Lenovo ThinkSystem RAID 940 Series Internal RAID Adapters

Product Guide

The ThinkSystem RAID 940 family of PCIe 4.0 12 Gbps SAS RAID controllers are high-performance RAID-on-chip (ROC) server adapters for connectivity to drives internal to the server. These adapters support RAID levels 0, 1, 10, 5, 50, 6 and 60, and include an extensive list of RAS and management features.

The ThinkSystem RAID 940-16i is shown in the following figure.

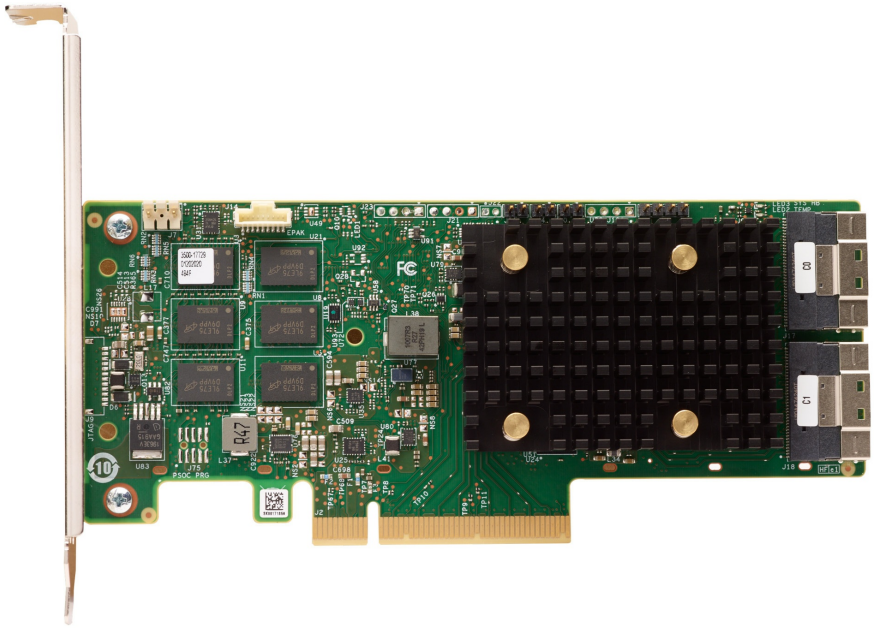

Figure 1. ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Adapter

Did you know?

The RAID 940 Series adapters all have a PCIe 4.0 host interface which doubles the bandwidth between the server and the adapter, compared to the previous generation RAID 930 adapters. This improves overall performance of the storage subsystem by supporting up to 3 million IOPS (JBOD mode) and up to 3 million IOPS in RAID (random reads).

RAID on Chip-based controllers such as the RAID 940 adapters have a dedicated processor that offloads all RAID functions from the server's CPU. With hardware acceleration for RAID 5 and 6 operations plus up to 8 GB dedicated memory for caching, the 940-8i, 16i and 32i offer the ultimate performance for ThinkSystem servers.

Part number information

The following table provides the ordering part numbers for the adapters.

Table 1. Part numbers and feature codes

Part number	Feature code	Description
4Y37A09728	B8NY	ThinkSystem RAID 940-8i 4GB Flash PCIe Gen4 12Gb Adapter
4Y37A09729	B8NW	ThinkSystem RAID 940-8i 8GB Flash PCIe Gen4 12Gb Adapter
4Y37A09730	BC4U,B8NZ	ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Adapter
4Y37A09735	B8P0	ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Internal Adapter
4Y37A09733	B8P8	ThinkSystem RAID 940-32i 8GB Flash PCIe Gen4 12Gb Adapter

The ThinkSystem RAID 940-8i is shown in the following figure.

