Coaxial Cable

CATV 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 CATV. However, choosing the incorrect coaxial cable can degrade the overall signal transmission and/or allow outside EMI/RFI interference to be induced into the signal causing high noise levels. This in turn can result in poor picture quality.

There are various construction types for coaxial 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 coaxial 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:

CENTER CONDUCTOR material made of bare copper is recommended for optimum performance in CCTV signal transmission. Because a CCTV video signal is a base-band 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 it’s copper coating provides a path for the 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 on front page). Although it may be less expensive than pure copper, it is not suitable for and is not recommended for CCTV. 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 of the skin effect transmission characteristics at higher frequencies.

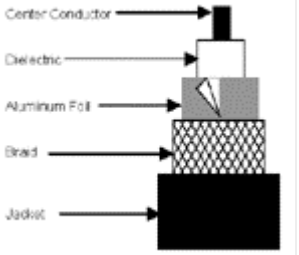
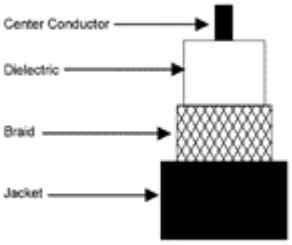
If a cable is chosen with copper-covered steel, the sync pulse information will be attenuated causing distortion of the video signal. Another guideline used in the selection of center conductor construction is the cables installation as to fixed or pan and tilt applications. If the cable is going to 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 stranded conductor because a solid conductor construction will eventually break under the constant strain being placed on the cable at the same point.

DIELECTRIC MATERIAL of a coax cable is also another key area that should be addressed. The dielectric material and it's 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 chemical expansion foam or gas injected foamed composition of these materials is recommended (see chart below).

Dielectric Electrical Comparison					
Dielectric	Nom. Capacitance	Vel. of Prop.	Non. Imp	Nom. Attenuation	
				Mhz	db/100ft.
Solid Polyethylene	22 pf/ft.	66%	75 Ω	50 Mhz	2.9 Ω
				100Mhz	3.3 Ω
Foam Polyethylene	16.2 pf/ft.	83%	75 Ω	50 Mhz	2.0 Ω
				100 Mhz	2.8 Ω

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 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 interferences. Anything less is usually not acceptable for CCTV. To provide increased shielding in the RFI range, a construction of an aluminum foil tape is acceptable as long as a high percentage copper braid is still used to provide the low D.C.R. return path.

CATV vs. CCTV Cable Construction	
CATV cable	CCTV cable
	

A cable with a combination aluminum foil shield and a low coverage aluminum braid (see above diagram) commonly used for CATV 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, and do not provide the type of shielding required for CCTV video transmission.

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 inside buildings.

Plenum rated cables are required for use in ducts, plenums and other space used for environmental air without conduit as per the NEC. Polyethylene is recommended for outdoor applications where the cable may be subjected to the elements and a high degree of moisture, sunlight, and where 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 the proper cable type for your installation.

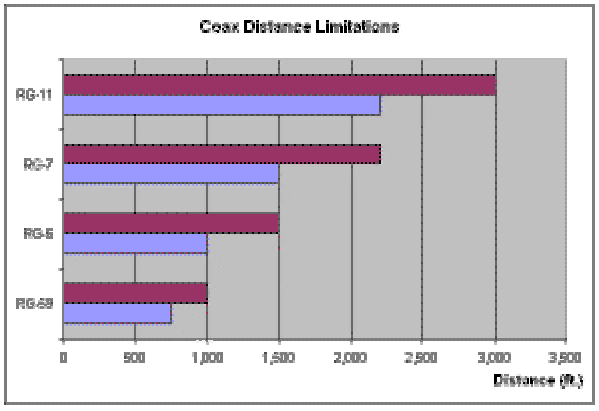
COAXIAL CABLE PARAMETERS vary depending on the type of coax construction. All coax cables have a characteristic impedance. The impedance of CCTV equipment is 75 ohms; therefore, in order to have

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) is chosen, then you will experience signal loss and reflections 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 that is 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, RG-7, and RG-11.

An RG-59 cable is the most commonly used coax because it is small in diameter and easy to work with. The RG-11 cable is the largest in diameter and harder to work with. The RG-6 and RG-7 sizes are between the two. The difference between the RG types are not just size, but also the attenuation characteristics and therefore the transmission distance.

RG-59 type cable has the highest attenuation of the three other types and you can expect to get a distance of about 750 to 1,000 ft. RG-6 type cable has lower attenuation characteristics than the RG-59 and you can expect distances of about 1,000 to 1,500 ft. RG-7 type cable has lower attenuation characteristics than RG-59 and RG-6, and you can expect distances of about 1500 ft. to 2200 ft. RG-11 type cable has the lowest attenuation characteristics and you can expect distances of 2200 ft-3000 ft.



These distances are based on the fact that all cable parameters described earlier are adhered to. If you need to go beyond 3,000 ft., then you need to use amplifiers or fiber optic cable as a method of transmission.

INSTALLATION CONSIDERATIONS

INDOOR ENVIRONMENTS are the most common for coaxial cable

installations. A few tips on installing coaxial cable are as follows:

- First and foremost, follow all NEC requirements when installing coaxial cables.
- 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.
- 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 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 cold climate areas, bury the cable below the frost line.

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