

Oracle® 6.4 TB NVMe SSD User Guide

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Using This Documentation

- **Overview** – Provides specifications and describes how to install, administer, and service the Oracle 6.4 TB NVMe SSD.
- **Audience** – Trained technicians and authorized service personnel who have been instructed on the hazards within the equipment and qualified to remove and replace hardware.
- **Required knowledge** – Advanced experience troubleshooting and replacing hardware.

Product Documentation Library

Documentation and resources for this product and related products are available at: <https://www.oracle.com/goto/oraclevflashf640/docs>

Feedback

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Product Overview

This section describes the specifications and capabilities of Oracle 6.4 TB NVMe SSD.

Review the following product information sections before you install or service your Oracle 6.4 TB NVMe storage drive.

Description	Links
Learn about Oracle 6.4 TB NVMe SSD features and functions.	“Oracle 6.4 TB NVMe SSD Overview” on page 11
Review specifications and capabilities.	“Specifications” on page 17

Note - To install the Oracle 6.4 TB NVMe SSD in a specific server, refer to your server documentation. For information about restrictions and use of Oracle 6.4 TB NVMe SSDs on your server, see the most recent version of the server product notes.

Oracle 6.4 TB NVMe SSD Overview

These topics provide an overview of Oracle 6.4 TB NVMe SSD features and functions:

- [“About Oracle 6.4 TB NVMe SSDs” on page 12](#)
- [“Key Features” on page 13](#)
- [“Characteristics” on page 13](#)
- [“Status Indicators” on page 15](#)
- [“About Oracle PCIe NVMe Switch Cards and Oracle 6.4 TB NVMe SSDs” on page 16](#)

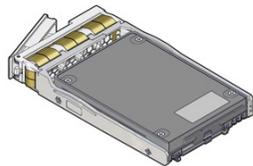
About Oracle 6.4 TB NVMe SSDs

Oracle 6.4 TB NVMe SSDs offer high performance with low latency and a low processor (CPU) burden. The Oracle 6.4 TB NVMe SSD is a PCIe Gen3 storage drive that is designed with the high-performance controller interface – NVMe (Non-Volatile Memory Express), delivering leading performance, low latency, and high quality of service.

Oracle 6.4 TB NVMe SSD is designed with advanced enterprise multi-level cell NAND (TLC 3D NAND) technology for high-level performance and write durability. With PCIe Gen3 support and NVMe queuing interface, Oracle 6.4 TB NVMe SSD delivers sequential read speeds of up to 3.28 GB/s IOPS (input/output operations per second) for 128KB Block Size, QD256 and sequential write speeds of up to 2.15 GB/s IOPS for 128KB Block Size, QD256. This product also delivers random read speeds of up to 694,564 IOPS for 4KB Block Size, QD256 and random write speeds of up to 216,021 IOPS for 4KB Block Size, QD256. Taking advantage of the direct path from the storage to the CPU by means of NVMe, Oracle 6.4 TB NVMe SSD exhibits low average read latency of 7 μ sec and write latency of less than 18 μ s for sequential access to the SSD.

Oracle 6.4 TB NVMe SSD is a block storage device, with block sizing optimization capabilities. You can use the NVMe SSD for either nonpersistent or persistent data.

The following illustration shows an Oracle 6.4 TB NVMe SSD.



Related Information

- [“Key Features” on page 13](#)
- [“Characteristics” on page 13](#)
- [“Status Indicators” on page 15](#)
- [“About Oracle PCIe NVMe Switch Cards and Oracle 6.4 TB NVMe SSDs” on page 16](#)
- [“Specifications” on page 17](#)

Key Features

Oracle 6.4 TB NVMe SSD has the following key features.

Key Feature	Description
Consistently high IOPS and throughput	<ul style="list-style-type: none"> ■ Sequential read speeds of up to 3.28 GB/s IOPS for 128KB Block Size, QD256 ■ Sequential write speeds of up to 2.15 IOPS for 128KB Block Size, QD256 ■ Random read speeds of up to 694,564 GB/s IOPS for 4KB Block Size, QD256 ■ Random write speeds of up to 216,021 IOPS for 4KB Block Size, QD256
Sustained low latency	<ul style="list-style-type: none"> ■ Offers high-performance with low latency and a low CPU burden. ■ Less than 18 µsec for sequential access to the SSD.
High Endurance Technology (HET)	<ul style="list-style-type: none"> ■ Includes HET NAND silicon enhancements. ■ Includes SSD NAND management techniques to extend SSD write endurance up to 5 drive writes per day for five years.
End-to-end data-path protection	Includes multiple levels of data-path protection.
Enhanced power-loss data protection	Energy storage components complete buffered writes to the persistent flash storage in case of a sudden power loss.
Power loss protection capacitor self-test	Supports testing of the power loss capacitor. Power is monitored using SMART (Self-Monitoring, Analysis, and Reporting Technology) attribute critical warning.
Out-of-band management	Managed through the SMBUS.
Thermal monitoring and throttling	Provides continuous full bandwidth performance with flash memory module temperatures up to 73°C.

Related Information

- [“About Oracle 6.4 TB NVMe SSDs” on page 12](#)
- [“Characteristics” on page 13](#)
- [“Status Indicators” on page 15](#)
- [“About Oracle PCIe NVMe Switch Cards and Oracle 6.4 TB NVMe SSDs” on page 16](#)
- [“Specifications” on page 17](#)

Characteristics

Oracle 6.4 TB NVMe SSD has the following hardware and software characteristics.

