Oracle® 3.2 TB NVMe SSD User Guide

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Using This Documentation

- **Overview** – This user guide provides detailed procedures that describe installation, configuration, and service of the Oracle 3.2 TB NVMe SSD.
- **Audience** – Technicians, system administrators, authorized service providers, and users.
- **Required knowledge** – Experience with servers and advanced understanding of server storage systems. Advanced experience troubleshooting and replacing hardware.

Product Documentation Library

Documentation and resources for this product and related products are available at http://www.oracle.com/goto/oracleflashf320/docs.

Feedback

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

Product Overview

These topics describe the specifications and capabilities of the Oracle 3.2 TB NVMe SSD (non-volatile memory express, solid-state drive).

Review the following product information sections before you install or service your Oracle 3.2 TB NVMe storage drive:

Description	Links
Learn about Oracle 3.2 TB NVMe SSD features and functions.	“Oracle 3.2 TB NVMe SSD Overview” on page 9
Review specifications and capabilities.	“Specifications” on page 14

Oracle 3.2 TB NVMe SSD Overview

These topics provide an overview of Oracle 3.2 TB NVMe SSD features and functions:

- “About the Oracle 3.2 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 3.2 TB NVMe SSDs” on page 13

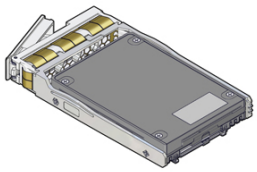
About the Oracle 3.2 TB NVMe SSD

The Oracle 3.2 TB NVMe SSD presents outstanding performance with instant responsiveness to the host system, by applying the Peripheral Component Interconnect Express (PCIe) 3.0 interface standard, and the highly efficient Non-Volatile Memory Express (NVMe) Protocol. The Oracle 3.2 TB NVMe SSD delivers wide bandwidth of 3.1 GB/s for sequential read speed and 1.75 GB/s for sequential write speed under 20W of power. With the help of a Toggle 2.0

NAND Flash interface, the Oracle 3.2 TB NVMe SSD delivers Quality of Service of 95 µsec for random 4 KB read of 1 M IOPS and 60 µsec for random 4 KB write of 120 K IOPS in the sustained state. By combining the enhanced reliability NAND Flash memory silicon with NAND Flash management technologies, the Oracle 3.2 TB NVMe SSD delivers the extended endurance of up to 5 Drive Writes Per Day (DWPD) for 5 years, which is suitable for enterprise applications, in a 2.5-inch form factor.

The Oracle 3.2 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 3.2 TB NVMe SSD:



Related Information

- “Specifications” on page 14
- “Product Overview” on page 9

Key Features

Oracle 3.2 TB NVMe SSD has the following key features:

- NVM Express (NVMe)
- PCI Express Gen3 - Single port x4 lanes
- Enhanced Power-Loss Data Protection
- LDPC and XOR Engine ECC
- End-to-End Data Protection
- Up to 128 I/O Queues per Port
- Deallocate (TRIM) Command
- PCI Express AER (Advanced Error Reporting)
- 129 vectors for MSI-X Support
- SSD Enhanced S.M.A.R.T. Feature Set

- Hardware based AES-XTS 256-bit Encryption Engine
- Static and Dynamic Wear Leveling
- Supports SFF-8639 SMBus

Related Information

- “Specifications” on page 14
- “Product Overview” on page 9

Characteristics

The Oracle 3.2 TB NVMe SSD has the following hardware and software characteristics:

Characteristic	Value
Device name	PM1725 3.2 TB eMLC Flash NVMe SFF
Manufacturing name	3.2 TB V-NAND NVMe SSD MZWLK3T2HCJL-000U3
Style	■ Small form factor (SFF) SSD ■ 2.5-inch Form Factor ■ SFF-8639-compatible connector
Capacity	3.2 TB
NAND	Samsung 3D (V-NAND), 3 Cell (TLC)
Flash controller	Samsung EPIC controller
Flash controller firmware	Samsung flash controller
Minimum operating system versions	■ Oracle Solaris 11.3 (SRU 2) ■ Oracle Linux 6.7, based on UEK4 (Unbreakable Linux Kernel Release 4) ■ Oracle Linux 7.2, based on UEK4 (Unbreakable Linux Kernel Release 4)
Management utilities	Oracle Hardware Management Pack For more information about management utilities, refer to the server documentation.
Hardware, firmware, and software compatibility	Refer to “Oracle 3.2 TB NVMe SSD Product Notes” in *Oracle Flash Accelerator F320 PCIe Card and Oracle 3.2 TB NVMe SSD Product Notes*.
Life monitoring capability	■ Provides alerts for proactive replacement of the drive before the endurance is depleted ■ Provides endurance remaining in NVMe SMART logs
Status indicators	■ Blue, amber, and green LEDs on drive bracket indicate status ■ See “Status Indicators” on page 12.

