



## 7.10 DYNAMIC FREQUENCY SELECTION

### LIMIT

According to §15.407 (h) and FCC 06-96 appendix “compliance measurement procedures for unlicensed-national information infrastructure devices operating in the 5250-5350 MHz and 5470-5725 MHz bands incorporating dynamic frequency selection”.

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

Requirement	Operational Mode		
	Master	Client (without radar detection)	Client(with radar detection)
Non-Occupancy Period	Yes	Yes	Yes
DFS Detection Threshold	Yes	Not required	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 radar detection)	Client(with radar detection)
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**

Maximum Transmit Power	Value (see note)
≥200 Milliwatt	-64 dBm
< 200 Milliwatt	-62 dBm

Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna.

Note 2: Throughout these test procedures an additional 1 dB 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.



**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 (µsec)	PRI (µsec)	Minimum Percentage of Successful Detection	Minimum Trials
5	8-20	1-3	50-100	5-20	1000-2000	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	0.33	70%	30



## **DESCRIPTION OF EUT**

### **Overview Of EUT With Respect To §15.407 (H) Requirements**

The EUT operates over the 5250-5350 & 5500-5700 MHz range as a Client Device that does not have radar detection capability.

The antenna assembly utilized with the EUT has a gain of 5.5 dBi.

The highest power level is 18.28 dBm EIRP in the 5500 ~ 5700MHz band.

The EUT uses two transmitter connected to two 50-ohm coaxial antenna ports via a diversity switch. Two antenna port is connected to the test system since the EUT has two antenna.

The Slave device associated with the EUT during these tests does not have radar detection capability.

WLAN traffic is generated by streaming the video file TestFile.mp2 “6 ½ Magic Hours” from the Master to the Slave in full motion video mode using the media player with the V2.61 Codec package.

TPC is not required since the maximum EIRP is less than 500 mW (27 dBm).

The EUT utilizes the 802.11a architecture, with a nominal channel bandwidth of 20 MHz.

The Master Device is a Cisco Aironet 802.11a/b/g Access Point, FCC ID: LDK102056.

The rated output power of the Master unit is < 23dBm (EIRP). Therefore the required interference threshold level is -62 dBm. After correction for antenna gain and procedural adjustments, the required conducted threshold at the antenna port is  $-62 + 5 = -57$ dBm.

The calibrated conducted DFS Detection Threshold level is set to -62 dBm. The tested level is lower than the required level hence it provides margin to the limit.

### **Manufacturer’s Statement Regarding Uniform Channel Spreading**

The end product implements an automatic channel selection feature at startup such that operation commences on channels distributed across the entire set of allowed 5GHz channels. This feature will ensure uniform spreading is achieved while avoiding non-allowed channels due to prior radar events.



## **TEST AND MEASUREMENT SYSTEM**

### **System Overview**

The measurement system is based on a conducted test method.

The short pulse and long pulse signal generating system utilizes the NTIA software. The Vector Signal Generator has been validated by the NTIA. The hopping signal generating system utilizes the CCS simulated hopping method and system, which has been validated by the DoD, FCC and NTIA. The software selects waveform parameters from within the bounds of the signal type on a random basis using uniform distribution.

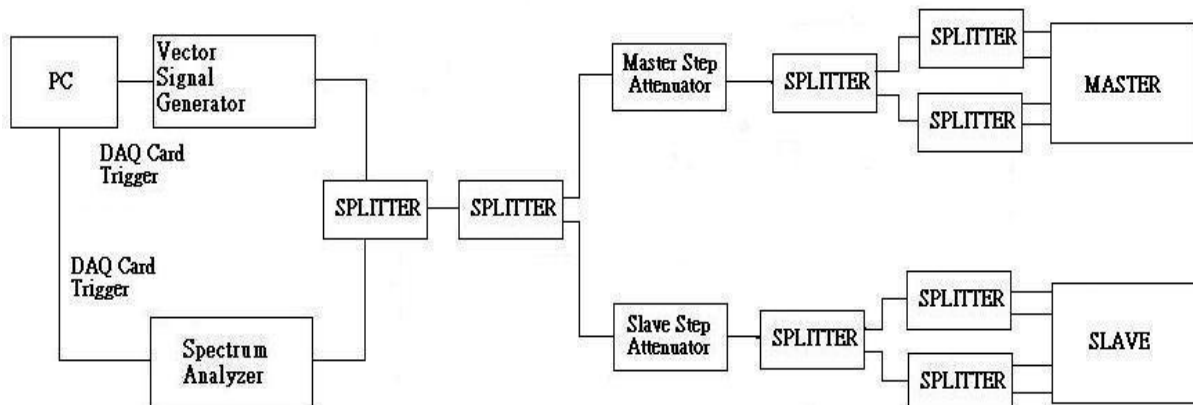
The short pulse types 2, 3 and 4, and the long pulse type 5 parameters are randomized at run-time.

The hopping type 6 pulse parameters are fixed while the hopping sequence is based on the August 2005 NTIA Hopping Frequency List. The initial starting point randomized at run-time and each subsequent starting point is incremented by 475. Each frequency in the 100-length segment is compared to the boundaries of the EUT Detection Bandwidth and the software creates a hopping burst pattern in accordance with Section 7.4.1.3 Method #2 Simulated Frequency Hopping Radar Waveform Generating Subsystem of FCC 06-96 APPENDIX. The frequency of the signal generator is incremented in 1 MHz steps from FL to FH for each successive trial. This incremental sequence is repeated as required to generate a minimum of 30 total trials and to maintain a uniform frequency distribution over the entire Detection Bandwidth.

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 time-domain resolution is 3 msec / bin with a 24 second sweep time, meeting the 22 second long pulse reporting criteria and allowing a minimum of 10 seconds after the end of the long pulse waveform.

Should multiple RF ports be utilized for the Master and/or Slave devices (for example, for diversity or MIMO implementations), 50 ohm termination would be removed from the splitter so that connection can be established between splitter and the Master and/or Slave devices.

### **Conducted Method System Block Diagram**





### **System Calibration**

Connect the spectrum analyzer to the test system in place of the master device. Set the signal generator to CW mode. Adjust the amplitude of the signal generator to yield a measured level of  $-62$  dBm on the spectrum analyzer.

Without changing any of the instrument settings, reconnect the spectrum analyzer to the Common port of the Spectrum Analyzer Combiner/Divider and connect a 50 ohm load to the Master Device port of the test system.

Measure the amplitude and calculate the difference from  $-62$  dBm. Adjust the Reference Level Offset of the spectrum analyzer to this difference. Confirm that the signal is displayed at  $-62$  dBm. Readjust the RBW and VBW to 3 MHz, set the span to 10 MHz, and confirm that the signal is still displayed at  $-62$  dBm.

The spectrum analyzer displays the level of the signal generator as received at the antenna ports of the Master Device. The interference detection threshold may be varied from the calibrated value of  $-62$  dBm and the spectrum analyzer will still indicate the level as received by the Master Device.

Set the signal generator to produce a radar waveform, trigger a burst manually and measure the level on the spectrum analyzer. Readjust the amplitude of the signal generator as required so that the peak level of the waveform is at a displayed level equal to the required or desired interference detection threshold. Separate signal generator amplitude settings are determined as required for each radar type.

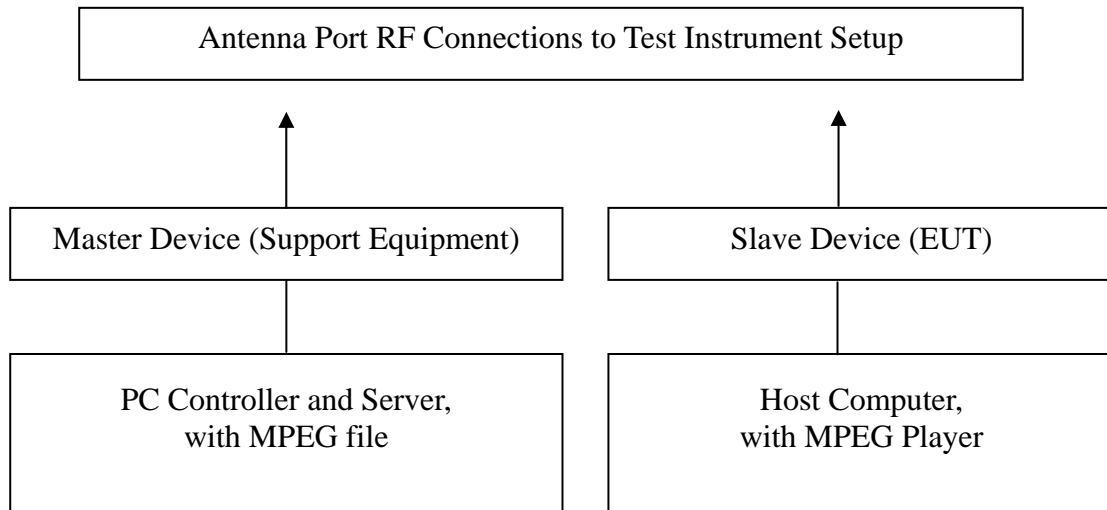
### **Adjustment Of Displayed Traffic Level**

Establish a link between the Master and Slave, adjusting the Link Step Attenuator as needed to provide a suitable received level at the Master and Slave devices. Stream the video test file to generate WLAN traffic. Confirm that the WLAN traffic level, as displayed on the spectrum analyzer, is at lower amplitude than the radar detection threshold. Confirm that the displayed traffic is from the Master Device. For Master Device testing confirm that the displayed traffic does not include Slave Device traffic. For Slave Device testing confirm that the displayed traffic does not include Master Device traffic.

If a different setting of the Master Step Attenuator is required to meet the above conditions, perform a new System Calibration for the new Master Step Attenuator setting.



