

Fusion ioMemory™ VSL® 3.2.11

Table of Contents

Table of Contents	2
Fusion ioMemory VSL 3.2.11 User Guide for VMware ESXi	6
Legal Notices	6
Introduction	7
Overview	7
About the ioMemory Platform	7
Performance	7
Endurance	7
Reliability	7
Fusion ioMemory VSL Software Installation	8
VMDirectPathIO	8
Command-Line Installation	8
ESXi Command Line	8
Installation Overview	9
Downloading the Software	9
Transferring the Fusion ioMemory VSL files to the ESXi Server	11
Transfer Methods	11
vCLI Example	11
Installing the ioMemory VSL on ESXi 5.x	12
vCLI Installation	13
Command-line Installation	13
Upgrading the Firmware	13
Configuration	15
Enabling PCIe Power Override	15

- Enabling the Override Parameter 16
 - Determine Serial Number(s) 16
 - Setting the Parameter 17
- Configuring the Device to Support VM Disks 17
- Modifying a VMware Resource Pool to Reserve Memory 18
- Performance and Tuning 20**
 - Disable CPU Frequency Scaling 20
 - Limiting ACPI C-States 20
 - Setting ACPI C-State Options 20
- Monitoring and Managing Devices 21**
 - Management Tools 21
 - Stand-alone Tools 21
 - Data-source Tools 21
 - Example Conditions to Monitor 22
 - Device Status 22
 - Temperature 22
 - Health Reserves Percentage 23
 - Write (Health Reserves) Status 23
 - Device LED Indicators 24
 - Three LEDs 24
 - One LED 25
- Maintenance 26**
 - Uninstalling the Software 26
 - Uninstalling the software in ESXi 5.x 26
 - Unloading or Disabling the Software Driver 26
 - Loading or Enabling the Driver 27
 - Loading or Enabling the Fusion ioMemory VSL Driver 27

- Detaching a Fusion ioMemory device 28
- Disabling Auto-Attach 28
 - Disabling Auto-Attach in ESXi 28
- Unmanaged Shutdown Issues 29
 - Improving Rescan Times 29
 - Default Fast Rescan 29
 - Faster Rescans Using Module Parameters 29
 - RMAP Parameter 30
 - RSORT Parameter 31
- Appendix A - Command-line Utilities Reference 33**
 - fio-attach 34
 - fio-beacon 35
 - fio-bugreport 35
 - fio-detach 36
 - fio-format 37
 - fio-pci-check 39
 - fio-status 39
 - fio-update-iodrive 42
- Appendix B - Monitoring the Health of Devices 45**
 - Health Metrics 45
 - Health Monitoring Techniques 45
 - Software RAID and Health Monitoring 46
- Appendix C - Using Module Parameters 47**
- Appendix D - Working with ioMemory Devices and VMDirectPathIO 49**
- Appendix E - Upgrading Devices from VSL 2.x to 3.x 50**
 - Upgrade Procedure 50
- Fusion Powered Support 55**

E-Mail55

Warranty Support55

Telephone Support55

Web55

Fusion ioMemory VSL 3.2.11 User Guide for VMware ESXi

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Introduction

Overview

Congratulations on your purchase of a SanDisk® solid-state storage device. This guide explains how to install, troubleshoot, and maintain the Fusion ioMemory™ VSL® software for your Fusion ioMemory devices.

NOTE-

Throughout this manual, when you see a reference to any **Fusion ioMemory device**, you may substitute your particular device(s) from the *Supported Devices* list located in the *Fusion ioMemory VSL Release Notes*.

ATTENTION!

Products with Multiple Devices

Some products, such as a Fusion ioMemory ioDrive Duo device, are actually comprised of **multiple Fusion ioMemory devices**. If your product consists of multiple Fusion ioMemory devices, you will manage each Fusion ioMemory device as an independent device.

For example, if you have a Fusion ioMemory ioDrive Duo device, you can independently attach, detach, and/or format each of the two Fusion ioMemory devices. Each of the two devices will be presented as an individual device to your system.

About the ioMemory Platform

The ioMemory platform combines Fusion ioMemory VSL software (VSL stands for Virtual Storage Layer) with ioMemory hardware to take enterprise applications and databases to the next level.

Performance

The ioMemory platform provides consistent microsecond latency access for mixed workloads, multiple gigabytes per second access and hundreds of thousands of IOPS from a single product. The sophisticated ioMemory architecture allows for nearly symmetrical read and write performance with best-in-class low queue depth performance, making the ioMemory platform ideal across a wide variety of real world, high-performance enterprise environments.

The ioMemory platform integrates with host system CPUs as flash memory to give multiple (and mostly idle) processor cores, direct and parallel access to the flash. The platform's cut-through architecture gives systems more work per unit of processing, and continues to deliver performance increases as CPU power increases.

Endurance

The ioMemory platform offers best-in-class endurance in all capacities, which is crucial for caching and write-heavy databases and applications.

Reliability

The ioMemory platform eliminates concerns about reliability like NAND failures and excessive wear. The all-new intelligent, self-healing feature called Adaptive Flashback provides complete, chip-level fault tolerance. Adaptive Flashback technology enables an ioMemory product to repair itself after a single chip or a multi-chip failure without interrupting business continuity.

Fusion ioMemory VSL Software Installation

Before continuing with the installation of this software, please read the following:

1. Ensure that your operating system is included in the list of **supported operating systems** contained in the *Fusion ioMemory VSL Release Notes* for this release.
2. Before installing the Fusion ioMemory VSL software, make sure you have properly installed the Fusion ioMemory device(s). Refer to the *Fusion ioMemory Hardware Installation Guide* for full details and hardware requirements.

ATTENTION!

Every Fusion ioMemory device in a system must be upgraded to the appropriate firmware.

For example, if you have a system running Fusion ioMemory VSL software version 2.3.1 with Fusion ioMemory devices previously installed, and you want to install new Fusion ioMemory ioDrive2 devices (that require the latest version of the firmware), then you will need to upgrade all of the existing devices with firmware that supports this version of the Fusion ioMemory VSL software. Follow the upgrade path in the *Fusion ioMemory VSL Release Notes* to determine the upgrade sequence.

WARNING!

Upgrade Previous Devices First

If you have Fusion ioMemory devices configured for Fusion ioMemory VSL software version 2.x or earlier, you must upgrade their firmware before installing new devices in the system. See [Upgrading Devices from VSL 2.x to 3.x on page 50](#) for the upgrade instructions.

VMDirectPathIO

The ESXi Fusion ioMemory VSL software is only required if you plan to use the device as a VMFS Datastore. If, however, you are passing the device(s) through to a guest operating system (using VMDirectPathIO -- also known as PCI passthrough), you do not need to install the Fusion ioMemory VSL software on the ESXi system. Instead, install the Fusion ioMemory VSL software on the guest operating system. For example, you would pass the device through to a Windows VM and then install the Windows Fusion ioMemory VSL software on that VM (consult the *Fusion ioMemory VSL User Guide for Windows* for installation and user instructions).

There are special considerations when passing through a Fusion ioMemory device, for more information, see [Working with ioMemory Devices and VMDirectPathIO on page 49](#) before proceeding with passing through the device.

Command-Line Installation

Unless you use VUM, you will need to use a command-line interface to install the Fusion ioMemory VSL software. In order to manage the Fusion ioMemory devices and Fusion ioMemory VSL software, you **must** use a Command-Line Interface (CLI).

ESXi Command Line

VMware provides the **vCLI** (vSphere Command-Line Interface) to run against your ESXi system. You should install a vCLI package on a physical machine running Linux or Windows. For more information on VMware's vCLI, see <http://www.vmware.com/support/developer/vcli/>

ATTENTION!

We do not recommend using the vCLI within a virtual machine that is hosted on your ESXi system. The Fusion ioMemory VSL software installation and configuration processes involve rebooting the host.

You may choose to use the **TSM** (Tech Support Mode), also known as **Shell** or **SSH** (when used remotely), instead of the vCLI to install the Fusion ioMemory VSL software. The TSM/Shell may be required for managing/troubleshooting your device with the command-line utilities.

WARNING!

VMware suggests that the TSM only be used "for the purposes of troubleshooting and remediation." VMware recommends using the vSphere Client or any other VMware Administration Automation Product to perform routine ESXi host configuration tasks that do not involve a troubleshooting scenario. For more information visit VMware's Knowledge Base article on using this mode: <http://kb.vmware.com/kb/1017910>.

Installation Overview

1. Download the latest version of the software at <https://link.sandisk.com/commercialsupport>.
2. If you are installing this version of Fusion ioMemory VSL software on a system with Fusion ioMemory ioDrive devices configured with firmware for Fusion ioMemory VSL software version 2.x, you must carefully follow the instructions in the [Upgrading Devices from VSL 2.x to 3.x on page 50](#). (Follow those instructions instead of the normal installation instructions.)
3. If you have a previous version of the Fusion ioMemory VSL software installed, you will need to uninstall the Fusion ioMemory VSL software and the utilities.
4. Install the latest version of the Fusion ioMemory VSL software and command-line utilities.
5. Reboot the ESXi system; this will load the Fusion ioMemory VSL software driver and attach the Fusion ioMemory device(s).
6. Determine if you need to upgrade the firmware to the latest version, see [Upgrading the Firmware on page 13](#).
7. Follow the instructions in [Configuring the Device to Support VM Disks on page 17](#).

ATTENTION!

The Fusion ioMemory device is meant to be used as a data storage disk or caching device. Installing an ESXi operating system and booting from the ioMemory device is not supported. ESXi installers may permit you to install the ESXi OS on an ioMemory device. This is not supported, and the installation will fail on reboot.

Downloading the Software

ATTENTION!**ESXi 5.5 Driver Rollup**

If you download the Driver Rollup installer for ESXi 5.5 or later, then this version (3.2.11) of the ioMemory VSL

software (including the utilities) may already be included with the ESXi installer. If you are upgrading, you must read the upgrade notes in the *Fusion ioMemory VSL Release Notes* and uninstall any previous versions of the ioMemory VSL software before you run the installer for ESXi 5.5 (see [Uninstalling the Software on page 26](#)). Once you have installed the ESXi 5.5 operating system which includes the ioMemory VSL software, you may need to update the firmware on the ioMemory device(s). See [Upgrading the Firmware on page 13](#) for more information.

Download the installation packages to a remote machine (preferably one that has the vCLI and/or vSphere client installed).

The Fusion ioMemory VSL software is available as an offline bundle from <https://link.sandisk.com/commercialsupport>. Navigate to the appropriate folder for your operating system.

Example offline bundle to download:

- `scsi-iomemory-vsl_<version>.offline-bundle.zip`

ATTENTION!

