Table of Content

Overview

This Training Guide is organized into three Modules:

- Cable Technology
- Radio Frequency (RF) Measurement
- RF Drop Line Installation Planning

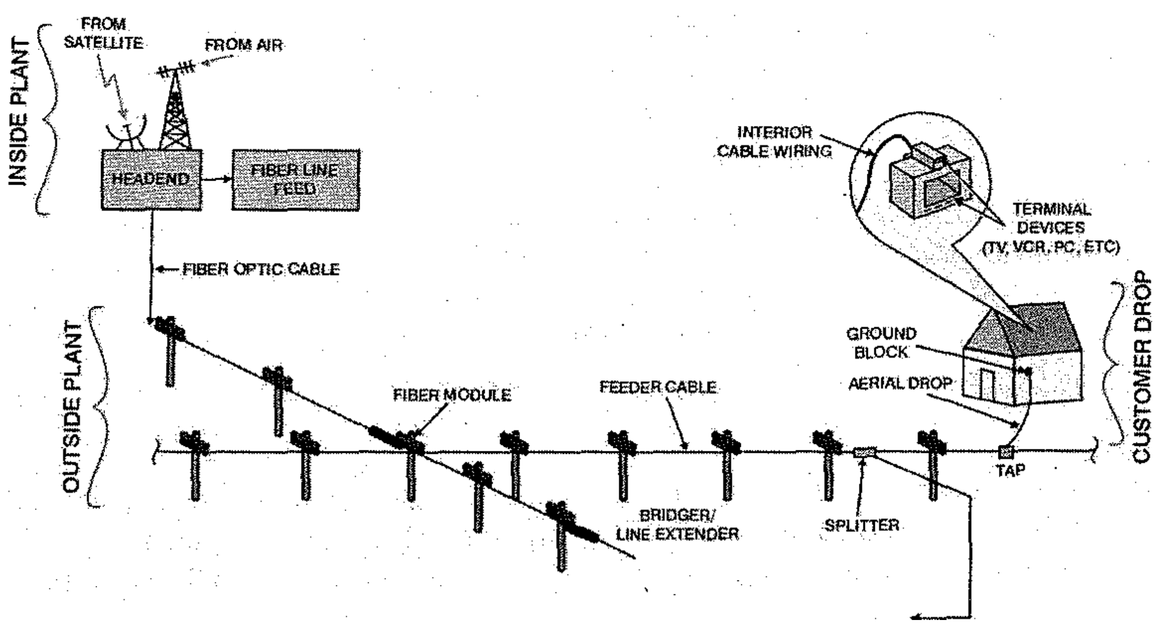
Cable Technology

This section provides information on the fundamentals of cable technology. The section describes the following:

- Cable System
- Hybrid Fiber/Coax Network
- Frequency Spectrum
- Radio Frequency (RF) Energy
- Cable System Components

Cable System

The cable system can be broken down into three broad subsystems: the inside plant, the outside plant and the customer drop. These three subsystems work together to provide a variety of telecommunications services to the customer. Each of these subsystems is composed of individual components that are critical to the safe, efficient, and economical operation of the cable system.



Cable System Components

Inside Plant (Head-end)

The inside plant (ISP) includes facilities where various processes are performed. These facilities are known as head-ends, hubs, central offices, etc. Each has its own function but all are designed to process signals for the cable plant. The primary technical building in the cable system is the head-end, which houses all of the equipment to receive, modify and transmit cable TV to the system. The head-end and hubs also contain telephony equipment that allows end users to place telephone calls over the cable network and cable modem systems allow high-speed Internet access.

One primary function is to house the electronics used to receive signals from a variety of sources, process and condition the signals, and transmit them over the cable system. Equipment includes modulators, demodulators, fiber-optic receivers and transmitters, signal security, amplifiers, and combination networks.

Signal security is provided at the head-end. Because Cablevision wants to earn full revenue from pay channels and content, Analog programming is scrambled at the head-end. Customers must have an analog converter to de-scramble the signals for display on their televisions. Digital services use Conditional Access (CA) to encrypt signals at the head-end. Customers must have a digital converter to de-encrypt the signals for display on their televisions.

The hea-dend is also the central location in the cable system for receiving programming signals. The head-end is the location from which cable signals are sent to the trunk network to be transmitted throughout the area. Signals are combined and then interfaced with the trunk cable through a launch amplifier. The head-end also provides the technology to extract return path · transmission (two-way cable information).

Outside Plant

Outside plant (OSP) includes the entire cable network from the head-end hubs to the tap. The cable installed by Cablevision and other cable companies allows cable services to be delivered directly to the end customer over a single wire. This network is designed to transport radio frequency (RF) signals over great distances with high quality and reliability.

Both the forward and the return signal design must be considered when installing a drop system.

Customer Drop

The transition from the outside plant to the customer drop is the tap. This is a passive device that picks off a small amount of signal from the network and makes it available for a single customer. It is also the combination point for the return signal from the customer into the network.

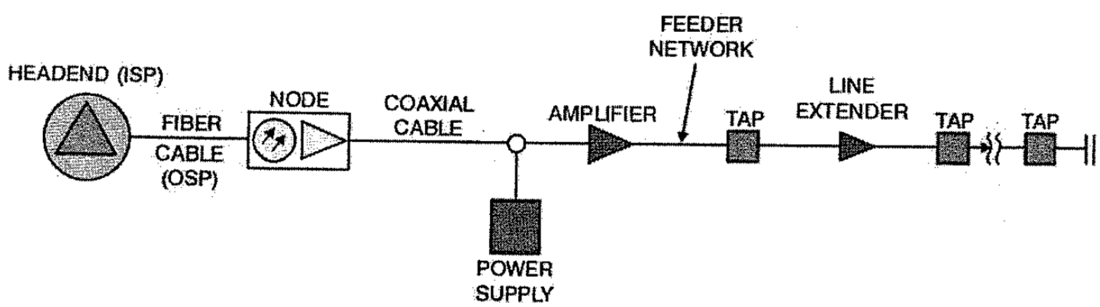
Signal Fundamentals

A critical portion of any cable system's network is the customer drop. This short segment of network is the critical final element in providing good quality service to the customer. The integrity of the design and installation of the drop will directly affect the customer. Care must be taken when installing a new drop to ensure that it will enjoy a long, serviceable life. The customer drop connects the cable network to all devices in the home to be served. It must be properly installed to ensure signal integrity. In-home wiring must be aesthetically pleasing to the customer and also must be installed safety. Poorly planned wiring will result in unsatisfactory reception and signal losses.

