

Election Systems & Software
EVS6000
Electrical Test Plan for compliance with the
2005 Voluntary Voting System Guidelines
(VVSG)

Prepared by



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*Accredited by the Election
Assistance Commission (EAC) for
Selected Voting System Test
Methods or Services*

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Revision History

Date	Release	Author	Revision Summary
<i>June 27, 2017</i>	1.0	Darrick Forester	Initial Release
<i>July 25, 2017</i>	1.1	Darrick Forester	Update section 5.2.2 Electrostatic Disruption to the specified test level of 8 kV for contact discharge.
<i>August 15, 2017</i>	2.1	Jon Panek	Updated to include ExpressVote 2.1 with external scanner
<i>September 6, 2017</i>	2.2	Jon Panek	Updated section 2.0 Electrical Test Summary, Electrical Power Disturbance: Surges of $\pm 15\%$ line variations of nominal line voltage
<i>December 12, 2017</i>	2.3	Darrick Forester	Updates for EAC initial comments
<i>December 20, 2017</i>	2.4	Jon Panek	Updates for additional EAC comments

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1.0 Introduction

1.1 Overview

This test plan covers the EMC (Electromagnetic Compatibility) and EMI (Electromagnetic Interference) test requirements and methods for the ES&S EVS6000, hereafter known as the Unit Under Test (UUT), to the requirements as stated in Election Assistance Commission 2005 Voluntary Voting System Guidelines (VVSG).

1.2 Qualifications

The UUT supplied by ES&S is representative of product produced in their volume manufacturing process.

1.3 Client

Election Systems & Software
11208 John Galt Blvd
Omaha, NE 68137

1.4 Company Information

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1.5 Test Facility Location

NTS, EMI / EMC
1736 Vista View Drive
Longmont, CO 80504

1.6 Reference Documents

- Election Assistance Commission: 2005 Voluntary Voting System Guidelines (EAC VVSG), 2005 Version 1.0, Volumes I and II.
- NIST Handbook 150-22, 2008
- EAC Decision on Request for Interpretation 2007-05 (COTS)
- EAC Decision on Request for Interpretation 2008-02 Battery Back Up for Op Scan
- EAC Decision on Request for Interpretation 2008-10 (EFT)
- EAC Decision on Request for Interpretation 2009-03 Battery Back Up for Central Count
- EAC Decision on Request for Interpretation 2010-01 Voltage Levels and ESD Test
- EAC Notice of Clarification 07-05: Voting System Test Laboratory (VSTL) responsibilities in the management and oversight of third party testing.
- EAC Notice of Clarification 08-001: Validity of Prior Non-Core Hardware Environmental and EMC Testing.
- SLI Standard Lab Procedure SLP-VC-23: Hardware Test Management
- SLI Standard Lab Procedure SLP-VC-24: Subcontractor Laboratory Management

2.0 Electrical Test Summary

Table 1: Test Requirements Summary for ES&S EVS 6000

Test Name	Test Spec.	VVSG Reference	Requirement	Comments
Electromagnetic Emissions Tests				
Radiated Electromagnetic Emissions	FCC, Part 15 ANSI C63.4	V1, 4.1.2.9 V1, 4.1.7.1 V1, 2.1.4 (c) V2, 4.8	Class B	
Conducted Electromagnetic Emissions	FCC, Part 15 ANSI C63.4	V1, 4.1.2.9 V1, 4.1.7.1 V1, 2.1.4 (c) V2, 4.8	Class B	
Electromagnetic Immunity Tests				
Electrostatic Disruption	IEC 61000-4-2 (2008-12) Ed.2.0	V1, 4.1.2.8 V1, 4.1.7.1 V1, 2.1.4 (b) V2, 4.8	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 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).	
Electromagnetic Susceptibility	IEC 61000-4-3 (1996)	V1, 4.1.2.10 V1, 4.1.7.1 V1, 2.1.4 (b) V2, 4.8	A field of 10 V/m modulated by a 1 kHz 80% AM modulation over the frequency range of 80 MHz to 1000 MHz, without disruption of normal operation or loss of data.	1 GHz
Electrical Fast Transient	IEC 61000-4-4 (2004-07) Ed. 2.0	V1, 4.1.2.6 V1, 4.1.7.1 V1, 2.1.4 (b) V2, 4.8	± 2 kV AC & DC external power lines. ± 1 kV on Input / Output lines (signal, data, control lines) longer than 3 meters (signal, data, control lines) longer than 3 meters Repetition Rate for all transient pulses will be 100 kHz	
Lightning Surge	IEC 61000-4-5 (1995-02)	V1, 4.1.2.7 V1, 4.1.7.1 V1, 2.1.4 (b) V2, 4.8	± 2 kV AC line to line ± 2 kV AC line to earth + or - 0.5 kV DC line to line >10m + or - 0.5 kV DC line to earth >10m ± 1 kV I/O sig/control >30m	
Conducted RF Immunity	IEC 61000-4-6 (1996-04)	V1, 4.1.2.11 V1, 4.1.7.1 V1, 2.1.4 (b) V2, 4.8	10V rms over the frequency range 150 KHz to 80 MHz with an 80% amplitude modulation with a 1 KHz sine wave AC & DC power 10V sig/control >3 m over the frequency range 150 KHz to 80 MHz with an 80% amplitude modulation with a 1 KHz sine wave	
Magnetic Fields Immunity	IEC 61000-4-8 (1993-06)	V1,4.1.2.12 V1, 4.1.7.1 V1, 2.1.4 (b)	AC magnetic 30 A/m at 60 Hz	

