The Media Streaming Journal

March 2022

Covering Audio and Video Internet Broadcasting

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Welcome to The Media Streaming Journal

Welcome to the latest edition of The Media Streaming Journal.

Community stations serve geographic communities and communities of interest. Additionally, these stations feature popular and relevant content to a local, specific audience that commercial broadcasters or media organizations often overlook.

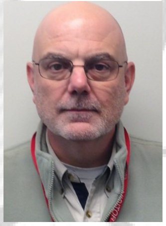
The key to growing a successful Community broadcast station is to effectively plan and operate such an outlet to maximize the audience and growth potential while providing quality programming. Both knowledge and skill are prerequisites for establishing and maintaining such a station.

Please feel free to contact either the Publication Director (Derek Bullard) or myself if you have any questions or comments regarding The Media Streaming Journal.

Namaste

David Childers

The Grand Master of Digital Disaster
(Editor In Chief)



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Newspaper Interviews

New York Times

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Helsinki Finland

Open Source Developer

Developed software architecture to continuously source multimedia content to Youtube Live servers.
Scenic Television – The sights and sounds of nature on the Internet.
http://www.ScenicTelevision.com

Projects

Researched and developed documentation for Peercast P2P multimedia streaming project.
http://en.wikipedia.org/wiki/PeerCast

Researched and developed technical documentation for NSV / Winamp Television.
http://web.archive.org/web/20080601000000*/http://www.scvi.net

MidSummer Eve Webfest

A virtual International festival focusing on Digital art and Free Software that was coordinated by OrganicaDTM Design Studio.

Presentation and discussion regarding Internet multimedia content distribution.
http://web.archive.org/web/20061104230522/http://www.organicadtm.com/index.php?module=articles&func=display&catid=37&aid=61

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The Media Streaming Journal

What is in this edition of the Media Streaming Journal

Certificate in Community Radio Technology

Module 1: Community Radio: An Introduction
Module 2: Setting up of CRS
Module 3: Studio Technology
Module 4: Audio Production
Module 5: Audio Post Production
Module 6: Studio Operations
Module 7: Radio Transmission Technology
Module 8: FM Transmitter Setup
Module 9: Practical Internship Handbook

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Certificate in Community Radio Technology

This is course material created by CEMCA (Commonwealth Educational Media Centre for Asia) for the Certificate In Community Radio Technology. It covers all aspects of organization and operation of community radio stations.

Commonwealth Educational Media Centre for Asia
Broadcast Engineering Consultants India Ltd.

Certificate in Community Radio Technology

1

Community Radio: An Introduction

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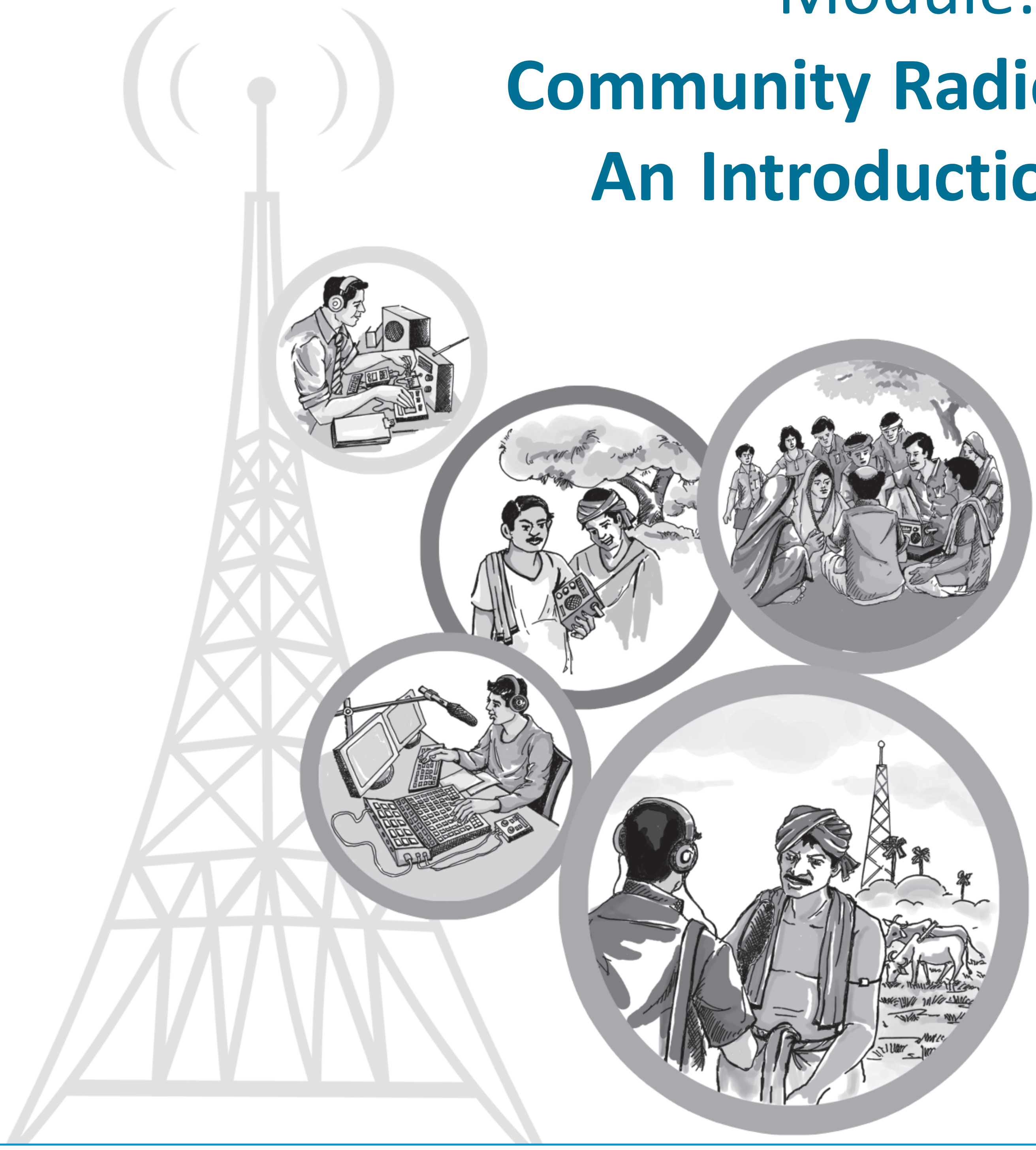
Module: 1
Community Radio: An Introduction



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Certificate in Community Radio Technology

Courses	Modules	Units
Course I: Understanding Community Radio (3 Credits, 90 Hours)	**Module 1** Community Radio: An Introduction	**Unit 1 :** Community Radio: Concept and Evolution **Unit 2:** Context, Access and Equity **Unit 3:** Community Radio: Policy Guidelines **Unit 4:** Technology for CR: Guiding Principles
	Module 2 Setting up of CRS	**Unit 5:** Components of CR Station **Unit 6:** Radio Waves and Spectrum **Unit 7:** Basics of Electricity **Unit 8:** Power Backup and Voltage Stabilisation
Course II: Community Radio Production: System & Technology (5 Credits,150 Hours)	**Module 3** Studio Technology	**Unit 9:** Basics of Sound **Unit 10:** Analog and Digital Audio **Unit 11:** Components of the Audio Chain **Unit 12:** Studio Acoustics
	Module 4 Audio Production	**Unit 13:** Audio Hardware and Field Recording **Unit 14:** Free and Open Source Software **Unit 15:** Telephony for Radio
	Module 5 Audio Post Production	**Unit 16:** Sound Recording and Editing **Unit 17:** Mixing and Mastering **Unit 18:** File Formats and Compression **Unit 19:** Storing and Retrieval
	Module 6 Studio Operations	**Unit 20:** Good Engineering Practices for Studio Setup **Unit 21:** Studio Equipment: Preventive & Corrective Maintenance **Unit 22:** Content Distribution: Alternative Mechanisms
Course III: Community Radio Transmission: System & Technology (2 Credits, 60 Hrs)	**Module 7** Radio Transmission Technology	**Unit 23:** Components of Transmission Chain **Unit 24:** Components of FM Transmitter **Unit 25:** Antenna and Coaxial Cable **Unit 26:** Propagation and Coverage
	Module 8 FM Transmitter Setup	**Unit 27:** Transmitter Setup: Step-by-step **Unit 28:** Transmission System-Preventive and Corrective Maintenance **Unit 29:** Transmission Setup-Good Engineering Practices
Course IV: Technical Internship (2 Credits, 60 Hrs)	**Module 9** Practical Internship Handbook	**Section A:** Introduction **Section B:** Activities to be Conducted During the Practical Internship **Section C:** The Internship Journal and Self-Assessment Paper **Section D:** Assessment of Internship **Section E:** Appendices

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About the Module

Module Description

This module is first part of the Course – I: Understanding Community Radio, and gives an introduction and overview of Community Radio including its concept and evolution along with the basics of Radio Broadcasting in India.

The first module, ***"Community Radio: An Introduction"*** has four Units. The first Unit provides you with a historical perspective of the emergence of community radio in India besides giving a brief idea of the other two tiers of broadcasting viz., public service broadcasting and private sector broadcasting.

Community Radio is fundamentally linked to the idea of 'voice-to-voiceless' and is a tool for social change. The second Unit, besides throwing light on these aspects, also introduces you to issues such as developmental implications of Community Radio Stations, freedom of speech, gender equity and provides an opportunity for one to read up a bit more on existing community radio stations and measure them against some of the principles behind the setting up of a CR station.

Third Unit will focus on the existing community radio policy in India and its salient features. You will realise how the policy framework affects the technology and programming of community radio. A background on the campaign for community radio in India and the various actors behind it also find more than a mention in this Unit.

Since the programme is intended to develop technical competencies of those associated with CR stations, the fourth Unit will discuss the fundamental principles and key decisions one will need to take before deciding on the technology. These decision points will be the key to minimising downtime and maximising flexibility of operations.

Module Objectives

- To provide a historical perspective on the evolution of Community Radio (CR) in India;
- To discuss the principles behind setting up of CR;
- To discuss the policy guidelines and their impact on technology and content of a CR station; and
- To discuss the fundamental principles behind deciding the technology for a CR station.

Units in the Module

- Community Radio: Concept and Evolution
- Context, Access and Equity
- Community Radio: Policy Guidelines
- Technology for Community Radio: Guiding Principles

UNIT 1

Community Radio: Concept and Evolution

Structure

1.1 Introduction

This Unit will help you to understand community radio as a concept. There are no technology-related topics in this Unit but rather, basic material related to the history of radio in India, and the evolution of community radio.

This Unit will also give you a few case studies of community radio stations across Asia. You will need access to select reading materials, and a visit to the nearest community radio station is highly recommended.

You will need at least four hours to complete this Unit including carrying out some of the activities mentioned below.

1.2 Learning Outcomes

After going through this Unit, you will be able to:

- discuss the basics of radio broadcasting in Asia – including history and evolution of community radio;
- explain the evolution and emergence of community radio, especially in India; and
- discuss a few model community radio stations across Asia.

1.3 Radio Broadcasting in India

This section will introduce you to the history of radio broadcasting in India, including a history of the public service broadcasting sector – All India Radio, and the emergence of the private radio sector. It will not only give you a historical perspective on both these sectors, but will also help you distinguish these sectors from community radio.

Radio came to India during its infancy in the Western part of India. For much of its history, it has remained a part of the government, with private broadcasters commencing operation only in the early 2000s (though many were regularly purchasing airtime by the mid-1990s.)

In British India, radio broadcasting began, in a small way, in July 1923 with programmes by the Radio Club of Bombay and other radio clubs. However, on a larger scale, radio broadcasting was started in India by a private company *viz*., Indian Broadcasting Company Ltd. (IBC) in 1927, which was authorized by the government vide an agreement of July 23, 1927 to operate two radio stations : the Bombay Station began on 23 July 1927, and the Calcutta station followed on 26

August 1927. On 1 March 1930, however, the company went into liquidation. The government took over the broadcasting facilities and started running the service as the Indian State Broadcasting Service (ISBS) from 1st April 1930 (on an experimental basis for two years, and permanently from May 1932). On June 8, 1936, the ISBS was renamed All India Radio (AIR).

On 1 October 1939 the AIR launched its External Service with a broadcast in Pushtu. It was intended to counter radio propaganda from Germany directed to Afghanistan, Iran and the Arab nations. When India became independent in 1947, the AIR network had only six stations (in Delhi, Bombay, Calcutta, Madras, Lucknow, and Tiruchi) and the total number of radio sets in the country at that time was about 275,000.

In the interim period, Radio Ceylon, based in Colombo, captured Indian hearts and wallets by broadcasting Hindi (Bollywood) songs. Radio Ceylon was started in 1923, and quickly set high standards for broadcasting. But it came into its own at the end of the Second Wold War, when Allied Forces – who had been using it for wartime broadcasts – handed it back to the Govt. of Ceylon. The 1950s and 1960s were the golden age of Hindi film music and Radio Ceylon played plenty of it with the result that Radio Ceylon's powerful transmissions began to be the preferred listening service in South Asia. It made household names of several of its producers and comperes and gave rise to popular programmes like the *Binaca Geet Mala* and *Lipton Ke Sitare.* Advertising revenue streamed from India to Ceylon in vast quantities. On 3 October 1957 the Vividh Bharati Service was launched by All India Radio to compete with Radio Ceylon. Television broadcasting which began in Delhi in 1959 as part of AIR, was split off from the All India Radio network and became independent TV public service broadcasting network – Doordarshan on 1 April 1976.

Today, All India Radio's Home Service consists of 403 stations across the country, broadcasting in 23 languages and 146 dialects. All India Radio covers 92% of the terrain and 99% of the population of the country.

Formation of Prasar Bharati

From the day it was started, the radio service was run by the Government of India, whether it was the British or the Indian government after Independence. This meant that all the people working in the radio stations were government employees, and all the money required for setting up and running the radio stations was provided by the government. In 1975, however, India saw a brief period during which content on the radio and television was alleged to be only about those topics that the government approved. As a result, a great public debate ensued for making All India Radio and Doordarshan totally separate and independent of the Government and thus function truly as a Public Broadcaster. It was argued that the objective of the public service broadcasting sector is to cover issues which would be in public interest and not for profit or only entertainment. Moreover, public service broadcasting is aimed at programmes catering to all sections of the population – rich or poor, urban or rural, men or women.

A bill *viz.,* Prasar Bharati Bill was, accordingly, introduced in the Parliament to bring the above mentioned objective into effect. The Prasar Bharati Bill was debated in Parliament at great length to come to a consensus as to how this public service broadcasting sector would operate. Finally, in 1997, the Prasar Bharati Act was passed by Parliament, and a separate organization was incorporated which was known as Prasar Bharati. It was to be an independent public service oriented corporation, which would manage both All India Radio and Doordarshan. The funds, staff and programming would be managed by this corporation. Prasar Bharati is, however, still not able to generate adequate funds and has to be rescued by the Government. The Chief of Prasar Bharati is appointed by the Ministry of Information and Broadcasting of the Government of India, but is given special protection in order to provide functional autonomy.

1.3.1 Public Service Broadcasting

Public service broadcasting in India today is probably one of the largest of all such operations in the world. All India Radio has a wide range of home services which cater to every part of the country, and almost all the officially recognized languages and dialects. The service is very popular, especially in remote and rural areas, where there is no other media penetration – including private FM radio (explained in the next sub-section) or television. The programmes cater even to rural audiences including programmes on agriculture, local culture, livelihood, and folk music. The All India Radio service has one national service which broadcasts from Delhi and can be picked up by the regional stations in each state. Each state also has a number of regional services which include one main station, usually in the capital of the state, and then smaller stations installed in specific districts. The regional and smaller stations may also relay programmes from larger stations, such as the national service. For example, the Bangalore AIR station relays news or music programmes from AIR Bombay on certain occasions. The relay service is also useful in broadcasting national news which would be the same for all the stations. In terms of modes of transmission, All India Radio in FM, MW and SW mode. The Medium Wave services are mostly the regional stations which cover entire districts or states, and cater to a wide range of audience, while FM Services mostly work as local radios. You will find that both FM and MW are explained in more detail in later chapters.

Activity 1.1

Try tuning into a FM or AM (MW and SW) service of AIR broadcasting. Try to list down the kind of programmes that are covered in both types of service. Is there any difference between AIR and other kinds of radio programmes which you can hear in your location? This exercise should take you about 45 minutes.

1.3.2 Emergence of Private Radio Sector

The private radio broadcasting sector, as the name suggests, is primarily distinguished from public service broadcasting in terms of ownership of the radio. While public service broadcasting was first owned by government and then by Prasar Bharti, private broadcasting is owned by private companies. Ministry of Information and Broadcasting, in the early 90s, felt that while All India Radio programmes were being heard in large part of the country, there was a need to diversify content by bringing in private players on AIR's platform.

AIR thus began selling airtime blocks on its FM services to private broadcasters and producers, who then broadcast these programmes over AIR FM Channels. Among the first private entities to enter this business was Times FM, which commenced operations in 1993. So much was the popularity gained by Times FM, that there was a clamour for allotment of airtime slots by many other entities. This led to litigations which forced AIR to withdraw the scheme. Meanwhile, there was a landmark Supreme Court judgement in the case of West Bengal Cricket Association v/s Union of India, which held that the airwaves are public property, with the government's role restricted to management and regulation. The implication was that private parties had an equal right to broadcast in India.

The Government of India, vide its notification made on 1 July 1999, opened the doors of FM broadcasting to private operators by offering to allot 108 channels in 40 cities. Alongside, it also earmarked a channel for education in each of the 40 cities. As a result, a number of private stations began to come up, the first of which was Radio City, in Bangalore, in 2001. Even though ultimately only 22 channels could get operationalized covering 12 cities, they revolutionized radio listening in the country thus creating a demand of more channels in Phase II.

Responding to the demand for more channels, FM Policy Phase II was notified in 2005 during which 225 additional FM channels came up across India, raising the total number of channels to 245 in 86 cities. As things stand today, Phase III policy has already been notified in 2011, with the intention of raising the total number of stations to 839 across 294 cities in India but its roll-out is awaited.

1.4 Community Radio: Evolution

Community radio is the third tier of radio broadcasting in India – the first two being public service and private broadcasting. Thus community radio is that sector of radio which is owned by localized geographical communities, wherein participation, ownership and daily management of the radio station is by the same community the radio seeks to serve.

A typical community radio station is characterized by programmes which are produced by local people, in the local language or dialect, and talks about locally relevant issues. It is different from public radio because public service radio typically caters to a much larger audience, and most of the programming is done by broadcasting professionals. In community radio, the audience is limited to a few villages or localities, and the programming is done by local people, who mostly have had no prior experience in radio. Finally, community radio is a medium which is recognized globally, in helping the community/marginalized people express their opinion on various matters concerning the community, as well as talk about local development issues. Both of which, private and public service radio can only do to a very limited extent.

Community Radios had already become a reality in many parts of the world. The 1995 Supreme Court judgement that airwaves are public property also generated a discussion within civil society organizations working on community driven media. Neighbouring nations such as Nepal had already experimented with community radio since the early 1990s, and many CR stations were doing sterling work by then. Could India not have a process to set up CR stations?

Civil society activism resulted in a joint activism and advocacy agenda called the Pastapur Declaration in 1998. The declaration was so named after the venue – Pastapur in Medak District, Andhra Pradesh - where discussions were held and the declaration adopted. This became the framework for further discussion with the Government.

Sustained advocacy with the Government of India resulted in the first Community Radio Policy in 2002, which allowed educational institutions across the country to set up small scale local radio station. Supported by several international agencies such as UNESCO and UNDP, civil society organizations and government functionaries continued thrashing out revisions to the 2002 policy, which was only partially enabling. This resulted in the revised CR Policy Guidelines of November 2006, which allowed registered civil society organizations also to apply for CR licenses; and which forms the current framework for CR in India.

1.4.1 Concept and Role of CRS

The Indian sector of community radio is perhaps the only one in Asia which is separate and distinct from private and public radio broadcasting. This sector, as per current policy guidelines is mainly framed in terms of development and improving quality of life for communities radio seeks to serve. This includes women's issues, health, education, culture, local music, economic and social development, to name a few. The details about the Community Radio Policy in India are given in Unit 3 of this module.

Concept of Community Radio

The key concept of Community Radio (CR) is that of giving the voiceless a voice. Even in places where there is extreme poverty, it has been shown through many studies that what people value the most is to have a voice. This means that they value their right to speak out on what is affecting them, speak out on their identity, and speak to document their ways of life, cultures and traditions. Therefore, community radio is often seen as giving a voice to those who are often voiceless. This means that community radio should always prefer those who are marginalised in society and give them an opportunity to speak. For example, in India, community radios could provide opportunities to communities belonging to the Dalits, minorities, sex workers, people with disabilities, senior citizens, tribals, etc..

In addition to this, the concept of community radio is strongly associated with many other values including that of better governance, documenting and using languages, oral histories and cultures, promoting gender equality and sensitivity, as well as educating and entertaining its community.

Finally, the concept of community radio can be summed up in the words of Louie Tabing, a community radio pioneer from the Philippines, who said community radio can give a community member the opportunity to “Be you, Be New and Be True”.

Playing diverse roles – A global picture

One of the first community radio stations to be started in the world was a radio station started by miners in Bolivia in the 1940s. The radio station was mainly supposed to represent the issues related to the mining industry in Bolivia from the workers point of view. Since then, community radio has spread rapidly to most parts of the world, with South Asian countries (like India, Pakistan, Sri Lanka, Afghanistan, Bhutan) being relatively late entrants.

In Latin American countries like Brazil, Guatemala, Argentina, community radio stations are heavily political in nature. They are connected to people’s movements, which are usually connected to issues concerning people’s rights on topics such as the right to choose a political candidate, right to education, etc. Further, the social and developmental role of the church has been recognized, and religious institutions like the church have been allowed to broadcast on radio. In European countries, the community radio movement has been mainly seen as a strong alternative to mainstream media. Often these community radio stations represent view points and opinions of the people on the street, which are often missing in mainstream and private media. These radio stations also give opportunities to independent musicians and folk artistes who do not get a chance to play their music on other media. In Africa and now in Asia, community radio has been largely seen as a medium which can help in development of the people and improve their quality of life.

1.4.2 Community Radio in India Today

At present, there are about 145 functioning community radio stations in India. At present Delhi and Tamilnadu have maximum number of community radio stations and the numbers are slowly increasing in Uttar Pradesh and Bihar. Of the total number of community radio stations, about 100 of them are licensed to educational institutions or agricultural centres (Krishi Vigyan Kendras). The rest of them are licensed to community-based organizations or civil society institutions. There are many community radio stations that are broadcasting only fresh content on a daily basis, but majority of them are repeating content from the same day or previous day broadcast.

There are government advertisements (from various ministries) available, but CR stations have to empanel themselves with the Directorate of Audio Visual Publicity (DAVP) to avail of the advertisements. Sponsored programmes are also available via DAVP. In addition, CR stations can also broadcast commercials related to local goods and services. Ministry of Information and Broadcasting is planning to introduce a centrally administered scheme to fund community radio stations through various activities including setting up and capacity building.

One of the problems with community radio stations in India is its uneven distribution across the geography of the country. Most of the community radio stations are located in urban centres or semi-urban centres. There are none, or very few, community radio stations in very remote, rural, conflict, border and coastal areas of the country. For example, at present there are no community radio stations in Jharkhand, or large parts of the North East.

Activity 1.2

This activity is meant to enable you to identify and recognise the three tiers of radio broadcasting in India. You may need about 45 minutes to one hour to complete this activity. Tune into your radio set on AM and FM separately and list out available radio stations of each of the following categories:

a) Public Service

b) Private FM radio stations and,

c) Community radio stations

1.5 Some CR Initiatives

This section uses a few examples of community radio from around the world to illustrate some basic principles and/or some processes that could be beneficial to community radio stations in any part of the world. (For the purpose of more detailed study, case studies of these community radio initiatives have been included as ‘Additional Reading’ material).

The Tambuli Project in the Philippines

Tambuli project is a typical example of Community Radio Station at a place (Olutanga Island) where Government services related to community welfare such as education, health, law enforcement, banking facilities and communication system are poor. Visitors to the island are therefore astonished to find that this island, eight hours away by boat from the city of Zamboanga, operates a radio station. The islanders, themselves, were incredulous when the Tambuli project proposed the facility to them in 1993. They became even more doubtful when full control of the station was given to them.

The station runs mainly news and public affairs programmes anchored by a main personality. Other producers and reporters join in with features, news, tips and regular programme segments. It was surprising that inspite of the poverty of the island, large number of people owned portable VHF amateur transceivers. These transceivers are being gainfully employed for most of inputs concerning news and public affair programmes.

This project is easily recognized as one of the earliest promoters and pioneers of community radio in Asia. Louie Tabing, one of the founders of the Tambuli project has written a case study which demonstrates one of the most fundamental aspects of community radio stations – community participation, management and ownership. In this case study, Mr. Tabing involved community participation and opinions on even whether there should be a community radio established in their region at all. After multiple rounds of discussion in the community, the project also facilitated the establishment of a separate council called the Community Media Council with its own management.

From that step onwards, the case study is very useful to showcase how community groups can be involved in every step of operationalizing a community radio station. The project involved community groups in identifying the location of the studio, building the studio, and finally building capacities of local people to work as staff for the new radio station. The programming which resulted in this radio station is also a model example in terms of how it involved ordinary community people from various class, literacy and religious backgrounds.

The Radio Sagarmatha Project in Kathmandu

This project, like Tambuli, is also perhaps one of the most well-known and pioneering initiatives in the sub-continent. The Nepal Forum for Environmental Journalism (NEFEJ) was one of the driving forces behind the creation of Radio Sagarmatha. Astonishingly, even today, Nepal does not have an explicit policy for community radio. However, due to a liberalization of the airwaves, community groups as well as private corporations are allowed to apply for licenses on equal terms. From 1993 to 1997, Radio Sagarmatha existed as a physical space with audio equipment, trained staff and a bank of local programming. It was only after Radio Sagarmatha threatened to go live without a license that the government of

Nepal granted them a license. The Sagarmatha case study illustrates the power of advocacy organizations, the utility of community radio in an urban setting, and also the benefit of a structured radio station in terms of social and financial sustainability. The radio station is headed by a seven member board with representation from all partner NGOs. It has a staff of a programme director, six full time producers, two technicians, a music librarian, an engineer, an accounts officer and a station helper. Additionally, at the time of writing, the station also had about 26 volunteers, who are reimbursed for actual expenses and/or paid a small honorarium.

Unlike the Tambuli project, the Radio Sagarmatha also functions as an effective public service broadcaster. The Tambuli project did indeed provide public service through its operations but was much more focused on its own community. Radio Sagarmatha on the other hand provided a much more universalist kind of programming which suited its urban presence.

The Radio Ujjas Project in Kutch, Gujarat

Radio Ujjas is an initiative by the Kutch Mahila Vikas Sanghatan (KMVS), a non-profit organization based in Gujarat, India. This model is partly similar to the Radio Sagarmatha project to the extent that it was also operating without an operational and explicit community radio policy. However, Ujjas Radio was one of the first initiatives to produce locally relevant programming but distribute the programmes via the local All India Radio station in Bhuj.

The Ujjas Radio initiative is known for its strong emphasis on women participation as well as focus on gender in its programming. This is reflected in the focus on women's participation in the parent organization KMVS itself. They work in Kutch District, one of the largest districts in India, but also with one of the lowest literacy levels. The radio station has been known to make effective use of local folk songs, traditions, art and culture in their radio programmes to create a strong bridge with their listeners.

The radio station requires its reporters and volunteers to organize community level meetings and discussions where the community places forward its requirements, needs and concerns. Based on this information, the Radio Ujjas team produces programmes in the local language and dialect. After the programme has been aired, the reporters collect feedback through personal interactions, letters, phone calls etc. Of late, the radio station is also known to air programmes on governance, utilization of welfare resources, disaster management and other such areas. This case study is effective in understanding how women's participation can play a strong role in activating a community radio's presence and sustainability. It is also useful to get a glimpse into how arts, culture, local language and dialects can be leveraged usefully by a community radio station.

1.6 Let Us Sum Up

In this Unit, you have learnt to distinguish between public service radio, private radio and community radio. Further, you have also learnt how community radio came about in India, including what role it plays and what is its concept. You have also come to know about the history of development of radio broadcasting in the country including a brief idea about the various modes of broadcasting including that of Private Broadcasting & Community Radio.

1.7 Model Answers to Activities

The information gathered in the activities presented in this module should be your own experiences. Both activities are hands-on activities.

1.8 Additional Reading

- UNESCO (2001). *Community Radio Handbook*. Retrieve from http://www.unesco.org/webworld/publications/community_radio_handbook.pdf
- Radio Ujjas: Giving Voice to the Women of Kutch, Best Practice Documentation (2001), Retrieve from http://tinyurl.com/nv8edde
- Tabing, L. (2002). *How to do community radio: a primer for community radio operators.* UNESCO. Retrieve from http://unesdoc.unesco.org/images/0013/001342/134208e.pdf.

UNIT 2

Context, Access and Equity

Structure

2.1 Introduction

2.2 Learning Outcomes

2.3 Developmental Implications of CR

- 2.3.1 Concept of Development
- 2.3.2 CR and Social Change

2.4 Freedom of Speech

- 2.4.1 Voice for the Marginalised
- 2.4.2 Right To Information

2.5 Community Participation

- 2.5.1 Gender Equity
- 2.5.2 Culture and Identity

2.6 Let Us Sum Up

2.7 Model Answers to Activities

2.1 Introduction

In this Unit you will develop further on the basic understanding of community radio, which you studied in Unit 1 earlier. You will go deeper into how community radio is fundamentally linked to concepts of development and tool for social change. Further, you will also study how the concept of local participation is central to community radio.

This Unit is, like the previous one, purely theoretical and to complete this Unit, you will need to familiarize yourself with concepts of development, community participation, voice to the voiceless and gender equity. As a special activity you will be reading up on existing community radio stations and try to measure them against concepts which are mentioned in this Unit.

2.2 Learning Outcomes

After going through this Unit, you will be able to:

- define community radio in the context of development, voice to the voiceless and community participation.
- list and describe how communities can participate in community radio with respect to gender equity and culture and identity.
- analyse community radio with respect to voice for the marginalised and the Right to Information.
- appreciate the conceptual underpinnings of community radio in terms of larger concepts such as development, free speech, gender equity and notions of participation.

2.3 Developmental Implications of CR

In this section, you will study about the theme of development and how it can be linked to the community radio sector. You will further study about the concept of development itself, and how community radio can be used for social change.

2.3.1 Concept of Development

Development, in this case, refers to human development. It was perhaps the renowned economist Amartya Sen, who first laid out a framework for human development. In the 1980s the leading development approach closely linked a country's economic progress to the increase in its citizens' quality of life. The Human Development approach arose partly as a result of growing criticism to this approach. The need for an alternative approach to human development became clear due to several reasons - the wealth created with economic progress was not 'trickling down' to the poorer sections of the society; crime, ill-health and lack of education continued to spread in many countries in spite of economic growth.

Amartya Sen said, "Human development, as an approach, is concerned with what I take to be the basic development idea: namely, advancing the richness of human life, rather than richness of the economy in which human beings live, which is only part of it."

In 1990, the United Nations Development Programme (UNDP) published their Human Development Report, known as HDR 1990. The publication of this report expanded the understanding of the term development and sharpened the discourse on human development.

Over the years, the UNDP along with prominent economists like Mahbub Ul Haq, developed the Human Development Index (HDI), a measure of human development primarily based on indices of life expectancy, education and income.

It is worth pausing how community radio can contribute to human development either through the primary indices of the HDI or through other contextually relevant indices – ranging from human rights or civil liberties to cultural rights and so on.

The fundamental assumption within the community radio sector is very closely tied to the capabilities approach developed by Amartya Sen. Community radio, as a key enabler of people's voices and their participation in their affairs, allows communities to exercise their choices by giving them a voice and an agency. A community radio station, in an ideal scenario, will work together with its community to identify and refine locally relevant indices of human development, and prioritize the most pressing needs of the community.

2.3.2 CR and Social Change

While social change is a term often bandied about in the communication for development sector, it is rarely defined in specific terms for community radio stations to apply the concept on the ground. It is widely accepted that some of the terms and concepts, central to the notion of human development, are economic growth, participation and freedom, equity, security, social progress and sustainability. While these terms could be applied to virtually any community, it must be remembered that community radio is a concept which is applied at a local level. Therefore it is insufficient to work with such broad concepts and terms while trying to use community radio to bring about social change.

How then, does one go about using community radio for social change?

Participatory Research

Community radio stations involve their communities in a process of participatory research (mostly ethnographic action research) using tools such as focus group discussions, interviews, public meetings and so on. The people living in the coverage area of the radio are expected to contribute with a list of the main problems which obstruct their quality of life and development. Sometimes, the issues could be related to transparent governance while at other times it could be lack of health or education infrastructure. The staff of the community radio stations should have enough skills to engage their communities in a fruitful dialogue and discussion to accurately identify the most pressing of the people's problems.

Participatory Programming

Once the problems are identified, the community radio station then initiates a multi-stakeholder process by involving them in production programming. Most social problems are complex and involve the cooperation of various stakeholders – different community members, government departments/agencies, civil society organizations and so on. Community radio stations can either produce one-off programmes or develop a campaign wherein different dimensions of the same social problem can be addressed in depth through the participation of the various stakeholders

Feedback from the Community

While the programmes are being aired, it is vital for a community radio station to gauge the response from its listeners. Most traditional media outlets take feedback from their audiences after the programme is completed, and some media outlets publish the responses as well. However, due to the localised nature of a community radio station, it is imperative that audiences be engaged with the programming on a continuous basis, so that all programming is shaped by community responses as much as possible. This not only gives a sense of ownership to the community, but also ensures that the programming done is locally relevant and contextual.

2.4 Freedom of Speech

All citizens of India are granted the fundamental right to freedom of speech and expression as enshrined under the Article 19 (1) A of the Indian Constitution. Traditionally, the discourse of human development was seen as separate from that of political rights and civil liberties, including that of freedom of speech. However, more recent trends have included the right to free speech as an important part of the development process.

Community radio, as an independent, objective, and non-profit medium, is expected to provide a platform educating people about the various aspects of Freedom of Speech.

Let us now look at two ways in which freedom of speech or giving a voice to the voiceless can be seen as development within the community radio context.

2.4.1 Voice for the Marginalised

Communities of interest or those defined by geography, are never uniform or homogenous. Even within a small village, there are poor and rich people, people of different castes, men and women, senior citizen and children, able and disabled people. While some people may have the power and the resources to be articulate, it is very often the case, that those without the resources, or those who have been historically, socially, or culturally marginalised tend to remain silent.

The role of community radio is not only to ensure the participation of the community in general terms, but also to give a special priority to the marginalised groups and/or individuals within a given community.

Similar to the process of participatory research mentioned above in the previous section, community radio stations should identify the most marginalised groups and individuals within a community. This process of identification can be done by mapping information flows, caste-based spatial understanding of a community, interviews, statistical data gathered from government agencies, and so on.

Once marginalised groups and individuals are identified, it is the duty of community radio stations to ensure that they are given a voice on the platform of radio. Dalits, tribals, women, people with disabilities, sexual minorities, senior citizens, minority religions, children and people below the poverty line are some of the commonly marginalised groups in most communities. However, community radio stations should get more specific with the identification of these groups through a thorough research process and provide a voice to them.

Having a voice, or the ability to speak out is power in itself, and when community radio gives power to the people who have remained voiceless, these marginalised communities are transformed into valid citizens and a valid constituency whose needs must be recognized and acted upon.

2.4.2 Right To Information

The Right to Information Act has come into force in late 2005, and is a landmark piece of legislation. Prior to this Act, most government related information was not readily available to the general public, as it was protected under the Official Secrets Act, 1923. However, after the passing of the Right to Information Act, all government departments were asked to be transparent with their information, and provide information to any member of the public who requests it.

The Right to Information Act is applicable to both the Central government as well as the State government and their respective agencies, bodies, ministries etc. As part of the Act, any citizen of India can request any government body or public authority for information. The said body is mandated to provide the information within a maximum period of 30 days.

Community radio stations often function as community hubs for dialogue and as meeting spaces. Community radio stations can play a valuable role by educating the community members about the RTI Act and helping them to use the facility whenever necessary.

2.5 Community Participation

Community participation is a concept that is fundamental and central to community radio. The participation of the community is one of the main features through which this radio can be distinguished from private mainstream radio or public service radio. However, community participation is a complex concept which has many dimensions, all of which need to be adhered and addressed to.

Full time staff

It is fairly common for community radio stations to have full time staff who are retained with salaries, supported either through donors or through community funding. The staff may comprise either members of the community or media professionals hired from outside the community. Even if the full time staff are from the community, it complicates the notion of participation. The staff think that they are representing the community when they go out into the field, but the community may see them as representatives of the radio station, which in turn is represented by an educational institution or a non-profit organization. Thus, community participation is only partially fulfilled even when community members join the radio on a full time basis.

Production

Another common pattern is to involve the community members in the production of radio programmes. As you will see from Units later in the module, the production of radio programmes has two aspects – technical and content. A radio station can involve the community in technical aspects by inviting them to handle the microphones, mixing console, digital audio workstation etc. The content aspect pertains to involving community members who lend their voices to programmes – be it a radio drama or an interview. However, even within production, the participation of the community can be enhanced beyond these aspects. With respect to the technical aspect, the radio station can invest in a capacity building process, where community members are not only just involved in handling the equipment but are also empowered to maintain the equipment and make informed choices about new equipment or upgrading existing equipment. With respect to the content aspect, the radio station can involve the community members in decision making regarding the topic of the programme, the format of the programme, lending their voices to the programme, identifying niche audiences for the programme, and finally selecting an appropriate time to broadcast the programme.

Management

A key feature of community radio is the management of the radio station by the community that it seeks to serve. Most community radio stations make do with a program advisory committee which ‘advises’ the community radio station on matters related to programming. Of course, the management of a community radio station goes beyond programming. The other aspects of management are administrative, personnel, technical, financial and social. A community radio can seek to be true to its name only when it appoints a management committee which retains complete control over all these aspects of management. Community management of the radio station is important in terms of the community feeling empowered, giving them authority, to shape the vision and functioning of the radio station, and finally, ensuring that the priorities of a community radio station remain locally relevant and contextual.

Community radio stations need to constitute a community based management committee which is fair, objective, skilled at management and representative of the community who will not abuse their positions of power. There are no standardized rules, regulations or norms towards constituting a management committee for a community radio station. However, community radio stations, apart from learning from their peers’ experiences, can also devise strategies based on their particular context and their community.

Thus it can be said that the concept of participation cannot be limited to the mere presence of the community at specific points of the functioning of a radio station. Instead, participation should be quantitatively and qualitatively enhanced to mean handing over power and decision making to individuals who are representative of the larger community.

2.5.1 Gender Equity

While there are many issues which are specific to a particular place (lack of schools, health issues etc), there are other aspects of social change which are universally applicable in any context. In India, one can safely assume the universal aspects of social change worthy of attention to include gender dynamics, caste, class and religion.

While caste and religion may be aspects that are unique to India’s diverse population, the issue of gender dynamics is a global issue and cuts across different social contexts. Community radios can play an important role in educating the members of the community about the gender equality but at the same time they have also to ensure that they follow the principle themselves.

Thus, while a community radio station may have done the participatory research, involved community groups at all levels – from research to management - it is still critical for a community radio station to evaluate community participation and its own functioning from a gender perspective.

At every stage, whether it is in terms of focus group discussions towards identifying programming topics, or constituting a management committee, a community radio station may set basic guidelines to ensure gender equity.

2.5.2 Culture and Identity

Globally, it is accepted that there is a strong link between culture, identity and the media. The UN Convention (of 2005) on the Protection and Promotion of the Diversity of Cultural Expression states that:

> *"Cultural diversity is strengthened by the free flow of ideas, and that it is nurtured by constant exchanges and interactions between cultures; freedom of thought, expression and information, as well as diversity of the media that enables cultural expressions to flourish within societies"*

One of the most under-explored areas with respect to a community radio station is the area of culture and identity. Both, culture and identity are terms which are often contested and reinterpreted constantly in various contexts. With India gaining independence in 1947, the priority of the national government at the centre was to build a national identity. Prime Minister Jawaharlal Nehru wanted to create a feeling of Indianness through various ways – including the setting up of the All India Radio and Doordarshan, which went a long way in showcasing the cultural, social and political identity of India as a whole. However, it must be acknowledged that India is a diverse country, with more than 25 states, and more than a hundred languages and dialects spoken all over the country. In terms of religion as well, India is one of the most diverse countries. Community radios can, therefore, play a great complimentary role in this direction.

India is also known for diverse landscapes, castes, food cultures, terrains and landscapes, political cultures and so on. At every level of societal formation, if there is one thing that is consistent in India, it is diversity and pluralism. There is hardly any community in India which is completely homogenous in terms of culture and identity. In this context, it is the responsibility of a community radio station to reflect the cultural diversity of its community and respect various identities of its people.

One of the primary tasks of a community radio station is to identify and map the cultures and identities of its communities. This can be done through a mapping of various religions, castes, languages and dialects spoken in the community which the radio station seeks to serve. After this initial layer of mapping, the radio station can add another layer of diversity in terms of cultural practices. Different religions and castes tend to have their own set of cultural practices. Another possible layer could be various practices associated with each culture – including festivals, rituals, folk tales, etc.

This kind of intensive mapping will reveal a wealth of information which is unrelated to the wider paradigm of social development, and is yet extremely relevant to the social fabric of any community.

Community radio stations can embark upon collecting oral histories and testimonies as a way of documenting the culture and identity of its community members. However, the purpose of their oral histories and testimonies should not be to keep these locked up, but to broadcast them and use them in such a way as to keep the culture and identity of a community alive through daily interaction and exchange.

Activity 2.1

List out 5 programme ideas for community radio stations, based on Right to Information, Gender Equality, and Promotion of Cultural Diversity.

To do this activity, you may need about 90 minutes.

2.6 Let Us Sum Up

As you have seen, the concept of community radio is towards serving the interests of the community in which it operates. To serve a community well, it is imperative for the community radio station to understand the social, political and cultural context in which it is operating, and further to be sensitive to this context in its day-to-day working. Further, community radio stations also have a responsibility to promote equality in gender relations and the diversity of cultural expressions within its community.

You have also seen how community radio can be contextualized to framework related to development for social change. Development for social change includes the right to freedom of speech and expression which can become an enabler towards other aspects of social change, including economic development, literacy and well-being, seeking justice and so on.

2.7 Model Answers to Activities

2.1 Please fill your ideas against the themes as given below:

Sl	Programme Ideas	Theme
1	A radio drama on a villager, who wants an information regarding the consumption of electricity in his village. He visits the office of the competent authority, but doesn't get the information. Finally, he gets the information through Right to Information Act, 2005.	Right to Information
2		Gender Equality
3		Promotion of Cultural Diversity.

UNIT 3

Community Radio: Policy Guidelines

Structure

3.1 Introduction

At the backdrop of what was discussed in the preceding two units, this unit will help you to understand the community radio policy of the Ministry of Information and Broadcasting, Government of India. We have focused on how the policy framework affects the technology of community radio as well as the programming and structure of community radio.

The Unit will also give you a sense of the community radio movement and how the current policy has evolved over the last decade to become what it is now. You will not need to do any hands-on work in this Unit, but it is recommended that you access select reading materials. You may need approximately seven hours to complete the Unit, including working on the three Activities given in Section 3.3.

3.2 Learning Outcomes

After going through this Unit, you will be able to:

- examine the basics of the community radio policy in India.
- explain how specific clauses in the community radio policy affects technology as well as content on community radio.
- discuss on how policy has evolved, and what further improvements can be made to the policy framework on community radio.

3.3 CR Policy Guidelines and Implications

This section will provide a broad explanation of the current community radio policy framework, how it has evolved over the years, and how policy framework has been shaping community radio sector in India.

3.3.1 Historical Background

You have already read in Unit 1 the brief history of radio broadcasting in India including the emergence of Public Service Broadcasting and Private Broadcasting. You have also been introduced to the concept and role of Community Radios and their present position in India. You will now read more about community radios in this Unit from the point of view of policy related to them. As mentioned in Unit 1, in 2002, after various civil society declarations, and multiple consultations with UN organizations and government agencies, Ministry of Information and Broadcasting announced policy guidelines for community radio. However, the community was defined and restricted to educational institutions only. However, this policy did not satisfy the vision articulated by many, and the pressure continued on the government to make the policy more accessible and friendly towards civil society groups. On November 16, 2006, the Ministry released a revised policy guideline which opened up community radio broadcasting to NGOs, educational institutions and agricultural institutions.

Early days of community radio in India

Even before Community Radios came up as a result of Government Policy, Community groups were beginning to use community radio in various parts of the country by different means. For example, women's collectives in Karnataka and Andhra Pradesh had started initiatives like Namma Dhwani and Sangam Radio, respectively. In Jharkhand, community groups were using the local All India Radio station to voice their concerns through an initiative called "Chala Ho Gaon Mein". In Uttarakhand, community groups calling themselves "Heval Vaani" and "Mandakini Ki Awaaz" were using WorldSpace satellite radio to express themselves. These groups were also now demanding that they be given licenses to broadcast on FM so that they need not depend on other media.

As a result of the various initiatives as indicated above there was serious evidence that community broadcasting (even if via AIR or WorldSpace) can bring about benefits to the marginalised communities. At the same time, community members were also vigorously advocating for an independent community radio platform. Government examined the various aspects of the issues and came up with a policy in 2002. However, this policy defined community as only educational institutions which were affiliated to State or Central governments. Under this policy, Anna University in Chennai city, became the first "community radio" station in the country in 2004. While this opening up of the airwaves to educational institutions was welcomed, community groups all over the country made it very clear that this was not community radio. According to them, Community Radio meant community ownership of the means of programme production, and until community groups could obtain a license from the government, the definition of community radio would always be incomplete.

In 2006, the government released an amended set of policy guidelines which opened up community radio to three broad sectors – educational institutions, non-profit organizations and agricultural institutions. The basic principles of this policy are as follows:

> *It should be explicitly constituted as a 'non-profit' organisation and should have a proven record of at least three years of service to the local community. The CRS to be operated by it should be designed to serve a specific well-defined local community.*
>
> *It should have an ownership and management structure that is reflective of the community that the CRS seeks to serve.*
>
> *Programmes for broadcast should be relevant to the educational, developmental, social and cultural needs of the community. It must be a*

Legal Entity i.e. it should be registered under the Registration of Societies Act or any other such Act relevant to the purpose.

Activity 3.1

Visit a public, a private and a community radio in your locality and try to compare the merits and demerits of all three categories of radio.

3.3.2 Policy related to Content

The policy guidelines contain advisories on content and technical issues related to community radio. This section will take a look at some of the content related advisories for community radio.

- From the policy guidelines given below, it may be seen that the content code is basically the same for all radio stations in the country except that the programme needs to be of relevance to the community:

  1) *The programmes should be of immediate relevance to the community. The emphasis should be on developmental, agricultural, health, educational, environmental, social welfare, community development and cultural programmes. The programming should reflect the special interests and needs of the local community.*
  2) *Atleast 50% of content shall be generated with the participation of the local community, for which the station has been set up.*
  3) *Programmes should preferably be in the local language and dialect(s).*
  4) *The Permission Holder shall have to adhere to the provisions of the Programme and Advertising Code as prescribed for All India Radio.*
  5) *The Permission Holder shall preserve all programmes broadcast by the CRS for three months from the date of broadcast.*
  6) *The Permission Holder shall not broadcast any programmes, which relate to news and current affairs and are otherwise political in nature.*

- Further, the content regulation section also states that there shall be nothing in the programme broadcast which:

  1) *Offends against good taste or decency;*
  2) *Contains criticism of friendly countries;*
  3) *Contains attack on religions or communities or visuals or words contemptuous of religious groups or which either promote or result in promoting communal discontent or disharmony;*

4) *Contains anything obscene, defamatory, deliberate, false and suggestive innuendoes and half truths;*
5) *Is likely to encourage or incite violence or contains anything against maintenance of law and order or which promote anti-national attitudes; contains anything amounting to contempt of court or anything affecting the integrity of the Nation;*
6) *Contains aspersions against the dignity of the President / Vice President and the Judiciary;*
7) *Criticises, maligns or slanders any individual in person or certain groups, segments of social, public and moral life of the country;*
8) *Encourages superstition or blind belief;*
9) *Denigrates women;*
10) *Denigrates children ;*
11) *May present/depict/suggest as desirable the use of drugs including alcohol, narcotics and tobacco or may stereotype, incite, vilify or perpetuate hatred against or attempt to demean any person or group on the basis of ethnicity, nationality, race, gender, sexual preference, religion, age or physical or mental disability.*

- The Permission Holder shall ensure that due care is taken with respect to religious programmes with a view to avoid:

1) Exploitation of religious susceptibilities; and
2) Committing offence to the religious views and beliefs of those belonging to a particular religion or religious denomination.

One of the major controversies that the policy has generated is related to the restrictions on broadcasting of news and current affairs on community radio. However, in practice it is informally understood that broadcast of any non-political information will not be penalized. The Government’s hesitation in allowing political programming on community radio is based on the fact that community radio stations can inflame passions by broadcasting wrong information or handling the situations insensitively.

Activity 3.2

What are the strengths and weaknesses of the policy related to content regulation. What changes would you make and why? Discuss in your own words in about 350 words.

To complete this activity, you may need about 90 minutes.

3.3.3 Policy related to Technical Parameters

Community radio operates in the FM (Frequency Modulation) band, and purely on technical terms, it is no different from those AIR stations and private radio stations that also operate on FM.

Earlier, All India Radio used to operate only in MW (Medium Wave)-AM (Amplitude Modulation) band of the spectrum. While, at this point, it may not be important to fully understand the technical difference between AM and FM bands it would suffice to know that FM band-2 in which FM broadcasting takes place in India, is between 87-108 MHz and Medium Wave (MW) band for broadcasting is between 562.5-1606.5 KHz. While various aspects of Radio Wave propagation would be discussed in detail in Module 2, it would be of interest to know that FM has many advantages over MW(AM). It is because of these advantages that it is increasingly being used by AIR in conjunction with MW for domestic broadcasting and has also been chosen for private and community broadcasting. These advantages are:

- High fidelity
- Stereophonic quality
- Uniform day and night coverage
- Freedom from noise
- Capture effect
- Saving in power requirements
- Value added services possible

Within the FM band, let us look at the technology related conditions that are stipulated in the policy guidelines:

> *CRS shall be expected to cover a range of 5-10 km. For this, a transmitter having maximum Effective Radiated Power (ERP) of 100 Watts would be adequate. However, where the applicant organisation is able to establish that it needs to serve a larger area or the terrain so warrants, higher transmitter wattage with maximum ERP upto 250 Watts can be considered on a case-to-case basis, subject to availability of frequency and such other clearances necessary from the Ministry of Communication & IT. Requests for higher transmitter power above 100 Watts and upto 250 Watts shall also be subject to approval by the Committee constituted under the Chairmanship of Secretary, Ministry of Information & Broadcasting.The maximum height of antenna permitted above the ground for the CRS shall not exceed 30 meters. However, minimum height of Antenna above ground should be at least 15 meters to prevent possibility of biological hazards of radiofrequency (RF) radiation. Universities, Deemed Universities and other educational institutions shall be permitted to locate their transmitters and antennae only within their main campuses. For NGOs and others, the transmitter and antenna shall be located within the geographical area of the community*

they seek to serve. The geographical area (including the names of villages / institution etc) should be clearly spelt out along with the location of the transmitter and antenna in the application form.

Activity 3.3

Log on to the internet and download the following documents. They are community radio policies of India and the neighbouring country Bangladesh.·

- Indian policy: **http://tinyurl.com/ozc8ccu**·
- Bangladesh policy: **http://tinyurl.com/nwxso8y**

Now, compare the two policy documents and list out the similarities and differences. Discuss the relative strengths and weaknesses of each policy document in terms of basic principles, content and technical regulation.

3.4 Let Us Sum Up

In this Unit, you have learnt the basic policy of Community Radios in India including the regulatory sections related to both content and technology. You now have a good idea of the basic principles governing community radio in India. You have also learnt what are the areas of programming that are allowed and what is not. Further, you have got a basic understanding of what kind of technology is allowed to operationalise community radio in India.

3.4 Model Answers to Activities

The information gathered in the activities presented in this module should be your own experiences. All the activities are hands-on activities.

UNIT 4

Technology for Community Radio: Guiding Principles

Structure

4.1 Introduction

In this Unit, we will discuss the core principles of community radio technology, including the key decisions that have to be taken by the CR technician responsible for setting up and managing the technological setup and process within a CRS.

The Unit will present a systematic set of decision points on the basis of which equipment must be selected by the CR technician. Such selection is to ensure the continued viability of the station by minimizing downtime and maximizing flexibility of operations.

4.2 Learning Outcomes

After completing this Unit, you will be able to:

- examine the availability of different types of technology for Community radio.
- differentiate between indigenous and imported equipment.
- explain the serviceability of these equipment.
- analyze the issues related to warranty and back-up.
- assess the cost factors involved in selecting appropriate technology for CRS.

4.3 CR Technology: The Basis of Selection

In the previous Units, you have already examined the philosophy and guiding principles of community radio, as well as some examples of community radio from around the world. You would also have understood the key components of the community radio guidelines that govern the establishment of CR in India. But how do all these impact the decisions we make regarding the technology and the equipment that we will use in the CR station? What must we keep in mind when we select equipment? How do we decide the technologies that will most suit our CR station and the community that will own, run and manage it?

In this section, we will examine the fundamental decisions we will have to make when we proceed to set up a CR station. We will understand how we must weigh different technological options available to us considering our needs and budget, and then, within that framework the basic principles for making a choice of technical equipment to be used at our station.

4.3.1 Technological Options

Selection of technology is an important step in the planning for any project, what to say of Community Radio Stations, which are low cost ventures. The very first aspect which has to be taken into consideration, while going for a technology, is whether it is a proven one or is only at a teething stage. Secondly, it has to be ensured that the chosen technology not only meets the requirements but is also suited to the environment in which it is to be used.

In the case of Community Radio, however, the choice of technology is not that far and wide taking into consideration the stipulations in the Government policy in respect of transmission mode and a very wide usage of certain type of technology on the programme production side. On the transmission side, it is already mandated that they would be on FM in Analog mode. Moreover, because of low permissible ERP, Community Radios broadcast mono and thus use only mono-compatible transmitters. As far as programme recording and production is concerned, the use of digital technologies and computer aided broadcasting setups have become universal. Digital Audio Workstations (DAWs), which are computer based systems designed to record, edit and playback audio, are thus being used by all the radio stations including Community Radios. Even for field recordings of audio and other events outside the studio environment, portable digital recorders are being used. As such the choice before a CRS planner boils down to the selection of equipment within the framework of technology.

4.3.2 The Importance of Robust and Low Cost Equipment

While we keep in mind the social and cultural impact of community radio, it is important to remember that radio is a technological medium: Everything that is going to be said or heard over radio passes through a series of technological steps that creates the scientific miracle of modern day broadcasting. Of course, this also means that if a single link in that chain fails, the entire process may come to a grinding halt!

It is true that modern digital technologies and the computerization in broadcasting has made this challenge less daunting. Computers now let us perform functions that in earlier times would have required several devices. You can now use a computer to record sound in a studio, as well as adjust the audio and edit it. But this can also, sometimes, cause problems. A few years ago, the failure of a specific component, meant replacing it with a new one. Today, the fact that a variety of functions are handled by a single computerized unit means that we will have to suspend all the activities on that unit while the problem is fixed.

Community Radio seeks to provide a voice to the voiceless and the marginalized, and lets communities to share information within themselves. In line with this philosophy, community radio stations are often located in areas that have lower media penetration, and where economically weaker communities may reside –

since these are precisely the areas and communities that are most in need of such a medium in order to express themselves. Often, as a result, CR stations operate in remote areas, in places where availability of electrical supply and repair facilities present a continuous challenge; and where exposure to disaster – floods, fires, landslides – may be a reality in the life of the people who live there. Simultaneously, CR is typically a low cost activity, often funded by community contributions, and managed and run by volunteers from the community.

So, here we have a practical challenge: not only do we have to select technologies and processes that cost less to purchase and maintain (since funds are scarce) but we also have to find technical equipment that are also inherently less prone to breakdowns, and which will continue to work under stressful climatic and usage conditions! Figure 4.1 illustrates the search for the elusive sweet spot between these two decision points.

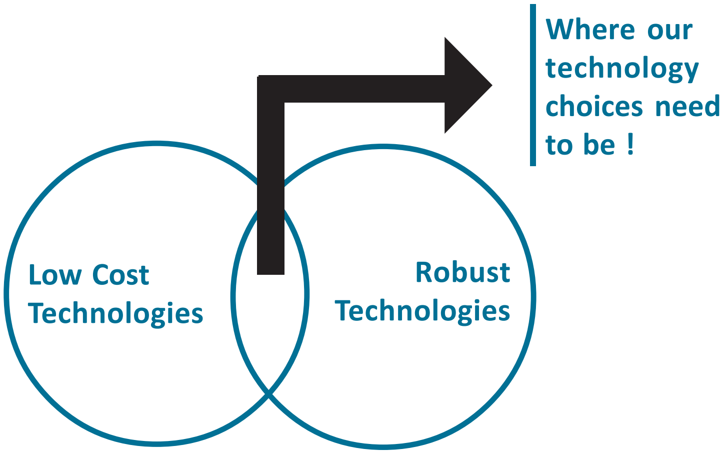

Figure 4.1: The twin challenges of robustness and cost

So, as you can see, the choice of technologies and equipment is critical to the process of community radio. It is for this reason that we will continuously examine and evaluate every piece of equipment and technological process on the basis of five key considerations:

a. The availability of any existing equipment, and that of space within the proposed station site for installation, along with that of electrical and civil infrastructure.
b. The kind of programmes that the station intends to produce and broadcast.
c. The funds at the station's disposal (for the initial investment, and recurring expenses).
d. The availability of trained maintenance manpower and/or repair facilities for the equipment.
e. The pros and cons of buying locally manufactured equipment versus imported equipment; and of selecting between authorized dealers and the unauthorized ("grey") market.

Let us now look at each of these considerations in some detail, so that we can understand the implications of each of these factors.

4.3.3 Current Availability of Equipment, Space and Infrastructure

The very first part of our decision-making process is to review the status of available equipment and space to set up our studios so that we can make optimum use of the available resources in terms of space and equipment. We also have to analyse possible equipment choices in terms of what is physically available in the market and what other stations are using for their setups. Asking around, and consulting resources on the internet – perhaps even conducting a few site visits to other stations may help to fix our ideas.

In other words, we have to start by asking ourselves:

a. Do we currently have any equipment that could be used for the CRS? (recorders, computers, furniture)

b. Do we currently have access to a space where we can set up transmitting, recording and editing spaces? (If yes, how much space is this, how do we want to utilize this and what is the minimum we can make do with)

c. What is everyone else using? Why? How much does it cost? Is any of it clearly redundant?

Hopefully, if you are careful and honest in asking yourself these questions, you will realize that there are items you can spare from other processes, or which could easily be donated for the CR process by friends and well-wishers (computers, for instance). You will also understand the reasons why other CR stations have acquired the equipment and setups that they have; where they made their purchases from, and how much it cost them. You can use this information to build an equipment and infrastructure wishlist.

At this stage, don't worry about how realistic your wishlist is. It is likely that you will have much more on that list than you will eventually be able to acquire. It will give you a place to start from in terms of continuing your assessment, and whittling down to a list that actually fits within your other plans and budgets. The important thing will be to have a clear list of items you require, with a clear understanding of their purpose within your setup – and the understanding is the critical part of this initial investigation. If we buy equipment A from this manufacturer, do we necessarily have to buy equipment B from the same manufacturer to ensure compatibility? What grade of cable did Station X buy, and how much better did it do than the one bought by station Z? Which one complained more about frequent cable replacement? Did Station Y buy this just because it looks good, or because it offered best value for money?

Similarly, it is best to assess possible space and infrastructural availability right away. Computerization has meant that large working spaces are no longer the norm for a radio station, with accessibility and placement within a community being of greater importance. But, if a lot of production work must go on at the same time when a studio recording is taking place, multiple editing and recording setups are vital. No matter how small, multiple computers will take up some space!

Again, if one expects to record a lot of folk music and local singers, a larger studio will be required, because local troupes often consist of several members. And if the programming hours are likely to be for several hours right from the start, then a second working space may be called for, as other production work cannot stop when the broadcast is happening. Additional construction and waterproofing work may also be called for if an existing structure is poorly built.

Needless to say, electrical infrastructure is also key to the whole process, and it is important to assess how much the electrical demands of our station is likely to be, both from the point of view of the raw consumption, and from the point of view of the costs we are likely to incur. This is intricately linked to our decisions regarding working flexibility (two studios are likely to result in a greater electrical load, as are multiple editing setups, for instance).

Assuming an electrical connection is available, and once we have assessed the basic load we are likely to place on this connection, it is important to assess whether electricity is available on a continuous basis or not. If not, we may have to provide for electrical backup system and depending on the type of system one selects, this may place additional consumption loads on the connection (in the case of inverters and UPS systems); or may require fuel and maintenance (direct generation systems); or large capital investments (for solar power systems or wind energy systems, for instance.)

Once you have this basic information organized, you can begin to think of some of the other factors outlined below, so that you can hone your list into a more workable and practical list.

Activity 4.1

Visit or speak to at least three community radio stations, and enquire about the field recording units that they are using. Find out the following details in each case:

1. What make and model are the units?
2. What media do their recorder units record on? (cassette, SD card, internal memory?)
3. Why did they select this make and model? (What are the key features that they like in it?)

4. What has their experience with the equipment been? (Have there been any failures or repairs? Would they buy something else if they could?)
5. Which dealer did they buy the recorders from? How did they identify this dealer?
6. What is the cost of the recorder unit(s)?

Create a table reflecting this information so that you can compare the recorder units.

4.3.4 The Station's Programme/Content Mix

At first glance, it may appear a bit confusing. Aren't we jumping too far ahead? Doesn't programme production come *after* we have everything in place? How could the programmes we intend to make possibly be related to the specific technological choices we make? As it happens, the two are linked in a very fundamental way.

Every CRS is unique in its choice of the kind of programming that it develops and broadcasts. Some stations depend totally on live studio situations, and prefer to broadcast directly from the studio or the field. Such stations tend to require less by way of equipment for recording and editing, since most of their programming does not need editing. It should be obvious that buying several computer workstations for the purposes of editing content would be pointless in such a situation.

Other stations may depend more on pre-developed ('pre-produced' or 'canned') programming, with fewer programmes going directly out of the studio as live programmes. Not having an adequate number of editing setups in such a situation would be equally counterproductive.

Similarly, some CRS setups may come up in communities where the availability of mobile phones is high. In such cases, making interactive programmes where the listeners can call in and participate in programmes, or leave feedback, becomes an important way for the station to connect to its audience. On the other hand, creating an elaborate infrastructure for live 'call-ins' becomes pointless if the local availability of mobile phones is low, and there is no one who could call in!

The first step, therefore, to deciding what kind of equipment to acquire is to assess the content that will be developed. Depending on the kind of content, we will then decide to invest in a greater proportion of field equipment or more editing systems (where we expect to do a larger proportion of pre-edited programming), or more telephone lines (where we expect to do more phone-in programmes), or even additional studio spaces (where we expect to do a lot of studio-based productions or live programming).

It is worth noting that this is not a one time process – content evolves over time, and may require changes in technical infrastructure to keep in step with changing realities. To continue our previous example, if the number of mobile phones within the station's listenership goes up over time, one must plan for the incorporation of systems that allow the station to connect with these listeners as mobile phones become more commonly available.

4.3.5 Budgetary and Cost Factors

Deciding how much you want to spend on the CRS's technology infrastructure is central to our decision-making process on CR technology. In some ways, it's like building a house. You can build a one room cottage, or a 20 room mansion, and both would be houses - though of very different kinds. So which one should you aim for?

The 20 room mansion always looks attractive – but are you really going to use the extra room? On the other hand, the one room cottage may be easy to build with the funds you have right now. But, you can't get over the feeling that you might run out of space soon. What a quandary!

As always, it helps to be systematic and rational while taking this call. To continue the house analogy that we used, the key is to deciding how much space you need to live right now and how much you can build right now with available funds. You can then plan for the space you will need in future, and plan your immediate construction in a way that lets you expand it as time and money allow in future.

One way to work this out where equipment for a CRS is concerned is to draw up a phased budget for equipment and studio infrastructure. Ask yourself these four questions:

a. How much money is available immediately from the funds in hand?
b. How much can we borrow or receive from somewhere for this purpose and is the rate at which we will have to return it reasonable?
c. How much do we expect to spend each year on repairs and maintenance?
d. How much can we dedicate each year for upgrades and new equipment/ infrastructure?

Answering these questions will give you clues to two parts of your phased budget: (a) and (b) will help you understand how much you can spend right now; and (b), (c) and (d) will let you plan your recurring costs – the costs that you will undertake on a monthly or annual basis as part of your station's running costs in order to expand and modify your technical setup. As a general rule, you might like to spend 15% less than what you have budgeted, so that you can make some funds available for related accessories, budget over-runs and fluctuations in prices.

At this point, a word of caution is in order. Many people tend to see the available budget as the only deciding factor in selecting technical equipment for a CRS. In some ways, this is true. It is a fact of life that we can only purchase something if we have the money to buy it with or can arrange for the money, in a way that allows us to pay it back from our income. But to look at affordability alone would be a mistake. Buying the lowest cost item often means ignoring factors like audio quality and robustness, both of which are vital considerations to small setups with limited means. Would you buy the cheapest motorcycle on the market if you also knew that it gave the least mileage, or if it had a reputation for breaking down twice a month? Of course not. You would choose the motorcycle that has the best reputation for toughness and fuel economy, even if it costs a little more. You would then decide the maximum you could spend without stretching yourself so far that you would be deep in debt, or could not afford other necessities in life. In short, your decision would be based on the **total cost of ownership**, rather than the up-front cost.

Decisions regarding technical equipment are decided on a similar basis: a **lifecycle cost** for each piece of equipment, rather than the basic cost. Audio recorder X may be available for half the price of recorder Y but may also fail thrice as fast, making it much more expensive to run across a period of time. Computer A may be cheaper than Computer Y, but may consume more electricity, making it costlier to run in the long run.

4.3.6 Serviceability and Maintenance Support

A key component of our decision-making will also be based on the twin concepts of serviceability and availability of maintenance support for the technical equipment we acquire.

By **serviceability**, we mean how easy is it to fix the equipment if something goes wrong with it? And by **maintenance support**, we mean are there qualified technicians and spare parts available easily nearby to help attend to issues with the equipment in our CRS?

Since many CR stations are likely to be in areas where equipment manufacturers are unlikely to have direct offices, these are very important considerations. Imagine a situation where our primary transmitter unit fails with the closest service centre three days away. It is unlikely for you to resume broadcasting within a week! Similarly, since many of the pieces of equipment you use may be imported, spare parts may be dependent on international shipping schedules – which may mean delays of weeks or months even with a service centre handy.

The ideal situation would be to use equipment that has service support directly from the manufacturer no more than a day’s journey away, and, where simple problems can be attended to easily by individuals within the CRS itself with basic tools and easy fixes. (This is not always possible, of course, but is a factor one must pay attention to while acquiring equipment.)

Thus, an equipment supplier willing to train team members in 'preventive maintenance' – regular maintenance that prevents equipment from suffering major failures – is always to be preferred to one who is merely willing to offer warranty coverage. Similarly, a supplier who offers on-site service at no cost to the station is preferable to those who offer 'carry-in' support. Finally, where warranties and guarantees are concerned, it must be obvious that equipment that carries longer duration coverage or one that covers all (or nearly all) parts is far better than one that offers partial/shorter period coverage.

A linked consideration, in case service support will be hard to come by, is the investment that may be required in training the CRS team members in key maintenance tasks; and in keeping relevant spares in stock.

Preventive maintenance and robust equipment go a long way towards sparing one the shocks of equipment failure and the consequent heartbreak of down-time. Adequate thinking on these counts could make the difference between a station which struggles everyday and one which makes the business of broadcast look as effortless as the process of listening to the radio.

Activity 4.2

Visit your local market or shopping centre and locate at least three radio and TV repair shops. Discuss the capabilities of the repair technicians at each shop and examine them on the following parameters. Try and score each capability on a scale of 1 to 10.

1. What kind of equipment and utilities can the shop handle repairs for?
2. Is the shop an authorized service centre for any brand or item? (8 points out of 10 for being an authorized centre for any brand; 9 for being authorized by two manufacturers; 10 points for more than that.)
3. Do the repair technicians there have any kind of formal training? (ITI, repair course, training from any branded company?) (7 points for ITI trained; 8 for a diploma from any well known course; 9 for a degree holder.)
4. If they see a new item which they have never handled before, how do they assess whether they can perform the repairs?
5. Are they willing to share the contact details of some customers, so that you can conduct a customer satisfaction check? (5 points if they share; one additional point for each good review.)

If they are willing to respond to point (5), call the individuals whose contact details you have received and ask for their feedback on the shop's performance.

Rank the shops in decreasing order of capability, as revealed by your total points.

4.3.7 Modularity and Redundancy

An additional important step to take while planning your CR setup is to plan your equipment in a manner that allows work to continue even if portions of the setup fail. We do this by planning systems and equipment which can perform dual roles, and which can be re-configured if necessary, to cut out the equipment that has failed.

Modularity

Within the course materials that you are being provided for this course of study, there are a number of individual 'modules', each covering a specific subject or sub-topic within the larger discussion of technology for CR. As time goes by, specific Units can be revised and updated to keep the course up-to-date. This is more effective in terms of time and effort than revising the whole course matter each time. In other words, the course has been planned in a modular fashion, allowing us to adjust and change individual parts with some flexibility.

In the same way, equipment and technology for CR can be modular at two levels:

a. The individual equipment unit itself could be manufactured in a modular fashion by the manufacturer, allowing one to upgrade sections of it easily to increase its capabilities or fix faulty parts.
b. Our equipment planning can be modular in nature, allowing us to restructure the way different parts of it are connected together in case equipment malfunctions or if we need to expand our setup in future.

The first aspect above, is important from the maintenance and service point of view, as seen in sub-section 4.3.6. If there are sections of the equipment which we can remove and replace with a new part easily, we will be able to get a longer working life out of the unit. From this point of view, you may like to consider assembled computer systems for your work, rather than branded systems. Branded systems often carry proprietary components that are hard to replace or upgrade; or replacing which may need warranties. Assembled systems, on the other hand, allow the flexibility of building a system with components that you can handpick without compromising and which can then be replaced individually for upgrades and repairs.

Planning your equipment setup in a modular fashion is equally important. If your entire setup is set in stone, and nothing can be moved without sacrificing essential functionality, chances are that your process could be crippled if any single part of its goes down. A modular setup allows you to avoid such an event. For example, you may have a computer that plays out your broadcast programming, and a playback unit that plays CDs or USB drives for pre-recorded programming. A good setup would be one where these components are connected through a patch panel, which allows you to bypass the computer if it fails, and play pre-recorded programming directly off a CD or DVD in an emergency.

Redundancy

By now, it should be clear that the more modular a piece of equipment, and the more modular your setup is as a whole, the easier it will be to manage and maintain your technical infrastructure. Which brings us to a related concept – redundancy. **Redundancy**, at its simplest, is to be able to have more than one unit of equipment performing the same function.

At one level, one could consider having as many units of a single item available as the budget and practicality allows, so that you are protected from the failure of one of those units. Thus, if you can afford it, it is always a good idea to have more than one field recorder available. This way, not only can recordings happen at different places simultaneously but it also means that we will never be threatened if any one recorder needs repair or servicing. (Of course, the practicality lies in balancing out the number of units against the budget and a realistic assessment of how many units could ever be needed simultaneously: If there are only two people in the team to conduct field recordings, it may not make very much sense to get 10 field recorders just to be safe!)

At the other level, there are often pieces of equipment which overlap in functionality. A computerized Digital Audio Workstation (or DAW) can be used for recording and editing audio and can also be used as a playback system to play programmes stored on its hard disk drive. Some digital field recorders also have functions where they may be used as a studio microphone to be connected directly to a DAW for recordings. When the need arises, the secondary functionality of such units could be used to fill in when a primary unit fails: the DAW for playback instead of a CD player, for instance.

If our planning for equipment setup can include such multi-functional units, this obviously allows us to mix-and-match our equipment more flexibly, which is a good thing. But it should be noted that this means the equipment needs to be purchased with these features in mind, which calls for a high degree of knowledge about each unit. It also calls for a certain nimbleness of mind, that allows us to see the possibilities for re-deploying a specific unit for a different purpose. Hopefully, after completing this course, you will have both, the knowledge and the insight, to be able to do this successfully!

4.3.8 Indigenous or Imported? Authorized Dealer or Grey Market?

If you have successfully negotiated your way through selecting the complement of equipment that you need to acquire, it is time to start thinking about where you will make these purchases from, and considerations linked to this decision.

Choosing between locally manufactured and imported equipment

One of the things that a technician working for a CRS has to face continuously is the lack of options with regard to equipment manufacturers for radio. Most manufacturers who make high quality audio equipment are based in the developed world, which means most of the equipment is imported. This means duties and excise charges make equipment very expensive. It also means that repair and maintenance facilities for such equipment may be hard to come by. And this sometimes skews the process of equipment selection.

In some ways, this process has actually become more difficult over the last decade or so. As import procedures and regimes have been eased steadily over the last two decades, and many manufacturers have set up local sales and service offices to support their products, the availability of equipment and brands has certainly gone up. But this has not always translated into efficient after-sales service.

This situation poses a challenge when we source equipment for a CR station, since the larger part of the available equipment is still manufactured abroad. Good quality equipment does not always mean good after-sales service. Can we choose the best equipment for the task, when we know our investment may be doomed if the equipment fails?

A good rule to follow in this case, is to not go by the raw specifications and quality of the equipment, but by its reputation in local conditions. It may be imported, and service may be hard to come by; but some pieces of equipment acquire a good reputation in local conditions and reveal themselves to be hardy and robust when exposed to dust and moist conditions, as are often found in India. In the interests of affording the equipment with the greatest number of features and possibly the highest possible quality for the price, a certain amount of risk may be inevitable during the selection process. Preventive maintenance and a handling protocol that can be taught to individuals handling the equipment – including simple things like cleanliness and checklists for equipment accessories – can go a long way towards mitigating some of these risks and giving years of trouble-free usage.

Alternatively, if you do not wish to risk anything at all, and cannot do without assured repair facilities - all other things being equal - always select the equipment that can be repaired without too much effort.

Activity 4.3

Locate the closest authorized dealer to your location for the following audio equipment brands:

1. Sennheiser
2. Sony
3. Tascam

Note the contact details for each, and contact each of them to note the following pieces of information:

1. Ordering procedure (Do they need a purchase order? Do they need payment in advance? What is the anticipated delivery time once an order is placed?)
2. Payment mechanism (Do they need 100% payment in advance? Will they accept payment on delivery? How will they accept payment – cheque, demand draft, bank transfer?)
3. What service support and standard warranties do they offer on their equipment?

4.4 More on Maintenance and Servicing

In the previous section, we have seen some of the things we must keep in mind when selecting the technical equipment that we will use in our CRS. One of the important considerations, as discussed in Section 4.3.6, is the vital role of service and maintenance backup in keeping the technology humming smoothly.

As you must have already understood, the larger question of adequate service and maintenance support is linked to issues like buying equipment from authorized dealers, and of decisions related to selecting between imported and locally made equipment. Of these, two considerations require special attention from any person tasked with handling the technology in a CRS: Warranties and Annual Maintenance Contracts; and the importance of backups and fail-safes.

4.4.1 Warranties

When a manufacturer sells you a piece of equipment, they usually promise to correct manufacturing defects or other faults in the equipment for a specified period of time from the date of sale. This promise is called a **warranty**.

Warranties may be as short as a couple of months, or as long as 5 or 10 years. The most common durations are 1 to 2 years. For most audio equipment, warranties are limited to 6 months.

Warranties may be **limited** in which case only specific components or faults may be covered; or **comprehensive** which means anything which could go wrong will be covered and rectified. Similarly, they may promise **onsite service** which means you can call the manufacturer or service agent if a fault arises, and they will come to where the equipment is installed at their cost to fix it; or offer **carry-in service** which means you must take the equipment to the nearest service centre yourself.

An important thing to remember is that warranties are only applicable if there is proof of the date of sale. This means you must always get a bill from the supplier when you buy equipment, so that this provides proof of the start date for the warranty. Some manufacturers require that the warranty card enclosed with the equipment be completed and returned to them with the dealer's stamp. Others may require you to register the details of your purchase over the internet. Enquire about this at the time of purchase, and keep the bills and warranty cards in safe custody.

4.4.2 Annual Maintenance Contracts (AMCs)

Many equipment suppliers and service agencies offer a contract under which they charge a flat annual fee that covers any and all faults and repairs that may arise in a piece of equipment, or an equipment setup as a whole. The amount charged under this contract is calculated on the basis of the likelihood of a fault arising, and the travel and time they would have to invest to fix problems that arise. The amount is charged irrespective of whether a fault arises or not, and is usually payable in advance for the period of coverage. Such contracts are called annual maintenance contracts, or AMCs.

AMCs, it must be noted, only promise to keep the equipment in good running orders. They don't necessarily promise that any parts that may need replacement will be replaced with original spare parts made by the original manufacturer. So use your judgment before entering into such an arrangement with anybody.

Another thing to remember is that AMCs should only be considered once the basic warranty offered by the manufacturer is over; otherwise the AMC is just a waste of money on repairs that would have been carried out for free anyway.

AMCs are usually a good idea for equipment that undergoes a lot of wear and tear, like battery-based power inverters, or Uninterruptible Power Supply (UPS) units, or air conditioner units. The parts in these units are reasonably standardised and there are usually service agents in most places who can offer AMC services for these items.

AMCs for audio equipment are rare, and it would be wise to check what items and faults are covered by the AMC if such an arrangement is offered. Often, turnkey service providers who set up whole studios offer AMC arrangements on request. Sometimes, manufacturers provide a kind of AMC arrangement directly from the company. You pay a flat fee on an annual basis for an 'extended warranty' arrangement, where the company offers to fix faults for a period beyond the original warranty period.

Always check on the background of the person or organization offering the AMC, to ensure that it is has a good history of providing quality service. Talk to existing clients of the agency to verify whether their experience has been good. Extended care or extended warranty plans from the manufacturer, though often expensive, may assure you of original parts and technicians who know the equipment well – so keep that in mind.

4.4.3 Back-ups and Fail-safes

In Section 4.3.7, we have already seen the importance of redundancy in equipment, as a method to protect your CRS from failure of equipment. A related concept is the maintenance of backups, and the creation of procedures to fail-safe your technical processes and equipment.

Back-ups can be of two types:

a. Backups for data and content creation; and
b. Backups for essential infrastructure

Content and data backups

We must not forget that the key output of a community radio station is the content and programming that it creates. When we produce programmes and broadcast them, we should also provide for mechanisms to keep the produced programmes safe. This includes both pre-recorded programmes, as well as live programmes.

Since most CR stations today use modern digital equipment, where audio is stored as files on computers, it is a good idea to create a regular system by which these files are copied onto an external device or medium as well. A usual practice is to maintain one set of the recordings and programmes on one of the working computer systems in the CRS; and to have a backup on an external hard disk drive, which is attached to the primary computer system on a daily or weekly basis in order to copy the recently created programming and recordings. Some CR stations backup their produced programmes on DVD or CD media as well. This way, if a computer fails (‘crashes’) or recordings are mistakenly erased from the main systems, there is always a spare copy of the recordings and programmes that you can retrieve from. (Imagine doing an interview with the Prime Minister, and finding that you erased it by mistake!)

Content and programming backup is also important from the point of view of the community radio policy, which mandates that every CRS should preserve the programming broadcast over the previous 90 days. This is mandated so that if there is a complaint received from a listener regarding objectionable content, the programming can be produced before the appropriate authorities for a decision. This makes the continuous and systematic backup of programming doubly important, because the CRS can be penalised for not being able to produce the programme in question.

But don't make the mistake of assuming only the programmes and recordings need to be backed up: CR stations also store a lot of essential data connected with their programmes. This could include listener data, programme ideas, scripts, volunteer records, financial data, and reports to donors. All of this also needs to be backed up regularly, as losing any of it could be disastrous.

Backups for essential infrastructure

Of all the key backups we need from an infrastructural point of view, the most important of all is the provision for electrical backup. Continuous supply of electricity remains a challenge in many parts of the country and even a moment's loss of electricity for a radio station can mean an abrupt halt in the middle of a broadcast.

CR stations therefore provide for power failures by installing inverters and UPS systems, both of which use batteries to store electricity, and release it when the power gets cut off. Some have additional backup by also installing direct generation systems (DG sets or generators), which run on diesel, petrol or kerosene, and use a motor to generate electricity. In this way, the stations assures itself of having a continuous supply of electricity throughout any kind of interruption which is very important in times of natural disasters, because radio stations often act as information lifelines during emergencies.

Other kinds of infrastructural backup could involve the development of spare studio spaces; or the availability of secondary telephone or internet connections – a wireless internet connection to back up a wired DSL internet connection, for example. A key backup concept could also be the creation of a pool of volunteers or team members within the CRS who can conduct simple repairs and essential maintenance, to avoid dependence on the availability of external assistance.

Activity 4.4

Visit or speak to at least three community radio stations, and enquire about the electrical backup systems they are using. Find out the following details in each case:

1. What systems are they using currently? (Inverters, UPSs, DG sets, or all three?)
2. Why did they feel the need to install these systems, and how much power backup do they need in a day?

3. What are the challenges they notice for the system(s) they are using?
4. What did the basic setup cost them (raw equipment cost), and what are the recurring costs (replacement of batteries, fuel)?

Draw up a table reflecting the relative merits and demerits of each of these types of electrical backup systems.

4.5 Let Us Sum Up

In this Unit, we examined the important principles that we must keep in mind while deciding the technological and equipment setup for a CRS. Our decision must revolve around the twin concepts of low cost and robustness. While deciding what kind of technical equipment to acquire, we need to take into consideration a variety of factors, ranging from what is already available to the station, to the kind of programmes the station intends to make; the funds that can be raised; the availability of service and maintenance facilities and technicians; how modular the systems are; and how much redundancy we can build into our selection of equipment. Choosing between locally manufactured and imported equipment; and authorized and grey market suppliers are also important decision-making points.

Special attention also needs to be given to service and maintenance related concepts like warranties and AMCs, as well as extended warranty processes offered by manufacturers. Most importantly, CR stations must plan for adequate safety of their content, programming and data; as well as the availability of key infrastructure backups like electrical power and technical manpower.

4.6 Model Answers to Activities

The information gathered in the activities presented in this module are best presented in the form of tables. This will allow you to compare your results easily. In each case, a sample is filled in for you to see how you can complete each table.

Activity 4.1

Sl. No	CRS Name/ Make	Unit Name	Storage	Cost	Dealer	Reason for selection/ remarks
1.	Radio Awaaz	Zoom H-2	SD Card (Upto 4 GB)	Rs.13500	Rivera Digitec Pvt. Ltd. 409, Nirman Kendra Off. Dr. Edwin Moses Road, Mumbai 400011, India Tel: (91) 22-24939051 Fax: (91) 22-56604461 E-mail: rivera@bom3.vsnl.net.in (Contact person: Mr.Subhash Khandelwal, Mobile: 09820075805)	- Recommended by other CR stations when eqnuiries were made - Uses regular AA cells - Easy to use - Accepts external microphones - High quality recording at moderate price

Activity 4.2

Sl. No.	Name of Shop	Can Repair	Authorized Service for	Formal Training	Assessment of Capacity	Customer Review	Overall Points
1.	Sarvesh Radio	Radio sets TVs Amplifiers & audio equipment (6 /10)	Philips (8 /10)	Yes / ITI trained electronics repair technicians (7 /10)	Methodical approach to repair. Informs customer about costs before undertaking repair. Willing to learn new technologies, have a plan for updating skills (8 /10)	2 reviews Good, some times slow in response. Excellent and dependable (7 /10)	36 /50

Activity 4.3

Sl. No	Brand	Authorized Dealer/ Service	Order Process	Payment Terms	Standard Warranties & Coverage
1.	Tascam	Setron India Private Limited E-2, Greater Kailash Enclave -1, N. Delhi-110048 Tel: +91-11-26242250, 26241150/601 Fax: +91-11-26242150 E-Mail: sales@setronindia.com (Sales + Service)	Purchase order along with advance payment (hard copy required) Delivery within 15 days of receipt of order by courier	100% advance by DD/Cheque/ Bank Transfer Shipping cost extra (enquire before placing order for quotation)	All equipment warranties as per manufacturer Standard warranties are 1 year Extended warranty available for specific items: Request for quotation where available

Activity 4.4

Sl. No	Type of power backup	Pros	Cons
1.	Generator (DG set)	Power capacity high Relatively low maintenance on a day-to-day basis Usable for extended hours Stable power source	Fuel costs high High initial cost Stocking fuel cumbersome Servicing a challenge Cannot be used indoors Larger capacity units will need a lot of space Sometimes noisy + exhaust

Additional Readings

- UNESCO (2001). *Community Radio Handbook*. Retrieve from http://www.unesco.org/webworld/publications/community_radio_handbook.pdf
- Tabing, L. (2002). *How to do community radio: a primer for community radio operators.* UNESCO. Retrieve from http://unesdoc.unesco.org/images/0013/001342/134208e.pdf.
- Pavarala, V. and Malik, K. (2007). *Other Voices: The Struggle for Community Radio in India*. Sage Publications

Glossary

AM Radio:	Amplitude Modulation.
AMC:	Annual Maintenance Contract. A contract with a repair agency or the original supplier whereby the agency providing the AMC offers to fix all faults that crop up and keep the equipment in running order for a flat annual fee payable irrespective of whether service is actually required or not.
Authorized dealer:	A dealer or supplier of equipment permitted officially by the manufacturer to supply their equipment.
Backup:	An alternative or safety measure. Used as a term with reference to power supply (meaning inverters, generators, etc.); spare equipment (a second field recorder, say); data (an additional copy of a programme or recording, say); or an alternative plan.
Budget:	The allocated amount of funds available for a particular purpose or purchase.
Community broadcasting:	Broadcasting, which is owned by communities, and also operated by the very communities it seeks to serve. While community radio stations advance public good and public interest, their scope is usually limited to their communities defined either by geography or communities of specific interests.
Effective Radiated Power (ERP):	ERP is a calculated measurement that takes into account the peak output of a transmitter. For example, a transmitter of 50 Watt power can have an ERP of 100 Watts.
Extended warranty:	An optional extension to the original warranty period, usually at additional cost to the buyer.
Fail-safe:	A secondary or alternate plan, or device or process, in case the primary device or plan fails.
FM Radio:	Frequency Modulation.
Gender equity:	A concept based on UN Declaration of Human Rights that believes that all genders should be treated equally both in legal and social institutions irrespective of their race, ethnicity, language, degree of ability and income etc.
Grey market:	The unauthorized market for equipment, where equipment is usually available through channels that bypass official customs duties and taxes.

Imported equipment:	Equipment that has been manufactured in a foreign country and brought into the country of use.
Indian Telegraph Act:	A law that governs the use of telegraphy, phones, communication, radio, telex and fax in India. It gives the Government of India exclusive privileges of establishing, maintaining and working telegraphs.
Indigenous manufacture:	Manufacture of an item within the country of use.
Low cost equipment:	Equipment that costs less to purchase than other comparable units.
Maintenance support:	Availability of technicians to fix problems and keep equipment in good running order.
Modularity:	A measure of how a process or equipment setup has been arranged, such that portions or sections can be changed without affecting the rest of the structure.
Narrowcasting:	It is a process which involves playback of programmes through loudspeakers, or audio cassettes or any other such medium for a controlled group of people who can then discuss and give feedback on the programmes immediately.
Non-profit organisation:	Usually an NGO that uses its surplus revenues to achieve its goals rather than looking it as profit for distribution as dividend.
Participatory research:	Research that includes the active involvement of the subjects of research. It involves a systematic inquiry, with the collaboration of those affected by an issue under study.
Private radio broadcasting:	Broadcasting, which is owned by private individuals or companies. Programming may be influenced by the owners, and usually are decided on a commercial basis.
Programme & content mix:	The proportion of various types of issues and programme formats in a radio station's broadcast.
Public service broadcasting:	Broadcasting, which is funded by public money, works on an autonomous basis and independent of the government, and works towards advancing public interest and public good.
Redundancy:	The concept of building in safety margins or alternate processes or equipment into a setup, such that the functions of one unit can be taken over by another in case of emergency or failure.
Robust:	(Equipment) Tough, hardy, able to withstand difficult conditions.

Serviceability:	The ease of obtaining repair and maintenance support (for equipment).
Social change:	Alteration in the social order of a society including change in social institutions, social behaviour and social relations. Social change is a dynamic concept as against development which suggests that a society has reached a goal.
State List:	It is a list of items on which the State governments can take decisions. Examples include law and order, agriculture, prisons, public health etc. A concurrent list is also provided for in the federal nature of the Indian Constitution under which both Central and State governments can take decisions. For example, education.
Union List:	It is a list of items on which only the Central government can take decisions. Examples include defence, communications, citizenship, railways, banking etc.
Volunteer:	In the context of community radio, these are usually members of the community who work with the community radio. Across the world, there are volunteers who work on paid and non-paid basis. Some volunteers work on technical aspects, while others work on programming, or capacity building, marketing and so on.
Warranty:	A written guarantee, issued to the purchaser of an article by its manufacturer, promising to repair or replace it if necessary within a specific period. Usually applies if the fault can be shown to be a manufacturing defect.
Women's collectives:	Self-help groups of women, who come together, save small sums of money and help each other out in order to improve the quality of life.

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Certificate in Community Radio Technology

Setting up of CRS

2

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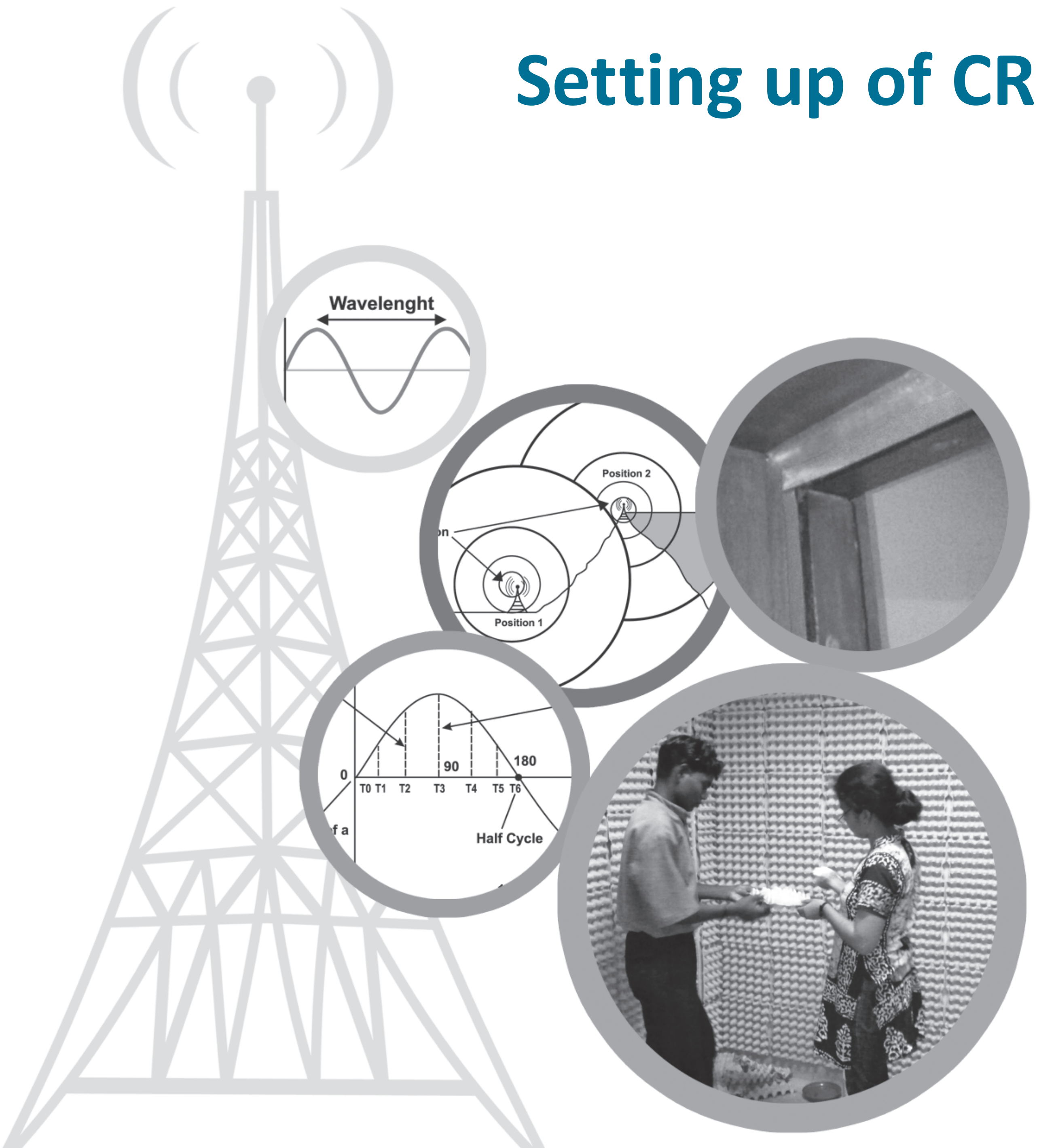
Module: 2

Setting up of CRS



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Certificate in Community Radio Technology

Courses	Modules	Units
Course I: Understanding Community Radio (3 Credits, 90 Hours)	**Module 1** Community Radio: An Introduction	**Unit 1 :** Community Radio: Concept and Evolution **Unit 2:** Context, Access and Equity **Unit 3:** Community Radio: Policy Guidelines **Unit 4:** Technology for CR: Guiding Principles
	Module 2 Setting up of CRS	**Unit 5:** Components of CR Station **Unit 6:** Radio Waves and Spectrum **Unit 7:** Basics of Electricity **Unit 8:** Power Backup and Voltage Stabilisation
Course II: Community Radio Production: System & Technology (5 Credits, 150 Hours)	**Module 3** Studio Technology	**Unit 9:** Basics of Sound **Unit 10:** Analog and Digital Audio **Unit 11:** Components of the Audio Chain **Unit 12:** Studio Acoustics
	Module 4 Audio Production	**Unit 13:** Audio Hardware and Field Recording **Unit 14:** Free and Open Source Software **Unit 15:** Telephony for Radio
	Module 5 Audio Post Production	**Unit 16:** Sound Recording and Editing **Unit 17:** Mixing and Mastering **Unit 18:** File Formats and Compression **Unit 19:** Storing and Retrieval
	Module 6 Studio Operations	**Unit 20:** Good Engineering Practices for Studio Setup **Unit 21:** Studio Equipment: Preventive & Corrective Maintenance **Unit 22:** Content Distribution: Alternative Mechanisms
Course III: Community Radio Transmission: System & Technology (2 Credits, 60 Hrs)	**Module 7** Radio Transmission Technology	**Unit 23:** Components of Transmission Chain **Unit 24:** Components of FM Transmitter **Unit 25:** Antenna and Coaxial Cable **Unit 26:** Propagation and Coverage
	Module 8 FM Transmitter Setup	**Unit 27:** Transmitter Setup: Step-by-step **Unit 28:** Transmission System-Preventive and Corrective Maintenance **Unit 29:** Transmission Setup-Good Engineering Practices
Course IV: Technical Internship (2 Credits, 60 Hrs)	**Module 9** Practical Internship Handbook	**Section A:** Introduction **Section B:** Activities to be Conducted During the Practical Internship **Section C:** The Internship Journal and Self-Assessment Paper **Section D:** Assessment of Internship **Section E:** Appendices

Videos in the Module:

1. **Components of a CR Station**
   by Hemant Babu
2. **Power Backup for CRS**
   by Hemant Babu
3. **Introduction to Radio Waves**
   by Vasuki Belavadi

1. http://tinyurl.com/ogqhsmf
2. http://tinyurl.com/pdqcrgt
3. http://tinyurl.com/p5kykyc

CONTENTS

CONTENTS

About the Module

In the previous module, you would have got not only an introduction to the concept of community radio, but also an idea about some of the guiding principles behind community radio, the basic technology in community radio, how community radio can be used in the context of gender and equity and so on. Now that you have put that behind you, the first step in becoming a technician for community radio is to start thinking about how to set up a community radio. This module gets you started on setting up a community radio, and the basic things you must know before beginning. This module has four units which will provide you with basic knowledge related to setting up of a community radio station.

The components of a CR station are meant for you to understand the basic building blocks of what constitutes a radio station. However, some of the components are explored in-depth in the later modules.

The Unit on radio waves and spectrum will be important for you to get an analytical understanding of the underlying technology of radio. While you may not get an opportunity to put this knowledge to use on a day-to-day basis, you will find this useful in understanding radio at a fundamental level. Remember that competent technicians don’t just solve problems, but they know why those problems occur as well!

The Unit on basics of electricity is geared to give you a theoretical understanding of how electricity works. While working as a technician in community radio, it very well may be the case that you will be asked to solve issues which have to deal with power supply or in other words, electricity. Often there are issues like excessive voltage, uneven supply (i.e. dips or surges) of power, frequent power cuts and so on. If you have a good understanding of the concepts behind electricity, then it will equip you to come up with the best solution given the context of a particular community radio.

The last Unit is related to power backup and voltage stabilisation. As noted above, this is a problem which occurs frequently in most rural community radio stations. Choosing the right power backup or voltage stabilisation solution can be a complex task and requires a sound knowledge of how backup and stabilisation can be configured in the context of underlying principles as well as available resources at your disposal. Interestingly the Unit also mentions various alternative energy sources which could be used for power backup. Not only will this knowledge help you to propose environmentally friendly solutions but it could also be an economically viable solution in the long term!

Module Objectives

- Familiarity with processes and principles involved in setting up a community radio station
- Understanding of the technology behind radio waves and electromagnetic spectrum
- Familiarity with solutions related to power backup and stabilisation of voltage

Units in the Module

- Components of a CR Station
- Radio Waves and Spectrum
- Basics of Electricity
- Power Backup and Voltage Stabilisation

UNIT 5

Components of a CR Station

Structure

5.1 Introduction

By now, you have already received a broad grounding in the philosophy of community radio, as well as an understanding of the essential decision points according to which we select equipment and technology for a CR station.

This Unit will now discuss the various components of a CRS station, and will provide an overview of how these components are related to each other. It will discuss the key points we need to keep in mind while deciding on a site for the CRS; as well as when we setup the studio and production spaces. Through these discussions, this Unit will provide a broad introduction to the CRS as a whole, details of which you will study in further Units. You may require approximately 40 hours to complete this Unit.

5.2 Learning Outcomes

After working through this Unit, you will be able to:

- discuss various components of a CRS;
- describe the issues related to appropriate space and site selection for a CRS;
- describe how to plan the utilization of the available space for the various tasks in a CRS;
- describe the preparatory work in a studio, including acoustic treatment, soundproofing and related arrangements;
- explain the broad interactions between various technical components of a CRS.

5.3 The CR Station: Siting and Space Definition

Having understood the philosophy of community radio and the criteria for selection of equipment, it is now time to understand the first steps in actually setting up a CRS i.e. finding a relevant location, and dividing the available space into studio and working spaces.

5.3.1 Site selection

One of the most important decisions we have to take for the setting up of a CRS, from a social purpose point of view as well as a technological point of view, is where to locate it. This process is called **site selection**, or **siting**, and is based on a number of critical considerations. Let us look at some of the criteria we need to keep in mind:

The physical location and distribution of the served community

The core of a community radio station is its listener community, by which we mean the core group of listeners whose information needs the station will serve, and for whom it will provide a platform for expression. Given this, it is important that the station should be in a place where these community members can access it easily, and participate regularly in programme creation. In short, the station should be accessible to every member of the local community, young or old, man or woman, physically sound or differently abled. This is why the Community Radio Guidelines (2006), which lay out the regulations governing CR in India, also make it mandatory to establish the CRS within the geographical area where its potential listener community resides.

We can achieve this by first mapping where the potential listeners of the CRS stay, work and live. Once we have a clear picture of this, we must try to locate the CRS as centrally within this area as possible, so that it is roughly equidistant for all the people who live around it.

Simultaneously, we must also try to situate it in a building or space that is already familiar to the community members, and which they are likely to pass during their daily routine: near the village panchayat, say, or a community centre (if there is one). Some CR stations are set up near key crossroads within the locality, or near market places. Note that this can be a challenge where community residential spaces are clustered by caste or profession: many Indian villages are divided into caste–based and ethnicity–based sectors. It is best to place the CRS in a neutral space, where everyone can be encouraged to participate without hesitation. In keeping with our philosophy of community ownership, the station should be housed in a community donated or provided building. This way, it will become an intrinsic part of the community's life from the outset. It will also avoid the nuisance value – not to mention financial burden–of paying rent, and being subject to the whims and fancies of a landlord. This is especially important from the point of view of transmission licensing, which locks down your transmitter location to a given physical location for the duration of the license.

Local geography and terrain

The second most important criterion to keep in mind is the physical layout of the land: whether it is totally flat, undulating, or whether it has a slope or a depression anywhere.

This is important because the propagation of FM, the radio transmission technology used for community radio broadcasting, is **line of sight**. This means the transmission can only be heard when the radio receiver set can electronically 'see' the transmission antenna, with no or few obstacles. This means we must choose a location for the station (and by extension, the antenna and the mast/ tower it is mounted on) which is not surrounded by tall buildings, or hidden by a hill or mountain – or situated inside a depression in the local landscape. Such obstacles will block the signal and result in no-reception ("shadow") zones within the transmission area.

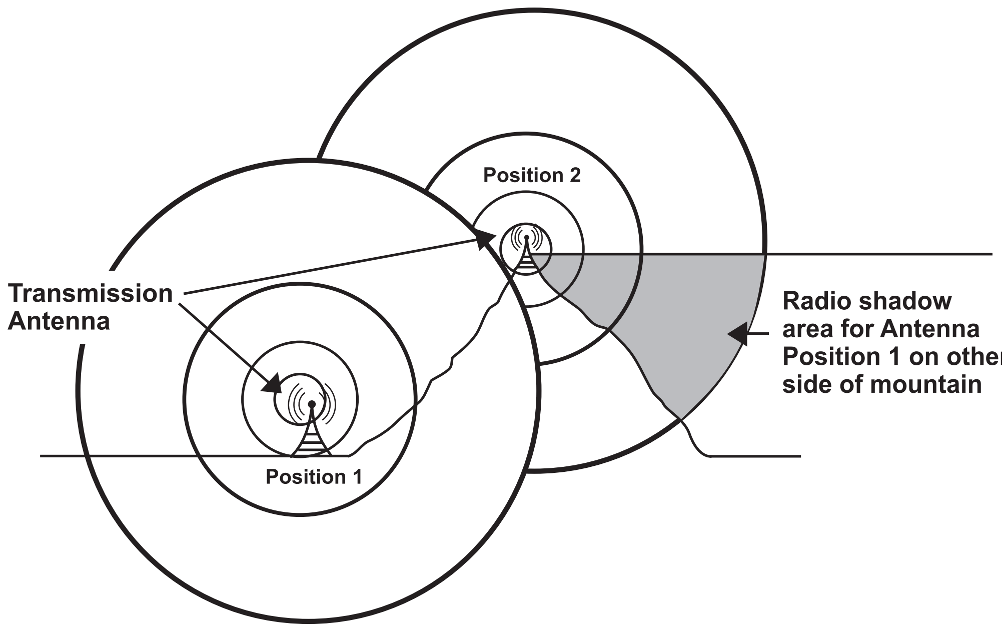


Figure 5.1: *Radio shadow zone caused by a mountain situated near the CRS.*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/UNESCO, 2008*

Of course, this does not mean that we cannot use this phenomenon to our advantage on occasion: CR stations, by design and purpose, are low-output power stations, meant to reach comparatively small areas. But if our community happens to reside in a hilly or mountainous area, setting the CRS on the slope, or at the tallest accessible point in the area may well give it additional range. Just as standing on a hill gives you a vantage point for a commanding view of the surrounding area, such a site could increase your effective range, and reach a larger audience. Such considerations must not, of course, over-ride our primary consideration of accessibility and community participation – so don't go locating the CRS at a place only a mountaineer or rock climber could access! Moreover, mounting the antenna at a height greater than 30M from the average terrain of the geographical community may pose problems in getting the technical clearance from the authorities.

Local noise levels

Even while we try to locate the CRS in an accessible place, as close to community life as possible, we have to try and keep ambient noise levels low. By 'ambient noise', we mean the general noise levels in the area. Good recording quality is dependent on having minimum background sound, unless we are trying to create a feel of the area and context. If the ambient noise levels are high, we will have to invest more effort and resources in blocking the external sound from reaching the studio. (This is called "sound proofing" the studio.) On the other hand, if we can find a site that is accessible but where the ambient noise levels are low, we will need to do comparatively little to make the studio spaces suitable for recording audio.

Transmission signal strength

Transmission signal strength is a measure of how powerful the Effective Radiated Power (ERP) of the transmission system is. Just as a brighter bulb illuminates a larger area, a transmission system of higher output power can reach a larger area with the signal it transmits. Another factor that affects the signal strength is the effective height of the antenna above the average terrain (EHAAT). At a purely theoretical level, some areas could benefit by an increase in EHAAT, which could overcome physical barriers or geographical factors to some extent.

At a practical level, though, the transmission strength for a CRS is limited to 100 Watts of Effective Radiated Power (ERP) by the Community Radio Guidelines (2006) issued by the Govt of India. So we cannot increase the strength of our signal output in order to reach a greater area. However, the policy guidelines do allow for increase in ERP of up to 250 Watts in special cases such as if the community is sparsely distributed in the region surrounding the proposed site; there are challenges related to broadcasting in hilly or heavily obstructed terrain. In case these conditions exist, it is possible that the station could be allowed a higher transmission output.

The trade off between siting criteria

While it is important to keep the four factors we have discussed above in mind, we must also be realistic in understanding that we will rarely find an ideal site that meets all these requirements at the same time. You will have to trade off all these factors against each other, and take a decision that is in the best interests and purpose of the station. Very often, you will find that the decision is only partly in your hands, since the decision may eventually have to be taken on the basis of pure convenience and the availability of adequate space. So keep these criteria in mind to the extent possible when weighing options against each other.

5.3.2 Space allocation

Now that we have selected a suitable site for our CRS, it is time to examine how we will divide up the space that we have into suitable work spaces. Again, it is wise to remember that CR stations often work with community donated spaces, and often without the resources to put up a building from scratch. So it requires a bit of ingenuity to adapt the ideas in this section into feasible plans.

Broadly, there are three types of spaces that a CR station needs besides the transmission set up:

a. A broadcast studio (often also called the ‘live’ studio)

b. A production studio (often also called a ’recording’ studio)

c. An office and administrative space

Let us look at these three spaces in detail.

The **Broadcast studio** is the primary studio space for the station. This is where the broadcast is managed from, and where the announcer or programme compere sits during the broadcast to make announcements. It is often referred to as the ‘live’ studio, because the audio from the studio floor can be played out directly over the transmission system.

The **Production studio** or the recording studio is the space where recordings are done for programmes that will later be edited and finished. The production studio is usually equipped with a sound booth or a recording floor where audio can be recorded in carefully controlled conditions.

The **Office space or administrative area** is the place where the volunteers and CRS team members can sit and work on production-related or management-related tasks. It is the space where scripts are written, records are maintained, and where visitors can make enquiries.

But, a small or medium CRS setup may actually have space for only one small studio that has to make do as the broadcast and the production studio. This can sometimes pose practical challenges to time management, because programme editing tasks may have to be suspended when the studio goes ‘live’ for broadcast. If broadcast hours for such a stadium are extended, and take up more than six hours a day, this will leave very little time for other editing work, because editing usually takes far more time than a live programme. In such cases, some CR stations dedicate one or more systems in their administrative areas for editing work when they can be spared.

Beyond these three basic spaces, if there is additional space available, the CRS could use it to set up a training hall, or a spare studio, or even a store where the equipment and recording archives can be maintained. Some CR stations develop outdoor spaces where they can conduct meetings, or hold gatherings and functions. Some have even been able to set up small kitchen spaces, so that everyone can have a cup of tea, or cook small meals as they work.

If it is feasible, it may also help to have a small enclosed area separating the entrance to the broadcast studio from the other spaces, so that you pass through two doors in order to enter the studio proper. Such a space is called a sound lock; and it serves to insulate the studio from external noise, specially when a broadcast is in progress. Opening only one door at a time keeps outside noises from filtering in.

In the next section, we will examine some sample layouts for CR station setups and we will discuss some of the special arrangements that we have to make in studios to ensure good audio quality.

Activity 5.1

Assume that you have to set up a community radio station in the area you live in. Make a survey of the area, and identify some locations and/or existing buildings where you could possibly set up the CRS. Draw a table as given below, and award each site points to enable you to select the top three locations. Against each criterion, award the site points from 0 to 5, with 0 being 'totally unsuitable' and 5 being 'excellent'. A sample entry has been done for you to show you how to do this. Replace these numbers with the points for your site.

Site details	Available space	Accessibility	Proximity to community gathering places	Ambient noise levels	Total
Site 1 (*Name*)	3	4	2	4	13/20
Site 2 (*Name*)					
Site 3 (*Name*)					

5.4 Studios for CR Stations

In the previous section, we have discussed some of the common space setups and studio arrangements in a CR station. Let us now look at some possibilities in which the studios partition of CRS can be laid out.

5.4.1 Sample layouts

The basic one-room CRS

As you can see from Figure 5.2, the basic one room CRS, has single space that serves as the broadcast, recording, storage and work space. This kind of a setup

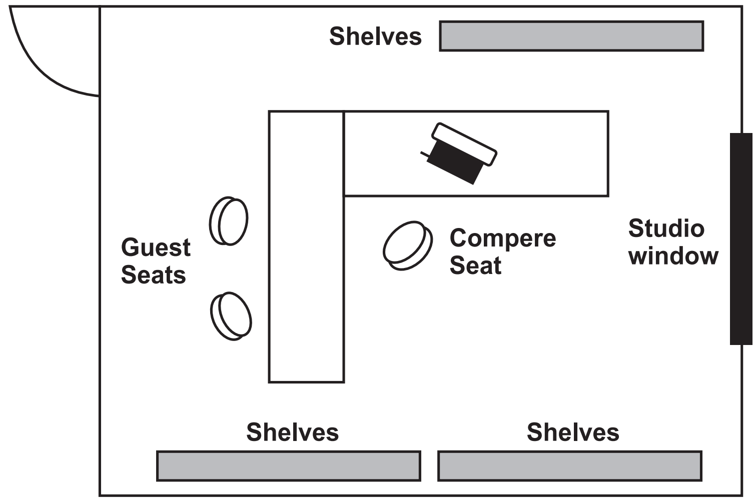


Figure 5.2: *A sample one room CRS layout*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/ UNESCO, 2008*

only requires a small area, and very little setup time. On the other hand, with this kind of a setup, it can sometimes be a challenge to do more than pre-recorded or talk based programming, since you may not have space in the studio to record radio drama, or groups of musicians.

A simple 3 studio CRS

A CRS layout that allows us the kind of space depicted in Figure 5.3 provides for a better distribution of space, and a better distribution of tasks across the spaces. Note that the door at the bottom of the schematic would lead to the remaining spaces of the station, if such spaces are available. If they are not, this may constitute the CRS in its entirety. The voice booth in the centre can be used flexibly to provide a recording floor for both the production studio on the left and the broadcast studio on the right.

A full featured CRS: Layout 1

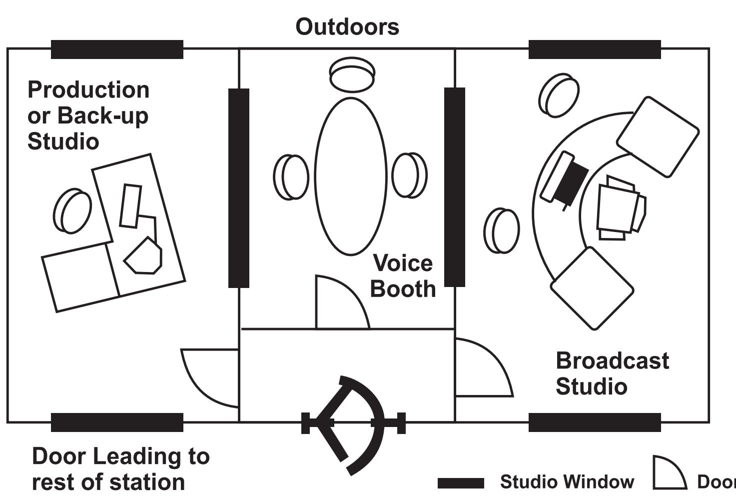


Figure 5.3 :*The three room simple CRS layout gives a little more flexibility.*
Source: *CR: A User's Guide to the Technology: N. Ramakrishnan/ UNESCO, 2008*

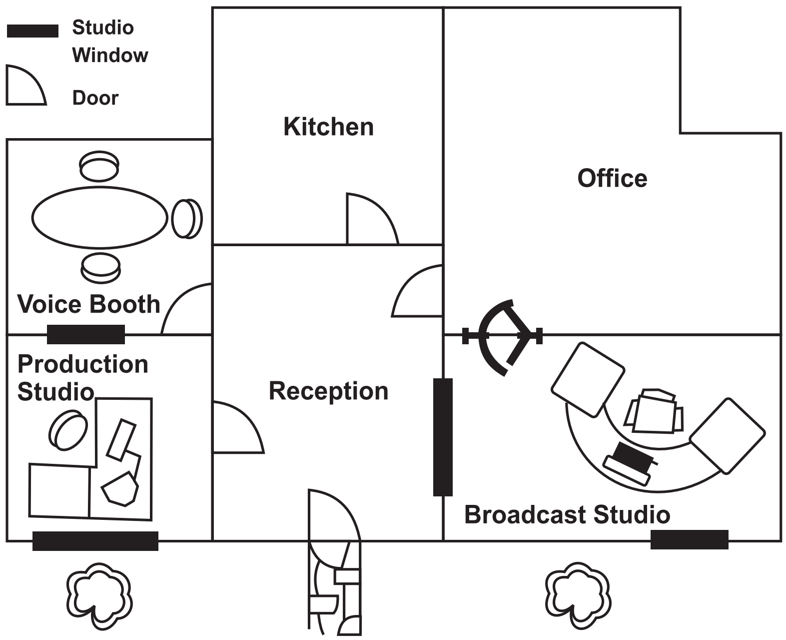


Figure 5.4: *This layout allows us to house a reception area where we can greet guests, as well as an office.*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/UNESCO, 2008*

Where we have the space and the resources to be able to establish a more well-equipped CRS, we can set up a station that looks like the one shown in Figure 5.4, Note that we can now accommodate a formal office space, as well as a kitchen and a reception where we can seat and meet guests and visitors. Since the production studio is completely separated from the broadcast studio, programme recordings can carry on even during broadcast hours.

A full featured CRS: Layout 2

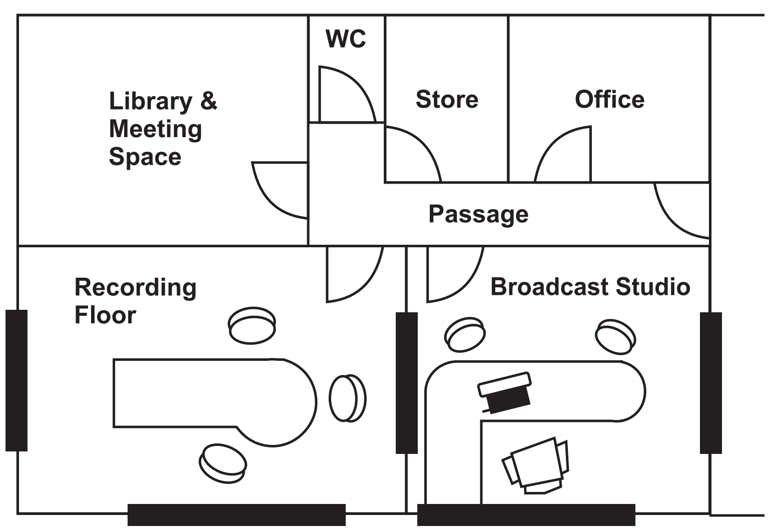


Figure 5.5: *This layout allows us to house a reception area where we can greet guests, as well as an office.*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/ UNESCO, 2008*

If we change our priorities slightly and dispense with the kitchen space, we can create a library and meeting/training space for the station, as well as a small store for equipment. In Figure 5.5, we have dispensed with the production studio as well – with recordings done in the broadcast studio when it is free. This may also allow us to have a slightly larger recording floor.

Hence it is important to realize that there is no 'standard' way to set up a CRS space and studios. You have to be very clear about how much space is available, and what the priorities are. While these sample layouts are meant to bring out some of the decisions you will take, on the basis of these, priorities may not be implemented as they are shown! Depending on the resources available, you may like to equip a small one room station to start with, then slowly expand the station by setting up more studio spaces, offices and editing rooms. This will allow you to start small, with comparatively less resources; and also to think about the new spaces as you set them up.

5.4.2 Acoustic treatment & sound proofing

Understanding ambient sound and reverberation/echo

In any enclosed space, recording audio faces two challenges: unwanted sounds in the background ("ambient noise"); and echo/reverberation.

Ambient noise refers to any background sound that we do not wish to have in our recording. We have already discussed the need to keep ambient noise as low as possible when selecting a station site; but this alone will not guarantee a complete absence of ambient noise. There may be other people working at the station, and there may still be the occasional noisy vehicle passing by outside, which may cause noise that ends up in the recording.

Echo and reverberation, on the other hand, are caused by sound reflecting off the walls and floor of an enclosed space. The reflected sound reaches your ears a fraction of a second after the original, making it sound a little extended, and giving it the 'hollowness' that we associate with empty rooms. (This is especially noticeable in smaller rooms – bathrooms, for instance, since the tiled walls of a bathroom provide hard surfaces that reflect the sound even more. Try singing in the bathroom and see how different it is from when you sing the same song outdoors.)

If the difference between the original sound and the reflected sound is too short for you to perceive them as separate sounds, we call the effect **reverberation** (or **reverb**, for short). If, on the other hand, the sounds are perceived distinctly, we call it an **echo**.

As human beings, we can learn to ignore unwanted sounds and focus on what we want to hear. In a noisy gathering, where a large number of people are talking at the same time, you can still focus on what one of those people are saying. Microphones, on the other hand, are machines, that cannot make this distinction.

Thus, if we record in a space that has high ambient noise or reverb, what you get is an indistinct ('muddy') recording that does not sound clear at all, and which is difficult to edit. It should be clear, then, that if we are to record sound 'cleanly' – that is, we would like the sound to be recorded as faithfully as possible, and with as little unwanted sound and reverb as possible, we must make some special arrangements within the studio spaces to minimize the impact of both.

Sound proofing

The easier of the two to address, in some ways, is the ambient noise. We have to find an effective way to block external sounds from coming into the studio. We do this with a variety of different techniques. This can be more easily done in rural areas and sparsely populated areas when compared to urban and densely populated areas.

To start with, the studio spaces should be housed in a building with thick load bearing exterior walls – 9" or more if possible. The masonry itself acts as an effective insulation against sound transmission. It also helps to have a free standing building, because there is a greater chance of sound filtering through the walls in a wall-to-wall construction, where adjoining buildings share walls.

We can also set up a set of double doors at the studio entrance, so that people entering the studio have to open the first door, close it, and then open the second door to come in. The space between the two doors then acts as an additional layer of insulation, and is called a **sound lock**. The doors themselves can be made of layers of plywood in a wooden frame, with glasswool or thermocol sheets sandwiched between the outer layers. This makes the door thick and sound-absorbing, but light. Rubber gasketing around the edges creates a air-tight and sound-proof seal for the doors, so that sound doesn't enter through any cracks. A glass porthole fitted in the studio doors at eye level allows people to peer in, so that they do not interrupt a running broadcast or recording.

Figure 5.6 : *A studio entrance door. Note how the door fits into the jamb against the blue gasket, making a soundproof seal. Photo courtesy: N.Ramakrishnan/ Ideosync*

Lastly, all windows in the studio area opening on the exterior – and it is a good idea to have them, since this will allow natural light to come in – should be **double glazed**. This means the windows should have not one, but two panes of glass, each set in a rubber or silicone gasket. Each of the glass panes should ideally be at least 5 mm thick, with a separating air space of 5-8 cm between them. The two panes should be angled slightly towards each other, so that they don't set up any internal reflection of sound between them, causing the panes to buzz.

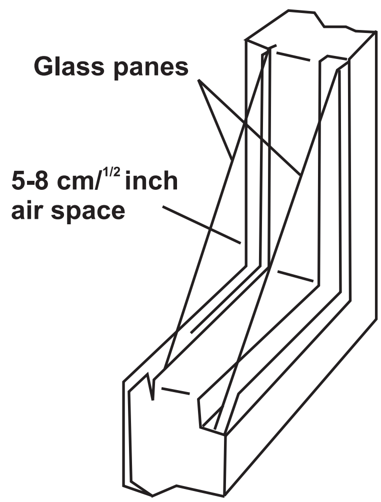


Figure 5.7: *A double glazed window: Cross Section*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/UNESCO, 2008*

It is important to remember that sounds enter through the smallest gaps. So ensure that there are no unnoticed cracks or gaps in the studio walls, or any hidden ventilators. Any ducts or pipes passing through the space should be well grouted – that is, the gaps around it should be filled with cement or plaster of paris (POP), so that the gaps are closed.

The large window between the control room – the space where the recording is made – and the studio floor itself also needs some special attention. This is an important window, since the person doing the recording (in the control room) and the artistes or guests in the studio communicate through this window. We follow the same principle as what we saw for the exterior windows to create a double panel window with angled panes. Remember to put in some silica gel between the panes to prevent moisture from condensing between the panes, where it would be difficult to clean.

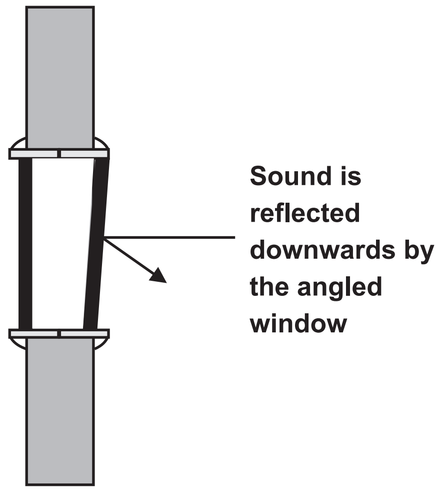


Figure 5.8: *The studio – control room partition (cross section). Note the angled pane which reflects sounds downwards and away from the source.*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/UNESCO, 2008*

Acoustic treatment

Now it is time to pay attention to the techniques and materials which we will use to cut down (or "dampen") reverberation in the studio space. Some of this will be achieved by the angled window panes themselves, which will cut down sound reflection from the window spaces.

A professional grade studio uses a wooden frame over each wall, fitted with large fibreboard or corkboard tiles. The tiles are fitted over packed layers of glasswool, and each tile has variably sized holes drilled through it. Once fitted, the holes let the sound pass through, where the glasswool dampens it, and absorbs it. Other studios use angled wooden sections fitted to the walls to reflect the sound unevenly. Floors and ceilings may be mounted on absorbent materials like cork, or cushioned by spring systems or rubber runner. All these techniques are quite expensive, and are usually charged by the installers on a 'per square foot area' basis.

Community radio station budgets calls for use of local materials in an intelligent way, so that we can achieve the same purpose with less expense. Note that this does not mean compromising on the quality of acoustic treatment, or the resulting audio quality.

One way to start is to establish the studio area in a space where the walls do not exactly parallel each other on all sides: parallel walls create maximum reflections. Walls that have insets and bends can often help reduce the problem to a great extent.

A simple way to cut reverb down sharply is to attach materials to the wall and break up the hard surface. The low cost and easy way to do this is to use cardboard egg trays – the kind used by grocery shops to store eggs. Use a strong glue to paste these trays on the vertical walls and ceiling in even rows, so that the indented surfaces point inwards facing the studio. The soft papier-mâché material of the tray, along with the uneven surface give a striking reduction in audio reflection from the walls. Remember to treat the trays with a strong insecticide before you paste them on to the walls.

Figure 5.9*: Egg tray covered walls in Gurgaon Ki Awaaz CRS, Gurgaon*
Photo courtesy: N.Ramakrishnan/Ideosync

Some studios have successfully used sheets of cane matting hung from the ceiling in front of each wall. Others have used thick curtains on rails all around the studio space – the folds in the curtains and the materials absorb and deflect sound and the curtains can be opened selectively to reveal sections of the reflective wall in order to change the audio characteristics of the space.

While the above description has given you a fair idea about 'acoustic treatment and sound proofing', you will learn about it in detail in Module 3 under the head, "Studio Acoustics".