Hybrid Fiber/Coax Network

The Hybrid Fiber/Coax (HFC) network is formed when a fiber cable is run from the headend or hub to an optical node in the field. The node converts the light signal to RF and passes the signal to a short coaxial distribution network. This coaxial network feeds a small number of homes in the immediate area around the node. Adjacent areas are fed from other nodes.

This architecture uses the fiber's low loss characteristics to deliver high-quality signals to the center of the area and the convenience of coaxial cable to deliver these signals to the customer. The short coaxial leads (often just two to four amplifiers) are very reliable and contribute little noise or distortion to the signals. The distribution "design" scheme calls for an area to have more than 500 homes serviced by a single node (in reality, the actual number can vary as well as the design for a particular system). Hybrid fiber/coax cable is a passive component because it is not powered and does not modify the transmitted signal.



Hybrid Fiber/Coax Cable System

Frequency Spectrum

Radio frequency (RF) energy is subdivided into a series of groupings (spectrum) based on the frequency. Each spectrum is further subdivided into bands with each band having its own upper and lower frequency limits and its own characteristics. For example, sound is in the lower energy spectrum, and light is in the upper energy spectrum. The radio frequency spectrum falls somewhere in the middle. Signal frequency is based on a reference of cycles per second. The cycles per second reference is named Hertz (Hz) in honor of a pioneer in the electronics field.

Over-the-Air RF Spectrum Users

- AM-Radio
- FM-Radio
- Citizen Band (CB)
- Air Traffic Control
- Police
- Armed Forces

Signal Fundamentals

The Federal Communications Commission (FCC) maintains jurisdiction over, assigns and monitors the bandwidths for the over-the-air RF spectrum. In addition to cable TV, ham radio, police, fire, air traffic control, military units, cellular phone and many others use the same RF spectrum. Each cable company is required by the FCC to regularly monitor signal leakage in the cable plant.

The monitoring must be completed quarterly, and a formal report must be submitted to the FCC once a year. The report is the Cumulative Leakage Index report, also referred to as the CLI. It is a numerical representation of the total amount of signal leakage in the cable system.

The two forms of leakage:

EGRESS or LEAKAGE – Undesired emission of signal out of the cable systems wires into the air.
INGRESS – Foreign signals that enter the cable systems wires.

RF Signal Levels

The Radio Frequency (RF) spectrum consists of a series of RF carriers, each of which "carry" some type of information. These carriers may be used for video pictures, sound, data, and phone calls. Each RF carrier operates at a unique frequency. These frequencies are like traffic lanes on a highway; a carrier can "carry" its information down its lane without affecting its adjacent carriers. The width of the "traffic lane" is equivalent to the bandwidth assigned to that carrier; this is referred to as a "channel." The bandwidth of the channel determines how much information can be carried at one time.

Each carrier on the system has a frequency and an RF level. The RF level in cable telecommunications is measured in dBmV (decibel millivolt); that is, the level is measured on a logarithmic scale based on 1/1000 of a volt. An RF signal can be positive (+12 dBmV) or can be negative (-3 dBmV). In both cases, the indication is the RF level versus 1 mV. A negative number indicates that the RF level is less than 1 mV; a positive number indicates that the RF level is greater than 1 mV.

In the cable system you will be working with many types of carriers. The most common is digital video and its associated audio - a TV channel. These channels are 6 MHz wide and carry one television program (and its associated sound). Each channel contains two carriers: a video carrier that carries the picture information and audio carrier that carries the sound.

Television Signal

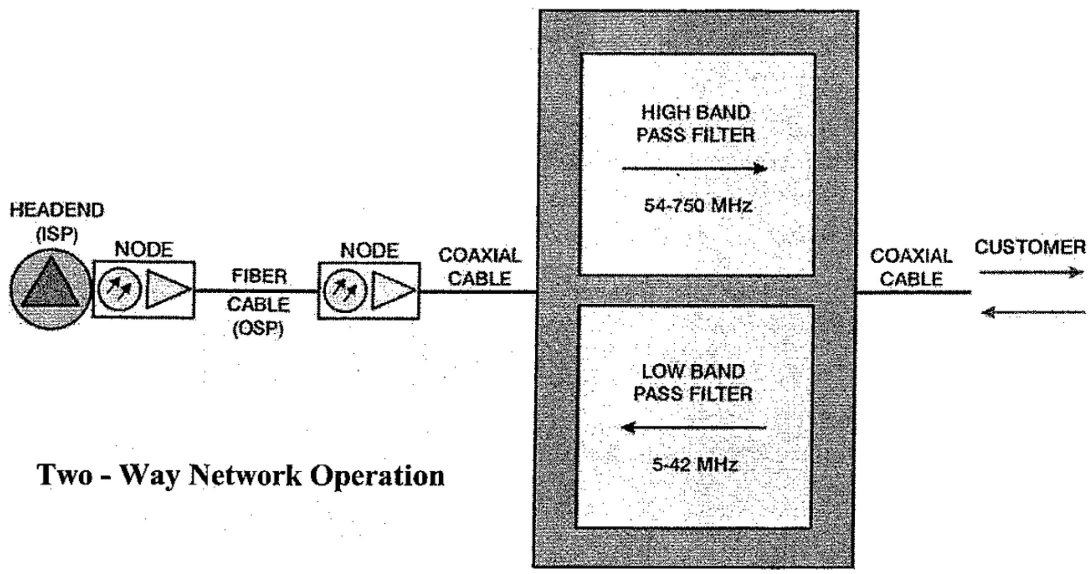
Today, many channels are available, and a variety of methodologies exist to transmit and receive television signals.

The digital television picture contains three types of information: video, color, and audio. All three must be transmitted and received without distortion to create a complete program. Basic video information is black and white and also includes synchronization information to keep the receiver locked to the transmitted signal. Color is separate from, but linked to, the black and white information. Audio is the third type of information needed to make a complete signal.

