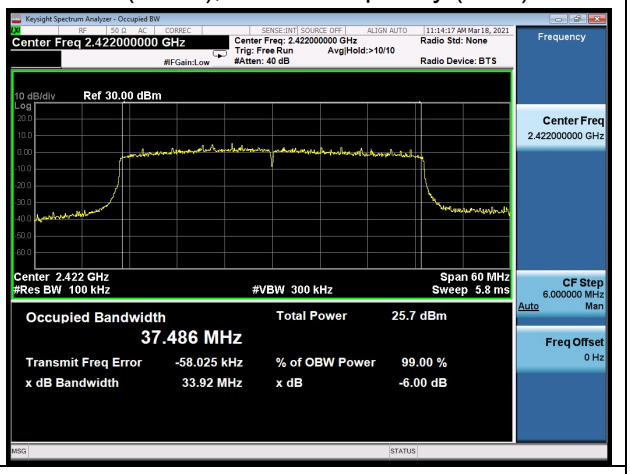
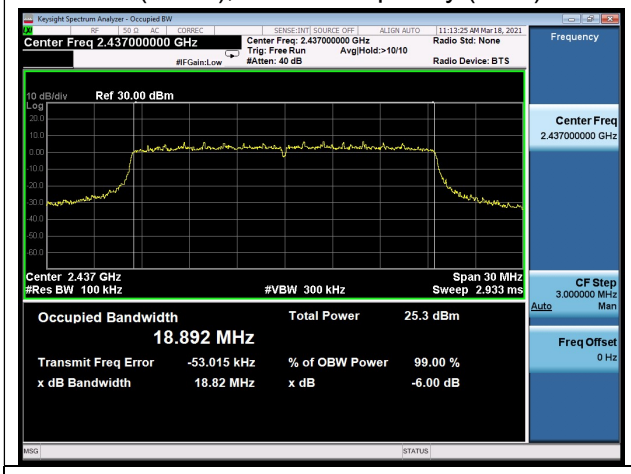
802.11ax(HE20), Carrier frequency (MHz): 2412

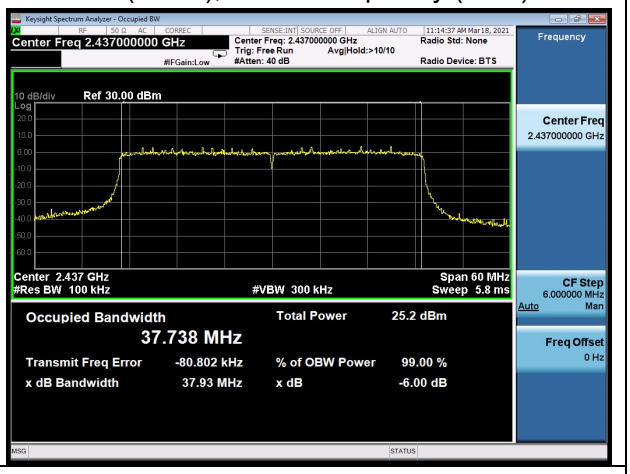
802.11ax(HE40), Carrier frequency (MHz): 2422



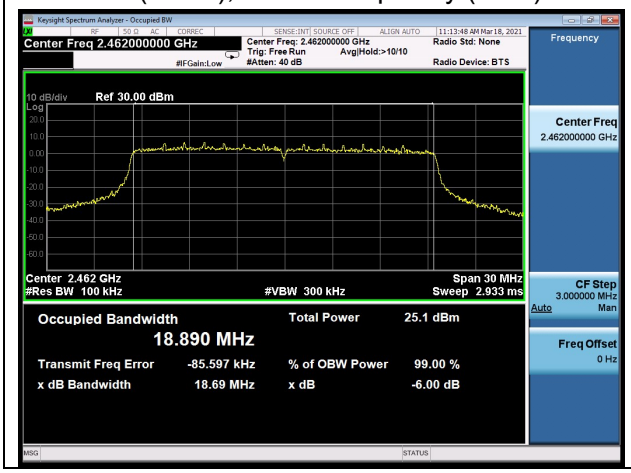
802.11ax(HE20), Carrier frequency (MHz): 2437



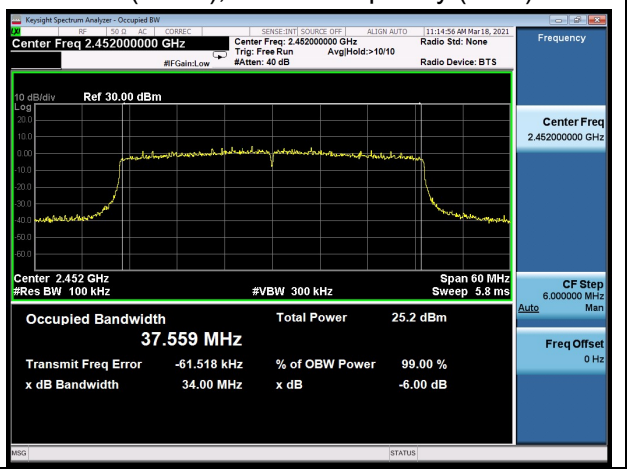
802.11ax(HE40), Carrier frequency (MHz): 2437



