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**DataFAX Document #: 5973021** – *Page 1 of 4*

(03/08/96)

CCTV system consists of many components

and each is critical to the quality of the video picture

that is reproduced. Many system designers specify very

specific criteria for the hardware; however, when it

comes to the transmission media, only general information

is given.

A

**Choosing The Correct**

**Coaxial Cable For**

**CCTV Applications**

The following is reprinted with permission from Penn Wire/CDT. This article first appeared in the February

1996 issue of West Penn Technical Wire, a technical bulletin published by West Penn.

into the signal causing high noise levels. This in turn

can result in poor picture quality.

There are various construction types for coastal

cable. Understanding the various parameters of coaxial

cable and selecting the proper cable for a CCTV system

will eliminate wasted time, money, and aggravation.

A CCTV video signal is comprised of both low

frequency components (horizontal and vertical sync

pulse information), and high frequency components

(video information). In order to transmit this full spectrum

of frequencies with little distortion or attenuation,

it is important to select the correct cable that meets the

specifications for CCTV transmission.

**CCTV 75 Coax Cable**

Selecting the correct transmission media for CCTV

is one of the most vital aspects of designing a quality

system and yet it is the least understood topic in system

design. You can have the highest quality hardware components

in a system but if the video signal is not transmitted

by the proper media, your whole system will

suffer. Many of the common video problems with picture

quality can be avoided by selecting the proper transmission

media and following proper installation techniques

and procedures.

**Coaxial Cable Types**

CCTV video signals are commonly transmitted

using coaxial cable. Coaxial cable is designed to transmit

the complete video frequency range with minimum

distortion or attenuation, making it an excellent choice

for CCTV. However, choosing the incorrect coaxial

cable can degrade the overall signal transmission and/

or allow outside EMI/RFI interference to be introduced

®

The parameters to consider are mechanical characteristics

such as the center conductor material, dielectric

material, shield type and material, and jacket

material. The electrical characteristics such as resistance,

capacitance, impedance and attenuation are critical

for proper transmission. The following explains each

component:

**Copper**

**Bare Copper Conductor Copper-Covered Steel**

**Copper**

**Coating**

**Steel**

**Core**

**Gauge Material Resistance**

**20 AWG Copper 10** **D.C.R.**

**20 AWG Copper-Covered Steel 40** **D.C.R.**

**Jacket**

**95% Copper**

**Braided Shield**

**Foamed**

**Dielectric**

**Bare Copper**

**Center Conductor**

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**Center Conductor**

Center Conductor material made of bare cooper is

recommended for optimum performance in CCTV signal

transmission. Because a CCTV video signal is a

baseband composite video with fairly low frequency

components compared to a CATV video signal, the low

D.C. resistance that copper provides will greatly improve

the video signal transmission.

Coaxial cable is also available with a

copper-covered steel center conductor. The steel core

of a copper covered steel center conductor provides

extra cable strength, while its copper coating provides

a path for RF signal. This construction technique is used

due to the fact that the higher the frequency of an electronic

signal transmission, the more the signal travels

on the outer surface of a conductor. This phenomena is

known as “skin effect”.

A copper-covered steel center conductor has a

much higher D.C. resistance than bare copper and

greatly attenuates the lower frequency components of

a CCTV video signal (refer to table). Although it may

be less expensive than pure copper, it is not suitable for

CCTV and is not recommended. Coaxial cable that utilizes

a copper-covered steel center conductor is usually

designed for, and more suitable for use in CATV

and other RF applications because the skin effect transmission

characteristic at higher frequencies.

The attenuation chart clearly shows the difference

between copper and copper-covered steel. Especially

take note of the lower frequency range where the sync

pulse information is transmitted.

line used in the selection of center conductor construction

is the cable’s installation as to fixed or pan and tilt

applications. If the cable is going to be used on a CCTV

camera that will be in a fixed position, then a solid conductor

is acceptable. However, if the cable will be used

in a pan and tilt application, then you should choose a

standard conductor because a solid conductor construction

will eventually break under the constant strain being

placed on the cable at the same point.

**Dielectric Material**

Dielectric Material of a coax cable is also another

key area that should be addressed. The dielectric material

and its composition is critical as it sets up the electrical

characteristics such as capacitance, velocity of

propagation, impedance, and attenuation of the cable.

These parameters will determine signal strength and

transmission distance. It is recommended to choose a

dielectric with excellent electrical properties such as

polyethylene or FEP. Such material will give you lower

capacitance and a higher velocity of propagation. This

results in a cable with low-loss characteristics and reduced

attenuation of the signal. To improve the electrical

properties even further, a foamed or cellular composition

of these materials is recommended (see chart).

**Attenuation Chart**

Notice the big difference in attenuation between

the two materials. If a cable is chosen with copper covered

steel the sync pulse information will be attenuated

causing distortion in the video signal. Another guide-

**Braided Shield**

A braided shield is the proper type of shield for

CCTV and has two key purposes. One is to provide a

low D.C. resistance ground path and the second is to

provide shielding of outside interference from distorting

the video signal. The shielding should be constructed

**Attenuation (db/100 Ft.)**

**2.0**

**1.0**

**0.1**

**0 .50 1.0 10.0**

**Frequency (MHz)**

**RG59 Coaxial Cable with**

**Copper Covered Steel**

**RG59 Coaxial Cable**

**with Bare Copper**

**Dielectric Electrical Comparison**

**Nom. Vel. of Nom. Nom. Attenuation**

**Dielectric Capacitance Prop. Imp. MHZ db/100 ft.**

**Solid 50 MHZ 2.9**

**Polyethylene 100 MHZ 3.3**

**Foam 50 MHZ 2.0**

**Polyethlene 100 MHZ 2.8**

**22 pf/ft 66% 75**

**17 pf/ft 78% 75**

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of bare copper to provide a low D.C.R. return path. It

should have a 95% or better braid coverage in order to

provide adequate shielding from outside electrical

interference’s. Anything less is usually not acceptable

for CCTV. To provide increased shielding in the RFI

range, a construction of an aluminum foil tale is acceptable

as long as a high percentage copper braid is

used to provide the low D.C.R. return path.

**Coaxial Cable Parameters**

Coaxial Cable Parameters vary depending on the

type of coax construction. All coax cables have a characteristic

impedance. The impedance of CCTV V equipment

is 75 ohms; therefore in order to have minimum

losses, it is important to choose a cable with a matching

impedance of 75 ohms. If a coax cable of another

impedance (50 ohm or 93 ohm) cable is chosen, then

you will experience signal loss and reflection resulting

in short distance transmission and poor picture quality.

Coaxial cables are also available in different RG

types. RG stands for Radio Guide and is a term used

when sending Radio Frequency (RF) signals down a

coaxial cable. 75 ohm coaxial cable comes in several

sizes with the most common types being RG 59, RG 6,

and RG 11.

An RG 59 cable is the most commonly used coax

because it is smaller in diameter and easy to work with.

The RG 11 cable is the largest in diameter and harder

to work with. The RG 6 size is between the two. The

difference between the RG types is not just size, but

also the attenuation characteristics and therefor the

transmission distance. Typically, the coax cable transmission

limitations for CCTV will be as follows:

The RG 59 has the highest attenuation of the three types

and you can expect to get a distance of about 750 -

1,000 ft. The RG 6 has lower attenuation characteristics

than RG 59 and you can expect distances of about

1,000 - 1,500 ft. The RG 11 type has the lowest attenuation

characteristics and you can expect distances of

2,5000 - 2,000 ft.

**CCTV vs. CATV Cable Construction**

A cable with a combination aluminum foil shield

and low coverage aluminum braid (see diagram) commonly

used for CATV is not is not acceptable! Because

aluminum shields have a much higher D.C. resistance

return path and the braided portion of these type of

cables provide only a low percentage of coverage, they

do not provide the type of shielding required for CCTV

video transmission.

**Jacket**

Jacket choice is mainly determined by the environment

where the cable will be installed. The cable

jacket provides two major functions. One is to provide

protection from the elements a cable may be subjected

to and the second is to provide solid termination. PVC

is a good choice for most applications located inside a

building. Plenum rated cables are required for use in

ducts, plenums and other space used for environmental

air without conduit as per NEC.

Polyethylene is recommended for outdoor applications

where the cable may be subjected to the elements

and a high degree of moisture, sunlight, and abrasion

resistance is required. Do not install indoor rated

cable in aerial, direct burial or underground pipe. An

indoor-rated cable is not designed for these harsh environments

and the electrical and mechanical characteristics

will degrade over a period of time and will need

to be replaced. Always follow the NEC code for proper

cable type for your installation.

**Coax Distance Limitations**

**95% Bare Copper Shield Bare Copper**

**CCTV**

**CATV**

**45-65% Aluminum Braid**

**Aluminum Foil Shield**

**Copper- Covered**

**Steel Conductor**

**RG/59**

**RG/6**

**RG/11**

**500 1,000 1,500 2,000**

**Distance**

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These distances are based on the fact that all cable

parameters described earlier are adhered to. If you need

to go beyond 2,000 ft., then you need to use amplifiers

or use fiber optic cable as a method of transmission.

**Installation Considerations**

Indoor environments are the most common for

coaxial cable installations. A few tips for installing coaxial

cable are as follows:

1. First and foremost, follow all NEC requirements

when installing coaxial cables.

2. Distribute the pulling tension evenly over the cable

and do not exceed the minimum bend radius. Exceeding

the maximum pulling tension or the minimum

bend radius of a cable can cause permanent

damage both mechanically and electrically to the

cable.

3. When pulling cable through conduit, clean and

deburr the conduit completely and use proper lubricants

in long runs.

