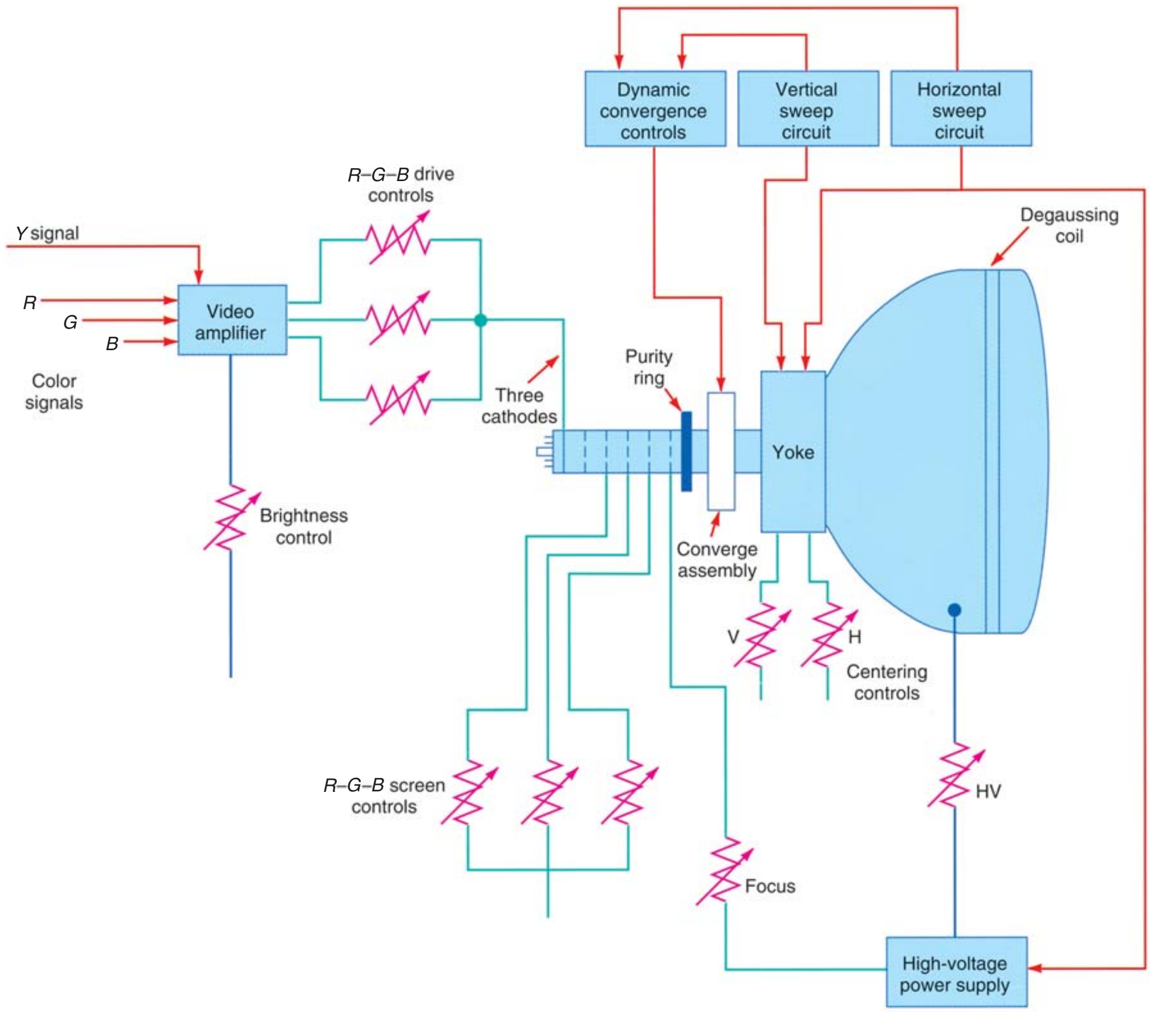
Figure 23-17 Color picture tube circuits.



projection, Digital Light Processing (DLP), and a few others. These new displays are more expensive than CRTs, but they have brought two major benefits to TV displays.

