TEST REPORT

Covering the
DYNAMIC FREQUENCY SELECTION (DFS)
REQUIREMENTS
OF

FCC Part 15 Subpart E (UNII), RSS-210 Annex 9

Motorola - Enterprise Mobility Products
Model(s): AP-6521

FCC ID: UZ7AP6
IC CERTIFICATION #:   109AN-AP6

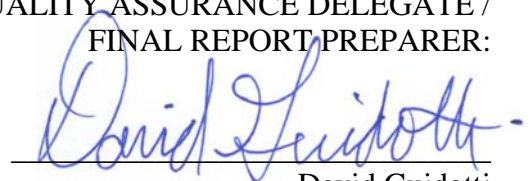|	
COMPANY:	Motorola - Enterprise Mobility Products 6480 Via Del Oro San Jose, CA, 95119
TEST SITE:	Elliott Laboratories 41039 Boyce Road Fremont, CA 94538
REPORT DATE:	June 8, 2012
FINAL TEST DATE:	May 11, 2012
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A2LA
ACCREDITED
Testing Cert #0214.26

REVISION HISTORY

Rev #	Date	Comments	Modified By
1.0	06-08-2012	Initial Release	-

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SCOPE

Test data has been taken pursuant to the relevant DFS requirements of the following standard(s):

- FCC Part 15 Subpart E Unlicensed National Information Infrastructure (U-NII) Devices.

- RSS-210 Annex 9 Local Area Network 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 Motorola - Enterprise Mobility Products model AP-6521 and therefore apply only to the tested sample. The sample was selected and prepared by Dan Scheve of Motorola - Enterprise Mobility Products.

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 the Motorola - Enterprise Mobility Products model AP-6521 complied with the DFS requirements of FCC Part 15.407(h)(2) RSS-210 Annex A9.

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.

TEST RESULTS

TEST RESULTS SUMMARY – FCC Part 15, CLIENT DEVICE

Table 1 FCC Part 15 Subpart E Client Device Test Result Summary						
Description	Radar Type	EUT Frequency	Measured Value	Requirement	Test Data	Status
Channel closing transmission time N40	Type 1	5510MHz	6.1ms	200+60msec	Appendix B	Pass
Channel move time N40	Type 1	5510MHz	1.908sec	10 Seconds	Appendix B	Pass
Channel closing transmission time N20	Type 1	5520MHz	6.46ns	200+60msec	Appendix B	Pass
Channel move time N20	Type 1	5520MHz	1.943sec	10 Seconds	Appendix B	Pass
Non-occupancy period - associated	Type 1	5540MHz	1800 sec	> 30 minutes	Appendix B	Pass
Passive Scanning	N/A	N/A	Refer to manufacturer attestation			
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

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Motorola - Enterprise Mobility Products model AP-6521 is an Access Point configured to act only as a Wireless Intrusion Protection System (WIPS) sensor. In this configuration, the WIPS sensor monitors the RF environment. When an access point is determined by the WIPS server to be unauthorized for operation on the network, the WIPS sensor sends shutdown commands to that access point once another client has associated.

The sample was received on May 11, 2012 and tested on May 11, 2012. The EUT consisted of the following component(s):

Manufacturer	Model	Description	Serial Number	FCC ID
Motorola	AP-6521-60020-US	WIPS sensor	11264521176083	UZ7AP6

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

Operating Modes (5250 – 5350 MHz, 5470 – 5725 MHz)

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

☐   Client Device with In-Service Monitoring

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

	5250 – 5350 MHz	5470 – 5725 MHz
Lowest Antenna Gain (dBi) (Antenna PN ML-2452-APAG2A1-01)	2	2
EIRP Output Power (dBm)	29	29

☐   Power can exceed 200mW eirp

Channel Protocol

☒   IP Based

ENCLOSURE

The EUT enclosure measures approximately 1.25 by 6 by 5.5 inches. It is primarily constructed of uncoated coated plastic.

