

StarSign[®] Bio Token 3.0

USB Token

Reference Manual
Edition 07.2005



Giesecke & Devrient

ID No. 30016576

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This hardware key is in compliance with the following test specification:

CEI EN 61000-4-2; CEI EN 61000-4-3; CISPR22

as required by:

CEI EN 61000-6-1, CEI EN 61000-6-2, CEI EN 61000-6-3, CEI EN 61000-6-4

which are specified for the following test:

- “ESD Immunity test”
- “Radiated radio-frequency and electromagnetic field immunity test”
- “Radiated Emission Verification”

In compliance with the “Essential Requisites” for the EMC Directive 89/336/EEC.



FCC ID: TIJ-BIOTOKEN

Giesecke & Devrient GmbH
StarSign® Bio Token 3.0
Supply: 5V DC
Absorption: 150 mA

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

IMPORTANT REMARKS

Due to the limited space on the product shell, all FCC certification references are on this technical manual.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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About StarSign Bio Token 3.0

Characteristics

StarSign Bio Token 3.0 is a USB-PKI token based on the STARCOS 3.0 operating system. The token comprises a fingerprint sensor and on-token fingerprint verification functionality. The biometric data never leaves the token.

StarSign Bio Token 3.0 is supported by StarSign middleware and can therefore be used for all public key applications supporting MS CAPI (CSP) or PKCS#11.

Fingerprint verification can be used instead of – or in addition to – PIN verification, granting a higher user convenience and a real tie between user and token. This is particularly of interest in applications that require non-repudiation.

Features

Features of StarSign Bio Token 3.0 include:

- Based on STARCOS 3.0 operating system
- On-token sensor, image processing and biometric verification (on-card matching)
- Supported by StarSign middleware; use with all public key applications supporting MS CAPI (CSP) or PKCS#11
- Security system according to 7816-4; secure writing and messaging
- Cryptographic authentication and key management
- Encryption
 - Symmetric encryption: DES, 3DES
 - Asymmetric encryption: RSA-CRT with up to 2048 bits
- Support of up to 4 logical channels
- Biometric enrollment and verification functionality
- LED status indication

Related Standards

StarSign Bio Token 3.0 adheres to the following standards:

- ISO/IEC 7816-3
- ISO/IEC 7816-4
- ISO/IEC 19794-2



More information on the relevant standards may be found in the appendix (see 'C Reference Literature' on page 19).

About the Document

Target Group This manual addresses developers and specialists of smart card applications.

Required Knowledge In order to use StarSign Bio Token 3.0, you should be familiar with:

- Smart card hardware/software
- Related ISO/IEC standards
- Experience in biometric user authentication and cryptographic services

This document assumes that you have a basic understanding of Microsoft Windows terminology and actions. Should you feel that this is not the case, it is suggested that you refer to your Windows manuals first.

Notation In order to facilitate access to required information and to provide quick orientation, the following graphical aids and notations have been used:

| This convention | Indicates |
|-----------------|----------------------------------|
| Italic | Operating system command or mode |



Notes comprise hints and recommendations useful when working with StarSign Bio Token 3.0.



Please read warnings carefully - they are specified to prevent severe malfunctions and loss of data!

The header page of each chapter features an overview of the topics covered in the chapter. All technical terms and abbreviations used are explained in a glossary at the end of the manual.

1 Basics

This chapter provides you with background information on StarSign Bio Token 3.0.

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1.1 General Introduction to Biometrics

Scope Biometrics is the science of measuring physical or behavioral characteristics unique to an individual such as face, voice or fingerprint to verify a person's identity. Biometric characteristics can be described as something we are.

Biometrics and other Types of User Authentication Unlike user authentication based on something the user knows, such as a PIN or password, or something he or she has, e.g. a smart card or other token, biometric systems work by relying on a biometric characteristic - something that is both unique and inseparably tied to the person. While PINs, passwords and keys can be forgotten, lost, lent or stolen, biometrics cannot. The user himself becomes the means of identification, the biological password.

Biometric user authentication can elevate overall system security and enhance ease of use, as users no longer have to remember PINs and passwords.

