# GE MDS LLC

# Orbit MCR and Orbit ECR

# FIPS 140-2 Cryptographic Module
# Non-Proprietary Security Policy

**Version: 2.10**

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# 1 Introduction

This document defines the Security Policy for the GE MDS Orbit Multiservice Connect Router (MCR) and Edge Connect Router (ECR) module family, hereafter denoted the Module. The Module is a secure wireless communications device, which operates on cellular bands (2G/3G/4G LTE), licensed and unlicensed bands, and 802.11 Wi-Fi. The Module meets FIPS 140-2 overall Level 2 requirements.

## 1.1 Variants and Order Packages

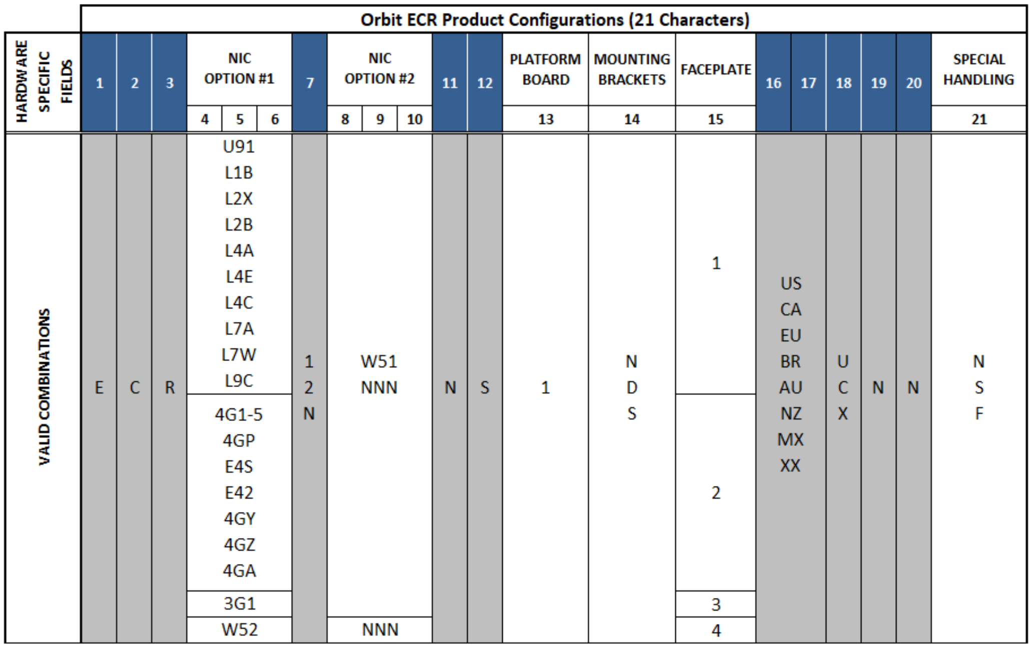
The Module validation encompasses the following components:

- **Chassis**: ECR Chassis v1.0, MCR Chassis v1.0
- **Internal components**: U91, L1B, L2X, L2B, L4A, L4E, L4C, L7A, L7W, L9C, 4G1, 4G2, 4G3, 4G4, 4G5, 4GP, 4GY, 4GZ, 4GA, E4S, E42, W51, W52, 3G1, NNN. These do not perform cryptographic operations.
- **Platform boards**: ECR: 1; MCR: 1, 2 and 3. Changes to these result in a new designated type.
- **Orbit Firmware** v7.1.1 and v7.1.3

These components are included with other options (e.g. faceplates, special handling, mounting brackets) to create an order package, as described in Tables 1 and 2 (below). The possible order packages are defined by a 21 character configuration string that is constructed upon order entry and determines which options are populated in the factory. The columns shown in gray, are for items that have no impact on the cryptographic modules (e.g. country/regulatory, safety certification, reserved fields). The NICs and GPS are not security relevant because they do not perform cryptographic operations or process critical security parameters (CSPs).

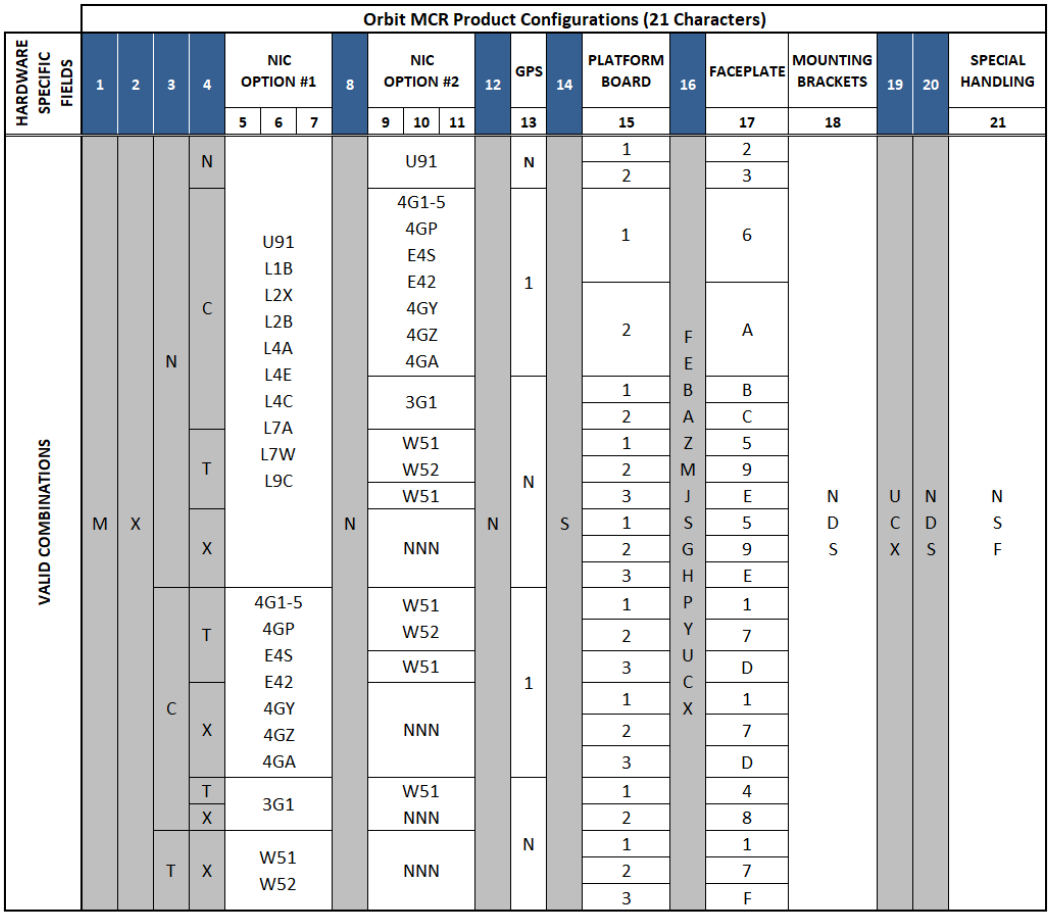
The Module is a multi-chip standalone embodiment; the cryptographic boundary is the device chassis.

**Table 1 – Small Form Factor Cryptographic Module Configurations**



| | Orbit ECR Product Configurations (21 Characters) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HARDWARE SPECIFIC FIELDS | 1 | 2 | 3 | NIC OPTION #1 | 7 | NIC OPTION #2 | 11 | 12 | PLATFORM BOARD | MOUNTING BRACKETS | FACEPLATE | 16 | 17 | 18 | 19 | 20 | SPECIAL HANDLING |
| | | | | 4 \| 5 \| 6 | | 8 \| 9 \| 10 | | | 13 | 14 | 15 | | | | | | 21 |
| VALID COMBINATIONS | E | C | R | U91<br>L1B<br>L2X<br>L2B<br>L4A<br>L4E<br>L4C<br>L7A<br>L7W<br>L9C | 1<br>2<br>N | W51<br>NNN | N | S | 1 | N<br>D<br>S | 1 | US<br>CA<br>EU<br>BR<br>AU<br>NZ<br>MX<br>XX | U<br>C<br>X | N | N | N<br>S<br>F |
| | | | | 4G1-5<br>4GP<br>E4S<br>E42<br>4GY<br>4GZ<br>4GA | | | | | | | 2 | | | | | | |
| | | | | 3G1 | | | | | | | 3 | | | | | | |
| | | | | W52 | | NNN | | | | | 4 | | | | | | |

