

Chapter 3: **COMMUNICATIONS SYSTEMS**



 **DIGITAL OVERDRIVE**

Chapter 3: Communications Systems

There are many different types of communications systems available today. Communicating information has become one of the most important functions of the 21st century. In this chapter, we will explore 4 different types of systems: wireless communication systems, computer systems, networking and video systems. Most people use each one of these every single day so knowing how various types of systems work is a necessity.

Wireless Communication Systems

In the past century, wireless communication systems have evolved to include some very interesting applications. Three of the most significant systems are cellular phones, satellite television and satellite radio.

Cellular Phone History

The concept for cell phones was first devised in 1947, but the technology and infrastructure was not quite advanced enough. The FCC (Federal Communications Commission) in the United States permitted AT&T to conduct research at that time but limited the number of conversations that could be had within a cell to 23.

In 1968, the FCC decided the technology was worth pursuing so new towers started to go up that could service an area within a few miles of the tower. This spurred on more research resulting in the first phone call to be made on a modern handset in 1973. Dr

Martin Cooper of Motorola made the first call, to his rival at Bell Labs.

In 1978, Bell Labs started the first trial of cell phones in Chicago with a group of 2000 customers. While the US was still testing the idea, the first commercial system began operating in Tokyo in 1979. The FCC however, waited until 1982 to approve a cellular system for the United States. In 1983, the first commercial system began operating in Chicago. Full deployment of the cell phone began in 1984 in the US and 1985 in Canada. By 1987, there were over 1 million cellular customers in the US.

The next evolution in the cell phone industry was the introduction of PCS (Personal Communication Service) phones. PCS was a digital service that allowed more subscribers to be added to the network. It used the 1.9 GHz radio spectrum band instead of the older analog 800 MHz band. In 1994, the FCC approved this system for use in the US. Canada followed suit in 1995. By 1997, 4 million wireless devices were in use in Canada and over 50 million in the US.

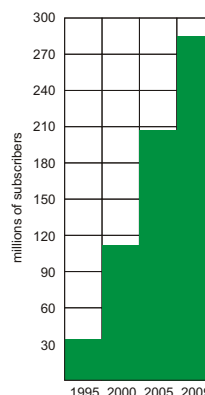
In the past decade, cell phones have evolved into an essential communications device. Phones now have colour screens, built-in cameras and MP3 players. Services include e-mail, text messaging, voice mail, caller ID and much more. There are over 17

Production Notes

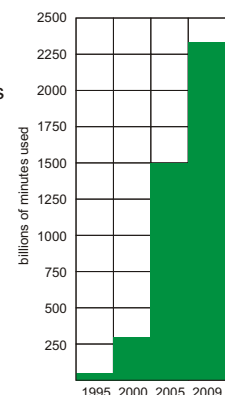
- Introduction
- Wireless Communication Systems
- Cellular Phone History
- First Modern Handset
- Cell Phone Trials
- PCS system



Total Wireless Subscribers in the United States 1995 - 2009



Total Number of Cell Phone Minutes Used in the United States 1995 - 2009



million wireless devices used in Canada each day with over 47% of all phone calls now made from a cell phone. In the US, there were 285 million wireless subscribers in 2009 who used 2.3 trillion minutes and sent 152.7 billion text messages each month.

*Source: http://ctia.org/media/industry_info/index.cfm/AID/10319

How Cell Phones Work

Let's compare cell phones and CB radio which is commonly used in police cars and transport trucks. Cell phones are full-duplex communications devices. That means that each person in a 2-way conversation uses a different frequency, allowing each to talk at the same time. This differs from CB radio which is half-duplex, where only one person can talk at a time. Cell phones have thousands of channels available to be used versus the 40 for CB radio. Finally, cell phones have a world wide range, whereas CB radio only extends for 5 miles or 8 km.

Cell phones have quickly become one of the most popular forms of wireless communication in the world. The basic concept of how these phones work is quite simple. "Cells" are made up of a series of towers that service a particular geographic area. When the user travels, the call is transferred to the closest tower.

Each cell is approximately 10 square miles or 26 square kilometres. The cell phone carrier divides up the area into various hexagons in order to make sure every section is covered completely. Within each cell is a tower and a base station that transmits the low power signal. The base station has all of the equipment contained in it to power all of the frequencies being used.

The cell phones themselves have low power transmitters in them as well. This is what connects with the closest tower. Since

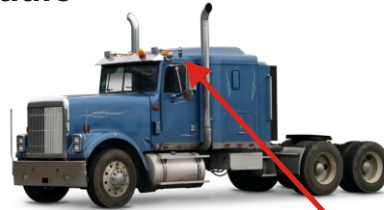


Touchscreen devices and smartphones will drive up data use on cell phones

Production Notes

- Wireless Subscriber Stats
- How Cell Phones Work
- Comparison With CB Radio
- Cells
- Diagram of CB Radio vs. Cellular
- Diagram of Cells and Towers

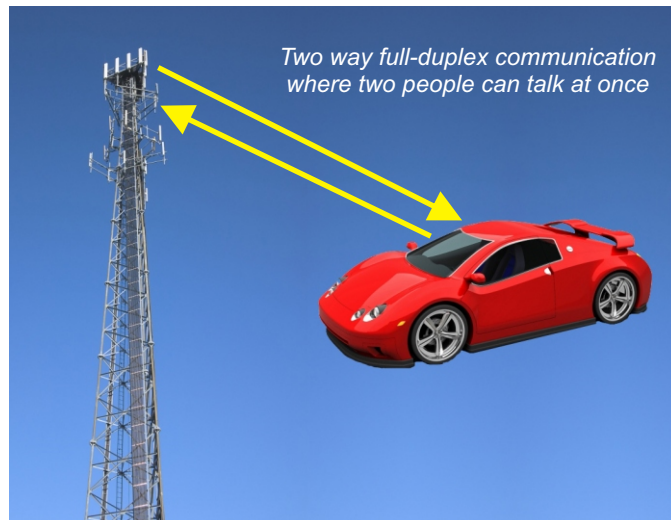
CB Radio



Two way half-duplex communication where only one person can talk at a time



Cellular Communication

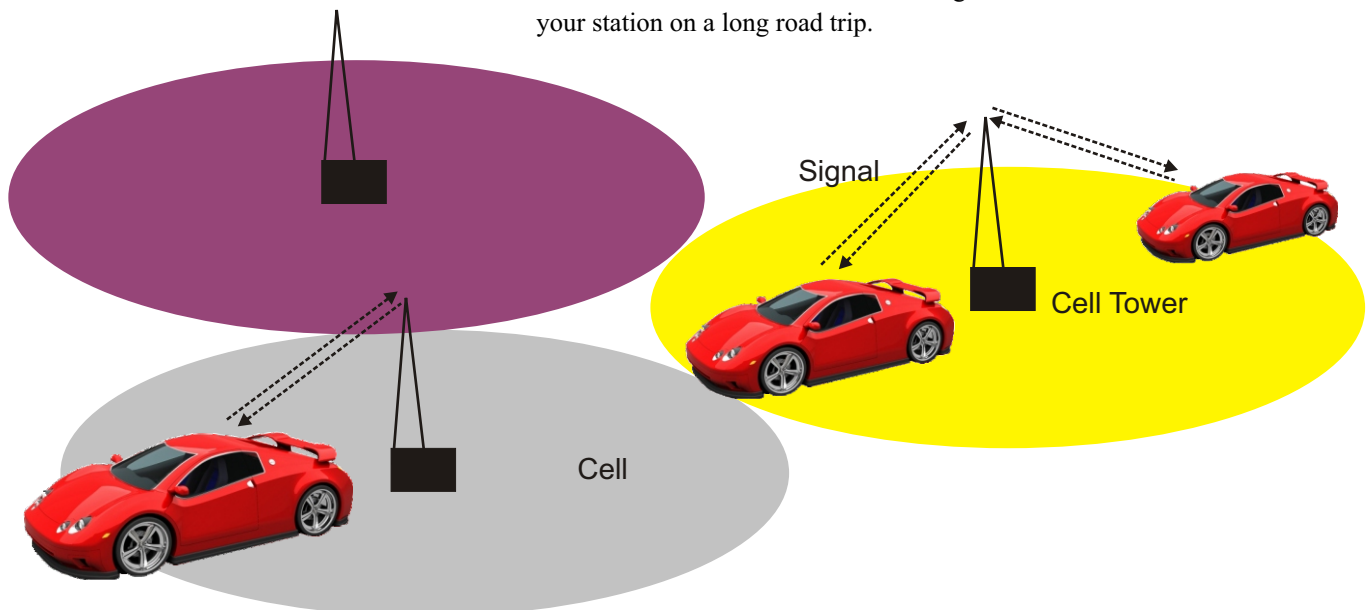


Two way full-duplex communication where two people can talk at once

the phone has a low power consumption, batteries can be smaller making cellular phone very small and mobile.

