PAN-OS 11.0 running on PA-400 Series, PA-800 Series, PA-1400 Series, PA-3200 Series, PA-3400 Series, PA-5200 Series, PA-5400 Series, PA-5450, and PA-7000 Series NGFWs

FIPS 140-3 Non-Proprietary Security Policy

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1. General

Palo Alto Networks offers a full line of next-generation security appliances. Our platform architecture is based on our single-pass engine, PAN-OS, for networking, security, threat prevention, and management functionality that is consistent across all platforms. The devices differ only in capacities, performance, and physical configuration.

The cryptographic modules meet the overall requirements applicable to Level 2 security of FIPS 140-3.

Table 1 - Security Levels

ISO/IEC 24759 Section 6. [Number Below]	FIPS 140-3 Section Title	Security Level
1	General	2
2	Cryptographic Module Specification	2
3	Cryptographic Module Interfaces	2
4	Roles, Services, Authentication	3
5	Software/Firmware Security	2
6	Operational Environment	N/A
7	Physical Security	2
8	Non-Invasive Security	N/A
9	Sensitive Security Parameter Management	2
10	Self-Tests	2
11	Life-Cycle Assurance	3
12	Mitigation of Other Attacks	N/A
Overall Level		2

2. Cryptographic Module Specification

Purpose

The Palo Alto Networks PA-400 Series, PA-800 Series, PA-1400 Series, PA-3200 Series, PA-3400 Series, PA-5200 Series, PA-5400 Series, PA-5450, and PA-7000 Series NGFWs (hereafter referred to as the modules) are multi-chip standalone hardware modules that provide network security by enabling enterprises to see and control applications, users, and content – not just ports, IP addresses, and packets – using three unique identification technologies: App-ID, User-ID, and Content-ID. These identification technologies, found in Palo Alto Networks' enterprise firewalls, enable enterprises to create business-relevant security policies – safely enabling organizations to adopt new applications, instead of the traditional "all-or-nothing" approach offered by traditional port-blocking firewalls used in many security infrastructures.

Features and Benefits

- Application visibility and control: Accurate identification of the applications traversing the network enables policy-based control over application usage at the firewall, the strategic center of the security infrastructure.
- Visualization tools: Graphical visibility tools, customizable reporting and logging enables administrators to make a more informed decision on how to treat the applications traversing the network.
- Application browser: Helps administrators quickly research what the application is, its behavioral characteristics and underlying technology resulting in a more informed decision making process on how to treat the application.
- User-based visibility and control: Seamless integration with enterprise directory services facilitates application visibility and policy creation based on user and group information, not just IP address. An XML API enables integration with other, 3rd party user repositories.
- Real-time threat prevention: Detects and blocks application vulnerabilities, viruses, spyware, and worms; controls web activity; all in real-time, dramatically improving performance and accuracy.

- File and data filtering: Taking full advantage of the in-depth application inspection being performed by App-ID, administrators can implement several different types of policies that reduce the risk associated with unauthorized file and data transfer.
- Legacy firewall support: Support for traditional inbound and outbound port-based firewall rules mixed with application-based rules smooth the transition to a Palo Alto Networks next generation firewall.
- Networking architecture: Support for dynamic routing (OSPF, RIP, BGP, etc.), virtual wire mode and Layer 2 / Layer 3 modes facilitate deployment in nearly any networking environment.
- Policy-based Forwarding: Forward traffic based on policy defined by application, source zone/interface, source/destination address, source user/group, and service.
- Virtual Systems: Create multiple virtual "firewalls" within a single device as a means of supporting specific departments or customers. Each virtual system can include dedicated administrative accounts, interfaces, networking configuration, security zones, and policies for the associated network traffic.
- VPN connectivity: Secure site-to-site connectivity is enabled through standards-based IPSec VPN support while remote user access is delivered via SSL VPN connectivity.
- Quality of Service (QoS): Deploy traffic shaping policies (guaranteed, maximum and priority) to enable positive policy controls over bandwidth intensive, non-work related applications such as streaming media while preserving the performance of business applications.
- Real-time bandwidth monitor: View real-time bandwidth and session consumption for applications and users within a selected QoS class.
- Purpose-built platform: combines single pass engine with parallel processing hardware to deliver the multi-Gbps performance necessary to protect today's high-speed networks.

Tested Configurations

The configurations for this validation are highlighted in Table 2.

Model	Hardware [Part Number and Version]	Firmware Version	Distinguishing Features
PA-410	910-000231, Physical Kit: 920-000454	11.0.3-h12	RJ45 interfaces, USB, LED, Power supply, Ground stud
PA-415	910-000280, Physical Kit: 920-000455	11.0.3-h12	RJ45 ports, SFP/SFP+ ports, USB ports, Micro-USB, LED, Power
PA-440	910-000212, Physical Kit: 920-000454	11.0.3-h12	RJ 45 interfaces, USB, LEDs, Micro USB
PA-445	910-000281, Physical Kit: 920-000455	11.0.3-h12	RJ 45 interfaces, USB, LEDs, Micro USB
PA-450	910-000232, Physical Kit: 920-000454	11.0.3-h12	RJ 45 interfaces, USB, LEDs, Micro USB
PA-460	910-000230, Physical Kit: 920-000454	11.0.3-h12	RJ 45 interfaces, USB, LEDs, 1 Micro USB
PA-820	910-000120, Physical Kit: 920-000185	11.0.3-h12	RJ45 Ports, Micro-USB, SFP, SFP/SFP+, Power, LEDs, USB
PA-850	910-000119, Physical Kit: 920-000185	11.0.3-h12	RJ45 Ports, Micro-USB, SFP, SFP/SFP+, Power, LEDs, USB
PA-1410	910-000267, Physical Kit: 920-000392	11.0.3-h12	RJ45 ports, SFP/SFP+ ports, HSCI ports, USB ports, Micro-USB, LED, Power
PA-1420	910-000269, Physical Kit: 920-000392	11.0.3-h12	RJ45 ports, SFP/SFP+ ports, HSCI ports, USB ports, Micro-USB, LED, Power
PA-3220	910-000162, Physical Kit: 920-000212	11.0.3-h12	RJ45 ports, SFP/SFP+ ports, QSFP+ ports, HSCI ports, USB ports, Micro-USB, LED, Power
PA-3250	910-000163, Physical Kit: 920-000212	11.0.3-h12	RJ45 ports, SFP/SFP+ ports, QSFP+ ports, HSCI ports, USB ports, Micro-USB, LED, Power
PA-3260	910-000164, Physical Kit: 920-000212	11.0.3-h12	RJ45 ports, SFP/SFP+ ports, QSFP+ ports, HSCI ports, USB ports, Micro-USB, LED, Power
PA-3410	910-000241, Physical Kit: 920-000333	11.0.3-h12	1 x 1000Base-T (management) - RJ-45, 1 x 10Gb Ethernet (HA) - SFP+, 1 x console - RJ-45, 1 x management (USB) - micro-USB, 10 x 1Gb Ethernet/10Gb Ethernet - SFP/SFP+, 12 x 1/2.5/5/10GBase-T - RJ-45, 2 x 1000Base-T (HA) - RJ-45, 4 x 25Gb Ethernet - SFP28
PA-3420	910-000242, Physical Kit: 920-000333	11.0.3-h12	1 x 1000Base-T (management) - RJ-45, 1 x 10Gb Ethernet (HA) - SFP+, 1 x console - RJ-45, 1 x management (USB) - micro-USB, 10 x 1Gb Ethernet/10Gb Ethernet - SFP/SFP+, 12 x 1/2.5/5/10GBase-T - RJ-45, 2 x 1000Base-T (HA) - RJ-45, 4 x 25Gb Ethernet - SFP28
PA-3430	910-000243, Physical Kit: 920-000333	11.0.3-h12	1 x 1000Base-T (management) - RJ-45, 1 x 10Gb Ethernet (HA) - SFP+, 1 x console - RJ-45, 1 x management (USB) - micro-USB, 10 x 1Gb Ethernet/10Gb Ethernet - SFP/SFP+, 12 x 1/2.5/5/10GBase-T - RJ-45, 2 x 1000Base-T (HA) - RJ-45, 4 x 25Gb Ethernet - SFP28

PA-3440	910-000244, Physical Kit: 920-000333	11.0.3-h12	1 x 1000Base-T (management) - RJ-45, 1 x 10Gb Ethernet (HA) - SFP+, 1 x console - RJ-45, 1 x management (USB) - micro-USB, 10 x 1Gb Ethernet/10Gb Ethernet - SFP/SFP+, 12 x 1/2.5/5/10GBase-T - RJ-45, 2 x 1000Base-T (HA) - RJ-45, 4 x 25Gb Ethernet - SFP28
PA-5220	910-000132, Physical Kit: 920-000186	11.0.3-h12	RJ45 ports, SFP/SFP+, QSFP28 port, QSFP+ ports, HSCI ports, SFTP+ ports, Power supply, LEDs, USB
PA-5250	910-000131, Physical Kit: 920-000186	11.0.3-h12	RJ45 ports, SFP/SFP+, QSFP28 port, QSFP+ ports, HSCI ports, SFTP+ ports, Power supply, LEDs, USB
PA-5260	910-000125, Physical Kit: 920-000186	11.0.3-h12	RJ45 ports, SFP/SFP+, QSFP28 port, QSFP+ ports, HSCI ports, SFTP+ ports, Power supply, LEDs, USB
PA-5280	910-000157, Physical Kit: 920-000186	11.0.3-h12	RJ45 ports, SFP/SFP+, QSFP28 port, QSFP+ ports, HSCI ports, SFTP+ ports, Power supply, LEDs, USB
PA-5410	910-000252, Physical Kit: 920-000320	11.0.3-h12	1 x 1000Base-X (management) – SFP, 1 x 40Gb Ethernet (management) - QSFP+, 1 x console - RJ-45, 1 x micro-USB, 12 x 10Gb Ethernet - SFP+, 2 x 1 Gigabit Ethernet (High Availability) – SFP, 4 x 25Gb Ethernet - SFP28, 4 x 40Gb Ethernet/100Gb Ethernet - QSFP28, 8 x 1/2.5/5/10GBase-T - RJ-45
PA-5420	910-000253, Physical Kit: 920-000320	11.0.3-h12	1 x 1000Base-X (management) – SFP, 1 x 40Gb Ethernet (management) - QSFP+, 1 x console - RJ-45, 1 x micro-USB, 12 x 10Gb Ethernet - SFP+, 2 x 1 Gigabit Ethernet (High Availability) – SFP, 4 x 25Gb Ethernet - SFP28, 4 x 40Gb Ethernet/100Gb Ethernet - QSFP28, 8 x 1/2.5/5/10GBase-T - RJ-45
PA-5430	910-000254, Physical Kit: 920-000320	11.0.3-h12	1 x 1000Base-X (management) – SFP, 1 x 40Gb Ethernet (management) - QSFP+, 1 x console - RJ-45, 1 x micro-USB, 12 x 10Gb Ethernet - SFP+, 2 x 1 Gigabit Ethernet (High Availability) – SFP, 4 x 25Gb Ethernet - SFP28, 4 x 40Gb Ethernet/100Gb Ethernet - QSFP28, 8 x 1/2.5/5/10GBase-T - RJ-45
PA-5440	910-000255, Physical Kit: 920-000320	11.0.3-h12	1 x 1000Base-X (management) – SFP, 1 x 40Gb Ethernet (management) - QSFP+, 1 x console - RJ-45, 1 x micro-USB, 12 x 10Gb Ethernet - SFP+, 2 x 1 Gigabit Ethernet (High Availability) – SFP, 4 x 25Gb Ethernet - SFP28, 4 x 40Gb Ethernet/100Gb Ethernet - QSFP28, 8 x 1/2.5/5/10GBase-T - RJ-45
PA-5450*	910-000223, Physical Kit: 920-000309, PA-5400 BC-A: 920-000293, PA-5400 MPC-A: 910-000195, PA-5400 NC-A: 910-000194, PA-5400 DPC-A: 910-000204	11.0.3-h12	Networking cards, Data processing cards, Base cards, Management processor cards, Electrostatic Discharge, LEDs, Logging Drive Corner, USB, Console port, HSCI-A/B, Logging ports, Management Ports, HA ports, Ejector Tabs, RJ45, QSFP28, SFP/SFP+, Ground Studs, Fans, Power
PA-7050**	910-000102, Physical Kit: 920-000112, PAN-PA-7050-SMC-B: 910-000185,	11.0.3-h12	Networking cards, Log/Data processing cards, Log forwarding cards, Management processor cards,

	PAN-PA-7000-DPC-A: 910-000169, PAN-PA-7000-LFC-A: 910-000183, PAN-PA-7000-100G-NPC-A: 910-000156		RJ45 ports, SFP ports, SFP+ ports, HSCI ports, QSFP+ ports, Power supply, Power Switch, LEDs, USB
PA-7080**	910-000122, Physical Kit: 920-000119, PAN-PA-7080-SMC-B: 910-000186, PAN-PA-7000-DPC-A: 910-000169, PAN-PA-7000-LFC-A: 910-000183, PAN-PA-7000-100G-NPC-A: 910-000156	11.0.3-h12	Networking cards, Log/Data processing cards, Log forwarding cards, Management processor cards, RJ45 ports, SFP+, HSCI, QSFP+, Power Switch, LEDs, USB

* Palo Alto Networks PA-5450 firewalls are tested with the following cards that can be configured for use in the Approved mode of operation

PA-5450 Cards

- Base Card (BC): PA-5400 BC-A P/N: 920-000293
- Management Processor Card (MPC): PA-5400 MPC-A P/N: 910-000195
- Networking Card (NC): PA-5400 NC-A P/N: 910-000194
- Data Processor Card (DPC): PA-5400 DPC-A P/N: 910-000204

**PA-7050/7080 uses the following cards below. The required cards include the SMC (must use either the 7050 or 7080 to match the chassis), LFC, and at least one NPC. A DPC can be optionally utilized as well, but must be accompanied by at least one NPC.

Network Processing Cards:

- PAN-PA-7000-100G-NPC-A: P/N: 910-000156

Log Forwarding Card:

- PAN-PA-7000-LFC-A: P/N: 910-000183

Log/Data Processing Card:

- PAN-PA-7000-DPC-A: P/N: 910-000169

Switch Management Cards:

- PAN-PA-7080-SMC-B: P/N: 910-000186
- PAN-PA-7050-SMC-B: P/N: 910-000185

Table 2 - Cryptographic Module Tested Configuration

Approved Mode of Operation

The following procedure will put the modules into the Approved mode of operation:

- Install physical kit opacity shields and tamper evidence seals according to the Physical Security Policy section. Physical KitFIPS kits must be correctly installed to operate in the Approved mode of operation. The tamper evidence seals and opacity shields shall be installed for the module to operate in the Approved mode of operation.
- During initial boot up, break the boot sequence via the console port connection (by pressing the maint button when instructed to do so) to access the main menu.
- Select “Continue.”
- Select the “Set FIPS-CC Mode” option to enter the Approved mode.
- Select “Enable FIPS-CC Mode”.
- When prompted, select “Reboot” and the module will re-initialize and continue into “FIPS-CC” mode (Approved mode).
- The module will reboot.
- In “FIPS-CC” mode, the console port is available as a status output port.
- Once the module has finished booting, the Crypto Officer can authenticate using the default credentials that come with the module
    - Once authenticated, the module will automatically require the operator to change their password; and the default credential is overwritten

The module will automatically indicate the Approved mode of operation in the following manner:

- Status output interface will indicate "**** FIPS-CC MODE ENABLED ****" via the CLI session.
- Status output interface will indicate "FIPS-CC mode enabled successfully" via the console port.
- The module will display "FIPS-CC" at all times in the status bar at the bottom of the web interface.

Should one or more power-up self-tests fail, the Approved mode of operation will not be achieved. Feedback will consist of:

- The module will output "FIPS-CC failure"
- The module will reboot and enter a state in which the reason for the reboot can be determined.
- To determine which self-test caused the system to reboot into the error state, connect the console cable and follow the on-screen instructions to view the self-test output.

Note: Disabling FIPS-CC mode causes a complete factory reset, which is described in the Zeroization section below.

Non-Compliant State

Failure to follow the directions in the Approved Mode of Operation above and Section 11 will result in the module operating in a non-compliant state.

Zeroization

The following procedure will zeroize the module:

- Access the module's CLI via SSH, and command the module to enter maintenance mode; the module will reboot
  - Note: Establish a serial connection to the console port
- After reboot, select "Continue."
- Select "Factory Reset"
- The module will perform a zeroization, and provide the following message once complete:
  - "Factory Reset Status: Success"

Note: Following the completion of this procedure, the module will be placed back into an uninitialized state.

Uninitialized State

If the module does not successfully transition into the Approved mode of operation, or zeroization is performed, the module will be in an uninitialized state. It is required to initialize the module in order to perform cryptographic functions.

Approved and Allowed Algorithms

The following table details the cryptographic algorithms and their algorithm certificates. Only the algorithms, modes, and key sizes specified in this table are used by the module. The CAVP certificate may contain more tested options than listed in this table.

Table 3 - Approved Algorithms

CAVP Cert	Algorithm and Standard	Mode/Method	Description / Key Size(s) / Key Strength(s)	Use / Function
A2138	Conditioning Component AES-CBC-MAC SP 800-90B	AES-CBC-MAC	128 bits	Vetted conditioning component for ESV Cert. #E70
A2153				Vetted conditioning component for ESV Cert. #E68
A2165				Vetted conditioning component for ESV Cert. #E72, E73

CAVP Cert	Algorithm and Standard	Mode/Method	Description / Key Size(s) / Key Strength(s)	Use / Function
A2541				Vetted conditioning component for ESV Cert. #E71
A3453	AES-CBC [SP 800-38A]	CBC	128, 192 and 256 bits	Encryption Decryption
A3453	AES-CCM [SP 800-38C]	CCM	128 bits	Encryption Decryption
A3453	AES-CFB128 [SP 800-38A]	CFB128	128 bits	Encryption Decryption
A3453	AES-CTR [SP 800-38A]	CTR	128, 192 and 256 bits	Encryption Decryption
A3453	AES-GCM [SP 800-38D]	GCM**	128 and 256 bits	Encryption Decryption
A3453	Counter DRBG [SP 800-90Arev1]	CTR DRBG	AES 256 bits with Derivation Function Enabled	Random Bit Generator
A3453	ECDSA KeyGen (FIPS 186-4)	ECDSA KeyGen	P-256, P-384, P-521	Key Generation
A3453	ECDSA KeyVer (FIPS 186-4)	ECDSA KeyVer	P-256, P-384, P-521	Public Key Validation
A3453	ECDSA SigGen (FIPS 186-4)	ECDSA SigGen	P-256, P-384, P-521 with SHA2-224, SHA2-256, SHA2-384, and SHA2-512	Signature Generation
A3453	ECDSA SigVer (FIPS 186-4)	ECDSA SigVer	P-256, P-384, P-521 with SHA-1, SHA2-224, SHA2-256, SHA2-384, and SHA2-512	Signature Verification
A3453	HMAC-SHA-1 [FIPS 198-1]	HMAC	HMAC-SHA-1 with λ=96, 160	Authentication for protocols
A3453	HMAC-SHA2-224 [FIPS 198-1]	HMAC	HMAC-SHA2-224 with λ=224	Authentication for protocols
A3453	HMAC-SHA2-256 [FIPS 198-1]	HMAC	HMAC-SHA2-256 with λ=256	Authentication for protocols
A3453	HMAC-SHA2-384 [FIPS 198-1]	HMAC	HMAC-SHA2-384 with λ=384	Authentication for protocols
A3453	HMAC-SHA2-512 [FIPS 198-1]	HMAC	HMAC-SHA2-512 with λ=512	Authentication for protocols
A3453	KAS-ECC-SSC Sp800-56Ar3	KAS	P-256/P-384/P-521	Key Exchange
A3453	KAS-FFC-SSC SP 800-56Ar3	KAS	MODP-2048/3072/4096	Key Exchange
A3453	KDF IKEv2 [SP 800-135rev1] (CVL)	IKEv2 KDF	SHA2-256, SHA2-384, SHA2-512	IKEv2
A3453	KDF SNMP [SP 800-135rev1] (CVL)	SNMPv3 KDF	Engine ID: 80001F88043030303030 343935323630	SNMPv3
A3453	KDF SSH [SP 800-135rev1] (CVL)	SSHv2 KDF	SHA-1, SHA2-256, SHA2-512	SSH
A3453	RSA KeyGen (FIPS 186-4)	RSA KeyGen (FIPS 186-4)	2048, 3072, and 4096 bits	Key Pair Generation
A3453	RSA SigGen (FIPS 186-4)	RSA SigGen (FIPS 186-4)	2048, 3072, and 4096-bit with hashes 256/384/512	Signature Generation
A3453	RSA SigVer (FIPS 186-4)	RSA SigVer (FIPS 186-4)	2048, 3072, 4096-bit (per IG C.F) with hashes SHA-1/224+++/256/384/512 (Signature Verification)	Signature Verification

CAVP Cert	Algorithm and Standard	Mode/Method	Description / Key Size(s) / Key Strength(s)	Use / Function
			+++ This Hash algorithm is not supported for ANSI X9.31	
A3453	SHA-1 [FIPS 180-4]	SHA	SHA-1	Digital Signature Generation/Verification Non-Digital Signature Applications (e.g. component of HMAC)
A3453	SHA2-224 [FIPS 180-4]	SHA2	SHA-224	Digital Signature Generation/Verification Non-Digital Signature Applications (e.g. component of HMAC)
A3453	SHA2-256 [FIPS 180-4]	SHA2	SHA-256	Digital Signature Generation/Verification Non-Digital Signature Applications (e.g. component of HMAC)
A3453	SHA2-384 [FIPS 180-4]	SHA2	SHA-384	Digital Signature Generation/Verification Non-Digital Signature Applications (e.g. component of HMAC)
A3453	SHA2-512 [FIPS 180-4]	SHA2	SHA-512	Digital Signature Generation/Verification Non-Digital Signature Applications (e.g. component of HMAC)
A3453	Safe Primes Key Generation [RFC 3526]	Safe Primes Key Generation	MODP-2048, MODP-3072, MODP-4096	Safe Primes Key Generation
A3453	Safe Primes Key Verification [RFC 3526]	Safe Primes Key Verification	MODP-2048, MODP-3072, MODP-4096	Safe Primes Key Verification
A3453	TLS v1.2 KDF RFC7627 (CVL)	TLS v1.2 KDF RFC7627	TLS v1.2 Hash Algorithm: SHA2-256, SHA2-384	TLS
AES Cert. #A3453 and HMAC Cert. #A3453	KTS [SP 800-38F]	SP 800-38A, FIPS 198-1, and SP 800-38F. KTS (key wrapping and unwrapping) per IG D.G.	AES-CBC or AES-CTR plus HMAC 128, 192, and 256-bit keys providing 128, 192, or 256 bits of encryption strength	Key Wrapping
AES-CCM Cert. #A3453	KTS [SP 800-38F]	SP 800-38C and SP 800-38F. KTS (key wrapping and unwrapping) per IG D.G.	AES-CCM 128-bit keys providing 128 bits of encryption strength	Key Wrapping
AES-GCM Cert. #A3453	KTS [SP 800-38F]	SP 800-38D and SP 800-38F. KTS (key wrapping and unwrapping) per IG D.G.	AES-GCM 128 and 256-bit keys providing 128 or 256 bits of encryption strength	Key Wrapping
KAS-ECC-SSC Cert. #A3453, KDF IKEv2 Cert. #A3453	KAS [SP 800-56Arev3]	SP 800-56Arev3. KAS-ECC per IG D.F Scenario 2 path (2).	P-256, P-384, and P-521 curves providing 128, 192, or 256 bits of encryption strength	Key Exchange with protocol KDF

CAVP Cert	Algorithm and Standard	Mode/Method	Description / Key Size(s) / Key Strength(s)	Use / Function
KAS-ECC-SSC Cert. #A3453, KDF SSH Cert. #A3453	KAS [SP 800-56Arev3]	SP 800-56Arev3. KAS-ECC per IG D.F Scenario 2 path (2).	P-256, P-384, and P-521 curves providing 128, 192, or 256 bits of encryption strength	Key Exchange with protocol KDF
KAS-ECC-SSC Cert. #A3453, TLS v1.2 KDF RFC7627 Cert. #A3453	KAS [SP 800-56Arev3]	SP 800-56Arev3. KAS-ECC per IG D.F Scenario 2 path (2).	P-256, P-384, and P-521 curves providing 128, 192, or 256 bits of encryption strength	Key Exchange with protocol KDF
KAS-FFC-SSC Cert. #A3453, KDF IKEv2 Cert. #A3453	KAS [SP 800-56Arev3]	SP 800-56Arev3. KAS-FFC per IG D.F Scenario 2 path (2).	2048, 3072, and 4096-bit keys providing 112, 128, or 150 bits of encryption strength	Key Exchange with protocol KDF
KAS-FFC-SSC Cert. #A3453, KDF SSH Cert. #A3453	KAS [SP 800-56Arev3]	SP 800-56Arev3. KAS-FFC per IG D.F Scenario 2 path (2).	2048-bit key providing 112 bits of encryption strength	Key Exchange with protocol KDF
KAS-FFC-SSC Cert. #A3453, TLS v1.2 KDF RFC7627 Cert. #A3453	KAS [SP 800-56Arev3]	SP 800-56Arev3. KAS-FFC per IG D.F Scenario 2 path (2).	2048-bit key providing 112 bits of encryption strength	Key Exchange with protocol KDF
Vendor Affirmed	CKG (SP 800-133rev2)	Section 5.1, Section 5.2, Section 6.1	Cryptographic Key Generation; SP 800-133 and IG D.H (symmetric keys and asymmetric seeds).	Key Generation Note: The symmetric keys and seeds used for asymmetric key pair generation are produced using the unmodified/direct output of the DRBG

The module is compliant to IG C.H: GCM is used in the context of TLS, IPsec/IKEv2, SSH:

- For TLS, The GCM implementation meets Scenario 1 of IG C.H: it is used in a manner compliant with SP 800-52 and in accordance with Section 4 of RFC 5288 for TLS key establishment, and ensures when the nonce_explicit part of the IV exhausts all possible values for a given session key, that a new TLS handshake is initiated per sections 7.4.1.1 and 7.4.1.2 of RFC 5246. During operational testing, the module was tested against an independent version of TLS and found to behave correctly
    - From this RFC, the GCM cipher suites in use are TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256, TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384, TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256, and TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384.
- For IPsec/IKEv2, The GCM implementation meets Scenario 1 of IG C.H: it is used in a manner compliant with RFCs 4106 and 7296 (RFC 5282 is not applicable, as the module does not use GCM within IKEv2

itself). During operational testing, the module was tested against an independent version of IPsec with IKEv2 and found to behave correctly.

