

# FVD Expert 9100 US

## Specification

HW Technical Description



Version 1-4

November 15, 2012



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PDR 8-10	Subsection 8.6.1
PDR 8-11	Subsection 8.6.2
PDR 8-12	Subsection 8.6.2.3
PDR 8-14	Subsection 8.6.5
PDR 8-15	Subsection 8.6.7.1
PDR 8-16	Subsection 8.6.7.2
PDR 8-18	Subsection 8.7
PDR 8-21	Subsection 8.9.3

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# 1 About this document

## 1.1 Introduction

This document specifies the configuration and technical description of the Expert 9100 US Fare Vending Device (FVD) for the SEPTA New Payment Technologies (NPT) system.



**NOTE:**

Features not listed in the table or explicitly defined in the Technical Specification are excluded.

## 1.2 Audience

The intended audience of this document includes the SEPTA NPT project members.

## 1.3 Related Documents

This Fare Vending Device Hardware Specification document is part of a larger series, which includes:

**Manuals**

- [1] Fare Vending Device Overview – 10-000-00x-xxx E00 BH
- [2] Fare Vending Device Functional Specification – 10-000-00x-xxx E00 BH
- [3] Fare Vending Device Compliance Matrix – 10-000-00x-xxx E00 BH



## 1.4 Subsystems Overview

The FVD Expert 9100 US for the SEPTA NPT project consists of the ticket vending machines according to Table 1-1: Subsystems Overview.

Subsystem/Functions	Full Function	Cashless
	FVD	FVD
Type	Stationary	Stationary
Base	Expert 9100 US	Expert 9100 US
Issue Smart Media	Smart Media Dispenser Modules	Smart Media Dispenser Modules
Issue MMSR	AP5200MC	AP5200MC
Issue receipts	AP4200	AP4200
Accept coins	RS28.7-1	
Escrow and change in coins	5 fully equipped drums plus 2 dummies	
Escrow coins	Yes	
BUCOs	Yes	
Accept banknotes	B2B300XE	
Escrow banknotes	B2B300XE	
Recycle banknotes	B2B300XE	
Accept credit and debit cards	EFT Solution	EFT Solution
Swipe reader for magnetic stripe — MMSR	Yes	Yes
Front illumination	Yes	Yes
Heating	Yes	Yes
Communication	Via LAN	Via LAN
Information panel	No	Yes
Set for internal housing illumination	Yes	Yes
Audio amplifier and loud-speaker	Yes	Yes
Electronic control unit (MCU4.0 with 2GB RAM, including COMO and licensed Windows)	Yes	Yes
EFT-PoS terminal	Yes	Yes
UMTS antenna (only for GSM connected devices)	Yes	Yes
Viper	Yes	Yes
Siren	Yes	Yes
Dry contact	Yes	Yes
Power manager with temperature sensor	Yes	Yes

**Table 1-1: Subsystems Overview**

## 1.5 Expert 9100 US Common Functionalities

The FVD Expert 9100 US is based on the Expert 9x00 Ticket Vending Machine family and provides the following common functionalities (depending on the type of configuration):

- Selecting the defined products on the touch-screen display
- Adding value or a product onto a transit account linked to the General Purpose Reloadable (GPR) card issuing receipts
- Paying with banknotes
- Returning banknotes
- Encoding and printing magnetic fare media from fan-folded Magnetic Media Swipe Reader (MMSR) stock
- Dispensing GPR cards from stackers
- Paying with credit and debit cards — Electronic Transfer of Funds (EFT) module
- Paying with coins
- Returning coins

## 2 Components

The following subsections include information on the Expert 9100 US ticket vending machine components.

### 2.1 Fare Vending Device — Full Function, Cashless

This subsection describes the general characteristics of the Expert 9100 US.



**Figure 2-1: FVD Expert 9100 US Overview**

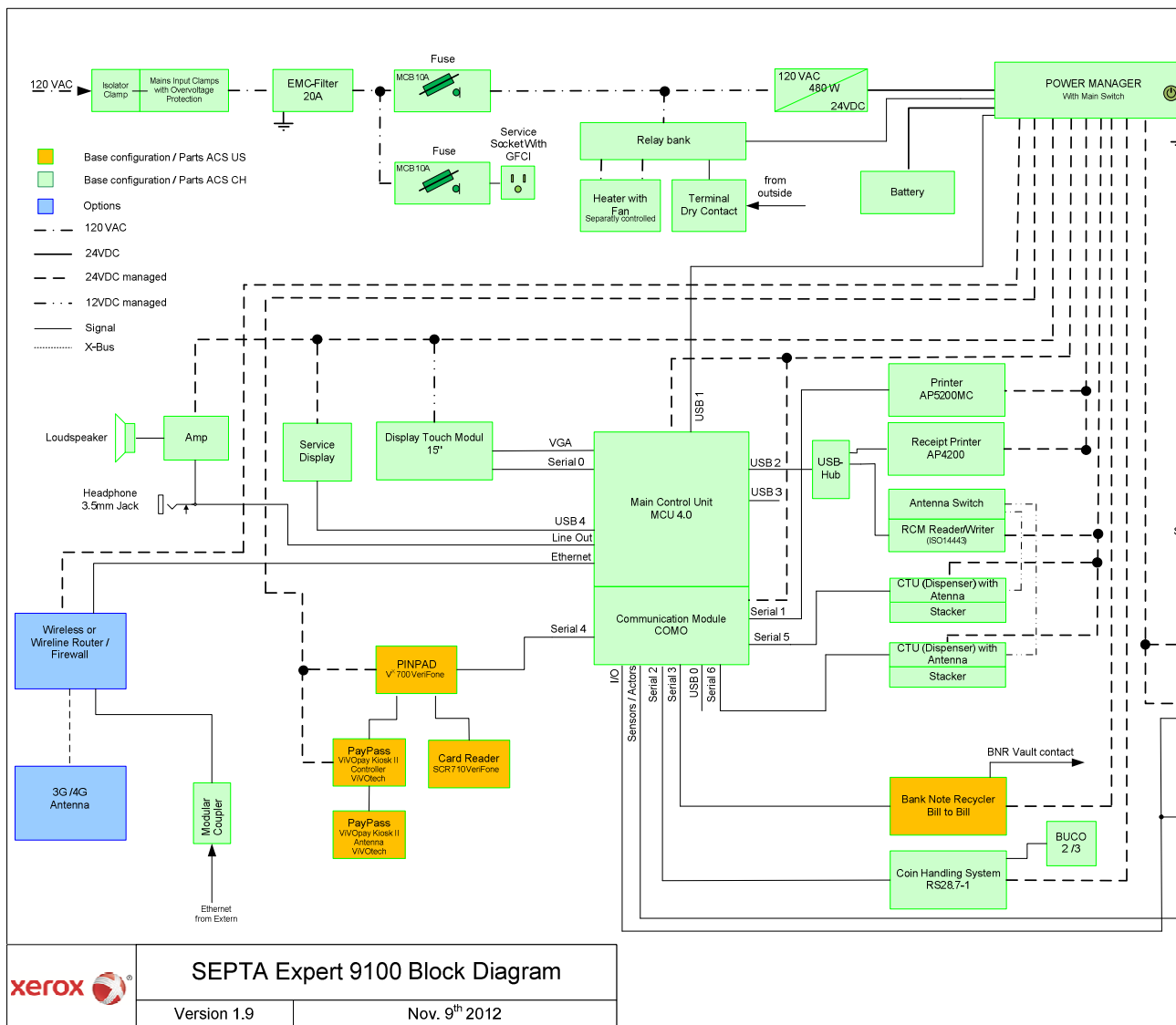
	Name	Description
1	Cabinet	The cabinet protects the interior of the Expert 9100 US and the modules. An option for a two sides and roof protection against forced intrusion is available.
2	Door	The door gives access to the modules. The four door hinges, invisible from outside, are on the left-hand side in order to open the door from right to left up to a maximum angle of 128°. The conductive seal provides the necessary EMC connection. The front of the door has: <ul style="list-style-type: none"> <li>• Pictograms — symbols for passenger instructions — as provided by SEPTA</li> <li>• Braille and raised text instructions for visually impaired passengers — as provided by SEPTA</li> </ul>
3	Pedestal	The closed pedestal provides the mechanical and grounding interface between the floor and the cabinet.
4	Banner	Customer-specific printed banner — optional.
5	Touch-Screen Display	15-inch LCD-TFT display with touch screen. It allows the passenger, as well as the service personnel, to interact with the FVD Expert 9100 US.
6	EFT-PoS Module	The EFT-Point of Sale (PoS) module — composed of frame, privacy protection, dip reader, contactless reader and PIN Pad — allows the passenger to pay by credit or debit card.
7	Output Tray	Receipts, issued fare media — Smart Media — and change in coins fall into this receptacle equipped with an LED, which can be illuminated during this process. It has a transparent flap that keeps the issued items from falling out and protects the output tray from dust.
8	Coin Handling System Module	The self-replenishing coin handling system RS28.7-1 allows the passenger to pay with coins. It is capable of validating up to 15 different coins and works according to the last in, first out (LIFO) principle. This prevents any type of money laundering.
9	BNR	The BNR CashCode B2B300XE allows the passengers to pay with banknotes. The banknote vault has a capacity of 1,000 banknotes.
10	Audio Amplifier and Loudspeaker	The audio amplifier and loudspeaker will support the passenger during sales.

