

Voting System Qualification Test Report
Elections Systems and Software, LLC
Unity, Release 4.0.0.3, Version 4

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Executive Summary

The application for certification by Elections Systems and Software (ES&S) of its Unity, Release 4.0.0.3, Version 4 voting system was completed on January 21, 2014. The Bureau of Voting Systems Certification (BVSC) began certification test activities on January 28, 2014. BVSC examined the following new and/or upgraded features and hardware:

- Digital Scan 200 (DS200) Hardware version 1.3

- DS200 Firmware version 1.5.5.0

- Engineering Change Order (ECO) 899 – Adding a 1GB DRAM option for the DS200 hardware version 1.2

The system includes the DS200 and Model 100 (M100) optical scan tabulators, AutoMARK ballot marking device and iVotronic Direct Recording Electronic (DRE) tabulator, used for accessible voting and Model 650 (M650), which is an optical scan central count ballot tabulator.

Qualification test results affirm that the voting system under test, ES&S Unity Release 4.0.0.3, Version 4 meets the applicable requirements of the Florida Voting Systems Standards, Florida Statutes and Rules and the Help America Vote Act (HAVA) for usability and accessibility. Therefore, the Florida Division of Elections, Bureau of Voting Systems Certification recommends that the voting system be certified for sale and use in the state of Florida.

Introduction

The Unity voting system is a paper-based voting system with elements for compliance with HAVA provisions for Americans with Disabilities Act (ADA) accessibility. The voting system is comprised of the following: The election management system (EMS), the DS200 and M100 precinct count tabulators, the iVotronic DRE with optional accessible tactical interface (ATI) required to comply with ADA specifications, the AutoMark Voter Assistance Terminal, and the M650 central count tabulator.

Background

The *Unity Release 4.0.0.3, Version 4* system is based upon the *Unity Release 4.0.0.3, Versions 1-3* system. The 4.0.0.3 Release versions were certified in 2010 and 2011. The Unity voting system is built upon the 4.0.0.0 series of the Unity software suite, which was initially certified in November 2007, in Tallahassee, Florida.

System Overview

Unity 4.0.0.3 version 4 is a suite of software applications that, when used in conjunction with the ES&S family of ballot tabulators and voting machines, allows an election authority to fully administer and conduct an election. This includes the front-end tasks of maintaining an administrative database, the creation of an election definition, the layout of paper and electronic ballots, and the setting up of the tabulators and voting machines. It also includes the back-end tasks of acquiring and aggregating election results, and printing and exporting results files and reports.

The Election Management System (EMS) is made up of several software applications that accomplish required election activities. The specific application names are listed below.

1. EDM - Election Data Manager
2. ESSIM - Election Image Manager
3. iVIM - iVotronic Image Manager
4. HPM - Hardware Programming Manager
5. ERM - Election Reporting Manager

The DS200 digital scanner scans voted ballots inserted in any orientation. Both sides of the ballot are processed simultaneously with high-resolution scanners. After processing voter selections, the DS200 drops the ballot into an attached, secure ballot box. Product features are listed below:

1. Touchscreen
2. Ballot input
3. Thermal printer access
4. Election media storage compartment



Figure 1 - DS200 Digital Scanner

The Model 100 optical scanner is the predecessor to the DS200 digital scanner. It uses a visible light-based mark recognition system to identify valid marks. The Model 100 accepts ballots inserted in any orientation. Optical sensors simultaneously read both sides of the ballot and record the voter's selections. After processing the ballot, the M100 automatically places the ballot into an attached, secure ballot box. Product features include:

- 1. LCD display and control panel
- 2. Ballot Feed Path
- 3. Thermal printer access
- 4. Election media storage