First, the displays are flat or thin. CRTs require depth to function properly and so take up a great deal of room on a table or desk. The typical depth of a CRT is 18 to 24 in. LCD and plasma displays are very thin and rarely more than 5 in thick.

Second, these alternative displays can be made in much larger sizes. The maximum CRT size made today is 36 in. Other displays can be made in sizes from about 37- to 60-in diagonal measurement. Many of these displays are capable of being wall-mounted. As costs continue to decline and as digital and high-definition television programming becomes available, more TV screens will use these modern display techniques.

The operational details of these displays are way beyond the scope of this book, but here is a brief summary of the most common types.

Plasma. A plasma screen is made up of many tiny cells filled with a special gas. When the gas is excited by an electric signal, the gas ionizes and becomes a plasma that glows brightly in shades of red, blue, and green. The cells are organized to form triads or groups of the three colors that are then mixed and blended by your eye to form the picture. Scanning signals turn on the cells horizontally as in a CRT.

LCD. Liquid-crystal displays use special chemicals sandwiched between pieces of glass. These chemicals are designed to be electrically activated so that they block light or pass light. A bright white light is placed behind the screen. Then the red, blue, and green sections of the screen are enabled to pass the desired amount of light. The screen is also made in the form of groups of three color dots or segments to produce any desired color. Electric signals scan across the color dots horizontally, as in other TV sets, to reproduce the picture. LCD screens are very common in computer video monitors but are now practical for TV sets. As prices decline more TV sets will use them.

Projection screens. A popular large screen option is an LCD projection TV. A very bright light is passed through a smaller LCD screen and then through a lens, creating a picture from 40 to 60 in diagonally. Another projection screen uses Texas Instruments' Digital Light Processing (DLP) chips. These chips are made with microelectromechanical systems (MEMS). They consist of thousands of tiny mirror segments each whose tilt angle is controllable. These mirrors reflect light through color lenses to create a very large back-projected image.

23-3 Cable TV

CATV (cable TV)

Cable TV, sometimes called *CATV,* is a system of delivering the TV signal to home receivers by way of a coaxial cable rather than over the air by radio wave propagation. A cable TV company collects all the available signals and programs and frequency-multiplexes them on a single coaxial cable that is fed to the homes of subscribers. A special cable decoder box is used to receive the cable signals, select the desired channel, and feed a signal to the TV set. Today, most TV reception is by way of a cable connection instead of an antenna.

CATV Background

Many companies were established to offer TV signals by cable. They put up very tall high-gain TV antennas. The resulting signals were amplified and fed to the subscribers by cable. Similar systems were developed for apartments and condominiums. A single master antenna system was installed at a building, and the signals were amplified and distributed to each apartment or unit by cable.

Modern Cable TV Systems

Headend

Today, cable TV companies, generally referred to as multiple (cable) systems operators (MSOs), collect signals and programs from many sources, multiplex them, and distribute them to subscribers (see Fig. 23-18). The main building or facility is called the *headend.* The antennas receive local TV stations and other nearby stations plus the special cable channel signals distributed by satellite. The cable companies use parabolic dishes to pick up the so-called premium cable channels. A cable TV company uses many TV antennas and receivers to pick up the stations whose programming it will redistribute. These signals are then processed and combined or frequency-multiplexed onto a single cable.