The offline bundle may be within a .zip archive: `iomemory-vsl-<version>.zip`

Firmware

Also download the firmware archive file, for example:

`fusion_<version>.<date>.fff`

libvsl Package

We recommend downloading and installing the VSL management library. This library is required if you decide to use a remote management tool based on the SMI-S interface. For more information on these tools see [Monitoring and Managing Devices on page 21](#). Example filename:

- `libvsl-1.01.0-5X-offline-bundle.<version>.zip`

Upgrading to SCSI Version

The `scsi` device version of the Fusion ioMemory VSL software allows you to:

- Use devices that are greater than 2TB in capacity.
- Use more than 16 Fusion ioMemory devices in a host system.

WARNING!

Upgrading to SCSI

Read the *Upgrading to SCSI Version on VMware Hypervisors* section in the *Fusion ioMemory VSL Release Notes* for this release if you are upgrading from a block version of the Fusion ioMemory VSL software to the SCSI version. Please follow the steps provided in that section, as inadvertent selections during the upgrade process may clear data from the device.

Transferring the Fusion ioMemory VSL files to the ESXi Server

You will need to transfer the firmware file to the ESXi host. Also, depending on your ESXi version and your preferred installation method, you may need to transfer the two bundle installation files to the host as well. We recommend transferring all the files at this point, and then choosing the installation method later.

Whichever method you choose for transferring the file(s), we recommend saving the file(s) to a datastore on the host. The example paths to the bundles and firmware in this guide will show them located in a `bundles` directory on a datastore:

```
/vmfs/volumes/<datastore>/bundles/
```

Where `<datastore>` is the name of the datastore.

Transfer Methods

You may transfer the file(s) using one of many methods, including:

- vSphere Client
- vCLI `vifs` command
- SCP (using SSH)

The file(s) can be copied to the host from your remote machine, or from an NFS share.

vCLI Example

Described below are the steps for transferring files to the ESXi host using vCLI.

1. On your remote machine, make sure you have downloaded the appropriate files, and take note of their location.
2. Choose an available datastore (with at least 200MB of available storage) on the hypervisor that you will use to temporarily store the bundles.
3. Create a directory in the datastore named `bundles` using the `vifs` remote command:

```
vifs --server <servername> --mkdir "[<datastore>]bundles"
```

The brackets (`[]`) and quotes (`"`) are required. Substitute your datastore name for the `<datastore>` variable.

NOTE-

You will be prompted to enter the username and password for the ESXi host. For convenience, you can add the following options to each command:

```
--username <username> --password <password>
```

ATTENTION!

vCLI in Windows

When using the vCLI in Windows, many of the commands are slightly different. Most of the commands

end with .pl. Throughout this document, when you run the vCLI in windows, be sure to include the .pl to the command. This command would be:

```
vifs.pl --server <servername> --mkdir "[<datastore>]bundles"
```

4. Use the following example command line to transfer the file(s) one by one to the bundles directory of the datastore:

```
vifs --server <servername> --put "<path-on-local-machine>/<filename>" "[<datastore>]bundles/<filename>"
```

Where <filename> is the full filename, for example:

- fusion_<version>.<date>.fff
- iomemory-vsl_<version>.offline-bundle.zip.

Installing the ioMemory VSL on ESXi 5.x

NOTE-

VUM Installation

These instructions describe how to install the ioMemory VSL on a single hypervisor. However, if you are familiar with, and use, the VMware Update Manager (VUM) plugin for the Virtual Center Server (vCenter Server), you can use that to install the ioMemory VSL on multiple hosts. Please see the vCenter Server documentation for more details on VUM.

ATTENTION!

Uninstall

An update/upgrade installation is not recommended. Instead, uninstall the previous version of the ioMemory VSL software before you install this version. See [Uninstalling the Software on page 26](#) for more information on uninstalling the software.

WARNING!

Upgrading to SCSI

Read the *Upgrading to SCSI Version on VMware Hypervisors* section in the *Fusion ioMemory VSL Release Notes* for this release if you are upgrading from a block version of the Fusion ioMemory VSL software to the SCSI version. Please follow the steps provided in that section, as inadvertent selections during the upgrade process may clear data from the device.

You may choose to install the software using the vCLI or Shell (SSH). Whether you use the Shell or vCLI, **you must first transfer the files to a datastore on the ESXi host.**

ATTENTION!

The offline bundle may be within a .zip archive: `iomemory-vsl-<version>.zip`. Unpack the offline bundle for installation.

vCLI Installation

1. Install the bundle by running the following command against your ESXi 5.x system using the vCLI:

```
esxcli --server <servername> software vib install -d <offline-bundle>
```

Where `<offline-bundle>` is the **absolute path** to the offline bundle on the hypervisor host. For example, if the offline bundle is in the `bundles` directory of a datastore with the name of `datastore1`, the (local) path would be: `/vmfs/volumes/datastore1/bundles/iomemory-vsl_<version>.offline-bundle.zip`

ATTENTION!

This absolute path must begin with a forward slash (/) or ESXi will return an error message.

- a. If you also wish to install the `libvsl` offline bundle, repeat the above step using the path to the `libvsl` offline bundle.
2. Reboot your ESXi system.

The ioMemory VSL and command-line utilities are installed on the host.

Command-line Installation

1. Install the bundle by running the following command against your ESXi 5.x system using TSM/SSH:

```
esxcli software vib install -d <offline-bundle>
```

Where `<offline-bundle>` is the **absolute path** to the offline bundle on the hypervisor host. For example, if the offline bundle is in the `bundles` directory of a datastore with the name of `datastore1`, an example (local) path would be: `/vmfs/volumes/datastore1/bundles/iomemory-vsl_<version>.offline-bundle.zip`

- a. If you also wish to install the `libvsl` offline bundle, repeat the above step using the path to the `libvsl` offline bundle.
2. Reboot your ESXi system

The ioMemory VSL and command-line utilities are installed on the host. Continue on to [Upgrading the Firmware on page 13](#).

Upgrading the Firmware

With the Fusion ioMemory VSL software loaded, you should check whether the Fusion ioMemory device's firmware is up-to-date and then update the firmware if needed. You can do this with the command-line utilities.

NOTE-

Make sure you have downloaded the firmware archive file that goes with this version of the Fusion ioMemory VSL software.

ATTENTION!

There is a specific upgrade path that you must take when upgrading a Fusion ioMemory device. Consult the *Fusion ioMemory VSL Release Notes* for this Fusion ioMemory VSL software release before upgrading Fusion ioMemory devices.

Also refer to the *Fusion ioMemory VSL Release Notes* for this Fusion ioMemory VSL software release for any Known Issues affecting firmware upgrades.

WARNING!

Do not attempt to downgrade the firmware on any Fusion ioMemory device; doing so may void your warranty.

When installing a new Fusion ioMemory device along with existing devices, you must upgrade all of the currently installed devices to the latest available versions of the firmware and Fusion ioMemory VSL software before installing the new devices. Consult the *Fusion ioMemory VSL Release Notes* for this Fusion ioMemory VSL software release for any upgrade considerations.

ATTENTION!**Upgrading Guest OS**

If you are using your Fusion ioMemory device within a guest OS (for example, using VMDirectPathIO), you must power cycle the host server after you upgrade the device(s). Just restarting the virtual machine will not apply the firmware update.

More information on these command-line utilities is available in [Command-line Utilities Reference on page 33](#). All command-line utilities require TSM/Shell enabled.

1. Run the `fio-status` utility and examine the output. See [fio-status on page 39](#) for usage information.
 - If any device is in minimal mode and the reason is listed as outdated firmware, then update the firmware.
 - If a device is not in minimal mode, but the firmware listed for that device is a lower number than the latest firmware version available with this version of the Fusion ioMemory VSL software, then the firmware is old, but not outdated.
2. If the firmware is old or outdated, update it using the `fio-update-iodrive` utility. See [fio-update-iodrive on page 42](#) for complete information and warnings.

Configuration

Once you have your Fusion ioMemory device and Fusion ioMemory VSL software installed and loaded, and the firmware on the device is current, you may need to configure the device and/or software. This section outlines some of the common configurations that you may need to consider.

Enabling PCIe Power Override

If you have installed any products with multiple Fusion ioMemory devices, such as the Fusion ioMemory ioDrive Duo device, the device may require additional power to properly function (beyond the minimum 25W provided by PCIe Gen2 slots). Even if additional power is not required for your device, all dual Fusion ioMemory devices that receive additional power may benefit with improved performance.

Fusion ioMemory ioDrive2 Duo devices **must** have additional power in order to properly function. For more information on which devices require additional power, see the section on *Power Cables for Multi-device Products* in the *Fusion ioMemory Hardware Installation Guide*.

This additional power may be provided in two ways:

- **External Power Cable:** See the *Fusion ioMemory Hardware Installation Guide* for information on installing the external cable.

NOTE-

When a power cable is used, all of the power is drawn from the cable and no power is drawn from the PCIe slot.

- **Enabling Full Slot Power Draw:** Some PCIe slots provide additional power (often up to 75W of power). If your slot is rated to provide at least 55W, you may allow the device to draw full power from the PCIe slot by setting a Fusion ioMemory VSL software module parameter. For more information on enabling this override parameter, see the instructions in the next section.

NOTE-

This parameter overrides the setting that prevents device(s) from drawing more than 25W from the PCIe slot. The parameter is enabled per device (using device serial numbers). Once the setting is overridden, each device may draw up to the full 55W needed for peak performance.

WARNING!

If the slot is not capable of providing the needed amount of power, enabling full power draw from the PCIe slot may result in malfunction or even damage server hardware. You are responsible for any damage to equipment due to improper use of this override parameter and SanDisk expressly disclaims any liability for any damage arising from such improper use. Contact Customer Support if there are any questions or concerns about the override parameter use.

Before you enable this override parameter, ensure that each PCIe slot you will use is rated to provide enough power for all slots, devices, and server accessories. Consult the server documentation, BIOS interface, setup utility, and/or use `fio-pci-check` (if available) to determine the slot power limits.

ATTENTION!

Confirm with Server Manufacturer

Contact the server manufacturer to confirm the power limits and capabilities of each slot, as well as the entire system.

The following are important considerations:

- If you are installing more than one dual Fusion ioMemory device and enabling the override parameter for each device, make sure the motherboard is rated to provide 55W power to each slot that is used.

ATTENTION!

For example, some motherboards safely provide up to 75W to any one slot, but run into power constraints when multiple slots are used to provide that much power. Installing multiple devices in this situation may also result in server hardware damage. Consult with the manufacturer to determine the total PCIe slot power available.

- The override parameter, if enabled correctly, will persist in the system, and will enable full power draw on an enabled device even if the device is removed and then placed in a different slot within the same system. If the device is placed in a slot that is not rated to provide 55W of power, you may damage your server hardware.
- This override parameter is a setting for the Fusion ioMemory VSL software per server, and is not stored in the device. When moved to a new server, the device will default to the 25W power limit until an external power cable is added or this override parameter is enabled for that device in the new server. Consult with the manufacturer to determine the total PCIe slot power available for the new server.