Activity 5.2

Visit the following kinds of rooms, and examine the audio reflections and reverberation level in each (you may have to clap or make a sound to check):

1. A tiled bathroom;
2. A regular living room space with furniture and curtains;
3. A large hall (a marriage hall or closed canteen space);
4. An auditorium meant for music performances. Which has the most reverberation? Where do you think the reverberation will be useful, and where is it not so useful?

5.4.3 Other considerations

Beyond matters like the layout of the station and studios, and the sound proofing and acoustic treatment of the recording spaces, there are a few further decisions we need to take before we get around to the actual configuration of equipment within the station. Let us look briefly at some of these arrangements.

Dust-proofing the studio

One of the greatest challenges of working with technical equipment, especially the electronic ones in tropical countries, is the climatic and environmental conditions that the equipment has to face. And of all these conditions, the biggest enemy of equipment is dirt and dust – so much so, that a large proportion of breakdowns and maintenance issues happens simply because we do not have procedures in place to prevent dust collection.

Since the studio spaces are expected to be used by multiple individuals and members of the community, the only realistic way to keep the spaces dust-free is to encourage a sense of belonging and ownership of the space by everyone, so that keeping it neat like one's home becomes second-nature for everyone. Shoes should be left outside the main entrance – a shoe rack and a signboard there are good ideas. The rubber gaskets we discussed in Section 5.4.2, can also play a dual role: they can provide a seal that prevents dust from entering the studio, if everyone can follow the simple procedure of keeping the doors closed at all times.

Many spaces that are used by CR stations are not originally designed for use as studios and broadcast stations. As a result, they often have inconvenient windows and doors that provide multiple entry points for dust and dirt. If you are faced with this situation, replan your layout so that you minimize entry points into rooms and studios. Windows and doorways can be bricked up, or sealed with double paned glass in order to preserve the natural light. Make the station spaces as easy to clean as possible – leave as few nooks and crannies where dust can gather as possible.

Air conditioning: Should we or shouldn't we?

To start with, let us be clear that air conditioning a CRS is not mandatory. It may not even be necessary. If your station is housed in an old traditional building with high ceiling, or one with floors above, or in the hills or by the sea, it may already be cool enough.

However, if your station is set in a building with an exposed terrace, or in a place with a really hot climate, air conditioning may become necessary. This may be compounded by our attempts to keep dust out, as this may mean we may have blocked several natural vents for the circulation of air. Some equipment can also heat up a lot in use – transmitters, for instance, or poorly ventilated computers.

If air conditioning is necessary, the best kind are split AC units, where there is an internal blower unit, and an external compressor unit, with pipes connecting the two. These are better, because the compressor unit is noisy, and by keeping it out of the studio, we are avoiding unnecessary ambient noise. A window AC would not do, since exterior noise would come through the AC's internal mechanism into the studio. Ducted systems that cover the whole station space would be best, but are often too expensive for CR stations.

When installing a split AC within a studio, ensure that the hole in the wall where the piping and tubes go through is properly grouted and sealed. Also ensure that the compressor unit outside is installed with sufficient space around it, and off the ground. Remember that in humid conditions, water can drip from the interior unit. There should be a drainpipe leading out of the unit which is also directed outside the studio along with the other piping.

In conclusion, it may feel good to have cool air within the studio, but AC units come with their own downsides:

1. They consume a lot of power, which can mean large recurring power bills for the station. It also means that if your station is in a power poor area, the investment may not be worth it.
2. They require regular maintenance to run at peak efficiency, which means an additional task for the CRS team – not to mention servicing and maintenance costs.

Estimating the station's AC requirements

The cooling capacity of ACs are rated in BTUs (British Thermal Units) or more usually in tons (1 ton = 12000 BTU per hour). The ton measure refers to the volume of air that can efficiently be cooled by the AC, and 1 ton, 1.5 ton and 2 ton ACs are most common.

Divide the cubic feet volume of your room by 600 to arrive at the basic tonnage capacity required.

Add 0.5 tonnes for every 10 people occupying the room at the same time.

Similarly add 0.5 tonnes for every 1500 watts of appliances or lighting present in the room (A computer would consume about 300 watts and a regular bulb, 40 to 60 watts).

Calculate the volume of your space on a similar basis for a rough estimate of the AC capacity that you need.

Selecting appropriate studio furniture

Installing studio equipment means, of course , that we also need to have some furniture to place our equipment on. Once again, the key concepts to remember are: hard wearing, and modular. Essentially, a CRS needs furniture which can withstand heavy use, and which we can re-order into a different pattern as per our requirements. It would also be best to have a reasonable idea of what equipment you are going to buy before finalizing the furniture, so that we can be sure that the dimensions are correct. Depending on what is more convenient, furniture can be ready-made, or made to order by a carpenter.

Office furniture is probably the easiest to set up and arrange. Plan for a couple of working desks, a few computer tables, and storage units for files, papers and stationery.

Studio furniture needs some special attention in terms of design. The traditional professional studio configuration is to have a half-moon shaped or U-shaped desk, in the middle of which the compere or recordist sits. The idea is to have all parts of the table within easy arm's reach, so that the compere can simultaneously attend to multiple devices as he or she speaks into the microphone. But given our purpose, and the low-cost philosophy, almost any furniture configuration can be put to good use.

Keep in mind that:

- Even desks carrying various pieces of equipment should allow you at least some working space which you can use to hold notes or write on. If the desk is so covered with equipment that you cannot move for fear of knocking something off, it is hardly a practical arrangement.
- Studio chairs should be sturdy, and must not squeak or groan when sat upon. Most importantly, they should be comfortable to sit on for extended periods of time – so get the best chairs you can.
- In the control room, the furniture should be set up in such a way that the recordist can easily look through the window onto the studio floor without straining or getting up.

The studio floor itself can be kept as bare as possible, to allow it to be used flexibly. But a small round table with a couple of chairs is not a bad idea, as it will allow you to conduct interviews there. If you expect your studio floor to regularly be used for panel discussions though, by all means feel free to get a larger table that can seat four or five people.

Studios should also have plenty of shelf space for storage. You can never have enough storage! Shelves should preferably be closed, and must accommodate manuals, cables, accessories, and small ancillary equipment. Expensive items, especially those that are issued to team members on request, should be stored in locked cupboards for safety purposes.

Many modern studio equipment also come in ready– to-fit standard slotted racks. These racks are generally made to standard sizes in multiples of 44 mm (see Figure 5.9 below), allowing the stacking of recorders, patch panels and amplifiers, and making space-use more efficient.

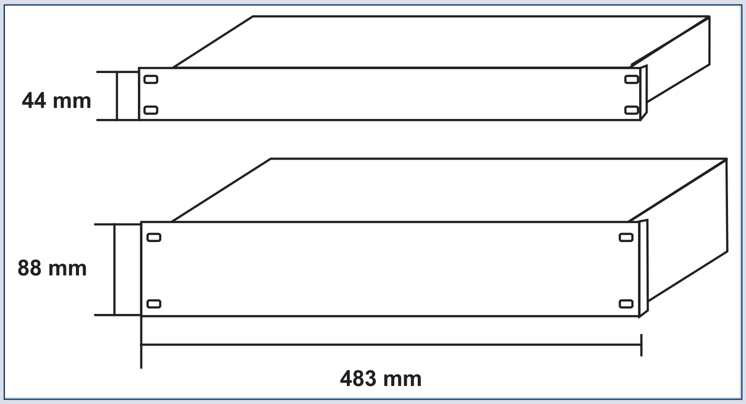


Figure 5.9: *Standard rack mount panels. These can be used to mount CD players and amplifiers vertically one above the other.*
Source: *CR: A User's Guide to the Technology, N.Ramakrishnan/UNESCO, 2008*

Always keep in mind that with imaginative use of furniture, you can easily obtain a far better alternative than buying a great deal of expensive furniture. Good planning, and a sensible carpenter go a long way in terms of making the best use of limited space!

Activity 5.3

Of the possible sites and spaces that you have identified in activity 5.1, select the best option as per the parameters in that activity. Now draw a plan of the existing structure there, and plan how you would adapt the spaces in order to establish a CRS in that space. Pay special attention to:

1. Creating studio space(s)
2. Creating a small work or office space
3. Existing doors and windows you may need to brick-up or double glaze
4. New windows, walls or access doors you may need to create.

5.5 Equipment for CR (schematic level only)

Now that we have learnt how to plan the layout and preparation of the CR stations' various work areas and studios, it is time for us to become familiar with the actual equipment in a CR station.

In this section, we will understand the basic categorization of the various pieces of equipment. We will also see a schematic layout of how the various components connect to each other. In later Units, you will get a detailed understanding of each piece of equipment, its various types, and its functions.

5.5.1 An overview of the programme production process

Before we move on to looking at the equipment, we need to understand the process by which a programme is made. This will help us understand the specific purpose of each piece of equipment, and the part it plays in our community radio station.

The process of making a programme is divided into four broad processes:

1. **Pre-production:** This is the preparatory phase, and includes the time spent on research, scriptwriting, scheduling of recordings, logistical arrangements and so on. This is the least technology based part of the process, as it is mostly about designing the creative inputs for the programme.

2. **Production:** This includes the actual process of recording the programme, in the field and in the studio. 'Recording' means the act of capturing the audio and storing it in a retrievable fashion on a computer, or SD card or cassette. 'Field recording' means all the portions of the programme that are recorded outside the studio, and usually on battery-operated portable recording units (field recorders). 'Studio recording' refers to all the recording that is conducted within the studio space. Production may be conducted in phases, over several days.
3. **Post-production:** This is the process of reviewing our recorded content, and editing it into a final programme which includes the various components that we have planned: music, sound effects, interviews, narration and so on. Editing is the process of collating the components in the correct order, as they will appear in the final programme – as well as a process of removing the parts we do not consider necessary. It is usually done on computerized editing systems, using software designed for the task.
4. **Mixing and Mastering:** This is the process of finalizing the programme, and includes adjusting the audio levels so that they are even throughout the programme ('mixing') and the export of a single, seamless programme from the various components we have stitched together while editing ('mastering').

5.5.2 A schematic overview of a field recording setup

Field recording equipment typically consists of a setup like this:

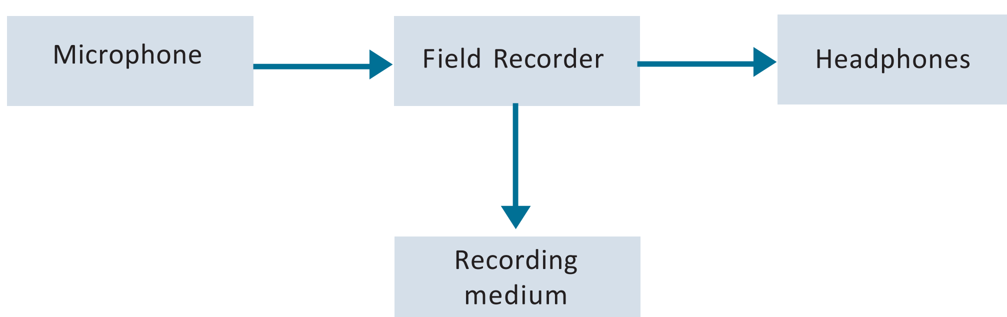


Figure 5.10: *An overview of field recording equipment. The direction of the arrows shows you the direction in which the audio is flowing.*

As you can see from Figure 5.10, the kit usually consists of a microphone; a field recording unit; headphones to listen to the audio as we record it; and a recording medium (also called a storage medium), something we store the recorded audio on. It could be cassettes; digital storage media, like flash memory; or optical media like CDs or DVDs. The direction of the arrows indicates the signal flow.

5.5.3 A schematic overview of the production studio

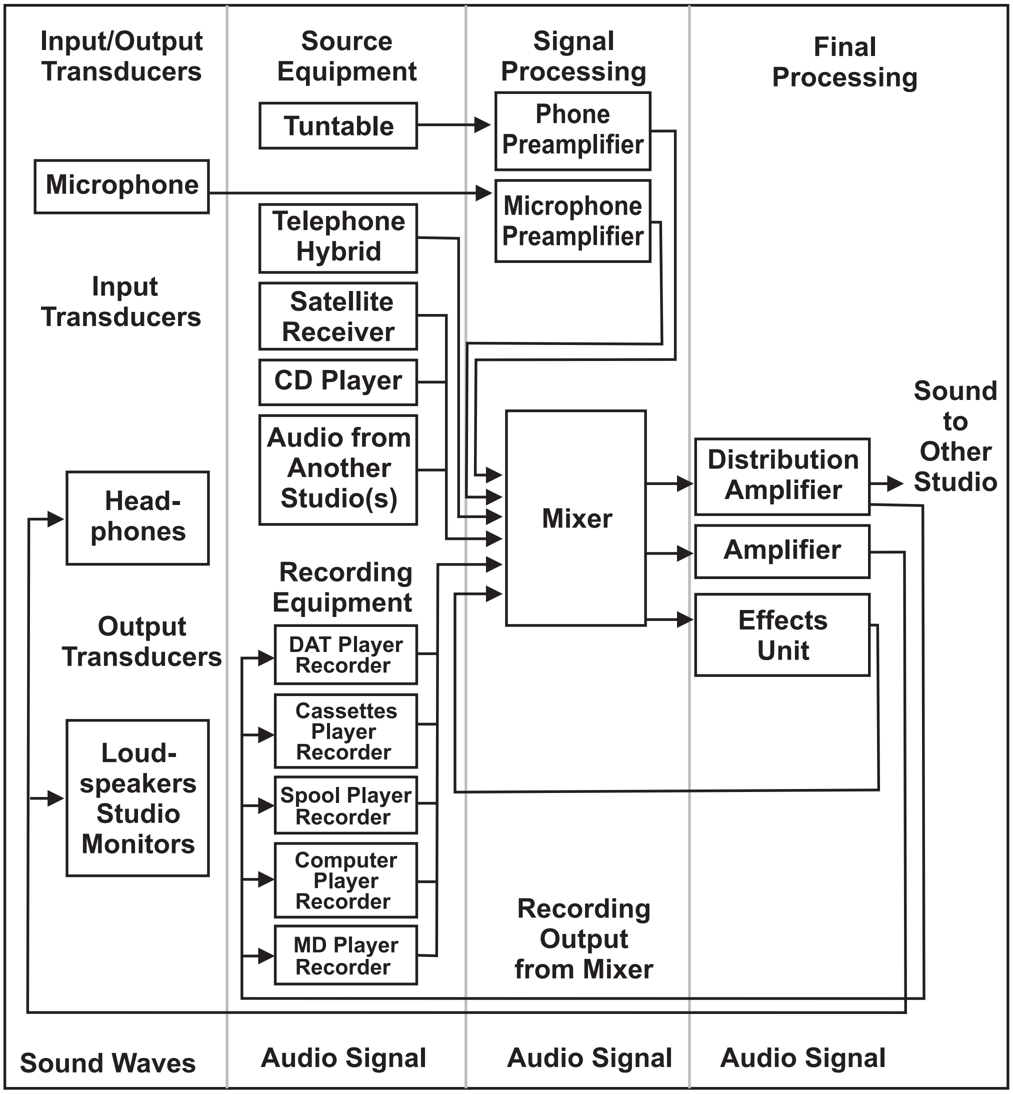


***Figure 5.11:** A schematic overview of the production studio*

As we have noted in a previous section, a production studio is a studio setup where we can record programmes and edit them, but which is not connected directly to the transmission or broadcast system.

Within this setup, the equipment falls into six broad categories:

1. **Input transducers**: This covers all the equipment that converts the sounds we want to record into electrical signals that can be recorded. In practical terms, this includes all the variety of microphones we use to record audio in the studio.

2. **Audio source units**: This covers all the equipment that we can play recorded audio content from in order to incorporate it into our programme. This includes: CD players, computers, cassette decks, LP turntables, MiniDisc players, and solid state players.
3. **Signal processing and management units**: This includes all the equipment we could use to combine or modify the audio signal that we are generating in the studio. Of these, the most important is the mixer unit, which lets us control the relative levels of various audio streams, and combine them into one consolidated output. It could also include any pre-amplifier units that we may use to boost signals from a telephone connection or from the microphones before we feed it into the mixer unit.
4. **Final processing units**: This includes amplifier units that lets us forward the signal to other studios; effects units that lets us add effects to the audio; and distribution amplifiers that lets us split the output audio for recording on multiple devices at one time – or for monitoring on headphones or speaker units.
5. **Recording units**: This includes any devices that we use to record the finalized audio, and includes computers (or Digital Audio Workstations – DAWs); MD (MiniDisc) or Digital Audio tape recorders; or flash based digital recorders, which record on SD (Secure Digital) cards or CF (Compact Flash) cards. Computer based recording systems are the most common nowadays, since the DAW also lets us do the editing function on the same unit.
6. **Output transducers**: This includes all the devices we use to listen to the audio that is being generated. It includes headphone units; as well as speaker (“monitor”) units.

Look at the diagram in Figure 5.11 carefully to understand how all these components are interconnected, and how the signal flow is achieved. The diagram also shows you what form the audio is in at a given stage: Whether it is still in the form of sound waves, or whether it is in the form of an electrical signal.

5.5.4 A schematic overview of the broadcast studio

As we have noted in a previous section, a broadcast studio is a studio setup from where we can conduct programmes that can go live on air; or from which we can playback pre-recorded programmes for transmission. In some cases, the broadcast studio also includes facilities for recording and editing programmes – and in many small stations, there is only one studio which doubles as a production and broadcast studio.

Examine the diagram in Figure 5.12.

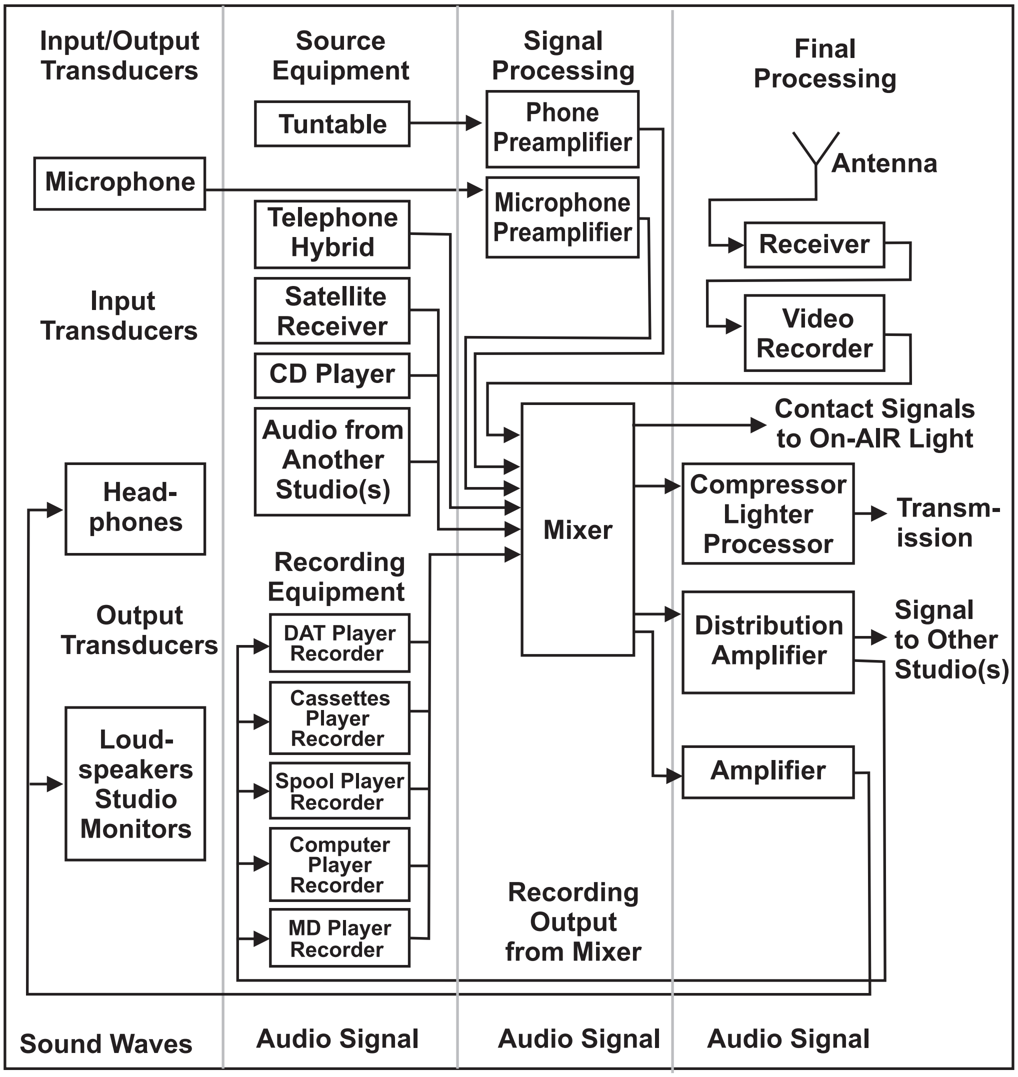


Figure 5.12: *A schematic overview of the broadcast studio*

As you will notice, the basic structure of the devices is very similar to what you saw in the production studio. We have the same input transducers, audio sources, signal processing & management devices, final processing devices, and output transducers. We have only two principal additions in the broadcast studio over the production studio viz. a **Compressor/Limiter** and feed going to the transmitter.

The **Compressor/Limiter** is a device that limits the signal when it goes beyond a fixed level; and compresses the audio that exceeds this limit, by squashing it back into the defined limit. These are comparatively rare in CR stations, and are more commonly found in commercial radio stations.

Finally, there is a seventh category of equipment viz., **Transmission equipment** which transmits the programme on the assigned frequency of the station via the co-axial cable and the antenna. Within the studio, this usually means the transmitter unit, which actually does this task.

5.5.5 A schematic overview of the transmission setup

At this point, it is also worth looking briefly at the components of the transmission system itself.

Look at the diagram in Figure 5.13. As you can see, the audio signal from the broadcast mixer unit undergoes final processing, and is then fed through the Studio-Transmitter Link (STL) to the transmitter unit in case the studio and transmitter are not co-located. At most of the Community Radio Stations, however, Studio and Transmitter are co-located. As such ST Link is not required in most of the cases. The transmitter device generates the carrier radio wave, and combines the audio with the carrier so generated before sending it to the antenna unit. The process of combining the audio with the carrier is known as modulation, more details about which are given in Section 6.4.2.

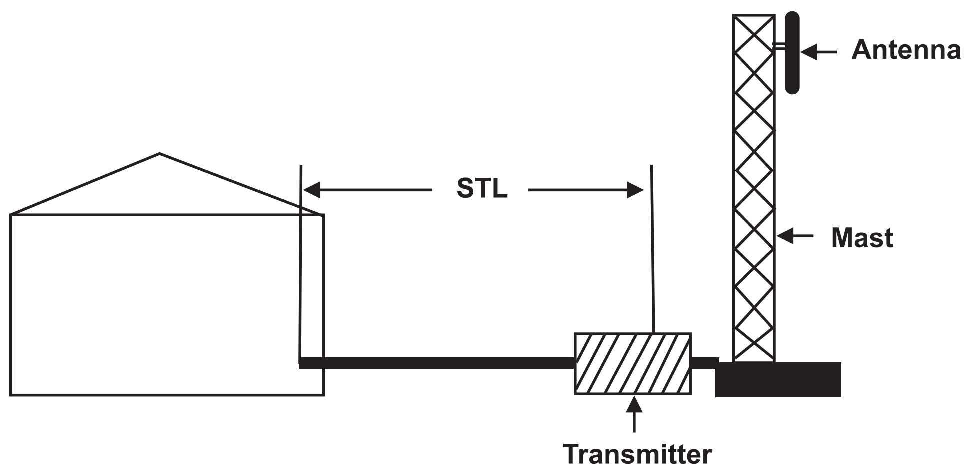


Figure 5.13: *A schematic overview of the transmission setup*

The signal reaches the antenna through the antenna cable, and is then dispersed into the air by the antenna, which is usually mounted on top of a tower or mast. This is shown in Figure 5.14.

At the reception or listener's end, this combined radio signal is received by the radio set, which carries its own little antenna to pick up the radio wave in question. Within the radio set, the radio wave is filtered out, and the audio signal stripped out. This is then fed to the speaker unit on the radio, from where we hear the original audio waves as shown in the second figure of Figure 5.14.

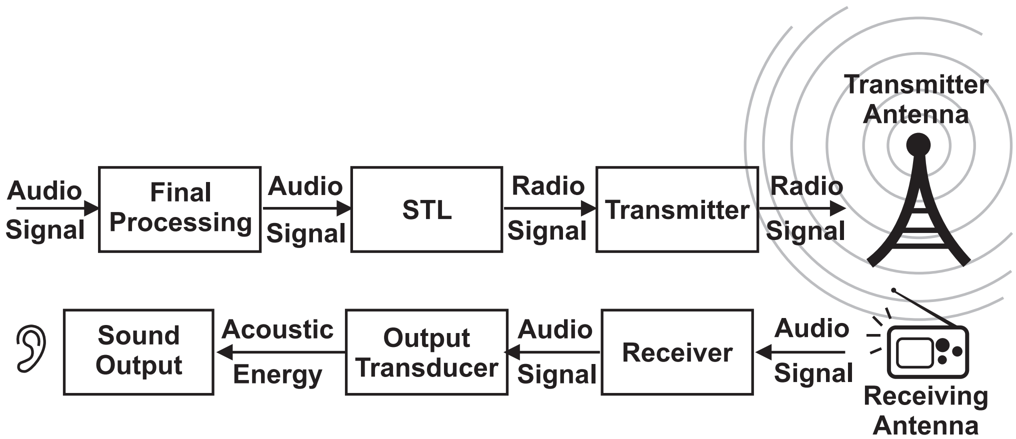
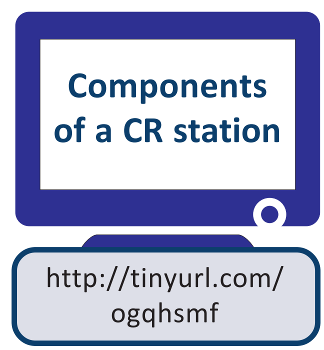


Figure 5.14: *Transmission: From studio to antenna*

5.6 Setting up a CRS: Activity and Video



Now that you have a good understanding of the components of a CR station, please see the video titled 'Components of a CR station', which is available at the Youtube site of CEMCA http://tinyurl.com/ogqhsmf.

The video provides you knowledge on the suitable location, studio design and walkthrough of a working CR station (Must Radio, Mumbai). In this video, you will examine the spaces used by the CRS; the studio designs; the acoustic treatment used; and the equipment the CRS is using. You will also see the CR station's transmission setup, including its mast, and the broadcast antenna. You will also see some animation based explanations of some of the key concepts that you have learnt.

Once you have viewed the video, complete the activity below.

Activity 5.4

With reference to the CRS that you saw in the video study material, write:

1. Three key features of the station that you feel would be appropriate for a CRS in your area;
2. Three key features of the station that you feel would NOT be appropriate for your area.

With each feature, write a short explanation of why you consider this feature appropriate or inappropriate.

5.7 Let Us Sum Up

This unit focused on the key decisions we have to take while choosing a location for a CRS, as well as on planning how to divide the available space into working spaces for the station. It also talked about the advantages and disadvantages of some sample layouts presented in the unit, along with the ancillary considerations (air-conditioning, furniture choice, acoustic treatment, soundproofing) that we must keep in mind.

We have also seen overviews of the field recording setup; the production studio; the broadcast studio; and the transmission system. We are also sure that you have understood the process of how the transmitted signal reaches the receiver/listener; and the process of programme production (pre-production, production, post-production, mixing and mastering).

Finally, we viewed a walk-through video of an actual CRS, and understood the practical application of many of these concepts.

5.8 Model Answers to Activities

Activity 5.1

A sample entry has already been completed for you in the table shown in the activity. Use that as a model to frame the rest of your entries.

Activity 5.2

The spaces with the least reverberations are the living room space and the large hall.

The spaces with the greatest reverbs are the tiled bathroom and the auditorium. The tiled bathroom's reverb is uncontrolled, since it is not designed as a space for audio. The auditorium's reverb is more controlled, since the hall has been designed to control and emphasize the reverb of certain kinds of reverb – typically, vocalists and instrumentalists on the stage.

Activity 5.3

Since the space that you will redesign in this activity is something you will select from a real location, there is no standard answer that can be presented here. Remember that your diagram/plan should look something like those given in Figures 5.2 – 5.5, and must clearly show what you intend to change and how.

Activity 5.4

Note: This exercise is based on your practical exposure of a community radio station. Please go through the Video available in the CEMCA's YouTube site and then try to answer from yourself.

UNIT 6

Radio Waves and Spectrum

Structure

6.1 Introduction

In previous Units, we discussed a range of issues relating to community radio. These issues were about the philosophy guiding the concept of community owned and community managed media; the policies governing the establishment of community radio stations in India; the factors we need to keep in mind while deciding a location for the station; and the various considerations we need to address while designing and setting up a CRS.

It is now time to take a pause and look at a fresh set of basics to sharpen our understanding further: what are radio waves, and where do they come from? How does the process of radio broadcast actually happen? When did it start? In this Unit, you will learn about the science behind radio broadcasting, and the natural phenomenon of electromagnetism. You will also learn about how the usage of radio waves are governed in this country. For studying this Unit, including working on the various Activities, you may need around 40 hours of study.

6.2 Learning Outcomes

After working through this Unit, you will be able to:

- discuss radio waves and their implications for CR.
- explain the broadcasting spectrum for radio.
- describe different frequencies of operation of radio broadcasting.
- analyze issues related to regulation of radio waves, spectrum and frequency.

6.3 Electromagnetic Spectrum and Radio Waves

Before we begin to understand what radio broadcasting is all about, and how this process takes place, it is important that we first understand some fundamental facts and measures related to the science behind radio broadcasting. For this, we must go back to some of the basic physical properties of waves, energy and radiation.

6.3.1 Basic characteristics: Amplitude, Frequency and Wavelength

You must all have thrown a pebble into a pool or puddle of water at some point in your lives. What happens? The stone causes a series of ripples that start at the point where the stone hits water, and spreads out in concentric circles or rings

from that point outwards. Simply put, the energy which the flying pebble possessed at the moment it hit the water surface, has been converted into the up and down movement ('oscillation') of the water particles, which have now formed WAVES. Hope you are now able to visualise the concept of waves. Here, you can watch a small video, which will help you to understand the concept of waves more clearly. Please visit at http://tinyurl.com/p5kykyc for the video titled 'Introduction to Radio Waves'.

So a 'wave' is an up-and-down or side-to-side movement of the particles in a medium. We usually represent waves graphically as given in Figure.6.1.

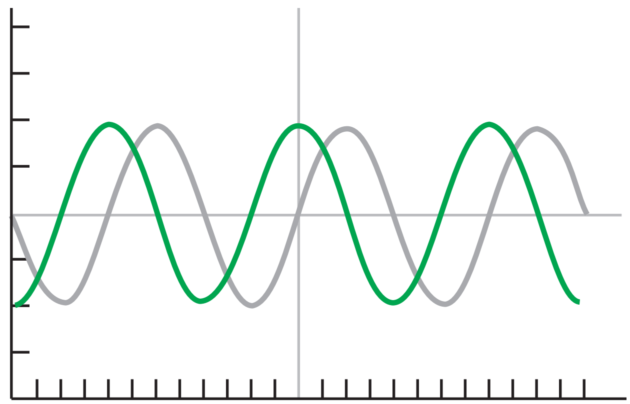


Figure 6.1: *Waves: Shape and propagation.*

Note that the green waveform represents the wave when it starts. The grey waveform shows the same wave an instant later, when it has 'moved' to the right.

There are three key qualities of a wave that we must become familiar with. These are:

1. Amplitude: This is the difference between the highest ('peak') and the lowest portion ('trough') of a wave, and is a measure of the strength of the wave. The larger the amplitude, the higher the energy of the wave, and the greater the distance it will travel. In terms of sound waves or audio waves, the larger the amplitude, the louder the sound. The concept of amplitude and frequency is illustrated in Figure 6.2.

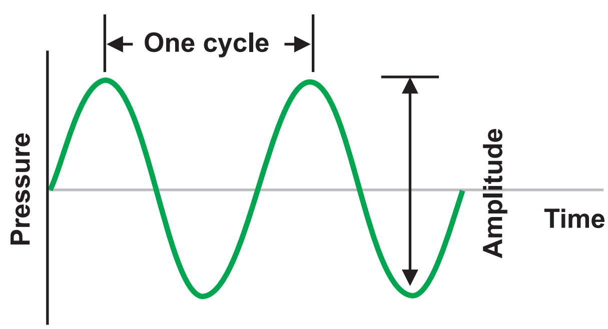


Figure 6.2: *The amplitude of a wave / One 'cycle'*

2. Frequency: Frequency refers to the number of waves that pass through a given point in space every second as shown in Figure 6.3.

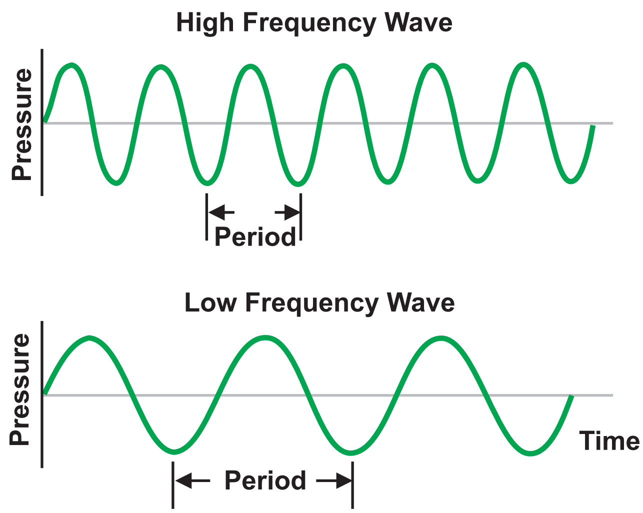


Figure 6.3: *High frequency and low frequency waves*

If you look at the diagram in Figure 6.3, the wave on top has a greater number of cycles within the same distance as compared to the lower wave. Thus, you will see that if we choose any one point on the horizontal line, and imagine both waves moving to the right at the same speed, more cycles of the wave on top will have passed that point after one second than for the lower wave. The upper wave could thus be said to have a 'higher frequency' and the lower wave a 'lower frequency'.

Frequency is measured in Hertz (Hz). One Hertz (1 Hz) corresponds to one cycle crossing at a given point in space every second. (By extension, a wave with a frequency of 100 Hz would have a 100 cycles pass that point every second.)

3. Wavelength: Wavelength refers to the distance between two successive waves, as shown in Figure 6.4.

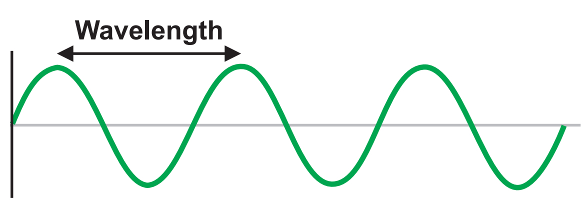


Figure 6.4: *Wavelength of a wave*

This distance can be measured as the difference between two adjoining peaks, or two adjoining troughs.

Frequency and wavelength have an inverse relationship, which means the greater the frequency of a wave, the shorter the wavelength; and vice-versa.

6.3.2 Radiant energy and Electromagnetic Spectrum

Have you ever stood in the sunlight and felt its warmth on your skin and face? But the Sun is a ball of hot gas millions of kilometres away from us, across the vast empiness of space. How could its heat reach us across this vast distance and through a vacuum?

The answer is that every object gives off energy in various ways. Objects at a higher temperature give off more energy and objects at a lower temperature give off less. The Sun, being a superhot ball of gas where nuclear reactions are going on continuously, gives off energy in a number of different ways. This 'giving off' of energy is called **radiation**; and the energy so given off is termed **radiant energy**.

Radiant energy could be in the form of light, or heat, both of which we can immediately sense with our eyes and our skin respectively. Then again, it could be in the form of such waves that we cannot see or hear, or even feel directly with our limited senses, but which can be detected by devices that we build. One example is X-Rays, the invisble rays that are used by medical science to look through skin and flesh to see parts of our skeleton. Together, all these kinds of radiant energy are often called **Electromagnetic Wave Radiation**, since the energy is actually radiated in the form of waves, and has properties linked to both, electricity and magnetism. (**Electricity** is the phenomenon of the flow of charged particles from one point to another in a conducting medium, such as a copper wire; and **magnetism** is the phenomenon whereby some material can attract or repel other objects.)

Waves in water, or sound in air are both examples of waves which need a medium to travel through: water and air, respectively. Electromagnetic wave radiation, on the other hand, can travel across vacuum, without any medium. (They may, however, be impeded or affected by any electric or magnetic material or conductors in their path.)

Unlike water or air, which can move physically – up and down or side to side – when set in motion, electromagnetic wave radiation does not physically move any particles. Rather, an electromagnetic wave may be understood as the change in the levels of electromagnetic charge in a given point in space over a period of time.

All electromagnetic waves travel at the speed of light in a vacuum. The speed of light is a constant 299,792,498 metres per second – which is very fast indeed! For all practical purposes, over short and medium ranges, this is almost instantaneous, which is why even if a bulb is switched on a long distance away, you see it immediately – because the time taken for the light to reach you is so short that you cannot perceive the gap.

Electromagnetic wave radiation is mostly classified on the basis of the frequency of the waves that are radiated. They range from comparatively low frequency waves (in the **KiloHertz** or thousands of Hertz range) to comparatively high frequency waves (in the **GigaHertz** – or millions of Hertz – and **TeraHertz** – or billions of Hertz, or higher range). Together, all the frequencies of electromagnetic waves are called the **electromagnetic spectrum**.

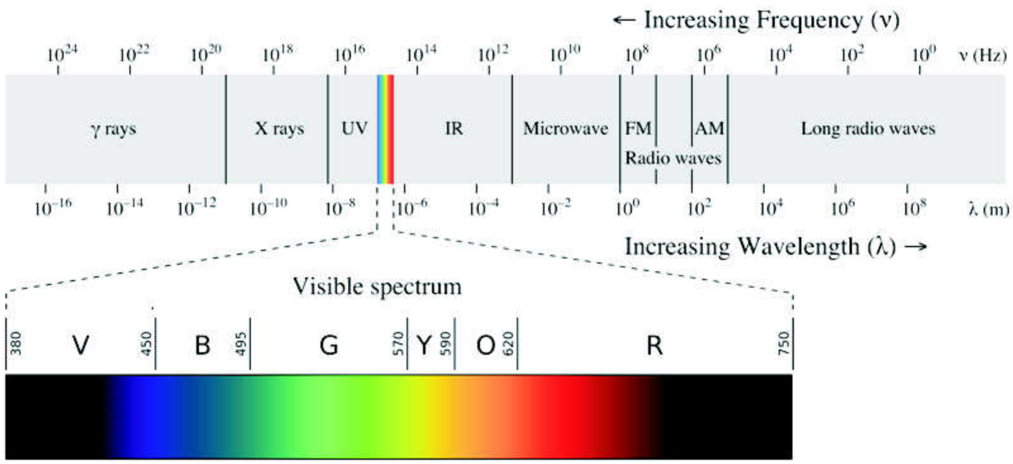


Figure 6.5: *The electromagnetic spectrum, with inset showing visible light. Note the direction of increasing frequency of the electromagnetic waves.*

As you can see from Figure 6.5, **Visible light** forms one part of the electromagnetic spectrum which is perceivable by us with our eyes. This portion of the electromagnetic spectrum is, appropriately, called the visible spectrum, and is composed of the familiar colours Violet, Indigo, Blue, Green, Yellow, Orange and Red (known by the acronym VIBGYOR), which we see in a rainbow; or when sunlight is split by a prism. In the visible spectrum, red is at the lower frequency end, and violet at the higher frequency end. Above the blue end of visible light – that is at higher frequencies than blue light – lie **Ultraviolet Rays**, **X-Rays** and **Gamma Rays**. Below the red end – that is, at lower frequencies than red light – lie **Infra Red Rays**, **Micro Waves** and **Radio Waves**.

6.3.3 The Radio Spectrum

Radio waves are those electromagnetic waves that typically fall within the 3 Kilohertz (kHz) and 300 Gigahertz (GHz) range of frequencies.

They can occur naturally – the Sun and other astronomical bodies, as well as lightning are sources of radio waves. Radio waves are used for location beacons, and to generate direction signals for radio location. They are also used for broadcasting, which means producing them by artificial means, so that they can carry an audio signal of our choice to a distant place.

The following table (sourced from Wikipedia) shows the entire gamut of radio frequencies and how they are categorized.

DESCRIPTION OF RADIO WAVE BAND	FREQUENCY RANGE
Extremely Low Frequency (ELF)	3 Hz/100 mm – 30 Hz/10 mm
Super Low Frequency (SLF)	30 Hz/10 mm – 300 Hz/1 mm
Ultra Low Frequency (ULF)	300 Hz/1 mm – 3 kHz/100 km
Very Low Frequency (VLF)	3 kHz/100 km – 30 kHz/10 km
Low Frequency (LF)	30 kHz/10 km – 300 kHz/1 km
Medium Frequency (MF)	300 kHz/1 km – 3 MHz/100 m
High Frequency (HF)	3 MHz/100 m – 30 MHz/10 m
Very High Frequency(VHF)	30 MHz/10 m – 300 MHz/1 m
Ultra High Frequency (UHF)	300 MHz/1 m – 3 GHz/100 mm
Super High Frequency (SHF)	3 GHz/100 mm – 30 GHz/10 mm
Extremely High Frequency (EHF)	30 GHz/10 mm – 300 GHz/1 mm
Tremendously High Frequency (THF)	300 GHz/1 mm – 3 THz/0.1 m

Different frequencies of radio waves have different propagation characteristics in the Earth's atmosphere. Longer waves may cover a part of the Earth very consistently through ground wave propagation. Shorter waves can reflect off the ionospheric magnetic layer of the atmosphere, and travel around the world. Much shorter wavelengths bend or reflect very little and travel on a line of sight.

Different parts of the radio spectrum are used for different radio transmission technologies and applications. Radio spectrum is typically government regulated in developed countries and, in some cases, is sold or **licensed** to operators of private radio transmission systems (for example, cellular telephone operators or broadcast radio and television stations). Ranges of allocated frequencies are often referred to by their provisioned use (for example, 'cellular spectrum' or 'television spectrum'). Some parts of the radio spectrum are unlicensed – for example, the frequencies used for **Wireless Fidelity** or **WiFi** internet, or **Citizen Band (CB)** radio. Cordless telephones also use an unlicensed part of the radio spectrum.

Activity 6.1

Visit an office that has a WiFi connection. If there is no such office nearby, you can visit a store that stocks router and computer equipment. Examine the WiFi router available, and check the radio frequency range used by it. Note the name of the router, the WiFi band it is using (802.11b, g or n), and the frequency range.

6.4 Frequency Bands for Radio Broadcasting

For practical reasons, radio spectrum is subdivided into smaller sections called **Bands**, which are further subdivided into specific frequencies called **channels**. Each of the ranges you see in the table above is actually a Band (VHF Band, UHF Band, and so on).

By international convention, certain bands have been reserved for certain kinds of broadcasting, as we have noted previously. In this section, we will understand the primary bands assigned for radio broadcasting globally.

6.4.1 Medium Wave (MW) and Shortwave (SW)

In most countries across the world including India, the band between 535 kHz and 1605 kHz is reserved for **Medium Wave** radio broadcasting. Medium Wave is often shortened to **MW**, the letters you see on a radio tuner dial. 'Medium Waves' refers to the size or wavelength of the corresponding radio waves, which range from 560 metres to 187 metres. (This means each wave in a medium radio wave is 187 metres or more in length – upto a maximum of more than half a kilometre!)

One of the key characteristics of medium waves is that their principal mode of propagation is through ground and they follow the curvature of the ground well. They can also get reflected from the atmosphere's ionosphere at night allowing medium-to-long-range broadcasting. Some of the countries of the world are using medium wave transmitters upto 2000 Watts (2 MW) power, covering a range of several hundred kilometres radius. MW transmissions, however, suffer from night time shrinkage of service because of interference from sky wave signal, which is otherwise absent in daytime. All India Radio is making use of the Medium Wave band for its domestic broadcasting and also for service to neighbouring countries with transmitters ranging from 1 KW to 1000 KW.

Shortwave as a medium of radio communication received its name because the wavelengths in this band are shorter than 200 m (1500 kHz) which marked the original upper limit of the medium frequency band first used for radio communications. Short wave is also known as HF (High Frequency) that covers the range of 3-30 MHz for radio broadcasting.

Initially thought to be useless, shortwave radio is used for long distance communication by means of reflection from the ionosphere. This mode of propagation is also known as **skywave** or **skip propagation,** allowing communication around the curve of the Earth. It is therefore mostly used for international broadcasts by various countries including India. In India, however, Shortwave (HF) is also used for supplementing its domestic MW services by virtue of special dispensation given to it by being a tropical country.

Medium Wave and Shortwave broadcasting is conducted in Amplitude Modulation (AM), regarding which you will read more in the section below.

6.4.2 Amplitude Modulation (AM) & Frequency Modulation (FM)

Radio broadcasting can be categorized not only on the basis of the frequency bands that are used, but also by the precise method used for creating the radio signal. Let us understand this in greater detail.

As we have understood in a previous section, radio broadcasting is achieved by combining the source audio (the audio signal) with a radio carrier wave. A signal is any electronic stream that carries information. A carrier wave, as the name suggests, is a high frequency radio wave on which the audio signal can be mounted, or with which, you can say, it can be combined, in order to carry the audio signal much further than it would otherwise go. (Just as having a vehicle can let you travel comfortably over larger distances, the carrier wave carries the audio signal over a greater distance owing to its higher energy and greater capacity to travel over a distance without being dissipated). The process of combination of the carrier wave with the audio signal is called **modulation of the carrier wave**.

One of the ways in which this can be done is through **amplitude modulation** or **AM.** In AM, the modulation of the carrier wave results in the creation of a wave with the frequency characteristics of the radio wave, but whose amplitude varies according to the audio signal.

Consider the diagrams in Figure 6.6:

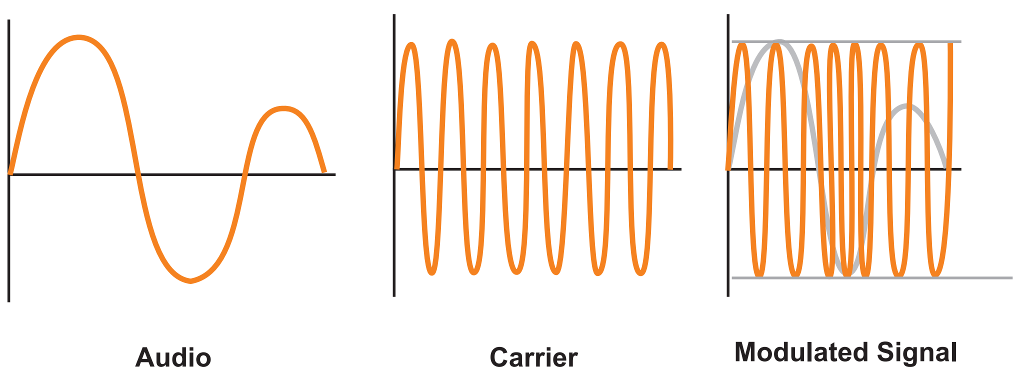


Figure 6.6: *Amplitude Modulation. Note the shape of the final output wave.*

As you can see, the output radio signal continues to have the carrier wave's frequency, but now has an amplitude variation that resembles the original audio. AM broadcasting continues to be the modulation technology used for MW and SW radio broadcasting.

The key challenge of AM broadcasting is that it is easily disturbed by natural phenomena like lightning, or by the sparkplugs from motor cars; or even high tension electrical cables, which generate strong magnetic fields around themselves.

Frequency Modulation, or **FM**, was a modulation technology that was developed subsequent to the invention of AM. In the case of FM, the modulated wave continues to have the same amplitude as the original carrier wave, but now has variations in frequency that correspond to the frequencies of the audio signal, as shown in Figure 6.7. You will learn more in detail about Frequency Modulation in Module-7, Unit 23.

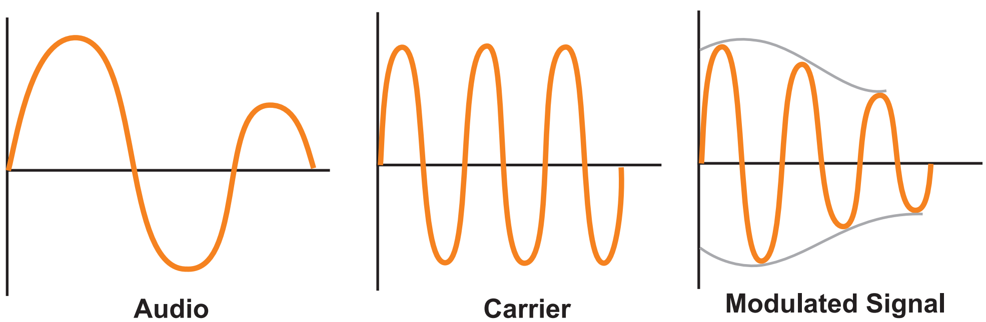


Figure 6.7: *Frequency Modulation. Note the varying frequency of the final output wave.*

Frequency modulation provides excellent high fidelity audio, and the ability to broadcast stereo audio – discrete signals for the left and right speakers – with comparatively few complications. It is also not disturbed by atmospheric or electrical phenomena, making it well suited to urban broadcasting. The advantages of FM over MW (AM) have already been given in Module-1. It is because of those advantages that it has been chosen for Community Radio. FM broadcasting is primarily a line of sight (LOS) propagation, although propagation also takes place beyond LOS by means of diffraction, scatter and ducting. You will learn more about frequency modulation and radio propagation in Module-7, Units 23 & 26. However, the summary of various modes is given below:

AMPLITUDE MODULATION (AM)			
Mode MF/MW	Total Band 300-3000 KHz	B'casting Band 526.5-1606.5 KHz	Propagation Ground wave (Day & Night) Sky wave (Night)
HF/SW	3-30MHz	3-30 MHz	Sky wave (Day & Night)
FREQUENCY MODULATION (FM)			
Mode VHF	Total Band 30-300 KHz	B'casting Band 40-230 MHz FM Band 87-108 MHz	Propagation Direct wave with ground reflected wave upto L.O.S. Diffraction, Scatter and Ducting beyond L.O.S.

Activity 6.2

Compile a list of all the radio stations that can be heard in your area. Present them as a table divided by type of modulation: FM and AM. Within AM, indicate if the station is MW or SW (if available). Include the frequency of broadcast for each channel.

6.5 A Brief History of Radio Broadcasting

Before we conclude this Unit, it is now time to take a quick look at the history of radio and radio broadcasting a part of which you have already learnt in Unit-1.

6.5.1 The International Experience

Radio waves were first predicted by the British physicist James Clerk Maxwell as part of his calculations on the wave theory of electromagnetism in 1865. Maxwell suggested that light and electromagnetism were connected phenomena. The first successful radio transmission was made in 1879 by James Edward Hughes but it was only in 1889 that the German physicist Heinrich Hertz proved conclusively that Hughes' experiment involved the transmission of electromagnetic (radio) waves. It is after Heinrich Hertz that our measure of frequency, the Hertz, is named.

By 1892, the physicist Nikola Tesla had demonstrated the transmission of energy through radio waves and predicted that it could be used for the transmission of information. This was subsequently demonstrated by the Italian physicist Guglielmo Marconi, who made the first practical radio transmission system capable of transmitting a signal over a range of one to two kilometres. (Though Marconi is widely regarded as the first radio broadcaster, there were a large number of researchers on radio by then, and this status is disputed. Indian scientist J.C.Bose is now co-credited in many publications as the inventor of radio broadcasting.) Marconi would later set up a company to explore the military and commercial possibilities of radio.

Though there are many claimants to the title, it is often quoted that Reginald Fessenden made the first radio broadcast on Christmas Eve in 1900, from Massachusetts, USA. Shortly thereafter, Marconi made the first experimental radio transmission across the Atlantic Ocean (London to New York) in 1901. Within the next twenty years, formal licensing of stations began on both sides of the Atlantic. Companies like Telefunken in Germany, NESCO in the USA, and British Marconi and American Marconi began to establish strong presence for radio; and radio began to be used for entertainment, music and education.

By the 1930s, Edwin H. Armstrong had invented FM transmission, which overcame several of the issues that plagued AM transmission, as we have seen in the previous section. By the 1940s, FM transmission was a commercial reality in Europe and America. During World War II (1939 – 1945), radio played an important part in propaganda broadcasts, as well as early warning systems for air raids.

By the 1950s, television had begun to replace the radio as the chief source of information and entertainment in the United States. Early TV stations developed during the 1930s, but only became really popular following the war years. But radio received a renewed resurgence in 1960, when Japan's Sony Corporation invented the first **transistorized pocket radio**, one that could be powered by small AA batteries. Radio suddenly became the portable medium everybody could enjoy as they moved about. And, with the resurgence of popular music in that country, radio became the young people's medium for music.

Radio underwent a decline through the 1980s and 1990s, in the face of changing listening habits. The increasing presence of television globally, as well as the increasing emphasis on live TV coverage of sports and public events meant that radio became a niche music medium. However, Video Cassette Recorders (VCRs) and Compact Discs (CDs) meant media could be increasingly consumed in a non-broadcast per-convenience basis, which disturbed traditional models. FM radio, in particular, began to rely on a core audience of commuters who listened to radio in cars while driving.

However, the 1980s and 90s also saw an increasing sense of localization which meant there was also a new interest in volunteer driven community radio, with countries such as Australia, Bolivia, and Colombia showing a resurgence of small stations broadcasting in local languages. Many countries have reserved frequencies for educational and civil society/non-profit radio.

The 2000s heralded a new beginning in the history of radio with three new developments: **streaming radio** stations on the internet, which use internet protocols to offer music and content globally; **mobile telephones** with FM radio receivers built in; and **satellite direct-to-receiver broadcasting**.

6.5.2 Radio Broadcasting in India

As you have learnt in Unit-1, radio broadcasting in India, though initially started as a private enterprise in 1927, had mostly remained in government hands till the year 2000, when it was opened to private broadcasters by offering to allot 108 channels in 40 cities. You have also learnt about the formation of Prasar Bharati and emergence of private Broadcasting & Community Radios in quite some detail there. Here we will recapitulate the brief history of Community Radio Scheme and learn about the technological journey of radio transmissions in brief.

Besides the decision to invite private participation in radio broadcasting as mentioned above, the Government also introduced the scheme of Community

Radio Stations. To start with, the government vide its notification made in December 2002, opened this scheme to established educational institutions/ organizations recognised by the Central and State Governments. Later in 2006, it broadened the policy by bringing it into the ambit of Non-Profit organizations in order to allow greater participation by civil society, specially on issues related to development and social change, thus giving birth to the Community Ratio Stations in their present form, about whose concept and evolution you have already learnt in Unit-1 of Module-1.

In terms of technology, Medium Wave (MW/MF) ably supported by Short Wave (SW/HF) remained the mainstay of domestic broadcasting in the country till FM was introduced on a large scale in All India Radio in late eighties. Although, FM was brought into the AIR network on an experimental basis, between 1977 and 1984 by installing 10 KW transmitters in four metros – the first one coming up in Chennai on 23rd July, 1977 – it was introduced in a big way only in late eighties when it was decided to install 100 FM Transmitters across the country. FM has been assigned as a technology for both Private Broadcasting and also for Community Radios.

Activity 6.3

How many CR stations are currently operational in India? Compile a current list of operational CR stations. Include details of the name of the licensee and which state the CRS has been set up in.

6.6 Regulatory Bodies and Processes

Any discussion of the radio waves would be incomplete without a discussion of the key regulatory bodies that govern broadcasting i.e. use of the radio waves for broadcasting globally and within India.

As we have seen, in the West, radio came up through a series of entrepreneurial and research experiments. By 1926, the government of the United States felt a need to create a regulatory body that could oversee adjudication as well as use of frequencies by competing entities, which resulted in the setting up of the **Federal Radio Commission** that year. The commission was expected to regulate radio use “as the public interest, convenience, or necessity” required.

By 1934, however, the commission was replaced by the newly constituted **Federal Communications Commission** which oversaw all communications related decision making from a regulatory and adjudicatory point of view. This was a far reaching thought in the early days of mass communication as we now see it today; and was the core model adopted in many countries as time passed.

Internationally, the UN body known as the **International Telecommunications Union (ITU)** oversees spectrum allocation agreements and conventions across its member countries. Originally established as the International Telegraphic Union in May 1865 – and thereby predating the UN as an organization – it was envisioned as a cooperative body for establishing standards for the then nascent telegraphic system.

Today, it is a specialized UN agency of the United Nations that is responsible for issues that concern all information and communication technologies. The ITU coordinates the shared global use of the radio spectrum, promotes international cooperation in assigning satellite orbits, works to improve telecommunication infrastructure in the developing world, and assists in the development and coordination of worldwide technical standards.

ITU also organizes worldwide and regional exhibitions and forums, such as ITU TELECOM WORLD, bringing together representatives of government and the telecommunications and ICT industry to exchange ideas, knowledge and technology.

The ITU is active in areas including broadband Internet, latest-generation wireless technologies, aeronautical and maritime navigation, radio astronomy, satellite-based meteorology, convergence in fixed-mobile phone, Internet access, data, voice, TV broadcasting, and next-generation networks. Within it, the ITU-R subgroup is responsible for decisions regarding global radio communications (including the decision on bands allocated for special services, frequency allocations to global zones and individual countries, and so on.)

ITU is based in Geneva, Switzerland. Its membership includes 193 Member States and around 700 Sector Members and Associates.

Within India, the key decision making body is the **Wireless Planning and Coordination Wing (WPC)** of the Ministry of Communications & Information Technology of the Government of India. The department is responsible for issuing amateur radio licenses, allocating spectrum, and monitoring the use of allotted spectrum. The WPC is headquartered in New Delhi and has regional branches in Mumbai, Chennai, Kolkata and Guwahati. WPC is divided into major sections like **Licensing and Regulation (LR)**, **New Technology Group (NTG)** and the **Standing Advisory Committee on Radio Frequency Allocation (SACFA)**.

WPC is responsible for the following key functions:

1) To make rules in India for wireless transmission.
2) To follow international wireless communication rules.
3) Conduct radio telephony and telegraphy exams in India.
4) Monitor illegal use of frequencies.
5) Conduct frequency management, i.e. allot frequencies to Indian wireless users and clear interference in wireless.

SACFA makes the recommendations on major frequency allocation issues; formulation of the frequency allocation plan; making recommendations on the various issues related to the International Telecom Union (ITU); and siting clearance of all wireless installations in the country.

As far as community radio is concerned, applicants approach WPC for the allocation of a frequency (issued in the form of a **Frequency Allocation** or **FA letter**), and permission to set up a wireless broadcasting station (given in the form of a **Wireless Operating License**, or **WoL**). The annual spectrum fee, currently Rs.19,700/- annum, is also payable by the allottee to WPC. Permission to set up a transmission system at a specific location is given by the SACFA wing, in the form of a **siting clearance letter**.

6.7 Let Us Sum Up

Through this Unit, you have been introduced to the concept of waves, and their characteristics: frequency, wavelength and amplitude. You have understood electromagnetism as a natural phenomenon, and the related concepts of radio waves, and radio spectrum. You have also learnt about the division of radio spectrum into bands, and then into channels/frequencies.

We have also seen overviews of the modulation processes used for radio broadcasts: Amplitude Modulation (AM) and Frequency Modulation (FM). Finally, we have understood the role of key regulatory bodies, national and international, that decide issues ranging from frequency allocation to spectrum management: the ITU (and its subsector, the ITU-R); the WPC of the Govt. of India, and its various wings, including the SACFA wing.

6.8 Model Answers to Activities

Activity 6.1

WiFi routers use an unlicensed part of the radio spectrum. These frequencies lie in the 2.4 GHz band, and usually range from 2.4 GHz to 2.4835 GHz.

The router that I checked is a Micronet 980 PS, which can operate on the 802.11 b and g bands, in the 2.4 GHz range.

Activity 6.2

S.No.	Station	Frequency Modulated (FM) or Amplitude Modulated (AM)	Frequency of broadcast
1.	Vividh Bharati (AIR) (Delhi)	AM (MW)	1368 kHz
2.	Radio Mirchi	FM	98.3 MHz
3.	Hit FM	FM	95 MHz
4.	AIR FM Gold	FM	106.4 MHz
5.	AIR FM Rainbow	FM	102.6 MHz

Activity 6.3

A current list of CRS licenses issued by the Ministry of Information & Broadcasting, Govt. of India, is available at this link: http://www.mib.nic.in/linksthird.aspx. Use this as a basis to make a list as follows:

S.No	Name of CRS licensee	State
1.	Abid Ali Khan Educational Trust Radio Mirchi	Andhra Pradesh
2.	Keshav Memorial Education Society AIR FM Gold	Andhra Pradesh
3.	Boon Education, Environment & Rural Development Society	Andhra Pradesh
4.	Deccan Development Society	Andhra Pradesh
5.	University of Hyderabad	Andhra Pradesh

UNIT 7

Basics of Electricity

Structure

7.1 Introduction

In Unit 5, you have studied that power supply switch gear is required to connect power to all the audio recording, editing, playback, transmitting and ventilation equipment. Size and ratings of components of power supply switch gear depend on the connected load and number of hours the equipment are kept ON. In the next Unit 8, you will learn about the sources of backup supply and process of voltage stabilization. Knowledge of electrical basics that we will discuss in this Unit shall help in operation, maintenance and servicing of power supply equipment. In this Unit, we shall focus on the following topics:

- Electrical basics
- AC/DC current
- Load distribution
- Power consumption and conservation

In the video on electrical basics and power supply backup systems, you will also get a chance to study the visual representation of these basic concepts including graphical representations of AC/DC voltage and current waves as described in this Unit. The glossary given at the end shall be helpful in understanding the content of this Unit.

You may require about 10 hours to complete this Unit including solving the questions given in the Activities.

7.2 Learning Outcomes

After working through this Unit, you will be able to:

- list and describe the fundamentals of electrical basics.
- describe phase, neutral and earthing.
- differentiate between AC/DC currents.
- analyse the colour coding of wiring.
- explain load distribution and balance.

7.3 Electrical Basics

Any person, for example, an engineer or a technician dealing with power supply equipment must have a clear understanding of the electrical basics such as current, voltage, and power. Touching any terminal or wire without knowledge may be even fatal. In this section, you will learn the fundamentals of the following terms:

- Electrical Current, Voltage and Power
- Phase, Neutral and Earthing.

Let us now define electrical current, voltage and power.

7.3.1 Electrical Current, Voltage and Power

As you are aware that all equipment are specified for its power, voltage and current. For example, a 100 watt bulb means it will consume 100 watt of power when connected to 230 V mains supply. When a particular voltage is applied to the equipment, amount of current flowing through it will depend on its resistance. In this subsection, you will learn about the basic concepts of current, voltage, resistance, power and energy. You will also learn about the fundamental Ohm's law which gives the relation between current, voltage and resistance.

Current (I)

The term 'current' is used to denote the rate at which electricity flows. It is the quantity of electricity which passes through a given point in one second. The magnitude of the current depends not only upon its operating voltage but also upon the nature and dimensions of the path through which it circulates. The symbol 'I' is used to denote current and its unit of measurement is called an Ampere (A). The current flows from a point of high potential (+ve) to a point of low potential (-ve).

Electromotive force (E) / Voltage (V)

Voltage is defined as electrical pressure or electromotive force which causes the flow of current in any circuit. It is called as Electromotive Force (EMF). Symbol E/V is used to denote it. Voltage is sometimes referred to as potential. The unit of electromotive force/voltage is volt. Volt is defined as the potential difference across a resistance of one ohm carrying a current of one ampere.

Resistance (R)

Resistance is defined as that property of a substance which opposes the flow of electricity through it. It is represented by R. The unit of resistance is Ohm (Ω). Ohm is the resistance of a circuit in which one ampere current flows when potential of one volt is applied across its two terminals. Its bigger unit is megaohm which is equal to 10^6 ohms. Its smaller units are microohm (10^{-6} ohm) and milliohm (10^{-3} ohm).

Resistance of a Conductor

Cables and wires are used for connecting voltage to the load which can be any equipment or machine. These conductors or wires have a definite resistance which cause drop in voltage till it reaches the equipment.

Resistance of a conductor varies:

- Directly as its length (i.e. as conductor length increases resistance increases).
- Inversely as its cross section (i.e. as cross section of conductor increases the resistance decreases).
- With temperature depending upon the temperature coefficient of a particular material of a conductor.

Resistivity (ρ)

The resistivity of any material is the resistance of a piece of material having a unit length and unit sectional area. Its symbol is ρ (rho) and unit of measurement is ohm-meter.

Power (P)

Power is defined as the rate of doing work. The electrical unit of power (P) is the Watt (abbreviation W). Bigger unit of power is called kilowatt (kW) which is equal to 1000 watts.

Power is also defined as the product of voltage and current.

Using the symbols, we can write;

1W = 1Vx1A or W =V x I

Energy

Energy can be defined as power x time. Energy = V x I x t, where t is the time in seconds. The unit of energy is Joule, which is equivalent to flow of 1 ampere of current at 1 volt for 1 second. The practical unit for energy is the kilowatt hour and is given by:

Watts x hour/1000 = kWh. 1kWh is equivalent to 1 unit of energy or power consumed.

Ohm's Law

Ohm's law is the most fundamental and basic law which defines the relationship between voltage, current and resistance. Ohm's law states that the current in a DC circuit is directly proportional to the applied voltage and is inversely proportional to the resistance of the circuit.

Using the symbols I, V and R to represent the current, voltage and resistance respectively, Ohm's law can be written as: I = V/R or V= I x R

7.3.2 Phase, Neutral and Earthing

In this subsection, you will learn the basic concepts of Phase, Neutral and Earthing commonly used in AC power supply distribution system.

Phase Voltage

In case of single phase supply, the phase voltage used is 230 Volts with respect to neutral. In case of three phase supply system, the voltage between any one of the three phases with respect to neutral is 230 V. Voltage between any two phases out of three phase is 400 V ($\sqrt{3}$ x 230 V= 1.73x 230 = 400 volts).

The rating and size of switch gear, cables, MCBs etc. depend upon the power, voltage and currents that they can safely handle. You will learn about load distribution on single or three phase supply and circuit breakers in Section 7.5.

Neutral

The second or return terminal of each load/equipment is connected to the neutral. When phase supply is connected to the load through a switch, the current flows from phase, passes through the equipment and returns through its neutral.

For small loads like bulbs, fans and tube lights, switches are not provided in the neutral wire. However, for a group or large loads neutral is provided through linked switches/MCBs. For a single phase working, the size of neutral wire is same as that of phase wire. Whereas for three phase balance loads, size of neutral is usually half the size of phase wires.

Earthing

Earthing is a process by which all metallic parts of any appliance or instrument are connected to an earth electrode buried deep in the ground to maintain them at zero potential.

Earthing is necessary to:

- Protect operating personnel from electric shock during short circuit or leakage of phase.
- Protect operating personnel, equipment and building during lightning.

Earth resistance is the minimum resistance in ohms provided by the earth system. It should be as low as possible (preferably less than one ohm).

As per Indian Electricity Rules, double earth is to be provided for all those equipment working on three phase supply, power supply switch boards and three phase motors of 5HP and more.

Earth resistance of the earth pit is measured by using the earth tester. You will learn more details on checking the earth conductivity in Unit 28 of Module 8.

Activity 7.1

To do this activity, you may need about 20 minutes to write down the answers in the space provided. This activity will help you in understanding the basics of electricity including the relationship between the voltage, current, resistance and power.

Question 1: Define power in an electrical circuit. What is its unit of measurement? When a voltage of 100V (DC) is applied to a heater, a current of 10A flows through it. How much do you think will be the power of that heater?

Question 2: A wire has a resistance of 10 ohms. Find out the resistance of another wire of same material but having thrice the length and twice the cross-section area.

Question 3: Define Ohm's law and its application to electrical circuit. A circuit has a resistance of 50 ohms. How much current will flow through it when a voltage of 200 V is applied across it?

Question 4: What is earthing? Why is it necessary to run earth wire along with phase and neutral to connect supply to the equipment rack? What can happen if there is a break in earth wire?

7.4 AC/DC Current

In this section, you will learn some of the commonly used electrical basics relevant to AC and DC circuits. Here, you can watch a video at http://tinyurl.com/pdqcrgt. This video is explaning about the basics of electricity, AC-DC currents, electrical phase load balancing, power inversion and voltage stabilisation, colour coding of the wires etc.

Power Backup for CRS

http://tinyurl.com/pdqcrgt

Alternating Current (AC)

AC means alternating current in which current or voltage changes its direction and magnitude with time. Variations of current and voltage take the shape of a sinusoidal wave. The graph of the AC voltage is shown in Figure 7.1.

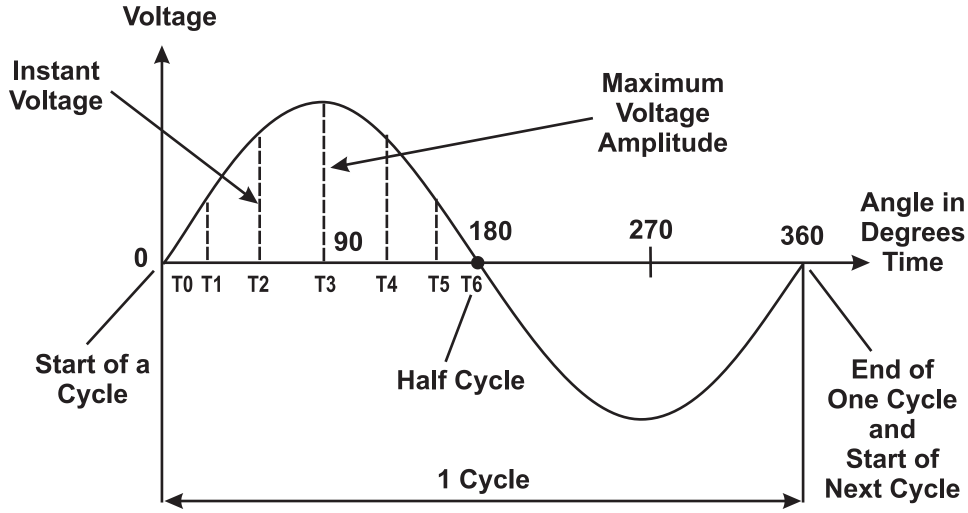


Figure 7.1*: Graphical representation of AC voltage*

As may be seen in Figure 7.1, the X-axis represents the angle in degrees covered in time 't' by a voltage/current wave and Y-axis represents the amplitudes of voltage and current. The voltage varies from zero to maximum (at 90 degrees) and back to zero (at 180 degrees) in half cycle. In the second half cycle, the voltage becomes negative, goes to minimum value (at 270 degrees) and then comes back to zero (at 360 degrees) thereby completing one cycle. The amplitudes v_1 to v_5 represent the instant values of voltages at times t_1 to t_5.

The important characteristics of this sinusoidal AC voltage wave with reference to Figure 7.1 are as follows:

- A complete change in value and direction of alternating voltage is called one cycle.
- The time taken to complete one cycle is called its period.
- Number of cycles that this sinusoidal wave travels in one second is called its frequency.
- The frequency of AC supply used in India is 50 cycles/second.
- The maximum value attained by the voltage in half cycle is called its amplitude or maximum value.
- Voltage value at any instant of time in the cycle is called its instantaneous value.

Relation between voltage and currents in AC circuits

When a sinusoidal AC voltage is applied to the equipment, the current varies according to the type of load. The load may be resistive, inductive or capacitive. Figure 7.2 shows the graphical representation of relationship between the applied voltage and the resultant current produced by it for various types of loads.

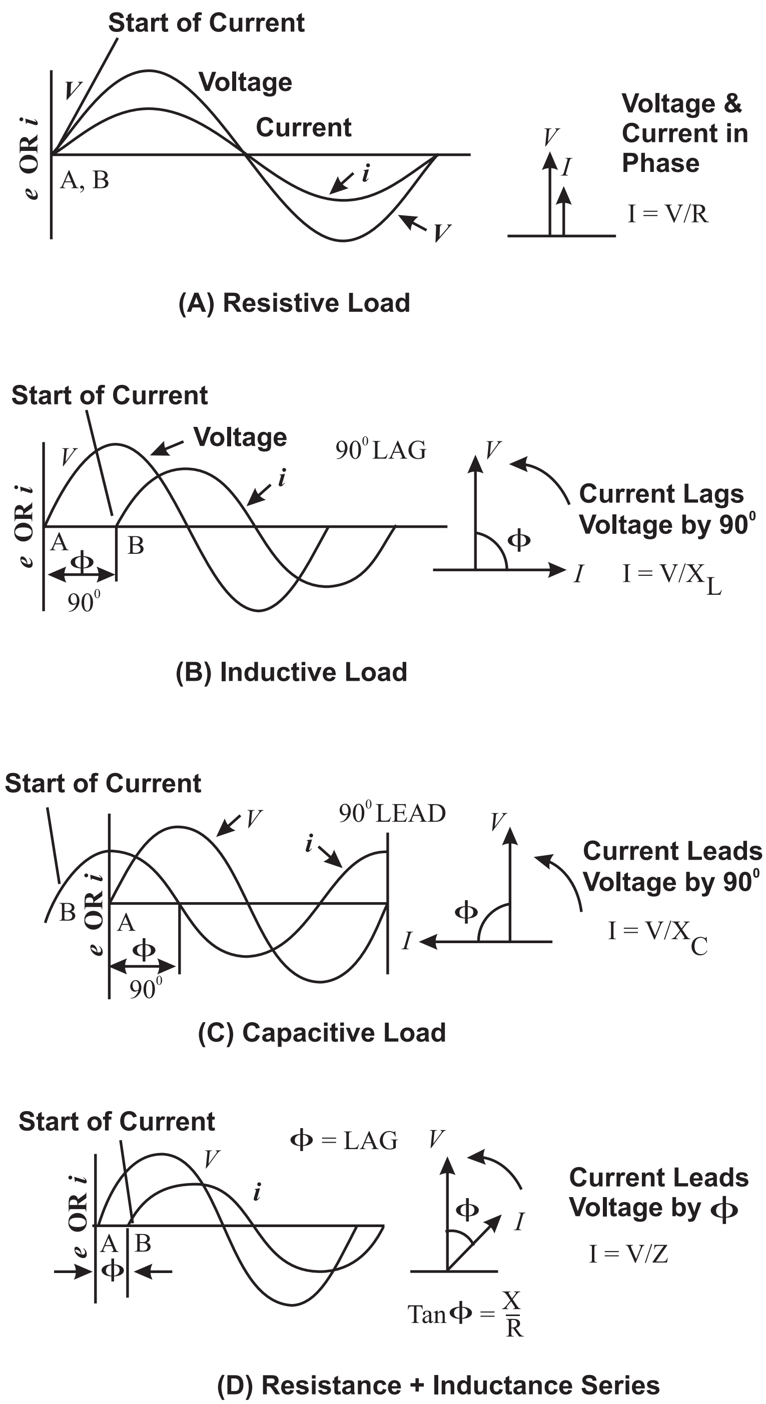


Figure 7.2: *Graphical representation of voltage for different types of load.*

In Figure 7.2(A) to 2(D), X-axis represent the angle travelled in degrees and Y-axis represent the amplitudes of both voltage and current waves. The location of start of voltage cycle (**point A**) and start of current cycle (**point B**) in Figure 7.2(A) to 2(D) may be *noted* for different types of loads. When the load is pure resistive, the current is in phase with the applied voltage (*both A and B are together*). If load is a pure inductive, the current lags behind the voltage by 90 degrees (*B starts after a delay*). If load is a pure capacitive, the current will lead the voltage by 90 degrees *(B starts before A*). Figure (D) illustrates the practical case where the load used is a combination of resistance and inductance, which is found in almost all the equipment. Here also current starts after a delay by an *angle ö* which depends on ratio of resistance to its impedance value.

Power factor

As seen in the Figure 7.2 above, when AC voltage is applied to any load which is not purely resistive, the current produced may not be in phase with the applied voltage. Current may lead or lag from the applied voltage by some angle. Usually the angle is represented by symbol φ (phi). *Cosine of this angle (cosφ) is called the power factor of that load.* Ideally, power factor (P.F) is unity for a pure resistive load ($\varphi=90^0$, cos 90 = 1). It is less than unity for reactive (non resistive) loads. Low power factor reduces the true power thereby reducing the efficiency of the system.

Direct Current (DC)

DC means Direct Current. It does not change its direction and magnitude and is steady at all the times. For example, the voltage generated by battery cells, accumulators and dynamos is pure DC. Most of the modern equipment such as portable recorders, small power transmitters and computers work with regulated DC power supplies. This DC power supply is however, obtained by rectifying the AC supply by use of AC to DC adaptors. Equipment operating on 2-wire DC requires a source of supply which can give constant desired rated voltage. Conventional current flows from positive (+) terminal marked red to negative (-) terminal marked black or blue. All the relations between current, voltage and power including ohm’s law mentioned above in section 7.3 are fully applicable to DC circuits.

Activity 7.2

To do this activity, you may need about 15 minutes to write down the answers in the space provided. This activity will help you understand the difference between AC and DC supplies and their applications.

Question 1: What do you understand by AC or DC supply? Give one example of each type.

Question 2: Explain the difference between average current and RMS current. Which of these currents is used for calculating the power in AC circuit?

Question 3: What do you mean by the term power factor in AC supply? What is its ideal value? How power factor can be improved.

7.5 Load Distribution

Before applying for power supply connection, it is necessary to estimate the total load requirements of a Radio Station. Based on this load, a single phase or three phase power supply connection is obtained. Load distribution circuit is planned by using suitably rated cables, switches and circuit breakers. In this section and the sub-sections that follow, you will learn the following:

- Single Phase and Three Phase Distribution
- Balancing of Loads
- Circuit Breaker(MCB), Isolator and ELCB

Let us first proceed with single phase and three phase distribution system.

7.5.1 Single Phase and Three Phase Distribution

Single phase distribution

As the power supply load requirement of a Community Radio Station is small, of the order of 5 to 10kW, single phase distribution is normally used. In this system, all the equipments of the station are divided into different groups and the single phase supply (240V) is connected to respective equipment of the group through properly rated switches. The size and rating of cables and MCBs depend on the amount of current flowing through them. Figure 7.3 illustrates a single phase power supply distribution arrangement for a typical Community Radio Station.

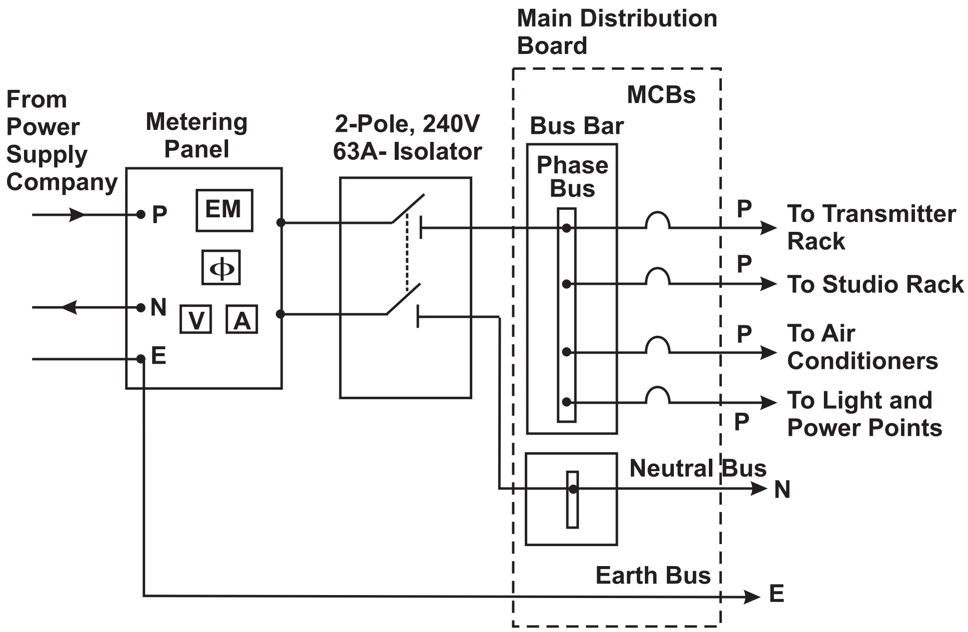


Figure 7.3: *Schematic showing the single phase load distribution*

In Figure 7.3, you will note that in case of single phase distribution, the input supply is terminated at the metering panel having energy meter, voltmeter and an ammeter. The output of metering panel is connected to main distribution board via an isolator switch. This switch is used to disconnect the power supply to the distribution board while servicing or making connections in bus-bar for further distribution. The output of the main distribution board is divided into different groups such as transmitter, studio, air conditioner, light and power loads by use of properly rated MCBs. The further distribution to each equipment is given through three-pin sockets or individual switches. This type of distribution reduces the size and rating of cables, MCBs etc. You may also note that neutral and earth wire to individual equipment is not provided through switches.

Three phase distribution

In large installations, where the total connected load is more, it is advantageous to take 3 phase supply from the electric company. Three phase 3-wire system is suitable if the load is fully balanced (such as three phase motors). However, in most of the cases, the station load is mixed i.e. some of the equipment including lights and fans may operate on single phase whereas some others may operate on three phase supply. In such cases, three phase 4-wire system is usually used. In this system, there are three 'lines' and a neutral. The voltage between any one 'line' and neutral is 240V and voltages between the 'lines' is 415V. Figure 4 illustrates the three phase 4-wire distribution system for a typical Radio Station.

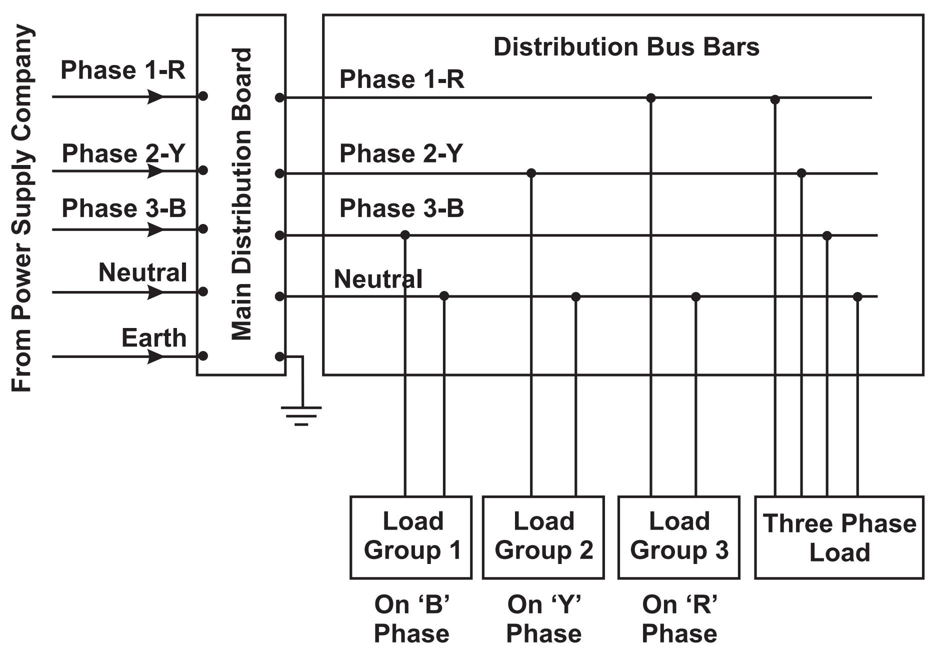


Figure 7.4: *Schematic of three phase 4-wire distribution*

As seen in Figure 7.4, three phases and neutral are first terminated on a metering panel similar to that of single phase distribution. The output of metering panel is connected to a bus-bar system through an isolator switch. The output of bus-bars is connected to a distribution board having MCBs for each group of load. The equipment and machines operating on single-phase are connected to one of the phase (R, Y, or B) and neutral. Equipment working on three phase supplies such as high power transmitters and motors are connected to three lines marked 1, 2, 3, and neutral. While distributing the loads, it is necessary that all electrical wiring at any installation is done in accordance with the relevant Code of Practices issued by Bureau of Indian Standards. Separate insulated and colour coded wires and cables are used for phase, neutral and earthing.

The colour code used for identification of these wires in case of single phase distribution is as follows:

- Red for phase
- Black for Neutral
- Green for Earth

In case of a three phase power supply distribution system, the colour code for three phases is R (Red), Y (Yellow) and B (Blue). Black and Green are used for neutral and the earth respectively.

7.5.2 Balancing Load

In this sub-section you will learn what is balancing of loads.

In case of three phase distribution system, if the power factors and the phase (or line) currents of the three phases are not equal then the load is called unbalanced load. It is therefore, necessary that all the equipment operating on single phase are connected to each phase in such a way that phase (or line) currents of each phase are nearly equal. Inductive loads reduce the power factor, therefore, special care is taken for balancing the inductive loads. This is done by checking the current and power factor of each phase separately. Low power factor, if noted, is to be improved by providing suitably rated power factor correction capacitors.

7.5.3 Circuit Breaker (MCB), Isolator and ELCB

In this section, you will learn the functions and use of the following:

- Circuit Breaker (MCB)
- Isolator
- ELCB

Let us start first with Circuit Breakers.

Circuit Breaker (MCB)

A circuit breaker is a device which connects the phase (phases) of supply to the distribution boards or individual equipment under normal conditions. However, during overloads and fault conditions the circuit breaker automatically trips the power supply to whole or part of the circuit depending upon its position in the distribution circuit. It can be reset manually once the fault is cleared.

Miniature Circuit Breakers (MCBs) are now being used widely as protective devices in consumer premises for group switching and individual circuits. MCBs are available in a wide range (0.5A to 100A) for the desired applications.

Selection of MCB for a particular application depends on the following:

- Power rating of load (i.e. Wattage indicated on equipment/ appliance)
- Switching currents
- Normal running currents
- Breaking currents
- Operating time requirements

Isolators

Isolators are conventionally used switches which are provided at input of main distribution board. They are usually manually operated switches and are used to isolate the main supply while doing repairs and servicing. For example, a TPN (Three Phase Neutral) switch is provided at the first input stage of the Main Distribution Board to isolate/switch off the supply before doing any repair or maintenance in the Distribution Board.

ELCB (Earth Leakage Circuit Breaker)

ELCB is a special type of a circuit breaker which detects the unwanted potential in the earth circuit. All the metallic components of any switch or distribution board are connected to earth and there is no potential or voltage at these points. However, due to some fault or leakage, if a sufficient potential (usually greater than 50 V) is developed in the earth circuit, then ELCB detects this fault (normally called earth leakage fault) and trips the main supply before it causes any damage to the equipment and the personnel.

Activity 7.3

To do this activity, you may need about 20 minutes to write down the answers in the space provided. This activity will help you understand the difference between AC and DC supplies and their applications.

Question 1: Why three phase distribution is better than single phase for higher and balanced loads?

Question 2: How can we know that the loads in three phase system are not balanced?

Question 3: What is the difference between MCB, Isolator and ELCB with respect to their field of application?

We will now proceed to learn the practical aspects of calculating power consumption and steps to conserve power as required in field.

7.6 Power Consumption and Conservation

In this section, you will learn what is power consumption and conservation.

Power consumption means the amount of power (energy) consumed by the user. Monthly consumption is noted from the energy meter installed by the electric company at the premises of the user. Power consumption is noted in number of units. One kilowatt hour is equivalent to one unit. For example, if one kilowatt of load is kept on for one hour, power consumed will be equal to one unit.

The power consumption of a Radio Station depends on the following points:

- Total connected load or contract demand.
- Maximum demand (load of all those equipment which are kept on simultaneously during transmissions).
- Duration for which the loads are kept on.
- Power factor of the load.

Consumption is calculated by noting how much load was kept for how many hours. Calculations for connected load and maximum demand can be clearly understood from the data given in Activity 7.4 for a typical CR Station. Power consumption and bill can also be worked out.

Power Conservation

Power conservation means saving energy by using highly efficient and energy saving techniques. Some electric companies motivate energy users to reduce their consumption by giving certain concessions.

Since the transmitter and most of the studio equipment are all solid state, the power consumption is very small. Most of the consumption is due to air-conditioning units and lights and fans. Power consumption can be reduced by taking suitable measures as described in the following page.

Steps for conserving power:

- Use minimum possible air-conditioners and that too with energy saver modes.
- Use Compact Fluorescent Lights (CFL) instead of incandescent light bulbs.
- Switch off all equipment such as mixers, recorders, computers and other equipment when not in use.
- Use transmission time efficiently.
- Use maximum possible natural light.
- Use thermally insulated walls and ceiling to have a maximum efficiency of cooling system.
- Use slogans to remind people to be cautious in conserving energy, such as
- Help conserve energy. Turn off lights when leaving.

Activity 7.4

Power supply loads of a particular CRS are given in the Table below. On the basis of load and hours of operation shown against each item, calculate the total daily and monthly consumption. Also calculate the monthly power supply bill by taking rate at Rs 5 per unit (1 kWh).

Sl. No.	Equipment	Load (Wattage)	Qty.	Hours of Operation	Total consump-tion in kWh (units) per day	Total monthly consump-tion (30 days)
1	50 W Transmitter operating at 50% efficiency	100 W	1	10		
2	Equipment rack with audio processor/ exhaust fan and power amplifier etc.	500 W	1	10		
3	Audio mixers/ consoles	500 W	1	10		

4	Computers/ audio work stations	500 W	2	10	
5	Air conditioners (1ton)	1500 W	2	10	
6	Tube lights	40 W	8	10	
7	Fans/exhaust fans	60 W	2	10	
8	Street light/ office lights/ corridor lights	60 W	4	12	
9	Total monthly consumption				
10	Total monthly Bill @ Rs 5 per unit				

To do this activity you may need about 30 minutes to write down the answers in the space provided. This activity will help you in calculating and analyzing the power consumption bills. Proper analysis will help you in understanding the importance of power conservation. By taking suitable measures you can conserve a lot of power.

7.7 Let Us Sum Up

In this Unit on Electrical Basics you have learnt:

- That knowledge of electrical basics is essentially required for understanding the operation, maintenance and safety of equipment and operating personnel.
- The definitions of basic terms such as current, voltage, resistance and power. When any voltage is applied to the equipment current flows through it. The quantity of current depends on the power rating of that equipment.
- That the Ohm's law is a most fundamental law which decides the relation between current, voltage and the resistance offered by the equipment. According to this law the current in any circuit is directly proportional to the applied voltage and inversely proportional to the resistance of a circuit.

- That in case of single phase 2-wire system, supply from the electric company is connected to the consumer's premises by two wires. One wire which is having a potential of 240 V is called a phase wire or a 'live' wire. The second wire is called the neutral or the return wire. In order to protect equipment and the operating personnel from electric shocks due to leakage or short circuits, a third wire called earth wire is also provided.
- To differentiate between AC/DC currents and their applications. Generation, transmission and distribution are much easier and economical on AC supplies. (However, DC supply is more suitable for DC motors, battery chargers etc.)
- Load distribution on single phase and three phase systems along with identification of colour codes of wiring. (The specifications and code of practice have been standardized by Bureau of Indian Standards).
- To balance the loads in case of three phase distribution system.
- Method to calculate the power consumption for a typical Community Radio Station. (A Lot of power can be saved by using efficient and energy conservation techniques).

7.8 Model Answer to Activities

Activity 7.1

Question 1: Power is defined as rate of doing work. Its unit of measurement is watt. Power = voltage x current = 100x10 =1000watt =1kW

Question 2: Resistance of second wire = Resistance of first wire x ratio of length / ratio of cross-section

= 10 x 3 /2 = 5 ohm

Question 3: Ohm's law states that current in a circuit is directly proportional to the applied voltage and inversely proportional to its resistance provided other conditions like temperature are same.

I= V/R = 200V/50 ohms = 4 Amp.

Question 4: Connecting a metallic part of a body of equipment to the low resistance earth pit is called earthing. It is necessary to keep the equipment at zero potential. If earth wire breaks, voltage can develop on metallic parts. Any person touching the rack can get electric shock during leakage or short circuit faults.

Activity 7.2

Question 1: In AC supply, its voltage and current alternate in magnitude and direction at a certain frequency with time. In DC supply, voltage and current are of constant value and do not vary with time. Power supply received from Electric Company is AC where as a car battery gives DC supply.

Question 2: Average current is the mean value of instant currents in half cycle of AC supply and is equal to sum of instant values divided by number of instant values. RMS current is the root mean square value of an alternating current. RMS value is used for calculating power in AC circuits.

Question 3: Power factor is the cosine of angle of lead or lag of current from the voltage in the non resistive equipment like induction motor. Its ideal value is one. Power factor can be improved by connecting suitably rated capacitors in parallel to non resistive load.

Activity 7.3

Question 1: Power consumption in three phase system is less for same load. Transmission and distribution losses are less. Size of the conductors required are smaller.

Question 2: If the power factors and the phase (or line) currents of the three phases are not equal, we can say the loads are unbalanced.

Question 3: MCBs are used to trip the power supply under overload conditions. Isolators are used to isolate supply during servicing or repairs. ELCBs are used to protect the system during earth leakage faults.

Activity 7.4

Sl. No.	Consumption per day in kWh (Units)	Consumption per month in kWh (Units)(30 days)
1	1000 watt-hours = 1kWh	30 kWh =30 units
2	5000 watt-hours = 5kWh	150kWh = 150 units
3	5000 watt-hours = 5kWh	150 kWh = 150 units
4	10000 watt-hours = 10kWh	300kWh = 300 units
5	30000 watt-hours = 30 kWh	900 kWh = 900 units
6	3200 watt-hour = 3.2 kWh	96 kWh = 96 units
7	1200 watt-hour = 1.2 kWh	36 kWh = 36 units
8	2880 watt-hour = 2.88 kWh	86.4 kWh= 86 units
9		Total consumption per month = 1748 units
10		Total monthly bill @Rs. 5/unit = Rs 8740

UNIT 8

Power Backup and Voltage Stabilisation

Structure

8.1 Introduction

In Unit 7, you have learnt about electrical basics including current, voltages, and power, and the difference between AC/DC currents. You have also studied about load distribution and balancing of loads with regular power supply input. In this Unit, you will learn about the sources of power backup and voltage stabilisation and their necessity in a Community Radio Station. You will also learn how power distribution gets modified by adding backup power supplies. In the sections/ subsections that follow, the need for backup supply and various sources of backup supply will be described under the following heads:

- Power Backup and Voltage Stabilisation
- Inverter
- UPS
- Generating Sets
- Voltage Stabilisers and CVTs
- Alternative Sources of Energy (solar, wind, hybrid)

In the video on electrical basics and power backup system, you will get a chance to study the visual representation of electrical basics which you have studied in Unit 7 such as AC/DC voltages and currents, load balancing, and colour coding of wires through graphics and animation. Video will also include the explanation of power backup systems, power inversion and voltage stabilization including alternate power generation systems which you are going to learn in this Unit. Glossary given at the end of this Unit will help you in understanding the content of this Unit.

You may require about 10 hours to complete this Unit including solving the questions given in the Activities.

8.2 Learning Outcomes

After going through this Unit, you will be able to:

- define various terms used in connection with backup supplies.
- list and describe the backup supplies used at a typical Community Radio Station.
- examine the process of UPS, Inverter and Genset and use them in CRS.
- analyze and compare the pros and cons of using different types of backup supplies.
- access various alternative sources of energy and apply some of these sources at the CRS.

8.3 Power Backup and Voltage Stabilization

In this section and the subsequent subsections that follow you will learn about the following:

- Power Backup and Voltage Stabilisation
- Inverter
- UPS
- Gen-sets
- Voltage Stabilisers and CVTs

Before going to start with Power Backup, you can again watch the video, which you have already got the reference in the previous unit (http://tinyurl.com/pdqcrgt). This video gives explanation of key electrical concepts and power backup systems through graphics and animation. The video also explains alternate power generation systems including photovoltaic, solar, thermal and wind.

As you are aware, the AC main input supply provided by the State Electricity Boards at most of the stations is not stable and reliable. Large variations and fluctuations in voltages are very common. In order to run a smooth transmission without any breakdown in service, it is necessary to have a standby or backup source of power supply which can be used during failures of AC main input supply. Similarly, voltage stabilisers are necessary to control the variations and fluctuations in incoming voltages.

In Unit 7, you have also learnt that before applying for power supply connection with the Electricity Department, you have to intimate the connected load and maximum demand required for Community Radio Station. Power supply load is usually calculated in terms of KVA (Kilo Volt Ampere) or in KW (Kilo Watt). Since generation of electricity through generators and other alternate sources is costlier than the supply received from Electricity Departments, it is therefore, necessary to know the minimum essential load that has to be switched on during mains supply failures.

In a typical Community Radio Station, essential load is of the order of about 3KVA (Kilo Volt Ampere). The second criterion is to know the duration for which the backup system should be able to generate 3KVA output. It is a normal practice to plan a battery backup for about an hour or two depending upon the failure rate of AC mains supply at that station. If the durations of power supply failure are longer and frequent, provision of diesel generator becomes more economical.

Figure 8.1 shows the block schematic of single phase power supply distribution along with power back interconnection for a typical Community Radio Station.

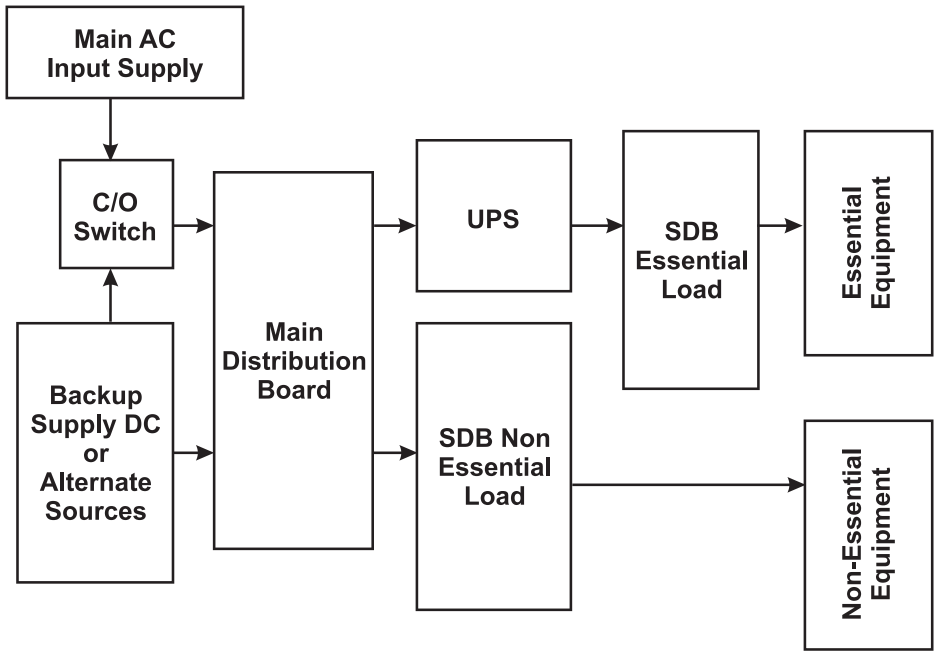


Figure 8.1: *Block schematic showing single phase power supply distribution including backup*

As may be seen in Figure 8.1, UPS system is added only for the essential loads. During prolonged failure of mains supply, standby supply can be extended through a second feeder, inverter, diesel generator or any alternate source. In subsections that follow, you will learn more about various backup power sources in detail.

Let us begin with the Inverter.

8.3.1 Inverter

In this subsection, you will learn about the inverter. An inverter is a device that converts DC voltage supplied either by a rectifier or the battery into AC voltage. Inverters are also used to supply AC power from various DC sources such as solar panels or wind turbines. Inverters are classified into different categories according to the output wave form generated by it. The main types include: square wave, modified sine wave and the pure sine wave. Square wave and modified sine wave inverters have high harmonic content and therefore, are not suitable for electronic equipment like tape recorders and transmitters. Pure sine wave inverters produce nearly perfect sine wave and are compatible with AC mains supply. The design is more complex and per unit power costs more.

Figure 8.2 below shows the schematic arrangement of the inverter which will help you in understanding its principle of operation.

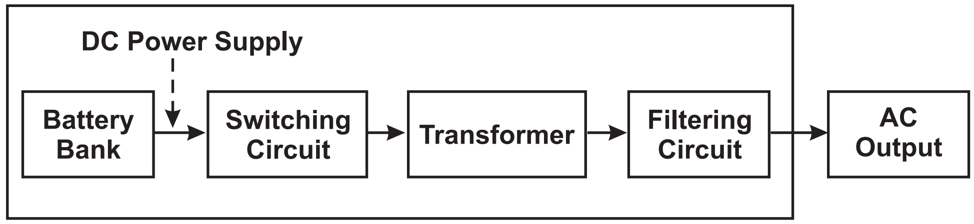


Figure 8.2: *Schematic arrangement of Inverter.*

It can be seen from Figure 8.2 that inverters are made up of appropriate transformers, switching and control circuits to give required output voltage at 50 Hz. A filtering circuit is provided at the output to remove the harmonics and to get the pure sine wave.

The DC power is connected to the centre tap of primary of a transformer through a switch. The switch is turned on and off at a specific frequency to produce alternating pulses in the primary winding. The alternations in the primary winding induce alternating current in the secondary winding. Primary to secondary turn ratio of the transformer decides the AC output voltage of the inverter and filtering circuit is used to remove harmonies.

Solid state inverters have no moving parts and are used widely for applications to computers and other electronic equipment. In case of electronic inverters, the 'On/Off' switching operation is performed by transistors and other forms of semiconductor devices. Inverters are also the main component in the UPS.

Inverters are normally specified in terms of KVA ratings and back up durations. The backup time for which the inverter can provide rated output depends on the ampere-hour capacity of the battery used in the inverter. The ampere-hour capacity is the maximum current it can deliver for one hour (see Box 1 below).

Box 1

For example, if capacity of a typical maintenance free 12 V battery is 50 Ah (ampere-hours), it means it can deliver 50 A of current for one hour or 25 A for two hours or 12.5 A for four hours. Series parallel combination of number of such batteries is used to give the desired backup period for the rated load. Putting two batteries in series doubles the voltage whereas Ah capacity remains the same. Putting two batteries in parallel keeps the voltage same but doubles the Ah capacity.

Activity 8.1

What is an Inverter? What are its important components? Briefly describe the function of each component. To do this activity, you may need about 15 minutes to write down the answers, in about 150 words, in the space provided. This activity will help you in understanding the principle of operation of the inverter.

8.3.2 Uninterrupted Power Supply (UPS)

In the preceding subsection you have learnt about the inverter. In this subsection, you will learn the most important backup source called UPS in which inverter is the main component. UPS, as the name suggests is a system of power supply that can continue to give uninterrupted power supply in the event of mains failure to various equipment connected to it for the duration it has been designed.

Uninterrupted Power Supply (UPS) systems have now become an essential requirement for almost all the Community Radio Stations so as to maintain continuity of broadcast transmission during failures or shut downs of regular power supply. It also acts as a buffer for voltage variations and fluctuations.

The capacity of UPS is normally specified in VA (volt amperes) or KVAs (kilo-volt amperes) and requirement is based on the essential load to be kept on during power supply failures. Standard low power units of 1KVA to 5KVA rating which are suitable for CRS are available in the market.

Power rating/capacity of UPS depends on maximum load of all equipment that are essentially to be kept switched 'ON' and for how much duration. As most of the CRSs are located in remote localities where AC mains supply is either not available during most of the time or it is erratic with a lot of fluctuations and variations in voltages, UPS becomes a necessity and are to be procured according to the requirement. It must be remembered that higher the rating of UPS, higher will have to be the battery capacity and therefore the cost increases. At places, such as university campus where power supply is fairly steady and breakdowns are minimum or places having a diesel generator backup, the size and rating of UPS can be small.

Components of UPS

A UPS system comprises of following essential components:

- A Rectifier and filtering circuit
- A Battery Bank
- A separate battery charger
- An Inverter

- On/Off and By-pass switches
- Harmonic Suppression Circuit
- Control and Protection Circuits
- Status and Fault Indicators

The functions of all the above components of UPS are explained in the paragraph given below and also in the paragraphs giving the description of types of UPS.

Input AC mains supply to UPS is first stepped down and rectified. It is filtered to remove the ripples and connected to a DC bus where battery is also connected. A separate charger is also provided for charging the batteries. The DC output from rectifier or the battery is connected to the inverter which converts the DC voltage back to AC voltage. Harmonic Suppression filter removes the harmonics to give a pure sine wave output voltage. Control and protection circuits are used to protect the UPS and the equipment against short circuits and over loads. Bypass switches are also provided to isolate batteries and input power supply during trouble shooting and maintenance. Applications of UPS vary depending on the type of UPS and method of use.

Types of UPS

Depending upon the required application, Uninterruptible Power Supply units can broadly be divided into three categories:

- On-line UPS
- Off-line UPS
- Line-interactive UPS

Let's briefly describe each of the three types of UPS.

On-line UPS

In On-line UPS, the load is always connected at the output of Inverter. The schematic arrangement showing the principle of operation is illustrated in Figure 8.3.

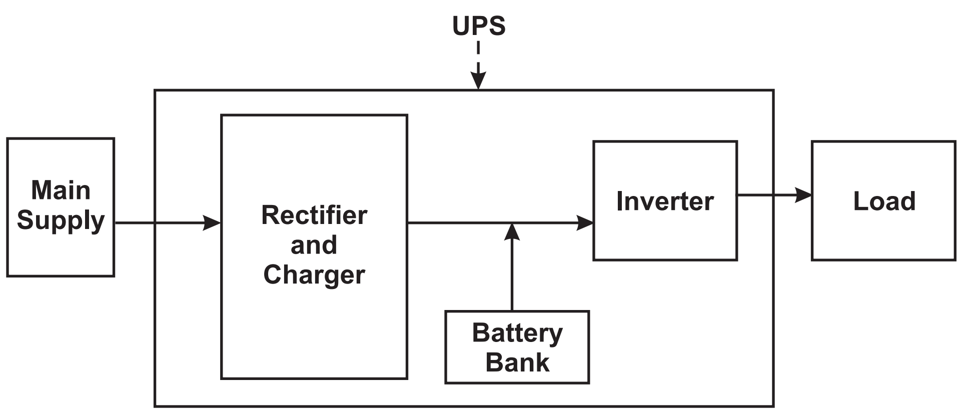


Figure 8.3: *Block schematic of on-line UPS*

As seen in Figure 8.3, AC main supply is first rectified and filtered to remove the harmonics or ripples and is connected in parallel to a battery bank. DC output of a rectifier and a battery is connected to the inverter circuit which reconverts the DC supply to AC supply. When main supply is off, DC supply of battery remains connected to the Inverter unit which continues to supply AC power supply to transmitter or studio equipment without any interruption. In this system, the transmitter or equipment remain on till the battery gets discharged.

The salient features of on-line UPS are:

- Inverter is on all the time and supplies output power even if main AC supply is available.
- Running time of the inverter on battery is generally less (half an hour to one hour) and depends on ampere hour capacity of battery.
- Batteries remain charged as long as AC main is through. It gets discharged during mains failure and gets recharged on restoration of main supply.

Off-line UPS

As seen in Figure 8. 4, the equipment is kept energized with mains supply. A charger operating from AC mains keeps the battery charged. The output of the inverter is normally not connected to the load. It gets connected to load through a manual or automatic change over switch as desired.

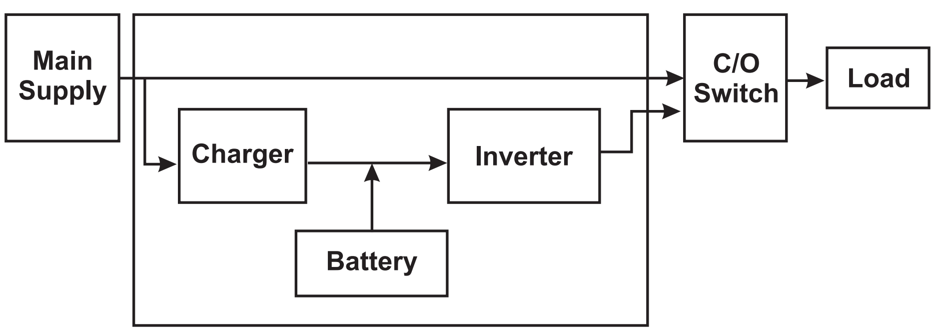


Figure 8.4: *Schematic arrangement of off-line UPS*

The salient features of off-line UPS are::

- Power for equipment is directly derived from AC Mains.
- Inverter is off when the mains supply is present.
- Batteries remain charged.
- Inverter turns on only when the mains supply goes off.
- Off-line UPSs provide no inherent protection from spikes which are dangerous for electronic equipment.

- They are more appropriate for areas with minimal power problems.
- They are the cheapest among the three types in terms of costs.

Line-Interactive UPS

A schematic arrangement showing the working of line-interactive UPS is illustrated in Figure 8.5.

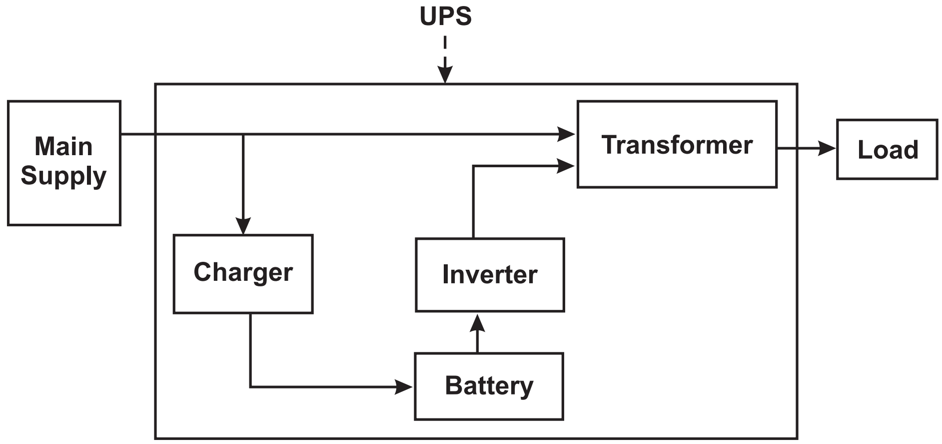


Figure 8.5: *Schematic arrangement of line-Interactive UPS*

As shown in Figure 8.5, AC supply is directly connected to the load via a transformer. Battery is not connected in parallel. However, it gets charged through a separate charger operated from the mains. Inverter supply is also on and connected to the load. Both the supplies are sharing the load. In case of mains failure, inverter continues to keep the system on. It is called line-interactive because it corrects the line voltages or switches to backup supply when variations are more and beyond the correction range.

The salient features of line-interactive UPS are:

- Battery power is only utilized when mains supply is not available.
- Line-interactive UPS is useful when voltage fluctuations are of more concern than breakdowns.
- An electronic circuit monitors the dips and spikes of mains input supply.

Activity 8.2

You are working in a Community Radio Station where power supply breakdowns are frequent. You are asked to suggest a suitable UPS for your station. What are the important points which you must consider before suggesting a particular type of UPS for your station? To do this activity you may take about 15 minutes, to write down the answers in about 150 words, in the space provided. This activity will help you in understanding the requirements and functioning of various types of UPS.

8.3.3 Generator Sets

In this subsection, you will learn another important back up source called Genset. The 'generator' is opposite of 'motor'. A motor converts electrical energy into mechanical energy whereas the *generator* converts mechanical energy produced by fossil fuels to electrical energy.

Because of the limitations of Ah (ampere hour) capacity of batteries, UPS cannot deliver output voltages especially when the power supply breakdowns are for longer durations, since the batteries get discharged.

Alternative source of AC supply is therefore, necessary. UPS with higher capacity of batteries become very expensive. Initial cost of generator may also be high but they are essential where breakdowns in power supply are for longer durations.

Generators of various sizes and types are available. Like UPS, generators are specified by KVA (Kilo-Volt Amperes) ratings. Portable generators can generate electricity by using kerosene, petrol or diesel. However, higher rated generators usually run on Diesel and hence are named as diesel generator.

Rating of DG set is decided on the load of CRS. If CRS is an independent isolated set up, the rating of DG is decided on the basis of maximum load requirement of equipment that are to be kept on during failure of normal power supply. However, when CRS is a part of a larger set up like university campus, where higher capacity DG sets may already be available, separate smaller DG sets may not be required. A separate line for DG supply can be extended.

Principle of operation of DG set

Every generator set has got basically two parts; the engine and the alternator. Like any other car engine, fuel energy is converted to mechanical energy which rotates a magnet. This rotating magnet, called the rotor, turns within a stationary set of conductors wound in coils on an iron core, called the stator. The rotating magnetic field induces an AC voltage in the stator windings. An automatic voltage control device controls the field current to keep output voltage constant. The output frequency of an alternator depends on the number of poles and the rotation speed used.

The salient features of Gen-sets are:

- Most commonly used as standby sources where power supply breakdowns are of longer durations.
- Suitable where fuels required for the Gen-set are available.
- Emit harmful exhaust gases.
- Initial costs are high.

Activity 8.3

Under what conditions do you feel Gen-set is necessary even if UPS has been provided at a particular Community Radio Station? Compare the functions and limitations of each.

To do this activity, you may need about 15 minutes to write the answers, in about 100 words in the space provided. This activity will help you in understanding the functioning and necessity of Gen-sets as well as UPS.

8.3.4 Voltage Stabilisers and CVTs

You might have observed that electronic equipment get damaged due to fluctuations in power supply.

In order to protect them, it is essential to use Voltage Stabilisers. In this subsection, you will learn functions and use of Voltage Stabilisers and Constant Voltage Transformers (CVTs).

Voltage stabilisers are the devices which control the variations/fluctuations of the main AC input power supply.

Basically three types of voltage stabilisers are used:

1. AVRs (Automatic Voltage Regulators)
2. CVTs (Constant Voltage Transformers)
3. EVRs (Electronic Voltage Regulators)

Automatic Voltage Regulators (AVRs)

In AVRs, input voltage is sensed and a control circuit provides a command to a motor which changes the tapping on the secondary winding to set it to the preset value. AVR has got certain limitations. It takes finite time to sense the variation and then to change the tapping of transformer. Its response time is therefore, higher. Presently servo stabilisers are most commonly used. Single-phase stabilisers usually employ only one variable auto-transformer driven by a motor and one sensing circuit. Servo mechanism automatically controls the tap changes in auto transformer by moving wiper on taps of transformer.

Constant Voltage Transformers (CVTs)

CVTs are also used to give constant voltage output. Its principle of operation is different from that of AVR. It works on the principle of magnetic saturation. When the iron core of a transformer is in saturation, large changes in winding current due to variations in input supply, result in small changes in output voltages. These transformers use LC (Inductor–Capacitor) 'tank circuit' tuned to the AC frequency of the supply to filter out the harmonics.

Saturating transformers provide a simple rugged method to stabilize an AC power supply. However, the operation in saturated region has the disadvantage of poor efficiency and sine wave distortion.

Electronic Voltage Regulators (EVRs)

EVRs use power semiconductor devices for regulation and are better than mechanical voltage regulators because of higher performance and speed of regulation. They are suitable for low voltage (< 600 V). A large range of EVRs are available in the market giving variety of useful features (see Box 2 below).

Box 2

Specifications of a typical Electronic Voltage Regulator:

- Microprocessor based closed loop control system.
- Digital voltmeter to read input and output voltages.
- Digital ammeter to read out current.
- Timer with delay of usually 5-10 seconds to avoid nuisance tripping.
- Output cutoff protection for over voltage and under voltage.
- Efficiency better than 98%.
- Use of Semiconductor devices in place of relays and switches.
- No effect of load power factor

Activity 8.4

Differentiate between the working principles of an Automatic Voltage Regulator (AVR), a Constant Voltage Transformer (CVT) and Electronic Voltage Regulator. Why Electronic Voltage Regulators are more suitable for CRS than AVRs and CVTs?

To do this activity, you may need about 15 minutes to write down the answers in about 150 words in the space provided. This activity will help you in understanding the functioning of different types of voltage stabilisers.

8.4 Alternative Sources of Energy

In this section, you will learn about the alternative sources of energy that can be used for generating power at places where regular power supply is either not available or very unreliable. Because of the depleting fossil fuels and increasing fuel costs, Government of India is giving special incentives/concessions for the development and use of alternative energy sources. The use of renewable power generation systems reduces the use of expensive fuels, allows cleaner generation of electric power and also improves the standard of living of many people in remote areas.

These alternative sources of power generating systems include:

- Solar Energy System
- Wind Turbines
- Hybrid Power System

Let us start with solar systems.

8.4.1 Solar Energy System

In this system, electricity is generated by using the light energy of the sun. A solar cell or photovoltaic cell is a device that converts light into electric current using photovoltaic effect. Solar cells produce direct current (DC) power, which fluctuates with the sunlight intensity. For practical use, this usually requires conversion to certain desired voltages or alternating current (AC) through the use of inverters. Multiple solar cells are connected inside the modules. Modules are wired together to form arrays connected to an inverter, which produces power at the desired voltage.

In developing countries like India, batteries or additional power generators are often added as backups to the solar power.

Such stand-alone power systems permit operations at night and other times of limited sunlight.

Concentrated photovoltaic (CPV) systems employ sunlight concentrators to focus more light on the surface of photovoltaic cells. Solar concentrators of all varieties are used, and these are often mounted on a solar tracker in order to keep the focal point upon the cell as the sun move across the sky. Concentrated Photovoltaics are useful as they can improve efficiency of PV solar panels drastically.

The salient features of solar power generators are:

- Photovoltaic systems use no fuel.
- Modules typically last for 25 to 40 years.
- Cost of installation is almost the only cost, as there is very little maintenance required.
- Unlike fossil fuel based technologies, solar power does not lead to any harmful emissions during operation.
- Solar power is seasonal, suggesting the need for long term storage system.
- Use of solar energy for operating CRS at a remote location is the most feasible option where making availabie, of mains supply, is not economical.

8.4.2 Wind Turbines

Wind is another alternate source of energy which is used to generate electricity. Wind turbine is a device that converts kinetic energy of the wind into mechanical energy and then to electrical energy. You might have seen a large number of turbines rotating especially near the sea coasts where high winds are continuously blowing throughout the year. These are called wind farms. A large wind farm consists of hundreds of individual wind turbines which are connected to electric power transmission network.

Principle of operation

Large size blades mounted atop a tower are connected to a turbine via a gear box. When a strong wind blows, the turbine rotates a rotor of an induction generator causing production of an alternating current. The mechanism in the gear box controls the movement of rotor at a constant speed. The output from a single turbine can vary greatly and rapidly as local wind speeds vary. When more turbines are installed over a large area and connected together, the average power output becomes less variable. The electricity generated by each turbine is coupled to transmission lines for distributing to the users.

The salient features of wind power are:

- Generation of electricity through wind is restricted to the areas/zones where constant winds are blowing during most of the time.
- It is a source of clean energy without any harmful emissions.
- The effects on the environment are generally less problematic than those from other power sources.
- It has low ongoing costs, but a moderate capital cost.
- With the improvements in wind turbine technology, the generation costs have also considerably reduced.

Small domestic wind turbines can be used to provide electricity to isolated locations normally not connected by regular power supplies. Isolated communities, that otherwise rely on diesel generators can use wind turbine as an alternative source. Individuals may purchase these systems to reduce their dependence on grid electricity for economic reasons. Wind turbines have been used for household electricity generation in conjunction with battery storage over many decades in remote areas.

8.4.3 Hybrid Power System

As you are aware, generation of electricity both from solar and wind energies is intermittent due to seasonal changes. As such they can't be accepted as a reliable supply. Wind power and solar power can, however, be profitability used as complementary to each other due to there being more wind in winter and more sun in summer.

On daily to weekly time scales, high pressure areas tend to bring clear skies and low pressure winds, whereas low pressure areas tend to be windy and cloudy. This effect has led to use of a hybrid power system using both solar and wind energies simultaneously. A combination of both Hybrid power systems by definition contain a number of other power generation devices such as photovoltaic, micro hydro and/or fossil fuel generators. In addition battery banks can also be used in parallel to store the energy for its later use.

Figure 8.6 illustrates the schematic diagram of a small scale hybrid power station. They are generally independent of large centralized electric grids and are used in remote areas as stand–alone projects.

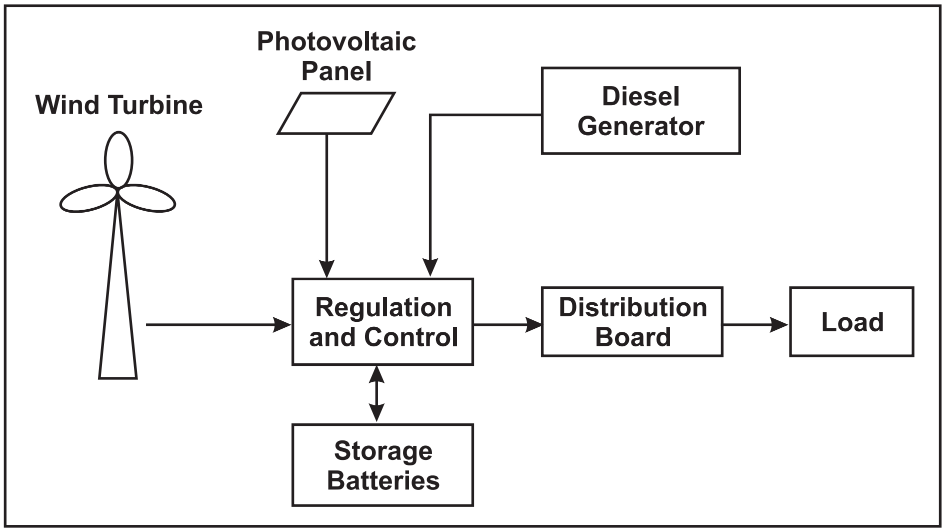


Figure 8.6: *Schematic showing the hybrid power system*

As seen in the Figure 8.6, electricity generated by the wind turbine, photovoltaic and diesel generator has been combined along with storage batteries. At a time, any of the sources can be used depending upon the availability of wind, sunlight or the diesel. In some remote areas even the electricity generated by micro hydro system can be combined with either the wind or solar power.

These hybrid power systems are very useful and suitable for community radio stations, media centres and repeaters for mobile towers especially for remote and isolated locations where extending of centralized electric grids are not feasible due to economic reasons.

Activity 8.5

What is hybrid system of power Generation? Enumerate the conditions where the use of hybrid power generation system is more reliable than any other single alternate source of energy.

To do this activity, you may need about 15 minutes to write down the answers in about 150 words in the space provided. This activity will help you in understanding the functioning and importance of alternate sources of energy.

8.5 Let Us Sum Up

In this Unit on 'Power Backup and Voltage Stabilisation', you have learnt that:

AC mains power supply provided at most of the remote locations is either not available or is not steady. In order to broadcast continuous transmissions from a Community Radio Station without any interruption, backup power supply sources are necessary. Most commonly used backup power sources include: inverter, UPS and Gen-sets. In remote locations where extending of centralized supply grid is economically not feasible, alternate energy sources such as wind and solar energy can be used to generate required power. Fortunately, the power consumption of a typical Community Radio Station is very less, therefore, conventional backup supply sources such as Inverters, UPS and Gen-sets as well as alternate sources like Sun and Wind power can easily be used. Inverter converts DC power supply of battery to AC voltage required for operating the electronic equipment. Voltage regulators are used to control variations in the input AC supply to give steady supply. UPS provides uninterrupted power supply to equipment at the rated voltage during failure of main supply. You have learnt three types of UPS along with their salient features depending upon their applications. Small DG sets are used to supply power when the duration of break downs in main supply are longer and beyond the capacity of UPS battery. Batteries are the critical components of Inverters and UPS. Capacity of battery is specified in terms of Ampere-hour which means how much maximum current the battery can supply for one hour before getting discharged. Backup durations of Inverter and UPS are therefore, limited to the Ampere-hour capacity of battery bank.

You have also learnt the process of power generation by alternate sources like Sun and Wind. In solar power systems, light energy of the sun is converted into electrical energy by use of Photovoltaic cells. Wind turbines convert kinetic energy of wind into electrical energy. Since both the Sun and Wind power systems provide intermittent supply due to seasonal variations, a hybrid power system combining power generated by two or more sources can provide a constant supply to meet the load requirements of a Community Radio Station.

8.6 Model Answers to Activities

Activity 8.1

Inverter is a device that converts DC voltage of battery to 240 V/50 Hz AC supply.

Important components of an Inverter with their functions are given below:

(i) Battery Bank acts as a source of DC supply.

(ii) Switching circuit interrupts the DC supply at a specific fixed frequency to produce alternate pulses in the primary winding of a transformer.

(iii) Transformer converts the changes in primary to give 240V/50 Hz AC supply in the secondary by using its fixed primary to secondary turn ratio.

(iv) Filtering circuit at the output of the transformer removes the harmonics to give pure sine wave output.

Activity 8.2

Following important points are to be considered before deciding the type and rating of UPS:

(i) Total essential load in KVA that is to be powered through UPS to decide the power rating of UPS.

(ii) Pattern of power supply failures to decide the duration for which the uninterrupted power supply is required.

