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Fingerprint identification for stand-alone or client-server solutions

VeriFinger SDK

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CONTENTS

VeriFinger is a fingerprint identification technology designed 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 stand-alone and Web-based solutions on Microsoft Windows, Linux, macOS, iOS and Android platforms.

- 1500+ end-user product brands in 100+ countries used the VeriFinger algorithm over the past 26 years.
- Technology awards in NIST MINEX, PFT III, SlapSeg, FpVTE and FVC evaluations.
- 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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Features and capabilities

Performance numbers are provided for a PC with Intel Core i7-8xxx family processor.

In 1998 Neurotechnology developed **VeriFinger**, a **fingerprint identification technology** designed for biometric system integrators. Since that time, Neurotechnology has released more than 10 major and minor versions of the VeriFinger, providing most powerful fingerprint recognition algorithms to date. Numerous awards in competitions and technology evaluations, including NIST MINEX, PFT III and SlapSeg III, have been received by Neurotechnology's fingerprint recognition algorithms.

The VeriFinger algorithm is based on deep neural networks and 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 up to 40,000 flat fingerprints per second (see the "technical specifications" chapter for more details). Also, the matching algorithm has a special mode for matching different scale fingerprint records, as well as optional matching of mirrored fingerprints.

- **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. The image quality determination can tell if a finger is too wet, too dry, pressed too much or not enough, or if only tips of fingers are present.

- **Spoof fingerprint detection.** A deep learning based scanned fingerprint image classification is used to separate live/non-live fingerprints to detect finger presentation attack. This feature covers spoofing attempts performed with ecoflex, wood glue, latex and gelatin and is useful for fraud identification.

- **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 0.6 seconds (for flat fingerprints).

- **Compact fingerprint template.** VeriFinger allows to configure the number and size of fingerprint features in a fingerprint template. Combined with unlimited database size, this capability allows to optimize target system size and performance

- **Scanner-specific algorithm optimizations.** VeriFinger SDK includes algorithm modes that help to achieve better results for the supported fingerprint scanners.

Technology Awards

VeriFinger fingerprint identification technology has received numerous awards in competitions and technology evaluations since its release in 1998.

MINEX evaluations by NIST

- **MINEX III** evaluation was successfully passed in 2015. VeriFinger algorithm is part of the MegaMatcher technology, which was tested by NIST. In **2023** Neurotechnology achieved **first place in the fingerprint template matching** category of the NIST MINEX III evaluation. Combined with the existing **first position in the template generator interoperability category**, Neurotechnology is the **top vendor within the MINEX III**

- **MINEX Ongoing** evaluation was successfully passed in 2014. The **second place in the Ongoing MINEX ranking** for fingerprint matching algorithms was achieved. VeriFinger algorithm as part of the MegaMatcher technology was recognized by the NIST as fully MINEX compliant.

FVC-onGoing results

- In 2020 Neurotechnology's **fingerprint** recognition algorithm has shown the **top result** at the FVC-onGoing evaluation. The fingerprint extractor and matcher, which are included in VeriFinger SDK as part of the MegaMatcher technology, were ranked as the **most accurate** for both FV-STD-1.0 and FV-HARD-1.0 benchmarks.

PFT III (Proprietary Fingerprint Template) Evaluation

- Different versions of Neurotechnology's fingerprint recognition algorithm were submitted to the NIST Proprietary Fingerprint Template Evaluation. The algorithm's template matching accuracy was among the best participants at the previous PFT II evaluation. Our latest submissions to the ongoing **PFT III** are in average the **most accurate** algorithms in all the tests.

SlapSeg III Evaluation

- Neurotechnology's slap fingerprint segmentation algorithm showed off as a **top performer** in the SlapSeg III evaluation, featuring the **fastest** performance and almost the **best accuracy** in most categories of the evaluation

Historic awards and certifications

- **FpVTE 2012** – in 2015 NIST recognized Neurotechnology's fingerprint identification algorithm as **one of the fastest and most accurate** among the evaluation's participants.

- **FpVTE 2003** – one of the best reliability results in the Middle Scale Test were shown. Neurotechnology participated in FpVTE 2003 under the name *Neurotechnologija*.

- In 2011 **FBI certified Neurotechnology's implementation of WSQ image format support**. Certificates and additional information are available.

- Neurotechnology participated in the Fingerprint Verification Competition several times (FVC2000, FVC2002, FVC2004, FVC2006) and **won numerous medals for reliability and performance**.

Contents of VeriFinger 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, macOS, iOS and Android. 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 13.1 SDKs are available:

- **VeriFinger 13.1 Standard SDK** is designed for PC-based, embedded and mobile 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, macOS, iOS and Android operating systems.

- **VeriFinger 13.1 Extended SDK** is designed for biometric **client-server** application development. It contains all features and components of the Standard SDK. Additionally, the SDK includes Fingerprint Client component licenses for PCs and mobile devices, sample client applications, tutorials and a **ready-to-use matching server** component.

The table below compares VeriFinger 13.1 Standard SDK and VeriFinger 13.1 Extended SDK. See the licensing model for more information on specific license types.

Component licenses that are included with a specific SDK		
	VeriFinger 13.1 Standard SDK	**VeriFinger 13.1 Extended SDK**
• Fingerprint Matcher	1 single computer license	1 single computer license
• Mobile Fingerprint Matcher	1 single computer license	1 single computer license
• Fingerprint Client		3 single computer licenses
• Mobile Fingerprint Client		3 single computer licenses
• Fingerprint Extractor	1 single computer license	1 single computer license
• Mobile Fingerprint Extractor	1 single computer license	1 single computer license
• Matching Server		+

VeriFinger 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:

	Windows	**Linux**	**macOS**	**iOS**	**Android**
• C/C++	+	+	+		
• Objective-C [1]				+	
• C#	+				
• Java	+	+	+		+
• Visual Basic .NET	+				
• Python 3	+	+			

(1) There are no tutorials for the Objective-C language.