**Table 2-1: FVD Expert 9100 US — Hardware Shown in Figure**

Name	Description
Printer Module for MMSR	The thermal printer module for MMSR, AP5200MC, is used to print, encode and issue fan-folded MMSR.
GPR Dispenser Module	There is space for up to 2 Smart Media dispenser modules — magazine with encoding and transport unit.
Paper Printer Module	The thermal paper printer module, such as AP4000, is used to print and issue receipts for passengers and service personnel.
Communication Module	In the standard version, a modular coupler allows the connection to the LAN. There is an option to configure the FVD Expert 9100 US with a wireless communication module. The wireless communication module allows communication between the FVD and the backend or the bank clearing house to be established in case of an EFT-POS payment over GPRS, EDGE, UMTS or HSDPA.
MCU Module	The MCU 4.0 — controlling and supervising the FVD Expert 9100 US — consists of an SBC, a COMO, a mass storage device and a CF card as backup media.
Heating	The FVD Expert 9100 US is equipped with a heater and with temperature monitoring.
Headphone Connector	A headphone connector — 3.5-mm mono jack — is installed on the FVD front panel..

**Table 2-2: FVD Expert 9100 US — Hardware Not Shown in Figure**

# 2.2 Block Diagram



**xerox** SEPTA Expert 9100 Block Diagram  
Version 1.9 Nov. 9<sup>th</sup> 2012

# 2.3 Housing

The following figures and tables provide information regarding Expert 9100 US housing.

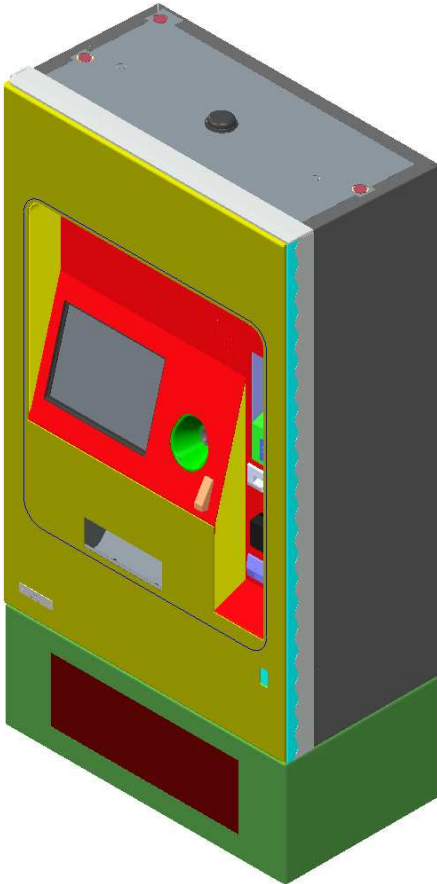


Figure 2-2: Expert 9100 US (Indicative Only, in mm)

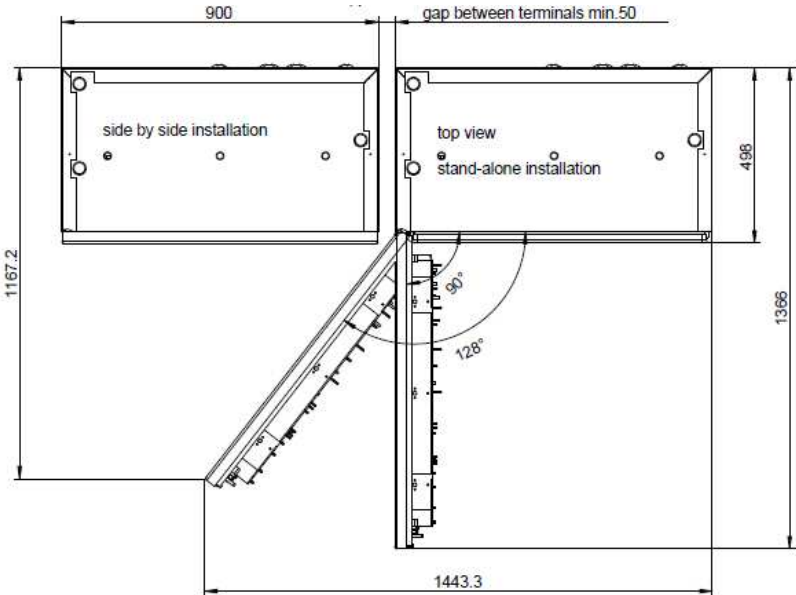


Figure 2-3: FVD Door Opening in mm

Feature	Description
Key Characteristics	Housing: 2 mm stainless steel, brushed Door: 3 mm stainless steel, brushed
Dimensions	H x D x W: 1423 mm x 500 mm x 900 mm, excluding pedestal
Material	Stainless steel (V2A), (1.4301, AISI 304)
Fixation Housing/Pedestal	The FVD housing is fixed by four M12 screws — secured with Loctite — onto the pedestal.
Intrusion of Fluids and Objects	The specific intrusion of fluids and objects will be avoided by the respective design of the construction (use of shutters). Remaining fluids that enter the FVD through operation openings will be collected and drained to the outside. Fluids that enter and do not harden, glue or corrode will not cause damage or interference in the FVD.
Flammability	The parts accessible from the outside of the housing unit are metal, glass or synthetic. These parts are flame-retardant and will only allow minimal deformation under the impact of a 30-second flame from a cigarette lighter.
Accessible Parts	All parts accessible from the outside are mounted on the inside. The housing has no screws that can be loosened from the outside.
Color and surface treatment	Color HMI Area to be decided by SEPTA Exposed surfaces are stainless steel with a #4 Brushed finish.
Writing/Labels/Pictograms	Color RAL — to be decided with SEPTA by FDR
Coat Inside	Stained and passivated
Hinges	The hinge construction contains four bracket hinges that are blind-mounted on the left-hand side.
Door Opening Brackets	The door of the FVD can be fixed mechanically in the open angle of approximately 90, 120 and 128 degrees. The protrusion of the door, measured from the front of the housing, is approximately: 900mm at an angle of 90 degrees 742mm at an angle of 128 degrees

**Table 2-3: Housing Datasheet**

 **NOTE**

Features not listed in the table or explicitly defined in the Technical Specification are excluded.

For easy movement and installation there are three holes in the roof. After installation they will be covered by plates with seals.

Any sharp edges have been deburred for safety reasons.



## 2.4 Pedestal

The purpose of the pedestal is to:

- Simplify the installation — the power and communication cables coming from outside terminate in it
- Provide a reliable earth connection
- Allow proper leveling of the Expert 9100 US

Feature	Description
Dimensions	H x D x W: 380 mm x 500 mm x 900 mm
Material	Stainless steel (V4A), (1.4404, AISI 316L)
Color and surface treatment	Exposed surfaces are stainless steel with a #4 Brushed finish.
Intrusion of Fluids and Objects	The specific intrusion of fluids and objects will be avoided by the respective design of the construction. Remaining fluids that enter the pedestal through operation openings will be collected and drained to the outside. Fluids such as soft drinks that enter and do not harden, glue or corrode will not cause damage or interference in the pedestal.
Flammability	The parts accessible from the outside are metal.
Accessible Parts	All parts that are accessible from the outside are mounted on the inside. The pedestal has no screws that can be loosened from the outside.

**Table 2-4: Pedestal Datasheet**

# 2.5 Lock Arrangement

The following subsections, figures and tables provide further information regarding the locking arrangement on the FVD.

## 2.5.1 Overview

The door and lock of the FVD are monitored by three contact switches: one contact mounted at the top, one contact mounted at the bottom of the FVD door, and one lock contact. These are directly connected to the adapter door control printed circuit boards (PCB), which generates an alarm, if necessary.



**Figure 2-4: Contact Switches on the Housing**

This combination allows recognizing the four states for the door shown in Table 2-5: Lock Arrangement.

Switch Status	Explanation
Door closed Lock closed	Normal status of the FVD, ready for operation.
Door open Lock open	Service status of the FVD, ready for service work to be carried out.
Door open Lock closed	Door has possibly been opened irregularly, possible break-in attempt!
Door closed Lock open	Door not closed correctly.

**Table 2-5: Lock Arrangement**

The FVD can interpret each of these states and trigger an appropriate message or alarm, if necessary. The detailed FVD functional description is located in the PDR deliverable Fare Vending Devices Functional Specifications.

## 2.5.2 Lock Plan

FVD door lock and module locks will be defined in the locking plan.

Switch Status	Lock No	Code	Key No
Housing door (Cyberlock)		A	Cyberlock tbd
Coin drum pull-out (release)		B	TH0293
Coin vault pull-out (release)		B	TH0293
Banknote vault pull-out (release)		C	Crane tbd
BUCO pull-out (release)		B	TH0293
Coin vault opening (cash)		D	TH0294
Banknote vault opening (cash)		E	Crane tbd
BUCO opening (cash)		D	TH0294
Crank key		F	840.7861

**Table 6 – Lock plan FVD**

Switch Status	Lock No	Code	Key No
Pedestal door		G	TH0295

**Table 7 – Lock plan FVD pedestal**

Feature	Description
Pull-out (release)	Allows to remove the coin / banknote vault from the FVD
Opening (cash)	Allows direct access to the cash

**Table 8 – Lock plan related to money containers**

The RS28.7 coin drum block is provided with a spring loaded latch that has the facility to be locked with a padlock.

The door has a 5 point locking system and a security lock (DOM half-length cylinder – supplied by ACS). Once this security lock has been removed, the door can be opened using a crank key.

## 2.5.3 Door Lock Mechanism

The door lock mechanism is constructed to be robust and stable. This design is proofed and reliable. The design has been used in the field on most frequently used sites for over 20 years.



**Figure 2-5: Locking System on Door Side and Housing Side**

## 2.6 Human Machine Interface

This subsection contains information on the Human Machine Interface (HMI).

### 2.6.1 Display-Touch-Module

The passenger user interface represents the HMI for the passenger for all sales operations. The information displayed on the Liquid Crystal Display (LCD) guides the passenger through the sales process.

In order to display complex tariff structures, to simplify the passenger's task to quickly select a product, and to have no restrictions for future HMI adaptations, the FVD is equipped with a touch display module. It consists of an infrared touch screen and a 15-inch LCD-Thin Film Transistor (TFT) panel. The selection may be acknowledged by an acoustic signal — loud-speaker.

