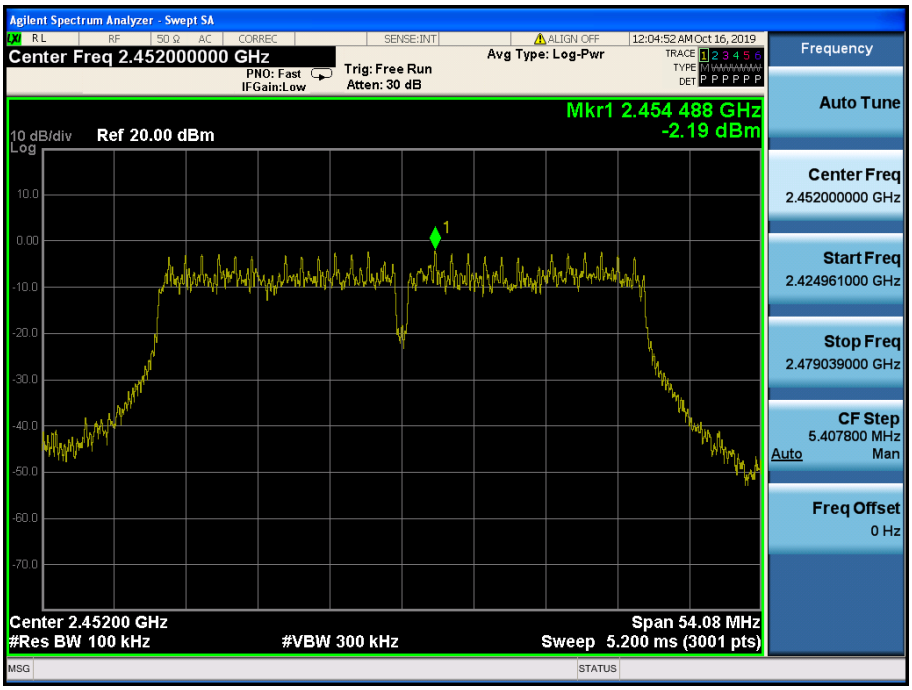
Conducted Spurious Emissions



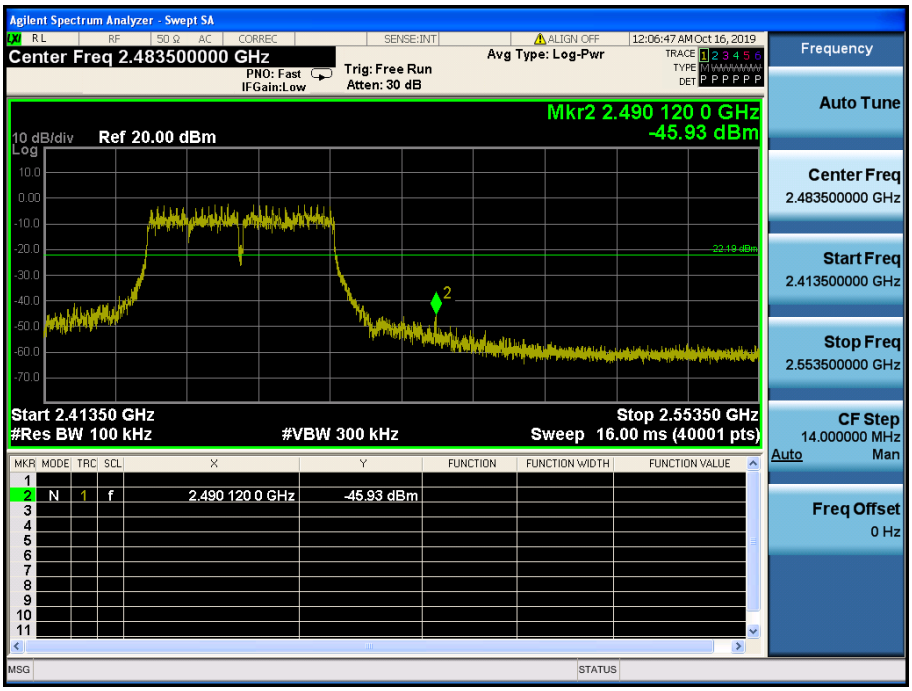


TM 6 & ANT 2 & 2452

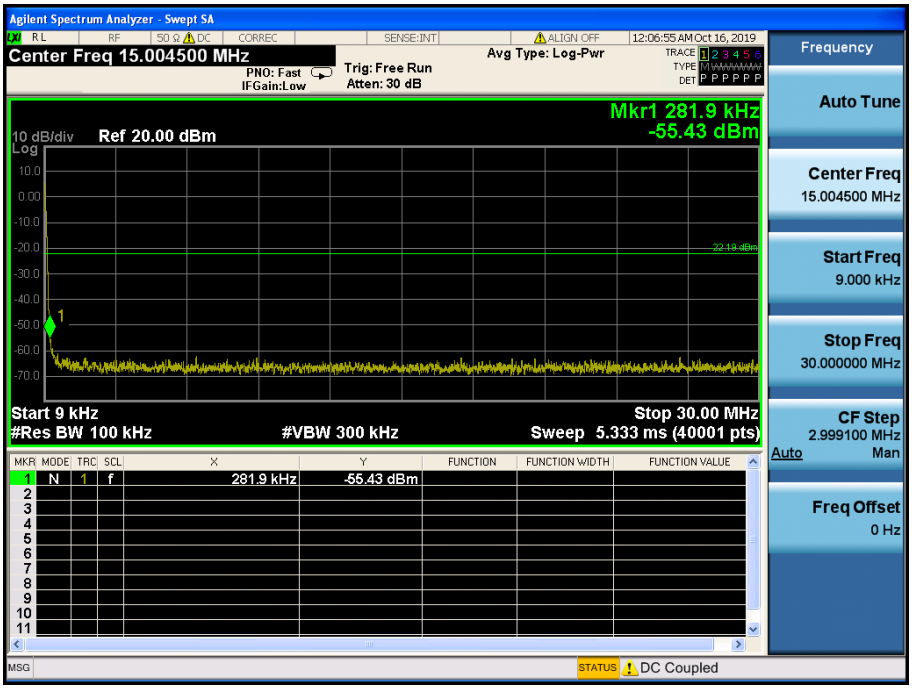
Reference

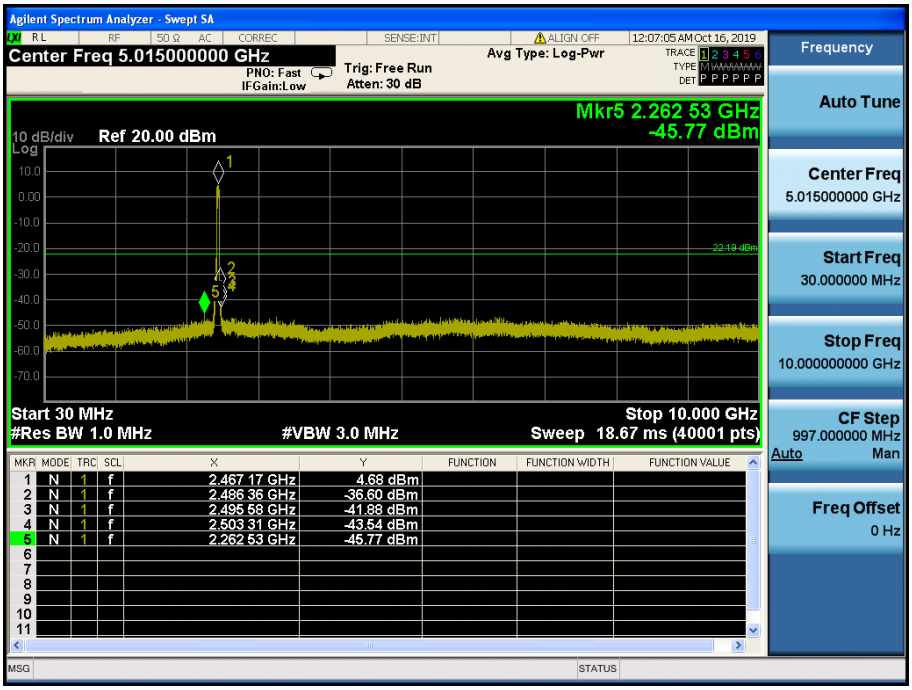


High Band-edge

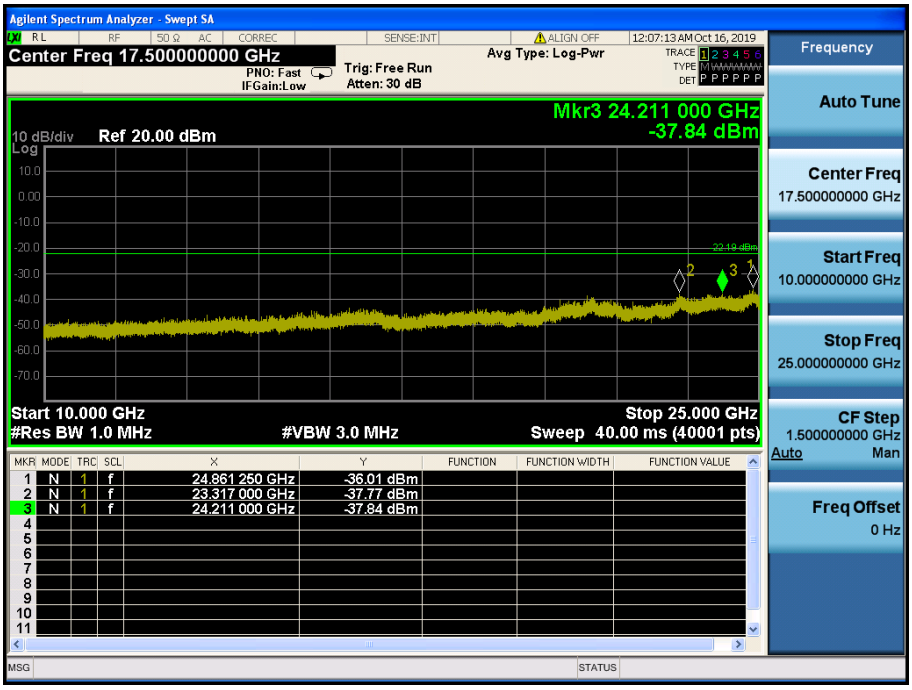


Conducted Spurious Emissions





Conducted Spurious Emissions



