

How ATMs Work

Automated Teller Machine (ATM)

An **automated teller machine (ATM)** is a computerized telecommunications device that provides the **customers** of a **financial institution** an access to **financial transactions** in a public space without the need for a human clerk or **bank teller**. On most modern ATMs, the customer is identified by inserting a plastic **ATM card** with a **magnetic stripe** or a plastic **smartcard** with a **chip**, that contains a unique card number and some security information, such as an expiration date or **CVC (CVV)**. Security is provided by the customer entering a **personal identification number (PIN)**.



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Alternative uses

ATMs include many functions which are not directly related to the management of one's own bank account, such as:

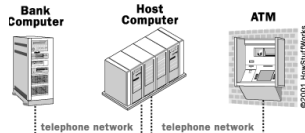
- Deposit currency recognition, acceptance, and recycling
- Paying routine bills, fees, and taxes (utilities, phone bills, social security, legal fees, taxes, etc.)
- Printing bank statements
- Updating passbooks
- Loading monetary value into stored value cards
- Purchasing
- Postage stamps
- Lottery tickets
- Train tickets
- Concert tickets
- Movie tickets
- Shopping mall gift certificates
- Games and promotional features^[52]
- Donating to charities^[53]
- Cheque Processing Module
- Adding pre-paid cell phone credit.



How ATMs Work

How Do ATMs Work?

An ATM is simply a **data terminal** with two input and four output devices. Like any other data terminal, the ATM has to connect to, and communicate through, a **host processor**. The host processor is analogous to an Internet Service Provider (ISP) in that it is the gateway through which all the various ATM networks become available to the cardholder (the person wanting the cash).



Most host processors can support either **leased-line** or **dial-up** machines. Leased-line machines connect directly to the host processor through a four-wire, point-to-point, dedicated **telephone line**. Dial-up ATMs connect to the host processor through a normal phone line using a **modem** and a toll-free number, or through an Internet service provider using a local access number dialed by modem.

How ATMs Work

Sensing Bills

The cash-dispensing mechanism has an **electric eye** that counts each bill as it exits the dispenser. The bill count and all of the information pertaining to a particular transaction is recorded in a **journal**. The journal information is printed out periodically and a hard copy is maintained by the machine owner for two years.

Besides the electric eye that counts each bill, the cash-dispensing mechanism also has a **sensor** that evaluates the **thickness** of each bill. If two bills are stuck together, then instead of being dispensed to the cardholder they are diverted to a **reject bin**. The same thing happens with a bill that is excessively worn, torn, or folded.

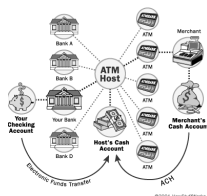
The number of **reject bills** is also recorded so that the machine owner can be aware of the quality of bills that are being loaded into the machine. A high reject rate would indicate a problem with the bills or with the dispenser mechanism.



How ATMs Work

Settlement Funds

- When a cardholder wants to do an ATM transaction, he or she provides the necessary information by means of the card reader and keypad.
- The ATM forwards this information to the host processor, which routes the transaction request to the cardholder's bank or the institution that issued the card.
- If the cardholder is requesting cash, the host processor causes an electronic funds transfer to take place from the customer's bank account to the host processor's account.
- Once the funds are transferred to the host processor's bank account, the processor sends an approval code to the ATM authorizing the machine to dispense the cash.
- The processor then ACHs the cardholder's funds into the merchant's bank account, usually the next bank business day. In this way, the merchant is reimbursed for all funds dispensed by the ATM.



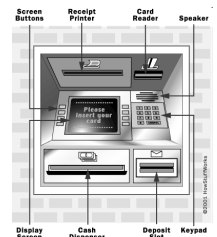
"ACH" is short for "automated clearing house." This bank terminology means that a person or business is authorizing another person or business to draft on an account.

How ATMs Work

Parts of the Machine

An ATM has two input devices:

- **Card reader** - The card reader captures the account information stored on the **magnetic stripe** on the back of an ATM/debit or credit card. The host processor uses this information to route the transaction to the cardholder's bank.
- **Keypad** - The keypad lets the cardholder tell the bank what kind of transaction is required (cash withdrawal, balance inquiry, etc.) and for what amount. Also, the bank requires the cardholder's personal identification number (**PIN**) for verification. Federal law requires that the PIN block be sent to the host processor in **encrypted** form.