**Test Setup**



**TEST RESULTS**

*No non-compliance noted*



**Test Plot**

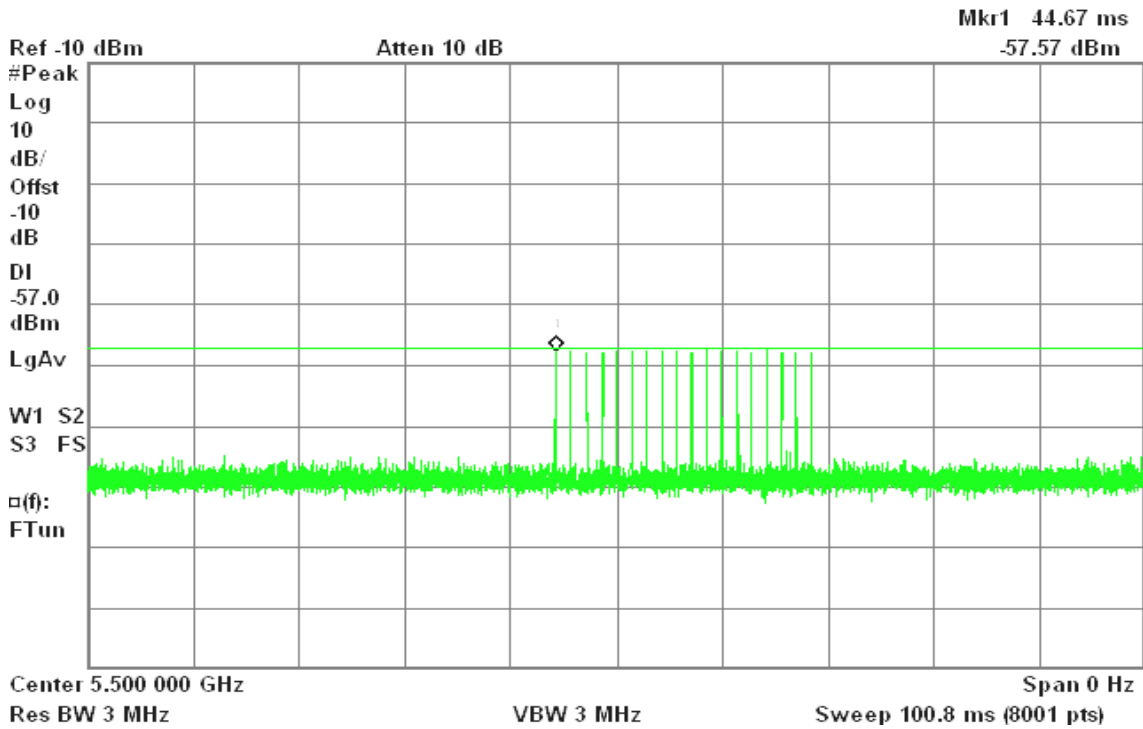
**PLOTS OF RADAR WAVEFORMS**

**draft 802.11n Standard-20 MHz mode**

**Sample of Short Pulse Radar Type 1**

Agilent 10:34:37 Mar 23, 2009

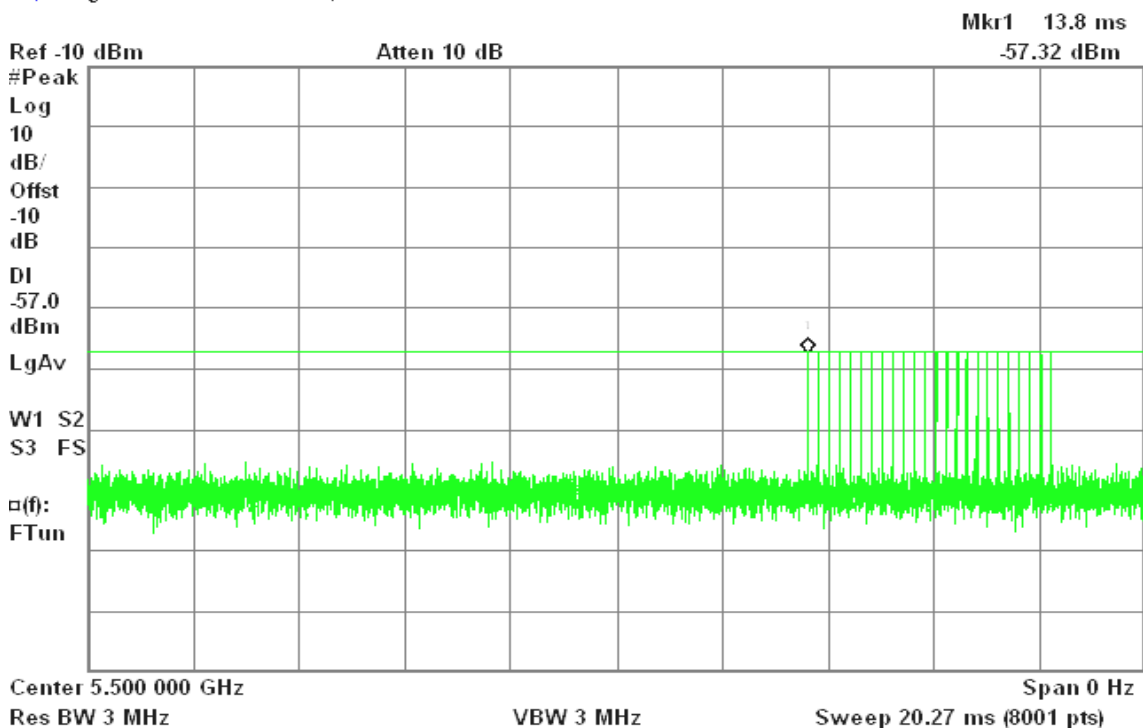
R T



**Sample of Short Pulse Radar Type 2**

Agilent 10:36:02 Mar 23, 2009

R T



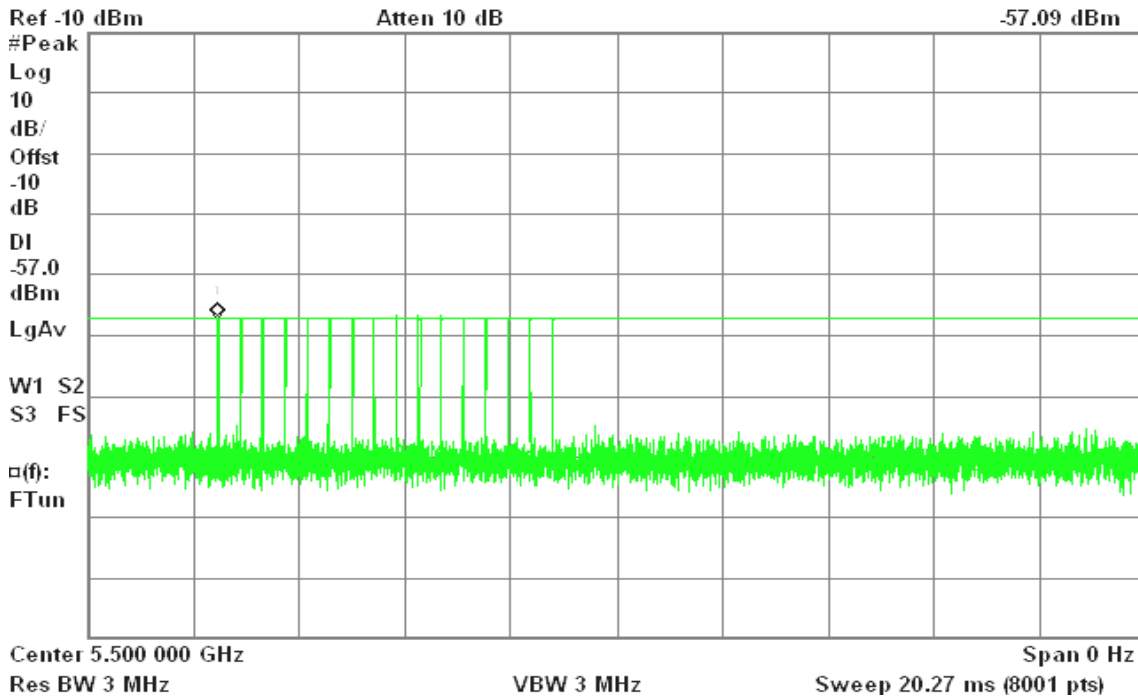


### Sample of Short Pulse Radar Type 3

Agilent 10:45:43 Mar 23, 2009

R T

Mkr1 2.503 ms  
-57.09 dBm

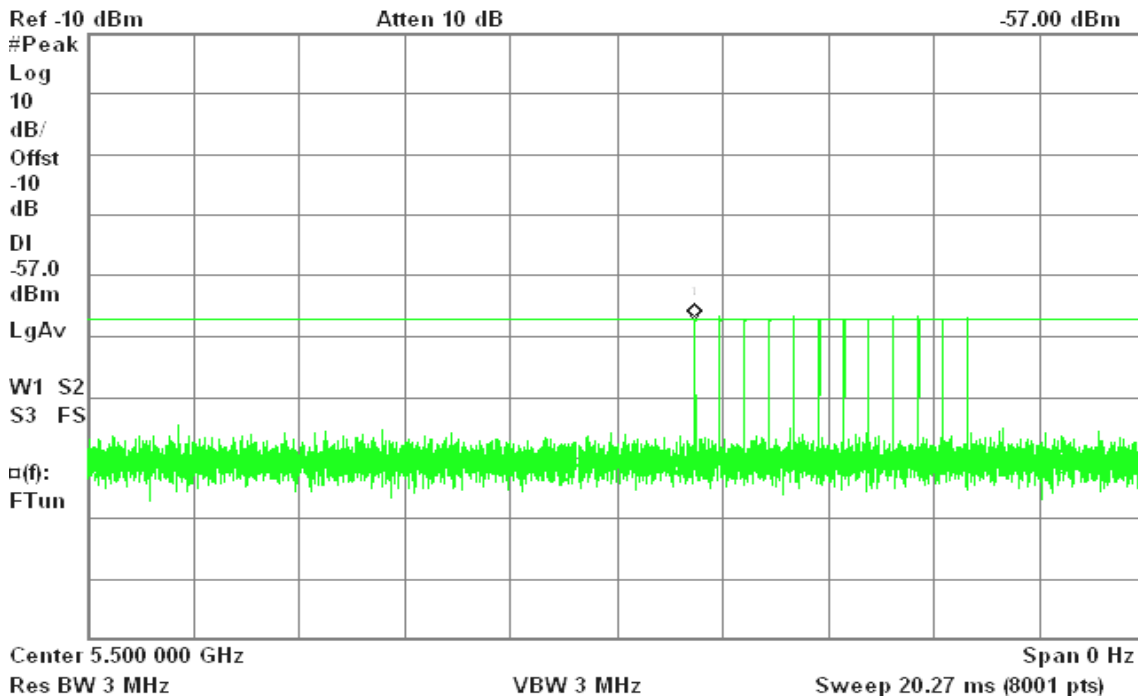


### Sample of Short Pulse Radar Type 4

Agilent 10:46:31 Mar 23, 2009

R T

Mkr1 11.62 ms  
-57.00 dBm





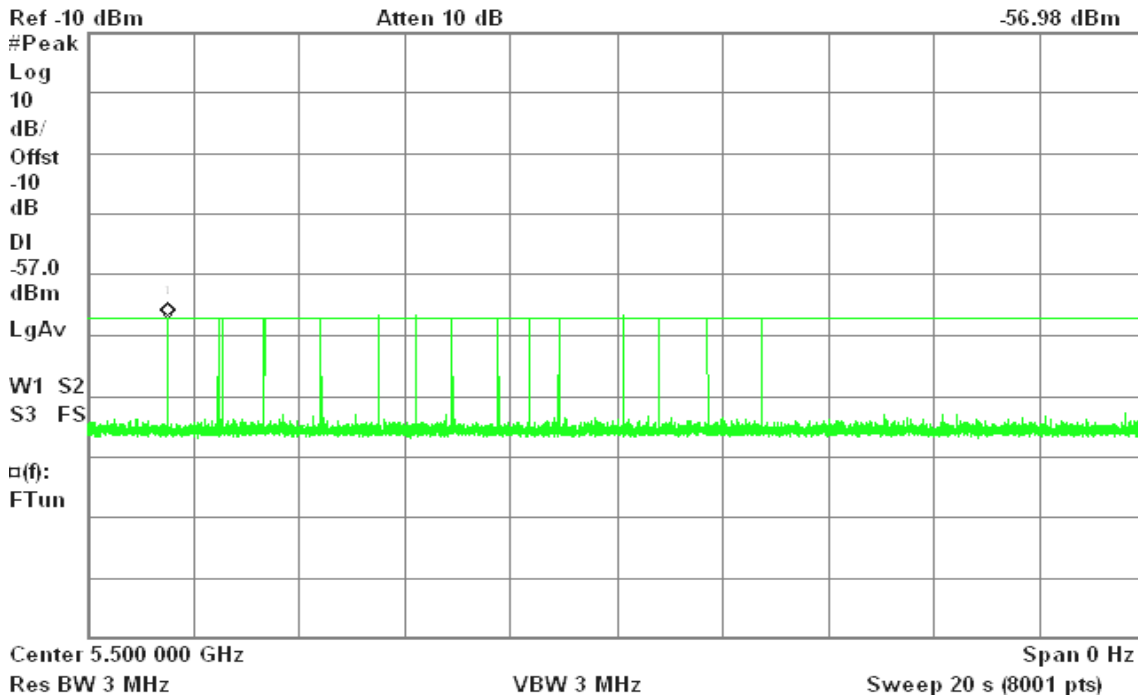


### Sample of Long Pulse Radar Type 5

Agilent 10:48:07 Mar 23, 2009

R T

Mkr1 1.515 s  
-56.98 dBm

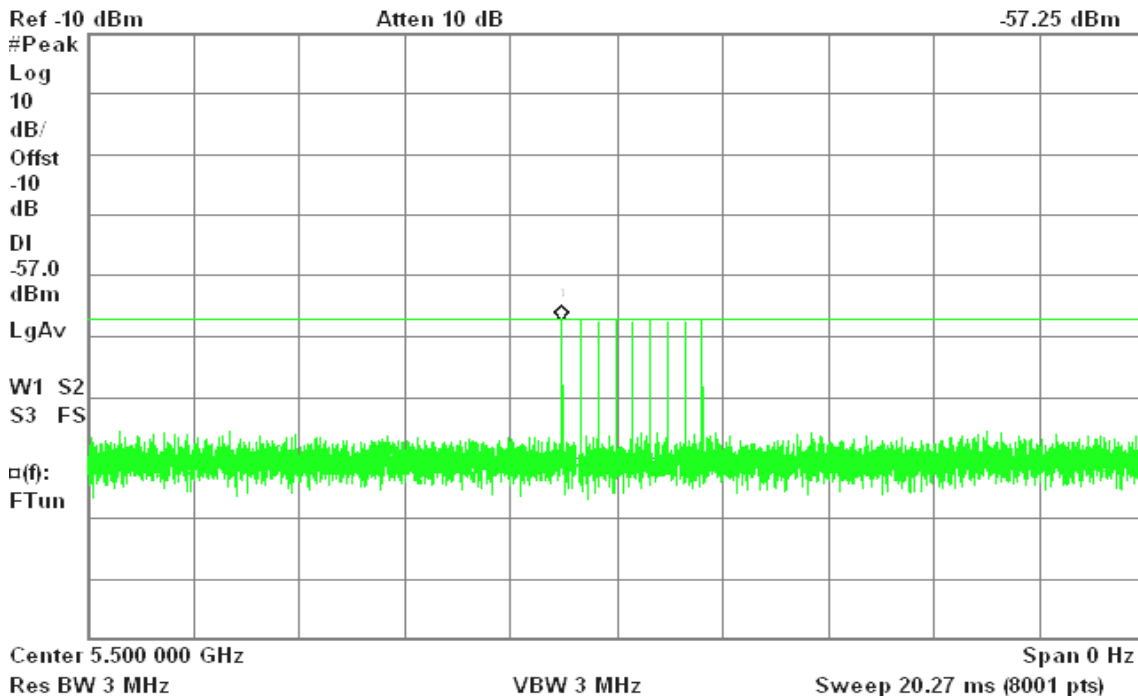


### Sample of Frequency Hopping Radar Type 6

Agilent 10:47:10 Mar 23, 2009

R T

Mkr1 9.102 ms  
-57.25 dBm



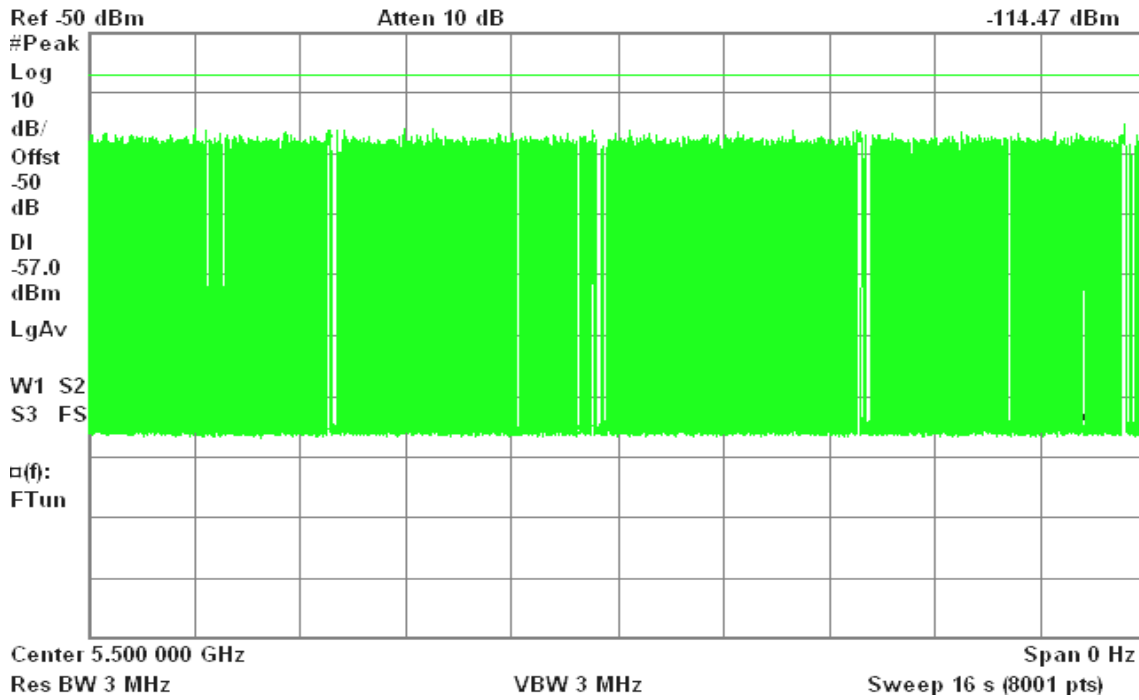


