

Livescribe™ Architecture Overview

Version 1.1



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Livescribe Mobile Computing Platform

Livescribe has developed a new paper-based computing platform that bridges the gap between the paper and digital worlds. The platform enables a broad range of new applications in personal productivity, learning, communication, and self expression.

The Livescribe platform includes:

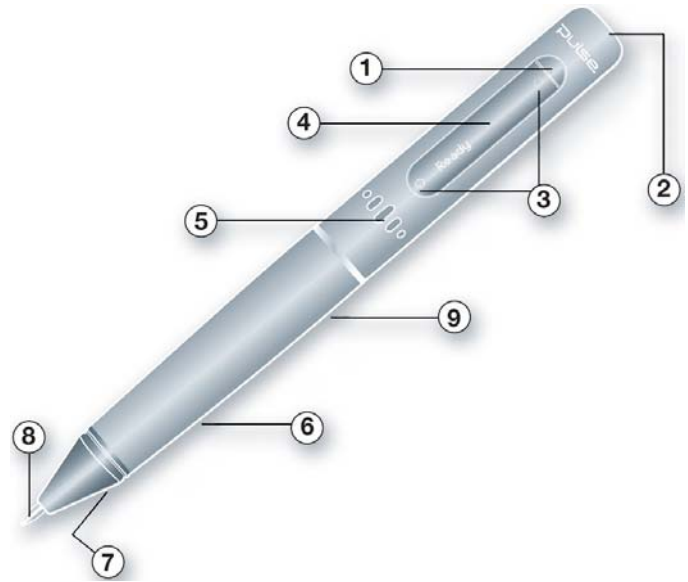
- **Pulse™ Smartpen:** a Montblanc-size computer with advanced processing power, audio/visual feedback, and substantial memory for handwriting capture, audio recording, and applications
- **Livescribe™ Dot Paper:** technology that enables interactive, “live” documents using plain paper printed with micro-dots
- **Software Applications and Tools:** a breadth of solutions that leverage audio/ink capture, handwriting recognition, and Internet connectivity to enhance personal productivity, learning, communication and self expression
- **Development Tools:** easy-to-use tools for consumers and developers to create, publish, and share or sell new applications and content online



Pulse Smartpen

The Livescribe Pulse smartpen is an advanced paper-based computer, providing both audio and visual feedback, powerful processing capabilities, and substantial built-in storage. The Pulse smartpen integrates several components and technologies. It also uses firmware and application software to support the interaction of all of its components and to enable built-in handwriting recognition, and applications such as Paper Replay, among many others.

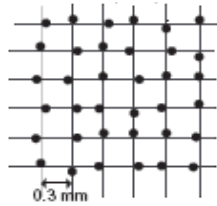
1. Power button
2. Stereo headset jack with an external microphone input
3. Two built-in microphones
4. Organic Light-Emitting Diode (OLED) display
5. Built-in monophonic speaker
6. USB 2.0 connector
7. Infrared camera
8. Removable ink cartridge
9. Rechargeable lithium battery (non-removable)



Livescribe Dot Paper

To perform its many operations, the Pulse smartpen requires Livescribe dot paper. This paper is standard paper with printed microdots on its surface. These dots are nearly invisible to the human eye. However, the Pulse smartpen can easily see these dots and uses them to know which page you are writing on and the exact location on that page. The Pulse smartpen can even see these dots through the ink you write on your pages.

The microdots are printed on each page in a special pattern based on technology from Anoto, Inc. This dot pattern consists of small dots (100 micrometers in diameter) arranged with a spacing of approximately 0.3 mm. The dot pattern overlays an imaginary square grid. The dots are slightly displaced from the grid, with each dot in one of four possible positions, forming the proprietary Anoto dot pattern.



