Unit 9

Buses, Video, and Upgrades
CPU

Memory

Video Adapter

Keyboard Controller

System Controller
What is a Bus?

- Signal Pathways
- A way of passing information between components inside and outside the computer.
- A modular way of expanding the functions or capabilities of the computer.
PC Bus Architectures

- ISA
- MCA
- EISA
- VL-Bus
- PCI
- AGP
- PCI Express
- PC Card
The Original IBM PC Bus

- Introduced on the original IBM PC
- 8- bit data path
- 4.77-MHz clock
- 8 Interrupts - Only one of which was available for expansion boards.
- 4 DMA Channels - Only one of which was available for expansion boards.
The Original IBM PC Bus

8-Bit Card

8-Bit Slot
Industry Standard Architecture (ISA) Bus

- Introduced on the IBM AT Computer
- 16-bit data path
- Backward compatible with IBM-PC Bus
- 8-MHz clock
- 15 Interrupts
- 7 DMA Channels
Industry Standard Architecture (ISA) Bus

16-Bit Card

16-Bit Slot

8-Bit Section

Added Pins
Industry Standard Architecture (ISA) Bus
Micro-Channel Architecture (MCA) Bus

- Introduced on the IBM PS/2
- 16-bit or 32-bit data path
- 10-MHz clock
- Configured by software rather than by jumpers or switches
- Not compatible with the ISA bus
- Bus Mastering
Bus Mastering

• Allows data to be passed from one device to another without CPU intervention.

• Allows a controller card to take control of the bus, leaving the CPU free to concentrate on other tasks.
Bus Mastering vs. DMA

- DMA can send data from peripheral to RAM or from RAM to peripheral, without the intervention of the CPU.

- Bus Mastering can send data from peripheral to peripheral, without the intervention of the CPU.
Extended ISA Bus (EISA)

• The industry’s answer to the MCA bus
• Backward compatible with ISA
• 16-bit or 32-bit data path
• 8-MHz Clock
• Configured by software, not jumpers or switches
• Bus Mastering
CPU

High Speed
CPU Bus

Local Bus
Slots

BUS
Controller

Low Speed
I/O Bus

ISA Bus
Slots
VESE Local Bus (VL-Bus)

- Clock speed same as the processor
- 32-bit data path
- Regular ISA slot with local bus connector added
- Bus Mastering
Peripheral Component Interconnect (PCI)

- Developed for Pentium-class processors
- 32-bit and 64-bit data path versions
- 33-MHz Clock
- Processor Independent
- Plug and Play with Bus Mastering
Peripheral Component Interconnect (PCI) Bus
Accelerated Graphics Port (AGP)

- Developed for high speed graphics cards
- Frees the PCI bus from making video transfers
- Used only for video cards
- Considered a port rather than a bus
- 66 MHz, 32-Bit
Accelerated Graphics Port (AGP)
The PC Card

- **TYPE 1**: Memory
- **TYPE 2**: Modem or LAN Adapter
- **TYPE 3**: Hard Disk Drive
PC Card

• Personal Computer Memory Card International Association (PCMCIA)

• Originally designed for adding memory to portable computers

• A universal bus that can accommodate any type of device

• Can be used with desktop PCs with the proper adapter

• “Hot Swapping” capability
What is the Universal Serial Bus?
Feature...

• It’s an external expansion bus using cables (outside the PC).

• Can daisy chain 127 peripherals to a port
Feature...

- Plug-and-Play, hot-pluggable, automatic configuration
- USB 1 provides 12 megabits/second data transfer rate
- USB 2 provides 480 Mbps
- USB peripherals can be powered by the USB bus (+5 volts DC).
Feature...

