

# Oracle® 1.6 TB NVMe SSD User Guide

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# Using This Documentation

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- **Overview** – This user guide provides detailed procedures that describe installation, configuration, and service of Oracle's 1.6 TB NVMe SSD.
- **Audience** – This guide is intended for 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.

This preface contains the following sections:

- [“Product Documentation Library” on page 7](#)
- [“Feedback” on page 8](#)
- [“Change History” on page 8](#)

## Product Documentation Library

Late-breaking information and known issues for this product are included in the product notes. Refer to the Oracle 1.6 TB NVMe SSD Documentation Library:

<http://www.oracle.com/goto/oracleflashf160/docs>

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**Note** - For specific installation instructions, refer to your server documentation. For information about restrictions and use of the Oracle 1.6 TB NVMe SSD on your server, see the most recent version of the server product notes.

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Documentation	Link
All Oracle products (Including servers.)	<a href="https://docs.oracle.com">https://docs.oracle.com</a>
Oracle 1.6 TB NVMe SSD Documentation Library	<a href="http://www.oracle.com/goto/oracleflashf160/docs">http://www.oracle.com/goto/oracleflashf160/docs</a>
Oracle System Assistant	Refer to the server's administration guide.
Oracle Integrated Lights Out Manager (ILOM)	<a href="http://www.oracle.com/goto/ilom/docs">http://www.oracle.com/goto/ilom/docs</a>

Documentation	Link
Oracle Hardware Management Pack	Refer to the server's administration guide. <a href="http://www.oracle.com/goto/ohmp/docs">http://www.oracle.com/goto/ohmp/docs</a>
My Oracle Support	<a href="https://support.oracle.com">https://support.oracle.com</a>

## Feedback

Provide feedback about this documentation at: <http://www.oracle.com/goto/docfeedback>

## Change History

The following lists the release history of this documentation set:

- April 2016. Edit revision.
- October 2015. New server introduction. Revised electrical specifications.
- July 2015. New server introduction.
- December 2014. Initial publication.

# Product Overview

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These topics describes the specifications and capabilities of the Oracle 1.6 TB NVMe SSD (non-volatile memory express, solid-state drive).

Review the following product information sections before you install or service your Oracle 1.6 TB NVMe storage drive:

Description	Links
Learn about Oracle 1.6 TB NVMe SSD features and functions.	<a href="#">“Oracle 1.6 TB NVMe SSD Overview” on page 9</a>
Review specifications and capabilities.	<a href="#">“Specifications” on page 15</a>

## Oracle 1.6 TB NVMe SSD Overview

These topics provide an overview of Oracle 1.6 TB NVMe SSD features and functions:

- [“About the Oracle 1.6 TB NVMe SSD” on page 9](#)
- [“Key Features” on page 10](#)
- [“Characteristics” on page 11](#)
- [“Status Indicators” on page 12](#)
- [“About Oracle PCIe NVMe Switch Cards and 1.6 TB NVMe SSDs” on page 14](#)

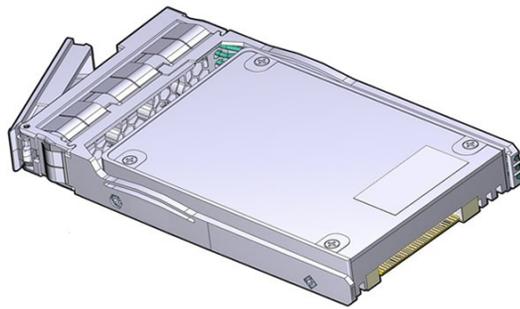
## About the Oracle 1.6 TB NVMe SSD

Oracle's 1.6 TB NVMe SSD offers high performance with low latency and a low CPU burden. The 1.6 TB NVMe SSD is a PCIe Gen3 storage drive that is designed with the new high performance controller interface – NVMe (Non-Volatile Memory express), delivering leading performance, low latency and high quality of service.

The Oracle 1.6 TB NVMe SSD is designed with advanced enterprise multi-level cell NAND (eMLC) technology for high-level performance and write durability. With PCIe Gen3 support and NVMe queuing interface, the 1.6 TB NVMe SSD delivers excellent sequential read performance of up to 2500MB/sec and sequential write speeds of up to 1500MB/sec. The Oracle 1.6 TB NVMe SSD delivers very high random read IOPS of 260K and random write IOPS of 42K for 8KB operations and random read IOPS of 440K and random write IOPS of 70K for 4KB operations. Taking advantage of the direct path from the storage to the CPU by means of NVMe, Oracle 1.6 TB NVMe SSD exhibits low latency of less than 20 µsec for sequential access to the storage drive.

The Oracle 1.6 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 1.6 TB NVMe SSD:



## Related Information

- [“Specifications” on page 15](#)
- [“Product Overview” on page 9](#)

## Key Features

The Oracle 1.6 TB NVMe SSD has the following key features:

Key Feature	Description
Consistently high IOPS and throughput	■ Sequential read speeds of up to 2500MB/sec (2.5GB/sec).

Key Feature	Description
	<ul style="list-style-type: none"> <li>■ Sequential write speeds of up to 1500MB/sec.</li> <li>■ Delivers random read IOPS of 440K and random write IOPS of 70K for 4KB operations.</li> </ul>
Sustained low latency	<ul style="list-style-type: none"> <li>■ Offers high-performance with low latency and a low CPU burden.</li> <li>■ Less than 20 µsec for sequential access to the SSD.</li> </ul>
High Endurance Technology (HET)	<ul style="list-style-type: none"> <li>■ Includes High Endurance Technology (HET) NAND silicon enhancements.</li> <li>■ Includes SSD NAND management techniques to extend SSD write endurance up to 5 drive writes per day for five years.</li> </ul>
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 attribute critical warning.
Out-of-band management	Managed through the SMBUS.
Thermal throttling and monitoring	Provides continuous full bandwidth performance with flash memory module temperatures up to 73° C.

