802.11-HT40 (DFS)

Low Channel (5 270 ㎒)

High Channel (5 310 ㎒)

802.11-HT40 (DFS)

Low Channel (5 510 ㎒)

High Channel (5 670 ㎒)

ANT1

802.11a (Non-DFS)

Low Channel (5 180 ㎒)

Middle Channel (5 220 ㎒)

High Channel (5 240 ㎒)

802.11a (DFS)

Low Channel (5 260 ㎒)

Middle Channel (5 300 ㎒)

High Channel (5 320 ㎒)

802.11a (DFS)

Low Channel (5 500 ㎒)

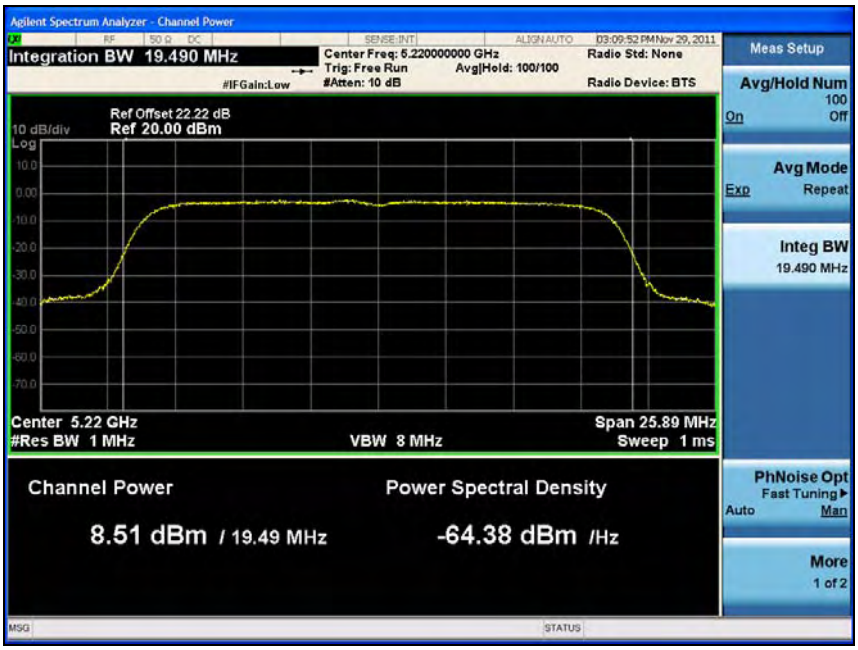
Middle Channel (5 600 ㎒)

High Channel (5 700 ㎒)

802.11n-HT20 (Non-DFS)

Low Channel (5 180 ㎒)

Middle Channel (5 220 ㎒)



High Channel (5 240 ㎒)

802.11-HT20 (DFS)

Low Channel (5 260 ㎒)

Middle Channel (5 300 ㎒)

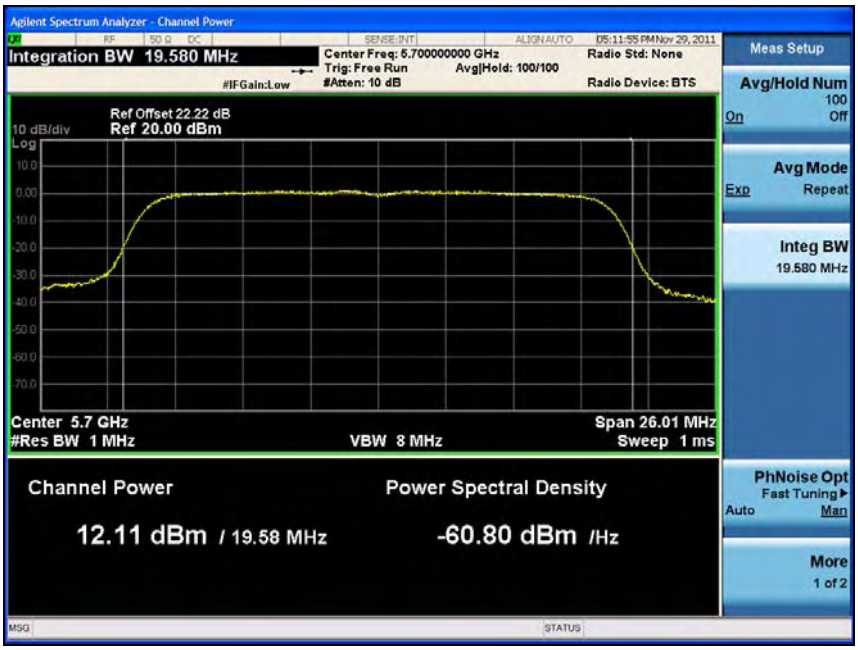
High Channel (5 320 ㎒)

802.11-HT20 (DFS)

Low Channel (5 500 ㎒)

Middle Channel (5 600 ㎒)

High Channel (5 700 ㎒)



802.11n-HT40 (Non-DFS)

Low Channel (5 190 ㎒)

High Channel (5 230 ㎒)

802.11-HT40 (DFS)

Low Channel (5 270 ㎒)

High Channel (5 310 ㎒)

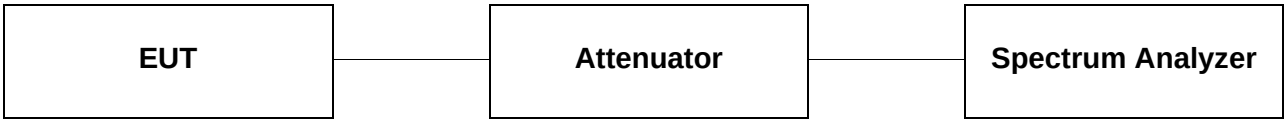
802.11-HT40 (DFS)

Low Channel (5 510 ㎒)

High Channel (5 670 ㎒)

6. Peak power spectral density

6.1. Test setup



6.2. Limit

6.2.1. FCC 15.407

(a)(1)

For the band 5.15-5.25 ㎓ band, the peak power spectral density shall not exceed 4 ㏈m in any 1 ㎒ band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the peak transmit power and the peak power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

(a)(2)

For the band 5.25–5.35 ㎓ and 5.47–5.725 ㎓ bands, the peak power spectral density shall not exceed 11 ㏈m in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the maximum conducted output power and the peak power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

6.2.2. IC RSS-210

A9.2(1) Band 5150-5250 MHz

The e.i.r.p.. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

A9.2(2) Band 5250-5350 MHz

The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

A9.2(3) Band 5600-5650 MHz

The power spectral density shall not exceed 11 dBm in any 1.0 MHz band.

6.3. Test procedure

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set span to encompass the entire emission bandwidth of the signal.
4. Set RBW=1 MHz, VBW ≥ 3 MHz, Number of points in sweep ≥ 2 span / RBW, Sweep time = auto, Detector = RMS.
5. If transmit duty cycle < 98 percent, use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98 percent, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to “free run”.
6. Trace average at least 100 traces in power averaging (i.e., RMS) mode.
7. Use the peak search function on the spectrum analyzer to find the peak of the spectrum.

