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TEST REPORT

Covering the
DYNAMIC FREQUENCY SELECTION (DFS)
REQUIREMENTS
OF

FCC Part 15 Subpart E (UNII)

Motorola Inc.
Model(s): AP-650 (MB82) With Int. and Ext. Antennas

COMPANY:	Motorola Inc. One Motorola Plaza Holtsville, NY 11742
TEST SITE:	Elliott Laboratories 684 W. Maude Ave Sunnyvale, CA 94085
REPORT DATE:	June 4, 2010
FINAL TEST DATE:	May 24, 2010
TEST ENGINEER:	David W. Bare
AUTHORIZED SIGNATORY:	Mark Briggs Staff Engineer

ACCREDITED

Testing Cert #2016-01

REVISION HISTORY

Revision #	Date	Comments	Modified By
-	June 4, 2010	Initial Release	-

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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 Motorola Inc. model AP-650 (MB82) in accordance with these standards.

Test data has been taken pursuant to the relevant DFS requirements of the following standard(s). In the cases of ETSI (EN) standards, testing was limited to those aspects covering essential requirements under article 3.2 of the R&TTE Directive pertaining to DFS:

- 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 Motorola Inc. model AP-650 (MB82) with Int. and Ext. antennas and therefore apply only to the tested samples. The samples were selected and prepared by Terry Richards of Motorola Inc.

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 samples of Motorola Inc. model AP-650 (MB82) 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 Motorola Inc. model AP-650 (MB82) are wireless network sensor dual radios with internal or external antennas. They incorporate the Motorola MB82 Access Point Radio Module. The EUTs are rated 48VDC, 270mA supplied from a POE switch or adapter (sold separately).

The samples were received on May 24, 2010 and tested on May 24, 2010. The EUTs tested were:

Manufacturer	Model	Description	Serial Number	FCC ID
Motorola Inc.	AP-650 (MB82)	Wireless Network Sensor (Int. Ant.)	9297522200021	Contains FCC ID U7ZMB82
Motorola Inc.	AP-650 (MB82)	Wireless Network Sensor (Ext. Ant.)	9296522200041	Contains FCC ID U7ZMB82

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

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

☐ Master Device

☐ Master Device (excluding 5600-5650 MHz) - Note that operation in the 5600-5650 MHz sub-band is disabled so the ability to detect 0.8us pulse widths as detailed in the footnote to EN 301 893 V1.4.1 in the Official Journal (OJ C 280/64 of 2008-11-04) is not required. Operation in the remainder of the 5470 – 5725 MHz band and in the 5250-5350 MHz band after April 2009 requires the detection of interleaved radars.

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

☐ Client Device with In-Service Monitoring

Channel Protocol

☒ IP Based

☐ Frame Based

☐ OTHER _____

ENCLOSURE

The EUT (Int. Ant.) enclosure measures approximately 24 by 19.5 by 5 centimeters. It is primarily constructed uncoated plastic.

The EUT (Ext. Ant.) enclosure measures approximately 22 by 14 by 4centimeters. It is primarily constructed steel.

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
Motorola, Inc	*AP-7131*	*Access Point*	*8248520900416*	*Contains UZ7AP7131*
Symbol Technologies Inc.	Symbol Power Injector 1 Port	POE Injector	R082560500250 54001	DoC
Netgear	FS105	Ethernet switch	FS05339CB586 027	DoC
IBM	T42p	Thinkpad	L3-4MNZ1	DoC
Dell	Latitude D830	Laptop	4NFW3G1	D0C
AirDefense, Inc	1250	Security device	1251092218	Class A
Symbol Technologies Inc.	Symbol Power Injector 1 Port	POE Injector	R082560500250 53701	DoC
Dell	Inspiron 8600	Laptop	JMB3551	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)
EUT Power/Ethernet	POE adapter	Cat 5	Unshielded	0.2
POE adapter	Switch	Cat 5	Unshielded	1.8
AP Power/Ethernet	POE adapter	Cat 5	Unshielded	0.2
POE adapter	Switch	Cat 5	Unshielded	1.8
Dell Ethernet	Switch	Cat 5	Unshielded	1.8
IBM Ethernet	Switch	Cat 5	Unshielded	1.8
AirDefense Ethernet	Switch	Cat 5	Unshielded	1.8
Dell DC Power	AC Adapter	Multiwire	Shielded	1.6
IBM DC Power	AC Adapter	Multiwire	Shielded	1.6
AirDefense Power	AC Mains	Three wire	Unshielded	1.8

EUT OPERATION

The EUT was operating with the following software.

