TEST REPORT

Covering the DYNAMIC FREQUENCY SELECTION (DFS) REQUIREMENTS OF

FCC Part 15 Subpart E (UNII)

Intel Corporation
Model(s): Centrino® Advanced-N 6205

COMPANY:	Intel Corporation 2111 N.E. 25th Avenue Hillsboro, CA, 97124
TEST SITE:	Elliott Laboratories 684 W. Maude Ave Sunnyvale, CA 94085
REPORT DATE:	September 3, 2010
FINAL TEST DATE:	August 26, 2010
TEST ENGINEER:	Mehran Birgani

AUTHORIZED SIGNATORY: Mark Briggs
Staff Engineer

ACCREDITED
Testing Cert #2016.01

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SCOPE

The Federal Communications Commission and the European Telecommunications Standards Institute (ETSI) publish standards regarding Electromagnetic Compatibility and Radio spectrum Matters for radio-communications devices. Tests have been performed on the Intel Corporation model Centrino® Advanced-N 6205 in accordance with these standards.

Test data has been taken pursuant to the relevant DFS requirements of FCC Part 15 Subpart E Unlicensed National Information Infrastructure (U-NII) Devices.

Tests were performed in accordance with these standards together with the current published versions of the basic standards referenced therein as outlined in Elliott Laboratories test procedures.

The test results recorded herein are based on a single type test of the Intel Corporation model Centrino® Advanced-N 6205 and therefore apply only to the tested sample. The sample was selected and prepared by Robert Paxman of Intel Corporation.

OBJECTIVE

The objective of the manufacturer is to comply with the standards identified in the previous section. In order to demonstrate compliance, the manufacturer or a contracted laboratory makes measurements and takes the necessary steps to ensure that the equipment complies with the appropriate technical standards. Compliance with some DFS features is covered through a manufacturer statement or through observation of the device.

STATEMENT OF COMPLIANCE

The tested sample of Intel Corporation model Centrino® Advanced-N 6205 complied with the DFS requirements of FCC Part 15.407(h)(2)

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

DEVIATIONS FROM THE STANDARD

No deviations were made from the test methods and requirements covered by the scope of this report.

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Intel Corporation model Centrino® Advanced-N 6205 is a PCIe Half Mini Card form factor IEEE 802.11a/b/g/n wireless network adapter that operates in both the 2.4 GHz and 5.0 GHz spectra. The card supports 2x2 MIMO for 802.11n modes in both 20MHz and 40MHz channels. In legacy modes 1x2 operation is supported.

The card is being certified with both full modular approval and limited modular approval. The two versions are electrically identical using the same hardware and firmware with respect to DFS functions. The full modular version is intended for factory installation only by the oem (FCC ID:PD962205ANH; IC:1000M-62205ANH). The limited modular version is intended to allow the oem to permit user installation when the host system is provided with a bios locking feature that prevents unauthorized installation (FCC ID:PD962205ANHU; IC:1000M-62205ANHU). All versions are approved under Intel model 62205ANHMW with the exception of the limited modular approval for Canada which is approved as model 62205ANHU (see table below).

A sample was received and tested on July 30, 2010. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Mac Address
Intel Corporation	62205ANHMW	Express PCI Wireless Adapter	00150063ADA
	62205ANHU		

The manufacturer declared values for the EUT operational characteristics that affect DFS are as follows:

<u>Operating Modes (5250 – 5350 MHz, 5470 – 5725 MHz)</u>

☐ Master Device

☒ Client Device (no In Service Monitoring, no Ad-Hoc mode)

☐ Client Device with In-Service Monitoring

<u>Antenna Gains / EIRP (5250 – 5350 MHz, 5470 – 5725 MHz)</u>

	5250 – 5350 MHz
Lowest Antenna Gain (dBi)	2.75
Highest Antenna Gain (dBi)	3.7
Output Power (dBm)	15.3

☐ Power can exceed 200mW eirp

<u>Channel Protocol</u>

☒ IP Based

ENCLOSURE

The EUT has no enclosure. It is designed to be installed within the enclosure of a host computer.

MODIFICATIONS

The EUT did not require modifications during testing in order to comply with the requirements of the standard referenced in this test report.

SUPPORT EQUIPMENT

The following equipment was used as local support equipment for testing:

Manufacturer	Model	Description	Serial Number	FCC ID
Cisco Systems	*RM1252AG-A-K9*	*Wireless AP*	*FTX209906V*	*LDK102062*
Dell	PP02X	Laptop Computer (file server)	JMB3551	DoC
Toshiba	PSA G8U-0400 1W	Laptop computer	49290792Q	DoC
Airlink 101	AR430W	Router	030008256167	RRK-AR430W

The italicized device was the master device.

EUT INTERFACE PORTS

The EUT was installed inside a laptop computer during testing.

EUT OPERATION

The EUT was operating with software: driver 13.0.0.238.

