Dominion Voting System for Sequoia WinEDS Edge2Plus Model 300, HAAT90, HAAT100 Hardware Test Report for compliance with the Federal Election Commission (FEC) 2002 Voting System Standards (VSS)

By

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Revision History:

Version	Date	Comments	Contributors
1.0	11/14/2011	Initial Release, Hardware Test Report	D. Forester
2.0	11/18/11	Updates based on review comments	D. Forester, L. Hoppert

Approved:

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Test Manager:	Date: 11/18/2011

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1 Introduction

1.1 Testing Overview

SLI performed hardware testing to address ambiguity in the reporting of results for the third party hardware testing conducted on specific components of the WinEDS system during the iBeta test engagement.

The Sequoia Edge2Plus Model 300, HAAT90, and HAAT100 (hereafter referred to as EUT) were tested to the 2002 Voting System Standards (VSS). The testing performed for compliance is defined in *Table 1 Hardware Electrical Test Requirement.*

1.2 Scope

This report, prepared by SLI Global Solutions, documents the tests performed, test procedures used and the results obtained during the specified testing of the EUT. The report incorporates the testing data from tests performed by or under the direction of SLI Global Solutions.

1.3 Hardware Test Report Attachments

The following attachments from EMC Integrity, INC. apply to this Test Report:

1. EDGE2PLUS Model 300, ERB10906 Rev. C, Hardware Test Report
2. HAAT100, ERB10904 Rev. B, Hardware Test Report
3. HAAT90, ERB10905 Rev. B, Hardware Test Report
4. HAAT90, ERB11027, Hardware Test Report

1.4 Reference Documents

- FEC 2002 Voting System Standards Volume I, Sec. 3
- FEC 2002 Voting System Standards Volume II, Sec. 4
- NIST Handbook 150-22, 2008 Edition: National Voluntary Laboratory Accreditation Program – Voting System Testing. May 2008
- Election Assistance Commission: NOC 07-05: Voting System Test Laboratory (VSTL) responsibilities in the management and oversight of third party testing.
- Election Assistance Commission: NOC 08-001: Validity of Prior Non-Core Hardware Environmental and EMC Testing.
- Election Assistance Commission: Decision on Request for Interpretation 2010-01 Voltage Levels and ESD Test.
- Sequoia Voting Systems Edge2Plus Model 300, Operators Manual, Document Version 3.15, August 2010
- Sequoia Voting Systems HAAT90, Operators and Maintenance Manual, Document Version 2.18, August 2010
- Sequoia Voting Systems HAAT100, Operators and Maintenance Manual, Document Version 1.19, August 2010
- Sequoia Voting Systems HAAT90, Approved Parts List, HW Rev. A1.1, Document Ver. 1.03, June 2010
- Sequoia Voting Systems HAAT100, Approved Parts List, HW Rev. A0.7, Document Ver. 1.04, July 2010
- SLI Standard Lab Procedure SLP-VC-23: Hardware Test Management

- SLI Standard Lab Procedure SLP-VC-24: Subcontractor Laboratory Management

1.5 Hardware Testing Requirement

Table 1 shows the test requirement for the EUT.

Table 1 –Hardware Electrical Test Requirement: Edge2Plus Model 300, HAAT90, and HAAT100

Applicable	Test Name	Test Specification	VSS Reference	Requirement	Comments
Electromagnetic Immunity Tests					
X	ESD	IEC 61000-4-2 (2008) Ed.2.0	V1, 3.2.2.8 V2, 4.8.3	Vote scanning and counting equipment for paper-based systems, and all DRE equipment, shall be able to withstand ±15 kV air discharge and ±8 kV contact discharge without damage or loss of data. The equipment may reset or have momentary interruption so long as normal operation is resumed without human intervention or loss of data. Loss of data means votes that have been completed and confirmed to the voter. The test levels stated in IEC 61000-4-2, Edition 2.0, contact discharge, are the test method and shall be applied at the specified test level only, 8 kV. Air discharge shall be used where contact discharge cannot be applied and all test levels shall be used (2, 4, 8, 15 kV). (RFI 2010-01)	Voting systems are required to be immune to ESD up to the limits of 8 KV, contact discharge, and 15 KV, air discharge. During exploratory pre-testing investigation of the possibility of windowing effects should be explored. If there are indications that a unit has sensitivity at a lower voltage but not at a higher voltage, test levels shall be added to evaluate the immunity at lower voltage levels. (RFI 2010-01)