Client Device: Software version 5.0.0.0-005SR

The EUT, under normal operating conditions, is designed to transmit for brief periods of time to disable rogue APs and client devices. As it is not capable of streaming the FCC video file from the master device, and in accordance with the procedure designed by Motorola and approved by the FCC/NTIA, a second client device was setup to stream the movie file during testing. The streamed file was the "FCC" test file and the second client device was using Windows Media Player Classic as required by FCC Part 15 Subpart E.

The EUT was configured to transmit its short duration message (lasting at least seconds). The radar bursts from the test equipment were timed to coincide with the first 3 seconds after enabling transmissions of the EUT to ensure that the control signals from the master device to close the channel were appropriately handled by the client device under test and the channel was closed within the required time.

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

TEST RESULTS

TEST RESULTS SUMMARY – FCC Part 15, CLIENT DEVICE

Table 2 FCC Part 15 Subpart E Client Device Test Result Summary – AP-650 Int. Ant.						
Description	Radar Type	Radar Frequency	Measured Value	Requirement	Test Data	Status
Channel closing transmission time	Type 1	5300 MHz	6.76 ms	60 ms	Appendix B	Passed
Channel move time	Type 1	5300 MHz	6.133 s	10 s	Appendix B	Passed
Non-occupancy period - associated	Type 1	5520 MHz	> 30 minutes	> 30 minutes	Appendix B	Passed
Passive Scanning	N/A	N/A	Refer to manufacturer attestation			

Table 3 FCC Part 15 Subpart E Client Device Test Result Summary – AP-650 Ext. Ant.						
Description	Radar Type	Radar Frequency	Measured Value	Requirement	Test Data	Status
Channel closing transmission time	Type 1	5300 MHz	6.2 ms	60 ms	Appendix B	Passed
Channel move time	Type 1	5300 MHz	5.927 s	10 s	Appendix B	Passed
Non-occupancy period - associated	Type 1	5540 MHz	> 30 minutes	> 30 minutes	Appendix B	Passed
Passive Scanning	N/A	N/A	Refer to manufacturer attestation			

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 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.