Two-Way Network Operation

The HFC network provides two-way communication, which enables interactive services. The HFC network is designed using bidirectional (forward/downstream and reverse/upstream) amplifiers (ones that amplify signals in both directions but at different frequencies). The node operates two-way by using an optical laser transmitter. Signals from a customer's terminal devices are transmitted on a low RF frequency into the network, through the customer drop, to the node, and then to the head-end or hub.

Preventing unwanted signal ingress into the network provides the greatest challenge when operating a two-way HFC network. Ingress can enter the network at any point and travel upstream to the node. When the ingress is strong enough, it can interfere with the desired upstream communication signals. Stray signals can enter the network in many areas. Poorly shielded connectors, cracked cables, and loose amplifier covers are just a few sources. Installation craftsmanship and attention to detail are critical in controlling ingress.



Two - Way Network Operation

Radio Frequency (RF) Energy

Radio frequency (RF) refers to the band within the spectrum assigned for radio communications. The RF spectrum consists of a series of carriers, each of which "carry" some type of information. These carriers are used for video pictures, sound, data, phone calls, etc. Each RF carrier operates at a unique frequency range (called the bandwidth) and represents a channel. The bandwidth of the channel determines how much information may be carried at one time.

Each carrier on the system will have a frequency and an RF level. Signal levels must be measured to verify that the proper amount of signal strength exists at various points throughout the cable system.

The unit of measure used to define the amount of signal energy in the cable system is the decibel millivolt (dBmV).

By definition, 0 dBmV is a power level of one one-thousandth of a volt or 1 millivolt (1 millivolt = 0.001 volt). The specific voltage level, when measured in a cable system of 75 ohm characteristic impedance, is the signal level that is the reference for all single-point measurements.

The level is measured on a logarithmic scale based on one one-thousandth of a volt. The scale begins at 0 dBmV, which is equal to 1 millivolt. An RF signal may be positive (+12 dBmV), or it may be negative (-3 dBmV). In both cases, the indication is the RF level vs. 1 V. A negative number indicates that the RF level is less than I mV; a positive number indicates that the RF level is greater than 1 mV.

Measuring and Calculating Signal Levels

The decibel is a numeric representation of the ratio between two signal powers. There are two key concepts you will need to understand in order to grasp how the decibel is used: relative and absolute measurements.

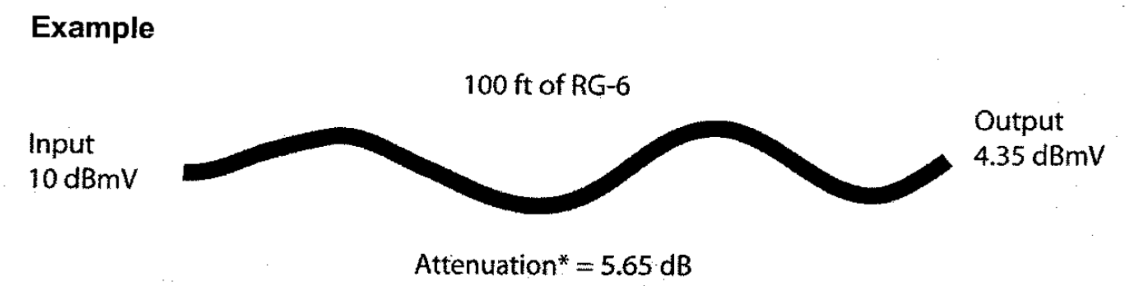
Relative Measurements

Relative measurements are used to quantify changes in signal strength. When the measurement represents the ratio between two signal powers, the decibel is a relative measurement. When using this kind of measurement, rather than a direct measurement, makes working with many measurements a simpler process. For example, signal levels entering and exiting a length of cable are measured in decibels. Calculating the difference between the two measurements gives a comparison of the input and output signal levels.

Attenuation might vary between manufacturers.

To find the attenuation or loss of the cable in decibels (dB), subtract the output level from the input level. To find the amount of gain in dB for an amplifier, subtract the input signal level from the output level.

Relative measurement is the ratio of two signal voltages, input to output, designated as dB (decibels).



RG-6 coaxial cable has a 5.65 dB attenuation* per 100 feet at 750 MHz. A signal entering the coaxial cable will lose 5.65 dB its signal strength.

If a signal10 dBmV in strength passes through the cable, it will come out 4.35 dBmV because of the 5.65 attenuation.

**Attenuation can vary depending of the type of coaxial cable used:*

RF Energy Relative Measurements

Digital Signal Basics

This section is an introduction to the digital signals. It includes an overview of digital technology and the digital converter's capabilities.

Digital Processing Basics

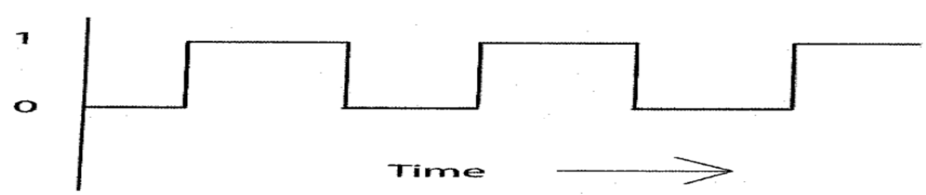
Up until the advent of digital video and audio technology, all cable TV broadcasts were analog. The video and audio inputs of most TVs, VCRs, and stereo equipment are still analog, and some analog channels are still broadcast over the cable system. However, the trend in the cable industry is to move towards digital broadcasting. Digital offers several advantages over analog, especially picture and sound quality. This section describes analog and digital signaling, and how the digital converter processes digital signals.

Digital vs. Analog Signals

Traditional cable channel broadcasts use analog signals to deliver audio/video services to customers. When information is broadcast in analog form, it is represented as a changing amplitude or frequency of the broadcast signal. See the Frequency Spectrum section in this module for analog signal information.

The defining characteristic of an analog signal is that it does not have any defined "states" or levels. The information in a signal continuously varies in frequency and/or amplitude between a minimum and maximum value, as determined by the transmission and receiving equipment. Information is transmitted by taking a base signal of a given frequency, called a "carrier," and altering its amplitude or frequency. When this new signal is transmitted, any changes to the amplitude or frequency that occur between the transmitter and receiver affect the information carried by the analog signal. Changes to a broadcast analog signal can come from electrical equipment, other transmitters, and natural radio sources that emit radio energy at a frequency similar to that of the analog signal. These unwanted changes to the broadcast signal are called "interference" or "noise." In an analog cable broadcast, noise is seen as snow or heard as static.