1.6 Hardware Electrical Testing Summary

Table 2 shows the test performed on the EUT.

Note that the SLI Hardware Specialist performed an operational status check on all EUT prior to and following each test at EMC Integrity.

Table 2 – Hardware Test Summary

Type of test	Configuration	Result P/F	Comments – Details around failure points (if any), etc
Electrostatic Disruption			
Electrostatic Disruption	Edge2Plus 300 W / APS External Printer (UTG300)	PASS	The Edge2Plus 300 **complied** with the testing. Successfully performed operational status check demonstrating that all functions and features have been correctly executed.

Type of test	Configuration	Result P/F	Comments – Details around failure points (if any), etc
	HAAT100 W / Printer and IMPR attached	PASS	The HAAT100 **complied** with the testing.

At +4kV to locking mechanism, font size on the print reel changed. The Dominion representative stated that this was an acceptable condition. SLI evaluated this behavior and agreed this was an acceptable condition.

Please refer to section 3 for test observations.

At ±6, ±8kV to locking mechanism printer stopped printing. Resumed normal operation after voltage was removed.

At ±6, ±8kV to printer cable connector, printer stopped printing. Resumed normal operation after voltage was removed. At -8kV to base of wireless antenna, unit locked up. Operator intervention was required to continue operation. Retested at -8kV without service interruption or operator intervention.

Successfully performed operational status check demonstrating that all functions and features have been correctly executed. |

Type of test	Configuration	Result P/F	Comments – Details around failure points (if any), etc
	HAAT90 W / Printer, and IMPR attached	FAIL	The HAAT90 *failed to comply* with the testing on 9/7/11 & 9/8/11. Test performed on 9/7/11: +4kV air discharges to front seam, ±8kV air discharge to front seam and seam around operator panel. At +15kV air discharges to front seam and seam around operator panel, display went blank. The Dominion representative had to reset the EUT. Repeated test of ±15kV. Original failure did not repeat but operator panel was no longer functional. The Dominion representative reset the EUT but unit no longer functioned. Test performed on 9/7/11. +8kV air discharge to upper edge of front panel caused display to go blank. EUT could not recover.
Electrostatic Disruption Re-test, Oct 14, 2011	HAAT90 W / Printer, and IMPR attached	PASS	The HAAT90 *complied* with the testing on 10/14/11. At ±4kV, ±8kV, ±15kV air discharge was applied to lower right corner of front panel and to front seam. ±8kV, ±15kV discharge was applied to sides of front panel. +15kV to display caused display to blank. Retested at +15kV point without service interruption and with no errors. Please refer to section 5 for additional details regarding test observation. Successfully performed operational status check demonstrating that all functions and features have been correctly executed.

2   Test Hardware & Software

2.1   Equipment Under Test (EUT)

This table identifies the initial system configuration at check-in for hardware testing.

