# IFX_CCI_000068h/77h/80h G12 Security Target

## Release

## About this document

### Scope and purpose

This document is the Security Target for the Infineon IFX_CCI_000068h, IFX_CCI_000077h, IFX_CCI_000080h design step G12 security controllers.

### Intended audience

Composite product developers, Common Criteria Evaluators and Certifiers.

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# 1 Introduction (ASE_INT)

## 1.1 ST reference

The ST has the title IFX_CCI_000068h/77h/80h G12 Security Target, Rev. 1.01 and is dated 2023-08-04.

## 1.2 TOE reference

The full TOE name is:

IFX_CCI_000068h, IFX_CCI_000077h, IFX_CCI_000080h design step G12 with firmware version 80.505.04.1,
optional HSL version 04.05.0040,
optional UMSLC version 02.01.0040,
optional NRG™ version 06.10.0002
and user guidance documents

The TOE is identified by the components as described in the physical scope, chapter 1.4.2 .

- The Hardware version, design step and Firmware version can be read out form the chip by the Generic Chip Identification Mode (GCIM). The procedure how to read that data is described in the Programmers Reference Manual.
- The correct library versions can be verified by the corresponding hash values as defined in chapter 8.

## 1.3 TOE overview

### 1.3.1 TOE definition and usage

The TOE consists of a smart card IC (Security Controller), firmware and user guidance meeting high requirements in terms of performance and security. The TOE is designed by Infineon Technologies AG and is intended to be used in smart cards for security-relevant applications and as developing platform for smart card operating systems according to the life cycle model from [PP0084]. The TOE is the platform for the Embedded Software but the Embedded Software itself is not part of the TOE. The TOE does not require any non-TOE hardware/software/firmware.

### 1.3.2 TOE major security features

- Dual CPU in lockstep mode to detect integrity errors during processing
- Memory integrity protection
- Memory encryption
- Bus masking for security peripherals
- Hardware True RNG
- Symmetric coprocessor for AES encryption and decryption
- Global alarm system with security life control
- Tearing safe NVM write
- Armv8-M compliant MPU and SAU
- Robust set of sensors and detectors
- Redundant alarm propagation and system deactivation principle
- Peripheral access control
- Leakage control of data dependent code execution
- Device phase management

- The optional MISE provides masked and  side-channel hardened arithmetical and logical CPU instructions.
- Instruction Stream Signature (ISS) coprocessor. The ISS can optionally be used to protect the CPU instruction flow. The hardware-based integrity protection concept of the TOE already provide a very effective program flow protection, such that the ISS is actually not needed. The ISS can nevertheless be used for compatibility reasons or as a very conservative additional countermeasure.

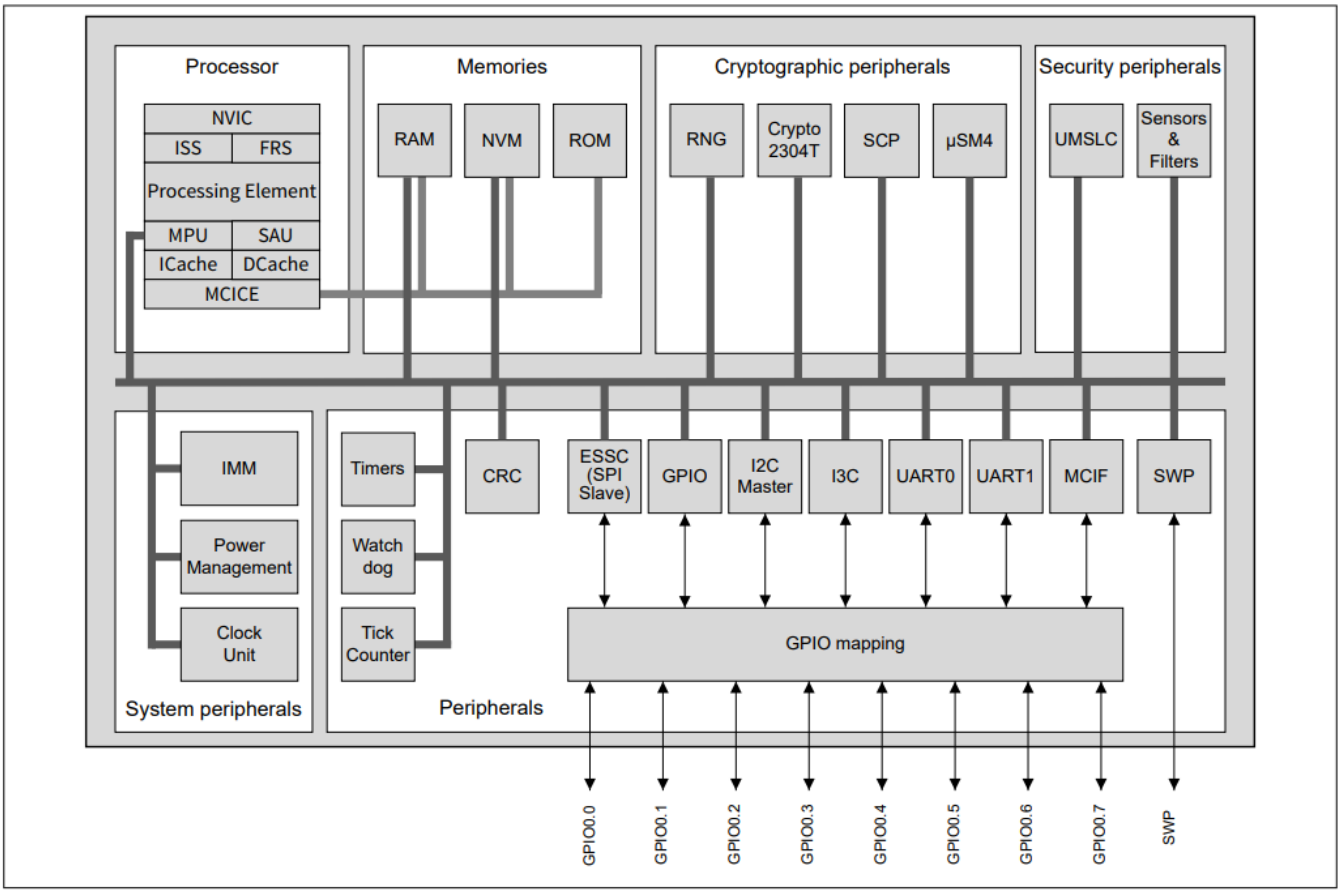
## 1.4 TOE description

### 1.4.1 TOE components

#### 1.4.1.1 TOE hardware

Figure 1 shows schematically the TOE hardware.

**Figure 1 TOE hardware**




The TOE hardware consists of the following blocks:

- Processor
  - CPU according to Armv8-M mainline architecture.
  - Armv8-M compatible NVIC controller
  - Armv8-M compatible Memory Protection Unit (MPU) with 8 regions
  - Armv8-M compatible Security Attribution Unit (SAU) with 8 regions
  - Instruction Stream Signature (ISS) coprocessor
  - Fast Random Source (FRS) nonce generator coprocessor.

  - EDC protected caches for memory access and instruction fetch
  - MCICE provides encryption and EDC protection for RAM, ROM and NVM
- Memories
  - encrypted and EDC protected ROM
  - encrypted and EDC protected RAM
  - encrypted and EDC protected NVM
- Peripherals
  - Timers
  - Watchdog
  - Tick counter
  - CRC accelerator
- System peripherals
  - Clock unit
  - Interface Management Module (IMM)
  - Power Management
  - System Peripheral Access Unit (SPAU) to manage access to peripherals.
- Cryptographic peripherals
  - RNG according to class PTG.2 of [AIS 31]
  - Crypto2304T coprocessor for long modular integer arithmetic
  - SCP for secure AES computation
  - µSM4 accelerator for SM4 cryptographic algorithm.
- Security peripherals
  - UMSLC
  - Sensors
- I/O Interfaces
  - UART for ISO 7816-3
  - I3C slave which can also be used as I2C slave
  - I2C master
  - SPI slave
  - SWP slave
  - Miller interface
  - GPIO ports

The TOE has a global alarm system that puts the TOE into a secure state after tamper detection.

### 1.4.1.2 Firmware

The TOE Firmware consists of the Boot software, which provides secure start-up and contains the Flash Loader code.

### 1.4.1.3 Libraries

The TOE can be ordered with the following libraries to support the security coding of embedded software:

- UMSLC library to test the chips sensors

- HSL library to provide tearing safe write for the NVM

In addition, the TOE can be ordered with a NRG™ SW library. This is a proprietary cryptographic protocol for transport and ticketing applications. Please note that NRG™ is not part of the TSF.

## 1.4.2 Physical scope

### 1.4.2.1 Hardware/Firmware

**Table 1 Hardware/Firmware components**

| Component | Version |
|---|---|
| Hardware | IFX_CCI_000068h<br>IFX_CCI_000077h<br>IFX_CCI_000080h |
| Design step | G12 |
| Firmware | 80.505.04.1 |
| Flash Loader | 10.01.0001 |

### 1.4.2.2 Libraries

The following libraries can be optionally ordered.

