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SPYCOS 3.0 microSDHC™ TrustedFlash Module FIPS 140-2 Non-Proprietary Security Policy

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Contents

1. Introduction

This Security Policy specifies the security rules under which the SPYCOS 3.0 microSDHC™ TrustedFlash Module operates. The acronym SPYCOS stands for "SPYRUS Cryptographic Operating System". The SPYCOS 3.0 microSDHC™ TrustedFlash Module conforms to FIPS 140-2 Security Requirements for Cryptographic Modules.

Included in these rules are those derived from the security requirements of FIPS 140-2 and additionally, those imposed by SPYRUS, Inc. These rules, in total, define the interrelationship between:

1. Operators,
2. Services, and
3. Critical Security Parameters (CSPs).

The terms "SPYCOS 3.0 microSDHC™ TrustedFlash Module", and "module" are synonymous.

1.1 SPYCOS 3.0 microSDHC™ TrustedFlash Module Overview

The SPYCOS 3.0 microSDHC™ TrustedFlash Module is the latest addition to the SPYRUS family of cryptographic module ICs that enable both smart card and USB cryptographic tokens while offering secure AES 256-bit encrypted storage of user data on the internal flash.

The SPYCOS 3.0 microSDHC™ TrustedFlash Module enables security critical capabilities such as operator authentication, message privacy, integrity, authentication, and non-repudiation; and secure storage, all within a tamper-evident protective coating. The SPYCOS 3.0 microSDHC™ TrustedFlash Module communicates with a host computer via the ports/interfaces defined in Table 2-1 and Table 2-2.

1.2 SPYCOS 3.0 microSDHC™ TrustedFlash Module Implementation

The SPYCOS 3.0 microSDHC™ TrustedFlash Module is implemented as a multi-chip module as defined by FIPS 140-2.

The SPYCOS 3.0 microSDHC™ TrustedFlash Module is available in a microSD embodiment with an enclosed encrypted flash drive. All Interfaces have been tested and are compliant with FIPS 140-2. Product Identification (including unique part number) for the SPYCOS 3.0 microSDHC™ TrustedFlash Module is shown in the table below:

Table 1-1 SPYCOS 3.0 microSDHC™ TrustedFlash Module Product Identification

Form Factor	Part Number(s)	FW Version
SPYCOS 3.0 microSDHC™ TrustedFlash	851-315013F (16GB)	1.0
	851-315014F (32GB)	

The designations "(16GB)" and "(32GB)" refer to the sizes in gigabytes of the flash memory components in the modules described by the corresponding part number. All other electronic components and functionality of these modules are identical in every other respect. Images of the above form factors are shown in the figure below:

Figure 1 SPYCOS 3.0 microSDHC™ TrustedFlash Form Factors

1.3 SPYCOS 3.0 microSDHC™ TrustedFlash Module Cryptographic Boundary

The Cryptographic Boundary is defined to be the physical perimeter of the SPYCOS 3.0 microSDHC™ TrustedFlash and the potting material it is embedded in (see Figures 2 and 3).

The Memory Controller manages data to be encrypted and stored on flash memory and decrypts and enables data flows from flash memory to the host, as requested by the user. In addition, the Memory Controller mediates APDU commands from the user and sends them to the SPYCOS 3.0 microSDHC™ component for processing. Response codes from the SPYCOS 3.0 microSDHC™ such as success / error codes are directed by the Memory Controller to the host.

No hardware or firmware components that comprise the SPYCOS 3.0 microSDHC™ TrustedFlash are excluded from the requirements of FIPS 140-2.

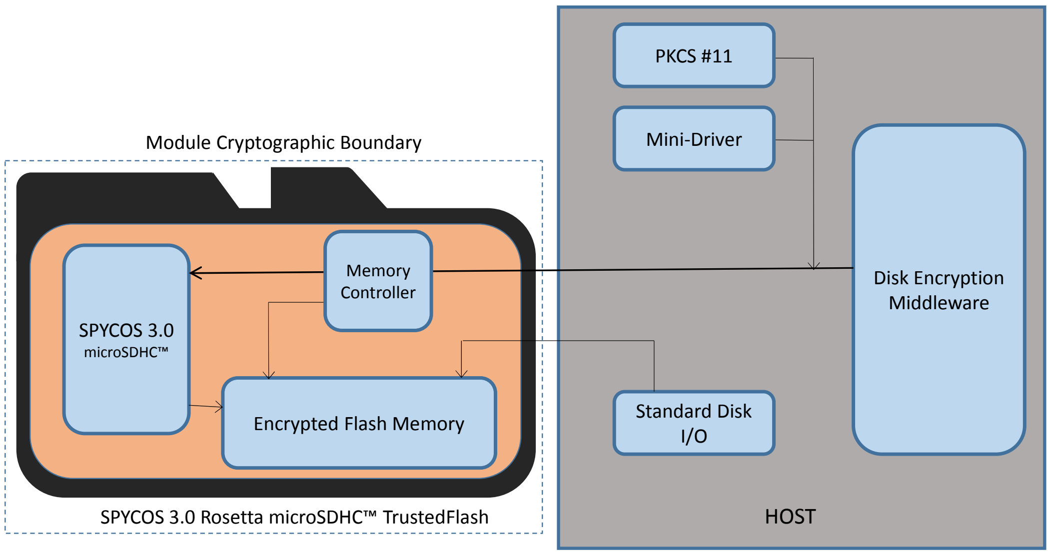


Figure 2 SPYCOS 3.0 microSDHC™ TrustedFlash Block Diagram

1.4 Approved Mode of Operation

The module only operates in an Approved mode of operation.

The SPYCOS 3.0 microSDHC™ TrustedFlash Module Approved mode of operation is comprised of the SPYCOS 3.0 microSDHC™ TrustedFlash Module command set.

Approved mode of operation commands which are successfully completed will return a standard success return code. The Error return codes are dependent upon the cause of the failure. Services available under the Approved mode of operation are detailed in Table 3-1 of this Security Policy.

