



Technical Report

Introduction to NetApp EF560 Flash Array

Feature Overview with SANtricity 11.25

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Abstract

Scaling from 4.8TB up to 384TB capacity with a single set of dual active controllers, the NetApp® EF560 flash array raises the bar for EF-Series all-flash storage performance and is delivered in one of the industry's most reliable and cost-effective platforms. This document highlights the hardware and software features of the EF560 and is a great starting point to introduce system details to sales engineers, partners, service providers, and customers.

TABLE OF CONTENTS

1	EF-Series EF560 Flash Array with SANtricity 11.25	5
2	EF560 Performance Characteristics	6
3	SANtricity Storage Manager 11.25	7
3.1	SANtricity Management Integration	9
4	SANtricity OS 11.25 Performance Improvements	10
5	SANtricity 11.25: Reliability, Availability, Serviceability	10
5.1	New RAS Features	10
5.2	SANtricity Standard and Premium Features	12
6	Support Tool Enhancements	13
6.1	Config Advisor	14
6.2	E/EF-Series Sizer	15
6.3	Synergy	16
6.4	Hardware Universe	16
6.5	Host Utilities	17
7	SANtricity 11.25 Software Specifications for EF560 Hardware	17
8	Hardware Overview	18
8.1	EF560 Controller-Drive Shelf	18
8.2	EF560 controller-drive shelf	18
8.3	Controller Host Interface Features	21
8.4	Hardware LED Definitions	22
9	Expansion-Drive Shelves	31
9.1	Greenfield Installation	31
9.2	Expansion-Drive Shelf Hot Add	32
10	EF-Series Product Support	35
10.1	Controller-Drive Shelf Serial Number	35
10.2	License Keys	35
11	Summary	38

References	40
Version History	40

LIST OF TABLES

Table 1) Available software packages for SANtricity management integration.	9
Table 2) SANtricity APIs and toolkits.	9
Table 3) Operation modes for FIPS drives.	11
Table 4) EF560 standard features using SANtricity OS 11.25.	13
Table 5) SANtricity OS 11.25 copy services features.	13
Table 6) SANtricity software boundaries for EF560-based storage systems.	17
Table 7) EF560 physical characteristics.	19
Table 8) EF560 maximum power specifications per shelf fully loaded with listed drive type.	19
Table 9) EF560 technical specifications.	19
Table 10) Drive feature matrix as of March 2016.	20
Table 11) EF560 controller-drive shelf and expansion-drive shelf LED definitions (front panel).	23
Table 12) EF560 controller-drive shelf and expansion-drive shelf power supply LED definitions.	24
Table 13) Ethernet management port LED definitions.	26
Table 14) SAS drive expansion port LED definitions.	26
Table 15) Controller base feature LED definitions.	26
Table 16) 4-port 12Gb SAS HIC LED definitions.	28
Table 17) 4-port optical 16Gb FC HIC LED definitions.	29
Table 18) 4-port optical 10Gb iSCSI HIC LED definitions.	30
Table 19) 2-port 56Gb IB HIC LED definitions.	30

LIST OF FIGURES

Figure 1) EF560 4K 100% read IOPS performance.	6
Figure 2) SANtricity Storage Manager 11.25 EMW.	8
Figure 3) SANtricity Storage Manager 11.25 AMW: Summary tab view of a storage system.	8
Figure 4) Customer value: EF-Series performance gains at no additional customer investment.	10
Figure 5) Config Advisor download site landing page.	14
Figure 6) Performance sizing report.	16
Figure 7) EF560 controller-drive shelf.	18
Figure 8) Hardware Universe drives by OS and platform.	21
Figure 9) EF560 HIC options.	22
Figure 10) LEDs on front panel of EF560 controller-drive and expansion-drive shelves.	23
Figure 11) LEDs on EF560 integrated power supply and fan units (rear view).	24
Figure 12) Controller Properties dialog box.	25

Figure 13) LEDs on left side of EF560 controller canister.	25
Figure 14) LEDs on 4-port 12Gb wide-port SAS HIC.	28
Figure 15) LEDs on 4-port optical 16Gb FC/10Gb iSCSI HIC.	29
Figure 16) LEDs on 2-port 56Gb IB HIC.	30
Figure 17) EF560 flash array with four expansion-drive shelves.	31
Figure 18) SANtricity Storage Manager cable connections report.	32
Figure 19) Drive shelf hot-add A-side cabling first expansion-drive shelf.	33
Figure 20) Drive shelf hot-add B-side cabling first expansion-drive shelf.	33
Figure 21) Drive shelf hot-add A-side cabling first expansion-drive shelf.	34
Figure 22) Drive shelf hot-add B-side cabling first expansion-drive shelf.	34
Figure 23) SANtricity Storage Manager AMW storage array profile.	35
Figure 24) Feature enable identifier.	36
Figure 25) Premium Features dialog box: Feature pack section highlighted.	38

1 EF-Series EF560 Flash Array with SANtricity 11.25

Data-driven companies need technology solutions that provide high availability and extreme flexibility; offer ease of installation, configuration, and management; and, perhaps most importantly, meet critical performance objectives. The decision to deploy an infrastructure capable of supporting demanding applications has implications on a variety of operating decisions within an IT organization. Decisions such as acquisition, deployment methodology, best practices, usability, and growth must be taken into account to serve the demands of users, and the total cost of ownership must allow the company to remain competitive now and in the future.

The EF560 flash array leverages the latest in solid-state disk (SSD) technologies combined with efficient multicore processing that extends a strong heritage of handling diverse workloads and providing superior business value through the acceleration of latency-sensitive and high-IOPS applications. The flash array is designed to deliver microsecond latency requirements and is built on a storage architecture backed by more than 20 years of storage development experience and more than 850,000 systems shipped.

The extensive configuration flexibility, custom performance-tuning capabilities, and complete control over data placement make the NetApp EF560 an ideal choice for mission-critical applications. Its GUI-based performance and management tools provide key information about storage input/output (I/O) from multiple viewpoints, allowing administrators to make informed decisions about configuration adjustments to further refine performance.

The NetApp EF560 can:

- Increase the speed of business with microsecond response times.
- Eliminate overprovisioning and improve IT efficiency.
- Achieve the transactional performance of 1,000 15K RPM drives in a two-rack-unit-high enclosure that requires just 5% of the available rack space, power, and cooling as compared to the storage systems that run on spinning disks.
- Detect and resolve issues quickly with advanced monitoring and proactive repair.
- Protect against data loss and downtime with NetApp point-in-time Snapshot images, remote replication, data assurance, and drive security (encryption at the drive).
- Leverage the enterprise-proven SANtricity® Storage Manager to manage multiple EF storage systems.

By combining extreme IOPS, microsecond response times, scale-up capacity, and enterprise-grade reliability, the NetApp EF560 flash array helps IT shops to increase productivity and achieve faster business results.

The EF560, available with up to 76.8TB of raw SSD storage in a single 2U enclosure and expandable up to 384TB, provides capacity and superior reliability to meet the requirements of the most demanding organizations. This technical report provides details regarding the EF560 features and architecture, including an overview of workload characterizations performed on an EF560 across a wide variety of I/O types. Some installation and configuration best practices are provided, including observations based on test data, but for detailed installation and configuration details, refer to the technical publications located in the E-Series and EF-Series Systems Documentation Center (<http://mysupport.netapp.com/eseries>).

Note: This document uses the following terms interchangeably with the terms used in NetApp SANtricity Storage Manager and in the technical publications for the product:

- Tray = shelf = enclosure.
- Drive tray = drive shelf.
- Drive = disk.
- Canister = module.
- SANtricity OS = controller firmware.

- SANtricity Storage Manager = storage management software.
- Storage system = storage array.
- Drawer = one of the five drawers in the DE6600 shelf. This term does not apply to other shelf models.
- SANtricity 11.25 = SANtricity Storage Manager 11.25 plus SANtricity OS 8.25.
- SANtricity OS 8.25 = controller firmware 8.25, the associated NVSRAM software, and matching environmental services module firmware.

2 EF560 Performance Characteristics

Describing system performance is always challenging because individual performance results are functions of many variables that must align to achieve a given result. The following section provides a brief introduction to the ranges of performance delivered by the EF560. For a more detailed description of raw system performance, refer to the NetApp EF560 Performance Guide with SANtricity 11.25 technical report. For more detailed performance information in the context of specific field configurations, refer to the individual technical reports specific to your configuration or use the [E-Series Sizing Tool](#) to match performance targets with configurations that can meet the individual requirements.

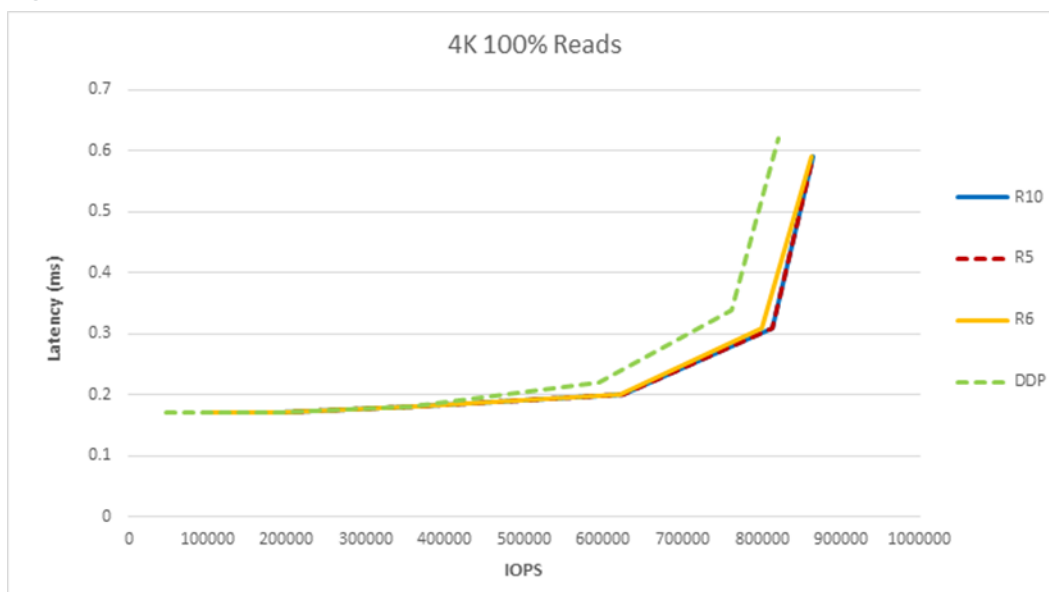
IOmeter Performance Data

The intent of the testing was to demonstrate common system response behaviors associated with given workloads on a heavily utilized storage system. Iometer (www.iometer.org) was used to generate the I/O across the full capacity of the system and at various queue depths using all eight 16Gb FC host interface ports.

Figure 1 shows performance for the EF560 in a 100% 4K random read workload in three different storage configurations, all using 24 SSDs. For more information about performance expectations under different workload configurations, RAID or Dynamic Disk Pool (DDP) protection schemes, and host protocol connection types, refer to the online Sizing Tool.

The key point to note from the graph in Figure 1 is the maximum performance of the system: >825,000 IOPS at less than 800 microseconds and 500,000 IOPS at 200 microseconds. For this workload the RAID configuration did not make a difference.

Figure 1) EF560 4K 100% read IOPS performance.



The EF560 performance characteristics demonstrated are the achievable IOPS at ultralow latency levels, but the system also provides an extended performance range to support critical workloads across a wide range of applications and use cases.

3 SANtricity Storage Manager 11.25

EF-Series systems are managed by the SANtricity Storage Manager desktop application. Simple to download and install, SANtricity Storage Manager provides an intuitive, wizard-led GUI as well as full support for a CLI. SANtricity Storage Manager is based on the Oracle Java framework and can be installed on a Microsoft Windows, Solaris, or Linux operating system (OS) platform.

SANtricity Storage Manager supports both out-of-band and in-band system management. NetApp generally recommends using an out-of-band management host that does not participate in the data delivery workload. In-band management is useful for cases in which there is no IP network access to remote storage systems, but it requires in-band traffic connections to the storage system from a local host.

Note: Refer to <https://mysupport.netapp.com/eseries> for instructions on installing, configuring, and using SANtricity Storage Manager 11.25.

SANtricity Storage Manager 11.25 is supported on 64-bit OS platforms and enables storage administrators to perform the following tasks:

- Set up network connections.
- Commission new storage systems.
- Configure NetApp AutoSupport® (ASUP™) settings and preferences.

Note: For ASUP to function, the persistent monitor service must be running on the primary management server and not on multiple management servers/PCs.

- Provision volumes and map the storage to hosts.
- Set up and manage storage features such as NetApp Snapshot copies, volume copy, synchronous mirroring, asynchronous mirroring, and solid-state drive (SSD) read cache.
- Perform hardware and software maintenance activities, including upgrades to manage EF-Series storage systems.

When the SANtricity management client is installed on a desktop OS, the following limitations apply:

- Simultaneous user sessions are limited to eight sessions.
- Desktop systems cannot run the host agent for in-band management and send I/O traffic to the EF-Series storage system.

SANtricity Storage Manager has two windows that provide management functionality and offer a graphical representation of the storage system:

- **Enterprise management window (EMW).** When SANtricity Storage Manager is initiated, the EMW appears first, as shown in Figure 2 The EMW is used to add the storage systems that are managed and monitored through SANtricity Storage Manager.
- **Array management window (AMW).** From the EMW, the AMW can be launched to access summary views and detailed information about individual storage systems, as shown in Figure 3 The AMW is used to configure, maintain, and manage a storage system and its components.

In addition, the script editor for a storage system can be opened from the EMW, and configuration of the system can be accomplished by using a saved configuration or a custom script.

Figure 2) SANtricity Storage Manager 11.25 EMW.