When you turn on your phone, it sends codes out over the control channel which is a frequency used for the base station and cell phone to talk to each other. The codes it sends contains the following information: the System Identification Number (who the cell phone provider is), the identity of the phone and who owns the phone. The System Identification Number is checked with the one programmed into the phone. If that provider is located in the area, then a call can be made. If not, the user will get a message saying there is no service.

When a call is made to your phone, it goes to a central office in the area called the Mobile Telephone Switching Office. This office can connect you with the other phone that could either be another cell phone or a land line phone. The MTSO finds you by the constant registration request that your phone is sending it. It is like a tracking device. Once it finds your cell phone, 2 frequencies are picked and you are connected with the other caller.



As you travel, the signal strength in your current cell will decrease. But it will also increase in the cell you are approaching. At some point, your call will transfer from one cell to another and new frequencies will be sent to your phone indicating that a switch has occurred.

Satellite Radio

Satellite radio is one of the newest communications systems for the consumer market. Traditional radio has been around for over 100 years and has always been a free service for consumers. Operating costs for radio stations are covered by the revenue generated from advertisers. Satellite radio is a paid subscription based service with most revenue coming from a monthly fee.

There are some key differences between traditional and satellite radio, the most important being reception of the signal. Most radio stations are clear within a 40 mile or 64 kilometre radius of the transmitting tower. Satellite radio is clear right across North America, from coast to coast. There would be no need to change your station on a long road trip.

Production Notes

- How Cell Phones Work
- Making Calls
- Diagram of Traveling from Cell to Cell
- Satellite Radio
- Differences Between Traditional Radio and Satellite Radio

The other significant difference is programming. Traditional radio plays all sorts of music with the occasional specialty station thrown in for news or sports. Satellite radio is all specialty stations, catering to all types of music. You select the style you want to listen to. You can even listen to comedy stations, news stations or traffic stations for individual cities 24 hours a day. Satellite does not offer programming for local radio stations which is a key feature in local municipalities.

So how does all of this work? Historically, the two major players in this market were XM Satellite Radio and Sirius Satellite Radio (now merged as a new company called Sirius XM in the US). Each of them has their own satellites orbiting the earth. XM uses 2 geostationary satellites that orbit the earth 22,223 miles (35,764km) above the earth. At this distance, the satellites “hang” there and will always be located over the exact same spot on the earth as it rotates. XM transmits the digital audio signal to the satellite from its ground office in Washington DC to the 2 satellites. The satellites then bounce the signal back to radio receivers on earth. Anyone who subscribes to the service and has a satellite radio receiver can receive up to 100 stations as well as information that is embedded in the signal. This information is usually the song title, artist, genre, etc. XM also has a network of ground transmitters that receive the signals and broadcast the stations in cities where improved strength may be needed. XM and Sirius merged in the United States in 2008 but the two companies remain separate in Canada.

Satellite TV

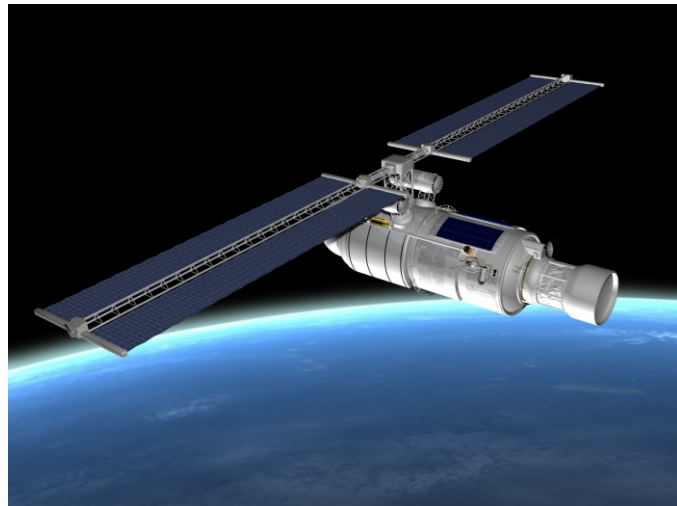
Since commercial television broadcasting began in the 1930's, consumers have had very little choice with regards to what they

watch. You either received your signal from an antenna or through cable. Channels were set with no choice or very much variety. In the 1990's, satellite television changed all of that. The first chapter discussed the evolution of satellite TV, now we need to know how it works.

Satellite TV works in a very similar fashion as satellite radio except there is one more step in the process. The first component in the system is the source of the programming. This will be a station like CNN, or HBO. They send their signals via fibre optic cable or their own satellite to the broadcast centre, the second component.

Production Notes

- Satellite Radio
- How Satellite Radio Works
- XM Satellite Radio
- Satellite TV
- How Satellite TV Works
- Components of a Satellite TV System



The broadcast centre is the provider of the programming (DirecTV, Star Choice, etc). All the signals come into this centre and are then sent to the third component, the satellites. The satellites receive the signal from the broadcast centre and retransmit them to the ground using a special type of encryption to ensure the signal cannot be stolen. The fourth component, the dish, picks up this signal and sends it into the viewer's home where the fifth component, the receiver, decodes and decrypts the signal and displays it on a TV.

Computer and Networking Systems

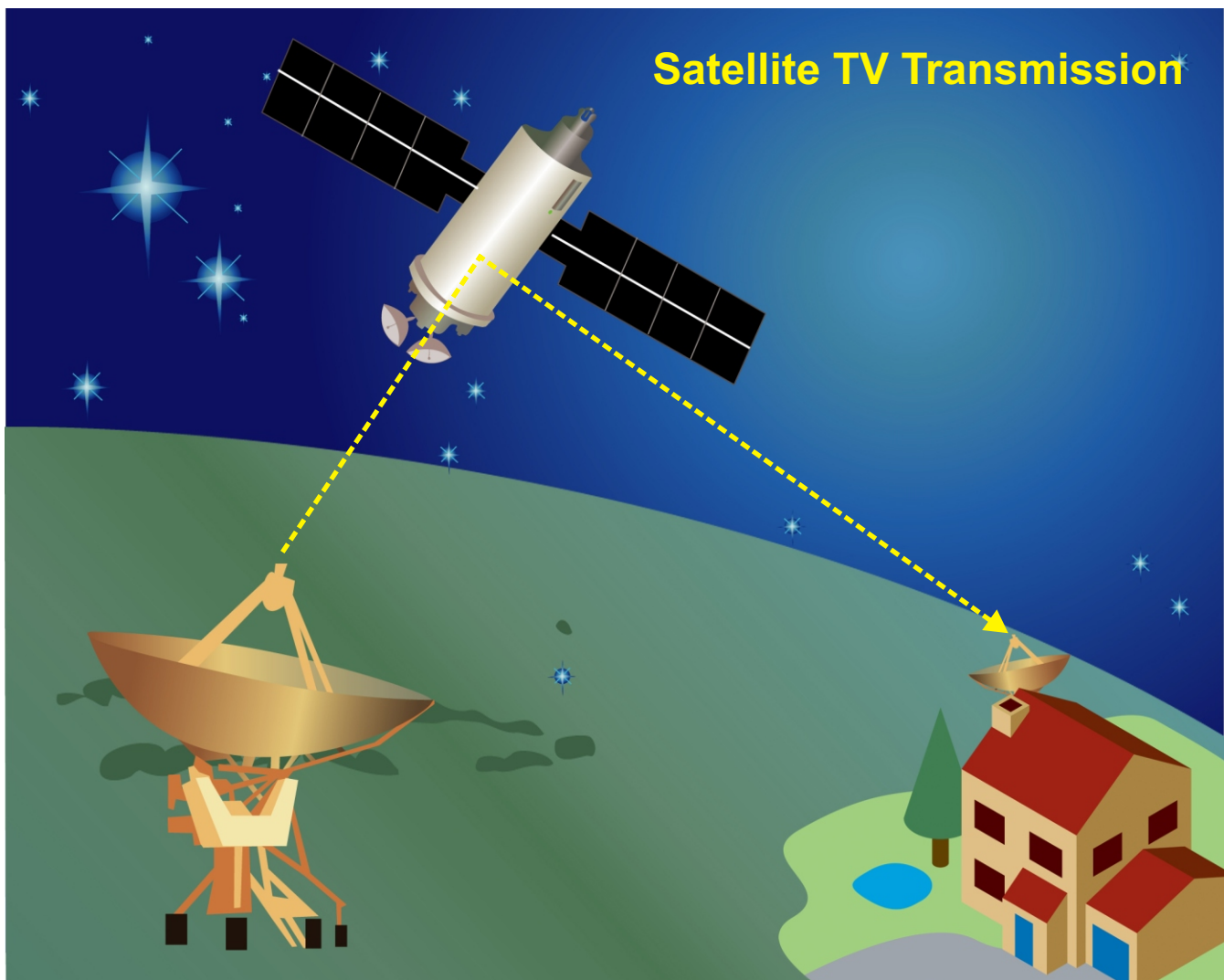
Almost every type of communications system involves a computer. In order to work in this industry and understand what is going on, it is important to know the parts of a computer and how networks work.