### Plot of WLAN Traffic from Slave

Agilent 16:29:01 Mar 20, 2009

R T

Mkr1 14.98 s  
-114.47 dBm



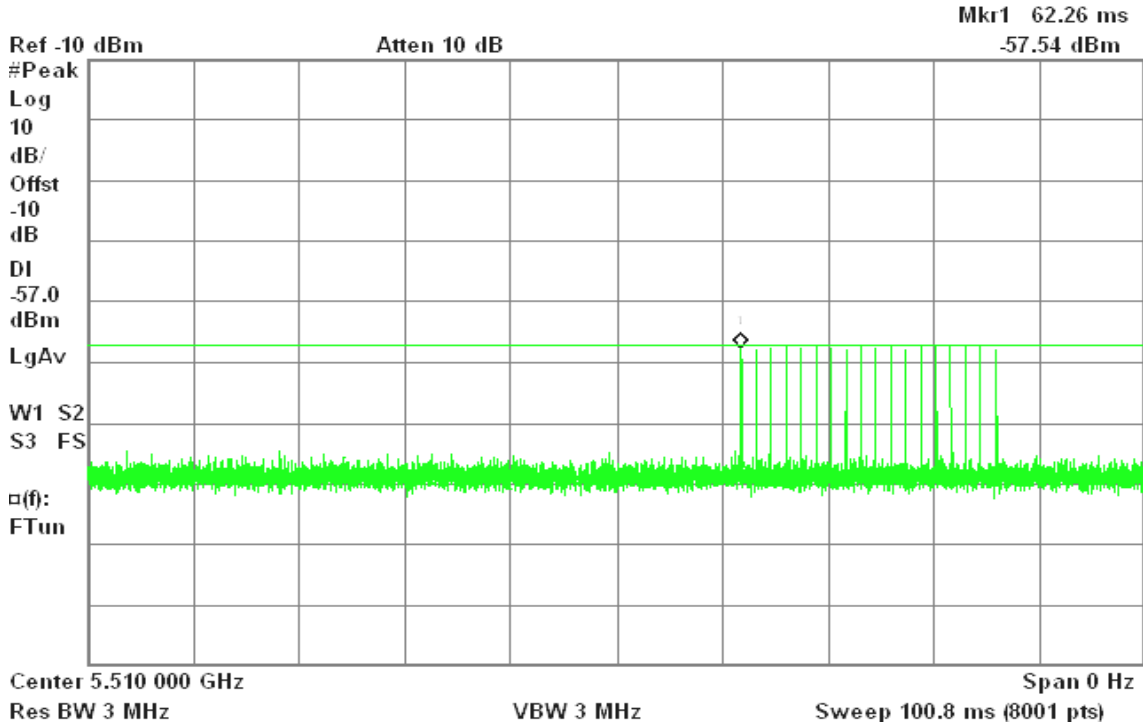


**draft 802.11n Wide-40 MHz mode**

**Sample of Short Pulse Radar Type 1**

Agilent 10:52:29 Mar 23, 2009

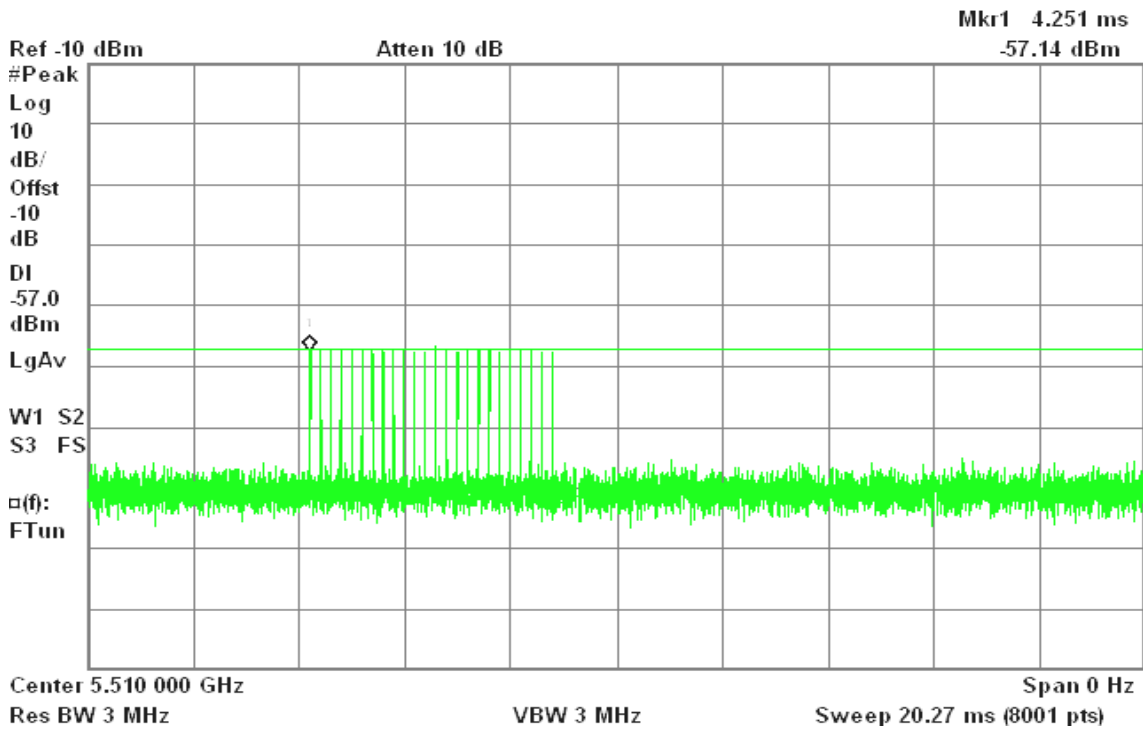
R T



**Sample of Short Pulse Radar Type 2**

Agilent 10:51:37 Mar 23, 2009

R T

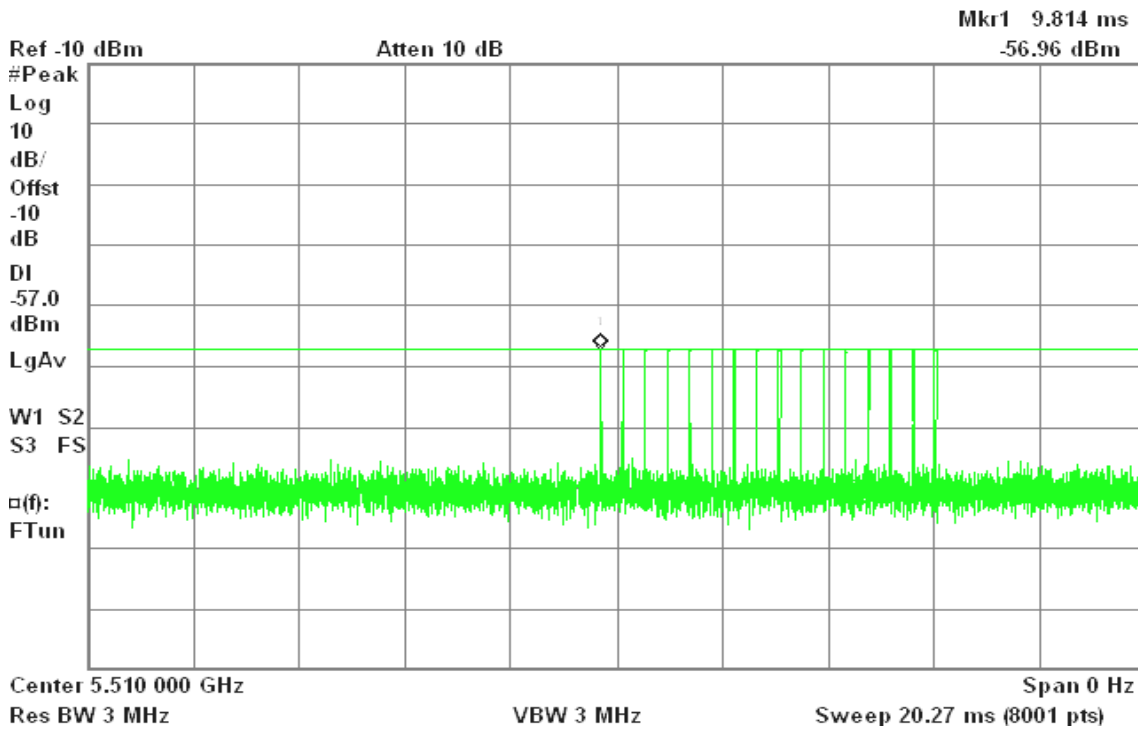




### Sample of Short Pulse Radar Type 3

Agilent 10:51:04 Mar 23, 2009

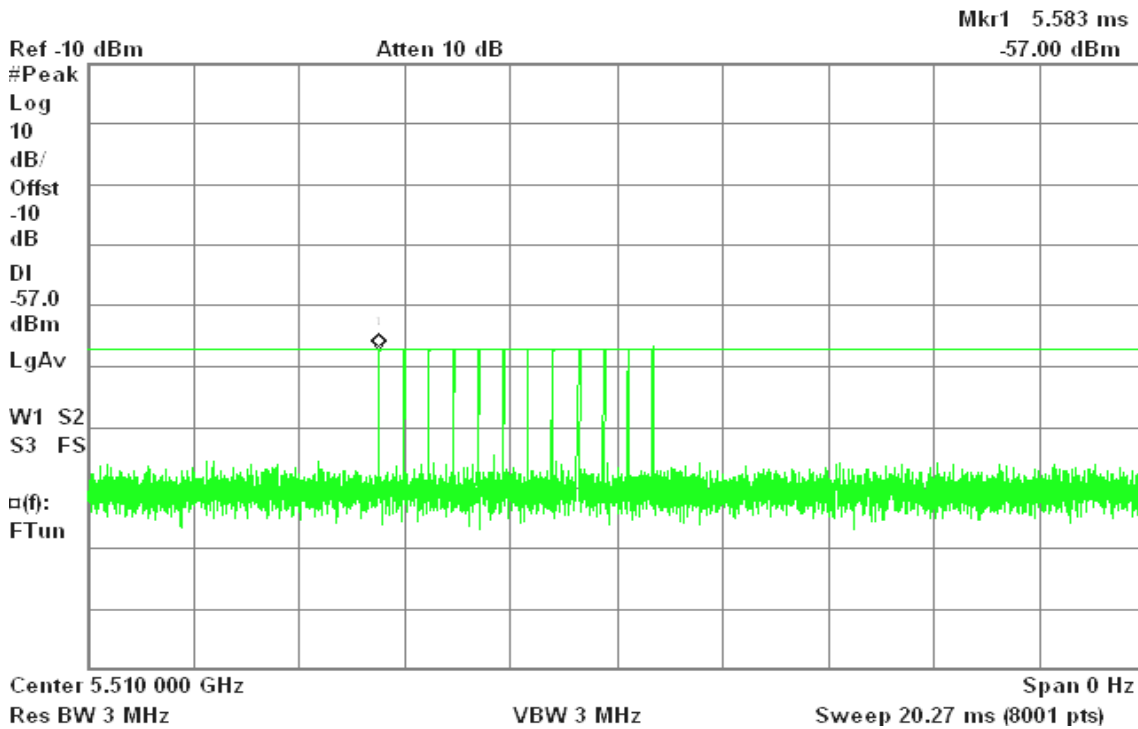
R T



### Sample of Short Pulse Radar Type 4

Agilent 10:50:22 Mar 23, 2009

R T



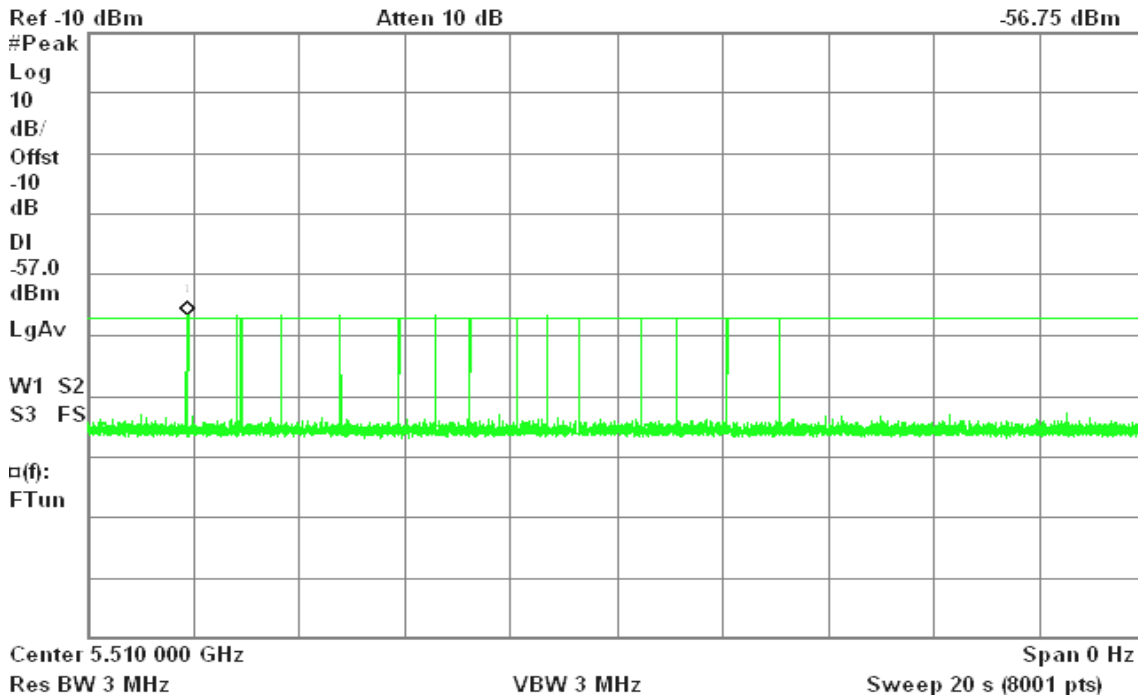


### Sample of Long Pulse Radar Type 5

Agilent 10:48:54 Mar 23, 2009

R T

Mkr1 1.873 s  
-56.75 dBm

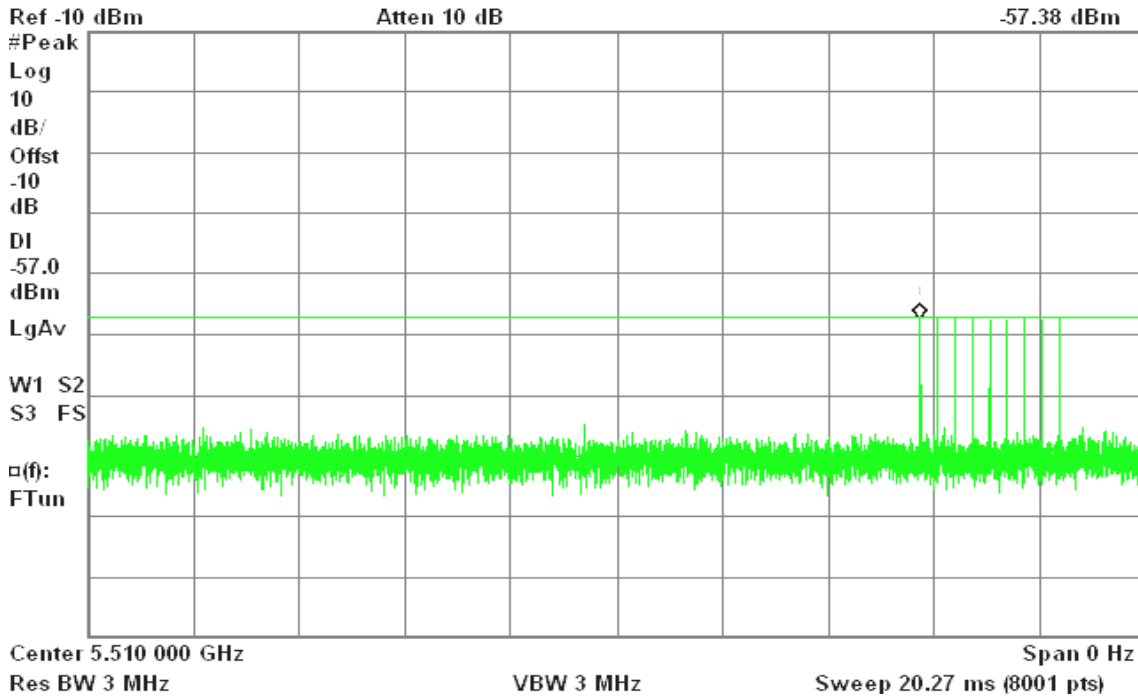


### Sample of Frequency Hopping Radar Type 6

Agilent 10:49:46 Mar 23, 2009

R T

Mkr1 15.96 ms  
-57.38 dBm

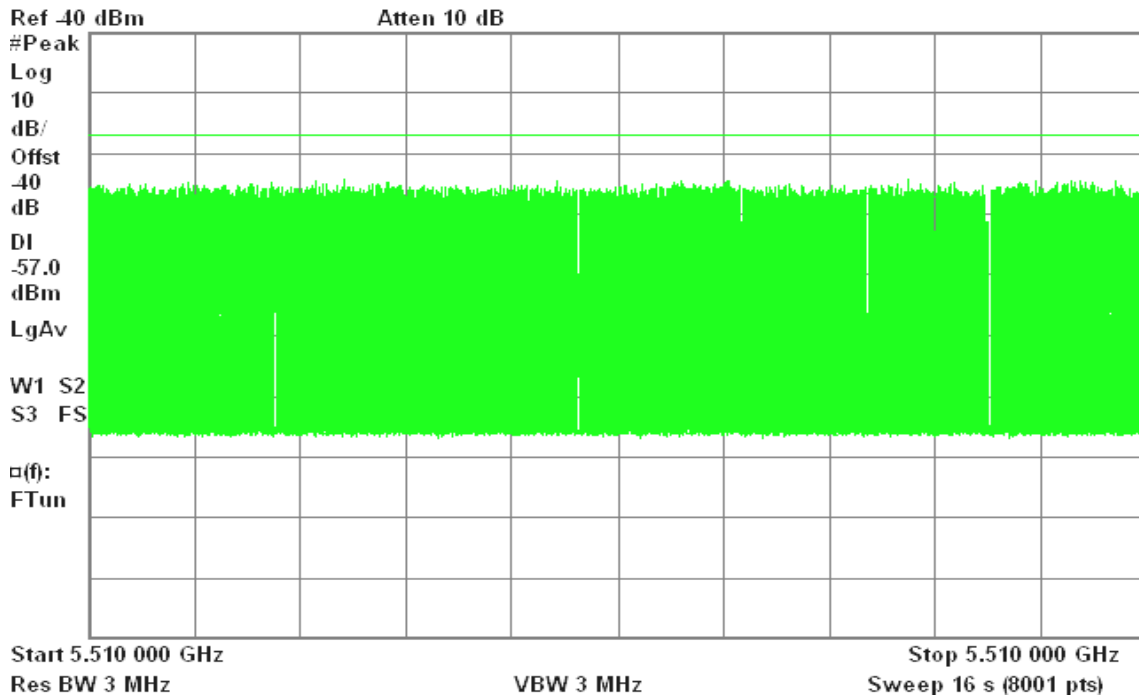




### Plot of WLAN Traffic from Slave

Agilent 13:49:13 Mar 20, 2009

R T