MODIFICATIONS

The EUT did not require modifications during testing in order to comply with the requirements of the standard(s) 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
Local to EUT				
Motorola	AP-PSBIA-1P3-AFR	POE Injector (EUT)	D083164410001E8A01	N/A
Air Defense Inc.	3650 Rev.1	WIP Server	36510901094	Class A
D-Link	DGS-2208	Hub	F36J69A008432	DoC
Phihong	POE60U-560(G)-VC-R	POE Injector (AP)	-	-
Motorola	*AP-7131N firmware 5.2.0.0-126461X*	*Access Point*	*9151520900220*	*UZ7AP7131N*
Remote to EUT				
IBM	E5500	Laptop Computer	DPDGXG1	DoC
Dell	Inspiron 8600	Laptop Computer /w Linksys WPC600N (client device)	07898349890344	DoC

The italicized device was the master device.

EUT INTERFACE PORTS

The I/O cabling configuration during testing was as follows:

Port	Connected To	Cable(s) Description	Shielded or Unshielded	Length (m)
Ethernet Port (EUT)	POE Injector (EUT)	CAT 5	Unshielded	1.0
POE Injector (EUT)	Hub	CAT 5	Unshielded	2.0
Ethernet Port (AP)	POE Injector (AP)	CAT 5	Unshielded	1.0
POE Injector (AP)	Hub	CAT 5	Unshielded	2.0
Ethernet Port (WIP Server)	Hub	CAT 5	Unshielded	2.0
Ethernet Port (IBM laptop)	Hub	CAT 5	Unshielded	10.0

EUT OPERATION

The EUT was operating with the following software. The software is secured by encryption to prevent the user from disabling the DFS function.

Client Device: 5.2.0.0-1234413X

As the EUT (in sensor mode) is not designed to function as a WLAN and stream data over the network, the master device was configured to stream the "FCC" test file to the support client device laptop. The EUT was associated with the master device on the operating channel. Prior to applying radar to the master device, the EUT was instructed (by the WIPS server) to terminate the master device. This is the only operating condition where the EUT would transmit. Radar was applied to the master device on the channel being monitored by the sensor. The master device detected the radar signals and sent the requisite command packets for all clients to vacate the channel. The master device jumped to a new channel and the previous channel was monitored to ensure no further transmissions from the EUT were present on that channel.

Alternate loading was used when doing client DFS Testing on the device which supports AirDefense Mode. This is a normal operating mode in the access point when it is operating in Client Mode under the control of another Access Point. AirDefense mode is a monitor mode of operation - not setup to transfer data or information. The access point in Air Defense mode monitors all devices attempting to operate on a protected system comparing the devices against a database of authorized devices. This alternate method was approved per KDB787637.

RADAR WAVEFORMS

Table 2 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 3 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 4 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

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.
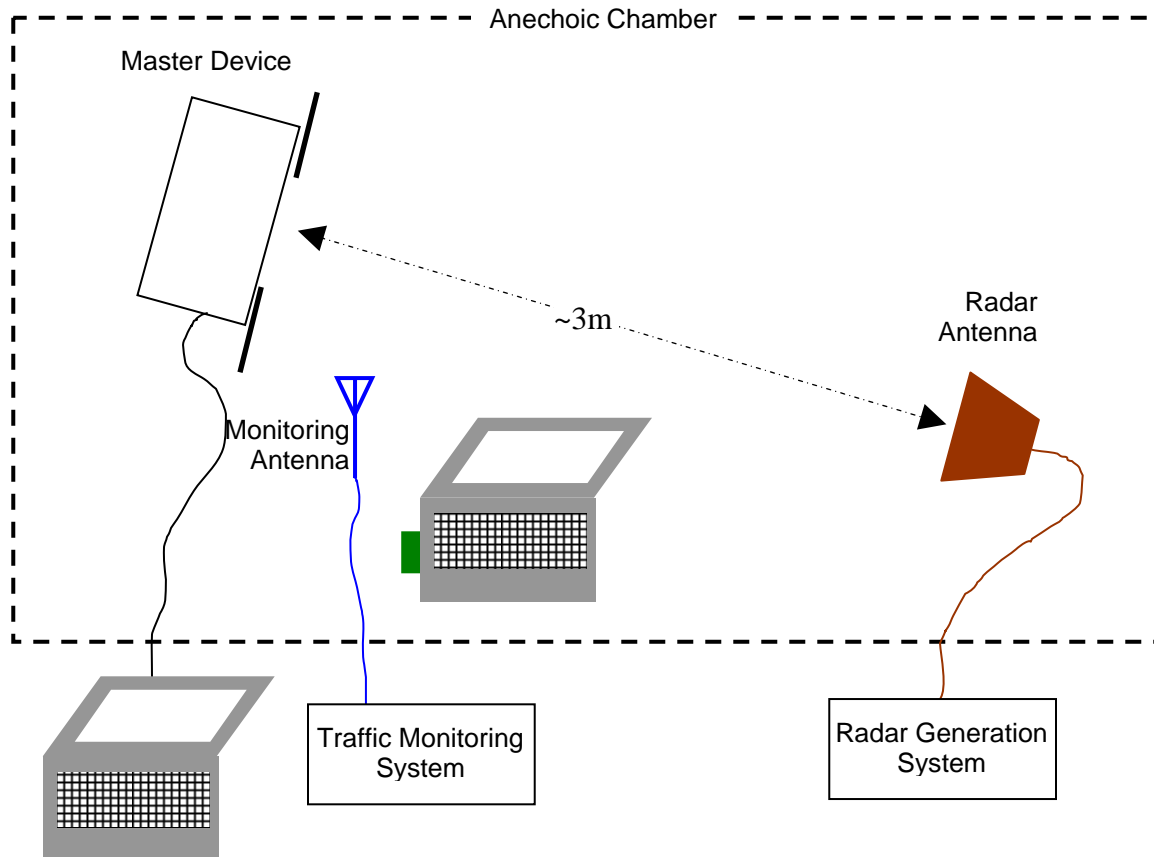