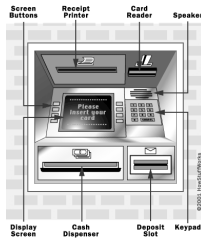


How ATMs Work

Parts of the Machine

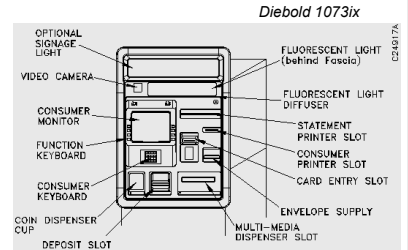
An ATM has four output devices:

- **Speaker** - The speaker provides the cardholder with auditory feedback when a key is pressed.
- **Display screen** - The display screen prompts the cardholder through each step of the transaction process. Leased-line machines commonly use a monochrome or color CRT (cathode ray tube) display. Dial-up machines commonly use a monochrome or color LCD.
- **Receipt printer** - The receipt printer provides the cardholder with a paper receipt of the transaction.
- **Cash dispenser** - The heart of an ATM is the safe and cash-dispensing mechanism. The entire bottom portion of most small ATMs is a safe, because it contains the cash.



How ATMs Work

Parts of the Machine

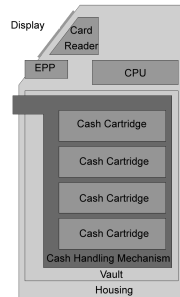


How ATMs Work

Hardware

An ATM is typically made up of the following devices:

- **CPU** (to control the user interface and transaction devices)
- **Magnetic and/or Chip card** reader (to identify the customer)
- **PIN** Pad (similar in layout to a **Touch tone** or **Calculator** keypad), often manufactured as part of a secure enclosure.
- **Secure cryptoprocessor**, generally within a secure enclosure.
- **Display** (used by the customer for performing the transaction)
- **Function key** buttons (usually close to the display) or a **Touchscreen** (used to select the various aspects of the transaction)
- **Record Printer** (to provide the customer with a record of their transaction)
- **Vault** (to store the parts of the machinery requiring restricted access)
- **Housing** (for aesthetics and to attach signage to)



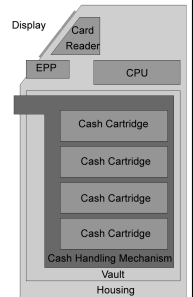
How ATMs Work

Hardware

The **vault** of an ATM is within the footprint of the device itself and is where items of value are kept.

Mechanisms found inside the vault may include:

- Dispensing mechanism (to provide **cash** or other items of value)
- Deposit mechanism, including a Cheque Processing Module and Batch Note Acceptor (to allow the customer to make deposits)
- Security sensors (Magnetic, Thermal, Seismic)
- Locks: (to ensure controlled access to the contents of the vault)
- Journaling systems; some are electronic (a sealed flash memory device based on proprietary standards) or a solid-state device (an actual printer) which accrues all records of activity, including access timestamps, number of bills dispensed, etc.

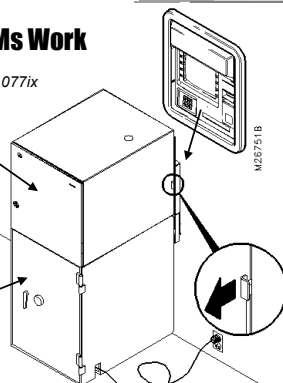


How ATMs Work

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Top chassis devices
consumer & operator
interface devices

Save devices
operator interface devices

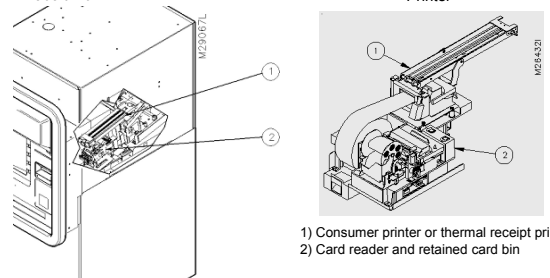


How ATMs Work

Top chassis consumer interface devices

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Printer

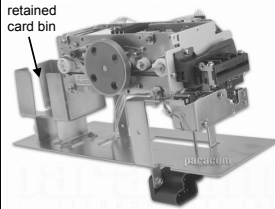


- 1) Consumer printer or thermal receipt printer
- 2) Card reader and retained card bin

How ATMs Work

Top chassis consumer interface devices

Magnetic card reader



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The retained card bin holds all activator cards that are not returned to consumers.