**Table 2 Libraries**

| Component | Version | Date |
|---|---|---|
| HSL | 04.05.0040 | 2022-10-06 |
| UMSLC | 02.01.0040 | 2022-09-06 |
| NRG™ | 06.10.0002 | 2022-11-21 |

*Note: The user guidance for the UMSLC, NRG™ and HSL libraries is located in the Programmers Reference Manual.*

### 1.4.2.3 User guidance documents

**Table 3 User guidance**

| Component | Version | Date |
|---|---|---|
| TEGRION™ SLC21 (32-bit Security Controller – V24)<br>Hardware Reference Manual | 4.2 | 2023-08-04 |
| SLx2 security controller family<br>Programmer's Reference Manual SLx2_DFP | 1.2.0 | 2023-07-05 |
| SLC21 32-bit Security Controller - V24<br>Security Guidelines | 1.00-3001 | 2023-07-26 |
| SLC21 (32-bit Security Controller – V24)<br>Production and personalization manual Flash Loader V10 | 10.01 | 2023-06-28 |
| Crypto2304T V4, User Manual | 2.0 | 2023-07-14 |
| SLC21 (32-bit Security Controller – V24) Errata sheet | 1.1 | 2023-02-27 |

### 1.4.3 Logical scope

The logical scope of the TOE consists of the logical security features provided by the TOE. These features are listed in chapter 1.3.2. This chapter explains the features in more detail.

#### 1.4.3.1 TSF

The following features of the TOE are part of the TSF:

- The Processor has a duplicated CPU running in lockstep mode to detect integrity errors. The CPU registers and the cache RAM are protected by 32-bit ECC codes used as an EDC.
- ROM, RAM and NVM content is cryptographically encrypted according to [AIS 46]
- ROM, RAM and NVM content is integrity protected by an EDC with at least 28 bits.
- A hardware true RNG according to class PTG.2 of [AIS 31].
- A symmetric coprocessor for performing masked AES ECB encryption.
- The data buses connecting the CPU and the cryptographic peripherals are encrypted using a bus encryption with dynamic keys which are changed in each transfer.
- Peripheral access control can be used to provide individual access control of all peripherals for the different security states of the processor (i.e., secure/non-secure, privilege/non-privilege).
- The chip has the following sensors.
  - voltage low and high
  - temperature low and high
  - low frequency
  - light fault attack detectors

  If the values are out of range a security alarm is issued.
- Security Life control is used to check proper working of sensors and alarm system by runtime triggered tests.
- In case the core or a peripheral detects a security violation it performs three countermeasures
  - goes into local alarm state.
  - propagates the alarm to the other peripherals and core which then go also into alarm state.
  - triggers a security reset.
- The HSL detects if NVM has not been correctly written due to a tearing event. The next time an HSL function is called, the embedded software is informed by the HSL that a tearing event has occurred. The HSL provides functions to correct the corrupted data by either roll-back or roll-forward.
- The Armv8-M Memory Protection Unit (MPU) and Security Attribution Unit (SAU) with 8 regions each are provided which can be used as a logical firewall for the embedded software.
- If the chip is switched to User mode it cannot be switched back to Test mode. If the Flash Loader is permanently disabled, it cannot be reactivated again.
- The optional Masked Instruction Set Extension (MISE) coprocessor provides an Armv8-M Custom Data Path Extension (CDE) with side-channel improved (masked) variants of common 32-bit instructions. The most important instructions are MAND, MBIC, MEOR, MORN, MORR, MADD and MSUB (with and without carries).
- The processor system comes with several supporting features to assist side-channel protected software implementations. One common software countermeasure is masking. However, the user needs to take special care when processing masked data together with its masks to avoid that they (or parts of them) are unintentionally combined in hardware resulting in a degradation of the desired side-channel security level. Therefore, the processor system has several measures in place to support the software in keeping the masked data and masks separated.

- Fast Random Source (FRS) nonce generator coprocessor. This RNG was not evaluated according to [AIS 31] and its output shall therefore not be used for applications requiring a certified RNG. It is used internally to support security features of the security architecture.
- Program flow integrity protection: The Instruction Stream Signature (ISS) coprocessor can optionally be used by the IC embedded software to detect illegal program flows and trigger an alarm.
- A coprocessor for accelerating long arithmetic operations to support RSA and ECC cryptography. This coprocessor has no dedicated security countermeasures. The embedded software must implement security countermeasures.

The TOE has memory-mapped registers as interfaces to the peripherals.

The interfaces to the libraries are C language APIs.

### 1.4.4 TOE delivery

The TOE delivery formats and delivery lifecycle according to [PP0084] application note 1 are shown in the following table.

**Table 4 Forms of delivery**

| Component | Format | Life cycle | Delivery method |
|---|---|---|---|
| Hardware | bare die (sawn wafer) | 3 | Postal transfer in cages |
| | PG-X2QFN-20 | 4 | Postal transfer in cages |
| | CSP | 4 | Postal transfer in cages |
| Firmware | binary image | 3 or 4[1] | In ROM/NVM of hardware |
| Libraries | object files | n/A | secure download via iShare |
| Documents | personalized PDF | n/A | secure download via iShare |

### 1.4.5 Production sites

The TOE may be handled at different production sites, but the silicon is produced at TSMC fab 15 in Taiwan only. The production site can be determined by reading out the GCIM.

### 1.4.6 Configurations

This TOE is represented by various configurations called products. The module design, layout, and footprint, of all products are identical. The degree of freedom for configuring the TOE is predefined by Infineon Technologies AG. Table 5 shows TOE hardware/firmware configurations. The chip must be ordered with the desired NVM value. The value cannot be changed afterwards. Bill per Use is not supported.

**Table 5 TOE configuration options**

| Component | Values | Identification |
|---|---|---|
| NVM | 800, 1024, 1800 kb | IFX mailbox |

[1] depends on hardware delivery format.

| Component | Values | Identification |
|---|---|---|
| MISE | available / not available | IFX mailbox |

### 1.4.7 Initialisation with embedded software

This TOE is equipped with Flash Loader software (FL) to download user software, i.e. an operating system and applications. Various options can be chosen by the user to store software onto the NVM.

**Table 6 Order Options to initialize the TOE with customer software**

| Option | TOE status |
|---|---|
| The user or/and a subcontractor downloads the software into the NVM. Infineon Technologies does not receive any user software. | The Flash Loader can be activated or reactivated by the user or subcontractor to download software into NVM. In case the Flash Loader is active, it may be either in life cycle stage “Pinletter” or “Activated”. When “Activated” a mutual authentication needs to be performed. In “Pinletter” a valid Pinletter provided by Infineon Technologies AG needs to be presented to enter “Activated” stage. |
| The user provides software to download into NVM to Infineon Technologies AG. The software is loaded into NVM during chip production. | There is no Flash Loader present. |
| The user provides software to download into NVM to Infineon Technologies AG. The software is loaded into NVM during chip production. | The Flash Loader is blocked by Infineon but can be activated or reactivated by the user or subcontractor to download software into NVM. The user is required to provide a reactivation procedure as part of the software to Infineon Technologies AG. |
| The user provides software to download into NVM to Infineon Technologies AG. The software is loaded into NVM during chip production. | The Flash Loader is active. The user can either download software or activate the software already present in NVM. |

# 2 Conformance (ASE_CCL)

## 2.1 Conformance claims

This ST and TOE claim conformance to

- [CC2] extended
- [CC3] conformant

### 2.1.1 PP claims

This ST is strictly conformant to [PP0084]. The assurance level is EAL6 with the augmentation ALC_FLR.1.

The Security IC Platform Protection Profile with Augmentation Packages is registered and certified by the Bundesamt für Sicherheit in der Informationstechnik (BSI) under the reference [PP0084].

### 2.1.2 Package claims

This ST claims conformance to the following additional packages taken from [PP0084]:

- Package Authentication of the Security IC, section 7.2, conformant.
- Package Loader, Package 1: Loader dedicated for usage in secured environment only, section 7.3.1, conformant.
- Package Loader, Package 2: Loader dedicated for usage by authorized users only, section 7.3.2, augmented.
- Package AES; section 7.4.2, conformant.

The assurance level for the TOE is EAL6 augmented with the component ALC_FLR.1. Therefore, this ST is package-augmented to the packages in [PP0084].

## 2.2 Conformance rationale

The TOE is a typical security IC as defined in [PP0084].

The security problem definition of [PP0084] is enhanced by adding the Organisational Security Policy P.Firewall due to addition of the Armv8-M Memory Protection Unit and Security Extension. The security target remains conformant to [CC1] due to claim 289 as the possibility to introduce additional restrictions is given. The security target fulfils the strict conformance claim of [PP0084] due to application note 5.

# 3 Security Problem Definition (ASE_SPD)

## 3.1 Threats

### 3.1.1 Threats from PP0084

The following threats are defined and described in [PP0084] sections 3.2 and 7.2.1.