Figure 1 Test Configuration for radiated Measurement Method

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_{REF} (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:

$$\text{Applied level (dBm)} = R - G_{REF} + L$$

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 in one of two ways:

FCC/KCC Notice No. 2010-48 – 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.

ETSI[1] – the total time of all individual transmissions from the EUT that are observed from the end of the last radar pulse in the waveform. This value is required to be less than 260ms.

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).

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[1] This measurement method is used for MIC Table No. 45.

DFS CHANNEL AVAILABILITY CHECK TIME

It is preferred that the EUT report when it starts the radar channel availability check. If the EUT does not report the start of the check time, then the time to start transmitting on a channel after switching the device on is measured to approximate the time from power-on to the end of the channel availability check. The start of the channel availability check is assumed to be 60 seconds prior to the first transmission on the channel.

To evaluate the channel availability check, a single burst of one radar type is applied within the first 2 seconds of the start of the channel availability check and it is verified that the device does not use the channel by continuing to monitor the channel for a period of at least 60 seconds. The test is repeated by applying a burst of radar in the last 2 seconds (i.e. between 58 and 60 seconds after the start of CAC when evaluating a 60-second CAC) of the channel availability check.

To evaluate the channel availability check, a single burst of each radar type is applied at random periods during the 60-second channel availability check and it is verified that the device does not use the channel by continuing to monitor the channel for a period of at least 60 seconds. The test is performed a total of four times for each radar type.

Compliance with the channel loading requirement, where appropriate (i.e. when channel selection is not determined under control of the network), is demonstrated by power cycling the product multiple times and recording the channel selected for use. The distribution of channels is compared against a probabilistic channel selection to verify that the distribution falls within the expected random distribution (i.e. 1/n probability for each channel, given n channels) for the number of trials performed.

TRANSMIT POWER CONTROL (TPC)

Compliance with the transmit power control requirements for devices is demonstrated through measurements showing multiple power levels and manufacturer statements explaining how the power control is implemented.

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 Spectrum Analyzer, 9 kHz - 6.5 GHz	8595EM	780	25-Jan-13
EMCO	Antenna, Horn, 1-18GHz	3115	868	08-Jun-12
EMCO	Antenna, Horn, 1-18 GHz	3117	1662	04-Jun-12
Tektronix	500MHz, 2CH, 5GS/s Scope	TDS5052B	2118	07-Oct-12
Agilent	PSG, Performance Signal Generator, (installed options, HEH, HEC, 602, 420)	E8267C	2200	11-Jun-12

Appendix B Test Data Tables and Plots for Channel Closing

FCC PART 15 SUBPART E Channel Closing Measurements

Table 5 FCC Part 15 Subpart E Channel Closing Test Results					
Waveform Type	Channel Closing Transmission Time [1]		Channel Move Time		Result
	Measured	Limit	Measured	Limit	
Radar Type 1 – n40	6.1ms	60 ms	1.908sec	10 s	Pass
Radar Type 1 – n20	6.46ns	60 ms	1.943sec	10 s	Pass

After the final channel closing test the channel was monitored for a further 30 minutes. No transmissions occurred on the channel.