8.5 Radiated spurious emissions

▣ **Test Requirements and limit, §15.247(d), §15.205, §15.209**

In any 100 kHz bandwidth outside the operating frequency band, 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. In case the emission fall within the restricted band specified on 15.205(a) and (b), then the 15.209(a) limit in the table below has to be followed.

▪ **FCC Part 15.209(a) and (b)**

Frequency (MHz)	Limit (uV/m)	Measurement Distance (meter)
0.009 – 0.490	2400/F (kHz)	300
0.490 – 1.705	24000/F (kHz)	30
1.705 – 30.0	30	30
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

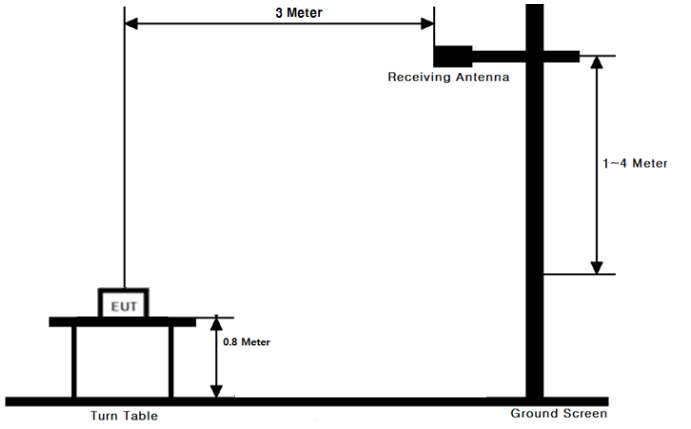
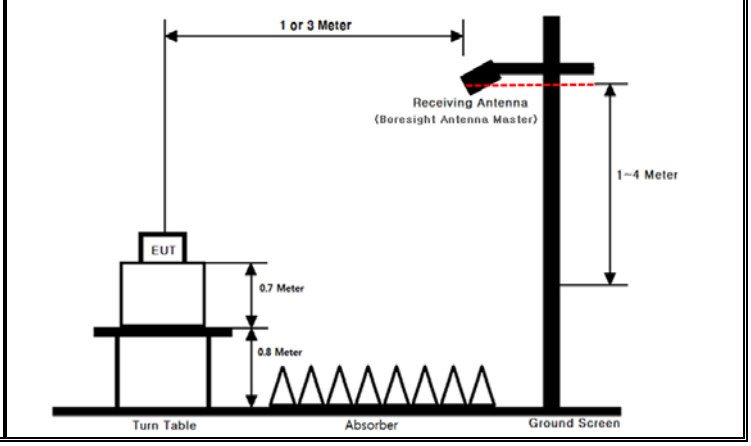
** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

