IBM Corporation

IBM ClevOS 3 OpenSSL Cryptographic Module

FIPS 140-3 Non-Proprietary Security Policy

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1 General

1.1 Overview

This document is the non-proprietary FIPS 140-3 Security Policy for the IBM ClevOS 3 OpenSSL Cryptographic Module. It contains the security rules under which the module must operate and describes how this module meets the requirements as specified in FIPS PUB 140-3 (Federal Information Processing Standards Publication 140-3) for an overall Security Level 1 module.

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1.2 Security Levels

Section	Title	Security Level
1	General	1
2	Cryptographic module specification	1
3	Cryptographic module interfaces	1
4	Roles, services, and authentication	1
5	Software/Firmware security	1
6	Operational environment	1
7	Physical security	N/A
8	Non-invasive security	N/A
9	Sensitive security parameter management	1
10	Self-tests	1
11	Life-cycle assurance	1
12	Mitigation of other attacks	1
	Overall Level	1

Table 1: Security Levels

1.3 Additional Information

In preparing the Security Policy document, the laboratory formatted the vendor-supplied documentation for consolidation without altering the technical statements therein contained. The further refining of the Security Policy document was conducted iteratively throughout the conformance testing, wherein the Security Policy was submitted to the vendor, who would then edit, modify, and add technical contents. The vendor would also supply additional documentation, which the laboratory formatted into the existing Security Policy, and resubmitted to the vendor for their final editing.

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2 Cryptographic Module Specification

2.1 Description

Purpose and Use:

The IBM ClevOS 3 OpenSSL Cryptographic Module (hereafter referred to as “the module”) is defined as a software module in a multi-chip standalone embodiment. It provides a C language application program interface (API) for use by other applications that require cryptographic functionality. The module consists of one software component, the “FIPS provider” i.e., fips.so, which implements the FIPS requirements, and the cryptographic functionality provided to the operator.

Module Type: Software

Module Embodiment: MultiChipStand

Module Characteristics

Cryptographic Boundary:

Components in white are only included in the diagram for informational purposes. They are not included in the cryptographic boundary (and therefore not part of the module’s validation). For example, the kernel is responsible for managing system calls issued by the module itself, as well as other applications using the module for cryptographic services.

Tested Operational Environment’s Physical Perimeter (TOEPP):

Figure 1 shows a block diagram that represents the design of the module when the module is operational and providing services to other user space applications. In this diagram, the physical perimeter of the operational environment (a general-purpose computer on which the module is installed) is indicated by a purple dashed line. The cryptographic boundary is represented by the component in the orange block, that is, the shared library implementing the FIPS provider (fips.so).

The connecting lines indicate the flow of data between the cryptographic module and its operator application, through the logical interfaces defined in Section 3.

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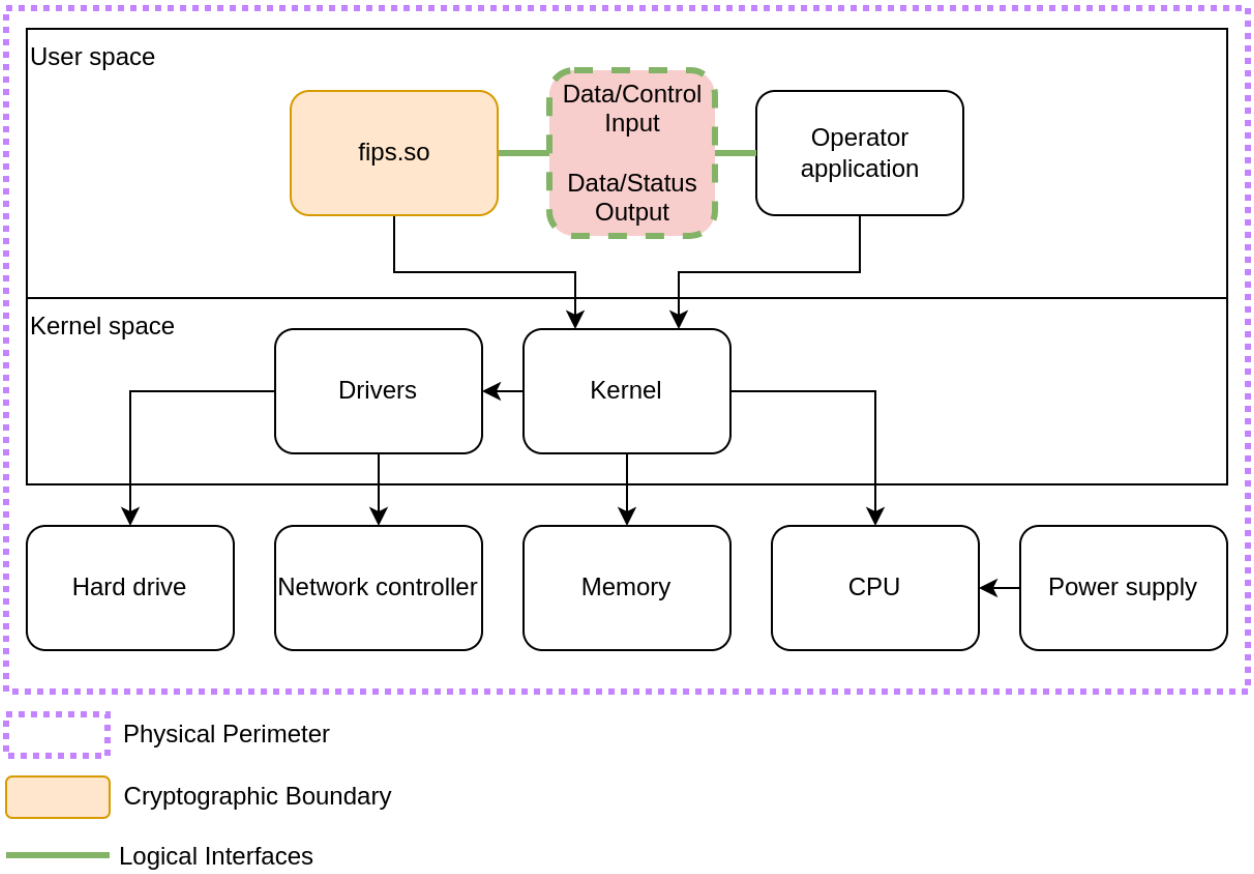

Figure 1: Block Diagram

2.2 Tested and Vendor Affirmed Module Version and Identification

Tested Module Identification – Hardware:

N/A for this module.

Tested Module Identification – Software, Firmware, Hybrid (Executable Code Sets):

Package or File Name	Software/ Firmware Version	Features	Integrity Test
fips.so	3.3.2-a8fdaac	N/A	HMAC-SHA-256

Table 2: Tested Module Identification – Software, Firmware, Hybrid (Executable Code Sets)

Tested Module Identification – Hybrid Disjoint Hardware:

N/A for this module.

Tested Operational Environments - Software, Firmware, Hybrid:

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Operating System	Hardware Platform	Processors	PAA/PAI	Hypervisor or Host OS	Version(s)
ClevOS 3.19	Lenovo SR650v3	Intel Sapphire Rapids Xeon 8474C	Yes	N/A	3.3.2-a8fdaac
ClevOS 3.19	Lenovo SR650v3	Intel Sapphire Rapids Xeon 8474C	No	N/A	3.3.2-a8fdaac

Table 3: Tested Operational Environments - Software, Firmware, Hybrid

Vendor-Affirmed Operational Environments - Software, Firmware, Hybrid:

Operating System	Hardware Platform
ClevOS 3	PIO-628U-TR4T+-ST031 (Intel Xeon E5-2620 *)
ClevOS 3	PIO-648R-E1CR36L+-ST031(Intel Xeon E5-2620 *)
ClevOS 3	IBM A10 Series (Intel Xeon 6126)
ClevOS 3	IBM A10 Series (Intel Xeon 6226)
ClevOS 3	IBM M10 Series (Intel Xeon 4110)
ClevOS 3	IBM M10 Series (Intel Xeon 4110R)
ClevOS 3	IBM C10 Series (Intel Xeon 4110)
ClevOS 3	IBM C10 Series (Intel Xeon 4210R)
ClevOS 3	IBM 4616-A2D Series (Intel Xeon 4416+)
ClevOS 3	IBM 4616-M2D Series (Intel Xeon 4416+)
ClevOS 3	IBM 4616-C2D Series (Intel Xeon 4416+)
ClevOS 3	IBM 4616-S3D Series (Intel Xeon Gold 6438N)
ClevOS 3	IBM 4616-S4D/S6D Series (Intel Xeon 4416+)
ClevOS 3	IBM 4616-A1D Series (Intel Xeon 4314)
ClevOS 3	IBM 4616-M1D Series (Intel Xeon 4314)
ClevOS 3	IBM 4616-C1D Series (Intel Xeon 4314)
ClevOS 3	IBM 4616-S2D Series (Intel Xeon 4314)
ClevOS 3	ThinkSystem SR630 V3 (Intel Xeon 6426Y)

Table 4: Vendor-Affirmed Operational Environments - Software, Firmware, Hybrid

The CMVP makes no statement as to the correct operation of the module or the security strengths of the generated SSPs when the module is ported if the specific operational environments are not listed on the validation certificate.

2.3 Excluded Components

There are no components excluded from the module.

2.4 Modes of Operation

Modes List and Description:

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Mode Name	Description	Type	Status Indicator
Approved mode	Automatically entered whenever an approved service is requested	Approved	OSSL_IBMCOS_FIPSINDICATOR_APPROVED (1)
Non-approved mode	Automatically entered whenever a non-approved service is requested	Non-Approved	OSSL_IBMCOS_FIPSINDICATOR_UNAPPROVED (0)

Table 5: Modes List and Description

Mode Change Instructions and Status:

The module automatically switches between the approved and non-approved modes depending on the services requested by the operator. The status indicator of the mode of operation is equivalent to the indicator of the service that was requested.

2.5 Algorithms

Approved Algorithms:

The table below lists all implemented modes or methods of operation for the approved cryptographic algorithms of the module that are employed for approved services (Approved Services table).

Algorithm	CAVP Cert	Properties	Reference
AES-CBC	A6907	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CBC	A6911	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CBC	A6912	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CBC-CS1	A6907	Direction - decrypt, encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CBC-CS1	A6911	Direction - decrypt, encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CBC-CS1	A6912	Direction - decrypt, encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CBC-CS2	A6907	Direction - decrypt, encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CBC-CS2	A6911	Direction - decrypt, encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CBC-CS2	A6912	Direction - decrypt, encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CBC-CS3	A6907	Direction - decrypt, encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CBC-CS3	A6911	Direction - decrypt, encrypt Key Length - 128, 192, 256	SP 800-38A

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Algorithm	CAVP Cert	Properties	Reference
AES-CBC-CS3	A6912	Direction - decrypt, encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CCM	A6907	Key Length - 128, 192, 256	SP 800-38C
AES-CCM	A6911	Key Length - 128, 192, 256	SP 800-38C
AES-CCM	A6912	Key Length - 128, 192, 256	SP 800-38C
AES-CFB1	A6907	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CFB1	A6911	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CFB1	A6912	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CFB128	A6907	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CFB128	A6911	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CFB128	A6912	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CFB8	A6907	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CFB8	A6911	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CFB8	A6912	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CMAC	A6907	Direction - Generation Key Length - 128, 192, 256	SP 800-38B
AES-CMAC	A6911	Direction - Generation Key Length - 128, 192, 256	SP 800-38B
AES-CMAC	A6912	Direction - Generation Key Length - 128, 192, 256	SP 800-38B
AES-CTR	A6907	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CTR	A6911	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-CTR	A6912	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-ECB	A6907	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-ECB	A6911	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-ECB	A6912	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-GCM	A6895	Direction - Decrypt, Encrypt IV Generation - External, Internal	SP 800-38D

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Algorithm	CAVP Cert	Properties	Reference
		Key Length - 128, 192, 256 IV Generation Mode - 8.2.1, 8.2.2	
AES-GCM	A6896	Direction - Decrypt, Encrypt IV Generation - External, Internal Key Length - 128, 192, 256 IV Generation Mode - 8.2.1, 8.2.2	SP 800-38D
AES-GCM	A6897	Direction - Decrypt, Encrypt IV Generation - External, Internal Key Length - 128, 192, 256 IV Generation Mode - 8.2.1, 8.2.2	SP 800-38D
AES-GCM	A6898	Direction - Decrypt, Encrypt IV Generation - External, Internal Key Length - 128, 192, 256 IV Generation Mode - 8.2.1, 8.2.2	SP 800-38D
AES-GCM	A6899	Direction - Decrypt, Encrypt IV Generation - External, Internal Key Length - 128, 192, 256 IV Generation Mode - 8.2.1, 8.2.2	SP 800-38D
AES-GCM	A6900	Direction - Decrypt, Encrypt IV Generation - External, Internal Key Length - 128, 192, 256 IV Generation Mode - 8.2.1, 8.2.2	SP 800-38D
AES-GCM	A6908	Direction - Decrypt, Encrypt IV Generation - External, Internal Key Length - 128, 192, 256 IV Generation Mode - 8.2.1, 8.2.2	SP 800-38D
AES-GCM	A6913	Direction - Decrypt, Encrypt IV Generation - External, Internal Key Length - 128, 192, 256 IV Generation Mode - 8.2.1, 8.2.2	SP 800-38D
AES-GCM	A6914	Direction - Decrypt, Encrypt IV Generation - External, Internal Key Length - 128, 192, 256 IV Generation Mode - 8.2.1, 8.2.2	SP 800-38D
AES-GMAC	A6895	Direction - Decrypt, Encrypt IV Generation - External Key Length - 128, 192, 256	SP 800-38D
AES-GMAC	A6896	Direction - Decrypt, Encrypt IV Generation - External Key Length - 128, 192, 256	SP 800-38D
AES-GMAC	A6897	Direction - Decrypt, Encrypt IV Generation - External Key Length - 128, 192, 256	SP 800-38D
AES-GMAC	A6898	Direction - Decrypt, Encrypt IV Generation - External Key Length - 128, 192, 256	SP 800-38D

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Algorithm	CAVP Cert	Properties	Reference
AES-GMAC	A6899	Direction - Decrypt, Encrypt IV Generation - External Key Length - 128, 192, 256	SP 800-38D
AES-GMAC	A6900	Direction - Decrypt, Encrypt IV Generation - External Key Length - 128, 192, 256	SP 800-38D
AES-GMAC	A6908	Direction - Decrypt, Encrypt IV Generation - External Key Length - 128, 192, 256	SP 800-38D
AES-GMAC	A6913	Direction - Decrypt, Encrypt IV Generation - External Key Length - 128, 192, 256	SP 800-38D
AES-GMAC	A6914	Direction - Decrypt, Encrypt IV Generation - External Key Length - 128, 192, 256	SP 800-38D
AES-KW	A6907	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38F
AES-KW	A6911	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38F
AES-KW	A6912	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38F
AES-KWP	A6907	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38F
AES-KWP	A6911	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38F
AES-KWP	A6912	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38F
AES-OFB	A6907	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-OFB	A6911	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-OFB	A6912	Direction - Decrypt, Encrypt Key Length - 128, 192, 256	SP 800-38A
AES-XTS Testing Revision 2.0	A6907	Direction - Decrypt, Encrypt Key Length - 128, 256	SP 800-38E
AES-XTS Testing Revision 2.0	A6911	Direction - Decrypt, Encrypt Key Length - 128, 256	SP 800-38E
AES-XTS Testing Revision 2.0	A6912	Direction - Decrypt, Encrypt Key Length - 128, 256	SP 800-38E
Counter DRBG	A6905	Prediction Resistance - No, Yes Mode - AES-128, AES-192, AES-256 Derivation Function Enabled - No, Yes	SP 800-90A Rev. 1

