RF, Wireless, and Computer Network Cables and Structured Wiring

Coax for RF

Coax cable is the only cable that works reliably at very high frequencies. Radio frequencies (RF) extend from about 100 kHz to over 30 GHz. Since radio signals are subject to noise and signal pick up from other sources, coax is the perfect solution because the outer braid provides isolation and protection. Coax also reduces the amount of radiation from the center conductor and prevents interference with nearby equipment.

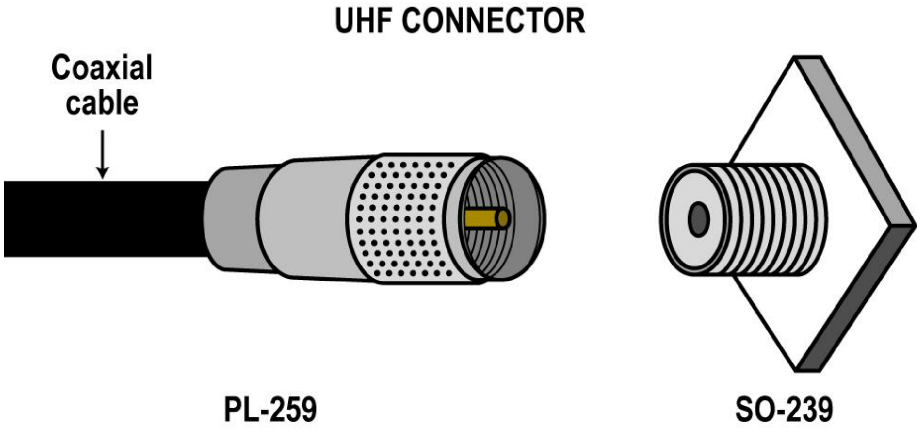
Coax cables are used in RF applications to connect antennas to wireless receivers and transmitters, connect one piece of equipment to another, and to connect test instruments to wireless equipment.

Coax Concerns

The main consideration in selecting a coax cable for RF is its attenuation per foot. The higher the frequency, the greater the attenuation of the cable. In other words, the attenuation per foot increases with frequency. It may only be 2 dB per 100 foot at 30 MHz but as much as 10 dB per hundred foot at 2 GHz. You should always select a cable with the lowest attenuation.

The related issue is how long the cable is. For short cables, attenuation is less of an issue as the loss is almost negligible. But when running a cable up to the antenna on a 200 foot tower, the loss can be considerable. In some applications, a power amplifier may have to be added to overcome the cable attenuation. Again, selecting a cable with the lowest loss per foot is the best solution.

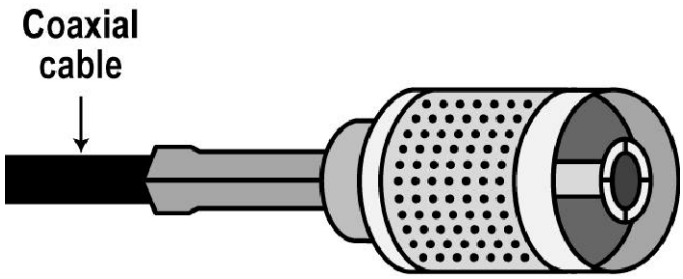
RF Connectors



RF and wireless applications using coax make use of a wide range of different connectors. For example, in short distance connections with smaller coax, the RCA phono, and BNC connectors described earlier are widely used.

When higher power is required, other connectors are used. One of the oldest and still widely used is the so-called UHF connector shown in the figure above. The plug is designated the PL-259 while the socket is called the SO-239.

N-Type RF Connectors



N-type RF connector

Another widely used RF connector is the N-type connector of shown here. It can handle higher power and is designed to maintain the cable characteristic impedance through the connection. It is a better connector for microwave frequencies above 1 GHz.