During testing the system was configured with a streaming video file from the master device (sourced by the PC connected to the master device via an Ethernet interface) to the client device.

The streamed file was the “FCC” test file and the client device was using Windows Media Player Classic as required by FCC Part 15 Subpart E.

RADAR WAVEFORMS

Table 1 FCC Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (μsec)	PRI (μsec)	Pulses / burst	Minimum Detection Percentage	Minimum Number of 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 2 FCC Long Pulse Radar Test Waveforms

Radar Type	Pulse Width (μsec)	Chirp Width (MHz)	PRI (μsec)	Pulses / burst	Number of *Bursts*	Minimum Detection Percentage	Minimum Number of Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Table 3 FCC Frequency Hopping Radar Test Waveforms

Radar Type	Pulse Width (μsec)	PRI (μsec)	Pulses / hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Detection Percentage	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

TEST RESULTS

TEST RESULTS SUMMARY – FCC Part 15, CLIENT DEVICE

Table 4 FCC Part 15 Subpart E Client Device Test Result Summary

Description	Radar Type	Radar Frequency	Measured Value	Requirement	Test Data	Status
Channel closing transmission time	Type 1	5300	1.44ms	<60ms	0	Complies
Channel move time	Type 1	5300	544ms	10s	0	Complies
Non-occupancy period - associated	Type 1	5300	> 30 minutes	> 30 minutes	0	Complies
Passive Scanning	N/A	N/A	Refer to manufacturer attestation, Appendix D			

Notes:
1) Tests were performed using the radiated test method.
2) Channel availability check, detection threshold and non-occupancy period are not applicable to client devices.

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level, with a coverage factor (k=2) and were calculated in accordance with UKAS document LAB 34.

Measurement	Measurement Unit	Expanded Uncertainty
Timing (Channel move time, aggregate transmission time)	ms	Timing resolution +/- 0.24%
Timing (non occupancy period)	seconds	5 seconds
DFS Threshold (radiated)	dBm	1.6
DFS Threshold (conducted)	dBm	1.2

DFS TEST METHODS

RADIATED TEST METHOD

The combination of master and slave devices is located in an anechoic chamber. The simulated radar waveform is transmitted from a directional horn antenna (typically an EMCO 3115) toward the unit performing the radar detection (radar detection device, RDD). Every effort is made to ensure that the main beam of the EUT's antenna is aligned with the radar-generating antenna.

