Advanced Host Controller Interface (AHCI) and Redundant Array of Independent Disks (RAID) on HP Compaq dc5850 Business PCs

Using AMD Array Management Software (RAIDXpert)

Introduction

A RAID (Redundant Array of Independent Disks) is a data storage scheme that uses two or more drives accessed in combination to improve fault tolerance. Initially used with servers, desktop PCs are increasingly using RAID controllers and extra ATA or SCSI disks. Newer system boards often have RAID controllers.

The HP Compaq dc5850 Business PC takes advantage of Serial Advanced Technology Attachment (SATA) and the integration of RAID into AMD's RS780 and SB700 chipsets. The HP Compaq dc5850 Business PC products incorporate RAID drive support through factory configurations. This white paper provides a basic overview of RAID technology, supported factory configurations of HP Compaq dc5850 Business PCs, and other supported RAID configurations.

Mirroring and Parity

Fault tolerance is achieved by mirroring or parity. Mirroring is 100% duplication of the data on two drives (RAID 1). Parity is used to calculate the data in two drives and store the results on a third drive (RAID 5). After a failed drive is replaced, the RAID controller automatically rebuilds the lost data from the other two drives. RAID systems may have a spare drive (hot spare) ready and waiting to be the replacement for a drive that fails.

Disk Striping

RAID improves performance by disk striping, which interleaves bytes or groups of bytes across multiple drives, so more than one disk is reading and writing simultaneously.MBR = Master Book Record

Basics of AHCI and RAID Technology

Definitions

Table 1 Basic AHCI and RAID Definitions

AHCI	Advanced Host Controller Interface, a specification for hardware and software, is a register interface for SATA, intended to add higher speed, NCQ and other features.
ATA	Advanced Technology Attachment.
BIOS	Basic Input/Output System, also known as system ROM.
Chipset	Term used to define a collection of integrated components required to make a PC function.
HDD	Hard disk drive.
IDE	Integrated Drive Electronics.

INF	Information file (.inf) used by Microsoft operating systems that support the Plug & Play feature. When installing a driver, this file provides the operating system needed information about driver filenames, driver components, and supported hardware.
JBOD	Just a Bunch of Drives
LD	Logical Drive
MDD	Meta Data, i.e. previous RAID configuration information
Migration	Term used to describe the movement of data from one configuration or usage model to another.
NCQ	Native Command Queuing.
Option ROM	Third-party module that is loaded by the System BIOS which provides extended support for a particular piece of hardware. The RAID Option ROM provides boot support for RAID volumes as well as a user interface for managing and configuring the system's RAID volumes.
PCI	Peripheral Components Interface.
PCIe	PCI express. A serial version of PCI.
PnP	Plug and Play.
RAID	Redundant Array of Independent Disks.
ROM	Read Only Memory.
SATA	Serial ATA.
Strip	Set of data on a single hard drive in a RAID 0 volume.
Stripe	Group of all strips going horizontally across all the hard drive members of a RAID 0 volume.

Table 2 RAID Drives

Mode	Purpose	Minimal HDD Required
RAID 0	Striped for Performance.	2
RAID 1	Mirrored for Protection.	2
RAID 0 + 1	Mirrored and Striped.	4*

* Not supported on HP Compaq dc5850 Business PCs.

NOTE: The following notes are important for RAID configuration.

- RAID 1 is the only RAID configuration that HP Compaq dc5850 Business PC products offer as factory configurations.

- The preconfigured systems:
  - Are complete RAID systems.
  - Have both drives installed.
  - Have the necessary Option ROM configuration.
  - Are preloaded and preinstalled with all required software.
  - Include a preinstalled operating system that is in mirrored mode out of the box.

Single Drive AHCI Configuration

To take advantage of single drive AHCI support, a change is required in F10 setup. To run a single drive configuration in AHCI mode:

1. Turn on or restart the computer by clicking **Start > Shut Down > Restart the Computer**.

2. Press **F10** as soon as the monitor light turns green.

   If you do not press **F10** at the appropriate time, you must restart the computer, and then press **F10** again to access the utility.

3. Select your language from the list, and then press **Enter**.

4. Use the arrow keys to select **Storage**.

5. Use the down arrow key to select **Storage Options,** and then press **Enter**.

6. Change **SATA Emulation** from **IDE** to **AHCI RAID**.

NOTE: Make sure the AMD RAID driver is loaded in the SW image prior to making the **F10** setup change. The operating system will not boot without this driver. The dc5850 factory SW image already contains this driver. This driver is also provided as a softpaq at www.hp.com.

Basic RAID Types

This section provides a brief explanation of the supported RAID configurations for HP Compaq dc5850 Business PCs.

RAID 0 with two hard drives (Striped)

Even though HP supports RAID 0, it is not the recommended configuration for business PC users. Lack of redundancy causes less than half the reliability of a single hard drive system since the Mean Time Between Failure (MTBF) of RAID 0 is equal to the MTBF of an individual drive, divided by the number of drives.

