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Fingerprint identification for PC and Web solutions

# VeriFinger SDK

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VeriFinger is a fingerprint identification technology intended for biometric systems developers and integrators. The technology assures system performance with fast, reliable fingerprint matching in 1-to-1 and 1-to-many modes.

VeriFinger is available as a software development kit that allows development of PC- and Web-based solutions on Microsoft Windows, Linux and Mac OS X platforms.

- 1500+ end-user product brands in 100+ countries used the VeriFinger algorithm over the past 14 years.
- Full NIST MINEX compliance and Fingerprint Verification Competition (FVC) awards since 2000.
- Fast rolled and flat fingerprint matching that is tolerant to fingerprint translation, rotation and deformation.
- Compact fingerprint template and unlimited database size.
- Available as multiplatform SDK that supports multiple scanners and multiple programming languages.
- Reasonable prices, flexible licensing and free customer support.



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# VeriFinger algorithm features and capabilities

*Performance numbers are provided for a PC with Intel Core 2 Q9400 processor (2.67 GHz).*

In 1998 Neurotechnology developed **VeriFinger**, a **fingerprint identification algorithm** designed for biometric system integrators. Since that time, Neurotechnology has released more than 10 versions of the VeriFinger algorithm, providing the most powerful fingerprint recognition algorithms to date.

The latest VeriFinger 6.5 version is **NIST MINEX compliant**, as it is based on the MegaMatcher fingerprint identification engine that has been acknowledged by NIST as suitable for use in personal identity verification (PIV) program applications.

The VeriFinger algorithm follows the commonly accepted fingerprint identification scheme, which uses a set of specific fingerprint points (minutiae) along with a number of proprietary algorithmic solutions that enhance system performance and reliability. Some are listed below:

- **Rolled and flat fingerprints matching.** The VeriFinger algorithm matches flat-to-rolled, flat-to-flat or rolled-to-rolled fingerprints with a high degree of reliability and accuracy, as it is tolerant to fingerprint deformations. Rolled fingerprints have much bigger deformation due to the specific scanning technique (rolling from nail to nail) than those scanned using the “flat” technique. Conventional “flat” fingerprint identification algorithms usually perform matching between flat and rolled fingerprints less reliably due to the mentioned deformations of rolled fingerprints.
- **Tolerance to fingerprint translation, rotation and deformation.** VeriFinger’s proprietary fingerprint template matching algorithm is able to identify fingerprints even if they are rotated, translated, deformed and have only 5 - 7 similar minutiae (usually fingerprints of the same finger have 20 - 40 similar minutiae) and matches 3,500 - 48,000 flat fingerprints per second (see the “technical specifications” chapter for more details).
- **Faster matching using pre-sorted database entries.** For some identification tasks the effective matching speed of VeriFinger may be increased to **20,000 - 60,000** fingerprints per second (on one processor core) by pre-sorting the database entries using certain global features. Flat fingerprint matching is performed first against database entries having global features most similar to those of the test fingerprint. If matching within this group yields no positive result, then the next set of the records with similar global features is selected for matching, and so on, until the matching is successful or the end of the database is reached. In many cases the correct match is found at the beginning of this search sequence. As a result, the number of comparisons required to obtain a positive fingerprint identification decreases drastically, and correspondingly, the matching speed will increase. See the “technical specifications” chapter for more details.
- **Identification capability.** VeriFinger functions can be used in 1-to-1 matching (verification), as well as **1-to-many** mode (identification).
- **Image quality determination.** VeriFinger is able to ensure that only the best quality fingerprint template will be stored into database by using fingerprint image quality determination during enrollment.
- **Adaptive image filtration.** This algorithm eliminates noises, ridge ruptures and stuck ridges for reliable minutiae extraction – even from poor quality fingerprints – with a processing time of 0.1 - 0.2 seconds (for flat fingerprints).
- **Features generalization mode.** This fingerprint enrollment mode generates the collection of generalized fingerprint features from a set of fingerprints of the same finger. Each fingerprint image is processed and features are extracted. Then the features collection set is analyzed and combined into a single generalized features collection, which is written to the database. This way, the enrolled features are more reliable and the fingerprint recognition quality considerably increases.
- **Scanner-specific algorithm optimizations.** VeriFinger 6.5 includes algorithm modes that help to achieve better results for the supported fingerprint scanners.



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# Contents of VeriFinger 6.5 Standard SDK and Extended SDK

VeriFinger SDK is based on VeriFinger fingerprint recognition technology and is intended for biometric systems developers and integrators. The SDK allows rapid development of biometric applications using functionality from the VeriFinger algorithm for Microsoft Windows, Linux and Mac OS X. VeriFinger can be easily integrated into the customer's security system. The integrator has complete control over SDK data input and output.

VeriFinger SDK includes the Device Manager library for working with the supported fingerprint readers. Integrators can also write **plug-ins to support their fingerprint readers** or other devices using the plug-in framework provided with the Device Manager.

The following VeriFinger 6.5 SDKs are available:

- **VeriFinger 6.5 Standard SDK** is intended for PC-based biometric application development. It includes Fingerprint Matcher and Extractor component licenses, programming samples and tutorials, fingerprint scanner support modules and software documentation. The SDK allows the development of biometric applications for Microsoft Windows, Linux or Mac OS X operating systems.
- **VeriFinger 6.5 Extended SDK** is intended for biometric **Web-based** and network application development. It contains all features and components of the Standard SDK. Additionally, the SDK includes Fingerprint Client component licenses, sample client applications, tutorials and a **ready-to-use matching server** component.

The table below compares VeriFinger 6.5 Standard SDK and VeriFinger 6.5 Extended SDK. See the licensing model for more information on specific license types.

| Component licenses that are included with a specific SDK | | |
|---|---|---|
| | **VeriFinger 6.5 Standard SDK** | **VeriFinger 6.5 Extended SDK** |
| • Fingerprint Matcher | 1 single computer license | 1 single computer license |
| • Fingerprint Client [1] | | 3 single computer licenses and 1 concurrent license |
| • Fingerprint Extractor | 1 single computer license | 1 single computer license |
| • Matching Server | | + |

(1) Fingerprint Client component includes Fingerprint Extractor, Fingerprint Segmenter, Fingerprint BSS and Fingerprint WSQ components, which can be also obtained separately.

