



ThinkSystem RAID 940-16i 4GB Flash PCIe Gen4 12Gb Adapter Installation and User Guide



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Chapter 1. Overview

The ThinkSystem RAID 940-16i 4GB Flash PCIe Gen4 12Gb Adapter, based on the SAS3916 tri-mode controller, is a high-performance PCIe-to-SATA/SAS/PCIe (tri-mode) storage adapter. The tri-mode SerDes technology enables operation of SAS, SATA, or PCIe (NVMe) storage devices in a single drive bay. A single controller can operate in all three modes concurrently: SAS, SATA, and PCIe/NVMe. The adapter negotiates between the speeds and the protocols to recognize and concurrently interface with these three storage devices types.

The adapter provides the following storage interface data transfer rates:

- SAS data transfer rates of 12Gb/s, 6Gb/s, and 3Gb/s per phy
- SATA transfer rates at 6Gb/s and 3Gb/s per phy
- PCIe (NVMe) data transfer rates of 16 GT/s, 8 GT/s, 5 GT/s, and 2.5 GT/s per lane

The following table summarizes key adapter features.

Table 1: Adapter Features

Adapter	940-16i
Ports	16 internal
I/O Processor	SAS3916
Form Factor	LP-MD2
Storage Interface Connectors	Two SFF-8654 x8
Host Interface	x8 PCIe 4.0
Storage Interface	SAS, SATA, and PCIe (NVMe)
Cache Memory	4 GB, 2666 MT/s, DDR4 SDRAM
Cache Protection	Yes
Super Capacitor	CVPM05 module

RAID Features

The following list includes primary RAID features that the adapter supports.

- RAID levels 0, 1, 5, and 6
- RAID spans 10, 50, and 60
- Online Capacity Expansion (OCE)
- Auto resume after loss of system power during array rebuild or OCE
- Single controller multipathing
- Load balancing
- Configurable stripe size up to 1 MB
- Fast initialization for quick array setup
- Check Consistency for background data integrity
- SSD support with SSD Guard™ technology
- Patrol read for media scanning and repairing
- Disk data format (DDF)-compliant Configuration on Disk (COD)
- Self-Monitoring, Analysis, and Reporting Technology (S.M.A.R.T) support
- Global and dedicated hot spare with revertible hot spare support
- Automatic rebuild
 - Enclosure affinity
 - Emergency SATA hot spare for SAS arrays
 - Enclosure management

- SCSI Enclosure Services (SES) (inband)
- SGPIO (sideband) or I²C (UBM)
- DataBolt bandwidth optimizer technology support for compatible expander-based enclosures
- Shield state drive diagnostic technology

Operating System Support

The adapter supports the operating systems in the following list.

- Microsoft Windows
- VMware vSphere/ESXi
- Red Hat Enterprise Linux
- SuSE Linux
- Ubuntu Linux
- Citrix XenServer
- CentOS Linux
- Debian Linux
- Oracle Enterprise Linux
- Fedora
- FreeBSD

Visit <http://support.lenovo.com>, and download the latest firmware and driver for the adapter.

PCIe Host Interface

The adapter's PCIe 4.0 host interface provides maximum transmission and reception rates of up to 128 GT/s (16GB/s per lane). The tri-mode controller uses a packet-based communication protocol to communicate over the serial interconnect.

Other PCIe host interface features include the following:

- Eight-lane PCIe host interface
- PCIe Hot Plug
- Power management
 - Supports the *PCI Bus Power Management Interface Specification Revision 1.2*
 - Supports Active State Power Management, including the L0 states, by placing links in a power-saving mode during times of no link activity
- Error handling
- High bandwidth per pin with low overhead and low latency
- Lane reversal and polarity inversion
- Single-phy (one-lane) link transfer rate of 16 GT/s, 8 GT/s, 5 GT/s, and 2.5 GT/s in each direction
- Eight-lane aggregate bandwidth of up to 16GB/s (16,000 MB/s)
- Support of x8, x4, x2, and x1 link widths

LED Management

Tri-Mode Storage Interface Features

The adapter's storage interface supports concurrent operation with SAS, SATA, and PCIe (NVMe) devices to provide a fully functional solution for any storage environment.

