Lenovo eXFlash DDR3 Storage DIMMs

Product Guide (withdrawn product)

eXFlash memory-channel storage is the newest innovative flash memory technology from Lenovo, first introduced with System x3850 X6 and x3950 X6 servers. eXFlash memory-channel storage is a high-performance solid-state storage device in a standard DIMM form factor that plugs into existing memory DIMM slots and is directly connected to the DDR3 system memory bus.

This new technology allows supported System x® servers to close the performance gap in storage I/O and deliver break-through performance for targeted workloads, such as analytical workloads, transactional databases, and virtualized environments. Lenovo eXFlash DIMMs offer significantly lower latency compared to traditional solid-state devices, such as eXFlash SSDs and even PCIe SSD adapters.

The following figure shows the eXFlash DDR3 Storage DIMM.

Figure 1. eXFlash DDR3 Storage DIMM

Did you know?

- eXFlash memory-channel storage is the industry's first flash memory device where data is transferred from the flash memory to the system memory directly through the DDR3 memory bus.
- eXFlash memory-channel storage provides scalable performance by using an array of eXFlash DIMMs in a parallel manner.
- eXFlash DIMMs feature WriteNow technology that helps to deliver less than 5 microseconds write latency.
- With FlashGuard protection, eXFlash DDR3 Storage DIMMs can be fully rewritten up to ten times per day throughout their entire five-year life expectancy.
- Rigorous testing of eXFlash DDR3 Storage DIMMs by Lenovo through the ServerProven® program ensures a high degree of confidence in storage subsystem compatibility and reliability. Providing additional peace of mind, these modules are covered under warranty.

Part number information

The following table lists the information for ordering part numbers and feature codes.

Table 1. Ordering part numbers and feature codes

Description	Part number	Feature code
eXFlash 200GB DDR3 Storage DIMM	00FE000	A4GX
eXFlash 400GB DDR3 Storage DIMM	00FE005	A4GY

The part numbers for the eXFlash DDR3 Storage DIMMs include the following items:

- One eXFlash DIMM module
- Documentation CD
- Technical Flyer
- Warranty Flyer
- *Important Notices* document

Features

Here are the key features of the eXFlash memory-channel storage:

- Ultra-low write latency with WriteNow technology
  - Less than 5 microseconds response time
  - Less wait time between transactions
  - Deterministic response time across varying workloads
  - Tight standard deviation on performance
  - Consistent performance for highest throughput and speed
- High scalability
  - Add multiple eXFlash DIMMs without experiencing performance degradation
  - Highest flash memory density within the server
- Maximized storage footprint with usage of existing unused DDR3 slots
  - Increases storage capacity without increasing your servers
  - Features industry-standard DDR3 form factor
  - Plugs into an existing DDR3 slot

eXFlash DIMMs are recognized by the server as solid-state storage devices like many other block storage devices. A specialized kernel driver is required for the operating system to use eXFlash DIMMs.

eXFlash DIMMs have the following key characteristics:

- Industry standard LP DIMM form factor supports standard DDR3 memory DIMM slots on selected System x servers.
- Uses cost-effective 19 nm MLC NAND technology with FlashGuard technology for high read and write performance to fulfill client needs in the enterprise space.
- High endurance, with up to 10 drive writes per day (DWPD) during a 5-year lifecycle to withstand applications with intensive read/write workloads.
- Up to 12.8 TB total flash memory-channel storage capacity per server.
- Support of up to 1600 MHz DDR memory speeds and the usage of available DDR3 memory channels.
- Support for intermixing with standard registered memory DIMMs (RDIMMs) on the same memory channel.

- FlashGuard technology extends the native endurance of commercial-grade MLC flash memory by using the following features:
    - Aggregated Flash Management
    - Advanced Signal Processing
    - Enhanced Error Correction
- DataGuard technology protects against data corruption and loss by using the following features:
    - Full data path protection
    - Flexible Redundant Array of Memory Elements (F.R.A.M.E.) data recovery algorithm
- EverGuard technology protects data in the event of unplanned power outages.

Solid-state storage has a huge but finite number of program/erase (P/E) cycles, which affects how long it can perform write operations and thus its life expectancy. Solid-state device write endurance is typically measured by the number of program/erase cycles that the device can incur over its lifetime, which is listed as Total Bytes Written (TBW) or Drive Writes Per Day (DWPD) in the device specification.