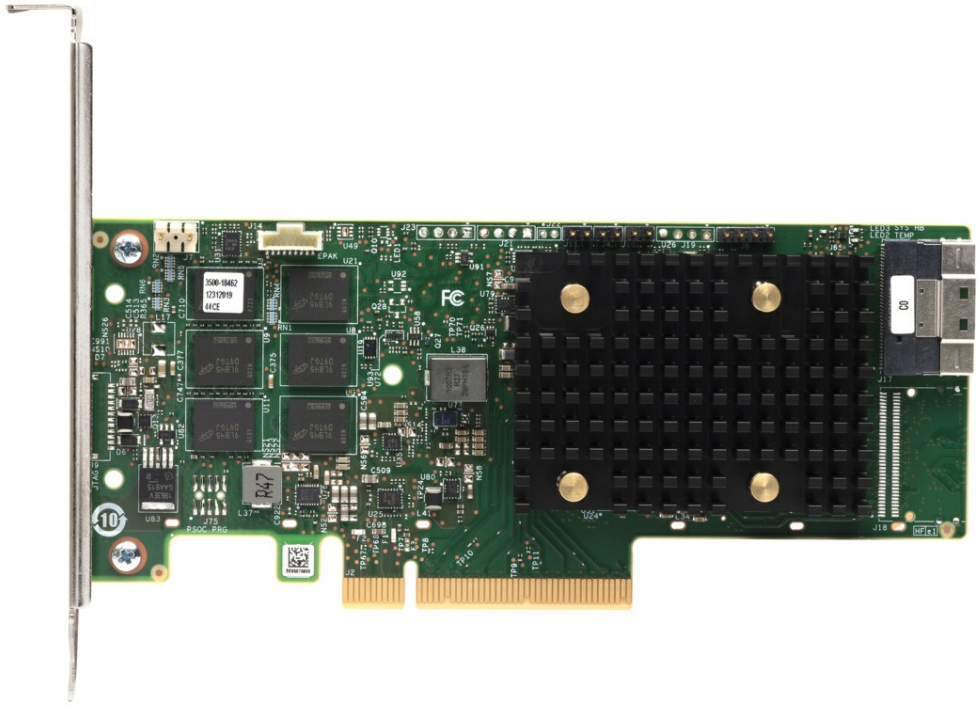

Figure 2. ThinkSystem RAID 940-8i 8GB Flash PCIe Gen4 12Gb Adapter

Technical specifications

The ThinkSystem RAID 940 Series internal RAID adapters have the following specifications:

- PCIe 4.0 x8 host interface, also compatible with a PCIe 3.0 host interface
- 12 Gbps SAS/SATA RAID controllers, based on the Broadcom MegaRAID 9560 adapter family
- 4GB or 8GB of integrated flash-backed cache
- Connectivity for up to 32 internal SAS or SATA drives:
  - RAID 940-8i supports up to eight internal SAS or SATA drives
  - RAID 940-16i supports up to 16 internal SAS or SATA drives
  - RAID 940-32i supports up to 32 internal SAS or SATA drives

- Support for intermixing SAS and SATA HDDs and SSDs. Mixing SAS and SATA drives in the same array is not supported. Mixing of HDDs and SSDs in the same array is not supported.
- Support for intermixing of 12 Gbps and 6 Gbps drives.
- Support for RAID 0, 1, 10, 5, 50, 6 and 60 standard
- Support for JBOD (non-RAID) drive state
- Support for logical drive sizes greater than 2 TB.
- Configurable stripe size up to 1 MB
- Supports 512e, 512n and 4K sector formatted drives
- Supports TRIM/UNMAP commands for SAS and SATA SSDs (JBOD and RAID volumes)
- Compliant with Disk Data Format (DDF) configuration on disk (CoD).
- S.M.A.R.T. support.
- Configuration through
    - XClarity Provisioning Manager UEFI interface
    - XClarity Controller web interface
    - XClarity Administrator Configuration Patterns
    - StorCLI command-line interface
    - LSI Storage Authority (LSA) GUI interface
    - UEFI Human Interface Infrastructure (HII)

Note: CacheCade is not supported by these adapters

The ThinkSystem RAID 940-16i Internal adapter is shown in the following figure.