Trunk cable

Coaxial cable

Feeders

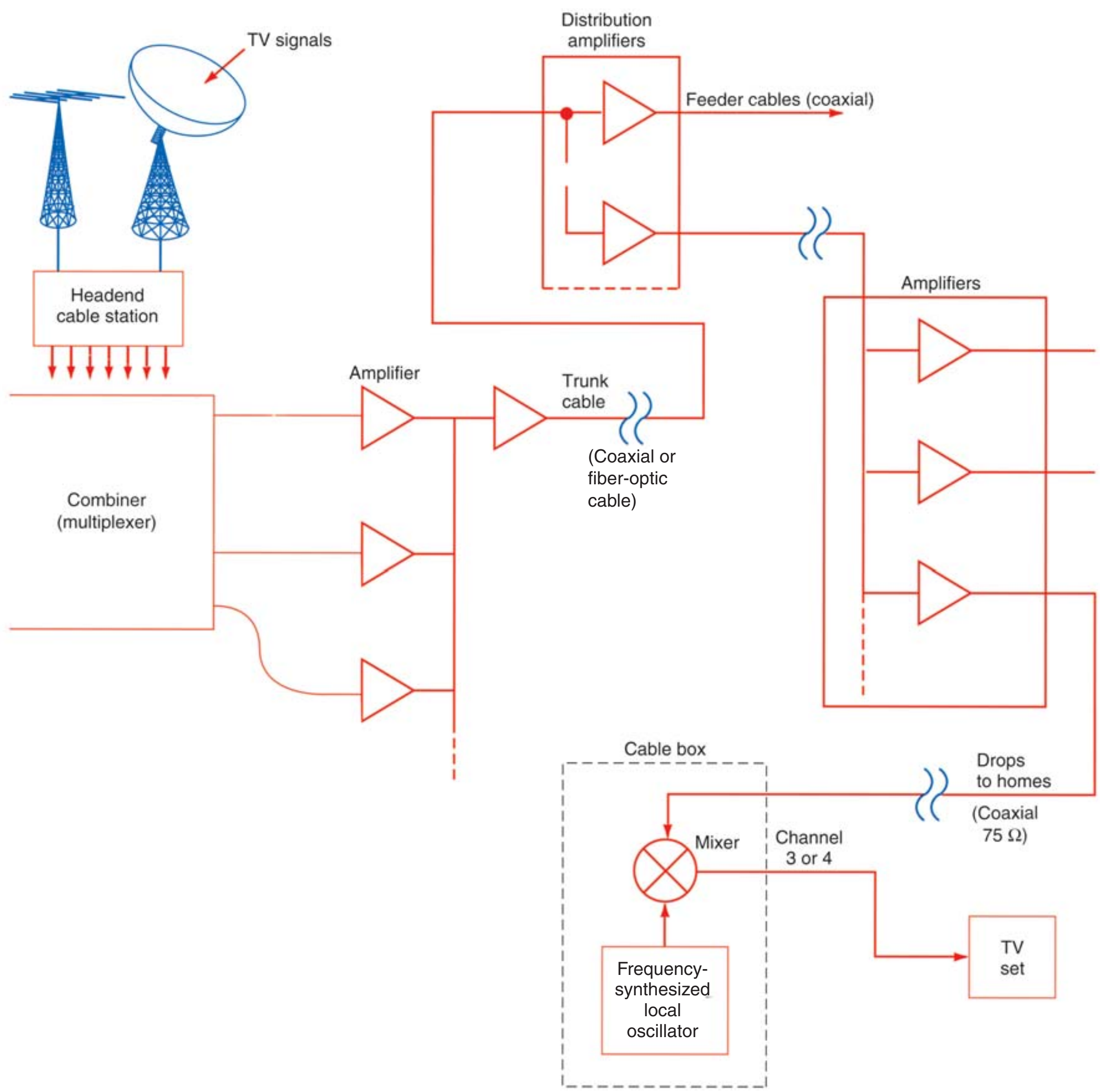
Drops

Hybrid fiber cable (HFC) system

The main output cable is called the *trunk cable.* In older systems it was a large, low-loss *coaxial cable*. Newer systems use a fiber-optic cable. The trunk cable is usually buried and extended to surrounding areas. A junction box containing amplifiers takes the signal and redistributes it to smaller cables, called *feeders,* which go to specific areas and neighborhoods. From there the signals are again rejuvenated with amplifiers and sent to individual homes by coaxial cables called *drops.* The overall system is referred to as a *hybrid fiber cable (HFC) system.*

The coaxial cable (usually 75 Ω RG-6/U) comes into a home and is connected to a cable decoder box, which is essentially a special TV tuner that picks up the cable channels and provides a frequency synthesizer and mixer to select the desired channel. The mixer

Figure 23-18 The modern cable TV system.



output is heterodyned to TV channel 3 or 4 and then fed to the TV set antenna terminals. The desired signal is frequency-translated by the cable box to channel 3 or 4 that the TV set can receive.