Outdoor installations require special installation

techniques that will enable the cable to withstand harsh

environments. When using cable in an aerial application,

lash the cable to a steel messenger wire. This will

help support the cable and reduce the stress on the cable

during wind, snow and ice storms. When direct burying

a cable, lay the cable without tension so it will not

be stressed by when earth is packed around it. When

burying in rocky soil, fill the trench with sand. Lay the

cable and then place pressure-treated wood or metal

plates over the cable. This will prevent damage to the

cable from rocky soil settling. In climate areas, bury

the cable below the frost line.

**Termination Techniques**

The solder method offers several advantages for

connectorization. This type of connector can be used

on solid or standard conductors. It allows for both solid

mechanical and electrical connections. The disadvantage

is that it takes more time to terminate than other

methods and “cold” solder joints can cause problems if

the connector is not soldered to the cable properly.

The Crimp Method is probably the most popular

method for terminating BNC connectors on coax cable.

Like the solder method, it can be used on solid or

stranded conductors and provides a good mechanical

and electrical connection. This method is the most popular

way to terminate because there is no need for soldering;

therefore installation time is reduced. Some

important points to remember when using the crimp

method is to use the proper size connector for the size

coax you are using. A tight fit on the cable is important

When crimping the connector, use the proper tool! Don’t

use pliers! Pliers are not designed to place the pressure

of the crimp evenly around the connector. Pliers will

only crush the cable and can degrade the electrical properties

of the cable.

The twist-on method is the quickest way of terminating

a coaxial cable; however, it does have some drawbacks.

When terminating the cable with this type of

connector, the center conductor is cut into by the center

pin on the connector, thus to much twisting can cause

damage to the center conductor. In pan and tilt installations

the constant movement of the cable may work the

connector loose and it is not recommended for this application.

Because there is no mechanical or electrical

crimp or solder connection, this connector is not as reliable

as the other methods.

**Conclusion**

Designing a CCTV system takes quality components,

engineering, and installation practices. Remember

the coax cable specified for a CCTV V system is a

key component of the system and is critical to the proper

operation of the system. Do not install anything less

than cable specifications suitable for CCTV. By following

the parameters covered in this technical paper,

you should have much success with your CCTV cabling.

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

**Twisted pair**

From Wikipedia, the free encyclopedia

Jump to: [navigation](http://en.wikipedia.org/wiki/Twisted_pair#mw-head), [search](http://en.wikipedia.org/wiki/Twisted_pair#p-search)

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| --- | --- |
| http://upload.wikimedia.org/wikipedia/en/thumb/9/99/Question_book-new.svg/50px-Question_book-new.svg.png | This article **needs additional** [**citations**](http://en.wikipedia.org/wiki/Wikipedia:Citing_sources#Inline_citations) **for** [**verification**](http://en.wikipedia.org/wiki/Wikipedia:Verifiability). Please help [improve this article](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit) by adding citations to [reliable sources](http://en.wikipedia.org/wiki/Wikipedia:Identifying_reliable_sources). Unsourced material may be [challenged](http://en.wikipedia.org/wiki/Template:Citation_needed) and [removed](http://en.wikipedia.org/wiki/Wikipedia:Verifiability#Burden_of_evidence). *(September 2007)* |

[](http://en.wikipedia.org/wiki/File:25_pair_color_code_chart.svg)

[http://bits.wikimedia.org/static-1.20wmf7/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:25_pair_color_code_chart.svg)

[25-pair color code](http://en.wikipedia.org/wiki/25-pair_color_code) Chart

**Twisted pair** cabling is a type of wiring in which two conductors of a single [circuit](http://en.wikipedia.org/wiki/Electronic_circuit) are twisted together for the purposes of canceling out [electromagnetic interference](http://en.wikipedia.org/wiki/Electromagnetic_interference) (EMI) from external sources; for instance, [electromagnetic radiation](http://en.wikipedia.org/wiki/Electromagnetic_radiation) from unshielded twisted pair (UTP) cables, and [crosstalk](http://en.wikipedia.org/wiki/Crosstalk) between neighboring pairs. It was invented by [Alexander Graham Bell](http://en.wikipedia.org/wiki/Alexander_Graham_Bell).

|  |
| --- |
| **Contents**   [[hide](http://en.wikipedia.org/wiki/Twisted_pair)]   * [1 Explanation](http://en.wikipedia.org/wiki/Twisted_pair#Explanation) * [2 History](http://en.wikipedia.org/wiki/Twisted_pair#History) * [3 Unshielded twisted pair (UTP)](http://en.wikipedia.org/wiki/Twisted_pair#Unshielded_twisted_pair_.28UTP.29) * [4 Cable shielding](http://en.wikipedia.org/wiki/Twisted_pair#Cable_shielding) * [5 Most common twisted-pair cables](http://en.wikipedia.org/wiki/Twisted_pair#Most_common_twisted-pair_cables) * [6 Solid core cable vs stranded cable](http://en.wikipedia.org/wiki/Twisted_pair#Solid_core_cable_vs_stranded_cable) * [7 Advantages](http://en.wikipedia.org/wiki/Twisted_pair#Advantages) * [8 Disadvantages](http://en.wikipedia.org/wiki/Twisted_pair#Disadvantages) * [9 Minor twisted pair variants](http://en.wikipedia.org/wiki/Twisted_pair#Minor_twisted_pair_variants) * [10 See also](http://en.wikipedia.org/wiki/Twisted_pair#See_also) * [11 References](http://en.wikipedia.org/wiki/Twisted_pair#References) * [12 External links](http://en.wikipedia.org/wiki/Twisted_pair#External_links) |

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=1)**] Explanation**

In [balanced pair](http://en.wikipedia.org/wiki/Balanced_pair) operation, the two wires carry equal and opposite signals and the destination detects the difference between the two. This is known as [differential mode](http://en.wikipedia.org/wiki/Differential_signaling) transmission. Noise sources introduce signals into the wires by coupling of electric or magnetic fields and tend to couple to both wires equally. The noise thus produces a common-mode signal which is cancelled at the receiver when the difference signal is taken.

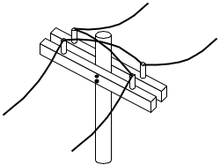
This method starts to fail when the noise source is close to the signal wires; the closer wire will couple with the noise more strongly and the [common-mode rejection](http://en.wikipedia.org/wiki/Common-mode_rejection_ratio) of the receiver will fail to eliminate it. This problem is especially apparent in telecommunication cables where pairs in the same cable lie next to each other for many miles. One pair can induce [crosstalk](http://en.wikipedia.org/wiki/Crosstalk) in another and it is additive along the length of the cable. Twisting the pairs counters this effect as on each half twist the wire nearest to the noise-source is exchanged.

Providing the interfering source remains uniform, or nearly so, over the distance of a single twist, the induced noise will remain common-mode. Differential signaling also reduces [electromagnetic radiation](http://en.wikipedia.org/wiki/Electromagnetic_radiation) from the cable, along with the associated [attenuation](http://en.wikipedia.org/wiki/Attenuation) allowing for greater distance between exchanges.

The twist rate (also called *pitch* of the twist, usually defined in twists per [meter](http://en.wikipedia.org/wiki/Meter)) makes up part of the specification for a given type of cable. Where nearby pairs have equal twist rates, the same conductors of the different pairs may repeatedly lie next to each other, partially undoing the benefits of differential mode. For this reason it is commonly specified that, at least for cables containing small numbers of pairs, the twist rates must differ.[[1]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dmray-0)

In contrast to **FTP** ([foiled](http://en.wikipedia.org/wiki/Foil_(metal)) twisted pair) and **STP** (shielded twisted pair) cabling, **UTP** (unshielded twisted pair) cable is not surrounded by any shielding. It is the primary wire type for [telephone](http://en.wikipedia.org/wiki/Telephone) usage and is very common for [computer networking](http://en.wikipedia.org/wiki/Computer_networking), especially as [patch cables](http://en.wikipedia.org/wiki/Patch_cable) or temporary network connections due to the high flexibility of the cables.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=2)**] History**

[](http://en.wikipedia.org/wiki/File:WireTransposition.png)

[http://bits.wikimedia.org/static-1.20wmf7/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:WireTransposition.png)

Wire transposition on top of pole

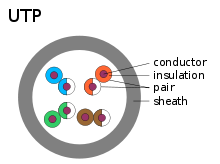
The earliest telephones used telegraph lines, or open-wire [single-wire earth return](http://en.wikipedia.org/wiki/Single-wire_earth_return) circuits. In the 1880s electric [trams](http://en.wikipedia.org/wiki/Tram) were installed in many cities, which induced noise into these circuits. [Lawsuits](http://en.wikipedia.org/wiki/Lawsuit) being unavailing, the telephone companies converted to [balanced circuits](http://en.wikipedia.org/wiki/Balanced_circuit), which had the incidental benefit of reducing [attenuation](http://en.wikipedia.org/wiki/Attenuation), hence increasing range.

As electrical power distribution became more commonplace, this measure proved inadequate. Two wires, strung on either side of cross bars on [utility poles](http://en.wikipedia.org/wiki/Utility_pole), shared the route with electrical [power lines](http://en.wikipedia.org/wiki/Power_line). Within a few years, the growing use of electricity again brought an increase of interference, so engineers devised a method called [wire transposition](http://en.wikipedia.org/wiki/Transposition_(telecommunications)), to cancel out the interference.

In wire transposition, the wires exchange position once every several poles. In this way, the two wires would receive similar EMI from power lines. This represented an early implementation of twisting, with a twist rate of about four twists per [kilometre](http://en.wikipedia.org/wiki/Kilometre), or six per [mile](http://en.wikipedia.org/wiki/Mile). Such open-wire balanced lines with periodic transpositions still survive today in some rural areas.