## Table 2 – Large Form Factor Cryptographic Module Configurations



| | Orbit MCR Product Configurations (21 Characters) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HARDWARE SPECIFIC FIELDS | 1 | 2 | 3 | 4 | NIC OPTION #1 | 8 | NIC OPTION #2 | 12 | GPS | 14 | PLATFORM BOARD | 16 | FACEPLATE | MOUNTING BRACKETS | 19 | 20 | SPECIAL HANDLING |
| | | | | | 5 \| 6 \| 7 | | 9 \| 10 \| 11 | | 13 | | 15 | | 17 | 18 | | | 21 |
| VALID COMBINATIONS | M | X | N | N | U91<br>L1B<br>L2X<br>L2B<br>L4A<br>L4E<br>L4C<br>L7A<br>L7W<br>L9C | N | U91 | N | N | S | 1 | F<br>E<br>B<br>A<br>Z<br>M<br>J<br>S<br>G<br>H<br>P<br>Y<br>U<br>C<br>X | 2 | N<br>D<br>S | U<br>C<br>X | N<br>D<br>S | N<br>S<br>F |
| | | | | | | | | | | | 2 | | 3 | | | | |
| | | | | C | | | 4G1-5<br>4GP<br>E4S<br>E42<br>4GY<br>4GZ<br>4GA | | 1 | | 1 | | 6 | | | | |
| | | | | | | | | | | | 2 | | A | | | | |
| | | | | | | | 3G1 | | N | | 1 | | B | | | | |
| | | | | | | | | | | | 2 | | C | | | | |
| | | | | T | | | W51<br>W52 | | | | 1 | | 5 | | | | |
| | | | | | | | | | | | 2 | | 9 | | | | |
| | | | | | | | W51 | | | | 3 | | E | | | | |
| | | | | X | | | NNN | | | | 1 | | 5 | | | | |
| | | | | | | | | | | | 2 | | 9 | | | | |
| | | | | | | | | | | | 3 | | E | | | | |
| | | | C | T | 4G1-5<br>4GP<br>E4S<br>E42<br>4GY<br>4GZ<br>4GA | | W51<br>W52 | | 1 | | 1 | | 1 | | | | |
| | | | | | | | | | | | 2 | | 7 | | | | |
| | | | | | | | W51 | | | | 3 | | D | | | | |
| | | | | X | | | NNN | | | | 1 | | 1 | | | | |
| | | | | | | | | | | | 2 | | 7 | | | | |
| | | | | | | | | | | | 3 | | D | | | | |
| | | | | T | 3G1 | | W51 | | N | | 1 | | 4 | | | | |
| | | | | X | | | NNN | | | | 2 | | 8 | | | | |
| | | | T | X | W51<br>W52 | | NNN | | | | 1 | | 1 | | | | |
| | | | | | | | | | | | 2 | | 7 | | | | |
| | | | | | | | | | | | 3 | | F | | | | |

The Module is intended for use by US Federal agencies and other markets that require FIPS 140-2 validated wireless network routers.

The FIPS 140-2 security levels for the Module are as follows:

**Table 3 – Security Level of Security Requirements**

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

## 1.2 Hardware and Physical Cryptographic Boundary

The physical forms of the Module are depicted in Figure 1. The boundary is the chassis of the device. The Module relies on RF antennas as input/output devices.

The module has two form factors, both of which have multiple variants. All port possibilities are encompassed in Table 4.

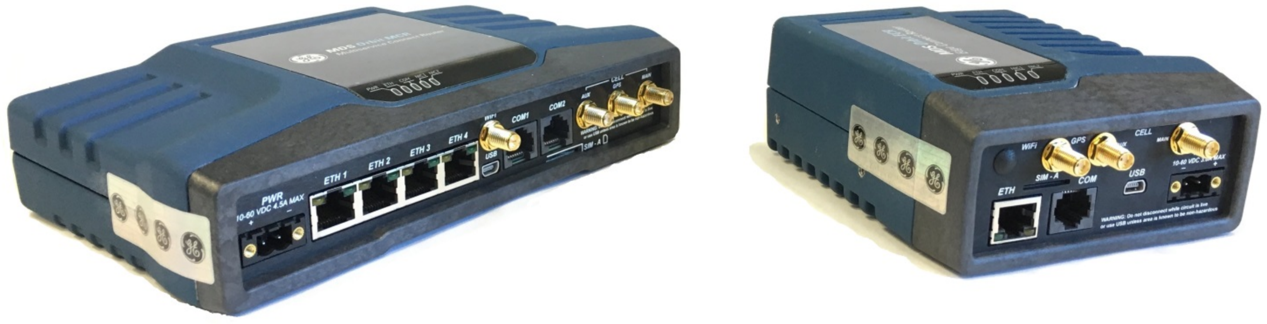


**Figure 1 – Module (Large Form Factor on left (MCR), Small Form Factor on right (ECR))**

**Table 4 – Ports and Interfaces**

| Port | Description | Logical Interface Type |
|---|---|---|
| Power input | 10-60 V DC | Power |
| RJ-45 Eth Ports (1, 2, or 4*) | Ethernet ports (metal shielded) | Control in \| Data in \| Data out \| Status out |
| RJ-45 Serial Ports (1 or 2*) | RS-232 or RS-485 (un-shielded) | Control in \| Data in \| Data out \| Status out |
| USB Mini (type B) | Virtual console port | Control in \| Data in \| Data out \| Status out |
| TNC port (0 or 1) | Licensed or unlicensed radio port | Control in \| Data in \| Data out \| Status out |
| SMA ports (0, 1, 2, or 3, female) | Cellular radio and/or GPS port | Control in \| Data in \| Data out \| Status out |
| RP-SMA port (0 , 1, or 2, female) | 802.11 Wi-Fi port | Control in \| Data in \| Data out \| Status out |
| SIM card slot (0,1, or 2) | SIM card slot | Data in |
| LED Status indicators | Five (5) LEDs to indicate device status | Status out |

*Large Form Factor (MCR) only

### 1.2.1 Excluded Components

In the MCR variant, the following components have been excluded:

- MAX3161 (serial transceiver)
- MAX3238 (serial transceiver)

These components are not security relevant and do not provide any cryptographic functionality. The data they process is taken directly from, or provided directly to, the module's ports and interfaces.

## 1.3 Firmware and Logical Cryptographic Boundary

The module contains a processor card containing a CPU, RAM, FLASH, and firmware within the cryptographic boundary.

## 1.4 Modes of Operation

The module supports both an Approved and a non-Approved mode of operation. The module is provided from the manufacturer in the non-approved mode. The Crypto Officer sets the mode of operation through the management interface. Internally, the module uses a boot parameter to explicitly operate in one of the modes of operation. To verify that a module is in the Approved mode of operation, the operator can query the FIPS Mode parameter through the system menu of any of the user interfaces.

FIPS mode for the device can be activated from the System menu in the UI. The user will be prompted for confirmation, as activating FIPS mode will result in a factory reset. A factory reset will clear all user settings, including CSPs. In addition, the non-Approved algorithms listed at the bottom of Section 2 are disabled.

Once the unit is brought into FIPS mode, default passwords and keys must be changed before the module will report that it has reached "FIPS operational status" (FIPS Approved mode + proper initialization). The user can query the FIPS operational status in the System menu in the UI. If these requirements have been met, FIPS operational status will be set to TRUE.

# 2 Cryptographic Functionality

The Module implements the FIPS Approved and Non-Approved but Allowed cryptographic functions listed in the tables below.

