Dell PowerEdge Express Flash NVMe PCIe SSD 2.5 inch Small Form Factor

User's Guide

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Notes, cautions, and warnings

(i) **NOTE: A NOTE indicates important information that helps you make better use of your product.**

△ **CAUTION: A CAUTION indicates either potential damage to hardware or loss of data and tells you how to avoid the problem.**

⚠ **WARNING: A WARNING indicates a potential for property damage, personal injury, or death.**

Contents

Overview

The PowerEdge Express Flash Non-Volatile Memory Express (NVMe) Peripheral Component Interconnect Express (PCIe) Solid State Device (SSD) 2.5 inch small form factor (SFF) is a high performance storage device designed for solutions requiring low latency, high I/O operations per second (IOPS), and enterprise class storage reliability and serviceability. The NVMe PCIe SSDs are offered as a Multi-Level Cell (MLC) or Triple-Level Cell (TLC) NAND flash technology with a high-speed PCIe 3.0 compliant interface. The high-speed PCIe 3.0 compliant interface helps improve performance for I/O bound solutions.

NVMe is the standardized, high-performance host controller interface that uses solid-state devices on a PCI Express bus (PCIe SSDs).

Topics:

- NVMe PCIe SSD architecture
- NVMe PCIe SSD 2.5 inch SFF features
- Supported operating systems for NVMe PCIe SSD

NVMe PCIe SSD architecture

The NVMe PCIe SSD solution provides the PCIe connectivity for up to 24 NVMe PCIe SSDs in selected systems.

The NVMe PCIe 2.5 inch SFF SSDs are available on selected PowerEdge systems starting from XS1715, SM1715, PM1725, and PM1725a device families in varying capacities.

In PowerEdge systems, multiple solutions are used to connect to a PCIe SSD backplane, allowing connectivity for up to 24 NVMe PCIe SSDs.

ⓘ **NOTE: To determine the maximum number of NVMe PCIe SSDs supported on your system, and for more information on extender adapters, see the system-specific Owner's Manual at Dell.com/support/manuals.**

PCIe interface

The SSD controller used on the NVMe PCIe SSD has a PCIe Generation 3 (8 GT/s) interface. The interface is a PCIe x4 lane width for a 16-channel flash memory controller, and is used to transmit or receive storage interface commands between the host and the NVMe PCIe SSD.

NVMe PCIe SSD 2.5 inch SFF features

The following topics describe the different features of the NVMe PCIe SSD.

Hot swap

ⓘ **NOTE: To check if your operating system supports NVMe PCIe SSD hot swap, see Supported operating systems for NVMe PCIe SSD .**

The NVMe PCIe SSD supports orderly hot swap allowing you to add or remove a device without halting or restarting the system in which the device is installed.

The supported NVMe PCIe SSD hot swappable functions are defined below:

Orderly or Hot Insertion	You insert a device into a running system where a similar device has not been previously inserted from the time it was last booted. The systems that support NVMe PCIe SSDs are configured to handle the PCIe resource balancing in the event of a hot insertion, when operating within a Dell supported operating system. This preset system configuration makes the hot insertion an orderly operation, if performed with supported operating systems.
Orderly Removal	You remove a device from a running system. Prior to physically removing the device, you must notify the system that the device is about to be removed. This notification defines hot removal as an orderly operation.
Orderly Swap	You remove a device from the system in an orderly fashion and replace it with a supported device. The device that is removed and the device that replaced it use the same device driver.

⚠ **WARNING: Do not remove an NVMe PCIe SSD without notifying the system first. For more information, see Preparing to remove an NVMe PCIe SSD.**

ⓘ **NOTE: Orderly hot swap is only supported when NVMe PCIe SSDs are installed in a supported Dell system running a supported operating system. Do not insert or remove an NVMe PCIe SSD while accessing the system BIOS or HII configuration. To ensure that you have the correct hardware setup for your NVMe PCIe SSD, see the system specific Owner's Manual at Dell.com/support/manuals.**

Device health

The NVMe PCIe SSD design is based on NAND flash technology. NAND SSDs have a finite number of program or erase cycles and a finite number of spare blocks (replacements for other worn or faulty NAND blocks).

The program erase cycles and spare blocks are continuously monitored for each NVMe PCIe SSD through various software management applications. For more information, see Configuring and managing your NVMe PCIe SSD 2.5 inch SFF device.

Self-Monitoring Analysis and Reporting Technology

The Self-Monitoring Analysis and Reporting Technology (SMART) feature set minimizes unscheduled system downtime by providing a method of early detection of device degradation or fault conditions. By monitoring and storing critical performance and calibration parameters, the SMART feature set attempts to predict degradation or fault conditions. Awareness of a negative reliability condition allows the host system to warn you of an impending risk of device failure and advise on appropriate action.

Remaining rated write endurance

NAND SSDs have a finite number of program erase cycles. The NVMe PCIe SSD is warranted to a maximum amount of data written to the device in total bytes written. The NVMe PCIe SSD self monitors for these limits, and software management applications notify you when you reach these limits.

ⓘ **NOTE: If you continue to write to the device after it reaches the threshold of total bytes written, the amount of time the NVMe PCIe SSD retains data while powered off decreases below device specifications. For more information, see Technical specifications.**

Device write status

NAND SSDs have a finite number of spare sectors. If the device exhausts the available spare sectors, the NVMe PCIe SSD enters **Write Protect** (Read-Only) mode. In **Write Protect** mode, you can only perform read operations to the device. The NVMe PCIe SSD self-monitors for these limits, and software management applications notify you when you reach these limits.

Supported operating systems for NVMe PCIe SSD

ⓘ NOTE: **NVMe PCIe SSD hot swap is not supported in VMware ESXi 5.5 or while accessing the BIOS or HII configuration.**

ⓘ NOTE: **For all operating system documents, see Dell.com/operatingsystemmanuals.**

ⓘ NOTE: **NVMe PCIe SSD is not supported as a boot device in Red Hat Enterprise Linux 6, SUSE Linux Enterprise Server 11, Microsoft Windows Server 2008 R2 SP1, Microsoft Windows Server 2012, or VMware.**

Only the following operating systems support the NVMe PCIe SSD devices:

- Microsoft Windows Server 2008 R2 SP1 (x64/EM64T) or later
- Microsoft Windows Server 2012 (x64/EM64T)
- Microsoft Windows Server 2012 R2
- Microsoft Windows Server 2016
- Red Hat Enterprise Linux 6.4 (x64/EM64T) or later
- Red Hat Enterprise Linux 7.0 or later
- SUSE Linux Enterprise Server 11 SP3 or later
- SUSE Linux Enterprise Server 12 or later
- VMware ESXi 5.5
- VMware ESXi 6.0 or later

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Technical specifications

> (i) **NOTE:** The specifications provided are for information purposes only and do not constitute an extension of Dell's warranty for this product.