Digital signals are characterized by having two or more discrete states, instead of an infinite number of states like an analog signal. The simplest form of a digital signal is amplitude modulated, like the one shown below.



Simple Digital Signal

In an amplitude-modulated digital signal, certain threshold amplitude values for a digital 1 and 0 signal are defined. This means that as long as the amplitude of a signal is above a certain value, the device receiving the signal will interpret it as a 1. Likewise, as long as the amplitude of the signal is under a certain value, the receiving device will interpret it as a 0. One advantage of this is that the signal can tolerate a certain amount of interference without the encoded information being corrupted. As long as the signal amplitude stays within specification for a 1 or 0, the receiver will interpret the signal correctly. Simple amplitude modulation of digital information is commonly used in fiber optics and digital electronic circuitry.

Transmission of Digital Signals

There are other ways of modulating digital information into a signal. Digital information can be transmitted by frequency modulation, where certain frequencies represent 0s and 1s. Frequency modulation was used by some older telephone modems. Digital television, however, does not use simple amplitude or frequency modulated signals. These modulation schemes do not make efficient use of the coaxial cable system's bandwidth.

Two different modulation schemes are used to transmit digital information over the coaxial cable plant. They are quadrature phase shift keying (QPSK) and quadrature amplitude modulation (QAM).

Quadrature Phase Shift Keying (QPSK)

QPSK uses changes in the phase of the broadcast signal to transmit digital 0s and 1s. The data to be transmitted is sampled in blocks of two bits, which can have for different values (00, 01, 10, 11). These blocks are transmitted by shifting the phase into four possible states. This allows more efficient use of bandwidth than simple amplitude and frequency modulation. In some cable systems, QPSK is used to transmit digital video and audio. However, the digital converter does not use QPSK for this purpose because it is less efficient than QAM. Instead, its use is limited to computer communication over the cable network via the DAVIC and DOCSIS modems.

QAM (Quadrature Amplitude Modulation)

QAM uses changes in both the amplitude and phase of the broadcast signal. This is similar to QPSK, except that QAM modulates the amplitude of the signal as well as the phase. QAM uses different numbers (levels) of combinations of phase and amplitude shifts to represent binary numbers.

16-QAM (16-level Quadrature Amplitude Modulation): The data to be transmitted is sampled in blocks of four bits, which can have 16 different values.

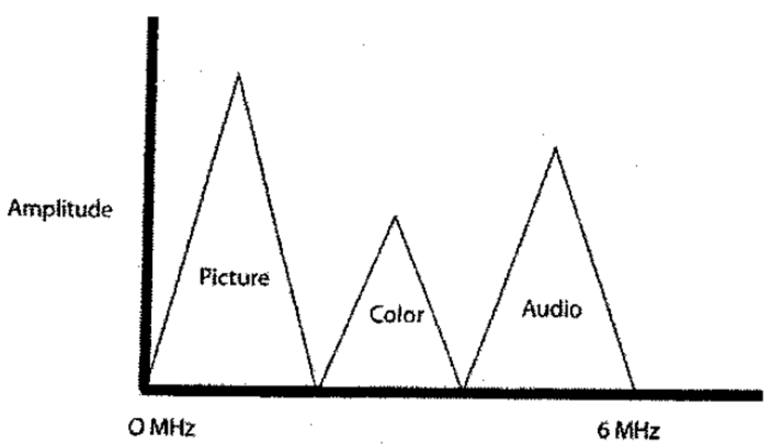
64-QAM (64-Ievel Quadrature Amplitude Modulation): The data to be transmitted is sampled in blocks of six bits, which can have 64 different values.

256-QAM (256-Ievel Quadrature Amplitude Modulation): The data to be transmitted is sampled in blocks of eight bits, which can have 256 different values.

This, coupled with much higher transmission speeds, allows QAM to transfer information roughly 30 times faster than QPSK. QAM is used to transmit digital video and audio, and is used by the DOCSIS modem of the digital converter. The QAM scheme used by the digital converter, which is state-of-the-art, uses the cable plant's bandwidth most efficiently.

Digital transmission of information has several advantages over analog transmission:

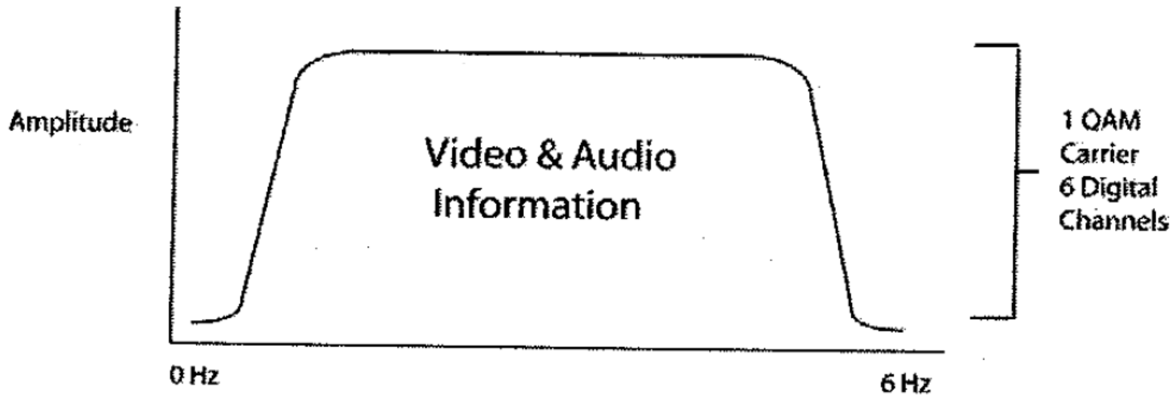
- Information is not as easily corrupted. An analog signal has an infinite number of states, so any change to the analog signal alters the information. A digital signal has distinct states that represent 0s and 1s and therefore can tolerate slight changes without altering the information.
- A digital receiver is capable of correcting corrupted information using error detection and correction technologies.
- A digital broadcasting system isn't as sensitive to low signal strengths. For example, if the signal strength at a customer's home is low, the digital converter may be able to show the digital channels with perfect clarity, but the analog channels will be snowy.
- Digital has the ability to transmit video, sound, and other information to one carrier instead of occupying several. The figure below shows a 6 MHz analog channel space occupied by its three carriers.