**Table 5 – Approved and CAVP Validated Cryptographic Functions**

| Algorithm | Description | Cert # |
|---|---|---|
| **OpenSSL** | | |
| AES | [FIPS 197, SP 800-38A]<br>Functions: Encryption, Decryption<br>Modes: ECB, CBC, CFB-128, CTR<br>Key sizes: 128, 192, 256 bits (ECB and CFB are 128-bit only) | 4539 |
| AES-CCM | [SP 800-38C]<br>Functions: Authenticated Encryption, Authenticated Decryption<br>Key sizes: 128, 192, 256 bits | 4539 |
| AES-CMAC | [SP 800-38B]<br>Functions: Generation, Verification<br>Key sizes: 128 bits | 4539 |
| AES-GCM* | [SP 800-38D]<br>Functions: Authenticated Encryption, Authenticated Decryption<br>Key sizes: 128, 192, 256 bits | 4539 |
| CVL:<br>KDF, Existing Application-Specific | [SP 800-135]<br>Functions: IKE v1 KDF, IKEv2 KDF, TLS v1.0/1.1 KDF, TLS 1.2 KDF, SSH KDF, SNMP KDF | 1219 |
| DRBG | [SP 800-90A]<br>Functions: CTR DRBG<br>Modes: AES-256<br>Security Strengths: 256 bits | 1496 |
| DSA | [FIPS 186-4]<br>Functions: Key Pair Generation, Signature Generation, Signature Verification<br>Key sizes: 2048, 3072 bits | 1210 |
| HMAC | [FIPS 198-1]<br>Functions: Generation, Verification<br>SHA sizes: SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 | 2997 |

| Algorithm | Description | Cert # |
|---|---|---|
| KTS | [SP800-38F §3.1]<br>Functions: Key Wrap, Key Unwrap<br>Mode: AES-CBC + HMAC<br>Strength: 128 or 256 bits | AES #4539<br>HMAC #2997 |
| RSA | [FIPS 186-4, ANSI X9.31-1998, and PKCS #1 v2.1 (PKCS1.5)]<br>Functions: Key Pair Generation, Signature Generation, Signature Verification<br>Key sizes: 2048, 3072 bits | 2471 |
| SHA | [FIPS 180-4]<br>Functions: Digital Signature Generation, Digital Signature Verification, non-Digital Signature Applications<br>SHA sizes: SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 | 3720 |
| Triple-DES | [SP 800-20]<br>Functions: Encryption, Decryption<br>Modes: TCBC<br>Key sizes: 3-key | 2416 |
| **Mocana** | | |
| AES | [FIPS 197, SP 800-38A]<br>Functions: Encryption, Decryption<br>Modes: CBC, CTR<br>Key sizes: 128, 192, 256 bits | 5887 |
| AES-KW | [SP 800-38F]<br>Functions: Key Wrap, Key Unwrap<br>Mode: KW<br>Key size: 128 bits | 5887 |
| CVL:<br>KDF, Existing Application-Specific | [SP 800-135]<br>Functions: TLS v1.0/1.1 KDF, TLS 1.2 KDF | 2118 |
| DRBG | [SP 800-90A]<br>Functions: CTR DRBG (Derivation Function and Prediction Resistance Enabled)<br>Modes: AES-256<br>Security Strengths: 256 bits | 2450 |

| Algorithm | Description | Cert # |
|---|---|---|
| DSA | [FIPS 186-4]<br>Functions: PQG Generation, PQG Verification, Key Pair Generation, Signature Generation, Signature Verification<br>Key sizes: 2048, 3072 bits | 1484 |
| HMAC | [FIPS 198-1]<br>Functions: Generation, Verification<br>SHA sizes: SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 | 3864 |
| KTS | [SP 800-38F]<br>Functions: Key Wrap, Key Unwrap<br>Mode: AES-KW<br>Strength: 128 bits | AES #5887 |
| RSA | [FIPS 186-4 and PKCS #1 v2.1 (PKCS1.5)]<br>Functions: Key Pair Generation, Signature Generation, Signature Verification<br>Key sizes: 2048, 3072 bits | 3085 |
| SHA | [FIPS 180-4]<br>Functions: Digital Signature Generation, Digital Signature Verification, non-Digital Signature Applications<br>SHA sizes: SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 | 4639 |
| Triple-DES | [SP 800-20]<br>Functions: Encryption, Decryption<br>Modes: TCBC<br>Key sizes: 3-key | 2867 |
| **Linux Kernel** | | |
| AES | [FIPS 197, SP 800-38A]<br>Functions: Encryption, Decryption<br>Modes: CBC, CTR<br>Key sizes: 128, 192, 256 bits | 5888 |
| AES-CCM | [SP 800-38C]<br>Functions: Authenticated Encryption, Authenticated Decryption<br>Key sizes: 128, 192, 256 bits | 5888 |
| AES-CMAC | [SP 800-38B]<br>Functions: Generation, Verification<br>Key sizes: AES with 128 bits | 5888 |

| Algorithm | Description | Cert # |
|---|---|---|
| AES-GCM* | [SP 800-38D]<br>Functions: Authenticated Encryption, Authenticated Decryption<br>Key sizes: 128, 192, 256 bits | 5888 |
| AES-GMAC | [SP 800-38D]<br>Functions: Generation and Verification of Message Authentication Code<br>Key sizes: 128, 192, 256 bits | 5888 |
| SHA | [FIPS 180-4]<br>Functions: Digital Signature Generation, Digital Signature Verification, non-Digital Signature Applications<br>SHA sizes: SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 | 4640 |
| Triple-DES | [SP 800-20]<br>Functions: Encryption, Decryption<br>Modes: TCBC<br>Key sizes:3-key | 2868 |
| **IEEE 802.11 Crypto API** | | |
| AES-KW | [SP 800-38F]<br>Functions: Key Wrap, Key Unwrap<br>Mode: KW<br>Key size: 128 bits | 5889 |
| KTS | [SP 800-38F]<br>Functions: Key Wrap, Key Unwrap<br>Mode: AES-KW<br>Strength: 128 bits | 5889 |
| **Libssh2** | | |
| CVL:<br>KDF, Existing Application-Specific | [SP 800-135]<br>Functions: SSH KDF | 1221 |

* The module is compliant to IG A.5: GCM is used in the context of TLS and IPSec/IKEv2. In the event of power loss, GCM keys are re-established as part of the re-establishment of the TLS or IPSec channel. The above behavior ensures the same GCM IV is never used twice.

**Table 6 – Approved Cryptographic Functions Tested with Vendor Affirmation**

| Algorithm | Description | IG Ref. |
|---|---|---|
| | [SP800-133]<br>Function: Key Generation | IG D.12 |

| Algorithm | Description | IG Ref. |
|---|---|---|
| CKG (Cryptographic Key Generation) | [133] Section 6.1 Asymmetric signature key generation using unmodified DRBG output | |
| | [133] Section 6.2 Asymmetric key establishment key generation using unmodified DRBG output | |
| | [133] Section 7.1 Direct symmetric key generation using unmodified DRBG output | |
| | [133] Section 7.3 Derivation of symmetric keys from a key agreement shared secret. | |
| | [133] Section 7.4 Derivation of symmetric keys from a pre-shared key | |
| | [133] Section 7.5 Derivation of symmetric keys from a password | |
| KDA, Key Extraction-then-Expansion | [SP 800-56C Rev 1]<br>Functions: HMAC-SHA1 KDF PRF is used for expanding Group and Pairwise keys in 802.1x used by the NX/LN and Wi-Fi. | IG D.10 |
| KDF, Password-Based | [SP 800-132]<br>Options: PBKDF with Option 1a<br>Functions: HMAC-based KDF SHA-256 with a 32-byte salt created from the username padded with zeros and 1024 rounds used to obfuscate the user password before storage. The user password is the input to the KDF and has a minimum length of 8 bytes. Keys derived from passwords, as shown in SP 800-132, may only be used in storage applications. The result is not used for generation of any MK material in FIPS mode. | IG D.6 |

**Table 7 – Non-Approved but Allowed Cryptographic Functions**

| Algorithm | Description |
|---|---|
| Diffie-Hellman, non-compliant to SP800-56A | [IG D.8]<br>Diffie-Hellman (CVL Cert. #1219, key agreement; key establishment methodology provides 112 or 128 bits of encryption strength)<br>Diffie-Hellman (CVL Cert. #1221, key agreement; key establishment methodology provides 112 bits of encryption strength) |
| MD5 within TLS | [IG D.2]<br>Use of MD5 along with SHA1 in TLS 1.0/1.1 KDF |
| NDRNG | [IG 7.15]<br>Hardware Derived Non-Deterministic RNG, using a ring oscillator. Seeds the FIPS Approved DRBGs with 256 bits of strength. OpenSSL implementation seeds and reseeds with 1024 bits from the HW RNG.  Mocana implementation seeds with 1152 bits and reseeds with 768 bits from the HW RNG. |

| Algorithm | Description |
|---|---|
| RSA, non-compliant to SP800-56B | [IG D.9]<br>RSA (key agreement; key establishment methodology provides 112 or 128 bits of encryption strength) |
| RSA, additional modulus sizes | [IG A.14]<br>RSA vendor affirmed moduli: 2049-3071 bits, 3073-16384 bits. |

