Operations Manual

For Validator 3 Product

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CUBIC
Transportation Systems

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The Cubic Validator-3 (FCC ID LVCVAL3LTE and IC ID 4387A-VAL3LTE) contains FCC IDs: LVCTR04, VPYLBEE5HY1MW and RI7LE910CXNF.
It contains IC IDs: 4387A-TR04, 772C-LBEE5HY1MW and 5131A-LE910CXNF.

FEDERAL COMMUNICATIONS COMMISSION NOTICES

The following Federal Communications Commission (FCC) notices apply:

1. The user is cautioned that changes or modifications to the Validator 3 that are not expressly approved by Cubic could void the user's authority to operate this equipment.

2. “NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference won’t occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
Reorient or relocate the receiving antenna.
Increase the separation between the equipment and the receiver.
Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
Consult the dealer or an experienced radio/TV technician for help.”

2a. “Cet équipement a été testé et déclaré conforme aux limites d'un appareil numérique de classe B, conformément à la partie 15 des règles de la FCC. Ces limites sont conçues pour fournir une protection raisonnable contre les interférences nuisibles dans une installation résidentielle. Cet équipement génère des utilisations et peut émettre de l'énergie de radiofréquence et, s'il n'est pas installé et utilisé conformément aux instructions, peut causer des interférences nuisibles aux communications radio. Cependant, il n'y a aucune garantie que des interférences ne se produiront pas dans une installation particulière. Si cet équipement cause des interférences nuisibles à la réception radio ou télévision, ce qui peut être déterminé en éteignant et en rallumant l'équipement, l'utilisateur est encouragé à essayer de corriger l'interférence par l'une des mesures suivantes :
- Réorientez ou déplacez l'antenne de réception.
- Augmenter la distance entre l'équipement et le récepteur.

- Branchez l'équipement sur une prise d'un circuit différent de celui sur lequel le récepteur est branché.
- Consultez le revendeur ou un technicien radio/TV expérimenté pour obtenir de l'aide."

3. "This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation."

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Acronyms and Abbreviations

BLE	Bluetooth Low Energy
Cubic	Cubic Transportation Systems, Inc.
CPU	Central Processing Unit
CSC	Contactless Smart Card
D-PAS	Discover Payment Application Specification
EMV	Europay, MasterCard, Visa
ISO	International Organization for Standards
LCD	Liquid Crystal Display
MAC	Message Authentication Code
MCBF	Mean Cycles Between Failures
PCI	Payment Card Industry
PCI PTS	Payment Card Industry PIN Transaction Security
PMU	Power Management Unit
RAM	Random Access Memory
RTC	Real Time Clock
SD	Secure Digital
SDRAM	Synchronous Dynamic Random-Access Memory
SRED	Secure Reading and Exchange of Data
TCH	Transit Control Head
USB	Universal Serial Bus
VDC	Volts, direct current
VLU	Vehicle Logic Unit

1. INTRODUCTION

This manual provides operation procedures for the Validator 3 product. It is intended for use by authorized transit personnel and contains equipment descriptions, operational instructions, and preventive maintenance procedures.

1.1 SAFETY

Throughout this manual WARNING, CAUTION and NOTE graphics are used to highlight areas where special attention must be used. Warnings and Cautions are used to highlight procedures or activities that may cause injury or death to personnel and possible damage to equipment. Notes are used to provide special instructions and clarification for procedures. Examples of each graphic are provided below.

WARNING

Operating procedures or practices cited to prevent the following operational or maintenance procedural step from causing serious injury or loss of life.

CAUTION

Operation procedures or practices cited to prevent the following operational or maintenance procedural step from causing injury to personnel or damage to equipment.

NOTE

An amplifying or explanatory comment related to procedural steps or text.

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2. FUNCTIONAL DESCRIPTION

This chapter provides detailed information on the validator features and function.