Cable TV is a popular and widely used service in the United States. More than 80 percent of U.S. homes have cable TV service. This service eliminates the need for antennas. And because of the direct connection of amplified signals, there is no such thing as poor, weak, noisy, or snowy signals. In addition, many TV programs are available only via cable, e.g., the specialized content and premium movie channels. The only downside to cable TV is that it is more expensive than connecting a TV to a standard antenna.

Signal Processing

Signal processing

The TV signals to be redistributed by the cable company usually undergo some kind of processing before they are put on the cable to the TV set. Amplification and impedance matching are the main processes involved in sending the signal to remote locations over what is sometimes many miles of coaxial cable. However, at the headend, other types of processes are involved.

Straight-through processing

Strip amplifier

GOOD TO KNOW

In cable TV, heterodyne processing translates the incoming TV signal to a different frequency. Microwave signals cannot be put on the cable, so they are converted to an available 6-MHz TV channel.

Heterodyne processing

Straight-Through Processors. In early cable systems, the TV signals from local stations were picked up with antennas, and the signal was amplified before being multiplexed onto the main cable. This is called *straight-through processing*. Amplifiers called *strip amplifiers* and tuned to the received channels pass the desired TV signal to the combiner. Most of these amplifiers include some kind of gain control or attenuators that can reduce the signal level to prevent distortion of strong local signals. This process can still be used with local VHF TV stations, but today heterodyne processing is used instead.

Heterodyne Processors. *Heterodyne processing* translates the incoming TV signal to a different frequency. This is necessary when satellite signals are involved. Microwave carriers cannot be put on the cable, so they are down-converted to some available 6-MHz TV channel. In addition, heterodyne processing gives the cable companies the flexibility of putting the signals on any channel they want to use.

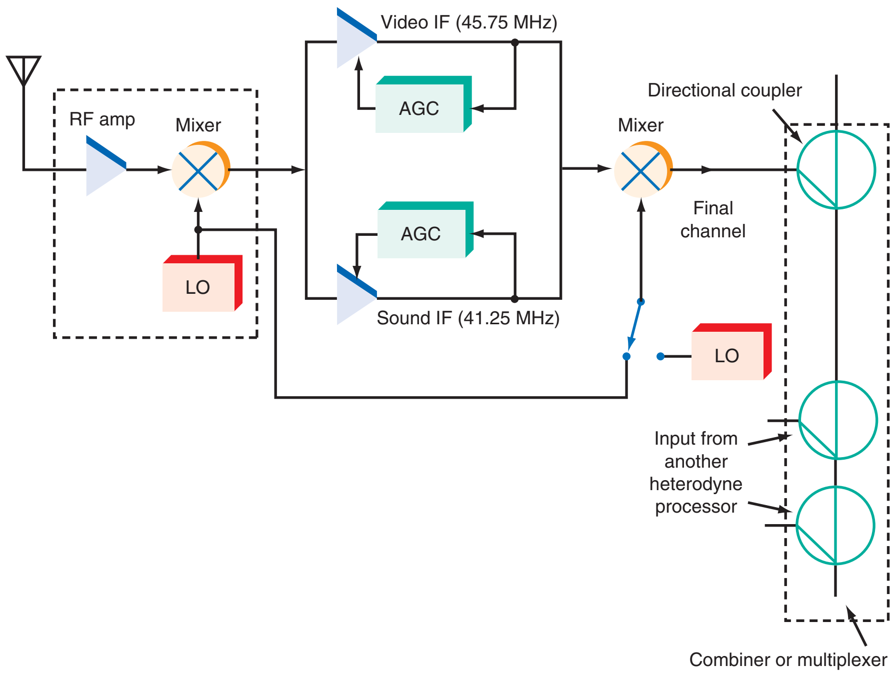
The cable TV industry has created a special set of nonbroadcast TV channels, as shown in Fig. 23-19. Some of the frequency assignments correspond to standard TV channels, but others do not. Since all these frequencies are confined to a cable, there can be duplication of any frequency that might be used in radio or TV broadcasting. Note that the spacing between the channels is 6 MHz.