Figure 3. ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Internal Adapter

The following table compares the specifications of the RAID 940 adapters.

Table 2. Specifications

Feature	RAID 940-8i 4GB	RAID 940-8i 8GB	RAID 940-16i 8GB	RAID 940-16i 8GB Internal	RAID 940-32i 8GB
Adapter type	RAID controller	RAID controller	RAID controller	RAID controller	RAID controller
Part number	4Y37A09728	4Y37A09729	4Y37A09730	4Y37A09735	4Y37A09733
Form factor	PCIe low profile	PCIe low profile	PCIe low profile	Custom	PCIe FHHL
Controller chip	Broadcom SAS3908	Broadcom SAS3908	Broadcom SAS3916	Broadcom SAS3916	Broadcom SAS3916 + SAS35x36R expander
Broadcom equivalent	MegaRAID 9560-8i 4G	MegaRAID 9560-8i 8G	MegaRAID 9560-16i 8G	MegaRAID 9560-16i 8G	MegaRAID 9367-32i 8G
Host interface	PCIe 4.0 x8	PCIe 4.0 x8	PCIe 4.0 x8	PCIe 4.0 x8	PCIe 4.0 x8
Port interface	12 Gb SAS	12 Gb SAS	12 Gb SAS	12 Gb SAS	12 Gb SAS
Number of ports	8	8	16	16	32
Port connectors	One x8 SFF-8654	One x8 SFF-8654	Two x8 SFF-8654	Four x4 SFF-8654	Four x8 SFF-8654
Drive interface	SAS, SATA	SAS, SATA	SAS, SATA	SAS, SATA	SAS, SATA
Drive type	HDD, SED, SSD	HDD, SED, SSD	HDD, SED, SSD	HDD, SED, SSD	HDD, SED, SSD
Hot-swap drives	Yes	Yes	Yes	Yes	Yes
Max devices	8	8	16	16	32
RAID levels	0, 1, 10, 5, 50, 6, 60	0, 1, 10, 5, 50, 6, 60	0, 1, 10, 5, 50, 6, 60	0, 1, 10, 5, 50, 6, 60	0, 1, 10, 5, 50, 6, 60
JBOD mode	Yes	Yes	Yes	Yes	Yes
Cache	4GB (Standard)	8GB (Standard)	8GB (Standard)	8GB (Standard)	8GB (Standard)
CacheVault cache protection with Flash	Yes	Yes	Yes	Yes	Yes
Performance Accelerator (FastPath)	Yes	Yes	Yes	Yes	Yes
SSD Caching (CacheCade Pro 2.0)	No	No	No	No	No
SED support	Yes (SafeStore)	Yes (SafeStore)	Yes (SafeStore)	Yes (SafeStore)	Yes (SafeStore)

To compare the RAID 940 Series adapters to other internal adapters, see the Lenovo ThinkSystem RAID Adapter and HBA Reference
https://lenovopress.com/lp1288-lenovo-thinksystem-raid-adapter-and-hba-reference

Features

The ThinkSystem RAID 940 adapters have the following standard features:

- MegaRAID FastPath SSD performance acceleration

  MegaRAID FastPath software provides high-performance I/O acceleration for SSD-based virtual drives by using a low latency I/O path to increase the maximum I/O per second (IOPS) capability of the controller. This feature boosts the performance of applications with a highly random data storage access pattern, such as transactional databases.

- MegaRAID flash cache protection

  MegaRAID flash cache protection uses NAND flash memory, which is powered by a CacheVault Power Module supercapacitor, to protect data that is stored in the controller cache. This module eliminates the need for a lithium-ion battery, which is commonly used to protect DRAM cache memory on PCI RAID controllers. To avoid the possibility of data loss or corruption during a power or server failure, flash cache protection technology transfers the contents of the DRAM cache to NAND flash using power from the offload power module. After the power is restored to the RAID controller, the content of the NAND flash is transferred back to the DRAM, which is flushed to disk.

