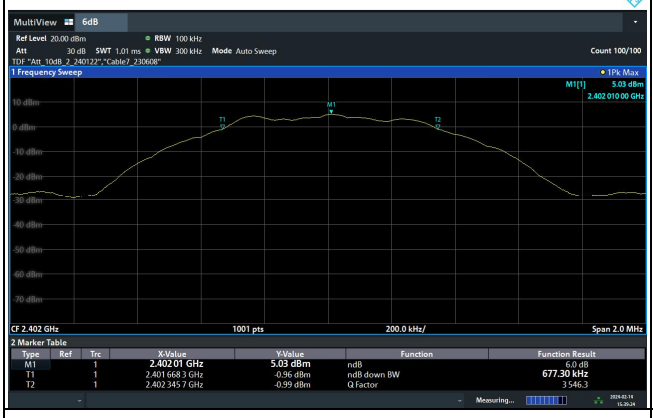
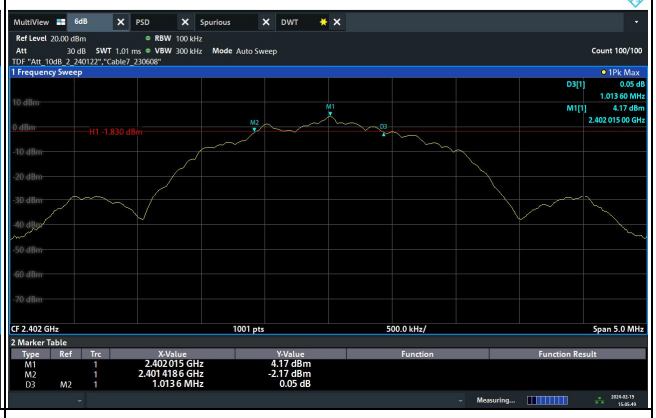
6 dB Bandwith

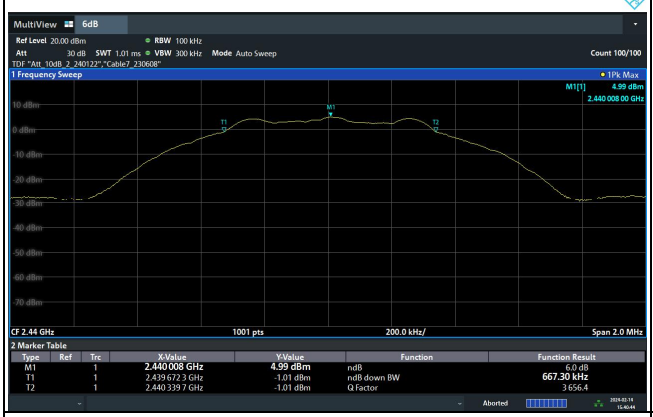
LE1M_2 402 MHz



LE2M_2 402 MHz

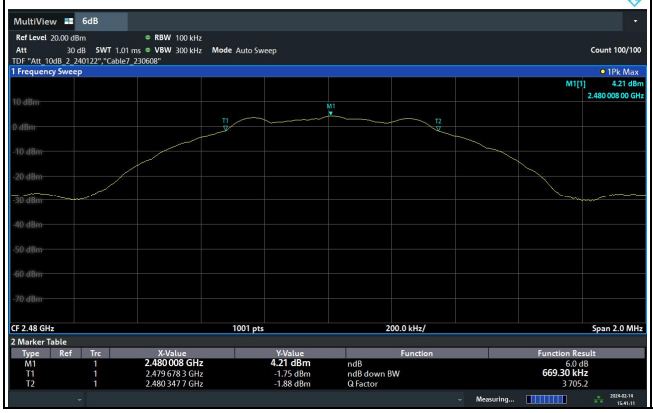


LE1M_2 440 MHz

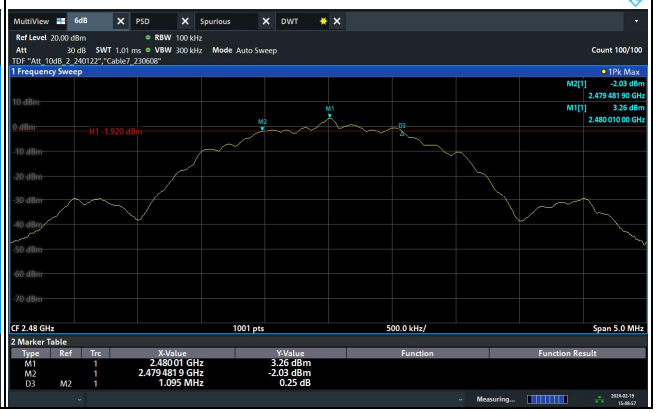


LE2M_2 440 MHz

LE1M_2 480 MHz



LE2M_2 480 MHz



6.3 Maximum Peak Output Power

6.3.1 Regulation

§15.247(b)(3) : For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

§15.247(b)(4) : The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

6.3.2 Test Procedure

The method of measurement used to test this DTS device is ANSI C63.10-2020.

One of the following procedures may be used to determine the maximum peak conducted output power of a DTS EUT.

Peak Power Measurement

1. RBW ≥ DTS bandwidth

a) Use the following spectrum analyzer settings:
   1) Set the RBW ≥ DTS bandwidth.
   2) Set VBW ≥ [3 x RBW].
   3) Set Span ≥ [3 x RBW].
   4) Sweep time : No faster than coupled (auto) time.
   5) Detector = Peak.
   6) Trace mode = Max hold.

b) Allow trace to stabilize

c) Use peak marker function to determinie the peak amplitude level

Average Power Measurement

Measurement using a power meter.

a) Averge Power measurement using an RF average power meter, as follows:

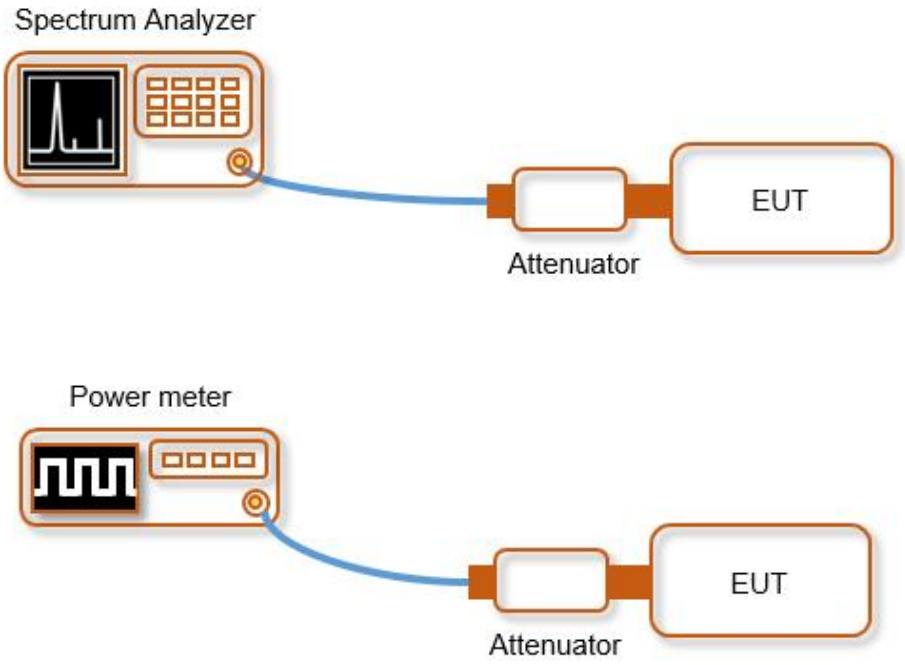
   1) The EUT is configured to transmit continuously, or to transmit with a constant duty cycle.
   2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power control level.
   3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.

b) If the transmitter does not transmit continuously, measure the duty cycle, D, of the transmitter output signal.

c) Measure the average power of the transmitter.
   This measurement is an average over both the ON and OFF periods of the transmitter.

d) Correct the measurement in dBm by adding [10 log (1 / D)], where D is the duty cycle.

6.3.3 Test Setup



6.3.4 Test Result

Test Mode	Channel	Frequency [MHz]	Peak Output Power [dBm]	Limit [dBm]	Margin [dB]
802.11b	1	2 412	3.63	30	26.37
	6	2 437	4.61		25.39
	11	2 462	3.79		26.21
802.11g	1	2 412	6.35	30	23.65
	6	2 437	6.30		23.70
	11	2 462	6.23		23.77
802.11n(HT20)	1	2 412	5.60	30	24.40
	6	2 437	6.09		23.91
	11	2 462	5.76		24.24
802.11n(HT40)	3	2 422	6.61	30	23.39
	6	2 437	5.95		24.05
	9	2 452	5.13		24.87
LE1M	0	2 402	5.12	30	24.88
	19	2 440	5.15		24.85
	39	2 480	4.37		25.63
LE2M	0	2 402	4.80	30	25.20
	19	2 440	4.76		25.24
	39	2 480	3.91		26.09

- The results are measured by Peak/average Power meter & Sensor.

Test Mode	Channel	Frequency [MHz]	DCCF [dB]	Average Power [dBm]	Max Average Power [dB]
802.11b	1	2 412	0.13	0.44	0.57
	6	2 437		1.67	1.80
	11	2 462		0.74	0.87
802.11g	1	2 412	0.40	-6.04	-5.64
	6	2 437		-6.24	-5.84
	11	2 462		-6.52	-6.12
802.11n(HT20)	1	2 412	0.44	-6.26	-5.82
	6	2 437		-6.44	-6.00
	11	2 462		-6.79	-6.35
802.11n(HT40)	3	2 422	0.93	-6.17	-5.24
	6	2 437		-6.63	-5.70
	9	2 452		-7.16	-6.23
LE1M	0	2 402	2.03	2.85	4.88
	19	2 440		2.87	4.90
	39	2 480		2.06	4.09
LE2M	0	2 402	4.08	-0.34	4.46
	19	2 440		-0.36	4.44
	39	2 480		-1.21	3.59

- The results are measured by Peak/average Power meter & Sensor.

6.4 Power Spectral Density

6.4.1 Regulation

§15.247(e) : For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

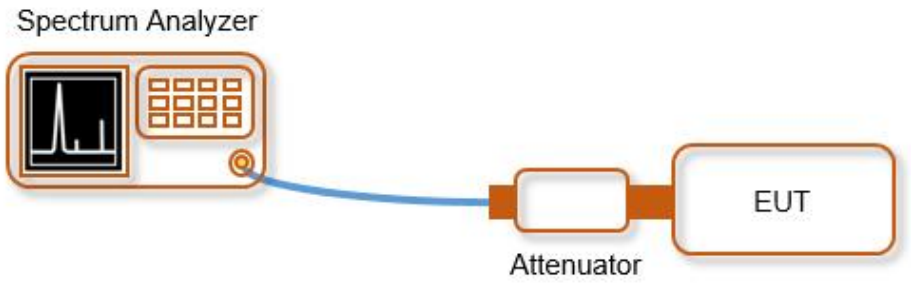
6.4.2 Test Procedure

The method of measurement used to test this DTS device is ANSI C63.10-2020.

The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:

a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span >1.5 times the DTS bandwidth.
c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = No faster than coupled (auto) time.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

