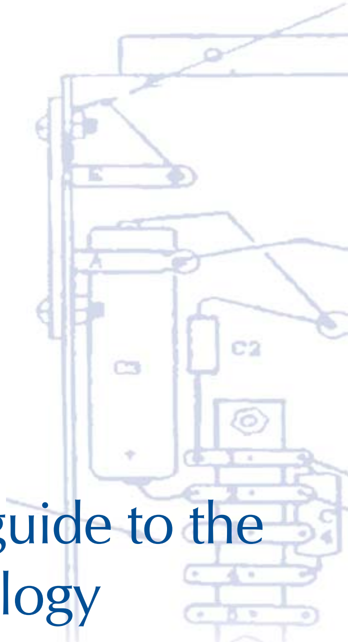

CR: A user's guide to the technology

A guide to the technology and technical parameters of community radio in India

N. Ramakrishnan

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ABOUT THE AUTHOR

N.Ramakrishnan is a development communications professional, trainer and author with more than a decade of experience in the development sector. He is also a cinematographer, editor, director, and technology enthusiast; and conducts workshops on community radio, developmental filmmaking and low cost radio and video technology.

With extensive experience in developing community-derived and community-oriented behaviour change materials, Ramakrishnan has worked on a number of behaviour change communication tools, including the National Award winning film *Nirankush,* on female infanticide in the Indian state of Rajasthan; and the acclaimed *Growing Up/Badhte Hum/Time of Our Lives* video module series on reproductive and sexual health for young people.

Ramakrishnan works with Ideosync Media Combine, a communication for development organization based in the NCR of Delhi, India,. He is currently engaged on several community radio and radio for development initiatives, including a cross border radio programme series on safe migration and HIV for Nepali, Garhwali and Kumaoni migrants.

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This manual has also been through an extensive process of review on the **Solution Exchange** and **CR India** e-discussion lists. **Mr.Arvind Kumar**, Director (Broadcasting Policy & Legislation), Ministry of Information & Broadcasting, Govt. of India, participated in this discussion by placing the use of this manual in the current context. The members of both lists have been more than generous with their time, and in sharing their vast experience and understanding of community radio technology and audio equipment for the betterment of this manual. Their combined knowledge is a wonderfully rich resource which I have made extensive use of in this volume.

In particular – and without in any way reducing the value of the contributions by the other members of both lists – I would like to extend my gratitude and thanks to the following community members who volunteered their time and energy :

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Last – but not least – my thanks and appreciation to my colleagues at **Ideosync Media Combine**, who helped organize a vast number of resources into something that I could use to write this manual; and to the members of **Hevalvaani** and **Mandaakini Ki Awaaz** CR groups in Uttarakhand, who provided valuable feedback on the kind of information that would make this manual usable and accessible to its users.

NRK

New Delhi
November 2007

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FOREWORD

The Government of India earlier this year announced its intention to establish 4000 community radio stations by 2008.

This has brought a flood of questions from prospective Community Radio applicants/operators and in particular: what equipment do you need to set up a community radio, and how much would it cost? While there are many solutions that are available off the shelf, our main line of advice has been “Costs depend on the context of the Community Radio Station you are trying to build”.

We also strive to bear in mind the Objectives of UNESCO’s programme stressing promotion of community access and engagement, and the Action Plan of the World Summit on the Information Society, (Tunis, 2005) which emphasises values of inclusive and pluralist knowledge societies. It is more to such inclusiveness and the level of participation of a community, together with relevant programming rather than the technology, that we owe the success of a community radio station.

Our further piece of advice therefore, is to “Begin small and grow inch-by-inch with your community”.

This manual is designed to accompany you in the demystification of each piece of equipment usually found in community radio stations; its role and function within a wider social context; advantages and disadvantages of its usage. For others who dare to be technically more adventurous detailed notes on equipment are also provided.

As hands-on participatory community development specialists it is in your interest to be aware of the different options open to you in sourcing, maintenance and operation of the equipment that is most suited to your individual needs. This manual is intended as a tool for such information and we hope you will find it useful in applying this knowledge to your own local environments.

It is through localisation not only of content, but also of technology that we may assist in accelerating the community radio movement in India and making the intentions of the Government a live reality.

Jocelyne Josiah
Advisor in Communication and Information for Asia
UNESCO New Delhi

What they said...

This is a miraculous power. I see Shakti, the miraculous power of God in it [radio].
Mahatma Gandhi

Radio is the theatre of the mind. Steve Allen

You can make good radio, interesting radio, great radio even, without an urgent question, a burning issue at stake.

Ira Glass

Radio could be the most wonderful public communication system imaginable, a gigantic system of channels – could be, that is, if it were capable not only of transmitting but of receiving, of making listeners hear but also speak, not of isolating them but of connecting them.

Bertolt Brecht (1930) - quoted in Lewis and Booth (1989)

Television is radio without the imagination.

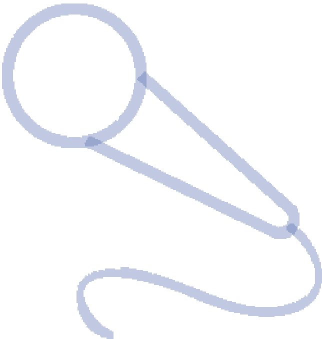
Anonymous

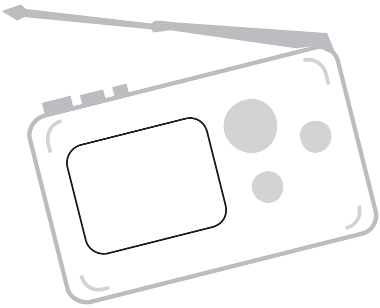
TV gives everyone an image, but radio gives birth to a million images in a million brains.

Peggy Noonan

It's a pleasure, a gift, an honor, to go in front of a microphone and communicate.

Larry King





You don't work for the radio station. You work for the people out there.

Wolfman Jack

Introduction

WHO IS THIS MANUAL FOR, AND HOW SHOULD IT BE USED?

Congratulations! If you're reading this, you have taken the first steps on a long and satisfying journey that should (we hope) culminate in the setting up and successful operation of a community radio station: A radio station by, for and from the people. With the Government. of India allowing community radio stations (CRS) in India in late 2006, a new chapter has begun for those who have been working towards creating media and technology access for communities – and to empower ourselves with an understanding of how to use these technologies to highlight our concerns, our ideas, and our cultural and traditional practices.

But in the excitement of gaining access to this truly participatory, inclusive and inexpensive mass medium, we often forget that radio is a **technological** medium – and that it calls for communities and civil society organizations working with radio to have an understanding of the technology, the equipment, and the processes and parameters that govern the setup, operation and successful running of a community radio station. It is all too easy to forget about the technology while we exult in the joy of hearing our own voices and our ideas over a speaker or radio set; but it is important to realize that the technology of radio is what allows us to preserve these thoughts and send them out to our listeners.

That could be your cue to say, Uh-oh, I'm not a technical person; this looks like it's going to lead to a lot of tech stuff - I'm not going to get all of this! How do I begin to understand all the jargon and the science?

Relax. That would be true – *if* this was a manual that intended to explain the construction of electronic circuits or the repair of complex recording and transmission equipment. But it's *not* that kind of manual: This is a manual for the everyman, the interested community member, the hobbyist, the NGO worker and all those of us who run for help when our TV remotes and cellular phones misbehave. In short, this is going to be an *easy* introduction to the technology of radio.

Reading this manual may not bring you to a level of understanding where you can take all the decisions and select all the equipment by yourself – especially since radio equipment changes and evolves all the time – but if you read this book cover to cover, it's probably going to give you a feel of the wide variety of technology options, decisions and concepts that you'll have to keep in mind while setting up a CRS. And it's going to help you take informed decisions on all those things.

So, in a nutshell, what this manual hopes to present is -

1. A user level understanding of how to set up and equip a CRS, and a taste of the kind of decisions you'll have to take while planning your CR set up;
2. An understanding of the types of equipment that a CRS requires, their functions and the costs involved;
3. An understanding of how the various components of a radio production and the broadcast process work together;
4. An understanding of CR related regulations, technical parameters and the licensing procedures applicable in India;
5. Enough insight into all the 'tech stuff' to inspire you to learn more about the electronics and physics part!

