



Dell Fusion ioMemory VSL 3.2.15

USER GUIDE FOR MICROSOFT WINDOWS

Tuesday, April 11, 2017



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Dell Fusion ioMemory VSL 3.2.15 User Guide for Microsoft Windows

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Part Number: 80-11-71089

Published: Tuesday, April 11, 2017

The following information boxes are used throughout the user guide to present important information:

NOTE-

Indicates a special note.

ATTENTION!

Indicates cautions to take into consideration when using the device and software.

WARNING!

Indicates warnings to take into consideration when using the device and software.



CAUTION— Safety Instructions

Use the following safety guidelines to help ensure your own personal safety and to help protect your system and working environment from potential

NOTE-

For complete information on U.S. Terms and Conditions of Sale, Limited Warranties and Returns, Export Regulations, Software License Agreement, Safety, Environmental and Ergonomic Instructions, Regulatory Notices, and Recycling Information, see the Safety, Environmental and Regulatory Information (SERI), End User License Agreement (EULA), and Warranty and Support Information (WSI) that shipped with your system.

Protecting Against Electrostatic Discharge

Electrostatic discharge (ESD) events can harm electronic components inside your system. Under certain conditions, ESD may build up on your body or an object, such as a peripheral, and then discharge into another object, such as your system. To prevent ESD damage, you must discharge static electricity from your body before you interact with any of your system's internal electronic components, such as a memory module. You can protect against ESD by touching a metal grounded object (such as an unpainted metal surface on your system's I/O panel) before you interact with anything electronic. When connecting a peripheral (including handheld digital assistants) to your system, you should always ground both yourself and the peripheral before connecting it to the system. Additionally, as you work inside the system, periodically touch an I/O connector to remove any static charge your body may have accumulated.

You can also take the following steps to prevent damage from electrostatic discharge:

- When unpacking a static-sensitive component from its shipping carton, do not remove the component from the antistatic packing material until you are ready to install the component. Just before unwrapping the antistatic package, be sure to discharge static electricity from your body.
- When transporting a sensitive component, first place it in an antistatic container or packaging.
- Handle all electrostatic sensitive components in a static-safe area.

SAFETY— General

- Observe and follow service markings. Do not service any product except as explained in your user documentation. Opening or removing covers that are marked with the triangular symbol with a lightning bolt may expose you to electrical shock. Components inside the compartments must be serviced only by a trained service technician.
- If any of the following conditions occur, unplug the product from the electrical outlet, and replace the part or contact your trained service provider:
 - The power cable, extension cable, or plug is damaged.
 - An object has fallen in the product.
 - The product has been exposed to water.
 - The product has been dropped or damaged.
 - The product does not operate correctly when you follow the operating instructions.
 - Use the product only with approved equipment.



- Operate the product only from the type of external power source indicated on the electrical ratings label. If you are not sure of the type of power source required, consult your service provider or local power company.
- Handle batteries carefully. Do not disassemble, crush, puncture, short external contacts, dispose of in fire or water, or expose batteries to temperatures higher than 60° Celsius (140° Fahrenheit). Do not attempt to open or service batteries; replace batteries only with batteries designated for the product.

SAFETY— When Working Inside Your System

Before you remove the system covers, perform the following steps in the sequence indicated.

ATTENTION!

Except as expressly otherwise instructed in Dell documentation, only trained service technicians are authorized to remove the system cover and access any of the components inside the system.

NOTE-

To help avoid possible damage to the system board, wait 5 seconds after turning off the system before removing a component from the system board or disconnecting a peripheral device.

1. Turn off the system and any connected devices.
2. Disconnect your system and devices from their power sources. To reduce the potential of personal injury or shock, disconnect any telecommunication lines from the system.
3. Ground yourself by touching an unpainted metal surface on the chassis before touching anything inside the system.
4. While you work, periodically touch an unpainted metal surface on the chassis to dissipate any static electricity that might harm internal components.

In addition, take note of the following safety guidelines when appropriate:

- When you disconnect a cable, pull on its connector or on its strain-relief loop, not on the cable itself. Some cables have a connector with locking tabs. If you are disconnecting this type of cable, press in on the locking tabs before disconnecting the cable. As you pull connectors apart, keep them evenly aligned to avoid bending any connector pins. Also, when you connect a cable, make sure both connectors are correctly oriented and aligned.
- Handle components and cards with care. Do not touch the components or contacts on a card. Hold a card by its edges or by its metal mounting bracket. Hold a component such as a microprocessor chip by its edges, not by its pins.



Introduction

Overview

Congratulations on your purchase of a Dell® 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 *Dell 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 *Dell 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 *Dell 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 *Dell Fusion ioMemory VSL Release Notes* to determine the upgrade sequence.

WARNING!

Upgrade Previous Devices First

If you have Legacy 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 82](#) for the upgrade instructions.

If you have Fusion ioMemory devices installed and in a RAID configuration, please read [Upgrading the Software with a RAID Configuration on page 36](#) before you upgrade the software and/or firmware.

Installation Overview

1. Download the latest version of the software at <http://dell.fusionio.com>.
2. If you are installing version 3.2.15 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 82](#). (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.
 - **Extracting the MSI File:** If you require the MSI file, you may extract it using the following command:

`<installname>.exe`



For example, you may need the MSI file to deploy the software via Group Policy on a Windows Server.

5. Determine if you need to upgrade the firmware to the latest version, see [Upgrading the Firmware on page 16](#).
6. Configure the device(s) by following the configuration instructions, for example [Adding a Filesystem on page 25](#), [Creating a RAID Configuration on page 25](#), etc.

Installing the Software

ATTENTION!

Do not install new Fusion ioMemory ioDrive2 devices with previously installed Fusion ioMemory ioDrive devices (that are configured for Fusion ioMemory VSL software version 2.x) without first completing the instructions in [Upgrading Devices from VSL 2.x to 3.x on page 82](#).

1. Review the *Dell Fusion ioMemory VSL Release Notes* available for this version of the software for additional steps that may be needed to complete the install.
2. For new device installations, make sure you have properly installed the device(s) before you install the Fusion ioMemory VSL software.
3. Log in as Administrator or have Administrator rights.
4. If needed, uninstall the existing Fusion ioMemory VSL software, utilities, etc., using **Programs and Features**, or **Add or Remove Programs** (depending on your version of Windows), in the **Control Panel**.
5. Restart the computer.

NOTE-

The Fusion ioMemory VSL installation program will attempt to remove previous versions of the software, however if it fails and a previous version is removed by the user after the newest version is installed, the Fusion ioMemory VSL software will no longer load after a restart. In that case, you need to a) run the Repair option in the installation program, from **Programs and Features** (or **Add or Remove Programs**) in the Control Panel, and b) restart the computer.

6. Download the Fusion ioMemory VSL installation program for Windows from <http://dell.fusionio.com> and save it to your desktop or a convenient directory.

- Dell_IO_Management_<releaseversion>.<buildversion>_x64.exe

NOTE-

Also download the fio-firmware-dell_<version>.<date>.fff firmware archive file for this release and save it in the same location.



ATTENTION!

Unified Utilities. If you plan to use the 4.2.1 (or newer) Unified Utilities on a VSL 3.2.15 server, you will also download the 4.2.1 (or newer) `fio-utils.msi` installer for VSL 4.2.1 (or newer) Release Version (and save it to a separate folder on your desktop or another convenient location) from <http://dell.fusionio.com> .

Only certain operating systems installed with VSL 3.2.15 can use the 4.2.1 (or newer) utilities. For the list of operating systems compatible with Unified Utilities on VSL 3.2.15 systems, refer to the 3.2.15 *Dell Fusion ioMemory VSL Release Notes*.

For Unified Utilities installation, after you run the 3.2.15 Fusion ioMemory VSL and utilities installer and upgrade the firmware, you will then execute the 4.2.1 (or newer) `fio-utils.msi` installer on your VSL 3.2.15 server. This installer will replace your VSL 3.2.15 utilities with the VSL 4.2.1 (or newer) Unified Utilities. See the end of this section for more information.

7. Run the Fusion ioMemory VSL installation program.
8. Click **Next**.
9. To select a different folder for the installation, browse to the folder and click **OK**. The default folder is `C:\Program Files\Dell IO Management`.
 - The installer also creates a folder for the VSL utilities. The default path is `C:\Program Files\Common Files\VSL Utils`
10. Follow the onscreen prompts to complete the install.
11. Choose **Finish** on the finish screen of the installer.

ATTENTION!

You may be prompted to reboot your system to complete the installation process. If you are not prompted to reboot, you should still reboot your system after completing the installation. If Windows does not recognize the Fusion ioMemory device(s) after rebooting, you may need to manually install the Fusion ioMemory VSL software for the device(s). See [Manual Installation on page 66](#) for information on manual installation.

ATTENTION!**Pagefile Support**

If your Fusion ioMemory device is configured for pagefile support, you may need to reboot a second time before Windows can create a permanent pagefile.



NOTE-

You may also install the Dell ioSphere software (optional GUI management software). Dell ioSphere software and documentation are available as a separate download.

NOTE-

Fusion ioMemory devices cannot be used as hibernation devices.

Once the system restarts, proceed to [Upgrading the Firmware on page 16](#).

ATTENTION!

Unified Utilities. After you run the 3.2.15 Fusion ioMemory VSL installer and upgrade the firmware, you can install the 4.2.1 (or newer) Unified Utilities if desired.

To install the Unified Utilities, you will execute (with Admin rights) the 4.2.1 (or newer) `fio-utils.msi` installer from the command prompt on your VSL 3.2.15 server. This installer will replace your VSL 3.2.15 utilities with the VSL 4.2.1 (or newer) Unified Utilities. No reboot is required.

For information on using the Unified Utilities on VSL 3.2.15 systems, including command differences between 3.2.15 and 4.2.1 (or newer) utilities, refer to the 3.2.15 *Dell Fusion ioMemory VSL Release Notes*.

Silent Install Option

ATTENTION!**Uninstall Previous**

If you have a version of the Fusion ioMemory VSL software previously installed, you must uninstall it first (see the information on a **Silent Uninstall** below). You must manually reboot the computer after installing the new version with the silent install option. This step must be performed prior using any Fusion ioMemory VSL utilities or functionality.

If you are installing remotely or with scripts, you can use the silent install option (`/quiet`) when you run the installation program in the command-line interface.

In the command-line interface, navigate to the folder that contains the `.exe` installer file, and run this command:

```
<installname>.exe /quiet
```

Where the `<installname>.exe` is the name of the installer file.

This option installs the Fusion ioMemory VSL software using its default settings, eliminating the need to "click Next" or select settings during install.



ATTENTION!

Be sure to use the `/quiet` parameter. The command-line quiet install parameter has changed and the installer no longer supports the abbreviated parameter (`/qn`). If you pass the `/qn` parameter to the installer, the installer will ignore the parameter and the installer GUI will launch.

Silent Uninstall

You may silently uninstall the Fusion ioMemory VSL software with this command:

```
<installname>.exe /uninstall /quiet
```

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 either the command-line utilities or the optional Dell ioSphere software (GUI).

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 *Dell Fusion ioMemory VSL Release Notes* for this Fusion ioMemory VSL software release before upgrading Fusion ioMemory devices.

Also refer to the *Dell 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 *Dell 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.

Command-line Interface

More information on these command-line utilities is available in [Command-line Utilities Reference on page 43](#). All command-line utilities require Administrator rights.

1. Run the `fio-status` utility and examine the output. See [fio-status on page 54](#) 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 60](#) for complete information and warnings.