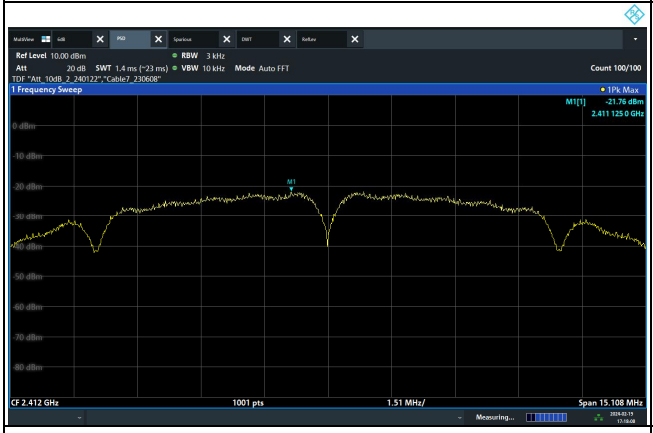
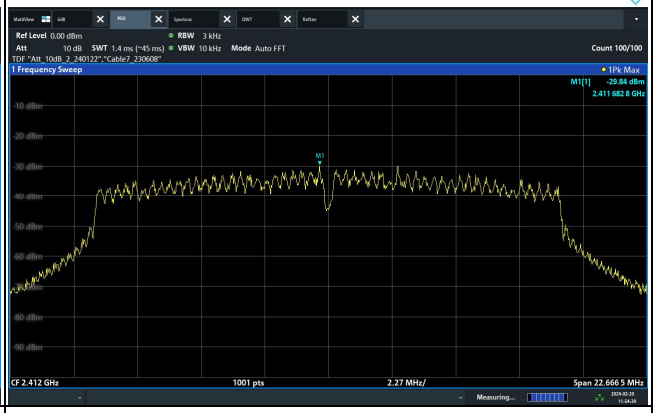
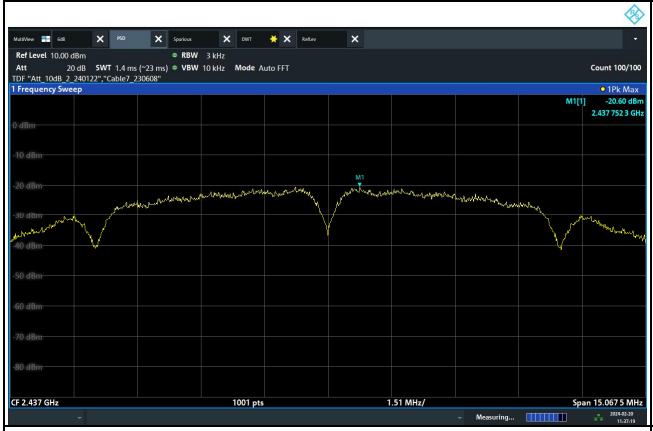
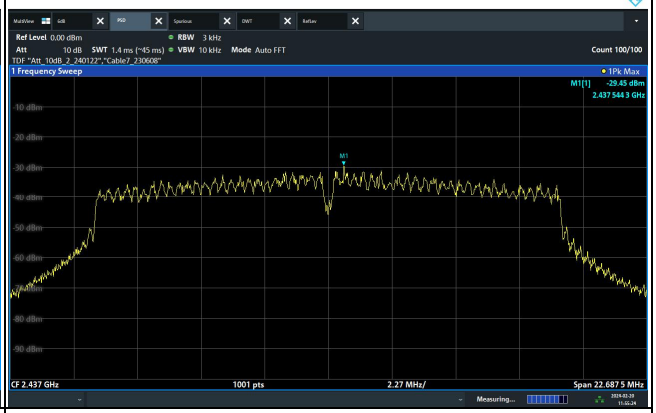
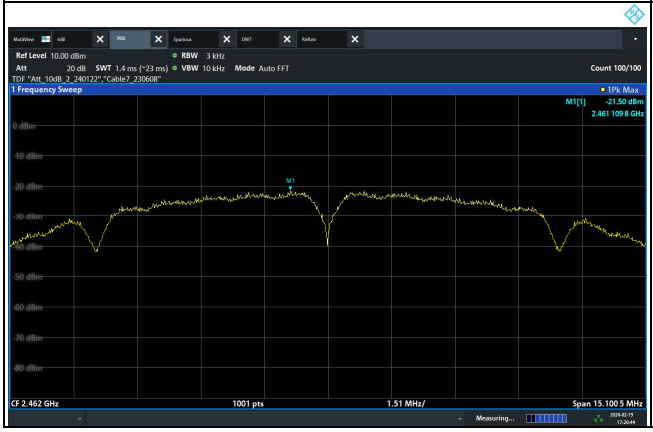
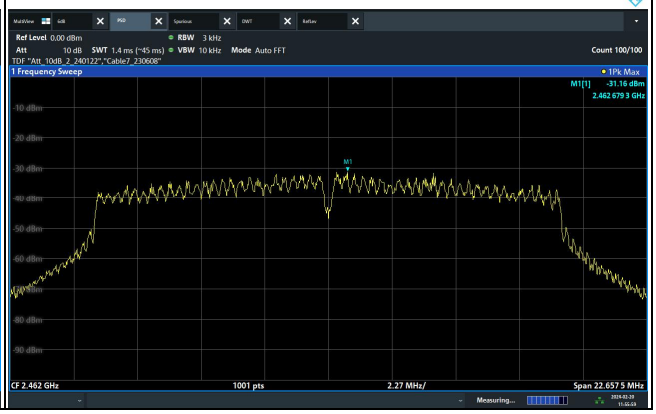
6.4.3 Test Setup