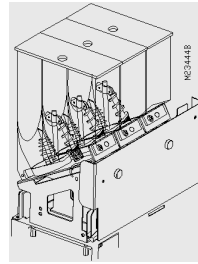
A card may be retained for the following reasons:

- The network commands the cash dispenser to retain the card.
- The card cannot physically be returned.
- The consumer fails to take the card within the time allowed after the transaction session ended.
- A power failure occurs while the card is in the card reader, and the option to return the card on power failure is not included.

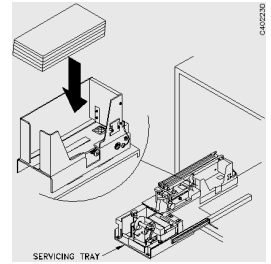
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Top chassis consumer interface devices

Coin Dispenser



Supplemental Dispenser Module



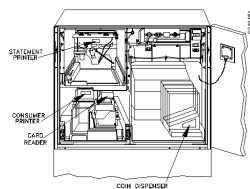
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How ATMs Work

Top chassis operator interface devices



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How ATMs Work

Top chassis operator interface devices

The operator uses top chassis operator interface devices to perform routine operations such as daily settlement, supply replenishment, and problem determination. The operator interface devices are also used for occasional operations such as setup and problem diagnosis of the cash dispenser.

Two levels of operator interfaces are available, the base operator interface and the full function operator interface.

The **base operator interface** uses the *keyboard display module (KDM)* along with the other operator interface devices. The base operator interface is intended for systems that require limited interaction with the operator.

The **full function operator interface** uses the same operator interface devices as the base operator interface but replaces the KDM with the *operator's display module (ODM)* system or devices external to the cash dispenser. Using the full function interface allows the operator a more flexible interaction with the cash dispenser.

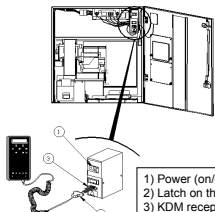
How ATMs Work

Top chassis operator interface devices

KDM (base operator interface)

The KDM is used with the base operator interface. The KDM is a hand-held device containing a 48-key keypad and a two-line (16 characters per line) display. It plugs into a connector near the power switch and is used as an input device during maintenance and diagnostic procedures.

Keyboard Display Module (KDM)



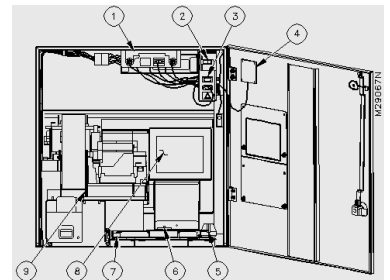
- 1) Power (on/off) switch
- 2) Latch on the KDM plug
- 3) KDM receptacle

How ATMs Work

Top chassis operator interface devices

ODM System (full function operator interface) Diebold 1077ix

1. I/O adapter panel
2. Power (on/off) switch
3. Maintenance mode switch
4. Status indicator
5. Internal card reader
6. Operator's pointing device
7. Mini-QWERTY keyboard
8. Operator's internal monitor
9. Journal printer



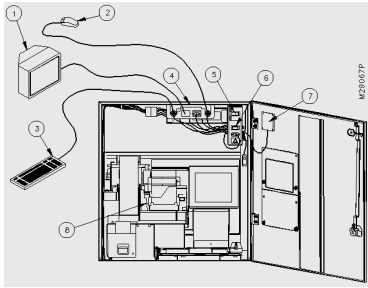
How ATMs Work

Top chassis operator interface devices

External Devices (full function operator interface)

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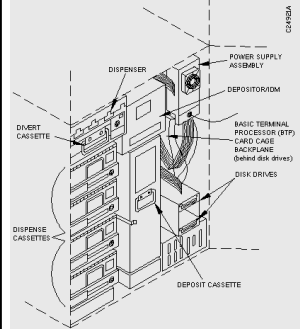
1. External VGA monitor
2. External pointing device
3. External keyboard
4. I/O adapter panel
5. Power (on/off) switch
6. Maintenance mode switch
7. Status indicator
8. Journal printer



How ATMs Work

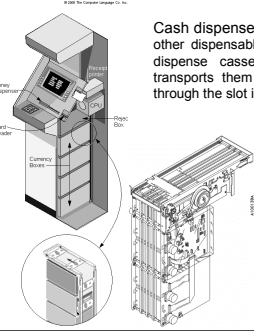
Save devices

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How ATMs Work

Save devices



Cash dispenser – draws notes (or other dispensable media) from the dispense cassettes, stacks, and transports them to the consumer, through the slot in the fascia.