The optical matrix touch screen consists of light emitting diodes (LED) and phototransistors placed directly opposite each other on both the X- and Y-axes. The frame construction consists of a PCB assembly carrying the optoelectronic components, which are mounted behind a protective infrared transparent bezel. The bezel protects the electronics against any damaging environmental influences.

The infrared controller activates the LEDs in sequence, forming a light-beam grid. An object — finger placed within the grid interrupts one or more beams of light, which allows the X and Y coordinates of the object's position within the grid to be determined.

Infrared systems are not subject to any mechanical loading, which makes them particularly suitable for applications that are endangered by vandalism.

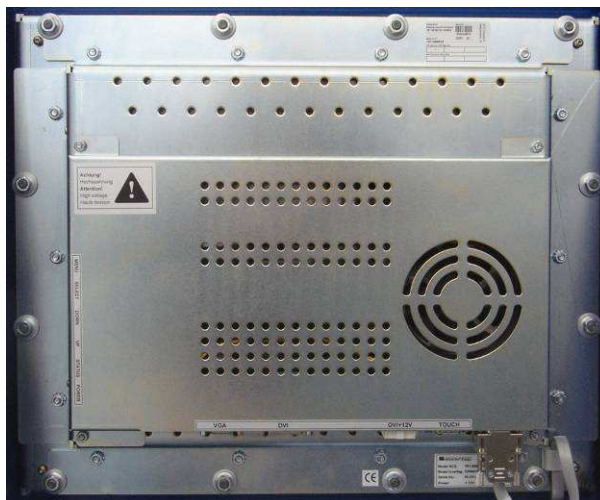
Feature	Description
Readability	The high brightness (600cd/m <sup>2</sup> ) allows a good readability in all light conditions. Although, as with all available LCDs, it is preferable that they are not under direct sunlight, as it will affect visual performance. Brightness and contrast are manually adjusted. The screen of the FVD has an inclination angle of 16 degrees.
Display	
Type	15-inch LCD-TFT transfective display
Visible Area	300 x 225 mm (width x height)
Resolution	1024 x 768 pixels
Colors	24 Bit — true color
Contrast	600:1
Glass specification	Security glass — 7.2-mm laminated tempered glass, antiglare edged
Filter	UV light sun protection to improve readability in unfavorable light conditions
Touch Screen	

Feature	Description
Active Operating Area	300 x 225 mm
Scanning Rate	25 frames/second
Touch Resolution	Infrared touch systems can be triggered by any object with a minimum diameter of 8.9 mm

**Table 2-9: HMI Datasheet Extraction**



**Figure 2-6: Display Touch Module — Front Side**



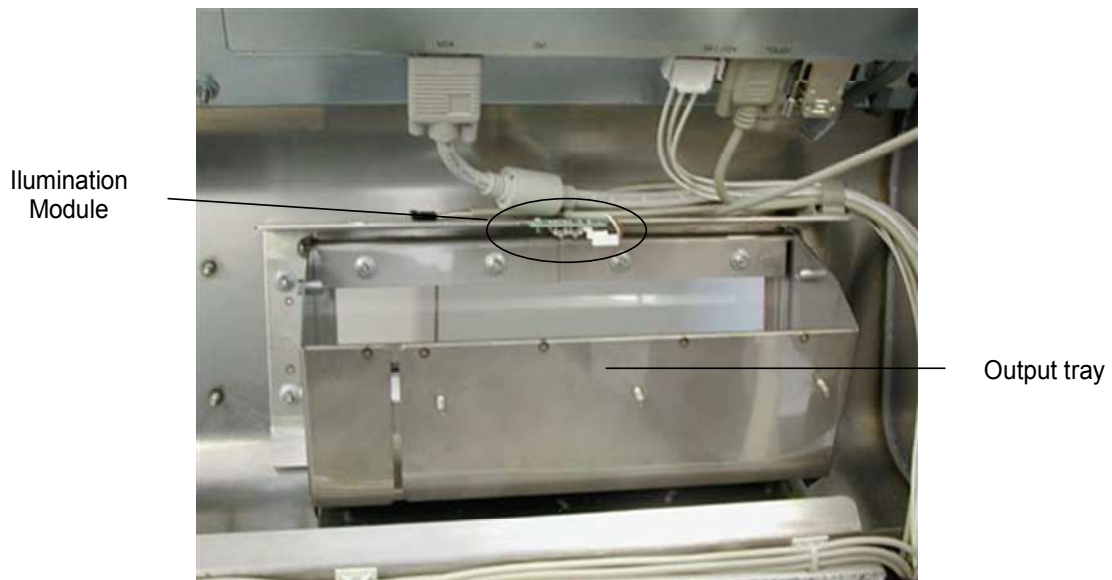
**Figure 2-7: Display Touch Module — Rear Side**

The display touch module is mounted in a way that allows for easy on-site replacement.

## 2.6.2 Output Tray

The issued GPRs and MMSRs and or returned coins — change or coins returned after a cancelled transaction — fall into the output tray. For removal, the passenger has to push the transparent plastic flap. During a certain time that is adjustable by software, the output tray is illuminated by a flashing LED.

The output tray is positioned in such a way that even handicapped passengers can grab the tickets and the change. However, it will be difficult for people with significant neuromuscular deficiencies to use the output tray. The design prevents access to the FVD through the output tray.



**Figure 2-8: Output Tray**

## 2.7 Coin Handling System RS28.7-1

The following subsections contain additional information regarding the RS28.7-1 coin handling system.

### 2.7.1 Overview

The RS28.7-1 is a self-replenishing/return coin handling system. It is capable of validating up to 15 different coins and works according to the LIFO principle. This prevents any type of money laundering in a cancelled transaction. In this case, the FVD returns inserted coins. The accepted coins are stored in up to seven coin drums. Each coin drum is an escrow and a self-refilling coin container. The capacity per drum is 50 coins.

