AccuVote-TSx

System Overview

Revision 1.0

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Copyright

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Part number: : 733-2621 TDP

Document History

Document Number	Date	Remarks
DPPTx00B	January 20, 2003	Initial document.

Table of Contents

2.2. System Overview

In the system overview, the vendor shall provide information that enables the test authority to identify the functional and physical components of the system, how the components are structured, and the interfaces between them.

2.2.1. System Description

The system description shall include written descriptions, drawings and diagrams that present:

a. A description of the functional components (or subsystems) as defined by the vendor (e.g., environment, election management and control, vote recording, vote conversion, reporting, and their interconnection);

b. A description of the operational environment of the system that provides an overview of the hardware, software, and communications structure;

c. A theory of operation that explains each system function, and how the function is achieved in the design;

d. Descriptions of the functional and physical interfaces between subsystems and components;

e. Identification of all COTS hardware and software products and communications services used in the development and/or operation of the voting system, identifying the name, vendor and version used for each such component, including:

   1. Operating systems;
   2. Database software;
   3. Communications routers;
   4. Modem drivers; and
   5. Dial-up networking software;

f. Interfaces among internal components, and interfaces with external systems. For components that interface with other components for which multiple products may be used, the TDP shall provide an identification of:

   1. File specifications, data objects, or other means used for information exchange; and
   2. The public standard used for such file specifications, data objects, or other means; and

g. Benchmark directory listings for all software (including firmware elements) and associated documentation included in the vendor's release in order of how each piece of software would normally be installed upon setup and installation.

2.2.1.1. Functional components

A description of the functional components (or subsystems) as defined by the vendor (e.g., environment, election management and control, vote recording, vote conversion, reporting, and their interconnection).

2.2.1.1.1. Environment

The AccuVote-TSx is intended for use either in a polling or early voting environment. One or more units may be installed at every voting location, one or more or the units being present intended for use by special needs voters. Any unit may be configured for special needs voting, for example, wheelchair access or audio voting.

AccuVote-TSx units must be stored according to designated temperature and humidity standards established by Diebold Election Systems, Inc., and unit batteries must be charged for a duration and frequency established by Diebold Election Systems, Inc. specifications prior to every election.

The AccuVote-TSx consists of two components, the tablet and base. The tablet contains the touch screen, PCMCIA and other data connectors, device electronics, and battery, whereas the base is used to support the unit, and acts as voting booth. The AccuVote-TSx is pre-installed in the the accompanying tablet, which is designed to assure optimal voting privacy. Telescoping voting booth legs provide clearance for wheelchair access, and may be adjusted in terms of height. The height and angle of display of the AccuVote-TSx's touch screen may also be modified to suit the convenience of the voter.

AccuVote-TSx units allow for wireless modem or local area network transmission capability, facilitating the programming of memory cards prior to the election, as well as the uploading of memory cards once the election has completed.

The election and ballot information resident on each unit is determined by the PCMCIA memory card programmed from the GEMS host computer.

Any AccuVote-TSx unit may be used to:

- Program PCMCIA memory cards,
- Accumulate vote totals for the polling location at multi-unit polling locations, and
- Upload election results to the GEMS host computer.

Shelter Requirements

The AccuVote-TSx may be stored in any enclosed and habitable facility ordinarily used as a warehouse or polling place, subject to a storage temperature of between -4° and 140° Fahrenheit. Units should be stored in designated packaging, preferably resting on shelving independently. Shelter should be supplied with AC power so that AccuVote-TSx batteries may be charged while in storage. Units should also be stored so that any individual unit may be removed from the storage subject to a minimum amount of rearrangement of other units.

Space Requirements

The AccuVote-TSx unit with voting booth require a 22"by 40" area for installation. A clear area should be provided in front of the unit, large enough for easy access by voters (including wheelchair access). The installation of the AccuVote-TSx neither impedes the performance of duties of polling place officials nor the orderly flow of voters in the polling place.

Furnishings and Fixtures

The AccuVote-TSx unit is normally operated inside of its designated voting booth, but will also function properly without the voting booth. The AccuVote-TSx may also be transported within the voting booth.

Electrical Supply

The AccuVote-TSx requires an input voltage of between 90V and 135V AC, a frequency of between 47 and 63 Hz, and operates at a maximum current of 0.8A when off or changing the battery, or 1.5A when on. Note that the unit will automatically charge and maintain the battery when AC voltage is applied whether the unit or turned on or not. The unit is provided with a battery (12Vdc, 4.5Ah.) for power backup in the event of a failure in the electrical supply.

A fully charged battery will allow the unit to operate for an minimum period of 2 hours, but may operate for up to four hours, depending on the operations performed. Batteries are cold-swappable, meaning that the unit may be powered off, the battery easily replaced, and the unit powered on again for continuous battery-driven operation. The display of system status and error messages remain fully operational while the unit is driven by battery power. In the event of a complete power failure, results are securely stored in permanent, non-volatile memory.

The AccuVote-TSx unit is fully operational without a battery installed, provided it is connected to AC power. Batteries are charged in under 3 hours while installed in an AccuVote-TSx unit connected to AC power. It is not necessary to leave the unit powered on while charging the battery.

2.2.1.1.2. Election management and control

Jurisdictional definition information, ballot content and layout, and geographically-determined election results reporting are driven from the GEMS host computer. Once ballot layout has been completed, PCMCIA memory cards establishing election and ballot characteristics of each voting device are programmed, and one memory card assigned to a designated AccuVote-TSx unit. Following election close, results from every memory card are accumulated to a designated Accumulator AccuVote-TSx unit at each polling location, then in turn uploaded by modem to the GEMS host computer.

Every memory card defined in GEMS corresponds to a unique physical AccuVote-TSx memory card as well as a unique set of results for that memory card. Once results from a memory card have been uploaded, it is not possible to re-upload those results, unless the results for a particular memory card have been explicitly cleared in GEMS. Once an election has been ended, it is not possible to cast any further votes.