- For SSH, the module meets Scenario 1 of IG C.H. The module conforms to RFCs 4252, 4253, and 5647. The fixed field is 32 bits in length and is derived using the SSH KDF; this ensures the fixed field is unique for any given GCM session. The invocation field is 64 bits in length and is incremented for each invocation of GCM; this prevents the IV from repeating until the entire invocation field space of 2^{64} is exhausted. (It would take hundreds of years for this to occur.)

In all of the above cases, the nonce_explicit is always generated deterministically. AES GCM keys are zeroized when the module is power-cycled. For each new TLS or SSH session, a new AES GCM key is established.

The module is compliant to IG C.F:

The module utilizes Approved modulus sizes 2048, 3072, and 4096 bits for RSA signatures. This functionality has been CAVP tested as noted above. The minimum number of Miller Rabin tests for each modulus size is implemented according to Table C.2 of FIPS 186-4. For modulus size 4096, the module implements the largest number of Miller-Rabin tests shown in Table C.2. RSA SigVer is CAVP tested for all three supported modulus sizes as noted above. The module does not perform FIPS 186-2 SigVer. All supported modulus sizes are CAVP testable and tested as noted above. The module does not implement RSA key transport in the approved mode.

The module does not have any algorithms that fall under:

- Non-Approved Algorithms Allowed in the Approved Mode of Operation
- Non-Approved Algorithms Allowed in the Approved Mode of Operation with No Security Claimed
- Non-Approved Algorithms Not Allowed in the Approved Mode of Operation

The following table documents the module's algorithms that are non-approved and not allowed for use in the approved mode of operation.

Table 4 - Supported Protocols in the Approved Mode

TLSv1.2
SSHv2
IPSec and IKEv2
SNMPv3

Note: These protocols were not reviewed or tested by the CMVP or CAVP.

Module Diagrams

Figure 1 depicts the logical block diagram for the modules. The cryptographic physical boundary includes all of the logical components of the modules and the boundary is the physical enclosure of the firewall.

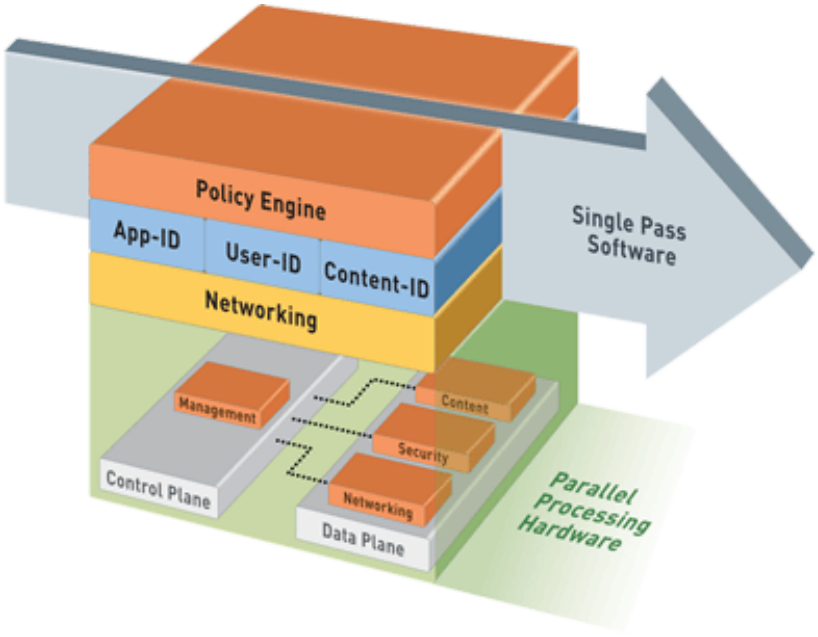


Figure 1 - Logical Diagram

Figures 2 - 29 depict the modules and their interfaces. Please refer to the appendices for depictions of the modules with the physical kits installed.

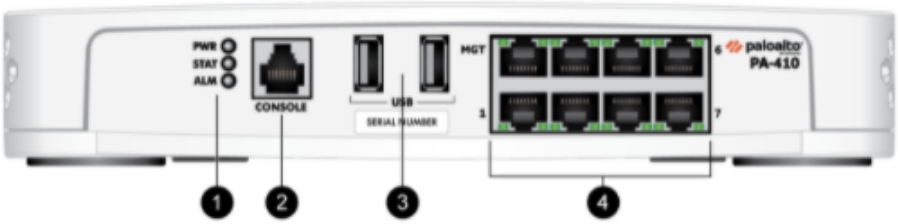


Figure 2 - PA-410 Front

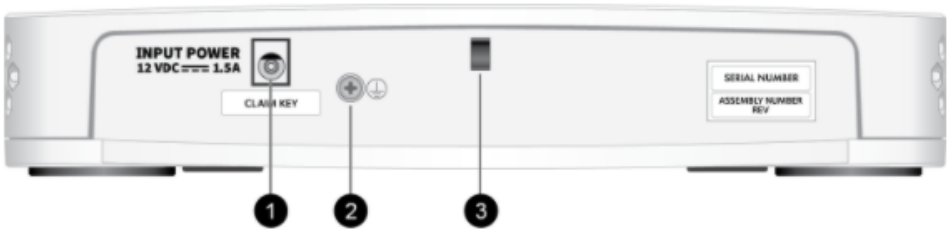


Figure 3 - PA-410 Rear

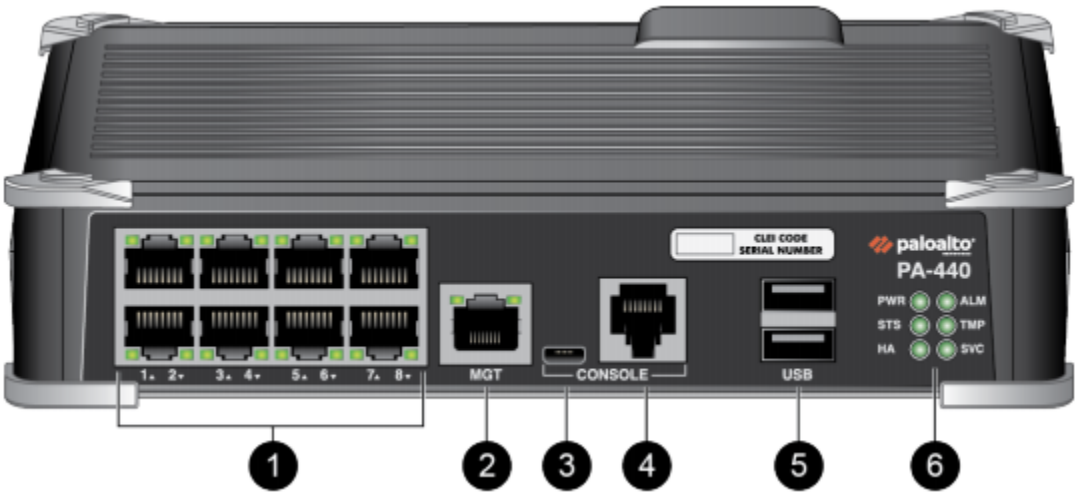


Figure 4 - PA-400 Front (PA-440/450/460 front panels are identical)

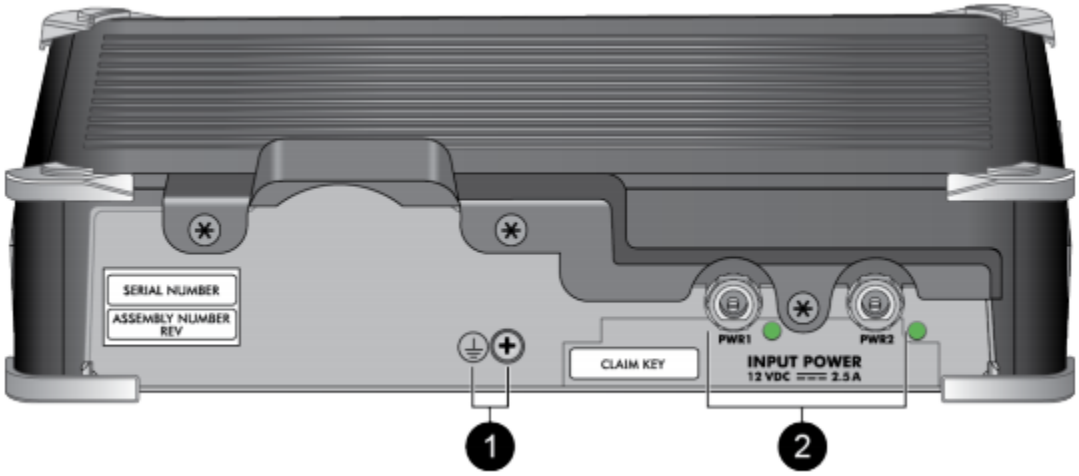


Figure 5 - PA-400 Rear (PA-440/450/460 rear panels are identical)

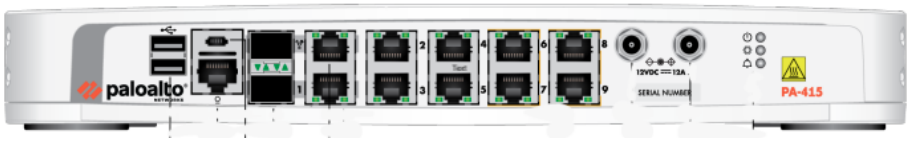


Figure 6 - PA-415/445 Front

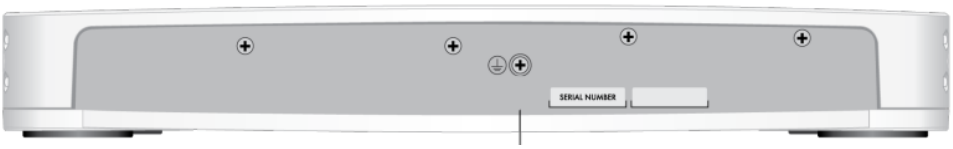


Figure 7 - PA-415/445 Rear

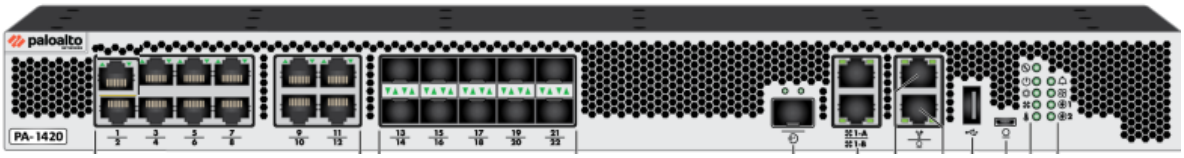


Figure 8 - PA-1400 Series Front

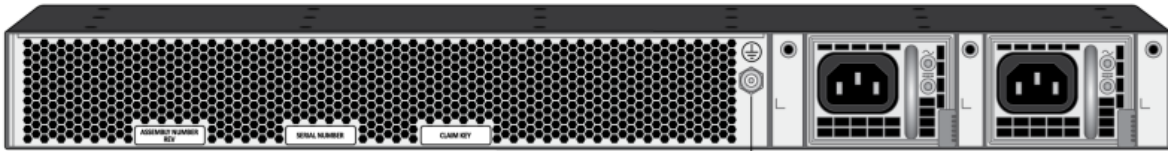


Figure 9 - PA-1400 Series Rear

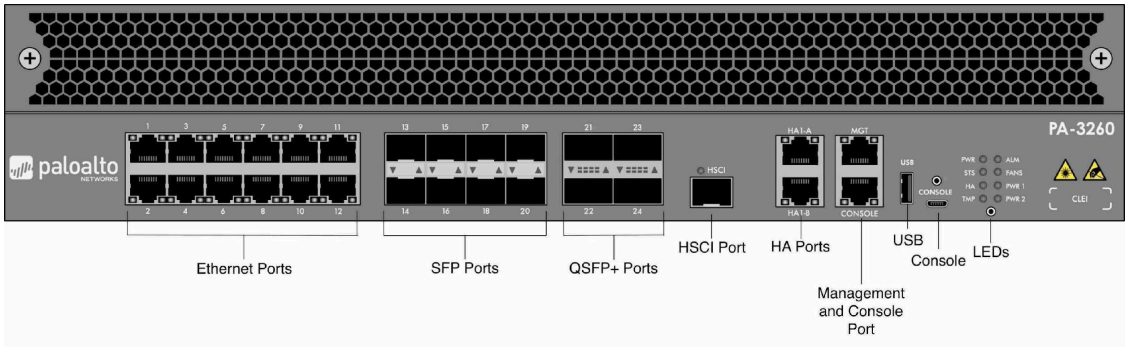


Figure 10 - PA-3200 Series Front

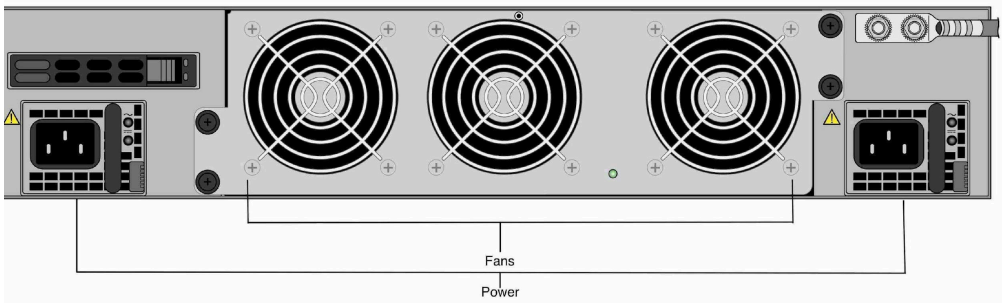


Figure 11 - PA-3200 Series Rear

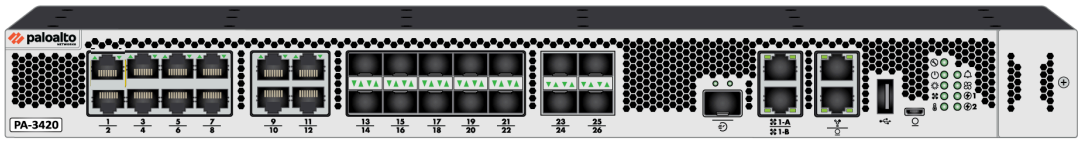


Figure 12 - PA-3410/3420 Front

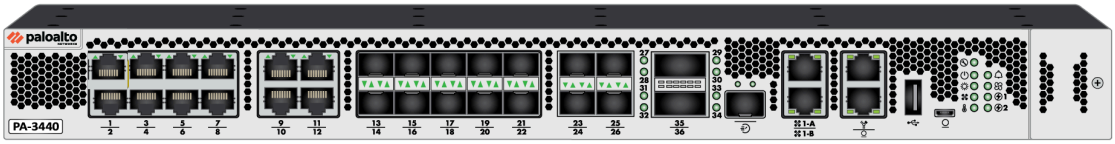


Figure 13 - PA-3430/3440 Front

Figure 14 - PA-3400 Rear

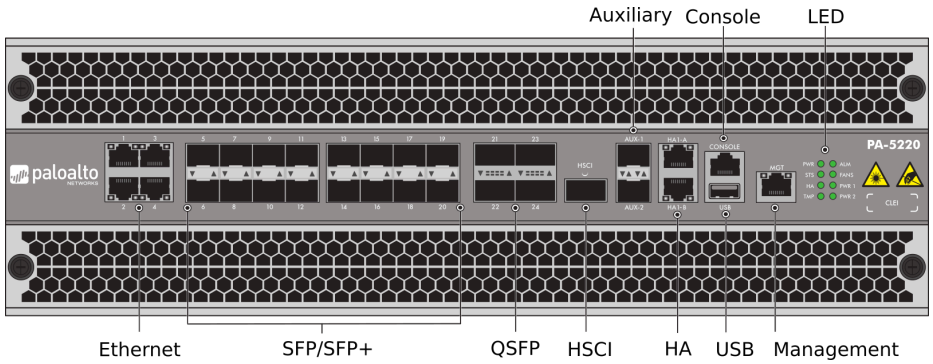


Figure 15 - PA-5200 Series Front

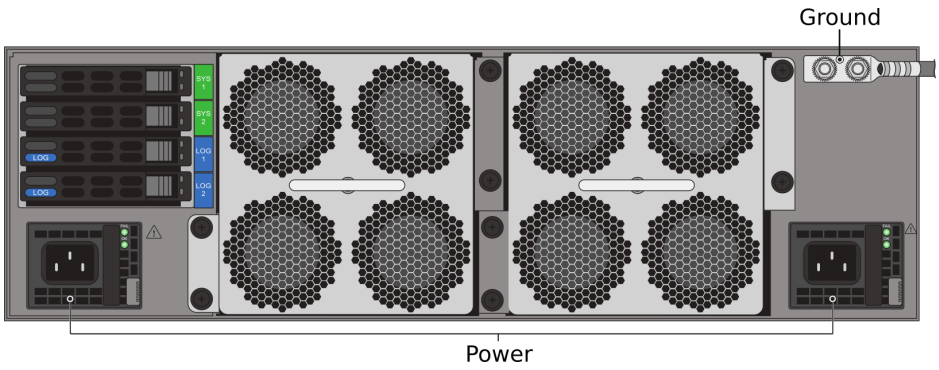


Figure 16 - PA-5200 Rear

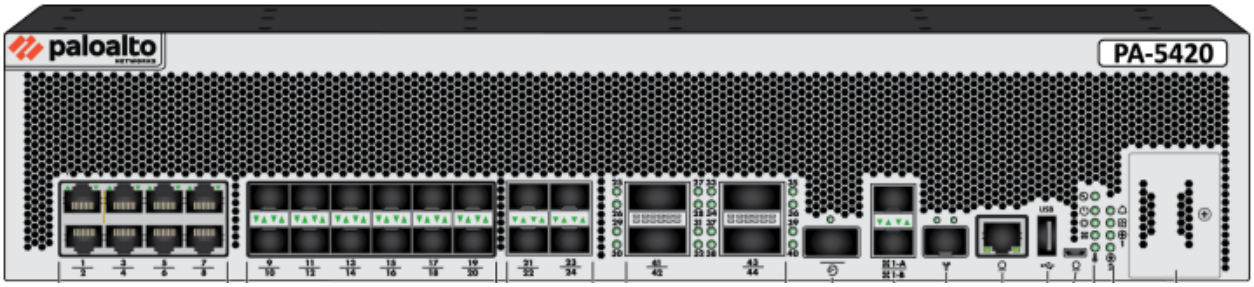


Figure 17 - PA-5410/5420/5430/5440 Front (Note: All modules are identical)

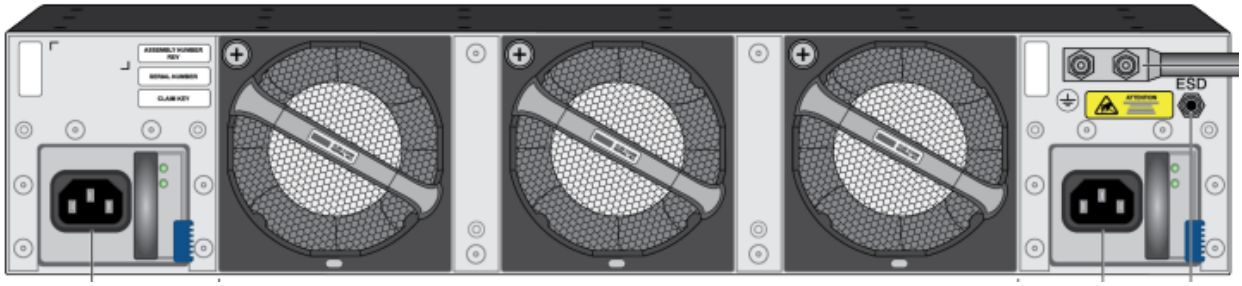


Figure 18 - PA-5410/5420/5430/5440 Rear (Note: All modules are identical)