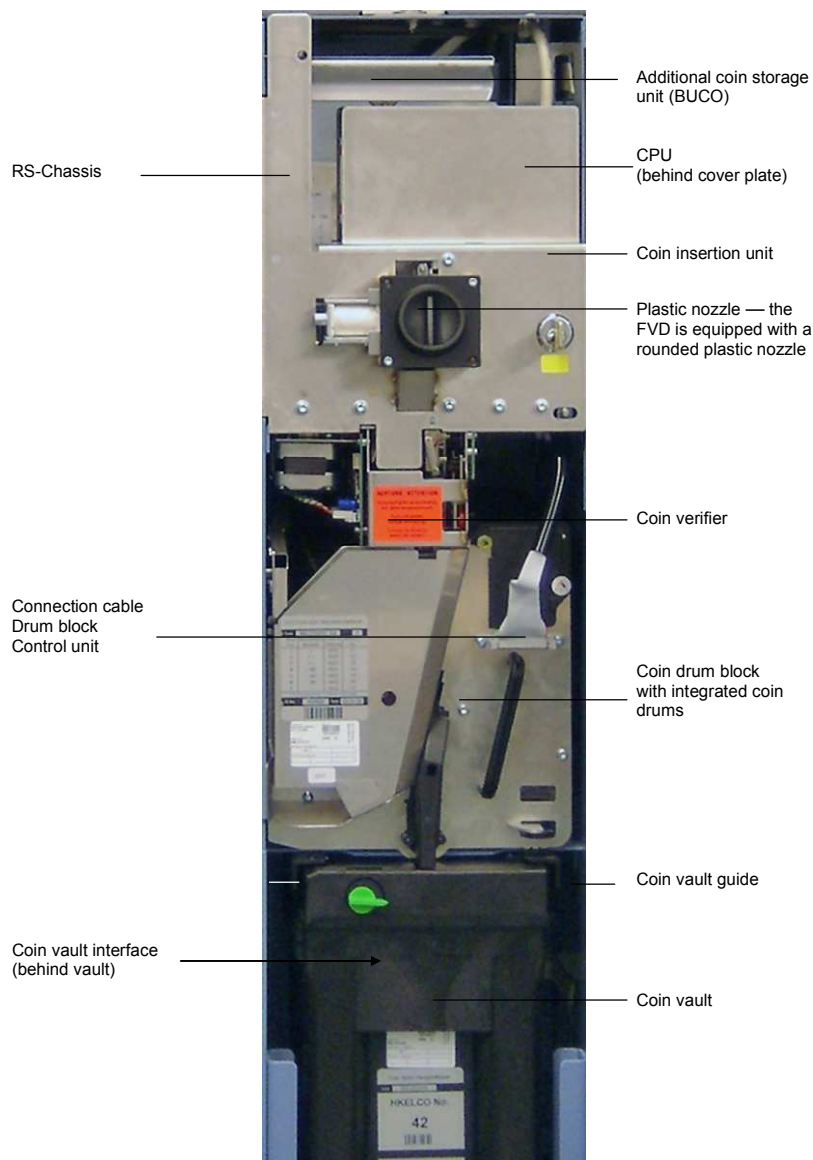


Figure 2-9: RS28.7-1



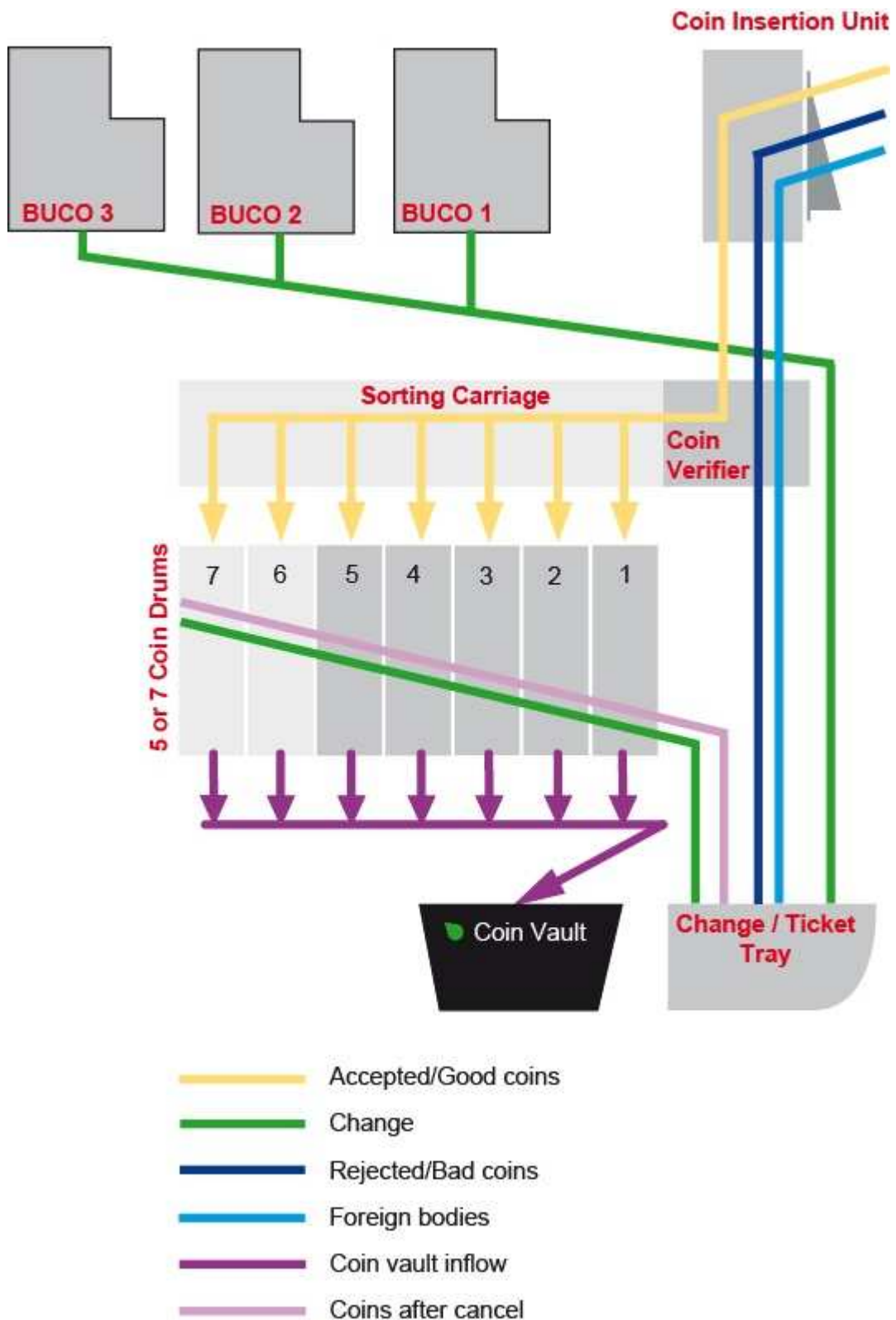
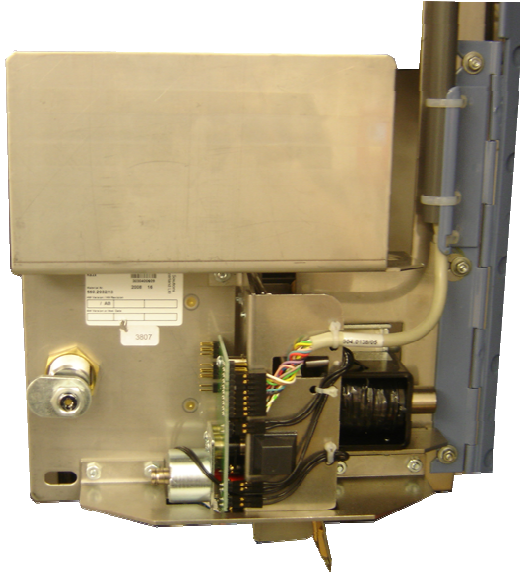


Figure 2-10: Cash Flowchart Diagram — Configuration Drum Block is Only Indicative

Two photoelectric sensors are installed in the coin insertion unit to detect inserted coins and coin blockages. “Dummy” drums are drums that are not configured to take coins. They are ready to be used at a later date with further configuration.

## 2.7.2 Coin Insertion Unit



**Figure 2-11: Coin Insertion Unit**

The coin insertion unit is composed of a dedicated complete door and the coin insertion unit mechanism. The coin insertion unit is capable of handling the inserted coins sequentially. Together with the coin verifying unit, it influences the acceptance rate of the RS28.7-1 change return system.

- If the coins are inserted at a rate slower than one coin per 1.7 seconds, the insertion flap is opened constantly.
- If the coins are inserted at a rate faster than one coin per 1.7 seconds, the coin insertion unit controls the coin flow by activating the insertion flap.
- Foreign bodies are directed straight to the output tray.

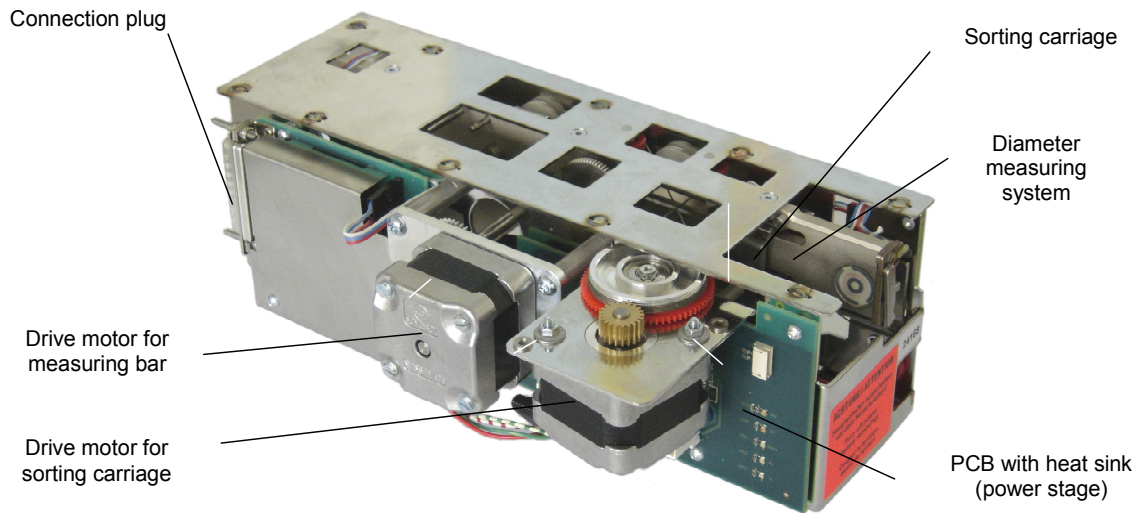
### 2.7.2.1 Coin Insertion Slot (FVD Door)

The coin insertion unit is equipped with a dirt flap to prevent foreign objects from being inserted into the coin insertion “nozzle.”

- **Material nozzle** — thermoplastic polyester PBT-30%GF
- **Color** — black

## 2.7.3 Coin Verifier Unit

Figure 2-12: Coin Verifier Unit shows a five-coin verifier, only indicative.



**Figure 2-12: Coin Verifier Unit**

Coins are verified and sorted in the coin verifier unit. Optimal verification of the coin is ensured by precisely fixing the coin mechanically in a defined position. All the measurements are made when the coin is static.

If a coin is judged to be good, the sorting carriage moves to the appropriate coin drum and deposits the coin there. This means that the coin is directed from being accepted to being stored in a completely controlled manner.

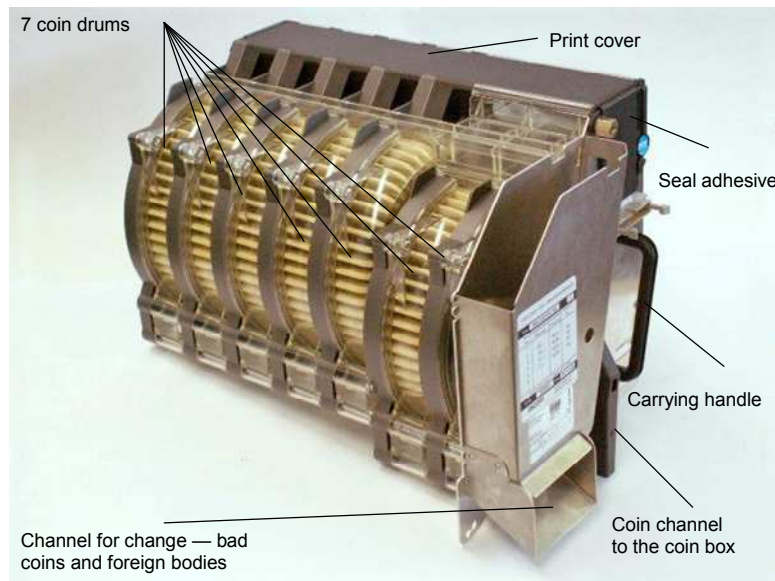
The following physical parameters must be tested:

- Diameter — mechanical measurement by "feel"
- Thickness — inductive measurement
- Eight different alloy parameters — four at the edges and four in the center
- The coin verifier unit can process the parameters of up to 15 different coins.

An individual ELCO number, or serial number, issued by the manufacturer uniquely identifies each coin verifier.