RAID 0 with two hard drives (Striped)

First Disk	Second Disk
Data Segment 1	Data Segment 2
Data Segment 3	Data Segment 4
Data Segment 5	Data Segment 6
Data Segment 7	Data Segment 8
Data Segment 9	Data Segment 10
Data Segment 11	Data Segment 12
Data Segment 13	Data Segment 14
Data Segment 15	Data Segment 16

In the previous table, each "Data Segment n" represents a group of data, known as a strip. In this case, each row represents a stripe. RAID 0 represented in the table above shows how information is segmented, made into chunks or strips, and stored across the stripes of the hard drive members of this RAID volume.

To better illustrate the concept of RAID 0 and striping, the following graphic shows how a sequence of data "ABCD…" is stored in a RAID 0 mode. In this example, each letter represents a segment or strip. The graphic shows how the various pieces of the information go to different hard drives. If any segment of RAID 0 fails, all information from all members is lost.

Figure 1 Performance - RAID 0 with two hard drives
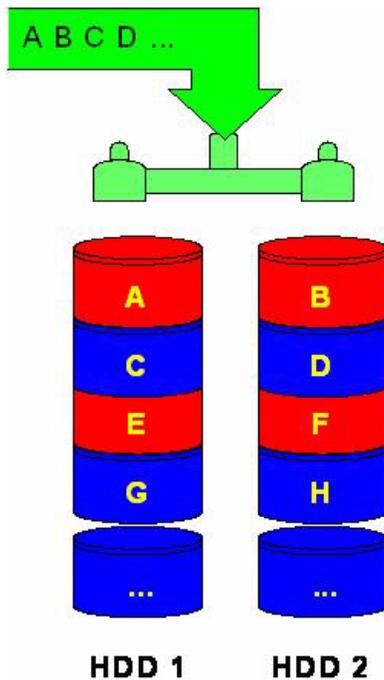
The HP Compaq dc5850 Microtower also allows for RAID 0 with three hard drives. However, reliability is less than a RAID 0 configuration with two hard drives.

RAID 0 with three hard drives is shown in the following figure:

Figure 2 RAID 0 - Three hard drives
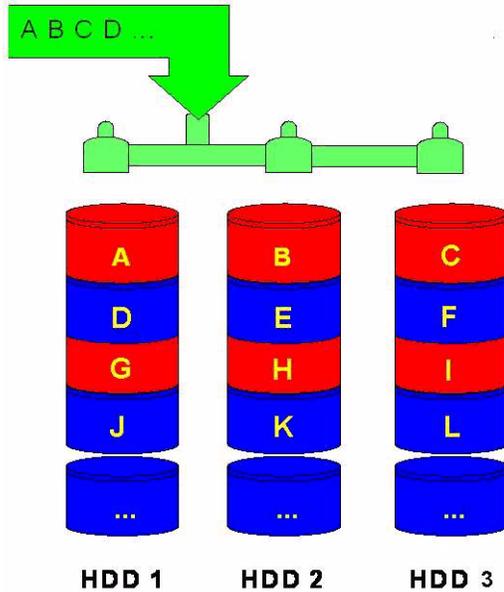
RAID 1 with two hard drives (Mirror)

Because it is a very cost-effective way to increase system storage reliability and a great value proposition, RAID 1 is the only RAID configuration that HP preconfigures for HP Compaq dc5850 Business PCs. RAID 1 provides high availability with minimal performance impact, as well as greater reliability compared to a single hard drive configuration.

RAID 1 has redundancy and hence is a true RAID. It more than doubles reliability because the MTBF of RAID 1 is equal to the MTBF of an individual drive multiplied by the number of drives (2). In other words, the probability of one hard drive failure on a given day is the square root of that same probability. Hypothetically, if the chances that a single hard drive fails is 1:2000, with RAID 1 the chance that both of your hard drives fail is 1:4,000,000.

Mirroring, segmentation, and striping have no real meaning in RAID 1. In the table and graphic, the data is arranged in rows for representation of different pieces of data.

Table 4 RAID 1 with two hard drives (Mirror)

First Disk	Second Disk
Data Segment 1	Data Segment 1
Data Segment 2	Data Segment 2
Data Segment 3	Data Segment 3
Data Segment 4	Data Segment 4

First Disk	Second Disk
Data Segment 5	Data Segment 5
Data Segment 6	Data Segment 6
Data Segment 7	Data Segment 7
Data Segment 8	Data Segment 8

In the previous table, each "Data Segment n" represents a group of data, known as a strip. In this case, each row represents a stripe. This table shows how information is duplicated in both hard drives. The size of the strips is mostly irrelevant and not a configurable option.

To better illustrate the concept of RAID 1 and mirroring, the following figure shows how a sequence of data "ABCD…" is stored in a RAID 1 volume. In this example, each letter represents a data segment. The graphic shows how the various pieces are replicated for both of the hard drives; hence, if any one member of the RAID 1 volume fails, the information is kept in the surviving members. After a hard drive failure, the user interface sends a notification so the failed hard drive can be replaced. No user information is lost in this scenario.

