ATA, IDE and EIDE

Overview

The **ATA** (*Advanced Technology Attachment*) standard is a standard interface that allows you to connect storage peripherals to PC computers. The ATA standard was developed on May 12, 1994 by the ANSI (document X3.221-1994).

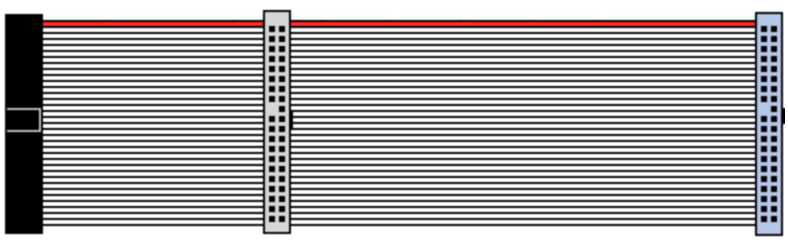
Despite the official name "ATA", this standard is better known by the commercial term **IDE** (*Integrated Drive Electronics*) or **Enhanced IDE** (**EIDE** or **E-IDE**).

The ATA standard was originally intended for connecting hard drives, however an extension called **ATAPI** (**ATA Packet Interface**) was developed in order to be able to interface other storage peripherals (CD-ROM drives, DVD-ROM drives, etc.) on an ATA interface.

Since the Serial ATA standard (written *S-ATA* or *SATA*) has emerged, which allows you to transfer data over a serial link, the term "**Parallel ATA**" (written *PATA* or *P-ATA*) sometimes replaces the term "ATA" in order to differentiate between the two standards.

The Principle

The ATA standard allows you to connect storage peripherals directly with the motherboard thanks to a **ribbon cable**, which is generally made up of 40 parallel wires and three connectors (usually a blue connector for the motherboard and a black connector and a grey connector for the two storage peripherals).



On the cable, one of the peripherals must be declared the **master** cable and the other the **slave**. It is understood that the far connector (black) is reserved for the master peripheral and the middle connector (grey) for the slave peripheral. A mode called **cable select** (abbreviated as **CS** or **C/S**) allows you to automatically define the master and slave peripherals as long as the computer's BIOS supports this functionality.

PIO Modes

Data transmission occurs thanks to a protocol called **PIO** (*Programmed Input/Output*), which allows peripherals to exchange data with the RAM with the help of commands managed directly by the processor. However, large data transfers can quickly impose a large workload on the processor and slow down the whole system. There are 5 PIO modes that define the maximum throughput:

PIO Mode	Throughput (Mb/s)
Mode 0	3.3
Mode 1	5.2
Mode 2	8.3
Mode 3	11.1
Mode 4	16.7

DMA Modes

The **DMA** (*Direct Memory Access*) technique allows computers to free up the processor by allowing each of the peripherals to directly access the memory. There are two types of DMA modes:

- The "single word" DMA, which permits the transfer of one single word (2 bytes or 16 bits) during each transfer session
- The "multi-word" DMA, which permits the successive transfer of several words in each transfer session

The following table lists the different DMA modes and their associated throughputs:

DMA Mode	Throughput (Mb/s)
0 (Single word)	2.1
1 (Single word)	4.2
2 (Single word)	8.3
0 (Multi-word)	4.2
1 (Multi-word)	13.3
2 (Multi-word)	16.7

Ultra DMA

The ATA standard is originally based on an asynchronous transfer mode, i.e. sending commands and sending data are clocked to the bandwidth of the bus and occur at each **rising edge** of the clock signal. However, sending commands and sending data do not occur simultaneously, i.e. a command cannot be sent as long as the data has not been received and vice versa.

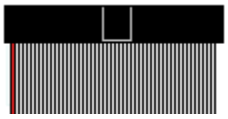
In order to increase the data throughput, it may seem logical to increase the clock signal frequency. However, on an interface where data are sent in parallel, increasing the frequency poses problems of electromagnetic interference.

Thus, **Ultra DMA** (sometimes abbreviated as **UDMA**) was designed with the goal of optimising the ATA interface as much as possible. The first concept of Ultra DMA consists in using the rising edges as well as the falling edges of the signal for the data transfers, meaning an increase in speed of 100% (with the throughput increasing from 16.6 Mb/s to 33.3 Mb/s). Moreover, **Ultra DMA** introduces the use of CRC codes for the detection of transmission errors. Thus, the different Ultra DMA modes define the frequency of data transfer. When an error occurs (when the received CRC does not correspond to the data), the transfer occurs in a lower Ultra DMA mode, or even without Ultra DMA.

Ultra DMA Mode	Throughput (Mb/s)
UDMA 0	16.7
UDMA 1	25.0

UDMA 2 (Ultra-ATA/33)	33.3
UDMA 3	44.4
UDMA 4 (Ultra-ATA/66)	66.7
UDMA 5 (Ultra-ATA/100)	100
UDMA 6 (Ultra-ATA/133)	133

With the introduction of Ultra DMA mode 4, a new type of cable ribbon was introduced in order to limit crosstalk. This type of ribbon cable adds 40 wires (for a total of 80) that are interleaved with the data wires in order to isolate them and have the same connectors as the 40-wire cable ribbon.



Only Ultra DMA modes 2, 4, 5 and 6 are truly implemented by hard drives.