Enrollment and Verification Before biometric authentication can be used to verify the identity of a user, a biometric enrollment has to be performed beforehand. This means that the characteristic data of the biometric trait has to be captured and saved as a reference in a separate process in advance to verification. During verification, the characteristic data of the biometric trait is captured again and compared to the previously stored reference data. If both data sets coincide to a sufficient level, access is granted.

Biometric Error Rates In contrast to a PIN or password comparison, two different photos or characteristic data sets captured of the same biometric trait will always differ a bit due to positioning, background lighting, etc. Thus, biometric comparison returns a figure which represents a level of coincidence, i.e. the probability that two presented data sets belong to the same person. Depending on a threshold value, access is granted or denied. As a consequence, a slight possibility remains that an unauthorized user be granted access to a protected system or that a legitimate user will be denied access. The threshold value responsible for the error rates can be set by the system administrator. These error rates are characteristic for all biometric systems and are called false acceptance rates (FAR) and false rejection rates (FRR).

Fingerprint Verification Fingerprint verification is not only the most prominent but also one of the most secure and well-understood biometric measures. Software converts the image of a fingerprint into digital form and extracts a set of characteristics, i.e. a template, unique to the user's fingerprint. The characteristic information from one fingerprint contains up to 60 key points. Crucial key points where finger-ridges end or split up are local features called minutiae. They provide unique, identifiable information.

1.2 Biometrics, Smart Cards and Tokens

On-Card Matching

In on-card matching biometric templates, i.e. data sets, are compared with a previously stored biometric reference template in the smart card processor itself. This happens in full analogy to the PIN verification where the entered PIN is sent to the smart card processor and compared on-card with a previously stored PIN. The advantage of this method is that the reference template is stored exclusively in the secure smart card processor environment, reliably protecting sensitive personal data against unauthorized access.

Access Rules

An individual access rule is assigned to each elementary file on the smart card processor. As a consequence, elementary files can be accessed (read/write/update) by cryptographic authentication, PIN verification, biometric authentication or a combination of all three.

Applications

The paramount application for biometrics in combination with cards and tokens is the use in public key infrastructures, where biometric user authentication can be used to enable the cryptographic functions or services offered by the smart card processor. Thus, for example, StarSign Bio Token can be used as a secure signature creating device, that can be legally tied to the token holder with on-card fingerprint verification.

1.3 LED Status

LED Arrangement

StarSign Bio Token 3.0 contains two bicolor LEDs on the top side for visually signaling its current status and operation to the user:

- Left LED
Illuminates in either green or yellow
- Right LED
Illuminates in either red or yellow



Fig. 1 Arrangement of the LEDs

LED Status/Mode

The LED states listed in the table signalize the current status and operation to the user:

| Status/Mode | LED indication | Description |
|-------------------|--|--|
| Idle | Green and red LEDs flash | Waiting for command |
| Place finger | Left yellow LED blinks | Wait for finger |
| Busy | Red LED blinks quickly | StarSign Bio Token 3.0 is busy |
| Success | Green LED illuminated | Enrollment/verification successful |
| Reject | Red LED illuminated | Enrollment/verification failed |
| Boot | Green and red LED illuminated | Booting device |
| <i>TEST</i> mode | Both yellow LEDs flash | Allow diagnostic commands |
| <i>ADMIN</i> mode | Left yellow LED flashes, red LED illuminated | Allows parameter configuration and firmware update |
| Firmware update | Both yellow LEDs illuminated | Signal firmware update status |

Fig. 2 LED status/mode

2 Command Reference

This chapter describes the StarSign Bio Token 3.0 command set. The commands are listed in alphabetical order.

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2.1 ENROLL FINGERPRINT

Scope

ENROLL FINGERPRINT is used to collect a reference data set from the user and store it in the smart card processor.

The command performs the following:

- Scans an image
- Generates a template
- Transmits the template to the smart card processor, where it is stored via the *UPDATE BINARY* command

In order to enhance the quality of the reference template, two or more templates can be merged to one large template.



Before carrying out this command you must create a file for the reference data on the smart card operating system. For details see STARCOS 3.0 reference manual edition 06/2005 or later.

Command

| CLA | INS | P1 | P2 |
|------|------|------|----|
| 'A0' | '10' | '00' | |

- P2 Specifies the merge parameter. Several templates can be merged into one large template before sending the master template to the smart card processor.