## **TEST CHANNEL AND METHOD**

All tests were performed at a channel center frequency of 5500 MHz utilizing a conducted test method.

## **CHANNEL MOVE TIME AND CHANNEL CLOSING TRANSMISSION TIME**

### **GENERAL REPORTING NOTES**

The reference marker is set at the end of last radar pulse.

The delta marker 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 aggregate time is calculated

Begins at (Reference Marker + 200 msec) and

Ends no earlier than (Reference Marker + 10 sec).



**draft 802.11n Standard-20 MHz Channel mode**

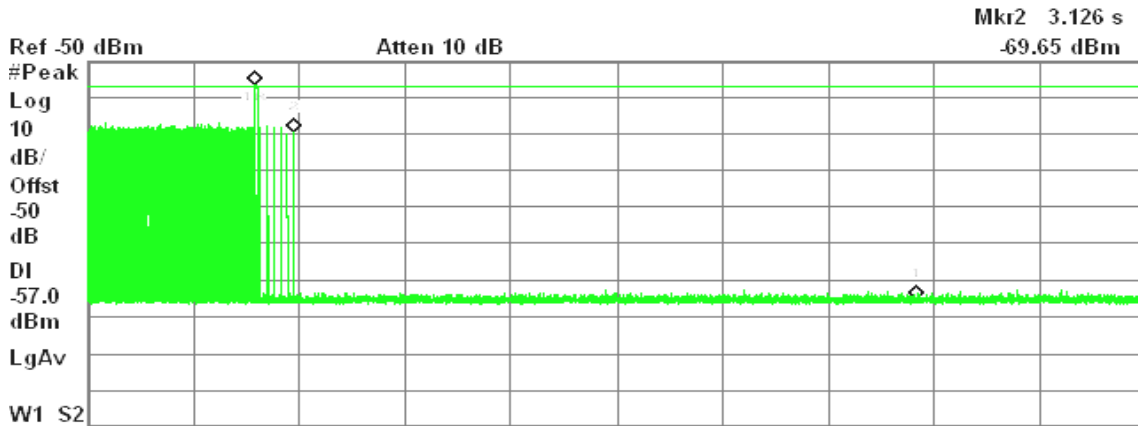
**Type 1 Channel Move Time Results**

No non-compliance noted.

Channel Move Time (s)	Limit (s)
3.126	10

Agilent 16:33:17 Mar 20, 2009

R T



Center 5.500 000 GHz Span 0 Hz  
Res BW 3 MHz VBW 3 MHz Sweep 16 s (8001 pts)

Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	2.538 s	-56.37 dBm
1Δ	(1)	Time	10 s	-58.98 dB
2	(1)	Time	3.126 s	-69.65 dBm





**draft 802.11n Wide-40 MHz Channel mode**

**Type 1 Channel Move Time Results**

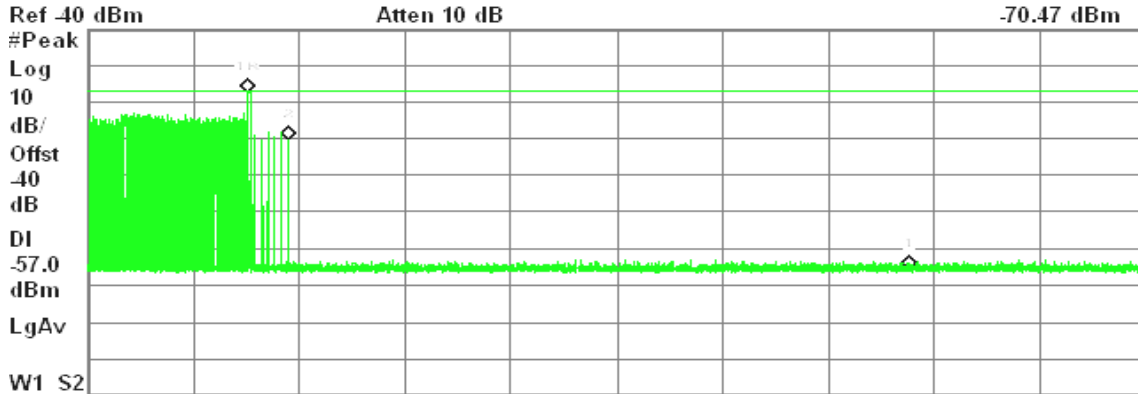
No non-compliance noted.

