



Business Desktops

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White Paper

Implementing Serial ATA on HP Business Desktops

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Abstract

This Technical Whitepaper covers the implementation of Serial ATA (SATA) technology on HP Desktop systems. This is not intended as a comprehensive overview of SATA technology.

Introduction

What is SATA?

SATA stands for Serial Advanced Technology Attachment. It is a new high-speed serial interface for mass storage that will eventually replace Parallel ATA (PATA), the current mass storage attachment standard.

Benefits of SATA

- **Higher bandwidth.** First generation SATA is 150MB/s transfer rate, the second generation is 300 MB/s. PATA is getting close to reaching its maximum limit at 100MB/s.
- **Thinner and longer cables.** SATA cables, 7 pins wide and up to 39.37 inches (1M) long, allow for better routing and cooling in a chassis. PATA ribbon cables are wide, 40 or 80 conductors, and limited to 18 inches.
- **Lower voltage.** SATA should allow the drive to operate at a lower data interface voltage via differential signaling. SATA drives use a lower data signaling voltage, 600mV, than PATA, 5V. SATA also uses a lower power delivery (3.3V, 12V) from the power supply than PATA (5V, 12V).
- **No jumpers.** SATA hard drives do not require jumpers to configure the drives. There is no longer Device 0, Device 1, or cable-select modes. SATA has a one-drive, one-connector relationship.

HP SATA-Ready

An HP SATA-ready system has a fully functional onboard SATA controller, onboard SATA sockets, SATA-compliant BIOS, and a power supply with SATA power connectors. Early HP SATA-ready systems will not be shipped from the factory with any SATA hard drives or their associated SATA cables. SATA hard-drive kits will be available through the HP website—these kits will include associated SATA cables. SATA configured systems will be available through the factory in the near future.



HP initial SATA-ready system will be able to support a maximum of two SATA devices. Certain chassis will only be able to physically support one SATA device. Also see the Attachment at the end of this document, [Valid PATA/SATA Configurations \(mixing rules\)](#), for more information regarding valid PATA/SATA configurations.

Hardware/ Software Considerations

Hardware

SATA Hard Drives

The maturity of SATA technology has increased rapidly. Some early SATA devices may be available on the market, but may not be of a high level of reliability. To this end, only SATA devices manufactured after June 2003 will be shipped and supported on HP systems.

Onboard SATA Sockets

The Intel I/O Controller Hub 5 (ICH5) Serial ATA Host Controller Interface (SATA-HCI) supports two SATA ports. Each port communicates point-to-point with the hard drive attached so that only one SATA drive can be attached to any single SATA port. Since there is no Device 0/Device 1 relationship, there are no jumpers to configure on SATA hard drives.

The number of physical SATA ports available on initial HP desktop systems will depend upon the particular model. All models will have two SATA ports available, except for the d530 Ultra-slim model, which was designed with only one port due to its compact size.

SATA Data Cable

The SATA Data Cable is dramatically unlike those of traditional PATA drives, as SATA uses a differential signaling protocol through a thin, 7-pin cable versus the current IDE 40/80 conductor cable. Figure 1 below shows a close-up of a SATA Data Cable connector header.



Figure 1: SATA Data Cable

The signal definition of the 7-pin connector includes 3 grounds, 2 transmit and 2 receive pins (see the following chart for the specific pin designation). On the device plug, the transmit pins are pins 2 and 3 and the receive pins are pins 5 and 6. On the host plug, this is reversed: 5 and 6 are the transmit pins and 2 and 3 are the receive pins.

Pin definitions of the SATA data connector

Pin	Usage	Notes
P1	GND	
P2	A+	Differential signal pair A
P3	A-	
P4	GND	
P5	B-	Differential signal pair B
P6	B+	
P7	GND	

SATA Power Connector

The power supply used in HP SATA-ready desktop systems will provide appropriate SATA power connectors. HP SATA-ready systems will have one SATA power connector for each SATA socket on the motherboard.