VeriFinger 6.5 SDK includes programming samples and tutorials that show how to use the components of the SDK to perform fingerprint template extraction or matching against other templates. The samples and tutorials are available for these programming languages and platforms:

| | **Microsoft Windows** 32 & 64 bit | **Linux** 32 & 64 bit | **Mac OS X** |
|---|---|---|---|
| **Programming samples** | | | |
| • C/C++ | + | + | + |
| • C# | + | | |
| • Sun Java 2 | + | + | + |
| • Visual Basic .NET | + | | |
| • Delphi | + | | |
| **Programming tutorials** | | | |
| • C | + | + | + |
| • C# | + | | |
| • Visual Basic .NET | + | | |
| • Sun Java 2 | + | + | + |
| • Delphi | + | | |



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# Biometric Components Description

## Fingerprint Matcher

The Fingerprint Matcher performs fingerprint template matching in 1-to-1 (verification) and 1-to-many (identification) modes. Also the Fingerprint Matcher component includes fused matching algorithm that allows to increase template matching reliability by:

- matching templates that contain 2 or more fingerprint records (note that Fingerprint Segmenter or Fingerprint Client components are required to perform template extraction from images that contain more than one fingerprint);
- matching templates that contain fingerprint, face, voiceprint and/or iris records (note that matching faces and irises requires to purchase Face Matcher, Voice Matcher and Iris Matcher components correspondingly - these components are available in *VeriLook 5.2 SDK*, *Verispeak 1.1 SDK* and *VeriEye 2.5 SDK* respectively; see these products brochures for more information).

"Technical specifications" and "reliability and performance tests" sections below contain information abour the template matching speeds and recognition quality in different scenarios.

One Fingerprint Matcher license is included with VeriFinger 6.5 Standard SDK and VeriFinger 6.5 Extended SDK. More licenses for this component can be purchased any time by VeriFinger 6.5 SDK customers.

## Fingerprint Client

The Fingerprint Client component is a combination of the **Fingerpint Extractor**, **Fingerprint BSS**, **Fingerprint Segmenter** and **Fingerprint WSQ** components. It is intended for the systems that need to support most or all functionality of the mentioned components on the same PC. Using these licenses allows to optimize component license costs as well as reduce license management.

Three non-concurrent licenses and one concurrent license for the Fingerprint Client component are included with VeriFinger 6.5 Extended SDK. More non-concurrent and concurrent licenses for this component can be purchased any time by VeriFinger 6.5 Extended SDK customers.

## Fingerprint Extractor

Fingerprint Extractor creates fingerprint templates from fingerprint images. Image quality control can be applied to accept only good quality fingerprint images.

The Fingerprint Extractor can generalize a fingerprint template from several fingerprint images to improve the template's quality.

See "technical specifications" section for the template extraction speed, the size of fingerprint template and the requirements for fingerprint image size and resolution.

One Fingerprint Extractor license is included with VeriFinger 6.5 Standard SDK and VeriFinger 6.5 Extended SDK. More licenses for this component can be purchased any time by VeriFinger 6.5 SDK customers.



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## Fingerprint BSS (Biometric Standards Support)

The Fingerprint BSS component allows to integrate support for fingerprint template and image format standards and additional image formats with new or existing biometric systems based on VeriFinger SDK.

These biometric standards are supported:

- **BioAPI 2.0 (ISO/IEC 19784-1:2006)** (Framework and Biometric Service Provider for fingerprint identification engine)
- **ISO/IEC 19794-2:2005** (Fingerprint Minutiae Data)
- **ISO/IEC 19794-4:2005** (Finger Image Data)
- **ANSI/INCITS 378-2004** (Finger Minutiae Format for Data Interchange)
- **ANSI/INCITS 381-2004** (Finger Image-Based Data Interchange Format)
- **ANSI/NIST-CSL 1-1993** (Data Format for the Interchange of Fingerprint, Facial, & SMT Information)
- **ANSI/NIST-ITL 1a-1997** (Data Format for the Interchange of Fingerprint, Facial, & SMT Information)
- **ANSI/NIST-ITL 1-2000** (Data Format for the Interchange of Fingerprint, Facial, & SMT Information)
- **ANSI/NIST-ITL 1-2007** (Data Format for the Interchange of Fingerprint, Facial, & Other Biometric Information)
- **ANSI/NIST-ITL 1a-2009** (Data Format for the Interchange of Fingerprint, Facial, & Other Biometric Information)

The Fingerprint BSS component allows conversion between Neurotechnology proprietary fingerprint templates, ISO/IEC 19794-2:2005, ANSI/INCITS 378-2004 and ANSI/NIST-ITL templates.

**Fingerprint pattern classification module** that allows to determine a fingerprint pattern class is included with Fingerprint BSS module. The classification is usually used in forensics, but also it can be used to increase fingerprint matching speed. The defined classes are:

- Left Slant Loop;
- Right Slant Loop;
- Tented Arch;
- Whorl;
- Scar;
- “Unknown” – for the nondetermined classes.

The Fingerprint BSS component also includes:

- JPEG 2000 image format support module with 1000 dpi Fingerprint Profile;
- NIST IHead image format support module;
- module with NIST Fingerprint Image Quality (NFIQ) algorithm, a standard method to determine fingerprint image quality.

**Latent Fingerprint Editor** is available with Fingerprint BSS component. In most cases automated image processing is unable to extract all minutiae or extracts a lot of false minutiae from latent fingerprint image (for example, taken from the crime scene). Therefore, an expert should manually edit a fingerprint template in order to submit it to an AFIS for the identification.

**Sample latent fingerprint template editor** (.NET) shows how to change minutia’s coordinates, direction, type and other parameters.

The Fingerprint BSS component can be used from **C/C++**, **C#** and **Java** applications on all supported platforms. **.NET** wrappers of Windows libraries are provided for .NET developers.

Licenses for the Fingerprint BSS component can be purchased anytime by VeriFinger 6.5 Extended SDK customers.



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## Fingerprint WSQ

The Fingerprint WSQ component allows to integrate support for WSQ (Wavelet Scalar Quantization) image format. The WSQ format allows to compress a fingerprint image up to 10-15 times. WSQ compression process is “lossy”, meaning that the reconstructed image is not equal to the original (some information is lost). However, the WSQ algorithm was specially designed to minimize the loss of fingerprint information therefore the reconstructed image is as close as possible to the original.