▪ **FCC Part 15.205 (a):** Only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	GHz	GHz
0.009 ~ 0.110	8.41425 ~ 8.41475	108 ~ 121.94	1300 ~ 1427	4.5 ~ 5.15	14.47 ~ 14.5
0.495 ~ 0.505	12.29 ~ 12.293	123 ~ 138	1435 ~ 1626.5	5.35 ~ 5.46	15.35 ~ 16.2
2.1735 ~ 2.1905	12.51975 ~ 12.52025	149.9 ~ 150.05	1645.5 ~ 1646.5	7.25 ~ 7.75	17.7 ~ 21.4
4.125 ~ 4.128	12.57675 ~ 12.57725	156.52475 ~	1660 ~ 1710	8.025 ~ 8.5	22.01 ~ 23.12
4.17725 ~ 4.17775	13.36 ~ 13.41	156.52525	1718.8 ~ 1722.2	9.0 ~ 9.2	23.6 ~ 24.0
4.20725 ~ 4.20775	16.42 ~ 16.423	156.7 ~ 156.9	2200 ~ 2300	9.3 ~ 9.5	31.2 ~ 31.8
6.215 ~ 6.218	16.69475 ~ 16.69525	162.0125 ~ 167.17	2310 ~ 2390	10.6 ~ 12.7	36.43 ~ 36.5
6.26775 ~ 6.26825	16.80425 ~ 16.80475	167.72 ~ 173.2	2483.5 ~ 2500	13.25 ~ 13.4	Above 38.6
6.31175 ~ 6.31225	25.5 ~ 25.67	240 ~ 285	2655 ~ 2900		
8.291 ~ 8.294	37.5 ~ 38.25	322 ~ 335.4	3260 ~ 3267		
8.362 ~ 8.366	73 ~ 74.6	399.90 ~ 410	3332 ~ 3339		
8.37625 ~ 8.38675	74.8 ~ 75.2	608 ~ 614	3345.8 ~ 3358		
		960 ~ 1240	3600 ~ 4400		

▪ **FCC Part 15.205(b):** The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector.
Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in §15.35 apply to these measurements.

▣ Test Configuration

Below 1GHz	Above 1GHz
	

▣ Test Procedure

1. The EUT is placed on a non-conductive table, emission measurements at below 1 GHz, the table height is 80 cm and 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 1 or 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.

▣ Measurement Instrument Setting for Radiated Emission Measurements.

The radiated emission was tested according to the section 6.3, 6.4, 6.5 and 6.6 of the ANSI C63.10-2013 with following settings.

Peak Measurement

RBW = As specified in below table, VBW ≥ 3 x RBW, Sweep = Auto, Detector = Peak, Trace mode = Max Hold until the trace stabilizes.

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

Average Measurement:

If continuous transmission of the EUT (D ≥ 98%) cannot be achieved and the duty cycle is constant (duty cycle variations are less than ±2%), then the following procedure shall be used:

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 x 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 x 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	1 Mbps	12.420	12.480	0.9952	NA
TM 2	6 Mbps	2.064	2.150	0.9600	0.18

Note1: Where, T= Transmission duration / D= Duty cycle
Note2: Please refer to the appendix I for duty cycle plots.