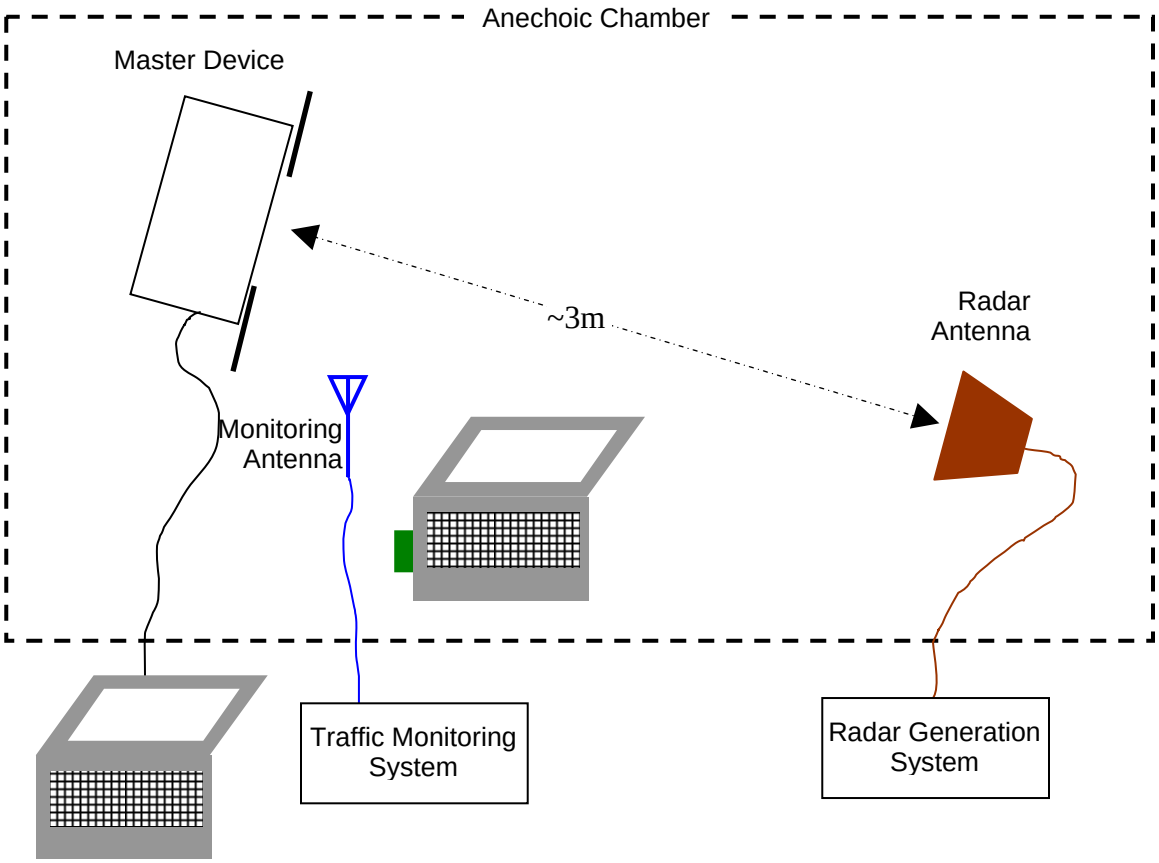

Figure 1 Test Configuration for radiated Measurement Method

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 in one of two ways:

FCC – 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 – 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).

Appendix A Test Equipment Calibration Data

Manufacturer	Description	Model #	Asset #	Cal Due
Hewlett Packard	EMC Spectrum Analyzer, 9 KHz-26.5 GHz	8593EM	1141	21-Dec-10
EMCO	Antenna, Horn, 1-18 GHz	3117	1662	04-May-12
Agilent	PSG Vector Signal Generator (250kHz - 20GHz)	E8267C	1877	24-Mar-11
Tektronix	500MHz, 2CH, 5GS/s Scope	TDS5052B	2118	28-Sep-10

Appendix B Test Data Tables and Plots for Channel Closing

FCC PART 15 SUBPART E Channel Closing Measurements

Table 4 FCC Part 15 Subpart E Channel Closing Test Results AP-650 Int. Ant.					
Waveform Type	Channel Closing Transmission Time [1]		Channel Move Time		Result
	Measured	Limit	Measured	Limit	
Radar Type 1	6.76 ms	60 ms	6.133 s	10 s	Passed

