

Preparing Advanced Format hard drives for Microsoft Windows installations on HP Business Notebook PCs and Desktop PCs

Technical white paper

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Executive summary

Designed for both SMB/enterprise users and consumers, this white paper provides instructions for preparing an Advanced Format hard drive for a Microsoft® Windows® installation on an HP Business Notebook or Desktop PC.

Historically, hard disk drives (HDDs) have used 512-byte sectors; however, this sector size is now limiting HDD capacity. To address this limitation, the industry is moving Advanced Format drives with 4096-byte (4-KB) sectors – eight times larger than current drive technology. With 4-KB sectors, less space is wasted on the physical media, making the drive easier to manufacture and able to support higher capacities.

First-generation Advanced Format drives retain backwards-compatibility by using external SATA communications based on a 512-byte sector; however, these drives – also known as 512e¹ drives – operate internally at 4 KB. Thus, any PC with a SATA interface can use an Advanced Format drive; however, depending on the operating system (OS) being installed, extra steps may be required to optimize performance.

If an OS that is not Advanced Format-aware is being used, you may need to take steps to align logical sectors (OS) with physical sectors (disk media). This white paper presents a range of scenarios involving the use of Advanced Format drives and describes the actions you should take to optimize the performance of your HP Business Notebook or Desktop PC.

In addition, this white paper presents a “Frequently asked questions” section and provides an appendix with additional technical background.

What does the Advanced Format drive mean to you?

This section outlines a range of scenarios involving the use of Advanced Format drives and describes actions that should be taken to optimize performance in each case. These actions typically depend on the operating system (OS) being used.

When running an OS that is not Advanced Format-aware in conjunction with an Advanced Format drive, your system may experience performance issues due to misalignment between logical sectors (OS) and physical sectors (disk media). In this case, you can typically use the Paragon Partition Alignment Tool to align the sectors, thus enhancing performance.

The following Windows platforms are Advanced Format-aware:

- Windows Vista® SP1 or later
- Windows 7
- Windows Preinstallation Environment (WinPE) 3.0 or later

Tables 1 and 2 outline a number of scenarios involving the use of Advanced Format-aware drives and recommends actions you should take to optimize the performance of your HP Business Notebook or Desktop PC.

¹ Where “e” indicates that these drives emulate conventional drives, maintaining backwards-compatibility with current computers by operating internally at 4 KB and externally at 512 bytes

Table 1. Links to information on optimizing performance in various scenarios involving the use of an Advanced Format drive

Scenario	Windows 7	Windows Vista SP1 or later	Windows Vista prior to SP1	Windows XP	Windows 2000	Linux	FreeDOS
You are installing a preinstalled image you received directly from HP	A	A	A	A	B	A	A
You are installing your own image using WinPE	C	C	C	C	C	C	B
You are installing your own image; you are not using WinPE	D	D	D	D	D	D	D
You are installing off-the-shelf (that is, non-HP) media	A	A	E	E	E	E	E
You are installing HP restore media	A	A	E	E	E	A	B
You are installing an HP F11 restore image	A	A	B	B	B	A	B
You are using Norton Ghost to re-image the drive	F	F	F	F	F	F	A

Table 2. Actions to be taken to optimize system performance, with links to the appropriate downloads provided

Scenario	Actions
A	<p>Your Advanced Format drive is aligned.</p> <p>To optimize performance with Windows 7 or WinPE, apply Microsoft Knowledge Base article 982018.</p> <p>Note: If you are upgrading your PC to Windows Vista SP1 or later or Windows 7, no realignment is required since these OSs are Advanced Format-aware.</p>
B	<p>This scenario is not supported by HP.</p>
C	<p>For WinPE installations prior to 3.0, install Windows Automated Installation Kit (AIK).</p> <p>To optimize performance with Windows 7 or WinPE, apply Microsoft Knowledge Base article 982018.</p> <p>For Intel platforms, upgrade to Intel Rapid Storage Technology (RST) 9.6 or later.</p> <p>For AMD platforms, upgrade to the latest version of the AMD Serial ATA (SATA) Advanced Host Controller Interface (AHCI) Driver.</p>
D	<p>Ensure that your imaging tools are Advanced Format-aware so that you can validate your infrastructure for Advanced Format readiness.</p> <p>To optimize performance with Windows 7 or WinPE, apply Microsoft Knowledge Base article 982018.</p> <p>For Intel platforms, upgrade to Intel Rapid Storage Technology (RST) 9.6 or later.</p> <p>For AMD platforms, upgrade to the latest version of the AMD SATA AHCI Driver.</p> <p>Note: When a Linux image is being installed, an Advanced Format drive has no impact if you create partitions with appropriate offset values². The Linux kernel performs accesses in multiples of the hardware page size, which is 4 KB on an x86 platform.</p>

² The same rule applies to Windows images.