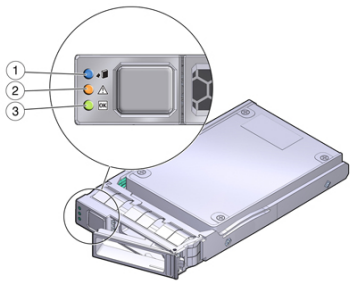
Related Information

- “Specifications” on page 14
- “Product Overview” on page 9
- “Servicing the NVMe Drive Using Oracle Hardware Management Pack” on page 43

Status Indicators

Use the Oracle 3.2 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 3.2 TB NVMe SSD.



Indicator	Color	Status
(1) Ready to Remove	Blue	■ OFF – The drive has not been prepared for removal. Normal operation. ■ 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.
(2) Service Action Required	Amber	■ OFF – Normal operation. ■ STEADY ON – Service action is required. The system has detected a fault with the drive. ■ BLINKING – Locater. Status indicator blinks on and off to locate drive.
(3) Power/ OK/ Activity	Green	■ STEADY ON (does not blink) – Drive is engaged and is receiving full power. Normal operation. ■ RANDOM BLINKING – There is drive activity. Status indicator blinks on and off to indicate activity. ■ OFF – Power is off, or installed drive is not recognized by the system.

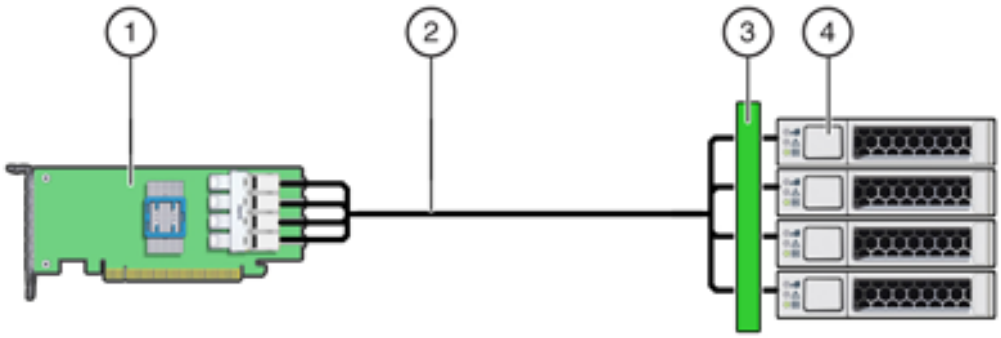
Related Information

- “Product Overview” on page 9
- “NVMe Drive Service Overview” on page 35

About Oracle PCIe NVMe Switch Cards and 3.2 TB NVMe SSDs

Servers equipped with 3.2 TB NVMe SSD drives 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 3.2 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 3.2 TB NVMe SSD storage drives in NVMe bays

Related Information

- “Specifications” on page 14
- “Product Overview” on page 9

Specifications

The following sections describe the specifications and capabilities of the Oracle 3.2 TB NVMe SSD:

- “Product Specification” on page 14
- “Environmental Specifications” on page 17
- “Electrical Specifications” on page 18
- “Reliability Specifications” on page 18
- “Physical Dimensions” on page 20

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

Product Specification

Oracle 3.2 TB NVMe SSD general specifications are shown in the following table:

Specification	Value
Capacity†	■ Usable capacity 3.2 TB ■ Max LBA: 6,251,233,968‡
PCIe	PCIe Gen3 - single port x4 lanes
Form factors	■ 2.5-inch SFF (small form factor) ■ SFF-8639 compatible connector
NAND	■ V2 128Gb NAND Flash Memory ■ V2_TLC HDP 16Landing (533Mbps)
Features	■ NVM Express (NVMe) ■ PCI Express Gen3 - Single port x4 lanes ■ Enhanced Power-Loss Data Protection ■ LDPC and XOR ECC ■ End-to-End Data Protection ■ Hot Plug/Removal Support ■ Up to 128 I/O Queues per Port