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[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.
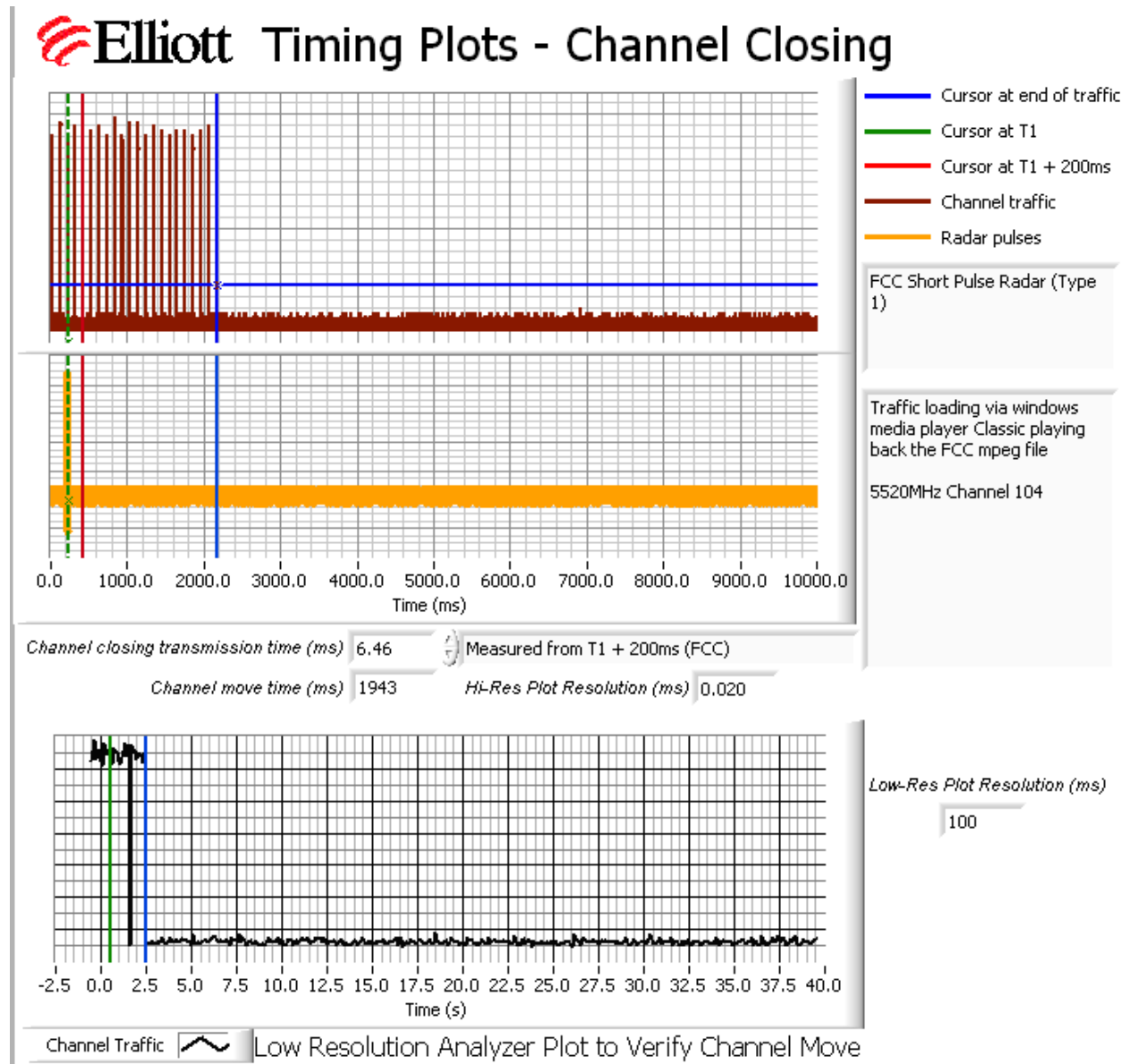
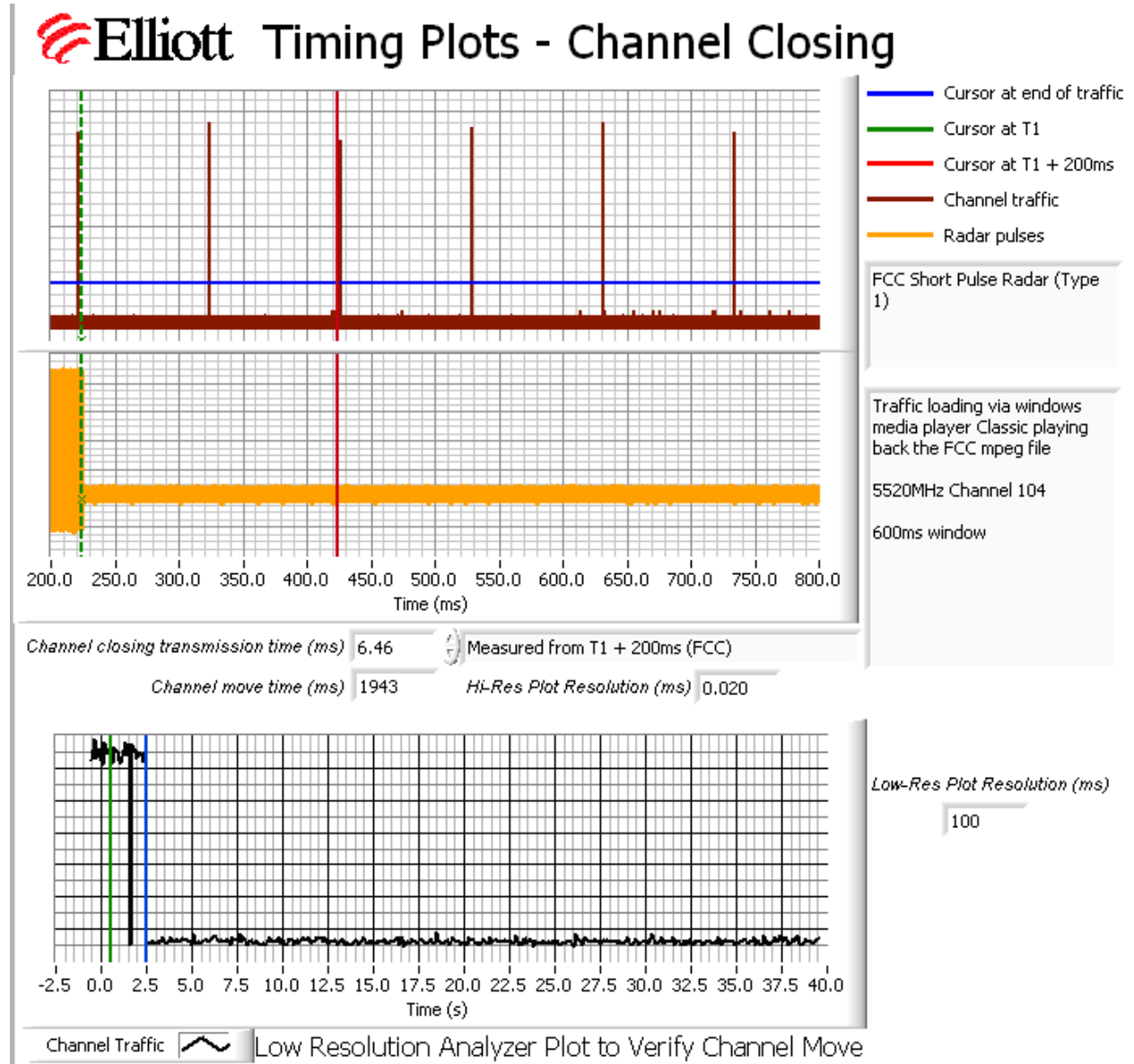**Figure 2 Channel Closing Time and Channel Move Time – 40 second plot – n20 Mode**