The SPYCOS 3.0 microSDHC™ TrustedFlash Module supports the following FIPS 140-2 Approved algorithms:

Table 1-2 SPYCOS 3.0 microSDHC™ TrustedFlash Module Approved Algorithms

Approved Algorithms					
CAVP Cert.	**Algorithm**	**Standard**	**Mode/Method**	**Key Lengths, Curves or Moduli**	**Use**
Encryption & Decryption					
1772	Triple-DES	SP800-67	ECB, CBC	192-bit	Data Encryption / Decryption
3028	AES	FIPS 197, SP800-38A	ECB, CBC, CTR	128-bit, 192-bit, 256-bit	Data Encryption / Decryption
4241	AES	FIPS 197, SP800-38A	ECB	256-bit	Data Encryption / Decryption
Digital Signatures					
578	ECDSA	FIPS 186-4	PKG SigGen SigVer	P-256, P-384, P-521	Key Generation, Digital Signature Generation and Verification
1611	RSA	FIPS 186-4	SHA-224, SHA-256, SHA-384, SHA-512	2048-bit	Key Generation, Digital Signature Generation and Verification
Message Authentication Code					
1913	HMAC	FIPS 198-1	HMAC-SHA1, HMAC-SHA224, HMAC-SHA256, HMAC-SHA384, HMAC-SHA512	112-bit 224-bit 256-bit 384-bit 512-bit	Message Authentication
Hash					
2529	SHS	FIPS 180-4	SHA-1, SHA-224, SHA-256, SHA-384, SHA-512		Message Digest
Key Agreement / Key Establishment					
419	CVL	SP800-56Arev2	ECC CDH Primitive	P-256, P-384, P-521	Shared Secret Computation
52	KAS	SP800-56Arev2	ECC	P-256, P-384, P-521	Key Agreement
3115	AES	FIPS 197, SP800-38F	KW	128-bit, 192-bit, 256-bit	Key Wrapping / Unwrapping
111	KBKDF	SP800-108	HMAC-SHA256		Key Derivation
Approved Deterministic Random Bit Generator					
658	DRBG	SP800-90A	Hash_based		Deterministic Random Bit Generation

NOTE 1: Operators should reference the transition tables that will be available at the CMVP Web site (http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-131Ar1.pdf). The data in the tables will inform users of the risks associated with using a particular algorithm and a given key length.

NOTE 2: The cryptographic module only supports the modes and key sizes listed in Table 1-2 and does not support any of the other modes or key sizes listed on the algorithm validation certificates.

Approved ECDSA (Cert. #578). The Digital Signature will provide between 128-bits to 256-bits of equivalent computational resistance to attack depending upon the size of the curves that are used (P-256, P-384, P-521).

Approved RSA (Cert. #1611). The Digital Signature with a 2048-bit key size will provide 112-bits of equivalent computational resistance to attack.

Approved SP800-56A, Section 5.7.1.2: ECC CDH Primitive (Cert. #419). The key establishment process will provide between 128-bits to 256-bits of equivalent computational resistance to attack depending upon the size of the ECC CDH curves that are used (P-256, P-384, P-521).

Approved KAS ECC (Cert. #52). The key establishment process will provide between 128-bits to 256-bits of equivalent computational resistance to attack depending upon the size of the keys that are used (P-256, P-384, P-521).

Approved KTS (Cert. #3115) key establishment methodology provides between 128 and 256 bits of encryption strength).

The following are available as “non-Approved” algorithms but allowed in FIPS mode:

Table 1-3 SPYCOS 3.0 microSDHC™ TrustedFlash Module Non-Approved but allowed Algorithms

Algorithm	Caveat	Use
NDRNG		HW NDRNG - Only used for seeding Approved SP800-90A DRBG
RSA Key Wrapping	Key wrapping; key establishment methodology provides 112 bits of encryption strength	Key establishment

1.5 FIPS 140-2 Security Levels

The SPYCOS 3.0 microSDHC™ TrustedFlash Module complies with the requirements for FIPS 140-2 validation to the levels defined in Table 1-4. The FIPS 140-2 overall rating of the SPYCOS 3.0 microSDHC™ TrustedFlash Module is Level 3.

Table 1-4 **FIPS 140-2 Certification Levels**

FIPS 140-2 Category	Level
1. Cryptographic Module Specification	3
2. Cryptographic Module Ports and Interfaces	3
3. Roles, Services, and Authentication	3
4. Finite State Model	3
5. Physical Security	3
6. Operational Environment	N/A
7. Cryptographic Key Management	3
8. EMI/EMC*	3
9. Self-tests	3
10. Design Assurance	3
11. Mitigation of Other Attacks	N/A
Overall Security Level	3

*NOTE: The SPYCOS 3.0 microSDHC™ TrustedFlash Module conforms to Level 3 EMI/EMC requirements specified by 47 Code of Federal Regulations, Part 15, Subpart B, Class B.

2. Ports and Interfaces

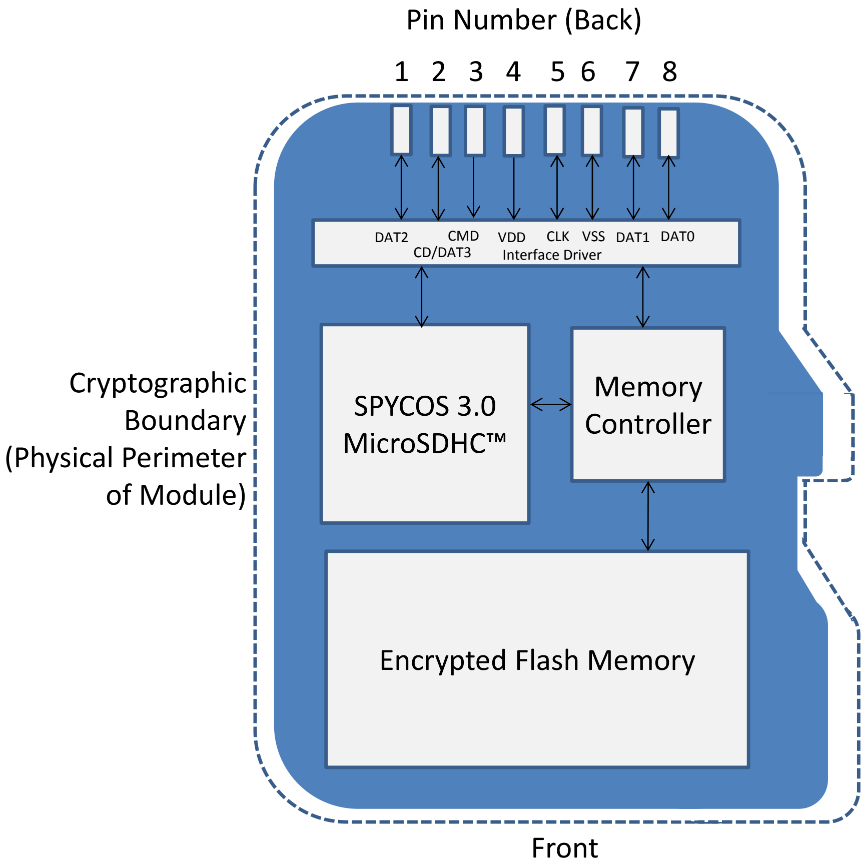
The SPYCOS 3.0 microSDHC™ TrustedFlash Module has 8 pins as described in the table below:

Table 2-2 Rosetta microSDHC™ Pins and Logical Interfaces

Pin	Name	Function	FIPS 140-2 Logical Interface
1	DAT2	Data in/out (byte 2)	Data Input / Data Output; Status Output
2	CD/DAT3	Card Detect / Data in/out (byte 3)	Data Input / Data Output; Status Output
3	CMD	Command Response	Control Input
4	VDD	Supply Voltage	Power Interface
5	CLK	Clock	Control Input
6	VSS	Ground	Power Interface
7	DAT1	Data in/out (byte 0)	Data Input / Data Output; Status Output
8	DAT0	Data in/out (byte 1)	Data Input / Data Output; Status Output

The SPYCOS 3.0 microSDHC™ TrustedFlash Module pinout is shown in the diagram below (Figure 3), with the cryptographic boundary indicated.

