FIPS 140-2 Security Policy

for

Aspen

Document Version 1.0.2

Sony Corporation

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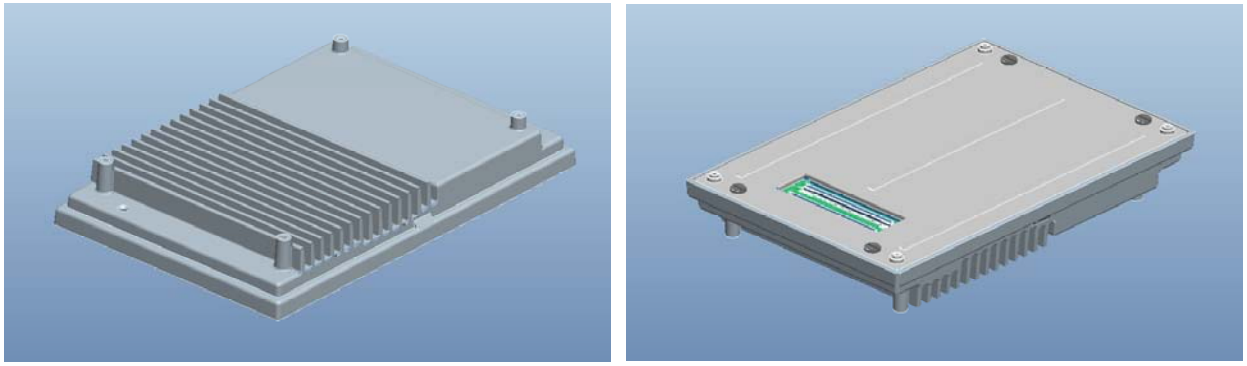
1. Module Overview

The Aspen cryptographic module is a multi-chip embedded cryptographic module encased in a hard opaque commercial grade metal case. The cryptographic boundary is defined as the entire metal case perimeter, including all hardware and firmware encapsulated within. The interfaces are all traces that cross the cryptographic boundary.

The primary purpose of the Aspen is to provide decryption, decoding/encoding of audio/video data for the digital cinema projector system in which it is used.

The illustration below shows the Aspen, along with the cryptographic boundary.



Top Side **Bottom Side**

Figure 1 - Image of the Aspen Cryptographic Module

The Aspen is validated in the following hardware / firmware versions:

- Hardware version: 1.0.0
- Firmware versions: 1.0.0 or 1.0.1

Aspen firmware configuration table is as follows.

Table 1 - Aspen Firmware Configuration

Component	Aspen Firmware version 1.0.0	Aspen Firmware version 1.0.1
MDC version	01.00.00	01.00.04
NSA version	01.00.00	01.00.05
CDM version	01.00.00	01.00.11
Kernel version	02.06.33	02.06.33
MBA version	01.00.00	01.00.01
CTU version	04.01.01	04.01.01
DSP version	01.00.06	01.00.06
Boot Loader version	01.00.00	01.00.00

2. Security Level

The Aspen meets the overall requirements applicable to Level 2 security of FIPS 140-2.

Table 2 - Module Security Level Specification

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

3. Modes of Operation

3.1. Approved Mode of Operation

The Aspen is designed to continually operate in a FIPS approved mode of operation. The Aspen supports the following FIPS approved cryptographic algorithms:

• AES with 128-bit key (as per FIPS 197)	
-CBC and ECB mode of operation	- Certificates: #1539, #1540
-CBC mode of operation (Decrypt only)	- Certificate: #1541
• SHA-1 with 160-bit hash value (as per FIPS 180-3)	- Certificates: #1364, #1365, #1367
• SHA-256 with 256-bit hash value (as per FIPS 180-3)	- Certificates: #1364, #1365, #1366
• HMAC-SHA-1 with 160-bit MAC value (as per FIPS 198)	- Certificates: #901, #902
• RSA Signature Generation/Verification with 2,048-bit key (as per FIPS 186-2)	- Certificates: #750, #751
• ANSI X9.31 RNG using AES (as per ANSI X9.31)	- Certificates: #829, #830
• FIPS 186-2 RNG using SHA-1 (as per FIPS 186-2)	- Certificate: #828

In addition to the above algorithms the Aspen employs the following Allowed non-FIPS approved cryptographic algorithms for use in the FIPS approved mode of operation.