**Table 8 – Protocols Allowed in FIPS Mode***

| Protocol | Description |
|---|---|
| EAP-TLS | [IG D.9]<br>Uses the same cipher suites as TLS (see below).<br>Used by IEEE 802.1x when performing mutual authentication, between Wi-Fi and NX/LN wireless devices and a RADIUS server. Uses Public Key (RSA or DSA) keys and X.509 Certificates. |
| IKE v1 | [IG D.8 and SP 800-135]<br>Key Exchange Mechanisms: Oakley Groups 14 & 15, DH key agreement with Pre-Shared Key and RSA authentication<br>Session Encryption: 3DES-CBC, AES-CBC, & AES-CTR encryption<br>Session Authentication: HMAC with SHA-1, SHA-256, SHA-384, SHA-512<br>Session Key Derivation: IKEv1 KDF with SHA-1, SHA-256, SHA-384, SHA-512 |
| IKE v2 | [IG D.8 and SP 800-135]<br>Key Exchange Mechanisms: Oakley Groups 14 & 15, DH key agreement with Pre-Shared Key and RSA authentication<br>Session Encryption: 3DES-CBC, AES-CBC, AES-CTR, AES-GCM (w/ 16 octet ICV) encryption<br>Session Authentication: HMAC-SHA1-96, HMAC-SHA1-160, AES-GCM (AEAD), AES-GMAC (128, 192, 256), HMAC-SHA-256-128, HMAC-SHA-384-192, HMAC-SHA-512-256 integrity<br>Session Key Derivation: IKEv2 KDF with CMACSHA-1, SHA-256, SHA-384, or SHA-512. |
| SNMPv3 | [IG D.8 and SP 800-135]<br>Session Encryption: AES-128-CFB<br>Session Authentication: HMAC-SHA1-96 |
| SSH v2 | [IG D.8 and SP 800-135]<br>Key Exchange Mechanisms: DH Group Exchange SHA1 & SHA256, DH Group 14 SHA1<br>Session Encryption: 3DES-CBC, AES-CBC (128, 192, 256), AES-CTR (128, 192, 256)<br>Session Authentication: HMAC-SHA1, HMAC-SHA256, HMAC-SHA512 |

| Protocol | Description |
|---|---|
| TLS v1.0/v1.1/v1.2 | [IG D.8 and SP 800-135]<br>OpenSSL Cipher suites:<br>TLS_DHE_DSS_WITH_AES_128_CBC_SHA<br>TLS_DHE_DSS_WITH_AES_128_CBC_SHA256<br>TLS_DHE_DSS_WITH_AES_128_GCM_SHA256<br>TLS_DHE_DSS_WITH_AES_256_CBC_SHA<br>TLS_DHE_DSS_WITH_AES_256_CBC_SHA256<br>TLS_DHE_DSS_WITH_AES_256_GCM_SHA384<br>TLS_DHE_RSA_WITH_AES_128_CBC_SHA<br>TLS_DHE_RSA_WITH_AES_128_CBC_SHA256<br>TLS_DHE_RSA_WITH_AES_128_GCM_SHA256<br>TLS_DHE_RSA_WITH_AES_256_CBC_SHA<br>TLS_DHE_RSA_WITH_AES_256_CBC_SHA256<br>TLS_DHE_RSA_WITH_AES_256_GCM_SHA384<br>TLS_DH_DSS_WITH_AES_128_CBC_SHA<br>TLS_DH_DSS_WITH_AES_128_CBC_SHA256<br>TLS_DH_DSS_WITH_AES_128_GCM_SHA256<br>TLS_DH_DSS_WITH_AES_256_CBC_SHA<br>TLS_DH_DSS_WITH_AES_256_CBC_SHA256<br>TLS_DH_DSS_WITH_AES_256_GCM_SHA384<br>TLS_DH_RSA_WITH_AES_128_CBC_SHA<br>TLS_DH_RSA_WITH_AES_128_CBC_SHA256<br>TLS_DH_RSA_WITH_AES_128_GCM_SHA256<br>TLS_DH_RSA_WITH_AES_256_CBC_SHA<br>TLS_DH_RSA_WITH_AES_256_CBC_SHA256<br>TLS_DH_RSA_WITH_AES_256_GCM_SHA384<br>TLS_PSK_WITH_AES_256_CBC_SHA<br>TLS_RSA_WITH_AES_128_CBC_SHA<br>TLS_RSA_WITH_AES_128_CBC_SHA256<br>TLS_RSA_WITH_AES_128_GCM_SHA256<br>TLS_RSA_WITH_AES_256_CBC_SHA<br>TLS_RSA_WITH_AES_256_CBC_SHA256<br>TLS_RSA_WITH_AES_256_GCM_SHA384<br>Mocana Cipher Suites:<br>TLS_RSA_WITH_AES_128_CBC_SHA<br>TLS_RSA_WITH_AES_128_CBC_SHA256<br>TLS_RSA_WITH_AES_256_CBC_SHA<br>TLS_RSA_WITH_AES_256_CBC_SHA256 |

*Protocols are not reviewed or tested by the CMVP or CAVP.

Non-Approved Cryptographic Functions for use in non-FIPS mode only:

- DES
- MD5
- RC4
- RSA, DSA, and ECDSA, disallowed variants (e.g. 1024, 1536, and non-NIST curves)
- PBKDF2 used for MK generation for use with Option 1b and 2a
- Ed25519
- Curve25519
- ChaCha20
- Poly1305

## 2.1 Critical Security Parameters

All CSPs used by the Module are described in this section. All usage of these CSPs by the Module (including all CSP lifecycle states) is described in the services detailed in Section 4.

**Table 9 – Critical Security Parameters (CSPs)**

| CSP | Description / Usage |
|---|---|
| | **Static Server Keys** |
| RSA Private Keys (X.509) | RSA (size 2048 to 16384 bits) private keys for various protocols which use X.509 certificates: TLS, IPSEC, EAP-TLS (for Wi-Fi device auth, licensed radio device auth, unlicensed radio device auth)<br>Can be generated or imported. Used for signatures (w/DH) or for RSA key transport. |
| DSA Private Keys (X.509) | DSA-2048 or DSA-3072 private keys for various protocols which use X.509 certificates: TLS, IPSEC, EAP-TLS (for WiFi device auth, licensed radio device auth, unlicensed radio device auth)<br>Can only be imported. Used for signature generation (w/ephemeral DH) or directly as a DH key (TLS_DH_* cipher suites). |
| SSH Private Keys | RSA and DSA private keys for SSH, size 2048 or 3072. Generated internally on initialization or manually. Used for signature generation (w/DH). |
| | **TLS Ephemeral Keys** |
| DH Private Key | DH-2048 or DH-3072 Private key used for PFS during a TLS exchange. |
| Master Secret | 384-bit TLS Master Secret derived from DH exchange |
| Session Encryption Keys | TLS Session encryption keys (AES-128, AES-256, or 3-key Triple-DES). |
| Session Auth Keys | TLS Session authentication keys (HMAC-SHA-1, or HMAC-SHA-256) |