Name of equipment (include model if appropriate)	Description	Qty	Serial No.	Rev. / Ver.	FW.
Edge2Plus Model 300 w/APS external printer (UTG300)	EDGE2Plus is a stand-alone DRE polling place voting machine that incorporates a color LCD integral touch screen, integrated (voter) privacy flaps, poll worker panel, internal memory for storing ballot data and voting records, removable results cartridge, and protective & public counters, and an APS external printer VVPAT (UTG).	1	SMPEPUCC04S10004 (S10004) **Case:** SMPEPUCC04S10002 (S10002)	C0.4 Ver. 1.2.74	N/A
HAAT100 (wireless) w / printer and attached IMPR	HAAT100 is an electronic table top Hybrid Activator, Accumulator, Transmitter. The HAAT100 serves as a precinct level accumulator for consolidating and printing the consolidated results and for transmission of unofficial results from all precinct voting devices over CDMA 1X secured networks to a central tally server. The IMPR device attaches to the HAAT80, 90, and 100 via a serial port interface. It is used for reading an Insight results cartridge.	1	357H100A07006177 IMPR: 577IMPRA10003191	A0.7 C1.1	4.3 ICR 2.14
HAAT90 w / printer and attached IMPR	HAAT90 is an electronic table top Hybrid Activator, Accumulator, Transmitter. The HAAT90 serves as a precinct level accumulator for consolidating and printing the consolidated results and for transmission of unofficial results over fixed telephone line networks to a central tally server.	1	334HT90A11001128 IMPR: 350IMPRA10003191	A1.1 A1.0	4.3 ICR 2.14

2.2   Support Hardware

The following hardware was used to support the testing

Hardware / Firmware	Manufacturer	O/S Ver.	Type
HAAT80 2.6.34 (used to activate voting cards)	Sequoia		HYBRID ACTIVATOR, ACCUMULATOR

2.3 Support Software

The following software was used to support the testing.

Manufacturer	Application(s)	Version
N/A		

2.4 Test Supplies

The following supplies were used to support the testing.

Test Supplies	Type
3 1/8 (UTG300 58-400) paper rolls (2)	Report printing and VVPAT validation on the EDGE2*plus*
3 1/8 x 300' paper rolls (6)	HAAT90 / HAAT100 printer paper
USB Cartridge	
Voting Card	
Jelly Switch Kit	
Stereo Headphones	

2.5 Engineering Change

The following Engineering Changes were installed in the EUT and were tested as part of the system.

ECO #	Description
N/A	

3   Test Requirements, Results and Observations

The SLI Hardware Specialist observed and evaluated all documented tests, all mitigations, and all behaviors of the equipment as documented below. SLI determined that all electrical tests documented here were performed according to the requirements of the IEC and the Federal Election Commission (FEC) 2002 Voting System Standards. All equipment that passed initially or after mitigation complies with 2002 VSS requirements.

3.1   Test Procedures –Electrical Tests

3.1.1   Operating Mode

Edge2Plus Model 300: Unit was prepared in Pre-LAT mode, playing continuous audio from a voting session created in Audio/Visual mode. During the ESD test, the device was able to keep playing continuous audio and recover automatically in case of any audio disruption, without user interaction. After each test voltage cycle completed, a ballot was manually cast for a total of ten votes to verify normal operations.

HAAT100: Unit was prepared in Pre-LAT mode, continuously printing a list of selection codes. During the ESD test, the HAAT100 was able to continue the printing process and recover automatically in case of any printing disruption, without user interaction.

HAAT90: Unit was prepared in Pre-LAT mode, continuously printing a list of selection codes. See section 3.1.8 for results and observations.

3.1.2   Exercising Software

Prior to and during testing, proper operation of the EUT shall be confirmed using Dominion Voting Systems software.

3.1.3   Operational Status Check

Prior to and following the execution of ESD testing, normal operation shall be verified by conducting an Operational Status Check. This verifies the equipment operation in all modes, demonstrating all functions and features that would be used during election operations.

3.1.4   Electrostatic Disruption

The test levels stated in IEC 61000-4-2, Edition 2.0, contact discharge, are the test method and shall be applied at the specified test level only, 8 kV. Air discharge shall be used where contact discharge cannot be applied and all test levels shall be used (2, 4, 8, 15 kV). (RFI 2010-01)

Vote scanning and counting equipment for paper-based systems, and all DRE equipment, shall be able to withstand ±15 kV air discharge and ±8 kV contact discharge without damage or loss of data. The equipment may reset or have momentary interruption so long as normal operation is resumed without human intervention or loss of data. Loss of data means votes that have been completed and confirmed to the voter.