Twisted pair cables were invented by [Alexander Graham Bell](http://en.wikipedia.org/wiki/Alexander_Graham_Bell) in 1881.[[2]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-1) By 1900, the entire American [telephone line](http://en.wikipedia.org/wiki/Telephone_line) network was either twisted pair or open wire with transposition to guard against interference. Today, most of the millions of kilometres of twisted pairs in the world are [outdoor landlines](http://en.wikipedia.org/wiki/Outside_plant), owned by telephone companies, used for voice service, and only handled or even seen by telephone workers.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=3)**] Unshielded twisted pair (UTP)**

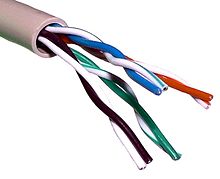
[](http://en.wikipedia.org/wiki/File:UTP-cable.svg)

[http://bits.wikimedia.org/static-1.20wmf7/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:UTP-cable.svg)

Unshielded twisted pair

UTP cables are found in many [Ethernet](http://en.wikipedia.org/wiki/Ethernet) networks and telephone systems. For indoor telephone applications, UTP is often grouped into sets of 25 pairs according to a standard [25-pair color code](http://en.wikipedia.org/wiki/25-pair_color_code) originally developed by [AT&T](http://en.wikipedia.org/wiki/AT%26T). A typical subset of these colors (white/blue, blue/white, white/orange, orange/white) shows up in most UTP cables.

For urban outdoor telephone cables containing hundreds or thousands of pairs, the cable is divided into smaller but identical bundles. Each bundle consists of twisted pairs that have different twist rates. The bundles are in turn twisted together to make up the cable. Pairs having the same twist rate within the cable can still experience some degree of [crosstalk](http://en.wikipedia.org/wiki/Crosstalk). Wire pairs are selected carefully to minimize crosstalk within a large cable.

[](http://en.wikipedia.org/wiki/File:UTP_cable.jpg)

[http://bits.wikimedia.org/static-1.20wmf7/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:UTP_cable.jpg)

Unshielded twisted pair cable with different twist rates

UTP [cable](http://en.wikipedia.org/wiki/Cable) is also the most common cable used in [computer networking](http://en.wikipedia.org/wiki/Computer_networking). Modern [Ethernet](http://en.wikipedia.org/wiki/Ethernet), the most common data networking standard, utilizes UTP cables. Twisted pair cabling is often used in data networks for short and medium length connections because of its relatively lower costs compared to [optical fiber](http://en.wikipedia.org/wiki/Optical_fiber) and [coaxial cable](http://en.wikipedia.org/wiki/Coaxial_cable).

UTP is also finding increasing use in [video](http://en.wikipedia.org/wiki/Video) applications, primarily in [security cameras](http://en.wikipedia.org/wiki/Security_camera). Many cameras include a UTP output with [screw terminals](http://en.wikipedia.org/wiki/Screw_terminal); UTP cable [bandwidth](http://en.wikipedia.org/wiki/Bandwidth_(signal_processing)) has improved to match the [baseband](http://en.wikipedia.org/wiki/Baseband) of [television](http://en.wikipedia.org/wiki/Television) signals.

While the [video recorder](http://en.wikipedia.org/wiki/Video_recorder) most likely still has unbalanced [BNC connectors](http://en.wikipedia.org/wiki/BNC_connector) for standard coaxial cable, a [balun](http://en.wikipedia.org/wiki/Balun) is used to convert from 100-[ohm](http://en.wikipedia.org/wiki/Ohm) balanced UTP to 75-ohm unbalanced. A balun can also be used at the camera end for ones without a UTP output. Only one pair is necessary for each video signal.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=4)**] Cable shielding**

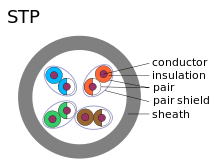
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| http://upload.wikimedia.org/wikipedia/en/thumb/f/f2/Edit-clear.svg/40px-Edit-clear.svg.png | This article **may require** [**cleanup**](http://en.wikipedia.org/wiki/Wikipedia:Cleanup) **to meet Wikipedia's** [**quality standards**](http://en.wikipedia.org/wiki/Wikipedia:Manual_of_Style). No [cleanup reason](http://en.wikipedia.org/wiki/Template:Cleanup/doc) has been specified. Please help [improve this article](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit) if you can. *(January 2011)* |

*Main article:* [*Electromagnetic shielding*](http://en.wikipedia.org/wiki/Electromagnetic_shielding)

[](http://en.wikipedia.org/wiki/File:FTP_cable3.jpg)

[http://bits.wikimedia.org/static-1.20wmf7/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:FTP_cable3.jpg)

ScTP, also known as FTP

[](http://en.wikipedia.org/wiki/File:STP-cable.svg)

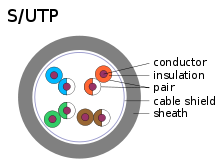
[http://bits.wikimedia.org/static-1.20wmf7/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:STP-cable.svg)

STP cable format

[](http://en.wikipedia.org/wiki/File:TwistedPair_S-FTP.jpg)

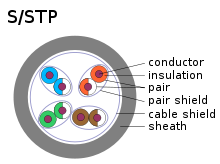
[http://bits.wikimedia.org/static-1.20wmf7/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:TwistedPair_S-FTP.jpg)

S-STP, also known as S/FTP.

[](http://en.wikipedia.org/wiki/File:S-UTP-cable.svg)

[http://bits.wikimedia.org/static-1.20wmf7/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:S-UTP-cable.svg)

S/UTP cable format

[](http://en.wikipedia.org/wiki/File:S-STP-cable.svg)

[http://bits.wikimedia.org/static-1.20wmf7/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:S-STP-cable.svg)

S/STP cable format

Twisted pair cables are often shielded in an attempt to prevent electromagnetic interference. Because the shielding is made of metal, it may also serve as a ground. However, usually a shielded or a screened twisted pair cable has a special grounding wire added called a drain wire.

This shielding can be applied to individual pairs, or to the collection of pairs. When shielding is applied to the collection of pairs, this is referred to as screening. Shielding provides an electric conductive barrier to attenuate electromagnetic waves external to the shield and provides conduction path by which induced currents can be circulated and returned to the source, via ground reference connection.

Shielded twisted pair (STP or STP-A)

150 ohm STP shielded twisted pair cable is defined by the IBM Cabling System specifications and is used with [token ring](http://en.wikipedia.org/wiki/Token_ring) or [FDDI networks](http://en.wikipedia.org/wiki/Fiber_Distributed_Data_Interface). This type of shielding protects cable from external EMI from entering or exiting the cable and also protects neighboring pairs from crosstalk.

Screened twisted pair (ScTP or F/TP)

ScTP cabling offers an overall sheath shield across all of the pairs within the 100 Ohm[[3]](http://en.wikipedia.org/wiki/Twisted_pair" \l "cite_note-anitech-2) twisted pair cable. F/TP uses foil shielding instead of a braided screen. This type of shielding protects EMI from entering or exiting the cable.

Screened shielded twisted pair (S/STP or S/FTP)

S/STP (Screened Shielded Twisted Pair) or S/FTP (Screened Foiled Twisted Pair) cabling offer shielding between the pair sets and an overall sheath shield within the 100 Ohm twisted pair cable. This type of shielding protects EMI from entering or exiting the cable and also protects neighboring pairs from crosstalk.

S/STP cable[[4]](http://en.wikipedia.org/wiki/Twisted_pair" \l "cite_note-siemon1-3) is both individually shielded (like STP cabling) and also has an outer metal shielding covering the entire group of shielded copper pairs (like S/UTP). This type of cabling offers the best protection from interference from external sources, and also eliminates *alien* [*crosstalk*](http://en.wikipedia.org/wiki/Crosstalk).[[4]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-siemon1-3)

Note that different vendors and authors use different terminology (i.e. STP has been used to denote both STP-A, S/STP, and S/UTP).[[3]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-anitech-2) See below for the ISO/IEC attempt to internationally standardise the various designations.

**Comparison of some old and new abbreviations, according to** [**ISO/IEC 11801**](http://en.wikipedia.org/wiki/ISO/IEC_11801)**:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Old name** | **New name** | **cable screening** | **pair shielding** |
| UTP | U/UTP | none | none |
| STP | U/FTP | none | foil |
| FTP | F/UTP | foil | none |
| S-STP | S/FTP | braiding | foil |
| S-FTP | SF/UTP | foil, braiding | none |

The code before the slash designates the shielding for the cable itself, while the code after the slash determines the shielding for the individual pairs:

TP = twisted pair

U = unshielded

F = foil shielding

S = braided shielding

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=5)**] Most common twisted-pair cables**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Type** | **Bandwidth** | **Applications** | **Notes** |
| [Level 1](http://en.wikipedia.org/wiki/Category_1_cable) |  | 0.4 MHz | Telephone and modem lines | Not described in EIA/TIA recommmendations. Unsuitable for modern systems.[[5]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-cisco-4) |
| [Level 2](http://en.wikipedia.org/wiki/Category_2_cable) |  | 4 MHz | Older terminal systems, e.g. [IBM 3270](http://en.wikipedia.org/wiki/IBM_3270) | Not described in EIA/TIA recommmendations. Unsuitable for modern systems.[[5]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-cisco-4) |
| [Cat3](http://en.wikipedia.org/wiki/Category_3_cable) | UTP[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | 16 MHz[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | 10BASE-T and 100BASE-T4 [Ethernet](http://en.wikipedia.org/wiki/Ethernet)[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | Described in EIA/TIA-568. Unsuitable for speeds above 16 Mbit/s. Now mainly for telephone cables[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) |
| [Cat4](http://en.wikipedia.org/wiki/Category_4_cable) | UTP[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | 20 MHz[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | 16 Mbit/s[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) [Token Ring](http://en.wikipedia.org/wiki/Token_Ring) | Not commonly used[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) |
| [Cat5](http://en.wikipedia.org/wiki/Category_5_cable) | UTP[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | 100 MHz[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | 100BASE-TX & 1000BASE-T [Ethernet](http://en.wikipedia.org/wiki/Ethernet)[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | Common in most current LANs[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) |
| [Cat5e](http://en.wikipedia.org/wiki/Category_5e_cable) | UTP[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | 100 MHz[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | 100BASE-TX & 1000BASE-T [Ethernet](http://en.wikipedia.org/wiki/Ethernet)[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | Enhanced Cat5. Same construction as Cat5, but with better testing standards. |
| [Cat6](http://en.wikipedia.org/wiki/Category_6_cable) | UTP[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | 250 MHz[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | [10GBASE-T](http://en.wikipedia.org/wiki/10_Gigabit_Ethernet) [Ethernet](http://en.wikipedia.org/wiki/Ethernet) | Most commonly installed cable in Finland according to the 2002 standard. SFS-EN 50173-1 |
| [Cat6a](http://en.wikipedia.org/wiki/Category_6a_cable) |  | 500 MHz | [10GBASE-T](http://en.wikipedia.org/wiki/10_Gigabit_Ethernet) [Ethernet](http://en.wikipedia.org/wiki/Ethernet) | ISO/IEC 11801:2002 Amendment 2. |
| [Class F](http://en.wikipedia.org/wiki/Class_F_cable) | S/FTP[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | 600 MHz[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) | Telephone, [CCTV](http://en.wikipedia.org/wiki/CCTV), [1000BASE-TX](http://en.wikipedia.org/wiki/Gigabit_Ethernet#1000BASE-TX) in the same cable. [10GBASE-T](http://en.wikipedia.org/wiki/10_Gigabit_Ethernet) [Ethernet](http://en.wikipedia.org/wiki/Ethernet). | Four pairs, S/FTP (shielded pairs, braid-screened cable). Development complete - ISO/IEC 11801 2nd Ed. |
| [Class Fa](http://en.wikipedia.org/wiki/Class_Fa_cable) |  | 1000 MHz | Telephone, [CATV](http://en.wikipedia.org/wiki/CATV), [1000BASE-TX](http://en.wikipedia.org/wiki/Gigabit_Ethernet#1000BASE-TX) in the same cable. [10GBASE-T](http://en.wikipedia.org/wiki/10_Gigabit_Ethernet) [Ethernet](http://en.wikipedia.org/wiki/Ethernet). | Four pairs, S/FTP (shielded pairs, braid-screened cable). Development complete - ISO/IEC 11801 2nd Ed. Am. 2. |

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=6)**] Solid core cable vs stranded cable**

A solid core cable uses one solid wire per conductor and in a four pair cable there would be a total of eight solid wires.[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5) Stranded conductor uses multiple wires wrapped around each other in each conductor and in a four pair with seven strands per conductor cable, there would be a total of 56 wires (2 per pair x 4 pairs x 7 strands).[[6]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-dcuse-5)

Solid core cable is supposed to be used for permanently installed runs. It is less flexible than stranded cable and is more prone to failure if repeatedly flexed. Stranded cable is used for fly leads at patch panel and for connections from wall-ports to end devices, as it resists cracking of the conductors. Stranded core is generally more expensive than solid core.

Connectors need to be designed differently for solid core than for stranded. Use of a connector with the wrong cable type is likely to lead to unreliable cabling. Plugs designed for solid and stranded core are readily available, and some vendors even offer plugs designed for use with both types. The punch-down blocks on patch-panel and wall port jacks are designed for use with solid core cable.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=7)**] Advantages**

* It is a thin, flexible cable that is easy to string between walls.
* More lines can be run through the same wiring ducts.
* UTP costs less per meter/foot than any other type of LAN cable.
* Electrical noise going into or coming from the cable can be prevented.[[7]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-cirris-6)
* [Cross-talk](http://en.wikipedia.org/wiki/Cross-talk) is minimized.[[7]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-cirris-6)

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=8)**] Disadvantages**

* Twisted pair’s susceptibility to electromagnetic interference greatly depends on the pair twisting schemes (usually patented by the manufacturers) staying intact during the installation. As a result, twisted pair cables usually have stringent requirements for maximum pulling tension as well as minimum bend radius. This relative fragility of twisted pair cables makes the installation practices an important part of ensuring the cable’s performance.
* In video applications that send information across multiple parallel signal wires, twisted pair cabling can introduce signaling delays known as [skew](http://en.wikipedia.org/wiki/Skew) which results in subtle color defects and ghosting due to the image components not aligning correctly when recombined in the display device. The skew occurs because twisted pairs within the same cable often use a different number of twists per meter so as to prevent crosstalk between pairs with identical numbers of twists. The skew can be compensated by varying the length of pairs in the termination box, so as to introduce [delay lines](http://en.wikipedia.org/wiki/Delay_lines) that take up the slack between shorter and longer pairs, though the precise lengths required are difficult to calculate and vary depending on the overall cable length.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=9)**] Minor twisted pair variants**

Loaded twisted pair

A twisted pair that has intentionally added [inductance](http://en.wikipedia.org/wiki/Inductance), formerly common practice on telecommunication lines. The added inductors are known as [load coils](http://en.wikipedia.org/wiki/Load_coil) and reduce attenuation for [voiceband](http://en.wikipedia.org/wiki/Voiceband) frequencies but increase it on higher frequencies. Load coils cause distortion in voiceband on very long lines. [[8]](http://en.wikipedia.org/wiki/Twisted_pair#cite_note-7). In this context a line without load coils is referred to as an unloaded line.

Bonded twisted pair

A twisted pair variant in which the pairs are individually bonded to increase robustness of the cable. Pioneered by [Belden](http://en.wikipedia.org/wiki/Belden_Inc.), it means the electrical specifications of the cable are maintained despite rough handling.

Twisted ribbon cable

A variant of standard [ribbon cable](http://en.wikipedia.org/wiki/Ribbon_cable) in which adjacent pairs of conductors are bonded and twisted together. The twisted pairs are then lightly bonded to each other in a ribbon format. Periodically along the ribbon there are short sections with no twisting to enable connectors and [pcb](http://en.wikipedia.org/wiki/Printed_circuit_board) headers to be terminated using the usual ribbon cable [IDC](http://en.wikipedia.org/wiki/Insulation-displacement_connector) techniques.

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=10)**] See also**

* [Balanced line](http://en.wikipedia.org/wiki/Balanced_line)
* [Category 5 cable](http://en.wikipedia.org/wiki/Category_5_cable)
* [Ethernet over twisted pair](http://en.wikipedia.org/wiki/Ethernet_over_twisted_pair)
* [Litz wire](http://en.wikipedia.org/wiki/Litz_wire)
* [Registered jack](http://en.wikipedia.org/wiki/Registered_jack)
* [TIA/EIA-568-B](http://en.wikipedia.org/wiki/TIA/EIA-568-B)
* [Tip and ring](http://en.wikipedia.org/wiki/Tip_and_ring)
* [Copper wire and cable](http://en.wikipedia.org/wiki/Copper_wire_and_cable)

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=11)**] References**

* 1. [**^**](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dmray_0-0) ["Crosstalk dependence on number of turns/inch for twisted pair versions of the endcap umbilical cable"](http://www.hep.ph.ic.ac.uk/~dmray/pdffiles/TP_umbilical_studies.pdf). <http://www.hep.ph.ic.ac.uk/~dmray/pdffiles/TP_umbilical_studies.pdf>.
  2. [**^**](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-1) [US 244426](http://worldwide.espacenet.com/textdoc?DB=EPODOC&IDX=US244426), Bell, Alexander Graham, "Telephone-circuit", issued 1881 . See also TIFF format scans for [USPTO 00244426](http://patimg1.uspto.gov/.piw?Docid=00244426&idkey=NONE)
  3. ^ [***a***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-anitech_2-0) [***b***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-anitech_2-1) [Anitech Systems MP 4000 Manual](http://www.anitech-systems.com/MP4000/manual/briefs/ICM-4020E_Hub_Switch_Route_Cable_BR120501.pdf)
  4. ^ [***a***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-siemon1_3-0) [***b***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-siemon1_3-1) [Grounding for Screened and Shielded Network Cabling - Siemon](http://www.siemon.com/us/white_papers/06-07-20-grounding.asp)
  5. ^ [***a***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-cisco_4-0) [***b***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-cisco_4-1) ["CCNA: Network Media Types"](http://www.ciscopress.com/articles/article.asp?p=31276). <http://www.ciscopress.com/articles/article.asp?p=31276>.
  6. ^ [***a***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-0) [***b***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-1) [***c***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-2) [***d***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-3) [***e***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-4) [***f***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-5) [***g***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-6) [***h***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-7) [***i***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-8) [***j***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-9) [***k***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-10) [***l***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-11) [***m***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-12) [***n***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-13) [***o***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-14) [***p***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-15) [***q***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-16) [***r***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-17) [***s***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-18) [***t***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-19) [***u***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-dcuse_5-20) ["Comparison between CAT5, CAT5e, CAT6, CAT7 Cables"](http://discountcablesusa.com/ethernet-cables100.html). <http://discountcablesusa.com/ethernet-cables100.html>.
  7. ^ [***a***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-cirris_6-0) [***b***](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-cirris_6-1) ["Twisted Pair Testing"](http://www.cirris.com/testing/twisted_pair/twist.html). <http://www.cirris.com/testing/twisted_pair/twist.html>.
  8. [**^**](http://en.wikipedia.org/wiki/Twisted_pair#cite_ref-7) [cisco.com: *Understanding Line Impairments*](http://www.cisco.com/en/US/tech/tk801/tk36/technologies_tech_note09186a00800a8663.shtml), visited 2012-06-04

