Tech Tips

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Choosing the Right Coaxial Cable

Coaxial cables are one of the most prolific medias used in telecommunications today. They can be used for virtually every telecommunications application (voice, data, and video). Some of the most common uses for coaxial cable are video distribution, either broadband (CATV) or baseband (CCTV) and connections to antennas for 'wireless' transmissions. Choosing the right coaxial cable for the application is critical for proper signal transmission. There are numerous criteria to consider when choosing the right coaxial cable; impedance and attenuation are two which will be discussed here.

Another important consideration is where the cable will be installed. We will also discuss the requirements for various environments such as indoors (riser and plenum) and outdoors.

Applications may be defined by the 'impedance' of the transmission media required for good signal transmission. Video applications are traditionally 75 Ohm applications, while 'antenna' connections have traditionally been 50 Ohm applications. Another 75 Ohm application is Digital Signaling used in Telephone Central Offices commonly known as DS-3/DS-4.

Even though the video application may be 75 Ohm some consideration must be given to the center conductor used in the coaxial cable. The signal frequency is one determining factor when considering the center conductor. Signal energy does not necessarily travel within the conductor. As the frequency increases, the signal energy moves to the outside of the conductor, this is known as the skin effect. Traditional CATV signals are in the range from 5 MHz to 1000 MHz (the system may be a 450, 550, 650, or 850 MHz). The important thing is the low end which is 5 MHz and allows us to use Copper Covered Steel (CCS) or Copper Clad Aluminum (CCA) center conductor for CATV distribution. Closed Circuit Television (Baseband) video transmission uses lower frequencies and therefore requires a 'bare copper' center conductor.

Attenuation is defined as loss of signal over distance. Attenuation is directly proportional to frequency; the higher the frequency the higher the attenuation. Attenuation is also proportional to the size of the conductor; the larger the conductor the lower the attenuation. Another factor which affects attenuation is the Velocity of Propagation of the cable.

Attenuation is the driving factor when determining how far a signal will travel effectively via a coaxial cable. Attenuation is measured or expressed in decibels (dB) per distance (normally 100 ft or 100 meters). Since attenuation is directly proportional to frequency, we normally show attenuation for the frequencies of interest (i.e. for CATV 5, 10, 20, 55, … 450, 550, 650, 750, 1000 Mhz).

When considering the proper coaxial cable for a CATV signal distribution, the attenuation is a critical component which leads us to conductor and therefore cable size. A Series 59 cable uses a 20 AWG center conductor. A Series 11 cable is constructed with a 14 AWG conductor. If you recall we stated that the larger the conductor the less attenuation. A 14 AWG is twice the size of a 20 AWG and therefore has approximately half the attenuation. Therefore a signal (at the same frequency and power) can be transmitted twice the distance via a Series 11 cable as a Series 59 cable.

Coaxial cables are used today in numerous applications for the transmission of data, video and connection to antennas for wireless applications. They are run inside virtually every enterprise space such as an entire campus, a single building, a single-family or mixeduse residence, and even in automobiles. Coaxial cable are used to connect enterprise spaces within a single community or subdivision. Since coaxial cables are used everywhere, it is important to choose the right one.

Consider the Specific Application

The first consideration is the application. Will the cable be installed for a video system or a wireless system? If the cable will be used to transmit cable TV (CATV) or closed circuit TV (CCTV), then a 75 Ohm cable should be used. If the cable is to be used for a data application such as DS-3 or DS-4 the cable will also be 75 Ohm and referred to as a 734 or 735 cable (734 and 735 cables are outside the scope of this document). If the cable will be used for data from an access point – such as an antenna – in a wireless system, then a 50 Ohm cable should be used.

Cable Type (by impedance)	Application	Cable Type Designators
50 Ω	Data Applications, Wireless Applications, Specialty Appliances	RG58, RG8
75 Ω	Video, CATV, CCTV and Security, Data	59 (RG-59) Series 6 (RG-6) and Series 11 (RG-11), 734 and 735

Indoor or Outdoor Designs

Another consideration is the location of the cable. Will it be run inside a building or outside between buildings? Indoor cables have different requirements than outdoor cables. Just as indoor cables should not be used in the outside plant, outdoor cables should not be used indoors. For coax cable, the National Electrical Code (NEC) states that “listing and marking shall not be required where the length of cable within the building, measured from its point of entrance, does not exceed 15 meters (50 feet), and the cable enters the building from the outside and is terminated at a grounding block.”

An indoor cable must meet requirements as specified in the NEC. In the United States, if cable is placed in the ventilation or air return space, a plenum-rated (CMP or CATVP) cable must be used. If the cable is not placed in the plenum space and has a vertical distance of more than three stories, a riser-rated (CMR or CATVR) cable must be used.

Another safety factor for indoor cable is chemical resistance for industrial applications. An outdoor cable does not have to meet these strict safety requirements, but must be designed for temperature extremes, provide UV resistance, handle additional loading from wind and ice, and ingress of water and corrosion of the conductors. A polyethylene (PE) jacket is better suited for outside plant cables, while a PVC jacket is better suited for indoor. To prevent water ingress in outdoor cables, a water blocking compound is placed underneath the outer jacket..

Signal Transmission and Electrical Performance

An Important performance criteria to consider is attenuation. Attenuation is the reduction of signal strength over the length of cable. Signal frequency is the number of alternating current cycles per second. It can be as high as 3 GHz or 3 billion cycles per second.

In order to reduce attenuation and accommodate signal frequency, it is important to determine the correct size for the cable. Frequency doesn't factor into the cable size. The correct size depends on the distance the signal must travel,

Attenuation loss is measured in decibels (dB) per 100 feet or 100 meters at a specific frequency. If the frequency is higher, there is greater attenuation loss and a shorter distance that the signal can travel. In general, a bigger cable provides better attenuation performance and allows for longer distance.

Specific Cable Designs

Once we have considered the specific application, the location of the cable, and signal transmission variables, then it is time to consider the cable design. The size of a cable for the 50 Ohm wireless application is governed by the allowable loss and sometimes the power requirements of the system.

For 75 Ohm video applications, we need to select the cable for the specific application. Some common examples include:

- Security (CCTV) – between the camera and monitor
- Broadband (CATV) – from the service provider to the television
- Broadcast – such as RGB for high-definition television or gaming

Security video is transmitted with an analog signal at relatively low frequency. Most CATV providers operate in the range between 5 and 1000 MHz or 1 GHz. Broadcast video is typically transmitted over a short distance and may use a digital signal and high frequency. These cables may bundle individual cables into a package to carry multiple signal video (RGB is an example). Since each application has unique design challenges, it is important to select the cable design that corresponds to the specific application.

Three common types of 75 Ohm video cable are available for coax applications. No correlation exists between the RG number and cable size (a smaller number does not mean a smaller cable or vice versa..

- **Series 59 (commonly known as RG-59)** is the smallest cable with a 20 AWG, 0.032-inch conductor and a 0.19-inch outer cable diameter
- **Series 6 (commonly known as RG-6)** is an intermediate cable in size with an 18 AWG, 0.04-inch conductor and a 0.27-inch outer cable diameter
- **Series 11 (commonly known as RG-11)** is the largest in size with a 14 AWG, 0.064-inch conductor and a 0.40-inch outer cable diameter

Conclusion

Designing a network using coaxial cable requires full consideration of the application, the location, signal frequency, and performance requirements. The coax cable is one key component to the proper operation of the video transmission system. It is important to perform due diligence when selecting the right coax cable.

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