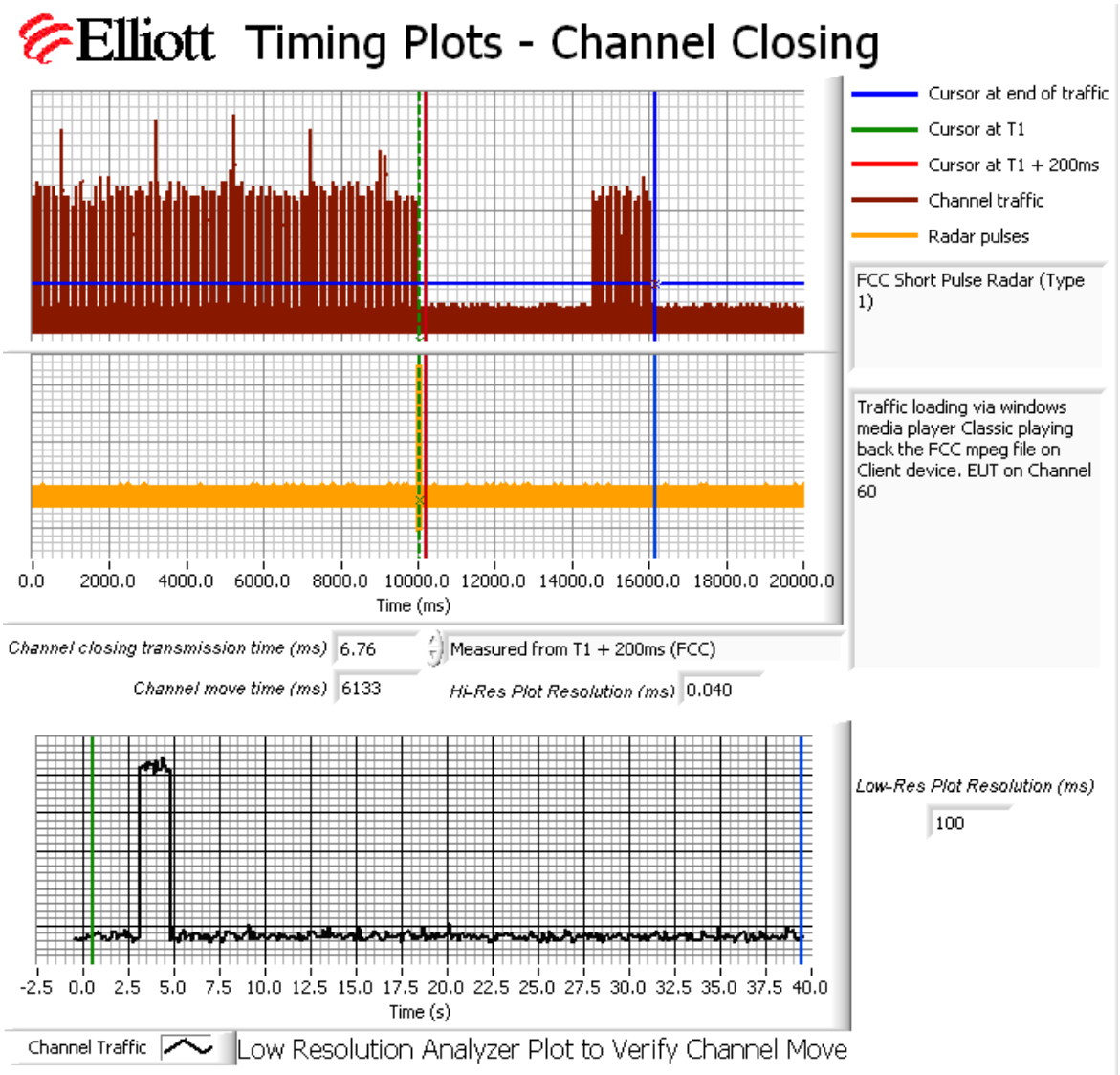

Figure 2 Channel Closing Time and Channel Move Time – AP-650 Int. Ant.

Note: EUT transmissions are the high amplitude peaks in the plot. The rest of the traffic is the AP sending movie data to the second client.

[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.