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Test Name	Test Spec.	VVSG Reference	Requirement	Comments
		V2, 4.8		
Electrical Power Disturbance	IEC 61000-4-11 (1994-06)	V1, 4.1.2.5 V1, 4.1.7.1 V1, 2.1.4 (b) V2, 4.8	Voltage dip of 30% of nominal @10 ms; Voltage dip of 60% of nominal @100 ms & 1 sec Voltage dip of >95% interrupt @5 sec Surges of ±15% line variations of nominal line voltage Electric power increases of 7.5% and reductions of 12.5% of nominal specified power for a period of up to four hours at each level.	

3.0 Product Description

3.1 Intended Use

The UUT is intended to be used in the polling place environment.

3.2 Unit Under Test

Model No.	Serial No.	Description	Qty
DS200 v1.2	DS0113390699 DS0113390294	Precinct Tabulator on metal ballot box	2
DS200 v1.3	DS0316370315 DS0316370375	Precinct Tabulator on plastic ballot box	2
DS450	DS4516053016 DS4516053020	Central Tabulator	2
DS850	DS8516080263 DS8517050300	Central Tabulator	2
ExpressVote v1.0	EV0115371779 EV0114340047	Precinct Universal Voting System	2
ExpressVote v2.1	EV0215380012 EV0216310071	Precinct Universal Voting System	2
ExpressVote v2.1 w/ external QR barcode scanner	EV0216310075	Precinct Universal Voting System	1
ExpressVote XL	XL0117040030 XL0117040035	Precinct Tabulator	2
ExpressTouch	ET0117380002 ET0117390033	DRE	2

3.3 Product Information – General

Product Information	Description
Product Name(s)	DS200 v1.2, DS200 v1.3, DS450, DS850, ExpressVote v1.0, ExpressVote v2.1, ExpressVote XL, ExpressTouch, ExpressVote v2.1 w/ external QR barcode scanner
Modes used for testing	Admin – continuous ballot printing or scanning operations are used during each EMC test executed depending on the device. ExpressTouch, ExpressVote XL Supervisor Menu > Advanced Settings > Diagnostic Tests > Continuous Operation Test ExpressVote 1.0, ExpressVote 2.1 Official Mode > System Maintenance > Ballot Diagnostic > Continuous Print Test DS200 1.2, DS200, 1.3 Admin > Load Election > Pre-Operational Status Check > Continuous ballot scanning > Post-Operational Status Check DS450, DS850 Admin > Load Election > Pre-Operational Status Check > Continuous ballot scanning > Post-Operational Status Check
Product type	Industrial

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3.3.1 Power

Power Requirements - DS200 v1.2 & v1.3	
Input Voltage Rating as it appears on unit, power supply, or power brick	90-264VAC
Input Current (specify @ 230 Vac/50 Hz)	1A @230VAC
Input Power	120VAC
Power Requirements – DS450	
Input Voltage Rating as it appears on unit, power supply, or power brick	100-240VAC
Input Current (specify @ 230 Vac/50 Hz)	5A unit only/9A with accessories
Input Power	120VAC
Power Requirements – DS850	
Input Voltage Rating as it appears on unit, power supply, or power brick	100-240VAC
Input Current (specify @ 230 Vac/50 Hz)	8.0A unit only/12A with accessories
Input Power	120VAC
Power Requirements – ExpressVote v1.0, v2.1, v2.1 w/external QR barcode scanner	
Input Voltage Rating as it appears on unit, power supply, or power brick	100-240VAC
Input Current (specify @ 230 Vac/50 Hz)	2.2A Max
Input Power	120VAC
Power Requirements – ExpressVote XL	
Input Voltage Rating as it appears on unit, power supply, or power brick	100-125VAC / 50-60Hz
Input Current (specify @ 230 Vac/50 Hz)	Not Universal input.
Input Power	120VAC
Power Requirements – ExpressTouch	
Input Voltage Rating as it appears on unit, power supply, or power brick	100-240VAC
Input Current (specify @ 230 Vac/50 Hz)	2.0A
Input Power	120VAC