**Table 7 Threats from [PP0084]**

| Threat | Description |
|---|---|
| T.Phys-Manipulation | Physical Manipulation |
| T.Phys-Probing | Physical Probing |
| T.Malfunction | Malfunction due to Environmental Stress |
| T.Leak-Inherent | Inherent Information Leakage |
| T.Leak-Forced | Forced Information Leakage |
| T.Abuse-Func | Abuse of Functionality |
| T.RND | Deficiency of Random Numbers |
| T.Masquerade_TOE | Masquerade the TOE |

### 3.1.2 Threats defined in this ST

There are no additional threats defined in this ST.

## 3.2 Organizational security policies

### 3.2.1 Organizational security policies from PP0084

The organizational policies from [PP0084] sections 3.3, 7.3.1, 7.3.2 and 7.4 are applicable.

**Table 8 Organisational Security Policies from [PP0084]**

| OSP | Description |
|---|---|
| P.Process-TOE | Protection during TOE Development and Production |
| P.Crypto-Service | Cryptographic services of the TOE |
| P.Lim_Block_Loader | Limiting and Blocking the Loader Functionality |
| P.Ctrl_Loader | Controlled usage to Loader Functionality |

### 3.2.2 Organizational security policies defined in this ST

This ST defines an additional organisational security policy specific to the MPU Extension and Security Extension.

**Table 9 Memory region-based access control**

| OSP | Definition |
|---|---|
| P.Firewall | The TOE must enable the IC dedicated software and the end-user embedded software to manage and control access to regions in memory. |

## 3.3 Assumptions

### 3.3.1 Assumptions defined in [PP0084]

The TOE assumptions about the operational environment are defined and described in [PP0084] section 3.4.

**Table 10 Assumptions from [PP0084]**

| Assumption | Description |
|---|---|
| A.Process-Sec-IC | Protection during Packaging, Finishing and Personalization |
| A.Resp-Appl | Treatment of User Data |

### 3.3.2 Assumptions defined in this ST

There are no additional assumptions defined in this ST.

# 4 Security Objectives (ASE_OBJ)

## 4.1 Security objectives for the TOE

### 4.1.1 Security objectives for the TOE defined in PP0084

**Table 11 Security objectives for the TOE from [PP0084]**

| Objective | Description |
|---|---|
| O.Phys-Manipulation | Protection against Physical Manipulation |
| O.Phys-Probing | Protection against Physical Probing |
| O.Malfunction | Protection against Malfunctions |
| O.Leak-Inherent | Protection against Inherent Information Leakage |
| O.Leak-Forced | Protection against Forced Information Leakage |
| O.Abuse-Func | Protection against Abuse of Functionality |
| O.Identification | TOE Identification |
| O.RND | Random Numbers |
| O.Cap_Avail_Loader | Capability and availability of the Loader |
| O.Ctrl_Auth_Loader | Access control and authenticity for the Loader |
| O.Authentication | Authentication to external entities |
| O.AES | Cryptographic service AES |

### 4.1.2 Security objectives for the TOE defined in this ST

**Table 12 Security Objectives for the TOE**

| Objective | Definition |
|---|---|
| O.Firewall | **Firewall based Access Control**<br>The TOE must provide the IC dedicated software and the end-user embedded software with the capability to define restricted memory access and code execution to memory addresses. The TOE must enforce the access of software to these memory regions depending on access attributes. |

## 4.2 Security objectives for the operational environment (OE)

### 4.2.1 OEs defined in [PP0084]

**Table 13 Security objectives for the operational environment from [PP0084]**

| Objective | Description |
|---|---|
| OE.Resp-Appl | Treatment of user data of the Composite TOE |
| OE.Process-Sec-IC | Protection during composite product manufacturing |
| OE.Lim_Block_Loader | Limitation of capability and blocking the Loader |
| OE.Loader_Usage | Secure communication and usage of the Loader |
| OE.TOE_Auth | External entities authenticating of the TOE |

*Note: OE.TOE_Auth is available if the Flash Loader is available.*

### 4.2.2 OEs defined in this ST

There are no additional OEs defined in this ST.

## 4.3 Security objectives rationale

The security objectives rationale of the TOE is defined and described in [PP0084] section 4.4, 7.3.1, 7.3.2 and section 7.4.2.

The objectives O.Firewall added in this ST cover the organisational security policy P.Firewall that states that IC dedicated software and end-user embedded software must be able to manage and control access to regions in memory.

# 5 Extended Components Definition (ASE_ECD)

## 5.1 Extended components defined in [PP0084]

The [PP0084] defines the following extended components used in this ST:

- FMT_LIM.1
- FMT_LIM.2
- FAU_SAS.1
- FDP_SDC.1
- FCS_RNG.1
- FIA_API.1

## 5.2 Extended components defined in this ST

There are no extended components defined in this ST.

# 6 Security Requirements (ASE_REQ)

## 6.1 Security functional requirements

For the CC operations the following convention is used:

- CC operations which have been already completed in [PP0084] or [AIS 31] are typeset without underline.
- CC (nested) iteration operations are started by a slash "/" symbol, followed by an iteration identifier text. Iterations may be recursively nested.
- CC operations which are completed in this ST are underlined and the assigned footnote shows the original template text. Iteration operations are typed in normal font (i.e. without underline).

### 6.1.1 Hardware random number generators

Random numbers generation according to **Class PTG.2** of [AIS 31].

**Table 14 FCS_RNG.1/TRNG**

| FCS_RNG.1/TRNG | Random Number Generation |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | No dependencies. |
| FCS_RNG.1.1/TRNG | The TSF shall provide a physical random number generator that implements:<br>(PTG.2.1) A total failure test detects a total failure of entropy source immediately when the RNG has started. When a total failure is detected, no random numbers will be output.<br>(PTG.2.2) If a total failure of the entropy source occurs while the RNG is being operated, the RNG prevents the output of any internal random number that depends on some raw random numbers that have been generated after the total failure of the entropy source[1].<br>(PTG.2.3) The online test shall detect non-tolerable statistical defects of the raw random number sequence (i) immediately when the RNG has started, and (ii) while the RNG is being operated. The TSF must not output any random numbers before the power-up online test has finished successfully or when a defect has been detected.<br>(PTG.2.4) The online test procedure shall be effective to detect non-tolerable weaknesses of the random numbers soon.<br>(PTG.2.5) The online test procedure checks the quality of the raw random number sequence. It is triggered continuously[2]. The online test is suitable for detecting non-tolerable statistical defects of the statistical properties of the raw random numbers within an acceptable period of time. |
| FCS_RNG.1.2/TRNG | The TSF shall provide 32-bit numbers[3] that meet |

[1] [selection: prevents the output of any internal random number that depends on some raw random numbers that have been generated after the total failure of the entropy source, generates the internal random numbers with a post-processing algorithm of class DRG.2 as long as its internal state entropy guarantees the claimed output entropy]

[2] [selection: externally, at regular intervals, continuously, applied upon specified internal events].

[3] [selection: bits, octets of bits, numbers [assignment: format of the numbers]]

| FCS_RNG.1/TRNG | Random Number Generation |
|---|---|
| | (PTG.2.6) Test procedure A (None)[1] does not distinguish the internal random numbers from output sequences of an ideal RNG.<br>(PTG.2.7) The average Shannon entropy per internal random bit exceeds 0.997. |

### 6.1.2 Cryptographic services implemented in hardware

**Table 15 FCS_COP.1/AES**

| FCS_COP.1/AES | Cryptographic operation |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | [FDP_ITC.1 or FDP_ITC.2 or FCS_CKM.1]<br>FCS_CKM.4 |
| FCS_COP.1.1/AES | The TSF shall perform decryption and encryption in accordance with a specified cryptographic algorithm AES in ECB mode[2] and cryptographic key sizes 128 bit, 192 bit, 256 bit[3] that meet the following: [FIPS 197], [SP 800-38A]. |

*Note: The input to the AES algorithm must be provided in two XOR shares. By fixing one share to zero a standard ECB mode result.*

**Table 16 FCS_CKM.4**

| FCS_CKM.4 | Cryptographic key destruction |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | [FDP_ITC.1 or FDP_ITC.2 or FCS_CKM.1] |
| FCS_CKM.4.1 | The TSF shall destroy cryptographic keys in accordance with a specified cryptographic key destruction method overwriting or zeroing[4] that meets the following: None[5]. |

### 6.1.3 TSF testing

An attacker may try to circumvent the alarm system and secure wiring by physical manipulation (e.g. by cutting alarm lines). To counter those threats, the chip provides the User Mode Life Cycle (UMSLC) tests to check the integrity of those security features. Those test functions are provided as a software library and can be triggered on demand of the Embedded Software of the Composite TOE.