Channel Move Time (s)	Limit (s)
3.038	10

Agilent 13:59:18 Mar 20, 2009

R T

Mkr2 3.038 s  
-70.47 dBm



Start 5.510 000 GHz      Stop 5.510 000 GHz  
 Res BW 3 MHz      VBW 3 MHz      Sweep 16 s (8001 pts)

Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	2.432 s	-57.40 dBm
1Δ	(1)	Time	10 s	-48.30 dB
2	(1)	Time	3.038 s	-70.47 dBm

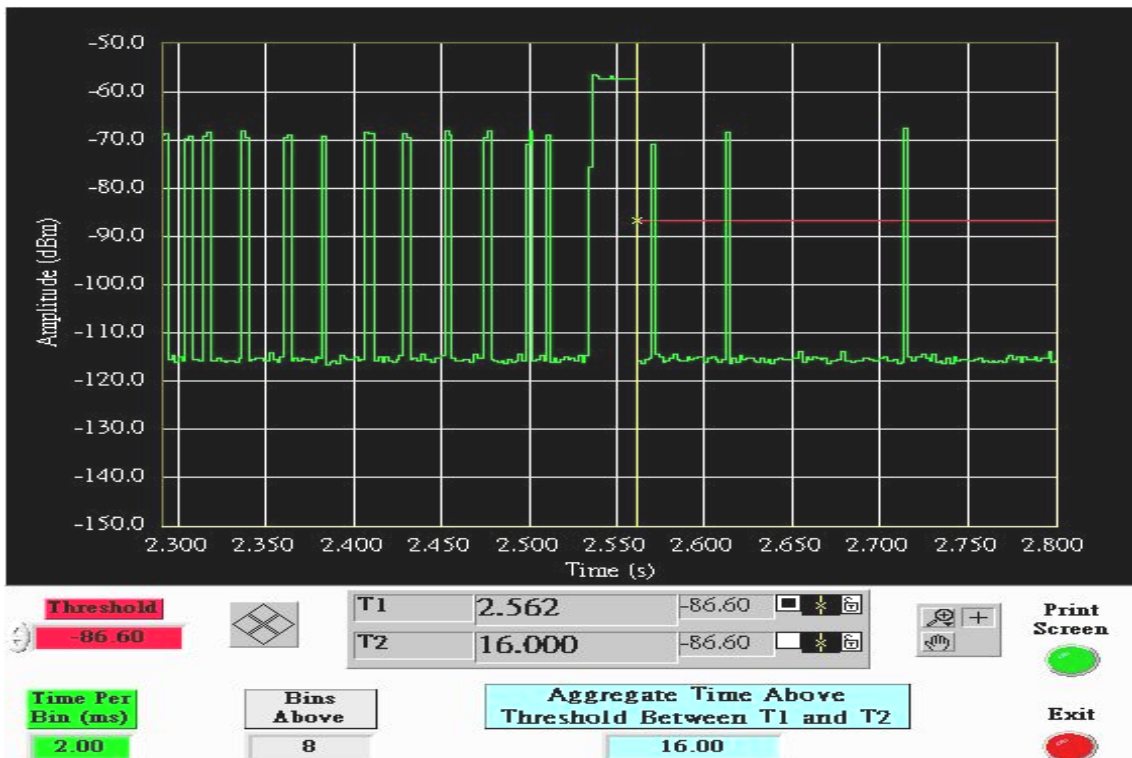
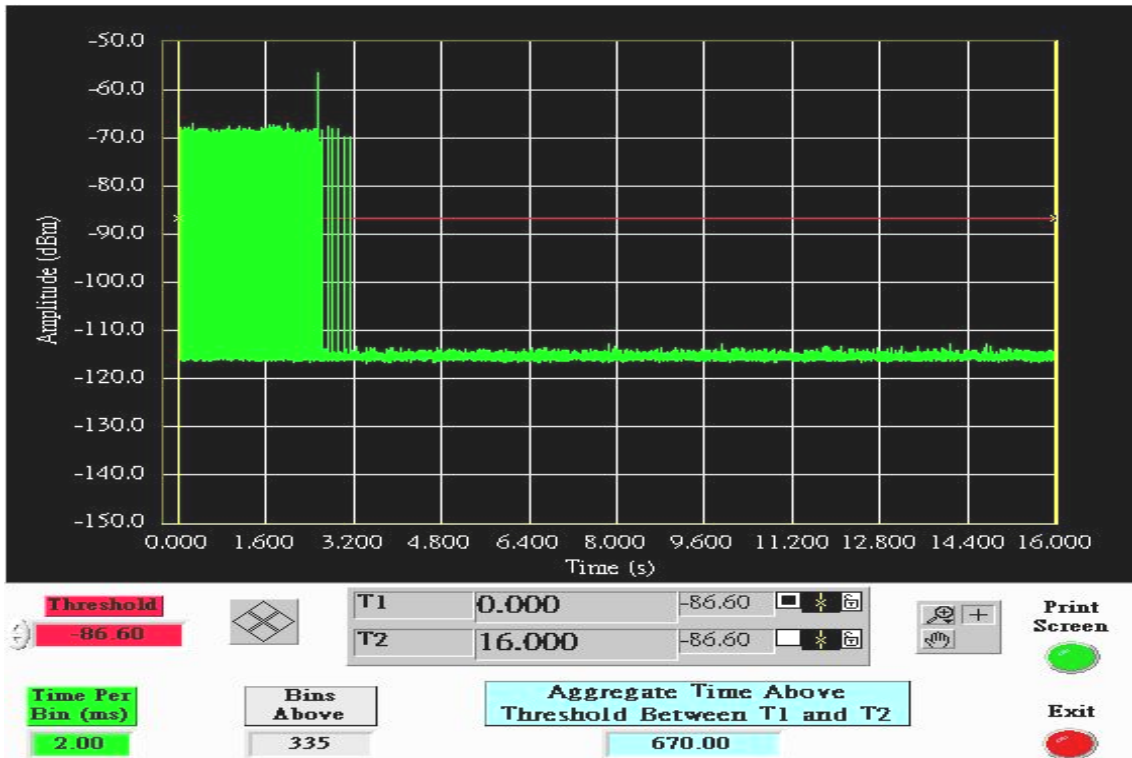


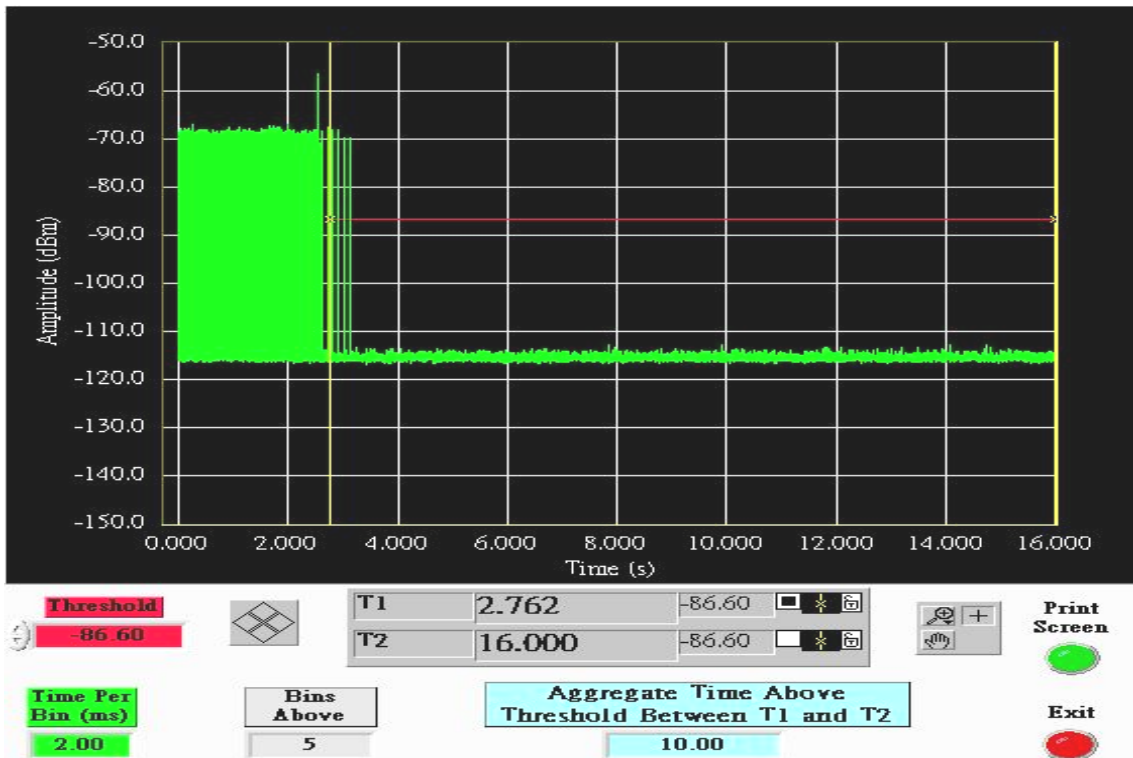
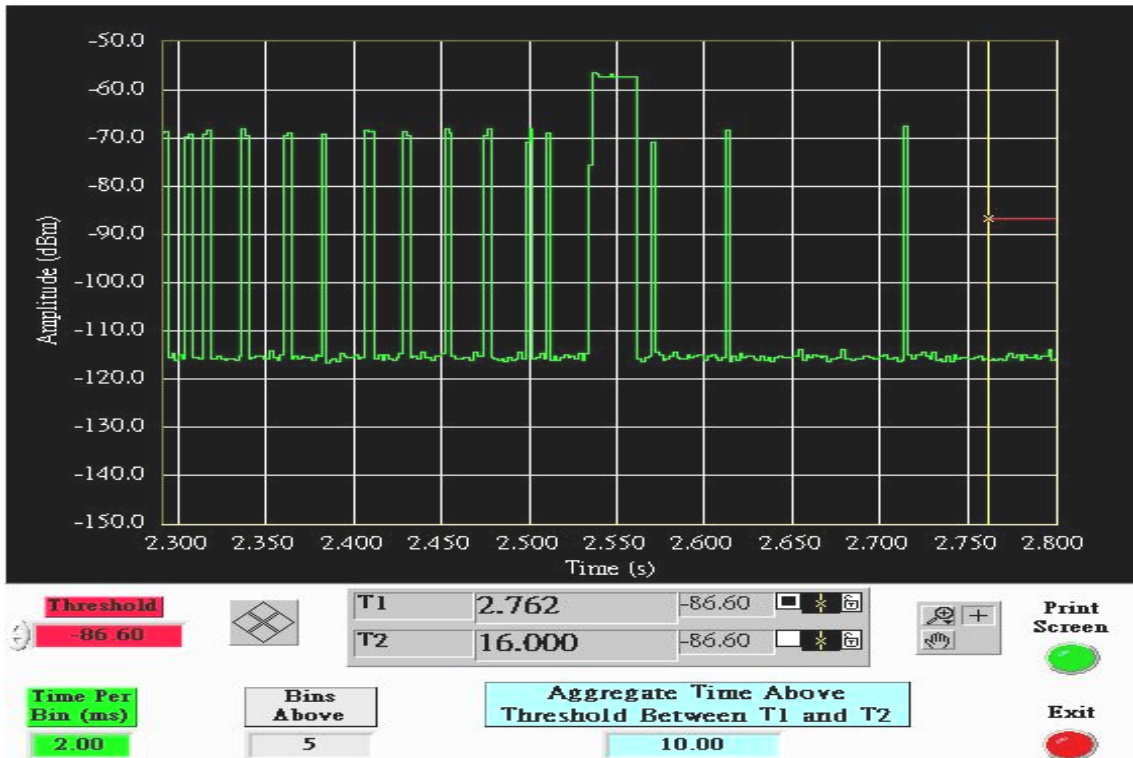
**draft 802.11n Standard-20 MHz Channel mode**

**Type 1 Channel Closing Transmission Time Results**

No non-compliance noted.

