NPCT7xx TPM 2.0 rev 1.38
FIPS 140-2 Security Policy

Revision 1.0.4

March 5, 2019

Revision Record

Revision	Date	Comments
1.0.0	August 15, 2018	First version
1.0.1	August 28, 2018	Updates following review feedback
1.0.2	December 9, 2018	Updates following review feedback
1.0.3	January 6, 2019	Updates following review feedback
1.0.4	March 5, 2019	Final version for publication

Table of Contents

Figures

Tables

1. Module Description

1.1 General Description

The Nuvoton Trusted Platform Module ("Module") is a hardware cryptographic module that implements advanced cryptographic algorithms, including symmetric and asymmetric cryptography, as well as key generation and random number generation.

The Module is a single-chip module that provides cryptographic services utilized by external applications. The Module meets the requirements of FIPS Pub 140-2.

The Module meets commercial-grade specifications for power, temperature, reliability, shock, and vibrations, and includes chip packaging to meet the physical security requirements at Physical Security Level 3.

The FIPS 140-2 conformance testing was performed on the following configurations of the Nuvoton NPCT7xx TPM 2.0:

- Firmware versions: 7.2.1.0
- Hardware version 1: LAG019 in TSSOP28 package
- Hardware version 2: LAG019 in QFN32 package
- Hardware version 3: LAG019 in UQFN16 package

The TPM2.0 packages are shown below.

Figure 1. LAG019 in QFN32 Package

Figure 2. LAG019 in UQFN16 Package

Figure 3. LAG019 in TSSOP28 Package

The physical cryptographic boundary of the Module is the outer boundary of the chip packaging.

Figure 4 shows a logical diagram of the Module:

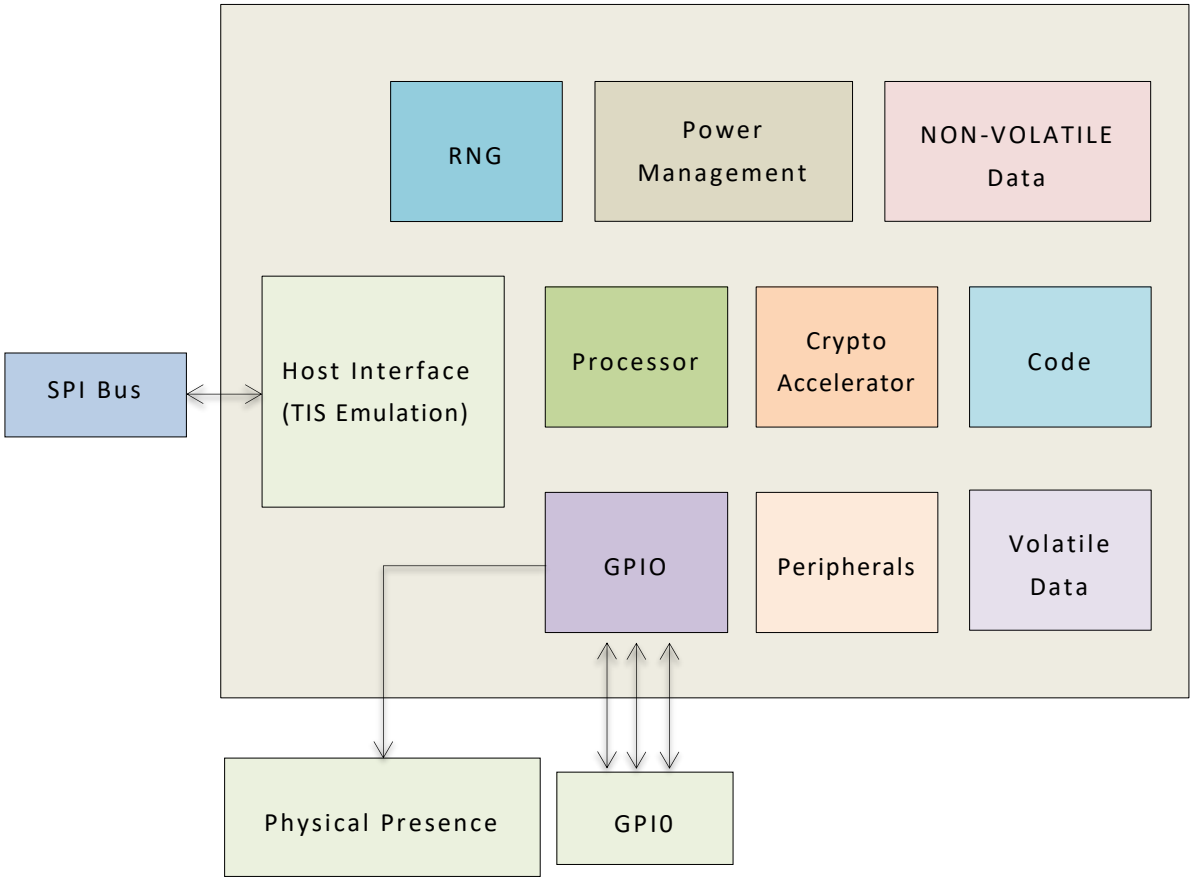

Figure 4. TPM 2.0 Logical Block Diagram

The Module was tested to meet overall Security Level 2 of the FIPS PUB 140-2 standard. The Security Level for each section of FIPS PUB 140-2 is specified in Table 1.

Table 1. Security Levels

FIPS 140-2 Section	Security Level
Cryptographic Module Specification	2
Cryptographic Module Ports and Interfaces	2
Roles, Services and Authentication	2
Finite State Model	2
Physical Security	3
Operational Environment	N/A
Cryptographic Key Management	2
EMI/EMC	3
Self Tests	2
Design Assurance	2
Mitigation of Other Attacks	N/A

1.2 Approved Modes

For some TPM host platforms, it might take too much time to execute all self tests during power up. Therefore, the TPM supports the following two Approved modes.

1.2.1 Approved Mode 1

This mode is the default mode when the TPM powers up.

Table 2. Approved Mode 1

Properties	Description
Definition	Transient mode
Configuration	This mode is the default mode when the TPM powers up. It assumes a list of basic algorithms that is going to be used for basic TPM commands. The algorithms are: SHA1, SHA256, SHA384, HMAC, KDFa, KDFe and AES. These algorithms are tested in _TPM_Init. Thus all the algorithms from this list are tested before the first command is executed.
Services available	All services that do not use asymmetric cryptography (RSA, ECDSA, ECDH)
Algorithms used	SHS / HMAC / AES / DRBG / KDF
CSPs used	Only asymmetric CSPs cannot be used (RSA and ECC keys)
Self tests	SHS / HMAC / AES / DRBG / KDF and firmware integrity test

1.2.2 Approved Mode 2

This mode is the Approved mode of operation when all CSPs are accessible.

Table 3. Approved Mode 2

Properties	Description
Definition	Full Approved mode of operation
Configuration	There are three ways to move to Mode 2: 1. TPM2_SelfTest(fullTest = YES) command. 2. TPM2_SelfTest(fullTest = NO) command. If the firmware is in Mode 1, the command returns TPM_RC_TESTING. Immediately after that, the firmware runs a self test equivalent to TPM2_SelfTest(fullTest = YES). If a command is received before the TPM has completed self test execution, the TPM will first complete SelfTest and then execute the command. 3. Command that requires Mode 2 (all commands not listed in PTP section 5.5.1.6, Self Test and Early Platform Initialization). Incremental ST does not move to Mode 2 even if all the algorithm testing is completed using this command.
Services available	All services
Algorithms used	All supported algorithms
CSPs used	All CSPs
Self tests	SHS / HMAC / AES / DRBG / KDF / RSA / ECDH / ECDSA and firmware integrity test

2. Cryptographic Functions and Critical Security Parameters (CSPs)

2.1 Supported Cryptographic Functions

The Module's cryptographic functions are outlined in Table 4.