3.3.2 Services

Services Requested	
Formal or Engineering level tests	Formal
Test Specifications	Per VVSG 1.0, Vol I & II

3.3.3 Support Equipment (SE)

Support Equipment (SE)			
Name	Model No.	Serial No.	Description
Dell S2810dn Laser Printer	0NW8WW	CN-0NW8WW-71971-59F-E207	DS450 report printer
OKI B431d Laser Printer	N22202A	AK59045055A0	DS850 report printer
OKI Microline 420 Printer	D22900A	AK62018690E0 AK68006600E0	DS450 and DS850 report printer

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UPS	APC Pro 1500	N/A	DS450 and DS850 UPS
Universal Voting Console (UVC)	2.0.0	UVC05170045	Detachable audio-tactile keypad and ADA support peripheral for use w/ExpressVote XL and ExpressTouch
QR Bar Code Scanner	N/A	N/A	Optional external QR barcode scanner provides the ability to read a barcode that automatically preloads voters' contest choices via the Ballot Online application or automatically selects the voter's correct ballot style.

3.3.4 Support Equipment - I/O Cabling

I/O Cabling					
Model No.	Description	I/O Type		Length (m)	QTY
		UUT-UUT	UUT - SE		
DS450	Report Printer – Dell S2810 Laser Printer		X	2	1
DS450	Report Printer – OKI 420 Dot Matrix Printer		X	2	1
DS450	UPS – APC Pro 1500		X	2	1
DS850	Report Printer – OKI B431d Laser Printer		X	2	1
DS850	Report Printer – OKI 420 Dot Matrix Printer		X	2	1
DS850	UPS – APC Pro 1500		X	2	1
ExpressVote Booth	QR Barcode Scanner		X	2	1
ExpressVote XL	Universal Voting Console (UVC)		X	~2	1
ExpressTouch	Universal Voting Console (UVC)		X	2	1

3.4 UUT Firmware

UUT Firmware		
Name	Version / Revision	Functionality
DS200 v1.2	2.17.0.0	Election Firmware
DS200 v1.3	2.17.0.0	Election Firmware
DS450	3.1.0.0	Election Firmware
DS850	3.1.0.0	Election Firmware
ExpressVote v1.0	1.5.0.0	Election Firmware
ExpressVote v2.1	2.4.0.0	Election Firmware
ExpressVote v2.1 w/ext. QR barcode scanner	2.4.0.0	Election Firmware
ExpressVote XL	1.0.0.0	Election Firmware
ExpressTouch	1.0.0.0	Election Firmware

3.5 AC Power Adapter

Product	Manufacturer	Model	Serial Number
DS200 v1.2	Wall Industries	P/N: DTA80A21Y24ESS	PW74022959
DS200 v1.3	Wall Industries	P/N: DTEA11011C-ESS	Model: EA11011C-240

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ExpressVote v1.0	MEGA	P/N: MDS160T-P240	MDS160T-P240-0618
ExpressVote v2.1	MEGA	P/N: MDS160T-P240	MDS160T-P240-0618

3.6 Accessories

Type	Model	Function
Headphones	N/A	Audio
USB Media	N/A	Election Media, Results
Activation Cards w/Ballot Style	N/A	ExpressVote Cards, Supervisor
Test Ballots	N/A	Scanning
Ballot Box	N/A	Ballot Collection
Rocker Switch	N/A	Two-position switch assistive technology that can assist voter's who are unable to use the ExpressVote touch screen or the audio tactile keypad.

3.7 Engineering Changes

Engineering Change (EC)#	Description
N/A	

4.0 Test Plan

4.1 Units Under Test

Backup Units of the same model with unique serial numbers may use throughout EMC/EMI testing meeting the following criteria:

- Issue with UUT
- UUT are identical hardware
- All hardware components are listed in Manufacturer's BOM or APL.

4.2 Operating Modes and Configurations for Electrical Testing

4.2.1 *Operating Mode*

Prior to and during testing, proper operation of the UUT shall be confirmed using ES&S software. An operational status check shall be performed prior to and after each test to fully exercise the UUT and ensure that no damage has occurred as a result of the test.

