Intel 320 Series SSD
User's Information for Dell PowerEdge Products

2012 - 08

Rev. A00

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About This Document

This document describes features and behaviors of the Intel 320 Series SSDs that you may encounter when using these drives in a Dell PowerEdge server.

Compatible Hardware

12th Generation PowerEdge Servers

The following 12th Generation Dell PowerEdge servers are currently qualified as compatible with the Intel 320 Series SDDs:

- PowerEdge R820
- PowerEdge R720
- PowerEdge R720xd
- PowerEdge R620
- PowerEdge T620
- PowerEdge R520
- PowerEdge R420
- PowerEdge R320

The following controllers are supported by these servers for use with the Intel SSDs:

- H710
- H710P
- H310

Note that the H810 and S110 controllers are **NOT** qualified for use with the Intel SSDs.

11th Generation PowerEdge Servers

The following 11th Generation Dell PowerEdge servers are currently qualified as compatible with the Intel 320 Series SDDs:

- PowerEdge R910
- PowerEdge R815
- PowerEdge R715
- PowerEdge M915

The following controllers are supported by these servers for use with the Intel SSDs:

- H700
- H200

Note that the H800, S100, and S300 controllers are **NOT** qualified for use with the Intel SSDs.

NOTE: Additional servers and controllers may be qualified in the future as compatible with Intel 320 Series SDDs. Contact your Dell sales representative for the latest information.

SSD Hard Drive Indicator Patterns

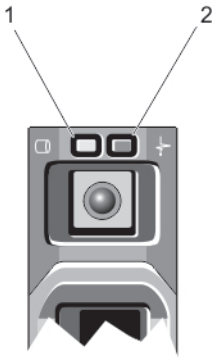

Figure 1. Hard-Drive Indicators

1. hard-drive activity indicator (green)
2. hard-drive status indicator (green and amber)

Drive Activity Indicator

NOTE: The drive activity indicator behavior on an SSD is noticeably different than that of a hard disk drive. When SSD I/O activity is occurring, the indicator will switch on and remain on without blinking. This is normal behavior.

SSD Drive Activity Indicator Pattern	Condition
Off	No drive activity
Steady green	Drive I/O activity occurring

Drive Status Indicator

The hard-drive status indicator functions the same as that of a hard disk drive.

SSD Drive Status Indicator Pattern (RAID Only)	Condition
Blinks green two times per second	Identifying drive or preparing for removal
Off	Drive ready for insertion or removal

SSD Drive Status Indicator Pattern (RAID Only)	Condition

NOTE: The drive status indicator remains off until all hard drives are initialized after the system is turned on. Drives are not ready for insertion or removal during this time.

Blinks green and off	Predicted drive failure
Blinks green slowly	Drive rebuilding
Steady green	Drive online
Blinks green three seconds and off six seconds	Rebuild aborted

Controller BIOS Configuration Utility Behavior

The BIOS Configuration Utility is a storage management application embedded on PowerEdge Raid Controller (PERC) cards that configures and maintains RAID disk groups and virtual disks. (For more information on the utility, see the Dell PowerEdge RAID Controller User's Guide.)

The utility's **Physical Disk Management** screen displays physical disk information and action menus. On the right side of the screen, the SSD's **Certified** field will be set to "No." This is normal behavior and does not indicate an issue with the drive.

