

VotingWorks

Electrical Hardware Test Plan

v5.2

VWS-24003-ELHTP-05

Prepared for:

Vendor Name	<i>VotingWorks</i>
Vendor System	<i>VxSuite 4.0</i>
EAC Application No.	<i>VXS4</i>

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Assistance Commission (EAC)
for Selected Voting System Test
Methods or Services***



Revision History

Date	Release	Author	Revision Summary
01/24/2025	1.0	S. Ramage	Initial Release
02/10/2025	2.0	S. Ramage	Corrections
07/13/2025	3.0	S. Ramage	Retest
10/14/2025	4.0	S.Ramage	VxMarkScan only
03/25/2026	5.0	S.Ramage	Added TA numbers, removed IEC years, updated Voltage Dips
08/25/2026	5.1	S.Ramage	Removed 'Proprietary'
08/31/2026	5.2	S.Ramage	508 review and corrections

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1 INTRODUCTION

This test plan covers the EMC (Electromagnetic Compatibility) and EMI (Electromagnetic Interference) test requirements and methods for the **VotingWorks** VxSuite 4.0 voting system, hereafter known as the Equipment Under Test (EUT), to the requirements as stated in Election Assistance Commission Voluntary Voting System Guidelines Version 2.0 (EAC VVSG 2.0).

1.1 Qualifications

The EUT supplied by **VotingWorks** is representative of product produced in their volume manufacturing process.

1.2 Hardware Test Lab Facility

Element Materials Technology Denver-Longmont
1736 Vista View Drive
Longmont, Colorado 80504

1.3 Reference Documents

1. Election Assistance Commission Voluntary Voting System Guidelines 2.0
2. Election Assistance Commission Voluntary Voting System Guidelines (VVSG) v 2.0, Test Assertions v 1.3
3. NIST Handbook 150-2020
4. NIST Handbook 150-22-2021
5. Election Assistance Commission Voting System Testing and Certification Program Manual, United States Election Assistance Commission, v 3.0
6. SLI Compliance VSTL Quality System Manual, Rev. 4.1 Aug. 14, 2023

2 Product Description

2.1 Intended Use

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

2.2 Equipment Under Test

Product/Model	Serial Number	Description	Qty
VxMarkScan	MK-11-005	VxMarkScan is an accessible ballot marking device (BMD). After Poll Worker assistance to get started, Voters use VxMarkScan to mark,	1



		verify, and cast their ballot in visual-touch, audio-tactile, and limited dexterity interaction modes. PVR is stored in bin to be scanned later. VxMarkScan does not produce cast-vote records (CVRs).	
VxScan	SC-11-007	VxScan is used by voters to Scan ballots, displays instructions and accurate feedback to users visually and audibly, accepts user inputs on a touchscreen, rejects invalid ballots and double-sheet ballots, stores ballots securely in the ballot box. Poll Workers save cast-vote records (CVRs), print accurate reports before and after scanning ballots.	1

2.3 Power

Requirement	Type
AC mains	Yes
Input Voltage Rating as it appears on unit, power supply, or power brick	100-240V
VxMarkScan - Input Current (specify @ 230 Vac/50 Hz)	2.5A
VxScan - Input Current (specify @ 230 Vac/50 Hz)	6.5A
Input Current (specify @ 230 Vac/50 Hz)	6.5A
Single or Multi-Phase (If multi-phase, specify delta or wye)	Single
Input Power connector a 2-prong, 3-prong, 4 prong or 5 prong plug	3-prong
Does EUT have more than 1 power cord.	No

2.4 Support Equipment (SE)

Product/Model	Serial Number	Description	Qty
Smart Cards	TBD	Programable Smart Cards for election	3
Headphones	TBD	Optional Attachment to the VxMarkScan for user with visual impairments	1
Sip and Puff	TBD	Optional Attachment to the VxMarkScan for user with dexterity impairments	1
Ballot Box	TBD	Purpose made, plastic, collapsible ballot box for use with VxScan	1
APC	TBD	UPS for VxMarkScan, VxScan	2



2.5 EUT Software/Firmware

Name	Version	Functionality
VotingWorks Software (all)	TBD	Election software for operational status check.

2.6 Accessories

Type	Model	Function
Test Ballots	N/A	Pre-mark Test Ballots
SanDisk 64G USB	N/A	Load election definitions, record CVRs and audit logs.