Optional GUI - Dell ioSphere software

You can use the Dell ioSphere software to check the status of your Fusion ioMemory devices. If the Dell ioSphere software indicates that the device's firmware is outdated, you can also use the Dell ioSphere software to upgrade the device firmware. Consult the Dell ioSphere software documentation for more information on installing and using the software.



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.

Setting the ioMemory VSL Options

You can configure the Fusion ioMemory VSL software using various module parameters. Individual module parameters are described throughout this guide. For a complete list of all parameters and how to implement them see [fio-config on page 46](#).

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 *Dell Fusion ioMemory Hardware Installation Guide*.

This additional power may be provided in two ways:

- **External Power Cable:** See the *Dell 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 a Specified Maximum Power Draw:** Some PCIe slots provide additional power (often up to 75W of power). You may allow the device to draw a specified maximum 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 with the specified maximum power value in Watts).

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. Refer to the **12G PowerEdge Server Slot Support Matrix** PDF located at <http://dell.fusionio.com> for information on supported 75W PCIe slots.



WARNING!

If the slot is not capable of providing the needed amount of power, enabling a specified maximum 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 Dell | 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.

Refer to the matrix to determine if your slot provides 75W. The `fio-status` and `fio-pci-check` utilities may incorrectly display a 75W slot as a 25W slot.

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 the specified maximum 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 the specified maximum 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 the specified maximum 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 power limit set by the BIOS for that PCIe slot unless 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`:** You determine the adapter serial number differently depending on whether the device is an Fusion ioMemory ioDrive Duo device or an Fusion ioMemory ioDrive2 Duo device

Fusion ioMemory ioDrive Duo devices: Run the `fio-status` command-line utility. Sample output:

```
fio-status
...
Adapter: Dual Adapter
Fusion-io ioDrive Duo 1.28TB, Product Number:24X4P, SN:94126
ioDrive Duo HL, PN:00190000107
...
```

With Fusion ioMemory ioDrive Duo devices, the adapter serial number is simply the serial number that appears after the adapter `Product Number`. In this example, that adapter serial number is 94126.

Fusion ioMemory ioDrive2 Duo devices: Run the `fio-status` command-line utility. Sample output:

```
fio-status
...
Adapter: Dual Controller Adapter
Dell ioDrive2 Duo 2410GB MLC, Product Number:7F6JV,
SN:US07F6JV7605121J0010
...
fct0    Attached as 'fioa' (block device)
SN:1149D2717-1121
...
fct1    Attached as 'fiob' (block device)
SN:1149D2717-1111
...
```

The adapter serial number is the number that is common to each of the `fctx` Fusion ioMemory devices. In this example, 1149D2717 is the adapter serial number.

ATTENTION!

With Fusion ioMemory ioDrive2 Duo devices, the adapter serial number is **NOT** the number that appears after the `Product 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 45](#) for more information.



Setting the Parameter in VSL 3.2.15

Set the module parameter by using the fio-config utility and specifying a new value for the `external_power_override` parameter. Please refer to the examples below.

Example 1:

You can use the override parameter to specify the maximum amount of power that specified devices should pull (in Watts).

```
fio-config -p FIO_EXTERNAL_POWER_OVERRIDE <SN-value>:<W-value>
```

Where the `<SN-value>:<W-value>` for this parameter is a comma-separated list of value pairs with adapter serial numbers and the maximum amount of power each device should pull (in Watts).

For example, `1149D0969:40,1159E0972:40,1331G0009:40` would allow three devices (with serial numbers 1149D0969, 1159E0972, and 1331G0009) to each draw a maximum of approximately 40W.

Any cards in the server not set using this module parameter will use the power limit set by the BIOS for that PCIe slot.

Example 2:

You can use the override parameter to specify the maximum amount of power *all devices* in the system should pull (in Watts). Use the new serial number wildcard (*) to specify all devices in the system.

```
fio-config -p FIO_EXTERNAL_POWER_OVERRIDE *: <W-value>
```

Where the `*:<W-value>` for this parameter is the serial number wildcard (*) that includes all cards in the system, and the maximum amount of power all devices should pull (in Watts).

For example, `*:50` would allow all cards in the system to draw a maximum of approximately 50W.

ATTENTION!

Do not use serial numbers with the (*) wildcard (do not mix commands in Examples 1 and 2).

ATTENTION!

You must reboot or unload/load the driver to enforce any parameter changes.

Virtual Controller Configuration

Depending on your use case and application, you may benefit from configuring supported devices to use Virtual Controller technology.

When configured, each physical Fusion ioMemory device is split into two (virtual) logical devices. Splitting the Fusion ioMemory device into two virtual devices has the following implications:



- **Latency:** There is no affect on latency.
- **Throughput:** The total peak I/O bandwidth of the device is approximately the same.
- **IOPS:** Depending on the use of the virtual devices (especially the average I/O size), the peak IOPS for each virtual device is about the same for a non-split device. In other words, the combined peak IOPS of the two virtual devices can be nearly double that of a non-split device. For details, see in the *Maintenance* section.
- **Capacity:** Due to virtualization overhead, the combined capacity of the two virtual devices is slightly less than that of a single-controller device. See the *Dell Fusion ioMemory VSL Release Notes* for a list of compatible devices and their Virtual Controller capacities.

Converting your Fusion ioMemory device to a Virtual Controller configuration will split the Fusion ioMemory device into two logical devices.

For 512B I/Os, the combined IOPS performance of the two virtual devices is approximately double that of a single-controller device. For 4KiB I/Os, there is more than an 80% improvement in IOPS performance with virtual devices. For 16kB and larger I/Os, there is no improvement of total IOPS performance over a non-Virtual Controller configuration.

Latency in the virtual devices is unaffected, and the combined bandwidth of the two virtual devices is the same as it would be without the split. Due to the overhead of an additional device, the combined capacity of the two virtual devices is slightly less than that of a single-controller device.

Splitting a single physical device into multiple virtualized devices, or merging multiple virtualized devices back to a single physical device, requires a low-level format, which will erase all of the data on the device. Be sure to back up all of your data.

Supported Devices

Only relatively new devices (with few writes performed) may be split or merged. Devices with too much wear are unsuitable for converting to or from a Virtual Controller configuration. Merging virtual devices may also result in additional wear (depending on the wear differences of the two virtual devices).

To be suitable for splitting or merging, devices (including Virtual Controller devices) must have 90% or more of their remaining rated endurance of Petabytes Written (PBW). This rating as well as the current percentage remaining is visible in `fio-status` with the `-a` option. For example:

```
fio-status /dev/fct1 -a
...
Rated PBW: 17.00 PB, 99.95% remaining
```

In the above example, the device is suitable for conversion because it has more than 90% of the rated PBW remaining.

If you attempt to merge or split a device that does not support Virtual Controller technology or a device that has too much wear, the update utility will not allow the conversion and the firmware upgrade will not take place. See the Release Notes for a list of devices that support Virtual Controller technology and their capacities after the conversion.



Multi-device Products

For products with more than one Fusion ioMemory device, such as a Fusion ioMemory ioDrive2 Duo device, you must configure all of the Fusion ioMemory devices to Virtual Controller technology at the same time. All of the devices must also be merged at the same time. For example, the two Fusion ioMemory devices in a Fusion ioMemory ioDrive2 Duo device will be converted into four virtual devices. The utility will not allow a conversion if you attempt to split or merge only one physical device in a multi-device product.

Splitting Controllers

Be sure to use firmware that supports Virtual Controller technology. Consult the Release Notes to determine if the firmware for that release supports Virtual Controller technology.

1. Back up all of your data. Because a low-level format is needed to complete the conversion, all of the user data on your device will be erased.
2. Use the `fio-update-iodrive` command-line utility to configure a Fusion ioMemory device to use Virtual Controller technology:
 - Use the `--split` option to split the controller.
 - Use the `-d` option to specify a device, otherwise all installed devices that can be split will be split.
 - Specify the firmware path, and check the *Dell Fusion ioMemory VSL Release Notes* to make sure the firmware supports Virtual Controller technology.

Example:

```
fio-update-iodrive --split -d /dev/fct0 <firmware-path>
```

After rebooting, each physical device will be split into two virtual devices. Each Fusion ioMemory device will therefore split into two logical devices, each with a unique device path. For example, `/dev/fct0` may become `/dev/fct0` and `/dev/fct1`. You will manage each device as a unique device.

3. Reboot.
4. Load the Fusion ioMemory VSL driver.
5. Run `fio-status` to determine which devices need to be formatted.
6. Low-level format the device(s). For example:

```
fio-format /dev/fct0 /dev/fct1
```

Formatting will erase all user data, be sure to back up your data. You can reverse the split by merging the controllers (without losing data) up until you format the virtual devices.



Merging Controllers

If your Fusion ioMemory device (including the two virtual devices) is suitable for merging, then you will be able to use the `fio-update-iodrive` utility to merge the virtual devices back into one physical device.

1. Back up all of your data. Because a low-level format is needed to complete the merge, all of the user data on your device will be erased.
2. Use the `fio-update-iodrive` command-line utility to configure the device for merging:
 - a. Use the `--merge` option to merge the virtual devices.
 - b. Use the `-d` option to specify a device.

ATTENTION!

The `fio-update-iodrive` utility only successfully works against one of the two virtual devices for each physical Fusion ioMemory device. Out of the two virtual devices, only the first virtual device (in terms of device numbering) is linked to the physical device (and the firmware). The second virtual device is not linked, and any firmware operation against that second virtual device will fail with this message:

```
Error: Device '/dev/fctx' had an error while updating. This device does not support firmware update.
```

This is expected, and the error will not affect the update/merge of the first (linked) virtual device. The update operation will complete on all devices that can merge and otherwise accept firmware changes.

- c. Specify the firmware path, and check the *Dell Fusion ioMemory VSL Release Notes* to make sure the firmware supports Virtual Controller technology.

Example:

```
fio-update-iodrive --merge -d /dev/fct0 <firmware-path>
```

3. Reboot.
4. Load the Fusion ioMemory VSL driver.
5. Run `fio-status` to determine which devices need to be formatted.
6. Low-level format the device(s). For example:

```
fio-format /dev/fct0
```

WARNING!

Formatting will erase all user data, be sure to back up your data. You can reverse the merge by splitting the controllers (without losing data) up until you format the merged device.



Device Naming

The Fusion ioMemory device receives a name and number as part of the install process for identification. The syntax is `fctx` where `x` indicates the device number: 0, 1, 2, etc. For example, `/dev/fct0` indicates the first Fusion ioMemory device installed on the system. Use the Dell iSphere software or the `fio-status` utility to view this device number.

Adding a Filesystem

With Fusion ioMemory device(s) and Fusion ioMemory VSL software installed, you can now use the Windows Disk Management utility to make your device available to applications. Typically, Windows detects the new device, initializes it, and displays it in Disk Management. You can then add partitions, format a volume, or create a RAID configuration on your Fusion ioMemory device using the standard Windows procedures (see the *Windows Disk Management Utility* documentation for more details).

NOTE-

Devices with >2TB Capacities

Devices with capacities greater than 2TB require the following partition types:

- **Single device:** GPT (GUID Partition Table)
- **Multiple devices** (for a RAID configuration): Dynamic Disk

These devices also require sector sizes greater than 512B (we recommend 4kB sectors). When you use `fio-format` to format devices with capacities greater than 2TB, the default sector size is 4KB.