2.1 VALIDATOR

Customers seeking to board a vehicle pay their fare by simply presenting contactless media at the validator, shown in **Figure 2-1.** The location on the validator where the customer presents their media is instantly recognizable with graphics and messaging shown on the display. The customer can either tap or bring the media close to the display for processing.

Figure 2-1.Validator

Depending on the media type presented, the validator begins reading when the contactless media is approximately 1.9 inches from the display. When the media has been successfully read, the display on the validator provides a visual indication that the media has been read successfully.

Upon a successful read, all authentication and local validation actions are performed automatically by the validator.

The validator contains a Point of Interaction (POI) device that is a highly secure Level 1/Level 2 compliant contactless payment reader for the processing of open loop contactless payment media and closed loop proximity smart cards.

The device can read and process a wide variety of International Organization for Standards (ISO) 14443 compliant smartcards and portable devices employing Near Field Communications (NFC) technology such as NFC phones and smart wearables.

The validator components include the following:

- Liquid crystal display (LCD)
- A fast, low power central processing unit (CPU)
- Synchronous dynamic random-access memory (SDRAM)
- Flash memory
- Serial input/output (I/O) port
- Battery

- Audio and speaker module
- Universal Serial Bus (USB) interfaces
- Ethernet port interface
- Bluetooth® interface

The validator uses the Linux operating system and can be installed in several types of station level equipment.

2.1.1 User Interface

The user interface is the traveler presenting media and the device giving an audio and visual response. The components involved are the display, the POI device and the audio output.

2.1.1.1 Display

The display provides full graphic screens that include information and transaction feedback to the Traveler. In addition, it is also capable of displaying video files. See **Figure 2-2**. Display features include:

- Integrated 5-inch full color, sunlight-readable display.
- Visible across all normal lighting conditions, including day and night operation.
- Visual indicator to designate the presentation area and the transaction results, as well as messages such as an indication of a valid tap or of a low account balance.
- LCD transmissive mode display, viewable from 0 to 45 degrees on either side.
- Variable brightness and backlighting under software control. The design includes using ambient light data from a sensor to control the brightness level so that it is appropriate for the environment.

Figure 2-2. Validator Display

2.1.1.2 POI Device

The POI device is a secure contactless card reader that provides the Traveler interface for transacting with smart media.

It supports card initialization (wake-up), anti-collision, authentication, media selection, and read/write functions for the following media types:

- EMV approved contactless payment cards

- MasterCard® M/Chip
- Visa® Contactless Payment Specification (VCPS)
- American Express® ExpressPay
- Discover® Network (D-PAS)
- MIFARE DESFire™ EV1, EV2
- MIFARE Classic™
- MIFARE Ultralight C™, MIFARE Ultralight™
- MIFARE Plus™

2.1.1.3 Audio Output

The validator has one speaker below the center of validator which plays audio tones corresponding to valid and invalid taps.

Characteristics of the audio interface include the following:

- One weather-resistant speaker emits audio tones or voice instructions using wav resource files.
- Tone frequency and duration is software configurable through substitution of audio resource files.
- Audio volume is software adjustable and is capable of 70dB at maximum from 1 meter away.

The validator can communicate with an existing vehicle logic unit (VLU) / Transit Control Head (TCH) using the available connectivity, like Ethernet RJ-45.

2.1.2 Device Communications

The device sends and receives information through ports and wireless communication.

2.1.2.1 Ethernet

The validator provides an RJ-45 connection for provision of 10/100/1000 Base-T Ethernet. Ethernet is routed from the host device through the Personality Module to the POI device. Within the Personality Module, any power from a power over Ethernet supply is taken off before passing the Ethernet signals to the POI device via an adapter cable.

2.1.2.2 Bluetooth

Bluetooth connectivity is provided for configuration and diagnostics. The validator supports:

- Bluetooth 5
- Bluetooth Low Energy (BLE)

2.1.2.3 Serial

The validator provides a serial output via RS-485.