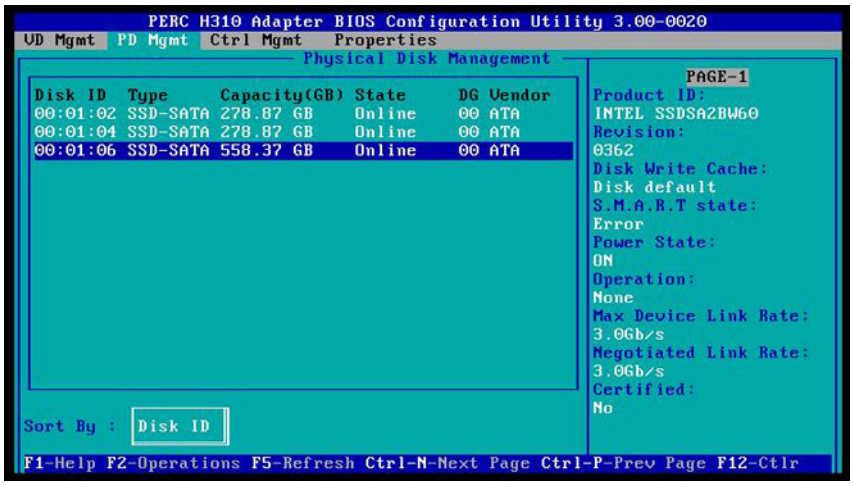

Figure 2. Controller BIOS configuration utility

OMSA Drive Information Page

SMART Predictive Failure Notification Support

SMART trips for actual drive errors will be noted on the **Physical Disks** page of the OpenManage Server Administrator (OMSA) **Storage** subsection. If such an error occurs, "Yes" will be displayed in the **Failure Predicted** column of this page.

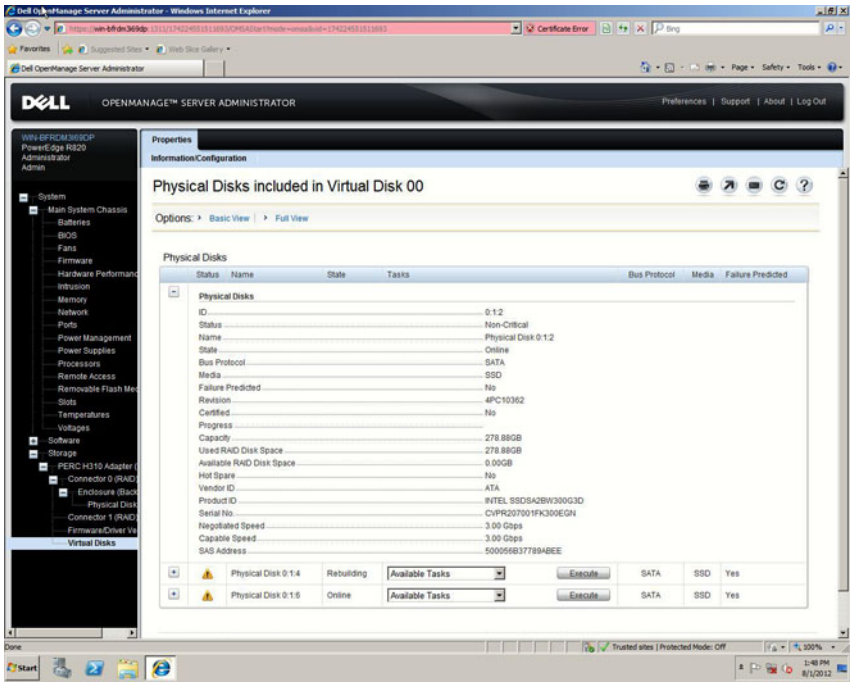

Figure 3. Drive information page with predictive failure notice

SMART Wear Out Indicator Not Supported

Although the Intel SSD 320 Series drives log SMART attribute E9, Media Wear Out Indicator, that captures the remaining life of the SSD as a percentage, the OMSA **Physical Disks** page does not report this indicator.

OMSA Warnings

NOTE: Dell OpenManage Server Administrator (OMSA) will displays a yellow warning icon next to the Intel SSDs, as noted below. These warning icons do not indicate a current or pending problem with the drive. They only appear because the drive is not recognized by OMSA as a "Dell-branded" drive.

System Alerts Page

A yellow warning icon and a"Non-Dell-supplied disk drive has been detected." message will be displayed next to each Intel SSD drive. This is normal behavior and does not indicate an issue with the drive.