Aggregate Transmission Time (ms)	Limit (ms)	Margin (ms)
10	60	-50





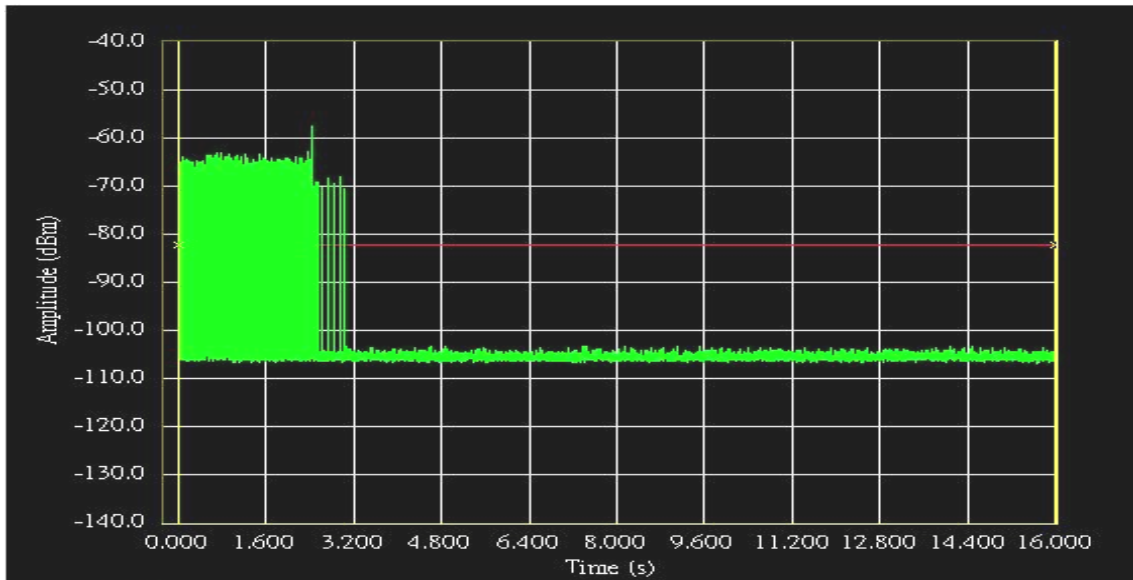


**draft 802.11n Wide-40 MHz Channel mode**

**Type 1 Channel Closing Transmission Time Results**

No non-compliance noted.

Aggregate Transmission Time (ms)	Limit (ms)	Margin (ms)
10	60	-50



Threshold: -82.12

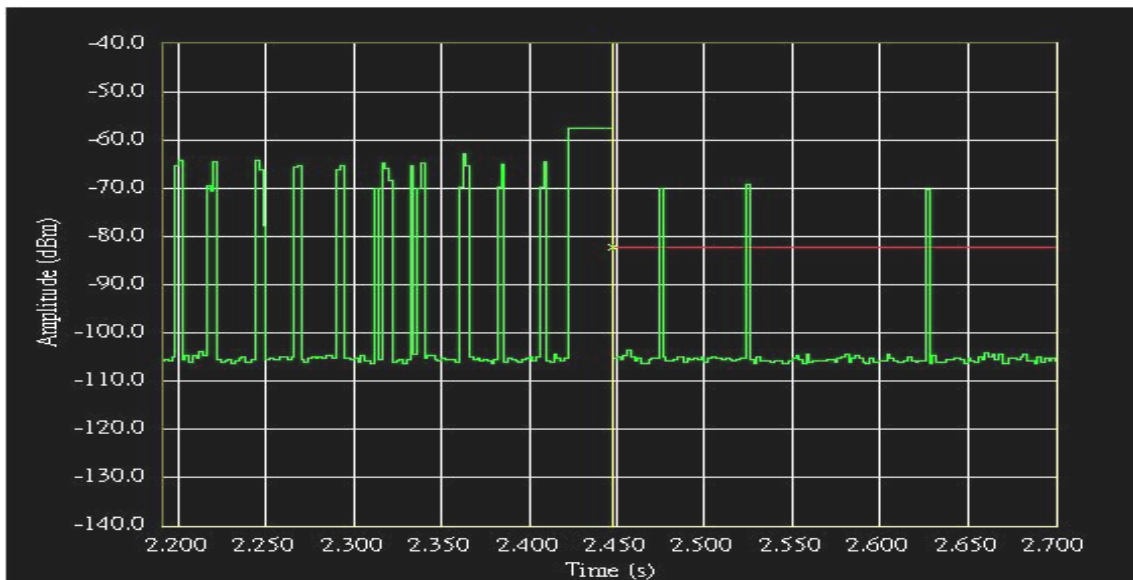
T1: 0.000, T2: 16.000

Time Per Bin (ms): 2.00

Bins Above: 365

Aggregate Time Above Threshold Between T1 and T2: 730.00

Print Screen, Exit



Threshold: -82.12

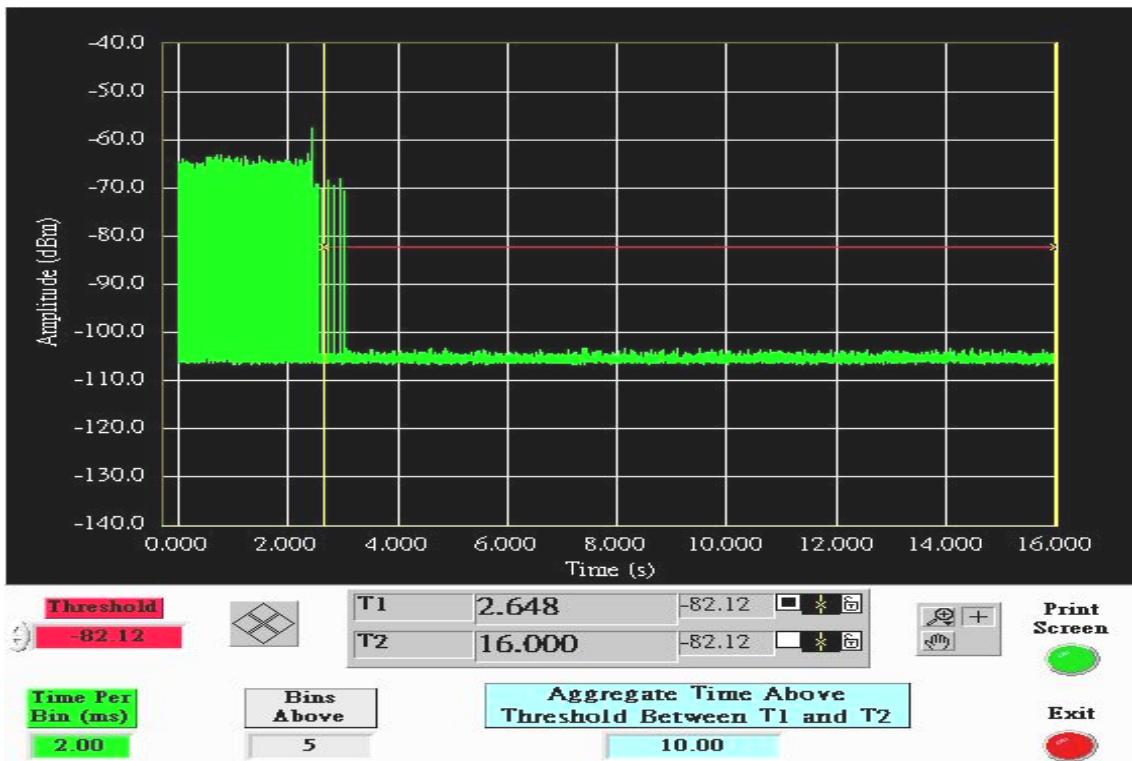
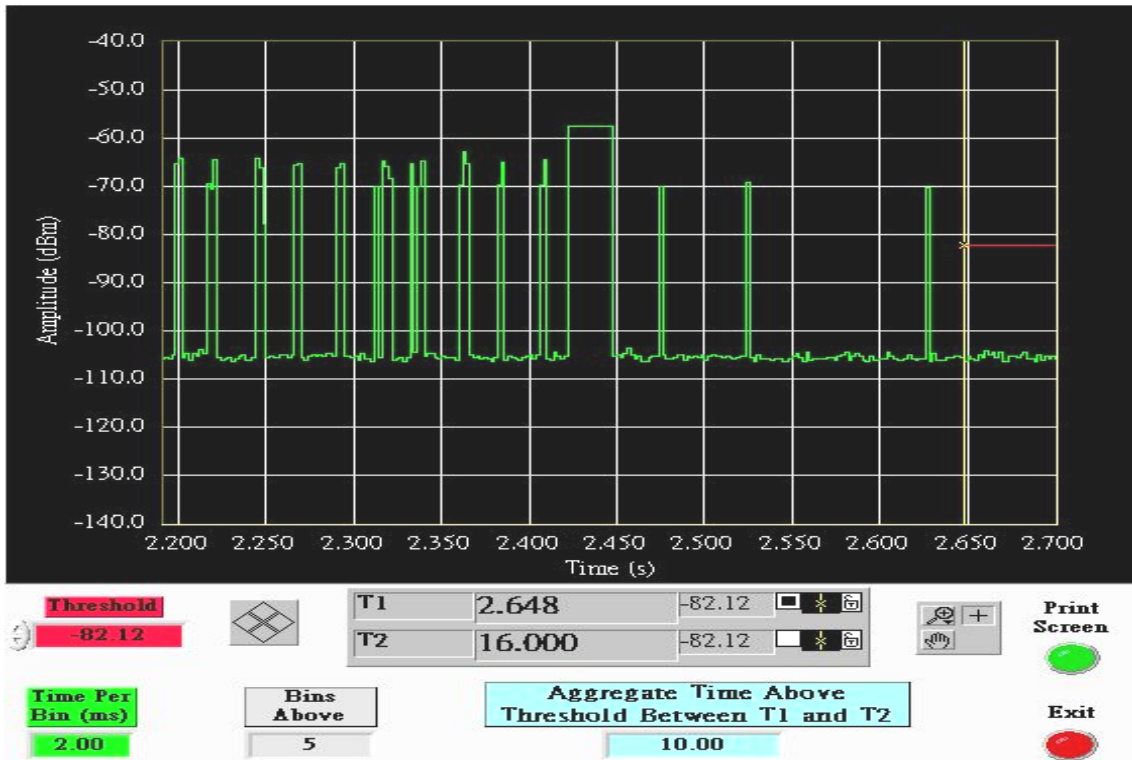
T1: 2.448, T2: 16.000

Time Per Bin (ms): 2.00

Bins Above: 8

Aggregate Time Above Threshold Between T1 and T2: 16.00

Print Screen, Exit





**draft 802.11n Standard-20 MHz Channel mode**

**Type 5 Channel Move Time Results**

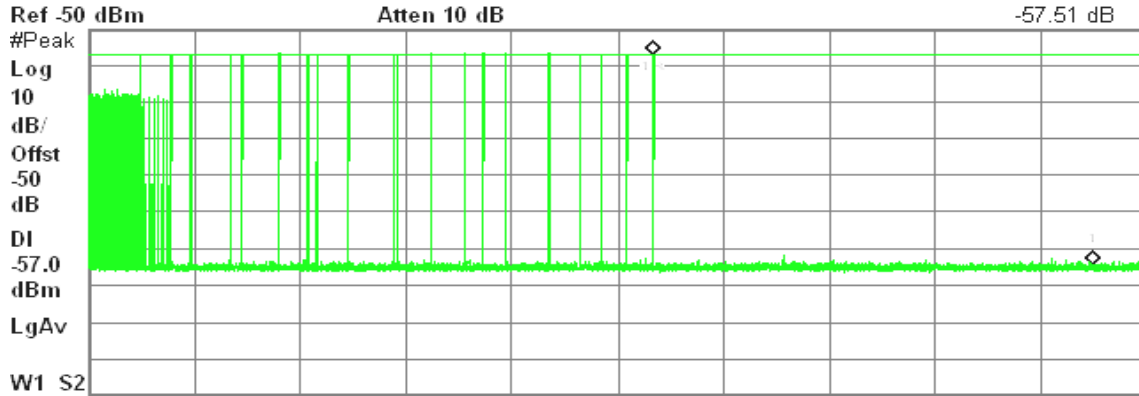
No non-compliance noted: The traffic ceases prior to the end of the radar waveform, therefore it also ceases prior to 10 seconds after the end of the radar waveform.

Agilent 16:36:03 Mar 20, 2009

R T

Δ Mkr1 10 s

-57.51 dB



Center 5.500 000 GHz Span 0 Hz  
 Res BW 3 MHz VBW 3 MHz Sweep 24 s (8001 pts)

Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	12.8 s	-56.99 dBm
1Δ	(1)	Time	10 s	-57.51 dB



**draft 802.11n Wide-40 MHz Channel mode**

**Type 5 Channel Move Time Results**

No non-compliance noted: The traffic ceases prior to the end of the radar waveform, therefore it also ceases prior to 10 seconds after the end of the radar waveform.