Average Measurement:

If continuous transmission of the EUT (D ≥ 98%) cannot be achieved and the duty cycle is not constant (duty cycle variations equal or exceed ±2%), then the following procedure.

1. RBW = 1 MHz (unless otherwise specified).
2. VBW ≥ 1 / T.
3. Detector = peak.
4. Video bandwidth mode or display mode:
   1) The analyzer shall be set to ensure that video filtering is applied in the power domain.
   Typically, this requires setting the detector mode to RMS (power averaging) and setting the average-VBW type to power (rms).
   2) As an alternative, the analyzer may be set to linear detector mode. Ensure that video filtering is applied in linear voltage domain (rather than in a log or dB domain). Some analyzers require linear display mode to accomplish this. Others have a setting for average-VBW type, which can be set to "voltage" regardless of the display mode.
5. Sweep time = auto.
6. Trace mode = max hold.

VBW setting

Test Mode	Date rate	T_{on}(ms)	T_{on+off} (ms)	1 / T
TM 3	MCS 7	0.228	0.339	VBW ≥ 4.39 kHz
TM 4	MCS 7	0.128	0.229	VBW ≥ 7.81 kHz
TM 5	MCS 15	0.136	0.247	VBW ≥ 7.35 kHz
TM 6	MCS 15	0.088	0.189	VBW ≥ 11.36 kHz

Note1: Please refer to the appendix I for duty cycle plots.

▣ Test Results: Comply

Please refer to next page for data table and the appendix II for worst data plots.

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

Tested Frequency (MHz)	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	T.F (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)
2412	2374.97	H	X	PK	51.50	1.71	N/A	N/A	53.21	74.00	20.79
	2375.20	H	X	AV	41.80	1.71	N/A	N/A	43.51	54.00	10.49
	4823.92	H	X	PK	49.23	5.50	N/A	N/A	54.73	74.00	19.27
	4823.96	H	X	AV	44.54	5.50	N/A	N/A	50.04	54.00	3.96
	7235.90	V	X	PK	47.53	7.91	N/A	N/A	55.44	74.00	18.56
	7235.03	V	X	AV	39.66	7.91	N/A	N/A	47.57	54.00	6.43
2437	4874.02	H	X	PK	47.75	5.63	N/A	N/A	53.38	74.00	20.62
	4873.97	H	X	AV	42.33	5.63	N/A	N/A	47.96	54.00	6.04
	7312.37	V	X	PK	45.46	8.03	N/A	N/A	53.49	74.00	20.51
	7312.02	V	X	AV	37.97	8.03	N/A	N/A	46.00	54.00	8.00
2462	2487.93	H	X	PK	49.20	1.90	N/A	N/A	51.10	74.00	22.90
	2487.85	H	X	AV	40.92	1.90	N/A	N/A	42.82	54.00	11.18
	4923.95	H	X	PK	47.68	5.70	N/A	N/A	53.38	74.00	20.62
	4923.95	H	X	AV	40.70	5.70	N/A	N/A	46.40	54.00	7.60
	7386.96	V	X	PK	47.00	7.95	N/A	N/A	54.95	74.00	19.05
	7387.03	V	X	AV	39.05	7.95	N/A	N/A	47.00	54.00	7.00

Note.

1. The radiated emissions were investigated 9kHz to 25GHz. And no other spurious and harmonic emissions were found above listed frequencies.
2. Sample Calculation.
   Margin = Limit – Result / Result = Reading + T.F+ DCCF + DCF / T.F = AF + CL – AG
   Where, T.F = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain,
   DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor
3. Information of Distance Factor
   For finding emissions, the test distance might be reduced from 3m to 1m. In this case, the distance factor(-9.54dB) is applied to the result.
   - Calculation of distance factor = 20 log(applied distance / required distance) = 20 log(1 m / 3 m) = -9.54 dB
   When distance factor is “N/A”, the distance is 3 m and distance factor is not applied.