3 Equipment Under Test

Backup units of the same model with unique serial numbers may be used throughout EMC/EMI testing provided the following criteria are met:

- Issue with EUT.
- Identical hardware.
- All hardware components are listed in Manufacturer's Bill of Materials (BOM) or Approved Parts List (APL).

3.1 Operating Modes and Test Configurations

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

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

- VotingWorks VxMarkScan

1. USB with signed election package
2. Election Manager Smart Card for election
3. Poll Worker Smart Card for election
4. APC
5. HeadPhones
6. Sip and Puff
7. Privacy screen



Setup for EMC Testing

1. Unfold stand
2. Add tray to stand
3. Put power brick in tray
4. Put VxMarkScan on stand
5. Attach Ballot Box
6. Plug in APC to external power supply
7. Plug in VxMarkScan to APC
8. Power on VxMarkScan
9. Insert HeadPhones in front jack ("primary jack")
10. Insert sip and puff
11. Place privacy screen around VxMarkScan
12. Insert EM Card
13. Insert signed election package
14. Remove EM card / USB
15. Insert PW card
16. Select Precinct
17. Remove PW Card
18. Place a ballot into scanner. It will repeatedly feed the same ballot (shoeshine) without fully dropping it into the box.
19. Device is now ready for testing

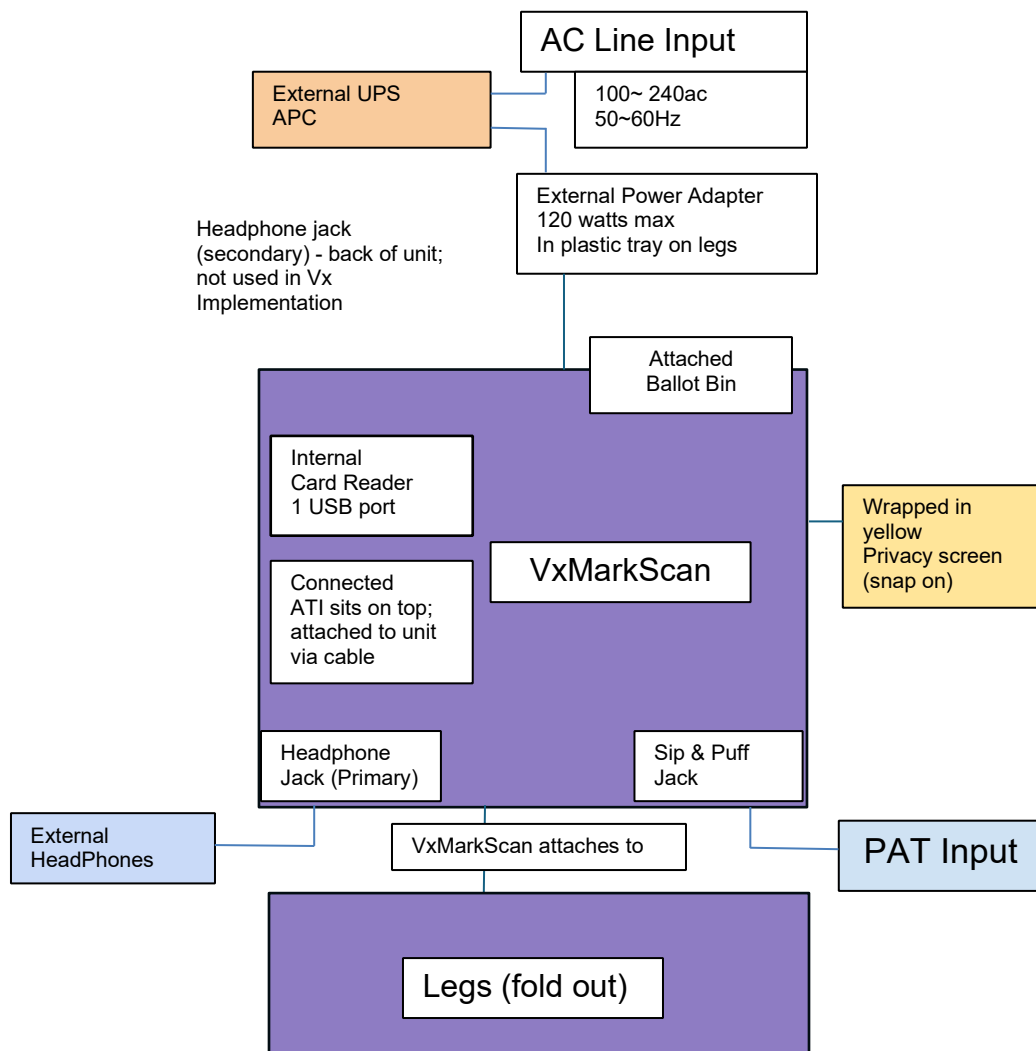


- VotingWorks VxScan

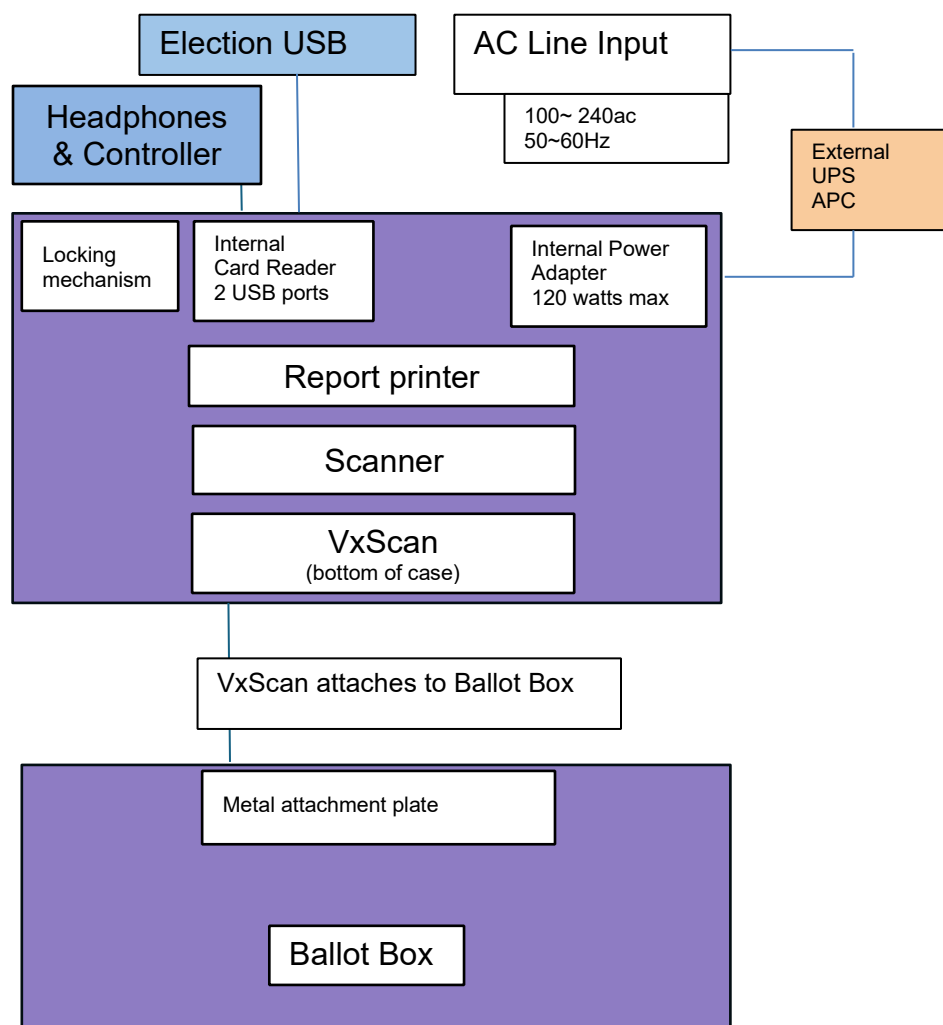
1. USB with signed election package
2. Election Manager Smart Card for election
3. Poll Worker Smart Card for election
4. Anker Solix
5. USB for CVRs
 - a. Setup for EMC Testing
6. Unfold ballot box
7. Attach VxScan to top of ballot box
8. Plug in Anker Solix to external power supply
9. Plug in VxScan to Anker Solix (automatically powers on)
10. Insert EM card
11. Insert signed election package
12. Remove EM card
13. Insert PW card
14. Open polls
15. Wait for zero report to print
16. Remove PW card
17. Place a ballot into scanner. It will repeatedly feed the same ballot (shoeshine) without fully dropping it into the box.
18. Device is now ready for testing

3.2 Block Diagram

VxMarkScan Configuration



VxScan Configuration



3.3 Treatment of Test Failures

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



3.4 Backup Unit

Backup unit of the same model with unique serial numbers may be used throughout EMC/EMI testing provided the following criteria are met:

- Issue with the EUT.
- Backup unit is identical to the EUT.
- All hardware components are listed in Manufacturer's BOM or APL.