Agilent 14:05:58 Mar 20, 2009

R T

Δ Mkr1 10 s  
-47.79 dB



Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	12.68 s	-57.20 dBm
1Δ	(1)	Time	10 s	-47.79 dB



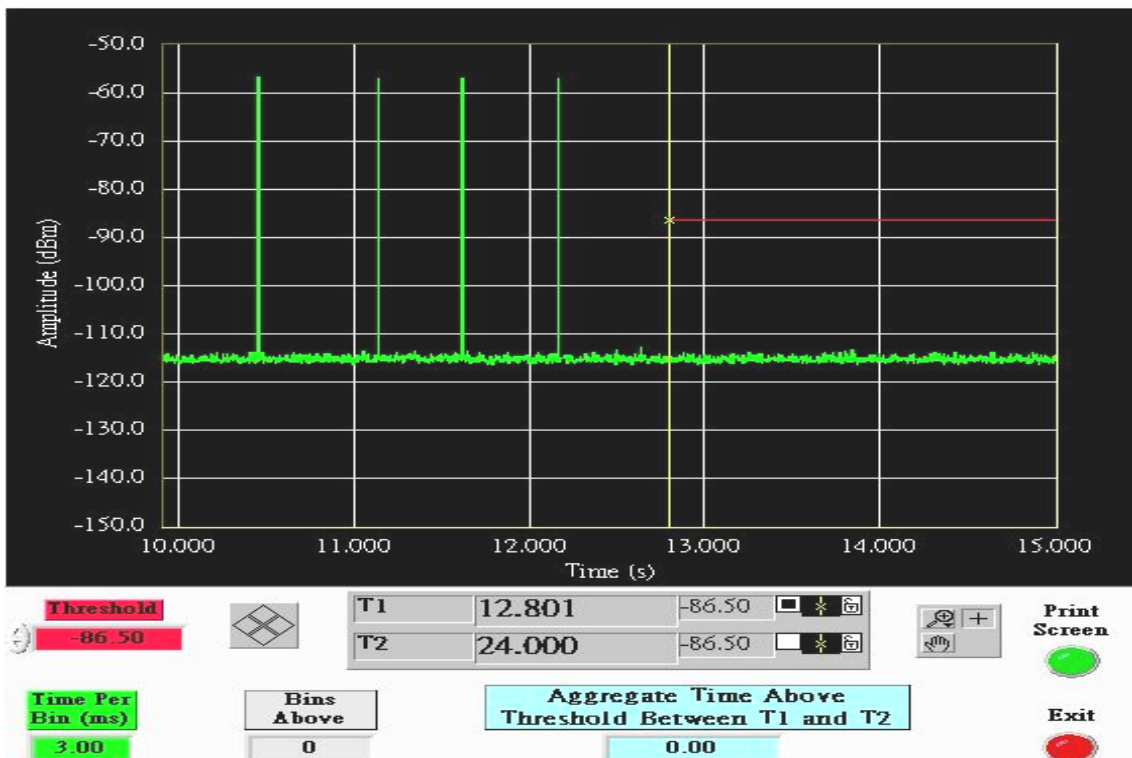
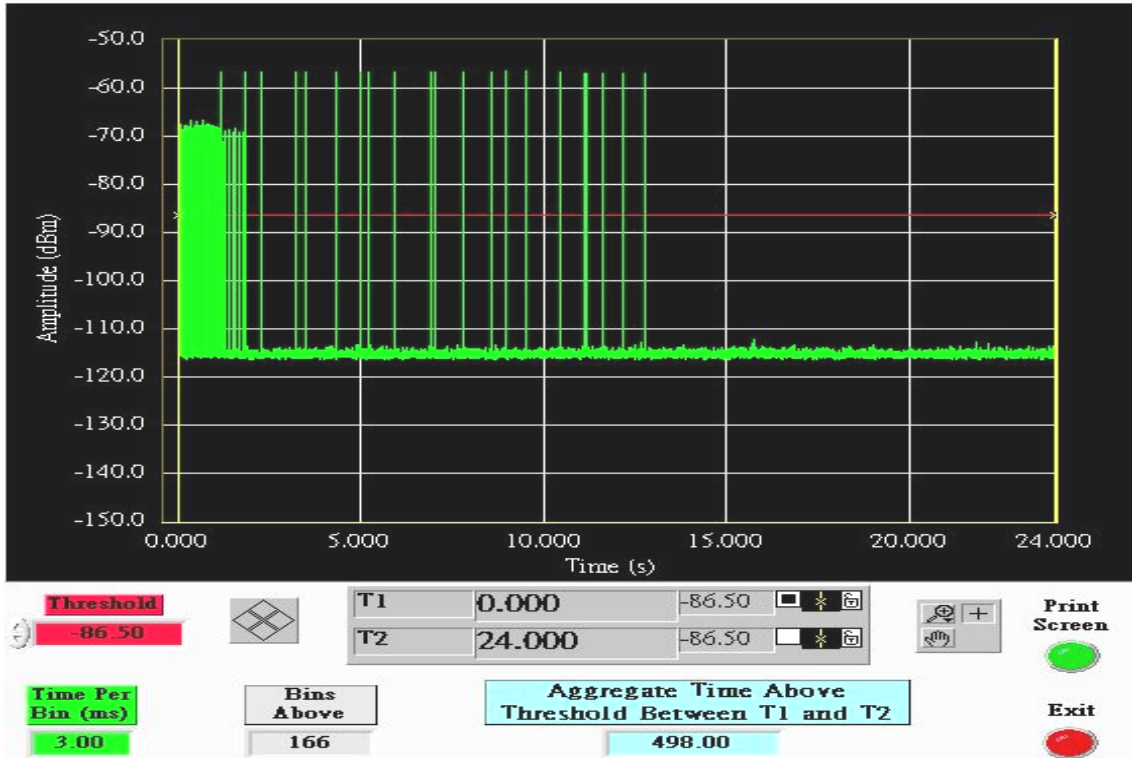


**draft 802.11n Standard-20 MHz mode**

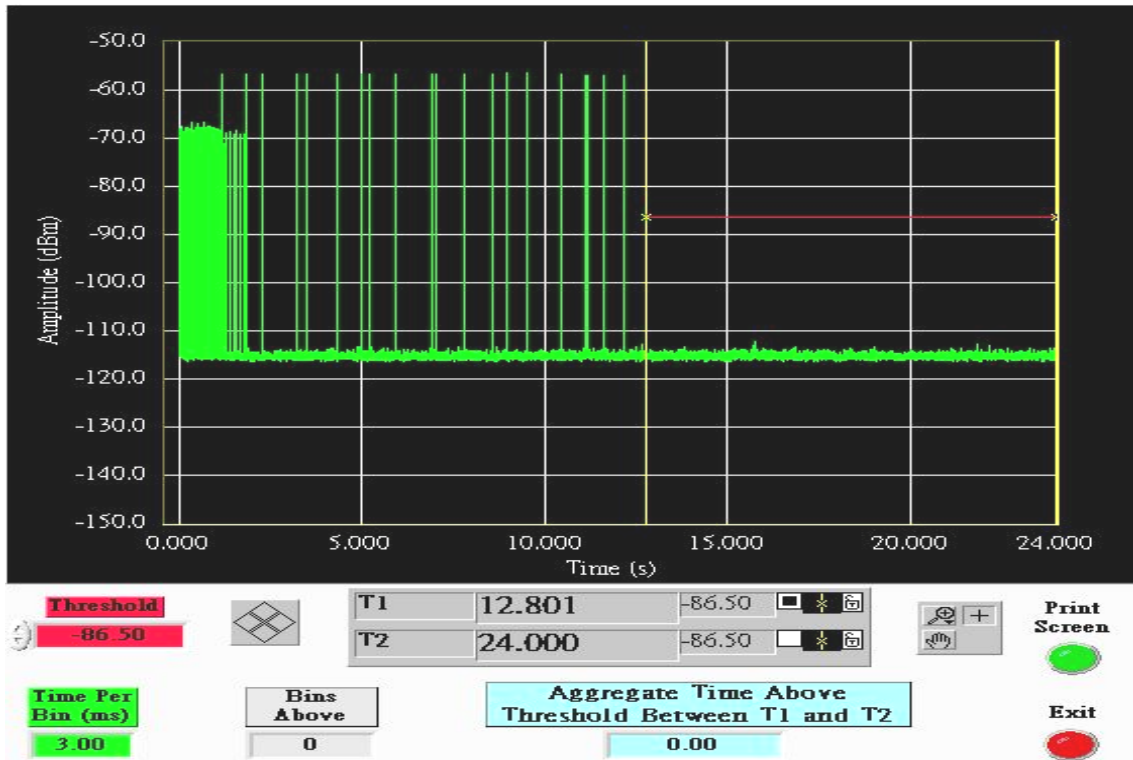
**Type 5 Channel Closing Transmission Time Results**

*No non-compliance noted.*

Aggregate Transmission Time (ms)	Limit (ms)	Margin (ms)
0	60	-60







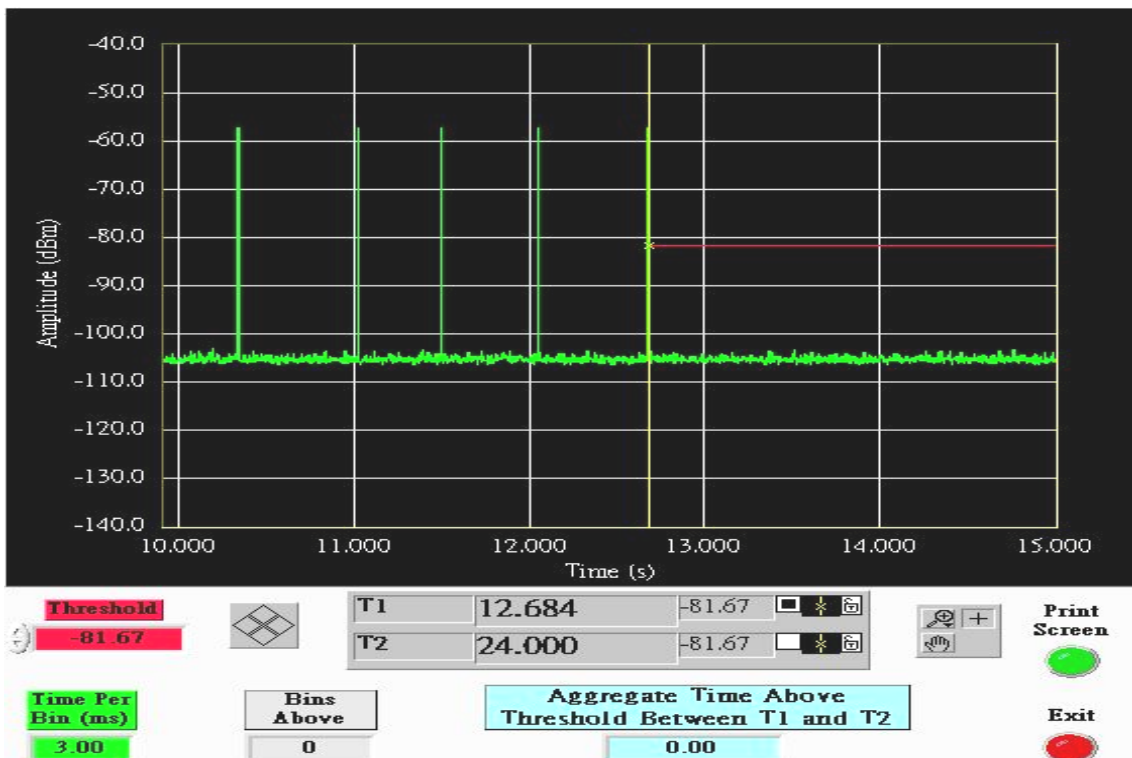
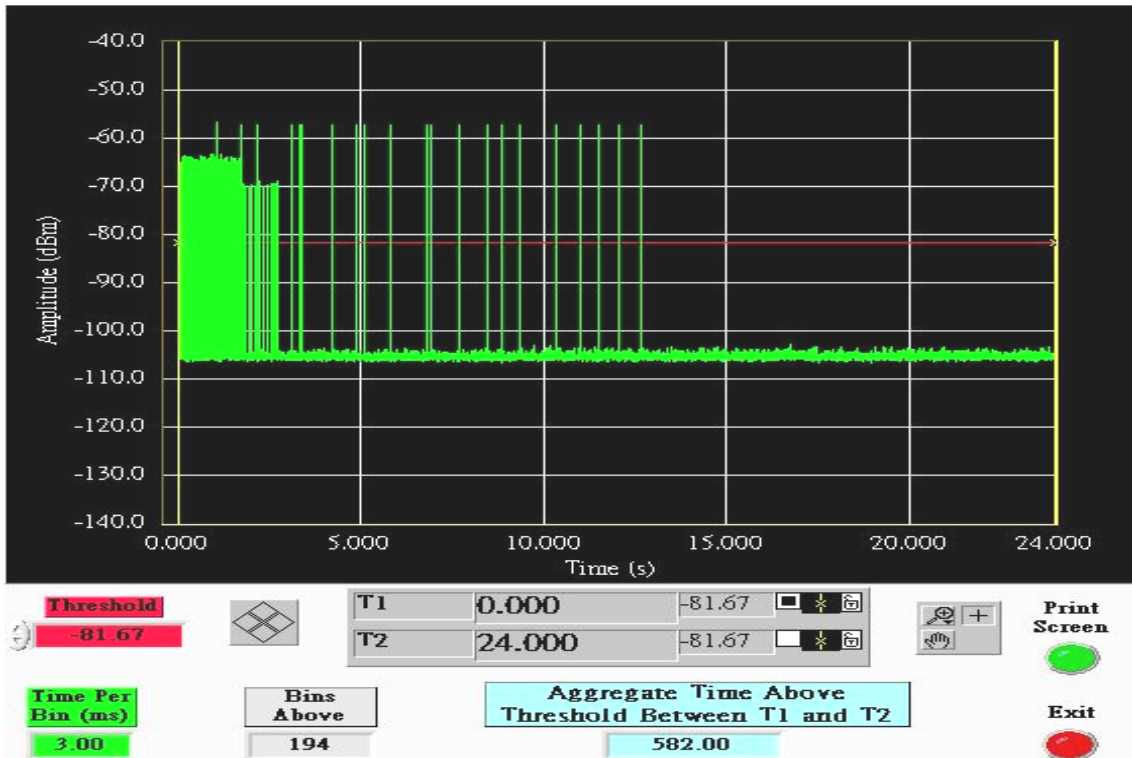