- PCIe (NVMe) interface features:
 - Up to sixteen x1, eight x2, or four x4 NVMe direct-attach drive support
 - Data transfer at 16 GT/s, 8 GT/s, 5 GT/s, and 2.5 GT/s
 - Independent resets and configuration
 - Common reference clock and separate reference clock independent SSC (SRIS) support
- SAS features:

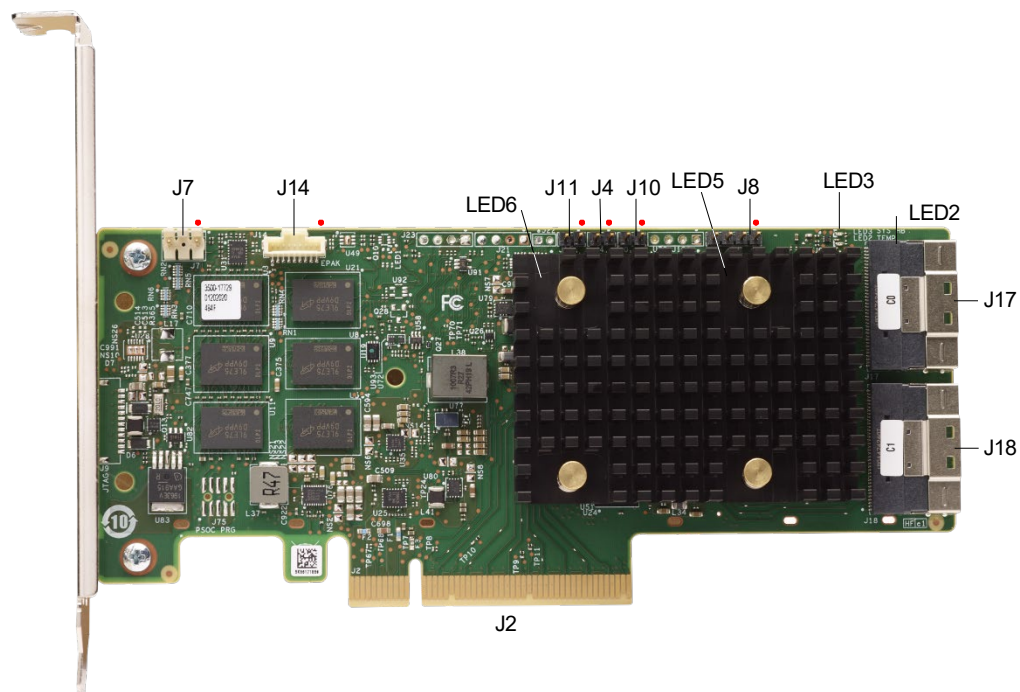
- SAS data transfers at 12Gb/s, 6Gb/s, and 3Gb/s
- DataBolt technology on all SAS phys to improve performance
- Serial, point-to-point, enterprise-level storage interface
- Wide ports that contain multiple phys
- Narrow ports that contain a single phy
- SAS phy power management
- Data transfer by using SCSI information units
- T10 data protection management
- Support for persistent connection capability
- Support for SPL-3 initiate close capability
- Configurable Rx and Tx polarity inversion
- Configurable phy-to-disk mapping
- Configurable SSC
- SATA interface features:
 - SATA and STP data transfers at 6Gb/s and 3Gb/s
 - Addressing of multiple SATA targets through an expander

Adapter Characteristics

The adapter is a 6.127 in. × 2.712 in. (155.65 mm × 68.90 mm) board. The component height on the top and bottom of the adapter complies with the PCIe specification.