Characteristic	Value
Device name	<ul style="list-style-type: none"> ■ 7335940 ■ ICDPC2DD2ORA6.4T
Manufacturing name	<ul style="list-style-type: none"> ■ 6.4 TB TLC 3D NAND Flash NVMe SFF ■ SSDPE2ME064T4S
Style	Small form factor (SFF) SSD SFF-8639-compatible connector 2.5-inch Form Factor, 15mm Z-height 3.5-inch Form Factor (Oracle Server X7-2L)
Capacity	6.4 TB
NAND	Advanced enterprise multi-level cell NAND (TLC 3D NAND) technology for high-level performance and write durability
Flash controller	ASIC 1 Intel Flash Memory NVMe Controller
Flash controller firmware	Intel custom and proprietary PCIe to NAND flash controller
Minimum operating system versions	<ul style="list-style-type: none"> ■ Oracle Linux 7.3[†] ■ Oracle Linux 6.9[‡] ■ Oracle VM 3.4.4 ■ Oracle Solaris 11.3 SRU 23 ■ Windows Server 2016 ■ Windows Server 2012 R2 ■ VMware ESXi 6.5 Update 1
Hardware, firmware, and software compatibility	Refer to “Supported Hardware and Software” in <i>Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes</i> .
Life monitoring capability	<ul style="list-style-type: none"> ■ Provides alerts for proactive replacement of the drive before the endurance is depleted ■ Provides endurance remaining in NVMe SMART logs
Status indicators	<ul style="list-style-type: none"> ■ Blue, amber, and green LEDs on drive bracket indicate status See “Status Indicators” on page 15.
Management utilities	<ul style="list-style-type: none"> ■ Oracle Integrated Lights Out Management (ILOM). For information, refer to the product information page at: https://www.oracle.com/servers/technologies/integrated-lights-out-manager.html. For documentation, refer to the Oracle Integrated Lights Out Manager (ILOM) 5.0 Documentation Library at: https://www.oracle.com/goto/ilom/docs You can find descriptions of new Oracle ILOM 5.0 features in the <i>Oracle ILOM Feature Updates and Release Notes</i>. ■ Oracle Hardware Management Pack, available with the Oracle Solaris OS or as a standalone product with other OS. For information, refer to the product information page at: https://www.oracle.com/servers/technologies/hardware-management-pack.html. For documentation and OS support matrix, refer to the Oracle Hardware Management Pack 2.4 Documentation Library at: https://www.oracle.com/goto/ohmp/docs

Characteristic	Value
	<p>Oracle Hardware Management Pack for Oracle Solaris 11.4 Documentation Library at https://docs.oracle.com/cd/E79568_01/index.html</p> <p>In addition, the following software is available to manage multiple systems in a data center:</p> <p>Oracle Enterprise Manager Ops Center, available software to manage multiple systems in a data center. For information, refer to the product information page at: https://www.oracle.com/enterprise-manager/technologies/. For documentation, refer to the Oracle Enterprise Manager Cloud Control Documentation Library at: https://docs.oracle.com/en/enterprise-manager/related-products.html</p> <p>For more information about management utilities, refer to the server documentation.</p>

[†]With Unbreakable Enterprise Kernel Release 4 Update 4 (UEK R4u4) or the Red Hat Compatible Kernel

[‡]With Unbreakable Enterprise Kernel Release 4 Update 4 (UEK R4u4) or the Red Hat Compatible Kernel

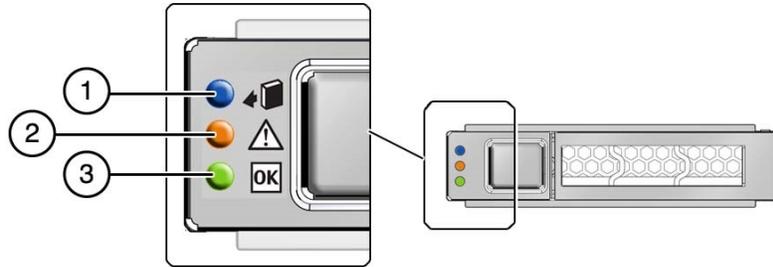
Related Information

- “About Oracle 6.4 TB NVMe SSDs” on page 12
- “Key Features” on page 13
- “Status Indicators” on page 15
- “About Oracle PCIe NVMe Switch Cards and Oracle 6.4 TB NVMe SSDs” on page 16
- “Specifications” on page 17
- “Oracle 6.4 TB NVMe SSD Product Notes” in *Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes*

Status Indicators

Use Oracle 6.4 TB NVMe SSD status indicators to determine the status of each drive and perform service actions as required. Three status indicator LEDs are located on the drive bracket to indicate status and diagnose NVMe storage drive issues.

The following illustration shows status indicator LEDs for Oracle 6.4 TB NVMe SSD.



Call Out	Status LED or Button	Icon and Color	Description
1	Ready to Remove	 Blue	Indicates that a drive can be removed during a hot-service operation. <ul style="list-style-type: none"> ■ OFF – Server is operating normally, ■ STEADY ON – Lights when the storage drive is ready to be removed from the server in response to an action initiated from the server operating system.
2	Fault-Service Required LED	 Amber	Indicates that the drive has experienced a fault condition. <ul style="list-style-type: none"> ■ OFF – Storage drive is operating normally, ■ STEADY ON – A fault is present in the storage drive.
3	OK/Activity LED	 Green	Indicates the drive's availability for use. Indicates the operational state of the storage drive. <ul style="list-style-type: none"> ■ OFF – AC power is not present or Oracle ILOM boot is not complete. ■ BLINK – Blinks to show storage drive activity. Storage drive indicator blink rates vary by activity. ■ STEADY ON – The storage drive is functioning normally.

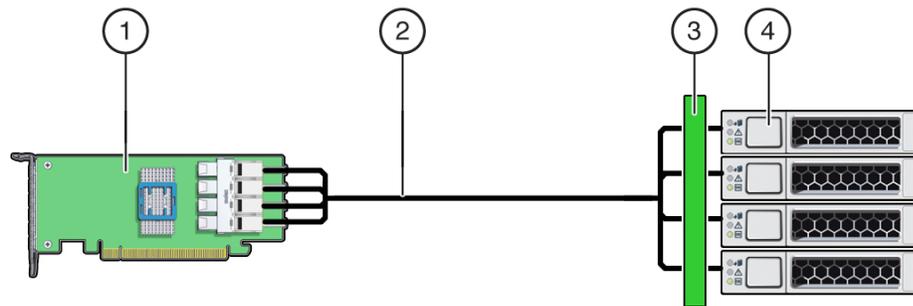
- [“About Oracle 6.4 TB NVMe SSDs” on page 12](#)
- [“Key Features” on page 13](#)
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- [“Specifications” on page 17](#)

About Oracle PCIe NVMe Switch Cards and Oracle 6.4 TB NVMe SSDs

Oracle 6.4 TB NVMe SSDs on some servers require a PCIe low-profile form factor NVMe switch controller card to facilitate connections between the host root port and the NVMe

devices. Oracle PCIe NVMe Switch Card provides high bandwidth and low latency for up to four NVMe drives. Oracle PCIe NVMe Switch Card plugs into a low profile x4 PCIe Gen3 card slot and uses sixteen lanes to support four NVMe storage drive devices.

The following illustration shows four Oracle 6.4 TB NVMe SSDs connected to one Oracle PCIe NVMe Switch Card in an x86 server configuration.