Specification	Value
	■ Deallocate (TRIM) Command ■ PCI Express AER (Advanced Error Reporting) ■ 129 vectors for MSI-X Support ■ SSD Enhanced S.M.A.R.T. Feature Set ■ Hardware based AES-XTS 256-bit Encryption Engine ■ Static and Dynamic Wear Leveling ■ Supports SFF-8639 SMBus
Drive Configuration	■ Form Factor: SFF-8639 2.5-inch ■ Interface: PCI Express Gen3 x4 ■ Bytes per Sector: 512, 520, 4096, 4160 Bytes
Performance Specifications * •	■ Data Transfer Rate: (128KB data size) [5] ■ Sequential Read Up to 3,100 MB/s ■ Sequential Write Up to 1,800 MB/s ■ Data I/O Speed: [6] (4KB data size, Sustained) ■ Random Read Up to 750K IOPS [7] ■ Random Write Up to 120K IOPS [8] ■ Latency: (Sustained random workload) [9] ■ Random Read [10] (typical): 90 µsec ■ Write (typical): 20 µsec [11] ■ Drive Ready Time (typical): 2 sec [12] ■ Quality of service (QoS) - Read/Write (99%) 95/60 µsec ■ Performance Consistency - Read/Write (99.9%) Up to 99/95%
Compliance	■ PCI Express Base Specification Rev. 3.0 ■ NVM Express Specification Rev. 1.1b ■ Enterprise SSD Form Factor Ver. 1.0a
Certifications And Declarations	cUL, CE, TUV-GS, CB, CE, BSMI, KCC, VCCI, C-Tick, FCC
Product Ecological Compliance	RoHS
Reliability Specifications	■ Uncorrectable Bit Error Rate: 1 sector per 1017 bits read ■ MTBF: 2,000,000 hours ■ Power on Cycles (Ambient): 20,000 ■ Component Design Life: 5 years ■ Endurance: 5 DWPD ■ PBW (@4KB Random Write): 29.2 PB ■ Data Retention: 3 months
Environmental Specifications	■ Temperature, Case (Tc^5) [13] ■ Operating: 0 ~ 70° C ■ Non-operating: -45 ~ 85° C [14] ■ Humidity (Non-operating) 5 ~ 95% ■ Shock 1,500 G / 0.5msec ■ Vibration - Sinusoidal 20 Gpeak, 10 ~ 2000Hz

Specification	Value
Power Requirements	■ Supply Voltage / Tolerance: 12V±10% ■ Active (max. RMS): 20 W [15] ■ Idle (typ.): 7 W
Physical Dimension	■ Width: 69.85 +/-0.25 mm ■ Length: 100.20 +/-0.25 mm ■ Height: 14.80 +/-0.20 mm ■ Weight: Up to 190 g
Operating Systems	■ Oracle Solaris 11.3 (SRU 2) ■ Oracle Linux 6.7, based on UEK4 (Unbreakable Linux Kernel Release 4) ■ Oracle Linux 7.2, based on UEK4 (Unbreakable Linux Kernel Release 4) Refer to the "Oracle 3.2 TB NVMe SSD Product Notes" in *Oracle Flash Accelerator F320 PCIe Card and Oracle 3.2 TB NVMe SSD Product Notes*.

[†]Capacity shown represents the total usable capacity of the SSD which may be less than the total physical capacity. A certain area in physical capacity, not in the area shown to the user, might be used for the purpose of NAND flash management.

[‡]Max. LBA shown represents the total user addressable sectors in LBA mode and calculated by IDEMA rule.

[*]Based on PCI Express Gen3 x4, Random performance measured using FIO in Ubuntu with queue depth 32 by 16 workers and Sequential performance with queue depth 32 by 16 worker. Actual performance may vary depending on use conditions and environment.

[•]Random performance was measured by using FIO in Ubuntu with queue depth 32 by 16 workers. Measurements were performed on a full Logical Block Address (LBA) span of the drive in sustained state. Actual performance may vary depending on use conditions and environment.

[5]Sequential performance was measured by using FIO in Ubuntu with queue depth 32 by 16 workloads. Actual performance may vary depending on use conditions and environment.