The following figure shows the connectors and LED locations on the adapter.

Figure 1: Card Layout for the ThinkSystem RAID 940-16i 4GB Flash PCIe Gen4 Adapter



The following table describes the headers and connectors on the adapter.

Table 2: Headers and Connectors

Connector	Type	Description
J2	Standard edge card connector	The interface between the storage adapter and the host system. With the PCIe interface, this connector provides power to the board and an I ² C interface connected to the I ² C bus for the Intelligent Platform Management Interface (IPMI).
J4	Default serial boot ROM (SBR) header	2-pin connector. Reserved.
J7	Advanced software options hardware key header	2-pin connector. Enables support for selected advanced features.
J8	Onboard serial UART connector	4-pin connector. Reserved.
J10	Global HDD activity LED header	2-pin connector. Connects to an LED that indicates activity on the drives connected to the adapter.
J11	Global drive fault LED header	2-pin connector. Connects to an LED that indicates whether a drive is in a fault condition.
J14	CacheVault power module interface	9-pin connector. Connects the adapter to a CacheVault power module.
J17, J18	Storage interface connectors	Two SFF-8654 8-port internal connectors. Connect the adapter by cable to the storage devices.

The following figure shows the connectors and LED locations on the adapter. A red circle near each header and connector identifies pin 1 in the figure.

Table 3: LED Designations

LED	Type	Description
LED 2	Yellow controller over temperature	Stays on solid to indicate that the SAS3916 device temperature sensor is over the temperature threshold. When the device is in the proper temperature range, this LED is off.
LED 3	Green system heartbeat	Indicates that the SAS3916 RoC ASIC is operating normally. This LED blinks at 1 Hz.
LED 5	Yellow supercap fault	Indicates that the CacheVault power module is in fault state or is over temperature. This LED resides on the nonheat-sink side of the board.
LED 6	Green ONFI activity	Indicates when the ONFI is active for cache offload or recovery. This LED resides on the nonheat-sink side of the board.

Chapter 2. Adapter Installation Instructions

This chapter provides detailed instructions on how to install your adapter. To install the adapter, follow these steps:

1. **Unpack your adapter.**

Unpack and remove the adapter. Inspect the adapter for damage. If it appears damaged, contact Lenovo or your reseller support representative.

ATTENTION

To avoid the risk of data loss, back up your data before you change your system configuration.

2. **Turn off the power to the system.**

Turn off the power to the computer, and disconnect the AC power cord. Remove the computer cover. Refer to the system documentation for instructions. Before you install the adapter, make sure that the computer is disconnected from the power and from any networks.



CAUTION

Disconnect the computer from the power supply and from any networks to which you will install the adapter, or you risk damaging the system or experiencing electrical shock.

3. **Review the adapter connectors.**

4. **Check the mounting bracket on the adapter.**

If required for your system, replace the full-profile mounting bracket that ships on the adapter with the low-profile bracket supplied. Complete the following steps to attach the low-profile bracket.

- a) Using a No. 1 Phillips screwdriver that is ESD safe, remove the two Phillips screws that connect the full-profile bracket to the board. Unscrew the two screws located at the top and bottom edges of the board. Avoid touching any board components with the screwdriver or the bracket.
- b) Remove the full-profile bracket. Do not damage the adapter.
- c) Place the adapter on top of the low-profile bracket. Position the bracket so that the screw holes in the tabs align with the openings in the board.
- d) Using a No. 1 Phillips torque screwdriver that is ESD safe, set to a maximum torque of 4.8 ± 0.5 inch-pounds. Replace the two Phillips screws removed in Step a.

ATTENTION

Exceeding this torque specification can damage the board, connectors, or screws, and can void the warranty on the board.

ATTENTION

Damage caused to the board as a result of changing the bracket can void the warranty on the board. Adapters returned without a bracket mounted on the board will be returned without return merchandise authorization (RMA) processing.