Enabling the Override Parameter

Determine Serial Number(s)

Before you enable this parameter, determine the **adapter serial number** for each device you will put in a compatible slot. Use the `fio-status` command-line utility to determine the adapter serial number(s).

NOTE-

Serial Number Label

You may also inspect the adapter serial number label(s) on the device(s) to determine the serial number(s). However, as a best practice, confirm that each serial number is an adapter serial number by running `fio-status`. The adapter serial number label resides on the back of all Fusion ioMemory ioDrive Duo devices and Fusion ioMemory ioDrive2 Duo devices. On Fusion ioMemory ioDrive Duo devices, it is on the PCB component that is attached to the PCIe connector.

- **Using `fio-status`:** Run the `fio-status` command-line utility. Sample output:

```
fio-status
...
Adapter: Dual Controller Adapter
Fusion-io ioDrive2 DUO 2.41TB, Product Number:F01-001-2T41-CS-0001, FIO
SN:1149D0969
External Power: NOT connected
PCIe Power limit threshold: 24.75W
Connected ioMemory modules:
fct2:   SN:1149D0969-1121
fct3:   SN:1149D0969-1111
```

In this example, 1149D0969 is the adapter serial number.

- **Using `fio-beacon`:** If you have multiple devices installed, you may use the `fio-beacon` utility to verify where each device is physically located. Consult the utility documentation [fio-beacon on page 35](#) for more information.

Setting the Parameter

Set the module parameter by using the `esxcfg-module` command and changing the value for the `external_power_override` parameter. Example:

```
esxcfg-module --server <server-name> iomemory-vsl -s 'external_power_
override=<value>'
```

ATTENTION!

The the remote option (`--server`) is only required for the vCLI.

Where the `<value>` for this parameter is a comma-separated list of adapter serial numbers. For example:
1149D0969,1159E0972,24589

ATTENTION!

You must reboot the ESXi system to enforce any parameter changes.

Configuring the Device to Support VM Disks

ATTENTION!

512B Sector Sizes

ESXi VMFS requires 512B physical sector sizes. Depending on your device type and how it has been used, you may need to format it to 512B sectors. For example, new Fusion ioMemory ioScale devices come pre-formatted with 4kB sector sizes. You may want to run `fio-format` utility against all of the devices in the system.

- If needed, format the device to 512B physical sector sizes.

WARNING!

Formatting the device will erase all user data, see [fio-format on page 37](#) for full information.

- Run the following command in the TSM/Shell:

```
fio-format /dev/fct*
```

Within the vSphere Client, select the **Configuration** tab. Under **Hardware** click **Storage**, then click **Add Storage** located on the top right corner. The Add Storage wizard will appear. Use this wizard to configure the device.

For more information, and an explanation of options (including setting the VM File System Block Size), consult your vSphere documentation.

NOTE-

You can also create a VMFS datastore using `fdisk` and `vmkfstools` in the Tech Support Mode (directly on the ESXi host), however **this method is not supported by VMware**.

ATTENTION!

The type of virtual disk we recommend is "thick." A "thin" provisioning will conserve space, but may degrade performance significantly.

Once the storage has been added and configured, it is now possible to store virtual machines on the Fusion ioMemory device(s).

Modifying a VMware Resource Pool to Reserve Memory

Under certain circumstances, the ESXi operating system may temporarily require most, if not all, of the RAM available on the system, leaving no memory for the Fusion ioMemory VSL software.

NOTE-

For example, a host running VMware View may need to rapidly provision multiple VDI images. This may happen so quickly that the host memory is temporarily exhausted.

If the VMs starve the Fusion ioMemory VSL software of RAM, the Fusion ioMemory device(s) may go offline or stop processing requests. To address this use case, follow the procedure and guidelines below for limiting memory consumed by the VMs.

We recommend limiting RAM available to the VMs equal to: Total Host RAM - RAM equivalent to 0.5% of the total Fusion ioMemory device capacity (see the **Example Scenario** below for more information on this calculation). The easiest way to set this limit is by modifying the user pool.

The exact amount to limit is workload dependent, and will require tuning for specific use cases. If 0.5% is not enough, consult the RAM requirements in the *Fusion ioMemory VSL Release Notes* for an idea of how much RAM the VSL may use in worst-case scenarios.

To modify the user pool, follow the steps below, using the vSphere client:

1. Click the **Summary** tab in the vSphere client to view the current memory usage and capacity.
 - Also visible is the total Fusion ioMemory device datastore capacity, make note of that capacity.
2. Navigate to the **user Resource Allocation** window:
 - a. Select the host -> **Configuration** tab -> **Software** pane -> **System Resource Allocation** link -> **Advanced** link
 - b. The **System Resource Pools** appear.
 - c. Select the **user** node under the host tree.
 - d. The details for the user appear below, click the **Edit settings** link.
 - e. The **user Resource Allocation** window appears.
3. Limit the Memory allocated to the VMs.
 - a. Under **Memory Resources**, clear the **Unlimited** checkbox so you can set the limit for memory resource allocation.
 - b. You can now set the limit on VM memory consumption.

Example Scenario:

An ESXi host has

- Memory capacity of 36852MB
- Total Fusion ioMemory device datastore capacity of 320GB (or approximately 320000MB).

$320000\text{MB device capacity} * 0.5\% \text{ of device capacity} \sim 1600\text{MB of RAM equivalent.}$

$36852\text{MB total memory capacity} - 1600\text{MB free} = 35252\text{MB of memory limited to the host.}$ The new value under **Limit in Memory Resources** would be 35252MB

Performance and Tuning

Fusion ioMemory devices provide high bandwidth, high Input/Output per Second (IOPS), and are specifically designed to achieve low latency.

As Fusion ioMemory devices improve IOPS and low latency, the device performance may be limited by operating system settings and BIOS configuration. These settings may need to be tuned to take advantage of the revolutionary performance of Fusion ioMemory devices.

While Fusion ioMemory devices generally perform well out of the box, this section describes some of the common areas where tuning may help achieve optimal performance.

Disable CPU Frequency Scaling

Dynamic Voltage and Frequency Scaling (DVFS) are power management techniques that adjust the CPU voltage and/or frequency to reduce power consumption by the CPU. These techniques help conserve power and reduce the heat generated by the CPU, but they adversely affect performance while the CPU transitions between low-power and high-performance states.

These power-savings techniques are known to have a negative impact on I/O latency and IOPS. When tuning for performance, you may benefit from reducing or disabling DVFS completely, even though this may increase power consumption.

DVFS, if available, is often configurable as part of your operating systems power management features as well as within your system's BIOS interface. Within the operating system and BIOS, DVFS features are often found under the Advanced Configuration and Power Interface (ACPI) sections; consult your computer documentation for details.

Limiting ACPI C-States

Newer processors have the ability to go into lower power modes when they are not fully utilized. These idle states are known as ACPI C-states. The C0 state is the normal, full power, operating state. Higher C-states (C1, C2, C3, etc.) are lower power states.

While ACPI C-states save on power, they can have a negative impact on I/O latency and maximum IOPS. With each higher C-state, typically more processor functions are limited to save power, and it takes time to restore the processor to the C0 state.

When tuning for maximum performance you may benefit from limiting the C-states or turning them off completely, even though this may increase power consumption.

Setting ACPI C-State Options

If your processor has ACPI C-states available, you can typically limit or disable them in the BIOS interface (sometimes referred to as a Setup Utility). ACPI C-states may be part of the Advanced Configuration and Power Interface (ACPI) menu. Consult your computer documentation for details.

Monitoring and Managing Devices

SanDisk provides many tools for managing your Fusion ioMemory devices. These tools will allow you to monitor the devices for errors, warnings, and potential problems. They will also allow you to manage the devices including performing the following functions:

- Firmware upgrades
- Low-level formatting
- Attach and detach actions
- Device status and performance information
- Configuring Swap and Paging
- Generating bug reports

Management Tools

SanDisk has provided several tools for monitoring and managing Fusion ioMemory devices. These include stand-alone tools that require no additional software and data-source tools that can be integrated with other applications.

Consider the descriptions of each tool to decide which tool (or combination of tools) best fits your needs.

ATTENTION!

The Fusion ioMemory VSL software does print some error messages to the system logs, and while these messages are very useful for troubleshooting purposes, the Fusion ioMemory VSL software log messages are not designed for continual monitoring purposes (as each is based on a variety of factors that could produce different log messages depending on environment and use case). For best results, use the tools described in this section to regularly monitor your devices.

Stand-alone Tools

- **TSM/Shell Command-line Utilities:** These utilities are installed with the ioMemory VSL software and are run manually in a terminal. In order to use these utilities on ESXi, the TSM (Tech Support Mode)/Shell must be enabled. The `fio-status` utility provides status for all devices within a host. The other utilities allow you to perform other management functions. See [Command-line Utilities Reference on page 33](#) for full details.

Data-source Tools

These data-source tools provide comprehensive data, just like the stand-alone tools, but they do require integration with additional software. At a minimum, some tools can interface with a browser. **However, the benefit of these tools is that they can be integrated into existing management software that is customized for your organization.**

These tool packages and documentation are also available as separate downloads (separate from the Fusion ioMemory VSL software packages).

- **SMI-S CIM Provider:** The CIM provider allows you to monitor and manage your devices using the Common Information Model. You can use a normal CIM browser, or customize your existing application to interface with the CIM provider.
 - **Optional Remote SMI-S Scripts:** These optional scripts provide remote management of the software and devices without enabling Tech Support Mode (TSM). These scripts integrate with the CIM provider and together the two tools make a complete solution.

Example Conditions to Monitor

This section gives examples of conditions you can monitor. It is intended as an introduction and not as a comprehensive reference. These conditions will have slightly different names, states, and values, depending on the tool you choose. For example, an SNMP MIB may have a different name than a SMI-S object or an API function.

In order to properly monitor these conditions, you should become familiar with the tool you choose to implement and read the documentation for that tool. You may also discover additional conditions that you wish to frequently monitor.

For quick reference, the possible states/values of these conditions are described as Normal (**GREEN**), Caution/Alert (**YELLOW**), or Error/Warning (**RED**). You may implement your own ranges of acceptable states/values, especially if you use a data-source tool.

Device Status

All of the monitoring tools return information on the status of the Fusion ioMemory devices, including the following states:

GREEN	Attached
YELLOW	Detached, Busy (including: Detaching, Attaching, Scanning, Formatting, and Updating)
RED	Minimal Mode, Powerloss Protect Disabled

If the device is in Minimal Mode, the monitoring tool can display the reason for the Minimal Mode status.