Call Out	Description
1	Oracle PCIe NVMe Switch Card
2	Server NVMe Connecting Cable
3	Server NVMe Disk Backplane
4	Oracle 6.4 TB NVMe SSD storage drives in NVMe bays

Related Information

- [“Specifications” on page 17](#)
- [“About Oracle 6.4 TB NVMe SSDs” on page 12](#)

Specifications

The following sections provide the specifications and capabilities of Oracle 6.4 TB NVMe SSD:

- [“Product Specification” on page 18](#)
- [“Environmental Specifications” on page 20](#)
- [“Electrical Specifications” on page 21](#)
- [“Reliability Specifications” on page 21](#)
- [“Physical Dimensions” on page 23](#)

Note - For server specifications, see the most recent version of the server product notes.

Product Specification

Oracle 6.4 TB NVMe SSD general specifications are listed in the following table.

Specification	Value
Capacity	Usable capacity 6.4 TB
	Unformatted capacity (total user addressable sectors in LBA mode) 12,502,446,768
PCIe	PCIe Gen3 x4
Form factors	U.2 2.5-inch 15mm
	<ul style="list-style-type: none"> ■ SFF-8639 compatible connector (U.2) ■ 2.5-inch SFF (small form factor) ■ 15mm Z-height
Performance ^{†‡}	<ul style="list-style-type: none"> ■ Sequential read speeds of up to 3.28 GB/s IOPS for 128KB Block Size, QD256 ■ Sequential write speeds of up to 2.15 GB/s IOPS for 128KB Block Size, QD256 ■ Random read speeds of up to 694,564 IOPS for 4KB Block Size, QD256 ■ Random write speeds of up to 216,021 IOPS for 4KB Block Size, QD256
	Latency
	<ul style="list-style-type: none"> ■ Sequential Latency (typical) Read/Write: 7/9 μseconds ■ Random Latency (typical) Read/Write: 79/34 μseconds ■ Power On to Ready Latency (typical): 2 seconds
Components	<ul style="list-style-type: none"> ■ High-endurance Intel TLC 3D NAND flash memory 32-tier ■ One Intel flash memory NVMe controller ASIC
Reliability	<ul style="list-style-type: none"> ■ Uncorrectable Bit Error Rate (UBER): 1 sector per 10¹⁷ bits read ■ Mean Time Between Failure (MTBF): 2 million hours

Specification	Value
	<ul style="list-style-type: none"> ■ T10 DIF (data integrity field) end-to-end data protection <p>See “Reliability Specifications” on page 21.</p>
Power	<ul style="list-style-type: none"> ■ 3.3V and 12V supply rail 3.3Vaux for SMBUS ■ Active/Idle (typical): Up to 25W/4W (typical) ■ Enhanced power-loss data protection. ■ Oracle 6.4 TB NVMe SSDs support NVMe specifications for RTD3 Resume Latency and RTD3 Entry Latency. RTD3R Resume latency allows 12 seconds of margin for devices to safely start before main power is applied to the device controller. RTD3E Entry latency allows 10 seconds of margin for active devices to safely shutdown before main power is removed from the device controller. <p>See “Electrical Specifications” on page 21.</p>
Certifications and declarations	UL, CE, C-Tick, BSMI, KCC, Microsoft WHCK, VCCI
Compliance	<ul style="list-style-type: none"> ■ NVM Express 1.2b ■ PCI Express Base Specification Rev 3.1 ■ Enterprise SSD Form Factor Version 1.0a ■ PCI Express Card Electro-Mechanical (CEM) Specification Rev 3.0
Endurance rating	<ul style="list-style-type: none"> ■ Up to 37.4 PBW (petabytes written) ■ 2.92 Drive Writes/day (JESD219 workload)
Altitude (simulated)	<ul style="list-style-type: none"> ■ Operating: -1,000 to 10,000 ft ■ Non-operating: -1,000 to 40,000 ft
Temperature	<ul style="list-style-type: none"> ■ Operating: <ul style="list-style-type: none"> ■ 0 to 35°C ambient, 0 to 70°C case with specified airflow ■ Temperature monitoring (in-band and by way of SMBUS) ■ Thermal throttling ■ Non-operating: -55 to 95°C
Airflow	More than 450 LFM (linear feet/minute, at 25/35°C, airflow towards the connector)
Weight	Up to 125 gm
Shock	1,000 G/0.5 msec
Vibration	<ul style="list-style-type: none"> ■ Operating: 2.17 GRMS (5-700Hz) ■ Non-operating: 3.13 GRMS (5-800Hz)
Product ecological compliance	RoHS

[†]Performance values vary by capacity and form factor.

[‡]Performance specifications apply to both compressible and incompressible data.

Related Information

- [“Oracle 6.4 TB NVMe SSD Overview” on page 11](#)

- [“Oracle 6.4 TB NVMe SSD Service Overview” on page 37](#)

Environmental Specifications

Oracle 6.4 TB NVMe SSDs operate and are stored in an environment defined by the parameters and specifications in the following table.

Specification	Value
Operating temperature	<ul style="list-style-type: none"> ■ 0 to 35°C ambient, 0 to 70°C case with specified airflow ■ Operational environment: 5°C to 35°C (dry bulb)
Non-operating temperature	Storage and transit environment: -55°C to 95°C (dry bulb)
Temperature monitoring	<ul style="list-style-type: none"> ■ Temperature monitoring in-band and by way of SMBUS ■ Thermal throttling when approaching maximum composite throttling temperature See “Troubleshooting Oracle 6.4 TB NVMe SSD Cooling” on page 43 for more information on thermal throttling. ■ Thermal shutdown when drive exceeds maximum component temperature
Dry bulb temperature	Maximum dry bulb temperature is derated by 3.3°C per 1000 m above 500 m
Altitude (Simulated)	<ul style="list-style-type: none"> ■ Operating: -1,000 to 10,000 ft ■ Non-operating: -1,000 to 40,000 ft
Relative humidity range	<ul style="list-style-type: none"> ■ Operational environment: 8% to 80% noncondensing ■ Storage and transit environment: 5% to 95% noncondensing ■ Non-operating: -20°C to 75°C noncondensing
Thermal sensors	<ul style="list-style-type: none"> ■ Thermal sensors on the storage drives monitor flash memory modules ■ Thermal sensor temperature cannot exceed 73°C ■ See illustration in “Troubleshooting Oracle 6.4 TB NVMe SSD Cooling” on page 43 for thermal sensor locations.
Airflow requirement	More than 450 LFM (linear feet/minute) at 25/35°C, airflow towards the connector

Note - For specific site planning guidelines and best practices, refer to the server documentation and product notes for your server. Refer to the system site planning guide, if available.