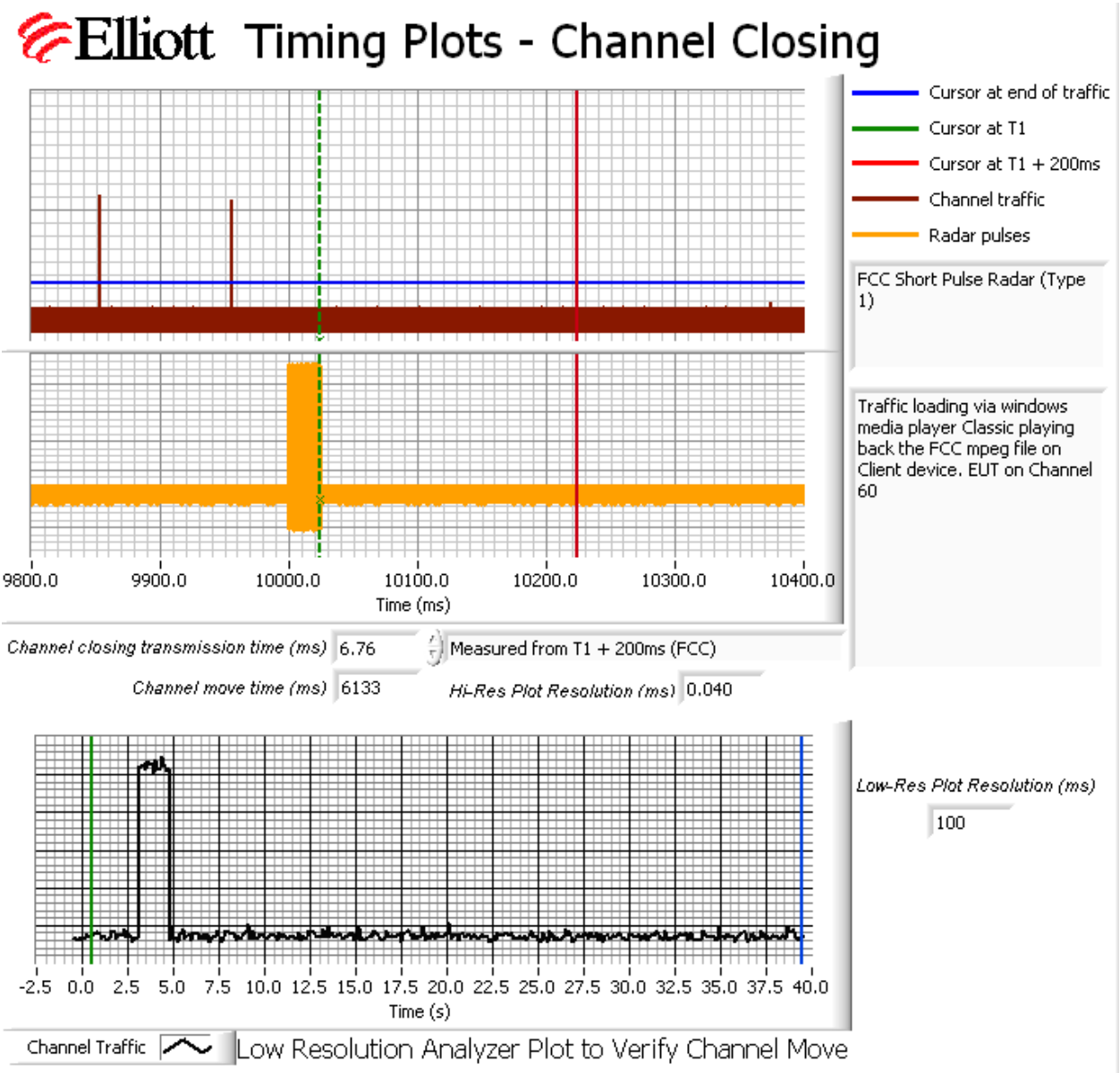

Figure 3 Close-Up of Transmissions Occurring More Than 200ms After The End of Radar