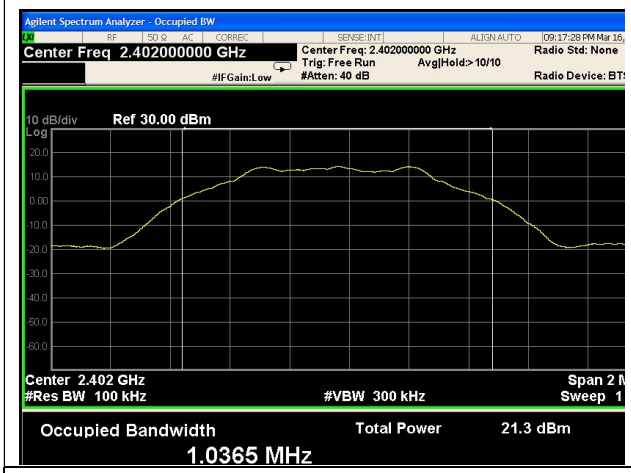
802.11ax(HE20), Carrier frequency (MHz): 2437



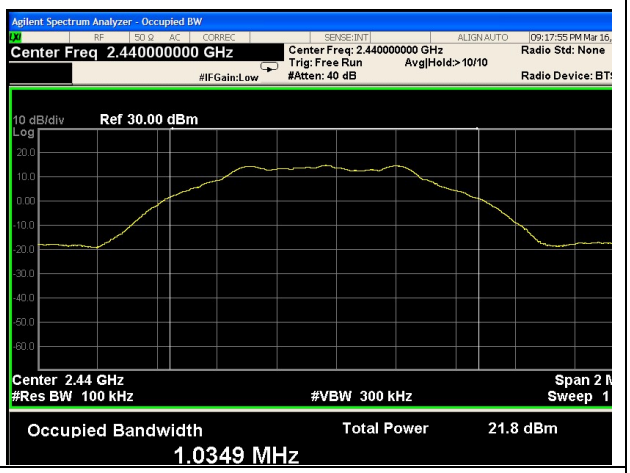
802.11ax(HE40), Carrier frequency (MHz):2452



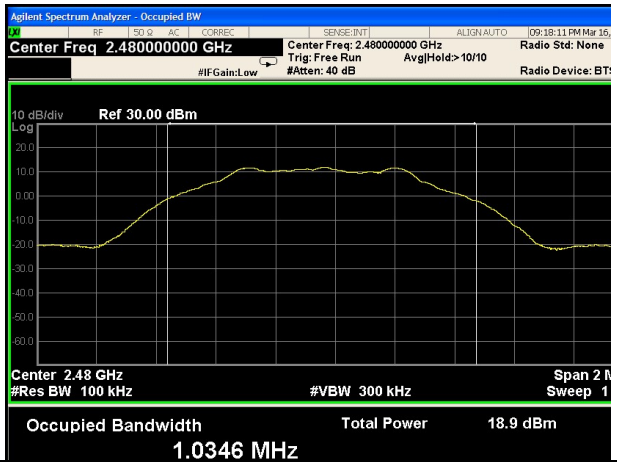
Bluetooth LE (125K) Carrier frequency (MHz): 2402



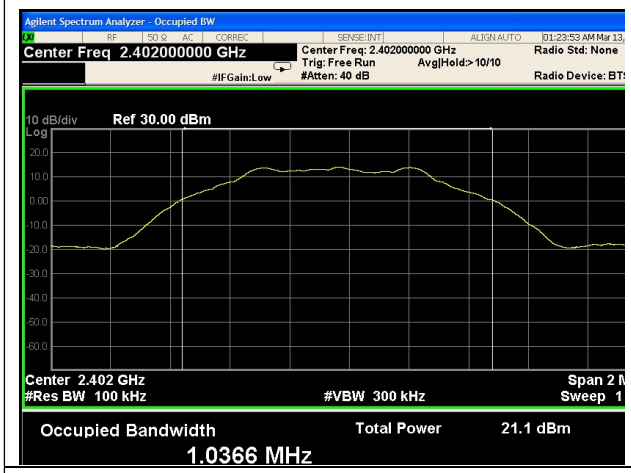
Bluetooth LE (125K) Carrier frequency (MHz): 2440



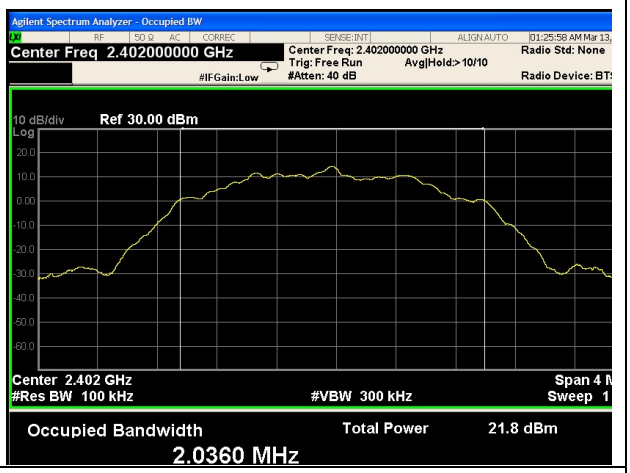
Bluetooth LE (125K) Carrier frequency (MHz): 2480