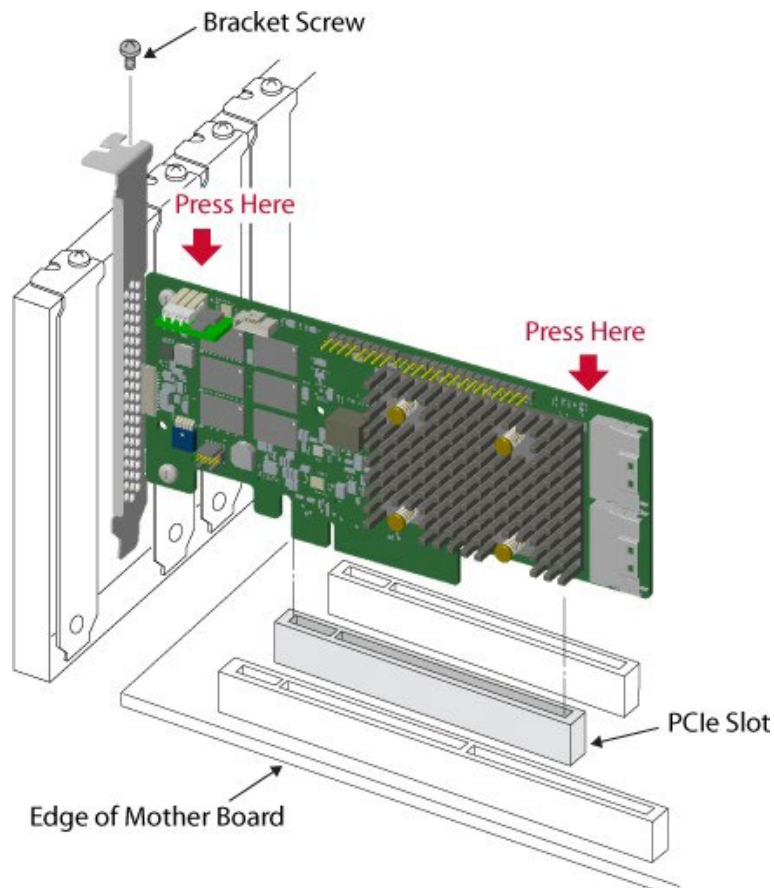
- ## 5. **Insert the adapter into an available PCIe slot.** Select a PCIe slot, and align the adapter's PCIe bus connector to the slot, as shown in the following figure. Press down gently, but firmly, to make sure that the adapter is seated correctly in the slot. Secure the bracket to the computer chassis with the bracket screw.

Refer to [ThinkSystem Server Documentation Center](#), select your product, and review the Install server hardware options section for detailed instructions.

NOTE

Adapters with a x8 host interface can operate in x8 or x16 slots. However, some x16 PCIe slots support only PCIe graphics cards; an adapter installed in one of these slots will not function. Refer to the guide for your motherboard for information about the PCIe slots.

Figure 2: Installing an Adapter in a PCIe Slot



6. Configure and install the SAS and SATA devices in the host computer case.

Refer to documentation for the devices for any preinstallation configuration requirements.

7. Connect the adapter to the devices. Connect the appropriate cable with the connectors on one end to connect to the adapter and the appropriate connector on the other end to attach to the backplane connector.

The maximum cable length is 1 meter (39.37 in.). A single wide-port SAS device cannot connect to phys controlled by different SAS cores or PDBs.

Refer to [ThinkSystem Server Documentation Center](#), select your product, and review the internal cable routing section for detailed instructions.

8. Provide the required airflow for the installed adapter.

9. Turn on the power to the system. Reinstall the computer cover, and reconnect the AC power cords. Make sure that the power is turned on to the storage devices before or at the same time that the power is turned on to the host

computer. Turn on power to the host computer. If the computer is powered on before these devices, the devices might not be recognized.