What it's *not* going to do is make you an **expert** on every aspect of radio and CRS setup – that's beyond the scope of any single book or document, and requires years of practical experience and learning. It's going to place some options in front of you and it's going to give you further resources you can access to learn more: Web based and print material, as well as organizations and individuals who can advise and assist you while you learn and build your CR setup.

It is also important to stress that community radio stations work out of single rooms with basic equipment; as well as dedicated buildings housing multiple studios and packed with all kinds of high technology. Both can produce brilliant, locally relevant, interesting programmes. It's up to you to decide what kind of a setup is most appropriate for your station, a decision you must base on five things:

1. The kind of programmes that you plan to broadcast;
2. The amount of money at your disposal;
3. The kind of spaces that are available for you to set up a CR station in the area you will be operating in (rented or self owned; constructed to your requirements or an existing space reconfigured);
4. Your ability to handle the costs and effort required to maintain your equipment, and support the costs involved in acquiring consumables and recurring costs like the spectrum fee; and finally
5. Your ability to access trained people to operate and maintain your equipment (and/or training resources to build a pool of trained manpower to fulfil these functions.)

Depending on a combination of these factors, you may mix and match and adapt the ideas that you will find in this manual to arrive at a unique solution which will meet your requirements.

In the same spirit of selection and adaptation, we have also tried to make this manual as adaptable to your needs as possible: To start with, we've included several **notes pages** at the end of this manual so that you can add your own notes and comments based on your own research and experimentation. We've also included a variety of **diagrams and illustrations/photographs** to give you an idea of the equipment, devices and setups referred to in the text.

We've also tried to include helpful **notes** and **comments** where possible, identified by the following icons:

Warning! Things you must remember to avoid damage to equipment or injury

Remember! Things you should keep in mind from the information immediately preceding the icon.

Maintenance related information that you should remember to keep your equipment in good working order.

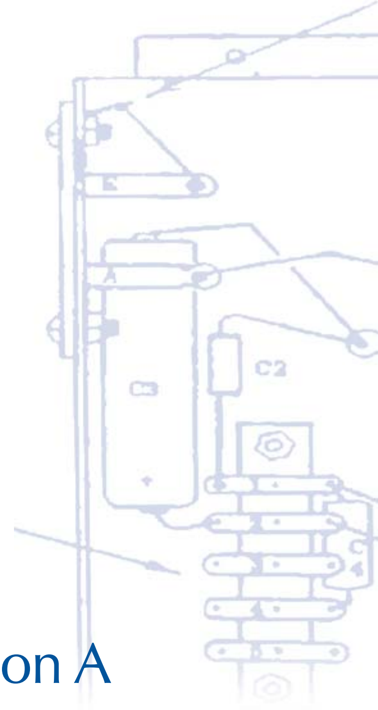
Cross references to other parts of the manual. This symbol may also refer you to the **Detailed notes on equipment** section (Section B) that follows the main manual. This includes detailed explanations of several concepts and types of equipment, to allow you to understand equipment specifications better.

The appendices at the end of this manual give you lists of equipment vendors, lists of advisers and organizations already working on CR and suggested equipment setups on which you can base your own assessment of the equipment combinations you require. All these lists will need revision as time goes by: New equipment and equipment suppliers turn up all the time, so it is probably a good idea to jot down information on any new vendor or piece of equipment that you come across. All the costs are in Indian Rupees, and have been converted from US Dollar rates at 1 USD = INR 40, the rate current at the time of publication of this manual. (But the exchange rates and prices change all the time too, so do check on this before you take any final decisions!)

Last, but not least, remember that this manual is *not* an encyclopaedia – and it's not trying to be one. This is a ready resource for the interested user, which you can also use as training material. It is impossible to give a detailed understanding of everything that is included in this manual in a single volume. But if this manual leaves you feeling a little more confident about your understanding of the technology of community radio, we'll consider its job done.

We welcome your **comments** on the manual, so that we can constantly update and revise this document. Please write in to the addresses given on the first flyleaf of the book.

Once again, welcome to the world of community radio! We hope this manual plays a part in improving your understanding of the medium and the technology involved in running a community radio station.



Section A

Community Radio : An Overview

Chapter 1

So What Is Radio And How Does It Work?

To many of us, the first time we listen to the radio can be a magical experience. The prospect of using a device that seems to be an illimitable source of so many different kinds of music and programmes is a stunning concept, and many of us struggle to come to terms with it.

One of the trainees at a workshop I conducted, who came from a small village in a remote part of the country, told me that the first time he saw and heard a radio, he spent a lot of time debating whether he should open it up and release all the people inside it. He didn't - but as he will attest to, the experience is one to which we grow quickly accustomed - even addicted.

Few of us stop to ponder about the process by which the sound we are hearing is captured, joined, corrected and sent out to the little box in front of us. How does a programme get made and go on air, anyway? To understand this, it's important to have an overview of the entire process of radio broadcasting. We'll start by looking at the broad picture, and as we go further along in this manual, we'll have a look at each of the processes and equipment involved in greater detail.

Radio broadcasting: The processes - and some terms

The process of making and broadcasting radio programmes combines **teamwork, creativity, punctuality** and **technology.** It often involves a number of people working in tandem and with reference to each other; and it's an intricate process where every part of the chain has to work correctly for the programme to be of **good quality** and for it to reach the listener **on time.**

From a holistic point of view, radio broadcasting includes five discrete processes:

1. **Research and pre-production** (ideation on the programme, and preparing for the production)

2. **Production** (Recording or gathering the sounds that will be included in the programme)

3. **Post-production** (Editing, or selecting the best portions of the recorded sound, and assembling them together in a logical and coherent fashion; and finalizing the programme)

4. **Transmission/Broadcast** (Sending the programme out over the airwaves, so that your listeners can listen to it on their radio sets)
5. **Feedback** (Getting your listeners' opinions and inputs on the programme that was broadcast, so that future programmes can be improved.)

Let's have a closer look at what exactly each of these steps involves:

1. **Research and pre-production :** As with most things in life, the process of radio broadcasting begins with an idea - and research. The idea can be based on your **observations** (say, problems with the water supply in your area) or a **recent event** (say, someone in your area winning a dance contest); or on the basis of a **need felt by the listener group** or 'audience' that you are addressing (say, you receive a request to make a magazine programme on local events). The research (often called **formative research**, because it helps 'form' the programme) involves the process of reading any background material that is available on the idea, along with meeting people within the community who know more about the issues that need to be included in the programme. Once you have gathered all this information, you start identifying the **specific people** who you would like to interview or record for the programme, as well as the other **sounds** that you will include in the

Members of a community radio group discuss programme ideas with members of their community

programme to give listeners a feel of the places and people who are presented in the programme. The last step in this process, of course, is deciding the **logistics** of the production - that is, the setting up of appointments, deciding when to record your interviews and sounds, and deciding on and arranging for the equipment that will be required.

As we shall see, this is the least technological of the four steps, as it primarily requires only your notes, paper, pen - well, a computer if you have access to one - a telephone (or other means to contact people)...and time. At the end of the pre-production process, one should ideally have:

- A complete **outline script** for the programme (if it's a fictional programme, like a radio drama, then this will include the final dialogues for all the characters; if it's a documentary or magazine programme, this will include a reasonably detailed outline of what you expect the interviews to be like, along with references to the sounds you will be recording);

- A **run down sheet**, which is a production schedule, and gives a day by day and hour by hour definition of when, where and what you will be recording;
- A **time frame** within which you expect to complete the recording and the final programme. (This last may often not be completely in your hands, especially if you are broadcasting on a regular basis - in which case, the day and time each programme needs to go on air, every week, is really how your schedules are decided.)

2. **Production :** This is the process of actually **recording** the voices and sounds that you will need to make the programme - and this is where the technical part of the broadcasting process really begins. We use a variety of devices and material to record or store the sound we are gathering, so that we can arrange it in the way we like later on.