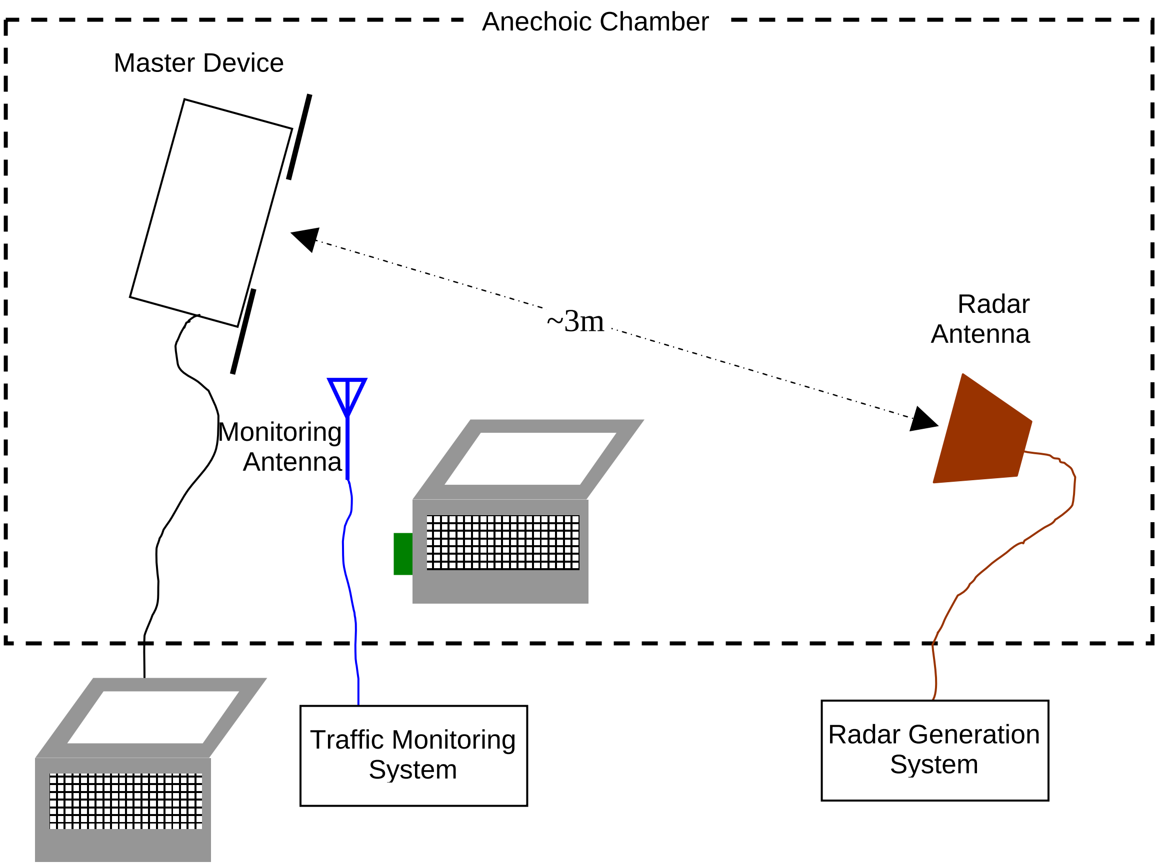


Figure 1 Test Configuration for radiated Measurement Method

The signal level of the simulated waveform is set to a reference level equal to the threshold level (plus 1dB if testing against FCC requirements). Lower levels may also be applied on request of the manufacturer. The level reported is the level at the RDD antenna and so it is not corrected for the RDD's antenna gain. The RDD is configured with the lowest gain antenna assembly intended for use with the device.

The signal level is verified by measuring the CW signal level from the radar generation system using a reference antenna of gain G (dBi). The radar signal level is calculated from the measured level, R (dBm), and any cable loss, L (dB), between the reference antenna and the measuring instrument:

Applied level (dBm) = R – GREF + L

If both master and client devices have radar detection capability then the device not under test is positioned with absorbing material between its antenna and the radar generating antenna, and the radar level at the non RDD is verified to be at least 20dB below the threshold level to ensure that any responses are due to the RDD detecting radar.

The antenna connected to the channel monitoring subsystem is positioned to allow both master and client transmissions to be observed, with the level of the EUT's transmissions between 6 and 10dB higher than those from the other device.

DFS MEASUREMENT INSTRUMENTATION

RADAR GENERATION SYSTEM

An Agilent PSG is used as the radar-generating source. The integral arbitrary waveform generators are programmed using Agilent's "Pulse Building" software and Elliott custom software to produce the required waveforms, with the capability to produce both un-modulated and modulated (FM Chirp) pulses. Where there are multiple values for a specific radar parameter then the software selects a value at random and, for FCC tests, the software verifies that the resulting waveform is truly unique.

With the exception of the hopping waveforms required by the FCC's rules (see below), the radar generator is set to a single frequency within the radar detection bandwidth of the EUT. The frequency is varied from trial to trial by stepping in 5MHz steps.

Frequency hopping radar waveforms are simulated using a time domain model. A randomly hopping sequence algorithm (which uses each channel in the hopping radar's range once in a hopping sequence) generates a hop sequence. A segment of the first 100 elements of the hop sequence are then examined to determine if it contains one or more frequencies within the radar detection bandwidth of the EUT. If it does not then the first element of the segment is discarded and the next frequency in the sequence is added. The process repeats until a valid segment is produced. The radar system is then programmed to produce bursts at time slots coincident with the frequencies within the segment that fall in the detection bandwidth. The frequency of the generator is stepped in 1 MHz increments across the EUT's detection range.

The radar signal level is verified during testing using a CW signal with the AGC function switched on. Correction factors to account for the fact that pulses are generated with the AGC functions switched off are measured annually and an offset is used to account for this in the software.

The generator output is connected to the coupling port of the conducted set-up or to the radar-generating antenna.

CHANNEL MONITORING SYSTEM

Channel monitoring is achieved using a spectrum analyzer and digital storage oscilloscope. The analyzer is configured in a zero-span mode, center frequency set to the radar waveform's frequency or the center frequency of the EUT's operating channel. The IF output of the analyzer is connected to one input of the oscilloscope.

A signal generator output is set to send either the modulating signal directly or a pulse gate with an output pulse co-incident with each radar pulse. This output is connected to a second input on the oscilloscope and the oscilloscope displays both the channel traffic (via the if input) and the radar pulses on its display.

For in service monitoring tests the analyzer sweep time is set to > 20 seconds and the oscilloscope is configured with a data record length of 10 seconds for the short duration and frequency hopping waveforms, 20 seconds for the long duration waveforms. Both instruments are set for a single acquisition sequence. The analyzer is triggered 500ms before the start of the waveform and the oscilloscope is triggered directly by the modulating pulse train. Timing measurements for aggregate channel transmission time and channel move time are made from the oscilloscope data, with the end of the waveform clearly identified by the pulse train on one trace. The analyzer trace data is used to confirm that the last transmission occurred within the 10-second record of the oscilloscope. If necessary the record length of the oscilloscope is expanded to capture the last transmission on the channel prior to the channel move.