Parts of the Motherboard

Most people think that computers are very complex pieces of hardware, when truly they are made up of various

Production Notes

- Satellite TV
- Computer and Networking Systems
- Parts of the Motherboard
- Diagram of Satellite TV



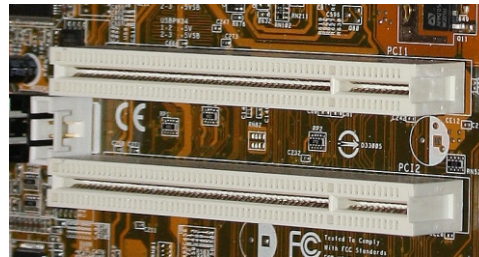
Components that are easily put together. Each component has a specific function. As long as you know what the function is, then you can put together a computer.

Let's start with explaining the basics. The first thing a computer needs is the case and power supply. Some cases come with power supplies, some are sold separately. It is important to have a good case and power supply to make sure your computer runs smooth. Cheap power supplies will stop functioning very easily. Get a power supply that has lots of power (400W and above) to make sure your computer can handle all the additional components you may add in the future. Cases with USB ports and audio connections on the front panel are preferred so you can easily connect peripherals like digital cameras.

Now let's look at the motherboard. This is the part of the computer where all of the components will attach and join together. It co-ordinates the communication between all of the individual devices. There are various types of motherboards. Some have just the standard parts built in like USB ports, parallel port, PS/2 mouse port and keyboard port. Others come with additional components already built-in like sound, video and network adapter. These are often referred to as "All-in-one" motherboards since there are very few components to buy and install. The disadvantage is that if one component breaks, the entire motherboard needs to be replaced. They do cost much less than buying all of the components separately.

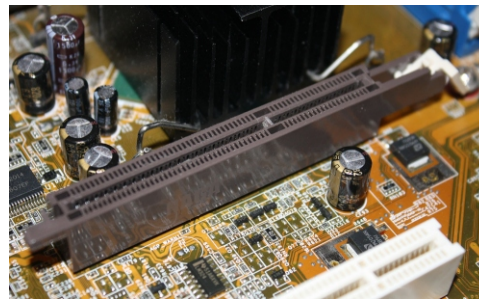
A. The CPU (Central Processing Unit) is also known as the processor. This is the brain of the computer where all of the instructions are processed. Speeds are measured in GHz (gigahertz) so the higher the number, the faster the computer is.

B. PCI Slots (Peripheral Component Interconnect) are expansion areas where you can add more cards to your computer. These cards may be audio cards, network cards, firewire cards etc. Different motherboards have different numbers of PCI slots so make sure you get one that has more of these rather than less.

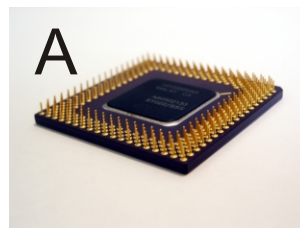


B

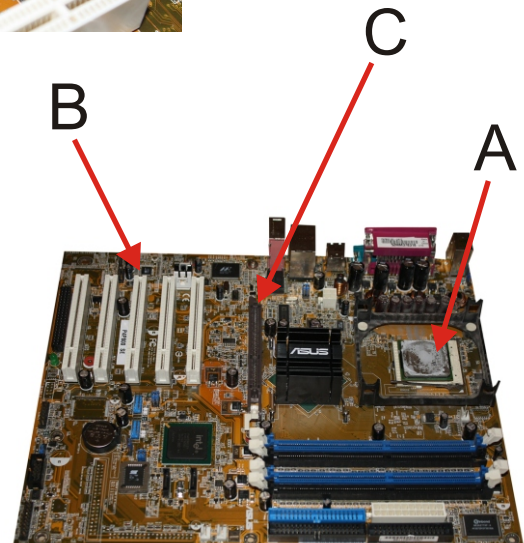
C. AGP Slot (Accelerated Graphics Port) is only used for video cards. It is the preferred connection over PCI for displaying graphics. The AGP slot is a high speed connection for the graphics to display graphics quickly.



C



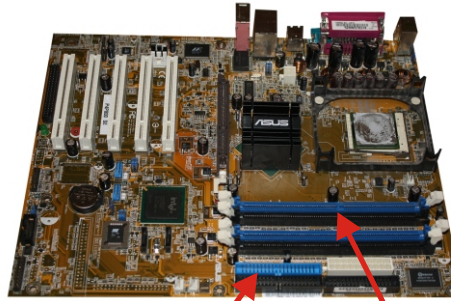
A



Production Notes

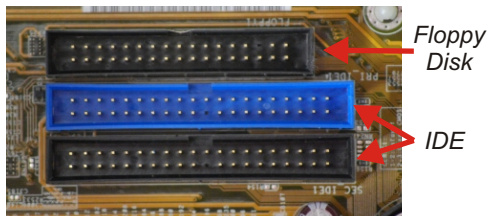
- Motherboard Basics
- Case and Power Supply
- Motherboard
- CPU (Central Processing Unit)
- PCI Slots
- AGP Slot

D. The IDE (Integrated/Intelligent Drive Electronics) connection on a motherboard is used to connect hard drives, CD and DVD drives to the motherboard. Most IDE cables have 2 connections on them. One end of the IDE cable connects to the motherboard and the other ends connect to two of the above devices. Make sure that the hard drive you are connecting has an IDE connection on it and not Serial ATA.



Production Notes

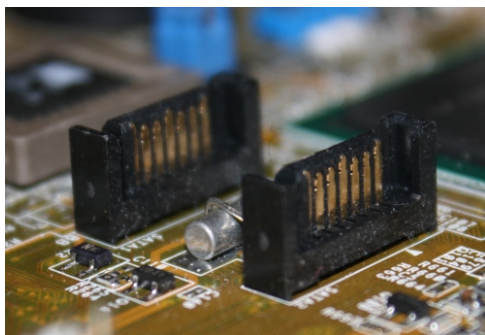
- IDE Connection
- Memory Slots
- Serial ATA Connection
- USB Ports
- PS/2 Ports
- Parallel Port



E. Memory Slots are where the RAM gets snapped into the motherboard. Most motherboards have 2 or 4 slots.

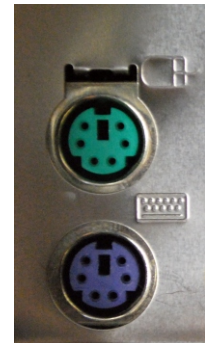


F. The Serial ATA (Advanced Technology Attachment) connection on a motherboard is the newest way to connect hard drives. It is the most advanced method of connecting hard drives. Make sure that the hard drive you are using is a S-ATA hard drive and does not have the IDE connection on it.



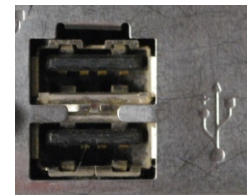
G. The PS/2 ports on a computer are used simply to connect a keyboard or mouse that uses the PS/2 connection type. Most keyboards and mice now use USB connections.

G



H. USB ports (Universal Serial Bus) are used to connect peripherals to the computer like printers, scanners and digital cameras. Computers usually have at least two of these built-in to the motherboard and more can be added by installing a PCI card that has more ports on it. The latest version is called USB 2.0 which is much faster at transferring information than the previous USB 1.1.

H



I. The Parallel Port is an older interface that was used to connect peripherals such as printers and scanners. The port is still included on motherboards because consumers don't want to have to purchase new printers and scanners when they buy a new computer.

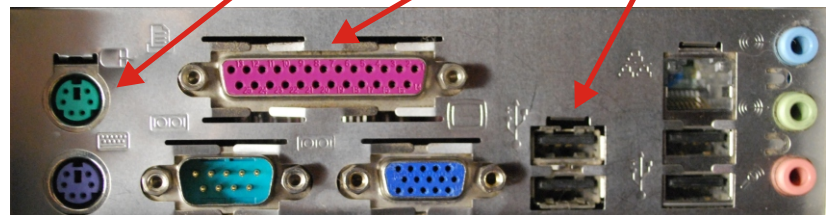
I



G

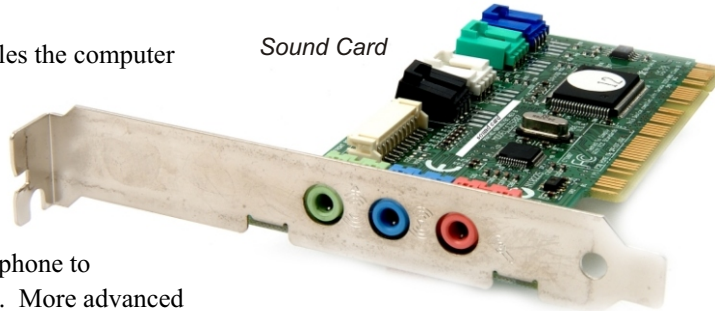
I

H



Computer Components

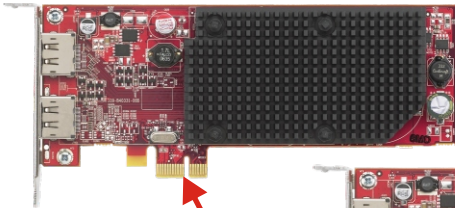
The sound card enables the computer to play music and sounds associated with programs through headphones or speakers. The most basic sound card will also let you attach a microphone to it for recording your voice. More advanced cards will have Line In and Line Out plugs for attaching external devices for recording. Some may even have outputs for surround sound capabilities. The average person will only require a basic card, however with computers becoming media centres, a higher card will be required for integration into home theatre systems. Sound cards will go into a PCI slot on your motherboard.