[1] [assignment: additional standard test suites]
[2] [selection: 128 bit, 192 bit, 256 bit]
[3] [selection: 128 bit, 192 bit, 256 bit]
[4] [assignment: cryptographic key destruction method]
[5] [assignment: list of standards]

**Table 17 TSF testing**

| FPT_TST.1 | TSF testing |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | No dependencies. |
| FPT_TST.1.1 | The TSF shall run a suite of self-tests at the request of the authorized user[1] to demonstrate the correct operation of alarm test and security optimized wiring tests[2]. |
| FPT_TST.1.2 | The TSF shall provide authorized users with the capability to verify the integrity of the boot code[3]. |
| FPT_TST.1.3 | The TSF shall provide authorized users with the capability to verify the integrity of alarm behaviour and security optimized wiring[4]. |

*Note: If the integrity of the boot code is violated, a security reset is triggered. The authorized user (i.e. the embedded software) can check if a security reset has been performed by reading the reset status register.*

### 6.1.4 Malfunctions

This chapter relates to the section “Malfunctions” in [PP0084] ch. 6.1.

The SFRs FRU_FLT.2 and FPT_FLS.1 are specified in [PP0084].

**Secure state of the TOE**

Application note 14 of FPT_FLS.1 requires to define the secure state of the TOE.

Definition: A **secure state** of the TOE is either a correct operation or one of the following exceptional states

- security reset
- global deactivation of the TOE (a.k.a. alarm state)
- fault handler

### 6.1.5 Abuse of Functionality

This chapter relates to the section “Abuse of Functionality” in [PP0084] ch. 6.1.

The SFRs FMT_LIM.1 and FMT_LIM.2 are specified in [PP0084].

**Table 18 FAU_SAS.1**

| FAU_SAS.1 | Audit Storage |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | No dependencies. |

[1] [selection: during initial start-up, periodically during normal operation, at the request of the authorized user, at the conditions [assignment: conditions under which self-test should occur]]

[2] [selection: [assignment: parts of TSF], the TSF]

[3] [selection: [assignment: parts of TSF data], TSF data]

[4] [selection: [assignment: parts of TSF], TSF]

| FAU_SAS.1 | Audit Storage |
|---|---|
| FAU_SAS.1.1 | The TSF shall provide the test process before TOE delivery[1] with the capability to store the initialization data and/or pre-personalization data and/or supplements of the security IC embedded software[2] in the access protected and not changeable areas of the non-volatile memory[3]. |

### 6.1.6 Physical Manipulation and Probing

This chapter relates to the section “Physical Manipulation and Probing” in [PP0084] ch. 6.1.

The SFR FPT_PHP.3 is specified in [PP0084].

**Automatic response of the TOE**

Application note 19 of FPT_PHP.3 requires to define the automatic response of the TOE.
Definition: An **automatic response of the TOE** means entering a secure state of the TOE.

**Table 19 FDP_SDC.1**

| FDP_SDC.1 | Stored data confidentiality |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | No dependencies |
| FDP_SDC.1.1 | The TSF shall ensure the confidentiality of the information of the user data while it is stored in the RAM, ROM, and NVM[4]. |

**Table 20 FDP_SDI.2**

| FDP_SDI.2 | Stored data integrity monitoring and action |
|---|---|
| Hierarchical to | FDP_SDI.1 |
| Dependencies | No dependencies. |
| FDP_SDI.2.1 | The TSF shall monitor user data stored in containers controlled by the TSF for EDC integrity errors[5] on all objects, based on the following attributes: the corresponding EDC value with a length of at least 28 bits in the RAM, ROM, and NVM[6]. |
| FDP_SDI.2.2 | Upon detection of a data integrity error, the TSF shall enter a secure state[7]. |

[1] [assignment: list of subjects]
[2] [assignment: list of audit information]
[3] [assignment: type of persistent memory]
[4] [assignment: memory area]
[5] [assignment: integrity errors]
[6] [assignment: user data attributes]
[7] [assignment: action to be taken]

### 6.1.7 Leakage

This chapter relates to the section “Leakage” in [PP0084] ch. 6.1.

The SFRs FDP_ITT.1, FPT_ITT.1 and FDP_IFC.1 are specified in [PP0084].

### 6.1.8 Application Firewall

The Application Firewall allows the embedded software to execute in four security levels and to assign access conditions to the address space related to the security levels. The security levels are:

- secure privilege
- secure non-privilege
- non-secure privilege
- non-secure non-privilege

The policy allows the embedded software to enforce the following trust relationship

- secure doesn’t trust non-secure independent of the privilege level
- secure privilege doesn’t trust secure non-privilege
- non-secure privilege doesn’t trust non-secure non-privilege

#### 6.1.8.1 Policy definition

**Subjects:**

- Processor

**Objects:**

- Memory addresses

**Operations:**

- FETCH(x): any instruction fetch from address x
- READ(x): any read access from address x
- WRITE(x): any write access to address x
- SG: secure gateway instruction
- BNS: any of the branch to non-secure code instructions
- FNC_RETURN: return from secure mode to non-secure mode
- HANDLER_S: call of any secure handler code. Of specific importance for this policy are the following handlers:
  - MEMFAULT_S: memory fault handler in secure mode
  - SECFAULT: security fault handler
- HANDLER_NS: call of any non-secure handler code. Of specific importance for this policy is the following handler:
  - MEMFAULT_NS: memory fault handler in non-secure mode
- EXC_RETURN: return from handler code

**Security attributes for processor:**

- sec: Boolean attribute designating secure/non-secure with values
  - true: processor is in secure mode.
  - false: processor is non-secure mode.

- handlermode: Boolean attribute designating handler / thread mode:
  - true: processor is in handler mode
  - false: processor is in thread mode

- nPriv_S: Boolean attribute designating privilege mode when sec = true with values.
  - true: processor runs in non-privilege mode.
  - false: processor runs in privilege mode.

- nPriv_NS: Boolean attribute designating privilege mode when sec = false with values.
  - true: processor runs in non-privilege mode.
  - false: processor runs in privilege mode.

**Security attributes for addresses:**

- PO(x): Boolean attribute assigned to address x.
  - true: Only privilege mode has access.
  - false: Privilege and non-privilege mode have access.

- acc(x): {N, R, RW} attribute assigned to address x.
  - N: no access allowed.
  - R: write access is declined
  - RW: read and write access is not declined.

- sec(x): {S, NS, NSC} attribute assigned to address x.
  - S: secure address.
  - NS: non-secure address.
  - NSC: secure address which is callable from non-secure address.

- XN(x): Boolean variable assigned to address x.
  - true: instruction fetch is declined.
  - false: instruction fetch is not declined.

**Definitions:**

- privileged := handlermode or (not nPriv_S and sec) or (not nPriv_NS and not sec)

**Rules:**

**Security Requirements (ASE_REQ)**

1. FETCH(x) is declined if
   (sec = false and sec(x) = S )
   or (sec = false and sec(x) = NSC and FETCH(x) ≠ SG)

2. READ(x) is declined if
   sec = false and sec(x) ≠ NS
3. WRITE(x) is declined if
   sec = false and sec(x) ≠ NS

4. FETCH(x) is declined if
   (privileged = false and PO(x) = true)
   or (XN(x) = true)
   or (acc(x) = N)
5. READ(x) is declined if
   (privileged = false and PO(x) = true)
   or (acc(x) =N)
6. WRITE(x) is declined if
   (privileged = false and PO(x) = true)
   or (acc(x) ≠ RW)

7. If one of rules 1, 2, 3 apply then the SECFAULT handler will be called.
8. If one of rules 4, 5 or 6 apply but none of rules 1, 2, 3 and sec=true then MEMFAULT_S handler will be called.
9. If one of rules 4, 5 or 6 apply but none of rules 1, 2, 3 and sec=false then MEMFAULT_NS handler will be called.

10. Modification of sec to value true is only allowed for SG, FNC_RETURN, EXC_RETURN or HANDLER_S.
11. Modification of sec to value false is only allowed for BNS and EXC_RETURN.
12. Modification of nPriv_S to value false is only allowed when handlermode = true and sec = true.
13. Modification of nPriv_S to value true is only allowed when sec = true.
14. Modification of nPriv_NS to value false is only allowed when handlermode = true
    or (sec = true and nPriv_S = false).
15. Modification of handlermode to value true is only allowed for HANDLER_S or HANDLER_NS.
16. Modification of handlermode to value false is only allowed for EXC_RETURN.
17. Modification of nPriv_NS to value true is only allowed when privileged = true

**Roles for management:**

The parameter x designates any address.