For more on recorders and microphones, see **Chapter 4: Field Recording Equipment** on Page 63

The recording process follows the schedule and script that were developed during the first step. During this process, we ensure that the sounds we are gathering are recorded at **good quality** - that is, following the technical parameters that we need to store the sound in a way that mimics the original sounds as closely as possible - and in a way which allows us to use and discard portions of it. We also keep checking to ensure that our recordings are **relevant** to the script for the programme.

A programme recording in process

At the end of the production process, typically, one should have:

- A completed set of **audio recordings** and **source materials** (including archival material, if required, and sound effects);

- A **field log sheet**, which gives details on the audio recorded on each cassette tape/disk used at the field recording stage. A good field log sheet will give you a preliminary idea of the recordings you have managed to obtain.
- **Notes on how to rewrite the script**, based on your outline script and on your assessment of which recordings are good enough to be included in the final programme.

3. **Post-production :** Post production starts with the process of listening to the recordings we made during the production phase, and selecting the portions that we would like to keep in the final programme. (The usual - though not entirely recommended - practice is to record as much material as possible within the time and resources that are at our disposal, so that we have the luxury of selecting the best sections.) This process, called **logging**, should result in a list of the relevant sections that you will refer to while editing, which is the term for the process of selecting and ordering our sections of sounds. **Editing** is the main part of the post production process, because this is where the raw material that we have gathered is shaped into the logical and orderly form suggested by the script we have written.

For more on editing equipment, see **Chapter 3/Section II: The Production Studio** on Page 57

When the editing is complete, the music (if any) selected and the arrangement finalized, we 'mix' the sound. **Mixing** involves the adjustment of the loudness of the various sounds we have incorporated, so that the programme is clearly audible, comfortable to hear, and feels seamless. The last step of the post production process is the **mastering** of the programme, where we store the final edited and mixed version of the programme in a way that allows us to **broadcast** or transmit it.

A Volunteer at a CR station edits a programme

4. **Broadcast/Transmission :** The final step of the radio broadcast process involves using the transmission equipment to put the programme 'on air'. Essentially, this means combining the sound of the final mastered programme with a radio signal and **broadcasting** it (sending it) through an antenna that

allows the combined signal to reach across space to your listeners' radio sets, where they can hear it.

For more on transmission equipment, see **Chapter 5: Transmission Equipment** on Page 69

The process of transmission is nearly **instantaneous**, which means the listeners can hear the programme almost exactly at the same time as it plays out over the transmitter. It also involves a precise technological process of **controlling** and **refining** the radio signal that is broadcast, so that listeners can listen to it at a specific setting on their radios, which is how one identifies a radio station. (90.4 MHz, say, or 102.8 MHz).

5. **Feedback :** Our work doesn't stop once the programme goes out over the airwaves, of course - we also need to understand what our listeners think about the programme and whether they understood it or not. When you are standing face to face with someone, it is relatively easy to judge whether the other person understands what you are saying (and what he or she thinks about your programme) from their expressions, their responses and their body language. But when the listener is unseen, as happens when using electronic media like radio or television, we have to evolve processes that let us obtain regular feedback. This usually involves mechanisms like a **postal** or **email address** that listeners can write to; or a **phone number** or **website** where listeners can leave their comments. It also means you have to look regularly into these comments and inputs, and revise your programmes accordingly. The radio station can also increase listener inputs and interactivity by creating **phone in** shows where callers can call a 'live' number and be heard as part of the broadcast.

For more on phone in equipment, see **Chapter 3/Section I: The Broadcast Studio** on Page 46

Listeners' letters programmes, where selected letters received are read out over the air, and **request programmes,** which offer listeners the opportunity to request music or specific types of programming, are also an important way to incorporate feedback.

A CR group volunteer records a listener's feedback

Radio waves: A brief look at some important concepts

Before we move on, it's important that we understand some basic concepts about radio - and **radio waves** in particular - so that some of the terms we will be using as we move further make sense. (Some of you may remember this from your physics classes in school!)

We've all seen ripples form in a pool of water when we toss in a pebble: The ripples start at the point where the stone hits the water, and spread out in concentric circles from that point outwards. Simply put, the energy the flying pebble possessed at the moment it hit the water surface has been converted into the up and down movement of the water particles, which have now formed **WAVES.** So a **'wave'** is an up-and-down or side-to-side movement of the particles in a medium, which we usually illustrate like this:

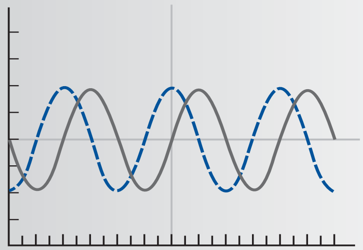


Fig 1-1. Simple sine wave

Radio waves are also similar to the ripples we see, except that they are not mechanical (in the sense of the water actually rising and falling): They are **electromagnetic**, which means they are actually rises and falls in the strength of a electrical-magnetic field around the point where the wave originates. (**Visible light** is also an electromagnetic wave - we don't really see anything oscillating or rising and falling, but we can perceive the light from an electric bulb perfectly well. In exactly the same way, when radio waves are emitted, we don't see any physical movement of any medium, but we can build electronic devices that can measure these waves and interpret them for us.)

Radio waves are emitted naturally by radiant sources like the sun and by radioactive minerals like uranium as they decay. But we can also build artificial sources of radio waves - **exciters** or **transmitters** - that we can control and use for our purposes.

Contd...

There are three properties of a radio wave that we will be most concerned with in our work with radio:

1. Amplitude : This is the difference between the highest and the lowest portion 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 the radio wave will travel.

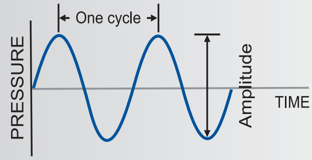


Fig 1-2. Amplitude

2. Frequency & wavelength : Frequency refers to the number of waves that pass through a given point in space every second, like this:

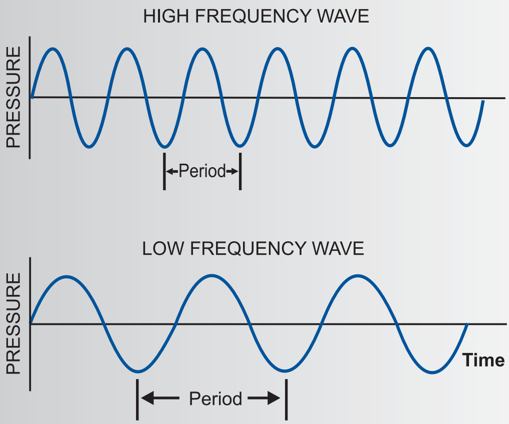


Fig 1-3. Frequency

Frequency is measured in **Hertz (Hz)**; and where radio is concerned, more often in **KHz** or **MHz**, which are measures equivalent to 1000 Hz and 1,000,000 Hz respectively. (Now you know what FM 104.7 means - the 104.7 refers to the frequency of the station, 104.7 MHz, which is where we need to tune our radio sets to receive the station's signal.)

Contd...

Wavelength refers to the distance between two successive waves, as shown here:

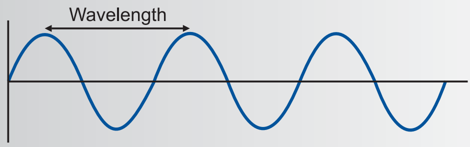


Fig 1-4. Wavelength

If you'll think about it a bit, frequency and wavelength have an **inverse relationship**, which means the greater the frequency of a wave, the shorter the wavelength; and vice versa.

Linking the technology to the production

Back to figuring out where the technology part overlaps the stages of making a radio programme, then. Let's understand where the technology plays a part within each of these five processes we just saw:

1. **Research & Pre-production:** As we have seen, this is not a particularly technology intensive phase. An understanding of computers - especially the ability to **write documents**, and do **research** on the internet - could be the primary 'technological' requirement in this phase, as is one's ability to use a **telephone** to make arrangements, talk to people and set up the production phase.