6.4. Test result

Ambient temperature : (24 ± 2) ℃
Relative humidity : 49 % R.H.

6.4.1. Non-DFS Band

Operation Mode	Antenna	Channel	Channel Frequency (㎒)	Peak power spectral density		Limit	
				FCC (㏈ m)	IC (㏈ m e.i.r.p.)	FCC (㏈ m)	IC (㏈ m e.i.r.p.)
11a	ANT0	Low	5 180	-5.13	-4.57	4	10
		Middle	5 220	-6.12	-5.56		
		High	5 240	-6.08	-5.52		
	ANT1	Low	5 180	-0.92	1.21		
		Middle	5 220	-2.68	-0.55		
		High	5 240	-3.09	-0.96		
11n_HT20	ANT0	Low	5 180	-4.97	-4.41		
		Middle	5 220	-6.02	-5.46		
		High	5 240	-6.13	-5.57		
	ANT1	Low	5 180	-1.30	0.83		
		Middle	5 220	-2.39	-0.26		
		High	5 240	-3.08	-0.95		
	ANT0+ANT1 (Calculated)	Low	5 180	0.25	4.64		
		Middle	5 220	-0.83	3.56		
		High	5 240	-1.33	3.06		
11n_HT40	ANT0	Low	5 190	-9.49	-8.93		
		High	5 230	-10.48	-9.92		
	ANT1	Low	5 190	-5.89	-3.76		
		High	5 230	-6.95	-4.82		
	ANT0+ANT1 (Calculated)	Low	5 190	-4.32	0.07		
		High	5 230	-5.36	-0.97		

6.4.2. DFS Band

Operation Mode	Antenna	Channel	Channel Frequency (㎒)	Peak power spectral density (㏈ m)	Limit (㏈ m)
11a	ANT0	Lower Band	5 260	-5.58	11
			5 300	-6.04	
			5 320	-6.10	
		Upper Band	5 500	-2.23	
			5 600	-2.11	
			5 700	1.47	
	ANT1	Lower Band	5 260	-2.20	
			5 300	-3.09	
			5 320	-3.60	
		Upper Band	5 500	-2.13	
			5 600	-3.12	
			5 700	1..47	
11n_HT20	ANT0	Lower Band	5 260	-5.70	
			5 300	-6.16	
			5 320	-6.25	
		Upper Band	5 500	-2.56	
			5 600	-2.52	
			5 700	1.28	
	ANT1	Lower Band	5 260	-2.31	
			5 300	-3.48	
			5 320	-3.67	
		Upper Band	5 500	-2.32	
			5 600	-2.86	
			5 700	1.62	
	ANT0+ANT1 (Calculated)	Lower Band	5 260	-0.67	
			5 300	-1.61	
			5 320	-1.76	
		Upper Band	5 500	0.57	
			5 600	0.32	
			5 700	4.46	

Operation Mode	Antenna	Channel	Channel Frequency (㎒)	Peak power spectral density (㏈m)	Limit (㏈m)
11n_HT40	ANT0	Lower Band	5 270	-10.06	
			5 310	-10.39	
		Upper Band	5 510	-6.63	
			5 670	-5.16	
	ANT1	Lower Band	5 270	-6.24	
			5 310	-7.61	
		Upper Band	5 510	-6.63	
			5 670	-6.71	
	ANT0+ANT1 (Calculated)	Lower Band	5 270	-4.73	
			5 310	-5.77	
		Upper Band	5 510	-3.62	
			5 670	-2.86	

ANT0

802.11a (Non-DFS)

Low Channel (5 180 ㎒)

Middle Channel (5 220 ㎒)

High Channel (5 240 ㎒)

802.11a (DFS)

Low Channel (5 260 ㎒)

Middle Channel (5 300 ㎒)

High Channel (5 320 ㎒)

802.11a (DFS)

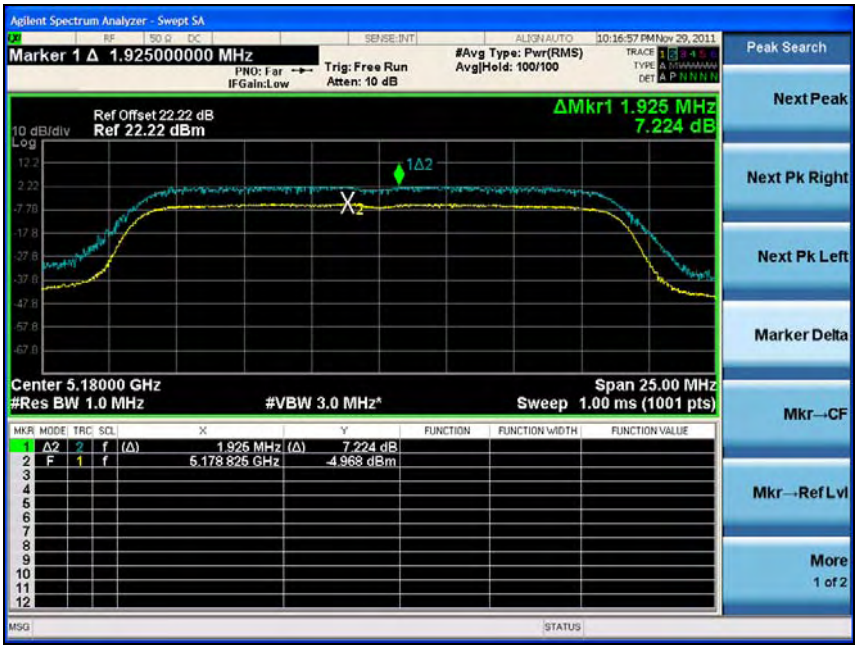
Low Channel (5 500 ㎒)

Middle Channel (5 600 ㎒)

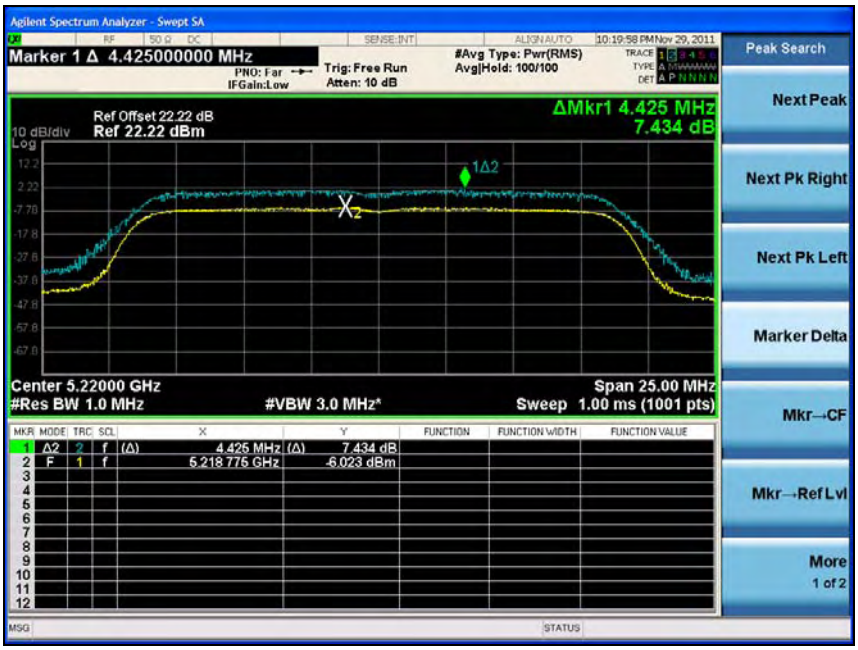
High Channel (5 700 ㎒)