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Algorithm	CAVP Cert	Properties	Reference
ECDSA KeyGen (FIPS186-5)	A6901	Curve - P-224, P-256, P-384, P-521 Secret Generation Mode - testing candidates	FIPS 186-5
ECDSA KeyGen (FIPS186-5)	A6902	Curve - P-224, P-256, P-384, P-521 Secret Generation Mode - testing candidates	FIPS 186-5
ECDSA KeyGen (FIPS186-5)	A6903	Curve - P-224, P-256, P-384, P-521 Secret Generation Mode - testing candidates	FIPS 186-5
ECDSA KeyGen (FIPS186-5)	A6904	Curve - P-224, P-256, P-384, P-521 Secret Generation Mode - testing candidates	FIPS 186-5
ECDSA KeyGen (FIPS186-5)	A6909	Curve - P-224, P-256, P-384, P-521 Secret Generation Mode - testing candidates	FIPS 186-5
ECDSA KeyGen (FIPS186-5)	A6916	Curve - B-233, B-283, B-409, B-571, K-233, K-283, K-409, K-571 Secret Generation Mode - testing candidates	FIPS 186-5
ECDSA KeyVer (FIPS186-4)	A6901	Curve - P-192	FIPS 186-4
ECDSA KeyVer (FIPS186-4)	A6902	Curve - P-192	FIPS 186-4
ECDSA KeyVer (FIPS186-4)	A6903	Curve - P-192	FIPS 186-4
ECDSA KeyVer (FIPS186-4)	A6904	Curve - P-192	FIPS 186-4
ECDSA KeyVer (FIPS186-4)	A6909	Curve - P-192	FIPS 186-4
ECDSA KeyVer (FIPS186-4)	A6916	Curve - B-163, B-233, B-283, B-409, B-571, K-163, K-233, K-283, K-409, K-571	FIPS 186-4
ECDSA KeyVer (FIPS186-5)	A6901	Curve - P-224, P-256, P-384, P-521	FIPS 186-5
ECDSA KeyVer (FIPS186-5)	A6902	Curve - P-224, P-256, P-384, P-521	FIPS 186-5
ECDSA KeyVer (FIPS186-5)	A6903	Curve - P-224, P-256, P-384, P-521	FIPS 186-5
ECDSA KeyVer (FIPS186-5)	A6904	Curve - P-224, P-256, P-384, P-521	FIPS 186-5
ECDSA KeyVer (FIPS186-5)	A6909	Curve - P-224, P-256, P-384, P-521	FIPS 186-5
ECDSA KeyVer (FIPS186-5)	A6916	Curve - B-233, B-283, B-409, B-571, K-233, K-283, K-409, K-571	FIPS 186-5
ECDSA SigGen (FIPS186-5)	A6901	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Component - No, Yes	FIPS 186-5
ECDSA SigGen (FIPS186-5)	A6902	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Component - No, Yes	FIPS 186-5

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Algorithm	CAVP Cert	Properties	Reference
ECDSA SigGen (FIPS186-5)	A6903	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Component - No, Yes	FIPS 186-5
ECDSA SigGen (FIPS186-5)	A6904	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Component - No, Yes	FIPS 186-5
ECDSA SigGen (FIPS186-5)	A6909	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Component - No, Yes	FIPS 186-5
ECDSA SigGen (FIPS186-5)	A6910	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA3-224, SHA3-256, SHA3-384, SHA3-512 Component - No, Yes	FIPS 186-5
ECDSA SigGen (FIPS186-5)	A6916	Curve - B-233, B-283, B-409, B-571, K-233, K-283, K-409, K-571 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Component - No, Yes	FIPS 186-5
ECDSA SigGen (FIPS186-5)	A6917	Curve - B-233, B-283, B-409, B-571, K-233, K-283, K-409, K-571 Hash Algorithm - SHA3-224, SHA3-256, SHA3-384, SHA3-512 Component - No, Yes	FIPS 186-5
ECDSA SigVer (FIPS186-4)	A6901	Component - No Curve - P-192 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-4
ECDSA SigVer (FIPS186-4)	A6902	Component - No Curve - P-192 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-4
ECDSA SigVer (FIPS186-4)	A6903	Component - No Curve - P-192 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-4
ECDSA SigVer (FIPS186-4)	A6904	Component - No Curve - P-192 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-4
ECDSA SigVer (FIPS186-4)	A6909	Component - No Curve - P-192 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-4

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Algorithm	CAVP Cert	Properties	Reference
ECDSA SigVer (FIPS186-4)	A6910	Component - No Curve - P-192 Hash Algorithm - SHA3-224, SHA3-256, SHA3-384, SHA3-512	FIPS 186-4
ECDSA SigVer (FIPS186-4)	A6916	Component - No Curve - B-163, B-233, B-283, B-409, B-571, K-163, K-233, K-283, K-409, K-571 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-4
ECDSA SigVer (FIPS186-4)	A6917	Component - No Curve - B-163, B-233, B-283, B-409, B-571, K-163, K-233, K-283, K-409, K-571 Hash Algorithm - SHA3-224, SHA3-256, SHA3-384, SHA3-512	FIPS 186-4
ECDSA SigVer (FIPS186-5)	A6901	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-5
ECDSA SigVer (FIPS186-5)	A6902	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-5
ECDSA SigVer (FIPS186-5)	A6903	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-5
ECDSA SigVer (FIPS186-5)	A6904	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-5
ECDSA SigVer (FIPS186-5)	A6909	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-5
ECDSA SigVer (FIPS186-5)	A6910	Curve - P-224, P-256, P-384, P-521 Hash Algorithm - SHA3-224, SHA3-256, SHA3-384, SHA3-512	FIPS 186-5
ECDSA SigVer (FIPS186-5)	A6916	Curve - B-233, B-283, B-409, B-571, K-233, K-283, K-409, K-571 Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	FIPS 186-5
ECDSA SigVer (FIPS186-5)	A6917	Curve - B-233, B-283, B-409, B-571, K-233, K-283, K-409, K-571 Hash Algorithm - SHA3-224, SHA3-256, SHA3-384, SHA3-512	FIPS 186-5
Hash DRBG	A6905	Prediction Resistance - No, Yes Mode - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	SP 800-90A Rev. 1
HMAC DRBG	A6905	Prediction Resistance - No, Yes Mode - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256	SP 800-90A Rev. 1
HMAC-SHA-1	A6901	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1

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Algorithm	CAVP Cert	Properties	Reference
HMAC-SHA-1	A6902	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA-1	A6903	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA-1	A6904	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA-1	A6909	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-224	A6901	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-224	A6902	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-224	A6903	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-224	A6904	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-224	A6909	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-256	A6901	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-256	A6902	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-256	A6903	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-256	A6904	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-256	A6909	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-384	A6901	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-384	A6902	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-384	A6903	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-384	A6904	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-384	A6909	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512	A6901	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512	A6902	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512	A6903	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512	A6904	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512	A6909	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1

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Algorithm	CAVP Cert	Properties	Reference
HMAC-SHA2-512/224	A6901	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512/224	A6902	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512/224	A6903	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512/224	A6904	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512/224	A6909	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512/256	A6901	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512/256	A6902	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512/256	A6903	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512/256	A6904	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA2-512/256	A6909	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA3-224	A6910	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA3-256	A6910	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA3-384	A6910	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
HMAC-SHA3-512	A6910	Key Length - Key Length: 112-524288 Increment 8	FIPS 198-1
KAS-ECC-SSC Sp800-56Ar3	A6901	Domain Parameter Generation Methods - P-224, P-256, P-384, P-521 Scheme - ephemeralUnified - KAS Role - initiator, responder	SP 800-56A Rev. 3
KAS-ECC-SSC Sp800-56Ar3	A6902	Domain Parameter Generation Methods - P-224, P-256, P-384, P-521 Scheme - ephemeralUnified - KAS Role - initiator, responder	SP 800-56A Rev. 3
KAS-ECC-SSC Sp800-56Ar3	A6903	Domain Parameter Generation Methods - P-224, P-256, P-384, P-521 Scheme - ephemeralUnified - KAS Role - initiator, responder	SP 800-56A Rev. 3
KAS-ECC-SSC Sp800-56Ar3	A6904	Domain Parameter Generation Methods - P-224, P-256, P-384, P-521 Scheme -	SP 800-56A Rev. 3

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Algorithm	CAVP Cert	Properties	Reference
		ephemeralUnified - KAS Role - initiator, responder	
KAS-ECC-SSC Sp800-56Ar3	A6909	Domain Parameter Generation Methods - P-224, P-256, P-384, P-521 Scheme - ephemeralUnified - KAS Role - initiator, responder	SP 800-56A Rev. 3
KAS-FFC-SSC Sp800-56Ar3	A6919	Domain Parameter Generation Methods - ffdhe2048, ffdhe3072, ffdhe4096, ffdhe6144, ffdhe8192, MODP-2048, MODP-3072, MODP-4096, MODP-6144, MODP-8192 Scheme - dhEphem - KAS Role - initiator, responder	SP 800-56A Rev. 3
KDA HKDF SP800-56Cr2	A6918	Derived Key Length - 2048 Shared Secret Length - Shared Secret Length: 224-8192 Increment 8 HMAC Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256, SHA3-224, SHA3-256, SHA3-384, SHA3-512	SP 800-56C Rev. 2
KDA OneStep SP800-56Cr2	A6915	Derived Key Length - 2048 Shared Secret Length - Shared Secret Length: 224-8192 Increment 8	SP 800-56C Rev. 2
KDA TwoStep SP800-56Cr2	A6915	MAC Salting Methods - default, random KDF Mode - feedback Derived Key Length - 2048 Shared Secret Length - Shared Secret Length: 224-8192 Increment 8	SP 800-56C Rev. 2
KDF ANS 9.42 (CVL)	A6901	KDF Type - DER Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Key Data Length - Key Data Length: 112-4096 Increment 8	SP 800-135 Rev. 1
KDF ANS 9.42 (CVL)	A6902	KDF Type - DER Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Key Data Length - Key Data Length: 112-4096 Increment 8	SP 800-135 Rev. 1
KDF ANS 9.42 (CVL)	A6903	KDF Type - DER Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Key Data Length - Key Data Length: 112-4096 Increment 8	SP 800-135 Rev. 1
KDF ANS 9.42 (CVL)	A6904	KDF Type - DER Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Key Data Length - Key Data Length: 112-4096 Increment 8	SP 800-135 Rev. 1

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Algorithm	CAVP Cert	Properties	Reference
KDF ANS 9.42 (CVL)	A6909	KDF Type - DER Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Key Data Length - Key Data Length: 112-4096 Increment 8	SP 800-135 Rev. 1
KDF ANS 9.42 (CVL)	A6910	KDF Type - DER Hash Algorithm - SHA3-224, SHA3-256, SHA3-384, SHA3-512 Key Data Length - Key Data Length: 112-4096 Increment 8	SP 800-135 Rev. 1
KDF ANS 9.63 (CVL)	A6901	Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Key Data Length - Key Data Length: 128-4096 Increment 8	SP 800-135 Rev. 1
KDF ANS 9.63 (CVL)	A6902	Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Key Data Length - Key Data Length: 128-4096 Increment 8	SP 800-135 Rev. 1
KDF ANS 9.63 (CVL)	A6903	Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Key Data Length - Key Data Length: 128-4096 Increment 8	SP 800-135 Rev. 1
KDF ANS 9.63 (CVL)	A6904	Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Key Data Length - Key Data Length: 128-4096 Increment 8	SP 800-135 Rev. 1
KDF ANS 9.63 (CVL)	A6909	Hash Algorithm - SHA2-224, SHA2-256, SHA2-384, SHA2-512, SHA2-512/224, SHA2-512/256 Key Data Length - Key Data Length: 128-4096 Increment 8	SP 800-135 Rev. 1
KDF ANS 9.63 (CVL)	A6910	Hash Algorithm - SHA3-224, SHA3-256, SHA3-384, SHA3-512 Key Data Length - Key Data Length: 128-4096 Increment 8	SP 800-135 Rev. 1
KDF KMAC Sp800-108r1	A6906	Derived Key Length - Derived Key Length: 256	SP 800-108 Rev. 1
KDF SP800-108	A6906	KDF Mode - Counter, Feedback Supported Lengths - Supported Lengths: 112-4096 Increment 8	SP 800-108 Rev. 1
KDF SSH (CVL)	A6901	Cipher - AES-128, AES-192, AES-256 Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1
KDF SSH (CVL)	A6902	Cipher - AES-128, AES-192, AES-256 Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1

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Algorithm	CAVP Cert	Properties	Reference
KDF SSH (CVL)	A6903	Cipher - AES-128, AES-192, AES-256 Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1
KDF SSH (CVL)	A6904	Cipher - AES-128, AES-192, AES-256 Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1
KDF SSH (CVL)	A6909	Cipher - AES-128, AES-192, AES-256 Hash Algorithm - SHA-1, SHA2-224, SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1
KMAC-128	A6910	Message Length - Message Length: 0-65536 Increment 8 Key Data Length - Key Data Length: 128-1024 Increment 8	SP 800-185
KMAC-256	A6910	Message Length - Message Length: 0-65536 Increment 8 Key Data Length - Key Data Length: 128-1024 Increment 8	SP 800-185
PBKDF	A6901	Iteration Count - Iteration Count: 1000-10000 Increment 1 Password Length - Password Length: 8-128 Increment 1	SP 800-132
PBKDF	A6902	Iteration Count - Iteration Count: 1000-10000 Increment 1 Password Length - Password Length: 8-128 Increment 1	SP 800-132
PBKDF	A6903	Iteration Count - Iteration Count: 1000-10000 Increment 1 Password Length - Password Length: 8-128 Increment 1	SP 800-132
PBKDF	A6904	Iteration Count - Iteration Count: 1000-10000 Increment 1 Password Length - Password Length: 8-128 Increment 1	SP 800-132
PBKDF	A6909	Iteration Count - Iteration Count: 1000-10000 Increment 1 Password Length - Password Length: 8-128 Increment 1	SP 800-132
PBKDF	A6910	Iteration Count - Iteration Count: 1000-10000 Increment 1 Password Length - Password Length: 8-128 Increment 1	SP 800-132
RSA KeyGen (FIPS186-5)	A6901	Key Generation Mode - probableWithProbableAux Modulo - 2048, 3072, 4096, 6144, 8192 Primality Tests - 2powSecStr Private Key Format - standard	FIPS 186-5
RSA KeyGen (FIPS186-5)	A6902	Key Generation Mode - probableWithProbableAux Modulo - 2048, 3072, 4096, 6144, 8192	FIPS 186-5