Required Actions

If the device is in Minimal Mode, the action will depend on the reason. For example, if the reason is outdated firmware, then you will need to update the firmware.

Temperature

Fusion ioMemory devices require adequate cooling. In order to prevent thermal damage, the Fusion ioMemory VSL software will start throttling write performance once the on-board controller reaches a specified temperature. If the controller temperature continues to rise, the software will shut down the device once the controller temperature reaches the maximum operating temperature.

These temperatures depend on the device. Newer Fusion ioMemory devices have higher thermal tolerances. Consult the *Fusion ioMemory Hardware Installation Guide* to determine the thermal tolerances of all devices you will monitor. **This table uses the following controller thermal tolerances:** 93°C throttling, 100°C shutdown.

GREEN	<93°C
YELLOW	93-99°C
RED	100°C

You may wish to shift the conditions by a few degrees so the **YELLOW** condition exists before throttling occurs. For example:

GREEN	<90°C
--------------	-------

YELLOW	90-96°C
RED	97°C

ATTENTION!**NAND Board Temperature**

Newer Fusion ioMemory devices also report the temperature of the NAND Boards. This is also a critical temperature to monitor. Consult the *Fusion ioMemory Hardware Installation Guide* to see if your device reports this temperature and to see the temperature thresholds.

Required Actions

If the temperature is at or approaching the **YELLOW** condition, you must increase the cooling for your system. This may include increasing the fan speed, bringing down the ambient temperature, reducing write load, or moving the device to a different slot.

Health Reserves Percentage

Fusion ioMemory devices are highly fault-tolerant storage subsystem with many levels of protection against component failure and the loss nature of solid-state storage. As in all storage subsystems, component failures may occur.

By pro-actively monitoring device age and health, you can ensure reliable performance over the intended product life. The following table describes the Health Reserve conditions.

GREEN	>10%
YELLOW	4% -10%
RED	0% - 3%

At the 10% healthy threshold, a one-time warning is issued. At 3%, the device is considered unhealthy and enters *write-reduced* mode. At the 1% threshold, the device will enter *read-only* mode.

For complete information on Health Reserve conditions and their impact on performance, see [Monitoring the Health of Devices on page 45](#).

Required Actions

The device needs close monitoring as it approaches 0% reserves and goes into write-reduced mode, which will result in reduced write performance. Prepare to replace the device soon.

Write (Health Reserves) Status

In correlation with the Health Reserves Percentage, the management tools will return write states similar to these:

GREEN	Device is healthy
YELLOW	Device is getting close to entering reduced write mode.
RED	Device has entered reduced-write or read-only mode to preserve the flash from further wearout.

Required Actions

The device needs close monitoring as it approaches 0% reserves and goes into write-reduced mode, which will result in reduced write performance. Prepare to replace the device soon.

Device LED Indicators

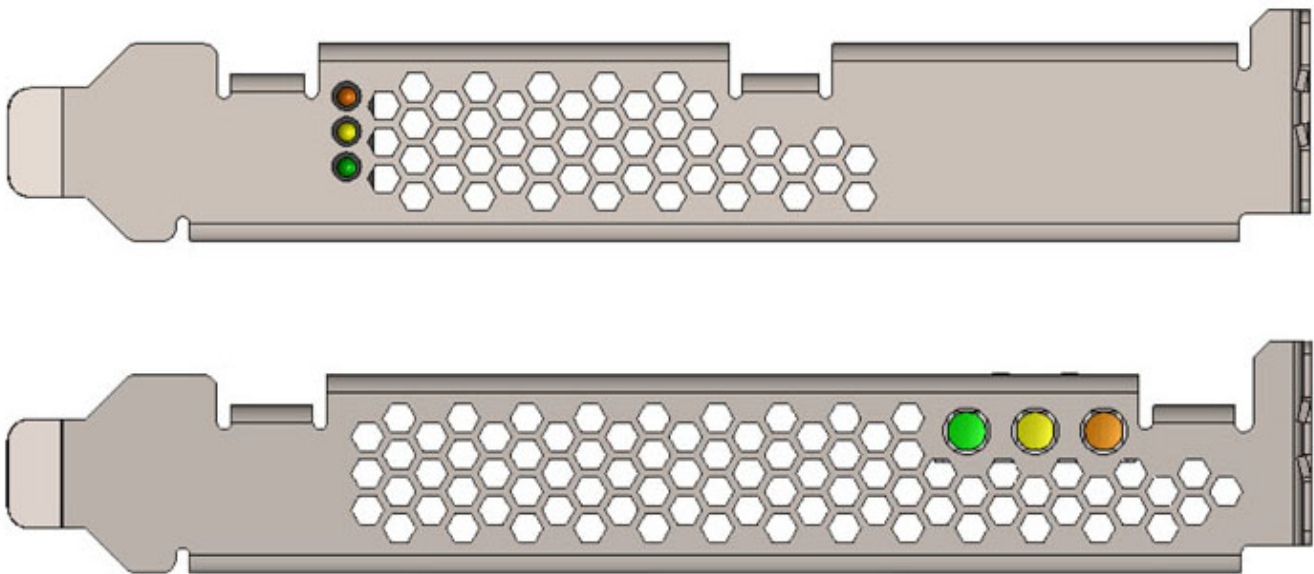
If you have physical access to the devices and depending on your device configuration, you can use the LED indicator(s) on the bracket to monitor their status. Consult the subsections below to determine if your device uses one or more LED indicators and what behaviors are indicated.

ATTENTION!

Fusion ioMemory devices may have an additional LEDs (that are not on the bracket, as shown below). You can ignore those other LEDs, as they are not meant for monitoring device and software functionality.

Three LEDs

The LEDs on your device should be similar to one of these configurations:



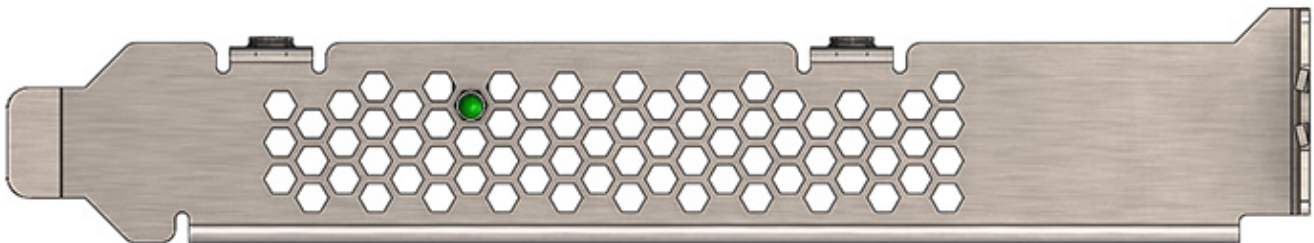
This table explains the information that these LEDs convey:

Green	Yellow	Amber	Indication	Notes
OFF	OFF	OFF	Power is off.	
OFF	OFF	LIT	Power is on. Problem with device, or driver not loaded (and device unattached).	Use <code>fio-status</code> to view problem, or load driver (and attach device).
LIT	OFF	OFF	Power is on. Driver loaded (device may or may not be attached).	You may need to attach the device.

LIT	FLASHING	OFF	Writing (Rate indicates volume of writes).	Can appear in combination with the Read LED indication.
FLASHING	OFF	OFF	Read (rate indicated volume of reads).	Can appear in combination with the Write LED indication.
LIT	LIT	LIT	Location Beacon.	Use the <code>fiio-beacon</code> utility to initiate this behavior.

One LED

If your device has one LED, it should be similar to this configuration:



This table explains the information that the LED conveys:

LED	Indications	Notes
LIT	Power is on and driver is working.	
FLASHING (Fast)	Read and/or write activity.	The faster flashing only indicates activity, it does not reflect the amount of data that is read or written. The flashing may not indicate reads from empty sectors (all zeros).
FLASHING (Slow)	Location beacon.	Use the <code>fiio-beacon</code> utility to initiate this behavior.
OFF	This indicates one of the following: Power is off, driver is not loaded, or driver is not working.	Check <code>fiio-status</code> to see if device is attached and there are no errors.

Maintenance

This section explains additional software maintenance functions not covered in the sections [Configuration on page 15](#) and [Monitoring and Managing Devices on page 21](#).

In ESXi, some of these maintenance tasks are only accessible through VMware's Tech Support Mode (also known as Shell/SSH).

WARNING!

VMware suggests that the TSM only be used "for the purposes of troubleshooting and remediation." VMware recommends using the vSphere Client or any other VMware Administration Automation Product to perform routine ESXi host configuration tasks that do not involve a troubleshooting scenario. For more information visit VMware's [Knowledge Base article](#) on using this mode.

Uninstalling the Software

Uninstalling the software in ESXi 5.x

To uninstall the Fusion ioMemory VSL package, run this command using the vCLI from a **remote machine** (remove `--server <servername>` if you are on the host CLI):

1. Remove the VIB containing the driver & utilities:

Block version command:

```
esxcli --server <servername> software vib remove -n block-iomemory-vsl
```

SCSI version command:

```
esxcli --server <servername> software vib remove -n scsi-iomemory-vsl
```

Unloading or Disabling the Software Driver

If you need to diagnose or troubleshoot a problem, you may need to unload or disable the Fusion ioMemory VSL software. Both methods will take the Fusion ioMemory VSL software offline, however we recommend disabling the Fusion ioMemory VSL software autoloading and rebooting rather than unloading the Fusion ioMemory VSL driver.

ATTENTION!

You **must** properly unmount and detach all Fusion ioMemory devices before unloading the Fusion ioMemory VSL driver. However if you disable autoloading and then reboot, the devices will safely unmount and detach on shutdown and then not auto attach or mount on boot.

If you must unload the driver (and detach an Fusion ioMemory device), carefully read all of the warnings in [fio-detach on page 36](#) (or the optional remote management documentation) before running the detach utility. Failure to follow the instructions may cause errors, data loss and/or corruption.

Again, we recommend disabling autoloading rather than directly unloading the driver.

Disabling the Fusion ioMemory VSL software Autoload

The Fusion ioMemory VSL driver automatically loads by default when the operating system starts. By disabling the autoload and rebooting, the Fusion ioMemory VSL software will be offline.

To disable driver auto-load, run this command in the TSM/Shell and then reboot the system:

```
$ esxcfg-module --disable iomemory-vsl
```

NOTE-

If you disable the driver autoload in ESXi 5.1 or newer, you also disable the ability to directly load the driver. You will need to re-enable the driver to load the driver.

This prevents the Fusion ioMemory VSL driver from loading on boot, so the device won't be available to users. However, all other services and applications are available.

Unloading the Fusion ioMemory VSL Driver

If you need to unload the driver for diagnostic or troubleshooting purposes, you **must** properly unmount and detach all Fusion ioMemory devices.