802.11n-HT20 (Non-DFS)

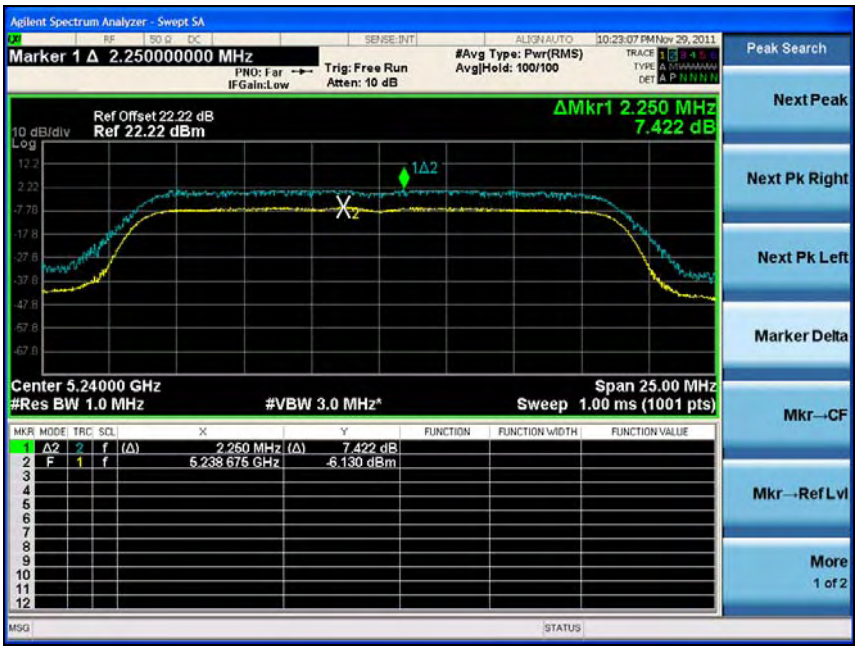
Low Channel (5 180 ㎒)



Middle Channel (5 220 ㎒)

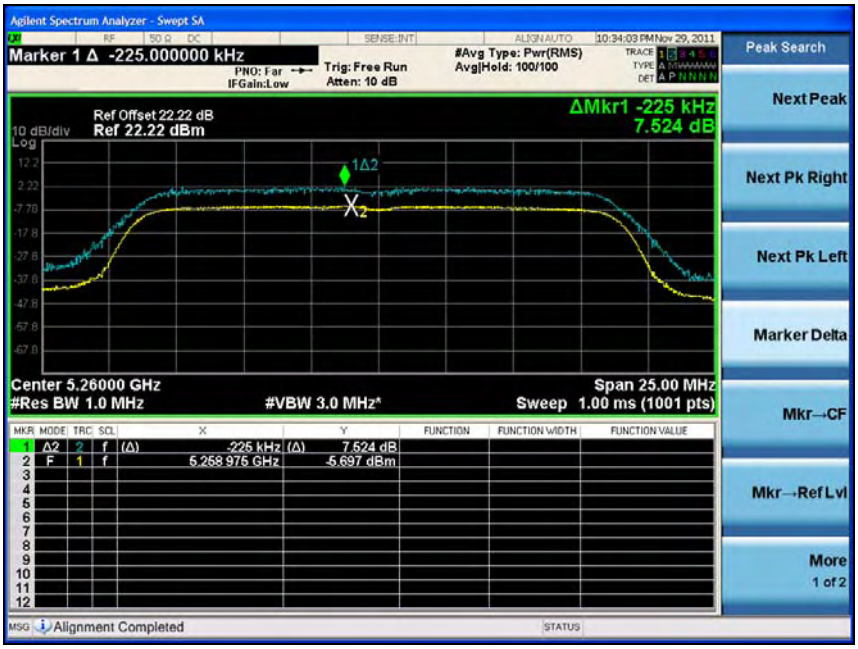


High Channel (5 240 ㎒)

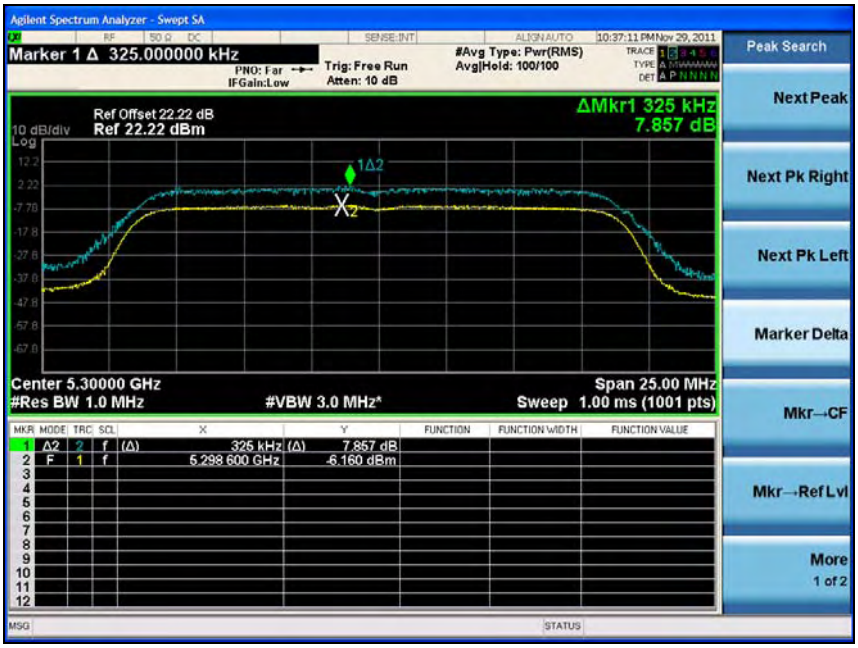


802.11-HT20 (DFS)

Low Channel (5 260 ㎒)



Middle Channel (5 300 ㎒)



High Channel (5 320 ㎒)

802.11-HT20 (DFS)

Low Channel (5 500 ㎒)

Middle Channel (5 600 ㎒)

High Channel (5 700 ㎒)

802.11n-HT40 (Non-DFS)

Low Channel (5 190 ㎒)

High Channel (5 230 ㎒)

802.11-HT40 (DFS)