Figure 3 Reliability: RAID 1 - Mirroring

7
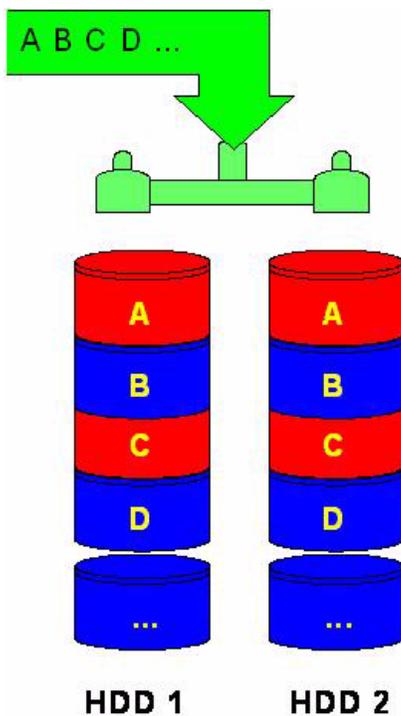
Configurations

Recommended configurations

HP recommends factory configurations of the preinstalled RAID offerings for the HP Compaq dc5850 Business PCs.

The preinstalled RAID offering is a RAID 1 volume of two identical SATA hard drives, and either two SATA 80GB/8MB cache, two SATA 160GB/8MB cache, or two SATA 250GB/8MB cache drives.

NOTE: HP Compaq dc5850 Business PCs support Microsoft Windows XP Professional Service Pack 2 (SP2), Microsoft Vista 32, and Microsoft Vista 64.

HP Compaq dc5850 Business PCs are based on the AMD RS780 and SB700 chipsets, which is a combined hardware and software RAID solution. The SB700 mass storage controller operates in either IDE or AHCI RAID mode. Changing the mode of the controller changes the PCI device ID and class code, requiring different device drivers in most operating systems.

NOTE: HP recommends and only supports Microsoft's IDE driver stack based on ATAPI.SYS and AMD drivers for HP Compaq Business PC products, including all supported RAID configurations.

WARNING: The PCI Device ID of the mass storage controller changes after changing the BIOS "SATA Emulation" Computer Setup option. Changing SATA Emulation from IDE mode to RAID mode is the equivalent of connecting the hard drives to a new add-on RAID storage controller. The installed operating system on the hard drive is unaware of this new mass storage controller. If the operating system does not have the RAID drivers installed, the operating system will fail to boot. For example, Microsoft XP Professional (SP2) or Microsoft Vista will cause a blue screen and/or reboot when attempting to boot in RAID mode without the RAID drivers installed.

HP Backup and Recovery interactions

After enabling and configuring RAID, restore the system using backup CDs. After completing the restore, reinstall HP Backup and Recovery. These steps are necessary for the F11 restore to function properly.

Additional technical information will be provided in the future for customers who want to add RAID software image deployment capabilities.

Before proceeding, follow the steps below to identify which version shipped with your system.

1. Click **Start** > **Search**.
2. Click **All files and folders**.
3. Type `supp*.ini` in the name field.

4. Enter the drive letter of the HP Recovery partition and \isos. Example: `d:\isos`.
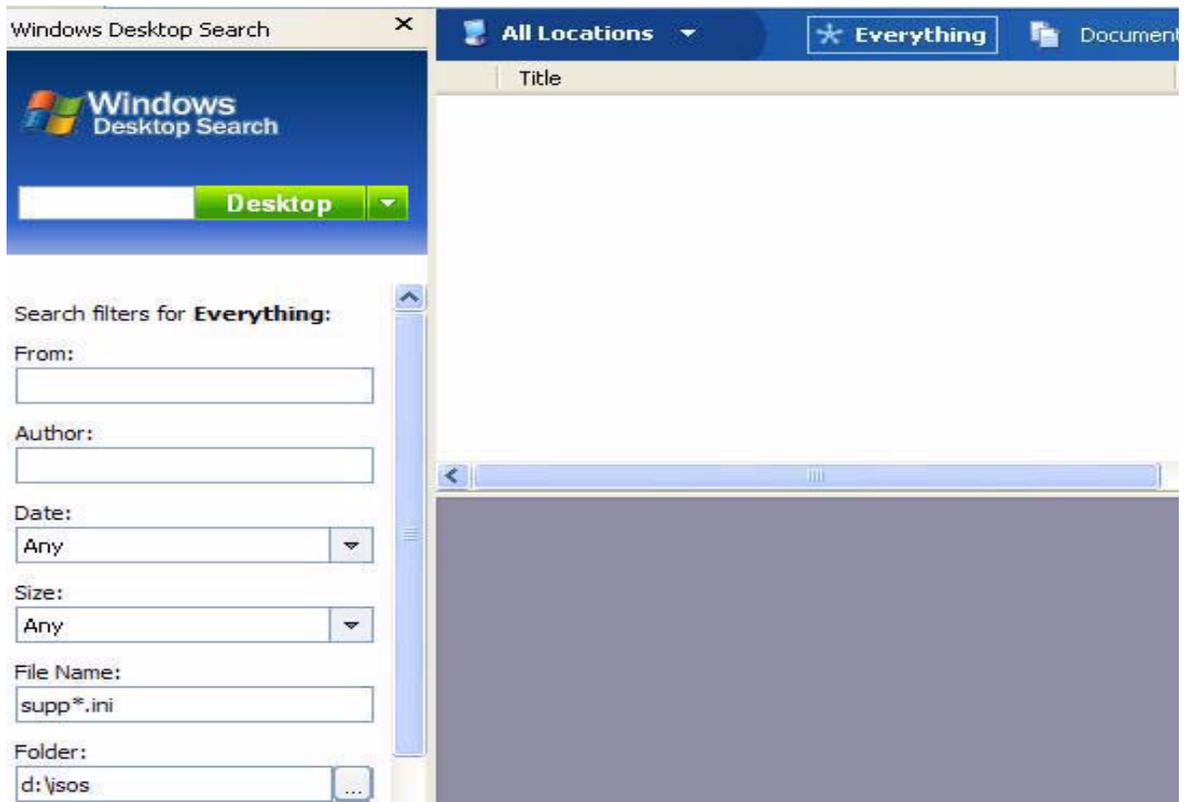
5. Click **Search**. Search results may locate more than one .ini file. Double click to open the .ini files until you locate the file containing HP Backup and Recovery.