Table 1. Technical specifications

Features	Description
NAND type	Multi-Level Cell (XS1715, SM1715)
	Triple-Level Cell (PM1725/PM1725a)
Hot swappable	Yes
Embedded data protection enabled	Yes
Device write cache	Yes
Bootable device	Yes (UEFI boot starting on select 13th Generation PowerEdge systems)
Self-monitoring enabled	Yes
Offline data retention	Up to three months after total bytes written reaches 100%
General	
Model	XS1715
	SM1715
	PM1725
	PM1725a
Device protocol	NVMe
NVMe standard	1.0 (XS1715, SM1715)
	1.1 (PM1725)
	1.2 (PM1725a)
Bus protocol	PCIe
Bus protocol version	3.0
Backplane interface	Combo-connector (SFF-8639)

> (i) **NOTE:** For more information on the combo-connector, see http://www.ssdformfactor.org.

Physical Dimensions

Height	69.9 mm
Width	14.8 mm
Length	100.2 mm

Device Capacity

Unformatted capacity	400 GB, 800 GB, 1.6 TB, 3.2 TB, and 6.4 TB
User-addressable sectors	400 GB: 781,422,768 LBAs
	800 GB: 1,562,824,368 LBAs
	1.6 TB: 3,125,627,568 LBAs
	3.2 TB: 6,251,233,968 LBAs
	6.4 TB: 12,502,446,768 LBAs
Bytes per sector	512 Bytes
Rated Write Endurance (TBW) for XS1715 family	400 GB: 5.1 PB (7 DWPD)
	800 GB: 8.3 PB (7 DWPD)
	1.6 TB: 16.7 PB (7 DWPD)
Rated Write Endurance(TBW) for SM1715 family	800 GB: 14.6 PB (10 DWPD)
	1.6 TB: 29.2 PB (10 DWPD)
	3.2 TB: 58.4 PB (10 DWPD)
Rated Write Endurance(TBW) for PM1725 and PM1725a families	800 GB: 7.3 PB (5 DWPD)
	1.6 TB: 14.6 PB (5 DWPD)
	3.2 TB: 29.2 PB (5 DWPD)
	6.4 TB: 58.4 PB (5 DWPD)

Environment

Operating temperature	0 °C to 70 °C
Shock	1500 G/0.5 ms
Vibration	7 Hz to 500 Hz at 3.08 G

Power Requirements

Active power	25 W

Electrical characteristics

Voltage input	3.3 V and 12 V

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Getting started with NVMe PCIe SSD

The NVMe PCIe SSD 2.5 inch SFF devices you ordered with your system are preconfigured and ready for use. For more information, see Configuring NVMe PCIe SSD 2.5 inch SFF in different operating systems, or see Configuring and managing your NVMe PCIe SSD 2.5 inch SFF device.

Topics:

- Configuring NVMe PCIe SSD 2.5 inch SFF in different operating systems
- Servicing your NVMe PCIe SSD 2.5 inch SFF device

Configuring NVMe PCIe SSD 2.5 inch SFF in different operating systems

In Windows-based systems, the NVMe PCIe SSDs have a controller entity and a device entity. The controller entity is displayed under the **Storage** controller menu in the **Device Manager**.

(i) **NOTE: When configured in the Dell S140 RAID volumes, separate device entries will not be shown. For more information, see Dell S140 documentation at Dell.com/support/manuals.**

Use the controller entity when installing or updating the NVMe PCIe SSD driver. You can configure the NVMe PCIe SSD for use on Windows from **Computer Management** > **Storage** > **Disk Management Tool**.

On Linux based systems, you can configure the NVMe PCIe SSD from the partitioning tool by specifying or selecting the device name. The device name for NVMe PCIe SSDs is **/dev/nvmeXn1**, where X is the number corresponding to each NVMe PCIe SSD in the system (for example: **/dev/nvme0n1; /dev/nvme1n1; /dev/nvme2n1** and so on).

Use OpenManage Server Administrator for managing and performing NVMe PCIe SSD related tasks. For more information, see Configuring and managing your NVMe PCIe SSD 2.5 inch SFF device.

In VMware systems, you can configure the NVMe PCIe SSD as datastore or for a passthrough operation. You can use vSphere Client to configure the NVMe PCIe SSD. Configuring PCIe devices as passthrough is not recommended due to the following limitations:

- You are not able to take snapshots of the Virtual Machine (VM).
- Your VM is no longer able to use fail over features such as VMotion and Distributed Resources Scheduler (DRS).
- You are not able to hot add any other device to the VM such as a USB key. To add an additional device, first shut down the VM.

Configuring NVMe PCIe SSD as passthrough is not recommended outside of Dell-specific solutions. See the solution-specific documentation at **Dell.com/support/manuals**.

Servicing your NVMe PCIe SSD 2.5 inch SFF device

If you need to remove or replace your NVMe PCIe SSD 2.5 inch SFF device, you can remove the device from a system that is operational through an orderly removal process. This operation is only supported on Windows and Linux-based systems. See Supported operating systems for NVMe PCIe SSD .

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ⓘ **NOTE: Do not insert or remove an NVMe PCIe SSD while accessing the system BIOS or HII configuration.**

To remove your NVMe PCIe SSD 2.5 inch SFF from a running system, use the **Prepare to Remove** task in OpenManage Server Administrator. You can safely remove the device from the system under the following conditions after you use the **Prepare to Remove** task:

· The NVMe PCIe SSD LED blinks in a pattern that indicates that the device is preparing for removal.
· The NVMe PCIe SSD is no longer accessible by the system.

For more information, see Running physical device tasks.

You can also remove or replace your NVMe PCIe SSD while the system is offline.

Replacing and configuring hardware

⚠ **CAUTION: All work must be performed at an electrostatic discharge (ESD) safe workstation to meet the EIA-625-requirements for handling electrostatic discharge sensitive devices. All actions must be performed following the latest revisions of the IPC-A-610 ESD recommended practices.**

⚠ **CAUTION: Many repairs may only be done by a certified service technician. You should only perform troubleshooting and simple repairs as authorized in your product documentation, or as directed by the online or telephone service and support team. Damage due to servicing that is not authorized by Dell is not covered by your warranty. Read and follow the safety instructions that came with the product.**

ⓘ **NOTE: For complete information on U.S. Terms and Conditions of Sale, Limited Warranties and Returns, Export Regulations, Software License Agreement, safety, Environmental and Ergonomic Instructions, Regulatory Notices, and Recycling Information, see the Safety, Environmental and Regulatory Information, End User License Agreement, and Warranty and Support Information that shipped with your system.**

All PowerEdge Express Flash Non-Volatile Memory Express (NVMe) Peripheral Component Interconnect Express (PCIe) Solid-State Devices (SSDs) connect to the system board through the 2.5 inch SFF NVMe capable backplanes. The NVMe PCIe SSD backplane is mounted on the front chassis assembly of the system. NVMe PCIe SSDs are supplied in hot swappable device carriers that are compatible with the PCIe SSD bays.