[6]Random performance was measured by using FIO in Ubuntu with queue depth 32 by 16 workloads. Measurements were performed on a full Logical Block Address (LBA) span of the drive in sustained state. Actual performance may vary depending on use conditions and environment.

[7]The read latency is measured by using FIO in Ubuntu and 4KB transfer size with queue depth 1 on a random workload of sustained state.

[8]The write latency is measured by using FIO in Ubuntu and 4KB transfer size with queue depth 1 on a sequential workload of sustained state.

[9]Typical values.

[10]The random read/write latency is measured by using FIO in Ubuntu and 4KB transfer size with queue depth 1 on a random workload of sustained state.

[11]The sequential read/write latency is measured by using FIO in Ubuntu and 4KB transfer size with queue depth 1 on a sequential workload of sustained state.

[12]The maximum taking time to be ready for receiving commands after power-up (CSTS.Ready=1). It is expected that I/O commands may not be completed at this point.

[13]Tc is measured at the hottest point on the case with the airflow condition of more than 2.5 CFM at 25° C of ambient temperature.

[14]Storing (or shipping) without power connection.

[15]Active power is measured using IOMeter2006.

Related Information

- "Product Overview" on page 9
- "NVMe Drive Service Overview" on page 35

Environmental Specifications

The Oracle 3.2 TB NVMe SSD operates and is stored in an environment defined by the parameters and specifications that are shown in the following table:

Specification	Value
Operating temperature †	0 to 70° C
Non-operating temperature ‡	Storage and transit environment: –-45 to 85° C
Altitude (Simulated)	■ Operating: -1,000 to 10,000 ft ■ Non-Operating: -1,000 to 40,000 ft
Relative humidity range	■ Operational environment: 8% to 80% noncondensing ■ Storage and transit environment: 5% to 95% noncondensing
Temperature monitoring	■ Temperature monitoring in-band and by way of SMBUS. ■ See “Troubleshooting NVMe Drive Cooling” on page 41 for more information on thermal throttling.
Thermal sensors	■ Thermal sensors on the storage drives monitor flash memory modules. ■ Thermal sensor temperature cannot exceed 76° C ■ See illustration in “Troubleshooting NVMe Drive Cooling” on page 41 for thermal sensor locations.
Airflow requirement	More than 450 LFM (linear feet/minute, at 25/35° C, airflow towards the connector)
Shock *	Non-operating 1,500G
Vibration •	Non-operating 20 Grms (10~2,000Hz, Sweep sine)

†Tc is measured at the hottest point on the case with the airflow at more than 2.5 CFM and at 25° C ambient temperature.

‡Storing (or shipping) without power connection.

*Shock specifications assume that SSD shall be mounted with screws when input vibration is applied. Vibration may be applied in 3 axes (x, y and z) with a half sine waveform of 0.5ms duration in non-operating condition.

•Vibration specifications assume that SSD shall be mounted with screws when input vibration is applied. The input vibration may be applied in 3 axes (x, y and z) and lasts during 15 minutes per axis.

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

The Oracle 3.2 TB NVMe SSD receives electrical power from the PCI Express +12 VDC and +3.3 VDC power rails as shown in the following electrical specification 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	300 mV pp 10Hz – 100 KHz	300 mV pp 10Hz – 100 KHz
	50 mV pp 100KHz – 20 MHz	50 mV pp 100KHz – 20 MHz
Power Consumption [5]	12 V Active [6] ■ Read 16W ■ Write 20W Idle[7]: 7W Off: 0W	Max 1 mA (at Read current)
Inrush Current	1.8 A	10 mA (1 ms rising time)

†The components inside the SSD were designed to endure a range of voltage fluctuations, which might be induced by the host system,

‡For 12 V operating voltage, the minimum allowable is 10.8 V and the maximum is13.2 V.

*For 3.3 Vaux, the minimum allowable voltage is 2.97V and the maximum is 3.63V.

•Fall time needs to be equal or better than minimum in order to guarantee full functionality of enhanced power loss management.

[5]Power consumption was measured in the 12 V power pins (#P13~#P15) of the connector plug in SSD. The active and idle power is defined as the highest averaged power value, which is the maximum RMS average value over 100 ms duration.

[6]The measurement condition for active power is assumed for 100% sequential read or write.