Figure 2 - M100 Optical Scanner

The AutoMARK voter assistance terminal (VAT) acts like a smart pencil. It supports assistive ballot marking for voters with low vision, voters who are blind, voters with limited dexterity or physical disabilities, or voters who want to read or hear ballot content in an alternate language. Voters navigate the ballot using the system touchscreen, physical keypad, or an ADA support peripheral such as a sip and puff device. The device visually guides the voter through the ballot marking process with screen prompts and symbols. Screen controls meet all applicable guidelines for size and readability. Physical keys are shaped and positioned to provide an intuitive voting session and labeled in both Braille and text to indicate function. The system includes a mandatory vote summary screen that requires voters to confirm or revise selections

prior to marking a paper ballot. Once the voter has marked the ballot, the voter removes the ballot from the AutoMark VAT and inserts the ballot into the precinct tabulator (DS200 or M100). If the AutoMARK VAT has the optional AutoCAST ballot box, the voter has the option to return the marked ballot to the voter and insert the ballot into the precinct tabulator or the option to cast the ballot directly into the attached AutoCAST ballot box.



Figure 3 - AutoMARK (VAT)

The iVotronic Direct Recording Electronic (DRE) is used in precinct polling places and early voting centers. Voters make selections from the electronic display/touch screen using a finger or device, such as a sip and puff or accessible tactical interface (ATI) designed to assist the target selection process. When the voter is finished voting, their selections are cast electronically for immediate tabulation. The iVotronic is capable of presenting the ballot to voters in alternative languages and has the ability to present an audio-only ballot, for visually-impaired voters. The audio only ballot presentation enables the voter review ballot content in an audio format through headphones. In this instance, the voter uses tactile buttons to navigate, select options and to cast the ballot. The iVotronic can also present a combination audio/visual ballot. This mode displays the ballot and, when screen objects such as race/proposition titles, race/proposition selections {candidate name, yes/no} are selected, reads selected items to the voter in an audio format, through headphones. Selections are made using the select button on the iVotronic tactile button array.



Figure 4 - iVotronic DRE

The M650 is an optical scan central ballot counter. The scanner’s dual-printer configuration supports a continuous audit log and the printing of results reports directly from the scanner. ERM can also process scanner totals by reading results saved to Zip Disk. The M650 includes the following components:

1. Control Panel
2. Input Hopper
3. Scanner Read Path
4. Output Hopper
5. Report Printer (not pictured)
6. Audit Printer (not pictured)



Figure 5 - M650 Central Count Scanner

Components under Review

BVSC examined the DS200 firmware upgrade from version 1.5.3.0 to 1.5.5.0, and hardware version 1.3. Hardware version 1.3 consists of revisions to the main board because of component end of life. Firmware version 1.5.5.0 includes a change to the main board, as well as the replacement of the power management board firmware (from version 1.2.0.1 to 1.2.11.1) and scanner firmware (from version 2.21.0.0 to 3.0.1.1). In addition, BVSC assessed various enhancements that were implemented with firmware 1.5.5.0, including logging activities, performance and usability improvement, a networking option and displayed messaging updates, as well as upgrades to the DS200 ballot box. BVSC included a DS200 with ECO 899 in the testing. This ECO allows the optional upgrade from 512MB DRAM to 1GB DRAM in DS200 hardware versions 1.2.x.

DS200 #	H/W Version	F/W Version	DRAM	USB Stick	Notes
1	1.2.2	1.5.5.0	512M	SanDisk 2G	
2	1.2.3.0	1.5.5.0	1G	Delkin 1G	ECO899
3	1.3	1.5.5.0	1G	Delkin 1G/8G	Used 8G USB stick for MBC
4	1.2.3.0	1.5.5.0	512M	Delkin 2G	
5	1.2.1	1.5.5.0	512M	Delkin 4G	
6	1.3	1.5.5.0	1G	Delkin 1G	

Table 1 - DS200 Equipment Used for Certification

DS200#3 and DS200#6 are identical hardware and firmware. DS200#1-5 were used for the initial tests. After completing the mock election testing on DS200#3, it was used to conduct the mass ballot count. DS200#6 was included in the remainder of the testing with DS200#1, 2, 4, and 5, so that each test was performed on all of the hardware versions under test.