Neurotechnology’s implementation of WSQ 3.1 fingerprint image compression was **certified by the FBI** as compliant with the accuracy requirements in the Wavelet Scalar Quantization (WSQ) Gray-Scale Fingerprint Image Compression Specification, Version 3.1.

The component can be used from **C/C++, C#** and **Java** applications on all supported platforms. **.NET** wrappers of Windows libraries are provided for .NET developers.

Licenses for the Fingerprint WSQ component can be purchased anytime by VeriFinger 6.5 Extended SDK.

## Fingerprint Segmenter

The Fingerprint Segmenter components separates fingerprints if an image contains more than one fingerprint. This component enables Fingerprint Extractor component to process fingerprints from scanned **tenprint** card or image captured using scanners that allow to scan two or more fingers at once.

The component can be used from **C/C++**, **C#** and **Java** applications on all supported platforms. **.NET wrappers** of Windows libraries are provided for .NET developers.

The Fingerprint Segmenter licenses can be purchased anytime by VeriFinger 6.5 Extended SDK customers.



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## Matching Server

The Matching Server is ready-to-use software intended for building moderate size web-based and other network-based systems like local AFIS or multi-biometric identification system. The Server software runs on a server PC and allows to perform the biometric template matching on server side using Fingerprint Matcher component.

**Multi-biometric matching** can be enabled by running components for fingerprint, face, voiceprint and iris matching on the same machine.

**Client communication module** that allows sending a task to the Matching Server, querying status of the task, getting the results and removing the task from server, is included with MegaMatcher 4.3 SDK, VeriFinger 6.5 SDK, VeriLook 5.2 SDK, VeriEye 2.5 SDK and VeriSpeak 1.1 SDK. This module hides all low level communications and provides high-level API for the developer.

The components and database support modules with source codes included for Matching Server component are listed in the table below. Custom modules for working with other databases can also be developed by integrator and used with the Matching Server software.

The table below shows what components are available with Matching Server software.

| Components | Microsoft Windows<br>32 & 64 bit | Linux<br>32 & 64 bit | Mac OS X |
|---|---|---|---|
| • Matching server software | + | + | + |
| • Server administration tool API | + | + | |
| **Database support modules** | | | |
| • Microsoft SQL Server | + | | |
| • PostgreSQL | + | + | |
| • MySQL | + | + | |
| • Oracle | + | + | |
| • SQLite | + | + | + |
| **Programming samples** | | | |
| • C# client | + | | |
| • Visual Basic .NET client | + | | |
| • Sun Java 2 web client | + | + | + |
| **Programming tutorials** | | | |
| • C/C++ | + | + | |
| • C# | + | | |
| • Visual Basic .NET | + | | |

The Matching Server component requires a **special license** that allows to run the component on all machines that run the fingerprint, face, iris or palm print matching components obtained by an integrator. The Matching Server software is included with VeriFinger 6.5 Extended SDK.

Also the Matching Server component is included with these Neurotechnology SDKs (see their brochures for more info):

- MegaMatcher 4.3 Standard or MegaMatcher 4.3 Extended SDK;
- VeriLook 5.2 Extended SDK;
- VeriEye 2.5 Extended SDK.
- VeriSpeak 1.1 Extended SDK.



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# Supported fingerprint scanners under Microsoft Windows

*List of fingerprint scanners supported by VeriFinger SDK under Linux and Mac OS X is available on the next page.*

| | Windows XP | | Windows Vista | | Windows 7 | |
|---|---|---|---|---|---|---|
| | 32 bit | 64 bit | 32 bit | 64 bit | 32 bit | 64 bit |
| • ACS AET62 / AET65 | + | | + | + | + | + |
| • ARH AFS 510 | + | | + | + | + | + |
| • Atmel FingerChip | + | | | | | |
| • Athena ASEDrive IIIe Combo Bio F2 | + | + | + | + | + | + |
| • AuthenTec AES4000 / AES2501B / AES2550 / AES2660 / AES2810 | + | | + | + | + | + |
| • BioLink U-Match MatchBook v.3.5 | + | | + | | | |
| • Biometri-CS CS-Pass | + | | + | + | + | + |
| • Biometrika Fx2000 / Fx3000 | + | | + | | | |
| • Biometrika HiScan | + | | | | | |
| • Cross Match L SCAN 500P / Guardian / Verifier 300 / 310 / 320 | + | + | + | + | + | + |
| • Digent FD1000 | + | | | | | |
| • DigitalPersona U.are.U 2000 | + | | + | | | |
| • DigitalPersona U.are.U 4000 / 4500 | + | + | + | + | + | + |
| • Fujitsu MBF200 | + | | | | | |
| • Futronic FS50 / FS80 / FS82 / FS88 / FS90 / eFAM | + | + | + | + | + | + |
| • Futronic FS60 | + | | + | | + | |
| • Green Bit DactyScan26 / DactyScan84n | + | | + | | + | |
| • Hongda S500 / S680 / S700 | + | | + | | | |
| • id3 Certis Image | + | | | | | |
| • Intech SOP1 | + | | | | | |
| • Integrated Biometrics LES650 | + | + | + | + | + | + |
| • Jstac Athena 210 | + | | | | | |
| • Koehlke KIAU-5110B3 / KIA-UM01 | + | | + | | + | |
| • L-1 DFR 2080 / DFR 2090 | + | | + | | + | |
| • L-1 DFR 2100 / DFR 2300 | + | | + | + | + | + |
| • Lumidigm Mercury / Venus Series sensors | + | + | + | + | + | + |
| • NITGEN Fingkey Hamster / Fingkey Hamster II / Fingkey Mouse III / eNBioScan-F | + | + | + | + | + | + |
| • SecuGen Hamster III / Hamster Plus / Hamster IV / iD-USB SC / iD-USB SC/PIV | + | + | + | + | + | + |
| • Shanghai Fingertech BIOCA-111 | + | | + | | + | |
| • Startek FM200 | + | | + | | | |
| • Suprema BioMini / BioMini Plus / SFR300-S / SFU300 | + | + | + | + | + | + |
| • Suprema RealScan-G10 / RealScan-10 / RealScan-D / RealScan-S | + | | + | | + | |
| • Tacoma CMOS | + | | + | | | |
| • Testech Bio-i | + | | + | | | |
| • TST Biometrics BiRD 3 | + | | + | | | |
| • UPEK Eikon / Eikon Solo / Eikon To Go / EikonTouch 300/700 / TCRU1C / TCRU2C | + | | + | + | + | + |
| • ViRDI FOH02SC | + | | + | | + | |
| • VistaMT Multimodal Biometric Device[1] | + | + | + | + | + | + |
| • ZKSoftware ZK4000 / ZK6000 / ZK7000 / ZK8000 | + | | + | | + | |
| • ZKS-1000 | + | | | | | |
| • Zvetco Verifi P4000 | + | | + | + | + | + |

(1) The list of supported OS is given only for fingerprint scanner part of the device; the device is also able to capture faces and irises.