(iii) Ampere-hour capacity of battery bank to decide how much load in KVA is to be kept 'ON' and for how many hours.

(iv) Salient features of each type of UPS to suit to the specific requirement. Since the breakdowns are for longer durations in this case, on-line UPS will be more suitable.

(v) Availability of metering, control and protection circuits.

(vi) Availability of a rated capacity UPS from a branded company providing adequate Guarantee/Warranty and after-sale service.

(vii) Cost factor to suit to available budget.

Activity 8.3

Provision of the Gen-set is necessary at all those isolated or remotely located stations where the regular AC main supply is either not available or is not reliable due to low voltages and frequent variations. Gen-set works as a standby back-up source during non availability of regular power supply. Gen-set is required even to charge the battery of UPS which might have got discharged after a few hours of use during mains failure. The limitations of Gen-set include: pollution, noise, wear and tear, and necessity to store enough fuel.

The function of UPS is different than that of Gen-set. UPS is provided to give a constant voltage supply to the system under normal working conditions as well as during power fluctuations and failures. The limitation of UPS is its Ampere-hour capacity. It requires charging of battery after each discharge. Life of battery is limited.

Activity 8.4

An Automatic Voltage Regulator (AVR) works on the principle of automatically changing the tapping of the secondary winding of a transformer depending upon the input voltage to give a preset rated output voltage. Since it is a mechanical regulator its response time is higher.

A Constant Voltage Transformer (CVT) works on the principle of magnetic saturation. Here, an iron core of the transformer works in a saturated condition where the output voltage remains practically constant even with a large change in the input supply voltage.

An Electronic Voltage Regulator (EVR) uses semiconductor devices to control the variations in the input. They are very fast in response as compared to mechanical regulators using motorized tap-changers. The efficiency and performance of an EVR is much better than an AVR and a CVT. The EVR is therefore, more suitable for the protection of the electronic equipment used in a CRS.

Activity 8.5

Generation of electricity by alternate sources such as sun and wind is mostly intermittent due to seasonal changes in environment. In hybrid system, two or more alternate power generation sources are connected in parallel. Either of the two is sufficient to give the required power supply. Usually battery bank is also used to store the energy for later use. The hybrid system can give uninterrupted power supply throughout the year.

The use of hybrid power generation is more suitable under following conditions:

i. Where the AC main supply is either not available or completely unreliable.

ii. Where the supply generated by a single alternate source is intermittent due to seasonal changes.

iii. Where maintenance of continuous supply using alternate sources is required throughout the year.

iv. Where extending the centralized grid to isolated or remotely located places is either not feasible or economical.

Glossary

Siting	The process of deciding a location for a community radio station, or for the transmission setup within a CRS.
Radio shadow zone	An area where a radio signal cannot be received, usually on account of a geographical or man-made obstacle that blocks radio waves.
Ambient noise	Any unwanted sound in an area where a recording is conducted.
Effective Radiated Power (ERP)	The net output power of a transmission system, usually a combination of the basic output strength of the transmitter, adjusted for the gains and losses provided by the transmission cable and antenna system.
Broadcast studio	A studio space dedicated for the purposes of conducting 'live' broadcasts, or from which programmes may be transmitted.
Production studio	A studio space dedicated to conducting recordings which can be edited later on.
Reverberation	The phenomenon of perceived extension of a sound due to reflection from nearby surfaces. Typically, the phenomenon is called reverberation when the reflection time is 0.1 – 1 milliseconds. Also see Echo.
Echo	The phenomenon of hearing a succession of reflections of an original sound that steadily decrease in amplitude. Typically there is a clearly perceptible gap between the original sound and its reflection.
Acoustic treatment	The process of reducing reflection of audio in a given space, through the use of audio absorbing materials.
Sound proofing	The process of using materials and construction techniques to keep ambient noise out of a recording space.
'Clean' and 'muddy' sound	'Clean sound' refers to sound where there is clarity throughout the frequencies it is made up of. Muddy sound refers to sound where the constituent frequencies are indistinct, leading to a perceived loss of clarity in the sound.
Sound lock	A space created between a studio room's internal and external doors, in order to minimize the intrusion of external noises.

Double glazing	The technique of using two panes of glass or acrylic sheet in a window, with an air space sandwiched inbetween. Used for minimizing the transmission of external sounds, as well as temperature control.
“Dampening” reverberation	The process of using sound absorbent materials to absorb or reduce (‘dampen’) reverberation in a space.
Dust proofing	The process of preventing the penetration of dust into a device or a space.
Air conditioning	The process of controlling the temperature in an enclosed space through the use of refrigeration or heating devices.
Programme production	The process of making an audio programme. ***Pre-production:*** Preparatory work, including scripting. ***Production:*** The actual recording of the programme in the field and in the studio. ***Post-production:*** Including editing and the addition of components like music and sound effects. ***Mixing:*** The act of adjusting the relative levels of all the audio components so that the programme is easy to hea.r ***Mastering:*** The act of combining all the components into a single mixed audio file or programme.
Field recorder	A portable recording instrument for conducting recordings in the field.
Microphone	An instrument to convert acoustic (sound) energy into electrical signals that can be recorded onto a medium.
Recording medium	Any medium (magnetic tape, flash memory, magnetic disks) which can be used to record and retain a set of electronic or digital information for playback at a later time.
Headphones	A pair of wearable speaker (or audio monitor) units, typically fitted on a band that can be worn over one’s head.
Input transducer	A device that can convert an input sound or audio signal to another form of energy. The most common type of input transducer is a microphone, which converts audio (acoustic) energy into an electrical signal.
Audio source	Any object or individual which can act as a generator of acoustic energy. A singer in a studio and a CD player are both audio sources.
Audio management	The process of controlling, manipulating and directing an audio signal.

Signal processing	The manipulation of an audio signal in order to adjust various parameters including its mix of frequencies, amplitude, and level of reverb (to name a few).
Final processing	The process of making final adjustments to an audio signal before the conclusion of editing or mastering work.
Output transducer	A device to convert an audio signal to a different type of energy for monitoring or transmission. A transmitter and a speaker are both examples of output transducers.
Audio monitors	A device to hear an audio signal being edited or manipulated within a audio device. These could be headphones or speaker units.
Compressor	A device or software used to reduce the amplitude of the audio signal within a system in order to keep it within a pre-defined upper limit.
Limiter	A device or software control used to limit or cut off an audio signal at a pre-defined upper limit
Transmission system	A combination of transmitter, transmission cable and antenna typically used for broadcasting audio or video content using a broadcast medium.
Transmitter	A device that generates a carrier wave and combines it with a supplied signal in order to broadcast a combined signal.
Mast	A tall (usually metal) vertical pole or segmented structure on which an antenna can be mounted.
Antenna	A device to radiate radio frequency energy into the atmosphere; or to receive radio frequency energy from the atmosphere.
Studio-Transmitter Link (STL)	The connection between the studio and the transmitter. At its most basic, this is the cable connecting the audio output from the studio to the transmitter input. A more complex version uses a microwave connection between the studio and a remotely placed transmission system.
Carrier radio wave	The radio frequency wave on which the audio signal is mounted or combined to facilitate the broadcasting of radio signal.
Receiver	A device to receive radio signals, usually through an antenna.
Sound waves	The way acoustic energy spreads from its source in a repeating pattern of high-pressure and low-pressure regions

	moving through a medium. This is usually represented in the form of a wave.
Audio signal	Any stream of energy that carries the equivalent of an information bearing sound. Thus speech is an audio signal.
Waves	The phenomenon by which energy passes through a medium by the upward and downward or side to side oscillation of particles in that medium.
Frequency	The property of a wave that denotes the number of complete waves that cross a given point in space in one second.
Hertz	A unit named after the scientist Heinrich Hertz, indicative of one wave crossing a point in space every second.
Wavelength	A measure of the physical distance between two adjoining peaks or troughs of a wave.
Amplitude	A property of a wave indicative of the physical distance between the peak and the trough of the wave.
Radiant energy	The phenomenon by which energy is conveyed or radiated from one point to another, with or without a medium.
Electromagnetic Wave Radiation	The phenomenon whereby electromagnetic waves (radio waves, light) are propagated.
Electromagnetic spectrum	The range of all frequencies of electromagnetic waves.
Visible spectrum	The range of electromagnetic frequencies that humans perceive as visible light of all colours.
Radio Spectrum	The range of all radio frequency electromagnetic waves
Radio Wave Bands	The classification of radio frequency waves by groups of frequencies. (UHF, VHF etc.)
Medium Wave (MW)	Amplitude Modulated waves in the range from 560 metres to 187 metres.
Short Wave (SW)	Radio communication using the upper MF (medium frequency) and all of the HF (high frequency) portion of the radio spectrum, between 1,800–30,000 kHz.
Modulation	The process of combining two waves to result in a wave that has some properties of both of its constituents.
Amplitude Modulation (AM)	Modulation that results in a wave with the frequency properties of one wave (the carrier wave) and the varying amplitude characteristics of the second (audio signal).

Frequency Modulation (FM)	Modulation that results in a wave with the amplitude properties of one wave (the carrier wave) and the varying frequency characteristics of the second (audio signal).
Transistorized portable radio	A small portable radio receiver that uses electronic components called transistors.
Community radio	Radio stations owned, managed and run by community groups, focusing on local issues, local culture, and local dialects.
Streaming radio	The process of using internet protocols to transmit audio over the internet.
Mobile phones	Portable telephone units that work on cellular radio technologies. Also known as cell phones.
Satellite direct-to-receiver radio	Radio broadcast directly from satellites to radio units equipped with satellite antennas. Popular services like Sirius, XM and Worldspace (now closed) are examples.
Siting Clearance	Permissions from the Dept. of Telecommunications in India allowing the placement of a radio transmitter at a fixed location
Wireless Operating License (WoL)	Permissions from the Dept. of Telecommunications in India formally allowing a radio station to start broadcasting.
Apparatus	Electrical apparatus that includes all equipment, machines, fittings and other accessories using power supply for its operation.
Circuit	An arrangement of conductor or conductors for conveying energy.
Circuit Breaker	A device capable of making or breaking the circuit under all conditions and are designed to break the current automatically under abnormal conditions.
Conductor	Any wire, cable or plate used for conducting energy.
Cutout	A fusible cutout used for interrupting the transmission of power supply to the building or equipment.
Earth electrode	A pipe or plate buried deep in the pit to provide a low resistance earth connectivity for earthing the equipment.
Earthing system	An electrical system in which all the conductors are earthed.
Lightning arrestor	A device used for protecting the equipment, personnel or building during lightning.

Linked switch	A switch with all the poles mechanically linked so as to operate simultaneously.
AC mains supply	The normal AC (alternating current) supply connection provided by electricity department or company.
Ampere-hour	The unit to specify the capacity of battery.
Backup supply	Supply generated locally at a station to operate the equipment or appliances during failure or shutdown of normal AC mains supply.
Battery bank	The set of batteries used in series-parallel combination to give desired ampere-hour capacity from a backup power system.
Connected load	The total power consumption (as per name plate on the equipment) of all the equipment installed at a station.
Maximum demand	The maximum units of electricity required to operate the equipment simultaneously at any instant of time.
Power rating	Of an Inverter, UPS or Generator is the maximum kilo-volt ampere load it can deliver.
Ripple	The small unwanted residual periodic variations present in the DC supply after rectification.
Solar array	The set of number of solar panels used to generate electricity.
Wind farm	The area where a large number of wind turbines are located to generate electricity from wind.

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Certificate in Community Radio Technology

Studio Technology

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Module: 3
Studio Technology

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Certificate in Community Radio Technology

Courses	Modules	Units
Course I: Understanding Community Radio (3 Credits, 90 Hours)	**Module 1** Community Radio: An Introduction	**Unit 1 :** Community Radio: Concept and Evolution **Unit 2:** Context, Access and Equity **Unit 3:** Community Radio: Policy Guidelines **Unit 4:** Technology for CR: Guiding Principles
	Module 2 Setting up of CRS	**Unit 5:** Components of CR Station **Unit 6:** Radio Waves and Spectrum **Unit 7:** Basics of Electricity **Unit 8:** Power Backup and Voltage Stabilisation
Course II: Community Radio Production: System & Technology (5 Credits,150 Hours)	**Module 3** Studio Technology	**Unit 9:** Basics of Sound **Unit 10:** Analog and Digital Audio **Unit 11:** Components of the Audio Chain **Unit 12:** Studio Acoustics
	Module 4 Audio Production	**Unit 13:** Audio Hardware and Field Recording **Unit 14:** Free and Open Source Software **Unit 15:** Telephony for Radio
	Module 5 Audio Post Production	**Unit 16:** Sound Recording and Editing **Unit 17:** Mixing and Mastering **Unit 18:** File Formats and Compression **Unit 19:** Storing and Retrieval
	Module 6 Studio Operations	**Unit 20:** Good Engineering Practices for Studio Setup **Unit 21:** Studio Equipment: Preventive & Corrective Maintenance **Unit 22:** Content Distribution: Alternative Mechanisms
Course III: Community Radio Transmission: System & Technology (2 Credits, 60 Hrs)	**Module 7** Radio Transmission Technology	**Unit 23:** Components of Transmission Chain **Unit 24:** Components of FM Transmitter **Unit 25:** Antenna and Coaxial Cable **Unit 26:** Propagation and Coverage
	Module 8 FM Transmitter Setup	**Unit 27:** Transmitter Setup: Step-by-step **Unit 28:** Transmission System-Preventive and Corrective Maintenance **Unit 29:** Transmission Setup-Good Engineering Practices
Course IV: Technical Internship (2 Credits, 60 Hrs)	**Module 9** Practical Internship Handbook	**Section A:** Introduction **Section B:** Activities to be Conducted During the Practical Internship **Section C:** The Internship Journal and Self-Assessment Paper **Section D:** Assessment of Internship **Section E:** Appendices

Video in the Module:

1. **Characteristics of Sound**
   By Vasuki Belavadi
2. **Digital vs Analogue and Mono vs Stereo Audio**
   By Vasuki Belavadi
3. **Acoustics & Noice Reduction**
   By Hemant Babu

1. http://tinyurl.com/qahdxzx
2. http://tinyurl.com/ofzsm72
3. http://tinyurl.com/nbyzl64

CONTENTS

CONTENTS

About the Module

This module is first in line of the four modules that makes course II viz., "CR Production: System Technology". As its name suggests, it is all about making of an audio studio. It has four Units with the first one (Unit 9) discussing the basics of sound, its properties and components and how changing any one of the components can change the quality of sound. This Unit also describes the differences between mono and stereo audio.

Unit 10 in this module explains digital audio signals in depth, while summing up the characteristics of analogue audio. It also explains concepts such as sampling, quantisation, bit error rate etc.

Unit 11 in this module concentrates on the Audio Chain and how physical components of recording and reproduction systems i.e. broadcast equipment are connected together in a studio and the signal flow-path taken by the sound from acquisition to its reception by the listener. You will also learn about the hardware required to produce programmes in a studio and outdoors.

Unit 12 deals with Studio Acoustics and introduces you to the basics of acoustic such as reverberation, echo, sound refraction, etc, all of which are crucial to designing a sound proof audio studio. It describes in detail the sources of noise inimical to good radio production and provides tips on how to avoid noise.

Since, there are a variety of sound proofing materials available in the market, it also describes to what extent each material absorbs sound to make the studio noise proof. The crucial elements of an audio studio such as sound proof door, observation window etc are also discussed to provide an idea of how an audio studio could be set up.

Module Objectives

- To discuss properties and components of sound
- To discuss the difference between analogue and digital audio
- To understand the hardware required for field recording and setting up a studio
- To discuss the fundamental principles and the care to be taken, while setting up an audio studio

Units in the Module

- Basics of sound
- Analogue and Digital Audio
- Components of the Audio Chain
- Studio Acoustics

UNIT 9

Basics of Sound

Structure

9.1 Introduction

The earlier Units introduced the concept of Community Radio, the policy guidelines in India, technology and the components of a Community Radio Station (CRS). This Unit will introduce the characteristics of sound, which is a basic ingredient of radio. In order to understand how sound works in different situations, it is equally important to understand the components of sound. This unit will explain the different types of sound that will go into the making of any radio programme.

Some of the concepts might be hard to comprehend. However, this Unit will have activities that ideally require access to the internet, an audio recorder and headphones. The video links provided as a part of this Unit will help to understand more clearly, some of the concepts discussed in this Unit.

9.2 Learning Outcomes

After working through this Unit, you will be able to:

- List and describe the characteristics of sound
- Explain the difference between pitch and volume
- Identify sounds that have different attack, sustain and decay
- Explain the process of propagation of sound waves
- Identify and differentiate between mono and stereo sound

9.3 Understanding Sound

Sound is all pervasive. Right from the time we wake up in the morning and turn on the tap in the bathroom until we go back to sleep. Sounds are of different types, intensities and pitches. One cannot imagine the world without sound. Try to lock yourself up in a room and close the door and all the windows. Sit for about an hour without moving. You will realise what it is to live without sound.

We use sound to communicate with each other. We say “it sounds good” when the sound we hear is pleasing to our ears, but if it gets louder and noisy we feel uncomfortable. You may have noticed that certain sounds are by themselves significant. For example, when we hear the doorbell, we know we need to open the door. When we hear the police siren or the horn of an ambulance, we get alarmed.

What is sound? Sound is created when an object vibrates. Tap on a table and you hear a light sound. Now, thump on the table, the sound gets louder. What happens when you thump on the table is that the molecules in the air, around your fist and the table vibrate at very great speed. It is this vibration that you perceive as sound. When you just tap the table, the speed of displacement of molecules is lesser than when you thump the table. You hear a faint sound when you tap the table and the sound gets louder when you thump it. The sensation of loudness depends on the intensity with which you tap or thump the table.

The intensity of sound is measured in decibel units (dB) and is logarithmic in nature. Therefore, if 10 dB is ten times 1 decibel, 20 dB is 100 times 1 dB (10 × 10=100) and 40 dB is 10,000 times 1 dB (10 × 10 × 10 × 10 = 10,000).

The 'threshold of hearing', that is, when sound is just about audible, is about 0 dB. The following table (Figure 9.1) should give you an idea of sound in different situations:

Sound sources (noise) Examples with distance	Sound Pressure in db
Jet aircraft, 50 m away	140
Threshold of pain	130
Threshold of discomfort	120
Discotheque	100
Diesel truck, 10 m away	90
Footpath of a busy road	80
Vacuum cleaner	70
Conversational speech	60
Average home	50
Quiet library	40
Quiet bedroom at night	30
Background in Radio studio	15
Rustling leaves in the distance	10
Hearing threshold	0

Figure 9.1: *Table explaining the loudness of sound in different situations*

So how do we hear sound? When something makes a noise, it sends vibrations or sound waves through the air.

The human eardrum is a stretched membrane like the skin of a drum. When the sound waves hit the eardrum, it vibrates and the brain interprets these vibrations as sound. However, when the intensity of sound increases beyond a certain level, we try to close our ears! Fig 9.2 explains how sound enters your ear and how these signals are sent to the brain to process.

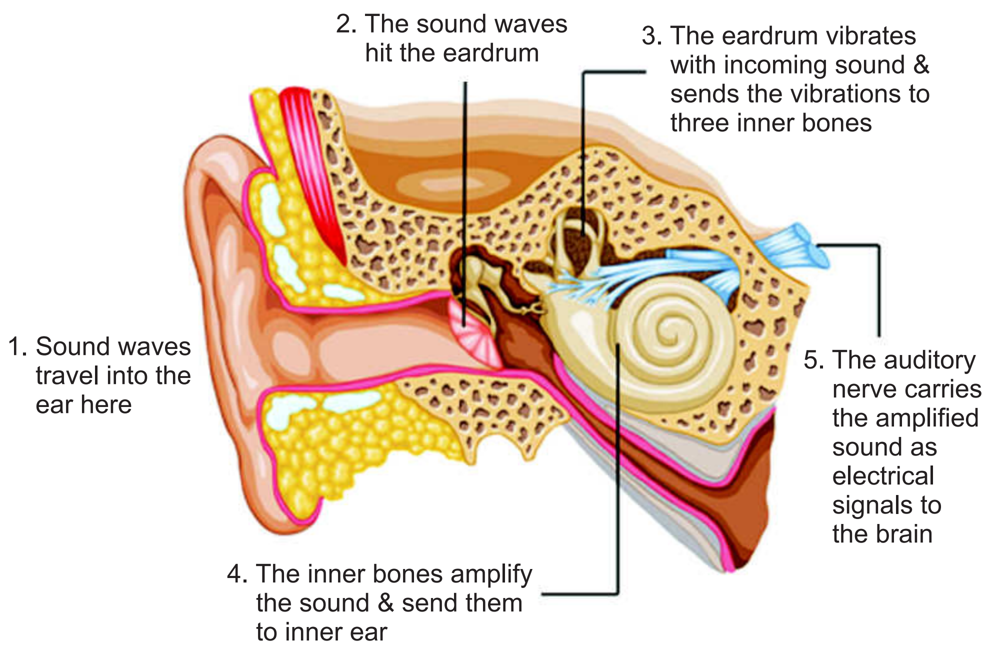
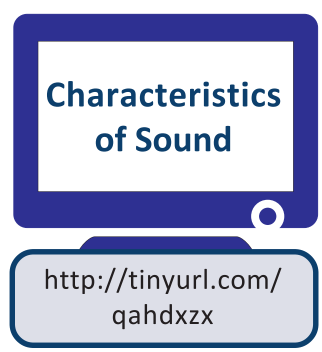


Figure 9.2: *Sound waves that enter the ear hit the eardrum and signals from the back-end of the eardrum, which are carried to the brain to process the waves.*

As the sound level increases, for example, when you get really close to loudspeakers at a festival *mandap* (at around 110 dB), you feel really uncomfortable and close your ears. Constant exposure to any sound above 90 decibels can eventually damage our ears.

9.4 Characteristics of Sound



We have already learnt in our high school physics that sound travels in the form of waves. They are basically mechanical waves. This means that they require a medium to travel. When you speak, your speech travels through air. However, sound cannot travel through vacuum. For your clarity of the concept on characteristics of sound, please go through the video at http://tinyurl.com/qahdxzx. Please read this section of the Unit and watch the video. All types of sound have the following characteristics:

- Wavelength
- Amplitude
- Frequency

9.4.1 Wavelength

Wavelength (Figure 9.3) can be described as the distance between any point on the wave and a corresponding point on the next wave. Sound waves are longitudinal waves; their wavelength can be measured as the distance between two successive compressions (higher pressure and density regions) or two successive rarefaction (lower pressure and density regions). Wavelength is measured in metres.

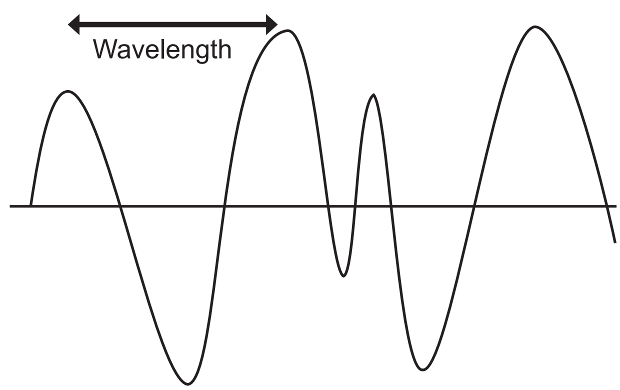


Figure 9.3: *Wavelength of sound*

9.4.2 Amplitude

Amplitude indicates the height of a sound wave as shown in the figure 9.4 — how loud the sound is. The higher the 'height' of the wave, the louder it is and vice-versa. Amplitude also indicates how strong a sound is.

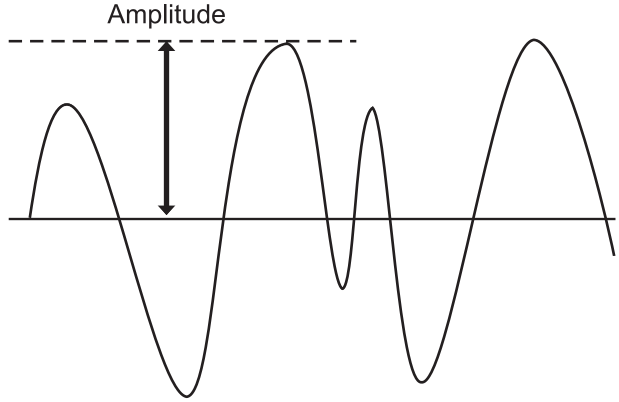


Figure 9.4: *Amplitude of a sound wave*

9.4.3 Frequency

Frequency is the number of times the wavelength occurs in one second (Figure 9.5). Frequency is measured by the number of sound vibrations in one second. If the source of sound vibrates faster, the frequency is higher and vice-versa. For example, if you examine the wave of the strums of a guitar, it will be different from those of the thud on a table. This means the higher the number of vibrations from the sound source, the higher the frequency. In turn, the higher the frequency, the higher the pitch. Frequency is measured in Hertz (Hz). One Hertz = one vibration/ second. The number of times an object vibrates determines its frequency.

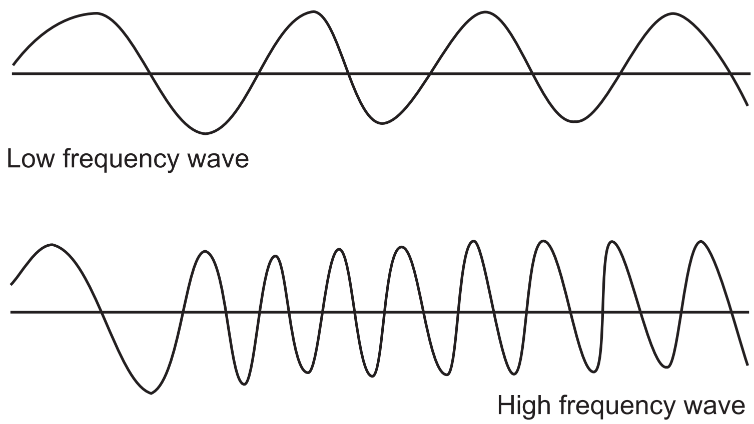


Figure 9.5: *Frequency of a sound wave*

Activity 9.1

If you know the frequency of sound, you can easily measure its wavelength. How does one do it? Just enter the url: http://www.mcsquared.com/wavelength.htm in your browser. Now, enter the required values in the field and hit the 'Wavelength' button. It will provide the answer.

The tool provided above is based on a programmed formula that provides answers to a value you enter in the required field. It automatically calculates the wavelength of a particular sound if you know the frequency.

9.5 Components of Sound

In order to understand how sound works in different situations, it is important that we study its properties. Modification of any of the components of sound can alter its effect in a radio production. Let us proceed to understand the different components of sound.

9.5.1 Pitch and Volume

The frequency of a sound determines its pitch. The higher the frequency, higher will be the pitch and vice-versa. Frequencies are grouped as Low frequencies (bass) - sounds of thunder and gunshots, Midrange frequencies - a telephone ring or normal speech and High frequencies (treble) - small bells or even shrieks. Sounds of lower frequencies are powerful. Sounds of midrange frequencies are energetic. Humans are most sensitive to midrange frequencies. High frequency sounds make their presence felt and add quality to the sound track. Different objects have different frequencies. When you pluck a rubber band, the frequency of sound it generates is less than the thinnest string on a guitar. Therefore, by extension, the pitch of the rubber band is less than the pitch of the thinnest string on a guitar.

Now, let us look at loudness or volume. This is also called amplitude of sound. The loudness of a sound depends on the intensity and distance of the sound stimulus. Obviously, a bomb explosion is louder than the bursting of a tetra-pack, despite both being at the same distance. This is due to the bomb explosion displacing more number of molecules than a tetra-pack. Loudness is relative. A sound that is very loud in a small room cannot even be heard on a busy street. Take a plastic cover and blow air into it. Now, hold its neck tight and burst it in a small room. The sound can be loud. But, if you try the same on a busy street, you might not even hear it properly.

Just a word of caution: one should not confuse pitch with volume or amplitude. They are two different things. For example, one can speak at a high volume, but at a very low pitch.

Activity 9.2

This activity will help you understand the difference between high and low pitch. The same activity can also be used to understand the difference between pitch and volume.

Take four steel cups of equal size from your kitchen. Now, fill one of them with water almost up to the top. Fill the next one about three-fourths full. The third one about half full. Leave the fourth cup empty. Next take a table teaspoon and tap each of the four cups in succession.

9.5.2 Timbre, Harmonics

Timbre and harmonics are that quality of sound that enables you to distinguish them from each other even when they are at the same pitch. To understand this better, let us first discuss harmonics. Say you pluck the string of a guitar or a *sitar.* The string sets off a main frequency at a certain volume but you also faintly hear other frequencies. Now, try the same with a rubber band. The main frequency and the resultant 'child' frequency that it produces are less than the one produced by the string of a guitar and *sitar*. The ability of an object to produce child frequency gives soothing sound. Therefore, the sound of a guitar is more pleasant than that of a rubber band.

Timbre is the combination of a basic frequency, the child frequency and the overtones that a sound produces. It is this combination that enables you to differentiate between two different trumpets, although they are at the same volume. In a way, the pitch of the sound also contributes to the timbre. If actor Amitabh Bachchan and Asrani speak at the same volume, you will be able to instantly recognise their voices because of the timbre. In short, the unique quality and characteristic of every sound can be described as its timbre.

Activity 9.3

This activity will help you understand the difference between timbres of different sounds. Take two cups, one made of steel and another made of glass of equal size from your kitchen. Now, fill one of them with water about half full. Fill the next one half full with sand. Then take a table teaspoon and tap each of the two cups in succession.

9.5.3 Rhythm, Tempo

Rhythm in simple words means, the silences between sounds. Rhythm is everywhere, the way one speaks, the ping-pong on a tennis table, the ticking of a clock, the hoofs of horses, the way it rains, and in clapping. The way sounds and silences are patterned form rhythms.

The rate at which rhythm repeats itself defines tempo. Walking has a particular rhythm. When you walk slowly, you walk at a slow tempo. When you begin to walk fast, the tempo and rhythm both change. In other words, the speed of rhythm is tempo. Musicians normally use the words rhythm and tempo to describe the way their music has been composed.

Activity 9.4

This activity is meant to understand the relationship between Rhythm and Tempo. You have surely done this in your childhood. But let's do it again.

Take two empty coconut shells. Find a flat stone and begin to tap the coconut shells in a way to reproduce the way a horse gallops. Initially, tap the shells in slow succession. Gradually, increase the speed at which you tap the shells on the stone and notice the gaps between the sounds and silences. You will also notice that the tempo, the frequency at which the gaps decrease simultaneously sound increases.

9.5.4 Attack, Sustain, Decay

Different genres and formats of radio production comprise at least 10-15% of sound effects. Understanding attack, sustain and decay of sound is crucial to using sound effects in a radio production. Every sound takes a certain time to rise up to its maximum amplitude, remains there for some time and then dies down. This of course, depends on the kind and nature of sound being used. Study the graph given below (Figure 9.4).

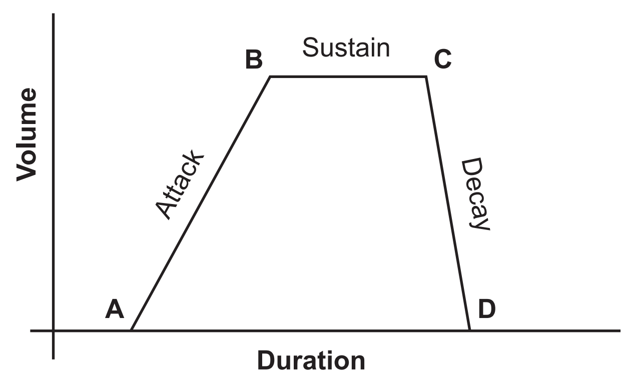


Figure 9.4: *Attack, sustain and decay represented in the form of a graph. The volume of sound is represented on the 'x' axis and the duration of attack, sustain and decay is on the 'y' axis*

The above graph denotes that the sound takes certain time to reach its highest volume starting from A to B. Having reached B, it stays there for some time up to C and then begins to die down from C to D. The duration that a sound takes to go from A to B can be termed attack. The duration from B to C can be termed sustain. Similarly, the duration from C to D can be termed decay.

The time taken by different sounds to reach their highest volume (attack) is different. For example, the sound from a pistol takes a very short time to reach its highest volume. It also dies down almost immediately. On the other hand, if one were to tear a paper slowly, the attack is slow. This sound sustains for a slightly longer duration and also dies down a bit slowly. The sound of waterfalls on the other hand takes longer to reach its peak, sustains for a longer duration and dies too, rather slowly.

One can change the attack, sustain and decay of a sound by changing the speed of sound. Try it out when you work with audio editing software.

9.6 Propagation of Sound

We have already learnt that sound travels in longitudinal waves. We have also learnt the various characteristics and components of sound. We further learnt that sound requires a medium to travel. Sound travels through air, through liquids, solids and gas. But, it cannot traverse through vacuum. This is because there are no particles in vacuum to get compressed and exploded.

Does sound travel with equal speed through all media? No, it travels fastest through solids. Even among solids, it travels the fastest through more tightly packed materials, which means sound travels faster through metals, than it does through wood. For example, it also travels faster in liquids than in gas. This is again because molecules in liquid are more tightly packed than in gas and air.

Does temperature play a role in propagation of sound? Of course it does. When it is hot, molecules in air are more excited and travel with more energy. Therefore, sound also travels faster in higher temperatures than it does in sub-zero temperatures.

Sound not only travels fast or slow depending on the medium, it also gets reflected when it hits a surface. Sound is reflected better from smooth surface than rough and tightly packed materials. Therefore, sound gets better reflected from a glass surface than from a surface that is covered with foam-like material. More porous the material, the absorption will be more. This is the principle behind acoustic treatment in studios.

It is worth noting that larger the surface area, better the reflection. And reflection of sound is manifested in echo. You do not seem to experience echo in a small room. However, when you shout out loud in a hilly area, your voice hits the mountains, gets reflected and returns to your ears, that is why you hear an echo. The number of echoes are dependent on the number of reflections that your shout experiences. Similarly, the roaring of thunder is also due to successive reflections of sound from clouds and the earth surface. Heavier the clouds, more thunderous is the echo.

9.7 Types of Programme Sound

Switch on a radio set and listen to a couple of programmes. You will hear people speaking, some music and also probably some sound effects in some programmes. However, the sound, music, speech used for an educational programme will be different from the one used for a peppy film-based programme. The mood of the programme determines the kind of sound one uses. However, they all use sound of three different types:

Spoken sound, sound effects and music

It must be remembered that sound is not incidental to a programme. It requires conscious planning at the pre-production stage. The nature of a programme, the mood of a scene in a radio drama or documentary or even an educational programme decides the kind of spoken words, music and sound effects. It would be absurd to include 'twangs' in a serious scene of a radio drama.

Spoken sound can be in the form of a narration or a character's dialogue. Obviously, an RJ's introduction to a programme is spoken sound. The manner in which the person speaks affects the effectiveness of the spoken word. The voice itself, emphasis on certain words, the inflection, the pitch and its loudness all contribute immensely to the overall effect. Dialogues in a radio drama cannot be delivered like a news reader's announcement of headlines. Interview speech is normally slow at the beginning. However, when the questioning becomes intense, the volume and sometimes the pitch too go up.

Anything other than music or spoken word is a sound effect. The creak of a chair, bang of a door, a ring tone, falling of books, the wang of a laser gun etc are all examples of sound effects.

Sound effects are also of three types. **Contextual** sounds emerge from a sound source as a consequence of an action. The dialogue in a drama is contextual sound. Let's say a person is in a fit of anger and shoots a person in a radio drama. The sound of the gun shot, although added as a sound effect is contextual sound (also called diegetic sound) because it emerged from within the story. **Descriptive** sounds, as the name itself suggests, adds to the mood of the scene. Say a person is sitting on a rock and throwing pebbles into a pond. The sound of the pebble hitting the water is contextual. However, if one adds the sound of wind, it adds to the feeling of the character's despair. It enhances the person's feeling of sadness. This kind of sound is called descriptive sound. **Commentative** sound is added by the programme producer to add to the overall impact. Say two people begin to fight over their chance near a water-pump. The cackle of hens that are interspersed during the fight is commentative sound.

Music and sound effects serve to provide transition between scenes. Intelligent sound designers use sound as a transition. Say a scene is ending with the heroine's father declaring that the daughter will go abroad to study. The sound of an aircraft faded in at the end of the scene suggests that the heroine has flown abroad without having to show an aircraft. Sound, therefore, provides transition and continuity between scenes linking them.

Sound effects are extensively used in radio programmes to compensate, augment or to add realism. A whole art of *manually creating and recording sound effects* or *foleying* goes into this. For example, walking on dry leaves (by stamping on a few dry leaves), horses galloping (using dry coconut shells) or even munching of biscuits (by actually munching them) etc can all be recorded in the studio using simple techniques. The art of recording these sound effects in the studio is called **foleying**.

Music is an important tool in the hands of a radio producer. Music helps to draw the attention of the listener to the programme through emphasis. Listen to some radio station signature tunes to understand this. The name of the radio station is repeated between two breaks to inform the listeners that they are on a particular radio station. Music is also used in the background to emphasise or intensify action, set pace, unify transition, indicate time or evoke a mood or as foreground music that is diegetic, like someone playing an instrument in shot or miming to a playback.

Music of a particular kind evokes similar feeling universally. Music helps the producer in releasing feelings of disgust, love, hurt, sadness, joy or even restlessness. It is the choice of the music instrument, the rhythm and tempo that create the desired effect. The signature tune of a newscast is totally different from one of a soap opera. The instruments and tempo of music used in newscasts, game shows, and contests is totally different from the one in melodramas and romantic episodes.

9.8 Mono and Stereo Sound

One can record sounds in two ways: mono and stereo. Mono or monophonic sound is recorded or created on one single channel. In effect, what it means is that even if you have two speakers, you listen to the same thing on both the speakers. In this case, the audio signal that is recorded or created is passed through a single channel to both the speakers. Mono recording is best used when making just talk programmes. Mono sound is mostly used in telephony, where the emphasis is on the speech rather than the aesthetics of the conversation. One single microphone is enough to record mono audio.

However, when one is required to produce programmes with various sounds including speech, music and sound effects, stereo recording is preferred. Different sounds are recorded in different tracks on two different channels. Therefore, when you listen to a music track recorded on stereo, you can listen to different instruments on different speakers. For example, the *tabla* plays prominently on one speaker while the violin and *sitar* play on the other. Stereo sound gives one a more natural listening experience than mono sound. To record stereo sound one might require more than one microphone. One advantage with stereo sound is that it provides a spatial illusion. Some sounds may appear to be coming from the right side, from near and some from far and on the left.

Refer to the chapter on Recording Hardware and Field Recording to know more about mono and stereo microphones.

9.9 Let Us Sum Up

In this chapter, you learnt about the basics of sound and how it is propagated. You also learnt about its properties and components. Remember the differences between pitch and volume. The frequency of a particular sound has an impact on its pitch.

We then learnt about the three different kinds of sound that is speech, music and sound effects. Creating sound effects in a studio is called foleying.

We then proceeded to learn about how sound effects and music contribute to creating the overall mood of a radio programme. We also learnt the basic differences between mono and stereo sound.

In the next lesson, we will understand about analogue and digital audio, the differences between them and their applications.

9.10 Feedback to Check Your Progress

1. What are the key characteristics of sound?
2. What is the relationship between Pitch and Volume?
3. Explain attack, sustain and decay of sound. Give examples for fast, medium and slow attack of sound. Similarly, give examples for slow decay of sound.
4. What are different types of programme sound? Explain in detail giving examples?
5. Explain Mono and Stereo sound.

9.11 Model Answers to Activities

Activity 9.1

Once you go to the URL www.mcsquared.com/wavelength.htm you will see a field asking you to enter the frequency for which the website will give you the wavelength. Think of a radio station which you listen to often. However, please remember that you will be required to enter the value in Hz, whereas the stations' frequency will be given in Mega Hertz. Remember that Mega is equal to 1000 Kilos and 1 Kilo is equal to 1000 units of whatever you are measuring. Therefore, 90.4 Mega Hertz is equal to 90.4 multiplied by 10 to the power of 6. Try entering in different range of frequencies to see what are the wavelengths, whether they are in inches, feet or meters.

Activity 9.2

Notice the change in the sounds each of the cups creates. The cup that is empty creates sound with the highest pitch, whereas the one completely filled with water creates sound with the lowest pitch. Now, repeat the experiment by tapping the cups a bit harder. You will notice that while the pitch of sound emanating from each cup remains the same, the volume gets louder. You can also try out this experiment with glass bottles.

Activity 9.3

Notice the change in the sounds each of the cups creates. The cup filled with sand produces sound that is uniquely different from the one with water. That is because the harmonics set off by the two cups are different.

Activity 9.4

Try creating sounds with different objects at varying rhythms. Once you have created a rhythm, try increasing and decreasing the tempo. You are expected to notice the difference between rhythm and tempo and how the increase or decrease in tempo can change the rhythm. The same principle is used in editing software.

UNIT 10

Analog and Digital Audio

Structure

10.1 Introduction

In the previous Unit, you have studied 'the basics of sound'. As we now understand, sound is a form of vibration that travels through the air or another medium and can be heard when it reaches our ear. Sound is a form of a wave of compression and rarefactions, similar to the ripples on a pond, when a stone is thrown in it. One of the characteristics of sound is 'frequency', which is the number of vibrations per second. A human being can hear sound of frequency lying in the range 20 Hz to 20,000 Hz. In acoustical terms, audio refers to 'sound' or 'reproduction of sound' and audio work involves the production, recording, manipulation and reproduction of sound waves. In this Unit, we will discuss about analogue and digital audio, their characteristics and compression of audio. About 8 hours should be devoted to understand and learn this Unit.

10.2 Learning Outcomes

After completion of this Unit, you will be able to:

- define analogue and digital audio, their characteristics, sampling and quantization, bandwidth, nyquist criteria
- explain frequency response characteristics, signal-to-noise ratio, audio compression and different file formats, open source and proprietary codec
- calculate audio file size and space required for its storage on hard disk or CD.

10.3 Definition of Analogue and Digital

Analogue means continuous and digital implies discrete or discontinuous. For example, a clock; an analogue clock uses the positions of the hands to describe the time. The hands move smoothly around the clock to describe the time of day. As such, an analogue clock is a continuously flowing representation of the time of day. Whereas, a digital clock uses distinct or individual digits and not hands to describe the time and each digit is a specific numerical value that describes the time of day. So it is not smooth flowing, but is characterized by discrete numbers that tell the time.

An analogue signal is a continuous signal in which the information changes as a response to certain changes in physical phenomenon. In other words, we can say that it is a continuous signal, where the time varying feature of the signal is a representation of some other time varying quantity, for example sound or voice we hear. So, an analogue audio signal is a smooth continuously flowing representation of music or sound.

The word *digital* implies something that uses a digit or number to describe something. Digital signal is a non-continuous signal having discrete values. It has only two values – On or Off or Ones and Zeros, just like a light switch in our house which is either in ON position or OFF position. They change in steps. This is expressed using two digits 0 and 1, called binary numbers. Each '0' or '1' is called a 'bit', which is an abbreviation of the term 'binary digit'. So, digital audio signal is represented by multiple distinct events, also known as digital samples.

As such, any analogue signal is represented by a waveform with continuous range of values whereas digital signals are discrete time signals with discontinuous values to represent information as shown in Figure 10.1.

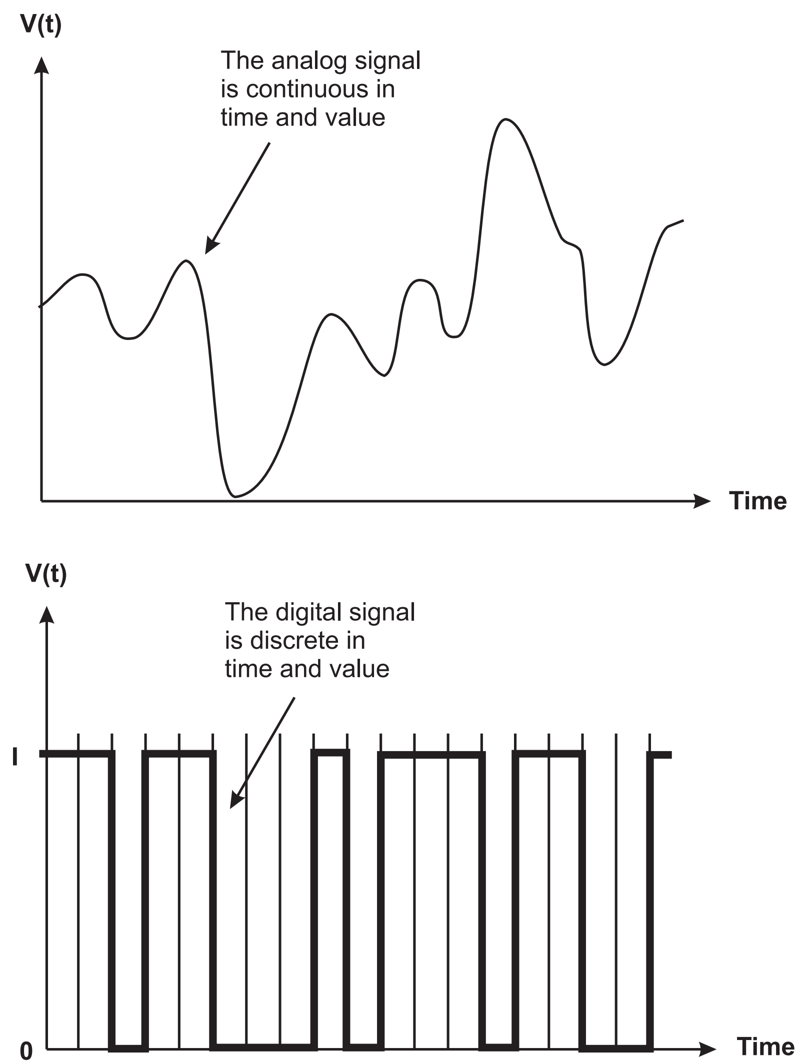


Figure 10.1: *Analogue and digital signal*

As shown in Figure 10.1, analogue signal varies continuously in amplitude or height as time progresses, like electrical signal. Analogue signal can assume any value whereas digital signal can take only two definite discrete values, zero and one. Anything different from these values is discarded.

10.4 Analogue Audio

The dictionary meaning of 'audio' is 'hearing or audible sound'. Sound is nothing but pressure waves of air. Sound is just a vibration. When we beat a drum or pluck a guitar string, it starts vibrating. When it moves outward from its resting position, it squeezes air molecules into a compressed area, away from the sound source. This is called compression. As the vibrating membrane or string moves inward from its normal resting position, an area of lower than normal atmospheric pressure is created called rarefaction. So sound waves are successive areas of air compression or rarefaction. The areas of compressed and rarefied air move out from the sound source in the form of sound wave at the speed of sound, which is nearly 340 meters per second. It arrives at our ears in the form of periodic variations in atmospheric pressure called sound-pressure waves. Our eardrums also vibrate to match the air pressure and this sensation is transmitted to the brain as sound. As such, if there was no air, no sound would be heard. In the waveform shown in Figure 10.2, the horizontal axis represent time and vertical axis represent pressure. The initial high pressure or compression is followed by low pressure or rarefaction, which ultimately dies down.

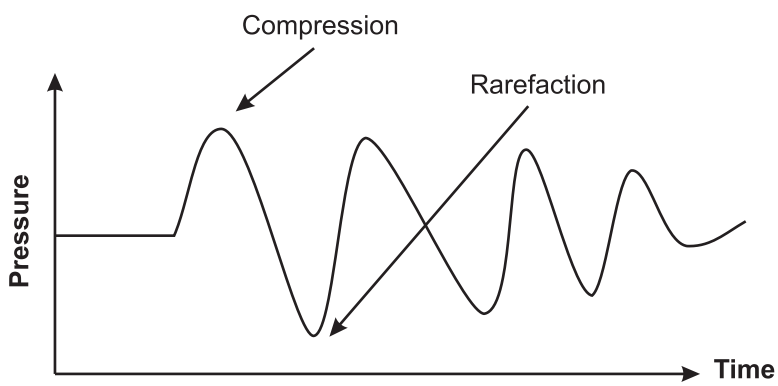


***Figure 10.2**: Analogue sound wave*

As such, analogue audio is a representation of a series of sound signals that change continuously and is analogous to the air pressure waves of the sound. It is a representation of the intensities of those waves in a different form, such as voltage.

Activity 10.1

Explain the differences between Digital Audio and Analogue Audio in about 200 words.

10.5 Characteristics of Analogue Audio

We have already seen that waves have three main characteristics — wavelength, frequency and amplitude. In particular, analogue signals have three main characteristics which define them. These are:

- Amplitude (a measure of how loud they are),
- Frequency or wavelength (a measure of how often they change),
- Phase

Speech is an example of an analogue signal. These characteristics distinguish one waveform or signal from the other. These are as shown in Figure 10.3.

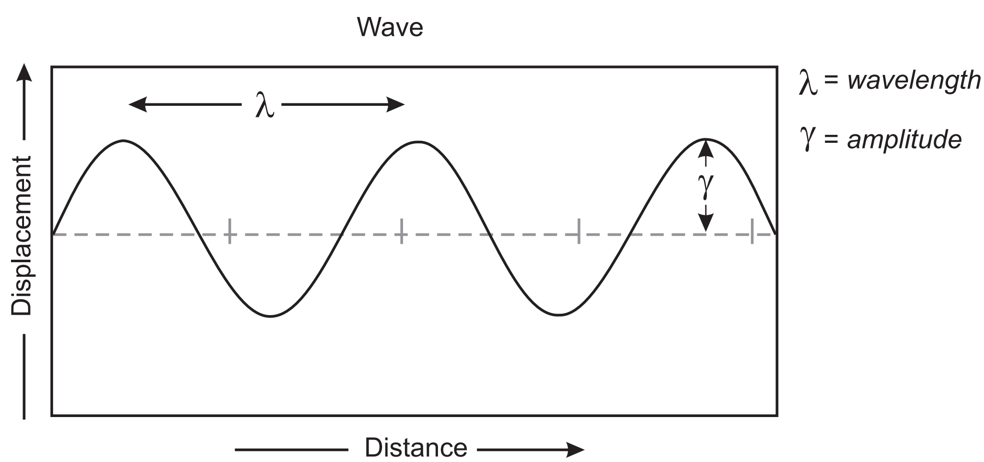


Figure 10.3: *Characteristics of analogue audio waveform*

In the previous Unit, we have already studied what wavelength, frequency and amplitude are. Let us now proceed to understand the term Phase.

10.5.1 Phase

Phase is the rate at which a signal changes its relationship with respect to time. It is expressed as degrees. One complete cycle of a wave begins at a certain point, and continues till the same point is reached. Phase shift occurs when the cycle does not complete, and a new cycle begins before the previous one has fully completed, as shown in Figure 10.4. This implies that there is a time delay between the two waves.

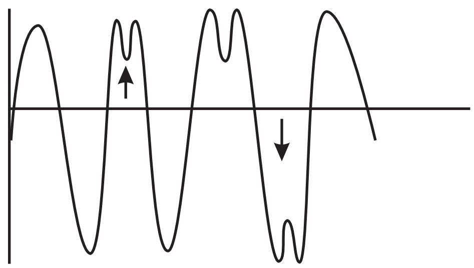


Figure 10.4: *Phase shift of waves*

10.5.2 Frequency Response

Frequency response measures the output level of an audio device at different frequencies 20–20,000 Hz range. It is a series of level measurements made at different frequencies and results displayed on a graph showing level vs. frequency. The graph represents how a device will respond to audio frequencies and how it will affect an audio signal. If the measured signal level is same at all frequencies, the curve will be a flat, straight line from left to right known as a flat frequency response curve. This indicates that the device passes all frequencies equally. So for an audio system, one of the objectives of frequency response analysis is to test the reproduction of the input signal with no distortion.

10.5.3 Mono and Stereo Audio Signal

As explained earlier, we cannot hear sound in vacuum because there is no air to carry the sound waves. The only reason we hear a clap or a bird sing or a guitar play is that those audio sources cause a wave of air to travel to our ear. The sound waves coming from all directions in open air cause the eardrums to vibrate at the same frequency as the sound waves that the source produced. This vibration causes the sound that we hear. In real life, we hear natural sound or audio coming from multiple directions all the time. Our brain converts these sounds into a 3-dimensional audio image that helps in determining from where the sound originated and to judge its distance. This gives rise to the concept of directional or stereo sound and non-directional or mono sound formats.

Mono and Stereo are two classifications of audio signal format, how it is recorded and reproduced. The key difference between the mono and stereo has to do with the use of channels to record or reproduce the sound. Mono describes a sound that is only from one channel while stereo uses two channels. A mono sound signal contains no directional information whereas a stereo signal allows you to distinguish which sound is coming from which direction, which is very similar of being in the same room as the sound was created. Stereo sound provides listeners with a much more natural experience as compared to mono where the sound comes from a single direction. Stereo signal produces a spatial magic by creating the illusion that you are in the middle of a three-dimensional sound source. Stereo audio sounds are clearer than mono, and our brain can detect distance and depth better.

In Mono systems, the signal contains no level and arrival time or phase information that would replicate or simulate directional information. A stereo sound signal contains synchronized directional information from the left and right aural fields. Consequently, true stereophonic sound systems have two independent audio signal channels, one for the left field and one for the right field. The left channel is fed by a mono microphone pointing at the left field and the right channel by a second mono microphone pointing at the right field. The signals that are reproduced have a specific level and phase relationship to each other, so that when played back through a suitable reproduction system, there will be an apparent image of the original sound source.

10.5.4 Signal-to-Noise Ratio

An analogue signal is continuous. It can change at any rate. But, its main disadvantage is that these are prone to various kinds of degradations like noise and distortion, which change the signal waveform which might be quite distracting to hear. Signal-to-noise ratio, S/N or SNR is a measure of degradation level of the audio signal. It is a measure of the level of the audio signal compared to the level of noise present in the output signal. It is a measurement that describes how much noise is in the output w.r.t. the signal level. In other words, S/N is a measure of signal strength relative to background noise. The ratio is usually measured in decibels (dB).

If the incoming signal strength V_s is in micro-volts and the noise level V_n is also in micro-volts, then the signal-to-noise ratio, S/N, in decibels is given by the formula

$$S/N = 20 \log_{10}(V_s/V_n)$$

Ideally, V_s is greater than V_n, so S/N is positive. The higher the S/N, better it is. For example, a signal to noise ratio of 100dB means that the level of the audio signal is 100dB higher than the level of the noise and it is better than a signal output with a S/N ratio of 90dB. For reliable communication, signal level should be much higher than the noise level at the point of reception.

The primary disadvantage of analogue signals is the noise i.e. random unwanted variation of the audio signal. As the signal is transmitted or electronically processed, at each step some noise due to electronic circuitry or signal path is introduced. This noise is additive and the signal degrades progressively with the result that the S/N ratio deteriorates and in the extreme case the signal can be overpowered by noise. Noise can show up as 'hiss' and inter-modulation distortion in the audio signal. This degradation is impossible to recover, since there is no way to distinguish the noise from the signal as amplifying the signal to recover attenuated parts of the signal amplifies the noise also. The solution lies in going digital, since digital signals can be transmitted, stored and processed without introducing noise.

Activity 10.2

i. Explain the difference between Mono and Stereo signal.
ii. Define amplitude, frequency, time period and wavelength of an audio signal.
iii. Find time period and wavelength of a 10 kHz (10,000 Hz) audio signal.

10.6 Digital Audio

As mentioned earlier, digital signal is non-continuous with discrete values. It has only two values – On or Off or Ones and Zeros called binary. The analogue audio, which is a continuous signal is measured at specific time intervals and its amplitude at each of these points stored. This results in a string of numbers which depict the waveform in its development over time, rather than representing it by the continously changing property in an analogue recording medium. Digital audio refers to encoding of audio signal in digital form rather than in analogue form. For this, analogue audio signal is passed through an analogue-to-digital (A/D) converter and is then encoded and digitized or converted to a digital signal. The instantaneous voltage level of analogue audio is sampled or measured at an instant and then these samples are encoded into a stream of zeros and ones in binary format that digitally represents the voltage level at that instant. At reception point, the digital signal is converted back to analogue audio with the help of digital-to-analogue converter.

10.7 Characteristics of Digital Audio

Similar to analogue audio which has two characteristic frequency (time component) and amplitude (signal level), digital audio also has two characteristics – sampling (which represents time component) and quantization (represents signal level).

10.7.1 Sampling

Sampling is the method of converting analogue information to digital data. When analogue audio is converted into digital form, samples of changing audio waveform are taken at specific intervals and these samples of signal level are converted into a binary stream based on its voltage level and stored for further processing or reproduction. This process is called digitization, which uses sampling to store data from an analogue waveform. Once a reading is taken, this value is stored and held until the next sample. This is known as sample-and-hold and is common in most digital audio systems. The reading of signal level is done at a rate fixed by a sample clock within the A/D converter and this is known as the sampling frequency or 'Sampling Rate'. Figure 10.5 shows digitized audio.

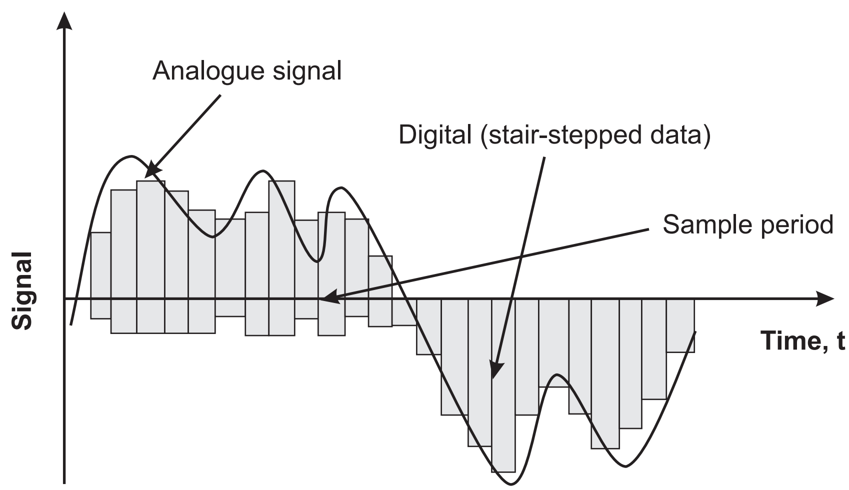


Figure 10.5: *A digital signal*

Here 'Y' axis represents signal voltage and 'X' axis represents time. Samples of analogue signal are taken from time to time and each sample is converted into a number based on its voltage level. How frequently samples are taken or captured is called "Sampling Rate". It is the number of times per second that the analogue signal is measured. For example, if a sampling rate of 20,000 Hz is used, this means in one second 20000 points will be sampled and it corresponds to 1/ 20000th of a second. During sampling process, the analogue signal is sampled at time intervals determined by the sampling rate and a binary-encoded word is generated equivalent to analogue voltage level at that point. This process is repeated at next sampling interval continuously. During the reverse process i.e. digital-to-analogue conversion, these binary numbers will be converted back into voltages. So, the resulting analogue audio waveform will not be perfect replica of original signal because during analogue-to-digital conversion, all the points of analogue signal were not taken up. Only samples were taken up. Any values that existed between sample points would be suppressed during digital to analogue conversion.

As such, the more samples we take i.e. higher the sampling rate, the more perfect will be the analogue signal produced by digital-to-analogue conversion. But, the sampling is directly related to time component, which subsequently determines the overall bandwidth of the system. The higher the sampling rate, higher is the bandwidth range and more storage space is required to store the resulting digital data.

If the sampling rate is too high, the quality of output will be very close to the original but it will require more storage space. In case the sampling rate is too low, the output quality will be bad. To strike a balance, best sampling rate is decided with the help of the **Nyquist Sampling Theorem,** according to which, "for accurate reproduction of signal, the sampling rate must be at least twice the highest frequency or the bandwidth of the source signal that is to be represented". We know that audible range is 20 Hz to 20 kHz. Therefore, in audio systems, we need to use a minimum sampling rate of at least 40 kHz or 40,000 samples per second. However, due to design considerations, a sample rate of 44.1KHz is used. An audio CD has a sample rate of 44.1 kHz or 44 kHz for short.

In view of this, all high frequencies greater than the sampling frequency must be removed before start of sampling, otherwise some error frequencies would enter into signal path causing harmonic distortion, which is called **Aliasing**. For example, if we take 30,000 samples per second, we can capture frequencies upto 15,000 Hz only. Any frequencies higher than the Nyquist frequency (30 kHz in this case) are perceptually "folded" back down into the range below the Nyquist frequency. This effect is known as Foldover or Aliasing. The approximate new alias frequency can be calculated as:

Alias = sampling frequency - input frequency

For example, if the audio signal contained an input frequency of 22KHz sampled at a rate of 40KHz, the sampling process would misrepresent that frequency as 18 KHz (40KHz – 22 KHz), a frequency that might not have been present at all in the original signal.

So, aliasing can result in addition of frequencies to the digitized audio signal those were not present in the original signal, and unless we know the exact spectrum of the original signal there is no way to know which frequencies actually belong to the digitized sound and which are the result of aliasing.

As such, to eliminate aliasing frequencies, it's essential to use a low-pass filter before the A/D conversion stage to remove any frequencies above the Nyquist frequency. This would allow all the frequencies upto sampling frequency to pass and block all frequency above this. But, it is impractical to design such a tight filter with infinite attenuation above or below a certain cut-off frequency. As such, a sample rate is chosen which is usually above the theoretical requirement e.g. a sampling rate of 44.1 kHz is chosen for audio CDs to accurately reproduce signal in audible range upto 20 kHz.

10.7.2 Quantization

Quantization is the process of converting continuous analogue audio signal to a digital signal with discrete numerical values. It represents the amplitude component of the digital sampling process during analogue-to-digital (A-to-D) conversion of the signal. This is the number of digits in the digital representation of each sample. This process of converting voltages to numbers is known as **Q*uantization*.** These numbers are expressed as a string of binary digits (1 or 0). So the voltage level of analogue signal at discrete sample points (during digitization) is translated into binary digits or bits for digital storage. Thus, the value of each sample will be stored on a fixed-length variable basis – 8 bit or 16 bit. If we use 8 bits, the lowest value will be zero and the highest will be 255 (2^8 = 256 levels). If 16 bits are used, the lowest value will be zero and the highest 65,535 (2^{16} = 65536). The number of bits used to represent the number determines the resolution with which we can measure the amplitude of the signal. The higher the bit size, better the quality but more storage space will be needed. Using a 16 bit variable will require twice the storage space than 8 bit variable as the file size will be doubled, but quality will be far better. Audio CDs use 16 bit resolution. The size of an uncompressed audio file depends on the number of bits processed per second, called the **Bit Rate** and total time duration of the audio signal. The bit rate depends on the sampling rate and bit resolution i.e. no. of bits used. Usually,

Bit rate (Bits per second) = bit resolution x sampling rate, and

File size (in bits) = bit rate x recording time or duration of audio signal

For example, 1 second of mono audio signal with 16 bit resolution will have a file size of approx. 88 Kilobits. (16 bits per sample x 44000 samples per second x 1 second = 704,000 and 704,000 / 8 bits per byte = 88,000 bytes H” 88 KB).

For stereo, total bit-rate will be 88 x 2 = 176KB/second and an hour of CD-quality stereo audio file would be 176 KB/sec x 3600 seconds/hour = 633,600 KB H” 634 MB, which is about the size of a CD.

An analogue signal is continuous and during sampling, each sample is rounded up to the nearest value, which in turn deviates from the original source signal. This results in quantisation errors, which produce audible noise known as quantisation noise in the output. It is unavoidable, but it can be reduced to an acceptable level by using more bits to represent each number.

10.7.3 Bit Error Rate

When a digital signal is transmitted over a communication channel, the bit stream may be effected by distortion and noise of the path. It is denoted in terms of **Bit Errors**. The number of bit errors is number of received data bits that have been altered due to noise and distortion etc. while passing through a communication channel. Bit Error Rate (BER) is the number of bit errors divided by the total number of bits transferred during a fixed time interval. It is a measure of the performance of the communication channel.

10.7.4 Dither

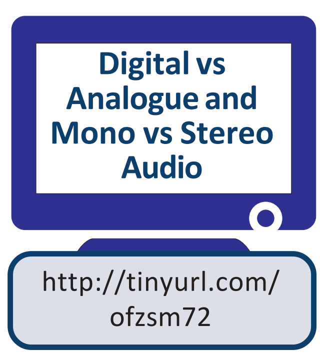
During sampling and quantization, the amplitude of audio signal is sampled at specific rate and rounded off to nearest discrete value. This results in quantisation errors in the form of audible effects of adding low level harmonic distortion in the encoded signal, which is called quantisation noise. It is possible to make this quantization noise more audibly acceptable by adding a small noise-like signal to the original signal before quantization. A common method of reducing quantisation noise is a technique called **Dither.** A very low-level noise is added to the signal prior to analogue-to-digital conversion. This noise forces the quantisation process to jump between adjacent levels at random. This makes the digital system to behave as if it has an analogue noise-floor. This helps the A/D circuit to detect whether the lower-level signal is closer to “0” or “1”, thereby making the quantization error independent of signal level. This makes the audible effect far more natural on the human ear. Dither is not generally considered necessary at higher bit depths, such as 24-bit and above, as the human ear cannot hear quantisation errors at this quality. However, when converting to 16-bit and lower, dither becomes necessary to maintain high audible quality.

10.7.5 Jitter

Jitter is the undesired deviation from true periodicity of a periodic waveform, while passing through an electronic circuit. It can be due to several reasons such as error in the clock, which is producing timing pulses or power supply and even data stream itself due to inter modulation. Analogue-to-digital or digital-to-analogue circuits are synchronous digital systems each controlled by a clock which carries timing information. The clock has to be precise and accurate. The two clocks can never be exactly the same and so timing pulse or frequency of the clocks will vary slightly or miniscule. This results in deviation of discrete samples from the precise sample timing intervals. This is called jitter. It produces noise and degrades the sound of a digital audio system.

As such, during the conversion of audio signal from analogue-to-digital and digital-to-analogue, due to jitter, the samples are taken at non-uniform time intervals and the variation of time between them causes error in the signal reproduction.

Hope, you have already got an idea regarding analogue and digital audio and the differences between both of them. Here, you should watch a video on Digital Analogue Audio Mono Stereo Differences. The link for this video is - http://tinyurl.com/ofzsm72. It will help you to understand the topic.



Activity 10.3

i. What is Nyquist criteria for sampling rate? What will happen if sampling rate is too high?

ii. If sampling rate of 44100 Hz is used, what will be the distance between each sampling point?

iii. If a CD uses 44100 Hz sampling rate with 16 bit resolution, how much storage space is required for storing a one hour stereo audio?

10.8 Compression and Audio Codec

As discussed in Section 10.7.2, the size of an uncompressed audio file after quantization depends on the number of bits processed per second and total time duration of the audio signal which in turn depends on the sampling rate and no. of bits used. An hour of CD-quality stereo audio file with 16 bit resolution and 44.1 kHz sample rate would be 44100 *x* 2 *x* 2 *x* 60 *x* 60 = 635 MB size, which is about the size of a CD. Thus, uncompressed digital audio files require a large storage space. It is often required to make an audio file size smaller to optimise the storage capacity and data transfer rate while downloading audio files via the internet.

Reduction in size of data or file in order to save space or transmission time is called Compression or audio compression. It helps in storage or transmission of same amount of data in fewer bits, thus making the transmission of the data faster. Compression falls into two main categories: Lossless Compression and Lossy Compression. Compression is lossless, if the received data can be restored as an exact replica of the original. The decompressed file and the original are identical. In Lossy compression, file size is reduced by removing some of the data. This causes a reduction or loss in audio quality during the compression or decompression process. Lossy compression is used mainly for audio and video files because the loss in data quality is not easily recognised by the human ear and is imperceptible.

10.8.1 Audio File Types/Formats

File format is a specific way to encode data or information that is to be saved as a computer file. Without a format specification, a file is just a meaningless string of ones and zeros. The format specifications help the file to be properly interpreted and rendered. A digital audio file is stored in a specific file format or type. These may be compressed or uncompressed formats, which contain waveform data that can be played with audio playback software. There are a number of different types of audio file formats, the most common being Wave and MPEG Layer-3. The type is determined by the file extension (characters after the "." in the file name). Common audio file extensions include .wav, .aiff, .mp3 etc. The encoding for a specific type of file format is done with the help of codecs. Codec is a program or algorithm that encodes and decodes data to convert a file between different formats. For example, ".wav" file can be encoded with the "PCM" codec and ".mp3" file uses "MPEG Layer-3" codec. Thus, a codec performs the encoding and decoding of the raw audio data while data is stored in a file with a specific audio format. The audio file formats can be grouped as:

- Uncompressed audio formats, such as WAV, AIFF. WAV is the standard audio file format used mainly in Windows PC environment, whereas AIFF format (Audio Interchange File Format) is used by Apple for the Mac.
- Formats with Lossless compression such as WMA (Windows Media Audio lossless)
- Formats with Lossy compression such as MP3 (MPEG Layer-3), MP4.

10.8.2 Open and Proprietary Formats

An *Open* format is one where the description of the format is available to all the users. For example ASCII, PDF, .Doc, HTML are the open file formats. As the format definition is freely available, anyone can in principle write software to access data stored using that format.

Whereas, a *Proprietary* format is one that is owned by an individual or a company/corporation. For example AutoCAD's .dwg drawing format, the MP3 MPEG Audio Layer 3 format and Adobe Photoshop's .psg image format. Most proprietary formats are closed, meaning that the definition of the format is not available to the public. This means that data stored in the format can only be accessed using the format owner's software.

Activity 10.4

What are different types of file formats? How do Open source and Proprietary Formats differ?

10.9 Let Us Sum Up

In this Unit, you have learned how to distinguish between analogue and digital audio. Further you have also learned the various characteristics of analogue audio, i.e. amplitude and frequency, as well as the characteristics of digital audio, i.e. sampling and quantization. Further, you have learned with respect to digital audio, how digital audio files can be compressed using a variety of file formats and codecs. You should have a basic understanding about differences between open and proprietary audio file formats as well.

10.10 Model Answers to Activities

Activity 10.1

Analogue signal is a continuous signal which can take any value, whereas a digital signal can take only discrete values such as analogue numbers. Analogue signals are affected by noise and distortion as compared to digital signal. Give comparison.

Activity 10.2

i. Mono signal contains no directional information about sound origination, whereas stereo produces a sense of direction and distance. Stereo adds liveliness and gives a natural experience to hearing music or audio.

ii. Find using the relations:

$$T = 1/f, \quad \lambda = v/f, \; v = 3 \times 10^8 \text{ m/sec.}$$

Activity 10.3

i. Explain Nyquist Sampling Theorem: Sampling rate must be at least twice the highest frequency of source signal. Also explain Aliasing effect.

ii. In 1 second, 44100 samples will be taken and it corresponds to 1/44100th of a second. Explain Sampling.

iii. Calculate using bit rate and file size:

Bit rate (Bits per second) = bit-resolution x sampling rate,

File size (in bits) = bit rate x recording time or duration of audio signal

Activity 10.4

Explain uncompressed and compressed file formats i.e. .wav, .aiff, mp3 etc. alongwith ASCII, PDF, HTML.

Mono signal contains no directional information about sound origination, whereas stereo produces a sense of direction and distance. Stereo adds liveliness and gives a natural experience to hearing music or audio.

UNIT 11

Components of the Audio Chain

Structure

11.1 Introduction

In the previous Unit, various aspects related to analogue and digital audio were discussed. In this Unit, we will discuss about the 'audio chain' which shows how physical components of recording and reproduction systems i.e. broadcast equipment are connected together in a studio and the signal flow-path taken by the sound from acquisition to its reception by the listener. You will learn about broadcast microphone theory, equipment for programme production, audio mixers, amplifiers, monitoring speakers, digital audio workstations (DAWs) and field recorders. About 10 hours should be devoted to understand and learn this Unit (including working out various activities).

11.2 Learning Outcomes

After completion of this Unit, you will be able to:

- describe different types of microphones based on transducers
- discuss the features and characteristics of microphones and their polar patterns
- describe various equipment for programme production
- explain the typical audio chain in a broadcast studio

11.3 Audio Chain in a Typical Broadcast Studio

Normally, the programme originates from a studio and is then broadcast using a transmitter, which might be Amplitude Modulated (AM) or Frequency Modulated (FM) mode. The broadcast of a programme from source to the listener involves use of a device to pick up sound i.e. microphones, recording/playback and signal processing equipment, routing of audio signal from studio to transmitter location using a studio transmitter link and finally the transmitter. Figure 11.1 shows a simplified block schematic of the audio chain of a broadcast studio.

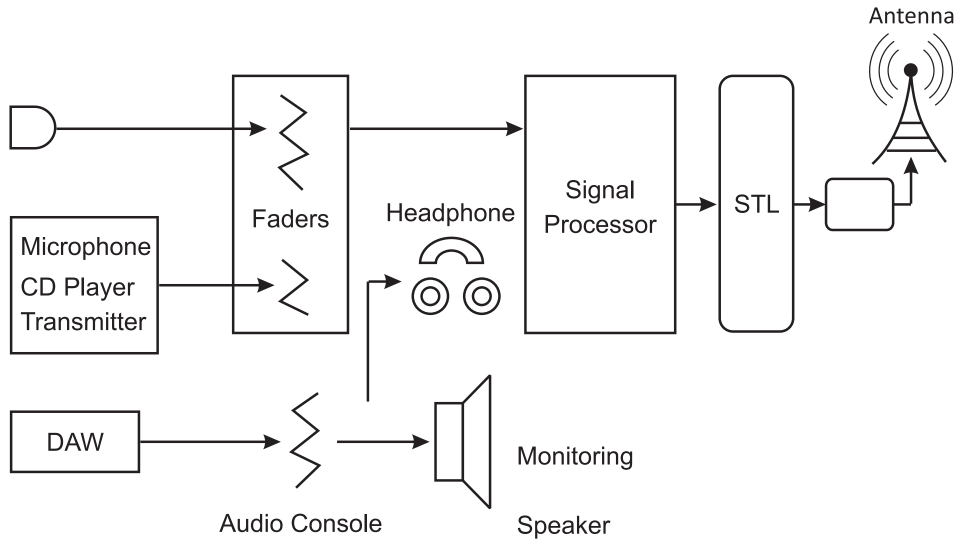


Figure 11.1: *Audio Chain of a broadcast studio*

Audio chain shows linkage of various equipment starting with various sound sources, such as a microphone to pick up announcer's voice, a CD player or a digital audio workstation (DAW), mixer or audio console, signal processing equipment, monitoring speakers and studio transmitter link (STL) for broadcasting. A broadcast studio is an acoustically treated sound proof room for production and broadcast of a programme. The microphone is the first equipment that picks up the voice of announcer or artist and transforms it into an audio signal. All the sound sources like CD players, DAWs and microphones are connected to an audio or mixer console which is used for mixing and controlling the programmes for recording and transmission.

11.4 Microphone

The fundamental purpose of a microphone is to convert sound energy to electrical energy, in which the voltage and current are proportional to the original sound. So a microphone is acoustic to sound transducer that converts sound to an electrical signal. Microphones use electromagnetic induction effect or capacitance effect or piezoelectric effect for converting sound to electrical signal. For this purpose, microphones use a thin membrane known as a diaphragm. The sound waves cause the diaphragm to vibrate and this vibration is converted by a transducer into electrical signals. Microphone output is very low level, which is approximately –70 dBm and it requires a boost to make it usable. There are three major parts of any microphone:

- **A Diaphragm** vibrates in accordance with air pressure of sound waves. It must be lightest possible to accurately reproduce high frequency sounds.
- **A Transducer** converts the vibrations of diaphragm into an equivalent electrical signal.

- **A Casing** provides mechanical support and protection for the diaphragm and the transducer and also helps in controlling the directional response of the microphone.

11.5 Types of Microphones

There are a number of types of microphones in common use. These can be divided or classified into two main types:

(i) Classification by type of Transducer – depending on the internal structure and also the method used to convert sound energy into electrical signal.

(ii) Classification by Pick-Up or depending on Directional Properties.

11.5.1 Classification by Transducer Type or Internal Structure

Depending on the internal configuration, the microphones can be labelled into three types:

(a) Dynamic Microphones

(b) Ribbon Microphones

(c) Condenser microphones

i) ***The Dynamic Microphone***

This is also called 'Moving Coil Microphone'. This type of microphone works on the principle of electromagnetic induction. When a coil of wire moves inside a magnetic field an electrical current is generated in the wire. Sound waves cause movement of a thin metallic diaphragm and an attached coil of wire located inside a permanent magnet. When the diaphragm vibrates in response to the incoming sound waves, the coil moves backwards and forwards in the magnetic field. This causes a current in the coil. The amount of current is determined by the speed of motion of the diaphragm. A common configuration is shown in Figure 11.2.

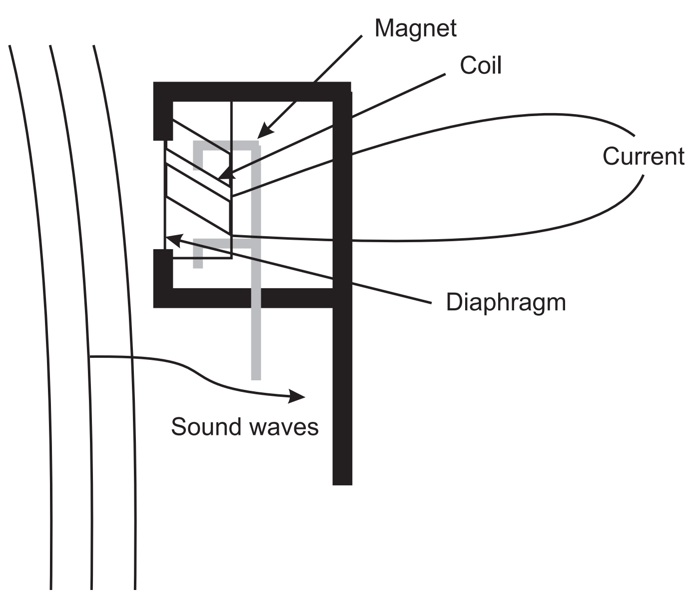


Figure 11.2: *Dynamic Microphone - Block Diagram.*

The response of a microphone to high frequency signals depends upon the moving parts. This type of microphone is relatively heavy, as both the diaphragm and the coil moves. Thus, the frequency response falls off above 10 kHz. However, their resonance peaks around 4–5 kHz and this provides an inbuilt boost that improves speech, singing or vocal intelligence.

ii) ***The Ribbon Microphone***

The Ribbon microphones also operate on the principle of electromagnetic induction to convert sound energy to voltage. In this type of microphone, the transducer is a long thin strip of aluminium foil, which moves within a magnetic field to generate a current and hence voltage. The aluminium foil is also called ribbon, is vibrated directly by the moving molecule of air of the sound waves. As such, no separate diaphragm is required. A common configuration is shown in Figure 11.3.

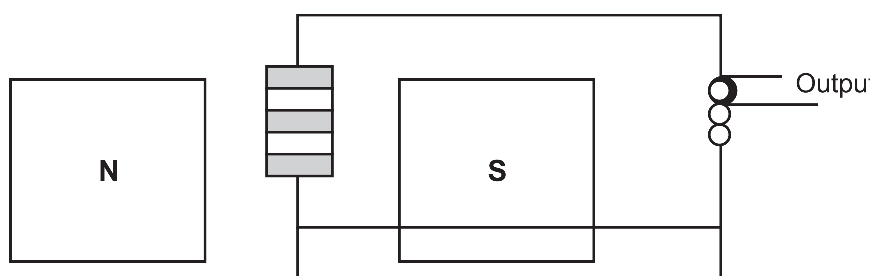


Figure 11.3: *A Ribbon Microphone*

However, this type of microphone has a relatively low output signal, so an output transformer is needed to boost the signal level. The foil's lower weight as compared to a moving coil gives it a smother and higher frequency response to around 14 kHz. As such, such microphones are good for quality studio recording of acoustic instruments.

iii) ***The Condenser Microphone***

The condenser microphone has two electrically charged plates in the form of a thin movable diaphragm and a fixed solid back plate rather than a vibrating wire coil. This makes up an electronic component known as a capacitor or a condenser with positively and negatively charged plates and air in between. The capacitor stores energy in the form of an electrostatic field. Due to sound pressure, the diaphragm moves causing a change in spacing between the two plates and this changes the capacitance resulting in corresponding change in voltage. A voltage is required across the capacitor for this to work. This voltage is either supplied by a battery in the microphone or by an external source called Phantom power. A block of condenser microphone is shown in Figure11.4.

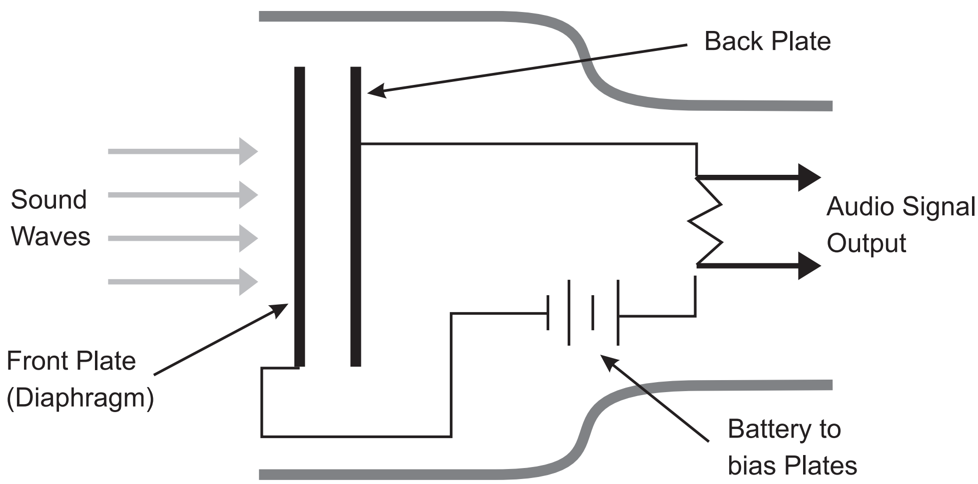


Figure 11.4: *A Condenser Microphone*

A condenser microphone has an omni-directional pattern. To make it directional, small holes are made in the back plate, which delays the arrival of sound at the rear of the diaphragm to coincide with the same sound at the front, which then cancels the sound out. These microphones have very good high as well as low frequency response.

Activity 11.1

i. What is an audio chain?
ii. What is Phantom Power?
iii. What are the major parts of a microphone?

Answer each question in about 50-100 words.

11.5.2 Classification by Pick-Up or Directional Properties

Some microphones pick up sound equally from all directions. Others pick up sound only from one direction or a particular direction. Every microphone has a property of directionality. The factor which determines the directional response of a microphone is the way the diaphragm is exposed to sound. The pickup pattern of microphones describes a three dimensional orientation in space relative to sound sources. The directional response of a microphone is represented graphically. This graph is called a Polar Pattern. The polar pattern shows the level of signal pick-up from all angles and at different frequencies.

In general, pickup patterns fall into following three categories:

(a) Omnidirectional
(b) Bi-directional
(c) Unidirectional

i) Omnidirectional Microphone

An omnidirectional microphone picks up sound equally from all directions. The diaphragm is exposed to the open air on one side only. The air on the other side is enclosed by an airtight structure, so that it is unaffected by the sound. The outside pressure determines the activating force. As the microphone is small compared with the wavelength of the sound being received, it will not obstruct the pressure waves coming from the sides or back of the casing and as such the response of microphone will be the same in all directions. The polar pattern will be as shown in Figure 11.5. These microphones are mostly used for recording of vocal groups or choirs. The major drawback of omnidirectional microphones is their sensitivity to feedback. Due to this, proper placement is necessary for covering a live programme.

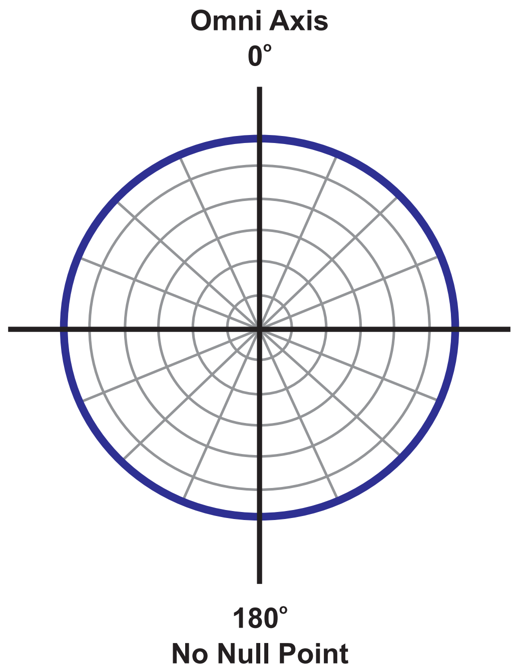


Figure 11.5: *Polar Pattern of Omni-directional Microphone*

ii) The Bi-directional

These microphones pick up sound from the front and the back side of the microphone, but rejects sounds from the left and right sides of the microphone. The sensitivity of the microphone on the sides is low. The polar pattern of such microphones is as shown in Figure 11.6. The frequency response is better on the front side of the microphone. Bi-directional microphones are excellent for capturing a vocal or instrumental duet, and face-to-face interviews using a stationary single microphone. Normally, these types of microphones are optimally positioned above a sound source.

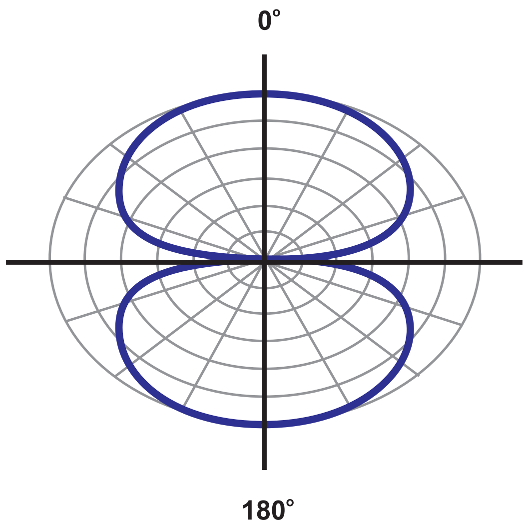


Figure 11.6: *Polar Pattern of Bi-directional Microphone*

iii) The Unidirectional or Cardioid Microphone

This is the most popular configuration for microphones. The Cardioid microphone picks up the sound primarily from one direction i.e. in the front and reduced pickup from the side and the back. This helps in isolating the signal source from the background noise or from other sound sources on the side. They are named cardioid because the polar pattern is heart-shaped as shown in Figure 11.7.

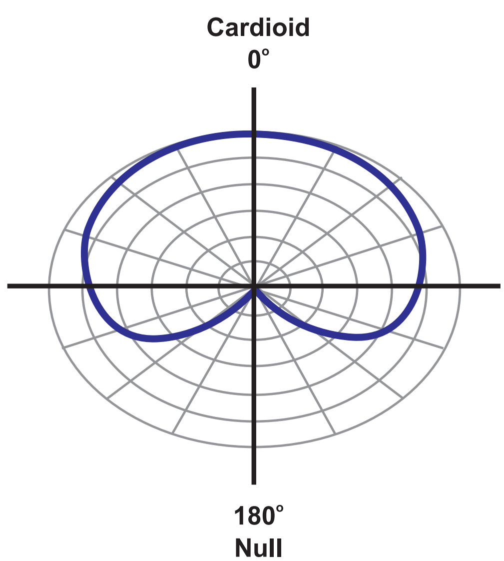


Figure 11.7: *Polar Pattern of Cardioid Microphone*

The cardioid microphone is ideal for general use. Handheld microphones are usually cardioid. Cardioid microphones have different frequency response near to the sound source and at a distance from the sound source. This is called **'Proximity Effect'**. There is a boost in low to mid frequencies as the distance between the sound source and the microphone decreases. Omni-directional microphones do not exhibit the effect. There are many variations of the cardioid pattern such as the hypercardioid as explained below.

iv) The Hypercardioid Microphone

By changing the number and size of the openings on the case of the microphone, the directional characteristics of the microphone can be increased, so that there is even less sensitivity to sounds on the back sides. These microphones are very directional and eliminates sound from the sides and the rear. The polar pattern is as shown in Figure 11.8. Due to the long thin design, these hypercardioids are often referred to as shotgun microphones.

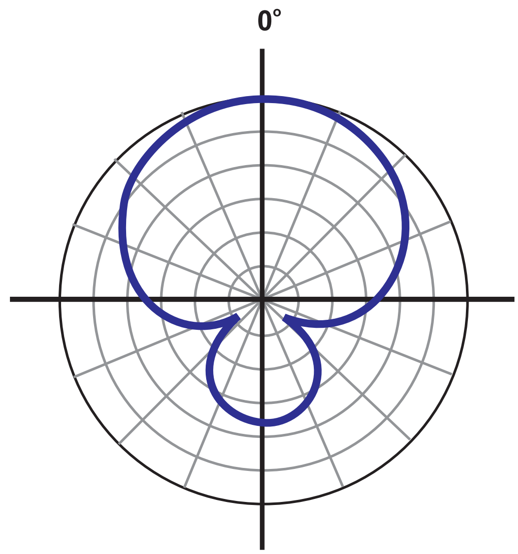


Figure 11.8: *Hyper cardioid Polar Pattern.*

Activity 11.2

i. What are the different types of microphone based on pick-up?

ii. What do you understand by the proximity effect?

Answer each question in about 100-150 words.

11.6 Equipment for Programme Production

Various equipment are available in a studio for programme production and broadcast. The broadcast of a programme from source to listener involves use of studios, audio mixer, playback equipment etc. The equipment meets the requirement of recording, editing, storage and playback. A digital audio workstation with suitable software is utilized for recording and playback facility. The programme may either be live, recorded or field based from OB spot. Basic studio equipment are briefly discussed below.

11.6.1 Audio Mixer

A mixer combines an array of inputs into a few controllable outputs. It is a device which takes two or more audio signals as inputs, mixes them together and provides one or more output signals. It is used for mixing and controlling the programmes. The input signals can be of different levels starting from the microphone. It has the facility to adjust the audio levels of input and output. The mixer provides additional outputs for monitoring, recording and broadcast purposes. Figure 11.9 shows an audio mixer with five inputs and outputs.

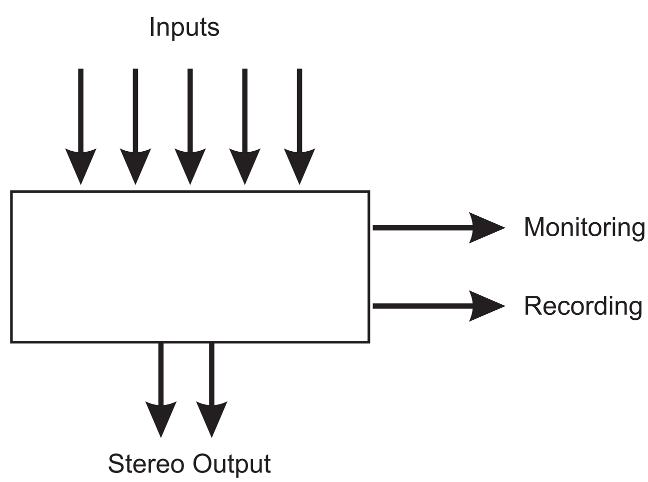


Figure 11.9: *Audio Mixer block diagram*

11.6.2 Amplifiers

Signal amplifiers are the electronic devices that have the ability to boost a relatively small input signal. Amplification is necessary because the desired signal is usually too weak to be directly useful. Amplifiers can be thought of as a black box containing an active device, such as transistors or integrated circuits (ICs), which has two input terminals and two output terminals. Audio amplifiers and audio pre-amplifiers are used to increase the amplitude of sound signals. As explained earlier, the output from a microphone is at very low level (-70 dBm). Pre-amplifiers are used to boost low-level signal from a microphone. The microphone output forms one of the input signals to audio mixer, where it is amplified by a pre-amplifier module and then amplified by a programme amplifier module of the audio mixer, which can be used for recording, monitoring to drive speakers and broadcast purposes. Audio amplifiers used in a broadcasting studio have almost a flat frequency response within a variation of 1 dB with a harmonic distortion of less than 1 %.

11.6.3 Monitoring Speakers and Headphones

A monitoring speaker performs an opposite function to a microphone, i.e. it converts electrical signal into sound wave. Monitoring speakers are provided to monitor the sound quality being recorded and broadcast. The studio monitor should have flat frequency response, so that it reproduces the audio exactly as it sounds, without boosting or reducing any frequencies in the process. Studio monitors may be passive or active. Passive monitors need a separate monitoring power amplifier, whereas active monitors have a built-in amplifier.

Passive monitors are driven by a monitoring amplifier. The monitor output from the mixer is fed to monitoring amplifier which drives the loudspeakers provided in studio and control room. Normal input level to the monitoring amplifier is about -12 dBm in matching condition. The monitoring amplifier and speakers are designed to have a flat frequency response without any sound enhancing effect, so as to faithfully reproduce all the audible frequencies at the same level. Active monitors have built to in power amplifier which drives the speakers. However, placement of speakers also effects the reproduction of sound.

Headphones are also used for monitoring of programmes in the studios. These help in placement of sound source, so that it is not affected by environmental interference from the room. However, monitoring through headphones emphasize low-level sounds. Headphones work on the same principles, which are applicable to loudspeakers.

11.6.4 Digital Audio Work Station

Nowadays, computers are being used for recording and playback of audio. Thus a computer used is called a Digital Audio Workstation (DAW). DAW is a computer system designed to record, edit and playback digital audio. DAW consists of a host computer hardware, professional audio interface hardware, which performs both analogue to digital (A/D) and digital to analogue (D/A) conversion, an audio processing software such as Cubase, Audacity, Adobe Audition etc. Data is stored on hard drives. The computer acts as a host for the sound card and software provides processing power for audio editing. The software controls the two hardware components and provides a user interface to allow for recording and editing. There are no. of advantages in using DAWs for audio production:

- It is easy to handle, longer audio files for recording and editing.
- The audio is recorded on computer hard disk, like audio can be accessed at any point within the recorded file i.e. random access of audio content is possible.
- Non-destructive editing of audio file helps in keeping the original file without any changes.

11.6.5 Field Recorders

Field recording implies recording of audio or other events outside the studio environment. Field recorders are designed for OB recordings and electronic news gathering. A field recorder is a portable digital recorder that runs on batteries, is light weight and creates high-quality audio recording on removable digital media like flash card or internal drive. These can have an inbuilt internal stereo mike and also provision for connecting an external mike on USB port, which can also be used to connect to a DAW in order to transfer the field recording for editing and playback. It is possible to select the recording format like WAV or MP3 and name the file. Some of the field recorders have also in-built facility for editing the file.

Activity 11.3

i. What are field recorders?

11.7 Let Us Sum Up

In this Unit, we have discussed regarding audio chain in a typical broadcast studio. You have also learned the various types of microphones. Further, we have also discussed the equipment needed for programme production, such as audio mixer, amplifier, monitoring speakers and headphones, digital audio workstation, field recorders etc.

11.8 Model Answers to Activities

Activity 11.1

i. An audio studio chain shows linkage of various equipment starting with various sound sources, such as a microphone to pick up announcer's voice, a CD player or a digital audio workstation (DAWs), mixer or audio console, signal processing equipment, monitoring speakers and studio transmitter link (STL) for broadcasting. The microphone is the first equipment that picks up the voice of announcer or artist and transforms it into an audio signal. All the sound sources like CD players, DAWs and microphones are connected to an audio or mixer console which is used for mixing and controlling the programmes for recording and transmission.

ii. Phantom Power is used with condenser microphones. It is a DC voltage (48V), which is connected to a condenser microphone as its diaphragm needs an electric current for it to function like a capacitor.

iii. There are three major parts of any microphone:

(a) A Diaphragm vibrates in accordance with air pressure of sound waves. It must be the lightest possible to accurately reproduce high frequency sounds.

(b) A Transducer converts the vibrations of diaphragm into an equivalent electrical signal.

(c) A Casing provides mechanical support and protection for the diaphragm and the transducer and also helps in controlling the directional response of the microphone.

Activity 11.2

i. Every microphone has a property of directionality. Some microphones pick up sound equally from all directions, while others pick up sound only from one direction or a particular direction. The directional response of a microphone is represented graphically by polar pattern, which shows the level of signal pick-up from all angles and at different frequencies. Based on the pickup patterns, microphones fall into following three categories:

(a) Omnidirectional

(b) Bi-directional,

(c) Unidirectional

ii. Directional microphones (like cardioid microphones) have different frequency response near to the sound source and at a distance from the sound source. This is called 'Proximity Effect' that produces a boost in low to mid frequencies as the distance between the sound source and the microphone decreases.

Activity 11.3

A field recorder is a portable digital recorder that runs on batteries, is light weight and creates high-quality audio recording on removable digital media like flash card or internal drive. These are used for OB recordings and electronic news gathering. These can have an inbuilt internal stereo mike and also provision for connecting an external mike on USB port.

UNIT 12

Studio Acoustics

Structure

12.1 Introduction

For Community Radio Stations, studios are built for programme production, post production and broadcast. These studios are acoustically designed rooms. For achieving best recording and broadcast quality from these studios, all undesirable sound terms as noise must be kept under control. Noise from air-conditioners, outside environment, human-made noise from traffic movement and industrial activities are inappropriate for programme production and recording. Construction of studio with reference to the *noise control* is an important aspect for realising high quality of sound.

For ensuring the recordings to be exact reproduction of original we must understand as to how sound behaves in an enclosed room. *The science of sound is called as **Acoustics***. It is important to understand the fundamental of acoustics for understanding concepts of studio acoustics and for controlling noise in the sound studios. In this Unit, you will learn about acoustics of the studios, sound isolation, sound absorption, noise sources, and acoustic treatment.

This Unit will require about five hours of study.

12.2 Learning Outcomes

After going through this Unit, you will be able to:

- describe Acoustics.
- explain the necessity of noise control.
- analyse noise sources.
- discuss isolation and absorption.
- describe and categorise different types of acoustic treatment.

12.3 Studio Acoustics

Acoustics is a science that deals with the study of sound waves. The application of acoustics is involved in sound and noise control. In broadcast industry, acoustics is a very important aspect while planning for studio building and studio area within a building. ***Studio Acoustics*** administers the principles and a process of how sound behaves in an enclosed space. Studio Acoustics mainly deals with the enhancing of sound quality generated inside the studio and minimizing the outside noise entering the studio. A video is produced on the '**Studio Acoustics'** and it is available at http://tinyurl.com/nbyzl64. You may first watch this video and then read the following details on the topic.

Acoustics & Noise Reduction

http://tinyurl.com/nbyzl64

To understand Studio Acoustics we must know the basic phenomenon of sound waves propagating in a studio. In Unit 9 we have read about sound wave propagation mechanism. Like any other wave, sound waves also show wave characteristics when they encounter an obstruction in the room. These are reflection, refraction and diffraction. When sound wave strikes the wall surface a portion of it is *reflected,* portion of it is *refracted* and portion of it is *diffracted*. In addition to these phenomena behavioural characteristics like Sound Absorption and Sound Diffusion are made use of in designing the interior of studios. Extent to which each of these phenomena takes place depends upon the structure and shape of the obstacle, and also on the frequency of sound waves. *Figure 12.1* shows the behaviour of the sound wave when it strikes acoustically treated wall.

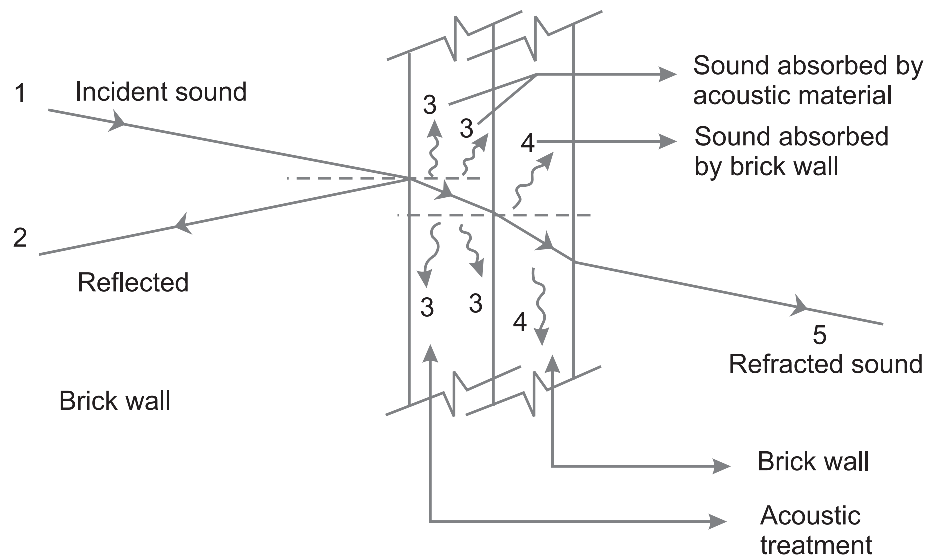


Figure 12.1: *Behaviour of Sound Wave on striking Wall*

Phenomena of sound propagation

Reflection

Bouncing back of sound after striking a flat and hard surface is known as reflection of sound. In close rooms, the sound will reflect and re-reflect till its intensity weakens and it dies completely. A single strong reflection can be heard as an *echo.* When lots of reflections combine, it gives rise to reverberation effect. ***Reverberation Time*** *is the amount of time it takes a loud and short sound to die away by 60 dB drop in loudness.* The reverberation time desired in a room depends on the activity for which room or studio it is designed.

Refraction

Refraction is the change in the direction of travel of the sound by differences in the velocity of propagation. The refraction of wave due to difference in the density of medium is shown in *Figure 12.1 (wave 5)*. The change in the velocity may be due to:

- Density of the mediums,
- Temperature gradient in atmosphere.

Diffraction

The diffraction phenomenon is described as the apparent bending of waves around small obstacles (compared to wavelength) and the spreading out of waves past small openings (compared to wavelength). The diffraction of a wave is shown in *Figure 12.2*.

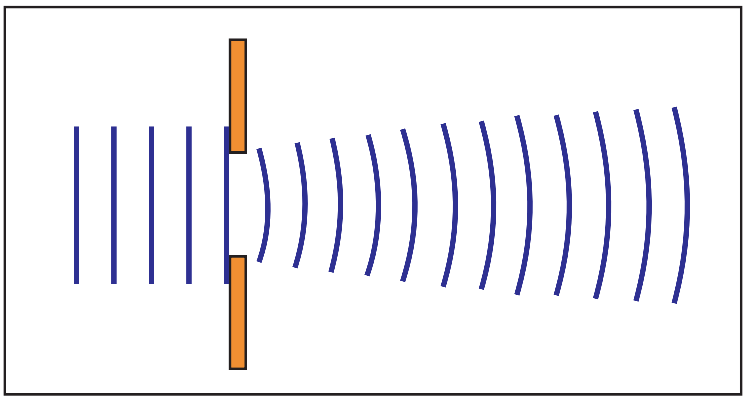


Figure 12.2a: *Diffraction of Sound Wave*
[Wide Gap - Small Diffraction Effect]

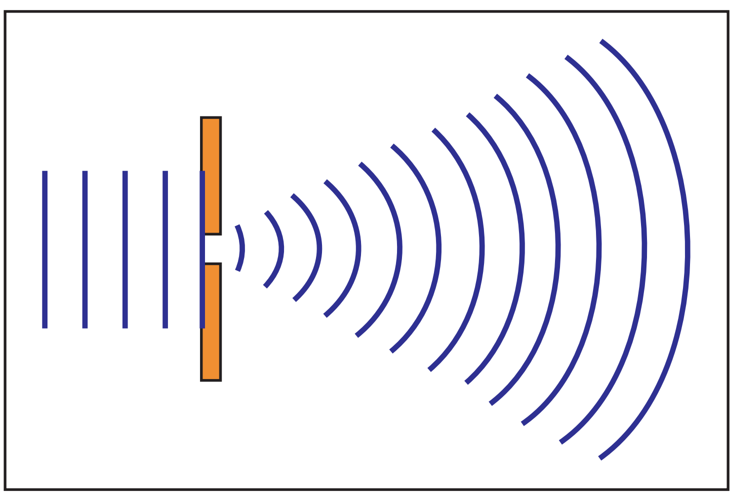


Figure 12.2b: *Diffraction of Sound Wave*
[Narrow Gap - Large Diffraction Gap]

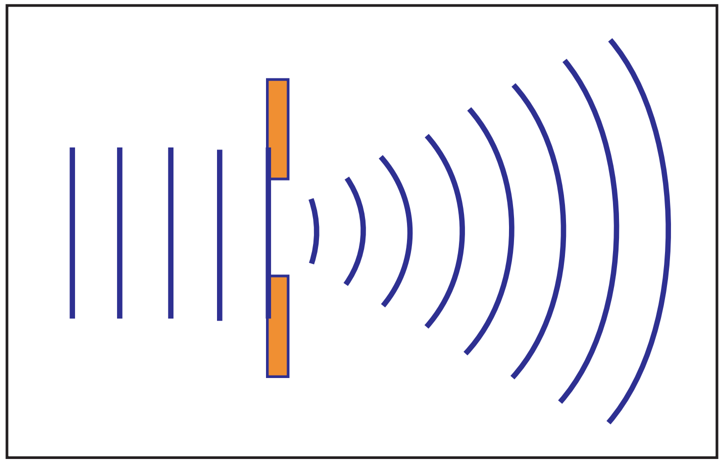


Figure 12.2c: *Diffraction of Sound Wave*
[Large Wavelength - Large Diffraction Effect]

Reverberation

You have already read about reverberation in Unit 9. It is the collection of reflected sounds from the surfaces in an enclosure like studio. In an auditorium, reverberation is helpful in overcoming the loss of sound waves. However, if reverberation is more, it makes the sound un-intelligible and leads to loss of articulation. Reverberation time is dependent on the volume of the room. Reverberation is due to the sound wave reflections from hard floor, wall or ceiling surfaces. It can be reduced by replacing some of the hard and reflective parts of the walls with soft and absorptive sections of acoustic material.

RT60 = 0.161V / S α (Metric System)

Where

V = Total Volume

S = Surface Area

α = Absorption Coefficient

Note It

Acoustics in broadest sense, is the science of sound.

Studio Acoustics is defined as those qualities of a space that affect the production, transmission and perception of music or speech.

12.4 Noise Sources

Noise can be classified into two types depending upon the medium used by noise for propagation. Noise which propagates from the source via air as a medium is known as ***Air-Borne Noise***. Noise that travels a part of its journey by means of vibration of a solid structure is known as ***Structure-Borne Noise.*** Whenever there is a physical connection between vibrating machine and supporting structure, vibration energy is transmitted into the supporting structure from which it may be radiated as audible sound or felt as vibration.

Noise in a studio can originate from:

- Outside the studio
- Inside the studio itself

Note It

Structure borne noise is attenuated by isolation, while airborne noise is reduced by absorption.

Noise originated from outside the building

Main sources of noise from outside of studio are:

- Heavy industries in nearby areas
- Noisy streets
- Unwanted sound from adjacent rooms
- Airplanes, road and rail traffic movements

During planning phase of the studio, these noises can be avoided and minimised by selecting the studio site in a quiet environment. Setting up of studios should be avoided near railway lines, highways, airports and industrial areas. For avoiding noise from the busy street, studios are located at the back side of the building, so that front portion of the building acts as a sound barrier for the studio.

Noise from inside the studio

Noise from inside the studio consists of:

- Air-conditioning noise due to air flow
- Noise from illumination lights
- Noise from cooling fans in Audio Work Stations and other electronic equipments etc.

By providing absorbers and diffusers in the AC duct, we can reduce noise due to airflow. Also always try to use the electronic equipment with low noise type to avoid noise from the illumination lights and cooling fans of equipment.

12.5 Sound Isolation

Sound Isolation is an acoustic treatment for reducing the effects of exterior noise. Main motive of isolation is to reduce the level of sound entering an enclosed space and preventing the transmission of sound energy into adjoining air space. During studio designing, Sound Isolation techniques are used for controlling the sound and noise to the acceptable levels to ensure that the programme recording is free from unwanted noise. Sound Proof Doors, Observation Windows and walls are, therefore, designed after proper calculation of the *Transmission loss* for the material used in studio construction. The actual process of sound isolation involves inserting insulating material into the walls, as well as above the ceiling and below the floor.

Isolation of the studio is required mainly from:

- Footfall, dragging of furniture,
- Adjacent room, corridor noise,
- Air-Conditioner, Diesel Generator and lift noise and vibrations

Sound Isolation from footfall, dragging of furniture etc.

Noise due to footfall, dragging of furniture, falling of object is classified as structure borne noise. Such a noise travels in the framed structure building to long distances. Steel and concrete frame buildings provide a path for such noise and spoil the programme production. For controlling such type of noise, studios are generally constructed as a load bearing building structures.

Sound Isolation from adjacent room or corridor noise

Monitoring in control room and conversation nearby corridors may cause leakage of this sound in a studio. Poor isolation of the partitions and thin acoustic treatment leads to leakage of adjacent room noise and this leakage of sound or noise from such areas may disturb the recording in the studio.

During planning of the studio and associated rooms, proper sound isolation can be designed by keeping the two different sound sources or studios at a distance, so as to minimize sound transmission from adjacent rooms. Also additional isolation is achieved by providing an acoustically treated ***buffer room (Sound Lock),*** at the entrance of the studio, so that corridor noise does not leak to the studio through the entrance door. To avoid leakage through corridors, all the partition walls in the studios should be constructed up to the real ceiling height of the studio.

Control of air-conditioning, diesel generator and lift noise

Noise due to Air-Conditioning Plants can get transferred to the studios as structural borne noise as well as air borne noise. Measures to be taken to minimize such a transfer of noise are explained below:

- Generally, AC plants are installed in a separate building to reduce the transfer of structure borne noise. Apart from their installation in different building, such machines are installed on rubber pads which act as a damper for vibration. AC plant and Ducts are connected via flexible connection to minimize the structure borne noise. Water pipes for condensers are also isolated from walls with proper packing material to avoid transmission of vibrations.
- The supply and return duct of AC plant act as the path for Air borne noise from AC plant. To reduce such noise, entire length of supply and return duct is treated with sound absorbing materials e.g. glass wool and mineral wool.
- Lastly, the speed of the blower is also kept low for controlling the airborne noise from air flow of the AC plant.

For controlling the **Diesel Generator and Lift machine room** noise, designing and planning should be done in such a way, that these machines are either installed in structurally isolated block or in a separate building away from the studio. For reducing the vibration footprint, the Generator and Lift Machine Room is mounted on anti-vibration mounting, such as rubber pads.

As you are aware that sound can travel through any medium, but sound intensity is reduced in the transition from one material to another. The amount of reduction known as ***Transmission Loss*** is related to the density of the wall. The difference of the sound level of sound wave 1 to that of refracted wave 5 as shown in *Figure 12.1* is the transmission loss of sound energy, while travelling from the room to outside environment. Sound isolation generally known as *Transmission Loss* against airborne noise is determined by its mass per unit area.

Transmission Loss (TL) = 20 Log f + 20 Log w

Where

f = Frequency

w = Surface Mass of Barrier

Sound Transmission Class (STC)

The Sound Transmission Class is a rating of the effectiveness of a material to reduce the transmission of airborne sound. Some of the STC values along with their rating are provided in *Table 12.1.* The condition of the room is also explained in the table for the corresponding STC value. The STC rating and Transmission

Losses at different frequencies of different construction material are provided in the *Table 12.2.*

Table 12.1: *Subjective Equivalent of different STCs for Studio*

STC	Conditions	Subjective Rating
<30	Normal speech heard and understood	Poor
30-35	Loud speech heard and understood; normal speech heard but not understood	Fair
35-40	Loud speech heard but not understood; normal speech faint	Good
40-45	Loud speech faint; normal speech in-audible	Very good - minimum required for studios
>45	Loud sounds faint	Excellent - design goal for most professional studios

Table 12.2: *STC and Transmission Loss*

Sl. No.	Material	Transmission Loss (in dB)				STC Rating (in dB)		
		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	
1	Gypsum Board - 12.5 mm	14	20	24	30	30	27	27
2	Brick Wall - 100 mm	31	33	39	47	55	61	45
3	Solid Wood Door - 50 mm with airtight casketing and drop seal	29	31	31	31	39	43	35
4	Laminated Glass - 12.5 mm	34	35	36	37	40	51	39
5	Mineral Fibre acoustic ceiling tile - 12.5 mm	6	10	12	16	21	21	17

12.6 Sound Absorption

Sound absorption is the process by which we can reduce the reflection of the sound energy by the surfaces. As we have already seen from the absorption phenomenon of sound wave in *Figure 12.1* that when sound wave strikes the acoustically treated surface, some of the sound wave penetrate the acoustic material covering the wall and portion of that sound energy is retained by the absorbing material. This absorbed sound energy is converted into heat energy, thereby, preventing any re-transmission or reflection of sound wave from the surface. The absorbing material is required to be selected on the basis of frequency distribution of noise and the purpose of the use of studio. Different absorbers show different absorption characteristics which are non-uniform over the complete frequency spectrum.

For achieving optimum R/T characteristics, combination of acoustic absorbers is used in the studio. Every material has some absorptive qualities. This is described by its coefficient of absorption, a number between 0 and 1, the value 0 corresponds to totally reflective and 1 corresponds to an open window. These numbers can be used to compare material and to predict the results of treatment. Some of the commonly used absorbers are:

- ***i. Porous Materials:*** Porous materials are used for the absorption of Mid and High Frequencies. Mineral wool, glass wool are members of this class. These materials are very good absorbers and are most effective in *Mid and High Frequencies.* These absorbers are used with the covering material which acts as a face of such absorbers. Fabric used as a Carpet and Curtain also act as absorber for Mid and High Frequencies.
- ***ii. Fibrous Materials:*** Insulation boards, perforated tiles fall in fibrous material category. The tiny holes in the fibrous material act as a trap which is responsible for the absorption of sound and dissipation of the sound energy. The Absorption of these materials increases with increase in the softness of the material. These materials have very poor absorption on low frequencies.
- ***iii. Panel/Resonant Absorbers:*** Panel absorbers are thin wooden ply/ veneers with an air cavity behind. This is generally used as *Low Frequency Absorber (LFA).*

Sound Absorption Co-efficient

Sound Absorption Co-efficient is defined as the ratio of sound energy absorbed to that arriving at a surface or medium.

The sound absorption co-efficient indicates how much of the sound is absorbed in the actual material. The absorption co-efficient can be expressed as:

$\alpha = I_a / I_i$

Where

I_a = Sound Intensity Absorbed (W/m^2)

I_i = Incident Sound Intensity (W/m^2)

Total Sound Absorption

The total sound absorption in a room can be expressed as:

$A = S_1 \alpha_1 + S_2 \alpha_2 + .. + S_n \alpha_n = \Sigma S_i \alpha_i$

Where

A = Absorption of the room (m^2)

S_n = Area of the Actual Surface (m^2)

α_n = Absorption Coefficient of the Actual Surface

The Absorption Coefficients of various construction materials at different frequencies are provided in *Table 12.3*. The last column of the table 12.3 provides the *Noise Reduction Coefficient* of the respective material. NRC is the scalar representation of the amount of the sound energy absorbed upon striking a particular surface.

Table 12.3: *Absorption Coefficients*

Sl. No.	**Material**	**Sound Absorption Coefficient**				**NCR Number**		
		125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	
1	Painted Masonry Wall	0.08	0.05	0.05	0.07	0.08	0.08	0.06
2	Gypsum Board -12.5 mm	0.27	0.10	0.05	0.04	0.07	0.08	0.07
3	Window Glass	0.30	0.22	0.17	0.13	0.07	0.03	0.15
4	Fabric on the wall	0.08	0.06	0.10	0.16	0.25	0.32	0.14
5	Linoleum Flooring	0.02	0.03	0.03	0.03	0.03	0.03	0.03
6	Wooden Flooring	0.15	0.12	0.10	0.06	0.06	0.06	0.09
7	Thin Carpet Flooring	0.03	0.06	0.10	0.20	0.43	0.63	0.20
8	Thick Carpet Flooring with under padding	0.08	0.28	0.38	0.40	0.48	0.70	0.39
9	Mineral Fibre acoustic ceiling tile - 12.5 mm	0.45	0.50	0.53	0.69	0.85	0.93	0.64

12.7 Noise Control

Good acoustics is a main requirement of high quality broadcasting or recording studio. Noise control measures are provided in studios, control rooms, and other technical areas in order to achieve the acoustic conditions desirable for the various types of programmes.

Some basic approaches for controlling noise in a studio are:

- Locating the studio in a quiet environment
- Reducing the noise energy within the room
- Reducing the noise output of the source
- Placing an insulating barrier between the noise and the room
- Using Sound Lock area before studio entry

12.7.1 Acoustic Treatment

Acoustic treatment refers to placing a suitable material on the wall surface, ceiling and floor that will have a direct effect on the sound quality. For reduction of echo, dead spots, reverberation points, reflection points and unnecessary sound magnification in the enclosed space acoustic treatment is applied. For limiting the unwanted noise acoustic treatment uses noise control measures, which reduces the noise level to the extent which is inaudible for human ears. The two distinct requirements may need to be considered when designing acoustic treatments are:

- *Improvement of sound within a room*, and
- *Reduction in sound leakage* to and from adjacent rooms or outdoors.

Design of Acoustic Treatment

In previous sections of this Unit we have learnt about how sound behaves in an enclosed room. For designing an acoustic treatment for a particular room some of the basic concepts you must keep in mind are:

- On hitting a surface, some of sound is absorbed, some of sound wave is reflected and some of it is transmitted through the surface. Dense surfaces will isolate sound well, but reflect sound back into the room whereas porous surfaces will absorb sound well, but will not isolate the room.
- The main way to minimize sound transmission from one space to another is adding mass and decoupling the spaces.
- Sound bounces back and forth between hard, parallel surfaces.

- The best way to stop sound transmission through a building structure is to isolate the sound source from the structure.
- Every object and material used in acoustics has a resonant frequency at which it is virtually an open window to sound. Different materials have different resonant frequencies.
- Trapped air (Air Gap) is a very good de-coupler.
- Airtight construction is a key concept. Sound, like air and water will leak through any small gap and will result in diffraction.

Note It

Acoustics treatment is required so that musical qualities of intimacy, timbre, balance, dynamic range, fullness of tone, loudness etc. should be preserved.

12.7.2 Technical requirements for construction of studio

Height:

During designing phase of a studio sufficient height is planned for providing space for acoustic treatment of the ceiling.

Wall Thickness:

For achieving better sound isolation outer walls must be kept thick (more than the normal wall thickness) to provide better transmission loss to the noise.

No Pillar/Column:

No pillar or column (for clear and obstacle free working, and to minimize structure borne noise).

Observation Window:

Provision of Observation Window between recording booth and recording studio and between Control Room and Transmission Room for visual continuity. Observation window is constructed with double glass and are fitted at an angle.

Sound Proof Door:

The transmission loss depends upon the density of the SP Door. Sound Proof Door is provided for better sound insulation. A door leaf with magnetic seal and gasket provides good sound isolation.

Structural Isolation:

Structural isolation between machine block and studio, and between office block and studio reduces the structure borne noise. A structural isolation gap of 75 mm width right from foundation level up to the roof height is provided between the two blocks. Wherever required, only flexible connections are used for linking these blocks for running electrical cables, duct etc.

Shape:

a. Avoid circular shape to avoid acoustic defects such as sound foci.

b. Avoid cubical shape.

c. Fairly rectangular as per aspect ratio given in *Table 12.4*

Table 12.4: *Aspect ratio of Studio as per Volume*

S.No.	Volume	Aspect Ratio		
	(Cu. Mtrs)	Length	Width	Height
1	Up to 250	1.6	1.3	1
2	650 to 1250	2.5	1.5	1
3	2000 to 4000	3	2	1
4	4000 Upwards	3.3	2.2	1

Volume of Studio:

a. The volume of an enclosure for music recording is related to the number of musicians.

b. An empirical formula establishes the following relation between the number of performers and the volume of the studio

$v = 21n + 55$

Where

v = Volume in cubic meters

n = Number of performers

Activity 12.1

During your visit to a Community Radio Station, have a look on acoustic treatment of different studio rooms. Note down the various materials used for the treatment studied in this Unit. Fill in the details in the proforma given below. This will help you identify the types of acoustic treatment and visualize their significance.

A. Primary use of the rooms

S. No.	Item	Utilization
1	Room 1	
2	Room 2	
3	Room 3	
4	Room 4	
5	Room 5	

B. What are the overall studio dimensions?

S. No.	Item	Dimension
1	Length	
2	Width	
3	False Ceiling Height (FCH)	
4	Real Ceiling Height (RCH)	

C. What are the finishes on the ceiling?

S. No.	Material	Thickness of Material
	Real Ceiling	
1		
2		
	False Ceiling	
1		
2		

D. What are the finishes on the floor?

S. No.	Material	Thickness of Material
1		
2		

E. What are finishes on each wall?

S. No.	Material	Specification
	East wall	
	West wall	
	North wall	
	South wall	

F. Sound Proof Door

S. No.	Parameter	Specifications
1	Height	
2	Width	
3	Thickness	

G. Observation Window

S. No.	Parameter	Specifications
1	Height	
2	Width	
3	Thickness	
4	No. of glasses	

12.8 Let Us Sum Up

As we have learnt in the beginning of this Unit, the science of acoustics can be wide-ranging and confusing. We have seen how sound waves behave in an enclosed space like studio and effects of objects within the studio. In this Unit, we have learnt about the necessity of noise control and how we can achieve good acoustic to ensure the most advantageous flow of sound. We have discussed about the different noise sources and different ways to diminish the noise from these sources. Phenomena of Sound Isolation and Absorption were discussed, which are very important for understanding acoustic requirement and design. We have learnt different characteristics of construction materials towards sound isolation and absorption. We have discussed technical requirements for studio construction, like studio height, wall thickness and shape and volume.

It is a known fact that broadcasting studios should be free from noise and be designed for optimum R/T requirements. These requirements are duly taken care of at the design and installation stage. However, sufficient precautions should be taken during maintenance i.e. painting etc. and at the stage of making any additions or changes in the studios, so that the characteristics are not altered.

12.9 Model Answers to Activities

The information gathered in the activity presented in this module should be your own experiences. The activity is hands-on activity here.

12.10 Additional Readings

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Glossary

Acoustics:	The science that deals with the study of sound waves.
Amplitude:	It is signal strength or height of signal. The loudness of sound. Commonly called volume. Measured in decibels.
Attack:	The time sound takes to reach its peak.
Audio File size:	Space required for storage of an audio file.
Bandwidth:	It is the difference between upper and lowest frequency of an audio signal.
Bit Error Rate:	Error introduced by communication channel in transmission of a digital signal.
DAW:	Digital Audio Work station. A computer that allows one to record, edit and add effects to an audio programme, most of the times independent of hardware.
Decay:	The time sound takes to die down.
Diaphragm:	A small membrane in a microphone which vibrates in accordance with air pressure of sounds wave.
Dither:	Method used for reducing quantization noise.
File Formats:	WAV, MP3, PCM, AIFF
Foleying:	Creating sound effects in a studio
Frequency:	Rate at which a signal changes per second or number of cycles per second. Measured in Hertz.
Hyper-cardioid:	Very directional microphone, which eliminates sound from the sides and the back.
Jitter:	Deviation of discrete samples from precise sample timing intervals due to error in clocks.
Mono sound:	Audio recorded and heard on just one channel. Both speakers reproduce the same sound.
Quantization and Quantization Noise:	Conversion of continuous signal to digital signal.
Reflection:	Bouncing back of sound after striking a flat and hard surface.

Refraction:	Changes in the direction of travel of the sound by differences in the velocity of propagation.
Sampling:	Method of converting analogue signal into digital signal.
Sound absorption:	The process by which we can reduce the reflection of the sound energy by the surfaces.
Sound Isolation:	Acoustic treatment of studio space to reduce the effects of exterior noise.
Stereo:	Audio recorded on more than one channel. Sound is heard differently on right and left speakers.
Sustain:	The time sound remains at its peak.
Transducer:	Converts vibrations of diaphragm into an equivalent electrical signal.
Unidirectional microphone:	Which picks up the sound primarily from one direction i.e. in the front and reduced pickup from the side and the back.
Wavelength:	The distance between any point on the wave and a corresponding point on the next wave. Measured in metres.