[7]The idle state is defined as the state that the host system can issue any commands into SSD at any time.

Related Information

- “Product Overview” on page 9
- “NVMe Drive Service Overview” on page 35

Reliability Specifications

The Oracle 3.2 TB NVMe SSD reliability specifications are shown in the following table:

Specification	Value
Uncorrectable Bit Error Rate (UBER) †	< 1 sector per 10^{17} bits read Rate of occurrence of data errors, equal to the number of data errors per bits read as specified in the JESD218 document of JEDEC standard.
Mean Time Between Failures (MTBF) ‡	2 million hours
Data Retention *	3 months
Drive Write Per Day (DWPD) •	5 drive writes per day over 5 years
Petabyte Written (PBW) [5]	29.2 PB
Sustained Random Read/Write Performance (IOPS) - Maximum[6]	■ Random 4KB Read: 750K ■ Random 4KB Write: 120K ■ Random 8KB Read: 390K ■ Random 8KB Write: 60K
Sequential Read/ Write Performance - Maximum [7]	■ Sequential 128KB Read MB/s 5,500 ■ Sequential 128KB Write MB/s 1,800
Latency [8] (sustained state)	■ Random Read/Write: 90 / 20 µsec[9] ■ Sequential Read/Write: 90 / 20 µsec[10] ■ Drive Ready Time: 2 seconds[11]
Quality of Service (QoS) [12]	■ Quality of Service (99%) ■ Read (4KB) µsec QD=1 95, QD=128435 ■ Write (4KB) µsec QD=1 60, QD=128 5795 ■ [13] ■ Quality of Service (99.99%) ■ Read (4KB) µsec QD=1 140, QD=128 565 ■ Write (4KB) µsec QD=1 200, QD=128 9540[14]
IOPS Consistency [15]	■ Random Read (4 KB) % 97 ■ Random Write (4 KB) % 94 ■ Random Read (8 KB) % 94 ■ Random Write (8 KB) % 92
Out of Band Management (SMBUS)	Provides out-of-band management by means of SMBUS interface. This requires 3.3V auxiliary voltage. SMBUS access includes the VPD page and temperature sensor.
Hot Plug Support	Supports PCIe presence detect and link-up detect

†For the enterprise application, JEDEC recommends that UBER shall be below 10-16.

‡By definition, Mean Time between Failures (MTBF) is the estimated time between failures occurring during SSD operation.

[*]Data retention was measured by assuming that SSD reaches the maximum rated endurance at 40C in power-off state.

[•]The endurance of SSD in enterprise application is defined as the maximum number of drive writes per day that can meet the requirements specified in the JESD218 document of JEDEC standard.

[5]Relational formula between DWPD and PBW is below: PBW = DWPD x 365 x 5 x User capacity

[6]Random performance was measured by using FIO in Ubuntu with queue depth 32 by 16 workers. Measurements were performed on a full Logical Block Address (LBA) span of the drive in sustained state. Actual performance may vary depending on use conditions and environment.

[7]Sequential performance was measured by using FIO in Ubuntu with queue depth 32 by 16 worker. Actual performance may vary depending on use conditions and environment.

[8]Typical values.

[9]The random read/write latency is measured by using FIO in Ubuntu and 4KB transfer size with queue depth 1 on a random workload of sustained state.

[10]The sequential read/write latency is measured by using FIO in Ubuntu and 4KB transfer size with queue depth 1 on a sequential workload of sustained state.

[11]The maximum taking time to be ready for receiving commands after power-up (CSTS.Ready=1). It is expected that I/O commands may not be completed at this point.

[12]QoS is measured using FIO (99/99.99 %) with queue depth 1 and 128 on 4 KB random and write.

[13]QoS is measured as the maximum round-trip time taken for 99 % of commands to host.

[14]QoS is measured as the maximum round-trip time taken for 99.99 % of commands to host.

[15]IOPS consistency measured using FIO with queue depth 128.

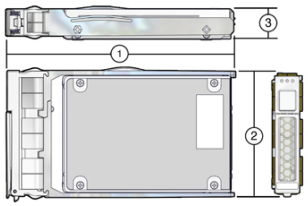
IOPS Consistency (%) = (IOPS in the 99.9% slowest 1-second interval)/(average IOPS during the test).