- Auto-resume on array rebuild or array reconstruction after the loss of system power

  Auto-resume uses non-volatile RAM (NVRAM) to save the rebuild progress during a host reboot or power failure to automatically resume from the last checkpoint. Auto-resume ensures that data integrity is maintained throughout the process. The card supports a number of features that can be implemented without rebooting the server. Applications, such as email and web server, benefit from avoiding downtime during the transition.

- Online Capacity Expansion

  Online Capacity Expansion (OCE) allows the capacity of a virtual disk to be expanded by adding new physical disks or making use of unused space on existing disks, without requiring a reboot.

- Online RAID Level Migration

  Online RAID Level Migration (RLM), which is also known as logical drive migration, can migrate a virtual disk from any RAID level to any other RAID level without requiring a reboot. System availability and application functionality remain unaffected.

- Fast initialization for quick array setup

  Fast initialization quickly writes zeros to the first and last sectors of the virtual drive. This feature allows you to immediately start writing data to the virtual drive while the initialization is running in the background.

- Consistency check for background data integrity

  Consistency check verifies that all stripes in a virtual disk with a redundant RAID level are consistent. The consistency check mirrors data when an inconsistent stripe is detected for RAID 1 and re-creates the parity from the peer disks for RAID 5 or RAID 6. Consistency checks can be scheduled to take place periodically.

- Extensive online configuration options and advanced monitoring and event notification

  Management tools provide convenience for the configuration of logical volumes and alerting when errors have occurred or are about to occur.

- Patrol read for media scanning and repairing

  Patrol read is a background sentry service that pro-actively discovers and corrects media defects (bad sectors) that arise normally as a disk drive ages. The service issues a series of verify commands, and if a bad block is discovered, the card's firmware uses RAID algorithms to re-create the missing data and remap the sector to a good sector. The task is interruptible based on controller activity and host operations. The firmware also provides an interface where the patrol read task can be initiated, set up for continuous operation, and terminated from a management application. Patrol read can be activated by a manual command or automatically.

- Global and dedicated hot spare with revertible hot spare support

  A hot spare rebuilds data from all virtual disks within the disk group in which it is configured. You can define a physical disk as a hot spare to replace a failed drive. Hot spares can be configured as either global or dedicated. A global hot spare allows any physical drive to be designated as a hot spare. A dedicated hot spare allows the user to assign a hot spare drive to a particular array of the same drive type.

- Drive roaming

  Drive roaming occurs when the physical disks are changed to different ports on the same controller. When the drives are placed on different channels, the controller detects the RAID configuration from the configuration data on the drives.

- MegaRAID SafeStore support for self-encrypting drive (SED) services

  MegaRAID SafeStore encryption services offer instant secure erase and local key management for self-encrypting drives. This technology represents a step forward in securing data on a disk drive from any unauthorized access or modification resulting from theft, loss, or repurposing of drives. Instant secure erase permanently removes data when repurposing or decommissioning SEDs. SafeStore local key management provides the necessary management and protection of SEDs by using a simple pass phrase, security key identifier, and security key file that can be set and applied to all SEDs that are assigned to a RAID adapter. This feature removes the complexity of managing each SED’s unique encryption key, and it essentially relieves the administrator of most of the daily tasks of securing data.

- Hardware Secure Boot

  The on-board controller incorporates advanced security through hardware secure boot. The hardware secure boot feature permits only authenticated firmware to execute on the adapter. The controller’s Internal Boot ROM establishes an initial Root of Trust (RoT). Hardware secure boot authenticates and builds a Chain of Trust (CoT) with succeeding firmware images using the RoT meaning only authorized firmware is executed on the adapter. Lenovo provides the signed firmware images making the use of hardware secure boot transparent to customers, while providing confidence in the security of the solution.

- XClarity Provisioning Manager for pre-boot array configuration and management

  Provisioning Manager is the ThinkSystem UEFI-based application that includes a RAID setup wizard to help you configure drive groups and virtual disks before installing or booting the operating system.