3.1.5   Test Results

The Edge2Plus Model 300 and HAAT100 successfully met the ESD requirements of the Federal Election Commission (FEC) 2002 Voting System Standards (VSS) volumes I & II. Testing was performed on September 7 & 8, 2011 at EMC Integrity in Longmont, Colorado. The test results are provided in the attached reports:

- EDGE2PLUS Model 300, ERB10906 Rev. B, Hardware Test Report
- HAAT100, ERB10904 Rev. B, Hardware Test Report

3.1.6 Observations

- **HAAT100 -** At +4kV to locking mechanism, the font size on the print reel changed. Review of HAAT100 tape showed the font size had changed and showed some precinct sequence numbers missing. Printing continued without disruption or user interaction.

3.1.7 Transmit

Edge2Plus Model 300 - At the completion of ESD testing, the device was shipped back to SLI. The following steps were performed by SLI to verify normal operations and all verification steps passed:

- Close polls
- Verify - Total Votes Cast = 10
- Print Result Reports
- Remove the Results Cartridge for consolidation with HAAT100 that was used for ESD testing
- Perform Operational Status Check

HAAT100 - At the completion of ESD testing, the device was shipped back to SLI. The following steps were performed by SLI to verify normal operations and all verification steps passed:

- Consolidate Data Results from Edge2Plus – Cast Ballots (Ten); Display messages:
  - Consolid….Edge2P, S/N: 10004
  - Printing*** OK-205 Edge2P 10004
  - Printing OK-205 Edge2P 10004
  - * HAAT *, PreLat Ver. 2.6.34, Signal S:5/5 Q:5/5
- Transmit Data Results
  - Printed report of transmitted results reflects the number of votes cast - Ten
- Perform Operational Status Check

3.1.8 HAAT90 Failed To Comply

The HAAT90 *failed to comply* with the ESD testing performed on 9/7/11 & 9/9/11. ESD testing was performed at EMC Integrity in Longmont, Colorado. The test results are provided in the attached report.

- HAAT90, ERB10905 Rev. B, Hardware Test Report

HAAT90 Issue 9/7/11: +4kV air discharges were applied to front seam, ±8kV air discharges were applied to front seam and seam around operator panel. At +15kV air discharges to front seam and seam around operator panel, the display went blank. The Dominion representative had to reset the EUT. On repeated test at ±15kV, the original failure did not repeat but the operator panel was no longer functional. Next, the Dominion representative reset the EUT with same result: the operator panel was no longer functional.

HAAT90 mitigation:

The HAAT90 mitigation was performed by the Dominion representative and was observed and evaluated by the SLI Hardware Specialist.

- Opened device, reset all cables, tightened any loose screws
- Replaced 3200 PCB Controller Part No. BG-3200V20, and upgraded the firmware to 4.3 due to the board replacement to bring it to the proper configuration.
  - A total of 3 controller boards (same board) were used, with one coming up with an "SRAM" error during startup (bad board).
    - Reset EUT with the same result: operator panel was no longer functional.

HAAT90 Re-Test Results 9/9/11:

The HAAT90 *failed to comply* with the ESD testing performed on 9/9/11.

Issue 9/9/11: The +8kV air discharge to upper edge of front panel caused the display to go blank.

- ESD retested on the HAAT90 Sept. 9 with the same results as on Sept. 7.
- Issues included: display screen flat line, operator panel no longer functional, device unable to initialize.

Criterion C - *temporary loss of function or degradation of performance, the correction of which requires operator intervention.*

4 HAAT90 Failure and Mitigation

4.1 Testing Overview – Retest

SLI scheduled and supervised hardware testing to address ESD failures reported in EMC Integrity report *ERB10905 Rev. B, Hardware Test Report* conducted on the HAAT90. See Table 2 – Hardware Test Summary for details.