**[**[**edit**](http://en.wikipedia.org/w/index.php?title=Twisted_pair&action=edit&section=12)**] External links**

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| http://upload.wikimedia.org/wikipedia/en/thumb/4/4a/Commons-logo.svg/30px-Commons-logo.svg.png | Wikimedia Commons has media related to: [***Twisted-pair cables***](http://commons.wikimedia.org/wiki/Category:Twisted-pair_cables) |

* [Telecommunications Virtual Museum](http://www.telcomhistory.org/vm/sciencePhonesWork.shtml)
* [Independent comparative study UTP vs. STP for 10GBase-T](http://www.utp-vs-stp.com)

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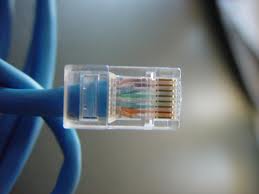
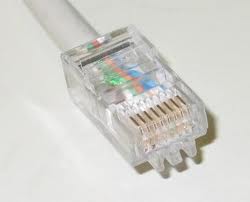
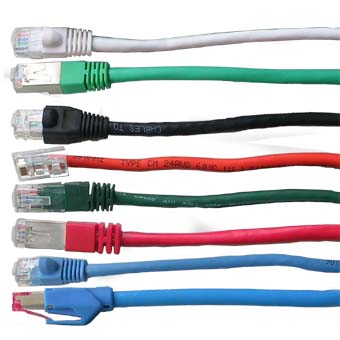
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# Chapter 4: Cabling

## What is Network Cabling?

Cable is the medium through which information usually moves from one network device to another. There are several types of cable which are commonly used with LANs. In some cases, a network will utilize only one type of cable, other networks will use a variety of cable types. The type of cable chosen for a network is related to the network's topology, protocol, and size. Understanding the characteristics of different types of cable and how they relate to other aspects of a network is necessary for the development of a successful network.

The following sections discuss the types of cables used in networks and other related topics.

* Unshielded Twisted Pair (UTP) Cable
* Shielded Twisted Pair (STP) Cable
* Coaxial Cable
* Fiber Optic Cable
* Cable Installation Guides
* Wireless LANs
* Unshielded Twisted Pair (UTP) Cable

Twisted pair cabling comes in two varieties: shielded and unshielded. Unshielded twisted pair (UTP) is the most popular and is generally the best option for school networks (See fig. 1).

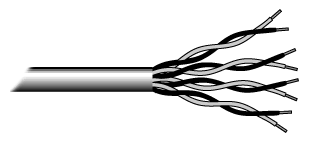


Fig.1. Unshielded twisted pair

The quality of UTP may vary from telephone-grade wire to extremely high-speed cable. The cable has four pairs of wires inside the jacket. Each pair is twisted with a different number of twists per inch to help eliminate interference from adjacent pairs and other electrical devices. The tighter the twisting, the higher the supported transmission rate and the greater the cost per foot. The EIA/TIA (Electronic Industry Association/Telecommunication Industry Association) has established standards of UTP and rated six categories of wire (additional categories are emerging).

#### Categories of Unshielded Twisted Pair

|  |  |  |
| --- | --- | --- |
| **Category** | **Speed** | **Use** |
| 1 | 1 Mbps | Voice Only (Telephone Wire) |
| 2 | 4 Mbps | LocalTalk & Telephone (Rarely used) |
| 3 | 16 Mbps | 10BaseT Ethernet |
| 4 | 20 Mbps | Token Ring (Rarely used) |
| 5 | 100 Mbps (2 pair) | 100BaseT Ethernet |
| 1000 Mbps (4 pair) | Gigabit Ethernet |
| 5e | 1,000 Mbps | Gigabit Ethernet |
| 6 | 10,000 Mbps | Gigabit Ethernet |

### Unshielded Twisted Pair Connector

The standard connector for unshielded twisted pair cabling is an RJ-45 connector. This is a plastic connector that looks like a large telephone-style connector (See fig. 2). A slot allows the RJ-45 to be inserted only one way. RJ stands for Registered Jack, implying that the connector follows a standard borrowed from the telephone industry. This standard designates which wire goes with each pin inside the connector.

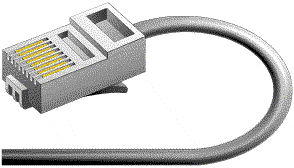


Fig. 2. RJ-45 connector

## Shielded Twisted Pair (STP) Cable

Although UTP cable is the least expensive cable, it may be susceptible to radio and electrical frequency interference (it should not be too close to electric motors, fluorescent lights, etc.). If you must place cable in environments with lots of potential interference, or if you must place cable in extremely sensitive environments that may be susceptible to the electrical current in the UTP, shielded twisted pair may be the solution. Shielded cables can also help to extend the maximum distance of the cables.

Shielded twisted pair cable is available in three different configurations:

1. Each pair of wires is individually shielded with foil.
2. There is a foil or braid shield inside the jacket covering all wires (as a group).
3. There is a shield around each individual pair, as well as around the entire group of wires (referred to as double shield twisted pair).

## Coaxial Cable

Coaxial cabling has a single copper conductor at its center. A plastic layer provides insulation between the center conductor and a braided metal shield (See fig. 3). The metal shield helps to block any outside interference from fluorescent lights, motors, and other computers.

http://fcit.usf.edu/network/chap4/pics/coaxial.gif

Fig. 3. Coaxial cable

Although coaxial cabling is difficult to install, it is highly resistant to signal interference. In addition, it can support greater cable lengths between network devices than twisted pair cable. The two types of coaxial cabling are thick coaxial and thin coaxial.

Thin coaxial cable is also referred to as thinnet. 10Base2 refers to the specifications for thin coaxial cable carrying Ethernet signals. The 2 refers to the approximate maximum segment length being 200 meters. In actual fact the maximum segment length is 185 meters. Thin coaxial cable has been popular in school networks, especially linear bus networks.

Thick coaxial cable is also referred to as thicknet. 10Base5 refers to the specifications for thick coaxial cable carrying Ethernet signals. The 5 refers to the maximum segment length being 500 meters. Thick coaxial cable has an extra protective plastic cover that helps keep moisture away from the center conductor. This makes thick coaxial a great choice when running longer lengths in a linear bus network. One disadvantage of thick coaxial is that it does not bend easily and is difficult to install.

### Coaxial Cable Connectors

The most common type of connector used with coaxial cables is the Bayone-Neill-Concelman (BNC) connector (See fig. 4). Different types of adapters are available for BNC connectors, including a T-connector, barrel connector, and terminator. Connectors on the cable are the weakest points in any network. To help avoid problems with your network, always use the BNC connectors that crimp, rather screw, onto the cable.

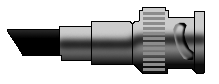


Fig. 4. BNC connector

## Fiber Optic Cable

Fiber optic cabling consists of a center glass core surrounded by several layers of protective materials (See fig. 5). It transmits light rather than electronic signals eliminating the problem of electrical interference. This makes it ideal for certain environments that contain a large amount of electrical interference. It has also made it the standard for connecting networks between buildings, due to its immunity to the effects of moisture and lighting.

Fiber optic cable has the ability to transmit signals over much longer distances than coaxial and twisted pair. It also has the capability to carry information at vastly greater speeds. This capacity broadens communication possibilities to include services such as video conferencing and interactive services. The cost of fiber optic cabling is comparable to copper cabling; however, it is more difficult to install and modify. 10BaseF refers to the specifications for fiber optic cable carrying Ethernet signals.

The center core of fiber cables is made from glass or plastic fibers (see fig 5). A plastic coating then cushions the fiber center, and kevlar fibers help to strengthen the cables and prevent breakage. The outer insulating jacket made of teflon or PVC.

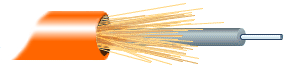


Fig. 5. Fiber optic cable

There are two common types of fiber cables -- single mode and multimode. Multimode cable has a larger diameter; however, both cables provide high bandwidth at high speeds. Single mode can provide more distance, but it is more expensive.

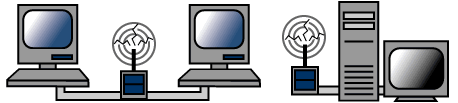
|  |  |
| --- | --- |
| **Specification** | **Cable Type** |
| **10BaseT** | Unshielded Twisted Pair |
| **10Base2** | Thin Coaxial |
| **10Base5** | Thick Coaxial |
| **100BaseT** | Unshielded Twisted Pair |
| **100BaseFX** | Fiber Optic |
| **100BaseBX** | Single mode Fiber |
| **100BaseSX** | Multimode Fiber |
| **1000BaseT** | Unshielded Twisted Pair |
| **1000BaseFX** | Fiber Optic |
| **1000BaseBX** | Single mode Fiber |
| **1000BaseSX** | Multimode Fiber |

## Installing Cable - Some Guidelines

When running cable, it is best to follow a few simple rules:

* Always use more cable than you need. Leave plenty of slack.
* Test every part of a network as you install it. Even if it is brand new, it may have problems that will be difficult to isolate later.
* Stay at least 3 feet away from fluorescent light boxes and other sources of electrical interference.
* If it is necessary to run cable across the floor, cover the cable with cable protectors.
* Label both ends of each cable.
* Use cable ties (not tape) to keep cables in the same location together.

## Wireless LANs



More and more networks are operating without cables, in the wireless mode. Wireless LANs use high frequency radio signals, infrared light beams, or lasers to communicate between the workstations, servers, or hubs. Each workstation and file server on a wireless network has some sort of transceiver/antenna to send and receive the data. Information is relayed between transceivers as if they were physically connected. For longer distance, wireless communications can also take place through cellular telephone technology, microwave transmission, or by satellite.

Wireless networks are great for allowing laptop computers, portable devices, or remote computers to connect to the LAN. Wireless networks are also beneficial in older buildings where it may be difficult or impossible to install cables.