- XClarity Controller web interface for remote storage management

  XClarity Controller (XCC) is the systems management processor integrated in all ThinkSystem servers. The XCC web interface allows you to perform storage inventory, create and edit virtual disks, view events, import a new controller configuration, and perform firmware updates on the adapter.

Note: MegaRAID CacheCade and MegaRAID Storage Manager are not supported.

The ThinkSystem RAID 940-32i is shown in the following figure.

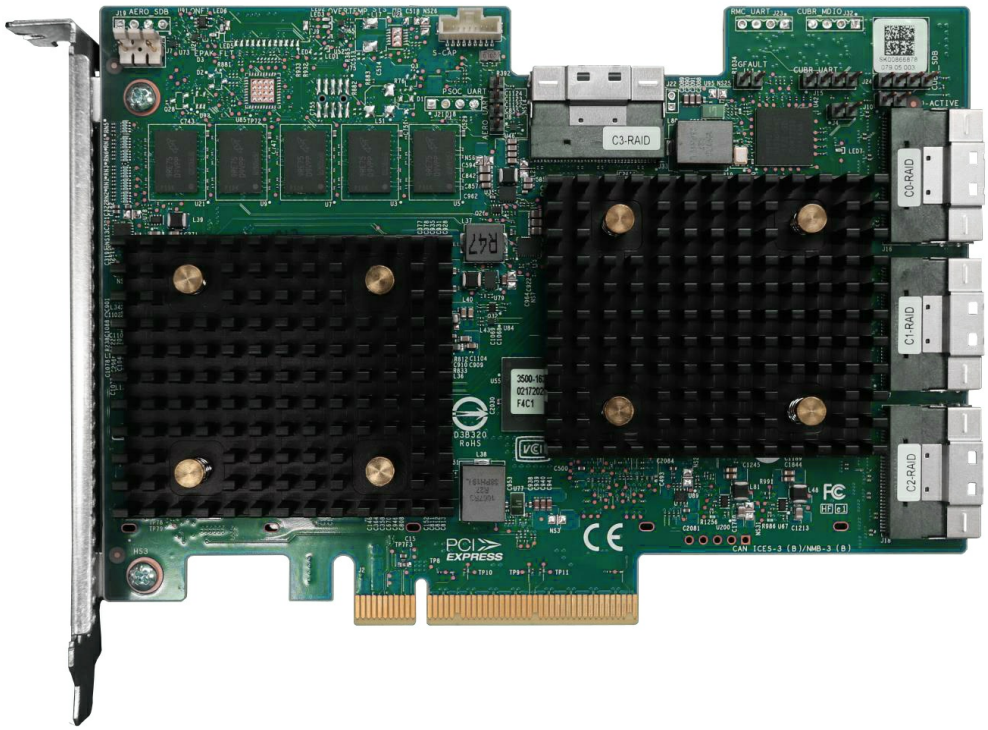

Figure 4. ThinkSystem RAID 940-32i 8GB Flash PCIe Gen4 12Gb Adapter

Server support

The following tables list the ThinkSystem servers that are compatible.

Table 3. ThinkSystem server support (Part 1)

Part number	Description	Intel 2S								AMD			
		ST550 (7X09/7X10)	SR530 (7X07/7X08)	SR550 (7X03/7X04)	SR570 (7Y02/7Y03)	SR590 (7X98/7X99)	SR630 (7X01/7X02)	SR650 (7X05/7X06)	SR670 (7Y36/37/38)	SR635 (7Y98/7Y99)	SR655 (7Y00/7Z01)	SR645 (7D2Y/7D2X)	SR665 (7D2W/7D2V)
4Y37A09728	ThinkSystem RAID 940-8i 4GB Flash PCIe Gen4 12Gb Adapter	N	N	N	N	N	N	N	N	N	N	Y	Y
4Y37A09729	ThinkSystem RAID 940-8i 8GB Flash PCIe Gen4 12Gb Adapter	N	N	N	N	N	N	N	N	N	N	Y	Y
4Y37A09730	ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Adapter	N	N	N	N	N	N	N	N	N	N	Y	Y
4Y37A09735	ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Internal Adapter	N	N	N	N	N	N	N	N	N	N	Y	Y
4Y37A09733	ThinkSystem RAID 940-32i 8GB Flash PCIe Gen4 12Gb Adapter	N	N	N	N	N	N	N	N	N	N	N	Y