4.2 HAAT90 ESD Retest

As a result of the HAAT90 failing to comply with ESD tests performed on 9/7/11 & 9/9/11, the test was re-scheduled for October 14, 2011.

4.2.1 *Mitigation*

Mitigation was performed at SLI under the control of an SLI representative prior to October 14th testing. All replacement components used can be identified in the Sequoia Voting Systems Approved Parts List. SLI evaluated the mitigations employed and confirmed that no engineering changes were required as a result of these mitigations.

Mitigation included:
- Four components were replaced on the HAAT90 prior to re-test on Oct. 14
  - Power Charger Board, Part No. AP-3200PWBE1
  - 3200 PCB Controller, Part No. BG-3200V20
  - LCM Display with cable, Part No. YC-G2406ASB
  - LCM supporting frame (Membrane keypad panel), Part No. FP-32LCDV

- A pre-ESD test was performed by a Dominion representative and witnessed by the SLI Hardware Specialist. The HAAT90 was in continuous printing mode during the test. Voltage levels (kV):
  - ±4kV Air Discharge
  - ±8kV Air Discharge
  - ±15kV Air Discharge

5   HAAT90 Test Requirements, Results and Observations

5.1   Test Procedures –Electrical Tests

5.1.1   Operating Mode

HAAT90: Unit prepared in Pre-LAT mode, continuously printing a list of selection codes. During the ESD test, the HAAT90 was able to continue the printing process and recover automatically in case of any printing disruption, without user interaction.

5.1.2   Exercising Software

Prior to and during testing, proper operation of the EUT shall be confirmed using Dominion Voting System software.

5.1.3   Operational Status Check

Prior to and following the execution of ESD testing normal operation shall be verified by conducting an Operational Status Check. This verifies the equipment operation in all modes, demonstrating all functions and features that would be used during election operations.

5.1.4   Electrostatic Disruption

The test levels stated in IEC 61000-4-2, Edition 2.0, contact discharge, are the test method and shall be applied at the specified test level only, 8 kV. Air discharge shall be used where contact discharge cannot be applied and all test levels shall be used (2, 4, 8, 15 kV). (RFI 2010-01)

Vote scanning and counting equipment for paper-based systems, and all DRE equipment, shall be able to withstand ±15 kV air discharge and ±8 kV contact discharge without damage or loss of data. The equipment may reset or have momentary interruption so long as normal operation is resumed without human intervention or loss of data. Loss of data means votes that have been completed and confirmed to the voter.

5.1.5   Test Results:

The HAAT90 successfully met the ESD requirements of the Federal Election Commission (FEC) 2002 Voting System Standards (VSS) volumes I & II. Testing was performed on October 14, 2011 at EMC Integrity in Longmont, Colorado. The test results are provided in the attached report:

- HAAT90, ERB11027, Hardware Test Report

5.1.6   Observations:

- **HAAT90 –** During one of the tests, voltage cycle to locking mechanism, the font size on the print reel changed. Review of HAAT90 tape showed the font size had changed and showed some precinct sequence numbers missing. Printing continued without disruption or user interaction. At some point printer paper had to be replaced while the device was still running. Once printer paper was replaced, normal font size returned. Printing continued without disruption or user interaction.

5.1.7 *Transmit*

HAAT90 - At the completion of ESD testing, the device was shipped back to SLI. The following steps were performed by SLI to verify normal operations and all verification steps passed:

- Transmit Configuration; Display messages:
  - Packing Data…..
  - Connecting To Network through PBX Simulator
- Print Configuration Transmission
- Configuration verified in HAAT90 Listener log files: "Ok Transmission Has Been Stored In Local Database"
- Perform Operational Status Check

At the completion of the HAAT90 configuration, files were successfully transmitted to verify normal operations.