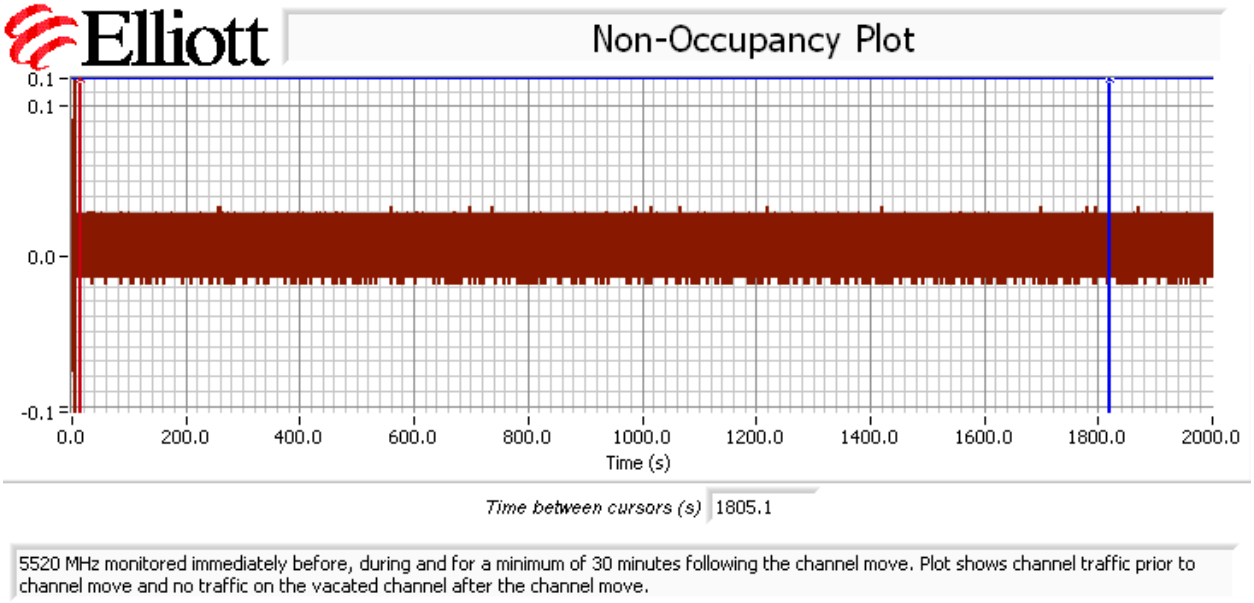

Figure 4 Radar Channel Non-Occupancy Plot

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.

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

Table 5 FCC Part 15 Subpart E Channel Closing Test Results AP-650 Ext. Ant.					
Waveform Type	Channel Closing Transmission Time [1]		Channel Move Time		Result
	Measured	Limit	Measured	Limit	
Radar Type 1	6.2 ms	60 ms	5.927 s	10 s	