'00'

Final enroll command

'01'

Non-final enroll command



Non-final enroll commands grab images, but extracted characteristic features are stored in the internal RAM of StarSign Bio Token 3.0 and not on the smart card processor.

The final enroll command grabs a final image, extracts features, assembles or merges these features with the features in the internal RAM of StarSign Bio Token 3.0 and finally stores them on the smart card processor.

Response

| SW1 | SW2 |
|------|------|
| '90' | '00' |

Status Bytes

This command may return one of the following status bytes.

| Code | Description |
|---------|-------------------------------------|
| '90 00' | Successful operation |
| '65 81' | Memory failure |
| '69 82' | Security status not satisfied |
| '69 86' | Command not allowed (no current EF) |
| '6A 84' | Not enough memory space in the file |
| 'A7 00' | General ARM7 error |
| 'A7 01' | Unknown instruction |
| 'A7 02' | Length error |
| 'A7 11' | Timeout error |
| 'A7 12' | Sweep too slow |
| 'A7 13' | Sweep too fast |
| 'A7 14' | Sweep not straight |
| 'A7 15' | Sweep too short |
| 'A7 16' | Too many defect lines on sensor |
| 'A7 17' | Image quality too bad |
| 'A7 18' | Too few features |
| 'A7 19' | Merge failed |
| 'A7 1A' | Try again error |
| 'A7 1B' | Resync error |
| 'A7 1C' | Maximum number of merges exceeded |
| 'A7 81' | Invalid parameter |

2.2 VERIFY FINGERPRINT

Scope

VERIFY FINGERPRINT is used to verify a user's fingerprint. It initiates fingerprint image acquisition, processing and feature extraction.

The features are sent to the smart card processor for on-card verification and the outcome is reported in the response APDU to the host.

The command performs the following:

- Scans an image
- Generates a template and transmits it to the smart card processor, where it is compared with the reference template (see '2.1 ENROLL FINGERPRINT' on page 10) via the *VERIFY* command.



Biometric threshold, retry counter and access rules have to be configured in the file system of STARCOS. For details see STARCOS 3.0 reference manual edition 06/2005 or later.

Command

| CLA | INS | P1 | P2 |
|------|------|------|----|
| 'A0' | '20' | '00' | |

- P2 Specifies the Key Identifier (KID) used to reference the biometric data stored in the smart card processor during the enrollment phase (see '2.1 ENROLL FINGERPRINT' on page 10).

Response

| SW1 | SW2 |
|------|------|
| '90' | '00' |

Status Bytes

This command may return one of the following status bytes.

| Code | Description |
|---------|--|
| '90 00' | Successful operation |
| '63 Cx' | Verification failed (x represents the number of remaining retries) |
| '64 00' | File or data missing; enrollment file corrupt |
| '69 82' | Security status not satisfied |
| '69 83' | Authentication method blocked |
| '69 85' | Conditions of use not satisfied |
| '6A 82' | Application or file not found |
| '6A 88' | Referenced data not found |
| 'A7 00' | General ARM7 error |
| 'A7 01' | Unknown instruction |

| Code | Description |
|---------|----------------------------------|
| 'A7 02' | Length error |
| 'A7 20' | General verify fingerprint error |
| 'A7 11' | Timeout error |
| 'A7 12' | Sweep too slow |
| 'A7 13' | Sweep too fast |
| 'A7 14' | Sweep not straight |
| 'A7 15' | Sweep too short |
| 'A7 16' | Too many defect lines on sensor |
| 'A7 17' | Image quality too bad |
| 'A7 18' | Too few features |
| 'A7 1A' | Try again error |
| 'A7 1B' | Resync error |
| 'A7 81' | Invalid parameter |

2.3 VERSION INFO

Scope

VERSION INFO is used to request public information on StarSign Bio Token 3.0 from the host.

Parameter P2 of the command APDU specifies the item tag of the version information to be retrieved. The response data returns the requested version information.