To unload the Fusion ioMemory VSL driver, run this command in TSM:

```
vmkload_mod -u iomemory-vsl
```

Loading or Enabling the Driver

Loading or Enabling the Fusion ioMemory VSL Driver

If you have previously disabled driver autoload, you may want to re-enable it and then reboot. Otherwise, you may bring the driver online by loading directly. If you load the driver, you will need to re-attach the Fusion ioMemory devices in your system. See [fio-detach on page 36](#) for more information.

NOTE-

If you disable the driver autoload in ESXi 5.1 or newer, you also disable the ability to directly load the driver. You will need to re-enable the driver to load the driver.

If you enable driver autoload and then reboot, the Fusion ioMemory devices should attach automatically (unless you have disabled auto attach, see below).

NOTE-

Depending on your situation, you may want to both re-enable driver autoload (to ensure that the Fusion ioMemory VSL driver will load on the next boot) and directly load the driver to bring it online immediately.

Enabling Fusion ioMemory VSL Driver Autoload

To enable the Fusion ioMemory VSL driver (on boot) after maintenance, run this command in the TSM/Shell and reboot the system.

```
$ esxcfg-module --enable iomemory-vsl
```

After a reboot, if the driver is enabled, then it will appear in the modules listed when this command is run:

```
$ esxcfg-module --query
```

Loading the Fusion ioMemory VSL Driver

To immediately load the Fusion ioMemory VSL software, run the following command:

```
vmkload_mod iomemory-vsl
```

This command loads the driver with default parameters (even if you have modified the parameters). You can force the driver to load with modified parameters, for example:

```
vmkload_mod iomemory-vsl auto_attach=0
```

See [Using Module Parameters on page 47](#) for a list of these parameters.

Detaching a Fusion ioMemory device

We do not recommend detaching Fusion ioMemory devices that are used as datastores. The best practice is to:

1. Disable auto-attach (see the next sub-section)
2. Reboot
3. Perform the necessary maintenance operations
4. Re-enable auto-attach
5. Then reboot again.

If you must detach an Fusion ioMemory device, carefully read all of the warnings in [fio-detach on page 36](#) (or the optional remote management documentation) before running the detach utility. Failure to follow the instructions may cause errors, data loss and/or corruption.

Disabling Auto-Attach

When the Fusion ioMemory VSL software is installed, it is configured to automatically attach any devices when the Fusion ioMemory VSL software is loaded. Sometimes you may want to disable the auto-attach feature (to assist in troubleshooting or diagnostics).

Disabling Auto-Attach in ESXi

To load the Fusion ioMemory VSL software on boot with auto-attach disabled, set the `auto_attach` parameter equal to 0 using the vCLI:

```
esxcfg-module -s 'auto_attach=0' iomemory-vsl
```

This will not be enforced until you reboot the system. **To enable auto-attach**, set the parameter back to 1.

Unmanaged Shutdown Issues

Unmanaged shutdowns due to power loss or other circumstances can force the Fusion ioMemory device to perform a consistency check during the restart. This may take several minutes to complete.

ATTENTION!

Check `fio-status` after a crash to see if the devices are in an "Attaching" state.

Although data written to the Fusion ioMemory device is not lost due to unmanaged shutdowns, important data structures may not have been properly committed to the device. This consistency check (also called a rescan) repairs these data structures.

Improving Rescan Times

The rescan of the device (also called a consistency check) the VSL performs after an unmanaged shutdown may take an extended period of time depending on the total capacity of the device(s) that the Fusion ioMemory VSL software needs to scan.

Default Fast Rescan

By default, all Fusion ioMemory devices formatted with the `fio-format` utility are formatted to have improved rescan times. You can disable this default fast rescan by reformatting the device and using the `-R` option. Disabling this feature will reclaim some reserve capacity that is normally set aside to help improve rescan times.

If you leave the default fast rescan feature in place you can also take further steps to improve rescan times by implementing one of the following module parameters.

Faster Rescans Using Module Parameters

These two module parameters require the default fast rescan formatting structure, and they also use system memory (RAM) to help improve rescan times. The extra memory enables the rescan process to complete faster, which reduces downtime after a hard shutdown. This memory allocation is only temporary and is freed up after the rescan process is complete.

If you decide to use one of these parameters, you will need to set the upper limit of RAM used by that parameter. To do this, you will need to determine how much RAM each parameter may use in your scenario, how much system RAM is available, and (therefore) which parameter is more suited for your use case.

For more information on setting module parameters, see [Using Module Parameters on page 47](#).

Here is a quick comparison of the two parameters:

- **RMAP Parameter**
 - **Fastest:** This improvement results in the fastest rescan times.
 - **Less Scalable:** (All or nothing.) This parameter requires enough RAM to function. If the RAM limit is set too

low, then the Fusion ioMemory VSL software will not use RMAP at all, and it will revert back to the default fast rescan process.

- **Target Scenario:** This parameter will improve any use case if there is enough RAM available for the parameter. It is more suited for smaller capacity Fusion ioMemory devices and/or systems with fewer Fusion ioMemory devices installed. We also recommend it for devices that have been used for many small random writes.

- **RSORT Parameter**

- **Faster:** This improves rescan times over the default fast rescan process.
- **Scalable:** With this parameter, the Fusion ioMemory VSL software works with the system RAM to improve rescan times until it reaches the RAM limit set in the parameter. At that point, the software reverts back to the default fast rescan process.
- **Target Scenario:** This parameter will improve rescan times in any use scenario. It is especially useful in systems with multiple Fusion ioMemory devices and/or larger-capacity Fusion ioMemory devices. We also recommend it when Fusion ioMemory devices are used to store databases.

RMAP Parameter

The `rmap_memory_limit_MiB` parameter sets the upper memory (RAM) limit (in mebibytes) used by the Fusion ioMemory VSL software to perform the RMAP rescan process. You should only use this option if you have enough memory for all of your Fusion ioMemory devices in the system. If you do not have enough memory to use this option, use the RSORT parameter instead.

Because this parameter requires a set amount of memory, it often works best with fewer Fusion ioMemory devices and/or smaller-capacity Fusion ioMemory devices in a system, but the determining factor is how much memory is in the system and whether there is enough to set the appropriate memory limit.

This parameter requires 4.008 bytes of RAM per block of Fusion ioMemory device capacity.

1. First determine the number of blocks that are formatted for each device.
 - a. This information is visible when you format the device using the `fio-format` utility.
 - b. Or you can estimate the number of block using the device capacity and the formatted sector size.

This example shows a quick estimation of the number of blocks on a 400GB device with 512B size sectors (2 sectors per KB):

$$400\text{GB} * 1000\text{MB/GB} * 1000\text{KB/MB} * 2 \text{ Blocks/kB} = 800,000,000 \text{ Blocks}$$

2. Multiply the number of blocks by 4.008 bytes of RAM per block (and translate that into MiB) to determine the memory limit that is required for this parameter to function.

- a. In the example above there were 800 million blocks:

$$800,000,000 \text{ Blocks} * 4.008\text{B/Block} * 1\text{KiB}/1024\text{B} * 1\text{MiB}/1024\text{KiB} = \sim 3058\text{MiB of RAM}$$

- b. In this example, you would need about 3100 MiB of RAM available in your system for a 400GB Fusion ioMemory device formatted for 512B sectors, and you would need to set the RMAP parameter to 3100.

NOTE-

Default Value

The RMAP parameter is, by default, set to 3100. It is set to this low default value so the rescan process does not use all of the RAM in systems that have less available memory.

- If the RMAP value is too low for the number of Fusion ioMemory device blocks in the system, then the Fusion ioMemory VSL software will not use the RMAP process to improve rescan times, it will just use the default fast rescan process. (RMAP is an all-or-nothing setting.)
 - If you don't have enough system memory to use the RMAP parameter, consider using the RSORT parameter. The RSORT parameter will use its RAM limit to improve the rescan process, and then the Fusion ioMemory VSL software will revert to the default fast rescan process to finish the consistency check.
3. Set the module parameter to the value you have determined. See [Using Module Parameters on page 47](#) for more information on setting parameters.

RSORT Parameter

The `rsort_memory_limit_MiB` parameter sets the memory (RAM) limit used by the Fusion ioMemory VSL software to perform the RSORT rescan process. The RSORT rescan process is faster than the default rescan process and we recommend using it to rescan devices that are used as datastores for databases.

If this parameter is given any memory limit, the Fusion ioMemory VSL software will use the RSORT process until either the rescan is done or it consumes the memory limit. If the process runs out of memory, it will revert to the default fast rescan process. However, in order to optimize the use of this process, you can calculate the target RAM usage and set the limit based on that target. There is no penalty for setting a high limit, the RSORT process will only use the RAM it needs (up to the limit that is set).

This target is based on 32 bytes per write extent. For example, if your database writes 16kB at a time, there is one write extent per 16kB of Fusion ioMemory device capacity.

NOTE-

Blocks per Write Extent

One measure of the the benefits of the RSORT process is to see how many blocks are written per write extent. The RSORT process improves rescan times over the default fast rescan process on when a device has 8 or more blocks written per extent. For example, if your Fusion ioMemory device is formatted to 512B sector sizes (2 sectors per KB), and your database writes in 8KB chunks, then your database writes 16 blocks per write extent and RSORT would improve the rescan times.

1. First determine the number of blocks that are formatted for each device.
 - a. This information is visible when you format the device using the `fiio-format` utility.
 - b. Or you can estimate the number of block using the total device capacities and their formatted sector sizes.

This example shows a quick estimation of the number of blocks on 1200GB of Fusion ioMemory device capacity with 512B size sectors (2 sectors per KB):

```
1200GB * 1000MB/GB * 1000KB/MB * 2 Blocks/kB = 2,400,000,000 Blocks
```

2. Divide the number of blocks by the write extents per block to determine the total possible number of write extents on the device(s).
 - a. In the example above there were 2.4 billion blocks. We will assume 16KB write extents (32 blocks per write on 512B sectors):

```
2,400,000,000 Blocks * 1 Write Extent/32 Blocks = 150,000,000 Writes
```

3. Multiply the number of writes by 32 bytes of RAM per write (and translate that into MiB) to determine the memory target for this parameter.
 - a. In the example above there were 150 million write extents:

```
150,000,000 Writes * 32B/Write * 1KiB/1024B * 1MiB/1024KiB = ~4578MiB of RAM
```

- b. In this example, you would want to set the RSORT limit to about 4600 MiB of RAM available in your system for 1200GB of Fusion ioMemory device capacity formatted for 512B sectors.

NOTE-

Default Value

The RMAP parameter is, by default, set to 0m and it has a maximum of 100000 (100GB).

4. Set the module parameter to the value you have determined. See [Using Module Parameters on page 47](#) for more information on setting parameters.