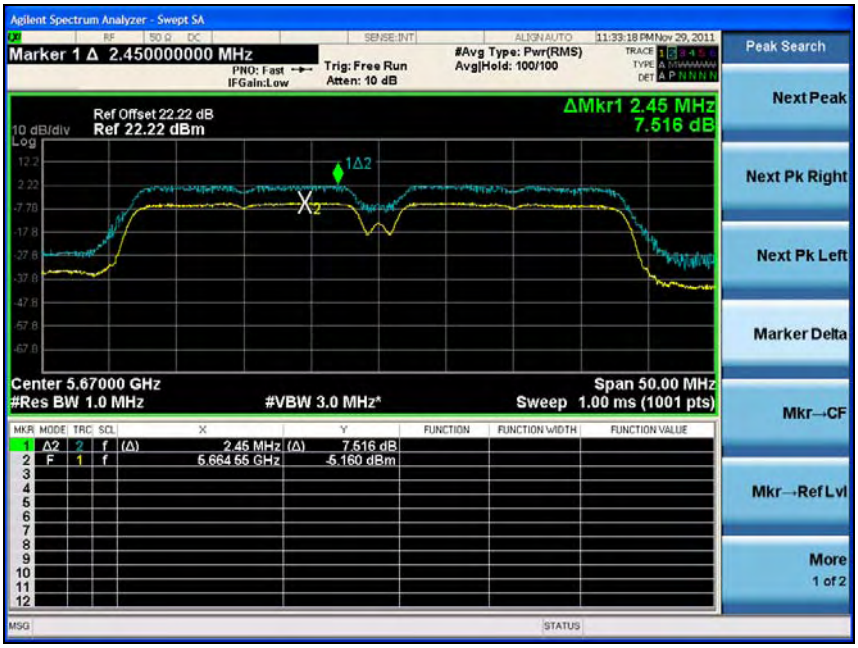
Low Channel (5 270 ㎒)

High Channel (5 310 ㎒)

802.11-HT40 (DFS)

Low Channel (5 510 ㎒)

High Channel (5 670 ㎒)



ANT1

802.11a (Non-DFS)

Low Channel (5 180 ㎒)

Middle Channel (5 220 ㎒)

High Channel (5 240 ㎒)

802.11a (DFS)

Low Channel (5 260 ㎒)

Middle Channel (5 300 ㎒)

High Channel (5 320 ㎒)

802.11a (DFS)

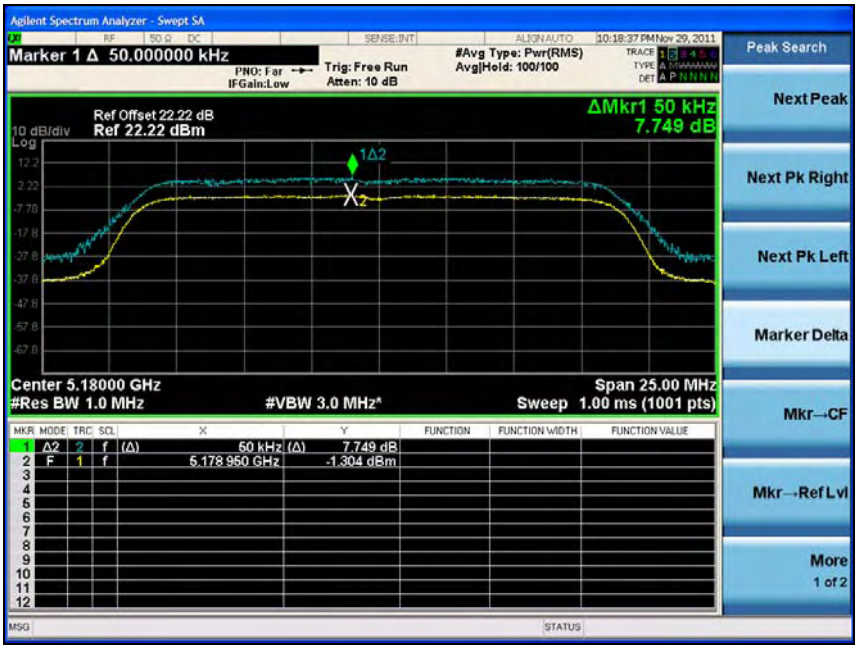
Low Channel (5 500 ㎒)

Middle Channel (5 600 ㎒)

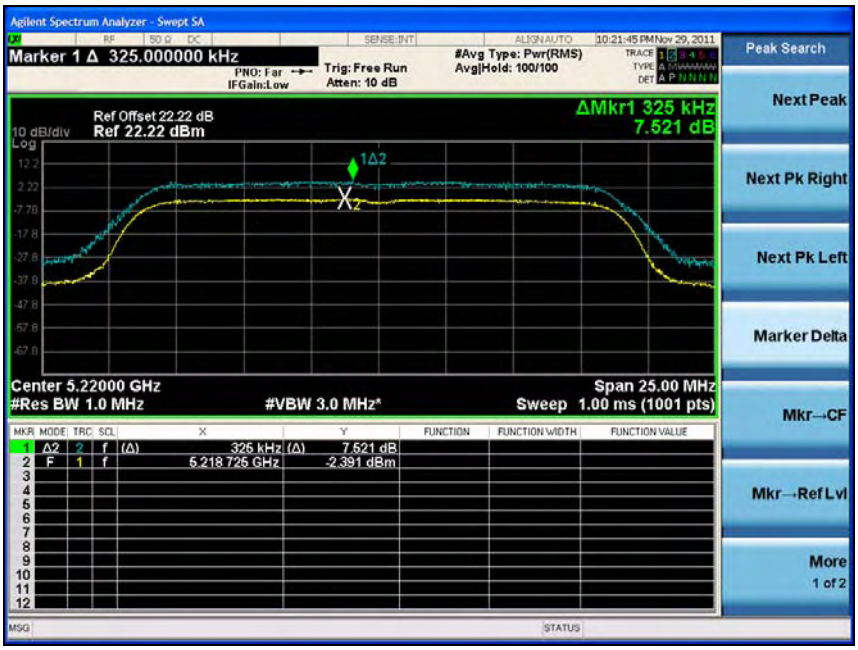
High Channel (5 700 ㎒)

802.11n-HT20 (Non-DFS)

Low Channel (5 180 ㎒)



Middle Channel (5 220 ㎒)



High Channel (5 240 ㎒)

802.11-HT20 (DFS)