Analog Channel

Digital transmission uses one signal occupying most of the 6 MHz channel space. Since a digital signal is made up of distinct parts (0s and 1s), it can contain many different types of information. Because information can be easily extracted from a digital signal, multiple channels can be placed into a single QAM signal. This process is called "multiplexing."

Each QAM signal can contain six or more digital channels, as shown in the figure below, and each channel contains its own video and audio information.



Digital Channel

Digital Parameters

There are two main parameters use to check digital signal transmission: BER (Bit Error Rate) and MER (Modulation Error Rate).

Digital Channel Tuning

In order for the digital converter to display a digital channel, it must:

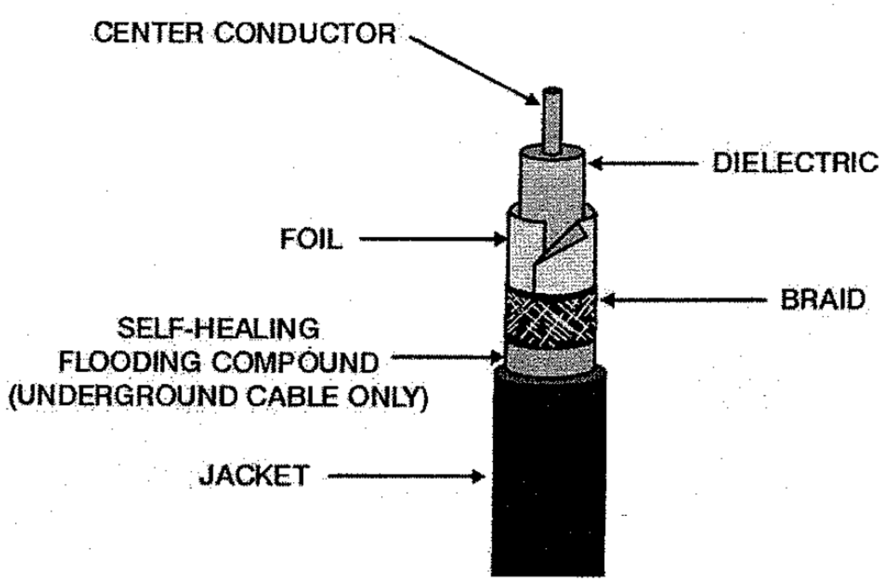
- Tune in the QAM signal containing the digital channel
- Extract the appropriate channel from the multiplexed QAM signal
- Decode the digital video stream

When switching channels within the same QAM signal, there is a slight delay as the new stream is extracted from the signal and the digital converter waits for a new I-frame. When switching channels that are in different signals, a longer delay occurs. This is because the digital converter must tune to the new frequency and then extract the appropriate stream, as opposed to simply extracting a new stream from the same signal. When changing to a digital channel, there is a slight delay as the digital converter waits for a new I-frame, and the QAM-to-QAM delay adds to that. This longer delay is normal behavior.

Coaxial Cable

The primary cable used by the industry is coaxial cable. Coaxial cable gets its name because there are two conductors: the shield and the center conductor. There is an insulating material between the two conductors called the dielectric. The electrical properties of the cable depend on the exact spacing between the shield and the center conductor, their surface area, and the nature of the dielectric material. A layer of weatherproofing material outside the shield is called the jacket. The jacket can be eliminated in cables with a continuous shield and where weather exposure is not a problem.

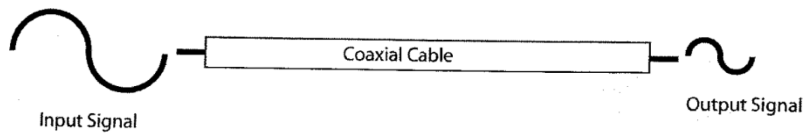
High frequency signals, such as those used in this industry, behave very differently than DC or low frequency AC. The cable must remain uniform to maintain its electrical characteristics. This can only be achieved if great care is taken to maintain the shield in perfect cylindrical form and if the connectors are properly applied. Rigid shielded cables are usually found in the outside plant network and range from about a 1/2-inch diameter to more than 1 inch. In contrast, the customer drop consists of a flexible shielded cable ranging from approximately 112 to 1/4 inch in diameter.



Coaxial Cable

Attenuation

Coaxial cable has a property called attenuation. Attenuation is the decrease or loss of the RF signal strength as it travels down the coax.



Attenuation on Coaxial Cable

This attenuation varies as a function of frequency, length of the cable, cable size, temperature and material. The main factors to consider for field service are the cable size, cable length, temperature and frequency:

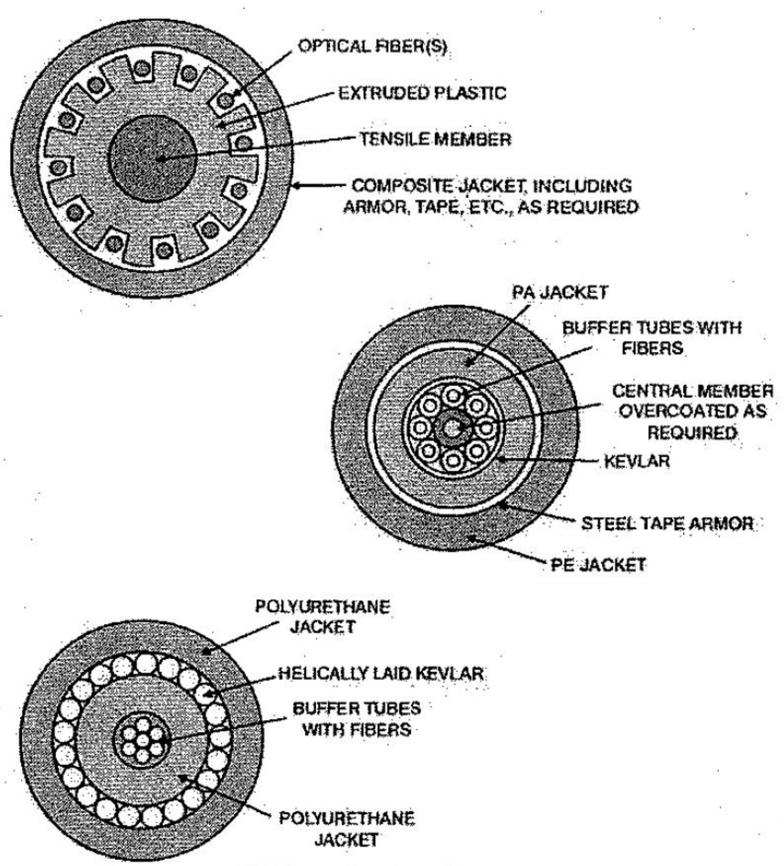
- Frequency: As the frequency of the signal increases, the attenuation of the signal increases
- Cable size: As the diameter of the cable increases, the attenuation of the signal decreases
- Length: As the length of the cable increases, the attenuation of the signal increases
- Temperature: As the temperature increases, the attenuation of the signal increases