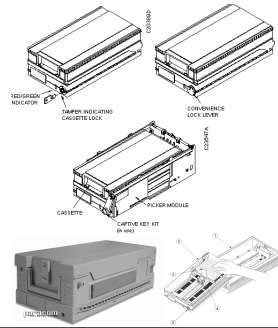
Rubber rollers move one bill at a time from the currency box (each holds about 2,000 bills) to the dispenser area. A sensor determines if two or more bills are stuck together or if the wrong denomination was pulled and causes them to be inserted into the reject box.

How ATMs Work

Save devices

Dispense Cassettes

Divert Cassette



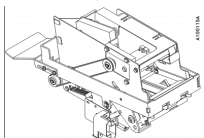
If a note is unacceptable (too mutilated or crumpled to dispense), or if a multiple pick occurs, the dispenser diverts the note(s) to the divert cassette.

How ATMs Work

Save devices

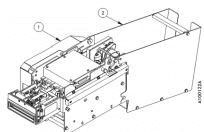
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Depositor



When the consumer inserts an envelope into the deposit slot, the **Depositor** transports it to the Deposit Cassette. As the envelope is transported, it is imprinted by the Deposit Printer with a message of up to 55 characters.

Intelligent Depository Module



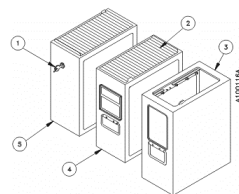
An optional **Intelligent Depository Module (IDM)** is available that will accept a variety of deposit items (various sizes of checks, envelopes, and documents) in addition to the standard deposit envelope.

How ATMs Work

Save devices

Deposit Cassettes

After the consumer's deposit envelope is imprinted by the Deposit Printer, the envelope is delivered to the Deposit Cassette. Deposit Cassettes can hold approximately 500 filled deposit envelopes and are available in either standard (non-locking) or Secure Deposit Cassettes that close and lock automatically when removed from the Depositor.



Deposit Cassette



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How ATMs Work

Save devices

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C Terminal Processor (CTP)



The C terminal processor (CTP) has either a 90 MHz or 166 MHz Pentium™ microprocessor and provides a full range of cash dispenser functions.

The CTP has the following features:

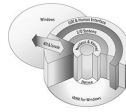
- PC architecture
- 16 MB of RAM (standard) to 128 MB of RAM (maximum)
- PCI primary video display
- Cash dispenser-specific features including DES hardware, battery backed-up SRAM, multi-protocol high-side communications port, and a subsystem bus port (with cash dispenser parallel I/O)
- Integrated device electronics (IDE) controller
- Five ISA expansion slots (three full-size and two half-size)
- Two PCI slots
- Two PC serial ports and one PC parallel port
- Optional second video card
- One or two 2 MB floppy disk drives
- Hard disk drive

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Software

With the migration to commodity PC hardware, standard commercial "off-the-shelf" operating systems and programming environments can be used inside of ATMs. Typical platforms used in ATM development include RMX, OS/2, and Microsoft operating systems (such as MS-DOS, PC-DOS, Windows NT, Windows 2000, Windows XP Professional, or Windows XP Embedded). Java, Linux and Unix may also be used in these environments.

Linux is also finding some reception in the ATM marketplace. An example of this is Banrisul, the largest bank in the south of Brazil, which has replaced the MS-DOS operating systems in its ATMs with Linux. Banco do Brasil is also migrating ATMs to Linux.

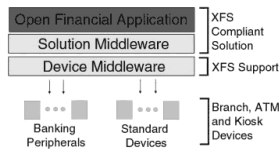


How ATMs Work

XFS (Extensions for Financial Services)

With the move to a more standardized software base, financial institutions have been increasingly interested in the ability to pick and choose the application programs that drive their equipment. WOSA/XFS, now known as CEN XFS (or simply XFS), provides a common API for accessing and manipulating the various devices of an ATM regardless of the manufacturer.

Notable ATM software that operates on XFS platforms include Triton PRISM, Diebold Agilis, CR2 BankWorld, KAL Kalinite, NCR Corporation Apra Edge, Phoenix Interactive VISTAatm, and Wincor Nixdorf Protapas.