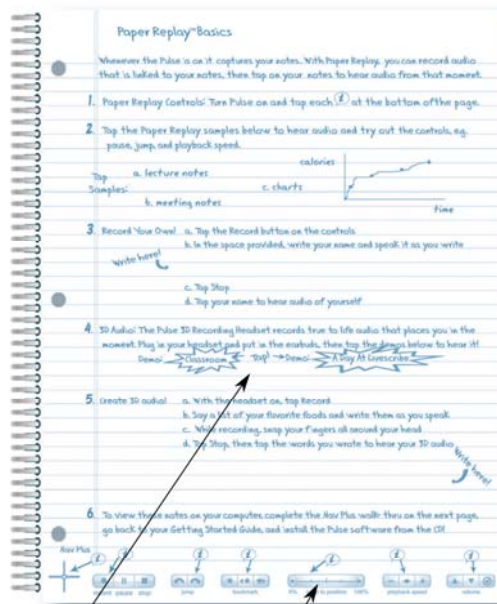
The dot pattern identifies the specific page and locations on the page of the notes you write. The Pulse smartpen uses the dot pattern in a way similar to geographical positioning system (GPS). But, instead of identifying locations on land, it finds locations on paper and stores your writing as digital ink using those locations. Using this patented dot-positioning system (DPS), the Pulse smartpen precisely tracks its own movement on paper. As a result, anything you write – words, numbers or drawings – can be stored, recognized, and intelligently responded to.

The area of the entire Anoto dot pattern is huge, and represents a piece of paper the combined size of Europe and Asia. Livescribe dot paper is based on a subset of the entire Anoto dot pattern.

Open Paper and Fixed Print Paper

The Livescribe Pulse smartpen can use two kinds of dot paper: Open Paper and Fixed Print. A printed page can contain Open Paper regions, Fixed Print regions, or both:

- **Open Paper (OP):** Open Paper refers to regions of a Livescribe dot page that various Pulse smartpen applications can claim at runtime. When a user runs a particular application and writes on those dots, the application can claim these dots.
- **Fixed Print (FP):** Fixed Print refers to regions of a Livescribe dot page that are defined by a Pulse smartpen application during application development. No other application can claim them at run time. Printed graphics on the page identify these areas to the Pulse smartpen user as “paper controls” for operating the application.



Open Paper

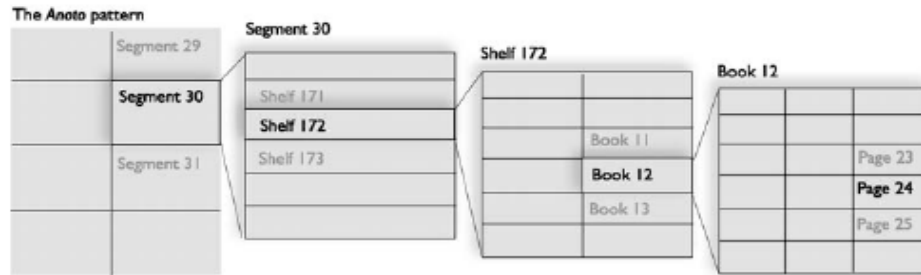
Fixed Print

Most of the paper products from Livescribe contain both Open Paper and Fixed Print regions. For instance, the pages of the Livescribe notebooks have Fixed Print controls at the bottom and Open Paper dots in the blank lines above them. These Fixed Print controls allow users to record, pause, and stop audio sessions while writing notes, access various points in the audio stream, manipulate playback speed, and adjust volume. The special Nav Plus control in the lower left-hand corner activates the main menu, visible on the Pulse smartpen's OLED display.

Open Paper areas (lined or not lined) above the Fixed Print controls can be used by any Open Paper application, such as Paper Replay to capture notes and audio, and Quick Commands, such as Quick Calc, where a user write math problems and have the Pulse smartpen calculate and display the answers.

Dot Pattern Organization

Because the Anoto dot pattern space is so large, the Anoto dot pattern used by Livescribe is divided into smaller parts called pattern pages for administrative and licensing purposes. Pattern pages are grouped into books, which are grouped into shelves, and each shelf belongs to a segment, as shown below. In a specific segment all pattern pages have the same size; all books hold the same amount of pages; and all shelves hold the same amount of books.



A company can license a unique part of the pattern to implement a service or application. During the license period, the company has exclusive use of the licensed pattern area.