To fully exercise all the features of each ES&S model, test software is run during electrical tests to exercise the model's particular hardware features.

During testing, the hardware is exercised via test software as follows:

- DS200 HDW 1.2 on steel ballot box – tests all DS200 operations – Tabulation, Reporting and Diverter on Boot up
- DS200 HDW 1.3 on plastic ballot box – tests all DS200 operations – Tabulation, Reporting
- DS450 HDW 1.0 – Tests all functionality of DS450 – Tabulation, Reporting, Audit Log Report
- DS850 HDW 1.0 – Tests all functionality of DS850 – Tabulation, Reporting, Audit Log Report
- ExpressVote 1.0 – Tests all functionality of ExpressVote – Key pad, Audio, Activation card printer
- ExpressVote 2.1 – Tests all functionality of ExpressVote – Key Pad, Audio, QR barcode scanner, and Activation card printer.
- ExpressVote 2.1 w/external QR barcode scanner – Tests all functionality of ExpressVote – Key Pad, Audio, external QR barcode scanner, and Activation card printer.
- ExpressVote XL – Test all functionality of the ExpressVote XL - Tabulation, Reporting, Audio, Universal Voting Console
- ExpressTouch – Test all functionality of the ExpressTouch - Reporting, Audio, Universal Voting Console

4.2.2 *Device Test Configuration*

DS200 v1.2 Tabulator on Metal Ballot Box

DS200 v1.3 Tabulator on DS200 Carry Case on Plastic Ballot Box

DS450 on cart w/ report printers and UPS

DS850 on cart w/ report printers and UPS

ExpressVote v1.0 w/ Booth and QR barcode scanner

ExpressVote v2.1

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ExpressVote v2.1 tabletop, w/ external QR barcode scanner
ExpressVote XL w/ Universal Voting Console (UVC)
ExpressTouch w/ Booth and Universal Voting Console (UVC)

4.3 Treatment of Test Failures

Failures of electrical tests or failures of the exercising software to perform shall be documented in the electrical test report.

4.4 Test Documentation

A test report shall be attained from the test lab that meets the pertinent requirements of EN45001, and ISO/IEC17025, "General Requirements of Testing and Calibration Laboratories".

5.0 Electrical Tests

5.1 Electromagnetic Emissions

Objective: To verify that the electromagnetic emissions generated by the product under normal use and in the product's intended environment are below a level as specified by the 2005 VVSG.

5.1.1 Radiated Electromagnetic Emissions

Test Method: FCC Part 15, Radio Frequency Devices

Deviations from Test Method: None

Exit Criteria: The UUT shall meet the following emissions limits:

Frequency Band (MHz)	Class B Equipment 10m Measurement Distance (dBuV/m)
30 – 88	29.5
88-216	33.1
216 – 960	36.6
960-1000	43.5
(GHz) 1000-5000	43.5

5.1.2 Conducted Electromagnetic Emissions

Test Method: FCC Part 15, Radio Frequency Devices

Deviations from Test Method: None

Exit Criteria: The UUT shall meet the following emissions limits:

Frequency Band (MHz)	Class B Equipment Quasi-Peak Measurement (dBuV)	Average Measurement (dBuV)
0.15 – 0.5	66 decreasing with the log of the frequency to 56	56 decreasing with the log of the frequency to 46
0.5 – 5.0	56	46
5.0 – 30	60	50

5.2 Electromagnetic Immunity

Objective: To verify that the product performs as intended when exposed to different types of electromagnetic energies that may be encountered under normal use in the product's intended environment.

5.2.1 Immunity Compliance Criteria

Criteria A: The UUT shall be able to withstand the test without disruption of normal operation or loss of data.

Criteria B: The UUT shall be able to withstand the test 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.

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Criteria C: The COTS and support equipment may have temporary loss of function or degradation of performance, the correction of which requires operator intervention or system reset.

5.2.2 Electrostatic Disruption

Test Method: IEC61000-4-2, Ed. 2, Electrostatic Disruption Test, (2008)

Test Levels: **Will not exceed the required ESD limits for all ESD test levels.**

Test Location	Discharge Voltage +/- (kV)
Indirect Contact: HCP	8.00
Indirect Contact: VCP	8.00
Direct Contact to Metallic Surfaces	8.00
Air Discharges to Insulated Surfaces	2.00, 4.00, 8.00, 15.00

Deviations from Test Method: None

Exit Criteria: B

5.2.3 Electromagnetic Susceptibility

Test Method: IEC61000-4-3, Radiated, Radio-Frequency, Electromagnetic Field Immunity Test, (1996)

Test Levels:

Frequency Range (MHz)	Test Level (V/m)	Modulation / Sweep
80.0 to 1000.0	10	80% AM at 1.0kHz, 1% steps with 3s dwell
Clock Frequencies	10	80% AM at 1.0kHz, 1% steps with 3s dwell

Deviations from Test Method: None

Exit Criteria: A

5.2.4 Electrical Fast Transient

Test Method: IEC61000-4-4, Electrical Fast Transient Test, (1995-01)

Note: Repetition Rate for all transient pulses will be 100 kHz

Test Levels:

Coupling Mode	Test Voltage +/- kV
AC & DC Line Cord	2.0
All external wires >3m no control	1.0

Deviations from Test Method: None

Exit Criteria: A

5.2.5 Lightning Surge

Test Method: IEC61000-4-5, Lightning Surge Test, (1995-02)

Test Levels:

Coupling Mode	Test Voltage +/- kV
Differential Mode	2
Common Mode	2
Differential Mode >10m	+ or - 0.5
Common Mode >10m	+ or - 0.5
I/O sig/control >30m	1

Deviations from Test Method: None

Exit Criteria: A

5.2.6 Conducted RF Immunity

Test Method: IEC61000-4-6, Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields, (1996-04)

Test Levels:

Test Point	Frequency Range (MHz)	Test Level (Vrms)	Modulation / Sweep
AC & DC Power >3m in length	0.150Khz to 80Mhz	10	80% AM at 1.0kHz 1% steps with 3s dwell
I/O cables >3M in length	Clock Frequencies	10	80% AM at 1.0kHz 1% steps with 3s dwell

Deviations from Test Method: None

Exit Criteria: A

5.2.7 Magnetic Fields Immunity

Test Method: IEC61000-4-8, Power Frequency Magnetic Field Immunity Test, (1993-06)

Test Levels: AC magnetic fields of 30 A/m at 60 Hz

Deviations from Test Method: None

Exit Criteria: A

5.2.8 Electrical Power Disturbance

Test Method: IEC61000-4-11, Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests, (1994-06)

Test Levels:

Electrical Power Disturbance
30% dip @ 10ms
60% dip @ 100 ms and 1 sec
> 95% interrupt @ 5 sec

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Surges of $\pm 15\%$ line variations of nominal line voltage

Electric power increases of 7.5% and reductions of 12.5% of nominal specified power supply for a period of up to four hours at each power level

Deviations from Test Method: None

Exit Criteria: A

6.0 Handling Hardware Anomalies and Incidents

6.1 Hardware Test Anomalies

An anomaly with the subcontractor's test equipment or a procedural misstep can cause a test to fail. For any suspected test equipment issue or procedural error, analysis will be performed and the decision whether to continue testing based on the severity of the anomaly will be appropriately tracked. The subcontractor test lab will issue a corrective action to address any test equipment and/or procedure errors. This is part of the hardware test subcontractor's quality system process that allows the hardware test lab to train all personnel, repair/calibrate equipment, and prevent any recurrence.

6.2 Hardware Incident Process

For every test failure of any voting system component at the hardware test lab, the lab completes a data sheet (per their laboratory procedures and templates) and immediately informs the SLI Hardware Specialist. This can be communicated in the daily status update, with the data sheet attached.

- Failure Analysis: Once a failure has occurred, the SLI Hardware Specialist will be involved with the subcontractor test lab(s) to identify the hardware discrepancy in the device. The results of the analysis will be documented and tracked in the discrepancy reporting tool used for the test campaign. The analysis will focus on the failure, what caused the failure, the severity (minor or major), and possible impacts to other testing.
- Mitigation: The SLI Hardware Specialist monitors any work done by the manufacturer, with the full understanding of what is occurring and why.
 - The Manufacturer will document what work is done and the SLI Hardware Specialist will sign off on or can stop the work at any time.
 - The Hardware Specialist will determine the number of "minor" fixes the manufacturer can incorporate without a re-start of the test.
 - A **minor** change made by the manufacturer can include grounding the chassis or adding ferrites.
 - Any **major** component replacement is cause for failing a test and requiring a restart. Example: Bad motherboard. Analysis: What was the cause; did the ESD test cause the motherboard to malfunction? Does this impact other hardware tests? The Manufacturer can only replace like for like components and this process must be monitored by the SLI Hardware Specialist.
 - Any modification to the equipment is followed up with the related manufacturer EC(s). All related ECs must be entered into the hardware test report and the certification test report.

When issues are identified during hardware environmental testing, they result in discrepancies. Discrepancies are tracked in the discrepancy reporting tool.