For more on office computer equipment, see **Chapter 6: Telecommunication & Other Ancillary Equipment** on Page 86

2. **Production:** The very first part of the radio broadcasting system is the conversion of the sound we want to preserve into electrical energy, so that it can be stored (**recorded**). This is achieved with a microphone, a device that converts - or **transduces** - sound energy into electrical energy.

For more on microphones, see **Section B: Microphones** on Page 198

Once the sound is converted into electrical energy, we can not only store it and recreate the original sound from it a later time, we can make changes to it in a variety of ways: The **audio signal**, as it is now called, can be amplified, or made louder; it can be **filtered** to remove unnecessary portions of it - and most importantly for us, it can be **edited** and joined to other audio signal sections.

For more on recorders, see **Section B: Field Recorders** on Page 184

CR volunteers learn to edit audio on a computerized editing system.

The microphone is usually connected to a device that stores the audio signal in a retrievable form. These devices, known as **recorders,** range from small portable units to very large and highly accurate models.

The electrical signal may be stored through a second process of transduction, in the form of **analog** or **digital data** on a magnetic medium (tapes, hard disks), digital data on electronic solid state memories (compact flash and secure digital cards), digital data on an optical medium (CDs, DVDs, Blu-Ray or HD-DVD disks), or even as a combination of both (minidisks or MDs).

3. **Post production:** The post production phase is still more technology intensive: Not only do we now have the audio signals recorded during the production phase (in one or more of several media), we may want to record more sounds to add to what we have already recorded: That means we have more work for our microphones and recorders. We may also use a variety of already recorded sounds from other **source equipment - CD players, DVD players, cassette decks -** that will also provide us more audio signals.

For more on CD players, see **Section B: Compact Disc Players** on Page 141
For more on cassette decks, see **Section B: Cassette Tapes & Cassette Recorders** on Page 134

Once all this is gathered together, and our selection of audio signals made, we will edit the programme on an **editing console** or a **computer** using suitable software that lets us pick, order and mix the audio signals.

For more on editing consoles, see **Chapter 3/Section II: The Production Studio** on Page 57

If we are using modern digital equipment to edit, the process may involve converting the audio signals once more from the format they were recorded in into **digital data,** which can then be manipulated on a computer.

For more on digital audio, see **Section B: Analog & Digital Audio** on Page 124

The final mix or master can then be removed from the editing console or the computer in whatever **format** we choose, and on our choice of **media** for broadcast. We may also use a variety of **signal processors** - mixers, filters, equalizers, limiters - at any point in this process to make corrections to the quality of the audio.

For more on mixers, see **Chapter 3/Section I: The Broadcast Studio** on Page 44 and **Chapter 3/Section II: The Production Studio** on Page 54

For more on compressor/limiters consoles, see **Section B: Compressor/Limiters** on Page 149

A recorder connected to a portable digital editing console for the transfer of recorded material. The transferred audio will then be edited during post production.

4. **Transmission/Broadcast:** Perhaps the most purely technological step of the entire broadcast process, transmission involves the combination of the final **audio signal** of our programme along with a **radio wave** of highly specific and identifiable characteristics; and the **transmission** or broadcast of the combined radio signal. The three primary items of equipment required to do this are a **playback source** to play back the final audio signal/programme (say, a cassette deck or a CD player), a **transmitter** to combine the audio signal with an internally generated radio wave; and an **antenna** that lets us radiate the combined radio signal into the air.

For more on transmission equipment, see **Chapter 5: Transmission Equipment** on Page 69

At the listener's end, this step requires the use of a **radio receiver set** - more often shortened simply to 'radio' - to catch or receive the signal we have sent out. The radio receiver allows the listener to **tune the set** to receive the specific wave that we have broadcast, and extract the audio signal from it.

The extracted audio signal, once again in the form of electrical energy, is then subjected to a transduction process in a **loudspeaker** or a **headphone** - devices that change the electrical energy back into sound, so that we can listen to it.

Listeners in the community listen to a radio programme

5. **Feedback:** Strictly speaking, simple feedback processes don't need any technology at all - the simplest feedback process is to ask listeners to write **letters** to the station! The technology part becomes important if we ask listeners to **email** or **phone** in their comments (in which case we need an internet connection and a computer); a telephone line or mobile connection (possibly with a **recording system** attached so that we can receive and store comments that are phoned in); and if we're ambitious, an adapter that lets us connect callers directly to the studio for a 'live' phone in programme where they can be heard or recorded as part of the programme.

So that, then, is a summary of the way the technology, the creativity and the teamwork that go into producing a radio programme go together.

Ready for more? Plunge on!

CR volunteers from Radio Tambuli in the Phillipines learn about radio recording equipment. Learning about radio and transmission requires a sense of application and interest, rather than a technical education or a background in engineering.

Chapter 2

Technology - I
Designing The Station & Studio Spaces

In an ideal world, members of every community would be able to build their own CR stations to suit their own unique and specific requirements. But it's not an ideal world, and CR stations often have to adapt to whatever spaces are available to it – usually a rented or community donated pre-built space that may not entirely meet the station's needs.

This makes understanding the station's design and infrastructure doubly important, because it means we have to be clear about each of the adaptations we may have to make – why we need to do it, and how best to do it in order to make it meet our requirements. Let's start by looking at some basic issues we need to address while setting up a community rardio station.

Section A: Siting the CR station

There are four primary criteria for selecting a site for your CR station:

1. **Local geography and terrain;**
2. **The physical distribution of the community** your station will be broadcasting to;
3. **The strength of the radio signal** you will be transmitting;
4. **Local noise levels**

Of these four considerations, the primary consideration is **easy accessibility** by the members of your community: The very essence of a CR station is that members of the community should be able to **participate** in the process of making programmes. So it won't do to have the station in a place where only a few of your listeners will be able to access it. Many CR stations work out of spaces close to the **village panchayat** or **community center**. Others are set up near **local crossroads** or **market places**. Think about all the members of your community when you decide a site for the station. Ideally it should be a place which all sections of the community can access: Young and old, men and women, able bodied and physically challenged.

Having said that, we also have to ensure that there isn't too much noise around the CR station itself. Your recording areas and working areas may need to be comparatively **noise free** to ensure good audio quality. A noisy marketplace, for instance, may force you to adopt much more extensive measures to isolate yourself from the noise than usual.

In most cases, the antenna/mast and the station are located in close proximity to each other for a variety of technical considerations. Since FM radio transmission is line of sight, the transmission can only reach areas that can electronically 'see' the transmitting antenna. This means we must choose a site that does not have too many natural or man made obstacles in the path of the radio signal - that is, it would be preferable to not choose a site where a hill, mountain or high-rise building could prevent some of our potential listeners from hearing the station's broadcast.

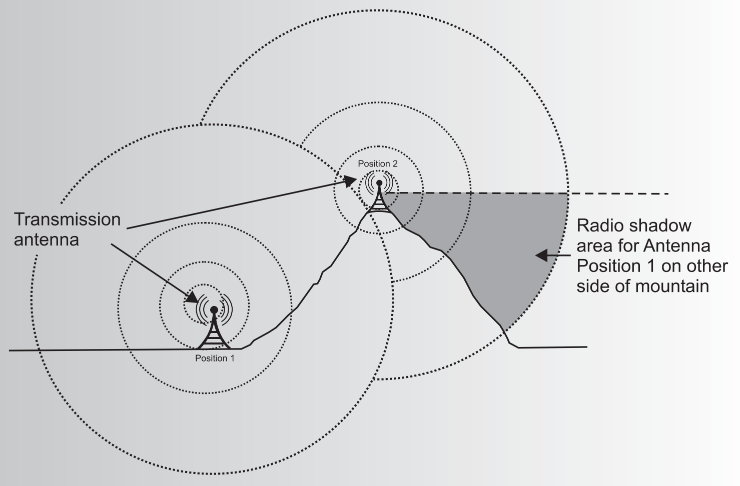


Fig 2-1. Radio shadow area caused by obstructions near antenna

The line of sight principle, however, can present some direct benefits as well: CR stations generally have transmitters of limited output, as they are meant to service smaller areas - but selecting a good site for the station can **maximize your transmission range**. Just as standing on a tall hill can give you a commanding view of the surrounding area, placing your antenna at a high vantage point can increase your effective range, and let you broadcast to a larger audience.