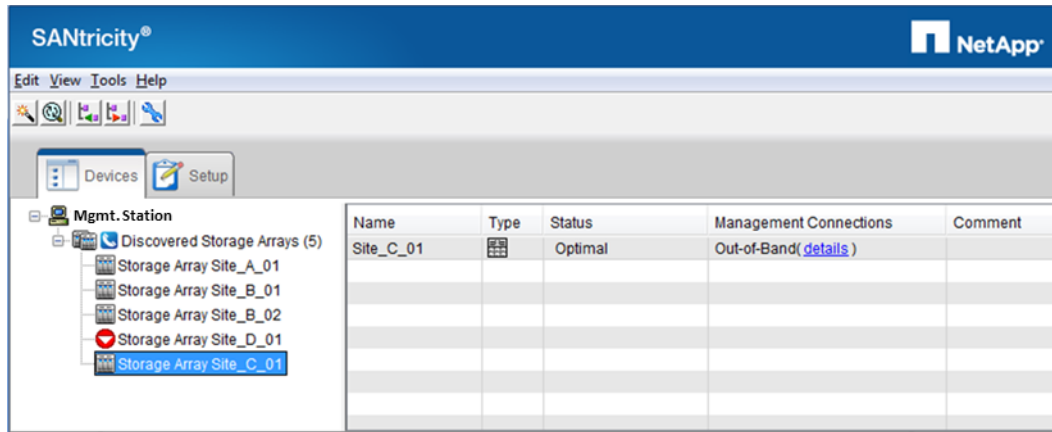
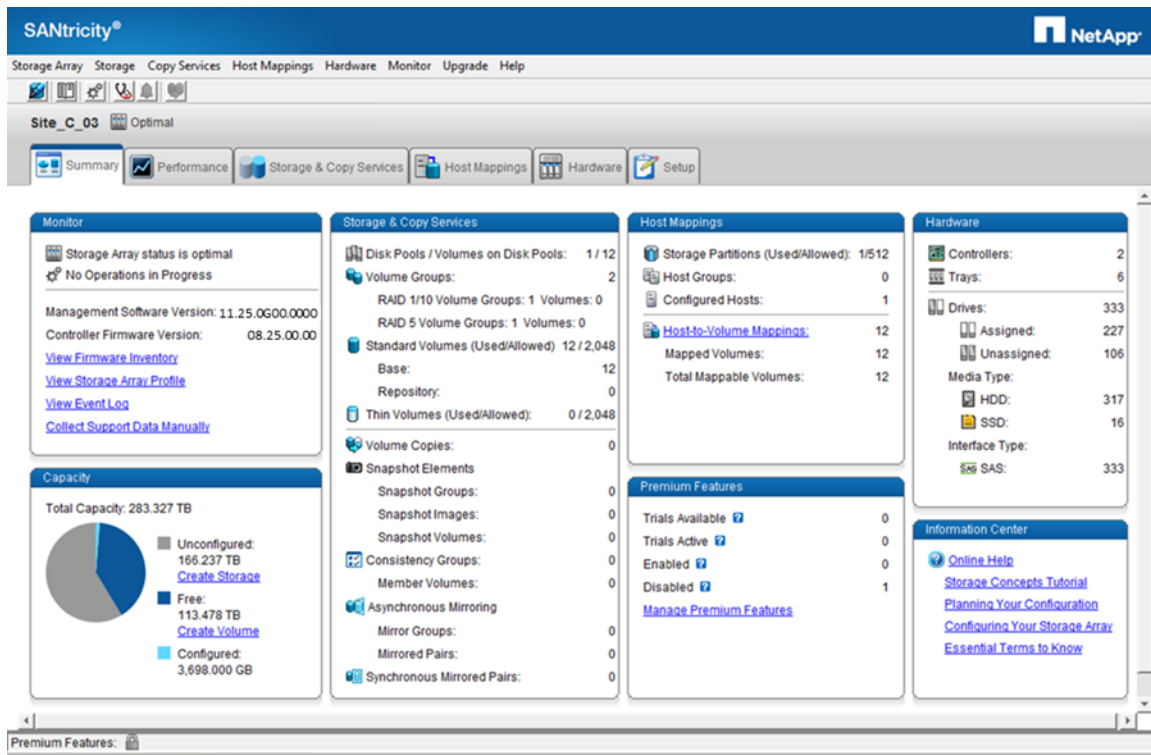


Figure 3) SANtricity Storage Manager 11.25 AMW: Summary tab view of a storage system.



EF560 storage systems are now shipped preloaded with SANtricity OS 8.25. The SANtricity Storage Manager software version 11.25 must be downloaded from the NetApp Support site and loaded on the management server before discovering storage systems running SANtricity OS 8.25. Previous versions of SANtricity Storage Manager do not manage the EF560 arrays running SANtricity OS 8.25, but the SANtricity Storage Manager version 11.25 manages the new EF560 arrays and all of the previous EF-Series array software versions from the last five years.

Note: Creating an account on the NetApp Support site can take 24 hours or more for first-time customers. New customers should register for Support site access well in advance of the initial product installation date.

3.1 SANtricity Management Integration

While E-Series storage systems are easily installed in most physical data center environments, implementing a new system does require using SANtricity Storage Manager for basic commissioning. This creates a small learning curve, but you do not need to learn the complete management interface if you already use other common storage management interfaces. To expedite the adoption of E-Series storage systems using existing tools and skills, NetApp recommends leveraging the benefits of various SANtricity plug-ins; APIs; providers; and utilities for applications such as Oracle and SQL Server and OSs such as Windows, Linux, and VMware.

Table 1 shows the software packages available to anyone with an active NetApp Support site account and current EF-Series product support agreement. Go to <http://mysupport.netapp.com/NOW/cgi-bin/software/> and select E-Series/EF-Series SANtricity Management Plug-ins for the plug-ins.

Table 1) Available software packages for SANtricity management integration.

Software Package	Use
SANtricity plug-in for VMware vCenter	Configure, manage, monitor, and perform datastore to LUN mapping in vSphere client.
SANtricity storage replication adapter for VMware vCenter Site Recovery Manager	Automate management of replicated datastores and disaster recovery, including testing DR plans.
SANtricity VASA provider (VMware APIs for storage awareness)	<ul style="list-style-type: none">Report storage volume capabilities to vSphere for SLO management.
SANtricity add-in for Microsoft SQL Server Management Studio	Monitor and tune performance for SQL Server database storage, create volumes and Snapshot copies for SQL Server databases.
SANtricity plug-in for Oracle EM	Perform storage volume to database mapping, monitor and report on performance.
VMware Site Recovery Manager adapter	Note: Automate DR failover and enable DR plan testing in VMware environment.
SANtricity management pack for Microsoft System Center Operations Manager	1. Monitor health status and send storage alerts to Microsoft System Center.

Table 2 shows the SANtricity APIs and toolkits that can be used for scripting and custom integration into other management tools: Go to <http://mysupport.netapp.com/NOW/cgi-bin/software/> and select E-Series/EF-Series SANtricity Management Plug-ins for the web services software and documentation. Go to http://mysupport.netapp.com/NOW/download/tools/santricity_powershell_toolkit for the PowerShell toolkit.

Table 2) SANtricity APIs and toolkits.

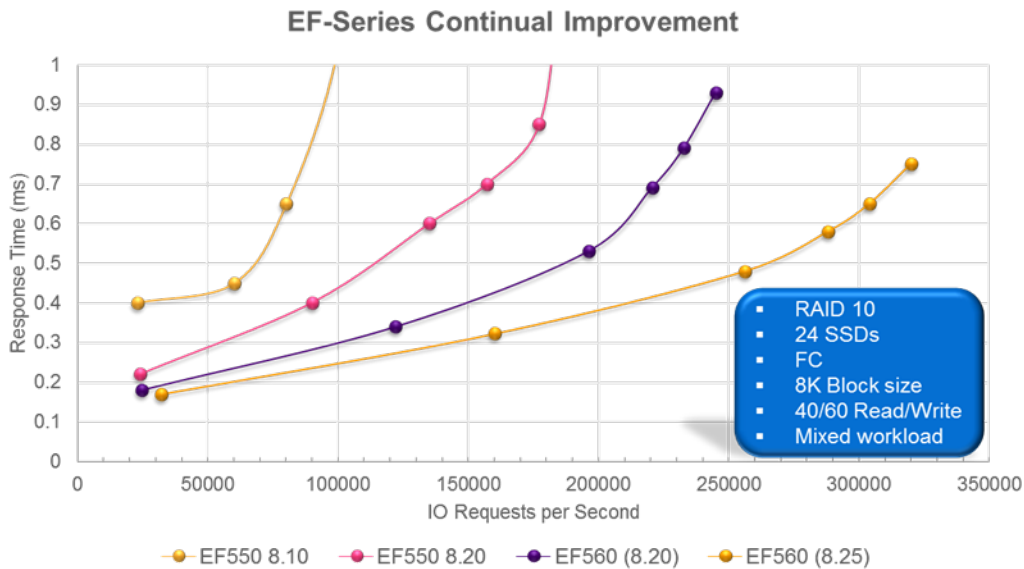
APIs and Toolkits	Description
SANtricity web services proxy	Web APIs that provide a collection of REST interfaces to configure, manage, and monitor E-Series systems.
SANtricity Toolkit for Microsoft Windows PowerShell	More than 100 cmdlets enabling storage administration of E-Series systems.

4 SANtricity OS 11.25 Performance Improvements

Running SANtricity OS 11.25 in the all-SSD EF560 flash array delivers significant performance improvements over previous generations of EF-Series flash arrays running SANtricity OS 8.10 or 8.20. With more effective utilization of CPU cores for parallel operation, SANtricity OS 8.25 raises the I/Os per second (IOPS) capabilities of the controllers while further reducing average I/O latency.

SANtricity OS 11.25 improves top-end IOPS by up to 35% and reduces I/O latency by up to 25% compared to SANtricity OS 11.20. The results are significant improvements in application transaction performance, making databases run more quickly, websites respond more quickly, and jobs finish more quickly. Figure 4 demonstrates the performance advances EF-Series customers have received with no additional investment.

Figure 4) Customer value: EF-Series performance gains at no additional customer investment.



5 SANtricity 11.25: Reliability, Availability, Serviceability

EF-Series systems have a rock-solid reputation for reliability and availability. The SANtricity 11.25 release builds on that legacy by adding new reliability, availability, and serviceability (RAS) features and more drive choices.

5.1 New RAS Features

New functionality available with SANtricity 11.25 adds to an already impressive list of RAS features and capabilities offered with the EF-Series portfolio.

- If the associated drives support DA, the DA feature is enabled by default when volumes are created. Previously, the system did not determine if the HICs supported DA. As a result, if the array had iSCSI or IB HICs, you needed to delete DA volumes if you forgot to manually disable DA. In SANtricity OS 11.25, the system automatically disables the DA feature if it determines that the HICs do not support it.
- When DA detects a data integrity error, the previous behavior was to lock down the storage array. Accessing the array again required engagement with NetApp Support. In SANtricity OS 11.25, some data integrity issues now cause the storage array to enter a safe mode that allows the administrator to access information and collect support data.

Note: Some data integrity issues still cause the storage array to enter lock-down mode when the data in question cannot be recovered using the DA feature tools.

Simple Network Time Protocol (SNTP)

The Simple Network Time Protocol (SNTP) is a time-maintenance feature that is used to keep the clocks in the storage array synchronized. When this feature is enabled, the SANtricity OS periodically queries the configured SNTP server for a time specification and uses it to update the controller's clock.

Split FC-iSCSI Protocol Support in a Single EF560 Storage Array

Split protocol support on a single EF560 storage array increases the flexibility for host connectivity to serve a wide set of use cases, including Fibre Channel for high-performance workloads and long-distance mirroring through iSCSI for disaster recovery. The quad-port optical HIC supports either 16Gb FC or 10Gb iSCSI, but SANtricity OS 11.25 provides the option to use this HIC in a new split protocol mode. A feature key can be applied through SANtricity Storage Manager to convert this HIC to FC-iSCSI split mode, in which ports 1 and 2 operate as 10Gb iSCSI and ports 3 and 4 operate as 16Gb FC. A new unified SFP supports both protocols at these speeds. As required, a different feature pack can be applied later to convert the protocol from FC-iSCSI split mode back to all FC or all iSCSI.

Note: The new unified SFPs do not support 1Gbps iSCSI.

Federal Information Processing Standards (FIPS) Drive Support

The full disk encryption (FDE) feature offers a higher level of assurance with Federal Information Processing Standards (FIPS) 140-2 level 2–validated drives. These FIPS-compliant drives are a type of secure-capable drive, similar to FDE drives, that have an extra level of security, including tamper-resistant seals on the drive casing and other FIPS-approved protocols that are different than standard FDE drives.

How FIPS Drives Work with SANtricity 11.25

When FIPS drives are secure-enabled in an EF560 storage array, an initialization process is performed in accordance to the specific drive model's FIPS security policy. There is nothing preventing the user from mixing drive types within a volume group or disk pool. However, in order for a volume group or disk pool to be FIPS compliant, all the drives must be FIPS drives. Table 3 shows how FIPS drives operate, based on to what type of volume group or disk pool they are added.

Table 3) Operation modes for FIPS drives.

If a FIPS Drive Is Added to a ...	It Operates in This Mode ...
Nonsecure-capable volume group or disk pool	Nonsecure mode (like any other drive in that volume group or pool).
Secure-capable volume group or disk pool containing FDE drives and FIPS drives	Nonsecure mode until security is enabled for the volume group or disk pool. However, the volume group or disk pool is not FIPS compliant.
Secure-capable volume group or disk pool containing all FIPS drives	Nonsecure mode until security is enabled for the volume group or disk pool. After that, the volume group or disk pool is considered FIPS compliant.

Note: All FIPS-compliant drives are FDE drives, but not all FDE drives are FIPS 140-2 level 2–compliant drives.

After an all FIPS drive volume group or disk pool is created, only FIPS drives can be added to that volume group or pool both for replacing a failed drive or for growing the volume group or disk pool capacity.

To enable security for secure-capable drives, the drive security premium feature license must be purchased, and the associated license key file must be loaded on the storage system. After this is installed, security can be enabled for specific volumes using SANtricity Storage Manager. This automatically activates FIPS if the associated physical drives are FIPS compliant.

FIPS Drive Considerations with SANtricity 11.25 Features

FIPS drives can be used with most SANtricity features, including:

- Synchronous/asynchronous mirroring
- SANtricity Snapshot
- Volume copy
- Dynamic Disk Pools or standard RAID

Although FIPS drives can function as nonsecure drives, there are multiple other system interactions that take on unique characteristics or require specific limitations when FIPS drives are used in the secure-enabled mode. For example, FDE drives with security enabled can be reprovisioned in the storage system and repurposed without providing the security key. In contrast, the security key is required to erase data from or repurpose a secure activated FIPS drive.

