IDE/ATA Interface

Objectives

- Learn about each of the ATA standards
- Identify the ATA connector and cable
- Learn how to set jumpers for master, slave and cable select configurations
- Understand how IDE transfer data
- Learn about the newest form of ATA-Serial ATA

IDE Interface

The primary interface used to connect a hard disk drive to a PC is typically called IDE (Integrated Drive Electronics).

IDE refers to the fact that the interface electronics or controller is built into the drive and is not a separate board.

Although technically the correct name for the interface is ATA, many persist in using the IDE designation today.

The primary purpose of the hard disk controller, or interface, is to transmit and receive data to and from the drive.

IDE Origins

The earliest IDE drives were called hardcards and were nothing more than hard disks and controllers bolted together and plugged into a slot as a single unit.

Companies got the idea to redesign the controller to replace the logic board assembly on a standard hard disk and then mount it in a standard drive bay just like any other drive.

IDE Interface

As mentioned earlier, IDE (now referred to as ATA) is a generic term that applies to any drive with a built in disk controller.

ATA is a 16-bit parallel interface, meaning that 16 bits are transmitted simultaneously down the interface.

A new interface called a serial ATA was officially introduced in late 2000.

IDE Origins

Compaq was the first to incorporate a special bus adapter in its system to adapt the 98-pin AT(ISA) bus edge connector on the motherboard to a smaller 40-pin header-style connector.
IDE Bus Versions

- Four main types of IDE interfaces have been based on three bus standards.
  - Serial AT Attachment (SATA)
  - Parallel AT Attachment (ATA) IDE based on 16-bit ISA
  - XT IDE (based on 8-bit ISA)
  - MCA IDE (based on 16-bit Micro Channel)
- Of these, only the ATA versions are used today.
- The improved versions of parallel ATA are referred to as ATA-2 and higher.

ATA IDE

- Control Data Corporation, Western Digital, and Compaq created the first ATA-IDE interface drive and were first to establish the 40-pin ATA connector pinout.

ATA Standards

- The ATA interface is controlled by an independent group of representatives from major PC, drive, and component manufacturers called Technical Committee T13.
  - They are responsible for all interface standards relating to the parallel AT Attachment storage interface.
  - A second group called the Serial ATA Workgroup has formed to create the Serial ATA Standards.

ATA-1

- 40/44 pin connectors and cabling
- Master/slave drive configuration
- Signal timing for basic PIO and DMA modes
- CHS and LBA

ATA-2

- Faster PIO and DMA transfer modes
- Defined standard CHS/LBA translation methods for support drives up to 8.4G

ATA-3

- Eliminated single-word (8-bit) DMA transfer protocols
- SMART (Self Monitoring, Analysis, and Reporting Technology)
- Mandatory LBA support
- ATA security mode
ATA/ATAPI-4
- Ultra-DMA/33
- Integral ATAPI support
- Optional 80-conductor, 40-pin cable
- Another standard approved the same year, tailgate, defines standard for firewire external drives

ATAPI
- Advanced Technology Attachment Packet Interface (ATAPI)
  - Extension to the ATA specification
  - Enables non-hard drive devices to connect to the PC via ATA controllers
  - Same rules on jumper settings
  - Hard drives get BIOS thru the System BIOS and CMOS
  - Non-hard drives get BIOS thru an option ROM or software driver

ATA-5
- Ultra ATA/66
  - Faster transfer rate
  - Faster clock rate\(\Rightarrow\) increased interference
  - \(\Rightarrow\) require newer 40-pin, 80-conductor cable
- Cable-select feature
- Color-coded connectors
- CRC error detection

ATA-6
- Ultra ATA/100
- LBA address extended from \(2^{28}\) to \(2^{48}\) sectors
  - Support drives larger than 137GB
  - CHS addressing made obsolete
  - Sector count per command increased from 8 bits to 16 bits

ATA-7
- UDMA mode 6
  - 133MBps
- Included Serial ATA 1.0
- Last version of PATA?

SATA/ATAPI-8
- Still in draft stage
- Main feature
  - The replacement of read long/write long functions
  - Improved HPA management
  - Faster SATA speed
ATA I/O Connector

The ATA interface connector is normally a 40-pin header-type connector with pins spaced 0.1 inches apart and generally keyed to prevent the possibility of installing it upside down.

Plugging in an IDE cable backward usually won’t cause any permanent damage, however, it can lock up the system and prevent it from running at all.

ATA cable

- Length
  - 10"
  - 80-conductor: 27"
  - Longer?
- Avoid Rounded Cable

Dual Drive Configurations

Dual drive ATA installations can cause problems because each drive has its own controller and both controllers must function while being connected to the same bus.