Channel availability check time timing plots are made using the analyzer. The analyzer is triggered at start of the EUT's channel availability check and used to verify that the EUT does not transmit when radar is applied during the check time.

The analyzer detector and oscilloscope sampling mode is set to peak detect for all plots.

DFS MEASUREMENT METHODS

DFS – CHANNEL CLOSING TRANSMISSION TIME AND CHANNEL MOVE TIME

Channel clearing and closing times are measured by applying a burst of radar with the device configured to change channel and by observing the channel for transmissions. The time between the end of the applied radar waveform and the final transmission on the channel is the channel move time.

The aggregate transmission closing time is measured as the total time of all individual transmissions from the EUT that are observed starting 200ms at the end of the last radar pulse in the waveform. This value is required to be less than 60ms.

DFS – CHANNEL NON-OCCUPANCY AND VERIFICATION OF PASSIVE SCANNING

The channel that was in use prior to radar detection by the master is additionally monitored for 30 minutes to ensure no transmissions on the vacated channel over the required non-occupancy period. This is achieved by tuning the spectrum analyzer to the vacated channel in zero-span mode and connecting the IF output to an oscilloscope. The oscilloscope is triggered by the radar pulse and set to provide a single sweep (in peak detect mode) that lasts for at least 30 minutes after the end of the channel move time.

For devices with a client-mode that are being evaluated against FCC rules the manufacturer must supply an attestation letter stating that the client device does not employ any active scanning techniques (i.e. does not transmit in the DFS bands without authorization from a Master device).

SAMPLE CALCULATIONS

DETECTION PROBABILITY / SUCCESS RATE

The detection probability, or success rate, for any one radar waveform equals the number of successful trials divided by the total number of trials for that waveform.

THRESHOLD LEVEL

The threshold level is the level of the simulated radar waveform at the EUT’s antenna. If the test is performed in a conducted fashion then the level at the rf input equals the level at the antenna plus the gain of the antenna assembly, in dBi. The gain of the antenna assembly equals the gain of the antenna minus the loss of the cabling between the rf input and the antenna. The lowest gain value for all antenna assemblies intended for use with the device is used when making this calculation.

If the test is performed using the radiated method then the threshold level is the level at the antenna.

Appendix A Test Equipment Calibration Data

Manufacturer	**Description**	**Model #**	**Asset #**	**Cal Due**
Hewlett Packard	EMC Analyzer	8595EM	780	05-Jan-11
Tektronics	Digital Oscilloscope	TDS5052B	2118	28-Sep-10
Agilent	PSG Vector Signal Generator	E8267C	1877	24-Mar-11
EMCO	1-18GHz Horn antenna	3115	1779	Transmit only
EMCO	1-18GHz Horn antenna	3115	1142	02-Aug-12

Appendix B Test Data and Plots for Channel Closing and non Occupancy

FCC PART 15 SUBPART E Channel Closing Measurements

Waveform Type	Channel Closing Transmission Time [1]		Channel Move Time		Result
	Measured	Limit	Measured	Limit	
Radar Type 1	1.44 ms	60 ms	544 ms	10 s	Complied

Table 5 FCC Part 15 Subpart E Channel Closing Test Results

The first pair of channel closing plots (Figure 2: Channel Closing) has 40 seconds of data on the lower plot (low resolution) and 10 seconds of data on the upper (high resolution plot to show the final transmission is well before the maximum 10 second channel move time has elapsed.

Figure 3: Channel Closing 600ms window provides a zoom-in for the high resolution (upper) timing plot to show the 600ms after the radar burst as requested by the FCC. This shows that there were only two, very short duration transmissions after the initial 200ms following the radar, consistent with control signals. The resolution for the upper plot in both the 40-second and 600ms data is 20µs.

After the final channel closing test the channel was monitored for a further 30 minutes. No transmissions occurred on the channel. Refer to Figure 4: Non-Occupancy Plot for details.

[1] Channel closing time for FCC measurements is the aggregate transmission time starting from 200ms after the end of the radar signal to the completion of the channel move. The 10.66ms measurement includes transmissions within the 200ms period immediately following the end of the radar burst and is, therefore, an over-estimation of the channel closing transmission time.