All transactions, including the casting of ballots, are logged to the AccuVote-TSx Audit Log, which may be printed at any time prior begin of voting, or following the end of the election.

Voters are uniquely identified to the AccuVote-TSx units by means of voter access smart cards, which are created using proprietary Diebold Election Systems, Inc. voter access card creation tools, such as the Voter Card Encoder or VCProgrammer. Once the voter has cast a ballot, it is not possible to continue voting with the same voter access card. The voted voter access card must be returned to pollworkers in order for the card to be prepared for the next voter.

Recording Requirements

The AccuVote-TSx:

a. Records every entry made by the user,
b. Adds permissible voter selections correctly to constituent memory components,
c. Verifies the correctness of user selections, and adds selections correctly to memory,
d. Allows the addition of some types of data directly by the election official or designee, including the Challenge Id, as well as ballot presentation criteria,
e. Verifies the correctness of data entered directly by the user, and the addition of the selections correctly to memory,
f. Preserve the integrity of election management data stored in memory against corruption by stray electromagnetic emissions, and internally generated spurious electrical signals; and
g. Logs corrected data errors by the system.

Memory Stability

The AccuVote-TSx employs widely recognized technology for election results retention, both internal flash memory and external PCMCIA flash memory, that allows error-free data retention for at least 22 months.

For internal memory, the AccuVote-TSx employs Intel StrataFlash devices, guaranteed for over 100,000 erase cycles per block. These devices can retain data for up to 20 years. For removable memory, TBD PCMCIA Flash memory cards are used. These Flash cards have an endurance of over 300,000 erase cycles and have an MTBF of 1,000,000 hours.

2.2.1.1.3. Vote recording

Vote recording occurs by means of touching the AccuVote-TSx unit's LCD in designated contact positions, which vary according to the currently displayed window. Candidate positions are indicated by outlines of boxes, positioned adjacent to candidate names. The selection of a candidate causes the voting box to be filled with an X, colored in with red; once the number to vote for has been attained in a race, all remaining candidate or response voting boxes disappear. It is not possible to vote for more candidates or responses than the number to vote for.

Write-in candidates are entered by means of touching the appropriate letters and symbols on an electronic keyboard displayed upon selection of a write-in candidate. Buttons on the display may be touched in order to advance the ballot, return to a prior page of the ballot, or review or cast the ballot. On the other hand, numeric keypad entries determine action to be taken when voting the audio ballot.

The AccuVote-TSx voting booth:

a. Is integral to, and makes provision for, the installation of the AccuVote-TSx,

b. Ensures stability against movement or overturning during entry, occupancy, and exit by the voter,

c. Provides privacy for the voter, and is designed so as to prevent observation of the ballot by any person other than the voter, and

d. Is capable of meeting the accessibility requirements stipulated in section 2.2.7.1 of the FEC requirements.

2.2.1.1.4. Reporting

The AccuVote-TSx supports the following reporting requirements:

a. Results are reported on each AccuVote-TSx device for the corresponding memory card, ie. vote center/machine combination, and on the Accumulator AccuVote-TSx unit, for all memory cards at the polling location. Geographical reporting for selected precincts or districts may be performed from the GEMS software once memory cards have been uploaded to GEMS.

b. The number of ballots cast on the AccuVote-TSx unit is printed on the Election Totals report after the election has been ended.

c. The Election Totals report lists candidate and measure response totals for each race as well as the count of blank votes, undervotes, overvotes, and write-ins, for the memory card. Note that total overvotes from ballots cast on the AccuVote-TS will always be 0, since it is not possible to overvote using this voting device.

d. A consolidated tally of all votes cast in the election for any race is not produced by the AccuVote-TSx, as this is produced by the GEMS software.

e. Overvote statistics for any particular race may be printed in an individual memory card's Election Totals report, for all memory cards at a polling location with an Accumulated Totals report, or for any selection of precincts or districts from GEMS. Note that total overvotes from ballots cast on the AccuVote-TS will always be 0, since it is not possible to overvote using this voting device.

f. The Audit Log may be printed once the election has been ended, election results reports printed, results accumulated and uploaded, and any other audit-worthy function performed.

g. The printing of AccuVote-TSx election results reports or transmission of results over telecommunications lines does not cause data to be altered or destroyed.

2.2.1.2. Operational environment

A description of the operational environment of the system that provides an overview of the hardware, software, and communications structure.

2.2.1.2.1. Hardware structure

Physical requirements

Mechanical specifications

The AccuVote-TSx will be 19.8” wide, 23.2” high, and 6.8” thick.

The AccuVote-TSx will weigh 24.6lbs with tablet, and 10lbs without the tablet.

Display

The AccuVote-TSx will be installed with a 15” TFT LCD.

Printer

The AccuVote-TSx includes an internal printer as standard equipment.

Smart card reader

The AccuVote-TSx utilizes a smart card reader for input of voter information.

Security

The AccuVote-TSx is designed with the power switch located behind a locked panel. Access to PCMCIA slots is limited by means of lockable doors.

VIBS keyboard

The AccuVote-TSx includes audio voting functionality. This option, which calls for the addition of a keypad and headphones, allows people with limited sight to vote. A standard 3x4 numeric keypad is sufficient for the task. This keypad should incorporate a dimple to clearly identify the keypad as either computer or telephone configuration.

Materials & processes

The AccuVote-TSx tablet and base will be manufactured using blend of polycarbonate and ABS (Acrylonitrile Butadiene Styrene), a type of polymer.

Display configuration

The AccuVote-TSx is intended to operate with the portrait mode.

Display resolution

The AccuVote-TSx display is configured for 1024 x 768 resolution, with color depth between 16 and 24 bits per pixel.

Touch screen

The AccuVote-TSx is designed with a touch screen utilizing resistive touch technology. The screen will be operated by the user’s finger(s).