Note: There is a manual process to erase drives when the key is unknown, but it requires both physical access and system administration access to accomplish the task. Full details are available in the SANtricity Storage Manager online help.

For a complete description of FIPS drive functionality in E-Series arrays, contact your NetApp or partner sales representative.

AutoSupport OnDemand

NetApp AutoSupport (ASUP) is an integrated and efficient monitoring and reporting technology that constantly checks the health of NetApp storage systems. It is one of the most important and effective troubleshooting tools for customers and for NetApp Customer Support Delivery (CSD).

The new AutoSupport OnDemand feature in SANtricity 11.25 shifts control of AutoSupport delivery to the NetApp Support back-end servers. Anytime an EF-Series flash array prepares to deliver an ASUP message, it checks first with the ASUP back end for permission to deliver.

OnDemand introduces the ability for an EF-Series flash array to check in periodically with the ASUP back end to determine if there are any pending ASUP actions for the storage array. OnDemand also allows NetApp technical support to request retransmission of a particular ASUP message or request that a new ASUP message be collected and sent to NetApp. The storage array is informed of the pending action the next time it checks in with the NetApp back-end servers.

For more information about the ASUP feature, go to <http://mysupport.netapp.com/eseries> and click the Review Storage Concepts link.

5.2 SANtricity Standard and Premium Features

EF-Series systems ship with significant storage management features that can be simply activated from SANtricity Storage Manager, but there are also two premium features offered with EF560 flash arrays:

- Drive security
- FIPS drive support

For premium feature activation, contact your NetApp or partner sales representative to purchase the required license keys. Table 4 provides a consolidated list of EF560 standard features when running SANtricity 11.25.

Table 4) EF560 standard features using SANtricity OS 11.25.

EF560 Standard Features with SANtricity OS 11.25
Storage partitions. Individual host without shared LUNs to host groups with shared LUNs or a combination of both.
Thin provisioning. Overcommit storage and add capacity when you actually need it. Note: Not recommended for high-performance workloads.
Data assurance (T10 PI). Makes sure of data integrity to the drive, which is especially important with large-capacity drives.
Nondisruptive controller firmware upgrade. Using ALUA host type with multiple paths to hosts combined with a wizard-driven upgrade process that activates one controller at a time, makes sure that upgrades do not affect host-to-LUN access.
Online drive firmware upgrade. Upgrades one drive at a time and tracks writes to the affected drives during the upgrade window; should only be used during very low write I/O periods. Note: Parallel drive firmware upgrades are supported offline to more quickly upgrade multiple drives during a maintenance window.
Proactive drive monitor and data evacuator. Nonresponsive drives are automatically power-cycled to see if the fault condition can be cleared. If the condition cannot be cleared, the drive is flagged as failed. For predictive failure events, the evacuator feature starts to remove data from the affected drive in an effort to move the data before the drive actually fails. If the drive fails, rebuild picks up where the evacuator was disrupted, thus reducing the rebuild time.
Changing host protocol. Supported using a new feature pack key; go to https://mysupport.netapp.com/eseries (Upgrades >Hardware) for the open license key and detailed instructions.

Table 5 provides a comprehensive list of standard copy services features with EF560 storage arrays.

Table 5) SANtricity OS 11.25 copy services features.

EF560 Standard Features with SANtricity OS 11.25
SANtricity Snapshot copies. Point-in-time Snapshot copies.
Synchronous mirroring. Real-time mirroring to a remote site (usually within 10Km). Note: Requires filing a PVR to receive a premium feature key at no cost. Implementations require a review to make sure that mirroring is a fit for customer requirements. Contact your NetApp sales representative for more information.
Asynchronous mirroring. Mirroring to a remote site where RPO = 0 is not a requirement.
Volume copy. Used to spin off volumes for test/dev or analytics purposes.

See technical report [Deploying NetApp E-Series and EF-Series Copy Services with Oracle and SQL Server Databases](#) for additional details and use case information using SANtricity copy services features.

6 Support Tool Enhancements

Improving the customer experience is the central goal of NetApp enablement tools. To continue the legacy of prioritizing enablement tools, several key enhancements have been implemented.

6.1 Config Advisor

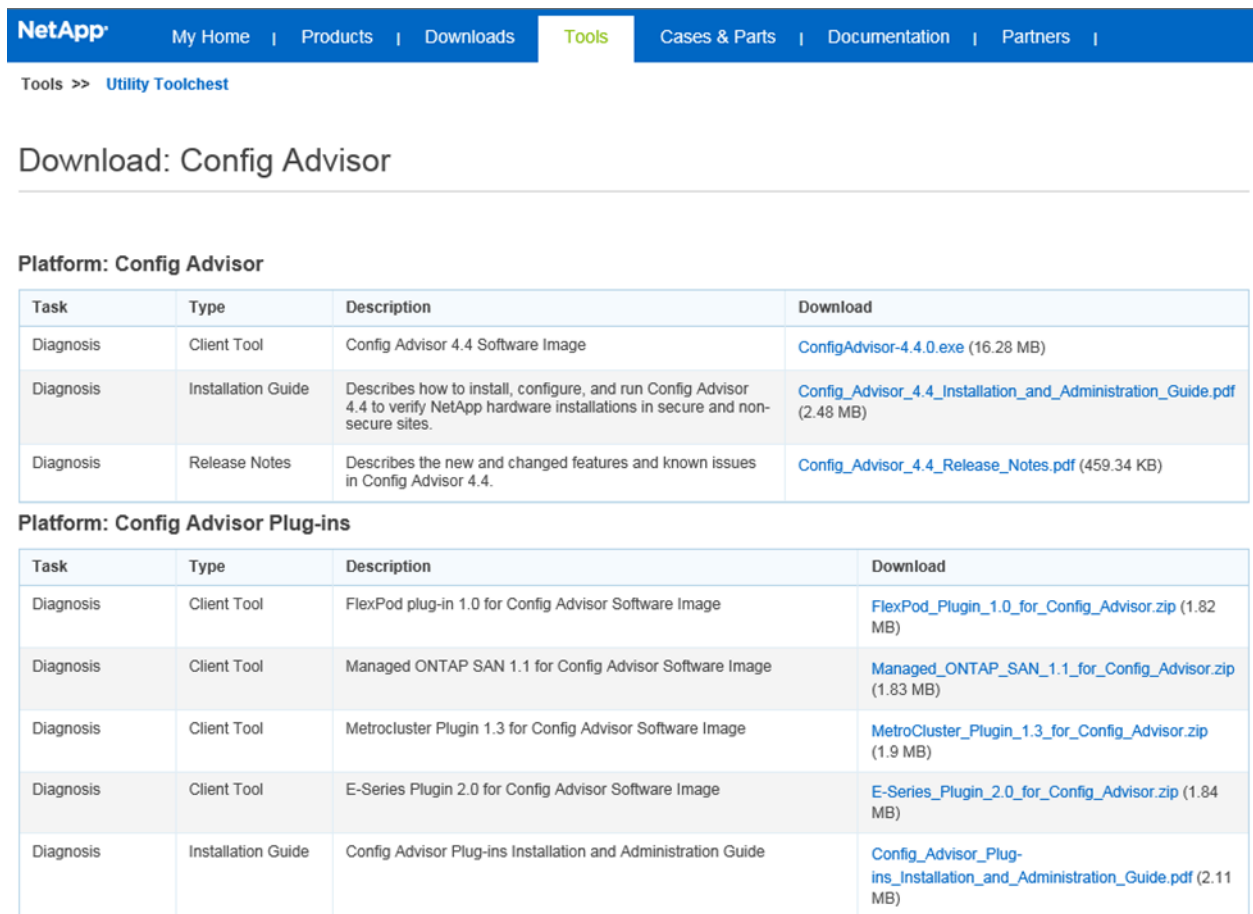
[Config Advisor](#) is a configuration validation and health check tool for NetApp systems. Config Advisor can be used to check a NetApp system for the correctness of hardware installation and conformance to NetApp recommended settings. It collects data and runs a series of commands on the hardware, then checks for cabling, configuration, availability, and best practice issues.

Config Advisor 4.4 release enables support for EF-Series host-side checks and additional EF-Series configuration checks in addition to the standard checks.

Config Advisor creates PDF, Word, and Excel reports on the system configuration summary and health check results. It also sends Config Advisor AutoSupport data back to NetApp over HTTP; this data can be viewed through SmartSolve.

To download the Config Advisor tool, the additional plug-in for E-Series (including EF-Series), and associated installation documentation for both software packages (see Figure 5), use the Config Advisor link, acknowledge the EULA, and select Continue. For general installation instructions, use the Config Advisor 4.4 Installation and Administration Guide followed by Config Advisor Plug-Ins Installation and Administration Guide for details on how to install the E-Series plug-in.

Figure 5) Config Advisor download site landing page.



NetApp My Home | Products | Downloads | **Tools** | Cases & Parts | Documentation | Partners |

Tools >> [Utility Toolchest](#)

Download: Config Advisor

Platform: Config Advisor

Task	Type	Description	Download
Diagnosis	Client Tool	Config Advisor 4.4 Software Image	ConfigAdvisor-4.4.0.exe (16.28 MB)
Diagnosis	Installation Guide	Describes how to install, configure, and run Config Advisor 4.4 to verify NetApp hardware installations in secure and non-secure sites.	Config_Advisor_4.4_Installation_and_Administration_Guide.pdf (2.48 MB)
Diagnosis	Release Notes	Describes the new and changed features and known issues in Config Advisor 4.4.	Config_Advisor_4.4_Release_Notes.pdf (459.34 KB)

Platform: Config Advisor Plug-ins

Task	Type	Description	Download
Diagnosis	Client Tool	FlexPod plug-in 1.0 for Config Advisor Software Image	FlexPod_Plugin_1.0_for_Config_Advisor.zip (1.82 MB)
Diagnosis	Client Tool	Managed ONTAP SAN 1.1 for Config Advisor Software Image	Managed_ONTAP_SAN_1.1_for_Config_Advisor.zip (1.83 MB)
Diagnosis	Client Tool	Metrocluster Plugin 1.3 for Config Advisor Software Image	MetroCluster_Plugin_1.3_for_Config_Advisor.zip (1.9 MB)
Diagnosis	Client Tool	E-Series Plugin 2.0 for Config Advisor Software Image	E-Series_Plugin_2.0_for_Config_Advisor.zip (1.84 MB)
Diagnosis	Installation Guide	Config Advisor Plug-ins Installation and Administration Guide	Config_Advisor_Plug-ins_Installation_and_Administration_Guide.pdf (2.11 MB)

Config Advisor Workflow and Key Features

Config Advisor has three major components:

- **Data collector.** The data collector supports multiple data input methods, including support for secure site data collection.
- **Analysis engine.** The analysis engine takes the collected data and performs a series of configuration validation and best practices checks. The analysis engine checks for at-risk systems, checks for systems that require firmware updates, and performs network switch checks. It also performs specific checks for clustered Data ONTAP®, Data ONTAP operating in 7-Mode, MetroCluster™, FlexPod®, and EF-Series systems.
- **Presentation layer.** The presentation medium is very flexible; users can view the output using Config Advisor's intuitive UI, or they can generate PDF, Excel, or MS Word reports for these contents.

6.2 E/EF-Series Sizer

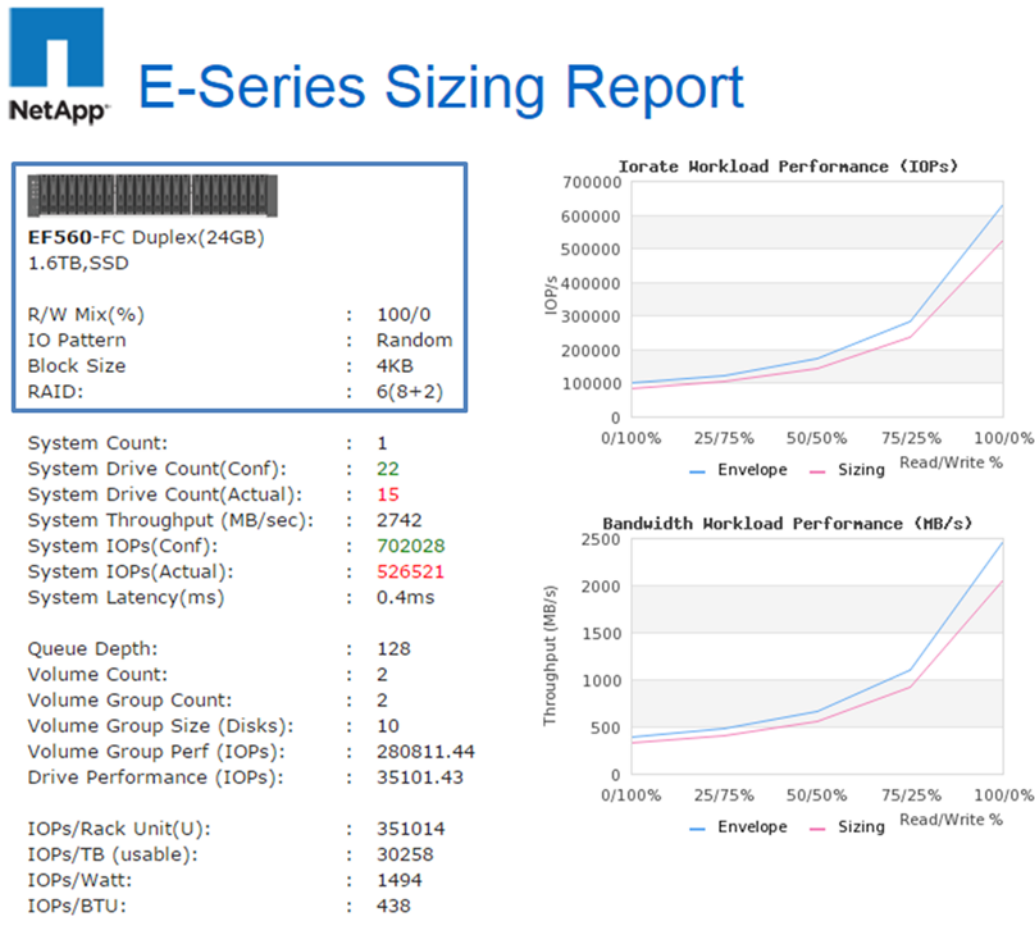
The [E-Series Performance Sizing](#) tool allows sales engineers and partners to make sure that specific E-Series and EF-Series customer architectures are properly sized to meet customer performance requirements.

