Ultra ATA/100 Extends Existing Technology While Increasing Performance and Data Integrity

High-Speed Hard Drive Interface Increases the Ultra ATA/66 Burst Transfer Rate to 100 MB/s

Overview/Executive Summary

PC performance increases steadily from year to year due to the constant development of high-speed microprocessors. As microprocessors become faster and faster, a corresponding increase in data transfer rates between hard drives and system memory is required. For desktop and portable computers, the Advanced Technology Attachment (ATA) interface is the most popular protocol for moving data between the hard drive controller and system memory.

Ultra ATA/100 is the latest version of the ATA hard drive data transfer protocol. A low-cost extension of the Ultra ATA/66 hard drive interface, Ultra ATA/100 increases burst data rates significantly over previous iterations of the protocol. Also known as Ultra DMA/100 and Feature ATA, Ultra ATA/100 allows host computers to send and receive data at 100 MB/s—considerably faster than the 66.6 MB/s data transfer speeds of Ultra ATA/66. The result is maximum disk performance under PCI local bus environments.

At its fast burst data rates, Ultra ATA/100 will go farther than Ultra ATA/66 in removing bottlenecks associated with data transfers, especially during sequential operations. Ultra ATA/100 also delivers heightened data integrity to the EIDE interface through use of a 40-pin 80-conductor cable, and CRC (Cyclic Redundancy Check) error detection code. The 80-conductor cable reduces crosstalk and improves signal integrity by providing 40 additional ground lines between the 40-pin IDE signal and ground lines. The connector is plug-compatible with existing 40-pin headers, and the incremental cost for the cable should be minimal. As with Ultra ATA/66, CRC ensures the integrity of transferred data.
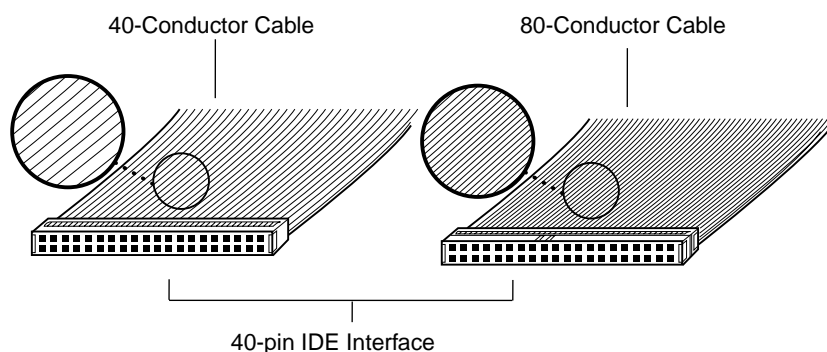

Figure 1. Ultra ATA/100 40-Pin, 80-Conductor Cable

Newly introduced Western Digital hard drives support Ultra ATA/100. They transmit and receive data at higher rates, and thereby provide better performance. The Ultra ATA/100 protocol is also endorsed by the industry's leading chipset and motherboard manufacturers.

Ultra ATA/100 hard drives are 100 percent backwards compatible with Ultra ATA/66, Ultra ATA/33, and DMA, as well as with existing EIDE/IDE hard drives, CD-ROM drives, and host systems.

Background

Ultra ATA/100 is the latest ATA/IDE hard drive data transfer protocol for moving data between the hard drive buffer and the system memory. The previous interface was Ultra ATA/66, with a maximum burst transfer rate of 66.6 MB/s. Prior to Ultra ATA/66 was Ultra ATA/33 with a maximum burst transfer rate of 33.3 MB/s.

By increasing the burst transfer rates of IDE drives, Ultra ATA/100 brings the effective transfer rate of the system's bus and the drive's internal data rate that much closer into balance. Ultra ATA/100 allows system designers to provide greater system throughput, particularly for long sequential transfers required by audio/visual applications.