Computer Networking Connections

Computer networking is the interconnection of PC, laptops, and peripherals so they can talk to one another, exchange emails, access data bases, or connect to the Internet. The computer network inside an office or building is usually called a local area network (LAN). Larger networks covering a city or large campus are called metropolitan area networks (MAN). An example is the cable TV network. Even larger networks covering an entire country or world wide are referred to as wide area networks (WAN). Examples are the long distance telephone network and the Internet.

Most MANs and WANs use fiber optical cable. LANs use mostly twisted pair connections.

Ethernet LAN

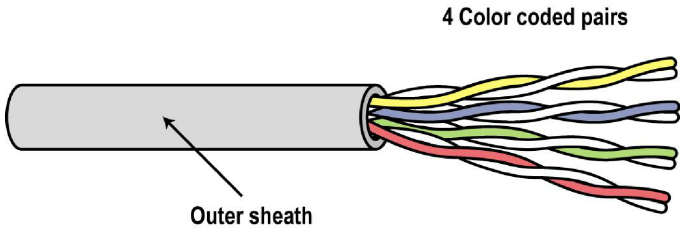
The most widespread LAN is called Ethernet. It was invented back in 1973 by Robert Metcalfe. It eventually became the IEEE standard 802.3. The basic data rate is 10 Mbps.

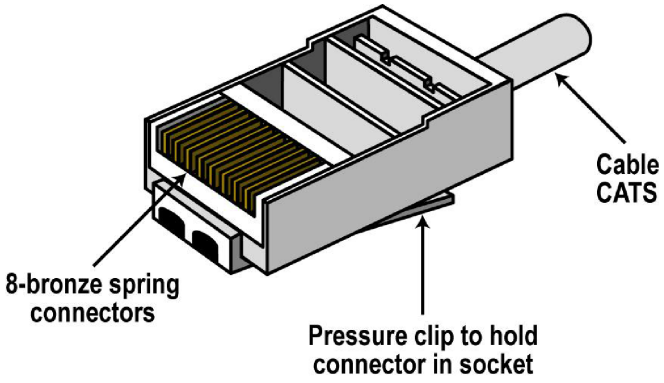
The initial Ethernet used coax cable to connect computers. The larger RG-8/U cable was used for longer connections while the smaller RG-58/U cable was used in shorter connections. These versions of Ethernet were referred to as 10BASE-5 for the large coax and 10BASE-2 for the smaller coax. The 10 designates 10 Mbps while the 5 indicates a maximum length of 500 feet. The 2 means 200 feet maximum length.

Coax is no longer used in Ethernet installations. Virtually all LAN wiring since the 1990s has been twisted pair cable. Initially, the four pair cable shown with the designation CAT3 was used. Later, CAT5 became the more popular version.

Fast Ethernet

A speedier version of Ethernet was developed in the mid 1990s called Fast Ethernet. It permits transmission of serial data at a rate of 100 Mbps. It is designated as 100BASE-T. It uses the four twisted pairs as shown in the top figure. CAT5 cable had to be used as it was designed to handle the higher speeds. Connectors are the RJ-45 as shown the bottom figure.





Gigabit Ethernet

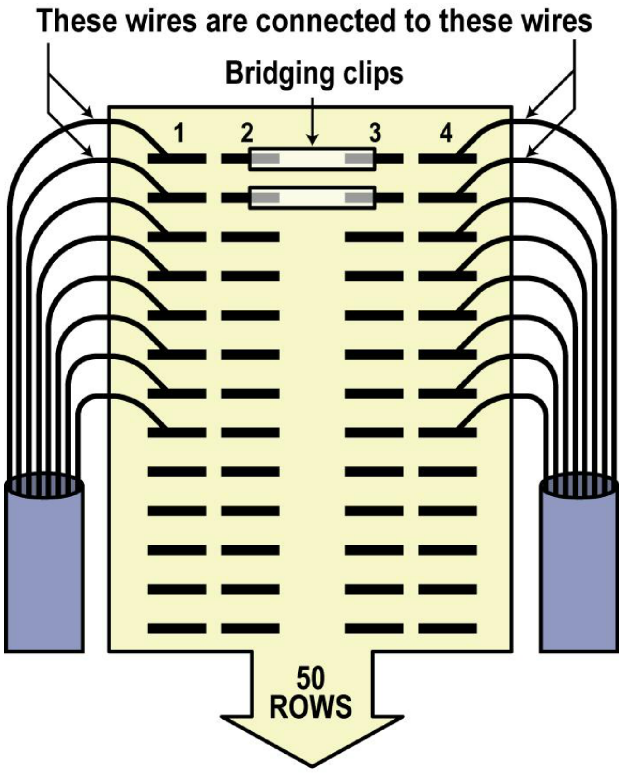
A newer faster version of Ethernet permits speeds to 1 gigabit per second or one billion bits per second. It is known as One Gigabit Ethernet or 1GE. It typically uses CAT5e cable because of its ability to carry data at higher rates over longer distances. The maximum range is 100 meters.