The two most common types of infrared communications used in schools are line-of-sight and scattered broadcast. Line-of-sight communication means that there must be an unblocked direct line between the workstation and the transceiver. If a person walks within the line-of-sight while there is a transmission, the information would need to be sent again. This kind of obstruction can slow down the wireless network. Scattered infrared communication is a broadcast of infrared transmissions sent out in multiple directions that bounces off walls and ceilings until it eventually hits the receiver. Networking communications with laser are virtually the same as line-of-sight infrared networks.

### Wireless standards and speeds

The Wi-Fi Alliance is a global, non-profit organization that helps to ensure standards and interoperability for wireless networks, and wireless networks are often referred to as WiFi (Wireless Fidelity). The original Wi-Fi standard (IEEE 802.11) was adopted in 1997. Since then many variations have emerged (and will continue to emerge). Wi-Fi networks use the Ethernet protocol.

|  |  |  |
| --- | --- | --- |
| **Standard** | **Max Speed** | **Typical Range** |
| **802.11a** | 54 Mbps | 150 feet |
| **802.11b** | 11 Mbps | 300 feet |
| **802.11g** | 54 Mbps | 300 feet |
| **802.11n** | 100 Mbps | 300+ feet |

### Wireless Security

Wireless networks are much more susceptible to unauthorized use than cabled networks. Wireless network devices use radio waves to communicate with each other. The greatest vulnerability to the network is that rogue machines can "eves-drop" on the radio wave communications. Unencrypted information transmitted can be monitored by a third-party, which, with the right tools (free to download), could quickly gain access to your entire network, steal valuable passwords to local servers and online services, alter or destroy data, and/or access personal and confidential information stored in your network servers. To minimize the possibility of this, all modern access points and devices have configuration options to encrypt transmissions. These encryption methodologies are still evolving, as are the tools used by malicious hackers, so always use the strongest encryption available in your access point and connecting devices.

A NOTE ON ENCRYPTION: As of this writing WEP (Wired Equivalent Privacy) encryption can be easily hacked with readily-available free tools which circulate the internet. WPA and WPA2 (WiFi Protected Access versions 1 and 2) are much better at protecting information, but using weak passwords or passphrases when enabling these encryptions may allow them to be easily hacked. If your network is running WEP, you must be very careful about your use of sensitive passwords or other data.

Three basic techniques are used to protect networks from unauthorized wireless use. Use any and all of these techniques when setting up your wireless access points:

Encryption.

Enable the strongest encryption supported by the devices you will be connecting to the network. Use strong passwords (strong passwords are generally defined as passwords containing symbols, numbers, and mixed case letters, at least 14 characters long).

Isolation.

Use a wireless router that places all wireless connections on a subnet independent of the primary private network. This protects your private network data from pass-through internet traffic.

Hidden SSID.

Every access point has a Service Set IDentifier (SSID) that by default is broadcast to client devices so that the access point can be found. By disabling this feature, standard client connection software won't be able to "see" the access point. However, the eves-dropping programs discussed previously can easily find these access points, so this alone does little more than keep the access point name out of sight for casual wireless users.

### Advantages of wireless networks:

* Mobility - With a laptop computer or mobile device, access can be available throughout a school, at the mall, on an airplane, etc. More and more businesses are also offering free WiFi access ("Hot spots").
* Fast setup - If your computer has a wireless adapter, locating a wireless network can be as simple as clicking "Connect to a Network" -- in some cases, you will connect automatically to networks within range.
* Cost - Setting up a wireless network can be much more cost effective than buying and installing cables.
* Expandability - Adding new computers to a wireless network is as easy as turning the computer on (as long as you do not exceed the maximum number of devices).

### Disadvantages of wireless networks:

* Security - Be careful. Be vigilant. Protect your sensitive data with backups, isolated private networks, strong encryption and passwords, and monitor network access traffic to and from your wireless network.
* Interference - Because wireless networks use radio signals and similar techniques for transmission, they are susceptible to interference from lights and electronic devices.
* Inconsistent connections - How many times have you hears "Wait a minute, I just lost my connection?" Because of the interference caused by electrical devices and/or items blocking the path of transmission, wireless connections are not nearly as stable as those through a dedicated cable.
* Speed - The transmission speed of wireless networks is improving; however, faster options (such as gigabit Ethernet) are available via cables. If you are only using wireless for internet access, the actual internet connection for your home or school is generally slower than the wireless network devices, so that connection is the bottleneck. If you are also moving large amounts of data around a private network, a cabled connection will enable that work to proceed much faster.
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# Optical fiber cable

From Wikipedia, the free encyclopedia

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[http://bits.wikimedia.org/static-1.20wmf6/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Fiber_optic_illuminated.jpg)

A [TOSLINK](http://en.wikipedia.org/wiki/TOSLINK) optical fiber cable with a clear jacket. These plastic-fiber cables are used mainly for digital audio connections between devices.

An **optical fiber cable** is a [cable](http://en.wikipedia.org/wiki/Cable) containing one or more [optical fibers](http://en.wikipedia.org/wiki/Optical_fiber). The optical fiber elements are typically individually coated with plastic layers and contained in a protective tube suitable for the environment where the cable will be deployed.

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A multi-fiber cable

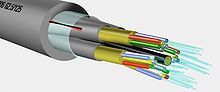
Optical fiber consists of a [core](http://en.wikipedia.org/wiki/Core_(optical_fiber)) and a [cladding](http://en.wikipedia.org/wiki/Cladding_(fiber_optics)) layer, selected for [total internal reflection](http://en.wikipedia.org/wiki/Total_internal_reflection) due to the difference in the [refractive index](http://en.wikipedia.org/wiki/Refractive_index) between the two. In practical fibers, the cladding is usually coated with a layer of [acrylate polymer](http://en.wikipedia.org/wiki/Acrylate_polymer) or [polyimide](http://en.wikipedia.org/wiki/Polyimide). This coating protects the fiber from damage but does not contribute to its [optical waveguide](http://en.wikipedia.org/wiki/Optical_waveguide) properties. Individual coated fibers (or fibers formed into ribbons or bundles) then have a tough [resin](http://en.wikipedia.org/wiki/Resin) [buffer](http://en.wikipedia.org/wiki/Buffer_(optical_fiber)) layer and/or core tube(s) extruded around them to form the cable core. Several layers of protective sheathing, depending on the application, are added to form the cable. Rigid fiber assemblies sometimes put light-absorbing ("dark") glass between the fibers, to prevent light that leaks out of one fiber from entering another. This reduces [cross-talk](http://en.wikipedia.org/wiki/Cross-talk) between the fibers, or reduces [flare](http://en.wikipedia.org/wiki/Lens_flare) in fiber bundle imaging applications.[[1]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-0)

[](http://en.wikipedia.org/wiki/File:Lc-sc-fiber-connectors.jpg)

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Left: [LC/PC](http://en.wikipedia.org/wiki/Optical_fiber_connector#Types) connectors  
Right: SC/PC connectors  
All four connectors have white caps covering the [ferrules](http://en.wikipedia.org/wiki/Ferrule).

For indoor applications, the jacketed fiber is generally enclosed, with a bundle of flexible fibrous [polymer](http://en.wikipedia.org/wiki/Polymer) *strength members* like [aramid](http://en.wikipedia.org/wiki/Aramid) (e.g. [Twaron](http://en.wikipedia.org/wiki/Twaron) or [Kevlar](http://en.wikipedia.org/wiki/Kevlar)), in a lightweight plastic cover to form a simple cable. Each end of the cable may be *terminated* with a specialized [optical fiber connector](http://en.wikipedia.org/wiki/Optical_fiber_connector) to allow it to be easily connected and disconnected from transmitting and receiving equipment.

[](http://en.wikipedia.org/wiki/File:Optical_breakout_cable.jpg)

[http://bits.wikimedia.org/static-1.20wmf6/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Optical_breakout_cable.jpg)

An optical fiber breakout cable

For use in more strenuous environments, a much more robust cable construction is required. In *loose-tube construction* the fiber is laid [helically](http://en.wikipedia.org/wiki/Helix) into semi-rigid tubes, allowing the cable to stretch without stretching the fiber itself. This protects the fiber from tension during laying and due to temperature changes. Loose-tube fiber may be "dry block" or gel-filled. Dry block offers less protection to the fibers than gel-filled, but costs considerably less. Instead of a loose tube, the fiber may be embedded in a heavy polymer jacket, commonly called "tight buffer" construction. Tight buffer cables are offered for a variety of applications, but the two most common are "Breakout" and "Distribution". Breakout cables normally contain a ripcord, two non-conductive dielectric strengthening members (normally a glass rod epoxy), an aramid yarn, and 3 mm buffer tubing with an additional layer of Kevlar surrounding each fiber. The ripcord is a parallel cord of strong yarn that is situated under the jacket(s) of the cable for jacket removal.[[2]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-1) Distribution cables have an overall Kevlar wrapping, a ripcord, and a 900 micrometer buffer coating surrounding each fiber. These *fiber units* are commonly bundled with additional steel strength members, again with a helical twist to allow for stretching.

A critical concern in outdoor cabling is to protect the fiber from contamination by water. This is accomplished by use of solid barriers such as copper tubes, and water-repellent jelly or water-absorbing powder surrounding the fiber.

Finally, the cable may be armored to protect it from environmental hazards, such as construction work or gnawing animals. Undersea cables are more heavily armored in their near-shore portions to protect them from boat anchors, fishing gear, and even [sharks](http://en.wikipedia.org/wiki/Shark), which may be attracted to the electrical power that is carried to power amplifiers or repeaters in the cable.

Modern cables come in a wide variety of sheathings and armor, designed for applications such as direct burial in trenches, [dual use as power lines](http://en.wikipedia.org/wiki/Power_line_communication), installation in conduit, lashing to aerial telephone poles, [submarine installation](http://en.wikipedia.org/wiki/Submarine_communications_cable), and insertion in paved streets.