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- E You should first install the image and then run the [Paragon Partition Alignment Tool](#) to align sectors.
- Note:** If you are downgrading your PC to Windows XP or Windows Vista, you are impacted since these OSs are not Advanced Format-aware.
-
- F Before beginning the re-imaging, ensure that the partitions on your Advanced Format drive have appropriate offset values (see [Validating partition alignment](#)).
- To optimize performance with Windows 7 or WinPE, [apply](#) Microsoft Knowledge Base article 982018.
-

Important tips

Installing Windows Vista (prior to SP1), Windows XP or Windows 2000

If you are planning to install Windows Vista (prior to SP1), Windows XP or Windows 2000 on an Advanced Format drive, you should first install the image and then run the [Paragon Partition Alignment Tool](#) to align sectors.

Extending the partition in Windows XP mini-setup

You may receive errors if you attempt to extend the partition in Windows XP mini-setup (unattend file setting). This issue occurs because DISKPART cannot accommodate the new MBR partition structure.

The solution is to change the value of the **ExtendOemPartition** parameter from **1** to **0**. For more information, refer to Microsoft Knowledge Base article [240126](#).

Encrypting drives

For optimal data protection, you should ensure that encrypted Advanced Format drives are suitably aligned. Thus, before encrypting an Advanced Format drive, you should run the [Paragon Partition Alignment Tool](#) on this drive.

An encrypted drive that is misaligned should be decrypted, aligned and then re-encrypted.

Aligning drives in a RAID configuration

If two or more Advanced Format drives have been configured for RAID, running the [Paragon Partition Alignment Tool](#) on these drives aligns partitions at 2,048 sectors. Since a starting offset of 2,048 supports most stripe-unit sizes, performance would be enhanced³ due to the elimination of redundant disk operations.

Running the Paragon Partition Alignment Tool ensures support for the stripe-unit sizes associated with most RAID configurations, including RAID 0, 1, and 5.

Using third-party deployment tools

Platforms that are Advanced Format-aware may experience alignment issues when used in conjunction with third-party deployment tools. Contact the particular vendor for requirements for running their deployment tool.

³ Compared to a scenario with misaligned drives

Replacing a drive on a Windows 2000 platform

If you are replacing an older drive on a Windows 2000 platform, you may need to update the registry if you are using an Advanced Format drive as a replacement.

The drives originally installed on Windows 2000 platforms tend to have capacities below 137 GB, which is typically less than an Advanced Format drive. Thus, if your Advanced Format drive is larger than 137 GB, you must enable 48-bit logical block addressing (LBA) support in the system registry in order to make all of your storage available. Perform the following steps:

1. Start the registry editor (**regedt32.exe**).
2. Browse to and select the following registry key:
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Atapi\Parameters
3. From the **Edit** menu, select **Add Value** and add the following registry value:
Value name: EnableBigLba
Data type: REG_DWORD
Value data: 0x1
4. Quit the registry editor.

Enhancing performance with many small writes (as with ImageX)

Among the issues addressed by Microsoft Knowledge Base article 982018 is performance degradation associated with a Windows 7 or WinPE platform performing many small writes to an Advanced Format drive. For example, using the ImageX command-line tool to apply a Windows image (.wim file) to an Advanced Format drive would take significantly longer than applying the same image to a traditional hard drive.

To optimize performance, you should [apply](#) the appropriate hotfix to your HP Business Notebook and Desktop PCs, as described in [Enhancing the performance of small writes](#).