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Certificate in Community Radio Technology

Audio Production

4

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Module: 4

Audio Production

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Certificate in Community Radio Technology

Courses	Modules	Units
Course I: Understanding Community Radio (3 Credits, 90 Hours)	**Module 1** Community Radio: An Introduction	**Unit 1 :** Community Radio: Concept and Evolution **Unit 2:** Context, Access and Equity **Unit 3:** Community Radio: Policy Guidelines **Unit 4:** Technology for CR: Guiding Principles
	Module 2 Setting up of CRS	**Unit 5:** Components of CR Station **Unit 6:** Radio Waves and Spectrum **Unit 7:** Basics of Electricity **Unit 8:** Power Backup and Voltage Stabilization
Course II: Community Radio Production: System & Technology (5 Credits,150 Hours)	**Module 3** Studio Technology	**Unit 9:** Basics of Sound **Unit 10:** Analog and Digital Audio **Unit 11:** Components of the Audio Chain **Unit 12:** Studio Acoustics
	Module 4 Audio Production	**Unit 13:** Audio Hardware and Field Recording **Unit 14:** Free and Open Source Software **Unit 15:** Telephony for Radio
	Module 5 Audio Post Production	**Unit 16:** Sound Recording and Editing **Unit 17:** Mixing and Mastering **Unit 18:** File Formats and Compression **Unit 19:** Storing and Retrieval
	Module 6 Studio Operations	**Unit 20:** Good Engineering Practices for Studio Setup **Unit 21:** Studio Equipment: Preventive & Corrective Maintenance **Unit 22:** Content Distribution: Alternative Mechanisms
Course III: Community Radio Transmission: System & Technology (2 Credits, 60 Hrs)	**Module 7** Radio Transmission Technology	**Unit 23:** Components of Transmission Chain **Unit 24:** Components of FM Transmitter **Unit 25:** Antenna and Coaxial Cable **Unit 26:** Propagation and Coverage
	Module 8 FM Transmitter Setup	**Unit 27:** Transmitter Setup: Step-by-step **Unit 28:** Transmission System-Preventive and Corrective Maintenance **Unit 29:** Transmission Setup–Good Engineering Practices
Course IV: Technical Internship (2 Credits, 60 Hrs)	**Module 9** Practical Internship Handbook	**Section A:** Introduction **Section B:** Activities to be Conducted During the Practical Internship **Section C:** The Internship Journal and Self-Assessment Paper **Section D:** Assessment of Internship **Section E:** Appendices

Video in the Module:

CONTENTS

CONTENTS

About the Module

Module Description

In previous modules, you were introduced to the concept of community radio (CR) and its related frameworks. You further received a foundation in the basics of audio (analogueue and digital), electricity, and principles of acoustics.

This module introduces you to the concept of audio recording, that is, the principles and practice of capturing sounds,converting them to a storable form,and storing them in a recording medium for later recovery. You will also understand the various types of hardware that are used to record audio in the field and in the studio, and the concept of using free and open source software (FOSS).

You will also learn about telephony related applications for radio, including the use of hardware and software to create interactive programmes with call-in segments; as well as the use of mobile telephones and systems to connect your listenership with the CR stations.

Module Objectives

- To introduce the concept of recording and storing audio
- To introduce the hardware related to audio recording
- To explain the concept of free and open source software solutions for audio production
- To examine the available options for telephony interfaces for radio

Units in the Module

- Unit 13: Audio Hardware and Field Recording
- Unit 14: Free and Open Source Software
- Unit 15: Telephony for Radio

UNIT 13

Audio Hardware and Field Recording

Structure

13.1 Introduction

In the preceding units, you were introduced to various pieces of hardware used in an audio studio. You learnt about the differences between analogue and digital audio, as well as the components of the audio chain that enables you to record, produce and broadcast radio programmes. You were also introduced to the importance of acoustic treatment of a studio and the various materials that go into the treatment. It is now time to delve a little deeper into the equipment required for recording in the field and in the studio.

In this unit, you will learn about the tools—microphones, mixers and recorder—that you will use for this purpose. You will also learn about digital audio workstations and sound cards, and the cables and connectors that we use to link the various pieces of equipment together. Finally, you will also receive some tips on recording good audio in the field.

While going through the unit, you will need to do four activities (the model answers of which are given in Section 13.13). You will need approximately four hours to complete this unit.

13.2 Learning Outcomes

After going through this unit, you will be able to:

- identify microphones based on their pickup patterns.
- identify and explain the differences between dynamic and condenser microphones.
- list and describe the features of different types of audio recorders.
- identify and describe the use of different kinds of audio connectors and headphones.
- identify a digital workstation and describe its features.

13.3 Hardware for Audio Recording

Depending on whether you are recording audio in a studio or in the field, you require four basic pieces of equipment: (1) a microphone; (2) an audio recorder; (3) a pair of headphones; (4) and an audio mixer. If you are recording in a studio, the audio recorder is usually replaced by a computer capable of recording audio directly into a software recorder. Before going through the various equipment needed for sound recording in the studio and in the outside you may watch a

video on 'Studio Recording Hardware and Field Recording' at http://tinyurl.com/ppkowtp. This video will help you to apprehend the various instruments needed in the recording process, either inside the studio or outside.

Let us look at these in greater detail.

1. ***Microphone:*** A microphone is basically a transducer that converts sound waves into electrical waves. The electrical waves can then be either amplified using loudspeakers, or recorded and stored. Microphones are either built-in—as in computers, telephones, or mobile phones—or free-standing devices, like those you use in an auditorium or in a studio. They come in various sizes and shapes. It must be remembered that no one microphone serves all purposes. In fact, it is the purpose that decides what kind of microphone one should use.

2. ***Audio recorder:*** An audio recorder is a device that records the electrical signals emerging from a microphone as audio files. These audio files can then be electronically moved from one device to another (for instance, a computer) and edited. There are several types of audio recorders in the market: some easy to use, some economical and some that combine both these characteristics in addition to being robust. We will examine the different kinds of audio recorders later in this unit.

3. ***Headphones:*** Headphones are devices that are used to listen to the audio signal being played back by a playback device. In some ways, they are comparable toa small pair of speakers mounted on a band that can be worn over the head. Headphones are also useful when you want to listen to audio without disturbing others around you.

4. ***Audio mixer:*** An audio mixer is a device that helps connect multiple audio sources to a recorder, while also helping you to refine and improve the quality of the sound. Mixers are often used to individually control the sound from each source independently, in order to achieve a good balance between the various sources.

5. ***Computer:*** For the purposes of audio recording and editing, the computers we use are called digital audio workstations (DAWs). They are different from the computers we use for day-to-day office work and Internet browsing in that they are more powerful; and also have a variety of audio inputs and outputs. Most will also have a sound card, which is a device that can convert analogue audio to digital audio, and vice versa. Some may be designed to work with specific hardware that can be connected to them to record and edit audio files.

13.4 Microphones

You have already learnt about the details of various types of microphones in Section 11.4 of the previous module. You have got to knowtherein that microphones are classified into two main types namely classification by the type of transducers and classification by pickup, that is, directional properties. You have also been made familiar with the polar diagrams of various types of microphones. It is important to know the different kinds of microphones available in the market so that one can put them to appropriate use. The purpose could be recording just speech or music, or evenbird and animal calls. For our purposes, we will limit ourselves to the microphones that radio professionals use all over the world and deal with the key considerations while selecting them along with their basic characteristics and usage.

13.4.1 Key Considerations while Selecting Microphones

Before purchasing or hiring a microphone, one would do well to consider the following five factors:

1. ***Impedance:*** Impedance, as the word itself suggests, means resistance offered to the flow of the electrical audio signal. You may have noticed that big audio players that come with a microphone (for karaoke) have a very short cable. This is because they have very high impedance, that is, they offer high resistance to the flow of the signal to the recorder. If the cable isvery long, the signal that reaches the recording device would be too weak for any practical purpose. On the other hand, a microphone with low impedance can be used with a long cable, since the signal strength that emerges will still be quite strong. Most professional microphones are of low impedance, making them best suited for audio recording. Impedance is measured in ohms. Professional microphones have an impedance of 200 ohms or lower.

2. ***Frequency response:*** This is a microphone’s capability to receive high and low sounds. A good, professional microphone can receive frequencies ranging from 20 to 25,000 Hz.

3. ***Pickup pattern:*** Situations may demand requirement of a producer to record sound either from one direction, two directions or all directions. Situations may also require the producer to actively reject sounds from other directions while picking up sounds clearly from one. There are different microphones that meet these requirements. The choice of a microphone is often determined by this requirement. You can read more about this in Section 13.4.2, where we discuss different pickup patterns.

4. ***Balanced andUnbalanced microphones:*** Microphones can be balanced or unbalanced. Balanced microphones are best used for professional recording purposes. An unbalanced connection uses two wires: The centre conductor carries the audio signal, while the shield or basket carries the ground wire. On the other hand, a balanced connection uses three wires. Two separate signal wires inside the shield carry the plus and minus signals (opposite polarity). The shield is connected to the ground, and protects the signals from external electromagnetic interference. This makes the system more

immune to noise from poor electrical wiring in a room, computers, etc. With an unbalanced microphone, one of the signal wires is the shield and the other is the positive signal. Any noise picked up on the shield will be fed directly into the amplifier or mixer input.

5. ***Sensitivity:*** The ability of a microphone to pick up very faint sounds is termed as its sensitivity. High-sensitivity microphones are normally used in studios and low-sensitivity microphones on the field, where the chances of the microphone moving or being hit by strong wind are greater.

13.4.2 Microphones Categorized by Directionality

Omni-directional microphones

An omni-directional microphone can pick up sound from all directions. They are very easy to use and most of the basic microphones found in the market are of this type. These microphones are normally the ones that a *tentwallah* (a person who rents out tents) uses during community functions.

Uni-directional microphones

You may have noticed in music shows that even though instruments are placed close to each other, the microphone placed above one instrument does not pick up sound from another. These microphones preferentially pick up sound from one direction, while rejecting sounds from other directions. Such microphones are called uni-directional microphones. They are widely used for recording in outdoor interviews (where unwanted ambient noise levels are high), and in panel discussions in studio situations. From a pickup pattern point of view, their patterns look like an inverted heart, which is why they are sometimes also called **cardioid microphones**. Some cardioid microphones are designed to be more directional than others, which are called **super-** and **hyper-cardioid microphones**. These are used for recording sounds from far away. Some hypercardioid microphones can pick up sound from as far as 300–500 metres!

Bi-directional microphones

A **bi-directional** microphone can pick up sounds from the front or the rear of the microphone, but not from the sides. Their polar patterns are usually in the shape of a figure-8. Bi-directional microphones are very sensitive by construction, and need to be handled carefully. When not placed carefully, they can produce pops, and are best avoided for fieldwork. They are very useful for discussions when two persons are seated across a table for an interview.

13.4.3 Microphones Categorized by Construction

Dynamic microphones

Also called moving coil microphones, dynamic microphones are rugged and robust and are mostly used in field situations. They are more resistant to unwanted vibration and wind rumble. The microphones that are used by rock stars are normally of the dynamic type. Typically, their frequency range lies between 40 and 18,000 Hz. Figure 13.1 below shows a popular dynamic microphone.

Figure 13.1: *A dynamic microphone.*
(Source: Jnan Taranga, KKHSOU, Guwahati)

Condensor microphones

Condensor microphones are much more sensitive microphones, and are generally used for studio applications. Typically, their frequency range covers the entire human hearing range from 20–20,000 Hz. Unlike dynamic microphones, condenser microphones need an external power supply. Some condenser microphones have a battery attachment within the body of the microphone itself. Batteries are usually replaceable, as required. Others need power delivered to them through the microphone cable itself, an arrangement called **Phantom power**, and often denoted by the symbol **+48V** or **P48**. Figure 13.2 shows a popular condensor microphone.

Figure 13.2: *A condensor microphone.*
(Source: Jnan Taranga, KKHSOU, Guwahati)

Activity 13.1

This activity will require access to different kinds of microphones. If you have access to a community radio station (CRS) or to a studio, this will not be a challenge. If you do not, you may use a mobile phone or a cassette recorder with a built-in microphone or any device on which you can make an audio recording.

Place the microphone on a table and connect it to a recorder, or turn on the recorder. Now record the audio:

a. By speaking directly in front of it
b. By speaking next to it
c. By speaking sitting next to it

Do this one by one with each microphone and notice the differences in the recordings. Note down the results. If you have access to different microphones, repeat the exercise using each type and see if you can identify whether they are uni-, omni- or bi-directional microphones.

13.5 Audio Recorders

Audio recorders are devices that can receive an audio signal from a microphone input, and store them in a recording medium. Audio recorders can be designed for use in the studio, or may be compact enough to be used in the field. For practical purposes we will consider the latter, since most studios nowadays tend to record directly on computerized digital audio workstations (DAWs).

The older generation of portable analogue audio recorders included cassette recorders, and reel-to-reel spool tape recorders, both of which record on magnetic tape. The newer generation of audio recorders are digital and record on digital media like secure digital (SD) or compact flash (CF) cards, or hard disks. You have already learnt about analogue and digital audio in Unit 10.

Portable field audio recorders usually come with built-in microphones good enough to record broadcast grade audio. Some of them even come with wind filters, and record on easily available and reusable digital media.

Just search on the Internet for digital audio recorders and you will be surprised by the variety in their kinds and prices, each one of them claiming to be the best. You will also find both expensive and inexpensive recorders. You may have noticed that you can record on a slightly high-end mobile phone too. However, just like microphones, there are considerations when purchasing a professional audio recorder. Check out the specifications before purchasing a recorder to suit your budget.

When purchasing a digital audio recorder, you should check for the following:

- Recording format: Should be able to record in .WAV format, 16/24 bit. It is better if it can also record 'mp3' format at varying bit rates.
- Should have built-in stereo microphones, preferably covered with a wind shield

- Should have a provision for line-in stereo, input for external microphone (preferably XLR input)
- Should have a provision to connect headphones to monitor audio
- Should have built-in speakers
- Should have adjustable controls for input audio levels
- Should have an audio level indicator (VU meter)
- Should have a media card slot with a capacity for high data storage (2 GB or more)
- Should have a USB cable and connector slot to enable import of audio files to a computer
- Some recorders are capable of recording from a landline telephone cable. Some can also be connected to a computer and used as a microphone to record directly into the computer using an audio software.
- Some recorders come with built-in batteries that can be charged. Others accept consumer grade batteries of AA or AAA type. For recorders that use the latter, you will require some rechargeable cells of appropriate size, preferably of the Nickel Metal Hydride (NIMH) type. As a general practice, it is always good to carry a couple of extra chargeable batteries, so that you do not run out of power during an extended day's recording.

Figure 13.3: *Zoom, Olympus and Tascam manufacture some of the most popular digital audio recorders.*
(Source: Jnan Taranga, KKHSOU, Guwahati)

The most popular type of recorders available in the market today are **digital flash memory recorders**. These recorders make digital recordings onto flash memory cards, such as **compact flash (CF) cards** and **secure digital (SD) cards**. Usually, they have an option to save as uncompressed linear PCM or in a compressed format such as MP3. For a given size of memory card, you can record for a longer duration using a compressed format but at a lower quality. Some of these recorders record on a built-in flash memory.

Such digital recorders are preferred by a wide number of people because they are highly portable (can fit into a pocket) and can be used with very little experience. Transfer of files from such a recorder to a computer for editing is easy. In fact, with a bit of patience, one can also rename the audio files stored on the recorder. Identifying the files after transferring them onto a computer also becomes easy. In fact, some recorders also provide for simple editing within the recorder itself! Yet another important advantage of such recorders is that they make it easy to record and post podcasts on the Internet.

Flash cards are a very useful recording medium since they are robust, use less power supply (particularly when your audio recorder uses replaceable batteries), and enable faster data transfers. They usually come in different capacities—from 512 MB to 64 GB. To record audio, a 2GB or 4GB solid state card is more than adequate. You will learn more about storage media in Unit 19 on Storage and Retrieval.

13.6 Audio Cables and Connectors

Just like any other piece of audio hardware, there are scores of audio cables and connectors available in the market. Every audio cable and connector serves a particular purpose, and it is important that we know the key features of the common ones in order to be able to make the right choices.

13.6.1 Balanced and Unbalanced Cables

In an earlier discussion in this unit (Section 13.4.1), we learnt about balanced and unbalanced microphones. It should stand to reason that both these types of microphones will require appropriately matched cables and connectors to carry the signal they generate.

The simpler type of cable is the **unbalanced cable**. These are cables with a single central conductor, and a woven metal basket (or **shield**) on the outside, with the entire combination encasedin plastic insulation. The shield is meant to absorb stray electromagnetic interference from the surroundings.

Any circuit is complete only when the electrical signal has an incoming and a return path. In the case of the unbalanced cable, the central core provides one of the paths, and the metal shield the other. Unfortunately, this means that any interference that the shield picks up will be added to the audio signal. This can cause disturbances or hums in the recording. Figure 13.4 shows an unbalanced cable.

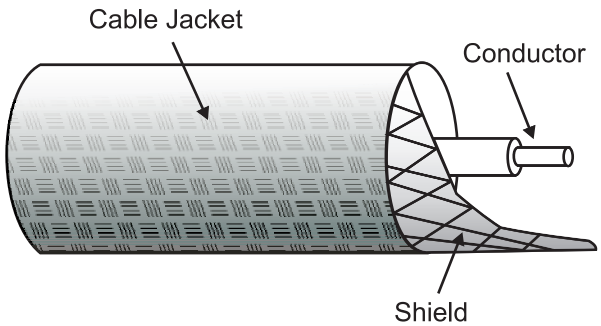

Figure 13.4: *An unbalanced cable. Note the lone central conductor and the two layers of insulation, one of which separates the central core from the shield.*

On the other hand, a **balanced cable** is a cable containing two cores, one positive and the othernegative, which are twisted together and surrounded by an overall shield. Only the two core wires carry the signal and the shield is grounded directly to the frame of the audio equipment. This allows the shield to perform its function of trapping external electromagnetic interference. As a result, the audio signal is completely noise free. Figure 13.5 shows a balanced audio cable.

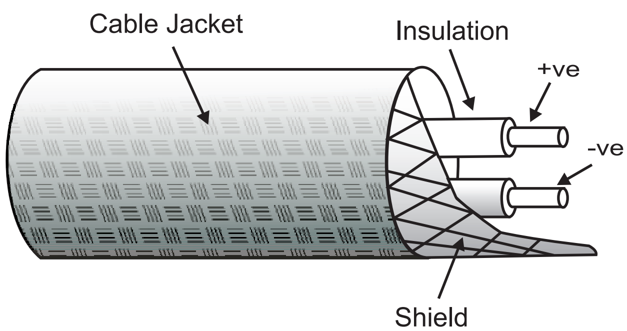

Figure 13.5: *An balanced cable. Note the dual core wires.*

Having dealt with cables, let us discuss connectors now.

13.6.2 Audio Connectors

Audio connectors are the devices used to connect cables to audio devices or one audio cable to another. There are a large variety of connectors, and they are also available in balanced and unbalanced varieties. Let us look at the most commonly used ones.

RCA connectors

RCA connectors are named after the Radio Corporation of America, who invented this type of connector. The male RCA plug consists of a central pin measuring approximately two millimetres (mm) in diameter, and an outer shell whose inside diameter is approximately six mm. The plug shell is slotted rather than threaded, to facilitate quick insertion and removal from the female jack or receiver. Typically, the cable carries the plug, and the audio device carries the jack. The RCA connector does not provide a balanced audio output. This type of connector is often used in home entertainment systems. You can see a pair of RCA plugs in Figure 13.6 below.

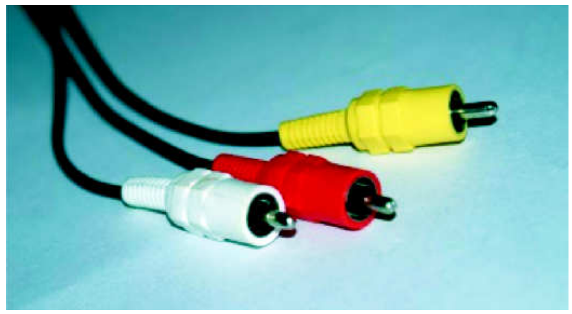

Figure 13.6: *A pair of RCA connectors.*
(Source: Jnan Taranga, KKHSOU, Guwahati)

XLR connectors

XLR connectors are the global standards for balanced audio output. 'XLR' stands for Ground (X) – Left (L) – Right (R). As its name suggests, it has three pins—two carrying the signal (and connected to the two core wires of a balanced cable) andthe third connected to the shield or ground. XLR connectors also feature a small lock that allows male and female connectors to be connected securely. This allows XLR plugs to be connected to sockets firmly, with no fear that the connector will come out of the socket by accident. They even help to lengthen cables by connecting them with a pair of XLR connectors.

XLR connectors also come in a mini-XLR variety. These are normally used with field wireless microphones and field recorders. You can see a pair of XLR connectors in Figure 13.7.

Figure 13.7: *A pair of XLR connectors. The one on the left is the female connector; and the one on the right the male connector.*
(Source: Jnan Taranga, KKHSOU, Guwahati)

TRS Connectors

'TRS' stands for tip-ring-sleeve, since this connector uses contact points on a single pin-like connector to convey the separate signals. These connectors usually come in two varieties, **mono jacks** and **stereo jacks**. The mono jacks are distinguished by a single black or white insulating ring towards the tip. The stereo jacks have two insulating rings towards the top, with the tip representing the left channel, the first metal ring to the right channel and the lower 'sleeve' connected to the shield. The mono jacks are usually used with instrument amplifiers. The stereo jacks are used with stereo devices, and are often used as connectors for headphones.

A larger variety of TRS connectors is the **phono** or **quarter inch (1⁄4") jack**, named after its pin that is a quarter-inch wide (see Figure 13.8). The smaller variety, often called the **EP** or **mini-phono jack**, has a 1⁄8" inch (3.5 mm) wide pin. The former is more commonly found on professional equipment and the smaller one on consumer grade equipment like MP3 players and mobile phones.

Figure 13.8: *¼" phono jacks. The one on the left is mono, the one on the right is stereo (Source: Jnan Taranga, KKHSOU, Guwahati)*

13.7 Headphones

Headphones are devices that are used to listen to audio, a process also known as **monitoring audio**. Typically, most units are like small speaker units mounted on a headband that allows them to be worn comfortably on the user's head. Like connectors, there are a variety of headphones, with a number of different uses. In this section, we will look at some of the commonly used types.

Ear bud headphones

These are probably the most common types of headphones, as they are used with all kinds of portable music players and mobile phones. Also called **earphones**, they are often provided as free accessories with these devices. While some low-quality ear bud headphones fit loosely within the external ear, there are some that fit into the ear canal itself. While earphones are good for listening to music, they are best avoided to monitor audio while recording. Figure 13.9 shows a pair of earphones.

Figure 13.9: *Two pairs of simple earphones. The pair on the right has an ear canal* adapter for snug fit.
(Source: WikiMedia Commons, *http://tinyurl.com/4eboaz3*)

On-ear headphones

These are headphones that sit on the ears rather than over them. As a result, they are usually a bit smaller and lighter than over-the-ear models. They tend to have foam or sometimes leatherette pads for extra comfort, and usually have adjustable headbands for a snug fit. These headphones are normally good on treble but not on bass. Since they don't cover the ears, ambient noise tends to enter the ears, making it difficult to monitor audio in critical conditions. They are therefore best used in office situations, for simple listening purposes, or for conducting voice chats over the Internet. Figure 13.10 shows a pair of on-ear headphones.

Figure 13.10: *On-ear headphones*
(Source: Jnan Taranga, KKHSOU, Guwahati)

Over-the-ear headphones

These are traditional-looking headphones, with cushioned pads that enclose and cover the whole ear. This makes them more comfortable to wear over long periods, and they generally deliver good sound quality. Bulkier than other types of headphones, these are best suited for audio monitoring purposes in the studio as well as in the field. Some varieties also cancel out noise, making it easier for the producer/technical personnel to monitor audio. The balanced headphone variety under this category provides the same impression as the sound you would be hearing from two or more speakers. Figure 13.11 shows a pair of professional over-the-ear headphones.

Figure 13.11: *A pair of over-the-ear headphones. Note the cups that cover the entire ear. (Source: Jnan Taranga, KKHSOU, Guwahati)*

Activity 13.2

This activity will require access to different kinds of connectors and headphones. If you have access to a CRS or to a studio, this will not be a challenge. If you do not, you may collect different kinds of cables and connectors that you have access to at home,or go to a local audio-parts shop and ask for whatever connectors they have. You may have to visit anaudio equipment shop to see some headphones.

Now, draw two boxes one above the other on a piece of paper. Place the different kinds of audio connectors in the first row of boxes. In the second row, identify and name the kind of audio connector. Match your answers with the figures given in this unit. You should be able to identify all the connectors correctly.

Now repeat the exercise with different kinds of headphones. Also use the headphones, if you can, and notice how over-the-ear headphones prevent outside sound from interfering with the audio you are listening to.

13.8 Recording Audio in the Field

Using portable digital audio recorders have made field recordings easy because of more than one reason. Since the audio they record are in the form of files, transferring them onto a computer, renaming them and other storage disks as backups is easy. It is also easy to rename files to avoid confusion if there are multiple files to be used in one single programme. Audio takes very little storage space and therefore optimum quantities can be recorded in order to produce a good programme.

The most common formats that are recorded in the field are **voxpops, interviews, features, documentaries,** and **news segments**. Interviews are a common feature among these formats and portable recorders come in very handy to make programmes in these formats.

Let us now look at some of the key processes and procedures to be followed while conducting a field recording.

The pre-production phase: Key points to remember

While making an audio programme and recording audio for it, you must always do your planning and ground work before hand. This means you should ideate and come up with a script for your production first. You must also identify people to be interviewed, and places you will interview them in; fix appointments; and take any necessary permissions to conduct recordings. In addition, you will have to keep the following things in mind:

1. **Weather:** The ideal weather conditions for radio field recording depends on what exactly you are wanting to record; but for most situations, a dry and calm (less windy) day is ideal. On other days of the year, take care to protect your equipment from rain. A small umbrella comes in handy both in summer and monsoon. If you intend to travel long distances for a field recording, check on the weather conditions at your destination before you leave.
2. **Time:** Even in the best of situations, field recordings take a lot of time. Keep time for walking/driving from one place to another, waiting for people, and other unforeseen delays. Traffic can pose a major problem in urban settings. Planning your time is extremely important, and so is time management. Keep adequate time for non-production activities like lunch. Keep spare time for every activity, and a backup plan ready in case you are unable to complete what you need to within the allocated time.

3. **Batteries andstorage cards:** Irrespective of the kind of battery your recorder uses, carry an extra set of batteries and a charger. Having to return to your base just to charge batteries can mean losing out on time, energy, money, and most importantly, the people you wish to interview. By the same logic, keep an extra storage card of the kind used in your recorder handy. An interview could go longer than you thought, and you don't want to miss out on recording something just because you ran out of space.
4. **Mobility:** Do you have your entire production kit neatly packed? Are the audio recorder, batteries, cables and any accessories neatly stored? Do you have a headphone? Are all pieces of equipment working properly? Are the headphone and microphone cables coiled properly? Are non-production items like biscuits or a water bottle in a different bag? Check for all of these before setting out onyour recording trip.

The production phase: Key points to remember

You make or break your production depending on how you handle this phase. You may have all the equipment—microphones, recorder, batteries, storage cards, headphones—organized and ready. But if you don't use them right when you conduct the recording, no amount of post-production work can make your programme better.

Use the following checklist to ensure that all goes well during the field recording:

- Make sure your recorder is working. Check the recorder's display once in a while.
- After pressing the record button, start by saying the subject, location and time of your recording. This may not be always possible but is definitely possible before conducting interviews. In case you lose your notes later on, you will be at least able to understand what you have recorded.
- Use a quiet location to record interviews. Switch off fans and air conditioners while recording interviews. Microphones have a tendency to pick up those sounds.
- Record the room tone (when nobody is talking) for about 3–4 minutes. This tip is also useful when recording interviews outdoors. Whileediting, this tone can be used across the interview on another track to maintain continuity.
- Always point the microphone to the source of the sound. Place it at least 3 to 6 inches away from the source.
- Microphones need a critical distance to record the right quality of audio. If you take the microphone too close, the audio will be distorted and the recording may have pops of air from the speaker's mouth. On the other hand, taking it far away from the source of the sound is likely to result in a weak and hollow sound quality.
- If you are using handheld microphones, always talk across them. The microphone is best placed at the chest position. However, if you are using a uni-directional microphone, you should keep it close to the mouth.

- Sit down when you have to interview children. This way you can place the microphone at a comfortable position for both of you.
- Do not conduct interviews while walking. People tend to get distracted and there may be long pauses in sentences.
- Do not ask close-ended questions. Asking a question that begins with 'do you...' invariably results in a one word 'yes/no' answer. Ask questions that begin with 'what', 'how', 'why'.
- When recording interviews with more than one person, alert them in advance to speak only when the recorder/microphone is pointed at them.
- Do not place the recorder on the ground/table to record interviews. If you have an external microphone attached, hold the recorder in one hand, where you can see the audio levels on the screen, and the microphone in the other. whileusing abuilt-in microphone, hold the recorder in whichever hand you find it comfortable—but remember to keep an eye on the audio level meter!
- Use microphone stands where possible, to keep the microphones steady.
- When using multiple microphones for a talk show, place the second microphone at least twice the distance away from the user as the first. (For example, if you place one microphone at a distance of one foot from two speakers, place the next microphone at least two to three feet away from the first one.) This helps prevent phase cancellation, a phenomenon where the signal from one microphone may be partially cancelled out by the signal from the other, resulting in a poor recording.
- In a noisy environment, position the interviewee so that his back is against the area with the lowest noise or disturbance. That way, when the microphone is pointed at him or her, the noisiest areas will be behind the microphone, and the person's voice will be recorded more clearly.
- Nod your head during an interview. Avoid 'hmm', 'uh' and 'oh!', although not at all times. Too many aural responses from you might make it too conversational, and result in audio that is difficult to edit later.
- Use directional microphones wherever necessary.
- Switch off/fade out microphones when not in use.
- Use a windshield when using microphones outdoors, and pop filters when recording indoors. This avoids wind or breath from hitting the microphone.
- Always use headphones/speakers when recording sound outdoors/indoors.
- Never allow the audio to consistently touch the 'red' mark or zero level on your audio recorder's level meter.
- Record Sound on Tape (SoT) without fail. This is a track containing just the sounds in the environment, without the speakers' voices. Also known as ambient sound, this lends character to your programme by providing the listener a clue to the environment in which the interview or discussion is being conducted.

- Eye contact is very important when recording interviews. Look the person in his or her eye when asking questions.
- Listening to your interviewee is also extremely important. It helps you ask additional questions that might bring new insights to the programme.
- Always monitor sound from the recorder as you conduct the recording. You will know immediately if there has been any kind of disturbances in the recording.

It is also important to remember some key points with regard to taking care for your microphone units:

- Do not tap or blow into any microphone to test it. Just talk.
- Keep microphones in their pouches when not in use.
- Store microphones safely in an almirah or a box.
- Keep microphones away from moisture, water and fire, as well as physical shocks of any kind.
- Switch off the microphones after use, if they have in-built off/on switches. This is especially important for battery powered condensor microphones.
- Remove the batteries if not in use. Replace them with new but similar type batteries periodically.
- Use high-quality connectors and cables for microphones.
- Do not pull out a connector holding the cable. Always grasp the connector (jack) to disconnect.
- Do not leave heavy microphones dangling from a cable. Do not swing them holding the cable either.
- Do not use any liquid whatsoever to clean microphones.

Activity 13.3

Using the tips mentioned above, record a paragraph from a book using a recorder with a built-in microphone.

Do this exercise in different situations like a small room, big room and outdoors, keeping the microphone once close to you and once a bit far away from you.

Playback the audio you have recorded and notice the differences in each of the situations.

13.9 Portable Audio Mixers

You have earlier learnt about studio audio mixers. Here you will get to know the functions performed by audio mixers:

- **Control the volume of signals** coming from various inputs (microphones, audio players, etc.) using faders. The faders help in regulating the input levels of sound coming from various sources.
- **Combine and balance the inputs coming from various sources**, by sliding the faders up and down. For example, in an audio mixer with six inputs, you connect six microphones to record a musical score. Controlling each source by way of its dedicated fader helps one in balancing the input of each instrument, so that we make the combined output pleasant to hear.
- **Equalize the audio**, that is, manipulate the frequency characteristics of the input sound. Equalizing involves controlling the audio signal by increasing some wanted frequencies and decreasing the unwanted ones. For example, you can reduce hiss in speech by equalizing the input.
- **Auxiliary Send** ("Aux Send") is used to send the output to other external devices like an effects generator. The output from the Aux Send is again taken back into the audio mixer, mixed and routed through the final output.
- **Route the mixed and equalized audio signals** to a specific output (a recorder/speaker/headphone).
- **Enable monitoring** of all the functions mentioned above through speakers/headphones as they are being recorded/broadcast.

Audio mixers come in handy both in live and post-production situations. In a live situation, audio inputs are first balanced and equalized and the recording done.

Professional audio mixers also have a provision to connect a headphone or a pair of speakers to monitor the output. Some audio mixers are also capable of providing the phantom power supply to microphones when needed. It is always better to purchase audio mixers that can provide phantom power supply.

Portable audio mixers come in handy for use in the field when there is more than one source of sound. It allows one to combine the signals from multiple audio sources, be it microphones or other audio players, and mix them all. They work either on direct power supply or batteries. The output from the field audio mixer is then connected to the input of an audio recorder. The audio recorder then records the mixed audio from various sources. Figure 13.12 shows a model of field mixer.

Figure 13.12: *Portable audio mixer.*
(Source: Jnan Taranga, KKHSOU, Guwahati)

Professional portable field mixers have the following features:

- Can take in any number of audio inputs from 2 to 6
- Provide phantom power for condenser microphones
- Gain and level controls
- Monitor headphones
- Can be low cut filters by cutting out low frequencies while recording outdoors
- Can act as limiters by preventing distortion of audio even when it is very high
- Provide balanced outputs to connect to a recorder

If you have to work with portable audio mixers, ensure the following:

- It has enough audio inputs.
- It has a warning signal for signal overloads.
- Don't mix or overlap audio and power cables. Keep them as far as possible from each other.

13.10 Sound Cards

A sound card is a peripheral that is connected to a computer. It is sometimes also called a **sound board** or an **audio card**.

Most computers come with some form of a basic sound card to edit and playback audio. So how does one identify if a computer has a sound card? If your computer has inputs for a microphone and a headphone on the back of the CPU (Central Processing Unit), which is the box that houses your computer's hardware, your computer has a sound card. It must be noted that while some cards only playback audio, **duplex sound cards** enable simultaneous input and output of audio, and also enable audio recording.

Some of the motherboards used in computers have good sound cards that are integrated into the motherboards themselves. However, most computers used for professional audio usually need an independent sound card. These are usually plugged into the Peripheral Component Interconnect (PCI) slot on the motherboard. Figure 13.13 shows a sound card of this kind.

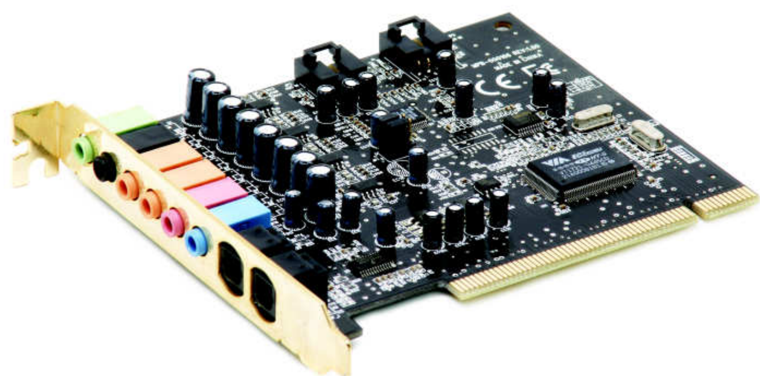

Figure 13.13: *An internal sound card. Only the silvered surface at the front and the coloured connectors are visible at the rear of the CPU cabinet.*
(Source: WikiMedia Commons, *http://tinyurl.com/32ssttc*)

A sound card also acts as an **analogue to digital convertor (ADC)**. In other words, it converts analogue signals coming from your microphone to digital bits that can berecorded/stored on the computer. It also has a **digital to analogue convertor (DAC)** to output the digital signal through speakers, which need an analogue signal.

The purchase of the sound card will depend on your requirement and budget. Budget sound cards can cost anywhere between INR 1,000–5,000. A professional high-end sound card could cost INR 1,00,000or more! For purposes of editing audio, a sound card that is in the range of INR 2,000–3,000 should be quite adequate.

13.11 Digital Audio Workstations (DAWs)

A digital audio workstation (DAW) is nothing but a computer one can use to record audio in a studio or even use for the post-production work of radio programmes.

In the early days of digital audio editing on a computer, one would have to connect hardware like an audio mixer or effects generator to the computer. While the software would help in merely editing together all the audio, all sweetening of audio (including balancing, equalizing, and applying audio effects) would have to be done by the external hardware. Of late, however, computers above a certain grade, with even moderate sound cards, are capable of doing everything from assembly of the programme through to the mixing, balancing, equalization and effects works within the computer's software interface itself.

Today's computer and audio recording/editing software often come with built-in software-based mixing consoles, plugins and effects, which help in completing everything from recording to post-production work right on the computer.

The key things to look for in a computer to be used as a DAW are as follows:

- A high-end processor (the Intel i-series processors work well)
- A power supply (SMPS) of 400W or greater
- Random Access Memory (RAM) anywhere between 2–4GB (more is better)
- A hard disk of a minimum 500 GB capacity, with 1 TB preferred
- As many USB 2.0 (Universal Serial Bus) ports as possible to import and export audio from the system
- A good sound card—one with an external breakout and multiple connector options is always preferred
- A pair of good speakers to monitor audio

There are several choices for digital audio processing software available in the market, ranging from Free and Open Source Software (FOSS) options to proprietary solutions. More about their functions will be discussed in Units 16 and 17 in Module 5.

Activity 13.4

Turn off a computer in your studio, unplug it and try to open it up. If you do not know how to open it, ask for assistance. You will need to open some screws on the case to lift one side of it.

Now try to identify the sound card in the computer's CPU tower. It is normally situated near the slots where you plug in a headphone or an external microphone to the computer. See if it has a (green) slot to connect a headphone or a set of speakers. See if you can identify the make of the sound card. Now switch on the computer and play back some music on the computer with speakers connected to the appropriate socket. You should be able to hear the audio on the speakers.

13.12 Let Us Sum Up

A microphone and an audio recorder are the two minimum pieces of equipment required to record audio on the field.

When recording audio, one needs to take care of the ambience to avoid external noise from getting recorded. Monitoring audio using the right type of headphone is imperative if you have to record good audio.

One must also be able to identify different kinds of audio connectors in order to be able to use them with different pieces of equipment in different situations.

A digital audio workstation is a computer that uses a software to perform edits, sweeten audio and output audio in different formats including .wav and mp3 formats.

13.13 Model Answers to Activities

Activity 13.1

The quality of audio recorded largely depends on the microphone you use, your distance from it and the direction of the source of the sound. When you speak in front of it, the quality of audio is better than when you speak sitting behind it or next to it. In the case of the latter, the audio will sounda little hollow. You will also notice major differences when you record audio using uni-, bi- and omni-directional microphones. You will notice that the audio recorded using an omni-directional microphone has more noise than the ones recorded using uni- and bi-directional microphones.

Activity 13.3

When you record audio in a big hall, and the microphone is far away from the primary audio source, the audio sounds hollow and full of reverberations. This is because sound waves hit nearby objects and are reflected back into the microphone. Similarly, there is considerable noise when you record audio outdoors.

On the other hand, when the recorder is very close to the source, the possibility of eliminating hollow sound is more. Therefore, the distance from the source of the sound and the ambience plays a major role in the quality of audio you record.

UNIT 14

Free and Open Source Software in CR

Structure

14.1 Introduction

There are many misconceptions about the words **free software** and **open source software** in the minds of computer users. Many think that free software means you can download it from the Internet without monetary payment. There is also a belief that free software is acceptable for amateur work, but not for professional work. Some people believe that free software is difficult to use, and that there is no support available, that it is good only for computer 'nerds'—people who are expert computer users.

In this unit you will learn the correct meaning of free and open source software, the philosophy behind the free software movement. You will also understand their usability, prevalence and relevance in the community radio (CR) sector. It may be noted here that 'Free Software' and 'Open Source' software have different meanings, though they are quite often used interchangeably. In this unit, you will learn about the difference between the two terms, and some of the open source software used the world over in CR stations.

While going through the unit, you will need to do four activities (the model answers of which are given in Section 14.6). You will need approximately ten hours to complete this unit.

14.2 Learning Outcomes

After going through this unit, you will be able to:

- define open source and free software.
- describe the historic and philosophical background of the open source movement.
- analyse the pros and cons of free software, as compared to its commercial counterparts.
- list available open source software that are useful in CR stations.

14.3 What is Free and Open Source Software?

The free and open source software movement heralded a new era of knowledge building society—one which was non-hierarchical, adhering to the principles of equal access, freedom to use, adapt, modify and redistribute. Both the terms, though quite often used interchangeably, are not really synonyms. Both the terms are underpinned by a similar value structure, even though they are different in their philosophical approaches.

The **Free Software Foundation** has been promoting the term **Free Software**, whereas the **Open Source Initiative** has been using the term **Open Source Software**.

14.3.1 Definitions

There are no classical definitions available for either of the terms. The Free Software Foundation's explanation published in February 1986 pointed to two fundamental principles to describe the term free software. First and foremost, the term 'free' does not refer to the price or cost of the software. Instead, it refers to the freedom it gives you to use, modify or redistribute the software.

For example, in the sentence "All human beings are free", the word free does not refer to a cost or monetary value, but to the concept of freedom. On the other hand, if I say "My restaurant is going to distribute lunch for free today", the meaning of the word free refers to the cost or monetary value. So, free software is free as in 'freedom' and not as in 'free lunch'!

The second principle that the Free Software Foundation emphasized was the freedom to change a software program, so that the control over the program lay with the user, rather than the original creator. Naturally, this means that the source code must be made available to the user, so that he or she can make changes in it.

These two primary principles were later codified as four 'Levels of Freedom', to which a software had to confirm in order to qualify as free software. They were as follows:

- **Freedom 1:** The freedom to run the program for any purpose.
- **Freedom 2:** The freedom to study how the program works, and change it in order to make it do what you wish.
- **Freedom 3:** The freedom to redistribute copies so you can help your neighbour.
- **Freedom 4:** The freedom to improve the program, and release your improvements (and modified versions in general) to the public, so that the community benefits as a whole.

In 1997, Bruce Perens, a renowned software programmer, published the **Debian Free Software Guidelines**, which were subsequently adopted as the core principles behind open source software by the Open Source Initiative, the organization that promotes the term 'open source software'. Though the guidelines were similar to those that governed the term 'free software', they further emphasized the philosophical differences between the two terms.

The Debian Free Software Guidelines referred to the "Cathedral Vs Bazaar", a much talked about article written by Eric Raymond in the same year, which differentiated between two models of knowledge building by comparing them to contrasting architectural styles. The way a cathedral is built is very centralized: very few people or architects have a complete vision of the building, and everyone else is a cog in the wheel, executing a sub-task within the larger purpose of cathedral building. The roles are very well defined and the whole idea is based on hierarchical relationships and superior/inferior roles. Traditionally, the knowledge or commercial software was built in this way. For example, the complete source code for the Microsoft Windows operating system is a highly guarded secret, and very few people have access to it.

On the other hand, the bazaar approach of knowledge building is open, non-hierarchical and user-driven. Like a local bazaar (market), everyone in a society has the freedom to use, adapt, modify and redistribute a given piece of software. There are no superior authorities to decide who does what; roles are not defined; and everyone has the freedom to do what he or she likes to do.

14.3.2 History

The concept of free sharing of technological information is not new. It has been in existence since time immemorial, far before the computer was even invented. Even our mothers and grandmothers have shared information and procedural tricks with friends and family! It is in the same spirit that the twin concepts of free and open software were created.

Even in the field of software, informal sharing of source code was an accepted concept much before the current movement of free and open source software came into existence. In the early days of computers, in the 1950s and 1960s, all software were bundled with their source codes as there was no standardization in hardware. For the software to work on different hardware setups and operating systems, some modifications were absolutely necessary—and this meant each user needed access to the full source code.

By the early 1970s, however, the winds of change had started blowing. Computers came out of the academic and research institutes and into the corporate offices. The growth of the software industry was inevitable, as the corporate houses and individuals thought of diverse ways of using computers. Around the same time AT&T, the global telecom giant, gave the UNIX operating system free of cost to governments and academic institutes. UNIX was free, but not open source, as it did not come with the permission to modify or redistribute it. In the 1980s, AT&T stopped free distribution and started charging for the software. By then, the users were so used to UNIX that most of them paid for the software. This was the first major instance of software licensing. However, there were some exceptions: software like X Window System, which enabled the graphical interfaces, continued to be distributed as an open source software.

The free and open source software movement got a major boost with the advancement of the Internet. The Internet provided a much-needed sharing platform for small and big initiatives towards writing software. With increasing net-based connectivity, many organizations and individuals started websites to share software.

In 1983, Richard Stallman started the **GNU Project** to develop a free and open source kernel for a new computer operating system similar to the UNIX OS earlier developed by AT&T. However, there was no real kernel as part of GNU Project till the time Linux appeared on the scene.

It was in 1989 that the first version of the **GNU General Public License** was published. The second version was published in 1991. In the same year, Linus Torvalds shared the first version of the Linux kernel, which drew attention from volunteer communities across the world. In no time, Linux emerged as the first and complete free and open source computer operating system.

The development of Linux demonstrated to the world that the bazaar model of development was viable and efficient. In addition, it made complete business sense to have decentralized, customizable platforms.

Linux is packaged in a format known as a **Linux distribution** (or **distro**). They are now available for desktop computers, servers and embedded devices. There are now a variety of popular distributions created by a number of organizations and individuals, which include **Debian** and its derivatives such as **Ubuntu** and **Linux Mint, Red Hat Enterprise Linux** (and its derivatives such as **Fedora** and **CentOS**), **Mandriva/Mageia**, **openSUSE** (and its commercial derivative **SUSE Linux Enterprise Server**), and **Arch Linux**. Linux distributions include the Linux kernel, supporting utilities and libraries, and usually a large amount of application software to fulfil the distribution's intended use.

The Linux distribution for desktops is generally accompanied by the **X Window System** that provides the graphical interface. **GNOME**, **KDE**, **Xfce** and **Unity** are some of the prominent desktop environments that a desktop user can choose from. By default all of them use **Mozilla Firefox** as web browser, **Libre Office** or **Open Office** as the office suite, and **GIMP** as the image editor. There are usually a host of multimedia applications which are bundled as part of the distribution.

The Linux distribution for servers typically includes **Apache HTTP server**, **MySQL database**, and **PHP5** as web application. This combination is known as **LAMP**, and is the most popular configuration for the web servers. LAMP usually includes **SSH server**, an FTP server for the hosting of remote management applications.

Apart from Linux, there are a few more significant kernels for operating systems. **FreeBSD** and **NetBSD**, both derived from **386BSD**, are noteworthy among them. The development of FreeBSD as well as NetBSD started around 1993. In the last 20 years, it has gained significant ground. Technology giant Yahoo has been using FreeBSD since the year 2000.

14.3.3 Current Scenario

Eric Raymond's famous article, *The Cathedral vs Bazaar*, had an electrifying effect on many software programmers and companies; and many readily adopted the bazaar model of knowledge development. The first among the companies that made a philosophical statement through their actions was **Netscape Communications Corporation (NCC)**. The company released its flagship browser **Netscape Navigator** as free software. The code for Netscape today forms the basis for Mozilla's Firefox browser and **Thunderbird** email client.

Thanks to the comparative marketing muscle of proprietary software companies like Microsoft and Apple, open source software's penetration in the consumer market has been very slow. But on mission critical computing, super computers, web servers, DNS servers and similar applications, Linux and other Unix-like operating systems dominate by a significant margin.

The chart above will show you how the most powerful supercomputers in the world, as listed with http://top500.org are using Unix-like or Linux operating system.

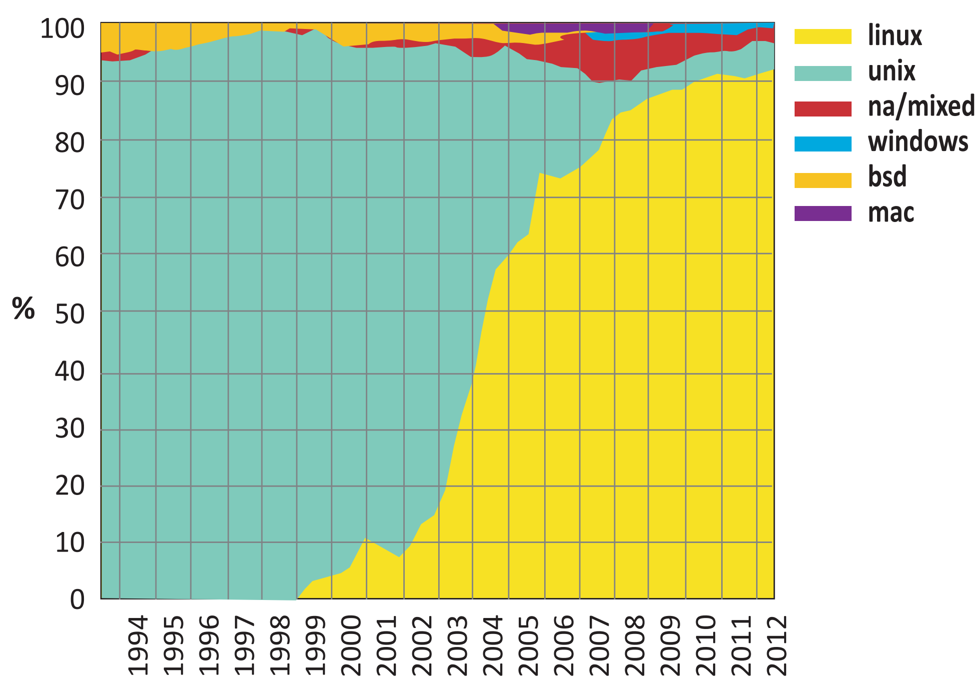

Figure 14.1: *A graphical representation of the relative shares of the various popular operating systems on the top 500 supercomputers in the world (1994–2011).* (Source: WikiMedia Commons, *http://tinyurl.com/qxovbma*)

In the broader server industry, **Apache HTTP server** is the indisputable market leader. Similarly, as per the industry estimate, more than 65 per cent of web servers in the world are running on Linux server distribution. Among desktop computers, **Microsoft's Windows operating system** is still dominating, though its market share has dropped with every version over the last decade. A large chunk of what Windows desktop version lost has been captured by **Apple's iOS**.

On the other hand, there is a concerted movement towards greater acceptability of Linux desktop with public institutions. The federal government of Brazil is well known for its support for Linux. The Russian military is also reportedly creating its own Linux distribution for strategic use.

The Indian state of Kerala has made it mandatory for all state-run schools to use Linux on their computers. Spain and Germany in Europe, as well as the continents of Australia and Africa are emerging as the powerhouse of Linux users.

Linux is getting popular in the netbook market as well. Companies like Asus and Acer have started shipping netbooks loaded with specially customized Linux operating systems.

Apart from the operating system domain, the open source software movement is taking centre stage in other areas of computerized activity as well. For example, for computerized EPABX telephony systems, **Asterisk** is the most advanced system and is used by all leading telephone companies. For audio streaming, **Icecast** and **Shoutcast** are the leading types of software developed by the open source community.

The **Android mobile OS**, used on many mobile phones today, is a classic open source development. Google developed Android based on a Linux kernel, and has kept the source code accessible and revisable. Within a few short years, Android has emerged as the primary challenger to Apple's proprietary iOS, used on its flagship iPhone and iPad devices.

Activity 14.1

For this activity, you will require access to a computer where you have permission to install software. You will also need an installable copy of any Linux distribution, on a CD or downloaded from the Internet and then you will need to burn it to a CD.

Install any distribution of Linux on a computer to work side-by-side with the existing operating system.

14.4 Open Source Software for CR

It has been observed the world over that CR stations require more openness, flexibility and higher levels of customization in their operations. They need to be able to expand their processes and systems organically over a period of time, and even shrink them, under certain circumstances. Also, the technologies used in CR stations need to be cost effective. Given these requirements, the open source and free software movement is a natural fit with CR movement, both of which strive to provide equal access, transparency, openness and scalability to communities.

Across the globe, many community media practitioners have preferred open source software for the following reasons:

- Freedom to use and share the software
- Freedom to modify and adapt the software to their unique situations
- Free support from the global community, which is often seen as far superior to the paid support by a company providing a proprietary software
- Cost effectiveness

In this section, we will briefly examine a sampling of time-tested open source software used in the various functions of a CR station. It should be noted that the software listed in this section constitute a very small part of a large open source software pool. The selection is also subjective and in accordance with the personal preferences of the author. Students should feel encouraged and free to explore other open source software, and not restrict themselves to what is listed here.

14.4.1 Sound Recording, Editing, Mixing and Mastering

Sound recording and editing are core activities in any CR station; and every technician working in a CR must have a better than fair understanding of the software used for the purpose. There are literally hundreds of free and open source software available for these purposes, many of which are well-known. Few of them which are not known are described below.

Audacity

Audacity is one of the most commonly used audio recording and editing software used in CR stations the world over. It is a non-linear, multi-track and feature-rich editing system that works on Windows, Mac or Linux platforms. The main features of the software include the following:

- Recording live audio
- Converting magnetic tape recordings and LP records into digital recordings or CDs
- Editing Ogg Vorbis, MP3, WAV or AIFF sound files
- Cutting, copying, splicing or mixing sounds together
- Changing the speed or pitch of a recording

There are many plugins and add-ons you can find on the Internet to extend the functionality of Audacity, and use the software as you like. Figure 14.2 shows you what the interface looks like.

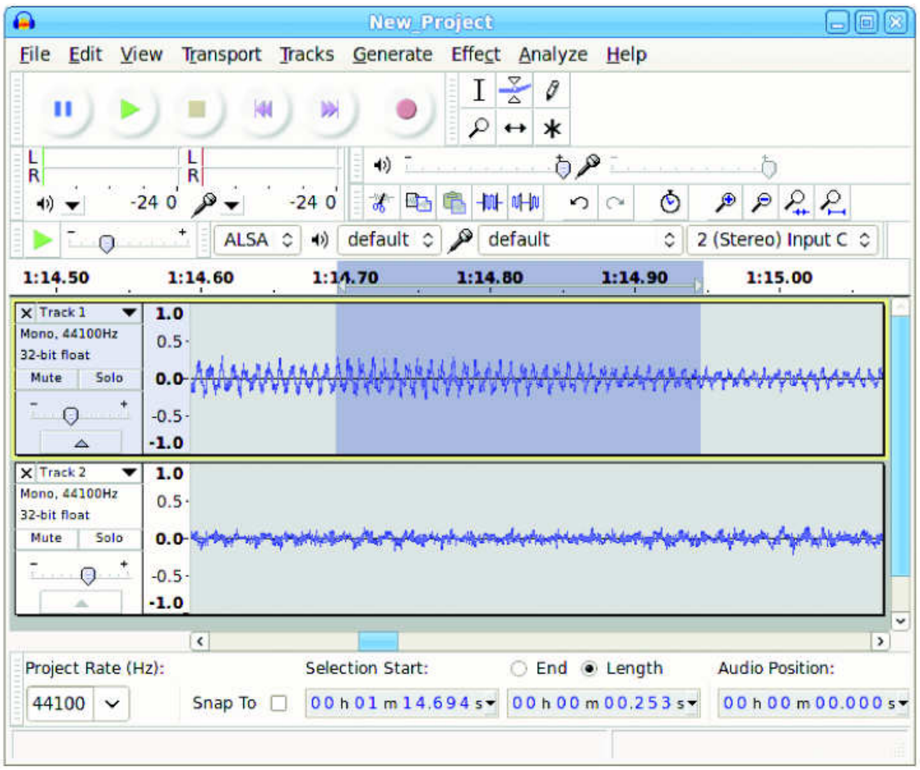

***Figure 14.2:** The Audacity editing interface.*
(The screenshot was captured by the author)

Ardour

Ardour belongs to the JACK Audio Connection Kit environment. It is one of the most efficient and professional audio editing and recording software available to the open source community. It is a complete digital audio workstation, useful for live recordings, concert recordings, and composition. For a complete list of features, visit http://www.ardour.org.

Figure 14.3 shows you what the Ardour interface looks like.

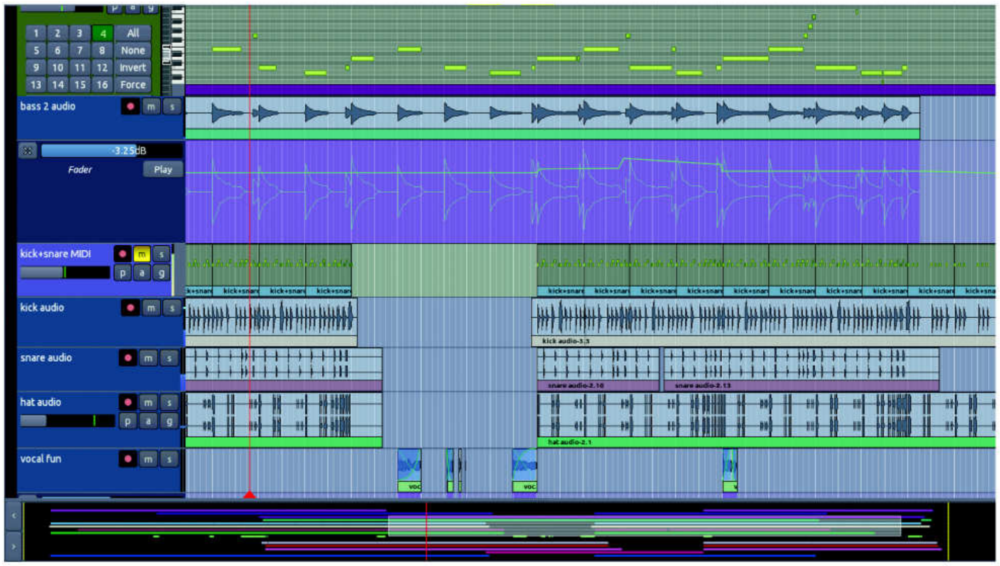

Figure 14.3: *The Ardour software interface.*
(The screenshot was captured by the author)

JAMin

JAMin is the Jack Audio Connection Kit Audio Mastering interface. JAMin is an open source application designed to perform professional audio mastering of stereo input streams. JAMin is licensed under the Gnu Public License (GPL).

The features of JAMin are as follows:

- Linear filters
- JACK I/O
- 30 band graphic EQ
- Spectrum analyser
- 3 band peak compressor
- Lookahead brickwall limiter
- Multiband stereo processing
- Presets and scenes
- Loudness maximizer

Figure 14.4 shows you the JAMin software interface.

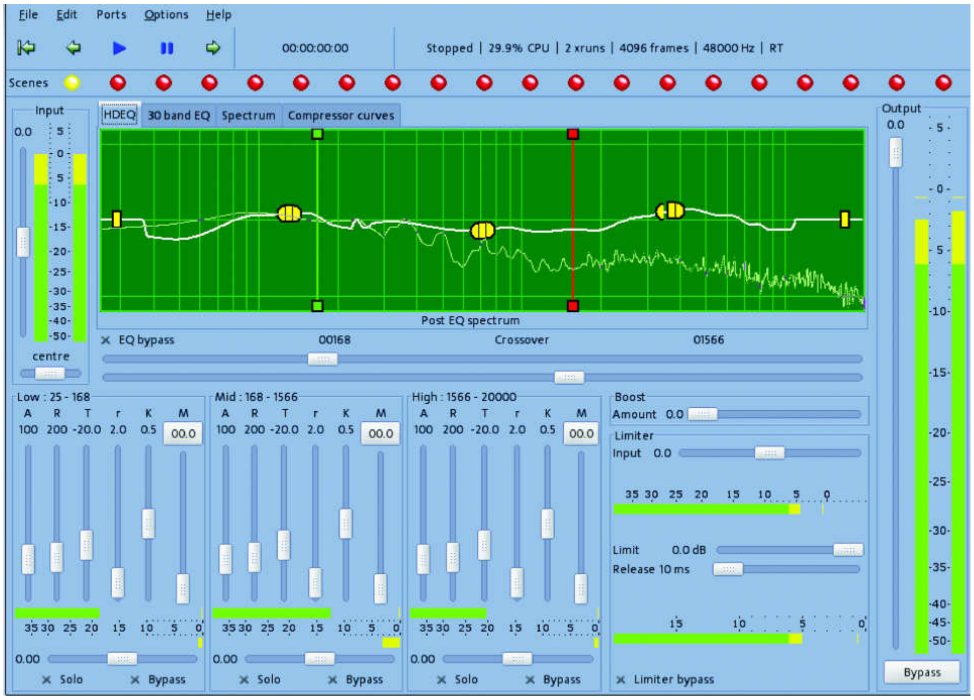

Figure 14.4: *The JAMin software interface.*
(The screenshot was captured by the author)

Activity 14.2

Carry out a comparative analysis of the software listed below:

1. Audacity vs Adobe Audition
2. Ardour vs Nuendo
3. GIMP vs Adobe Photoshop
4. Mixxx vs WinAmp
5. Mozilla Firefox vs Internet Explorer

List the pros and cons of each type of software as part of your analysis.

14.4.2 Radio Automation

Radio automation software are used for different functions in a radio station. They are used for **scheduling** (presetting the time when a particular programme plays), **logging** (listing the order of play of the aired programmes) and **playout** (the playing of a preset list of programmes). Many radio stations in India use just a simple playlist software like WinAmp as playout system; but the use of a well-configured radio automation software can give a professional touch to a CR station, with pre-defined fades-in and fades-out for programmes, jingle management, advertising management, live assist, telephony and many features that come in handy in a radio station.

There are not many radio automation software in the free and open source domain. There are some free software like Zara Radio Free, but many of those are available with no clear commitment to open source. In this section, you will be introduced to three types of radio automation software, which have clearly stated their commitment to the open source movement.

Airtime

Airtime is one of the most advanced server-based radio automation system, developed by Sourcefabric. It runs on a web server to enable scheduling, logging, playout, live assists, and also streaming to any Internet radio. This software was earlier known as **Campcaster**.

To be able to install airtime, you need to be proficient in installing web server with PHP, Apache2, mail server and PostgreSQL. The installation requires some practice before you can master it. However, once it is installed, it is an easy software to use. The software does not run on your computer. You need to access it via an intranet or the Internet on your web browser like Mozilla, Chrome or Internet Explorer. As it is server based, the software for the end-user is cross platform. That means you can run any operating system—Windows, Mac OSX or Linux—and the software will be accessible in exactly the same way. Figure 14.5 shows you the Airtime media library and playlist builder interface.

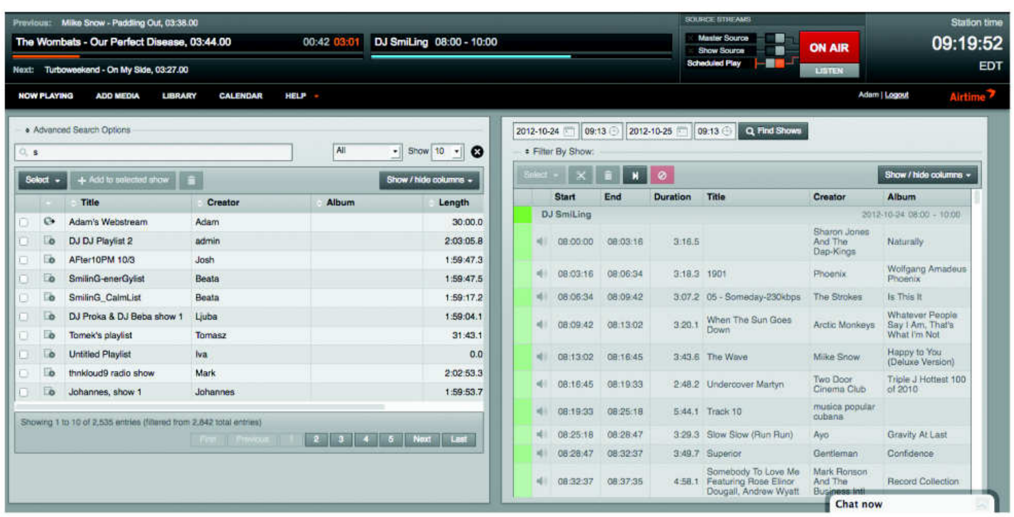

Figure 14.5: *Source fabric's Airtime automation software: Media library and playlist builder (The screenshot was captured by the author)*

For a complete list of features, please visit http://www.sourcefabric.org. If your CRS has good Internet connectivity, you may also avail the hosted solution offered by Airtime, provided on the professionally managed servers of Sourcefabric, the team that has designed airtime.

Figure 14.6 shows the scheduling interface in Airtime.

Figure 14.6: *Source fabric's Airtime automation software: Schedule builder interface (The screenshot was captured by the author)*

Rivendell

Rivendell is a complete radio broadcast automation solution, with facilities for the acquisition, management, scheduling and playout of audio content. It is a feature-rich software with further emphasis on touch-based operations, that is, it is optimized for touch screen based computers.

Rivendell uses industry standard components like the GNU/Linux Operating system with Audio Science HPI driver architecture. It also works with the open source JACK Audio Connection Kit and with the MySQL database engine.

One of the limitations of Rivendell is that its documentation is limited to few distributions of Linux, and that it does not have a repository-based installation service. Figure 14.7 shows a view of the Rivendell administrative panel, from which its primary functions can be controlled.

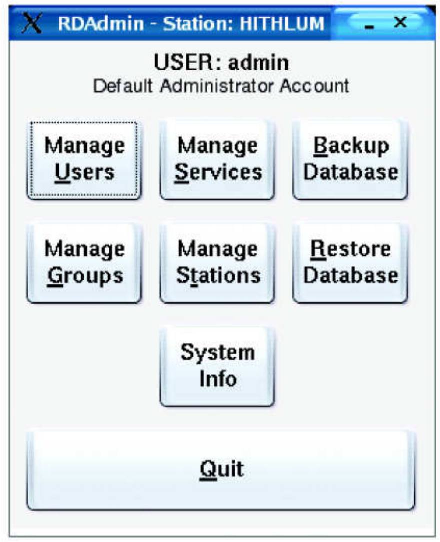

Figure 14.7: *Rivendell software Administrative panel*
(The screenshot was captured by the author)

Figure 14.8 shows a view of the Rivendell's built-in editing capabilities, which allow you to correct audio without moving into a separate software environment.

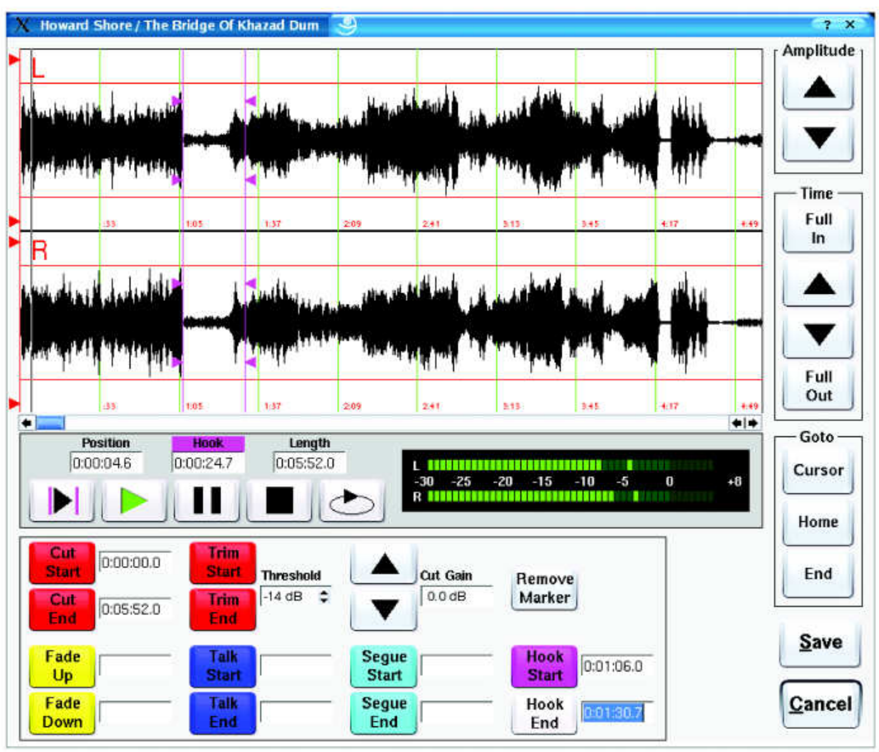

Figure 14.8: *Rivendell software's built-in audio editor*
(The screenshot was captured by the author)

GRINS (Gramin Radio Inter Networking System)

GRINS is one of the most widely used radio automation software in Indian CR stations, and has been developed by the Indian organization Gramvaani. Apart from offering the standard features of a radio automation system (namely scheduling, playout and logging), GRINS also offers complete integration of mobile telephony within its interface, including SMS (Short Messaging Service). Released under the Apache license version II, GRINS currently works only on Ubuntu 12.4 LTS version, which is a Linux-based distribution.

Some of the features of GRINS are as follows:

- **Full telephony integration** without need of a telephone hybrid or changes to mixer settings. You can receive calls, record calls, put calls on air, have live call-in programmes. You can even maintain a searchable database of your callers within the GRINS interface
- **Preview of audio**. Since GRINS uses multiple sound cards, you can preview audio over your headphones even while some other programme is playing live.
- **Streaming audio support**. GRINS supports streaming over IceCast or ShoutCast servers, making it Internet radio ready.

Figure 14.9 shows you the GRINS telephony interface.

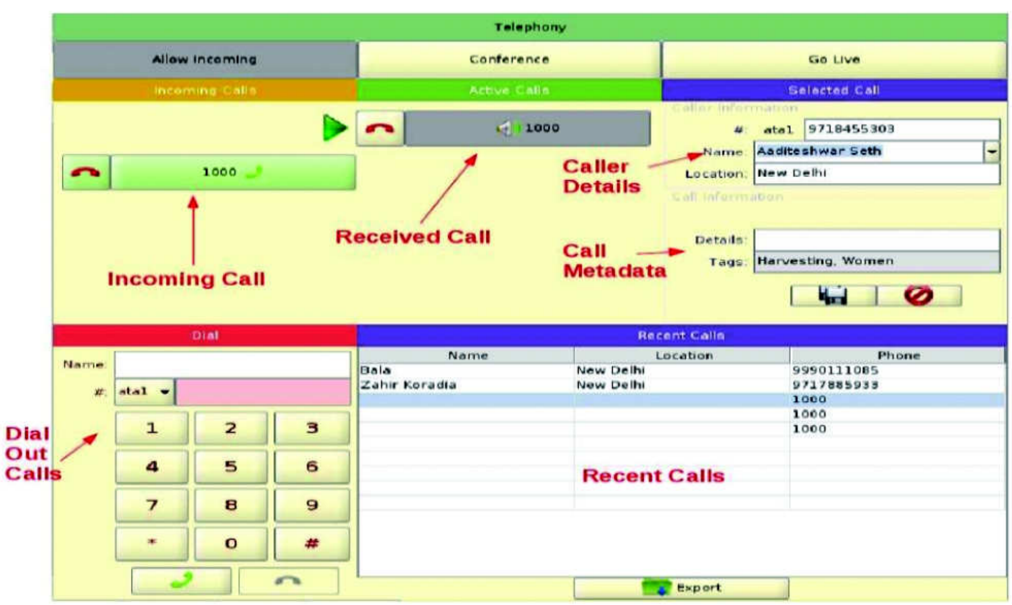

Figure 14.9: *A screenshot of the GRINS telephony console.*
As you can see from the image, there are provisions to make, receive and log calls.
(The screenshot was captured by the author)

Activity 14.3

Using any open source audio editor, edit a three-minute monologue on open source technology. It may be useful for you to write the script first before recording it.

After editing your own speech, take an output in an open source format.

14.4.3 Other Useful Software

The open source domain is a goldmine of highly useful software, with hundreds of options for every possible application need. In this sense, it is worth noting some other key open source software that could be of use in a CR station.

One such application is called **IDJC**, which is the short form of **Internet DJ Console**. The software is designed for Internet-based radio jockeying. As a radio announcer or jockey, you can sit anywhere in the world and run either Internet radio or even FM radio. The software has two players and you can use them in tandem to play a programme on one while you cue the next programme on the other. It has auxiliary inputs as well as a complete telephony function built into it; and you can use Skype or a SIP-based telephone to either receive calls or make calls to your listeners. It also lets you stream audio to six different Icecast or Shoutcast servers simultaneously.

The limitation of IDJC is that it works only on Linux and that too specifically with the JACK Audio Connection Kit. To use it, you need to be reasonably well versed with both associated software. Figure 14.10 shows you the IDJC interface.

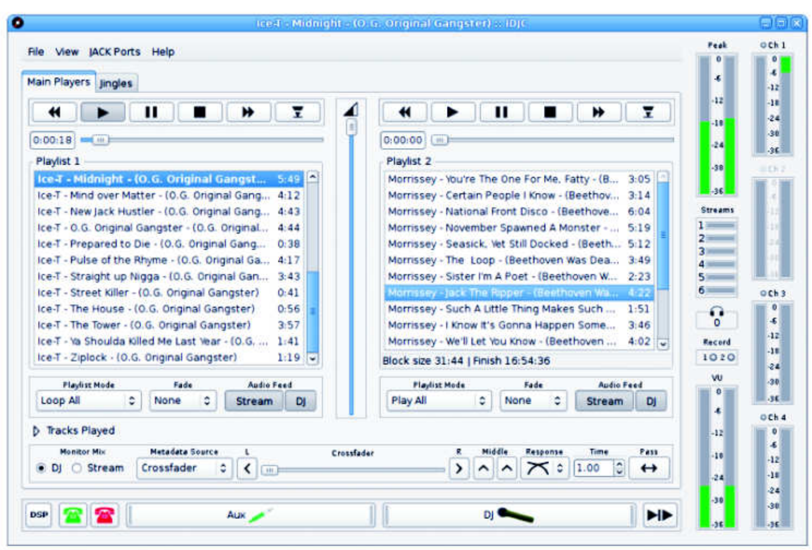

Figure 14.10: *A screenshot of the IDJC interface.*
You can play items from the two queued lists on the left and right alternately.
(The screenshot was captured by the author)

Another piece of software that is similar to IDJC is **Mixxx**. This software also has two players and a live assist. It can also stream to an Icecast or Shoutcast server. As compared to IDJC, there are two distinct advantages of Mixxx. The first is that it is a cross platform software, which means it can run on Windows, Linux or Mac. The second is that it can run on Advance Linux Sound Architecture (ALSA) or Jack Audio Connection Kit. Moreover, the look is skinnable, meaning you can customize its look and feel as per your preferences. There are a lot of 'skins' available for the software.

Activity 14.4

Compile a list of open source software that can be used for CR purposes. The list should be divided into two heads: 'Recording, Mixing and Editing'; and 'Radio Automation'.

14.5 Let Us Sum Up

In this unit we have understood that 'Free and Open Source Software' does not necessarily mean software that are available for free, even though many of the open source software are actually available free of cost. Free and open source software are those which come with the freedom to be used, modified and redistributed. There is also no restriction on putting open source software to commercial use. In fact, there are a large number of companies today that earn a tidy profit based on open source technologies.

You have also understood the philosophical basis on which the entire open source software movement rests on: equal access, sharing and community knowledge base are some of the key concepts that are driving the open source movement.

It may be noted here that the proprietary development model has not been able to match the speed at which open source community has been able to develop complex software. Also, many types of commercial software are actually the derivatives of work that has happened in the open source domain. Philosophically, open source environment is more suitable to CR and efforts must be made to avoid using proprietary software.

14.6 Model Answers to Activities

Activity 14.1

While investigating Linux distributions alongside your existing operating system, you must have found Ubuntu 12.4 or Fedora 17 or Mint or Debian. These are all Linux-based operating systems, either based on the Debian core or the RedHat core. You would have also noticed that all Linux distribution packages come with a package called **Grub**, which allows you to have multiple operating systems on the same computer. The same program also allows you to choose which operating system you want to use at a given point in time.

Activity 14.2

The comparative analysis must have shown you that software in open source domain give more freedom and functionality in some areas, while they fall short of their commercial counterparts in others. There are two reasons for this. The first reason is that in specialized areas like sound editing, proprietary software have had a much longer experience and history, while the open source software alternatives have been in existence for a comparatively shorter period of time. The second reason is that many audio or video codecs are of a proprietary nature, and are therefore not accessible to the open source community, preventing them from creating extended functionality based on such codecs.

Activity 14.3

While recording and editing your own speech on an open source based digital audio workstation, you must have noticed that you can perform most operations as efficiently as you can in any proprietary software commercially available in the market. You may also have noticed that there is no perceptible difference in the final output. At the same time, you may have fumbled or struggled to invoke some of the same functionalities, as some of the commands and terminologies are different in the open source alternatives.

Activity 14.4

While compiling the list of open source software, you must have noticed that in addition to the software listed in this unit, there are many more options available in the open source domain. You may have also come across software that are free and open source but at the same time also have a price tag. This underscores the fact that free and open source software does not necessarily mean ‘free of cost’.

14.7 Additional Readings

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UNIT 15

Telephony for CR

Structure

15.1 Introduction

In the previous units in this course, you learnt that CR is meant to be a participatory medium of communication. The success of CR can be determined by the extent of participation of the community it is intended to serve. Though there are many ways to ensure and encourage participation, one of the most significant ways is the telephone.

You must have heard many radio programmes on commercial as well as on CR stations that make use of phones to connect the listeners to the station. These are generally known as phone-in programmes. In phone-in programmes, a conversation with a listener is either recorded or incorporated into a 'live' programme on the broadcast system. Many radio stations also use the phone system for conducting polls or recording listener feedback.

For many years, wired landline telephone systems were the only option; and the cost and effort of cable laying meant phone densities even in urban areas was very low. However, over the past two decades, the telephone system in the country has been revolutionized by the advent of mobile (cellular) telephony. Tele-density, which means the availability of telephone system per unit of population, has increased multifold, not only in the cities but also in the rural areas. This has made the use of telephony in broadcast even more important a tool to engage the audience and in making the programmes more participatory.

In this unit, we will discuss various tools to incorporate landline as well as mobile telephones into your broadcast environment. You will also learn about the conventional and modern ways to bring your listeners' voice on the radio. In addition, you will learn how to use SMS and Interactive Voice Response (IVR) systems in a broadcast environment.

It may be noted here that the rate of technological innovation and change is very rapid in the telephony sector. What we are discussing here is a general overview of the available options. This unit is for you to understand the vast possibilities and potential that telephony brings to CR; to understand the principles behind the use of telephony in radio broadcasting and use the available resources to their best potential.

15.2 Learning Outcomes

After going through this unit, you will be able to:

- describe the various tools used to incorporate telephony in radio broadcasts.
- discuss various ways of using telephones for broadcasting.

- describe the uses of computer-based telephony systems.
- analyse the pros and cons of various telephony systems.

15.3 Conventional Landline-based Systems

Before the availability of mobile phones, fixed line or landline phones were the only telephone system available to the world. In technical parlance, the landline phones are known as the PSTN (Public Switched Telephone Network) phones. Essentially, the system is composed of centralized line switching systems called exchanges, with copper wire based cables connecting the exchanges to each individual telephone subscriber's instrument. Each instrument/line is allotted a specific subscriber number, which identifies it uniquely on the network. The lines are energized by a constant electrical voltage supplied by the exchange instrumentation. Dialling a specific number activates the switching system, which then connects the two instruments, with the audio at each end travelling as electrical impulses through the copper wire system.

PSTN lines have been in use by radio stations all over the world including All India Radio and BBC World Service, with which we are quite familiar. In India, however, the use of the telephone system became very extensive with the emergence of private commercial FM stations that started taking listener calls very frequently and broadcasting them live. The commercial sector also saw the emergence of talk radio: Radio Miaow, was launched as a pre-dominantly chat radio, and most of the programmes on Radio Miaow were talk based.

So how do we actually connect in a conversation happening on a telephone landline into our audio process in a studio? Let's look at the most popular ways in which this can be done.

15.3.1 Speakerphone–Microphone Combination

One of the easiest ways to achieve PSTN-based telephony in a radio station is to a have good quality speakerphone in the studio coupled with an external microphone. In this solution, what you do is put incoming and outgoing calls on the speakerphone mode, so that you can hear the caller at the other end over the unit's in-built speaker. You can then place an external microphone to pick up this sound and send it to the mixer. This solution has been tried out in many CR stations the world over and also in India.

The biggest drawback of this solution is that, more often than not, the sound quality is extremely poor. Quite often, the voice is barely audible on the receiving end, or the ratio of the sound to ambient noise or noise on the line is hopelessly adverse. This is mainly because of an impedance mismatch. The external microphone and the speaker of the phone affect each other, as they both have their own magnetic fields.

Figure 15.1 shows a simple speakerphone unit.

Figure 15.1: *A common speakerphone unit. Note the speaker grille under the handset. (The screenshot was captured by the author)*

15.3.2 Transformer-based Interface

To overcome the interference issue that comes with speaker–microphone combinations, some radio stations have used pickup transformer-based solutions. This method will require you to have a few soldering skills, and the confidence to do some wiring on your own. It may not be very easy; but if it is done well, it can work very well indeed.

In this method, you need to select a speakerphone that has a line-out connector. You will need to plug the appropriate jack into this socket, expose the wires at the other end, and solder the exposed wires at the other end of the connector cable to the inputs of an old time cassette recorder playback head. (If the speakerphone unit does not have a line-out socket, you can solder the lead to the inputs leads connected to the speaker on the unit.) Now take another cassette player head, and align it in close proximity with—but not touching—the first one. The second head is then wired to a cable that is connected into the appropriate input socket on your mixing console. The two cassette player heads together form a combination known as a pickup transformer. By this method you can transfer the sound signal across without having electrical contact, and thereby avoiding the problem known as impedance mismatch.

15.3.3 Telephone Hybrids

In commercial radio stations, the telephone-based programmes are generally conducted through what is known as telephone hybrid instrument. Simply speaking, a telephone hybrid is a sophisticated telephone instrument that is capable of routing the sound signals, incoming as well as outgoing, to a mixer console. It works exactly in the same manner as a normal telephone instrument. You can insert one or more telephone lines in it, and can route the audio to the mixing console without any impedance mismatch, distortion or echo.

The basic technology involved in making a telephone hybrid is the impedance matching circuit. The impedance mismatch happens because the receiving line carries two different signals—for voice as well as the base voltage to make the telephone line operative. When we single out the voice part—since we are only interested in the voice and not the other line information—it creates an impedance mismatch, which in turn leads to distortion and echo. A good telephone hybrid should give you a voice output that is of broadcast quality.

Some of the high-end broadcast consoles have telephone hybrids built in to the mixer console itself. That means you can plug in your telephone line directly to the console, and the console will allow you to receive or make calls. However, these broadcast consoles are far more expensive than a normal sound mixing console. Most CR stations do not prefer to spend large sums of money on such consoles; and would prefer to look for other solutions for their telephony-based programmes.

Activity 15.1

Record a phone conversation with your friend on a computer using a simple speakerphone. All operating systems have a default recording application. You may use that; or if you have access to one, you may use a digital audio workstation.

Use a simple microphone to connect to the ‘mic-in’ port of your desktop computer. If you are using a laptop, it is possible that it has a built-in microphone that you can use.

15.4 GSM/CDMA Solutions

With the arrival of mobile phones, the communication landscape has changed dramatically. In this era of rapid spread of mobile phones, the CR stations could not afford to ignore the integration of mobile phones with the broadcasting environment. Today, a mobile phone is being used as an instrument to provide live feeds from a distant event, to engage listeners in conversations that can be heard on air, or simply to solicit comments and feedback from listeners on a real-time basis. In addition, the use of SMS as an instrument for conducting surveys has also become very popular. Here, we will examine various methods of integrating mobile phones in your broadcast environment.

15.4.1 Bluetooth Interface

Bluetooth is a short range radio transmission standard developed for use to connect computer peripherals wirelessly, and since adapted for use on mobile phones. One of the tried and tested ways to use mobile phones in your broadcast environment is to use Bluetooth-based interfaces that can help in plugging your mobile phones into your mixing console. The device works like this:

- A Bluetooth-enabled mobile phone pairs up with the Bluetooth sound interface.
- The Bluetooth sound interface has a slot to insert a microphone, and a port to take a line out connection.
- Insert a microphone in the Bluetooth interface.
- Take a line out from Bluetooth interface to your mixing console.

Now when you receive a call on your mobile phone, your voice and the caller's voice will be simultaneously transferred to your mixing console.

The biggest drawback of this solution is that Bluetooth interfaces are not readily available in the Indian market. There are a couple of companies abroad that make such devices professionally, but they are quite expensive. Moreover, the import shipping costs and the custom duties add to the price.

15.4.2 GSM Dongle (Modem)

GSM stands for **Global System for Mobile communications**, and is the most popular standard worldwide for mobile telephone signals. GSM modems are one of the easiest ways to incorporate telephony into your broadcast.

In this solution, you can purchase any GSM dongle marketed by the mobile phone companies: TATA Docomo, Vodafone, Idea, BSNL or Airtel. Almost all others have a branded dongle which works with their SIM (Subscriber Information Module) cards. You can buy any one of them depending on the availability of the network in your studio area. However, be careful when you choose the dongle: all dongles are not voice enabled. This means that on some of them, you can access the Internet but not use them to make or receive voice calls. When you buy one, ensure that the dongle is voice enabled. Figure 15.2 shows you a typical GSM dongle.

Figure 15.2: *A typical GSM dongle unit.*
HSDPA stands for High Speed Data Packet Access, a type of high speed mobile connectivity protocol. (The screenshot was captured by the author)

One disadvantage of these dongles is that many of these dongles are locked to their specific service by the mobile service providers. This means that the dongle will not work with any SIM card other than the one from the service provider you have purchased it. For instance, if you buy a dongle from Idea, it will not work with a Vodafone SIM card. You will have to use the SIM card supplied by Idea. You can bypass this by buying a dongle supplied directly by manufacturers like Huawei or Micronet. These dongles are not locked to a specific service, and you can use a SIM from the service provider of your choice in them, and even change the SIM if you are not satisfied with the service. This may also be a cheaper option in terms of cost.

Once you acquire a dongle, using it is very simple. You insert the dongle on your PC or laptop—usually into a computer's USB port—and it will ask you to install a software. Once you have this software installed, you can either make or receive a call. You can even connect to the Internet, but this is not what we will discuss here.

The voice here is routed through the sound card of your PC or laptop. That means you need to have a headphone and microphone attached to your sound card. In a broadcast environment, what you can do is that you can plug the sound card's line out to your mixing console, and connect a dynamic microphone to your sound card's microphone input. When the caller speaks, you will hear it through your mixing console. When you speak into the two microphones, one is connected directly to your computer, and the other to your mixing console. This is the way your listener, as well as your caller, will be able to listen to you on air.

Activity 15.2

Make a list of USB modems (dongles) available in the market, which support voice communication. You need to look at the technical specification of the modem to ascertain if it supports voice.

15.5 Voice Over Internet Protocol (VoIP)

Considered to be the future of telephony, Voice Over Internet Protocol (VoIP) has already found its way into the CR sector. Many radio stations have already started using VoIP-server based telephony in their programming in diverse ways. With the help of VoIP servers, CR stations are using voice, SMS and IVR to make their programmes more participatory and accessible to their listeners through their mobile phones.

There are many ways you can define and explain VoIP. For ease of understanding, let us examine the definition and explanation provided by Wikipedia, which reads as follows:

"Voice over IP (VoIP, abbreviation of Voice over Internet Protocol) is a methodology and broad range of technologies for the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet. Other terms commonly associated with VoIP are IP telephony, Internet telephony, voice over broadband (VoBB), broadband telephony, IP communications, and broadband phone service.

Internet telephony refers to communications services—voice, fax, SMS, and/or voice-messaging applications—that are transported via an IP network, rather than the public Switched Network (PSTN)."

This definition makes it clear that VoIP is a mechanism that transports audio and data signals through IP networks like the Internet. It handles most of the multi-media applications, meaning you can distribute voice, text, images and video using the same protocol.

Thus, VoIP opens up a completely new arena for CR stations to reach out to their audience and engage them in programming. A VoIP server can seamlessly integrate with your broadcast environment, so that you can use phone-in and phone-out with ease.

CR stations using GRINS as a play-out software (see Section 14.4.2 in Unit 14 of this module) can make calls directly out of their radio automation system, with the help of a built-in Asterisk server, which uses VoIP protocols. The GRINS user can also send and receive SMS from the same interface.

You will now learn how you can use VoIP in a real-time broadcast environment. First of all, you will have to configure a VoIP server on your setup. You have a host of proprietary options and quite a few open source options for this: Elastix or FreeSWITCH, for instance. However, the most widely used VoIP server is called Asterisk. You need to know a little about computer programming before you can install or configure Asterisk.

After installing Asterisk, you need to provide the server a GSM or PSTN gateway to start making calls to the outside world. Many hardware options are available in the market today to configure a gateway. Companies like Digium and Cisco are well-known for their gateway products for professional uses.

If this seems difficult, you can use one of the many online VoIP services instead. **Skype** or **Gtalk** (now part of Google Hangouts) are also available in India now. You will have to buy credit on these systems, that is, prepay some money so that you can call PSTN networks and mobile numbers from the system to make phone calls. You can also get a permanent Skype-linked telephone number on which your callers can call you.

However, remember that currently VoIP services are more expensive than normal telephony in India. Experts in the field believe that the situation is bound to change, and that VoIP will become cheaper in the future. Many corporate houses who use phones on a large scale are switching over to VoIP services to cut down their telephone bills. Similarly, most call centres have been using VoIP for their operations.

With a VoIP server installed, you can even use Interactive Voice Response (IVR) systems to engage with your listeners, as well as make your programming available 'on demand'. This means you can have an IVR that prompts any caller to press a number to listen to a pre-selected programme. As you will learn in Unit 22, some of the IVR-based initiatives like **Jharkhand Mobile Vaani** and **CGNet Swara** utilize IVR functionality for community-driven media initiative.

Activity 15.3

- Make a phone call using an online telephony service.
- Prepare a list of possible uses of an Asterisk server at home, office and a CRS.

15.6 Use of SMS

Most—if not all—of us are familiar with the term **SMS**, which stands for **Short Messaging Service**. It is one of the most widely used communication tools across the globe. Today, all mobile phones support the SMS service, which is provided by all mobile service providers. SMS is derived from the older system of radio telegraphy. In the early years of mobile telephony, short messages used to be sent through devices called pagers, a service which eventually got incorporated into the **Global System for Mobile Communication (GSM)** standard. Later, SMS services were extended to **CDMA (Code Division Multiple Access)** networks, as well as some landline networks. As per the global standards, SMS messages are restricted to 160 characters per message.

15.6.1 User Case Scenarios for SMS

In a CR setup, you will see very creative use of SMS. They are generally used for the following activities in a typical CR setup.

- **Listeners' feedback:** It is important for any CR to know the minds of its listeners. One of the ways to get listener feedback is to encourage them to send SMS to the radio station, which the station can compile and incorporate into a feedback mechanism.
- **Live participation:** SMS is also a useful tool to encourage listener participation in programmes. One of the important aspects of any CR station is the participatory nature of the medium. In a live programme, a radio jockey or announcer can encourage listeners to participate in the programme with their text messages, which can be read out during live broadcast. You can even do request shows using SMS-based requests.
- **Surveys and polling:** Many radio stations use SMS as a tool for surveys or to understand public opinion on a variety of subjects. For example, in a particular village, if a road has been newly paved, the CR announcer can ask the members of the community if they are satisfied with the quality of the road by sending an SMS with "YES" or "NO" to the station's number. This feedback could be compiled to present an opinion.
- **Competitions:** Many CR stations have used SMS as a voting tool for community-based competitions. For example, a CR station called Radio Bundelkhand in Central India ran a competition to showcase singing talent from the local communities. New singers were given a chance to sing on radio, and the community members were asked to vote for the best singer through SMS.

15.6.2 Technological Options

In the previous section, you were introduced to a few examples of the creative usage of SMS. You can figure out many more such uses in collaboration with the programming team. Once you understand the usage, it may not be very difficult to select the appropriate technology for the purpose. Let us understand some of the technological options available:

- The simplest method is to buy an **average mobile phone with a SIM card** of your choice to send and receive SMSs for your radio station. However, it may be noted that it may not be very comfortable or fast to use a normal mobile phone for sending bulk SMSs for your radio station, or even receive large volumes of SMSs in response. However, as a trial or beginning, it may not be a bad idea to use a phone.
- You can even use **GSM modems**, discussed in Section 15.4.2. These modems are generally provided with a software to send SMS. If your modem has been manufactured by a company like Huawei, it will have bundled software like Mobile Partner or Mobile Connect. Both these types of software can send and receive SMS.

- There are many **online SMS services** available. Some are free and some are paid. You may check out the following web links for examples and possible services:

  http://www.160by2.com

  http://www.ofsms.in

  http://www.mysms.com
- Most of these services let you send free SMS. Given the fact that they are free of cost, they have certain limitations. Some of these free services have a daily cap on the number of SMSs you can send, while some will let you send only 140 characters instead of the stipulated 160. (The service provider may use 20 characters to piggy-back advertisements along with your messages!)
- There are also specialized **software for bulk SMSs,** which are generally used by advertisers. These software have multiple abilities to send or receive SMS based on region, time or context. However, most of them are not free, and may cost a lot of money. You may select one of these software if your radio station can afford the cost.
- An excellent option is the free and open source software **Frontline SMS**, which is being extensively used the world over by many radio stations. This software is browser-based, and works with a large variety of mobile phones and GSM modems. (Go to www.frontlinesms.com to see a complete list of supported phones and GSM modems. It may be a good idea to consult the database before buying a phone or a modem for the purpose or installing the software on your computer.) The software can handle bulk SMSs with ease while keeping a meticulous database of all the SMSs you send or receive, also allowing categorization and time-based search. It also maintains a list of your contacts. Figure 15.3 shows you the main window of the Frontline SMS software.

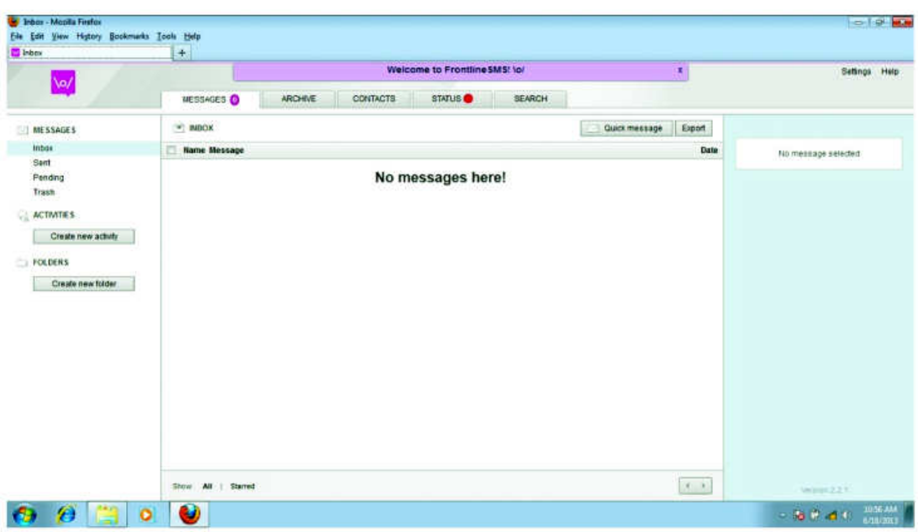

Figure 15.3: *The primary interface for Frontline SMS (The screenshot was captured by the author)*

Caution

Bulk SMS, which is interpreted as a form of telemarketing, is regulated under the Telecom Commercial Communications Customer Preference Regulation, 2010. Under this regulation, any activity that can be termed as telemarketing can be carried out only after due registration with the authority. The authority also maintains a registry of individual customers, with their preferences regarding the type of unsolicited messages they want to receive or whether they want to receive any messages at all.An unsolicited SMS sent to a number which is registered under the Do Not Call Registry can result in a complaint against the sender of the SMS, who can then be liable for penal action. If your radio station wants to use SMS in a major way, then it may be necessary to register as a telemarketing entity. If you just want to send a few SMSs per day, you can verify if the number you want to send the message to is registered under the No Call registry by simply going to http://www.ndnc.in.

Figure 15.4 shows you the contacts window, through which you can look up the details of the contacts stored within FrontlineSMS.

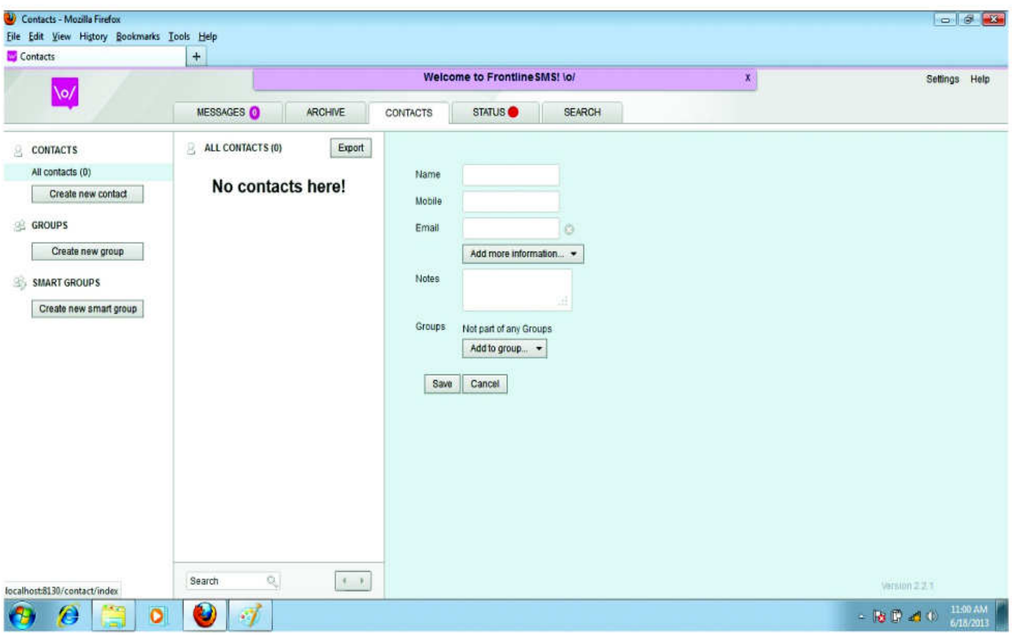

Figure 15.4: *The contacts window of Frontline SMS*
(The screenshot was captured by the author)

Activity 15.4

- Use your mobile phone to send a survey SMS to your friends and colleagues. You should select a question that can be answered in a simple "Yes" or "No", and the question should be one to which all of them can respond. It could be a simple question like "Are you happy with your current job?" You should compile the answers in a spreadsheet, and come up with a conclusion. For example, if 3 out of 10 friends say "no", you could present this as "30 per cent of the respondents said they were not happy with their jobs".
- Use three online SMS services and do a comparative analysis of their pros and cons.

15.7 Let Us Sum Up

In this unit, you learnt about the various options available to a CR station in terms of incorporating telephony in their broadcast environment. You already know that use of telephones is absolutely necessary in a broadcast environment to ensure the participation of your audience, and in making your station more community-driven.

There are simple solutions like using a speakerphone with an external microphone. However, these solutions offer limited functionality and restrict you to just voice communication. Also the resultant quality of voice is not good enough when you use such solutions. The conventional telephone hybrid also falls in the same category. Though it is easy to use and provides better sound quality, one is still dependent on otherwise undependable PSTN lines, many of which are poorly maintained. Additionally, landline phones are not easily available in the hinterlands.

On the other hand, digital telecommunications technologies have not only made it possible to improve audio quality but also placed a plethora of possibilities at your disposal. If you use GSM modems, you can utilize SMS functionality. The availability of GSM networks is also superior to that of landline phones.

However, if you really want to optimise the telephony in CRS, you have to wholeheartedly embrace several of the newer technologies available for this purpose. A telephony server operating in the CRS can change the way members of the community participate in the programming and listen to its programmes. Though telephony servers are not very easy to configure, there are many ready-made solutions available that a CRS can put to use.

15.8 Model Answers to Activities

Activity 15.1

If you used the external mike to record from the speakerphone, you must have noticed as you bring the microphone close to the speakerphone, a humming or a whistling sound ensues. This is due to microphone feedback caused by electromagnetic interference. You will have to put it at a distance where the disturbance is the minimum. This is one of the drawbacks of this method.

Activity 15.2

While making the list of GSM modems, you would have come across some which are marketed by mobile phone companies like Vodafone, Airtel or Idea. These modems, though marketed by individual mobile companies, are usually manufactured by only one or two companies globally. Most of the GSM modems available in India are manufactured by a Chinese company called Huawei. So, it may be easier to look at the product list of Huawei itself, which is available on the company's website.

Activity 15.3

If you are planning to procure a GSM modem, it could be cheaper to look at some of the reselling portals like quickr.com or olx.com. You may find them cheaper there. As mentioned earlier, it is necessary to check if the modem you are buying supports voice communication.

Activity 15.4

While looking for online telephony services, you must have come across services like Skype, GTalk, Akiga, and so on. You must have also noticed that the sound quality of online phones are far superior than your normal landline or even mobile phone, provided your Internet connectivity is good enough. The bandwidth and speed of your Internet connectivity is the key to a good telephony experience.

While researching on the subject of Asterisk applications, you must have realized that there are many uses for Asterisk in a home or office setup. To understand the functionality of Asterisk in particular, and VoIP in general, please have a look at http://www.voip-info.org/.

15.9 Additional Readings

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Glossary

Unit 14: Audio Hardware and Field Recording

Microphone	It is basically a transducer that converts sound waves into electrical waves.
Audio Recorder	It is a device that, with a microphone connected to it, records sound as audio files.
Headphones	These are instruments that help you monitor audio that you are recording or editing.
Audio Mixer	It is a device that helps channel different audio inputs, and helps you balance, sweeten and output to a recording device
Impedance	As the word itself suggests, it means resistance offered to the flow of sound.
Frequency Response	This is a microphone's capability to receive high and low sounds.
Omni-directional Microphone	It is a microphone that can pick up sound from all directions.
Uni-directional Microphone	It is a microphone that can pick up sound only from one direction.
Bi-directional Microphone	It is a microphone that picks up sounds from the front or the rear but does not respond to sounds from the sides.
Solid State Cards	These are chips that store information in EEPROM flash memory embedded inside them.
RCA	Adapted from the name Radio Corporation of America, it is a plug and a jack designed for use with a cable for both very low and very high frequencies.
XLR	Adapted from the Canon plug X, Left and Right, it is the universally used connector for a balanced audio output.
Phono Jack	It is a type of TRS jack. There are two types, namely the mono jack and the stereo jack. Just 'phono' refers to the ¼" size. Mini-phono generally refers to the 1/8" jack.
Sound Card	It is a peripheral that is connected to a computer to edit and playback audio.

DAW	It stands for Digital Audio Workstation. A computer one can use to record audio in a studio or even use for post-production of radio programmes.

Unit 15: Audio Hardware and Field Recording

FOSS	It stands for Free and Open Source Software.
OS	It stands for operating system, which starts up the computer and provides basic functionality.
GNU	It is a UNIX like computer operating system developed by GNU Project.
GPL	It stands for General Public License, one of the most popular software license used by the open source community. There are currently three versions of the license available.
Linux	It is a free and open source computer operating system used extensively in the server segment.
UNIX	It is a free and open source computer operating system based on which many operating systems have been built, including Linux and Apple's OSX.
Proprietary	It is a type of software license which is not free and of which users are liable to pay the license holder for its usage and distribution.
Distro	It is an abbreviation for the word **distribution**. Linux has many flavours, like Ubuntu, Fedora, Debian, and Mint. All these flavours are known as distros.

Unit 16: Telephony for CR

PSTN	It is the abbreviation for Public Switched Telephone Network—a network that is generally used in landline phones.
GSM	It is the abbreviation for Global System for Mobile Communication.
CDMA	It is the abbreviation for Code Division Multiple Access. The other format is TDMA, which means Time Division Multiple Access.

Telephone Hybrid	It is a device that can route voice from the PSTN line or a landline phone to any sound device like mixing console or a speaker system.
GSM Dongle	It is a USB device that can modulate and de-modulate GSM data.
VoIP	It is the abbreviation for Voice Over Internet Protocol. To make it simple it is name for Internet based telephone system.
IVR	It stands for Interactive Voice Response systems, used generally by the service industry for receiving customer calls.
Asterisk	One of the most popular server software for telephony, it can also handle EPBX functionalities apart from IVR.

CEMCA

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Certificate in Community Radio Technology

5

Audio Post Production

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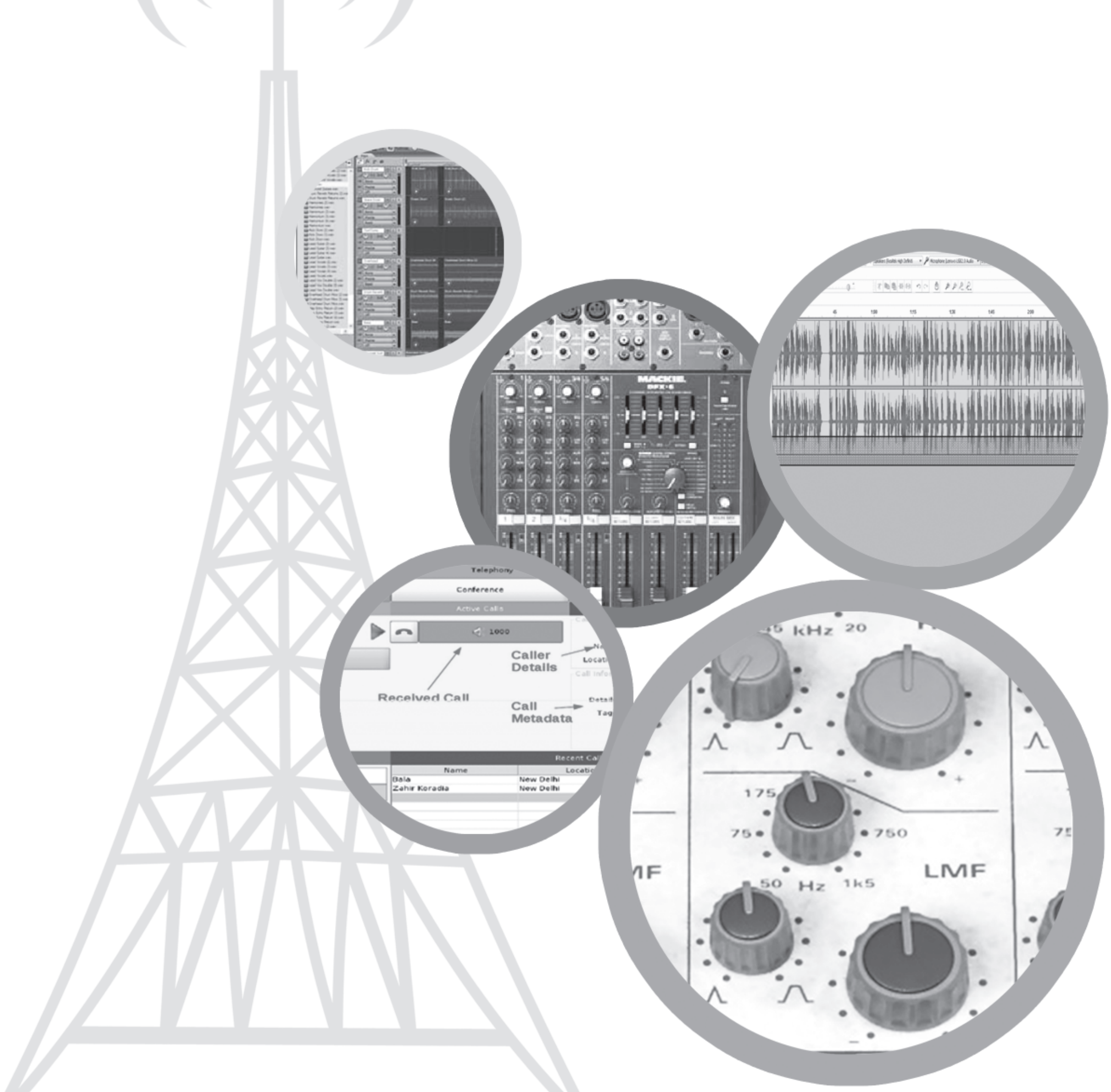
Course - III
Community Radio Transmission: System & Technology

Module: 5
Audio Post Production



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Certificate in Community Radio Technology

Courses	Modules	Units
Course I: Understanding Community Radio (3 Credits, 90 Hours)	**Module 1** Community Radio: An Introduction	**Unit 1 :** Community Radio: Concept and Evolution **Unit 2:** Context, Access and Equity **Unit 3:** Community Radio: Policy Guidelines **Unit 4:** Technology for CR: Guiding Principles
	Module 2 Setting up of CRS	**Unit 5:** Components of CR Station **Unit 6:** Radio Waves and Spectrum **Unit 7:** Basics of Electricity **Unit 8:** Power Backup and Voltage Stabilisation
Course II: Community Radio Production: System & Technology (5 Credits,150 Hours)	**Module 3** Studio Technology	**Unit 9:** Basics of Sound **Unit 10:** Analog and Digital Audio **Unit 11:** Components of the Audio Chain **Unit 12:** Studio Acoustics
	Module 4 Audio Production	**Unit 13:** Audio Hardware and Field Recording **Unit 14:** Free and Open Source Software **Unit 15:** Telephony for Radio
	Module 5 Audio Post Production	**Unit 16:** Sound Recording and Editing **Unit 17:** Mixing and Mastering **Unit 18:** File Formats and Compression **Unit 19:** Storing and Retrieval
	Module 6 Studio Operations	**Unit 20:** Good Engineering Practices for Studio Setup **Unit 21:** Studio Equipment: Preventive & Corrective Maintenance **Unit 22:** Content Distribution: Alternative Mechanisms
Course III: Community Radio Transmission: System & Technology (2 Credits, 60 Hrs)	**Module 7** Radio Transmission Technology	**Unit 23:** Components of Transmission Chain **Unit 24:** Components of FM Transmitter **Unit 25:** Antenna and Coaxial Cable **Unit 26:** Propagation and Coverage
	Module 8 FM Transmitter Setup	**Unit 27:** Transmitter Setup: Step-by-step **Unit 28:** Transmission System-Preventive and Corrective Maintenance **Unit 29:** Transmission Setup-Good Engineering Practices
Course IV: Technical Internship (2 Credits, 60 Hrs)	**Module 9** Practical Internship Handbook	**Section A:** Introduction **Section B:** Activities to be Conducted During the Practical Internship **Section C:** The Internship Journal and Self-Assessment Paper **Section D:** Assessment of Internship **Section E:** Appendices

Video in the Module:

1. **Sound recording & editing**
   By Ramnath Bhat
2. ***Audio Formats & Compression***
   By Ramnath Bhat

1. http://tinyurl.com/ohcffan
2. http://tinyurl.com/nhpypz7

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About the Module

Module Description

A radio station is known and identified by its sound design. From signature tune to jingles and from live announcement to recorded programmes, the production of sound is one of the most important aspects of a radio station.

In a typical radio station a sound recordist is as critical and important as a musician, singer or a speaker, even though the listeners hardly know him. The sound recordists have been the unsung heroes of radio stations. But, in the recent years, especially in the community radio sector globally, there is a trend to identify sound recordist and recognise the work put in by them.

From the rapid transition of analog to digital sound technology, the job of a sound recordist has undergone a formidable change in the recent years. Today, sound recordists are accomplishing task in much shorter time as compared with their counterparts in the analogue era. At the same time, the expectations from a sound technician has increased multifold with the ever expanding horizon of sound technology. Currently, the sound technologist need to be on their toes to keep up with rapidly changing concepts and tools.

In a community radio station, the job of a sound technician is an ideal mix of conceptual clarity, practical knowledge of tools and creativity. You will discover this aspect as you go through this module in theory and practice.

Module Objectives

This module is designed to equip a community radio technician with basic sound production concepts, tools and skills. After learning this module a learner should be able to:

- Carry out studio and field recording
- Edit a sound track
- Mixing sound in multiple tracks
- Mastering sound after noise removal, frequency adjustments in a desired audio format
- Convert sound from one format to the other
- Store sound files in different mediums and retrieve them as per requirement

UNIT 16

Sound Recording and Editing

Structure

16.1 Introduction

In previous Units, you have understood the basics of sound, as well as an overview of the field equipment you use for audio recording in the field, as well as in the studio. You have also learnt about file formats, microphones and related equipment, and the concepts of digital and analog audio.

In this Unit, you will build on this understanding by taking the first few steps towards recording audio in the field and the studio, and towards editing and adding effects to the edited content.

An important concern: there are thousands of different kinds of field recorder units and models available, and more keep appearing every single day. Similarly, computer operating system versions keep changing, and the software we use for recording and editing audio on a computer often changes. To give a very specific examples; this unit will be rapidly obsolete, it would become outdated almost as soon as it is published. Therefore, we are going to talk about the key controls and functions that are shared by most field recorders and computer recording and editing systems (often called Digital Audio Workstations, or DAWs). You will need to use this Unit along with user manuals and resources specific to the device or software that you are using in order to understand the specifics of that instrument or software.

16.2 Learning Outcomes

After working through this Unit, you will be able to:

- present the recording process in a block diagram
- describe graphical output of recording (in editing software)
- analyse the concepts of single and multi-track recording
- describe the process of audio level adjustments and balancing
- discuss the concept of audio editing and the tools we use to achieve this
- explain the meaning of digital signal processing and related effects as applied to audio

16.3 What is Sound Recording?

When we say we are 'recording audio', we are essentially referring to the act of capturing sound and then storing it on a medium, from which we can recover and play back the original sound at the time of selecting.

In this section, we are going to take a closer look at two types of sound recording: field recording and studio recording. Many of the concepts and basic ideas underlying both types of recording are the same, but as different devices are used, they become slightly different, and the way we adjust some of the settings are likely to be different.

Additionally, in this day and age, virtually all recording is digital. Analog recording has almost vanished. Our discussion, therefore, will proceed on the assumption that our audio is stored and utilized on digital devices and on media that support this.

16.3.1 The concept of recording audio

By the term 'recording audio', essentially we are talking about four sub-processes that together result in a successful and accurate capture of a sound that we can hear. These four processes are:

1. **Using a transducer to convert the audio energy generated by a sound into an electrical signal:** A transducer is a device that converts one form of energy into another. In our case, the transducer of choice is the **microphone**, which converts audio into electrical form, an audio signal essentially, the electrical form of the acoustic energy, which corresponds exactly to the frequency and amplitude of the original sound(s).
2. **Transferring the audio signal to a recording device:** The audio signal is usually routed through cables to a device that houses the recording medium. In this field, the device is the recorder unit itself, which usually has a slot or housing for the recording medium like a hard disk, an SD card, or a similar item, and the cable is the wire that connects the microphone to the recorder unit. Similarly, in the studio, there is a cable connecting the microphone to the computer in addition, in some cases of a mixer unit, multiple mics or source of units are connected.
3. **Conversion of the audio signal to a digital stream:** As we have previously seen in the Unit on analog and digital audio, modern audio signal processing supposes the conversion of the analog audio signal generated by the microphone to a digital form for storage. This process is called A/D conversion (analaog-digital conversion), and is carried out in a field recorder within the recorder itself. In a DAW, this may be carried out within the sound card installed within the system or in an external breakout unit that comes as part of the sound card, or even in the mixer unit itself, if the mixer is digital.
4. **Storage of the digitized audio:** This is the final stage of the recording process, and involves storing the binary data generated by the A/D convertor on the storage medium. In a field recorder, this is likely to be flash (or EEPROM) storage of some kind either as built in solid-state memory, or an SD (Secure Digital) card, or a CF (Compact Flash) card. In a

computer, this is likely to be a magnetic storage disk also known as a Hard Disk Drive (HDD) or a Solid State Drive (SSD), which is also a form of flash memory.

Dear learner, by this time you have got some ideas on sound recording and its four processes. Here you can watch a video, which will help you to comprehend the concept in a better way. The video is on 'Sound Recording and Editing'. This video will also help you to explain the concept of audio editing, which is incorporated in this Unit at section 16.5. To go through the video, you may visit http://tinyurl.com/nhpypz7.

16.3.2 The concept of audio levels

Did you ever experience loud sound, that could harm your ears? Loud sound can be very painful and can actually cause physical damage to your ears, including permanent deafness, if you are exposed to it for too long.

Why does this happen? At its simplest level, this is because your ears can take a certain loudness of sound and no more. Beyond this, it overloads the sensory apparatus of your ear and instead of a signal that goes to your brain, it becomes pain.

At the other extreme, if the sound you are hearing is very low, you will not be able to make out the sound at all. Even if you strain your ears, you will get nothing useful that you can understand.

In exactly the same way, every audio apparatus that we use has an upper limit to the sheer volume of sound that it can be exposed to. If sound is beyond this limit, the apparatus will not be able to perform well in its function of transduction or signal processing, resulting in a recorded audio, which wll not be a trustable reproduction of the original sound. And, just as the extremely low sound cannot be heard well by your ears, an extremely low sound will result in a very poor signal that cannot be recorded accurately.

This means, that for every audio apparatus that we use, there is a particular level to which we have to keep adjusting the audio input to, so that we may get the best possible recording. This is achieved by creating a measure of the level of input, which we can see as we record the audio. On most devices, the physical representation of this measure is in the form of a **Volume Unit (VU) Meter**. On digital devices, this is usually presented as a pair of moving bars against a calibrated scale with the movement of the bars linked to the incoming audio level. The level of the audio is either controlled automatically by the device's circuitry, or there is a provision of a pair of buttons that let you raise or reduce the input level in order to keep the levels at an appropriate setting.

Audio levels are measured in **DeciBels** (or **dB** for short), a relative measure based on a logarithmic scale. As a rough measure, each change of Six dB represents a doubling or halving of the input sound; a sound registering at 6 dB is twice as loud as a sound registering at 0 dB, and half as much as one at 12 dB. As a convention, VU meters show 0 dB at one end, usually the right in horizontal meters and the top in vertical meters, and negative dB values before that. The understanding is that 0 dB represents the maximum audio level that the instrument can accept without distorting it , that is, recording or processing it inaccurately, and the levels below that represent a percentage of this maximum value. You will find VU meters on any good field recorder, mixer unit or as part of any audio software that lets you record audio.

As a general rule, on digital VU meters, it is a good practice to keep the levels between -12 dB and -6 dB, with the odd loud sound going up to -3 dB. Never let the level reach 0 dB.

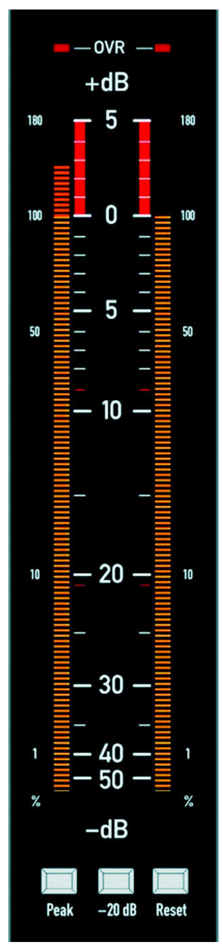


Figure 16.1: *A typical digital VU meter. Aim to keep the audio between the -10 dB and the -5 dB mark, with loudest noises not reaching the 0 dB mark. VU meter image; Source: http://en.wikipedia.org/wiki/File:PPM_IEC_268-10_I_DIN.jpg; CC BY-SA*

16.3.3 The recording process

We can now look at the series of steps that we follow to make a recording.

Step 1: Connect up the recording equipment

Microphone needs to be connected to the appropriate sockets on the recording equipment, using the appropriate and compatible connectors. Care must be taken to ensure that the output from the microphone is physically compatible with the recording equipment. Some recorders can only accept signals from powered, usually condenser microphones. Others will accept only unpowered, usually dynamic microphones. If there are control surfaces like mixers or sound card breakout boxes in between, they have to be connected and switched on. The recording medium must be in place with adequate storage space to accept the estimated duration of incoming audio. Power sources must be checked to ensure a continuous and assured supply during the recording. In the case of a field recorder, this means inserting and checking battery cells, in the case of a DAW and related equipment, this means power supplies, adaptors and relevant battery cells, as the case may be. An audio monitoring device, preferably headphones should be attached to the recorder units, for the recordist to monitor the audio while recording. Some devices may also have various sensitivity settings for connected microphones. This will need to be set as per the specific microphone connected and should be pre-tested.

Step 2: Position the microphone in front of the audio source or speaker

The audio source may be an instrument or a person. In a previous Unit, you have already seen the principles of good microphone position. The primary concern is to place it, where extraneous noises will not hit it and where streams of wind caused by the instrument or the person’s breath will not hit it. If there are multiple sound sources and multiple microphones, it becomes doubly important to position the microophones in a way that they capture only the sound they are dedicated to, so that we may have an easier time of adjusting the relative levels of each of the different sources.

Step 3: Check the audio levels

Most audio equipment, whether in field or studio will have a preview mode, where you can make the device recording ready, but do not actually start recording. In many field recorders, this is achieved by pressing the record button once with a second press activating the recording process. The record button is usually the one marked with a round red circle. In software records on DAWs, there may be a software button marked with the same symbol or a menu option that lets you put the system in a preparatory mode. The preparatory mode lets you view the current levels of audio input on the VU meters. It is good practice to make each speaker or instrumentalist speak or play in turn, so that we can ensure that all of them register at roughly the correct place on the meter for good quality recording. If the level is not correct, this may necessitate changing the position of the microphone or adjusting a control on the mixer or software interface to bring the audio to the correct level. Sometimes, it may also mean asking a speaker to speak more loudly or softly.

Step 4: Commence recording

As noted, this may involve pressing a given physical or software button once or a given number of times. Most recording units will also have a visual indication that recording has started. This may be a black or red colour dot or circle that appears on the screen display or the commencement of a time counter (usually in the hh:mm:ss format); or both.

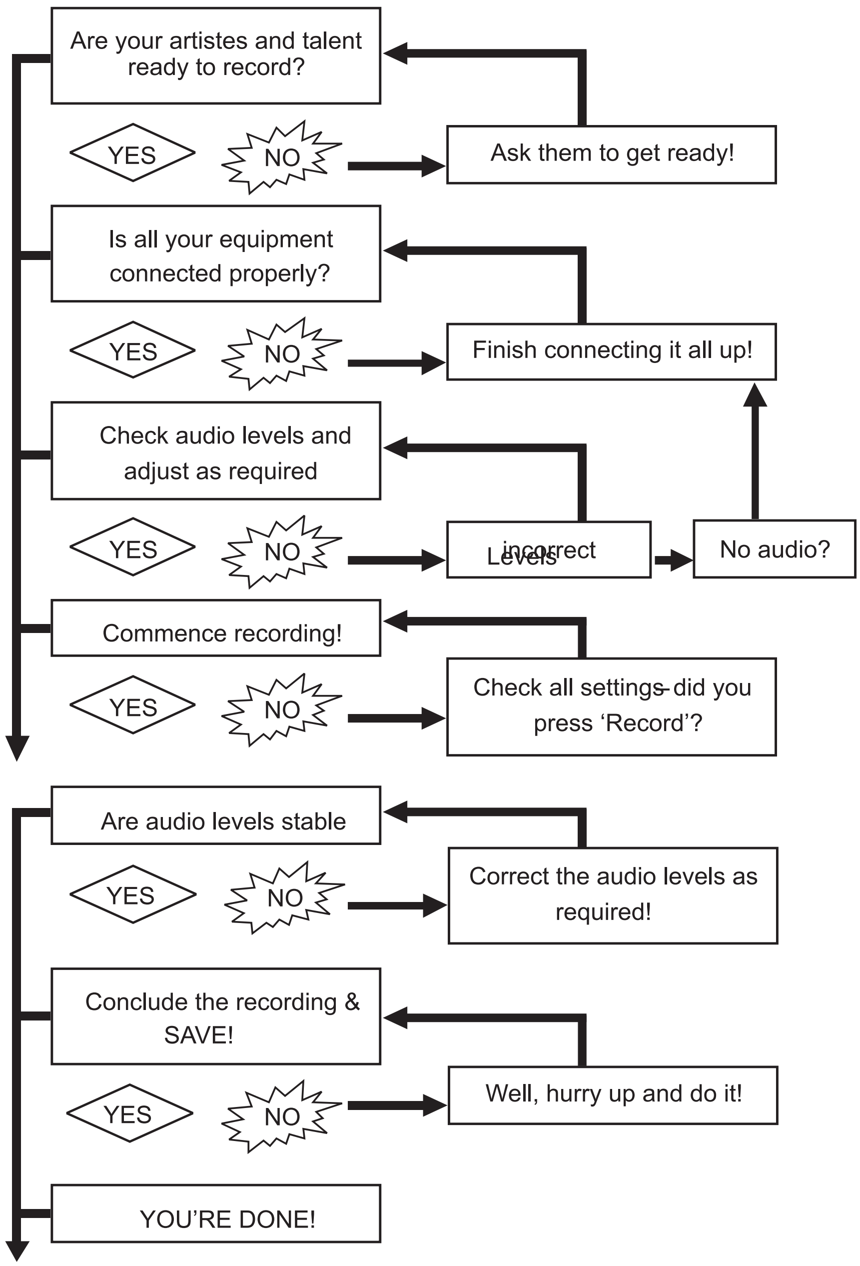
Step 4: Monitoring and adjustments during recording

An experienced recordist will listen over headphones during the recording and keep a hand on the level controls in order to adjust for sudden changes in loudness caused by someone leaning closer to a microphone, or raised voices impulsively. Where there is a mixer, this adjustment may be made using the faders on the mixer. An experienced recordist will be able to adjust on the basis of what he or she is hearing on their headphones, which will be set in advance to a constant level the recordist is used to. Many recordists will then not feel the need to look at the level meters at all. In some cases, where pop or blow has disturbed the audio, or if there is a lack of clarity in enunciation, or an external noise has overshadowed the audio, vigilant monitoring will let you identify whether the recording needs to be interrupted, or the last sentence needs to be spoken again.