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# Supported fingerprint scanners under Linux and Mac OS X

*List of fingerprint scanners supported by VeriFinger SDK under Microsoft Windows is available on the previous page.*

| | Linux (x86) | | Mac OS X (x86) | |
|---|---|---|---|---|
| | 32-bit | 64-bit | 32-bit | 64-bit |
| • ACS AET62 / AET65 | + | + | + | + |
| • ARH AFS 510 | + | + | | |
| • BioLink U-Match MatchBook v.3.5 | + | | | |
| • DigitalPersona U.are.U 4000 / 4500 | + | + | | |
| • Fujitsu MBF200 | + | + | + | + |
| • Futronic FS50 / FS80 / FS82 / FS88 / FS90 | + | | + | + |
| • Futronic eFAM | + | + | + | + |
| • Integrated Biometrics LES650 | + | | | |
| • Lumidigm Mercury / Venus series sensors | + | | | |
| • NITGEN eNBioScan-F | + | | | |
| • SecuGen Hamster III | + | | | |
| • Suprema BioMini / BioMini Plus / SFR300-S / SFU300 | + | | | |
| • Tacoma CMOS | + | + | + | + |
| • UPEK Eikon / Eikon Solo / Eikon To Go / EikonTouch 300 / 700 / TCRU1C / TCRU2C | + | + | | |



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## System requirements

- **PC** or **Mac** with **x86 (32-bit)** or **x86-64 (64-bit)** compatible processors. 2GHz or better processor is recommended.
- At least **128 MB of free RAM** should be available for the application. Additional RAM is required for applications that perform 1-to-many identification, as all biometric templates need to be stored in RAM for matching. For example, **25,000 templates** (each with 2 fingerprints inside) require about **50 MB of additional RAM**.
- **Free space on hard disk drive (HDD):**
  - at least 1 GB required for the development.
  - 100 MB required for VeriFinger components deployment.
  - Additional space would be required in these cases:
    - VeriFinger does not require the original fingerprint image to be stored for the matching; only the templates need to be stored. However, storing fingerprint images on hard drive for the potential future usage is recommended.
    - Usually a database engine runs on a separate computer (back-end server). However, DB engine can be installed on the same computer for standalone applications. In this case HDD space for templates storage must be available. For example, 25,000 templates (each with 2 fingerprints inside) stored using a relational database would require about 60 MB of free HDD space. Also, the database engine itself requires HDD space for running. Please refer to HDD space requirements from the database engine providers.

- **Fingerprint scanner.** VeriFinger SDK includes support modules for more than 90 fingerprint scanner models under different platforms (see previous section for the list of supported scanners). Integrators can also write **plug-ins to support their fingerprint readers** using the plug-in framework provided with the Device Manager from the VeriFinger SDK.
- **Database engine** or connection with it. VeriFinger templates can be saved into any DB (including files) supporting binary data saving. VeriFinger Extended SDK contains the following support modules for Matching Server:
  - Microsoft SQL Server (only for Microsoft Windows platform);
  - PostgreSQL (for Microsoft Windows and Linux platforms);
  - MySQL (for Microsoft Windows and Linux platforms);
  - Oracle (for Microsoft Windows and Linux platforms);
  - SQLite (for all platforms).

- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching Server component (included in VeriFinger Extended SDK). Communication with Matching Server is not encrypted therefore, if communication must be secured, a dedicated network (not accessible outside the system) or a secured network (such as VPN; VPN must be configured using operating system or third party tools) is recommended.



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- **Microsoft Windows specific requirements:**
  - Microsoft Windows XP / Vista / 7 / Server 2003 / Server 2008, 32-bit or 64-bit. 32-bit platform may be recommended for applications with fingerprint scanners, as most scanners have only 32-bit support modules.
  - Microsoft .NET framework 2.0 or newer (for .NET components usage).
  - One of following development environments for application development:
    - Microsoft Visual Studio 2005 SP1 or newer (for development under C/C++, C#, Visual Basic .Net);
    - Sun Java 1.5 SDK or later;
    - Delphi 7.

- **Linux specific requirements:**
  - Linux 2.6 or newer kernel, 32-bit or 64-bit. 32-bit platform are recommended for applications with fingerprint scanners, as most scanners have only 32-bit support modules.
  - glibc 2.7 or newer.
  - GTK+ 2.10.x or newer libs and dev packages (to run SDK samples and applications based on them).
  - GCC-4.0.x or newer (for application development).
  - GNU Make 3.81 or newer (for application development).
  - Sun Java 1.5 SDK or later (for application development with Java).
  - pkg-config-0.21 or newer (optional; only for Matching Server database support modules compilation).

- **Mac OS X specific requirements:**
  - Mac OS X (version 10.4 or newer).
  - XCode 2.4 or newer (for application development).



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# Technical Specifications

**500 dpi** is the recommended fingerprint image resolution for VeriFinger. The minimal fingerprint image resolution is 250 dpi.

All fingerprint templates should be loaded into RAM before identification, thus the maximum fingerprint templates database size is limited by the amount of available RAM.

The table below shows the technical specifications of VeriFinger 6.5 algorithm. The algorithm's performance depends on fingerprint scanner that was used for collecting fingerprint images, thus the specifications are given for two groups of flat fingerprint scanners:

- **Biometric scanners** in these specifications are scanners with fingerprint sensor's **platen size smaller than 1" x 1"**. These scanners are usually compact and inexpensive. An example of biometric scanner is DigitalPersona U.are.U 4000.
- **AFIS-class scanners** in these specifications are flat fingerprint scanners that have higher quality sensors with **at least 1" x 1" platen** and produce fingerprint images of at least **500 x 500 pixels** or even larger images. These scanners are mostly intended for use in large-scale AFIS projects that need to collect high quality fingerprint images. An example of AFIS-class scanner is Cross Match Verifier 300

VeriFinger fingerprint template matching algorithm can use more than one processor core on **multi-core processors**. The specifications are provided for these processors:

- Intel **Core 2 Q9400** (4 cores), running at **2.67 GHz** clock rate;
- Intel **Core i7-2600** (4 cores), running at **3.4 GHz** clock rate.