3.5 Test Documentation

A test report shall be obtained from the test lab that meets the pertinent requirements ISO/IEC17025 (E), "General Requirements for the Competence of Testing and Calibration Laboratories", 2017-11.

4 EMC/EMI Test Requirements

4.1 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 FCC Federal Communications Commission, Part 15; Class A or B requirements for radiated emissions by testing per ANSI C63.4-2014.

Class A is utilized for non-polling locations, and Class B is utilized for polling locations.

VVSG 2.0 Requirement 1.2-I – FCC Part 15 Class A and B Conformance

Voting devices must comply with the requirements of the *Rules and Regulations of the Federal Communications Commission, Part 15, Class B [FCC19a]*.

1. Voting devices located in polling places must minimally comply with Class B requirements.
2. Voting devices located in non-polling place settings such as back offices must minimally comply with Class A requirements.

TA1.2-I 1: The voting system **MUST** comply with the Rules and Regulations of the Federal Communications Commission, Part 15; Class A or Class B requirements for radiated and conducted emissions by testing per ANSI C63.4-2014.



TA1.2-I 2: The voting system documentation **MUST** indicate whether devices comprising the system are intended to be located in non-polling places (Class A) or polling places (Class B).

4.1.1 Radiated Electromagnetic Emissions

Frequency Bands:

30 MHz - 1 GHz, FCC Part 15. Class B.

1 GHz - 10 GHz, FCC Part 15. Class B.

Deviations from Test Method: None

4.1.2 Conducted Electromagnetic Emissions

Frequency Bands:

150 kHz - 30 MHz, FCC Part 15. Class B.

Deviations from Test Method: None

4.2 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.

4.2.1 Electrostatic Disruption

VVSG 2.0 Requirement 2.7-K – Electrostatic discharge immunity

All electronic voting systems must withstand, without disruption of normal operation or loss of data, electrostatic discharges (ESD) associated with human contact and contact with mobile equipment (such as service carts and wheelchairs).

TA2.7-K 1: The voting system **MUST** be able to withstand testing in accordance with the latest IEC 61000-4-2, level 4, applying an air discharge or a contact discharge according to the nature of the enclosure of the voting system, and without damage, disruption of normal operation, or loss of data.

TA2.7-K 2: Application of electrostatic discharge points to COTS components **MAY** be performed.

TA2.7-K 3: The voting system may cycle power or have momentary interruption of power provided that normal operation is resumed without human intervention or loss of data.

Test Level 4:

Will not exceed the required ESD limits for all ESD test levels.

Test Location	Test 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

4.2.2 Electromagnetic Susceptibility (Radiated RF Immunity)

VVSG 2.0 Requirement 2.7-G – Electrical disturbance

The voting system must continue to operate in the presence of electrical disturbances generated by other devices and people and must not cause electrical disruption to other devices and people.

TA2.7-G 1: The voting system MUST be able to withstand testing in accordance with the latest IEC 61000-4-3 standard for radiated immunity, without disruption of normal operation or loss of data.

Test Level 3:

Test field strength (V/m)	Frequency Range (MHz)	Modulation/Sweep
10 V/m	80 to 1000	1 kHz 80% AM, 1% steps with 3s dwell

Deviations from Test Method: None

4.2.3 Electrical Fast Transient (EFT)

VVSG 2.0 Requirement 2.7-I – Withstand conducted electrical disturbances

All electronic voting systems must withstand conducted electrical disturbances that affect the power ports of the system.

TA2.7-I 1: The voting system MUST be able to withstand testing in accordance with the latest IEC 61000-4-4 standard for electrical fast transient protection, without disruption of normal operation or loss of data.