Step 5: Conclude the recording and ensure that the recording has been saved

In most cases, stopping the recording involves pressing the STOP button (a button marked with a black square) or the RECORD button once again. Usually, when recordings are concluded, it will take the device a couple of seconds to preserve or 'save' the data onto the recording medium. In computerized DAWs, this may not occur till you physically ask the computer to 'save' the recording: this may be selected from the menu options available or done by a combination of key presses. In most Windows based computers, the key press will be (Control + S), that is, the S letter key is to be depressed with the CTRL key already depressed. Computers may also ask you to give a name to the file and choose where to store it on the computer. In most portable audio recorders, the name will be assigned by default as per the recorder's own naming system. It is always worth playing back the recording briefly to ensure that all is well.

Graphically, this may be represented as a flow chart like this:



Activity 16.1

If you have access to a professional or semi-professional field recording unit, do this activity with that unit. Alternatively, you may conduct this with a recording application on your mobile phone or with a microphone connected to your desktop computer or laptop, using any recording utility on the system.

(For example, Windows Recorder on Windows XP OS.) Decide a simple theme for a short three minute interview. Good examples would be: My dream job or An issue I feel strongly about. Ask a friend to help. Discuss the theme with him or her and develop a set of questions that you can ask. Then, follow the process outlined in the flowchart earlier in this section, and conduct and record a short interview on the selected subject.

16.4 Single and Multi-track Recording

16.4.1 Single track recording and multi-track recording

Let us first understand the difference between a **track** and a **channel.** In a previous unit where you have learnt about stereo sound, you must have understood the concept of separate channels for left and right audio streams. A **channel** in the sense we mean it here, not to be confused with TV channels or the kind that need to be tuned on a radio, is a discrete audio path that denotes audio to be played back over left, right, or both monitors equally or in a specific proportions.

A **track** on the other hand is the composite net result of a recording from a specific source or sources. In a field recorder, as per our previous examples, we may have many sources but we combine them all by positioning them in front of our microphone or by using a field mixer into a single track.

It must be obvious that when we record on most field recorders, we can only record and hear one track at a time. If we have multiple sources together, we have to put them all on the same track and find a way to position them in front of a single microphone, so that everything sounds reasonably clear, or use a field mixer to mix multiple microphones and give a single output that goes onto that one track. It is very unlikely that you will be able to use the second option.

Figure 16.2: *Multiple sources recorded on a single microphone, resulting in a mono track. The squiggles are the graphic representation of the audio also known as the waveform display of the audio*

The important thing to remember is that a track may be in mono or in stereo. As a matter of practice, most recordings are made as mono tracks, whether it is in the studio or on the field. It is only after editing and finalization that stereo enters the picture. When we are finished with arranging our various audio sections, we decide what should be heard over the left and right monitors and separate these sounds into two discrete channels, left and right, in the final finished track.

There are, of course, some recorders with in-built microphones which are capable of recording audio in stereo right away. The microphone to the left records the sounds from the left, and the microphone to the right records sounds from the right. But even with such recorders, it is good practice to do mono-recording, if possible; there will be settings that allow you to do so.

In a studio, however, we can have a little more flexibility, since things are more in our control. We can position singers and instrumentalists as we like and we can even build little enclosures to separate them from one another. This means, we can use multiple microphones in the same space and position them so that they pick up different sounds. For example, Microphone 1 for the vocalist and mic 2 for the tabla player accompanying him or her. It is obvious that recording these sounds separately, is logical to next step, so that we can adjust and arrange each sound separately. This is why most audio editing or recording softwares found on DAWs will allow you to provide several discrete sound inputs to the system, each of which can be recorded separately on a different track of the recording software. This is called **multi-track recording**.

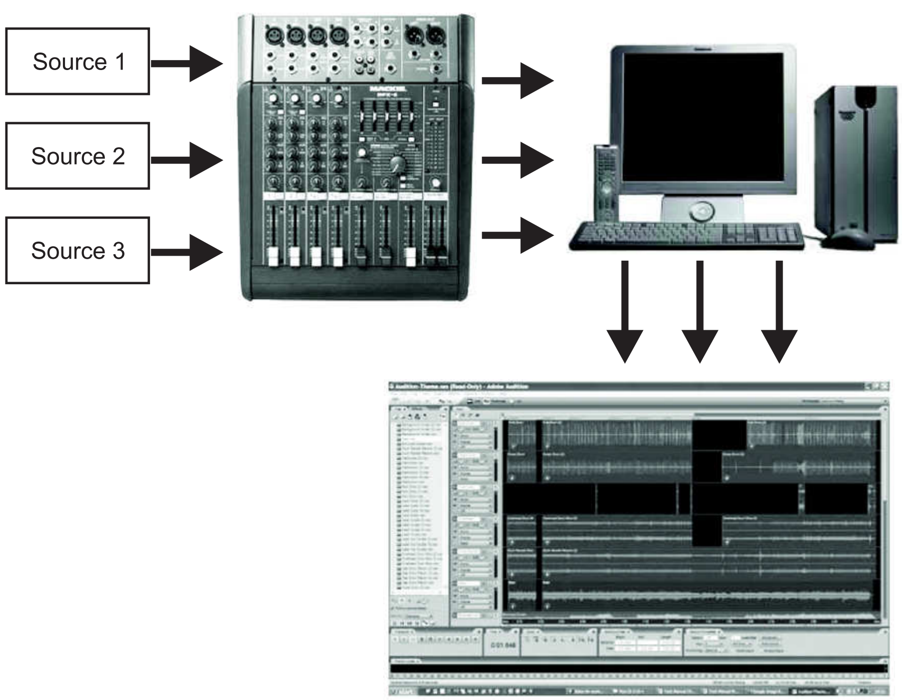


Figure 16.3: *Multiple sources recorded through a mixer to a DAW, resulting in multiple mono tracks. This is called multi-track recording.*

16.4.2 Recording when listening to a reference track

One of the most important aspects of being able to record on multiple tracks, simultaneously in the studio is to be able to listen to the previously recorded track(s), while recording (or 'laying down') a new track.

Consider a situation where the members of a musical troupe cannot come together at a common time to the studio to record or where the studio is too small to accommodate the whole group together. How do we record their songs?

The solution is provided by multi-track recording, where we can record the musicians one by one with each listening to the previous tracks while recording their own. Naturally, this calls for a considerable amount of practice within the group, so that everyone can play or sing their parts perfectly. The previous tracks are played back to the recording artiste over a pair of headphones as part of what is known as a studio monitor or foldback system. ('Foldback', since the system returns audio to the originating space, or 'folds' it back.)

The usual practice in these cases is to first decide a basic beat or tempo for the song, which is then recorded as a beat on the first track or generated by the recording system as a 'click track' – a track with tones generated at regular intervals, like a ticking clock. The percussion instrument players then come in and record their instruments by listening to the click track; the instrumentalists come in one by one to add their tracks on top and the vocalists come in last, so that they have the benefit of listening to all the background music at once as they sing. There are many, who prefer to record in a different order and that's perfectly okay.

This has obvious benefits in a non-music situation as well. Think of a phone-in programme, where people are calling in on the studio phone line while the guest and anchor are in the studio. Since, the audio is coming from different source devices, they are likely to require different adjustments in order for them to match each other in terms of quality and audio level. This can be achieved by using a mixer unit, where both feeds can be on separate feeder channels. It can also be used by recording them in to two separate tracks on the recording software with the adjustments pre-applied to the respective tracks by the software.

Activity 16.2

Assume you are a recordist in a music studio. You have to set up a recording of an acoustic popular music group that includes the following four individuals, who will come in at different times to record their sections:

1. The vocalist
2. The lead guitarist
3. The drummer
4. The flautist

Can you work out the order in which you will record the four in a multi-track setup?

16.5 What is Audio Editing?

Now, that we have a basic understanding of the process of recording audio, it is time to look at the post-production process called editing.

16.5.1 The concept of editing audio

At its most basic, editing is a process of cutting out what we do not require and joining together the sections that we do in order to create a whole that makes sense and is worth listening to.

It should be understood by now that making a radio programme involves a process of recording several different components like interviews, sound effects, music, narration and so on, at several different points in time. Naturally, at some point we will have to decide what to keep, and in which order. The process of refining and ordering our audios is what we refer to as **audio editing**.

In some ways, editing begins at the time we write our scripts, since we are already beginning to decide what to keep and in what order we are going to present our information or ideas. Some others, however, feel that it actually begins at the point where we have completed most of our recordings and are beginning to log and review our recording to decide what the important bits are. Both are correct, in many ways,. The specific process that we will discuss in this section is the process we undertake once we have our recorded material in hand, and are physically in a position to sit before our Digital Audio Workstation. But, before we go further, let's understand the four key steps that audio editing is made of.

16.5.2 The process of audio editing

Step 1: Transfer, import and categorization of audio

Above all, audio editing and editing in general is a matter of organization. So the very first process we undertake is the process of bringing all the recorded materials together and organize them. We are, of course, assuming that you have been able to record what you want, keep it safe till now; and keep notes about your recording in a way that you can locate what you want.

When it comes to field recordings, it is selecting the recordings or tracks that we want, and **transferring** them to the DAW system. It is good practice to keep all the recordings for a given programme in one folder on the computer we are using for the purpose and keep field recordings in one sub-folder, studio recording in another, and music and sound effects in a third. Then we will transfer our field recordings now to the appropriate sub-folder within the one for the programme that we are about to create.

The studio recordings, similarly, will need to be copied from wherever on the system they are or from a different system, if another system has been used for that recording, into the appropriate sub-folder. Music and sound effects, if we have gathered some already, go into the third folder. Needless to say, we may continue adding items to all three folders as we progress.

Once we have all these items in their respective folders, we will need to open a new file in the audio editing software, give it an identifiable name, and save it within the programme folder that we have previously created. This editing file is often termed the **session file**. We will then tell the editing software where all the relevant clips that we would like to use are – a process usually referred to as **importing the audio**. In most softwares, this is achieved by the command: **File>Import** on the main menu. In some cases, this may be done by simply selecting the relevant clips, and click-dragging them to the clips window of the software. (Click-dragging is the process of pressing the left button of the mouse over the clips while all the clips are selected and simply moving the mouse over to the target window we would like to transfer them to, then letting go of the mouse button.)

If you have done this correctly, you should now see the name of your programme file somewhere at the top of the main editing window; and all your audio clips in a window somewhere in the main interface of the editing software.

Step 2: Placing the clips on the timeline

Most audio editing softwares have a part of the interface known as a **timeline**. The timeline is the space where you may arrange the clips in their chronological order, that is, in you will listen to them in order and layer them in tracks, so that it becomes easier for you to decide which audio overlaps the other portion of the audio. The usual convention is for tracks to be arranged vertically, so that you have a series of tracks from top to bottom and for clips to be arranged horizontally within each track in the order of play. The clips on a given track will usually be arranged one behind the other, edge butted up against edge, so that there are no gaps between them rather they are like the carriages in a train. This process is called **assembly**.

A vertical moving marker indicates the portion of the timeline that is currently being played out for you to hear. It is often called the **play head**, after the old convention of the magnetic head over which tapes once used to pass. (It is commonly called as the **cursor**). Note that all clips across the various tracks that are currently under the play head will be heard simultaneously. The play head usually moves from left to right, with a scale at the bottom or top of the timeline indicating the present position of the playback.

The other convention that you need to know is the distribution of your audio across tracks. Typically, Tracks 1 and 2 will be used for voice, Tracks 3 and 4 for music and Tracks 5 and 6 for sound effects and ambient sound. This arrangement lets you to keep all your material organized, besides letting you make adjustments between clips of a similar nature. You may change this as you choose: what is important is that you have a standard procedure. If your edit is simple, you may like to reduce this to four tracks, with the first for voice, the second for music; the third for sound effects and the fourth for ambient sound.

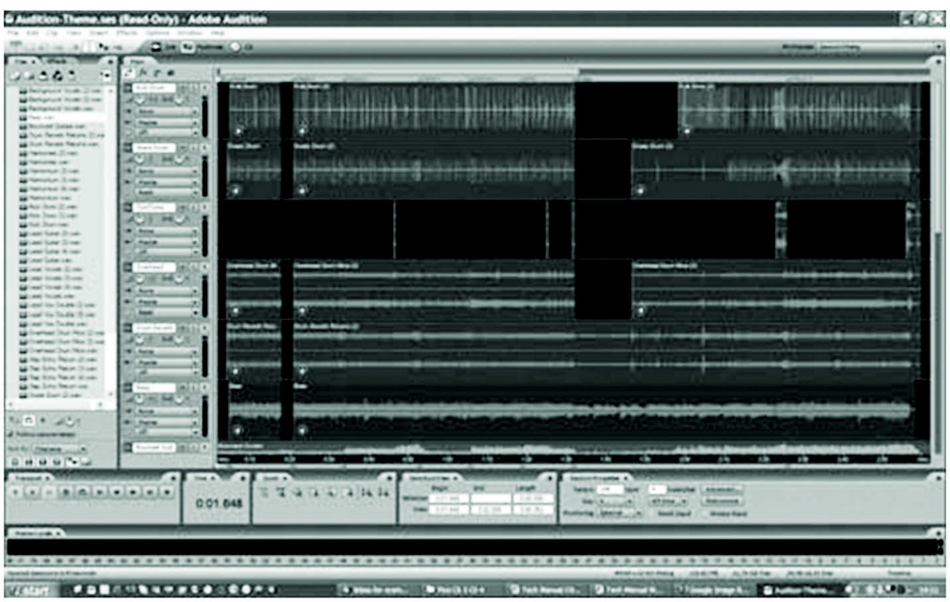


Figure 16.4: *The editing interface. Note the source clips in the window to the left; the name of the editing session file at the top; the timeline with the various tracks arranged vertically, and the audio clips placed on the timeline.*

Step 3: Cutting and reordering

Now, comes the business of actually removing the sections of audio we do not wish to retain. All editing software gives you the tools to **cut** audio at a particular point; **copy** audio from point to point; **move** audio from one point to another; and **paste** audio that you have cut or copied from another point. These four commands are usually enough for what we have to accomplish next.

If you have placed your audio on the timeline as per your script, the audio should now represent more or less the flow of ideas that you originally imagine within the programme. The general system is then to listen to the audio from the beginning, while referring to your notes on what to keep out of each clip. Whenever you reach a point, where you need to excise a portion, you place the playhead at the beginning of this portion (this, to the left margin), and make a cut. You then move the playhead to the end of the relevant portion (to the right margin of the section) and make a second cut, like cutting out a section of ribbon in the middle of a larger piece. This will leave a gap in the audio on the timeline. You then simply select all the clips to the right of this gap and drag them leftwards to close the gap. Repeated systematically across the entire timeline you will have a series of ordered clips, which contain precisely the audio you wish to retain.

Before we progress to the next step, it is worth remembering some key concerns that we should keep in mind:

a. **Cadence and rhythm**: Every person has a way of speaking, including a pattern of breathing when one speaks that gives our speech a characteristic set of pauses and spaces. You may like to cut out irrelevant sections of the audio, unwanted interruptions in the ambient audio (barking dogs, a telephone ringing, a slamming door), and the long silences which interrupt the flow of the audio. But, if you cut too much, the speech will lose its natural rhythm and become staccato and unnatural, not to mention unpleasant to hear. Similarly, the entire programme should present the things you wish to include at a particular pace that is neither too even nor too rushed. In many cases, this pace will wax and ebb, giving the programme itself a character.

b. **Cutting order:** Typically, one would start by cutting and reordering the voice tracks first; followed by the ambient audio linked to the voice tracks, then the sound effect tracks and finally the music tracks. This is because the core structure of the programme is usually decided by the spoken sections, so it makes sense to cut these first. Music is mainly used for mood and punctuation, so it makes sense to do this last, when the timing and order are more or less finalized. Not doing it in this order often results in wasted effort in re-doing adjustments and cutting over and over across all the tracks.

c. **Reinvention:** Presumably, the arrangement of your audio clips on the timeline reflects the flow of ideas and concepts presented in your original script. But, as you cut a programme, you will find that new linkages form between the materials and sometimes a whole new presentation of the story begins to appear. Be alert to this, and how it meets the purpose of your original script. Sometimes, being open to such a change can make a programme more dynamic and convey ideas in a better way.

Step 4: Finalizing the cut

If you have successfully made it this far, you should have the entire programme and all the components that you require within it, more or less in their final places. At some points, you would have made some preliminary adjustments to audio and created the relevant overlaps of audio that allow each section to flow smoothly to the next (**'transitions'**). This completed stage is called the **rough cut** of the programme. Your rough cut may be upto half or a third longer than the time envisioned for the final programme, leaving some scope for further refinement.

This is the time to preview the programme with others for suggestions and to test whether the programme can be understood in its current form and whether it is having the impact that you desired. Often, this may be the time to do another round of recording, in case something needs to be fixed or augmented. It may also be at times to strengthen your heart and admit that the programme is not making enough sense and redo the entire programme.

Once you have made these relevant additions or replacements to the rough cut, you are ready to undertake one final round of trimming and refinement, where you will adjust the clips to their final positions and lengths, remove any unwanted material that still remains, and even lose sections or sequences that are not completely relevant to the programme. The last is often a difficult process, as it is the most creative endeavour, which concerns programme length and broadcast schedules and often forces us to take harsh decisions with otherwise excellent material.

The last round of refinement should result in a programme with a timeline where everything left clearly belongs in the programme and where the various components are in the exactly correct positions they should be. This means the music starts at the exact instant it is required, and the sound effects synchronized as they should be. The product at this stage is called the **final cut** or simply **fine cut** for short. It now only needs to be **mixed** and **mastered** (see Unit 17) for the programme to be broadcast or distributed.

16.5.3 Destructive & non-destructive editing

In the early days of audio editing, working with the raw material on tape often meant that once edited, it became virtually impossible to recover the original audio clips unless you maintained multiple copies of each recording. Such editing is called **destructive editing**, since each change that you made irretrievable changed the recorded material itself.

This is where editing softwares and working with audio on a DAW are remarkably different. Editing in the older system often meant using the raw material itself, working with digital material means two things. One, that you can make multiple copies without fear of audio loss; and two, that when we place a clip on the timeline and make changes to it, we are not actually affecting the original clip.

Thus, when you make a cut on a clip placed in the timeline, you are not actually slicing off a section of the original clip forever: rather, you are telling the software that you want it to start playing the clip from the point forwards, Similarly, placing the clips in a particular order on the timeline merely instructs the software about the order you want the clips played in.

The safety of the original clips means they can be imported repeatedly into different programes, and retained in their original form indefinitely. Thus, **timeline based multitrack editing** on most audio editing softwares is also called **non-destructive editing**, as it does not affect the source materials in any way.

It should be noted here that most editing softwares also have a different mode, where clips may be edited individually rather than as we do on the multitrack setup. This mode is sometimes called the 'edit mode' – is **destructive**, in this, changes made to the clip are saved permanently, changing it forever. Edit mode or whatever it is referred to in your editing software of choice, should be clearly understood and used only in specific circumstances.

Activity 16.3

Practice these commands on audio editing software of your choice. If you have access to a computer, but do not have an audio editor installed, you can download Audacity from http://audacity.sourceforge.net/.

16.6 Equalization and Digital Audio Processing Equalization (effects etc)

Now that we have understood the basics of audio editing, there is one further concept that we need to be familiar with: the ways in which we can change the quality of audio and add some effects to the sound. (Note that this is not to be confused with the term 'sound effects', which indicates ambient sound items like dogs barking, or the sound of a door closing.). Let us start by looking at the adjustments we can make to audio quality.

16.6.1 Equalization

As you may remember from a previous unit, human beings can hear frequencies between 20 Hz and 20,000 Hz. Within these, the human voice tends to range between 500 Hz and 5,000 Hz. For practical purposes, we divide these audible frequencies into three groups: **Low frequencies** (LF), which cover the range between 20Hz and 500 Hz; **Mid Frequencies** (MF), which cover the range between 500 Hz and 5,500 Hz; and **High Frequencies** (HF), which cover the range between 5,500 Hz and 20,000 Hz.

Low frequencies are also sometimes referred to as **bass** frequencies and high frequencies as **treble**. You may already be familiar with the bass and treble controls on music systems. The bass control increases or decreases the level of the bass or low frequencies; and the treble control adjusts the level of the high frequencies. As every sound is usually a complex mix of various frequencies from low to high, adjusting these controls affects the amount you hear of a specific range of frequencies. This process of adjusting the relative levels of the frequencies you hear in a particular sound is called **equalization**.

In professional equipment, equalization controls are usually found on a mixer unit; or within the editing or recording software (where they may be present as a software controls). Typically, the equalization controls in professional equipment look like the ones in Figure 16.5:

Figure 16.5: *Equalization controls on a hardware mixer unit. The two knobs on top control LF and HF; and the collection of knobs below together adjust MF. Equalizer section image Source:http://en.wikipedia.org/wiki/File:Equaliser-section.jpg; CC by BYSA*

There are usually two knobs for the low and high frequencies. Since, the mid frequencies cover the human vocal range, there needs to be finer control over this range, and therefore, there are more than one knob. One knob controls the level of the mid frequencies *per se*. The second one called the **Q-Control** or simply 'Q' for short; controls the area within the 500 – 5500 Hz range that is affected most, by the first knob allowing a finer degree of control.

Between all the knobs it is possible too:

- improve clarity
- add bass to a thin voice and reduce the bass of a heavy voice
- make voices more audible against a noisy background
- emphasize or de-emphasize specific instruments or voices among a cluster of instruments or voices

As a rule, unless one is an advanced user and clearly understands the consequences of changing the equalization settings, one tries to record sound without any adjustments whatsoever except for basic audio levels. Equalization is applied at the editing stage to refine and polish the sound.

16.6.2 Digital audio processing (DAP) and effects

Digital Signal Processing refers to the manipulation of audio in its digital form, in order to introduce several types of variations and corrections to the audio. Where they once required special signal processing units that were distinct pieces of equipment in themselves, they are now routinely found as an integral part of digital mixers, and especially most editing software.

Among the many different types of processing that could be applied are:

1. Filters

Filters refer to a screening process that lets selected frequencies of audio pass through while restricting others. Thus, a **low cut filter** will sharply reduce the levels of frequencies below a certain limit within a specific sound (usually those under 200 Hz). Similarly, a **hi-pass filter** will let only high frequencies over a certain limit through. A **band-pass filte**r can let you adjust a precise range of frequencies say, the mid-frequencies to be let through while the HF and LF are sharply diminished.

2. Compressors and limiters

Compressors look for audio that is crossing a certain preset audio level limit, at which point they restrict or ‘compress’ the excess audio to stay within the prescribed limit. **Limiters**, on the other hand will sharply cut off the portion that exceeds the preset limit.

3. Clean up

While recording audio, we often record subtle background hums that come from fans, industrial equipment or even electrical wiring related issues. Even the Earth’s electromagnetic field sometimes registers as a background noise on unprotected cabling. Clean up processing can remove many of these intrusive presences. For example, the hiss often found on old tape recordings can often be cleaned up in editing software by applying a **hiss corrector**, which samples the offending frequencies, then subtracts it from the entire audio clip. Properly and skillfully used, you can make ambient noise vanish completely from recordings, but be aware that improper selection of the clean up areas can leave your audio sounding weak and toneless.

4. Effects

While the number of available digital effects now number in the hundreds and even thousands, there are relatively few which are commonly used outside the music industry. The most common ones are:

i. **Delay effects:** These include reflection effects with delays that mimic the reverberation (‘reverb’) of various spaces ranging from small rooms to concert halls, echoes on mountain sides and even the muffled ‘deadness’ of a padded cell. The effects controller usually allows you to set the precise delay time, allowing you to vary the effect precisely or use a preset that sounds like a given situation.

ii. **Chorus effects:** These make a single voice sound like several, by repeating the voice with minor delays and variations of tonality. The effect is of a chorus of several voices saying to sing the same thing.

iii. **Distortion effects:** Distortion refers to a range of sounds that change the shape or feel of the original sound to mimic the broken effect of exceeding peak audio levels, or of making the voice sound dry and robotic. **Flanger effects** and **‘wah-wahs’**, often used for musical instruments, fall within this category as well.

iv. **Telephone effect:** The technology used in older telephone microphones, as well as their built-in emphasis on mid-frequencies (in the interest of voice quality), give the voice an odd inflection that is characteristic of landline telephones. When rendering telephonic conversations for a radio programme, especially in dramatic situations, this effect mimics the audio quality of the telephone voice and with a subtle reduction in the level of one of the two voices, a realistic sense of someone speaking over a telephone line can be created.

Nowadays, in most cases, the effect is added merely by selecting the relevant portion of the audio and selecting the effect from a drop down menu. A set of controls then lets you adjust the various parameters related to the effect. When applied from a digital mixer, the effects section is generally activated by a specific button, after which the specific effect may be selected from a displayed list.

Lastly, an important concept to remember is the proportion of the original sound to the processed sound that we retain in the final mix that we make. Original audio – the audio as it was before the application of the effect is often referred to as **‘dry’ audio**. The audio after being processed is often referred to as the **‘wet’**

audio. Sometimes, adjusting the proportion of the two and retaining components of both can make the sound ‘feel’ much better to the ear.

Activity 16.4

Using Audacity as a point of reference, make a complete list of the possible list of effects available within the software. Write a short description of each effect.

Sound Recording and Editing

http://tinyurl.com/nhpypz7

16.7 Understanding the DAW and Editing Software (Integrated Vedio)

Now that you have a good understanding of the components of a CR station, please watch the *video ‘Sound Recording & Editing’ once again. You may also watch the video on studio recording hardware for related information*.

The video provides you a detailed step-by-step visual explanation of a Digital Audio Workstation (DAW) and the audio editing software installed on it. In this video, you will see the entire workflow involved in editing and completing a programme till the fine cut stage, including:

- Transferring field recordings into the system and importing them into the editing software
- Conducting a studio recording
- Laying all the audio materials on the timeline and executing an edit

Once you have viewed the video, complete Activity 16.5 below.

Activity 16.5

With reference to the DAW and editing software that you saw in the video, investigate at least three popular audio editing software available currently and compare them on the following parameters:

1. Cost
2. Base operating system required
3. Features
4. Reputation (you may have to read reviews on the internet to understand this)

Which would you select for your CRS, and why?

16.8 Let Us Sum Up

In this Unit, you have been introduced to the concept recorded audio, and understood the procedure by which we capture a recording. We have also understood the process of audio editing, and understood the key steps we have to take in order to successfully select and edit audio into a programme.

We have understood the distinction between tracks and channels, and the difference between destructive and non-destructive editing. We have also seen the primary editing controls that we use to gather and refine audio as part of our editing process from assembly to rough cut to fine cut.

Finally, we have understood the concepts of digital signal processing and the addition of effects to the recorded audio in order to manipulate and correct it as required.

16.9 Model Answers to Activities

Activity 16.1

This activity tests your ability to follow the entire process of setting up and conducting a recording.

For a topic like 'My Dream Job', possible questions could be:

1. Tells us about your dream job.
2. Why do you consider this your dream job?
3. Do you think you will have the opportunity to ever hold a job like the one you dream of?

Activity 16.2

In a mult-track recording situation, the recording preferably starts with the percussionist. The order in which the recordings should happen, therefore, are:

1. The drummer
2. The guitarist
3. The flautist
4. The vocalist

Activity 16.3

In Section 16.5.3, you have seen a list of common commands and shortcuts that can be used as part of your operations on a DAW. It must be noted that these commands are only indicative, and can differ somewhat from software to software; and especially from operating system to operating system. For example, the CTRL+X 'cut' command on most Windows based software's becomes a CMD(Command)+X operation on Apple computers. It is worth familiarizing yourself with the specific variation of the command that is applicable to the software and OS that you are working on as part of this activity.

Activity 16.4

The list of internal effects in the Audacity audio editing software is as follows:

Sl. No.	Effect Name	Description of Effect
1.	Amplify	This effect increases or decreases the volume of a track or tracks.
2.	Bass Boost	Boost the low frequencies selectively.
3.	Echo	Introduces a delayed repeat of the original sound
4.	Fade in	Slowly increases level of audio
5.	Fade Out	Slowly decreases level of audio
6.	FFT Filter	A general filter that allows selective amplification of frequencies
7.	Invert	Flips audio samples upside down to allow common sounds to cancel
8.	Noise Removal	Removes selected frequencies from the audio, once selected
9.	Phaser	Combines phase shifted audio with original signal
10.	Reverse	Reverses the audio clip, so that it plays back to front
11.	Wah-Wah	Copies the wah-wah guitar effect

Activity 16.5

As part of this activity, you will realize that there are a large variety of audio editing softwares available in the market, and as FOSS softwares on the internet. Each of them has their own advantages and disadvantages in terms of cost and functionality. Similarly, the specific editing software you select may be available for multiple platforms and operating systems, or may be limited to a specific OS. Audacity, for example, is available for Windows, Linux and Mac OSX. Audition is available only for Windows and Mac OSX.

When taking a call on which one will actually be the best for your process or CRS, you will usually have to consider all these factors, as well as other factors, like the OS that the rest of the team is most familiar with and the OS running on other computers in the CRS before settling on one.

UNIT 17

Mixing and Mastering

Structure

17.1 Introduction

In the previous Unit, you learnt about the concepts of audio recording and editing. You were introduced to the workflows involved in both processes, and the key commands and tools that are used to import, arrange and shape audio using an audio editing software.

In this Unit, you will build on this by understanding the skill of balancing and levelling audio, and getting the edited programme mix ready. You will also learn the process of exporting the completed programme as a single mixed file with a specific set of parameters.

As in the previous Unit, it is important to remember that there are a large variety of operating systems, audio editing software and editing setups/DAWs available, today. Though the specific details and commands may differ between each of them, the basic principles involved in both mixing and mastering are pretty much the same across each of them. Thus, it is more important for you to understand the principles and objectives of each of these processes, rather than the minutiae of the software commands that will execute each process, since those can easily be ascertained from user manuals and while you work with the software itself.

17.2 Learning Outcomes

After working through this Unit, you will be able to:

- explain the concept of multi-track audio mixing.
- discuss the need to match clip volumes and balance audio
- explain the concept of mastering and exporting a final output file.

17.3 Mixing

If you have successfully done your editing work to the fine cut stage, it means you will now have a session file here:

1. The clips have already been arranged on the timeline in their appropriate tracks (Voice on 1 and 2; Music on 3 & 4; and Sound Effects on 5 & 6 or whatever convention you have decided to follow).
2. The audio clips have been trimmed to their appropriate lengths (that is, we have only retained the portions of the recorded audio that we require in the programme).
3. Each clip is in the precise position on its track, where it is required with

the appropriate breathing space in the edit for the audio playback to sound natural and well paced.

4. The basic transitions have been executed with fade-ins, fade-outs, cross fades and other transitions already in place.

In this section, you will now understand three advanced procedures that need to be executed in order to finalize the audio, and make it ready to listen to: audio levelling, balancing and panning. Together, the three process let you **mix the audio**: adjust the audio levels of the various components and segments, so that we can hear the audio clearly comfortably, with our attention being drawn to the correct portion of the audio as required. Let us look at each of these processes in turn.

17.3.1 Levelling: The need to adjust clip levels

Audio levelling is the process of raising or lowering the audio levels of individual audio clips in order to make them all sound more or less of the same perceived volume.

But why do this at all? If we have recorded the audio keeping the audio levels in mind, then surely we have sufficiently addressed the issue already?

The answer is not that simple. Recording each individual item at the appropriate recording level may mean the clip itself has been recorded quite well, but that does not guarantee that the clips will sound good when you place them next to each other. Therefore, we have to undergo a second process **levelling**, in order to adjust the levels of the clips with reference to each other and to our programme level.

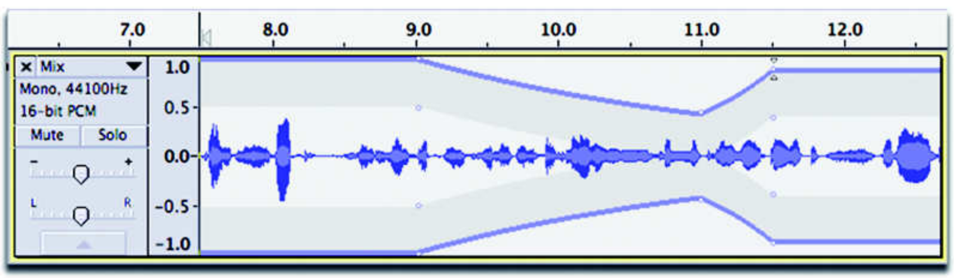
We need to do this so that:

- The clips transition smoothly from one to the other as we hear them, making the programme feel like one smooth whole, rather than the segmented composite it actually is;
- The clips can all stay within a certain audio level range, which will ensure that the audio does not distort by going outside the range, the equipment can handle (this will also ensure that we are able to combine the audio with the radio carrier wave for broadcast with no loss of quality).

Of course, the biggest reason we need to do this is so that our listeners can have an easier time of it, staying at a constant distance from their radio units rather than alternately leaning closer to hear better, and putting their fingers in their ears. If each clip were to play at a different level, it would make for a very awkward listening experience and would not let us concentrate on what was being said at all.

Naturally, it is important for us to still preserve some sections as relatively louder or softer than others. If people are naturally soft spoken, we need to keep their voices boosted, but still a shade less than the average voice on the programme. Similarly, if someone speaks in a booming, loud voice, we need to keep that slightly higher in level than the rest. Only then will the natural differences between the voices show up clearly. If we have to adjust all the voices mechanically to one level just by looking at the VU meter, this would be very unnatural. So one must use judgement and subjective hearing to make some of these calls.

Physically, the act of increasing or decreasing the level of a single clip is achieved in most audio editing software by one of two processes (many software allow you to do it both ways). By opening the property attributes of a given clip and increasing or decreasing the levels on a sliding scale, or by actually typing in the desired dB value in a box or by graphic interface. The graphic interface is usually in the form of a level overlay on the clip itself. Dragging the overlay line towards the bottom reduces the level below its current level. (Note that the same overlay usually lets you assign change points or nodes, and create fade in and fade out. But, what the graphical interface will usually not let you do is boost the levels beyond their current levels).



igure 17.1: *A clip on the timeline in the Audacity software. Note the graphical overlay that has been used to adjust the audio levels at various points in the clip in order to even out the perceived audio volume through its duration.*

17.3.2 Balancing: The need to adjust track levels

As we have already seen, a good and systematic audio editor tries to bunch similar types of audio into the same track(s), so that it becomes easier to edit a given type of audio. Having all the voice clips in Tracks 1 and 2, for example will save us from the bother of scrolling up and down in the timeline, while we are editing the voice segments of the programme.

There is another reason for this: once we have levelled the clips on a given track to a target value, having the same kind of audio on a track allows us to raise the volume or level of the track as a whole, affecting all the clips on the track together. Let us see why we would want to do this.

On the average, the most important part of an audio (radio) programme is the spoken word, because it is only through the words that we hear on the programme that ideas and concepts become clear. (The exception is probably instrumental music based programmes where words are not required to the listeners to appreciate the programme. But spoken words will be required in some point if not several times to introduce the artiste and the show).

Though, we will include variety of audio besides spoken words, but we will always favour the spoken word in most programmes in terms of audibility and clarity. Therefore, we need to adjust the level of the music track in such a way that the music is heard, but does not overpower the voice. Similarly, sound effects need to be heard in as natural a way as possible, but without obstructing the clarity of the spoken word. A thunderclap may be an important part of setting the scene in a dramatic production, but must be timed to a gap in the dialogue, with rumble of the thunder extending under the next stretch of dialogue without preventing the listener from hearing the dialogue itself.

The ability to adjust track levels as a whole is especially important in multitrack music recordings, where the ability to adjust the percussion (drum/tabla) track against the vocal track and the key instrumental (harmonium, veena, violin/sarangi) tracks will make a difference between a good sound track and a confused one where you may not be able to hear the lyrics of the song clearly, or hear the soloist play his or her piece.

By combining our individual adjustment of clip levels (levelling) with the raising of lowering of track levels as whole, we will eventually be able to achieve an ideal combination of levels that not only lets us hear everything with the emphasis that we desire. This adjustment levels across tracks is called **balancing** and as we shall see balancing along with the process of panning, is the core in the act of mixing audio.

As in clip levelling, there are controls that allow you to adjust the level of the track as a whole. These will usually be in the form of a set of controls on the far left or far right of the track display. The tools may include a window, where you can type in a physical value (in dB) for the adjustment required, or a software knob that can be turned left or right to adjust the track level. Some software have a slider in the same place which is used for the same purpose.

Figure 17.2: *The track level controls next to the track in a popular software editor. Note that the same controls are repeated for every track, allowing similar adjustments to be made to every track. Note the three individual VU meters marked A, B and C, indicating the audio levels for each individual track*

Activity 17.1

For this activity, you will need access to an audio editing software. If you have one already installed on an accessible computer, you may use that. If you need one, download Audacity from http://audacity.sourceforge.net/.

Import any audio file into the software and place it on the timeline. Create a three second fade in one of the audio at the start of the clip, and a five second fade out of the audio on the clip.

17.3.3 Panning: Adjusting spatial distribution

You are already familiar with the concepts of **mono** and **stereo** sound. The basic difference is that in **mono audio**, irrespective of the number of monitor (speaker) units attached to the output, the same audio is fed to all the monitors, giving no spatial distribution to the sound. In **stereo audio**, different audio channels are fed to the right and left monitors, resulting in a spatially distributed audio experience. Some sounds are heard from just the left speaker, others only from the right speaker, and some from both speakers, resulting in a lifelike sense of distribution of the sound sources across the entire arc in front of us.

This effect is created not at the time of recording the audio, but after the editing is over, at the time of finalizing the audio. Controls for the purpose allow us to decide which channel a specific clip or track will be directed to and by how much. We can thereby create the sense of spatial distribution we have just discussed.

This spatial distribution of audio is called **panning the audio**. The original control used for this purpose used to be a resistor knob on hardware mixers called the **panchromatic potentiometer**, shortened to **PAN-POT** for convenience. This knob would be physically turned left or right of a central point to create the distribution of the audio across the two channels with extreme left being ‘only left’ and extreme right being ‘only right’. Points in-between would result in a partial distribution. The act of using the PAN-POT came, naturally, to be called, ‘panning’; and continues to be the term of choice for the process today.

In modern software audio editors, there are sometimes similar software knobs provided next to each track, close to the level controls to perform the same function. Many software auditors also allow you to achieve this with a graphic interface based tool, usually an overlay line horizontally in the middle of the clip. Raising the line towards the top of the clip pans the audio to the left and lowering it to the bottom of the clip pans the audio to the right speaker. It goes without saying that a lot of people, new to editing on software platforms get confused between the overlays for panning and level adjustment and get the two mixed up, a costly and time consuming mistake to make.

Using the panning function takes experience; a keen ear and a sense of music production that lets you understand how the acoustics of performances works. It is not something that you should experiment with till you consider yourself an advanced user of the system.

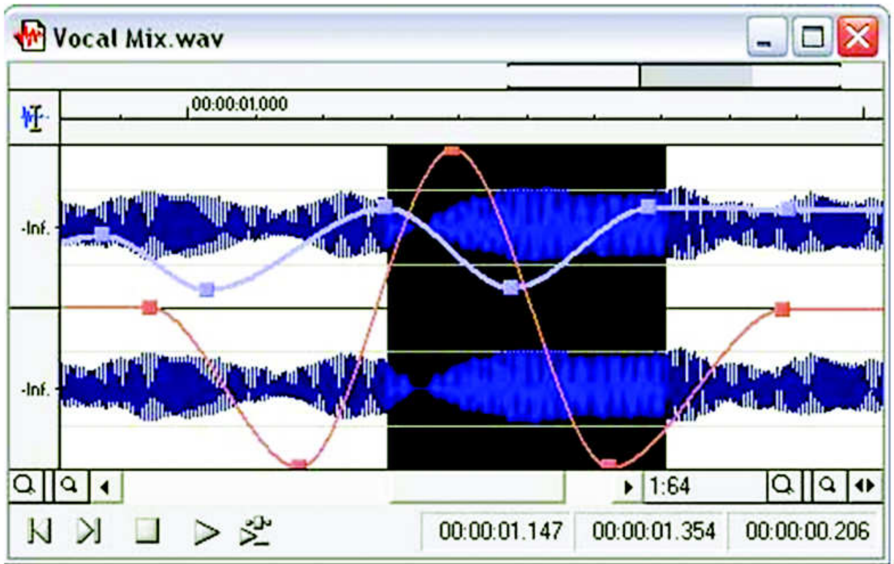


Figure 17.3: *A clip showing audio level adjustment as well as PAN adjustments.*

Note the graphical PAN overlay on the clip, which lets you pan individual clips.

17.3.4 Mixing audio

We can now summarize the process of mixing like this:

1. Levelling the audio at the individual clip level.
2. Balancing the relative levels of the various tracks.
3. Adjusting the spatial distribution of the audio to create the stereo effect.

Between the three, we will have achieved our purpose of making the audio listening-worthy, so to speak, in terms of its clarity, emphasis and in its ability to make the listener pay attention to the specific part of it we would like him or her to concentrate on.

The most important thing to remember while mixing is that it is important to set a **target audio level** for the final mix that we can standardize across programmes, so that our station's programming as a whole will be heard at more or less the same volume setting. Each station and broadcast agency has its own regulations regarding where exactly this target level should be, based on its technical setup and its preferences.

The best rule that one can follow is to set a target standard level between -12 dB and -6 dB, with the softest sounds going no lower than -16 dB or -18 dB and the loudest sounds touching no higher than -3 dB. If most of the programme lies around the -9 dB mark, this preserves a reasonable variation in the audio. You should be careful to see that none of the audio goes to the 0 dB mark at all, because that is the limit of what the system will handle safely without distorting the audio.

As noted in a previous section, if we skip the third step and leave all the tracks evenly distributed across both channels called **centering the audio**, we will end up with what is termed a **mono-mix.** The output will be mono audio with no difference between the signals going to the left and right speakers, if they are present. If there is a single speaker, as is found on many small transistor radios, this will not make a difference either way.

If we perform the third step, and assign spatial values to each clip and/or track by panning, we will end up with what is known as a **stereo mix:** an audio mix that will have the audio distributed across an imaginary arc in front of the listener. Such a mix, when played out through a pair of left and right speakers will recreate the sense of stereo listening that we usually feel by virtue of our two ears. Of course, this supposes that we have appropriate equipment to play out the stereo mix to a pair of speakers, the effect does not work with only one speaker.

Again, given that most CR stations have very low power transmission systems, it is wise not to attempt stereo mixing and outputs. These are not only time consuming and require greater expertise, but requires **stereo transmission systems** if they are to be broadcast successfully. Stereo transmission systems are more expensive than mono transmission systems, and also give a lower transmission range for the same power output, both are serious considerations for a small CRS. The overwhelming majority of CRSs usually prefer a mono transmission system as a result.

As the final product of the mixing process, some editors like to select all the clips and tracks for which they have made adjustments, and generate a fresh combined clip that incorporates all the elements together. This fresh clip is generated on one of the free tracks left after the audio has been laid on the first few tracks. This process is often called **mixing down** or **bouncing** the clips/tracks.

However, as you will see in the next section, this is an unnecessary action, since the process of mastering essentially incorporates this process of combining already. However, it is worth bouncing the mix to a fresh track as a sort of trial, if you like to preview the expected end product once for audio levels before mastering.

Activity 17.2

For this activity, you will need access to audio editing software. If you have one already installed on an accessible computer, you may use that. If you need one, download Audacity from http://audacity.sourceforge.net/.

Import at least two audio speech files to the software and place them on the timeline with the first clip on Track 1 and the second clip on Track 2. Ideally, Track 1 should be spoken by one person, and Track 2 should be another person. (If you can record audio that in Track 1 one person is asking some questions and in Track 2 another person is responding that would be ideal.)

Use the graphical volume controls to adjust the relative audio levels and balance the audio.

Now, use the graphical PAN controls available in your software to pan Track 1 fully to the left, and Track 2 fully to the right. Play the file back on a stereo speaker pair to check whether Track 1 (the interviewer) can heard from the left speaker, and Track 2 (the interviewee) from the right speaker.

17.4 Mastering and Export

To put it simply, **mastering** is the process of generating the edited finalized audio programme as a single mixed audio file in a format of one's choice.

During editing, the programme is composed of numerous segments and pieces. In order to manage the programme all these segments have to be put into a single piece, so that it can be lined up for playout and broadcast. If the programme remain as different component pieces then it would become a herculean task to line up the pieces. Mastering allows the generation of this mixed and finalized file with the levels varying as per the mixing settings and adjustments that one has previously made.

Before, we discuss the process of mastering further, let us look at some of the parameters which we have to keep in mind, while generating the audio programme in its final form. You may have to refer to the Unit on analog and digital audio (Unit 10) to brush up on some of these terms and parameters.

1. **Mono or stereo:** As we have already seen, depending on the mix, and availability of our skills and the infrastructure we have to make a mono or stereo final output.
2. **Sampling rate:** This is the number of samples each second of audio in your audio is divided into. You would have to set this while setting up the

audio editing software. Typically, CD quality audio is sampled at 44100 hz (or 44.1 kHz). Audio for video use is sampled at 48 kHz.

3. **Bit rate:** This is the amount of data per second that is transported in the stream of data that gets played out, while you play certain types of audio files. It is usually measured in **kilobits per second (kbps)**. Typical values for FM quality audio are 96 kbps. CD quality audio will range from 128 – 192 kbps. Higher than this is strictly phrohibited for playback use on the system, rather than broadcast. Some softwares allow you to choose between **Fixed Bit Rate (FBR)** output files and **Variable Bit Rate (VBR)** files. In VBR files the system decides in which portion of the file, depending on the complexity of the audio, to use a higher bit rate and where to use a lower bit rate. In the interests of interoperability between systems, it is wise to stay with fixed bit rate files, where the entire file is encoded at a standard bit rate, as given above.
4. **File format:** The final audio can be exported in one of several types of audio formats (or file types) that are commonly used. Generally, while recording and editing, we keep audio uncompressed and therefore record and edit in the WAVE (.wav) format. The final master file can be in WAVE format (larger file size) or MP3 (smaller file size). Depending on the other parameters selected, selecting the MP3 option could create a file several times smaller than the equivalent WAVE file, resulting in enormous space savings. MP3 files are fine for most broadcast purposes, and have the dual advantage of being easy to line up in most audio player softwares on computers.

Thus, a typical output format for a CRS programme would be:

MP3/Mono/44100 Hz/128 kbps

It is best to discuss and settle on a standard file naming system for final master files, as well as common parameters for final master file generation. This will make everyone export their final programme files at the same settings, and will lead to an even sounding broadcast, not to mention make recognizing the master outputs easy.

Where the process of mastering goes, once the editing is complete and the clips have been levelled and balanced, we select all the clips on all the tracks on the timeline simultaneously. This can be achieved by shift-clicking the individual clips (which is more time consuming), or by selecting one clip and then using the CTRL+A command to select all the clips.

In most editing software, the next step is to **export the finished file**. This is usually achieved by using the menu command: **File > Export**. Within this command, you may be prompted to select between several choices (selected audio/all audio etc.): select the options that let you export the entire audio. You may then be presented with a window where you can select the other parameters, and name the file that is going to be exported. (In some cases, you will just get a window where you can name the file and decide where it is going to be saved. In such cases, there is usually a button marked '**Settings'** somewhere within that window, clicking on which will give you the choices noted above. Note that some of the choices may need a specific file type to be selected in order to be activated.)

Once all the settings are set, and all parameters selected, clicking on OK should generate the final master file, which can then be saved in a location of your choice on the DAW. Note that the 'export' command actually performs the mixdown or bounce function, saving us from the additional step.

It is good practice to keep the master exported file of the programme in the same programme folder, which also contains the component recordings related to the programme and the connected session files. An additional copy of the file can be stored in a separate folder, from which playouts can be lined up. In fact, as a general principle, it is a good idea to keep two copies of all recordings for a programme, preferably on a different disk on the same computer or on an external backup device. This ensures that even if something gets accidentally deleted on the system, you have what is known as a **safety copy** of every file.

Activity 17.3

Continuing from the activity presented in Activity 17.2, import two instrumental music pieces into the same session file where you have the interview audio.

Place the first instrumental piece at the beginning of the programme and create a 3-second fade at the start of the music piece. Keep the music on for five seconds, then fade it down, so that it carries on under the first question on Track 1 before fading it completely.

Take the second instrumental clip, and place it at the end of the programme, so that it overlaps the end of the last response on Track 2 by about five seconds. Fade the end music up slowly under this last response, such that it reaches full level about two seconds after the last word is spoken. Keep the end audio up for five seconds, before fading it out over four seconds.

Rebalance the audio for all the clips till you are satisfied with the relative levels.

Now use the 'export' command on your software to export a single combined file with the following parameters: Mp3/128 kBps/44.1 kHz sampling. Name this file 'Test.mp3'.

17.5 Let Us Sum Up

In this Unit, you learnt the final steps of the programme post-production process: namely, mixing and mastering.

Mixing is the process of setting the relative levels of all the components of audio sections, so that we have a listening experience that is both smooth and even and also directs the attention of the listener correctly.

Mastering is the process of combining all the constituent component files into one final file, whose file parameters and formats are standardized. This final file will have audio levels that vary as per the mixing related adjustments that has been made.

Mixing and mastering are done as per several parameters, which require a considerable amount of thought before selection (mono/stereo; FBR/MBR; file format; etc.).

17.6 Model Answers to Activities

Activity 17.1, 17.2, 17.3

The activities in this Unit are oriented around actually executing certain tasks on a software editor. For this, you will require access to a computer, and an audio editing software.

Your successful execution of these activities is based on the amount of time you will spend working on the software, and your willingness to experiment.

Try to follow the instructions closely, and use your judgement to assess what could be improved in the audio you are hearing as a result of your activity work.

UNIT 18

File Format and Compression

Structure

18.1 Introduction

Having learnt about the techniques of production and post-production in Unit 17, it is now time for us to proceed to learn the different formats in which audio files exist and how they can be used. We will also learn the various compression techniques. Scores of audio formats exist; some are software dependent and some are computer platform dependent.

In addition to audio formats, we will also learn about audio compression and its effects on audio.

It is important to know the different audio formats and audio compression techniques, since each file format has a specific application. For example, at the end of this chapter, you will realise that mp3 file format is a compressed file that occupies less space and can be easily used for broadcast and podcasting purposes. Also understanding open file formats versus proprietary ones helps one in deciding which file format to use in a particular instance.

You will need about four hours to complete this Unit, including completing the activities mentioned in this Unit.

18.2 Learning Outcomes

After working through this Unit, you will be able to:

- discuss different types of audio formats.
- explain compression techniques., compress audio into different formats.
- compare and identify different file formats.

18.3 Types of Audio Formats

There are a number of file formats in the world of audio. When we talk of file formats, we are basically discussing digital files. Remember, digital information is only ‘1s’ and ‘0s’. How these ‘1s’ and ‘0s’ are organised, determines the kind of file format. It is the difference in organisation of this information that differentiates an image file from an audio file.

File formats are nothing, but the way information is organised so that equipment or software understand them easily to work with them. For example, when you save a Microsoft Word file, the file format is “.doc”. This means that all information in that file is organised in a way to enable software such as Microsoft Word to interact with (open, edit and save) it. Some file formats can interact only with specific software/equipment, whereas some can interact with more than one software/equipment. For example, an audio file such as mp3 can be opened by more than one software solutions.

Following are examples of file formats that you might encounter sometime at work:

- Images : BMP, JPG, SVG, GIF, PNG
- Text document : DOC, ODT,
- Sound : MP3, WAV, OGG
- Video : WMV, QuickTime, h264, mp4

The number of file formats has only increased over the years and technicians around the world have been constantly working on reducing file sizes, while trying to retain the originality of sound.

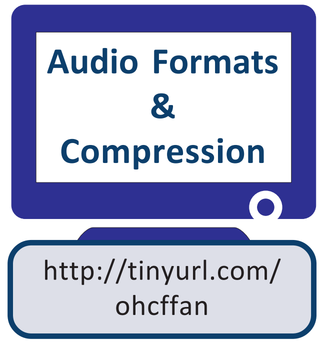
However, depending on the software one uses or the computer operating system (Windows, Mac, Linux etc), audio formats are either open standard or proprietary in nature. Open standard formats are those that will play across software and computer operating systems. On the other hand, proprietary formats will only work with specific software and on specific operating systems.

Before we proceed to understanding file formats, it is important to understand the difference between file format and codec.

A codec (short for Compression-Decompression or Coder-Decoder) means the way the audio is compressed and stored is called the *codec.* It is a piece of software that compresses an audio file and later decompresses it to be heard properly. Some file types always use a particular codec. For example, '.mp3' files always use the MPEG Layer-3 codec. Other files like '.wav' support can use different codecs like 'PCM', MPEG3 and many other codecs.

A file format is normally associated with a media player. Certain media players can play multiple file formats. Some can only play particular formats.

In short, a file format contains the content, the audio, and the codec is like a container. Let us draw an analogy here. Say you have a book with text and colourful images. You can print it on normal paper or on glossy paper. Printing it on glossy paper will make the colourful images stand out. The text and colourful images are the contents the file format. The normal paper or glossy paper is the codec. Let's take the example of an audio file itself. Say you have an audio file that is about one hour long. If you wish to stream it over the internet, you will need a certain codec such as MPEG Layer-3. This way, the file size is optimised for internet and streaming becomes easy.



Before going into the details of the various concepts of audio formats and compression, you can watch the video available at the CEMCA YouTube site - http://tinyurl.com/ohcffan. This video will help you to enumerate the concepts of audio formats and compression.

The most popular file formats, both open standard and proprietary are as follows:

- *wav* - standard audio file format used mainly in Windows PCs. Commonly used for storing uncompressed (PCM), CD-quality sound files, which means that they can be large in size around 10MB per minute of music. It is less well known that wav files can also be encoded with a variety of codecs to reduce the file size (for example the GSM or mp3 codecs).
- *mp3* - the MPEG Layer-3 format is the most popular format for downloading and storing music. By eliminating portions of the audio file that are essentially inaudible, mp3 files are compressed to roughly one-tenth the size of an equivalent PCM file while maintaining decent audio quality. This reduces the file size to a great extent. As a result, Mp3 files are popular for streaming on the internet and for storage purposes.
- *ogg* - a free, open source container format supporting a variety of codecs, the most popular of which is the audio codec Vorbis. Vorbis files are often compared to MP3 files in terms of quality.
- *flac* - a lossless compression codec. Lossless compression is like zipping a file but for audio. If you compress a PCM file to flac and then restore it again it will be a perfect copy of the original. (All the other codecs discussed here are lossy which means a small part of the quality is lost). The cost of this loss is that the compression ratio is not good.
- *au* - the standard audio file format used by Sun, Unix and Java. The audio in au files can be PCM or compressed with suitable codecs.
- *aiff* - the standard audio file format used by Apple. It is like a wav file for the Mac operating system.
- *wma* - The popular Windows Media Audio format is owned by Microsoft. Designed with Digital Rights Management (DRM) abilities for copy protection.
- *aac* - the Advanced Audio Coding format is based on the MPEG4 audio standard owned by Dolby.
- *ra* - a Real Audio format designed for streaming audio over the Internet. The .ra format allows files to be stored in a self-contained fashion on a computer, with all of the audio data contained inside the file itself. *.ram* is a text file that contains a link to the Internet address where the Real Audio file is stored. The .ram file itself does not contain any audio data.

Activity 18.1

Search the internet for the following file formats: mp3, ogg, au, mpeg2 and ra. Now try opening each of these files using Windows Media Player (WMP) on your computer.

You will notice that the player can only open certain file formats. This is because, while WMP interacts with some of them, it cannot with the others.

18.4 Need for Compression

When talking of compression, one should avoid getting confused between compression during recording and compressing audio files.

Voice has a dynamic range and so is the case with some instruments. As a result of this dynamic range, while recording, sound goes through several highs and lows. Compression during recording reduces such extreme shifts, reduces dynamic range and polishes the sound by controlling maximum levels and maintaining higher average loudness. Compression using hardware or software can also be used to slightly tweak an audio track to make it sound natural without distorting it in any manner. On the other hand, compressing beyond a limit can destroy the audio.

The compression that we are discussing here is *data compression*. But what exactly happens during compression? Compression of data essentially reduces the number of bits by removing redundant information thereby converting it to a file size of lesser size. All the wonderful pictures that you see on the internet were originally large files. Compression to web resolution reduces the file size by removing a lot of redundant information (mostly required for printing purposes) without affecting the way the picture looks. Images are optimised for web so that they load faster when you visit a web page.

Similarly, a smaller, compressed file reduces the amount of storage space required making it possible to store more music or video on a portable music player or hard drive and files can be transferred more quickly via the Internet or between storage devices. This means that when compressed the size of the file reduces.

Activity 18.2

This activity is meant to understand the meaning of data compression. Transfer a photograph from a camera that is about 1.5 MB or more to in a computer. Open the image using the Microsoft Office Picture Manager on your computer. Now zoom out the picture. You will still see a clear image. Next hit the Edit Pictures button. On the right side, you will see a number of options. Go down to the last option that says Compress Pictures. Click it. You will see the actual size of the original image.

Next, select the Web pages option. You will notice that the size of the image on the screen is reduced. You will also notice that the file size of the compressed size has reduced. Click the Ok button and save the file.

Now, open the file in the same Picture Manager. You will notice that while the picture looks almost original, however, when you zoom in, you will notice that the picture got a bit softer.

18.5 Compression Techniques

Compression is the process of reducing the size of a file by arranging data contained in it in a more efficient manner. By doing this, one is effectively removing the number of bits used to store any information. For example, in a Microsoft Word file, if you have entered text providing more space or you have redundant and repetitive words and phrases, it is naturally going to occupy more space. However, when you remove the unwanted spaces and redundant words and phrases, the size of the file is reduced.

Similarly, in the same Word file if you have used high resolution images, the size of the file would be very high. On the other hand, if you use smaller images (with smaller file sizes) the total size of the file will significantly decrease.

One step further, if you use a software to convert it into a .zip file, its size is again reduced. What you have basically done is to remove all redundant information to reduce the file size. It is now easy for you to email the document.

Compression can happen in two ways: Lossless and Lossy. Say you have an uncompressed .wav file. You can compress it to another file format using the lossless and lossy method.

In the lossless method, the file size is reduced but the quality of the audio is not compromised. Lossless compression is normally used when the quality of the audio is critical, say for example, on a music CD.

The lossy method of compression uses data compression methods where the file size is reduced but retains information that is just about useful. The mp3 files that we download from the internet are not of great quality but just about useful to store on our portable players and mobiles to listen to them on the go.

The amount of data an audio file format retains is measured in Kilobits per second (Kbps) (the bitrate). The higher the bitrate, the more data stored and the higher the audio quality.

You will know how to compress the file using reduced bitrates in the chapter on editing.

18.6 Comparison of Formats (tabular)

The following table (Figure 18.6.1) should give you a fair idea of the quality of audio compressed at different bitrates and their file sizes. All file sizes mentioned below are approximates only.

Quality (estimate)	Format (compression type)	Bitrate (Kbps)	Filesize (KB/min)	Compression Type
CD Quality	Uncompressed WAV	1411	105,000	None
	MP3	128	960	Lossy
	RA	96	720	Lossy
	WMA	92	690	Lossy but lossless in WMA9
	OGG	112	840	Lossy
	AAC	80	600	Lossy
FM Radio	MP3	96	720	None
	RA	64	480	Lossy
	WMA	56	420	Lossy
	OGG	67	500	Lossy but lossless in WMA9
	AAC	56	420	Lossy
AM Radio	MP3	64	480	None
	RA	32	240	Lossy
	WMA	20	150	Lossy
	OGG	32	240	Lossy but lossless in WMA9
	AAC	20	150	Lossy

Figure 18.6.1: *A comparative table showing the approximate kilobits per second and the corresponding audio quality*

Activity 18.3

Record a programme in an audio studio. Save the recording as a .wav file. Now, import the same audio file into an audio editing software such as Audacity and export it as an

- Mp3 file
- Ogg Vorbis file
- Mp2 file

Now check the size of each of the files you have converted and notice how their sizes will be different. Now repeat this exercise using different Bitrates (you can do it by choosing 'Options' before exporting the file) and then notice how their sizes differ. Also playback each of these files and notice the difference in quality.

18.7 Format Converters

Choosing the right audio compression for a given purpose is important. What is even more important is the format one chooses to convert the audio file into. There are two ways in which audio file formats can be converted. One method is by using hardware and another, using software.

Using hardware: The method is used while converting audio either from digital to analog or vice-versa. For example, analog to digital audio convertors (from tape/vinyl turntable to digital audio files). The convertor uses output from the analog audio player and feeds it into a piece of hardware that converts and outputs the file as a digital file through a USB interface that can be saved using software on a computer. The USB interface (the output from the convertor) is connected to the computer, which serves as an input. The software on the computer then digitises the file and outputs the same as a digital file.

This conversion method is used when archival material is in analog format (on tapes) and need to be converted to digital format for sharing purposes.

Activity 18.4

Through this activity we will attempt to convert analog audio from tape to a digital audio file. You will need:

1. A cassette tape recorder with an audio output
2. An audio cassette with some recording on it
3. An audio cable that connects output from the cassette recorder and serves as an input to your computer microphone
4. Audacity, a free and open source audio editing software

On your computer, launch Audacity. Load the cassette into your audio recorder and press the play button. On Audacity, press the record button. The audio playing on the cassette recorder will be 'captured'. Next export the file to a file format of your choice. You now have converted analog audio into digital audio.

Using software: Using software basically means that you already have a digital audio file in one format and you wish to convert it into another format to suit a purpose. Conversion of the file format means that one is converting an audio file into a lossless or lossy format. An uncompressed audio file can be compressed into another file format using lossless or lossy mode. On the other hand, a file that is already compressed in lossy format cannot gain anything even if converted into a seemingly uncompressed format.

Conversion from uncompressed to a lossy format will result in reduction of file size and quality, while conversion to a lossless format will compress the bit slightly in order without losing out on the audio quality of the original file.

There are several audio conversion software solutions, both free and licensed. One only needs to download them from the internet and use it on a computer. The audio recording/editing software Audacity too serves as an audio file format convertor. Using this format, you can convert a .wav file into an mp3 file and several other formats as provided by the software.

18.8 Let Us Sum Up

In this chapter, we discussed the different audio formats and how some are open standard and some proprietary. The most popular audio formats in vogue and their uses have also been detailed in this chapter.

We then moved on to understanding lossy and lossless compression, the hardware method and software methods of file conversions.

In the next Unit, you will learn about the different file storage and archiving options for audio. We will also discuss audio archiving and its importance in community radio.

18.9 Feedback to Check Your Progress

1. What is a file format? What use is it when it comes to dealing with digital files?
2. What are the most popular audio file formats?
3. What is compression? What actually happens when you compress a file?
4. Explain the terms lossy and lossless compression.
5. Explain the techniques behind audio file compression.

18.10 Model Answers to Activities

Activity 18.1

You would have noticed that a software player like Windows Media Player recognises only proprietary file formats such as mp3 or wma. A player like VLC Media Player will recognize both proprietary and open source file formats. You should remember that if you are producing a digital audio file that will be sent to many people who will be using different computers with different audio systems and with different media players, it would be better to have the same file saved under different formats so that all people can access the file easily.

Activity 18.2

What the Picture Manager has essentially done is to remove all the redundant data (the finer details, actually) available in the image file and compress it for the internet. However, the picture still looks almost like the original although smaller in size. Therefore, when you zoom in, you will see that the compressed picture is drastically different from the original file. It has become slightly fuzzy and the details available in the original would be missing from the compressed image. In short, the quality has also undergone a change.

Activity 18.3

.wav is an uncompressed file format and is of good quality. However, mp3, ogg and mp2 are compressed formats and the quality also suffers a bit. However, the file size is reduced significantly thanks to compression. Compression is also dependent on the Bitrate. Lower the bitrate, lesser the file size and more the compression.

Activity 18.4

You would have noticed that when you record the output from a audio cassette on to a digital audio file on Audacity, there is a difference between analog audio and digital audio. You should pay attention to the process of how an audio file (converted from analog) increases the mobility of the file. This means that you can import and export the digital audio file on a variety of softwares as compared to audio on the cassette.

UNIT 19

Storing and Retrieval

Structure

19.1 Introduction

In the previous Units you learnt about digital audio editing, mixing and mastering using software, compression of files and file formats.

In this Unit, you will learn about the various data storage devices, their characteristics and uses. You will also learn about audio archiving techniques and meta-data tagging.

You will proceed from learning the various back up techniques to types of storage devices like CDs, DVDs, magnetic and solid state devices and their characteristics.

Thereafter, you will learn the significance of archiving in a radio station, the factors that go into archiving and the reasons thereof.

Searching for files when you have thousands of them, can be an uphill task. Meta data tagging is an effective way of narrowing down to the file you are searching. This Unit will also explain meta data tagging and methods of adding such tags to files.

File sizes (both uncompressed and compressed) have an impact on the way one stores them and the space required to store them. Decisions need to be taken on whether to use uncompressed file formats or otherwise to store them or archive them for future use. This chapter will help you decide on the storage devices and teach you back-up techniques to maintain redundancy in terms of file maintenance. Redundance (meaning having multiple copies of the same file) is not a sin when it comes to radio stations.

You will need at least six hours to successfully complete this Unit, if you undertake all the activities seriously.

19.2 Learning Outcomes

After working through this Unit, you will be able to:

- describe various data back-up techniques.
- discuss storage devices.
- explain audio archiving.
- use meta data tagging and logging.

19.3 Data Back-up Techniques

Audio files are at the heart of any radio station. Losing these crucial files can mean stoppage of broadcast. Important files always have the habit of being deleted, most likely by accident. However, a file once lost will take a long time, energy and money to recreate. Thankfully, one can create a backup of all the files in use. A back-up is like making a copy of the existing files and storing them away for future use.

Backing up files is like having an insurance plan in place. Back up files always come handy when one's system crashes or someone deletes a file by accident.

For a radio station that is meant to be on air all the time, having a backup plan is crucial. Every radio station worth its name will necessarily have a backup plan. A backup plan is dependent on the following factors:

- *Importance of data:* It cannot be stressed enough that audio files are central to the working of a radio station. All audio files are important. However, there are some that are more important than others in terms of priority. Music loops and sound effects are important (and need back-up too), but they could be less important than the programmes themselves that can be used over a period of time. For example, if you have a programme on the biography of a national leader, you might want to back up that file for future use too.
- *The data itself:* What kind of data is important to you? Are the project files from your editing software, or just the output files in uncompressed format or just the mp3 files that you finally use for broadcast? Account for the data itself while drawing up a backup plan.
- *Frequency of change:* How often does the data change? For example, the CR policy requires that you backup all audio files broadcast for the last three months. This means, you will need to backup all the audio files that you have broadcast for each of the 90 days.
- *Backup equipment:* Your backup plan also depends a lot on the kind of equipment you have. What kind of media does your radio station have in order to execute the backup plans?
- *Backup schedules:* How often will you need to do a backup? Daily, twice a week, weekly, fortnightly or just monthly? Radio stations would do well to backup daily.

Broadly, backups can be classified as:

- **Daily backups:** As the name itself suggests, one could backup either the project file or even the outputs on a daily basis.
- **Incremental backups:** If the same file/programme undergoes a change over a period of time, the latest version replaces the earlier version. For

example, if you were to make a programme on Right to Information (RTI) today and back it up, the changes made to the law and the programme four years later will be replaced by the earlier file. This means that you will now be broadcasting a more current version of the programme.

- **Copy backups:** Irrespective of whether a project/file have undergone changes or not, they are backed up for future use. Take the earlier example of the programme on RTI. You may have produced a programme three years ago and backed up a file. While you make a new programme, you might use the same project file but save it under a different name. In this case, you will have a backup for programmes you produced three years back and the most recent one too.

Radio stations would do well to follow the Daily and Copy backup plans to be on the safer side.

One can backup files either on the computer itself in a different folder or on different media. While backing up files in a different folder on the computer itself can be convenient, if the hard disk of the computer crashes, one loses all data. Backing up files on external media storage would be wisest thing to do at all time.

So how does one determine a backup solution? Consider the following factors:

- **Capacity:** What is the amount of data you need to backup on a daily basis? How much space would one need for a month or a year?
- **Frequency:** How often would you want to create backups?
- **Retrieval speed:** How fast can you retrieve the data? This decides the storage device on which you backup.
- **Cost:** Ofcourse, this, is a decisive factor, particularly for community radio stations.

In the next section, we will discuss the different kinds of storage devices.

Activity 19.1

Visit the nearest radio station and find out:

a) If they have back up plans mentioned above?

b) If yes, how frequently do they back up audio?

c) Do they back up audio manually (transferring each file to a storage device) or does a computer software do it for them?

d) How much space is required to store a day's audio files that have been broadcast?

19.4 Storage Devices

Storage devices are those that can store information and support a system for accessing and retrieving the information using hardware interface. A storage device is a physical piece of equipment that can hold data/information. The information can be anything that can be stored electronically: software programs, source code, images, audio or video files, office documents, spreadsheet numbers, and a host of other file types. Mass-storage devices typically store information in files. A file system defines how the files are organized in the storage media.

A storage device is used when large amounts of data needs to be stored/ transferred from one place and retrieved at another place and at the time of using a hardware interface.

There are basically three types of materials that serve as storage devices:

- **Magnetic:** All the hard disks, storage tapes etc are all magnetic types.
- **Optical:** CDs, DVDs, Blu-ray discs etc that run and retrieve data using an optical interface are called optical storage devices.
- **Solid state:** All the memory sticks (pen drives), flash cards, memory cards etc. are all solid state storage devices.

Magnetic storage devices: These devices store all information/data in the form of magnetised dots. Small electromagnets in the drive create these dots, enable them to read them and also erase them. Magnetic storage devices can either be hard disks (fixed or removable) or even magnetic tapes.

Fixed magnetic storage disks are the ones that are found in computers. They act as the main storage device for a computer. Storing, accessing and retrieving data from these disks can be done at amazing speeds. They also have amazing capacities. For example, most computers today come with hard disks that range from 100 GB to even 2 Terra bytes (2000 GB)!

One of the advantages of such drives is that they make storing of files and backing up very easy. However, the disadvantage is that if they happen to crash all the data is likely to be lost forever.

Portable hard disks are removable types and can be carried from one place to another. They are mostly connected to the computer using a USB cable or a Firewire cable. They too come in large capacities and can be used to store a variety of data.

One of the major advantages with hard disks is that information can be stored on it and it will store the data even when the computer is switched off. When the computer is switched on or when a portable type is connected to a computer, the latter recognises it and helps us retrieve the files.

Magnetic tape: This type of storage, often called the tertiary storage types are used in large servers when the data is very huge in size.

Rotation per minute (rpm) is a major factor that determines the performance of a hard disk. Hard disk spins can range between 3600 rpm and 7200 rpm. The rigidity of the disk and the high-speed rotation allows more data to be recorded on the surface. The disk that spins faster can use smaller magnetic charge to make current flow to the read/write head. The drives' heads can also use a lower density current to record data on the disk.

Optical storage disks*:* An optical storage device is one in which laser technology is used to write and read data from the disk. The most popular storage devices next to the magnetic disk drives are the optical drives. These include CDs, DVDs and Blu-ray disks.

CD stands for compact disc and is still the most universally compatible format for wide audio distribution. A standard CD-ROM can hold about 700 megabytes of data and can be played back on a computer CD drive and most DVD players.

DVD stands for digital versatile disc. A standard VCD stores video and audio data in MPEG-1 format. A standard DVD stores its data in MPEG-2 format. A DVD player or a computer equipped with a DVD drive is required to play DVDs. A DVD is a very high-density optical storage medium. It holds almost thrice the data VCDs can hold. A typical movie of 2½ hr requires two VCDs. The same movie requires only one DVD. You can now imagine how much audio a DVD can hold.

The following table should give you an idea of the kinds of CDs and DVDs available in the market.

Disc	Disc Types	Data Capacity	Mp3 audio
CD	CD-ROM, CD-R, CD-RW	700 MB	80 mins
DVD	DVD-ROM, DVD+R, DVD-R, DVD RW	4.7 GB	72 hours
	Single layer, double sided	9.4 GB	140+ hours
	Dual layer, single sided	8.5 GB	120+ hours
	Dual layer, double sided	17 GB	240+ hours

Although optical disks are widely available in the market and nearly all computers come with optical disk drives and software to read and write data, these are soon losing out to hard disk drives. The main reason for the fading popularity of optical disks is that they are very delicate and any scratch on the disk means that the data cannot be retrieved. Hard disks on the other hand are very robust and can retain data for a much longer period of time.

Solid state storages*:* These new storage devices do not have any moving parts. Flash memory and pen drives are very common today. Flash memory is usually found in digital cameras, digital camcorders and mobile phones. A suitable drive is needed to read/write on flash memory. Pen drives use the same technology to read and write data. Currently, pen drives are capable of storing more than 32 GB of information. Recent pen drives are coming out with an inbuilt mp3 player too. A USB drive is required to connect a pen drive to your computer.

Major advantages with pen drives is that they are compact and portable, removable, faster to use, comes with high storage capacities and are more reliable, since they do not have any moving parts.

Other types of solid state storage devices, include memory cards. There are several different types of memory cards but for purposes of our study we will examine the following:

	SD Cards: The Secure Digital (SD) cards. They are the most popular cards used in audio and video applications. They are mostly the size of a postage stamp and even have a lock switch to protect the contents from being erased. Any piece of equipment that has SD written on its package will accept these cards. They come in two varieties — SDHC and SDXC. These cards are available in capacities varying from 4 to 64 GB.
	The Compact Flash cards are used by some audio recorders. They are slightly thick, bigger and even more reliable. What's more, they are even cheaper than the SD cards. They too come in the range of 2-4GB capacities.
	Micro SD cards work on the same principle as SD cards. They are much smaller and are mostly used in mobile phones etc. Although very small, they can hold a large amount of data ranging from 1-64GB. However, one drawback is that they are too very small and run the risk of getting lost in the melee of production.
	Some other consumer end audio recorders also use xD cards. They too work similar to SD cards but these days are more limited to being used by Olympus products. Yet another drawback is that their capacities are limited.

Activity 19.2

Note:

This activity will need some persuasion since not all human beings are cooperative. Visit a shop that sells CDs, DVDs and solid state cards. Request them to show all the varieties they have. Now, examine the boxes and compare the contents with the notes you have with you. In all probabilities, you have used some of these storage devices, but may not have taken the time out to notice the differences between/among them. Check how their size, capacities specifications, particularly in the case of DVDs, affect their usage.

19.5 Audio Archiving

CR stations produce a variety of programmes ranging from health, sanitation, education, agriculture and entertainment. They also have a bank of music and sound effects that they can use over a period of time. However, as time passes, managing the astounding number of files can be an uphill task. Maintaining a searchable archive of files that can be used, shared and distributed later can be a daunting task, if proper archiving mechanisms are not put in place. Audio archiving is crucial to the functioning of a community radio station for the following reasons:

- **Policy requirement:** The Community Radio Policy of India requires all CR stations to maintain archives of three months. The policy guidelines state:
- **The Permission Holder** shall provide such information to the Government on intervals, as may be required. In this connection, the Permission Holder is required to preserve recording of programmes broadcast during the previous three months failing which Permission Agreement is liable to be revoked.
- **Smooth functioning:** As mentioned earlier, archiving (or backing up programmes) is also useful for the smooth functioning of the radio station. A programme that one may want to use later or share it with other radio stations or even distribute among community members for a small fee will be easier if proper archiving mechanisms are in place.
- **Reflect:** CR stations can look back once in, maybe two years to look at the kind of programming they have been doing and make changes to it.
- **Celebrate:** If your station has completed a milestone (say, five years) you might want to celebrate it by playing back select programmes from the past.

- **Audio heritage:** Community radio stations do a lot of oral history. These histories are important to look back on change. They help us understand how people experienced lives in a certain socio-political, cultural context and importantly also point us to what has not changed, since then.

19.5.1 Factors for archiving audio

So what factors does one consider when archiving audio?

- The storage device
- The file format
- The space available/required
- Searchability (remember, we want to be able to locate the right file from among the thousands)
- Speed of retrieval

One of the simplest ways of archiving is to use hard drives. One can probably allocate one hard drive for each year and label them, accordingly. Another way of doing it is by storing all the files on the internet, which is expensive and time consuming.

Yet another way of archiving audio is to use a storage system but use software to label the audio files properly so that they can be searched easily using the software. While there are a number of licensed software solutions, use of open source is desirable. For example, UNESCO recommends using WINISIS and Greenstone Software (http://unesdoc.unesco.org/images/0018/001808/180855e.pdf). Yet another software solution that can be explored is Avalon (http: //www.avalonmediasystem.org/software) that claims be open source.

In any case, the purpose of using such software solutions is to ensure that they meet all the requirements of archiving.

For an audio archive to be searchable, it will need to have all the pertinent data available for each of the audio files. This now takes us to Meta data tagging.

19.5.2 Meta data tagging

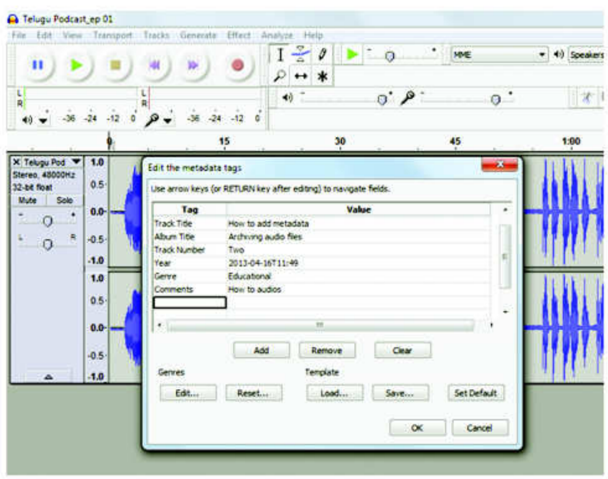
What is data tagging? We all give names to our audio files. However, when there are audio files on the same topic (say there are 200 programmes on environment or 2000 songs of a local folk artiste), how does one narrow down the search to a particular file? The solution is meta data tagging.

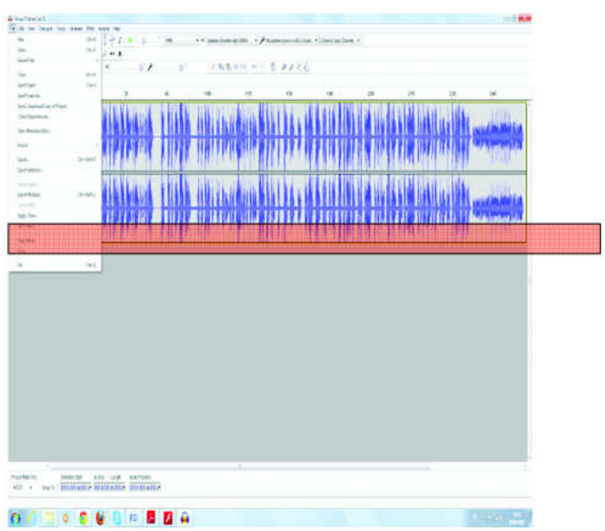
So what is meta data tagging? Simply, it is data that describes other data. Metadata can be used to describe digital files such as videos, images, documents, audio files and more. Digital files and assets are given value by the metadata that describes them, not only by making it possible to locate and repurpose them, but also to ensure others who wish to use or license an asset can find out where it has originated from.

Most of the times the metadata entries that your audio editor provides are good enough and are searchable. It is searchable more easily when the metadata itself can be exported as a separate file. For example, how does one go about adding metadata to an audio file, while using Audacity?

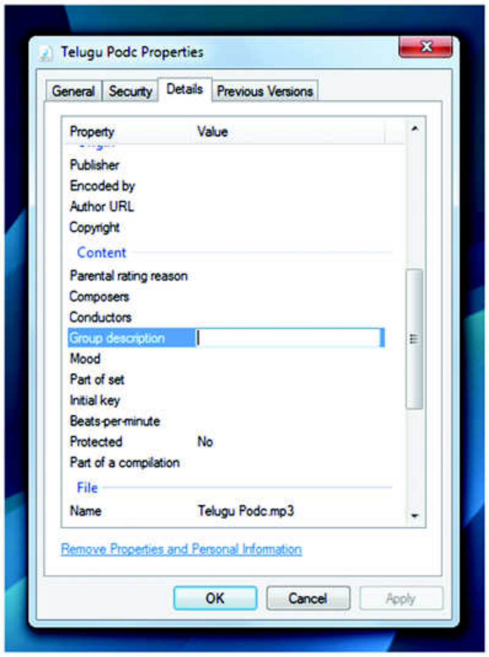
Here are some simple steps to follow:

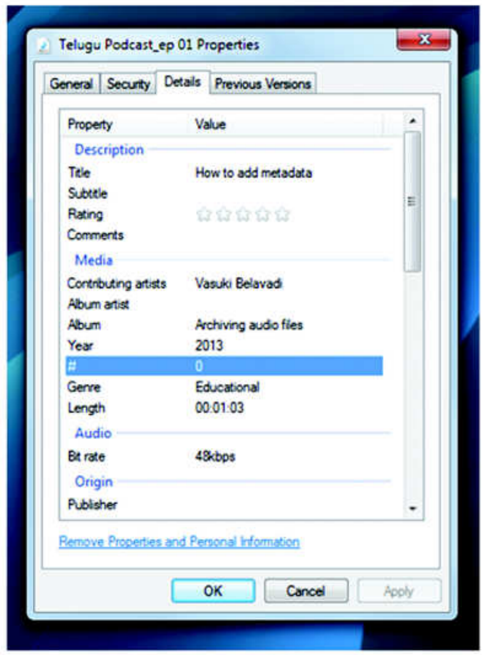
- Import your audio into Audacity
- Click ‘File’ and then ‘Open Metadata Editor’
- Enter the metadata. One can also add other fields to customise the data to be available.





Export the file. The file is then exported along with the metadata. So, how does one know the metadata has been included in the file? One way of finding out is to right click on the file and clicking properties. Then click on the 'Details' tab in the properties window. If the metadata has been entered, you will find it in there.





When such and more detailed information about an audio file are available, searching for it becomes easier. Although, there might be more than one file on the topic, it is easier to narrow down to the file at least.

It is worth to add as many details as possible soon after editing in the audio editor itself, so that the file becomes more searchable.

The typical details one would want to enter as meta data are mentioned in the table below:

Name of the file	Year of production
Name of the creator	Copyright details (Organisation, year etc)
Name of the publisher (the organisation)	Whether file is protected or not
The genre of programme (feature, drama, interview etc)	Composers, Conductors, Beats per minute, Whether it is part of a compilation (in the case of music)
Date of production	Additional comments (Ex: during 2004 floods)

The more details the more searchable it becomes. If you are using GRINS (Gramvaani) to schedule & broadcast your programmes, you will see why these details are significant

Activity 19.3

There is yet another way of adding metadata tags to a file. Try this activity to see if you are successful in entering metadata. Yet another way of adding meta data to an already existing audio file is to do it to the file itself. Follow these simple steps to do so:

1. Right click the audio file and click Properties
2. In the Properties window, click the Details tab
3. Slowly scroll down and click next to each of the single items that appear under the Content section. You can enter a number of details there.
4. Click the OK button.
5. Now right click the file and click Properties.
6. In the Properties window, click the Details tab. You will see all the details you had entered in there.

19.6 Logging

In radio, the word logging is used in two ways. One, before editing, where you make a list of audio files you have recorded, select portions of the audio clip to edit in etc. The other time you hear the word logging is during transmission.

If your radio station is using a broadcast automation software (that helps one in creating playlists, scheduling, taking phone-calls and broadcasting), it would also probably come with a programme logging option. Programme logging simply means creating a list of all the programmes (including the on-air announcements, PSAs, commercials, jingles, break bumpers etc).

Earlier, logging of all programmes used to be done manually. One would have to actually sit and listen to all programmes one after the other and enter them into a register. No longer. The software that automates your broadcast in all probabilities creates a programme log too. A programme log is necessary because it is:

- **A legal requirement:** If you are playing songs that require you to pay a license fee, the licensor, in all probability will require you to keep a log of all the songs you have played. This is to ensure that you have not infringed copyright.

- **Beneficial to the RJs:** Keeping a programme log is beneficial to radio jockeys; it lets them know which files/songs have been played/not played. This will help them create an interesting playlist.

Another important logging feature on broadcast automation software is the phone calls you receive at your station. This feature not only lists out all the numbers, but if you store the names of the callers **(Figure 19.5.1)**, they will help you give a personal touch to the call when you receive a call from the same number. You can probably identify the caller by name to her surprise. This goes a long way in carrying forward a good conversation on radio.

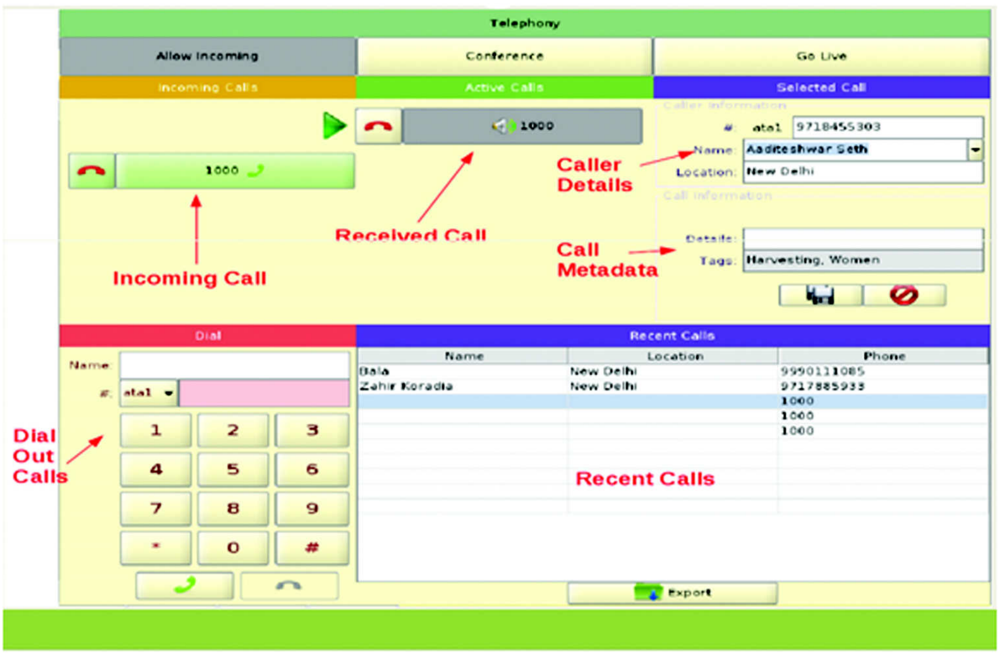


__Figure 19.5.1:__ Screenshot of the telephony component of GRINS broadcast automation software. This allows you to store the names of the callers and save a list too.

19.7 Let Us Sum Up

In this Unit, we have learnt about the various data back-up techniques and the hardware required for the same. We also emphasised on the back-ups by classification. We learnt that there are magnetic and optical storage devices and which ones to use for longevity.

The importance of audio archiving for a community radio station was discussed in detail and the various methods by which archiving is done. Links have also been provided to open source software that can be used for archiving.

All audio files must be searchable from an archive. Meta data tagging is the best proven method for this purpose. We learnt how to add meta data to files while editing and already existing audio files in the bank.

In the next couple of Units, we will concentrate on best practices in studio operations, basic maintenance of radio studio and field equipment and alternative methods of content distribution.

19.8 Feedback to Check Your Progress

1. What is back up? What are the different back up techniques?
2. Explain in detail the different kinds of storage devices available in the market today.
3. What is meta data tagging? What is its significance in archiving?
4. How does one add meta data tags to an audio file? Explain the different methods to do so.

19.9 Model Answers to Activities

Activity 19.1

When you visit the radio station, you are expected to observe the methods through which the staff are backing up their programmes, if at all. If they are storing the audio files on the same computer which they use on a day-to-day basis, then it is an unsafe backup option as the computer could crash anytime due to extensive usage. If they are backing up their programmes on cassettes and/or Compact Discs, it is an expensive and unsafe option since these physical media are expensive to procure on a continual basis and are also prone to scratches or other kinds of damage. The preferable options for backup are hard drives which are reserved purely for backup or if they are backing up their progammes on a secure web server which is independent of physical machines. However, please note that both these latter options are also expensive and limited and the radio station may have to take a balanced decision depending on the monetary resources at their disposal.

You may also observe the frequency of their backing up procedures. Ideally, if they are producing programmes on a daily basis, then the backup should also take place daily. However, due to limited number of people working at their radio station, and due to lack of bandwidth, they may take longer to backup their programmes. Finally, also please observe whether the back up is done manually or through a software like GRINS (on Linux) or Time Machine (on Apple). Obviously, manual back up is time consuming and prone to minor errors. Please also make a note of the amount of space that is required by the radio station to create back up. If the radio station is saving files in mp3 format, then lesser space will be required while saving backup files as wav files will need exponentially more space.

Activity 19.2

Once you have persuaded a shopkeeper to show you various storage devices at his shop, you are expected to observe how different devices have different storage capacities. You will observe that different devices are of different sizes too. The storage devices in the past, like CDs and DVDs are larger in size because they are optical drives which are meant to be read on computers or CD players. The recent devices like SD cards, micro SD cards etc are meant for more compact devices like cameras and mobile phones. The fact that some SD cards are restricted to some readers is because of a phenomenon called Digital Rights Management (DRM). This is also the reason why different phones have different charging cables and ports with different voltage and power readings.

Activity 19.3

Yet another way of adding meta data to an already existing audio file is to do it to the file itself. Follow these simple steps to do so:

1. Right click the audio file and click Properties
2. In the Properties window, click the Details tab
3. Slowly scroll down and click next to each of the single items that appear under the Content section. You can enter a number of details there.
4. Click the OK button.
5. Now right click the file and click Properties.
6. In the Properties window, click the Details tab. You will see all the details you had entered in there.

Glossary

A/D Conversion	Conversion of an audio signal from analog to digital. In a field recorder, this usually happens within the field recorder itself. In the studio, this happens within a sound card or a digital mixer.
Assembly	The process of arranging audio clips with reference to each other in order to create an audio programme.
Audio editing	The process of removing unnecessary audio from recordings, as well as the process of reordering and arranging audio.
Audio levelling	The process of adjusting the mutual levels of all the clips of audio in a programme to make it possible to listen to the programme at approximately the same level setting.
Audio levels	A measurement of the amplitude of the audio signal.
Audio recording	The process of capturing and storing audio on a medium.
Backup	Back up is like making a copy of the existing files and storing them away for future use.
Balancing	The process of adjusting audio levels between various segments of the programme.
Band pass filter	A filter that removes a collective set of frequencies from an audio clip.
Bouncing the audio	The process of mixing multiple tracks down to a single track. Sometimes done in order to control the number of tracks being used, or as a preliminary step to exporting.
Cadence and rhythm	The pace and feel of the edited programme.
Centering the audio	Removing any spatial distribution adjustments to audio in a programme to result in audio that can be heard evenly across left and right speakers.
Chorus effect	A type of multiplier effect where a single voice or instrument can be made to sound like a group of voices or instruments.
Compact Flash	Another commonly used type of flash storage medium. Often referred to as CF.
Cutting	The process of editing and refining audio.

Cutting order	The order in which the audio is going to be edited.
DeciBels (dB)	A standard unit used to measure the loudness, and thereby the related amplitude of a given audio signal.
Destructive & non-destructive editing	Destructive editing is a process where the act of editing changes the source material permanently. Non-destructive editing is a process where the act of editing only changes references to the source material, without affecting their source material itself.
Digital Audio Workstation (DAW):	A computerized system to manage, edit and process audio.
Digital Signal Processing (DSP):	The process of manipulating and adjusting digital audio content.
Distortion effects	Effects like the Flanger – wah-wah which make the original sound feel more unnatural by deliberately distorting the audio.
Dry and wet audio	The raw audio before any effects or processing is called 'dry'audio. The audio once processed or with effects applied is called 'wet' audio.
Editing tools	The tools available within an audio editing software in order to trim, refine, and rearrange audio content within the software.
Equalization	The process of adjusting the relative mix of frequencies in a given piece of audio.
Exporting the final file	Sending the final mixed audio file out of a software editor as a single file in a format and a quality of choice.
Field Recording	A recording conducted outside the studio.
File formats	The specific way in which the audio file stores the digital information. Different file formats employ different algorithms to store the relevant audio information, ranging from comparatively lossy processes to comparatively loss free methods. Common file formats include WAV, MP3, FLAG, OGG.
Final cut	The finished programme that includes all the relevant audio and the related transitions.
Fixed Bit Rate (FBR)	A setting employed while exporting to certain file formats (especially MP3), where the data rate is constant throughout the file.

Flash storage	A type of reusable digital storage medium that is based on electronic transistor gates. Common types are SSDs, SD cards and CF cards.
Graphic overlay tools	Visual tools provided by many software editing tools to allow easy adjustment of parameters like clip volume, stereo panning etc.
Hi pass filter	A filter that allows only high frequency audio to pass.
High Frequency (HF)	Frequencies in the range between 5500 Hz and 20000 Hz. Also known as treble.
Hiss corrector	A noise filter that removes high frequency hiss noise from an audio clip
Importing audio	The process of listing audio references to the clips within an audio software, to allow the placement and manipulation of the audio within the software.
Logging	A list of all the programmes/phone calls received by the radio station.
Low cut filter	A filter that removes low frequencies from an audio clip.
Low Frequency (LF)	Frequencies in the range between 20Hz and 500 Hz. Also known as bass.
Mastering	The process of creating a final mixed down file in an audio format and quality of choice for storage, playback and/or broadcast.
Metadata	Data that describes other data. Metadata can be used to describe digital files such as videos, images, documents, audio files and more.
Mid frequency (MF)	Frequencies in the range between 500 Hz and 5500 Hz.
Mixdown	A final composite track or file which combines all the audio segments of a given audio programme, with all audio level adjustments completed.
Mixing audio	The process of raising and lowering audio levels of different clips in a strategic manner in order to result in smooth transitions between the various segments of the programme.
Mono & Stereo audio	Audio recorded on a single channel without any determination of spatial spread is called Mono audio. Information recorded on two channels which together offer a spatial distribution of the audio is called Stereo audio.

Mono-mix	A final mix that results in audio with no spatial definition, that can be heard evenly across left and right speakers.
Optical storage device	A disk in which laser technology is used to write and read data from the disk. Examples: CD/DVD/Blue-ray disk.
PAN-POT	Short for Panchromatic potentiometer, a tool to adjust the spatial distribution of audio in a stereo space.
Panning	The function provided by the PAN-POT tool, referring to the distribution of audio signals in a stereo space.
Playhead/ Cursor	A tool available in most audio editing softwares to represent the actual point in the audio placed on the timeline that is being played back.
Q-control	A control to set the mid point of an adjustment affecting the mid-frequencies on an equalizer.
Reference track	A track recorded to provide a constant point of reference when recording subsequent tracks as part of a multi-track recording. Also known as a Click track, for the rhythmic clicks often recorded as part of the reference.
Reordering	The process of re-arranging audio clips.
Reverberation/ Echo effect	A type of delay effect that creates a repetition of the original audio after a pause. If the pause is short, the result is a perceived extension of the original sound, called reverb. If the delay results in a distinct gap between original and repeat, the repeat is called an echo
Rough cut	A first assembly of the programme content that approximates the programme.
Safety copy	A backup copy of a file, in order to avoid unforseen losses due to data corruption or system failure.
SD Card	Secure Digital Cards are a type of commonly used flash storage.
Session file	A file opened within an audio editing software in order to conduct the business of editing, mixing and mastering.
Single track & multi-track recording	When a recording places a single or a composite signal on one track of a recording unit, it is called a single track recording. When multiple discrete signals are placed on different tracks on a recording unit, it is called a multi-track recording.
Solid State Devices	Chips that store data. These chips do not have any moving parts but are cost effective.

Spatial distribution of audio	The division of sounds across left and right channels in order to create a listener experience that duplicates the human experience of listening with two ears.
SSD	Solid State Drive. A large capacity drive based on flash storage.
Stereo mix	A final mix with audio distributed across the left and right channels/speakers, in order to create a listening experience that mimics human being by natural hearing.
Stereo transmission system	A transmission system that is capable of broadcasting stereo audio.
Storage device	Storage devices are those that can store an information and support a system for accessing and retrieving the information using a hardware interface.
Studio Recording	A recording conducted within the studio.
Target audio level	A reference level selected for a programme to which all the audio clips will be adjusted in order to achieve a final mix.
Telephone effect	An effect to copy the effect of a voice heard over a telephone instrument, typically by reducing levels, removing the low frequencies, and emphasizing the mid-tones.
Timeline	A tool within most common audio editing softwares which allows one to arrange sections of audio with reference to each other in time.
Transferring audio	The process of moving recorded audio from one device to another, typically from a field recorder to an editing system.
Transitions	The changeover of one audio clip to another, and the effects applied to make that change smooth. (For example, a cross fade.)
Variable Bit Rate (VBR)	A setting employed while exporting to certain file formats (especially MP3), where the data rate varies based on the complexity of the content at a given point in the audio.
Volume Unit (VU) meter	A standard meter used to measure audio levels on a device.

CEMCA

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Certificate in Community Radio Technology

Studio Operations

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Module: 6
Studio Operations

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Certificate in Community Radio Technology

Courses	Modules	Units
Course I: Understanding Community Radio (3 Credits, 90 Hours)	**Module 1** Community Radio: An Introduction	**Unit 1 :** Community Radio: Concept and Evolution **Unit 2:** Context, Access and Equity **Unit 3:** Community Radio: Policy Guidelines **Unit 4:** Technology for CR: Guiding Principles
	Module 2 Setting up of CRS	**Unit 5:** Components of CR Station **Unit 6:** Radio Waves and Spectrum **Unit 7:** Basics of Electricity **Unit 8:** Power Backup and Voltage Stabilization
Course II: Community Radio Production: System & Technology (5 Credits,150 Hours)	**Module 3** Studio Technology	**Unit 9:** Basics of Sound **Unit 10:** Analog and Digital Audio **Unit 11:** Components of the Audio Chain **Unit 12:** Studio Acoustics
	Module 4 Audio Production	**Unit 13:** Audio Hardware and Field Recording **Unit 14:** Free and Open Source Software **Unit 15:** Telephony for Radio
	Module 5 Audio Post Production	**Unit 16:** Sound Recording and Editing **Unit 17:** Mixing and Mastering **Unit 18:** File Formats and Compression **Unit 19:** Storing and Retrieval
	Module 6 Studio Operations	**Unit 20:** Good Engineering Practices for Studio Setup **Unit 21:** Studio Equipment: Preventive & Corrective Maintenance **Unit 22:** Content Distribution: Alternative Mechanisms
Course III: Community Radio Transmission: System & Technology (2 Credits, 60 Hrs)	**Module 7** Radio Transmission Technology	**Unit 23:** Components of Transmission Chain **Unit 24:** Components of FM Transmitter **Unit 25:** Antenna and Coaxial Cable **Unit 26:** Propagation and Coverage
	Module 8 FM Transmitter Setup	**Unit 27:** Transmitter Setup: Step-by-step **Unit 28:** Transmission System–Preventive and Corrective Maintenance **Unit 29:** Transmission Setup–Good Engineering Practices
Course IV: Technical Internship (2 Credits, 60 Hrs)	**Module 9** Practical Internship Handbook	**Section A:** Introduction **Section B:** Activities to be Conducted During the Practical Internship **Section C:** The Internship Journal and Self-Assessment Paper **Section D:** Assessment of Internship **Section E:** Appendices

Video in the Module:

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About the Module

Module Description

Module 6 on studio operations is the last module of Course II: CR Production System and Technology. Module 6 deals with practical aspects of studio installation, operations and maintenance and content distribution using alternative mechanisms. After studying modules 3, 4 and 5 covering studio technology, production and post-production, it is important to learn the practical aspects of the studio operations. This module covers good engineering practices to be followed in installation and operation of the studios, preventive and corrective maintenance aspects to ensure that studio equipment give trouble-free service. This module also covers the study of alternative mechanisms for content distribution. It involves 37 hours of learning and has assignment and video to help your learning. It has three units. With this you will complete studying Course II and will be ready to take up Course III on Transmission System and Technology.

Module Objectives

After completion of the module, the learner should be able to:

- Demonstrate proper techniques of wiring, fixing of connectors, soldering and use of tools and equipment for studio work.
- Carry out preventive and corrective maintenance of studio and equipment installed therein.
- Describe different methods of content sharing using alternative platforms.

Units in the Module

- Unit 20 : Good Engineering Practices for Studio Setup
- Unit 21 : Studio Equipment: Preventive and Corrective Maintenance
- Unit 22 :Content Distribution: Alternative Mechanisms

UNIT 20

Good Engineering Practices for Studio Setup

Structure

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- 20.4.3 Crimping tools

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20.7 Let Us Sum Up

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20.1 Introduction

In Unit 11, you learnt about the working and use of the components of an audio chain, starting from microphones to programme production equipment such as audio mixers and digital work stations. However, in order to get the best performance from these equipment, it is necessary to follow certain good engineering practices during the installation stage itself. "**Good engineering practice**" is a term applied to all the activities related to the quality setup of a studio project. It means that each activity must be completed with perfection and precision. It is a skill which comes with practice. In this unit, you will learn about the good engineering practices involved in the installation, wiring, fixing of connectors, use of tools and equipment, and day-to-day operations in a community radio station especially with reference to studio equipment. In Unit 29, you will learn about the good engineering practices in respect of transmitter, RF cable and antenna system. In this unit, we shall focus on the application of good engineering practices in respect of the following topics:

- Tools and equipment
- Techniques of handling various tools
- Types of connectors
- Types of audio cables

In the video on "Working with Tools", you will get a chance to see the demonstration on the techniques of use of various tools for wiring, soldering, stripping and crimping. It will show various types of audio connectors along with the process and precautions required while fixing of these connectors. The video will also demonstrate the use of test and measuring equipment for checking the performance of the studio equipment. This will definitely help you in understanding the use of a right tool for a specific job.

The glossary at the end of the module shall be helpful in understanding the content of this unit.

You may need about 8 hours to complete this unit including answering the questions given in the Activities.

Key words: Audio/Line cable, Mic cable, RF cable, Connectors, Soldering, Tools

20.2 Learning Outcomes

After going through this unit, you will be able to:

- list, identify and describe various types of cables and their usage.
- list, identify and describe various types of connectors and their usage.

- describe the techniques of using soldering, stripping and crimping tools for wiring and interconnecting of cables in a studio setup.
- describe the process and precautions to be observed while fixing the cable end connectors.
- describe the use of various test and measuring equipment for checking the performance measurements of the studio equipment.

Let us begin with tools and equipment.

20.3 Tools and Equipment

For installation and testing of a CRS, it is essential to follow certain engineering practices in respect of wiring and fixing of connectors. Proper use of tools and equipment helps in achieving quality results. In this section, you are going to study about the list of various tools and equipment required at a community radio station along with the purpose and function of each item. Table 20.1 gives a list of the tools and equipment commonly used at a CRS.

Table 20.1: List of Tools and Equipment along with Field of Application

Sl. No.	Tools and Equipment (including test and measurements)	Field of Application/Use
1	Soldering irons of 40W and 100W with tips of various sizes	For soldering pins of audio cables and connectors.
2	Temperature controlled soldering station with accessories	For soldering joints on printed circuit boards etc. where controlling of temperature is important.
3	Set of screw drivers of assorted sizes	For opening the covers of equipment, accessories and connectors etc.
.4	Set of watchmaker's screw drivers	For opening and tightening of mounting screws of PCBs, miniature connectors etc.
5	Spanner set	For opening and tightening of nuts and bolts.
6	Hand drill with assorted sizes of drill bits	For drilling holes on PCBs and mounting plates.
7	Crimping tools	For fixing the lugs and connectors requiring pressure fitting.
8	Set of pliers (long nose, wire stripper, cutter etc.)	For cutting cables, stripping of cable insulations and fixing of connectors.

9	Multi meter (digital)	For checking voltages, currents and resistances of circuits.
10	Continuity tester	For checking continuity of wires and cables.
11	Phase tester	For checking the availability of phase voltage.
12	Light duty blower/ suction	For removing the dust from racks and cubicles
13	Light duty vacuum cleaner	For cleaning the delicate units such as PCBs.
14	Earth tester	For measurement of Earth resistance.
15	Megger (insulation tester)	For checking the insulation resistance between the live and earth wires.
16	Tong tester (Clip-on-meter)	For measuring the currents flowing through phase wires.
17	Sound level meter	For acoustic measurements of studios.
18	Audio Generator	For feeding audio frequencies at the required frequencies and levels to Equipment while doing the measurements.
19	Audio Analyser	For checking the performance measurements of audio equipment such as frequency response, distortion and signal-to-noise ratio.
20	Cathode Ray Oscilloscope	For studying and analysing the waveforms during repairs and trouble shooting.

In Table 20.1, you can see the function of each tool and equipment and their requirement for the installation of a studio set up in a CRS. The video on “Working with Tools” showing the use of these tools and equipment will make the concepts more clear. Good engineering practices here mean using these items with precision and perfection. However, you will be able to develop the necessary skills only by practice. Before going into the details, you should watch the video, which is available at http://tinyurl.com/nr5rtpc .

Working with Tools

http://tinyurl.com/nr5rtpc

Activity 20.1

While viewing the video, you should note and identify the tools and equipment (including the test and measurements) along with their use. Write down your observations on list of tools and their use as shown in the video and others described in the text of Section 20.3 above in about 100 words in the space provided. To do this activity, you may need about 15 to 20 minutes. This activity will help you appreciate in identification of various types of tools and equipment. This activity may also help you in understanding the necessity of proper tools for different types of applications.

Having learnt the identification and field of use of various tools, we will now proceed to discuss the techniques required while using these tools in the following section.

20.4 Techniques of Handling Various Tools

In this section and the subsections that follow, you will learn about the techniques of handling various tools required for soldering, stripping, crimping and fixing of connectors.

20.4.1 Soldering tools

In this subsection, you will learn about the various types of soldering tools, accessories and techniques required for making a good solder joint. There is a huge range of solder joints to be made in an installation starting from fixing of tiny chip resistors on circuit boards to large size VHF connectors. A large variety of soldering irons, tips and solder wire (metal) are available in the market. You have to choose a right tool for each specific job. In this section, we will focus our discussion on soldering and fixing of connectors on audio cables and soldering joints especially applicable only to CRS setups.

Figure 20.1 shows tools and accessories required for soldering.

Figure 20.1(A): *Soldering station*

Figure 20.1(B): *Soldering tools*

As can be seen in Figure 20.1(A), the list of tools consists of a soldering iron, solder wire, a side-cutter and a few soldering tips of different sizes. Different soldering jobs will need different tools and different temperatures too. For example, for replacing a resistor on a printed circuit board, you will need a fine tip, a lower temperature and finer grade solder. You may also require a magnifying glass to see the fine tracks on the PCB. On the other hand, for fixing an XLR connector, you will require a larger tip, higher temperature and thicker solder. Use of clamps and holders are also handy when you are soldering audio cables. Figure 20.1 (B) shows a temperature controlled soldering station with which you can do good soldering jobs at the required temperature such as on printed circuit boards.

While choosing a soldering iron for a particular application, you may have to consider the following important points:

- Wattage of a soldering iron.
- Adjustable or fixed temperature control settings on a soldering station.
- Portable or bench use type of soldering iron.
- Size of the soldering tip.

Soldering Accessories

In the process of soldering, you may require a large number of accessories which are helpful in doing professional jobs. Some of these accessories with their functions in described brief are below:

(i) Solder

It is the soldering metal which is used for making solder-joints. The most commonly used type of solder is rosin core. The rosin is a flux, which cleans as you solder. Rosin core solder comes in three main types – 50/50, 60/40 and 63/37. These numbers represent the percentage of tin and lead present in the solder as shown in Table 20.2.

Table 20.2: Composition of different types of soldering metal

Solder Type	% Tin	% Lead	Melting Temp (°F)
50/50	50	50	425
60/40	60	40	371
63/37	63	37	361

As can be seen in Table 20.2, the type of solder metal to be selected depends on the percentage of tin and lead used in them. Also note the melting temperature shown against each type of solder metal. Higher the percentage of lead in a solder, higher is the melting temperature.

(ii)Soldering Iron Tips

Tips of different sizes are available. Try to use the right sized tip for the specific job.

(iii) Soldering Iron Stand

It is a heat resistant cradle for your iron to sit in, so that you may not have to put it down on the bench while it is hot.

(iv) Magnifying glass

If you are doing work on PCBs (printed circuit boards), you may need to get a magnifying glass. This will help you see the fine tracks on the PCB. Soldering of small chip resistors are pretty difficult without a magnifying glass.

(v) Solder suckers

These are spring loaded devices that suck the melted solder out of the joint. They help in making a smooth and perfect solder joint.

Soldering Techniques

In order to have a perfectly soldered joint, it is necessary to learn soldering techniques. Soldering technique involves the following four steps:

Step 1: Preparation

Whatever you want to solder, it is necessary to make preliminary preparations such as opening the parts of a connector, cleaning the contact surface area with use of proper tools. Select a proper size tip. An oversized solder tip may even spoil the connector. Take necessary precautions to put the sleeves first on to the cable side before soldering so that these can be fitted to the connector after soldering.

Step 2: Stripping

Strip the insulation of the cable wire up to the length required for making the connection by use of a wire stripper or a knife. Be sure to cut the insulation up to the exact length required otherwise, the connections may create problems. The inner conductor may touch the outer while bending or pulling the cables.

Step 3: Tinning

After stripping the wires to a required length, you should 'tin' the wires and connector pins before you attempt to solder them. This process of tinning coats or fills the wires or connector-contacts with solder so that you can easily make a quick and smooth solder joint. Be careful not to overheat the wire, otherwise cable insulation will also start to melt. The larger the copper core, the longer it will take to heat up enough to draw the solder in. Hence, it is advisable to use a higher temperature soldering iron for larger cables. Once you have tinned both parts, you are ready to solder them together.

Step 4: Soldering

Once you have tinned the stripped strands of the conductor, soldering job becomes easy. You simply need to place your soldering iron onto the contact to melt the solder. When the solder in the contact melts, slide the wire into the connector pin. Remove the iron and hold the wire still while the solder solidifies again. You will see the solder 'set' as it goes hard. This should all take around 1-3 seconds.

If it does not go so well, you may find that either the insulation has melted or the extra solder has made the joint thick enough which may not fit in the connector. If this is the case, you should de-solder the joint and start again. See Box 1 for important soldering tips.

Note It

Box1

Soldering Tips

1. Don't move the joint until the solder has cooled.
2. Keep your iron tip clean.
3. Use the proper type of iron and tip size.
4. Clean the contact-surfaces to be soldered thoroughly.
5. Don't overheat the contacts otherwise the cable insulation or the connector will get damaged.
6. Don't use excess solder metal; otherwise, spike or ball will be formed.

20.4.2 Stripping tools

In this subsection, you will learn the techniques of using stripping tools. Stripping means removing the insulation from the end of the cable and exposing the portion of copper core that is to be soldered. You can either use a wire stripper, side cutter, or a knife to do this. There are many types of wire strippers, and most of them work on the same line. Figure 20.2 (A) and Figure 20.2 (B) show the pictures of a wire stripper and a side cutter respectively.

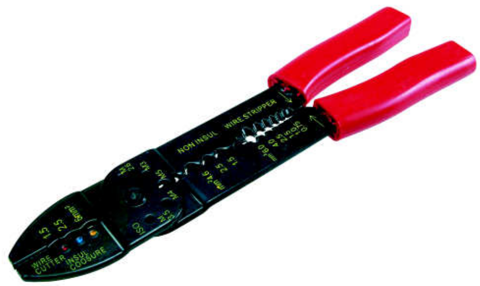

Figure 20.2 (A): Wire stripper   ***Figure 20.2 (B):*** Side cutter

As seen in Figure 20.2 (A), a wire stripper has got pre-set notches for different sizes of cables. Using a right notch will cut the insulation up to the preset depth only and not the strands of the conductors. Be sure to use a proper size stripper, otherwise, you are likely to cut some of the strands of the cable conductor. On the other hand, some people prefer to use a knife or side cutter as shown in Figure 20.2 (B). If you are using a side cutter, you have to be extra careful to cut only the insulation and not the copper conductor.

20.4.3 Crimping Tools

In some of the cases, we require to fix the lugs/connectors on the wires and cables, which may or may not require soldering. In such cases crimping tools are used. Crimping tools are the tools which are used to fix the lugs or connectors by putting a large pressure or a force on them. With a large force/pressure, the strands of a conductor and the sleeve of a lug are compressed to such an extent that the connection becomes a perfect joint.

For example, in case of larger size aluminium core power cables, use of crimping tools is essential as soldering of such cables is difficult. After stripping the insulation of a conductor, use the exact size of lug which just fits on it.

Use of crimping tool however, needs a caution. The lug size must not be more than the size of a bare conductor. The lug fitted on a cable must sit in the jaws of a crimping tool. The pressure applied by the lever-operated handle should be enough to compress the lug to a required pressure. It should not be too high to crush the lug or connector. For fixing lugs on power cables of higher sizes, usually a large lever-operated or even hydraulic crimping tools are used. However, in case of community radio stations, most of the connectors are fitted by soldered joints or by a light duty crimping tools wherever applicable.

Activity 20.2

To do this activity, you may need about 10 minutes to write down the answers in the space provided. This activity will help you in understanding the techniques of using the right tool for each specific job.

Question 1: Why are soldering guns not recommended for printed circuit boards and audio cables?

Question 2: What is the difference between a normal soldering iron and a temperature controlled soldering station?

Question 3: What does a 60/40 type of solder metal mean?

Question 4: What precaution must be observed while using a wire stripper?

Question 5: State a case where crimping tool is necessary.

Now let us move to the next topic, which is on the various types of connectors used in a CRS.

20.5 Types of Connectors

In the preceding sections of this unit, you learnt about the various tools and techniques used for fixing these connectors on cables. In this section and the subsections that follow, you will learn the following types of connectors that are used in a CRS setup:

- Audio connectors
- RF connectors

Let us discuss these connector types one by one.

20.5.1 Audio Connectors

A large variety of audio connectors are available in the market. Of these, the following 3 types of audio connectors are commonly used with audio equipment:

1. XLR connectors

XLR connectors are the most commonly used industry standard connectors. They are also called cannon conductors. The connectors are circular in design and available in 3 to 7-pin types. However, 3-pin XLR connectors are mostly used for feeding balanced mono or unbalanced stereo signals. Even the majority of professional microphones use the XLR connector.

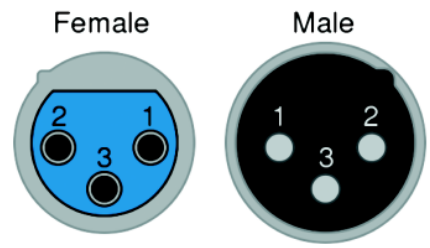

Figure 20.3 (A): *3-Pin* XLR cable connectors ***Figure20.3 (B):*** *3- Pin XLR chassis connectors*

As shown in Figure 20.3 (A) and (B), XLR connectors are available in male and female versions in both cable and chassis mounting designs, comprising a total of four styles. A special feature with XLR type of connector is that the ground connection is established before the signal lines are connected. The pin details of a 3-pin XLR connector are given below:

- Pin 1 is the earth (or shield)
- Pin 2 is the +ve (or 'hot')
- Pin 3 is the -ve (or 'cold)

These pin details are necessary while fixing the connector on an audio cable. Shield is used to connect Pin 1 to the earth wire, whereas red wire is connected to Pin 2 and white /black wire to Pin 1.

2. RCA connectors

The second type of connector, commonly used in audio circuits, is called RCA connector. Such types of connectors are mostly used in consumer-level audio and video systems including home stereos, videos, DVDs etc. Figure 20.4 shows different varieties of RCA connectors commonly used in commercial audio equipment.

Figure 20.4: *RCA connectors*

As you may see in Figure 20.4, the design of these connectors is a simple non-locking male/female connection. The male plug has a centre pin surrounded by a ring, whereas the female socket has a corresponding hole for the pin and a slightly smaller surrounding ring. The connection is made by simply pushing the plug into the socket. It is wired the same way as a mono jack: the centre pin is the +ve, and the outer ring is the -ve or shield.

The most common colour convention used in this type of connectors is as follows:

- Yellow: For video signals.
- Red: For audio (right channel).
- White or black: For audio (left channel).

A common problem with RCA connectors is that the male centre pin can easily touch the female shield ring when making the connection. Also, being a non-locking connector, the connection can fall apart which sometimes causes the centre pin to stay in contact with the ring or other objects. This results in a nasty hum or buzz.

3. TRS (Tip-Ring-Sleeve) connectors

The third type of commonly used audio connector is called a TRS or a phone connector. TRS (Tip-Ring-Sleeve) connectors are known by many different names, such as phone plug/jack, headphone jack or audio jack. This nomenclature is mostly based on their use. The term "jack" is particularly common for this type of connectors. Figure 20.5 shows various types of TRS connectors.

Figure 20.5: *TRS (Phone) male connectors*

Note the size of TRS connectors as shown in Figure 20.5. The length, thickness, shapes and the three parts (tip, ring and sleeve) of each connector may be noted. Even though they may differ in size, shape and length, they are functionally the same. These connectors are very common in audio equipment. The original 1/4" size was used in early telephone switchboards and has since become a standard connector for musical and other audio equipment. The jack is available in three sizes: 2.5mm (3/32"), 3.5mm (1/8") and 6.3mm (1/4") but the wiring for all of them is the same.

Connectors can be either mono (tip/sleeve) or stereo (tip/ring/sleeve). Some plugs are able to carry more signals for use with camcorders, laptops and other applications.

Stereo plugs can also be used to feed a single balanced audio signal instead of unbalanced stereo. Possible configurations are as given here:

	Unbalanced Mono	**Balanced Mono**	**Stereo**
Tip	Signal	Positive / Hot	Left channel
Ring	(Not connected)	Negative / Cold	Right channel
Sleeve	Ground / Return	Ground	Ground

20.5.2 RF (Radio Frequency) Connectors

In this sub-section, we will discuss various types of RF connectors used in a community radio station. The connectors that are used for carrying radio frequency (RF) signals are called RF connectors. The size and type of a RF connector typically depends on the size of cable to which it is connected, which further depends on the frequency of operation and the RF power passing through it. Various types of RF connectors commonly used are:

- N type (Neill) Connector
- EIA type (Electronic Industries Alliance)
- BNC type (Bayonet Neill Councelman)
- SMC (Sub Miniature Connector)
- TNC (Threaded Neill Connector)

For low power FM transmitters and antenna systems, usually ‘N’ type of connectors are used. For high power transmitters (above 1kW) and antenna systems, ‘EIA’ types of connectors are used. BNC types of connectors are common for radio and test equipment and upto exciter stage where the power is 10 to 30 watts. SMC and TNC types of connectors are commonly used for interconnecting the RF stages/modules within the transmitters.

All the above RF connectors are available in two types, namely chassis type and cable end type. Both types are further subdivided into two categories, namely male type and female type. Chassis types (usually female types) are used for mounting on panels of equipment. In field mostly, cable end connectors (usually male type) are used for connecting them on cable ends. Figure 20.6 (A) and 20.6 (B) show N (male) and BNC (male) types of RF connectors.

Figure 20.6 (A): *N (male) type connector*

Figure 20.6 (B): *BNC (male) type connector*

As may be seen in Figure 20.6 (A) and (B), RF connectors are typically used with coaxial cables and are designed to maintain the shielding that the coaxial design offers. The ends of coaxial cables usually terminate with connectors. Coaxial connectors are designed to maintain a coaxial form across the connection.

Another important point about RF connectors is that they must have the same impedance as that of coaxial cables; otherwise there will be signal reflection and losses. In case of FM transmitters, almost all the RF connectors used are of 50 ohm impedance.

Activity 20.3

Imagine that you are working in a community radio station. From the details learnt so far in this unit, previous units, and from the various videos which you have seen, prepare a list of the different types of connectors used, starting from microphone to the antenna system and complete the table given below. Visualizing the audio chain in your mind may help you in answering this activity.

To do this activity, you may need about 20 minutes including writing down the answers briefly in the space provided.

This activity will help you in identifying and understanding the purpose of the use of different types of connectors required in a community radio station.

Sl. No.	Type of connector	Location	Purpose/Function

20.6 Types of Audio Cables

In this section, you will learn about different types of audio cables commonly used in community radio stations. We will also discuss special types of audio cables which are used as microphone cables.

There are two main types of audio cables that are most commonly used in interconnecting of different equipment in an audio chain:

1.Single core shielded cable

In a single core shielded cable, the single core is used as the +ve, or 'hot' and the shield is used as the -ve, or 'cold' line. The constructional details of a single-core shielded cable are illustrated in Figure 20.7.

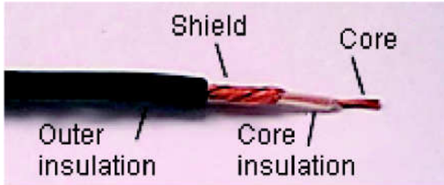

Figure 20.7: *Single-core shielded cable*

As shown in Figure 20.7, a single core cable consists of one inner conductor and a shield separated by an insulating material. The shield works as a second or a return conductor. The audio signal travels between the inner line called a hot line and an earth line. Unbalanced audio cables are commonly associated with the 1/4" TS and the RCA connectors and are used for unbalanced audio systems.

2. Two core shielded cable

A 2-core shielded cable has one core as the +ve line, and the other core as a –ve line. The shield is earthed. Figure 20.8 illustrates the constructional details of a 2-core shielded cable.

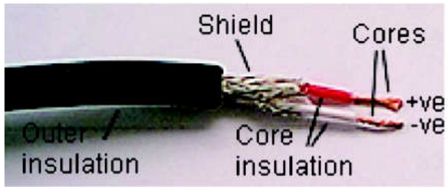

***Figure 20.8**: Two-core shielded cable*

Figure 20.8 shows that a 2-core shielded cable has two inner conductors and a shield; a *hot* line (positive), *cold* line (negative) and an *earth*. This type of cable is used mostly for the balanced audio circuits. The audio signal is transmitted on both the hot and cold lines, but the voltage in the cold line is inverted (i.e. the polarity is changed). Hence, it is negative when the hot signal is positive. It minimizes unwanted noise and interference in audio cables. This type of connection is very important in sound recording and production because it allows for the use of long cables while reducing susceptibility to external noise.

For example, if the power amplifiers of a public address system are located at a distance from the mixing console, it is a normal practice to use balanced lines for the signal paths from the mixer to the amplifiers. Many other components, such as graphic equalizers and effects units, have balanced inputs and outputs.

Balanced circuits use 3-pin connectors, usually the XLR or TRS phone connector. XLR connectors, for instance, are usually used with microphones whereas TRS jack plugs are usually used for mixer inputs and outputs.

Microphone cables

Microphone cables connect microphones to mixers (desk, consoles etc). Most professional mixers' microphone inputs are designed with "balanced" circuits to help decrease or eliminate noise and unwanted radio frequency interference (RFI).

***Figure 20.9:** Twisted pair microphone cable*

As seen in Figure 20.9, a microphone cable consists of a twisted pair of copper conductors (typically 6 mm in diameter). These conductors are covered with one of three types of shielding: braided, spiral, and foil shielding. Braided shield is best for microphone cables whereas spiral shield is a little more flexible and less expensive than braided. Foil shields are unreliable in cables and are designed for portable use.

Good shielding in microphone cables help in preventing electromagnetic interference. Microphone cables are used to carry stereo audio signal of frequency range 20 Hz to 20 kHz having 50 ohm impedance from the microphone to mixing console.

Choosing the right microphone cable

Most professional Low-Z (low impedance) microphone outputs can easily be run up to 500 feet. However, Hi-Z (high impedance) microphones have the same roll off problems that guitar cables have and their lengths should be limited to 20 feet or less to avoid high frequency attenuation.

Microphone cables come in a wide variety of diameters. Nature enthusiasts need for their sound recordings small cables that will roll up into the compartment. To conserve space, Tape recorders use microphone cables about the diameter of a normal pencil (1/4"). Balanced mic cables are quieter than unbalanced mic cables because 1/2 of the signal travels on one of the two conductors and they tend to cancel out extraneous signals that jump on both conductors.

Activity 20.4

To do this activity, you may need about 15 minutes including writing down the answers in the space provided. This activity will help you in identifying different types of audio cables in respect of their constructional and functional details.