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 Client component is 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 13.1 SDK, VeriSpeak 13.1 SDK and VeriEye 13.1 SDK respectively; see these products brochures for more information).

The Fingerprint Matcher component matches 40,000 fingerprints per second.

One Fingerprint Matcher license is included with VeriFinger 13.1 Standard SDK and VeriFinger 13.1 Extended SDK. The license can be used on Microsoft Windows, Linux x86-64 or macOS platform. More licenses for this component can be purchased any time by VeriFinger 13.1 SDK customers.

Mobile Fingerprint Matcher

The Mobile Fingerprint Matcher has the same functionality, as the Fingerprint Matcher. It matches 3,000 fingerprints per second and is designed to be used in embedded or mobile biometric systems, which run on ARM Linux, Android or iOS devices. The Android devices should be based on at least Snapdragon S4 system-on-chip (Krait 300 processor with 4 cores running at 1.51 GHz).

One Mobile Fingerprint Matcher license is included with VeriFinger 13.1 Standard SDK and VeriFinger 13.1 Extended SDK. The license can be used on Android, iOS or Linux ARM platform. More licenses for this component can be purchased any time by VeriFinger 13.1 SDK customers.

Fingerprint Client

The Fingerprint Client component includes the capabilities of Fingerprint Extractor component with additional fingerprint image segmentation. It also provides functionality for fingerprint template and image formats support based on biometric standards, as well as advanced image formats support and latent fingerprint editor application.

Fingerprint Client creates fingerprint templates from fingerprint images.

Proprietary image quality control may be applied to accept only good quality fingerprint images. Advanded feedback is available to provide information if a finger is: too wet, too dry, pressed too much, pressed not enough or placed incorrectly with only tips of fingers visible.

The Fingerprint Client extracts a single fingerprint template in 0.6 seconds. The specified performance requires a PC or laptop with at least Intel Core i7-4771 processor.

The Fingerprint Client can generalize a fingerprint template from several images that contain the same fingerprint to improve the template's quality.

The **fingerprint image segmentation** module is used to separate fingerprints if an image contains more than one fingerprint. This functionality enables the Fingerprint Client component to process fingerprints from scanned **tenprint** card or image captured using scanners that allow to scan two or more fingers at once.

Fingerprint pattern classification module is included with the Fingerprint Client component to determine a fingerprint pattern class. 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 and "Unknown" – for the nondetermined classes.

The Fingerprint Client component also includes support modules for **advanced image formats**:

- **JPEG 2000** image format support module with 1000 ppi Fingerprint Profile;
- NIST **IHead** image format support module;
- module with NIST Fingerprint Image Quality (**NFIQ 2.1**) algorithm, a standard method to determine fingerprint image quality.
- **WSQ (Wavelet Scalar Quantization)** image format module allows to compress a fingerprint image up to 10-15 times, as well as read images in this format. 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

Latent Fingerprint Editor is available with the Fingerprint Client 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 Client component allows to integrate support for **fingerprint template and image format standards** with new or existing biometric systems based on VeriFinger SDK. These formats and standards are supported:

- **Neurotechnology proprietary** fingerprint template format
- **BioAPI 2.0 (ISO/IEC 19784-1:2006)** (Framework and Biometric Service Provider for fingerprint identification engine)
- **CBEFF V1.2 (ANSI INCITS 398-2008)** (Common Biometric Exchange Formats Framework)
- **CBEFF V2.0 (ISO/IEC 19785-1:2006 with Amd. 1:2010, 19785-3:2007 with Amd. 1:2010)** (Common Biometric Exchange Formats Framework)
- **CBEFF V3.0 (ISO/IEC 19785-3:2015)** (Common Biometric Exchange Formats Framework)
- **ISO/IEC 19794-2:2005** with **Cor. 1:2009** (Biometric Data Interchange Formats – Finger Minutiae Data (General Record and On-Card Formats)) and **Amd.2:2015** (XML encoding and clarification of defects);
- **ISO/IEC 19794-2:2011** with **Cor. 1:2012** (General Record and On-Card Formats);
- **ISO/IEC 19794-4:2005** with **Cor. 1:2011** (Biometric Data Interchange Formats - Finger Image Data)
- **ISO/IEC 19794-4:2011** with **Cor. 1:2012** (Biometric Data Interchange Formats - Finger Image Data) and **Amd. 2:2015** (XML encoding and clarification of defects)
- **ISO/IEC 29794-1:2016** (Biometric sample quality)
- **ANSI/INCITS 378-2004** (Finger Minutiae Format for Data Interchange)
- **ANSI/INCITS 378-2009** with **Amd. 1:2010** (Finger Minutiae Format for Data Interchange)
- **ANSI/INCITS 381-2004** (Finger Image-Based Data Interchange Format)
- **ANSI/INCITS 381-2009** with **Amd. 1:2011** (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)
- **ANSI/NIST-ITL 1-2011** (Data Format for the Interchange of Fingerprint, Facial, & Other Biometric Information)
- **ANSI/NIST-ITL 1-2011 Update:2013 Edition 2** (Data Format for the Interchange of Fingerprint, Facial, & Other Biometric Information)
- **ANSI/NIST-ITL 1-2011 Update:2015** (Data Format for the Interchange of Fingerprint, Facial, & Other Biometric Information)

The Fingerprint Client component allows conversion between Neurotechnology proprietary fingerprint templates, ISO/IEC 19794-2:2005, ISO/IEC 19794-2:2011, ANSI/INCITS 378-2004, ANSI/INCITS 378-2009 and ANSI/NIST-ITL templates.