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

Test Level 3:

- a. +2 kV and –2 kV on External Power lines (both AC and DC)
- b. +1 kV and –1 kV on Input/Output lines (signal, data, and control lines) longer than 3 meters
- c. Repetition Rate for all transient pulses will be 100 kHz

Deviations from Test Method: None

4.2.4 Lightning Surge

VVSG 2.0 Requirement 2.7-I – Withstand conducted electrical disturbances

All electronic voting systems must withstand conducted electrical disturbances that affect the power ports of the system.

TA2.7-I 2: The voting system MUST be able to withstand testing in accordance with the latest IEC 61000-4-5 standard for lightning surge protection, without disruption of normal operation or loss of data.

Test Levels 3-4: Differential Mode – 2kV, Level 3. Common Mode – 2kV, Level 4.

Test Voltage: +/- kV	Coupling Mode
+/- 2 kV	AC line to line (Differential Mode)
+/- 2 kV	AC line to earth (Common Mode)
+/- 0.5 kV	DC line to line >10m (Differential Mode)
+/- 0.5 kV	DC line to earth >10m (Common Mode)
+/- 1 kV	I/O signal/control >30m

Deviations from Test Method: None

4.2.5 Electrical Power Disturbance (Voltage Dips and Overvoltage)

VVSG 2.0 Requirement 2.7-I – Withstand conducted electrical disturbances

All electronic voting systems must withstand conducted electrical disturbances that affect the power ports of the system.

TA2.7-I 3: The voting system MUST be able to withstand testing in accordance with the latest IEC 61000-4-11 standard for power dips, interruptions, and variations immunity, without disruption of normal operation or loss of data.



TA2.7-I 4: The voting system MUST not be disturbed by a temporary overvoltage of 120 % normal line voltage lasting from 3 ms to 0.5 s, applied in gradual steps of overvoltage across the line and neutral terminals.

TA2.7-I 5: The voting system MUST not be disturbed nor overheat for a permanent overvoltage of 10% above the nominal 120 V rating of the voting system, applied in gradual steps of overvoltage across the line and neutral terminals.

Test Class 1:

Electrical Power Disturbance – Voltage Dips

- 30% of nominal @10 ms
- 60% of nominal @100 mms & 1 sec
- >95% interrupt @5 sec

Electrical Power Disturbance – Overvoltage

- +10% of nominal 1hr.
- Surges (3ms to 0.5s) of +20% of line variations of nominal 30 min.

Deviations from Test Method: None

4.2.6 Conducted RF Immunity

VVSG 2.0 Requirement 2.7-J – Emissions from other connected equipment

All elements of an electronic voting system must be able to withstand the conducted emissions generated by other elements of the voting system.

TA2.7-J 1: The voting system MUST be able to withstand testing in accordance with the latest IEC 61000-4-6 standard for conducted immunity, without disruption of normal operation or loss of data.

Test Level 3:

Conducted RF Energy
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

Deviations from Test Method: None



5 EMC/EMI Test Summary

The following Table shows the tests to be performed on the EUT.

Test	Test Specification	VVSG 2.0	Comments
Electromagnetic Emissions Tests			
Radiated Electromagnetic Emissions	FCC, Part 15 Class A/B ANSI C63.4-2014. Class B [FCC19a]	1.2-I TA1.2-I 1 TA1.2-I 2	VxScan only
Conducted Electromagnetic Emissions	FCC, Part 15 Class A/B ANSI C63.4-2014. Class B [FCC19a]	1.2-I TA1.2-I 1 TA1.2-I 2	VxScan only
Electromagnetic Immunity Tests			
Electrostatic Disruption	IEC 61000-4-2	2.7-K TA2.7-K 1 TA2.7-K 2 TA2.7-K 3	Both VxMarkScan and VxScan
Electromagnetic Susceptibility	IEC 61000-4-3	2.7-G TA2.7-G 1	VxScan only
Electrical Fast Transient	IEC 61000-4-4	2.7-I TA2.7-I 1	VxScan only
Lightning Surge	IEC 61000-4-5	2.7-I TA2.7-I 2	VxScan only
Electrical Power Disturbance	IEC 61000-4-11	2.7-I TA2.7-I 3 TA2.7-I 4 TA2.7-I 5	VxScan only
Conducted RF Immunity	IEC 61000-4-6	2.7-J TA2.7-J 1	VxScan only

End of ELEC Hardware Test Plan