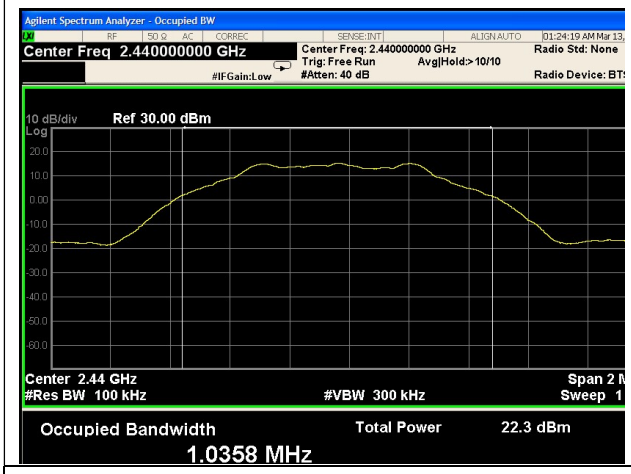
Bluetooth LE (1M) Carrier frequency (MHz): 2402



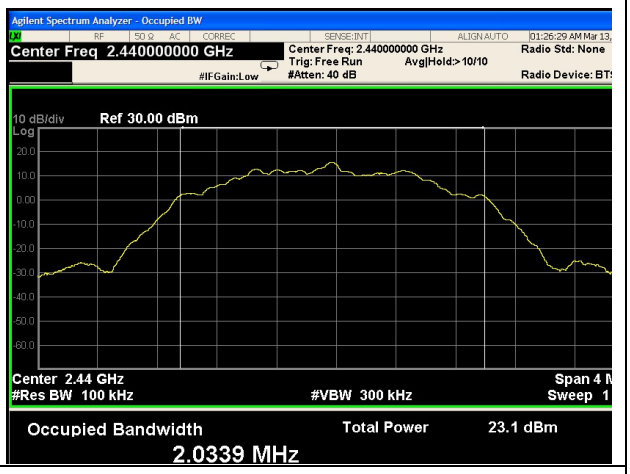
Bluetooth LE (2M) Carrier frequency (MHz): 2402



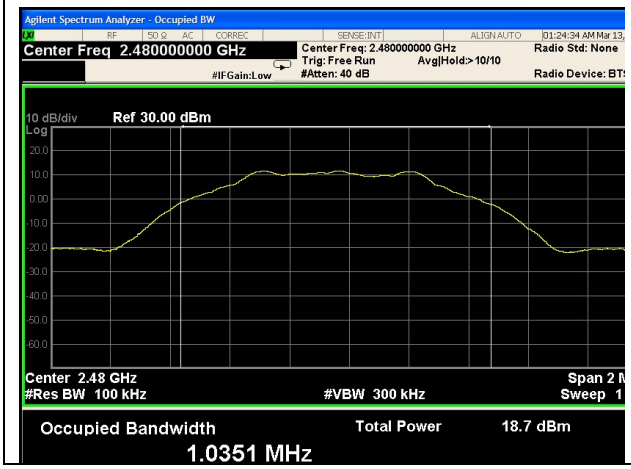
Bluetooth LE (1M) Carrier frequency (MHz): 2440



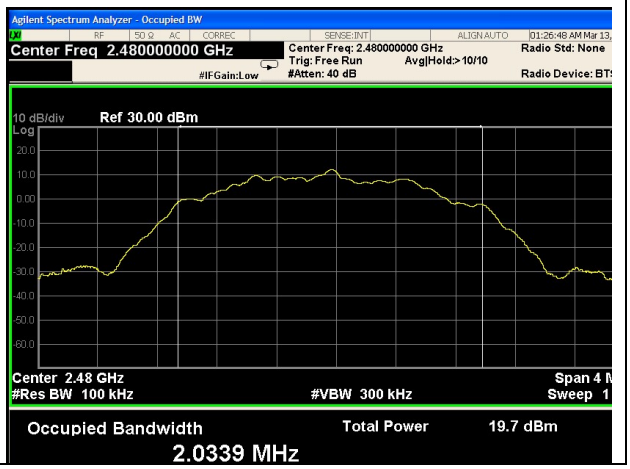
Bluetooth LE (2M) Carrier frequency (MHz): 2440



Bluetooth LE (1M) Carrier frequency (MHz): 2480



Bluetooth LE (2M) Carrier frequency (MHz): 2480



5.3. Band Edge

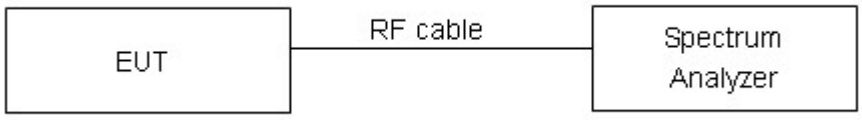
Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

The EUT was connected to the spectrum analyzer through an external attenuator (20dB) and a known loss cable the band edge of the lowest and highest channels were measured. The peak detector is used and RBW is set to 100 kHz and VBW is set to 300 kHz on spectrum analyzer. Spectrum analyzer plots are included on the following pages.