SATA hard drives use a different power connector than the traditional 4-pin PATA power connector. The SATA power connector is a 15-pin connector (see the following chart for the specific pin definition). System power supplies must be capable of delivering 12V, 5V and 3.3V voltages.

Pin definitions of a SATA power connector:

Pin	Usage	Notes
P1	V3.3	3.3V power
P2	V3.3	3.3V power
P3	V3.3	3.3V power
P4	GND	
P5	GND	
P6	GND	
P7	V5	5V power
P8	V5	5V power
P9	V5	5V power
P10	GND	
P11	Reserved	
P12	GND	
P13	V12	12V power
P14	V12	12V power
P15	V12	12V power

Figures 2 and 3 following show the connection of the SATA Data Connector to the hard drive interface and a close-up of the SATA Data Cable and Power Socket aligned with the hard drive interface connector.

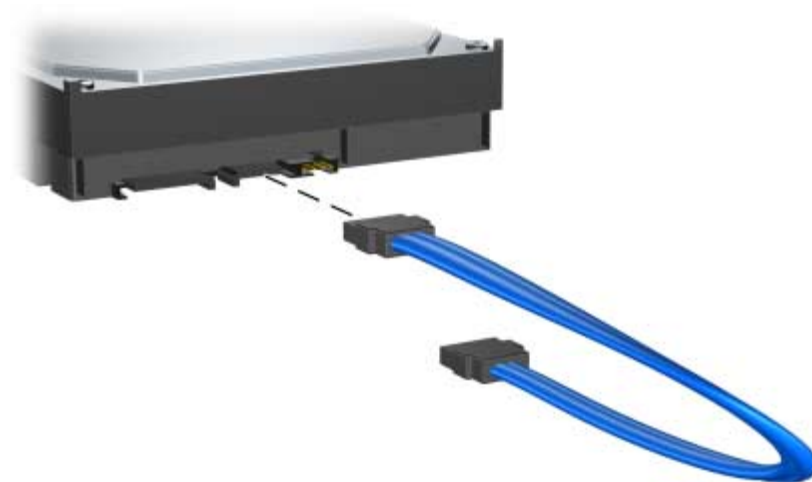


Figure 2: Interface for SATA Data Connector

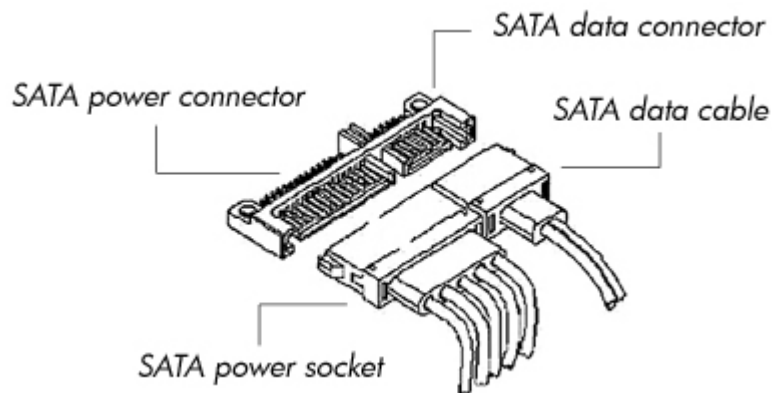


Figure 3: SATA interface connectors



Customers who decide to use SATA hard drives on older systems through an add-in SATA controller must purchase a power adapter cable to convert a traditional power connector to a SATA power connector. Also, since the older power supplies do not have 3.3V capability, only SATA drives with 5V/12V power interfaces can be used on older systems.

BIOS

This section provides a progressive discussion of the overall BIOS strategy in implementing SATA technology. First, the fundamental differences between Legacy Mode and Native mode are defined. Next is a look at how these modes are aligned under their respective controllers when the SATA Configurations are in either **Add as Separate Controller** (Enhanced Mode; the BIOS default setting) or **Replace Primary IDE Controller** (Compatibility Mode). These modes are discussed in more detail later (see [BIOS Settings: F10 Setup](#)). A Quick View Chart at the end of this section organizes these modes graphically.