## Related Information

- [“Specifications” on page 15](#)
- [“Product Overview” on page 9](#)

## Characteristics

The Oracle 1.6 TB NVMe SSD has the following hardware and software characteristics:

Characteristic	Value
Device name	<ul style="list-style-type: none"> <li>■ 1.6 TB eMLC Flash NVMe SFF SSDPE2ME016T4S</li> </ul>
Manufacturing name	<ul style="list-style-type: none"> <li>■ 1.6 TB eMLC Flash NVMe SFF SSDPE2ME016T4S</li> </ul>
Style	Small form factor (SFF) SSD
Capacity	2.5-inch Form Factor, 15mm Z- height, SFF-8639-compatible connector 1.6 TB
NAND	Advanced enterprise multi-level cell NAND (eMLC) technology for high-level performance and write durability

Characteristic	Value
Flash controller	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"><li>■ Oracle Solaris 11.3</li><li>■ Oracle Solaris 11.2 (SRU 5)</li><li>■ Oracle Linux 6.5, based on UEK3 (Unbreakable Linux Kernel Release 3)</li></ul>
Management utilities	<ul style="list-style-type: none"><li>■ Oracle Hardware Management Pack</li><li>■ Oracle System Assistant</li></ul> <p>For more information about management utilities, refer to the server documentation.</p>
Hardware, firmware, and software compatibility	Refer to the <a href="#">“Oracle 1.6 TB NVMe SSD Product Notes”</a> in <i>Oracle Flash Accelerator F160 PCIe Card and Oracle 1.6 TB NVMe SSD Product Notes</i> .
Life monitoring capability	<ul style="list-style-type: none"><li>■ Provides alerts for proactive replacement of the drive before the endurance is depleted</li><li>■ Provides endurance remaining in NVMe SMART logs</li></ul>
Status indicators	<ul style="list-style-type: none"><li>■ Blue, amber, and green LEDs on drive bracket indicate status</li><li>■ See <a href="#">“Status Indicators”</a> on page 12.</li></ul>

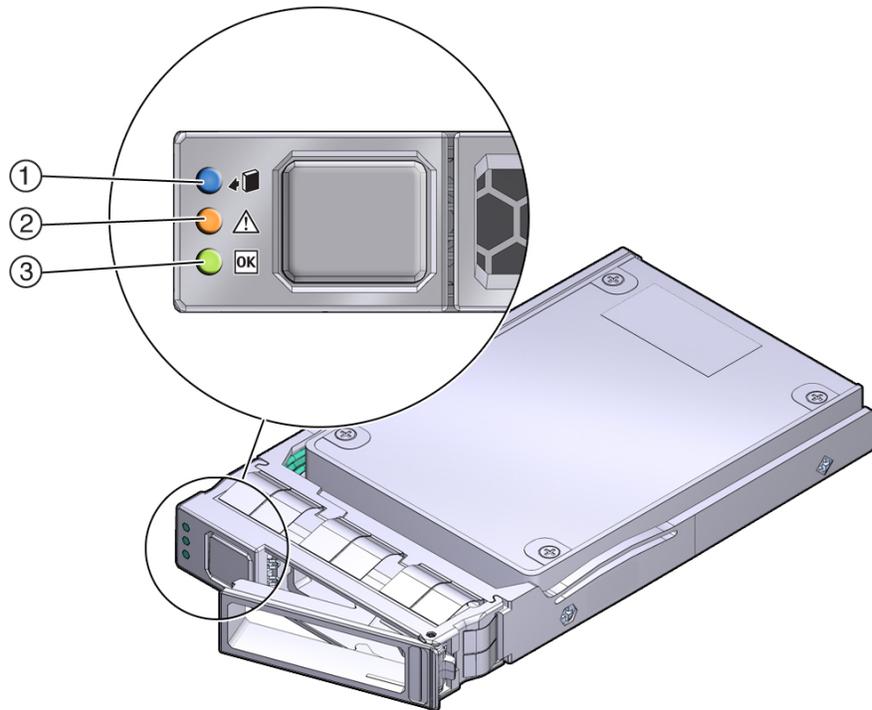
## Related Information

- [“Specifications”](#) on page 15
- [“Product Overview”](#) on page 9
- [“Servicing the NVMe Drive Using Oracle Hardware Management Pack”](#) on page 43

## Status Indicators

Use the Oracle 1.6 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 the Oracle 1.6 TB NVMe SSD.



Indicator	Color	Status
(1) Ready to Remove	Blue	<ul style="list-style-type: none"> <li>■ OFF – The drive has not been prepared for removal. Normal operation.</li> <li>■ STEADY ON – The drive is in standby power state. The drive can be removed safely during a hot-plug operation. A lit Ready to Remove indicator indicates that service action is allowed on the drive.</li> </ul>
(2) Service Action Required	Amber	<ul style="list-style-type: none"> <li>■ OFF – Normal operation.</li> <li>■ STEADY ON – Service action is required. The system has detected a fault with the drive.</li> </ul>
(3) Power/OK/Activity	Green	<ul style="list-style-type: none"> <li>■ STEADY ON (does not blink) – Drive is engaged and is receiving full power. Normal operation.</li> <li>■ RANDOM BLINKING – There is drive activity. Status indicator blinks on and off to indicate activity.</li> <li>■ OFF – Power is off, or installed drive is not recognized by the system.</li> </ul>

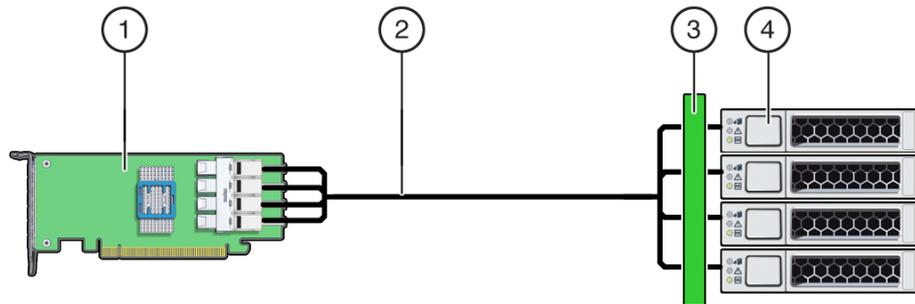
## Related Information

- [“Product Overview” on page 9](#)
- [“NVMe Drive Service Overview” on page 35](#)

## About Oracle PCIe NVMe Switch Cards and 1.6 TB NVMe SSDs

1.6 TB NVMe SSD drives 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. This Oracle PCIe NVMe Switch Card provides high bandwidth and low latency for up to four NVMe drives. The Oracle PCIe NVMe Switch Card plugs into a low profile x8 PCIe Gen 3 card slot and uses sixteen lanes to support four NVMe storage drive devices.