Test Setup



Limits

Rule Part 15.247(d) specifies that “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.”

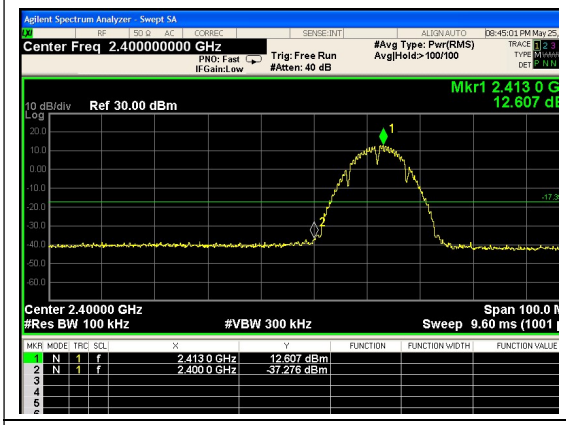
Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 1.96.

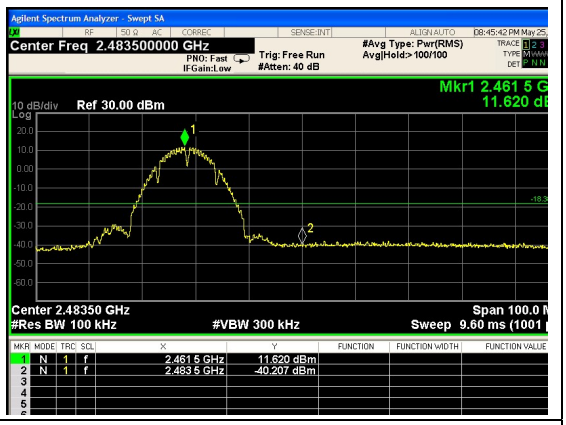
Frequency	Uncertainty
2GHz-3GHz	1.407 dB