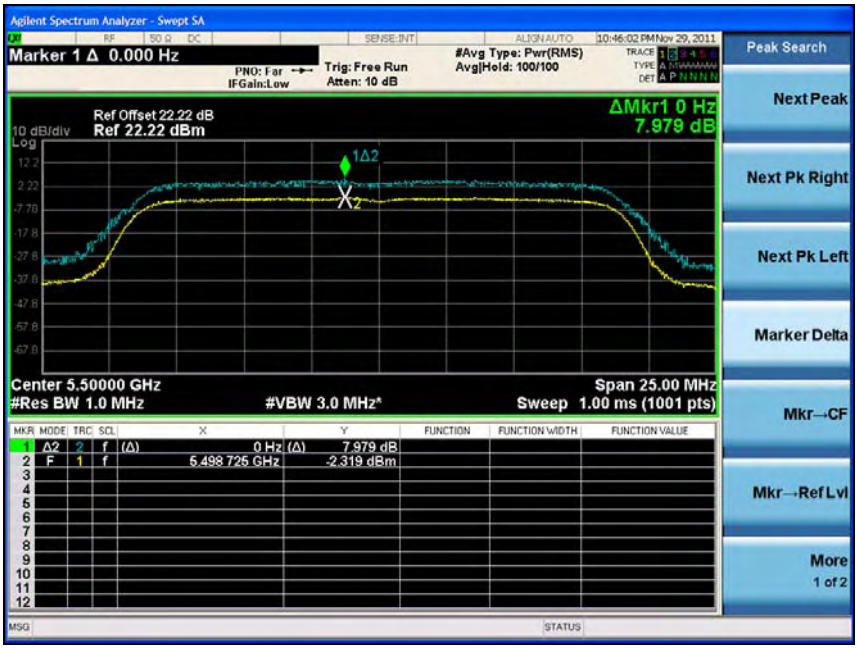
Low Channel (5 260 ㎒)

Middle Channel (5 300 ㎒)

High Channel (5 320 ㎒)

802.11-HT20 (DFS)

Low Channel (5 500 ㎒)



Middle Channel (5 600 ㎒)

High Channel (5 700 ㎒)

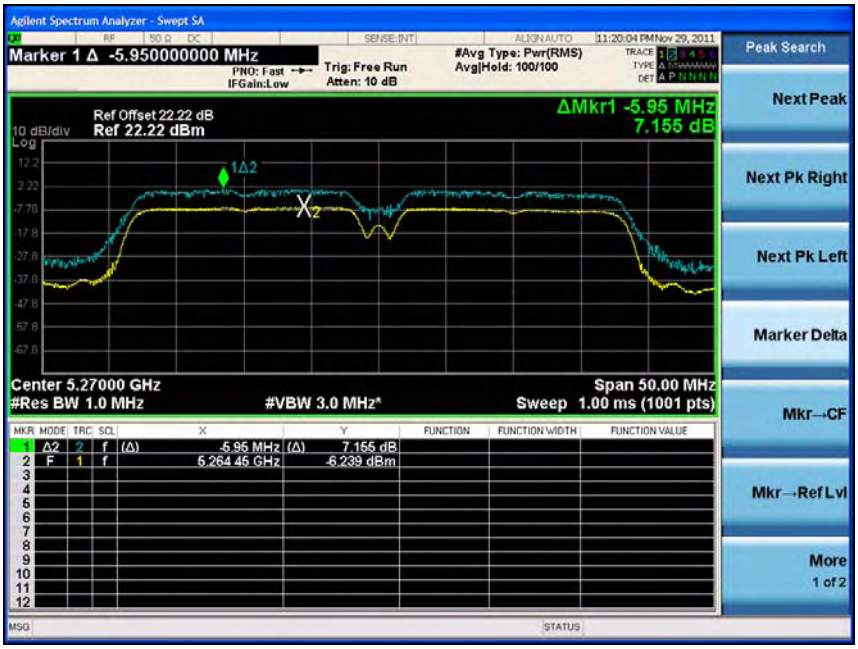
802.11n-HT40 (Non-DFS)

Low Channel (5 190 ㎒)

High Channel (5 230 ㎒)

802.11-HT40 (DFS)

Low Channel (5 270 ㎒)



High Channel (5 310 ㎒)

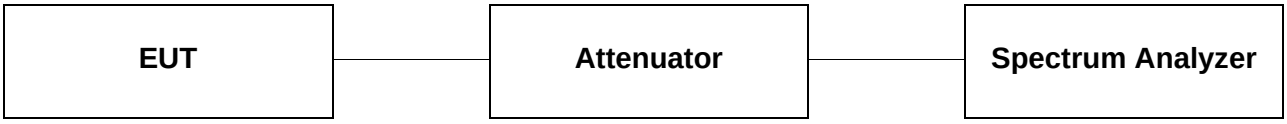
802.11-HT40 (DFS)

Low Channel (5 510 ㎒)

High Channel (5 670 ㎒)

7. Peak excursion

7.1. Test setup



7.2. Limit

The ratio of the peak excursion of the modulation envelope (measured using a peak hold function) to the peak transmit power (measured as specified above) shall not exceed 13 ㏈ across any 1 ㎒ bandwidth or the emission bandwidth whichever is less.

7.3. Test procedure

1. Place the EUT on the table and set it in the transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
3. Set span to encompass the entire emission bandwidth of the signal.
4. Set RBW=1 MHz, VBW ≤ 3 MHz, Detector = Peak, Trace mode = max-hold.
5. Allow the sweeps to continue until the trace stabilizes and use the peak search function on the spectrum analyzer to find the peak of the spectrum.
6. Compute the ratio of the maximum of the peak-max-hold spectrum to the PPSD.
7. Repeat the above procedure until the measurements for all frequencies are completed.

7.4. Test result

Ambient temperature : (24 ± 2) ℃
Relative humidity : 49 % R.H.

7.4.1. Non-DFS Band

Operation Mode	Antenna	Channel	Channel Frequency (㎒)	Peak excursion (㏈)	Limit (㏈)
11a	ANT0	Low	5 180	8.58	13
		Middle	5 220	8.67	
		High	5 240	8.55	
	ANT1	Low	5 180	8.41	
		Middle	5 220	8.37	
		High	5 240	8.30	
11n_HT20	ANT0	Low	5 180	7.22	
		Middle	5 220	7.43	
		High	5 240	7.42	
	ANT1	Low	5 180	7.75	
		Middle	5 220	7.52	
		High	5 240	8.05	
11n_HT40	ANT0	Low	5 190	7.52	
		High	5 230	7.19	
	ANT1	Low	5 190	7.35	
		High	5 230	7.32	

7.4.2. DFS Band

Operation Mode	Antenna	Channel	Channel Frequency (㎒)	Peak excursion (dB)	Limit (dB)
11a	ANT0	Lower Band	5 260	8.61	13
			5 300	8.69	
			5 320	8.65	
		Upper Band	5 500	8.86	
			5 600	8.65	
			5 700	8.66	
	ANT1	Lower Band	5 260	8.42	
			5 300	8.54	
			5 320	8.33	
		Upper Band	5 500	8.40	
			5 600	8.57	
			5 700	8.43	
11n_HT20	ANT0	Lower Band	5 260	7.52	
			5 300	7.86	
			5 320	8.18	
		Upper Band	5 500	8.00	
			5 600	7.92	
			5 700	7.53	
	ANT1	Lower Band	5 260	8.00	
			5 300	8.14	
			5 320	7.99	
		Upper Band	5 500	7.98	
			5 600	7.92	
			5 700	7.10	
11n_HT40	ANT0	Lower Band	5 270	7.53	
			5 310	7.40	
		Upper Band	5 510	7.55	
			5 670	7.52	
	ANT1	Lower Band	5 270	7.16	
			5 310	7.38	
		Upper Band	5 510	7.32	
			5 670	7.44	