Table 4. Cryptographic Functions

Function	Function Name	Key Size in Bits	Use	Standard	CLV
AES Encryption and Decryption using OFB, CFB and CTR modes	AES	128 256	Data Encryption and Decryption	FIPS 197, SP800-38A	5390
RSA Signature Generation and Verification using RSASSA-PKCS1-v1_5 and RSASSA-PSS modes	RSASA	2048	Digital Signature	FIPS 186-4, PKCS#1 v2.1	2883
RSA Decryption Operation Primitive	RSADP	2048	Key Transport Primitive	SP800-56B	1856
RSA Encryption and Decryption using RSAES-PKCS1-v1_5 and RSAES_OAEP modes	RSAES	2048	Key Transport	SP800-56B, PKCS#1 v2.1	Vendor Affirmed
Generation of RSA Keys	RSAKG	2048	Key Pair Generation	FIPS 186-4	2883
Generation of symmetric keys and seeds when generating private keys for asymmetric key algorithm[1]	CKG	128 256	Key Generation	SP800-133	Vendor Affirmed
ECDSA Signature Generation and Verification using P-256 and P-384 curves	ECDSA	256 384	Digital Signatures	FIPS 186-4	1425
Generation of ECDSA Keys	ECCKG	256 384	Key Pair Generation	FIPS 186-4	1425

[1] The resulting symmetric key or generated seed is an unmodified output from the DRBG.

Function	Function Name	Key Size in Bits	Use	Standard	CLV
ECC Key Agreement using Full Unified and One Pass DH schemes	ECDH	256 384	Key Agreement	SP800-56A	179
HMAC HASH Message Authentication Code using SHA-1, SHA2-256 and SHA2-384	HMAC	160 256 384	Keyed Message Digest	FIPS 198-1	3572
SHS Hash using SHA-1, SHA2-256 and SHA2-384	SHA	N/A	Message Digest	FIPS 180-4	4325
Deterministic Random Bit Generation (DRBG) CTR_DRBG AES-256[2]	DRBG	256	DRBG	SP800-90A	2088
Key Derivation Function (KDF) using Counter mode with HMAC[3]	KDFa	160 256	Key Derivation	SP800-108	200
AES Key Wrapping with HMAC	AKWH	128 256	Key Wrapping	SP800-38F	5390, 3572

Note: There are some algorithm modes that were tested but not implemented by the module. Only the algorithms, modes, and key sizes that are implemented by the module are shown in this table.

[2] The derivation function is not used during instantiation of the CTR_DRBG.
[3] For algorithms TPM_ALG_KEYEDHASH and TPM_ALG_SYMCIPHER in [1], part 2.

2.2 Non-Approved but Allowed Algorithms

Table 5 summarizes TPM 2.0 functions that are not approved but allowed.

Table 5. Non-Approved but Allowed Algorithms

Function	Function Name	Key Size in Bits	Use
NDRNG (entropy source)	NDRBG[4]	N/A	Entropy source for the DRBG

2.3 Non-Approved Algorithms

Table 6 summarizes TPM 2.0-specified algorithm functions that do not meet the FIPS 140-2 cryptographic requirements. Usage of these algorithms in a TPM application is limited to non-cryptographic functions. The module will enter Non-Approved mode upon any cryptographic use of any of these algorithms.

Table 6. Non-Approved Algorithms

Function	Description
SHA-1	Used for digital signature verification (legacy) and any non-digital signature application. Not used for digital signature generation.
RSA	Not permitted for digital signature generation, key agreement and key transport schemes with key size = 1024. Usage of 1024 bit keys considered equivalent to plaintext or obfuscation versus cryptography.
XOR	XOR obfuscation used as a hash-based stream cipher.
MGF1	RSAES_OAEP mask generation function equivalent to plaintext or obfuscation versus cryptography.
ECDAA	Used for object creation and approved actions on keys that are non-FIPS compliant. Not used for cryptography. Usage considered plaintext or obfuscation.
EC Schnorr	Used for signing and verifying signatures that are non-FIPS compliant. Not used for cryptography. Usage considered plaintext or obfuscation.