## 2.7.4 Coin Drum Block

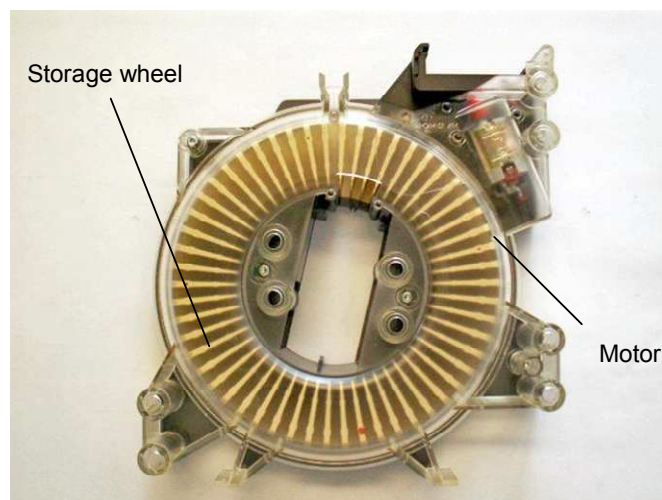
The coin drum block, or change storage unit, contains seven identical coin drums. The coin drum block is protected against unauthorized manipulation by a seal — coin vault security.



**Figure 2-13: Coin Drum Block**

## 2.7.5 Coin Drum

A maximum of 50 coins can be stored in each coin drum. If a sale action is aborted, the passenger receives back the same coins he inserted himself. Each coin drum is coded with its own ELCO number. It is only possible to exchange individual coin drums in the workshop. In the field, the whole coin drum block must be exchanged.



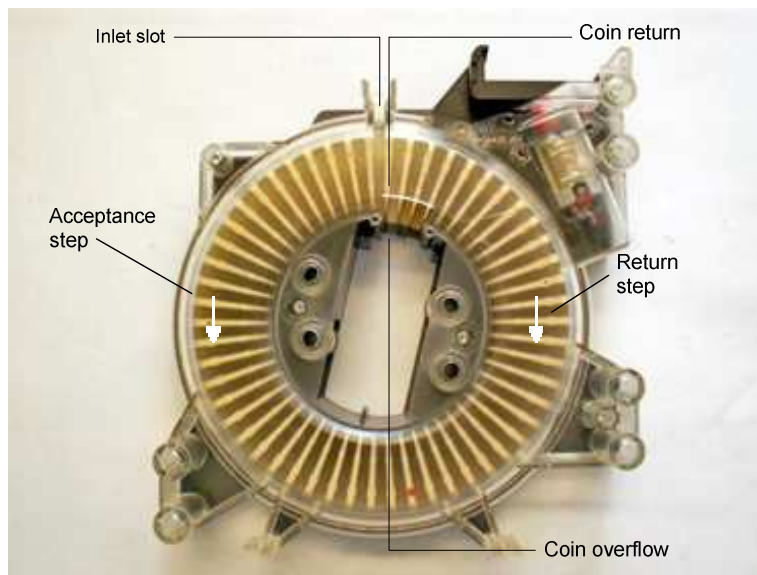
**Figure 2-14: Coin Drum Block Storage**

The coin drums can be refilled in the field by using a special refill function. Coins are inserted in the coin insertion unit with the FVD door closed.

### 2.7.5.1 Cash Acceptance

The sorting carriage of the coin verifier moves an accepted coin to the right drum, where it is dropped into the empty storage section of the coin drum. This causes the storage wheel to

move one step anti-clockwise to accept the next coin. An empty section is again positioned under the inlet slot, ready to accept the next coin.



**Figure 2-15: Principle Underlying the Function of the Coin Drum**

### 2.7.5.2 Cash Return

The storage wheel turns clockwise back one step. The last inserted coin is now positioned under the inlet slot. Each time the wheel moves back one step, a coin falls through the return channel. When the coin has been returned, the wheel makes an acceptance step and an empty section is available again to store a coin.

If the drum is full, the coin above the overflow is sent through a channel into the coin vault.

Parameter	Description
Max. drums per block	7
Max. coin diameter	33.5 mm
Max. coin thickness	3.4 mm
Max. coins per drum	50

**Table 2-10: Drum Configuration Datasheet Extraction**

** NOTE**

Drum position 7 is for coins with a maximum diameter of 24 mm.

### 2.7.5.3 Drum Function

- “T” — drum for one denomination only
- “f” — in front part of coin drum block
- “r” — in back part of coin drum block
- **ELCO No.** — Each drum is coded with an individual ELCO number, or serial number, that is issued by the manufacturer and uniquely identifies each drum.

Drum Position	Drum Function	Denomination USD	ELCO No.
1f	T	not configured	
2	T	1.00	
3	T	0.25	
4	T	0.25	
5	T	0.10	
6r	T	0.05	
7r	T	not configured	

**Table 2-11: Configurable Drum Assignment**

## 2.7.6 Coin Vault

The coin vault — volume 4.5 liters — is the final coin container, where coins coming from the self-refilling coin drums accumulate. The shutter in the lid opens automatically when it is inserted into the FVD and locks again when it is removed. After the emptying procedures in the collection center the shutter is preset.

The current contents of the coin vault are monitored by the FVD software and compared with the threshold values — provided within the device configuration data CD — for the coin vault “almost full” alert and the coin vault “full” alert. An individual ELCO number, serial number, issued by the manufacturer uniquely identifies each coin vault.

The coin vault complies with the applicable security standards, such as drop test, break-in, etc.

Parameter	Description
ELCO No.	Continuous
Volume	4.5 liters maximum, or roughly 2000 coins
Dimensions	169 x 232 x 210 mm
Weights	Empty 1.3 kg
Full	Approximately 15 kg

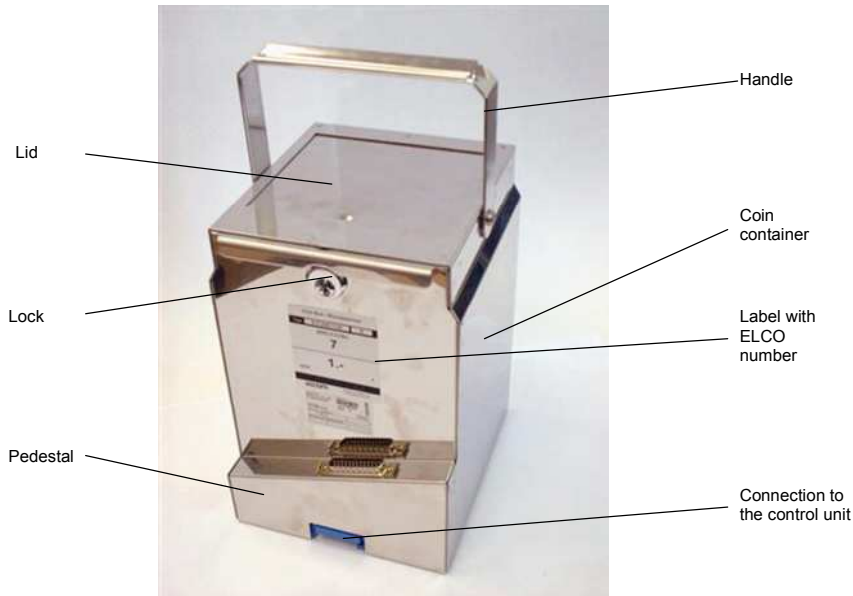
**Table 2-12: Coin Vault Datasheet Extraction**



**Figure 2-16: Coin Vault**

## 2.7.7 Bulk Coin Storage Unit

The Bulk Coin Storage Unit (BUCO) is designed to store coins with a maximum diameter of 29.5 mm and a maximum thickness of 2.50 mm. It is basically a capacity extension of the coin drums. Thanks to its large capacity, the BUCO assures a prolonged availability of the most frequently used coins for change return. The BUCO contains a handle that allows for easy removal and transport by revenue officers. The process for changing BUCOs will be explained in the Maintenance and Training manuals at Final Design Review (FDR).



**Figure 2-17: Principle Underlying the Function of the BUCO**

Physically, the FVD can hold up to three BUCOs, each for a different type of coin, whereby one BUCO is placed inside the RS-chassis and the others outside on a pedestal. The coins being returned to the passenger fall through an opening in the base of the BUCO into the output tray. An optical sensor in the base of the BUCO records the number of coins returned.

Each BUCO has its unique ELCO number. This allows a clear identification of every BUCO. A signal indicates the status of the BUCO. It becomes active once the BUCO is empty. The BUCO is not self-refilling and must always be filled with the correct type and number of coins. See Table 2-13: BUCO — Initial Configuration and Capacity.

Parameter	Denomination	Initial Quantity	BUCO Capacity
First BUCO	\$0.05	One per FVD	2,000
Second BUCO	\$0.25	One per FVD	1,500
Third BUCO	\$1.00	One per FVD	1,000

**Table 2-13: BUCO — Initial Configuration and Capacity**

**NOTE**

Note: Only one type of coin can be put in the BUCO. If physical parameters vary between different series of the same coin, such as old and new, only one type can be filled in.



## 2.8 Banknote Recycler

The following subsections contain additional information on the banknote recycler (BNR).

### 2.8.1 Banknote Recycler CashCode

The Bill-to-Bill™ 300XE bill recycler was developed to validate bills that have a width of up to 82 mm. Compared to the previous front-load bill recycler models, the Bill-to-Bill™ 300XE has the following distinctive features:

- It utilizes a lightweight plastic shockproof cash box.
- It has three recycling cassettes with a capacity of 100 bills each, with an option for secured lockable.
- It has the capacity to dispense up to one pack of 20 bills.

The Bill-to-Bill™ 300XE bill validator consists of five main modules:

- The Bill-to-Bill 300XE™ recycler is designed to accommodate bills of different sizes from 62- to 82-mm wide, and from 125- to 172-mm long, which represents most of the world currencies.
- Certain currencies have different widths depending on denomination. For accurate validation of such currencies, the Bill-to-Bill™ 300XE validating head has a centering mechanism that aligns the bills for processing different widths.
- The lockable-removable cash box is used for temporary storage of validated bills. It can be locked with two standard 3/4-inch tubular locks.
- Bill capacity refers to the number of new bills that the cash box can store. Actual cash box capacity can decrease in real applications due to variations in thickness of street-grade bills.
- The Bill-to-Bill™ 300XE housing joins all the other modules. It is meant to be permanently secured inside a host machine.
- Software updates can be easily applied to Bill-to-Bill™ 300XE using a memory card or through a network.
- The bill-to-bill system uses radio frequency identification electronic tracking in cash boxes.