Related Information

- “Product Overview” on page 9
- “Servicing the NVMe Storage Drive” on page 35

Physical Dimensions

The following diagram shows Oracle 3.2 TB NVMe SSD physical dimensions:



Specification	Dimension
(1) Length	100.20+/- 0.25 mm maximum (3.955 in.)
(2) Width	69.85 +/- 0.25 mm (2.75 in.)
(3) Height	14.80 +/-0.20 mm (0.59 in.)
Weight	190 g maximum (6.7 oz)

Related Information

- “Product Overview” on page 9

Preparing the NVMe Storage Drive for Installation

These topics provide information about preparing an Oracle 3.2 TB NVMe SSD for installation:

Description	Links
Review Prepare for Installation procedure.	“Prepare for Installation” on page 23
Gather the required tools.	“Required Tools” on page 24
Unpack the shipping kit.	“Ship Kit Contents” on page 24
Review safety information.	“Observing Safety Precautions” on page 25
Review electrostatic discharge (ESD) safety measures.	“ESD Safety Measures” on page 26
Review 3.2 TB NVMe SSD Optimization Guidelines.	“Oracle 3.2 TB NVMe SSD Optimization Guidelines” on page 27
Update your system to the latest software release.	“Update Your System to the Latest Software Release” on page 28

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.

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.

▼ Prepare for Installation

1. **Gather the required tools.**

   See “Required Tools” on page 24.

2. **Unpack the shipping kit that includes the SSD.**

   a. **Unpack the SSD in a static free environment.**
   See “Ship Kit Contents” on page 24.

   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 26.

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 need the following tools for most service operations:

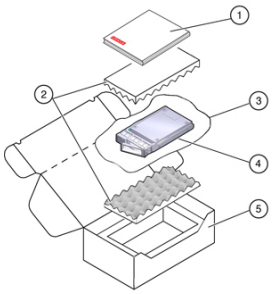
- Antistatic wrist strap
- Antistatic mat

Related Information

- “Preparing the NVMe Storage Drive for Installation” on page 23
- “ESD Safety Measures” on page 26

Ship Kit Contents

The Oracle 3.2 TB NVMe SSD ship kit contains the components shown in the following illustration:



1. Documentation
2. Foam
3. Antistatic bag
4. Oracle 3.2 TB NVMe SSD
5. Packaging

Related Information

- “Preparing the NVMe Storage Drive for Installation” on page 23
- “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 25
- “Safety Symbols” on page 26
- “ESD Safety Measures” on page 26
- “Perform ESD Prevention Measures” on page 27

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 servers 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 drives, require special handling.

- Place ESD-sensitive components and other PCBs on an antistatic mat.
- Wear an antistatic wrist strap when handling ESD-sensitive components (not provided).

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

Related Information

- “Perform ESD Prevention Measures” on page 27
- “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 26
- “NVMe Drive Service Overview” on page 35

Oracle 3.2 TB NVMe SSD Optimization Guidelines

To optimize preformance, observe the following guidelines when setting up Oracle 3.2 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 3.2 TB NVMe SSDs is designed to provide the 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 3.2 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 them into smaller transfer sizes.
- The Oracle 3.2 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 3.2 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 14.

Related Information

- "Preparing the NVMe Storage Drive for Installation" on page 23
- Tuning ZFS When Using Flash Storage `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 3.2 TB domains into a single 12.8 TB volume.

Refer to the documentation for more information at `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.

Note - System firmware update releases include Oracle 3.2 TB NVMe SSD component firmware updates. When system firmware updates, as described in the server documentation, the Oracle 3.2 TB NVMe SSD firmware automatically updates.

1. **Check the Oracle 3.2 TB NVMe SSD Product Notes for the latest firmware requirements, available at the Oracle 3.2 TB NVMe SSD Documentation Library. Go to:**

   `http://www.oracle.com/goto/oracleflashf320/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 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 F320 PCIe Card and Oracle 3.2 TB NVMe SSD Product Notes*
- "Update the NVMe Storage Drive Firmware" in *Oracle Flash Accelerator F320 PCIe Card and Oracle 3.2 TB NVMe SSD Product Notes*
- "Verify Oracle 3.2 TB NVMe SSD Operation" in *Oracle Flash Accelerator F320 PCIe Card and Oracle 3.2 TB NVMe SSD Product Notes*
- "Product Overview" on page 9
- "NVMe Drive Service Overview" on page 35

Installing the NVMe Storage Drive

These topics provide information about installing the Oracle 3.2 TB NVMe SSD into a server.