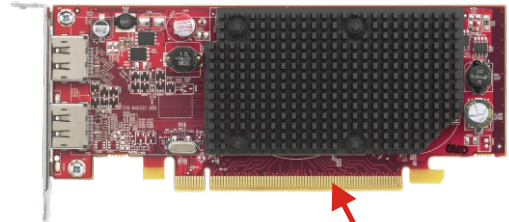
Sound Card



Video Card



PCIe Video Card
1x speed

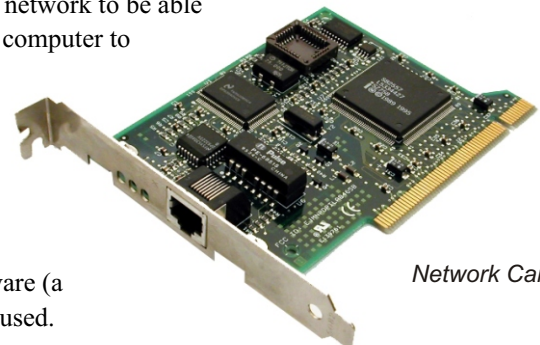


PCIe Video Card
16x speed - the longer connection type makes the speed of the card much faster

Interface which can be found on many of the new types of video cards.

The video card is the component that will allow you to display your graphics on a monitor. Video cards have many options these days that can be somewhat confusing. The first is the type of slot the video card plugs into on the motherboard. The AGP or PCIe (PCI Express) slot is the preferred location to install a card as opposed to a regular PCI slot. So make sure your video card is an AGP or PCIe card. The second option is the amount of RAM the card has. This is what helps the computer display more complex graphics quicker. Look for cards with higher amounts of RAM like 128MB or 256MB. The third option is the output types. The two common types for hooking up your monitor are the standard VGA or the new connection type known as DVI. DVI is commonly used on LCD monitors. Simply check that the monitor connection and your video card match. There are other output options like composite video and S-video for recording on to VHS tape or displaying on a TV set, but these are not used very often anymore. The new standard for sending images to a TV or connecting to a monitor is the HDMI

Network cards have two functions that they can be used for. The first is to connect to an existing hard-wired network to be able to transfer files from one computer to another or access a server. The second function is to access a high speed internet connection. In order to perform both functions, additional external hardware (a router) would have to be used.



Network Card

Production Notes

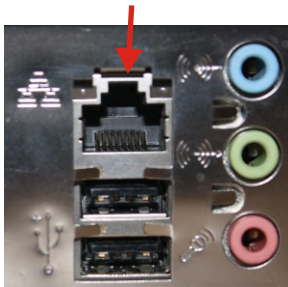
- Computer Components
- Sound Card
- Video Card
- Network Card

DVI Monitor Connection



Network cards have various speeds 10Mbps (the slowest), 100Mbps and 1000Mbps (the fastest). Mbps is megabits per second, a measure of speed. On an all-in-one motherboard, these are sometimes called RJ-45 LAN ports.

Network connection on a All-in-One motherboard



RAM (Random Access Memory) is a type of memory in the computer that can be used by programs to perform necessary tasks. This type of memory is not permanent. The contents that are loaded into it will disappear when program are closed and when the computer is turned off. There are many different types of RAM so make sure when building or upgrading a computer you get the right type of RAM that your motherboard supports. The type will be contained in the motherboard manual or could be found on-line from the manufacturer's website.



RAM

Hard drives are the part of the computer where data is permanently stored. When you install a program or save a file, it all gets stored on the hard drive. Hard drives come in 2 common speeds, 5400RPM and 7200RPM. The latter has the fastest access

time and is required for doing video editing. The size of hard drives is measured in GB (gigabytes). The more gigabytes a hard drive has, the more information it can store. They also come with two different types of connections for the motherboard IDE and S-ATA. Many new computers have both types of connections on them but hard drives themselves will only use 1 type. Make sure that you select a hard drive that matches what your motherboard uses to connect to it.

Hard Drive



IDE Cable



CD and DVD drives are used to load programs and also store data. CD burners and DVD burners can store large amounts of information on CD and DVD discs that can be removed from the computer. They are sometimes called "removable storage". The latest DVD burners can store 8.5GB of information on a dual layer disc. These burners are called DVD-RW DL, where DVD is the disc type, RW tells you that rewriteable discs can be used (those that can be erased and used again) and the DL stands for dual layer which increases the capacity of the disc.



Production Notes

- Network Card
- RAM
- Hard Drives
- CD/DVD Drives and Burners

The keyboard and mouse are considered to be input components. The keyboard is the typing interface while the mouse helps you navigate the screen and select options.



The monitor has evolved from the older CRT (Cathode Ray Tube) technology that gave us big bulky monitors to the new LCD (Liquid Crystal Display) which is very thin and takes up very little space. The monitor displays the information the computer is sending through the video card. It is the visual interface between the user and the computer.

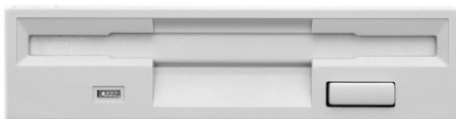
Production Notes

- Keyboard and Mouse
- Floppy Disk Drive
- Monitor
- Firewire Card



An LCD monitor

The floppy disk drive is quickly disappearing and will not be found on many new computers. It stores information on a removable 3.5 inch disk. The memory is very limited with only 1.44MB (megabytes) of total space, approximately 486 times smaller than a CD and 5833 times smaller than the highest capacity DVD.



A floppy disk drive

Firewire cards (IEEE1394) are used to connect digital video cameras or other firewire peripherals to the computer. They are high speed ports that give a consistent flow of information unlike USB which can vary.



3.5 inch floppy disks

Computer Networking

Computer networks aren't just for businesses and schools anymore. Many homes now have networks so that multiple computers can share internet access, files and printers. Basic home networks can come in two forms wired and wireless. Both work the same way except one has wires to connect computers together and the other one doesn't.

Wired and wireless networks that want to share internet access and peripherals have 4 components in them the modem, router, network card and computer. Each performs a specific task in order for your network to function properly. Let's look at each component and what it does.

The modem is the device that allows the high speed internet connection to enter your home. The modem will have 1 of two types of cables connected to it that comes from outside of the house. It will either be a phone line or a cable line. This line connects into the modem which processes the signal. The modem is then connected to the router using a network cable, often referred to as a "CAT 5", "Category 5" or "RJ-45" cable.

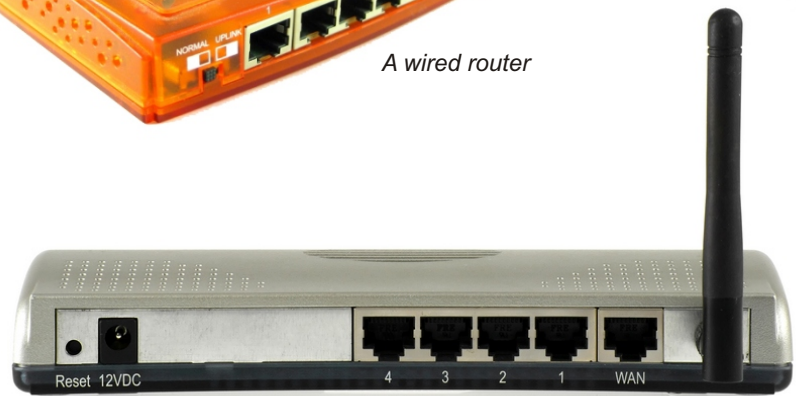


A cable modem

The router is where all of the various signals are processed for distribution to the various computers in the network. The router will have a port on it to connect the modem to. It will also have 4 or more other network ports to attach the computers to. If the network you are using is wired, then all of the individual cables from each computer will plug into the router. If it is a wireless network, no cables will be connected. The signal will be received through the router's antenna.