Figure 3 SPYCOS 3.0 microSDHC™ TrustedFlash form factor pinout and cryptographic boundary



3. Roles and Services

The module supports two roles, Crypto-officer and User, and enforces the separation of these roles by restricting the services available to each one.

Crypto-officer Role: The Crypto-officer is responsible for initializing the module. Before issuing the module Rosetta microSDHC™ to an end User, the Crypto-officer initializes the module with private keying material and certificate information. The Crypto-officer cannot use private keys loaded on the module. The module validates the Crypto-officer identity before accepting any initialization commands. The Crypto-officer is also referred to as the Site Security Officer (SSO).

User Role: The User role is available after the module has been loaded with a User personality. The User can load, generate and use private keys.

The module validates the User identity before access is granted.

3.1 Services

The following table (Table 3-1) describes the services provided by the module. The User/SSO column denotes the roles that may execute the service.

Table 3-1 **SPYCOS 3.0 microSDHC™ TrustedFlash Module Services**

Service	Description	User / SSO
AES UNWRAPKEY	Supports key export by using the AES unwrap key process to decrypt a wrapped key data block, and then storing it in the internal key register or the key file.	User
AES WRAPKEY	Supports key export by using the AES wrap key process to encrypt the internal symmetric key data that is transmitted to the host.	User
AUTHENTICATE SECURE CHANNEL	Validates the secure channel between the host and the module.	User, SSO
BLOCK PIN	Blocks user PIN access. Resets attempt count for the User PIN to zero and prohibits User PIN logon until an UNBLOCK PIN command is executed by the SSO / Administrator role.	User, SSO
CHANGE PASSWORD	Change the User password or SSO password.	User, SSO
CHECK PASSWORD	User / SSO Inputs a password Phrase to authenticate the SSO or the User.	User, SSO
CREATE	A file of type DF, SF, or EF is created[1].	User, SSO
DECRYPT	Performs a decryption process on the input data and sets up the plaintext data for retrieval. Supports multiple modes of decryption for user data.	User
DELETE	Deletion of a file or directory.	User, SSO
DIRECTORY	Retrieval of directory.	User, SSO
ECC GENERATE KEY	Creates an ECC public/private key pair for signing/verifying or transport.	User
ECDH COMPUTE SECRET	Generates a shared secret, Z, and either returns it to the caller or caches it for use with the KDF function.	User
ECDSA SIGN	Computation of a digital signature using the ECDSA algorithm using the hash value.	User
ECDSA VERIFY	Performs an ECDSA signature verification on the provided hash data. The signature is returned using SPYRUS Elliptic Curve RAW encoding.	User, SSO
ENCRYPT	Performs a symmetric encryption process on the input data and returns the ciphertext data. Supports multiple modes of encryption for user data. Get Response must be issued to retrieve the data.	User
ENVELOPE	Sends the APDU commands through the secure channel established previously between the host and the module. The session key is generated	User, SSO

[1] Refer to ISO/IEC 7816-4 for definition of file types and file system

Service	Description	User / SSO
	during the secure channel establishment (see Manage Secure Channel). The encryption mode used is the AES CBC mode.	
EXTEND	Extension of the length of a file or directory.	User, SSO
FIPS_INFO	Returns a value indicating whether the module is in FIPS Mode (1) or not (0).	User, SSO
GENERATE HMAC KEY	Generates an HMAC key and initializes the currently selected file for use with the HMAC commands.	User
GENERATE IV	See Generate Symmetric Key Command	User
GENERATE RANDOM	Generates a random number and also handles the generation of Initialization Vectors (IVs) and Message Encryption Keys (MEKs). Can be invoked prior to authentication (GET UNAUTHENTICATED RANDOM)	User
GENERATE SYMMETRIC KEY	Used to generate Message Encryption Keys (MEKs). It can also generate random numbers and IVs.	User
GET PUBLIC	Retrieves the public key information of an ECC key.	User, SSO
GET RESPONSE	Retrieval of the module response.	User, SSO
GET SPYCOS VERSION	Retrieves firmware version of module.	User, SSO
GET STATUS	Query on the current status of a File.	User, SSO
HASH FINALIZE	Completes the hash operation and returns the hash value.	User, SSO
HASH INITIALIZE	Initializes internal state to prepare for hashing operations.	User, SSO
HASH PROCESS	Optional function called to hash a block of data when its length is an even multiple of the hash algorithm block size.	User, SSO
HMAC FINALIZE	Processes any remaining bytes in the message and retrieves the HMAC value.	User
HMAC INITIALIZE	Generates a HMAC message authentication code.	User
HMAC PROCESS	Processes the message in even multiples of the hash algorithm's block size.	User
IMPORT HMAC KEY	Imports an HMAC key and initialize the currently selected file for use with the HMAC commands.	User
INIT PIN FILE	Used to generate the K of N authentication shared data to the current selected PIN file. Upon a successful execution of the Init PIN File command, two external shared secrets and two logon PINs are generated with the default values.	SSO
KDFEXTERNAL	Passes the external KDF data to the hash function.	User
KDFFINAL	Completes the generation of the key and queues it for output to the host.	User
KDFINTERNAL	Passes the KDF data found inside the module to the hash function.	User
KDFSTART	Sets up the internal hash engine for hashing the subsequent data. The hash type is determined by the settings in specified input parameters.	User