If Windows does not initialize the device, you can do so manually. To initialize an Fusion ioMemory device,

1. Select **Start > Control Panel**.
2. Click **Administrative Tools**.
3. Click **Computer Management**.
4. Click **Disk Management** in the Storage section of the console tree.
5. Locate and right-click the Fusion ioMemory device in the list of storage devices on the right. (If the Fusion ioMemory device does not appear in the list, choose **Rescan Disks** from the Action menu. You may also need to restart your computer to display the Fusion ioMemory device in the list.)
6. Click **Initialize Disk**.

You can now use the Disk Management Utility to add a file system to your Fusion ioMemory device.

Creating a RAID Configuration

You can use your Fusion ioMemory device as part of a RAID configuration with one or more additional Fusion ioMemory devices. To do so, you must format your Fusion ioMemory devices as dynamic volumes. In turn, you can then use these dynamic volumes to create multi-disk RAID configurations (spanned, striped, mirrored, or RAID 5).

For specific steps to perform a RAID configuration, see the *Windows Disk Management Utility* documentation for details.



NOTE-

If you are using RAID1/Mirroring and one device fails, be sure to run a fio-format on the replacement device (not the remaining good device) before rebuilding the RAID.

Using the Device as a Page Files Store

To safely use the Fusion ioMemory device with page files (also known as Virtual Memory) requires passing the `preallocate_memory` kernel module parameter. To set this parameter, use either the optional Dell ioSphere software (see Dell ioSphere software documentation), or use the `fio-config` command-line utility (see [fio-config on page 46](#) for the full utility instructions):

```
fio-config -p FIO_PREALLOCATE_MEMORY 1149D2717-1121,1149D2717-1111,10345
```

- Where 1149D2717-1111,1149D2717-1111,10345 are serial numbers obtained from `fio-status`, see [fio-format on page 52](#).

Once you have set this parameter, you can go into the system settings and use the Fusion ioMemory device(s) to store the paging files. For more information see [Using the Windows Page Files on page 71](#).

NOTE-

Be sure to provide the serial numbers for the Fusion ioMemory device, not an adapter, when applicable.

ATTENTION!

You must have enough RAM available to enable the Fusion ioMemory device with pre-allocation enabled for use as swap. Attaching a Fusion ioMemory device, with pre-allocation enabled, without sufficient RAM may result in the loss of user processes and system instability.

Consult the *Dell Fusion ioMemory VSL Release Notes* for RAM requirements with this version of the Fusion ioMemory VSL software.

NOTE-

The `preallocate_memory` parameter is recognized by the Fusion ioMemory VSL software at load time, but the requested memory is not actually allocated until the specified device is attached.

Setting the Amount of Preallocated Memory

If you enable devices for preallocation (as described above), the Fusion ioMemory VSL software will automatically preallocate the amount of memory based on your formatted sector size. If you have a sector size that is less than 4KiB (for example, 512B sectors), then the Fusion ioMemory VSL software will preallocate a very large amount of memory (calculated for worst-case scenarios based on 512B sectors).

See the *Dell Fusion ioMemory VSL Release Notes* for worst-case RAM requirements based on formatted sizes. The Fusion ioMemory VSL software preallocates enough memory for worst-case scenarios in order to avoid an out-of-



memory situation where the Fusion ioMemory device would no longer function due to insufficient memory (resulting in a system crash).

Operating systems normally use at least 4KiB blocks of data for virtual memory, so it would be safe in most cases for the Fusion ioMemory VSL software to preallocate enough memory for a worst-case scenario based on 4KiB sectors. There are two ways to force the Fusion ioMemory VSL software to preallocate based on 4KiB block sizes:

- **Format the device to 4KiB sectors.** With preallocation enabled, the Fusion ioMemory VSL software will automatically preallocate memory based on 4KiB blocks of data. Use `fio-format` to format the Fusion ioMemory device with 4KiB sector sizes.
- **Use the `PREALLOCATE_MB` parameter.** This parameter sets the amount of memory that the Fusion ioMemory VSL software will preallocate for every Fusion ioMemory device in the system that is enabled for preallocation (as described in the previous section).

WARNING!

Ensure that you are preallocating enough system memory. If you do not allocate enough memory and you attempt to use the device for paging files (due to a miscalculation or entry error), the system may crash as memory resources are depleted.

1. Determine the amount of system memory needed for every device in a worst-case scenario.
 - a. See the *Dell Fusion ioMemory VSL Release Notes* for worst-case RAM requirements based on sector sizes.
 - b. You can base this calculation on the sector size that aligns with the data block size that your operating system uses for virtual memory.
2. Set the parameter by using the `fio-config` command-line utility (see [fio-config on page 46](#) for the full utility instructions):

```
fio-config -p PREALLOCATE_MB <value>
```

Where `<value>` is the amount of system memory in MB that the Fusion ioMemory VSL software should preallocate for **every** Fusion ioMemory device that is enabled for preallocation. For example, if you entered a value of 3500, then the Fusion ioMemory VSL software will preallocate about 3.5GB of RAM for every Fusion ioMemory device that is enabled for preallocation in that system.

ATTENTION!

In order for the preallocation of memory to be effective, this value should be larger than the default memory usage of the device (as reported by running `fio-status -a`).

Discard (TRIM) Support

With this version of the Fusion ioMemory VSL software, Discard (also known as TRIM) is enabled by default.



Discard addresses an issue unique to solid-state storage. When a user deletes a file, the device does not recognize that it can reclaim the space. Instead the device assumes the data is valid.

Discard is a feature on newer filesystem releases. It informs the device of logical sectors that no longer contain valid user data. This allows the wear-leveling software to reclaim that space (as reserve) to handle future write operations.

ATTENTION!

Windows does not support TRIM with a RAID 5 configuration.

TRIM on Windows Server 2008 R2 and Newer

Windows Server 2008 R2 and newer have built-in TRIM support. With these operating systems, Fusion ioMemory devices work with Windows TRIM commands by default.



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.



Setting NUMA Affinity

Servers with a NUMA (Non-Uniform Memory Access) architecture may require special installation instructions in order to maximize Fusion ioMemory device performance. This includes most multi-socket servers.

On some servers with NUMA architecture, during system boot, the BIOS will not associate PCIe slots with the correct NUMA node. Incorrect mappings result in inefficient I/O handling that can significantly degrade performance. To prevent this, you must manually assign Fusion ioMemory devices optimally among the available NUMA nodes.

See [NUMA Configuration on page 78](#) for more information on setting this affinity.

Setting the Interrupt Handler Affinity

Device latency can be affected by placement of interrupts on NUMA systems. We recommend placing interrupts for a given device on the same NUMA node that the application is issuing I/O from. If the CPUs on this node are overwhelmed with user application tasks, in some cases it may benefit performance to move the the interrupts to a remote node to help load-balance the system.

Many operating systems will attempt to dynamically place interrupts across the nodes, and generally make good decisions.

Windows IRQ Policy

By default, Windows uses a policy of `IrqPolicyAllCloseProcessors` and a priority of `IrqPriorityNormal`, which should work best for most applications.

If manual tuning is needed, Windows provides the Interrupt Affinity Policy Tool. Information on this tool can be found at: <http://msdn.microsoft.com/en-us/windows/hardware/gg463378>. The settings that the application changes are listed at: [http://msdn.microsoft.com/en-us/library/ff547969\(v=vs.85\).aspx](http://msdn.microsoft.com/en-us/library/ff547969(v=vs.85).aspx).

With Windows Server 2008 or newer on a machine with more than 64 logical processors, there's an additional GroupPolicy parameter that can be set through the registry in order to set the affinity to a different processor group. This is documented at: <http://msdn.microsoft.com/en-us/windows/hardware/gg463349>.



Monitoring and Managing Devices

Dell | 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

Dell | 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

These stand-alone tools do not require any additional software.

- **Command-line Utilities:** These utilities are installed with the ioMemory VSL software and are run manually in a terminal. 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 43](#) for full details.
- **Dell ioSphere software:** The GUI browser-based Dell ioSphere software allows you to monitor and manage every Fusion ioMemory device installed in multiple hosts across your network. It collects all of the alerts for all Fusion ioMemory devices and displays them in the Alert Tab. You may also set up the Dell ioSphere software to send email or SMS messages for specific types of alerts or all alerts. The Dell ioSphere software packages and documentation are available as separate downloads.

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).

- **SNMP Subagent:** The Dell | SanDisk SNMP AgentX subagent allows you to monitor and manage your Fusion ioMemory devices using the Simple Network Management Protocol. You can use a normal SNMP browser, or customize your existing application to interface with the subagent.
- **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.

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 *Dell 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 *Dell 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 69](#).

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.

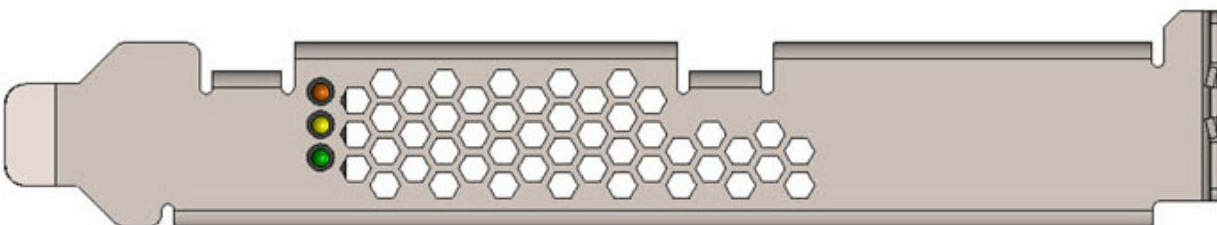
Device LED Indicators

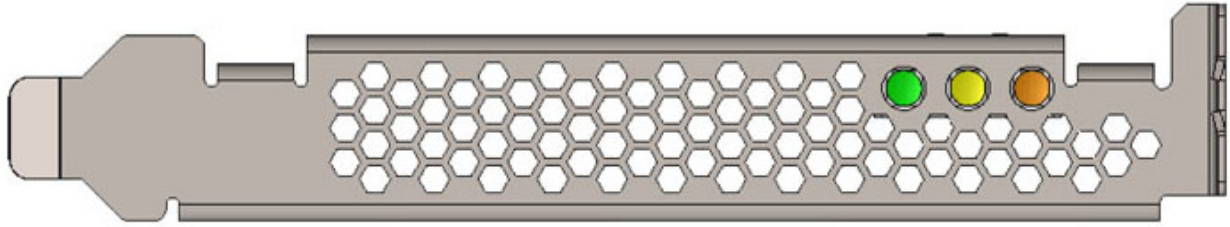
If you have physical access to the devices and depending on your device configuration, you can use the LED indicator(s) on the bracket to monitor their status.

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.

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>fio-beacon</code> utility to initiate this behavior.



Maintenance

This section explains additional software maintenance functions not covered in the sections [Configuration on page 18](#) and [Monitoring and Managing Devices on page 31](#).

Uninstalling the Software

To uninstall the Fusion ioMemory VSL software,

1. Go to **Start > Control Panel**.
2. Click **Programs & Features**.
3. Select the **Fusion ioMemory VSL** entry.
4. Click **Uninstall**.

Windows uninstalls the Fusion ioMemory VSL software folder along with all files and folders.

Upgrading the Software with a RAID Configuration

ATTENTION!

Be sure to read the *Dell Fusion ioMemory VSL Release Notes* document that comes with each new release as well as these installation instructions to ensure no loss of data when performing upgrades.

To upgrade the Fusion ioMemory VSL software with a RAID configuration in place:

1. Shut down any applications that are accessing the Fusion ioMemory devices.
2. Open the Fusion ioMemory VSL utilities folder. (The default location for this release is C:\Program Files\Common Files\VSL Utils.)
3. Use the `fio-config` utility to disable auto attach. For example:

```
fio-config -p AUTO_ATTACH 0
```

Your Fusion ioMemory device will no longer automatically attach the next time you restart the computer.