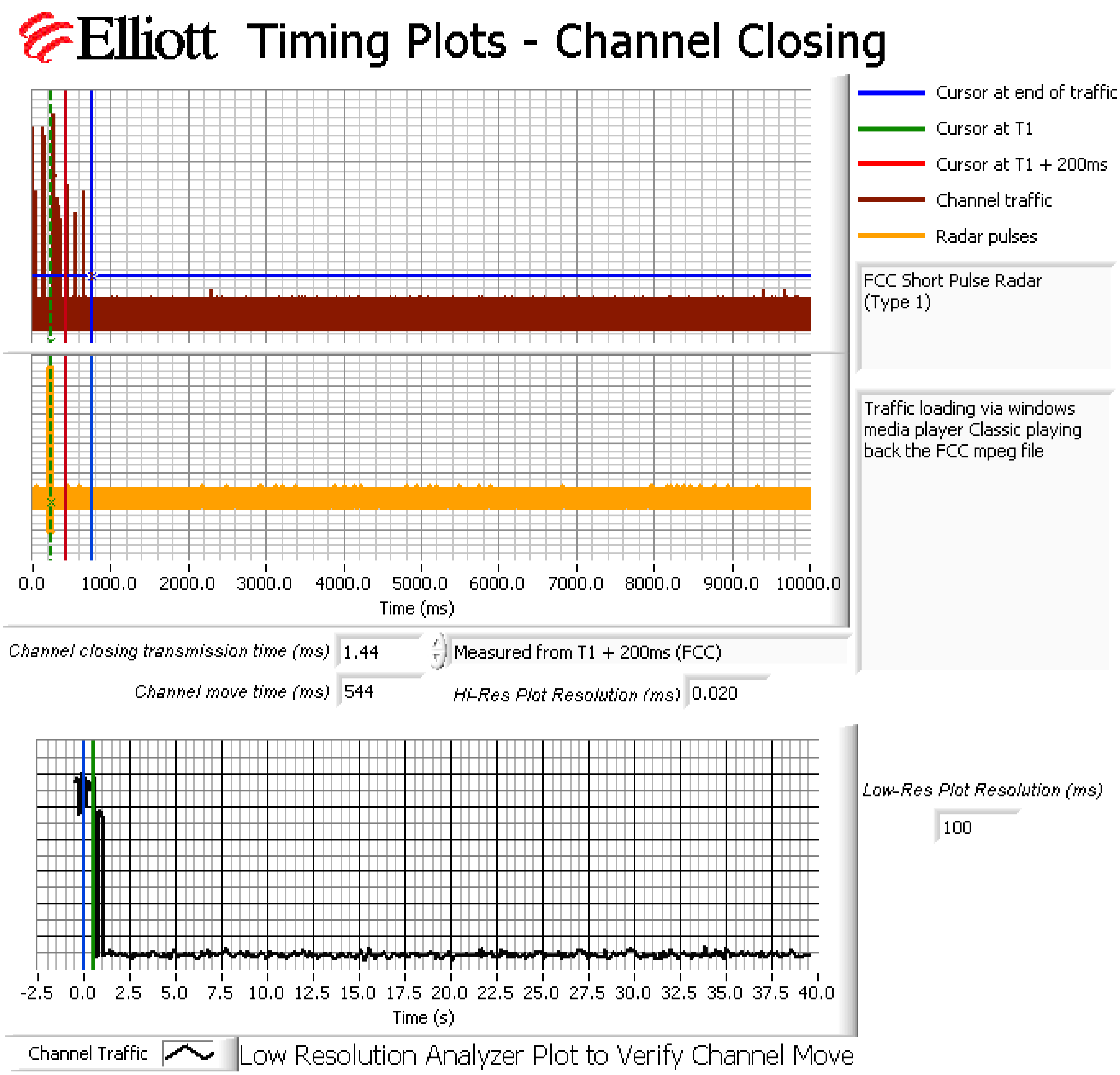


Figure 2: Channel Closing

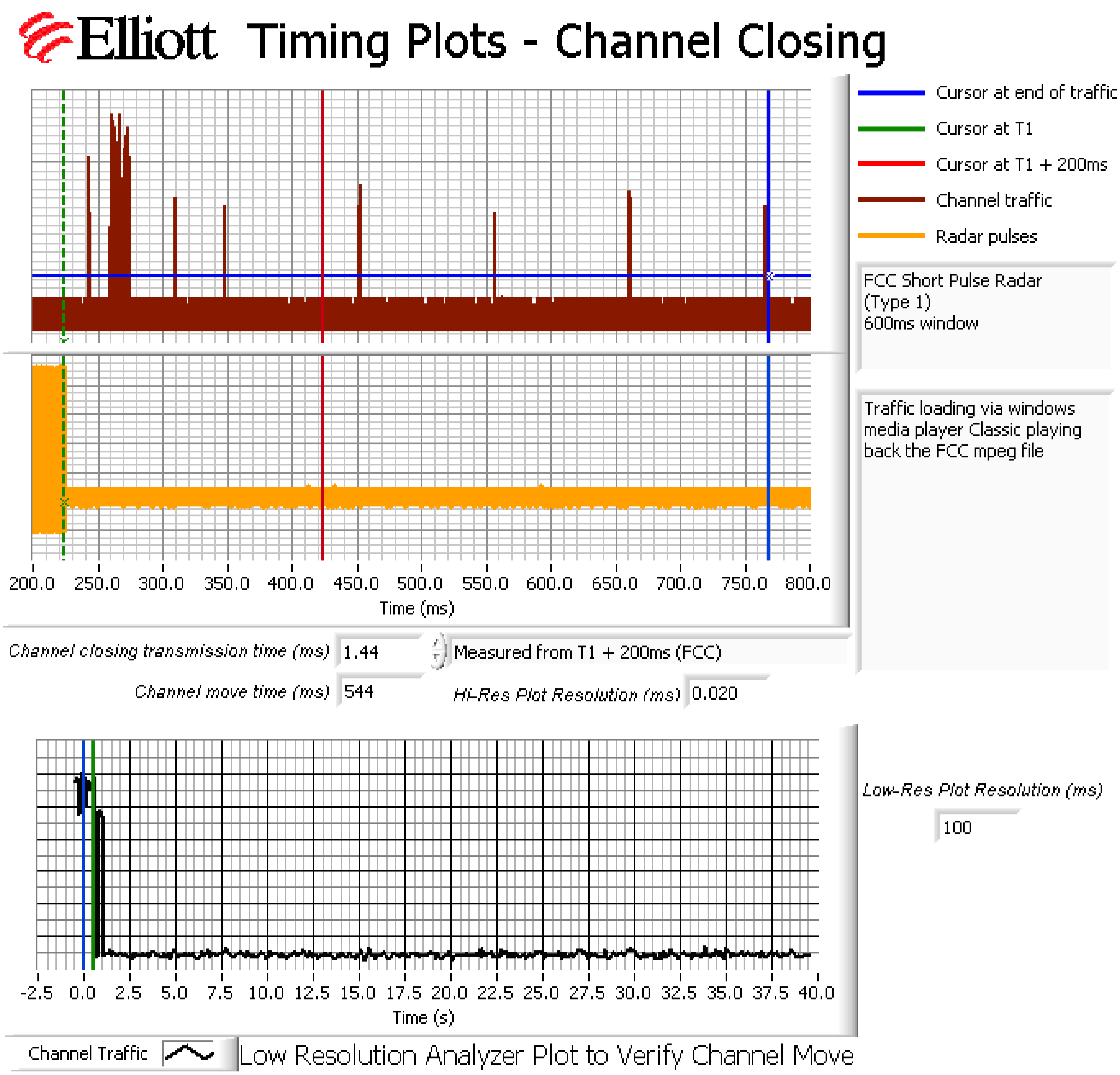


Figure 3: Channel Closing 600ms window

The non-occupancy plot was made over a 30-minute time period following the channel move time with the analyzer IF output connected to the scope and tuned to the vacated channel. No transmissions were observed after the channel move had been completed.

After the channel move the client re-associated with the master device on the new channel.