To order a Recovery Disc Set, go to the following Web site, select your region, and click the **Technical support after you buy** link under the **Call HP** heading to obtain the support center telephone number for your region. You will need the computer model and serial number of your system before calling.

http://welcome.hp.com/country/us/en/wwcontact_us.html

Other supported configurations

The HP Compaq dc5850 Business PC products support two other RAID configurations:

- Two hard drive configuration.
  - Two equal size/type SATA hard drive RAID configurations in RAID 0 or RAID 1.
  - Maximum of two SATA optical drives.
- Three hard drive configuration (only on HP Compaq dc5850 Microtower).
  - Three equal size/type SATA hard drive RAID configurations in RAID 0.
  - Maximum of one SATA optical drive.

Unsupported configurations

The HP Compaq dc5850 Business Desktop PC products only support the best user experience and highest possible reliability. As a result, HP does not support the following combinations of RAID hard drives:

- Different sizes.

- Different speeds (5400 rpm, 7200 rpm, etc.).

- Old and new technologies (SATA 1.5 GB and SATA 3.0 GB).

- NCQ hard drives and non-NCQ drives.

- Different cache size.

- RAID combinations of hard drives with any operating system other than Microsoft XP Pro (SP2) or Microsoft Vista using Microsoft's IDE driver stack based on ATAPI.SYS and AMD drivers.

- RAID configurations of two or more 10,000 RPM hard drives.

Non-RAID Drive Detection Scheme

Operation	System Condition		
	RAID 1 or 0 Working	**RAID 1 Degraded**	**No RAID Configured**
Add blank HDD (hard disk drive)	Add HDD as RAID Ready	Add HDD as Raid Ready* (RAID 1 auto-rebuild when hotplug blank HDD only)	Add HDD as RAID Ready
Add HDD with MBR and MDD Add HDD with MBR and no MDD	Add HDD as whatever RAID mode defined in the MDD of the HDD Add HDD as JBOD	Add HDD as whatever RAID mode defined in the MDD of the HDD Add HDD as JBOD	Add HDD as whatever RAID mode defined in the MDD of the HDD Add HDD as JBOD
Add HDD with MDD and no MBR (once as a LD but has been deleted)	Add HDD as RAID Ready*	Add HDD as RAID Ready* (RAID1 auto-rebuild when hotplug blank HDD only)	Add HDD as RAID Ready*
Add HDD with MDD and no MBR	Add HDD as Spare Drive**	Auto-rebuild (RAID1 auto-rebuild can directly work with Spare Drive)	Add HDD as Spare Drive**

You can "clean" a HDD by selecting Secure Erase in SB700 Option ROM to make sure no MBR or MDD data is left on the HDD before testing.

*** Spare Drive can be configured from RAIDXpert. It will write a flag into MDD for driver and Option ROM to recognize it as Spare Drive.*

MBR = Master Book Record

MDD = Meta Data, i.e. previous RAID configuration information

JBOD = Just a bunch of drives

LD = Logical Drive

Configuring RAID on non-factory preinstalled configurations

The remaining sections of this white paper describe steps to set up supported RAID configurations where customers have not purchased factory preinstalled RAID configurations.

WARNING: Before configuring RAID in the Option ROM interface, be sure to back up all data. Once a RAID configuration is saved, the drives will no longer be bootable until an operating system is re-installed.

NOTE: You will need a diskette drive to use the downloaded HP softpaq required for Windows XP CD or Microsoft Vista DVD installation. The softpaq must be downloaded to a diskette.

Enabling RAID through F10 System BIOS

1. Turn on or restart the computer by clicking **Start** > **Shut Down** > **Restart the Computer**.

2. Press **F10** as soon as the monitor light turns green.

    If you do not press **F10** at the appropriate time, you must restart the computer, and then press **F10** again to access the utility.