ATA Standards

The ATA standard comes in several versions, which were introduced successively:

ATA-1

The **ATA-1** standard, better known as IDE, allows you to connect two peripherals on a 40-wire cable and offers an 8 or 16-bit transfer rate with a throughput of the order of 8.3 Mb/s. **ATA-1** defines and supports *PIO modes* (*Programmed Input/Output*) 0, 1 and 2 as well as **multi-word DMA mode** (**Direct Memory Access**) 0.

ATA-2

The **ATA-2** standard, better known as **EIDE** (or sometimes **Fast ATA**, **Fast ATA-2** or **Fast IDE**), allows you to connect two peripherals on a 40-wire cable and offers an 8 or 16-bit transfer rate with a throughput of the order of 16.6 Mb/s.

ATA-2 supports **PIO modes** 0, 1, 2, 3 and 4 and **multi-word DMA modes** 0, 1 and 2. In addition, ATA-2 allows you to increase the maximum disk size from 528 Mb, which is imposed by the ATA-1 standard, to 8.4 Gb thanks to **LBA** (*Large Block Addressing*).

ATA-3

The **ATA-3** standard (also called *ATA Attachment 3 Interface*) represents a minor revision of ATA-2 (with downward compatibility) and was published in 1997 under the standard X3.298-1997. The ATA-3 standard brings the following improvements:

- Improved reliability: ATA-3 enables the increased reliability of high-speed transfers
- **S.M.A.R.T** (*Self-Monitoring Analysis and Reporting Technology*: a function intended to improve reliability and prevent against failures
- Security function: the peripherals can be protected by a password added to the BIOS. When the computer is started, it verifies that the password encoded in the BIOS corresponds to the one stored on the drive. This allows you to prevent the drive from being used on a different computer.

ATA-3 is not a new mode but supports *PIO modes* 0, 1, 2, 3 and 4 as well as**DMA modes** 0, 1 and 2.

ATA-4

The **ATA-4** standard, or **Ultra-ATA/33**, was defined in 1998 under the standard ANSI NCITS 317-1998. ATA-4 modifies the LBA mode in order to increase the disk size limit to 128-Gb drives.

LBA addresses in ATA-4 are 28-bit. Each sector represents 512 bytes, so the exact disk size limit in LBA mode is as follows:
2^{28}*512 = 137 438 953 472 bytes
137 438 953 472/(1024*1024*1024)= 128 Gb

ATA-5

In 1999, the **ATA-5** standard defined two new transfer modes: **Ultra DMA modes 3 and 4** (mode 4 is also called *Ultra ATA/66* or *Ultra DMA/66*). What is more, it offers automatic detection of the type of ribbon cables being used (80 or 40 wires).

ATA-6

Since 2001, **ATA-6** defines **Ultra DMA/100** (also called *Ultra DMA mode 5* or *Ultra-ATA100*), which allows drives to theoretically reach throughputs of 100 Mb/s.

In addition, ATA-6 defines a new functionality, called *Automatic Acoustic Management* (**AAM**), which allows drives that support this function to automatically adjust access speeds in order to reduce running noise.

Finally, the ATA-6 standard allows a 48-bit LBA of the sectors of the hard drive, called LBA48 (Logical Block Addressing 48 bits). Thanks to LBA48, it is possible to use 2^48 hard drives with 512 bytes per sector, which equals a disk size limit of 2 petabytes.

ATA-7

The **ATA-7** standard defines **Ultra DMA/133** (also called *Ultra DMA mode 6* or *Ultra-ATA133*), which allows drives to theoretically reach throughputs of 133 Mb/s.

Summary Table

Name	ANSI Standard	Synonym	Mode (PIO/DMA)	Throughput (Mb/s)	Comments
ATA-1	ANSI X3.221-1994	IDE	PIO mode 0	3,3	
			PIO mode 1	5,2	
			PIO mode 2	8,3	
			DMA mode 0	8,3	
ATA-2	ANSI X3.279-1996	EIDE, Fast ATA, Fast ATA-2	PIO mode 3	11,1	28-bit LBA
			PIO mode 4	16,7	
			DMA mode 1	13,3	
			DMA mode 2	16,7	

ATA-3	ANSI X3.298-1997		PIO mode 3	11,1	SMART, 28-bit LBA
			PIO mode 4	16,7	
			DMA mode 1	13,3	
			DMA mode 2	16,7	
ATA-4/ATAPI-4	ANSI NCITS 317-1998	Ultra-ATA/33, UDMA 33, Ultra DMA 33	UDMA mode 0	16,7	Ultra DMA 33 and supports CD-ROMs (ATAPI)
			UDMA mode 1	25,0	
			UDMA mode 2	33,3	
ATA-5/ATAPI-5	ANSI NCITS 340-2000	Ultra-ATA/66, UDMA 66, Ultra DMA 66	UDMA mode 3	44,4	Ultra DMA 66, uses a 80-wire cable
			UDMA mode 4	66,7	
ATA-6/ATAPI-6	ANSI NCITS 347-2001	Ultra-ATA/100, UDMA 100, Ultra DMA 100	UDMA mode 5	100	Ultra DMA 100, LBA48 and the AAC (Automatic Acoustic Management) function
ATA-7/ATAPI-7	ANSI NCITS 361-2002	Ultra-ATA/133, UDMA 133, Ultra DMA 133	UDMA mode 6	133	Ultra DMA 133

Source: http://en.kioskea.net/contents/392-ata-ide-and-eide