**VeriFinger 6.5 algorithm specifications for maximized matching accuracy scenario**

| | Biometric scanners | | AFIS scanners | |
|---|---|---|---|---|
| | Core 2 Q9400 | Core i7-2600 | Core 2 Q9400 | Core i7-2600 |
| Template extraction time (seconds) | 0.15 - 0.20 | 0.09 - 0.12 | 0.20 - 0.25 | 0.12 - 0.15 |
| Matching speed using 1 core (fingerprints per second) | 4,000 - 8,000 | 8,250 - 14,500 | 3,500 - 4,000 | 7,750 - 8,250 |
| Matching speed using 4 cores (fingerprints per second) | 16,000 - 32,000 | 33,000 - 58,000 | 14,000 - 16,000 | 31,000 - 33,000 |
| Matching speed with database pre-sorting [1] using 1 core (fingeprints per second) | 20,000 - 40,000 | 41,250 - 72,500 | 17,500 - 20,000 | 38,750 - 41,250 |
| Template size (bytes) | 4,000 - 5,500 | | 5,000 - 6,000 | |

**VeriFinger 6.5 algorithm specifications for maximized matching speed scenario**

| | Biometric scanners | | AFIS scanners | |
|---|---|---|---|---|
| | Core 2 Q9400 | Core i7-2600 | Core 2 Q9400 | Core i7-2600 |
| Template extraction time (seconds) | 0.15 - 0.20 | 0.09 - 0.12 | 0.20 - 0.25 | 0.12 - 0.15 |
| Matching speed using 1 core (fingerprints per second) | 7,000 - 12,000 | 14,000 - 24,500 | 6,750 - 7,250 | 14,250 - 14,750 |
| Matching speed using 4 cores (fingerprints per second) | 28,000 - 48,000 | 56,000 - 98,000 | 27,000 - 29,000 | 57,000 - 59,000 |
| Matching speed with database pre-sorting [1] using 1 core (fingeprints per second) | 35,000 - 60,000 | 70,000 - 122,500 | 33,750 - 36,250 | 71,250 - 73,750 |
| Template size (bytes) | 700 - 900 | | 800 - 1000 | |

**VeriFinger 6.5 algorithm specifications for minimized template size scenario**

| | Biometric scanners | | AFIS scanners | |
|---|---|---|---|---|
| | Core 2 Q9400 | Core i7-2600 | Core 2 Q9400 | Core i7-2600 |
| Template extraction time (seconds) | 0.15 - 0.20 | 0.09 - 0.12 | 0.20 - 0.25 | 0.12 - 0.15 |
| Matching speed using 1 core (fingerprints per second) | 6,000 - 10,000 | 12,500 - 21,000 | 5,750 - 6,250 | 12,500 - 13,000 |
| Matching speed using 4 cores (fingerprints per second) | 24,000 - 40,000 | 50,000 - 84,000 | 23,000 - 25,000 | 50,000 - 52,000 |
| Matching speed with database pre-sorting [1] using 1 core (fingeprints per second) | 30,000 - 50,000 | 62,500 - 105,000 | 28,750 - 31,250 | 62,500 - 65,000 |
| Template size (bytes) | 200 - 380 | | 250 - 450 | |

*[1] For databases with 500 or more fingerprints. Use with smaller sample fingerprint databases typically yields lower speed.*



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# Reliability and Performance Tests Results

We present the testing results to show how VeriFinger 6.5 technical specifications correspond the practical algorithm's performance and reliability evaluations.

| Flat fingerprint image databases used for VeriFinger 6.5 algorithm testing | | | | | |
|---|---|---|---|---|---|
| Experiment number and description | | Fingerprint reader | Images | Unique fingers | Image size (pixels) |
| 1 | Neurotechnology internal fingerprint database 1 | DigitalPersona U.are.U 4000 | 1,400 | 140 | 318 x 330 |
| 2 | Neurotechnology internal fingerprint database 2 | Futronic FS80 | 1,700 | 170 | 320 x 480 |
| 3 | SONATEQ Fingerprint Database SQ FDB1-75TS1 subset – only left index fingerprint images used | Cross Match Verifier 300 LC | 7,500 | 1,500 | 640 x 480 |

Three tests were performed with each database:

- **Test 1** maximized **matching accuracy**. VeriFinger 6.5 algorithm reliability in this test is shown as **blue curves** on the ROC charts.
- **Test 2** maximized **matching speed**. VeriFinger 6.5 algorithm reliability in this test is shown as **green curves** on the ROC charts.
- **Test 3** minimized **template size**. VeriFinger 6.5 algorithm reliability in this test is shown as **red curves** on the ROC charts.

Template matching was performed using **all 4 cores** of the processor. The performance tests were performed on PCs with these processors:

- Intel **Core 2 Q9400** (4 cores), running at **2.67 GHz** clock rate;
- Intel **Core i7-2600** (4 cores), running at **3.4 GHz** clock rate.

| VeriFinger 6.5 algorithm tests, Experiment 1 (DigitalPersona U.are.U 4000) | | | | |
|---|---|---|---|---|
| | | Test 1 | Test 2 | Test 3 |
| Average fingerprint template size (bytes) | | 4204 | 696 | 284 |
| Average template extraction speed (seconds) | Core 2 Q9400 | 0.146 | | |
| | Core i7-2600 | 0.088 | | |
| Template matching speed (fingerprints per second) | Core 2 Q9400 | 28748 | 47576 | 39492 |
| | Core i7-2600 | 58080 | 96088 | 83512 |
| FRR at 0.001% FAR | | 0.4127 % | 0.9841 % | 1.3810 % |

| VeriFinger 6.5 algorithm tests, Experiment 2 (Futronic FS80) | | | | |
|---|---|---|---|---|
| | | Test 1 | Test 2 | Test 3 |
| Average fingerprint template size (bytes) | | 5555 | 905 | 362 |
| Average template extraction speed (seconds) | Core 2 Q9400 | 0.199 | | |
| | Core i7-2600 | 0.118 | | |
| Template matching speed (fingerprints per second) | Core 2 Q9400 | 16752 | 28424 | 24156 |
| | Core i7-2600 | 33984 | 57776 | 50416 |
| FRR at 0.001% FAR | | 0.4444 % | 0.8627 % | 1.1760 % |