3. Select your language from the list, and then press **Enter**.

4. Use the arrow keys to select the **Storage** menu.

5. Use the down arrow key to select **Storage Options,** and then press **Enter**.
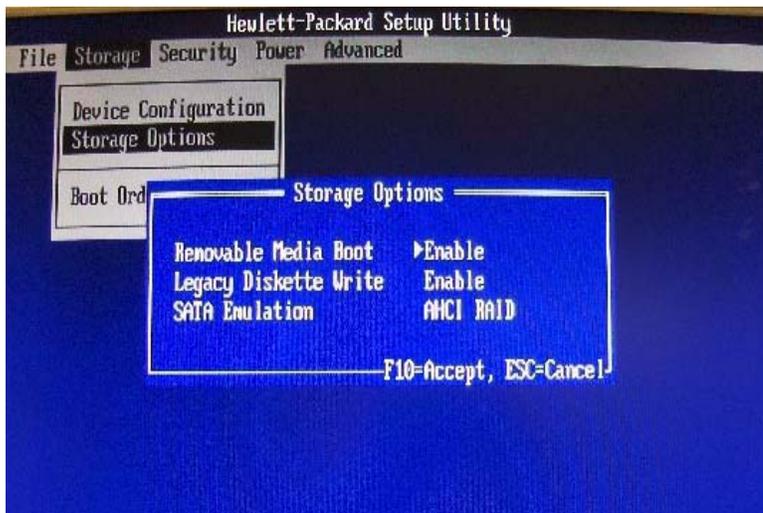
6. On the **Storage Options** menu, use the down arrow key to select **SATA Emulation**.

7. Press the right arrow key until **AHCI RAID** displays, and then press **F10** to accept.

8. To apply and save changes, select **File** > **Save Changes and Exit**.

    •   If you do not want to apply your changes, select **Ignore Changes and Exit**.

    •   To reset to factory settings, select **Apply Defaults and Exit**.

NOTE: Applying default settings never changes or resets the SATA Emulation mode (RAID vs. IDE). This setting must always be changed by selecting the appropriate mode from the F10 Setup Utility under Storage Options.

CAUTION: Do NOT turn the computer power off while the ROM is saving the F10 Computer Setup changes because the CMOS could become corrupted. Only turn the computer off after exiting the F10 Setup screen.

Configuring RAID Option ROM

Before proceeding you will need the following:

- Microsoft Windows XP CD-ROM or Microsoft Vista DVD and Product Key.

- RAID driver diskette. To create one, go to www.hp.com/support. Select your country and language, select **Download drivers and software**, enter the model number of the computer, and press **Enter**.

You can only access Computer Setup at system startup. To access the Computer Setup Utilities menu and enable RAID:

1. Turn on or restart the computer by clicking **Start** > **Shut Down** > **Restart the Computer**.

2. Press **Ctrl + F** as soon as the monitor light turns green to enter the RAID configuration utility. If you do not press **Ctrl + F** at the appropriate time, you must restart the computer, and then press **Ctrl + F** again to access the utility.

   The screen below displays briefly during boot up. The RAID configuration utility is English only. To configure RAID in other languages, use the Web-based RAID configuration utility.

Configuring RAID Volume using the Option ROM

Once you are in the Option ROM you can access the FastBuild Utility Main Menu by pressing **Ctrl + F**.