- secure AF management: privileged = true and sec = true
- non-secure AF management: privileged = true

### 6.1.8.2 SFRs

**Table 21 FDP_ACC.2/AF**

| FDP_ACC.2/AF | Complete access control |
|---|---|
| Hierarchical to | FDP_ACC.1 |
| Dependencies | FDP_ACF.1 |

| FDP_ACC.2/AF | Complete access control |
|---|---|
| FDP_ACC.2.1/AF | The TSF shall enforce the Application Firewall access control policy[1] on subjects, objects and operations defined in 6.1.8.1[2] and all operations among subjects and objects covered by the SFP. |
| FDP_ACC.2.2/AF | The TSF shall ensure that all operations between any subject controlled by the TSF and any object controlled by the TSF are covered by an access control SFP. |

**Table 22 FDP_ACF.1/AF**

| FDP_ACF.1/AF | Security attribute based access control |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | FDP_ACC.1<br>FMT_MSA.3 |
| FDP_ACF.1.1/AF | The TSF shall enforce the Application Firewall access control policy[3] to objects based on the following: The subjects, objects, operations and associated security attributes defined in 6.1.8.1[4]. |
| FDP_ACF.1.2/AF | The TSF shall enforce the following rules to determine if an operation among controlled subjects and controlled objects is allowed: Rules defined in 6.1.8.1[5]. |
| FDP_ACF.1.3/AF | The TSF shall explicitly authorise access of subjects to objects based on the following additional rules: None[6]. |
| FDP_ACF.1.4/AF | The TSF shall explicitly deny access of subjects to objects based on the following additional rules: None[7]. |

**Table 23 FMT_MSA.3/AF**

| FMT_MSA.3/AF | Static attribute initialisation |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | FMT_MSA.1<br>FMT_SMR.1 |
| FMT_MSA.3.1/AF | The TSF shall enforce the Application Firewall access control policy[8] to provide restrictive[9] default values for security attributes that are used to enforce the SFP. |

[1] [assignment: access control SFP]

[2] [assignment: list of subjects and objects, and operations among subjects and objects covered by the SFP]

[3] [assignment: access control SFP]

[4] [assignment: list of subjects and objects controlled under the indicated SFP, and for each, the SFP-relevant security attributes, or named groups of SFP-relevant security attributes]

[5] [assignment: rules governing access among controlled subjects and controlled objects using controlled operations on controlled objects]

[6] [assignment: rules, based on security attributes, that explicitly authorize access of subjects to objects].

[7] [assignment: rules, based on security attributes, that explicitly deny access of subjects to objects].

[8] [assignment: access control SFP, information flow control SFP]

[9] [selection, choose one of: restrictive, permissive, [assignment: other property]]

| FMT_MSA.3/AF | Static attribute initialisation |
|---|---|
| FMT_MSA.3.2/AF | The TSF shall allow the none[1] to specify alternative initial values to override the default values when an object or information is created. |

*Note: Restrictive means that the security attributes for all addresses are sec(x) = S*

**Table 24 FMT_MSA.1/AF/S**

| FMT_MSA.1/AF/S | Management of security attributes |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | [FDP_ACC.1 or FDP_IFC.1]<br>FMT_SMR.1<br>FMT_SMF.1 |
| FMT_MSA.1.1/AF/S | The TSF shall enforce the Application Firewall access control policy[2] to restrict the ability to modify[3] the security attributes PO(x), acc(x), sec(x), XN(x)[4] to secure AF management in case sec(x) = S[5]. |

**Table 25 FMT_MSA.1/AF/NS**

| FMT_MSA.1/AF/NS | Management of security attributes |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | [FDP_ACC.1 or FDP_IFC.1]<br>FMT_SMR.1<br>FMT_SMF.1 |
| FMT_MSA.1.1/AF/NS | The TSF shall enforce the Application Firewall access control policy[6] to restrict the ability to modify[7] the security attributes PO(x), acc(x), XN(x)[8] to secure or non-secure AF management in case sec(x) = NS[9]. |

**Table 26 FMT_SMF.1/AF**

| FMT_SMF.1/AF | Specification of management functions |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | No dependencies. |
| FMT_SMF.1.1/AF | The TSF shall be capable of performing the following management functions: Modification of the security attributes PO(x), acc(x), sec(x), XN(x)[10]. |

[1] [assignment: the authorized identified roles]
[2] [assignment: access control SFP(s), information flow control SFP(s)]
[3] [selection: change_default, query, modify, delete, [assignment: other operations]]
[4] [assignment: list of security attributes]
[5] [assignment: the authorized identified roles]
[6] [assignment: access control SFP(s), information flow control SFP(s)]
[7] [selection: change_default, query, modify, delete, [assignment: other operations]]
[8] [assignment: list of security attributes]
[9] [assignment: the authorized identified roles]
[10] [assignment: list of management functions to be provided by the TSF]

**Table 27 FMT_SMR.1/AF**

| FMT_SMR.1/AF | Security Roles |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | FIA_UID.1 |
| FMT_SMR.1.1/AF | The TSF shall maintain the roles secure AF management and non-secure AF management[1]. |
| FMT_SMR.1.2/AF | The TSF shall be able to associate users with roles. |

### 6.1.9 Authentication of the Security IC

The TOE shall implement the Package "Authentication of the Security IC" from [PP0084], ch. 7.2.

**Table 28 FIA_API.1**

| FIA_API.1 | Authentication Proof of Identity |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | No dependencies. |
| FIA_API.1.1 | The TSF shall provide a authentication mechanism according to [ISO9798_2] section 7.3.3, Mechanism MUT.CR-Three-pass authentication[2] to prove the identity of the TOE to an external entity. |

*Note: FIA_API is only available, if the Flash Loader is active.*

### 6.1.10 Flash loader

The TOE provides a Flash Loader to download user data into the NVM, either during production of the TOE or at customer site. This TOE shall support both Loader packages from [PP0084] section 7.3.

- Package 1: Loader dedicated for usage in secured environment only
- Package 2: Loader dedicated for usage by authorized users only

The SFRs FDP_UCT.1 and FDP_UIT.1 are specified in [PP0084].

**Table 29 FMT_LIM.1/Loader**

| FMT_LIM.1/Loader | Limited Capabilities - Loader |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | FMT_LIM.2 |
| FMT_LIM.1.1/Loader | The TSF shall be designed and implemented in a manner that limits its capabilities so that in conjunction with "Limited availability (FMT_LIM.2)" the following policy is enforced: Deploying Loader functionality after permanent deactivation[3] does not allow stored user data to be disclosed or manipulated by unauthorized user. |

[1] [assignment: the authorised identified roles]

[2] [assignment: authentication mechanism]

[3] [assignment: action]

**Table 30 FMT_LIM.2/Loader**

| FMT_LIM.2/Loader | Limited availability - Loader |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | FMT_LIM.1 |
| FMT_LIM.2.1/Loader | The TSF shall be designed in a manner that limits its availability so that in conjunction with "Limited capabilities (FMT_LIM.1)" the following policy is enforced: The TSF prevents deploying the Loader functionality after permanent deactivation[1]. |

*Note: The User Guidance for this TOE requires the Flash Loader to be permanently deactivated prior delivery to the end user (Phase 7).*

**Table 31 FTP_ITC.1**

| FTP_ITC.1 | Inter-TSF trusted channel |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | No dependencies. |
| FTP_ITC.1.1 | The TSF shall provide a communication channel between itself and Administrator User or Download Operator User and Image Provider[2] that is logically distinct from other communication channels and provides assured identification of its end points and protection of the channel data from modification or disclosure. |
| FTP_ITC.1.2 | The TSF shall permit another trusted IT product to initiate communication via the trusted channel. |
| FTP_ITC.1.3 | The TSF shall initiate communication via the trusted channel for deploying Loader for downloading User Data and modification of authentication keys[3]. |

*Note: The download operation is authenticated by the Administrator User or the Download Operator User but the download image may be encrypted and authenticated by a different role. This role is called the "Image Provider". Thus, the download operation provides in effect a trusted channel between the Image Provider and the Flash Loader.*

**Table 32 FDP_ACC.1/Loader**

| FDP_ACC.1/Loader | Subset access control - Loader |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | FDP_ACF.1 |
| FDP_ACC.1.1/Loader | The TSF shall enforce the Loader SFP on<br>(1) the subjects Administrator User, Download Operator User and Image Provider[4],<br>(2) the objects user data in NVM[5],<br>(3) the operation deployment of Loader. |

[1] [assignment: action]

[2] [assignment: users authorized for using the Loader]

[3] [assignment: rules]

[4] [assignment: authorized roles for using Loader]

[5] [assignment: memory areas]

**Table 33 FDP_ACF.1/Loader**

| FDP_ACF.1/Loader | Security attribute based access control - Loader |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | FMT_MSA.3 |
| FDP_ACF.1.1/Loader | The TSF shall enforce the Loader SFP to objects based on the following:<br>(1) the subjects Administrator User, Download Operator User and Image Provider[1] with security attributes None[2].<br>(2) the objects user data in NVM[3] with security attributes None[4]. |
| FDP_ACF.1.2/Loader | The TSF shall enforce the following rules to determine if an operation among controlled subjects and controlled objects is allowed:<br>The authenticated Administrator User or authenticated Download Operator User can replace the user data by new user data when the new user data is authorized by the Image Provider[5]. |
| FDP_ACF.1.3/Loader | The TSF shall explicitly authorise access of subjects to objects based on the following additional rules: None[6]. |
| FDP_ACF.1.4/Loader | The TSF shall explicitly deny access of subjects to objects based on the following additional rules: None[7]. |

*Note: The Image provider authenticates with the flash loader implicitly by providing a correctly signed and encrypted download image. An Image provider authentication must always be preceded by an Administrator User or Download Operator User authentication.*

### 6.1.10.1 SFRs added in this ST

The following SFRs have been added to the SFRs from Flash Loader package 2 of [PP0084] in order to describe the management of the various Flash Loader authentication keys.