Conduct of Tests / Findings

The test objective was to verify that the voting system met the applicable requirements of the Florida Voting Systems Standards (FVSS), Florida Statutes and Administrative Rules, and the Help America Vote Act (HAVA) for usability and accessibility.

The FVSS qualification examination for this effort encompassed a physical and functional audit, as well as additional tests to verify that the 1.5.5.0 firmware upgrade and enhancements and the ballot box modification did not affect the operation of the DS200 versions under test.

Physical Audit

Physical audit activities encompassed comparing and validating the version numbers, and systems configuration software items used to set up the system with the descriptions submitted on the application for certification (DS-DE 71). BVSC examined the updated DS200 firmware, Version 1.5.5.0, to ensure that it matched the submitted documentation. BVSC performed this examination by using the vendor's firmware extract tool. BVSC compared the extracted firmware with the firmware sent with the trusted build from Wyle Laboratories¹.

Findings:

The extracted firmware matched the firmware from the trusted build for each of the 6 DS200 units under test.

Systems Setup & Configuration

BVSC used the currently certified ES&S Unity 4.0.0.3, Version 3 configuration for certification test activities since there were no changes to any part of the system other than the DS200 firmware.

The Windows XP operating system on the Unity server was updated to Service Pack 3 using a trusted executable of the Windows Server Update Services (WSUS) offline update tool obtained from Wyle Laboratories.

Functional System Audit

BVSC used a Primary and General Election from the ES&S Unity 4.0.0.3, Version 3 (certified on August 15, 2011) for the test activities conducted in this certification. The functional system audit activities included testing all of the menu items on the DS200, mock election testing, and a DS200 mass ballot count. The mass ballot count used a General Election. All other testing activities used a Primary Election. Specific details of these activities follow.

¹ Wyle Laboratories is a test lab that is federally certified (by the U. S. Elections Assistance Commission) to test voting systems.

Mock Election Testing – Primary Election

The conduct of mock elections included election cycle events such as loading media into the tabulators, opening and closing of polls, casting ballots, election night and post-election reporting. The testing involved all election voting methods and included the following reporting groups: early voting, absentee, election day, provisional and provisional after 7:00 p.m. This activity also included testing to verify that the change to the motherboard, scanner board, and power management board did not affect the DS200's ability to the modem results.

BVSC used DS200 numbers 1 through 5 for the mock election testing. BVSC completed all mock election activities on DS200 #3 first, which was then used for the Mass Ballot Count. BVSC then completed the mock election activities on DS200s #1, 2, 4, and 5.

Pre-Election Activities

BVSC printed ballots for the Primary Election using the Advanced Ballot Solutions Ballot-On-Demand (BOD) printer. BVSC created the mock election test deck, the folded ballot test deck and the ballot sensitivity test deck from these ballots.

BVSC selected ballots for the mock election test deck to ensure that each of the various ballot styles were represented. 67 ballots were chosen including Republican, Democratic, and No Party Affiliation (NPA) ballots for each split in each precinct.

BVSC marked 6 ballots with the AutoMARK and the 61 ballots by hand. Ballots were marked in a 1-2-3 pattern and included one blank ballot and three overvoted ballots. BVSC hand audited the test deck to create expected results.

BVSC created election media for the 5 DS200 units being used for the mock election testing. BVSC verified the firmware on each tabulator's Compact Flash (CF) memory card against the trusted build, then booted each tabulator and inserted the election media.

Election Activities

For each unit under test, BVSC:

- Opened the polls and inspected the printout.
- Ran the test deck through the tabulator.
- Closed the polls, and inspected the poll closing printout.
- Transferred the results from the tabulator to the Unity server via modem.

Post-Election Activities

BVSC printed results from ERM, then verified the results by:

- Reconciling the results from ERM to the expected results.
- Reconciling the results from the close polls report to the expected results.
- Reconciling the results from ERM to the results from the close polls report.