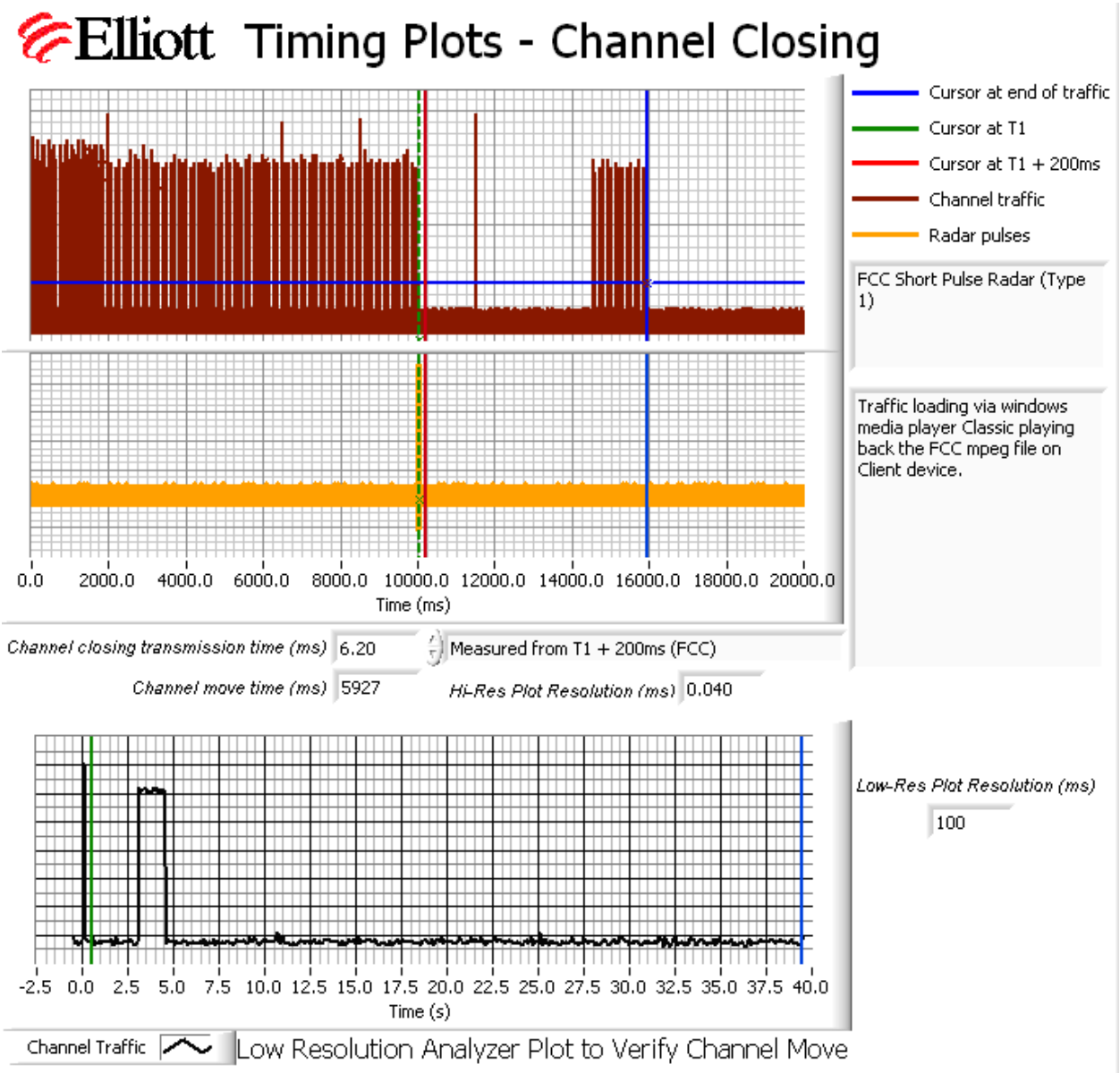

Figure 5 Channel Closing Time and Channel Move Time – AP-650 Ext. Ant.

Note: EUT transmissions are the high amplitude peaks in the plot. The rest of the traffic is the AP sending movie data to the second client.

[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.