Validating partition alignment

This section outlines the following options for validating partition alignment:

- Using the DISKEXT command-line utility (for Windows XP or later platforms)
- Using the Windows Management Information Command-line (WMIC) utility (for Windows XP or later platforms)
- Using the DISKPART command-line utility (for Windows 7 platforms)

Sample calculations are also provided.

Using DISKEXT

1. After the operating system has been installed, download the DISKEXT utility from <http://technet.microsoft.com/en-us/sysinternals/bb896648>; install.
2. Run **diskext** from the Windows command line.
3. Identify the **Partition Starting Offset** value of each partition and divide by 4096. If the value is divisible, the partition is aligned

Using WMIC

1. After the operating system has been installed, run **wmic** from the Windows command line.
2. At the resulting prompt, type **partition list full** to display information about system partitions.
3. Identify the offset value of each partition and divide by 4096. If the value is divisible, the partition is aligned.

Using DISKPART

1. Boot the system via bootable Windows PE 3.0 RAM media.
2. Execute the DISKPART utility to display information about specific system partitions.
For example, use the following script to display information about Disk 0, Partition 1 (as shown in Figure 1):

```
diskpart  
select disk 0  
select partition 1  
detail partition
```

Figure 1: Sample script output

```
Partition 1  
Type : 07  
Hidden: No  
Active: No  
Offset in Bytes:1048576
```

Volume ###	Ltr	Label	Fs	Type	Size	Status	Info
* Volume 1			NTFS	Partition	9 GB	Healthy	

3. Divide the offset value of the selected partition by 4096. If divisible, the partition is aligned.

Sample validation

The example shown in Table 3 shows the sizes and offsets associated with four partitions. All eight values must be divisible by 4,096.

Table 3. Validating the alignment of four sample partitions

Partition	Partition size	Starting offset
0	208,666,624 B	1,048,576 B
	$208,666,624 \div 4,096 = 50,944$	$1,048,576 \div 4,096 = 256$
1	732,388,392,960 B	209,715,200 B
	$732,388,392,960 \div 4,096 = 178,805,760$	$209,715,200 \div 4,096 = 51,200$
2	17,449,353,216 B	732,388,392,960 B
	$17,449,353,216 \div 4,096 = 4,260,096$	$732,388,392,960 \div 4,096 = 178,805,760$
3	107,864,064 B	750,047,461,376 B
	$107,864,064 \div 4,096 = 26,334$	$750,047,461,376 \div 4,096 = 183,117,056$

Enhancing the performance of small writes

Performance degradation can occur on a Windows 7 or WinPE platform that performs many small writes to an Advanced Format drive. For example, using the ImageX command-line tool to apply a Windows image (.wim file) to an Advanced Format drive would take significantly longer than applying the same image to a traditional hard drive.

This issue has been addressed in Microsoft Knowledge Base article [982018](#). The typical user should apply the associated hotfix as needed; IT professionals can follow the procedure described below.

Important

The following procedure is intended for the IT professional.

Perform the following steps apply the hotfix:

1. Download the Windows PE hotfix to your c: drive from the Microsoft Support site at <http://support.microsoft.com/hotfix/KBHotfix.aspx?kbnm=982018&kbIn=en-us>.
2. Unzip the download file by double-clicking on it.
3. The **Windows6.1-KB982018-x86.MSU** file should appear in your c: drive. Expand this file:
 - a. Launch the command prompt with Administrator rights.
 - b. At the prompt, enter the following:
expand.exe c:\Windows6.1-KB982018-x86.MSU -f:* c:
4. Select **Start**→**All Programs**→**Windows OPK or Windows AIK**.
5. Right-click **Deployment Tools Command Prompt** and then select **Run as administrator**.
6. At the prompt, expand the Windows PE image by mounting **boot.wim** to be updated into a location by entering the following:
imagex.exe /mountrw c:\winpe_x86\ISO\sources\boot.wim 1
c:\winpe_x86\mount
7. Create a scratch directory:
mkdir c:\winpe_x86\sandbox
8. Apply the hotfix to your boot.wim image:
Dism.exe /image=c:\winpe_x86\mount /ScratchDir=c:\winpe_x86\sandbox
/Apply-Unattend=c:\Windows6.1-KB982018-x86.xml
9. Commit the Windows PE image by un-mounting boot.wim to be updated into a location by entering the following:
imagex.exe /unmount /commit c:\winpe_x86\mount

Frequently asked questions

I am not sure I have an Advanced Format drive. What should I do?