A newer and forthcoming version of Ethernet permits the transmission of data at a rate of ten gigabits per second. It is called 10GE. It uses all four pairs in a CAT6 cable and the maximum distance is about 50 meters. 10GE systems are not available yet but an IEEE standard should be ratified in 2006 with real products to emerge shortly thereafter.

Ethernet Wiring

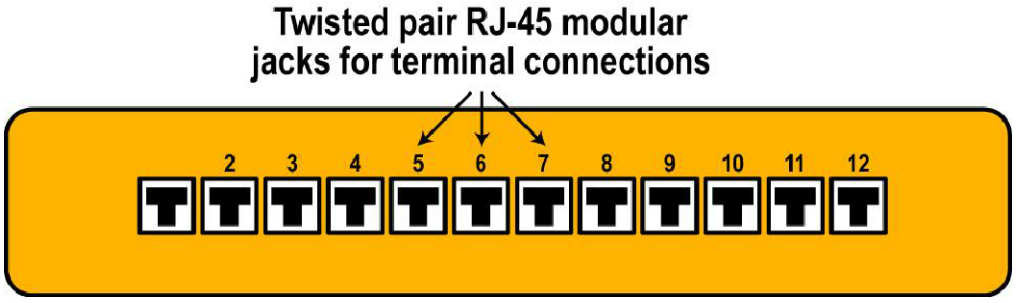
Ethernet wiring is usually strung in ceilings and walls when a building is built. Wall plates with RJ-45 jacks are put into every office and room. Computers plug into the network wiring this way.

At the other end of all those CAT5/6 cables is one of two arrangements. In some cases, the cables are terminated at a punch down block just like those used in telephone wiring.



Pin 1 is internally connected to pin 2
Same with pins 3 and 4

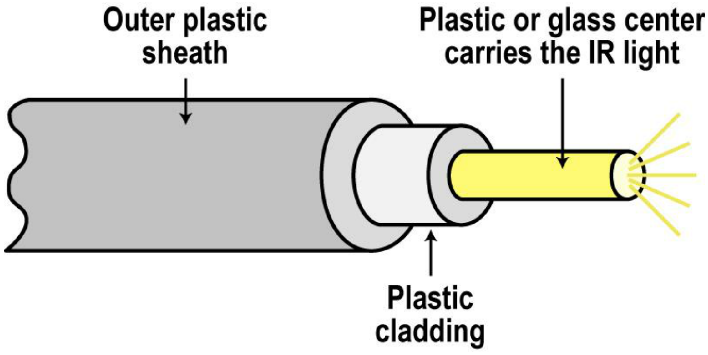
Ethernet Hub



In some cases, the cables terminate at a hub or switch. An Ethernet hub is simply a common connecting point for multiple Ethernet connections as shown above. The hub is a box with RJ-45 jacks that are wired together inside.

An Ethernet switch looks like a hub with multiple RJ-45 jacks. Internally electronic switches route the connections to that part of the network the computer is trying to access. Switches automate the connections while speeding up transmissions. The hubs and switches are ultimately connected back to the servers that operate the LAN.