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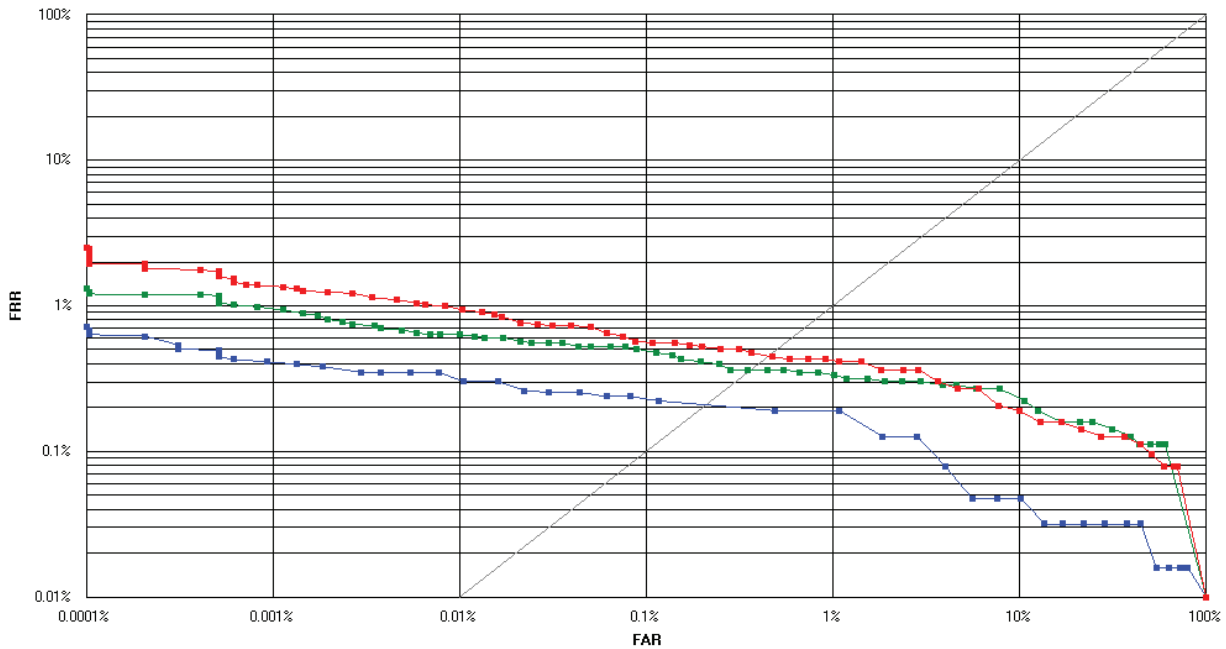
| VeriFinger 6.5 algorithm tests, Experiment 3 (SONATEQ FDB1-75TS1 subset) | | | | |
|---|---|---|---|---|
| | | Test 1 | Test 2 | Test 3 |
| Average fingerprint template size (bytes) | | 5500 | 911 | 365 |
| Average template extraction speed (seconds) | Core 2 Q9400 | 0.235 | | |
| | Core i7-2600 | 0.141 | | |
| Template matching speed (fingerprints per second) | Core 2 Q9400 | 15908 | 28760 | 24760 |
| | Core i7-2600 | 32168 | 58360 | 51224 |
| FRR at 0.001% FAR | | 0.2133 % | 0.3000 % | 0.3333 % |

Receiver operation characteristics (**ROC**) curves are usually used to demonstrate the recognition quality of an algorithm. ROC curves show the dependence of false rejection rate (**FRR**) on the false acceptance rate (**FAR**).

VeriFinger fingerprint identification algorithm versions consistently have shown some of the best results for reliability in several biometric competitions, including the International Fingerprint Verification Competition (FVC2006, FVC2004, FVC2002 and FVC2000) and the National Institute of Standards & Technology (NIST) Fingerprint Vendor Technology Evaluation (FpVTE 2003), where Neurotechnology ranked among the top five companies for accuracy in single-finger tests.




**VeriFinger 6.5 SDK and VeriFinger Embedded 1.1 SDK matching engines with fingerprint templates from Neurotechnology internal database, captured with DigitalPersona U.are.U 4000 reader:**
- **Minimized template size scenario**
- **Maximized matching speed scenario**
- **Maximized matching accuracy scenario**