Even if you are not sure you have an Advanced Format drive, you can still follow the procedures described in this white paper. Changing your installation methods to accommodate 4-KB sector alignment does not negatively impact a drive with 512-byte sectors.

My operating system is Advanced Format-aware; however, I do not have an Advanced Format drive. Do I need to do anything?

No changes are required to support 4-KB sector alignment in drives with 512-byte sectors.

What happens if I do not align my partitions?

Your Advanced Format drive will work; however, applications may fail because of the unexpected slow-down.

What impact does the Advanced Format drive have on Linux users?

Use Linux kernel 2.6.33 and above; do not create MS-DOS-compatible partitions.

The RedFlag Linux (kernel version 2.6.31 and above) shipped by HP is Advanced Format-aware.

For information on partition alignment for SUSE Linux, refer to

<http://www.novell.com/support/viewContent.do?externalId=7007193&sliceId=1>.

What happens if I am running an older operating system with conventional drives or a mixture of conventional and Advanced Format drives?

You can safely set up 4-KB sector alignment in a mixed environment or even if you only have drives with 512-byte sectors.

It is immaterial whether you are running – or plan to run – Windows XP or Windows 2000 or a newer operating system. However, you must use Windows 7 or Windows Vista SP1 or later to partition the hard drive.

Are there any differences between Advanced Format drive models?

Some drive models have noticeably superior performance, though slightly higher potential for data loss.

Many vendors are switching to the Advanced Format drives without making any other changes. Some vendors have made the transition more transparent to users and have optimized the performance of their software by delaying disk writes. While these sequential writes can improve performance, they keep data in the cache longer; thus, if you fail to align one of these write-optimized drives, there is a greater risk of data loss.

Why did HP choose to support emulation rather than drives with 4-KB native sector format?

While this was considered, the existing system infrastructure has been designed around a logical 512-byte sector – notably the hard disk boot device. The resources needed to update the environment would have been vast; for example, a BIOS update would be required for every system. Moreover, some operating systems do not support booting to 4-KB native drives. Older applications and games would not be able to run, while there would be no performance advantage for a customer. Thus, HP elected to not pursue this approach at this time.

Where can I build an Advanced Format drive-aware image?

As long as it is validated, you can create a custom image on either a conventional drive or an Advanced Format drive.

Is there any value to using the Paragon Partition Alignment Tool with a solid state drive (SSD)?

Many modern SSDs feature an internal memory configuration that corresponds to 4-KB sectors.

SSDs memory cells degrade over time, following a large number of write operations; thus, if partitions are misaligned, not only will performance be degraded but you also increase the risk of premature drive failure.

Using the [Paragon Partition Alignment Tool](#) to align partitions will eliminate all redundant read/write operations, thus enhancing drive performance and potentially extending the life of the drive.

I have an image created for a drive with 512-byte sectors that I know is not aligned appropriately for an Advanced Format drive. Can I use Norton Ghost to install this image on an Advanced Format drive?

Yes, you can align the partitions by using the command-line switch **-align=1MB** when you start Ghost.

Appendix A: Technical background

Since standards were introduced in 1956, industry-standard HDDs have used 512-byte sectors on their internal media. However, this relatively small sector size constrains storage capacity and has also caused manufacturing capabilities to reach a limit.

Under the sponsorship and support of the International Disk Drive Equipment and Materials Association (IDEMA), manufacturers of industry-standard HDDs are transitioning from 512-byte to 4-KB sectors on HDDs with SATA interfaces, increasing the utilization of storage space and making the newer disks easier to manufacture.

HDD manufacturers began shipping these Advanced Format drives (4-KB sectors) in the fourth quarter of 2010 as newly-announced models. Previously-announced and currently-shipping models are not expected to transition to media with 4-KB sectors.

By using standard 512-byte sector SATA communications, first-generation Advanced Format drives maintain backwards-compatibility with current computers. Thus, these drives – sometimes referred to as 512e drives or translated drives – operate internally at 4 KB and externally at 512 bytes. However, this disparity in sector sizes can lead to performance issues.