Modes of Operation

Two addressing and interrupt servicing modes are available for accessing AT Attachment (ATA) mass storage devices: Legacy Mode and Native Mode. In both modes of operation, commands and status are passed between the host and device through the ATA Command Block and Control Block registers. These two register blocks have separate I/O base addresses.

Legacy Mode

This mode is traditionally used to access devices attached to embedded IDE controllers, and it is the mode assumed by many legacy operating systems.

Each channel requires two I/O address ranges and an IRQ. These resources are fixed and cannot be changed.

- Primary Channel
Command Block: 1F0h – 1F7h
Control Block: 3F6h
IRQ 14
- Secondary Channel
Command Block: 170h – 177h
Control Block: 376h
IRQ 15

Native Mode

This mode is traditionally used to access devices attached to add-in cards, and it is not supported by many legacy operating systems.

Addresses are assigned by PCI Plug-n-Play BIOS. The IRQ is shared with multiple controllers. Base Address Registers for the Command and Control Block are found in the PCI Configuration Space:

- Offset 10h – Primary Command base address
- Offset 14h – Primary Control base address
- Offset 18h – Secondary Command base address
- Offset 1Ch – Secondary Control base address



Certain third-party, hard-drive-related applications may not function properly with SATA drives in Native Mode because the software assumes the drives are assigned the Legacy Mode resources.

BIOS Settings: F10
Setup

SATA can be configured in the system BIOS Setup utility under **Storage Options**. Two options can be configured under **SATA Configuration: Add as a Separate Controller** and **Replace Primary IDE Controller**.



Current HP systems have the default **SATA Configuration** set to **Add as Separate Controller** to simplify configuration when installing a SATA device. This mode is appropriate in the Microsoft Windows 2000 or Windows XP operating system environment. See [Recommended Operating Systems](#).

Default Setting: Add as Separate Controller (Enhanced Mode)

- Required for Windows 2000 and Windows XP
- Parallel ATA controller in Legacy Mode
- SATA controller in Native mode

This allows for a maximum of 6 devices, 4 PATA and 2 SATA, to be connected simultaneously (see [SATA Configuration Table](#) later).



The maximum number of devices may be further limited by the number of chassis drive bays, SATA power connectors on the power supply, and SATA data connectors.

Non-default Setting: Replace Primary IDE Controller (Compatibility Mode)

- Both PATA and SATA controllers are in Legacy Mode
- To be used with these operating systems: Windows 9x, Windows NT, and Linux

This allows for a maximum of 4 devices, 2 PATA and 2 SATA, to be connected simultaneously. SATA device 0 is mapped into the Primary Device 0 location and SATA device 1 is mapped to the Primary Device 1 location. In this mode, any PATA devices physically attached to the Primary PATA channel will become inaccessible to the operating system (see [SATA Configuration Table](#) later).

Quick View Chart:

Default (BIOS setting)	Non-Default (BIOS setting)
Enhanced Mode: Add as Separate Controller	Compatibility Mode: Replace Primary IDE Controller
PATA in Legacy Mode SATA in Native Mode	PATA & SATA in Legacy Mode
Windows 2000 & Windows XP	Windows 9x, Windows NT, Linux

Boot Ordering in BIOS Setup

The **Boot Order** menu specifies the order in which storage devices (e.g., diskette, IDE CD-ROM, hard disk, NIC) are booted. The designation of Hard Disk under the menu represents the specific hard drive that is booted.

The default boot order from F10 Setup is:

- CD-ROM
- Diskette drive (A:)
- USB device
- Hard drive (C:)
- Network controller

The **Controller Order** menu specifies which controller is booted first.