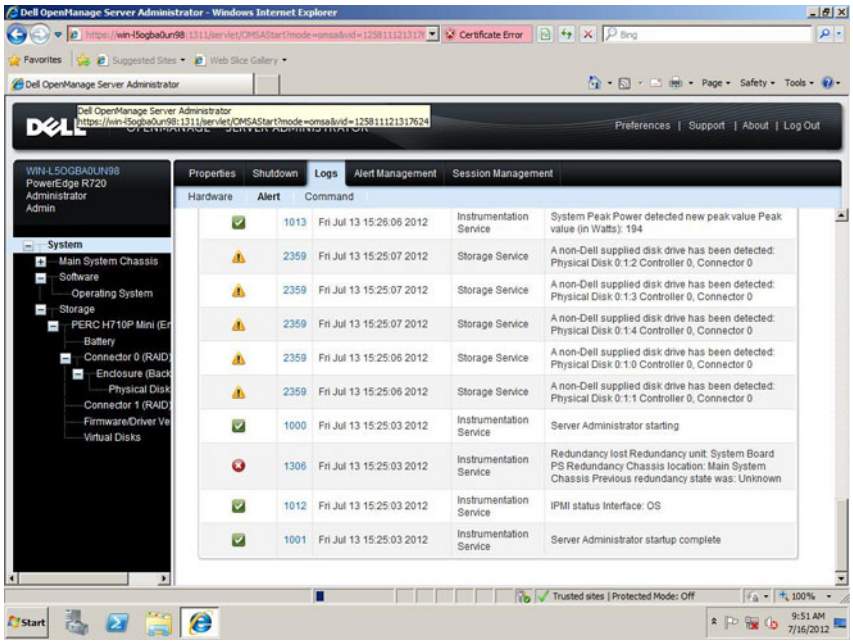

Figure 4. OMSA system alerts page

Storage Pages

Within the **Storage** section of OMSA, a yellow warning icon will appear on the controller page, and the **Physical Disks** page. This is normal behavior and does not indicate an issue with the drive.