⚠ **CAUTION: Before removing or installing an NVMe PCIe SSD from a system that is turned on, see Preparing to remove an NVMe PCIe SSD.**

ⓘ **NOTE: For information on removing and installing system components, see the system-specific Owner's Manual at Dell.com/support/manuals.**

Topics:

- Removing NVMe PCIe SSD from system
- Installing NVMe PCIe SSD in system

Removing NVMe PCIe SSD from system

If you are removing an NVMe PCIe SSD from a system that is turned on, proceed to step 1. If not, skip to step 2.

⚠ **CAUTION: To prevent data loss, it is mandatory that you prepare the NVMe PCIe SSD for removal before physically removing the NVMe PCIe SSD.**

1   Use the **Prepare to Remove** task in OpenManage Server Administrator to safely remove an NVMe PCIe SSD from the system.
    See Preparing to remove an NVMe PCIe SSD.

    This task causes the status LED on the NVMe PCIe SSD to blink.

    ⚠ **CAUTION: The NVMe PCIe SSD LED blinks in a pattern that indicates that the device is preparing for removal. When you initiate a prepare to remove operation, ensure that your NVMe PCIe SSD is no longer accessible by the system before you physically remove the NVMe PCIe SSD.**

    You can safely remove the NVMe PCIe SSD from the system under the following conditions after you use the **Prepare to Remove** task:

- The NVMe PCIe SSD LED blinks in a pattern that indicates that the device is preparing for removal. For more information, see NVMe PCIe SSD Carrier LED indicators.
- The NVMe PCIe SSD is no longer accessible by the operating system.

2 Press the release button and open the NVMe PCIe SSD carrier release handle to release the NVMe PCIe SSD.

3 Slide the NVMe PCIe SSD out of the slot.

> ⓘ NOTE: To maintain proper system cooling, all empty NVMe PCIe SSD bays must have device blanks installed. For instructions on how to install an NVMe PCIe SSD blank, see the system-specific Owner's Manual at Dell.com/support/manuals.
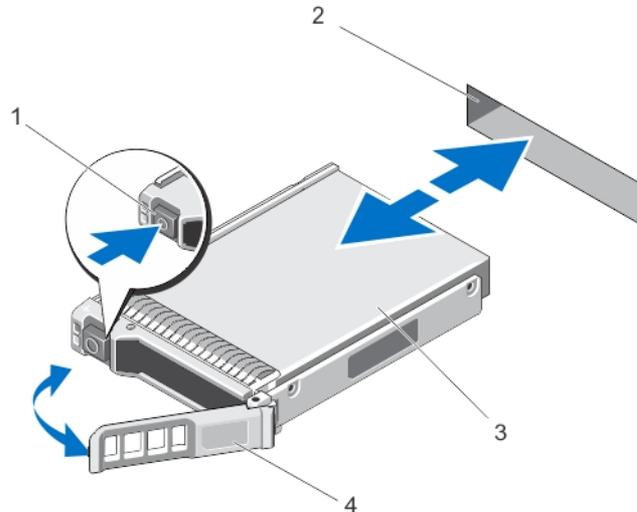
Figure 1. Removing and Installing NVMe PCIe SSD From/Into System

| 1 | release button | 2 | NVMe PCIe SSD slot |
| 3 | NVMe PCIe SSD | 4 | NVMe PCIe SSD carrier handle |

Installing NVMe PCIe SSD in system

> ⚠ WARNING: Inserting an NVMe PCIe SSD carrier and attempting to lock its lever next to a partially installed carrier can damage the partially installed carrier's shield spring, making it unusable.

When installing an NVMe PCIe SSD, ensure that the adjacent devices are installed.

1 Press the release button, and open the handle.

2 Slide the NVMe PCIe SSD carrier into the NVMe PCIe SSD bay until the carrier contacts the backplane.

3 Close the NVMe PCIe SSD carrier handle to lock the device in place.

> ⓘ NOTE: Do not insert or remove an NVMe PCIe SSD while accessing the system BIOS or HII configuration.

Driver installation

For the current list of operating systems supported by NVMe PCIe SSD, see Supported operating systems for NVMe PCIe SSD .

Topics:

- Downloading NVMe PCIe SSD drivers
- Installing or upgrading NVMe PCIe SSD driver for Microsoft Windows Server 2008 R2 SP1, 2012, 2012 R2, and 2016
- Installing or upgrading NVMe PCIe SSD 2.5 inch SFF driver for Red Hat Enterprise Linux or SUSE Linux Enterprise Server
- Installing or upgrading NVMe PCIe SSD driver for VMware
- Booting from NVMe PCIe SSD

Downloading NVMe PCIe SSD drivers

To download NVMe PCIe SSD drivers:

1 Go to **Dell.com/support**.
2 Specify a Service Tag or express service code in the **Enter a Service Tag or Express Service Code** field or in the **Browse for a product** option click the **View products** drop-down.
3 Select **Servers, Storage, & Networking**.
4 Select **PowerEdge**.
5 Select your system.
   The drivers that are applicable to your selection are displayed.
6 Select **Drivers and Downloads**.
7 Select **Solid State Storage**.
   The NVMe PCIe SSD drivers that are applicable to your system are displayed.
   From the available list, download the latest NVMe PCIe SSD drivers to a USB drive, CD, or DVD.

Installing or upgrading NVMe PCIe SSD driver for Microsoft Windows Server 2008 R2 SP1, 2012, 2012 R2, and 2016

ⓘ **NOTE: For a complete list of supported operating systems, see Supported operating systems for NVMe PCIe SSD .**

ⓘ **NOTE: Use the procedures in this section to install or upgrade the driver for Windows. The driver is updated frequently. To ensure that you have the current version of the driver, download the latest Windows driver from Dell.com/support. For more information, see Downloading NVMe PCIe SSD drivers.**

ⓘ **NOTE: Close all applications on your system before you update the driver.**

ⓘ **NOTE: Windows Server 2012 R2 contains an in-box NVMe driver; however Dell requires updating to the latest driver to ensure full Express Flash NVMe PCIe SSD support.**

ⓘ **NOTE: Windows Server 2016 contains an in-box NVMe driver fully supported by Dell. However, we still recommend you to check Dell.com/support for the latest driver updates.**

To install or upgrade the NVMe PCIe SSD driver for Windows Server using Dell Update Package (DUP):

1   Insert the media containing the latest driver that you downloaded from **Dell.com/support/drivers**.
2   Double-click the executable and follow the on-screen instructions to install the NVMe PCIe SSD driver using DUP.