[4] The estimated amount of entropy provided by the NDRNG is 376.32624 bits.

3. Ports and Interfaces

The ports of the Module are:

- SPI Bus
- PP (Physical Presence) Pin
- Platform Reset
- Power

The logical interfaces and the mapping of the logical interfaces to the physical ports of the Module are described in the table below.

Table 7. Ports and Interfaces

Logical Interface	Description	Physical Ports
Control Input Interface	Control Input commands issued to the chip	SPI Bus PP pin Platform Reset Power
Status Output Interface	Status data output by the chip	SPI Bus
Data Input Interface	Data provided to the chip as part of the data processing commands	SPI Bus PP pin Platform Reset
Data Output Interface	Data output by the chip a part of the data processing commands	SPI Bus PP pin Platform Reset
Power Interface	Power interface of the chip	Platform Reset Power

The Module does not include a maintenance interface.

4. Roles, Authentication and Services

The three operation roles implemented by the Module are summarized in the table below.

Table 8. Roles

Role	Acronym	High Level Description
Crypto-Officer	CO	Also known as “Object Administrator”; installs and configures the Module, controls certification, changes authorization
Object User[6]	OU	Uses the object to executes services
Duplicate[7]	DUP	Duplicates an object (if object duplication is allowed)

The Module provides three authorization types to identify the role: Password, HMAC and Policy.

Password Authorization - A plaintext password value presented to authorize an action or identify a role. A plaintext password may be only appropriate for cases in which the path between the caller and the TPM is trusted or when the password is well known.

HMAC Authorization – Proving the knowledge of a shared secret via challenge-response HMAC protocol to authorize an action or identify a role. HMAC key is the shared secret.

Policy Authorization – Also known as “Enhanced Authorization”, allows entity-creators or administrators to require specific tests or actions to be performed as authorization method or identity proof. The specific policy is encapsulated in a digest value that is associated with an entity. An entity has a policy that defines the conditions for use of an entity. A policy may be arbitrarily complex. However, the policy is expressed as one (statistically unique) digest called the *authPolicy*.

Both HMAC and Policy authorizations include rolling nonce values as part of the protocol, as a challenge and to prevent a replay-attack.

Note: For commands that require Platform Authorization and commands that require a hierarchy authorization, it is possible to require an additional out-of-band authorization. This may use a dedicated pin in the TPM – also known as “Physical Presence” (PP). The TPM maintains a table of the commands that require that PP be asserted to authorize command execution. Only certain commands may be included in this table.

[6] For the context of FIPS 140-2, the Object User is mapped to the User role.
[7] For the context of FIPS 140-2, the Duplicate User is mapped to the Crypto-Officer role.

4.1 Authentication

4.1.1 Dictionary Attack (DA) Protection

The TPM incorporates mechanisms that provide protection against guessing or exhaustive searches of authorization values stored within the TPM.

The DA protection logic is triggered when the rate of authorization failures is too high. If this occurs, the TPM enters Lockout mode preventing any operation that requires use of a DA protected object. Depending on the settings of the configurable parameters, the TPM can "self-heal" after a specified amount of time or be programmatically reset using proof of knowledge of an authorization value or satisfaction of a policy (i.e., using lockoutAuth).

While authorization values that are expected to be high-entropy values will not need DA protection, lockoutAuth is always DA-protected even though it may have high-entropy.

4.1.2 Authorization Strength

The Module authenticates operator actions using authorization tokens. Consider most conservative TPM command throughput on the bus and command execution duration, would allow 1,000 commands per second or 60,000 attempts per minute.

Password and HMAC Authorization Strength

When a high-entropy authorization token is used (where DA protection may be disabled), each value, statistically, has the same probability to be chosen. For worst case scenario, assume SHA-1 output values size (160 bit array), producing 2^{160} different possible values.

Probability for randomly successful attempt is 2^{-160}, assuming 60,000 trials per minute would produce probability for success in one minute: $2^{-160} \times 60{,}000 = 4.1 \times 10^{-44} < 10^{-5}$.