Figure 3 Close-Up of Transmissions Occurring More Than 200ms After The End of Radar – n20 Mode
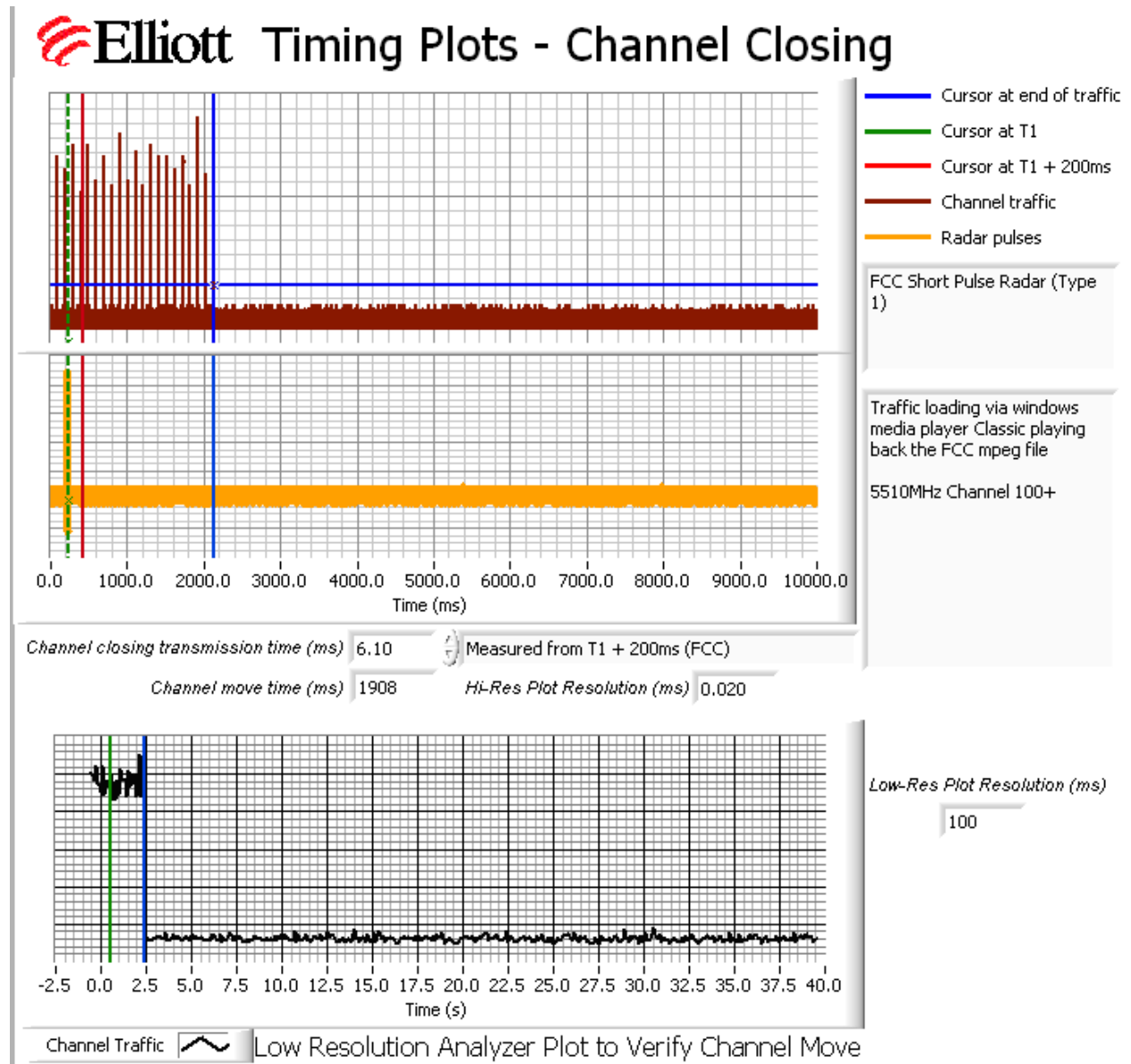