The following illustration shows four Oracle 1.6 TB NVMe SSDs connected to one Oracle PCIe NVMe Switch Card in an x86 server configuration.



### Legend

1. Oracle PCIe NVMe Switch Card
2. Server NVMe Connecting Cable
3. Server NVMe Disk Backplane
4. Oracle 1.6 TB NVMe SSD storage drives in NVMe bays

### Related Information

- [“Specifications” on page 15](#)
- [“Product Overview” on page 9](#)

## Specifications

The following sections provide the specifications and capabilities of the Oracle 1.6 TB NVMe SSD:

- [“Product Specification” on page 15](#)
- [“Environmental Specifications” on page 17](#)
- [“Electrical Specifications” on page 18](#)
- [“Reliability Specifications” on page 18](#)
- [“Physical Dimensions” on page 20](#)

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

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## Product Specification

Oracle 1.6 TB NVMe SSD general specifications are shown in the following table:

Specification	Value
Capacity	Usable capacity 1.6 TB  Unformatted capacity (total user addressable sectors in LBA mode) 3,125,627,568
PCIe	PCIe Gen3 x4
Form factors	<ul style="list-style-type: none"> <li>■ 2.5-inch SFF (small form factor)</li> <li>■ SFF-8639 compatible connector</li> <li>■ 15mm Z-height</li> </ul>
Performance <sup>††</sup>	Sequential Read/Write: Up to 2500/1500 MB/sec  Sequential Latency (typical) Read/Write: 20/20 µsec  Random Latency (typical) Read/Write: 120/30 µsec  Power On to Ready Latency (typical): 2 sec  IOPS <ul style="list-style-type: none"> <li>■ Random Read/Write 4KB 70/30: Up to 160,000</li> <li>■ Random Read/Write 8KB 70/30: Up to 75,000</li> <li>■ Random 4K Read: Up to 440,000</li> </ul>

## Specifications

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Specification	Value
	<ul style="list-style-type: none"> <li>■ Random 4K Write: Up to 70,000</li> <li>■ Random 8K Read: Up to 260,000</li> <li>■ Random 8K Write: Up to 42,000</li> <li>■ Random Read/Write Consistency 4K/8K: 90%</li> </ul>
Components	<ul style="list-style-type: none"> <li>■ High Endurance Intel® 20nm eMLC NAND Flash Memory</li> <li>■ Intel® Flash Memory NVMe Controller ASIC</li> </ul>
Reliability	<ul style="list-style-type: none"> <li>■ Uncorrectable Bit Error Rate (UBER): 1 sector per 10<sup>17</sup> bits read</li> <li>■ Mean Time Between Failure (MTBF): 2 million hours</li> <li>■ T10 DIF protection</li> </ul> <p><a href="#">“Reliability Specifications” on page 18</a></p>
Power	<ul style="list-style-type: none"> <li>■ 3.3V and 12V supply rail</li> <li>3.3Vaux for SMBUS</li> <li>■ Active/Idle (typical): Up to 25W/4W (typical)</li> <li>■ Enhanced power-loss data protection.</li> </ul> <p><a href="#">“Electrical Specifications” on page 18</a></p>
Certifications and declarations	UL, CE, C-Tick, BSMI, KCC, Microsoft WHQL, VCCI
Compliance	<ul style="list-style-type: none"> <li>■ NVM Express 1.0c</li> <li>■ PCI Express Base Specification Rev 3.0</li> <li>■ Enterprise SSD Form Factor Version 1.0a</li> <li>■ PCI Express Card Electro-Mechanical (CEM) Specification Rev 2.0</li> </ul>
Endurance rating	<ul style="list-style-type: none"> <li>■ Up to 14 PBW (petabytes written)</li> <li>■ 5 Drive Writes/day (JESD219 workload)</li> </ul>
Altitude (simulated)	<ul style="list-style-type: none"> <li>■ Operating: -1,000 to 10,000 ft</li> <li>■ Non-Operating: -1,000 to 40,000 ft</li> </ul>
Temperature	<ul style="list-style-type: none"> <li>■ Operating: <ul style="list-style-type: none"> <li>■ 0 to 35° C ambient, 0 to 70° C case with specified airflow</li> <li>■ Temperature monitoring (In-band and by way of SMBUS)</li> <li>■ Thermal throttling</li> </ul> </li> <li>■ Non-Operating: -55 to 95° C</li> </ul>
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"> <li>■ Operating: 2.17 GRMS (5-700Hz)</li> <li>■ Non-Operating: 3.13 GRMS (5-800Hz)</li> </ul>
Product ecological compliance	RoHS

<sup>†</sup>Performance values vary by capacity and form factor.

<sup>‡</sup>Performance specifications apply to both compressible and incompressible data.