The E Series Sizer tool is available for NetApp employees and is also open for partner access. If you are unable to access this tool, contact your NetApp sales engineer.

Figure 6 shows a performance sizing report, which includes four major sections:

- **Hardware and workload.** The boxed area in Figure 6 represents the hardware and workload section where users enter the expected hardware and workload.
- **Sizing.** The next section shows the sizing output.
 - The numbers in red show the actual system drive count and the actual system IOPS. These values are used to determine the drive count needed to meet the performance and IOPS target.
 - The numbers in green show the configured system drive count and the configured system IOPS. These values are used to determine the drive count needed based on RAID group size and IOPS performance.
- **Metrics.** This section shows various metrics such as volume group performance, drive performance, and IOPS/rack unit.
- **Charts.** The charts on the right side of the report present performance as two sets of data points: envelope is the performance curve representing a fully configured system, and sizing is the performance curve representing the sized solution.

Figure 6) Performance sizing report.



6.3 Synergy

[NetApp Synergy](#) is a NetApp tool used for accurately designing NetApp configurations. An emphasis is placed on showing realistic capacity yield and environmental details. Advantages of using Synergy over traditional spreadsheets or alternative tools include automatic product updates, best practices enforcement, alignment to the sales workflow, and data sharing with users and tools.

Synergy 6, the latest release, is a full web-accessible experience that is compatible with mainstream browsers such as Microsoft Internet Explorer, Google Chrome, and Mozilla Firefox.

Note: The Synergy User Guide is located here: <https://forums.netapp.com/docs/DOC-14888>.

The Synergy tool is available for NetApp employees and is also open for partner access. If you are unable to access this tool, contact your NetApp sales engineer.

6.4 Hardware Universe

[Hardware Universe](#) (HWU) is a web-based tool that provides a visual presentation of the complete NetApp line of hardware products. Hardware Universe is available for NetApp employees and is also open for partner access. If you are unable to access this tool, contact your NetApp sales engineer.

Hardware Universe provides the information needed to make side-by-side comparisons of the various NetApp platforms in terms of capacity, memory size, maximum spindle count, and other features.

HWU has three components:

- HWU poster is a one-stop location to find specifications for all NetApp products.
- HWU application provides the complete NetApp hardware portfolio in a web application.
- HWU mobile application represents the complete NetApp hardware portfolio in a mobile application for iPhone or Android.

Note: The Hardware Universe User Guide is located here:
http://hwu.netapp.com/Resources/hwu_ug.pdf.

6.5 Host Utilities

When customers implement E-Series with Windows and Linux operating systems, they can use the settings in the [Host Utilities Kits](#) to properly configure each host, according to the latest Interoperability Matrix Tool (IMT) guidance. The kits are on the NetApp Support site at Downloads > Software > Host Utilities—SAN. Currently, the Linux and Windows kits support E-Series and FAS implementations. Other available kits support FAS implementations only.

7 SANtricity 11.25 Software Specifications for EF560 Hardware

Table 6 lists the SANtricity software specifications for EF560-based storage systems.

Table 6) SANtricity software boundaries for EF560-based storage systems.

Components	Maximum
Storage Hardware Components	
Shelves (system and expansion)	5
Drives	120
Logical Components	
Partitions	512
Volumes	2,048
Volumes per consistency group	64
Consistency groups per system	32
Thin volumes per system	2,048
Disk pools per system	20
Snapshot Copies	
Per Snapshot group	32
Per volume	128
Per storage system	2,048
Snapshot Volumes	
Per Snapshot copy	4
Per system	2,048
Snapshot Groups	

Components	Maximum
Per volume	4
Per system	1,024
Mirrors	
Legacy mirrors per system	128
Mirrors per system	128
Mirrors per volume	1
Mirrors per asynchronous mirror group	64
Asynchronous mirror groups per system	4

8 Hardware Overview

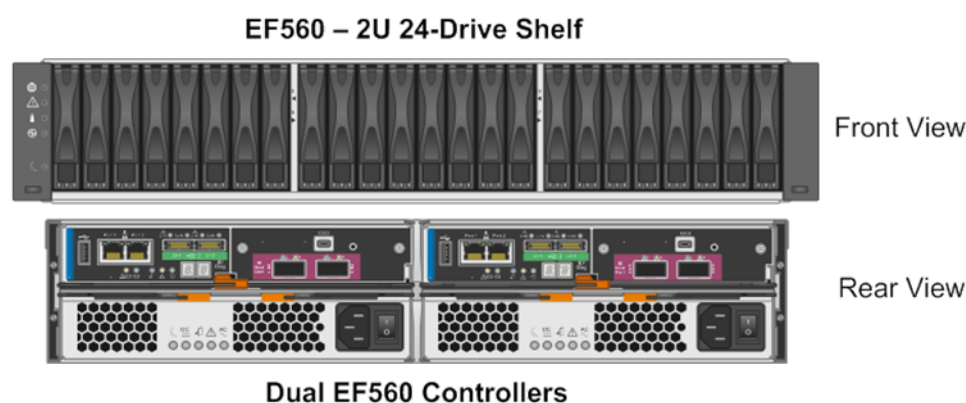
The EF560 storage system was released with SANtricity 11.10; however, newer SANtricity software versions are fully compatible with the EF560 hardware and provide dramatically better performance than SANtricity 11.10. As a result, NetApp recommends upgrading EF560 SANtricity software to the latest version available on the NetApp Support site.

8.1 EF560 Controller-Drive Shelf

The EF560 is available in a 2U 24-drive shelf that holds up to twenty-four 2.5-inch SSDs and features dual RAID controllers and dual power supplies with integrated fans. The EF560 flash array supports up to 120 SSDs with the addition of four expansion-drive shelves.

Each of the two EF560 controllers has a combination of onboard storage-side SAS drive expansion ports and add-on host interface ports.

Figure 7) EF560 controller-drive shelf.



8.2 EF560 controller-drive shelf.

The EF560 controller has the following base hardware features:

- Dual Ethernet ports for management-related activities
- SAS, FC, iSCSI, or IB ports for host connection
- SAS drive expansion ports to attach expansion-drive shelves

Note: One of the host I/O port options must be ordered when the controller is purchased.

Table 7 lists the physical characteristics of the EF560 controller-drive shelf.

Table 7) EF560 physical characteristics.

Dimensions and Weight	EF560 Controller-Drive Shelf (DE5600 Shelf with Dual Controllers and 1.6TB SSDs Fully Populated)
Height	3.47" (8.81cm)
Width	19" (48.26cm)
Depth	19.6" (49.78cm)
Weight (max.)	58.59lb (26.58kg)

Table 8 lists both the typical power specifications and the equipment-rated power specifications of the EF560 flash array. The table assumes that the shelves are in a dual-controller configuration and fully loaded with drives.

Table 8) EF560 maximum power specifications per shelf fully loaded with listed drive type.

EF560 Controller-Drive Shelf	Typical Operating Power			Equipment-Rated Power		
	kVA	Watts (AC)	BTU/Hr	kVA	Watts (AC)	BTU/Hr
EF560 dual controller and 1.6TB SSDs fully populated	0.457	452.9	1545.6	0.627	620.67	2,117.8

Table 9 lists the technical specifications for the EF560 storage system.

Table 9) EF560 technical specifications.

Specification	EF560
Maximum raw system capacity	384TB
Maximum number of drives per system	120
Shelf form factor	2U, 24 drives
Drive types supported	400GB, 800GB, or 1.6TB, 3.2TB SSD
Memory	24GB (12GB per controller) – Optionally 96GB (48GB per controller with FC or iSCSI protocol only – memory upgrade kits not supported)
Host I/O (controllers must match; a software feature pack can be applied to convert the 4-port FC and iSCSI HICs to FC-iSCSI split mode)	8-port 12Gb SAS (4-port 12Gb SAS [wide-port] per EF560 controller)
	8-port 16Gb FC (4-port 16Gb FC per EF560 controller)
	8-port 10Gb iSCSI (4-port 10Gb iSCSI per EF560 controller)
	4-port 56Gb IB (2-port 56Gb IB per EF560 controller) – default is iSER but can be changed to SRP with a new feature pack key
Expansion-drive shelves supported	DE5600 (2U, 24 drives): 4 expansion shelves max.
High-availability (HA) features	Dual active controllers with automated I/O path failover
	Support for RAID 0, 1 (10 for 4 drives or more), 5, and 6 or DDP

Specification	EF560
	Redundant, hot-swappable storage controllers, disk drives, power supplies, and cooling fans
	SANtricity proactive drive health monitoring with the drive evacuator feature to identify problem drives and begin removing data before hard failures occur
	Automatic drive fault detection, failover, and rebuild by using global hot spare drives for standard RAID and spare pool capacity in the case of DDP
	Mirrored data cache with battery backup and destage to flash
	Online controller firmware and NVSRAM upgrade
	Online ESM firmware and drive firmware upgrade (consult CSS for guidance before performing ESM or drive firmware upgrades)
	SANtricity Persistent Monitor and AutoSupport, for making periodic copies of the storage system configuration

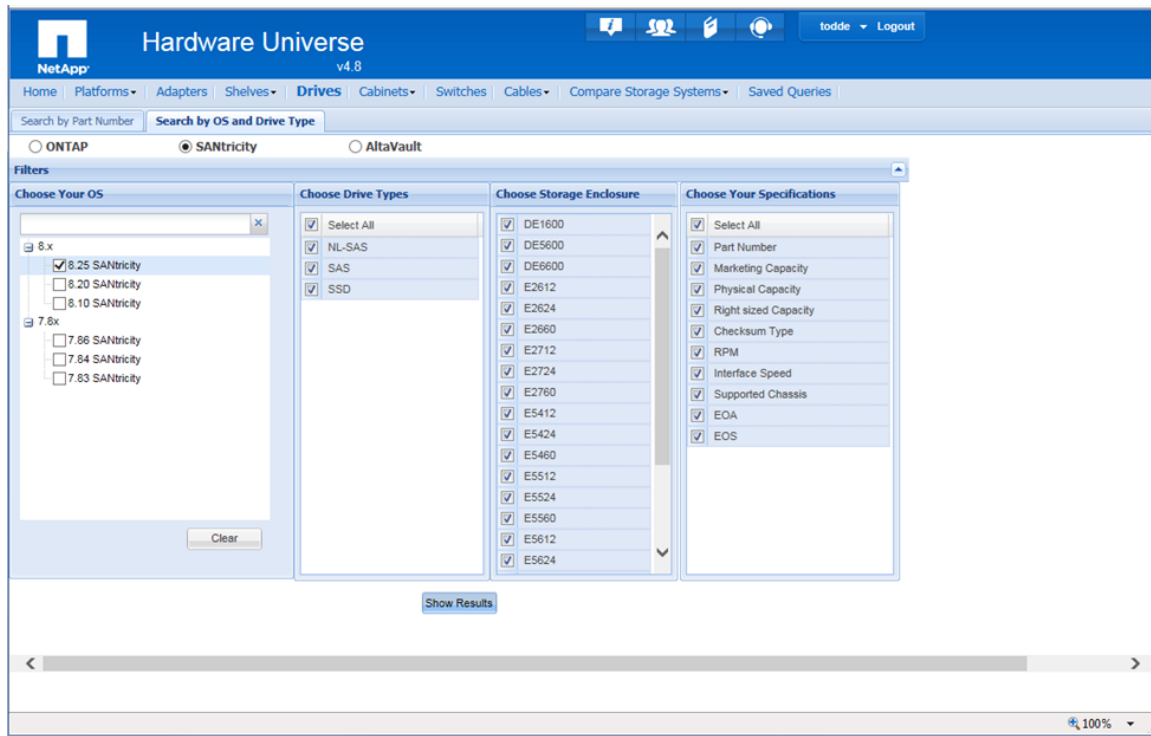
Table 10 provides a reference matrix of supported drive types and associated advanced features, including full disk encryption (FDE) and FIPS. The information is accurate as of March 2016.

Table 10) Drive feature matrix as of March 2016.

Drive Type	Data Assurance (DA): T10 PI	Full Disk Encryption (FDE)	Federal Information Processing Standards (FIPS 140-2 Level 2)
400GB SSD	x		
800GB SSD	x	x	
1.6TB SSD	x		
3.2TB SSD	x		

Current drive availability information is always available in [Hardware Universe](#). Figure 8 shows the navigation to select drives by OS and platform compatibility.

Figure 8) Hardware Universe drives by OS and platform.



For additional information, refer to the [NetApp EF560 Flash Array Datasheet](#).