Question 1: What is the difference between the unbalanced and balanced audio systems?

Question 2: Why is working with balanced audio system better than unbalanced one?

Question 3: Why is shielding necessary in microphone cables?

20.7 Let Us Sum Up

In this unit on 'Good Engineering Practices', you have learnt that:

- For any project, certain good engineering practices are necessary to get the best quality and performance out of the Equipment installed in that project. Doing the right job in the right manner is a skill that comes only by practice.

- A variety of tools and equipment such as soldering iron, wire stripper and an audio analyser are used for installation, wiring and testing the performance of the Equipment. The video demonstration on use of tools and measuring equipment will further help you in developing the skill and confidence.
- Soldering, stripping and crimping are the techniques which are learnt mainly by practice. You have also learnt and understood certain precautions which are to be taken while soldering and fixing connectors. A little overheating can melt the insulation of the cable connector or the track of the printed circuit board thereby damaging the connector or the PCB.
- Various types of audio and RF connectors are used in the CRS. You have seen that selection and use of the right type of connector is very important.
- Various types of audio cables are used for the interconnection of components of the transmission chain. Both balanced and unbalanced cables are used depending upon the requirements of the circuit. Shielded audio cables help in minimizing the interference in audio signals due to RF pick up, noise and hum.

20.8 Model Answers to Activities

Activity 20.2

1: Soldering guns don't have temperature control and can get too hot easily. This can result in damage to circuit boards, melting of cable insulation, and can even cause damage to connectors.

2: In normal soldering iron, there is no method to control the temperature, whereas in the temperature controlled soldering station, the temperature can be preset to any desired temperature.

3: It means that soldering metal consists of 60% of tin and 40% of lead.

4: A proper size wire stripper must be used, which may only cut the insulation and not the strands of the conductor.

5: In case of power supply cables having aluminium conductor where soldering is not practically possible, lugs are fitted by use of proper size crimping tools.

Activity 20.4

1: In unbalanced systems the audio signal flows between one line and the earth, whereas in balanced circuits, the signal flows between two lines independent of the earth wire.

2: Working with balanced systems is better as they are less sensitive to noise and interference.

3: Since the output of a microphone is of very low level, shielding of the cable protects the signal from interference due to noise and hum.

20.9 Additional Readings

- *Electrical connector – Wikipedia, the free encyclopedia*. (n.d.). Retrieved March 3, 2014, from http://en.wikipedia.org/wiki/Electrical_connector
- *Florida Sound Engineering Co., Inc. | Welcome! | Home Page*. (n.d.). Retrieved from http://www.floridasound.com
- *Media College – Video, Audio and Multimedia Resources*. (n.d.). Retrieved from http://www.mediacollege.com
- *Pro Co Sound – On Stage with the Best*. (n.d.). Retrieved from http://www.procosound.com

UNIT 21

Studio Equipment: Preventive and Corrective Maintenance

Structure

21.1 Introduction

In Unit 11, you learnt about the functioning of equipment used in audio chain of a CRS studio. In Unit 20, you learnt about the good engineering practices used in installation, wiring and testing of studio equipment. In this unit, you will learn about the preventive and corrective maintenance aspects of studio equipment, which are essential to keep them in perfect working condition. This helps in timely detection and forewarning about the likelihood of occurrence of any major fault or malfunctioning of studio equipment which may result in service breakdown. Preventive maintenance implies regular cleaning, checking, testing and measurement of equipment to keep them in working order as per accepted norms and standards, which may help in preventing a major breakdown. Corrective maintenance can be defined as the maintenance which is required to bring the equipment back to the working order once it has failed or worn out. A regular preventive maintenance schedule such as weekly, monthly, quarterly etc. helps in achieving this purpose. In this unit, we will discuss the following issues:

- Importance of cleanliness and dust-free environment in studios
- Dressing of cabling
- Earthing of equipment
- Handling of microphones
- Ventilation and fresh air in the studio
- Maintenance of Digital Audio Work Stations (DAWs)

You may require about 6 hours of study to learn this unit including answering the questions given in the Activities.

The glossary given at the end of the module will help you in understanding the content of this unit.

21.2 Learning Outcomes

After completion of this unit, you will be able to:

- describe the importance of cleanliness and dust-free environment in the studios.
- explain the purpose of dressing of cables.
- underline the importance of earthing of equipment and check earth connectivity.
- describe the process involved in handling of microphones.

- discuss the issues related to the maintenance of AC plants and ventilation in the studios.
- describe the maintenance of DAWs.

Let us begin with cleanliness and dust-free environment.

21.3 Cleanliness and Dust-free Environment

We all know cleanliness is next to godliness. The studio environment is to be kept clean and dust-free because dust is one of the main enemies of broadcast media (including CDs/tapes) and playback/recording equipment. Cleanliness is absolutely necessary. No eating, drinking or smoking is to be permitted inside the studio premises. All rubbish must be thrown in the dustbins. Dust can damage console faders, switches, CD Players, DAWs and other switch gear. Dust is the enemy of electrical contacts and faders. Dust and dirt prevents the intimate contact of replay heads to media which is essential for the accurate retrieval of information. Dust can cause "head crashes" of computer hard discs which may lead to irretrievable loss of data. The effective prevention of dust and other kinds of dirt is, therefore, an indispensable measure for a broadcast environment. For this purpose, routine dusting with anti-static dusting should be done daily. A head cleaner or alcohol can be used for cleaning of fader contacts and switches. A schedule should be prepared for keeping the equipment clean and dust-free. For this purpose, the following guidelines may be followed:

- Use a light duty blower for suction of dust from equipment and racks.
- Clean all rack-mounted equipment in control room and studio.
- Clean all the tag blocks, patch cords and patch panels.
- Clean recording and playback equipment and all PCBs.

Activity 21.1

To do this activity, you may need about 10 minutes including writing down the answers in the space provided. This activity will help you in understanding the importance of cleanliness and dust-free environment in respect of preventive maintenance.

Question 1: Why is a clean and dust-free environment important for broadcast equipment?

Question 2: What steps should be followed for keeping the equipment dust-free?

Having learnt the importance of cleanliness and dust-free environment, we will now discuss dressing of cabling.

21.4 Dressing of Cabling

In this section, you will learn the significance of dressing of cables. Dressing of cables plays a very important role in preventive maintenance. Cable dressing means properly aligning and positioning the cables in a neat and orderly manner in the studio trenches and audio racks. Proper cable termination practices should be followed for the complete and accurate transfer of both analogue and digital information signals. All the cables should be properly identified and labelled. Extra length of cables should be avoided and cables should not be too long. However, enough slack in length should be left in case it needs to be re-terminated or rerouted for any reason. All the signal cables, except power cables, should be laid parallel and orderly bunched. Tie wraps or hook and loop straps should be used to secure the cables and they should be evenly spaced throughout the dressed length. Cable dressing ensures that cables used are neatly arranged and easy to trace, when required. All the audio wiring and power wiring should be laid separately; otherwise there may be hum generation. For this purpose, cable documentation should be done to keep track of types of cables laid, their destination, numbering for identification, the path followed and termination details. The following guidelines may be followed for cabling:

- Use separate paths for power and signal/audio cables so as to reduce the electromagnetic induction effect (EMI).
- Wherever the power and audio cables must cross, these should be laid at right angles to neutralize EMI effect.
- Cables should be properly tagged, strapped, identified and laid in trenches/racks.
- All signal/audio cables should enter from the left side of the rack at the back and power cables from the right side of the rack.
- Use contact cleaner for cleaning the contacts to ensure good contact.

Activity 21.2

To do this activity, you may need about 10 minutes including writing down the answers in the space provided. This activity will help you in understanding the necessity of dressing of cables.

Question 1: Why is dressing of cables needed?

Question 2: What guidelines should be followed while laying power and audio cables in a studio?

Now let us proceed to discuss the next section which is on earthing connections.

21.5 Earthing Connections

In this section, you will learn about the significance of earthing connection in a studio set up.

As a safety measure, earthing is essential and mandatory. Earthing connects the body of the equipment to the earth electrode. It is a physical connection between the exposed metallic parts of an electrical equipment/appliance and the earth, which is known to have zero potential. Proper earthing provides an alternative and easy path for leakage or faulty current to flow. It ensures that any exposed conductive part of the appliance does not reach a dangerous level of potential or voltage that endangers the user's life. For any electrical system to be safe, proper insulation and earthing must be provided for protection and safety of staff and equipment operations. Earthing is done to provide a conducting path to the ground for the fault current which may flow due to a short circuit. The body of the equipment is earthed so that fault current flows to the ground and the operator remains safe; otherwise the operator may get a fatal shock. For this purpose, a pit is formed by digging the earth and putting some charcoal and salt at the bottom and placing a metallic plate with an electrode over it, to which earthing copper or aluminium metal strip is connected. As a precautionary measure, there should be at least two independent earthing connection paths for safety of equipment and personnel. A proper earthing system should have least electrical resistance. Lower the earth resistance, better it is for the safety of equipment and personnel. The earth resistance can be measured using an instrument called 'Megger'.

Failure of earthing can result in:

- Danger to equipment and operating staff due to short circuit and malfunctioning of electrical switch gear.
- RF pick up from nearby radio frequency sources leading to noise and distortion in sound recording and broadcast.
- Following steps can ensure prevention of faults due to bad earthing:
- Regular inspection of earthing strip or cables.
- Watering of earth pits regularly to keep earth resistance within specified limits.
- Regular checking of continuity of earthing connection from equipment to earth pits.
- Measuring earth resistance every quarterly.

Activity 21.3

To do this activity, you may need about 10 minutes including writing down the answers in the space provided. This activity will help you in understanding the necessity of earthing in a studio setup.

Question 1: What is the importance of equipment earthing?

Question 2: What is the importance of checking continuity between the equipment and earth pits?

Having learnt the importance of earthing in studios, we will now discuss the next topic, which is on handling of microphones.

21.6 Handling of Microphones

In this section, you will learn about the practices to be adopted in handling of microphones. Microphones are costly equipment and extremely fragile. Microphones are very stable over long periods of time, provided that they are handled properly. The components of the microphone are fragile and can get damaged by misuse. The following practices should be adopted for proper functioning of microphones:

- Keep it clean. The microphone screen can get dusty. It should be cleaned regularly.
- All the microphones have a diaphragm in one form or the other. The diaphragm is exposed to the air. So it should be protected and handled carefully.
- High-sound pressure levels (SPL) can damage the diaphragm.
- Most of the microphones are made of metal, which can rust easily. To prevent rusting, a bag of silicone gel should be kept inside the microphone case.
- The ribbon microphones should be stored vertically because the ribbon inside the microphone is installed vertically. This prevents any slack in the ribbon if stored horizontally.
- Keep condenser microphones out of direct sunlight because high heat can damage the diaphragm.
- Phantom power, i.e., + 48V should be switched off or disabled before plugging in/out ribbon microphone.
- Microphones should not be installed too close to a loud/blaring instrument as this will damage the diaphragm.

Activity 21.4

To do this activity, you may need about 10 minutes including writing down the answers in the space provided. This activity will help you in understanding the precautions and instructions required while handling the microphones.

Question 1: What precautions should be followed while handling various types of microphones?

21.7 Ventilation and Fresh Air

In this section, you will learn that by maintaining the ventilation equipment properly, occurrence of a number of faults in studio equipment can be averted. An efficient ventilation system and its proper maintenance are essential for the broadcast studio environment. For this purpose, an air conditioning system is provided for cooling and dehumidification in the studios. This involves control of temperature, humidity, ventilation and movement of fresh air. Ventilation is a process by which stale air is removed and fresh air is supplied to the studios. Regular preventative maintenance of AC plants is, therefore, essential to ensure trouble-free operation of the studio equipment. It helps in improving the quality of programme production as well. Pre-season maintenance is also important. It can help to avoid a system failure in severe hot or cold conditions. While the system is in operation, the following monitoring checks should be carried out regularly as part of routine maintenance:

- Measure indoor dry and wet bulb temperature.
- Measure and adjust air flow.
- Check vent system for proper operation.
- Listen for any abnormal noise.
- Inspect, clean and change air filters.
- Inspect and clean blower assembly.
- Inspect for any gas leakage.
- Check thermostat settings.
- Check electrical connections.
- Lubricate moving parts.

Activity 21.5

To do this activity, you may need about 10 minutes including writing down the answers in about 50 words in the space provided. This activity will help you in understanding the techniques of maintenance of ventilation system including air-conditioning of studios.

Question 1: What are the monitoring checks to be followed for maintenance of AC plants and ventilation system at the studios?

21.8 Preventive Maintenance of Digital Audio Workstations

In the preceding section you learnt about the technique of maintaining ventilation system in the studios. In this section, you will learn the steps to be taken for maintaining the digital audio workstations.

As mentioned in earlier units, Digital Audio Workstations (DAWs) are used for recording and playback in broadcast studios. It is an high-end computer having large RAM and hard disk capacity with professional audio cards and professional audio software for programme production and playback. Preventive maintenance of DAWs is essential for reliable functioning. It helps to detect serious problems, prevent system crashes and reduce equipment down time. A regular periodic maintenance schedule should be drawn up to take care of the following issues involved in maintenance of DAWs:

- Scan the memory and hard disk of the DAW regularly to protect the system from any virus. For this, use a genuine professional antivirus software.
- Always keep the backup of important data and program files.
- Clean CPU fan, CPU, keyboard, mouse etc. to make the system dust-free.
- De-fragment the hard disk.
- Run system performance diagnostics to check the health status of the DAW.
- Always maintain system software and networking updates.
- Do head cleaning of CD drives periodically.
- Do cleaning of cards, subassembly units and other components at regular intervals.
- Check and maintain UPS and its batteries. Always make a habit to put the load on battery to ensure that the system is capable of working on battery backup during mains failure. Overcharges and deep discharges reduce the life of batteries.

Activity 21.6

To do this activity, you may need about 10 minutes including writing down the answers in the space provided. This activity will help you in understanding the techniques of doing the preventive maintenance of DAWs.

Question 1: How can you prevent virus attack to your digital audio workstation?

Question 2: Why should you take a regular backup of data?

21.9 Let Us Sum Up

In this unit, we have discussed preventive and corrective maintenance of studio equipment and system. In this process, you have learnt that:

- A dust-free and clean environment is very much essential in the broadcast studios. It helps in curtailing the occurrence of faults due to accumulation of dust.
- Dressing of cables with proper identification and termination helps in ease of cable tracing in case of cable faults.
- Maintenance of ventilation equipment and uninterrupted connectivity reduces the breaks in transmissions.
- Earth conductivity and continuity of earth connections to studio equipment and racks is important for protection of equipment and staff in case of short circuit and lightning. Earth resistance should be very low for this purpose.
- Microphones are delicate equipment. These are essential for recording and broadcasting of programmes and should be handled with care to prevent any damage.
- Regular preventive maintenance of AC plants and other ventilation equipment is to be carried out. This helps in controlling rise in temperature, humidity and improving ventilation in studios.
- Nowadays high-end computers, called Digital Audio Workstations, are used for recording and playback of programmes in broadcast studios. Regular maintenance of DAWs should be done to prevent their failure and loss of data stored on hard disks. Use of properly rated UPS systems and maintenance of batteries help in curtailing faults due to failure or variations in mains supply.

21.10 Model Answers to Activities

Model answers to questions given in Activities 21.1 to 21.6.

Activity 21.1:

1: Dust can damage console faders, disk heads of CD players and audio workstations.

2: Do not allow eating and drinking in the studios. Do routine dusting daily with anti-static duster. Use a head cleaner for cleaning of fader contacts and switches.

Activity 21.2:

1: All the cables should be properly identified and labelled as this helps in ease of cable tracing in case of cable faults and relaying.

2: All the audio and power wiring should be laid separately otherwise there may be hum generation due to electromagnetic induction.

Activity 21.3:

1: Proper earthing provides an alternative and easy path for leakage or faulty current to flow. This prevents danger to equipment and operating staff due to short circuit and mal-functioning of electrical switch gear.

2: To protect equipment and staff in case of short circuit and lightening, it is essential to regularly check continuity between earth connections and studio equipment.

Activity 21.4:

1: Microphones are delicate equipment. These are essential for recording and broadcasting of programmes and should be handled with care to prevent any damage.

Activity 21.5:

1: The following checks will be done:

- Measure indoor dry and wet bulb temperature.
- Measure and adjust air flow.
- Check vent system for proper operation.

- Inspect, clean and change air filters.
- Inspect and clean blower assembly.
- Check for any gas leakage.
- Check thermostat settings.
- Check electrical connections.

Activity 21.6:

1: Install anauthenticated anti-virus software and regularly update for latest virus definition database.

2: Regular data backup should be undertaken to prevent any loss of data due to hard disk failure.

21.11 Additional Readings

- Gookin, D. (2009). *Troubleshooting & maintaining your PC all-in-one for dummies: [6 books in one ; hardware, software, laptops, internet, networking, maintenance]*. Hoboken [NJ: Wiley.
- McCartney, T. (2003). *Recording studio technology, maintenance, and repairs*. New York: McGraw-Hill.

UNIT 22

Content Distribution: Alternative Mechanisms

Structure

22.1 Introduction

In unit 14, you learnt about the open source software used for recording, editing and playback of programmes in production studios. In unit 15, you learnt about the telephony application software for phone-in, SMS, IVRS etc. In Units 16 to 19, you learnt about the sound recording and editing, mixing and mastering, file formats and compression, and storing and retrieval of programmes in studios only. However, in this unit, you will learn about distribution and sharing of content using alternate platforms.

In an era of convergence of media, it may feel very restrictive to use only FM medium to reach to your audience. As we know the FM radio is bound by the geographical boundaries based on the transmission power. In the case of community radio in India we are bound by 50 Watts of power that roughly translate to a coverage radius of about 10 km. On the other hand, the technology is surpassing the geographical limitations. An email sent from a desktop can reach anywhere in the world in a matter of seconds, whereas a voice on FM radio may not reach beyond 10 km. As the technology advances you may realize that there are many ways to reach out to your target audience. Hence it would be useful for a community radio technologist to understand alternative mechanisms to broadcast in addition to the FM radio.

Apart from understanding different technologies for communication, it is critically important to understand how we can forge a convergence of media. In other words, we need to understand how different technologies can feed into each other and make use of strategic advantages of available mediums like the Internet, mobile etc.

In addition to the use of alternative mediums, there is also a vast potential to sharing programmes, information and skills with other radio stations. With the growth of the Internet, sharing has become easier and there are quite a few ways of sharing content. In this Unit, you will learn about how to broadcast on Internet, share content and even create community owned communication infrastructure based on wireless technology. Therefore, in the process of learning of this unit, we will discuss the following topics one by one as given below:

- Internet
- Wireless Mesh Networking (WiMesh)
- Mobile Telephony

To complete this unit, you may need about 6 hours of study. The glossary at the end of the module will help you in understanding the contents of this unit.

22.2 Learning Outcomes

After going through this unit, you will be able to:

- describe various alternative platforms available for publishing and broadcasting.
- discuss strategic advantages and disadvantages of alternative platforms.
- analyse various methods of convergence of tools.
- list out and describe various content sharing methods.
- describe the fundamentals of wireless networking.
- discuss the use of mobile telephony as a broadcasting mechanism.

Let's now begin with the Internet.

22.3 Internet

All of you are more than familiar with the Internet. However, what we are going to learn here is the use of Internet as an alternative publishing medium or a medium to share content across the world and other community radio stations. It may be noted here that though Internet is a very powerful tool, its reach in the rural parts of India is still not upto the mark. The access of Internet is far less than what is desirable. Hence in the present scenario, it cannot be seen as an alternative to terrestrial radio but can be used as a supplement. In this section and the sub-sections that follow, we will discuss some of the more popular and technically advanced methods of sharing content over internet which include:

- Podcasting
- Streaming
- Social networking
- Content sharing sites

22.3.1 Podcasting or Audio Blogging

Podcasting is a method of publishing in which an audio or video file is stored on a web server and listeners can listen to the file either through a browser or by virtue of being a podcast client. This is a good example of push technology which works on publisher and subscriber model. There are many podcast clients available on the Internet for listeners as well as publishers. In addition, there are plenty of sites that allow you to create a podcast account. Using such podcast account, you can publish your audio or digital content on the Internet. You can even embed a podcast link in your website so that a listener can listen to your audio on your website rather than going on to the third website.

The term podcast is a combination of two words Ipod — which is a popular audio device by Apple Inc — and Broadcast. Many users of the technology have opposed the term podcast as they say it gives undue credit to Apple which had very little to do with the development of the technology. Those who are opposed to the term podcast refer it as Audio Blogging.

The Audio Blogging or Podcast uses the unicast protocol. Unicast protocols send a separate copy of the media stream from the server to each recipient. This model, however, does not scale well when many users want to hear the same audio programme concurrently.

Podcast should not be confused with webcast which is a concept that refers to streaming technology. There is a basic difference between Podcast and Streaming. We will learn about it in subsequent paragraphs.

Podcast require a podcast server which could be similar to a web server. However, a specific programme should be running for any web server to act as a podcast server as well. It is possible to run a podcast server out of your own desktop computer but it may not be a very feasible option since you have to keep your desktop machine power on all the time. Also there are security risks if the protection provided along with podcast is not up to date.

The other alternative is to use one out of many hosted solutions. Many groups and companies provide hosted solution for podcast. Some of them charge monthly or yearly fees, whereas some are completely free of cost. You may choose one of them to suit your requirement.

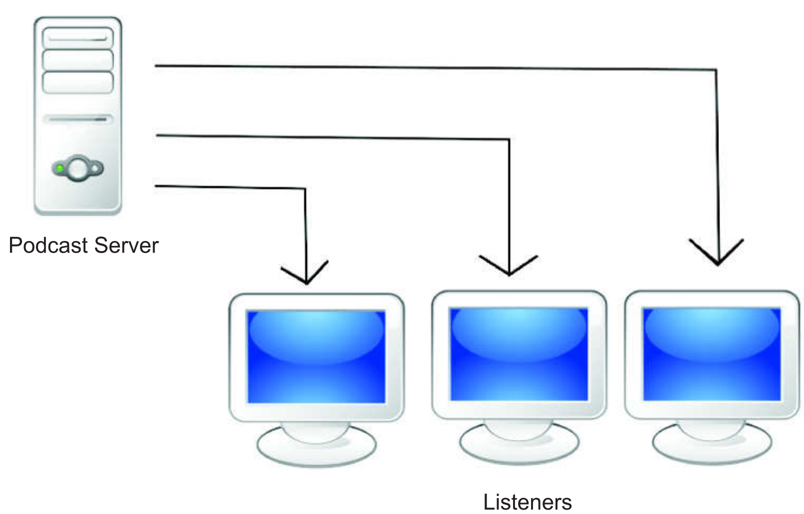

Figure 22.1: *Unicast network*

Figure 22.1 shows a typical example of Unicast Network. As you can see in the figure, the server is putting out different stream of data for each listener.

22.3.2 Streaming

Streaming is the closest counterpart on Internet to FM broadcast. If you are doing a live broadcast on your FM based community radio, the listeners at the other end can receive your voice almost simultaneously. They can listen as you speak. In other words, they are listening on real-time basis. Similarly, in streaming over Internet, the audio content is delivered to the listeners on a real-time basis.

Unlike audio blogging, the streaming content does not need to be placed on the server but the listener can stream directly out of the publisher's desktop. Most audio streams use multicast protocol. This protocol sends a single stream from the server to all the connected recipients. This protocol was developed to reduce the server/network loads resulting from duplicate data streams that occur when many recipients receive unicast content streams independently.

Use of multicast protocol has certain limitations since the recipient does not have an audio-on-demand facility. For example, if an audio programme starts at 12 noon and a listener joins the stream at 12.30, he or she would lose half an hour of programme, just like in an FM radio. Also you cannot play back a content that is streaming. However, there are ways to mitigate this limitation by deploying caching servers or buffered media players.

Streaming requires a streaming server and a streaming client. Again, you have a choice of hosting your own server. What you need to consider here is that what kind of Internet bandwidth is available to you. Remember that a streaming server hosted at your own location would consume a lot of bandwidth and you may find it difficult to carry out your normal Internet work like checking emails or surfing a website. Also a low bandwidth will restrict the number of simultaneous listeners you can have. Needless to say, lower the bandwidth, lower the number of listeners. However, you can increase the number of listeners on a lower bandwidth if you are willing to compromise with audio quality. Alternatively, you may consider a hosted solution. There are many companies around the world which provide hosted solution. However, practically none of them are free. They charge nominal fees for a year or month.

There are several types of streaming servers. The prominent among them are Windows Media Services, developed by Microsoft and Darwin Streaming server developed by Apple Inc. Both these servers are proprietary and they do not come for free. ShoutCast is another streaming server developed by Nullsoft, a company that is known for its popular Winamp media player. ShoutCast is available free of cost but it is not an open source application. The Nullsoft has kept it as a proprietary solution. One of the most popular streaming server is called IceCast. The IceCast is the most versatile and is free of cost and also available in open source domain.

The server applications mentioned in the previous paragraph are to be installed on a server. Also, you will need a desktop software that will encode your audio and stream up to the server which in turn will stream down to the listeners.

It is noteworthy that, with growing number of smart phones in the market, the streaming audio has become one of the critical ways of distributing content. Any mobile phone that is running Android, Blackberry, Windows or IOX can receive a stream generated by servers.

Following is the list of clients available for Icecast server. Note that this is just an indicative list. You will find many more sophisticated and versatile clients across various operating systems. GRINS, a radio automation software promoted by Gram Vaani, also allows simultaneous streaming to Icecast server.

Source clients

The source clients that are known to work with Icecast 2 are given in Table 22.1 and Media players that support Icecast 2 are shown in Table 22.2.

Table 22.1: Source clients

Application	Platform	Download Link
IceS	Linux/Unix	http://www.icecast.org/ices.php
Oddcast/Edcast	Windows	Formerly at http://www.oddsock.org/tools
Edcast reborn	Windows	http://code.google.com/p/edcast-reborn/
Muse	Linux/Unix	http://muse.dyne.org
Darkice	Linux/Unix	http://darkice.sourceforge.net/
SAM2	Windows	http://www.spacialaudio.com
ezstream	Windows	http://www.icecast.org/ezstream.php
Nicecast	Mac OSX	http://www.rogueamoeba.com/nicecast/
IceGenerator	Linux/Unix	http://sourceforge.net/projects/ icegenerator
Orban Opticodec-PC	Windows	http://www.orban.com/
freej	Linux/Unix	http://freej.org/
Traktor DJ Studio 3	MacOS X, Windows	Native Instruments
Savonet/ Liquidsoap	Linux/Unix, Windows	http://savonet.sourceforge.net/
DeeFuzzer	Linux/Unix	http://pypi.python.org/pypi/DeeFuzzer/

RoarAudio	Linux/Unix, Windows	http://roaraudio.keep-cool.org/roaraudio.html
RoarAudio PlayList Daemon	Linux/Unix, Windows	http://roaraudio.keep-cool.org/rpld.html
butt - broadcast using this tool	Linux/Unix, Mac OSX, Windows	http://butt.sourceforge.net/
Mixxx	Linux/Unix, Mac OSX, Windows	http://mixxx.org/
iCast	iOS	http://icast.anthonymyatt.net
MPD - Music Daemon	Linux/Unix, Mac OSX	http://mpd.wikia.com/wiki/Music PlayerDaemon_Wiki
KRADradio	iOS	Linux/Unixhttp://kradradio.com/

Table 22.1 gives a list of source clients using application with platform. Download link of each application is also shown along with them for easy reference.

Table 22.2: Media players that support Icecast streaming

Application	**Platform**	**Download Link**
foobar2000 (mp3 + ogg vorbis)	Windows	http://www.foobar2000.org
winamp 2.x, 5.x (Not 3.x) (mp3 + ogg vorbis)	Windows	http://www.winamp.com
XMMS(mp3 + ogg vorbis)	Linux/Unix	http://www.xmms.org
Zinf(mp3 + ogg vorbis)	Linux/Unix, Windows	http://zinf.sourceforge.net
MPlayer	Linux/Unix, Windows, Mac OSX	http://www.mplayerhq.hu
Xine	Linux/Unix	http://www.xine-project.org/home
VLC	Linux/Unix, Windows, Mac OSX	http://www.videolan.org

Figure 22.2 is an example of Multicast Network. As you can see in the figure, the media server is putting out one stream and the same stream is being tapped by multiple users

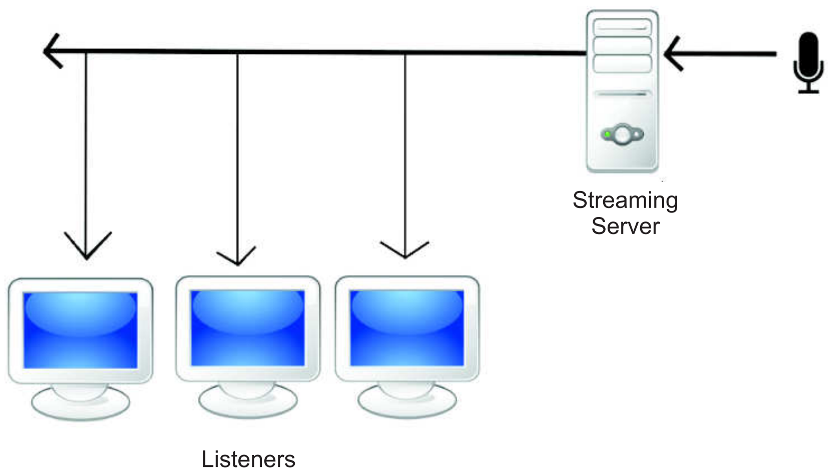

Figure 22.2: *Multicast network*

Activity 22.1

Search for an audio blogging portal and note one blog on the community media course you have undertaken. You can search for free blogging sites on your search engine and choose the one you like. Also write the name of the blog writer and the website searched.

To do this activity, you may need about 15 minutes including writing down the answer in the space provided.

This activity will help you in understanding and using the alternative platforms available for content distribution.

22.3.3 Social Networking Sites

Social networking sites have become very popular in the past few years. Sites like Facebook, Youtube, LinkedIn or Myspace have millions of users who can turn out to be your listeners if you know how to use the social networking sites effectively. Though there is no single formula to be effective on these social networking sites which are very dynamic and evolving, some suggestions are given below to help you in making use of these sites.

- Popularise your radio station by having a dedicated page on social networking sites like Facebook, Twitter, Pinterest or MySpace. You can even publish your schedule on these sites and write about the programmes your station is broadcasting.

- Put a direct link to your podcast or live stream (you will learn about live stream later on in this unit).
- Use these sites as a feedback mechanism if your radio station is broadcasting in the areas where your listeners have Internet access.
- You can even upload audio or video giving glimpse of your programme on these sites.

22.3.4 Content Sharing Sites

Content sharing in a multi-lingual and diverse country like India is a very complex concept where not only the language but even the dialect matters. Even otherwise the core concept of the community radio is community-specific programming which limits the use of content sharing among the community radio stations.

Sharing of content goes a long way in enhancing the scope of learning. It is not only about sharing content but it is also about sharing ideas, concepts, formats and style. Internet plays an important role in exchange of programmes among the community radio stations.

There has been a slow start to the idea of content sharing in India. The first portal that came up was EK duniya anEK awaz. Available at http://www.edaa.in, it is now publishing user generated content in 26 languages. You can upload the content for free as all the content uploaded on the site is available for free under creative common license. Yet another initiative called Manch has been launched in 2013 for encouraging content sharing and collaboration among community media practitioners. The site is available at http://manch.net.in.

Activity 22.2

Write a blog on the current important event of the day. Publish your blog on a social networking site and see your popularity by seeing the comments of friends and users.

To do this activity, you may need about 15 minutes including writing down the blog in about 50 words in the space provided.

This activity will help you in understanding the method of sharing the content of the blog written by you with your friends and listeners.

22.4 Wireless Mesh Networking (WiMesh)

Many believe that Wi-Fi Mesh Networking, which is also known as WiMesh, can make our world more connected than it is today. This emerging technology can seamlessly connect vast geographical area in the most humane way. Some experts also assert that WiMesh is more a sociological project than a technical one.

A wireless mesh network, in very simple terms, can be described as a network of hundreds or even thousands of wireless devices which are capable of transmitting as well as receiving RF signals. The most commonly used device in a mesh network is the commonly available Wi-Fi routers, which are used in offices or homes for distributing Internet connectivity. These routers in a mesh network are called nodes that talk to each other. These nodes not only transmit data generated by its owner but also help passage of data generated by other nodes. Nodes use the common Wi-Fi standards known as **802.11a, b and g** to communicate wirelessly with users, and, more importantly, with each other. Radio signals generated and received by the Wi-Fi devices are at a higher frequency of 2.4 GHz and 5.8 GHz as against 88 MHz to 108 MHz in FM.

There are multiple uses of such networks. Imagine your office or a home Local Area Network that is expandable to your entire village or even city. In that case you can easily run a community radio over Internet or you can even run a community TV. You can have a telephone system that does not cost you when you receive or make a call. You can easily give Internet access to most remote areas or run tele-education programme in a school or even run a tele-medicine programme in your village. The usage of such a network is of immense value but the cost is negligible.

The most important advantage of such network is the fact that you do not require a license from the Government since frequency spectrum of 2.4 GHZ and 5.8 GHz have been de-licensed almost in all the countries including India.

Figure 22.3 shows how a small village can form a wireless network. All the houses in a village are wirelessly linked to each other. Each house is having at least two wireless access points. Note that there is also Internet gateway. Similarly, the second image in Figure 22.3 shows how many villages which have their own wireless network can be linked to each other.

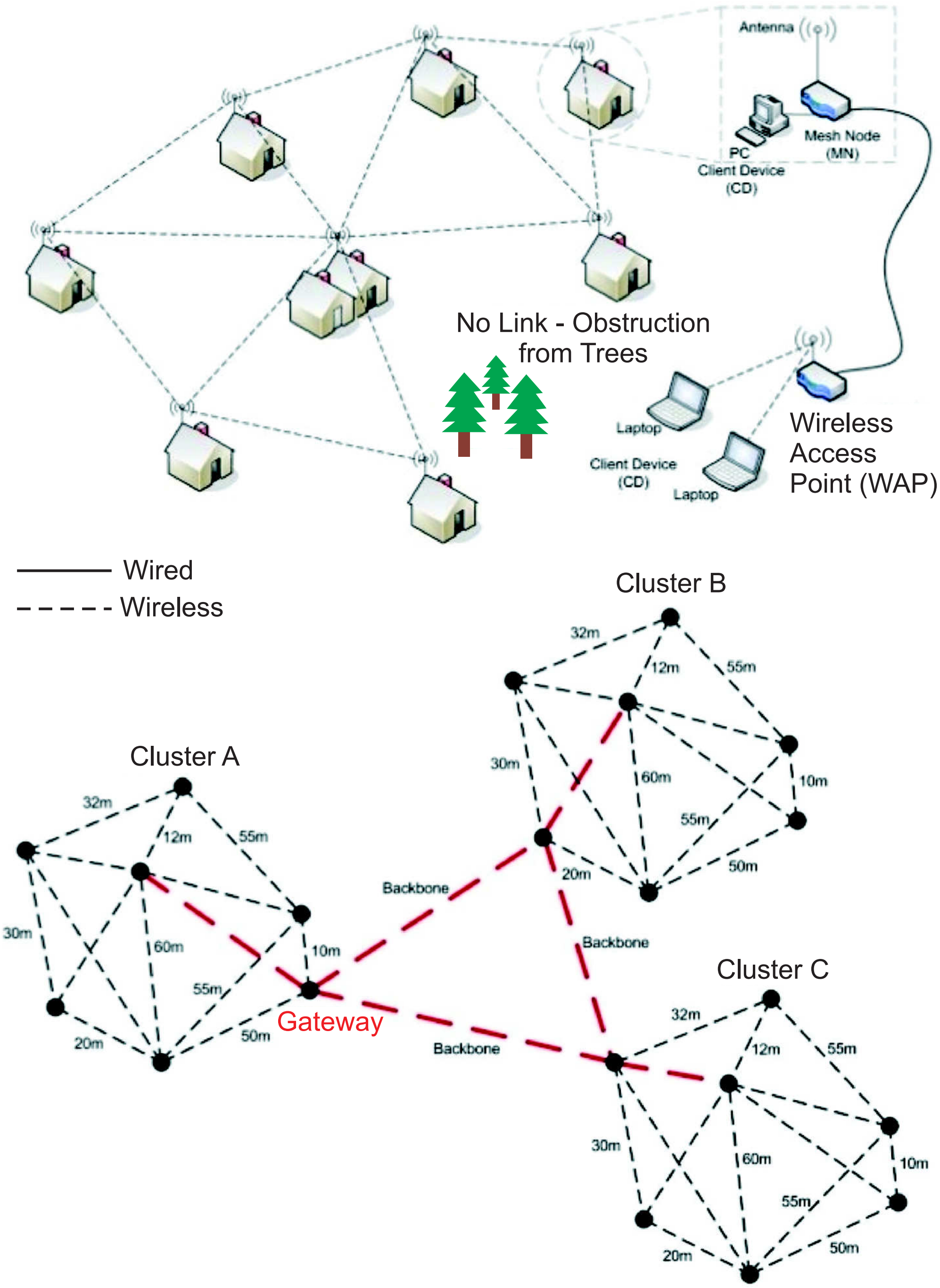

__Figure 22.3:__ Clustered mesh with backbone

Activity 22.3

Prepare a small map, using any mapping site like http://maps.google.com for a possible mesh network in your neighbourhood. You will have to find out your location on the google map and other locations which you want to cover under your network. Once you have identified the locations, draw a line linking them.

Label them on the lines similar to that shown in Figure 22.3.

To do this activity, you may need about 30 minutes including writing down the answers in the space provided.

This activity will help you in understanding the use of mapping sites for creating a mesh network in your neighbourhood.

22.5 Mobile Telephony

In this section, you will learn how a mobile phone can easily be used for distribution of digital content. It is a well known fact that if there is any communication medium in the hands of the largest number of people in India, it is the mobile phone. Using mobile phone for distribution of digital content or even broadcasting is a reality that a radio technician today cannot afford to ignore. Though there are many possibilities, a few tried and tested ways of distributing content on mobile phone include:

- Caller tunes
- IVR based audio repository

We will briefly discuss them here.

22.5.1 Caller Tunes

If you have a short but very catchy audio clip which you may want to convert into a caller tune for mobile phones, you can create a page on your website to list such caller tunes for listeners to download on their mobile phones. You can even use social networking sites like Facebook or Twitter to draw listeners to your caller tunes. Film industry has been using caller tunes to popularise songs and dialogues of movies for quite some time now. It is one of the low cost options of content distribution. The caller tune eco-system spreads on its own. Having downloaded once, a user can easily transfer it to friends and colleagues via bluetooth or USB.

22.5.2 IVR Based Audio Repository

IVR stands for Automatic Voice Response. When you call a bank or your mobile company, you must have heard an automatic voice prompting you to select a number for the kind of services you require, for example dial 1 for banking service, dial 2 for credit card services etc.

This technology is in use for many years to give information to listeners. However, in the community media domain, it is also used for collecting information from listeners and playing it back to other listeners. An open source technology, called Asterisk, has made it very easy to configure an IVR system. Using Asterisk, you can configure an IVR prompting listeners to record their message on to the server. In the next stage you can review or edit the message recorded by a listener and play back to other callers. Asterisk is a software that can be installed on Linux or Unix based system.

The advantage of this is the fact that you have millions of potential listeners because of deep penetration of mobile in the society. On the other hand, the disadvantage is that you are dependent on telecom service provider. Also each call to the IVR server will cost the caller unless the cost is absorbed by the host organisation.

In India, there are two such experiments currently in operation and we will briefly discuss them. CGNet Swara was launched in the predominantly tribal region of Chhattisgarh and it acquired considerable popularity at least in the minds of media thinkers. CGNet Swara publicized a mobile number. A listener is expected to give a missed call to that number and the number will call you back. Once a listener gets a call, he or she can record a message, news or even a song. This recording would be reviewed by community editors and put into a bulletin for the day. At a specific allotted time of the day, a listener can give a missed call to the number again and get a call back from the server. In this call, the day's bulletin is read out to the listener. You can get more information on CGNet Swara, which is now supported by Microsoft, at http://cgnetswara.org.

A similar experiment was initiated by Gramvaani Community Media Pvt Ltd called Mobile Vaani. Mobile Vaani also uses Asterisk based IVR system to collect and publish information in rural Jharkhand. You can see more details about Mobile Vaani at http://gramvaani.org.

Activity 22.4

Using the Internet sites, prepare a list of five community radio stations in India, which are streaming on Internet. Also note the type of media server being used by them.

To do this activity, you may need about 15 minutes including writing down the answers in the space provided.

This activity will help you in learning the advantages of using streaming on the Internet.

Sl. No.	Name of the community radio station using streaming on the Internet.	Details of websites	Type of media server used
1			
2			
3			
4			
5			

22.6 Let Us Sum Up

In this unit, we looked beyond the conventional FM transmission as a method of broadcasting and sharing content. It is believed that with the growing trend towards digitalisation, the analogue FM transmission will become obsolete and digital transmission of data and voice will take over. Though there are many impediments in the path of complete digitalisation, it is imperative for a radio technician to understand the trend and undercurrents.

We understood the importance of Internet in community media in general and community radio in particular. As a community radio technician you can help your station in garnering maximum listenership by making effective use of social networking sites to the content sharing sites. Do not forget audio blogging. It may appear to be a relatively non-exciting mode of communication but has a huge potential.

On the other hand, streaming is closest to FM broadcasting in terms of effort and methodology. From the listener's point of view, listening to FM radio and Internet radio is almost the same barring the difference in technology, receiver and cost. While FM radio is cheap to listen but restrictive in terms of its reach, the Internet radio is comparatively expensive to listen but has no geographical restriction. It is always beneficial to run the Internet radio and FM radio in parallel.

Wireless Mesh Networking is one of the emerging areas and holds a great promise for the future. The model, which is the most participatory in nature, is being adopted by many communities across the world. In this model, the community is in the centre and its members own and operate the communication infrastructure. It requires a very high level of community motivation, mobilisation and capacity building. The advantage of WiMesh is that you are not restricted to radio alone. You can do many things, such as run a community TV station, run a local telephone exchange, provide access to Internet, facilitate tele-medicine and tele-education to rural population, etc where these are needed the most. And most important of all, it brings a sense of connected community.

On the other hand, the mobile-based communication model is also a fast emerging solution. It is riding on rapidly growing number of mobile users across the world among rich and poor communities even though based on the current experiments in India, it may be stated that it has a limited functionality and it has a recurring cost factor.

22.7 Model Answers to Activities

Activity 22.1

While searching for free blogging sites, you may have come across sites like blogger.com, wordpress.com or weebly.com. These are all good sites and you can choose whichever you like. But it would be useful to choose one which has topics similar to the one you want to write on.

Activity 22.2

Once you have written your blog, you inform your friends and colleagues and encourage them to have a look at it. Remember, every click on your blog will be recorded by the blogging server and would help you in gaining popularity.

Activity 22.3

While trying to make a map, you might have noticed that there are differences in geo-locations as recorded by google map and the actual. One of the better ways of finding accurate geo-location is to use Global Positioning System device which are available in the market. These devices are expensive though. You can probably use your mobile phone if it has a GPS sensor or even assisted GPS system. Look at the technical specification of your phone to determine if you could use your phone.

Activity 22.4

While looking for the streaming community radio station, you would notice that most of them are using Icecast or Shoutcast servers. These are the most popular media server.

22.8 Additional Readings

- *Building a Rural Wiremesh Network, A Do-It-Yourself guide to planning and building Freifunk based mesh network Meraka Institute*. (2007). Retrieved from http://wirelessafrica.meraka.org.za
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- *Example Community Broadband Wireless Mesh Network Design*. (2007, June 20). Retrieved from http://www.tranzeo.com/products/docs/EnRoute500-Mesh-sample-design-report.pdf
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Additional Activity

In order to improve your knowledge and skill further on the use of alternative mechanisms for content distribution, write a comparative analysis of various content sharing sites. It would be useful to have your thoughts also recorded in the analysis.

Glossary

Audio	means the audio frequency signals lying in the range of 20 Hz to 20 kHz.
Audio Blogging or Podcasting	is a term used for publishing digital content on the Internet.
Audio Cable	means cable used for carrying audio frequency signals.
Audio Connector	means connector used in the audio frequency range.
Content Sharing Sites	are the Internet sites that are designed specifically for sharing content of community radio.
IVR	stands for Interactive Voice Response.
Line Cable	means an audio cable used for connecting the input channels to the mixer.
Microphone Cable	means a cable used for connecting output of the microphone to the mixer or any other recording equipment.
RF	means radio frequency used for transmitting of programmes. In our case, it means frequencies transmitted by stations in FM band (88MHz to 108MHz).
RF Connector	means connector used in radio frequency range.
Social Networking Sites	are Internet sites that run on user-generated contents.
Solder	means a solder metal (wire) used for soldering the joints.
Streaming	is a term used for live transmission of data over the Internet.
WiMesh (Wireless Mesh Networking)	is a community-owned network of Wi-Fi nodes.

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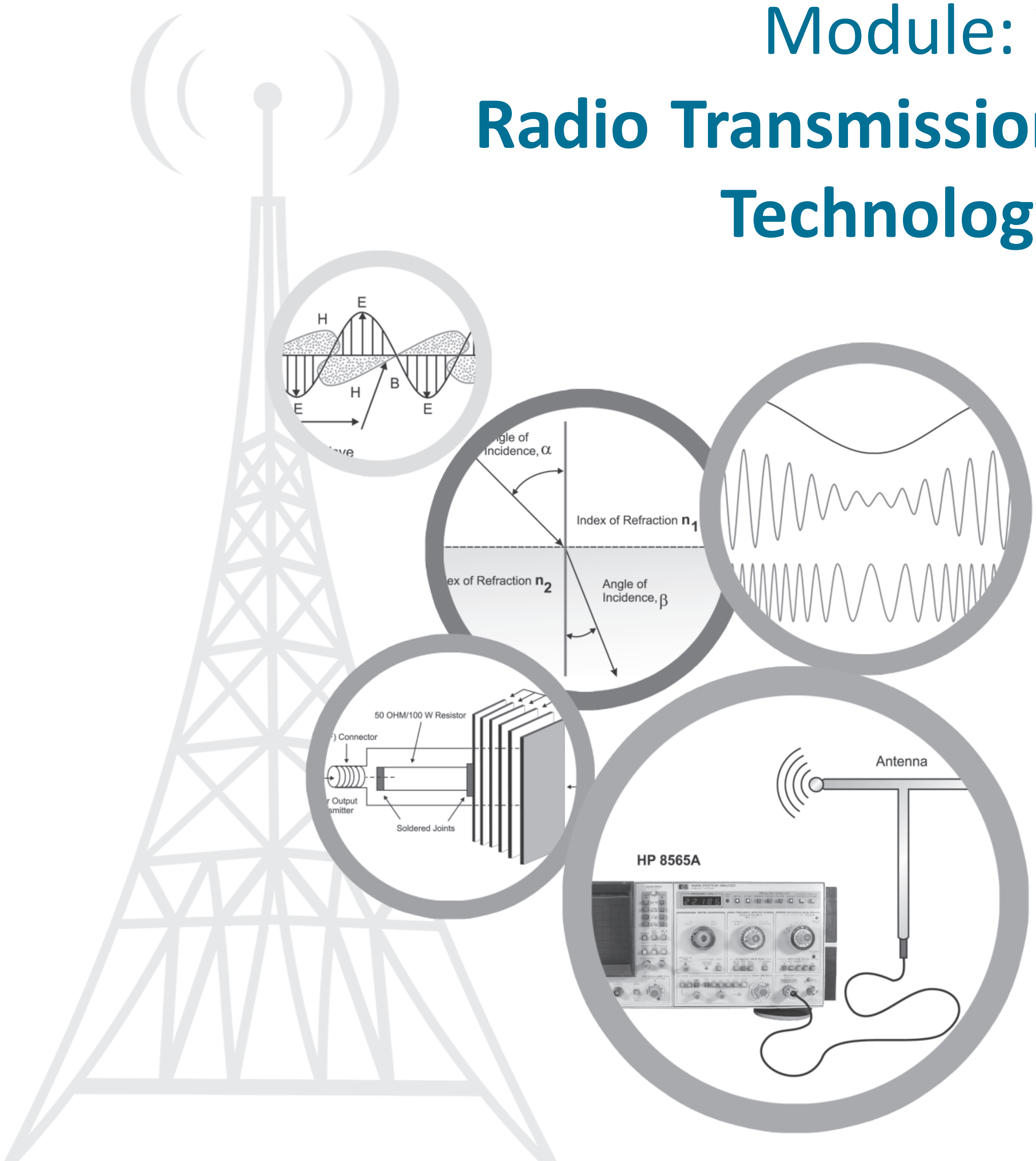
7

Radio Transmission Technology

Module: 7
Radio Transmission Technology



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Certificate in Community Radio Technology

Courses	Modules	Units
Course I: Understanding Community Radio (3 Credits, 90 Hours)	**Module 1** Community Radio: An Introduction	**Unit 1 :** Community Radio: Concept and Evolution **Unit 2:** Context, Access and Equity **Unit 3:** Community Radio: Policy Guidelines **Unit 4:** Technology for CR: Guiding Principles
	Module 2 Setting up of CRS	**Unit 5:** Components of CR Station **Unit 6:** Radio Waves and Spectrum **Unit 7:** Basics of Electricity **Unit 8:** Power Backup and Voltage Stabilization
Course II: Community Radio Production: System & Technology (5 Credits,150 Hours)	**Module 3** Studio Technology	**Unit 9:** Basics of Sound **Unit 10:** Analog and Digital Audio **Unit 11:** Components of the Audio Chain **Unit 12:** Studio Acoustics
	Module 4 Audio Production	**Unit 13:** Audio Hardware and Field Recording **Unit 14:** Free and Open Source Software **Unit 15:** Telephony for Radio
	Module 5 Audio Post Production	**Unit 16:** Sound Recording and Editing **Unit 17:** Mixing and Mastering **Unit 18:** File Formats and Compression **Unit 19:** Storing and Retrieval
	Module 6 Studio Operations	**Unit 20:** Good Engineering Practices for Studio Setup **Unit 21:** Studio Equipment: Preventive & Corrective Maintenance **Unit 22:** Content Distribution: Alternative Mechanisms
Course III: Community Radio Transmission: System & Technology (2 Credits, 60 Hrs)	**Module 7** Radio Transmission Technology	**Unit 23:** Components of Transmission Chain **Unit 24:** Components of FM Transmitter **Unit 25:** Antenna and Coaxial Cable **Unit 26:** Propagation and Coverage
	Module 8 FM Transmitter Setup	**Unit 27:** Transmitter Setup: Step-by-step **Unit 28:** Transmission System-Preventive and Corrective Maintenance **Unit 29:** Transmission Setup–Good Engineering Practices
Course IV: Technical Internship (2 Credits, 60 Hrs)	**Module 9** Practical Internship Handbook	**Section A:** Introduction **Section B:** Activities to be Conducted During the Practical Internship **Section C:** The Internship Journal and Self-Assessment Paper **Section D:** Assessment of Internship **Section E:** Appendices

Video in the Module:

Coaxial Cable and FM Antenna

By Ramnath Bhat

http://tinyurl.com/q2n6wm5

CONTENTS

CONTENTS

About the Module

Module Description

The first module of Course III: CR Transmission: System & Technology deals with the transmission technology used in the broadcast of community radio (CR) programmes/signals generated at the studio of the CR station. In Courses I and II, you studied about basic CR and studio production of CR programmes. In this unit, you will learn how these programmes are broadcast by a frequency modulation (FM) transmitter using radio frequency (RF) signals in FM-band for reception by FM radio receivers. The first module of Course III is on Radio Transmission Technology, which has four units. These four units cover the basic components of the transmission chain and their features and applications (Unit 23), important components of the FM transmitter (Unit 24) and FM antenna (Unit 25) as well as the propagation and coverage of FM radio frequency signals (Unit 26). This module would need about 26 hrs of study. As a part of this module, a video of antenna installation aspects is also included. After getting a good idea of FM transmission technology through this module, you will further study the practical aspects of transmitter set-up in the next module, that is, Module 8. A good understanding of the basic concepts of this module will help you learn and grasp better the practical aspects of transmitter set-up.

Module Objectives

After going through this module, you should be able to:

- Enumerate various components of the FM transmission chain and its features and applications.
- Explain various components of a typical FM transmitter as used for CRS-FM transmission.
- Describe different types of FM antenna particularly those used for CRS transmitters, their features and the coaxial cable used to connect with the transmitter.
- Explain propagation and coverage of RF signals in special reference to FM propagation.

Units in the Module

- Unit 23: Components of Transmission Chain
- Unit 24: Components of FM Transmitter
- Unit 25: Antenna and Coaxial Cable
- Unit 26: Propagation and Coverage

UNIT 23

Components of Transmission Chain

Structure

23.1 Introduction

In Units 5, 11 and 13, you learnt about the functions and use of audio mixers and audio work stations as a part of studio chain. In this unit, you will learn about various components of the transmission chain and the functions performed by each of these. The components of a transmission chain, which will be described in this unit, include the following:

- Transmission chain overview
- Live transmission (live console)
- Pre-recorded transmission (radio automation/scheduling)
- Connectivity (from studio to transmitter)
- Audio processor/limiter
- FM transmitter
- Principles of FM transmission
- Antenna (types and polarization)

We shall discuss the above components in the order as given.

You will learn in detail about FM transmitter and antenna in the next two units.

You may require about 6 hours to complete this unit including answering questions in various activities.

23.2 Learning Outcomes

After going through this unit, you will be able to:

- list and describe various components of a transmission chain such as mixer, workstation, processor, transmitter and antenna.
- describe their features and application in respect of CR stations.
- describe the requirements of connectivity between a studio and the transmitter.
- explain the necessity of using an audio processor in the transmission chain.
- explain the basic terms and concepts used in FM transmissions.
- explain different types of antennae and polarizations.

23.3 Transmission Chain Overview

The function of transmission chains is to transmit the programmes by routing them through the playback console to the studio-transmitter link, on to the audio processor and then to the transmitter, and further on to the antenna for broadcast of RF signals on air. The main components of the chain are shown in Figure 23.1. Details of all these components of a transmission chain are described in the sections below.

23.4 Live Transmission (Live Console)

In this section, you will learn the difference between a live console and a production console, and also the salient features of a live console.

A console that is used for feeding the programmes to the transmitter during transmissions is called a live console. Here the announcer selects one of the many programmes which is scheduled for transmission. He plays the selected programme from the playback equipment and routes the output of the console to the input of the transmitter through the processor. On the other hand, a production console is used for producing the programmes by mixing two or more source signals to record the requisite programme. Its output is recorded and kept for later transmission as per schedule.

Figure 23.1 illustrates a typical transmission chain used at almost all the CR stations.

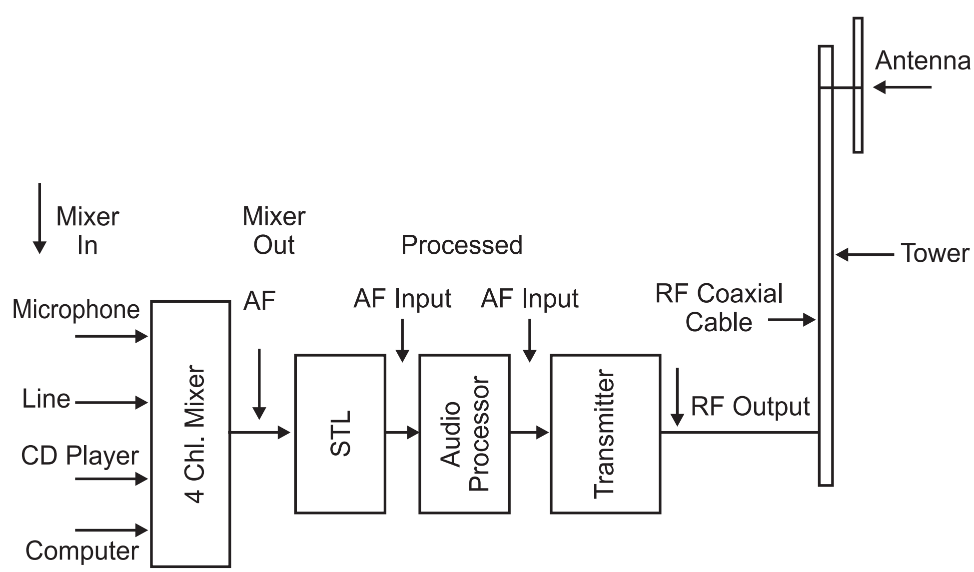


Figure 23.1: *Schematic diagram illustrating the components of transmission chain*

You may note the sequence in which the components of the transmission chain are connected in Figure 23.1. Each stage and the type of signal available at the input and output of that stage are labelled for the purpose of understanding the process. The audio mixer/console selects one out of the four input channels that is to be broadcast. A studio transmitter link (STL) feeds the selected channel to the audio processor. An STL is, however, not required where the studio and the transmitter are co-located, which is generally the case with most CR stations. The audio processor processes the audio signals to increase the average modulation and at the same time limits the audio level to protect the transmitter from over-modulation. The output of this processor is fed to the input of the transmitter. The transmitter then converts the processed audio signals into frequency modulated (FM) radio frequency (RF) signals at the rated output power. The output of the transmitter is connected to the antenna system mounted on top of the tower via an RF coaxial cable. An antenna system converts the RF out of the transmitter to electromagnetic (EM) waves travelling in all directions.

All the components of the transmission chain will be discussed in detail in this section as also subsequent sections.

Let us now begin with the first component of the chain, that is, audio mixer/ console, which is used as a live or transmission console. You have already studied about audio mixer/console in the unit on studio chain. We will here recapitulate these concepts to refresh your memory.

An audio mixer/console used in broadcast or transmission studio is an electronic device which is used to select and route one out of a number of playback equipment connected to it as input channels. The input playback equipment can be anything from the list below:

- A microphone
- A CD player
- A playback deck
- A line feed having a live programme
- A computer or a workstation

All these pieces of equipment, called the input channels, are connected to the audio mixer. An Audio Mixer is identified according to the number of input channels. For example, a 4-channel mixer will have facility to connect four channels as input channels and any one of them can be selected as output for feeding it to the next stage. These channels can be mono or stereo, digital or analog as per requirement.

Audio mixers/consoles of various models and ranges are available in the market. Prominent manufactures being Behringer, Soundcraft, Studer, Yamaha, Sonifex, etc. Cost may vary depending on the number of input and output channels, mono or stereo, analog or digital and additional features/facilities provided by the manufacturers. Since the CR stations have low budgets, simple 4/6 channel consoles are mostly used depending upon their specific requirements. Whatever may be the type/model or brand used, the principle of operation remains the same.

A typical analog mixer has three main sections, as follows.

1. Channel Inputs

All the input channels are terminated on the mixer generally through good quality audio cables by using XLR connectors. Each channel has its own switch and a fader or a knob to control its volume level. The selected channel is connected to the input bus. Some channels (like microphones) are connected to the input bus via pre-amplifiers to boost their levels.

2. Master Output

The selected channel is connected to another set of switch, fader and amplifier, called the master output channel, which feeds the selected programme to the next stage in the transmission chain after adjusting its output to a desired level. All other input channels remain isolated by keeping the switches/faders in the 'Off' position.

3. Audio Level Metering and Monitoring Facility

Audio level metering facilities are provided to monitor and control the output level to its nominal level. Usually, there are one or more volume units (VU) or peak meters to indicate the levels of each channel and the master output. Generally, a split of input or output signal is extended on a separate jack/connector (called Aux. Out) to facilitate connecting of auxiliary equipment for monitoring and measurement.

Apart from the essential components discussed above, the number of additional features is also provided in these consoles, such as

- Audio oscillator for calibration and level adjustments
- Phantom supplies for microphones
- Equalizers for correcting the frequency response
- Colour coding for quick identification of the operator

In order to maintain proper transmission standards, the output level and impedance of each equipment must match with the input level and impedance of the next stage. For example, the nominal level set at the output of audio console is 0VU (+4dBu). Audio levels in consoles are displayed in VU (see Box 1) or in decibels (see Box 2).

Note It

Box 1

VU meter

A volume unit (VU) meter is a device used for displaying the signal level in audio equipment.

The VU meter normally measures the average level of the signal. It averages the peaks and troughs of short durations and thus reflects the perceived loudness of the signal.

A value of 0VU corresponds to a voltage level of 1.23 Volts (RMS) of an alternating frequency of 1,000Hz measured across 600 ohm load. This is equal to +4 dBu (on a decibel scale with reference to 0.775V).

Note It

Box 2

Decibel (dB)

The decibel is a logarithmic unit that indicates the ratio of a physical quantity (usually power, voltage level of any signal) relative to a specified reference level. In electronics, the gains of amplifiers, attenuation of signals, and signal to noise ratios are often expressed in decibels.

A decibel symbol is often qualified with a suffix that indicates which reference quantity has been used.

For example, dBm indicates a reference level of one milliwatt, while dBu is referred to 0.775 volts RMS.

Mathematically,

Power gain in dB = $10 \log_{10} (P_1 / P_0)$, where P_1 is the power level to be measured and P_0 is the reference power.

Voltage gain in dB = $20 \log_{10} (V_1 / V_0)$, where V_1 is the voltage level to be measured and V_0 is the reference voltage.

Activity 23.1

To complete this activity, you may need about 15 minutes including writing down the answers in the space provided.

This activity will help you understand the concepts and functions of the components of a transmission chain in a CR station. This will also help you in understanding the representation of audio levels in volume units and decibel units.

Question: 1 How is a live console functionally different from a production console?

Question: 2 A VU (volume unit) question meter connected at the output of an audio mixer displays a level of ‘0’ VU on its scale. What does ‘0’ VU correspond to?

Question: 3 What is the decibel (dB) unit used for audio levels? Why is a decibel symbol often written with a suffix? What is the difference between dB_m and dB_u?

23.5 Pre-recorded Transmission (Radio Automation/ Scheduling)

In this section, you will learn about pre-recorded transmissions, radio automation and scheduling.

In CRS set-ups, most of the programmes are pre-recorded either in the studio or in the field. They are played from the playback or transmission studios. Nowadays, a large variety of digital audio workstations (DAW) using radio automation software are available in the market but the one that best meets the requirements is used by a particular CR station. You learnt about the details of audio workstation in Unit 13 including its recording, editing and other features. In this section, you will learn about the functional requirements as far as scheduling and automatic transmission of pre-recorded programmes are concerned.

An audio workstation is a computer-based system which is solely designed to work as an all-in-one machine. It is able to record, edit, store, retrieve and play back as desired. With the help of a customized radio automation package, the operator can schedule the transmission for a day on real-time basis. It can automatically transmit the scheduled programmes on air.

Some of the features mostly available in almost all the software are:

- Semantically searchable records from library
- Retrieval of records from the stored data
- Preview of selected programme(s)
- Scheduling (auto transmission on real-time basis)
- Automatic fault diagnosis
- Logging and certification of all audio/data
- Master fader for control of transmission levels

As you learnt in the previous section of this unit, the most important parameter is to control the output levels of the selected programme (which may be either from the workstation or any other playback channel selected by the operator) to ensure that we do not overload the chain beyond the specified levels.

Activity 23.2

To complete this activity, you may need about 15 minutes including writing down the answer in about 100 words in the space provided.

This activity will help you in understanding the concept and function of digital workstations.

Question: What is an audio workstation? Why is it becoming more popular to use it in CRS? Briefly describe its main functions.

Let us now move to the second component of the chain, that is, connectivity from the studio to the transmitter.

23.6 Connectivity (from Studio to Transmitter)

Your next step is to feed the output of the transmission studio to the transmitter, which may or may not be located in the same room. For this purpose, a suitable connectivity is required between the studio and the transmitter. In this section, you will learn about the various modes of connectivity used from the studio to the transmitter.

In most CR stations, studio and transmitter are co-located, may be in the same room or adjoining rooms. But in some of the situations, it is not possible to locate the transmitter with antenna and tower at a place where the studio is located. In such situations, it becomes necessary to provide a suitable connectivity between them.

The various modes of connectivity are as follows:

1. ***Dedicated Physical Cable Pairs***

   In most of the CR stations, the distance between the studio and the transmitter may not be so much that it requires hiring telephone or leased lines. The transmitter may be located in the same campus but at a small distance from the studio. In such cases, a good quality shielded audio cable is laid locally to provide the connectivity. The cable must be passed through suitable conduits or pipes to avoid getting damaged.

2. ***Telephone Lines or Leased Lines***

   The Department of Telecommunication is having a large network of telephone cables or lines laid in all the cities for providing telephone connections to the subscribers. This department provides and extends any number of pairs between two locations (studio and transmitter in our case) on demand. These are the easiest and cheapest modes of connectivity. However, the technical quality of this pair may or may not be up to the mark. It has limited bandwidth. Moreover, if the distance is more between the studio and the transmitter, the loss due to use of cable is huge. Nowadays, good quality broadband ISDN or leased lines are also available but they are costlier.

3. ***VHF or Microwave Links***

   The connectivity between the studio and the transmitter can also be provided by use of point-to-point VHF or microwave links if the distance is more. Technically, the quality through this link is much better, but it has got a lot of limitations and restrictions. Separate siting and frequency clearances from Wireless Planning and Coordination (WPC) are necessary like a CRS. It involves extra spectrum fees apart from cost of towers and link equipment. The option is simply not cost effective for a low-budget CR station.

Laying of dedicated physical pairs for providing connectivity from the studio to the transmitter is the best possible option. The losses due to length of the cable can easily be compensated at the input transmitter.

23.7 Audio Processor/Limiter (if not Processed through the PC)

In Unit 17, you learnt about adjusting and balancing of levels at the mixer output. In this section, you will learn why it is necessary to process these audio signals again before feeding them to the transmitter.

Normally, the audio signals received from the broadcast studio are already processed and level controlled through the transmission console. However, since live consoles use different types of live or pre-recorded programmes, the recording levels may not be uniform.

An audio processor/limiter is needed to:

- Protect the transmitter against over modulation
- Increase average modulation or loudness

A large variety of audio processors are available in the market with varying range of features. The prominent ones are Orban, Alto pro, Behringer and Veronica. Whatever may be the type and brand of processor, the basic functions remain the same.

Every audio processor has the following three components:

- The compressor
- The limiter
- The peak clipper

The compressor is used to compress the large dynamic range of signals in a programme. It increases the average modulation level and thereby loudness in the programme.

The limiter limits the peaks in programmes beyond a set level to protect the transmitter from over-modulation.

The peak clipper cuts very high peaks, which are otherwise beyond the limiting level.

Various controls are provided in every processor to set the compression ratio, attack time, release time and thresholds of limiting and clipping. These are to be adjusted in accordance with the procedures given in the operating manual of each processor. The points to be kept in mind are:

- Nominal input levels of transmitters to get desired deviation.
- Quality of programme may not get deteriorated due to over-setting of compression and limiting.

You will learn about setting of controls and alignment of a transmission chain in practical workshop.

23.8 FM Transmitter

The next component of the tranmitter chain is the main FM transmitter, which is used to generate the frequency modulated RF signal of required power for feeding the transmission antenna for broadcast of RF signals. The FM transmitter is generally a stand-alone unit housed in a rack mountable box. Generally, a transmitter with 50 or 100 watt of power is used for CRS. The output of the transmitter is fed to the transmitting antenna mounted on the pole or tower. You will learn more about FM transmitters in the next unit.

Activity 23.3

To complete this activity, you may need about 15 minutes including writing down the answers in the space provided.

This activity will help you learn the necessity and functions of connectivity and audio processor in the transmission chain.

Question: 1 Why is connectivity required from a studio to a transmitter?

Question: 2 What are the essential technical requirements which the connectivity link must fulfil?

Question: 3 Differentiate briefly between the functions of a compressor and a limiter in an audio processor.

23.9 Principles of FM Transmission

The next and the most important component in the transmission chain is the FM transmitter. An FM transmitter converts processed audio signals to frequency modulated RF signals before feeding them to the antenna system. In Unit 24, you will learn in detail about the functions and descriptions of each subunit within the transmitter. In Unit 6, you were introduced to frequency bands used in FM radio broadcasting. In this section, you will recapitulate/learn various terms used in understanding the basic principles of FM transmission.

Frequency Modulation

Frequency modulation is a type of modulation in which the frequency of the carrier wave is changed by the instantaneous amplitude of the modulating signal, whereas frequency of the modulating signal changes the rate of change of the carrier wave. In this process, the amplitude of the modulated carrier wave is kept constant, which is the most important feature of frequency modulation.

Modulating Signal

Audio frequency signal containing the information or content of the programme (output of mixer), which is to be transmitted, is called modulating signal. This signal is a complex wave containing frequencies varying from 30 Hz to 15 kHz with varying amplitudes. In case of stereo transmissions, about which you will learn later in this section, the maximum frequency of the modulating signal can go up to 53 kHz.

Carrier Wave

It is the radio wave that acts as a carrier to transmit the message/information contained in the modulating signal to the listeners through the electromagnetic wave radiated by the antenna. The frequency of the carrier wave is the frequency that is allotted to a particular radio station in the VHF band (88 to 108 MHz). For example, if 90.4 MHz is allotted to a particular CR station, then 90.4 MHz is called the carrier frequency for that station. Each radio station is identified by its allotted carrier frequency. If frequency of this carrier wave is varied with the modulating signal, frequency modulated wave is obtained.

Figure 23.2 illustrates the principle of frequency modulation (FM).

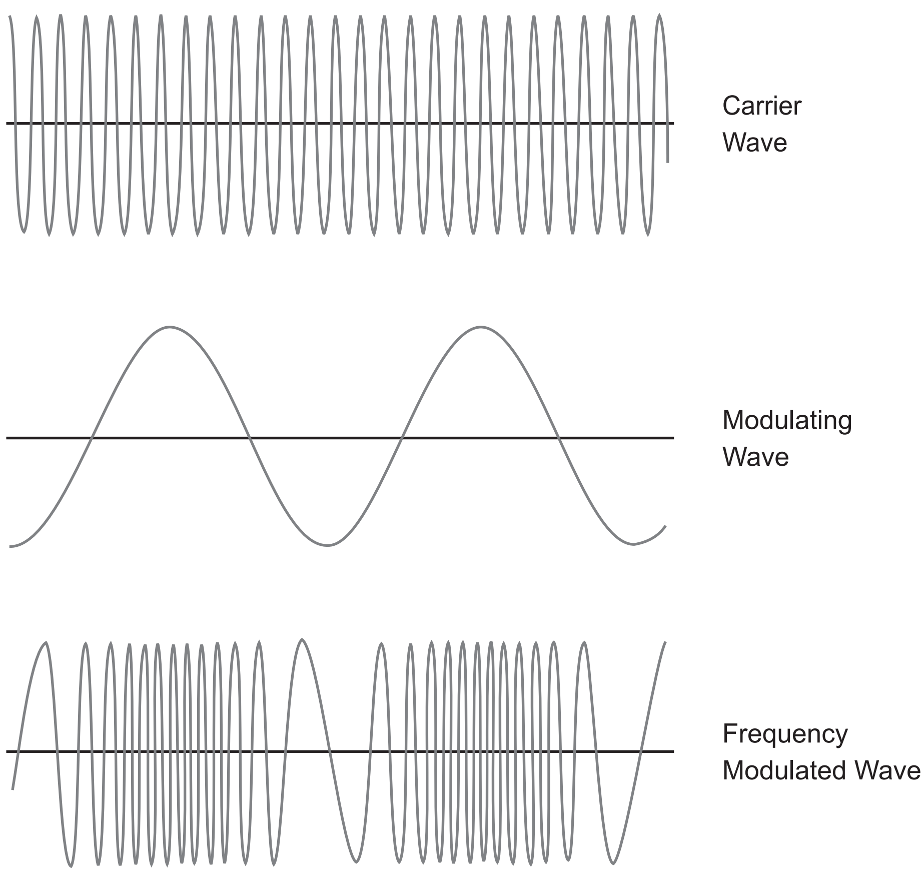


Figure 23.2: *The principle of frequency modulation*

Figure 23.2 shows three types of waves, namely carrier wave, modulating signal and the frequency modulated output wave. You should note the difference in wave shapes of the three waves. In all the three waves, the X-axis represents the time (i.e., number of cycles travelled by a wave in one second) and the Y-axis represents the amplitude. The first wave on the top is the un-modulated carrier wave. It represents the frequency of the radio station. Its amplitude and frequency remain constant. The middle one represents the audio signal, also known as the modulating signal. It is the signal that changes the frequency of carrier wave to get the FM wave (bottom wave). An important point to note here is that as the amplitude of modulating signal increases (during positive half cycle of modulating signal), the frequency of carrier wave also increases. As the amplitude of modulating signal decreases (during negative half cycle of modulating signal), the frequency of carrier wave also decreases. Another point which you should note here is that the amplitude of the carrier wave remains the same before and after modulation.

Frequency Deviation

The amplitude of the modulating signal causes the carrier frequency to deviate (shift) on both sides of its central frequency by a certain amount. This amount of deviation is measured in kHz. Deviation is proportional to the amplitude of the modulating voltage. If we increase the amplitude of the modulating signal, the deviation also increases. In the Indian system of FM broadcasting, the maximum deviation allowed is +/- 75 kHz, which is treated as equivalent to 100% modulation in case of amplitude modulated (AM) transmissions.

Example:

If 0.5V level of audio signal deviates the FM carrier frequency by 10 kHz, then the deviation produced by 2V level of audio signal will be 40 kHz {(10/0.5)x2 = 40}.

Deviation Ratio

The ratio of maximum deviation from the carrier frequency to the maximum frequency in the modulating signal is called the deviation ratio.

Deviation ratio = Maximum frequency deviation/Maximum frequency in the audio signal

A deviation ratio of 5 (75 kHz/15kHz = 5) is the maximum allowed in case of FM broadcasting.

Modulation Index

The rate at which the carrier frequency shifts from its centre frequency to give a certain deviation depends on the frequency of modulating signal. The ratio of frequency deviation to the frequency of modulating signal is called the modulating index.

Modulation index = Frequency deviation in kHz/ Modulating frequency in kHz.

For example, If 5 kHz audio frequency (1V level) causes a frequency deviation of 20 kHz, the modulation index will be 4 (20 kHz/5kHz =4).

Note It

Note that the change in modulating frequency (with same amplitude) does not change the deviation; however, it changes the modulation index.

Bandwidth in FM

In FM broadcasting, bandwidth is the frequency band around carrier frequency containing sidebands of significant amplitudes. Bandwidth is dependent on the number of sidebands produced by the modulating signal and varies with modulation index. It is a complex process. In practice, it is determined by a rule of thumb called Carson's Rule.

Carson's Rule

It states that the bandwidth of modulated FM wave is twice the sum of deviation and the highest modulating frequency. For example, if the maximum deviation is 75 kHz and the maximum modulating frequency present in the modulating AF frequency is 15 kHz, then according to Carson's Rule, bandwidth works out to be 180 kHz [2 (75 + 15) = 180 kHz].

To prevent adjacent channel interference, a guard band of 20 kHz is provided. Thus, the maximum permissible bandwidth in FM broadcasting is 200 kHz.

Pre-emphasis

In speech and music, amplitude levels of high frequencies are always much weaker than those of low frequencies. Therefore, high frequencies with low amplitude are not able to cause sufficient deviation in FM. This effect causes reduction of signal to noise ratio at high frequencies.

In order to overcome this problem, high frequencies in the programme content are boosted by passing them through an RC network having a time constant of 50 or 75 microseconds. In India, pre-emphasis with 50 microsecond time constant has been adapted.

De-emphasis

A corresponding attenuation to high frequencies is necessary to be given in the receiver to get back the original level of high frequencies. This process is called de-emphasis. The time constant of de-emphasis has to be same as that of pre-emphasis, that is, 50 microseconds. By now, you might have understood why it is necessary to follow the same standards for a transmitter and a receiver to be compatible.

Mono/Stereo Transmissions

Most of the programmes broadcast by the CR stations are monophonic. However, FM transmitters are capable of transmitting stereo programmes. For this, the transmitter has to be equipped with an inbuilt stereo encoder card to enable L and R channels of stereo signals to be broadcast on a single channel transmitter. The encoder combines the three components, namely mono signal (30 Hz to 15 kHz), stereo signal (23 kHz to 53 kHz) and pilot frequency (19 kHz) to give multiplexed output signal called 'MPX' signal. This composite MPX signal is then used to frequency modulate the carrier to give a frequency deviation of +/- 75 kHz. In order to standardize the transmissions, a pilot tone system is used for stereophonic transmissions. Here, a pilot frequency (19 kHz) is added (at a low level of about 10%) along with monophonic and stereophonic signals. This pilot tone is used by the receivers to detect the stereo broadcast.

Transmission of Radio Data System (RDS)/Subsidiary Channel Authorization (SCA)

Radio text data (like station code, auto tuning, traffic information) and a supplementary speech quality channel (like support commentary) can also be transmitted simultaneously in addition to monophonic and stereophonic programmes by using subcarriers of 57 kHz and 67 kHz respectively. With the addition of RDS and SCA signals, the composite multiplexed output signal gets modified as shown in Figure 23.3.

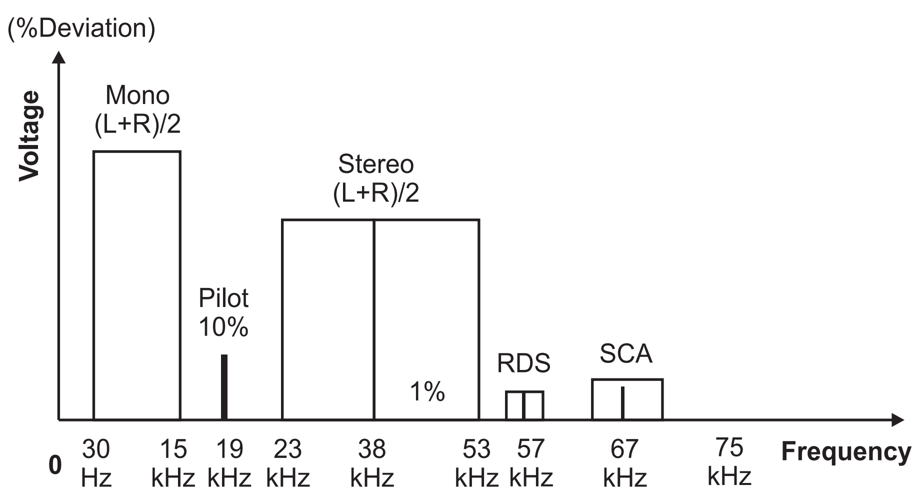


Figure 23.3: *Stereo multiplex baseband with RDS and SCA signals*

In Figure 23.3, the X-axis represents the frequency and the Y-axis represents the voltage or the percentage of deviation produced on each wave. Here also, you should note the relative placements of monophonic, stereophonic, RDS and SCA channels in the final composite multiplexed (MPX) output, called baseband signal. As can be seen in Figure 23.3, the monophonic transmission occupies the frequency band from 30 Hz to 15 kHz, whereas stereophonic transmission occupies a frequency band from 23 kHz to 53 kHz. Additional information to be broadcast using RDS and SCA is placed at 57 kHz and 67 kHz, respectively. The composite MPX output level is maintained in such a way that the maximum deviation due to this signal does not exceed +/- 75 kHz. Because of this feature of placement of frequencies, all these programmes can be simultaneously transmitted in FM. The listeners can receive any number of the programmes or data depending upon the availability of receivers/encoders with them.

Transmission Standards

In order to ensure compatibility of the transmitting and the receiving equipment, it is essential to have well-defined standards. Serious difficulties are felt by receiver manufacturers if uniform transmission standards are not adopted by the broadcasters. CCIR recommendation 450-1 defines the transmission standards for both monophonic and stereophonic transmissions (see Box 3).

Note It

Box 3

Transmission Standards for FM Broadcasting in India

1. Frequency Band = 88–108 MHz
2. Frequency Spacing = 100 kHz
3. Channel Bandwidth = 180 kHz
4. Max Frequency Deviation = +/- 75 kHz
5. Pre-emphasis Characteristics = 50 microseconds

A. Monophonic transmissions

1. Modulating frequency range (AF) = up 15 kHz

B. Stereophonic, RDS and SCA transmissions

1. Pilot tone system using frequency of 19 kHz

2. Sub carrier frequency for stereo = 38 kHz
3. Amplitude modulated with suppressed subcarrier system is used
4. Sidebands = +/–15 kHz of 38 kHz
5. Stereo channel (L – R difference signal)bandwidth = 30 kHz (23 kHz–53 kHz)
6. RDS sub carrier = 57 kHz (Deviation +/–2.2 kHz)
7. SCA sub carrier = 67 kHz (Deviation +/–5 kHz)

Activity 23.4

To complete this activity, you may need about 15 minutes including writing down the answers in the space provided.

This activity will help you in learning and understanding the basic principles of FM transmission.

Question: 1 What is frequency modulation (FM)? How does it differ from amplitude modulation (AM)?

Question: 2 What is meant by the term 'frequency deviation'? How much change in frequency deviation do you expect if the level of modulating audio signal is doubled?

Question: 3 Why are transmission standards necessary in FM broadcasting?

23.10 Antenna (Types and Polarization)

In this section, you will learn about the types of antenna and polarization used in CR stations. While only the functional details will be described in this section, more details of these components will be given in Unit 25.

The frequency modulated output of the transmitter is fed to the FM antenna via a low-loss coaxial cable.

Antenna is the final component in the transmission chain which actually converts the modulated FM carrier into electromagnetic waves.

Types of Antennae and Polarization

Different types of antenna are used in FM broadcasting. Practical antennae are classified into different types on the basis of their size, shape, method of mounting and the polarization used. The shape can be straight, folded, loop or helix. The basic type of antenna used is the dipole antenna. When the total length of two parts of the dipole antenna is equal to a half wavelength, it is called a half-wave dipole. When a number of radiating elements are mounted one above the other, it is called an antenna array. This increases the gain of the antenna. In most CR stations, 2-bay antennae are used.

Polarization is defined as the orientation of electric field component of the electromagnetic wave with respect to the ground plane. Three types of polarizations are used in FM broadcasting, namely,

- Horizontal
- Vertical
- Circular

Vertical polarization is most commonly used in CR stations especially because of its ability of providing higher and better signals in the case of portable radios.

Transmitter output is connected to an antenna through a coaxial cable. You will learn about the details regarding this in the next unit.

Activity 23.5

To complete this activity, you may need about 10 minutes including writing down the answers in the space provided. This activity will help you in understanding the functional characteristics of antenna system.

Question: 1 What is the function of an antenna in a transmission chain? Which type of antenna is commonly used in CR stations? What will happen if a 4-bay antenna is used instead of a 2-bay antenna?

Question: 2 Write down the names of three types of antenna polarizations used in FM broadcasting. Which type of polarization is preferred for a CR station?

(i) ....

(ii) ....

(iii) ....

23.11 Let Us Sum Up

In this unit on 'Components of Transmission Chain', you have learnt that:

- A transmission chain starts with an audio mixer through which the presenter plays back the selected pre-recorded or live programme and connects it to the next stage after controlling its levels.
- Pre-recorded transmissions can also be sent to the next stage automatically as scheduled by the operator by use of audio workstations.
- Physical cable pairs provide connectivity between the studio and the transmitter.
- In order to maintain proper transmission standards, the output level and impedance of each equipment must match with the input level and impedance of the following stage.
- An audio processor is used to process and control the signal levels before feeding them to the transmitter. Basically, it performs two functions. It compresses the signal to increase average modulation or loudness and limits the peaks that exceed beyond safe limit.
- An FM transmitter is a device that converts audio signals to frequency modulated (FM) radio frequency (RF) signals. The amplifier stages in the transmitter boost the level of RF signal to the desired output power (e.g., 50 or 100 Watts).
- Frequency modulation (FM) is the type of modulation through which the message contained in the audio signals is superimposed on the carrier wave by changing its frequency. The amount of shift in the carrier wave (called deviation) is proportional to the amplitude of the audio frequency. In FM broadcasting, the maximum deviation allowed is +/- 75 kHz.
- In case of stereo transmissions, a pilot tone system is followed in which a pilot frequency of 19 kHz is transmitted at a low level along with mono and stereo signals.
- The output of transmitter is fed to an antenna system by the use of a low-loss coaxial cable. The final component of the chain is the antenna, which converts the RF power output of the transmitter into electromagnetic (EM) waves.

23.12 Model Answers to Activities

Answers to Questions from Activities 23.1 to 23.5.

Activity 23.1

1 A console, which is used for transmission of different programmes simultaneously on air, is called a live or transmission console, whereas a normal production console is used in studios to record a new programme.

2 A VU (volume unit) meter normally measures the average level of audio signals in volume units. A '0' VU corresponds to a voltage level of 1.23 volts (RMS) of an alternating frequency of 1,000 Hz measured across 600 ohm load. This is equal to + 4 dB_u on a decibel scale with reference to 0.775 volts.

3 A decibel (dB) is a logarithmic unit indicating the ratios of the audio levels relative to specified reference level. A decibel symbol is often written with a suffix that indicates which quantity has been used as reference. A dB_m indicates that 1 milliwatt is taken as reference, whereas dB_u means 0.775 V (RMS) has been taken as reference.

Activity 23.2

An audio workstation is a computer-based system that is designed to work as an all-in-one machine. It can be used for recording, editing, storing, retrieving and playing back any programme at any time. Selecting a desired programme from a library of stored programmes has become as fast as a click of a mouse. Because of these features, the use of audio workstations is becoming more popular in CRS. Apart from the above mentioned functions, other important features include auto-scheduling, logging of time/date and programme information, and automatic fault diagnostics.

Activity 23.3

1 A suitable line or link connectivity is required for feeding the programmes from the output of transmission studio to the input of the transmitter.

2 Connectivity (line or link) should not offer any attenuation (loss) to the audio signals. Its frequency response should be flat up to 15 kHz. It should not have any noise, distortion or break.

3 A compressor circuit compresses the dynamic range of the programme according to the preset ratio to increase the average modulation level (loudness). The limiter circuit limits the peaks in the programmes to protect the transmitter from over-modulation.

Activity 23.4

1 In frequency modulation (FM), the frequency of the carrier wave is changed in accordance with the instantaneous amplitude of the modulating signal. In amplitude modulation (AM), the amplitude of the carrier wave is changed in accordance with the instantaneous amplitude of the modulating signal.

2 The amplitude of the modulating signal causes the carrier frequency to deviate (shift) on both sides of its central frequency by certain amount expressed in kHz. This shift in frequency is called frequency deviation. If amplitude of the modulating signal is doubled, the deviation produced will also be doubled.

3 Transmission standards are necessary to ensure compatibility of transmitting and receiving equipment. For example, a receiver manufacturer must know the system of modulation used in the transmitter.

Activity 23.5

1 The function of an antenna is to emit the RF output of the transmitter as electromagnetic (EM) waves into the air medium. A 2-bay vertically polarized antenna is commonly used in CRS. By using a 4-bay antenna, the antenna gain will increase, thereby increasing the coverage.

2 Three types of antenna polarizations used are horizontal, vertical and circular polarizations. Vertical polarization is commonly used in CRS.

UNIT 24

Components of FM Transmitter

Structure

24.1 Introduction

As you know by now, the FM transmitter is one of the most critical components in the transmission chain. It is a piece of equipment without which a CR station cannot exist. A technician engaged in running a CR station must understand the FM transmitter in a greater detail, with its general designing concepts, various blocks and functions, areas of vulnerability, precautionary maintenance and troubleshooting. In this unit, you will learn about the various components of an FM transmitter. Many of these components are essentially used in community broadcast, while some of the components that you will find here may not be found in transmitters used in community broadcast systems. However, it is necessary for you to understand how an FM transmitter in its totality looks like. After understanding the basic transmitter in this unit, you will learn about transmitting antenna and propagation in the subsequent units.
Thereafter, you will get an opportunity to have hands-on practical on a transmitter to get familiarized with practical aspects. You will take about eight hours to complete this unit.

24.2 Learning Outcomes

After going through this unit, you will be able to:

- identify various parts of an FM transmitter.
- clearly explain its functions and understand its criticality.
- identify faults and suggest remedial measures.
- outline the basic maintenance of a transmitter.

24.3 FM Transmitter Overview

An FM transmitter comprises the following main units:

- Power supply
- Exciter
- Modulator
- Amplifier
- Filter

A block diagram of the transmitter is shown in Figure 24.1.

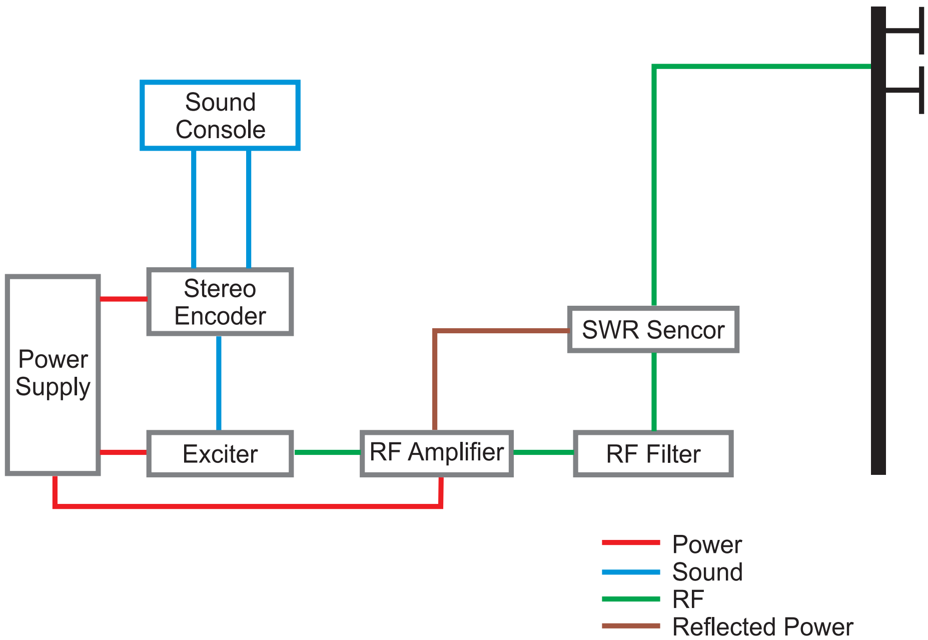


Figure 24.1: *Block diagram of an FM transmitter*

Opened out details of the transmitter

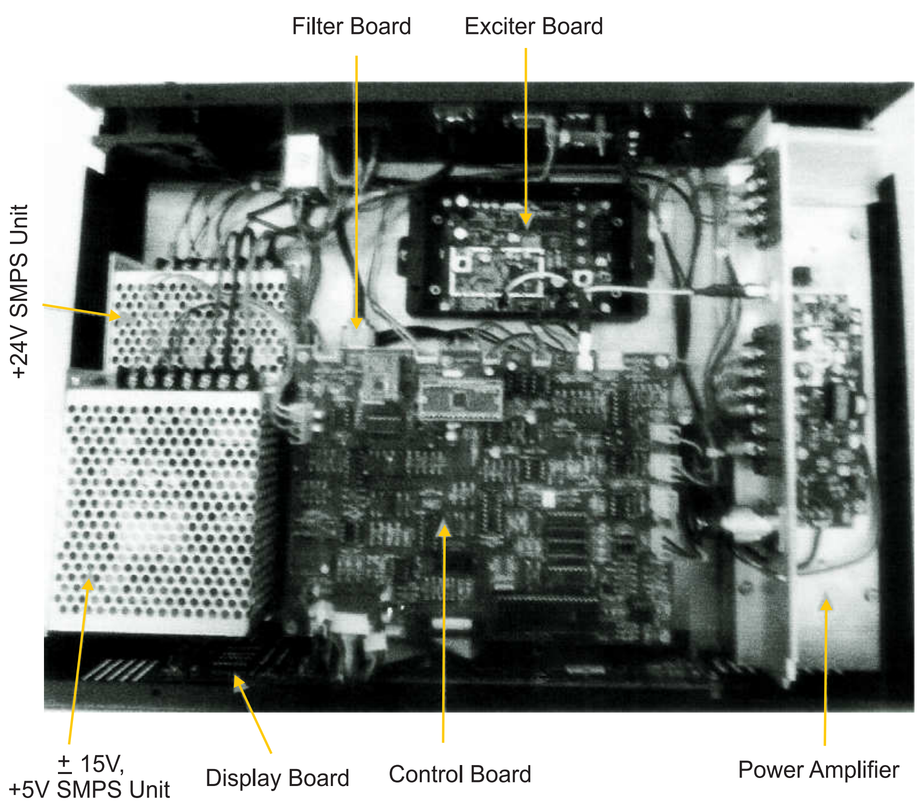


Figure 24.2: *Opened out details of a transmitter*

Detailed descriptions of the different units of a transmitter are given in the sections below.

24.4 Power Supply

It is very important to understand power supply in greater detail for proper handling of the transmission system. It has been observed that malfunctioning of power supply is responsible for different troubles that creep into the transmission system. To understand power supply, you have to first understand alternate current, its conversion to direct current and supply of different voltages to the transmission system.

24.4.1 Alternate Current

You have learnt about alternate current in the unit titled 'Basics of Electricity'. Alternating current supply, as you may know, approximates 230 V in 50 Hertz cycle that powers most of the appliances in our homes. When you plug in any home appliance like TV or washing machine, you don't know what is really flowing out of the wall socket as you assume that it would be a supply of 230 V.

However, when you power in a sophisticated and critical component like an FM transmitter, it is important to know whether what is flowing out of the wall socket is appropriate for the system.

How to check the wall socket is a subject that you have already learnt in the unit on Basics of Electricity, but here it is necessary to ascertain whether the quality of the cable and the plug that supplies 230 V AC power to the transmitter is proper and supplies consistent power to the transmitter. Generally, the cable is supplied by the transmitter manufacturer based on the flow of current required by the transmitter. An engineer's job is to ascertain that the same and not a similar cable is used for this purpose. If for some reason the cable is misplaced or has become faulty, which is highly unlikely, it is necessary to check with the manufacturer the type of cable that should be used.

In many cases you must have seen that the cable that has a three pin plug on one end does not fit properly in the socket due to use of a non-standard socket. In such cases, do not use any temporary measures and arrange for a proper cable.

24.4.2 Switch Mode Power Supply (SMPS)

Since most of the units of the transmitter require DC supply for its operation, almost all the transmitters convert 230 V AC power to DC power of various voltages as per the requirement of the transmitter. This function is carried out by a Switch Mode Power Supply (SMPS). SMPS is used in almost everything in our day-to-day life. Take any electronic device that is handy to you right now, for example, your mobile phone. The charger of your mobile phone is an SMPS. It takes 230 V AC from your wall socket and supplies the required DC current to your mobile battery for charging. Similarly, the charger of a laptop is also an SMPS. If you open a computer box, you will find an SMPS inside, supplying power to the various components of the computer like mother board, DVD ROM, or hard disk.

In a normal FM transmitter, there is a requirement of different DC voltages for different functions. In some transmitters, a single SMPS supplies different voltages, whereas in some transmitters, different voltages are supplied by different SMPS.

All SMPS units have both input and output. In most cases, the input would be 230 V AC current, whereas the output will differ based on the design of the transmitter or a specific function that the SMPS is expected to carry out.

24.5 Audio Processing

24.5.1 Compressor/Limiter

In many transmitters, especially designed for low-powered and low-cost community radio transmitters, the compressor is found within the transmitter box. You have learnt about the function of compressors in greater details in Unit 23 titled "Component of Broadcast Chain". The limiter or compressor that is found inside the transmitter box or sometimes even part of the exciter has no or very little manual control. These limiter exciters are optimized at 100 per cent for broadcast. That means it will give a consistent level of sound without over-modulating the transmitter.

As you already know, compressor/ limiter is an automatic volume/level control or, let us say, programmed volume/level control that keeps the audio level at a consistent loudness. When someone speaks too loud, it will automatically reduce the volume and when someone speaks too softly, it will automatically increase the volume.

24.5.2 Stereo Encoder

You have studied about stereo sound in Unit 9 on Basics of Sound. Stereo is a sound that is divided into left and right channels given to different speakers. Now you may wonder what if you want to broadcast stereo sound (two L and R channels) through your transmitter. The problem here is that the transmitter works only on one frequency and cannot carry two different channels-left and right-in the stereo.

The solution is that you combine the two channels into one signal and feed it to the transmitter. This process is called multiplexing/encoding. Any stereo tuner receiving this signal decodes the multiplex back into separate left and right audio signals. The stereo coder and the receiver decoder synchronize with each other using a 19 kHz pilot tone, which is also added to the multiplex signal. Thus, the decoded signal will play out of a stereo radio in two separate channels-left and right-with two speakers attached to the radio.

Please note that most transmitters used in CR stations transmit it mono. There are two reasons for this. The most important reason is that most of the radio receivers used by the community members are low-cost mono. So, even if a CR transmits stereo signals, a majority of its listeners are going to listen it in mono. Second, reception of stereophonic signal requires higher signal. As a result, a stereo transmitter may have smaller coverage area as compared to a mono transmitter of the same power.

24.6 Exciter

Exciter is a very important part of the transmission system. The exciter, as its name suggests, excites the transmission system. In this part, radio signals of low power are generated, locked to a frequency and then modulated with audio frequency. This clearly means that there are three processes taking place here simultaneously. To understand the functioning of an exciter, you need to study radio signal generation, locking it to a frequency and modulating it to carry the audio signal.

It would be sufficient here to know that radio signals are generated through oscillation at a desired frequency. To achieve the desired frequency, all modern transmitters use a technology called phase-locked loop. This technology is used to ensure that oscillation does not deviate from the desired frequency.

24.6.1 Phase-locked Loop (PLL)

PLL is the abbreviation of phase-locked loop, a concept that is widely used in any kind of synchronization process. In a transmitter, it is used to achieve a steady frequency, say 90.4 MHz, at which a transmitter would radiate.

In the world of electronics, it is quite a complex concept, but for our purpose let us try and understand with an example. Every household in your neighborhood will have a wall clock and you must have noticed many of them showing slightly different time. Now, if these clocks are left to themselves, your neighborhood will never know what the accurate time is. So, you need to introduce one reference time, which could be Indian Standard Time (IST). Thus, every time a clock deviates, the owner of the clock can adjust the time to IST. Now imagine this process is automatized. Every time a clock deviates from the IST, it corrects itself. This kind of mechanism can be put in place with PLL.

In the case of CR transmitters, every time a frequency oscillator deviates from a set frequency–let us say, 90.4 MHz–an electronic circuit brings the oscillation back to 90.4 MHz. Thus, frequency generation with PLL becomes rock steady.

24.6.2 Audio Modulation

Now, your exciter has generated the frequency that needs to be modulated with sound. Remember the full form of FM-frequency modulation. As you know, sound broadcasting can be carried by two different modes. One is called amplitude modulation (AM) and the other is called frequency modulation (FM). You have already learnt about them in Unit 24. For recapitulation, however, the wave forms of both these types of modulated signals are reproduced in Figure 24.3.

In an exciter, there is a process of modulating radio frequency with audio signals in frequency modulation mode. It is here that the signal to noise ratio is determined and so also the level of modulation. It is also here that where the modulation level is generally adjusted.

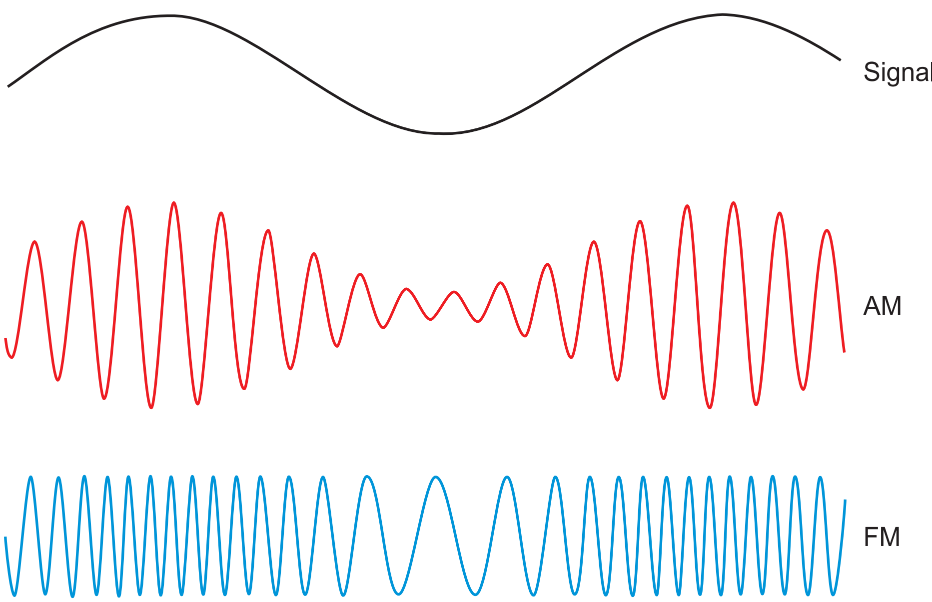


Figure 24.3: *AM and FM modulation*

24.6.3 First Stage Amplification

The modulated frequency generated with the help of PLL is generally very low in terms of power. It may be sometimes in a few milliwatts. Before the RF power is supplied to the amplifier, it needs to be pre-amplified to a level suitable for the amplifier design. For example, if your amplifier is designed to give 20 dB gain (You may find this in detail in the technical specification document provided by your transmitter manufacturer), then 1 W of RF power will be amplified to 100 W. That makes it necessary for the exciter to generate 1 W, so that an amplifier can amplify it to 100 W.

Activity 24.1

Answer the following questions:

Question-1: What is the role of a PLL circuit?

Question 2: Draw a diagram showing amplitude modulation and frequency modulation and briefly explain the difference between the two.

Question 3: If possible, visit the nearest CR station and check power output of the exciter. You may refer to the manufacturer's literature. Write your observations.

24.7 Amplifier

RF amplification is a complex process. To begin with, it requires a low power radio signal that will have to pass through the final stage output transistor and induction coils. Also required is a filter circuit to cut out spurious and harmonics. Here, we will discuss the important components/process of amplification.

24.7.1 SMPS

As discussed earlier, the amplifier of the transmitter will require DC voltage. The power unit inside your transmitter box, known as SMPS, would be giving necessary DC voltage to the amplifier. In any transmitter, this would be the most critical and vulnerable component. If you find your amplifier not working, the first thing you need to check if the SMPS output voltage being supplied to the amplifier.

24.7.2 RF Input

The main function of an amplifier is to take small amount of RF power and amplify it to the necessary levels. That means there would be an RF power inlet in the amplifier. Different amplifiers have different input sockets: some use SO239 or UHF type sockets; some may use N type sockets; and some amplifiers use BNC types. If your exciter unit and amplifier unit are in the same box, the connectivity may differ. But remember that RF power is never carried anywhere without shielded cables. So, from the exciter unit to the amplifier you will see a coaxial cable, which transports the RF power to the amplifier.

24.7.3 Main Pallet (Circuit Board)

The main pallet is the printed circuit board that handles the entire amplification process. On this board you will find various coils, trimmers, RF chokes and other electronic components. Unless you are in a position to understand the whole process in great detail, it is most advisable to refrain from touching this part of the amplifier in the absence of proper tools and testing equipment.

24.7.4 Heat Sink

Most of the amplifier pallets are mounted on a heat sink, which is made of high grade aluminium blocks designed in such a way that it has the maximum surface area in a small form factor to absorb and radiate maximum heat. As the amplifier will generate radio frequency signals, it will also generate heat in proportion to the RF power. This heat has to be captured and thrown away from the amplifier unit. The heat sinks are used to capture all the heat that the amplification process generates.

The heat sink is supplemented by DC fans. In some transmitters, the fans are used to bring in cool air from outside in the transmitter box to keep the heat sink cooler. In some cases, the fans are used for throwing out hot air. But in many transmitters the fans work in both directions, that is, bring in cool air and throw out hot air. Fans are the only moving parts in the transmitter and quite likely to develop snag. These fans have ball bearings that can be damaged by their close proximity to RF.

24.7.5 Main Output Transistor

This output transistor is the core of your entire transmission system. It is this electronic part that generates the power output. It is one of the most expensive and vulnerable parts in the transmitter. It can easily be destroyed and, once damaged, it cannot be repaired. It is advisable not to touch or fiddle with it during maintenance

24.7.6 Standing Wave Ratio (SWR) Mismatch and Thermal Protection

Advanced transmitters available in the market have built-in protection for high SWR and thermal overloads. The function of the SWR protection circuit is to ensure that the transmitter is protected against very high SWR by switching off the transmitter (You will learn about it in the unit on Antenna). This circuit will fold up the power of the transmitter if it detects a very high SWR. The high SWR could be caused by many conditions such as damage to the antenna, break in the feeder cable or malfunctioning of connectors. If this condition persists, the reflected power will damage or sometimes even destroy the main output transistor.

Similarly, if the cooling mechanism of the transmitter fails, the transmitter will start getting heated up due to RF power. Thermal overload protection is provided to take care of this eventuality and shut down the transmitter.

24.7.7. Display Panel

Though it is not absolutely necessary, it is quite useful to have a display panel on the transmitter. This panel displays operating parameters of a transmitter when switched on. It could display the following parameters:

- Operating Frequency
- Output Power
- Reflected Power

Audio Levels or Modulation Levels

There are many advanced transmitters that provide the facility of changing certain parameters like frequency. But all transmitters do not let the user change the parameters from the control panel.

Please note that parameters shown in the display are for reference only. Sometimes the actual parameters measured with calibrated test equipment, which you may otherwise not find in a CR station, could differ from what is displayed in the built-in display panel.

24.7.8 Filter

Every oscillation process generates spurious signals, which are not intended to be generated. These signals could be anywhere in the radio frequency spectrum. They could even be harmonics in the exact multiple of the operating frequency but in a completely different band of spectrum. The spurious signals do not affect your transmission as much as it affects other equipment that may be using RF spectrum. Any transmitter that generates a spurious beyond the prescribed limit is known as a "dirty transmitter".

ITU(R) and other national regulatory bodies have specified limits for spurious and harmonic radiations. It is, therefore, necessary that a transmitter filters out such radiations. For this purpose, all transmitters have a filter that suppresses the spurious and harmonious signals. There are different designs of filters but all of them are located at the last stage before the RF signals go out to the antenna through the feeder cable.

24.7.9 Switchover Panel

There is a general practice in radio stations to always keep a back-up transmitter. If one of the transmitters fails, the broadcast could be switched over to the spare transmitter. A community FM transmitter can use an automatic switchover system or a manual switchover system for this purpose. In an automatic system, both the transmitters are kept simultaneously switched on. The power of one transmitter is sent to the antenna system, while the second transmitter power would be sent to a dummy load that will convert the power into heat and absorb.

In the case of a manual system, you have to physically disconnect the malfunctioning transmitter from the audio and antenna system and connect the spare transmitter.

If your station is well-designed and you are well versed with the process of switching over, it may take less than a minute.

Please remember that automatic switchover panel would consume a bit of power. In high-powered systems, like that of a commercial radio station, this loss of power could be considered negligible, but in a CR station where the permitted power is just 50 W, even a single watt loss is undesirable. For this reason, most CR stations prefer manual switchover.

24.8 Transmitter Maintenance and Fault Diagnosis

After getting an idea about the components of an FM transmitter and the functions of its parts, it will be desirable to have an idea about the basic maintenance of an FM transmitter and fault diagnosis techniques. These are detailed below:

Note It

Box-1

Transmitter Maintanance and Checkup

A transmitter is very critical and perhaps one of the most expensive pieces of equipment in a CR station. Experience shows that an FM transmitter can run flawlessly for years if it is installed properly and maintained with meticulous regularity. Here are some of the maintenance tasks that should be carried out on daily, weekly and monthly bases.

Daily Tasks:

1. Ensure that the transmitter area/room is properly cleaned and no dust is allowed to settle in any corner.
2. Check the power and reflected power on the front panel and make a note of it in a log book so that if any fault is developing you have a historic perspective.

3. Check the modulation levels on the front panel and audio quality on a standard radio receiver. Look out for any hum or unusual sound.
4. Check all the connectors for any visible sign of stress, heat or any abnormality.
5. Give a visual check of the antenna system and see if there is any misalignment.

Weekly Tasks:

1. Take a weekly maintenance shutdown if your radio station is running 24 hours.
2. Check the phase, neutral and earthing of your AC power supply. Use multi meter for the purpose.
3. In monsoon season ensure that humidity level is under control in the transmitter area

Monthly Task

1. If you have manually switchable 1+1 configuration, then switch the operational transmitter from A to B or the reverse.
2. De-dust the transmitter with an air blower. Remember to necessarily open the lead of the transmitter. An electric blower (not the one used for hair styling) is generally used for cleaning.

Note It

Box 2

Troubleshooting:

If one fine morning, or not so fine morning, you start receiving calls from your listeners that they cannot hear anything, or you switch on the transmitter and the power indicator does not show power or shows inadequate power, the first thing you should do is not to panic. Please follow the diagnosis methodology as mentioned here.

- First of all, tune your radio to the frequency of your radio station. If you hear complete silence, it means the transmitter is working fine but the trouble is with your speech input equipment. Check your mixer or the source output and also the connectivity between your audio source and the transmitter.

- If your callers say they cannot hear anything, please calm them down and ask the following questions:
    - Ascertain if they cannot hear anything or they can hear your station with a lot of noise.
    - Ask what kind of radio receiver they are using.
    - Ask since when they have been facing this trouble.
- Give a quick look at the front panel power meter on your transmitter. Check the forward and reflected power. You may come across the following situations:
    - Power is very less than stipulated 50 W: In this circumstance, first check the reflected power. If it shows more than 1.8 SWR, you know that the trouble is with your antenna system. Check all connectivity and the antenna alignment. In such circumstances, it is advisable to switch off the transmitter or switch over to a back-up transmitter.
    - You may see there is no power at all: In this situation, tune in your radio receiver close to the transmitter, if you cannot hear your station at all, then the origin of the fault could be at the exciter level. But if you can hear your station well, it means the amplification process is not working due to some fault in the amplifier.

Even if you find the fault, do not carry out any repair before talking to the supplier of your transmitter. Please call your supplier, explain the problem and discuss your diagnosis before you carry out any repair.

Activity 24.2

Answer the following questions

Question 1: What is the function of an RF filter?

Question 2: Draw a block diagram of a transmitter describing the generation of an RF carrier, modulation and process of amplification.

24.9 Let Us Sum Up

Now we know that an FM transmitter is divided mainly in two sections, namely an exciter and an amplifier. Both the sections could be in one box or separate boxes. Both the sections will require separate DC power current, which is provided by a Switch Mode Power Supply (SMPS).

The exciter generates small amount of RF power and supplies it to the amplifier, which in turn amplifies the power and propagates it through an antenna. This simple process also involves modulation of frequency with sound and filtration of spurious and harmonics. All transmitters have front panel display that shows some of the basic parameters like operating frequency, output power, reflected power, modulation levels, etc. A good transmitter must have a thermal and SWR protection.

Remember a transmitter does not require much tweaking once installed correctly. All that a technician is expected to do is to keep the transmitter in a clean and dust-free environment and regularly monitor its operations.

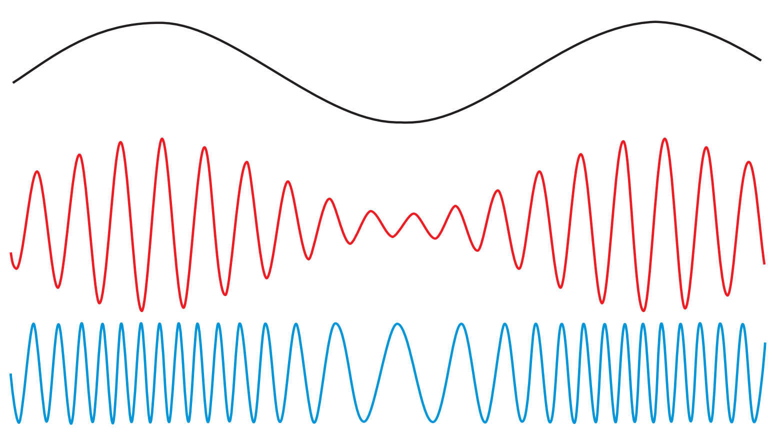
24.10 Modal Answers to Activities

Activity 24.1

1. A phase-locked loop (PLL) is a control system that generates output based on input reference signal. A PLL circuit comprises a variable frequency oscillator and phase detector. The circuit takes the phase of an output oscillator and compares its frequency with the phase of the input and its frequency. On any variation it corrects the frequency of output phase.

   In a CR transmitter, the PLL is used at the exciter stage to lock the exciter frequency to the desired frequency allocated to the radio station by the government (WPC, DOT).

   PLLs are widely used in many types of electronic applications including radio, telecommunications and computers.



2. As can be seen in the diagram, in the case of AM the sound signal affects the amplitude of the carrier wave, whereas in FM the frequency of the carrier itself is modulated with the sound wave. The difference is that AM can travel very long distance but the sound quality is not as good, whereas in FM, though it travels comparatively shorter distance, it produces a very good sound quality.

Activity: 24.2

1. As we all know, the oscillation process produces some amount of spurious and harmonics. Spurious is a frequency not deliberately created but gets generated in the process of oscillation. Any other signal that a transmitter generates outside its desired frequency is called harmonics. There are international standards for spurious and harmonics.

   An RF filter is designed to filter out these spurious and harmonics so that a transmitter does not generate a signal that can interfere with other devices. In short, it keeps the spectrum clean.

24.11 Additional Readings

- Gibilisco, S. (2002). *Teach yourself electricity and electronics*. New York: McGraw Hill.
- Noll, A. Michael. (2001). *Principles of modern communications technology.* Artech House.
- HYPERLINK “http://www.itu.int/rec/R-REC-BS.450-3-200111-I/en”Transmission standards for FM sound broadcasting at VHFHYPERLINK “http://www.itu.int/rec/R-REC-BS.450-3-200111-I/en”. *ITU Rec. BS.450*. International Telecommunications Union.

UNIT 25

FM Antenna and Coaxial Cable

Structure

25.1 Introduction

In Unit 23, you learnt about the components of a transmission chain. Then in Unit 24, you learnt about the main component of the transmission chain, the FM transmitter. The output of the transmitter is connected to the antenna for on-air broadcast of RF signals. You were introduced to the types of antenna and polarization in Unit 23. In this unit, you will learn about the constructional details, technical specifications, functions and application aspects of the following components of the complete antenna system.

- Dummy load
- Coaxial cable
- Antenna system
- Supporting structure of antenna system
- Lightning arrestor
- Grounding system

As a part of this unit, in the video on “Types of Antenna and Installation”, you will see the different types of antennae and their mounting arrangements on towers/ poles. You will also see how tower foundations, grounding and lightning arrestor arrangements are provided in a typical CR station.

You will learn about propagation and coverage aspects linked with the different types of antennae in the next unit, that is Unit 26, on propagation and coverage aspects.

You may need about 6 hours to complete this unit including answering the questions given in the activities.

25.2 Learning Outcomes

After reading this unit, you will be able to:

- list and describe the types of dummy load, coaxial cables, FM antennae and supporting towers used in a typical CR station.
- describe the constructional details of dummy load and its application.
- describe the constructional details of coaxial cables and their characteristics.
- identify and describe different types of FM antennae.
- define polarization and underline the significance of different types of polarization.

- differentiate between horizontal and vertical radiation patterns produced by practical antennae.
- list and describe different types of towers used in CR stations.
- explain the meaning and significance of VSWR.
- justify the necessity of lightning arrestor and grounding system.

We will begin with dummy load.

25.3 Dummy Load

In this section, you will learn about the purpose, constructional details and working principle of dummy loads provided in CR stations.

Dummy load is a device that is used to test the working of a transmitter before its output is connected to a cable and an antenna. The difference between a dummy load and an antenna is that a dummy load converts the RF energy into heat and not into electromagnetic waves, as is done by an antenna. Dummy loads are available in different types depending upon their power handling capacities. Dummy loads used for testing of high-power transmitters require forced air or water cooling. Since the power of a transmitter to be tested in CR stations is of the order of only 50 to 100 W, a small dummy load capable of dissipating a power of 100 W with convection cooling is sufficient.

Figure 25.1 shows the cut-out details of a typical dummy load capable of dissipating 100 W power, which is commonly used in CR stations.

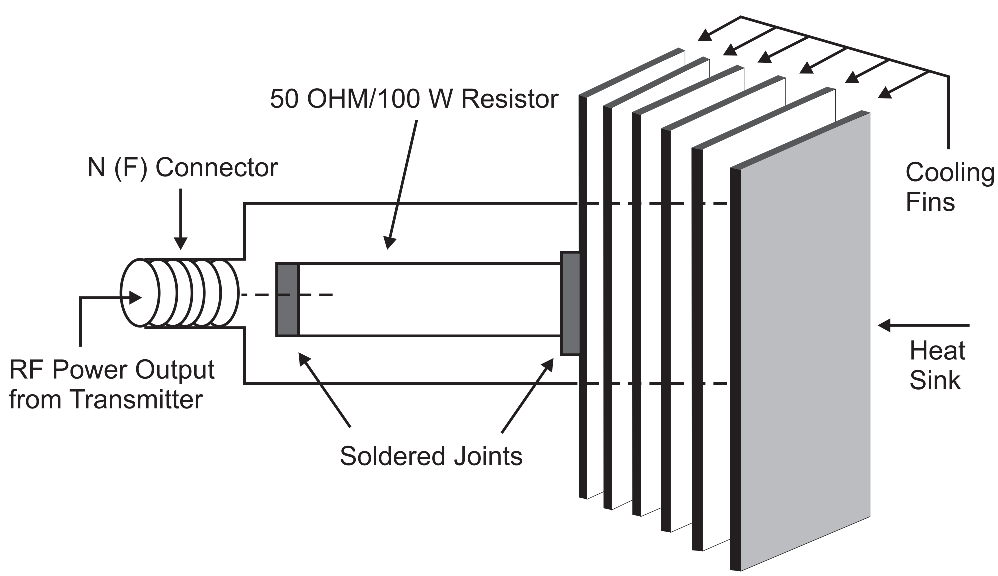


Figure 25.1: *Cut-out details of dummy load*

As can be seen in Figure 25.1, a dummy load consists of a 50 ohm/100 W non-inductive carbon resistor mounted on a heat sink having a large surface area and fins to dissipate the heat. One terminal of the resistor is connected to an 'N' (Female) type of connector and the other terminal is connected to the body of heat sink. When RF power of transmitter is connected to a dummy load via 'N' connector, it gets heated like any other heater. The heat produced in the resistor is dissipated in air by the heat sink. The surface area of heat sink is large enough to dissipate heat generated in the resistor to the surrounding air without raising its temperature.

The basic technical specifications/requirements of a dummy load are as follows:

- It should be purely resistive.
- It should not radiate RF energy in the air medium.
- Its power dissipation capacity must not be less than that of transmitter power.
- Its impedance should remain constant and should not vary with application of RF power.
- VSWR (Voltage Standing Wave Ratio, which will be explained later) of a perfectly matched dummy load is unity (1:1) but should not exceed 1.05:1.

Specifications of different models supplied by different firms vary according to the design of their products but you have to see that the minimum specified requirements are met while selecting a dummy load.

Activity 25.1

To complete this activity, you may need about 10 minutes including writing down the answers in the space provided. This activity will help you in understanding the constructional and functional details of the dummy loads.

Question 1: What is the purpose of providing a dummy load in a CR station?

Question 2: Why are non-inductive resistors used in the construction of a dummy load?

Question 3: Why are fins and a large surface area provided in a dummy load?

Question 4: What should be the input impedance of a dummy load?

Question 5: Why are water-cooled/oil-cooled dummy loads used with high-power FM transmitters?

Now let us discuss the next important component of a transmission chain, that is, a coaxial cable and connectors.

25.4 Coaxial Cables and Connectors

In this section, you will learn about the purpose, constructional details and characteristics of the types of coaxial cables commonly used in CR stations.

The cables used for connecting the RF output of a transmitter to the antenna system are called coaxial cables. They come in different sizes and ratings. The size and type of coaxial cable depends on the power of the transmitter and attenuation (loss) of cable at the operating frequency. Since CRS set-up consists of a low power transmitter of the order of 50 W to 100 W, a low-loss cable of ½" size having foam dielectric is sufficient. Figure 25.2 shows the constructional details of a typical coaxial cable.

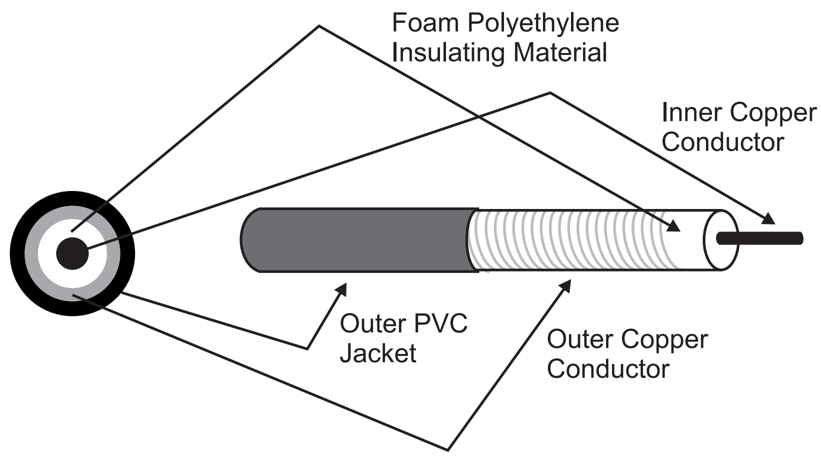


***Figure 25.2**: Schematic diagram showing construction of coaxial cable*

As can be seen in Figure 25.2, a coaxial cable is made of two conductors, called the inner conductor and the outer conductor. The inner conductor is usually made of aluminium or copper and the outer conductor is made of corrugated copper sheet. The inner conductor is held in central position of the outer tubular conductor throughout the length of the cable by use of a uniform layer of insulating foam polyethylene dielectric material. A protective layer of PVC jacket is provided over the outer conductor to avoid any possible damage during handling and use.

Materials used for making inner and outer conductors may vary from manufacturer to manufacturer. However, the constructional design remains the same. Higher sized cables (Cables of size higher than 7/8") are available with air or foam dielectric which can be procured as desired by the user. Cables with air dielectric require pressurization to avoid entry moisture in them.

Important terms/specifications commonly used in identification and selection of coaxial cables are as follows:

Characteristic Impedance

The characteristic impedance of a coaxial cable, usually denoted as $Z_{0,}$ is defined as the ratio of the voltage to the current for a single propagating wave (frequency). Its unit of measurement is ohms. The characteristic impedance of a coaxial cable normally used in CRS is 50 ohms.

Power Rating

The power rating of a cable is the average power that it can transfer continuously to the antenna system without any heating and change in its designed parameters at its operating frequency. It is frequency dependent. The average power rating decreases as the operating frequency increases. Its unit of measurement is watts or kilowatts.

Attenuation

When any RF signal travels in a coaxial cable, its power gets attenuated over the length of the coaxial cable. This attenuation or loss is expressed in dB (decibels) per 100 metre length.

See Box 1 for its mathematical formula.

Box 1

The attenuation (α) of RF cables is defined as follows:

$$\alpha = 10 \log (P_1/P_2) \text{ in dB/100m}$$

where,

P_1 = Input power fed into a cable terminated with the nominal value of its characteristic impedance

P_2 = Power reached at the end of the cable

Attenuation is the frequency dependent and is expressed as dB per unit of length. It increases as the frequency increases.

The material used in construction of the cable affects all the three parameters of a coaxial cable, as mentioned above.

Cables are normally received with end connectors connected to them. In case, if it is necessary to fix connectors on site, appropriate connectors as recommended by the manufacturer are to be used. You will learn more about the method of fixing these connectors in Unit 29 and practical workshop.

Activity 25.2

To complete this activity, you may need about 10 minutes including writing down the answers in the space provided.This activity will help you in understanding the characteristics of an RF coaxial cable.

Question 1: Why should we use a low-loss cable in a CRS?

Question 2: What type of dielectric material is used between inner and outer conductors of a typical ½” coaxial used in CRS?

Question 3: What do you mean by the term characteristic impedance of a coaxial cable?

Question 4: 50 W output of a transmitter is fed to an antenna. Calculate the attenuation in decibel units if only 25 W reaches the antenna?

Question 5: What is the relation between average power rating and frequency of operation in an RF coaxial cable?

Now we move to the last and most important component in a transmission chain in a CR station, that is, its antenna system.

25.5 Antenna System

In previous sections, you learnt about dummy loads and coaxial cables. The RF output from the transmitter is fed to the antenna system via a coaxial cable. It is the antenna that converts the RF output of the transmitter into electromagnetic waves received by listeners through their receivers. It is, therefore, the antenna that plays a major role in affecting the coverage of the station. In this section and the subsections that follow, you will learn in detail about the following characteristics of antennae:

- Types of antennae
- Gain of antennae
- Polarization
- Radiation patterns

Let us begin with the types of antennae commonly used in CR stations.