All functionalities of the Fingerprint Client 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.

Three licenses for the Fingerprint Client component are included with VeriFinger 13.1 Extended SDK. The licenses can be used on Microsoft Windows, Linux x86-64 or macOS platform. More licenses for this component can be purchased any time by VeriFinger 13.1 Extended SDK customers.

Mobile Fingerprint Client

The Mobile Fingerprint Client component has the same functionality as the Fingerprint Client and is designed to run on **Android** or **iOS** or ARM Linux devices. The component extracts a single fingerprint template in **1.2 seconds**.

Three licenses for the Mobile Fingerprint Client component are included with VeriFinger 13.1 Extended SDK. The licenses can be used on Android, iOS or ARM Linux platform. More licenses for this component can be purchased any time by VeriFinger 13.1 Extended SDK customers.

Fingerprint Extractor

Fingerprint Extractor creates fingerprint templates from fingerprint images. Fingerprint templates can be stored in the following formats by the Fingerprint Extractor component:

- Neurotechnology proprietary fingerprint template format;
- ISO/IEC 19794-2:2005 with Cor. 1:2009 (Biometric Data Interchange Formats – Finger Minutiae Data (General Record and On-Card Formats));
- ISO/IEC 19794-2:2011 with Cor. 1:2012 (General Record and On-Card Formats) and Amd.2:2015 (XML encoding and clarification of defects);
- ANSI/INCITS 378-2004 (Finger Minutiae Format for Data Interchange);
- ANSI/INCITS 378-2009 with Amd. 1:2010 (Finger Minutiae Format for Data Interchange).

Proprietary image quality control may be applied to accept only good quality fingerprint images.

Fingerprint Extractor can generalize a fingerprint template from several fingerprint images to improve template quality.

The component extracts a single fingerprint template in 1.34 seconds. The specified performance requires a PC or laptop with at least Intel Core i7-4771 processor.

One Fingerprint Extractor license is included with VeriFinger 13.1 Standard SDK and VeriFinger 13.1 Extended SDK. More licenses for this component can be purchased any time by VeriFinger 13.1 SDK customers.

Mobile Fingerprint Extractor

The Mobile Fingerprint Extractor has the same functionality as the Fingerprint Extractor and is designed to be run on Android or iOS or ARM Linux devices. The component extracts a single fingerprint template in 1.34 seconds.

One Mobile Fingerprint Extractor license is included with VeriFinger 13.1 Standard SDK and VeriFinger 13.1 Extended SDK. The license can be used on Android, iOS or ARM Linux platform. More licenses for this component can be purchased any time by VeriFinger 13.1 SDK customers.

Matching Server

The Matching Server is ready-to-use software intended for building moderate size client-server 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 13.1 SDK, VeriFinger 13.1 SDK, VeriLook 13.1 SDK, VeriEye 13.1 SDK and VeriSpeak 13.1 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	Linux	macOS
• 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	+		
• Java 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 13.1 Extended SDK.

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

- MegaMatcher 13.1 Standard or MegaMatcher 13.1 Extended SDK;
- VeriLook 13.1 Extended SDK;
- VeriEye 13.1 Extended SDK.
- VeriSpeak 13.1 Extended SDK.

Supported Fingerprint Scanners under Microsoft Windows

List of fingerprint scanners supported by VeriFinger SDK under Linux, macOS, iOS and Android are available on the next page.

	Windows 7	Windows 8	Windows 10/11
• Abilma UNITY	+	+	
• ACS AET62 / AET65	+	+	
• Aratek A400 / A600 / A800 / A900 / FRO900			+
• ARH AFS 510	+		+
• Athena ASEDrive IIIe Combo Bio F2	+	+	
• BioLink U-Match MatchBook v.3.5	+	+	+
• Biometrika Fx2100 / HiScan / HiScan PRO			+
• Cross Match Guardian 100 / 200 / 300 / Module / USB	+	+	+
• Cross Match L Scan 500P / Patrol / Patrol ID / Verifier 320	+	+	+
• DERMALOG LF10 / F1 / ZF1		+	+
• DigitalPersona U.are.U 4500 / 5100 / 5160 / 5200 / 5300 / EikonTouch 710	+	+	+
• Futronic FS10 / FS26 / FS50 / FS64 / FS80 / FS82 / FS88 / FS88H / FS90 / eFAM	+	+	+
• Futronic FS60		+	+
• Green Bit DactyID20 / MultiScan527 / DactyScan84c	+	+	
• Green Bit DactyScan40i			+
• HID Lumidigm M / V series sensors	+	+	+
• HFSecurity HF-4000 / HF-7000	+	+	
• Integrated Biometrics Columbo / Kojak / Sherlock / Watson Mini	+	+	+
• Jenetric LIVETOUCH QUATTRO / LIVETOUCH QUATTRO Compact	+	+	+
• Mantra MAPRO-CX / MARC10 / MELO31 / MFS500 / MORPHS	+	+	+
• NASPS NSP303A			+
• Neubio MARS 02	+	+	
• NEXT Biometrics NB-2033 / NB-3010 / NB-3023 / NB-65200 / NB-65210	+	+	+
• NITGEN Fingkey Hamster / Fingkey Hamster II / Fingkey Mouse III	+	+	+
• NITGEN eNBioScan-F / eNBioScan-C1 / eNBioScan-D Plus / NScan-T	+	+	+
• SecuGen Hamster III / Hamster Plus / Hamster IV / Hamster Air	+	+	+
• SecuGen Hamster Pro / Pro 20 / Pro Duo CL/SC/PIV / iD-USB SC / iD-USB SC/PIV	+	+	
• Startek FM220U		+	+
• Suprema BioMini / BioMini Plus / BioMini Plus2 / BioMini Slim / BioMini Slim 2	+	+	+
• Suprema RealScan-G10 / RealScan-10 / RealScan-D / RealScan-FC	+	+	+
• Suprema RealScan S60			+
• Tatvik TMF20			+
• Thales Cogent CS500f / CSD101i			+
• TopLink Pacific BLUEFiN	+	+	
• Umpi TopScan			+
• UPEK Eikon / Eikon Solo / Eikon To Go / EikonTouch 300 / 500 / 700 / TouchChip	+	+	+
• ZKTeco SLK20R / ZK9500	+	+	+
• Zvetco Verifi P5100	+	+	