Service	Description	User / SSO
LOAD CRYPTOGRAPHIC DATA	Supports RSA / ECDSA signature verification or RSA Wrap Key operation.	User, SSO
LOAD IV	See Load Key.	See Load Key
LOAD KEY	An overloaded function that performs Load MEK (Message Encryption Key), Load IV, or Delete Key.	User
LOAD SECRET	Loads one of two authentication codes required for K of N logon. This is a prerequisite to changing the Admin/SSO password, User password, or either of the authentication codes.	User, SSO
LOCK	Disables all operations on this file. The file can still be selected and the status information can still be retrieved, but its contents cannot be accessed.	User, SSO
MANAGE SECURE CHANNEL	Establishes the secure channel between the host and the module. Specific codes, sent by the host, initialize and terminate the secure channel.	User, SSO
READ BINARY	Binary read from a file, given the offset and length.	User, SSO
RSA GENERATE KEYPAIR	Creates an RSA key pair to be used for signing/verifying or transport. The user must have created the RSA keying file (with appropriate access controls) prior to issuing the GENERATE command.	User
RSA SIGN DATA	Signing a message or data object using RSA signature.	User
RSA UNWRAP KEY	Enables completion of public key exchange of a MEK.	User
RSA VERIFY SIGNATURE	Verifying an RSA signature on a message.	User, SSO
RSA WRAP KEY	Invocation of an RSA Key wrap service.	User
SELECT	Setting a current file within a logical channel.	User, SSO
SELF TEST	Automatically performed at power-up and can be executed on-demand via power cycling the module.	User, SSO
SET KEY	Setting one of the 3 key pointers to the key registers to be used for encryption and decryption using the following symmetric encryption algorithms: AES, 3TDES.	User
UNBLOCK PIN	Used by an SSO to restore User PIN logon access.	SSO
UNLOCK	Enable a previously Locked file.	User, SSO
UPDATE BINARY	Update of the data in the currently selected EF[2] with the data provided.	User, SSO
XAUTH ENROLL	Set up the shared symmetric key for use with the challenge and response authentication process.	User, SSO
XAUTH EXTERNAL AUTHENTICATION	Submits the encrypted result of the challenge data retrieved from the XAUTH Get Challenge command.	User, SSO
XAUTH GET CHALLENGE	Establishes the challenge and response authentication process by first requesting the random challenge for the current session. The resulting challenge data is output to the host to	User, SSO

[2] Refer to ISO/IEC 7816-4 for definition of file types

Service	Description	User / SSO
	calculate the encrypted response for use in comparison with the XAUTH External Authentication command.	
ZEROIZE	Zeroization of the module. Performed using DELETE FILE with recursive argument.	User, SSO
MOUNT	TrustedFlash command. Mounts the encrypted drive to the host's filesystem.	User
UNMOUNT	TrustedFlash command. Unmounts the encrypted drive from the host's filesystem.	User, SSO
GETFWINFO	Returns the FW version information	SSO, User
GETCIDINFO	Returns the CID information	SSO, User
LOCK DRIVE	Locks drive in order to perform recovery of corrupted drive and key material. Disables Write access.	SSO
UNLOCK DRIVE	Restores access to drive after a Lock operation. Restores Write access.	SSO, User
REFRESH	The IO firmware sets a REFRESH flag to allow the Module's firmware to search the file system without having to power-off and power-on again.	SSO, User
READ FLASH	Low-level command. Reads encrypted data on the Flash Drive. Activated by Mount command. Deactivated by Unmount command.	User
WRITE FLASH	Low-level command. Writes encrypted data on the Flash Drive. Activated by Mount command. Deactivated by Unmount command.	User

In addition to the services listed above in Table 3-1, the following non-security relevant services may be executed while the operator is unauthenticated:

- CREATE
- DELETE
- DIRECTORY
- EXTEND
- FIPS_INFO
- GET UNAUTHENTICATED RANDOM
- GET RESPONSE
- GET SPYCOS VERSION
- GET STATUS
- READ BINARY
- SELECT
- SELF TEST
- UPDATE BINARY

4. Identification and Authentication

4.1 Initialization Overview

The module is initialized at the factory with a Default SSO PASSWORD Phrase. The SSO must change the default value during logon to make the module ready for initialization. During initialization the module allows the execution of only the commands required to complete the initialization process.

Before a User can access or operate the module, the SSO must initialize it with the User PASSWORD Phrase. The SSO is authorized to log on to the module any time after initialization to change parameters. The module allows 10 consecutive failed SSO logon attempts before it zeroizes all key material and initialization values. In the *zeroized* state, the SSO must use the Default SSO PASSWORD Phrase to log on to the module and must reinitialize all module parameters.

A User must log on to a module to access any on-board cryptographic functions. To log on the User must provide the correct User PASSWORD Phrase. The module allows 10 consecutive failed logon attempts before it blocks the stored User Password. User information stored in the module in non-volatile memory remains resident.

4.2 Authentication

The module implements identity-based authentication which is accomplished by PIN or Password[3] entry by the operator. On invocation by the operator, the module waits for authentication of the User or SSO role by entry of a Password Phrase. There is only one User and one SSO Password allowed per module. Multiple User and SSO accounts are not permitted. The authentication password strength available for each supported role is indicated in Table 4-1 below.

Once a valid PASSWORD Phrase has been accepted the module cryptographic services may be accessed. The CHECK PASSWORD command includes either the User PASSWORD Phrase as a parameter (or) the SSO PASSWORD Phrase as a parameter. If successful, either the User or SSO gains access to the module.

Table 4-1 Identification and Authentication Roles and Data

Role	Type of Authentication	Authentication Data – (Strength)
Crypto-officer (SSO)	Identity-based	Password (6 - 20 Bytes)
User	Identity-based	Password (6 - 20 Bytes)

The module stores the number of logon attempts in non-volatile memory. The count is reset after every successful entry of a User PASSWORD Phrase by a User and after every successful entry of the SSO PASSWORD Phrase by the SSO. If the User role fails to logon to the module in 10 consecutive attempts, the module will zeroize the User

[3] The terms PIN and Password and PASSWORD Phrase are used synonymously in this document.

PASSWORD Phrase, block all of the User Private Keys and Public Keys, block all of the User Key Registers and disallow User access. The module then transitions to a state that is initialized only for the SSO to perform restorative actions. Restorative actions performed by the SSO may include reloading of initialization parameters, unblocking the User PASSWORD Phrase, or zeroization of the module. When the module is powered up after zeroization, it will transition to the Zeroized State, where it will only accept the Default SSO PASSWORD Phrase. After the Default SSO PASSWORD Phrase has been accepted, the module transitions to the Uninitialized State and must be reinitialized, as described in section 6.

4.3 Strength of Authentication

The strength of the authentication mechanism conforms to the following specifications in Table 4-2. The calculations are based on the enforced minimum PASSWORD Phrase size of 6 bytes.