Related Information

- [“Product Overview” on page 11](#)
- [“Oracle 6.4 TB NVMe SSD Service Overview” on page 37](#)

Electrical Specifications

Oracle 6.4 TB NVMe SSD electrical specifications are listed in the following table.

Specification	Value
Power feeds	<ul style="list-style-type: none"> ■ 3.3V and 12V Supply Rail ■ 3.3Vaux for SMBUS
Enhanced power-loss data protection	Active/Idle: Up to 25W/4W (typical)
Power consumption	<ul style="list-style-type: none"> ■ Active Write - Average = 22W ■ Active Read - Average = 10W ■ Idle = 4W

Oracle 6.4 TB NVMe SSD receives electrical power from the PCI Express +12 VDC and +3.3 VDC power rails as listed in the following table.

Specification	12 V Operating Characteristics	3.3 V aux Operating Characteristics
Operating voltage range	12 V (+10%/-20%)	3.3 V (+-9%)
Rise time (max/min)	50ms/1ms	50ms/1ms
Fall time (max/min)	5s/1ms	5s/1ms
Noise level	1000 mV pp at 10 Hz – 100 KHz	300 mV pp at 10 Hz – 100 KHz
	100 mV pp at 100 KHz – 20 MHz	50 mV pp at 100 KHz – 20 MHz
Minimum off time	3s	3s
Inrush current (typical peak)	1.5 A	1.5 A
Maximum average current	2.45 A	1 mA

Related Information

- [“Oracle 6.4 TB NVMe SSD Overview” on page 11](#)
- [“Oracle 6.4 TB NVMe SSD Service Overview” on page 37](#)

Reliability Specifications

Oracle 6.4 TB NVMe SSD reliability specifications are listed in the following table.

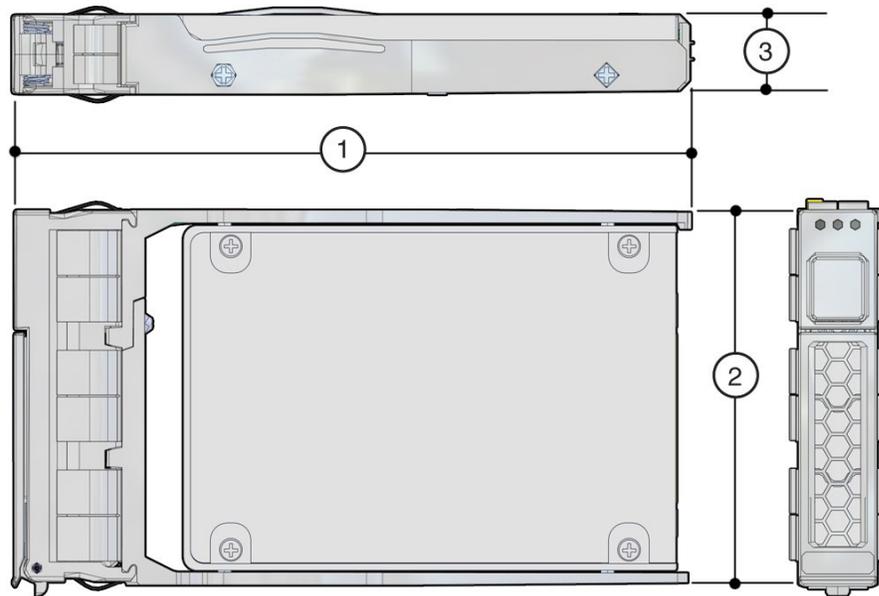
Specification	Value
Uncorrectable Bit Error Rate (UBER)	<p>Uncorrectable bit error rate will not exceed one sector in the specified number of bits read.</p> <p>In the unlikely event of a non-recoverable read error, the storage drive will report it as a read failure to the host; the sector in error is considered corrupt and is not returned to the host.</p> <p>< 1 sector per 10¹⁷ bits read</p>
Mean Time Between Failures (MTBF)	<p>2 million hours</p> <p>Mean Time Between Failures is estimated based on Telcordia methodology and demonstrated through Reliability Demonstration Test (RDT).</p>
Data Retention	<p>The time period for retaining data in the NAND at maximum rated endurance. Three months power-off retention once storage drive reaches rated write endurance at 40°C.</p>
Endurance Rating	<ul style="list-style-type: none"> ■ Up to 34.61 PBW (petabytes written) <p>Endurance rating verification is defined to establish UBER <1E-16 at 60% upper confidence limit.</p> <ul style="list-style-type: none"> ■ 2.92 Drive Writes/day (JESD219 workload) <p>The number of drive writes is such that the storage drive meets the requirements according to the JESD219 standard.</p>
Temperature Sensor	<p>Internal temperature sensor with an accuracy of +/- 2°C over a range of -10°C to +85°C, which can be monitored using NVMe Health Log.</p> <p>The sensor has an accuracy of +/- 3°C over a range of -20°C to 125°C. SMBUS temperature sensor is not reported in NVMe Health Log.</p> <p>Drive provides out-of-band access to temperature by means of SMBUS.</p>
Out-of-Band Management (SMBUS)	<p>Provides out-of-band management by means of SMBUS interface. This requires 3.3V auxiliary voltage.</p> <p>SMBUS access includes the VPD page and temperature sensor.</p>
Hot-Plug Support	<p>Supports PCIe presence detect and link-up detect.</p> <p>Device advanced power loss protection provides robust data integrity. During IOs, the storage drive integrated monitoring enables the integrity of already committed data on the media and commits acknowledged writes to the media.</p> <p>See “Servicing Oracle 6.4 TB NVMe SSDs” on page 37.</p>

Related Information

- [“Oracle 6.4 TB NVMe SSD Overview” on page 11](#)
- [“Servicing Oracle 6.4 TB NVMe SSDs” on page 37](#)

Physical Dimensions

The following diagram shows Oracle 6.4 TB NVMe SSD physical dimensions.



Specification	Dimension
(1) Length	100.45 mm maximum (3.955 in.)
(2) Width	69.85 +/- 0.25 mm (2.75 in.)
(3) Height	15.0 +/-0.5 mm (0.59 in.)
Weight	125 g maximum (4.4 oz)

Related Information

- [“Oracle 6.4 TB NVMe SSD Overview” on page 11](#)

Preparing Oracle 6.4 TB NVMe SSD for Installation

This section provides information about preparing an Oracle 6.4 TB NVMe SSD for installation.