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

Installation Overview

Read this overview information section before installing the Oracle 3.2 TB NVMe SSD into a server.

- “NVMe Storage Drive Installation Overview” on page 31
- “Oracle 3.2 TB NVMe SSD Optimization Guidelines” on page 27

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

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

NVMe Storage Drive Installation Overview

To install your 3.2 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.	"Preparing the NVMe Storage Drive for Installation" on page 23
2.	Insert the SSD in an available drive slot.	"Install a New NVMe Storage Drive (CRU)" on page 32

Refer to the servers 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 3.2 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 servers service manual for drive locations on the server.

   Refer to "Supported Servers and Operating Systems" in *Oracle Flash Accelerator F320 PCIe Card and Oracle 3.2 TB NVMe SSD Product Notes*.

   Note - Before installing an Oracle 3.2 TB NVMe SSD 2.5-inch small form factor drive, locate a server slot on the servers front panel labeled NVMe (with SFF-8639 disk backplane and connector) that is capable of supporting the Oracle 3.2 TB NVMe SSD. Your server chassis must contain NVMe equipment, including Oracle NVMe Switch Controller Cards and cables. Refer to the servers service manual for NVMe SSD installation instructions.

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

   If the optional NVMe storage drives are installed in the servers front 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 servers service manual.

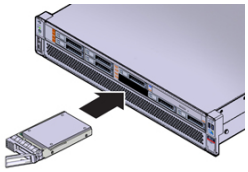
4. **Prepare the SSD for installation.**

See “Preparing the NVMe Storage Drive for Installation” on page 23.

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 servers service manual.

7. **Slide the Oracle 3.2 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.**

   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 systems OS.**
      Upon completed installation, the Oracle 3.2 TB NVMe SSD is visible to your server operating system.

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

Refer to the servers administration guide.

Related Information

- “Product Overview” on page 9
- “NVMe Drive Service Overview” on page 35

Servicing the NVMe Storage Drive

These topics provide service information for the Oracle 3.2 TB NVMe SSD.

Description	Links
Review service task and troubleshooting information.	“NVMe Drive Service Overview” on page 35
Review NVMe drive component serviceability information.	“Component Serviceability” on page 36
Remove and replace NVMe drives.	“Replace An Existing NVMe Storage Drive (CRU)” on page 37
Contact My Oracle Support (MOS).	“Technical Support” on page 40
Troubleshoot NVMe drive thermal issues.	“Troubleshooting NVMe Drive Cooling” on page 41
Use Oracle Hardware Management Pack utilities command line interface (CLI) tools to service the NVMe drive.	“Servicing the NVMe Drive Using Oracle Hardware Management Pack” on page 43

NVMe Drive Service Overview

For service, the Oracle 3.2 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 3.2 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 3.2 TB NVMe SSD requires no periodic maintenance. For data protection, the Oracle 3.2 TB NVMe SSD is equipped with energy storage components that allow it 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 3.2 TB NVMe SSD and do not require periodic maintenance.

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

Component Serviceability

The following service actions can be performed on a 3.2 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 after a device orderly shutdown. The Oracle Flash Accelerator F320 PCIe Card supports PCIe presence detect and link-up detect. 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 3.2 TB NVMe SSD (and fillers)	Hot CRU	“Installing the NVMe Storage Drive” on page 31 “Replace An Existing NVMe Storage Drive (CRU)” on page 37

Component	Serviceability	Replacement Instructions
		For instructions on safe installation and removal of SSDs, refer to the servers service manual.
Oracle PCIe NVMe Switch Card	Cold	For instructions on safe installation and removal of cards, refer to the servers service manual.
	FRU	
NVMe cables	Cold	For instructions on safe installation and removal of cables and connected drive backplane, refer to the servers service manual.
	FRU	

See Also:

- “Product Overview” on page 9
- “Technical Support” on page 40

▼ Replace An Existing NVMe Storage Drive (CRU)

Replace an Oracle 3.2 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 a server 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 anti-static practices as described in “ESD Safety Measures” on page 26.

The following task provides an example procedure. Follow the servers service manual instructions.