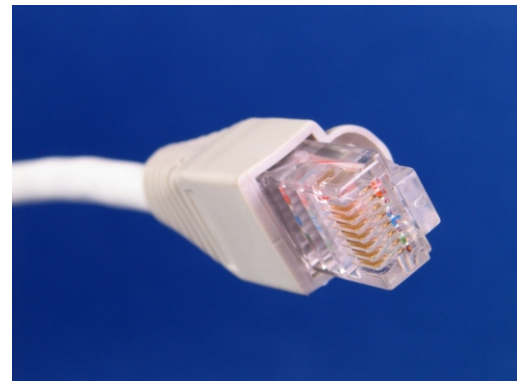
A wired router



A wireless router

The signal from the router is distributed to each computer which will receive it using the network card. In a wired system, the network cable will plug directly into the network card. In a wireless system, the wireless network card install in the computer or plugged into a USB port will receive the signals with a built-in antenna. The network card processes the signal and then sends it through the computer to be displayed on the monitor.

An RJ-45 cable
(network cable, CAT 5 cable)

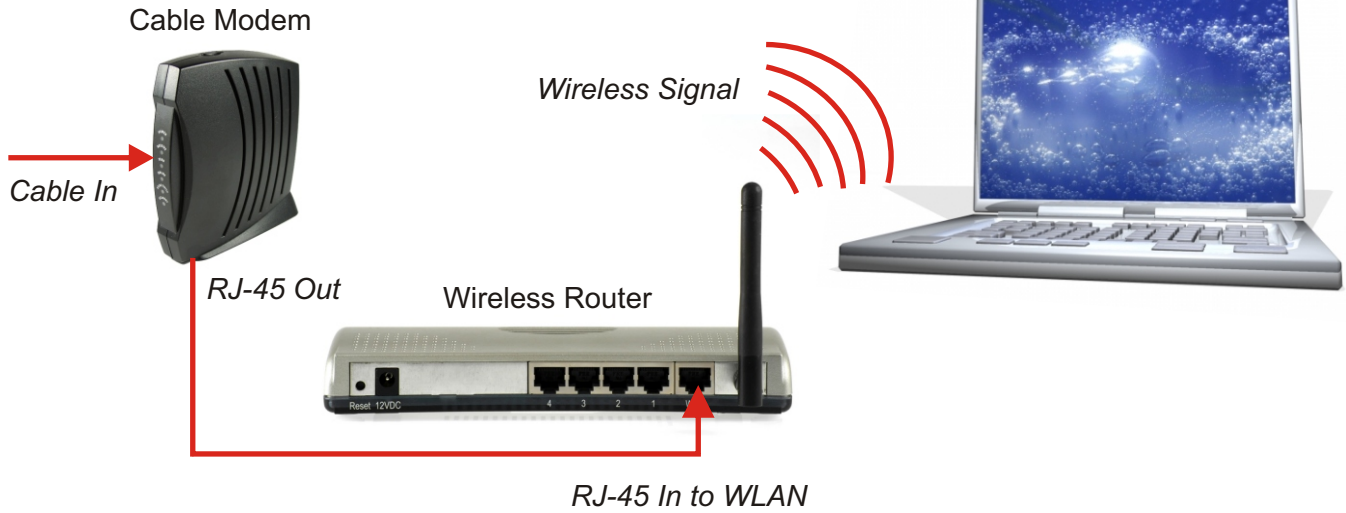


Production Notes

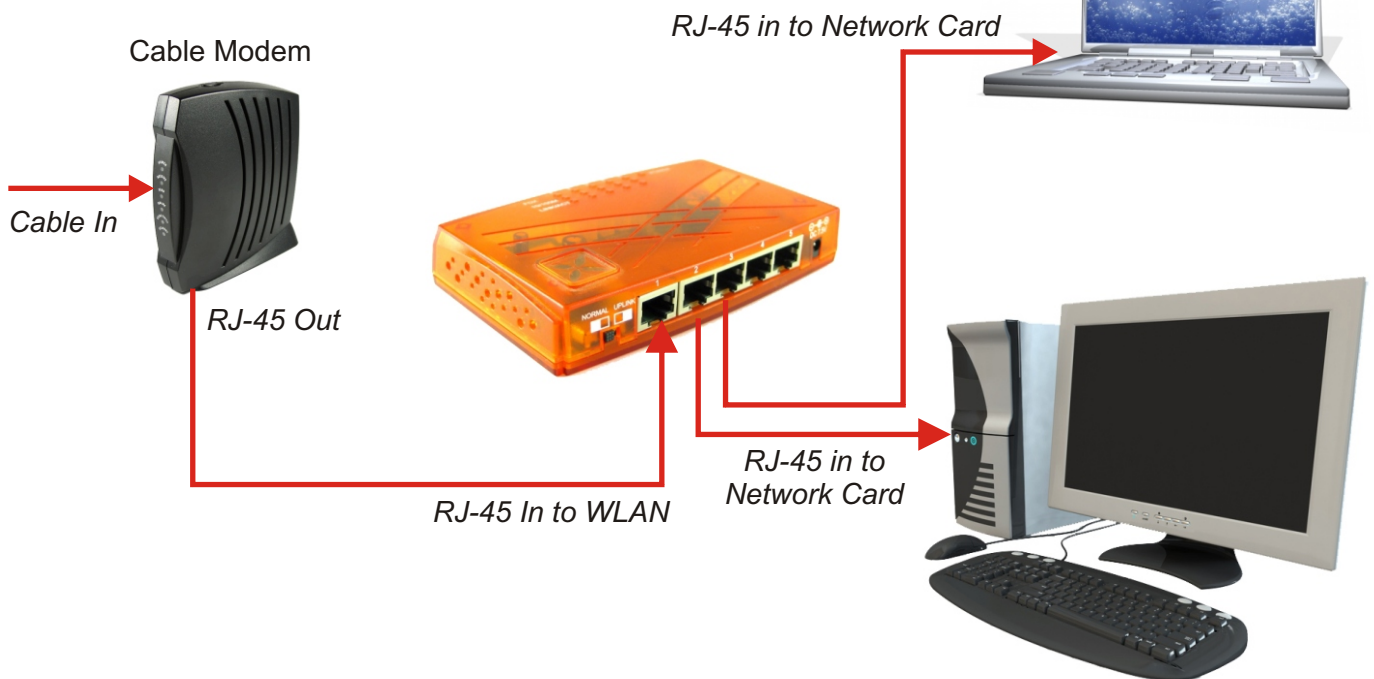
- Computer Networking
- Wireless Networks
- Wired Networks
- Modem
- Router
- Network Card



Wireless Network



Wired Network



There are a few key differences between wired and wireless networks. The first major difference is the speed of the connection. Most wired networks can transfer files at 100Mbps or 1000Mbps depending on the network card and routers speeds. Wireless networks are 54Mbps, 108Mbps or 300Mbps making the transfer speeds slower than the fastest wired network. The second difference is the fluctuation in transfer speeds. Wired networks will maintain a consistent flow of information whereas wireless networks will vary depending on how close the computer is to the router. Speeds can drop off significantly the further away you are.

The third difference is cabling. Wired network have a lot of cabling that needs to be run through walls which can be very difficult to do in an existing house. Walls would have to be opened up in order to run cables and install outlets. Wireless networks have no wires to run, the signal is transmitted throughout the house and can be picked up almost anywhere. This makes it much easier to access the internet from a laptop.

The final difference is the cost. Wired network cards cost about 5 times less than a comparable wireless card. Routers are about 3 to 4 times less for wired networks. Wireless networks are a heftier investment for hardware but may be worth the cost when it comes to purchasing cables and having to pay for installation of the cables.

You can see that networks are quite easy to set up. That is why more and more homes are installing them. As the speed of wireless networks increases and the costs associated with them decrease, they will become commonplace. Homes of the future will have extensive networks in them not only for the computers but for all communications devices.

Video Systems

There are many different types of video systems that exist today. In this section we will explore 2 different types of video systems. The first is videotape systems, the most common way of recording television shows from TV and also recording home videos. The second system that will be looked at is television systems, how television works in analog and digital form.

Videotape: Principles of Video Recording

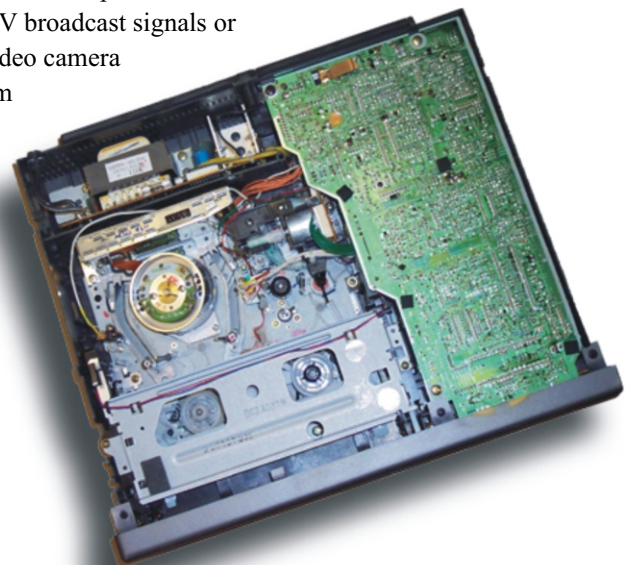
In order to understand how videotape is used, we must first look at how it is made and how a VCR works. Almost every home now is equipped with at least one VCR and TV. But how many people know how these two household items really work? This section will help you to understand the workings of videotape, VCR's, and TV's.