Test Results: PASS

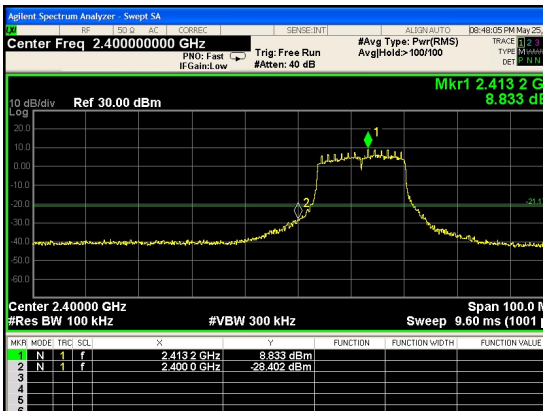
802.11b, Channel No.: 1



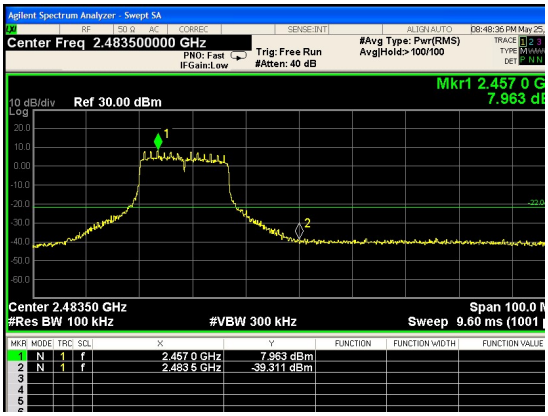
802.11b, Channel No.: 11



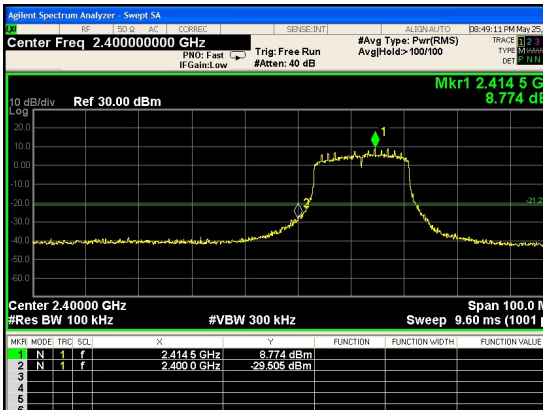
802.11g, Channel No.: 1



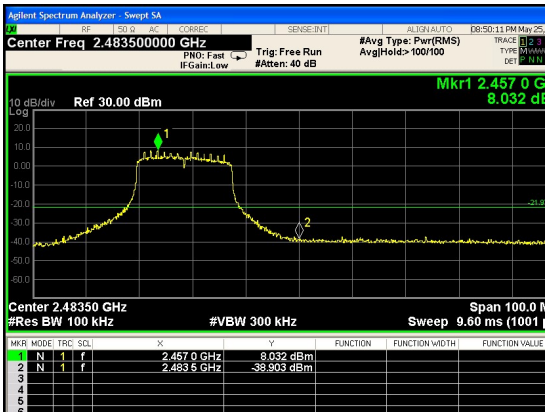
802.11g, Channel No.: 11



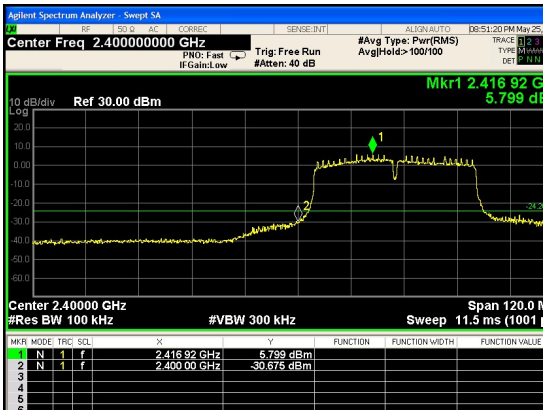
802.11n(HT20), Channel No.: 1



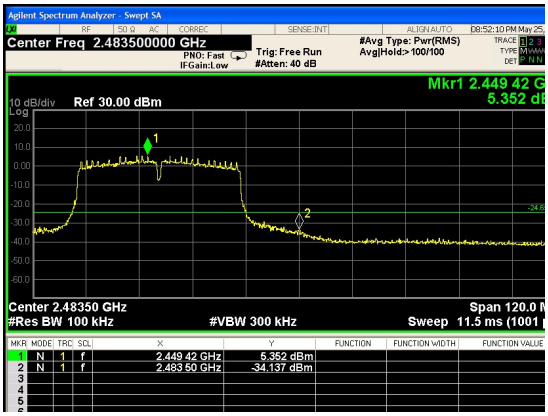
802.11n(HT20), Channel No.: 11



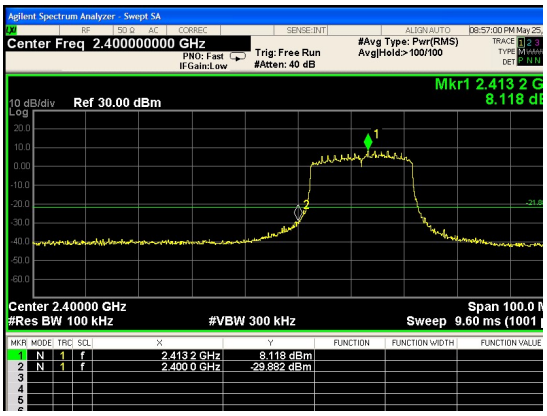
802.11n(HT40), Channel No.: 3



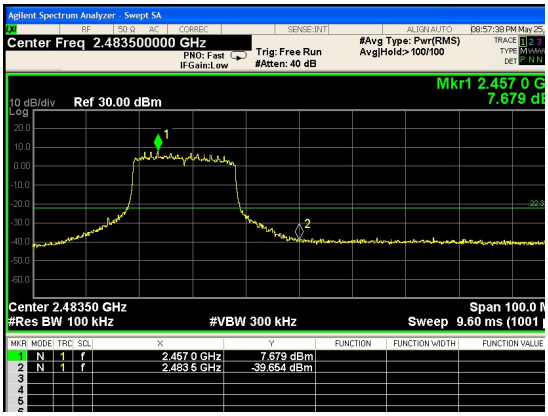
802.11n(HT40), Channel No.: 9



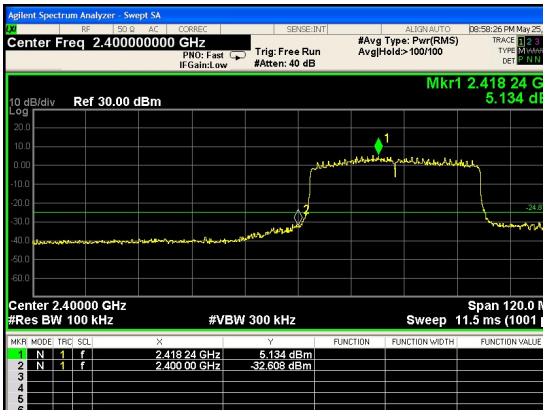
802.11ax(HE20), Channel No.: 1



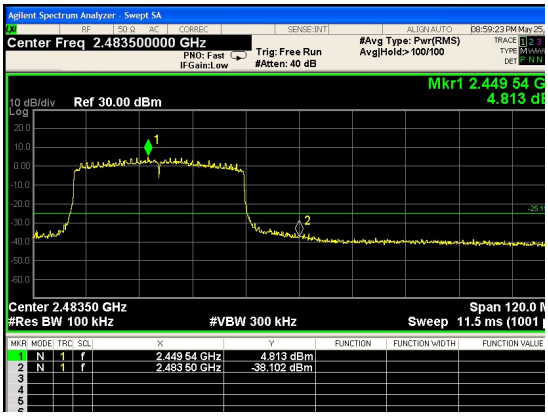
802.11 ax(HE20), Channel No.: 11



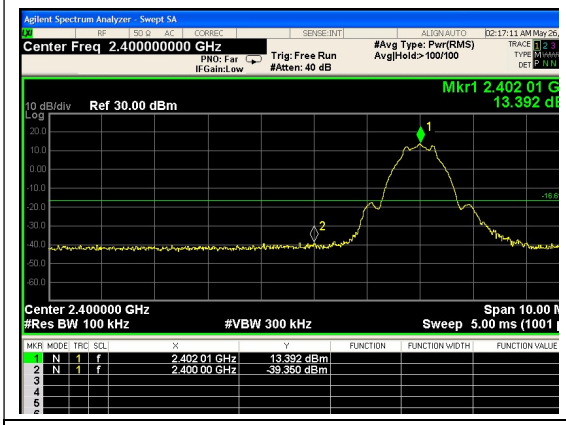