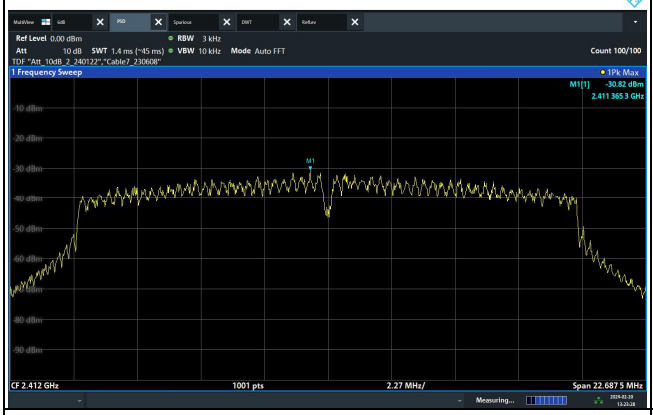
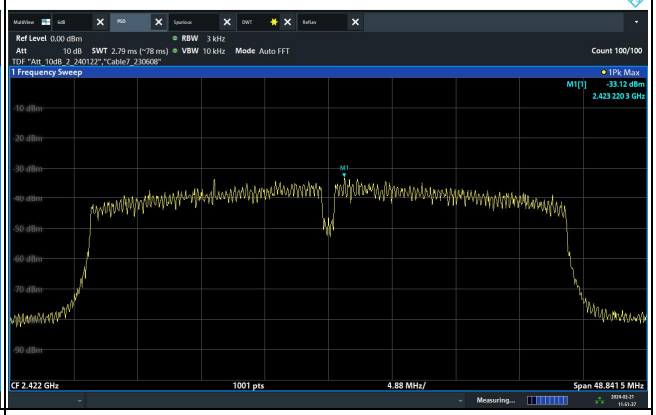
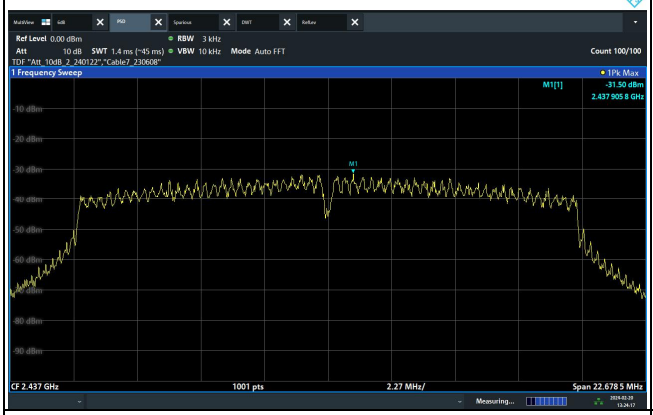
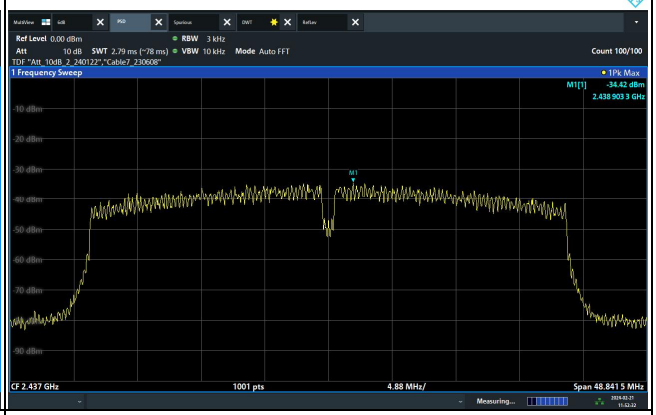
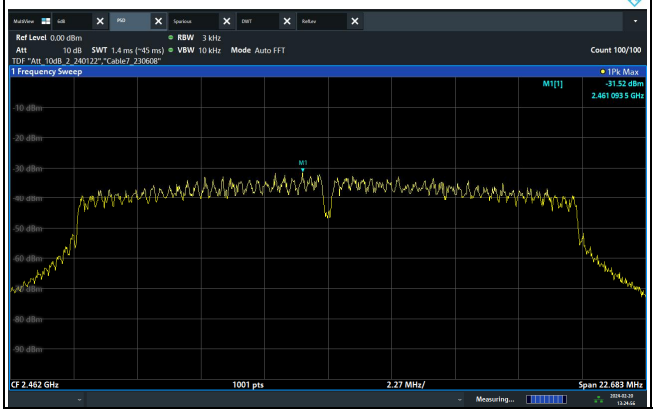
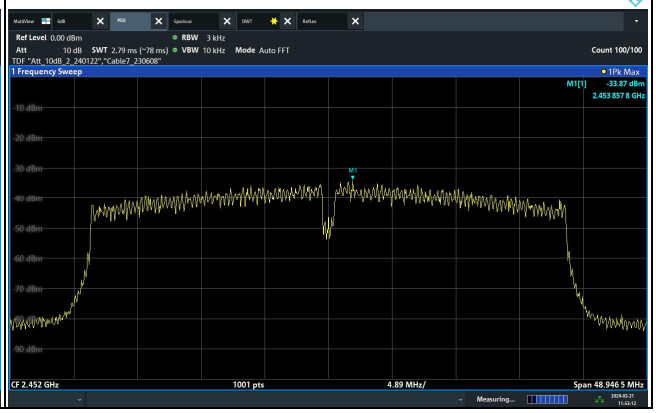