Language requirements

The unit will be able to support all the major languages, including, but not limited to, English, Spanish, French, German, Chinese, Korean, and Japanese.

VIBS interface

VIBS (Visually Impaired Ballot Station) provides an interface with which voters may vote on audio ballots. Every AccuVote-TSx unit is to be configured with VIBS capability. VIBS functionality is manifested with a headphone jack, allowing the voter to listen to the audio ballot by means of a set of headphones. Second, keypad input is provided, allowing the audio voter to enter the voting selection.

Ergonomic considerations

A smart card is used to identify the user to the AccuVote-TSx, and activate the unit for voting. The smart card reader must be installed at the front of the unit for ease of voter access. An electronic keyboard is

also activated on the touch screen, allowing voters to define write-in candidate names. The AccuVote-TSx may be used in a standing or seated position, as a result of raising or lowering the voting booth.

Electronic requirements

Below is an electronic block diagram of the AccuVote-TSx terminal.

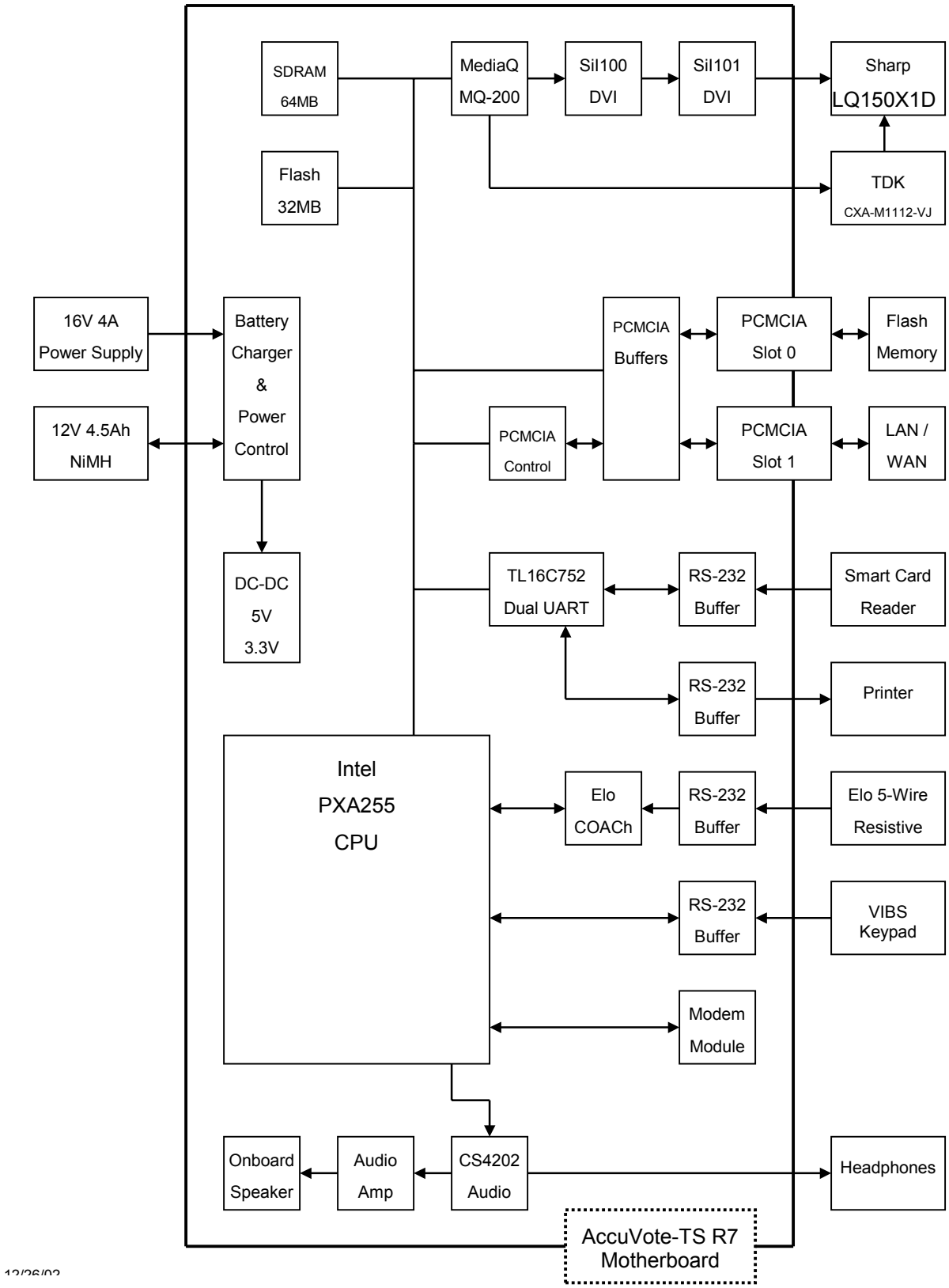

Figure 2-1. AccuVote-TSx block diagram

Operating system

The AccuVote-TSx unit is intended to operate using the Microsoft Windows CE embedded operating system.

Drivers

Diebold Election Systems, Inc. and Stellcom will design software drivers for the AccuVote-TSx modem, printer, and possibly other components.

Memory

RAM

The AccuVote-TSx will be designed with 64MB SDRAM. Future AccuVote-TSx revisions may be installed with 128MB or 256MB, depending on application needs.

Flash ROM

Federal Election Commission guidelines for DRE voting machines require election results to be stored in redundant memory, in order to assure that election results are not lost should primary storage fail. To facilitate this requirement, election data and results will be stored on both internal Flash ROM and external PCMCIA flash card. The internal Flash ROM will be used to store the application.

The initial system will have 32MBytes of Flash EEPROM. Future hardware revisions may have 64MB depending on the application's requirements.

Modem

The modem is a daughterboard type module, supported directly on the motherboard, so that a PCMCIA or other external device is not required. The modem speed will be determined, and may be between 2.4K and 56Kbaud.