Appendix A - Command-line Utilities Reference

These command-line utilities are only accessible through VMware's **Tech Support Mode** (also known as TSM/Shell) on ESXi.

WARNING!

VMware suggests that the TSM only be used "for the purposes of troubleshooting and remediation." VMware recommends using the vSphere Client or any other VMware Administration Automation Product to perform routine ESXi host configuration tasks that do not involve a troubleshooting scenario. For more information visit VMware's [Knowledge Base article](#) on using this mode.

NOTE-

SMI-S Management

You may choose to use the SMI-S remote management tools instead of TSM command-line utilities. The SMI-S remote management tools provide a management experience similar to these command-line utilities. For more information, see [Management Tools on page 21](#)

The Fusion ioMemory VSL software installation packages include various command-line utilities, installed by default in `/usr/sbin`. These provide a number of useful ways to access, test, and manipulate your device.

ATTENTION!

There are some additional utilities installed in the `/usr/sbin` directory that are not listed below. Those additional utilities are dependencies (used by the main Fusion ioMemory VSL utilities), and you should not use them directly unless Customer Support advises you to do so.

Utility	Purpose
<code>fio-attach</code>	Makes a Fusion ioMemory device available to the OS.
<code>fio-beacon</code>	Lights the Fusion ioMemory device's external LEDs.
<code>fio-bugreport</code>	Prepares a detailed report for use in troubleshooting problems.
<code>fio-detach</code>	Temporarily removes a Fusion ioMemory device from OS access.
<code>fio-format</code>	Used to perform a low-level format of a Fusion ioMemory device.
<code>fio-pci-check</code>	Checks for errors on the PCI bus tree, specifically for Fusion ioMemory devices.
<code>fio-status</code>	Displays information about the device.
<code>fio-update-iodrive</code>	Updates the Fusion ioMemory device's firmware.

NOTE-

There are `-h` (Help) and `-v` (Version) options for all of the utilities. Also, `-h` and `-v` cause the utility to exit after displaying the information.

fio-attach**Description**

Attaches the Fusion ioMemory device and makes it available to the operating system. The command displays a progress bar and percentage as it operates.

NOTE-

In most cases, the Fusion ioMemory VSL software automatically attaches the device on load and does a scan. You only need to run `fio-attach` if you ran `fio-detach` or if you set the Fusion ioMemory VSL software's `auto_attach` parameter to 0.

NOTE-

If the Fusion ioMemory device is in minimal mode, then auto-attach is disabled until the cause of the device being in minimal mode is fixed.

Syntax

```
fio-attach <device> [options]
```

where `<device>` is the name of the device node (`/dev/fctx`), where `x` indicates the device number: 0, 1, 2, etc. For example, `/dev/fct0` indicates the first Fusion ioMemory device detected on the system.

Option	Description
<code>-r</code>	Force a metadata rescan. This may take an extended period of time, and is not normally required. ATTENTION! Only use this option when directed by Customer Support.
<code>-c</code>	Attach only if clean.
<code>-q</code>	Quiet: disables the display of the progress bar and percentage.

Notes

If a device attaches, but the claiming process hangs, then one or more of the devices may not have been properly unclaimed when they were previously detached. The improperly unclaimed device(s) are preventing other devices from being claimed.

To solve this issue, attempt to attach each of the other devices individually. This will claim the device or devices that were improperly unclaimed and allow the hung device to proceed with attaching. You may then run `fio-detach`, if desired, on any devices to detach them again.

fio-beacon

Description

Lights the Fusion ioMemory device's LED(s) to locate the device. You should first detach the Fusion ioMemory device and then run `fio-beacon`.

Syntax

```
fio-beacon <device> [options]
```

where <device> is the name of the device node (`/dev/fctx`), where *x* indicates the card number: 0, 1, 2, etc. For example, `/dev/fct0` indicates the first Fusion ioMemory device detected on the system. The device numbers are visible using `fio-status`.

Option	Description
-0	Off: (Zero) Turns off the LED beacon.
-1	On: Lights the LED beacon.
-p	Prints the PCI bus ID of the device at <device> to standard output. Usage and error information may be written to standard output rather than to standard error.

fio-bugreport

Description

Prepares a detailed report of the device for use in troubleshooting problems.

Syntax

```
fio-bugreport
```

Notes

This utility captures the current state of the device. When a performance or stability problem occurs with the device, run the `fio-bugreport` utility and contact Customer Support at support@fusionio.com for assistance in troubleshooting.

The output will indicate where the bugreport is saved.

ATTENTION!

Upload Report

For best results, do not email the bug report file. Instead please create a case (by emailing Customer Support), and then upload the report to the case using a web browser.

ATTENTION!

The `fio-bugreport` utility uses `vm-support` to gather information including system logs. If `vm-support` fails, this utility will fail to gather the system logs.

Sample Output

```

~ # fio-bugreport
VMkernel-5.0.0
Report output: /var/tmp/fio-bugreport-20111006.223733-sc07HE.tar.gz
OS: VMware-ESXi-5.0.0

...

Building tar file...

Please attach the bugreport tar file
  /var/tmp/fio-bugreport-20090921.173256-sdv9ko.tar.bz2
to your support case, including steps to reproduce the problem.
If you do not have an open support case for this issue, please open a support
case with a problem description and then attach this file to your new case.

```

For example, the filename for a bug report file named `fiobugreport-20090921.173256-sdv9ko.tar.bz2` indicates the following:

- Date (20090921)
- Time (173256, or 17:32:56)
- Misc. information (`sdv9ko.tar.bz2`)

fio-detach**Description**

Detaches the Fusion ioMemory device. By default, the command also displays a progress bar and percentage as it completes the detach.

Unmounting the Device**WARNING!****Read Carefully**

Read the following instructions carefully. Detaching a device while mounted, or under use, can cause errors, data loss and/or corruption.

In most cases, we do **not** recommend using the `fio-detach` utility to ensure that a device is detached. Instead, as a best practice, follow the instructions in [Disabling Auto-Attach on page 28](#) as a safe detach workaround.

Before you use this utility, you must make sure each device is unmounted, and we recommend that you put the host system in maintenance mode.

Syntax

```
fio-detach <device> [options]
```

where <device> is the name of the device node (/dev/fctx), where x indicates the card number: 0, 1, 2, etc. For example, /dev/fct0 indicates the first Fusion ioMemory device detected on the system.

Option	Description
-q	Quiet: Disables the display of the progress bar and percentage.

Notes

Attempting to detach a Fusion ioMemory device may fail with an error indicating that the device is busy. This typically may occur if the Fusion ioMemory device is in use by VM, or some process has the device open.

fio-format

Description

ATTENTION!

The `fio-format` utility requires that the Fusion ioMemory VSL software be loaded with the Fusion ioMemory device(s) detached. Refer to [fio-detach on page 36](#) for details.

Performs a low-level format of the Fusion ioMemory device. By default, `fio-format` displays a progress-percentage indicator as it runs.

ATTENTION!

Use this utility with care, as it deletes all user information on the device. You will be prompted as to whether you want to proceed with the format.

NOTE-

VMFS (VMware File System), the filesystem employed by ESXi, requires 512 byte sector size.

NOTE-

If you do not include the `-s` or `-o` options, the device size defaults to the advertised capacity. If used, the `-s` and `-o` options must include the size or percentage indicators.

WARNING!

Do not interrupt the formatting! We recommend adding power backup to your system to prevent power failures during formatting. If formatting is interrupted, please contact Customer Support.

Syntax

```
fio-format [options] <device>
```

where <device> is the name of the device node (/dev/fctx), where x indicates the device number: 0, 1, 2, etc. For example, /dev/fct0 indicates the first Fusion ioMemory device detected on the system. Use `fio-status` to view this number.

Options	Description
-b <size B K>	<p>Set the block (sector) size, in bytes or kibibytes (base 2). The default is 512 bytes. For example: <code>-b 512B</code> or <code>-b 4K</code> (B in 512B is optional).</p> <hr/> <p>ATTENTION!</p> <p>ESXi only supports 512B sector sizes for use in VMFS datastores. Do not format your Fusion ioMemory device with any other sector size if you plan to use VMFS. If you are passing the device through to a VM (using VMDirectPathIO), then the guest VM can use any sector size appropriate for the guest OS. In this case, formatting is done in the guest.</p> <hr/>
-f	Force the format size, bypassing normal checks and warnings. This option may be needed in rare situations when <code>fio-format</code> does not proceed properly. (The "Are you sure?" prompt still appears unless you use the <code>-y</code> option.)
-q	Quiet mode: Disable the display of the progress-percentage indicator.
-s <size M G T %>	<p>Set the device capacity as a specific size (in TB, GB, or MB) or as a percentage of the advertised capacity:</p> <ul style="list-style-type: none"> • T Number of terabytes (TB) to format • G Number of gigabytes (GB) to format • M Number of megabytes (MB) to format • % Percentage, such as 70% (the percent sign must be included)
-o <size B K M G T %>	<p>Over-format the device size (to greater than the advertised capacity), where the maximum size equals the maximum physical capacity. If a percentage is used, it corresponds to the maximum physical capacity of the device. (Size is required for the <code>-o</code> option; see the <code>-s</code> option above for size indicator descriptions.)</p> <hr/> <p>ATTENTION!</p> <p>Before you use this option, please discuss your use case with Customer Support.</p> <hr/>
-R	Disable fast rescan on unclean shutdown to reclaim some reserve capacity.
-y	Auto-answer "yes" to all queries from the application (bypass prompts).

You must re-attach the device in order to use the Fusion ioMemory device. See [fio-attach on page 34](#) for details.

fio-pci-check

Description

Checks for errors on the PCI bus tree, specifically for Fusion ioMemory devices. This utility displays the current status of each Fusion ioMemory device. It also prints the standard PCI Express error information and resets the state.

NOTE-

It is perfectly normal to see a few correctable errors when `fio-pci-check` is initially run. Subsequent runs should reveal only one or two errors during several hours of operation.

Syntax

```
fio-pci-check [options]
```

Option	Description
-d <value>	1 = Disable the link; 0 = bring the link up (Not recommended).
-e	Enable PCI-e error reporting.
-f	Scan every device in the system.
-n	Do not perform any writes to config space. Will prevent errors from being cleared.
-o	Optimize the Fusion ioMemory device PCIe link settings by increasing the maximum read request size if it is too low.
-r	Force the link to retrain.
-v	Verbose: Print extra data about the hardware.

fio-status

Description

Provides detailed information about the installed devices. This utility operates on either `fctx` or `fiox` devices. The utility depends on running as root and having the Fusion ioMemory VSL driver loaded. If no driver is loaded, a smaller set of status information is returned.

`fio-status` provides alerts for certain error modes, such as a minimal-mode, read-only mode, and write-reduced mode, describing what is causing the condition.