Table 4-2 Strength of Authentication

Authentication Mechanism	Strength of Mechanism
Single Password-entry attempt / False Acceptance Rate	The probability that a random 6-byte Password-entry (using only 93 keyboard characters[4]) attempt will succeed or a false acceptance will occur is 1.5456185 x 10^{-12}. The requirement for a single–attempt / false acceptance rate of no more than 1 in 1,000,000 (i.e. less than a probability of 10^{-6}) is therefore met.
Multiple Password-entry attempts in one minute	There is a maximum bound of 10 successive failed authentication attempts before zeroization occurs. The probability of a successful attack of multiple attempts in a one minute period is no more than 1.5456185 x 10^{-11} due to the enforced maximum number of logon attempts. This is less than one in 100,000 (i.e., 1 x10^{-5}), as required.

4.3.1 Obscuration of Feedback

Feedback of authentication data to an operator is obscured during authentication (e.g., no visible display of characters result when entering a password). The PASSWORD Phrase value is input to the CHECK PASSWORD command as a parameter by the calling application. No return code or pointer to a return value that contains the PASSWORD Phrase is provided.

4.3.2 Non-weakening Effect of Feedback

Feedback provided to an operator during an attempted authentication shall not weaken the strength of the authentication mechanism. The only feedback provided by the CHECK PASSWORD command is a return code denoting success or failure of the operation. This information in no way affects the probability of success or failure in either single or multiple attacks.

[4] The character set available for PINs is at least all alphanumeric characters (upper and lower cases) and 31 special keyboard characters comprising the set {~ ! @ # $ % ^ & * ( ) _ + - = { } [ ] | \ : ; " ' < , > . ? /}.

4.3.3 Generation of Random Numbers

The GENERATE RANDOM command can be invoked only after authentication of the User. The SP800-90A DRBG algorithm is used for all authenticated RNG calls.

5 Key Management

5.1 CSP Management

Table 5-1 **SPYCOS 3.0 microSDHC™ TrustedFlash Module CSPs**

CSP Designation	Use
ECDSA Private Key	The Private Key of the User employed in Elliptic Curve digital signing operations.
ECC CDH Private Key	Used in ECC CDH key agreement.
Hash DRBG Seed	Used only in generating the initial state of the SP800-90A Hash_DRBG.
Hash DRBG Internal State	Hash DRBG V and C values; Used only in generating the initial state of the SP800-90A DRBG
HMAC Key	Used to generate HMAC message authentication code. Used to derive the DEK
AES Message Encryption Key (AES MEK)	AES Secret Key for User data encryption/decryption and key wrapping.
TDES Message Encryption Key (TDES MEK)	Three-Key Triple-DES Secret Key for User data encryption/decryption only.
RSA Private Key for Digital Signatures	The Private Key of the User employed in RSA digital signing operations.
RSA Private Key for Key Establishment	The Private Key of the User employed in RSA Key Unwrapping.
Secure Channel Session Key	ECDH / AES key used to encrypt and decrypt PASSWORD data transmitted to the module
SSO Password Phrase	A secret 6 - 20 bytes value used for SSO authentication.
User Password Phrase	A secret 6 - 20 bytes value used for User authentication.
ECC CDH Shared Secret	Used in ECC CDH key agreement.
KDF State	Used in ECC CDH key agreement.
Key Derivation Key	Used to key the SHA 256 HMAC KDF process.
SP 800-108 KDF Internal State	Current state of the SP 800-108 Key Derivation Process.
Disk Encryption Key (DEK)	Used for all Encrypt / Decrypt operations on Encrypted Flash (disk).

5.2 Public Key Management Parameters

Table 5-2 **SPYCOS 3.0 microSDHC™ TrustedFlash Public Key Management Parameters**

Key Management Parameter	Use
ECDSA Public Key	The Public Key of the User employed in Elliptic Curve digital signing operations.
RSA Public Key for Digital Signatures	The Public Key of the User employed in RSA digital signature verification operations.
RSA Public Key for Key Establishment	The Public Key of the User employed in RSA Key Wrapping.
ECC CDH Public Key	The Public Key used in ECC CDH key agreement.

5.3 CSP Access Matrix

The following table (Table 5-3) shows the services (see section 3.1) of the SPYCOS 3.0 microSDHC™ TrustedFlash Module, the roles (see section 3) capable of performing the service, the CSPs (see section 5.1) that are accessed by the service and the mode of access (see next paragraph) required for each CSP. The following convention is used: If only one of the roles applies to the service, that role appears alone. If both roles may execute the service, then "User, SSO" is indicated. If either one (but not the other) then "User" or "SSO" is indicated. In the last option it is a matter of organizational policy which of the roles may execute the service.

Access modes are R (read), W (write) and E (execute). Destruction is represented as a W.

Table 5-3 **SPYCOS 3.0 Rosetta microSDHC™ TrustedFlash Module Access Matrix**

Service	User / SSO	Access Type	CSP Access
AES UNWRAPKEY	User	R,E	AES Message Encryption Key (AES MEK)
AES WRAPKEY	User	R,E	AES Message Encryption Key (AES MEK)
AUTHENTICATE SECURE CHANNEL	User, SSO	R,W W W,E W,E	ECC CDH Private Key Secure Channel Session Key ECC CDH Shared Secret KDF State
BLOCK PIN	User, SSO	E	User Password Phrase SSO Password Phrase
CHANGE PASSWORD	User, SSO	W	User Password Phrase SSO Password Phrase
CHECK PASSWORD	User, SSO	R	User Password Phrase SSO Password Phrase
CREATE	User, SSO	N/A	N/A
DECRYPT	User	R R	AES Message Encryption Key (AES MEK) TDES Message Encryption Key (TDES MEK)
DELETE	User, SSO	N/A	N/A
DIRECTORY	User, SSO	N/A	N/A