4. Uninstall the Fusion ioMemory VSL software in **Windows Add/Remove Programs**.
5. Restart the computer.
6. Download the latest Fusion ioMemory VSL software package from <http://dell.fusionio.com> .
7. Unzip and install the Fusion ioMemory VSL software. While finishing installation, click the "No" button to select a manual restart.
8. Open the Fusion ioMemory VSL utilities folder. (The default location is C:\Program Files\Common



Files\VSL Utils)

9. Use the `fio-config` utility to re-enable auto attach. For example:

```
fio-config -p AUTO_ATTACH 1
```

Your Fusion ioMemory device will now automatically attach the next time you restart the computer.

10. Update the firmware of the devices. Follow the steps in [Upgrading the Firmware on page 16](#).

NOTE-

Restart the computer after the firmware upgrade is complete. The Fusion ioMemory VSL Check Utility will run at next boot.

Windows now detects your devices in the RAID configuration with the upgraded software.

Defragmentation

The Fusion ioMemory device does not need to be defragmented. Some versions of Windows, however, run defragmentation as a scheduled task automatically. If necessary, you should turn off automatic defragmentation.

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). To do so:

NOTE-

You can also use the Dell ioSphere software to enable or disable auto-attach. See the Dell ioSphere software documentation for more information.

1. Open the command-line interface with Administrator permissions.
2. Run the following command:

```
fio-config -p AUTO_ATTACH 0
```

- a. See [fio-config on page 46](#) for more information on setting parameters.

Once you restart your system, your Fusion ioMemory device will no longer automatically attach until you re-enable auto attach (see [Enabling Auto-Attach on page 38](#))

When you finish troubleshooting the Fusion ioMemory VSL software issue, use the `fio-attach` utility or the Dell ioSphere software to attach the Fusion ioMemory device(s) and make them available to Windows.



Enabling Auto-Attach

To re-enable auto-attach after disabling it using the method described in [Disabling Auto-Attach]:

1. Open the command-line interface with Administrator permissions.
2. Run the following command:

```
fio-config -p AUTO_ATTACH 1
```

See [fio-config on page 46](#) for more information on setting parameters.

The next time you restart your Windows system, your Fusion ioMemory device will automatically attach.

Unmanaged Shutdown Issues

Unmanaged shutdown due to power loss or other circumstances can force the Fusion ioMemory device to perform a consistency check during restart. This may take several minutes or more to complete and is shown by a progress percentage during Windows startup.

You can cancel this consistency check by pressing Esc during the first 15 seconds after the "Fusion Consistency Check" message appears at the prompt. If you choose to cancel the check, however, the Fusion ioMemory device(s) will remain unavailable to users until the check is done. (You can perform this check later on using Dell ioSphere software's Attach function).

Although data written to the Fusion ioMemory device will not be 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 or ioSphere 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 [fio-config on page 46](#).

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 4,000 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):

```
400GB * 1000MB/GB * 1000KB/MB * 2 Blocks/kB = 800,000,000 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 Blocks * 4.008B/Block * 1KiB/1024B * 1MiB/1024KiB =  
~3058MiB 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 [fio-config on page 46](#) 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 `fio-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):

$$1200\text{GB} * 1000\text{MB/GB} * 1000\text{KB/MB} * 2 \text{ Blocks/kB} = 2,400,000,000 \text{ Blocks}$$

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):

$$2,400,000,000 \text{ Blocks} * 1 \text{ Write Extent}/32 \text{ Blocks} = 150,000,000 \text{ Writes}$$

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:

$$150,000,000 \text{ Writes} * 32\text{B/Write} * 1\text{KiB}/1024\text{B} * 1\text{MiB}/1024\text{KiB} = \sim 4578\text{MiB of RAM}$$



- 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 [fio-config on page 46](#) for more information on setting parameters.



Appendix A - Command-line Utilities Reference

The Fusion ioMemory VSL software installation packages include various command-line utilities, installed by default in `C:\Program Files\Common Files\VSL Utils`. These provide a number of useful ways to access, test, and manipulate your device.

ATTENTION!

Unified Utilities. If you plan to use the 4.2.1 (or later) utilities (Unified Utilities) on a VSL 3.2.15 server, please refer to the 3.2.15 *Dell Fusion ioMemory VSL Release Notes* for information on which 3.2.15 operating systems can use Unified Utilities, and for differences between the 3.2.15 and 4.2.1 (or later) utilities.

ATTENTION!

There are some additional utilities installed in the `C:\Program Files\Common Files\VSL Utils` 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.

NOTE-

Administrator Rights: The command-line utilities require administrator rights in order to run under Windows (right-click the **Command Prompt** menu item and select **Run as administrator**.)

To run these utilities from a command line, you must either change to the directory which contains them (by default, `C:\Program Files\Common Files\VSL Utils`) or add that directory to your system path. As a convenience, if you used the Windows installer then the utilities directory has been added to the system path for you. Otherwise, see the documentation for your version of Windows for information about adding a directory to the system path.

Utility	Purpose
fio-attach	Makes a Fusion ioMemory device available to the OS.
fio-beacon	Lights the Fusion ioMemory device's external LEDs.
fio-bugreport	Prepares a detailed report for use in troubleshooting problems.
fio-config	Enables configuration parameters for device operation.
fio-detach	Temporarily removes a Fusion ioMemory device from OS access.



Utility	Purpose
fio-format	Used to perform a low-level format of a Fusion ioMemory device.
fio-pci-check	Checks for errors on the PCI bus tree, specifically for Fusion ioMemory devices.
fio-status	Displays information about the device.
fio-sure-erase	Clears or purges data from the device.
fio-update-iodrive	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. This creates a block device in `/dev` named `fiox` (where `x` is `a`, `b`, `c`, etc.). You can then partition or format the Fusion ioMemory device, or set it up as part of a RAID array. 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.

You can specify multiple Fusion ioMemory devices. For example, `/dev/fct1 /dev/fct2` indicates the second and third Fusion ioMemory devices installed on the system.



Option	Description
-r	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.
-c	Attach only if clean.
-q	Quiet: disables the display of the progress bar and percentage.

fio-beacon

Description

Lights the Fusion ioMemory device's LED(s) to locate the device.

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 <http://support.dell.com> for assistance in troubleshooting.



`fio-bugreport` runs several information-gathering utilities and combines the resulting data into a text file. The results are saved in the `utils` directory (default installation path is `C:\Program Files\Common Files\VSL Utils`) in a `.cab` file that indicates the date and time the utility was run.

Sample Output

```
C:\Program Files\Common Files\VSL Utils\fio-bugreport.exe
Generating bug report. Please wait, this may take a while...
-----
Gathering all Windows Event Logs...DONE
Gathering Fusion Windows Event Logs...DONE
Gathering System Information...DONE
Running fio utilities...DONE
Compressing to CAB file...DONE
Bug report has successfully been created:
fio-bugreport-20090921_173256.cab.
  Please attach this file to your support case.
  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 `fio-bugreport-20090921_173256.cab` indicates the following:

- Date (20090921)
- Time (173256, or 17:32:56)

fio-config

Description

Sets and gets Fusion ioMemory VSL software configuration parameters for device operation. For a list of parameters, see **Parameters Reference** below.

In order for the parameter value(s) to be enforced, you must either reboot the system or first disable and then re-enable all Fusion ioMemory devices in the **Device Manager**. This will reload the Fusion ioMemory VSL software with the values(s) enabled. Be sure to use the `-p` option if you plan to reboot.

Syntax

```
fio-config [options] [<parameter>] [<value>]
```

where `<parameter>` is the Fusion ioMemory VSL software parameter you wish to set, and `<value>` is the value you wish to set for the parameter.

Options	Description
<code>-e</code>	Enumerate configuration parameter names and values.



Options	Description
-g <name>	Get the configuration parameter.
-p <name>	Set and make the configuration parameter persistent. Use this option if you want the parameter setting to remain after a reboot.
-s <name>	Set the configuration parameter in memory only.
-V	Print verbose information.
-v	Print version information.

Parameters Reference

The following table describes the Fusion ioMemory VSL software parameters you can set with the `fio-config` utility.

ATTENTION!

`fio-config` parameters (listed in the table below) must be entered in uppercase to function properly.

MSI (Message Signaled Interrupts) is enabled by default for this platform, and it cannot be disabled using `fio-config`.

Other than `FIO_PREALLOCATE_MEMORY` and `FIO_EXTERNAL_POWER_OVERRIDE`, all `fio-config` parameters are global—they apply to all Fusion ioMemory devices in the computer.

ATTENTION!

By setting the `FIO_PREALLOCATE_MEMORY` and `FIO_EXTERNAL_POWER_OVERRIDE` parameter, you **overwrite previous values**. If you wish to add additional serial numbers to the list, you must list the new serial numbers as well as the previously entered numbers. To clear the list, set the parameter without any values.

Parameter	Default (min/max)	Description
AUTO_ATTACH	1 (0, 1)	Always attach the device on driver load (1).
IODRIVE_TINTR_HW_WAIT	0 (0, 255)	Interval (microseconds) to wait between hardware interrupts.



Parameter	Default (min/max)	Description
FIO_EXTERNAL_POWER_OVERRIDE	No devices selected	<p>Allows designated device(s) to draw the specified amount (s) of power in Watts from the PCIe slot. Where the <SN-value>:<W-value> for this parameter is a comma-separated list of value pairs with adapter serial numbers and the maximum amount of power each device should pull (in Watts).</p> <hr/> <p>ATTENTION!</p> <p>You can use a serial number wildcard (*) to set this module parameter for all cards in the system. Use with care, see Enabling PCIe Power Override on page 18 for more information.</p> <hr/>
FORCE_MINIMAL_MODE	0 (0, 1)	Force minimal mode on the device (1), this parameter is set to false (0) by default.
PARALLEL_ATTACH	0 (0, 1)	Enable parallel attach of multiple devices (1), this parameter is set to false (0) by default.
FIO_PREALLOCATE_MEMORY	0	<p>For the selected device(s), pre-allocate all memory necessary to have the device usable as swap space. For example:</p> <div><pre>fio-config /dev/fct0 -p FIO_PREALLOCATE_MEMORY "1234,54321"</pre></div> <p>where "1234" and "54321" are serial numbers obtained from fio-status.</p>



Parameter	Default (min/max)	Description
WIN_LOG_VERBOSE	1 (0, 1)	<p>Enabled (1) by default, the Fusion ioMemory VSL software will write additional messages to the event log. This will assist Customer Support in troubleshooting any device issues or failures.</p> <hr/> <p>NOTE- To disable verbose logging, set this parameter value to (0)</p> <hr/>
WIN_DISABLE_ALL_AFFINITY	0 (0, 1)	<p>When WIN_DISABLE_ALL_AFFINITY is set to 0, the driver will enable interrupt and worker thread affinity in the driver. When WIN_DISABLE_ALL_AFFINITY is set to 1, the driver will disable all affinity settings. This is an override of any other affinity settings. The driver must be reloaded for this parameter to take effect.</p>



Parameter	Default (min/max)	Description
WIN_DISABLE_DEFAULT_NUMA_AFFINITY	0 (0, 1)	<p>When WIN_DISABLE_DEFAULT_NUMA_AFFINITY is set to 0, during initialization, the driver will query Windows for the affinity settings assigned to the adapter by the OS. This is what is known as the "default NUMA affinity". Once the affinity is queried correctly, the driver sets the affinity of the adapter's interrupt and associated worker threads to the default OS setting. This generally has the effect of setting the affinity of the interrupt and worker threads to all processors on a single NUMA node in the system. When WIN_DISABLE_DEFAULT_NUMA_AFFINITY is set to 1, the driver will ignore the affinity settings assigned to the adapter by the OS. The driver must be reloaded for this parameter to take effect.</p>
FIO_AFFINITY	N/A	<p>FIO_AFFINITY is a list of <affinity specification> triplets to specify the affinity settings of all adapters in the system. Each item in the triplet is separated by a comma, and each triplet set is separated by a semicolon.</p> <hr/> <p>ATTENTION!</p> <p>For syntax information and examples showing the use of this parameter, see NUMA Configuration on page 78.</p> <hr/>



Parameter	Default (min/max)	Description
WIN_SCSI_BUS_ID	0 (0, 254)	<p>This parameter sets the Windows SCSI ID number for all Fusion ioMemory devices in the system to avoid conflicts with other SCSI device IDs. The default value, 0, is off and no IDs are set. Any value between 1–254 will set the SCSI IDs for all Fusion ioMemory devices in the system to that number.</p> <hr/> <p>NOTE-</p> <p>Fusion ioMemory devices do not directly use SCSI IDs, so any non-conflicting number will do.</p>

fio-detach

Description

Detaches the Fusion ioMemory device and removes the corresponding `fctx` Fusion ioMemory device block device from the OS. The `fio-detach` utility waits until the device completes all read/write activity before executing the detach operation. By default, the command also displays a progress bar and percentage as it completes the detach.