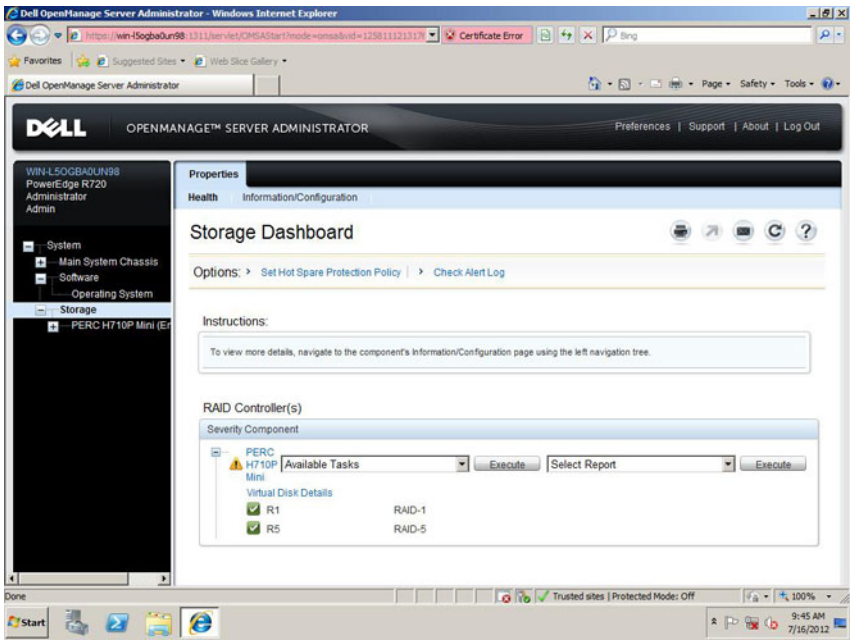

Figure 5. Controller page

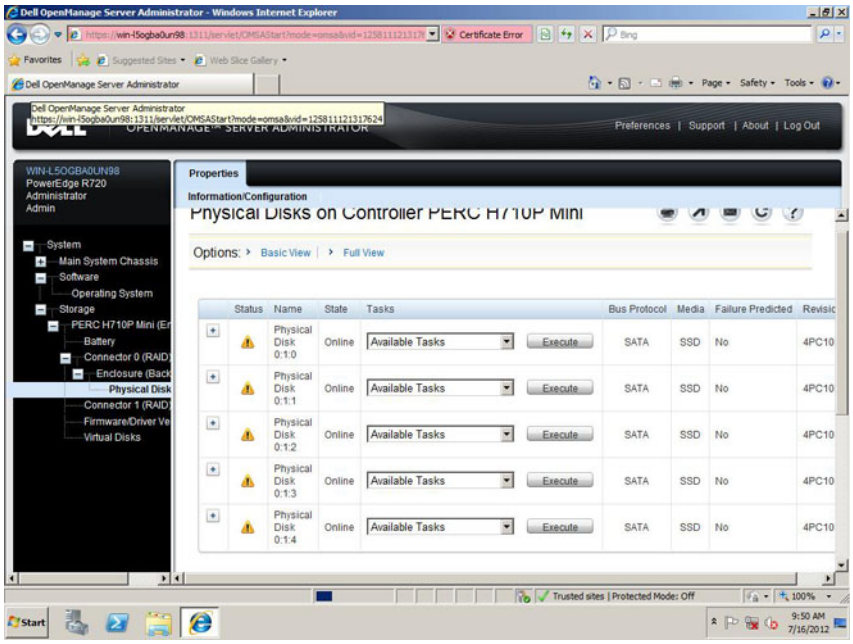

Figure 6. Physical disks page

Wear Usage Monitoring

The Smartmon Tool

You can use a software tool — Smartmon — that monitors three Self-Monitoring, Analysis, and Reporting Technology (SMART) attributes for SSDs. Smartmon includes a command line utility, **smartctl**, used to check these attributes.

Obtaining the Smartmon Tool

The Smartmon tool is available from the following sources:

- From Intel as part of the "Intel Solid-State Drive Toolbox" at **http://downloadcenter.intel.com**.
- From **http://sourceforge.net/apps/trac/smartmontools/wiki**.

NOTE: Use the latest version of the Smartmon tool with the Intel 320 Series SSDs.

SMART Attributes

The three primary attributes measured by the Smartmon tool are:

- Workload Timer ID E4h — Time elapsed during the current workload.
- Timed Workload Host Reads Percentage ID E3h — Percentage of I/O operations that are read operations during the last workload timer loop.
- Timed Workload Media Wear Indicator ID E2h — Drive wear during the last wear timer loop, as a percentage of the maximum rated cycles.

NOTE: You must run the workload to be evaluated for at least 60 minutes for these SMART drive attributes to register.

Smartmon Tool and smartctl Resources

For details of the Smartmon tool, the **smartctl** utility, and SMART attributes, refer to:

- "Intel Solid-State Drive 320 Series in Server Storage Applications" and "Intel Solid-State Drive 320 Series Enterprise Server/Storage Application Product Specification Addendum," available at **http://downloadcenter.intel.com**.
- **smartctl** man page, available at **http://smartmontools.sourceforge.net/man/smartctl.8.html**.

Monitoring Drive Wear Example Using the Smartmon Tool — Linux RAID Environments

Note that the specific options in this example may not apply to your system. For details of the **smartctl** commands and options, see the resources in "Smartmon Tool and smartctl Resources."

1. Find the OS name for the storage device or RAID array.
2. Find device ID's for the device or array in step 1 using MegaCli using the following command:
   MegaCli64 –pdlist –aAll
3. For each device ID use the following command:
   smartctl -a -d sat+megaraid,N /dev/sdX
   - *N* represents the device ID identified in step 2.
   - *X* represents the storage device or RAID array identified in step 1.
4. In the **smartctl** output, Attribute ID# 233, Media Wearout Indicator, will indicate the remaining drive life as a percentage under the VALUE column. For example, a value of 85 means 85% of the drive's life remains.

Monitoring Drive Wear Example Using the Smartmon Tool — Non-RAID Environments

Note that the specific options in this example may not apply to your system. For details of the **smartctl** commands and options, see the resources in "Smartmon Tool and smartctl Resources."

1. Find the OS name for the storage device.
2. For each device ID use the following command:
   smartctl -a -d sat/dev/sdX.
   - *X* represents the storage device or RAID array identified in step 1.
3. In the **smartctl** output, Attribute ID# 233, Media Wearout Indicator, will indicate the remaining drive life as a percentage under the VALUE column. For example, a value of 85 means 85% of the drive's life remains.

Using the Smartmon Tool to Estimate Wear Usage — Windows RAID Environments ONLY

NOTE: In a Windows RAID environment, an individual SSD device cannot be directly accessed behind the LUN (Logical Unit or RAID configured set) so it must be temporarily moved to a NON-Windows (Linux) SMART-capable system during portions of the procedure as noted below, in order to issue SMART commands to the drive.