Remember that these are just a few points you need to consider while selecting the site for your CRS: There's always a **trade off** between all these criteria, and a site that may be excellent from the point of view of one of these criteria may fail miserably on another. You will have to weigh your options and select a site which combines as many of these qualities as possible. Also keep in mind that the spaces and sites a community is able to create or develop for a CRS are often more a matter of **convenience** and ready **availability** than any of these considerations - though it would be nice if the community as a whole can be sensitized to these issues so that its members can weigh possible options before taking a decision.

Section B: Defining the spaces

There are three types of spaces that a community radio station generally needs:

1. **A broadcast studio:** This is the primary studio space for the station, the place where the programme audio is broadcast from and the programme presenter (or compere) sits. This space is often used as the 'live' studio, from where audio is played out to the transmitter, and where one or two person interviews can be conducted by an interviewer.

For more on equipment for a broadcast studio, see **Chapter 3/Section I: The Broadcast Studio** on Page 39

2. **A production studio:** This is the space where recordings can be done, and programmes edited and refined for later broadcast. The production studio is usually equipped with a sound booth or recording floor, where sound can be recorded in carefully controlled conditions.

For more on equipment for a production studio, see **Chapter 3/Section II: The Production Studio** on Page 49

3. **Office space:** Somewhere where we can meet visitors who visit the station, and where the people working at the CR station can work together on production related or administrative tasks.

For more on office and telecommunication equipment see **Chapter 6: Telecommunication & Other Ancillary Equipment** on Page 77

A small CR setup may actually have a single space that fulfills all these functions, and that's perfectly all right. The most common approach for middle level CR stations is to have a single space setup that combines the functions and necessities of both studio spaces - including a small recording floor - with a separate office cum meeting space.

If you have more funds and access to more space, you might like to define clearly demarcated spaces for all three; and there's really no limit to how large and well equipped each of these spaces can be.

Thus a simple setup for a **single room CR station** could be like like the one shown in Fig 2-2 (below).

The single room acts as both broadcast and production studio, or **multi-purpose studio,** and is also used to store the studio materials and equipment. Realistically, this space should be at least 12 feet long and 12 feet wide: Any smaller, and it would really be cramped!

A **two** or **three room CR station setup** (Fig 2-3) on the other hand, gives us a little more flexibility to arrange our spaces. It could still have a single studio space that combines the production and broadcast units, but could include a separate space in which to meet people and run the administrative functions of the station.

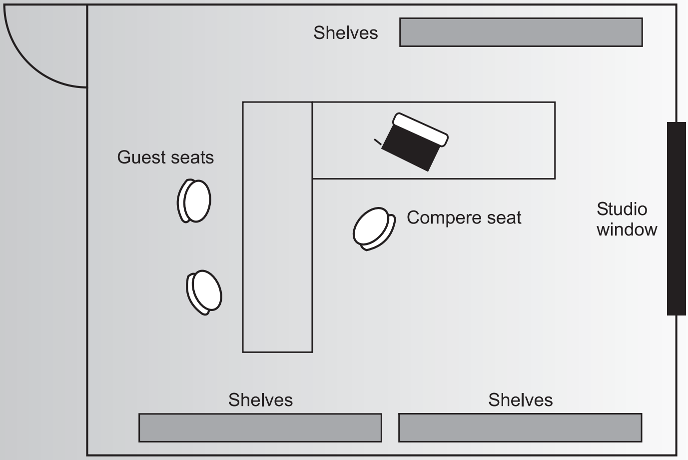


Fig 2-2. Simple single room CR setup

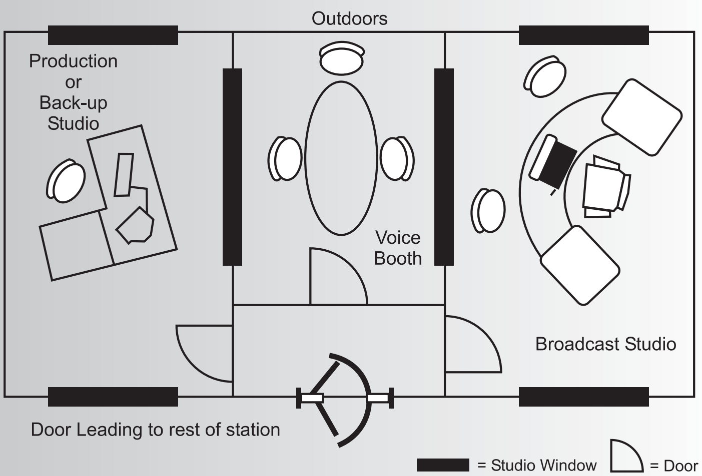


Fig 2-3. Simple three room CR setup

A still more complex CR station setup could resemble something like this:

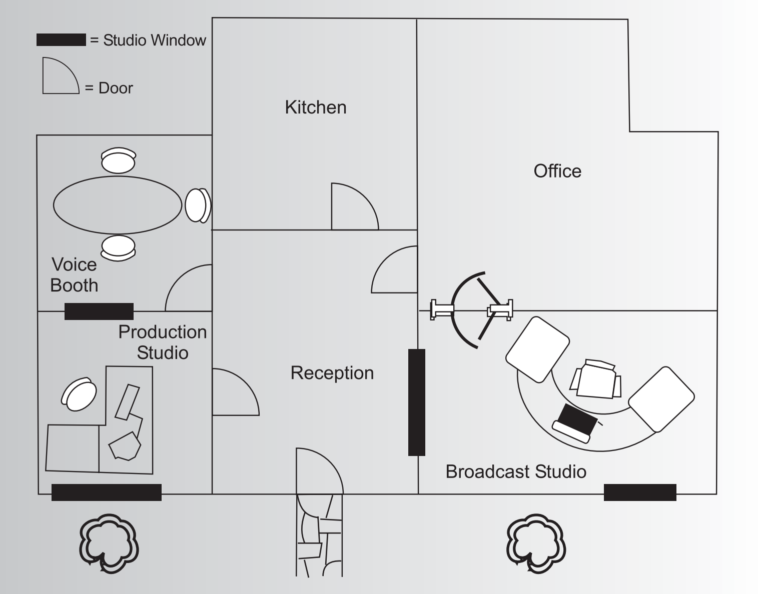


Fig 2-4. Larger CR setup A

In this kind of setup, the main office and reception lead to the studio spaces, but can be kept quite separate in operation. More importantly, it means the production studio can carry on with its work of preparing features and 'canned' (pre-recorded) programmes for broadcast while programme hosts continue playing out programmes and doing the live programmes from the broadcast studio.

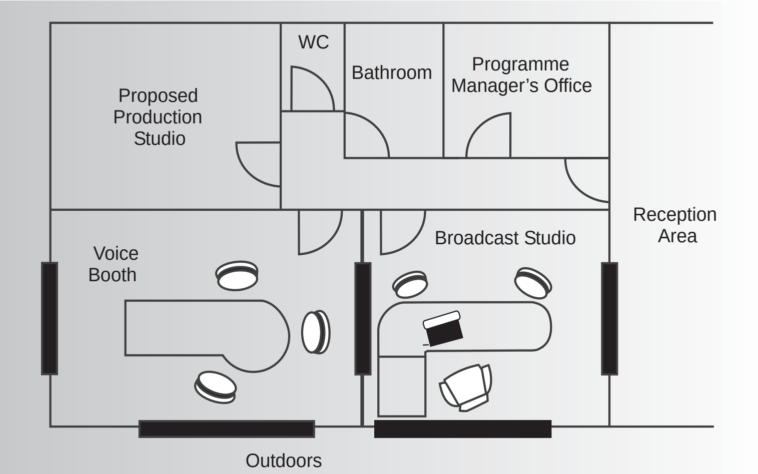


Fig 2-5. Larger CR setup B

Note that the diagrams given here are suggestions based on existing CR setups - they are not meant for you to copy literally while setting up your own CR station! Use these as a reference to conceptualize your own setups, which will probably have to work with a different layout. It's often a good idea to start with whatever spaces are available and expand slowly rather than try and set up a sprawling multi-room set up right away. The idea, after all, is to get programming on the air first, rather than see the station as an end in itself! As your community's programming needs increase and your volunteer base and staff increase, you can expand and equip your station spaces bit by bit. This will not only allow you keep your initial costs low, it will also allow you to think about each section of the station as you set it up.