Syntax

```
fio-status [<device>] [<options>]
```

where `<device>` is the name of the device node (`/dev/fctx`), where `x` indicates the card number: 0, 1, 2, etc. For example, `/dev/fct0` indicates the first Fusion ioMemory device detected on the system.

If <device> is not specified, `fio-status` displays information for all cards in the system. If the Fusion ioMemory VSL driver is not loaded, this parameter is ignored.

Option	Description
-a	Report all available information for each device.
-e	Show all errors and warnings for each device. This option is for diagnosing issues, and it hides other information such as format sizes.
-c	Count: Report only the number of Fusion ioMemory devices installed.
-d	Show basic information set plus the total amount of data read and written (lifetime data volumes). This option is not necessary when the -a option is used.
-fj	Format JSON: creates the output in JSON format, which can be used for scripted management applications.
-fx	Format XML: creates the output in XML format.
-u	Show unavailable fields. Only valid with -fj or -fx.
-U	Show unavailable fields and details why. Only valid with -fj or -fx. <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>NOTE-</p> <p>Some <code>fio-status</code> fields are unavailable depending on the operating system or device. For example, some legacy fields are unavailable on newer Fusion ioMemory devices.</p> </div>
-F<field>	Print the value for a single field (see the next option for field names). Requires that a device be specified. Multiple -F options may be specified.
-l	List the fields that can be individually accessed with -F.

ATTENTION!

Output Change

The standard formatting of `fio-status` output has changed compared to the output from Fusion ioMemory VSL software version 2.x. This will affect any custom management tools that used the output of this utility.

Basic Information: If no options are used, `fio-status` reports the following basic information:

- Number and type of devices installed in the system
- Fusion ioMemory VSL software version

Adapter information:

- Adapter type
- Product number
- External power status
- PCIe power limit threshold (if available)
- Connected Fusion ioMemory devices

Block device information:

- Attach status
- Product name
- Product number
- Serial number
- PCIe address and slot
- Firmware version
- Size of the device, out of total capacity
- Internal temperature (average and maximum, since Fusion ioMemory VSL software load) in degrees Centigrade
- Health status: healthy, nearing wearout, write-reduced or read-only
- Reserve capacity (percentage)
- Warning capacity threshold (percentage)

Data Volume Information: If the `-d` option is used, the following data volume information is reported *in addition* to the basic information:

- Physical bytes written
- Physical bytes read

All Information: If the `-a` option is used, all information is printed, which includes the following information *in addition* to basic and data volume information:

Adapter information:

- Manufacturer number
- Part number
- Date of manufacture
- Power loss protection status
- PCIe bus voltage (avg, min, max)
- PCIe bus current (avg, max)
- PCIe bus power (avg, max)
- PCIe power limit threshold (watts)
- PCIe slot available power (watts)
- PCIe negotiated link information (lanes and throughput)

Block device information:

- Manufacturer's code
- Manufacturing date
- Vendor and sub-vendor information
- Format status and sector information (if device is attached)
- FPGA ID and Low-level format GUID
- PCIe slot available power
- PCIe negotiated link information
- Card temperature, in degrees Centigrade
- Internal voltage (avg and max)
- Auxiliary voltage (avg and max)
- Percentage of good blocks, data and metadata
- Lifetime data volume statistics
- RAM usage

Error Mode Information: If the Fusion ioMemory VSL software is in minimal mode, read-only mode, or write-reduced mode when `fio-status` is run, the following differences occur in the output:

- Attach status is "Status unknown: Driver is in MINIMAL MODE:"
- The reason for the minimal mode state is displayed (such as "Firmware is out of date. Update firmware.")
- "Geometry and capacity information not available." is displayed.
- No media health information is displayed.

fio-update-iodrive

ATTENTION!

You should back up the data on the Fusion ioMemory device prior to any upgrade as a precaution.

Description

ATTENTION!

Your Fusion ioMemory devices must be detached before running `fio-update-iodrive`. See [fio-detach on page 36](#) for details or [Disabling Auto-Attach on page 28](#) for information on disabling auto-attach.

Updates the Fusion ioMemory device's firmware. This utility scans the PCIe bus for all Fusion ioMemory devices and updates them. A progress bar and percentage are shown for each device as the update completes.

WARNING!

It is extremely important that the power not be turned off during a firmware upgrade, as this could cause device failure. If a UPS is not already in place, consider adding one to the system prior to performing a firmware upgrade.

WARNING!

Note that when running multiple firmware upgrades in sequence, it is critical to reboot and then both load the Fusion ioMemory VSL driver and attach the Fusion ioMemory device(s) after each firmware upgrade step. Otherwise the on-device format will not be changed, and there will be data loss.

WARNING!

Do not use this utility to downgrade the Fusion ioMemory device to an earlier version of the firmware. Doing so may result in data loss and void your warranty. Contact Customer Support at <https://link.sandisk.com/commercialsupport> if you have issues with your upgrade.

NOTE-

The default action (without using the `-d` option) is to upgrade all Fusion ioMemory devices with the firmware contained in the `fusion_<version>.<date>.fff` firmware archive file. Confirm that all devices need the upgrade prior to running the update. If in doubt, use the `-p` (Pretend) option to view the possible results of the update.

ATTENTION!

Upgrade Path

There is a specific upgrade path that you must take when upgrading Fusion ioMemory device. Consult the *Fusion ioMemory VSL Release Notes* for this Fusion ioMemory VSL software release before upgrading Fusion ioMemory devices.

NOTE-

If you receive an error message when updating the firmware that instructs you to update the midprom information, contact Customer Support.

NOTE-

When using VMDirectPathIO, if you upgrade the firmware on an Fusion ioMemory device, you must cycle the server power to have the change take place. Just restarting the virtual machine won't apply the change.

To update one or more specific devices:

- If the Fusion ioMemory VSL driver is loaded, use the `-d` option with the device number.

Syntax

```
fiio-update-iodrive [options] <firmware-path>
```

where `<firmware-path>` is the full path to the firmware archive file `fusion_<version>.<date>.fff` available at <https://link.sandisk.com/commercialsupport>. The firmware archive path will depend on where it is located on the ESXi host. For example, you could transfer the archive to a folder on a datastore and then use the path to the file in that folder.

Option	Description
-d	<p>Updates the specified devices (by <code>fctx</code>, where <code>x</code> is the number of the device shown in <code>fiio-status</code>). If this option is not specified, all devices are updated.</p> <hr/> <p>ATTENTION!</p> <p>Use the <code>-d</code> option with care, as updating the wrong Fusion ioMemory device could damage your device.</p> <hr/>
-f	<p>Force upgrade (used when directed by Customer Support).</p> <hr/> <p>ATTENTION!</p> <p>Use the <code>-f</code> option with care, as it could damage your card.</p> <hr/>
-l	List the firmware available in the archive.
-p	Pretend: Shows what updates would be done. However, the actual firmware is not modified.

Option	Description
-c	Clears locks placed on a device.
-q	Runs the update process without displaying the progress bar or percentage.
-y	Confirm all warning messages.

If you arrived at this section from [Upgrading the Firmware on page 13](#), you should return to that section.

Appendix B - Monitoring the Health of Devices

This section describes how the health of Fusion ioMemory devices can be measured and monitored in order to safeguard data and prolong device lifetime.

Health Metrics

The Fusion ioMemory VSL software manages block retirement using pre-determined retirement thresholds. The Fusion ioSphere software and the `fio-status` utilities show a health indicator that starts at 100 and counts down to 0. As certain thresholds are crossed, various actions are taken.

At the 10% healthy threshold, a one-time warning is issued. See [Health Monitoring Techniques on page 45](#) for methods for capturing this alarm event.

At 0%, the device is considered unhealthy. It enters *write-reduced* mode, which somewhat prolongs its lifespan so data can be safely migrated off. In this state the Fusion ioMemory device behaves normally, except for the reduced write performance.

After the 0% threshold, the device will soon enter *read-only* mode -- any attempt to write to the Fusion ioMemory device causes an error. Some filesystems may require special mount options in order to mount a read-only block device in addition to specifying that the mount should be read-only.

Read-only mode should be considered a final opportunity to migrate data off the device, as device failure is more likely with continued use.

The Fusion ioMemory device may enter failure mode. In this case, the device is offline and inaccessible. This can be caused by an internal catastrophic failure, improper firmware upgrade procedures, or device wearout.

NOTE-

For service or warranty-related questions, contact Customer Support at <https://link.sandisk.com/commercialsupport>.

NOTE-

For products with multiple Fusion ioMemory devices, these modes are maintained independently for each device.

Health Monitoring Techniques

`fio-status -a`: Output from the `fio-status` utility (using the `-a` option) shows the health percentage and device state. These items are referenced as "Media status" in the sample output below.

```
Found 3 ioMemory devices in this system
Fusion-io driver version: 3.x.x build xxxx
```

```
Adapter: Single Adapter
          Fusion-io ioDrive 1.30TB, Product Number:F00-001-1T30-CS-0001,
SN:1133D0248, FIO SN:1134D9565
...
Media status: Healthy; Reserves: 100.00%, warn at 10.00%; Data: 99.12%
Lifetime data volumes:
  Physical bytes written: 6,423,563,326,064
  Physical bytes read   : 5,509,006,756,312
```

The following Health Status messages are produced by the `fio-status` utility:

- Healthy
- Read-only
- Reduced-write
- Unknown

Fusion ioSphere software: In the Device Report tab, look for the Reserve Space percentage in the right column. The higher the percentage, the healthier the drive is likely to be.

Software RAID and Health Monitoring

Software RAID stacks are typically designed to detect and mitigate the failure modes of traditional storage media. The Fusion ioMemory device attempts to fail as gracefully as possible, and these new failure mechanisms are compatible with existing software RAID stacks. A Fusion ioMemory device in a RAID group will fail to receive data at a sufficient rate if: a) the device is in a write-reduced state, and b) it is participating in a write-heavy workload. In this case, the device will be evicted from the RAID group. A device in read-only mode will be evicted when write I/Os are returned from the device as failed. Catastrophic failures are detected and handled just as though they are on traditional storage devices.

Appendix C - Using Module Parameters

The following table describes the module parameters you can set by using the `esxcfg-module` command.

Sample Command:

```
esxcfg-module --server <server-name> iomemory-vsl -s '<parameter>=<value>'
```

NOTE-

You must reboot the ESXi system to enforce any parameter changes.