A pattern page is identified by a page address, which is a combination of four numbers, like this: *segment.shelf.book.page*

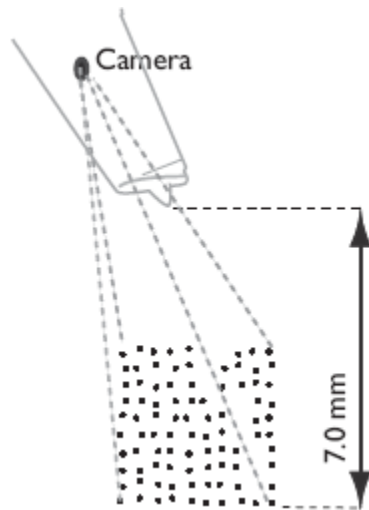
For example, 1.2.3.4 denotes pattern page 4 in book 3, which is located on shelf 2 in segment 1.

The first pattern page in a book and the first book on a shelf are identified as number 0. An asterisk (*) in an address is used to address an entire book or shelf. For example, 1.2.3.* means all pattern pages in book 3, which is located on shelf 2 in segment 1.

How the Pulse Smartpen Works

When you power on the Pulse smartpen and begin writing on Livescribe paper, the Pulse smartpen captures and stores the notes you write. To capture your writing, the Pulse smartpen uses its built-in infrared camera to take digital snapshots of the dot pattern as the tip moves over the paper as you write.

The camera takes snapshots between 50 and 100 times per second. Instead of taking snapshots exactly where the tip is, the infrared camera takes snapshots of the dot pattern up to 7 mm from the tip, depending on how you hold the Pulse smartpen.



The Pulse smartpen processes these snapshots by calculating the absolute position of your writing based on the entire dot pattern for the notebook you are using, and then stores the snapshots for processing.

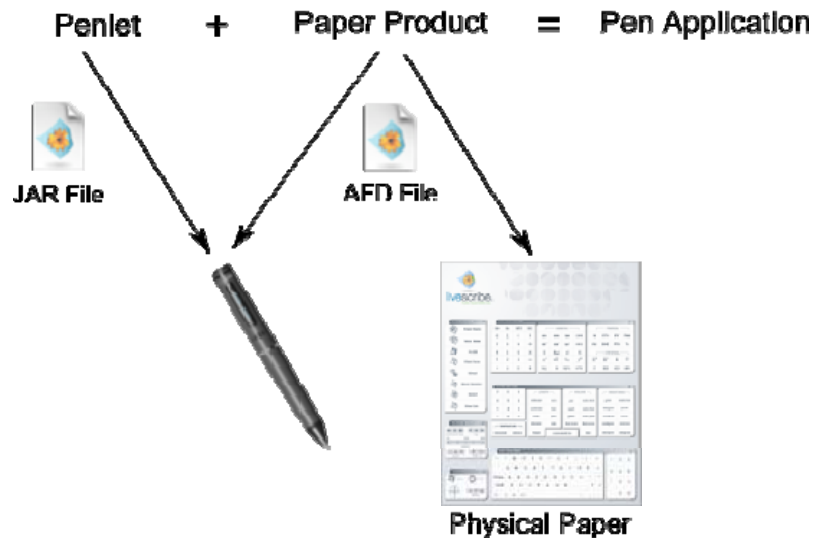
You can record audio along with your written notes by activating the record feature of the Pulse smartpen. This feature is called Paper Replay. When recording audio, the Pulse smartpen links the recorded audio to your notes based on the dot pattern grid. With this information, the Pulse smartpen can play back the audio that was recorded at the exact time you were writing your notes. Specifically, when you tap on your notes with the Pulse smartpen, it locates the position where you are tapping and starts to play back the audio at the position linked to that paper location.



Pulse Smartpen Applications

Pulse smartpen applications are fundamental to the Livescribe mobile computing platform. These applications associate a user's Pulse smartpen actions (writing, tapping, and audio recording) to Livescribe dot paper.

The most basic definition of a Pulse smartpen application is a *Penlet and an associated Paper Product*.



A *Penlet* is a Java application developed to interact with specific active areas defined on a *Paper Product*. The *Penlet* handles smartpen events and performs actions dictated by the active regions. You create a *Penlet* using the Livescribe Java API and a Livescribe IDE plug-in. The Livescribe Java API based on the Java Platform, Micro Edition (Java ME) and CLDC (Connected Limited Device Configuration).