## [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=2)] Capacity and market

Modern fiber cables can contain up to a thousand fibers in a single cable, with potential bandwidth in the terabytes per second. It is estimated that no more than 1% of the optical fiber buried in recent years is actually "lit".[*[citation needed](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)*] Companies can lease or sell the unused fiber to other providers who are looking for service in or through an area. Many companies are "overbuilding" their networks for the specific purpose of having a large network of [dark fiber](http://en.wikipedia.org/wiki/Dark_fiber) for sale, reducing the overall need for trenching and municipal permitting.[*[citation needed](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)*]

In recent years[[*when?*](http://en.wikipedia.org/wiki/Wikipedia:Manual_of_Style_(dates_and_numbers)#Chronological_items)] the cost of small fiber-count pole-mounted cables has greatly decreased due to the high Japanese and South Korean demand for [fiber to the home](http://en.wikipedia.org/wiki/Fiber_to_the_home) (FTTH) installations.[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]

## [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=3)] Reliability and quality

Optical fibers are inherently very strong, but the strength is drastically reduced by unavoidable microscopic surface flaws inherent in the manufacturing process. The initial fiber strength, as well as its change with time, must be considered relative to the stress imposed on the fiber during handling, cabling, and installation for a given set of environmental conditions. There are three basic scenarios that can lead to strength degradation and failure by inducing flaw growth: dynamic fatigue, static fatigues, and zero-stress aging.

Telcordia GR-20, *Generic Requirements for Optical Fiber and Optical Fiber Cable*, contains reliability and quality criteria to protect optical fiber in all operating conditions.[[3]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-2) The criteria concentrate on conditions in an outside plant (OSP) environment. For the indoor plant, similar criteria are in Telcordia GR-409, *Generic Requirements for Indoor Fiber Optic Cable*.[[4]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-3)

## [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=4)] Cable types

* OFC: [Optical fiber, conductive](http://en.wikipedia.org/w/index.php?title=Optical_fiber,_conductive&action=edit&redlink=1)
* OFN: [Optical fiber, nonconductive](http://en.wikipedia.org/w/index.php?title=Optical_fiber,_nonconductive&action=edit&redlink=1)
* OFCG: [Optical fiber, conductive, general use](http://en.wikipedia.org/w/index.php?title=Optical_fiber,_conductive,_general_use&action=edit&redlink=1)
* OFNG: [Optical fiber, nonconductive, general use](http://en.wikipedia.org/w/index.php?title=Optical_fiber,_nonconductive,_general_use&action=edit&redlink=1)
* OFCP: [Optical fiber, conductive, plenum](http://en.wikipedia.org/w/index.php?title=Optical_fiber,_conductive,_plenum&action=edit&redlink=1)
* OFNP: [Optical fiber, nonconductive, plenum](http://en.wikipedia.org/w/index.php?title=Optical_fiber,_nonconductive,_plenum&action=edit&redlink=1)
* OFCR: [Optical fiber, conductive, riser](http://en.wikipedia.org/w/index.php?title=Optical_fiber,_conductive,_riser&action=edit&redlink=1)
* OFNR: [Optical fiber, nonconductive, riser](http://en.wikipedia.org/wiki/Optical_fiber,_nonconductive,_riser)
* OPGW: [Optical fiber composite overhead ground wire](http://en.wikipedia.org/wiki/Optical_fiber_composite_overhead_ground_wire)
* ADSS: [All-Dielectric Self-Supporting](http://en.wikipedia.org/w/index.php?title=All-Dielectric_Self-Supporting&action=edit&redlink=1)

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| --- | --- |
| [[icon]](http://en.wikipedia.org/wiki/File:Wiki_letter_w_cropped.svg) | This section requires [expansion](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit). *(June 2008)* |

## [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=5)] Jacket material

The jacket material is application specific. The material determines the mechanical robustness, aging due to UV radiation, oil resistance, etc. Nowadays PVC is being replaced by halogen free alternatives, mainly driven by more stringent regulations.

|  |  |  |  |
| --- | --- | --- | --- |
| **Material** | **Halogen-free** | [**UV**](http://en.wikipedia.org/wiki/Ultraviolet) **Resistance** | **Remark** |
| [LSFH](http://en.wikipedia.org/wiki/Low_smoke_zero_halogen) Polymer | Yes | Good[[5]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-4) | Good for indoor use |
| [Polyvinyl chloride](http://en.wikipedia.org/wiki/Polyvinyl_chloride) (PVC) | No | Good[[6]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-5) | Being replaced by LSFH Polymer |
| [Polyethylene](http://en.wikipedia.org/wiki/Polyethylene) (PE) | Yes | Poor[[7]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-6)[[8]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-7)[[9]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-8) | Good for outdoor applications |
| [Polyurethane](http://en.wikipedia.org/wiki/Polyurethane) (PUR) | Yes | ***?*** | Highly flexible cables |
| [Polybutylene terephthalate](http://en.wikipedia.org/wiki/Polybutylene_terephthalate) (PBT) | Yes | Fair?[[10]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-9) | Good for indoor use |
| [Polyamide](http://en.wikipedia.org/wiki/Polyamide) (PA) | Yes | Good[[11]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-10)-Poor[[12]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-11) | Indoor and outdoor use |

## [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=6)] Color coding

### [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=7)] Patch cords

The buffer or jacket on patchcords is often color-coded to indicate the type of fiber used. The strain relief "boot" that protects the fiber from bending at a connector is color-coded to indicate the type of connection. Connectors with a plastic shell (such as [SC connectors](http://en.wikipedia.org/wiki/SC_connector)) typically use a color-coded shell. Standard color codings for jackets and boots (or connector shells) are shown below:

|  |  |
| --- | --- |
| **Buffer/jacket color** | **Meaning** |
| Yellow | [single-mode optical fiber](http://en.wikipedia.org/wiki/Single-mode_optical_fiber) |
| Orange | [multi-mode optical fiber](http://en.wikipedia.org/wiki/Multi-mode_optical_fiber) |
| Aqua | 10 gig laser-optimized 50/125 micrometer multi-mode optical fiber |
| Grey | outdated color code for [multi-mode optical fiber](http://en.wikipedia.org/wiki/Multi-mode_optical_fiber) |
| Blue | Sometimes used to designate [polarization-maintaining optical fiber](http://en.wikipedia.org/wiki/Polarization-maintaining_optical_fiber) |

|  |  |  |  |
| --- | --- | --- | --- |
| **Connector Boot** | | **Meaning** | **Comment** |
| Blue | | Physical Contact (PC), 0° | mostly used for single mode fibers; some manufacturers use this for [polarization-maintaining optical fiber](http://en.wikipedia.org/wiki/Polarization-maintaining_optical_fiber). |
| Green | | Angle Polished (APC), 8° |  |
| Black | | Physical Contact (PC), 0° |  |
| Grey, | Beige | Physical Contact (PC), 0° | multimode fiber connectors |
| White | | Physical Contact (PC), 0° |  |
| Red | |  | High optical power. Sometimes used to connect external pump lasers or Raman pumps. |

Remark: It is also possible that a small part of a connector is additionally colour-coded, e.g. the leaver of an E-2000 connector or a frame of an adapter. This additional colour coding indicates the correct port for a patchcord, if many patchcords are installed at one point.

### [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=8)] Multi-fiber cables

Individual fibers in a multi-fiber cable are often distinguished from one another by color-coded jackets or buffers on each fiber. The identification scheme used by [Corning Cable Systems](http://en.wikipedia.org/wiki/Corning_Cable_Systems) is based on EIA/TIA-598, "**Optical Fiber Cable Color Coding**." EIA/TIA-598 defines identification schemes for fibers, buffered fibers, fiber units, and groups of fiber units within outside plant and premises optical fiber cables. This standard allows for fiber units to be identified by means of a printed legend. This method can be used for identification of fiber ribbons and fiber subunits. The legend will contain a corresponding printed numerical position number and/or color for use in identification.[[13]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-interfacebus-12)

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  | | --- | --- | | **EIA598-A Fiber Color Chart**[[13]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-interfacebus-12) | | | **Position** | **Jacket color** | | 1 | Blue | | 2 | Orange | | 3 | Green | | 4 | Brown | | 5 | Slate | | 6 | White | | 7 | Red | | 8 | Black | | 9 | Yellow | | 10 | Violet | | 11 | Rose | | 12 | Aqua | | 13 | Blue with black tracer | | 14 | Orange with black tracer | | 15 | Green with black tracer | | 16 | Brown with black tracer | | 17 | Slate with black tracer | | 18 | White with black tracer | | 19 | Red with black tracer | | 20 | Black with yellow tracer | | 21 | Yellow with black tracer | | 22 | Violet with black tracer | | 23 | Rose with black tracer | | 24 | Aqua with black tracer | | |  |  |  | | --- | --- | --- | | **Color coding of Premises Fiber Cable**[[13]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-interfacebus-12) | | | | **Fiber Type / Class** | **Diameter (µm)** | **Jacket Color** | | Multimode 1a | 50/125 | Orange | | Multimode 1a | 62.5/125 | Slate | | Multimode 1a | 85/125 | Blue | | Multimode 1a | 100/140 | Green | | Singlemode IVa | All | Yellow | | Singlemode IVb | All | Red | |

## [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=9)] Propagation speed and delay

Optical cables transfer data at the [speed of light](http://en.wikipedia.org/wiki/Speed_of_light) in glass (slower than vacuum). This is typically around 180,000 to 200,000 km/s, resulting in 5.0 to 5.5 microseconds of latency per km. Thus the round-trip delay time for 1000km is around 11 ms.[[14]](http://en.wikipedia.org/wiki/Optical_fiber_cable" \l "cite_note-13)

## [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=10)] Losses

|  |  |
| --- | --- |
| http://upload.wikimedia.org/wikipedia/en/thumb/f/f2/Edit-clear.svg/40px-Edit-clear.svg.png | This article **may be too** [**technical**](http://en.wiktionary.org/wiki/technical#Adjective) **for most readers to understand**. Please help [improve](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit) this article to [make it understandable to non-experts](http://en.wikipedia.org/wiki/Wikipedia:Make_technical_articles_understandable), without removing the technical details. The [talk page](http://en.wikipedia.org/wiki/Talk:Optical_fiber_cable) may contain suggestions. *(April 2012)* |

Typical modern multimode graded-index fibers have 3 dB/km of attenuation loss at 850 nm and 1 dB/km at 1300 nm. 9/125 singlemode loses 0.4/0.25 dB/km at 1310/1550 nm. POF (plastic optical fiber) loses much more: 1 dB/m at 650 nm. Plastic optical fiber is large core (about 1mm) fiber suitable only for short, low speed networks such as within cars.[[15]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-14)

Each connection made adds about 0.6 dB of average loss, and each joint (splice) adds about 0.1 dB.[[16]](http://en.wikipedia.org/wiki/Optical_fiber_cable#cite_note-15) Depending on the transmitter power and the sensitivity of the receiver, if the total loss is too large the link will not function reliably.