**Table 34 FMT_MTD.1/Loader**

| FMT_MTD.1/Loader | Management of TSF data |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | FMT_SMR.1<br>FMT_SMF.1 |
| FMT_MTD.1.1/Loader | The TSF shall restrict the ability to modify, delete[8] the Authentication keys for Administrator User, Download Operator User and Image Provider[9] to Administrator User, Download Operator User[10]. |

[1] [assignment: authorized roles for using Loader]

[2] [assignment: SFP relevant security attributes, or named groups of SFP relevant security attributes]

[3] [assignment: memory areas]

[4] [assignment: SFP-relevant security attributes, or named groups of SFP-relevant security attributes]

[5] [assignment: rules governing access among controlled subjects and controlled objects using controlled operations on controlled objects]

[6] [assignment: rules, based on security attributes, that explicitly authorise access of subjects to objects].

[7] [assignment: rules, based on security attributes, that explicitly deny access of subjects to objects]

[8] [selection: change_default, query,modify, delete, clear, [assignment: other operations]]

[9] [assignment: list of TSF data]

[10] [assignment: the authorised identified roles]

*Note: The Administrator User can manage the keys for Administration User, Download Operator User and Image Provider.*
*The Download Operator User can delete the key for Image Provider and Download Operator and modify keys for the Download Operator User only.*
*The image provider cannot modify any keys or perform authentication with the Flash Loader. It can only build encrypted and authenticated loadable images.*

**Table 35 FMT_SMR.1/Loader**

| FMT_SMR.1/Loader | Security roles |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | FIA_UID.1 |
| FMT_SMR.1.1/Loader | The TSF shall maintain the roles Administrator User, Download Operator User, Image Provider[1]. |
| FMT_SMR.1.2/Loader | The TSF shall be able to associate users with roles. |

*Note: Image provider is the role who maintains the key which is used to encrypt and integrity protect the download image.*

**Table 36 FMT_SMF.1/Loader**

| FMT_SMF.1/Loader | Specification of Management Functions |
|---|---|
| Hierarchical to | No other components. |
| Dependencies | No dependencies. |
| FMT_SMF.1.1/Loader | The TSF shall be capable of performing the following management functions: Change Key, Invalidate Key[2]. |

*Note: "Change Key" of this SFR means the "modify" operations from SFR FMT_MTD.1/Loader, "Invalidate Key" of this SFR means the "delete" operation from SFR FMT_MTD.1/Loader.*

**Table 37 FIA_UID.2/Loader**

| FIA_UID.2/Loader | User identification before any action |
|---|---|
| Hierarchical to | FIA_UID.1 |
| Dependencies | No dependencies. |
| FIA_UID.2.1/Loader | The TSF shall require each user to be successfully identified before allowing any other TSF-mediated actions on behalf of that user. |

## 6.2 Security assurance requirements

In the following Table 38, the security assurance requirements and compliance rationale for augmented refinements are given.

**Table 38 SAR list and refinements**

| SAR | Refinement |
|---|---|
| ADV_ARC.1 | Refined in [PP0084] |

[1] [assignment: the authorised identified roles]

[2] [assignment: list ofmanagement functions to be provided by the TSF]

### Security Requirements (ASE_REQ)

| SAR | Refinement |
|---|---|
| ADV_FSP.5 | The refinement of ADV_FSP.4 from [PP0084] can also be applied to the assurance level EAL 6 comprising ADV_FSP.5. The assurance component ADV_FSP.4 is extended to ADV_FSP.5 with aspects regarding the level of description. ADV_FSP.5 requires a semi-formal description in addition. The refinement is still valid. |
| ADV_IMP.2 | The refinement of ADV_IMP.1 in [PP0084] requires the evaluator to check for completeness. In case of ADV_IMP.2 the entire implementation representation has to be provided anyhow. A check for completeness is also applicable in case the entire implementation representation is provided. |
| ADV_INT.3 | No refinement |
| ADV_TDS.5 | No refinement |
| ADV_SPM.1 | No refinement |
| AGD_OPE.1 | Refined in [PP0084] |
| AGD_PRE.1 | Refined in [PP0084] |
| ALC_CMC.5 | The refinement of ALC_CMC.4 from [PP0084] details how configuration management has to be also applied to production. This is also applicable for ALC_CMC.5. ALC_CMC.5 is not specifically focused on production. |
| ALC_CMS.5 | The refinement of ALC_CMS.4 from [PP0084] can also be applied to the assurance level EAL 6 comprising ALC_CMS.5. The assurance package ALC_CMS.4 is extended to ALC_CMS.5 with aspects regarding the configuration control system for the TOE. The refinement is still valid. |
| ALC_DEL.1 | Refined in [PP0084] |
| ALC_DVS.2 | Refined in [PP0084] |
| ALC_FLR.1 | No refinement |
| ALC_LCD.1 | No refinement |
| ALC_TAT.3 | No refinement |
| ASE_CCL.1 | No refinement |
| ASE_ECD.1 | No refinement |
| ASE_INT.1 | No refinement |
| ASE_OBJ.2 | No refinement |
| ASE_REQ.2 | No refinement |
| ASE_SPD.1 | No refinement |
| ASE_TSS.1 | No refinement |
| ATE_COV.3 | The refinement of ATE_COV.2 in [PP0084] clarifies how to deal with testing of security mechanisms for physical protection. It further requests the TOE to be tested under different operating conditions. These refinements are also applicable for ATE_COV.3, which requires complete TSFI coverage. |
| ATE_DPT.3 | No refinement |
| ATE_FUN.2 | No refinement |
| ATE_IND.2 | No refinement |
| AVA_VAN.5 | Refined in [PP0084] |

### 6.2.1 Security Policy Model (SPM) details

[CC3] requires in ADV_SPM.1.1D to define the not modelled SFRs.

The rational for the excluded SFRs are as follows:

- SFRs for cryptographic services are not modelled by convention
- SFRs for physical functions cannot be logically modelled
- SFRs for internal functions have no visible logical interface

The developer shall provide a formal security policy model for the SFRs of this ST with the exception of the SFRs from the following table[1].

**Table 39 SFRs excluded from SPM**

| SFR | Reason for exclusion |
|---|---|
| FCS_RNG.1/* | cryptographic services |
| FCS_COP.1/* | cryptographic services |
| FCS_CKM.4/* | cryptographic services |
| FPT_TST.1 | physical function |
| FRU_FLT.2 | physical function |
| FPT_FLS.1 | physical function |
| FPT_PHP.3 | physical function |
| FDP_SDC.1 | physical function |
| FDP_ITT.1 | internal function |
| FPT_ITT.1 | Internal function |
| FDP_IFC.1 | Internal function |

*Note: A star "*" means all iterations of that SFR*

## 6.3 Security requirements rationale

### 6.3.1 Rationale for the Security Functional Requirements

The security requirements rationale identifies the modifications and additions made to the rationale presented in [PP0084].

#### 6.3.1.1 Additional SFRs related to O.Firewall

**Table 40 Rationale for SFRs related to O.Firewall**

| SFR | Rationale |
|---|---|
| FDP_ACC.2/AF | The SFR with the respective SFP require the implementation of an area-based memory access control. |
| FDP_ACF.1/AF | The SFR allows the TSF to enforce access to objects within the respective SFP based on security attributes and defines these attributes and defines the rules based on these attributes that enable explicit decisions. |

[1] [assignment: list of policies that are formally modelled]

| SFR | Rationale |
|---|---|
| FMT_MSA.3/AF | The SFR requires that the TOE provides default values for the security attributes used in the SFP. Because the TOE is a hardware platform, these default values are generated by the reset procedure. |
| FMT_MSA.1/AF/S | The SFR requires that authorized users can manage TSF attributes. It ensures that the access control attributes associated to secure addresses can be managed only by code running in secure and privilege mode . |
| FMT_MSA.1/AF/NS | The SFR requires that authorized users can manage TSF attributes. It ensures that the access control attributes associated to non-secure addresses can be managed by code running in secure or non-secure privilege mode . |
| FMT_SMF.1/AF | The SFR is used for the specification of the management functions to be provided by the TOE. Being a hardware platform, the TOE allows the management of the security attributes by making the hardware registers accessible to software to enable modification. |
| FMT_SMR.1/AF | This SFR defines the roles used for management of the security attributes. The roles are defined by the security attribute of the fetch address of the CPU instruction. |

#### 6.3.1.2 Additional SFRs related to O.Ctrl_Auth_Loader

**Table 41 Rationale for additional SFRs related to O.Ctrl_Auth_Loader**

| SFR | Rationale |
|---|---|
| FMT_MTD.1/Loader | This SFR requires that the TOE provides management functions for modification and deletion of authentication keys. |
| FMT_SMR.1/Loader | This SFR requires that the roles to management keys are defined |
| FMT_SMF.1/Loader | This SFR requires that the key management functions are defined |
| FIA_UID.2/Loader | This SFR requires that management functions can only be executed by authorized roles. |

#### 6.3.1.3 Additional SFRs related to O.Phys-Manipulation

The FPT_TST.1 component allows that particular parts of the security mechanisms and functions provided by the TOE can be tested after TOE delivery. This feature is important to detect direct physical manipulations by a FIB device in order to disable the alarm system of the chip.