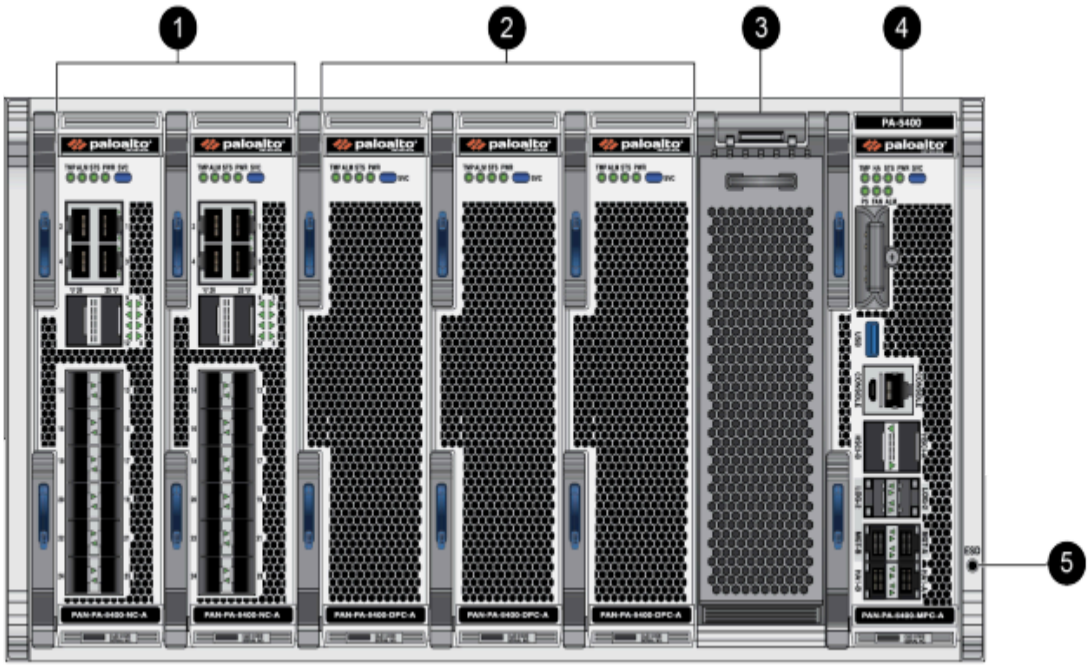


Figure 19 - PA-5450 Front

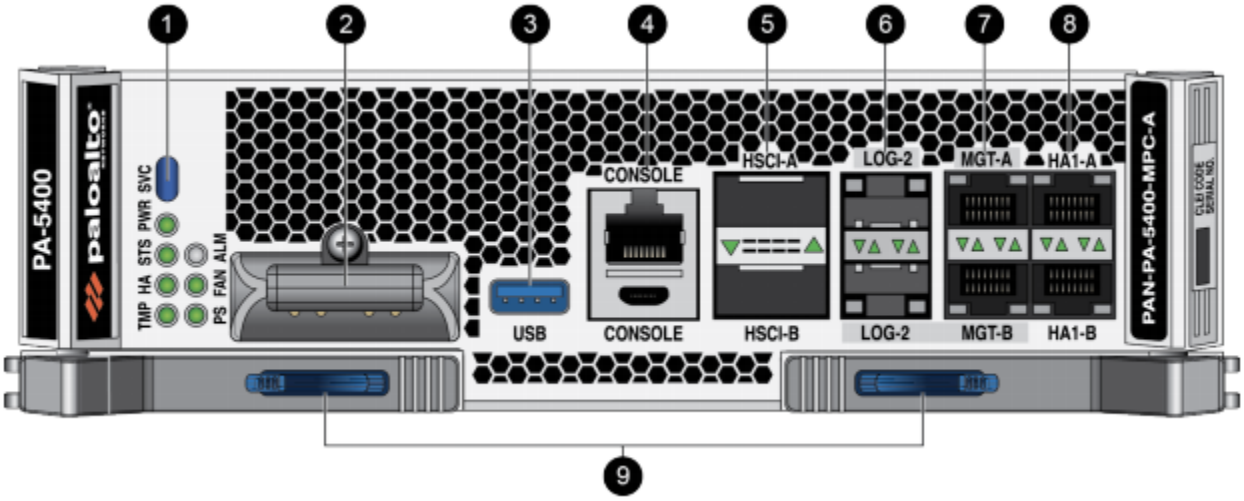


Figure 20 - PA-5450 Management Processor Card

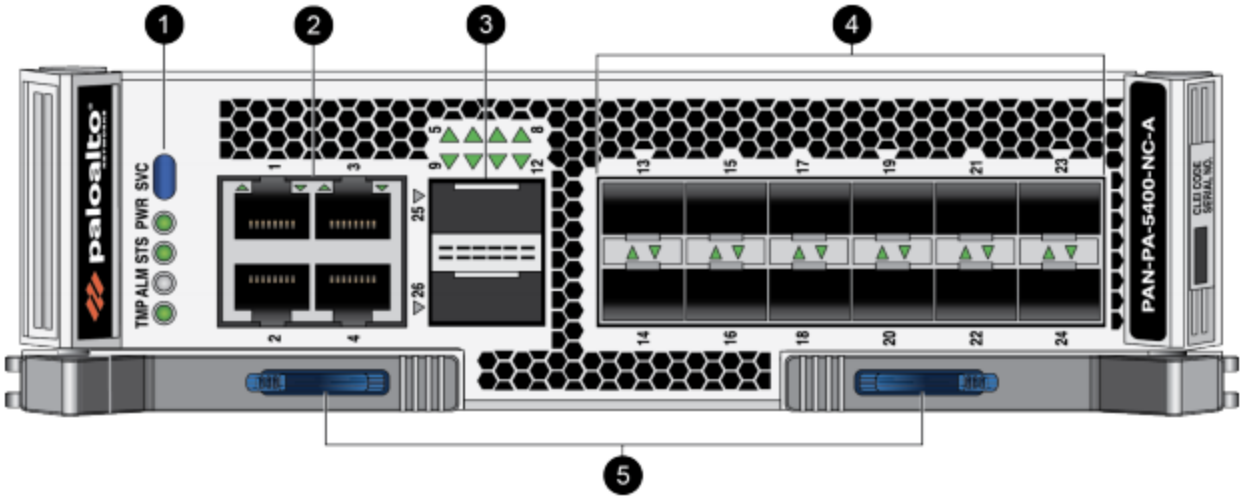


Figure 21 - PA-5450 Networking Card

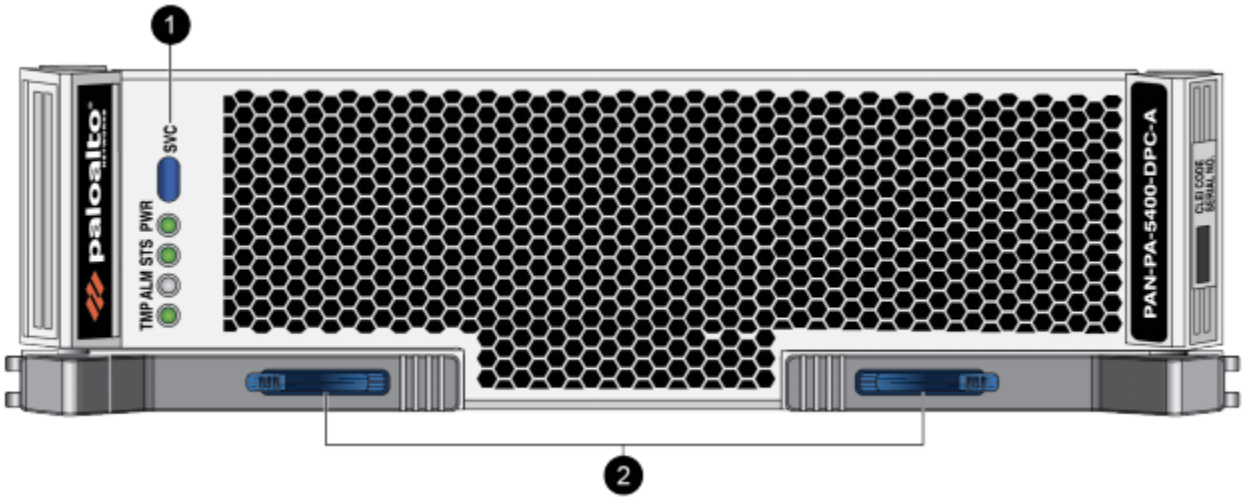


Figure 22 - PA-5450 Data Processing Card

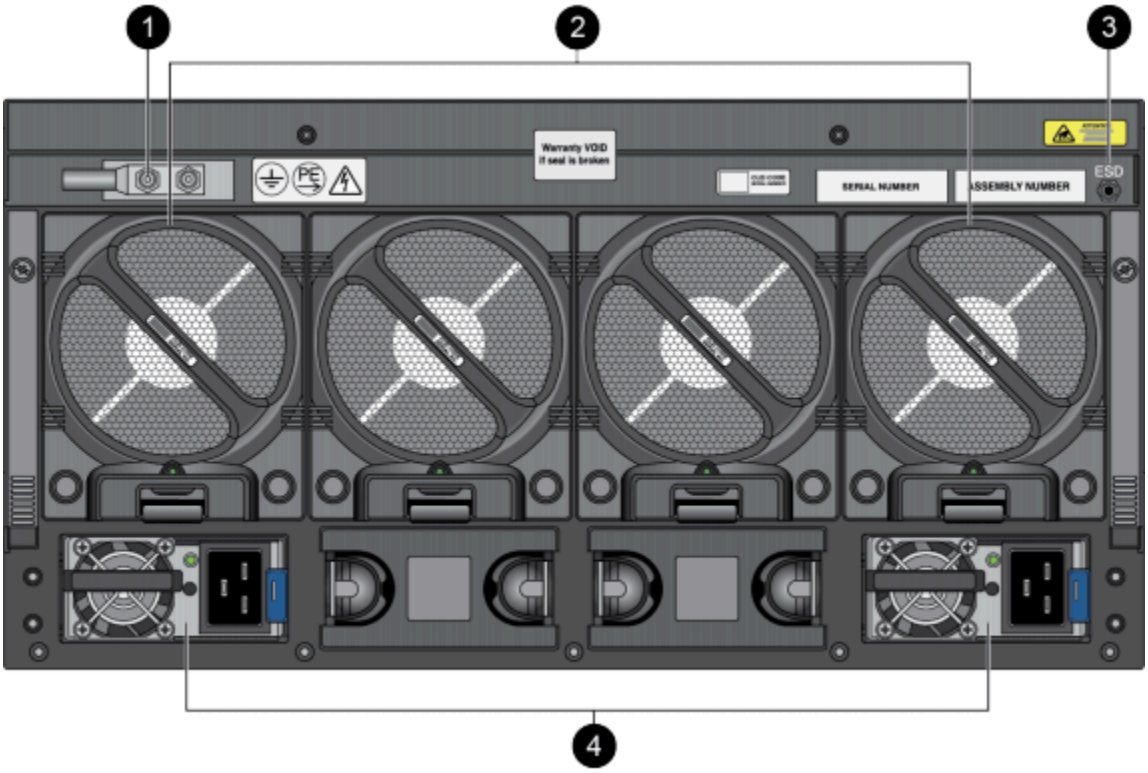


Figure 23 - PA-5450 Rear

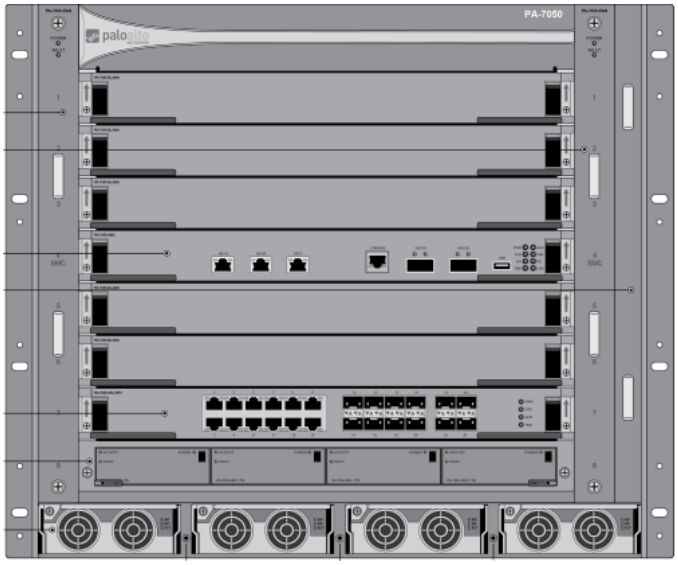


Figure 24 - PA-7050 Front[1]

[1] Note: The PA-7050 can include various cards – see Table in Cryptographic Module Specification for line cards that are supported. It is required that an SMC is used with other networking cards

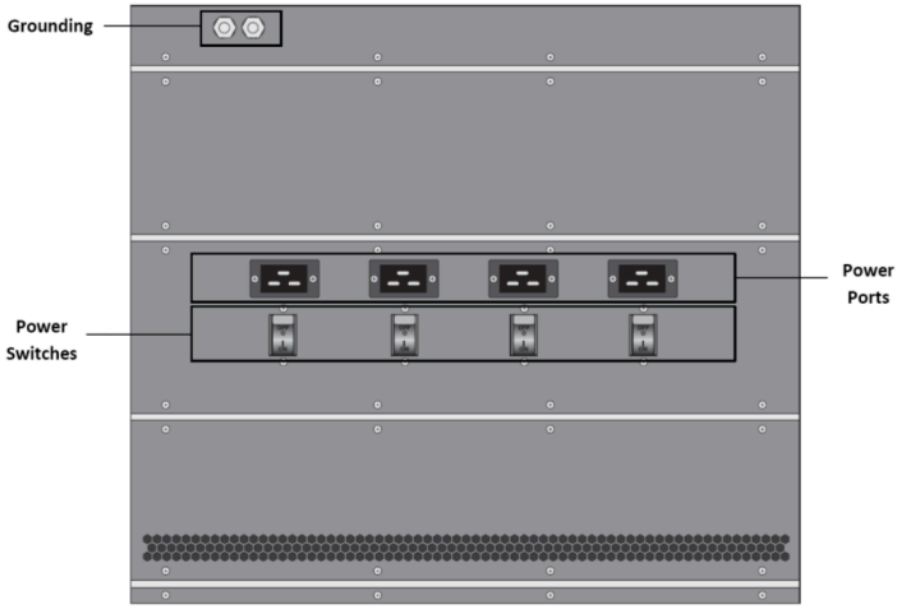


Figure 25 - PA-7050 Back

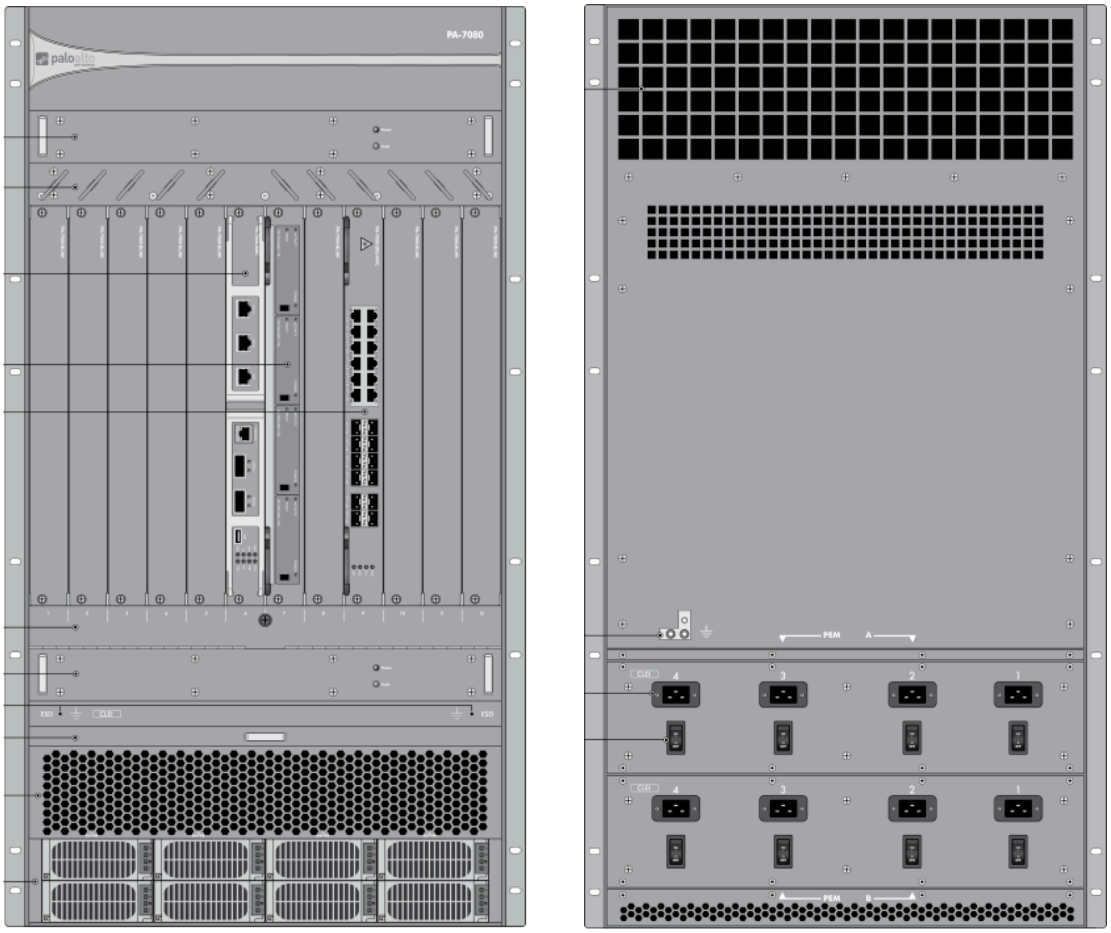


Figure 26 - PA-7080 Front (on Left) and Back (on Right) Interfaces[2]

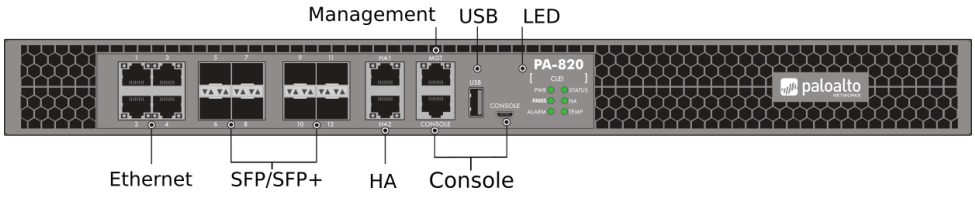


Figure 27 - PA-820 / PA-850 Front Interfaces

[2] Note: The PA-7080 can include various cards – see Table in Cryptographic Module Specification for line cards that are supported. It is required that an SMC is used with other networking cards

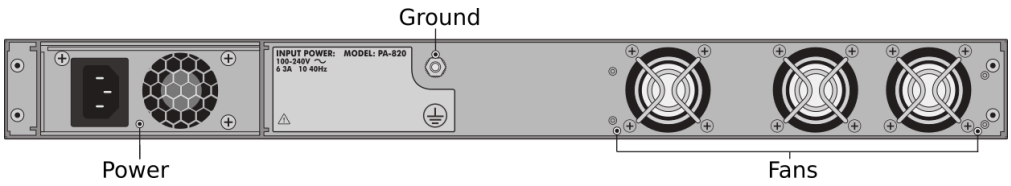


Figure 28 - PA-820 Rear Interfaces

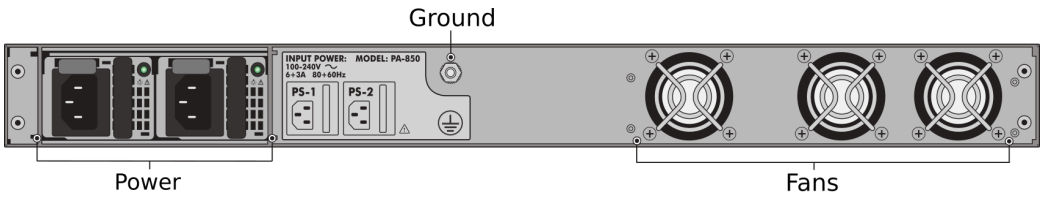


Figure 29 - PA-850 Rear Interfaces

3. Cryptographic Module Interfaces

The modules are multi-chip standalone modules with ports and interfaces as shown below. The modules do not implement a control output interface.

Table 5 - Ports and Interfaces[3]

Physical Interface	Logical Interface	Data that passes over port/interface
HSCI *(PA-1400 Series, PA-3200 Series, PA-3400 Series, PA-5200 Series, PA-5450, PA-7000 Series)*	Data input, control input, data output, status output	SSH
LED	Status output	Module status via LED indicators
Micro USB Console *(PA-800 Series, PA-1400 Series, PA-3200 Series, PA-3400 Series, PA-415/PA-445, PA-440/PA-450/PA-460, PA-5400 Series, PA-5450, PA-7050, PA-7080)*	Status output	Self-test output
Power	Power	N/A
Power switch *(PA-7000 Series)*	Control input	Power input switch

[3] Interfaces depicted in Figures 2-29 above, but not listed in this table are disabled or do not transfer any data.

QSFP+ *(PA-3260, PA-3430/PA-3440, PA-5250, PA-5260, PA-5280, PA-5400 Series, PA-7000 Series)*	Data input, control input, data output, status output	TLS, IPsec, or SSH
QSFP28 *(PA-3400 Series, PA-5200 Series, PA-5400 Series, PA-5450, PA-7000 Series)*	Data input, control input, data output, status output	TLS, IPsec, or SSH
RJ45 Console	Status output	Self-test output
RJ45 Ethernet	Data input, control input, data output, status output	TLS, IPSec
RJ45 HA *(PA-1400 Series, PA-3200 Series, PA-5200 Series, PA-5400 Series, PA-5450, PA-7050, PA-7080)*	Data input, control input, data output, status output	SSH
RJ45 Log *(PA-5450)*	Data input, control input, data output, status output	TLS, IPsec
RJ45 MGT *(PA-400 Series, PA-1400 Series, PA-3200 Series, PA-3400 Series, PA-440/PA-450/PA-460, PA-5400 Series, PA-5450, PA-7000 Series)*	Data input, control input, data output, status output	TLS, SSH
SFP *(PA-415, PA-455, PA-800 Series, PA-1400 Series, PA-3200 Series, PA-3400 Series, PA-5200 Series, PA-7000 Series)*	Data input, control input, data output, status output	TLS, IPSec, or SSH
SFP+ *(PA-800 Series, PA-1400 Series, PA-3200 Series, PA-3400 Series, PA-5200 Series, PA-5400 Series, PA-5450, PA-7050, PA-7080)*	Data input, control input, data output, status output	TLS, IPSec, or SSH
SFP28 *(PA-3400 Series, PA-5400 Series)*	Data input, control input, data output, status output	TLS, IPSec

4. Roles, Services, and Authentication

Services

While in the Approved mode of operation, all CO and User services are accessed via SSH or TLS sessions. Approved and allowed algorithms, relevant CSPs, and public keys related to these protocols are accessed to support the following services. CSP access by services is further described in the following tables.

Table 6 - Roles, Service Commands, Input and Output

Role	Service	Input	Output
Crypto Officer	Show Version	Query module for version	Module provides version
Crypto Officer, User	Security Configuration Management	Configuring and managing cryptographic parameters and setting/modifying security policy, including creating User accounts and additional CO accounts via CLI or WebUI	Confirmation of service via Configuration Logs
Crypto Officer	Other Configuration	Networking parameter configuration, logging configuration, and other non-security relevant configuration via CLI or WebUI	Confirmation of service via Configuration Logs
Crypto Officer, User	View Other Configuration	Query module for current non-security relevant configuration via WebUI or CLI	Confirmation of service via Configuration Logs
Crypto Officer, User, RA VPN, S-S VPN	Show Status	Query status of the module via WebUI or CLI	Module status information via CLI or System Logs
RA VPN, S-S VPN	VPN	Initialize VPN connection	Confirmation of service via System Logs
Crypto Officer	Firmware Update	Loading new image	Message output noting version updated successfully
Unauthenticated	Zeroize	Initiate zeroization command	Console Output
Unauthenticated	Self-Tests	Power removal	Console Output
Unauthenticated	Show Status (LEDs)	N/A	LEDs

Assumption of Roles

The modules support four distinct operator roles, User and Cryptographic Officer (CO), Remote Access VPN, and Site-to-site VPN. The cryptographic modules enforce the separation of roles using unique authentication credentials associated with operator accounts. The modules support concurrent operators.

The modules do not provide a maintenance role or bypass capability.

The modules all support the use of a password (i.e. Memorized Secret as per SP 800-140E). Upon first boot, the module requires that the Cryptographic Officer change the password from the default one to a custom one. The module automatically enforces a minimum password length of at least 8 characters. In FIPS-CC mode, the module automatically enforces a maximum of 10 failed attempts. Passwords stored in the module are hashed using SHA-256, and any passwords that are transported into/out of the module are protected via TLS 1.2.

The passwords for the RA VPN and S-S VPN roles are created as part of the Security Configuration Management service allocated to the Cryptographic Officer.

Table 7 - Roles and Authentication

Role	Authentication Method	Authentication Strength
Cryptographic Officer	Memorized Secret (Unique Username/password) and/or Single-Factor Cryptographic Software (certificate common name / public key-based authentication)	<u>Password-based</u> The minimum length is eight (8) characters[4] (95 possible characters). The probability that a random attempt will succeed or a false acceptance will occur is $1/(95^8)$ which is less than 1/1,000,000. The probability of successfully authenticating to the module within one minute is $10/(95^8)$, which is less than 1/100,000. The firewall's configuration supports at most ten failed attempts to authenticate in a one-minute period. <u>Certificate/Public key-based</u> The security modules support public-key based authentication using RSA 2048 and certificate-based authentication using RSA 2048, RSA 3072, RSA 4096, ECDSA P-256, P-384, or P-521. The minimum equivalent strength supported is 112 bits. The probability that a random attempt will succeed is $1/(2^{112})$ which is less than 1/1,000,000. The probability of successfully authenticating to the module within a one minute period is $288{,}000{,}000/(2^{112})$, which is less than 1/100,000. The firewall supports at most 4,800,000 new sessions per second.
User	Memorized Secret (Unique Username/password) and/or Single-Factor Cryptographic Software (certificate common name / public key-based authentication	
Remote Access VPN (RA VPN)	Memorized Secret (Unique Username/password) and/or Single-Factor Cryptographic Software (certificate common name / public key-based authentication	
Site-to-Site VPN (S-S VPN)	IKE/IPSec Pre-shared keys - Identification with the IP Address and authentication with the Pre-Shared Key or certificate based authentication	The pre-shared key authentication method has a minimum security strength[5] of 95^6. The probability of successfully authenticating to the module is $1/(95^6)$, which is less than 1/1,000,000. The number of authentication attempts is limited by the number of new connections per second supported (4,800,000) on the fastest platform of the Palo Alto Networks firewalls. The probability of successfully authenticating to the module within a one minute period is $288{,}000{,}000/(95^6)$, which is less than 1/100,000. The security modules support public-key based authentication using RSA 2048 and certificate-based authentication using RSA 2048, RSA 3072, RSA 4096, ECDSA P-256, P-384, or P-521.

[4] In FIPS-CC Mode, the module checks and enforces the minimum password length of eight (8) as specified in SP 800-63B. Passwords are securely stored hashed with salt value, with very restricted access control, and rate limiting mechanism for authentication attempts.

[5] Note: The security strength (95^6) is based on the use of ASCII characters that are utilized, which surpasses the 6 character random number password allowance that sets a baseline minimum acceptable strength of 10^6.

		The minimum equivalent strength supported is 112 bits. The probability that a random attempt will succeed is $1/(2^{112})$ which is less than 1/1,000,000. The probability of successfully authenticating to the module within a one minute period is $288,000,000/(2^{112})$, which is less than 1/100,000. The fastest firewall supports at most 288,000,000 new sessions per second to authenticate in a one-minute period.

CSP Access Rights

The table below 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 or derives the SSP.

R = Read: The SSP is read from the module (e.g. the SSP is output).

W = Write: The SSP is updated, imported, or written to the module.

E = Execute: The module uses the SSP in performing a cryptographic operation.

Z = Zeroise: The module zeroises the SSP.