802.11 ax(HE40), Channel No.: 3



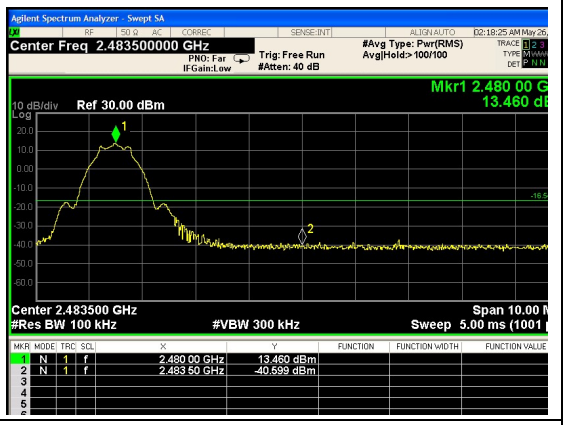
802.11 ax(HE40), Channel No.: 9



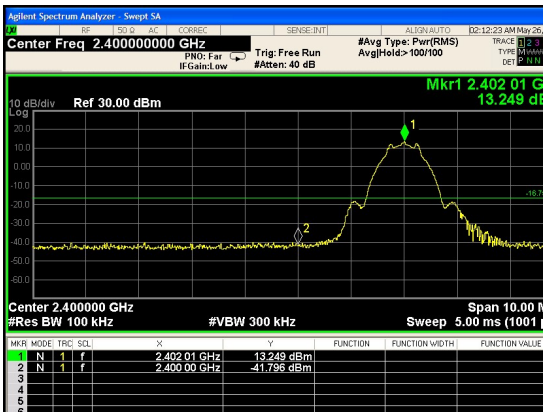
Bluetooth LE (125K), Channel No.: 0



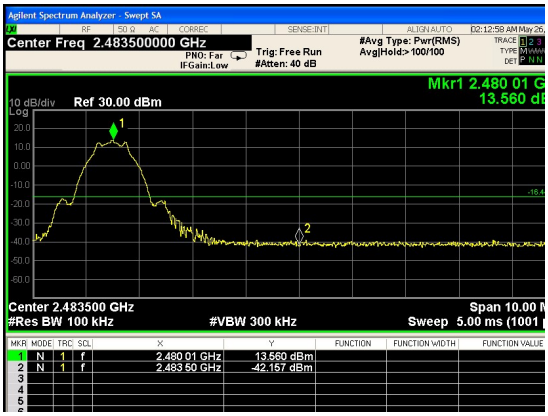
Bluetooth LE (125K), Channel No.: 39

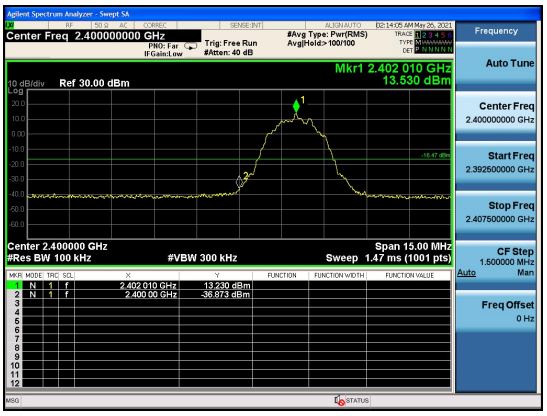
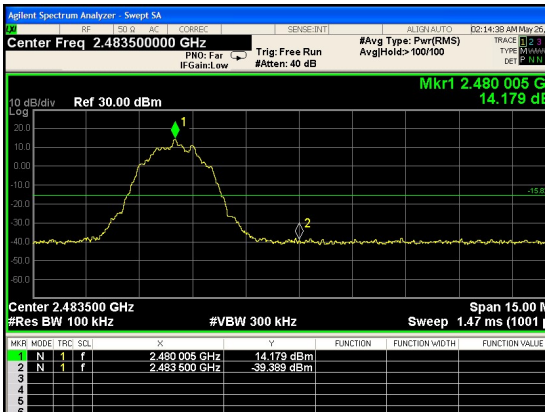


Bluetooth LE (1M), Channel No.: 0



Bluetooth LE (1M), Channel No.: 39



Bluetooth LE (2M), Channel No.: 0	Bluetooth LE (2M), Channel No.: 39
	

5.4. Power Spectral Density

Ambient condition

Temperature	Relative humidity	Pressure
23°C ~25°C	45%~50%	101.5kPa

Method of Measurement

During the process of the testing, The EUT was connected to Spectrum Analyzer with a known loss. The EUT is max power transmission with proper modulation.