If a lower entropy authorization token is used (e.g., memorized PIN or password), a combination of password size (i.e., determines size of entropy) and DA protection setting should be selected to meet the FIPS requirements. The requirement of an eight-character password string with TCG's default DA settings[8] (maxTries = 3; recoveryTime = 1,000 seconds) would produce the necessary strength. For the worst case, assume an eight-digit PIN, allowing 10^8 different possible values with equal probability. The TCG default DA settings listed above would allow three trials before lockout (for duration of over a minute). The probability for a randomly successful attempt is 10^{-8}, assuming 3 trials would produce the probability for success in less than one minute: $10^{-8} \times 3 = 3 \times 10^{-8} < 10^{-5}$.

Policy Authorization Strength

Since policy authorization is expressed as (statistically unique) digest, for worst case scenario, assume SHA-1 output values size (160 bit array), producing 2^{160} different possible values.

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[8] See [1] part 1

Probability for randomly successful attempt is 2^{-160}, assuming 60,000 trials per minute would produce probability for success in one minute: $2^{-160} \times 60{,}000 = 4.1 \times 10^{-44} < 10^{-5}$.

4.1.3 Authorization Token Value Selection

TPM permits the creation of objects with NULL authorization (empty buffer). However, to meet the Authorization Strength listed in Section 4.1.2, roles should not use NULL authorization values for CSPs.

The TPM Crypto-Officer's role is to set proper authorization values for the Storage and Endorsement hierarchies (if there is no OS managing these authorization values for the user).

4.2 Services

Table 9 lists all Module services, the affected CSPs, and the associated roles:

Table 9. Module Services

Service	Description	CSP	Role
Get Status	The Module implements a Get Status commands that returns the status of the Module, including success or failure of self tests. Note: This service (e.g., TPM2_GetCapability) does not require authentication	None	CO, OU, DUP
Self Tests	The Module runs power-on self tests automatically when powered on and on demand. Note: This service (e.g., TPM2_Selftest) does not require authentication	None	CO, OU, DUP
Encrypt	Used to encrypt data	Encryption keys, Public storage keys, Platform keys	CO, OU, DUP
Decrypt	Used to decrypt data	Encryption keys, Private storage keys, Endorsement keys, Platform keys	CO, OU

Service	Description	CSP	Role
Zeroize	Used to zeroize (irreversibly destroy) Module's cryptographic keys and CSPs	Encryption keys, Public verification keys, Public storage keys, Private storage keys, Identity keys, HMAC keys, Endorsement keys, Platform keys, DRBG seed, DRBG Entropy Input, DRBG “V”, DRBG Key	CO
MAC, MAC Verify	Used to calculate and verify MAC for data	HMAC keys	CO, OU
Key Generate	Used to generate keys	Encryption keys, Public verification keys, Public storage keys, Private storage keys, Identity keys, Ephemeral keys, HMAC keys, Endorsement keys, Platform keys, DRBG seed, DRBG Entropy Input, DRBG “V”, DRBG Key	CO, OU
RSA Verify	Used to verify data using RSA	Public verification keys, Platform keys, Firmware Update key	CO, OU
RSA Sign	Used to sign data using RSA	Identity keys, Platform keys	CO, OU
ECDSA Verify	Used to verify data using ECDSA	Public verification keys, Platform keys	CO, OU
ECDSA Sign	Used to sign data using ECDSA	Identity keys, Platform keys	CO, OU

Service	Description	CSP	Role
Key Import	Used to import keys	Encryption keys, Public verification keys, Public storage keys, Private storage keys, Identity keys, HMAC keys, Platform keys	CO
Key Duplicate	Used to export keys	Encryption keys, Public storage keys, Private storage keys, Ephemeral keys, HMAC keys, Platform keys	CO, DUP
Key Agreement	Used to derive a key	Ephemeral Keys, Endorsement keys, Platform keys	CO, OU
TPM Identity	Used to authenticate TPM Identity to other parties	Identity keys	CO, OU
TPM Endorsement	Used to prove to other parties that TPM is a genuine TPM	Endorsement keys	CO, OU
TPM Get Random	Used to generate random data Note: This service does not require authentication.	DRBG seed, DRBG Entropy Input, DRBG “V”, DRBG Key	CO, OU
TPM Stir Random	Used to add entropy to the random bit generator Note: This service does not require authentication.	DRBG seed, DRBG Entropy Input, DRBG “V”, DRBG Key	CO, OU
Install Module	Installs Module	HMAC keys, Platform keys	CO
Firmware Update	Updates Module’s firmware. Requires Platform Authorization.	Firmware Update key	CO