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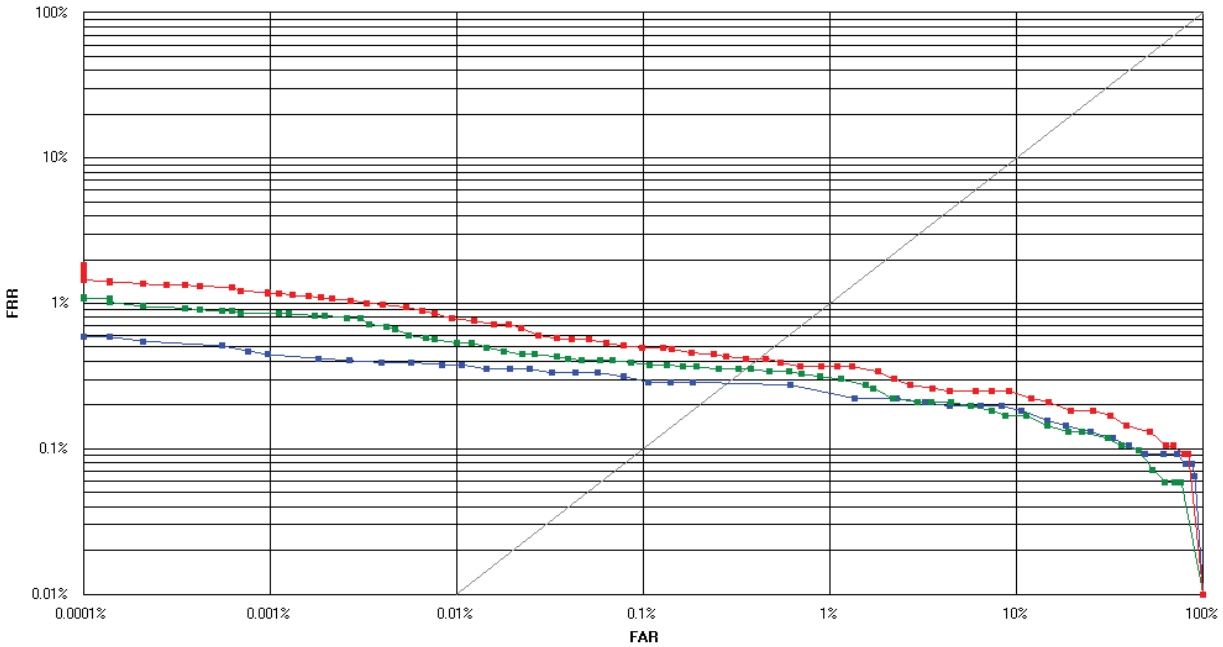
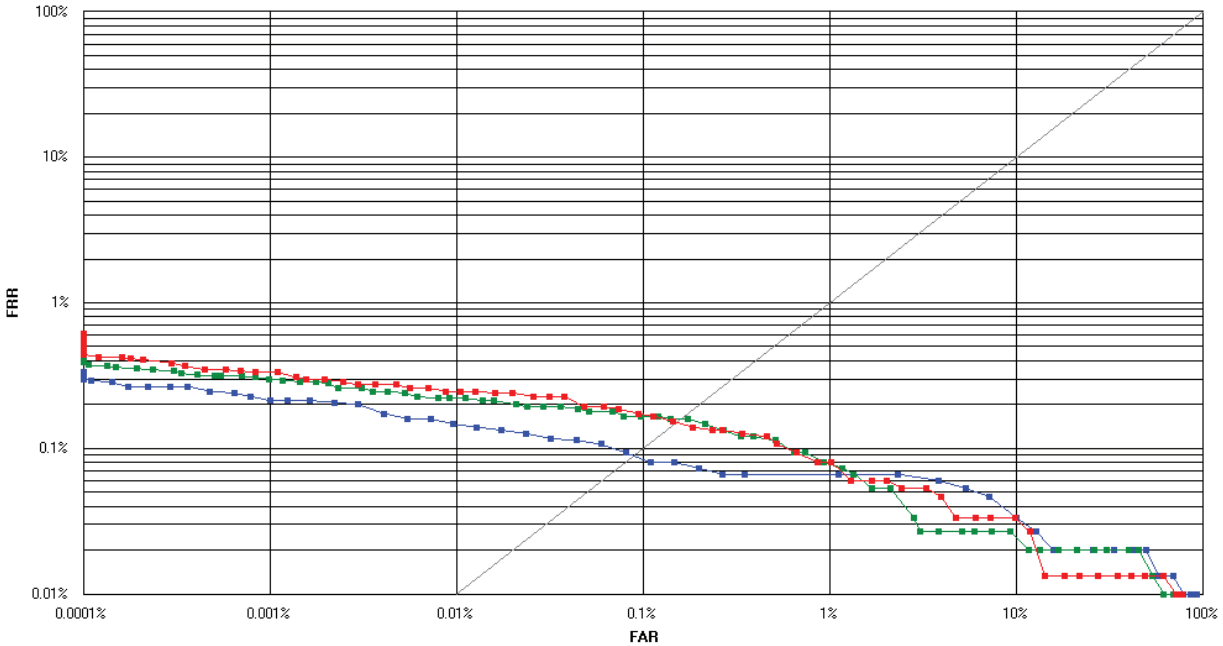



VeriFinger 6.5 SDK and VeriFinger Embedded 1.1 SDK matching engines with fingerprint templates from Neurotechnology internal database, captured with Futronic FS80 reader:
- Minimized template size scenario
- Maximized matching speed scenario
- Maximized matching accuracy scenario




VeriFinger 6.5 SDK and VeriFinger Embedded 1.1 SDK matching engines with fingerprint templates from a subset of SONATEQ Fingerprint Database SQ FDB1-75TS1:
- Minimized template size scenario
- Maximized matching speed scenario
- Maximized matching accuracy scenario



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# VeriFinger Demo, Trial SDK and Related Products

VeriFinger **algorithm demo** application and VeriFinger **30-day SDK Trial** are available for downloading at ***www.neurotechnology.com/download.html.***

These products are related to VeriFinger SDK:

- **VeriFinger Embedded SDK** – a product for fingerprint recognition on **Android** smartphones, tablets and other mobile devices. Produces fingerprint **templates** that are the **same** as in VeriFinger SDK, thus can be also used for developing biometric client-side mobile applications for systems with server-side based on VeriFinger Extended SDK. See "VeriFinger Embedded SDK" brochure for more information.
- **MegaMatcher SDK** – intended for development of AFIS or multi-biometric fingerprint, face, iris, voice and palm print identification products. See "MegaMatcher SDK" brochure for more information.
- **MegaMatcher Accelerator 4.0** – a solution for building the server-side of a large-scale AFIS; available in Standard and Extended versions; a single MegaMatcher Accelerator Standard matches 35 million fingerprints per second and the Extended matches 100 million fingerprints per second.
- **MegaMatcher On Card SDK** – a product for fingerprint, iris and face matching on smart cards. See "MegaMatcher On Card SDK" brochure for more information.
- **Free Fingerprint Verification SDK** – a **freeware** SDK intended for adding fingerprint verification functionality into various applications. See our web site for more information.



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# Licensing VeriFinger SDK

The following licensing model is intended for **end-user** product developers. Integrators who want to develop and sell a VeriFinger-based development tool (with API, programming possibilities, programming samples, etc.), must obtain permission from Neurotechnology and sign a special VAR agreement.

## Product Development

An integrator should obtain either a VeriFinger 6.5 Standard SDK (EUR 339) or VeriFinger 6.5 Extended SDK (EUR 859) to develop a product based on VeriFinger technology. The SDK needs to be purchased just once and may be used by all the developers withing the integrator's company.

VeriFinger SDKs include a number of components; each particular component has specific functionality. A **license** for an individual VeriFinger component is required for **each CPU** that **runs** the component (a processor can have any number of cores).

| VeriFinger SDK components and licenses included with a specific SDK | | |
|---|---|---|
| **Component types** | **VeriFinger 6.5 Standard SDK** | **VeriFinger 6.5 Extended SDK** |
| • Fingerprint Matcher | 1 single computer license | 1 single computer license |
| • Fingerprint Client (1) | | 3 single computer licenses and 1 concurrent license |
| • Fingerprint Extractor | 1 single computer license | 1 single computer license |
| • Matching Server | | + |

(1) Fingerprint Client component includes Fingerprint Extractor, Fingerprint Segmenter, Fingerprint BSS and Fingerprint WSQ components, which can be also obtained separately.