Service	User / SSO	Access Type	CSP Access
ECC GENERATE KEY	User	W	ECC CDH Private Key
ECDH COMPUTE SECRET	User	N/A	N/A
ECDSA SIGN	User	R	ECDSA Private Key
ECDSA VERIFY	User, SSO	R	ECDSA Private Key
ENCRYPT	User	R R	AES Message Encryption Key (AES MEK) TDES Message Encryption Key (TDES MEK)
ENVELOPE	User, SSO	R,E	Secure Channel Session Key
EXTEND	User, SSO	N/A	N/A
FIPS_INFO	User, SSO	N/A	N/A
GENERATE HMAC KEY	User	R,E	HMAC Key
GENERATE IV	User	N/A	N/A
GENERATE RANDOM	User	R W	Hash DRBG Seed Hash DRBG Internal State Key Derivation Key
GENERATE SYMMETRIC KEY	User	W W	AES Message Encryption Key (AES MEK) TDES Message Encryption Key (TDES MEK)
GET PUBLIC	User, SSO	N/A	N/A
GET RESPONSE	User, SSO	N/A	N/A
GET SPYCOS VERSION	User, SSO	N/A	N/A
GET STATUS	User, SSO	N/A	N/A
HASH FINALIZE	User, SSO	N/A	N/A
HASH INITIALIZE	User, SSO	N/A	N/A
HASH PROCESS	User, SSO	N/A	N/A
HMAC FINALIZE	User	W	HMAC Key
HMAC INITIALIZE	User	W	HMAC Key
HMAC PROCESS	User	W	HMAC Key
IMPORT HMAC KEY	User	R,W	HMAC Key
INIT PIN FILE	SSO	R,W R,W	User Password Phrase SSO Password Phrase
KDFEXTERNAL	User	N/A	N/A
KDFFINAL	User	N/A	N/A
KDFINTERNAL	User	N/A	N/A
KDFSTART	User	N/A	N/A
LOAD CRYPTOGRAPHIC DATA	User, SSO	N/A	N/A
LOAD IV	User	N/A	N/A
LOAD KEY	User	W,D W,D	AES Message Encryption Key (AES MEK) TDES Message Encryption Key (TDES MEK)

Service	User / SSO	Access Type	CSP Access
LOAD SECRET	User, SSO	R R	User Password Phrase SSO Password Phrase
LOCK	User, SSO	N/A	N/A
MANAGE SECURE CHANNEL	User, SSO	W, E W	ECC CDH Private Key Secure Channel Session Key
READ BINARY	User, SSO	N/A	N/A
RSA GENERATE KEYPAIR	User	W W	RSA Private Key for Digital Signatures RSA Private Key for Key Establishment
RSA SIGN DATA	User	R,E	RSA Private Key for Digital Signatures
RSA UNWRAP KEY	User	R R R	RSA Private Key for Key Establishment AES Message Encryption Key (AES MEK) TDES Message Encryption Key (TDES MEK)
RSA VERIFY SIGNATURE	User, SSO	R,E	RSA Private Key for Digital Signatures
RSA WRAP KEY	User	R W W	RSA Private Key for Key Establishment AES Message Encryption Key (AES MEK) TDES Message Encryption Key (TDES MEK)
SELECT	User, SSO	N/A	N/A
SELF TEST	User, SSO	N/A	N/A
SET KEY	User	N/A	N/A
UNBLOCK PIN	SSO	W W	User Password Phrase SSO Password Phrase
UNLOCK	User, SSO	N/A	N/A
UPDATE BINARY	User, SSO	N/A	N/A
XAUTH ENROLL	User, SSO	N/A	N/A
XAUTH EXTERNAL AUTHENTICATION	User, SSO	N/A	N/A
XAUTH GET CHALLENGE	User, SSO	N/A	N/A
ZEROIZE	User, SSO	W	ECDSA Private Key ECC CDH Private Key Hash DRBG Seed Hash DRBG Internal State HMAC Key AES Message Encryption Key (AES MEK) TDES Message Encryption Key (TDES MEK) RSA Private Key for Digital Signatures RSA Private Key for Key Establishment Secure Channel Session Key SSO Password Phrase User Password Phrase ECC CDH Shared Secret KDF State

Service	User / SSO	Access Type	CSP Access
			Key Derivation Key SP 800-108 KDF Internal State Disk Encryption Key (DEK)
MOUNT	User	W W	Disk Encryption Key (DEK) SP 800-108 KDF Internal State
UNMOUNT	User, SSO	W W	Disk Encryption Key (DEK) SP 800-108 KDF Internal State
GETFWINFO	User, SSO	N/A	N/A
LOCK DRIVE	SSO	W	ECDSA Private Key ECC CDH Private Key Hash DRBG Seed Hash DRBG Internal State HMAC Key AES Message Encryption Key (AES MEK) TDES Message Encryption Key (TDES MEK) Disk Encryption Key (DEK) RSA Private Key for Digital Signatures RSA Private Key for Key Establishment Signatures Secure Channel Session Key SSO Password Phrase User Password Phrase ECC CDH Shared Secret KDF State Key Derivation Key SP 800-108 KDF Internal State Disk Encryption Key (DEK)
UNLOCK DRIVE	User, SSO	N/A	N/A
REFRESH	SSO, User	N/A	N/A
READ FLASH	User	E	Disk Encryption Key (DEK)
WRITE FLASH	User	E	Disk Encryption Key (DEK)

5.4 Destruction of Keys and CSPs

The module has the ability to destroy all keys and CSPs stored in the module by invoking the ZEROIZE service. The service performs the following:

- Destruction of keys and CSPs stored in the SPYCOS 3.0 microSDHC™ component by a recursive call to the DELETE command.
- Destruction of keys and CSPs stored in the Memory Controller

The DELETE command is part of the ZEROIZE service. The DELETE command and ZEROIZE service do not represent two independent ways to zeroize. To zeroize the entire module, the operator must issue the ZEROIZE service.

The contents of the file(s) being deleted are erased and over written. Should a power-down occur during the execution of the zeroization of keys and CSPs, the action of zeroization will resume on a subsequent power-on event, ensuring that access to zeroized information is prevented.

6 Setup and Initialization

The uninitialized module has only a root directory with minimal version and manufacturing information in specific files. There is no information pertaining to the User or SSO or their authentication data, such as Passwords, stored on the uninitialized module as shipped to the customer.

Initialization of the module is accomplished by setting up a security domain by following the procedures below:

- The SSO creates a new application directory on the module;
- The SSO creates a PIN file that is associated with the SSO and User;
- The SSO initializes the PIN files;
- The SSO may optionally set a default Password or set the User Password Phrase:
    - If the User Password Phrase is set by the SSO, the User will not be able to change their Password.
- The SSO uses FIPS_INFO command to confirm FIPS mode.

The module is now in FIPS mode and operators may logon with the CHECK PASSWORD command. See section 4.2 for a description of the CHECK PASSWORD process.

7 Physical Security

The module is packaged to meet FIPS 140-2 Level 3 Security. The module is packaged with physical security mechanisms that destroy the chip if physical attacks are launched against it. This is achieved using a hard, opaque, tamper-evident coating on the module.

The module hardness testing was only performed at a single temperature (70.5 ^{o}F) and no assurance is provided for Level 3 hardness conformance at any other temperature.