- Standardized connectors
- Five meter-long peripheral connections
Ordinary USB Peripherals

- Cartridge, Tape, and Floppy Drives
- Modems
- Printers, Scanners
- ISDN, T1 Interfaces (Network Applications)
- Input devices such as Mice, Joysticks, Keyboards, Graphics Tablets
- Multimedia Game Equipment
Not So Ordinary USB Peripherals

• Digital Cameras
• Digital Speakers
• Video Monitors
• Biometric Security Devices
• Multi-User Games
• Digital Audio Devices
More Not So Ordinary USB Peripherals

- Hubs
- CTI Devices
- Telephony (PBX, Digital Telephones)
Video Systems and Monitors
Horizontal Scanning Frequency

• The number of lines per second scanned by the monitor.

• Varies from about 15 KHz to over 50 KHz.

• A popular scan rate is 31.5 KHz.

• At this rate, one horizontal line is scanned in 26.66 microseconds.
The Horizontal Scanning Frequency is determined by the Horizontal Sync Signal.
Vertical Retrace
Vertical Scanning Frequency (Refresh Rate)

- The number of times per second that the whole screen is scanned.
- Varies from about 50Hz to over 100Hz.
- Popular vertical scan rates are 60Hz and 70Hz.
- At 70Hz, the entire screen is painted in about 14.28 milliseconds.
The Vertical Scanning Frequency is determined by the Vertical Sync Signal.
# The Screen Refresh Rate

<table>
<thead>
<tr>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>43 Hz</td>
</tr>
<tr>
<td>60 Hz</td>
</tr>
<tr>
<td>72 Hz</td>
</tr>
<tr>
<td>75 Hz</td>
</tr>
</tbody>
</table>
Interlaced Mode

60 Hz
Different resolutions often use different scan frequencies.

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Horizontal Freq.</th>
<th>Vertical Freq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>640x480</td>
<td>31.5KHz</td>
<td>60Hz</td>
</tr>
<tr>
<td>800x600</td>
<td>37.8KHz</td>
<td>72Hz</td>
</tr>
<tr>
<td>1024x768</td>
<td>35.5KHz</td>
<td>87Hz</td>
</tr>
</tbody>
</table>
## The Screen Resolution

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Colors</th>
</tr>
</thead>
<tbody>
<tr>
<td>320 x 200</td>
<td>4, 256</td>
</tr>
<tr>
<td>640 x 200</td>
<td>2</td>
</tr>
<tr>
<td>640 x 350</td>
<td>16</td>
</tr>
<tr>
<td>640 x 480</td>
<td>16, 256, 32K, 64K, 16 Million</td>
</tr>
<tr>
<td>800 x 600</td>
<td>256, 32K, 64K, 16 Million</td>
</tr>
<tr>
<td>1024 x 768</td>
<td>256, 32K, 64K, 16 Million</td>
</tr>
<tr>
<td>1280 x 1024</td>
<td>256, 32K, 64K, 16 Million</td>
</tr>
</tbody>
</table>
## Resolution vs. Monitor Size

<table>
<thead>
<tr>
<th>Monitor Size</th>
<th>Max Useful Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-inch</td>
<td>640 x 480</td>
</tr>
<tr>
<td>14-inch</td>
<td>800 x 600</td>
</tr>
<tr>
<td>15-inch</td>
<td>800 x 600</td>
</tr>
<tr>
<td>17-inch</td>
<td>1024 x 768</td>
</tr>
<tr>
<td>21-inch</td>
<td>1600 x 1200</td>
</tr>
</tbody>
</table>
Measuring Screen size

Screen size is measured diagonally.
Aspect Ratio = \frac{\text{Horizontal Size}}{\text{Vertical Size}}
The LCD Display

• The **LCD** is the second most common type of display technology.

• **LCDs** offer several advantages:
  – Flat display area
  – Low power
  – Larger viewable area
Advantages

• Generally more expensive than comparable CRT display.

• Resolutions can be less than a comparable CRT.

• LCD displays do not:
  – Emit electromagnetic radiation
  – Have high voltages present in the chassis.
• Available for both desktop and notebook.

• Two common LCD technologies:
  – Active-Matrix Analog is common on smaller low cost displays
  – Active-Matrix Digital is used in larger high-end displays.
• LCDs use a unique material called liquid crystal.