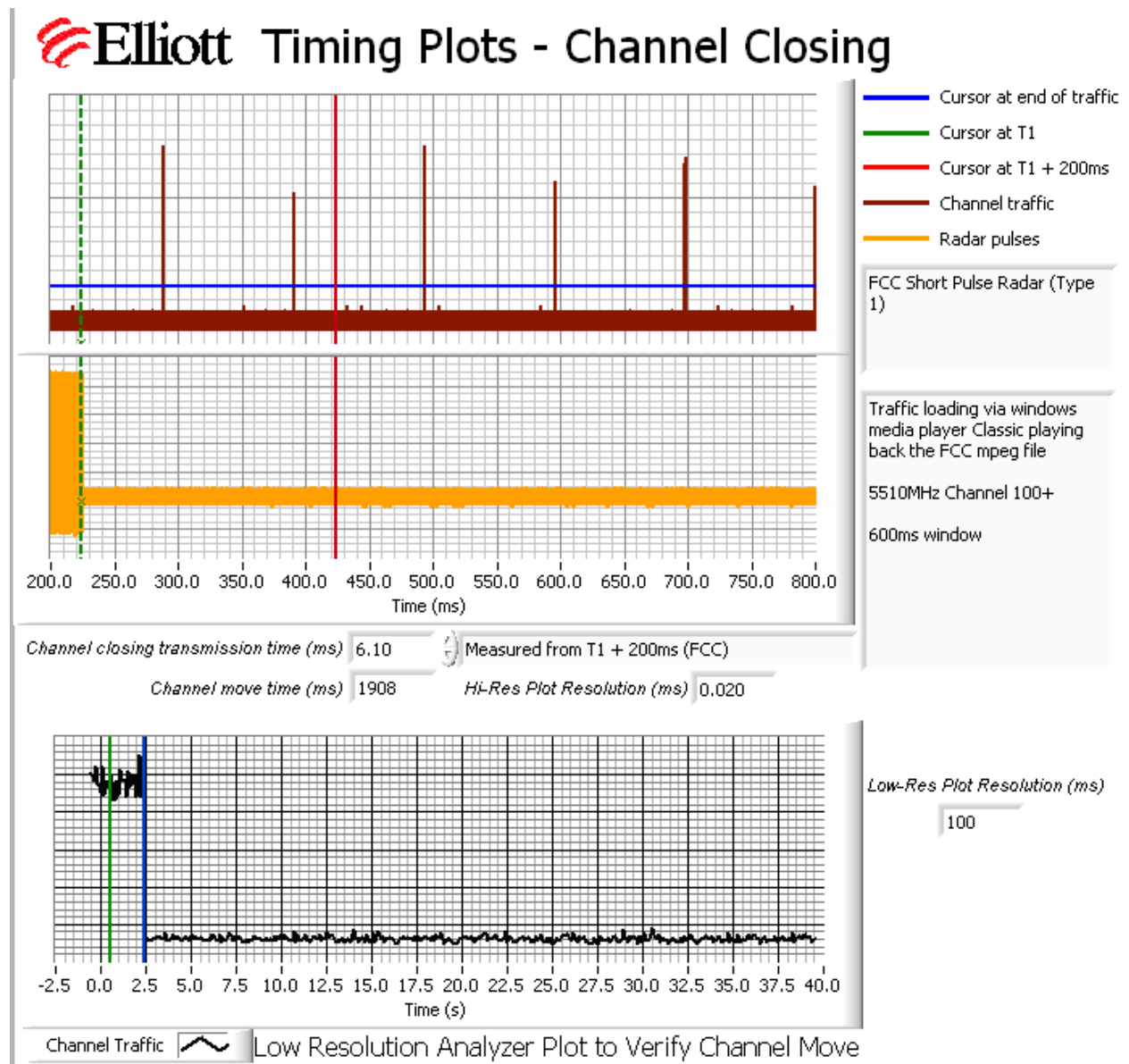**Figure 4 Channel Closing Time and Channel Move Time – 40 second plot – n40 Mode**