Table 4. ThinkSystem server support (Part 2)

Part number	Description	E	1S Intel				4S Intel				Dense/ Blade			
		SE350 (7Z46/7D1X)	ST50 (7Y48/7Y50)	ST250 (7Y45/7Y46)	SR150 (7Y54)	SR250 (7Y51/7Y52)	SR850 (7X18/7X19)	SR850P (7D2F/2D2G)	SR860 (7X69/7X70)	SR950 (7X11/12/13)	SD530 (7X21)	SD650 (7X58)	SN550 (7X16)	SN850 (7X15)
4Y37A09728	ThinkSystem RAID 940-8i 4GB Flash PCIe Gen4 12Gb Adapter	N	N	N	N	N	N	N	N	N	N	N	N	N
4Y37A09729	ThinkSystem RAID 940-8i 8GB Flash PCIe Gen4 12Gb Adapter	N	N	N	N	N	N	N	N	N	N	N	N	N
4Y37A09730	ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Adapter	N	N	N	N	N	N	N	N	N	N	N	N	N
4Y37A09735	ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Internal Adapter	N	N	N	N	N	N	N	N	N	N	N	N	N
4Y37A09733	ThinkSystem Raid 940-32i 8GB Flash PCIe Gen4 12Gb Adapter	N	N	N	N	N	N	N	N	N	N	N	N	N

Operating system support

The following tables list the supported operating systems for the adapters:

- ThinkSystem RAID 940-8i 4GB Flash PCIe Gen4 12Gb Adapter, 4Y37A09728
- ThinkSystem RAID 940-8i 8GB Flash PCIe Gen4 12Gb Adapter, 4Y37A09729
- ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Adapter, 4Y37A09730
- ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Internal Adapter, 4Y37A09735
- ThinkSystem RAID 940-32i 8GB Flash PCIe Gen4 12Gb Adapter, 4Y37A09733

Tip: These tables are automatically generated based on data from Lenovo ServerProven.

Table 5. Operating system support for ThinkSystem RAID 940-8i 4GB Flash PCIe Gen4 12Gb Adapter, 4Y37A09728

Operating systems	SR645	SR665
Microsoft Windows Server 2016	Y	Y
Microsoft Windows Server 2019	Y	Y
Red Hat Enterprise Linux 8.1	Y	Y
SUSE Linux Enterprise Server 12 SP5	Y	Y
SUSE Linux Enterprise Server 12 SP5 with Xen	Y	Y
SUSE Linux Enterprise Server 15 SP1	Y	Y
SUSE Linux Enterprise Server 15 SP1 with Xen	Y	Y
VMware vSphere Hypervisor (ESXi) 6.7 U3	Y	Y
VMware vSphere Hypervisor (ESXi) 7.0	Y	Y

Table 6. Operating system support for ThinkSystem RAID 940-8i 8GB Flash PCIe Gen4 12Gb Adapter, 4Y37A09729

Operating systems	SR645	SR665
Microsoft Windows Server 2016	Y	Y
Microsoft Windows Server 2019	Y	Y
Red Hat Enterprise Linux 8.1	Y	Y
SUSE Linux Enterprise Server 12 SP5	Y	Y
SUSE Linux Enterprise Server 12 SP5 with Xen	Y	Y
SUSE Linux Enterprise Server 15 SP1	Y	Y
SUSE Linux Enterprise Server 15 SP1 with Xen	Y	Y
VMware vSphere Hypervisor (ESXi) 6.7 U3	Y	Y
VMware vSphere Hypervisor (ESXi) 7.0	Y	Y

Table 7. Operating system support for ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Adapter, 4Y37A09730