Power supply

Since the AccuVote-TSx is to be used in a variety of domestic and international environments, the product must be capable of functioning with either 120V/60 Hz or 240V/50 Hz AC power.

The power supply will be integrated into the base, however an external "brick" adapter will be available for operating in a tablet-only configuration.

The system must provide sufficient standby power that the unit can be operated for at least 2 hours, preferably 4 hours, without external AC power.

Connectivity

The method of loading election data onto the AccuVote-TSx's PCMCIA Flash Card will be by means of a modem or LAN/WAN/wireless card plugged into the PCMCIA slot.

Optional accessories

VIBS interface

The VIBS option shall be available for all of the AccuVote-TSx machines.

Internal modem

The AccuVote-TSx modem is a daughterboard module that is configured at the point of manufacture.

Environmental requirements

Temperature & humidity

The AccuVote-TSx may be stored in a temperature range of -4 to 140 °F, and may be operated in a temperature range of 50 to 95°F. Humidity tolerances conform to MIL-STD-810D, Method 507.2, Procedure I-Natural Hot-Humid.

Shock & vibration

The AccuVote-TSx is able to sustain the bench handling requirements in MIL-STD-810D, Method 516.3, Procedure VI, as well as the vibration tolerances specified in MIL-STD-810D, Method 514.3, Category 1-Basic Transportation, Common Carrier.

Drop test

The AccuVote-TSx is capable of withstanding a drop from 20".

Regulatory requirements

Compliance

The unit will be UL, CSA, VDE certified and tested to meet CE and FCC EMC requirements.

Electrical Power Disturbance

The AccuVote-TSx will be able to withstand, without disruption of normal operation or loss of data, surge conditions stipulated in EN61000-4-5:1995 Severity Level 3 and EN61000-4-11: 1994.

Electrical Fast Transient

The AccuVote-TSx will be able to withstand, without disruption of normal operation or loss of data, all of the fast transients stipulated in EN61000-4-4:1995 Severity Level 2.

Lightning Surge

The AccuVote-TSx is able to withstand, without disruption of normal operation or loss of data, all of the lightning surge conditions specified in the FEC System Hardware Specifications.

Electrostatic Disruption

The AccuVote-TSx will be able to withstand ±15 kV air discharge and ±8 kV contact discharge without damage or loss of data.

Electromagnetic Radiation

The AccuVote-TSx will comply with the Rules and Regulations of the Federal Communications Commission, Part 15, Class B requirements for both radiated and conducted emissions.

Electromagnetic Susceptibility

The AccuVote-TSx will be able to withstand an electromagnetic 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.

Conducted RF Immunity

The AccuVote-TSx will be able to withstand, without disruption of normal operation or loss of data, conducted RF energy of 10V AC & DC power, and 10V, 20 sig/control >3m.

Magnetic Fields Immunity

The AccuVote-TSx will be able to withstand, without disruption of normal operation or loss of data, AC magnetic fields of 30 A/m at 60 Hz.

Qualification testing

Diebold Election Systems, Inc. will be responsible for conducting qualification testing on a prototype unit to verify that the required specifications have been met.

Servicing requirements

The AccuVote-TSx will be designed for easy removal and replacement of the key components and assemblies for repair and replacement purposes.

A keyboard port is to be provided with the terminal to simplify the technician's operation of the system.

Interfaces

The AccuVote-TSx motherboard interfaces with the:

- power
- battery
- LCD
- inverter for the LCD
- touch screen
- printer
- smart card reader
- VIBS keypad
- VIBS headphones
- modem
- PCMCIA (2)

2.2.1.2.2. Software structure

Election-related functionality, including voting, is provided by the Ballot Station firmware, which runs exclusively on the AccuVote-TSx, in a Windows CE environment. No other software application is present on the AccuVote-TSx, and no access to the operating system or physical device is provided, other than by means of the Ballot Station firmware.

The Ballot Station firmware offers five basic modes of operation:

- Download
- Pre-Election Testing Mode
- Election Mode
- Post Election Mode
- Supervisor Functions

These modes are entered according to the status of the election on the memory card, or the presence of a Supervisor card in the smart card reader at startup.

The main window for every usage mode indicates the name of the mode, the name and date of the election, the name and identifier of the vote center, the number of ballots cast on the system for the election (public counter), the serial number of the machine, the system total counter (protected counter), and the status of the backup battery.

Download Mode

This is entered if no election exists on the memory card. The download module allows the user to download data onto one or more memory card. This mode also allows the user to configure the communications method to be used when communicating with the GEMS host computer. Election data is stored on a removable memory card.

Pre-Election Testing

This mode is entered when the memory card installed on the AccuVote-TSx is in Pre-Election Testing Mode, which is the mode a memory card is in when first downloaded. Pre-Election Testing Mode allows the election administrator to perform a variety of tests on the election data to validate the data prior to the election. These functions include the following:

Test Count

Test Count is used to perform a variety of Test Counts to verify the ballot data is correct. These tests include the following sub-tests:

Count Test

This allows voting and casting of ballots in an identical manner as to what is used in the Election Mode, in order to verify that votes are being counted and tallied on ballots as expected. Test counting options include:

- Not Using Voter Card
- Logic and Accuracy Test

'Not Using Voter Card' allows the operator to vote ballots without have to use individually programmed voter access cards. A precinct and party combination must be selected prior to voting the ballot. It is not necessary to select the precinct and party combination if voter access cards are used to vote test ballots.

Logic and Accuracy Test options include the Manual Logic and Accuracy Test as well as an Automatic Logic and Accuracy Test. The Automatic Logic and Accuracy Test is configured with one ballot with the first candidate in every race selected, two ballots with the second candidate in every race selected, three ballots with the third candidate selected, and so on. The Manual Logic and Accuracy Test, on the other, generates the same iterations of ballots as the Automatic Logic and Accuracy Test, however, the operator manually determines the voting positions assigned, rather than the first, second, third, and so on voting position being automatically assigned.