Section C: Important considerations while setting up the spaces

Besides deciding the broad separation of your station and studio spaces, there are some important additional considerations to keep in mind. Thinking about these in advance helps to make operation and utilization of the station facilities and studios easier, even while it helps us keep everything orderly and easy to maintain.

1. Dust free atmosphere

The primary concern with all studio spaces is keeping them **dust free** and **clean**. Dust and grime are the worst enemies of sensitive broadcast and production equipment - and a major portion of the defects and breakdowns that happen in studios could be avoided with simple dust proofing and preventive maintenance.

For more information on maintenance see **Chapter 7: Planning for Maintenance & Management** on Page 91

The doors leading to the studio spaces should **fit wel**l, and should be kept closed (if not locked) whenever possible. You may have to equip some or all of the doors with **rubber gasket**s in order to make them dust proof. Since the studio spaces are likely to be entered and used frequently by members of the community, it's probably also a good idea to **build a work ethic** and a system where everyone can be inspired to treat the station spaces as their own, and keep them neat and clean in much the way they would their own homes. (Strategically placed **signs** all around the office and within the studio may play a useful role here - inspire people to help keep dust out!)

Dust free also means leaving all street shoes outside - a **shoe rack** for this purpose is probably a good idea - with people in the studios either in socks or barefoot. Some stations like to keep separate sets of **slippers** that are used exclusively within the studio space.

Spaces that are used for CR studios are often not designed for a radio station type setup, so they often have inconvenient doorways and windows. If you are faced with **multiple entrances** and **exits**, it is wise to plan your space in a way that allows you to use one of the doors as the **primary access point**. Similarly, windows can be bricked up or otherwise built over to close the space or - and this is usually much nicer - sealed with **double pane glass**, so that dust stays out even while the light can still come in. Double glazing also plays a dual role for **acoustic treatment** (see below).

> Try to keep the space utilization logical and easily cleanable: Don't design nooks and crannies that are hard to reach, because that is a recipe for dirt and disaster.

2. Air conditioning

Air conditioning is by no means mandatory or even necessary for a CRS: If your CRS is built around low cost cassette recorder based equipment, or hardy solid state memory devices, it may be totally unnecessary to air-condition the studios. Simple precautions like having an **insulated terrace**, or housing your CRS in old-fashioned **double walled** or **thick-walled high-ceilinged buildings** may be an equally effective solution to keeping equipment cool and protected. If your station is situated in the hills, or by in a coastal area, the weather conditions may be temperate enough to dispense with air conditioning.

However, depending on the local weather conditions and the kind of equipment that you have invested in, air-conditioning on some scale may have to be considered. If we seal all the windows in order to keep the studio(s) dust free, then air circulation and ventilation inside the studio spaces can be a problem. So let's just say that if the outside temperature and dust conditions warrant it, and if you can afford it, it may be wise to invest in air conditioning units for the studio spaces, both in the interests of keeping the spaces **cool** and so that there is some **filtration** of the air inside. (More complex setups could include an air filtration unit, but that would be a luxury for most CR stations.)

Where they are required, the best ACs for studio use are **split air conditioners,** where the blower unit is in the studio, but the condenser and the fan unit, which make most of the noise, are safely outside the studio. A professional and expensive setup would probably dispense with individual AC units altogether, and set up a **central ducted AC system**, with a cooling tower on the terrace or in the grounds outside the station - but that is a prospect that should only be considered if you have a lot of funds at your disposal, and a very large space with a number of rooms and studios.

Having said that, air conditioning, while attractive in the hot and dusty conditions that are common across much of South Asia, has its own downside - and it can be a serious downside:

1. **ACs require a regular mains power supply -** if your station is in a power poor area, or has regular power cuts or 'brown-outs', it could render an investment in ACs pointless.
2. **ACs consume a lot of power and are expensive to run.** If your wiring is not up to the mark, and you cannot afford a big power bill, ACs are a bad idea. The wiring will have to be of good enough grade to take the load an AC places on it, often 1500 - 2000 watts or more.
3. **ACs need maintenance too -** It's not enough to simply install an AC and use it whenever you want. You have to plan for a regular maintenance schedule for the unit, and keep it in good running order, which adds to your maintenance related expenses and responsibilities.

Making an estimate of your 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 **square feet area 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.

3. Acoustic treatment

When we record sound, it's always a good idea to record the sound as **cleanly** as possible - that is, we try to record the sound as faithfully as possible, with **no unnecessary background noise** and as little **echo** or **reverberation** as possible. By reverberation - or reverb, as it's more commonly known - we mean the hollow sound that you hear when you speak or make a noise in an empty room: The sound bounces off the walls all around you, and reaches your ears a fraction after the original sound reaches you, giving it the 'hollowness' or echoing quality. (Anybody who has ever whistled or hummed a few snatches of a song in a bathroom knows this as the 'bathroom effect': The hard tiled surfaces in a bathroom emphasize the effect quite a bit.) As human beings, we are able to discount the reflected sound in our brains, but machines cannot do this - and the sound a microphone 'hears' in a room with a lot of reverb can quite ruin the recording.

We increase the clarity of the sound in our studios by **acoustically treating** the space: Simply put, this means we prevent outside sounds from getting into the space (**sound proofing**), and we find ways to keep the reverberation of our studio space down.

There's always a debate about the acoustic treatment part of studio set up: How much of a priority should it be for a community radio setup? There is no easy answer to this question, except to say that it depends on your **choice of spaces** and the **availability of funds**. Personally, I would say the cost or size of your setup should not be an excuse for poor audio quality or production values, so you should try and make the best use of **local expertise**, your **research** and your **creativity**. A CR setup can afford to make more compromises and can afford to deal with less stringent recording needs than a commercial station; but a sense of application can achieve a lot, as we will see.

a. **Sound proofing:** The first step to acoustic treatment is the isolation of the studio from outside noises. And the first step to achieving that is to set up your station and studio space in a **quiet locality** as far away from busy thoroughfares as possible, while remaining within the community. (This is usually easier in a rural area than in a town or an urban area, but if you look hard enough, you should be able to find a space that is less exposed to outside sounds.)

The other way to soundproof your studio is to have **multiple surfaces** with air trapped between them.. For example, it's usually a good idea to have a set of **double doors** at the studio entrance, if that is feasible. (At the very least, a thick, well fitting door with rubber gaskets around the door edges should be possible, with some help from a good carpenter.) The air trapped between the two doors in a double door system (a '**sound lock**') keeps outside sounds from traveling through. Studio doors should preferably be fitted with a small glass panel - like a porthole - at eye level, so that one can peer in before actually entering, in case a recording or broadcast is taking place.

It helps greatly to have **thick outside walls** - 9 inch thick load bearing walls are great - and if the studio isn't part of a wall-to-wall construction setup where the next building or house physically shares the same wall, that's great as well. Studio windows that open to the outside should ideally be **sealed** and **double glazed**. This means we have to install two window panes of glass that are at least 5 mm thick, with about 5 - 8 cm of air in between, like this:

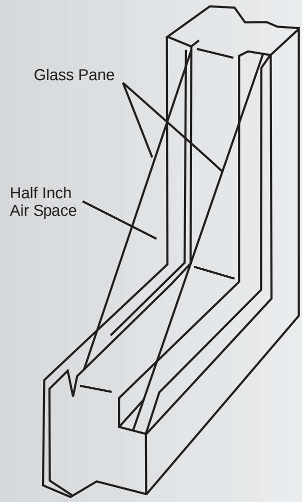


Fig 2-6. Double glass window cross section

Note that the two glass panes are **angled slightly** with reference to each other - this is so that any sound that enters the outer pane doesn't end up being reflected repeatedly between the two panes, causing them to rattle or buzz. It's also a good idea to ensure that the channels the glass panes rest in and the frames holding them in place are padded with **thermocol** or a thin strip of **rubber**.