5. Key and CSP Management

Table 10 specifies each cryptographic key or CSP utilized by the Module.

For access type description, the following acronyms are used:

W - Write; the CSP is updated/written by the TPM

E - Execute; the CSP is used by the TPM for execution

TPM commands that have CSP as input/output parameters shall use parameter encryption.

Table 10. Cryptographic Keys

Key or CSP	Func.	Usage	Service - Access
Encryption keys	AES AKWH KDFa DRBG CKG	Used to: - Wrap keys: for import/duplication, for wrapping keys stored outside the TPM and for session keys (audit or parameter encryption) - Encrypt/decrypt input/output parameters - Decrypt credentials Keys generated using DRBG, derived using KDFa or securely transported using public/private storage keys.	Encrypt - E Decrypt - E Zeroize - W Key Import - E, W Key Generate - W Key Duplicate - E
Public verification keys	RSASA RSAKG ECDSA ECCKG DRBG	Used to verify signatures on data, as service for external application, or as part of Authorization Policy verification. Keys may be generated in the TPM (as part of Identity key generation) or loaded from external source.	Zeroize - W Key Generate - W RSA Verify - E ECDSA Verify - E Key Import - W
Public storage keys	RSAES RSAKG KDFa DRBG	Used to transport keys generated externally or generated by TPM. Keys may be generated in the TPM (as part of Private storage key generation) or imported from external source.	Encrypt - E Zeroize - W Key Generate - W Key Import - W Key Duplicate - E
Private storage keys	RSAES RSAKG KDFa AKWH DRBG	Used to transport keys generated externally or generated by TPM. Keys may be generated in the TPM (stored encapsulated or wrapped outside the TPM) or imported from external source.	Decrypt - E Zeroize - W Key Generate - W Key Import - E, W Key Duplicate - E

Key or CSP	Func.	Usage	Service - Access
Identity keys	RSASA RSAKG ECDSA ECCKG KDFa AKWH DRBG	Authorization tokens used to prove TPM identity to other parties. Used to sign information generated or controlled by the TPM. Keys may be generated in the TPM (stored encapsulated or wrapped outside the TPM) or imported from external source.	Zeroize - W Key Generate - W RSA Sign - E ECDSA Sign - E Key Import - W TPM Identity - E
Ephemeral keys	ECDH ECCKG KDFa AKWH DRBG	Used to exchange secrets to establish a symmetric key, using One-Pass Diffie-Hellman. Used for: - Encryption of authorization session salt - Secret sharing for duplication - Secret sharing for credentials Keys may be generated in the TPM (stored encapsulated or wrapped outside the TPM) or imported from external source.	Key Generate - W Key Duplicate - E Key Agreement - E
HMAC keys	HMAC AKWH DRBG CKG	Used to calculate and verify MAC codes for data. Used for: - Ensuring association of credential with a loaded object - Access or usage authorization - Symmetric signing - Audit Keys may be generated in the TPM (stored encapsulated or wrapped outside the TPM) or imported from external source.	Zeroize - W MAC, MAC Verify - E Key Generate - W Key Import - W Key Duplicate - E Install Module - W, E
Endorsement keys	RSAES RSAKG ECDH ECCKG KDFa DRBG	Authorization tokens used to prove to the external parties that TPM is a genuine TPM. Keys may be generated in the TPM or installed during TPM manufacturing.	Decrypt - E Zeroize - W Key Generate - W Key Agreement - E TPM Endorsement - E