Coaxial cable will display different attenuation at different frequencies. The RF signal attenuation at 750 MHz (channel 116) is three to four times the attenuation at 54 MHz (channel 2). As signals at various frequencies travel down a cable, the signals at the higher end of the frequency band attenuate more than those at the lower end. Coaxial cable is a passive component because it is not powered and does not intentionally modify the transmitted signal.

Fiber-Optic Cables

The other major cable used in the industry is fiber-optic cable. These cables consist of many tiny strands of fiber-optic glass packaged in a protective cable. The cable can be installed in aerial or underground networks. A single fiber-optic strand, no larger than a human hair, has the capacity to transport hundreds of video channels along with voice and data traffic. The type of fiber-optic line used by Cablevision is single-mode fiber.

Fiber-optic cables require much less amplification because fiber-optic strands have very low loss. For example, the loss of fiber is around 112 dB per mile vs. >100 dB per mile for a very large coaxial cable. The fiber strand is immune to external electrical interference, completely passive, and very light in weight. These properties make fiber-optic technology the perfect medium to transport signals over long distances. Fiber-optic cable is a passive component because it is not powered and does not modify the transmitted signal.



Fiber-Optic Cable

Trunk Amplifiers

To compensate for the coaxial cable's attenuation, active devices called feeder amplifiers are added along the network transmission lines. The amplifiers amplify, or boost, the level of the RF signal. The definition of amplification is increased signal strength, with minimal distortion. That means that the amplifier will amplify the cable signal but ideally does not amplify unwanted frequencies or noise that can invade the transmission line. However, there is a limit to the number of amplifiers that can be connected in series because each amplifier adds distortion to the signal. Amplifiers are active devices, meaning they are powered and modify the cable signal.

In-House (Drop) Amplifier

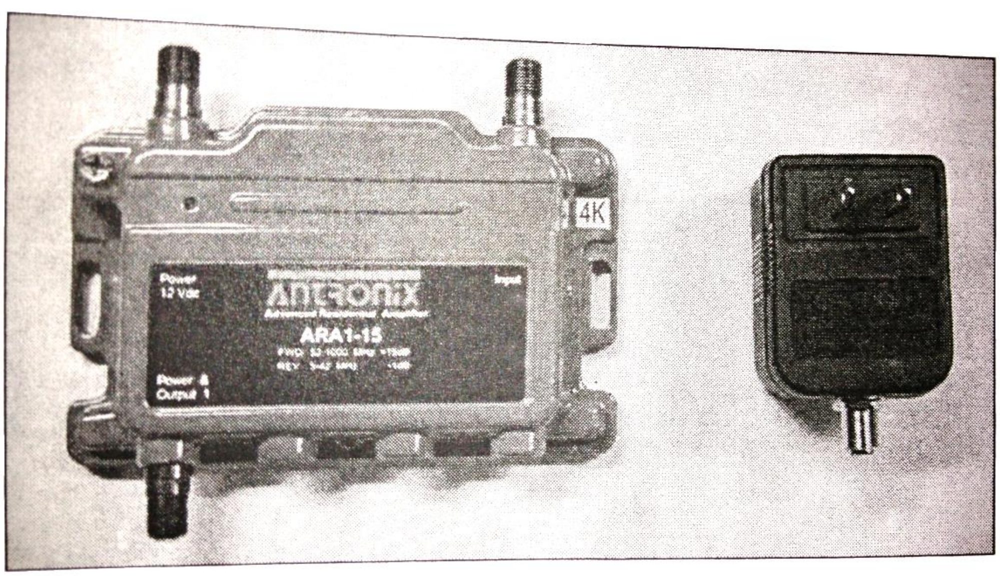
In some cases, the accumulated forward signal loss is so great that the tap signal level is too low and cannot provide a satisfactory signal to the customer drop. In these cases, an in-house (drop) amplifier is used.

An in-house amplifier can also be used to overcome excessive split losses (created by multiple outlets) or to overcome losses due to excessive cable length. In addition, it can be used to service homes that require long drops. In-house amplifiers are not designed to compensate for network or drop faults. If the minimum input signal is not available from the drop to properly feed an amplifier, a change to the network or the drop is required.

The in-house amplifier used is a low-noise (typically 3 dB noise ratio), low distortion amplifier that is powered from the home. The amplifier is capable of two-way operation, with the return side being passive. Prior to the installation of an in-house amplifier, the installer must consider how the device will fit into the drop network. The in-house amplifier is an active device because it is powered and modifies the signal.

The amplifier is to be installed, electrically, inside the home immediately after the ground block (and the telephony network interface unit (NIU) when residential telephony service is provided). It will also be placed prior to any other signal splitting. This protects the amplifier from the weather and helps to stabilize its temperature.

In-house amps should be installed inside the house to properly protect the component.