Table 8 - Approved Services

Service	Description	Approved Security Functions		Keys and/or SSPs	Roles	Access rights to Keys and/or SSPs	Indicator
Show Version	Query the module to display the version	N/A		N/A	CO	N/A	Version displayed via System Logs / CLI / UI
Security Configuration Management	Configuring and managing cryptographic parameters and setting/modifying security policy, including creating User accounts and additional CO accounts	CKG RSA KeyGen (FIPS 186-4) RSA SigGen (FIPS 186-4)		RSA Private Keys	CO	G/W/E	Configuration/System Logs
		CKG ECDSA KeyGen (FIPS 186-4) ECDSA SigGen (FIPS 186-4)		ECDSA Private Keys	CO	G/W/E	
		KAS	TLS v1.2 KDF RFC7627	TLS Pre-Master Secret	CO	G/E/Z	
			TLS v1.2 KDF RFC7627	TLS Master Secret	CO	G/E/Z	
			CKG, ECDSA KeyGen (FIPS 186-4), ECDSA KeyVer (FIPS 186-4), KAS-ECC-SSC, KAS-FFC-SSC, Safe Primes Key Generation, Safe Primes Key Verification	TLS DHE/ECDHE Private Components	CO	G/E/Z	
				TLS DHE/ECDHE Public Components		G/E/R/W/Z	
		KTS	HMAC-SHA2-256 HMAC-SHA2-384	TLS HMAC Keys	CO	G/E/Z	
			AES-CBC	TLS Encryption Keys	CO	G/E/Z	
		KTS	AES-GCM				
		KTS	HMAC-SHA-1 HMAC-SHA2-256	SSH Session Authentication Keys	CO	G/E/Z	

			HMAC-SHA2-512				
			AES-CBC, AES-CTR	SSH Session Encryption Keys	CO	G/E/Z	
		KTS	AES-GCM				
		KAS	KDF SSH	SSH DHE/ECDHE Private Components	CO	G/E/Z	
			KAS-ECC-SSC KAS-FFC-SSC Safe Primes Key Generation, Safe Primes Key Verification	SSH DHE/ECDHE Public Components		G/E/R/W/Z	
		N/A		CO, User, RA VPN Password	CO	G/E/W	
		Counter DRBG		DRBG Seed	CO	G/E	
				DRBG V			
				DRBG Key			
				Entropy Input String			
		KDF SNMP		SNMPv3 Authentication Secret	CO	W/E	
		KDF SNMP		SNMPv3 Privacy Secret	CO	W/E	
		HMAC-SHA-1 HMAC-SHA2-224 HMAC-SHA2-256 HMAC-SHA2-384 HMAC-SHA2-512		Authentication Key	CO	G/E/Z	
		AES-CFB		Session Key	CO	G/E/Z	
		N/A		Protocol Secrets	CO	W/E	
		RSA SigVer (FIPS 186-4) ECDSA SigVer (FIPS 186-4)		CA Certificates	CO	G/R/E/W	
		ECDSA SigVer (FIPS 186-4)		ECDSA Public Keys	CO	G/R/E/W	
		RSA SigVer (FIPS 186-4)		RSA Public Keys	CO	G/R/E/W	
		RSA SigVer (FIPS 186-4) ECDSA SigVer (FIPS 186-4)		SSH Host Public Key	CO	G/R/E/W	
		RSA SigVer (FIPS 186-4)		SSH Client Public Key	CO	W/E	
		RSA SigVer (FIPS 186-4)		Public key for software load test	CO	W/E	
Other Configuration	Networking parameter configuration, logging configuration, and other non-security relevant configuration	RSA SigGen (FIPS 186-4)		RSA Private Keys	CO	G/W/E	Configuration/System Logs
		ECDSA SigGen (FIPS 186-4)		ECDSA Private Keys	CO	G/W/E	
		KAS	TLS v1.2 KDF RFC7627	TLS Pre-Master Secret	CO	G/E/Z	
			TLS v1.2 KDF RFC7627	TLS Master Secret	CO	G/E/Z	
			CKG, ECDSA KeyGen (FIPS 186-4), ECDSA KeyVer (FIPS 186-4), KAS-ECC-SSC, KAS-FFC-SSC, Safe Primes Key Generation, Safe Primes Key Verification	TLS DHE/ECDHE Private Components	CO	G/E/Z	
				TLS DHE/ECDHE Public Components		G/E/R/W/Z	
		HMAC-SHA2-256 HMAC-SHA2-384		TLS HMAC Keys	CO	G/E/Z	
		AES-CBC or AES-GCM		TLS Encryption Keys	CO	G/E/Z G/Z	
		HMAC-SHA-1 HMAC-SHA2-256 HMAC-SHA2-512		SSH Session Authentication Keys	CO		

		AES-CBC, AES-CTR, or AES-GCM		SSH Session Encryption Keys	CO	G/E/Z	
		KAS	KDF SSH	SSH DHE/ECDHE Private Components	CO	G/E/Z	
			CKG, ECDSA KeyGen (FIPS 186-4), ECDSA KeyVer (FIPS 186-4), KAS-ECC-SSC, KAS-FFC-SSC, Safe Primes Key Generation, Safe Primes Key Verification	SSH DHE/ECDHE Public Components		G/E/R/W/Z	
		N/A		CO, User, RA VPN Password	CO	G/E/W	
		Counter DRBG		DRBG Seed	CO	G/E	
				DRBG V			
				DRBG Key			
				Entropy Input String			
		RSA SigVer (FIPS 186-4) ECDSA SigVer (FIPS 186-4)		SSH Host Public Key	CO	G/R/E/W	
		RSA SigVer (FIPS 186-4)		SSH Client Public Key	CO	W/E	
View Other Configuration	Read-only of non-security relevant configuration	N/A		CO, User, RA VPN Password Note: includes all items in "Other Configuration"	CO, User	W/E	Configuration/System Logs
Show Status	Provides status information of the module	RSA SigGen (FIPS 186-4)		RSA Private Keys	CO, User	E	Configuration/System Logs
		ECDSA SigGen (FIPS 186-4)		ECDSA Private Keys	CO, User	E	
		KAS	TLS v1.2 KDF RFC7627	TLS Pre-Master Secret	CO, User	G/E/Z	
			TLS v1.2 KDF RFC7627	TLS Master Secret	CO, User	G/E/Z	
			CKG, ECDSA KeyGen (FIPS 186-4), ECDSA KeyVer (FIPS 186-4), KAS-ECC-SSC, KAS-FFC-SSC, Safe Primes Key Generation, Safe Primes Key Verification	TLS DHE/ECDHE Private Components	CO, User	G/E/Z	
				TLS DHE/ECDHE Public Components		G/E/R/W/Z	
		HMAC-SHA2-256 HMAC-SHA2-384		TLS HMAC Keys	CO, User	G/E/Z	
		AES-CBC or AES-GCM		TLS Encryption Keys	CO, User	G/E/Z	
		HMAC-SHA-1 HMAC-SHA2-256 HMAC-SHA2-512		SSH Session Authentication Keys	CO, User	G/E/Z	
		AES-CBC, AES-CTR, or AES-GCM		SSH Session Encryption Keys	CO, User	G/E/Z	
		Counter DRBG		DRBG Seed	RA VPN	G/E	
				DRBG V			
				DRBG Key			
				Entropy Input String			

		KAS	KDF SSH	SSH DHE/ECDHE Private Components	CO	G/E/Z	
			CKG, ECDSA KeyGen (FIPS 186-4), ECDSA KeyVer (FIPS 186-4), KAS-ECC-SSC, KAS-FFC-SSC, Safe Primes Key Generation, Safe Primes Key Verification	SSH DHE/ECDHE Public Components		G/E/R/W/Z	
VPN	Provide network access for remote users or site-to-site connection	KTS	HMAC-SHA-1 HMAC-SHA2-256 HMAC-SHA2-384 HMAC-SHA2-512	S-S VPN IPSec/IKE Authentication Keys	S-S VPN	G/E/Z	Configuration/System Logs
			AES-CBC	S-S VPN IPSec/IKE Session Keys	S-S VPN	G/E/Z	
		KTS	AES-CCM				
		KTS	AES-GCM				
		KAS	KDF IKEv2	S-S VPN IPSec/IKE DHE/ECDHE Private Components	S-S VPN	G/E/Z	
			CKG, ECDSA KeyGen (FIPS 186-4), ECDSA KeyVer (FIPS 186-4), KAS-ECC-SSC, KAS-FFC-SSC, Safe Primes Key Generation, Safe Primes Key Verification			G/E/R/W/Z	
				S-S VPN IPSec/IKE DHE/ECDHE Public Components			
		N/A		S-S VPN IPSec Pre-Shared Keys	S-S VPN	W/E	
		ECDSA SigVer (FIPS 186-4)		ECDSA Public Keys	S-S VPN	W/E	
		RSA SigVer (FIPS 186-4)		RSA Public Keys	S-S VPN	W/E	
		RSA SigGen (FIPS 186-4)		RSA Private Keys	RA VPN	E	
		ECDSA SigGen (FIPS 186-4)		ECDSA Private Keys	RA VPN	E	
		KAS	TLS v1.2 KDF RFC7627	TLS Pre-Master Secret	RA VPN	G/E/Z	
			TLS v1.2 KDF RFC7627	TLS Master Secret		G/E/Z	
			CKG, ECDSA KeyGen (FIPS 186-4), ECDSA KeyVer (FIPS 186-4), KAS-ECC-SSC, KAS-FFC-SSC, Safe Primes Key Generation, Safe Primes	TLS DHE/ECDHE Public Components	RA VPN	G/E/R/W/Z	
				TLS DHE/ECDHE Private Components	RA VPN	G/E/Z	

			Key Verification				
		KTS	HMAC-SHA2-256 HMAC-SHA2-384	TLS HMAC Keys	RA VPN	G/E/Z	
			AES-CBC	TLS Encryption Keys	RA VPN	G/E/Z	
		KTS	AES-GCM				
		CKG, AES-CBC or AES-GCM		RA VPN IPSec Session Keys	RA VPN	G/E/Z	
		CKG, HMAC-SHA-1		RA VPN IPSec Authentication	RA VPN	G/E/Z	
		Counter DRBG		DRBG Seed	RA VPN	G/E	
				DRBG V			
				DRBG Key			
				Entropy Input String			
		RSA SigVer (FIPS 186-4)) ECDSA SigVer (FIPS 186-4)		CA Certificates	RA VPN	W/E	
		ECDSA SigVer (FIPS 186-4)		ECDSA Public Keys	RA VPN	W/E	
		RSA SigVer (FIPS 186-4)		RSA Public Keys	RA VPN	W/E	
Firmware Update	Provides a method to update the firmware of the module	RSA SigVer (FIPS 186-4)		Public key for firmware content load test Note: Includes all keys from Other Configuration	CO	E	Configuration/System Logs
Zeroize	Destroys all keys in the module	N/A		All keys and SSPs	CO	Z	Zeroization indicator
Self-Test	Initiates self-tests and integrity test	HMAC-SHA2-256, ECDSA SigVer (FIPS 186-4)		Software integrity verification key	CO	E	System Logs
Show Status	Provides status of the module	N/A		N/A	All	R	LEDs

Note: Configuration/System Logs for Approved services above will indicate FIPS-CC mode is enabled, configuration requirements from Section 11 are followed, and that the service succeeded.

5. Software/Firmware Security

The module performs the Firmware Integrity test by using HMAC-SHA-256 and ECDSA signature verification (HMAC and ECDSA Cert. #A3453) during the Pre-Operational Self-Test. In addition, the module also conducts the firmware load test by using RSA 2048 with SHA-256 (Cert. #A3453) for the new validated firmware to be uploaded into the module.

The pre-operational self-tests can be initiated by power cycling the module. When this is performed, the module automatically runs the cryptographic algorithm self-tests in addition to the pre-operational firmware integrity test.

6. Operational Environment

The FIPS 140-3 Operational Environment requirements are not applicable because the module does not contain a modifiable operational environment. The operational environment is limited since the modules include a firmware load service to support necessary updates. New firmware versions within the scope of this validation must be validated through the FIPS 140-3 CMVP. Any other firmware loaded into these modules is out of the scope of this validation and requires a separate FIPS 140-3 validation.

7. Physical Security

The multi-chip standalone modules are production quality containing standard passivation. Chip components are protected by an opaque enclosure. There are tamper evident seals that are applied on the modules by the Crypto-Officer. All unused seals are to be controlled by the Crypto-Officer. The seals prevent removal of the opaque enclosure without evidence. The Crypto-Officer must ensure that the module surface is clean and dry. Tamper evident seals must be pressed firmly onto the adhering surfaces during installation and once applied the Crypto- Officer shall permit 24 hours of cure time for all tamper-evident seals. The Crypto-Officer should inspect the seals and shields for evidence of tamper every 30 days. If the seals show evidence of tamper, the Crypto-Officer should assume that the modules have been compromised and contact Customer Support.

Note: For ordering information, see tables in Cryptographic Module Specification for Kit part numbers and versions. Opacity shields and Tamper Seals are included for the kits.

Refer to this document's Appendices for instructions on installation of the tamper seals and opacity shields.

Table 9 - Physical Security Inspection Guidelines

Physical Security Mechanisms	Recommended Frequency of Inspection/Test	Inspection/Test Guidance Details
Tamper-Evident Seals (PA-7080, PA-7050, PA-5220, PA-5250, PA-5260, PA-5280, PA-3220, PA-3250, PA-3260,PA-410/440/450/460, PA-5450, PA-5410/5420/5430/5440, PA-3410/3420/3430/3440, PA-1410/1420, PA-415/PA-445, PA-820/PA-850)	30 days	Verify integrity of tamper-evident seals in the locations identified in the Physical Kit Installation Guide. Seal integrity to be verified within the modules operating temperature range.
Top, Bottom, Front and Rear Opacity Shields (PA-7050 PA-5450)	30 days	Verify that the plenums and opacity shields have not been deformed from their original shape, thereby reducing their effectiveness
Front and Rear Covers (PA-800 Series, PA-3220, PA-3250, PA-3260)	30 days	Verify that front and rear covers have not been deformed from their original shape, thereby reducing their effectiveness
Front Cover (PA-7080, PA-5450, PA-5410/5420/5430/5440, PA-1410/1420, and PA-3410/3420/3430/3440)	30 days	Verify that front cover has not been deformed from its original shape thereby reducing its effectiveness

8. Non-Invasive Security

No approved non-invasive attack mitigation test metrics are defined at this time.

9. Sensitive Security Parameter Management

The following table details all the sensitive security parameters utilized by the module.

Table 10 - SSPs

Key/SSP/Name/Type	Strength	Security Function and Cert. Number	Generation	Import/Export	Establishment	Storage	Zeroization	Use & Related Keys
CA Certificates	112 bits minimum	RSA SigVer (FIPS 186-4) ECDSA SigVer (FIPS 186-4) Cert. #A3453	DRBG, FIPS 186-4	TLS or SSH Session Key Encrypted	N/A	HDD/RAM – plaintext	HDD – Zeroize Service RAM - Zeroize at session termination	ECDSA/RSA Public key - Used to trust a root CA intermediate CA and leaf /end entity certificates (RSA 2048, 3072, and 4096 bits) (ECDSA P-256, P-384, and P-521)
RSA Public Keys	112 bits minimum	RSA SigVer (FIPS 186-4) Cert. #A3453	DRBG, FIPS 186-4	TLS or SSH Session Key Encrypted or Plaintext TLS handshake	N/A	HDD/RAM – plaintext	Zeroize Service	RSA public keys managed as certificates for the verification of signatures, establishment of TLS, operator authentication and peer authentication. (RSA 2048, 3072, or 4096-bit)
RSA Private Keys	112 bits minimum	RSA SigGen (FIPS 186-4) Cert. #A3453	DRBG, FIPS 186-4	TLS or SSH Session Key Encrypted	N/A	HDD/RAM – plaintext	HDD – Zeroize Service RAM - Zeroize at session termination	RSA Private keys for generation of signatures, authentication or key establishment. (RSA 2048, 3072, or 4096-bit)
ECDSA Public Keys	128 bits minimum	ECDSA SigVer (FIPS 186-4) Cert. #A3453	DRBG, FIPS 186-4	TLS or SSH Session Key Encrypted or Plaintext TLS handshake	N/A	HDD/RAM – plaintext	Zeroize Service	ECDSA public keys managed as certificates for the verification of signatures, establishment of TLS, operator authentication and peer authentication. (ECDSA P-256, P-384, or P-521)
ECDSA Private Keys	128 bits minimum	ECDSA SigGen (FIPS 186-4) Cert. #A3453	DRBG, FIPS 186-4	TLS or SSH Session Key Encrypted	N/A	HDD/RAM – plaintext	HDD – Zeroize Service RAM - Zeroize at session termination	ECDSA Private key for generation of signatures and authentication (P-256, P-384, or P-521)
TLS DHE/ECDHE Private Components	112 bits minimum	KAS-ECC-SSC KAS-FFC-SSC Cert. #A3453	DRBG, SP 800-56A Rev. 3	N/A	N/A	RAM - plaintext	Zeroize at session termination	Ephemeral Diffie-Hellman private FFC or EC component used in TLS (DHE 2048, ECDHE P-256, P-384, P-521)
TLS DHE/ECDHE Public Components	112 bits minimum	KAS-ECC-SSC KAS-FFC-SSC Cert. #A3453	DRBG, SP 800-56A Rev. 3	Plaintext - TLS handshake	N/A	N/A	Zeroize at session termination	Diffie_Hellman or EC Diffie-Hellman Ephemeral values used in key agreement (DHE 2048, ECDHE P-256, P-384, P-521)

TLS Pre-Master Secret	N/A	TLS v1.2 KDF RFC7627, Cert. #A3453	KAS SP 800-56A Rev. 3	N/A	N/A	RAM – plaintext	Zeroize at session termination	Secret value used to derive the TLS Master Secret along with client and server random nonces
TLS Master Secret	N/A	TLS v1.2 KDF RFC7627 Cert. #A3453	TLS v1.2 KDF RFC7627	N/A	N/A	RAM – plaintext	Zeroize at session termination	Secret value used to derive the TLS session keys
TLS Encryption Keys	128 bits minimum	AES-CBC or AES-GCM Cert. #A3453	TLS v1.2 KDF RFC7627	N/A	TLS, KAS SP 800-56A Rev. 3	RAM - plaintext	Zeroize at session termination	AES (128 or 256 bit) keys used in TLS connections (GCM; CBC)
TLS HMAC Keys	256 bits minimum	HMAC-SHA2 -256 HMAC-SHA2 -384 Cert. #A3453	TLS v1.2 KDF RFC7627	N/A	TLS, KAS SP 800-56A Rev. 3	RAM - plaintext	Zeroize at session termination	HMAC keys used in TLS connections (HMAC-SHA2-256 /384) (256, 384 bits)
SSH DHE/ECDHE Private Components	112 bits minimum	KAS-ECC-SS C KAS-FFC-SS C Cert. #A3453	DRBG, SP 800-56A Rev. 3	N/A	N/A	RAM - plaintext	Zeroize at session termination	Diffie Hellman or EC Diffie-Hellman private (DH Group 14, ECDH P-256, ECDH P-384, ECDH P-521)
SSH DHE/ECDHE Public Components	112 bits minimum	KAS-ECC-SS C KAS-FFC-SS C Cert. #A3453	DRBG, SP 800-56A Rev. 3	Plaintext SSH handshake	N/A	RAM - plaintext	Zeroize at session termination	Diffie Hellman or EC Diffie-Hellman public component (DH Group 14, ECDH P-256, ECDH P-384, ECDH P-521)
SSH Host Public Key	112 bits minimum	RSA SigVer (FIPS 186-4) ECDSA SigVer (FIPS 186-4) Cert. #A3453	DRBG, FIPS 186-4	N/A	N/A	HDD/RAM – plaintext	Zeroize Service	SSH Host Public Key (RSA 2048, RSA 3072, RSA 4096, ECDSA P-256, P-384, or P-521)
SSH Client Public Key	112 bits minimum	RSA SigVer (FIPS 186-4) Cert. #A3453	N/A	Encrypted via SSH or TLS	N/A	HDD/RAM – plaintext	Zeroize Service	Public RSA key used to authenticate client. (RSA 2048, 3072, and 4096 bits)
SSH Session Encryption Keys	128 bits minimum	AES-CBC, AES-CTR, or AES-GCM Cert. #A3453	KDF SSH	N/A	SSH, KAS SP 800-56A Rev. 3	RAM - plaintext	Zeroize at session termination	Used in all SSH connections to the security module's command line interface. (128, 192, or 256 bits: AES CBC or CTR) (128 or 256 bits: AES GCM)
SSH Session Authentication Keys	160 bits minimum	HMAC-SHA-1 HMAC-SHA2 -256 HMAC-SHA2 -512 Cert. #A3453	KDF SSH	N/A	SSH, KAS SP 800-56A Rev. 3	RAM - plaintext	Zeroize at session termination	Authentication keys used in all SSH connections to the security module's command line interface (HMAC-SHA-1, HMAC-SHA2-256, HMAC-SHA2-512) (160, 256, 512 bits)
S-S VPN IPSec/IKE DHE or ECDHE Private Components	112 bits minimum	KAS-ECC-SS C KAS-FFC-SS C Cert. #A3453	DBRG, SP 800-56A Rev. 3	N/A	N/A	RAM - plaintext	Power cycle	Diffie-Hellman or EC Diffie-Hellman private component used in key establishment (DHE 2048, DHE 3072, DHE 4096,

								ECDHE P-256, P-384, P-521)
S-S VPN IPSec/IKE DHE or ECDHE Public Components	112 bits minimum	KAS-ECC-SSC KAS-FFC-SSC Cert. #A3453	DRBG, SP 800-56A Rev. 3	N/A	N/A	RAM - plaintext	Power cycle	Diffie-Hellman or EC Diffie-Hellman public component used in key agreement (DHE 2048, DHE 3072, DHE 4096, ECDHE P-256, P-384, P-521)
S-S VPN IPSec/IKE Session Keys	128 bits minimum	AES-CBC, AES-CCM, AES-GCM Cert. #A3453	KDF IKEv2	N/A	IPSec/IKE, KAS SP 800-56A Rev. 3	RAM - plaintext	Zeroize at session termination	Used to encrypt IKE/IPSec data. These are AES (128, 192, or 256 CBC) IKE keys and (128, 192 or 256 CBC, 128 CCM, 128 or 256 GCM) IPSec keys
S-S VPN IPSec/IKE Authentication Keys	160 bits minimum	HMAC-SHA-1 HMAC-SHA2-256 HMAC-SHA2-384 HMAC-SHA2-512 Cert. #A3453	KDF IKEv2	N/A	IPSec/IKE, KAS SP 800-56A Rev. 3	RAM - plaintext	Zeroize at session termination	(HMAC-SHA-1, SHA-256, SHA-384 or SHA-512) Used to authenticate the peer in an IKE/IPSec tunnel connection. (160, 256, 384, 512 bits)
S-S VPN IPSec Pre-Shared Keys	N/A	N/A	N/A	Encrypted via SSH or TLS	N/A	HDD/RAM – plaintext	Zeroize Service	PSK used in conjunction with HMAC listed above for authentication. Entered into the module by the Crypto Officer once authenticated
RA VPN IPSec Session Keys	128 bits minimum	AES-CBC or AES-GCM Cert. #A3453	CKG, DRBG	N/A	N/A	RAM - plaintext	Zeroize at session termination	Used to encrypt remote access sessions utilizing IPSec. (AES 128-CBC, 128/256-GCM)
RA VPN IPSec Authentication	160 bits	HMAC-SHA-1 Cert. #A3453	CKG, DRBG	N/A	N/A	RAM - plaintext	Zeroize at session termination	(HMAC-SHA-1, 160 bits) Used in authentication of remote access IPSec data.
Firmware integrity verification key	128 bits	HMAC-SHA2-256, ECDSA SigVer (FIPS 186-4) Cert. #A3453	N/A	N/A	N/A	HDD - plaintext	N/A	Used to check the integrity of all software code (HMAC-SHA-256 and ECDSA P-256) (Note: This is not considered an SSP)
Public key for firmware content load test	112 bits	RSA SigVer (FIPS 186-4) Cert. #A3453	N/A	N/A	N/A	HDD - plaintext	N/A	Used to authenticate software/firmware and content to be installed on the firewall (RSA 2048 with SHA-256)
CO, User, RA VPN Password	N/A	SHA2-256 Cert. #A3453	External	Encrypted via SSH or TLS	N/A	HDD - a password hash (SHA2-256)	Zeroize Service	Authentication string with a minimum length of eight (8) characters.
Protocol Secrets	N/A	N/A	N/A	Encrypted via IPSEC, SSH or TLS	N/A	HDD/RAM – plaintext	Zeroize Service	Secrets used by RADIUS or TACACS+ (8 characters minimum)

Entropy Input String	256 bits	CKG (vendor affirmed), Counter DRBG Cert. #A3453	Entropy as per SP 800-90B	N/A	N/A	RAM - plaintext	Power cycle	Entropy input string coming from the entropy source Input length = 384 bits
DRBG Seed	256 bits	CKG (vendor affirmed), Counter DRBG Cert. #A3453	Entropy as per SP 800-90B	N/A	N/A	RAM - Plaintext	Power cycle	DRBG seed coming from the entropy source Seed length = 384 bits
DRBG Key	256 bits	CKG (vendor affirmed), Counter DRBG Cert. #A3453	Entropy as per SP 800-90B	N/A	N/A	RAM - plaintext	Power cycle	AES 256 CTR DRBG state Key used in the generation of a random values
DRBG V	128 bits	CKG (vendor affirmed), Counter DRBG Cert. #A3453	Entropy as per SP 800-90B	N/A	N/A	RAM - plaintext	Power cycle	AES 256 CTR DRBG state V used in the generation of a random values
SNMPv3 Authentication Secret	N/A	KDF SNMP Cert. #A3453	N/A	Encrypted via TLS/SSH	N/A	HDD/RAM – plaintext	Zeroize Service	Used to support SNMPv3 services (Minimum 8 characters)
SNMPv3 Privacy Secret	N/A	KDF SNMP Cert. #A3453	N/A	Encrypted via TLS/SSH	N/A	HDD/RAM – plaintext	Zeroize Service	Used to support SNMPv3 services (Minimum 8 characters)
Authentication Key	160 bits minimum	HMAC-SHA-1 HMAC-SHA2-224 HMAC-SHA2-256 HMAC-SHA2-384 HMAC-SHA2-512 Cert. #A3453	KDF SNMP	N/A	N/A	HDD/RAM - Plaintext	Zeroize Service	HMAC–SHA-1/224/256/384/512 Authentication protocol key (160 bits)
Session Key	128 bits minimum	AES-CFB Cert. #A3453	KDF SNMP	N/A	N/A	HDD/RAM - Plaintext	Zeroize Service	Privacy protocol encryption key (AES 128/192/256 CFB)

Note: SSPs are implicitly zeroized when power is lost, or explicitly zeroized by the zeroize service. In the case of implicit zeroization, the SSPs are implicitly overwritten with random values due to their ephemeral memory being reset upon power loss. For the zeroization service and zeroization at session termination, the SSP's memory location is overwritten with random values.