Properly used and worked on, outside windows on the studio spaces are not an issue at all - in fact, once you've cut off the intrusion of external noise, it may excite attention about your work from passers-by who can watch your studio in action, especially if your studio windows face a street. Internal windows opening into other rooms in the station are equally interesting if designed well, as it lets other people in the station remain involved in what's happening in the studios and lets visitors peek in as well.

Remember that sounds slips through the smallest gaps - so pay attention to small crevices and ventilator spaces. All of those are potential sources of unwanted outside sound!

b. **Cutting down the reverberation:** Now that we've cut out the outside sound, it's time to explore how to cut down the reverberation in our studio space. Reverberation treatment is especially vital for the spaces within the station where the microphones will actually be used - the **recording booth** or stage, for example.

A **professional grade studio,** if you have the funds for it, would use **fibreboard**, **coirboard** or **gypsum panels**, along with **glasswool**. Some studios use a variety of **angled wooden surfaces** attached to the walls to control and manage the sound reflections. Floors and ceilings in a professional studio may also be built of absorbent materials like **cork**, mounted on a **shock absorbing frame** supported on a dampening cushion of springs or rubber runners. This kind of acoustic treatment needs to be installed by an expert, and is usually quite expensive, being charged on a square foot basis.

However, a little understanding of how sound waves are reflected by surfaces, along with a sense of invention can achieve a lot: A number of community radio stations use simple low cost techniques to reduce the reverb in the studio.

To start with, it helps to have rooms that don't have continuous walls that exactly parallel each other, because parallel walls create the most echoes. If one of the walls has a **staggered construction**, with sections that are slightly ahead or behind the other, this can cut down the reverb quite a bit. A simple way to reduce the reflection is to attach something to the walls that reduces the reflection of sound from them. The easiest and simplest way of doing this is to acquire a large number of **egg trays**, the papier mache trays that eggs are supplied in. If you have enough of these, you can physically paste them over the entire wall, edge to edge, with any strong glue. The indented surfaces and the soft material of the trays absorb and dampen the reflections to a very great extent. (Make sure you treat the trays with a strong **pesticide** to keep out cockroaches and other bugs).

Radio Muye, Suriname (Caribbean) – note the creative use of rattan panels in the studio for acoustic treatment

Alternative low cost techniques are to paste **foam sheet** - 1.5" or 2" thick foam sheet is best - across the entire wall surface, and cover it with cloth; or to hang **thick double panel drapes** - velvet or any other fabric with a thick pile work best - from floor to ceiling, with plenty of folds and ruffles in the fabric to create a varied surface. Remember to put a **carpet or dhurrie** on the floor, as thick as you can arrange; and to cover the ceiling with acoustic material as well - floors and ceilings reflect sound too!

It is worth exploring other low cost construction materials that are used commonly in your area to see whether we can use them for acoustic treatment: Many low cost studios successfully use materials like panels of dried hay and porous clay attached to the walls; or even rattan and bamboo screens made out of woven strips of cane or bamboo!

A studio in Radio Toco, Trinidad & Tobago (Caribbean). This one uses cloth and padding for the walls.

c. **The recording floor/stage - control room partition:** When we have a single room setup, which combines the functions of both studios, there is usually no separate recording space at all: Interviews, recordings and broadcasts all happen within the same space. If at all there is a separate recording space in this kind of a setup, it is usually if the form of a small **booth**. This booth may be as small as a closet or cubicle. It generally has a small door on one side and may accommodate one or two people.

On the other hand, when we have the luxury of a separate production studio or a larger dual purpose studio, the studio space can be sub-divided more clearly into a **recording floor** and a **control room**, as shown in the three room studio diagram shown in Fig 2-5. In this case, by **recording floor**, we mean the acoustically treated area where the microphones are actually placed, and where guests or performers actually speak, sing or play their instruments. Ideally this space should accommodate at least 3 - 4 people at a time, and should be paid greater attention from an acoustic treatment point of view.

The **control room**, then, is the space where the producer or sound recordist sits with his equipment and from where he/she guides the recording process.

In such setups, the **partition** between the recording floor and the control room is of great importance, as it also needs to be factored in when planning the acoustic treatment of the recording floor. The partition itself could be of

solid brick and **mortar**, if you want to make it permanent. Alternatively, it could be constructed of a **wood frame** and **plywood**, with **thermocol** or **glasswool** in the gap between the two sides, for better sound insulation. The door to the recording floor can then be built into the partition with good quality plywood, and equipped with rubber gaskets to provide a good seal.

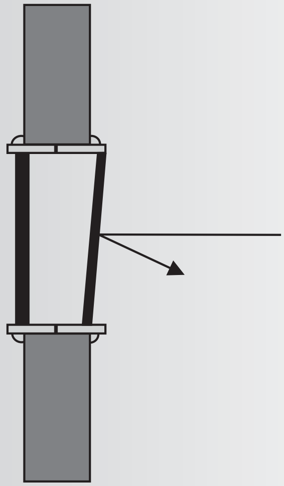


Fig 2-7. Double paned and one tilted glass pane partition

The greatest attention, though, has to be given to the **window** in the partition between the two spaces: It is vitally important for the sound recordist or producer to signal the people inside the studio during the recording process, and this window is used for that purpose. It is often quite large, covering a substantial portion of the partition, to allow one to see the entire recording floor and - like the external windows in the studio (if any) - needs to be **double glazed**, with **non parallel panes** and **rubber** or **silicone mounted glass panels**, to avoid sounds from the control room entering the recording space. It's a good idea to get a few packets of **silica gel**, a substance that absorbs moisture, and place it between the two glass panels when you fit them in place: This will absorb any moisture that would otherwise condense on the inside of the glass if the weather grows colder.

4. Furniture

Once our spaces are broadly defined, it's time to think about the kind of furniture that we'll need to utilize and operate in these spaces conveniently and comfortably. And the key words to remember here are **reconfigurable** and **hard-wearing.**

It may also help to have an accurate idea of the equipment you are going to install - especially the **dimensions** of mixers or monitors - before acquiring any furniture or asking a carpenter to make them.

It is best to think in terms of furniture that could be **mixed and matched** in a variety of ways so that we can adapt our setup to different needs. At the same time, we need furniture that doesn't get damaged or scratched easily with use, as we would like to keep our studios and offices looking good for visitors even if they are constantly utilized all through the year.

The office space is comparatively easy to kit out, with a couple of **desk spaces** (desks with drawers are to be preferred), some comfortable **working chairs**, a **filing cabinet** (optional, a shelf or a cupboard will be fine) and **wall space** where we can hang some pin boards and whiteboards if we need them.

The studios need more attention, especially the broadcast studio and the control room. Traditionally, professional studios use a **curved half moon shaped** (or broad vee-shaped) desk with the compere or recordist sitting in the inner curve. This kind of a desk allows the compere/recordist to access different pieces of equipment on all sides with a minimum of movement, an important consideration when he or she may be talking into a microphone even while he/she is operating the mixer, CD player or studio computer. But depending on the space you have and the kind of equipment you are using, there is absolutely no reason why any desk shape that fits cannot be used. Just remember that:

(a) The desk should give you some **working space** along with any equipment on it, so that you don't keep knocking expensive equipment off it every time you move;

(b) Your studio chairs should be **sturdy**, should not **squeak**, and should be **comfortable** enough to be occupied for extended periods of time;

(c) For control room desks, the desk and chair should be oriented in a way that lets the producer/recordist **look comfortably into the recording floor** space through the window without having to move or get up.

(d) The furniture should give you **access to the back panels** of the equipment easily to be able to connect and disconnect cables, and so that you can perform maintenance related tasks.