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Algorithm	CAVP Cert	Properties	Reference
		Primality Tests - 2powSecStr Private Key Format - standard	
RSA KeyGen (FIPS186-5)	A6903	Key Generation Mode - probableWithProbableAux Modulo - 2048, 3072, 4096, 6144, 8192 Primality Tests - 2powSecStr Private Key Format - standard	FIPS 186-5
RSA KeyGen (FIPS186-5)	A6904	Key Generation Mode - probableWithProbableAux Modulo - 2048, 3072, 4096, 6144, 8192 Primality Tests - 2powSecStr Private Key Format - standard	FIPS 186-5
RSA KeyGen (FIPS186-5)	A6909	Key Generation Mode - probableWithProbableAux Modulo - 2048, 3072, 4096, 6144, 8192 Primality Tests - 2powSecStr Private Key Format - standard	FIPS 186-5
RSA SigGen (FIPS186-5)	A6901	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
RSA SigGen (FIPS186-5)	A6902	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
RSA SigGen (FIPS186-5)	A6903	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
RSA SigGen (FIPS186-5)	A6904	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
RSA SigGen (FIPS186-5)	A6909	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
RSA SigGen (FIPS186-5)	A6910	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
RSA SigVer (FIPS186-2)	A6901	Signature Type - PKCS 1.5, PKCSPSS Modulo - 1536	FIPS 186-4
RSA SigVer (FIPS186-2)	A6902	Signature Type - PKCS 1.5, PKCSPSS Modulo - 1536	FIPS 186-4
RSA SigVer (FIPS186-2)	A6903	Signature Type - PKCS 1.5, PKCSPSS Modulo - 1536	FIPS 186-4
RSA SigVer (FIPS186-2)	A6904	Signature Type - PKCS 1.5, PKCSPSS Modulo - 1536	FIPS 186-4
RSA SigVer (FIPS186-2)	A6909	Signature Type - PKCS 1.5, PKCSPSS Modulo - 1536	FIPS 186-4
RSA SigVer (FIPS186-4)	A6901	Signature Type - PKCS 1.5, PKCSPSS Modulo - 1024	FIPS 186-4
RSA SigVer (FIPS186-4)	A6902	Signature Type - PKCS 1.5, PKCSPSS Modulo - 1024	FIPS 186-4
RSA SigVer (FIPS186-4)	A6903	Signature Type - PKCS 1.5, PKCSPSS Modulo - 1024	FIPS 186-4
RSA SigVer (FIPS186-4)	A6904	Signature Type - PKCS 1.5, PKCSPSS Modulo - 1024	FIPS 186-4

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Algorithm	CAVP Cert	Properties	Reference
RSA SigVer (FIPS186-4)	A6909	Signature Type - PKCS 1.5, PKCSPSS Modulo - 1024	FIPS 186-4
RSA SigVer (FIPS186-5)	A6901	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
RSA SigVer (FIPS186-5)	A6902	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
RSA SigVer (FIPS186-5)	A6903	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
RSA SigVer (FIPS186-5)	A6904	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
RSA SigVer (FIPS186-5)	A6909	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
RSA SigVer (FIPS186-5)	A6910	Modulo - 2048, 3072, 4096 Signature Type - pkcs1v1.5, pss	FIPS 186-5
Safe Primes Key Generation	A6919	Safe Prime Groups - ffdhe2048, ffdhe3072, ffdhe4096, ffdhe6144, ffdhe8192, MODP-2048, MODP-3072, MODP-4096, MODP-6144, MODP-8192	SP 800-56A Rev. 3
Safe Primes Key Verification	A6919	Safe Prime Groups - ffdhe2048, ffdhe3072, ffdhe4096, ffdhe6144, ffdhe8192, MODP-2048, MODP-3072, MODP-4096, MODP-6144, MODP-8192	SP 800-56A Rev. 3
SHA-1	A6901	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA-1	A6902	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA-1	A6903	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA-1	A6904	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA-1	A6909	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-224	A6901	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-224	A6902	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-224	A6903	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4

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Algorithm	CAVP Cert	Properties	Reference
SHA2-224	A6904	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-224	A6909	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-256	A6901	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-256	A6902	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-256	A6903	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-256	A6904	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-256	A6909	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-384	A6901	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-384	A6902	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-384	A6903	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-384	A6904	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-384	A6909	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512	A6901	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512	A6902	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512	A6903	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4

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Algorithm	CAVP Cert	Properties	Reference
SHA2-512	A6904	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512	A6909	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512/224	A6901	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512/224	A6902	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512/224	A6903	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512/224	A6904	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512/224	A6909	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512/256	A6901	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512/256	A6902	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512/256	A6903	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512/256	A6904	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA2-512/256	A6909	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 180-4
SHA3-224	A6910	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 202
SHA3-256	A6910	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 202
SHA3-384	A6910	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 202

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Algorithm	CAVP Cert	Properties	Reference
SHA3-512	A6910	Message Length - Message Length: 0-65536 Increment 8 Large Message Sizes - 1, 2, 4, 8	FIPS 202
SHAKE-128	A6910	Output Length - Output Length: 16-65536 Increment 8	FIPS 202
SHAKE-256	A6910	Output Length - Output Length: 16-65536 Increment 8	FIPS 202
TLS v1.2 KDF RFC7627 (CVL)	A6901	Hash Algorithm - SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1
TLS v1.2 KDF RFC7627 (CVL)	A6902	Hash Algorithm - SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1
TLS v1.2 KDF RFC7627 (CVL)	A6903	Hash Algorithm - SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1
TLS v1.2 KDF RFC7627 (CVL)	A6904	Hash Algorithm - SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1
TLS v1.2 KDF RFC7627 (CVL)	A6909	Hash Algorithm - SHA2-256, SHA2-384, SHA2-512	SP 800-135 Rev. 1
TLS v1.3 KDF (CVL)	A6918	HMAC Algorithm - SHA2-256, SHA2-384 KDF Running Modes - DHE, PSK, PSK-DHE	SP 800-135 Rev. 1

Table 6: Approved Algorithms

Vendor-Affirmed Algorithms:

Name	Properties	Implementation	Reference
Asymmetric Cryptographic Key Generation (CKG)	Key Type:Asymmetric	N/A	SP 800-133Rev2 section 4, example 1

Table 7: Vendor-Affirmed Algorithms

Non-Approved, Allowed Algorithms:

N/A for this module.

Non-Approved, Allowed Algorithms with No Security Claimed:

N/A for this module.

Non-Approved, Not Allowed Algorithms:

Name	Use and Function
AES GCM (external IV)	Encryption
DSA	Signature Generation, Signature Verification, Key Pair Generation, Key Pair Verification
ECDSA with curve P-192, B-163, K-163	Key Pair Generation, Signature Generation
ECDSA (pre-hashed message)	Signature Verification (pre-hashed message)
RSA X9.31	Signature Generation, Signature Verification
RSA primitive	Asymmetric Encryption, Asymmetric Decryption

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Name	Use and Function
RSA-OAEP	Asymmetric Encryption, Asymmetric Decryption
RSASVE	Secret Value Encapsulation, Secret Value Decapsulation

Table 8: Non-Approved, Not Allowed Algorithms

2.6 Security Function Implementations

Name	Type	Description	Properties	Algorithms
Encryption with AES	BC-UnAuth	SP 800-38A and SP 800-38E. Encryption		AES-CBC: (A6907, A6911, A6912) AES-CBC-CS1: (A6907, A6911, A6912) AES-CBC-CS2: (A6907, A6911, A6912) AES-CBC-CS3: (A6907, A6911, A6912) AES-CFB1: (A6907, A6911, A6912) AES-CFB128: (A6907, A6911, A6912) AES-CFB8: (A6907, A6911, A6912) AES-CTR: (A6907, A6911, A6912) AES-ECB: (A6907, A6911, A6912) AES-OFB: (A6907, A6911, A6912) AES-XTS Testing Revision 2.0: (A6907, A6911, A6912)
Decryption with AES	BC-UnAuth	SP 800-38A and SP 800-38E. Decryption		AES-CBC: (A6907, A6911, A6912) AES-CBC-CS1: (A6907, A6911, A6912) AES-CBC-CS2: (A6907, A6911, A6912) AES-CBC-CS3: (A6907, A6911, A6912) AES-CFB1: (A6907, A6911,

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Name	Type	Description	Properties	Algorithms
				A6912) AES-CFB128: (A6907, A6911, A6912) AES-CFB8: (A6907, A6911, A6912) AES-CTR: (A6907, A6911, A6912) AES-ECB: (A6907, A6911, A6912) AES-OFB: (A6907, A6911, A6912) AES-XTS Testing Revision 2.0: (A6907, A6911, A6912)
Authenticated Encryption with AES	BC-AuthEncrypt	SP 800-38D. Authenticated encryption		AES-CCM: (A6907, A6911, A6912) AES-GCM: (A6895, A6896, A6897, A6898, A6899, A6900, A6908, A6913, A6914) AES-KW: (A6907, A6911, A6912) AES-KWP: (A6907, A6911, A6912)
Authenticated Decryption with AES	BC-AuthDecrypt	SP 800-38D. Authenticated decryption		AES-CCM: (A6907, A6911, A6912) AES-GCM: (A6895, A6896, A6897, A6898, A6899, A6900, A6908, A6913, A6914) AES-KW: (A6907, A6911, A6912) AES-KWP: (A6907, A6911, A6912)
Message Authentication Generation with AES	MAC	SP 800-38B and SP 800-38D Message authentication generation		AES-CMAC: (A6907, A6911, A6912) AES-GMAC: (A6895, A6896, A6897, A6898,

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Name	Type	Description	Properties	Algorithms
				A6899, A6900, A6908, A6913, A6914)
Message Authentication Generation with HMAC	MAC	FIPS 198-1. Message authentication generation		HMAC-SHA-1: (A6901, A6902, A6903, A6904, A6909) HMAC-SHA2-224: (A6901, A6902, A6903, A6904, A6909) HMAC-SHA2-256: (A6901, A6902, A6903, A6904, A6909) HMAC-SHA2-384: (A6901, A6902, A6903, A6904, A6909) HMAC-SHA2-512: (A6901, A6902, A6903, A6904, A6909) HMAC-SHA2-512/224: (A6901, A6902, A6903, A6904, A6909) HMAC-SHA2-512/256: (A6901, A6902, A6903, A6904, A6909) SHA-1: (A6901, A6902, A6903, A6904, A6909) SHA2-224: (A6901, A6902, A6903, A6904, A6909) SHA2-256: (A6901, A6902, A6903, A6904, A6909) SHA2-384: (A6901, A6902, A6903, A6904, A6909) SHA2-512: (A6901, A6902, A6903, A6904, A6909) SHA2-512/224: (A6901, A6902,

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Name	Type	Description	Properties	Algorithms
				A6903, A6904, A6909) SHA2-512/256: (A6901, A6902, A6903, A6904, A6909) SHA3-224: (A6910) SHA3-256: (A6910) SHA3-384: (A6910) SHA3-512: (A6910) HMAC-SHA3-224: (A6910) HMAC-SHA3-256: (A6910) HMAC-SHA3-384: (A6910) HMAC-SHA3-512: (A6910)
Message Authentication with KMAC	MAC	SP 800-185. Message authentication generation		KMAC-128: (A6910) KMAC-256: (A6910)
Random Number Generation with DRBG	DRBG	SP 800-90ARev1. Random number generation		HMAC DRBG: (A6905) Hash DRBG: (A6905) Counter DRBG: (A6905)
Signature Generation with ECDSA	DigSig-SigGen	FIPS 186-5. Signature generation		ECDSA SigGen (FIPS186-5): (A6901, A6902, A6903, A6904, A6909, A6910, A6916, A6917) SHA2-224: (A6901, A6902, A6903, A6904, A6909) SHA2-256: (A6901, A6902, A6903, A6904, A6909) SHA2-384: (A6901, A6902, A6903, A6904, A6909) SHA2-512:

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Name	Type	Description	Properties	Algorithms
				(A6901, A6902, A6903, A6904, A6909) SHA2-512/224: (A6901, A6902, A6903, A6904, A6909) SHA2-512/256: (A6901, A6902, A6903, A6904, A6909) SHA3-224: (A6910) SHA3-256: (A6910) SHA3-384: (A6910) SHA3-512: (A6910)
Signature Generation with RSA	DigSig-SigGen	FIPS 186-5. Signature generation. Per IG C.F, RSA SigGen was CAVP tested with moduli sizes 2048, 3072, 4096 bits. The module supports moduli sizes larger than 4096 bits, up to 16384 bits.		RSA SigGen (FIPS186-5): (A6901, A6902, A6903, A6904, A6909, A6910) SHA2-224: (A6901, A6902, A6903, A6904, A6909) SHA2-256: (A6901, A6902, A6903, A6904, A6909) SHA2-384: (A6901, A6902, A6903, A6904, A6909) SHA2-512: (A6901, A6902, A6903, A6904, A6909) SHA2-512/224: (A6901, A6902, A6903, A6904, A6909) SHA2-512/256: (A6901, A6902, A6903, A6904, A6909) SHA3-224: (A6910) SHA3-256: (A6910)

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Name	Type	Description	Properties	Algorithms
				SHA3-384: (A6910) SHA3-512: (A6910)
Legacy Signature Verification with ECDSA	DigSig-SigVer	FIPS 186-4. Signature verification		ECDSA SigVer (FIPS186-4): (A6901, A6902, A6903, A6904, A6909, A6910, A6916, A6917) SHA-1: (A6901, A6902, A6903, A6904, A6909) SHA2-224: (A6901, A6902, A6903, A6904, A6909) SHA2-256: (A6901, A6902, A6903, A6904, A6909) SHA2-384: (A6901, A6902, A6903, A6904, A6909) SHA2-512: (A6901, A6902, A6903, A6904, A6909) SHA2-512/224: (A6901, A6902, A6903, A6904, A6909) SHA2-512/256: (A6901, A6902, A6903, A6904, A6909) SHA3-224: (A6910) SHA3-256: (A6910) SHA3-384: (A6910) SHA3-512: (A6910)
Signature Verification with ECDSA	DigSig-SigVer	FIPS 186-5. Signature verification		ECDSA SigVer (FIPS186-5): (A6901, A6902, A6903, A6904, A6909, A6910, A6916, A6917)

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Name	Type	Description	Properties	Algorithms
				SHA2-224: (A6901, A6902, A6903, A6904, A6909) SHA2-256: (A6901, A6902, A6903, A6904, A6909) SHA2-384: (A6901, A6902, A6903, A6904, A6909) SHA2-512: (A6901, A6902, A6903, A6904, A6909) SHA2-512/224: (A6901, A6902, A6903, A6904, A6909) SHA2-512/256: (A6901, A6902, A6903, A6904, A6909) SHA3-224: (A6910) SHA3-256: (A6910) SHA3-384: (A6910) SHA3-512: (A6910)
Legacy Signature Verification with RSA	DigSig-SigVer	FIPS 186-2, FIPS 186-4 Signature verification. Per IG C.F, RSA SigVer was CAVP tested with moduli sizes 1024, 2048, 3072, 4096 bits. The module supports moduli sizes larger than 4096 bits, up to 16384 bits.		RSA SigVer (FIPS186-2): (A6901, A6902, A6903, A6904, A6909) RSA SigVer (FIPS186-4): (A6901, A6902, A6903, A6904, A6909) SHA-1: (A6901, A6902, A6903, A6904, A6909) SHA2-224: (A6901, A6902, A6903, A6904, A6909) SHA2-256: (A6901, A6902, A6903, A6904,