Description	Links
Prepare to install the SSD.	“Prepare for Installation” on page 25
Gather the required tools.	“Required Tools” on page 26
Unpack the shipping kit.	“Ship Kit Contents” on page 26
Review safety information.	“Observing Safety Precautions” on page 28
Review electrostatic discharge (ESD) safety measures.	“ESD Safety Measures” on page 29
Review 6.4 TB NVMe SSD optimization guidelines.	“Oracle 6.4 TB NVMe SSD Optimization Guidelines” on page 30
Update your system to the latest software release.	“Update Your System to the Latest Software Release” on page 31

Note - To install Oracle 6.4 TB NVMe SSDs in a specific server, refer to your server documentation. For information about restrictions and use of Oracle 6.4 TB NVMe SSDs on your server, see the most recent version of the server product notes.

▼ Prepare for Installation

1. **Gather the required tools.**
See [“Required Tools” on page 26](#).
2. **Unpack the shipping kit that includes the storage drive.**
 - a. **Unpack the storage drive in a static-free environment.**

See [“Ship Kit Contents” on page 26](#).

- b. Remove the storage drive from its packaging, and place the drive on an antistatic mat, using good antistatic grounding procedures.**

See [“ESD Safety Measures” on page 29](#).

- 3. Carefully inspect the storage drive for shipment damage.**

If you notice any damage, contact Oracle Technical Support or your reseller support representative. See [“Technical Support” on page 44](#).

Required Tools

You will need the following tools for most service operations:

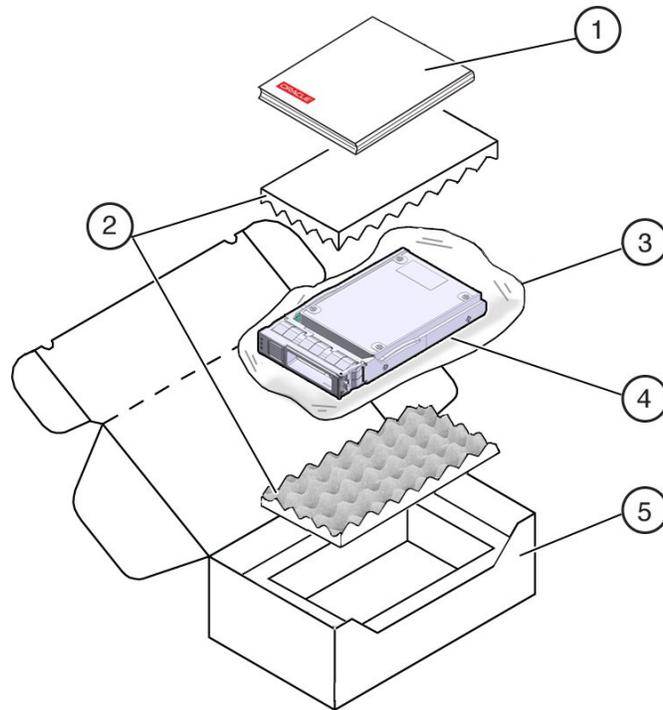
- Antistatic wrist strap
- Antistatic mat

Related Information

- [“ESD Safety Measures” on page 29](#)

Ship Kit Contents

The Oracle 6.4 TB NVMe SSD ship kit contains the components shown in the following illustration.



Call Out	Description
1	Documentation
2	Foam
3	Antistatic bag
4	Oracle 6.4 TB NVMe SSD
5	Packaging

Related Information

- [“Oracle 6.4 TB NVMe SSD Overview” on page 11](#)

Observing Safety Precautions

This section contains safety information about preventing equipment damage and personnel injury.

- [“General Safety Information” on page 28](#)
- [“Safety Symbols” on page 28](#)
- [“ESD Safety Measures” on page 29](#)
- [“Perform ESD Prevention Measures” on page 29](#)

General Safety Information

For your protection, observe the following safety precautions when setting up your equipment:

- Follow all cautions and instructions marked on the equipment.
- Follow all cautions and instructions described in the documentation shipped with your system and described in the server safety information.
- Follow the electrostatic discharge safety practices as described in this section.

Safety Symbols

Note the meanings of the following symbols that might appear in this document.



Caution - There is a risk of personal injury or equipment damage. To avoid personal injury and equipment damage, follow the instructions.



Caution - Hot surface. Avoid contact. Surfaces are hot and might cause personal injury if touched.



Caution - Hazardous voltages are present. To reduce the risk of electric shock and danger to personal health, follow the instructions.

ESD Safety Measures

Circuit boards and drives contain electronic components that are extremely sensitive to static electricity. Ordinary amounts of static electricity from clothing or the work environment can destroy the components located on these boards. Electrostatic discharge (ESD) sensitive devices, such as the storage drives, require special handling.

- Place ESD-sensitive components, such as printed circuit boards and storage drives on an antistatic mat (not provided).
- Wear an antistatic wrist strap when handling ESD-sensitive components.



Caution - Possible component damage. Do not touch components along connector edges.

▼ Perform ESD Prevention Measures

1. **Prepare an antistatic surface to set parts on during the removal, installation, or replacement processes.**

Place ESD-sensitive components such as the storage drives on an antistatic mat. The following items can be used as an antistatic mat:

- Antistatic bag used to wrap a replacement part
- ESD mat
- A disposable ESD mat (shipped with some replacement parts or optional system components)

2. **Attach an antistatic wrist strap.**

When servicing or removing server components, attach an antistatic strap to your wrist and then to a metal area on the chassis.

Related Information

- [“ESD Safety Measures” on page 29](#)
- [“Oracle 6.4 TB NVMe SSD Service Overview” on page 37](#)

Oracle 6.4 TB NVMe SSD Optimization Guidelines

To optimize performance, observe the following guidelines when setting up Oracle 6.4 TB NVMe SSDs in a server.

- Block size can be configured through a server operating system or file system and is set to a default size with Oracle databases.
- Oracle 6.4 TB NVMe SSDs are designed to provide best performance for data transfers that are multiples of 4k size and using addresses that are 4k aligned. Partitions should be aligned to start on 4k boundaries.
- The ZFS file system might require manual alignment. Oracle 6.4 TB NVMe SSD has a maximum transfer size of 128k. IO requests for larger transfer sizes are broken into transfer sizes of 128k or smaller. For optimal performance, transfer sizes should be limited to 128k to avoid additional overhead associated with breaking into smaller transfer sizes.
- Oracle 6.4 TB NVMe SSD should be formatted using a label of type EFI (`format -e` command).