Supported Fingerprint Scanners under Linux x86, Linux ARM and Android

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

	Linux x86-64	Linux ARM	Android
• Abilma UNITY	+	+	+
• ACS AET62 / AET65	+		
• Aratek A400 / A600			+
• Aratek BM5510 / BM7500			+ [2]
• Aratek FRO900	+		+
• ARH AFS 510	+		
• DigitalPersona U.are.U 4500 / 5100 / 5160 / 5200 / 5300	+	+	+
• Famoco FX100 Bio			+ [2]
• Futronic FS10 / FS26 / FS50 / FS80 / FS80H / FS82 / FS88 / FS88H	+		+
• Futronic FS28			+
• Futronic eFAM (FS84)	+	+	+
• Green Bit DactyScanID20 / DactyScan40i / DactyScan84c / MultiScan527	+		+
• HFSecurity HF-4000 / HF-7000			+
• Identos Tactivo Mini for Android Optical			+
• Integrated Biometrics Columbo / Kojak / Sherlock / Watson Mini	+		+
• Mantra MARC10 / MELO31			+
• Miaxis SM-201			+
• NEXT Biometrics NB-3010-U / NB-3023-U2 / NB-65200-U	+	+	+
• SecuGen Hamster IV / Hamster Plus / Hamster Pro / Pro 20			+
• SMUFS Biometric SMUFS BT			+
• Startek FPC360U			+
• Suprema BioMini / BioMini Plus / BioMini Slim / BioMini SFU-S20	+		+
• Suprema RealScan-D / SFR300-S / SFU300	+		
• TopLink Pacific BLUEFiN	+		+
• UPEK Eikon / Eikon Solo / Eikon To Go	+	+	+ [1]
• UPEK EikonTouch 300 / 500 / 700 / TouchChip TCRU1C / TCRU2C			+ [1]
• ZKTeco SLK20R			+
• Zvetco Verifi P5100	+		

(1) requires root access to the device.
(2) the device has pre-installed Android OS.

Supported Fingerprint Scanners under macOS and iOS

	macOS		iOS
	Intel	Apple M1	
• Fulcrum Biometrics mobileOne QuickDock			+
• Futronic FS50 / FS80 / FS80H / FS82 / FS88 / FS88H	+	+	
• NEXT Biometrics NB-3010-U / NB-3023-U2 / NB-65200-U	+		
• SMUFS Biometric SMUFS BT			+

System requirements

There are specific requirements for each platform which will run VeriFinger-based applications.

Microsoft Windows platform requirements

- Microsoft Windows **7** / **8** / **10** / **11**.

- PC or laptop with **x86-64 (64-bit)** compatible processors.

  - 2 GHz or better processor is recommended.
  - **AVX2 support is highly recommended.** Processors that do not support AVX2 will still run the VeriFinger algorithms, but in a mode, which will not provide the specified performance. Most modern processors support this instruction set, but please check if a particular processor model supports it.
  - The CPU plugin supports inference on Intel Xeon with Intel AVX2 and AVX-512, Intel Core processors with Intel AVX2, Intel Atom Processors with Intel SSE.

- **2 GB of free RAM is recommended** for general usage scenarios. It is possible to reduce RAM usage for particular scenarios. Also, additional RAM may be required for applications that perform 1-to-many identification, as all biometric templates need to be stored in RAM for matching.

- **Fingerprint reader.** VeriFinger SDK includes support modules for more than 120 fingerprint scanners under Microsoft Windows platform. 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 on Microsoft Windows platform: **Microsoft SQL Server**, **MySQL**, **Oracle**, **PostgreSQL** and **SQLite.**

- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching server component (included in VeriFinger Extended SDK). VeriFinger SDK does not provide communication encryption with the Matching server, therefore, integrators should secure the communication by themselves.

- Microsoft **.NET framework 4.5** or newer (for .NET components usage).

- One of following **development environments** for application development:

  - Microsoft Visual Studio 2012 or newer (for application development under C/C++, C#, Visual Basic .Net)
  - Java SE JDK 8 or newer
  - Python 3.x

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Android platform requirements

- A smartphone or tablet that is running **Android 5.0 (API level 21)** OS or newer.

  - If you have a custom Android-based device or development board, contact us to find out if it is supported.

- ARM-based **1.5 GHz processor recommended** for fingerprint processing in the specified time. Slower processors may be also used, but the fingerprint processing will take longer time.

- At least **1 GB 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.

- **Fingerprint reader.** VeriFinger SDK includes support modules for a number of fingerprint scanners under Android platform. 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.

- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching server component (included in VeriFinger Extended SDK). VeriFinger SDK does not provide communication encryption with the Matching server, therefore, integrators should secure the communication by themselves.

- **PC-side development** environment requirements:

  - Java SE JDK 8 (or higher)
  - AndroidStudio 4.0 IDE
  - AndroidSDK 21+ API level
  - Gradle 6.8.2 build automation system or newer
  - Android Gradle Plugin 4.1.2
  - Internet connection for activating VeriFinger component licenses

iOS platform requirements

- One of the following devices, running **iOS 11.0** or newer:
  - **iPhone 5S** or newer iPhone.
  - **iPad Air** or newer iPad models.

- At least **1 GB 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.

- **Fingerprint reader.** VeriFinger SDK includes support modules for several fingerprint scanners under iOS platform. Also, fingerprint images in **BMP**, **JPG, PNG** or **WebP** formats can be processed thus almost any third-party fingerprint capturing hardware can be used with the VeriFinger technology if it generates images in the mentioned formats.

- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching server component (included in VeriFinger Extended SDK). VeriFinger SDK does not provide communication encryption with the Matching server, therefore, integrators should secure the communication by themselves.

- **Development environment** requirements:

  - a Mac running macOS 10.13 or newer.
  - Xcode 9.3 or newer.

macOS platform requirements

- A Mac running **macOS 10.13** or newer.
  - 2 GHz or better processor is recommended.
  - x86-64 (**Intel**) and ARM (**Apple M1** family) processor architectures supported.

- **2 GB of free RAM is recommended** for general usage scenarios. It is possible to reduce RAM usage for particular scenarios. Also, additional RAM may be required for applications that perform 1-to-many identification, as all biometric templates need to be stored in RAM for matching.

- **Fingerprint reader.** VeriFinger SDK includes support modules for a number of fingerprint scanners under macOS platform. 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 **SQLite** support modules for Matching Server on macOS platform**.**

- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching server component (included in VeriFinger Extended SDK). VeriFinger SDK does not provide communication encryption with the Matching server, therefore, integrators should secure the communication by themselves.

- Specific requirements for **application development**:
  - XCode 9.3 or newer
  - GNU Make 3.81 or newer (to build samples and tutorials development)
  - Java SE JDK 8 or newer.

Linux x86-64 platform requirements

- **Linux 4.9 kernel** or newer is required.

- PC or laptop with **x86-64 (64-bit)** compatible processors.

  - 2 GHz or better processor is recommended.

  - **AVX2 support is highly recommended.** Processors that do not support AVX2 will still run the VeriFinger algorithms, but in a mode, which will not provide the specified performance. Most modern processors support this instruction set, but please check if a particular processor model supports it.

  - The CPU plugin supports inference on Intel Xeon with Intel AVX2 and AVX-512, Intel Core processors with Intel AVX2, Intel Atom Processors with Intel SSE.

- **2 GB of free RAM is recommended** for general usage scenarios. It is possible to reduce RAM usage for particular scenarios. Also, additional RAM may be required for applications that perform 1-to-many identification, as all biometric templates need to be stored in RAM for matching.

- **Fingerprint reader.** VeriFinger SDK includes support modules for a number of fingerprint scanners under Linux platform. 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.

- glibc 2.24 library or newer

- **Database engine** or connection with it. VeriFinger templates can be saved into any DB (including files) supporting binary data saving. VeriFinger Extended SDK contains **MySQL, Oracle, PostgreSQL** and **SQLite** support modules for Matching Server on Linux x86 / x86-64 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). VeriFinger SDK does not provide communication encryption with the Matching server, therefore, integrators should secure the communication by themselves.

- Specific requirements for **application development**:
  - gcc 6.3 or newer
  - GNU Make 3.81 or newer (to build samples and tutorials development)
  - Java SE JDK 8 or newer
  - Python 3.x

ARM Linux platform requirements

We recommend to contact us and report the specifications of a target device to find out if it will be suitable for running VeriFinger-based applications. There is a list of common requirements for ARM Linux platform:

- A device with ARM-based processor, running **Linux 3.2 kernel** or newer.

- ARM-based **1.5 GHz processor recommended** for fingerprint processing in the specified time.
  - **ARMHF** architecture (**EABI 32-bit hard-float ARMv7**) is required.
  - Lower clock-rate processors may be also used, but the fingerprint processing will take longer time

- At least **1 GB 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.

- **Fingerprint reader.** VeriFinger SDK includes support modules for several fingerprint scanners under ARM Linux platform. Also, fingerprint images in **BMP**, **JPG, PNG** or **WebP** formats can be processed thus almost any third-party fingerprint capturing hardware can be used with the VeriFinger technology if it generates images in the mentioned formats.

- glibc 2.17 library or newer

- **Network/LAN connection (TCP/IP)** for client/server applications. Also, network connection is required for using Matching server component (included in VeriFinger Extended SDK). VeriFinger SDK does not provide communication encryption with the Matching server, therefore, integrators should secure the communication by themselves.

- **Development environment** requirements:
  - gcc 4.8 or newer
  - GNU Make 3.81 or newer (to build samples and tutorials development)
  - Java SE JDK 8 or newer

Technical Specifications

500 ppi is the recommended fingerprint image resolution for VeriFinger. The minimal fingerprint image resolution is 250 ppi. Also, the matching algorithm has a special mode for matching different scale fingerprint records, like different image resolutions or age-related changes in finger size.

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.

VeriFinger biometric template extraction and matching algorithm is designed to run on **multi-core processors** allowing to reach maximum possible performance on the used hardware.