Key or CSP	Func.	Usage	Service - Access
Platform keys	AES RSAES RSASA RSAKG ECDH ECDSA ECCKG KDFa DRBG	Keys used by the Platform Firmware.	Encrypt - E Decrypt - E Zeroize - W Key Generate - W RSA Verify - E RSA Sign - E ECDSA Verify - E ECDSA Sign - E Key Import - E Key Duplicate - E Key Agreement - E Install Module - W, E
Firmware Update key	RSASA	Used to verify signature on firmware updates. Key installed at the module manufacturing.	RSA Verify - E Firmware update - E
DRBG seed	DRBG NDRBG	Used to seed the DRBG, generated by the NDRBG.	Zeroize - W Key Generate - E TPM Get Random - E TPM Stir Random - W
DRBG Entropy Input	DRBG NDRNG	Used as Entropy input for the DRBG's seeds, generated by the NDRBG.	Zeroize - W Key Generate - E TPM Get Random - E TPM Stir Random - W
DRBG "V"	DRBG	CTR_DRBG's internal state that is updated each time another block length number of bits of output are produced.	Zeroize - W Key Generate - E
DRBG Key	DRBG	CTR_DRBG's Key.	Zeroize - W Key Generate - E

6. Self Tests

6.1 Power-On Self Tests

The Module implements the following tests during power-on:

Table 11. Power-On Self Tests (POST)

Cryptography Function	Test Type
Firmware integrity	MAC using a 128-bit error detection code
HMAC	FIPS 198-1 KAT using SHA2-384
SHA-1, SHA2-256, SHA2-384	FIPS 180-4 KAT for each SHA type
AES Encryption / Decryption	FIPS 197 KAT from SP800-38A
KDFa	SP800-108 KAT
KDFe[9] (for ECDH)	SP800-56A KAT
DRBG	SP800-90A DRBG Health Tests (DRBG Generate, Reseed and Instantiate)

[9] SP800-56A, section 6.2.2.2. The KDF used is the “Concatenation Key Derivation Function (Approved Alternative 1)”.

6.2 Conditional Self Tests

The Module implements the following conditional tests:

Table 12. Conditional Self Tests

Cryptography Function	Condition	Test Type
POST	POST	All tests listed in Table 11
ECDSA sign / verify	TPM2_SelfTest(fullTest = YES) in transition to Approved Mode 2	FIPS 186-4 KAT
ECDH	TPM2_SelfTest(fullTest = YES) in transition to Approved Mode 2	SP800-56A KAT
RSA sign / verify	TPM2_SelfTest(fullTest = YES) in transition to Approved Mode 2	PKCS#1v2.1, FIPS 186-4 KAT
RSA key generation	Key Generation	Conditional pair-wise consistency check for RSA public-private key pairs each time an RSA key pair is generated, using FIPS 186-4
ECC key generation	Key Generation	Conditional pair-wise consistency check for ECDSA public-private key pairs each time an ECDSA key pair is generated, using FIPS 186-4
Firmware Load Test	Field Upgrade	Firmware update test during the firmware update. The digital signature is verified on the firmware image using an RSA (SHA2-256) algorithm, utilizing a 2048-bit Firmware Update key
DRBG	New bits are generated	Continuous Self Test
NDRNG	New bits are generated	Continuous Self Test

If a conditional or power-on self test fails, the Module enters an error state where both data output and cryptographic services are disabled.

7. Physical Security

The TPM is implemented as a single integrated circuit (IC) device that attaches to standard system PCBs. It is manufactured using de-facto standard integrated circuit manufacturing technologies, producing a device that meets all commercial-grade power, temperature, reliability, shock and vibration specifications.

The TPM IC physical package provides hardness, opacity and tamper-evidence protection conforming to FIPS 140-2 Physical Security Level 3. The TPM achieves this level of protection by implementing an enclosure that is both hard and opaque, as shown in the figures in Section 1. This type of IC package ensures that any physical tampering will always result in scratches, chipping or other visible damage on the enclosure.