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Name	Type	Description	Properties	Algorithms
				A6909) SHA2-384: (A6901, A6902, A6903, A6904, A6909) SHA2-512: (A6901, A6902, A6903, A6904, A6909) SHA2-512/224: (A6901, A6902, A6903, A6904, A6909) SHA2-512/256: (A6901, A6902, A6903, A6904, A6909) SHA3-224: (A6910) SHA3-256: (A6910) SHA3-384: (A6910) SHA3-512: (A6910)
Signature Verification with RSA	DigSig-SigVer	FIPS 186-5 Signature verification. Per IG C.F, RSA SigVer was CAVP tested with moduli sizes 1024, 2048, 3072, 4096 bits. The module supports moduli sizes larger than 4096 bits, up to 16384 bits.		RSA SigVer (FIPS186-5): (A6901, A6902, A6903, A6904, A6909, A6910) SHA2-224: (A6901, A6902, A6903, A6904, A6909) SHA2-256: (A6901, A6902, A6903, A6904, A6909) SHA2-384: (A6901, A6902, A6903, A6904, A6909) SHA2-512: (A6901, A6902, A6903, A6904, A6909) SHA2-512/224: (A6901, A6902, A6903, A6904, A6909) SHA2-512/256: (A6901, A6902,

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Name	Type	Description	Properties	Algorithms
				A6903, A6904, A6909) SHA3-224: (A6910) SHA3-256: (A6910) SHA3-384: (A6910) SHA3-512: (A6910)
Key Pair Generation with ECDSA	AsymKeyPair-KeyGen CKG	FIPS 186-5. Key pair generation		ECDSA KeyGen (FIPS186-5): (A6901, A6902, A6903, A6904, A6909, A6916) Asymmetric Cryptographic Key Generation (CKG): ()
Key Pair Generation with RSA	AsymKeyPair-KeyGen CKG	FIPS 186-5. Key pair generation. Per IG C.F, RSA KeyGen was CAVP tested with moduli sizes of 2048, 3072, 4096, 6144, 8192 bits. The module supports moduli sizes larger than 8192 bits, up to 16384 bits. The number of Miller-Rabin tests is compliant with Table B.1 of FIPS 186-5.		RSA KeyGen (FIPS186-5): (A6901, A6902, A6903, A6904, A6909) Asymmetric Cryptographic Key Generation (CKG): ()
Key Pair Generation with Safe Primes	AsymKeyPair-KeyGen CKG	SP 800-56Ar3. Key pair generation		Safe Primes Key Generation: (A6919) Asymmetric Cryptographic Key Generation (CKG): ()
Key Pair Verification with ECDSA	AsymKeyPair-KeyVer	FIPS 186-5 Key verification		ECDSA KeyVer (FIPS186-5): (A6901, A6902, A6903, A6904, A6909, A6916)

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Name	Type	Description	Properties	Algorithms
Legacy Key Pair Verification with ECDSA	AsymKeyPair-KeyVer	FIPS 186-4 Key verification		ECDSA KeyVer (FIPS186-4): (A6916, A6904, A6903, A6902, A6901, A6909)
Key Pair Verification with Safe Primes	AsymKeyPair-KeyVer	SP 800-56Ar3. Key pair verification		Safe Primes Key Verification: (A6919)
Key Derivation with KBKDF	KBKDF	SP 800-108r1. Key derivation		KDF KMAC Sp800-108r1: (A6906) KDF SP800-108: (A6906)
Key Derivation with KDA OneStep	KAS-56CKDF	SP 800-56Cr2. Key derivation		KDA OneStep SP800-56Cr2: (A6915)
Key Derivation with KDA TwoStep	KAS-56CKDF	SP 800-56Cr2. Key derivation		KDA TwoStep SP800-56Cr2: (A6915)
Key Derivation with KDA HKDF	KAS-56CKDF	SP 800-56Cr2. Key derivation		KDA HKDF SP800-56Cr2: (A6918)
Key Derivation with ANS X9.42 KDF	KAS-135KDF	SP 800-135r1. Key derivation		KDF ANS 9.42: (A6901, A6902, A6903, A6904, A6909, A6910)
Key Derivation with X9.63 KDF	KAS-135KDF	SP 800-135r1. Key derivation		KDF ANS 9.63: (A6901, A6902, A6903, A6904, A6909, A6910)
Key Derivation with SSH KDF	KAS-135KDF	SP 800-135r1. Key derivation		KDF SSH: (A6901, A6902, A6903, A6904, A6909)
Key Derivation with TLS 1.2 KDF	KAS-135KDF	SP 800-135r1. Key derivation		TLS v1.2 KDF RFC7627: (A6901, A6902, A6903, A6904, A6909)
Key Derivation with TLS 1.3 KDF	KAS-135KDF	RFC 8446. Key derivation		TLS v1.3 KDF: (A6918)
Key Derivation with PBKDF2	PBKDF	SP 800-132. Key derivation		PBKDF: (A6901, A6902, A6903, A6904, A6909, A6910)
Shared Secret Computation	KAS-SSC	SP 800-56Ar3. KAS-ECC-SSC and KAS-FFC-SSC, per IG D.F, Scenario 2 (1)	KAS-ECC-SSC Sp800-56Ar3 strength:112-256 bits KAS-FFC-SSC	KAS-ECC-SSC Sp800-56Ar3: (A6901, A6902, A6903, A6904, A6909)

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Name	Type	Description	Properties	Algorithms
			Sp800-56Ar3 strength:112-200 bits	KAS-FFC-SSC Sp800-56Ar3: (A6919)
Message Digest with SHA	SHA	FIPS 180-4 and FIPS 202. Message digest		SHA-1: (A6901, A6902, A6903, A6904, A6909) SHA2-224: (A6901, A6902, A6903, A6904, A6909) SHA2-256: (A6901, A6902, A6903, A6904, A6909) SHA2-384: (A6901, A6902, A6903, A6904, A6909) SHA2-512: (A6901, A6902, A6903, A6904, A6909) SHA2-512/224: (A6901, A6902, A6903, A6904, A6909) SHA2-512/256: (A6901, A6902, A6903, A6904, A6909) SHA3-224: (A6910) SHA3-256: (A6910) SHA3-384: (A6910) SHA3-512: (A6910)
Message Digest with SHAKE	XOF	FIPS 202. Message digest		SHAKE-128: (A6910) SHAKE-256: (A6910)

Table 9: Security Function Implementations

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2.7 Algorithm Specific Information

2.7.1 AES GCM IV

For TLS 1.2, the module offers the AES GCM implementation and uses the context of Scenario 1 of FIPS 140-3 IG C.H. The module is compliant with SP 800-52r2 Section 3.3.1 and the mechanism for IV generation is compliant with RFC 5288 and 8446.

The module does not implement the TLS protocol. The module's implementation of AES GCM is used together with an application that runs outside the module's cryptographic boundary. The design of the TLS protocol implicitly ensures that the counter (the nonce_explicit part of the IV) does not exhaust the maximum number of possible values for a given session key.

Alternatively, the Crypto Officer can use the module's API to perform AES GCM encryption using internal IV generation. These IVs are always 96 bits and generated using the approved DRBG internal to the module's boundary in compliance with Scenario 2 of IG C.H.

Finally, for TLS 1.3, the AES GCM implementation uses the context of Scenario 5 of FIPS 140-3 IG C.H. The protocol that provides this compliance is TLS 1.3, defined in RFC8446 of August 2018, using the cipher-suites that explicitly select AES GCM as the encryption/decryption cipher (Appendix B.4 of RFC8446). The module supports acceptable AES GCM cipher suites from Section 3.3.1 of SP800-52r2. The module's implementation of AES GCM is used together with an application that runs outside the module's cryptographic boundary. The design of the TLS protocol implicitly ensures that the counter (the nonce_explicit part of the IV) does not exhaust the maximum number of possible values for a given session key.

For both TLS 1.3 and TLS 1.2, in the event the module's power is lost and restored, the consuming application must ensure that a new key for use with the AES GCM key encryption or decryption under this scenario shall be established.

2.7.2 AES XTS

In accordance with FIPS 140-3 IG C.I, the module implements a check that ensures, before performing any cryptographic operation, that the two AES keys used in AES XTS mode are not identical. Key_1 and Key_2 shall be generated and/or established independently according to the rules for component symmetric keys from NIST SP 800-133r2, Section 6.3.

In addition, Section 4 of SP 800-38E states that the length of a single data unit encrypted or decrypted with AES XTS shall not exceed 2^{20} AES blocks, that is 16MB, of data per XTS instance.

The XTS mode shall only be used for the cryptographic protection of data on storage devices. It shall not be used for other purposes, such as the encryption of data in transit.

2.7.3 Key Derivation using SP 800-132 PBKDF2

The module provides password-based key derivation (PBKDF2), compliant with SP 800-132. The module supports option 1a from Section 5.4 of SP 800-132, in which the Master Key (MK) or a segment of it is used directly as the Data Protection Key (DPK). In accordance with SP 800-132 and FIPS 140-3 IG D.N, the following requirements shall be met:

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- Derived keys shall only be used in storage applications. The MK shall not be used for other purposes. The module accepts a minimum length of 112 bits for the MK or DPK.
- Passwords or passphrases, used as an input for the PBKDF2, shall not be used as cryptographic keys.
- The minimum length of the password or passphrase accepted by the module is 8 characters. Assuming the worst-case scenario of all digits, this results in the estimated probability of guessing the password to be at most 10^{-8}. Combined with the minimum iteration count as described below, this provides an acceptable trade-off between user experience and security against brute-force attacks.
- A portion of the salt, with a length of at least 128 bits (this is verified by the module to determine the service is approved), shall be generated randomly using the SP 800-90Ar1 DRBG provided by the module.
- The iteration count shall be selected as large as possible, as long as the time required to generate the key using the entered password is acceptable for the users. The module enforces the iteration count to be equal to or greater than 1000.

2.7.4 Compliance to SP 800-56Arev3 Assurances

The module does not establish SSPs using an approved key agreement scheme (KAS). However, it does offer some or all of the underlying KAS cryptographic functionality to be used by an external operator/application as part of an approved KAS. The module offers DH and ECDH shared secret computation services compliant to the SP 800-56ARev3 and meeting IG D.F scenario 2 path (1). In order to meet the required assurances listed in section 5.6 of SP 800-56Arev3, the module shall be used together with an application that implements the “TLS protocol” and the following steps shall be performed.

1. The entity using the module, must use the module's "Key pair generation" service for generating DH/ECDH ephemeral keys. This meets the assurances required by key pair owner defined in the section 5.6.2.1 of SP 800-56ARev3.
2. As part of the module's shared secret computation (SSC) service, the module internally performs the public key validation on the peer's public key passed in as input to the SSC function. This meets the public key validity assurance required by the sections 5.6.2.2.2 of SP 800-56ARev3.
3. The module does not support static keys therefore the "assurance of peer's possession of private key" is not applicable.

2.7.5 Legacy Algorithms

The module utilizes the following legacy algorithms as defined in SP 800-131Arev2:

- SHA-1 for RSA Signature Verification and ECDSA Signature Verification purposes.
- RSA Signature Verification, under FIPS 186-4, allows verifying signatures with 1024-bit keys. Under FIPS 186-2, allows verifying signatures with 1024, 1280, 1536, and 1792-bit keys.
- ECDSA Signature Verification, under FIPS 186-4, allows verifying elliptic curve-based signatures with curves P-192, K-163, and B-163.
- ECDSA Key Pair Verification, under FIPS 186-4, allows verifying elliptic curve-based keys with curves P-192, K-163, and B-163.

The CAVP certificates for these algorithms are listed in the Approved Algorithms table. These legacy algorithms can only be used on data that was generated prior to the Legacy Date specified in FIPS 140-3 IG C.M.

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2.8 RBG and Entropy

Cert Number	Vendor Name
E265	IBM Corporation

Table 10: Entropy Certificates

Name	Type	Operational Environment	Sample Size	Entropy per Sample	Conditioning Component
OpenSSL CPU Time Jitter RNG version 3.4.0	Non-Physical	ClevOS 3.19 on Lenovo SR650v3 with Intel® Xeon® 8474C (2X)	256	Full entropy	SHA3-256 cert. A6801; HMACSHA512 DRBG cert. A6817

Table 11: Entropy Sources

The module implements three different Deterministic Random Bit Generator (DRBG) implementations based on SP 800-90Ar1: Counter DRBG, Hash DRBG, and HMAC DRBG. Each of these DRBG implementations can be instantiated by the operator of the module, using the parameters listed specified in the *Security Function Implementations* table. When instantiated, these DRBGs can be used to generate random numbers for external usage.

As per the Public Use Document of entropy certificate E265, the entropy source provides full entropy of 256 bits.

In addition to the DRBG algorithms provided to the operator, the module internally uses two dedicated DRBG instances based on SP 800-90A Rev. 1 to generate seeds for asymmetric key pairs and random numbers for security functions.

They can also be accessed using the specified API functions. The following parameters are used:

- Private DRBG: AES-256 CTR_DRBG with derivation function. This DRBG is used to generate secret random values (e.g. during asymmetric key pair generation). It can be accessed using RAND_priv_bytes.
- Public DRBG: AES-256 CTR_DRBG with derivation function. This DRBG is used to generate general purpose random values that do not need to remain secret (e.g. initialization vectors). It can be accessed using RAND_bytes.

The public and private DRBGs are seeded with 384 bits of entropy and 256 bits of entropy are used to reseed each of the private and public DRBGs. The highest SSP security strength generated by the module is 256 bits. These DRBGs will always employ prediction resistance.

2.9 Key Generation

The module implements Cryptographic Key Generation (CKG, vendor affirmed), compliant with SP 800-133r2. When random values are required, they are obtained from the SP 800-90Ar1 approved DRBG, compliant with Section 4 of SP 800-133r2. This method does not use the value V as described in Additional Comment 2 of FIPS 140-3 IG D.H.

The following methods are implemented: Safe primes key pair generation, RSA key pair generation, ECC (ECDH and ECDSA) key pair generation.

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Intermediate key generation values are not output from the module and are explicitly zeroized after processing the service.

Additionally, the module implements the following key derivation methods: (KBKDF, KDA OneStep, KDA TwoStep, HKDF, ANS X9.42 KDF (CVL), ANS X9.63 KDF (CVL), SSH KDF (CVL), TLS 1.2 KDF (CVL), TLS 1.3 KDF (CVL), PBKDF2

All certificates can be found in the Approved Algorithms table.

2.10 Key Establishment

The module implements SSP transport and SSC methods as listed in the SFI table.

The module does not establish SSPs using an approved key agreement scheme (KAS). However, it does offer some or all of the underlying KAS cryptographic functionality to be used by an external operator/application as part of an approved KAS. The module provides Diffie-Hellman (DH) and Elliptic Curve Diffie-Hellman (ECDH) shared secret computation compliant with SP800-56Ar3, in accordance with scenario 2(1) of FIPS 140-3 IG D.F.

The module does not establish SSPs using an approved key transport scheme (KTS). However, it does offer approved authenticated algorithms that can be used by an external operator/application as part of an approved KTS. These are AES-CCM, AES-GCM, AES-KW, and AES-KWP.

2.11 Industry Protocols

The module implements the SSH KDF (CVL) for use in the SSH protocol (RFC 4253 and RFC 6668).