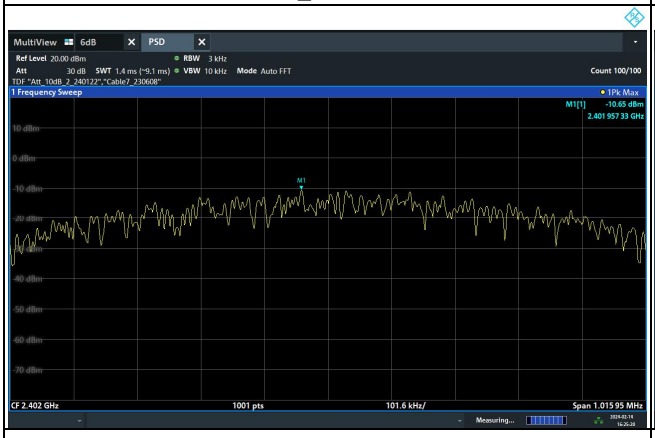
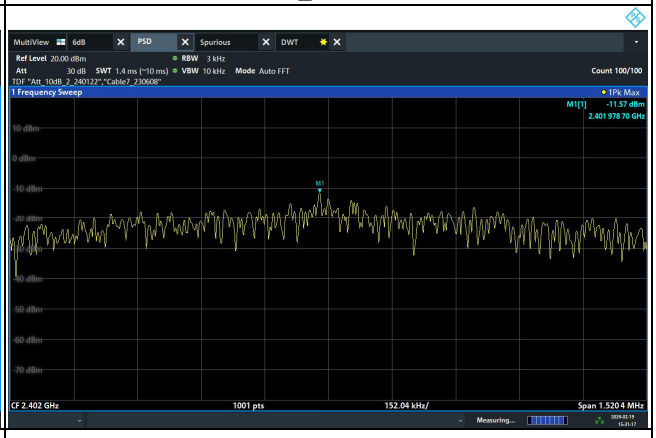
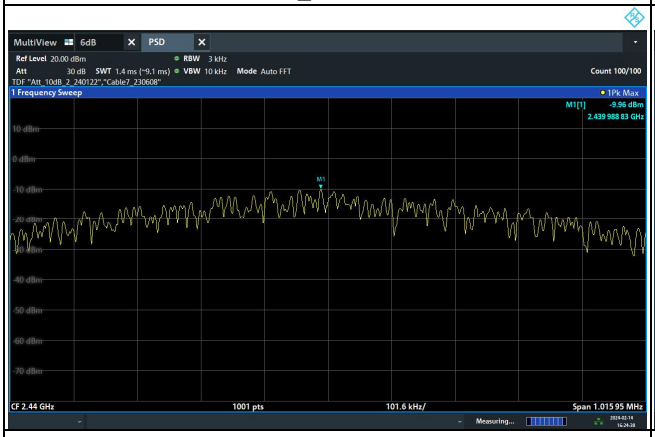
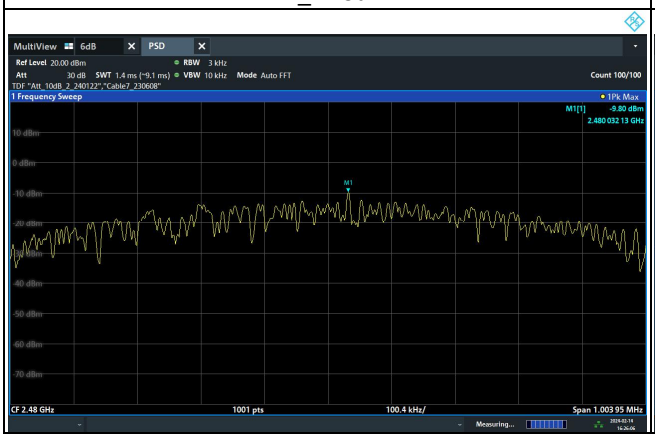
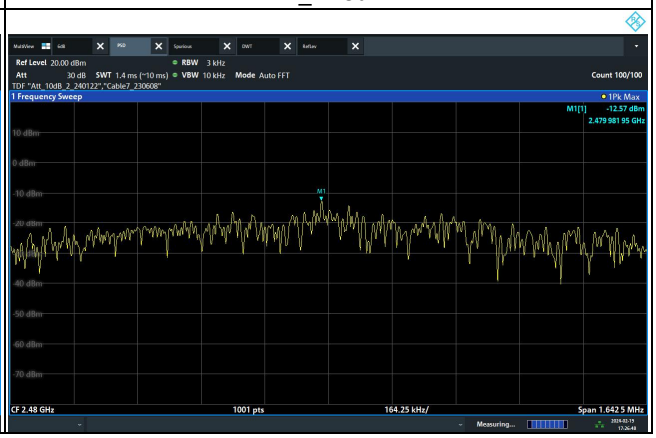
6.4.4 Test Result

Test Mode	Channel	Frequency [MHz]	3 kHz PSD [dBm]	Limit [dBm]	Margin [dB]
802.11b	1	2 412	-21.76	8	29.76
	6	2 437	-20.60		28.60
	11	2 462	-21.50		29.50
802.11g	1	2 412	-29.84	8	37.84
	6	2 437	-29.45		37.45
	11	2 462	-31.16		39.16
802.11n(HT20)	1	2 412	-30.82	8	38.82
	6	2 437	-31.50		39.50
	11	2 462	-31.52		39.52
802.11n(HT40)	3	2 422	-33.12	8	41.12
	6	2 437	-34.42		42.42
	9	2 452	-33.87		41.87
LE1M	0	2 402	-10.65	8	18.65
	19	2 440	-9.96		17.96
	39	2 480	-9.80		17.80
LE2M	0	2 402	-11.57	8	19.57
	19	2 440	-13.27		21.27
	39	2 480	-12.57		20.57

Test Plot of Power Spectral Density

Power Spectral Density	
802.11b_2 412 MHz	802.11g_2 412 MHz
	
802.11b_2 437 MHz	802.11g_2 437 MHz
	
802.11b_2 462 MHz	802.11g_2 462 MHz
	

Power Spectral Density	
802.11n(HT20)_2 412 MHz	802.11n(HT40)_2 422 MHz
	
802.11n(HT20)_2 437 MHz	802.11n(HT40)_2 437 MHz
	
802.11n(HT20)_2 462 MHz	802.11n(HT40)_2 452 MHz
	

Power Spectral Density	
LE1M_2 402 MHz	**LE2M_2 402 MHz**
	
LE1M_2 440 MHz	**LE2M_2 440 MHz**
	
LE1M_2 480 MHz	**LE2M_2 480 MHz**
	

6.5 Spurious Emission, Band edge and Restricted Bands

6.5.1 Regulation

§15.247(d) : 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 this section, 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)).

§15.209(a) : Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
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 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.

§15.205(a) : Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
[1]0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	([2])
13.36-13.41			

1Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

2Above 38.6

§15.205 (b) : Except as provided in paragraphs (d) and (e) of this section, 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.

6.5.2 Test Procedure

Spurious RF Conducted Emissions

a) Establish a reference level by using the following procedure:
   1) Set instrument center frequency to DTS channel center frequency.
   2) Set the span to ≥ 1.5 times the DTS bandwidth.
   3) Set the RBW = 100 kHz.
   4) Set the VBW ≥ [3 × RBW].
   5) Detector = peak.
   6) Sweep time = No faster than coupled (auto) time.
   7) Trace mode = max hold.
   8) Allow trace to fully stabilize.
   9) Use the peak marker function to determine the maximum PSD level.

b) Establish an emission level by using the following procedure:
   1) Set the center frequency and span to encompass frequency range to be measured.
   2) Set the RBW = 100 kHz.
   3) Set the VBW ≥ [3 × RBW].
   4) d) Detector = peak.
   5) e) Sweep time = No faster than coupled (auto) time.

6) f) Trace mode = max hold.
7) g) Allow trace to fully stabilize.
8) h) Use the peak marker function to determine the maximum amplitude level.

Spurious Radiated Emissions

1. The preliminary radiated measurement were performed to determine the frequency producing the maximum emissions in an semi-anechoic chamber at a distance of 3 meters.
2. The EUT was placed on the top of the 0.8-meter height, 1 x 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360º.
3. The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 kHz to 30 MHz using the loop antenna, and from 30 to 1000 MHz using the Bi-Log antenna, and from 1000 MHz to 26500 MHz using the horn antenna.
4. To obtain the final measurement data, the EUT was arranged on a turntable situated on a 4 x 4 meter in an semi-anechoic chamber. The EUT was tested at a distance 3 meters.
5. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector fuction with specified bandwidth.
6. The 0.8 m height is for below 1 GHz testing, and 1.5 m is for above 1GHz testing.