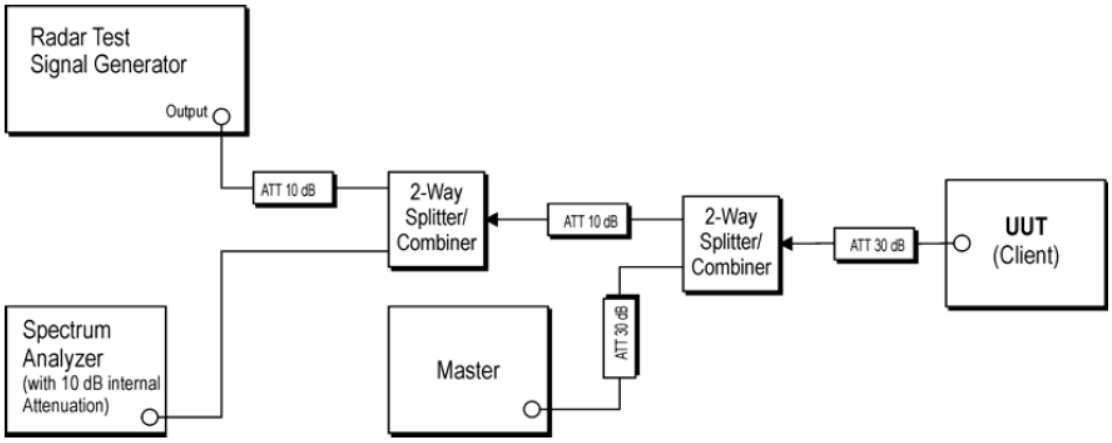
Captured images

Please refer to the PPSD captured image as above.

8. DFS (Dynamic Frequency Selection)

8.1. System overview

8.1.1. Set up of EUT



The radar signal generation equipment consists of a vector signal generator

The signal monitoring equipment consists of a spectrum analyzer set to display 8001 bins on the horizontal axis. The time domain resolution is 2 msec/bin with a 16 second sweep time, meeting the 10 second short pulse reporting criteria. The aggregate ON time is calculated by multiplying the number of bins above a threshold during a particular observation period by the dwell time per bin, with the analyzer set to peak detection and max hold.

The Slave is tested separately for compliance with the Channel Shutdown requirements, for the situation when the Slave device vacates the channel in response to detection of a radar by the Master.

All tests were performed at a channel center frequency of 5 310 ㎒ and 5 510 ㎒. Measurements were performed using conducted test methods.

8.2 Limit

§15.407 (h) and FCC 06-96 APPENDIX "COMPLIANCE MEASUREMENT PROCEDURES FOR UNLICENSED-NATIONAL INFORMATION INFRASTRUCTURE DEVCIES OPERATING IN THE 5250-5350 ㎒ AND 5470-5725 ㎒ BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION

Table 1: Applicability of DFS requirements prior to use of a channel

Requirement	Operational Mode		
	Master	Client (without DFS)	Client (with DFS)
Non-Occupancy Period	Yes	Yes (according to KDB 848637)	Yes
DFS Detection Threshold	Yes	Yes (according to KDB 848637)	Yes
Channel Availability Check Time	Yes	Not required	Not required
Uniform Spreading	Yes	Not required	Not required

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode		
	Master	Client (without DFS)	Client (with DFS)
DFS Detection Threshold	Yes	Not required	Yes
Channel Closing Transmission Time	Yes	Yes	Yes
Channel Move Time	Yes	Yes	Yes

Table 3: Interference Threshold values, Master or Client incorporating In-Service Monitoring

Maximum Transmit Power	Value (see note)
≥ 200 milliwatt	-64 ㏈ m
< 200 milliwatt	-62 ㏈ m
Note 1: This is the level at the input of the receiver assuming a 0 ㏈ i receive antenna Note 2: Throughout these test procedures an additional 1 ㏈ has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.	

KDB 848637 : Non-Occupancy Period for Client Device without radar detection

· Test results demonstrating an associated client link is established with the master on a test frequency;
· The client and DFS-certified master device are associated, and a movie can be streamed as specified in the DFS Order for a non-occupancy period test;
· The test frequency has been monitored to ensure no transmission of any type has occurred for 30 minutes. Note: If the client moves with the master, the device is considered compliant if nothing appears in the client non-occupancy period test. For devices that shut down (rather than moving channels), no beacons should appear;
· An analyzer plot that contains a single 30-minute sweep on the original channel.

Table 4: DFS Response requirement values

Parameter	Value
Non-occupancy period	30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds
Channel Closing Transmission Time	200 milliseconds + approx. 60 milliseconds over remaining 10 second period
The instant that the Channel Move Time and the Channel Closing Transmission Time begins is as follows: For the Short pulse radar Test Signals this instant is the end of the Burst. For the Frequency Hopping radar Test Signal, this instant is the end of the last radar burst generated. For the Long Pulse radar Test Signal this instant is the end of the 12 second period defining the radar transmission. The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate channel changes (an aggregate of approximately 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.	

Table 5 – Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (Microseconds)	PRI (Microseconds)	Pulses	Minimum Percentage of Successful Detection	Minimum Trials
1	1	1428	18	60%	30
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120

Table 6 – Long Pulse Radar Test Signal

Radar Waveform	Bursts	Pulses per Burst	Pulse Width (μsec)	Chirp Width (㎒)	PRI (μsec)	Minimum Percentage of Successful Detection	Minimum Trials
5	8-20	1-3	50-100	5-20	10002000	80%	30

Table 7 – Frequency Hopping Radar Test Signal

Radar Waveform	Pulse Width (μsec)	PRI (μsec)	Burst Length (ms)	Pulses per Hop	Hopping Rate (kHz)	Minimum Percentage of Successful Detection	Minimum Trials
6	1	333	300	9	0.333	70%	30

8.2. Description of EUT

The EUT operates over the 5 260 ㎒ ~ 5 320 ㎒ (11a/n-HT20-DFS), 5 270 ㎒ ~ 5 310 ㎒ (11n-HT40-DFS), 5 500 ㎒ ~ 5700 ㎒ (11a/n-HT20-DFS), and 5 510 ㎒ ~ 5670 ㎒ (11n-HT40-DFS) range.

The gain antenna assembly utilized with the master has a gain of 3.5 ㏈ i.