Command

| CLA | INS | P1 | P2 | L _e |
|------|------|------|----|----------------|
| 'A0' | '8A' | '00' | | |

P2 Specifies the item tag of the version information

'01'

StarSign Bio Token 3.0 firmware version, build date and time

'02'

Key info: CRC of currently valid authentication key

L_e Specifies the expected length: '00' <= length <= '80'

'00'

Returns the maximum available data

Response

| DATA | SW1 | SW2 |
|-----------------|------|------|
| Response string | '90' | '00' |

Status Bytes

This command may return one of the following status bytes.

| Code | Description |
|---------|----------------------------|
| '90 00' | Successful operation |
| 'A7 00' | General ARM7 error |
| 'A7 01' | Unknown instruction |
| 'A7 02' | Length error |
| 'A7 81' | Invalid parameter |
| 'A7 8A' | General version info error |

Appendix

The appendix contains additional information on StarSign Bio Token 3.0.

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A Overview of Status Bytes

Return Codes



For error codes not defined in the following see the STARCOS 3.0 reference manual.

The following error codes are defined.

| Status Bytes | Error code | Description |
|--------------|------------------------|---|
| '63 Cx' | | Counter provided by 'X' (valued from 0 to 15); exact meaning depending on the command |
| '64 00' | | State of non-volatile memory unchanged (SW2 = '00', other values are RFU) |
| '65 81' | | Memory failure |
| '69 82' | | Security status not satisfied |
| '69 85' | | Conditions of use not satisfied |
| '69 86' | | Command not allowed (no current EF) |
| '6A 84' | | Not enough memory space in the file |
| 'A7 00' | SW_ARM7 | General error |
| 'A7 01' | SW_UNKNOWN_INSTRUCTION | Unknown instruction |
| 'A7 02' | SW_LENGTH_ERROR | Length error |
| 'A7 10' | SW_ENROLL_FP | General enroll fingerprint error |
| 'A7 11' | SW_TIMEOUT | Timeout error |
| 'A7 12' | SW_SWEEP_TOO_SLOW | Sweep too slow |
| 'A7 13' | SW_SWEEP_TOO_FAST | Sweep too fast |
| 'A7 14' | SW_SWEEP_NOT_STRAIGHT | Sweep not straight |
| 'A7 15' | SW_SWEEP_TOO_SHORT | Sweep too short |
| 'A7 16' | SW_SENSOR_DEFECT | Too many defect lines on sensor |
| 'A7 17' | SW_IMG_QUALITY_TOO_BAD | Image quality too bad |
| 'A7 18' | SW_TOO_FEW_FEATURES | Too few features |
| 'A7 19' | SW_MERGE_FAILED | Merge failed |
| 'A7 1A' | SW_TRY_AGAIN | Try again error |

| Status Bytes | Error code | Description |
|--------------|---------------------------|--------------------------------------|
| 'A7 1B' | SW_IO_ERROR | Resync error |
| 'A7 1C' | SW_MAX_MERGE | Maximum number of merges exceeded |
| 'A7 20' | SW_VERIFY_FP | General verify fingerprint error |
| 'A7 30' | SW_SCAN_IMAGE | General scan image error |
| 'A7 40' | SW_GET_LINE | General get line error |
| 'A7 41' | SW_LINEINDEX_OUT_OF_RANGE | Line index out of range |
| 'A7 42' | SW_IMGDATA_NOT_AVAILABLE | Image data not available |
| 'A7 80' | SW_DIAGNOSTICS | General diagnostics error |
| 'A7 81' | SW_INVALID_PARAMETER | Invalid parameter |
| 'A7 82' | SW_CHANGE_MODE | General change mode error |
| 'A7 83' | SW_AUTHENTICATION_FAILED | Authentication failed |
| 'A7 84' | SW_GET_CHALLENGE_FAILED | General get challenge error |
| 'A7 85' | SW_INVALID_VALUE | Invalid value |
| 'A7 86' | SW_SET_PARAMETER_FAILED | General set parameter error |
| 'A7 87' | SW_CONDITION | Conditions of use not satisfied |
| 'A7 88' | SW_GET_PARAMETER_FAILED | General get parameter error |
| 'A7 8A' | SW_VERSION_INFO_FAILED | General version info error |
| 'A7 8C' | SW_SYSTEM_CONTROL_FAILED | General system control error |
| 'A7 93' | SW_KEY_BLOCKED | Authentication blocked, KFPC expired |

B Technical Specifications

Scope This section lists the technical specifications of StarSign Bio Token 3.0

Token Housing StarSign Bio Token 3.0 housing has the following characteristics.