You can use the following procedure to estimate wear in a Windows RAID production or application environment. This procedure applies to Linux and Windows operating systems, and RAID or non-RAID environments.

The high-level steps of the procedure are as follows:

- Obtain a baseline wear indicator
- Run the intended application for an extended time period
- Re-check the wear indicator
- Calculate wear over time

1. Make sure DIPM is disabled to ensure that the data collected is accurate.
2. Temporarily move the drive to a NON-Windows (Linux) SMART-capable system.
3. Issue the SMART EXECUTE OFF-LINE IMMEDIATE (D4h) sub-command 40h to reset the E4h (workload timer) attribute.
   - For example, utilizing **smartctl** version 5.43 in a Linux OS where the drive under test is **/dev/sda** you can enter the following command line:

     smartctl –t vendor,0x40 /dev/sda.

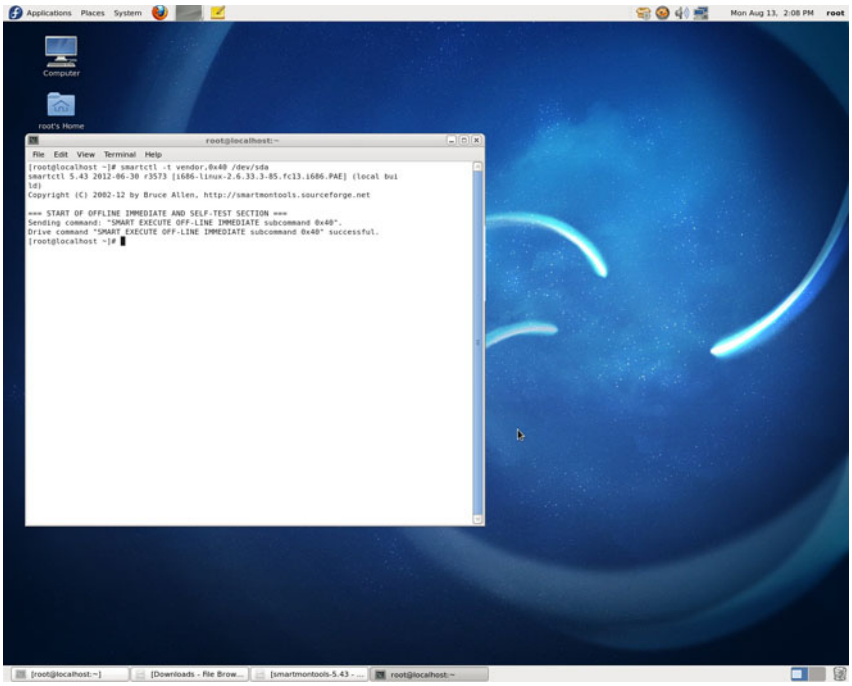

Figure 7. Resetting the SMART workload timer attribute

4. Return the drive to the Windows system where the workload will be measured.
5. Run the workload to be evaluated for at least 60 minutes (otherwise the drive wear attributes will not be available).
   - For this example, the workload was run for about 22 hours.
   - Iometer was used with a transfer size of 1MB with 100% random writes.
6. Do a clean system power down. Use either the ATA STANDBY IMMEDIATE command or leave the drive in the system for 10 minutes prior to shutting down the system. This ensures that the drive will store all the drive wear SMART attributes to persistent memory within the drive.
7. Return the drive to a non-Windows (Linux) SMART-capable system (the same system environment of step 2).
8. Read the drive wear attributes with the SMART READ DATA (D0h) command within 60 minutes after power-up.
   - For example, a drive in a system with **smartctl** version 5.43 captures the SMART Read Data by running the following command line:

     smartctl –A /dev/sda.

– Note that the attribute ID# are listed in decimal and not in Hex with the Attribute_NAME associated with Hard Drives.