Invisible IR light is used in commercial glass fiber communications because it has lower attenuation in such materials than visible light. However, the glass fibers will transmit visible light somewhat, which is convenient for simple testing of the fibers without requiring expensive equipment. Splices can be inspected visually, and adjusted for minimal light leakage at the joint, which maximizes light transmission between the ends of the fibers being joined.

The charts at [Understanding Wavelengths In Fiber Optics](http://www.thefoa.org/tech/wavelength.htm) and [Optical power loss (attenuation) in fiber](http://www.ad-net.com.tw/index.php?id=472) illustrate the relationship of visible light to the IR frequencies used, and show the absorption water bands between 850, 1300 and 1550 nm.

## [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=11)] Safety

Because the infrared light used in communications can not be seen, there is a potential [laser safety](http://en.wikipedia.org/wiki/Laser_safety) hazard to technicians. In some cases the power levels are high enough to damage eyes, particularly when lenses or microscopes are used to inspect fibers which are inadvertently emitting invisible IR. Inspection microscopes with optical safety filters are available to guard against this.

Small glass fragments can also be a problem if they get under someone's skin, so care is needed to ensure that fragments produced when [cleaving](http://en.wikipedia.org/wiki/Cleave_(fiber)) fiber are properly collected and disposed of appropriately.

## [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=12)] See also

|  |  |
| --- | --- |
| http://upload.wikimedia.org/wikipedia/en/thumb/4/4a/Commons-logo.svg/30px-Commons-logo.svg.png | Wikimedia Commons has media related to: [***Optical fiber cables***](http://commons.wikimedia.org/wiki/Category:Optical_fiber_cables) |

* [Distributed acoustic sensing](http://en.wikipedia.org/wiki/Distributed_acoustic_sensing)
* [Fiber optic coupler](http://en.wikipedia.org/wiki/Fiber_optic_coupler)
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* [TIA/EIA-568-B](http://en.wikipedia.org/wiki/TIA/EIA-568-B) Color coding for electrical cable
* [Optical fiber connector](http://en.wikipedia.org/wiki/Optical_fiber_connector) Fiber Optic connector types
* [Optical attenuator](http://en.wikipedia.org/wiki/Optical_attenuator) Fiber optic attenuator
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* [Optical power meter](http://en.wikipedia.org/wiki/Optical_power_meter)
* [Optical time-domain reflectometer](http://en.wikipedia.org/wiki/Optical_time-domain_reflectometer)
* [Parallel optical interface](http://en.wikipedia.org/wiki/Parallel_optical_interface)
* [Interconnect bottleneck](http://en.wikipedia.org/wiki/Interconnect_bottleneck)
* [ISO/IEC 11801](http://en.wikipedia.org/wiki/ISO/IEC_11801)

## [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=13)] Notes and references

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## [[edit](http://en.wikipedia.org/w/index.php?title=Optical_fiber_cable&action=edit&section=14)] External links

* [Fiber Optic Association](http://www.thefoa.org/tech/ref/basic/fiber.html) The FOA Reference Guide To Fiber Optics
* [Accurately Testing Fiber Optic Cables](http://thefoa.org/tech/ref/testing/accuracy/accuracy.html)

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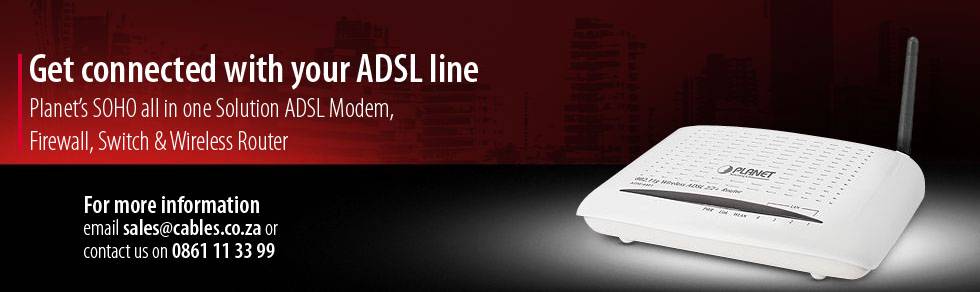
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| **Introduction to Hubs** | |
| **Part 1 - Introduction and Key Features**  An [Article](http://compnetworking.about.com/library/weekly/mpreviss.htm) by your Guide [Bradley Mitchell](http://compnetworking.about.com/mbiopage.htm) | |
| A special type of network device called the **hub** can be found in many home and small business networks. Though they've existed for many years, the popularity of hubs has exploded recently, especially among people relatively new to networking. Do you own a hub, or are you considering purchasing one? This article explains the purpose of hubs and some of the technology behind them... *(see below)* |  |

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| http://z.about.com |
| |  |  |  | | --- | --- | --- | | |  | | --- | | **More of this Feature** | | • [Which Hub is Right for You?](http://compnetworking.about.com/library/weekly/aa012801b.htm) | | | http://z.about.com | | http://z.about.com | | |  | | --- | | **Join the Discussion** | | "Hubs broadcast and repeat what they hear; switches provide dedicated bandwidth with very little window for collisions to take place due to their point-to-point nature." - [HNDPAUL](http://forums.about.com/ab-compnetwork/messages?&lgnf=y&msg=482.2) | | | http://z.about.com | | http://z.about.com | | |  | | --- | | **Related Resources** | | • [Best Dual-Speed Ethernet Hubs for Home](http://compnetworking.about.com/library/reviews/aatp-enethubs_dual_home.htm)  • [Internetworking Directory](http://compnetworking.about.com/cs/internetworking/) | | | http://z.about.com | | http://z.about.com |   **General Characteristics of Hubs**  A hub is a small rectangular box, often made of plastic, that receives its power from an ordinary wall outlet. A hub joins multiple computers (or other network devices) together to form a single network [segment](http://compnetworking.about.com/library/glossary/bldef-segment.htm). On this network segment, all computers can communicate directly with each other. [Ethernet](http://compnetworking.about.com/library/glossary/bldef-ethernet.htm) hubs are by far the most common type, but hubs for other types of networks such as [USB](http://compnetworking.about.com/library/glossary/bldef-usb.htm) also exist.  A hub includes a series of [ports](http://compnetworking.about.com/library/glossary/bldef-port.htm) that each accept a network cable. Small hubs network four computers. They contain four or sometimes five ports, the fifth port being reserved for "uplink" connections to another hub or similar device. Larger hubs contain eight, 12, 16, and even 24 ports.  **Key Features of Hubs**  Hubs classify as Layer 1 devices in the [OSI model](http://compnetworking.about.com/library/glossary/bldef-osi.htm). At the physical layer, hubs can support little in the way of sophisticated networking. Hubs do not read any of the data passing through them and are not aware of their source or destination. Essentially, a hub simply receives incoming [packets](http://compnetworking.about.com/library/glossary/bldef-packet.htm), possibly amplifies the electrical signal, and broadcasts these packets out to all devices on the network - including the one that originally sent the packet!  Technically speaking, three different types of hubs exist:   * passive * active * intelligent   **Passive hubs** do not amplify the electrical signal of incoming packets before broadcasting them out to the network. **Active hubs**, on the other hand, do perform this amplification, as does a different type of dedicated network device called a [repeater](http://compnetworking.about.com/library/glossary/bldef-repeater.htm). Some people use the terms **concentrator** when referring to a passive hub and **multiport repeater** when referring to an active hub.  **Intelligent hubs** add extra features to an active hub that are of particular importance to businesses. An intelligent hub typically is stackable (built in such a way that multiple units can be placed one on top of the other to conserve space). It also typically includes remote management capabilities via [SNMP](http://compnetworking.about.com/cs/snmp/index.htm) and [virtual LAN (VLAN)](http://compnetworking.about.com/cs/virtuallans/index.htm) support.  Hubs remain a very popular device for small networks because of their low cost. A good five-port Ethernet hub can be purchased for less than $30 USD. USB hubs cost only a bit more.  **Next page** > [Which Hub is Best for You?](http://compnetworking.about.com/library/weekly/aa012801b.htm) > Page 1, [2](http://compnetworking.about.com/library/weekly/aa012801b.htm)  » [Today's Commmunity Discussions](http://compnetworking.about.com/library/forum/blforumindex.htm) » [More Feature Articles](http://compnetworking.about.com/library/weekly/mpreviss.htm)  Top of Form     |  |  |  | | --- | --- | --- | | **Subscribe to the Newsletter** | | | | Name | Email |  |   Bottom of Form | |

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