ⓘ **NOTE: Dell provides the DUP to update drivers on systems running 2008 R2 SP1, Windows Server 2012, Windows Server 2012 R2, and Windows Server 2016 operating systems. DUP is an executable application that updates drivers for specific devices. DUP supports command line interface and silent execution. For more information, see the driver release notes at Dell.com/support/drivers .**

When DUPs are not used to upgrade the driver, follow the instructions below:

1   Insert the media containing the latest driver that you downloaded in Downloading NVMe PCIe SSD drivers.
2   Click **Start** > **Control Panel** > **System and Security**.
3   Select **Device Manager** under the **System** option.
    The **Device Manager** screen is displayed.
4   Double-click the entry to expand the **Storage** controllers. Alternatively, you can click the plus symbol next to the **Storage** controllers.
    For example, a 3.2 TB NVMe PCIe SSD device is displayed as `Dell Express Flash NVMe PM1725 3.2TB`.

    ⓘ **NOTE: If there is no NVMe PCIe SSD driver installed, the NVMe PCIe device is listed under the Other devices option. In this case, the NVMe PCIe device is displayed as PCIe device.**
5   Double-click the NVMe PCIe device for which you want to install or update the driver.
6   Click the **Driver** tab, and click **Update Driver**.
    The **Update Device Driver** screen is displayed.
7   Select **Browse my computer for driver software**.
8   Select **Let me pick from a list of device drivers on my computer**.
9   Select **Have Disk**.
10 Follow the steps in the wizard, and browse to the location of the driver files.
11 Select the **INF** file from the driver media.
12 Click **OK** to exit the wizard.
13 Click **Next**.

    ⓘ **NOTE: If there is more than one NVMe PCIe SSD in the system, repeat steps 4–13 for all remaining devices in the system.**
14 Restart the system for the changes to take effect.

    ⓘ **NOTE: Dell does not recommend loading the drivers from Windows Server 2012 R2 or other older Windows versions in Windows Server 2016.**

Installing or upgrading NVMe PCIe SSD 2.5 inch SFF driver for Red Hat Enterprise Linux or SUSE Linux Enterprise Server

ⓘ **NOTE: For a complete list of supported operating systems, see Supported operating systems for NVMe PCIe SSD .**

ⓘ **NOTE: Use the procedures in this section to install or upgrade the driver for Linux. The driver is updated frequently. To ensure that you have the current version of the driver, download the latest Linux driver from Dell.com/support. For more information, see Downloading NVMe PCIe SSD drivers.**

ⓘ **NOTE: Starting with RHEL 7.2 and SLES 12 SP1, there is a fully supported in-box driver. Earlier operating systems that may have an in-box driver are not supported. Dell recommends that you download the latest drivers from Dell.com/support.**

SUSE Linux Enterprise Server 11 and 12 drivers are provided in the Kernel Module Package (KMP) format while Red Hat Enterprise Linux 6 drivers are provided in the Kernel Module Loader (KMOD) format. KMODs are Red Hat Packet Manager (RPM)s and are driver packaging methods that contain kernel modules, instituted to better handle kernel update situations. To install or update the NVMe PCIe SSD driver:

1   For SLES, download the SUSE GPG Public key from the SUSE website and import by using the command `#rpm –import <GPG public key>`.

2   Uncompress the zipped tarball driver release package.

3   Install the driver package using the command: `rpm -ihv < driver rpm package name >.rpm`

> ⓘ **NOTE: Use `rpm -Uvh <package name>` when updating an existing package.**

4   Restart the system for the driver update to take effect.

5   After the system restarts, verify that the driver has been installed with the system command: `# modinfo nvme`

   The version shown in the output must match with the version of the package.

6   Verify that the driver has been loaded with the system command:`# lsmod | grep nvme` or `# cat /proc/modules | grep nvme`

   These commands return`nvme` if the driver is loaded.

   The NVMe PCIe SSDs are ready for use. See Configuring NVMe PCIe SSD 2.5 inch SFF in different operating systems.

Installing or upgrading NVMe PCIe SSD driver for VMware

ⓘ **NOTE: For a complete list of supported operating systems, see Supported operating systems for NVMe PCIe SSD .**

ⓘ **NOTE: Use the procedures in this section to install or upgrade the driver for VMware ESXi 5.5. To ensure that you have the current version of the driver, download the latest VMware ESXi 5.5 driver from Dell.com/support. For more information, see Downloading NVMe PCIe SSD drivers.**

ⓘ **NOTE: VMware ESXi 5.5 U3 and later contains an in-box driver. Dell recommends that you to go to VMware's download site for the latest NVMe driver and follow the documentation provided there for installation instructions.**

1   Transfer the NVMe PCIe SSD driver to the ESXi host using either vSphere Client Browse Datastore or an SFTP/FTP/SCP client.

   Using the vSphere Client:

   a   Navigate to the configuration.
   b   Select **Storage** from the hardware section.
   c   Right-click **Datastore**, and then select **Browse**.
   d   Upload the PCIe SSD driver to the datastore.

   Using an SFTP/FTP/SCP client:

   a   Launch the SFTP/FTP/SCP program.
   b   Extract the driver files from the *.zip file.
   c   Copy the PCIe SSD driver file to a local folder on the host.

2   Power off all VMs running inside the ESXi host operating system.

3   Enable the ESXi shell service.

   Using the vSphere client:

   a   Navigate to the Configuration tab of the host IP.
   b   Click **Software** > **Security Profile**.
   c   Click **Services** > **ESXi Shell** > **Properties**.
   d   Start the ESXi shell service.

   Directly from the host settings:

   a   Press <F2> to customize system settings.

  b Enter your user name and password.

  c Navigate to the troubleshooting options.

  d Enable the ESXi shell.

  e Enable SSH.

4 Install the NVMe PCIe SSD driver on the ESXi host.

  a Navigate to the datastore volume or file directory that contains the NVMe PCIe SSD driver, and run the following command: `esxcli software vib install /<complete_path_to_offline_driver>`.

  b Reboot the ESXi host.

5 Ensure that the driver has been correctly installed by running the following command: `esxcli software vib list | grep nvme`.

