

802.11-HT40 (DFS)







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802.11-HT40 (DFS)

Low Channel (5 510 Mz)







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ANT1

802.11a (Non-DFS)

Low Channel (5 180 Mz)

tegration BW 18.220 MHz	SENSE:INT Center Freq: 5.180000000 GH Trig: Free Run Avg	ALIGNAUTO	02:22:55 PM Nov 29, Radio Std: None	2011 Meas Setup
#IFGain:Low	#Atten: 10 dB		Radio Device: BT	Avg/Hold Num
Ref Offset 22.22 dB dB/div Ref 20.00 dBm				<u>On</u> Off
9 10				Avg Mode
0				Exp Repeat
				Integ BW 18.220 MHz
.0				
0				
nter 5.18 GHz			Span 24.2 M	1Hz
es BW 1 MHz	VBW 8 MHz		Sweep 1	ms
Channel Power	Power Spe	ctral Dens	sity	PhNoise Opt Fast Tuning P Auto <u>Man</u>
9.11 dBm / 18.22 м	Hz -63.4	19 dBm	/Hz	
				More 1 of 2
		STATU	S	

Middle Channel (5 220 Mz)



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High Channel (5 240 Mtz)



802.11a (DFS)

Low Channel (5 260 Mb)



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Middle Channel (5 300 Mtz)



High Channel (5 320 Mtz)



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802.11a (DFS)





Middle Channel (5 600 Mtz)



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High Channel (5 700 Mtz)



802.11n-HT20 (Non-DFS)



Low Channel (5 180 Mtz)

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Middle Channel (5 220 Mtz)



High Channel (5 240 Mtz)



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802.11-HT20 (DFS)





Middle Channel (5 300 Mtz)



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Mar

High Channel (5 320 Mtz)



802.11-HT20 (DFS)

er - Channel P Center Freq E. 500000000 GHz Trig: Free Run Avg|Held: 100/100 #Atten: 10 dB 05:06:42 PMNov 29, 2013 Radio Std: None Meas Setup tion BW 19.550 MHz Avg/Hold Num #IFGain:Low Radio Device: BTS Ref Offset 22.22 dB Ref 20.00 dBm AvgMod Exp Repea Integ BW 19.550 MHz Span 25.97 MHz Sweep 1 ms Center 5.5 GHz #Res BW 1 MHz VBW 8 MHz PhNoise Opt Power Spectral Density Channel Power Fast Tu 8.57 dBm / 19.55 MHz -64.34 dBm /Hz More 1 of 2

Low Channel (5 500 Mtz)

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Middle Channel (5 600 Mb)



High Channel (5 700 Mtz)



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802.11n-HT40 (Non-DFS)

Low Channel (5 190 Mtz)



High Channel (5 230 Mtz)



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802.11-HT40 (DFS)









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802.11-HT40 (DFS)









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

(a)(2)

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

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: F690501/RF-RTL005205

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 \geq 3 MHz, Number of points in sweep \geq 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 \ge 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.



t Number : F690501/RF-RTL005205

6.4. Test result

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

6.4.1. Non-DFS Band

Operation	Operation		Channel		power I density	Limit	
Mode	Antenna	Channel	Frequency (Mb)	FCC (dB m)	IC (dB m e.i.r.p.)	FCC (dB m)	IC (dB m e.i.r.p.)
		Low	5 180	-5.13	-4.57		
	ANT0	Middle	5 220	-6.12	-5.56		
110		High	5 240	-6.08	-5.52		
IId		Low	5 180	-0.92	1.21		
	ANT1	Middle	5 220	-2.68	-0.55		
		High	5 240	-3.09	-0.96		
		Low	5 180	-4.97	-4.41		
	ANT0	Middle	5 220	-6.02	-5.46		
		High	5 240	-6.13	-5.57		
	ANT1	Low	5 180	-1.30	0.83		
11n_HT20		Middle	5 220	-2.39	-0.26	4	10
		High	5 240	-3.08	-0.95		
		Low	5 180	0.25	4.64		
	ANT0+ANT1 (Calculated)	Middle	5 220	-0.83	3.56		
	(Galoalatoa)	High	5 240	-1.33	3.06		
	ΔΝΤΟ	Low	5 190	-9.49	-8.93		
		High	5 230	-10.48	-9.92		
11n HT40	ΔΝΤ1	Low	5 190	-5.89	-3.76		
111_1140		High	5 230	-6.95	-4.82		
	ANT0+ANT1	Low	5 190	-4.32	0.07		
	(Calculated)	High	5 230	-5.36	-0.97		