8.3 Controller Host Interface Features

By default, each EF560 controller includes two Ethernet management ports that provide out-of-band or in-band system management access and two SAS drive expansion ports that provide redundant drive expansion paths. EF560 controllers do not include built-in host ports, so they must be ordered with one of the following host interface cards (HICs) installed in each controller:

- 4-port 12Gb SAS HIC.
- 2-port 56Gb InfiniBand (IB) HIC. This HIC runs the iSCSI Extensions for RDMA (iSER) protocol as shipped, but it can be converted to SCSI RDMA Protocol (SRP) before initial use by applying a software feature pack in the field at no additional cost.
- 4-port optical HIC, which can be factory-configured as either 16Gb Fibre Channel or 10Gb iSCSI. A software feature pack can be applied in the field to change the host protocol of this HIC:
 - From FC to iSCSI
 - From iSCSI to FC
 - From either FC or iSCSI to FC-iSCSI split mode
 - From FC-iSCSI split mode back to FC or iSCSI

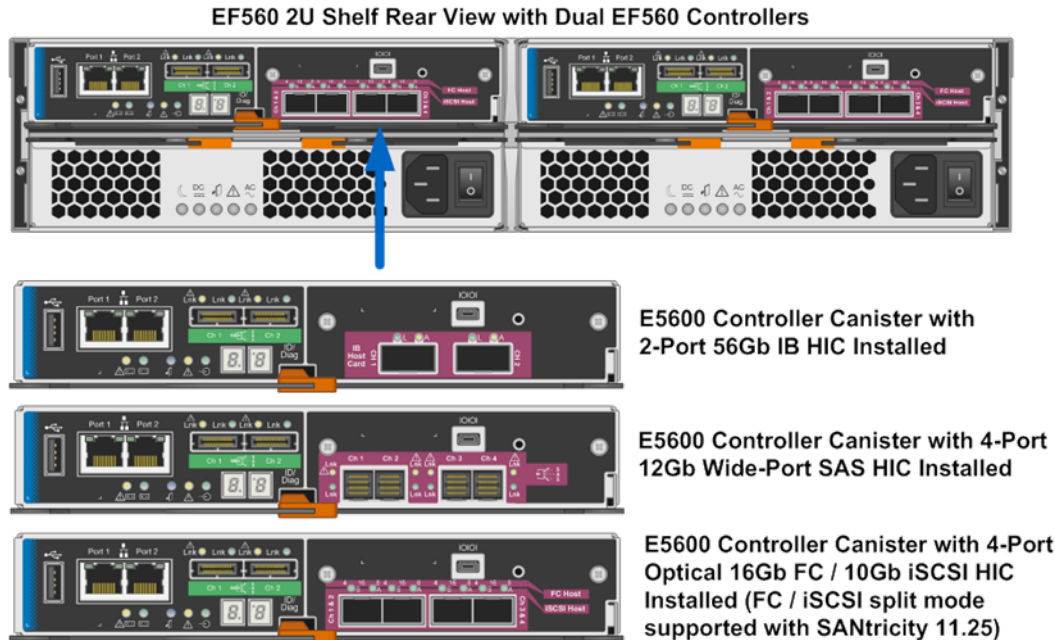
Note: In FC-iSCSI split mode, ports 1 and 2 operate as iSCSI and ports 3 and 4 operate as FC.

For step-by-step instructions for obtaining and applying software feature packs to change HIC protocol, go to the E-Series and EF-Series Systems Documentation Center (<http://mysupport.netapp.com/eseries>), click Upgrade/Convert the Host Interface Card, and select one of the PDFs listed for the EF560.

For optical connections, the appropriate SFPs must be ordered for the specific implementation. Consult the Hardware Universe for a full listing of available host interface equipment. Figure 9 provides a close-up view of the EF560 HIC options.

Both controllers in a storage system must be configured identically.

Figure 9) EF560 HIC options.



Note: All HICs support link speed autonegotiation. One exception is the unified SFP used with the 4-port optical HIC. This SFP does support 4/8/16Gb FC and 10Gb iSCSI, but it does not support 1Gb iSCSI. As a result, the unified SFP should not be used with iSCSI remote mirroring because it does not support a 10Gb/1Gb WAN link to the remote site. For this use case, use the 1Gbps iSCSI SPF.

8.4 Hardware LED Definitions

EF560 Shelf LEDs

The EF560 controller-drive shelf has LED status indicators on the front of the shelf and on the power supply units and fan units installed at the rear of the shelf. The LEDs on the front panel indicate systemwide conditions, and the LEDs on the power supply units and fan units indicate the status of the individual units.

Figure 10 shows the LEDs on the front panel of the EF560 controller-drive shelf.

Figure 10) LEDs on front panel of EF560 controller-drive and expansion-drive shelves.

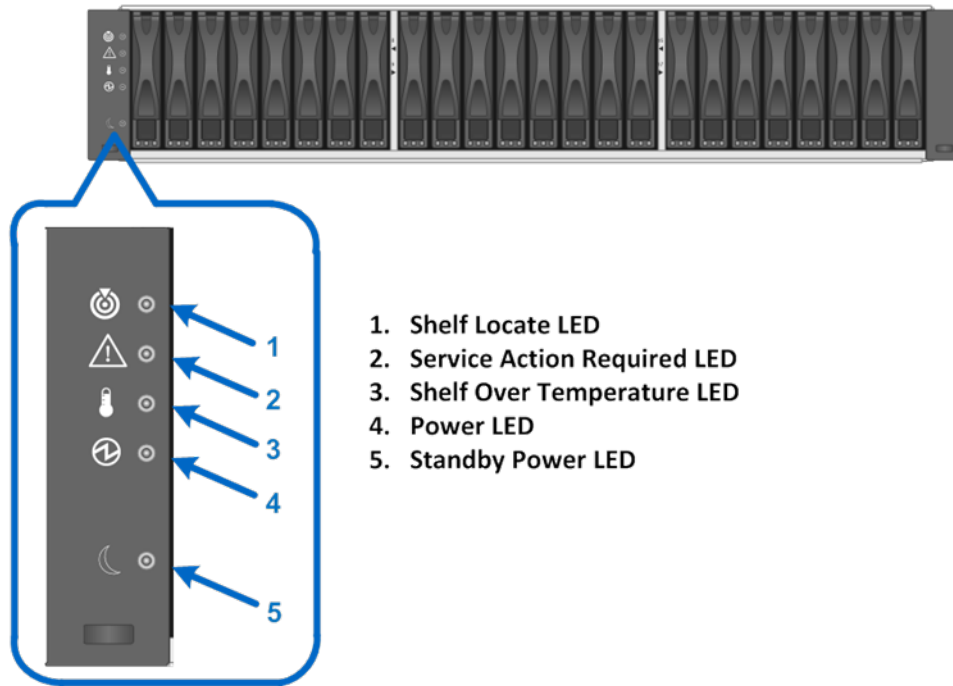


Table 11 defines the front-panel LEDs on the shelves. The LEDs are listed in the order matching the layout on the EF560 controller-drive shelf.

Table 11) EF560 controller-drive shelf and expansion-drive shelf LED definitions (front panel).

LED Name	Color	LED On	LED Off
Shelf locate	White	The LED lights up to make the controller-drive shelf easy to locate in the equipment rack.	Normal status.
Service action required	Amber	A component in the controller-drive shelf requires attention.	Normal status.
Shelf over temperature	Amber	The temperature of the controller-drive shelf has reached an unsafe level.	Normal status.
Power	Green	Power is present.	Power is not present.
Standby	Green	The controller-drive shelf is in standby mode.	The controller-drive shelf is not in standby mode.

Power Supply and Fan Unit LEDs

The EF560 controller-drive shelf and expansion-drive shelves support dual power supplies and fan canisters. Each power supply and fan canister unit is equipped with status LEDs shown in Figure 11 and defined in Table 12.

Figure 11) LEDs on EF560 integrated power supply and fan units (rear view).

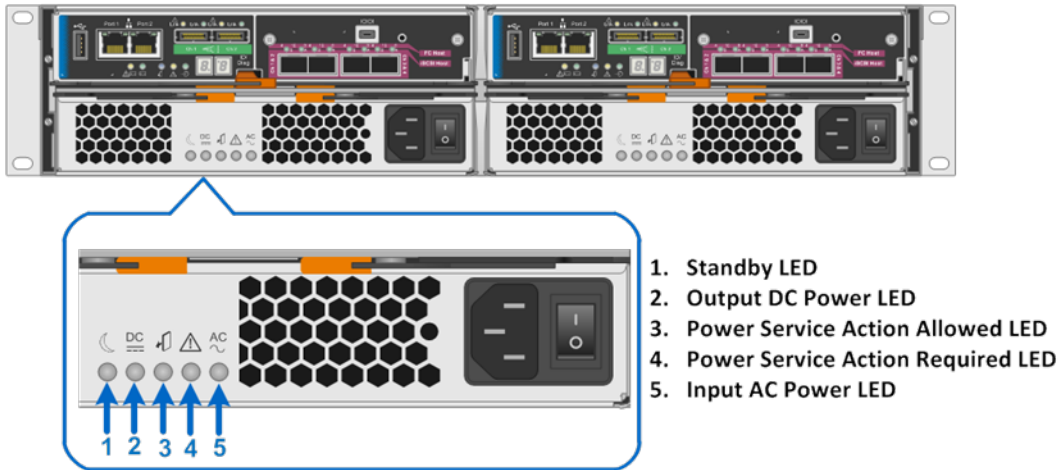


Table 12) EF560 controller-drive shelf and expansion-drive shelf power supply LED definitions.

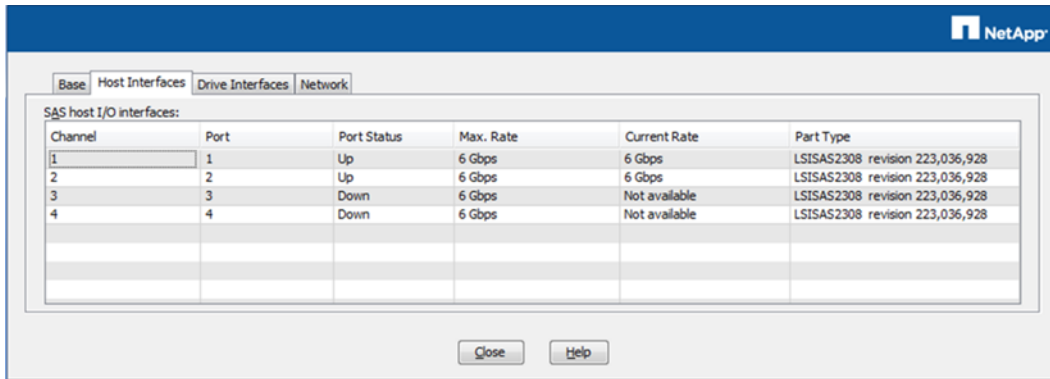
LED Name	Color	LED On	LED Off
Standby	Green	The controller-drive shelf is in standby mode.	The controller-drive shelf is not in standby mode.
Output DC power	Green	DC output power is present.	DC output power is not present.
Power service action allowed	Blue	The controller-drive shelf is in service mode.	The controller-drive shelf is not in service mode.
Power service action required	Amber	A power component in the controller-drive shelf requires attention.	Normal status.
Input AC power	Green	AC power is present.	AC power is not present.

EF560 Controller Canister LEDs

The EF560 controller canister has several LED status indicators. The LEDs on the left side of the canister refer to the onboard ports, including the Ethernet management ports, the SAS drive expansion ports, and the overall controller status. The LEDs on the right side of the canister refer to the status of the host ports.

Host port status can be verified by directly checking the port LEDs or by using the SANtricity Storage Manager GUI. The Host Interfaces tab of the Controller Properties dialog box, shown in Figure 12, details the status of each host I/O interface that is connected to the storage system.

Figure 12) Controller Properties dialog box.



Controller Base Port Status LEDs

Figure 13 shows the onboard LED status indicators on the left rear side of the EF560 controller. Most of the LEDs are lit when a fault condition exists; however, the battery charging LED and the cache active LED are lit when the battery is fully charged and the cache is active. The seven-segment LEDs provide status codes for both normal operation and fault conditions; the dot in the first seven-segment LED is the controller heartbeat indicator, which comes on when an intercontroller communication link has been established.

Figure 13) LEDs on left side of EF560 controller canister.

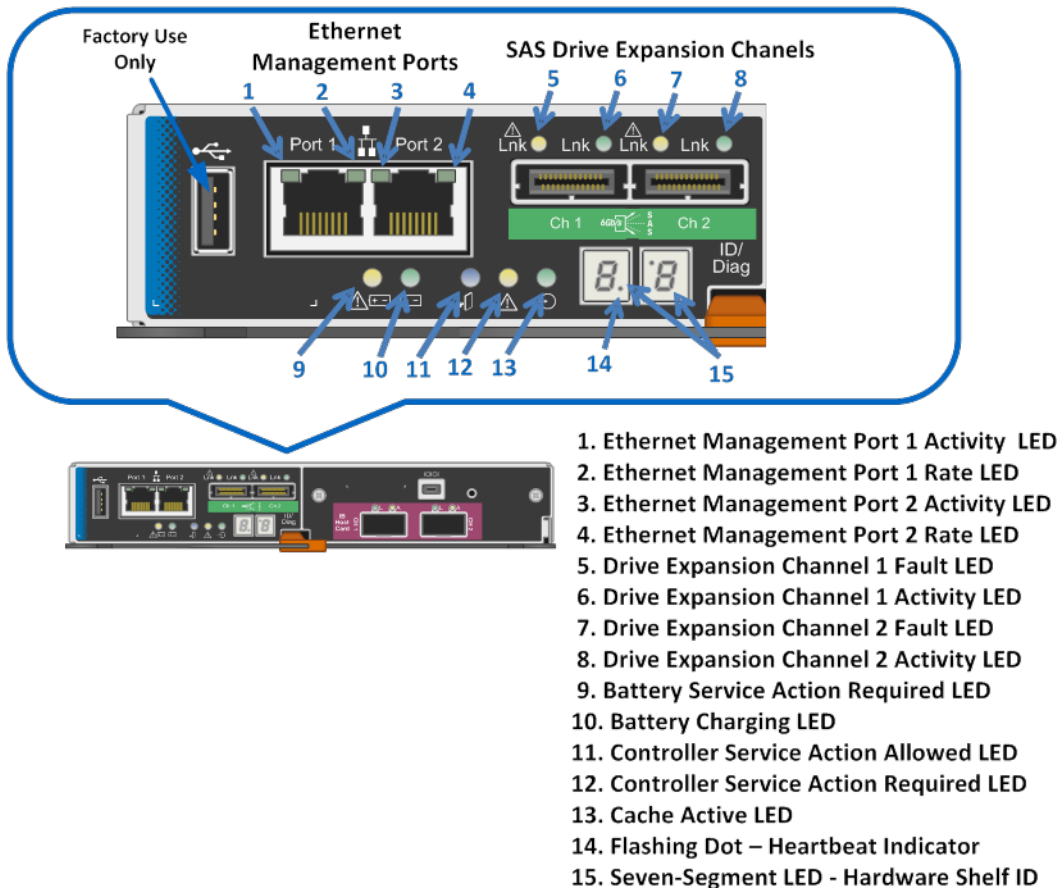


Table 13 defines the Ethernet management port LEDs on the controller (LEDs 1 through 4 in Figure 13).

Table 13) Ethernet management port LED definitions.

LED Name	Color	LED On	LED Off
Ethernet management port activity (top left corner of management port RJ-45 connectors)	Green	<ul style="list-style-type: none"> • Solid: The link is up without activity. • Blinking: The link is up with activity. 	A link error has occurred (link down).
Ethernet management port rate (top right corner of management port RJ-45 connectors)	Green	There is a 1000BASE-T rate.	There is a 10/100BASE-T rate.