GCM with internal IV generation in the approved mode is compliant with versions 1.2 and 1.3 of the TLS protocol (RFC 5288 and 8446) and shall only be used in conjunction with the TLS protocol. Additionally, the module implements the TLS 1.2 and TLS 1.3 key derivation functions for use in the TLS protocol.

For Diffie-Hellman, the module supports the use of the safe primes defined in RFC 3526 (IKE) and RFC 7919 (TLS). Note that the module only implements key pair generation, key pair verification, and shared secret computation. No other part of the IKE or TLS protocols is implemented (with the exception of the TLS 1.2 KDF (CVL) and 1.3 KDF (CVL)):

- IKE (RFC 3526): MODP-2048 (ID = 14), MODP-3072 (ID = 15), MODP-4096 (ID = 16), MODP-6144 (ID = 17), MODP-8192 (ID = 18)
- TLS (RFC 7919): ffdhe2048 (ID = 256), ffdhe3072 (ID = 257), ffdhe4096 (ID = 258), ffdhe6144 (ID = 259), ffdhe8192 (ID = 260)

For Elliptic Curve Diffie-Hellman, the module supports the NIST-defined P-224, P-256, P-384, and P-521 curves.

No parts of the SSH, TLS, or IKE protocols, other than those mentioned above, have been tested by the CAVP or CMVP.

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3 Cryptographic Module Interfaces

3.1 Ports and Interfaces

Physical Port	Logical Interface(s)	Data That Passes
N/A	Data Input	API input parameters
N/A	Data Output	API output parameters
N/A	Control Input	API function calls
N/A	Status Output	API return codes, error queue

Table 12: Ports and Interfaces

As a software-only module, the module does not have physical ports. The module does not implement a control output interface.

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4 Roles, Services, and Authentication

4.1 Authentication Methods

N/A for this module.

4.2 Roles

Name	Type	Operator Type	Authentication Methods
Crypto Officer	Role	CO	None

Table 13: Roles

The module supports the Crypto Officer role only. This sole role is implicitly and always assumed by the operator of the module. No support is provided for a maintenance role. There are no concurrent operators.

4.3 Approved Services

Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
Message Digest	Compute a message digest	1	Message	Message digest	Message Digest with SHA Message Digest with SHAKE	Crypto Officer
Symmetric Encryption	Encrypt a plaintext	1	AES Key, plaintext, IV	Ciphertext	Encryption with AES	Crypto Officer - AES Key: W,E
Symmetric Decryption	Decrypt a ciphertext	1	AES Key, ciphertext, IV	Plaintext	Decryption with AES	Crypto Officer - AES Key: W,E
Authenticated Symmetric Encryption	Encrypt and authenticate a plaintext	1	AES Key, plaintext, IV	Ciphertext, MAC tag	Authenticated Encryption with AES	Crypto Officer - AES Key: W,E
Authenticated Symmetric Decryption	Decrypt and authenticate a ciphertext	1	AES Key, ciphertext, MAC tag, IV	Plaintext or Failure	Authenticated Decryption with AES	Crypto Officer - AES Key: W,E
AES Message Authentication Generation	Compute a MAC tag using AES	1	AES Key, message	MAC tag	Message Authentication Generation with AES	Crypto Officer - AES Key: W,E

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Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
HMAC Message Authentication Generation	Compute a MAC tag using HMAC	1	HMAC Key, message	MAC tag	Message Authentication Generation with HMAC	Crypto Officer - HMAC Key: W,E
KMAC Message Authentication Generation	Compute a MAC tag using KMAC	1	KMAC Key, message	MAC tag	Message Authentication with KMAC	Crypto Officer - KMAC Key: W,E
TLS KDF Key Derivation	TLS key derivation	1	Shared Secret	TLS Derived Key	Key Derivation with TLS 1.2 KDF Key Derivation with TLS 1.3 KDF	Crypto Officer - Shared Secret: W,E - TLS Derived Key: G,R
KBKDF Key Derivation	Derive a key from a key-derivation key	1	Key-Derivation Key	KBKDF Derived Key	Key Derivation with KBKDF	Crypto Officer - Key-Derivation Key: W,E - KBKDF Derived Key: G,R
ANS X9.42 Key Derivation	Derive a key from a shared secret	1	Shared Secret	ANS X9.42 Derived Key	Key Derivation with ANS X9.42 KDF	Crypto Officer - ANS X9.42 Derived Key: G,R - Shared Secret: W,E
ANS X9.63 Key Derivation	Derive a key from a shared secret	1	Shared Secret	ANS X9.63 Derived Key	Key Derivation with X9.63 KDF	Crypto Officer - Shared Secret: W,E - ANS X9.63 Derived Key: G,R
HKDF Key Derivation	Derive a key from a shared secret	1	Shared Secret	HKDF Derived key	Key Derivation with KDA HKDF	Crypto Officer - Shared Secret: W,E - HKDF Derived Key: G,R
OneStep KDA Key Derivation	Derive a key from a shared secret	1	Shared Secret	KDA OneStep Derived Key	Key Derivation with KDA OneStep	Crypto Officer - Shared Secret: W,E - KDA

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Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
						OneStep Derived Key: G,R
TwoStep KDA Key Derivation	Derive a key from a shared secret	1	Shared Secret	KDA TwoStep Derived Key	Key Derivation with KDA TwoStep	Crypto Officer - Shared Secret: W,E - KDA TwoStep Derived Key: G,R
SSH KDF key derivation	Derive a key from a shared secret	1	Shared Secret	SSH KDF Derived Key	Key Derivation with SSH KDF	Crypto Officer - Shared Secret: W,E - SSH KDF Derived Key: G,R
PBKDF Key Derivation	Derive a key from a password	1	Password	PBKDF Derived Key	Key Derivation with PBKDF2	Crypto Officer - Password: W,E - PBKDF Derived Key: G,R
Random Number Generation	Generate random number	1	Number of bits	Random number	Random Number Generation with DRBG	Crypto Officer - Entropy Input: W,E - DRBG Seed: G,E - DRBG Internal State (V, Key): G,W,E - DRBG Internal State (V, C): G,W,E
KAS-FFC-SSC Shared Secret Computation	Compute a shared secret	1	DH Private Key (owner), DH Public Key (peer)	Shared Secret	Shared Secret Computation	Crypto Officer - Shared Secret: G,R - DH Private Key: W,E - DH Public Key: W,E

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Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
KAS-ECC-SSC Shared Secret Computation	Compute a shared secret	1	EC Private Key (owner), EC Public Key (peer)	Shared Secret	Shared Secret Computation	Crypto Officer - Shared Secret: G,R - EC Private Key: W,E - EC Public Key: W,E
RSA Digital Signature Generation	Generate a digital signature with RSA	1	RSA Private Key, message, hash algorithm	Signature	Signature Generation with RSA	Crypto Officer - RSA Private Key: W,E
ECDSA Digital Signature Generation	Generate a digital signature with ECDSA	1	EC Private Key, message, hash algorithm	Signature	Signature Generation with ECDSA	Crypto Officer - EC Private Key: W,E
RSA Digital Signature Verification	Verify a digital signature using RSA	1	RSA Public Key, message, signature, hash algorithm	Pass or Fail	Legacy Signature Verification with RSA Signature Verification with RSA	Crypto Officer - RSA Public Key: W,E
ECDSA Digital Signature Verification	Verify a digital signature using ECDSA	1	EC Public Key, message, signature, hash algorithm	Pass or Fail	Legacy Signature Verification with ECDSA Signature Verification with ECDSA	Crypto Officer - EC Public Key: W,E
RSA Key Pair Generation	Generate an RSA key pair	1	Modulus bits	Module Generated RSA Private Key, Module Generated RSA Public Key	Key Pair Generation with RSA	Crypto Officer - Module Generated RSA Private Key: G,R - Module Generated RSA Public Key: G,R - Intermediate Key Generation Value: G,E,Z

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Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
ECDSA Key Pair Generation	Generate an EC key pair	1	Curve	Module Generated EC Private Key, Module Generated EC Public Key	Key Pair Generation with ECDSA	Crypto Officer - Module Generated EC Private Key: G,R - Module Generated EC Public Key: G,R - Intermediate Key Generation Value: G,E,Z
Safe Primes Key Pair Generation	Generate an DH key pair	1	Group	Module Generated DH Private Key, Module Generated DH Public Key	Key Pair Generation with Safe Primes	Crypto Officer - Module Generated DH Private Key: G,R - Module Generated DH Public Key: G,R - Intermediate Key Generation Value: G,E,Z
ECDSA Key Pair Verification	Verify an EC key pair	1	EC Private Key, EC Public Key	Pass or Fail	Key Pair Verification with ECDSA Legacy Key Pair Verification with ECDSA	Crypto Officer - EC Private Key: W,E - EC Public Key: W,E
Safe Prime Key Pair Verification	Verify a DH key pair	1	DH Private Key, DH Public Key	Pass or Fail	Key Pair Verification with Safe Primes	Crypto Officer - DH Private Key: W,E - DH Public Key: W,E
Show Version	Return the name and version information	1	None	Module name and version	None	Crypto Officer

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Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
Show Status	Return the module status	1	None	Module status	None	Crypto Officer
Self-Test	Perform the CASTs and integrity test	1	None	Pass or Fail of self-tests	None	Crypto Officer
Zeroization	Zeroize any SSP	1	An SSP	None	None	Crypto Officer - AES Key: Z - HMAC Key: Z - KMAC Key: Z - Key-Derivation Key: Z - Shared Secret: Z - Password: Z - PBKDF Derived Key: Z - KBKDF Derived Key: Z - ANS X9.42 Derived Key: Z - ANS X9.63 Derived Key: Z - HKDF Derived Key: Z - KDA OneStep Derived Key: Z - KDA TwoStep Derived Key: Z - TLS Derived Key: Z - SSH KDF Derived Key: Z - Entropy

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Name	Description	Indicator	Inputs	Outputs	Security Functions	SSP Access
						Input: Z - DRBG Internal State (V, Key): Z - DRBG Seed: Z - DH Private Key: Z - DH Public Key: Z - EC Private Key: Z - EC Public Key: Z - RSA Private Key: Z - RSA Public Key: Z - Module Generated DH Private Key: Z - Module Generated DH Public Key: Z - Module Generated EC Private Key: Z - Module Generated EC Public Key: - Module Generated RSA Private Key: Z - Module Generated RSA Public Key: Z

Table 14: Approved Services

The module provides services to operators that assume the available role. All services are described in detail in the API documentation (manual pages). The Approved Services table and the Non-Approved Services table define the services that utilize approved and non-approved security functions in this module. For the respective tables, the convention below applies when specifying the access permissions (types) that the service has for each SSP.

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- **Generate (G):** The module generates or derives the SSP.
- **Read (R):** The SSP is read from the module (e.g., the SSP is output).
- **Write (W):** The SSP is updated, imported, or written to the module.
- **Execute(E):** The module uses the SSP in performing a cryptographic operation.
- **Zeroize (Z):** The module zeroizes the SSP.

To interact with the module, a calling application must use the EVP API layer provided by OpenSSL. This layer will delegate the request to the FIPS provider, which will in turn perform the requested service. Additionally, this EVP API layer can be used to retrieve the approved service indicator for the module. The ibm_ossl_query_fipsindicator() function indicates initially whether a given service is approved. After a cryptographic service was performed by the module, the API context (listed in the left column of Table 15) associated with this request can contain a parameter (listed in the right column of Table 15) which represents the approved service indicator.

Context	Service Indicator
EVP_CIPHER_CTX	OSSL_CIPHER_PARAM_IBMCOS_FIPS_INDICATOR
EVP_MAC_CTX	OSSL_MAC_PARAM_IBMCOS_FIPS_INDICATOR
EVP_KDF_CTX	OSSL_KDF_PARAM_IBMCOS_FIPS_INDICATOR
EVP_PKEY_CTX	OSSL_SIGNATURE_PARAM_IBMCOS_FIPS_INDICATOR
EVP_PKEY_CTX	OSSL_ASYM_CIPHER_PARAM_IBMCOS_FIPS_INDICATOR
EVP_MD_CTX	OSSL_DIGEST_PARAM_IBMCOS_FIPS_INDICATOR

Table 15: Service Indicator Parameters

4.4 Non-Approved Services

Name	Description	Algorithms	Role
Encryption	AES GCM (external IV)	AES GCM (external IV)	Crypto Officer
Key Pair Generation	Key pair generation	DSA ECDSA with curve P-192, B-163, K-163	Crypto Officer
Key Pair Verification	Key pair verification	DSA ECDSA with curve P-192, B-163, K-163	Crypto Officer
Signature Generation	Signature generation	DSA ECDSA with curve P-192, B-163, K-163 RSA X9.31	Crypto Officer
Signature Verification	Signature verification	DSA ECDSA (pre-hashed message) RSA X9.31	Crypto Officer
Asymmetric Encryption	Asymmetric encryption	RSA primitive RSA-OAEP	Crypto Officer

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Name	Description	Algorithms	Role
Asymmetric Decryption	Asymmetric decryption	RSA primitive RSA-OAEP	Crypto Officer
Secret Value Encapsulation	Secret value encapsulation	RSASVE	Crypto Officer
Secret Value Un-encapsulation	Secret value un-encapsulation	RSASVE	Crypto Officer

Table 16: Non-Approved Services

4.5 External Software/Firmware Loaded

The module does not load external software or firmware.

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5 Software/Firmware Security

5.1 Integrity Techniques

The integrity of the module is verified by comparing a HMAC-SHA2-256 value calculated at run time with the HMAC-SHA2-256 value embedded in the fips.so file that was computed at build time. The key used for the HMAC calculation is contained within the module.

5.2 Initiate on Demand

Integrity tests are performed as part of the pre-operational self-tests, which are executed when the module is initialized. The integrity test may be invoked on-demand by unloading and subsequently re-initializing the module, or by calling the OSSL_PROVIDER_self_test function. This will perform (among others) the software integrity test.

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6 Operational Environment

6.1 Operational Environment Type and Requirements

Type of Operational Environment: Modifiable

How Requirements are Satisfied:

The module shall be installed as stated in Section 11. If properly installed, the operating system provides process isolation and memory protection mechanisms that ensure appropriate separation for memory access among the processes on the system. Each process has control over its own data and uncontrolled access to the data of other processes is prevented.

6.2 Configuration Settings and Restrictions

Instrumentation tools like the ptrace system call, gdb and strace, userspace live patching, as well as other tracing mechanisms offered by the Linux environment such as ftrace or systemtap, shall not be used in the operational environment. The use of any of these tools implies that the cryptographic module is running in a non-validated operational environment.

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7 Physical Security

The module is comprised of software only, and therefore this section is not applicable.

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8 Non-Invasive Security

8.1 Mitigation Techniques

This module does not implement any non-invasive security mechanism, and therefore this section is not applicable.

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9 Sensitive Security Parameters Management

9.1 Storage Areas

Storage Area Name	Description	Persistence Type
RAM	Temporary storage for SSPs used by the module as part of service execution. The module does not perform persistent storage of SSPs.	Dynamic

Table 17: Storage Areas

SSPs are provided to the module by the calling application and are destroyed when released by the appropriate API function calls. The module does not perform persistent storage of SSPs.