- RSA only for key wrapping. (Key establishment methodology provides 112-bit of encryption strength)
- NDRNG for the seeding of the ANSI X9.31 RNGs
- SP 800-135rev1 TLS KDF
- HMAC-MD5 for the pseudo random function in TLS

The operator can be assured that the Aspen is in the approved mode by verifying that the firmware versions identified using the 'Get Status' service match each of the validated firmware component versions listed in Section 1.

3.2. Non-Approved Mode of Operation

The Aspen does not support a non-FIPS Approved mode of operation.

4. Ports and Interfaces

The physical interfaces for Aspen are the traces that cross the perimeter of the physical cryptographic boundary. The traces are used to support TLS with the following logical interfaces required by FIPS 140-2:

- Data Input
- Data Output
- Status Output
- Control Input

In addition, the Aspen receives power from an outside source and thus supports a power input interface.

- Power Input

5. Identification and Authentication Policy

5.1. Assumption of Roles

The Aspen supports two distinct operator roles (User and Crypto-Officer). The Aspen enforces the separation of roles using identity-based operator authentication. The Crypto-Officer and User are authenticated using the RSA 2048 signature verification algorithm.

Table 3 - Roles and Required Identification and Authentication

Role	Type of Authentication	Authentication Data
User	Identity-based operator authentication	RSA Digital Certificate
Crypto-Officer	Identity-based operator authentication	RSA Digital Certificate

5.2. Authentication Mechanism

The Aspen supports an authentication mechanism.

Table 4 - Strengths of Authentication Mechanisms

Authentication Mechanism	Strength of Mechanism
RSA Digital Certificate Verification	The authentication is based on RSA 2,048, which has an equivalent strength of 112-bit. Therefore, the probability with which a random attempt will succeed or a false acceptance will occur is 2^{-112} which is less than 1/1,000,000. There is a 10msec delay after each trial which limits the number of attempts per minute. The probability of a random attempt successfully authenticating to the Aspen within one minute is also $6000 * 2^{-112}$ ($< 2^{10} * 2^{-112} = 2^{-102}$) which is less than 1/100,000.

6. Access Control Policy

6.1. Roles and Services

Table 5 - Crypto-Officer Specific Services

Service	Description
Firmware Update	Updates the firmware of the Aspen.
Clear Log	All Security Log are deleted.
Zeroization	Destroys all plaintext CSPs.

* Note: If a non-FIPS validated firmware version is loaded onto the Aspen, then the Aspen is no longer an FIPS validated module.

Table 6 - Crypto-Officer and User Common Services

Service	Description
CPL Control	Controls and lists Digital Cinema Packages (DCP).
Get Parameter	Obtains each parameter which was set in the Aspen.
Get Status	Obtains the Aspen’s status and version number.
KDM Control	Controls the Key Delivery Message (KDM – import, read, store, clear).
Log Management	Obtains log data and tagging.
Playback	Plays back contents (Video and Audio).
Playback Preparation	Prepares and obtains the status of the playback.
Property Setting	Sets Real Time Clock (RTC) and network parameters.
Status Initialization	Initializes marriage and tamper status.
Adjust Playback Parameter	Adjusts parameters for playback and obtains the playback status.
Certificate Control	Obtains certificate information.

Table 7 - Unauthenticated Services

Service	Description
Show Status	Obtains Aspen status.
Self-tests	Performs power-up self-tests.

6.2. Definition of Critical Security Parameters (CSPs)

The following CSPs are included in the Aspen.

- Contents Encryption Key (CEK) - AES key used to decrypt contents.
- Content Integrity Key (CIK) - HMAC-SHA-1 key for integrity check of contents.
- Master Key (MK) - AES key used to protect all stored CSPs.
- TLS Session Key (TSK) - The AES key established in TLS.
- TLS MAC Secret (TMACS) - The HMAC key established in TLS.
- RSA Signing Key (RSK) - RSA private key used for generation of a digital signature for the log data and TLS session data.
- Device Private Key (DPK) - RSA private key used for decryption of CEK and decryption of wrapped cryptographic keys which are entered into the Aspen in TLS.
- TLS Premaster Secret (TPS) - The parameter used for key establishment in TLS.
- TLS Master Secret (TMS) - The parameter used for key establishment in TLS.
- PRF State (PS) - The internal state used for key establishment in TLS.
- Seed and Seed Key (SSK) - The secret values necessary for the FIPS approved RNGs.