Host data transfer rates must exceed media data transfer rates or else performance is reduced because of additional revolutions due to buffer full/empty conditions on reads/writes. The following chart plots the media data transfer rates over time (represented by the trendline), thus indicating the need for ever-higher host data transfer rates (represented by the shaded area).
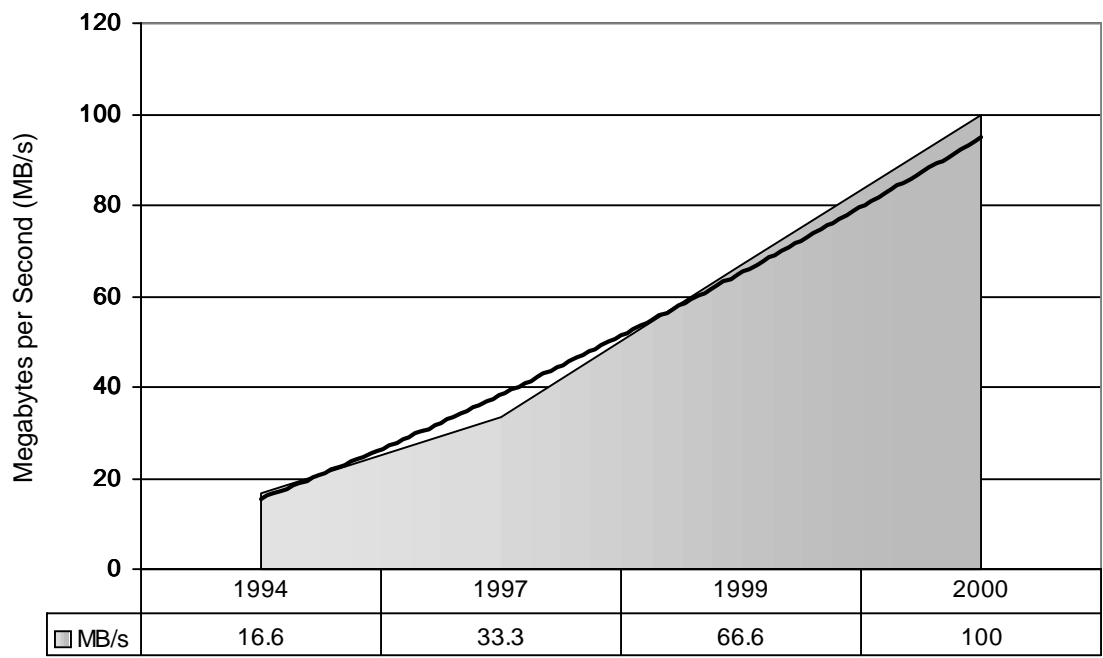
	1994	1997	1999	2000
☐ MB/s	16.6	33.3	66.6	100

Figure 2. Host and Media Data Transfer Rate Increase Over Time

As demonstrated in "Figure 2. Host and Media Data Transfer Rate Increase Over Time" on page 2, the industry has supported host transfer data rates doubling previously:

Host Transfer Data Rate Increase		
Mode	Rate	Year of Introduction
DMA Mode 2	16.6 MB/s	1994
Ultra ATA/33	33.3 MB/s	1997
Ultra ATA/66	66.6 MB/s	1999
Ultra ATA/100	100 MB/s	2000

With continued expansions in disk capacity and higher rotational speeds, the hard drive's internal disk rates also continue to increase. The transfer of large files, often written sequentially on the hard drive, is particularly affected by the transfer rate. During sequential reads, the hard drive, because of its fast internal data rate, may fill its buffer faster than the host can empty it when using the Ultra ATA/66 or the older multi-word DMA interfaces. Performance bottlenecks usually result in this connection between the host and the hard drive. Improving the interface to keep up with internal data rate improvements is exactly what Ultra ATA/100 achieves.

As previously mentioned, fast host data transfer rates help maintain sequential media transfers, but they also accelerate cache hits. The following table is based on all commands being either a cache hit (data comes from the buffer and has <1 ms latency), or a cache miss (data comes from the media and has >10 ms latency.)

Ultra ATA/100 Performance Benefit		
	Cache Miss	Cache Hit
Sequential	Yes	Yes
Random	No	Yes

Ultra ATA/100 Further Improves Transferred Data Integrity

The way signaling was performed on the ATA bus up through multi-word DMA Mode 2 (16.6 MB/s) was to send data in synchronous strobe mode but on the positive transition of the strobe signal only. The breakthrough Ultra ATA/33 extension was key to using both the positive and negative transitions of the strobe signal, effectively doubling the available transition frequency without actually increasing the frequency of the strobe. The result was to double the burst transfer rate. By having the hard drive as the source of both the strobe and the data during a read, Ultra ATA/33 eliminated both propagation and data turnaround delays. The elimination of these delays improved the timing margins. Ultra ATA/100 retains the same strobe frequency but increases the burst transfer rate three-fold over Ultra ATA/33.

The progressive advantage of Ultra ATA/100 is to increase transfer rates. However, a new 80-conductor cable is needed to ensure data integrity. The 40-pin interface cable of the earlier Ultra ATA/33 and multi-word DMA interfaces cannot handle the shorter cycle times for a 66.6 MB/s or 100 MB/s burst rate. The 80-conductor cable retains the same connector configuration as the standard 40-pin interface cable but has ground lines interleaved between all

signal lines. In other words, the 40 new lines are all ground (which act as shields) and no new signals are transferred.