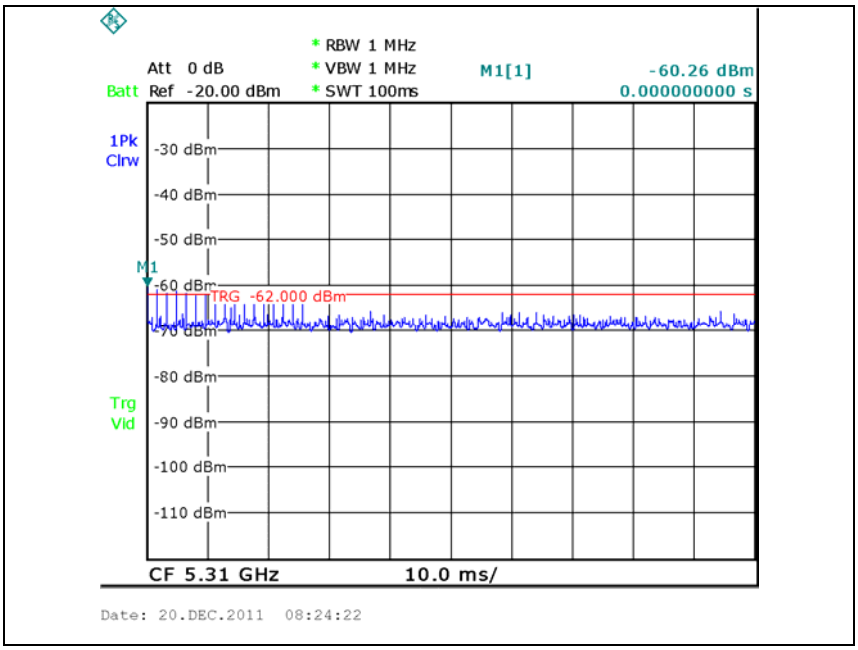
The rated output power of the master unit is <200 milliwatt. Therefore the required interference threshold level is -62 ㏈ m. After correction for antenna gain and procedure adjustments the required conducted threshold at the antenna port is -62 +3.5 = -58.50 ㏈ m

The calibrated conducted DFS Detection Threshold level is is -60 ㏈ m

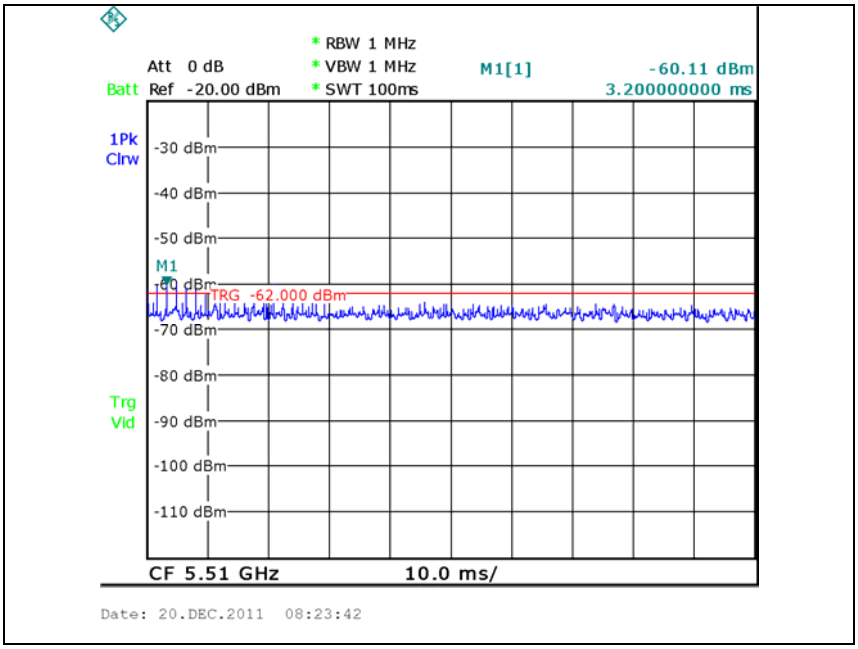
PLOTS OF RADAR WAVEFORMS AND WLAN TRAFFIC

Plot of radar waveform type 1

5 310 MHz

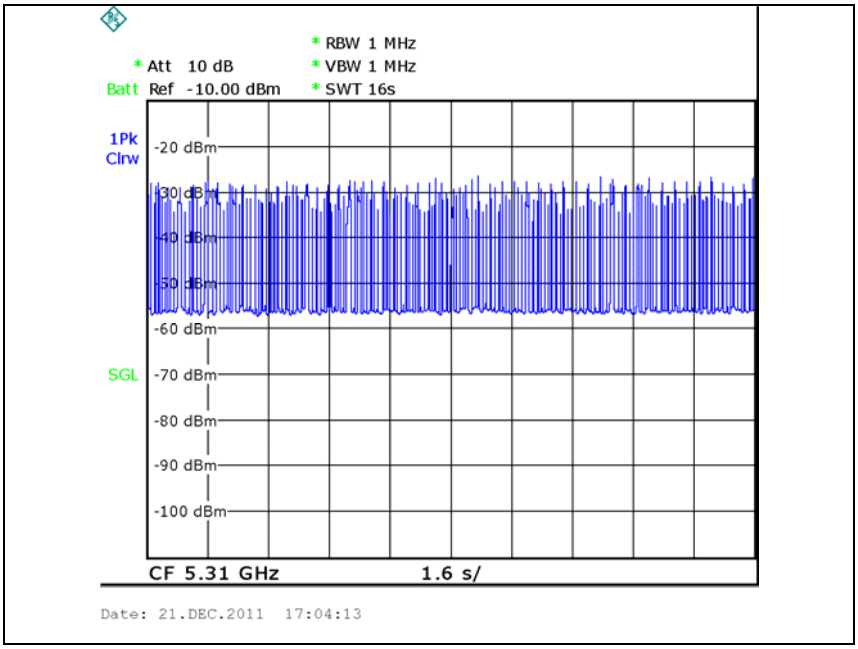


5 510 MHz

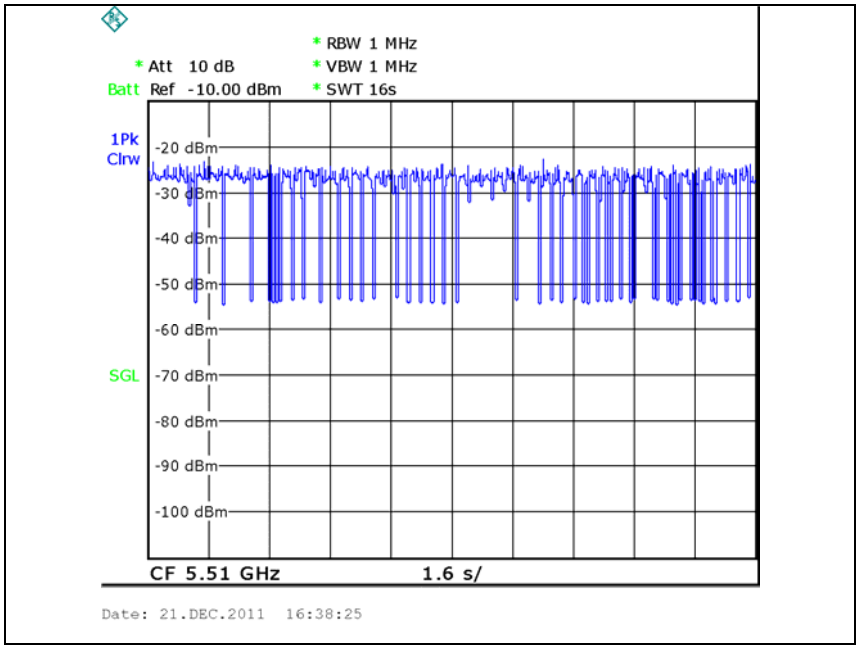


Plot of LAN traffic

5 310 MHz



5 510 MHz



The reference maker is set at the end of Last radar pulse.