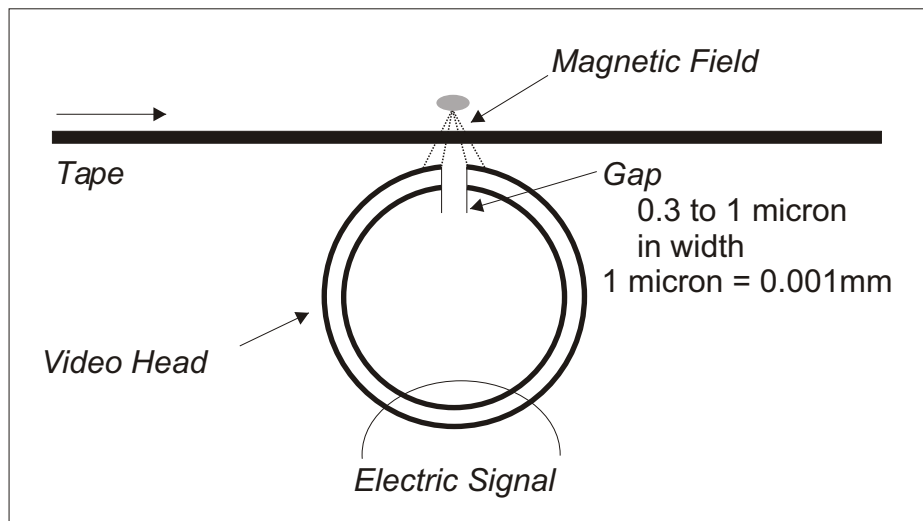
Videotape is a magnetic medium. An ordinary tape recorder uses a magnetic head to convert electric signals (from a microphone, radio, etc.) into magnetic signals that are stored on tape. Video is much the same. TV broadcast signals or pictures from a video camera are converted from electrical to magnetic patterns by special video heads that record the video signal on videotape.

To achieve a faster rate of signal transfer, video recorders use a rotating head

Production Notes

- Differences Between Wired and Wireless Network
- Video Systems
- Videotape: Principles of Video Recording





Videotape Signal Transfer

Production Notes

- Diagram of Videotape Signal Transfer
- Helical Scanning
- Video Tracks
- Diagram of Video Heads

system. Audio tape recorders use a stationary head. In VHS and S-VHS video systems, the head rotates at a speed of 30 times per second while the tape moves at 1 5/16 inches per second.

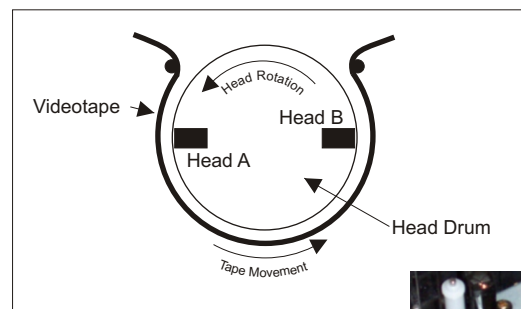
Helical Scanning is the movement of videotape diagonally across the video heads. The two video heads are mounted directly opposite each other on the head cylinder. The cylinder rotates 30 times per second and is angled so that the heads cross the tape diagonally.

As shown in the diagram to the right, the tape is wrapped around half the cylinder circumference. Therefore, Head A begins a track at the same instant the B ends a track and vice versa. Since each head records one track every 1/30 of a second, there are a total of 60 video tracks or fields recorded per second.

The diagrams on the next page show how videotape is played back on a VHS system. The diagram on the bottom right shows how videotape is recorded. There are four tracks on a standard VHS video cassette. These

four tracks are responsible for recording all the information necessary for playback in the future.

The Video Tracks are recorded in a diagonal fashion. As you can recall, this is because of the helical scanning system. Also notice that there are two video fields represented on the videotape. One is a solid line and one is a dashed line. Each line represents 1/60 of a second. One solid line and one dashed line put together form a



single video frame which is 1/30 of a second.

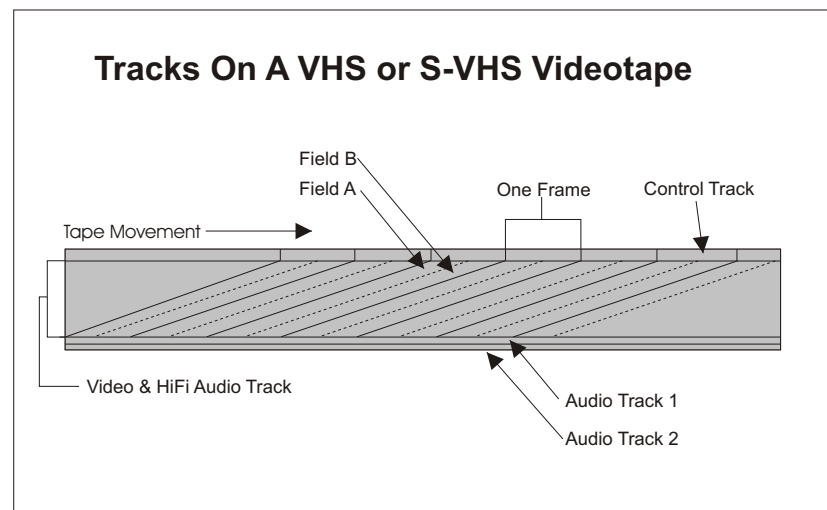
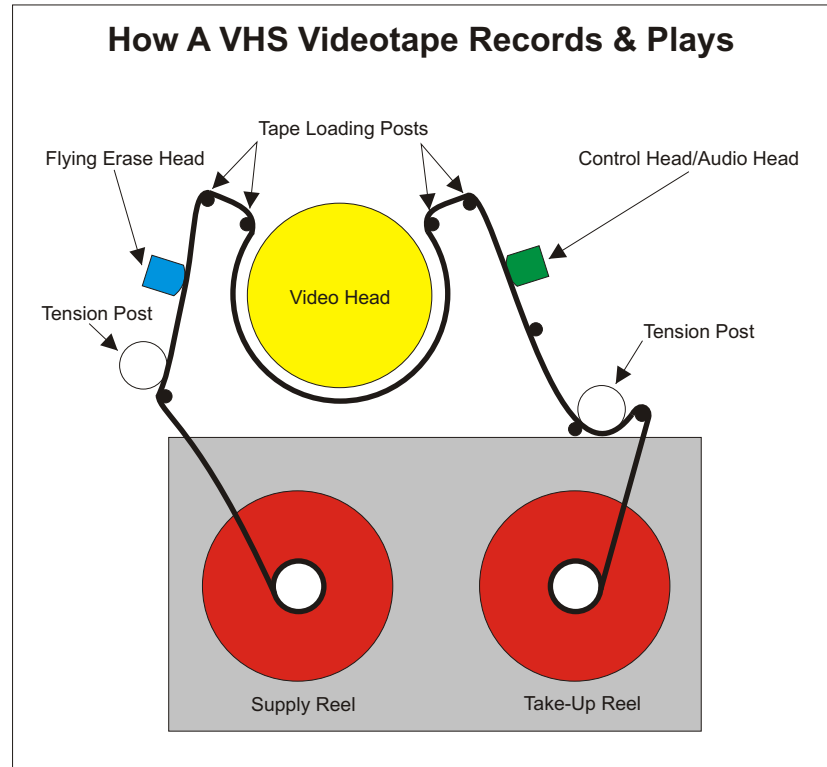
To help make sure that the video heads trace these tracks with exactly the same timing on playback as on recording, an extra track called the control track is recorded along the edge of every videotape. During playback this control signal is picked up by a fixed head and the control signal data is used as a synchronization reference.

The last two tracks on a videotape are the audio tracks. They are responsible for recording the audio signal that accompanies the video signal. There are two audio tracks on every videotape. These two audio tracks are often referred to as normal or mono audio. They both can be recorded at the same time as the video signal or re-recorded later on using a process known as audio dubbing. Each audio track is independent of the other allowing the editor to record on one at a time or both at once. When audio dubbing, the video track is not affected.