The TBW value that is assigned to a solid-state device is the total bytes of written data that a drive can be guaranteed to complete. Reaching this limit does not cause the drive to immediately fail; the TBW simply denotes the maximum number of writes that can be guaranteed. A solid-state device does not fail upon reaching the specified TBW, but at some point after surpassing the TBW value (and based on manufacturing variance margins), the drive reaches the end-of-life point, at which time the drive will go into read-only mode. Because of such behavior, careful planning must be done when you use SSDs in application environments to ensure that the TBW of the drive is not exceeded before the required life expectancy is reached.

Technical specifications

The following table presents technical specifications for the eXFlash DDR3 Storage DIMMs.

Table 2. eXFlash DDR3 Storage DIMM technical specifications

Feature	**200 GB**	**400 GB**
Part number	00FE000	00FE005
Interface	DDR3 up to 1600 MHz	DDR3 up to 1600 MHz
Hot-swap device	No	No
Form factor	LP DIMM	LP DIMM
Capacity	200 GB	400 GB
Endurance	Up to 10 drive writes per day (5-year lifetime)	Up to 10 drive writes per day (5-year lifetime)
Data reliability	< 1 in 10^{17} bits read	< 1 in 10^{17} bits read
Shock	200 *g,* 10 ms	200 *g,* 10 ms
Vibration	2.17 *g* rms 7-800 Hz	2.17 *g* rms 7-800 Hz
Maximum power	12 W	12 W

The following table presents performance characteristics for the eXFlash DDR3 Storage DIMMs.

Table 3. eXFlash DDR3 Storage DIMM performance characteristics

Characteristic	**200 GB**			**400 GB**		
Part number	00FE000			00FE005		
Server family tested	System x3650 M4 (E5-2600 v2)		X6 servers	x3650 M4 (E5-2600 v2)		X6 servers
Operational speed	1600 MHz	1333 MHz	1333 MHz	1600 MHz	1333 MHz	1333 MHz
IOPS reads*	135,402	135,525	144,672	135,660	135,722	139,710
IOPS writes*	28,016	28,294	29,054	41,424	41,553	43,430
Sequential read rate**	743 MBps	689 MBps	644 MBps	739 MBps	696 MBps	636 MBps
Sequential write rate**	375 MBps	376 MBps	382 MBps	388 MBps	392 MBps	404 MBps
Read latency***	150 ?s	151 ?s	141 ?s	150 ?s	151 ?s	144 ?s
SEWC write latency***	4.66 ?s	5.16 ?s	6.78 ?s	4.67 ?s	5.17 ?s	7.08 ?s

* 4 KB block transfers
* 64 KB block transfers
*** Latency measured at hardware (CLAT) exclusive of system latency (SLAT).

Supported servers

The following tables lists the server compatibility information for the eXFlash DDR3 Storage DIMMs.

Table 4. Support for servers with Intel Xeon v3 processors

Part number	Description	x3100 M5 (5457)	x3250 M5 (5458)	x3500 M5 (5464)	x3550 M5 (5463)	x3650 M5 (5462)	x3850 X6/x3950 X6 (6241, E7 v3)	nx360 M5 (5465)
00FE000	eXFlash 200GB DDR3 Storage DIMM	N	N	N	N	N	Y	N
00FE005	eXFlash 400GB DDR3 Storage DIMM	N	N	N	N	N	Y	N

Table 5. Support for servers with Intel Xeon v3 processors

Part number	Description	x3500 M4 (7383, E5-2600 v2)	x3530 M4 (7160, E5-2400 v2)	x3550 M4 (7914, E5-2600 v2)	x3630 M4 (7158, E5-2400 v2)	x3650 M4 (7915, E5-2600 v2)	x3650 M4 BD (5466)	x3650 M4 HD (5460)	x3750 M4 (8752)	x3750 M4 (8753)	x3850 X6/x3950 X6 (3837)	x3850 X6/x3950 X6 (6241, E7 v2)	dx360 M4 (E5-2600 v2)	nx360 M4 (5455)
00FE000	eXFlash 200GB DDR3 Storage DIMM	N	N	N	N	Y*	N	N	N	N	Y	Y	N	N
00FE005	eXFlash 400GB DDR3 Storage DIMM	N	N	N	N	Y*	N	N	N	N	Y	Y	N	N

* The x3650 M4 has limited support. See below.