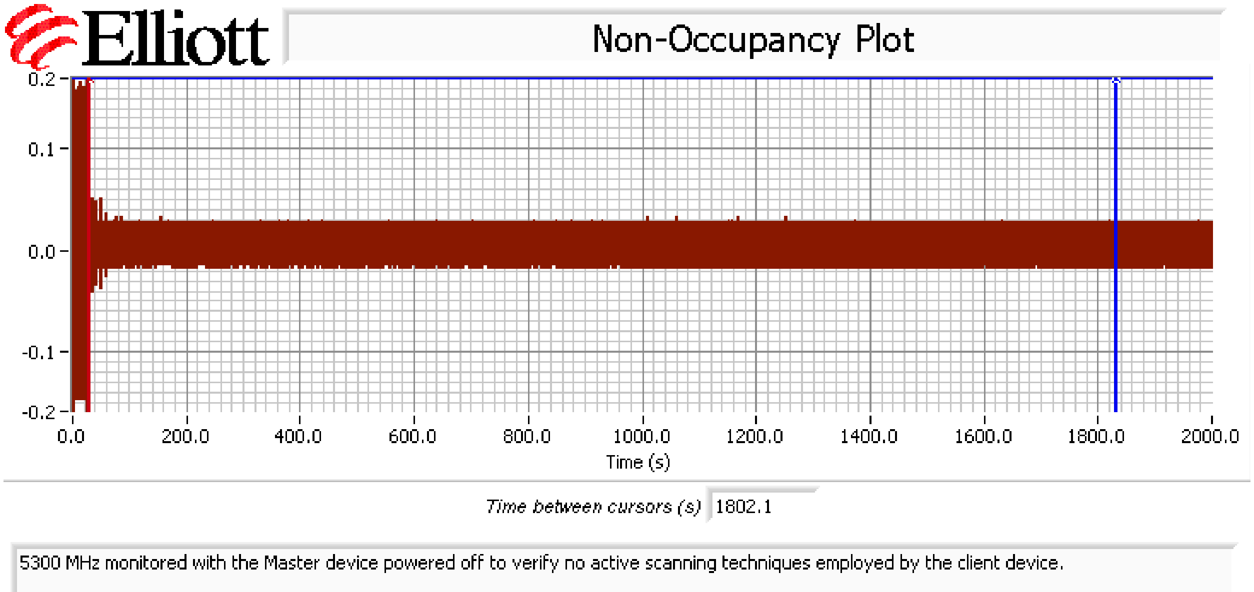
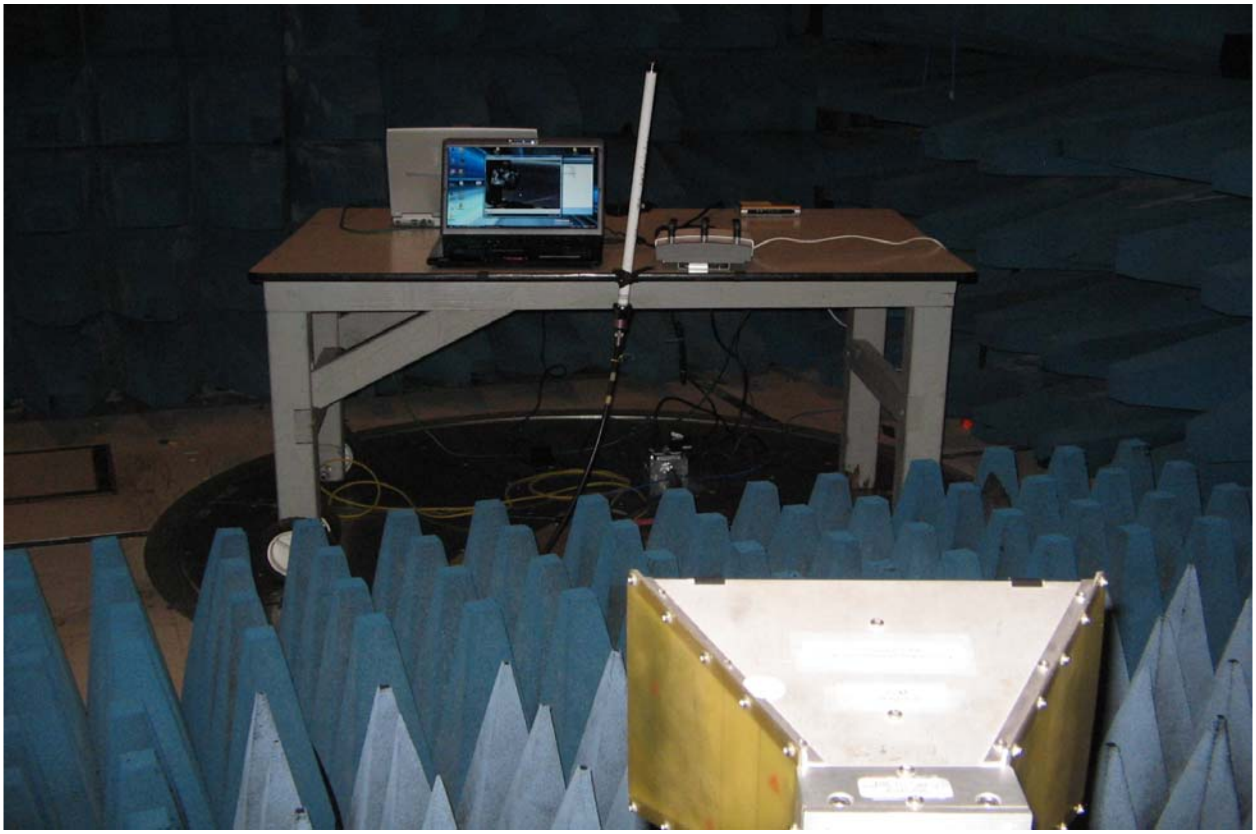