Module Parameter	Default (min/max)	Description
auto_attach	1 (0, 1)	<p>1 (default) = Always attach the device on driver load.</p> <p>0 = Don't attach the device on driver load.</p>
background_attach	1 (0, 1)	<p>1 (default) = The host scans and attaches Fusion ioMemory devices in the background while the system continues to boot.</p> <hr/> <p>ATTENTION!</p> <p>The default setting saves time on startup. However, in some instances the Fusion ioMemory devices may not be ready when the host system scans for datastores. If this is occurring, set this parameter to 0 and reboot.</p> <hr/> <p>0 = Force the host server to wait until all Fusion ioMemory devices are ready and attached before continuing to fully boot and become operational.</p>

Module Parameter	Default (min/max)	Description
external_power_override	No devices selected	<p>Allows selected devices to draw full power from the PCIe slot. Where the <value> for this parameter is a comma-separated list of adapter serial numbers.</p> <hr/> <p>ATTENTION! Use with care, see Enabling PCIe Power Override on page 15 for more information.</p> <hr/>
force_minimal_mode	0	<p>1 = Force minimal mode on the device. 0 = Do not force minimal mode on the device.</p>
parallel_attach	1	<p>1 = Enable parallel attach of multiple devices. 0 = Disable parallel attach of multiple devices.</p>
tintr_hw_wait	0 (0, 255)	Interval (microseconds) to wait between hardware interrupts. Also known as interrupt coalescing. 0 is off.

NOTE-

Other than `external_power_override`, module parameters are global — they apply to all Fusion ioMemory devices in the computer.

To query the current module parameters, use the following command:

```
esxcfg-module --server <server-name> iomemory-vsl -g
```


Appendix D - Working with ioMemory Devices and VMDirectPathIO

Each Fusion ioMemory device can either be used as a VMFS datastore in ESXi, or they can be passed through directly to a virtual machine. In VMware documentation this is often referred to as VMDirectPathIO and is commonly referred to as PCI passthrough.

ATTENTION!

If you are passing the device(s) through, you do not need to install the Fusion ioMemory VSL software on the ESXi system. Instead, install the software on the guest system. Only install the Fusion ioMemory VSL software on the host if you plan on creating a VMFS on the device(s).

NOTE-

When using VMDirectPathIO, if you upgrade the firmware on an Fusion ioMemory device, you must cycle the power on the VMware host server to have the change take place. Just restarting the virtual machine won't apply the change.

Using Products with Multiple Devices

Some products contain multiple devices, such as the Fusion ioMemory ioDrive Duo device. The ioMemory VSL does not support splitting the modules between two functions or virtual machines. The following scenarios are supported:

- Both Fusion ioMemory devices are used as a VMFS datastore in ESXi.
- Both Fusion ioMemory devices are passed through to the same virtual machine (using VMDirectPathIO).

Appendix E - Upgrading Devices from VSL 2.x to 3.x

This version of the Fusion ioMemory VSL software supports new features, including the latest generation of ioMemory architecture and improved Flashback protection. These features require the latest version of the Fusion ioMemory device firmware. Every Fusion ioMemory device in a system running 3.1.x or later must be upgraded to the latest version of the firmware.

For example, if you have a system running 2.x Fusion ioMemory VSL software with Fusion ioMemory ioDrive devices previously installed, and you want to install new Fusion ioMemory ioDrive2 devices (that require the latest version of the firmware), then you will need to upgrade all of the existing devices to the latest firmware version.

WARNING!

You cannot revert a device's firmware to an earlier version once you have upgraded the device (without voiding your warranty). If you experience problems with your upgrade, please contact Customer Support at support@fusionio.com.

WARNING!

Upgrading devices (previously configured for VSL 2.x.x) to work with VSL 3.x.x will require a low-level media format of the device. No user data will be maintained during the process. **Be sure to back up all data as instructed.**

ATTENTION!

Upgrade Path

Depending on the current firmware version of your devices, you may need to upgrade your device's firmware multiple times in order to preserve internal structures. Consult the *Fusion ioMemory VSL Release Notes* for the upgrade path. Visit <https://link.sandisk.com/commercialsupport> for all of the required software and firmware versions.

For more information on upgrading from one version to the next, see the *Fusion ioMemory VSL Release Notes* (available at <https://link.sandisk.com/commercialsupport>) for the version to which you will upgrade the device. Then follow the upgrade instructions in that version's user guide for your operating system (including the firmware update instructions).

Upgrade Procedure

While upgrading from VSL 2.x to 3.x, ensure that you follow the device upgrade path as described in the *Fusion ioMemory VSL Release Notes*. The device upgrade path outlines the specific order of firmware and VSL driver upgrades required for the VSL 2.x to 3.x upgrade.

Make sure that all previously installed Fusion ioMemory ioDrive devices are updated with the appropriate firmware and VSL software versions required for this upgrade.

ATTENTION!

Make sure to upgrade all existing Fusion ioMemory ioDrive devices to VSL 3.x **before** installing a new Fusion ioMemory ioDrive device in the same host.

If you install a new Fusion ioMemory ioDrive device before upgrading existing devices to VSL 3.x, the OS may not recognize the new device. This means that when you enter the `fio-status` command, the OS may return incomplete or incorrect information about the new device. In addition, the VSL 2.x driver may put the new device into minimal mode until the upgrade process is completed for the existing devices.

1. Prepare each existing Fusion ioMemory ioDrive device for upgrade.

- a. Back up user data on each device.

WARNING!

The upgrade process will require a low-level media format of the device. No user data will be retained during the process; **be sure to make a complete backup.**

Use a backup method of your choice. For best results, use software and backup devices that have proven effective in the past. Do not back up the data onto another Fusion ioMemory device on the same system. The backup must be to a local disk or to an externally attached volume.

- b. Run the `fio-bugreport` utility and save the resulting file. This will capture the device information for each device in the system. This device information will be useful in troubleshooting any upgrade issues. Sample command:

```
fio-bugreport
```

- c. Detach Fusion ioMemory ioDrive devices, for example:

```
fio-detach /dev/fct*
```

For more information, see [fio-detach on page 36](#).

2. Uninstall the 2.x Fusion ioMemory VSL software:

- a. Power off, or use vMotion to move, all of the virtual machines, and then put the host in maintenance mode.
 - b. Follow the instructions for your platform:
 - i. ESXi 5.x uninstall vCLI command:

```
esxcli --server <servername> software vib remove -n block-iomemory-vsl
```

- ii. ESXi 4.x vCLI uninstall procedure:

ATTENTION!

This version of the Fusion ioMemory VSL software is not compatible with ESXi 4.x. After uninstalling the 2.x driver, you will need to upgrade to ESXi 5.x before installing the new 3.x driver and related packages.

- i. Determine the bundle "bulletin" ID:

```
vihostupdate --server <server-name> --query
```

Sample output:

```
-----Bulletin ID-----
iomemory-vsl-2.2.0.7601742

-----Installed-----
2011-02-08T10:37:05

-----Summary-----
iomemory-vsl: block driver for ESXi 4.1.X
```

- ii. Remove the "bulletin" containing the driver & utilities:

```
vihostupdate --server <server-name> --remove --bulletin
<Bulletin-ID>
```

- iii. You will need to upgrade your VMware OS to ESXi 5.x before installing the new Fusion ioMemory VSL software and related packages. Refer to the list of supported operating systems contained in the *Fusion ioMemory VSL Release Notes* for this release.

- iii. ESX 4.x uninstall procedure:

ATTENTION!

This version of the Fusion ioMemory VSL software is not compatible with ESXi 4.x. After uninstalling the 2.x driver, you will need to upgrade to ESXi 5.x before installing the new 3.x driver and related packages.

- i. Enter the following command to determine the Bulletin ID of any previously installed versions:

```
esxupdate query
```

Sample Output

```

-----Bulletin ID-----
iomemory-vsl-3.0.6.360

-----Installed-----
2012-01-16T03:49:33

-----Summary-----
iomemory-vsl: block driver for ESX/ESXi 4.X

```

- ii. Run the following command to remove installed version(s):

```
esxupdate -b <Bulletin-ID> remove
```

- iii. You will need to upgrade your VMware OS to ESXi 5.x before installing the new Fusion ioMemory VSL software and related packages. Refer to the list of supported operating systems contained in the *Fusion ioMemory VSL Release Notes* for this release.

3. Install the new Fusion ioMemory VSL software and related packages.

- a. Download the Fusion ioMemory VSL offline bundle, firmware, and (optional) CIM provider from <https://link.sandisk.com/commercialsupport> . For more information, see the section [Downloading the Software on page 9](#) at the beginning of this guide.
- b. Install the Fusion ioMemory VSL software and utilities. Follow the instructions in the following section, then return to this procedure: [Installing the ioMemory VSL on ESXi 5.x on page 12](#)

NOTE-

Be sure to follow the suggestion to copy over the firmware file to the ESXi host, and make note of the firmware location.

- c. Reboot the system.

4. Update the firmware on each device to the latest version using `fio-update-iodrive`.

WARNING!

Prevent Power Loss

Take measures to prevent power loss during the update, such as using a UPS. Power loss during a firmware update may result in device failure. For all warnings, alerts, and options pertaining to this utility, see [fio-update-iodrive on page 42](#).

Sample syntax:

```
fio-update-iodrive <firmware-path>
```

Where `<firmware-path>` is the full path to the firmware archive file (`fusion_<version>.<date>.fff`) available at <https://link.sandisk.com/commercialsupport>. This command will update all of the devices to the selected firmware. If you wish to update specific devices, consult [fio-update-iodrive on page 42](#) for more options.

5. Reboot the system

6. **Destructive Step**

WARNING!

Running `fio-format` in the next step will erase the entire device, including user data. Once this format is started, the device cannot be downgraded to the 2.x driver without voiding your warranty. If you experience problems with your upgrade, please contact Customer Support at support@fusionio.com.

7. Format each device using `fio-format`, for example:

```
fio-format <device>
```

You will be prompted to confirm you wish to erase all data on the device.

ATTENTION!

The format may take an extended period of time, depending on the wear on the device.

8. Attach all Fusion ioMemory ioDrive devices, for example:

```
fio-attach /dev/fct*
```

9. Check the status of all devices using `fio-status`, for example:

```
fio-status -a
```

Your Fusion ioMemory ioDrive devices have now been successfully upgraded for this version of the Fusion ioMemory VSL software. You may now safely install any new Fusion ioMemory ioDrive devices.

Fusion Powered Support

We offer SanDisk Customer Services and Support by phone, e-mail and on the Web. For the most up-to-date contact information visit at <https://link.sandisk.com/commercialsupport> .

E-Mail

Our support e-mail address is: support@fusionio.com

E-mail is the fastest way to get simple questions answered. Please give a detailed description of your problem with your complete contact information (name, phone number, email address, location address).

Warranty Support

Warranty Support is available via support@fusionio.com and at <https://link.sandisk.com/commercialsupport> .

Telephone Support

ioFX Support

North America: (855) 322-5767

Enterprise Support

North America: (877) 816-5740

Country Numbers

For product support outside of North America, please use the number for the country/region closest to you. If that is not possible, please contact North America at +1 801 424 5474.

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