Method AVGPSD-1 was used for this test.

a) Set instrument center frequency to DTS channel center frequency

b) Set span to at least 1.5 times the OBW

c) Set RBW to:3kHz≤RBW≤100kHz

d) Set VBW≥[3x RBW]

e) Detector=power averaging(rms) or sample detector(when rms not available)

f) Ensure that the number of measurement points in the sweep 2[2 X span/RBWT]

g)Sweep time auto couple

h) Employ trace averaging(rms) mode over a minimum of 100 traces

i) Use the peak marker function to determine the maximum amplitude level.

j) If the measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat(note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced)

Method AVGPSD-2 was used for this test.

a) Measure the duty cycle(D)of the transmitter output signal as described in 11.6

b) Set instrument center frequency to DTS channel center frequency

c)Set span to at least 1.5 times the OBW

d) Set RBW to:3kHz≤RBW≤100Kh

e) Set VBW≥[3x RBW]

f)Detector= power averaging(rms) or sample detector (when rms not available)

g) Ensure that the number of measurement points in the sweep 2[2 X span/RBW]

h) Sweep time =auto couple

i) Do not use sweep triggering; allow sweep to "free run”

j) Employ trace averaging(rms) mode over a minimum of 100 traces

k) Use the peak marker function to determine the maximum amplitude level

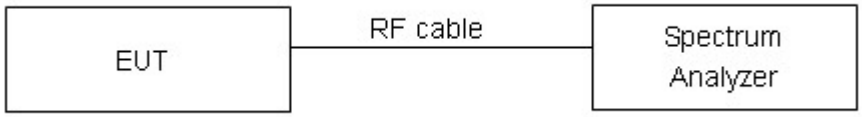
l) Add [10 log(1/ D)], where D is the duty cycle measured in step a), to the measured PSD to

compute the average PSD during the actual transmission time

m) If measured value exceeds requirement specified by regulatory agency then reduce RBW(but o less than 3 kHz) and repeat(note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced)

The conducted Power is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically.

Test setup



Limits

Rule Part 15.247(e) specifies that" 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. ''

Limits	≤ 8 dBm / 3kHz

Measurement Uncertainty

The assessed measurement uncertainty to ensure 95% confidence level for the normal distribution is with the coverage factor k = 2, U= 0.75dB.

Test Results:

Test Mode	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
Bluetooth (Low Energy) (125K)	0	-4.57	-2.50	8	PASS
	19	-2.90	-0.83	8	PASS
	39	-7.14	-5.06	8	PASS
Bluetooth (Low Energy) (1M)	0	-4.43	-2.32	8	PASS
	19	-3.23	-1.12	8	PASS
	39	-7.64	-5.53	8	PASS
Bluetooth (Low Energy) (2M)	0	-7.45	-2.53	8	PASS
	19	-5.90	-0.98	8	PASS
	39	-9.16	-4.24	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

SISO

Antenna 1

Test Mode	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11b	1	-12.51	-12.51	8	PASS
	6	-13.36	-13.36	8	PASS
	11	-13.98	-13.98	8	PASS
802.11g	1	-15.13	-15.13	8	PASS
	6	-16.29	-16.29	8	PASS
	11	-16.67	-16.67	8	PASS
802.11n HT20	1	-16.07	-16.07	8	PASS
	6	-17.25	-17.25	8	PASS
	11	-17.16	-17.16	8	PASS
802.11n HT40	3	-18.65	-18.65	8	PASS
	6	-19.69	-19.69	8	PASS
	9	-18.95	-18.95	8	PASS
802.11ax HE20	1	-18.16	-18.16	8	PASS
	6	-19.37	-19.37	8	PASS
	11	-19.40	-19.40	8	PASS
802.11ax HE40	3	-21.34	-21.34	8	PASS
	6	-22.06	-22.06	8	PASS

	9	-21.19	-21.19	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

Antenna 2

Test Mode	Channel Number	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Limit (dBm / 3kHz)	Conclusion
802.11b	1	-10.87	-10.87	8	PASS
	6	-10.70	-10.70	8	PASS
	11	-11.73	-11.73	8	PASS
802.11g	1	-16.00	-16.00	8	PASS
	6	-16.22	-16.22	8	PASS
	11	-16.71	-16.71	8	PASS
802.11n HT20	1	-16.57	-16.57	8	PASS
	6	-16.93	-16.93	8	PASS
	11	-17.29	-17.29	8	PASS
802.11n HT40	3	-19.37	-19.37	8	PASS
	6	-19.73	-19.73	8	PASS
	9	-19.06	-19.06	8	PASS
802.11ax HE20	1	-18.67	-18.67	8	PASS
	6	-18.96	-18.96	8	PASS
	11	-19.39	-19.39	8	PASS
802.11ax HE40	3	-21.88	-21.88	8	PASS
	6	-22.39	-22.39	8	PASS
	9	-21.44	-21.44	8	PASS
Note: Power Spectral Density =Read Value+Duty cycle correction factor					