## Related Information

- [“Product Overview” on page 9](#)
- [“NVMe Drive Service Overview” on page 35](#)

## Environmental Specifications

The Oracle 1.6 TB NVMe SSD operates and is stored in an environment defined by the parameters and specifications in the following table:

Specification	Value
Operating temperature	<ul style="list-style-type: none"> <li>■ 0 to 35° C ambient, 0 to 70° C case with specified airflow</li> <li>■ Operational environment: 5° C to 35° C (dry bulb)</li> </ul>
Non-operating temperature	Storage and transit environment: -55° C to 95° C (dry bulb)
Temperature monitoring	<ul style="list-style-type: none"> <li>■ Temperature monitoring in-band and by way of SMBUS</li> <li>■ See <a href="#">“Troubleshooting NVMe Drive Cooling” on page 41</a> for more information on thermal throttling.</li> </ul>
Dry bulb temperature	Maximum dry bulb temperature shall be derated by 3.3° C per 1000 m above 500 m
Altitude (Simulated)	<ul style="list-style-type: none"> <li>■ Operating: -1,000 to 10,000 ft</li> <li>■ Non-Operating: -1,000 to 40,000 ft</li> </ul>
Relative humidity range	<ul style="list-style-type: none"> <li>■ Operational environment: 8% to 80% noncondensing</li> <li>■ Storage and transit environment: 5% to 95% noncondensing</li> <li>■ Non-operating: -20° C to 75° C noncondensing</li> </ul>
Thermal sensors	<ul style="list-style-type: none"> <li>■ Thermal sensors on the storage drives monitor flash memory modules</li> <li>■ Thermal sensor temperature cannot exceed 73° C</li> <li>■ See illustration in <a href="#">“Troubleshooting NVMe Drive Cooling” on page 41</a> for thermal sensor locations.</li> </ul>
Airflow requirement	<ul style="list-style-type: none"> <li>■ More than 450 LFM (linear feet/minute, at 25/35° C, airflow towards the connector)</li> </ul>

**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 9](#)
- [“NVMe Drive Service Overview” on page 35](#)

## Electrical Specifications

Oracle 1.6 TB NVMe SSD electrical specifications are shown in the following table:

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

The Oracle 1.6 TB NVMe SSD receives electrical power from the PCI Express +12 VDC and +3.3 VDC power rails as shown in the following table:

Specification	12 V Operating Characteristics	3.3 Vaux 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 10Hz – 100KHz	300 mV pp at 10Hz – 100KHz
	100 mV pp at 100KHz – 20 MHz	50 mV pp at 100KHz – 20 MHz
Min off time	3s	3s
Inrush current (typical peak)	1.5 A	1.5 A
Max average current	2.45 A	1 mA

### Related Information

- [“Product Overview” on page 9](#)
- [“NVMe Drive Service Overview” on page 35](#)

## Reliability Specifications

The Oracle 1.6 TB NVMe SSD reliability specifications are shown in the following table:

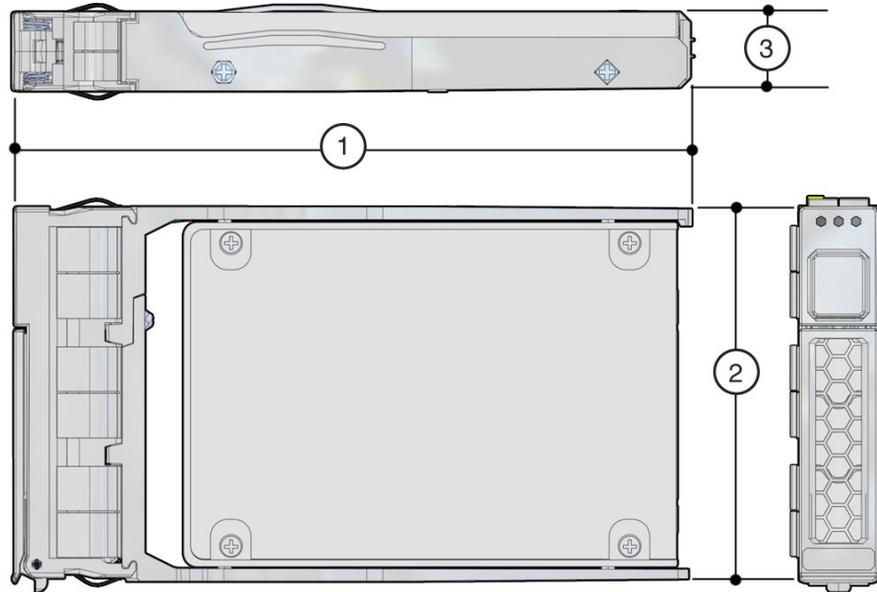
Specification	Value
Uncorrectable Bit Error Rate (UBER)	<p>Uncorrectable bit error rate will not exceed one sector in the specified number of bits read.</p> <p>In the unlikely event of a non-recoverable read error, the storage drive will report it as a read failure to the host; the sector in error is considered corrupt and is not returned to the host.</p> <p>&lt; 1 sector per <math>10^{17}</math> 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. 3 months power-off retention once storage drive reaches rated write endurance at 40° C.</p>
Endurance Rating	<ul style="list-style-type: none"> <li>■ Up to 14 PBW (petabytes written)</li> </ul> <p>Endurance rating verification is defined to establish UBER &lt;1E-16 at 60% upper confidence limit.</p> <ul style="list-style-type: none"> <li>■ 5 Drive Writes/day (JESD219 workload)</li> </ul> <p>The number of drive writes 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 SSD's integrated monitoring enables the integrity of already committed data on the media and commits acknowledged writes to the media.</p> <p>See <a href="#">“Servicing the NVMe Storage Drive” on page 35.</a></p>

## Related Information

- [“Product Overview” on page 9](#)
- [“Servicing the NVMe Storage Drive” on page 35](#)

## Physical Dimensions

The following diagram shows Oracle 1.6 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/-0.5 mm (0.59 in.)
Weight	125 g maximum (4.4 oz)

### Related Information

- [“Product Overview” on page 9](#)

# Preparing the NVMe Storage Drive for Installation

---

These topics provide information about preparing an Oracle 1.6 TB NVMe SSD for installation:

Description	Links
Review Prepare for Installation procedure.	<a href="#">“Prepare for Installation” on page 21</a>
Gather the required tools.	<a href="#">“Required Tools” on page 22</a>
Unpack the shipping kit.	<a href="#">“Ship Kit Contents” on page 22</a>
Review safety information.	<a href="#">“Observing Safety Precautions” on page 23</a>
Review electrostatic discharge (ESD) safety measures.	<a href="#">“ESD Safety Measures” on page 24</a>
Review 1.6 TB NVMe SSD Optimization Guidelines.	<a href="#">“Oracle 1.6 TB NVMe SSD Optimization Guidelines” on page 25</a>
Update your system to the latest software release.	<a href="#">“Update Your System to the Latest Software Release” on page 27</a>

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**Note** - For specific installation instructions, see your system installation guide. For information about installation and use of the SSD on your server, see the most recent version of the server product notes.