ATTENTION!

Before using this utility, ensure that the device you want to detach is **NOT** currently mounted and in use.

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.

You can specify multiple Fusion ioMemory devices. For example, `/dev/fct1 /dev/fct2` indicates the second and third Fusion ioMemory devices installed on the system. You can also use a wildcard to indicate all Fusion ioMemory devices on the system. For example, `/dev/fct*`



Option	Description
<code>-f</code>	<p>Force: Causes an immediate detach (does not save metadata).</p> <hr/> <p>ATTENTION!</p> <p>Although the <code>-f</code> (force) option causes the Fusion ioMemory device to detach, even in a RAID setup, it is strongly recommended to take the drives/volume offline using the Windows Disk Management plug-in, then perform the detach. Forcing the detach may result in loss of data.</p> <hr/>
<code>-q</code>	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 part of a software RAID (0,1,5) volume, is mounted, or some process has the device open.

Windows refuses the request to detach the drive associated with the Fusion ioMemory device because it is part of a RAID volume and may cause the volume to fail. This does not occur with simple volumes (such as a single Fusion ioMemory device). To detach in this case, take the volume offline using the Disk Management MMC plug-in application.

fio-format

Description

NOTE-

Fusion ioMemory devices ship pre-formatted, so `fio-format` is generally not required except to change the logical size or block size of a device, or to erase user data on a device. To ensure the user data is truly erased, use `fio-sure-erase`, see [fio-sure-erase on page 57](#) for more information.

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-

Using a larger block (sector) size, such as 4096 bytes, can significantly reduce worst-case Fusion ioMemory VSL host memory consumption. However, some applications are not compatible with non-512-byte sector sizes.



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
<code>-b <size B K></code>	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).
<code>-f</code>	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.)
<code>-q</code>	Quiet mode: Disable the display of the progress-percentage indicator.
<code>-s <size M G T %></code>	Set the device capacity as a specific size (in TB, GB, or MB) or as a percentage of the advertised capacity: <ul style="list-style-type: none">• <code>T</code> Number of terabytes (TB) to format• <code>G</code> Number of gigabytes (GB) to format• <code>M</code> Number of megabytes (MB) to format• <code>%</code> Percentage, such as 70% (the percent sign must be included)
<code>-o <size B K M G T %></code>	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.) <div>ATTENTION! Before you use this option, please discuss your use case with Customer Support.</div>
<code>-R</code>	Disable fast rescan on unclean shutdown to reclaim some reserve capacity.
<code>-y</code>	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 44](#) 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.

WARNING!

The Fusion ioMemory VSL software must be loaded to run this utility. Some PCI errors cannot be reset in Windows.

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 administrator 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 <code>-a</code> 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 <code>-fj</code> or <code>-fx</code> .
-U	Show unavailable fields and details why. Only valid with <code>-fj</code> or <code>-fx</code> . NOTE- 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.
-F<field>	Print the value for a single field (see the next option for field names). Requires that a device be specified. Multiple <code>-F</code> options may be specified.
-l	List the fields that can be individually accessed with <code>-F</code> .

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-sure-erase

ATTENTION!

As a best practice, do not use this utility if there are any Fusion ioMemory devices installed in the system that you do not want to clear or purge. First remove any devices that you do not want to accidentally erase. Once the data is removed with this utility it is gone forever. **It is not recoverable.**

WARNING!

Before you use this utility, be sure to back up any data that you wish to preserve.

WARNING!

Do not interrupt `fio-sure-erase` (by issuing a forced kill command, or powering down or resetting the system)! Interrupting `fio-sure-erase` could cause the Fusion ioMemory device to become unusable.



ATTENTION!

If the device is in Read-only mode, perform a format using `fio-format` before running `fio-sure-erase`. If the device is in Minimal mode, then `fio-sure-erase` cannot erase the device. Updating the firmware may take the device out of Minimal Mode. If the device remains in Minimal mode, contact Customer Support at <http://support.dell.com> for further assistance.

In order to run `fio-sure-erase`, the block device **must be detached**. See [fio-detach on page 51](#) section for more information.

Description

The `fio-sure-erase` is a command-line utility that securely removes data from Fusion ioMemory devices.

Registry Requirement

On Windows, a registry key must be created to configure the driver for ECC-bypass mode:

1. Locate the following key:

```
HKEY_LOCAL_
MACHINE\SYSTEM\CurrentControlSet\Services\fiodrive\Parameters
```

2. Create a DWORD key underneath it called "BypassECC" and set the value to "1".
3. Restart the computer before running the utility.

Syntax

```
fio-sure-erase [options] <device>
```

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. Use `fio-status` to view this device node, see [fio-status on page 54](#).

NOTE-

Products with Multiple Devices

`fio-sure-erase` works on individual Fusion ioMemory devices. For example, if you are planning to purge a Fusion ioMemory ioDrive Duo device, you will need to perform this operation on each of the product's two Fusion ioMemory devices.



Option	Description
-p	<p>Purge instead of Clear: performs a write followed by an erase. For more information on Purge, see below.</p> <hr/> <p>ATTENTION!</p> <p>Purging the device may take hours to accomplish, depending on the size of the device that needs to be purged.</p> <hr/>
-y	No confirmation: do not require a yes/no response to execute the utility.
-t	Do not preserve current format parameters, including device and sector size (reset to default).
-q	Quiet: do not display the status bar.

NOTE-

If you run `fio-sure-erase` with no options, a Clear is performed. For more information, see below.

When the utility completes, each block of memory consists of uniform 1 bits or 0 bits.

Clear Support

A "Clear" is the default state of running `fio-sure-erase` (with no options), and refers to the act of performing a full low-level erase (every cell pushed to "1") of the entire NAND media, including retired erase blocks.

Metadata that is required for operation will not be destroyed (media event log, erase counts, physical bytes read/written, performance and thermal history), but any user-specific metadata will be destroyed.

The following describes the steps taken in the Clear operation:

1. Creates a unity map of every addressable block (this allows `fio-sure-erase` to address every block, including previously unmapped bad blocks).
2. For each block, performs an erase cycle (every cell is pushed to "1").
3. Restores the bad block map.
4. Formats the device (the purpose of this is to make the device usable again, the utility erases all of the headers during the clear).

Purge Support

A "Purge" is invoked by using the `-p` option with `fio-sure-erase`. Purge refers to the act of first overwriting the entire NAND media (including retired erase blocks) with a single character (every cell written to logical "0"), and then performing a full chip erase (every cell pushed to "1") across all media (including retired erase blocks).

Metadata that is required for operation will **not** be destroyed (media event log, erase counts, physical bytes read/written, performance and thermal history), but any user-specific metadata will be destroyed.

The following describes the steps taken in the Purge operation:



1. Creates a unity map of every addressable block (this allows `fio-sure-erase` to address every block, including previously unmapped bad blocks).
2. For each block, performs a write cycle (every cell written to "0").
3. For each block, performs an erase cycle (every cell pushed to "1").
4. Restores the bad block map.
5. Formats the drive (the purpose of this is to make the drive usable again, the utility erases all of the headers during the clear).

fio-update-iodrive

ATTENTION!

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

Description

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 <http://support.dell.com> 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 `fio-firmware-dell_<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!

You must detach all Fusion ioMemory devices before updating the firmware.

ATTENTION!**Upgrade Path**

There is a specific upgrade path that you must take when upgrading Fusion ioMemory device. Consult the *Dell 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.

To update one or more specific devices:

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

Syntax

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

where <firmware-path> is the full path to the firmware archive file `fio-firmware-dell_<version>.<date>.fff` available at <http://dell.fusionio.com>. If you downloaded the .fff firmware archive file, then the firmware is most likely with the other downloaded packages.

Option	Description
<code>-d</code>	<p>Updates the specified devices (by <code>fctx</code>, where <code>x</code> is the number of the device shown in <code>fio-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/>
<code>-f</code>	<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/>
<code>-l</code>	<p>List the firmware available in the archive.</p>



Option	Description
-p	Pretend: Shows what updates would be done. However, the actual firmware is not modified.
-c	Clears locks placed on a device.
-q	Runs the update process without displaying the progress bar or percentage.
-y	Confirm all warning messages.
--split	Split the Fusion ioMemory device into virtual devices.
--merge	Merge the virtual devices of a Fusion ioMemory device.

If you arrived at this section from [Upgrading the Firmware on page 16](#), you should return to that section.



Appendix B - Troubleshooting Event Log Messages

The Windows System Event Log displays the following messages concerning the Fusion ioMemory device: Informational, Warnings, and Errors.

NOTE-

Each Fusion ioMemory device is numbered from 0 upwards. Use the `fio-status` utility or Dell ioSphere software to view this number for your device.

ATTENTION!

While these messages are very useful for troubleshooting purposes, the Fusion ioMemory VSL 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 [Monitoring and Managing Devices on page 31](#) to regularly monitor your devices.

Verbose Event Log Parameter

If you begin experiencing issues with your Fusion ioMemory devices, you should enable the `WIN_LOG_VERBOSE` Fusion ioMemory VSL parameter. This will expand the extent of the Fusion ioMemory VSL error log messages in the event log and provide additional crucial information for troubleshooting any issues.

Sample Command:

```
fio-config.exe -p WIN_LOG_VERBOSE 1
```

For more information on enabling parameters, see [fio-config on page 46](#).

Viewing Logs

To open the Windows Event Viewer,

1. Click **Start**.
2. Click **Computer** and right-click **Manage**.
3. Expand **Diagnostics**.
4. Expand **Event Viewer**.
5. Expand **Windows Logs**.
6. Select **System**.