Figure 5 Close-Up of Transmissions Occurring More Than 200ms After The End of Radar – n40 Mode
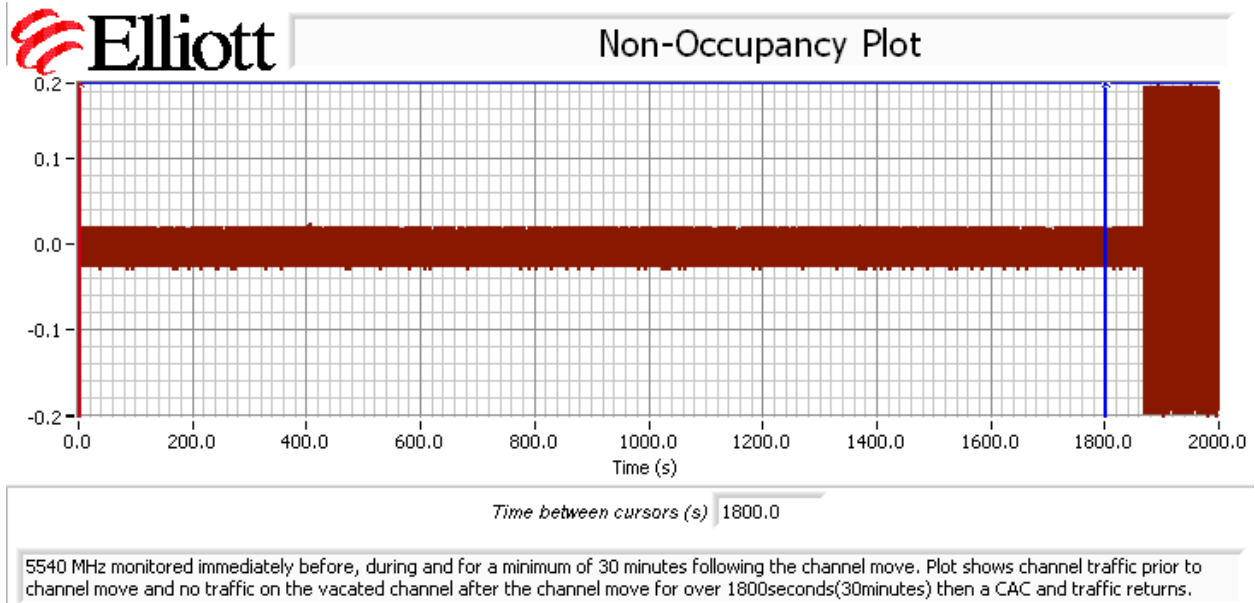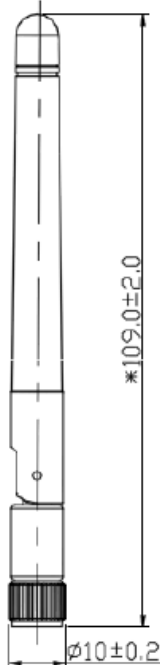
Figure 6 Radar Channel Non-Occupancy Plot