25.5.1 Types of Antennae

FM antennae come in different sizes and shapes. They are usually classified into different types according to their size, shape and number of radiating elements, type of polarization and mounting arrangements used depending upon the technical specifications required. The basic radiating element is a dipole of half wavelength in different shapes like straight, folded, loop, helix or slot depending upon the design. The thickness and type of material decide the mechanical strength, impedance and power handling capacity of the antenna. When a number of radiating elements are mounted one above the other, the gain of the antenna increases, thereby increasing the coverage area. In the subsections that follow, you will learn in detail about the different types of antennae depending upon their mounting arrangements, number of elements used and type of polarization.

Side Mounted and Panel Antennae

Besides the basic design aspects, there is another classification of antennae, which is based on their mounting on tower and which is more relevant to the user. Under this classification, antennae can be categorized into the following two categories:

- Side-mounted antennae
- Panel antennae

However, in the case of CR stations, only the former type, that is, side-mounted antennae are used because of their lower costs and ease of mounting. As such, only these will be discussed here.

Mounting of Side-mounted Antenna

An antenna can be mounted on the top of the tower or side of a tower section, as illustrated in Figure 25.3**.**

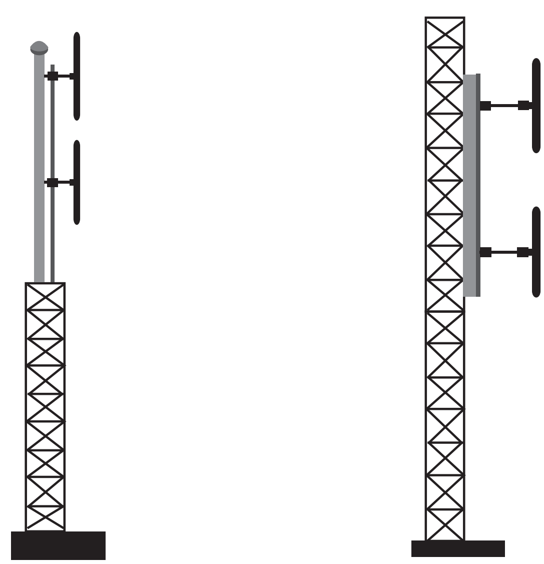


Figure 25.3: *(A)* Pole-mounted antenna *(B)* Side-mounted antenna

Figure 25.3 (A) shows the mounting arrangement of an antenna on the top of the tower. In this arrangement, two dipoles are mounted on a pole, which is fixed on the top of the tower. The thickness of the pole is smaller than the size of a cross section of the tower. In this case, the horizontal radiation pattern is nearly omni-directional. Figure 25.3 (B) shows an antenna mounted on the side of the tower. In this case too, the dipoles are mounted on a pole (called supporting structure) and the pole is clamped to the tower at a suitable distance. Even though the size of the supporting structure section is chosen to be much less as compared to the size of the supporting tower, the radiation pattern gets some directivity (pattern gets elongated due to more signal strength) in a particular direction due to presence of reflecting surface of the tower section. The type of mounting can be decided based upon the conditions existing at the site. Irrespective of the mounting, the most commonly used antenna in CR stations is described below.

Most Commonly Used Antenna in CRS – 2-Bay Vertically Polarized Antenna

Now you will learn more about a typical 2-bay vertically polarized FM antenna, which is most commonly used in CR stations. Only physical construction and technical specifications will be described here, whereas radiation, propagation and coverage aspects will be described in Unit 26.

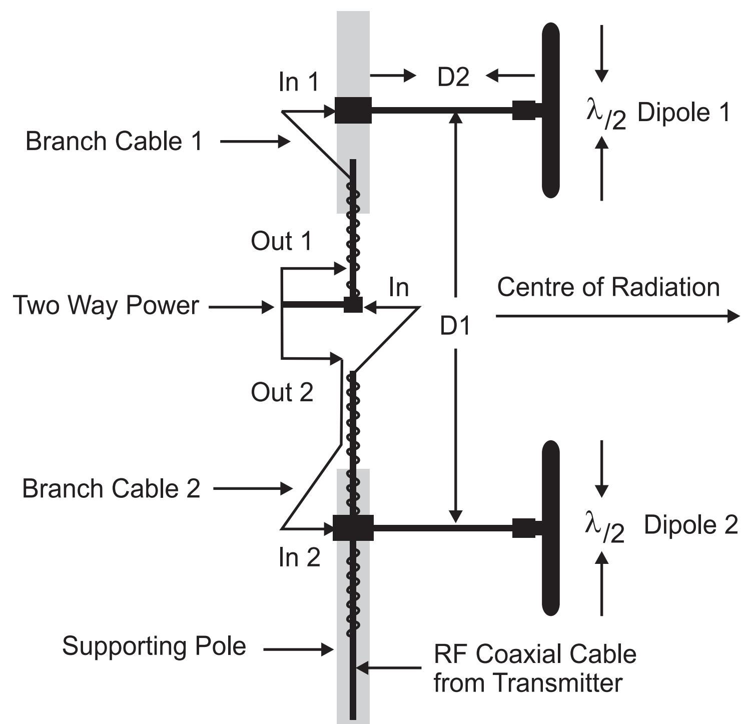


Figure 25.4: *Schematic diagram of 2-bay vertically polarized antenna*

Figure 25.4 illustrates a schematic diagram showing two dipoles of half wavelength each mounted on the pole. The output of the transmitter is connected to the input of a two way power divider, which gives two outputs equal in amplitude and phase that are fed to two dipoles through branch feeder cables. The spacing between two dipoles (D1) is very important and decides the gain and bandwidth. The material and thickness of dipoles decide the power handling capacity. With this type of antenna configuration, antenna gain of 3 dB (two times the power) and nearly omni-directional pattern is possible. Basic technical specifications and requirements of CR stations can easily be achieved with this type of antennae.

See Box 2 for relation between wavelength (denoted by λ, read as Lamda) and the operating frequency.

Box 2

> Wavelength (λ) in meters = c/f
>
> Where c is the velocity of light in vacuum = 3×10^8 m/s and f is the frequency of operation in Hertz.

Now we will discuss the types of antennae with reference to polarization.

25.5.2 Gain of Antenna

Gain of antenna is the gain that a particular antenna gives with reference to a standard single half dipole. It is expressed in dB. Normally CRS deploys a 2-bay vertically polarized antenna, which has a gain of 3 dB.

25.5. Polarization

In Unit 23, you were introduced to the basic idea of some types of polarizations. In this subsection, you will learn in detail about the concept of polarization and the types of polarization. Each type of polarization will be discussed with its application in a practical antenna.

Figure 25.5 illustrates the graphical representation of an EM (electromagnetic) wave.

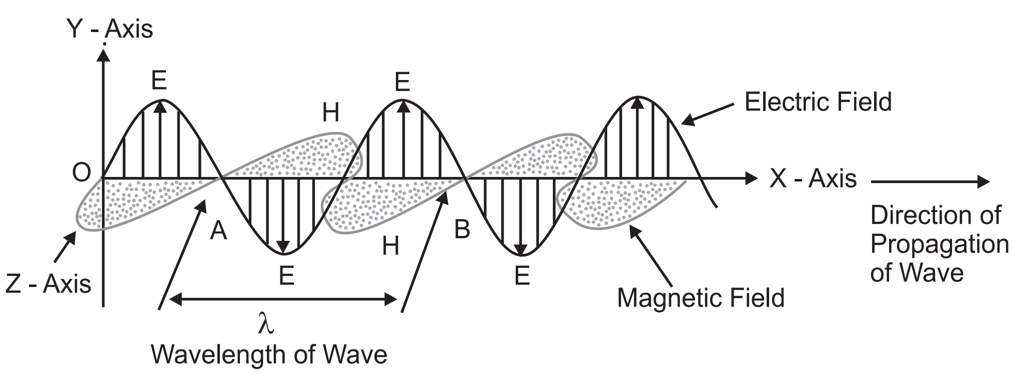


Figure 25.5: *Graphical representation of a plane wave*

As can be seen in Figure 25.5, an electromagnetic wave has two components, electric field **E** and magnetic field **H,** which are perpendicular to each other. Both are also perpendicular to the direction of travel of the wave. The direction of each component of electromagnetic wave should be noted. In this figure, direction of travel of wave is along X-axis, direction of E component is along Y-axis and that of H component is along Z-axis. *The plane of electric field E with respect to the ground is called the plane of polarization.* The wave shown in this figure is a vertically polarized wave.

Types of Polarization

Basically, three types of polarization are used in FM broadcasting:

1. Horizontal polarization
2. Vertical polarization
3. Circular polarization

Horizontal Polarization

When the plane of electric field component E is parallel to the ground, it is called horizontal polarization.

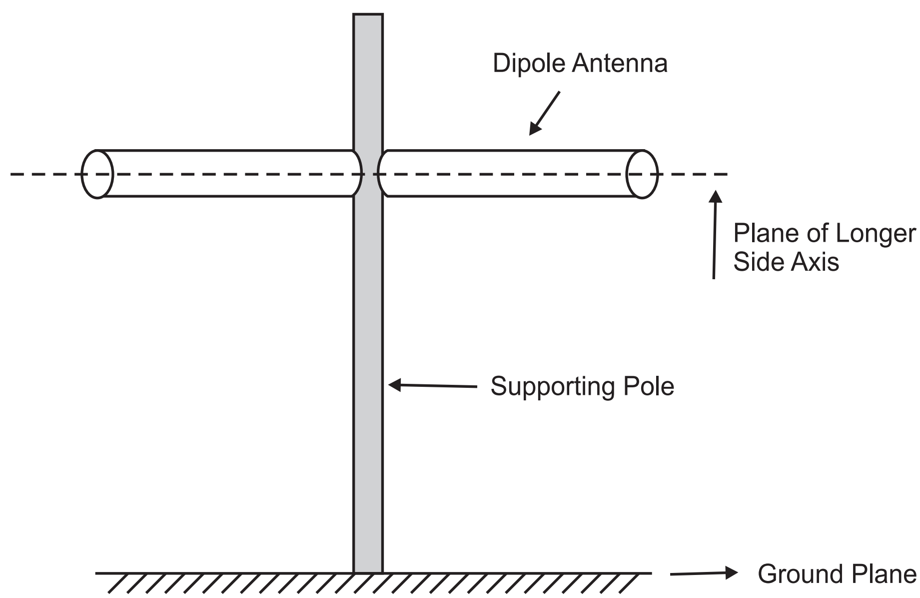


Figure 25.6: *Horizontally polarized antenna*

Figure 25.6 shows a horizontally polarized antenna. Note the direction of mounting of the longer side axis of the antenna. Physically, the radiating dipole element is mounted parallel to the ground and therefore, the antenna is called horizontally polarized antenna.

Vertical Polarization

If the orientation of electric field **E** is perpendicular to the ground, it is called vertical polarization.

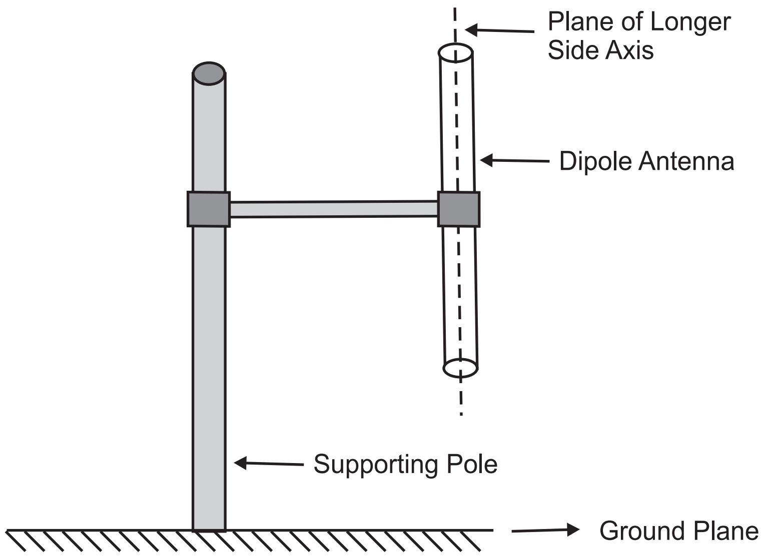


Figure 25.7: *Vertically polarized antenna*

As can be seen in Figure 25.7, the radiating dipole element is mounted perpendicular to the ground and the antenna is, therefore, called a vertically polarized antenna.

Circular Polarization

In circular polarization, two radiating dipole elements are mounted perpendicular to each other as shown in Figure 25.8. As a result, the **E** component of electromagnetic wave radiated by each dipole will be at right angle to each other. The resultant vector **E** of these two electric fields produced by each antenna travels in a circle. Such type of a wave is called circularly polarized wave.

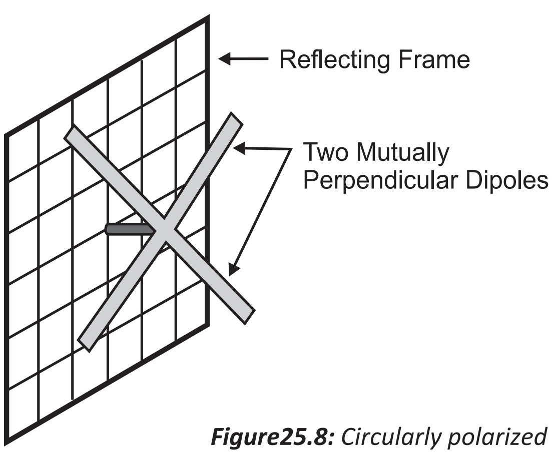


Figure25.8: *Circularly polarized antenna using crossed dipoles*

Figure 25.8 shows the mounting arrangement of a circularly polarized antenna. Here also note the mounting arrangement of two dipoles. These are mounted mutually perpendicular to each other. Practically, a circularly polarized antenna can be made in different forms and combinations by bending the dipoles, fixing the dipoles in right crossed or in crossed V shapes.

Choice of Polarization

Almost all the FM broadcasters in India, operating on high power, are using circularly polarized antennae to cater to both fixed and vehicular reception. However, in case of CRS which are operating on low power, a vertically polarized antenna is usually preferred because it is better suited for portable receivers and offers better antenna gain than the circularly polarized antenna.

Now, in the subsection that follows, you will learn an important characteristic of antenna called radiation pattern.

25.5.4 Radiation Patterns

When an RF output of the transmitter is fed to an antenna, it radiates electromagnetic waves in all directions producing different types of patterns. You will learn more details on radiation patterns in Unit 26. In this section, you will learn about the two important performance patterns produced by FM antennae called horizontal and vertical patterns.

Horizontal Pattern (Azimuthal Pattern)

A dipole antenna when mounted in a vertical position produces a horizontal pattern like a sphere radiating in all the radial directions. This pattern is used for calculating the field strength radiated along various radial directions.

Vertical Patterns

Vertical patterns of an antenna give the values of fields produced by the antenna in various angles of radiation in the vertical plane. The shape of pattern depends upon the length of the dipole and inter-bay spacing in terms of wavelength. As the length of dipole is increased from half wavelength to one wavelength or more, apart from the main lobe (Vertical Radiation Pattern), a number of side lobes also get generated. Study of these lobes gives a fair idea of formation of nulls in particular directions. The nulls can be filled by shifting the phase of the currents in one or more dipole elements of the array.

Horizontal and vertical patterns produced by a half-wave dipole are illustrated in Figure 25. 9.

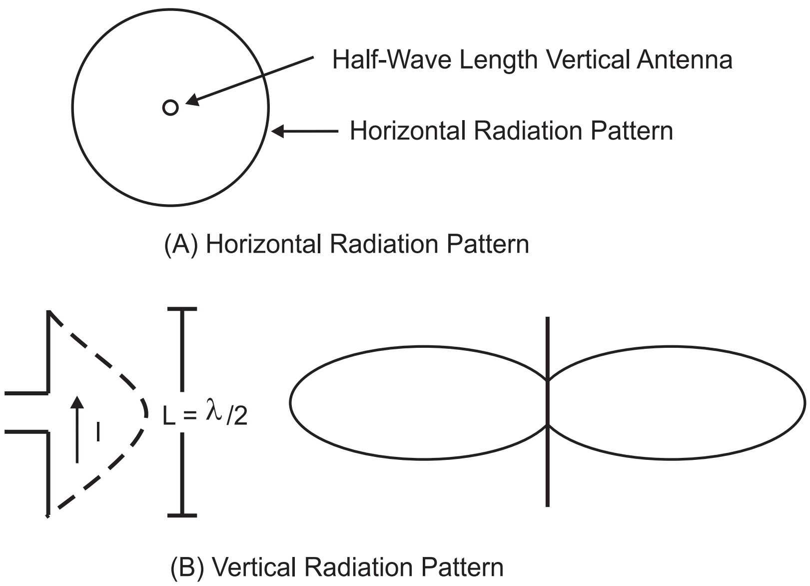


Figure 25.9: *Horizontal and vertical patterns of a half-wave dipole antenna*

Figure 25.9 (A) shows the top view of the horizontal pattern produced by a half-wave dipole antenna. Here, the dipole antenna is located in the centre. Horizontal pattern is a circular pattern giving signal levels in all azimuthal directions. Interpretation of horizontal pattern helps in knowing the field strength received along various radials while plotting coverage contours of any radio station. Figure 25.9 (B) shows the vertical pattern of a half-wave dipole. The main lobe of the vertical pattern looks like the number '8' spread horizontally. As can be seen in the figure, radiation along the vertical axis is practically nil. Vertical pattern helps in understanding the formation of side lobes and taking necessary action in taking care of nulls in the coverage area.

Hope you have already got an idea regarding the coaxial cable and antenna in the aforementioned sections of this unit. To make it easily understandable and before we will proceed further to study about the types of masts that are required for mounting the antenna, let us watch a video on antenna and coaxial cable. To watch this video, please visit the CEMCA YouTube site in this URL- http://tinyurl.com/q57aocx .

Coaxial Cable and FM Antenna

http://tinyurl.com/q57aocx

Activity 25.3

To complete this activity, you may need about 10 minutes including writing down the answers in the space provided. This activity will help you in understanding the important characteristics of an antenna on the basis of its type, mounting arrangement and the polarization used.

Question 1: Name the types of information available if we say an antenna used in a CR station is '2-bay vertically polarized pole-mounted dipole antenna'.

Question 2: What will be the type of polarization called if we mount two dipoles perpendicular to each other on the side of a tower and feed them with equal power?

Question 3: What information can we draw from the interpretation of a horizontal radiation pattern of an antenna?

Question 4: How can we get the same coverage if we use a single antenna instead of a 2-bay antenna?

Question 5: If your station is working at 100 MHz, what will be its wavelength in metres? What will be the length of a half-wave dipole used in the station?

25.6 Types of Mast/Tower

In the previous section, you learnt about the various types of antennae, polarization and the radiation patterns produced by them. You also learnt that mounting arrangement affects the pattern and the height of mast affects the coverage. In this section, you are going to learn about the following aspects of masts used for mounting an antenna:

1. Types of masts
2. Location
3. Foundation
4. Mounting of antenna on tower
5. VSWR

You will learn all these aspects of tower in the order they are given above. Let us begin with types of masts.

Types of Masts/Towers

The coverage of a CR station depends on the height of the antenna above the ground level. Higher the antenna, larger is the coverage. Masts or towers are required for supporting the antenna system at a desired height.

The towers for FM broadcast fall into two categories:

1. Self-supporting towers
2. Stayed or guyed masts

Self-supporting towers occupy a small area of ground and are therefore, attractive when the available open site area is restricted. They are usually of lattice construction. They require relatively less maintenance.

Stayed masts, also called guyed masts, occupy a considerable large space for anchoring the guys. They may be tubular or lattice.

Steel towers are more economical and less prone to twisting or bending.

Examples of self-supporting towers and guyed masts are shown in Figure 25.10.

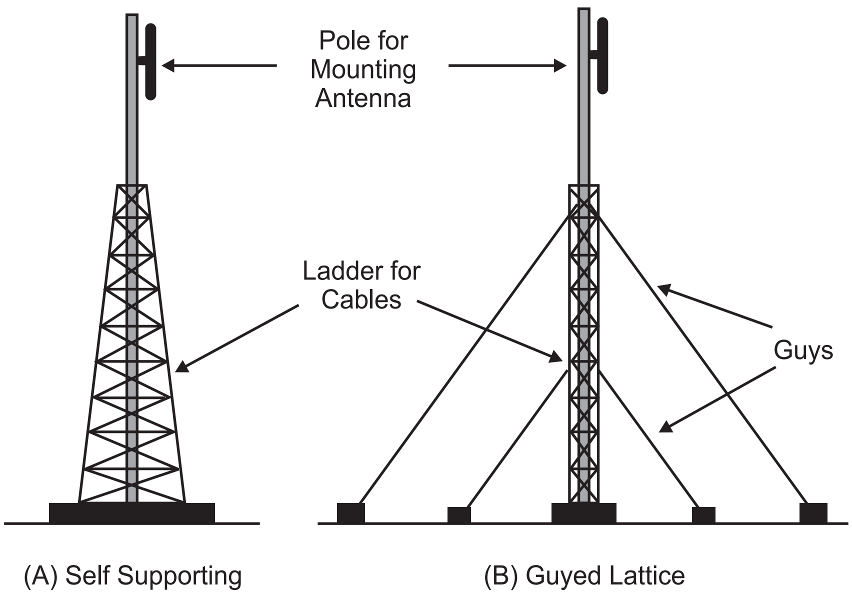


Figure 25.10: *Types of towers*

As seen in Figure 25.10, poles are mounted on top of both types of towers. Note the difference between the two types. The base and dimensions of tower sections are wider in case of a self-supporting tower, whereas a guyed tower is thinner but guys spread over a large area are required for supporting the tower.

Whatever may be the type of tower, essential technical requirements are as follows:

1. Towers must be strong enough to withstand the maximum wind speeds recorded in that area.
2. Clamping of antenna must be done properly to avoid any bending or twist of dipoles.
3. Galvanizing of steel members (coated with zinc) by the 'hot-dip' process and painting must be done at regular interval to avoid rusting and corrosion.
4. Provision should be made for lightning arrestor, ladders for climbing and cable routing.
5. Provision must be made for aviation obstruction lights as per rules in force.

25.6.1 Location

In this subsection, you will learn about the location of towers. Location of towers is important from the point of view of foundation and the coverage.

Since the objective of CR stations is to serve to a particular community residing in a small concentrated area or an institution like a university campus, the choice of location of the site is to a large extent limited to the available area. However, important points worth noting for deciding the location are as follows:

- Location should be at the centre of the service area and preferably at the elevated place.
- Location should be on firm ground.
- Land should not be low lying or marshy.
- An open space of about 6 x 6 M is required for the tower.
- The location of tower should be as near to the transmitter room as possible.
- Location of guy anchors should be exactly at 120 degrees from each other.

25.6.2 Tower and Foundation

In this subsection, you will learn about the points to be considered while deciding the tower and its foundation.

While erecting any tower, whether guyed or self-supporting, the design aspects relating to the structural stability, dead load of tower and antenna system and the wind speed must be considered.

It is a general practice that all the foundation and erection drawings are supplied by the firm delivering the tower. Technicians/engineers supervising the erection work must ensure that foundation and erection drawings are followed. The quality of material used by the contractor should also be strictly checked to avoid any untoward incident in future.

25.6.3 Mounting of Antenna and Cable on Tower

In this subsection, you will learn about the mounting of antenna and cable on tower. Mounting of antenna is a highly skilled job. All personnel required to work on high structures must undergo training before doing so. Normally, all the antenna and other accessories are shipped in dismantled condition, which are assembled on site.

The following instructions/guidelines must be followed while assembling and mounting of an antenna:

- Personnel should be equipped with protective clothing, hard hats and safety belts.

- Drawings and instructions for assembling on site must be understood clearly.
- Spacing between the dipoles must be maintained as per the drawings supplied by the manufacturer.
- A proper branch feeding cable for the respective dipole must be used as per drawing.
- The supervisor at ground must explain and confirm that the rigger/mast technician understands the instructions and guidelines in his language properly.
- Proper connectors supplied by the manufacturer must be fixed correctly as per instructions. Any wrong connector used or improperly fixed results in mismatch and correspondingly a loss of RF power.
- For supporting the RF cables, horizontal and vertical racks must be used.
- The cable must be clamped at every metre of the length with cable clamps of appropriate size.
- There should not be any sharp bends in RF cables. These bends may damage the cables.

25.6.4 VSWR

Now let us discuss a very important parameter called VSWR (Voltage Standing Wave Ratio), which is a measure of mismatch between the antenna and the cable. Our main purpose is to transfer all the output power of the transmitter to the antenna. To make this maximum power transfer possible, the characteristic impedance of the coaxial cable should match with the input impedance of the antenna.

When the impedance of the antenna differs from the specified value, part of the energy is reflected back towards the transmitter as reflected wave. The interaction between the forward and reflected waves sets up a voltage pattern in the cable, which varies between maximum and minimum values as shown in Figure 25.11.

VSWR is the ratio between the maximum and minimum values of voltage of the standing wave.

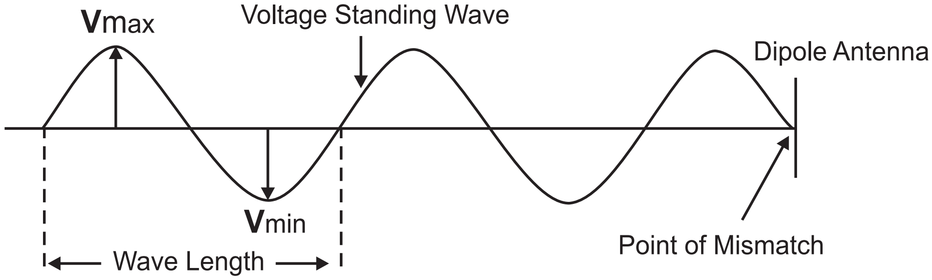


Figure 25.11: *Voltage Standing Wave Ratio*

Figure 25.11 shows a graphical representation of a standing wave formed by interaction of the incident wave and the reflected wave at the point of mismatch. The voltage standing wave has got a point of maxima and a point of minima. The ratio of Vmax to Vmin is called the VSWR. If this matching is perfect, no power is reflected back and VSWR is equal to unity (1:1).

You will learn more about VSWR measurements of antenna in Unit 29.

In the next section, you are going to learn about the protection of towers against lightning.

25.7 Lightning Arrestor

In this section, you will learn about lightning arrestor, which is provided on top of every tower to protect the tower, antenna system, coaxial cable, transmitter and operating personnel from lightning.

Virtually, all masts are subject to lightning strikes, and in tropical areas this incidence is high. The effects of lightning are well-known and the high levels of electrical energy that are generated can result in severe damage to a transmitting installation and even to the staff. It is not possible, of course, to prevent occurrence of lightning strikes but their effects can be minimized by careful design. Lightning tends to strike the highest well-defined point in an area. Masts or towers, particularly those sited on hills, are more vulnerable. The discharge of electrical energy associated with a lightning strike takes the form of a high-current pulse that passes from the point of strike (the top of mast) to the point of lower potential (usually the ground). The route taken by the discharge current can be via more than one path. It is very difficult to predict the path taken by lightning current. However, this path can be channelized by putting lightning arrestor on top of the tower. Lightning arrestor is of a very highly conductive material and connected to the nearest earth pit via copper strap. The earth pit is preferably provided in the wettest part of the site between the mast and the building. The purpose is to provide a low resistance path so that the voltage induced in the arrestor due to lightning is immediately connected to the earth before causing any damage to the equipment and staff. To ensure that lightning currents flow directly to earth without damaging the equipment and staff, it is essential that a transmitting station must have comprehensive grounding system. You will learn about this grounding system in the next section.

25.8 Grounding

In this section, you are going to learn about the grounding system, which is an essential requirement for protection of the equipment and the staff against lightning.

The objectives of grounding are to:

1. Provide safety to the equipment and personnel against lightning.
2. Reduce losses in radiating antenna system.

Earthing System

The earthing system consists of an ordinary plate or an extensive network of driven conductors and plates (called electrodes), buried deep into the soil. For this purpose, earth pits giving very low resistance value are made. Different types of earth pits are used. The most commonly used is GI Pipe earthing.

Alternate layers of salt and charcoal are added along with good earth to retain moisture and achieve good conductivity. The purpose is to get very low-resistance value of the order of less than 1 ohm. Where the ground is rocky, it may not be possible to excavate a pit to sufficient depth and in that case several smaller pits joined by copper straps should be used.

You will learn about the method of making earth connections and measurement of earth conductivity in Unit 28 and in practical workshop.

Activity 25.4

During your visit to a CR station, take a look at the dummy load, coaxial cable, antenna system, tower, lightning arrestor and grounding system used at that station. Note down the specifications for the important parameters of items studied in this unit. Fill in the details in the proforma given below. This will help you identify the types of these items and visualize their significance. You can refer to manufacturers' manuals in this regard.

A. Dummy load

Sl. No.	Parameter	Specification
1	Make	
2	Model no.	
3	Power rating	
4	Input impedance	
5	Type of cooling	

B. Coaxial cable

Sl. No.	Parameter	Specification
1	Size of cable	
2	Length of cable	
3	Make4Model no.	
5	Power rating	
6	Characteristic impedance	
7	Type of connectors	

C. Types of antenna

Sl. No.	Parameter	Specification
1	Type	
2	Make	
3	Model	
4	Number of radiating elements used	
5	Polarization used	

D. Supporting towers and mounting of antenna system

Sl. No.	Parameter	Specification
1	Type of tower	
2	Height of tower	
3	Height of antenna	
4	Mounting of antenna	
5	Foundation of tower	

E. Lightning arrestor and grounding system

Sl. No.	Parameter	Observations
1	Number of earth pits used	
2	Type of earth pit	
3	Watering arrangement	
4	Use of lightning arrestor	
5	Grounding of tower	

25.9 Let Us Sum Up

In this unit on FM antenna and coaxial cable, you have learnt that:

- **Dummy load** is required for testing the transmitter before it is connected to the antenna. The dummy load converts the RF power into heat without any RF radiations. The power rating of dummy load should not be less than the transmitter output power.
- **RF coaxial cable** is used to transfer transmitter output power to the antenna system. Feeder cables mostly used are low-loss cables. Power rating and attenuation are both frequency dependent. Power rating decreases as the frequency increases, whereas attenuation increases with increase in frequency.
- The **antenna system** is required to convert RF output of the transmitter into electromagnetic waves. We have also discussed various types of antennae and classified them into different categories according to design, construction and mounting arrangements. Important parameters of FM antennae are horizontal and vertical radiation patterns and the VSWR (Voltage Standing Wave Ratio). VSWR is the measure of degree of mismatch at the input of the antenna.
- **Towers** are required to mount the antenna system. We have, discussed two types of towers, namely self-supporting and guyed towers. Self-supporting towers are more stable and require smaller area for foundation. Foundation and structural designs are based on height of tower, dead load and wind load of antennae.
- To protect tower, antenna cable and operating staff from lightning, use of lightning arrestor and grounding of tower and cable is necessary. The tower, cable and body of the transmitter and electrical panels should be connected to the nearest earth pit by use of double copper strips. The location of the earth pit should be preferably in the wettest place to retain moisture and as near to the tower as possible. The earth resistance of earth pit should be less than one ohm.

25.10 Model Answers to Activities

Answers to questions given in Activities 25.1 to 25.3.

Activity 25.1

1. Dummy load is provided to check the output and performance of the transmitter before it is connected to the antenna.
2. Non-inductive resistors are used in the construction of a dummy load because dummy load should dissipate the RF power into heat and not radiate into air medium.
3. Large surface area and the fins help quick transfer of heat produced in the resistor of dummy loads into the room with raising the temperature.
4. Input impedance of the dummy load should be equal to the output impedance of the transmitter. It is equal to 50 ohms normally.
5. When the high power transmitters are tested on the dummy load, the heat transfer rate of convection or air cooled is not fast. Water-cooled or oil-cooled dummy loads are more efficient in quick transfer of heat.

Activity 25.2

1. The attenuation offered by low-loss cable is very less and as a result maximum power of transmitter can be fed into the antenna.
2. The dielectric material usually used is foam polyethylene.
3. The characteristic impedance of a coaxial cable is the ratio of voltage to the current for a single propagating wave (frequency).
4. Attenuation of a coaxial cable = 10 log P_1/ P_2 where P_1 is input power and P_2 is the power reaching at other end. Substituting the given values, we get attenuation = 10 log 50/25 = 10 log 2 =10x 0.3010 = 3 dB
5. The average power rating of a cable is inversely proportional to the frequency of operation. If frequency increases, average power decreases and vice versa.

Activity 25.3

1. It indicates that two dipoles have been used. It is a pole mounted antenna. Its polarization is vertical.

2. It will be called circular polarization.
3. From the interpretation of horizontal pattern, we can know the field strength in all the radial direction from the location of the antenna.
4. With a single antenna, the transmitter power required will be double than what is used with a 2-bay antenna for the same coverage.
5. Using the equation, Wavelength = Velocity of light in meters/frequency in Hz = $3x\ 10^8$ / 100 X 10^6 = 300/100 = 3 m. Length of half-wave dipole = ½ x 3 = 1.5 m

Activity 25.4

The information gathered in the activity should be your own and hand-on experiences.

UNIT 26

Propagation and Coverage

Structure

26.1 Introduction

In the previous unit 'FM-Antenna on RF Cable', you learnt about the components, which are used after the output stage of transmitter. These include dummy loads used for internal testing of transmitter; type of coaxial cable that connects the transmitter output to the antenna; types of antenna used for radiation of RF signal; tower and mounting of an antenna; VSWR; lightning arrestor; grounding; etc. The coaxial cable, also known as RF feeder line, carries the transmitter power from its output up to the antenna, which is normally mounted on top of the tower, and from there the RF propagates in various directions.

In this unit, you will learn about propagation and coverage of RF signals, particularly, FM broadcasting in VHF band. In order to have better understanding on propagation, we need to know about various RF frequency bands and their ranges, which are described under Section 26.3. The RF signals are radiated from the antenna and they propagate in different directions. RF signals, depending upon their frequency band, propagate through various layers of atmosphere. In Section 26.4, you will learn what the various layers of atmosphere are and how different RF signal behaves while passing through these layers. This section also mentions about phenomena like reflection, refraction, diffraction, ducting, etc., which RF signal encounters while propagating through various layers of atmosphere. In Section 26.5, you will learn about radio coverage and how it is affected by various factors like frequency, power of transmitter, gain of antenna, height of antenna, terrain condition, presence of environmental noise and also effective radiated power (ERP), which is a very common term used in planning of coverage. This section also defines shadow areas/shadow zones, which occur when RF signals are blocked by terrain condition or poor availability of signal. Shadow regions can be minimized and radio coverage can be maximized by proper selection of site where the antenna can be located at the highest available point/place. Such locations can be identified by examining the topography of the area and analysing toposheets of that particular region. In Section 26.6, you will learn about topography including toposheets and their usage. For planning of FM radio coverage, it is essential to understand the ITU-defined planning parameters, like channel spacing, minimum usable field strength, protection ratio, etc. These parameters are defined in Section 26.7. Field strength measurement is very commonly carried out for checking availability of radio coverage around a transmitter. Learning this in Section 26.8 and also drawing a radio coverage map by plotting the minimum required field strength measured around the transmitter antenna will help you have good understanding of the FM transmitter of a CR station.

You will take about 6 hours to complete this unit.

26.2 Learning Outcomes

After going through this unit, you will be able to:

- **define:**
  - (i) RF spectrum and various bands.
  - (ii) Various layers of atmosphere and what kind of radio waves propagates through them.
  - (iii) The parameters used for coverage planning of FM radio network.
- **list and describe:**
  - (i) The factors responsible for affecting radio coverage and creation of shadow region.
  - (ii) Various parameters used for planning of RF coverage network.
- **analyse:**
  - (i) the toposheet for selection of optimal location for transmitter tower to provide better coverage.
  - (ii) the field strength measurement data and check availability of desired signal for adequate radio coverage.
- **undertake field strength measurements survey and draw a coverage map.**

26.3 What is Spectrum?

Radio wave and spectrum subjects have already been described in detailed under Sections 6.3 and 6.4 of Unit 6 (Module 2). However, to refresh your memory, a brief overview on this subject is given below.

Electromagnetic spectrum is used to carry electromagnetic signals through space. The radio frequency spectrum, which is a part of electromagnetic spectrum, is shared by various radio communication services for variety of applications including public telecommunication services, aeronautical/maritime safety communications, radio and television broadcasting, radars, seismic surveys, rocket and satellite launching, earth exploration, natural calamities forecasting, etc.

The whole of the electromagnetic spectrum covers a huge range of frequencies. Radio frequencies themselves extend over a very large range as well. The range is further divided into different frequency bands as given in Table 1. Frequencies above 1 GHz are normally known as microwaves. As per National Frequency Allocation Plan (NFAP), 87–108 MHz band is used for FM radio broadcasting in India.

Table 1: RF Spectrum Bands

From	To	RF spectrum band
3 kHz	30 kHz	Very low frequency (VLF)
30 kHz	300 kHz	Low frequency (LF)
300 kHz	3 MHz	Medium frequency (MF)
3 MHz	30 MHz	High frequency (HF)
30 MHz	300 MHz	Very high frequency (VHF) **(FM Band 87 – 108 MHz)**
300 MHz	3 GHz	Ultra high frequency (UHF)
3 GHz	30 GHz	Super high frequency (SHF)
30 GHz	300 GHz	Extra high frequency (EHF)

Some bands used in microwaves:

Bands	Frequency range	Bands	Frequency range
L band	1 to 2 GHz	K_u band	12 to 18 GHz
S band	2 to 4 GHz	K band	18 to 26.5 GHz
C band	4 to 8 GHz	K_a band	26.5 to 40 GHz
X band	8 to 12 GHz		

RF spectrum is a valuable, scarce and finite natural resource that is needed for various services and applications. Therefore, its utilization is to be planned scientifically and carefully so that the scarce resource is managed effectively and optimally.

Activity 26.1

To complete this activity, you may need about 10 minutes including writing down the answers in the space provided below.

Question: 1 What is a microwave? Name some radio services that operate in microwave bands.

Question: 2 What is NFAP? Who is responsible for preparing this document?

26.4 Layers of Atmosphere and Radio Wave Propagation

The atmosphere consists of several layers. These layers are further divided based on the characteristics of the gases found in them. Each layer in the atmosphere is also referred to as a sphere. Radio waves, which are divided in different frequency bands, propagate differently in various layers of the atmosphere. This section describes layers of atmosphere, their distance from the surface of the earth, and how radio waves behave while propagating in these layers due to change in ionization and density of gases present.

Though the transmission of RF waves from a CR station's FM transmitter follow VHF propagation, learning about propagation of other waves MW, SW, microwaves will be helpful.

26.4.1 Troposphere

The first layer of the atmosphere is called the troposphere. It is the lowest part of atmospheric layer, extending from the earth's surface up to the bottom of the stratosphere. It starts from the surface of the ground and extends up to 10 km above the surface, as shown in Figure 26.1. The troposphere is the layer that we live in. The boundary between the troposphere and the stratosphere is called the 'tropopause'. The troposphere is characterized by decreasing temperature with height (at an average rate of 6.5^{o} C per kilometer).

Most of the radio transmissions operate in the lower layers of the earth's atmosphere, which is the troposphere. Some of the radio systems operating in this sphere are point-to-point, point-to-multi point, line-of-sight radio links in VHF and UHF bands, mobile radio networks in VHF and UHF bands, TV and FM broadcasting, etc.

It has been observed that the troposphere has an increasing effect on radio signals and radio communications systems, particularly, on frequencies above 30 MHz with the result that the radio signals are able to travel over greater distances beyond the line of sight.

The reason for radio signals travelling longer distance is that the refractive index of the air closer to the ground is slightly higher than that higher up. As a result, the radio signals are bent towards the area of higher refractive index, which is closer to the ground. It thereby extends the range of the radio signals.

26.4.2 Stratosphere

The next layer of atmosphere is called the stratosphere. It is the second layer of the atmosphere, as one moves upward from earth's surface. The stratosphere is above the troposphere and below the ionosphere. The top of the stratosphere occurs at a height of 50 km from ground. The boundary between the stratosphere and the ionosphere is called the stratopause. These are indicated in Figure 26.1. The stratosphere has either constant or slowly increasing temperature with height.

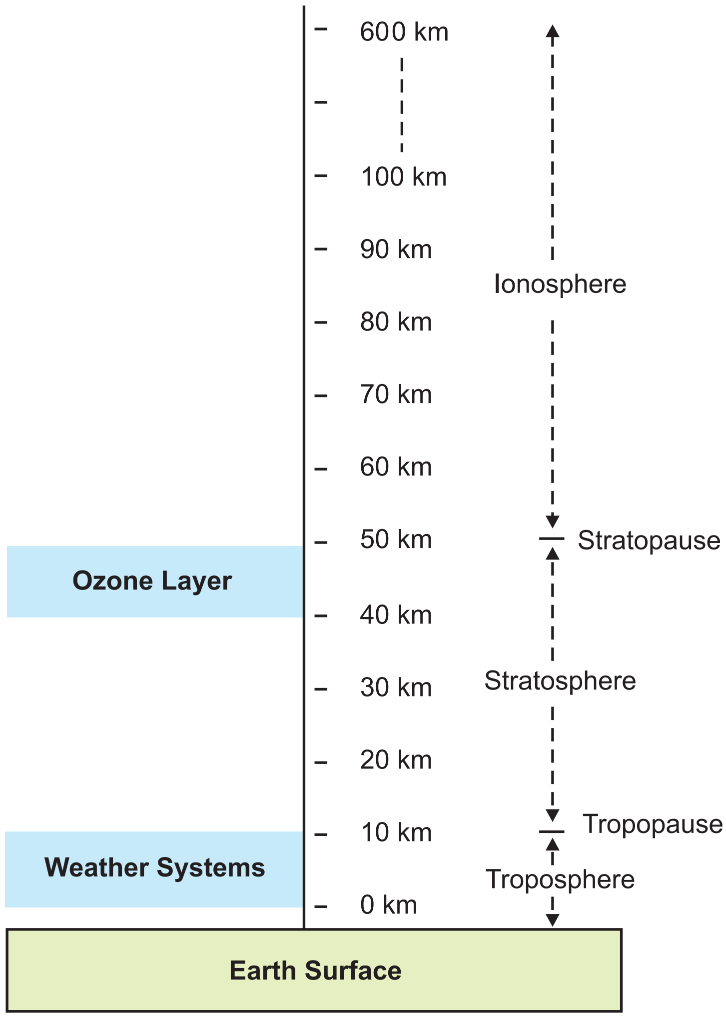


Figure 26.1: *Layers of atmosphere and their distances from earth surface*

26.4.3 Ionosphere

The ionosphere is the third layer of the atmosphere, as one moves upward from earth's surface. This layer is ionized by solar wind. It has practical importance because, among other functions, it influences radio propagation to distant places on the earth. This layer basically starts from the height of 50 km above the earth and extends up to the height of about 600 km. In case of radio waves passing through this layer or somehow penetrating into it, they will be affected by the specific phenomena of this layer. Some of the communication systems that experience these effects are those working in MF and HF radio transmission bands as well as satellite and space communication systems where one or both end point terminals are located on the ground. The ionosphere is sub-divided into several layers as described below and also shown in Figure 26.2.

D Layer

The D layer is located above the stratosphere. It is the innermost layer of ionosphere. Its range is from 50 km to 115 km with reference to the surface of the earth. The intensity of ionization is higher in the D layer because it is composed of the heavier gasses. High-frequency (HF) radio waves are not reflected by the D layer but suffer loss of energy therein. This is the main reason for absorption of HF radio waves, particularly, at 10 MHz and below with progressively smaller absorption as the frequency gets higher. The absorption is small at night and greatest about midday. The layer reduces greatly after sunset. A common example of the D layer in action is the disappearance of distant MW broadcast band stations in the daytime.

E Layer

The E layer is located above the D layer. It is the middle layer of ionosphere. Its range is from 115 to 160 km from the surface of the earth. The intensity of ionization is lesser in the E layer as compared to D layer because it is composed of less heavy gasses. This layer can only reflect radio waves having frequencies lower than about 10 MHz and may contribute a bit to absorption on frequencies above.

Sporadic-E (E_s)

The E_s layer (sporadic E layer) is characterized by small and thin clouds of intense ionization. Sporadic-E events may last from just a few minutes to several hours. This propagation occurs most frequently during summer months.

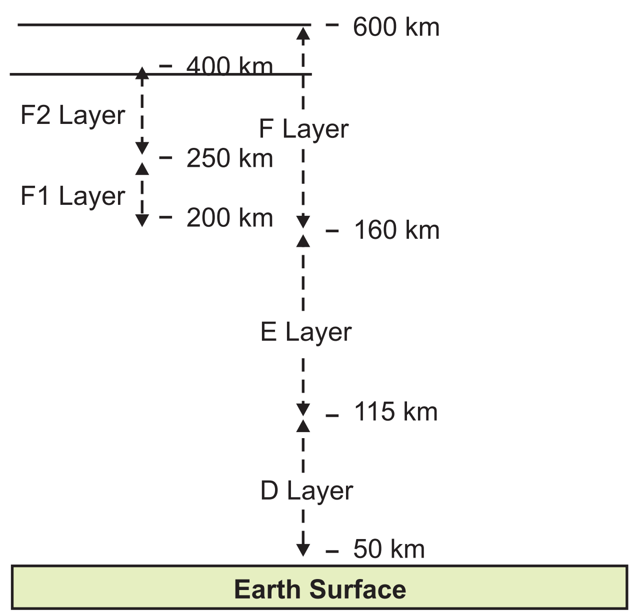


Figure 26.2: *Layers of ionosphere and distances from the earth surface*

F Layer

The F layer extends from about 200 km to about 600 km above the surface of the earth. It is the densest point of the ionosphere, which implies signals penetrating this layer will escape into space. The F layer consists of one layer at night, but during the day, a deformation often forms in the profile that is labelled as F1 and the other part as F2.

F1 Layer

The F1 layer is located above the E layer. Its range is from 200 to 250 km with respect to the earth. The intensity of ionization is lesser in the F1 layer with respect to E layer.

F2 Layer

This layer is located above the F1 layer. Its range is from 250 km to 400 km with respect to the earth. The intensity of ionization is lesser in F2 layer with respect to F1 layer. The F2 layer remains by day and night responsible for most skywave propagation of radio waves, facilitating high frequency (HF, or shortwave) radio communications over long distances.

26.4.4 Ground Wave/Sky Wave/Space Wave

Radio waves travel from one point to another (e.g.,a transmitter to a receiver) by different ways. These are mainly ground waves, sky waves and space or tropospheric waves.

The ground waves travel closer to the surface of the earth. The sky wave propagation, usually called ionospheric propagation, results due to bending of wave-path through ionosphere. This method of propagation accounts for long distance radio communication through shortwave both, during day and night time and also through medium wave during night.

Space wave represents energy that travels from the transmitting to the receiving antenna through earth's troposphere. Space wave propagation becomes essential in VHF bands because ground wave is attenuated to a negligible amplitude within a few hundred metres, while the ionosphere is not able to reflect any energy back to the earth in VHF range.

26.4.5 Effects of Wave Propagation in Different Media

When lights travel from one medium to another, three things happen: (i) some lights are reflected, (ii) some lights are absorbed and (iii) some get refracted.

Similarly, when radio wave propagates, the following can occur when the wave passes from one medium to another:

i) Reflection: some waves get reflected back into the same medium.
ii) Absorption: some waves get absorbed by the medium.
iii) Refraction: some waves get transmitted into the second medium at a different direction and velocity.

However, when a radio wave encounters an obstacle on its propagation path, it may bend around the obstacle. This bending phenomenon is called diffraction. Also, when a wave propagates in troposphere, another special phenomenon 'ducting' occurs due to temperature inversion.

Reflection

Reflected waves are neither transmitted nor absorbed, but are reflected from the surface of the medium they encounter. The basic analogy is similar to reflection of light by a mirror. If a wave is directed against a mirror, the wave that strikes the surface is called the incident wave, and the one that bounces back is called the reflected wave. This also occurs when a wave is transmitted skyward, reflect off the ionosphere, and returns to a receiving station. The angle of reflection equals the angle of incidence. Reflection of wave is illustrated in Figure 26.3, where the incident wave forms angle i to normal reflected at an angle r and travels in a different direction.

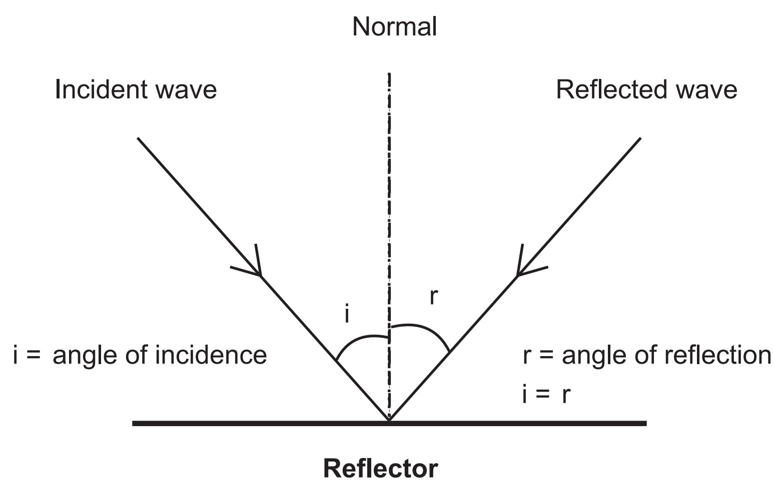


Figure 26.3: *Reflection of wave*

Refraction

The radio waves propagating in the earth's atmosphere always experience the wave refraction phenomenon. As the height increases, the air density and consequently its refractive index decreases. This non-homogeneous characteristic of air in the atmosphere causes deviation in the wave propagation path, so that they do not travel further in a straight direction. When the rate of refractive index changes linearly, the ray path would be an arc of a circle. Figure 26.4a shows a simple case of refraction where the refracted wave bends inward when it travels from one medium into another. The bending phenomenon is clearly visible. In Figure 26.4b, the same phenomenon is described in detail where the wave from medium 1 having refractive index n_1 travels to medium 2 with refractive index n_2. If the refractive index of medium 2 is higher than medium 1 then the wave will bend inward. If the refractive index of medium 2 is lower, it would bend outward. If we draw a normal at the point where the wave from medium 1 enters into medium 2, then it forms an angle α known as angle of incidence. In medium 2, the refracted wave bends inward forming angle of refraction β.

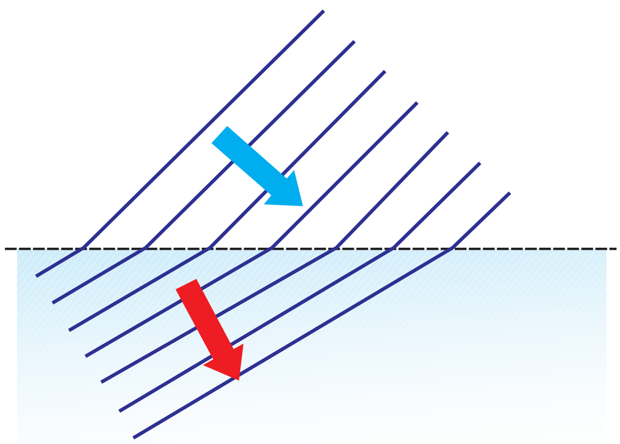


Figure 26.4a: *Refraction of wave*

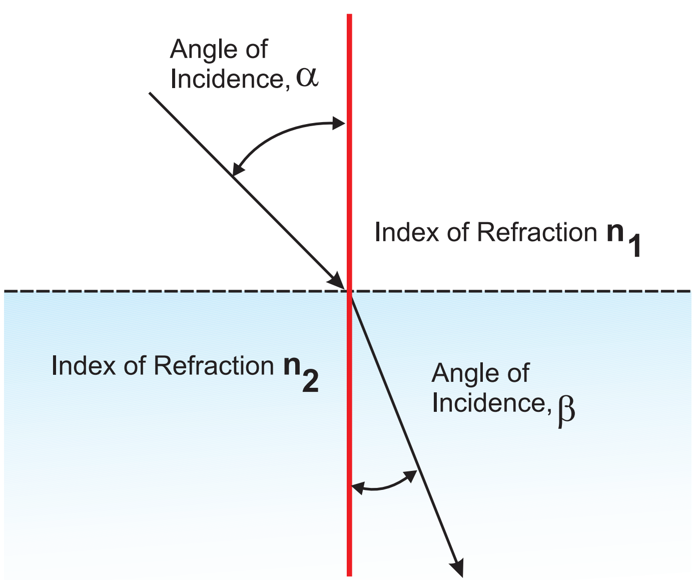


Figure 26.4b: *Refraction of wave with angle of refraction* β

Figure 26.4c shows how short wave frequencies get refracted from the ionosphere and return to the earth's surface at a longer distance. Because of this phenomenon, short wave signals travel several thousands of kilometres.

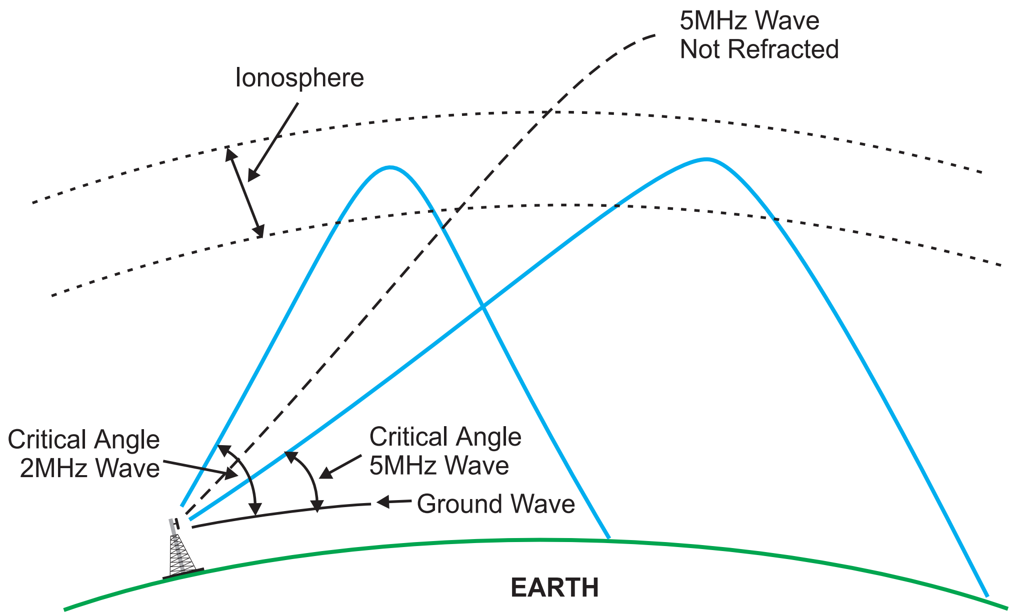


Figure 26.4c: *Short wave frequencies get refracted by ionosphere and travel longer distance*

Diffraction

When a radio wave encounters an obstacle in its path, it bends around the obstacle. This bending is called diffraction, and results in a change of direction of part of the energy from the normal line-of-sight path. Figure 26.5 shows a wave that is diffracted after it came across a partial obstructed object. When a wave front strikes the edge of an object, as shown in the figure, it bends inward and travels further in a different direction. Before reaching the object, the wave front was travelling in a horizontal direction and after passing through the edge of the object, it started travelling downward. This phenomenon is called diffraction.

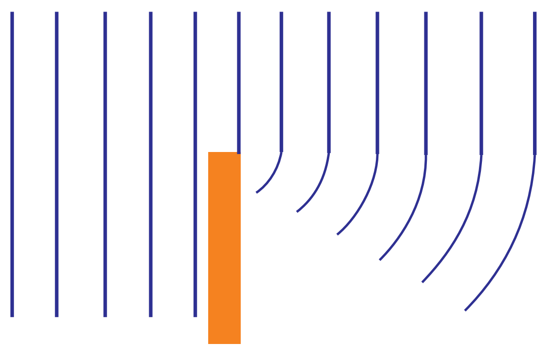


Figure 26.5: *Diffraction of wave*

Ducting

Ducting is one of the propagation phenomena that happen in the troposphere. Tropospheric ducting occurs when a radio signal is reflected off the troposphere and continues on a path that allows the signal to travel much farther than it normally would. This occurs when the temperature in the atmosphere experiences an inversion. When a temperature inversion occurs, radio waves that would normally continue into space beyond the earth's atmosphere are instead reflected and they continue to follow the curvature of the earth. Radio waves have been able to travel in excess of 1,000 km because of tropospheric ducting. TV signals travel longer distance over sea surface because of ducting. Figure 26.6 shows how the radio waves propagate because of total internal reflection between two layers forming a duct above the surface of the earth.

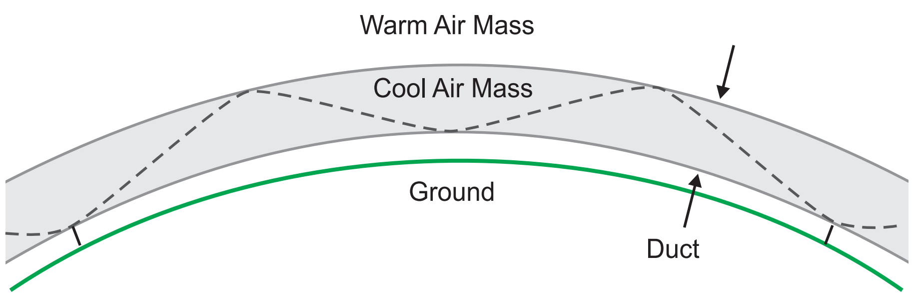


Figure 26.6: *Ducting*

Activity 26.2

To complete this activity, you may need about 15 minutes including writing down answers in the space provided below.

Question: 1 Name various types of radio communication systems that operate in VHF band in India.

Question: 2 What are the various effects that take place when VHF signal propagates in the troposphere?

26.5 Factors Affecting Coverage and Shadow Areas

RF signals are transmitted from the antenna of radio transmitters. These RF signals, depending on the frequency of operation, propagate through different layers of the atmosphere and reach various places. Radio receivers help in detecting these signals and reproduce the audio frequencies after demodulating them. However, the receiver can only be able to detect the signals that are above the minimum usable field strength. Availability of the area around the transmitting station which gets the signal of this strength or more is known as radio coverage area. Places where these signals do not reach from the transmitter due to obstruction of propagation condition are called shadow zones or shadow areas. The following sections explain these phenomena in detail.

26.5.1 Factors Affecting Coverage

Transmitter antenna radiate energy in all directions. Depending upon the design of antenna (e.g., directional or omni-directional), the intensity of energy radiation varies in different directions with respect to distance. As the distance from the location of the antenna increases, the intensity of the received signal decreases. The distance where the strength of received signal is just sufficient for the receiver to detect it without any interference is called radio coverage range. These distances from the transmitter/antenna in different directions around the antenna define radio coverage range.

RF coverage or availability of desired level of RF signal in a particular target area gets affected by various factors. Some of these major factors that affect the coverage of RF signals are as follows:

- The frequency on which the transmitter is operating
- The effective radiated power of the transmitting station, that is, ERP
- The type and design of antenna
- The height and location of the antenna
- The terrain profile and condition
- The amount of electromagnetic noise

Each of these above factors affects radio coverage and is taken into consideration in determining how far the radio signal would be able to provide effective coverage.

Frequency on which the transmitter is operating

Frequencies in higher order bands cover lesser area. In case of medium wave transmissions, the lower order band, e.g., around 600 kHz, provides wider coverage than higher order bands, say at 1500 kHz, under similar ground conditions (conductivity). An FM transmitter operating in VHF FM band (87 – 108 MHz) provides almost similar coverage.

Effective rated power of the transmitter

As a general rule, it can be said that the coverage of radio transmitter increases with its output power. The higher the power, greater is the coverage distance. Also since VHF is a line-of-sight propagation, the coverage is restricted by availability of line-of-sight. As such, increasing transmitter power beyond a certain point may not be able to increase its coverage range. However, in actual terms, it is the effective radiated power (ERP) of the transmitting station (which includes the contribution of the antenna system) that determines the coverage and not the transmitter power alone. You will learn about ERP in detail later in this subsection.

Type and design of antenna

The type and design of an antenna decide its gain. This gain increases the ERP, e.g., a 10 kW FM transmitter having an antenna of gain 3 dB would radiate 20 kW as ERP. A directional antenna has more gain in a particular direction, and thereby increases the range or coverage in that direction.

Antenna height and location

The most critical coverage factor is the height and location of the antenna. This is because the range of a radio coverage is theoretically limited to the radio horizon as reached by the radio antenna. Basically, the higher the height of the antenna, the greater the area it will cover. Therefore, FM antennae installed on hilltops provide wider coverage.

Terrain profile and condition

As radio waves follow a line-of-sight path, terrain variations can cause obstruction to propagation. Hills and valleys or any kind of high-rise structure that come in the direction of the line-of-sight path obstruct propagation. In such cases, if we increase the antenna height, we can reduce such obstruction, and thereby increase coverage.

Amount of electromagnetic noise

Presence of electromagnetic noise, industrial noise, or environmental noise around the receiver affects detection of weak RF signals and thereby affects radio coverage.

26.5.2 What is ERP?

Most of us are well aware of transmitter power, which the transmitter delivers to the feeder/RF cable that is connected to the antenna. However, this power may not be the same what the antenna delivers or radiates. It is mainly because of two factors: (i) the feeder/RF cable including multiplexer/diplexer/connectors causes some losses and (ii) the antenna may provide some gain depending upon its design. This gain of antenna varies with its type and directivity. Therefore, the ERP includes all gain and loss factors on the transmitting side and usually expressed in dBm, or dBw, or dBkw, etc. In fact, ERP is the product of the transmitter output power and antenna gain in the desired direction taking into account all losses caused by the RF feeder, connectors, etc.

Mathematically, ERP can be calculated as:

> ERP = (Transmitter Power – Feeder/RF cable loss) x Antenna gain
>
> For example, a 100w FM transmitter having a 30-meter long RF feeder cable causes a loss of 1dB and the gain of antenna is 4dB. Then, its ERP will be:
>
> Transmitter power – Feeder cable loss + Antenna gain (all in dB)
>
> = 100w (or 20 dBw) – 1 dB + 4 dB
>
> = 23 dBw
>
> = 200w (3 dB gain doubles the power)

26.5.3 Shadow Areas

In FM broadcasting network, reception of radio service gets hampered because of inadequate signal or any obstruction between the transmitting station and the targeted areas. These areas are called shadow zones or shadow areas. As an example, if the transmitter in a valley is located on one side of a hill, the other side will have no RF signal and thereby creates shadow areas.

Activity 26.3

To complete this activity, you may need about 5 minutes.

Qestion: 1 Find out the ERP of a transmitter having output power 200 w, losses due to feeder cable and joints 1.5 dB and antenna gain 4.5 dBi.

26.6 Topography

Topography is a broad term used to describe the detailed study of the earth's surface. It is a detailed description of a place or region located on a map. While topography includes vegetative and man-made features, it more commonly refers to a horizontal point of latitude and longitude. This includes changes in the surface such as mountains and valleys as well as features such as rivers, roads and buildings. Topography is closely linked to the practice of surveying, which is the practice of determining and recording the position of points in relation to one another.

Toposheet

India, with an area of 32,87,263 km^2, is covered by both topographical and geographical maps. The topographical maps are on sufficiently large scale of 1:25,000, 1:50,000, which are ideally suited for the professional work of geologists, geographers, foresters, engineers, planners, tourists, mountaineers, etc. On the other hand, the geographical maps are on such a small scale of less than 1:2,50,000 that they are useful mainly for synoptic views.

India is covered by nearly 385 toposheets on 1:2,50,000 scale, which are also called degree sheets. Each degree sheet has 16 toposheets of 1:50,000 scale and the whole of the country is covered by 1:50,000 rigorous metric surveys in more than 5,000 toposheets. Each 1:50,000-scale sheet contains four 1:25,000-scale sheets. Guide maps on scale of 1:10,000 and smaller are available for towns and cities in various states.

Topographic maps provide the graphical portrayal of objects present on the surface of the earth. These maps provide the preliminary information about a terrain and thus are very useful for engineering works, including planning of radio coverage network. For most part of India, topographic maps are available, which are prepared by the Survey of India. To identify a map of a particular area, a map numbering system has been adopted by the Survey of India.

For broadcast radio network planning, toposheets are useful for locating highest points where an antenna can be installed so that maximum coverage is achieved. However, since CR stations have to be located near the area of the target community, the coverage planning has to take into account the topography of a target area with a smaller community, which may not have much variation in topology.

26.7 Signal Requirements and Coverage Planning Parameters

The coverage planning of an FM transmitter in VHF band-II (for FM broadcasting in India it is 87–108 MHz) is a complex process. Preparation on planning of FM network requires understanding of minimum usable field strength, protection of wanted signal from other transmitters, noise protection requirements for city and rural areas, etc. To get a clear understanding of coverage planning, these parameters are explained below.

26.7.1 Transmission Characteristics (ITU-R BS-450-2)

ITU has defined FM transmission characteristics as per its recommendation BS-450-2. These characteristics define permissible range of parameters like AF bandwidth, maximum deviation, bandwidth of emission, pre-emphasis, maximum spurious emission, etc. These terms were defined and explained in Unit 23. However, for easy reference, these are summarized below:

AF bandwidth	:	15 kHz
Maximum deviation	:	± 75 kHz (Stereo Multiplex Signal)
Bandwidth of emission	:	180 kHz
Pre-emphasis	:	50 µ sec
Frequency tolerance	:	2000 Hz
Maximum spurious emission	:	– 60 dBc (60 dB below carrier)

26.7.2 Channel Spacing

Channel spacing is the difference in frequency between successive FM carriers. It is measured in kHz.

- Monophonic reception : optimum between 75 kHz and 100 kHz
- Stereophonic reception : optimum between 100 kHz and 150 kHz
- Optimum channel spacing : 100 kHz (used in India)
- Minimum frequency separation between transmitters co-located in the same city is 400 kHz (theoretically). But in India 800 kHz separation is presently being used between two transmitters operating in the same city in most of the places.

26.7.3 Minimum Usable Field Strength (E_{min})

For FM radio broadcasting, ITU has given, vide its Recommendation BS-450, different level of signal strength that are required for providing coverage to different geographical locations (Rural, Urban and Semi-Urban). ITU has also defined these parameters according to the type of reception, that is, mono or stereo as given in Table 2. While working out these recommendations, noise levels in different set of locations namely rural, urban and large city have been taken into consideration.

Table 2: Minimum Usable Field Strength

	Monophonic Reception	**Stereophonic Reception**
Rural Area	48 dB(mv/m)	54 dB(mv/m)
Urban Area	60 dB(mv/m)	66 dB(mv/m)
Large City	70 dB(mv/m)	74 dB(mv/m)

The field strength received from a given transmitter varies not only with location, but also with time. Therefore, FM radio services are normally planned to be available for 99% of the time in the case of national networks and 95% of the time for local services.

26.7.4 Radio Frequency Protection Ratio

A protection ratio is the required difference in field strength between a wanted and an interfering signal, and is normally expressed in dB. The required ratio falls as the frequency separation between the two stations increases, and is tabulated in Table 3.

Table 3: Protection Ratio

Frequency Spacing	**Monophonic**		**Stereophonic**	
(kHz)	***Steady***	***Troposphere***	***Steady***	***Troposphere***
0	36	28	45	37
100	12	12	33	25
200	6	6	7	7
300	–7	–7	–7	–7
400	–20	–20	–20	–20

26.7.5 CRS Frequencies

For proper operation of CR stations, WPC has identified specific frequency spots. These are 90.4, 90.8 and 107.8 MHz. As such, normally a CRS is allotted one frequency out of these frequencies. In addition, 91.2 MHz is also allotted wherever it is possible to do so.

Activity 26.4

To complete these activities, you may need about 10 minutes including writing down the answers in the space provided below.

Question:1 What is the channel spacing in VHF FM broadcasting? In USA, UK, Japan and India, what channel spacing is used in FM channels?

Question:2 Define protection ratios for co-channels (channels with same frequency repeated and at a different location) for stereophonic transmission in steady state.

26.8 Field Strength Measurements and Drawing an Actual Coverage Map

Measurement of field strength is important and essential to ensure effective planning and coverage of radio services, be it SW, MW or FM. Field strength meters measure the strength of RF signal available, which indicates whether the strength is good enough for desired reception. A field strength meter is quite commonly used for this purpose and therefore it is necessary to understand its operation and use. Also, it is necessary to learn the process of plotting and preparing of actual coverage map from these readings.

26.8.1 Field Strength Meter

A field strength meter is a microvolt meter or test receiver coupled with a suitable pick-up device (antenna) for measuring electrical and magnetic field strength.In broadcasting, it is used for propagation measurements, determination of coverage, radiation patterns of antennae, etc.

Basic Principles

A field strength meter comprises the following three essential parts:

- Pick-up device or transducer (antenna)
- Voltage measuring device
- Built-in calibration oscillator

Field strength is measured by comparing the voltage induced in the antenna circuit with the output of the built-in calibration oscillator.

Field Strength Measurement

A typical field strength measurement set-up is shown in Figure 26.7. It comprises a field strength meter, an antenna and a connecting cable. The antenna is connected to the input of the field strength meter through a cable. The measurement is carried out in two steps:

- First, the detector output of the receiver is adjusted up to certain indication E_o dB (μv/m) with the help of the attenuator.
- Second, the known output from calibration oscillator is fed to the receiver and the attenuator value is adjusted so as to get same output in the indicating device, that is, E_o dB (μv/m).

Measurement Range: Typical range –10 to + 160 dBμ

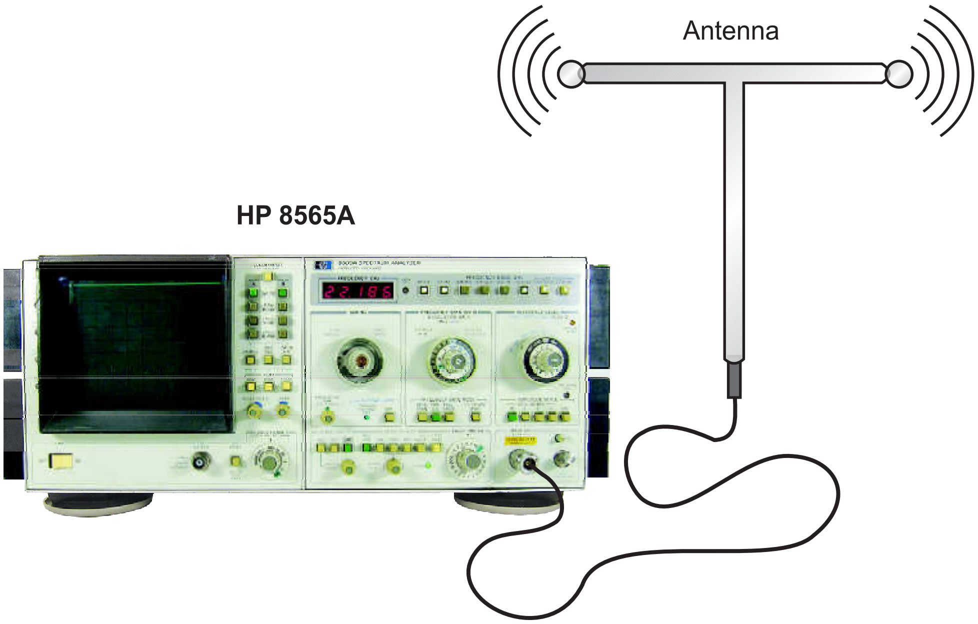


Figure 26.7: *Field strength measurement set-up*

Normally, field strength measurements are recorded when the CR station is set up or there is an issue of coverage not being satisfactory.

26.8.2 Drawing an Actual Coverage Map of an FM Transmitter

Let us carry out field strength measurement survey of a 300 w FM transmitter located in North-West Delhi to ascertain stereo and monophonic FM coverage. Since Delhi is an urban city, the desired field strength value should be 74 dB µv/m and 70 dB µv/m, respectively, for stereophonic and monophonic transmissions. These field strength values are measured and verified in a given direction at a particular distance from the FM transmitter. These distances for both stereo and mono transmissions are noted as shown in Table 4.

Table 4: Field strength measurement and coverage distance of 300 w FM transmitter

	Angle/Direction	**Distance in km for**	
		Stereo (74 dB µv/m)	**Mono** (70 dB µv/m)
1	0° / East	6.1	9.2
2	45° / North-East	6	8.9
3	90° / North	6.7	10.1
4	135° / North-West	6.2	10.3

5	180° / West	6.2	10.2
6	225° / South-West	6.1	10.4
7	270° / South	5.9	10
8	315° / South-East	5.8	9.8

Distances noted above (Table 4) for stereo and mono field strength values are plotted around the transmitter on a map, as shown in Figure 26.8. For stereophonic FM coverage, distances from the transmitter are marked in double line red colour around the transmitter. Areas under this double line red contour show coverage of stereo service. Similarly, areas under single line in grey colour contour around the transmitter show coverage map for mono service.

Figure 26.8: *Actual coverage map of a 300 w FM transmitter*

Activity 26.5

To complete this activity, you may need about 10 minutes including writing down the answer in the space given below.

Question: 1 Explain the procedures for measurement of field strength?

26.9 Let Us Sum Up

RF spectrum is defined in the range from 3 kHz to 300 GHz. This is further divided into various bands known as VLF, LF, HF, VHF, UHF, SHF and EHF. A spectrum over 1 GHz is known as a microwave.

Propagation of RF waves takes place in various layers of the atmosphere. These layers are known as troposphere, stratosphere and ionosphere. Most of the communication systems operate in troposphere. However, HF propagation through ionosphere helps in providing SW broadcast to longer distances.

Radio waves, while propagating in various medium (e.g., in troposphere), encounter reflection, refraction, diffraction, ducting, etc. These effects help operation of different types of communication systems for various purposes, e.g., refraction of HF by ionosphere facilitates short-wave broadcasting to longer distances, whereas troposphere/ducting extends microwave communication over longer distances.

Radio signals from FM transmitters propagate from the antenna and travel in different directions. These signals provide radio coverage but get attenuated with distance while travelling. The distance from the antenna at which the signal is attenuated to just minimum value, which is receivable by the receiver, defines radio coverage range. Radio coverage is affected by various parameters like frequency, transmitter power, antenna design and gain, antenna height and location, terrain condition, presence of noise, etc. Effective radiated power (ERP), which is the net output power radiated from the antenna after taking into account all losses and gain of the antenna, affects radio coverage. Radio coverage is normally not uniform around the transmitter because of terrain condition, which may cause obstruction to its propagation path. Such areas where radio signal strength is poor or is not available are called shadow areas.

Selection of antenna location is important, particularly when the terrain profile is not uniform and comprises hills and valleys. Proper selection of site helps in providing maximum radio coverage and minimizes shadow areas. Therefore, for site selection, knowledge on topography and use of toposheets are essential.

Understanding of planning parameters like channels spacing, minimum usable field strength, protection ratio, etc. is essential for FM radio coverage calculations and network planning. These parameters are defined in ITU-R recommendations. While planning FM radio coverage, one has to ensure that minimum usable field strengths are available within the targeted area and the wanted signal is protected from interference from other existing FM transmitters.

Field strength measurement survey is conducted to find out actual radio coverage of FM transmitters. When plotted over a map, these values indicate coverage of that radio service.

26.10 Model Answers to Activities

Activity 26.1

1. Microwave refers to electromagnetic energy having a frequency higher than 1 GHz, corresponding to wavelength shorter than 30 centimetres.

   Various radio services operate in microwave bands:

   i) Microwave links used for radio communication; for sending programme from the studio to the transmitter through STL (Studio-Transmitter Link)

   ii) Satellite communication: Up-linking to satellite, down-linking from satellite, satellite broadcasting (DTH service)

   iii) Telecommunications services

2. NFAP is the abbreviation of National Frequency Allocation Plan. This plan defines allocation of various services in different frequency bands. All spectrum users plan their services as per the provision given in the NFAP. Wireless Planning and Coordination (WPC) Wing of the Ministry of Communication and IT is responsible for preparing this plan. This plan is reviewed periodically, once in two years, in consultation with major spectrum users.

Activity 26.2

1. i) FM radio broadcasting (87–108 MHz)

   ii) Television broadcasting 54–68 MHz in Band-I; 174-230 MHz in Band-II

   iii) VHF radio links

   iv) VHF communications, walkie-talkie, etc.

   v) Aeronautical services

2. When VHF signal propagates in the troposphere, it may get reflected, absorbed, refracted or diffracted.

   When there is a temperature inversion, particularly over ocean, ducting may take place.

Activity 26.3

1. ERP = Transmitter power –Feeder cable loss + Antenna gain

   Transmitter power = 200 w = 23 dBw

   (1w = 0 dBw; 10w = 10 dBw; 100w = 20 dBw, 200w = 23 dBw), (3 dB gain doubles the power)

   Losses = 1.5 dB

   Gain = 4.5 dBi

   ERP = 23 dBw – 1.5 dB + 4.5 dBi = 26 dBw = 400 w

Activity 26.4

1. Channel spacing is the spacing between the main carrier frequency and the next immediate carrier. In FM broadcasting, FM channel carriers are separated by 100 kHz. For example, carrier of FM Gold in Delhi is 106.4 MHz and the next adjacent carrier frequency would be 106.5 MHz.

   Channel spacing for FM broadcasting in USA is 200 kHz, in UK it is 100 kHz, in Japan it is 100 kHz and in India it is 100 kHz.

2. Protection ratio is a value that ensures protection of wanted signals from unwanted signals. When co-channel frequencies of FM transmitters are repeated at different locations, within the coverage area of the wanted FM transmitter must be protected by the other FM transmitters operating in the same frequency at a different location. Protection ratio for these co-channels will depend on the type of coverage, that is, mono or stereo/steady or tropospheric. These values for co-channels or adjacent channels are defined in ITU-R, BS-450-2. According to the ITU rec, protection ratio for co-channel stereophonic transmission in steady state is 45 dB.

Activity 26.5

1. The field strength measurement set-up comprises a field strength meter/spectrum analyser, a calibrated antenna and a connecting cable. The antenna is connected to the input of the field strength meter through a cable. When measuring with a field strength meter, it is

important to use a calibrated antenna such as the standard antenna supplied with the meter. For precision measurements, the antenna must be at a standard height. A value of standard height frequently employed for VHF and UHF measurements is 10 metres.

The measurement is carried out as mentioned below:

- Calibrated antenna is to be installed at a standard height.
- Antenna is connected to the field strength meter.
- Meter is calibrated.
- Field strength readings are taken and corresponding distance from the transmitter is also noted.

26.11 Additional Readings

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Glossary

Antenna	is a device (transducer) that converts guided waves in cables into free space waves or vice versa.
Antenna Aperture (physical)	is a measure of the actual physical size of the antenna (physical cross section perpendicular to direction of propagation).
Antenna Gain	is the ability of the antenna system to give more field strength at a point in comparison to that would have been given by a single half-wave dipole when fed with the same power as that of the antenna system.
Antenna Efficiency	is the ratio of the radiated power to that of the input power supplied to the antenna.
Beam Width	of the antenna is a measure in degrees on the main lobe of the radiation pattern between the points where the radiated power has fallen to half of its maximum value.
CCIR	stands for Consultative Committee on International Radio-Regulations.
Dipole	is a pair of electric charges or magnetic poles that have equal magnitudes but opposite signs and are separated by a small distance.
Dynamic Range	is the difference between the lowest and the highest levels of notes produced by any musical instrument or a frequency operating system.
ERP	(Effective Radiated Power) means the total output power thrown in the air by the antenna system. This is generally calculated with a mathematical formula that takes into account the output power, cable loss and antenna gain.
ERP (Effective Radiated Power)	is the product of input power to the antenna and antenna gain. The power fed to the antenna as used here is equal to the transmitter power minus the losses in a coaxial cable.
Equalization	is a process through which the frequency response of any equipment is adjusted to the desired value.
Exciter	is the first stage of FM broadcasting where the RF signal is generated and modulated.
Free space	is a space that does not interfere with normal radiation and propagation of radio waves.

Half-wave Dipole	is an antenna whose length of its longer side is equal to half the wavelength at the frequency of operation.
Isotropic Radiator	is a radiator that radiates energy uniformly in all directions.
ITU	stands for International Telecommunication Union.
Heat Sink	is a specially designed aluminum plate to absorb heat.
Layers of Atmosphere	include troposphere, stratosphere, and ionosphere. The atmosphere consists of these layers. Ionosphere is further divided into D layer, E layer and F layer.
Minimum Usable Field Strength:	In case of FM radio broadcasting, different levels of signal strength is required for providing coverage to different geographical locations (rural, urban, semi-urban, etc). ITU defined these parameters according to the type of reception, that is, mono or stereo for different geographical condition, e.g., for stereophonic reception in rural areas it is 54 dB (mv/m).
NFAP (National Frequency Allocation Plan)	The Wireless Planning and Coordination (WPC) Wing of the Ministry of Communication and IT is responsible for preparing this plan. This plan is reviewed periodically, once in two years, in consultation with major spectrum users. This plan defines allocation of various services in different frequency bands. All spectrum users plan their services as per the frequency provisions in the NFAP.
Nominal Level	is the operating level at which the electronic equipment is designed to operate.
Output Power	is the total output that is measured at the transmitter equipment output.
Protection Ratio	is the required difference in field strength between a wanted and an interfering signal, and is normally expressed in dB.
Phantom supply	is a dc supply required for the operation of certain microphones for polarizing their transducer elements.
PLL (Phase Lock Loop)	is an electronic concept that helps devices to stick to a desired frequency.
RF Amplifier	is a device that amplifies the RF signal before sending it to the antenna.
RF Filter	is an electronic device that cuts out spurious and harmonics from radio frequency signals.
Reflected Power	is a portion of the output power thrown by the antenna system back to the transmitter.

Standing Wave Ratio (SWR)	is the ratio between the output power and the reflected power.
Shadow Areas	are the uncovered areas between transmitters or within the targeted areas of a transmitter due to unavailability of the desired level of RF signal because of obstruction or poor signal strength.
Signal to Noise Ratio (SNR)	is the ratio of nominal signal level to the noise level present in it.
SMPS (Switch Mode Power Supply)	converts alternate current into direct current and produces regulated supply.
Wavelength	is the length (in metres) of one cycle of the frequency of operation.
WPC (Wireless Planning and Coordination)	is a Wing of the Department of Telecommunications, which is responsible for planning of wireless services in the country. WPC issues the licence for operating frequency of a CR station.

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Certificate in Community Radio Technology

8

FM Transmitter Setup

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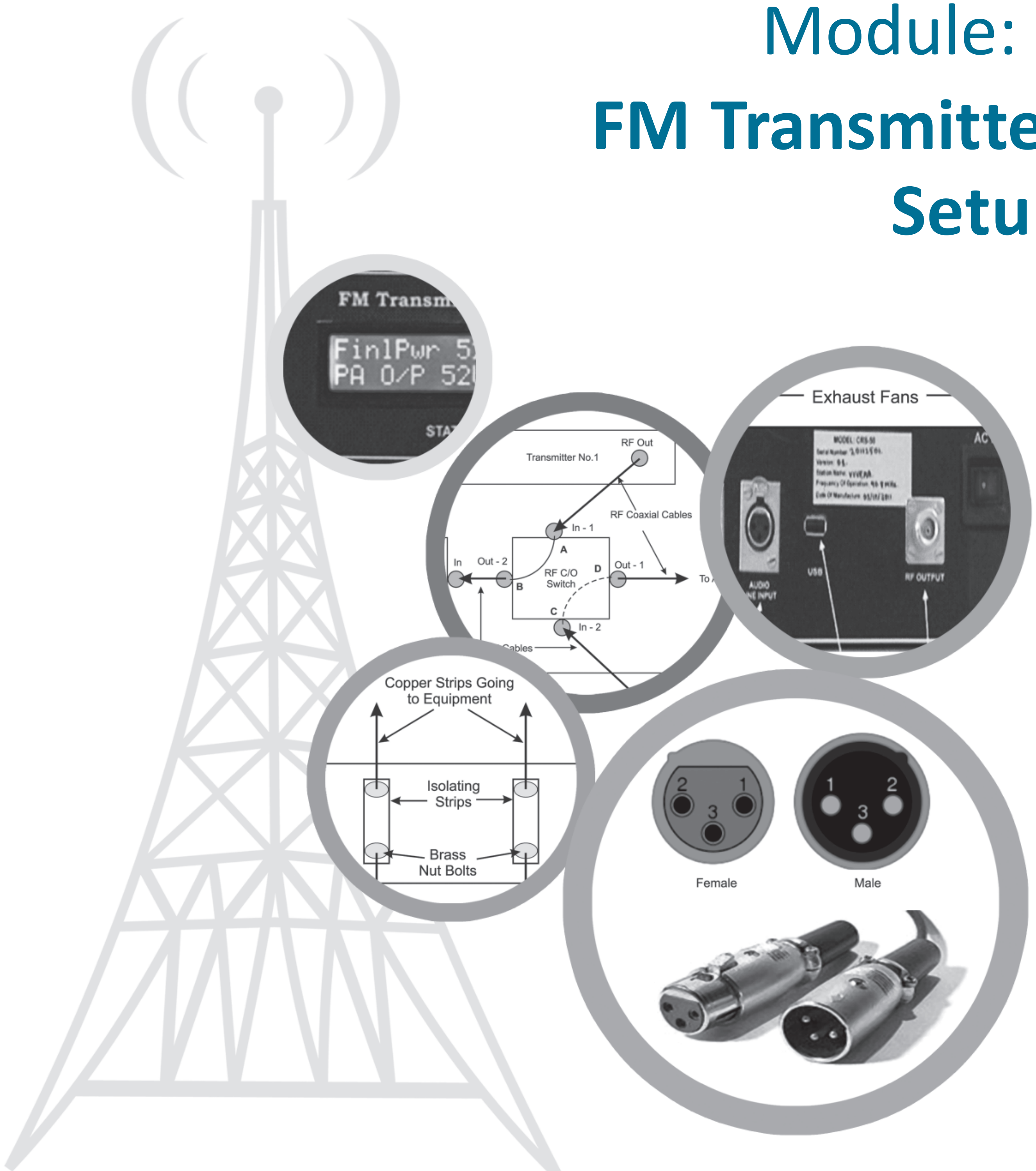
Module: 8
FM Transmitter Setup



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Module 8: FM Transmitter Setup

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Certificate in Community Radio Technology

Courses	Modules	Units
Course I: Understanding Community Radio (3 Credits, 90 Hours)	**Module 1** Community Radio: An Introduction	**Unit 1 :** Community Radio: Concept and Evolution **Unit 2:** Context, Access and Equity **Unit 3:** Community Radio: Policy Guidelines **Unit 4:** Technology for CR: Guiding Principles
	Module 2 Setting up of CRS	**Unit 5:** Components of CR Station **Unit 6:** Radio Waves and Spectrum **Unit 7:** Basics of Electricity **Unit 8:** Power Backup and Voltage Stabilization
Course II: Community Radio Production: System & Technology (5 Credits,150 Hours)	**Module 3** Studio Technology	**Unit 9:** Basics of Sound **Unit 10:** Analog and Digital Audio **Unit 11:** Components of the Audio Chain **Unit 12:** Studio Acoustics
	Module 4 Audio Production	**Unit 13:** Audio Hardware and Field Recording **Unit 14:** Free and Open Source Software **Unit 15:** Telephony for Radio
	Module 5 Audio Post Production	**Unit 16:** Sound Recording and Editing **Unit 17:** Mixing and Mastering **Unit 18:** File Formats and Compression **Unit 19:** Storing and Retrieval
	Module 6 Studio Operations	**Unit 20:** Good Engineering Practices for Studio Setup **Unit 21:** Studio Equipment: Preventive & Corrective Maintenance **Unit 22:** Content Distribution: Alternative Mechanisms
Course III: Community Radio Transmission: System & Technology (2 Credits, 60 Hrs)	**Module 7** Radio Transmission Technology	**Unit 23:** Components of Transmission Chain **Unit 24:** Components of FM Transmitter **Unit 25:** Antenna and Coaxial Cable **Unit 26:** Propagation and Coverage
	Module 8 FM Transmitter Setup	**Unit 27:** Transmitter Setup: Step-by-step **Unit 28:** Transmission System-Preventive and Corrective Maintenance **Unit 29:** Transmission Setup–Good Engineering Practices
Course IV: Technical Internship (2 Credits, 60 Hrs)	**Module 9** Practical Internship Handbook	**Section A:** Introduction **Section B:** Activities to be Conducted During the Practical Internship **Section C:** The Internship Journal and Self-Assessment Paper **Section D:** Assessment of Internship **Section E:** Appendices

Video in the Module:

CONTENTS

CONTENTS

About the Module

Module Description

This module is the second part of Course III - "CR Transmission: System & Technology". It deals with the practical aspects of the Transmitter setup. After studying the basics of transmission system in Units 23-26, it is imperative to learn the practical aspects of the transmitter setup and have some hands-on experience of the same to familiarise yourself with the actual practice at CR Stations. This module involves 32 hours of learning. It has three Units and covers the practical aspects of operation of a typical FM transmitter setup, handling and operating of the FM transmitter and also the preventive and corrective maintenance of the setup at CR Stations. Lessons about proper use of test and measuring equipment at the transmitter setup and installing and maintaining the transmitter with good engineering practices has also been included in this module. A video presentation is included as a part of this module (Unit 27), which is expected to give you a better understanding of the practical situation at a CR Station. The assignments in this module give you an opportunity to work on an actual transmission site at a convenient location nearby. This will give the confidence of working on a transmitter installation of a Community Radio Station. After completion of this module you will complete the study of Course III.

Module Objectives

After completion of this module the learner should be able to:

- Explain important aspects to be kept in mind while handling of a FM transmitter setup following step-by-step approach.
- Undertake preventive and corrective maintenance of the transmitter setup including main FM transmitter as well as ancillary equipment.
- Properly assist in installation and operation of the transmitter setup at CRS using good engineering practices.

Units in the Module

- Unit 27 : Transmitter Setup: Step-by-step
- Unit 28 : Transmitter System: Preventive & Corrective Maintenance.
- Unit 29 : Transmitter Setup: Good Engineering Practices

UNIT 27

Transmitter Setup: Step-by-step

Structure

27.1 Introduction

In Unit 23, you learnt about the components of transmission chain and in Unit 24, you learnt about the components of the transmitter. FM transmitters, suitable for Community Radio setup are available from number of suppliers. Each type/model may vary from the design point of view, but basic installation procedures are same. In this Unit you will learn about the step-by-step procedure to inter-connect the components of transmission chain, mount (install) the transmitter and make it operational.

The procedures/guidelines given in this Unit are by and large general. However, at places a specific reference to a FM transmitter type – CRS-50 of BECIL make has been made to explain the details. These procedures/guidelines can easily be used for any model with slight variations depending upon the type of Input/Output connectors provided in that transmitter.

During the 5-day Hands-on Workshop, you will get a chance to identify the input and output connectors and other wiring of the transmitter.

In the video presentation on FM Transmitters, you will have a chance to see clips from various CRSs showing different types and models of transmitters, dummy loads and other components manufactured and supplied by different firms. In the video, you should specifically note the back panel connectors, meters, and status as well as alarm indicators. Hand-outs plus video clips will help you in understanding the variations in different types and models of FM transmitter.

You may need about 6 hours to study this Unit including answering the questions given in the activities.

The step-by-step procedures for the following activities will be covered in this Unit:

- Connecting audio feed to the transmitter
- Back panel connectors
- Mounting the transmitter
- Interpretation of the transmitter meter readings and indications
- Transmitters with 1+1 operation along with changeover unit.

27.2 Learning Outcomes

After working through this Unit, you will be able to:

- connect audio feed to the transmitter by using suitable cables and connectors.

- use back panel connectors after identifying them and using mating connectors.
- mount the transmitter as per suggestive layout given by the firm.
- connect the RF coaxial cable coming from antenna to the transmitter output
- warm up the transmitter and make it operational.
- undertake interpretation of the transmitter, meter readings and indications.

Let us begin with connecting audio feed to the transmitter.

27.3 Connecting Audio Feed to the Transmitter

In Unit 23, while learning the components of transmission chain, you noted that audio output from transmission console is to be connected to the input of transmitter via studio-transmitter link and audio processor. In Unit 24, you learnt that every transmitter requires a specified audio input connector to feed the audio signal into the transmitter. Nominal and maximum input levels and the input impedance are also specified to get the desired deviation. In this section, you will learn the method of connecting audio feed to the transmitter.

In most of the transmitters, 3-pin XLR connector is usually provided at the rear side of the panel for connecting the Audio cable. In the technical specifications of the transmitter, type of connector, balanced or unbalanced, input impedance and nominal level for getting +/- 75 KHz deviation are also specified.

Follow the following step-by-step procedure for connecting the audio feed to the transmitter.

1. Decide the route and number of cables to be laid and estimate the length of each piece of audio cable required. (Make sure to consider all bends and extra loops before cutting the cable. The length of cable should not be unnecessarily large).
2. Identify the type of connectors at the output of Audio Mixer, Input and Output of Audio Processor (if provided) and at the Input of Transmitter.
3. Take required lengths of good quality shielded audio cable and number of ‘Cable Type Mating Connectors’ (see Figure 27.1).
4. Lay the cables either in conduit or in overhead tray as per decided route. (The route of cable should not foul with movements and crossing over power cables).
5. Identify and mark the cables.
6. Lace the cables properly.

7. Check the continuity of each wire in the cable with multi-meter.
8. Connect the type of connector required at each end by identifying the pins properly (see Box 1 for details).
9. Recheck the continuity again to ensure no shorting of any pins/wires has taken place while soldering.
10. Connect the connectors to the respective equipment.

Figure 27.1: *Types of XLR connectors (female/male)*

Figure 27.1 shows two types of XLR connectors, namely, panel mounting and cable end types. Both the types are available in Female and Male types. You have to be careful while selecting a connector. Usually for Audio Input, panel type XLR (female) connector is provided at the back panel of transmitter. Therefore, the mating cable type XLR (male) connector is to be used on audio cable for feeding the audio signals into the transmitter.

Box 1

XLR Connectors

3-Pin balanced XLR connectors are usually provided in all Audio equipment.

Types of Connectors

1. Chassis/Panel Mounting type
   a. Male type
   b. Female type

2. Cable Type
   a. Male type
   b. Female type

Pin connections

Pin 1 - Chassis ground (cable shield)

Pin 2 – Positive polarity for balance audio circuit (red – also called hot)

Pin 3 – Negative polarity for balanced audio circuit (white – also called cold)

27.4 Back Panel Connectors

Every transmitter manufacturer provides a number of input and output connectors on back panel to facilitate inter-connections from audio, power supply, RF equipment etc. In this section, you will know about various types of connectors provided on back panel of transmitter along with their functions.

Types of Input/Output connectors may slightly vary from manufacturer to manufacturer but their functions remain the same. Following back panel connectors (Chassis types) are usually provided by almost all the manufacturers to maintain uniformity. Types of connector with their functions are given below:

1. AUDIO LINE IN (XLR - F) - for feeding the audio signals to the input of transmitter.
2. AUDIO LINE OUT (XLR-M) - demodulated output for monitoring and measurements.
3. 3-Pin AC Mains socket for connecting 230/50HZ power supply with On/Off switch.
4. RF OUTPUT (N-F) - for connecting to RF Coaxial Cable.
5. USB OUTPUT - for remote monitoring and logging.

Figure 27.2 illustrates the back panel connectors of a typical 50 Watt FM transmitter (BECIL CRS-50).

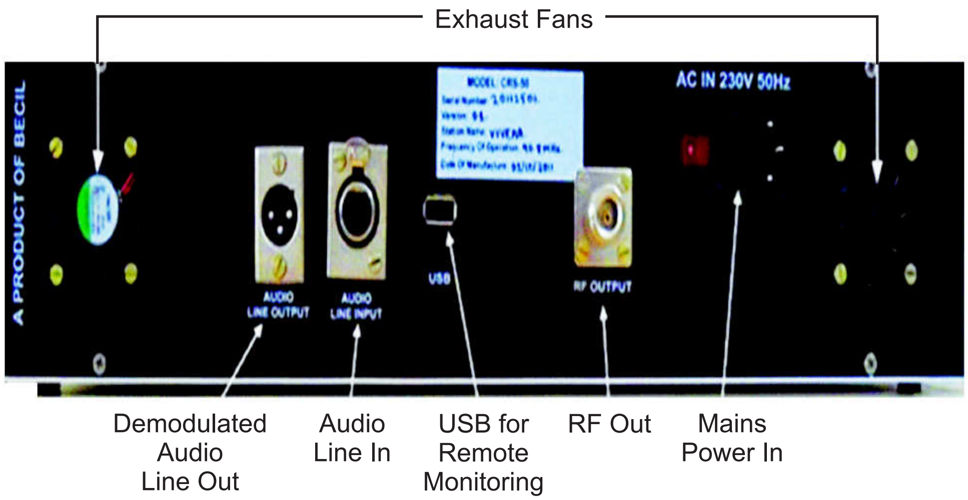

***Figure 27.2**: Back panel view of 50 Watt FM transmitter (BECIL CRS -50)*

Looking into the Figure 27.2, you should note that XLR (F) connector has been provided for 'Audio Line In' whereas XLR (M) connector has been provided for demodulated audio output. This demodulated output is provided for monitoring and measurement purposes. Also note that for RF output, N (F) type of connector has been provided. USB connector has also been provided in this transmitter for remote metering and monitoring purpose.

Activity 27.1

During "Hands-on Workshop" use the hand-outs given as step-by-step procedures in this Unit and try to identify and learn the following. Note the details in your words in the space provided. This Activity will help you in gaining the confidence for connecting audio feed to the transmitter.

Question1: Please write down various types of audio and RF connectors with their pin details.

Question 2: Identify and write down various types of audio, power supply and RF cables depending upon their applications.

1. Identify and write down the methods of fixing connectors to each type of cable keeping specific attention to removing the length of insulating material and soldering the pins.
2. Identify and write down the types of various back panel connectors provided in transmitter and the types of mating connectors and cables required for interconnection.
3. Identify and write down the type of connector for demodulated audio output connector and the type of cable used.

Transmitter Set-up

http://tinyurl.com/q57aocx

27.5 Mounting and Connecting the Transmitter

Having learnt the details of the back panel connectors of the transmitter in previous section, our next job is to mount (install) the transmitter. Here, you can watch a video on the transmitter setup. It will help you to articulate the entire process for setting up a transmitter. It is available in the CEMCA YouTube page at http://tinyurl.com/q57aocx**.** After going through the video material, now you may feel more comfortable to comprehend the technology of a transmitter. In this section and the sub-sections that follow, you will learn step-by-step procedure for following activities.

- Mounting of Transmitter
- Connecting the coaxial cable
- Warming up the transmitter.

Let us start with mounting of transmitter.

Considering the requirement and demand of Community Radio stations and the level of operating personnel, most of the manufacturers have developed their transmitter to make it simple, easy to operate and maintain by using plug and broadcast type of design.

However, if adequate precautions are not taken at the time of installation of transmitter and associated equipment, it may result in frequent failures and damage to transmitter.

Most of the CR stations prefer to work in 1+1 system with RF change-over unit. Normally, the equipment racks are received pre-wired with proper supporting frames and trays fixed during the fabrication process as per details of the order. Mounting of transmitter and associated components of rack is done at site as per the layout plan provided by the supplier.

Step-by-step procedure given in the Installation Manual, supplied by the firm, should therefore, be followed strictly.

However, a suggestive lay-out plan for mounting the equipment is shown in Figure 27.3 for the purpose of proper understanding. Optional items like UPS, Audio Processor and Auto Change-over switch have also been shown.

Caution:

1. Before starting the mounting process, ensure that all the power supply switches in the Main Distribution Board are kept in ‘Off’ position to avoid any shock or hazard due to accidental touch of live wires.
2. Even battery terminal to UPS should be kept disconnected.

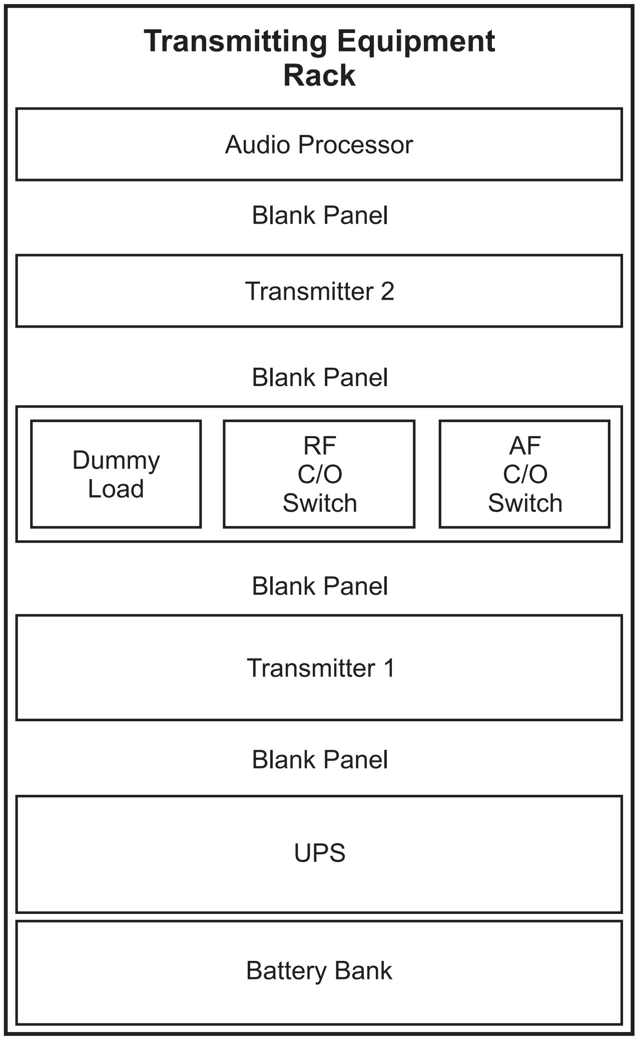

Figure 27.3*: Suggestive layout plan of transmitters and associated equipment.*

As may be seen in Figure 27.3, note the position of transmitters and other components in the rack. Battery bank has been provided at the bottom followed by UPS over it. A blank panel has been provided between equipments for proper air circulation and ease of removal while servicing. Dummy load and change over switch has been provided in the centre. Audio processor has been mounted on the top section.

Follow the following step-by-step procedure for mounting the transmitters:

Steps:

1. Decide the Lay-out Plan and place the rack

- Decide the location of transmitter rack. Normally a separate room adjoining Transmission studio is preferred. The room should be fully ventilated.

- In some cases it becomes necessary to keep the transmitter in transmission studio itself. In that case, the transmitter rack should be put in one corner so that the acoustic noise of exhaust fan is not picked up by the microphone during live announcements.
- The rack should be placed on a leveled surface and at least at a distance of 3’ from the wall to facilitate change of connections during servicing and maintenance.

2. ***Grout the rack***
   - Grout the rack with foundation screws in all the four corners so that the rack does not shake during taking out or putting back the components.

3. ***Lay copper strips for earthing the equipment rack***
   - Bring two copper strips (25mm wide x 3mm thick) from the earth pit via conduits buried deep in ground.
   - Terminate them on insulating plate (Bakelite or so) mounted on the wall.
   - Always use double brass nut bolts and facility to isolate the equipment during measurement of earth resistance. The arrangement is shown in Figure 27.4**.**
   - Connect copper strips from junction box on both sides of the rack with brass nut bolts and tighten them properly

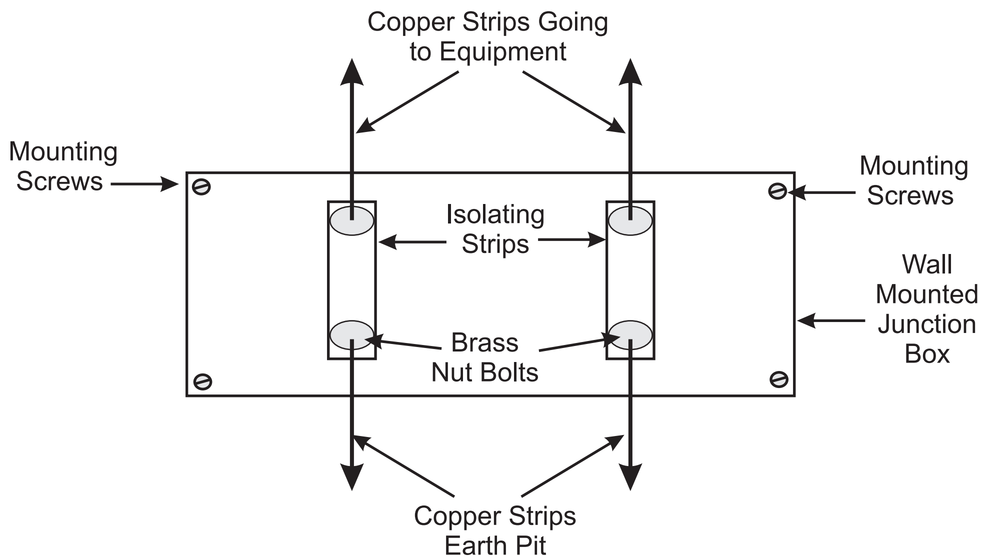

Figure 27.4: *Schematic arrangement of junction box showing distribution of copper strips for earthing.*

Figure 27.4 indicates that two copper strips have been brought from two separate earth pits and terminated on the wall mounted junction box. Two copper strips are taken out from this junction box through isolating plates and are connected to the equipment racks. Note that copper isolating plates can be removed for isolating the equipment before taking measurements.

Caution:

Equipment should never remain connected to earth pit while taking the resistance measurement of the earth pit. The voltage generated by Earth tester can damage the equipment.

4. ***Mount the Transmitter and Associated equipment in rack***
   - Follow the lay-out plan issued by the supplier otherwise use the suggestive lay-out plan given in Figure 27.3 above.
   - Mount the heavy components like 'On-line UPS' with battery bank on the base of rack.
   - Mount a small power distribution board with 4 to 5 standard good quality three - pin (5A) sockets for connecting UPS output supply to transmitters and processor etc. It is always preferable to have one or two additional sockets. The input supply to this distribution board should be connected via fuse and indicating lamp.
   - Mount the Dummy Load, RF Change-over switch and AF switch along with control circuit PCB (if provided).
   - Mount the transmitters and Audio processor (if provided).
   - Fix all the units with mounting screws and tighten them properly.
5. ***Connect all interconnecting cables between various units***
   - Connect power supply cables of all the equipment to power distribution board at UPS output.
   - Connect Input/Output audio cables to all the equipment such as Mixer output to Audio Processor input, Audio Processor output to AF switch input (if used) and AF switch outputs to both the transmitter Inputs.
   - Connect ribbon cables carrying the control commands from control circuit PCB to AF and RF switches (if auto changeover is provided).
   - Connect USB cables supplied along with the transmitters from USB ports of transmitters to Remote Switch or the computer.
   - Take three small lengths of RF cables connected with N (Male) connectors on both ends (usually supplied along with transmitters) and make connections as illustrated in Figure 27.5.
     - Connect RF Output of 'Transmitter 1' to 'IN 1' of RF changer-over switch.
     - Connect RF Output of 'Transmitter 2' to 'IN 2' of RF change-over switch.
     - Connect RF 'OUT 2' of change-over switch to Input connector of dummy load.

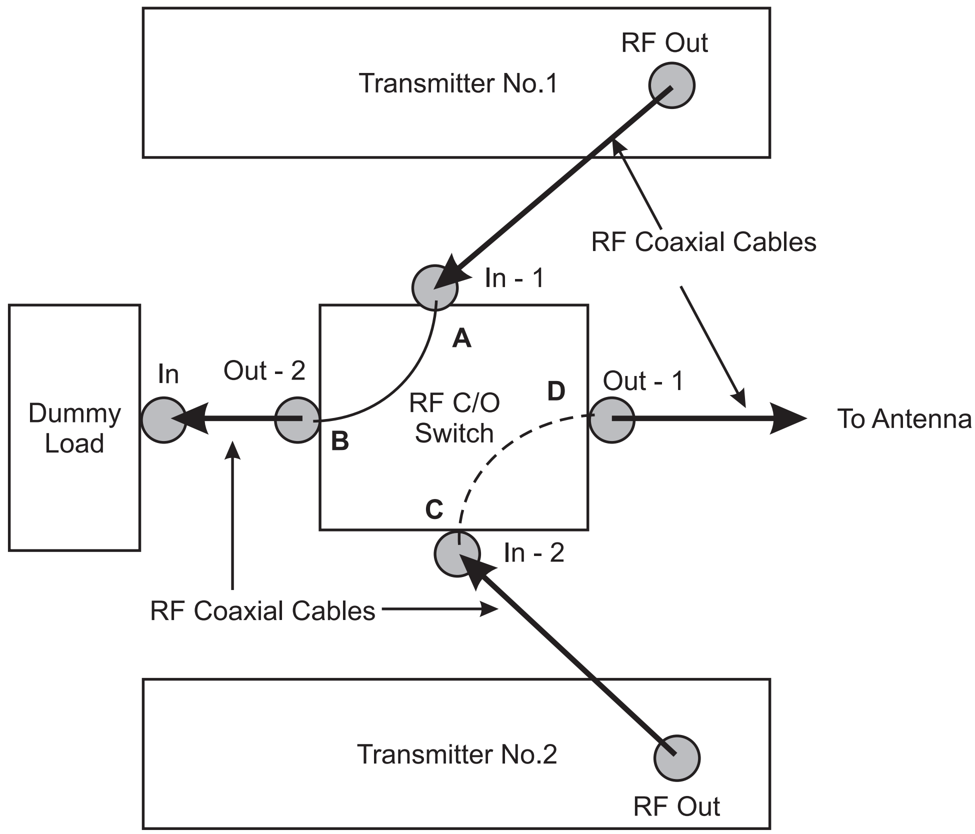

***Figure 27.5:** Schematic arrangement indicating the RF interconnection of two transmitters using change-over switch.*

Looking at Figure 27.4, you can see that RF outputs of both the transmitters are connected to the RF input ports of RF switch. Transmitter and Dummy load are connected to two RF output ports of RF switch. Note the connections of RF switch. In position ‘1’ (A is connected to B and C is connected to D), Transmitter 1 is connected to dummy load and Transmitter 2 is connected to antenna. When RF switch is changed to position ‘2’ (A-D, B-C), transmitter 1 gets connected to antenna and transmitter 2 to dummy load.

Note: RF ‘OUT-1’ of changeover switch will be connected to RF coaxial cable going to the antenna. You will do this connection in the next sub-section that follows.

27.5.1 Connecting the coaxial cable

In Unit 25, you were given instructions and guidelines to be followed while mounting of antenna and cable on tower. You also learnt about the Voltage Standing Wave Ratio (VSWR) of antenna and the need to keep it within specified limit. You will learn the method of measurement and adjustment of antenna

VSWR in Unit 29. In this section, you will learn the method of connecting the coaxial cable to the transmitter.

Let us now proceed with the method of connecting the coaxial cable.

After having mounted the antenna and cable on tower, the other end of the cable is to be taken inside the building. Follow the following steps given below.

Steps:

1. Ensure that coaxial cable is properly connected and supported on tower by use of adequate number of clamps.
2. Ensure that cable connector and all the connectors of antenna system are tight and sealed and there is no chance of moisture entering the cable.
3. Connect the bottom end of coaxial cable with RF cable connector if the cable is not received with pre-connected connector.
4. Bring the cable inside the building either through underground pipe or by making a small opening in the rear-side wall of transmitter.
5. Check VSWR measurements of cable and antenna to ensure that there is no fault in antenna system.
6. Ensure there is no pull or tension at the end connector of RF coaxial cable.
7. Now connect the cable connector to the output of RF change-over switch (RF Out-1 as indicated in Figure 27.5).

Having made all the interconnections, our next job is to test the transmitter on power.

27.5.2 Warming up the transmitter

In the previous sections, you learnt how to mount the transmitter and connect the inter-connecting cables.

In this section, you will learn step–by-step procedures for warming up the transmitter.

Note It

Ensure RF outputs of Transmitters are properly connected to Antenna or Dummy load through the RF change-over switch.

Caution:

For warming up the transmitter follow the steps given below.

Steps:

1. Ensure that all the connections are proper and power supply to rack is off.
2. Select transmitter 1 to Dummy load (A-B) and Transmitter 2 to Antenna (C-D).
3. Keep the 'power raise control' of transmitter (if provided) to minimum position.
4. Switch on power supply from Sub Distribution Board and check the availability of supply at the input and output of UPS. Wait for few minutes to check the abnormality (if any).
5. Now switch on the power supply to transmitter 1.
    - Check that the exhaust fans get switched on.
    - Check that there is no Alarm indication.
    - Slowly raise the power of transmitter by 'Power Raise Control' (if provided).
    - Note the readings on panel meters. Observe the output and reflected power readings.
    - Wait for some time and to let it get warm up and stable.
    - Feed 1 KHz tone from Audio mixer and check the deviation.
    - Feed the programme from Audio mixer and check the deviation.
    - Adjust the output level from the processor/mixer to ensure that deviations do not cross the limit of +/- 75 KHz.
    - Run for at least an hour to observe abnormality, if any.
    - If no abnormality is observed, remove the audio programme.
    - Switch 'OFF' transmitter 1.
    - Feel the components and observe symptoms of over-heating, if any.
6. **Select Transmitter 2 to Dummy load (C-B) and Transmitter 1 to Antenna (A-D) through RF change-over switch.**
7. Now switch 'ON' power supply of transmitter 2 and repeat the checks as per **step 5 above**.
8. Select transmitter 1 on Antenna and test it as per step 5. Observe output and reflected powers. The readings should not be more than the specified limits.
9. Select transmitter 2 on antenna and test it as per step 8.
10. Switch 'Off' the system completely and ask the rigger/mast technician to check the antenna and cable system for heating etc.

Now both the transmitters are ready for operation.

Activity 27.2

To do this activity, you may need about 10 minutes to write down the answers in the space provided. This activity will help you appreciate the significance of necessary precautions to be taken for the safety of operating personnel and the equipment before warming up the transmitter.

Question 1: What precaution must be taken while connecting the UPS output to the transmitter?

Question 2: Why isolating plates are used in junction box providing earth connectivity to equipments?

Question 3: What can happen if power supply to FM Transmitter is switched ON before connecting its RF output either to Dummy load or Antenna?

Question 4: Why is it necessary to seal RF connectors of coaxial cable?

Question 5: What precaution is necessary while changing faulty transmitter with good one?

Having warmed up the transmitters, now let us see what panel meter readings indicate.

27.6 Interpretation of the Transmitter Meter Readings and Indications

In the previous section, you learnt that while warming up the transmitter, panel meter readings of transmitter were noted. In this section, you will learn about the interpretation of these meter readings and indications and know their significance. All the manufacturers of transmitters provide some meters and indications to indicate the status or health of the transmitter or its subunits on the front panel of the transmitter. Some use LCD or bar-graph displays for important parameters such as Forward and Reflected power. Others may provide analogue meters. Apart from status monitoring, discrete LEDs are used to indicate the fault conditions such as over temperature and VSWR. Interpretation of panel meter readings and alarms help us to identify the faulty unit and take necessary preventive measures to isolate and repair the faulty unit.

Generally following panel meter readings and alarm indications are provided in most of the transmitters.

A. Panel meter readings

1. Forward or output power of transmitter going to the antenna.
2. Reflected power received back to the transmitter due to mismatch of antenna or cable.
3. Frequency Deviation to indicate the modulation level in transmitter.

B. Alarm Indications

1. VSWR or high reflection alarm to indicate the fault in antenna system.
2. High temperature alarm to indicate insufficient cooling or ventilation fault.
3. Output power failure alarm to indicate that RF output is below set limit.
4. DC power supply failure alarm to indicate the failure of power supply to power amplifier (PA).
5. Overload or high current alarm to indicate that Power amplifier is drawing higher current than normal value.

Figure 27.5 shows the panel meter readings and the alarms in BECIL FM transmitter type CRS -50. Different FM transmitter may have different types of panel indicators.

Figure 27.5: *Shows the front panel view of BECIL 50 watt FM transmitter type CRS-50*

Details of panel meter readings and alarms as shown in Figure 27.5 are explained in Box 2 along with their interpretations.

Box 2

Panel meter readings and alarms provided in BECIL CRS -50

1. Alpha Numeric LCD display indicates the status of following parameters;·

   - "FinlPwr" – (45 W-55W) – Final power delivered to Antenna·
   - "FinlRefl" – (0 W) – Power reflected from antenna·
   - "PA O/P" – (45-60 W) – Power delivered by Power amplifier·
   - "PA Refl" – (0 W) – Power reflected to Power amplifier

2. Bar-graph display indicates the frequency deviation at any instant of time due to audio signals. (+/- 75 KHz corresponding to 100% of modulation).

3. Discrete LED indications indicate the status/alarm of following 8 parameters. Blinking of LEDs indicate the faulty/alarm condition to draw the attention of the operator when the parameters exceeds the pre-set limits.

(i) "FinlPwr" - (It lights if the final power of transmitter going to antenna is less than 45 W or exceeds 55W).

(ii) "FinlRefl" - (It lights if the reflected power from antenna due to mismatch exceeds 2 watt).

(iii) "PA O/P" - (It lights if the output power delivered by PA (Power Amplifier) stage is not between 45 W to 60 W).

(iv) "PA Refl" - (It lights if the reflected power due to mismatch in filter circuit, cable or antenna exceeds 2 watts).

(v) "Temp" - (It lights if the temperature of heat sink exceeds 45^0 C).

(vi) "V_{DD} Volt" - (It lights if the DC power supply of PA varies from 27+/- 2V).

(vii) "I_{DD} Amp" - (It lights if the current drawn by power amplifier from DC supply is not within 4.0+/- 0.2A).

(viii) "Gate V" - (It lights if internal gate voltage applied to MOSFET is not within +4.0 to 4.5 V for 50 Watt).

Activity 27.3

To do this activity, you may need about 10 minutes to write down the answers in the space provided. This activity will help you appreciate the significance of displaying the panel meter readings and will give you confidence in isolating the faulty unit or stage.

Question 1: What will happen if important meter readings are not provided on front panel of the transmitter?

Question 2: Write the names of three important parameters which are usually displayed on all the transmitters.

(i) ....

(ii) ....

(iii) ....

Question 3: Write the names of three important alarms which are usually provided on all transmitters.

(i) ....

(ii) ....

(iii) ....

Question 4: What does an increase in reflected power on transmitter panel indicate?

Question 5: What does blinking of 'Temp' LED indicate?

27.7 Transmitter with 1+1 Operation Along with Changeover Unit

In the previous section, you learnt that a number of panel meters are provided on each transmitter. Health of the transmitter can be monitored by interpretation of these meter readings. In this section you will learn the concept of using transmitter with 1+1 operation.

In this concept, two transmitters each of 50 Watt output power along with change-over switch are used. One of the transmitters is normally 'ON' and is used for broadcasting the programmes. In case of fault in working (normal) transmitter, the second transmitter is selected through an RF change-over unit and is put on air to maintain continuity of broadcast service. This concept is well illustrated in Figure 27.5. Outputs of both the transmitters are connected to the two input ports of change-over switch. Dummy load and Antenna are connected to two output ports. In position '1' (A-B & C-D), transmitter 1 is connected to Dummy load and transmitter 2 to Antenna. When RF switch is changed to position '2' (A-D & B-C), Transmitter 1 gets connected to Antenna and transmitter 2 gets connected to Dummy load.

Two types of change-over switches are available such as;

- Auto Change-over Switch
- Manual Change-over Switch

In case of **auto change-over**, a control circuit PCB detects the fault in the working transmitter and selects the second transmitter by giving following **commands in sequence.**

- Switches off the faulty transmitter
- Disconnects faulty transmitter from antenna and connects it to dummy load. Disconnects good transmitter from dummy load and connects it to antenna. (By RF change-over switch).

- Disconnects audio input from faulty transmitter and connects to good transmitter by use of AF change-over switch.
- Switches 'ON' good transmitter and continues the transmission.

In case of **manual change-over**, the operation is very simple. On hearing the alarm or noticing the fault, above steps are done manually as follows;

- Switch off the faulty transmitter.
- Select good transmitter to antenna and faulty to dummy load just by moving the knob of RF change-over switch.
- Disconnect audio input cable-connector from transmitter one and connect it to the second transmitter.
- Switch 'ON' second transmitter and resume the service.

Though the automatic change-over operation is good, yet the system becomes complex and costly due to use of additional components such as Control circuit PCB, motorised RF and AF change-over switches. Even the wiring and installation require special skilled techniques. Most of the Community Radio stations have opted for 1+1 operation with Manual Change-over Switch because of simplicity and saving in cost.

Activity 27.4

Identify and work out the type and quantity of audio cable and connectors required to connect audio feed to transmitter in a typical Community Radio Station. During your visit to a particular Community Radio station identify and work out the following items.

1. Number and type of audio connectors provided at a CRS from the output of Audio mixer to the input of the transmitter.
2. Type and approximate length of audio cable/s used at that station for connecting the audio feed looking into the cable route.
3. Type and make of audio processor (if used).
4. Note the readings of panel meters provided in transmitter used at that station.
5. Note the list of alarms provided in the transmitter along with their function and limits set for alarm.
6. Note the location of all the components mounted in the equipment rack.
7. Note the type of coaxial cable and connectors used including routing of RF cable to bring it inside the building for connecting to the transmitter.

8. Check whether two transmitters have been provided through an RF switch, if so check the method of connections.
9. Identify the type and size of copper strip used for earthing and method of connecting to junction box and to equipment rack.
10. Check the method of fixing the cable trays and laying of RF cable to inside the building.

This activity will help you understand and apply the hand-outs/guidelines given in this Unit.

27.8 Let Us Sum Up

In this Unit, you have learnt step-by-step procedure for setting up the transmitter. You have learnt that:

- Identification of type of connector with their pin numbers is necessary before selecting a mating connector for feeding audio to the transmitter. You have also learnt that the type of audio cable to be connected also depends on the type of connector, and whether it is balanced or unbalanced.
- Different manufacturers provide different type of connectors on the back panel of their transmitter. Identification of these connectors is also necessary for selecting appropriate mating connectors with cables for extending the Input/Output feeds to previous or next stage.
- Step-by-step procedure is to be followed for mounting the transmitter including the precautions to be observed at each step. Mistakes or faults committed during mounting procedure are difficult to correct later on. A professionally installed transmitter normally gives a trouble-free service for many years.
- Fixing of RF Connector on coaxial cable is a highly skilled job. Any wrong or improper connections made on coaxial cable or use of wrong connectors result in sparking or mismatch to the transmitter.
- Warming up the transmitter also requires a step-by-step procedure including number of precautions to be taken. You have also learnt that none of the RF Output Connector should be kept open while switching on the transmitter. Secondly, no RF Input/Output connector should be opened when transmitter is ‘ON’.
- A panel meter and a number of alarm indicators are provided by each manufacturer on the front panel of the transmitter. Interpretation of the panel meter readings helps you to know the status and health of transmitter.

- Most of the CRSs work on 1+1 mode of operation of transmitters. In this mode one of the two transmitters is connected to the antenna and the second is connected to the dummy load. In case of fault in working transmitter, we can isolate the faulty transmitter and use the second good transmitter to maintain continuity of transmissions.

27.9 Model Answers to Activities

Answers to the questions given in Activities 27.2 and 27.3.

Activity 27.2

1. Input supply and battery connections to Inverter in UPS must be kept 'Off" otherwise 240 V output available in UPS may give an electric shock.
2. Isolating plates are provided to isolate the equipments while doing the earth resistance measurements.
3. The transmitter can get damaged due to high reflection from open RF output port.
4. RF connectors of coaxial cables must be sealed to avoid entry of moisture or water in cable. Moisture or water can cause sparking at connector or in cable resulting in breakdown of transmission.
5. Before changing over the transmitters, power supply to both the transmitters must be switched off first.

Activity 27.3

1. We will not be able to know the status and health of components inside transmitter. Preventive maintenance to avert failure of transmitter may not be possible.
2. Three important parameters usually displayed on transmitters are:
   (i) Output or forward power of transmitter
   (ii) Reflected power
   (iii) Frequency Deviation
3. Three important alarms usually provided on transmitters are:
   (i) VSWR (High reflected power)
   (ii) High temperature
   (iii) Failure of DC Power supply

4. Increase of reflected power on transmitter indicates mismatch at the output stage of transmitter, in coaxial cable or in antenna system.

5. Blinking of ‘Temp’ LED indicates increase in temperature due to inadequate cooling/ventilation. It can be due to failure of exhaust fan or choking of filter.

UNIT 28

Transmission System: Preventive and Corrective Maintenance

Structure

28.1 Introduction

In Unit 27, you learnt about the step-by-step procedure for mounting, warming up and testing of transmitters. In that process, you learnt that the fault in the transmitter can be diagnosed by interpreting various panel meter readings. Based on these readings and indications, you can take necessary preventive and corrective steps which may help you in preventing a major breakdown in transmissions. In this Unit, you are going to learn more about the preventive and corrective maintenance aspects of the transmitters. We will cover this Unit by discussing the following issues:

- Ventilation and preventing corrosion
- Probable causes of failure of transmitters
- Reporting on the basis of visual observation
- Checking earth conductivity
- Fault diagnostics and corrective maintenance

You will see a video showing the preventive and corrective maintenance procedures including testing and measurements on transmitters. Commonly followed practices will help you in troubleshooting the faults in transmitters and accessories. Glossary at the end of module will help you in understanding the terms used in this Unit.