**Figure 2-18: CashCode BNR**

## 2.8.1.1 CashCode Parameters

Parameter	Description
Bill Validation Rate	98% or higher
Bill Insertion	Lengthwise 4 ways
Escrow	Multi-bill programmable
Interfaces Supported	Bi-directional (RS232), USB
Protocols	CCNET
Firmware Updates	BlueChip™ Smart-Stick memory or downloadable
Operating Voltage	24 V DC
Power Requirements	4A max.
Bulk Loader	Speed 1.2 seconds per bill — up to 25 bills
Dimensions (W x H x D)	163 X 569 X 378 mm
Recycling Cassette	3 x 100 – 120 bill capacity intelligent cassettes
Drop Cassette Sizes A Valuable	1,000 bills
Approval	UL listed
Denomination	USD
Max. Number of Different Banknotes	13
Prepared Acceptance of Banknote Denominations	USD notes
Max. Quantity of Notes per Product Purchase	15
Number of Different Notes in Recycling Unit	3
Capacity of Different Notes in Recycling Unit	70/30
Maintenance	All components can be maintained completely from front side. Device can stay in mounted position.
BNR Definition of Change Notes	To be decided with SEPTA by FDR.
BNR Definition of Cash Box Denomination	To be decided with SEPTA by FDR.

**Table 2-14: CashCode Datasheet Extraction**

## 2.9 Electronic Transfer of Funds-Point of Sale

The following subsections contain information regarding the personal identification number (PIN) pad.

### 2.9.1 PIN Pad and LCD Display

The EFT solution — hardware, software, licenses and maintenance contract — is the VeriFone V<sup>x</sup>700, a vandal-resistant, low-power, outdoor-rated module. The form factor of the VeriFone V<sup>x</sup>700 is a 16-key PIN Pad with a 128 x 64 graphical display, which will be coupled with the VeriFone SCR710 smart card reader with multiple contactless interface modules to form a highly flexible payment solution.

It complies with the latest Payment Card Industry (PCI), PIN Entry Device (PED) and Europay, MasterCard and Visa (EMV) standards to protect cardholder information. It also has an IP65 rating and an impact resistance of 10J. It operates at a wide range of input voltages and incorporates low power and power saving modes to reduce consumption.

Feature	Description
Processor	200 MHz ARM9 32-bit microprocessor
Memory	6 MB: 4 MB flash, 2 MB SRAM — optional 12 MB
<b>Display</b>	
Type	LCD with backlight
Visible Area	128 x 64 pixel, 4 lines x 21 characters at standard font
<b>Keypad</b>	
Keypad	16-key keypad (3 x 4 numeric, plus four function keys); external interface for another four function, user-defined keys
<b>Security</b>	
Online/Offline	PCI PED 1.3 online and approved AES256 encryption offline
Key Management	Master/session and DUKPT
Authentication	VeriShield file authentication
<b>Power</b>	
Power Supply	9V DC to 28V DC
Consumption	1.5W full speed 1W low-power mode 0.39W sleep mode
<b>Connectivity</b>	
Connectivity	4 x RS232 serial ports 2 x USB 2.0 host ports 1 x USB 2.0 slave ports
Height (Overall)	132 mm
Width	100 mm
Depth	49 mm

Feature	Description
<b>Environmental Characteristics</b>	
Front Panel	Stainless steel
Temperature Range	-25°C to 60°C (-13°F to 140°F) operating temperature
Humidity	5% to 95% relative humidity (non-condensing) IP65 sealed
Durability	IK09 vandal resistant — 10 joules impact Petroleum and chemical resistant

**Table 2-15: VeriFone V<sup>700</sup> Datasheet Extraction**



**Figure 2-19: PIN Pad**

## 2.9.2 Card Reader

The VeriFone SCR710 — hardware, software, licenses and maintenance contract — provides track 1, 2, and 3 magnetic stripe-reading with a EMV 4.0 chip interface. The VeriFone SCR710 provides advanced security features such as Triple Data Encryption Standard (DES) (3DES) and is PCI PED 1.3-approved.

The reader is easily integrated into the FVD with a small form factor and shuts out foreign object insertions with an integrated shutter. The unit also meets exterior standards such as IP54, and is rated for extreme temperature ranges for outdoor usage.



Figure 2-20: VeriFone Card Reader

Feature	Description
Processor	ARM9
<b>Security</b>	
Online/Offline	PCI PED 1.3 online and approved 3DES encryption offline
<b>Power</b>	
Power Supply	12V DC to 25V DC
Consumption	2.4W max
<b>Connectivity</b>	
Connectivity	1 x serial port
<b>Environmental Characteristics</b>	
Temperature Range	-20°C to 60°C (-4°F to 140°F) operating temperature
Humidity	5% to 95% relative humidity (non-condensing)
Durability	IP54 front panel, IP34 internal rear enclosure

Table 2-16: VeriFone SCR710 Datasheet Extraction

## 2.9.3 Card Open Payment Contactless Reader

The ViVOpay Kiosk is a bolt-on external reader module that can be easily added to existing FVD systems to add new contactless payment functionality. The ViVOpay Kiosk's compact design and rugged weatherproof construction allows it to be used in self-ordering kiosk systems in public transit.

The ViVOpay Kiosk is certified with most contactless payment programs such as Maintenance Support Device (MSD)-based MasterCard® PayPass®, ExpressPay® from American Express®, Visa® payWave and Discover® Zip™ and capable of EMV-based OneSmart®, MasterCard® PayPass® and Visa® payWave quick Visa® Smart Debit/Credit (qVSDC).



Figure 2-21: ViVOpay Kiosk

Feature	Description
<b>Hardware</b>	
Processor	ARM processor
Audio/Visual	Beeper and LEDs
<b>Contactless Transactions</b>	
Interface	13.56 MHz ISO 14443 Type A/Type B and MiFare
Payment Applications	American Express® ExpressPay®, Discover® Zip™, MasterCard® PayPass® Mstripe (M/Chip capable), Visa® payWave MSD and (qVSDC capable), JCB/Jspeedy
<b>Power</b>	
Input Power	7.5-45V DC, 700mA
<b>Connectivity</b>	
Connectivity	1 x RS232 serial port
<b>Physical Characteristics</b>	
Height (overall)	107.4 mm
Width	31.5 mm
Length	78.0 mm
Weight	27.2 g (0.60 pounds)
<b>Environmental Characteristics</b>	
Front Panel	Weather-protected UV-rated plastic enclosure
Temperature Range	-25°C to 70°C (-13°F to 158°F) operating temperature -40°C to 85°C (-40°F to 185°F) storage temperature
Humidity	10% to 90% relative humidity (non-condensing)

Table 2-17: ViVOpay Kiosk Datasheet Extraction

## 2.10 Card Dispenser Unit

The following subsections contain information regarding the card dispenser unit.

### 2.10.1 Overview

The card dispenser unit is used to check and issue GPRs.

A card dispenser unit consists of:

- Card transport unit (CTU)
- Card dispenser with magazine
- GPR antenna for card dispenser unit

The CTU and the card reader/writer module are built into the FVD. The card magazine can easily be removed to refill cards. Each card magazine is filled with GPRs. Once filled, the card magazine is reconnected to the corresponding card dispenser module.

- In the case of a corrupt card, it will follow the usual path in the return channel. A flap will be activated to guide the card to drop onto a podium inside the FVD.
- The FVD comes with two card dispenser units for GPRs.

### 2.10.2 Card Transport Unit

The CTU implements the entire functionality required to mechanically move, hold and transport CSCs and CSTs. The rollers moving the card are made of specially treated polyurethane, which allows the CTU to be used under harsh environmental conditions.



**Figure 2-22: Card Dispenser Unit**

### 2.10.3 Card Dispenser with Card Magazine

The card magazine holds a maximum of 650 GPRs with a card thickness of 0.76 mm. An individual ELCO number, or serial number, issued by the manufacturer uniquely identifies each card magazine.

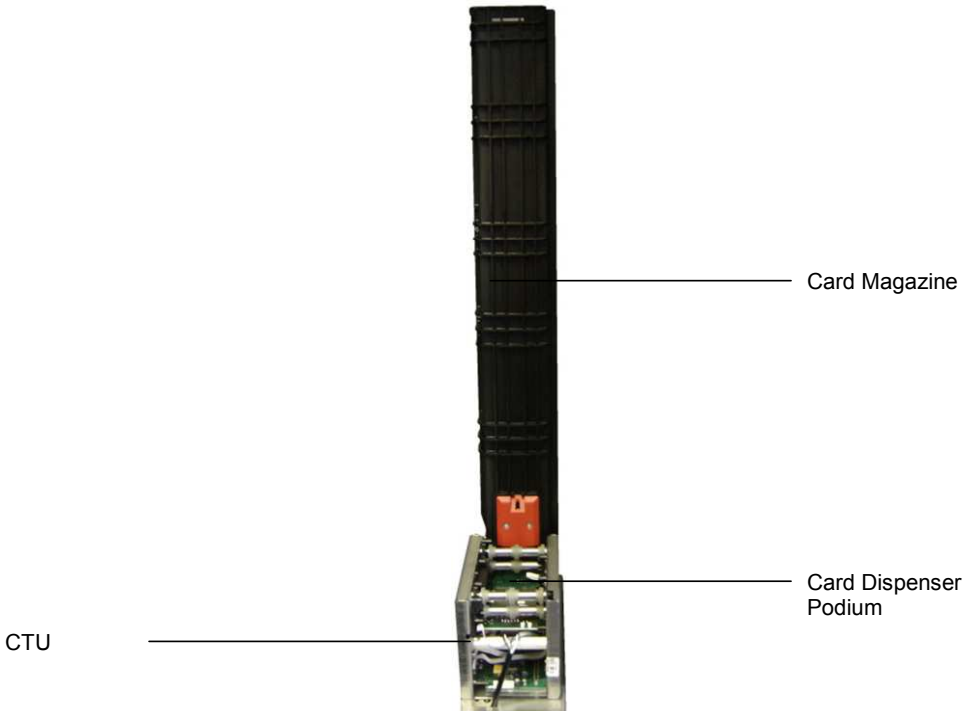


Figure 2-23: Card Dispenser with Card Magazine

### 2.10.4 Weight

The purpose of the weight in the card magazine is to put sufficient pressure on the cards throughout the entire dispensing process. There is also adequate pressure on the last cards to guarantee they are correctly dispensed.