Partition alignment

Modern operating systems use file systems with 4-KB sectors when formatting a partition. However, when the physical media and file system both use 4-KB sectors, while the SATA interface is 512-byte, misalignment can occur, impacting write performance.

Note

Misalignment occurs while file system sectors cross physical sector boundaries.

To address the risk of misalignment, a 512e drive emulates the logical 512-byte interface, taking care of all physical manipulation in the background, while maintaining backwards compatibility. However, emulation can affect performance with older operating systems such as Windows XP. This can be fixed by either reinstalling the operating system with newer install tools that are 4-KB sector-aware or using a utility that properly aligns the partitions and data on the drive.

The data on a 512e drive must be aligned to accommodate the following scenarios:

- **Short write accesses** (less than 4 KB)

Most accesses to a drive are 4 KB or greater. However, when the host writes less than 4 KB, all 4 KB on the media must be read, the old data modified with new data, and then written back to the media as a 4-KB physical sector.

For a typical user, accesses shorter than 4 KB are rare.

- **Misalignment**

In some cases, a logical address may not coincide with the beginning of a physical address.

For example, a data write may extend beyond the end of one physical sector. In this case, the drive must read both physical sectors to drive memory, modify both data sets, and then rewrite the new data to the media

In both scenarios, the drive reads the data from the media, modifies the old data with the new data and then rewrites the modified data to the media. Depending on the rotational speed of the drive, this could add 16 – 22 milliseconds to a write. Read performance is not impacted; the drive reads the whole 4 KB of data into drive memory and only sends out the data sector(s) needed.

Why alignment helps

Alignment issues with older operating systems are based on the starting point of partitions. In Windows XP, for example, the partition boot sector is located at logical block address 63, which is not divisible by eight. Thus, the remaining information in the partition information (directories and files) is not aligned to physical addresses on the disk drive.

However, if logical writes are aligned to physical sectors and write lengths are in multiples of 4 KB, then new data can completely replace old data; the drive does not have to perform any extra steps for a write operation.

Newer operating systems like Windows Vista SP1 or later and Windows 7 start the partition on logical block address 2048, which is divisible by eight. In addition, changes have been made in the operating system to reduce the number of writes less than 4 KB in length.

For more information

Microsoft KB article 982018

<http://support.microsoft.com/kb/982018>

Information on AIK for Windows 7

[http://technet.microsoft.com/en-us/library/dd349343\(W.S.10\).aspx](http://technet.microsoft.com/en-us/library/dd349343(W.S.10).aspx)

AIK for Windows 7 download

<http://www.microsoft.com/downloads/en/details.aspx?FamilyID=696dd665-9f76-4177-a811-39c26d3b3b34&displaylang=en>

Walkthrough: Create a Bootable Microsoft Windows PE RAM Disk on CD-ROM

[http://technet.microsoft.com/en-us/library/dd799303\(W.S.10\).aspx](http://technet.microsoft.com/en-us/library/dd799303(W.S.10).aspx)

Walkthrough: Create a Bootable Microsoft Windows PE RAM Disk on a USB Flash Disk

[http://technet.microsoft.com/en-us/library/dd744530\(W.S.10\).aspx](http://technet.microsoft.com/en-us/library/dd744530(W.S.10).aspx)

Walkthrough: Create a Bootable Microsoft Windows PE RAM Disk on a Hard Disk

[http://technet.microsoft.com/en-us/library/dd744359\(W.S.10\).aspx](http://technet.microsoft.com/en-us/library/dd744359(W.S.10).aspx)

DiskPart utility

<http://technet.microsoft.com/en-us/library/bb490893.aspx>

DiskExt utility

<http://technet.microsoft.com/en-us/sysinternals/bb896648.aspx>

Getting Started Guide for Windows Deployment Services

[http://technet.microsoft.com/en-us/library/cc771670\(W.S.10\).aspx](http://technet.microsoft.com/en-us/library/cc771670(W.S.10).aspx)

Partition alignment for SUSE Linux

<http://www.novell.com/support/viewContent.do?externalId=7007193&sliceId=1>

Intel RST support for 4-KB sectors

<http://www.intel.com/support/chipsets/ismm/sb/CS-031502.htm>

IDEMA Advanced Format downloads

<http://www.idema.org/?p=1563>

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