Findings:

Each unit under test correctly read the ballots in the test deck. The tabulator warned the voter when an overvoted ballot was read. The tabulator gave the voter the option to retrieve the ballot for correction or the cast the ballot as marked. The tabulator warned the voter when a blank ballot was read. The tabulator gave the voter the option to retrieve the ballot for correction or to cast the ballot as marked.

The results printed on the close polls report matched the expected results from the test deck audit. All units under test correctly sent the results via modem to the Unity server. The results from ERM matched the results on the tabulator close polls report and the expected results. BVSC noticed no discernible difference between the operation of DS200 #2, the unit with ECO 899, and any other unit under test.

Mass Ballot Count

DS200 #3 was used for the mass ballot count. BVSC used one test deck consisting of 360 ballots, with two cards each. BVSC ran the test deck fifteen times to reach the minimum 9,900-ballot requirement². A set of predetermined results was supplied and compared to the scanner results and the results reports from ERM. Specific details follow:

Election Definition used	General Election
Ballot Length	19"
Number of scanner units used	1
Number of test decks	1
Number of runs per test deck	15
Number of ballots per test deck	360
Number of cards per ballot	2
Total number of ballot cards cast	10800
Total number of vote targets	438,750

Table 2 – Mass Ballot Count Data

The time to cast a ballot was measured at intervals throughout the Mass Ballot Count. Results were:

Public Count	Time to Cast Ballot (seconds)
1000	7.10
1000 ³	7.72
1560	7.37
2000	7.51
2800	7.53
3000	7.37
4000	7.35
5000	7.40

Table 3 – Time to Cast Ballot

Findings:

The tabulator successfully read 10,800 ballot cards. The results from the poll closing report and from the ERM matched the expected results. The average time to cast a ballot was 7.42 seconds. The time to cast a ballot did not increase as the number of ballots cast increased.

² Florida Voting System Standards, Form DS-DE 101, Eff. 1-12-05, p.57

³ The DS200 only increments the public count when the first card in a multi-card ballot is counted. These times were measured for the two cards of the same ballot, so the public count did not increment between the two.

Additional details follow in the table below:

Mass Ballot Count – Acceptance Criteria	Expected	Actual
Did the memory registers overflow?	No	No
Did the public counters increment appropriately?	Yes	Yes
Did the tabulated results agree with the predetermined vote totals?	Yes	Yes
Number of errors (must not exceed 1 in 1,000,000 vote targets.) An error is defined as a target scan that produces a result other than the expected result.	≤1/1M vote targets	0

Table 4 – Mass Ballot Count Acceptance Criteria

Additional Testing

BVSC examined the following items to verify compliance with standards, statutes, and rules or to proactively review various functions for informational purposes. Specific details for each test activity are listed below:

- Assessment of the precinct tabulators battery life
- Conducting contest recounts per Florida Administrative Rule
- Ballot sensitivity analysis
- System failure/recovery
- Voting equipment clock update(Daylight Savings Time and Leap Year)
- Folded ballot handling

Battery Life Test

BVSC verified that the DS200 precinct tabulator, when disconnected from the electrical outlet, functioned for the time period stated in the vendor-submitted TDP documentation.⁴ The documentation states that the battery pack is capable of powering the system for two hours.

BVSC staff turned the power on the DS200 and disconnected the AC adapter. The equipment was left running on battery power overnight. The following morning, BVSC reconnected the AC adapter and reviewed the audit logs to determine the length of time the machine remained in a usable state, before complete drainage of the battery power occurred. The table below reflects the outcome of these tests.

Equipment	Power Cord Unplugged		Logged Battery Failure		Machine Use w/o Electric Power Source
	Time	Date	Time	Date	
DS200	17:07:45	02/04/2014	20:08:08	02/04/2014	3 hrs 23 secs

Table 5 – DS200 Battery Life Testing

Findings:

The battery pack powered the equipment for 150% of the stated minimum battery life.