The ATA standard provides the option of operating on the AT bus in a daisy-chained configuration.

The primary drive (drive 0) is called the master, and the secondary drive (drive 1) is called the slave.

Independent Device Timing

- What happens if two hard drives are connected to the same IDE cable but use different standards?
- Motherboard has Independent Device Timing feature?
  - No, run at the slower speed
  - Yes, each run at its own speed

Dual Drive Configurations

Most IDE drives can be configured with three settings.

The diagram illustrates the settings of master, slave, and cable select.

PATA Transfer Modes

- PIO
  - Programmed Input/Output
  - Involves CPU
  - 5 different modes, maximum speed 16.67MBps
- DMA
  - Hard drive to memory without CPU
  - 7 different modes with maximum 133MB/s
ATA Commands

- The ATA IDE interface was modeled after the WD1003 controller IBM used in the original AT system.
- All ATA IDE drives must support the original WD command set (eight commands) with no exceptions.
- All IBM compatible systems have built in ROM BIOS support for the WD1003, so they support ATA as well.
- In addition, the ATA specification added numerous commands to enhance performance and capabilities.

Identity Drive Command

- The Identity Drive command can tell you the following:
  - Number of cylinders
  - Number of heads
  - Number of sectors per track in the recommended translation mode
  - Number of cylinders in the current translation mode
  - Number of sectors per track in the current translation mode
  - Manufacturer and model number
  - Serial number
  - Buffer type

Host Protected Area

- 1996 Gateway
- ATA-4
- ATA SET MAX ADDRESS command
- Normally used for storing recovering or restoration software
- What's the implication of this in computer forensics?

Drive Capacity Limitations

- BIOS limitation
- ATA interface
- OS

Serial ATA

- With the introduction of ATA-6 it seems that the parallel ATA standard that has operated for the past ten years is running out of steam
- Sending data at rates faster than 100mb/sec down a parallel cable has problems with signal timing, electromagnetic interference, and integrity.
- The solution is in the serial ATA interface which is backward compatible with the parallel ATA.

SATA vs. Parallel ATA

- You can’t plug parallel ATA drives into a serial ATA host adapters and vice versa.
- The serial ATA uses much thinner cables with only 7 pins that are easier to plug in.
- Configuration of serial ATA is also simpler because the jumper settings for master/slave are no longer necessary.
Serial ATA Transfer Modes

- SATA-150
- SATA-300
- SATA-600
- Uses 8B/10B to encode/decode data sent along SATA cable
  - No 4 consecutive 0s
  - No more than six or fewer than four 0s/1s in a single 10-bit encoded character

SATA II

- Include external connections
  - 4 lanes x 300MBps/lane = 1200MBps
  - Up to 15 SATA drives to be connected to a SATA port
  - Can be used for RAID

Serial ATA

- More on SATA
  - Hot-swappable
  - Throughput of 150 MBps (with potential of 600 MBps)
  - A parallel ATA device (PATA) may be connected to SATA using a SATA bridge
  - Add SATA functionality via a PCI card
  - Only one device per controller

ATA Raid

- Redundant Array of Independent Disks
  - Designed to improve the fault tolerance of computer storage systems.
  - To improve reliability and performance, scientists proposed 6 levels of RAID.
  - Currently there are seven layers of RAID called RAID 0 through 6.

RAID Level 0

- Disk Striping
  - Writes data across multiple drives at once
  - Requires at least 2 hard drives
  - Does not provide redundancy
  - If any drive fails, the data is lost

RAID Level 1

- Disk Mirroring/Duplexing is the process of writing the same data to two drives at the same time
  - Requires at least two drives
  - Produces an exact mirror of the primary drive
  - Mirroring uses the same controller
  - Duplexing uses separate controllers
RAID Level 2

- Disk Striping with Multiple Parity Drives
  - Not used

RAID Levels 3 and 4

- Disk Striping with Dedicated Parity
  - Dedicated data drives and dedicated parity drives
  - Quickly replaced by RAID 5

RAID Level 5

- Disk Striping with Distributed Parity
  - Distributes data and parity evenly across the drives
  - Requires at least 3 drives
  - Most common RAID implementation

RAID Level 6

- Super Disk Striping with Distributed Parity
  - RAID 5 with asynchronous and cached data capability

Personal RAID

- ATA RAID controller chips have gone down in price
- Some motherboards are now coming with RAID built-in
- RAID has been around for 20 years but is now less expensive and moving into the desktop system

RAID

- [http://www.raid.com/04_00.html](http://www.raid.com/04_00.html)