2.1.2.4 USB

The validator has two internal USB 2.0 connectors, which are intended for use during setup, maintenance and are not available while pole mounted.

2.1.3 Power Management

The Power Management Unit (PMU) is a logical component that performs all power monitoring, conditioning and control within the validator. The validator further filters and fuses the onboard power and provides a surge protection circuit in case of unwanted spikes in voltage.

Validator power is derived from the onboard power system of the bus battery. Voltage can range from 8 to 36 Volts, direct current (VDC) nominally, while during some ignition or cold start events there may be transients of up to 60V. The validator is designed to run in the above range as well as handle any voltage spikes that may occur.

2.1.3.1 Battery

The Validator contains 2 super-capacitors which provide sufficient hold-up to allow for a safe shutdown during unexpected power loss.

A lithium coin cell is used within the validator for Real Time Clock (RTC) power.

The persistent data (e.g., audit registers) is saved to the flash, which theoretically has unlimited storage duration when powered down. The keys and RTC are backed up by the lithium coin cell battery.

The validator monitors the coin cell battery voltage. If the voltage falls under a warning threshold, a coin cell battery low event is generated to indicate that the coin cell battery needs to be replaced.

2.1.3.2 Power Loss

To protect the validator against corruption during a period of power loss, the validator includes supercapacitors that hold power for 5 seconds. A microcontroller monitors external power to ensure the device is aware of the power failure and able to power down safely. After a main power loss, the validator powers down under 5 seconds.

2.1.4 Software Design

The validator application software implements the following tasks:

- Business rules
- Back Office connectivity
- User interface
- Configuration

The validator calculates the required fare, deducts the correct fare from the stored value or stored rides on the card, and re-encodes the remaining value or number of rides to the card. If a transit pass is on the card, the Validator validates the transit pass and re-encodes the usage information on the card.

Transactions are stored in the unit and transmitted to the Back Office. The customer is immediately notified of fare status via the display and audible alerts.

The validators receive date/time synchronization on a regular basis from the Back Office to which it communicated with in real time via Ethernet or Wi-Fi. The validator also receives the appropriate software configuration from the Back Office.

2.1.4.1 Transaction Records and Storage

The validator generates and stores transaction records for each transaction performed and can store at least 30 days of payment transactions and risk mitigation lists. In the event of communications failure, transaction data is held in non-volatile flash until communications are restored and the data is uploaded to the Back

Office. Critical transaction data is also duplicated on a Secure Digital (SD) card which can be put in another device in the repair shop to send data in the event of communication failures.

2.1.5 Security

The validator is capable of being certified as a component of Payment Card Industry PIN Transaction Security (PCI PTS) –POI 5.0. The external interface compliant with the PCI PTS provides transaction encryption and key management protocols. The following features of the validator are designed to meet compliance with the PCI PTS.

- Remotely applies operating system patches.
- Destroys Contactless Smart Card (CSC) keys when the reader enclosure is opened. Note that the validator contains the reader module (POI device), which contains the CSC keys. When this reader module is opened, the keys are lost. To open it, you first must remove it completely from the validator. Simply removing the rear cover of the validator does not destroy the keys.
- Prevents any unauthorized access to the transaction data.
- Does not store/transmit/display/print any sensitive data including, but not limited to, personal account numbers.
- Only installs software from the Back Office when that software has Message Authentication Code (MAC) that verifies immediately prior to the installation.

2.1.5.1 Software and Configuration Updates

The validator software, as well as configuration, is downloaded from the Back Office. The software and configuration updates have version numbers as well as effective dates and times. The devices verify the integrity of the downloaded package before proceeding with the upgrade. An upgrade can either be immediate or based on an effective date and time.

2.1.6 Specifications

This section shows the design specifications of the Validator 3.

2.1.6.1 Physical Design

The physical design of the validator is:

- Dimensions—Width 6.88-inches, height 9.05-inches
- Depth— validator only 3.9-inches
- Weight—3.3 lbs. (The pole mount weighs 1.1 lbs.)