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 for over 1800 seconds then the Access Point performed a CAC and returned to the channel.

Appendix C Antenna Specification

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	Initial Release	9/4/11	T. Costello

ANTENNA CHARACTERISTICS		
PARAMETERS	**PERFORMANCE**	
Motorola P/N	ML-2452-APAG2A1-01	
Vendor P/N	AN2450-5709RS	
Antenna type	Omni-Directional	
Connector Type	SMA male RP	
Cable Type	N/A	
Cable P/N	N/A	
Cable Length (cm)	N/A	
Plenum Rated	No	
Frequency (MHz)	2400-2500	4900-5900
Max/Typ Peak Gain (dB)	2.7 / 2	2.0 / 1
Azimuth beam width (deg)	360	360
Elevation beam width (deg)	<=60	<=60
VSWR max	2.5	2.5
Polarization	vertical	vertical
Max Power (Watts)	10	10
Weight (lbs)	10 grams	
Storage Temp Range (C)	-40 / +85	
Operation Temp Range (C)	-30 / +70	
Outdoor Rated	No	

MOTOROLA SOLUTIONS

ANT: 11ABGN,DPA,2/1dBI,LP,CBL 0, RP-SMA-M

DOC NO:	SHEET:	REV:
ML-2452-APAG2A1-01	1 OF 2	A

Notes:
1. Part to be packaged in accordance with STI specification 50-4100-013 unless otherwise specified.
2. Part must comply with STI specification SP-12509-01 (RoHS) and have manufacturer's Declaration of Conformity on file.

Model: ML-2452-APAG2A1-01   Cut: Az/El   Pol: Vertical
2.45 GHz
Az - solid line
El - broken line
Max Gain(dBi): 2.0   Max Gain(deg): 339

Model: ML-2452-APAG2A1-01   Cut: Az/El   Pol: Vertical
5.7 GHz
Az - solid line
El - broken line
Max Gain(dBi): 2.0   Max Gain(deg): 308

MOTOROLA *SOLUTIONS*

ANT: 11ABGN,DPA,2/1dBI,LP,CBL 0, RP-SMA-M

DOC NO:	SHEET:	REV:
ML-2452-APAG2A1-01	2 OF 2	A

Notes:
1. Gains shown are typical.

Appendix D Test Configuration Photograph(s)