Operating systems	SR645	SR665
Microsoft Windows Server 2016	Y	Y
Microsoft Windows Server 2019	Y	Y
Red Hat Enterprise Linux 8.1	Y	Y
SUSE Linux Enterprise Server 12 SP5	Y	Y
SUSE Linux Enterprise Server 12 SP5 with Xen	Y	Y
SUSE Linux Enterprise Server 15 SP1	Y	Y
SUSE Linux Enterprise Server 15 SP1 with Xen	Y	Y
VMware vSphere Hypervisor (ESXi) 6.7 U3	Y	Y
VMware vSphere Hypervisor (ESXi) 7.0	Y	Y

Table 8. Operating system support for ThinkSystem RAID 940-16i 8GB Flash PCIe Gen4 12Gb Internal Adapter, 4Y37A09735

Operating systems	SR645	SR665
Microsoft Windows Server 2016	Y	Y
Microsoft Windows Server 2019	Y	Y
Red Hat Enterprise Linux 8.1	Y	Y
SUSE Linux Enterprise Server 12 SP5	Y	Y
SUSE Linux Enterprise Server 12 SP5 with Xen	Y	Y
SUSE Linux Enterprise Server 15 SP1	Y	Y
SUSE Linux Enterprise Server 15 SP1 with Xen	Y	Y
VMware vSphere Hypervisor (ESXi) 6.7 U3	Y	Y
VMware vSphere Hypervisor (ESXi) 7.0	Y	Y

Table 9. Operating system support for ThinkSystem RAID 940-32i 8GB Flash PCIe Gen4 12Gb Adapter, 4Y37A09733

Operating systems	SR665
Microsoft Windows Server 2016	Y
Microsoft Windows Server 2019	Y
Red Hat Enterprise Linux 8.1	Y
SUSE Linux Enterprise Server 12 SP5	Y
SUSE Linux Enterprise Server 12 SP5 with Xen	Y
SUSE Linux Enterprise Server 15 SP1	Y
SUSE Linux Enterprise Server 15 SP1 with Xen	Y
VMware vSphere Hypervisor (ESXi) 6.7 U3	Y
VMware vSphere Hypervisor (ESXi) 7.0	Y

Warranty

The adapters carry a 1-year limited warranty. When installed in a supported ThinkSystem server, the adapter assumes the server's base warranty and any warranty upgrades.

Operating environment

The adapters are supported in the following environment:

- Operating:
  - Temperature: 10°C to 55°C (50°F to 131°F)
  - Relative humidity: 20% to 80% (non-condensing)
- Storage
  - Temperature with package: -40°C to 105°C (-40°F to 221°F)
  - Relative humidity: 5% to 95% (non-condensing)

Agency approvals

The ThinkSystem RAID 940 adapters have the following agency approvals:

- USA (FCC 47 CFR part 15 Subpart B, class B)
- Canada (ICES -003, Class B)
- Taiwan (CNS 13438)
- Japan (VCCI V-3)
- Australia/New Zealand (AS/NZS CISPR 22)
- Korea (RRA no 2013-24 & 25)
- Europe (EN55022/EN55024)
- Safety: EN/ IEC/ UL 60950
- RoHS
- WEEE

Related publications and links

For more information, see the following documents:

- Lenovo ThinkSystem RAID Adapter and HBA Reference
  https://lenovopress.com/lp1288-lenovo-thinksystem-raid-adapter-and-hba-reference
- Lenovo ThinkSystem product publications:
  http://thinksystem.lenovofiles.com/help/index.jsp
- ServerProven hardware compatibility:
  http://www.lenovo.com/us/en/serverproven
- Lenovo RAID Management Tools and Resources:
  https://lenovopress.com/lp0579-lenovo-raid-management-tools-and-resources
- Lenovo RAID Introduction
  https://lenovopress.com/lp0578-lenovo-raid-introduction

Related product families

Product families related to this document are the following:

- RAID Adapters

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This document, LP1282, was created or updated on July 10, 2020.

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