6.3. Definition of Public Keys

The following are the public keys contained in the Aspen:

- Aspen Manufacturer Public Key - RSASSA 2048 public key used to verify a certificate chain of trust.
- Aspen Trusted Public Key - RSASSA 2048 public key used to verify a certificate chain of trust.
- RSA Verifying Key - RSASSA 2048 public key corresponding to the RSA Signing Key.
- Device Public Key - RSAES 2048 public key corresponding to the Device Private Key.
- Public Key for F/W Upgrade - RSASSA 2048 public key used to verify the digital signature over the firmware image to be upgraded.
- Operator Public Key - RSAES 2048 public key used to authenticate operators.

6.4. Definition of CSP Access Modes

Table 8 defines the relationship between CSP access modes and module services. The access modes shown in Table 8 are defined as follows:

- **Generate** **(*G*)**: Generates the Critical Security Parameter (CSP) using an approved Random Number Generator (RNG).
- **Use** **(*U*)**: Uses the CSP to perform cryptographic operations within its corresponding algorithm.
- **Entry** **(*E*)**: Enters the CSP into the Aspen.
- **Output** **(*O*)**: Outputs the CSP from the Aspen.
- **Zeroize** **(*Z*)**: Removes the CSP.

Table 8 - CSP Access Rights within Roles & Services

Role		Service Name	CSP (*Access Mode*)
C.O.	User		
X		Clear Log	TSK(*U*), TMACS(*U*)
X		Zeroization	All CSPs(*Z*), TSK(*U*), TMACS(*U*)
X		Firmware Update	TSK(*U*), TMACS(*U*)
X	X	CPL Control	TSK(*U*), TMACS(*U*)
X	X	Certificate Control	TSK(*U*), TMACS(*U*)
X	X	Get Parameter	TSK(*U*), TMACS(*U*)
X	X	Get Status	TSK(*U*), TMACS(*U*)
X	X	KDM Control	CEK(*E*, *Z*), CIK(*G*, *Z*), MK(*U*), DPK(*U*), TSK(*U*), TMACS(*U*), SSK(*U*)
X	X	Log Management	RSK(*U*), TSK(*U*), TMACS(*U*)
X	X	Playback	TSK(*U*), TMACS(*U*)
X	X	Playback Preparation	TSK(*U*), TMACS(*U*)
X	X	Property Setting	TSK(*U*), TMACS(*U*)
X	X	Status Initialization	TSK(*U*), TMACS(*U*), RSK(*U*)
X	X	Adjust Playback Parameter	CEK(*U*), CIK(*U*), TSK(*U*), TMACS(*U*)
Any	Any	Show Status	-
Any	Any	Self-Test	-

* TPS, TMS, and PS are entered or generated, used and zeroized in TLS establishment.

7. Operational Environment

The FIPS 140-2 Area 6 Operational Environment requirements are not applicable because the Aspen does not contain a modifiable operational environment.

8. Security Rules

The Aspen cryptographic module was designed with the following security rules in mind. These rules are comprised of both those specified by FIPS 140-2 and those derived from Sony's company policy.

1. The Aspen shall provide two distinct operator roles. These are the User role, and the Crypto-Officer role.

2. The Aspen shall provide identity-based authentication.

3. When the Aspen has not been placed in an authenticated role, the operator shall not have access to any cryptographic services.

4. The Aspen shall perform the following tests:

    i. Power-up Self-Tests:

        a. Cryptographic algorithm tests (for each implementation):

            - AES 128 CBC Encryption/Decryption Known-Answer Tests
            - AES 128 ECB Encryption/Decryption Known-Answer Test
            - ANSI X9.31 RNG Known-Answer Test
            - FIPS 186-2 RNG Known-Answer Test
            - SHA-1 Known-Answer Test
            - SHA-256 Known-Answer Test
            - HMAC-SHA-1 Known-Answer Test
            - RSA PKCS#1 v1.5 Signature Generation/Verification Known-Answer Test

        b. Firmware Integrity Test (CRC-16 and CRC-32)

        c. Critical Functions Test:

            - HMAC-MD5 Known-Answer Test
            - RSA OAEP Pair-wise Consistency Test
            - RSA PKCS#1 v1.5 Pair-wise Consistency Test (Encryption/Decryption)

    ii. Conditional Self-Tests:

   a. Continuous (RNG) Tests (ANSI X9.31 RNGs, FIPS 186-2 RNG, NDRNG)

   b. Firmware Load Test (RSA Digital Signature Verification)