Table 14 defines the LEDs for the SAS drive expansion ports used to connect expansion-drive shelves to the EF560 controller-drive shelf (LEDs 5 through 8 in Figure 13).

Table 14) SAS drive expansion port LED definitions.

LED Name	Color	LED On	LED Off
Standby	Green	The controller-drive shelf is in standby mode.	The controller-drive shelf is not in standby mode.
Output DC power	Green	DC output power is present.	DC output power is not present.
Power service action allowed	Blue	The controller-drive shelf is in service mode.	The controller-drive shelf is not in service mode.
Power service action required	Amber	A power component in the controller-drive shelf requires attention.	Normal status.
Input AC power	Green	AC power is present.	AC power is not present.

Table 15 defines the controller or system status LEDs (LEDs 9 through 15 in Figure 13).

Table 15) Controller base feature LED definitions.

LED Name	Color	LED On	LED Off
Battery service action required	Amber	The battery in the controller canister has failed.	Normal status.
Battery charging	Green	<ul style="list-style-type: none"> • Solid: The battery is fully charged. • Blinking: The battery is charging. 	The controller canister is operating without a battery, or the existing battery has failed.
Controller service action allowed	Blue	The controller canister can be removed safely from the controller-drive shelf.	The controller canister cannot be removed safely from the controller-drive shelf.
Controller service action required	Amber	Some fault exists within the controller canister.	Normal status.

LED Name	Color	LED On	LED Off
Cache active	Green	<ul style="list-style-type: none"> • Solid: The cache is active. • Blinking: After AC power failure, the cache offload is in process. 	The cache is inactive, or the controller canister has been removed from the controller-drive shelf.
Dot in lower right corner of first seven-segment LED	Green	A flashing dot indicates that the controller heartbeat is active.	If the dot is not lit, the controller heartbeat is not active (that is, the controller is not in service).
Two seven-segment LEDs	Green	<ul style="list-style-type: none"> • If the controller status code equals 99, then the controller is in service. • If the controller status code does not equal 99, then a fault condition exists. Contact technical support for further assistance. 	The controller is not powered on.

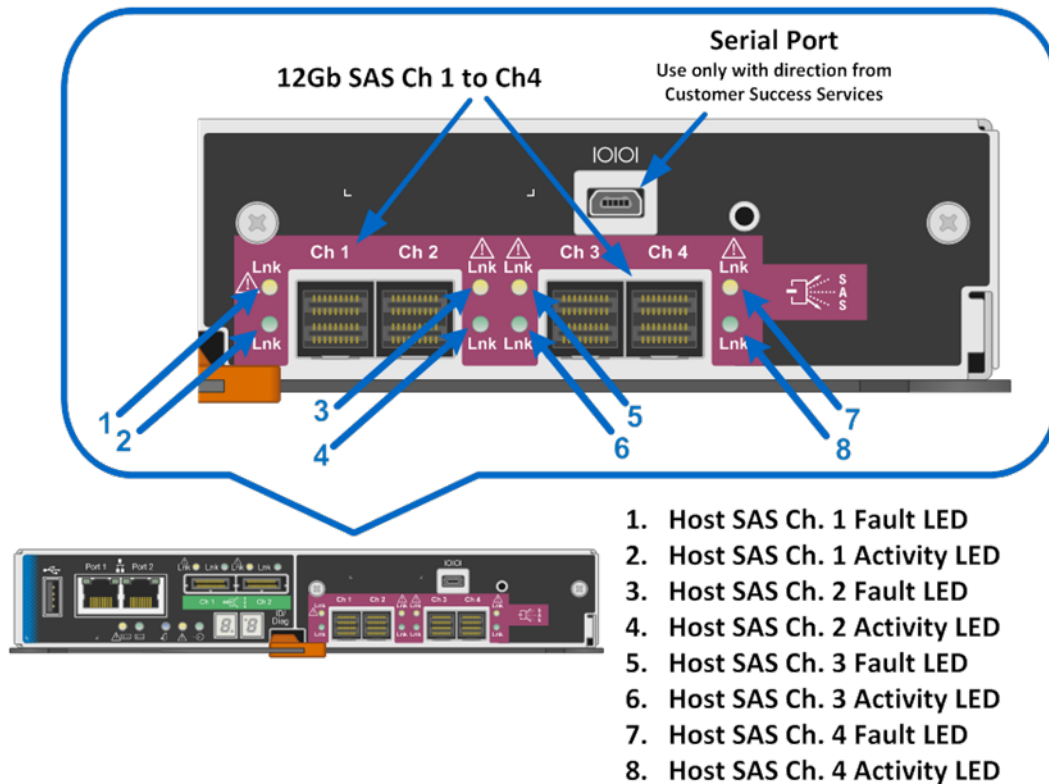
Note: Note: The battery service action required LED indicates that the battery timer has expired or the battery has failed the automatic battery test. This condition can seriously affect the system write performance because the write cache feature is disabled by default when the battery is not functioning normally.

The seven-segment LEDs display the shelf ID, and 99 is the normal ID for controller-drive shelves. Expansion-drive shelves display numbers starting with 00 and increasing as drive shelves are added to the storage system. These shelf IDs can be changed from the default numbering by using the SANtricity management interface. The seven-segment LEDs also display status codes under start-up conditions and some error conditions.

4-Port 12Gb Wide-Port SAS HIC LEDs

The 4-port 12Gb wide-port SAS HIC is shown in Figure 14. The host-side connection ports have status LEDs to indicate the connection status for each link between the storage system and various host-side hardware devices.

Figure 14) LEDs on 4-port 12Gb wide-port SAS HIC.



Note: The 12Gb SAS3 HIC uses mini-SAS HD (SFF-8643/8644) connectors.

Table 16 provides the definitions for the 12Gb SAS HIC LEDs.

Table 16) 4-port 12Gb SAS HIC LED definitions.

LED Name	Color	LED On	LED Off
Host SAS channel fault	Amber	At least one of the four PHYs is working, but another PHY cannot establish the same link to the device connected to the host input port connector.	Normal status.
Host SAS channel activity	Green	At least one of the four PHYs in the host input port is working, and a link has been established to the device connected to the input port connector.	A link error has occurred.

4-Port Optical 16Gb FC/10Gb iSCSI HIC LEDs

The EF560 supports a 4-port optical HIC that offers 16Gb FC protocol, 10Gb iSCSI protocol, or a combination of both protocols (FC-iSCSI split mode). When using this HIC and dual controllers, the EF560 flash array provides a maximum of eight 16Gb FC, eight 10Gb iSCSI ports, or four 10Gb iSCSI ports and four 16Gb FC ports. In split mode, ports one and two operate in iSCSI mode, and ports three and four operate using the FC protocol.

Figure 15 shows the LEDs on the 4-port optical HIC for the EF560 controller.

The optical HIC supports several SFP options, including several 16Gb FC or 10Gb SFP+ options and a unified adapter that supports both 16Gb FC and 10Gb iSCSI. The HIC also supports 10Gb iSCSI copper by using a special cable with built-in SFP+ adapters on the HIC end and an RJ-45 connector on the switch or host end of the cable. These cables are generally available from NetApp and have a 23ft (7m) length limitation.

Note: The unified SFP does not support 1Gb iSCSI. It does support 4/8/16Gb FC and 10Gb iSCSI.

Figure 15) LEDs on 4-port optical 16Gb FC/10Gb iSCSI HIC.

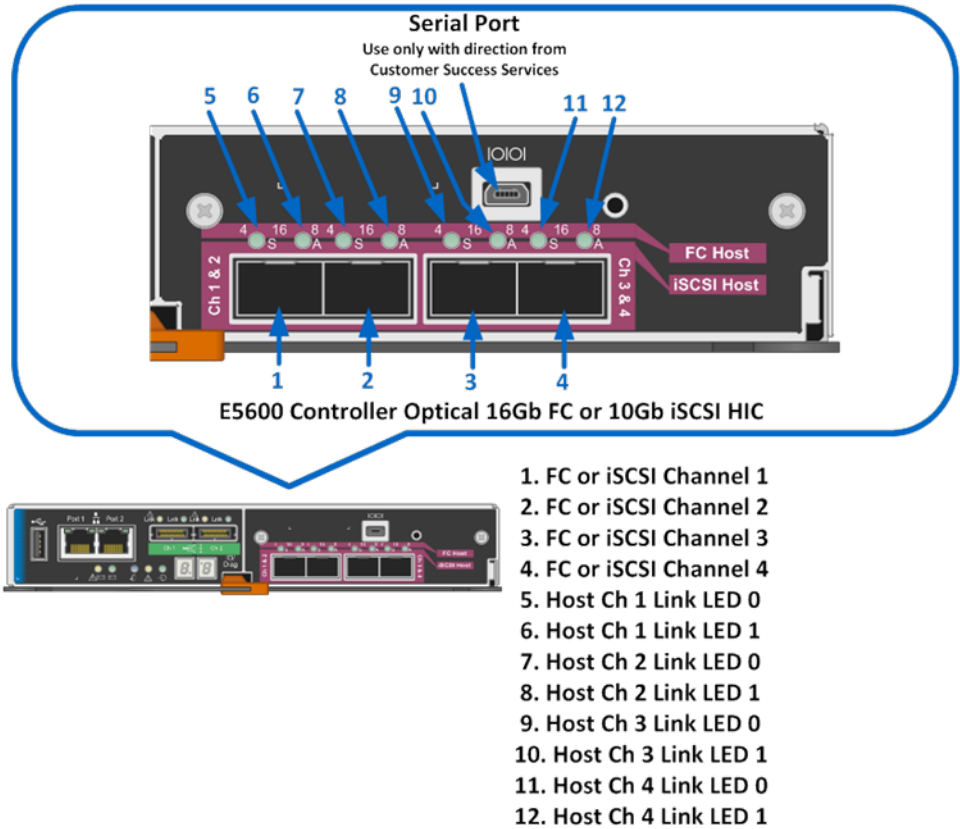


Table 17 defines the LEDs on the 4-port optical HIC when the FC protocol is used.

Table 17) 4-port optical 16Gb FC HIC LED definitions.

LED 0 (Left Side)	LED 1 (Right Side)	Link Rate	Color
Off	Off	Link down	N/A
On	Off	Link operating at 4Gbps	Green
Off	On	Link operating at 8Gbps	Green
On	On	Link operating at 16Gbps	Green

Table 18 provides the 4-port optical HIC LED definitions when the iSCSI protocol is used.

Table 18) 4-port optical 10Gb iSCSI HIC LED definitions.

LED Speed (Left Side)	LED Activity (Right Side)	Link Rate	Color
On	On	Link operating at 10Gbps; no activity	Green
	Blinking	Link operating at 10Gbps with active I/O in progress	Green
Off	On	Link operating at 1Gbps; no activity	Green
	Blinking	Link operating at 1Gbps with active I/O in progress	Green
Off	Off	Link down	N/A

2-Port 56Gb InfiniBand HIC LEDs

The EF560 controller supports a 56Gb IB HIC, but it autonegotiates link speed to accommodate 40Gb IB environments. Figure 16 shows the LEDs on the 2-port 56Gb IB HIC for the EF560 controller.

Figure 16) LEDs on 2-port 56Gb IB HIC.

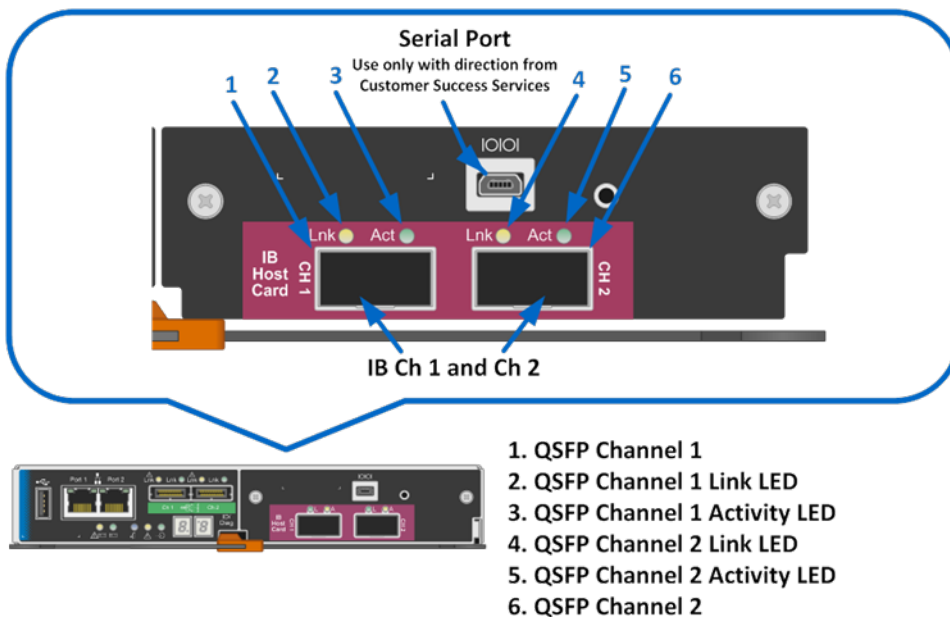


Table 19 defines the LEDs on the 2-port 56Gb IB HIC.

Table 19) 2-port 56Gb IB HIC LED definitions.

LED Name	Color	LED On	LED Off
QSFP link	Amber	The physical link is active.	The physical link is not active.

LED Name	Color	LED On	LED Off
QSFP activity	Green	<ul style="list-style-type: none"> Solid: The link is up without activity. Blinking: The link is up with activity. 	Green

For additional information about the EF560 controller and related hardware, refer to the EF560 Series documentation in the [NetApp Support site documentation](#) library.