Ensure that when the EFI label is created by ZFS, the default start sector is 256, which aligns S1 with 128k (if the block size is 512). The vtoc label default cylinder size is 50176 (224*224) blocks. If the block size is 512, the default Oracle Solaris operating system partition aligns with 512k. For example: $50176 * 512 = 49 * 512 * 1024$.

Specify and ensure 4k alignment: The default start sector of 34 for EFI labels is not a 4k aligned value. Use the partition subcommand of the Oracle Solaris `format` command to change the start sector to 256, or any other 128k aligned value. Note that there are 512B per sector.

- The ZFS file system automatically aligns partitions to start on 8k boundaries when a full disk is allocated to ZFS (recommended). If you allocate individual EFI partitions to a ZFS pool, ensure that the partition is 4k-aligned.
- For highest performance, ensure that the system meets the physical, environmental, and electrical specifications listed in [“Specifications” on page 17](#).

Related Information

- [“Preparing Oracle 6.4 TB NVMe SSD for Installation” on page 25](#)
- Tuning ZFS When Using Flash Storage https://docs.oracle.com/cd/E53394_01/html/E54818/chapterzfs-flash.html

Drive Volume Management

A volume manager can present multiple SSD devices as one larger volume. Use the Automatic Storage Management (ASM) volume manager or other volume manager to concatenate multiple flash memory domains. For example, a volume manager can be used to concatenate four 6.4 TB domains into a single 25.2 TB volume.

For more information about ASM, refer to "Introduction to Automatic Storage Management (ASM)" in the *Oracle Database Administrator's Guide, Release 18c*.

▼ Update Your System to the Latest Software Release

It is highly recommended that you update your system to the latest software release before you use the system. Software releases often include bug fixes, and updating ensures that your server software is compatible with the latest server firmware and other component firmware and software.

Note - System firmware update releases include Oracle 6.4 TB NVMe SSD component firmware updates. When system firmware updates, as described in the server documentation, Oracle 6.4 TB NVMe SSD firmware automatically updates.

- 1. Check the Oracle 6.4 TB NVMe SSD Product Notes for the latest firmware requirements.**

The most up-to-date Product Notes document is available at: <https://www.oracle.com/goto/oracleflashf640/docs>

- 2. Download and install any firmware updates required to support the SSD, host bus adapter (HBA), drive backplane, system BIOS, or OBP/system (SPARC) firmware.**

You can download the latest firmware and software updates from My Oracle Support at <https://support.oracle.com>.

For information about downloading Oracle 6.4 TB NVMe SSD firmware and software from My Oracle Support, refer to "Accessing Software Updates and Firmware Downloads" in *Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes*.

Refer also to the "Getting Server Firmware and Software Updates" in the server Installation Guide documentation.

Related Information

- [“Download the Device Software Package” in *Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes*](#)
- [“Update the NVMe Storage Drive Firmware” in *Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes*](#)
- [“Verify Oracle 6.4 TB NVMe SSD Operation” in *Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes*](#)
- [“Oracle 6.4 TB NVMe SSD Overview” on page 11](#)
- [“Oracle 6.4 TB NVMe SSD Service Overview” on page 37](#)

Installing Oracle 6.4 TB NVMe SSDs

This section contains information about installing Oracle 6.4 TB NVMe SSDs into a server drive bay.

Description	Links
Review installation tasks and performance tuning information before installing the SSD.	“Installation Overview” on page 33
Install a new SSD into a server.	“Install a New Oracle 6.4 TB NVMe SSD (CRU)” on page 34

Installation Overview

Read this overview information section before installing Oracle 6.4 TB NVMe SSD into a server.

For detailed instructions on how to install your 6.4 TB NVMe SSD, refer to your server service documentation or drive enclosure documentation. Refer to the server service manual for additional installation information.

The drive bracket assembly should not be disassembled for any reason by the user.

Oracle 6.4 TB NVMe SSD Installation Tasks

To install an Oracle 6.4 TB NVMe SSD into a supported server system, refer to the steps described in the following table.

Steps	Task	See
1.	Prepare the SSD for installation. Carefully unpack the SSD. Inspect the SSD for damage. Follow ESD precautions.	“Preparing Oracle 6.4 TB NVMe SSD for Installation” on page 25
2.	Insert the SSD in an available drive slot.	“Install a New Oracle 6.4 TB NVMe SSD (CRU)” on page 34

Related Information

- [“Product Overview” on page 11](#)
- [“Oracle 6.4 TB NVMe SSD Service Overview” on page 37](#)

▼ Install a New Oracle 6.4 TB NVMe SSD (CRU)

To install a new Oracle 6.4 TB NVMe SSD (2.5-inch small form factor, U.2) into a supported server:

- 1. Back up your data, as required, before changing your server configuration.**
- 2. Identify a supported and available slot in the server.**

Refer to the server service manual for drive locations on the server.

Refer to [“Supported Hardware and Software” in Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes](#).

Note - While using Oracle 6.4 TB NVMe SSD 2.5-inch small form factor drive, locate a server slot on the server panel labeled NVMe (with SFF-8639 disk backplane and connector) that is capable of supporting Oracle 6.4 TB NVMe SSD. Your server chassis must contain NVMe equipment, including Oracle NVMe Switch Controller Cards and cables. Refer to the server service manual for detailed NVMe SSD installation instructions.

- 3. Locate the storage drive filler panel in the server.**

If the optional NVMe storage drives are installed in the server front or back panel, they are labeled NVMe0, NVMe1, NVMe2, NVMe3 and so on. However, the server operating system assigns the installed storage drives different names. For the corresponding names assigned by the operating system, refer to the server service manual.

- 4. Prepare the SSD for installation.**

See [“Preparing Oracle 6.4 TB NVMe SSD for Installation”](#) on page 25.

5. Record the serial number of the NVMe SSD and NVMe slot number where the SSD will be installed.

This drive serial number (WWN) and server slot information can be used at a later time for identifying drives from the console. Refer to the server service manual.

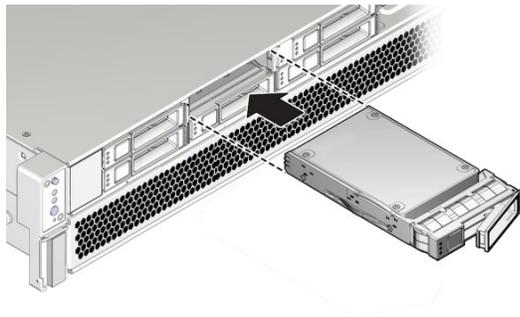
6. If necessary, remove the drive filler panel.

Remove the blank storage drive filler panel on the server chassis that aligns with the empty NVMe drive slot.