VeriFinger 13.1 fingerprint engine specifications				
	Embedded / mobile platform [1]		**PC-based platform** [2]	
Template extraction components	Mobile Fingerprint Extractor	Mobile Fingerprint Client	Fingerprint Extractor	Fingerprint Client
Template extraction time (seconds)	1.34	1.20	1.34	0.60
Template matching components	Mobile Fingerprint Matcher		Fingerprint Matcher	
Template matching speed [3] (fingerprints per second)	3,000		40,000	
Single flat/plain fingerprint record size in a template (bytes)	300 - 3,200 (configurable)			
Single rolled fingerprint record size in a template (bytes)	1,100 - 6,600 (configurable)			

Notes:

(1) Requires to be run on iOS or Android devices based on at least Snapdragon S4 system-on-chip with Krait 300 processor (4 cores, 1.51 GHz).

(2) Requires to be run on PC or laptop with at least Intel Core 7-8xxx family processor or newer to reach the specified performance.

(3) Speeds are provided for the maximized matching speed scenario. The templates should be extracted from images, which are not larger than 500 x 500 pixels. Setting the matching algorithm to higher accuracy or using templates from larger fingerprint images may require more powerful hardware to reach the specified speed

Reliability Tests Results

We present the testing results to show VeriFinger 13.1 template matching algorithm reliability on the data from different fingerprint readers.

Flat fingerprint image datasets used for VeriFinger 13.1 algorithm testing			
	Experiment 1	**Experiment 2**	**Experiment 3**
Fingerprint reader model	DigitalPersona U.are.U 5100	Futronic FS80	Cross Match Verifier 300 LC 2.0
Image / subject / unique finger counts	11900 / 73 / 730	8600 / 43 / 430	10400 / 67 / 670
Session count	10 - 20	20	10 - 20
Image size (pixels)	252 x 324	320 x 480	640 x 480

Two tests were performed with each database:

- **Test 1** maximized **matching accuracy**. The algorithm reliability in this test is shown as **blue curves** on the ROC charts.

- **Test 2** maximized **matching speed**. The algorithm reliability in this test is shown as **red curves** on the ROC charts.

VeriFinger 13.1 algorithm reliability tests						
	Experiment 1		**Experiment 2**		**Experiment 3**	
	Test 1	**Test2**	**Test 1**	**Test2**	**Test 1**	**Test2**
Average template size (bytes)	1740	318	2490	444	2439	442
EER	0.2070 %	0.8102 %	0.0786 %	0.3930 %	0.0379 %	0.1646 %
FRR at 0.1 % FAR	0.2906 %	1.1810 %	0.0734 %	0.5490 %	0.0216 %	0.2028 %
FRR at 0.01 % FAR	0.5565 %	1.5010 %	0.2632 %	0.6628 %	0.0732 %	0.2849 %
FRR at 0.001 % FAR	0.7906 %	1.8870 %	0.4370 %	0.7913 %	0.1092 %	0.4031 %

Receiver operation characteristic (**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**).
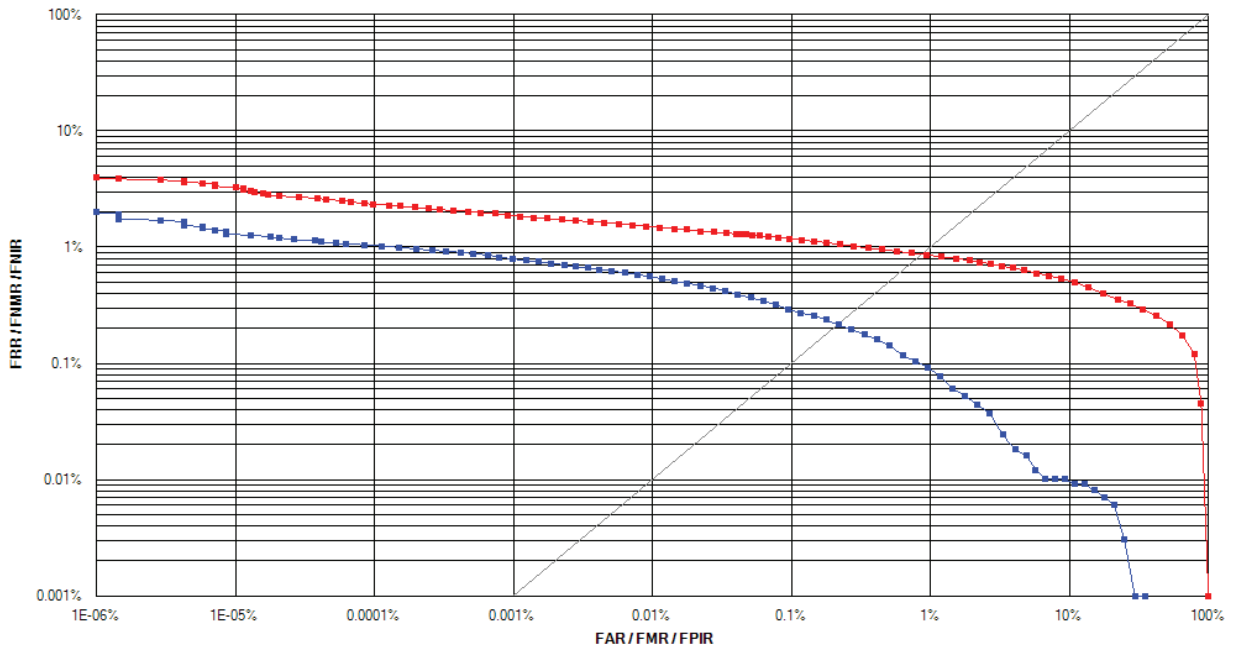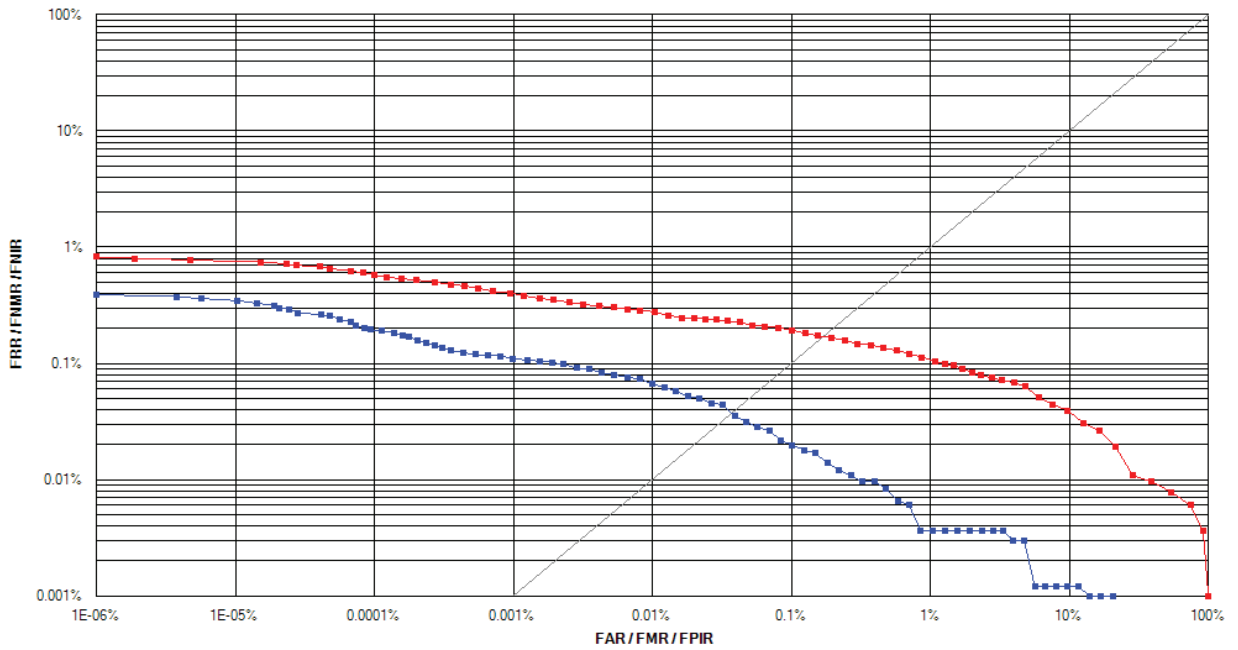