6 Using vSphere, place the ESXi host in maintenance mode and reboot the host.

7 Once the host reboots and is running, take the host out of maintenance mode.

Booting from NVMe PCIe SSD

Dell supports installation to Express Flash NVMe PCIe SSDs on select PowerEdge platforms that have been configured for UEFI BIOS boot mode. To determine whether or not NVMe PCIe SSDs may be used as a boot device on your system, see the system-specific Owner's Manual at **Dell.com/support/manuals**. OS installation to the NVMe PCIe SSD is only supported on the following Operating Systems:

· Windows Server 2012 R2 or later

· RHEL 7.0 or later

· SLES 12 or later

Installing Windows Server 2012 R2 on NVMe PCIe SSD

1 Ensure that the system BIOS is in UEFI boot mode.

2 Insert and boot to the installation media and launch the installation wizard.

3 Follow the instructions until you are asked where you want to install Windows Server 2012 R2, and then select the load driver option.

4 When the system prompts you, insert the driver media, or browse to the location at which the driver media data is stored.

5 Select the driver file, and then select the **Dell Express Flash** controller.

6 Click **Next**, and then complete the installation.

> ⓘ | NOTE: **The Windows Server 2016 does not require an updated driver to support booting from NVMe PCIe SSD.**

Installing RHEL 7.0 or later on the NVMe PCIe SSD

1 Extract and create the driver disk image on separate media such as a USB device, and install the media on the system.

2 Ensure that the system BIOS is in UEFI boot mode.

3 Insert and boot to the installation media and launch the installation wizard.

4 From the grub menu, append the `dd` parameter to the end of the kernel command line to prompt for a driver disk image during the OS installation process.

5 Follow the installation wizard to the conclusion of the installation process.

Installing SLES 12 or later on the NVMe PCIe SSD

1 Extract and create the driver disk image on separate media such as a USB device, and install the media on the system.

2 Ensure that the system BIOS is in UEFI boot mode.

3   Insert the media and launch the installation wizard.

4   Follow the installation wizard to the conclusion of the installation process.

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Configuring and managing your NVMe PCIe SSD 2.5 inch SFF device

The storage management applications enable you to manage and configure the NVMe PCIe SSD 2.5 inch SFF device. These applications also allow you to control and monitor multiple NVMe PCIe SSDs, and provide online maintenance.

The NVMe PCIe SSD solution supports Unified Extensible Firmware Interface (UEFI) and Human Interface Infrastructure (HII) for pre-operating system device management, OpenManage Server Administrator (OMSA) application for operating system device management, and Integrated Dell Remote Access Controller (iDRAC) with Lifecycle Controller for local or remote device management. The NVMe PCIe SSD solution supports UEFI, HII and iDRAC with Lifecycle Controller management on select PowerEdge systems only. OMSA for NVMe PCIe SSD device management is available on all supported PowerEdge systems.

ⓘ **NOTE: For more information about iDRAC/LC remote management, check your platform Owner's Manual.**

Topics:

- OpenManage Server Administrator
- Human Interface Infrastructure configuration utility

OpenManage Server Administrator

The OpenManage Server Administrator is a storage management application that provides features for managing components of the NVMe PCIe SSD solution on supported operating systems. The OpenManage Server Administrator application enables you to perform the NVMe PCIe SSD functions from a single graphical or command-line interface. For more information, see the OpenManage Server Administrator online help accessible from the application.

All storage management features for the NVMe PCIe SSD solution are accessible by selecting the **Storage** object, and then the **PCIe SSD Subsystem** in the **Server Administrator** tree view.

Storage information

To access **Storage Information**:

1. Expand the **Storage** tree object to display the storage component objects.
2. Expand the **PCIe SSD Subsystem** tree object.
   The **Storage Information** window is displayed under **Information/Configuration**.
3. To make changes to the Storage Information properties, click **Properties**.

Configure and manage NVMe PCIe SSD 2.5 inch SFF

Use the **Physical Device Properties** screen to view information about NVMe PCIe SSD 2.5 inch SFF and to run a NVMe PCIe SSD 2.5 inch SFF task.

To view the complete set of NVMe PCIe SSD 2.5 inch SFF properties, select **Full View** from the **Options** taskbar. Physical device properties are described below:

Name	Displays the name of the NVMe PCIe SSD. The name comprises the bay ID and the slot ID in which the NVMe PCIe SSD 2.5 inch SFF is installed.
State	Displays the current state of the NVMe PCIe SSD 2.5 inch SFF.
Bus Protocol	Displays the technology that the NVMe PCIe SSD 2.5 inch SFF is using.
Device Name	In Windows: **\\.\PhysicalDriveX**. In Linux: **/dev/nvmeXn1**.
Media	Displays the media type of the physical SSD.
Remaining Rated Write Endurance	Displays the warranted wear out level of the NVMe PCIe SSD (in percentage).
Firmware Revision	Displays the current running firmware version on the NVMe PCIe SSD.
Driver Version	Displays the current running driver version of the NVMe PCIe SSD.
Model Number	Displays the **Piece Part Identification** (PPID) of the NVMe PCIe SSD.
Capacity	Displays the full capacity of the device.
Form Factor	Displays the form factor of the NVMe PCIe SSD installed in the system.
Vendor ID	Displays the hardware vendor of the device.
Product ID	Displays the product ID of the device.
Serial No.	Displays the serial number of the device.
PCIe Negotiated Link Speed	Displays the speed of data transfer that the device negotiated upon initial communication. This speed is dependent on the speed of the device.
PCIe Maximum Link Speed	Displays the highest possible speed at which the device can transfer data.
PCIe Maximum Link Width	Displays the link width of the device.
Form Factor	Displays the form factor of the NVMe PCIe SSD installed in the system.

Running physical device tasks

1   Expand the **Storage** tree object to display the storage component objects.
2   Expand the **PCIe SSD Subsystem** object.
3   Select **Physical Devices**.
4   Select a task from the **Available Tasks** drop-down menu.
5   Click **Execute**.

NVMe PCIe SSD 2.5 inch SFF available tasks

The following are in the NVMe PCIe SSD drop-down menu:

·   Blink
·   Unblink
·   Prepare to Remove
·   Cryptographic Erase

- Export Log

Blink and unblink task for PCIe SSD

The **Blink** task allows you to find a device within a system by blinking the status LED on the device. If you need to cancel the **Blink** task or if the physical device continues to blink indefinitely, use the **Unblink** task.

Performing the blink or the unblink task

To perform the blink or unblink task:

1   Expand the **Storage** tree object to display the storage component objects.
2   Expand the **PCIe SSD Subsystem** object.
3   Expand the **PCIe SSD Extender** object.
4   Expand the **Enclosure (Backplane)** object.
5   Select the **Physical Devices** object.
6   Select the **Blink/Unblink** from the **Available Tasks** drop-down menu.
7   Click **Execute**.

Preparing to remove an NVMe PCIe SSD

⚠ | WARNING: Both the *Identify device* and *Prepare for removal* LED patterns consist of a quick on/off blink of the green LED. When you initiate a prepare to remove operation, ensure that your NVMe PCIe SSD is no longer accessible by the system before you physically remove the NVMe PCIe SSD.