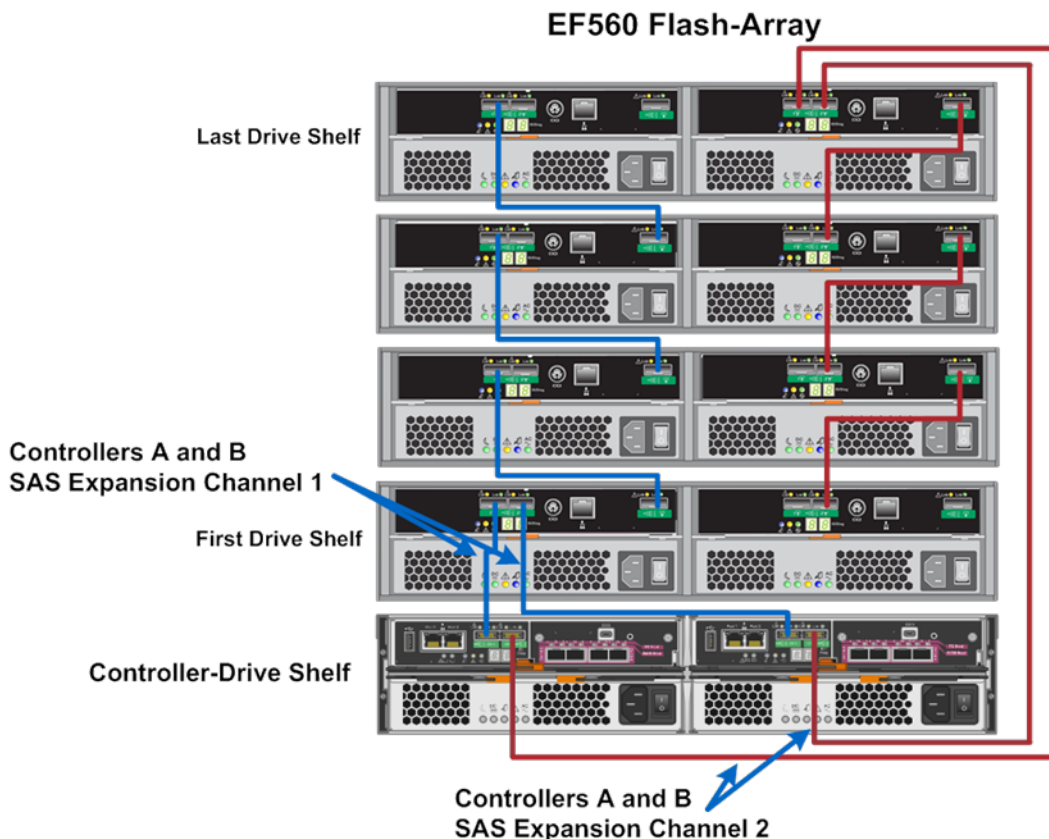
9 Expansion-Drive Shelves

EF560 flash arrays support scale-out architectures through the use of expansion-drive shelves that are added on to the controller-drive shelf.

9.1 Greenfield Installation


The EF560 layout is shown in Figure 17. The top-down and bottom-up cabling approach is used to guard against a lost-shelf fault and to enable hot-adding a shelf in the future.

Figure 17) EF560 flash array with four expansion-drive shelves.



The EF560 cabling is innovative because the dual ports on each controller are split across the A and B sides of the attached drive shelves. For correct drive shelf cabling, use the cable report in SANtricity Storage Manager, AMW > Monitor > Reports > Cable Connections, to trace each path as shown in Figure 18.

Figure 18) SANtricity Storage Manager cable connections report.



The table below shows how the ESMs in each expansion drive tray are connected. Use this table along with your actual hardware to ensure you have the appropriate cabling.

From	To
Controller A, Port 2	Drive Tray 2, ESM B (Right), In 1
Drive Tray 2, ESM B (Right), Out	Drive Tray 0, ESM B (Right), In 2
Drive Tray 0, ESM B (Right), Out	Drive Tray 1, ESM B (Right), In 2
Drive Tray 1, ESM B (Right), Out	Drive Tray 3, ESM B (Right), In 2
Controller A, Port 1	Drive Tray 3, ESM A (Left), In 1
Drive Tray 3, ESM A (Left), Out	Drive Tray 1, ESM A (Left), In 1
Drive Tray 1, ESM A (Left), Out	Drive Tray 0, ESM A (Left), In 1
Drive Tray 0, ESM A (Left), Out	Drive Tray 2, ESM A (Left), In 1
Controller B, Port 2	Drive Tray 2, ESM B (Right), In 2
Controller B, Port 1	Drive Tray 3, ESM A (Left), In 2

Save As... Close Help

Failure to cable expansion-drive shelves correctly can lead to a semilockdown state on the storage system that does not allow changes to the system configuration until the cabling issue is resolved.

Best Practice

When initially powering on an EF-Series flash array that includes expansion-drive shelves, power on the expansion-drive shelves first and wait one to two minutes per drive shelf before powering on the controller-drive shelf.

Best Practice

To power off an EF-Series flash array that includes expansion-drive shelves, confirm that all host I/O operations have stopped. Then, turn off both power switches on the controller-drive shelf and wait for all LEDs on the shelf to go dark. Finally, turn off both power switches on any attached expansion drive shelves and wait two minutes for the drive activity to stop.

9.2 Expansion-Drive Shelf Hot Add

EF-Series flash arrays support the addition of expansion-drive shelves and drive capacity to running storage systems. To prevent the loss of data availability to existing drive shelves when new drive shelves are added, the storage system must be cabled according to the cabling best practices that NetApp recommends. Two independent SAS channel paths must be available to the drive shelves so that one path can be interrupted when a drive shelf is added to the storage system while the other path maintains data availability to existing shelves.

The SANtricity Storage Manager cable audit report can be used to verify that the cabling is configured appropriately before and after adding additional drive shelves. After additional drive shelves have been successfully added to a storage system, SANtricity can be used to add capacity to existing volume groups and disk pools or to create new volume groups and disk pools.

When adding an expansion-drive shelf to an existing EF-Series flash array, it is critical to follow the specific hot-add installation steps in the order specified by E-Series Hardware Cabling Guide.

Note: For more information and assistance with adding an expansion-drive shelf to an existing production EF-Series system, go to <https://mysupport.netapp.com/eseries> and click the Cable the Hardware link or contact NetApp Customer Success Services.

Figure 19 and Figure 20 show the hot-add connectivity when a new shelf is added as the first expansion-drive shelf in the system. The cabling when adding the first expansion-drive shelf is not the same as the cabling for the second expansion-drive shelf.

Figure 19) Drive shelf hot-add A-side cabling first expansion-drive shelf.

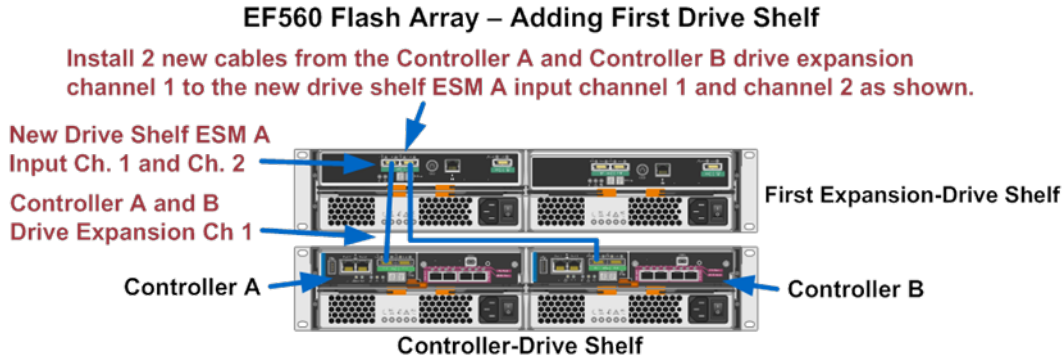


Figure 20) Drive shelf hot-add B-side cabling first expansion-drive shelf.

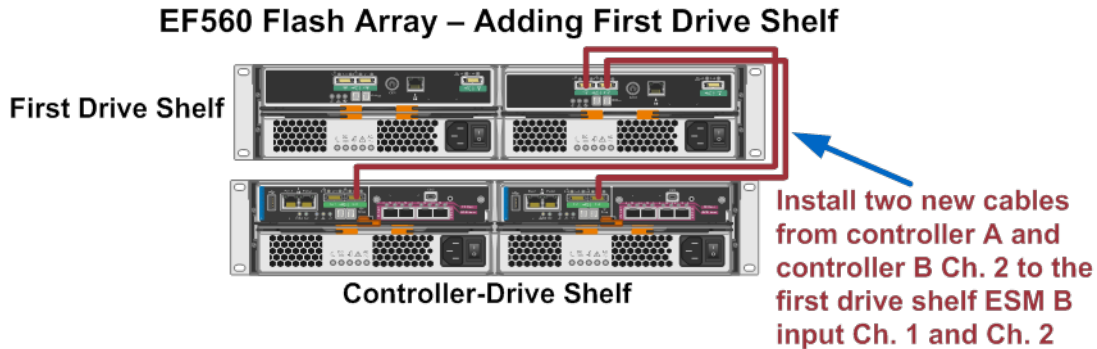
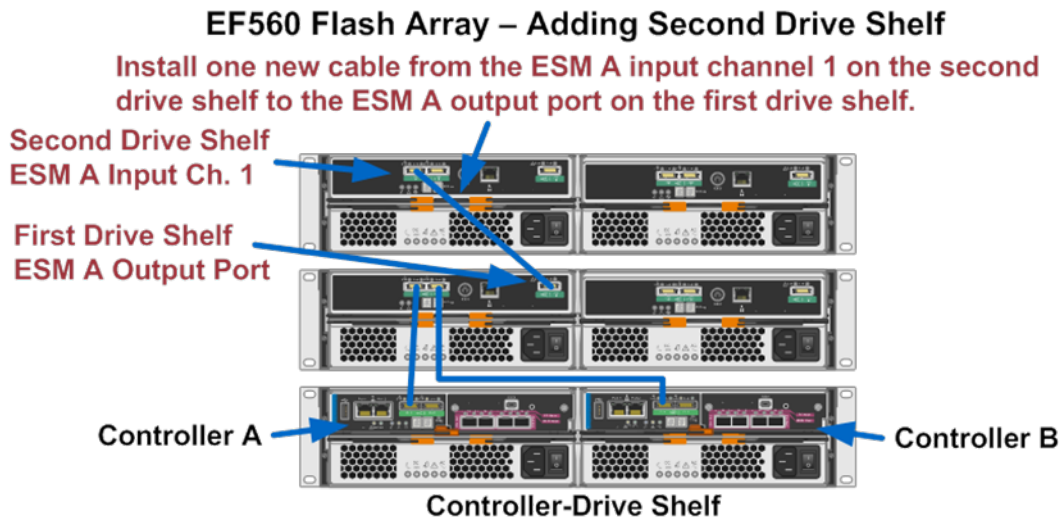


Figure 21 and Figure 22 show the hot-add connectivity when a new shelf is added as the second and up to the fourth expansion-drive shelf in the system.

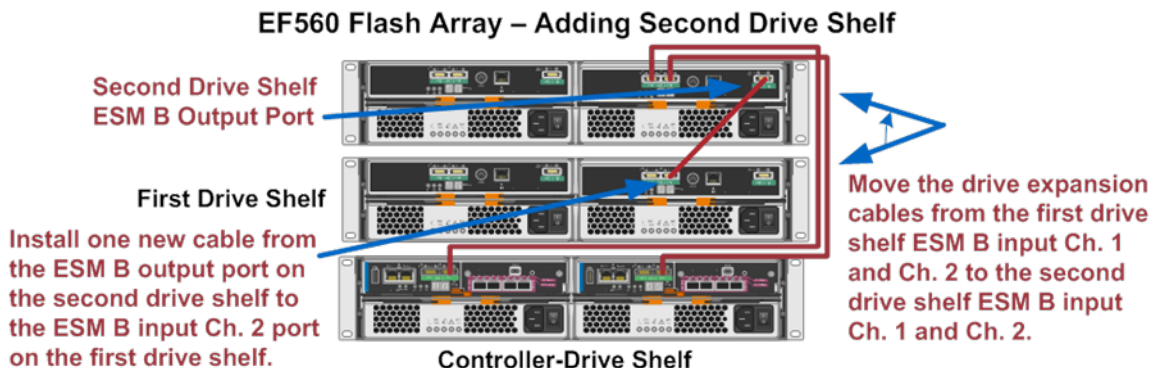
Figure 21) Drive shelf hot-add A-side cabling first expansion-drive shelf.



Use SANtricity Storage Manager to verify the new shelf is successfully discovered before moving the ESM B-side cables from the first expansion-drive shelf. The ESM A-side paths must be active before the ESM B-side paths are moved from the first expansion-drive shelf.

Note: Failure to establish active A-side paths before moving the B-side paths might result in the loss of availability of existing LUNs on the storage system until the cabling issue is resolved.

Figure 22) Drive shelf hot-add B-side cabling first expansion-drive shelf.



Best Practice

Plan carefully for any drive shelf hot-add activity on production storage systems. Verify that the following conditions are met:

- The existing power infrastructure can support the additional hardware.
- The cabling plan for the new shelf does not simultaneously interrupt the SAS expansion paths for controller A and controller B.

Note: Failure to preserve one active path to existing drive shelves during the procedure can cause host servers to lose access to their LUNs.

10 EF-Series Product Support

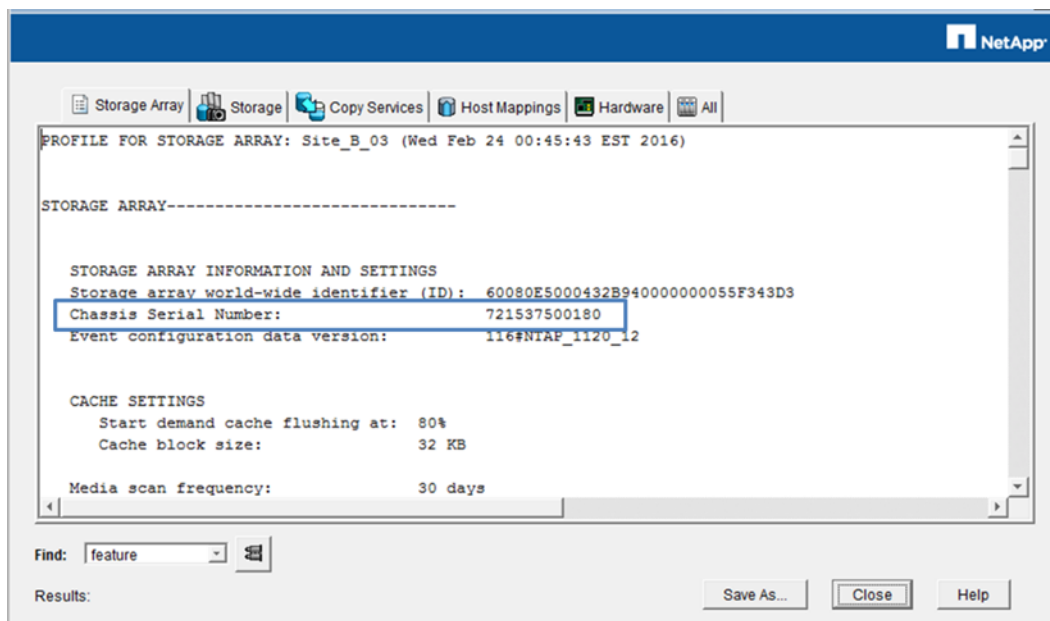
NetApp EF-Series flash arrays are identified by the serial number (SN) of the EF-Series system shelf, not the SNs of the individual controllers within the shelf. The correct SN must be registered for an EF-Series system because only the SN of the EF-Series system shelf can be used to log a support case with NetApp.