⁴ DS200 Operator’s Guide, Document Version 2.0, Firmware Version 1.5, Published October 18, 2013, page 15

Contest Recounts

To ensure that the voting equipment could be properly configured to meet Florida’s recount requirements, BVSC simulated a recount of overvotes and undervotes, for both a district wide and county wide contest, using the Primary Election. BVSC disabled all other races on the ballot to conduct this test. This task consisted of opening the polls, running zero tapes, casting 67 test deck ballots, closing the polls, and uploading the results into the ERM.

Findings:

The system performed as expected. Only the contests that were chosen as “recount” races showed results. Contests which were not chosen for the recount did not show any results in the ERM reports. Ballots with no votes in the chosen races were treated as blank. The system satisfied requirements of the Florida Statutes and Rules.

Ballot Sensitivity

BVSC used DS200 #6 for the ballot sensitivity analysis. BVSC created a test deck of 26 ballots for the ballot sensitivity analysis, using the primary election definition. BVSC ran the deck through the tabulator twice, evaluating the results after each run. The table below summarizes the ballot markings and the results from each run. All marks were a 1mm horizontal line through the vote target, with the exception of ballot 23, which was marked with a check and ballot 24, which was marked with an X.

Ballot Number	Marking Device	Results Run 1	Results Run 2
1	Staedler HB pencil	5 unreadable marks	6 unreadable marks
2	Staedler 4B pencil	OK	OK
3	Staedler H pencil	4 unreadable marks	5 unreadable marks
4	Staedler 3B pencil	3 unreadable marks	4 unreadable marks
5	Staedler 6B pencil	OK	OK
6	Staedler 2B pencil	2 unreadable marks	1 unreadable mark
7	Staedler 2H pencil	3 unreadable marks	4 unreadable marks
8	Staedler 5B pencil	OK	OK
9	Staedler 3H pencil	No Votes Detected	No Votes Detected
10	Staedler 4H pencil	No Votes Detected	No Votes Detected
11	Staedler B pencil	5 unreadable marks	6 unreadable marks
12	Staedler F pencil	6 unreadable marks	6 unreadable marks
13	Pigma Archival Ink	OK	OK
14	Office Depot #2 pencil	2 unreadable marks	1 unreadable mark
15	Red Ballpoint	OK	OK
16	Kathy Dent Blue Ballpoint	1 unreadable mark	2 unreadable marks
17	Green Highlighter	No Votes Detected	No Votes Detected
18	Orange Highlighter	OK	OK
19	Black Sharpie	OK	OK
20	Red Pilot	OK	OK
21	IR Pen	No Votes Detected	No Votes Detected
22	EF Black Felt Tip	OK	OK
23	Pilot G2 Black V	OK	OK
24	Pilot G2 Black x	OK	OK
25	Yellow Highlighter	No Votes Detected	No Votes Detected
26	Blue Highlighter	No Votes Detected	No Votes Detected

Table 6 - Ballot Sensitivity Test Deck and Results

Findings:

Florida law and FVSS have no requirements for this test so a pass / fail assessment was not conducted. The results of this review however shows that hard (H & F) and some soft (B) lead pencils may create undetectable or ambiguous marks. The DS200 Operator's Guide (page 6) recommends using a Bic Grip (Black) medium point roller ball pen, which is equivalent to the Pilot G2 Black roller ball pen used in this test. The pens the vendor actually provided for the test were the EF felt tip pens.

Simulated System Failure/Recovery

BVSC removed power from a DS200 with a bad battery, while the unit was open for elections. A good battery was installed and power restored. The DS200 recovered with no loss of data.

Findings:

The DS200 satisfactorily recovered from the catastrophic failure.

Time Change – DS200 [Daylight Savings Time / Leap Year]

Daylight Savings Time Testing

BVSC examined the DS200 to discover whether the time of day would “spring forward” one hour and “fall back” one hour with the Daylight Savings Time (DST) clock change. DS200s #1-5 were used for the Daylight Savings Time testing.