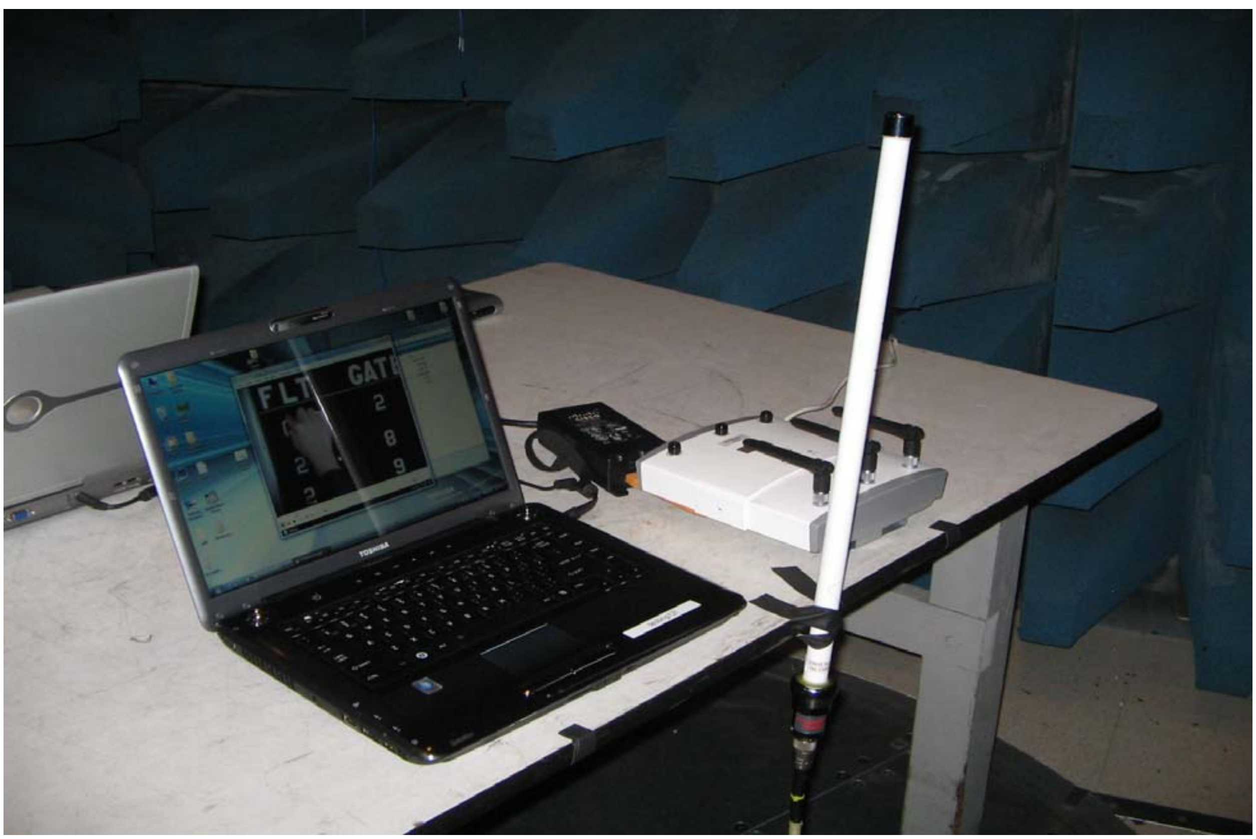