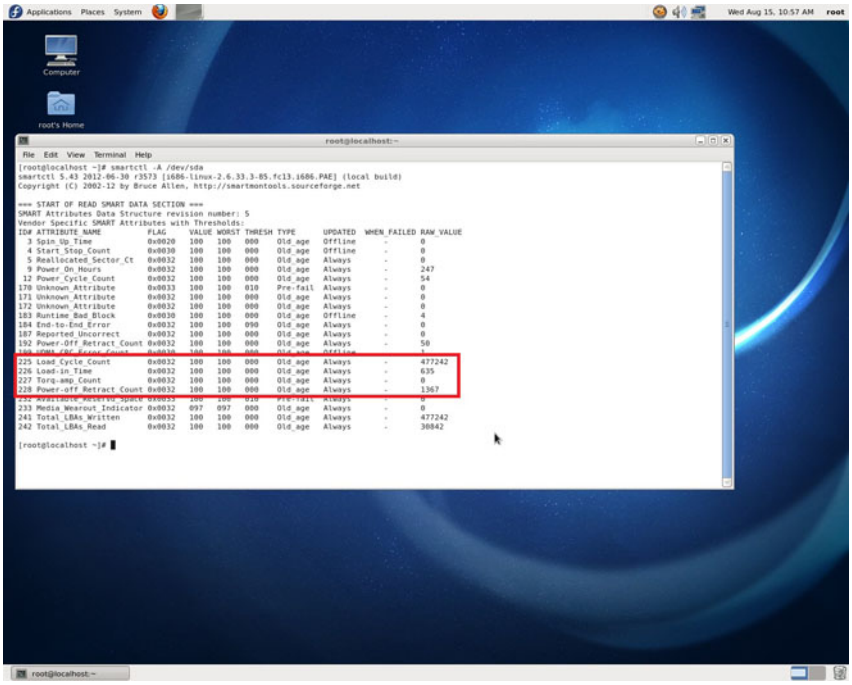

Figure 8. Reading the SMART drive wear attributes

The table below translates the data from **smartctl** to the Intel-supported SMART Attributes.

Table 1. Converting SMART attribute values

Attribute	Decimal ID	Hex ID	Raw Value
Host Writes Count	225	E1h	477242
Timed Workload Media Wear Indicator	226	E2h	635
Timed Workload Host Read/ Write Ratio	227	E3h	0
Workload Timer	228	E4h	1367

Calculating Estimated Drive Wear

From the data collected using smartctl, and the translated values, you can then calculate the drive wear rate based on the given workload. Using this example:

- Timed Workload Media Wear (E2h) has a raw value of 635. Therefore, the percentage wear rate = 635/1024 = 0.620%
- Timed Workload Host Read/Write Ratio (E3h) has a normalized value of 0, indicating that 0% of the operations were reads. This corresponds with the 100% random write workload set in Iometer.
- Workload Timer (E4h) has a raw value of 1367. Therefore the workload ran for 1367 minutes or 22.783 hours.

Given these values, the media wear percentage rate for this workload can then be calculated:

- Timed Workload Media Wear rate of 0.620% for every 1367 minutes:
  - Workload Media Wear Rate 0.027% per hour
  - Workload Media Wear Rate 0.653% per day

Using the drive in this 100% workload example, the drive wears at .653% per day.

- 100/.653 = 153
- In this exaggerated case, the drive will use 100% of wear in 153 days

NOTE: This sample usage case is an exaggerated workload of 100% writes. The wear rate and related values for this device's intended use in read-intensive environments will be notably different, with the wear rates markedly lower. The above workload was used in this case to demonstrate the procedure and calculations.

Adjusting SSD Usable Capacity to Improve Drive Performance

Some SSD performance gains can be realized in random write performance and endurance by configuring a small reduction in the drive's usable capacity. Intel provides details on this option in *Intel Solid-State Drive 320 Series in Server Storage Applications* at **http://www.intel.com**.

NOTE: If you wish to implement this feature, you **must** do so before the drive is initialized or written to in any way. After the drive contents are altered, secure erasure of the drive to change its usable capacity is not supported.

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Getting Help

Contacting Dell

NOTE: If you do not have an active Internet connection, you can find contact information on your purchase invoice, packing slip, bill, or Dell product catalog.

Dell provides several online and telephone-based support and service options. Availability varies by country and product, and some services may not be available in your area. To contact Dell for sales, technical support, or customer service issues:

1. Visit **support.dell.com**.
2. Select your support category.
3. If you are not a U.S. customer, select your country code at the bottom of the **support.dell.com** page, or select **All** to see more choices.
4. Select the appropriate service or support link based on your need.