| CSP | Description / Usage |
|---|---|
| **EAP-TLS Ephemeral Keys** | |
| DH Private Key | DH-2048 or DH-3072 Private key used for PFS during a TLS exchange |
| Master Secret | 384-bit TLS Master Secret derived from DH exchange |
| Session Encryption Keys | TLS Session encryption keys (AES-128, AES-256, or 3-key Triple-DES) |
| Session Auth Keys | TLS Session authentication keys (HMAC-SHA-1 or HMAC-SHA-256) |
| **EAPOL Keys** | |
| Pairwise Master Key | 256-bit shared secret keying material. Established as part of mutual authentication performed using EAP-TLS exchange between client and RADIUS server (802.1X). Can also be pre-shared. |
| Key Confirmation Key | 128-bit HMAC/SHA-1 key used for authentication of the EAPOL exchange. Derived from Pairwise Master Key using a KDF. |
| Key Encryption Key | 128-bit AES-CBC key used in AES-KEYWRAP protocol to encrypt the Unicast Temporal Key. Derived from Pairwise Master Key using a KDF. |
| Unicast Temporal Key | 128-bit (Wi-Fi) or 256-bit (NX/LN) AES-CCM key. Derived from Pairwise Master Key using a KDF. The first 128 bits of the 256 bits of key material is used when doing AES-128 (NX/LN). |
| Group Temporal Key | 128-bit (Wi-Fi) or 256-bit (Nx/LN) AES-CCM key. Created by access point and distributed to all peers, wrapped with key encryption key (enc) and key confirmation key (auth). The first 128 bits of the 256 bits of key material is used when doing AES-128 (NX/LN). |
| Integrity Group Temporal Key | 128-bit AES-CMAC key (Wi-Fi). Created by access point and distributed to all peers, wrapped with key encryption key (enc) and key confirmation key (auth). |
| **IKEv1 Keys** | |
| Pre-Shared Key | 160-512 bit key used to authenticate/encrypt VPN tunnel when using IKEv1 |
| SKEYID | 160-512 bit keys used by each IKE SA to derive the other key material |
| SKEYID_d | 160-512 bit keys used by each IKE SA to derive keys |
| SKEYID_e | Keys used by each IKE SA to protect the confidentiality of its messages (AES-128, AES-256, or 3-key Triple-DES) |
| SKEYID_a | Keys used by each IKE SA to authenticate messages (HMAC-SHA-1, HMAC-SHA-256, HMAC-SHA-384, or HMAC-SHA-512) |
| Child SA Keys | 128-512 bit keys used to protect each Child SA |
| **IKEv2 Keys** | |
| Pre-Shared Key | 160-512 bit key used to authenticate/encrypt VPN tunnel when using IKEv2 |

| CSP | Description / Usage |
|---|---|
| SKEYSEED | 160-512 bit keys used by each IKE SA to derive the other key material |
| SK_d | 160-512 bit keys used to derive new keys for each Child SA |
| SK_ai | 160-512 bit HMAC key used for authenticating the message exchanges from the Initiator to the Responder |
| SK_ar | 160-512 bit HMAC key used for authenticating the message exchanges from the Responder to the Initiator |
| SK_ei | Used for encrypting messages from the Initiator to the Responder (AES-128, AES-256, or 3-key Triple-DES) |
| SK_er | Used for encrypting messages from the Responder to the Initiator (AES-128, AES-256, or 3-key Triple-DES) |
| SK_pi | 160-512 bit HMAC keys used to generate the AUTH payload messages from the Initiator to the Responder |
| SK_pr | 160-512 bit HMAC keys used to generate the AUTH payload messages from the Responder to the Initiator |
| Child SA Keys | 128-512 bit keys used to protect each Child SA |
| **SSH Ephemeral Keys** | |
| Shared Secret | Derived from Diffie-Hellman 2048 Exchange |
| Exchange Hash | Derived from Diffie-Hellman 2048 Exchange |
| Session ID | The initial Exchange Hash between a Client and a Server (160-512 bits). Copied of Exchange Hash from first connection between a Client and a Server. |
| Client to Server Initial IV | Initial IV (64 or 128 bits) used with block ciphers for messages from the Client to the Server. Computed from Shared Secret, Exchange Hash, SSH Session ID and the byte “A” using the selected hash function. |
| Server to Client Initial IV | Initial IV (64 or 128 bits) used with block ciphers for messages from the Server to the Client. Computed from Shared Secret, Exchange Hash, SSH Session ID and the byte “B” using the selected hash function. |
| Client to Server Encryption Key | Used to encrypt data from Client to Server. Computed from Shared Secret, Exchange Hash, SSH Session ID and the byte “C” using the selected hash function. (AES-128, AES-256, or 3-key Triple-DES) |
| Server to Client Encryption Key | Used to encrypt data from Server to Client. Computed from Shared Secret, Exchange Hash, SSH Session ID and the byte “D” using the selected hash function. (AES-128, AES-256, or 3-key Triple-DES) |
| Client to Server Integrity Key | 160-512 bit HMAC key used to verify data from Client to Server. Computed from Shared Secret, Exchange Hash, SSH Session ID and the byte “E” using the selected hash function. |

| CSP | Description / Usage |
|---|---|
| Server to Client Integrity Key | 160-512 bit HMAC key used to verify data from Server to Client. Computed from Shared Secret, Exchange Hash, SSH Session ID and the byte "F" using the selected hash function. |
| **SNMPv3 Keys** | |
| Session Authentication Key | HMAC-SHA-1 key. Specified directly by security officer, or derived from passphrase via the SNMP KDF (SP800-135). |
| Session Encryption Key | AES-128 key. Specified directly by security officer, or derived from passphrase via the SNMP KDF (SP800-135). |
| **Remote Management protocol Keys** | |
| Pre-shared key | Pre shared key for remote management and to protect the programming protocol. Also used as a session HMAC (SHA1) key to provide authentication of Remote Management protocol handshake messages. (Size varies) |
| Remote Management programming session asymmetric private key | 2048-bit RSA key that is generated at the start of each reprogramming session. (Multicast file transport) |
| Remote Management programming session symmetric key | AES-256 key generated by RSA Key exchange, for use with AES-256-CCM protection of data blocks. (Multicast file transport) |
| **Other Keys & CSPs** | |
| Parameter Store encryption key | Encrypts values in the parameter database which are marked to be protected. (e.g., PSK values.) Initialized to default value. AES-128-CFB. |
| Certificate Store encryption key | Encrypts the certificate database (stored CSP data which is not in the parameter store). Initialized to default value. AES-256-CBC. |
| DRBG Seeds | Output values from the NDRNG to initialize the module's DRBGs. (≥768 bits) |
| DRBG States | Internal state values of the module's CTR DRBGs. (128-bit V, 256-bit Key) |
| **Passwords** | |
| Local passwords | Passwords used for operator authentication |
| RADIUS shared secret | Shared secret to mutually authenticate the RADIUS server and the module |
| One Time Passwords | Temporary passwords for one-time authentication |

| CSP | Description / Usage |
|---|---|
| SSH Client Shared Secret | Password used by the module to authenticate as a client to an external SSH server |

## 2.2 Public Keys

**Table 10 – Public Keys**

| Key | Description / Usage |
|---|---|
| RSA Public Keys (X.509) | RSA (size 2048 to 16384 bits) public device keys for various protocols which use X.509 certificates: TLS, IPSEC, EAP-TLS (for WiFi device auth, licensed radio device auth, unlicensed radio device auth)<br>Can be generated or imported, although generation requires external signing by a CA. Passed to client; used for signatures (w/DH) or for RSA key transport. |
| DSA Public Keys (X.509) | DSA-2048 or DSA-3072 public device keys for various protocols which use X.509 certificates: TLS, IPSEC, EAP-TLS (for WiFi device auth, licensed radio device auth, unlicensed radio device auth)<br>Can only be imported. Passed to client; used for signatures (w/DH). |
| CA Public Keys (X.509) | RSA (size 2048 to 16384 bits) or DSA public keys (size 2048 or 3072) corresponding to certificate authorities; for various protocols which use X.509 certificates: TLS, IPSEC, EAP-TLS (for WiFi device auth, licensed radio device auth, unlicensed radio device auth)<br>Can only be imported. |
| SSH Public Keys | RSA and DSA public keys for SSH (size 2048 or 3072). Generated internally on initialization or manually. Passed to client; used for signatures (w/DH). |
| Firmware package verification key | Used to verify new firmware packages. RSA-3072 with SHA-256. |
| HAB public key | RSA-3072 with SHA-256 to perform firmware integrity checking on boot. |
| TLS DH public key | DH-2048 or DH-3072 Public key used for PFS during a TLS exchange. Derived from TLS exchange. |
| Remote Management programming session asymmetric public key | RSA-2048 public key generated from the Remote Management programming session asymmetric private key at the start of each transmission of a data block. (Multicast file transport) |

# 3 Roles, Authentication and Services

## 3.1 Assumption of Roles

The module supports five (5) distinct operator roles: Admin (CO), Tech, Oper (User), SNMP, and Factory Reset. The cryptographic module enforces the separation of roles using individual sessions per operator. Re-authentication is enforced when changing roles. The module clears all authenticated sessions on power cycle.

The table below lists all operator roles supported by the module. The Module does not support a maintenance role or bypass capability. The Module supports concurrent operators, with the exception that each physical or virtual serial port can only support one operator at a time. The module supports a maximum of five (5) concurrent operators, which are physically separated by separate ports or logically separated by separate sessions. However, an Admin operator is always able to log in, in which case the Admin selects a currently active operator to be logged out.