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Software Manufacturers used in ATMs in Poland

Manufacturer	Program	Banks
Nomadsystem	Cortex	WBK, Bank Zach.
ACI	Trans 24	PKO S.A., PKO BP
	Base 24	Polcard
NCR	Switch Mark	in France
IFS International	TP2	Kredyt Bank
Stratus	ONZ	Bank Gdański
Arkansas Systems	Arksys	Bank Śląski

ATM Communication Security

Encrypting PIN Pad

The EPP contains the security processor, the software function, the encryption keys and memory to locally perform the PIN-encryption function. Any attempt to gain access to the EPP will destroy the encryption keys; resulting in failure of all subsequent ATM transactions, until the EPP is replaced and a new set of keys is installed.

The encrypting circuit may be:

- a microcontroller programmed to encrypt,
- application-specific integrated circuit (ASIC),
- microcontroller with external core with full implementation of the Triple DES encryption algorithm



Using a cryptographic algorithm, the EPP performs a variety of operations, including DES (Data Encryption Standard), Triple DES and MAC (Message Authentication Code).

ATM Communication Security

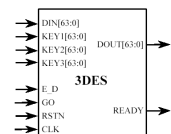
Example of Triple DES Core

This core is a full implementation of the Triple DES encryption algorithm.

Both encryption and decryption are supported.

Available as fully functional and synthesizable VHDL or Verilog soft-core.

Low gate count achieved (10500 gates).



Pin description

Name	Type	Description
RSTN	Input	Core reset, active low
CLK	Input	Core clock signal
GO	Input	Activates encryption or decryption
E_D	Input	Selects encryption or decryption
KEY0[63:0]	Input	Input key K0
KEY1[63:0]	Input	Input key K1
KEY2[63:0]	Input	Input key K2
DIN[63:0]	Input	Input data
DOUT[63:0]	Output	Output data
READY	Output	Ready to operate and output data valid

ATM Communication Security

Cryptographic algorithms DES & Triple DES (3DES)

The encryption method that has been a national standard since 1977 is **DES (Data Encryption Standard)** as described in ANSI X9.8.

DES uses a single secret key to encrypt the PIN at the ATM and the same key to decrypt the PIN after it is received by the processor, to verify the cardholder's identity. A key consists of 64 binary bits of which 56 bits are usually randomly generated and used directly by the algorithm. The other 8 bits are not used.

The strength of DES has been called into question because of the limited size of its key. In 1998 a group called the Electronic Freedom Foundation, using a specially developed computer called the DES Cracker, managed to break DES in less than 3 days. As general technology increases, so does the security required for ATM transactions.

A new specification, ANSI X9.52, was developed to use two 64-bit keys (effectively 128 bits) and apply them three times, hence the name **"Triple DES"**. The procedure for encryption is exactly the same as single DES, but it is repeated three times.

Triple DES technology offers a significantly higher level of security. Since it is based on the same algorithm as single DES, it can be introduced into the existing Electronic Funds Transfer (EFT) network with a minimum of disruption.

ATM Communication Security

Encryption and decryption of PIN-code with 3DES

Encryption:

$$O = E_{K_1}(D_{K_2}(E_{K_1}(I)))$$

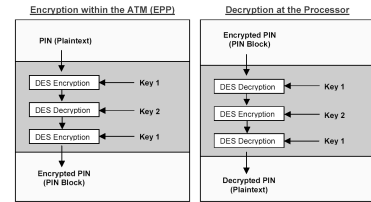
Decryption:

$$O = D_{K_1}(E_{K_2}(D_{K_1}(I)))$$

E/D – DES Encryption/Decryption

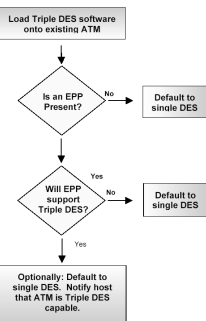
K1,K2 – secret keys

I/O – data blocks: input/output



ATM Communication Security

ATM Software Logic on Triton ATMs



Triple DES software is backwards compatible in that it will operate in terminals that are not equipped with an EPP or with an older EPP that is not Triple DES capable.

In situations where there is a question as to whether an existing ATM is equipped with an EPP that will support Triple DES, the status is determined and optionally reported to the processor through software.

Based on the software query diagram, the ATM will notify the processor of one of four possible statuses:

1. Not triple DES capable (no EPP present), default to single DES mode.
2. Not triple DES capable (EPP present, but not triple DES capable), default to single DES mode.
3. Triple DES capable and EPP present, but running in single DES mode.
4. Triple DES capable & operating in Triple DES mode.

Safety of Cash Dispensing Systems

Skimming



Safety of Cash Dispensing Systems



Safety of Cash Dispensing Systems



Safety of Cash Dispensing Systems



Safety of Cash Dispensing Systems



Safety of Cash Dispensing Systems