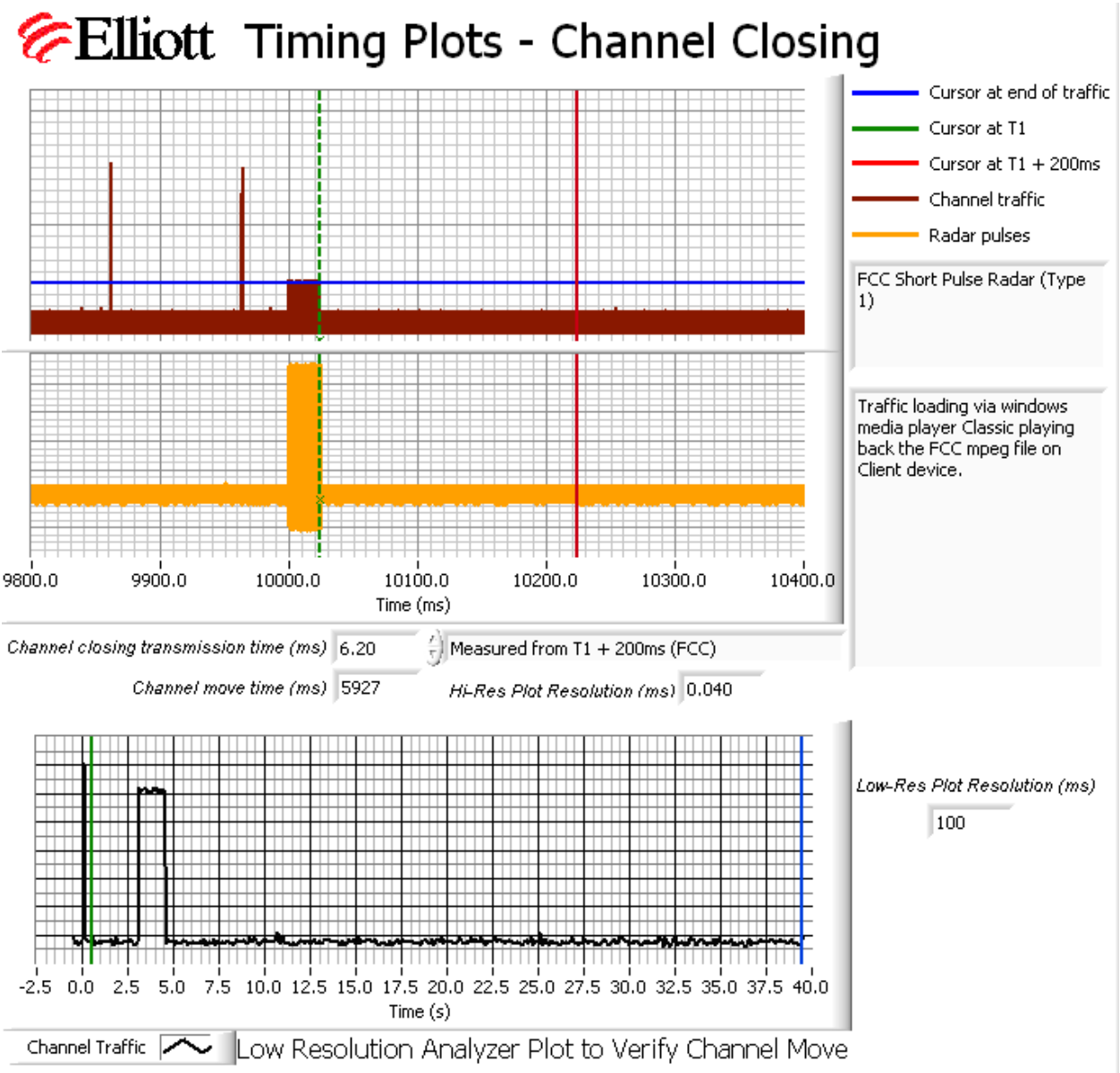

Figure 6 Close-Up of Transmissions Occurring More Than 200ms After The End of Radar

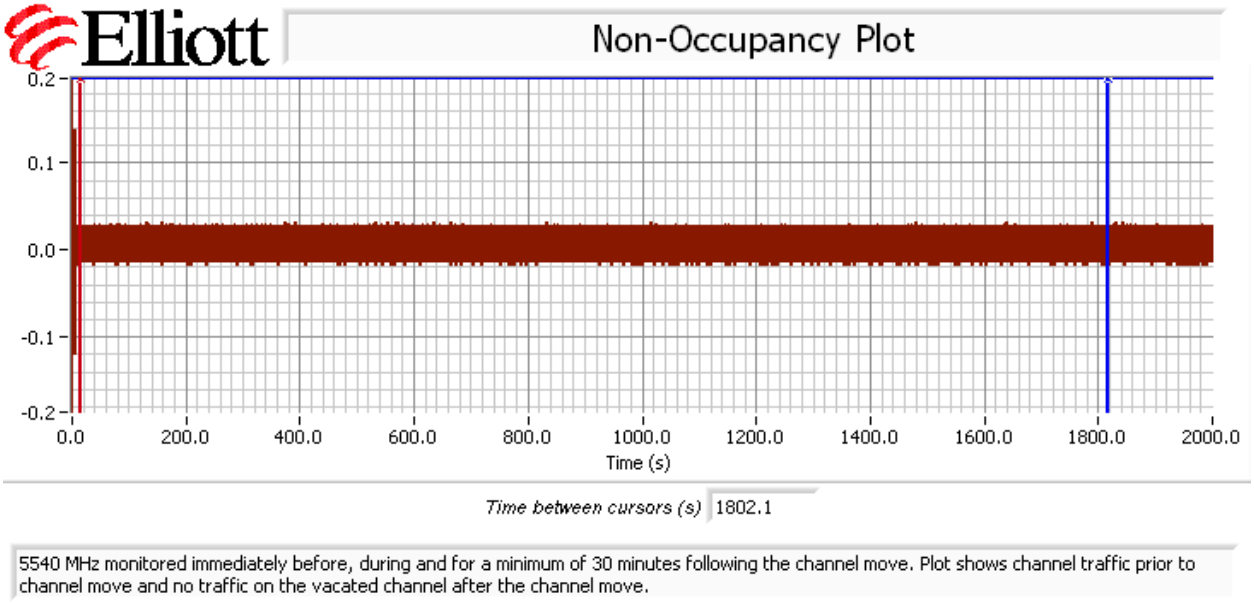

Figure 7 Radar Channel Non-Occupancy Plot

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.

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

Appendix C Test Configuration Photographs