Table 11 - Non-Deterministic Random Number Generation Specification

Entropy Source	Minimum number of bits of entropy	Details
Palo Alto Networks DRNG Entropy Source	256 bits	ESV Cert. #E68, E70, E71, E72, E73 Entropy source provides full entropy, which is provided in the 384 bit seed.
AMD Random Number Generator	256 bits	ESV Cert. #E27 When initialized per Section 11, the DRBG is seeded with 256 bits of entropy.
Octeon III Entropy Source	256 bits	ESV Cert. #E128 When initialized per Section 11, the DRBG is seeded with 256 bits of entropy.

10. Self-Tests

The cryptographic module automatically performs the following tests below. The operator can command the module to perform the pre-operational and cryptographic algorithm self-tests by cycling power of the module; these tests do not require any additional operator action.

Pre-operational Self-Tests

Pre-operational Firmware Integrity Test

- Verified with HMAC-SHA-256 and ECDSA P-256

Note: the ECDSA and HMAC-SHA-256 KATs are performed prior to the Software integrity test

Conditional self-tests

Cryptographic algorithm self-tests

- AES 128-bit ECB Encrypt Known Answer Test*
- AES 128-bit ECB Decrypt Known Answer Test *
- AES 128-bit CMAC Known Answer Test*
  *Note: Supported by the module cryptographic implementation, but only utilized for CAST
- AES 256-bit GCM Encrypt Known Answer Test
- AES 256-bit GCM Decrypt Known Answer Test
- AES 192-bit CCM Encrypt Known Answer Test
- AES 192-bit CCM Decrypt Known Answer Test
- RSA 2048-bit PKCS#1 v1.5 with SHA-256 Sign Known Answer Test
- RSA 2048-bit PKCS#1 v1.5 with SHA-256 Verify Known Answer Test
- RSA 2048-bit Encrypt Known Answer Test
- RSA 2048-bit Decrypt Known Answer Test
  Note: RSA Encrypt/Decrypt are only used for self-tests
- ECDSA P-256 with SHA-512 Sign Known Answer Test
- ECDSA P-256 with SHA-512 Verify Known Answer Test
- HMAC-SHA-1 Known Answer Test
- HMAC-SHA-256 Known Answer Test
- HMAC-SHA-384 Known Answer Test

- HMAC-SHA-512 Known Answer Test
- SHA-1 Known Answer Test
- SHA-256 Known Answer Test
- SHA-384 Known Answer Test
- SHA-512 Known Answer Test
- DRBG SP 800-90Arev1 Instantiate/Generate/Reseed Known Answer Tests
- SP 800-90Arev1 Instantiate/Generate/Reseed Section 11.3 Health Tests
- SP 800-56Ar3 KAS-FFC-SSC 2048-bit Known Answer Test
- SP 800-56Ar3 KAS-ECC-SSC P-256 Known Answer Test
- SP 800-135rev1 TLS 1.2 with SHA-256 KDF Known Answer Test
- SP 800-135rev1 SSH KDF with SHA-256 Known Answer Test
- SP 800-135rev1 IKEv2 KDF with SHA-256 Known Answer Test
- SP 800-90B RCT/APT Health Tests on Entropy Source
  Note: The SP 800-90B Health Tests are implemented by the entropy source.

Conditional Pairwise Consistency Self-Tests

- RSA Pairwise Consistency Test
- ECDSA/KAS-ECC Pairwise Consistency Test
- KAS-FFC Pairwise Consistency Test

Conditional Software Load test

- Firmware Load Test – Verify RSA 2048 with SHA-256 signature on software at time of load

Conditional Critical Functions Tests

- SP 800-56A Rev. 3 Assurance Tests (Based on Sections 5.5.2, 5.6.2, and 5.6.3)

Error Handling

In the event of a conditional test failure, the module will output a description of the error. These are summarized below.

Table 12 - Errors and Indicators

Cause of Error	Error State Indicator
Conditional Cryptographic Algorithm Self-Test or Software Integrity Test Failure	FIPS-CC mode failure. <Algorithm test> failed.
Conditional Pairwise Consistency or Critical Functions Test Failure	System log prints an error message.
Conditional Software Load Test Failure	System prints Invalid image message.

11. Life-Cycle Assurance

The vendor provided life-cycle assurance documentation describes configuration management, design, finite state model, development, testing, delivery & operation, end of life procedures, and guidance. For details regarding the approved mode of operation, see “Approved Mode of Operation''. For details regarding secure installation, initialization, startup, and operation of the module, see below.

Palo Alto Network provides an Administrator Guide for additional information noted in the “Reference Documents” section of this Security Policy.

Module Enforced Security Rules

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 140-3 Level 2 module.

1. The cryptographic module provides four distinct operator roles. These are the User role, Remote Access VPN role, Site-to-site VPN role, and the Cryptographic Officer role.
2. The cryptographic module provides identity-based authentication.
3. The cryptographic module clears previous authentications on each power cycle.
4. When the module has not been placed in a valid role, the operator does not have access to any cryptographic services.
5. Data output is inhibited during power-up self-tests, zeroization and error states.
6. Status information does not contain CSPs or sensitive data that if misused could lead to a compromise of the module.
7. There are no restrictions on which keys or SSPs are zeroized by the zeroization service.
8. The module maintains separation between concurrent operators.
9. The module does not support a maintenance interface or role.
10. The module does not have any external input/output devices used for entry/output of data.
11. The module does not enter or output plaintext SSPs.
12. The module does not output intermediate key generation values.
13. Pre-shared keys used for IKE/IPSec must be at least 6 bytes in length, but no more than 255 bytes.

Vendor imposed security rules

In FIPS-CC mode, the following rules shall apply:

1. The operator shall not enable TLSv1.0 or use RSA for key wrapping; it is disabled by default
    a. Checked via CLI using “show shared” command
2. The operator should not enable TLSv1.3, it is disabled by default.
    a. Checked via CLI using “show profiles” command
3. For devices supporting AMD entropy (PA-5410/5420/5430/5440), a minimum system uptime of 273 hours shall pass before the module can be used to ensure proper instantiation of the DRBG.
    a. Verify uptime via the following command: “show system info | match uptime”
    b. After this time, the server certificate (i.e. CA Certificate with Public/Private keys) and SSH Host Keys shall be regenerated using the following procedure:
        i. Login via CLI and issue the following commands:
            1. set deviceconfig system ssh profiles mgmt-profiles server-profiles <Name> default-hostkey key-type <RSA/ECDSA> <Key Size>
            2. set deviceconfig system ssh regenerate-hostkeys mgmt key-type <RSA/ECDSA> key-length <Key Size>
            3. set deviceconfig system ssh mgmt server-profile <Name>
            4. commit (Once complete, exit configure state)

5. set ssh service-restart mgmt

ii. Login via WebUI and create a new certificate chain
    1. Create new certificates via Device > Certificate Management > Certificates
    2. Navigate to Device > Setup > Management > General Settings > Click the gear icon
        a. Select “SSL/TLS Service Profile” and create a new profile with the certificates generated in previous step
        b. Click OK and commit the configuration

4. For devices utilizing Octeon III entropy, a minimum system uptime of 1 hour shall pass before the module can be used to ensure proper instantiation of the DRBG.
    a. Verify uptime via the following command: “show system info | match uptime”
    b. After this time, the server certificate (i.e. CA Certificate with Public/Private keys) and SSH Host Keys shall be regenerated. See Rule 3b above for procedure required
5. If using RADIUS, it must be configured using TLS.
    a. Checked via CLI using “show shared” command
6. If using TACACS+, configure the service route via an IPSec tunnel, and ensure the TACACS+ server is configured for a minimum password length of eight (8) characters or greater.
    a. Checked via CLI using “show deviceconfig” command

12. Mitigation of Other Attacks

The module is not designed to mitigate any specific attacks outside the scope of FIPS 140-3. These requirements are not applicable.

13. Definitions and Acronyms

API – Application Programming Interface
App-ID – Application Identification - Palo Alto Networks’ ability to identify applications and apply security policy based on the ID rather than the typical port and protocol-based classification.
BGP – Border Gateway protocol – Dynamic routing protocol
CA – Certificate authority
Content-ID – Content Identification – Palo Alto Networks’ threat prevention features including Antivirus, Antispyware, and Intrusion Prevention.
CO – Cryptographic Officer
DLP – Data loss prevention
Gbps – Gigabits per second
HA – High Availability
HSCI - High Speed Chassis Interconnect
IKE – Internet Key Exchange
IP – Internet Protocol
IPSec – Internet Protocol Security
LDAP – Lightweight Directory Access Protocol
LED – Light Emitting DiodeOCSP – Online Certificate Status Protocol
OSPF – Open Shortest Path First – Dynamic routing protocol
PAN-OS – Palo Alto Networks’ Operating System
QoS – Quality of Service
QSFP - Quad Small Form-factor Pluggable
RA VPN – Remote Access Virtual Private Network
RIP – Routing Information Protocol – Dynamic routing protocol
RJ45 – Networking Connector
RNG –Random number generator

S-S VPN – Site to site Virtual Private Network
SFP – Small Form-factor Pluggable Transceiver
SSL – Secure Sockets Layer
TLS – Transport Layer Security
USB – Universal Serial Bus
User-ID – User Identification – Palo Alto Networks' ability to apply security policy based on who initiates the traffic rather than the typical IP-based approach.
VPN – Virtual Private Network
XML – Extensible Markup Language

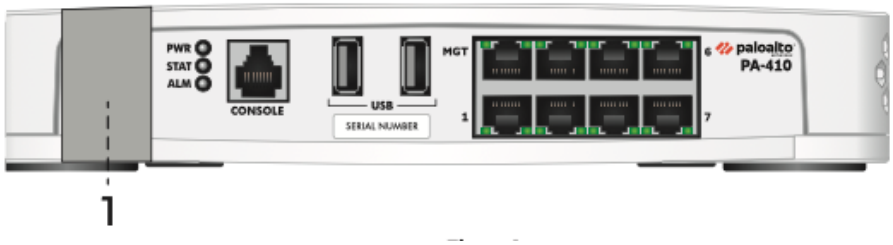
14. Reference Documents

FIPS 140-3 - FIPS Publication 140-3 Security Requirements for Cryptographic ModulesPalo Alto Networks Administrator's Guide :
https://docs.paloaltonetworks.com/content/dam/techdocs/en_US/pdf/pan-os/11-0/pan-os-admin/pan-os-admin.pdf

Appendix A - PA-410 - FIPS Accessories/Tamper Seal Installation (4 Seals)

The PA-410 requires four tamper labels. Refer to Table 2 of this document for the part number of the physical kit containing the tamper labels. The placement of these seals are needed in the following areas.

Affix one seal to the front of the module that connects to the top/bottom.



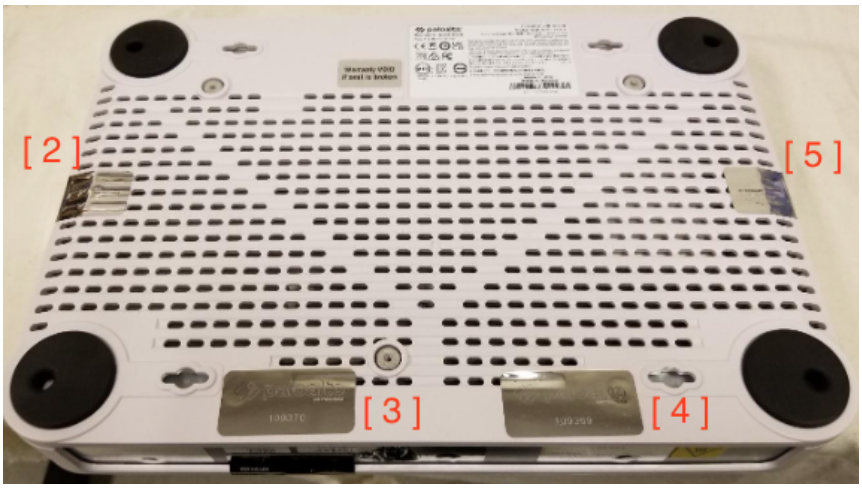
The left and right side of the module requires one seal each in the same location, as noted in the following area. This wraps to the top and bottom of the module. The last seal is placed on the rear side of the module, and wraps to the top and bottom of the module.

Appendix B - PA-415 - FIPS Accessories/Tamper Seal Installation (5 Seals)

The PA-415 requires 5 tamper labels in the following locations. Refer to Table 2 of this document for the part number of the physical kit containing the tamper labels. Affix the tamper labels as shown below:

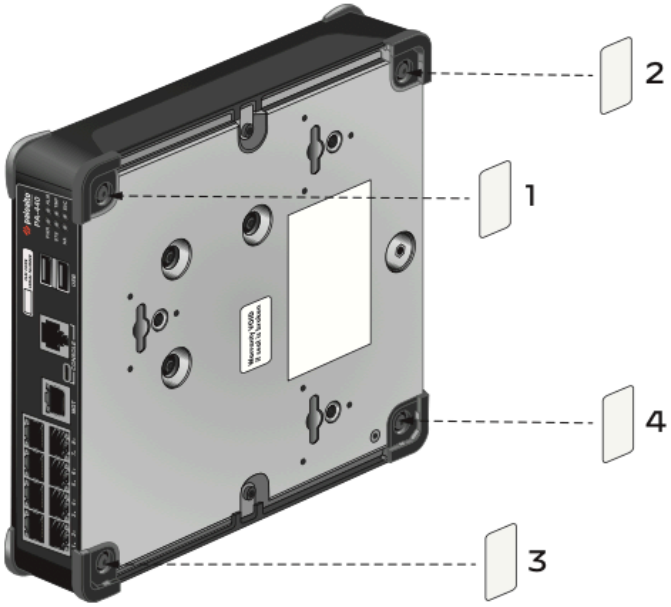
Attach one label on the top side that wraps around the rear side of the module:

Affix four labels on the bottom of the device. One on each side that wraps to the bottom of the module, and two in locations 3 and 4.



Appendix C - PA-440/450/460 FIPS Accessories/Tamper Seal Installation (4 Seals)

The PA-440/450/460 require four tamper labels that are placed at the same location as the modules have the same enclosure. Refer to Table 2 of this document for the part number of the physical kit containing the tamper labels. Affix the tamper labels on the rear of the module as shown below:

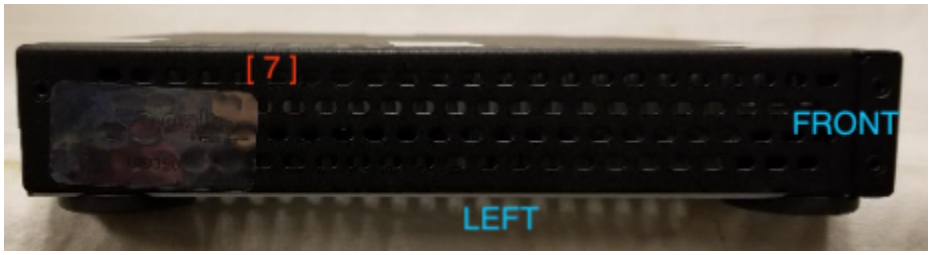


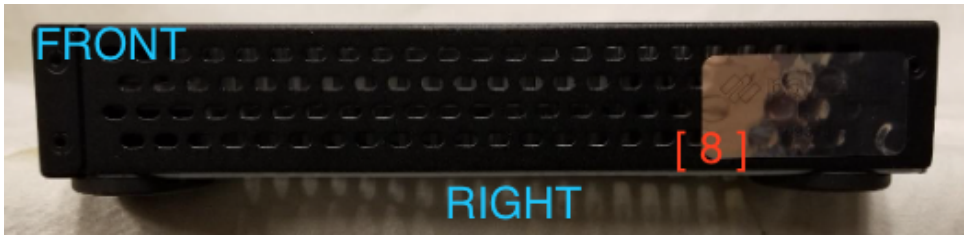
Appendix D - PA-445 FIPS Accessories/Tamper Seal Installation (8 Seals)

The Physical Kit for this module requires 8 tamper labels. Refer to Table 2 of this document for the part number of the physical kit containing the tamper labels. Placement is as follows.

Apply 6 seals on the top of the module:

Place one seal on the right and one seal on the left of the module:

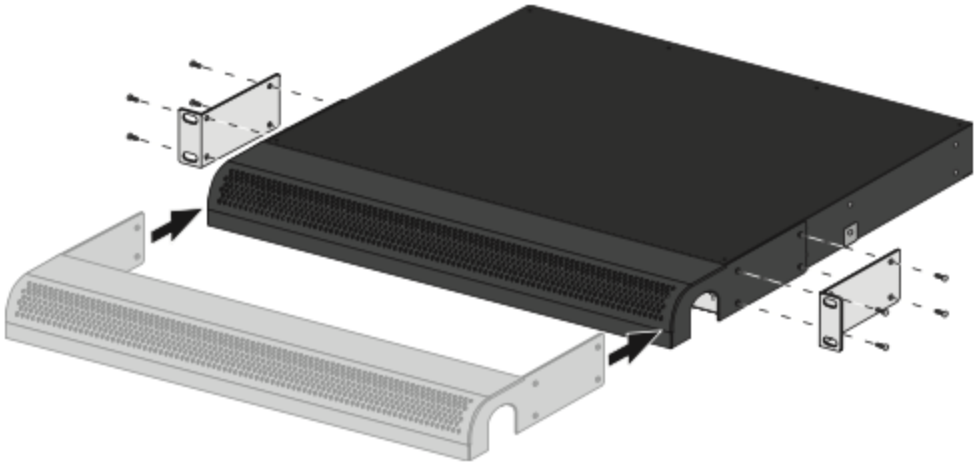


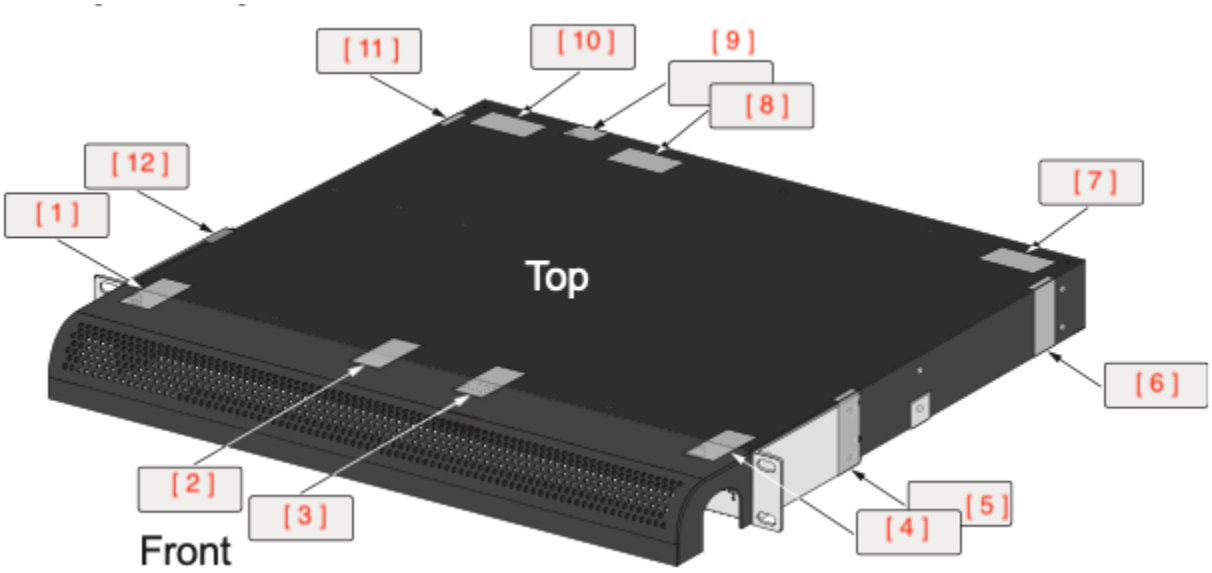


Appendix E - PA-1400 and PA-3400 Series FIPS Accessories/Tamper Seal Installation (12 Seals)

The PA-1410/PA-1420 and PA-3410/PA-3420/PA-3430/PA-3440 require 12 tamper labels that are placed at the same location on all devices in the series. Refer to Table 2 of this document for the part number of the physical kit containing the tamper labels and opacity shields. Affix the tamper labels and install the opacity shields on the module as shown below in the diagrams.

Install the front opacity shield as such:



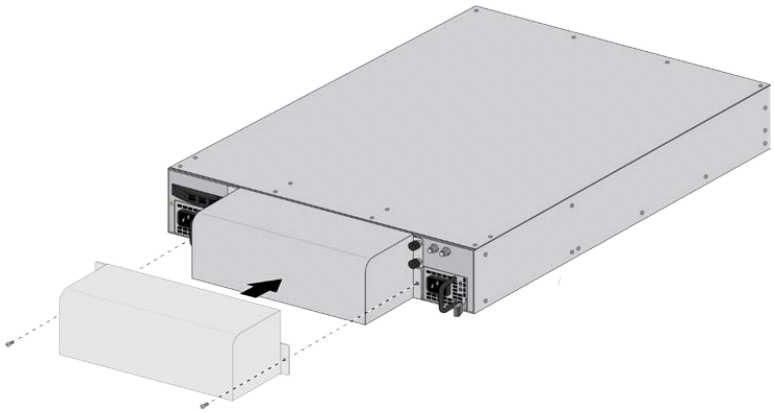


Note: Depending on the module, there may be 1 or 2 power supplies provided. Regardless of 1 or 2 being installed, the location of the tamper label is the same.

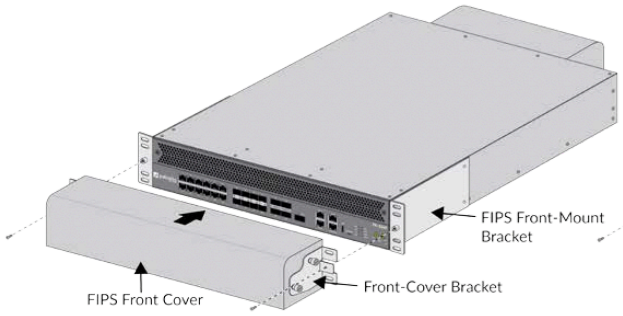
Appendix F – PA-3200 Series – FIPS Accessories/Tamper Seal Installation (19 Seals)

The PA-3220/PA3250/PA-3260 require 19 tamper labels that are placed at the same location on all devices in the series. Refer to Table 2 of this document for the part number of the physical kit containing the tamper labels and opacity shields. Affix the tamper labels and install the opacity shields as shown in the below diagrams.

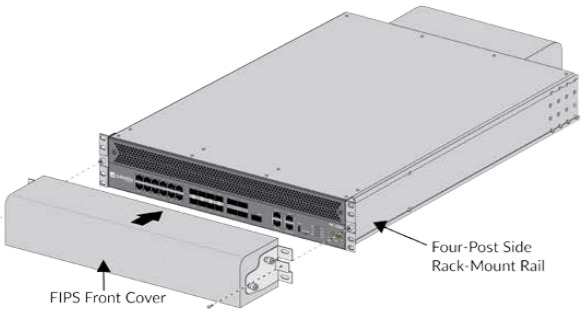
1. Install the back cover to the back of the firewall



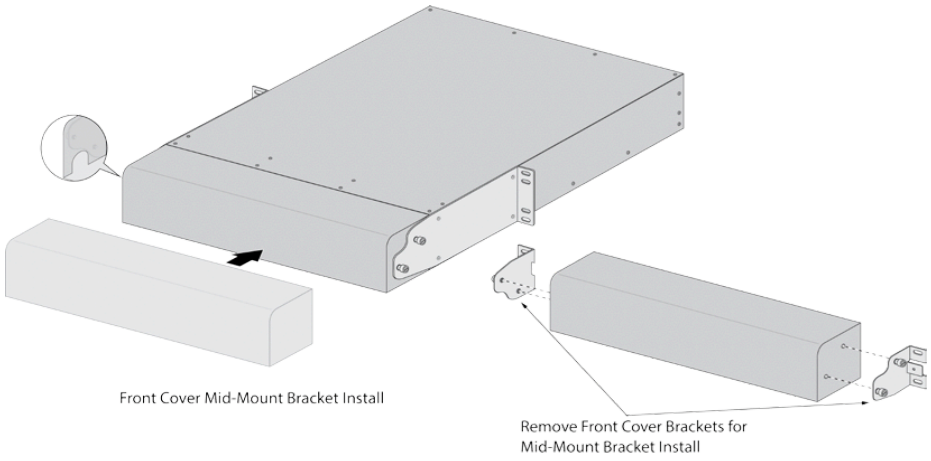
2. Attach the bracket to the firewall that will be used. Note: The firewall can use a mid-mount, front-mount or four-post mount. All seal placement is the same for the various use cases.