During boot, a BIOS message appears. The firmware takes several seconds to initialize. The configuration utility prompt times out after several seconds. The second portion of the BIOS message shows the adapter controller number, firmware version, and cache SDRAM size. The numbering of the adapters follows the PCIe slot scanning order used by the host motherboard.

10. Choose the correct storage profile.

11. Install the operating system driver. The adapters can operate under various operating systems. To operate under these operating systems, you must install the software drivers.





The hardware installation of your adapter is complete.





Chapter 3. Marks, Certifications, Compliance, and Safety Characteristics

Marks, Certifications, and Compliance

The design and implementation of the adapters minimize electromagnetic emissions, susceptibility to radio frequency energy, and the effects of electrostatic discharge.

Table 4: Adapter Marks and Certifications

Mark	Symbol	Description
Australia and New Zealand RCM		Meets the following standards: <ul style="list-style-type: none"> AS/NZS CISPR 32 CISPR 32:2015, Class B AS/NZS CISPR 32:2015, Class B
Canada EMC	CANADA ICES-003 CLASS B CANADA NMB-003 CLASSE B CAN ICES-3 (B)/NMB-3 (B)	Meets the following standards: <ul style="list-style-type: none"> ICES-003:2016 Issue 6: 2016, Class B CAN/CSA CISPR 22-10 CISPR 22:2008
Europe (CE)		Meets the following standards: <ul style="list-style-type: none"> EN55022/EN55024 EN55032 EN 55032:2015 +AC:2016, Class B EN 50022:2010 +AC:2011, Class B EN 55024:2010 +A1:2015
Korea (RRL)	 R-R-A8T-XXXXX	xxxxx = model number Meets the KN32/KN35 testing requirements.
Taiwan (BSMI)	 D3B320 RoHS	Meets the following standards: <ul style="list-style-type: none"> CNS 13438 CNS15663

Mark	Symbol	Description
USA / Canada Safety (UL Listed)		<p>For use with UL listed ITE equipment only.</p> <p>Meets the following standards:</p> <ul style="list-style-type: none"> • UL 60950-1, 2nd Edition, 2014-10-14 (Information Technology Equipment - Safety -Part 1: General Requirements) • CAN/CSA C22.2 No. 60950-1-07, 2nd Edition, 2014-10 (Information Technology Equipment -Safety -Part 1: General Requirements) • UL 62368-1, Second Edition • CAN/CSA C22.2 No. 62368-1-14
CB Scheme Safety	—	<p>Meets the following standards:</p> <ul style="list-style-type: none"> • IEC 60950-1:2005 (Second edition) + Am 1:2009 + Am 2:2013 • EN 60950-1: 2006 + A11: 2009 + A1: 2010 + A12: 2011 + A2: 2013 • IEC 62368-1:2014 (Second edition) • EN 62368-1:2014+A11: 2017
Japan (VCCI)		<p>Meets the following standards:</p> <ul style="list-style-type: none"> • V-3/2015.04, Class B • V-4/2012.04 • VCCI-CISPR 32:2016 • CISPR 32:2015
USA /Canada (FCC)		<p>Meets the following standards:</p> <ul style="list-style-type: none"> • 47 CFR FCC Part 15, Subpart B, Class B • ANSI C63.4:2014 • CISPR 32:2008
Morocco (CIMM)		<p>Meets the following standards:</p> <ul style="list-style-type: none"> • EN55022/EN55024 EN55032 • EN 55032:2015 +AC:2016, Class B • EN 50022:2010 +AC:2011, Class B • EN 55024:2010 +A1:2015
Country of Origin	Made in XXXX	XXXX indicates the country of origin.

Safety Characteristics

All tri-mode storage adapters meet or exceed the requirements of UL flammability rating 94 V0. Each bare board is also marked with the supplier name or trademark, type, and UL flammability rating. For the boards installed in a PCIe bus slot, all voltages are lower than the SELV 42.4V limit.

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