Choosing The Correct Coaxial Cable For CCTV Applications

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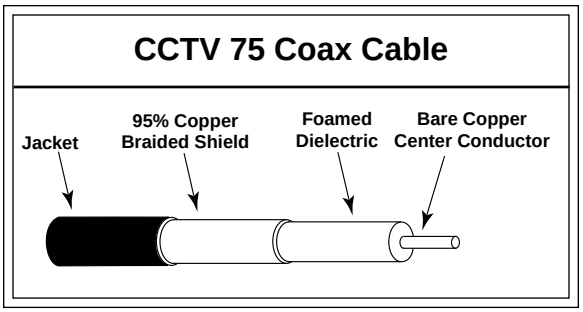
A CCTV system consists of many components and each is critical to the quality of the video picture that is reproduced. Many system designers specify very specific criteria for the hardware; however, when it comes to the transmission media, only general information is given.

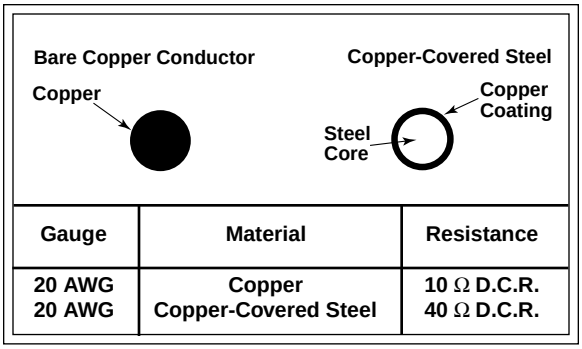


Selecting the correct transmission media for CCTV is one of the most vital aspects of designing a quality system and yet it is the least understood topic in system design. You can have the highest quality hardware components in a system but if the video signal is not transmitted by the proper media, 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 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.



Gauge	Material	Resistance
20 AWG	Copper	10 Ω D.C.R.
20 AWG	Copper-Covered Steel	40 Ω D.C.R.

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:

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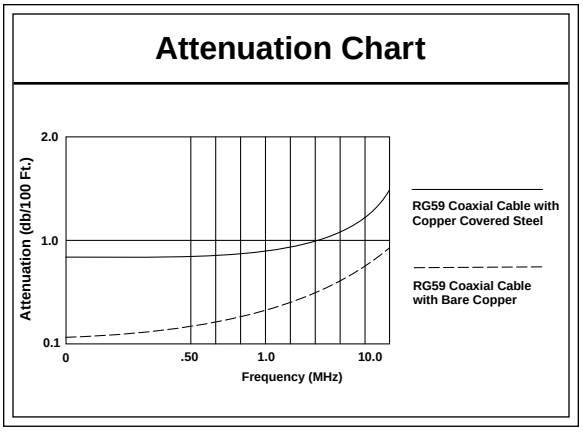
Center Conductor

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.



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 guideline 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).

Dielectric Electrical Comparison

Dielectric	Nom. Capacitance	Vel. of Prop.	Nom. Imp.	Nom. Attenuation MHZ	Nom. Attenuation db/100 ft.
Solid Polyethylene	22 pf/ft	66%	75Ω	50 MHZ 100 MHZ	2.9Ω 3.3Ω
Foam Polyethlene	17 pf/ft	78%	75Ω	50 MHZ 100 MHZ	2.0Ω 2.8Ω

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

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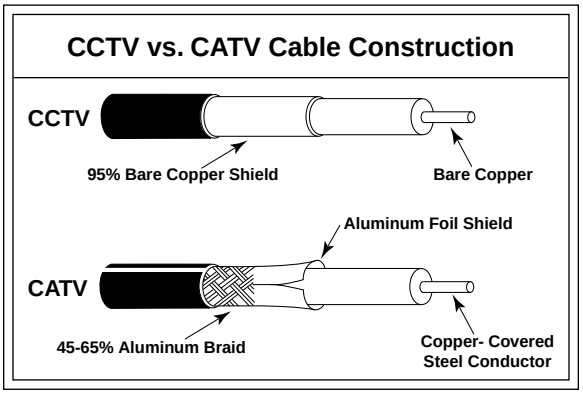
of bare copper to provide a low D.C.R. return path. It should have a 95% or better braid coverage in order to provide adequate shielding from outside electrical interference's. Anything less is usually not acceptable for CCTV. To provide increased shielding in the RFI range, a construction of an aluminum foil tale is acceptable as long as a high percentage copper braid is used to provide the low D.C.R. return path.



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.

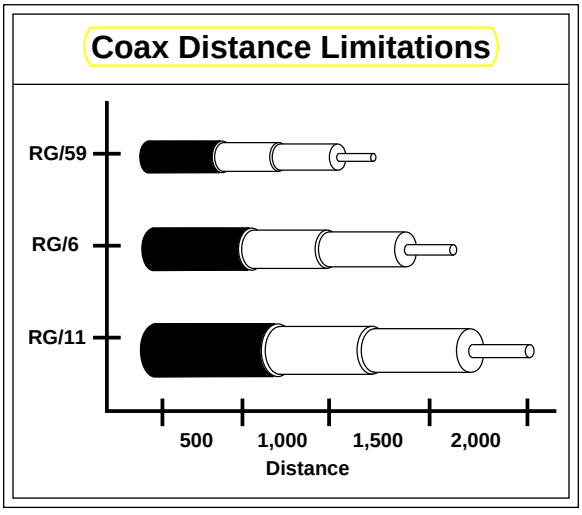
Polyethylene is recommended for outdoor applications where the cable may be subjected to the elements and a high degree of moisture, sunlight, and abrasion resistance is required. Do not install indoor rated cable in aerial, direct burial or underground pipe. An indoor-rated cable is not designed for 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.

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.



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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

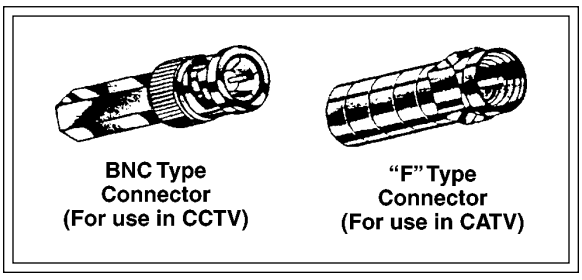
Indoor environments are the most common for coaxial cable installations. A few tips for installing coaxial cable are as follows:

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.