Figure 2-24: Card Magazine Weight



## 2.11 Card Access Module

The card access module (CAM) includes two antennas that are used to check the product of the GPRs. The antennas are installed into the two CTUs.

The mentioned CAM reader/writer is used to encode the cards (fare media on ISO/IEC 14443-2-compliant technology):

- Supports ISO 14443 Type A and B and ISO 14443 tags
- Support of maximum of four secure access modules (SAMs)
- Has an optional antenna switch to share the module with four antennas
- Has a Universal Serial Bus (USB) interface
- Has speed-optimized firmware
- Supports:
  - DESfire EV1 4K Version 2
  - MIFARE Ultralight C
  - MIFARE SAM AV2



**Figure 2-25: CAM Reader/Writer and Antenna Switch Module**

## 2.12 Printer System

The following subsections contain information regarding the printer system.

### 2.12.1 Overview

The FVD is equipped with one printer AP5200MC for MMSR and an AP4200 for paper receipts.

### 2.12.2 Magnetic Media Swipe Reader AP5200MC Printer



**Figure 2-26: Receipt Printer — AP 5200MC**

The printing module contains

- A burster to separate fan-folded MMSRs
- A magnetic encoding unit
- A printing unit

Its compact size and reliable hardware makes it the ideal module for the FVD environment.

Attributes of the AP5200MC:

- Supports two stocks of paper (fan folded)
- Rejection bin to sort defective media.
- Each stock with a capacity of maximum 1600
- Thermal printer module mounted on a removable guidance support
- Second path to switch over if one paper stock finish

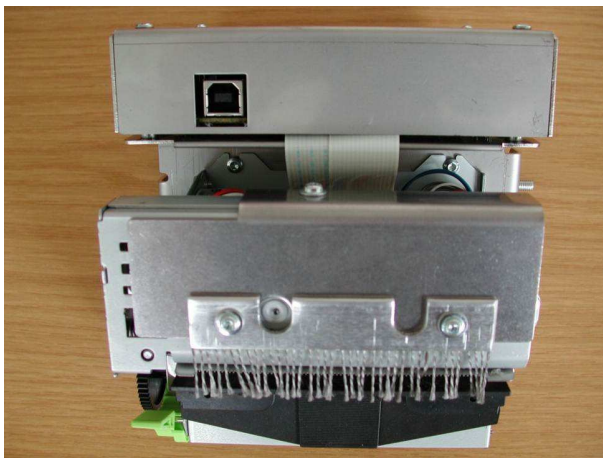
The paper feed path selects the paper media and feeds the selected paper to the reader.

Feature	Description
Print Method	Direct thermal
Resolution	203 x 203 dpi (8 dots/mm)
Magnetic Characteristics	Supported track: ISO Track 3 (according ISO 7811)
Bit Density	Between 75 and 210 bpi (in 14 steps)

**Table 2-18: AP5200MC — Datasheet Extraction**

### 2.12.3 Receipt Printer AP4200

The thermal printer module is mounted on a removable guidance support. One paper stock with a maximum capacity of 1,000 receipts is installed.



**Figure 2-27: Receipt Printer — AP 4200**

The printer uses the thermal printing technique. All types of media that are processed by this printer must have the same width. The paper must comply with the Xerox specification — it must be certified by Xerox and delivered by a Xerox-approved manufacturer.

Attributes of the AP4200:

- Thermal printer module mounted on a removable guidance support
- One stock with a capacity of maximum 1000 receipts.

### 2.12.4 Paper

The detailed paper specification will be part of a specific document.

Parameter	Description
Width	82.5 mm or approximately 3.25 inches
Length	Variable receipt length, from 50 mm to 100 mm or approximately 1.97 inches to 3.94 inches

**Table 2-19: AP 4200 Paper**

# 2.13 Control Electronics

The following subsections contain information regarding the technical data of the FVD.

## 2.13.1 Overview

The FVD is controlled by a personal computer (PC) platform with the necessary interfaces. The single board computer (SBC) is the most important component of the main control unit (MCU) 4.0. Those interfaces that are not provided on the SBC — serial 1 – serial 6, USB 0, input/output (I/O) and 24V out/door control — are integrated on the connector module (COMO), which is connected to the SBC internally via the USB.



Figure 2-28: MCU 4.0

Feature	Description
SBC and Hard Disk	SBC and host of FVD software application and operational data — in the red box
COMO	Interface module — in the black box

Table 2-20: SBC and COMO Information

A 2.5-inch hard disk serves as the permanent data carrier for the operating system and programs and cannot be replaced without opening the MCU 4.0.

## 2.13.2 Main Control Unit 4.0 Technical Data

See Table 2-21: MCU 4.0 — Datasheet Extraction.

Feature	Description
CPU	1.6 GHz, 32 bit
Hard Disk	Automotive 2.5-inch hard disk; >= 80 GB
Memory	4 GB max.
Ethernet	2x 10/100/1000 Base-T Ethernet
Display	Standard VGA
USB 1	5x USB 2.0 — four on the front, one USB on the COMO
Serial Port 2	COM1 on the front — Serial 1 COM3 – COM8 on the COMO
I/O Port	4 x TTL Output — open collector 8 x TTL Input — current loop 4 x switchable 24 V DC — 500mA
Audio	Line-in/line-out on the front for application wave messages
Power supply	24 DC, 35W max, 24 V for COMO

**Table 2-21: MCU 4.0 — Datasheet Extraction**

### NOTE

All USB 2.0 interfaces support bootable USB storage devices depending on the Basic Input Output System settings.

### NOTE

When numbering COM interfaces assigned by the operating system, onboard interfaces are counted first. As a result, “serial 1” corresponds to “COM3” on the COMO, “serial 2” corresponds to “COM4”, etc.

## 2.13.3 Backup Functionality

A compact flash card as a mobile data carrier and or backup medium with minimal 512 MB is required. If not inserted, the backup functionality is not available.

## 2.13.4 Operating System/Software

The operating system is Windows embedded Standard 2009 (Windows XP embedded).

## 2.14 Power Interfaces

The mains power standards shown in Table 2-22: MCU 4.0 — Datasheet Extraction are required.

Table 2-22: MCU 4.0 — Datasheet Extraction

Feature	Description
AC Input	115V +/-15%
Frequency	60 Hz +/-3 Hz
Current Standard	
Standby	< 1.2 A
Operation	< 2.8 A without heating
Worst Case	< 10 A

The AC main supply line to the FVD has to be fused with a 20 A fuse. Mains cable cross section depends on cable length. The maximum cross section of the terminal clamp is 4 mm<sup>2</sup>.

## 2.15 Power Supply

The power manager must be able to guarantee the finalization of an open product vending transaction and a secure PC shutdown in case of a mains failure.

An uninterruptible power supply is in the power manager integrated. The uninterruptible power supply (UPS) backup is an electrical apparatus that provides emergency power to a load when the input power source, typically mains power, fails.



Figure 2-29: Power Manager

UPS key characteristics are as shown in Table 2-23: Data of the Integrated UPS — Sheet Extraction.

Feature	Description
Power	480W
Voltage	24V DC UPS

Table 2-23: Data of the Integrated UPS — Sheet Extraction

## 2.16 X-Bus Device

The X-bus device acts as a slave I/O module connected to a proprietary bus system, mastered by the power manager. The power manager and their slave modules build an automatic I/O control system.

This configuration has the advantage of being able to control the security features without a host.

Door switch, lock switch and dry contact are connected to the X-bus device. An intrusion attempt will be detected. In case of an intrusion, the dry contact can control a siren or a flashing light.

An intrusion attempt can be detected in power state “on” or “off.”

## 2.17 Main Failure

As soon as the input voltage falls below the lower limit — mains failure — the UPS switches to battery and the power-fail signal is sent to the MCU 4.0. If the input voltage rises over the lower limit (mains power is back) before a timeout of approximately 2 seconds, the UPS switches back to the mains.

# 2.18 AC/DC Converter — Main Control Unit Supply

Figure 2-30: AC/DC Converter is an image of the AC/DC converter and Table 2-24: AC/DC Converter — Datasheet Extraction for MCU Supply contains specification information for the AC/DC converter.



Figure 2-30: AC/DC Converter

Feature	Description
AC Input	90V to 264V
Frequency	45 Hz to 65 Hz
Rating	480W
Power Factor	0.95

Table 2-24: AC/DC Converter — Datasheet Extraction for MCU Supply



## 2.19 Battery

Two serial valve-regulated lead-acid (VRLA) batteries are connected to the UPS. They provide secure internal feeding if the power supply voltage is disconnected.

The expected durability of the battery is between three and four years. However, batteries are consumable and are therefore excluded from the warranty. If the batteries are put in storage, they have to be recharged every six months for at least six hours in order to prevent potential damage.