VeriFinger 13.1 SDK matching engine with fingerprint templates from Neurotechnology internal database, captured with DigitalPersona U.are.U 5100 reader:
- Maximized extraction and matching speed scenario
- Maximized extraction and matching accuracy scenario
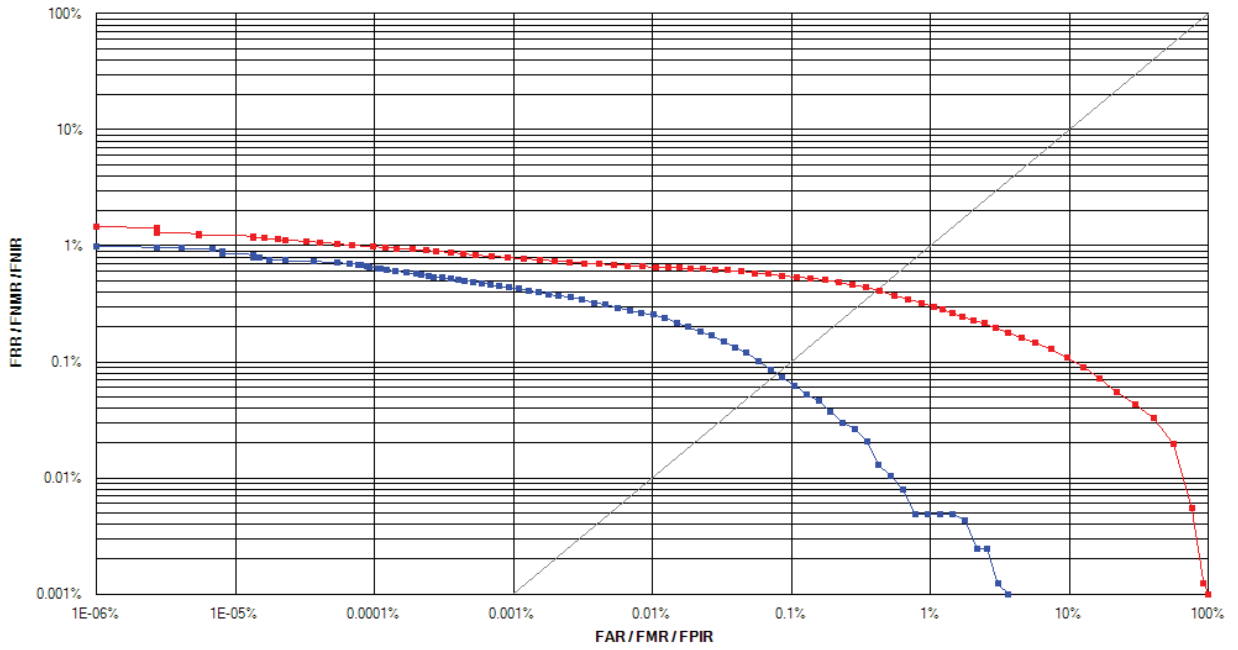
VeriFinger 13.1 SDK matching engine with fingerprint templates from Neurotechnology internal database,
captured with **Futronic FS80 reader:**
■ **Maximized extraction and matching speed scenario**
■ **Maximized extraction and matching accuracy scenario**

VeriFinger 13.1 SDK matching engine with fingerprint templates from Neurotechnology internal database,
captured with **Cross Match Verifier 300 LC 2.0 reader:**
■ **Maximized extraction and matching speed scenario**
■ **Maximized extraction and matching accuracy scenario**

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 (see the corresponding product brochure for more information):

- **MegaMatcher SDK** – for development of AFIS or multi-biometric fingerprint, face, iris, voice and palm print identification products.