The default controller order from F10 Setup is:

- Integrated IDE
- Integrated SATA

The order in which hard drives attached to a single controller are assigned drive letters is fixed and cannot be changed. For the integrated PATA controller, the order is

- Primary Device 0
- Primary Device 1
- Secondary Device 0
- Secondary Device 1

For the integrated SATA controller, the order is

- SATA 0
- SATA 1

SATA Configuration Table:

The following table illustrates the order in which hard drives are assigned drive letters for various combinations of SATA Configuration and Controller Order Setup options:

SATA Configuration	Controller Order	HDD Boot and Drive Letter Ordering
Add as a Separate Controller (default)	<ol style="list-style-type: none"> 1. Integrated IDE 2. Integrated SATA 	<ol style="list-style-type: none"> 1. IDE Primary Device 0 2. IDE Primary Device 1 3. IDE Secondary Device 0 4. IDE Secondary Device 1 5. SATA 0 6. SATA 1
Add as a Separate Controller	<ol style="list-style-type: none"> 1. Integrated SATA 2. Integrated IDE 	<ol style="list-style-type: none"> 1. SATA 0 2. SATA 1 3. IDE Primary Device 0 4. IDE Primary Device 1 5. IDE Secondary Device 0 6. IDE Secondary Device 1
Replace Primary IDE Controller	<ol style="list-style-type: none"> 1. Integrated IDE 2. Integrated SATA 	<ol style="list-style-type: none"> 1. IDE Secondary Device 0 2. IDE Secondary Device 1 3. SATA 0 4. SATA 1
Replace Primary IDE Controller	<ol style="list-style-type: none"> 1. Integrated SATA 2. Integrated IDE 	<ol style="list-style-type: none"> 1. SATA 0 2. SATA 1 3. IDE Secondary Device 0 4. IDE Secondary Device 1

Operating System

Recommended Operating Systems

When attaching SATA devices, HP recommends using one of the following operating systems:

- Windows XP Home Edition
- Windows XP Professional Edition
- Windows 2000 Professional Edition

These operating systems support accessing two controllers in Legacy Mode and additional controllers in Native Mode. By default, the HP BIOS configures the Primary and Secondary PATA controllers in Legacy Mode and the SATA controller in Native Mode. This is the recommended mode for these operating systems.

The shipping image contains each SATA-related Microsoft Quick Fix Engineering (QFE) available at the time of release.

Quick Fix Engineering (QFE)

Three QFEs must be applied for SATA. They can be obtained from:

- Q812415 <http://support.microsoft.com/default.aspx?scid=kb;en-us;812415>
- Q322359 <http://support.microsoft.com/default.aspx?scid=kb;en-us;322359>
- Q817472 <http://support.microsoft.com/default.aspx?scid=kb;en-us;817472>

ATAPI.SYS is replaced by both Q812415 and Q817472, but, if the QFEs are installed properly, the one from Q817472 is the one used. For Q817472 to take effect, an additional registry entry is required. Refer to the Microsoft Knowledge Base article relating to Q817472 at the corresponding webpage for more information.

Drivers

ATAPI.SYS	from Q817472 (Timeout/CRC QFE)
XP	5.1.2600.1211, 4/23/03
2K	5.0.2195.6741, 4/28/03
PCIINDEX.SYS	from Q812415 (S1 QFE)
XP	5.1.2600.1164, 1/31/03
2K	5.0.2195.6672, 2/25/03
INTELIDE.SYS	from Q322359 (ICH5 QFE)
XP	5.1.2600.1170, 2/19/03
2K	5.0.2195.6666, 2/19/03
MSHDC.INF	from Q322359 (ICH5 QFE)
XP	5.1.2600.1184, dated 3/12/03
2K	5.0.2195.6666, dated 2/19/03

Non-recommended Operating Systems

- Windows 9X and Windows NT:
These operating systems are not recommended for use with SATA because they do not comprehend the controller operating in Native Mode.
- Linux:
Linux currently does not have Native Mode SATA support. Users wishing to use SATA on these operating systems must configure the SATA subsystem for Legacy Mode (Replace Primary IDE Controller) in the BIOS Setup utility.