View Ballot Results

This function allows the tester to view the ballots that have been cast on the system. This is primarily used to verify the results from testing. A list of ballots cast is displayed, from which the operator may select a specific ballot, for which candidate selections are then displayed by race. Ballots are listed with a randomized ballot serial number, GEMS ballot Id, base precinct label, and in Pre-Election Testing Mode only, the sequence in which the ballot was cast.

Create Voter Card

The Create Voter Card function is used to create voter access cards for use in voting test ballots, or master voter access cards to be used with the Voter Card Encoder at the polls. Every voter access card is created for a particular base precinct and party combination – N.P. in case of a general election – as well as with ballot presentation options, such as Challenge, Challenge Id, Magnify, VIBS, and Hide Ballot.

Reporting

The AccuVote-TSx may print either Election Totals or Zero Totals reports; Zero Totals reports are printed prior to voting, and Election Totals reports are printed once voting has ended. Reports may be printed with the following options:

- in summary form or broken down by precinct
- in short or long format
- with or without write-in candidate names
- with or without cross-endorsed candidate detail

Transfer Results

The Transfer Results function is used to transfer the results from the AccuVote-TSx to GEMS. As with the download function, the user can modify the method of transferring the results to GEMS.

Results Accumulator

The Results Accumulator function allows for the accumulation of election results from multiple memory cards to a single Accumulator AccuVote-TSx unit. The Accumulator has the following sub-functions;

Load

This functions is used to load results onto the unit; in order to load results, insert the memory card to be loaded onto the unit, then press the Load button. Results may only be loaded for the same election/votecenter.

Delete

This is used to delete the selected results from the system.

Reporting

Accumulated results may be printed from the Results Accumulator function in the form of the Accumulated Totals report.

Transfer Results

This function is used to transfer all the results that have been loaded onto the system.

Clear Totals

This function is used to clear the election results from the system. Results are archived before deletion so they can be restored, if necessary.

Set For Election

This function sets the memory card to Election Mode. Once the memory card has been set to Election Mode, the AccuVote-TSx installed with the memory card will automatically appear in Election Mode upon reboot.

Election Mode

When an AccuVote-TSx is booted with a memory card installed in Election Mode, the Results Reporting function is automatically displayed prior to any ballots having been cast. At this point, the Zero Total report is printed, listing all candidate totals as 0. Since voting may be temporarily halted, then restarted, at any point in the voting process, as would be required in an early voting environment, the AccuVote-TSx may be powered on in Election Mode with ballots already cast, in which case the Results Reporting window does not appear.

Once the Zero Totals report has been printed, the AccuVote-TSx displays a screen prompting the voter to insert a voter access card. Once the voter access card has been inserted into the smart card reader, the ballot will be displayed on the unit corresponding to the precinct and party for which the card was created. If the election is configured with multiple languages, the voter selects the language of choice prior to voting.

Once the voter has finished voting the ballot, selections may be reviewed in the ballot review screen, and selections altered either by paging back into the body of the ballot, or touching the race on the ballot review screen for which selections are to change. Once the ballot is cast, the voter access card is ejected from the smart card reader, whereupon the voter returns the card to the designated pollworker.

It is not possible at this point to reuse the voter access card until it has been re-initialized for the next voter.

At election close, an authorized pollworker inserts a Supervisor card into the smart card reader, in tandem with a Supervisor password. The pollworker responds appropriately to a prompt asking whether the election is being ended, or the system shut down. Chosing to end the election allows the Election Totals report to be printed. Once the report has been printed, the memory card is automatically set to Post-Election Mode.

Post Election Mode

The following functions are available in Post-Election Mode:

- Results Reporting
- Transfer Results

- Accumulator

Supervisor Mode

Supervisor Mode by accessed by inserting a Supervisor card in tandem with the entry of a Supervisor password into the AccuVote-TSx smart card reader either prior to inserting a memory card or with a blank memory card installed, in Post-Election Mode, or in Post-Election Mode. Supervisor Mode is not accessible in Election Mode. The functions available in the supervisor mode depend on the state of the election. They include the following:

Challenged Voters

This function displays a list of ballots that are marked as challenged. Challenge ballots may be either accepted or rejected; no challenge ballots are included in Election Totals reports until they have been acepted.

View Ballot Results

See View Ballot Results in the Pre-Election mode.

Audit

This displays the audit information for the election. All election transactions, including ballot casting, are recorded in the audit log. The log can be viewed on the touch screen, or may be printed to the AccuVote-TSx's thermal printer.

Reset to Pre-Election

This function allows the memory card to be set to the Post-Election Mode. Prior to resetting the memory card, an Election Totals report is printed, then election results are cleared. Cleared results are automatically archived. This function is only available when the election is in Post-Election Mode.

Delete Election

This function is used to delete the current election. The election is archived prior to deletion.

Election Archives

This function is used to manage the election archives. It allows the user to restore elections, purge elections, restore results, and purge results.

System Setup

The setup function allows the user to set machine related options. In particular the following items can be defined:

MachineSN: This is the machine serial number and is recorded in the audit log when the system starts up, and is printed on all results reports.

Smart Card: This is the port the smart card is connected to.

Printer Port: This is the printer port the printer is connected to.

System Directory: This is the directory where system files reside.

Main Directory: This is the directory for the removable election media.

Backup Directory: This is the directory for the backup results files.

Network: Network-related configuration information may be defined in this function.

Calibration: This function allows the touch screen to be calibrated.

Date: This allows the user to set the system date.

The system Diagnostics are also accessed from the Setup function. The Diagnostics include the following options:

Test Printer: This allows the printer to be tested. The output to the printer is a 'barber pole' pattern of characters.

Test Serial Port: This allows testing of the systems serial ports, requiring a loopback connector to be plugged into the unit's serial port. If hardware flow control is specified, then the loopback connector must include the hardware control lines.