You may require about 6 hours of study to learn this Unit including solving the questions given in the activities.

28.2 Learning Outcomes

After working through this Unit, you will be able to:

- discuss issues related to ventilation and connectivity.
- undertake necessary steps to control dust, humidity and corrosion.
- check earth connectivity.
- identify and analyse the probable causes of failure of transmitter.
- report faults on the basis of visual observations.
- diagnose the faults on the basis of panel readings, alarms and observations.
- isolate the faulty stages/units
- undertake preventive steps to avert major breakdowns in service.
- take necessary corrective steps in getting the units repaired.
- run the transmissions with minimum breakdowns.

Let us begin the discussions with issues related to ventilation and preventing corrosion.

28.3 Ventilation and Preventing Corrosion

In Unit 27, you learnt that the transmitter must be installed in a well ventilated, dust and humidity-free room. You also learnt that before warming up the transmitter, cooling and exhaust fans must be on. In this section, you will learn various steps to control dust humidity and corrosion. All electronic equipments including transmitters are susceptible to failure due to following adverse environment conditions.

- High temperature
- Insufficient cooling
- Dust
- Humidity
- Corrosion

The situation gets aggravated if the level of humidity is high as in the case of coastal region. Such sultry weather with high temperature adds to formation of corrosion. It is observed that percentage of failure of transmitter due to above causes is quite high. However, the positive side of the picture is that all these faults can be controlled by doing proper preventive maintenance. Preventive maintenance is therefore, necessary to keep these conditions under check as far as possible.

Maintain a cool dust-free environment

Though due care is normally taken to ensure provision of proper ventilation at the time of installation, yet preventive maintenance is necessary to maintain these equipments in working order. Since most of the CRSs are located in remote localities, where long break downs in power supply are common, maintaining a cool environment becomes a problem especially in summer.

Given below are certain Do's and Don'ts. If you follow them, a number of breakdowns can be averted.

Do's and Don'ts

- Service the exhaust fans and ventilation equipment regularly.
- Check blocking of filters to have a clear flow of clean air.
- Clean all equipments mounted in the rack daily with a soft cloth.
- Check that no cobwebs are formed in the rack.
- Clean tag blocks and PCBs with soft brush.
- Use light duty suction type of blower for removing the dust from the rack.
- If equipments are installed in an air-conditioned room, the temperature may not be set too low to cause condensation of vapours. Condensation of water vapours may cause more harm to printed circuit boards than even high temperature.

- De-humidifiers may be used where humidity is more.
- The external exhaust fans must be switched 'ON' at least 10 to 15 minutes before transmission and may be switched 'OFF' at least 10 to 15 minutes after close down.
- Always make a habit to touch the equipment just after close down of transmission to check any symptoms of overheating.
- Take appropriate remedial measures to increase the ventilation or cooling if signs of over-heating persist.
- Ensure working of exhaust fans of transmitter every time when transmitter is switched on.

Activity 28.1

To do this activity, you may need about 10 minutes to write down the answers in the space provided. This activity will help you understand and appreciate the significance of proper ventilation for the transmitter.

Question 1: Why cool, dust-free and humidity controlled environment is necessary for a transmitter?

Question 2: What steps should be taken to avoid failures due to hot and humid weather?

Question 3: How can we reduce humidity?

Question 4: Why temperature should not be set too low in a transmitter room where air-conditioning unit is provided?

Question 5: How much heat does a 50 watt transmitter approximately dissipate continuously into the room?

Having learnt the importance of dust-free ventilated environment in averting the failure of transmitters in previous section, let us now see the other probable causes of failure of transmitter.

28.4 Probable Causes of Failure of Transmitters

In the previous section, you have learnt that transmitters are susceptible to failure in dusty, hot and humid environment. In this section and sub-sections that follow, you will learn probable causes of failure of transmitters. Important probable causes resulting in failure of transmitters are as follows:

- Connector issues
- Power supply/Voltage issues
- Earthing and Earth loops

Let us now begin with connector issues.

28.4.1 Connector Issues

Faults due to failure of Connectors account for an appreciable share of the total faults that occur in the transmitter set up. Connectors are mostly treated as weakest links especially in the RF circuits. A small mistake may cause mismatch or even sparking.

Connectors usually fail because of following three reasons:

1. Use of wrong connector
2. Connector not fitted properly
3. Connectors becoming loose due to improper handing or pulling the cables.

In all the three cases referred to above, the connectors become the weak links and account for frequent failures. Fixing a connector is a skilled job which can be learnt by practice only. You will gain this skill in '5-day hands-on Practical Training on community Radio'.

Connector faults are controllable faults. Following steps will help you in averting most of the faults which are due to connectors:

- Always use good quality connectors of reputed make and matching to the size of cables.
- Due care should be taken to fix the connectors properly.
- Instruction sheets are normally supplied by reputed manufactures for fixing the connectors. The lengths of insulating layer or sleeves must be cut as per dimensions specified therein.
- The length of inner connector should not be less. If it is so, it may not make proper contact with inner conductor of mating connector. It should not be too long to get bulged after connection.
- The strands of conductors and the soldering metal should not protrude or touch the other conductor.
- While checking, mounting or removing the connections, the cables should not be pulled. Pulling may result in breaking of inner connector or strands thereby resulting in bad connection.
- Connectors of RF coaxial cables especially used on antenna side must be sealed properly to avoid entry of moisture or water.
- Plug all the entry holes properly with glass wool to avoid entry of rodents. Rats have been found to cut cables especially the small ribbon cables.

Let us now move to the second and the most important issue, that is power supply/voltage.

28.4.2 Power Supply/Voltage Issues

Power supply and voltage faults contribute to a major share in the probable causes of failure of transmitters. In this sub-section, you will learn how such issues can be tackled to avoid a breakdown or fault.

The major cause of failure of electronic components is the sudden fluctuations in power supply voltages. Most of the CRS stations are located in remote isolated localities where regular stable power supply is normally not available all the time. Large breakdowns or shut downs and frequent variations in power supply voltages are a common phenomena. It is therefore, necessary to ensure a stable backup power supply source. Maintenance of batteries of the UPS is also a major issue. Life of battery is limited. Even recharging of batteries becomes a problem if mains supply fails for a longer duration. You have learnt about all these aspects on backup sources in Unit 8.

However, by taking following preventive steps, the occurrence of majority of the faults due to power supply can be curtailed.

- Mains input supply must be first regulated by use of Automatic Voltage Regulator (AVR) or Constant Voltage Transformer (CVT).
- Use preferably On-line UPS to operate transmitter and other essential equipment. On-line UPS provides transient free supply. Variations in input supply are practically not allowed to reach the transmitter.
- Have an adequate provision of battery backup which depends on its ampere-hour capacity.
- Ensure proper maintenance and servicing of power supply and backup supply units.
- Though the batteries used are generally maintenance-free batteries, yet they need certain attention. Efficient battery management and care is essential for the overall performance of the UPS.
- Life of battery is limited. Overcharging and deep discharges may be avoided as they reduce the life of battery further.
- Check panel meters displaying Input voltage, Output voltage and Output load Volt Ampere (VA) on batteries. These readings will help you to know the performance of UPS and status of batteries.
- Now-a-days, a number of softwares like Power Manager are available which work on various important parameters to know the status of batteries.

If power supply and voltage issues are maintained properly, the rate of failure of transmitters can be reduced appreciably.

28.4.3 Earthing and Earth Loops

Another important probable cause of failure of transmitter is disconnection of earth link (loop). This is a hidden element and is mostly neglected in maintenance, but its effect is felt in many ways such as:

- Non protection of equipment and personnel during lightning.
- Non protection of personnel and equipment during electric short circuit..
- All RF circuits including antenna system are generally unbalanced with earth connectivity providing the return path. Efficiency of these circuits decreases with increase in earth resistance.
- Increase in RF pick up level in equipment thereby deteriorating the quality.

Therefore, a regular maintenance and check up of earth pits and earth connectivity to transmitter and other equipment is essential. Ensuring following steps will help you in preventing the faults arising due to earthing and earth loops:

- Have a periodical visual inspection of earth electrode connections to ensure their rigidity and other signs of deterioration.
- Water the earth pit at regular interval to keep the earth resistance within specified limits.
- Measure the resistance of the earth pit at regular intervals at least once within three months.
- Ensure to disconnect the equipment from junction box while measuring the resistance of earth pit. (Refer the caution mentioned in Unit 27 while describing the mounting of transmitter).
- Check the connections from the earth pit to the equipment at regular intervals for ensuring their continuity.
- Check the continuity of connections with multi-meter at places where sheathed (or sleeved) copper strips or wires are used. This is all the more necessary in coastal areas where chances of breaking the connection are more due to rusting.

Regarding checking of earth conductivity, you will learn more in the following section 28.5.

Activity 28.2

To do this activity, you may need about 10 minutes to write the answers in the space provided. This activity will help you know and analyse the probable causes of failures of transmitters.

Question 1: Why connectors are usually called as weak links in transmission chain?

Question 2: Why frequent and deep fluctuations are considered more dangerous than the low or high voltages?

Question 3: How the use of UPS reduces the faults due to power supply?

Question 4: Why is efficient battery management essential for the performance of UPS?

Question 5: Why is it necessary to periodically check the continuity of earth wire?

In this section, you have learnt about the probable cause of failure of transmitters. In the next section you will learn the method of reporting faults on the basis of visual observation.

28.5 Reporting on the Basis of Visual Observation

So far in this Unit, you have learnt preventive methods like provision of proper ventilation to avoid dust, humidity and rusting. You have also learnt probable causes resulting in failure of transmitters. In spite of adequate care, faults do occur sometimes. In Unit 27, you learnt to interpret the panel meter readings giving the status and health of the transmitter. In this section, you will know how to report the fault on the basis of your visual observations.

During transmissions or while doing regular maintenance, you may observe certain abnormality or fault. For example, during transmission you may suddenly find that no programme is going on air. On checking the panel meter readings, you may notice that forward power has decreased and reflected power has increased. On further checking, you may notice an alarm indication showing high reflected power. In such a situation, you have to report to your seniors (and/or the supplier of transmitter) on the basis of your visual observations. Based on these observations, your senior or the supplier may come to the conclusion that the most probable cause of fault in this case is due to antenna. However, in some cases, you may be asked to give some further observations as well. Hence, it becomes necessary for you to keep your eyes and ears open to know what is happening in the transmitter room. Your reporting should be based on the following aspects:

- What are the panel readings – any abnormality?
- What are the alarm indications that you notice or hear?
- Which are the points where you touch and feel the heating?
- Is there any burning or overheating smell?
- Whether the exhaust fans are working or not?
- Whether any abnormal sound is heard from any moving machinery or part?

- Whether cooling/ventilation is insufficient?
- Whether power supply voltages are normal or more or less?
- Whether programme is being received from studio or not?

Thus, with your correct reporting on the basis of visual observations, it becomes easy for your supervisory officer to analyse the problem and guide you for further action to be taken to identify and isolate the fault. You will learn more on art of isolation in forthcoming section (28.7) on 'Fault diagnostics and corrective maintenance'

Now let us proceed to discuss how earth conductivity can be checked.

28.6 Checking Earth Conductivity

In the previous sub-section (28.4.3), you have noticed that increase of earth resistance or breaking of earth connectivity was one of the probable causes of failure of the transmitter. In this section you will learn method of checking earth conductivity or earth resistance as we normally call.

Checking of earth conductivity and connectivity is necessary to ensure protection of equipment and personnel from electric shocks and lightning. It provides a return path for the unbalanced RF circuits including RF coaxial cables and antenna system. Lower the earth resistance better is the efficiency of the antenna system.

The resistance of earth pit is measured by an instrument called 'Megger'. Direct reading meggers with digital display are available in market. They are very simple to operate and can be easily used for checking the earth resistance measurement. Figure 28.1 shows the method of connection and measurement.

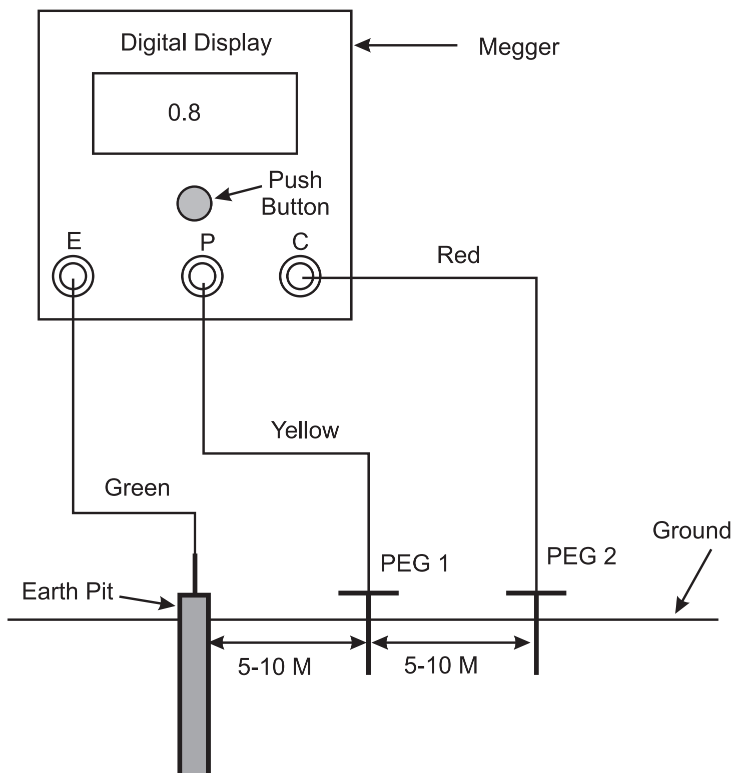

***Figure 28.1**: Checking of Earth conductivity*

As we see in Figure 28.1, digital Megger has got three terminals namely E, P, and C. Terminal E is connected to the earth pit. Terminals P and C are connected to two pegs driven in the ground at a distance of 5 to 10 metres from the earth pit. Note the colour code of wires used for each connection. They match the colour of terminals of the Megger. A push button is provided on the meter which when pressed, connects voltage to leads. The digital display directly reads the earth resistance in ohms.

Note It

Ensure that equipment are disconnected before start of earth resistance measurement.

Follow the steps for measurement**:**

- Make the connections as shown in Figure 28.1 ensuring the colour code of wires and connectors provided on the megger.
- Drive the two electrodes (pegs) at a distance of about 5 to 10 meters from the earth pit preferably in line.
- Connect the earth (ground) terminal lead to earth pit.
- Press the voltage generator button.
- Read the resistance reading shown on the display.
- The reading should normally be less than 1 Ohm
- If reading is more, check the connections.
- Put water in the pit and repeat the test after one or two days.
- Record the reading/observation in maintenance register.

Activity 28.3

To do this activity, you may need about 10 minutes to write the answers in the space provided. This activity will help you learn the method of reporting faults on the basis of your observations and the method of checking the earth conductivity.

Question 1: How reporting on the basis of your visual observations helps your superiors?

Question 2: Write any two forms of visual observations provided on the transmitter panel.

(i) ………………………………………………………………

(ii) ………………………………………………………………

Question 3: During transmission you heard an audible alarm. What are the points that you will check before reporting to your seniors?

Question 4: Why checking of earth conductivity and connectivity is necessary?

Question 5: Why the resistance of the earth pit should be as low as possible?

Now you are going to learn a very important part of this Unit which, if practiced, will help you in running trouble-free transmissions.

28.7 Fault Diagnostics and Corrective Maintenance

So far you have learnt preventive part of maintenance in this unit. You have also learnt to report the fault on the basis of your visual observations (section 28.5). In this section, you will learn how to diagnose a fault in the event of a breakdown and take necessary corrective steps to isolate and rectify it.

Transmitters provided at CRSs are generally plug-and-operate type transmitters. They are received as pre-tuned at factory and no user controls are generally provided on front panel for changing the operating conditions of the transmitter. Once installed and tested they are supposed to run without any problem provided certain requirements like proper dust-free ventilation, connectivity, power supply voltages and low earth resistance are maintained. These transmitters have got an important feature called “Automatic Power Control” (APC) or fold back facility. In case of any problem in transmitter or antenna, the automatic power control action of transmitter reduces the output power to a safe value to prevent further damage to the transmitter. However, a diagnostic approach method helps the operating staff to timely identify and isolate the faulty unit or section and take necessary corrective measures to get it repaired.

Now let us see what this diagnostic approach is. As all of you are well aware that a doctor diagnoses your disease by visual observations of the affected part of the body and by checking certain parameters such as temperature, blood pressure etc. Likewise, diagnostic approach for checking the health of transmitter involves some visual observations, meter readings and special measurements whenever it is necessary to diagnose the fault logically and systematically.

Diagnostic approach involves following steps to be taken on noticing the fault:

- Check all visible indications and alarms.
- Note panel meter readings.

- Interpret the meter readings and visible observations.
- Identify the faulty unit or circuit.
- Isolate the faulty unit.
- Repair the faulty unit.
- Check working of the repaired unit.
- Take performance measurements to ensure that the transmitter meets the specifications.
- Restore the service.

Now, let us take a few examples of panel meter readings and alarm indications which you have learnt in section 27.6 and try to diagnose the faults. The steps to isolate the faults along with corrective measures have also been explained.

1. ***Power Amplifier(PA) output power reduction fault***

   - The normal output power of transmitter was 50 watt. Suddenly you noticed that it has gone down to 40 watts.
   - On checking other panel meter reading you noticed that PA reflected power reading is 0 watt (normal)
   - On checking other visible indications you found PA power low and V_{DD} (DC supply to PA stage) indications are coming.
   - On interpretation, it can be concluded that DC power supply stage in the transmitter is giving low voltage than the desired value.
   - This transmitter should be switched off and second transmitter to be brought on air.
   - The fault along with observations may be reported to seniors/ supplier of transmitter.
   - After repairs of faulty power supply unit, the faulty transmitter should be tested.
   - Note the panel meter readings. P.A. output power meter should again read 50 watt.

2. ***High Temperature Alarm***

   - Suddenly, you heard an audible alarm in the transmitter room.
   - On checking the visual indications you found that 'High Temp' LED is blinking.
   - On further checking, you found that exhaust fan is not running.
   - You can conclude that high temperature alarm is coming because of insufficient cooling.
   - Switch OFF the transmitter and take second transmitter on air.
   - On checking you found fan is faulty. Its winding has become open.

- Replace the faulty fan with good one.
- Test the transmitter again to ensure that it is ready for use.

3. High VSWR Fault

- Suddenly, you heard an audible alarm in the transmitter.
- On checking the visual indications you found both Forward (final output power) and Reflected power indications are glowing.
- Panel meter readings also indicated low forward power and high reflected power.
- This indicates that fault is in RF cable or antenna system.
- To confirm the fault, switch off the transmitter and connect it to dummy load.
- On switching 'ON' transmitter on dummy load you found that the panel meter readings are normal and no alarm is coming.
- You can conclude that fault is in RF cable or antenna system.
- Take appropriate steps to get the antenna checked.
- On further check up by mast technician, sparking marks were observed on antenna side connector of branch feeder cable.
- Replace the connector.
- Check VSWR of antenna system. (You will learn about VSWR measurement and antenna adjustment issues in Unit 29).
- If VSWR is Ok, test the transmitter on antenna and re-run the transmission.

Now let us take an example of other type of fault not reflected by panel meter readings.

4. Noise level and distortion fault

Observation:

While monitoring the transmission you observed that quality of programme is not good. It is noisy and distorted.

Diagnosis:

- Feed the audio input signals directly in transmitter after bypassing the audio chain.
- If fault persists, switch off this transmitter and use second transmitter.
- Check the quality of programme again with second transmitter.

- If quality with second transmitter is good, then first transmitter is suspected.
- Inform your supervisory officer/service Engineer.
- Once it is ensured that the bad quality is due to the transmitter, performance measurements are required to be taken using the test and measuring equipment.

Now let us see the role of performance measurements in diagnosing a fault.

Performance Measurements

Deterioration in quality of programmes like noise and distortion can be judged by doing performance measurements. Performance measurements help both in preventive and corrective maintenance. If performance measurements are done periodically, you can easily assess the degradation of quality in advance and take necessary preventive action before the occurrence of fault.

Important periodical measurements which are to be done to ensure the best performance of transmitter include:

- RF Output power
- RF Frequency
- Frequency response
- Noise level
- Total Harmonic Distortion
- Spurious and harmonic radiations
- VSWR measurement of antenna

Test and Measuring Equipment

Special test and measuring equipments along with different types of connectors, cables and probes are required to do these measurements. You will also see a video showing preventive and corrective maintenance including use of test and measuring equipment.

List of a few important test and measuring equipments required to do these measurements includes:

- RF power meter
- RF frequency meter
- Audio signal generator
- Modulation Analyser
- Spectrum Analyser
- Network Analyser or Antenna Tester

Other important tools of diagnostic approach which will help you both in preventive and corrective maintenance include:

- Use of logger for recording the live transmissions including faults with date and time information.
- Knowledge of inter-wiring details of transmission chain
- Identification of part number of units and components
- Maintenance of adequate spares
- Contact numbers to avoid delay in calling service engineers.
- Maintenance of history sheets of equipment showing the types of faults and their frequency of occurrence.
- Following the maintenance schedule and keeping the records of maintenance done with symptoms observed.

Activity 28.4

To do this activity, you may need about 10 minutes to write the answers in the space provided. This activity will help you understand the significance of diagnostic approach and apply it while attending to the transmission duties in Community Radio stations.

Question 1: What is the advantage of using diagnostic approach in troubleshooting a fault in transmitter?

Question 2: Write in your words some steps of diagnostic approach which you may follow on noticing the fault.

(i) ....

(ii) ....

(iii) ....

(iv) ....

(v) ....

Question 3: What probable fault do the following observations indicate?

(i) No 'PA Output Power' reading on panel meter

....

(ii) Glowing of 'PA Reflected Power' LED

....

(iii) Glowing of 'Temperature' LED

....

Question 4: Why performance measurements are necessary for transmitters?

(i) ....

(ii) ....

Question 5: Name three important performance measurements which determine the audio quality of the programmes.

(i) ....

(ii) ....

(iii) ....

28.8 Let Us Sum Up

In this Unit you have learnt methods and procedures for doing preventive and corrective maintenance. In this process you have learnt that:

- Preventive steps help in controlling rise in temperature, humidity and improving ventilation. It helps in curtailing the occurrence of faults. Maintenance of ventilation equipment and uninterrupted connectivity reduces the breaks in transmissions.
- Earth conductivity and continuity of earth connections can be checked by use of megger and multi-meter respectively. Maintenance of low earth resistance and its proper connectivity to equipment protects working personnel from electric shocks. It also protects equipment and the personnel due to lightning.
- Probable causes resulting in failure of transmitters include use of wrong connectors or wrongly fitted connectors which become loose due to improper handling and pulling. Power supply failures and voltage fluctuations are the major causes resulting in failure of transmitters.
- Use of properly rated UPS systems helps in curtailing faults due to failure or variations in mains supply.
- Though the batteries used are generally maintenance free, they have got a limited life. Avoiding of overcharging and deep discharges increase the life of batteries.
- Visual observations of panel meter readings and alarms help us to identify the faulty stage.
- Diagnostic approach helps in systematic analysis and quick identification

of the faulty unit. Timely action in isolation of faulty unit prevents further damage to equipment. We have studied to use the diagnostic approach by considering some of the practical faults generally encountered in most of the transmitters.

28.9 Model Answers to Activities

Model answers to questions given in activities 28.1 to 28.4.

Activity 28.1

1. To protect solid-state devices which are susceptible to failure due to high temperature, dust and humidity.
2. By placing the transmitter either in an AC room or in a room having dust filters and exhaust fan.
3. By use of dehumidifiers.
4. To prevent condensation of water vapours which are more dangerous to the solid-state devices.
5. A 50 Watt transmitter normally consumes 120 to 130 watt of power supply. Out of which 50 watt is delivered as RF and balance 70 to 80 watts is dissipated as heat in the transmitter hall.

Activity 28.2

1. Because most of the faults observed in transmission chain, occur at connectors. This is especially the case when connectors are fixed at site and secondly, the power rating capacity of connectors is less than the cables.
2. Because most of the solid state devices used in transmitter are sensitive to transients produced by frequent fluctuations rather than low or high voltages.
3. Output voltages of UPS are constant. Fluctuations in AC mains are not passed on to the equipments connected at the output of UPS.
4. With efficient management system, unbalanced charging, over charging and deep discharging are prevented. This increases the life of batteries.
5. Because there can be breaks in earth wire due to rusting especially in coastal areas.

Activity 28.3

1. Reporting on the basis of observations help seniors to visualize the possible cause of failure.
2. (i) Panel meter readings (ii) Alarm indications
3. We will check the following points before reporting:
   - (i) Panel meter readings
   - (ii) Alarm indications
   - (iii) Any other symptoms of overheating, abnormal noise etc.
4. To ensure continuity of earth connectivity to body of equipment and to maintain the body of equipment at zero potential.
5. To provide low resistance path during short circuit or during lightning.

Activity 28.4

1. Diagnostic approach helps in quick identification of fault or faulty stage.
2. We will:
   - (i) Check all visual indications and alarms.
   - (ii) Note panel meter readings.
   - (iii) Interpret the visual indications and meter readings.
   - (iv) Identify the faulty unit or circuit.
   - (v) Isolate the faulty unit.
3. (i) Faulty Power Amplifier output stage.
   - (ii) Mismatch or VSWR fault in RF cable or Antenna system
   - (iii) Heat sink temperature is higher than set limit due to insufficient ventilation or faulty exhaust fan.
4. (i) To check the quality of programmes.
   - (ii) To ensure that the transmitter meets the claimed specifications.
5. (i) Frequency response measurements.
   - (ii) Noise level measurements.
   - (iii) Distortion measurements.

UNIT 29

Transmitter Setup: Good Engineering Practices

Structure

29.1 Introduction

In Unit 24 and Unit 25, you learnt about the basic description of FM transmitter and FM antenna as a part of Radio Transmission Technology. In Unit 27, you learnt about the step-by-step procedures for mounting and testing of transmitter, coaxial cables and antenna system. Further, in Unit 28, you studied about the preventive and corrective maintenance aspects of these components. In this Unit, we shall discuss about the good engineering practices which, if followed, will help you in running a trouble-free transmission service for your Community Radio Station. These good engineering practices cover both for installation and maintenance of transmitter setup.

While studying this Unit you will notice that good Engineering practices involve:

- Proper Planning
- Proper Selection (of equipment)
- Proper Installation
- Proper Maintenance

All the above aspects will be covered in the following sections of this Unit:

- Cable and connector issues
- Input and output issues
- Transmitter operation and upkeep issues
- Antenna adjustment issues

This Unit is presented in Question-Answer format (frequently asked questions - FAQs) so that a number of questions which may arise in your mind while learning this Unit will be answered.

In the Face-to-Face (F 2 F) counselling session, you will get chance to clear your doubts with the help of experts in the field. However, there are some Activities given in each section which you need to work out so as to help you appreciate the aspects of good engineering practices discussed in this Unit.

You will need about 6 hours of study to complete this Unit including the activities given in the Unit.

29.2 Learning Outcomes

After working through this Unit, you will be able to follow the good engineering practices to:

- analyse and discuss issues related to cable and connectors.
- list and analyse input and output issues in respect of transmitter.
- operate and upkeep the transmitter and associated equipment in good working condition.
- adjust the antenna and undertake VSWR measurement of the antenna.
- measure forward and reflected power of the transmitter.

It is important for you to go through FAQs carefully to fully understand the information given there, as such information is generally not available in text books. This will help you learn practical tips for becoming more confident and knowledgeable in these areas.

Let's begin with the issues related to Cable and Connector.

29.3 Cable and Connector Issues

In this section, you will learn how best you can apply your basic knowledge gained through the previous Units in tackling the cable and connector issues in the field. You will learn these aspects by going through the answers to the following questions frequently asked by the students.

Why do we use RF coaxial cable in FM broadcasting?

The transmission lines are required to feed output power of the transmitter to the antenna located on the top of tower. There are two types of transmission lines.

i) Parallel wire (Balanced lines)
ii) Coaxial cable (Unbalanced line)

In FM broadcasting, RF output of the transmitter is usually unbalanced and the performance characteristics of coaxial cables are much better than parallel lines, therefore, coaxial cables are preferred.

What are the selection criteria of coaxial cable?

Selection of type and size of cable is dictated by following three important specifications.

1. Characteristic impedance
2. Power rating
3. Attenuation

On what factors do characteristic impedance of the cable depend?

Characteristic impedance of the coaxial cable depends on the following parameters:

- Outer diameter of inner conductor
- Inner diameter of outer conductor
- Dielectric constant of insulating material

What will happen if we use an RF coaxial cable having a characteristic impedance of 75 ohms instead of 50 ohms?

Because of the mismatch, there will be high reflection back to the transmitter. Transmitter will see the load impedance of 75 instead of 50 ohms. (VSWR = Load Impedance/output impedance of transmitter. = 75/50 =1.5).

How can we measure the characteristic impedance if data sheet is not available?

Characteristic impedance of cable can be measured by use of operating bridge or a site master or network analyser as follows:

- Measure open circuit impedance by keeping other end open (Zoc)
- Measure short circuit impedance by shorting other end (Zsc)
- Calculate characteristic impedance (Zo) =√(Zoc x Zsc)].

How do we decide the average power rating requirement of coaxial cable?

Requirement of average power rating is decided on the basis of maximum transmitter output power allowed. Usually a minimum safety margin of 2 is taken. For example, for 100 watt transmitter, select a cable with at least double average power rating that is 200W.

How do we know the average power rating of coaxial cable?

The average power rating of cable can be known from the data sheet supplied by the cable manufacturer. The rating must be selected corresponding to the frequency of operation. The average power is specified at ambient temperature of 20 degrees centigrade. Degradation of rating for higher temperature must also be considered.

How do we know the attenuation of RF cable?

We can know the attenuation of RF cable from the data sheet supplied by the manufacturer. Attenuation is specified for a range of frequencies per 100 meter of length.

On what factors do the attenuation of RF cable depend?

Attenuation of RF coaxial cable primarily depend on:

i) Frequency of operation
ii) Resistance of the conductors
iii) Leakage across the dielectric material
iv) Length of the cable
v) Velocity factor of the material used

What will happen if the attenuation of RF coaxial cable is more?

The output power of transmitter reaching the antenna will be reduced by that amount. For example, if attenuation of length of cable used is say 3 dB, then we can say that only half of the power of transmitter will reach antenna. The coverage will correspondingly get reduced.

What type of connector should be used?

The original mating connectors (usually N-Male) recommended and supplied along with the cable must be used.

What precautions should we take while fixing the connectors?

Fixing of connector is a skilled job. Follow the instruction sheets provided along with the connectors especially while cutting the length of insulation for inner and outer conductor. A loosely fitted connector always remains the weak link. It may lead to overheating or sparking. With practice you can gain the necessary skill.

Why should we seal the connector and with what compound?

The connectors especially on antenna side must be sealed properly to avoid entry of moisture or rain water. Usually a sealing tube called 'Plast 2000' supplied along the cable is used.

Note It

A appropriately installed project requires minimum maintenance and results in minimum breakdowns.

Activity 29.1

To do this activity, you may need about 10 minutes to write down the answers in the space provided. This activity will help you appreciate the significance of good engineering practice in selection and use of RF coaxial cable and connectors.

Question 1: Why characteristic impedance is considered as the most important parameter while selecting RF coaxial cable?

Question 2: What will be the change in attenuation if the length of cable is changed from 50 m to 100 m?

Question 3: How much power of transmitter will reach its antenna if loss of cable is found to be 3 dB?

Question 4: What may happen if rain water enters the connector of one of the antenna dipole?

Question 5: Why the average power rating of RF coaxial cable shall not be usually less than twice the output power of the transmitter?

29.4 Input and Output Issues

In the previous section you have learnt how a good engineering practice helps in reduction of faults arising due to cable and connector issues. In this section, you will learn how good engineering practices can help you in tackling input and output issues in respect of transmitters.

What are the input issues that need to be tackled in respect of transmitters?

Following input issues should be tackled in respect of transmitters:

- Ensure proper audio input levels and connectivity: i.e. Audio levels from studio should not be low and there should not be any breaks in connectivity from studio to the transmitter.
- Ensure proper ventilation: i.e. Cooling and exhaust fans of transmitter must be 'ON' before switching on the transmitter.
- Ensure uninterrupted power supply to the transmitter: i.e. Input supply connected to the transmitter must be stable.

What are the issues related to audio feed to transmitter?

Issues related to audio feed to the transmitter are:

- Ensuring loss-less connectivity: i.e. Studio to transmitter link should not offer any loss to audio signals.

- Use of Audio Processor: i.e. Audio Processor should be used to increase average modulation and protect transmitter from over-modulation.
- Audio chain alignment: i.e. Audio levels at the input and output of all the equipments from studio to the transmitter should be adjusted to the nominal levels as specified by manufacturer of the equipment.

What are the points to be considered while connecting the audio feed to the transmitter?

You should check the following points before connecting the audio feed to the transmitter:

- Type of Input connector provided for audio connection to the transmitter: For example, XLR male or female connector.
- Whether the connector used is balanced or unbalanced type (for example, BNC unbalance or XLR balanced)?
- Input Impedance; i.e. 600 ohms or more than 10k ohm.
- Input sensitivity specified by the transmitter manufacturer: i.e. Minimum audio level with which the transmitter is capable of giving 100 % modulation (for example, - 10 dBm).
- Nominal input level required for giving +/- 75 kHz deviation (for example, +4 dBm)

On the basis of above information, you should select the type of mating connector and audio cable. You should adjust the audio input levels to the transmitter accordingly.

What type of audio cables should be used?

You should use good quality shielded balanced/unbalanced audio cable of reputed make specifying the number of strands, gauge and material. Use of balanced or unbalanced cable is to be decided on the basis of type of input and output connectors provided on the equipment to be connected.

What type of audio connectors should be used?

Most of the audio equipment such as Mixers, Audio processors and transmitters use 3-pin XLR type of connectors for audio inputs/outputs. Some of the transmitters requiring unbalanced input use BNC (F) connector. Corresponding mating connectors must be used for connecting to the cable ends.

What should we do if the output of audio processor is balanced and the transmitter input connector is unbalanced?

By use of repeat coil, you can connect balanced input on one side and unbalanced output from the other side. If impedance is also different, then you can use a matching transformer or a matching pad.

How do we know the nominal input level required for getting deviation of 75 KHz?

You can know the nominal level:

- From the technical specifications/data sheet supplied along with the transmitter.
- By feeding 1 KHz tone to the transmitter input and noting the level which gives a deviation of +/- 75 kHz.

What do we mean by Input Sensitivity of transmitter?

Input sensitivity of the transmitter is the minimum audio input level with which transmitter can give +/- 75 KHz deviation after adjustment of its input gain control.

Why do we need Audio processor at the input of the transmitter?

We need audio processor at input of the transmitter to:

- Increase the average modulation level (i.e. to increase loudness).
- Protect the transmitter against over modulation.

How do we adjust the audio chain alignment?

We adjust the audio chain by keeping output levels and input levels of all the equipments in chain as equal to their nominal levels. Usually it is set as +4 dB_u at all points in the chain.

Why do we limit the deviation to +/- 75 kHz?

In order to operate number of channels (stations) in the FM band, channel spacing and bandwidth are fixed internationally to have uniform and well defined transmission standards. A maximum modulating frequency of 15 kHz resulting in maximum deviation of +/- 75 kHz correspond to maximum allowed bandwidth of 180 kHz in FM broadcasting. Giving higher deviations can interfere with programmes of adjacent channel.

What are other important points which must be checked to ensure a good quality transmission?

You must ensure that;

- Recorded programmes are not noisy and are not having breaks.
- Recorded levels are uniform.
- Modulation levels are adequate and peaks are not causing constant over modulation.

What are the important output issues in respect of transmitters?

Important output issues in respect of transmitter are:

- Low or no Output Power
- Increase in Reflected Power
- Coverage not as expected – not reaching the target area
- Performance of output modulated signals not meeting the technical specifications.
- Quality of reception not up to the mark
- Interference to or from other channels

What should we do if forward power is low or not there?

Check whether it is due to faulty transmitter or there is no or low power supply. Follow diagnostic procedures learnt in Unit 28 to identify and isolate the fault.

What does increase in reflected power mean?

Increase in reflected power means that there is mismatch in cable or antenna system.

What should we do if reflected power increases?

Switch off the transmitter if reflected power increases. Check the VSWR of the antenna system (You will have to check the fault in antenna).

How do we measure VSWR of antenna?

VSWR of antenna is measured by use of Network analyser or a site master or an antenna tester (You will learn the method in forthcoming section on Antenna adjustment issues of this Unit).

What is the safe limit for VSWR?

Every transmitter manufacturer specifies the safe limit for its transmitter. It may be of the order of 1.2:1.

On what factors coverage area from a transmitter depends?

Coverage area of the transmitter depends on:

- Power fed to antenna (Transmitter output power minus cable loss)
- Antenna gain
- Height of the antenna above the ground

What do we mean by the term ERP?

The term ERP means Effective Radiated Power by the antenna. This is equal to the product of antenna gain and the power fed to the antenna. Power fed to antenna means transmitter output power minus the cable loss.

What is antenna gain?

It is the ratio of field strength that is given by antenna system at a particular point which would have been given by an isotropic antenna at the same point with the same input power.

What does an antenna gain of 3dBi means?

It is a logarithmic unit of expressing power gain of an antenna with reference to an isotropic antenna. It means antenna will radiate 3dB higher (double) power than that of isotropic antenna.

What action should we take if quality of reception is reported to be bad?

We should check the quality of programme step-by-step at the following points:

- Input of the mixer
- Output of mixer
- Output of Studio Transmitter Link
- Demodulated output of transmitter.
- Identify the cause as learnt in diagnostic approach method in Unit 28.
- Take performance measurements of faulty equipment if required.

Which measurements determine the quality of programmes?

Following three measurements usually determine the quality of programmes:

- Frequency response
- Signal to noise Ratio
- Total Harmonic Distortion

(You have learnt details about performance measurements in Unit 28).

What are the possible causes of interference from or to other channel?

Possible causes are:

- Less channel spacing (separation)
- Antenna problem (tuning not ok)
- Fault in filtering circuit

- Over modulation in adjacent channel
- Spurious radiation
- Poor earthing
- Receiver tuning may not be ok

Activity 29.2

To do this activity, you may need about 10 minutes to write down the answers in the apace provided. This activity will help you in understanding and solving the input and output issues involved in the transmitters.

Question 1: Why audio chain alignment is necessary?

Question 2: Why Repeat Coils are used in audio circuits?

Question 3: What equipment is used to control audio levels going to the input of transmitter?

Question 4: What does change in VSWR from 1.1 to 1.5 mean?

Question 5: What will happen to coverage if higher antenna gain is used?

29.5 Transmitter Operation and Upkeep Issues

So far in the previous sections of this Unit, you have learnt to solve the issues related to cable, connector, input and output. In this section, you will learn certain do's and don'ts which will help you in operation and upkeep of transmitter.

What are the important points which we must take care before switching on the transmitter?

You should ensure:

- Proper ventilation.
- Steady regulated power supply.
- RF output of transmitter is properly connected to antenna.
- Power raise control is in minimum position (if provided).
- Second transmitter (if available) is connected to dummy load and is switched 'OFF'.

What points should we check while switching on the transmitter?

You should check:

- Running of cooling/exhaust fan.
- Panel meter readings especially the forward and reflected powers.
- Alarm indications, if any.
- Abnormal symptoms for overheating, burning smell, sound etc.
- The deviation/levels once the steady output power is reached.

What points should we check during transmissions?

You should check the following points:

- Monitor ongoing programme for quality check.
- Note all panel meter readings including those of power supply and UPS just after start of transmission.
- Keep a watch on modulation level (deviations). Adjust if required.
- Keep a watch on alarms.
- Keep a watch on any symptoms of overheating and burning smell.

What actions should we take after close down of transmitter?

You should check the following points:

- Touch and feel the components for overheating.
- Check if there is any loose connection especially at the connector ends. Tighten or repair if required.
- Clean all the equipment with clean soft cloth.
- Clean all the tag blocks.
- Switch off the external fans/AC units at least 10-15 minutes after close-down.

What precautions should we observe while touching the equipment?

You must ensure that:

- All the power supply switches are 'Off'.
- Battery supply to the UPS is also 'Off'.
- No voltage is available at the point you are going to touch.
- 'LIVE' terminals are properly covered with acrylic boxes.
- RF output connectors are not opened when transmitter is 'ON'.

What is a periodical maintenance?

Periodical maintenance means any preventive maintenance done at regular intervals to avert possible breakdowns. It includes a periodical maintenance schedule for doing the type of maintenance.

What type of periodical maintenance schedule should be followed for up-keeping the Transmitter?

Periodical maintenance schedule depends on the type of maintenance such as:

- General cleaning, noting panel meter readings, checking tightness of nuts and bolts and overheating symptoms should be done on daily basis.
- Oiling and servicing of moving machinery like fans and AC units etc. should be done on weekly basis.
- Repairing and servicing of mains and backup power supply units should be done on monthly basis.
- Checking of earth resistance, earth connectivity, RF connectors of antenna system, cable clamps, lightning arrestor and aviation lights should also be done on quarterly basis.
- Performance measurements of transmitter must be done at least once a year.

What precautions should we take while measuring earth resistance?

Precautions to be taken are:

- Never do earth resistance measurements during transmissions.
- Power supply to equipments must be off.
- Isolate the earth connectivity to equipment before checking earth resistance.

What are the points to be checked while doing the antenna maintenance?

Check the following points:

- Tightness of nuts and bolts.
- Change in direction of antenna elements due to wind.
- Change in gap (spacing) between dipole elements.
- Checking of symptoms of rusting if any.
- Loosening or breaking of cable clamps
- Symptoms of overheating.
- Grounding connections of antenna cable and lightning arrestor.

- Checking of aviation lights (if provided).
- Cracks in sealing compound at connector ends.
- Spark marks at connectors, junction points, baluns [a matching device/ circuit which is used to connect balanced input of a dipole to an unbalanced RF coaxial cable (**Bal**ance to **Un**balance)] and small branch feeder cables.

Activity 29.3

To do this activity, you may need about 10 minutes to write down the answers in the space provided. This activity will help you in understanding the operation and up-keep issues of transmitters.

Question 1: Why any RF output connector should not be opened when the transmitter is 'ON'?

Question 2: Why earth resistance measurements should not be done when the transmitter is 'ON'?

Question 3: Why should we especially watch reflected power reading while switching on the transmitter?

Question 4: What precaution should we take while touching any point or terminal of any equipment?

Question 5: What is the effect of over modulation in FM transmissions?

29.6 Antenna Measurement and Adjustment Issues

In Unit 25, you learnt about various types of antennae, radiation patterns and VSWR. Antenna is the most critical and important component in the transmission chain. Any fault in antenna affects the transmission and coverage. In this section, you will learn various issues affecting the performance of antenna and necessitating repair and adjustment at site.

When antenna adjustment is necessary at site?

Though the antennae used in CR station are pre-tuned at factory before supply and do not require any tuning at site, yet after installation or after developing any fault during operations, it becomes necessary to adjust the antenna at site.

What are the causes of failure of antenna?

Antenna can fail due to:

- Displacement, bending or falling of dipole elements due to heavy winds.
- Entry of rain water in connectors or junction boxes
- Sparking in connectors or baluns or branch cables
- Lightning

How can we detect the antenna fault?

Any fault in antenna can be detected by:

- Checking reflected power on the transmitter panel meter.
- VSWR indication/alarm

Cause of antenna failure can be detected by going up on the tower and inspecting the antenna components

What is a balun?

Balun is a matching device/circuit which is used to connect balanced input of a dipole to an unbalanced RF coaxial cable (**Bal**ance to **Un**balance). It can be a transformer or LC network or a transmission line section.

What will happen if we use an antenna having an input impedance of 75 ohms instead of 50 ohms?

It will give high VSWR. VSWR = Impedance of Antenna/Characteristic impedance of cable = 75/50 = 1.5: 1.

How to sort out antenna related faults?

For sorting out all these antenna related faults at site, measurement of VSWR is necessary before and after adjustments.

In the subsection that follows you will learn method of VSWR measurement of antenna.

29.6.1 VSWR measurement of the antenna

What instrument is used for VSWR measurement?

VSWR measurement of antenna can be done by any of the following instruments.

Network Analyser or Antenna Tester or Site Master.

What are the components needed for doing the measurement?

Apart from any one of the instruments mentioned above, following components are also required.

- Precision short
- Precision open
- One standard 50 ohm termination

How do we do actual measurement?

Follow the step-by-step instructions given in the operating manual of the meter and message appearing on the display. Actual measurement is done as per the following steps generally in most of the Digital Instruments:

Setting frequency range

- Press Mode
- Select VSWR measurement
- Press Enter
- Select Frequency
- Press the starting frequency button F1
- Select the frequency e.g. 88.0 MHz with soft keys
- Press Enter. It will display the frequency
- Press stop frequency button F2
- Select the stop frequency e.g. 108 MHz
- Press Enter. It will display the stop or end frequency

1. Calibration

- Press start Cal button. Message to connect open appears on the display.
- Connect precision open connector at RF out and press Enter.
- Message to connect short will appear on display.
- Connect Precision Short at RF out and press enter.
- Message to connect Termination will appear.
- Connect 50 ohm termination at RF out.
- Message 'Calibration" completed.

2. Make the test set up as shown in Figure 29.1

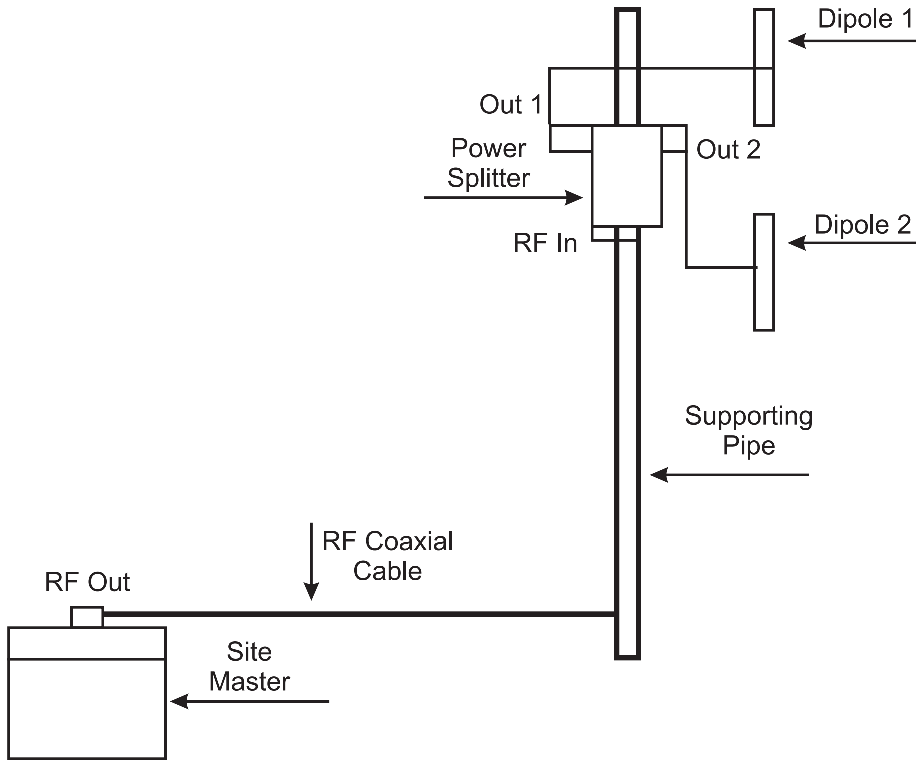

Figure 29.1*: Test set up for VSWR measurement*

Figure 29.1 shows the schematic of Test set up for VSWR measurement. As may be seen in the Figure 29.1, the 'RF OUT' of the Site-master is connected to the input of antenna system mounted on the top of the tower via main RF coaxial cable. (An antenna system consists of a power splitter and two dipoles. The two dipoles are connected to two outputs of power splitter via small RF coaxial cables called branch feeder cables).

3. Do VSWR measurement

- Connect the RF Cable (antenna connected on other side).
- Press Enter.
- Graph showing the VSWR in the entire selected band (88-108MHz) will appear on display.
- Move the marker to station frequency (say for example 90.4MHz).
- The meter will indicate the reading of VSWR at the station frequency.
- Note VSWR reading.

What will be the range of reading?

Under ideal matched condition it will be unity (1:1). The reading should not be more than the specified limit, usually 1.15:1.

What should we do if the reading is more than the specified limit?

If reading is more than the specified limit, antenna needs thorough check up for the following points:

- Loose connections at cable ends
- Break in continuity especially of inner conductor of connectors and cables
- Faulty balun or disconnection at dipole terminals
- Rusted connections at joints
- Sparking at connectors, balun or small branch feeder cables

What should we do after repairing the fault?

You should:

- Check VSWR again
- Normalize the cable connections to the transmitter
- Test transmitter on full power
- The reflected power reading should be either zero or less than 1 watt

29.6.2 Measurement of forward and reflected power of transmitter

In the previous section 29.4, you have learnt that one of the output issue was that transmitter may be giving low forward power (output power going to antenna). In this subsection, you will learn the method of measuring forward and reflected power at the transmitter output.

What is the instrument used for measuring output Power?

Output or reflected power of transmitter is measured by a power meter calibrated with a standard directional coupler or by using a 'Through-line RF Power meter'.

What are additional components required for doing the measurements?

Apart from power meter, following additional components are needed:

- A standard Directional coupler with known coupling ratio
- Forward and Reflected reading probes
- Power meter calibrated with the coupling ratio of standard directional coupler
- Two small lengths of low loss RF coaxial cables with end connectors
- Dummy load

How do we do actual measurements?

Follow the step- by-step procedure given below:

- Switch OFF the transmitter.
- Make connections as shown in Figure 29.2.
- Connect transmitter output to Dummy load through a standard Directional coupler.
- Connect power-meter probes at the directional coupler.
- Switch On the transmitter.
- Raise the power to the desired level.
- Read the power meter reading by selecting Forward power switch on meter panel.
- Note the **forward power** reading.
- Select Reflected power reading switch.
- Meter will now read the reflected power.
- Note the **reflected power** reading.

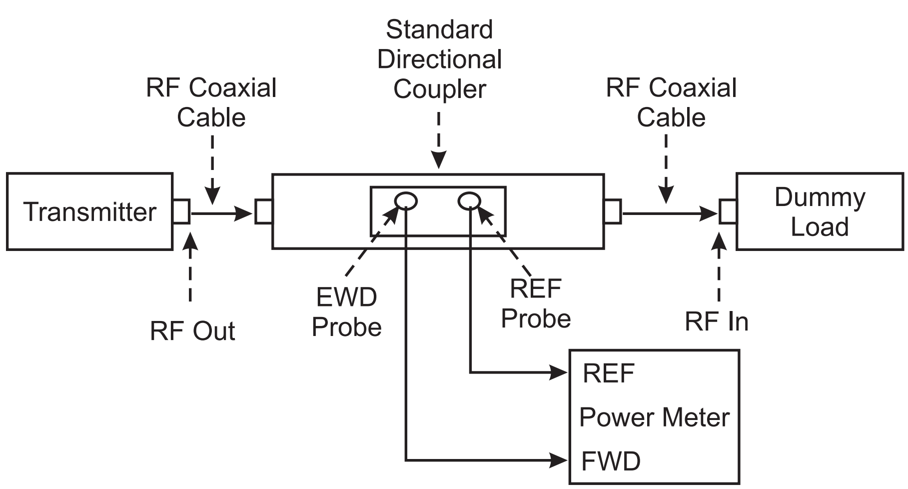

Figure 29.2: *Test set up for measurement of forward and reflected power*

Figure 29.2 shows the schematic of Test set up for measurement of forward and reflected power of a transmitter. As may be seen from the figure, the RF output of the transmitter is connected to the input of a dummy load via a standard directional coupler and small RF cables. Forward and reflected output ports of a standard coupler are connected to the forward and reflected Input ports of RF power meter through two probes.

How do we measure forward and reflected powers by using Through-line meter?

Forward and reflected powers can also be measured by use of a through-line meter connected at the output of transmitter or before dummy load. Basically this meter also contains an inbuilt directional coupler and probes for reading forward or reflected power.

Are there any precautions to be followed while doing the power measurements?

Yes, following precautions must be observed:

- The meter scale and the probes must match with the coupling ratio of the directional coupler.
- The measuring cables and dummy load must be rated for the power to be measured.
- Power should not be switched on till all the connections are made tight.
- No connector should be opened when transmitter is on.
- Some power meters are calibrated for a mid-band frequency, necessary correction must be used to get the correct reading in that case.

Activity 29.4

To do this activity, you may need about 10 minutes to write down the answers in the space provided. This activity will help you in understanding the antenna related problems.

Question 1: How can you ensure that high reflected power is due to antenna only?

Question 2: Why Balun is used in antenna?

Question 3: How much VSWR reading would you expect if antenna having an input impedance of 60 ohms is directly connected to a coaxial cable having a characteristic impedance of 50 ohms?

Question 4: Why calibration of Network analyser/site master is necessary before taking VSWR measurement.

Question 5: Why standard coupler is required for doing the forward and reflected power measurements?

29.7 Let Us Sum Up

In this Unit on 'Good Engineering Practices', you have learnt that:

- For any project, good engineering practices are necessary for ensuring trouble-free transmission service from the Community Radio Station both from the point of view of installation and maintenance.
- The selection of an RF cable depends on its characteristic impedance, attenuation and power rating capacity. If properly rated low-loss cable of 50 ohm characteristic impedance is not used, a lot of transmitter output power is wasted as heat in the cable self and only balance part of power reaches antenna. This results in reduction of coverage area. Similarly if appropriate connectors are not used or the connectors are not fitted properly, the breakdowns due to failure of connectors increase.
- The input issues include, maintenance of studio to transmitter connectivity, alignment of audio signals suiting to the input specifications of the transmitter.
- The output issues include ensuring of full transmitter output power and zero reflected power. The performance measurements of the transmitter are done to ensure that the transmitter meets all the technical specifications.
- The issues related to operation and upkeep of transmitter include switching On/Off of transmitter, checking symptoms of overheating, regular maintenance of ventilation, power supply and backup supply equipment.
- If VSWR increases, most probable cause of fault is due to antenna system. You have also learnt to undertake the measurement of VSWR of antenna by use of site master/antenna tester or network analyser.
- Measurement of forward or reflected power of transmitter can be done by use of power meter calibrated with the standard directional coupler.

29.8 Model Answers to Activities

Model answers to questions given in activities 29.1 to 29.4.

Activity 29.1

1. Because if cable with wrong characteristic impedance is used, reflection due to mismatch will result in high VSWR. We will not be able to switch on the transmitter.

2. Attenuation will be nearly double.
3. A loss of 3 dB means nearly half of the transmitter output power will reach the antenna.
4. Entry of rain water in antenna reduces impedance of antenna thereby increasing the VSWR. If VSWR is high the transmitter may even trip.
5. Keeping the safety margin, usually the rating of cable is twice the maximum power of the transmitter.

Activity 29.2

1. Audio chain alignment is necessary to get the best performance from the equipments. If audio input levels to any equipment are low or high than its nominal rated input level, the noise level and distortion may increase.
2. Repeat coils are used in audio circuits to match balanced audio output of any equipment to the unbalanced audio input of other equipment or viceversa.
3. Audio processor is used to set the limit of audio levels going to the input of transmitter.
4. It indicates heavy mismatch fault in antenna system. The reflected power will increase and the transmitter will trip.
5. Coverage depends on the output power of the transmitter and the antenna gain. Increase in antenna gain increases the coverage.

Activity 29.3

1. The transmitter may get damaged due to mismatch. Connector may spark over and we may even get RF burn.
2. Voltage generated by the earth tester may damage the transmitter. Secondly, the earth resistance measurements due RF pick up may not be accurate.
3. Reflected power meter reading of the transmitter is the most critical reading. It gives the status of the antenna system.
4. We must ensure that there is no dangerous voltage at the point or terminal. We may even get shock.
5. In FM, over modulation may not harm the transmitter but the higher deviation resulting from the over modulation may interfere in the adjacent channel. Quality in receiver may not be good.

Activity 29.4

1. In order to ensure whether fault is in antenna side or in the transmitter output circuit itself, we can test the transmitter on dummy load.
2. Balun is used to connect balanced input of dipole to the unbalanced output of RF coaxial cable.
3. VSWR is equal to the ratio of antenna impedance to characteristic impedance of cable, i.e. (60/50 =1.2). Therefore, VSWR reading will be equal to 1: 1.2.
4. Calibration of network analyser or site master is necessary to set a reference reading with standard known impedance. For example, if a meter is calibrated to 50 ohms, then the impedance of antenna will be checked with reference to 50 ohms only.
5. A standard coupler gives the known standard coupling ratio matching to probes and the meter scale calibrated for forward and reflected powers of the transmitter

Glossary

Antenna Efficiency	is the ratio of radiated power to that of the input power supplied to the antenna.
Antenna tester	is an instrument used for checking VSWR faults of antenna.
Attenuation	is the loss offered by the cable to a signal when it travels along its length and is expressed in dB (decibels) per 100 metre length.
Audio generator	is an instrument used for generating any frequency in the audio range at the desired output level required during testing of transmitters.
Characteristic Impedance (Z_0)	is the ratio of the voltage to the current for a single propagating wave (frequency). Its unit of measurement is ohms.
Decibel (dB)	is a logarithmic unit that indicates the ratio of a physical quantity (usually power, voltage level of any signal) relative to a specified reference level.
Distortion	is the change in wave shape of a signal at the demodulated output of the transmitter with respect to its input wave shape.
dBi	indicates gain with reference to an isotropic antenna.
dB_m	indicates a level with reference to one milli-watt of audio signal.
Forward power	means the final RF output power of transmitter going to the antenna via coaxial cable.
Frequency Response	of a transmitter is the plot of graph showing frequency versus amplitude for the range of frequencies.
Forward power	means the final RF output power of transmitter going to the antenna via coaxial cable.
Harmonic Distortion	is the distortion of wave shape of signal due to presence of harmonics of the signal frequency.
Isotropic antenna	is a radiator which radiates energy uniformly in all directions.
LCD	is a Liquid Crystal Display used for visual display of various parameters.

LED	is a Light Emitting Diode, a semiconductor device used as indicating lamp.
Modulation Analyser	is an instrument used for checking frequency response, noise level, distortion and other modulation analysis.
MOSFET	is a Metal Oxide Semiconductor Field Effect Transistor used in power amplifiers. Its three terminals are known as **Gate, Source** and **Drain.**
Network Analyser	is an instrument used for checking performance of antenna and other networks.
Nominal level	is the operating level at which the electronic equipment is designed to operate.
Phase Locked Loop (PLL)	is the control system that generates an output signal whose phase is locked to the phase of a reference signal. It provides stability to carrier frequency.
Power rating	of the cable is the average power which it can transfer continuously to the antenna system without any heating and change in its designed parameters at its operating frequency.
Reflected power	means the RF power reflected back to the transmitter due to mismatch of antenna.
Signal-to-Noise Ratio	is the ratio of level of the signal to the level of noise when signal is removed.
Spectrum Analyser	is an instrument used for checking frequency modulated side bands and spurious and harmonics emitted by transmitters.
Reflected power	means the percentage of RF power reflected back due to mismatch of antenna.
Signal to noise ratio	is the ratio of nominal signal level to the noise level present in it.
Spurious and Harmonic	radiation is the level of emission of all frequencies other than the frequency of operation.
Total Harmonic Distortion (THD)	of a signal is a measurement of total level of harmonics present in the output signal of a transmitter. It is measured as percentage of sum of the powers of all harmonic components to the power of fundamental audio frequency.
VSWR (Voltage Standing Wave Ratio)	indicates the degree of mismatch due to antenna or cable.

CEMCA

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Certificate in Community Radio Technology

Practical Internship Handbook

9

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Module: 9
Practical Internship Handbook

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Certificate in Community Radio Technology

Courses	Modules	Units
Course I: Understanding Community Radio (3 Credits, 90 Hours)	**Module 1** Community Radio: An Introduction	**Unit 1 :** Community Radio: Concept and Evolution **Unit 2:** Context, Access and Equity **Unit 3:** Community Radio: Policy Guidelines **Unit 4:** Technology for CR: Guiding Principles
	Module 2 Setting up of CRS	**Unit 5:** Components of CR Station **Unit 6:** Radio Waves and Spectrum **Unit 7:** Basics of Electricity **Unit 8:** Power Backup and Voltage Stabilization
Course II: Community Radio Production: System & Technology (5 Credits,150 Hours)	**Module 3** Studio Technology	**Unit 9:** Basics of Sound **Unit 10:** Analog and Digital Audio **Unit 11:** Components of the Audio Chain **Unit 12:** Studio Acoustics
	Module 4 Audio Production	**Unit 13:** Audio Hardware and Field Recording **Unit 14:** Free and Open Source Software **Unit 15:** Telephony for Radio
	Module 5 Audio Post Production	**Unit 16:** Sound Recording and Editing **Unit 17:** Mixing and Mastering **Unit 18:** File Formats and Compression **Unit 19:** Storing and Retrieval
	Module 6 Studio Operations	**Unit 20:** Good Engineering Practices for Studio Setup **Unit 21:** Studio Equipment: Preventive & Corrective Maintenance **Unit 22:** Content Distribution: Alternative Mechanisms
Course III: Community Radio Transmission: System & Technology (2 Credits, 60 Hrs)	**Module 7** Radio Transmission Technology	**Unit 23:** Components of Transmission Chain **Unit 24:** Components of FM Transmitter **Unit 25:** Antenna and Coaxial Cable **Unit 26:** Propagation and Coverage
	Module 8 FM Transmitter Setup	**Unit 27:** Transmitter Setup: Step-by-step **Unit 28:** Transmission System–Preventive and Corrective Maintenance **Unit 29:** Transmission Setup–Good Engineering Practices
Course IV: Technical Internship (2 Credits, 60 Hrs)	**Module 9** Practical Internship Handbook	**Section A:** Introduction **Section B:** Activities to be Conducted During the Practical Internship **Section C:** The Internship Journal and Self-Assessment Paper **Section D:** Assessment of Internship **Section E:** Appendices

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CONTENTS

Section A

Introduction

This handbook constitutes the final course module and the last Unit of the Certificate Course on Community Radio Technology (CCRT). Unit 30 is the sole Unit of Course IV. Students wishing to complete the certificate course will be required to undertake a mandatory 5-day practical internship at a working CR station, during which they will be required to complete a list of tasks, as well as produce a few gradable products which will form the basis of their assessment for this Unit and course. This manual details the internship and the assessment process which also forms its culmination.

A.1 On the Practical Internship

If you have received this handbook, it means you have successfully completed all 29 previous Units in the CCRT course. By now, you should have a thorough theoretical understanding of the many facets of community radio and related technology, covering:

- The context of CR, and the CR policy guidelines in India
- The basic principles of selection, installation and management of technologies for CR
- The scientific concepts behind radio broadcasting, and the concept of spectrum
- The concepts of audio recording, production and post-production (including field and studio recording, editing, mixing, and mastering)
- Field Recording equipment
- Studio Recording and Post Production equipment
- Transmission equipment, transmission and propagation
- Technologies for storage, retrieval and archiving of audio

- Telephony options for CR
- Software options for CR (including software for editing and post production, telephony, archiving and play-out management – and free and open source options for all of these)
- Preventive maintenance and good engineering and technical practices for CR

If you have diligently completed the practical exercises given within each Unit, and have watched or heard all the related audio and video materials provided, you will also have a reasonably thorough practical understanding of the concepts outlined above. It is now time for you to verify and expand this knowledge by testing it in a real-life situation.

As a student of the course, so far your learning has primarily consisted of reading study materials, and following the directions given to you as part of these materials. In many ways, it has been a passive exercise in learning. The practical internship is designed to give you a five day real-world experience in an operational community radio station. It will allow you to use many of the skills and learning that you have acquired as part of this course. Still more importantly, it will give you a chance to assess whether your understanding of technology for CR is complete, or whether there are specific areas which need strengthening.

An internship combines work experience with reflection and analysis. It is not an apprenticeship, and you will not just be working for the community radio station and completing tasks that the station team may assign you. By applying the skills you have learnt as part of this course during these five days, you will deepen your understanding of your learning, as well as the work that the community radio station does. It will also be the first time that you will be expected to draw specific conclusions and solve problems on your own, with practical consequences against which you will be assessed.

Internships are delicate balances between doing practical work and taking in the learning derived from such work. If the assignment and work outweigh the learning element, the experience could become boring and lose its educational value. On the other hand, if the learning outweighs the work you will do during this exercise, the internship will lose its unique participatory element, and resemble a field trip rather than an experiential learning experience – which is what it should ideally be. It will be your responsibility to maintain a dynamic balance between the two.

As you do this internship, you may notice a dramatic change in your relationship to your learning. Very few people – and possibly no one – may explain what it is you have to learn, and how you have to learn it. Beyond the instructions given in this handbook, the material, knowledge and skills may not be very clearly defined – and they will be interdependent, intertwined, and difficult to sort out. Often, you may not understand exactly what you have to do, how to do it - or how well you have done. The people working in the CR station will be too busy to spend time explaining everything to you. This may make you feel unsure of yourself, and of which direction to turn in, and what to do next. You will be largely on your own, and you alone will eventually be responsible for how you use this internship, and what you learn or fail to learn. It will be your job to transition from an assimilator and passive learner, to an active productive worker who defines what is to be learnt and how to learn it. You may be surprised at how difficult this transition can be – but you may be rest assured that if you do this successfully, a productive career in community radio awaits you!

At a practical level, as part of this internship, you will select (or be assigned), a community radio station – usually one in your area, where you will be familiar with the language used (though this is not guaranteed). You will also be assigned a specific individual in the station who will act as your mentor, guide and supervisor. This person will be responsible for overseeing your activities and assignments during the internship, and for assessing and rating your skills and capabilities. You will be given a series of tasks and activities to execute during the five days you will spend at the CR station. You will also be expected to maintain a journal of your activities, and write a self-assessment paper assessing your capacity and your internship learning. You will be graded on all three, your activities, the journal and the self-assessment paper – by your guide/instructor.

During the internship, you will be expected to demonstrate (and be graded on):

1. Active knowledge of community radio technology;
2. Problem solving skills and the ability to creatively use this knowledge to understand specific processes within the community radio station and suggest improvements and changes;
3. The ability to critically assess your learning and knowledge, with a view to identifying areas that need strengthening.

Overall, the internship period is expected to cover a period of 60 hours across a maximum of one week: 40 of these hours will be spent on the practical activities over 5 full days spent at the CRS, with one normal working day at the CR station for the intern being 8 hours. For our convenience, this may be assumed to be 9 am to 6 pm each day, with one hour off for lunch in the afternoon between 1 pm and 2 pm. The remaining 20 hours will be spent on the journal and self-assessment paper, both of which will need to be certified by the guide/instructor, for further submission to the course authorities on the completion of the internship.

A.2 Using this Handbook

This handbook has been designed with three purposes in mind:

1. To inform you regarding the objectives of your internship, and what you are expected to achieve during the five days you will spend at a CR station as part of this process;
2. To outline a series of tasks that you will need to undertake over these five days, in order to practically demonstrate your understanding of the information and knowledge that you have gained over the duration of this course;
3. To create a framework on the basis of which your comprehension of community radio technology, and your ability to apply this comprehension at a practical level in a real world situation, can be assessed.

Section A forms the **introductory** part of this handbook, and outlines the context in which the internship needs to be understood, and the purposes for which you are being asked to complete it.

Section B details a **day-by-day agenda** for the internship period, and specifies the activities you need to undertake during the 5 days of the internship, as well as the outputs of each of these activities.

Section C explains the process of keeping the **intern journal** and the purpose and writing of the **self-assessment paper**, both of which constitute final products emerging from this internship. The specific outputs of the activities (plans, diagrams, documents) outlined in Section B will be included as Appendices to the Journal.

Section D explains the process of assessment to be followed by the guide/ supervisor at the CRS, along with a questionnaire format that he/she will complete as part of your assessment.

The **Appendices** offer some useful hints and tips regarding your work during the internship.

Of the skills and capacity framework outlined in Section A.1 at the bottom of page 9, points 1 and 2 (knowledge of CR related technology and problem solving skills/ creative application of this knowledge) will be addressed by the activities that are outlined in Section B. Point 3 (ability to critically assess your learning) will be assessed through the review of your journal and the self-assessment paper that you will write at the conclusion of your internship. Your overall performance will be assessed through the assessment questionnaire included as Section D of this handbook. The journal, the self-assessment paper and the assessment questionnaire will be signed by your guide/supervisor, for you to submit as the final products of your internship. You will be graded on the basis of these three products.

For a short note on the relative responsibilities of the student intern, the guide/supervisor and the CRS itself, see Section A.3 below.

Go through each section of this internship manual carefully, and ensure that you follow the instructions provided in each section. Try to stay exactly on schedule as per the suggested activity plan, and discuss any issues or challenges with your guide/supervisor. Above all, be diligent about completing the relevant outputs from each activity, so that the products that you will be assessed upon are ready and are of the highest standard.

A.3 A Note on Key Responsibilities

At this point, before we progress to the actual activities themselves, it is important for us to understand the relative responsibilities of the student/intern, the guide/supervisor and the CRS itself, so that we can be clear what is expected from each of the three.

The student/intern is expected to:

1. Arrive as scheduled at the CRS, preferably one or two days in advance of the actual 5 day internship period, and report to the guide/supervisor;
2. Be available for at least one day following the 5-day internship period, to complete any assessment related work with the guide/supervisor (examination of journal, certification etc.);
3. Understand the working procedures and regulations applicable at the CRS, and abide by them;
4. Complete the activities outlined in this handbook, and produce all outputs requested;
5. Consult the guide/supervisor to resolve any problems or issues he/she cannot solve independently;
6. Schedule meetings or talking time with the CRS team members as may be required to complete the tasks that need to be completed;
7. Evaluate his/her own work, and critically review the learning that has been achieved, in order to record one's thoughts and observations accurately in the internship journal and self-assessment paper;
8. Follow high standards of professionalism and ethical behaviour;
9. Assist and help the CRS team should they request such assistance.

The guide/supervisor is expected to:

1. Orient the student/intern on his/her arrival at the CRS regarding the CRS, its rules and regulations and working timings; and perform any introductions to the team as may be necessary;

2. Make any preparations within the CRS that may be required for the intern to successfully work at the CRS and complete his/her tasks;
3. Review the student/intern's plans for how they expect to complete the required activities and tasks, and inform them of any specific requirements that the guide/supervisor has in terms of scheduling;
4. Integrate the intern as an active participant in the CRS's activities for the 5 day duration that the intern is present at the CRS, with a view to maximising his/her learning in the practical situation that the CRS offers;
5. Provide supervision by keeping an eye of the student/intern's attendance, and briefly reviewing each day's work (preferably at the start and end of each day, but at least once a day);
6. Provide any specific training inputs and problem solving that the student/intern may require assistance with;
7. Evaluate the student/intern's outputs, performance, and the degree that he/she has met the stated goals and objectives through a review of the activity outputs, internship journal and self-assessment paper;
8. Provide feedback on the student/intern's performance.

The CRS team, staff and management are expected to:

1. Make provisions to allow the student/intern to complete their internship process at the CRS, including the provision of a working space and access to its facilities and team members;
2. Provide any inputs that the student/intern may require to complete the required activities and tasks;
3. Provide guidance and support to the student/intern, so that he/she may derive a valuable learning experience from their time at the CRS;
4. Provide a friendly, supportive and non-threatening work environment that fosters learning and growth;
5. Establish a clear set of dos and don'ts for the student/intern, so that the student/intern does not accidentally impede the normal functioning of the CRS.

Section B

Activities to be Conducted During the Practical Internship

In this section, you will see a schedule for how you are expected to use your time over the five days of your practical internship at the community radio station.

The five days have been divided into 10 slots of approximately 4 hours each. During these slots, you will be expected to complete some tasks and activities to demonstrate your understanding of the subject of CR related technology. The tasks will allow you to practically implement some of the theoretical learning that you have received while studying previous chapters in the CCRT course.

At the end of each day, you are required to formally write up your notes and outputs related to the activities that day. This is not only in connection with the journal entry you will be required to make, but also to keep a record of the activity itself. Some of these outputs must be added to the journal that you will be writing, as appendices. You may write these notes on loose sheets of paper, appropriately sized for our journal book. Preserve them carefully with your journal, and paste them up in sequential order after the last journal entry (for +day 5).

Note to the Guide/Supervisor

The fact that your CRS is participating in this CCRT internship programme indicates that the facilities that need to be provided to the intern for this purpose must already have been explained and negotiated with your CRS. That said, please note that the following activities and exercises will require the intern to actively examine the CRS' equipment, studio facilities, infrastructure (electricals, telephone setup), transmission system and related items. You may be required to intercede on his or her behalf in order to ensure this access, and to help in gaining access as per this schedule to some of the facilities. While the station's functioning and requirement remain paramount, your intercession will help plan some of these activities in a way where the intern can complete his/her tasks with a minimum of disruption to the CRS' activities. For example, you could help the intern plan their time by interchanging some of the sessions – switching sessions within a day, or even between days if really necessary – based on your understanding of the CRS' requirements and your intern's learning requirements. Your assistance is deeply appreciated!

B.1 DAY 1

Session 1: 9 am – 1 pm

Objective: Understanding the field equipment setup in the CRS

Goals:
1. Review the field equipment inventory of the CRS (if it exists)
2. Physically identify the various pieces of equipment in the list
3. Suggest revisions to the inventory listing as necessary

This exercise is designed to familiarize you with the current equipment setup and technology use of the community radio station that you are interning with.

If the station already has a field equipment inventory, request access to the list. See if the equipment inventory is presented with the following heads and in a format like this:

Sl. No.	Items	Categories (Studio/Field)	Make	Serial Number/ID	Accessories	Cost	Date of Purchase	Warranty	Bill Details	Vendor/ Service Contact
1	Laptop (Office)	Studio	Sony VIAO	27545384 7008660	Power adaptor, Carry bag, Warranty Card, Recovery DVD	INR 25,000	1 March, 2014	1 Year	Bill no. 25456 dated 01/03/2014- CROMA	CROMA 1st Floor, Crown Mall 12/7, Faridabad- 03
2	ZOOM H2	Field	Zoom	7062586	SD Card, Wind Shield, Earphone, USB Cable, Desktop Stand, Mic Clip Adaptor, AC Adaptor	INR 12,000	13 March, 2014	1 Year	Bill no. 15489756 dated 13/03/2014- Rivera Digital	Rivera Digitec (I) Pvt. Ltd. 411 Nirman Kendra, Mahalaxmi (W), Mumbai-11
3	ZOOM H2	Field	Zoom	7062587	SD Card, Wind Shield, Earphone, USB Cable, Desktop Stand, Mic Clip Adaptor, AC Adaptor	INR 12,000	13 March, 2014	1 Year	Bill no. 15489756 dated 13/03/2014- Rivera Digital	Rivera Digitec (I) Pvt. Ltd. 411 Nirman Kendra, Mahalaxmi (W), Mumbai-11
4	ZOOM H2	Field	Zoom	7062588	SD Card, Wind Shield, Earphone, USB Cable, Desktop Stand, Mic Clip Adaptor, AC Adaptor	INR 12,000	13 March, 2014	1 Year	Bill no. 15489756 dated 13/03/2014- Rivera Digital	Rivera Digitec (I) Pvt. Ltd. 411 Nirman Kendra, Mahalaxmi (W), Mumbai-11

If not, make a note of the equipment heads that are missing from the CRS list. Now contact whoever is in charge of equipment issue at the CRS, and request that you be allowed to familiarize yourself with the equipment on the list. Inspect one piece of each of these items and understand the key functions of each piece of equipment.

Make a note of the following pieces of information:

1. Are the recorders digital or analogue? What medium do they record on? How are they powered?
2. Are the field microphones dynamic or condensor? If the latter, what is their power source?
3. How many field recording units are there? How many are for regular use, and how many are spares? Are they all in functioning order?
4. Does each kit have a carry pouch or bag? Is the carry bag waterproof?

Ask the person tasked with equipment issue, ask them about **two key challenges** that they have faced with their field equipment and how these were resolved.

If there is no equipment inventory in the CRS (which is unlikely), find out the reason for this.

Write up your notes neatly on a loose sheet of paper and preserve it. Paste it later into your journal as **Appendix - I.**

Session 2: 2 pm – 6 pm

Objective: Understanding the studio equipment setup in the CRS

Goals:
1. Review the studio equipment inventory of the CRS (if it exists)
2. Physically identify the various pieces of equipment in the list
3. Suggest revisions to the inventory listing as necessary

If the station already has a field equipment inventory, request access to the list. Follow the equipment inventory list template given for the field equipment for reference. If any heads have been left out, note the heads that could be added.

Request access to the studio. You may have to work out in advance whether this will be possible, because this must not conflict with or impede the regular working of the studio. You may be able to do this even while the studio is active, since it is primarily a tallying of the existing equipment against the list. However, if there are challenges to accessing the equipment, you may have to wait till the studio is free in order to do this. Discuss this with your supervisor in case you need to sort out a specific schedule in advance.

Make a note of the following pieces of information:

1. How many studios are there? Does the station have separate live and recording studios?
2. How many DAW units does the studio house? Are they assembled or branded? Can you determine their configuration?
3. What is the make of the primary studio mixer unit? How many channels does it have? How many are stereo and how many are mono?

4. What is the editing and post production software in use? Is it FOSS or is it proprietary?
5. Has the studio been acoustically treated? How?
6. Is the studio air-conditioned? If yes, what capacity is the AC unit, and what type is it? (Note: Information required is not just the brand or make, but the design of the AC itself – split, window AC, cassette type etc.) If it is not air-conditioned, why was this decision taken? (You may have to ask someone in the station the last question.)

Determine **two key challenges** that the CRS has faced with the studio infrastructure or the studio equipment.

If there is no equipment inventory in the CRS for the studio equipment (which is sunlikely), discover the reason for this.

Write up your notes neatly on a loose sheet of paper and preserve it. Paste it later into your journal as **Appendix - II.**

B.2 DAY 2

Session 3: 9 am – 1 pm

Objective: Understanding the siting, space and layout of the CRS

Goals:
1. Review the siting decisions made while setting up the CRS
2. Review the space distribution plan for the CRS

This exercise is designed to familiarize you with the layout of the CR station, and the decisions that were taken while locating the station at its existing location.

First enquire how and why the station came to be located where it is. Note down the following pieces of information:

1. How was the decision taken, and by whom?
2. Is it a community contributed space? Was it a pre-existing building?
3. What are the perceived advantages of the current location (at least 3)?
4. What are the disadvantages of the current location (if any)?
5. Has the present location posed any specific challenges? (Flooding during rains, hard to reach, electrical infrastructure and telephone infrastructure hard to install?)

Also note down your own assessment of the site, from a technical point of view. Use the points raised in Unit 5 of the CCRT course materials for reference.

Now ask whether there is a layout plan for the entire CRS building. If it was constructed from scratch, there should be an architect's plan or building plan available. If it is rented, or is in a pre-existing building, this may not be available.

If there is an existing plan, trace out a floor plan of the CRS onto a fresh sheet of paper. Mark out any internal walls and partitions that have been constructed in order to create the studio spaces. If you're drawing the plan from scratch, you can draw this as you go – but you will need to measure the dimensions with a measuring tape first. Draw the diagram as much to scale as possible. Mark all windows, doors and other features as possible.

If you have done this correctly, you should have a diagram that looks something like this:

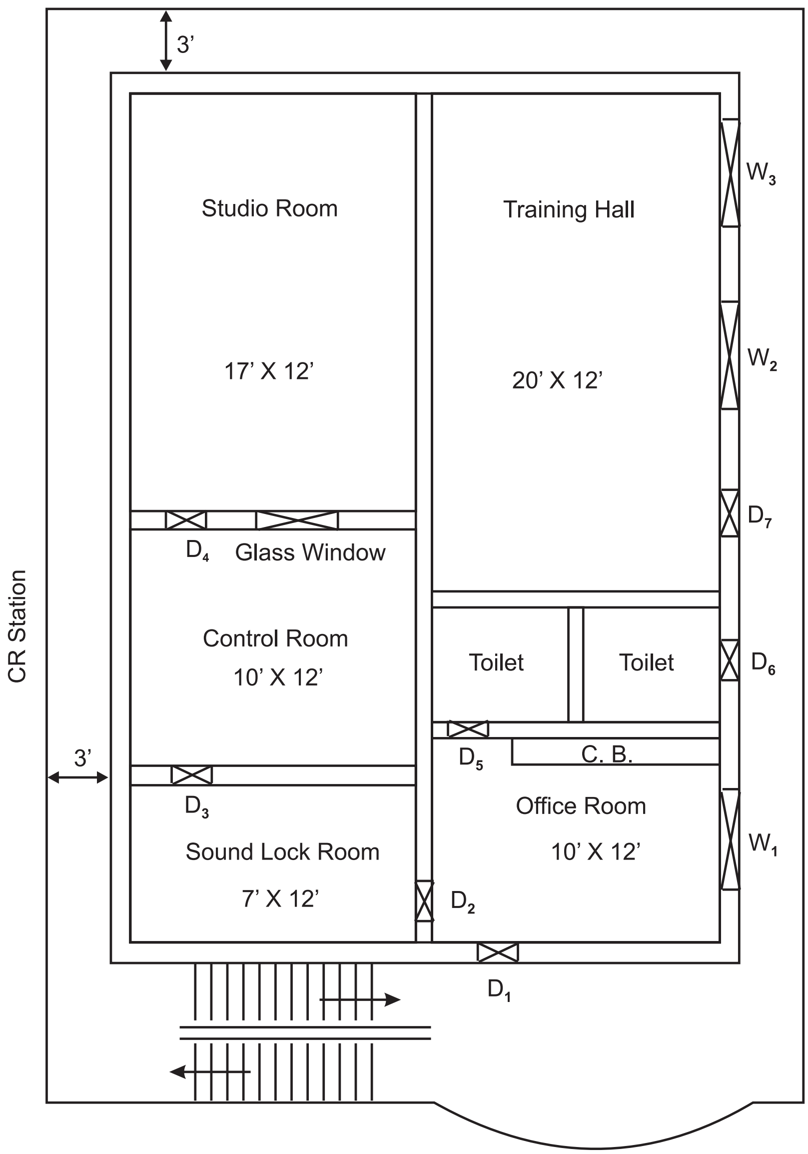


***Figure 1:** A Sample floor plan of a CRS (Courtesy the author)*

Now assess the spaces in the CRS: is the studio large enough for discussion programmes and music recordings with groups? Is the office area very cramped? Could there be less space used for storage and more used for some other purpose? Reassess the spaces and suggest an alternate distribution for the space by drawing a fresh diagram. Keep in mind existing external walls, load-bearing walls and windows. You may suggest the construction of new internal walls (or the demolition of some of them) as part of this exercise. Paste both floor plans and your write up of the notes you have taken on the site selection as **Appendix - III** in your journal.

Session 4: 2 pm – 6 pm

Objective: Understanding the electrical setup and backup arrangements in the CRS

Goals:

1. Review the electrical connections in the CRS premises
2. Examine the power distribution planning in the CRS
3. Examine the power backup arrangements in the CRS

This exercise is designed to familiarize you with the electrical arrangements in the CR station. Part of this exercise may require you to switch some of the electrical systems on and off, so check with your supervisors and/or others in the CRS team how and when this will be possible.

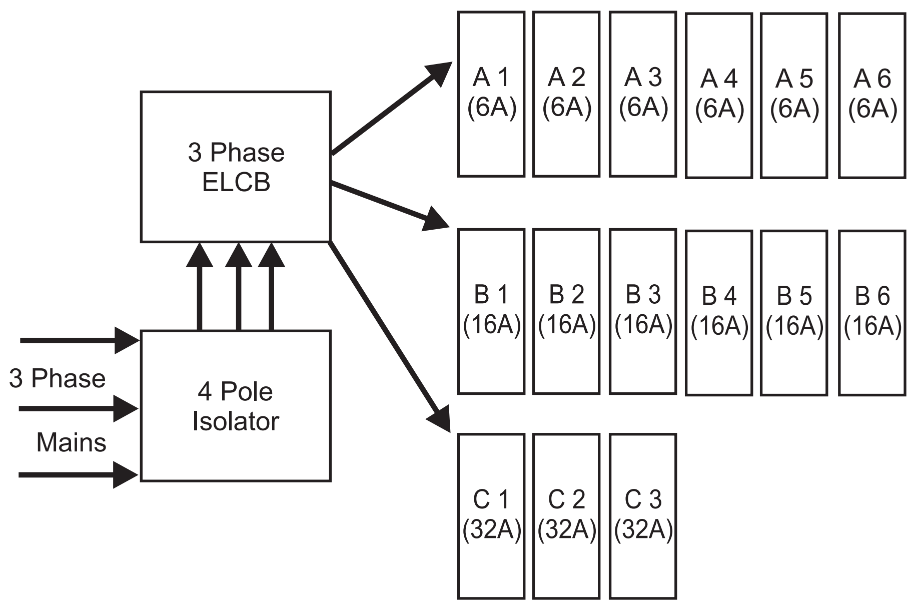
First determine where the primary electrical connection enters the building. Ask the station team how much the sanctioned load is. (If no one is actually sure, you should be able to ascertain this from the most recent electrical bill, if it is available.)

Now make the following observations:

1. Is the incoming electrical connection single phase or three phases?
2. Are the phases distributed to the internal wiring through simple fuses or MCBs?
3. Is there a circuit distribution diagram already? Is each MCB marked with the plugs or switches it controls?
4. If it is a three phase setup, are the ACs (if any) on a separate phase from the other electricals?
5. Is there a CVT or online UPS system installed? What are the power stabilization arrangements for the CRS? What is its capacity from a load point of view (how many Amperes of current can it handle?)
6. What are the power backup systems installed in the CRS? What is the total load the power backup systems can handle, and for how long?
7. If there is a DG (generator) unit, what is its service and maintenance interval? (The gap between two successive service schedules, measured in number of running hours.)

If there is no electrical circuit diagram, or MCB distribution plan, ask your supervisor whether it will be okay if you make one. This will benefit the station as well, but will require various circuits to be switched off temporarily one by one from the main distribution board, while you assess what switches and plug points have lost power as a result of each MCB or fuse you disconnect. This is likely to be disruptive, and you will also require the assistance of one or two people from the CRS team to do this successfully.

Now draw up a fuse/MCB distribution plan for the distribution board. The diagram should indicate where power from each phase is going; and the function of each of the fuses or MCBs. The diagrams should look something like this:



A 1 Training hall tube lights & fan
A 2 Office tube lights & fan
A 3 Control room lights + fan
A 4 Studio lights + wall fan
A 5 Control room & studio 5A wall Plug points
A 6 Office & training hall 5A wall plug points
B 1 Office 15A floor socket
B 2 Training hall 15A floor socket
B 3 Control room 15A socket (DAW)
B 4 Control room 15A socket (Rack)
B 5 Control room 15 A socket (Mixer)
B 6 Studio 15 A socket (Presenter)
C 1 Studio AC socket 32A
C 2 Office 32A socket
C 3 Training Hall 32A socket

Figure 2: *Sample distribution board diagram: Indicative only! (Courtesy the author)*

If for some reason, you are unable to draw a distribution diagram for the entire station, you may restrict your distribution plan diagram to just the studio space. (Explain why you could not do this for the entire station in your notes.) Your responses to the questions given in this session, along with the distribution plan, will constitute the product for this session. Paste them up in your journal at the appropriate point as **Appendix - IV**.

B.3 DAY 3

Session 5: 9 am – 1 pm

Objective: Understanding the audio chain

Goals:
1. Examine the audio chain setup in the studio
2. Draw a schematic view of the audio chain for reference

This exercise is designed to familiarize you with the connections between the various pieces of equipment in the studio at the CRS you are doing your internship at.

Ask for permission to examine the studio equipment at a time that it is free or not in direct use. (It may be possible to do this, for example, when editing work is going on rather than studio recording work.) Examine the studio component setup, and begin to diagram the entire studio component cabling and connections.

Pay special attention to:

1. Cabling used (2 core shielded/non shielded/single core etc.)
2. Connectors used (XLR male/female; ¼” phono balanced or unbalanced; mini phono etc.)
3. Stereo and mono channels and connections on equipment (especially mixers)

This is a time consuming process, so work hard and keep an eye on the clock. The station may already have a diagram of this sort – don’t just copy from that! Very often, these diagrams are prepared when the installation is first done, and do not reflect subsequent adjustments made to the setup, especially when equipment is replaced or re-configured.

If you have done this well, you should have a diagram that looks something like what is shown in the following page:

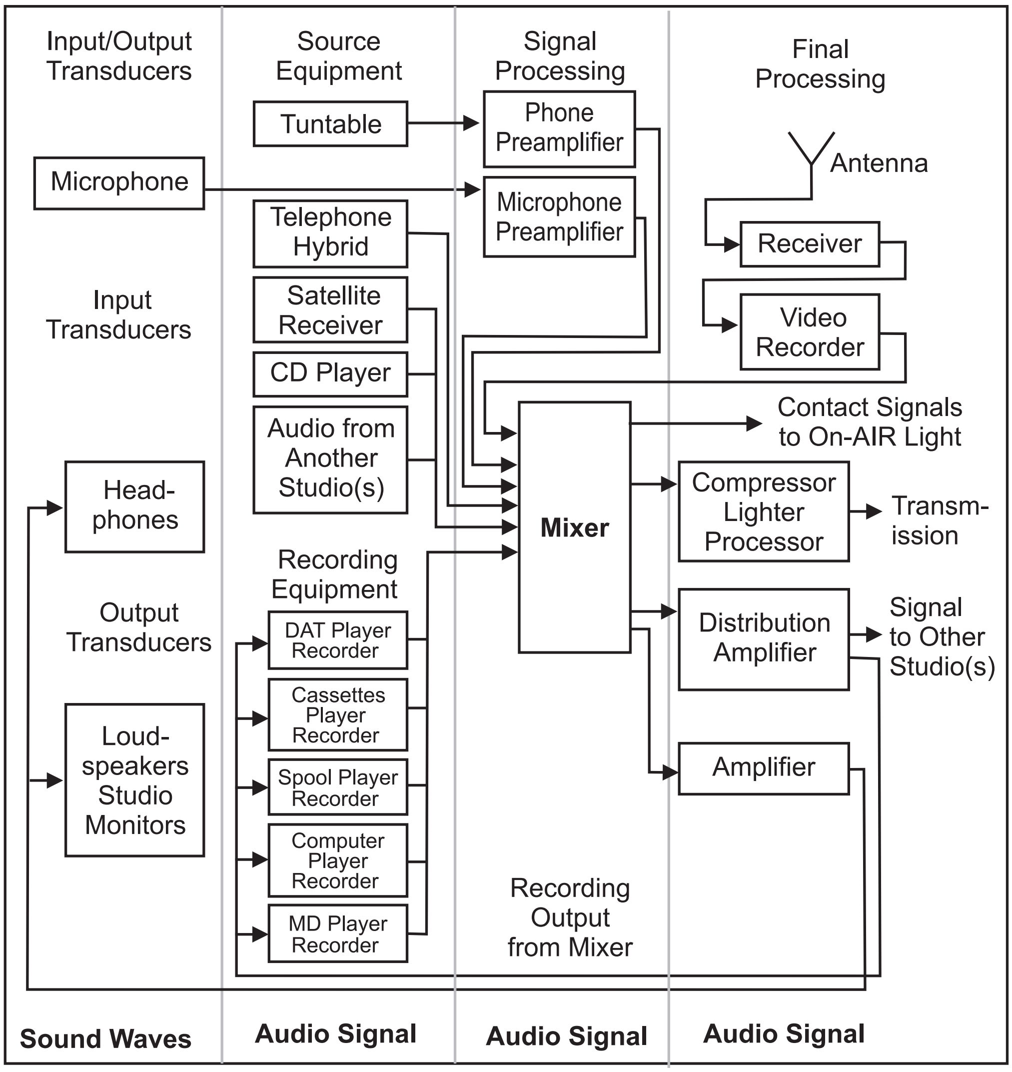


Figure 3: *Sample audio flow diagram (Courtesy the author)*

Note that this diagram does not show connections to the transmitter; and does not reflect connectors. Your diagram should do both.

The more details about the diagram, the better – so make it as large as you can. (Don't worry about the size – you can always fold it to include it in your journal.) And if the CRS does not have a diagram like this one, they could always use a large one to put up in the studio for reference.

Have your supervisor or someone very familiar with the studio check through your diagram before you finalize it. It may help to do a rough version first, so that you can make corrections. The diagram shown here has been designed on a computer, so don't worry if your diagram doesn't resemble it! Include your diagram as **Appendix V** in your journal.

Session 6: 2 pm – 6 pm

Objective: Understanding the field recording process

Goals:
1. Get familiar with using the field recorder
2. Conduct a short interview recording in an outdoor situation

This exercise is designed to familiarize you with field recording processes.

Request whoever is in charge of the station's field equipment to issue you one of the field recording units. This may only be allowed if a station team member accompanies you during the recording. This is a valid precaution, since you are not part of the station team, or a volunteer from the local community – and may not yet be familiar enough with the equipment to be trusted with it on your own.

Go through the process and tips on field recording in Unit 18 before you start. Check your equipment and ensure that all of it is in working order when it is issued to you.

Plan a short interview with a CRS team member about their experience working in the field of community media. Keep it short, and ask only 4-5 questions, which you can note down before you start. Practice starting and stopping the recording, and adjusting levels before you start. Also practice the movement of turning the mic towards you and towards your interviewee while conducting the interview: you should be able to do this without straining your arm too much.

Now select a suitable outdoor location where you can record your interview, and conduct the interview. Explain what you will be talking about to the person you are interviewing. Request them to not interfere while you are recording, even if they have more experience and see you doing something obviously wrong, as you need to learn the process.

Conduct the interview. Listen to it as soon as you have recorded it; and if you feel the audio quality should be better, you can try recording it again.

Pay special attention to:

1. Audio levels (keep them at the appropriate level suggested – usually between -12 and -9 dB)
2. Ambient noise
3. Overlap of voices
4. Incorrect operation or movement of the mic, leading to fluctuating audio levels
5. How you ask the questions, and the questions you ask (no close ended questions that demand only yes or no answers, no flubs while speaking, and so on).

Learn how to transfer the audio from the recorder to the DAW, and transfer the audio. Preserve the audio and keep a copy on CD or other media with you. You will need this recording for a later exercise.

B.4 DAY 4

Session 7: 9 am – 1 pm

Objective: Understanding studio recording

Goals:

1. Participate in a studio recording in the CRS
2. Suggest improvements in audio quality or recording process, if required

This exercise is designed to familiarize you with the process of studio based recordings in the CRS.

Prepare for the exercise by enquiring in advance regarding the programme productions scheduled for the day, so that you can find out what kind of a programme has been scheduled: music, discussion, phone-in, and so on. Talk to the programme producer(s) in the CRS team who are looking after this specific programme, and get some details regarding the programme:

1. Is this part of a series? (If yes and previous episodes have been recorded, try and listen to a couple of them beforehand.)
2. What is the programme format?
3. Is it going to feature one mic, or many deployed simultaneously?
4. Does it feature a phone-in component, where listeners will call?

Depending on the inputs you receive, spend some time in advance with the relevant equipment in the studio to quickly familiarize yourself with it. You will already have done this once when you did your initial review on the first day.

Take notes regarding the process that the team follows to record the programme, starting with the moment the participants/guests arrive for the recording, or the presenter is ready to do the recording. Try and simultaneously track what's happening at the recording end in the control room and what's happening on the studio floor, and portray them as a flowchart that reflects both processes. The flowchart should reflect all the activities in detail, including technical preparations being made.

The diagram in the next page shows how you could start the flowchart. The rectangular boxes represent what is happening in the control room, and the ovals what is happening on the studio floor.

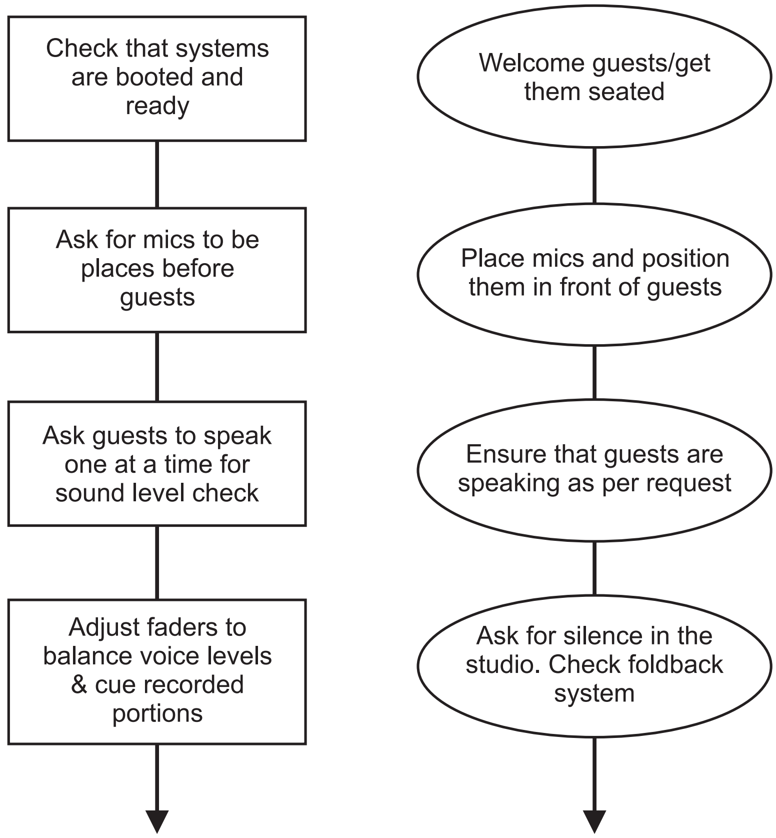


Figure 4: *A sample studio recording flowchart (Courtesy the author)*

This diagram is likely to be quite long, as there are many processes that take place simultaneously in the control room and the studio during a recording. Try and take notes in as much detail as you can.

Now listen to the recorded programme and check the overall audio quality. Is the audio even, and are all the voices heard at approximately the same level throughout the programme? Are some of the guests/speakers heard louder or lower than the others? Are there a lot of extraneous noises on the track?

Write your observations regarding the recorded audio (2 paragraphs or less), and include the flowchart as **Appendix VI** in your journal.

Note to the Supervisor on Session 7

If it is possible, allow the intern to do a studio recording exercise of his/her own in the studio, if it can be freed for a few minutes, rather than just observe the process. It would be far more valuable in terms of developing his/her confidence in working with the technology. If necessary, this can be done by rescheduling the activity on a different date and at a time when this can be more conveniently achieved.

Session 8: 2 pm – 6 pm

Objective: Understanding editing and post production

Goals:
1. Edit a small interview programme
2. Suggest improvements in audio quality or recording process, if required

This exercise is designed to familiarize you with the process of audio editing and mastering.

You have already recorded a field interview in Session 6. You will need to ask for time on one of the editing systems in the CRS to complete this exercise. Find out about the editing software that is being used in the CRS beforehand, and read up about it so that you are familiar with the basic controls. If it is FOSS based – Audacity, for instance – you may even have experimented with it on a system you have access to before you arrived at the CRS for your internship. Ask for your supervisor's assistance for this exercise, or anyone in the CRS team who can spare some time to explain the basic controls to you.

Import the audio you have recorded into the editing software. Your task is to edit the interview you have recorded into a short 3 minute programme. The programme must have the following characteristics:

1. It has to start and end with a short musical piece. Don't select an arbitrary piece – use something instrumental and in keeping with the tone and pace of the material.
2. The music must fade under the opening question, and fade up under the last response at the end of the interview before fading out completely.
3. You may decide to keep or not keep your voice asking the questions. If you do not, you must find a way to bridge the gap between answers.
4. Remove unnecessary gaps and pops in audio. But don't cut the programme breathlessly without any breathing space or pauses!
5. Once your programme is assembled, balance the various sections of audio out so that it sounds seamless and smooth from beginning to end.
6. Now find the controls to select the entire programme from beginning to end and export it as an MP3 file with the following parameters: **MP3/128 KBps/44100 kHz sampling/Mono.**
7. Save the exported file with a name that you will recognize, and in a folder where you will find it again.
8. Burn the final exported mp3 file as well as a folder with the original source materials onto a CD using the available CD writing software on the system. Put the CD in a cover and include it as **Appendix VII** in your journal.

Note to the Supervisor on Session 8

As noted for Session 7, it is important that the intern be given time to handle some of the controls on the editing system by himself or herself in order to gain experience on handling the editing software. Though there may be some hesitation within the CR team on doing this, it must be noted that the average volunteer does not arrive at the station after having studied for a certificate course in CR technology, especially one which includes several classroom sessions and practical exercises as part of the teaching content. Additionally, it is likely that the intern is already attached to a CR station in some fashion, and probably has some experience in the area.

B.5 DAY 5

Session 9: 9 am – 1 pm

Objective: Researching options for equipment

Goals:
1. Isolate one new piece of equipment that the station needs
2. Conduct research on the internet to offer a technical appraisal of possible options of the equipment that the station can acquire

This exercise is designed to familiarize you with the process of equipment acquisition in a real world situation. You have previously done a similar exercise as part of Unit 4.

Meet the station manager of the CRS, and ask him or her what their wish list of equipment is: is there a piece of hardware or software that they've been wanting to acquire, and haven't been able to select or appraise yet? Takes notes on the items he/she tells you. Ask if there are specific features that they are looking for in these items.

Select any one item from the list, and use a computer with internet access to research possible options for equipment or software. Put your findings down in a specs comparison sheet patterned after the one given in the following page. Ensure that this is equipment or software that is officially available within India, so that it may actually be acquired should the station choose to do so after your review. It is important that your comparison sheet carry the contact details for the local authorized dealer or reseller.

Equipment Comparison Sheet: Computers

Sl. No	Name of equipment	Brand/Make	Model	Cost	Specifications	Any special features	Reason for selection	Dealer details	Service center
1.	Processor								
2.	Motherboard								
3.	Casing/CPU Tower								
4.	Hard Drives (HDD)								
5.	SMPS								
6.	RAM								
7.	Video								
8.	Optical								
9.	Wireless								

Figure 5: *A sample equipment comparison sheet (Courtesy: the author)*

This sheet gives you the headers that you can compare different computers under: processor, motherboard, and so on. You may have to evolve slightly different sheets for different pieces of equipment, or for software.

Include a copy of your comparison sheet in your journal as **Appendix VIII**.

Session 10: 2 pm – 6 pm

Objective: Technical challenges debriefing

Goals:
1. Assess the key technical challenges faced by the CRS
2. Write up a technical note with recommendations on how these may be addressed.

As your final activity during your practical internship, you will conduct a technical review of the CRS, and identify up to 5 key technical issues that the CRS team feels it needs to address.

Select 4 - 5 CRS team members who are responsible for production and technical responsibilities within the team. Include the station director or station manager as one of the five. Conduct a short discussion with each team member to ascertain the key technical challenges that they feel need to be addressed.

Areas you may like to explore include:

1. What, in their opinion, in the last 18 months have been the three most serious technical issues or challenges faced by the CRS?
2. What has the impact of these technical issues been (enumerate for each one)?

3. What is likely to have caused the issue? Could these issues have been avoided with preventive maintenance?
4. Who finally addressed or solved each of the noted technical issues?

Use the notes from your four interviews to write a short technical review that captures the information in the following format:

- Technical issue No.1: (*Description*)
- Probable cause (if identifiable): (*Describe probable causes in bullet points*)
- Impact/Consequences: (*Describe the consequences in bullet points*)
- Avoidable by preventive maintenance: Yes/No *(Circle the right one)*
- Solution /provided by: *(Who solved the issue?) / (What was the solution?)*

Keep the details crisp and short. Don't write extended sentences and stay with bullet points. End your note with any recommendations that you may have for possible ways to avoid these technical challenges in future. Be creative, and use your knowledge of the field and your experience over the last five days to suggest practical and simple ways to avoid these issues or create fail-safes that will protect the station from serious downtime or outages due to these problems.

This concludes the list of tasks and activities to be completed by the intern during the practical internship period. The intern must complete all of these activities.None of them is optional. If the intern can squeeze in additional activities and tasks, this is to be recommended, as it will provide valuable field experience.

Section C

The Internship Journal and Self-Assessment Paper

Over and beyond the activities that you will undertake during the internship – and the outputs of each of those activities – you will be expected to create two important documents during this period: The Internship Journal and the Self-assessment Paper. The first is a kind of diary, or reflective record of your experiences. The second is a kind of self-assessment, where you will examine your learning from your experiences during the internship. Let us look at each of these in detail.

C.1 The Internship Journal

C.1.1 What is the purpose of the Internship Journal?

Taking the time to sit down and write about what you did during the day – activities, challenges, things you learned, feelings – is an important part of your internship. Writing this is in the form of a diary or journal allows you to reflect on your experience, and your discussions with others at the CRS, and with your supervisor. It challenges you to think about what you are drawing from the internship experience, and is therefore the first step towards critically reviewing your own work.

Thus, the Internship Journal is meant for you to:

1. **RECORD** your experiences, saving them for later review, so that you do not forget key details;
2. **REFLECT** on your experiences and how they connect to what you have learnt before – and to other things that you have learnt in life;
3. **ANALYZE** your experiences and interactions during the internship, to locate areas you can improve in, and key theoretical and practical areas that you need to be clear on.

The journal is meant to document your experience of the internship, and what you have learnt – and in this sense, ties together many of the components of your internship. Re-reading your journal later should let you relive the experience of the internship, and provide fresh understanding and insights regarding your experience. It will also give your supervisor an understanding of what you have done, and provide your evaluator a way to understand the details of your internship visit.

C.1.2 Writing an Internship Journal

There are several considerations to keeping a good journal. But the central thing to remember is that your attitude towards the writing of the journal can decide whether it is a useless chore to be completed, or a dynamic exploration of yourself. Here are some simple tips and techniques that will help you write your journal in an interesting, engaging, honest and purposeful way:

1. Start by setting aside a notebook or register for the journal. A register is to be preferred, since you may want to paste some of the work you do as part of your tasks within the pages – and a notebook page can sometimes be too small. A register of 40 pages or more will be fine. Write your name, address and enrolment number on the first page.
2. Set aside a scheduled time each day of your internship to write. Don't wait to do it on the last day, because you will forget a lot in the interim. Start with the day you arrive and report to your supervisor, if you like, rather than the first day of your internship at the CRS.
3. Make concise notes during the day, as you work, in a separate notes copy or notepad. Later that evening, you can expand these notes into a formal journal entry.
4. Typically, there should be at least one entry per day of the internship. But if you feel the need, you could make more than one as well. But quality counts, not quantity – don't write a 300 page journal for a five day internship!
5. Record thoughts, questions, and critical incidents. Don't just write a narrative description of your day. Don't write 'I got up at 6 am and got ready. Went to have my breakfast of *paranthas*'! And certainly don't write personal things about yourself – other people are going to read this!
6. If you feel there is a lot to say, write. This is the space to keep a record of major events, questions, discoveries and your feelings regarding your internship. Reflect and analyse things that concern you, especially things that help you clarify your own strengths and weaknesses, and your understanding of your course matter.
7. The journal is a document that will be assessed, but don't try to impress anyone. Your honesty is far more valuable than your trying to find ways to impress the evaluator.

As part of your journal writing, you may like to use this list of questions to decide what you want to write:

1. What was the most important thing I learnt today?
2. What are the key issues that I want to think more about?
3. What did I observe about the way everyone at the CRS does this work?
4. What things did I need help with? What did I do when I needed help?
5. What key facts do I need to remember?
6. How did what I learnt or did today relate to what I have studied before?
7. What ethical questions did I face, if any?
8. What human relations problems or logistical problems happened, which prevented or obstructed my work?
9. Did I hear any opinions or ideas that were very different from my own?
10. What do I need to remember for tomorrow?
11. What was the best thing that happened to me today?
12. How do the people at the CRS treat you, or respond to you?
13. Is what I learned during the course applicable directly to the work you need to do at the CRS, or does it require radical adaptation to make it useful in a real world situation?

A sample journal entry

17th August, 2014

The third day of my internship: Though I've only been here three days, I've seen so much happening and talked to so many people that it feels like I've been here forever!

Today afternoon, when I sat down to figure out the connection diagrams for the Radio Janhit studio, I finally realized the difference between seeing a neat diagram drawn in a textbook, and seeing a mess of cables running all over each other. Seeing those printed diagrams, somehow, always gave me the impression that all the cables in an audio studio would be neatly arranged, in parallel lines, with clear marking showing what was connected to what. At first glance, when I saw the cables running out and into the mixer – an Edirol M16DX – it kind of looked like that: Cables emerging from a hole in the desk, and plugging into the various connector sockets. It was only when I looked under the table that I realized there was no way I could tell what was going where at all: all the cables were the same blue shielded cable, of the same brand! I had to hold each one physically in my hand and trace it to its next connection point. And all this while I was crouched under the edit table, and people were moving around!

For a moment, I asked myself: is this really what I want to do in life? It was hot and sweaty work under the table. But then, I realized how challenging it was to actually do this – work out the entire system, keep marking the notes in my notebook. And how much I actually enjoyed this. I came out from under the table after 40 back-breaking minutes, but with all the cables pencilled into my notebook. I must have drunk a bottle of water straight, I was so thirsty! But it felt like I deserved the lunch break today.

Later, I thought back on how much more convenient it would have been if the station had had a wiring diagram drawn up when the studio was being installed. No one here really knows what cables are connected where, except those for the systems that are used most frequently. It was only when I drew up my diagram (see Appendix 3 at the end of the journal), that I realized that in an emergency, if the mixer or DAW broke down, all that had to be done to switch the system to a pre-recorded playback from the CD player was to change one connection on the patch panel. No one knew that, and it made me feel very proud to have explained it to everyone. Usually, what happens is that the station's broadcast gets delayed if the DAW is giving trouble, since the programmes are played off that computer. Sometimes the broadcast gets cancelled altogether. I could see that some of the CRS staff was impressed at this insight. I think they may stop seeing me as a nuisance to be tolerated now!

I think I should also do a similar exercise for the electrical wiring tomorrow. That seems even more incomprehensible to everyone!

C.2 The Self-Assessment Paper

C.2.1 What is the purpose of the Self-Assessment paper?

The self-assessment paper, in many ways, is a way to take stock of your entire internship experience, and crystallize the learning into a concrete individual assessment of how you did. It is like taking a step back from all that you did during the internship and asking: how did the experience connect to my course? How was it useful? How did I grow, or my understanding expand or change? How did I do?

In this sense, this is an exercise that you should make notes for throughout, but something you should write immediately after you complete your internship. It is probably a good idea to give yourself a full day to write this up immediately after you complete your five day stint at the CRS, and ask whether you can meet your guide/supervisor the day after that to certify your journal and paper.

C.2.2 How to write up the Self-Assessment paper

The self-assessment paper should not be more than two typewritten pages long, or more than five handwritten pages. Be concise, clear and to the point. Your name and enrolment number must be written prominently at the top of the paper.

Proofread it and make corrections. Keep it short. Language is important, since it may prevent what you're saying from even being understood.

Many of the questions that you have responded to while writing your journal entries will help you here as well. In addition, you may like to consider:

1. Your expectations of the internship, and whether they were met or not – and why
2. Your experience of executing the tasks and activities, what you learnt from them, and an evaluation of your performance on those tasks and activities
3. Specific problems that you encountered, and your assessment of how you responded to those problems
4. Any attitudes or biases that you had to face as a newcomer, and a fresher to the process
5. How your previous academic learning from the course prepared you for the internship (or didn't prepare you, as the case may be)
6. Whether your attitude, perspective or abilities changed - and how
7. Do you see a future for yourself as a CR technician, and why/why not
8. Specific strengths and weaknesses that you discovered during the internship in your personality or in your knowledge.
9. Any unresolved questions you have at the end of the internship
10. Any things that you would have done differently

The self-assessment paper can be a bit of a challenge, since most of us are not used to the kind of self-introspection and self-analysis that it calls for. However, it is an extremely important skill to learn, and will serve you well once you commence your professional careers as CR technicians: it will help you create a regimen for continued learning, and allow you to constantly update your skills.

In case you still find it confusing, here's a sample self-assessment paper outline. Base your paper on this, and feel free to make changes as you see fit. Each person's circumstances and self-assessment will be unique, and so will their papers. There are no right and wrong answers.

Sample self-assessment paper outline

1. Description of internship

a. Where and with whom; when
b. Overall experience
c. Key challenges & learning

2. Relationship of internship to previous academic learning

a. Was your academic learning from the course directly useful, or did it only provide a frame of reference, with on-ground realities largely different?
b. Give two examples to support your point of view

3. Assessment of internship from the point of view of:

a. Did the internship offer you an opportunity to practice what you had learnt in this course?
b. Do you feel the experience of the internship has changed you in any way, or impacted your understanding of the field of CR related technology? How?
c. Do you feel you were able to contribute usefully to the process in the CRS where you interned in any way?
d. Do you feel there were any specific obstacles or challenges that prevented you from achieving what you would have expected to?
e. If you could change anything about your internship, what would you change?
f. How would you rate your confidence in terms of being prepared as a CR technician after having tested out some of your skills during this internship?

4. Future plans

a. Which aspect of a career as a CR technician do you find most intriguing and interesting? Has this changed after this internship?

Section D

Assessment of Internship

This section is designed primarily to inform the guide/supervisor assigned to the intern at the CRS. It is meant to provide inputs on the assessment questionnaire that they are required to fill up to comment on the skill levels of the intern, and their understanding of the subject of CR related technologies.

Interns may find it useful to go through this format as well as the assessment questionnaire provided at the end of this manual, as it will inform them about how they are likely to be assessed.

D.1 Assessment Notes for the Guide/Supervisor

In previous sections of this manual, you will see a list of responsibilities for the intern, the guide/supervisor, and the CRS team to which the intern has been attached. This assessment section assumes that these responsibilities have been successfully implemented by the respective parties, and that the intern attached to your CRS has been able to execute the tasks assigned in Section B of this manual. It also assumes that as a guide/supervisor, you have been able to monitor the intern's work, and have been able to draw some conclusions based on the assignment outputs shared with you by the intern; and that you have been able to advise him/her on the writing of their journal and self-assessment papers.

Your assessment of the intern will be based on the questionnaire given in Section D.2 of this handbook. The questionnaire is meant to be detached and returned to the institution from where the intern is completing the CCRT course. (Details of the address to which the questionnaire must be despatched are given at the top of the form.)

The form must be completed only at the conclusion of the internship, either on the last day, or on the day set up to review the student/intern's journal and self-assessment report.

Please remember:

1. The point of the assessment is to help the student/intern identify the areas he or she could do better in, or increase the depth of their understanding in. It is not an absolute score or ranking in terms of a specific measure of knowledge. The focus is on the ability to convert knowledge into practice.

2. Very few of the interns will have extensive technology or engineering backgrounds before the CCRT course. Most will be community members working with – or aspiring to work with – local CR stations in their areas. Their understanding of the technology will be better than average after having undergone this course, but this is unlikely to have made them experts by the time they undergo their internships.
3. Accordingly, assess their skills with objectivity; and temper your expectations with an understanding that the intern is not yet a technological expert. This is not to say you must relax your expectations or accept shoddy or thoughtless work – only that your assessment must be flexible enough to accept that the intern is a student, and on a learning curve that will only conclude after a few years' professional experience.
4. Encourage creativity, and reward practical solutions from the intern. Also encourage independence of thought, and the ability to discuss and debate a point – or suggest alternative mechanisms to processes or systems that exist in the CRS currently.
5. Some of these categories of assessment will require your interaction with the intern to assess their thought processes and ability to comprehend. Use the interaction time you have with them to probe their flexibility of comprehension and ability to understand alternate viewpoints and priorities.
6. Please ensure that student details are entered correctly in the form: name, date of internship and enrolment number.
7. Each question in the questionnaire asks you to rank the ability or understanding of the student on a scale of 1 to 5, with 5 being 'excellent' and 1 'poor'. Place a clear tick mark in the appropriate box with a black or blue ball point pen. Please answer all the questions.
8. Any corrections or over-writing will need to be initialled by you, to specify that the corrections have been made by you.
9. The form needs to be signed by you and stamped with an organizational stamp – either that of the CRS, if it has an independent stamp, or of the parent institution which holds the CR license.
10. The form is an important part of the evaluation process, and constitutes the third and final product of the internship, along with the student's journal and self-assessment paper. Please retain a photocopy of the completed form, once stamped and signed by you, in your records, in case the original is misplaced or lost in transit.

D.2 Assessment Questionnaire

Please complete the form attached. Once completed, it may be detached from the handbook by tearing along the perforations. Please note the despatch instructions given in the previous section, and ensure that it is signed and stamped and that all student related information is given clearly.

Questionnaire

CCRT Internship Assessment Questionnaire

(To be completed only on completion of student internship)

Name of student/intern:

____

Institution of study:

____

Enrolment Number: ____________________ ***Enrolment date:*** __________________

Period of internship: From _____________________ To _____________________

Internship with: _______________________________________

Please rank the intern on the following parameters:

Section A: Professional conduct of intern

Sl. No.	**Skill/Ability/Assessment Point**	**Score/Ranking**			
		Excellent	Good	Fair	Poor
1.	Respect for CRS rules and regulations				
2.	Timeliness				
3.	Respect for others' time and work				
4.	General discipline				
5.	Presenting himself/herself, neatness & tidiness in work situation				

Section B: Technical knowledge of intern

Sl. No.	Skill/Ability/Assessment Point	Score/Ranking			
		Excellent	Good	Fair	Poor
1.	Understanding of technical setup for CR and identify various CR components				
2.	Understanding of technical concepts around audio, audio recording, digital and analogue audio				
3.	Understanding of studio acoustics and sound proofing				
4.	Understanding of production and post-production processes				
5.	Care in handling equipment				
6.	Ability to work on CRS equipment under supervision				
7.	Ability to work on CRS equipment without supervision				
8.	Ability to independently identify software and hardware components installed and list them				
9.	Ability to independently work out wiring diagrams, studio plans and electrical circuit diagrams				
10.	Ability to suggest variations or changes to existing setups and processes				
11.	Ability to independently diagnose possible causes of technical faults				
12.	Ability to examine documentation to identify equipment parameters and specifications				

13.	Understanding of transmission systems and transmission principles				
14.	Understanding of live and recorded audio				
15.	Understanding of audio chain, backup and archiving				
16.	Understanding of telephony for CR (including software and hardware options)				
17.	Understanding of play out management and scheduling				
18.	Ability to listen to audio and suggest improvements to audio quality				

Section C: Learning skills and intellectual flexibility

Sl. No.	Skill/Ability/Assessment Point	Score/Ranking			
		Excellent	Good	Fair	Poor
1.	Ability to understand unfamiliar processes when explained				
2.	Ability to absorb new information and comprehend it				
3.	Ability to adapt theoretical knowledge to practical situations				
4.	Willingness to take up additional tasks beyond those specified in internship				
5.	Ability to prioritize tasks and rank them in order of urgency				
6.	Ability to understand other perspectives, points of view and prioritisation factors (especially with a view to the technological aspects of CR)				

7.	Ability to present a reasoned argument for his/her point of view				
8.	Ability to weigh pros and cons of a technological decision				
9.	Ability to independently execute internship tasks without active external management and advice				
	OVERALL RANKING				

Name of guide/supervisor: ____

Name of CRS/Institution: ____

Designation: ____

Date of review/assessment: ____

Place:

(Signature & Seal)

Section E

Appendices

The appendices provide important advice to the intern, especially with a view to handling the unfamiliar circumstances and demands of a technical internship. Read through these carefully and absorb them – they could help you make the best of your time as a technical intern under the CCRT programme!

Appendix - I

Some Tips on Making the Most of Your Internship

Here are a few simple tips that can help make your internship an enjoyable and tension free experience where you can gain a tremendous amount of experience. For ease of comprehension, they have been categorized under some sub-heads, so that you can think cogently about them.

I. Managing Expectations

1. What are you expecting from the internship and the supervisor? Are you being realistic? Will you be disappointed if those expectations aren't met?
2. What do you think your supervisor and the others in the CRS team will expect from you?
3. Understand your responsibilities and what you will need to accomplish thoroughly. Discuss this in detail with your supervisor the day before the internship starts so that there are no misunderstandings.
4. Know to whom you will report and be responsible; who can ask you for assistance, support and inputs; and who cannot.

II. Daily Conduct & Discipline

1. Be careful with your appearance: dress appropriately and soberly.
2. Be friendly: make an extra effort to be accessible, and help out.
3. Keep your personal information and life to yourself.
4. Be positive and supportive: make others look good if you can.
5. Keep an open mind, and don't jump to conclusions. Make informed judgements.
6. Stay calm. No matter what.
7. Be systematic. Be thorough. Be accurate.
8. Communicate. Listen to other people and what they're saying. Don't blabber.
9. If you need help, ask. Don't hesitate. If you haven't understood something, ask for a clarification.
10. Be assertive. Present your points concisely and cogently.

III. Time Management

1. Plan and prioritize your day in advance. You are on a tight schedule. There is no excuse for not finishing a task you have been assigned on time. This is radio, where time and deadlines are exact.
2. Honour your working hours. Do not be tardy. Don't waste time. Use this for the learning opportunity it is.
3. Keep the toughest tasks for the time when you know you do your best work, or first thing in the morning, when you are freshest.
4. Be disciplined about time. Keep a time schedule handy to manage your time.

IV. Networking & Learning

1. Develop a systematic plan to cultivate contacts at the place you intern. You may one day work with these people because they were impressed with your work.
2. During breaks (lunch, tea) use the time to get to know others at the CRS – ask them about their work, their challenges, their responsibilities, their likes and dislikes.
3. Understand the technical challenges that the station has faced, and the solutions that were evolved or stumbled upon. Figure out what the weakest link in the technology has been.
4. Get familiar with the technical setup. Understand the equipment and its functioning. If you get a chance to assist or actively participate in

production or post production, jump at the chance. Ask whether you can work on the equipment when it is free, under supervision. Work extra hard to make all this happen along with your assignment work.

5. Ask questions. Identify the people willing to spend time to explain things to you and ask them for details about everything you want to know about.

It is up to you to make the best use of the internship period and not be a tourist who drifts in and out of the CRS!

Appendix - II

The Six Stages of Internship

Typically, every internship goes through six stages, from the moment you arrive the first day to the time you leave. In your case, the time is a bit short – but it is likely these six stages will get compressed into that time anyway. The trick is to get to the useful part of the internship as fast as you can, while spending less time on getting oriented and adjusted. Check these out!

1. Stage One: Arrival and reporting

You will probably arrive at the station a day early to check in before your internship, or meet your guide/supervisor. This can be a nervous time. Learn to relax and concentrate on the work at hand. You may feel 'Can I really do this?' anxiety.

2. Stage Two: Orientation and introductions

The first few hours of your first day on the internship will probably be spent getting the hang of the CRS, and meeting the people who work there or volunteer there. Prioritize and note down useful information. If you've met your supervisor in advance, you should be able to settle down more easily. Don't feel frazzled by all the new information. Understand the hierarchies in the station, who is more senior and who more junior; who commands and who is commanded.

3. Stage Three: Reconciling with reality

You may have some idealistic ideas regarding what you expect to achieve during the internship, or what you will work on, or the kind of support you will receive. You may realize that the reality of the internship may not resemble your expectations at all. You may also find that you have to generate your own enthusiasm, because no one may actively take an interest in what you're doing.

Don't be disappointed, and don't become negative about the whole experience. This is probably true of many professional situations, and the sooner you realize that it takes a fair time to carve a position for oneself and be taken seriously, the better it is for you. Use your time intelligently to learn, experience and grow.

4. Stage Four: Productivity and independence

This is really where you want to be for most of the internship period. The sooner you buckle down to the business of getting your activities completed, and to spending whatever spare time you can create on practice and learning useful things, the better for you. Try and get to this by the second day, and don't waste your time looking for support that may not live up to your expectations. Set your agenda, work hard, and be receptive to comments from the others in the station.

5. Stage Five: Closure

If you've worked hard and used your time well, this may well come before you expect it – and the time may have passed quicker than you know. Widen up your activities, check your schedules and review your own agenda for things that you needed to accomplish, and submissions that you need to make. Sort out anything that still needs to be completed. Discuss any final products with your guide/ supervisor. Say your goodbyes crisply, and be sure to exchange contact details, so that you can stay in touch. Be bright, cheerful and positive till you leave. Ask honestly for inputs on how you can improve your knowledge and your capacities.

6. Stage Six: Reflection

If you've maintained your notes well, and have been diligent about your activities, even this short internship will have given you plenty of food for thought. After a couple of days' break, review what the experience has taught you, and make notes regarding the areas you feel you will need more study and preparation in. Revise the notes in your journal and in your self assessment document, and plan for how you want to move forward from there. Congratulate yourself on having successfully completed the internship, and treat it as a learning experience for the day you actually start working full time at a CR station!

CEMCA

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