For instructions on how to remove drive filler panels, refer to the server service manual.

7. Slide the Oracle 6.4 TB NVMe SSD into the supported NVMe slot until the drive is fully seated.

The following figure shows how to insert the SSD in a server NVMe slot.



8. Close the drive latch to lock the drive in place.

9. Configure the server for the new SSD.

Refer to the server documentation library for detailed instructions. Refer to the server administration guide or the operating system documentation for detailed NVMe SSD configuration instructions.

- a. **If applicable, perform any required commands for your system to install the device driver for the new SSD.**
- b. **If applicable, perform any required commands for your system to recognize the new SSD.**

c. Verify successful installation of the SSD through your server operating system.

When the installation is complete, the Oracle 6.4 TB NVMe SSD is visible to your server operating system.

d. Configure the system to maximize flash technology.

Related Information

- [“Product Overview” on page 11](#)
- [“Oracle 6.4 TB NVMe SSD Service Overview” on page 37](#)

Servicing Oracle 6.4 TB NVMe SSDs

This section provides service information for Oracle 6.4 TB NVMe SSD.

Description	Links
Review service task and troubleshooting information.	“Oracle 6.4 TB NVMe SSD Service Overview” on page 37
Review NVMe drive component serviceability information.	“Component Serviceability” on page 38
Remove and replace NVMe drives.	“Replace an Existing Oracle 6.4 TB NVMe SSD (CRU)” on page 39
Troubleshoot NVMe drive thermal issues.	“Troubleshooting Oracle 6.4 TB NVMe SSD Cooling” on page 43
Contact Technical Support.	“Technical Support” on page 44

Oracle 6.4 TB NVMe SSD Service Overview

For service, Oracle 6.4 TB NVMe SSD contains updatable flash ROM for storing the BIOS and firmware, as well as NVRAM for storing nonvolatile configuration data. Use Oracle Hardware Management Pack to monitor and service the SSD. You can also use Oracle Hardware Management Pack for troubleshooting. See Server Management in [“Characteristics” on page 13](#) and refer to [“Server Management Tools” in Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes](#).

In addition, you can monitor Oracle 6.4 TB NVMe SSD health and flash media drive life through SSD bracket status indicator LEDs. The SSD has three status indicator LEDs on the drive bracket to indicate activity, drive life, and status. See [“Status Indicators” on page 15](#).

Oracle 6.4 TB NVMe SSD requires no periodic maintenance. For data protection, Oracle 6.4 TB NVMe SSD is designed with energy storage components to complete buffered writes to the persistent flash storage in case of a sudden power loss. These energy storage components are designed for the life of Oracle 6.4 TB NVMe SSDs and do not require periodic maintenance.

Refer to the server documentation for additional service information. Late-breaking information and known issues for the server are included in the server product notes. Late-breaking information and known issues for this product are included in the *Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes*.

Note - Refer to the server documentation for additional NVMe storage drive service and firmware download information. Refer to the server service manual for detailed removal and replacement instructions for NVMe SSDs.

Component Serviceability

The following service actions can be performed on an Oracle 6.4 TB NVMe SSD.

- Unmount an NVMe storage drive
- Remove an NVMe storage drive from the server
- Verify removal of an NVMe storage drive
- Install an NVMe storage drive in the server
- Power on an NVMe storage drive and attach a device driver

Refer to the server documentation for additional service information. Late-breaking information and known issues for this product are included in the [“Oracle Flash Accelerator F640 PCIe Card Product Notes”](#) in *Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes*.

Components are either hot serviceable or cold serviceable. Hot-service capability allows you to safely remove this component while the server is running. Cold-service capability requires a powered off state, therefore you need to remove power from the server.

Components are designated either CRU (customer-replaceable unit) or FRU (field-replaceable unit). CRU service capability allows trained technicians and authorized field service personnel to service this component. FRU service capability allows only authorized service personnel to service this component. Oracle 6.4 TB NVMe SSD is a CRU.

The following table lists the serviceability of NVMe components and directs you to replacement instructions.

Component	Serviceability	Replacement Instructions
Oracle 6.4 TB NVMe SSD (and fillers)	Hot CRU	“Installing Oracle 6.4 TB NVMe SSDs” on page 33

Component	Serviceability	Replacement Instructions
		“Replace an Existing Oracle 6.4 TB NVMe SSD (CRU)” on page 39 For instructions on safe installation and removal of SSDs, refer to the server service manual.
Oracle PCIe NVMe Switch Card	Cold FRU	For instructions on safe installation and removal of cards, refer to the server service manual.
NVMe cables	Cold FRU	For instructions on safe installation and removal of cables and connected drive backplane, refer to the server service manual.

Related Information

- [“Product Overview” on page 11](#)
- [“Technical Support” on page 44](#)

▼ Replace an Existing Oracle 6.4 TB NVMe SSD (CRU)

Replace an Oracle 6.4 TB NVMe SSD if the drive fails or the usable drive life has been exceeded.



Caution - Possible component damage. Different server platforms place NVMe-capable bays in different locations. To identify a server’s NVMe-capable bay, observe that the orange silk screen on the server is labeled **NVMe** before inserting an NVMe storage drive into an NVMe-capable slot. Your server chassis must contain an NVMe-capable configuration including Oracle NVMe Switch Controller Cards and cables.



Caution - Possible component damage. Circuit boards and drives contain electronic components that are extremely sensitive to static electricity. Ordinary amounts of static electricity from clothing or the work environment can destroy the components located on these boards. Do not touch the components along their connector edges. These procedures require that you handle components that are sensitive to electrostatic discharge. This sensitivity can cause the components to fail. To avoid damage, ensure that you follow antistatic practices as described in [“ESD Safety Measures” on page 29](#).

The following steps provide an example procedure. Follow the server service manual instructions for replacing an NVMe storage drive.

1. Prepare the server operating system, as required, before you remove drives.

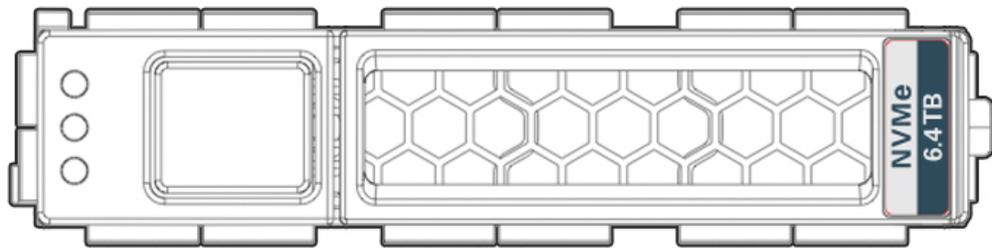
Follow the server service manual instructions for orderly shutdown during NVMe storage drive insertion and removal service actions.