Future of SATA

PATA is nearing the end of its scalability. At 100MB/s, it has hit a ceiling in its data transfer rate. SATA, on the other hand, is in its first generation, and much higher transfer rates are already planned for the future. SATA scalability:

First generation SATA transfer rate	150MB/s
Second generation SATA transfer rate	300MB/s
Third generation SATA transfer rate	600MB/s

HP plans to implement SATA fully over the coming years as the technology matures.

SATA on the WWW

SATA working group website:

<http://www.serialata.org/>

FAQ for Serial ATA and Windows:

http://www.microsoft.com/whdc/hwdev/tech/storage/serialATA_FAQ.msp

Attachment: Valid PATA/SATA Configurations (mixing rules)

SATA and PATA devices can work together in a single system, but how and where the devices are installed and configured must follow certain rules. The following charts ([Windows XP/Windows 2000](#) and [Windows 98/Windows NT](#)) show valid hard drive and optical drive configurations.

Global Rules:

1. HP systems from the factory will have either all PATA or all SATA drives, not a mix of the two.
2. A PATA hard drive should not be configured with a PATA optical device on the same controller. For example, an optical drive configured in the Device 1 position with a hard drive as the Device 0 is not recommended.
3. A PATA device should never be attached to the Device 1 position without another device attached as the Device 0.

Assumptions:

1. This chart displays a chassis capable of installing a total of six devices.



Six hard drives can only be installed in chassis with sufficient bays, and, in many cases, the maximum number of hard drives may displace other devices, such as the internal diskette drive.

2. There are no power cable restrictions: the power supply is capable of supporting up to four PATA devices and two SATA devices.

Windows XP/Windows 2000 (with default BIOS setting)

Configs	PATA/SATA Ports					
	Primary Device 0	Primary Device 1	Secondary Device 0	Secondary Device 1	SATA 0	SATA 1
1	HDD		ODD			
2	HDD		ODD	ODD		
3	HDD	HDD	ODD			
4	HDD	HDD	ODD	ODD		
5			ODD		HDD	
6			ODD	ODD	HDD	
7			ODD		HDD	HDD

Configs	PATA/SATA Ports					
	Primary Device 0	Primary Device 1	Secondary Device 0	Secondary Device 1	SATA 0	SATA 1
8			ODD	ODD	HDD	HDD
9	HDD		ODD		HDD	
10	HDD		ODD	ODD	HDD	
11	HDD	HDD	ODD		HDD	
12	HDD	HDD	ODD	ODD	HDD	
13	HDD		ODD			HDD
14	HDD		ODD	ODD		HDD
15	HDD	HDD	ODD			HDD
16	HDD	HDD	ODD	ODD		HDD
17	HDD		ODD		HDD	HDD
18	HDD		ODD	ODD	HDD	HDD
19	HDD	HDD	ODD		HDD	HDD
20	HDD	HDD	ODD	ODD	HDD	HDD
21	HDD					
22	HDD	HDD				
23	HDD				HDD	
24	HDD	HDD			HDD	
25	HDD				HDD	HDD
26	HDD	HDD			HDD	HDD
27	HDD		HDD			
28	HDD	HDD	HDD			
29	HDD		HDD	HDD		
30	HDD	HDD	HDD	HDD		
31					HDD	
32						HDD
33					HDD	HDD
34			HDD		HDD	
35			HDD	HDD	HDD	
36			HDD			HDD
37			HDD	HDD		HDD
38			HDD	HDD	HDD	HDD
39	HDD	HDD	HDD	HDD	HDD	HDD

HDD = Hard Disk Drive ODD = Optical Disk Drive

Windows 98/Windows NT (with non-default BIOS setting)

Configs	PATA/SATA Ports					
	Primary Device 0	Primary Device 1	Secondary Device 0	Secondary Device 1	SATA 0	SATA 1
1	HDD		ODD			
2	HDD		ODD	ODD		
3	HDD	HDD	ODD			
4	HDD	HDD	ODD	ODD		
5			ODD		HDD	
6			ODD	ODD	HDD	
7			ODD		HDD	HDD
8			ODD	ODD	HDD	HDD

HDD = Hard Disk Drive ODD = Optical Disk Drive

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