Passwords (including One Time Passwords) are stored in the module in hashed form (1024-round PBKDF2 with HMAC/SHA-256) and are considered CSPs. Entered passwords are either manually distributed over a local channel (e.g., serial connection) or logically protected by an encrypted channel (e.g., TLS, SSH).

**Table 11 – Roles Description**

| Role ID | Role Description | Authentication Type | Authentication Data |
|---|---|---|---|
| Admin (CO) | Access to all module functionality | Role-based | Username & Password |
| | | Role-based | One-Time Password |
| | | Role-based | RADIUS |
| Tech | Read/write access of non-CSPs; can also set own password | Role-based | Username & Password |
| | | Role-based | RADIUS |
| Oper (User) | Read-only operations | Role-based | Username & Password |
| | | Role-based | RADIUS |
| SNMP | Read-only operations over SNMP | Identity-based | ID & Password to derive SNMPv3 session key(s) |
| Factory Reset | Reset the module to factory defaults | Role-based | One-Time Password |

## 3.2 Authentication Methods

### 3.2.1 Normal Password

The module can use password-based authentication over CLI (Serial, USB, or SSH) the WebUI, NETCONF, or SNMPv3. By default, the module enforces a minimum length of eight (8) characters, including one (1) capital, one (1) lowercase, and one (1) numerical character. The Admin role can modify the requirements but cannot reduce the minimum length.

For a worst-case scenario, the Admin may require that a password contain eight (8) numeric characters, in which case a minimum-length password would be all numeric. The resulting probability of false authentication would be 1 in 10^8, which is less than 1 in 1,000,000.

The module allows 60 password attempts per minute. This is enforced by the time it takes the module to calculate a password hash with PBKDF2 (see Section 3.1). Combining this with the worst-case password complexity scenario, a one-minute session of random login attempts would have a success probability of 1 in 1,670,000, which is less than 1 in 100,000.

Note that the use of RADIUS does not affect the above password requirements.

### 3.2.2 One Time Password

The one-time password is a random 40-byte binary value. The value is hashed with PBKDF2 (see Section 3.1 for specifics) and compared against a stored digest.

Since the value is fully random, the probability of false authentication for a One Time Password is 1 in 256^40 (1 in approximately 2.14 x 10^96), which is less than 1 in 1,000,000. The same velocity checking described in Section 3.2.1 applies (60 attempts per minute), which means the success probability of a one-minute attack is 1 in 3.56 x 10^94, which is less than 1 in 100,000.

## 3.3 Services

All services implemented by the Module are listed in the tables below. Each service description also describes all usage of CSPs by the service. These services are available in the Approved mode and in the non-Approved mode.

**Table 12 – Authenticated Services**

| Service | Description | Admin | Tech | Oper | SNMP | Fact. Reset |
|---|---|---|---|---|---|---|
| Local User Authentication | Authenticate locally with a fixed username and password. | X | X | X | | |
| RADIUS User Authentication | Authenticate remotely using RADIUS | X | X | X | | |
| Authentication Data Management | Configure and change RADIUS shared secret, and passwords for all operators, excluding OTPs | X | | | | |
| Update Tech Password | Admin or Tech user updates Tech password | X | X | | | |

| Service | Description | Admin | Tech | Oper | SNMP | Fact. Reset |
|---|---|---|---|---|---|---|
| Generate OTP | Generate a One-Time Password for Admin or Factory Reset | X | | | | |
| One-Time Password Authentication | Authenticate using a One-Time Password (OTP) | X | | | | X |
| SNMP Session | Authenticate and query using an SNMP session<br>(SNMPv3 in FIPS mode, SNMPv1/v2c/v3 in non-FIPS mode) | | | | X | |
| SSH Session | Establish a session with a client using the SSH Service | X | X | X | | |
| SSH Client Session | Use SSH client to connect to remote SSH server. | X | X | X | | |
| Web UI Session | Establish a Web session with a client via the WebUI service<br>(HTTPS in FIPS mode, HTTP or HTTPS in non-FIPS mode) | X | X | X | | |
| SSH Server Management | Generate private/public key pair for use by SSH service | X | | | | X |
| Remote Management Service | Reprogram a device remotely via a secure file transfer | X | X | | | |
| IPSec/IKE VPN | Configure the secure end-to-end IP links, which use IPsec VPN and a pre-shared key or certificate-based setup | X | | | | |
| PKI/Certificate Management | Generate/upload private keys/certificates for use in certificate-based security setup. | X | | | | |
| Ethernet Device Authentication | Configure the IEEE 802.1X based authentication and MAC authentication bypass (MAB) based authentication. | X | | | | |
| WiFi Device Security | Configure secure Wi-Fi link which uses a pre-shared key or EAP-TLS/RADIUS using certificates. | X | | | | |
| NX/LN Device Security | Configure the secure radio link which uses a pre-shared key or EAP-TLS/RADIUS using certificates. | X | | | | |

| Service | Description | Admin | Tech | Oper | SNMP | Fact. Reset |
|---|---|---|---|---|---|---|
| Event Logging | Securely send event logs to central SYSLOG sever by configuring SYSLOG over TLS. | X | X | | | |
| Show Status | View module status parameters. | X | X | X | X | |
| Reset to factory settings | Resets the module to factory settings. | X | | | | X |

The majority of the module's authenticated services are for configuration purposes. Most of these are available over multiple interfaces – HTTPS, NETCONF, SSH, etc. Configuration of cryptography-related functionality is restricted to the Admin (CO) role. The Tech role is restricted to the configuration of non-cryptographic functionality.

**Table 13 – Unauthenticated Services**

| Service | Description |
|---|---|
| Self-tests | Run self-tests by power cycling the module. |
| General network services | Communicate on a network; provide DHCP, DNS, NTP, SNTP, NHRP, etc. |

Without authentication, the module is limited to generic network services. Unauthenticated operators cannot modify module CSPs in any way.

Table 14 defines the relationship between access to CSPs and the different module services. The modes of access shown in the table are defined as:

- G = Generate: The module generates the CSP.
- R = Read: The module reads the CSP, and exports it from the module.
- E = Execute: The module executes using the CSP.
- W = Write: The module writes the CSP with specified data.
- Z = Zeroize: The module zeroizes the CSP.

## Table 14 – CSP Access Rights within Services

| Service | CSPs | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RSA Private Keys (X.509) | DSA Private Keys (X.509) | SSH Private Keys | TLS Ephemeral Keys | EAP-TLS Ephemeral Keys | EAPOL Pairwise Master Key | Other EAPOL Keys | IKEv1 Keys | IKEv2 Keys | SSH Ephemeral Keys | SNMPv3 Keys | Static Remote Management Protocol Keys | Ephemeral Remote Mgmt Protocol Keys | Parameter Store encryption key | Certificate Store encryption key | DRBG Seeds and DRBG States | Local passwords | RADIUS Shared Secret | One Time Passwords | SSH Client Shared Secret |
| Local User Authentication | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | GEZ | WE | -- | -- | -- |
| RADIUS User Authentication | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | E | -- | GEZ | -- | E | -- | -- |
| Auth. Data Management | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | W | W | -- | -- |
| Update Tech Password | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | GEZ | W* | -- | -- | -- |
| Generate OTP | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | GEZ | -- | -- | GRZ | -- |
| OTP Auth. | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | WEZ | -- |
| SNMP Session | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | GEZ | -- | -- | E | -- | GEZ | -- | -- | -- | -- |
| SSH Session | -- | -- | E | -- | -- | -- | -- | -- | -- | GEZ | -- | -- | -- | -- | -- | GEZ | -- | -- | -- | -- |
| SSH Client Session | -- | -- | -- | -- | -- | -- | -- | -- | -- | GEZ | -- | -- | -- | -- | -- | GEZ | -- | -- | -- | RE |
| Web UI Session | E | E | -- | GEZ | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | E | GEZ | -- | -- | -- | -- |
| SSH Server Management | -- | -- | GW | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | GEZ | -- | -- | -- | -- |
| Remote Management | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | WE | GEZ | E | -- | GEZ | -- | -- | -- | -- |
| PKI/Certificate Management | GWEZ | GWEZ | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | E | WE | GEZ | -- | -- | -- | -- |
| IPSec/IKE VPN | -- | -- | -- | -- | -- | -- | -- | WGEZ | WGEZ | -- | -- | -- | -- | -- | E | GEZ | -- | -- | -- | -- |
| Ethernet Device Authentication | E | E | -- | GEZ | GEZ | E | WGEZ | -- | -- | -- | -- | -- | -- | E | E | GEZ | -- | -- | -- | -- |
| Wi-Fi Device Security | E | E | -- | GEZ | GEZ | GWEZ | WGEZ | -- | -- | -- | -- | -- | -- | E | E | GEZ | -- | -- | -- | -- |
| NX/LN Device Security | E | E | -- | GEZ | GEZ | GWEZ | WGEZ | -- | -- | -- | -- | -- | -- | E | E | GEZ | -- | -- | -- | -- |
| Event Logging | E | E | -- | GEZ | -- | E | -- | -- | -- | -- | -- | -- | -- | -- | E | GEZ | -- | -- | -- | -- |
| Show Status | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | R | R | -- | -- | R | -- | -- | R | -- | R |
| Reset to factory settings | ZG** | Z | ZG** | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z | Z |

* For the Tech role, password change is limited to the role's own password.