Signal Fundamentals

Care must be taken to maintain proper operating levels in order to ensure proper operation of the amplifier. The following specifications apply:

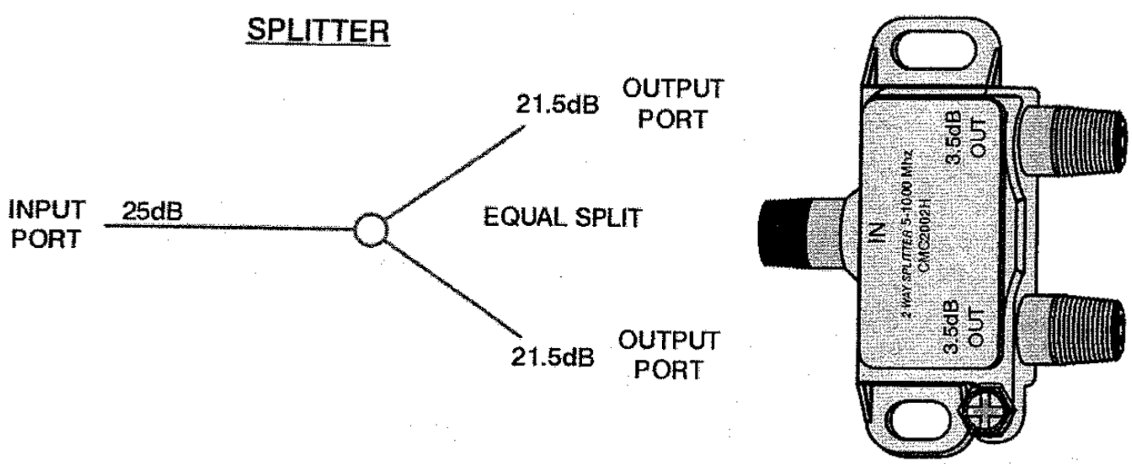
- Minimum analog video channel input level = +4.0 dBmV
- Maximum analog video channel input level = +11.0 dBmV
- Return signal loss = -1 dB
- Minimum amplifier input tilt = -5 dB
- Maximum amplifier input tilt = +7 dB

Check system and drop first. Installing an amplifier will usually be a last resort solution. Do not to use an amplifier as a "band-aid" solution to another problem.

Splitters

Splitters route the signals in many directions throughout the service area. Additionally, a network of coaxial cables (the feeder system) carries the signals from the trunk deeper into neighborhoods. Splitters and directional couplers ensure that the feeder cable passes every residence and business. Two-way splitters have equal attenuation on both output legs, so either output port will provide the same signal strength.

Splitters are passive devices because they are not powered and do not intentionally modify the cable signal.



Splitter

RF Measurement

This section describes the following:

- Signal level meters
- Signal level requirements
- Analog vs. other signals
- Forward testing
- Return path testing
- Final testing
- Types of Signal Level Meters

Signal Level Meters

To assist the technician in designing and testing an installation, a RF signal level meter (SLM) is provided. This test instrument can be tuned to a particular frequency and can directly measure the RF carrier level of any signal desired carrier frequency. The meter indicates the RF signal level in dBmV and aids in identifying the signal as video, audio, etc.

Some meters also use an analog tuning system that requires the operator to "peak" the measurement. This ensures that the meter is exactly tuned to the carrier frequency and is reading the maximum signal level. All meters should be calibrated and tested regularly.

Signal Level Requirements

Each consumer terminal device requires a minimum input level for proper operation and usually has a maximum input level to prevent overloading (FCC subscriber terminal requirement: 0 dBmV). Often a device can operate beyond these limits, but with reduced and unpredictable quality and reliability. In addition, many devices are two-way and produce their own RF signals that are to be transmitted back to the network and to the headend or hub. This return signal has a limited RF signal level range. The following are input limits for devices you will encounter:

Converter Input Levels (Digital)	Minimum: -10 dBmV Maximum: +10 dBmV
HSD/VoiP Modem Input Levels (Digital)	Minimum: -10 dBmV Maximum: +10 dBmV

When read with a standard SLM.

Analog Video vs. Other Signals

The analog video RF signal level is used as a reference level in cable telecommunication. All non-analog video signals are set at a level offset from the analog video carrier. For example, the audio carrier associated with a video program is set 10 to 17 dB below the video carrier. If you were to measure the video level of a channel and found it to be +12 dBmV, then you would expect to find it associated audio carrier at -3 dBmV, a difference of 15 dB.

Data and digital signals are usually carried 7 to 10 dB (64 QAM carrier) or 5 to 8 (256 QAM) below the RF signal level that an analog video carrier would have been assigned. This reduction of level acknowledges the digital signal. Higher RF signal levels are not needed for proper operation.

Forward Testing

After completing the installation, the RF levels should be tested at each device input. The RF level for one video carrier in each of the following ranges is to be measured and recorded for each converter.

- Low band channels 2-6
- FM channels 95-97
- Mid band channels 98, 99,14-22
- High band channels 7-13
- Super band channels 23-36
- Hyper band channels 37-158

If the device is a modem, telephony NIU, or other digital device, the RF signal level of that particular device must be recorded on the work order. The level reported should be the measured level plus any appropriate correction factor for that carrier.

Return Path Testing

The return path testing has two major elements: proper RF level and ingress. For the return path testing, a two-way device in the home is used. The headend controller puts that device into a training mode. In this mode, the return output level of the device is varied until the proper level is measured at the headend. The resultant return level is reported back to the billing system (CableData).

In some systems, a forward TV channel may be set aside to measure the return path. In these systems, a forward TV channel is used to display a spectrum analysis of the return band. A signal injected from a test generator at the home can be used to measure continuity and proper path level.

For these systems, a standard level is injected into the cable and the carrier viewed on the TV display. If a minimum RF level is observed, then the installation is within an acceptable range. In the future, automated systems similar in operation to the above will become available.

Final Testing

The final test is service quality. This includes checking the quality of each service supplied to the customer, such as picture quality, modem speed, or voice quality.

RF Drop Line Installation Planning

This section describes drop design and testing.

Drop Design and Testing

A key parameter when designing a cable telecommunications network is supplying the correct RF signal level to each consumer terminal. This design begins at the headend, continues through the outside plant, and is finalized in the drop and home wiring. This section covers the design planning for residential cable telecommunications installations.

Drop Planning

The customer drop is the final portion of the cable system. It connects the customer's equipment to the tap and provides television, data, network access, and telephone service. When designing an installation, a thorough understanding of the network interface RF signal level .and RF signal level requirements at the terminal device is needed. Coaxial cable used for the drop is much smaller in physical size than system plant cables. One end of the drop coax is connected to a port on the faceplate of the tap. The other end of the drop is installed in the building with the correct number of cables required to provide service to the customer's equipment.

A poorly installed drop is the cause of most problems in a telecommunications system. Proper installation is a key part of your responsibilities.

Forward Drop

The forward drop (from the tap to the customer) design must consider the available RF signal level at the tap, the total coaxial cable run, any splitting devices, and the needs of the devices to be served.