There is one additional feature on videotape and that is hi-fi audio. Hi-fi audio cannot be recorded later on like normal or mono audio. It is recorded at the same time the video signal is recorded. It is not shown as a track because it does not have one. It is embedded with the video signal and can only be altered using an insert edit. Insert edits replace both the video signal and the hi-fi audio. These two signals are not independent of one another. When the videotape is played back, some VCR's allow you to specify which audio you would like to listen to.

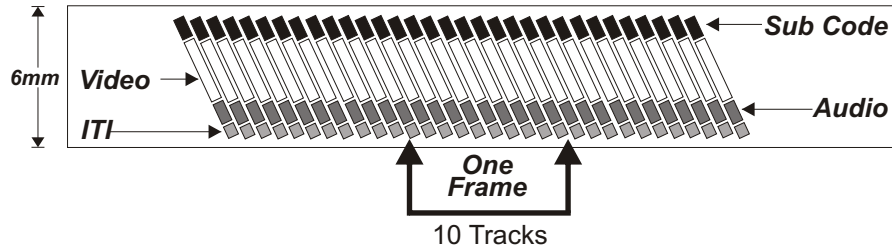
Digital Videotape

Digital videotape stores video and audio information as numbers instead of electrical





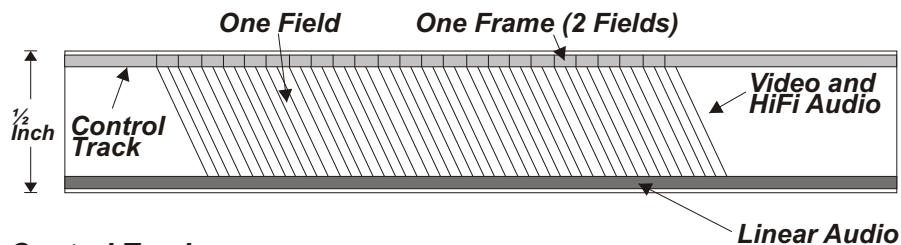
Mini-DV Digital Videotape



ITI (Insert Track Information):
Sector where information concerning data for the camcorder and audio dubbing are stored.

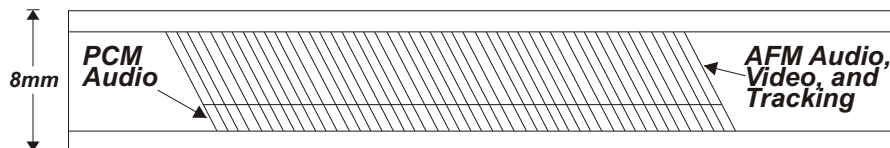
Sub Code:
Sector where index markers, still picture markers, and time code are stored.

S-VHS Videotape



Control Track:
Where information is stored that tells the VCR how fast to play the videotape back. No control track means that no picture is recorded.

Hi8 Videotape



PCM Audio (Pulse Code Modulation):
Audio that is recorded digitally.

AFM Audio (Audio Frequency Modulation):
The method used by 8mm, Hi8, and VHS Hi-fi to produce the audio track.

signals. The system is based on binary code that computers understand. Binary is considered a language. In this language there are only two numbers. Information is stored based on the number 0 and 1. The different combinations of zeros and ones are decoded by the player or camcorder and translated into a picture and also into sound. This has many advantages to it.

The first advantage is that storing numbers instead of an electrical signal is much easier to do. The electrical signal can degrade over time, leaving you with a distorted or even empty videotape. Numbers don't degrade over time. They will always stay the same.

The second advantage is that the video footage can be transferred to a computer system very efficiently and at a lower cost. Since the video and audio is already in a language that the computer understands, there is no need to translate it. This used to be done by expensive video capture cards. Now, all that is required is a firewire port to send the information through at a high speed.

The third advantage is that the picture quality is much better. With 500 lines of resolution, digital videotape makes the 230 lines of VHS look very primitive. This sort of high resolution tape was something that the average consumer or event videographer had only once dreamed of.

Videotape Formats

How many different types of videotape formats can you name? Most people will name about 2 or 3 types but there are far more than just those few. Videotape can be divided into three different categories: Consumer, Prosumer, and Professional.

Although each tape is classified in a category, there are instances where some formats are used in multiple categories.

Consumer Formats

In the consumer market there are nine videotape formats: VHS, VHS-C, S-VHS-C, 8mm, Hi8, Beta, Mini-DV, Digital 8, and HDV. Beta is an older format that is rarely used in today's market. It was first introduced by Sony in 1975 as a consumer format. VHS was invented and introduced by JVC shortly afterwards in 1976 as a competitive alternative to Beta. Both formats use tape that is 1/2 inch wide.

As consumer VHS VCR's became the home standard, more full-size VHS camcorders came onto the market. Since Sony was losing its Beta market share to JVC's VHS format, they decided to fight back in the camcorder market and introduced 8mm videotape. It allowed camcorders to become smaller and easier to travel with. This format took over as the most popular consumer camcorder format. The problem with 8mm was that it would not play back in the standard home VHS machines.

In the late 1980's JVC fought back and developed VHS-C or Compact VHS that would play back in a VHS machine with an adapter. Throughout most of the 1990's, VHS-C was the standard for consumer camcorders. This would all change as we approached the new millennium. Formats that were once considered to be in the prosumer level started to make their way into the consumer market.

Hi8, and S-VHS-C started to drastically drop in price because of the introduction of Mini-DV. These two formats were well established in the prosumer market but the

Production Notes

- Digital Videotape
- Advantages of Digital Videotape
- Videotape Formats
- Consumer Formats



new digital format caused a shift. Hi8 and S-VHS-C cameras went below the \$1000 level and would make their way down to \$500 by 2001. The success of these cameras at the consumer level was instant but short lived. Mini-DV would become more affordable with new consumer models being developed to compliment the prosumer cameras. Now, Mini-DV cameras start below \$400 and go up from there.

Prosumer Formats

The prosumer industry consists of professional videographers that videotape weddings and other special events. This new market emerged in the early 1980's and was expanding at a fast rate. The demand for quality video equipment at an affordable price was increasing. Professional formats were too expensive and consumer equipment was not good enough.

Once again, JVC and Sony came to the rescue of the professional videographer and developed two prosumer formats ("prosumer" is a combination of professional and consumer). JVC came out with Super VHS (S-VHS, S-VHS-C) in 1987 and Sony introduced Hi8 a little later. Each of these formats were drastic improvements on their respective VHS and 8mm formats and were housed within the same shell. The benefit of these formats were numerous. The S-VHS VCR's and camcorders allowed playback and recording in both S-VHS and VHS. Hi8 machines allowed the same except with 8mm. This enabled the professional videographer to master their videos on S-VHS or Hi8 and still make VHS or 8mm copies.



S-VHS had gained tremendous ground in the broadcast industry. Many small cable stations used this format as an inexpensive alternative to broadcast formats. Professional S-VHS is also used by educational institutions as a high quality teaching format. But both Hi8 and S-VHS have moved out of the prosumer level and have been replaced by digital formats.

Professional Mini-DV has some great advantages. The compact size makes it great for transporting. The 6mm wide tape can record digital video and audio for up to 80 minutes.

The professional 3-chip versions of the camcorder are what make this format viable at the prosumer level with video quality higher than Betacam which has long been the broadcast industry standard.

With 500 lines of resolution, Mini-DV is a welcome addition to the prosumer level.

The latest format to enter the prosumer level is HDV, a high-definition recording method that has a resolution up to 1080 lines. The format uses Mini-DV videotape to accomplish this. The quality is extremely good with a picture that is unrivaled at the prosumer level. Consumer versions are gradually being introduced by all of the top companies.



Production Notes

- Prosumer Formats
- History of Prosumer Videotape Formats

DID YOU KNOW?

Many of the new types of tapes that are being introduced are not new tapes at all. They are different ways of recording information onto existing tapes. For example, the new high-definition format called HDV actually uses a Mini-DV videotape to record on. The same is true for Digital 8 which used a Hi8 tape to record a digital signal onto.



VHS & S-VHS



3/4 Inch

DVCPRO



3/4 Inch SP

8mm



VHS-C



MI

Mini-DV



Betacam & Beta

DV



MPEG IMX

Different videotape formats, proportional in size to each other



Betacam SX

Professional Formats

Professional formats are those types of videotape that are used in the broadcast or television industry. In the past few years, the number of professional formats has risen. They include such formats as DVCAM, DVCPro, Betacam, Digital Betacam, Digital-S, and D-5.

The broadcast industry has entered the digital revolution by using computer hard drives for editing. Many companies now have editing cards that allow editors to edit their videos in real time with no rendering. The most popular editing systems used by TV and film producers are made by Avid. Their series of software extends from the prosumer to the professional. They will also be introducing the removable field production hard drive which will connect to a camera. All video footage will be recorded directly onto the hard drive. No videotape is involved. Digital video will eventually eliminate the need for videotape altogether.