9.2 SSP Input-Output Methods

Name	From	To	Format Type	Distribution Type	Entry Type	SFI or Algorithm
API input parameters	Operator calling application (TOEPP)	Cryptographic module	Plaintext	Manual	Electronic	
API output parameters	Cryptographic module	Operator calling application (TOEPP)	Plaintext	Manual	Electronic	

Table 18: SSP Input-Output Methods

The module only supports SSP entry and output to and from the calling application running on the same operational environment. This corresponds to manual distribution, electronic entry/output (“CM Software to/from App via TOEPP Path”) per FIPS 140-3 IG 9.5.A Table 1. There is no entry or output of cryptographically protected SSPs.

9.3 SSP Zeroization Methods

Zeroization Method	Description	Rationale	Operator Initiation
Free cipher handle	Zeroizes the SSPs contained within the cipher handle: EVP_CIPHER_CTX_free() clears and frees symmetric cipher context, EVP_MAC_CTX_free() clears and frees MAC context, EVP_KDF_CTX_free() clears and frees KDF context, EVP_RAND_CTX_free() clears and frees DRBG context, EVP_PKEY_free() clears and frees asymmetric key pair structures	Memory occupied by SSPs is overwritten with zeroes and then it is released, which renders the SSP values irretrievable. The completion of the zeroization routine indicates that the zeroization procedure succeeded.	By calling the cipher related zeroization API

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Zeroization Method	Description	Rationale	Operator Initiation
Automatic	Automatically zeroized by the module when no longer needed	Memory occupied by SSPs is overwritten with zeroes, which renders the SSP values irretrievable.	N/A
Module reset	De-allocates the volatile memory used to store SSPs	Volatile memory used by the module is overwritten within nanoseconds when power is removed.	By unloading and reloading the module

Table 19: SSP Zeroization Methods

9.4 SSPs

Name	Description	Size - Strength	Type - Category	Generated By	Established By	Used By
AES Key	Used for encryption, decryption, and message authentication	128, 192, 256 bits - 128, 192, 256 bits	Symmetric key - CSP			Encryption with AES Decryption with AES Authenticated Encryption with AES Authenticated Decryption with AES Message Authentication Generation with AES
HMAC Key	Used for hash-based message authentication	112-524288 bits - 112-256 bits	Symmetric key - CSP			Message Authentication Generation with HMAC
KMAC Key	Used for message authentication	128-1024 bits - 112-256 bits	Symmetric key - CSP			Message Authentication with KMAC
Key-Derivation Key	Used for key derivation	112-4096 bits - 112-256 bits	Symmetric key - CSP			Key Derivation with KBKDF
Shared Secret	Generated by shared secret computation and used for key derivation	224-8192 bits - 112-256 bits	Shared secret - CSP		Shared Secret Computation	Key Derivation with KDA OneStep Key Derivation

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Name	Description	Size - Strength	Type - Category	Generated By	Established By	Used By
						with KDA TwoStep Key Derivation with KDA HKDF Key Derivation with ANS X9.42 KDF Key Derivation with X9.63 KDF Key Derivation with SSH KDF Key Derivation with TLS 1.2 KDF Key Derivation with TLS 1.3 KDF
Password	Used for password-based key derivation	At least 8 characters - N/A	Password - CSP			Key Derivation with PBKDF2
PBKDF Derived Key	Generated by password-based key derivation	112-4096 bits - 112-256 bits	Symmetric key - CSP	Key Derivation with PBKDF2		
KBKDF Derived Key	Generated by key-based key derivation	112-4096 bits - 112-256 bits	Symmetric key - CSP	Key Derivation with KBKDF		
ANS X9.42 Derived Key	Generated by ANS X9.42 key derivation	128-4096 bits - 112-256 bits	Symmetric key - CSP	Key Derivation with ANS X9.42 KDF		
ANS X9.63 Derived Key	Generated by ANS X9.63 key derivation	128-4096 bits - 112-256 bits	Symmetric key - CSP	Key Derivation with X9.63 KDF		
HKDF Derived Key	Generated by HKDF key derivation	224-8192 bits - 112-256 bits	Symmetric key - CSP	Key Derivation with KDA HKDF		

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Name	Description	Size - Strength	Type - Category	Generated By	Established By	Used By
KDA OneStep Derived Key	Generated by OneStep KDA key derivation	2048 bits - 112-256 bits	Symmetric key - CSP	Key Derivation with KDA OneStep		
KDA TwoStep Derived Key	Generated by TwoStep KDA key derivation	2048 bits - 112-256 bits	Symmetric key - CSP	Key Derivation with KDA TwoStep		
TLS Derived Key	Generated by TLS KDF key derivation	112-1024 bits - 112-256 bits	Symmetric key - CSP	Key Derivation with TLS 1.2 KDF Key Derivation with TLS 1.3 KDF		
SSH KDF Derived Key	Generated by SSH KDF key derivation	112-256 bits - 112-256 bits	Symmetric key - CSP	Key Derivation with SSH KDF		
Entropy Input	Used for random number generation and seeding a DRBG (compliant with IG D.L)	128-384 bits - 128-256 bits	Entropy input - CSP			Random Number Generation with DRBG
DRBG Internal State (V, Key)	Used for random number generation (compliant with IG D.L)	Counter DRBG: 256, 320, 348 bits; HMAC DRBG: 320, 512, 1024 bits - Counter DRBG: 128, 192, 256 bits; HMAC DRBG: 128, 256 bits	Internal state - CSP	Random Number Generation with DRBG		Random Number Generation with DRBG
DRBG Internal State (V, C)	Used for random number generation (compliant with IG D.L)	880, 1776 bits - 128, 256 bits	Internal state - CSP	Random Number Generation with DRBG		Random Number Generation with DRBG
DRBG Seed	Used for random	CTR-DRBG: 256, 320,	Seed - CSP	Random Number		Random Number

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Name	Description	Size - Strength	Type - Category	Generated By	Established By	Used By
	number generation (compliant with IG D.L)	384 bits; HMAC/Hash-DRBG: 440, 888 bits - CTR-DRBG: 128, 192, 256 bits ; HMAC/Hash-DRBG: 256 bits		Generation with DRBG		Generation with DRBG
DH Private Key	Used for shared secret computation and key pair verification	2048-8192 bits - 112-200 bits	Private key - CSP			Key Pair Verification with Safe Primes Shared Secret Computation
DH Public Key	Used for shared secret computation and key pair verification	2048-8192 bits - 112-200 bits	Public key - PSP			Key Pair Verification with Safe Primes Shared Secret Computation
EC Private Key	Used for shared secret computation, digital signature generation, and key pair verification	P-224, P-256, P-384, P-521, K-233, K-283, K-409, K-571, B-233, B-283, B-409, B-571 bits - 112-256 bits	Private key - CSP			Signature Generation with ECDSA Key Pair Verification with ECDSA Shared Secret Computation
EC Public Key	Used for shared secret computation, signature verification, and key pair verification	P-192, P-224, P-256, P-384, P-521, K-163, K-233, K-283, K-409, K-571, B-163, B-233, B-283, B-409, B-571 bits - 80-256 bits	Public key - PSP			Signature Verification with ECDSA Key Pair Verification with ECDSA Shared Secret Computation

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Name	Description	Size - Strength	Type - Category	Generated By	Established By	Used By
RSA Private Key	Used for signature generation	2048-16384 bits - 112-256 bits	Private key - CSP			Signature Generation with RSA
RSA Public Key	Used for signature verification	1024-16384 bits - 80-256 bits	Public key - PSP			Signature Verification with RSA
Module Generated DH Private Key	DH private key generated by the module	2048-8192 bits - 112-200 bits	Private key - CSP	Key Pair Generation with Safe Primes		
Module Generated DH Public Key	DH public key generated by the module	2048-8192 bits - 112-200 bits	Public key - PSP	Key Pair Generation with Safe Primes		
Module Generated EC Private Key	EC private key generated by the module	P-224, P-256, P-384, P-521, K-233, K-283, K-409, K-571, B-233, B-283, B-409, B-571 bits - 112-256 bits	Private key - CSP	Key Pair Generation with ECDSA		
Module Generated EC Public Key	EC public key generated by the module	P-224, P-256, P-384, P-521, K-163, K-233, K-283, K-409, K-571, B-163, B-233, B-283, B-409, B-571 bits - 112-256 bits	Public key - PSP	Key Pair Generation with ECDSA		
Module Generated RSA Private Key	RSA private key generated by the module	2048-16384 bits - 112-256 bits	Private key - CSP	Key Pair Generation with RSA		
Module Generated RSA Public Key	RSA public key generated by the module	2048-16384 bits - 112-256 bits	Public key - PSP	Key Pair Generation with RSA		

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Name	Description	Size - Strength	Type - Category	Generated By	Established By	Used By
Intermediate Key Generation Value	Used for key pair generation	224-16384 bits - 112-256 bits	Intermediate value - CSP	Key Pair Generation with ECDSA Key Pair Generation with RSA Key Pair Generation with Safe Primes		Key Pair Generation with ECDSA Key Pair Generation with RSA Key Pair Generation with Safe Primes

Table 20: SSP Table 1

Name	Input - Output	Storage	Storage Duration	Zeroization	Related SSPs
AES Key	API input parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	
HMAC Key	API input parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	
KMAC Key	API input parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	
Key-Derivation Key	API input parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	KBKDF Derived Key:Derives
Shared Secret	API input parameters API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	DH Private Key:Generated From DH Public Key:Generated From EC Private Key:Generated From EC Public Key:Generated From
Password	API input parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	PBKDF Derived Key:Derives

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Name	Input - Output	Storage	Storage Duration	Zeroization	Related SSPs
PBKDF Derived Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Password:Derived From
KBKDF Derived Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Key-Derivation Key:Derived From
ANS X9.42 Derived Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Shared Secret:Derived From
ANS X9.63 Derived Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Shared Secret:Derived From
HKDF Derived Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Shared Secret:Derived From
KDA OneStep Derived Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Shared Secret:Derived From
KDA TwoStep Derived Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Shared Secret:Derived From
TLS Derived Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Shared Secret:Derived From
SSH KDF Derived Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Shared Secret:Derived From
Entropy Input		RAM:Plaintext	From service invocation to service completion	Automatic	DRBG Seed:Generates
DRBG Internal State (V, Key)		RAM:Plaintext	From DRBG instantiation to un-instantiation or internal zeroization	Free cipher handle Module reset	DRBG Seed:Generated From

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Name	Input - Output	Storage	Storage Duration	Zeroization	Related SSPs
DRBG Internal State (V, C)		RAM:Plaintext	From DRBG instantiation to un-instantiation or internal zeroization	Free cipher handle Module reset	DRBG Seed:Generated From
DRBG Seed		RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	DRBG Internal State (V, Key):Generates DRBG Internal State (V, C):Generates Entropy Input:Generated From
DH Private Key	API input parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	DH Public Key:Paired With Shared Secret:Derives
DH Public Key	API input parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	DH Private Key:Paired With Shared Secret:Generates
EC Private Key	API input parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	EC Public Key:Paired With Shared Secret:Generates
EC Public Key	API input parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	EC Private Key:Paired With Shared Secret:Generates
RSA Private Key	API input parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	RSA Public Key:Paired With
RSA Public Key	API input parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	RSA Private Key:Paired With
Module Generated DH Private Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Module Generated DH Public Key:Paired With Intermediate Key Generation Value:Generated From
Module Generated DH Public Key	API output parameters	RAM:Plaintext	From service invocation to	Free cipher handle Module reset	Module Generated DH Private Key:Paired With

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Name	Input - Output	Storage	Storage Duration	Zeroization	Related SSPs
			service completion		Intermediate Key Generation Value:Generated From
Module Generated EC Private Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Module Generated EC Public Key:Paired With Intermediate Key Generation Value:Generated From
Module Generated EC Public Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Module Generated EC Private Key:Paired With Intermediate Key Generation Value:Generated From
Module Generated RSA Private Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Module Generated RSA Public Key:Paired With Intermediate Key Generation Value:Generated From
Module Generated RSA Public Key	API output parameters	RAM:Plaintext	From service invocation to service completion	Free cipher handle Module reset	Module Generated RSA Private Key:Paired With Intermediate Key Generation Value:Generated From
Intermediate Key Generation Value		RAM:Plaintext	From service invocation to service completion	Automatic	Module Generated DH Private Key:Generates Module Generated DH Public Key:Generates Module Generated EC Private Key:Generates Module Generated EC Public Key:Generates Module Generated RSA Private Key:Generates Module Generated

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Name	Input - Output	Storage	Storage Duration	Zeroization	Related SSPs
					RSA Public Key:Generates

Table 21: SSP Table 2

The tables above summarize the Sensitive Security Parameters (SSPs) that are used by the cryptographic services implemented in the module in the approved services (Approved Services table).

SSPs, including CSPs, are directly imported as input parameters and exported as output parameters from the module. Because these SSPs are only transiently used for a specific service, they are, by definition, exclusive between approved and non-approved services.

9.5 Transitions

The SHA-1 algorithm, as implemented by the module, will be non-approved for all purposes starting January 1, 2031.

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10 Self-Tests

10.1 Pre-Operational Self-Tests

Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details
HMAC-SHA2-256 (A6901)	256-bit key	Message Authentication	SW/FW Integrity	Module becomes operational and services are available for use	Integrity test for fips.so
HMAC-SHA2-256 (A6902)	256-bit key	Message Authentication	SW/FW Integrity	Module becomes operational and services are available for use	Integrity test for fips.so
HMAC-SHA2-256 (A6903)	256-bit key	Message Authentication	SW/FW Integrity	Module becomes operational and services are available for use	Integrity test for fips.so
HMAC-SHA2-256 (A6904)	256-bit key	Message Authentication	SW/FW Integrity	Module becomes operational and services are available for use	Integrity test for fips.so
HMAC-SHA2-256 (A6909)	256-bit key	Message Authentication	SW/FW Integrity	Module becomes operational and services are available for use	Integrity test for fips.so

Table 22: Pre-Operational Self-Tests

The module performs pre-operational tests automatically when the module is powered on. The pre-operational self-tests ensure that the module is not corrupted. The module transitions to the operational state only after the pre-operational self-tests are passed successfully.

If the software integrity test fails, the module transitions to the error state (Section 10.3). The HMAC and SHA2-256 algorithms go through their respective CASTs before the software integrity test is performed.