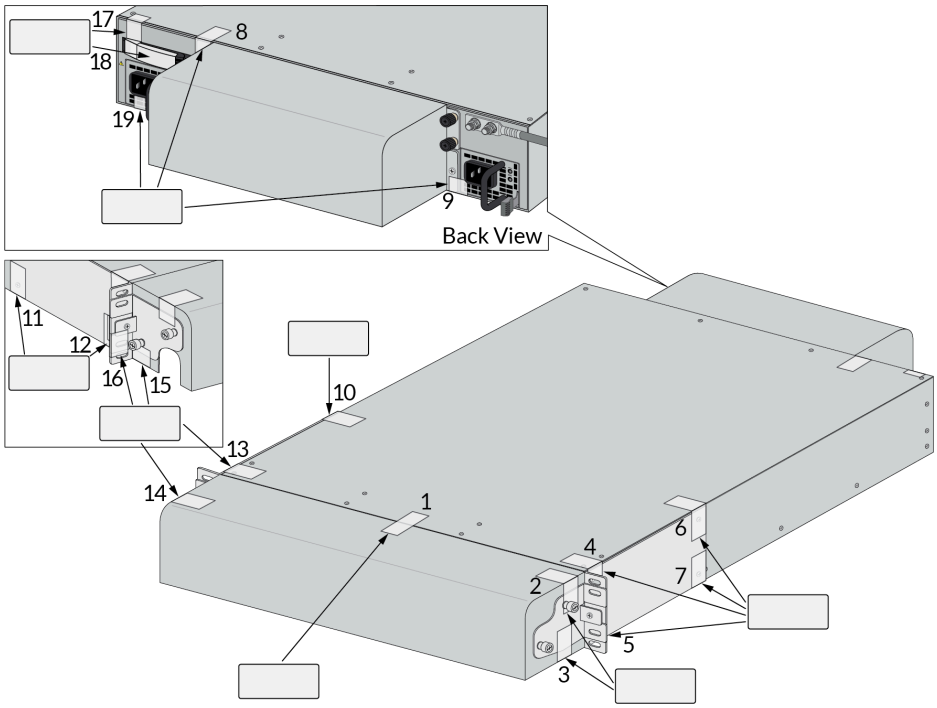
Front-Mount Install



Four-Post Rack Kit Install



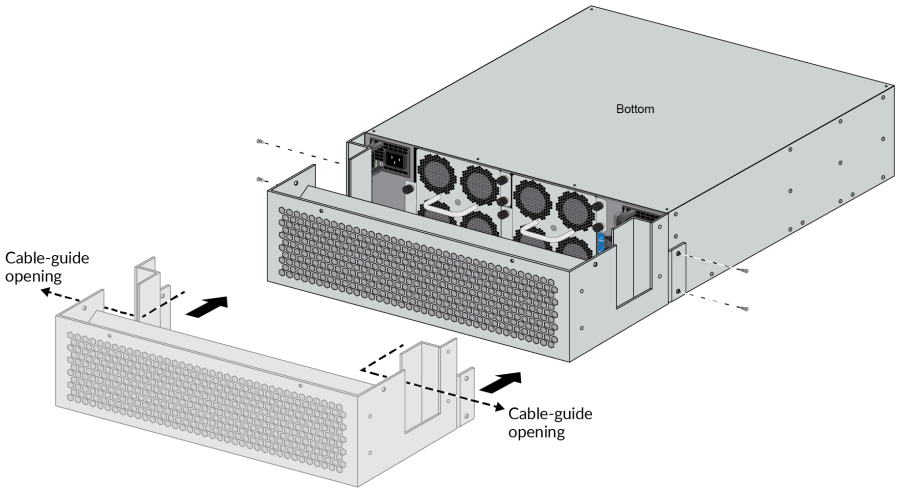
3. Place 19 tamper seals on the module. Note: Tamper seal placement is the same for all mount types. Seal #16 is required only for the front-mount of four-post rack installations. It is not required for the mid-mount installation



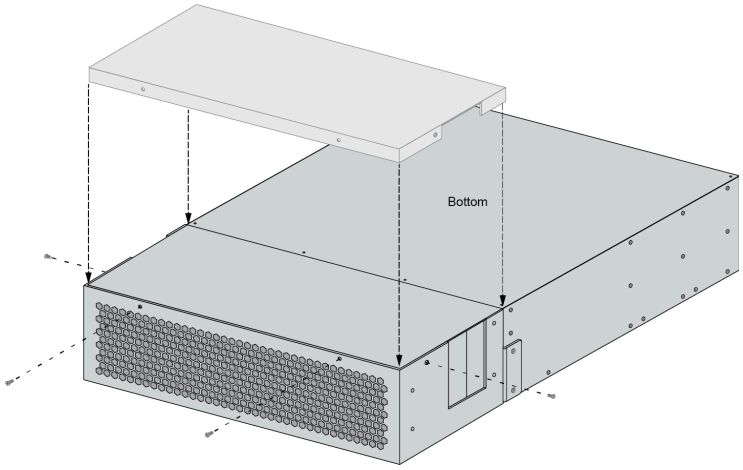
Appendix G - PA-5200- FIPS Accessories/Tamper Seal Installation (28 Seals)

The PA-5220/PA-5250/PA-5260/PA-5280 require 28 tamper labels that are placed at the same location on all devices in the series. Refer to Table 2 of this document for the part number of the physical kit containing the tamper labels and opacity shields. Affix the tamper labels and install the opacity shields as shown in the below diagrams.

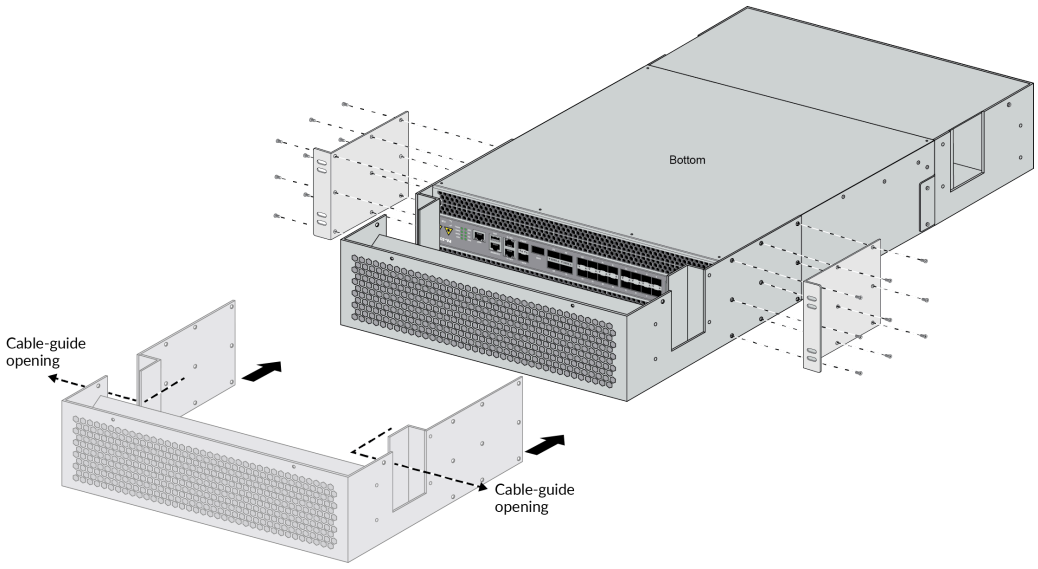
1. Place the firewall upside down on a flat Electrostatic Discharge (ESD) protected surface and ground yourself by touching a metal surface on the firewall.
2. Install power cables: plug the power cords in to the power inlets located on the back of the firewall and connect the ground lug and ground cable to the ground lug bolts (you cannot access these back ports after you attach the FIPS back cover).
3. Place the FIPS back cover onto the back of the firewall and attach it to the firewall using four (4) #8-32 x 1/4" screws (two (2) screws on each side of the cover). Route the power cables through the back-cover cable-guide openings.



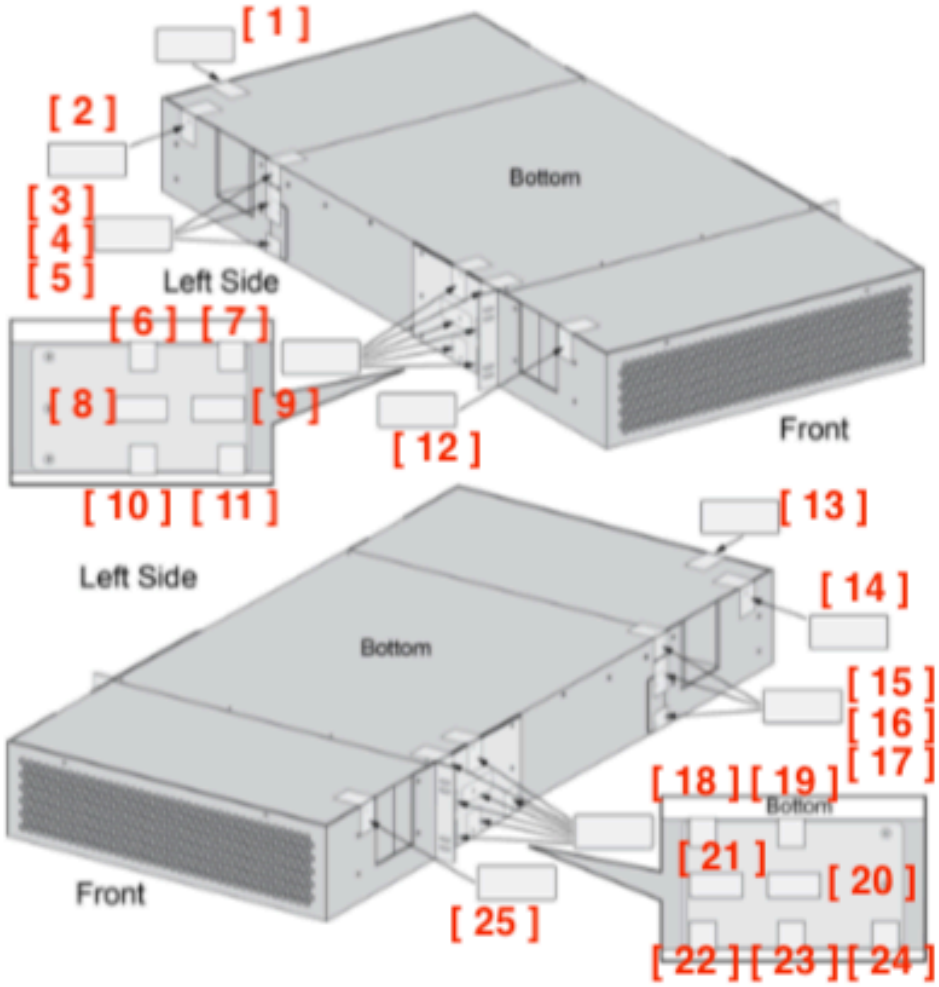
4. Attach the FIPS back-cover panel to the FIPS back cover using four (4) #4-40 x 1/4" screws (one (1) screw on each side of the cover and two (2) screws on the back of the cover).

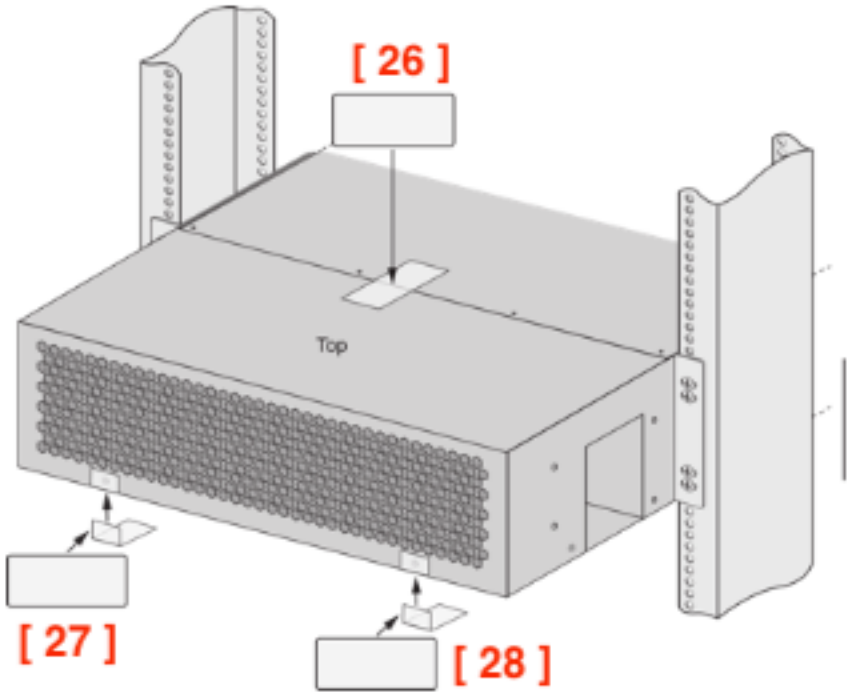


5. Place the FIPS front cover onto the front of the firewall and place the rack-mount brackets over the holes on the front cover. Attach the front cover and rack-mount brackets to the firewall using eighteen (18) #8-32 x 5/16” screws (shipped with the firewall)—use nine (9) screws on each side.



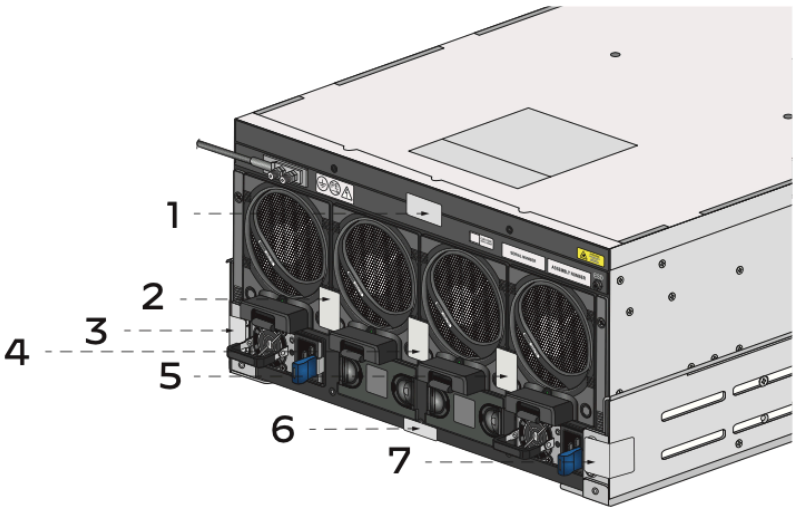
6. Apply a tamper-evident seal to each location shown in the illustrations (28 seals).



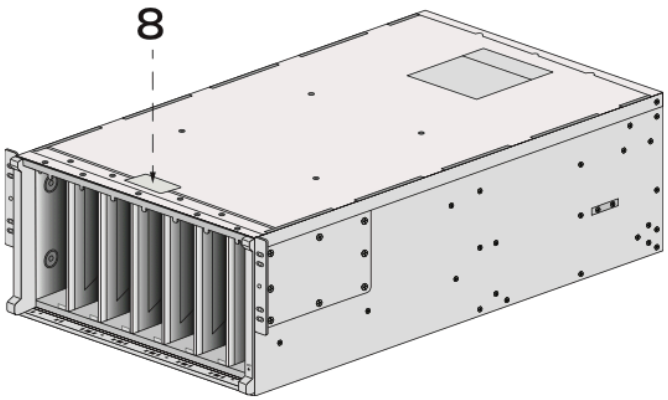

[26]
Top
[27]
[28]

Appendix F - PA-5450 FIPS Accessories/Tamper Seal Installation (12 Seals)

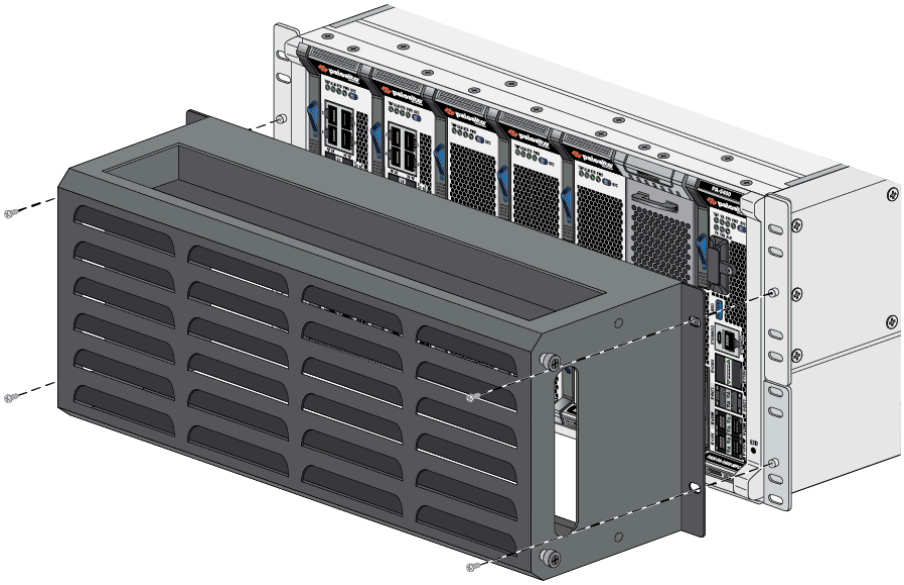
The PA-5450 requires twelve tamper seals. Follow the directions below to install the Physical Kit. Affix 7 seals at the locations on the rear of the device:



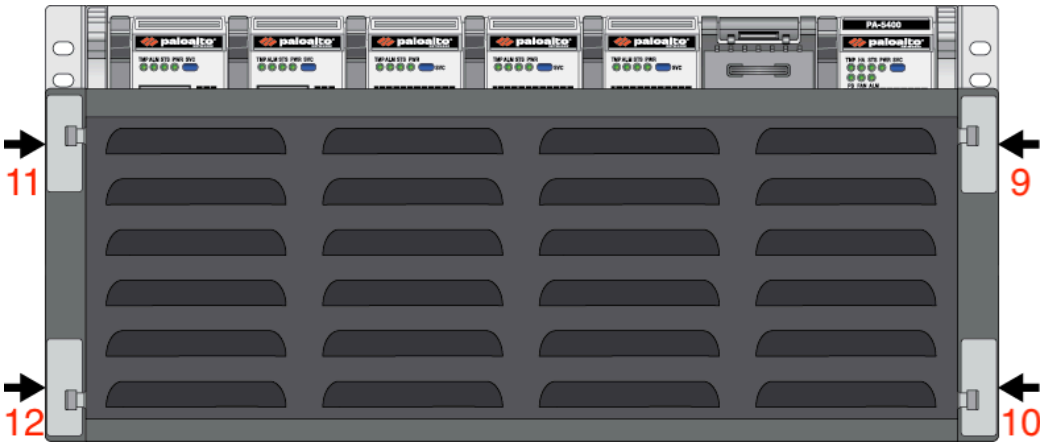
On the top cover of the module, place one seal at the following location:



Affix the front opacity shield to the front of the device and screw into the locations as below:

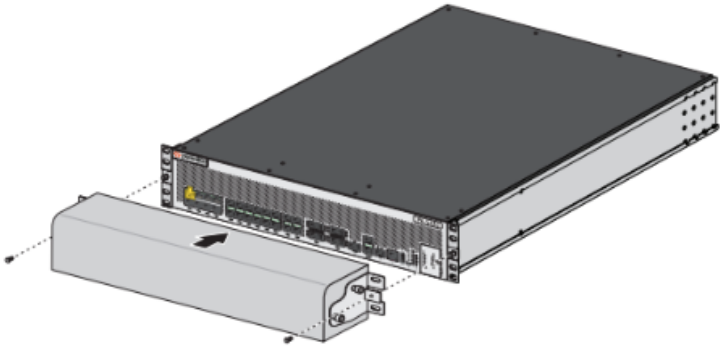


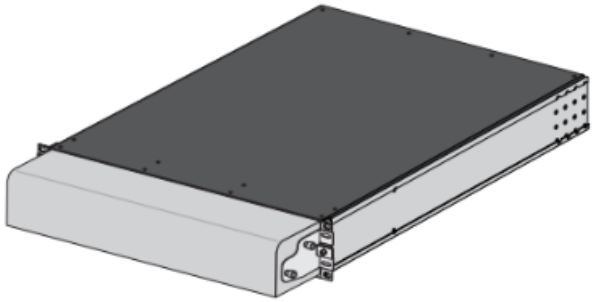
Finalize the process by adding four seals at the following locations to secure the screws:

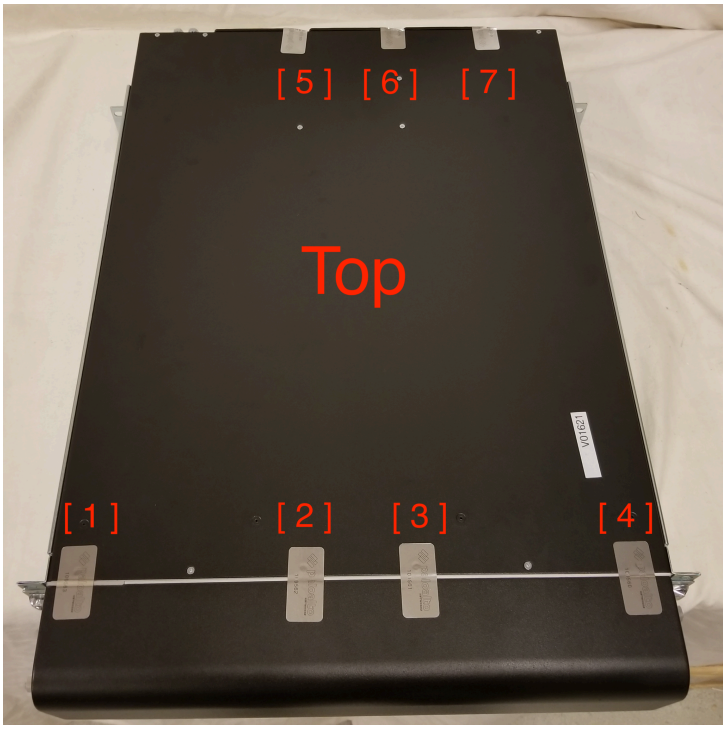


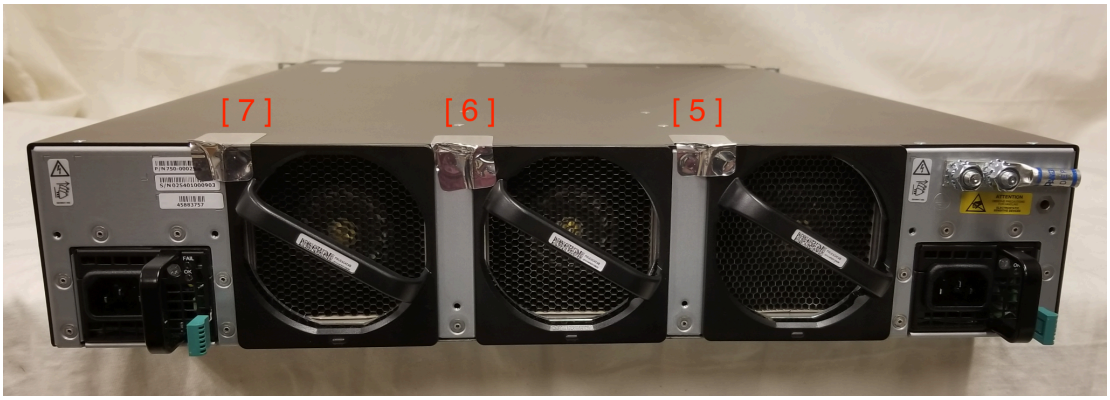
Appendix H - PA-5400 Series FIPS Accessories/Tamper Seal Installation (11 Seals)

The PA-5410/PA-5420/PA-5430/PA-5430 require 11 tamper labels. The location of the tamper labels placement is the same for all models in the series. Refer to Table 2 of this document for the part number of the physical kit containing the tamper labels and opacity shields. Affix the tamper labels and install the opacity shields as shown in the below diagrams.