Ultra ATA/33 introduced CRC (Cyclical Redundancy Check), a feature new to IDE that provides data protection verification. Ultra ATA/100 uses the same process. The CRC is calculated on a per-burst basis by both the host and the hard drive, and is stored in their respective CRC registers. At the end of each burst, the host sends the contents of its CRC register to the hard drive, which then compares it against its own register's contents. If the hard drive reports errors to the host, then the host retries the command containing the CRC error.

No change in the Ultra DMA protocol is required for Ultra ATA/100. When the protocol is used at speeds slower than 33.3 MB/s, both signal and data integrity still surpass that of multi-word DMA and earlier protocols at a given burst transfer rate, providing even greater data integrity margins.

Backward Compatibility

The Ultra ATA/100 protocol and commands are designed to be compatible with existing ATA devices and systems. Drives implementing Ultra ATA/100 are fully backwards compatible with older ATA modes, including Ultra ATA/66. It will handle all the data transfer modes. The slower modes will be supported with a different clock signal and clock divider. The slower modes previously worked with a standard 40-pin interface cable, but Ultra ATA/100 requires a 40-pin, 80-conductor cable for modes 3, 4, and 5.

	Data Transfer Rate (max.)	Cable	Conductors	CRC
DMA Mode 1	11.1 MB/s	40-pin IDE	40-pin	No
Multi-word DMA Mode 1	13.3 MB/s	40-pin IDE	40-pin	No
Multi-word DMA Mode 2	16.6 MB/s	40-pin IDE	40-pin	No
Ultra ATA Mode 2	33.3 MB/s	40-pin IDE	40-pin	Yes
Ultra ATA Mode 2	44.4 MB/s	40-pin IDE	40-pin	Yes
Ultra ATA Mode 4	66.6 MB/s	40-pin IDE	80-pin	Yes
Ultra ATA Mode 5	99.9 MB/s	40-pin IDE	80-pin	Yes

Hard drives that support Ultra ATA/100 also support Ultra ATA/66 and multi-word DMA, and can be used with existing multi-word DMA host systems. Installed PCs without Ultra ATA/100 capability can use new hard drives in legacy ATA modes at transfer rates up to 66.6 MB/s. However, by upgrading with an Ultra ATA/100 PCI adapter card, they can also take advantage of the interface's newer speed and data integrity features.

PC vendors who would like to incorporate the advantages of Ultra ATA/100 in new systems can do so by using new chipsets and motherboards from Intel and other leading vendors that license the technology. Although a new cable is required for Ultra ATA/100, the chipset pin count remains the same at 40.

System Requirements for Ultra ATA/100

To use the Ultra ATA/100 technology, a system must have:

1. *Ultra ATA/100 compatible logic either on the system motherboard, or on an Ultra DMA PCI adapter card*
2. *Ultra DMA compatible BIOS*
3. *DMA-aware device driver for the operating system*
4. *Ultra ATA/100-compatible IDE device such as a hard drive or CD-ROM drive*
5. *40-pin 80-conductor cable*

Western Digital's Future Hard Drives

With Ultra ATA/100, data integrity takes another leap forward, especially when coupled in Western Digital hard drives with Data Lifeguard™, an exclusive Western Digital feature that automatically detects, isolates and repairs problem areas on hard drives to prevent data loss. This continuous self-tuning process scans and repairs while the drive is idle. Data Lifeguard is both an enhancement and an extension to Western Digital's S.M.A.R.T. (Self Monitoring, Analysis and Reporting Technology) System that monitors and predicts the performance of hard disk drives. Data Lifeguard works independently from S.M.A.R.T. to provide a self-healing capability.

Together with Data Lifeguard, the Ultra ATA/100 feature enables Western Digital's new hard drives not only to provide maximum disk performance under PCI local bus environments, but also to furnish the highest data integrity possible.

Frequently Asked Questions

1. *I have an Ultra ATA/33 system today. How can I support Ultra ATA/100?*

   An existing system can be upgraded by purchasing a PCI-EIDE controller that supports Ultra ATA/100.

2. *Do Microsoft Operating Systems support Ultra ATA?*

   Windows releases indicate that they all support DMA transfers. The Ultra ATA data transfer rate is determined by your HDD, your controller, the BIOS, and the operating system. This applies for all the following Windows operating systems:
   - Windows 95 OEM Service Release 2 and higher
   - Windows NT Service Pack 3 and higher

3. *I don't have a system that supports Ultra ATA/100, can I run the Ultra ATA/100 HDD in it?*

   Yes, the HDD will not run in UATA/100 mode but instead is a slower compatible mode such as Ultra ATA/66, Ultra ATA/33 (33.3 MB/s), DMA Mode 2 (16.6 MB/s) or PIO Mode 4 (16.6 MB/s).