Table 6. Support for servers with Intel Xeon v3 processors

Part number	Description	x3100 M4 (2582)	x3250 M4 (2583)	x3300 M4 (7382)	x3500 M4 (7383, E5-2600)	x3530 M4 (7160, E5-2400)	x3550 M4 (7914, E5-2600)	x3630 M4 (7158, E5-2400)	x3650 M4 (7915, E5-2600)	x3690 X5 (7147)	x3750 M4 (8722)	x3850 X5 (7143)	dx360 M4 (7912, E5-2600)
00FE000	eXFlash 200GB DDR3 Storage DIMM	N	N	N	N	N	N	N	N	N	N	N	N
00FE005	eXFlash 400GB DDR3 Storage DIMM	N	N	N	N	N	N	N	N	N	N	N	N

Table 7. Support for Flex System servers

Part number	Description	x220 (7906)	x222 (7916)	x240 (8737, E5-2600)	x240 (8737, E5-2600 v2)	x240 (7162)	x240 M5 (9532)	x440 (7917)	x440 (7167)	x880/x480/x280 X6 (7903)	x280/x480/x880 X6 (7196)
00FE000	eXFlash 200GB DDR3 Storage DIMM	N	N	N	N	N	N	N	N	N	Y
00FE005	eXFlash 400GB DDR3 Storage DIMM	N	N	N	N	N	N	N	N	N	Y

eXFlash DIMM planning considerations

Consider the following rules when planning for eXFlash DIMMs:

- A maximum of one eXFlash DIMM per DDR3 memory channel is supported.
- At least one RDIMM must be installed in the same memory channel as eXFlash DIMM.
- eXFlash DIMMs only support RDIMMs; other memory types are not supported.
- eXFlash DIMMs with different capacities (that is, 200 GB and 400 GB) cannot be intermixed in the same server.
- eXFlash DIMMs are supported only in memory performance mode; other memory modes of operations (such as lockstep, memory mirroring, and memory sparing) are not supported.
- Processor C-states are not supported and must be disabled.

System x3650 M4 considerations

The x3650 M4 has limited support for eXFlash DIMMs. Only the following x3650 M4 components are supported by eXFlash DIMMs:

- Quantity: 4 or 8 eXFlash DIMMs; other eXFlash DIMM quantities are not supported.
- Operating system: Red Hat Enterprise Linux 6 Server x64 Edition (Update 4 or Update 5).

- Processor:
  - Intel Xeon Processor E5-2667 v2 8C 3.3GHz 25MB Cache 1866MHz 130W
  - Intel Xeon Processor E5-2643 v2 6C 3.5GHz 25MB Cache 1866MHz 130W
  - Intel Xeon Processor E5-2697 v2 12C 2.7GHz 30MB Cache 1866MHz 130W
  - Intel Xeon Processor E5-2690 v2 10C 3.0GHz 25MB Cache 1866MHz 130W
- Memory: 16 GB (1x16 GB, 2Rx4, 1.5V) PC3-14900 CL13 ECC DDR3 1866MHz LP RDIMM (00D5048).
- Adapter: Intel X520 Dual Port 10GbE SFP+ Embedded Adapter for System x.

System x3850 X6/x3950 X6 considerations

The x3850 X6/x3950 X6 has the following configuration rules for eXFlash DIMMs and only the following x3850 X6/x3950 X6 components are supported by eXFlash DIMMs:

- eXFlash DIMMs are only supported in DDR3 compute books. Compute books with DDR4 DIMMs are not supported
- Quantity: 1, 2, 4, 8, 16, or 32 eXFlash DIMMs; other eXFlash DIMM quantities are not supported.
- Install equivalent quantities of RDIMMs to match the quantities of eXFlash DIMMs up to 8 modules per CPU book (2 DIMMs per channel). Additional RDIMMs can be installed up to a quantity of 16 to populate all available DIMM slots (3 DIMMs per channel, 2 RDIMMs and 1 eXFlash DIMM).
- The 200 GB and 400 GB eXFlash DIMMs cannot be mixed.
- Performance memory mode must be selected. RAS (lockstep) memory mode is not supported.
- Only RDIMMs are supported by eXFlash DIMMs; LRDIMMs are not supported.