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6.4.2. DFS Band

Operation Mode	Antenna	Channel	Channel Frequency (Mb)	Peak power spectral density (dB m)	Limit (dB m)
			5 260	-5.58	
	ANTO	Lower Band	5 300	-6.04	
	ΔΝΤΟ		5 320	-6.10	
	ANTO		5 500	-2.23	
		Upper Band	5 600	-2.11	
110			5 700	1.47	
i la			5 260	-2.20	
		Lower Band	5 300	-3.09	
			5 320	-3.60	
	ANTI		5 500	-2.13	
		Upper Band	5 600	-3.12	
			5 700	147	
			5 260	-5.70	
		Lower Band	5 300	-6.16	11
	ANT0		5 320	-6.25	
		Upper Band	5 500	-2.56	
			5 600	-2.52	
			5 700	1.28	
			5 260	-2.31	
		Lower Band	5 300	-3.48	
11n HT20			5 320	-3.67	
111_1120	ANTI		5 500	-2.32	
		Upper Band	5 600	-2.86	
			5 700	1.62	
			5 260	-0.67	
		Lower Band	5 300	-1.61	
	ANT0+ANT1		5 320	-1.76	
	(Calculated)		5 500	0.57	-
		Upper Band	5 600	0.32	
			5 700	4.46	

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Operation Mode	Antenna	Channel	Channel Frequency (₩z)	Peak power spectral density (dB m)	Limit (dB m)
		Lower Band	5 270	-10.06	
	ΔΝΤΟ	Lower Band	5 310	-10.39	
		Upper Band	5 510	-6.63	
			5 670	-5.16	
	ANT1	Lower Band	5 270	-6.24	
11n HT40			5 310	-7.61	
		Linner Dend	5 510	-6.63	
		Opper Band	5 670	-6.71	
		Lower Band	5 270	-4.73	
	ANT0+ANT1	Lower Band	5 310	-5.77	
	(Calculated)	Linner Band	5 510	-3.62	
			5 670	-2.86	



ANT0

802.11a (Non-DFS)

Low Channel (5 180 Mtz)



Middle Channel (5 220 Mtz)



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High Channel (5 240 Mz)



802.11a (DFS)

Low Channel (5 260 Mt)



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Middle Channel (5 300 Mtz)



High Channel (5 320 Mz)





802.11a (DFS)

Low Channel (5 500 Mtz)



Middle Channel (5 600 Mtz)



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High Channel (5 700 ₩z)



802.11n-HT20 (Non-DFS)



Low Channel (5 180 Mz)



Middle Channel (5 220 Mbz)



High Channel (5 240 Mz)





802.11-HT20 (DFS)

Low Channel (5 260 Mz)



Middle Channel (5 300 Mtz)



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High Channel (5 320 Mz)



802.11-HT20 (DFS)

Low Channel (5 500 Mz)





Middle Channel (5 600 Mtz)



High Channel (5 700 Mtz)





802.11n-HT40 (Non-DFS)

Low Channel (5 190 Mtz)



High Channel (5 230 Mtz)



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802.11-HT40 (DFS)

Low Channel (5 270 Mtz)



High Channel (5 310 Mz)



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802.11-HT40 (DFS)

Low Channel (5 510 Mtz)



High Channel (5 670 Mb)



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ANT1

802.11a (Non-DFS)

Low Channel (5 180 Mtz)

Peak Search	D9:33:47 PM Nov 29, 2011 TRACE T 3 4 5 5 TYPE A MUMANAN DET A P N N N N	ALIGNAUTO /pe: Pwr(RMS) Id: 100/100	#Avg Avg H	un 3	Trig: Free R Atten: 10 dE		OO MHz PNO: Far IFGain:Lov	50 P 1750000	15	2 4	er
NextPeak	(r2 1.475 MHz 8.405 dB	ΔMk					dB m	ffset 22.2 2 2.22 dE	Ref Ref		Idiv
Next Pk Right		19 inthe 19 (But and	\$2∆3	-Â1	ىر مەربىي بىرمەمەر بىسى		ag(d))y===0,00,00,00,000	100			
Next Pk Lef	and the second second								de la construcción de la constru	Uper'	F . 1
Marker Delta											
Mkr→CF	Span 25.00 MHz 00 ms (1001 pts)	Sweep 1.			3.0 MHz*	VBW	#\	GHz Hz	000 0 N	5.18 N 1.	er : B\
Mkr→RefLv	FUNCTION VALUE	FUNCTION WIDTH	CTION	FUN 3	-0.915 dBm 8.405 dE -0.915 dBm	z z (Δ) z	× 5.181 400 GHz 1.475 MHz 5.181 400 GHz	Δ)	f f f	1 2 1	008 N N3 F
More 1 of 2											
		STATUS						_	-	-	-

Middle Channel (5 220 Mz)