Unmount the NVMe storage drives.

2. Identify the physical location of the NVMe drive that you want to remove.



Caution - Possible component damage. While using a U.2 2.5-inch 15mm form factor drive, locate a server slot on the server front panel labeled **NVMe** (with SFF-8639 disk backplane and connector) that is capable of supporting the Oracle 6.4 TB NVMe SSD and that is labeled as shown in the following figure. Never insert an NVMe storage drive into a non-NVMe capable slot that supports hard disk drives only (labeled HDD).



3. Observe the status indicator LEDs on the front panel of the drive to verify which drive in the server requires replacement.

- Verify that the blue OK to Remove status indicator LED on the NVMe storage drive is lit.
- Green (operational), amber (faulty disk), blue (SSD has been prepared for removal)
- See [“Status Indicators” on page 15](#).

4. Remove the NVMe storage drive from the server.

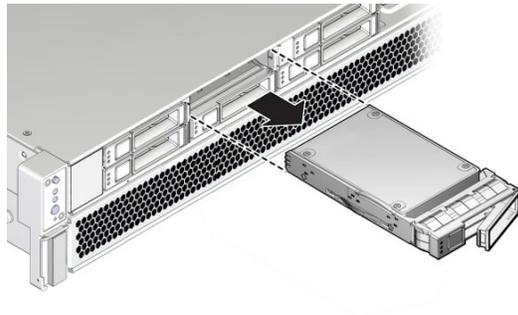
a. On the drive that you plan to remove, push the latch release button to open the drive latch.

Press the release lever button on the drive front panel and then tilt the lever into a fully opened position.

b. Grasp the opened release lever and gently slide the drive toward you.

- c. **If you are not immediately replacing the drive, insert a filler panel into the empty drive slot on the server.**

If you are not replacing the drive, install a filler panel in the empty drive slot to maintain proper airflow and perform administrative tasks to configure the server to operate without the drive.



5. **Verify removal of the NVMe storage drive.**

Follow the server service manual instructions for NVMe storage drive identification.

6. **Install (or replace) the NVMe storage drive.**

The drive is physically addressed according to the slot in which it is installed. It is important to install a replacement drive in the same slot as the drive that was removed.

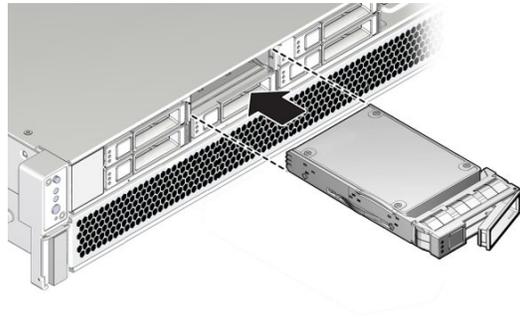
Refer to [“Supported Servers and Operating Systems”](#) in *Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes*.

- a. **Slide the drive into the vacant slot by pressing the middle of the drive faceplate with your thumb or finger.**

Slide the drive into the slot until the drive is fully seated.

- b. **Close the drive latch to lock the drive in place.**

Using your thumb or finger, press on the middle of the drive faceplate until the release lever engages with the chassis. Close the release lever until it clicks into place and is flush with the front of the server.



Caution - Possible component damage. While using a 2.5-inch form factor drive, locate a server slot on the server front panel labeled **NVMe** (with SFF-8639 disk backplane and connector) that is capable of supporting the Oracle 6.4 TB NVMe SSD. Never insert an NVMe storage drive into a non-NVMe capable hard disk drive slot (HDD).

7. **For hot-plug service actions, configure the NVMe storage drive and verify drive availability.**
 - Follow the server service manual instructions for NVMe storage drive configuration and identification.
 - Use appropriate software commands to return the system to an operational state:
 - Power on the NVMe storage drive, as required.
 - Attach a device driver, as required.
 - Re-activate mirror if manual intervention is required.
 - Re-sync mirror if manual intervention is required.

Related Information

- [“Product Overview” on page 11](#)
- [“Oracle 6.4 TB NVMe SSD Service Overview” on page 37](#)

Troubleshooting Oracle 6.4 TB NVMe SSD Cooling

Maintaining the proper internal operating temperature of the server is crucial to the health of the server. To prevent server shutdown and damage to components, address overtemperature and hardware-related issues as soon as they occur.

Use the status indicator LEDs to determine the status of the Oracle 6.4 TB NVMe SSD. The LEDs provide key status information to diagnose SSD issues. See [“Status Indicators” on page 15](#).

The Oracle 6.4 TB NVMe SSD is designed to provide continuous full bandwidth performance with temperatures up to 73°C. Qualified host platforms with required software updates operate with sufficient margin to the maximum temperature under worst case environments. Should the system maximum operating temperature be exceeded or a system fault occur that causes internal temperatures of the flash memory modules to rise above this limit, the SSD responds as follows:

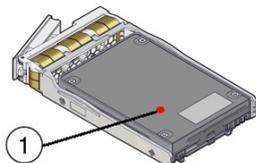
- 73°C – Drive write throttling is engaged to reduce SSD power.
 - SSD amber status indicator LED is lit, Service Action Required.
 - Temperature warning is displayed in utility output.
- 78°C – Additional drive write throttling is engaged.
 - SSD amber status indicator LED is lit, Service Action Required.
 - Critical temperature status is displayed in utility output.



Caution - Sustained critical temperatures might cause data loss.

Refer to the server documentation for additional service information.

The following image shows the Oracle 6.4 TB NVMe SSD temperature sensor location [1] (inside enclosure).



Related Information

- [“Status Indicators” on page 15](#)
- [“Product Overview” on page 11](#)
- [“Oracle 6.4 TB NVMe SSD Service Overview” on page 37](#)
- [“Technical Support” on page 44](#)

Technical Support

For technical assistance installing, configuring, or running Oracle 6.4 TB NVMe SSDs, contact Oracle Technical Support.

Go to <https://www.oracle.com/support/>. Please have your server Customer Support ID (CSI) ready. Sign in to My Oracle Support to open a service request. You must have purchased support to access My Oracle Support.

Related Information

- Refer to [“Supported Hardware and Software” in *Oracle Flash Accelerator F640 PCIe Card and Oracle 6.4 TB NVMe SSD Product Notes*](#).

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