- Procedure for unwanted emissions measurements below 1 000 MHz

a) The procedure for unwanted emissions measurements below 1 000 MHz is as follows:
   1) Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   2) RBW =

Frequency	RBW
9 kHz to 150 kHz	200 Hz to 300 Hz
0.15 MHz to 30 MHz	9 kHz to 10 kHz
30 MHz to 1000 MHz	100 kHz to 120 kHZ

   3) Detector = CISPR Quasi-peak
   4) Sweep time = auto couple
   5) Compliance shall be determined using CISPR quasi-peak detection; however, peak detection is permitted as an alternative to quasi-peak detection.

- Procedure for peak unwanted emissions measurements above 1 000 MHz

The procedure for peak unwanted emissions measurements above 1 000 MHz is as follows:

a) Peak emission levels are measured by setting the instrument as follows:
   1) RBW = 1 MHz.
   2) VBW ≥ [3 × RBW].
   3) Detector = peak.
   4) Sweep time = No faster than coupled (auto) time.
   5) Trace mode = max hold.
   6) Allow sweeps to continue until the trace stabilizes. Note that if the transmission is not ontinuous, then the time required for the trace to stabilize will increase by a factor of pproximately 1 / D, where D is the duty cycle. For example, at 50 % duty cycle, the easurement time will increase by a factor of two, relative to measurement time for ontinuous transmission.

- Procedure for average unwanted emissions measurements above 1 000 MHz

Option 1)

a) The procedure full power method is as follows:

1) RBW = 1 MHz.
2) VBW ≥ [3 × RBW].
3) Detector = RMS (power averaging), if [span / (# of points in sweep)] ≤ (RBW / 2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
4) Averaging type = power (i.e., rms):
   - As an alternative, the detector and averaging type may be set for linear voltage averaging.
   - Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
5) Sweep time = auto.
6) Perform a trace average of at least 100 traces.

Option 2)

b) The procedure duty cycle correction method is as followes:

1) RBW = 1 MHz.
2) VBW ≥ [3 × RBW].
3) Detector = RMS (power averaging), if [span / (# of points in sweep)] ≤ (RBW / 2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
4) Averaging type = power (i.e., rms):
   - As an alternative, the detector and averaging type may be set for linear voltage averaging.
   - Some instruments require linear display mode to use linear voltage averaging. Log or dB averaging shall not be used.
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 with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle.
   - If power averaging (rms) mode, then the applicable correction factor is [10 log (1 / D)], where D is the duty cycle.

Option 3)

c) The procedure Reduced VBW method is as follows:

1) RBW = 1 MHz.
2) VBW ≥ 1/*T*
3) Video bandwidth mode or display mode:
   - The instrument 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).
   - As an alternative, the instrument 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 instruments require linear

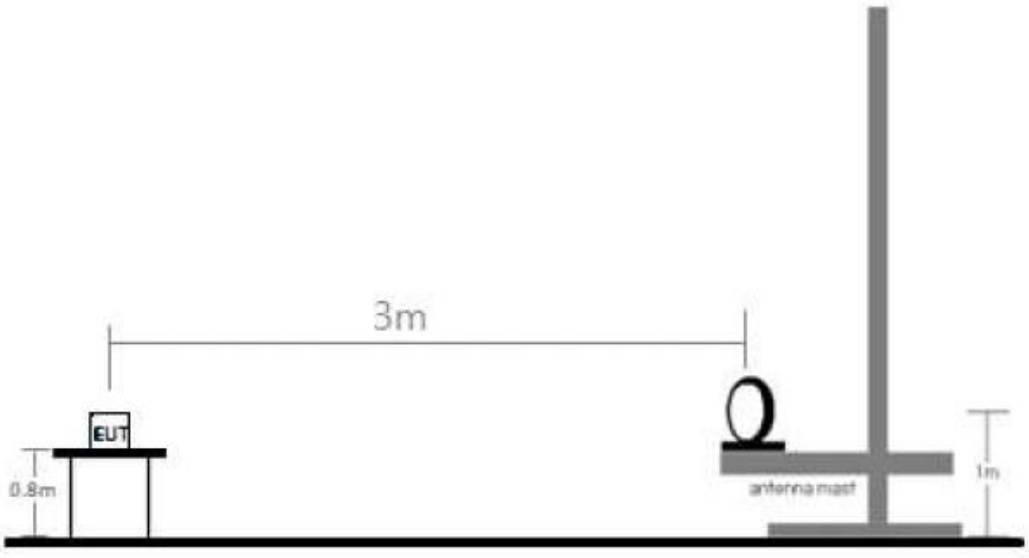
display mode to accomplish this. Others have a setting for average-VBW type, which can be set to "voltage" regardless of the display mode.

4) Detector = Peak
5) Sweep time = auto
6) Trace mode = max hold
7) Allow max hold to run for at least [50 x (1/D)] traces.

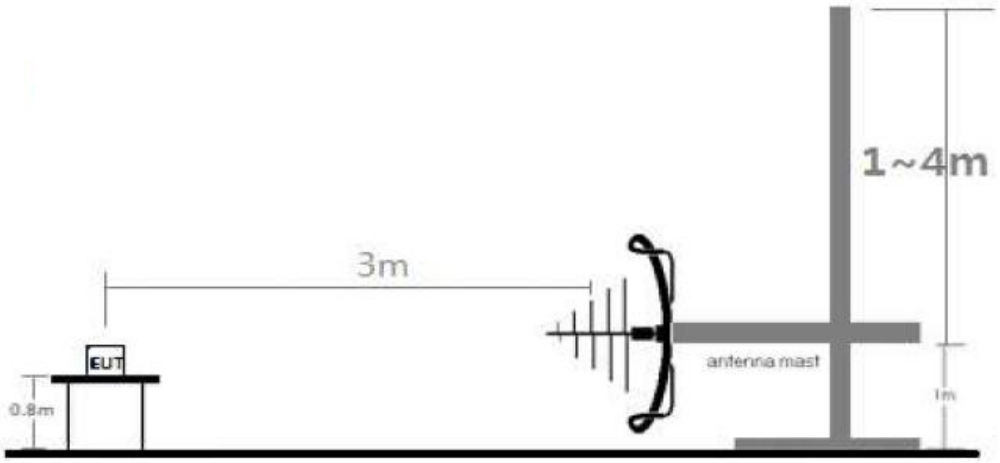
- Sample Calculation

- Field Strength Level [dBμV/m] = Analyzer Level [dBm] + 107 + AFCL [dB/m] + Duty Cycle Correction [dB]
- AFCL [dB/m] = Antenna Factor [dB/m] + Cable loss [dB]
- Margin [dB] = Field Strength Level [dBμV/m] – Limit [dBμV/m]