Test Card Reader: This is used to test the smart card reader. It performs the test by writing and reading a pattern of characters to the smart card. This will erase all the data on the smart card.

2.2.1.2.3. Communications structure

AccuVote-TSx units are capable of communicating with other AccuVote-TSx units as well as with the GEMS host computer. The AccuVote-TSx may transmit data either by wireless or wireline modem, local area network, or directly, over a RAS connection.

The AccuVote-TSx communicates with the GEMS host computer in order for memory cards to be programmed once ballot artwork has been completed. Once the election has ended, results from individual AccuVote-TSx units are accumulated to a single Accumulator AccuVote-TSx unit at the polling location, and following the completion of accumulation, results are uploaded to the GEMS host computer. The AccuVote-TSx functions on a strictly stand-alone basis in the course of voting.

Memory card programming is conventionally performed over a local area network, the GEMS host computer being connected to one or more AccuVote-TSx units over a hub. Vote center/machine Id combinations are queued on the AccuVote-TS Server v2 console in GEMS, and downloaded to memory cards installed in one of the AccuVote-TSx units designated for memory card programming.

Results accumulation is performed at polling locations featuring more than one AccuVote-TSx unit. Accumulation may be performed using wireline or wireless transmission. In order to perform wireline-based accumulation, memory cards are removed from all AccuVote-TSx units at the polling location, physically installed on a one-by-one basis into the PCMCIA slot of the Accumulator AccuVote-TSx unit, and loaded into the Results Accumulator. In order to perform wireless accumulation, a wireless modem card must be installed in each AccuVote-TSx prior to accumulation. Initiating the loading function on the Accumulator unit automatically accumulates results from all active units at the polling location.

Results uploading to the GEMS host computer may be performed by modem from the polls, or memory cards returned to election central for uploading over a local area network. Uploading from the polling location involves connecting a telephone cable to the Accumulator AccuVote-TSx unit, then uploading accumulated results to the host computer. Once results have successfully been uploaded, all of the vote center's memory cards listed in the AccuVote-TS Server v2 console are tagged as uploaded.

Memory cards returned to election central for uploading, on the other hand, are installed in an AccuVote-TSx unit designated for results uploading, installed in local area network configuration with the GEMS host computer. Every successfully uploaded memory card is marked in the AccuVote-TS Server v2 console as uploaded.

2.2.1.3. Theory of operation

A theory of operation that explains each system function, and how the function is achieved in the design.

The theory of operation of the AccuVote-TSx that explains each system function is described in section *2.2.1.2 Operational environment* in this document.

2.2.1.4. Functional and physical interfaces

Descriptions of the functional and physical interfaces between subsystems and components.

2.2.1.4.1. Firmware

This section describes functional relationships within the Ballot Station firmware.

Ballot Station firmware components are detailed in section *2.2.1.2.2 Software structure* in this document.

Each of the major functional areas of the Ballot Station firmware are designed to operate in sequence:

1. Once a memory card has been programmed, it is set to Pre-Election Testing Mode,
2. Once a memory card has been tested, it is set to Election Mode, and
3. Once the election has been ended, the card is automatically set to Post-Election Mode.

It is possible to alter the natural sequence of Ballot Station operating modes by resetting a memory card from Post-Election Mode to Pre-Election Testing Mode. Furthermore, while the configuration of Election Mode requires that a Zero Total report first be printed, votes to be cast during election day, then the election to be ended, before the Election Totals report is printed with election results tallies, individual functions available in Pre-Election Testing and Post-Election Modes may be selected in random order for optimal flexibility. However, these functions must be executed under strict procedural scrutiny in order to assure that election configuration proceeds correctly.

2.2.1.4.2. Operating system

This section describes functional relationships between system components and the operating system.

- *Display*: Interactive data display is done via an LCD display. The interface between the software and the physical display is done via Microsoft's Display Context API.
- *User Input*: The primary user input is done via the touch screen. The interface between the software and the physical touch screen is done via Microsoft's mouse interface.
- *Communications with GEMS*: Communications with GEMS, both download and upload, is done via network sockets using TCP/IP. The physical connection is usually done using a PPP connection over a serial connection, either via a direct serial port connection or a modem connection.
- *Persistent Storage:* Election data, audit, and ballot results are stored in persistent storage, which may be internal or removable. The interface with the persistent storage is via Microsoft's file system API.
- *Printer:* The printer in the system is accessed via its associated parallel port using Microsoft's file API's.

Utilizing Microsoft's Win32 API's, whether directly or through MFC objects, reduces the software's dependency on the particular hardware, and therefore makes it more portable.

2.2.1.4.3. Device components

This section describes functional relationships within hardware components of the AccuVote-TSx.

1. *Printer*: The processor communicates with the printer over a serial RS232 interface via external UART.
2. *Smart card*: The processor communicates with the smart card reader over a serial RS232 interface via external UART.
3. *Audio*: An AC 97 digital interface presents AC 97 compliant Codec output to the headphone jack and amplifier for speaker.
4. *Video*: The processor bus communicates via a Graphics Engine to a DVI transmitter/receiver pair, then on to the LCD TFT display.
5. *PCMCIA*: The processor communicates with the PCMCIA connectors directly via a processor interface.
6. *VIBS Keypad*: The processor communicates with the VIBS keypad over a serial RS232 interface via external UART.

7. *Touch screen*: The processor communicates with the touch screen over a serial RS232 interface via external UART.
8. *Modem*: The processor communicates with the modem over a serial RS232 interface via external UART.
9. *RAM Memory*: RAM memory communicates directly with the processor bus.
10. *Persistent Storage*: Persistent storage consists of NOR technology, and is connected directly to the processor bus.
11. *Real-Time Clock*: The real-time clock connects directly to the processor via the Synchronous Serial bus interface.
12. *System Power Management*: System Power Management connects directly to the processor via Inter-Integrated Circuit interface emulating a System Management bus (SMBus) protocol.