A *Paper Product* consists of:

- the physical dot paper a user interacts with using the Pulse smartpen
- an electronic file representation of the physical dot paper

The electronic file representation of a *Paper Product* is a proprietary container file called an Anoto Functionality Document (*AFD*). The *AFD* describes the *Paper Product* to *Penlets* and to other components in the Livescribe mobile computing platform. *AFD* files are installed on the Pulse smartpen along with *Penlets* that use them. This enables the Pulse smartpen to recognize and use the *Paper Product*.

Glossary

This section lists Livescribe terms and definitions.

3D Recording Headset: Earphones with embedded microphones that capture multi-directional, far-field audio and place objects in the sound landscape surrounding you.

AFD: The persistent electronic representation of a paper product. It is used for communication between the Livescribe system components (that is: the Pulse



smartpen, Livescribe Desktop, Livescribe Desktop, and Livescribe Application Tools).

Anoto pattern: consists of small dots (100 micrometers in diameter) arranged with a spacing of approximately 0.3 mm on an imaginary square grid.

Dot Paper: Physical paper with predefined Livescribe dot pattern printed on it.

Dots: Navigation points printed on dot paper that allow the Pulse smartpen to know its own location on the paper. Developed by Anoto, Inc.

Fixed Print (FP): Refers to a region of dot space on a Livescribe page that is pre-claimed by a Pulse smartpen application during application development. No other application can claim these areas dynamically at runtime. Usually, printed graphics on the page identify these areas to the Pulse smartpen user as “paper controls” for operating the application. Fixed Print regions can also pre-claim areas for interpreting strokes.

FP: See Fixed Print.

Livescribe Desktop: The computer component of the Livescribe platform. Livescribe Desktop that allows you to transfer, store, search, and replay notes from your computer. You can also upload your content to the Web, and manage applications and content on your Pulse smartpen.

Livescribe Online: The web community of Livescribe Pulse smartpen users who post and share Pulse smartpen content.

Nav Plus: A pre-printed or hand-drawn plus sign that lets you navigate your Pulse smartpen applications and files via the Menu system. Nav Plus controls are pre-printed Livescribe paper products, on the USB mobile charging cradle, and elsewhere. Users can create these dynamically on any unclaimed dot-space by drawing a cross and double tapping on the center of the cross.

Notebook: Either a dot paper notebook or a Digitized version of one that the Pulse smartpen can interact with and that Livescribe Desktop can recognize and interact with.

OP: See Open Paper.

Open Paper (OP) Application: An application that can dynamically claim Open Paper regions during runtime. OP applications are not bound to any Paper Product’s AFD file, allowing the application to use any unclaimed dot space. Once OP applications are launched (by the Menu or through some other gesture) the application may create dynamic regions for input UI controls.



Open Paper (OP): Sections of a Livescribe dot page that not currently claimed by a Pulse smartpen applications but are available to be claimed at runtime... When a user runs an application and writes on the dots, the application can claim them.

Paper Product: Definitions and resources required to identify and print dot paper. Paper Products are represented electronically to Penlets and Livescribe Desktop as Anoto Functionality Documents (AFDs).

Paper Replay: Pulse smartpen application that records audio (such as a lecture) at the same time that the user takes notes on Open Paper. Paper Replay synchronizes the notes with the recorded audio. Later, the user can tap on a note and play the audio that was recorded while that note was being written. The notes are considered indexes into the audio stream.

Penlet: Java application installed on the Pulse smartpen. Penlets are created using the Livescribe Java API and are based on the Java Platform, Micro Edition (Java ME) and CLDC (Connected Limited Device Configuration).

Quick Commands: A series of commands you can write on dotted paper to quickly learn the current status of your Pulse smartpen.

Session: (in Paper Replay) the audio (with or without linked notes) that is recorded between the time the user taps Start and Stop on the Paper Replay paper controls.

Smartpen Application: The combination of a Penlet and Paper Product that enables a Pulse smartpen to interact with dot paper.