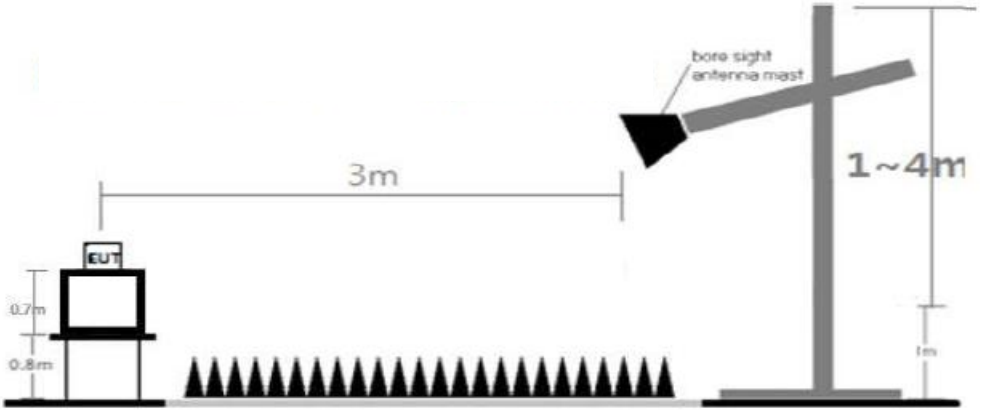
6.5.3 Test Setup

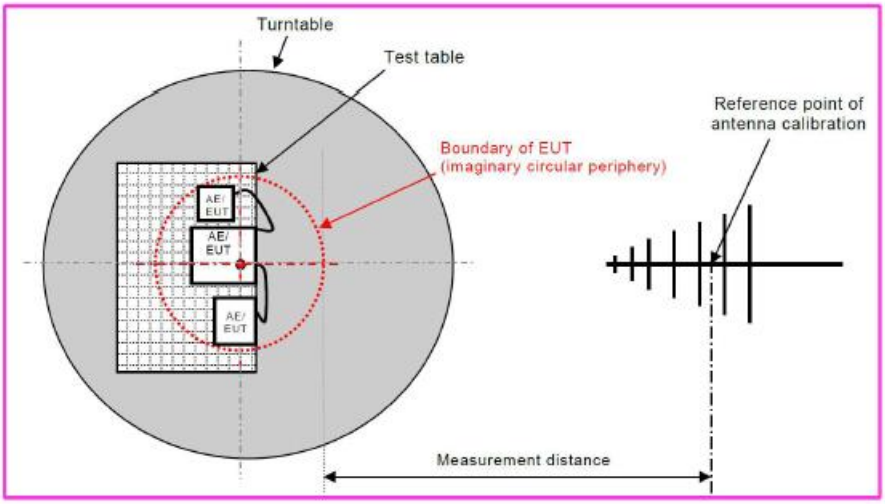


[Radiated Emission Test Setup Below 30 MHz]

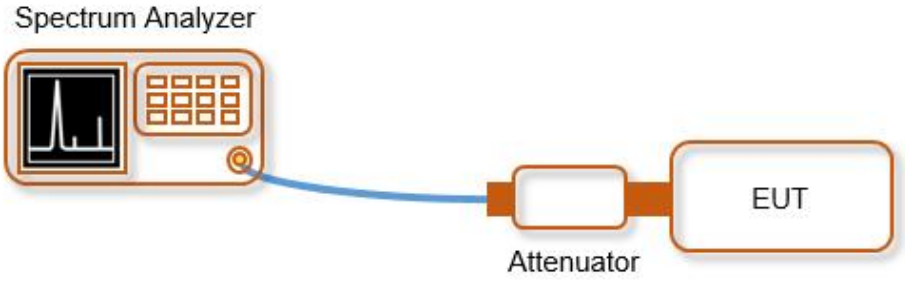


[Radiated Emission Test Setup Below 1 GHz]





[Radiated Emission Test Setup Above 1 GHz]