WARNING: Before configuring RAID, be sure to back up all data. Once a RAID configuration is executed and saved, data on the selected disks will no longer be retrievable.

```
FastBuild (tm) Utility (c) 2007 Advanced Micro Devices, Inc.
                          [ Main Menu ]

             View Drive Assignments........[ 1 ]

             Define LD.....................[ 2 ]

             Delete LD.....................[ 3 ]

             Controller Configuration......[ 4 ]




                          [ Keys Available ]
  Press 1..4 to Select Option                        [ESC] Exit
```
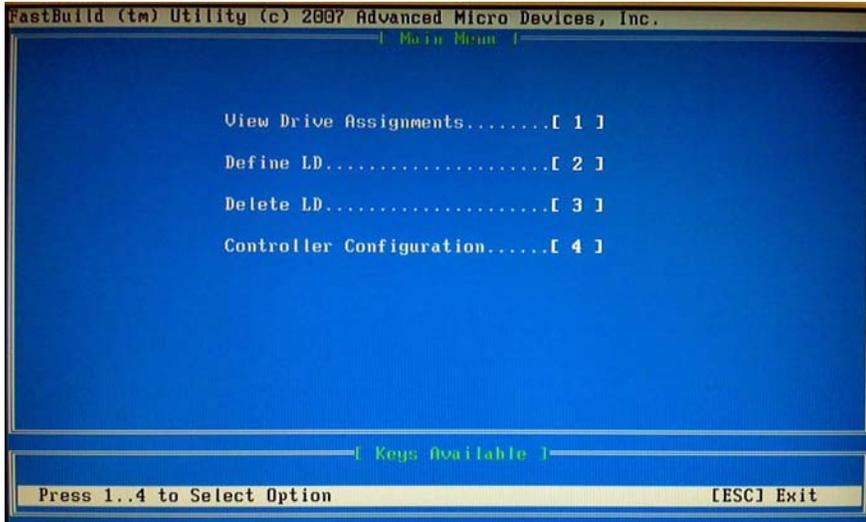
1. From the Main Menu press **3** to access the **Delete LD** screen. Use the arrow keys to select the drives. Press **Del** or **Alt + D** to delete the drives. At the prompt, press **Ctrl + Y** to delete or any other key to abort. Repeat until all drives are deleted. Press **Esc** to return to the main menu.

```
FastBuild (tm) Utility (c) 2007 Advanced Micro Devices, Inc.
                          [ Delete LD Menu ]

    LD No        RAID Mode      Total Drv   Capacity(GB)   Status

    LD  1        RAID 1             2          159.97      Functional
    LD  2        ----             ----       --------      ----
    LD  3        ----             ----       --------      ----
    LD  4        ----             ----       --------      ----
    LD  5        ----             ----       --------      ----
    LD  6        ----             ----       --------      ----
    LD  7        ----             ----       --------      ----
    LD  8        ----             ----       --------      ----
    LD  9        ----             ----       --------      ----
    LD 10        ----             ----       --------      ----




                          [ Keys Available ]
 [↑] Up [↓] Down [ESC] Exit [Del or Alt+D] Delete
```
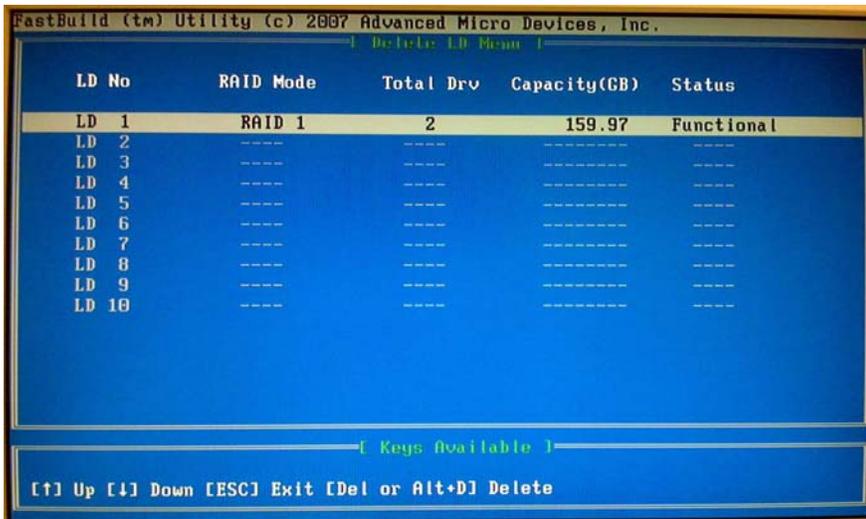
2. From the Main Menu press **1** to access the **View Drives Assignments** screen. The screen displays a detailed description of available physical drives, including channel, size and status. Press **Esc** to exit and return to the main menu.
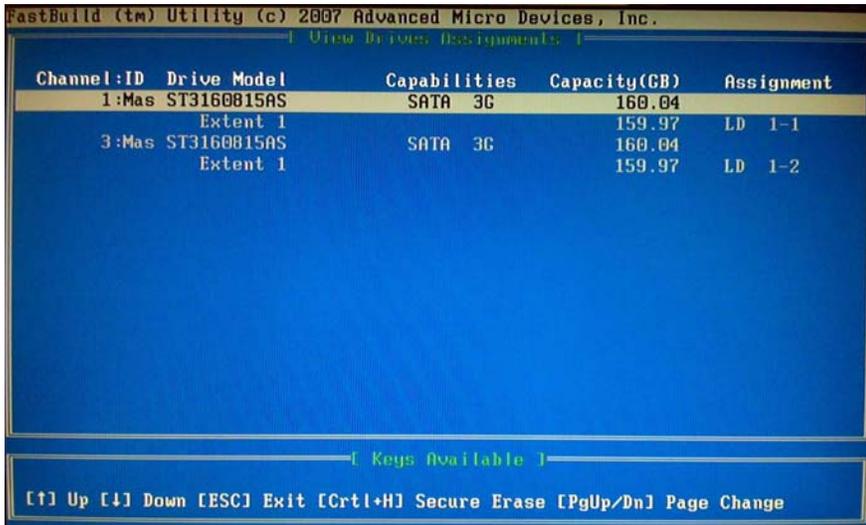
3. From the Main Menu press **2** to access the **Define LD** screen. This screen allows you to configure RAID settings and assignments.
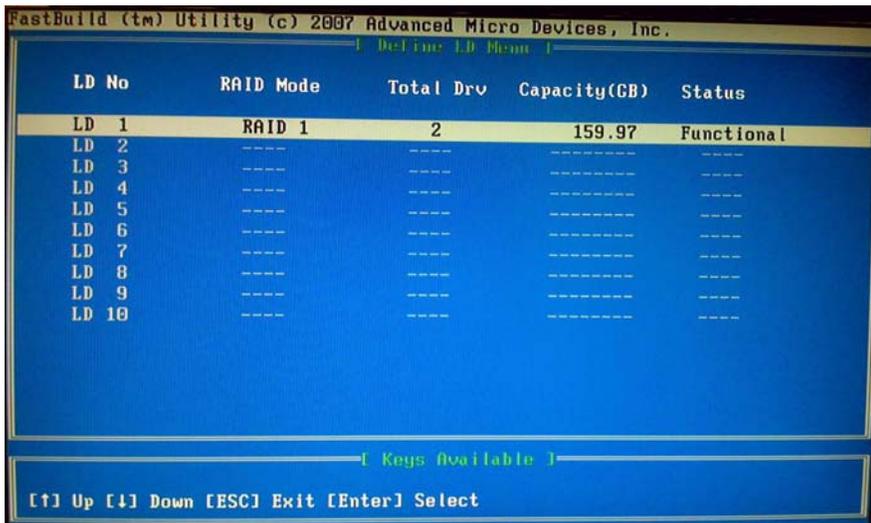
4. Use the arrow keys to scroll to the desired LD number and press **Enter**. The following screen appears. RAID 1 configurations should accept HP default settings. For all other configurations:

   - Use up and down arrow keys to toggle and the space bar to view and change options.

   - Under **Assignment**, select **Y** to enable the drive(s).

   - Press **Ctrl + Y** to save your settings.

- At the prompt, press **Ctrl + Y** to Modify Array Capacity or press any other key to use maximum capacity.
- Press **Esc** to exit and return to the main menu.
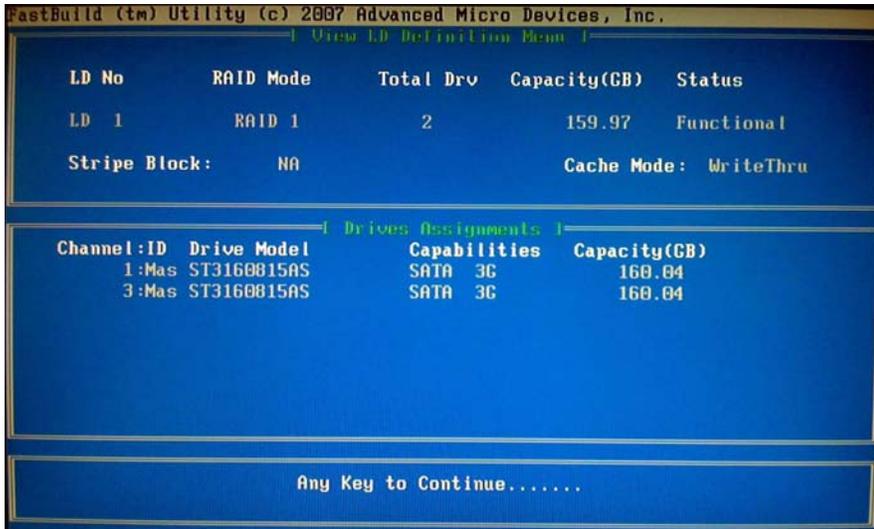
5. Press **Esc** to exit. At system prompt, press **Y** to reboot or any other key to go back.

Select boot order

To set up your system to boot from the CD, you may need to change the boot order in the F10 setup menu.

1. Turn on or restart the computer by clicking **Start** > **Shut Down** > **Restart the Computer**.

2. Press **F10** as soon as the monitor light turns green.

    If you do not press **F10** at the appropriate time, you must restart the computer, and then press **F10** again to access the utility.

3. Select your language from the list, and then press **Enter**.

4. Use the arrow keys to select **Storage**.

5. Use the down arrow key to select **Boot Order,** and then press **Enter**.

6. Use the down arrow key to select **ATAPI CD-ROM Drive**, and then press **Enter**. Press the arrow key up to the desired position in the boot order. Press **Enter** again and **F10** to accept the change.

7. To apply and save changes, select **File** > **Save Changes and Exit**.

    - If you do not want to apply your changes, select **Ignore Changes and Exit**.

    - To reset to factory settings, select **Apply Defaults and Exit**. This option restores the original factory defaults.

Notes for operating system installation

After creating a RAID disk volume in the option ROM and selecting the boot order, the operating system can be installed. Before proceeding, you will need the following:

- Microsoft Windows XP CD-ROM or Microsoft Vista DVD and Product Key.

- RAID driver diskette. To create, go to www.hp.com/support. Select your country and language, select **Download drivers and software**, enter the model number of the computer, and press **Enter**.

The following steps apply to either Microsoft Windows XP or Microsoft Vista installations.