- **MegaMatcher On Card SDK** – a product for fingerprint, iris and face matching on smart cards.

- **FingerCell SDK** – for integrating fingerprint recognition into embedded platforms, like low-power, low-memory microcontrollers.

- **Free Fingerprint Verification SDK** – a **freeware** SDK intended for adding fingerprint verification functionality into various applications.

- **NCheck Bio Attendance** – an end-user employee attendance management application designed as **ready-to-use time and attendance system** with biometric fingerprint, face and iris identification; the application uses VeriFinger fingerprint recognition algorithm to check person identity.

Licensing VeriFinger SDK

Product Development

An integrator should obtain either a VeriFinger 13.1 Standard SDK (EUR 339) or VeriFinger 13.1 Extended SDK (EUR 859) to develop a end-user product based on VeriFinger technology. The SDK needs to be purchased just once and may be used for all projects and by all the developers within the integrator's company.

See the "Contents of VeriFinger Standard SDK and Extended SDK" chapter (page 4) for the list of component licenses included with VeriFinger 13.1 Standard and VeriFinger 13.1 Extended SDK.

Integrators can obtain additional component licenses if more component licenses are required for the development process.

Product Deployment

To deploy their developed products, an integrator need obtain licenses of components for every **computer or device**, where component will be installed together with integrator's product. See Product Advisor to find out what specific components will be needed for the deployment of your system. Integrators can purchase additional VeriFinger component licenses if required at anytime.

License activation options

The components are copy-protected. The following license activation options are available:

- **Serial numbers** are used to activate licenses for particular VeriFinger components on particular computer or device. The activation is done via the Internet or by email. After activation the network connection is not required for single computer license usage.
  Notes:
    1. Activation by serial number is **not suitable for ARM-Linux** platform, except BeagleBone Black and Raspberry Pi 3 devices.
    2. Activation by serial number is **not suitable for virtual environments**.

- **Internet activation.** A special **license file** is stored on a computer or a mobile or embedded device; the license file allows to run particular VeriFinger components on that computer or device after **checking** the license over the Internet. **Internet connection** should be available periodically for a short amount of time. A single computer license can be **transferred** to another computer or device by moving the license file there and waiting until the previous activation expires.

- **Volume License Manager.** 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. Volume license manager is **used on site by integrators or end users** to manage licenses for VeriFinger components in the following ways:
    1. **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. .
    2. **Managing single computer licenses via a LAN or the Internet** – The license manager allows the management of installation licenses for VeriFinger components across multiple computers or mobile/embedded devices 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 or device on the network.
    3. **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.

Licenses Validity

All SDK and component licenses are perpetual and do not have expiration. There are no annual fee or any other fees except license purchasing fee. It is possible to move licenses from one computer or device to another. Neurotechnology provides a way to renew the license if the computer undergoes changes due to technical maintenance.

Licensing Agreement

The Licensing Agreement (*https://www.neurotechnology.com/mm_130_sla.html*) contains all licensing terms and conditions.

Note that you unambiguously accept this agreement by placing an order using Neurotechnology online ordering service or by email or other means of communications. Please read the agreement before making an order.

Other licensing options

- **VAR License.** The above described 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. For more information please contact us.

- **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. For more information please contact us.

Prices for VeriFinger products

- These prices are **effective February 13, 2024**. 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.
- Prices do not include local import duties or taxes.
- Product shipping costs depend on delivery country
- Our Customers with Solution Partner status are eligible for product discounts.

VeriFinger SDK	
VeriFinger 13.1 Standard SDK	€ 339.00
VeriFinger 13.1 Extended SDK	€ 859.00

Fingerprint components for PCs (prices per single computer license)			
Quantity	Fingerprint Extractor	Fingerprint Client [1]	Fingerprint Matcher
1-9	€ 20.00	€ 70.00	€ 25.00
10-19	€ 15.00	€ 51.00	€ 18.00
20-49	€ 13.00	€ 45.00	€ 16.00
50-99	€ 11.00	€ 40.00	€ 14.00
100-199	€ 10.00	€ 36.00	€ 12.50
200-499	€ 9.00	€ 32.00	€ 11.00
500 and more	Please contact us for more information		

Embedded fingerprint components (prices per single computer license)			
Quantity	Mobile Fingerprint Extractor	Mobile Fingerprint Client [1]	Mobile Fingerprint Matcher
1-9	€ 13.00	€ 45.00	€ 17.00
10-19	€ 10.00	€ 33.00	€ 12.00
20-49	€ 8.70	€ 29.00	€ 10.80
50-99	€ 7.50	€ 25.50	€ 9.60
100-199	€ 6.70	€ 22.80	€ 8.40
200-499	€ 6.00	€ 20.50	€ 7.60
500 and more	Please contact us for more information		

License management	
Volume license manager	€ 16.00

[1] These components are not available for VeriFinger Standard SDK customers.

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*