### 6.3.2 Dependencies of Security Functional Requirements

The dependencies of the SFRs which are defined in [PP0084] are resolved in [PP0084], ch. 6.3.2.
The following table lists the dependencies of the additional SFRs which are defined in this ST.

**Table 42 Dependencies of SFRs**

| SFR | Dependencies | Rationale |
|---|---|---|
| FDP_ACC.2/AF | FDP_ACF.1 | Fulfilled by FDP_ACF.1/AF |
| FDP_ACF.1/AF | FDP_ACC.1 | Fulfilled by FDP_ACC.2/AF, which is hierarchically higher |
| FMT_MSA.3/AF | FMT_MSA.1 | Fulfilled by FMT_MSA.1/AF/S and FMT_MSA.1/AF/NS |

| SFR | Dependencies | Rationale |
|---|---|---|
| | FMT_SMR.1 | Fulfilled by FMT_SMF.1/AF |
| FMT_MSA.1/AF/S<br>FMT_MSA.1/AF/NS | FDP_ACC.1 or FDP_IFC.1 | Fulfilled by FDP_ACC.2/AF, which is hierarchically higher |
| | FMT_SMR.1 | Fulfilled by FMT_SMF.1/AF |
| | FMT_SMF.1 | Fulfilled by FMT_SMF.1/AF |
| | FMT_SMR.1 | Fulfilled by FMT_SMF.1/AF |
| | FMT_SMF.1 | Fulfilled by FMT_SMF.1/AF |
| FMT_SMR.1/AF | FIA_UID.1 | The dependency is satisfied, because the role is identified by the execution context of the processor. |
| FMT_SMF.1/AF | None | No dependency |
| FDP_ACC.1/Loader | FDP_ACF.1 | Fulfilled by FDP_ACF.1/Loader |
| FDP_ACF.1/Loader | FMT_MSA.3 | Not applicable, because there are no security attributes defined |
| FMT_MTD.1/Loader | FMT_SMR.1 | Fulfilled by FMT_SMR.1/Loader |
| | FMT_SMF.1 | Fulfilled by FMT_SMF.1/Loader |
| FMT_SMR.1/Loader | FIA_UID.1 | Fulfilled by FIA_UID.2/Loader |
| FMT_SMF.1/Loader | None | No dependency |
| FIA_UID.2/Loader | None | No dependency |
| FPT_TST.1 | None | No dependency |
| FCS_COP.1/AES | FCS_CKM.4 | Fulfilled by FCS_CKM.4 |
| | [FDP_ITC.1 or FDP_ITC.2 or FCS_CKM.1] | The TOE does not provide services to generate symmetric keys. This will be done by the embedded software for the composite TOE. |
| FCS_CKM.4 | [FDP_ITC.1 or FDP_ITC.2 or FCS_CKM.1] | The TOE does not provide services to generate or import symmetric keys. This will be done by the embedded software for the composite TOE. |

### 6.3.3 Rationale of the Assurance Requirements

The TOE is a typical security IC as defined in [PP0084]. The rationale for EAL level and augmentation is as follows.

An assurance level EAL6 with the augmentations ALC_FLR.1 is required for this type of TOE since it is intended to defend against highly sophisticated attacks without a protective environment. This evaluation assurance package was selected to permit a developer to gain maximum assurance from positive security engineering based on good commercial practices. In order to provide a meaningful level of assurance that the TOE provides an adequate level of defence against such attacks, the evaluators should have access to all information regarding the TOE including the TSF internals, the low level design and source code including the testing of the modular design. Additionally the mandatory technical document [JIL] shall be taken as a basis for the vulnerability analysis of the TOE.

# 7 TOE Summary Specification (ASE_TSS)

The product overview is given in section 1.3.1. The Security Features are described below and the relation to the security functional requirements is shown. The TOE is equipped with the following security features to meet the security functional requirements:

**Table 43 TOE Security Features**

| Security Feature | Description |
|---|---|
| SF_DPM | Device Phase Management |
| SF_PS | Protection against Snooping |
| SF_PMA | Protection against Modification Attacks |
| SF_PLA | Protection against Logical Attacks |
| SF_HC | Hardware provided Cryptography |

## 7.1 SF_DPM: Device Phase Management

The life cycle of the TOE is split up into several phases (see [PP0084], ch. 1.2.3). Chip development and production (phase 2, 3, 4) and final use (phases 4-7) is a rough split-up from the TOE point of view. These phases are implemented in the TOE as test mode (phase 3) and user mode (phases 4-7). In addition a chip identification mode exists which is active in all phases. The chip identification data (O.Identification) is stored in a non-modifiable configuration page area of the non-volatile memory. Further TOE configuration data is stored in the same area. In addition, user initialization data can be stored in the NVM during the production phase as well. During this first data programming, the TOE is still in the secured environment and in test mode.

The covered security functional requirement is FAU_SAS.1 “Audit storage”.

During start-up of the TOE the decision for one of the various operation modes is taken dependent on phase identifiers. The decision of accessing a certain mode is defined as phase entry protection. The phases follow also a defined and protected sequence. The sequence of the phases is protected by means of authentication.

The covered security functional requirements are FMT_LIM.1 and FMT_LIM.2.

During the production phase (phase 3 and 4) or after the delivery to the customer (phase 5 or phase 6), the TOE provides the possibility to download a user specific encryption key and user code and data into the empty (erased) NVM area as specified by the associated control information of the Flash Loader software. Alternatively in case the user has ordered TOE derivatives without Flash Loader, software download by the user (phase 5 or phase 6) is disabled and all user data of the embedded software is stored on the TOE at Infineon premises. In case the user has ordered the TOE derivatives with Flash Loader enabled, the Flash Loader may either be received in a way, which requires an authentic Pinletter and authentication afterwards, or it may be received in a state, which immediately requires successful mutual authentication. The Pinletter process can exchange the default authentication key. Successful authentication is required before being able to use the download functionality of the Flash Loader. Once authenticated, the functionality to exchange the Flash Loader keys depending on the user’s identity is enabled. One of the keys, which can be exchanged is the Image Provider key. This key is used to decrypt and verify the integrity protected and encrypted download image. The authenticated user may also invalidate authentication keys depending on the user’s identity. After finishing the download operation, the Flash Loader has to be permanently deactivated prior delivery to the end user, so that no further load operation with the Flash Loader is possible. The Flash Loader uses AES CCM mode [SP800-38C] for encryption and integrity protection of payload and for authentication. For key usage diversification, the Flash Loader uses key derivation according to [SP 800-108].

The covered security functional requirements are FMT_LIM.1/Loader, FMT_LIM.2/Loader, FTP_ITC.1, FDP_UCT.1, FDP_UIT.1, FDP_ACC.1/Loader, FDP_ACF.1/Loader, FMT_MTD.1/Loader, FMT_SMR.1/Loader, FMT_SMF.1/Loader, FIA_UID.2/Loader and FIA_API.1.

Note that the SFRs FTP_ITC.1, FDP_UCT.1, FDP_UIT.1, FDP_ACC.1/Loader, FDP_ACF.1/Loader, FMT_MTD.1/Loader, FMT_SMR.1/Loader, FMT_SMF.1/Loader, FIA_UID.2/Loader and FIA_API.1 are only part of the TOE if the flash loader is active.

Each operation phase is protected by means of authentication and encryption.

The covered security functional requirements are FDP_ITT.1 and FPT_ITT.1.

## 7.2 SF_PS: Protection against Snooping

All contents of the memories RAM, ROM and NVM of the TOE are encrypted on chip to protect them against data analysis. The encryption of the memory content is done by the MCICE using a proprietary cryptographic algorithm. A complex key management and address scrambling provides protection against cryptographic analysis attacks. All security relevant transfers via the peripheral bus are dynamically masked and thus protected against readout and analysis. Leakage of data dependent code execution can be reduced by employing specific hardware features.

In addition, the optional Masked Instruction Set Extension (MISE) coprocessor provides an Armv8-M Custom Data path Extension (CDE) with side-channel improved (masked) variants of common 32-bit instructions. This will provide additional means for the embedded software to minimize side channel leakage.

The covered security functional requirements are FDP_SDC.1, FDP_IFC.1, FPT_PHP.3, FPT_ITT.1, FPT_FLS.1 and FDP_ITT.1.

Most components of the design are synthesized to disguise allocation of elements to certain modules of the IC. Physical regularity of the logic functions is thereby removed. The covered security functional requirement is FPT_PHP.3.

A further protective design method used is security optimized wiring. Certain security-critical wires have been identified and protected by special routing measures against probing. Additionally specific signal lines, required to operate the device, are embedded into shield lines of the chip to prevent successful probing. The covered security functional requirements are FPT_PHP.3, FPT_ITT.1, FDP_ITT.1 and FDP_IFC.1.

A low system frequency sensor FSE is implemented to prevent the TOE from single stepping. The sensor is tested by the User Mode Security Life Control UMSLC. The UMSLC library provides some wrapper functionality around the UMSLC hardware part containing measures against fault attacks. The covered security functional requirements are FPT_PHP.3 and FPT_FLS.1.