- dimensions closed: 80 x 33 x 17 mm
- dimensions open: 107 x 33 x 17 mm
- mechanism to protect sensor and USB interface from wear

Power Consumption 100 mA

Interfaces StarSign Bio Token 3.0 supports the following interfaces:

- USB 1.1
- PKCS#11 (with middleware)
- MS CAPI 1.0 (CSP) (with middleware)

Sensor Atmel swipe sensor

Operating System StarSign Bio Token 3.0 uses the following operating system with listed characteristics.

- STARCOS 3.0
- 72 kB EEPROM
- symmetric encryption: DES, 3DES
- asymmetric encryption: RSA-CRT with up to 2048 bits
- security system in accordance with ISO 7816-4
- up to 8 DF levels
- up to 4 logical channels
- secure write
- secure messaging
- memory management
- several authentication options

System Requirements StarSign Bio Token 3.0 has the following system requirements.

- IBM PC with Pentium 90 MHz processor or higher
- 32 MB RAM for Windows 2000, 2003 and XP
- free USB port

C Reference Literature

ISO

ISO/IEC 7816-3
Information technology -- Identification cards -- Integrated circuit(s)
cards with contacts -- Part 3: Electronic signals and transmission pro-
tocols
ISO/IEC, 1997

ISO/IEC 7816-4
Information technology -- Identification cards -- Integrated circuit(s)
cards with contacts -- Part 4: Interindustry commands for interchange
ISO/IEC, 1995

ISO/IEC FDIS 19794-2
Information technology - Biometric data interchange formats - Part 2:
Finger minutiae data
ISO/IEC, 2005

D

Glossary

3DES

The Triple-DES algorithm is a modified DES encryption. It consists of calling the DES algorithm three times in succession, with alternating encryption and decryption. If the same key is used for all three DES calls, the Triple-DES encryption corresponds to a normal DES encryption. However, if two or three different keys are used, Triple-DES encryption is significantly stronger than a single DES encryption.

CAPI

Crypto API

CRC

Cyclic Redundancy Check

A simple and widely used form of EDC (Error Detection Code) for the protection of data. The CRC must be computed using an initial value and a divider polynomial before it can be used.

CSP

Cryptographic Service Provider

Cryptographic support for Microsoft and other CryptoAPI products

DES

Data Encryption Standard

A standard cryptographic algorithm specified as DEA in ISO 873-1. An algorithm for symmetric cryptography. Now used as 'triple DES' in EMV operations (e.g., ARQC generation) where data is encrypted using the first half of a double length key, is decrypted using the second half, then re-encrypted using the first half again.

EF

Elementary File

EFs represent the actual data storage in the file tree of a smart card. EFs contain one of the following internal file structures: Transparent, Linear Fixed, Linear Variable or Cyclic.

FAR

False Acceptance Rate

Due to the nature of biometrics there is a slight possibility that an unauthorized user is granted access to a system protected by biometrics.

FRR

False Rejection Rate

Due to the nature of biometrics there is a slight possibility that a legitimate user is denied access to a system protected by biometrics.

KID

Key Identifier

PKCS

Public Key Cryptography Standards

PKI

Public Key Infrastructure

A series of procedures established by a Certification Authority for the generation, signing, distribution and revocation of the keys used in an asymmetric cryptography scheme.

RFU

Reserved for Future Use

RSA-CRT

Chinese Remainder Theorem

Special parameter setting for asymmetric crypto algorithm.

STARCOS

Smart Card Chip Card Operating System. Forms the basis of multi-functional smart card applications. STARCOS enables the implementation of various applications (e.g., electronic purse, access control to data networks, and digital signatures). Smart card operating systems control the data transfer, the storage areas, and process information; they manage the resources and supply all necessary functions for the operation and administration of a random number of applications.

USB

Universal Serial Bus

Port not only for connecting external peripheral devices such as keyboard, mouse, scanner, etc., but also USB hubs. These devices can be added during active operation.

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