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**Note** - NVMe storage drives are supported only on servers that are running Oracle Solaris or Oracle Linux operating systems. Servers that are running Oracle VM, Windows Server, Red Hat Enterprise Linux, SUSE Linux Enterprise Server, or VMware ESXi do not support NVMe drives.

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## ▼ Prepare for Installation

1. **Gather the required tools.**  
See [“Required Tools” on page 22](#).

2. **Unpack the shipping kit that includes the SSD.**
  - a. **Unpack the SSD in a static free environment.**  
See “[Ship Kit Contents](#)” on page 22.
  - b. **Remove the SSD drive from its packaging, and place the drive on an antistatic mat, using good antistatic grounding procedures.**  
See “[ESD Safety Measures](#)” on page 24.
3. **Carefully inspect the SSD drive for damage.**
  - a. **Inspect the drive for shipment damage. If any damage is detected, contact your supplier.**
  - b. **If you notice any damage, contact Oracle support, or your reseller support representative. Go to: <https://support.oracle.com>.**

## Required Tools

You will need the following tools for most service operations:

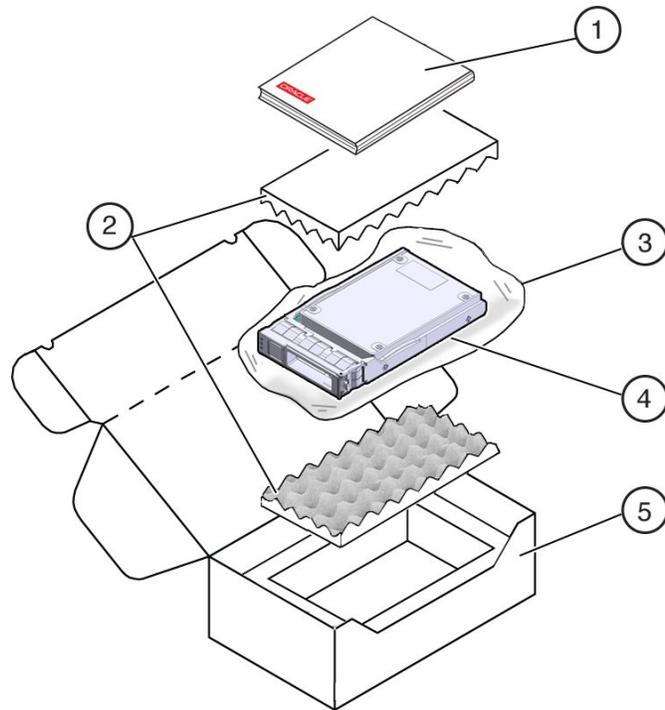
- Antistatic wrist strap
- Antistatic mat

### Related Information

- “[Preparing the NVMe Storage Drive for Installation](#)” on page 21
- “[ESD Safety Measures](#)” on page 24

## Ship Kit Contents

The Oracle 1.6 TB NVMe SSD ship kit contains the components shown in the following illustration:



1. Documentation
2. Foam
3. Antistatic bag
4. Oracle 1.6 TB NVMe SSD
5. Packaging

### Related Information

- [“Preparing the NVMe Storage Drive for Installation” on page 21](#)
- [“Product Overview” on page 9](#)

## Observing Safety Precautions

This section contains safety information about safeguarding the equipment and personnel from damage:

- [“General Safety Information” on page 24](#)
- [“Safety Symbols” on page 24](#)
- [“ESD Safety Measures” on page 24](#)
- [“Perform ESD Prevention Measures” on page 25](#)

## 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's 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:



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

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

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

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## 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 drives, require special handling.

- Place ESD-sensitive components and other PCBs on an antistatic mat (not provided).

- Wear an antistatic wrist strap when handling ESD-sensitive components.



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

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#### Related Information

- [“Perform ESD Prevention Measures” on page 25](#)
- [“NVMe Drive Service Overview” on page 35](#)

## ▼ Perform ESD Prevention Measures

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

Place ESD-sensitive components such as the printed circuit boards 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 (not provided).**

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 24](#)
- [“NVMe Drive Service Overview” on page 35](#)

## Oracle 1.6 TB NVMe SSD Optimization Guidelines

To optimize performance, observe the following guidelines when setting up Oracle 1.6 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.
- The Oracle 1.6 TB NVMe SSDs is 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. The Oracle 1.6 TB NVMe SSD has a maximum transfer size of 128k. IO requests for larger transfer sizes are broken into transfer sizes of size 128k or smaller. For optimal performance, transfer sizes should be limited to 128k to avoid additional overhead associated with breaking into smaller transfer sizes.
- The Oracle 1.6 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 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 the partition is 4k-aligned as discussed above. For optimal performance of ZFS with the 1.6 TB NVMe SSD, refer to the *ZFS Best Practices Guide* and the *ZFS Evil Tuning Guide*.
- For highest performance, make sure that the system meets the physical, environmental, and electrical specifications listed in “Specifications” on page 15.

### Related Information

- “Preparing the NVMe Storage Drive for Installation” on page 21
- Tuning ZFS When Using Flash Storage [http://docs.oracle.com/cd/E26502\\_01/html/E29022/chapterzfs-flash.html](http://docs.oracle.com/cd/E26502_01/html/E29022/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 1.6 TB domains into a single 6.4 TB volume.

Refer to the documentation for more information at [http://docs.oracle.com/cd/B28359\\_01/server.111/b31107/asmcon.htm](http://docs.oracle.com/cd/B28359_01/server.111/b31107/asmcon.htm).

## ▼ 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.

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**Note** - System firmware update releases include Oracle 1.6 TB NVMe SSD component firmware updates. When system firmware updates, as described in the server documentation, the Oracle 1.6 TB NVMe SSD firmware automatically updates.