Before the TPM is integrated into a target application system, it must be checked visually for tampering. After it is integrated, typically through soldering onto a PCB, it can be inspected for tampering by opening the application system enclosure and examining the TPM.

Module hardness testing was only performed at ambient room temperature; no assurance is provided for Level 3 hardness conformance at any other temperature.

8. Electromagnetic Interference and Compatibility (EMI/EMC)

The Module complies with the EMI/EMC requirements specified in Title 47, Code of Federal Regulations, Part 15, Subpart B, Unintentional Radiators, Digital Devices, Class B.

9. Crypto-Officer Guidance

9.1 Modes of Operation

The TPM has three modes of operation:

1. Approved Mode 1: Described in Section 1.2.1
2. Approved Mode 2: Described in Section 1.2.2
3. Non-Approved Mode: This mode is entered once one of the functions listed in Table 6 is used as cryptographic function. Before entering this mode, all CSPs must be zeroized.

For FIPS Compliant mode, (Approved Mode 1 and Approved Mode 2), do not use functions listed in Table 6 as cryptographic functions.

9.2 Installation

To install the Module in the Approved Mode of operation, do the following:

- The Module must be controlled physically during the installation.
- The Module must be connected on the PCB as described in the Module technical specifications. The connection must ensures one-to-one binding with the platform.
- The platform on which Module is installed should include BIOS and OS that initialize and control TPM hierarchies and set hierarchy's authorization value and policy. If the platform does not have such BIOS and OS, the crypto-officer shall install software to manage TPM hierarchies and set the hierarchy's authorization and policy.

9.3 Object Authorization

On object creation or changing object authorization, a password of at least eight characters shall be used. In addition, configure the module to enforce, at a minimum, a DA Setting policy where "maxTries" >=3 and "recoveryTime" >= 1,000.

9.4 .Object Duplication

The TPM2_Duplicate command allows sending objects to/from the NULL hierarchy, which sends it off-chip unprotected. This is not allowed in FIPS 140-2.

The command has an attribute, "encryptedDuplication", which should always be SET in order to be compliant with FIPS 140-2. This requires an inner symmetric wrapping prior to the object receiving symmetric encryption to go off-chip. This also prevents the new parent from being TPM_RH_NULL (see [1], part 2).

When Object is created, set the attribute "encryptedDuplication" in the object.

9.5 Object Import

The TPM2_Import command allows importing objects from external modules. Import to the TPM only CSPs coming from FIPS-compliant modules in FIPS Compliant mode.

10. Object User Guidance

The Object User shall follow the guidance in Sections 9.1, 9.3 and 9.5.

11. Duplicate Guidance

The Duplicate role shall follow the guidance in Section 9.4.

12. Acronyms

AES	Advanced Encryption Standard
CPU	Central Processing Unit
CSP	Critical Security Parameter
DA	Dictionary Attack
DRBG	Deterministic Random Bit Generator
ECC	Elliptic Curve Cryptography
EMC	Electro-Magnetic Compatibility
EMI	Electro-Magnetic Interference
FIPS	Federal Information Processing Standard
GPIO	General-Purpose Input Output bus
HMAC	Hash-based Message Authentication Code
I2C	Inter-Integrated Circuit bus
LPC	Low Pin Count bus
OTP	One-Time Programmable Memory
PCB	Printed Circuit Board
RAM	Random Access Memory
RSA	Rivest-Shamir-Adleman
SHS	Secure Hash Standard
SP	Special Publication
SPI	Serial Peripheral Interface bus
TCG	Trusted Computing Group
TIS	TPM Interface Specification
TPM	Trusted Platform Module

13. References

[1] TCG Trusted Platform Module Library Specification Family 2.0 Revision 1.38
https://www.trustedcomputinggroup.org/tpm-library-specification

[2] TCG PC Client Specific Platform TPM Profile (PTP) Specification for TPM Family 2.0 Revision 01.03 v22
https://trustedcomputinggroup.org/pc-client-platform-tpm-profile-ptp-specification

[3] FIPS 140-2
http://csrc.nist.gov/groups/STM/cmvp/standards.html#02

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