** "ZG" keys are zeroized and then replaced with newly generated values.

### Table 15 – Public Key Access Rights within Services

| Service | Public Keys | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | RSA Public Keys (X.509) | DSA Public Keys (X.509) | CA Public Keys (X.509) | SSH Public Keys | FW Package Verification Key | HAB public key | TLS DH Public Key | Remote Management Asymmetric Public Key |
| Local User Authentication | -- | -- | -- | -- | -- | -- | -- | -- |
| RADIUS User Authentication | -- | -- | -- | -- | -- | -- | -- | -- |
| Auth. Data Management | -- | -- | -- | -- | -- | -- | -- | -- |
| Update Tech Password | -- | -- | -- | -- | -- | -- | -- | -- |
| Generate OTP | -- | -- | -- | -- | -- | -- | -- | -- |
| OTP Auth. | -- | -- | -- | -- | -- | -- | -- | -- |
| SNMP Session | -- | -- | -- | -- | -- | -- | -- | -- |
| SSH Session | -- | -- | -- | E | -- | -- | -- | -- |
| SSH Client Session | -- | -- | -- | -- | -- | -- | -- | -- |
| Web UI Session | RE | RE | E | -- | -- | -- | GEZ | -- |
| SSH Server Management | -- | -- | -- | GW | -- | -- | -- | -- |
| Remote Management | -- | -- | -- | -- | -- | -- | -- | WE |
| PKI/Certificate Management | GWEZ | GWEZ | GWEZ | -- | -- | -- | -- | -- |
| IPSec/IKE VPN | -- | -- | -- | -- | -- | -- | -- | -- |
| Ethernet Device Authentication | RE | RE | E | -- | -- | -- | GEZ | -- |
| Wi-Fi Device Security | RE | RE | E | -- | -- | -- | GEZ | -- |
| NX/LN Device Security | RE | RE | E | -- | -- | -- | GEZ | -- |
| Event Logging | RE | RE | E | -- | -- | -- | GEZ | -- |
| Show Status | -- | -- | -- | -- | -- | -- | -- | R |
| Reset to factory settings | ZG* | Z | Z | ZG* | E | E | Z | Z |

* “ZG” keys are zeroized and then replaced with newly generated values.

# 4 Self-Tests

Each time the Module is powered up, it tests that the cryptographic algorithms still operate correctly and that the firmware has not been damaged. Power up self–tests are available on demand by power cycling the module.

On power up or reset, the Module performs the self-tests described in Table 16 below. All power-on self-tests must be completed successfully prior to any other use of cryptography by the Module. If any of the KATs fail, the Module enters the SOFT ERROR 1 state and reboots. If the Firmware Integrity test fails, the module either enters the HARD ERROR 1 state and halts (bootloader integrity failure) or enters the HARD ERROR 2 state and reboots (post-bootloader integrity failure).

The module will try to recover from Conditional Self-Test failures (SOFT ERROR 2 to retry the action or re-instantiate the library, and SOFT ERROR 3 to reject bad firmware); if this fails, the module enters the SOFT ERROR 1 state and reboots.

**Table 16 – Power Up Self-Tests**

| Test Target | Description |
|---|---|
| Firmware Integrity | RSA 3072 / SHA-256 verification of internal firmware on boot. |
| **OpenSSL** | |
| AES<br>Cert. #4539 | KATs: Encryption, Decryption<br>Mode: ECB<br>Key sizes: 128 bits |
| CCM<br>Cert. #4539 | KATs: Encryption, Decryption<br>Key sizes: 192 bits |
| CMAC<br>Cert. #4539 | KATs: Generation, Verification<br>Key sizes: AES (128, 192, 256 bits), Triple-DES (192 bits) |
| DRBG<br>Cert. #1496 | KATs: HASH DRBG, HMAC DRBG, CTR DRBG<br>Security Strengths: 128, 192, 256 bits |
| DSA<br>Cert. #1210 | PCT: Signature Generation, Signature Verification<br>Key sizes: 2048 bits |
| GCM<br>Cert. #4539 | KATs: Encryption, Decryption<br>Key sizes: 256 bits |
| HMAC<br>Cert. #2997 | KATs: Generation, Verification<br>SHA sizes: SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 |
| RSA<br>Cert. #2471 | KATs: Signature Generation, Signature Verification<br>Key sizes: 2048 bits |
| SHA<br>Cert. #3720 | KATs: SHA-1 |
| Triple-DES<br>Cert. #2416 | KATs: Encryption, Decryption<br>Modes: TECB<br>Key sizes: 3-key |
| **Mocana** | |
| AES<br>Cert. #5887 | KATs: Encryption, Decryption<br>Modes: ECB, CBC, CTR, CFB<br>Key sizes: 256 bits (128 for CFB) |

| Test Target | Description |
|---|---|
| DRBG<br>Cert. #2450 | KATs: CTR DRBG<br>Modes: AES-256<br>Security Strengths: 256 bits |
| DSA<br>Cert. #1484 | PCT: Signature Generation, Signature Verification<br>Key sizes: 2048 bits |
| HMAC<br>Cert. #3864 | KATs: Generation, Verification<br>SHA sizes: SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 |
| RSA<br>Cert. #3085 | KATs: Signature Generation, Signature Verification<br>Key sizes: 2048 bits |
| SHA<br>Cert. #4639 | KATs: SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 |
| Triple-DES<br>Cert. #2867 | KATs: Encryption, Decryption<br>Modes: TCBC,<br>Key sizes: 3-key |
| **Linux Kernel** | |
| AES<br>Cert. #5888 | KATs: Encryption, Decryption<br>Modes: CBC, CTR<br>Key sizes: 128, 192, 256 bits |
| CCM<br>Cert. #5888 | KATs: Encryption, Decryption<br>Key sizes: 128 bits |
| GCM<br>Cert. #5888 | KATs: Encryption, Decryption<br>Key sizes: 128, 192, 256 bits |
| SHA<br>Cert. #4640 | KATs: SHA-1, SHA-224, SHA-256, SHA-384, SHA-512 |
| Triple-DES<br>Cert. #2868 | KATs: Encryption, Decryption<br>Modes: TECB, TCBC<br>Key sizes: 3-key |
| CMAC<br>Cert. #5888 | KATs: Generation, Verification<br>Key sizes: AES with 128 bits |
| **IEEE 802.11 Crypto API** | |
| AES<br>Cert. #5889 and<br>Cert. #4539 | KATs: Encryption, Decryption<br>Modes: AES-KW<br>Security Strengths: 128 bits<br>Note: AES-KW Cert. #5889 uses the AES Cert. #4539 from OpenSSL, which provides the underlying KAT. |

**Table 17 – Conditional Self-tests**

| Test Target | Description |
|---|---|
| DRBG Health Checks | Performed conditionally per SP 800-90A-rev1 Section 11.3. |
| NDRNG | NDRNG Continuous Test performed when a random value is requested from the NDRNG. |

| Test Target | Description |
|---|---|
| DRBG<br>Certs. #1496 and #2450 | DRBG Continuous Test performed when a random value is requested from the DRBG. |
| DSA<br>Certs. #1210 and #1484 | DSA Pairwise Consistency Test performed on every DSA key pair generation. |
| RSA<br>Certs. #2471 and #3085 | RSA Pairwise Consistency Test performed on every RSA key pair generation. |
| Firmware Load | RSA 3072 / SHA-256 signature verification performed when firmware is loaded. |

# 5 Physical Security Policy

The module is encased in a metal enclosure, protected by a tamper-evident seal. Each form factor contains one (1) seal, which is placed on the left side of the device in the factory (see Figures 2 and 3). Ensure the seal is in-place at the location shown in the figures below, and that neither it nor the module enclosure have been damaged. During operational usage, it is recommended to inspect the seal and enclosure once every three months (Table 18). If the magnetometer (see Section 7) is active and calibrated, it is also recommended to inspect the tamper seal if the magnetometer logs an event.