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1. **Check the Oracle 1.6 TB NVMe SSD Product Notes for the latest firmware requirements, available at the Oracle 1.6 TB NVMe SSD Documentation Library. Go to:**

<http://www.oracle.com/goto/oracleflashf160/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 get the latest available system BIOS, Oracle Integrated Lights Out Manager (ILOM), firmware, and drivers from Oracle by performing the Get Updates task in Oracle System Assistant.**

An Internet connection is required. For instructions on how to use the Get Updates task, see the servers administration guide.

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

For information about downloading firmware and software from My Oracle Support, see “Getting Server Firmware and Software Updates” in the server documentation.

### Related Information

- [“Downloading the SSD Software Package” in Oracle Flash Accelerator F160 PCIe Card and Oracle 1.6 TB NVMe SSD Product Notes](#)

- “Update the NVMe Storage Drive Firmware” in *Oracle Flash Accelerator F160 PCIe Card and Oracle 1.6 TB NVMe SSD Product Notes*
- “Verify Oracle 1.6 TB NVMe SSD Operation” in *Oracle Flash Accelerator F160 PCIe Card and Oracle 1.6 TB NVMe SSD Product Notes*
- “Product Overview” on page 9
- “NVMe Drive Service Overview” on page 35

## Accessing Software Updates and Firmware Downloads

Product patches, updates and firmware are available on My Oracle Support at <https://support.oracle.com>. from the Patches and Updates tab. Information on accessing and using My Oracle Support can be found at the *My Oracle Support Welcome Center for Oracle Sun Customers and Partners*.

See “[Downloading the Drive Software Package](#)” on page 28.

### ▼ Downloading the Drive Software Package

To find the drive software package, access *My Oracle Support* and download the latest software package for the Oracle 1.6 TB NVMe SSD.

1. **Sign in to My Oracle Support at <https://support.oracle.com>.**
2. **Click the "Patches & Updates" tab.**
3. **In the "Patch Search" box on the right side, select "Product or Family (Advanced Search)".**
4. **Enter a partial product name for "Product is".**  
A list of matches displays.
5. **Select the product of interest.**  
Select one or more "releases" in the "Release is" drop down list.  
Close the pop-up window.
6. **Click Search.**  
A list of product downloads (listed as patches) displays.

**7. Select the download of interest.**

The Download Information Page displays.

If, on the Download Information Page, you get the message "You do not have permissions to download this Patch...", see *How Patches and Updates Entitlement Works* at <https://support.oracle.com> to help you determine the reason.



# Installing the NVMe Storage Drive

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These topics provide information about installing the Oracle 1.6 TB NVMe SSD into a server.

Description	Links
Review installation tasks and performance tuning information before installing SSD.	<a href="#">“Installation Overview” on page 31</a>
Install a new SSD into a server.	<a href="#">“Install a New NVMe Storage Drive (CRU)” on page 32</a>

## Installation Overview

Read this overview information section before installing the Oracle 1.6 TB NVMe SSD into a server.

- [“NVMe Storage Drive Installation Overview” on page 31](#)
- [“Oracle 1.6 TB NVMe SSD Optimization Guidelines” on page 25](#)

For information on how to install your 1.6 TB NVMe SSD, refer to your server service documentation or drive enclosure documentation.

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

## NVMe Storage Drive Installation Overview

To install your 1.6 TB NVMe SSD into a system, refer to the following table:

Steps	Task	See
1.	Prepare the SSD for installation. Carefully unpack the SSD. Inspect the SSD for damage. Follow ESD precautions.	<a href="#">“Preparing the NVMe Storage Drive for Installation” on page 21</a>

Steps	Task	See
2.	Insert the SSD in an available drive slot.	<a href="#">“Install a New NVMe Storage Drive (CRU)” on page 32</a>

Refer to the server's service manual for additional information.

### Related Information

- [“Product Overview” on page 9](#)
- [“NVMe Drive Service Overview” on page 35](#)

## ▼ Install a New NVMe Storage Drive (CRU)

To install a new Oracle 1.6 TB NVMe SSD (2.5 Inch small form factor) into a 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's service manual for drive locations on the server.

Refer to [“Supported Servers and Operating Systems” in Oracle Flash Accelerator F160 PCIe Card and Oracle 1.6 TB NVMe SSD Product Notes](#) at:

<http://www.oracle.com/goto/oracleflashf160/docs>

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**Note** - While using a Oracle 1.6 TB NVMe SSD 2.5-inch small form factor drive, locate a server slot on the servers panel labeled NVMe (with SFF-8639 disk backplane and connector) that is capable of supporting the Oracle 1.6 TB NVMe SSD. Your server chassis must contain NVMe equipment, including Oracle NVMe Switch Controller Cards and cables. Refer to the server's service manual for NVMe SSD installation instructions.

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

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

4. **Prepare the SSD for installation.**

See [“Preparing the NVMe Storage Drive for Installation” on page 21](#).

**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 servers service manual.

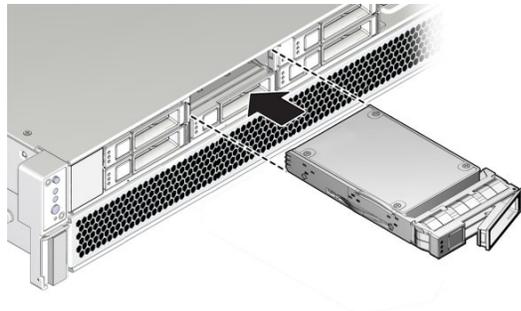
**6. If necessary, remove the drive filler panel.**

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's service manual.

**7. Slide the Oracle 1.6 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 servers administration guide or the OS documentation.

- 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 1.6 TB NVMe SSD is visible to your server operating system.

**d. Configure the system to maximize flash technology.**

**Related Information**

- [“Product Overview” on page 9](#)
- [“NVMe Drive Service Overview” on page 35](#)

# Servicing the NVMe Storage Drive

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These topics provide service information for the Oracle 1.6 TB NVMe SSD.