2.1.6.2 Processor

- Processor: Quad Core 1 GHz Cortex

2.1.6.3 Memory and Storage

- System memory consists of:
  - Random Access Memory (RAM): 2 gigabytes
  - Storage 32 gigabytes with 16 gigabytes available at a time (A/B side)
- Expansion Memory:

— Expansion port 2 USB 2.0 (not available while pole mounted) Serial RS232/RS485 (software selectable); Micro SD card for additional memory capacity

2.1.6.4 Temperature and Humidity

The temperature and humidity design targets are:

- Humidity range of 10 to 97 percent, non-condensing relative humidity
- Temperature range of -16.6 °F to 149 °F operating with solar load from direct sunlight through bus window and -22 °F to 176 °F storage

2.1.6.5 Startup Time

Cold boot—From application of power to validator ready is less than two minutes.

2.1.6.6 Design Life and Reliability

Design life and reliability are described in **Table 2-1**.

Table 2-1. Design Life and Reliability

Item	Description
Design Life	Validator components are designed to support a usable life of 12 years or greater.
Mean Cycles Between Failure	Mean cycles between failures (MCBF) is no less than 75,000 if maintenance guidelines are followed. Failures connected with mishandling, vandalism, and misuse are not covered within the MCBF figure.
Mean Time to Remove/Replace	The Mean Time to Remove and Replace (MTTR) the validator is less than 7 minutes.

2.1.6.7 Security and PCI Compliance

The inside of the validator is only accessible when it is removed from the pole it is mounted on. The validator is locked to the pole-mount by a high security Medeco lock. All data is securely retained in the validator, which is PCI compliant. The secure module reader used in the validator is:

- Secure Reading and Exchange of Data (SRED) compliant with the POI security standard.
- Certified to PCI PTS standard for POI devices.

The keys are stored on a tamper resistant area of the POI device reader within the validator and are injected in a secure facility at the Cubic Manufacturing Facility in Tullahoma, TN.

2.1.6.8 Entry Validation Transaction Time

The design for the transaction time from properly presented media to response on the validator display is less than 500 microseconds. Reading and processing of the media has the greatest variability because of the different form factors and implementations.

3. OPERATING PROCEDURES

This chapter provides screen examples and descriptions for operating a validator.

3.1 CONTACTLESS MEDIA

Travelers boarding a vehicle or subway pay their fare by presenting contactless media to the validator. The Traveler can either tap or position the media close to the area below the display for processing. **Figure 3-1** illustrates a Traveler presenting media to a validator on a bus, using a wearable/mobile device and using a smart card.

Figure 3-1. Using a Wearable Device and Smart Card Examples

Depending on the media type presented, the validator begins reading when the contactless media is approximately 1.9 inches from the display. When the media has been read successfully, the display provides a visual indication to the Traveler. An example is shown in **Figure 3-2**.

Figure 3-2. Valid Transaction Example

The result of the transaction displays for 3 seconds. While the results screen displays, the validator is ready to accept the next tap and does not have to wait for the **Idle Screen** to display. If there is another tap within the 3 seconds, the screen blanks momentarily to indicate the change.

3.2 AUDIO FEEDBACK AND DISPLAY INDICATORS

In addition to the screen display, the validator provides audio feedback in the form of a “Good” tone, “Bad” tone or “Warning” tone depending on the transaction results.

3.3 VALIDATOR SCREENS AND INDICATORS

This section provides information and examples for the validator screens and audio. The text in the screens is configurable and may change per the transit agency’s discretion.

NOTE

When the validator starts up after a reboot or power off, note the state on the display. The display stays OFF for a period of up to 60 seconds, showing a black screen with a red X and the NOT IN SERVICE text.