Flex System X6 considerations

The following rules apply when a server configuration is built with eXFlash DIMMs:

- The 200 GB and 400 GB eXFlash DIMMs cannot be mixed.
- Performance memory mode must be selected; RAS (lockstep) memory mode is not supported.
- Only RDIMMs are supported with eXFlash DIMMs; LRDIMMs are not supported.
- Only 8 GB or 16 GB RDIMMs are supported with eXFlash DIMMs; 4 GB RDIMMs and all LR-DIMMs are not supported.
- eXFlash DIMMs can only be installed in quantities of 2, 4, 8 and 12.
- Maximum quantities of eXFlash DIMMs in the X6 compute nodes:
  - 2-socket configuration: 12 eXFlash DIMMs
  - 4-socket scaled configuration: 24 eXFlash DIMMs
  - 8-socket scaled configuration: 24 eXFlash DIMMs

For the latest eXFlash DIMM compatibility information and additional requirements, refer to the *eXFlash DIMM Configuration and Support Requirements* document:
https://www-947.ibm.com/support/entry/myportal/docdisplay?lndocid=SERV-FLASHDM

For more information about the System x servers that support each eXFlash DIMM, see the ServerProven website:
http://www.lenovo.com/us/en/serverproven/

Supported operating systems

eXFlash DDR3 Storage DIMMs are supported by the operating systems listed in the following table.

Note: Windows Server 2016 is not supported.

Table 8. Supported operating systems

	x3650 M4	x3850 X6	x280 X6	x480/x880 X6
RHEL 6.3	Yes	Yes	No	No
RHEL 6.4	Yes	Yes	No	No
RHEL 6.5	Yes	Yes	Yes	No
RHEL 6.6	Yes	Yes	Yes	Yes
RHEL 7.0	Yes	Yes	No	No
RHEL 7.1	Yes	Yes	No	Yes
SLES 11 SP1	Yes	Yes	No	No
SLES 11 SP2	Yes	Yes	No	No
SLES 11 SP3	Yes	Yes	Yes	No
SLES 11 SP4	Yes	Yes	Yes	Yes
SLES 12	Yes	Yes	Yes	Yes
VMware ESXi 5.1 Update 2	Yes	Yes	No	No
VMware ESXi 5.5 Update 0	No	No	Yes	Yes
VMware ESXi 5.5 Update 1	Yes	Yes	No	No
VMware ESXi 5.5 Update 2	Yes	Yes	Yes	Yes
VMware ESXi 6.0	No	No	Yes	Yes
Windows Server 2008 R2 SP1	Yes	Yes	No	No
Windows Server 2012	Yes	Yes	Yes	Yes
Windows Server 2012 R2	Yes	Yes	Yes	Yes

For the latest eXFlash DIMM compatibility information and additional requirements, refer to the *eXFlash DIMM Configuration and Support Requirements* document:
https://www-947.ibm.com/support/entry/myportal/docdisplay?lndocid=SERV-FLASHDM

Warranty

The eXFlash DDR3 Storage DIMMs carry a 1-year, customer-replaceable unit (CRU) limited warranty. When they are installed in a supported Lenovo server, these modules assume your system's base warranty and any IBM ServicePac® upgrade.

Physical specifications

The eXFlash DDR3 Storage DIMMs have the following physical specifications.

Dimensions:

- Height: 8.5 mm (0.33 in.)
- Width: 30 mm (1.18 in.)
- Length: 133.3 mm (5.25 in.)

Operating environment

The eXFlash DDR3 Storage DIMMs are supported in the following environment:

- Temperature: 0 to 70 °C (32 to 158°F)
- Relative humidity: 5 - 95% (non-condensing)
- Maximum altitude: 5,486 m (18,000 ft)

Related publications and links

For more information, see the following documents:

- eXFlash DIMMs User Guide
  https://support.lenovo.com/docs/UM103549
- *The Benefits of eXFlash Memory-Channel Storage in Enterprise Solutions,* REDP-5089
  http://lenovopress.com/redp5089
- *System x Configuration and Options Guide*
  http://www.ibm.com/systems/xbc/cog/
- ServerProven
  http://www.lenovo.com/us/en/serverproven/xseries/storage/mcmatrix.shtml
- US Announcement Letter - eXFlash DDR3 Storage DIMMs (the same Announcement Letter as for System x3850 X6 and x3950 X6):
  http://ibm.com/common/ssi/cgi-bin/ssialias?infotype=dd&subtype=ca&&htmlfid=897/ENUS114-031

Related product families

Product families related to this document are the following:

- Drives
- Memory

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