The length and type of drop wire to be used form the tap to the ground block are critical. Two sizes of coax are available: RG-6 and RG-11. Each has different attenuation characteristics, material cost, ease of use and resultant drop neatness. Generally, the smaller the cable, the neater, the more economical, easier, and lowers the cost of the installation; but with higher RF attenuation. The choice is based on obtaining a targeted +8dBmV at 750 MHz at the ground block. The installer should choose the smallest cable that will provide this signal level. This level is only a target, and may vary from installation to installation. The table below lists the RF loss of each drop cable at various frequencies.

Coaxial Cable Attenuation

Frequency:	5	50	550	750	862	MHz
RG-6	**0.55**	**1.45**	**4.57**	**5.37**	**5.74**	**dB/100 feet**
RG-11	**0.34**	**0.94**	**2.97**	**3.52**	**3.8**	**dB/100 feet**

These numbers are bases on Trilogy Comm. RG-6 and RG-11 MVP drop cable. Use proper Attenuation losses that apply to your system or area. They might be different than the ones listed here.

To determine the cable size to use, an installer must know the distance from the tap port to the ground block. For example, if a drop length is 150 feet, the ground block RF signal level is calculated as shown in the table below.

Coaxial Cable Attenuation/100 Feet

Frequency	50 MHz		750 MHz		862 MHz	
Minimum Tap Port Level	11.0		17.0		19.0	dBmV
Drop Loss @ 1.45 dB/100 Feet	-2.18					dB
Drop Loss @ 1.45 dB/100 Feet			-8.01			dB
Drop Loss @ 1.45 dB/100 Feet					-8.61	dB
Ground Block Levels	8.82		8.99		10.39	dBmV

The cable loss is given in dB/!00 feet. These losses are multiplied by the cable length (in hundreds of feet, 1.5 in this example), and the cable loss is then calculated. The loss is subtracted from the available signal level at each frequency and the result is the ground block RF level.

In this case, with the minimum allowable RF signal levels at the tap, a 150 foot drop ofRG-6 produces acceptable levels at the ground block. Similar calculations may be done for other lengths to determine coax choice. The table below (a general rule of thumb) may be used to determine drop coax size.

Coaxial Cable Rule of Thumb	
For Drops of:	**Use**
0 to 150 feet	RG-6
151 to 250 feet	RG-11

For drops longer than 250 feet, measure the actual tap levels. From this and the planned drop length, the installer can calculate the ground block RF levels. If there is a sufficient level using RG-11, then the drop may proceed as normal. If the levels are below 8.0 dBmV, the installer may consider a drop amplifier or suggest an outside plant extension.

Internal Wiring

The internal wiring consists of RG-6 coaxial cable run to each device served and any signal splitting required due to the number of devices. The losses in both the cable and splitters must be considered.

In general, most signal-splitting occurs at the ground block. If multiple outlets are to be installed or if a modem is to be installed, each should have its own "home run" coax cable from the ground block splitting location to each area in the home.

When the signal is split to feed additional outlets, additional attenuation will be introduced to those outlets downstream. Ensure that each device is supplied with its proper minimum RF signal level. A two-way splitter will impose an attenuation of3.5 dB. With only a few splits, enough attenuation may be introduced into the network so that insufficient RF signal levels are delivered to the terminal device.

In addition to splitters, traps and telephony NIUs may be placed in the drop line feeding the home. Each of these devices has an RF signal loss that must be considered in the drop planning.

Reverse Considerations

The cable telecommunications network is a two-way communications system, and verification of the return path signal level is required.

The drop return path must be able to provide sufficient signal into the tap to be transported back to the headend.

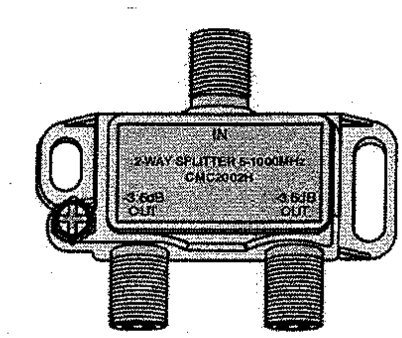
When calculating the return level into the tap port, the loss of all items in the return path to the tap are added; unless the specific frequency of transmission is known, the coaxial cable loss at 40 MHz should be used.

Installation of Splitters

Wherever a secondary TV set is installed, a signal splitter must be employed to provide a signal to this set. Splitters should be mounted with cable loops in such a way that water runs away from and not toward the fittings. Always select the correct splitter for the job. An FM splitter will not work to service a second TV, and a splitter with more output taps than necessary introduces added attenuation and can cause service problems.

Two-Way Splitter

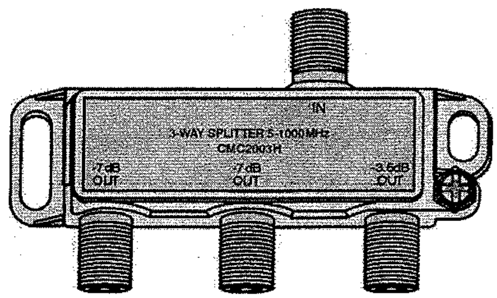
Two-way splitters have equal attenuation on both output legs, so either output port will provide the same signal strength.



Two-Way Splitter

Three-Way Splitter

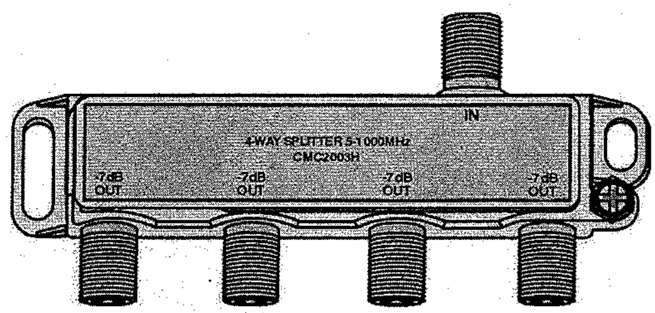
There are two types of three-way splitters available: balanced and unbalanced. Unbalanced splitters lose 7 dB to each of two of their output ports but only 3.5 dB to the third. Each port will be marked with its respective loss. If using an unbalanced splitter, connect the port with lowest loss (3.5 dB) to the longest cable run.



Three-Way Splitter

Four-Way Splitter

Four-way splitters tend to have equal attenuation on all four-output legs, so either output port will provide the same signal strength.



Four-Way Splitter