1. Insert the Windows XP CD-ROM or Microsoft Vista DVD and reboot the computer.

2. Press **F9** at the prompt to begin installation.

3. Select CD-ROM from the boot device list.

4. Remove the Windows XP CD-ROM or Microsoft Vista DVD, and insert the Restore Plus CD-ROM.

```
Attempting Boot From CD-ROM

Press any key to boot from CD or DVD...

Your Operating System CD/DVD was originally shipped as part of a Restore Plus!
kit.  For validation purpose, please remove the Operating System CD/DVD,
insert the Restore Plus! CD/DVD, and press <Enter>... _
```
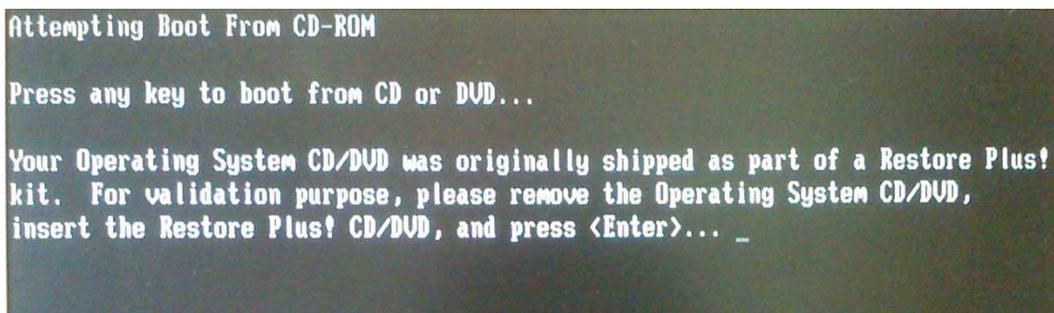
5. When prompted, remove the Restore Plus CD-ROM and reinsert the operating system CD or DVD.

```
Attempting Boot From CD-ROM

Press any key to boot from CD or DVD...

Your Operating System CD/DVD was originally shipped as part of a Restore Plus!
kit.  For validation purpose, please remove the Operating System CD/DVD,
insert the Restore Plus! CD/DVD, and press <Enter>...

A valid Restore Plus! CD/DVD was detected!
Please remove the Restore Plus! CD/DVD, reinsert the Operating System CD/DVD,
and press <Enter> to proceed with the installation of the Operating System...
```

6. Follow the instructions on the screen to select your language and preferences.

7. Insert the RAID driver diskette and press **ENTER** to select the RAID driver.

8. Press **ENTER** to complete the Microsoft Windows installation.

WARNING: Customer-created images MUST account for the RAID controller.

Failure to install and enumerate the RAID driver after enabling the RAID controller (with or without creating a volume) will result in a Windows boot failure (blue screen) for inaccessible boot device.

WARNING: The PCI Device ID of the mass storage controller changes after changing the BIOS "SATA Emulation" Computer Setup option. Changing SATA Emulation from IDE mode to RAID mode is the equivalent of connecting the hard drives to a new add-on RAID storage controller. The installed operating system on the hard drive is unaware of this new mass storage controller. If the operating system does not have the RAID drivers installed, the operating system will fail to boot. For example Microsoft XP Professional (SP2) or Microsoft Vista will cause a blue screen and/or reboot when attempting to boot in RAID mode without the RAID drivers installed.

Additional technical information will be provided in the future for customers who want to add RAID SW image deployment capabilities.

AMD Array Management Software (RAIDXpert)

This section of the paper focuses on how to configure RAID using AMD Array Management Software (RAIDXpert).

Java Runtime Environment

RAIDXpert will install JRE 1.4 on your system unless you already have JRE versions 1.3.0 or 1.4.

Console Software Installation

HP provides a softpaq for the AMD RAIDXpert utility installation. To download the softpaq, go to www.hp.com/support.

Log-in to RAIDXpert

1. Double-click on the RAIDXpert icon on your desktop.

2. When the opening screen appears, type **admin** in the Login ID field. Type **admin** in the Password field. Note: The RAIDXpert login and password are case sensitive.

3. Click the **Sign in** button.

Recommended Initial Settings

These settings are recommended and now is the best time to make them. You can change them later as necessary.

Administrator's Settings

To make the Administrator's password and notification settings:

1. In Tree view, under Administrative Tools, click on the **User Management** icon.

2. In the User Management Window, click on the **admin** link.

3. Click on the **Settings** tab.

4. If you want to change the default password, type the new password into the New Password field. Use up to 8 letters and numbers but no spaces or other characters.
5. Type the same password into the Retype Password field.
6. If you plan to set up Event Notification, type the Administrator's email address in the Email field.
7. Click on the **Submit** button. If the action was successful, the Management Window will display the message "Update Success."
8. If you plan to set up Event Notification, click on the **Events** tab.

The image above was shortened to fit into the available space.

9. Check the boxes of the notification events that you want to have reported to you via email and popup messages. To select events by their severity, check one of the four Select Events boxes at the top of the window.

10. Click the **Submit** button.

Utility Configuration

If you plan to set up Event Notification, you must select these settings.

1. In Tree View, under Administrative Tools, click on the **Utility Configuration** icon.

2. Enter the Sender's address in the Email Sender field. Be sure the sender has an account in your email system.

3. Enter your email server in the Email Server field.

4. Keep or change the Email Subject line.

5. Click the **Submit** button when you are done.

Degradation

In the unlikely event that one of your hard drives malfunctions, RAIDXpert reports the condition with popup messages. If Event Notification is set up, RAIDXpert also reports the conditions with email messages.

For More Information

A comprehensive RAIDXpert whitepaper is available at www.hp.com/support. Select your country and language, select **See support and troubleshooting information**, enter the model number of the computer, and press **Enter**. In the Resources category, click **Manuals (guides, supplements, addendums, etc.)**. Under **Quick jump to manuals by category**, click **White papers.**