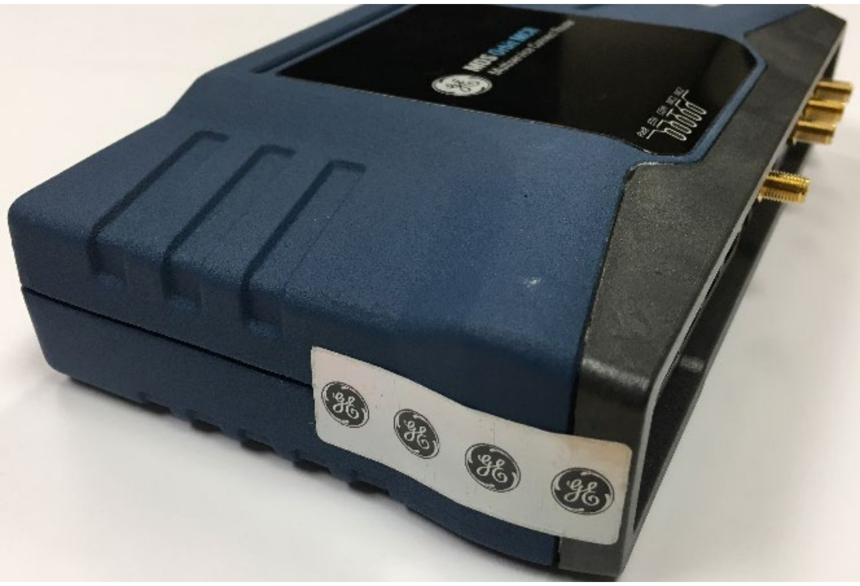


**Figure 2 – Tamper Seal Location (Large Form Factor)**

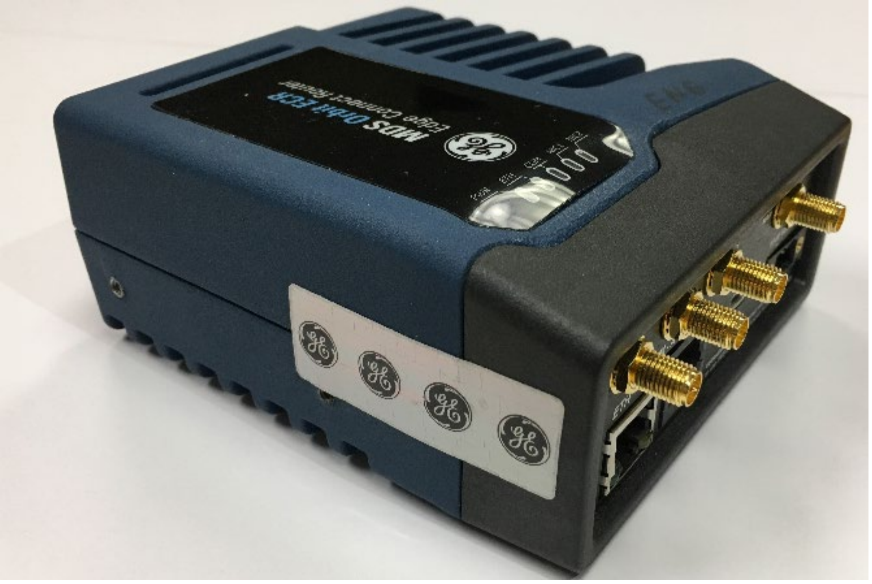


**Figure 3 – Tamper Seal Location (Small Form Factor)**

**Table 18 – Physical Security Inspection Guidelines**

| Physical Security Mechanism | Recommended Frequency of Inspection/Test | Inspection/Test Guidance Details |
|---|---|---|
| Tamper Evident Seal | 3 months; whenever magnetometer logs an event (if active) | Verify that the tamper evident seal placed on the side of the chassis is intact and shows no sign of delamination. See Figures 2 and 3 above for seal placement. |
| Module enclosure | Same as above | Verify that the module enclosure does not show any sign of forced entry.<br>Verify that the black cover (reading "MDS ORBIT MCR" or "MDS ORBIT ECR") has not been removed or damaged. |

If the above guidelines yield evidence of tamper, the Administrator should assume the module has been physically compromised, perform zeroization, and take system-level precautions as needed (e.g., revoke the trust of the module's certificates on other systems).

# 6 Operational Environment

The Module is designated as a limited operational environment under the FIPS 140-2 definitions. The Module includes a firmware load service to support necessary updates. New firmware versions within the scope of this validation must be validated through the FIPS 140-2 CMVP. Any other firmware loaded into this module is out of the scope of this validation and will require a separate FIPS 140-2 validation.

# 7 Mitigation of Other Attacks

The unit contains a three-axis magnetometer that can be used to detect changes in the unit's "magnetic environment" after installation (e.g., if the module is moved such that local magnetic fields change, or if a metal cabinet containing the Module is opened, or if the metal chassis of the Module itself is opened) and generate notification of the change if it exceeds configurable thresholds.

This does not provide Level 3 physical security (e.g., tamper response) but can be used in conjunction with the tamper evident seal to remotely detect and then locally verify that tamper has occurred.

# 8 Security Rules and Guidance

The Module design corresponds to the Module security rules. This section documents the security rules enforced by the cryptographic module to implement the security requirements of this FIPS 140-2 Level 2 module.

1. The module provides five (5) distinct operator roles: Admin (CO), Tech, Oper (User), SNMP, and Factory Reset.
2. The module provides a combination of role-based and identity-based authentication.
3. The module clears previous authentications on power cycle, as all session data is stored in volatile memory (RAM and tmpfs).
4. When the module has not been placed in a valid role, the operator does not have access to any cryptographic services aside from those allowed by IG 3.1.
5. The operator can command the module to perform the power up self-tests by cycling power or resetting the module.
6. Power up self-tests do not require any operator action.
7. Data output is inhibited during self-tests, zeroization, and error states. Data output is logically disconnected from the processes performing key generation. The network interface manager does not start up interfaces until long after FIPS tests are complete.
8. The UI provides the control/status/data interface separation for all network interfaces. The console port is a control interface except when the terminal server application has it in data mode.
9. Status information does not contain CSPs or sensitive data that if misused could lead to a compromise of the module.
10. There are no restrictions on which keys or CSPs are zeroized by the zeroization service.
11. The module supports concurrent operators.
12. The module does not support a maintenance interface or role.
13. The module does not support manual key entry.
14. The module does have external input/output devices used for entry/output of data.
15. Plaintext CSPs can be entered into the module, but the module will not output them upon being queried.
16. The module does not output intermediate key values.
17. The module limits the use of the same Triple-DES key to $2^{20}$ encryptions, based on only using the following IETF protocols, and $2^{16}$ for non-IETF protocols. The user is responsible for ensuring the module's compliance.
    a. SSH - RFC4251
    b. SCEP - draft-nourse-scep-23
    c. IPSec/IKE VPN - RFC6071, RFC2409 , RFC7296, RFC4307, RFC2451
18. The module supports communicating with a RADIUS server, which should be protected within an IPSEC tunnel setup by the user.

# 9 References and Definitions

The following standards are referred to in this Security Policy.

**Table 19 – References**

| Abbreviation | Full Specification Name |
|---|---|
| [FIPS140-2] | *Security Requirements for Cryptographic Modules*, May 25, 2001 |

**Table 20 – Acronyms and Definitions**

| Acronym | Definition |
|---|---|
| ECR | Edge Connect Router |
| EMC | Electromagnetic Compatibility |
| EMI | Electromagnetic Interference |
| HAB | High Assurance Boot |
| KAT | Known Answer Test |
| LN | Licensed radio module |
| MCR | Multiservice Connect Router |
| NX | Unlicensed radio module |
| OTP | One Time Password |
| RADIUS | Remote Authentication Dial-In User Service |
| RP-SMA | Reversed-Polarity SMA |
| SIM | Subscriber Identification Module |
| SMA | Sub-Miniature version A |
| TNC | Threaded Neill-Concelman |
| USB | Universal Serial Bus |