10.1 Controller-Drive Shelf Serial Number

EF-Series flash arrays are shipped preconfigured from the factory (controllers have HICs and batteries installed, and controllers are installed in the controller-drive shelf). The shelf SN is printed on a silver label affixed to the controller-drive shelf and is identified by the text “Serial” or “SN,” which is shown. The shelf SN is also included on the shelf UL sticker; however, this sticker is often not visible after the shelves are installed in a rack.

On a running storage system, the SN is also available through SANtricity Storage Manager by viewing the storage array profile, shown in Figure 23.

Figure 23) SANtricity Storage Manager AMW storage array profile.

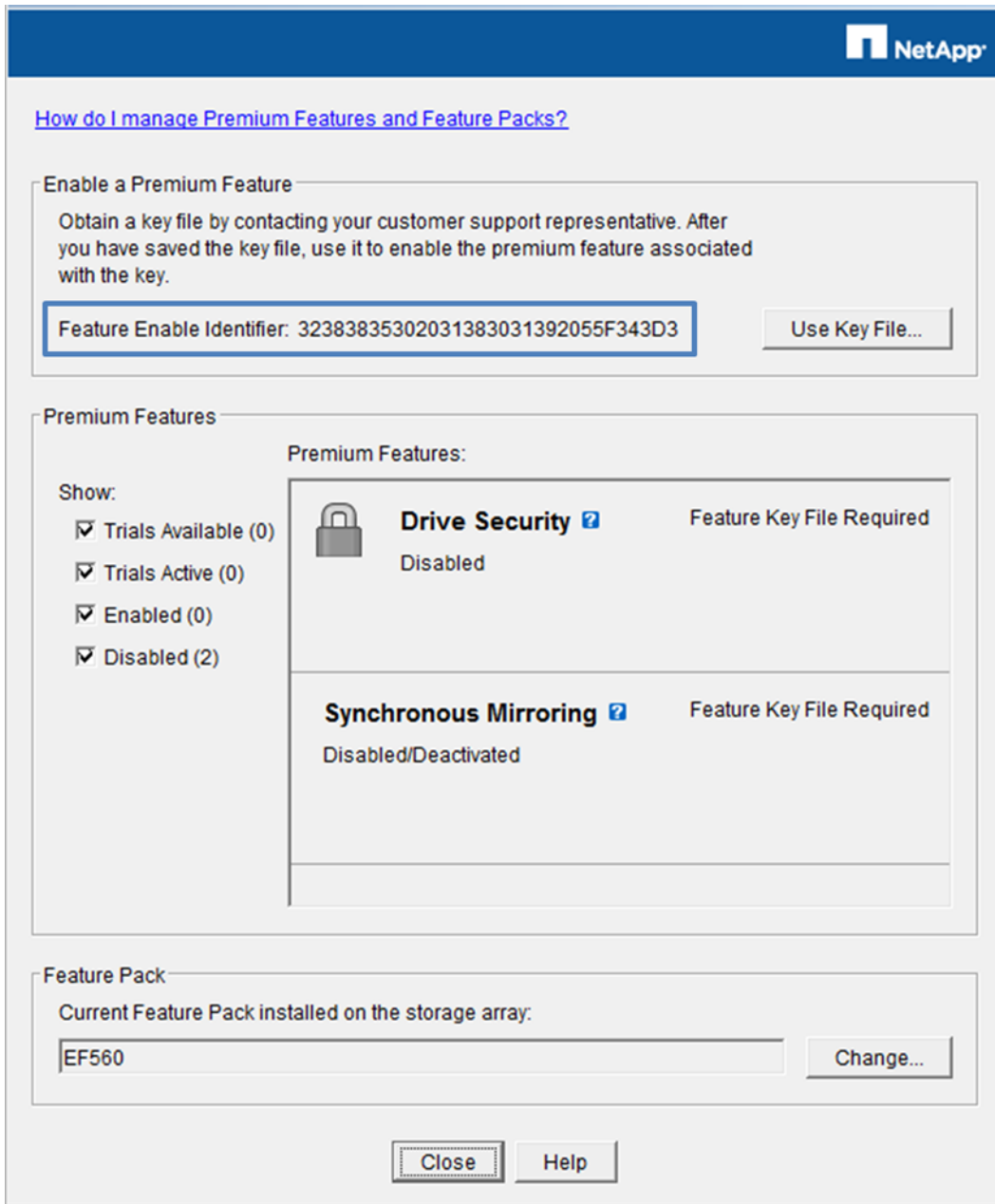


10.2 License Keys

Drive security and synchronous mirroring are the only EF-Series premium features in SANtricity 11.25; both require a license key file to activate the functionality. The drive security key must be purchased. The synchronous mirroring key is available at no additional cost, but customers must file a PVR so their specific use case can be reviewed to ensure the feature is appropriate and capable of meeting the performance requirements. Contact a NetApp sales representative for more information.

The drive security license key can be purchased by sending a request to a sales representative. The request must include the array feature-enable identifier that is listed in the Premium Features and Feature Pack Information dialog box (shown in Figure 24) and the storage system serial number (the serial number of the EF-Series system shelf).

Figure 24) Feature enable identifier.



The image shows a NetApp web interface for managing premium features. At the top is the NetApp logo. Below it is a link: "How do I manage Premium Features and Feature Packs?". The main section is titled "Enable a Premium Feature" and contains instructions: "Obtain a key file by contacting your customer support representative. After you have saved the key file, use it to enable the premium feature associated with the key." Below the instructions is a text field containing the "Feature Enable Identifier: 32383835302031383031392055F343D3" and a "Use Key File..." button. The next section is titled "Premium Features" and includes a "Show:" filter with four options: "Trials Available (0)", "Trials Active (0)", "Enabled (0)", and "Disabled (2)". The "Premium Features:" table lists two features: "Drive Security" (with a lock icon, status "Disabled", and "Feature Key File Required") and "Synchronous Mirroring" (status "Disabled/Deactivated", and "Feature Key File Required"). The bottom section is titled "Feature Pack" and shows "Current Feature Pack installed on the storage array:" with a text field containing "EF560" and a "Change..." button. At the very bottom are "Close" and "Help" buttons.

NetApp

[How do I manage Premium Features and Feature Packs?](#)

Enable a Premium Feature

Obtain a key file by contacting your customer support representative. After you have saved the key file, use it to enable the premium feature associated with the key.

Feature Enable Identifier: 32383835302031383031392055F343D3


Use Key File...

Premium Features

Show:

- ☒ Trials Available (0)
- ☒ Trials Active (0)
- ☒ Enabled (0)
- ☒ Disabled (2)

Premium Features:

	Drive Security ?	Feature Key File Required
Disabled		
Synchronous Mirroring ?		Feature Key File Required
Disabled/Deactivated		

Feature Pack

Current Feature Pack installed on the storage array:

EF560

Change...

Close Help

When the license key for the drive security feature has been purchased and the order has been processed in the NetApp order system, the key file can be generated by using the [NetApp Storage Array Premium Feature Activation Tool](#). The tool requires two types of information to generate license key files: the key activation code and the feature-enable identifier.

The 11-digit key activation code is system generated for purchased licenses and is attained by logging in to [NetApp Support](#) and viewing the system details under Products > My Support > Software Licenses. The EF-Series system shelf serial number should be used to access the specific system details and key codes.

The feature-enable identifier is a 32-digit code that is unique to a storage system. It can be located by using SANtricity to access the Premium Features and Feature Pack Information dialog box for the storage system.

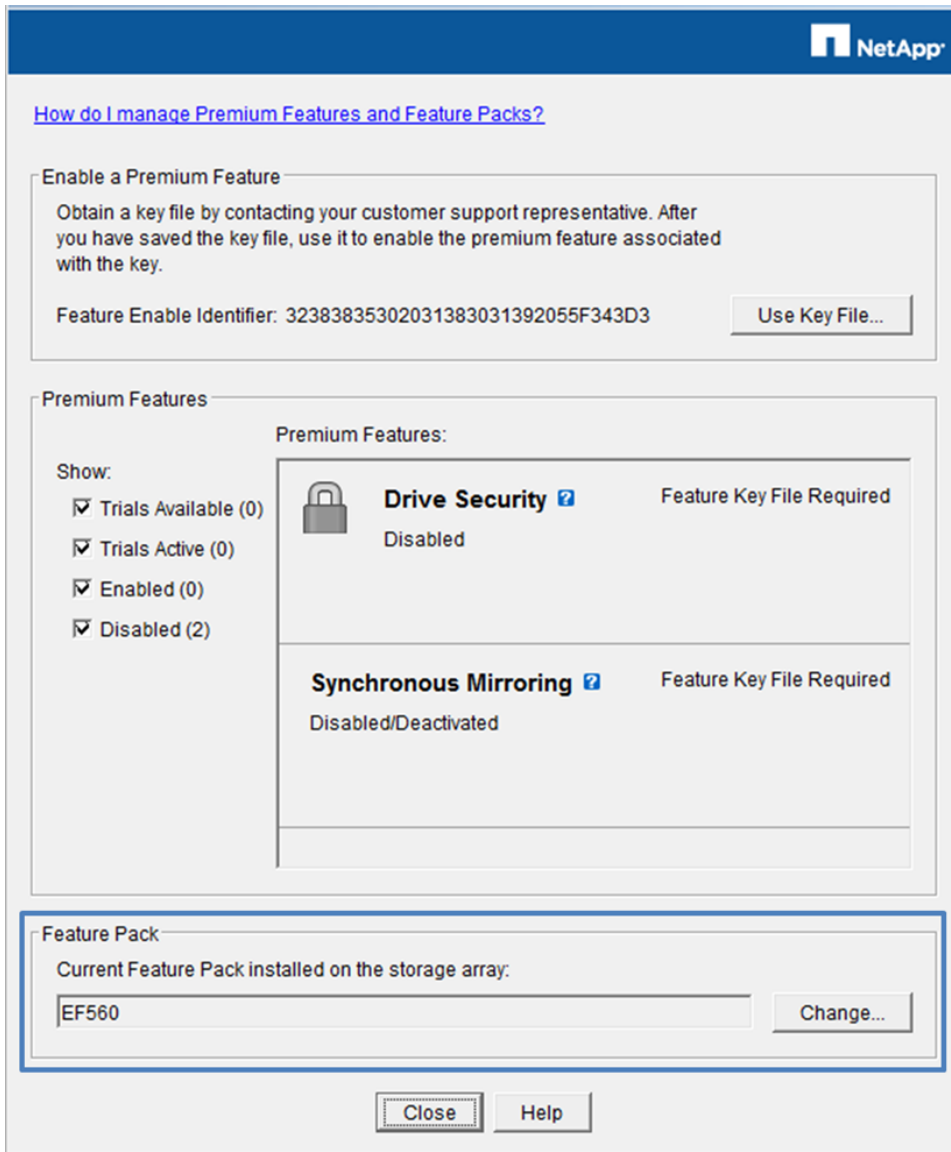
Customers must have a valid Support site account login and password to access, generate, and download the license key file.

Note: First-time users who apply for a new Support site account have access to their system details and to the license key site delayed for up to five business days while the registration information is validated and the user account is created. For this reason, NetApp recommends that customers create their Support site accounts as soon as their purchase order has been received by NetApp.

Feature Pack Keys

When EF560 controllers are equipped with the four-port optical HIC, feature pack keys are used to set/change the host interface protocol from FC to iSCSI or from iSCSI to FC. The process to generate a new feature pack key for your storage array is the same as the process to generate a premium feature key, except the 11-digit key activation code for each package is available at no additional cost and is listed in the hardware upgrade instructions per controller type available at <https://mysupport.netapp.com/eseries>. Figure 25 shows where to change the feature pack key for E-Series storage systems.

Figure 25) Premium Features dialog box: Feature pack section highlighted.



For issues with accessing license key files, open a support ticket with NetApp Customer Support Delivery using the serial number of the registered controller-drive shelf for the associated storage system.

11 Summary

The EF560 flash array provides superior performance in a 2U industry standard footprint that easily integrates into data centers across the globe. The flexible host interfaces autonegotiate to accommodate environments that are transitioning from older networks to new high-speed networks while offering high-speed support for greenfield installations. The choice of storage configurations easily supports general and dedicated workloads while providing the ability to tune the system for custom workloads.

For applications that require high-performance dedicated storage, the EF560 supports over 870,000 4K read IOPS with micromillisecond response times without sacrificing system RAS features or redundancy. The combination of speed, flexibility, supportability, and scalability makes the EF560 an industry-leading all-flash storage system that is well suited for all enterprise customers.

References

The following references were used in this TR:

- E-Series EF560 Datasheet:
<https://fieldportal.netapp.com/Core/DownloadDoc.aspx?documentID=142978&contentID=282603>
- E-Series Product Documentation (both online help in SANtricity 11.25 and from the NetApp Product Documentation Library)
- E-Series 11.25 scope of work and various product design specification documents not publicly available

Version History

As an option, use the NetApp Table style to create a Version History table. Do not add a table number or caption.

Version	Date	Document Version History
Version 1.0	March 2016	Document Version History Initial release concurrent with SANtricity 11.25.

Refer to the [Interoperability Matrix Tool \(IMT\)](#) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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