Figure 4: Non-Occupancy Plot

Appendix C Test Configuration Photographs





Appendix D Passive Scanning Attestation

August 27, 2010

American TCB
6731 Whittier Avenue Suite C110
McLean, VA 22101
USA

Subject: Model 62205ANHMW Wireless Lan PCIe Card
FCC ID's: PD962205ANH and PD962205ANH; IC: 1000M-62205ANH

Gentlemen:

Please be advised that the Model 62205ANHMW Wireless Lan PCIe card is manufactured for the global market but when marketed in North America under FCC ID's PD962205ANH or PD962205ANHU and IC: 1000M-62205ANH the EEPROM will be programmed at the factory to only operate and actively scan on these specific channels:

Channels 1-11, 2412-2462MHz 802.11b mode
Channels 1-11, 2412-2462MHz 802.11g mode
Channels 1-11, 2412-2462MHz 802.11n mode (20MHz channel)
Channels 3-9, 2422-2452MHz 802.11n mode (40MHz channel)

The following channels will be programmed at the factory to passively scan and will only listen and cannot send a probe request to initiate communication on these specific channels. Ad-hoc mode is always disabled on these passive channels.

Channels 12 &13, 2467 & 2472MHz 802.11b mode
Channels 12 &13, 2467 & 2472MHz 802.11g mode
Channels 12 &13, 2467 & 2472MHz 802.11n mode (20/40MHz channel)
Channels 36-48, 5180-5240MHz 802.11a mode
Channels 36-48, 5180-5240MHz 802.11n mode (20 MHz channel)
Channels 38-46, 5190-5230MHz 802.11n mode (40MHz channel)
Channels 52-64, 5260-5320MHz 802.11a mode
Channels 52-64, 5260-5320MHz 802.11n mode (20 MHz channel)
Channels 54-62, 5270-5310MHz 802.11n mode (40MHz channel)
Channels 100-140, 5500-5700MHz 802.11a mode
Channels 100-140, 5500-5700MHz 802.11n mode (20 MHz channel)
Channels 102-134, 5510-5670MHz 802.11n mode (40MHz channel)
Channels 149-165, 5745-5825 802.11a mode
Channels 149-165, 5745-5825MHz 802.11n mode (20 MHz channel)
Channels151-159, 5755-5795 802.11n mode (40MHz channel)

This information when programmed into the EEPROM will not be accessible and can not be changed by the end user.

If you have any questions please do not hesitate to contact us at 803-216-2344.

Sincerely,

Steven C. Hackett
Wireless Regulatory Engineer

Intel Corporation
100 Center Point Circle
Columbia, SC 29210