The cable company uses modules called *heterodyne processors* to translate the received signals to the desired channel (see Fig. 23-20). The processor is a small TV

Figure 23-19 Special cable TV channels. Note that the video or picture carrier frequency is given.

Channel	Frequency, video carrier, MHz	Channel	Frequency, video carrier, MHz
Low-Band VHF		Superband (cont.)	
2	55.25	N	241.25
3	61.25	O	247.25
4	67.25	P	253.25
5	77.25	Q	259.25
6	83.25	R	265.25
Midband VHF		S	271.25
A-2	109.25	T	277.25
A-1	115.25	U	283.25
A	121.25	V	289.25
B	127.25	W	295.25
C	133.25		
D	139.25	Hyperband	
E	145.25	AA	301.25
F	151.25	BB	307.25
G	157.25	CC	313.25
H	163.25	DD	319.25
I	169.25	EE	325.25
High-Band VHF		FF	331.25
7	175.25	GG	337.25
8	181.25	HH	343.25
9	187.25	II	349.25
10	193.25	JJ	355.25
11	199.25	KK	361.25
12	205.25	LL	367.25
13	211.25	MM	373.25
Superband		NN	379.25
J	217.25	OO	385.25
K	223.25	PP	391.25
L	229.25	QQ	397.25
M	235.25	RR	403.25

Figure 23-20 A heterodyne processor.



receiver. It has a tuner set to pick up the desired over-the-air channel. The output of the mixer is the normal TV IFs of 45.75 and 41.25 MHz. These picture and sound IF signals are usually separated by filters, and they incorporate AGC and provide for individual gain control to make fine-tuning adjustments. These signals are then sent to a mixer where they are combined with a local-oscillator signal to up-convert them to the final output frequency. A switch is usually provided to connect the input local oscillator to the output mixer. This puts the received signal back on the same frequency. In some cases this is done. However, setting the switch to the other position selects a different local-oscillator frequency that will up-convert the signal to another desired channel frequency.

Some heterodyne processors completely demodulate the received signal into its individual audio and video components. This gives the cable company full control over signal quality by making it adjustable. In this way, the cable company could also employ scrambling methods if desired. The signals are then sent to a modulator unit that puts the signals on carrier frequencies. The resulting signal is up-converted to the desired output channel frequency.

All the signals on their final channel assignments are sent to a *combiner,* which is a large special-purpose linear mixer. Normally, directional couplers are used for the combining operation. Figure 23-20 shows how multiple directional couplers are connected to form the combiner or multiplexer. The result is that all the signals are frequency-multiplexed into a composite signal that is put on the trunk cable.