10.2 Conditional Self-Tests

Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
SHA-1 (A6901)	SHA-1	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA-1 (A6902)	SHA-1	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
SHA-1 (A6903)	SHA-1	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA-1 (A6904)	SHA-1	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA-1 (A6909)	SHA-1	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA2-256 (A6901)	SHA2-256	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA2-256 (A6902)	SHA2-256	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA2-256 (A6903)	SHA2-256	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA2-256 (A6904)	SHA2-256	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA2-256 (A6909)	SHA2-256	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA2-512 (A6901)	SHA2-512	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA2-512 (A6902)	SHA2-512	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA2-512 (A6903)	SHA2-512	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA2-512 (A6904)	SHA2-512	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
						before the integrity test
SHA2-512 (A6909)	SHA2-512	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
SHA3-256 (A6910)	SHA3-256	KAT	CAST	Module becomes operational	Message digest	Test runs at power-on before the integrity test
HMAC-SHA2-256 (A6901)	SHA-256	KAT	CAST	Module becomes operational	Message authentication	Test runs at power-on before the integrity test
HMAC-SHA2-256 (A6902)	SHA-256	KAT	CAST	Module becomes operational	Message authentication	Test runs at power-on before the integrity test
HMAC-SHA2-256 (A6903)	SHA-256	KAT	CAST	Module becomes operational	Message authentication	Test runs at power-on before the integrity test
HMAC-SHA2-256 (A6904)	SHA-256	KAT	CAST	Module becomes operational	Message authentication	Test runs at power-on before the integrity test
HMAC-SHA2-256 (A6909)	SHA-256	KAT	CAST	Module becomes operational	Message authentication	Test runs at power-on before the integrity test
HMAC-SHA3-256 (A6910)	SHA3-256	KAT	CAST	Module becomes operational	Message authentication	Test runs at power-on before the integrity test
AES-CBC (A6907)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-CBC (A6911)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-CBC (A6912)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
AES-CCM (A6907)	128, 192, 256-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-CCM (A6911)	128, 192, 256-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-CCM (A6912)	128, 192, 256-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-CMAC (A6907)	128, 256-bit keys, generation	KAT	CAST	Module becomes operational	Message authentication	Test runs at power-on before the integrity test
AES-CMAC (A6911)	128, 256-bit keys, generation	KAT	CAST	Module becomes operational	Message authentication	Test runs at power-on before the integrity test
AES-CMAC (A6912)	128, 256-bit keys, generation	KAT	CAST	Module becomes operational	Message authentication	Test runs at power-on before the integrity test
AES-KW (A6907)	128, 256-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-KW (A6911)	128, 256-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-KW (A6912)	128, 256-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-KWP (A6907)	128, 256-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-KWP (A6911)	128, 256-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-KWP (A6912)	128, 256-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
						before the integrity test
AES-GCM (A6895)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-GCM (A6896)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-GCM (A6897)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-GCM (A6898)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-GCM (A6899)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-GCM (A6900)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-GCM (A6908)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-GCM (A6913)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-GCM (A6914)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-ECB (A6907)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
AES-ECB (A6911)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
AES-ECB (A6912)	128-bit keys, encrypt	KAT	CAST	Module becomes operational	Symmetric operation	Test runs at power-on before the integrity test
KDF SP800-108 (A6906)	Counter mode; HMAC-SHA-256; 128-bit input key	KAT	CAST	Module becomes operational	Key based key derivation	Test runs at power-on before the integrity test
KDA TwoStep SP800-56Cr2 (A6915)	HMAC-SHA2-256, 48-bit input secret	KAT	CAST	Module becomes operational	Password-based key derivation	Test runs at power-on before the integrity test
KDA OneStep SP800-56Cr2 (A6915)	SHA-224; 392-bit input secret	KAT	CAST	Module becomes operational	Shared secret key derivation	Test runs at power-on before the integrity test
KDF SSH (A6901)	SHA-1; 1056-bit input secret	KAT	CAST	Module becomes operational	Industry-based SSH KDF key derivation	Test runs at power-on before the integrity test
KDF SSH (A6902)	SHA-1; 1056-bit input secret	KAT	CAST	Module becomes operational	Industry-based SSH KDF key derivation	Test runs at power-on before the integrity test
KDF SSH (A6903)	SHA-1; 1056-bit input secret	KAT	CAST	Module becomes operational	Industry-based SSH KDF key derivation	Test runs at power-on before the integrity test
KDF SSH (A6904)	SHA-1; 1056-bit input secret	KAT	CAST	Module becomes operational	Industry-based SSH KDF key derivation	Test runs at power-on before the integrity test
KDF SSH (A6909)	SHA-1; 1056-bit input secret	KAT	CAST	Module becomes operational	Industry-based SSH KDF key derivation	Test runs at power-on before the integrity test
TLS v1.2 KDF RFC7627 (A6901)	SHA-256; 384-bit input secret	KAT	CAST	Module becomes operational	Industry-based TLS v1.2 KDF key derivation	Test runs at power-on before the integrity test
TLS v1.2 KDF RFC7627 (A6902)	SHA-256; 384-bit input secret	KAT	CAST	Module becomes operational	Industry-based TLS v1.2 KDF key derivation	Test runs at power-on before the integrity test
TLS v1.2 KDF RFC7627 (A6903)	SHA-256; 384-bit input secret	KAT	CAST	Module becomes operational	Industry-based TLS v1.2 KDF key derivation	Test runs at power-on

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
						before the integrity test
TLS v1.2 KDF RFC7627 (A6904)	SHA-256; 384-bit input secret	KAT	CAST	Module becomes operational	Industry-based TLS v1.2 KDF key derivation	Test runs at power-on before the integrity test
TLS v1.2 KDF RFC7627 (A6909)	SHA-256; 384-bit input secret	KAT	CAST	Module becomes operational	Industry-based TLS v1.2 KDF key derivation	Test runs at power-on before the integrity test
TLS v1.3 KDF (A6918)	Extract and expand modes; SHA-256	KAT	CAST	Module becomes operational	Industry-based TLS v1.3 KDF key derivation	Test runs at power-on before the integrity test
PBKDF (A6901)	SHA-256; 24 character password; 288-bit salt; Iteration count: 4096	KAT	CAST	Module becomes operational	Password-based key derivation	Test runs at power-on before the integrity test
PBKDF (A6902)	SHA-256; 24 character password; 288-bit salt; Iteration count: 4096	KAT	CAST	Module becomes operational	Password-based key derivation	Test runs at power-on before the integrity test
PBKDF (A6903)	SHA-256; 24 character password; 288-bit salt; Iteration count: 4096	KAT	CAST	Module becomes operational	Password-based key derivation	Test runs at power-on before the integrity test
PBKDF (A6904)	SHA-256; 24 character password; 288-bit salt; Iteration count: 4096	KAT	CAST	Module becomes operational	Password-based key derivation	Test runs at power-on before the integrity test
PBKDF (A6909)	SHA-256; 24 character password; 288-bit salt; Iteration count: 4096	KAT	CAST	Module becomes operational	Password-based key derivation	Test runs at power-on before the integrity test
PBKDF (A6910)	SHA-256; 24 character password; 288-bit salt;	KAT	CAST	Module becomes operational	Password-based key derivation	Test runs at power-on before the integrity test

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
	Iteration count: 4096					
Counter DRBG (A6905)	AES-128 with prediction resistance	KAT	CAST	Module becomes operational	Compliant with SP 800-90Ar1	Test runs at power-on before the integrity test
KDA HKDF SP800-56Cr2 (A5863)	SHA2-256 and 48-bit secret	KAT	CAST	Module becomes operational	Shared secret key derivation	Test runs at power-on before the integrity test
Hash DRBG (A6905)	SHA-256 with prediction resistance	KAT	CAST	Module becomes operational	Compliant with SP 800-90Ar1	Test runs at power-on before the integrity test
HMAC DRBG (A6905)	HMAC-SHA-256 with prediction resistance	KAT	CAST	Module becomes operational	Compliant with SP 800-90Ar1	Test runs at power-on before the integrity test
KAS-FFC-SSC Sp800-56Ar3 (A6919)	ffdhe2048	PCT	CAST	Module becomes operational	Shared secret computation	Test runs at power-on before the integrity test
KAS-ECC-SSC Sp800-56Ar3 (A6901)	P-256	KAT	CAST	Module becomes operational	Shared secret computation	Test runs at power-on before the integrity test
KAS-ECC-SSC Sp800-56Ar3 (A6902)	P-256	KAT	CAST	Module becomes operational	Shared secret computation	Test runs at power-on before the integrity test
KAS-ECC-SSC Sp800-56Ar3 (A6903)	P-256	KAT	CAST	Module becomes operational	Shared secret computation	Test runs at power-on before the integrity test
KAS-ECC-SSC Sp800-56Ar3 (A6904)	P-256	KAT	CAST	Module becomes operational	Shared secret computation	Test runs at power-on before the integrity test
KAS-ECC-SSC Sp800-56Ar3 (A6909)	P-256	KAT	CAST	Module becomes operational	Shared secret computation	Test runs at power-on before the integrity test
RSA KeyGen (FIPS186-5) (A6901)	N/A	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
RSA KeyGen (FIPS186-5) (A6902)	N/A	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation
RSA KeyGen (FIPS186-5) (A6903)	N/A	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation
RSA KeyGen (FIPS186-5) (A6904)	N/A	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation
RSA KeyGen (FIPS186-5) (A6909)	N/A	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation
RSA SigGen (FIPS186-5) (A6901)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
RSA SigGen (FIPS186-5) (A6902)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
RSA SigGen (FIPS186-5) (A6903)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
RSA SigGen (FIPS186-5) (A6904)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
RSA SigGen (FIPS186-5) (A6909)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
RSA SigGen (FIPS186-5) (A6910)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
RSA SigVer (FIPS186-5) (A6901)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
RSA SigVer (FIPS186-5) (A6902)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
RSA SigVer (FIPS186-5) (A6903)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
						before the integrity test
RSA SigVer (FIPS186-5) (A6904)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
RSA SigVer (FIPS186-5) (A6909)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
RSA SigVer (FIPS186-5) (A6910)	PKCS#1 v1.5 with SHA-256; 2048-bit key	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
ECDSA KeyGen (FIPS186-5) (A6901)	SHA2-256	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation
ECDSA KeyGen (FIPS186-5) (A6902)	SHA2-256	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation
ECDSA KeyGen (FIPS186-5) (A6903)	SHA2-256	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation
ECDSA KeyGen (FIPS186-5) (A6904)	SHA2-256	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation
ECDSA KeyGen (FIPS186-5) (A6909)	SHA2-256	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation
ECDSA KeyGen (FIPS186-5) (A6916)	SHA2-256	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation
ECDSA SigGen (FIPS186-5) (A6901)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
ECDSA SigGen (FIPS186-5) (A6902)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
ECDSA SigGen (FIPS186-5) (A6903)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
ECDSA SigGen (FIPS186-5) (A6904)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
ECDSA SigGen (FIPS186-5) (A6909)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
ECDSA SigGen (FIPS186-5) (A6910)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
ECDSA SigGen (FIPS186-5) (A6916)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
ECDSA SigGen (FIPS186-5) (A6917)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature generation	Test runs at power-on before the integrity test
ECDSA SigVer (FIPS186-4) (A6901)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
ECDSA SigVer (FIPS186-4) (A6902)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
ECDSA SigVer (FIPS186-4) (A6903)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
ECDSA SigVer (FIPS186-4) (A6904)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
ECDSA SigVer (FIPS186-4) (A6909)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
ECDSA SigVer	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
(FIPS186-4) (A6910)						before the integrity test
ECDSA SigVer (FIPS186-4) (A6916)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
ECDSA SigVer (FIPS186-4) (A6917)	SHA-256; P-224, P-256, P-384, P-521	KAT	CAST	Module becomes operational	Digital signature verification	Test runs at power-on before the integrity test
Safe Primes Key Generation (A6919)	N/A	PCT	PCT	Successful key pair generation	Signature generation & verification	Key pair generation
Safe Primes Key Verification (A6919)	N/A	KAT	CAST	Module becomes operational	SP 800-56A Rev. 3 Section 5.6.2.1.4	Test runs at power-on before the integrity test
KDF ANS 9.63 (A6901)	SHA-256; 192-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test
KDF ANS 9.63 (A6902)	SHA-256; 192-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test
KDF ANS 9.63 (A6903)	SHA-256; 192-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test
KDF ANS 9.63 (A6904)	SHA-256; 192-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test
KDF ANS 9.63 (A6909)	SHA-256; 192-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test
KDF ANS 9.63 (A6910)	SHA-256; 192-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test
KDF ANS 9.42 (A6901)	SHA-1 with AES-128 KW; 160-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test

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Algorithm or Test	Test Properties	Test Method	Test Type	Indicator	Details	Conditions
KDF ANS 9.42 (A6902)	SHA-1 with AES-128 KW; 160-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test
KDF ANS 9.42 (A6903)	SHA-1 with AES-128 KW; 160-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test
KDF ANS 9.42 (A6904)	SHA-1 with AES-128 KW; 160-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test
KDF ANS 9.42 (A6909)	SHA-1 with AES-128 KW; 160-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test
KDF ANS 9.42 (A6910)	SHA-1 with AES-128 KW; 160-bit input secret	KAT	CAST	Module becomes operational	Industry-based ANS X9.42 key derivation	Test runs at power-on before the integrity test
KMAC-128 (A6910)	KMAC-128	KAT	CAST	Module becomes operational	Key based key derivation	Test runs at power-on before the integrity test
KMAC-256 (A6910)	KMAC-256	KAT	CAST	Module becomes operational	Key based key derivation	Test runs at power-on before the integrity test

Table 23: Conditional Self-Tests

The module performs self-tests on all approved cryptographic algorithms as part of the approved services supported in the approved mode of operation, using the tests shown in the table above. The CASTs can be performed on demand by unloading and re-initializing the module. Data output through the data output interface is inhibited during the self-tests. If any of these tests fails, the module transitions to the error state.

10.3 Periodic Self-Test Information

Algorithm or Test	Test Method	Test Type	Period	Periodic Method
HMAC-SHA2-256 (A6901)	Message Authentication	SW/FW Integrity	On demand	Manually
HMAC-SHA2-256 (A6902)	Message Authentication	SW/FW Integrity	On demand	Manually
HMAC-SHA2-256 (A6903)	Message Authentication	SW/FW Integrity	On demand	Manually

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Algorithm or Test	Test Method	Test Type	Period	Periodic Method
HMAC-SHA2-256 (A6904)	Message Authentication	SW/FW Integrity	On demand	Manually
HMAC-SHA2-256 (A6909)	Message Authentication	SW/FW Integrity	On demand	Manually

Table 24: Pre-Operational Periodic Information

Algorithm or Test	Test Method	Test Type	Period	Periodic Method
SHA-1 (A6901)	KAT	CAST	On Demand	Manually
SHA-1 (A6902)	KAT	CAST	On Demand	Manually
SHA-1 (A6903)	KAT	CAST	On Demand	Manually
SHA-1 (A6904)	KAT	CAST	On Demand	Manually
SHA-1 (A6909)	KAT	CAST	On Demand	Manually
SHA2-256 (A6901)	KAT	CAST	On Demand	Manually
SHA2-256 (A6902)	KAT	CAST	On Demand	Manually
SHA2-256 (A6903)	KAT	CAST	On Demand	Manually
SHA2-256 (A6904)	KAT	CAST	On Demand	Manually
SHA2-256 (A6909)	KAT	CAST	On Demand	Manually
SHA2-512 (A6901)	KAT	CAST	On Demand	Manually
SHA2-512 (A6902)	KAT	CAST	On Demand	Manually
SHA2-512 (A6903)	KAT	CAST	On Demand	Manually
SHA2-512 (A6904)	KAT	CAST	On Demand	Manually
SHA2-512 (A6909)	KAT	CAST	On Demand	Manually
SHA3-256 (A6910)	KAT	CAST	On Demand	Manually
HMAC-SHA2-256 (A6901)	KAT	CAST	On Demand	Manually
HMAC-SHA2-256 (A6902)	KAT	CAST	On Demand	Manually
HMAC-SHA2-256 (A6903)	KAT	CAST	On Demand	Manually
HMAC-SHA2-256 (A6904)	KAT	CAST	On Demand	Manually