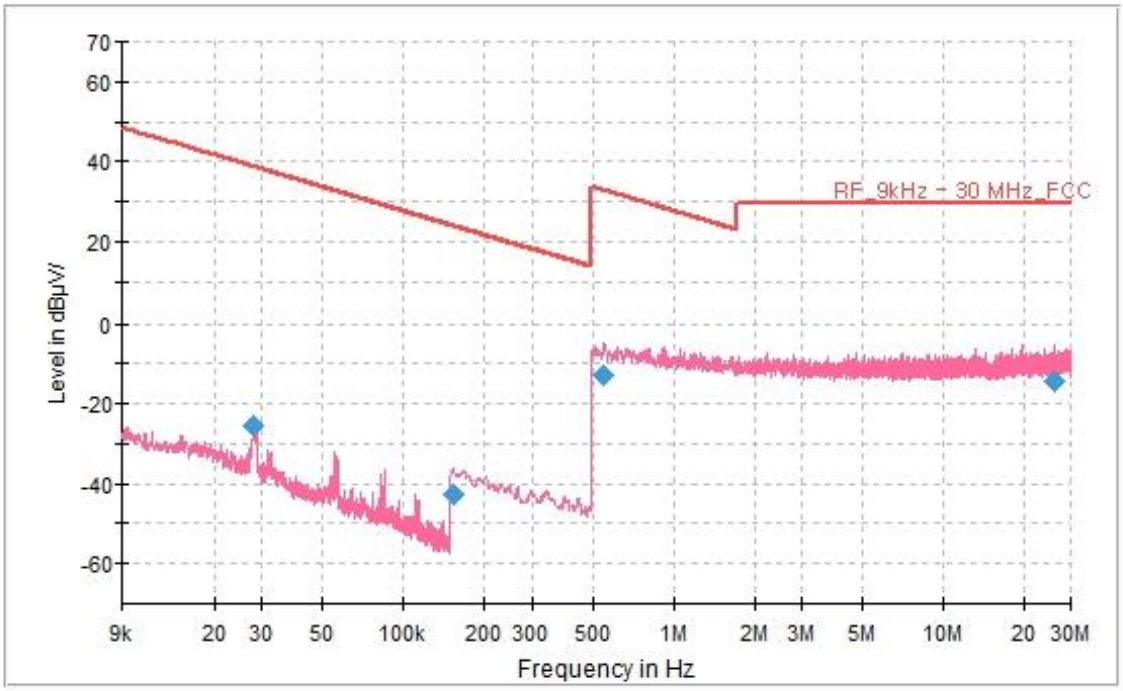


[Conducted Spurious Emission]

6.5.4 Test Result

Radiated Emission (Below 30 MHz)

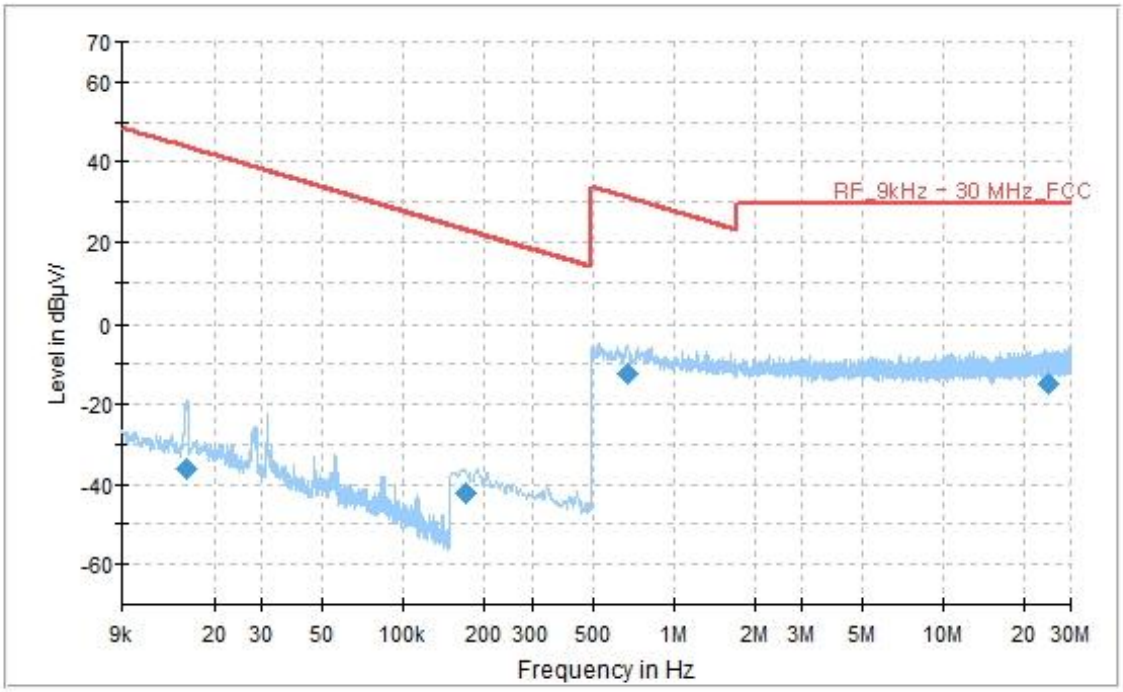
Worst case - RE(Below 30 MHz)_802.11n(HT40)_2 422 MHz



Frequency [MHz]	Quasi-peak Reading [dBuV]	Quasi-Peak Result [dBuV/m]	Distance Factor [dB]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Pol	Azimuth [deg]	Corrction Factor [dB/m]
0.028	33.84	-25.46	-80	38.71	64.17	100	Perpendicular	87	-59.30
0.154	16.83	-42.57	-80	23.87	66.44	100	Perpendicular	292	-59.40
0.548	6.32	-13.08	-40	32.82	45.91	100	Perpendicular	178	-19.40
26.257	2.99	-14.61	-40	29.54	44.15	100	Perpendicular	228	-17.60

Note)
1. Quasi Peak(dBuV/m) = QP Reading Value(dBµV) + Correction Factor(dB/m) + Distance Factor(dB)
2. Correction Factor(dB) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin(dB) = (Quasi Peak) Limit (dBµV/m) – (Quasi Peak) Result (dBµV/m)
4. We tested three kind of Antenna Pol (Parallel, Perpendicular, Ground parallel) and reported worst case antenna Pol.

Worst case - RE(Below 30 MHz)_LE1M_2 440 MHz



Frequency [MHz]	Quasi-peak Reading [dBuV]	Quasi-Peak Result [dBuV/m]	Distance Factor [dB]	Limit [dBuV/m]	Margin [dB]	Height [cm]	Pol	Azimuth [deg]	Corrction Factor [dB/m]
0.016	23.08	-36.32	-80	43.66	79.97	100	Ground parallel	234	-59.40
0.171	16.96	-42.44	-80	22.97	65.41	100	Ground parallel	183	-59.40
0.675	7.02	-12.38	-40	31.02	43.40	100	Ground parallel	208	-19.40
24.912	2.82	-14.88	-40	29.54	44.42	100	Ground parallel	110	-17.70

Note)
1. Quasi Peak(dBuV/m) = QP Reading Value(dBµV) + Correction Factor(dB/m) + Distance Factor(dB)
2. Correction Factor(dB) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin(dB) = (Quasi Peak) Limit (dBµV/m) – (Quasi Peak) Result (dBµV/m)
4. We tested three kind of Antenna Pol (Parallel, Perpendicular, Ground parallel) and reported worst case antenna Pol.