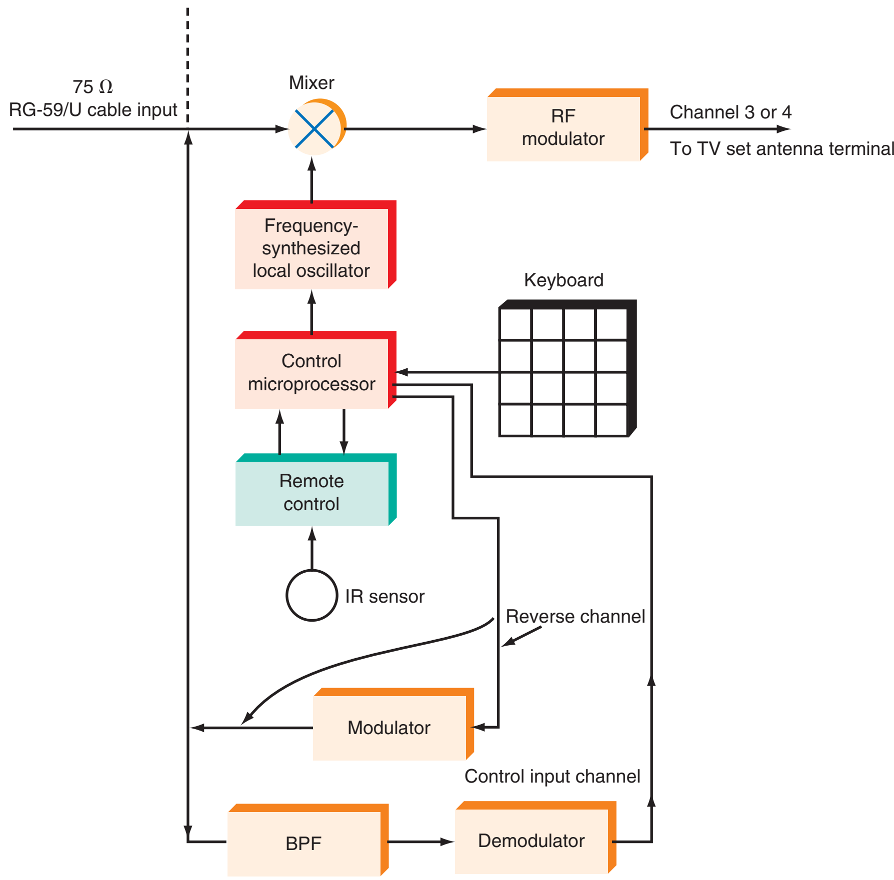
Cable TV Converter

The receiving end of the cable TV system at the customer's home is a box of electronics that selects the desired channel signal from those on the cable and translates it to channel 3 or 4, where it is connected to the host TV receiver through the antenna input terminals. The cable TV box is thus a tuner that can select the special cable TV channels and convert them to a frequency that any TV set can pick up.

Figure 23-21 shows a basic block diagram of a *CATV converter.* The 75-Ω RG-59/U cable connects to a tuner made up of a mixer and a frequency synthesizer local oscillator

CATV converter

Figure 23-21 Cable TV converter.



capable of selecting any of the desired channels. The synthesizer is phase-locked and microprocessor-controlled. Most control processors provide for remote control with a digital infrared remote control similar to that used on virtually every modern TV set.

The output of the mixer is sent to a modulator that puts the signal on channel 3 or 4. The output of the modulator connects to the TV set antenna input. The TV is then set to the selected channel and left there. All channel changing is done with the cable converter remote control.

Today, cable converters have many advanced features, among them automatic identification and remote control by the cable company. Each processor contains a unique ID code that the cable company uses to identify the customer. This digital code is transmitted back to the cable company over a special reverse channel. There are several 6-MHz channels below channel 2 that can be used to transmit special signals to or from the cable converter. The digital ID modulates one of these special reverse channels. These low channels can also be used by the cable company to turn on or disable a cable converter box remotely. A digital signal is modulated onto a special channel and sent to the cable converter. It is picked off by a special tuner or with a bandpass filter as shown in Fig. 23-21. The signal is demodulated, and the recovered signal is sent to the microprocessor for control purposes. It can be used to lock out access to any special channels to which the customer has not subscribed. The reverse channels can also be used for simple troubleshooting.

Digital Cable

The newest cable TV systems use digital techniques. The audio and video are transmitted in digital form in one or more of the regular 6-MHz-bandwidth analog channels to the cable box. A video compression technique is used to make the signal fit the