3.3.1 In Service Screen

When the validator is in service, the **In Service** screen displays with a black background and white text as shown in **Figure 3-3**. If it is in service, but cannot process EMV cards it displays with a card, as shown in **Figure 3-4**. The screen contains both a visual graphic and text message prompting the Traveler to tap their contactless fare media to the validator. The display is black when In Service with a white triangle and “Tap below” text.

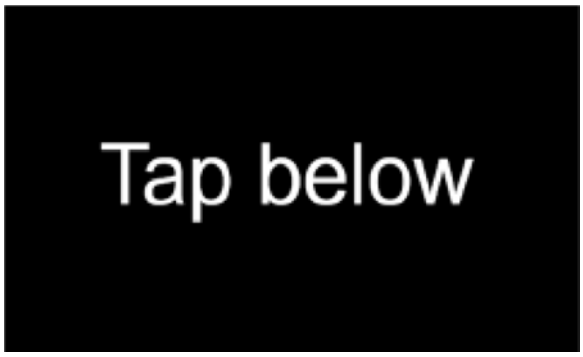

Figure 3-3. In Service Screen Example

Figure 3-4. In-Service No EMV Example

3.3.2 Out of Service Screen - Issue

When an issue or condition occurs that renders the validator out of service, the validator informs the Traveler of this by displaying the **Out of Service** screen. The black screen contains an X with the text message “Out of service”. There is no tone associated with the Out of Service screen.

An example of the Out of Service screen is shown in **Figure 3-5**.

Figure 3-5. Out of Service Screen Example

3.3.3 Fare Paid Screen

If the validator is in service and the fare media presented is valid, the validator displays the **Fare Paid** screen shown in **Figure 3-6**. The screen has a checkmark and a “good” tone sounds.

Figure 3-6. Fare Paid Screen

3.3.4 Denied Screens

There are various reasons that may cause media to be denied. There are specific screens that display along with a “bad” tone.

3.3.4.1 Not Accepted Screen

If the fare media presented is not valid on this device the validator displays the **Not Accepted** screen**,** as shown in **Figure 3-7.** The black screen contains an X, signifying a negative result, and the text message “Not accepted”. A “bad” tone sounds and the media is denied. The fare media may be invalid for various reasons including being rendered as such by the Back Office.

Figure 3-7. Not Accepted Screen Example

3.3.4.2 Card Expired Screen

If the validity period for the fare media presented has expired, the validator displays the **Card Expired** screen as shown in **Figure 3-8.** The black screen contains an X signifying a negative result, and the text message “Card has expired”. A “bad” tone sounds and the media is denied.

Figure 3-8. Card Expired Screen Example

3.3.5 Denied – Invalid Card Screen

The **Invalid Card** screen shown in **Figure 3-9** displays if the customer uses an agency card that is invalid. The black screen contains an X, signifying a negative result, and the text message “Invalid card”. A “bad” tone sounds and the media is denied.

Figure 3-9. Invalid Card Screen Example

3.3.5.1 Insufficient Balance Screen

When fare media is used with insufficient balance to cover the current fare, the **Insufficient Balance** screen **(Figure 3-10)** is displayed to the customer. The Insufficient Fare display includes the fare balance required to complete the transaction. A “bad” tone sounds and the media is denied.

Figure 3-10. Insufficient Balance Screen Example

3.3.5.2 Pass Expired Screen

When fare media is used with an expired pass, the **Pass Expired** screen (**Figure 3-11)** is displayed to the customer. After a timeout period, the validator returns to the **In Service Screen**. The black screen contains an X, signifying a negative result, with the text message “Pass expired”. A “bad” tone sounds and the media is denied.

Figure 3-11. Pass Expired Screen Example

3.3.6 Warning Screens

There are times when a medium is not denied, but the transaction cannot be completed. For these occasions a warning screen displays.

3.3.6.1 Try Again Screen

A fare media read error results in the **Tap Again** screen (**Figure 3-12)** to be displayed the customer. After a timeout period, the validator returns to the **In Service** screen. The black screen contains an X, signifying a negative result, with the text message “Please try again”. A “warning” tone sounds prompting the Traveler try again.