⚠ | CAUTION: To prevent data loss, it is mandatory that you use the Prepare to Remove task before physically removing a device.

Use the **Prepare to Remove** task to safely remove an NVMe PCIe SSD from the system. This task causes the status LEDs on the device to blink. You can safely remove the device from the system under the following conditions after you use the **Prepare to Remove** task:

- The NVMe PCIe SSD LED blinks in a pattern that indicates that the device is preparing for removal. See Table 2. NVMe PCIe SSD 2.5–inch SFF States and LED Indicator Codes.
- The NVMe PCIe SSD is no longer accessible by the system.

To perform the **Prepare to Remove** task:

1   Ensure that there is no I/O traffic running on the PCIe SSD.
    a   On Linux platforms, unmount any file systems mounted on the device.
2   Expand the **Storage** tree object to display the storage component objects.
3   Expand the **PCIe SSD SubSystem** object.
4   Expand the **PCIe SSD Extender** object, if applicable.
5   Expand the **Enclosure (Backplane)** object.
6   Select the **Physical Devices** object.
7   Select the **Prepare To Remove** from the **Available Tasks** drop-down menu task.
8   Click **Execute**.
    The following warning message is displayed:
    `"Warning: Are you sure you want to prepare the physical device for removal?"`
9   Select **Prepare to Remove Physical Device** to proceed or select **Go Back** to previous page to cancel the operation.

Performing cryptographic erase task for NVMe PCIe SSD

⚠️ **CAUTION: Performing a cryptographic erase on an NVMe PCIe SSD results in permanent loss of all data on the NVMe PCIe SSD.**

ⓘ **NOTE: During cryptographic erase, the host is not able to access the NVMe PCIe SSD.**

1 Expand the **Storage** tree object to display the storage component objects.

   a   On Linux platforms, unmount any file systems mounted on the device.

2 Expand the **PCIe SSD Subsystem** object.

3 3. Expand the **PCIe SSD Extender** object, if applicable.

4 4. Expand the **Enclosure (Backplane)** object.

5 5. Select the **Physical Devices** object.

6 Select the **Cryptographic Erase** task from the **Available Tasks** drop-down menu.

7 Click **Execute**.

   The following caution message is displayed:

   ```
   "When you perform the Cryptographic Erase operation, any data on
   the disk will be lost permanently. Are you sure you want to continue?"
   ```

8 Select **Cryptographic Erase** to proceed.

   A pop-up message is displayed: Are you sure you want to perform Cryptographic Erase on this physical device?

9 Click **OK** to proceed, or select **Go Back** to previous page to cancel the operation.

Exporting the log

1 Expand the **Storage** tree object to display the storage components.

2 Expand the **PCIe SSD Subsystem** object.

3 Expand the **PCIe SSD Extender** object, if applicable.

4 Expand the **Enclosure (Backplane)** object

5 Select the **Physical Devices** object

6 Select the **Export Log** task from the **Available Tasks** drop-down menu.

7 Click **Execute**.

8 Note where the log file will be exported.

9 Click **Export Log** and follow the instructions to complete.

Human Interface Infrastructure configuration utility

The Human Interface Infrastructure (HII) configuration utility is a standardized way of viewing and setting a device configuration. The HII configuration utility provides pre-operating system functionality and management for NVMe PCIe SSDs including:

· Viewing physical device properties
· Running physical device operations
· Retrieving debug information

ⓘ **NOTE: HII is only available starting on select Dell 13th generation PowerEdge systems.**

ⓘ **NOTE: Do not insert or remove an NVMe PCIe SSD from the HII configuration utility.**

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Entering the HII configuration utility

To enter the HII configuration utility:

1   Turn on the system.
2   Press F2 during system startup to enter the system setup.
3   Navigate to the **Device Settings** option.
4   Select the desired NVMe PCIe SSD to view its HII configuration page. Each device includes an entry such as: `PCIe SSD in Bay X Slot Y: Dell NVMe PCIe SSD Configuration Data.`

Viewing physical device properties

Follow the steps to view physical device properties:

1   Select **View Physical Device Properties** in the HII configuration utility.
2   Press **Esc** to return to the previous screen.
3   To exit the PCIe SSD HII configuration utility, click **Exit** in the top-right corner of the System Setup menu.

Erasing physical devices

⚠ CAUTION: Performing a cryptographic erase on an NVMe PCIe SSD results in permanent loss of all data on the NVMe PCIe SSD.

ⓘ NOTE: During a cryptographic erase, the host cannot access the NVMe PCIe SSD.

ⓘ NOTE: If the system reboots or experiences a power loss during a cryptographic erase, the operation aborts. Reboot the system and restart the process.

ⓘ NOTE: The cryptographic erase operation takes a few seconds to complete. While this operation is in progress, you cannot navigate away from this page.

To perform a cryptographic erase on an NVMe PCIe SSD from the HII configuration utility, do the following:

1   Navigate to the **Select Physical Device Operations** menu of the HII configuration utility.
2   Select **Cryptographic Erase**.
     The following warning message displays: `Performing a cryptographic erase results in permanent loss of all data on the device. Do you want to continue?`.
     You can select **Yes** or **No**.
3   Press Esc to return to the previous screen.
4   To exit the HII configuration utility, click **Exit** in the top-right corner of the System Setup menu.

Setting LED blinking

The LED blink option allows you to identify a physical device in the system. To start or stop the feature:

1   Navigate to the **Select Physical Device Operations** menu in the HII Configuration Utility.
2   Select the **Blink** option to begin LED blinking, or the **Unblink** option to end LED blinking.
3   Press Esc to return to the previous screen.
4   To exit the HII Configuration Utility, click **Exit** in the top-right corner of the System Setup menu.

Exporting the log

The **Export Log** option exports the NVMe PCIe SSD log to a text file. The log contains debug information of the NVMe PCIe SSD which can be useful while troubleshooting.

(i) **NOTE:** To save the log, you need a writable media with a UEFI-compatible file system attached to the system.

(i) **NOTE:** If there are no application devices inserted into the system when entering the Export Log HII screen, then the only option is to return to the previous page.

To export the NVMe PCIe SSD log from the HII configuration utility, do the following:

1   Navigate to the **Export Log** menu of the HII configuration utility.
2   Select the file system device to which the log will be exported.
3   Select the directory into which you want to save the log.
4   Enter the file name under which you want to save the log in the **File Name** text box.
     For example, NVMe.log.
5   Click **Export** and follow the instructions to complete.
6   To exit the HII configuration utility, click **Exit** in the top-right corner of the System Setup menu.

Exiting the HII configuration utility

(i) **NOTE:** Clicking Exit in any HII page takes you back to the System Setup main menu.

