ELEMENTS OF CABLE TELEVISION

Introduction

Cable television, from its inception, developed in western countries into two separate systems called—Master Antenna Television (MATV) and Community Cable Television (CATV). The purpose of MATV was to deliver strong RF signals from one or more suitably located antennas to every TV receiver in complexes like hotels and apartment buildings, while that of CATV was to receive, combine and distribute signals of terrestrial (OFF-THE-AIR) television broadcasts through a network of cables to subscribers residing in remote towns and villages beyond the service area of local TV stations.

However, with the advent of Satellite Television (SAT-TV), reception of signals from a large number of TV stations located far-away became possible. With this, MATV lost its significance and CATV developed into a complex multi-channel system and expanded in a big way both in big cities and small towns. This large expansion became possible, because cable TV does not have the restriction of channel allocations as is necessary in terrestrial television and can thus offer a variety of programmes on a large number of channels.

Modern Cable Systems carry and deliver signals of local and nearby TV stations that are available directly and of stations located far-away in and outside the country which are received through satellites. Besides, programmes earlier recorded on video tapes and discs are also distributed thereby offering a wide choice to CATV subscribers.

Cable systems meant for small towns, hotels and apartment buildings are less complex and offer six to eleven channels whereas CATV systems developed for large community areas and big hotels are quite complex and distribute television signals on 16 or 31 channels with provision to extend up to 50 or more channels.

From the technical point of view, a cable TV system can be divided into three main sections. These are:

1. Signal Reception (Outdoor Equipment)
2. Signal Processing (Indoor i.e. Control Room Equipment)
3. Signal Distribution (Cable Network).

As an introduction to cable television, each section is briefly described.

1.1 Signal Reception

The purpose of this section is to collect TV signals from different sources and on
conversion as necessary, deliver these through coaxial cables to corresponding signal processing units located in the control room. The reception of direct VHF and UHF broadcasts is done by installing conventional TV antennas and signals thus collected are sent directly through flat twin or coaxial cables to the signal processing section. However, collection of signals coming from satellites is quite complex, because the arriving signal is extremely weak and its frequency is very high, being in the super UHF i.e. microwave spectrum. Therefore, a high gain antenna becomes necessary. A horn type parabolic dish antenna of large diameter meets this requirement. This, when correctly oriented towards the satellite, collects signals arriving from it and reflects them to a common point called ‘focal point’ which is located in front and above the centre of antenna dish as shown in Fig. 1.1. A feed-horn is actually a small wave-guide section which is mounted at the focal point and its function is to receive signals reflected

Fig. 1.1. A typical dish antenna assembly with feed-horn and LNBF mounted side-by-side at its focal point.
towards it by the dish and deliver these to the close-by located low noise block converter (LNBC) as shown in the figure.

The down-link signals from most communication satellites are in C-band of frequency spectrum in the range of 3.7 to 4.2 Giga-Hertz (GHz) i.e. 3700 to 4200 MHz. In order to minimise losses in coaxial cables that carry dish antenna signals to control room, the collected signals are first translated to a lower frequency range. This is done by a low-noise block converter (LNBC), the building blocks of which are shown in Fig. 1.2. The composite signal collected by the feed horn is fed to a low noise amplifier (LNA) which is specially designed to provide enough gain while maintaining maximum possible signal-to-noise ratio. The LNA output is fed to a converter (mixer) which translates the incoming microwave signals to a lower frequency range of 950 to 1450 MHz. This is achieved by fixing local oscillator (LO) frequency of the converter at 5150 MHz and selecting only the difference products from its output. The difference products will thus have the desired range of 950 MHz (5150 MHz – 4200 MHz) to 1450 MHz (5150 MHz – 3700 MHz). A band-pass filter (BPF) at the output of mixer separates the wanted IF signals from other signals. It is amplified by a multistage IF amplifier and then sent through a high grade coaxial cable to the CATV station. If necessary, a low noise amplifier (LNA) is provided in the middle of coaxial cable-run to make-up for any losses in it [see (Fig. 1.3)]. This LNA is often called ‘Bullet Amplifier’.

The feed horn and LNBC unit [see Fig. 1.3] is called Front-End-Converter (FEC) and also referred to as ‘Outdoor Equipment’ because it is located in the open and close to where the dish antenna is mounted. It is often necessary to install 2, 4, 6 or even 8 dish antenna units with associated feed horn and LNBCs to collect signals from different satellites. Television programmes like movies, plays and songs recorded on video tapes and discs are also distributed on one or two channels of the CATV network. For this, video cassette recorders (VCRs) and C.D. players are provided in the control room.
1.2 Signal Processing

The signal processing unit, also called ‘Head-End Equipment’ consists of power dividers, satellite receivers, channel modulators, signal processors/amplifiers, VCRs, C.D. players and a combining network. Fig. 1.3 shows necessary details of processing different types of input signals which are briefly described.