5. The operator shall be capable of commanding the Aspen to perform the power-up self-test using recycling power.

6. Data output shall be inhibited during self-tests, zeroization, and error states.

7. Data output shall be logically disconnected from key generation processes.

8. Status information shall not contain CSPs or sensitive data that if misused could lead to a compromise of the Aspen.

9. The Aspen does not support simultaneous operation of more than two operators.

10. The Aspen shall not support a bypass capability or a maintenance interface.

11. If a non-FIPS validated firmware version is loaded onto the Aspen, then the Aspen ceases to be a FIPS validated module.

12. HMAC-MD5 is only used as the pseudo random function in TLS.

13. The Aspen only supports the electronic entry form of key establishment .

9. Physical Security Policy

9.1. Physical Security Mechanisms

The Aspen is a multi-chip embedded cryptographic module with the following physical security mechanisms:

- Production-grade components,
- The enclosure does not have any removable cover, door or ventilation slits. When the power supply from the outside is lost, all plaintext CSPs within the Aspen are zeroized,
- The enclosure is opaque and provides tamper evidence,
- The enclosure is sufficiently hard, providing tamper detection and response in accordance with FIPS 140-2 level 3 physical security requirements.

9.2. Operator Actions

Due to the intended deployment environment for the Aspen, Sony defers the physical inspection criteria to the end user of the cryptographic module. Any such inspection shall be based on the customer security policy, in particular with regards to the inspection frequency.

Table 9 - Inspection/Testing of Physical Security Mechanisms

Physical Security Mechanisms	Recommended Frequency of Inspection/Test	Inspection/Test Guidance Details
Non-Removable Enclosure	Every startup and reboot.	Inspect for scratches or deformation of the metal case. If such evidence is found, user should not use the module.
Tamper detection	Every startup and reboot.	If the module was zeroized, user should return it to Sony.

10. Policy on Mitigation of Other Attacks

The Aspen was not designed to mitigate other attacks outside of the specific scope of FIPS 140-2. Therefore, this section is not applicable.

Table 10 - Mitigation of Other Attacks

Other Attack	Mitigation Mechanism	Specific Limitations
N/A	N/A	N/A

11. Definitions and Acronyms

Table 11 -Definitions and Acronyms

Term	Definition
AES	**A**dvanced **E**ncryption **S**tandard
CDM	**C**ontents **D**ecryption and **D**ecode **M**odule
CPL	**C**ompositions **P**lay**l**ists
CRC	**C**yclic **R**edundancy **C**ode
CSP	**C**ritical **S**ecurity **P**arameter
CTU	**C**ounter **T**ampering & **T**amper Detection **U**nit
DCI	**D**igital **C**inema **I**nitiative
DCP	**D**igital **C**inema **P**ackage
DRNG	**D**eterministic **RNG**
DSP	**D**igital **S**ignal **P**rocessor
EMI / EMC	**E**lectro**m**agnetic **I**nterference / **E**lectro**m**agnetic **C**ompatibility
HMAC	**H**ash-based **M**essage **A**uthentication **C**ode
KDM	**K**ey **D**elivery **M**essage
MBA	**M**edia **B**lock **A**pplication
MDC	**M**edia **D**ecrypt & **D**ecode **C**ontroller
NSA	**N**ios & **A**udio Mapping
OAEP	**O**ptimal **A**symmetric **E**ncryption **P**adding
PAD	FPGA that processes video and audio data
PKCS	**P**ublic **K**ey **C**ryptography **S**tandards
PRF	**P**seudo **R**andom **F**unction
RNG	**R**andom **N**umber **G**enerator
RSA	**R**ivest-**S**hamir-**A**dleman
RSA ES/SSA	**RSA E**ncryption **S**tandard / **S**ecure **S**ignature **A**lgorithm

Term	Definition
RTC	**R**eal **T**ime **C**lock
SHA	**S**ecure **H**ash **A**lgorithm
TLS	**T**ransport **L**ayer **S**ecurity

12. Revision History

Date	Version	Description
Aug. 20, 2012	1.0.0	Initial public release.
Dec. 17, 2012	1.0.1	Incorporated comments from CST Lab.
Aug. 30, 2013	1.0.2	Incorporated comments from NIST.