Figure 3-12. Tap Again Screen Example

3.3.6.2 Present One Card Screen

When the validator detects multiple fare media in the Read Zone, the **Present One Card** screen **(Figure 3-13)**, is displayed to the customer. The black screen contains an X, signifying a negative result, with the text message “Present one card”. A “warning” tone sounds prompting the Traveler try again.

Figure 3-13. Present One Card Screen Example

3.3.6.3 Card Already Read Screen

If a Traveler attempts to use the same fare media that was just used for entry (within a configurable time), the card is denied, unless Passback features are set for this account. When this occurs, or if a Traveler inadvertently presents the same fare media again within the time period, the validator displays the **Card Already Read** screen as shown in **Figure 3-14**. A “warning” tone sounds prompting the Traveler and operator.

Figure 3-14. Card Already Read Screen Example

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4. PREVENTIVE MAINTENANCE PROCEDURES

This chapter provides schedules and methods for performing preventive maintenance tasks.

4.1 CLEANING MATERIALS

Cleaning materials are listed in **Table 4-1**.

NOTE

Cleaning agents that are not on the list below could have an unknown or harmful impact if used on device surfaces. Impacts may include degrading cosmetic or functional performance, damaging device surfaces or labels, causing immediate equipment failure or even causing longer term latent failures.

Table 4-1. Cleaning Materials List

Item	Purpose	Restrictions
Lint-free clean cloths	Exterior cleaning	
Mild Detergent and Water (1/30 ratio solution of water and sodium lauryl sulfate and/or sodium laurate sulfate such as Dawn mixed in a spray bottle)	General exterior cleaning	
Windex	Screen cleaning	Use on glass only.

WARNING

Cleaning solutions may contain chemicals dangerous to health.

4.2 PREVENTIVE MAINTENANCE SCHEDULE

Table 4-2 provides a schedule with suggested intervals for preventive maintenance. The actual frequency may be further developed and adjusted based on actual equipment operating conditions and environments.

Table 4-2. Schedule

Action	Frequency
Visually inspect the exterior of the Validator	As needed
Clean the exterior of the Validator	As needed
Verify that there is no visible damage to the Validator housing	Every 3 months
Verify that there is no visible damage to the Validator mount	Every 3 months
Verify that there is no visible damage to the Validator screen	Every 3 months
Verify that the Validator mount is tight and secure	Every 3 months
Verify that the Validator ID Label is present and readable	Every 3 months
Remove foreign substances from the Validator housing	Every 3 months
Verify that there is no visible damage to the Antenna housing	Every 3 months
Verify that the antenna mount is tight and secure	Every 3 months
Remove foreign substances from the antenna housing	Every 3 months
Verify function of the Validator by tapping an AFC 2.0 card to the reader	Every 3 months
LED test	Every 6 months
Speaker test	Every 6 months
Card reader test	Every 6 months
Verify that all connections at PDBs are secure	Every 6 months
Verify that PDBs are mounted securely	Every 6 months
Change lithium coin cell battery	Every 6 years

4.2.1 Visual Inspection

Visually inspect the validator each day for the following:

- Check exterior surfaces for grease, grime, dirt, or any other signs of wear, vandalism, or damage.
- Check the structural integrity.
- Clean if needed.

4.2.2 Cleaning

CAUTION

To prevent damage to the devices, do not use abrasive or metallic scrub pads for cleaning surfaces. Use only clean, lint-free cloths dampened as described in **Table 4-1***.*

To clean the validator:

Step 1. Dampen a clean, lint-free cloth with water and detergent solution (see **Table 4-1** for details) and wipe the surfaces to remove accumulated dirt and grime from the housing. Use the solution sparingly for best results.

Step 2. Remove surplus cleaner with a clean damp (water only), lint-free cloth.

Step 3. Dampen a clean, lint-free cloth with Windex and wipe the validator front glass.

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