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High Channel (5 240 Mz)



802.11a (DFS)

Low Channel (5 260 Mt)



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Middle Channel (5 300 Mtz)



High Channel (5 320 Mz)





802.11a (DFS)

Low Channel (5 500 Mtz)



Middle Channel (5 600 Mtz)



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High Channel (5 700 ₩z)



802.11n-HT20 (Non-DFS)



Low Channel (5 180 Mz)



Middle Channel (5 220 Mtz)



High Channel (5 240 Mb)





802.11-HT20 (DFS)

Low Channel (5 260 Mtz)



Middle Channel (5 300 Mtz)



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High Channel (5 320 Mz)



802.11-HT20 (DFS)

Low Channel (5 500 Mz)





Middle Channel (5 600 Mtz)



High Channel (5 700 Mtz)





802.11n-HT40 (Non-DFS)

Low Channel (5 190 Mtz)



High Channel (5 230 Mtz)



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802.11-HT40 (DFS)

Low Channel (5 270 Mtz)



High Channel (5 310 Mtz)



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802.11-HT40 (DFS)

Low Channel (5 510 Mtz)



High Channel (5 670 Mz)



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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 dB across any 1 Mb 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.



er: F690501/RF-RTL005205

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 (쌘)	Peak excursion (dB)	Limit (dB)
		Low	5 180	8.58	
	ANT0	Middle	5 220	8.67	
110		High	5 240	8.55	
11a		Low	5 180	8.41	
	ANT1	Middle	5 220	8.37	
		High	5 240	8.30	
	ANTO	Low	5 180	7.22	
		Middle	5 220	7.43	12
11n UT20		High	5 240	7.42	13
1111_1120		Low	5 180	7.75	
	ANT1	Middle	5 220	7.52	
		High	5 240	8.05	
	ΔΝΙΤΟ	Low	5 190	7.52	
11n UT40	ANTO	High	5 230	7.19	
1111_11140	ANT1 Low 5 190 High 5 230	5 190	7.35		
		High	5 230	7.32	



7.4.2. DFS Band

Operation Mode	Antenna	Channel	Channel Frequency (Mz)	Peak excursion (dB)	Limit (dB)
			5 260	8.61	
		Lower Band	5 300	8.69	
	ΔΝΤΟ		5 320	8.65	
			5 500	8.86	
		Upper Band	5 600	8.65	
119			5 700	8.66	
Πά			5 260	8.42	
		Lower Band	5 300	8.54	
	ΔΝΤ1		5 320	8.33	
			5 500	8.40	
		Upper Band	5 600	8.57	
			5 700	8.43	
		Lower Band	5 260	7.52	
	ANTO		5 300	7.86	
			5 320	8.18	
		Upper Band	5 500	8.00	10
			5 600	7.92	15
11n UT20			5 700	7.53	
1111_11120		Lower Band	5 260	8.00	
			5 300	8.14	
			5 320	7.99	
	ANTI		5 500	7.98	
		Upper Band	5 600	7.92	
			5 700	7.10	
		Lower Bond	5 270	7.53	
		LOWEI DAIIU	5 310	7.40	
	ANTO	Lippor Bond	5 510	7.55	
11n UT40			5 670	7.52	
1111_1140		Lower Bond	5 270	7.16	
			5 310	7.38	
		Lipper Bond	5 510	7.32	
		Upper Band	5 670	7.44	

Captured images

Please refer to the PPSD captured image as above.

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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 MHz and 5 510 MHz. Measurements were performed using conducted test methods.

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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 MI₂ AND 5470-5725 MI₂ BANDS INCORPORATING DYNAMIC FREQUENCY SELECTION

······ ··· ··· ·······················							
Demuirement	Operational Mode						
Requirement	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 1: Applicability of DFS requirements prior to use of a channel

Table 2: Applicability of DFS requirements during normal operation

	Operational Mode				
Requirement	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 ^{dB} m
< 200 milliwatt	-62 dB m

Note 1: This is the level at the input of the receiver assuming a 0 d^B i receive antenna Note 2: Throughout these test procedures an additional 1 d^B 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.

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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 Channe	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 4: DFS Response requirement values

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 (^{Mb})	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

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8.2. Description of EUT

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

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

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

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



PLOTS OF RADAR WAVEFORMS AND WLAN TRAFFIC

Plot of radar waveform type 1

5 310 MHz



5 510 MHz



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F690501/RF-RTL005205

Plot of LAN traffic

5 310 MHz



5 510 MHz



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F690501/RF-RTL005205

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	Not exceed to sec	
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	Not be less than 30 minute

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Plot of channel move time & aggregate channel closing transmission time



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Plot of Non-occupancy period





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