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Algorithm or Test	Test Method	Test Type	Period	Periodic Method
HMAC-SHA2-256 (A6909)	KAT	CAST	On Demand	Manually
HMAC-SHA3-256 (A6910)	KAT	CAST	On Demand	Manually
AES-CBC (A6907)	KAT	CAST	On Demand	Manually
AES-CBC (A6911)	KAT	CAST	On Demand	Manually
AES-CBC (A6912)	KAT	CAST	On Demand	Manually
AES-CCM (A6907)	KAT	CAST	On Demand	Manually
AES-CCM (A6911)	KAT	CAST	On Demand	Manually
AES-CCM (A6912)	KAT	CAST	On Demand	Manually
AES-CMAC (A6907)	KAT	CAST	On Demand	Manually
AES-CMAC (A6911)	KAT	CAST	On Demand	Manually
AES-CMAC (A6912)	KAT	CAST	On Demand	Manually
AES-KW (A6907)	KAT	CAST	On Demand	Manually
AES-KW (A6911)	KAT	CAST	On Demand	Manually
AES-KW (A6912)	KAT	CAST	On Demand	Manually
AES-KWP (A6907)	KAT	CAST	On Demand	Manually
AES-KWP (A6911)	KAT	CAST	On Demand	Manually
AES-KWP (A6912)	KAT	CAST	On Demand	Manually
AES-GCM (A6895)	KAT	CAST	On Demand	Manually
AES-GCM (A6896)	KAT	CAST	On Demand	Manually
AES-GCM (A6897)	KAT	CAST	On Demand	Manually
AES-GCM (A6898)	KAT	CAST	On Demand	Manually
AES-GCM (A6899)	KAT	CAST	On Demand	Manually
AES-GCM (A6900)	KAT	CAST	On Demand	Manually
AES-GCM (A6908)	KAT	CAST	On Demand	Manually
AES-GCM (A6913)	KAT	CAST	On Demand	Manually
AES-GCM (A6914)	KAT	CAST	On Demand	Manually
AES-ECB (A6907)	KAT	CAST	On Demand	Manually
AES-ECB (A6911)	KAT	CAST	On Demand	Manually
AES-ECB (A6912)	KAT	CAST	On Demand	Manually
KDF SP800-108 (A6906)	KAT	CAST	On Demand	Manually
KDA TwoStep SP800-56Cr2 (A6915)	KAT	CAST	On Demand	Manually
KDA OneStep SP800-56Cr2 (A6915)	KAT	CAST	On Demand	Manually

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Algorithm or Test	Test Method	Test Type	Period	Periodic Method
KDF SSH (A6901)	KAT	CAST	On Demand	Manually
KDF SSH (A6902)	KAT	CAST	On Demand	Manually
KDF SSH (A6903)	KAT	CAST	On Demand	Manually
KDF SSH (A6904)	KAT	CAST	On Demand	Manually
KDF SSH (A6909)	KAT	CAST	On Demand	Manually
TLS v1.2 KDF RFC7627 (A6901)	KAT	CAST	On Demand	Manually
TLS v1.2 KDF RFC7627 (A6902)	KAT	CAST	On Demand	Manually
TLS v1.2 KDF RFC7627 (A6903)	KAT	CAST	On Demand	Manually
TLS v1.2 KDF RFC7627 (A6904)	KAT	CAST	On Demand	Manually
TLS v1.2 KDF RFC7627 (A6909)	KAT	CAST	On Demand	Manually
TLS v1.3 KDF (A6918)	KAT	CAST	On Demand	Manually
PBKDF (A6901)	KAT	CAST	On Demand	Manually
PBKDF (A6902)	KAT	CAST	On Demand	Manually
PBKDF (A6903)	KAT	CAST	On Demand	Manually
PBKDF (A6904)	KAT	CAST	On Demand	Manually
PBKDF (A6909)	KAT	CAST	On Demand	Manually
PBKDF (A6910)	KAT	CAST	On Demand	Manually
Counter DRBG (A6905)	KAT	CAST	On Demand	Manually
KDA HKDF SP800-56Cr2 (A5863)	KAT	CAST	On Demand	Manually
Hash DRBG (A6905)	KAT	CAST	On Demand	Manually
HMAC DRBG (A6905)	KAT	CAST	On Demand	Manually
KAS-FFC-SSC Sp800-56Ar3 (A6919)	PCT	CAST	On Demand	Manually
KAS-ECC-SSC Sp800-56Ar3 (A6901)	KAT	CAST	On Demand	Manually
KAS-ECC-SSC Sp800-56Ar3 (A6902)	KAT	CAST	On Demand	Manually
KAS-ECC-SSC Sp800-56Ar3 (A6903)	KAT	CAST	On Demand	Manually

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Algorithm or Test	Test Method	Test Type	Period	Periodic Method
KAS-ECC-SSC Sp800-56Ar3 (A6904)	KAT	CAST	On Demand	Manually
KAS-ECC-SSC Sp800-56Ar3 (A6909)	KAT	CAST	On Demand	Manually
RSA KeyGen (FIPS186-5) (A6901)	PCT	PCT	On Demand	Manually
RSA KeyGen (FIPS186-5) (A6902)	PCT	PCT	On Demand	Manually
RSA KeyGen (FIPS186-5) (A6903)	PCT	PCT	On Demand	Manually
RSA KeyGen (FIPS186-5) (A6904)	PCT	PCT	On Demand	Manually
RSA KeyGen (FIPS186-5) (A6909)	PCT	PCT	On Demand	Manually
RSA SigGen (FIPS186-5) (A6901)	KAT	CAST	On Demand	Manually
RSA SigGen (FIPS186-5) (A6902)	KAT	CAST	On Demand	Manually
RSA SigGen (FIPS186-5) (A6903)	KAT	CAST	On Demand	Manually
RSA SigGen (FIPS186-5) (A6904)	KAT	CAST	On Demand	Manually
RSA SigGen (FIPS186-5) (A6909)	KAT	CAST	On Demand	Manually
RSA SigGen (FIPS186-5) (A6910)	KAT	CAST	On Demand	Manually
RSA SigVer (FIPS186-5) (A6901)	KAT	CAST	On Demand	Manually
RSA SigVer (FIPS186-5) (A6902)	KAT	CAST	On Demand	Manually

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Algorithm or Test	Test Method	Test Type	Period	Periodic Method
RSA SigVer (FIPS186-5) (A6903)	KAT	CAST	On Demand	Manually
RSA SigVer (FIPS186-5) (A6904)	KAT	CAST	On Demand	Manually
RSA SigVer (FIPS186-5) (A6909)	KAT	CAST	On Demand	Manually
RSA SigVer (FIPS186-5) (A6910)	KAT	CAST	On Demand	Manually
ECDSA KeyGen (FIPS186-5) (A6901)	PCT	PCT	On Demand	Manually
ECDSA KeyGen (FIPS186-5) (A6902)	PCT	PCT	On Demand	Manually
ECDSA KeyGen (FIPS186-5) (A6903)	PCT	PCT	On Demand	Manually
ECDSA KeyGen (FIPS186-5) (A6904)	PCT	PCT	On Demand	Manually
ECDSA KeyGen (FIPS186-5) (A6909)	PCT	PCT	On Demand	Manually
ECDSA KeyGen (FIPS186-5) (A6916)	PCT	PCT	On Demand	Manually
ECDSA SigGen (FIPS186-5) (A6901)	KAT	CAST	On Demand	Manually
ECDSA SigGen (FIPS186-5) (A6902)	KAT	CAST	On Demand	Manually
ECDSA SigGen (FIPS186-5) (A6903)	KAT	CAST	On Demand	Manually
ECDSA SigGen (FIPS186-5) (A6904)	KAT	CAST	On Demand	Manually
ECDSA SigGen (FIPS186-5) (A6909)	KAT	CAST	On Demand	Manually

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Algorithm or Test	Test Method	Test Type	Period	Periodic Method
ECDSA SigGen (FIPS186-5) (A6910)	KAT	CAST	On Demand	Manually
ECDSA SigGen (FIPS186-5) (A6916)	KAT	CAST	On Demand	Manually
ECDSA SigGen (FIPS186-5) (A6917)	KAT	CAST	On Demand	Manually
ECDSA SigVer (FIPS186-4) (A6901)	KAT	CAST	On Demand	Manually
ECDSA SigVer (FIPS186-4) (A6902)	KAT	CAST	On Demand	Manually
ECDSA SigVer (FIPS186-4) (A6903)	KAT	CAST	On Demand	Manually
ECDSA SigVer (FIPS186-4) (A6904)	KAT	CAST	On Demand	Manually
ECDSA SigVer (FIPS186-4) (A6909)	KAT	CAST	On Demand	Manually
ECDSA SigVer (FIPS186-4) (A6910)	KAT	CAST	On Demand	Manually
ECDSA SigVer (FIPS186-4) (A6916)	KAT	CAST	On Demand	Manually
ECDSA SigVer (FIPS186-4) (A6917)	KAT	CAST	On Demand	Manually
Safe Primes Key Generation (A6919)	PCT	PCT	On Demand	Manually
Safe Primes Key Verification (A6919)	KAT	CAST	On Demand	Manually
KDF ANS 9.63 (A6901)	KAT	CAST	On Demand	Manually
KDF ANS 9.63 (A6902)	KAT	CAST	On Demand	Manually
KDF ANS 9.63 (A6903)	KAT	CAST	On Demand	Manually

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Algorithm or Test	Test Method	Test Type	Period	Periodic Method
KDF ANS 9.63 (A6904)	KAT	CAST	On Demand	Manually
KDF ANS 9.63 (A6909)	KAT	CAST	On Demand	Manually
KDF ANS 9.63 (A6910)	KAT	CAST	On Demand	Manually
KDF ANS 9.42 (A6901)	KAT	CAST	On Demand	Manually
KDF ANS 9.42 (A6902)	KAT	CAST	On Demand	Manually
KDF ANS 9.42 (A6903)	KAT	CAST	On Demand	Manually
KDF ANS 9.42 (A6904)	KAT	CAST	On Demand	Manually
KDF ANS 9.42 (A6909)	KAT	CAST	On Demand	Manually
KDF ANS 9.42 (A6910)	KAT	CAST	On Demand	Manually
KMAC-128 (A6910)	KAT	CAST	On Demand	Manually
KMAC-256 (A6910)	KAT	CAST	On Demand	Manually

Table 25: Conditional Periodic Information

The module does not implement periodic self-tests.

10.4 Error States

Name	Description	Conditions	Recovery Method	Indicator
Error	The module immediately stops functioning	Software integrity test failure CAST failure PCT failure	Re-initialization of the module	Module will not load; Module is aborted for PCT failure

Table 26: Error States

If the module fails any of the self-tests, the module enters the error state. In the error state, the module immediately stops functioning and ends the application process. Consequently, the data output interface is inhibited, and the module accepts no more inputs or requests (as the module is no longer running).

10.5 Operator Initiation of Self-Tests

The software integrity tests and cryptographic algorithm self-tests can be invoked on demand by resetting the module or by invoking the OSSL_PROVIDER_self_test method. The

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pair-wise consistency tests can be invoked on demand by requesting the key pair generation service.

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11 Life-Cycle Assurance

11.1 Installation, Initialization, and Startup Procedures

On the ClevOS 3.19 operational environment, the module is distributed within the clevos-3.19.2.F1606-44_fips-accesser-usbiso.iso image.

There are no specific steps for installing the module, the module comes pre-installed as part of the operating system.

11.2 Administrator Guidance

The Approved and non-Approved modes of operation are specified in section 2.4. The administrative functions are specified in the Approved Services table. All the logical interfaces are specified in section 3.1. The requirements and restrictions that shall be considered when operating the module in approved mode are specified in section 2.7 and section 6.

The Crypto Officer must execute the openssl list -providers command. The Crypto Officer must ensure that the FIPS provider is listed in the output as follows:

name: IBM COS - OpenSSL FIPS Provider
version: 3.3.2-a8fdaac
status: 1

11.3 Non-Administrator Guidance

There is no non-administrator guidance.

11.4 Design and Rules

Not applicable.

11.5 Maintenance Requirements

Not applicable.

11.6 End of Life

As the module does not persistently store SSPs, secure sanitization of the module consists of unloading the module. This will zeroize all SSPs in volatile memory. Then, if desired, the package can be uninstalled from the system.

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12 Mitigation of Other Attacks

12.1 Attack List

Certain cryptographic subroutines and algorithms are vulnerable to timing analysis. The module mitigates this vulnerability by using constant-time implementations. This includes, but is not limited to:

- Big number operations: computing GCDs, modular inversion, multiplication, division, and modular exponentiation (using Montgomery multiplication).
- Elliptic curve point arithmetic: addition and multiplication (using the Montgomery ladder).
- Vector-based AES implementations.

12.2 Mitigation Effectiveness

RSA, ECDSA, ECDH, and DH employ blinding techniques to further impede timing and power analysis.

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Appendix A. Glossary and Abbreviations

AES	Advanced Encryption Standard
AES-NI	Advanced Encryption Standard New Instructions
API	Application Programming Interface
CAST	Cryptographic Algorithm Self-Test
CAVP	Cryptographic Algorithm Validation Program
CBC	Cipher Block Chaining
CCM	Counter with Cipher Block Chaining-Message Authentication Code
CFB	Cipher Feedback
CKG	Cryptographic Key Generation
CMAC	Cipher-based Message Authentication Code
CMVP	Cryptographic Module Validation Program
CPACF	CP Assist for Cryptographic Functions
CSP	Critical Security Parameter
CTR	Counter
CTS	Ciphertext Stealing
DH	Diffie-Hellman
DRBG	Deterministic Random Bit Generator
ECB	Electronic Code Book
ECC	Elliptic Curve Cryptography
ECDH	Elliptic Curve Diffie-Hellman
ECDSA	Elliptic Curve Digital Signature Algorithm
EVP	Envelope
FFC	Finite Field Cryptography
FIPS	Federal Information Processing Standards
GCM	Galois Counter Mode
GMAC	Galois Counter Mode Message Authentication Code
HKDF	HMAC-based Key Derivation Function
HMAC	Keyed-Hash Message Authentication Code
IKE	Internet Key Exchange
KAS	Key Agreement Scheme
KAT	Known Answer Test
KBKDF	Key-based Key Derivation Function

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KMAC	KECCAK Message Authentication Code
KW	Key Wrap
KWP	Key Wrap with Padding
MAC	Message Authentication Code
NIST	National Institute of Science and Technology
OAEP	Optimal Asymmetric Encryption Padding
OFB	Output Feedback
PAA	Processor Algorithm Acceleration
PCT	Pair-wise Consistency Test
PBKDF2	Password-based Key Derivation Function v2
PKCS	Public-Key Cryptography Standards
PSS	Probabilistic Signature Scheme
RSADP	RSA Decryption Primitive
RSAEP	RSA Encryption Primitive
RSA	Rivest, Shamir, Addleman
SHA	Secure Hash Algorithm
SSC	Shared Secret Computation
SSH	Secure Shell
SSP	Sensitive Security Parameter
TLS	Transport Layer Security
XOF	Extendable Output Function
XTS	XEX-based Tweaked-codebook mode with cipher text Stealing

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SP 800-133r2	**Recommendation for Cryptographic Key Generation** June 2020 https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-133r2.pdf
SP 800-135r1	**Recommendation for Existing Application-Specific Key Derivation Functions** December 2011 https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-135r1.pdf

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SP 800-140Br1 **CMVP Security Policy Requirements**
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https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-140Br1.pdf

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