## 7.3 SF_PMA: Protection against Modifying Attacks

The TOE has implemented a dual CPU running in lockstep mode and registers protected with 32 bit EDC. This mechanism reliably detects attacks on the code flow and data processed by the CPU. In the case of a detected attack, the TOE enters the secure state.

The TOE is equipped with a 28 bit EDC in RAM, a 28 bit EDC in NVM and a 32 bit EDC in ROM, which is realized in the MCICE peripheral. The EDC detects detect single- and multi-bit errors. In the case of an EDC error, the TOE enters the secure state.

The covered security functional requirements are FRU_FLT.2, FPT_PHP.3 and FDP_SDI.2.

A life test on internal security features is provided – it is called User Mode Security Life Control (UMSLC), which checks alarm lines for correct operation. This test can be triggered by user software during normal operation or via the UMSLC lib. If physical manipulation or a physical probing attack is detected, the TOE enters the secure

state (as defined in chapter 6.1.4). To further decrease the risk of manipulation and tampering of the detection system a redundant alarm propagation and system deactivation is provided.

The covered security functional requirements are FPT_FLS.1, FPT_PHP.3 and FPT_TST.1

The Instruction Stream Signature Checking (ISS) calculates a hash over all executed instructions and automatically checks the correctness of this hash value. If the code execution follows an illegal path an alarm is triggered. This feature can optionally be used for program flow integrity protection but it is not needed as the dual CPU and memory EDC mechanisms are far better suited to detect such attacks.

The Online Configuration Check (OCC) function controls the modification of relevant system settings. It is also useful as a measure against fault attacks and accidental changes. The content of the protected registers is permanently hashed and checked against a reference value. A violation generates an alarm event and leads to the secure state.

The TOE supports dynamical locking of dedicated peripherals. This way data flow between CPU and peripherals can be controlled. Manipulations utilizing access to specific peripherals can be prevented with this locking mechanism.

As physical effects or manipulative attacks may also target the program flow of the user software, a watchdog timer and a check point register are implemented. These features allow the user to check the correct processing time and the integrity of the program flow of the user software.

The covered security functional requirements are FPT_FLS.1, FDP_IFC.1, FPT_ITT.1, FDP_ITT.1 and FPT_PHP.3.

The HSL provides tearing safe write operations which can be utilized by the embedded software.

The covered security functional requirement is FPT_PHP.3.

The correct function of the TOE is only given in the specified range of environmental operating parameters. To prevent an attack exploiting that circumstance the TOE is equipped with a temperature sensor, glitch sensor and voltage sensor as well as backside light detection. The TOE falls into the defined secure state in case of a specified range violation. The defined secure state causes the chip internal reset process.

The covered security functional requirements are FRU_FLT.2 “Limited fault tolerance” and FPT_FLS.1 “Failure with preservation of secure state“.

## 7.4 SF_PLA: Protection against Logical Attacks

The TOE implements the Armv8-M Memory Protection Unit (MPU) with 8 regions and the Security Attribution Unit (SAU) with 8 regions according to [Armv8-M], ch. B10.

The SAU contains an Implementation Defined Attribution Unit (IDAU). The IDAU exempts the address ranges 4000 0000H - 5FFF FFFFH and A000 0000H - FFFF FFFFH from Security attribution.

During each start-up of the TOE the address ranges and MPU access rights are initialized by the Boot Software (BOS) with predefined values. The BOS maps a small region containing the start-up code for access of privilege software.

The SAU is disabled and all addresses are marked secure and non-secure not callable.

The covered security functional requirements are FDP_ACC.2/AF, FDP_ACF.1/AF, FMT_MSA.1/AF/S, FMT_MSA.1/AF/NS,, FMT_MSA.3/AF, FMT_SMF.1/AF and FMT_SMR.1/AF.

## 7.5 SF_HC: Hardware provided cryptography

The TOE is equipped with a random number generator as defined in the SFRs FCS_RNG.1/TRNG in chapter 6.1.1.

The covered security functional requirement is FCS_RNG.1/TRNG.

The TOE supports the encryption and decryption in accordance with the Advanced Encryption Standard (AES) and cryptographic key sizes of 128 bits or 192 bits or 256 bits that meet the standards as defined in chapter 6.1.2.

The covered security functional requirement are FCS_COP.1/AES and FCS_CKM.4.

# 8 Hash values of libraries

This chapter list the SHA256 hashes of the libraries from section 1.4.2.2.

**Table 44 SHA256 hash values**

| Lib | SHA256 |
|---|---|
| NRG™ | 3aec48b0449bc49e1f4e9c72390730108711ed450498bf9dffbbed1d342e06d0 |
| UMSLC | 74091c50254bc348a48a2e261a125735dca41f2419cd9541c3e6fbfdff63b529 |
| HSL | 5357585cff662d4dd45766bd682303ee31f66ebc41998a489b0124cef9b87e55 |

# 9 Cryptographic Table

**Table 45 Cryptographic table**

| Purpose | Cryptographic operation | Key size in bits | Standards |
|---|---|---|---|
| Confidentiality | AES in ECB mode provided by hardware | 128, 192, 256 | [FIPS 197]<br>[SP 800-38A] |
| Authenticated encryption | AES CCM | 128 | [SP 800-38C] |
| Key derivation | KDF in counter mode with AES CMAC as PRF | 128 | [SP 800-108], ch. 5.1<br>[SP 800-38B], ch. 6.2 |
| Random | Physical RNG PTG.2 | N/A | [AIS 31] |

# Acronyms

| Acronym | Description |
|---|---|
| AES | Advanced Encryption Standard |
| CSP | Chip Scale Package |
| ECC | Elliptic Curve Cryptography or Error Correction Code |
| EDC | Error Detection Code |
| ISS | Instruction Stream Signature |
| MISE | Masked Instruction Set Extension |
| MPU | Memory Protection Unit |
| NVIC | Nested Vectored Interrupt Controller |
| NVM | Non-Volatile Memory |
| OCC | Online Configuration Check |
| RAM | Random Access Memory |
| RNG | Random Number Generator |
| ROM | Read Only Memory |
| RSA | Rivest Shamir Adleman |
| SAU | Security Attribution Unit |
| SE | Security Extension |
| SPI | Serial Peripheral Interface |
| SPM | Security Policy Model |
| SWP | Single Wire Protocol |
| TOE | Target Of Evaluation |
| UMSLC | User Mode Security Life Control |

# References


| | |
|---|---|
| [AIS 31] | Anwendungshinweise und Interpretationen zum Schema<br>AIS 31, Version 3, 15.05.2013<br>Bundesamt für Sicherheit in der Informationstechnik |
| [AIS 46] | Anwendungshinweise und Interpretationen zum Schema<br>AIS 46, Version 3, 2013-12-04<br>Bundesamt für Sicherheit in der Informationstechnik |
| [Armv8-M] | Arm® v8-M Architecture Reference Manual, , ARM part number: AR100-DA-78000-r0p1-10eac0 |
| [CC1] | Common Criteria for Information Technology Security Evaluation Part12: Security Functional Requirements; Version 3.1 Revision 5 April 2017, CCMB-2017-04-001 |

### Acronyms

| | |
|---|---|
| [CC2] | Common Criteria for Information Technology Security Evaluation Part 2: Security Functional Requirements; Version 3.1 Revision 5 April 2017, CCMB-2017-04-002 |
| [CC3] | Common Criteria for Information Technology Security Evaluation Part 3: Security Assurance Requirements; Version 3.1 Revision 5 April 2017, CCMB-2017-04-003 |
| [FIPS 197] | Federal Information Processing Standards Publication, U.S. Department of Commerce, National Institute of Standards and Technology, Information Technology Laboratory (ITL), Advanced Encryption Standard (AES), FIPS PUB 197, as of 05/09/23 |
| [ISO9798_2] | ISO/IEC 9798-2: 2008 - Information Technology - Security techniques - Entity authentication - Part 2: Mechanisms using authenticated encryption. Fourth edition 2019-06 |
| [JIL] | Joint Interpretation Library, Application of Attack Potential to Smartcards, Version 3.2 November 2022 |
| [PP0084] | Security IC Platform Protection Profile with Augmentation Packages, Version 1.0, 13.01.2014, BSI-CC-PP-0084-2014 |
| [SP 800-38A] | National Institute of Standards and Technology (NIST), Technology Administration, U.S.<br>Department of Data Encryption Standard, NIST Special Publication 800-38A, Edition 2001 |
| [SP 800-38B] | National Institute of Standards and Technology (NIST), Special Publication 800-38B, May 2005 |
| [SP 800-38C] | NIST SP 800-38C: Recommendation for Block Cipher Modes of Operation: The CCM Mode for Authentication and Confidentiality, 2004-05 (up-dated: 2007-07-20) |
| [SP 800-108] | National Institute of Standards and Technology (NIST), Recommendation for Key Derivation Using Pseudorandom Functions, NIST SP 800-108r1, August 2022 |

## Revision history

| Rev. | Date | Description |
|---|---|---|
| 1.0 | 2023-07-31 | Release |
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