Components are copy-protected – a license is required for a component to run. License activation options are listed below on this page.

Additional component licenses may be obtained by VeriFinger 6.5 SDK customers as required by their development process.

## Product Deployment

To deploy a product developed with VeriFinger 6.3 / 6.4 / 6.5 SDK, an integrator need to obtain only the additional licenses required for the particular VeriFinger 6.5 components that will run on **each CPU** of their customer's computers. The available VeriFinger components and license types for product deployment are the same as for product development.

Each VeriFinger component running on a computer belonging to the integrator's customer requires a license. License activation options are listed below on this page.

Prices for VeriFinger 6.5 SDK and additional VeriFinger component licenses can be found in the next section.

Please refer to the License Agreement on Neurotechnology web site for all licensing terms and conditions.



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## Single computer licenses

A single computer license allows the installation and running of a VeriFinger component installation on one CPU (a processor can have any number of cores). Neurotechnology provides a way to renew the license if the computer undergoes changes due to technical maintenance.

Each single computer license requires **activation** for a VeriFinger component to run. The available activation options are listed below on this page.

Additional single computer licenses for VeriFinger components may be obtained at any time by VeriFinger SDK customers.

## Concurrent network licenses

Concurrent licenses are available for Fingerprint Client component, allowing the installation of this specific component on an unlimited number of computers. An application obtains a specific license to perform template creation (extraction). On average it takes 0.1-0.2 second for fingerprint enrolling. After this interval the license is released, making it available for another user. One Fingerprint Client concurrent license can be shared among hundreds of users, making this license especially **useful for web-based** software.

The number of simultaneously running Fingerprint Client component instances is limited by the number of concurrent licenses. Available license management options are listed below on this page.

Additional concurrent network licenses may be obtained at any time by VeriFinger SDK customers.

## License activation options

Single computer and concurrent network licenses are supplied in two ways:

- **Serial numbers** are used to activate licenses for particular VeriFinger components. The activation is done via the Internet or by email. After activation the network connection is not required for single computer license usage. Note: activation by serial number is not suitable for virtual environments.
- Licenses may be stored in a volume license manager **dongle**. License activation using volume license manager may be performed without connection to the Internet and is suitable for virtual environments.



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## Volume license manager

Volume license manager is used on site by integrators or end users to manage licenses for VeriFinger components. It consists of license management software and a dongle, used to store the purchased licenses. An integrator or an end-user may use the volume license manager in the following ways:

- **Activating single computer licenses** – An installation license for a VeriFinger component will be activated for use on a particular computer. The number of available licenses in the license manager will be decreased by the number of activated licenses.
- **Managing single computer or concurrent licenses via a LAN or the Internet** – The license manager allows the management of installation licenses for VeriFinger components across multiple computers in a LAN or over the Internet. The number of managed licenses is limited by the number of licenses in the license manager. No license activation is required and the license quantity is not decreased. Once issued, the license is assigned to a specific computer on the network.
- **Using license manager as a dongle** – A volume license manager containing at least one license for a VeriFinger component may be used as a dongle, allowing the VeriFinger component to run on the particular computer where the dongle is attached.

Additional VeriFinger component licenses for the license manager may be purchased at any time. Neurotechnology will generate an update code and send it to you. Simply enter the code into the license manager to add the purchased licenses.

## VeriFinger 6.5 enterprise license

The VeriFinger enterprise license allows an **unlimited use** of VeriFinger components in end-user products for a specific territory, market segment or project. Specific restrictions would be included in the licensing agreement.

The enterprise license price depends on the application size and the number of potential users of the application within the designated territory, market segment or project. VeriFinger enterprise licenses are intended for larger projects, with pricing starting at **EUR 20,000**.

VeriFinger algorithm **source code** may be included with a special source code licensing agreement for the selected customers, who are going to obtain VeriFinger enterprise license for at least EUR 100,000 or more.

For more information please contact us.



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# Prices for VeriFinger products

- These prices are **effective from April 2, 2012**. The prices may change in the future, so please **download and review the latest version** of the brochure before making an order.
- Quantity discounts do not accumulate over time.
- The prices do not include any local import duties or taxes.
- Product shipping cost depends on delivery country
- Our customers can gain a discount for our products by getting the Solution Partner status.

## VeriFinger SDK

| | |
|---|---|
| VeriFinger 6.5 Standard SDK | € 339.00 |
| VeriFinger 6.5 Extended SDK | € 859.00 |

## Fingerprint Client concurrent licenses

| | |
|---|---|
| Price per license | € 590.00 |

## Fingerprint Components (prices per single computer license)

| Quantity | Fingerprint Extractor | Fingerprint Client [1] | Fingerprint Matcher |
|---|---|---|---|
| 1-9 | € 20.00 | € 35.00 | € 25.00 |
| 10-19 | € 15.00 | € 26.00 | € 18.00 |
| 20-49 | € 13.00 | € 23.00 | € 16.00 |
| 50-99 | € 11.00 | € 20.00 | € 14.00 |
| 100-199 | € 10.00 | € 18.00 | € 12.50 |
| 200-499 | € 9.00 | € 16.00 | € 11.00 |
| 500-999 | € 8.00 | € 14.00 | € 10.00 |
| 1000-1999 | € 7.00 | € 12.00 | € 9.00 |
| 2000-3999 | € 6.40 | € 11.00 | € 8.00 |
| 4000-7999 | € 5.80 | € 10.00 | € 7.00 |
| 8000 and more | Please contact us for more information | | |

[1] Fingerprint Client component is not available for VeriFinger Standard SDK customers.

## License management

| | |
|---|---|
| Volume license manager | € 16.00 |

## VeriFinger enterprise license

| | |
|---|---|
| VeriFinger 6.5 enterprise license | Please contact us for more information |

VeriFinger products can be ordered:

- online, at ***www.neurotechnology.com/cgi-bin/order.cgi***
- via a local Neurotechnology distributor; the list of distributors is available at ***www.neurotechnology.com/distributors.html***



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