• Liquid Crystal has properties similar to water and crystal.

• By applying a voltage, the amount of light can be controlled.

• Color LCDs use color filters to create the color display.
Transparent Glass Plate

Liquid Crystal Molecules

Transparent Electrode
Components of the modern color LCD display include:

- A liquid crystal panel
- A backlight as a light source
- A thin film transistor (TFT) array
- Polarizing filters on both sides of the display.
Consider before selecting an LCD

- More difficult to switch resolutions.
- Analog LCD panels can use existing video card and connector.
- LCD may not have sufficient color depth.
- Many don’t react as quickly as CRTs.
Large screen LCD monitors are becoming a real display option.

- LCD monitors offer several advantages:
  - Larger effective viewing area
  - Produce a higher precision image
  - Flexible mounting options
  - No electromagnetic emissions.
Is an LCD suitable?

• Evaluate panel at native and other required resolutions.
  – Does existing video card support required features?
  – Support for analog and DVI inputs?
  – Contrast ratio high enough?
Working with Monitors
Picture Adjustments

- Reset Button
- Degauss
Horizontal Size
Pin Cushion
Bow
<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Pin</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Red</td>
<td>9</td>
<td>No Connection</td>
</tr>
<tr>
<td>2</td>
<td>Green</td>
<td>10</td>
<td>Sync Ground</td>
</tr>
<tr>
<td>3</td>
<td>Blue</td>
<td>11</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>Ground</td>
<td>12</td>
<td>Serial Data</td>
</tr>
<tr>
<td>5</td>
<td>Display Data Channel Ground</td>
<td>13</td>
<td>Horizontal Sync</td>
</tr>
<tr>
<td>6</td>
<td>Red Ground</td>
<td>14</td>
<td>Vertical Sync (VCLK)</td>
</tr>
<tr>
<td>7</td>
<td>Green Ground</td>
<td>15</td>
<td>Serial Clock</td>
</tr>
<tr>
<td>8</td>
<td>Blue Ground</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Opening a Monitor to Repair It
Basic Video Troubleshooting 101

• Is the monitor turned on?
• Is the monitor’s AC cord plugged in?
• Turn up brightness/contrast controls.
• Check the video cable.
Basic Video Troubleshooting 101

• Check Power On Self-Test (POST) beeps.

• Re-seat video card.

• Check any configuration switch settings.

• Swap video card, monitor, video cable.
Basic Video Troubleshooting 101

Enter Safe Mode or re-load video driver.
Video Display Adapters
Super VGA (SVGA)

• The standard for PCs and monitors.

• Popular SVGA formats include:
  – 800 by 600 pixels
  – 1024 by 768 pixels
  – 1280 by 1024 pixels

• The higher the resolution, the finer the detail displayed.

• The higher the resolution; the more information displayed.
Video Graphics Array (VGA)

- Resolution of 640 by 480 pixels.
- Introduced in 1987 by IBM as the PS/2
- First to use analog video outputs.
- First to use square pixels so vertical and horizontal lines have the same thickness.
- Replaced by SVGA in most applications.
Evolution of Video Display Adapters

- 1981  CGA  320 by 200 pixels
- 1984  EGA  640 by 350 pixels
- 1987  VGA  640 by 480 pixels
- Today  SVGA  800 by 600 pixels, or higher.
VGA

SVGA
The activities of the monitor are determined entirely by the PC.
The PC determines:

- the color
- the brightness
- and the position

of every pixel in the monitor’s display.
The PC sends five control signals to the monitor:

- The Red Video Signal.
- The Green Video Signal.
- The Blue Video Signal.
- The Horizontal Sync Pulse.
- The Vertical Sync Pulse.
The Video Controller in the PC

8-bit DAC

Analog outputs to monitor

8-bit DAC

8-bit DAC
The Input and Output of the Red DAC in the PC.