Error Messages

The following are common Event Log error messages, along with suggested solutions:

Message	Suggested Solution
Error: ioDrive(x) firmware is too old. The firmware must be updated.	Follow the instructions in Upgrading the Firmware on page 16 to update the firmware.
Error: ioDrive initialization failed with error code 0xerrorcode*	<ol style="list-style-type: none">1. Reinstall the Windows ioMemory VSL.2. Remove and reseal the Fusion ioMemory device.3. Remove and insert the Fusion ioMemory device in a different PCIe slot.
Error: ioDrive was not attached. Use the fio-attach utility to rebuild the drive.	This error may appear after an unmanaged shutdown. You can use either the [fio-attach] command-line utility or Dell ioSphere software to re-attach the device. This attach process may take up to ten minutes as the utility performs a consistency check on the device(s).
Warning: ioDrive was not loaded because auto-attach is disabled.	<p>The Fusion ioMemory device must attach to the Windows operating system to be available to users and applications. (This attach normally occurs at boot time.) As part of this attach process, the ioMemory VSL checks to see if there is an AutoAttach parameter in the Windows registry. If you create this Registry parameter to disable auto-attach, the attach operation does not complete.</p> <p>To attach an unattached device,</p> <ol style="list-style-type: none">1. Run the Dell ioSphere software.2. Select your unattached Fusion ioMemory device from the Device Tree.3. Click Attach.4. Confirm the Attach operation. <p>Your device now attaches to the Windows operating system. To re-enable Auto-Attach at boot time, refer to Enabling Auto-Attach on page 38.</p>

* Where 0xerrorcode is one of the error codes in the table below, or one of the 43 standard Windows "errno" definitions found at <http://msdn.microsoft.com/en-us/library/t3ayayh1%28v=vs.110%29.aspx>.

Error Code	Description
0xFFFFFC00	Uncorrectable ECC Error
0xFFFFFBFF	Uncorrectable ECC Error



0xFFFFFBFE	Invalid Media Format
0xFFFFFBFD	Unknown Error

ATTENTION!

The error code is converted to a negative number, and then reported in hexadecimal format. For example, `errno=1` is converted to `-1` and is represented as `0xFFFFFFFF`, and `errno=1024` is converted to `-1024` and is represented as `0xFFFFFC00`.

Informational Messages

The following is a common Event Log informational message:

Message	Additional Information
Affinity not set for ioMemory VSL device fct119 because either <code>WIN_DISABLE_ALL_AFFINITY</code> is set to true or "SetWorkerAffinity119" does not exist in the registry and <code>WIN_DISABLE_DEFAULT_NUMA_AFFINITY</code> is set to true.	<p>When <code>WIN_DISABLE_ALL_AFFINITY</code> is set to 0, the driver will enable interrupt and worker thread affinity in the driver.</p> <p>When <code>WIN_DISABLE_ALL_AFFINITY</code> is set to 1, the driver will disable all affinity settings. This is an override of any other affinity settings.</p> <p>Refer to fio-config on page 46 for more information about affinity settings.</p>



Appendix C - Manual Installation

The Windows Setup program will install Fusion ioMemory VSL software on your Windows operating system. However, there are some instances where you may need to manually install the software for a particular Fusion ioMemory device, including:

- After a software installation (including upgrade), Fusion ioMemory devices don't show up in `fio-status`.
- You install new Fusion ioMemory devices on a system that has previously installed Fusion ioMemory devices and Fusion ioMemory VSL software.

Follow the steps below for Windows Server 2008. This will ensure that the Fusion ioMemory VSL software is installed for a particular device. Repeat the steps for each device, if needed.

Manual Install on Windows Server 2008 and 2012

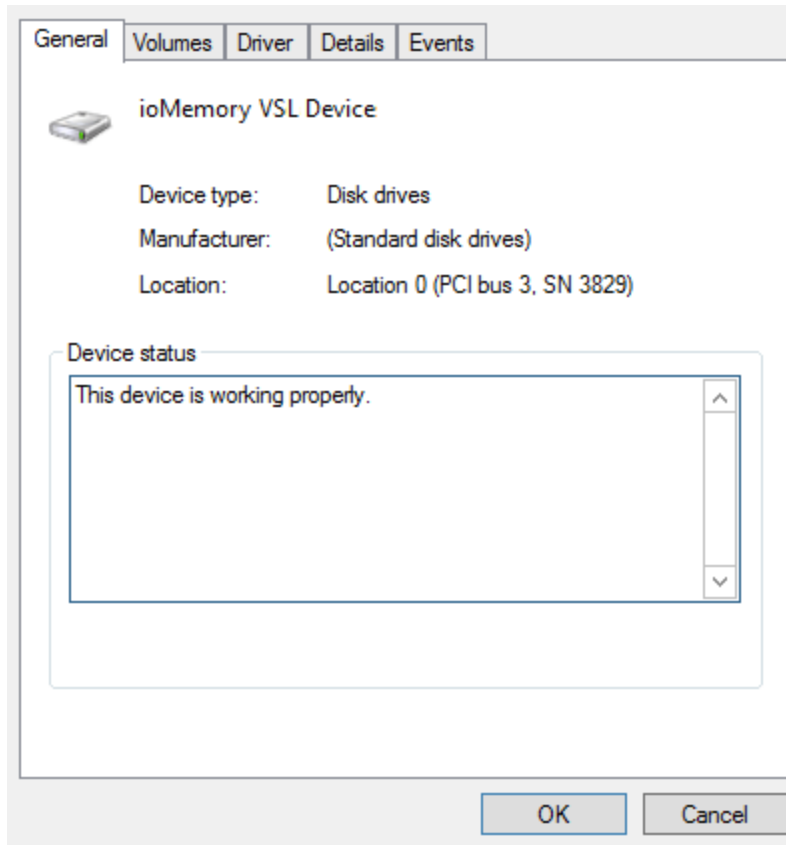
Before you manually install the Fusion ioMemory VSL software, make sure you have downloaded and run the Fusion ioMemory VSL Windows Setup program from <http://dell.fusionio.com>. This will install the Fusion ioMemory VSL software on the system, and you will now be able to install the Fusion ioMemory VSL software for each Fusion ioMemory device.

The Windows Driver Wizard may automatically detect the new Fusion ioMemory device and starts to locate its Fusion ioMemory VSL software after you restart the system. If this happens, you may skip to the Installation Wizard procedure below.

1. Launch the Device Manager.
 - In Windows Server 2008, choose **Start > Control Panel > Device Manager**.
 - In Windows Server 2012, from the **Server Manager** select **Tools** (in the upper right) > **Computer Management > Device Manager**.
2. Select **Fusion ioMemory VSL devices**.
3. Click on your Fusion ioMemory device(s) in the list. The Properties dialog box appears.

ATTENTION!

The device may be titled `Mass Storage Controller`.

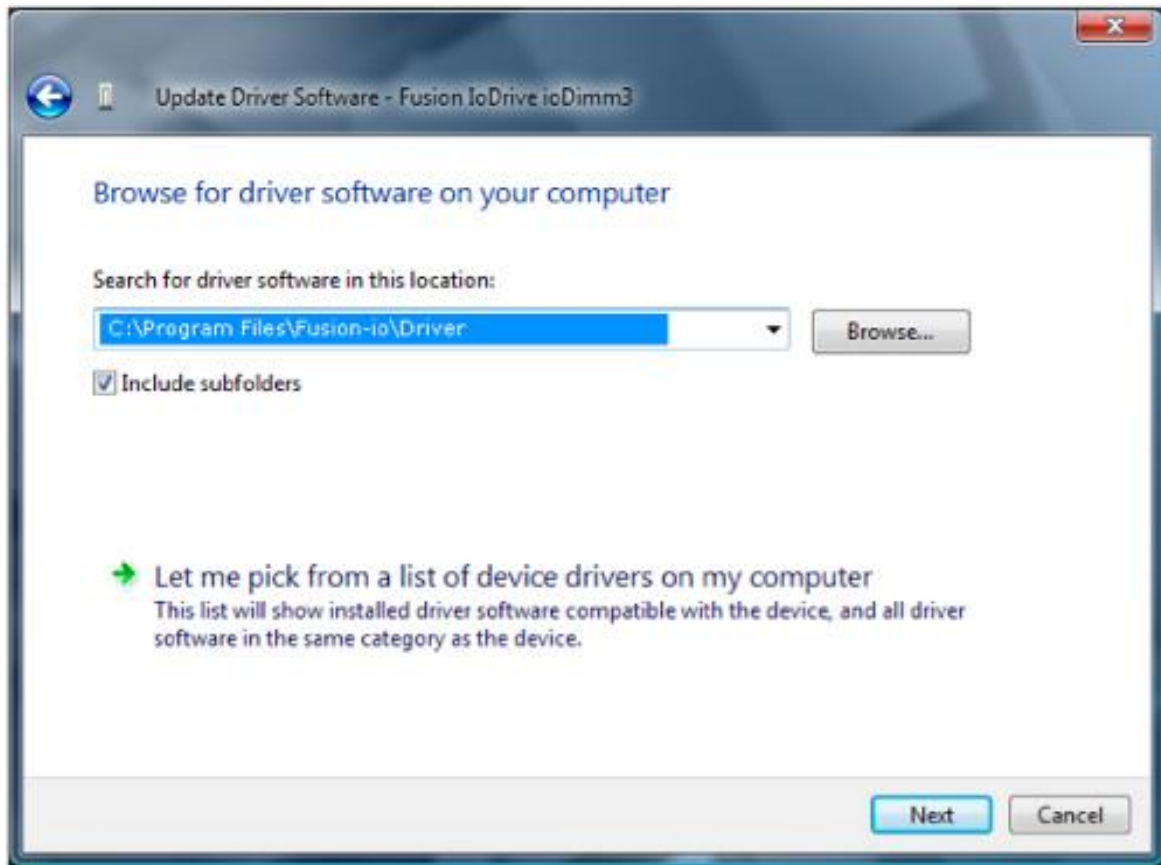


- a. If the **Device Status** reads `This device is working properly`, then the Fusion ioMemory VSL software has been installed.
 - b. If the device is not working correctly, you will need to manually install the software for that device. Continue with the manual installation.
4. Close the Properties dialog box.
5. Right-click on the device and choose **Update Driver**.
6. Follow the instructions below.



Installation Wizard

1. Windows will ask you to locate the software driver.



2. Click **Browse** next to the path field. Windows displays a file dialog.
3. Select the folder with the Fusion ioMemory VSL software (the default is C:\Program Files\Dell IO Management\<VSL-Version>\Driver).
4. Click **OK**.
5. Click **Next**.
Windows finds the correct software and installs the device software. When the driver installation completes,
6. Restart the computer.
7. Proceed to [Upgrading the Firmware on page 16](#) to continue.



Appendix D - 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 Dell 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 69](#) 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 <http://support.dell.com>.

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 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

Dell 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 E - Using the Windows Page Files

Introduction

This appendix describes how to effectively use paging (also called swap or Virtual Memory) files on Fusion ioMemory devices with Windows.

Using a page file with a traditional disk drive places practical limits on the usable size of the page file and virtual memory, due to the poor performance of disk drives in relation to RAM. Placing the OS paging file on one or more Fusion ioMemory devices allows much larger page files and usable virtual memory. This is due to the much faster response times and bandwidth on Fusion ioMemory devices versus hard disks.

Configuring Device Paging Support

The Fusion ioMemory VSL software can be configured to support paging files on one or more Fusion ioMemory devices. This requires that each Fusion ioMemory device used with a paging file pre-allocates the worst-case amount of memory it may need in any possible I/O scenario. This is done on a device instance.

Because of the extra host RAM memory use, paging should be enabled only on Fusion ioMemory devices that will actually hold a paging file. It is possible to place a single paging file on more than one Fusion ioMemory device. In this case Windows will stripe paging I/O across all available paging files, possibly providing additional performance to the Virtual Memory (VM) subsystem.

Fusion ioMemory VSL RAM Consumption

The amount of RAM pre-allocated per Fusion ioMemory device depends on the device's total size and the sector (block) size selected when formatting the drive (with `fio-format`).