MIMO

Without Beamforming

Test Mode	Channel Number	Power Spectral Density				Total PSD	Limit (dBm / 3kHz)	Conclusion
		Antenna 1		Antenna 2				
		Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	(dBm / 3kHz)		
802.11b	1	-10.47	-10.47	-10.88	-10.88	-7.66	5.61	PASS
	6	-12.02	-12.02	-11.03	-11.03	-8.49	5.61	PASS
	11	-12.86	-12.86	-11.92	-11.92	-9.35	5.61	PASS
802.11g	1	-15.94	-15.94	-15.69	-15.69	-12.80	5.61	PASS
	6	-16.89	-16.89	-15.97	-15.97	-13.39	5.61	PASS
	11	-17.25	-17.25	-16.58	-16.58	-13.89	5.61	PASS
802.11n HT20	1	-16.41	-16.41	-16.51	-16.51	-13.45	5.61	PASS
	6	-17.65	-17.65	-16.75	-16.75	-14.17	5.61	PASS
	11	-17.99	-17.99	-17.33	-17.33	-14.64	5.61	PASS
802.11n HT40	3	-19.37	-19.37	-19.62	-19.62	-16.48	5.61	PASS
	6	-20.25	-20.25	-20.53	-20.53	-17.38	5.61	PASS
	9	-19.69	-19.69	-19.06	-19.06	-16.35	5.61	PASS
802.11ax HE20	1	-20.10	-20.10	-18.41	-18.41	-16.16	5.61	PASS
	6	-19.71	-19.71	-18.84	-18.84	-16.24	5.61	PASS
	11	-19.84	-19.84	-19.39	-19.39	-16.60	5.61	PASS
802.11ax HE40	3	-21.79	-21.79	-21.80	-21.80	-18.79	5.61	PASS
	6	-22.67	-22.67	-22.47	-22.47	-19.56	5.61	PASS
	9	-21.99	-21.99	-22.24	-22.24	-19.11	5.61	PASS

Note: 1.Power Spectral Density =Read Value+Duty cycle correction factor

2. For Total PSD, according to KDB 662911 D01 Multiple Transmitter Output v02r01 2)a),the power spectral density=$10\log(10^{(\text{PSD antenna1 in dBm/10})}+10^{(\text{PSD antenna2 in dBm/10})}$

3. The manufacturer declared the transmitter output signals is CDD mode. And N_{ss}=1. According to KDB 662911 D01 Multiple Transmitter Output v02r01 2)f)(i): If all antennas have the same gain, Directional gain = G_{ANT} + Array Gain. For PSD measurements on all devices, Array Gain=10log(Nant/Nss)dB, so directional gain=GANT+Array Gain=5.38+10log(2/1)=8.39>6dBi.

So the power limt is 8+6-MAX(6, directional gain)dBm=5.61 dBm

With Beamforming

Test Mode	Channel Number	Power Spectral Density				Total PSD	Limit (dBm / 3kHz)	Conclusion
		Antenna 1		Antenna 2				
		Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	Read Value (dBm / 3kHz)	Power Spectral Density (dBm / 3kHz)	(dBm / 3kHz)		
802.11b	1	-11.60	-11.60	-12.10	-12.10	-8.83	5.61	PASS
	6	-12.69	-12.69	-12.52	-12.52	-9.59	5.61	PASS
	11	-13.75	-13.75	-13.34	-13.34	-10.53	5.61	PASS
802.11g	1	-16.27	-16.27	-17.01	-17.01	-13.61	5.61	PASS
	6	-17.54	-17.54	-17.20	-17.20	-14.35	5.61	PASS
	11	-17.90	-17.90	-17.73	-17.73	-14.80	5.61	PASS
802.11n HT20	1	-16.83	-16.83	-17.01	-17.01	-13.91	5.61	PASS
	6	-19.24	-19.24	-18.73	-18.73	-15.97	5.61	PASS
	11	-19.10	-19.10	-18.79	-18.79	-15.93	5.61	PASS
802.11n HT40	3	-20.42	-20.42	-20.31	-20.31	-17.36	5.61	PASS
	6	-21.94	-21.94	-21.35	-21.35	-18.62	5.61	PASS
	9	-19.63	-19.63	-19.41	-19.41	-16.51	5.61	PASS
802.11ax HE20	1	-19.40	-19.40	-18.44	-18.44	-15.88	5.61	PASS
	6	-19.90	-19.90	-19.35	-19.35	-16.61	5.61	PASS
	11	-19.97	-19.97	-19.70	-19.70	-16.82	5.61	PASS
802.11ax HE40	3	-22.07	-22.07	-21.69	-21.69	-18.86	5.61	PASS
	6	-23.44	-23.44	-22.55	-22.55	-19.96	5.61	PASS
	9	-22.01	-22.01	-21.71	-21.71	-18.85	5.61	PASS

Note: 1.Power Spectral Density =Read Value+Duty cycle correction factor

2. For Total PSD, according to KDB 662911 D01 Multiple Transmitter Output v02r01 2)a),the power spectral density=$10\log(10^{(\text{PSD antenna1 in dBm/10})}+10^{(\text{PSD antenna2 in dBm/10})}$

3. The manufacturer declared the transmitter output signals is CDD mode. And N_{ss}=1. According to KDB 662911 D01 Multiple Transmitter Output v02r01 2)f)(i): If all antennas have the same gain, Directional gain = G_{ANT} + Array Gain. For PSD measurements on all devices, Array Gain=10log(Nant/Nss)dB, so directional gain=GANT+Array Gain=5.38+10log(2/1)=8.39>6dBi.

So the power limt is 8+6-MAX(6, directional gain)dBm=5.61 dBm