Input

11111111
11111110
.
.
.
00000001
00000000

Output

0.7 Volts

0.0 Volts
Upgrading a Computer
Memory

- Few computers have enough
- What fits in this computer?
- SIMM or DIMM?
- SDRAM or DDR2?
- Speed?
Pentium I

• Add SIMMs in pairs
• Check the manual for specs
Pentium II/III/4

- Generally fewer free slots
- Add one DIMM at a time
- Bigger DIMMs are available
- PC-66, PC-100, PC-133
CPU Upgrades

• Cost vs. Benefit
• Role of the computer
• Can the motherboard support the upgrade?
• Do you need to update the BIOS?
Expansion Cards

• Before you buy the card:
  – What slot type
  – Are slots available?
  – Are the proper drivers available?
• Win 98, Win 2000, etc.
Drives

• Can the BIOS support a large drive?
• Can the BIOS be upgraded?
• Do you have enough power connectors?
• Do you have the software tools?
  – Bootable disk with FDISK, Format, etc.
Motherboards

• What type of case?
  – AT, ATX, Proprietary

• What type of motherboard?

• Do the back-panel connections match up?

• Can you connect front-panel cables?
Motherboards

• Can you use the old video adapter and memory?
• Do you want to use the old video board and memory?
• Do you need to buy a CPU, too?
• Is this project worth the cost?
Modems
PC-1

Phone System

Dial-Up Server
Two Sets of Issues

• Computer-to-Computer Issues
• Client-to-Network Issues
CPU vs. Phone Line

- Digital Signal
- High Speed
- Parallel Data

- Analog Signal
- Low Speed
- Serial Data
Digital

Analog
The Modem

- **Modulator / Demodulator**
- Converts the digital signals from the computer into the analog signals required by the telephone line.
- Converts the analog signals from the telephone line into the digital signals required by the computer.
Pulse Amplitude Modulation (PAM)

1 0 1 1 0 1
Each Amplitude Level Represents Two Bits
Baud

- Baud - A single state change of the analog signal.

- Baud Rate - The number of times per second that the analog signal changes state.

- In early modems, one baud usually represented one bit.

- In today’s modems, one baud represents more than one bit.
High Speed

Low Speed
Parallel

Serial
The UART

- Universal Asynchronous Receiver/Transmitter
- The heart of the Serial (COM) port.
- Converts parallel data required by CPU into serial data required by serial port.
- Converts serial data received at serial port into parallel data required by CPU.
Making the CPU and Phone Line Compatible (Transmit).

1. High Speed to Low Speed
2. Parallel to Serial

CPU ➔ UART ➔ Modem ➔ Phone Line

Buffer Memory
Making the CPU and Phone Line Compatible (Receive).

1. High Speed to Low Speed
2. Parallel to Serial

Digital to Analog
Two Types of Modems

• Internal – ISA or PCI board that fits inside the computer.

• External – Stand-alone box. Connects to one of the COM Ports.
Internal Modem

- CPU
- UART Function
- Modem Function
- Phone Line

Internal Modem
Modulation Standards

- V.22 – 1200bps standard
- V.22bis – 2400bps standard
- V.32 – 9600bps standard
- V.32bis – 14,400 standard
- V.FC – 28,800 standard
- V.34 – 33,600 standard
- V.90 – 56kbps standard
V.42 Error-Correction Standards

• Link Access Procedure for Modems (LAPM)

• Microcom Networking Protocol – 4 (MNP-4)
V.42bis Compression Standard.