Description	Links
Review service task and troubleshooting information.	<a href="#">“NVMe Drive Service Overview” on page 35</a>
Review NVMe drive component serviceability information.	<a href="#">“Component Serviceability” on page 36</a>
Remove and replace NVMe drives.	<a href="#">“Replace An Existing NVMe Storage Drive (CRU)” on page 37</a>
Contact My Oracle Support (MOS).	<a href="#">“Technical Support” on page 41</a>
Troubleshoot NVMe drive thermal issues.	<a href="#">“Troubleshooting NVMe Drive Cooling” on page 41</a>
Use Oracle Hardware Management Pack utilities command line interface (CLI) tools to service the NVMe drive.	<a href="#">“Servicing the NVMe Drive Using Oracle Hardware Management Pack” on page 43</a>

## NVMe Drive Service Overview

For service, the Oracle 1.6 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 [“Servicing the NVMe Drive Using Oracle Hardware Management Pack” on page 43](#).

In addition, you can monitor Oracle 1.6 TB NVMe SSD health and flash media drive life through SSD bracket status indicators (LEDs). The SSD has three status indicators on the drive bracket to indicate activity, drive life, and status. See [“Status Indicators” on page 12](#).

The Oracle 1.6 TB NVMe SSD requires no periodic maintenance. For data protection, the Oracle 1.6 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 the Oracle 1.6 TB NVMe SSD and do not require periodic maintenance.

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**Note** - Refer to the server documentation for additional NVMe Storage Drive service and firmware download information. Refer to the server's service manual for SSD detailed removal and replacement instructions.

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## Component Serviceability

The following service actions can be performed on a 1.6 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

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, so 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.

Refer to the server documentation for additional service information.

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

Component	Serviceability	Replacement Instructions
Oracle 1.6 TB NVMe SSD (and fillers)	Hot	<a href="#">“Installing the NVMe Storage Drive” on page 31</a>  <a href="#">“Replace An Existing NVMe Storage Drive (CRU)” on page 37</a>  For instructions on safe installation and removal of SSDs, refer to the server's service manual.
	CRU	
Oracle PCIe NVMe Switch Card	Cold	For instructions on safe installation and removal of cards, refer to the server's service manual.
	FRU	
NVMe cables	Cold	For instructions on safe installation and removal of cables and connected drive backplane, refer to the server's service manual.
	FRU	

**See Also:**

- [“Product Overview” on page 9](#)
- [“Technical Support” on page 41](#)

## ▼ Replace An Existing NVMe Storage Drive (CRU)

Replace an Oracle 1.6 TB NVMe SSD if the drive fails or the usable drive life has been exceeded.



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**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 a server NVMe-capable slot. Your server chassis must contain an NVMe capable configuration including Oracle NVMe Switch Controller Cards and cables.

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**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 anti-static practices as described in [“ESD Safety Measures” on page 24](#).

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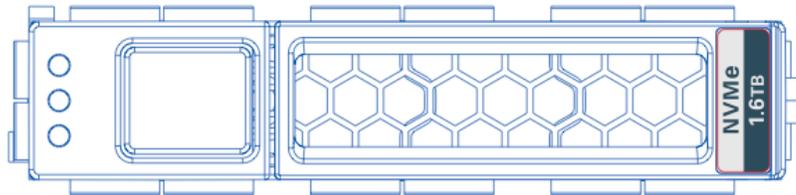
The following task describes an example procedure. Follow the server's service manual instructions.

- 1. Prepare the server operating system, as required, before you remove drives.**  
Follow the server's 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 2.5-inch form factor drive, locate a server slot on the server's front panel labeled **NVMe** (with SFF-8639 disk backplane and connector) that is capable of supporting the Oracle 1.6 TB NVMe SSD that is labeled as shown in the following figure. Never insert an NVMe storage drive into a non-NVMe capable slot that supports HDD only (labeled HDD).

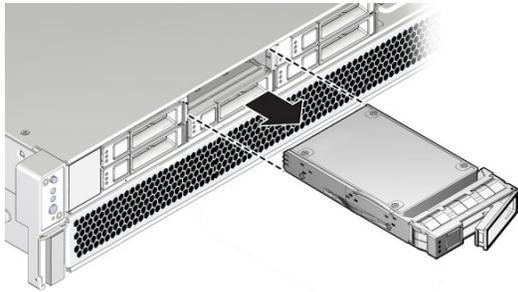
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3. **Observe the status indicators on the front panel of the drive to verify which drive in the server requires replacement.**
  - Verify that the Blue OK to Remove status indicator (LED) on the NVMe storage drive is lit.
  - Green (operational), Amber (faulty disk), Blue (SSD has been prepared for removal)
  - See [“Status Indicators” on page 12.](#)
4. **Remove the NVMe storage drive from the server.**
  - a. **On the drive 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's 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.

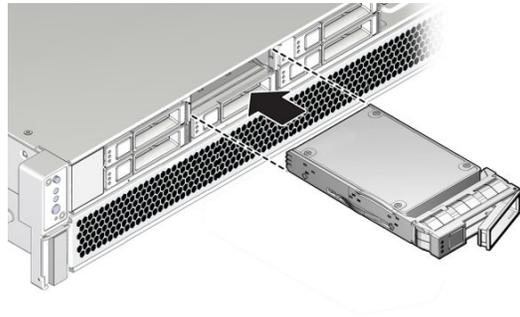
Refer to [“Supported Servers and Operating Systems” in Oracle Flash Accelerator F160 PCIe Card and Oracle 1.6 TB NVMe SSD Product Notes.](#)

**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's front panel labeled **NVMe** (with SFF-8639 disk backplane and connector) that is capable of supporting the Oracle 1.6 TB NVMe SSD. Never insert an NVMe storage drive into a non-NVMe capable slot (HDD).

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7. **For hot plug service actions, configure the NVMe storage drive and verify drive availability.**
  - Follow the server's 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

- [“Servicing the NVMe Drive Using Oracle Hardware Management Pack” on page 43](#)
- [“Product Overview” on page 9](#)

## Technical Support

For assistance installing, configuring, or running the Oracle 1.6 TB NVMe SSD, contact My Oracle Support (MOS).

### Related Information

- [“Contacting Technical Support” on page 41](#)
- [“Product Overview” on page 9](#)

## ▼ Contacting Technical Support

For assistance installing, configuring, or running the Oracle 1.6 TB NVMe SSD, contact My Oracle Support (MOS).