Table 7-1 **Inspection of Physical Security Mechanisms**

Form Factor	**Physical Security Mechanisms**	**Recommended Frequency of Inspection/Test**	**Inspection/Test Guidance Details**
SPYCOS 3.0 microSDHC™ TrustedFlash Module	Hard, opaque, tamper-evident coating.	As often as feasible, based upon organization security policy.	Inspect the case of the SPYCOS 3.0 microSDHC™ TrustedFlash Module cover for indicators of penetration (e.g. drill holes, cutting), cracking or other damage. If any signs of suspicious activity are observed, return

Form Factor	**Physical Security Mechanisms**	**Recommended Frequency of Inspection/Test**	**Inspection/Test Guidance Details**
			the cryptographic module to SPYRUS.

8 Self-Tests

The module performs both power-on and conditional self-tests. The power-on self-tests run automatically when power is restored to the module, without requiring any actions or inputs from the operator.

The module performs the following power-on self-tests:

- Firmware Integrity Test with 160-bit Error Detection Code on SPYCOS 3.0 microSDHC™
- Firmware Integrity Test with 32-bit Error Detection Code on Memory Controller
- Cryptographic algorithm known answer tests (KAT) for the SPYCOS 3. 0 microSDHC™:
  - Three-key Triple-DES KAT (encrypt)
  - Three-key Triple-DES KAT (decrypt)
  - AES KAT (encrypt)
  - AES KAT (decrypt)
  - ECDSA KAT (sign)
  - ECDSA KAT (verify)
  - ECC CDH Primitive "Z" computation KAT
  - RSA KAT (sign)
  - RSA KAT (verify)
  - HMAC (SHA-1, SHA-256, SHA-512) KAT
  - SP800-90A Hash DRBG KAT
- Cryptographic algorithm known answer tests (KAT) for the Memory Controller:
  - AES-ECB KAT (encrypt)
  - AES-ECB KAT (decrypt)

For all of the above Power-on Self-Tests on either the SPYCOS 3.0 microSDHC™ or the Memory Controller, the error status received after the failure of the test is 0X9292.

Power cycling allows either the User or SSO to perform any or all of the above tests on demand.

The module performs the following conditional tests only applicable to the SPYCOS 3.0 microSDHC™ as per Figure 2:

- ECDSA Pairwise Consistency Test
- ECC CDH Pairwise Consistency Test
- RSA Pairwise Consistency Test

- Continuous Test for Approved SP800-90A Hash DRBG
- Continuous Test for non-Approved NDRNG

For all of the above Conditional Self-Tests on the SPYCOS 3.0 microSDHC™, the error status received after the failure of the test is 0X9292.

9 Mitigation of Other Attacks

The module is not claimed to mitigate against any specific attacks.

Table 9-1 **Mitigation of Other Attacks**

Other Attacks	Mitigation Mechanism	Specific limitations
Not applicable.	Not applicable.	Not applicable.

Appendix A: Critical Security Parameters and Public Keys

The module supports the following CSPs:

1. ECDSA Private Key
- Type: FIPS 186-4, P-384
- Use: The Private Key of the User employed in Elliptic Curve digital signing operations.
- Generation: As per SP800-133 Section 6.1, key generation is performed as per FIPS 186-4 which is an Approved key generation method.
- Establishment: N/A
- Entry: Encrypted with AES-256
- Output: N/A
- Storage: Plaintext; stored in EEPROM
- Key-to-Entity: User
- Zeroization: Actively overwritten during ZEROIZE service

2. ECC CDH Private Key
- Type: SP 800-56A, 256-bit
- Use: Used in ECC CDH key agreement.
- Generation: As per SP800-133 Section 6.2, the random value (K) needed to generate key pairs for the elliptic curve is the output of the SP800-90A DRBG; this is Approved as per SP800-56A.
- Establishment: N/A
- Entry: Encrypted with AES-256
- Output: N/A
- Storage: Plaintext; transient in RAM
- Key-to-Entity: User
- Zeroization: Actively overwritten after channel closure; actively overwritten during ZEROIZE service

3. Hash DRBG Seed
- Type: SP800-90A, SHA-512, 888-bit
- Use: Used only in generating the initial state of the SP800-90A DRBG
- Generation: Internally generated using the NDRNG
- Establishment: N/A
- Entry: N/A
- Output: N/A
- Storage: N/A
- Key-to-entity: Process
- Zeroization: Actively overwritten during ZEROIZE service

4. Hash DRBG Internal State
- Type: SP800-90A, SHA-512, 1776-bit
- Use: Hash DRBG V and C values; Used only in generating the initial state of the SP800-90A DRBG

- Generation: Internally generated using the NDRNG
- Establishment: N/A
- Entry: N/A
- Output: N/A
- Storage: N/A
- Key-to-entity: Process
- Zeroization: Actively overwritten during ZEROIZE service

5. HMAC Key
- Type: FIPS 198 HMAC Key, minimum 112-bit
- Use: Used to generate HMAC message authentication code
- Generation: As per SP800-133 Section 7.1, key generation is performed as per the "Direct Generation" of Symmetric Keys which is an Approved key generation method.
- Establishment: N/A
- Entry: Encrypted with AES-256
- Output: Encrypted with AES-256
- Storage: Plaintext; stored in key register
- Key-to-entity: User
- Zeroization: Actively overwritten during ZEROIZE service

6. AES Message Encryption Key (AES MEK)
- Type: AES 128, 192, 256-bit ECB/CBC/CTR
- Use: Used for data encryption
- Generation: As per SP800-133 Section 7.1, key generation is performed as per the "Direct Generation" of Symmetric Keys which is an Approved key generation method.
- Establishment: N/A
- Entry: Encrypted with AES-256
- Output: Encrypted with RSA 2048
- Storage: Plaintext; stored in key register
- Key-to-entity: User
- Zeroization: Actively overwritten during ZEROIZE service

7. TDES Message Encryption Key (TDES MEK)
- Type: Three-key Triple-DES ECB/CBC, 192-bit
- Use: Used for data encryption
- Generation: As per SP800-133 Section 7.1, key generation is performed as per the "Direct Generation" of Symmetric Keys which is an Approved key generation method.
- Establishment: N/A
- Entry: Encrypted with Three-key TDES
- Output: Encrypted with RSA 2048
- Storage: Plaintext; stored in key register
- Key-to-entity: User
- Zeroization: Actively overwritten during ZEROIZE service

8. RSA Private Key for Digital Signatures
- Type: FIPS 186-4, 2048-bit
- Use: The Private Key of the User employed in RSA digital signing operations

- Generation: As per SP800-133 Section 6.1, key generation is performed as per FIPS 186-4 which is an Approved key generation method.
- Establishment: N/A
- Entry: Encrypted with AES-256
- Output: N/A
- Storage: Plaintext; stored in EEPROM
- Key-to-entity: User
- Zeroization: Actively overwritten during ZEROIZE service