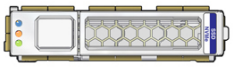
1. **Prepare the server operating system, as required, before you remove drives.**

   Follow the servers 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 servers front panel labeled **NVMe** (with SFF-8639 disk backplane and connector) that is capable of supporting the Oracle 3.2 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).



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.**

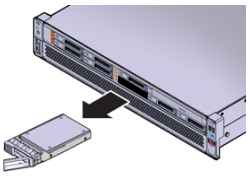
   a. **On the drive you plan to remove, push the latch release button to open the drive latch.**

      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 servers 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.

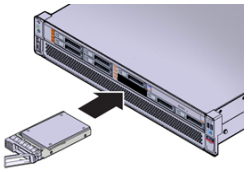
   Refer to "Supported Servers and Operating Systems" in *Oracle Flash Accelerator F320 PCIe Card and Oracle 3.2 TB NVMe SSD Product Notes*.

   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. Using your thumb or finger, press on the middle of the drive faceplate until the release lever engages with the chassis.

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

      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 servers front panel labeled **NVMe** (with SFF-8639 disk backplane and connector) that is capable of supporting the Oracle 3.2 TB NVMe SSD. Never insert an NVMe storage drive into a non-NVMe capable slot (HDD).

7. **For hot plug service actions, configure the NVMe storage drive and verify drive availability.**

   - Follow the servers 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 3.2 TB NVMe SSD, contact My Oracle Support (MOS).

Related Information

- “Contacting Technical Support” on page 40
- “Product Overview” on page 9

▼ Contacting Technical Support

For assistance installing, configuring, or running the Oracle 3.2 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 40
- “Product Overview” on page 9

Troubleshooting NVMe Drive Cooling

Maintaining the proper internal operating temperature of the server is crucial to a 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. Refer to the server documentation for additional service information.

The Oracle 3.2 TB NVMe SSD is designed to provide continuous full bandwidth performance with temperatures up to 70° C. Qualified host platforms with required software updates operate with sufficient margin to the maximum temperature under worst case environments.

Caution - Sustained critical temperatures might cause data loss.

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 Oracle 3.2 TB NVMe SSD responds as follows:

- 70° C - Operating temperature limit.
  - The SSD independently operates and provides continuous full bandwidth performance with temperatures up to 70° C.
  - 70° C is the Case maximum (based on hottest point on case surface). Tc is measured at the hottest point on the case with the airflow condition of more than 2.5 CFM at 25° C of ambient temperature.

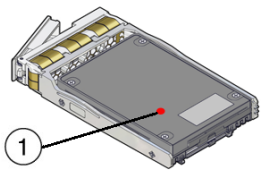
- 76° C - Drive write throttling is engaged to reduce SSD power.
  - SSD amber status indicator is lit, Service Action Required.

    See “Status Indicators” on page 12
  - First threshold for Dynamic Thermal Throttling (DTT). Critical temperature status displays in utility output: `Critical warning 1 - Temperature exceeded critical threshold.`

    Use the Oracle Hardware Management Pack CLI commands to determine the temperature and status of the Oracle 3.2 TB NVMe SSD. See “Verify Oracle 3.2 TB NVMe SSD Operation” in *Oracle Flash Accelerator F320 PCIe Card and Oracle 3.2 TB NVMe SSD Product Notes*.
- 83° C SSD I/O stop overtemp critical limit.
  - SSD component shuts down.
  - Critical temperature status displays in utility output: `Critical warning 1 - Temperature exceeded critical threshold.`

    Use the Oracle Hardware Management Pack CLI commands to determine the temperature and status of the Oracle 3.2 TB NVMe SSD. See “Verify Oracle 3.2 TB NVMe SSD Operation” in *Oracle Flash Accelerator F320 PCIe Card and Oracle 3.2 TB NVMe SSD Product Notes*.

The following image shows the Oracle 3.2 TB NVMe SSD temperature sensor location:



(1): SSD temperature sensor location

Related Information

- “Status Indicators” on page 12
- “Product Overview” on page 9
- “Technical Support” on page 40

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 3.2 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.
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 3.2 TB NVMe SSD Product Notes” in *Oracle Flash Accelerator F320 PCIe Card and Oracle 3.2 TB NVMe SSD Product Notes* for additional download information.

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 servers service manual.

   - Connect an Ethernet cable to the Gigabit Ethernet (NET) connectors as needed for OS support.
   - Connect to the service processors 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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