**Fig. 1.3.** Signal processing blocks for different types of input signals.

**LNBC Output:** The 500 MHz wide IF signal (950 MHz to 1450 MHz) is actually a multiplexed output of 12 separate transponder channels each having an effective bandwidth of 36 MHz (actual 40 MHz). In communication satellites, most of these channels carry television signals of different TV stations while the remaining cater to telephone and various data transmission services.

**Power Divider:** The IF signal from the LNBC is delivered to a signal splitter which is actually a multicoupler that divides the signal into independent paths. The signal splitter is commonly called a "Power Divider" because it enables equal division of signal power at its output ports.

**Satellite Receiver:** The satellite receiver accepts inputs from one of the output ports on the power divider. It is designed to select manually or by remote control any one of the channels present in the 500 MHz IF signal. The receiver tuner can thus be set to select any desired channel out of many available. On selecting the wanted channel, the receiver functions like a TV receiver and demodulates the received frequency modulated
(FM) signal of the selected channel to provide base-band signal. The term baseband signal is used to indicate the combined video (0-5 MHz) and SIF (FM) signal around 5.5 MHz. The sound IF (SIF) signal is further demodulated as in a TV receiver to obtain audio signal. It is either done in the satellite receiver or at the input of channel modulator.

Channel Modulator: A channel modulator functions as a mini TV transmitter to provide output in the same format as produced at any TV station. Each channel modulator receives video and audio signals from one satellite receiver and modulates these on carrier frequencies of the assigned cable channel. It then combines these outputs to form the composite output signal. The output of each channel modulator feeds into the combiner unit.

Terrestrial TV Signal: As explained earlier, signals of local or nearby TV stations are picked up by multichannel antennas installed at suitable locations. Each antenna output is fed to the combiner after necessary amplification. However, if it is to be shifted to another VHF channel, it is processed by a unit called 'signal processor' to obtain desired output before combining it with other modulator outputs. As necessary, the signal processor demodulates video and audio signals and then modulates these on carrier frequencies of the assigned cable channel.

VCR/C.D. Player: All VCRs/C.D. players enable two types of outputs. One is in the form of video (V) and audio (A) signals and the other in the standard TV format either on VHF channel 3/4 or any UHF channel between 30 to 39. In Fig. 1.3, baseband signal has been chosen as the output and fed to a channel modulator for further processing. The resulting output is then combined with other similar RF signals in the combiner (mixer) unit.

Combiner: This is a network with provision to accept outputs of different channel modulators and combine them to form a single wideband RF signal which is then distributed to subscribers over the cable network.

1.3 Signal Distribution

A representative signal distribution plan is shown in Fig. 1.4. The multiplexed output from the combiner is amplified before taking it to the distribution amplifier which is located at the geographical centre of the area to be served. From there, trunk lines carry the combined RF signal to distant locations. Trunk amplifiers are located on such trunk routes to compensate for signal loss in cables. Signal splitters also called direction-couplers are used to distribute cable signal from trunk lines to branch routes as shown in the figure. Passive matching networks, usually called 'TAP-OFFS', are provided along branch cable runs from where individual cable runs take the signal to TV receiver locations.

The signal level at the input of each TV receiver should be of the order of 1.5 mV (P-P) which is enough to generate good quality pictures. Since improperly terminated lines develop standing waves i.e. signal reflections, which result in disturbance and signal loss, the end of each distribution cable is terminated in a resistance (usually 75 ohms) which is equal to the characteristic impedance of the line. Such a termination provides correct impedance match to the line and hence, reflections are prevented.

Set-Top Converter: Drops i.e. connections to subscriber TV receivers are made either directly or through a VCR if in use. If the number of channels is not more than
Fig. 1.4. A representative signal distribution plan of a Cable TV system.
eleven, channel modulators are allotted the usual TV channels that lie in VHF I and III bands.

Depending on the mode of connection, the corresponding tuner of the TV receiver or VCR, is used to select incoming programmes on various channels. However, if the number of cable channels is large, it becomes necessary to look for an alternative to accommodate additional channels. For this, recent models of TV receivers have modified tuners that extend selection in the mid band, super band and hyper band i.e. higher frequency range than available on earlier receivers. Such TV receivers are called 'CABLE READY' and can also receive 'S' band channels.

However, with earlier TV receivers which do not have additional band provision, it becomes necessary to use an external converter which translates all incoming cable channels to a common VHF channel which is either channel No. 3/4 or a UHF channel. Such a converter is called 'SET-TOP CONVERTER' because it is usually put on top or along-side the television receiver.

The channel selection is done at the converter either manually or by remote control depending on its design. The cable coming from tap-off is connected at the input socket of the converter and its output goes to antenna input point of the TV receiver. The receiver is tuned to the chosen common channel and left there to receive all the incoming cable channels.