NOTE-

Consult the Release Notes for this version of the software for RAM usage per GB of Fusion ioMemory device.

Using a larger sector size significantly reduces the amount of host memory consumption needed for paging support. It is recommended that a 4K sector size be used because a) that is generally the natural size of a host memory page, and b) it minimizes overall host memory consumption. In Windows, NTFS will generally use a cluster size of 4K, so formatting to 512 is not useful except for applications that compatible only with 512-byte sector sizes.

The indicated amount is needed per Fusion ioMemory device that supports paging. You must carefully plan which Fusion ioMemory device(s) will be used to hold a paging file.

Non-paged Memory Pool

Pre-allocated memory for the Fusion ioMemory device comes from the Windows kernel non-paged memory pool. This pool dynamically grows as system components consume additional kernel memory. The maximum size of this



pool is restricted to 75% of RAM up to a maximum of 128GB.

The amount of in-use, non-paged pool memory should be noted when planning page file usage. This is because the Fusion ioMemory device pre-allocates RAM, and that reduces the available physical non-paged memory. The Fusion ioMemory VSL software will fail to load if the total pre-allocated memory plus the in-use, non-paged memory exceeds the maximum non-paged memory pool.

To determine the total non-paged memory pool use for two Fusion ioMemory devices, let's use the following example:

- One Fusion ioMemory device that requires 850 MB of RAM, and the other requires 1700 MB of RAM.

NOTE-

Consult the *Dell Fusion ioMemory VSL Release Notes* for this version of the Fusion ioMemory VSL software for RAM requirements.

- Both are formatted with a 4K sector size
- Both will support paging files

The current allocated non-paged pool is obtained from Task Manager and, in this example, has a value of 576 MiB. (Values shown in Task Manager are in MiB \[1024x1024 = 1 MiB\]). The total RAM on the system is 8000 MB and the OS is Server 2008 R2.

First, convert the 576 MiB into MB: $576 \text{ MiB} * (1 \text{ MB} / 1.048576 \text{ MiB}) = \sim 549 \text{ MB}$

To calculate the total available non-paged pool, use the following formula:

$$(8000 \text{ MB} \times 0.75) - 549 - 850 - 1700$$

which still leaves 2901 MB available for the non-paged pool.

Enabling/Disabling Paging Support

Memory pre-allocation occurs during Fusion ioMemory VSL software initialization. To enable paging support, you must enable the `FIO_PREALLOCATE_MEMORY` configuration item. This can be done using the `fio-config` command-line utility. This parameter is assigned a string with a list of decimal serial numbers of the Fusion ioMemory devices that will support a paging file. The Fusion ioMemory VSL software performs memory pre-allocation for those instances.

Below is an example of using the `fio-config` utility to enable paging and pre-allocation on two Fusion ioMemory devices with serial numbers 1234 and 17834. Serial number information can be obtained using the `fio-status` utility.

```
fio-config -p FIO_PREALLOCATE_MEMORY "1234,17834"
```

To disable paging support on all devices, use a value of 0 for `FIO_PREALLOCATE_MEMORY`:

```
fio-config -p FIO_PREALLOCATE_MEMORY "0"
```




To query the current value, run this command:

```
fio-config -g FIO_PREALLOCATE_MEMORY
```

An alternate method to manage (enable or disable) paging support is to use the Dell ioSphere software.

NOTE-

You must reload the Fusion ioMemory VSL software for the new pre-allocation setting to take effect. Typically this can be done by restarting the machine or using disable/enable within Device Manager for each Fusion ioMemory device instance.

Also, using the Windows System Properties to change paging file configuration requires a system restart before the properties are applied. Therefore, you can change both `FIO_PREALLOCATE_MEMORY` and the system page file configuration and then apply both with a single restart.

Windows Page File Management

By default, the Fusion ioMemory VSL software disables support for page files. The previous section described how to enable support for page files on one or more Fusion ioMemory devices. The following describes how to work with the built-in Windows control panels to configure and set up paging files on Fusion ioMemory devices.

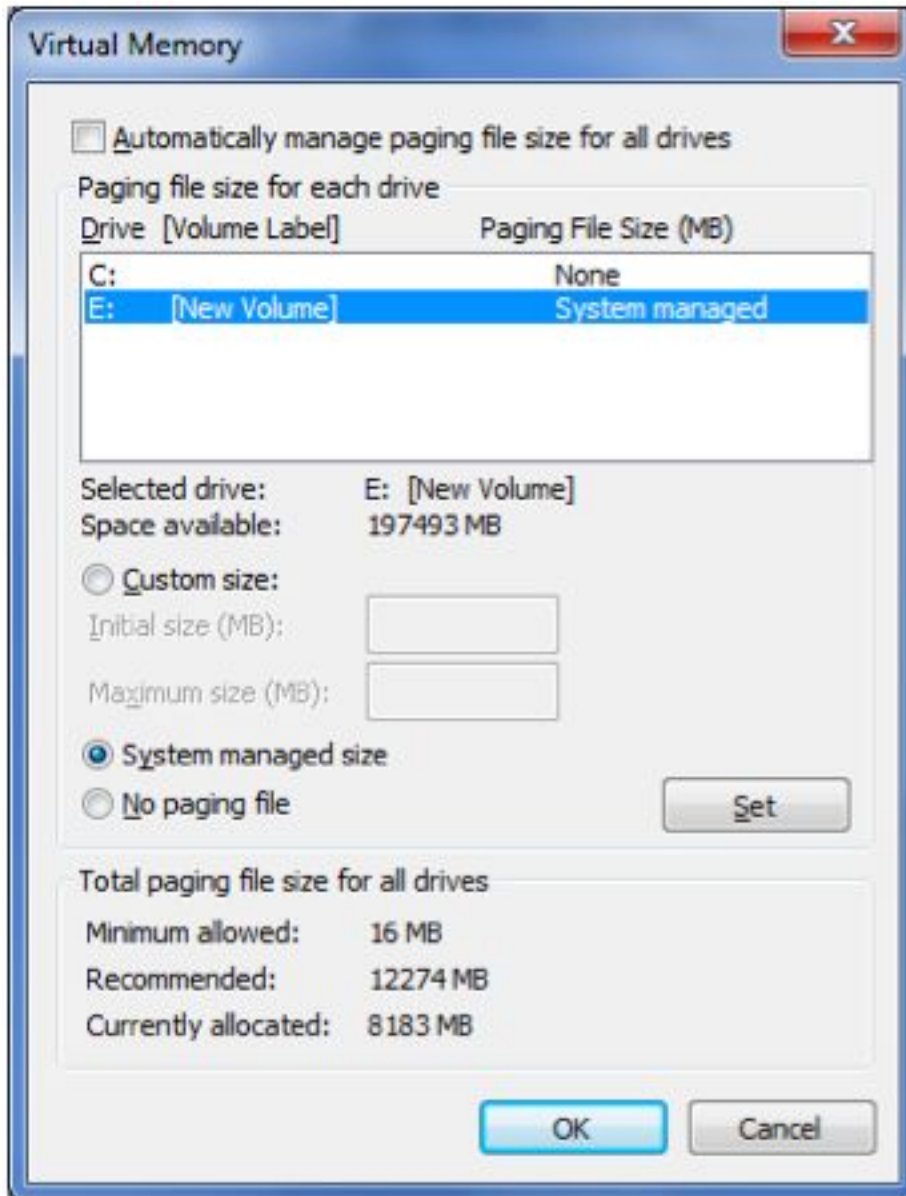
Setting Up Paging File(s)

To set up page files in Windows,

1. Go to **Control Panel** and double-click System.
2. Click **Advanced system settings** from the Task pane.
3. On the Advanced tab, click **Settings**. The Performance Options dialog opens.



4. On the Advanced tab, click **Change**. The Virtual Memory dialog opens.



Using this dialog, you can configure a page file for each available drive in the system. Selecting the "Automatically manage paging file size for all drives" checkbox causes Windows to create a single page file on the system drive, which is the drive the OS is started from. This checkbox should be cleared when using an Fusion ioMemory device with a paging file.

Windows supports up to 16 distinct paging files. To enable a page file on an Fusion ioMemory device,

1. Choose the Fusion ioMemory device from the device list.
2. Select the **Custom size** radio button.



3. Provide values in the **Initial size** and **Maximum size** fields.
4. When prompted to restart, click **Yes**. This is necessary for the new page file settings to take effect.
5. Click **Set** to save the setting. Do not omit this step, or your changes will be lost.
6. Click **OK**.

To remove a paging file on the drive, follow the steps earlier but select **No paging file**. For performance reasons, typically you will remove all paging files on any system hard disk.

NOTE-

The Virtual Memory dialog allows page files to be configured on available Fusion ioMemory devices, even if the Fusion ioMemory device has not been configured to support a page file. Even though the dialog allows enabling of the page file, following the required restart you'll notice that no page file was created on the device. Follow the directions earlier in this document to properly enable page file support on one or more Fusion ioMemory devices.

System Drive Paging File Configuration

By default Windows creates and manages a page file on the system boot drive (typically a hard disk), which is typically where Windows is installed. Keeping a regular page file on the system hard disk is generally not optimal, because the hard disk's I/O performance is many orders of magnitude slower than an Fusion ioMemory device. To remedy this, you can eliminate or minimize the size of the system boot drive page file, as explained later. Enabling page files on Fusion ioMemory devices (but not the system drive) improves Virtual Memory (VM) subsystem performance, as the VM manager stripes I/O across all available page files. Additionally, the Fusion ioMemory devices act as a very large memory store, which can greatly improve memory usage for large applications.

The Windows kernel uses the system disk page file to store crash dumps. Crash dumps may be small (mini-dumps) or large (full-kernel memory dumps). Typically, running without dump file support or with a small dump file is adequate. There are several possible system drive page file configurations:

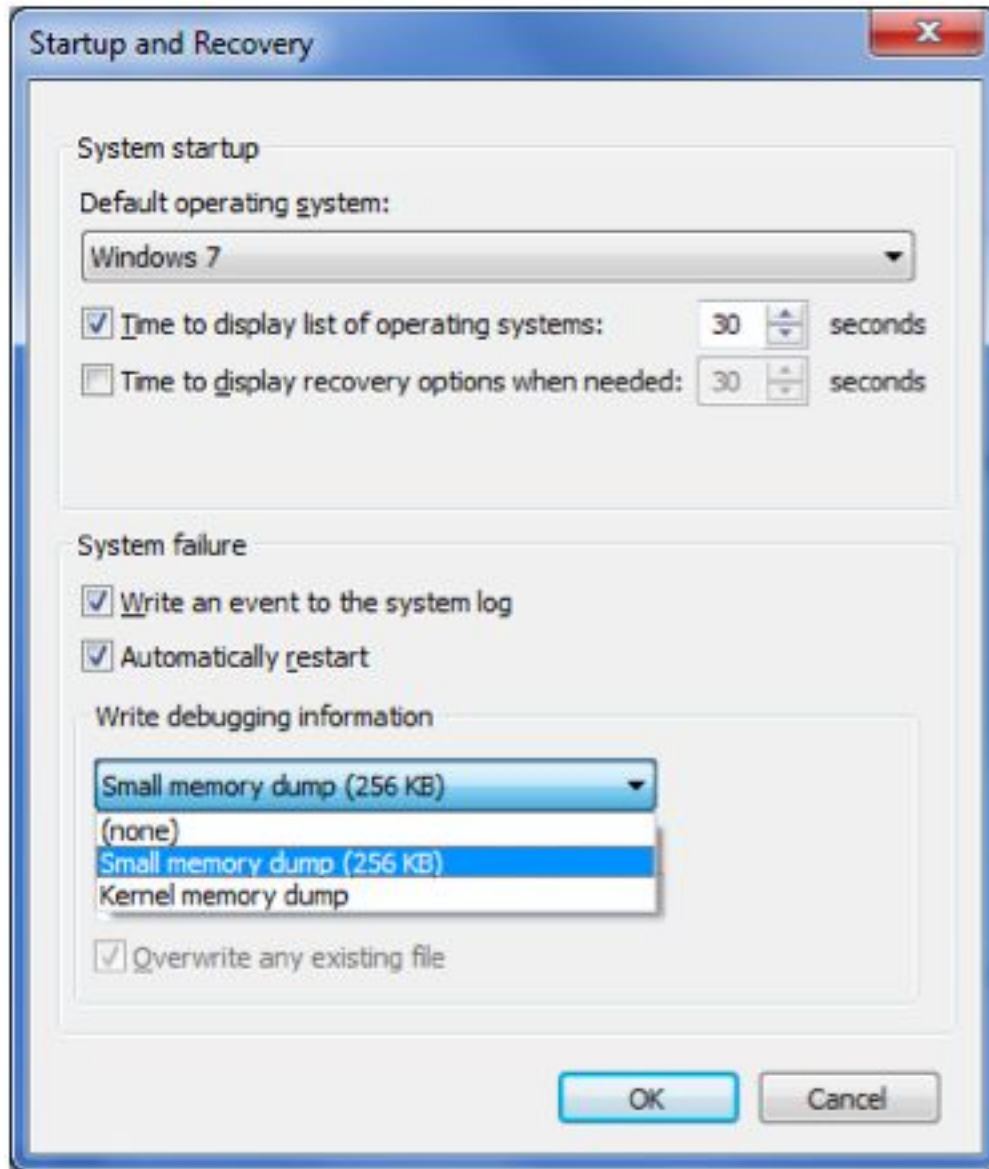
1. Eliminate all page files on any hard disks, including the system boot drive. Although this maximizes paging I/O on Fusion ioMemory devices, no post-mortem crash dump file will be available if a system crash occurs. However, it may be possible to re-enable a page file on the system drive and then reproduce the crash scenario.
2. Create a minimal-size page file on the system boot drive. The recommended minimum size is 16MB, although Windows may warn that a minimum 400MB page file is needed.
3. Create a page file large enough for a full-kernel memory dump. This typically requires a page file at least the size of installed RAM, with some recommending the size equal to RAM x 1.5.

To view or change the crash dump configuration,

1. Go to the **System Properties** dialog.
2. Click the **Advanced** tab.



3. In the Startup and Recovery section, click **Settings**. The Startup and Recovery dialog opens.



In the System Failure section you can change settings to handle the system log, restart, and debugging information.

Guaranteeing Minimum Committable Memory

If you enable "System managed size" or set a "Custom size" in the Virtual Memory dialog, you should do so with care. If the initial size is less than the desired amount of committable virtual memory, this can cause an application to have memory allocation failures if the amount of committed memory exceeds the currently allocated page file size or the initial size value. When committed memory exceeds the current page file size, a request to allocate additional memory will fail. The Windows Virtual Memory manager will slowly increase the size of the paging file up to the available size of its drive or to the "Maximum size" custom setting, whichever is smaller.



If you want to use a large amount of committed virtual memory (more than 1.5 times the amount of RAM) and avoid application memory allocation errors, the initial and maximum committed memory should be explicitly set for the expected application committed memory usage. These values should generally be the same.

How Large Should You Make the Paging File?

The following articles explain in great detail how to size the page file appropriately.

- Main Article Link: [Pushing the Limits of Windows](#)
- Specific section that documents virtual memory: [Pushing the Limits of Windows: Virtual Memory](#)

Verifying Page File Operation

To verify that a page file is actively placed on an Fusion ioMemory device, you can browse for hidden files at the drive's root. For example, run the following command at a prompt:

```
dir c: /ah
```

In the output listing there should be a file called `pagefile.sys`. If no page file is present, then recheck the page file configuration in the Virtual Memory dialog and verify that page file support has been enabled on the queried Fusion ioMemory device.

Page File Performance

Using an Fusion ioMemory device as the paging store can improve overall Virtual Memory system performance. Actual benefits will vary widely with an application's virtual memory usage and with hardware platform/performance.



Appendix F - NUMA Configuration

About NUMA Architecture

Servers with a NUMA (Non-Uniform Memory Access) architecture may require special installation instructions in order to maximize Fusion ioMemory device performance. This includes most multi-socket servers.

On some servers with NUMA architecture, during system boot the BIOS will not associate PCIe slots with the correct NUMA node. Incorrect mappings result in inefficient I/O handling that can significantly degrade performance.

Using the `FIO_AFFINITY` Parameter

Use this parameter to map devices with specific NUMA nodes.

ATTENTION!

The example below shows the final implementation of custom affinity settings. This implementation required an analysis of the specific system, including the system architecture, type and number of Fusion ioMemory devices installed, and the particular PCIe slots that were used. Your particular circumstances will require a custom analysis of your set-up. This analysis requires understanding of your system's NUMA architecture compared to your particular installation.

Your actual settings may be different than the example below, depending on your server configuration. In order to create the correct settings for your specific system, use `fio-status` to list all of the devices and determine the `<device-id>` (see below). Then use the example below of setting the `FIO_AFFINITY` parameter as a template and modify it for your particular system.

Determining the Bus Number

In order to create the correct settings for your specific system, use `fio-status` to list all of the devices' bus numbers. For example:

```
fio-status
Found 2 ioMemory devices in this system
...
    PCI:04:00.0
...
    PCI:0F:00.0
```

ATTENTION!

In Windows, the bus number is displayed in hex, but you need to enter the number in decimal. In this example, 04 is 4 and 0F is 15.



WARNING!

Note that the PCI device ID, including the bus number, may change if you change any of the PCI devices in the system. For example, if you add a network card or another Fusion ioMemory device. If the device ID changes, you will have to update the configuration.

FIO_AFFINITY Parameter

Configuring your Fusion ioMemory devices for servers with NUMA architecture requires the use of the `FIO_AFFINITY` parameter with the `fio-config` utility.

The `FIO_AFFINITY` parameter is a list of `<affinity specification>` triplets that specify the affinity settings of all devices in the system. Each item in the triplet is separated by a comma, and each triplet set is separated by a semicolon.

Syntax:

```
fio-config -p FIO_AFFINITY <affinity specification>[;<affinity specification>...]
```

Where each `<affinity specification>` has the following syntax:

```
<[domain number:]bus number>,[g|n]<group or node number>[,<hex mask>]
```

If domain number is not specified, it will be set to 0 (most common).

If there is no g or n character before the group/node number, then the number is assumed to be a group number.

The hex mask is optional. If it is not present, the mask is assumed to be `0xffffffffffffffff`. Also, the `0x` prefix is optional.

If the hex mask is a node mask, then the mask is relative to the node, not the group to which the node belongs.

Simple Example:

```
fio-config -p FIO_AFFINITY 1:7,n0,0xf;20,n1;80,7;2:132,4,0xff0
```

Has the effect of creating :

PCI Address (domain:bus)	Node/Group	Processor Affinity
1:7	node 0	processors 0 to 3 in the node (mask 0xf)
0:20	node 1	all processors in the node (no hex mask)
0:80	group 7	all processors in the group (no hex mask)
2:132	group 4	processors 4 to 11 in the group (mask 0xff0)



Advanced Configuration

If your server has multiple NUMA nodes and multiple Fusion ioMemory devices installed, you will need to make sure that the Fusion ioMemory devices are spread out among the various nodes.

While it may be optimal to pair devices to nodes that are electronically closer each device's PCIe slot (which would require an advanced understanding of your server's NUMA architecture and an analysis of the device installation), just simply spreading out all of the devices' node affinity among the available nodes should result in improved performance.

Checking the Log for Errors

If you enter a configuration that is not valid, then the settings will be disabled and an error will be available in the system logs.

For example:

```
fio-config -p FIO_AFFINITY 5,g0,0xf;6,0xf
```

In this example, the affinity for device `fct6` is set incorrectly, because there is no group/node number before the mask. The following errors appear in the system log:

```
2011-09-09T12:22:15.176086800Z - ERROR - FusionEventDriver - FIO_AFFINITY:
Invalid group or node number
2011-09-09T12:22:15.176086800Z - ERROR - FusionEventDriver - Invalid FIO_
AFFINITY parameter syntax at character 13: "5,g0,0xf;6,0x". Manual affinity
settings are disabled!
```

```
# fio-status
Found 2 ioMemory devices in this system
...
    PCI:04:00.0
...
    PCI:0F:00.0
```

ATTENTION!

In Windows, the bus number is displayed in hex, but you need to enter the number in decimal. In this example, 04 is 04 and 0F is 15.

In the example above the device IDs would be `0000:04:00.0` and `0000:15:00.0` on a system that had a domain of `0000`.

WARNING!

Note that the PCI device ID may change if you change any of the PCI devices in the system. For example, if you add a network card or another Fusion ioMemory device. If the device ID changes, you will have to update the configuration.



<device-id>	Node/Group	Processor Affinity
0000:04:00.0	node 1	all processors in node 1
0000:1d:00.0	node 0	all processors in node 0
0000:05:00.0	node 2	all processors in node 2
0000:1e:00.0	node 3	all processors in node 3



Appendix G - 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 <http://support.dell.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 *Dell Fusion ioMemory VSL Release Notes* for the upgrade path. Visit <http://dell.fusionio.com> for all of the required software and firmware versions.

For more information on upgrading from one version to the next, see the *Dell Fusion ioMemory VSL Release Notes* (available at <http://dell.fusionio.com>) 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 *Dell 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 51](#).

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

- a. Go to **Start > Control Panel**.
- b. Click **Programs & Features**.
- c. Select the Fusion ioMemory VSL entry.



- d. Click **Uninstall**.
 - e. Restart the computer.
 3. Install the new Fusion ioMemory VSL software.
 - a. Download the Fusion ioMemory VSL installation program for Windows at <http://dell.fusionio.com>
 - b. Run the Fusion ioMemory VSL installation program. The installation program presents a custom setup tree-view with options for installation.

NOTE-

Mouse over a component in the tree view to see its description.

- c. Click **Next**.
 - d. To select a different folder for the installation, browse to the folder and click **OK**. The default folder is C:\Program Files\Dell IO Management.

NOTE-

The uninstaller file is placed in the root of the default install folder (C:\Program Files\Dell IO Management).

- e. Follow the onscreen prompts to complete the install.
 - f. Choose **Reboot Now** on the finish screen of the installer.

ATTENTION!

For full installation instructions, see [Installation Overview on page 12](#).

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 60](#).

Sample syntax:

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



Where <firmware-path> is the full path to the firmware archive file (fio-firmware-dell_<version>.<date>.fff) available at <http://dell.fusionio.com> . This command will update all of the devices to the selected firmware. If you wish to update specific devices, consult [fio-update-iodrives on page 60](#) 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 <http://support.dell.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.



Dell Support

Contacting Dell

Dell provides several online and telephone-based support and service options. Availability varies by country and product, and some services may not be available in your area. To get help with your ioDrive and ioDrive Duo, contact your Dell Technical Service representative or access the Dell Support website at <http://support.dell.com>.

Choose the method of contacting Dell that is convenient for you.

NOTE-

The safety information that shipped with your system provides important safety and regulatory information. Warranty information may be included within this document or as a separate document. To access Dell documentation, go to <http://support.dell.com/manuals>.

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