- Uses a compression technique to reduce the size of outgoing data.
- Can compress data up to ~ 4 to 1.
- For example, a 33,600-bps Modem could transfer data at a rate up to about 134,400 bps.
The COM Port

• Also called Serial Port or RS-232 Port
• The link between PC and Modem.
• The external Modem connects to COM port on back of PC via serial cable.
• The internal Modem has built-in COM port that duplicates function of external COM port.
25-Pin Serial Port

9-Pin Serial Port
## Standard Modem COM Port Settings

<table>
<thead>
<tr>
<th>COM Port</th>
<th>IRQ</th>
<th>I/O Address (Hex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COM1</td>
<td>4</td>
<td>03F8</td>
</tr>
<tr>
<td>COM2</td>
<td>3</td>
<td>02F8</td>
</tr>
<tr>
<td>COM3</td>
<td>4</td>
<td>03E8</td>
</tr>
<tr>
<td>COM4</td>
<td>3</td>
<td>02E8</td>
</tr>
</tbody>
</table>
UART Speed

- Determines the Serial Port speed.
- 16550 UART chip can reach speeds of 256 kbps.
- 16440 UART chip can reach speeds of 115.2 kbps.
- 8250 UART was supplied with the original IBM XT machine.
Digital Subscriber Line (DSL) - A technique used for transmitting high-bandwidth data over twisted-pair telephone lines.
Central Office

Local Loop Analog

Central Office

Analog
Voice requires only about 4kHz of bandwidth.
For short distances, twisted-pair can handle frequencies much higher than 4kHz.
Connecting to the Internet

- Modem (POTS)
- ISDN
- T1 line
- Digital Subscriber Line (DSL)
Cost Vs. Bandwidth

Cost $ vs. Bandwidth

- Modem (POTS)
- ISDN
- DSL
- T1
Advantages of DSL

• Always-on connectivity
• High speed
• Flat-rate service
• Reliability
DSL takes advantage of the bandwidth not required by voice.
xDSL:

• Asymmetric Digital Subscriber Line (ADSL)

• Very High Data Rate Digital Subscriber Line (VDSL)
Asymmetric DSL – Allows more bandwidth downstream than upstream.
# Typical ADSL Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Data Rate</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Downstream</strong></td>
<td>1.5 Mbps</td>
<td>15,000 ft</td>
</tr>
<tr>
<td><strong>Upstream</strong></td>
<td>16 kbps</td>
<td>15,000 ft</td>
</tr>
<tr>
<td><strong>Downstream</strong></td>
<td>6.1 Mbps</td>
<td>9,000 ft</td>
</tr>
<tr>
<td><strong>Upstream</strong></td>
<td>640 kbps</td>
<td>9,000 ft</td>
</tr>
</tbody>
</table>
DSL is distance-sensitive

• You must be within about 12,000 to 18,000 feet of a central office.

• The distance is the path the wire takes, not the straight-line distance.

• Even so, the majority of the United States’ population lives and works within DSL range.
The DSL Provider

• The company that delivers DSL service to your home or business.
• Generally a phone company.
• Many DSL providers act as their own Internet Service Provider (ISP).
• Some areas have more than one DSL provider.
Customer Premises Equipment (CPE)

- Telco lingo for phone or DSL equipment in the home or office.
- Splitter/Filter
- DSL Modem or DSL Router
The DSL Modem

• Low cost.
• Requires no customer configuration.
• Acts as a bridge to your DSL provider’s TCP/IP network.
Problems with the DSL Modem Approach

• Single IP address
• The Internet Connection is not easily shared.
• Security concerns.
The DSL Router

• Higher cost
• Turns your local network into a separate TCP/IP LAN.
• May provide several services such as:
  – DHCP
  – NAT
  – Firewall
  – VPN
Small Office/Home Office (SOHO)

- HUB
- DSL Router
- Splitter/Filter
- Phone
- To/From DSL Provider
Digital Subscriber Line Access Multiplexer (DSLAM)

- Normally located at the Telco Central Office
- Concentrates data from numerous DSL connections into a high capacity backbone.
- Separates voice from data and sends each to its appropriate location.
Small Office/Home Office (SOHO)
Very High Data Rate Digital Subscriber Line (VDSL)

• An emerging technology
• Promises to deliver
  – Downstream speeds of 15 to 52 Mbps.
  – Upstream speeds of 1.5 to 2.3 Mbps.
• Over short distances (1000 to 4500 ft) of existing twisted pair phone lines.