2.2.1.5. COTS hardware/software

Identification of all COTS hardware and software products and communications services used in the development and/or operation of the voting system, identifying the name, vendor and version used for each such component, including:

a. Operating systems;
b. Database software;
c. Communications routers;
d. Modem drivers; and
e. Dial-up networking software;

COTS hardware and software products used in the AccuVote-TSx include the following:

- Windows CE operating system
- Sharp TFT LCD LQ150X1DG11
- ELO LCD Panelmount touchmonitor 1567L
- TDK DC AC connector (inverter for display backlight)
- Socket Communication ethernet PCMCIA card 8510-00093C with CF to PCMCIA adapter 8520-00025
- Wireless LAN card Orinoco/Proxim PCMCIA Card
- Sankyo smart card reader Model ICM0A0-0130
- AT Flash Card (election media) Sandisk Industrial grade (Part# SDP3B-128-101-80 for the 128MB card)
- Headphones
- Printer engine Citizen MLT-289

The specifications sheets for all off-the-shelf hardware components used in the AccuVote-TSx are listed in *Appendix H: Component Specifications* of the *AccuVote-TSx Technical Data Package*.

2.2.1.6. Interfaces

Interfaces among internal components, and interfaces with external systems. For components that interface with other components for which multiple products may be used, the TDP shall provide an identification of:

a. File specifications, data objects, or other means used for information exchange; and
b. The public standard used for such file specifications, data objects, or other means

Response to this section is addressed in section *2.2.1.4 Functional and physical interfaces* in this document.

2.2.1.7. Directory listings

Benchmark directory listings for all software (including firmware elements) and associated documentation included in the vendor's release in order of how each piece of software would normally be installed upon setup and installation.

The AccuVote-TSx is operated exclusively using the Ballot Station firmware, which operates over the Windows CE operating system. Installation of the system boot loader, operating system, and firmware are the domain of Diebold Election Systems, Inc.; no software installation or upgrading will be required by the client jurisdiction upon receipt from Diebold Election Systems, Inc.

Bootloader, operating system, and firmware installation and upgrade are performed with the installation of an upgrade PCMCIA card and the execution of several simple commands driven from the touch screen. These activities are to be performed only by qualified technical staff, with the approval of Diebold Election Systems, Inc. Firmware installation and upgrading instructions are described in *Appendix D: System Acquisition and Installation* in the *AccuVote-TSx Hardware Guide*.

2.2.2. System Performance

The vendor shall provide system performance information that includes descriptions of:

a. The performance characteristics of each operating mode and function in terms of expected and maximum speed, throughput capacity, maximum volume (maximum number of voting positions and maximum number of ballot styles supported), and processing frequency;

b. Quality attributes such as reliability, maintainability, availability, usability, and portability;

c. Provisions for safety, security, privacy, and continuity of operation; and

d. Design constraints, applicable standards, and compatibility requirements.

2.2.2.1. Performance characteristics

The performance characteristics of each operating mode and function in terms of expected and maximum speed, throughput capacity, maximum volume (maximum number of voting positions and maximum number of ballot styles supported), and processing frequency.

2.2.2.1.1. Speed

The AccuVote-TSx operates at a speed sufficient to respond to any operator and voter input without perceptible delay. The AccuVote-TSx incorporates an Intel Xscale microprocessor that operates at 265MHz.

2.2.2.1.2. Throughput

Transaction throughput on the AccuVote-TSx will vary according to the activity being performed. Typical AccuVote-TSx transactions are listed with expected processing time:

1. *Memory card programming*: The time taken for memory card programming varies, depending on the type of transmission connection between the GEMS host computer and the AccuVote-TSx, as well as the number of precincts, races, and candidates on the memory card.
2. *Ballot activation*: The amount of time take in ballot activation, namely the time from the insertion of the voter access card to the presentation of the instructions to vote screen, will be about 2 seconds. Ballot activation time is not dependent on ballot size.

3. *Touch screen response*: Irrespective of the activity performed, the touch screen will respond to user input in no more than 3 seconds.
4. *Voting*: The amount of time taken to vote the ballot will depend on the number of races, candidates, and responses on the ballot, the amount of race text present in each race, and is determined by the voter.
5. *Ballot casting*: Ballot casting occurs at an average speed of two seconds. The amount of time taken to cast a ballot is not dependent on race content, language, or audio usage.
6. *Printing reports*: The amount of time taken to print a Zero Total or Election Totals report depends on the number of precincts, races, candidates, and responses on the memory card, as well as the options with which the report is being printed.
7. *Audit report printing*: The amount of time taken to print the Audit report depends on the number of transactions present in the audit report.
8. *Results accumulation*: The amount of time taken for results accumulation varies according the number of ballots on a memory card, as well as the amount of information on individual ballots.
9. *Results uploading*: The time taken for memory card uploading varies, depending on the type of connection between the GEMS host computer and the AccuVote-TSx, as well as the number of precincts, ballots, races, and candidates on the memory card.

2.2.2.1.3. Volume

The AccuVote-TSx has been designed to withstand normal use without deterioration and without excessive maintenance cost for a period of ten years, as specified in section *2.4.4.2 Durability* in the AccuVote-TSx System Hardware Specifications.

2.2.2.1.4. Processing frequency

For information on processing frequency, see section *2.2.2.1.2 Throughput* in this document.

2.2.2.2. Quality

Quality attributes such as reliability, maintainability, availability, usability, and portability.

2.2.2.2.1. Reliability

See section *2.4.4.3 Reliability* in the *AccuVote-TSx System Hardware Specifications* for information concerning AccuVote-TSx reliability.

2.2.2.2.2. Maintainability

See section *2.4.4.4 Maintainability* in the *AccuVote-TSx System Hardware Specifications* for information concerning AccuVote-TSx maintainability.

2.2.2.2.3. Availability

See section *2.4.4.5 Availability* in the *AccuVote-TSx System Hardware Specifications* for information concerning AccuVote-TSx availability.