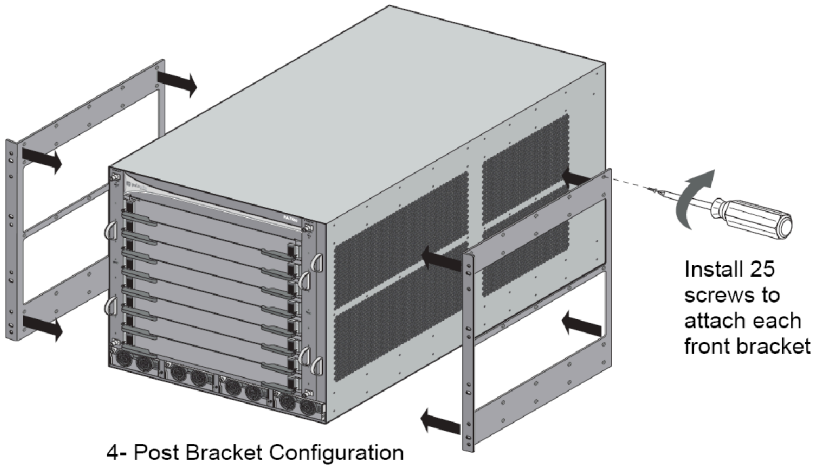




Appendix I - PA-7050 - FIPS Accessories/Tamper Seal Installation (24 Seals)

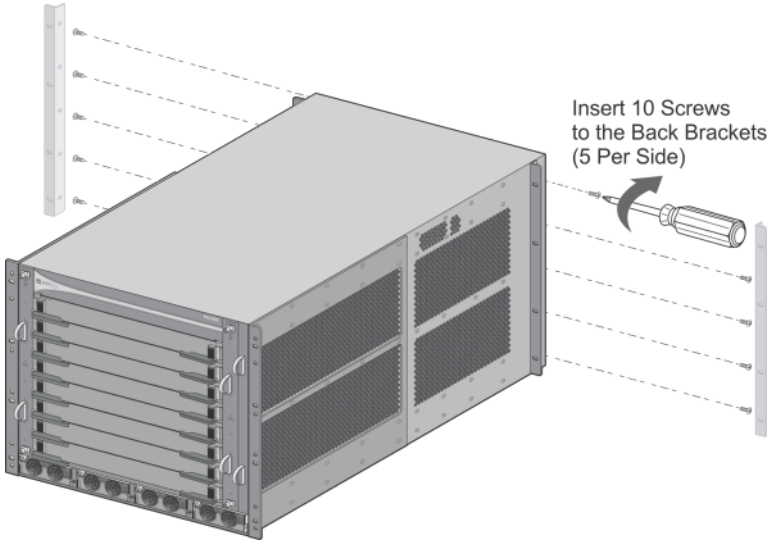
The PA-7050 requires 24 tamper labels. Refer to Table 2 of this document for the part number of the physical kit containing the tamper labels and opacity shields. Affix the tamper labels and install the opacity shields as shown in the below diagrams.

1. Attach front right rack mount brackets in 4-post rack position. Do not attach rear rack mount brackets. Note that brackets are rotated 180 degrees, so the screw holes lineup and the rack mount holes are now on the front of the chassis.

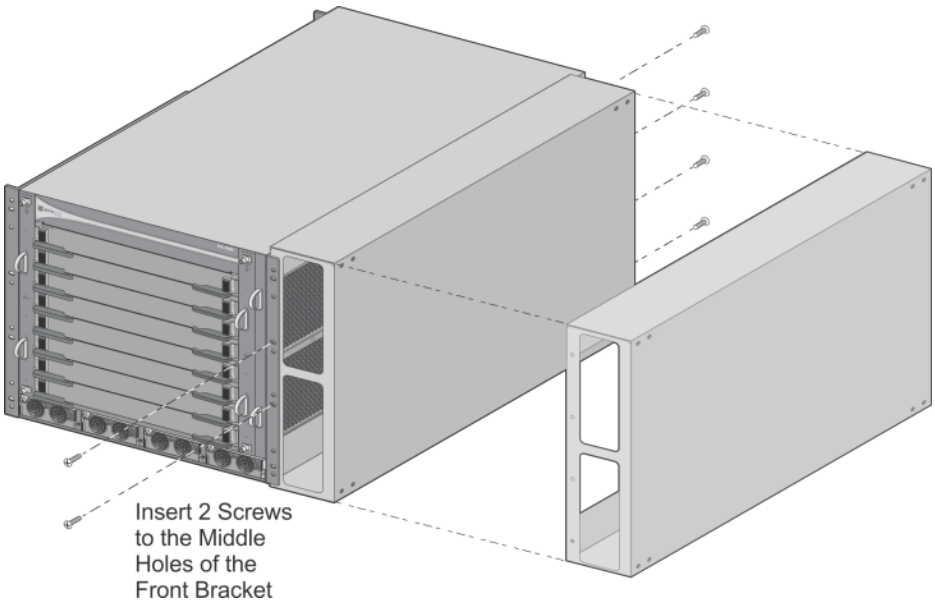


4- Post Bracket Configuration

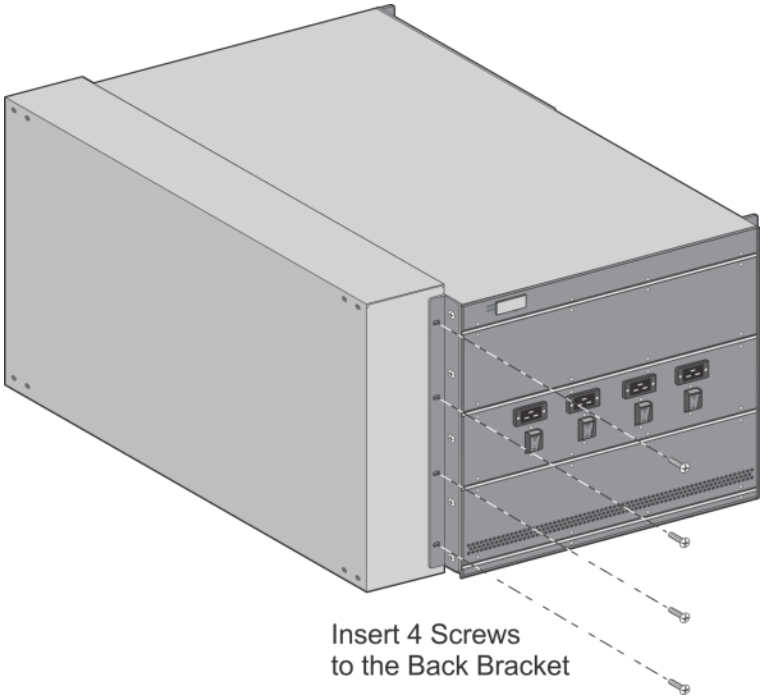
2. Align right plenum bracket with five (5) open screw holes. Attach air plenum brackets using five (5) of the remaining bracket screws as shown. Repeat for left side.



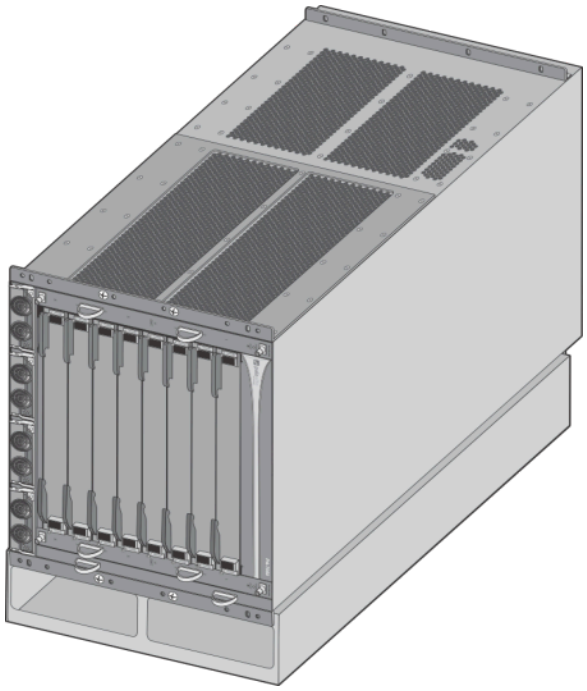
3. Attach bottom plenum to the front right rack mount bracket. Place only the middle two (2) screws.



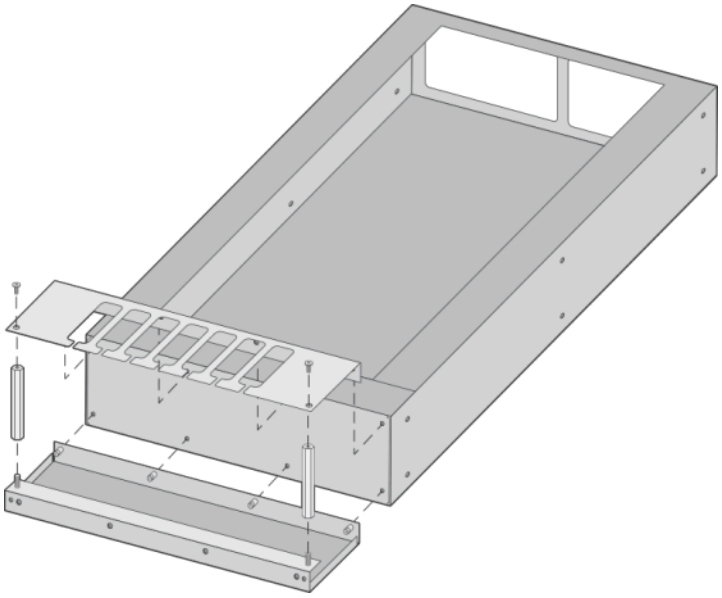
4. Attach the bottom plenum to the rearward right plenum bracket.



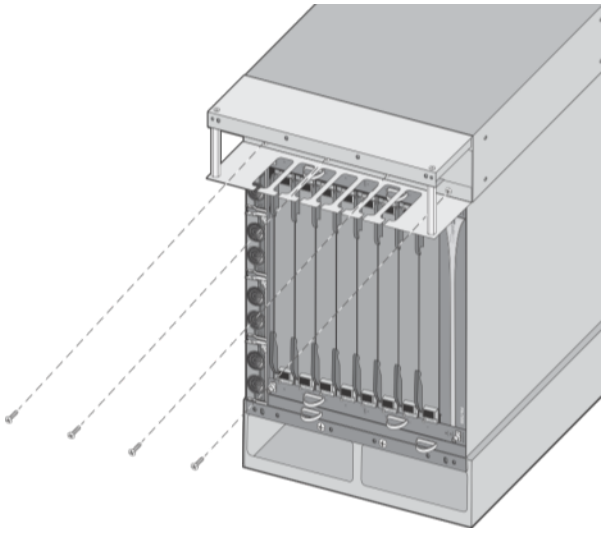
5. Rotate PA-7050 chassis clockwise 90 degrees onto the bottom plenum.



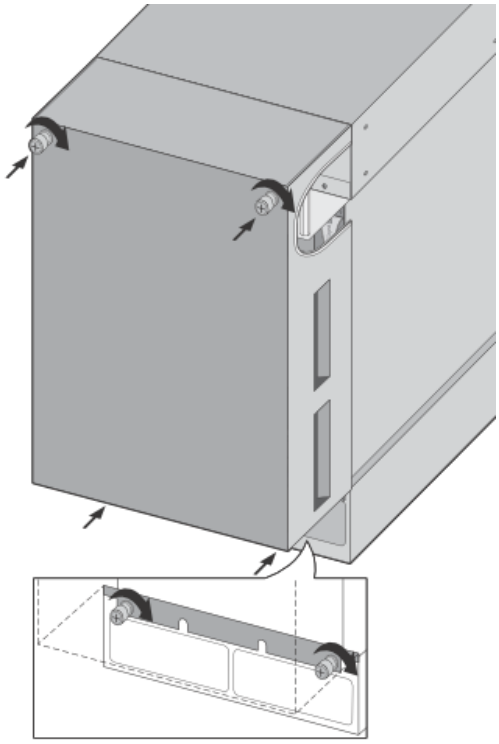
6. Assemble top plenum and cable guide hardware.



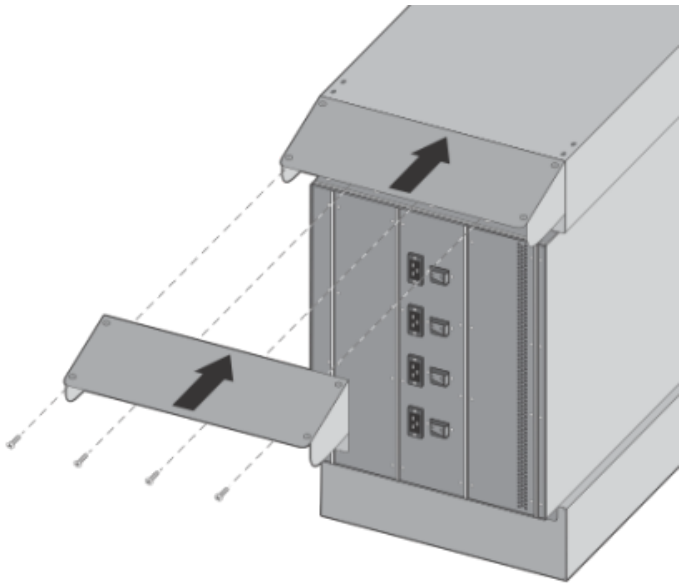
7. Attach top plenum to the front left rack mount bracket



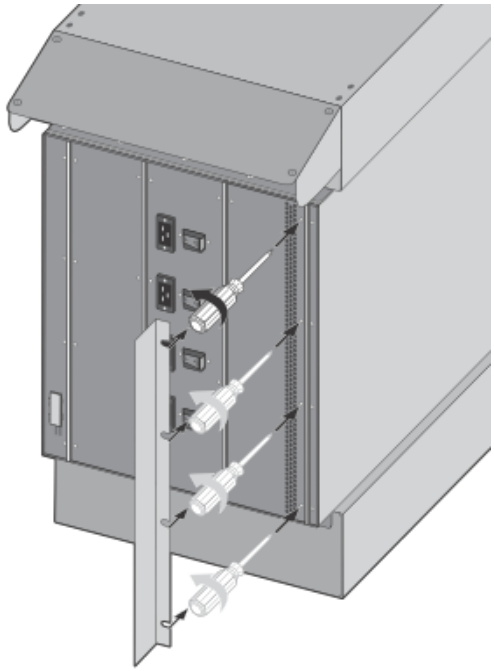
8. Attach front opacity shield using the four (4) captive screws



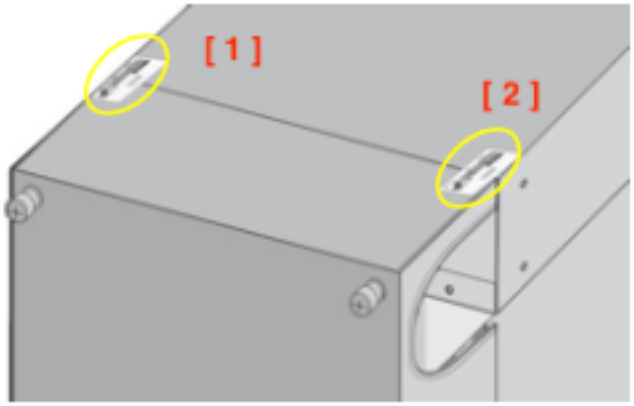
9. Attach top plenum to the rearward left plenum bracket along with plenum's rear opacity shield as shown



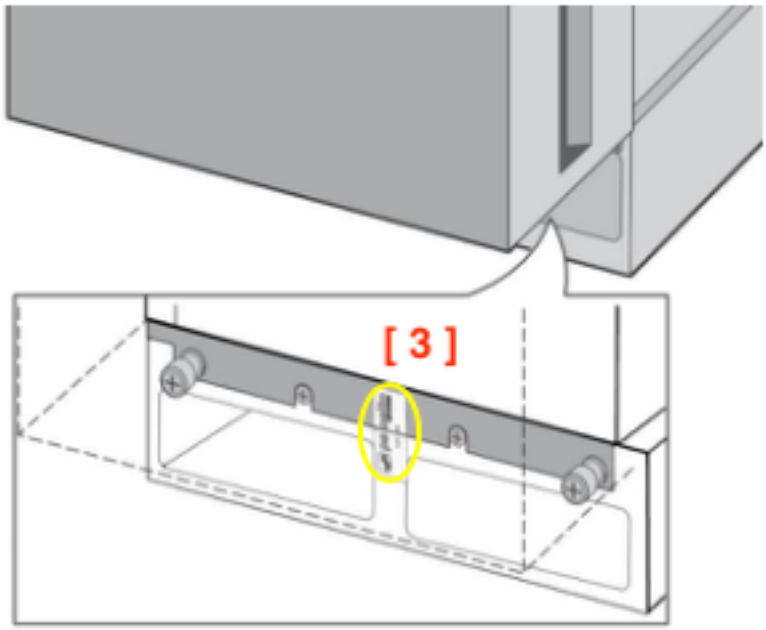
10. Loosen four (4) screws on the panel containing the power supply vent. Insert the power supply vent opacity shield and tighten screws.



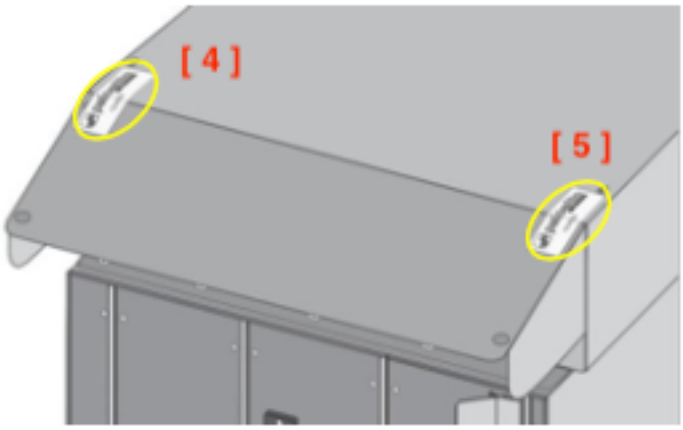
11. Facing the front of the module, affix two (2) seals to top of the front opacity shield, one (1) near left edge and one (1) near the right edge. Ensure the seals, when placed, overlap onto the top of the plenum, as shown. (2 total)



12. Facing the front of the module affix one (1) seal centered to the bottom of the front opacity shield to the bottom air plenum, as shown. (1 total)

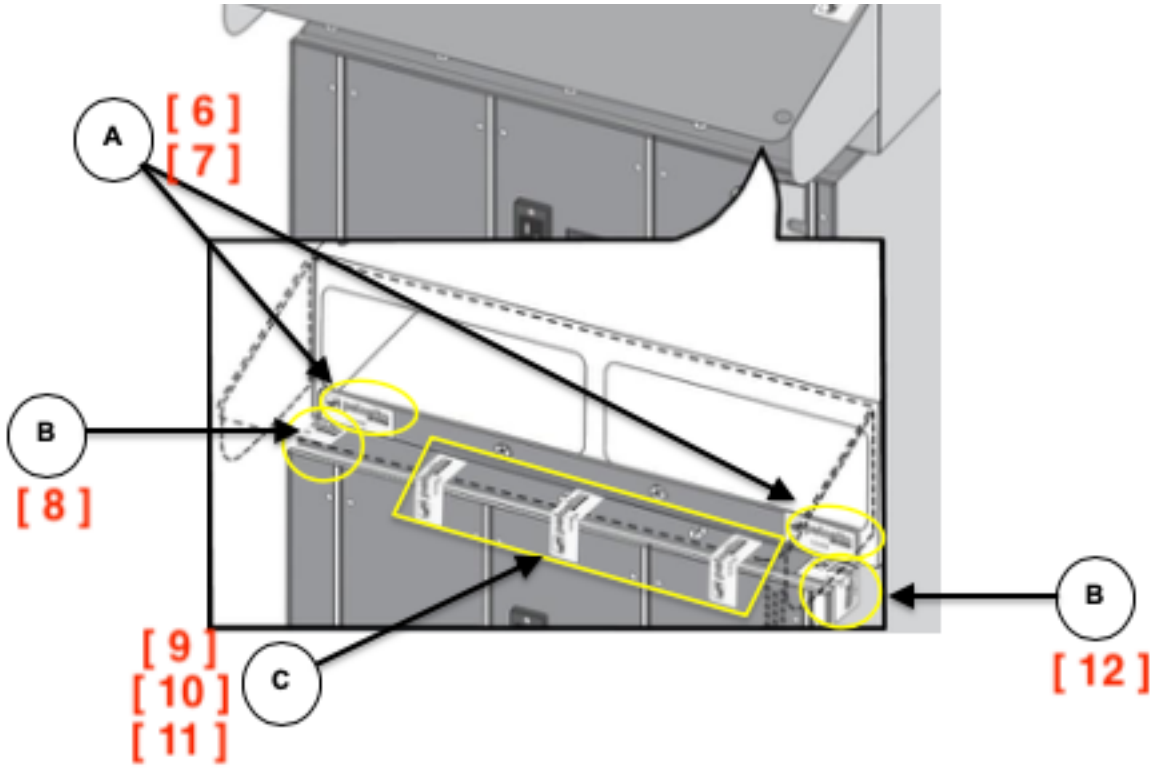


13. Facing the rear of the module, affix two (2) seals to top of the rear opacity shield, one (1) near left edge and one (1) near the right edge. Ensure the seals, when placed, overlap onto the top of the plenum, as shown.
(2 total)



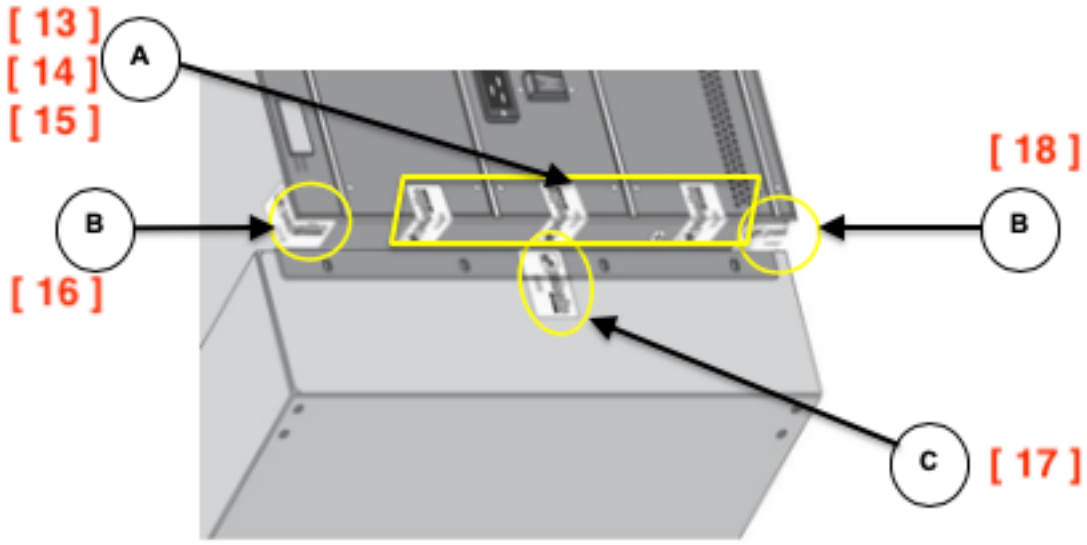
14. Facing the rear of the module;
    A. Affix one (1) seal to the top plenum/opacity shield, covering the left and right outermost screws, as shown.
    B. Affix one (1) seal to the left and right edge of the top plenum bracket folding over the outer edge of the module, as shown.
    C. Affix one (1) seal to the top of each rear panel (three (3). Ensure that the seals lap onto the top rear plenum brackets, as shown.

    (7 total)



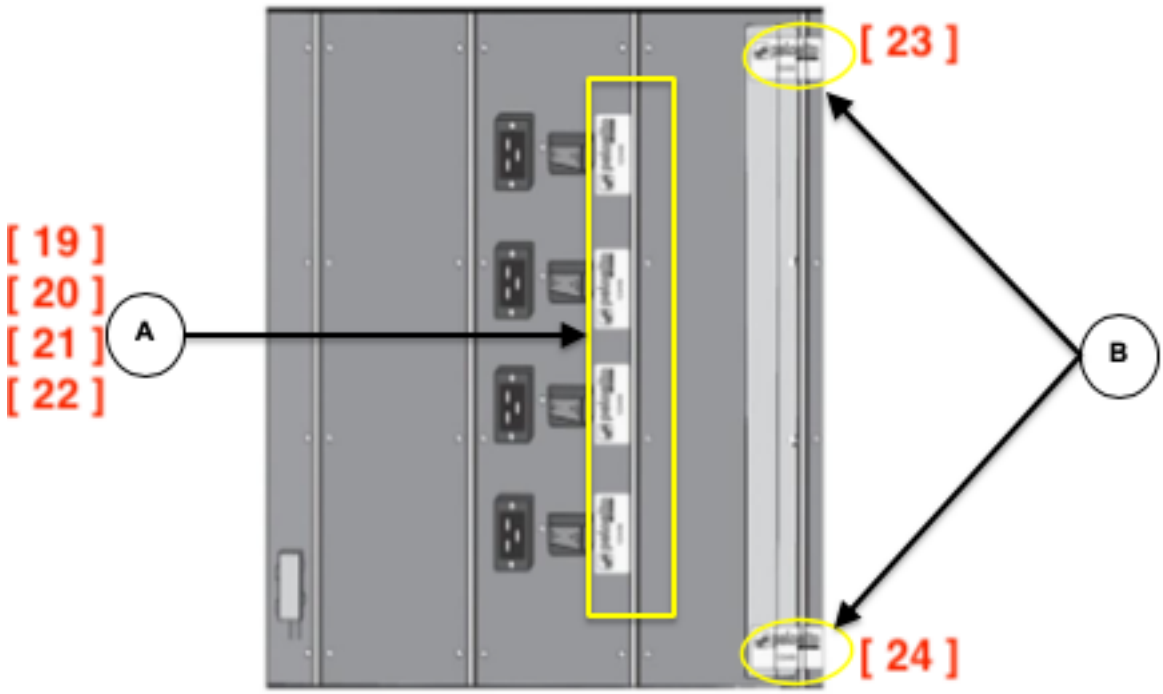
15. Facing the rear of the module,
    A. Affix one (1) seal to the bottom of each rear panel (three (3). Ensure that the seals laps onto the bottom rear plenum brackets, as shown.
    B. Affix one (1) seal to the left and right edge of the bottom plenum bracket folding over the outer edge of the module, as shown.
    C. Affix one (1) seal to the bottom plenum's rear side and the bottom plenum rear bracket.