The delta maker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time= (Number of analyzer bins showing transmission)*(dwell time per bin)

The observation period over which the aggregated time is calculated begins at (Reference Maker) and ends no earlier than (Reference Maker +10 sec)

8.3. Test result

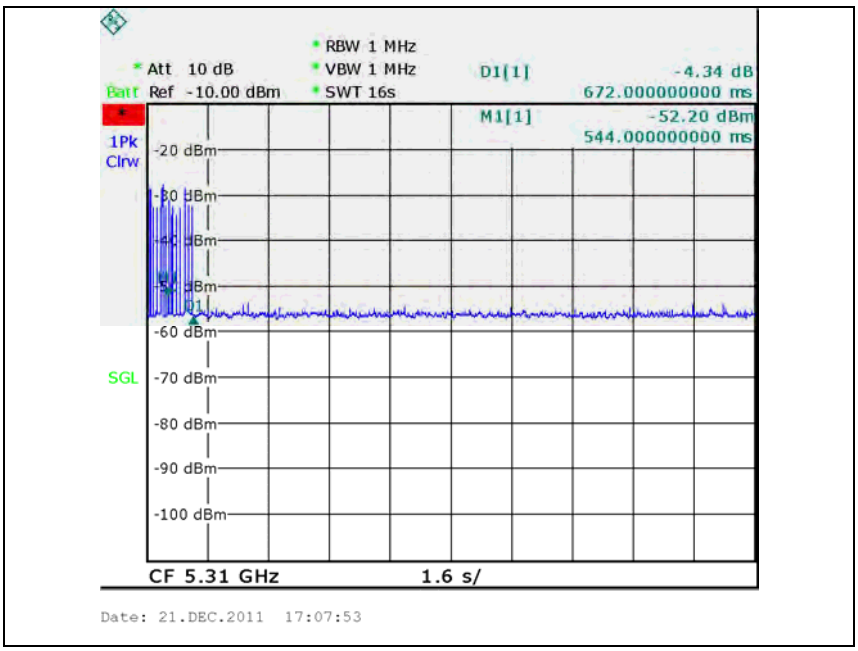
Frequency (MHz)	Channel Move Time (sec)	Limit
5 310	0.67	Not exceed 10 sec
5 510	0.80	
Frequency (MHz)	**Aggregate channel closing transmission time (msec)**	**Limit**
5 310	16	Not exceed 1 000 msec
5 510	24	

5 310 MHz : 2 * 8 = 16 msec
5 510 MHz : 2 * 12 = 24 msec

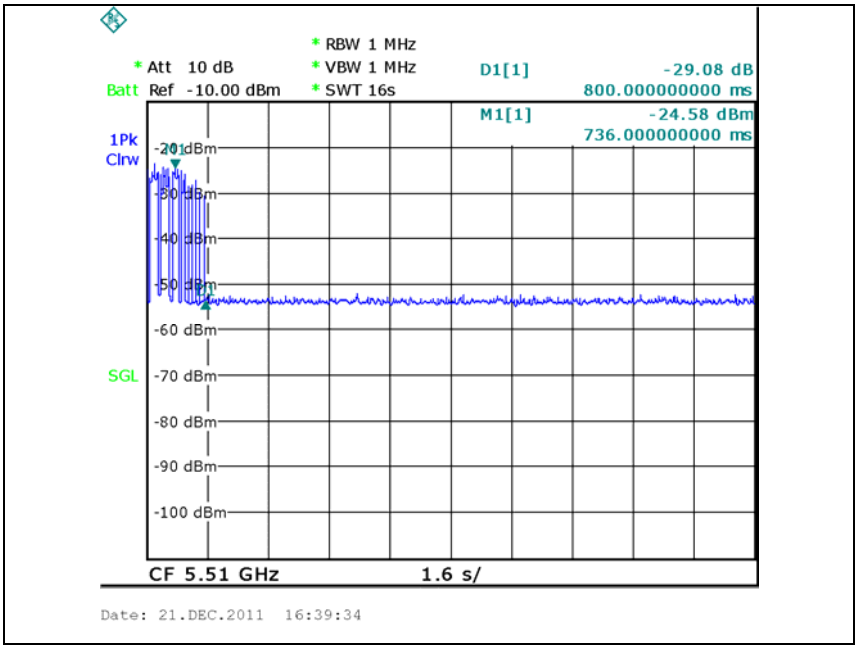
Frequency (MHz)	Non-occupancy period (min)	Limit
5 310	30	Not be less than 30 minute
5 510	30	

Plot of channel move time & aggregate channel closing transmission time

5 310 MHz

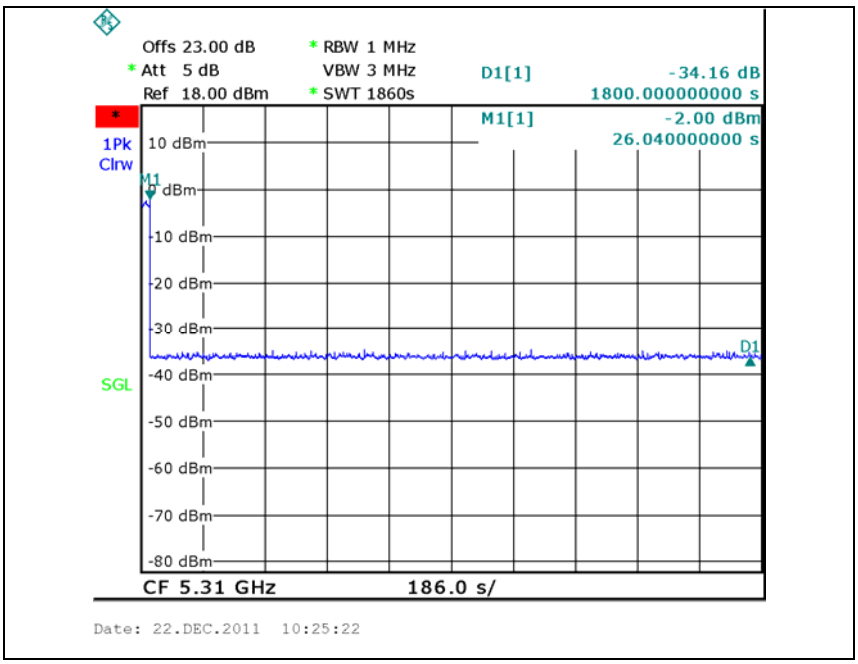


5 510 MHz



Plot of Non-occupancy period

5 310 MHz



5 510 MHz