**Before You Begin** Please have your CSI Customer Support ID ready.

### ● Go to My Oracle Support:

- **Go to:** <https://support.oracle.com>  
Sign in to My Oracle Support to open a service request.
- **Call Oracle support, using the appropriate number from the Oracle Global Customer Support Contacts Directory:**  
<http://www.oracle.com/us/support/contact-068555.html>

### Related Information

- [“Technical Support” on page 41](#)
- [“Product Overview” on page 9](#)

## Troubleshooting NVMe Drive 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 over temperature and hardware-related issues as soon as they occur.

The 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.

Use the status indicators to determine the status of the Oracle 1.6 TB NVMe SSD. The LEDs provide key status indicators to diagnose SSD issues. See [“Status Indicators” on page 12](#).

Should the system maximum operating temperature be exceeded or a system fault occur which 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 status indicator amber, Service Action Required.
  - Temperature warning displays in utility output.
- 78° C - Additional drive write throttling is engaged.
  - SSD status indicator amber, Service Action Required.
  - Critical temperature status displays in utility output.

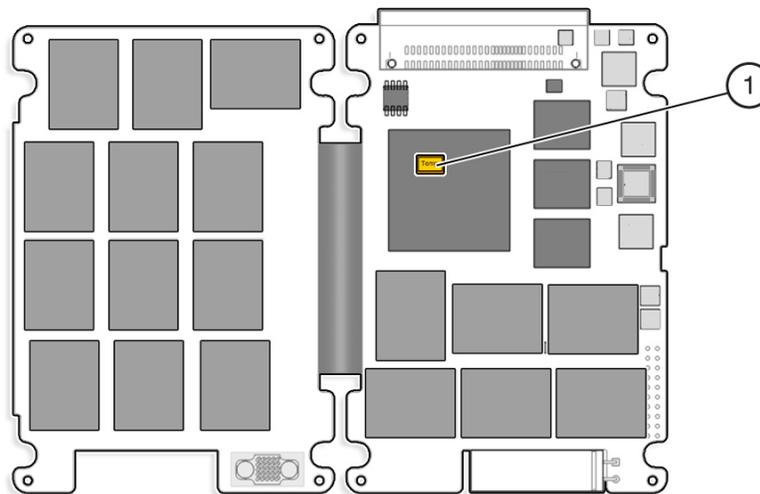


**Caution** - Sustained critical temperatures might cause data loss.

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Refer to the server documentation for additional service information.

The following image shows the SSD temperature sensor locations:



(1): SSD temperature sensor location (PCB both sides underneath ASIC)

#### Related Information

- [“Status Indicators” on page 12](#)
- [“Product Overview” on page 9](#)
- [“Technical Support” on page 41](#)

## Servicing the NVMe Drive Using Oracle Hardware Management Pack

The Oracle Hardware Management Pack utilities support command line interface (CLI) tools to service the Oracle 1.6 TB NVMe SSD. Oracle Hardware Management Pack tools provide commands and agents that operate at the operating system level and can be used across multiple systems. You can monitor hardware through the operating system, either remotely using SNMP or locally using CLI tools.

This section includes the following sections:

- [“Oracle Hardware Management Pack Documentation” on page 43](#)
- [“Access Command Line Interface \(CLI\) in Oracle Hardware Management Pack Utility” on page 44](#)

## Oracle Hardware Management Pack Documentation

Documentation for Oracle Hardware Management Pack can be found on the web at:

<http://www.oracle.com/goto/OHMP/docs>

The following table lists the Oracle Hardware Management Pack documentation.

Guide	Number	Description
Oracle Hardware Management Pack 2.3 Installation Guide	E52097	Overview of Hardware Management Pack components and instructions on installing Hardware Management Pack.

Guide	Number	Description
Oracle Server CLI Tools 2.3 User's Guide	E52099	Instructions on how to use the Oracle Hardware Management Pack CLI tools. Includes information on NVMe controller administration.
Oracle Server Management Agents 2.3 User's Guide	E52098	Details about installing and configuring the Oracle Server Management Agents, which enable you to manage servers at the operating system level.

### Related Information

- [“Access Command Line Interface \(CLI\) in Oracle Hardware Management Pack Utility” on page 44](#)
- [“Servicing the NVMe Drive Using Oracle Hardware Management Pack” on page 43](#)
- [“Product Overview” on page 9](#)

## ▼ Access Command Line Interface (CLI) in Oracle Hardware Management Pack Utility

To access the Oracle Hardware Management Pack CLI:

### 1. Obtain Oracle Hardware Management Pack.

- **Download the Oracle Hardware Management Pack at:**  
<https://support.oracle.com>
- **Get the Add-on software pack from Oracle System Assistant.**

Refer to [“Oracle 1.6 TB NVMe SSD Product Notes” in \*Oracle Flash Accelerator F160 PCIe Card and Oracle 1.6 TB NVMe SSD Product Notes\*](#) for additional download information at:

<http://www.oracle.com/goto/oracleflashf160/docs>

### 2. Access host server console devices remotely or locally.

Ensure that a KVM console is remotely or locally connected to the server.

Refer to the server's service manual.

- Connect an Ethernet cable to the Gigabit Ethernet (NET) connectors as needed for OS support.
- Connect to the service processor's Oracle ILOM over the network and connect an Ethernet cable to the Ethernet port labeled NET MGT.

- Access the Oracle ILOM command-line interface (CLI) locally using the management port and connect a serial null modem cable to the RJ-45 serial port labeled SER MGT.
- To interact with the system console locally, connect a mouse and keyboard to the USB connectors and a monitor to the DB-15 video connector.

**3. Open a CLI terminal.**

**4. Type a command.**

See [“Oracle Hardware Management Pack Documentation” on page 43](#).

Refer to the server documentation.

**Related Information**

- [“Oracle Hardware Management Pack Documentation” on page 43](#)
- [“Servicing the NVMe Drive Using Oracle Hardware Management Pack” on page 43](#)
- [“Product Overview” on page 9](#)



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