2.2.2.2.4. Usability

See section *2.4.5 Design and Construction* in the *AccuVote-TSx System Hardware Specifications* for information concerning AccuVote-TSx usability.

2.2.2.2.5. Portability

See section *2.4.5 Design and Construction* in the *AccuVote-TSx System Hardware Specifications* for information concerning AccuVote-TSx portability.

Since the combined tablet and base weigh 25lbs., and the tablet itself weighs only 10lbs, the AccuVote-TSx is quite portable, allowing for easy delivery to and from the warehouse, delivery to and from the from the polling locations, as well as installation at the polling places. Tablets may also easily be delivered to mobility challenged voters.

2.2.2.3. Provisions

Provisions for safety, security, privacy, and continuity of operation.

2.2.2.3.1. Safety

See sections *2.4.4.8 Safety* and *2.4.5.4 Safety* in the *AccuVote-TSx System Hardware Specifications*.

2.2.2.3.2. Security

For information on AccuVote-TSx security, see:

- *AccuVote-TSx System Security Specifications*
- section *2.3.2.1 Security* in the *AccuVote-TSx System Functionality Description*
- section *2.3.2.5.2 Operational requirements* in the *AccuVote-TSx System Functionality Description*

2.2.2.3.3. Privacy

The folding privacy panels built in to the AccuVote-TSx base provide an appropriate degree of privacy to the voter.

Audio voters are provided the option of voting with or without the visual ballot; voting without the visual ballot prevents any observation of ballot selections while audio voting is in progress.

2.2.2.3.4. Operational continuity

The AccuVote-TSx units operates problem free for the lifetime of the unit with correct AC power supplied. In the absence of AC power, the unit's Nickel Metal-Hidride battery allows 2 to 4 hours of continuous operation in case of AC power failure.

2.2.2.4. Additional considerations

Design constraints, applicable standards, and compatibility requirements.

2.2.2.4.1. Design constraints

AccuVote-TSx design is constrained by cost limitations determined by a reasonable market price, as well as the technological limitations of the components that comprise the unit. These constraints affect the capabilities offered by the individual components as well as component lifetime. These constraints are described in the *AccuVote-TSx System Hardware Specifications*, primarily in sections

- *2.4.2.2 Environmental requirements*
- *2.4.2.6.2 DRE System Processing Requirements*
- *2.4.4.3 Reliability*
- *2.4.4.4 Maintainability*

- *2.4.4.5 Availability*

2.2.2.4.2. Applicable standards

Hardware

Standards for AccuVote-TSx design are set out in *Appendix I: Configuration Management* in the AccuVote-TSx Technical Data Package.

Software

This section describes, or provides reference to, all standards or other documents that influenced the implementation policy, the approach, and the coding of the Ballot Station software.

Development methodology references and guidelines include the following:

- Rapid Application Development, by James Martin, 1991
- Software Engineering Methods, Management and CASE Tools, by Jag Sodhi, 1991

The software was written and is maintained by a small software development team. As such, much of the influence over the implementation policy, the approach, and the coding of the software has been directed by the programming experience of these individuals. Software engineering principles at Diebold Election Systems, Inc. are based on 'Fundamentals of Software Engineering', by Ghezzi, Jazayeri, and Mandrioli, 1991 Prentice-Hall.

Section *4 Software Standards* of the 2002 *Voting Systems Performance and Test Standards* provide the basis for the GEMS software design standards.

Diebold Election Systems, Inc. coding and style guidelines are detailed in *Appendix A: C++ Coding Style* in the Ballot Station Technical Data Package . This document is the basis for consistency and modularity in software developed at Diebold Election Systems.

Diebold Election Systems, Inc. uses CVS (concurrent Version System) for source code control. CVS maintains a repository for the source code that allows multiple developers to checkout, modify, merge and commit their work. The CVS repository keeps a complete history of all changes along with logs of what those changes were. Comments documenting changes, enhancements and bug fixes are to be generated when the modified programs are committed to the repository and not entered in the source code itself.

CVS is also used for software configuration management. When a release version of the software is prepared by the release engineer, that release is tagged with its release number in the CVS repository. This enables the release engineer or any developer to re-build any release with the same source code as the original release was made with.

All bugs reported prior to a software release are repaired, the repairs tested with software pre-releases by the Diebold Election Systems, Inc. Quality Control Department, and detailed in the subsequent software release's readme file. Software testing proceeds according to the standards established in:

- *Appendix B1: Test Standards*
- *Appendix B2: Test Log*
- *Appendix B3: Test Incident Report*
- *Appendix B4: Sample Test Procedure*
- *Appendix B5: Sample Test Plan*
- *Appendix E1: Test Plan Pre-Election Mode*
- *Appendix E2: Test Plan Election Mode*
- *Appendix E3: Test Plan Post-Election Mode*
- *Appendix E4: Test Plan Supervisor Test Procedure*

- *Appendix F: Acceptance Test Specifications*

in the Ballot Station Technical Data Package.

2.2.2.4.3. Compatibility requirements

The AccuVote-TSx offers the following in terms of compatibility:

1. Usage of the AccuVote-TSx is compatible with the needs of the contemporary voting population, in particular, the needs of voters with mobility, dexterity, or visual impairments.
2. Usage of the AccuVote-TSx is compatible with voting populations wishing to vote in languages other than English.
3. AccuVote-TSx design is compatible with the requirements of the Federal Election Commission's 2002 *Voting Systems Performance and Test Standards*.
4. Usage of the AccuVote-TSx is compatible with adminstrative requirements of electoral jurisdictions.
5. The Ballot Station firmware's functionality is compatible with the election management requirements of electoral jurisdictions.
6. The AccuVote-TSx's physical characteristics are compatible with the physical capabilities of election workers.
7. AccuVote-TSx design is compatible with cost-effect quality control policy, both at the point of manufacture, as well as in the client jurisdiction.