**Figure 2-31: Battery Module**

Feature	Description
Technology	VRLA
Voltage	2 x 12V DC
Capacity	2.3 Ah

**Table 2-25: Battery – Datasheet Extraction**

The capacity of the battery is sufficient to cover the FVD under complete load (including printing of tickets). This is under the following preconditions:

- The battery has been loaded completely before the first mains power failure
- The battery is in a good status

## 2.20 Service Plug

For service personnel, the FVD is equipped with one power outlet (115V, fused with 10A) inside the housing.



Figure 2-32: Service Plug

## 2.21 Siren

A siren is switched on for a preset period of time in case of:

- An unauthorized opening of the FVD door — break-in alarm, which is activated by the door/lock surveillance
- Opening of the door, but the service code is not entered within a given time or a wrong code is entered for three times

The siren is located behind the coin handling system in the FVD housing. This is intended to avoid a fast turning-off of the siren by a break-in.

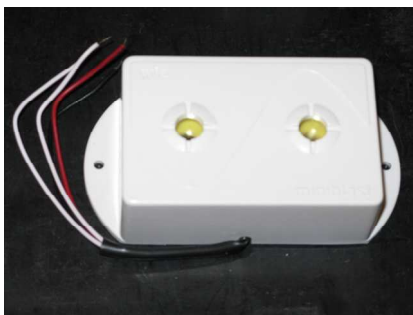


Figure 2-33: Siren

The siren is powered for at least one hour while operating on battery back-up.

Feature	Description
Volume	100 dB at a distance of 1 meter (door open) 75 dB at a distance of 1 meter (door closed)

Table 2-26: Siren — Sheet Extraction

## 2.22 Communication Interfaces

For the communication between the FVDs and Central Data Collection and Reporting System (CDCRS), there will be two different communication modules. On the “Full Function” FVD the NB1600-Wireline will be integrated, and in the “Cashless” FVD the NB1600-LTE will be integrated.

### 2.22.1 NB1600-Wireline Functions

The NB1600-Wireline is a local area network (LAN)-LAN communication module and acts as device server, industrial firewall, Virtual Private Network (VPN) router, protocol converter, I/O module or simple IPC.

The NB1600-Wireline industrial firewall function separates the local network from the factory LAN and allows a system to connect to a central server using only one VPN connection. Using TCP port 80 for the VPN allows the passing of most firewalls in a factory or on the customer side.



Figure 2-34: NB1600-Wireline

Feature	Description
Ethernet	2 Ethernet ports, 10/100 Mbps, Auto MDX, bridged or routed Connector type: RJ45
Digital I/O	2 digital inputs, maximum input voltage of 40V DC, minimum voltage for level 1 (set) is 7.2V DC, maximum voltage for level 0 (not set) is 5.6V DC. Note: A negative input voltage is not recognized. 2 digital outputs, limiting continuous current: 1 A, maximum switching voltage of 60V DC, 42 VAC (Vrms) Maximum switching capacity of 60 W Connector type: 8 pins of 15-pin terminal block
Serial Interface	Protocol: 3-wire RS232 Connector type: 3 pins of 15-pin terminal block
Service Interface	USB host interface providing support for memory de-

Feature	Description
	vices Connector type: USB type A
Power	Redundant power supply inputs Input voltage: 12V DC to 48V DC (-15%/+20%) Maximum power consumption: 5W Connector type: 2+2 pins of 15-pin terminal block
Dimensions	124.2 mm x 45 mm x 98.9 mm, ca. 450 g

**Table 2-27: NB1600-Wireline — Sheet Extraction**

## 2.22.2 NB1600-LTE Wireless Router — Optional

The NB1600-LTE is the industrial mobile broadband router in the FVD.

For mobile internet access a 2G/3G+/4G modem is embedded. All services from Global Packet Radio Service (GPRS) to Long Term Evolution (LTE) are supported — the best available service is selected automatically.

The NB1600-LTE offers two Ethernet ports that are highly configurable. Used as LAN ports, they may form a 2-port switch or have two separated and routed IP networks. Used as wide area network (WAN) ports, the NB1600-LTE acts as an industrial firewall with optional 3G backup and VPN client functionality.



**Figure 2-35: NB1600-LTE Wireless Router**

Feature	Description
Mobile interface	Multimode LTE/4G, HSPA+/3.5G, UMTS/3G, EDGE/2.5G, GPRS and GSM/2G  Global connectivity with LTE 800/900/1800/2100/2600 MHz and UMTS/HSPA+ 900/2100 MHz, GSM/GPRS/EDGE 850/900/1800/1900 MHz  Data rates: max. 100 Mbps downlink/50 Mbps uplink  Antenna connector: SMA female
Digital I/O	2 digital inputs, maximum input voltage 40V DC, mini-

Feature	Description
	<p>maximum voltage for level 1 (set): 7.2V DC, maximum voltage for level 0 (not set): 5.6V DC. Note: a negative input voltage is not recognized.</p> <p>2 digital outputs, limiting continuous current: 1 A, maximum switching voltage 60V DC, 42 VAC (Vrms), maximum switching capacity: 60W</p> <p>Connector type: 8 pins of 15-pin terminal block</p>
Ethernet	<p>2 Ethernet ports, 10/100 Mbps, Auto MDX, bridged or routed</p> <p>Connector type: RJ45</p>
Serial Interface	<p>Protocol: 3-wire RS232</p> <p>Connector type: 3 pins of 15-pin terminal block</p>
Service Interface	<p>USB host interface providing support for memory devices</p> <p>Connector type: USB type A</p>
Power	<p>Redundant power supply inputs</p> <p>Input voltage: 12V DC to 48V DC (-15%/+20%)</p> <p>Maximum power consumption: 5W</p> <p>Connector type: 2+2 pins of 15-pin terminal block</p>
Dimensions and Weight	124.2 mm x 45 mm x 98.9 mm, ca. 450 g

**Table 2-28: NB1600-LTE Wireless Router — Sheet Extraction**

### 2.22.3 Antenna

For the connection to Universal Mobile Telecommunications System (UMTS)/High Speed Packet Access (HSPA) and GPRS/Enhanced Data rates for GSM Evolution (EDGE), a combined antenna is used, which will be mounted on the roof of the FVD in a vandal-proof model. The antenna is inconspicuously mounted on the roof of the FVD, and is therefore not obviously visible.



**Figure 2-36: Antenna**

## 2.23 Loudspeaker and Connector for Headphone Audio Amplifier

For an acoustics passenger user interface a loudspeaker and a headphone connector (3.5 mm mono jack) are provided. The loudspeaker is operated by a 10W amplifier.

## 2.24 Service Panel

If the door is open, the maintenance application will be displayed on the internal service panel. When the door is closed, only the external touch screen is in use. By opening the door, “FVD out of order” appears on the external touch screen and no manipulation is possible on the external touch screen.

The behavior and the functionality of the internal service screen will be the same as that of the external touch screen. The log-in functionality has to be completed on the external touch screen. An in-depth description is explained in the Fare Vending Device Functional Specification document. Table 2-29: Service Panel — Sheet Extraction contains the specifications.



**Figure 2-37: Service Panel**

Feature	Description
Diagonal Size	7 inches
Active Area	152.4 x 91.44 mm
Bezel Opening Area	154.6 x 93.64 mm
Pixel Number	800 x RGB x 480 pixels
Pixel Pitch	0.1905 x 0.1905
Pixel Arrangement	RGB vertical stripe
Bezel Opening Area	a-si TFT active matrix
Display Colors	262k or 16.2M colors
Display Mode	Normal white
Surface Treatment	Antiglare, hard coating ( 3H )

**Table 2-29: Service Panel — Sheet Extraction**

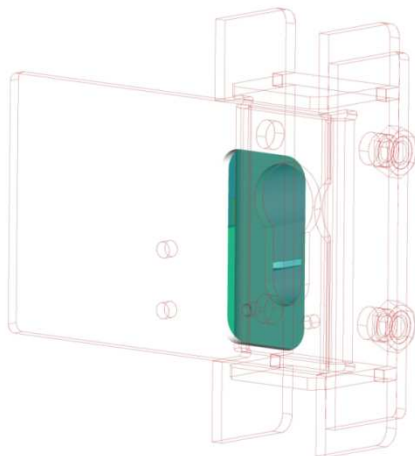
## 1.1 Dust Cover

The locking mechanism is flush mounted on the door plate and protects the drill resistant lock against dust.



**Figure 2-38: Dust CoverI**

Any dust or water that might stick on the cover falls along the housing inside and is dropped and drained out of the chassis at the bottom.



**Figure 2-39: Dust Cover (technical View)**

To open the cover the staff inserts a blocking pin or screwdriver into the small hole and moves the cover to the right exposing the lock. The cover can be secured in the open position by inserting the blocking pin deeper when the cover is in the open position. The cover is automatically closed by removing the blocking pin.



# 3 Norms and Standards

Table 3-1: Norms and Standards contains the norms and standards for CE/ETL, safety, electromagnetic compatibility and radio approval.

Criteria	Description
CE/ETL	Conformity declaration
Safety	Compliant with IEC 60950 with certification for the national characteristics for the United States
Electromagnetic Compatibility	Compliant with EN50121-4:2006/IEC 61000-6-2/IEC 61000-6-3
Radio Approval	Title 47 of the Code of Federal Regulations Part 15, Subpart

**Table 3-1: Norms and Standards**

## 3.1 Operational Conditions

The FVD operates under the temperature and humidity conditions shown in Table 3-2: Environment and Climate.

Criteria	Description
Maximum Temperature	+45°C (outdoor)
Minimum Temperature with Heating	-30°C (outdoor)
Relative Humidity	10 % to 90 % rH, non-condensing
Solar irradiation	No direct sunlight — the FVDs must be sheltered accordingly

**Table 3-2: Environment and Climate**