(i) **NOTE:** Press Esc from any HII page to return to the previous page.

To exit the HII configuration utility, click **Exit** in the top-right corner of the System Setup menu.

Troubleshooting

ⓘ **NOTE: To get help for your NVMe PCIe SSD, see Contacting Dell.**

Topics:

- Self-Monitoring Analysis and Reporting Technology errors
- NVMe PCIe SSD Carrier LED indicators
- Ungraceful system shutdown or power loss
- General errors

Self-Monitoring Analysis and Reporting Technology errors

The NVMe PCIe SSD solution is always monitored for errors by its internal software. If an error occurs, it is detected and recorded in an internal log. Based on the criticality of the error, the software may inform the host server that further action is needed. It signifies that the error condition occurred a specific number of times and that the device health needs attention.

NVMe PCIe SSD Carrier LED indicators

The LEDs on the NVMe PCIe SSD 2.5 inch SFF carrier indicate the state of each physical device. Each NVMe PCIe SSD carrier in your enclosure has an activity LED (green) and a status LED (bicolor, green/amber). The activity LED flashes whenever the device is accessed.
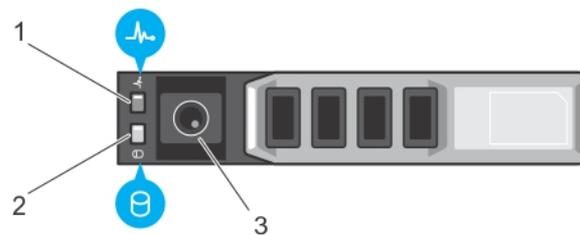
Figure 2. NVMe PCIe SSD Device Carrier LED Indicators

1	status indicator	2	activity indicator
3	release button		

While the operating system is running, the status indicator provides the current status of the device. The following table lists the device states along with the associated LED indicator codes.

Table 2. NVMe PCIe SSD 2.5 inch SFF States and LED Indicator Codes

State Name	Slot/Device State	Status LED (Green)	Status LED (Amber)
Device status off	The server or device is not powered up.	Off	Off
Device online	The device is powered up.	On	Off
Device identify (blink)	The device is identifying the slot location or is indicating the device has received a **Prepare for Removal** command from the host operating system.	On for 250 msec Off for 250 msec	Off
Device failed	The host operating system no longer has access to the device because the device is not responding or has encountered a critical error condition.	Off	On for 250 msec Off for 250 msec
Read only	The device will only service read operations.	Off	On for 250 msec Off for 250 msec
Predicted failure	The SMART feature set has predicted a degradation or fault condition.	Off for 250 msec On for 250 msec	On for 250 msec Off for 250 msec

Ungraceful system shutdown or power loss

If the host system experiences a power loss, the NVMe PCIe SSD may not have time to perform its internal shut down procedure. In such an event, the device may enter a recovery mode.

This recovery process is also known as rebuilding. During rebuilding, there is very limited access from the host operating system. After the recovery procedure is complete, the device is fully accessible from the host operating system.

ⓘ **NOTE: Dell recommends that you use power backup solutions for all Dell systems.**

General errors

The following section describes general errors related to NVMe PCIe SSD.

NVMe PCIe SSD description is truncated

Description	In Windows 2012 R2 , the device description is truncated from the **Device Manager** > **Disk Drives** view. For example, you see **NVMe Dell Express Flash** or **NVMe Dell Express Fla SCSI Disk Device** instead of **NVMe Dell Express Flash SCSI Disk Device**.
Cause	In Windows 2012 R2 , there is a new flag `STOR_FEATURE_DEVICE_NAME_NO_SUFFIX` that removes the `suffix` in the device friendly name. This is only seen in Windows 2012 R2 and this flag is enabled by design of the Windows 2012 R2 in-box driver. The Dell-provided NVMe driver uses the correct flag, but you may see the device name truncated intermittently.
Solution	This is a known issue and the message can be ignored.

Software RAID array created by using PCIe SSDs is not detected after SLES 11 is rebooted

Cause   The **boot.md** service is not started during RAID creation. The **boot.md** service must be enabled for the init process to start the MD-RAID device.

Solution   Run the command `# chkconfig boot.md` to verify if the **boot.md** service is on or off. This command should start the **boot.md** service. If it does not, run the command`# chkconfig boot.md` on to enable it.

NVMe PCIe SSD is not listed in the operating system

Cause   Hardware is not correctly installed.

Solution   Check the following components:

- **Devices**: Ensure that the NVMe PCIe SSDs are installed in an NVMe PCIe SSD backplane.

  > ⚠ **CAUTION: NVMe PCIe SSDs must be used with NVMe PCIe SSD backplanes. To ensure that you have the correct configuration for the NVMe PCIe SSD, see the platform-specific Owner's Manual at Dell.com/support/manuals.**

- **Backplane**: Ensure that the cables for the NVMe PCIe SSD backplane are connected correctly.**Cables**: PCIe cables are unique for the configuration. Ensure that the backplane cable connectors are connected to the backplane and the extender card or system board cable connectors are connected to the extender card. See Replacing and configuring hardware.
- **Extender card**: Ensure that the PCIe extender card, if used in your server configuration, is plugged into the correct supported slot. See the system specific Owner's Manual at **Dell.com/support/manuals**.

NVMe PCIe SSD is not displayed in device management in operating system

Cause   The device driver is not installed.

Solution   For more information, see *Driver Installation* section in this manual.

Cannot update firmware by using Dell Update Package (DUP)

Cause   The supported device driver for the operating system available on your system, is not installed or loaded.

Solution   Before you update the device firmware using DUP, ensure that the required device driver for the operating system available on your system is installed. For more information, see the Driver Installation section.

Linux fails to boot and prompts for the root password

Cause   A stale volume mount point is still present after a device removal or cryptographic erase.

Solution	Perform the following steps to recover from this situation:

1   Enter the root password to enter maintenance mode.

2   Remount the root filesystem as read-write using the following command: `mount -orw,remount/`.

3   Manually edit **/etc/fstab** to remove the nonexistent device entry.

I/O device error on write to NVMe PCIe SSD

Description

Windows event log may report the following entries on the first write attempt to an NVMe PCIe SSD: `Event ID 7: The device, \Device\Harddisk\DRX, has a bad block.`

When attempting to initialize the device using **Computer Management** > **Storage** > **Disk Management**, the following message is displayed: `Virtual Disk Manager, Data Error (cyclic redundancy check).`

Linux messages log may report the following entries on a write attempt to an NVMe PCIe SSD:

· `Buffer I/O error on device nvmeXn1, logical block Y (where X is the number corresponding to the device and Y is the logical block)`

· `nvmeXn1: unable to read partition table (where X is the number corresponding to the device)`

Cause

NVMe PCIe SSDs have a finite number of write cycles. When an NVMe PCIe SSD exhausts the number of writes, it goes into **Write Protect** (Read Only) mode.