BVSC set the clock on each unit to 03/09/2014 at 01:59 AM. BVC observed the clocks “spring forward” from 02:00 to 03:00.

BVSC set the clock on each unit to 11/02/2014 at 01:59 AM. BVSC observed the clocks “fall back” from 02:00 AM to 01:00 AM. The units were allowed to run, and the clocks did not “fall back” a second time when they reached 02:00 AM again.

Findings:

All DS200s tested properly handled Spring and Fall DST time changes.

Leap Year Testing

BVSC examined the DS200 to determine whether the voting equipment implemented the date change correctly during leap and non-leap years. DS200s #1-5 were used for Leap Year Testing.

BVSC set the clock on each unit to 02/28/2014 at 11:59 PM. BVSC observed the date change to 03/01/2014 at midnight as expected. BVSC set the clock on each unit to 02/28/2016 at 11:59 PM. BVSC observed the date change to 02/29/2016 at midnight as expected.

Findings:

All DS200s tested properly handled Leap Year and non-Leap Year date changes.

Folded Ballot Test

BVSC created a folded ballot test deck using the Primary Election definition. This test deck contained 12 ballots, of which a single set of four were each single-folded, C-folded, and Z-folded. Half of each type of

fold were folded forwards (the top of the ballot folds towards the voter) and half were folded backwards. Two of each type of fold, consisting of a forward fold and a backward fold had the folds avoid all vote targets. The other ballots were folded through one or more vote targets.

BVSC marked the ballots so that there were marks on vote targets with folds through them, votes on targets with the fold through another vote target in the same race, and races with folds through a vote target that did not have any valid marks in that race.

BVSC ran the test deck through the tabulator twice, and examined the results after each run. The results for each run were identical.

Findings:

All of the ballots, except one read correctly. The one ballot which did not produce the expected results was a single-folded ballot, folded backwards, with the fold through multiple vote targets. Staff folded this ballot several times to get the fold in the desired location, resulting in an exceptionally wide fold area. The tabulator saw this fold through the vote target as a valid mark, and counted it as such; however the situation on a ballot with an exceptionally wide fold area would not typically occur in an actual voting scenario.

Source Code Review

BVSC desk checked the source code and also examined it with the Klocwork static source code analysis tool. BVSC found no issues that posed significant safety, security, or operational risks.

Continuous Improvement / Recommendations

During testing, staff encountered no issues that preclude certification of the ES&S Unity Release 4.0.0.3, Version 4 voting system. BVSC makes the following recommendation solely for the purpose of improving the ease of usability and the efficiency of the system in any future release.

1. The intElect branding and logo have been removed from the ballot boxes and the DS200 covers, but remain at the top of the DS200 screens. ES&S should consider removing this logo from the DS200 screens in a future release of this software.

The recommendation has no bearing on the effectiveness of the voting system, its tabulation, or the accumulation of election results.

Conclusion

Qualification test results affirm that the voting system under test, ES&S Unity Release 4.0.0.3, Version 4, met applicable requirements of the Florida Voting Systems Standards, Florida Statutes and Rules, and the Help America Vote Act (HAVA) for usability and accessibility. The Florida Division of Elections, Bureau of Voting Systems Certification, recommends certification of the referenced voting system.

Appendices

Acronyms

ADA	Americans with Disabilities
ATI	Accessible Tactical Interface
BVSC	Bureau of Voting Systems Certification
CF	Compact Flash (memory cards)
COTS	Commercial off the Shelf (software/hardware)
DRE	Direct Recording Electronic
DS200	Digital Scan 200 (ES&S precinct scanner)
M650	Model 650 (ES&S central count scanner)
EAC	U.S. Elections Assistance Commission
EMS	Election Management System
ES&S	Elections Systems and Software
FVSS	Florida Voting Systems Standards
HAVA	Help America Vote Act
LAN	Local Area Network
M100	Model 100 (ES&S precinct scanner – predecessor to the DS200)
TDP	Technical Data Package

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