The biggest move in the professional industry is the change to high-definition video. Since all broadcasters are required to make the change to digital technologies and high definition, these tapes formats are becoming very popular. HDCAM is the most popular production format. It is even being used on feature films.

For now, videotape remains the dominant and preferred method for collecting video footage. Some consumer cameras have gone to DVD and hard drive recording but tape is still the top seller at all levels, consumer, prosumer and professional. The next move will be to tapeless recording which is being experimented with by most electronics companies. We may see tape disappear in the future, being replaced by storage cards.



Production Notes

- Professional Videotape Formats
- Digital Revolution
- HDCAM

Videotape Formats as of 2010

Consumer

Mini-DV	VHS-C
HDV	S-VHS-C
8mm	S-VHS
Hi 8	Digital 8
Beta	

Prosumer

Mini-DV (Pro)

Professional

DVCAM	DVCPro
DVCPro 50	Betacam
Betacam SP	Betacam SX
Digital Betacam	Digital-S
D1	D2
D3	D5
MII	MPEG-IMX
¾ Inch	¾ Inch SP
1 Inch	2 Inch
HDCAM	DVCPRO HD
DV	W-VHS
HDCAM-SR	

Note: These formats are all currently in use in production facilities. Not all are in wide use but are still used.

Television Systems

We all watch TV but how many people actually know how it works? Since we use televisions in video production to show us what is going on, we should know a little about how they work.

A TV picture is much like a movie in that it is made up of many separate pictures or frames that are reproduced in a high speed sequence. In the NTSC system (how we broadcast TV in North America) there are 30 frames per second. However, unlike in film, each of these frames is in turn made up of two fields which correspond to the odd and even scanning lines of the TV picture tube. Therefore there are 60 fields per second (the same as videotape).

If we break things down even further, there are 525 scanning lines in an NTSC picture. The relationship between these terms is shown in the diagram. Odd scanning lines (A) make up one field while even scanning lines (B) make up a second field. After the electron beam scans a field of 262.5 odd lines, it goes back up to the top and scans a field of 262.5 even lines, thereby completing one frame of 525 lines. When you watch TV you see 30 of these frames every single second.

By now, you may have noticed some interesting relationships between fields, frames, tracks, and cylinder head rotations. Namely, each head records a track on the videotape which corresponds to one field on the TV screen. Both heads are used to record or playback a frame. The point where one head takes up and the other leaves off could cause picture instability, so it is timed closely with the vertical sync component of the video signal. Therefore you do not see the crossover from one head or track to the next.

Digital Television

Digital television (DTV) is the newest method of broadcasting a television picture to your screen at home. The concept was first arrived at in the 1980's with the first standards being established in 1989. These standards were adopted in the United States in 1996.

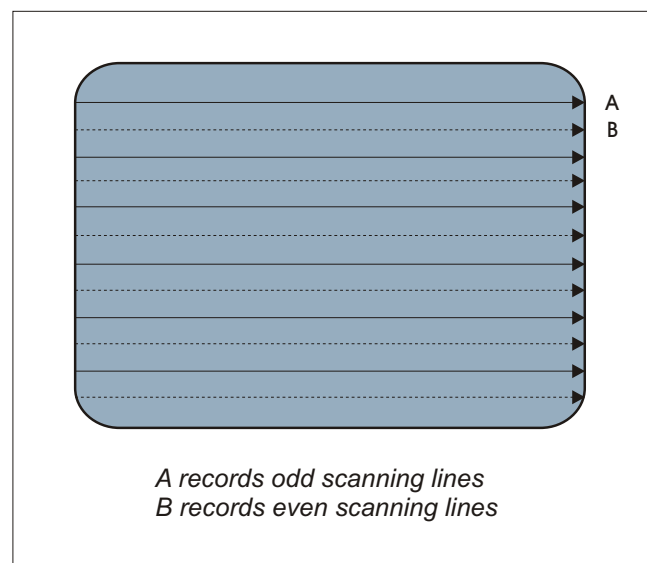
In a DTV system there are 3 main components: the broadcaster, the decoder, and the TV itself. The broadcaster can be a network broadcasting a show live, a cable company that provides you with programming, or a satellite system. Each of these types of broadcasters send the digital signal to your home. That is where the decoder is located. Most decoders for the moment are external boxes that decode the incoming signal and send it to your television set. If you do not have a digital television, you will see a difference in the overall picture quality and will hear great sound, but it will not be at its fullest level.

A digital television is the last component in a true digital system. It has the ability to display your digital picture in its true form.

Production Notes

- Television Systems
- The TV Picture
- NTSC
- Digital Television
- Components in a DTV System

Analog TV Picture



The most talked about digital television system is High Definition Television or HDTV. What makes HDTV stand out among all digital formats is that it has the highest overall quality. The first major feature is that the picture size is in a 16:9 ratio (like film) instead of the traditional 4:3 ratio that governs analog television. This gives the viewer a true cinematic experience when watching movies at home.

The second feature is the resolution. Resolution is the number of horizontal lines that the television displays. The more lines on a screen, the clearer the picture with better colour reproduction. Analog televisions display 525 lines in North America. That translates into just over 200,000 pixels on the screen. HDTV has 1080 lines and over 2 million pixels. When you do the math, that works out to be a picture that is 10 times more detailed than analog television.

The third important feature of HDTV is the sound quality. HDTV uses the Dolby Digital Surround Sound system known as AC-3. Again, this type of sound was only heard in theatres previously but is now a standard feature of High Definition.

So when will HDTV be entering a home near you? Well, it has already started. The first station to start broadcasting in HD was in Raleigh, North Carolina. WRAL led the pack even though they did not have to be broadcasting in High Definition until 2006. That is when all stations in the United States were to be capable of broadcasting in HDTV. You also need a set-top box to convert the digital signal to analog or buy a whole new TV set. Not to mention the fact that every cable broadcaster has to buy new equipment!

As of mid-2006, the implementation of

digital television and HDTV was behind schedule and the deadline would not be met by all broadcasters in the United States. Only the major networks had met the dates.

The FCC in the United States has now ended analog broadcasting and officially started digital broadcasting on February 17, 2009. The transition to DTV in the US is completed and the airwaves once used for analog will be used for other purposes. Canada is scheduled to make their change on August 31, 2011.

Production Notes

- HDTV
- Features of HDTV
- Implementation of HDTV

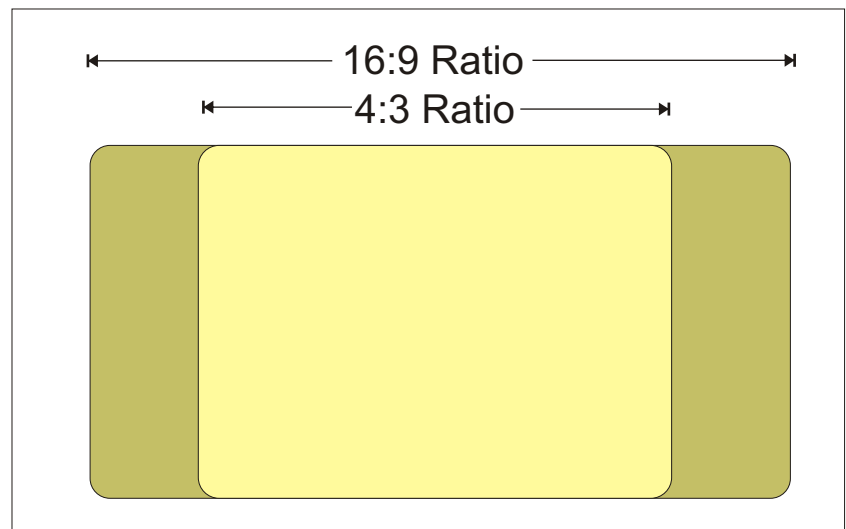
Pictures courtesy of Panasonic Canada



A standard TV with a 4:3 ratio



A widescreen TV with a 16:9 ratio



**R E V I E W Q U E S T I O N S**

The third chapter has covered many different topics that deal with types of communication systems. These have included videotape, formats, digital TV, cell phones, computer systems, and much more. Try these review questions and see how well you can answer them.

Chapter Three Review Questions

1. Describe how a video signal is put onto videotape. Use diagrams to enhance your answer.
2. The number 30 is frequently seen in technical video specifications. Invent a method to remember the key statistics about video recording using the number 30 and its relationship to specific items.
3. Define Helical Scanning.
4. Compare the similarities between satellite radio and satellite television.
5. Name the three categories of videotape formats. What are the formats in each category used for. Give examples of where you would use at least 1 format from each category.
6. Explain how a cell phone receives a call.
7. What is Digital Television? Give at least 3 characteristics of digital TV.
8. Outline how regular analog television works giving the key statistics for it.
9. Identify and explain 5 parts of a computer motherboard and 5 components that can be added to a computer.
10. Compare wireless and wired networks. How do they differ? How are they the same?