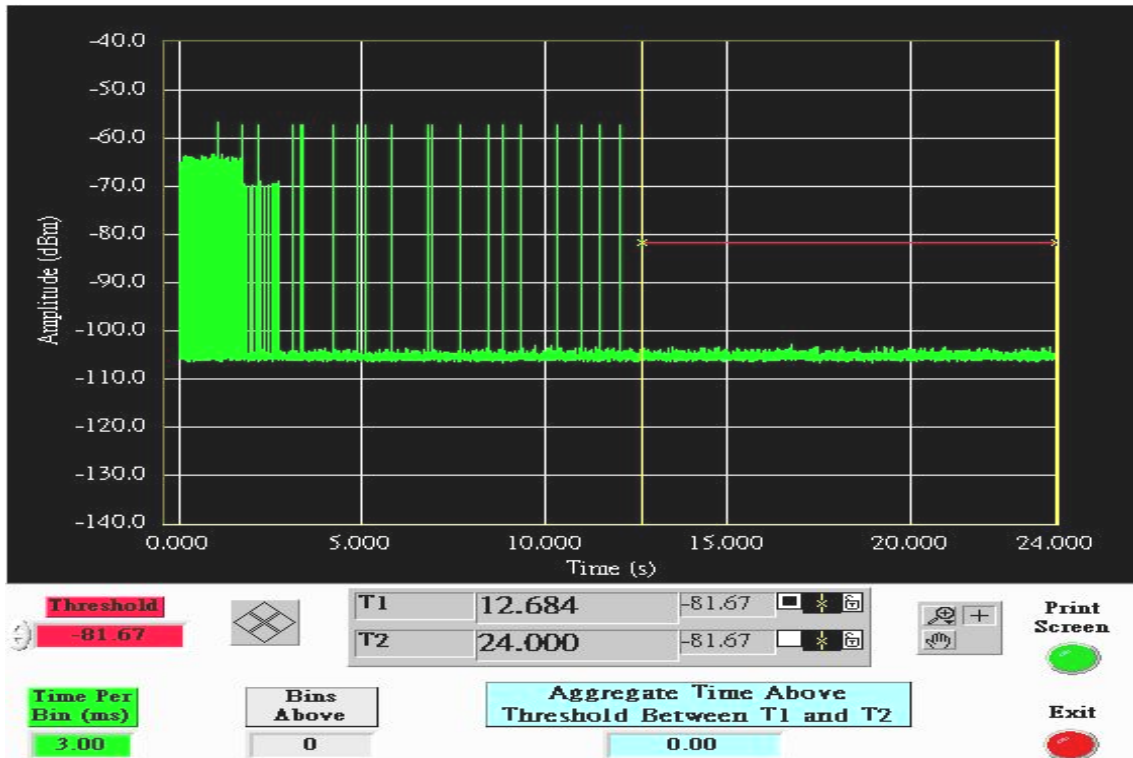
**draft 802.11n Wide-40 MHz mode**

**Type 5 Channel Closing Transmission Time Results**

No non-compliance noted.

Aggregate Transmission Time (ms)	Limit (ms)	Margin (ms)
0	60	-60







# NON-OCCUPANCY PERIOD

## draft 802.11n Wide-20 MHz mode

### Type 1 Non-Occupancy Period Test Results

No non-compliance noted.

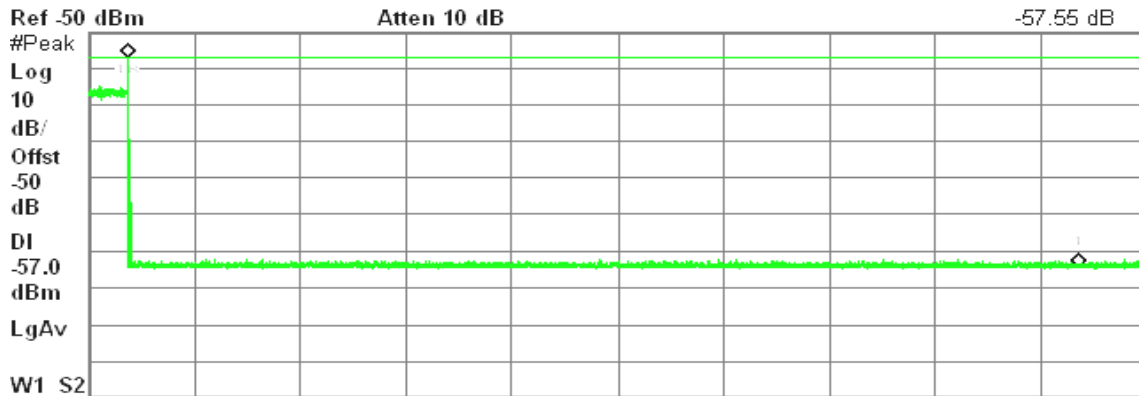
No EUT transmissions were observed on the test channel during the 30 minute observation time.

Agilent 09:39:45 Mar 23, 2009

R T

Δ Mkr1 1.8 ks

-57.55 dB



Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	73.75 s	-56.91 dBm
1Δ	(1)	Time	1.8 ks	-57.55 dB



### Type 5 Non-Occupancy Period Test Results

No non-compliance noted.

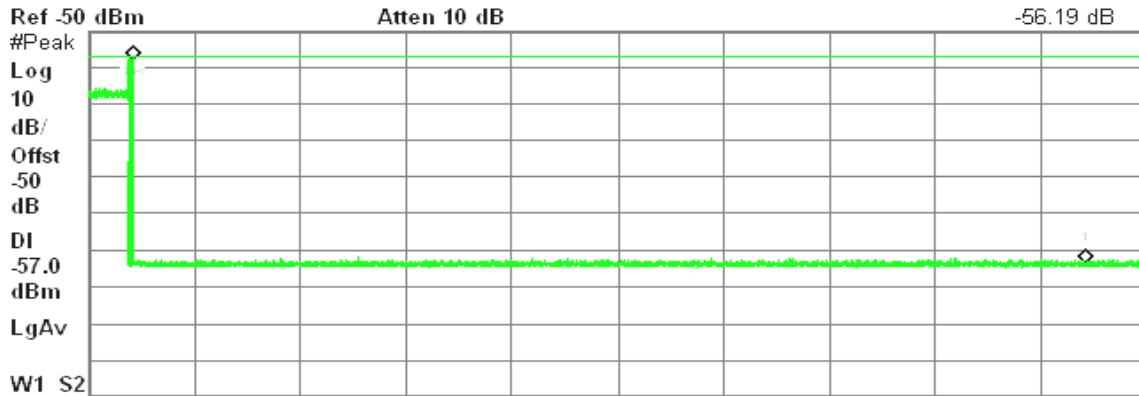
No EUT transmissions were observed on the test channel during the 30 minute observation time.

Agilent 10:26:47 Mar 23, 2009

R L

Δ Mkr1 1.8 ks

-56.19 dB



Center 5.500 000 GHz

Span 0 Hz

Res BW 3 MHz

VBW 3 MHz

Sweep 2 ks (8001 pts)

Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	85 s	-57.60 dBm
1Δ	(1)	Time	1.8 ks	-56.19 dB



**draft 802.11n Wide-40 MHz mode**

**Type 1 Non-Occupancy Period Test Results**

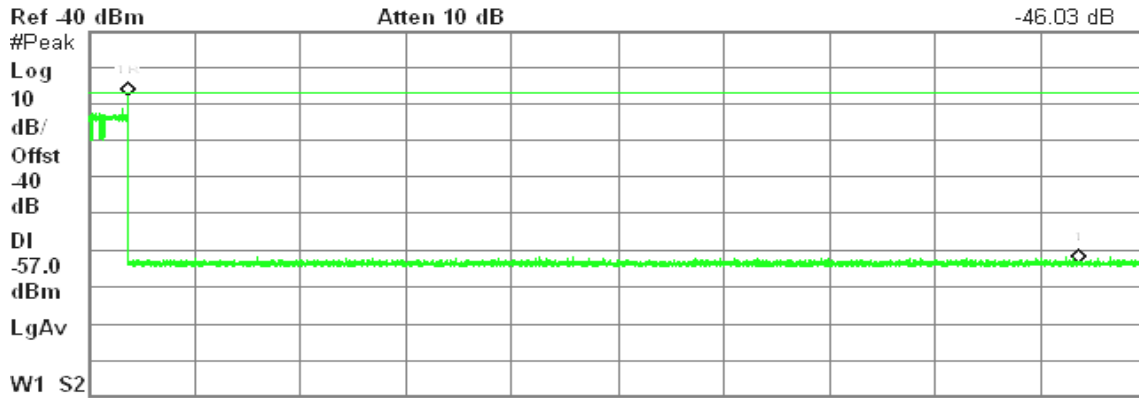
No non-compliance noted.

No EUT transmissions were observed on the test channel during the 30 minute observation time.

Agilent 16:23:54 Mar 20, 2009

R T

Δ Mkr1 1.8 ks



W1 S2  
Start 5.510 000 GHz  
Res BW 3 MHz  
VBW 3 MHz  
Stop 5.510 000 GHz  
Sweep 2 ks (8001 pts)

Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	72.75 s	-57.61 dBm
1Δ	(1)	Time	1.8 ks	-46.03 dB



### Type 5 Non-Occupancy Period Test Results

No non-compliance noted.

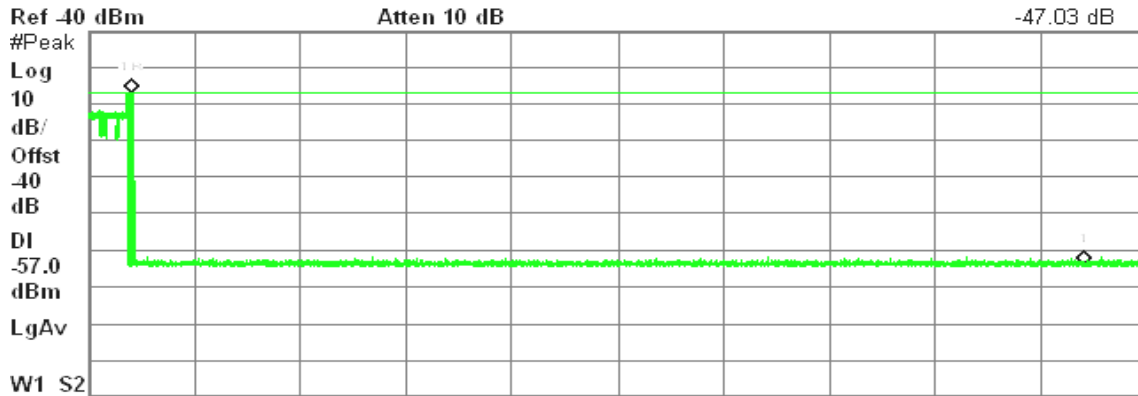
No EUT transmissions were observed on the test channel during the 30 minute observation time.

Agilent 15:46:50 Mar 20, 2009

R T

Δ Mkr1 1.8 ks

-47.03 dB



Start 5.510 000 GHz

Stop 5.510 000 GHz

Res BW 3 MHz

VBW 3 MHz

Sweep 2 ks (8001 pts)

Marker	Trace	Type	X Axis	Amplitude
1R	(1)	Time	81.5 s	-57.06 dBm
1Δ	(1)	Time	1.8 ks	-47.03 dB