    (6 total)



16. Facing the rear of the module;
    - Affix one (1) seal to cover one (1) screw for each power switch, as shown.
    - Affix one (1) seal to the top and bottom of the vent opacity shield, as shown. Please ensure that the captive screw is covered.

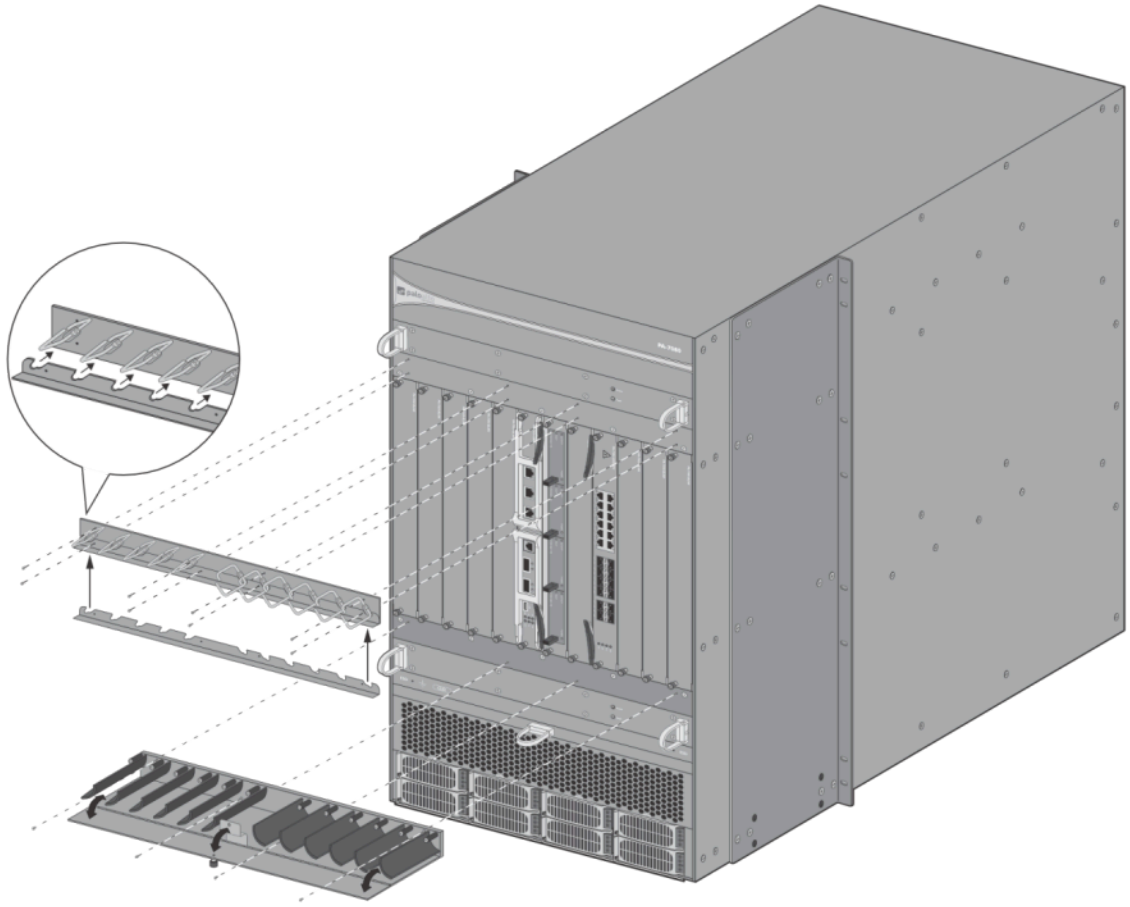
    (6 total)



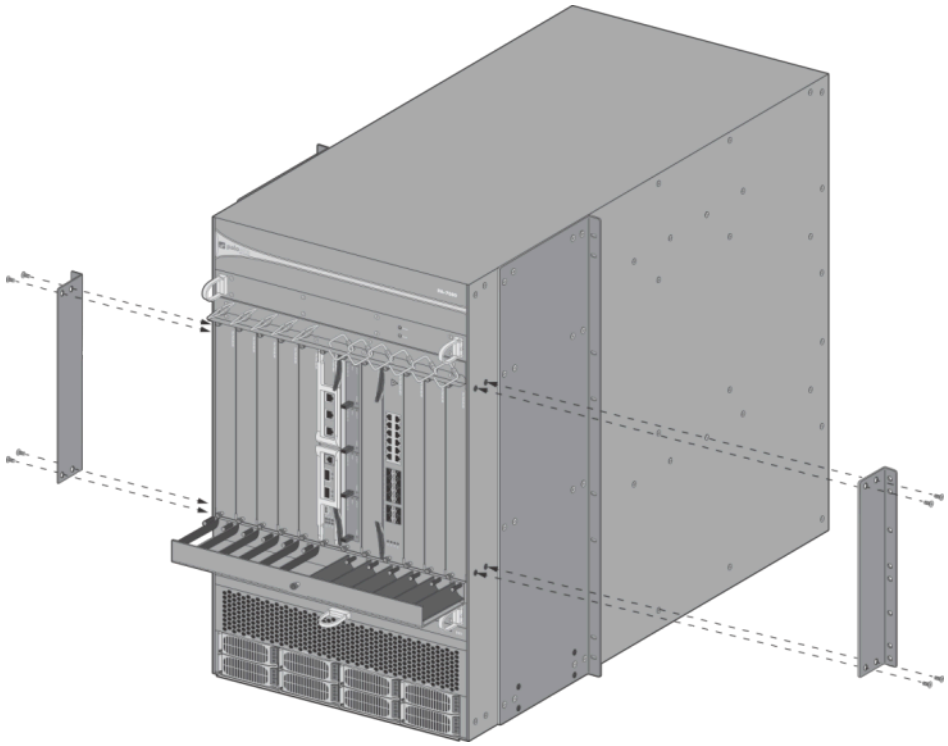
Appendix J - PA-7080 - FIPS Accessories/Tamper Seal Installation (10 Seals)

The PA-7080 requires 10 tamper labels. Refer to Table 2 of this document for the part number of the physical kit containing the tamper labels and opacity shields. Affix the tamper labels and install the opacity shields as shown in the below diagrams.

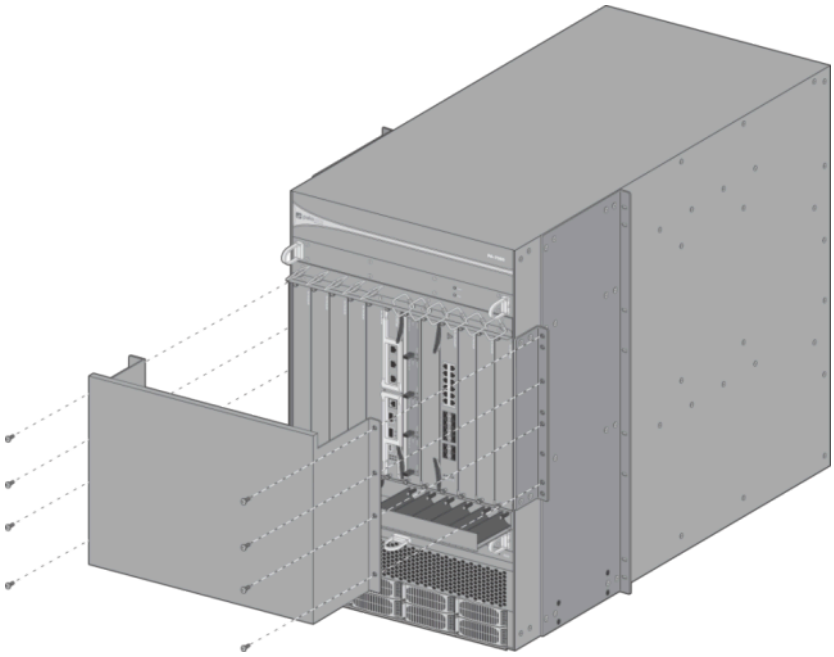
1. Using the supplied screws attach the Cable Manager Kit with upper opacity lip to the front of the PA-7080, as shown.



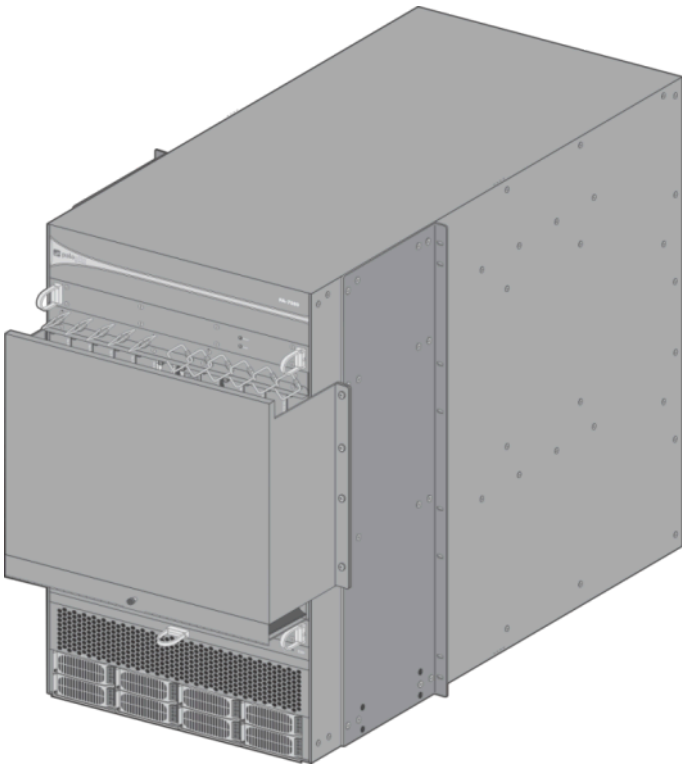
2. Using the supplied screws, attach the Left and Right Front Cover brackets to the sides of the PA-7080, as shown.



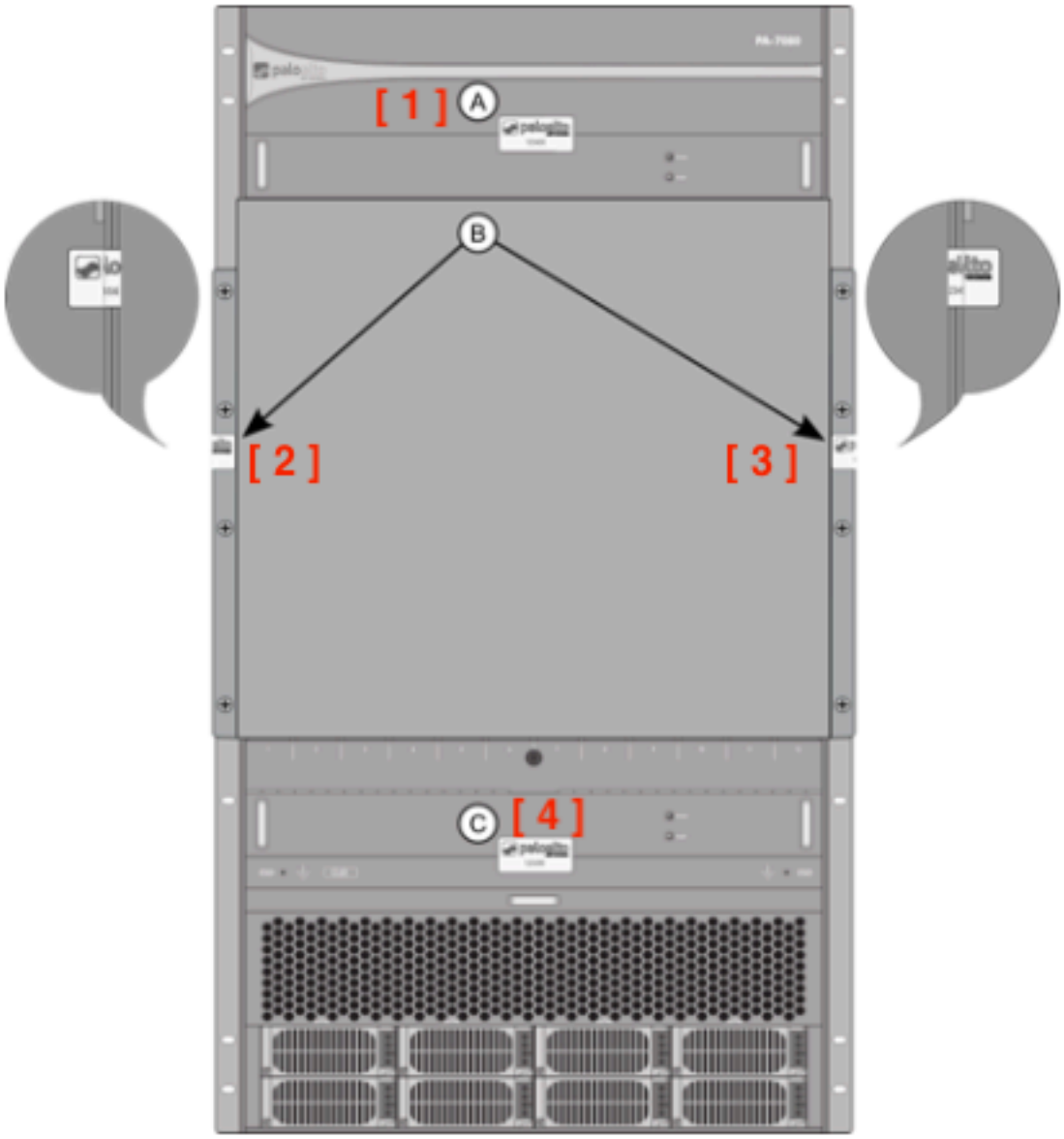
3. Using the supplied screws attach front opacity shield to the PA-7080 as shown.



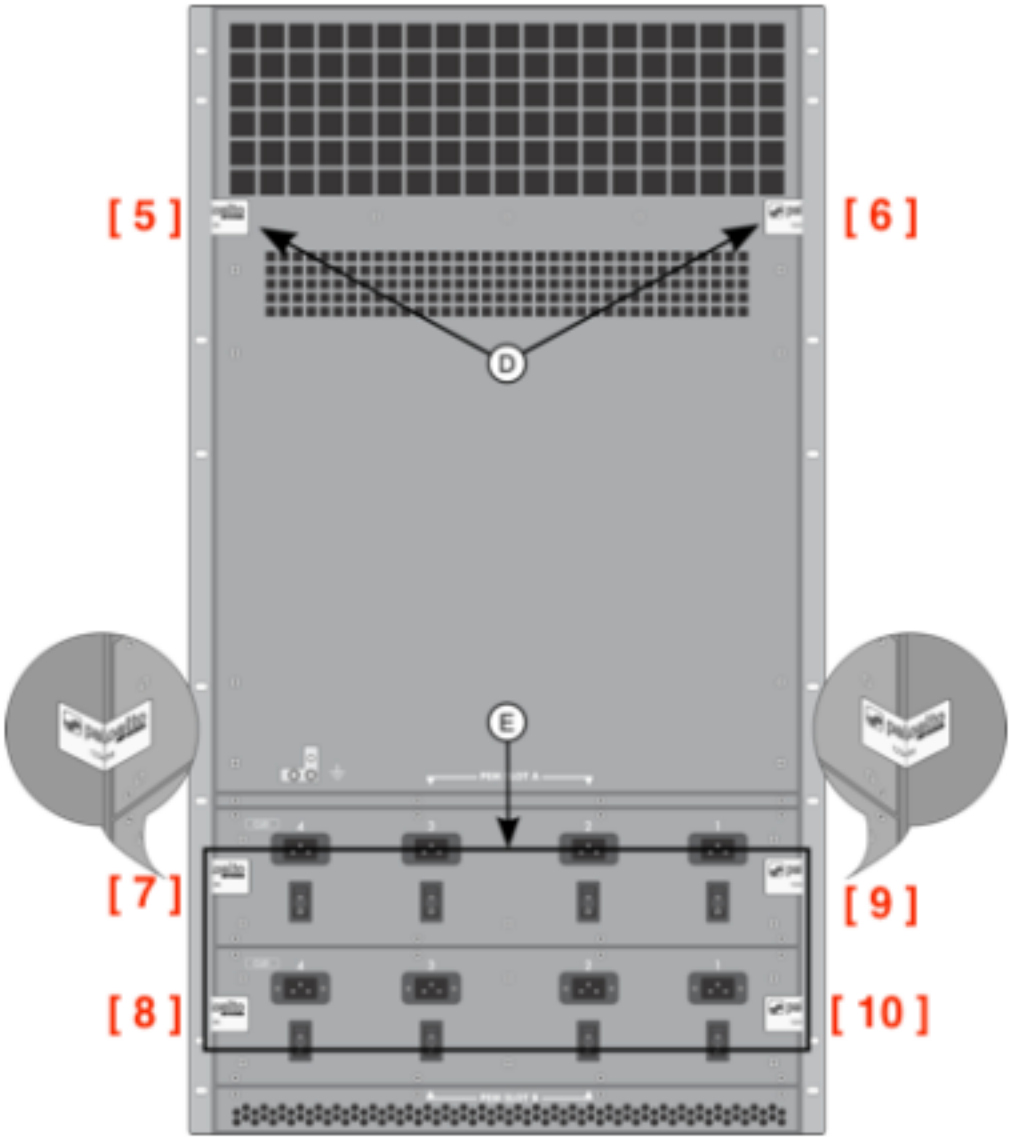
4. The final assembly for the PA-7080 with the Physical Kit is as shown.



5. Facing the front of the PA-7080:
   A. Affix one (1) seal to the front and center of the exhaust fan tray. Ensure the seal overlaps the seam with the front PA-7080 branding panel as shown. (1 total)
   B. Affix one (1) seal to the left and right outer edge of mounting flanges for the front opacity shield. Seals should fold over the edge of the cover flange and mounting bracket onto the side of the PA-7080. (2 total)
   C. Affix one (1) seal to the front and center of the air intake fan tray. Ensure the seal overlaps the seam with the PA-7080 electrostatic discharge port panel as shown. (1 total)



6. Facing the rear of the PA-7080;
   D. Affix one (1) seal to the left and right outer edge of the upper back panel. Seals should be placed just below the rear exhaust vent as shown. Seals should wrap around onto the sides of the PA-7080 (2 total).
   E. Affix one (1) seal to the left and right outer edges of each power entry module as shown. Seals should wrap around onto the sides of the PA-7080 (4 total).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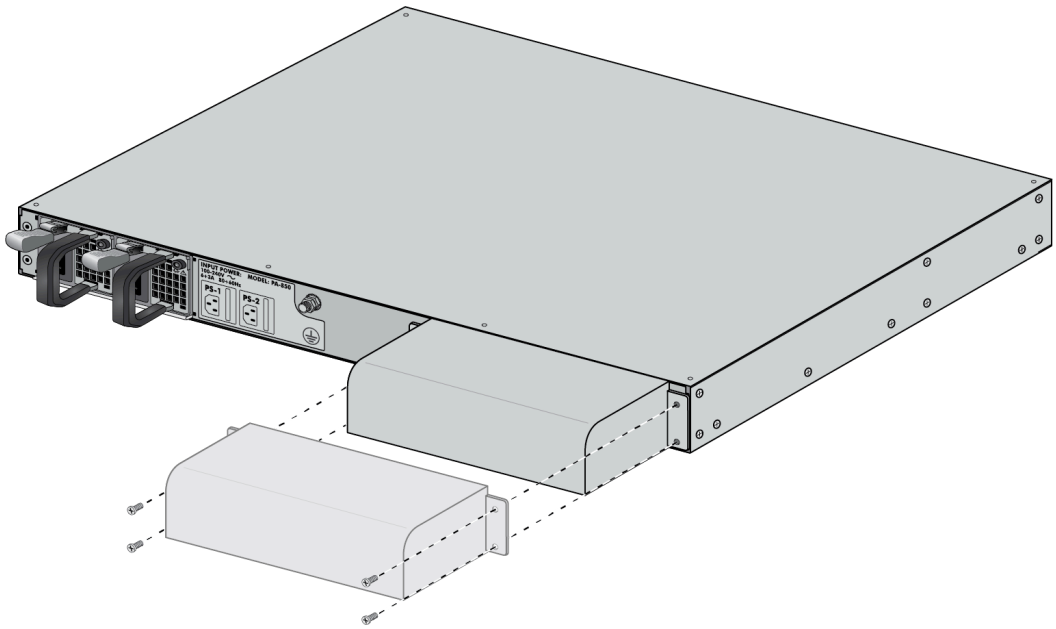
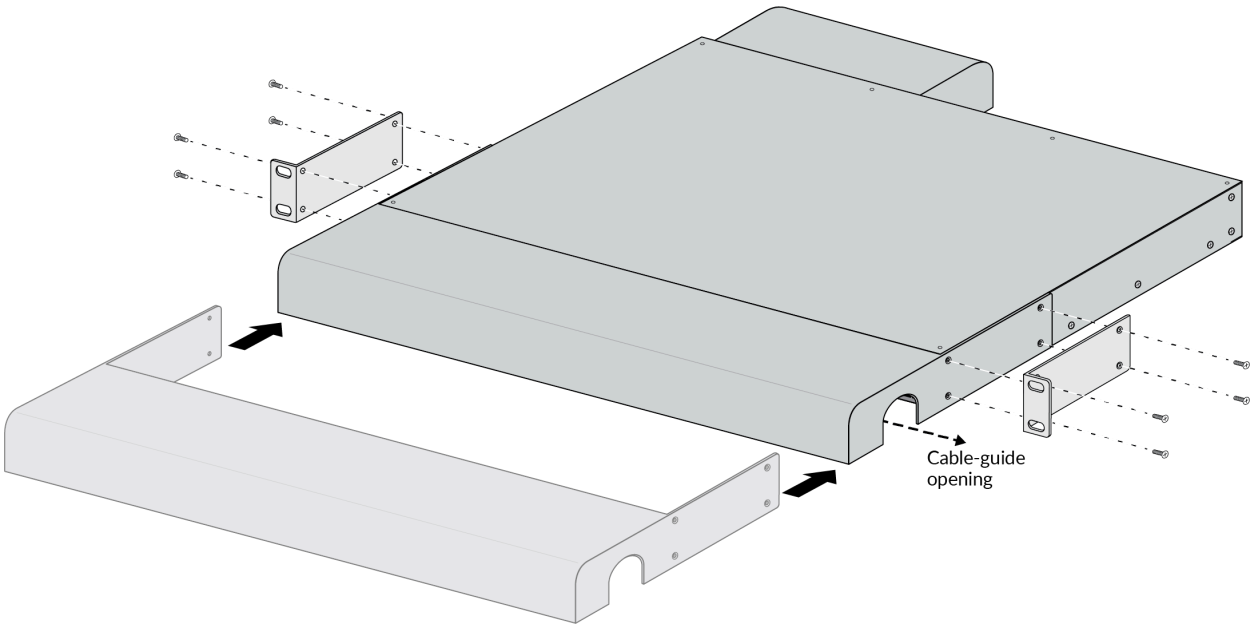
Appendix K - PA-800 Series - FIPS Accessories/Tamper Seal Installation (11 Seals)

The PA-820/PA-850 require 11 tamper labels. Refer to Table 2 of this document for the part number of the physical kit containing the tamper labels and opacity shields. Affix the tamper labels and install the opacity shields as shown in the below diagrams.

1. Place the firewall on a flat Electrostatic Discharge (ESD) protected surface and ground yourself by touching a metal surface on the firewall.
2. Place the physical kit back cover onto the back of the firewall and attach it using four #4-40 x 5/16 screws (two screws on each side of the back cover).



3. Insert the front (network, management, and console) cables in to the front ports.
4. Place the physical kit front cover onto the front of the firewall and place the rack-mount brackets over the holes on the front cover. Attach the front cover and rack-mount brackets to the firewall using eight (8) #6-32 x 5/16” rack-mount bracket screws (shipped with the firewall)—use four (4) screws on each side. Route the front cables through the front-cover cable-guide opening.



5. Apply a tamper-evident seal to each location shown in the following illustrations (eleven (11) seals total). The seal placement over the power supply of the PA-820 firewall and PA-850 firewall is slightly different as shown.