9. RSA Private Key for Key Establishment
- Type: FIPS 186-4, 2048-bit
- Use: The Private Key of the User employed in RSA Key Unwrapping
- Generation: As per SP800-133 Section 6.2, key generation is performed as per FIPS 186-4; this is an allowed method as per FIPS 140-2 IG D.9
- Establishment: N/A
- Entry: Encrypted with AES-256
- Output: N/A
- Storage: Plaintext; stored in EEPROM
- Key-to-entity: User
- Zeroization: Actively overwritten during ZEROIZE service

10. Secure Channel Session Key
- Type: AES-256 CBC
- Use: AES-256 CBC key used to encrypt and decrypt data transmitted to the module
- Generation: N/A
- Establishment: ECC CDH key agreement as per SP800-56A; allowed method as per FIPS 140-2 IG D.8 Scenario 1
- Entry: N/A
- Output: N/A
- Storage: Plaintext; Transient in RAM
- Key-to-entity: User
- Zeroization: Actively overwritten after channel closure; actively overwritten during ZEROIZE service

11. SSO Password Phrase
- Type: 6 - 20 byte Password Phrase
- Use: A secret 6 - 20 byte value used for Crypto-officer (SSO) authentication that is externally - created by SSO during initialization
- Generation: N/A
- Establishment: N/A
- Entry: Encrypted with AES-256
- Output: N/A
- Storage: Plaintext; stored in EEPROM
- Zeroization: Actively overwritten when CHECK PASSWORD and CHANGE PASSWORD services are executed by the SSO; actively overwritten during ZEROIZE service

12. User Password Phrase
- Type: 6 - 20 byte Password Phrase
- Use: A secret 6 - 20 byte value used for User authentication that is externally created by SSO during initialization
- Generation: N/A
- Establishment: N/A
- Entry: Encrypted with AES-256
- Output: N/A
- Storage: Plaintext; stored in EEPROM
- Zeroization: Actively overwritten when CHECK PASSWORD and CHANGE PASSWORD services are executed by the User; Actively overwritten during ZEROIZE service

13. ECC CDH Shared Secret
- Type: SP 800-56A, 256-bit
- Use: Used in ECC CDH key agreement.
- Generation: N/A
- Establishment: ECC CDH key agreement as per SP800-56A; allowed method as per FIPS 140-2 IG D.8 Scenario 1
- Entry: N/A
- Output: N/A
- Storage: Plaintext; transient in RAM
- Key-to-Entity: User
- Zeroization: Actively overwritten upon successful completion of SP800-56A; actively overwritten during ZEROIZE service

14. KDF State
- Type: SP 800-56A (SHA-256 Auxiliary Function H)
- Use: Used in ECC CDH key agreement.
- Generation: N/A
- Establishment: ECC CDH key agreement as per SP800-56A; allowed method as per FIPS 140-2 IG D.8 Scenario 1
- Entry: N/A
- Output: N/A
- Storage: Plaintext; transient in RAM
- Key-to-Entity: User
- Zeroization: Actively overwritten upon successful completion of SP800-56A; actively overwritten during ZEROIZE service

15. Key Derivation Key
- Type: FIPS 198 HMAC Key, 256-bit
- Use: Used to key the SP800-108 KDF process
- Generation: HASH_DRBG (on SPYCOS 3.0)
- Establishment: None
- Entry: None
- Output: None
- Key-to-Entity: User

- Storage: Key file on SPYCOS 3.0
- Zeroization: Zeroize Command

16. SP 800-108 KDF Internal State
- Type: SP800-108 KDF Counter mode (HMAC-SHA-256 PRF)
- Use: SP 800-108 internal values: Iteration count (i), Label, Context, Key Derivation key (KI) data length of the derived keying material (L).
- Generation: During SP 800-108 KDF Process
- Establishment: None
- Entry: None
- Output: None
- Key-to-Entity: User
- Storage: Plaintext in RAM also Context saved in Flash Memory
- Zeroization: Zeroize Command

17. Disk Encryption Key (DEK)
- Type: AES-256 ECB Encryption Key
- Use: For all Encrypt / Decrypt operations on Encrypted Flash (disk)
- Generation: By SP 800-108 KDF Process
- Establishment: None
- Entry: None
- Output: None
- Key-to-Entity: User
- Storage: Plaintext in key register in Memory Controller
- Zeroization: Zeroize Command

The module supports the following public keys:

1. ECDSA Public Key:
- Type: FIPS 186-4, P-256, P-384, P-521
- Use: The Public Key of the User employed in Elliptic Curve digital signing operations
- Generation: As per SP800-133 Section 6.1, key generation is performed as per FIPS 186-4 which is an Approved key generation method
- Establishment: N/A
- Entry: Encrypted with AES-256
- Output: Encrypted with AES-256
- Storage: Plaintext; stored in EEPROM
- Key-to-entity: User

2. RSA Public Key for Digital Signatures
- Type: FIPS 186-4, 2048-bit
- Use: The Public Key of the User employed in RSA digital signature verification operations
- Generation: As per SP800-133 Section 6.1, key generation is performed as per FIPS 186-4 which is an Approved key generation method
- Establishment: N/A

- Entry: Encrypted with AES-256
- Output: Encrypted with AES-256
- Storage: Plaintext; stored in EEPROM
- Key-to-entity: User

3. RSA Public Key for Key Establishment
   - Type: FIPS 186-4, 2048-bit
   - Use: The Public Key of the User employed in RSA Key Wrapping
   - Generation: As per SP800-133 Section 6.2, key generation is performed as per FIPS 186-4; this is an allowed method as per FIPS 140-2 IG D.9
   - Establishment: N/A
   - Entry: Encrypted with AES-256
   - Output: Encrypted with AES-256
   - Storage: Plaintext; stored in EEPROM
   - Key-to-entity: User

4. ECC CDH Public Key
   - Type: SP 800-56A, P-256, P-384, P-521
   - Use: Used in ECC CDH key agreement.
   - Generation: As per SP800-133 Section 6.2, the random value (K) needed to generate key pairs for the elliptic curve is the output of the SP800-90A DRBG; this is Approved as per SP800-56A.
   - Establishment: N/A
   - Entry: N/A
   - Output: Plaintext
   - Storage: Plaintext; transient in RAM
   - Key-to-Entity: User

Appendix B: CKG as per SP 800-133

In accordance with FIPS 140-2 IG D.12, the cryptographic module performs Cryptographic Key Generation (CKG) as per SP800-133 (vendor affirmed). Please see Appendix A above for further details.