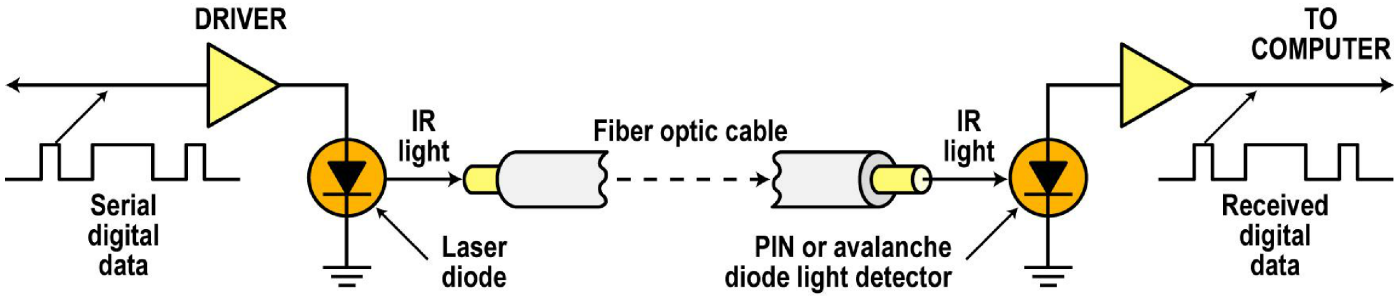
Fiber Optic Wiring



For some 1GE and 10GE connections, fiber optical cable is used instead of twisted pair. Fiber optical cable is a glass or plastic cable that carries infrared (IR) light.

Fiber optical cable permits faster data transmission over much longer distances. Most of the long distance telephone network is made up of fiber optical cable. All Internet cabling is fiber optic.

Fiber Optic Data Transmission



As shown in the figure above, the digital data to be transmitted is fed to an IR laser that transmits the data as light pulses down the cable. At the other end, an optical diode translates the light pulses back into digital data.

Common data rates are 2.5 Gbps and 10 Gbps. A 40 Gbps version is also available.

Fiber optical cable is beyond the scope of this module.

Structured Wiring

One of the terms you will hear today about home and building wiring is structured wiring or cabling. Structured wiring is a system or method of combining all of the various wiring in a home or building together and dealing with it as a whole. Today, most wiring is run separately for each function or service. There is AC power, DC low voltage, telephone, cable TV, twisted pair for computer networking, and possibly even fiber optic cable. You can add in things like audio, video, or security system wiring as well.

What structured wiring does is to collect all the wiring together and bundle it and run it to the places it needs to be. All cables terminate at a single wall plate instead of having multiple plates and connectors for each cable. All of the cables then terminate in a central location like a wiring closet. At this point, access is provided to all the cables. There are punch down blocks and a variety of connectors so that wiring configurations can be changed or new arrangements connected.

Benefits of Structured Wiring

Structured cabling is beneficial because it provides a central location where access to all wiring is convenient. It permits fast easy changes or additions to the wiring. It also provides an easy way to troubleshoot the system. There are no splices or other wire and cable twisting, soldering, etc. All cables are terminated in connectors so all wiring can be plugged in or removed fast. All connections are labeled so it is easy to see where each cable goes. Things can be connected, disconnected, or rerouted by simply going to the wiring closet and making the connections.

Many new homes are now being wired this way. You can always request structured wiring in a new home. It is too difficult to install it in an existing home because of the high labor cost to pull cable.

Structured wiring is also being used in commercial offices and buildings to permit the same benefits.

Types of Cables

The cabling used in structured wiring is standard types.

CAT5 or CAT6 with RJ-45 connectors is used for computer networking.

CAT3 or other twisted pair is used for telephone or low DC voltages.

RG-6/U is used for cable TV and all other video. F connectors are the most common connectors used.

Some fiber optic cabling is sometimes included.

The standard that applies to home structured wiring is TIA/EIA-570.

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