Solution

By using system management applications, you may check the NVMe PCIe SSD state to confirm if the NVMe PCIe SSD is in **Read-Only Mode**. For further instructions, contact a Dell Technical Service representative.

NVMe PCIe SSD performance measurement not optimal

Description

There are a number of factors that may alter the performance of an NVMe PCIe SSD. Dell recommends to take basic setup measures to ensure performance optimization of these devices.

Cause

NVMe PCIe SSD has not been preconditioned and/or BIOS settings are not optimal.

Solution

· Without preconditioning the NVMe PCIe SSD, performance measurements can be misleading as they may not reflect long-term performance of the device. Preconditioning enables flash management, which stabilizes data throughput over a period. For the Solid-State Storage Performance Test Specification, see **snia.org**.

· Configure the server for low latency performance. To achieve maximum performance with NVMe PCIe SSDs, change the server performance profile in the BIOS settings to **Performance**.

In Windows Server, OpenManage Server Administrator does not detect PCIe NVMe devices

In Windows Server 2012 R2

Description	Windows Server 2012 R2 contains an in-box NVMe driver that is not supported by OpenManage Server Administrator.
Cause	The operating system is using the in-box NVMe driver.
Solution	Install the latest NVMe driver available on **Dell.com/support**.

In Windows Server 2016

Description	Windows Server 2016 contains an in-box NVMe driver that is supported by OpenManage Server Administrator.
Cause	The operating system is not using the in-box or required NVMe driver.
Solution	Remove any NVMe drivers that is not specifically released for the Windows Server 2016.

Windows event ID 11 error reported in Windows event log

Description	Event ID 11 Error is reported in the Windows event log during each system boot.
Cause	This issue exists in the in-box Windows NVMe driver.
Solution	Install the latest NVMe driver available on **Dell.com/support**.

System becomes unresponsive when NVMe PCIe SSD is surprise removed

Description	System becomes unresponsive when the device is removed without first preparing the device for removal.
Cause	Surprise Removal is not supported in PowerEdge servers for NVMe PCIe SSD.
Solution	Execute the Prepare For Removal operation for the specific NVMe PCIe SSD from a Dell Management application. For more information, see Hot swap.

System becomes unresponsive or crashes when NVMe PCIe SSD is inserted

Description	System becomes unresponsive or crashes with inserting an NVMe PCIe SSD while accessing the system BIOS or HII configuration utilities.
Cause	Hot insertion is not supported in pre-operating system's system configuration utilities.

Solution   Insert only after allowing the operating system to fully load or when the server is powered off.

NVMe PCIe SSD is not seen after inserting in VMware ESXi 5.5

Description   Operating System will not detect the hot inserted device.

Cause   Hot Insertion is not supported in VMWare ESXi 5.5.

Solution   Reboot the host system after inserting the drive.

System is unable to inventory or manage NVMe PCIe SSDs from HII utility

Description   NVMe PCIe SSDs are not discovered in the HII utility.

Cause   HII support for NVMe PCIe SSDs was added on select 13th generation PowerEdge systems. There is no pre-OS management for NVMe PCIe SSDs in previous PowerEdge servers.

Solution   Use Dell's OpenManage Server Administrator to manage your NVMe PCIe SSD.

Getting help

Locating your system Service Tag

Your system is identified by a unique Express Service Code and Service Tag number. The Express Service Code and Service Tag are found on the front of a physical DR Series system by pulling out the information tag. The service tag can also be found on the Support page in the GUI. This information is used to route support calls to the appropriate personnel for resolution.

Contacting Dell

Dell provides several online and telephone based support and service options. If you do not have an active internet connection, you can find contact information about your purchase invoice, packing slip, bill, or Dell product catalog. Availability varies by country and product, and some services may not be available in your area. To contact Dell for sales, technical assistance, or customer service issues:

1   Go to Dell.com/support.
2   Select your country from the drop-down menu on the lower right corner of the page.
3   For customized support:
    a   Enter your system Service Tag in the **Enter your Service Tag** field.
    b   Click **Submit**.
        The support page that lists the various support categories is displayed.
4   For general support:
    a   Select your product category.
    b   Select your product segment.
    c   Select your product.
        The support page that lists the various support categories is displayed.
5   For contact details of Dell Global Technical Support:
    a   Click Global Technical Support.
    b   The **Contact Technical Support** page is displayed with details to call, chat, or e-mail the Dell Global Technical Support team.

Documentation matrix

The documentation matrix provides information on documents that you can refer to for setting up and managing your system.

Table 3. Documentation matrix

To...	See the...
Install your system into a rack	Rack documentation included with your rack solution
Set up your system and know the system technical specifications	*Getting Started With Your System* that shipped with your system or see **Dell.com/poweredgemanuals**
Install the operating system	Operating system documentation at **Dell.com/operatingsystemmanuals**
Get an overview of the Dell Systems Management offerings	*Dell OpenManage Systems Management Overview Guide* at **Dell.com/openmanagemanuals** > **OpenManage software**

To...	See the...
Configure and log in to iDRAC, set up managed and management system, know the iDRAC features, and troubleshoot by using iDRAC	*Integrated Dell Remote Access Controller User's Guide* at **Dell.com/idracmanuals**
Know about the RACADM subcommands and supported RACADM interfaces	*RACADM Command Line Reference Guide* for iDRAC at **Dell.com/idracmanuals**
Launch, enable, and disable Dell Lifecycle Controller, know the features, use and troubleshoot Dell Lifecycle Controller	*Dell Lifecycle Controller User's Guide* at **Dell.com/idracmanuals**
Use Dell Lifecycle Controller Remote Services	*Dell Lifecycle Controller Remote Services Quick Start Guide* at **Dell.com/idracmanuals**
Set up, use, and troubleshoot OpenManage Server Administrator	*Dell OpenManage Server Administrator User's Guide* at **Dell.com/openmanagemanuals** > **OpenManage Server Administrator**
Install, use, and troubleshoot OpenManage Essentials	*Dell OpenManage Essentials User's Guide* at **Dell.com/openmanagemanuals** > **OpenManage Essentials**
Know the features of the storage controller cards, deploy the cards, and manage the storage subsystem	Storage controller documentation at **Dell.com/storagecontrollermanuals**
Check the event and error messages generated by the system firmware and agents that monitor system components	*Dell Event and Error Messages Reference Guide* at **Dell.com/openmanagemanuals** > **OpenManage software**

Documentation feedback

Click the **Feedback** link in any of the Dell documentation pages, fill out the form, and click **Submit** to send your feedback.