A readymade studio desk with space for mixer, equipment and interviewer.

Recording floors are generally equipped with a small **'talk' table**, where the interviewer sits with the interviewee(s). This is removable, of course, should we decide to use the space for radio drama, when moving room will be required.

It's also a good idea to equip the studios with plenty of **shelf space**, open and with doors, to place pieces of equipment, cables, manuals, and related stuff. Expensive equipment may need to be stored in a more secure **metal cabinet**, or at least a shelf that can be locked. Equipment, especially if you have higher end pre-amplifiers and patch boards, may require the making or purchase of standardized **equipment racks** that allow you to fit the equipment rack style one above the other. These racks are generally made to standard heights in multiples of 44 mm (44mm, 88 mm and so on) and 483 mm/19" widths. The pieces of equipment designed to fit in them subscribe to the same standard - like this:

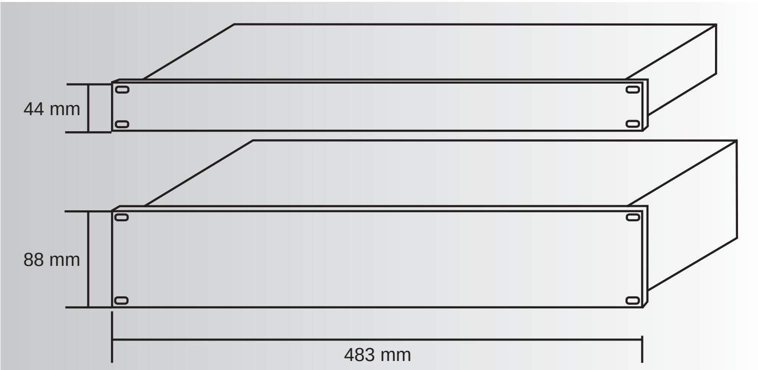


Fig 2-9. Standard rack mount

Remember that furniture should not be a limitation: Almost any furniture you can access can be used imaginatively to furnish your station. A good carpenter can also help you design furniture that fits the dimensions of your spaces precisely (something that may not always be possible with readymade furniture).

5. Electricals

Needless to say, setting up a community radio station means having adequate access to electricity. It also means having to deal with a whole lot of **cables** and **connecting wires** - microphones to mixers, recorders to mixers, broadcast studio to transmitter, and so on - running between equipment and from room to room. So it's wise to give this some thought in advance.

While it would be an asset to have someone who has an advanced knowledge of electrical systems and wiring as part of the team, it's not very difficult to grasp the basic electrical setup that we will be required to deal with in a community radio station. Given that we are dealing with expensive and sensitive electronic equipment in a CRS, the value of a **stable** and **risk free** electrical supply cannot be overemphasized.

To start with, it's a good idea to see that there are **adequate electrical points** and outlets in each room, especially the rooms in which much of the equipment is run. Points should generally be of the **3 pin line-neutral-ground type**, and electrical switches and points should preferably be from a reputed manufacturer and be certified by a standards organization like **BIS**. This ensures that the dimensions of the sockets conform to international standards and that **loose plugs** and **switch contacts** (which could cause sparking) do not result. Beware of counterfeit goods, which are plentifully available - so don't just go blindly by the brand.

Wiring is the second concern: always check that high grade wiring - **BIS marked** is highly preferable, as is **fire retardant wiring** - exists throughout the station. (You may consider getting the wiring done anew if it is of poor grade or undependable). Check that the distribution of power supply across the station is even, especially where multiple rooms are concerned, and that specific wire sets do not take the brunt of the load. 22/7 grade wiring is acceptable for most uses, with 22/4 grade wiring preferred for heavy load points. It is good practice to equip heavy load electrical points with the larger 3 pin sockets (also called **Power points** or **15A sockets**), which accept the corresponding larger three pin plugs. Lesser load points can utilize the smaller **3 pin (5A) sockets** and plugs. You can decide where you need to connect what equipment on the basis of the **power consumption** of each piece of equipment.

While on this subject, you may also like to ascertain whether the supply you have is **three phase** or **single phase**, with the former much to be preferred. Three phase connections are more usually available in urban or semi-urban settings, but offer the advantage of being able to **distribute the loads** you place on the supply across the three phases. (Besides, power tends to be available in one of the phases even in the event of a power cut, which means we can always make arrangements to reroute our supply from the active phase, if this is required.) Single phase, while being perfectly usable, does not permit us these advantages.

The incoming supply should ideally be routed through an **isolator**, which allows us to disconnect the entire wiring system from the main supply at any moment) or a **large load MCB** (miniature circuit breaker, a spring loaded switch system that trips or shuts off the supply if the load exceeds a certain value or if there is a short circuit of any kind). An **ELCB** (or Earth Leakage Circuit Breaker) is also a wise choice, as it is a device that automatically cuts off the power if there is a short circuit, or if there is an accidental contact - like

A typical three phase electrical isolator unit.
The unit allows the connection of three phase wires and the neutral wire.

someone coming in contact with a naked wire, for instance. Each point (or set of points and switches, as the case may be) should then be connected to individual **MCBs** of an appropriate rating, to enable us to cut off supply to individual problem areas for maintenance. The entire combination of ELCBs, isolators and MCBs should be mounted in a safely sheltered but accessible **circuit box** somewhere near the entrance of the station: Circuit boxes are available in several readymade sizes in any large electrical market and contain a **metal rail system** on which individual components can be mounted.

Also check the **approved load** available from the a/c (alternating current) mains supply: The original paperwork for the electricity connection should contain this information. If not, you can examine the record at the local electricity office. This should usually be given in **KW** (**Kilo Watts**, multiples of a 1000 Watts). Compare this with an estimate of the total consumption of the equipment you will be installing. Try and ensure that your 'load' never crosses 2/3rds of the total approved load. (For example, if you have an approved load of 5 KW, try to see that the sum total of all appliances, even the ones that aren't on all the time, doesn't exceed 3.5 KW. You can exceed this self-imposed limit, of course, up to the total rating, but it's a good idea to have some headroom and not strain your wiring too much).

If you feel your load may exceed this or approach your approved load, see if it might make sense to increase the approved load officially and get a greater electrical supply. You will need to apply to the local branch of the

Calculating appropriate ratings for your main power board

To select the correct rating for an individual MCB, first ascertain the **consumption** of the equipment or fixtures that you will be connecting to it: Most equipment manuals will tell you the consumption in **Watts**, and items like bulbs and fans are usually marked with **Wattage** figures. Use the formula:

$$W/V = A$$

where **W** is the consumption in **Watts**, **V** is the **voltage** of the system in **Volts** (usually 220 Volts in India) and **A** is the **current** drawn in **Amperes**, to calculate the corresponding current draw through the MCB. MCBs are marked with the maximum current draw in amperes that they will accept before tripping, with 6A, 10A, 15 A, 20A and 32 A being quite common. Select an MCB that exceeds the Amperage of the fixtures and equipment you intend to connect to that specific MCB: Keep an eye on the future, and select one that can accommodate a couple of extra pieces of equipment if need be. ACs and heavy draw equipment will need higher capacity MCBs, while all the lights and a couple of fans in a room may need a single 6A MCB.

Sum up the Amperage of all the equipment and fixtures on all the individual MCBs to arrive at the appropriate rating for the master isolator, MCB and/or ELCB (40 A and 63 A are the most common types, and should be fine for most setups). MCB and ELCB installation may require some electrical expertise, so consider this before starting any installations.

electricity department for this. Please note that rentals for electrical supply are based on KW slabs and that - depending on your location - there may be:

(a) a limit on the **maximum approved capacity** that you can obtain;

(b) a distinction between **residential** and **commercial** connections, with sharply higher rentals for the latter; which may make a difference to your operational budget;

(c) a lengthy **application** and **approval process** for the upgradation.

Finally, where electricals are concerned, we have to plan for **backup supply**: Transmission and production work cannot be interrupted if your primary energy supply fails for some reason. It is therefore wise to invest in a battery based backup system like an **inverter**, which will at least support the key equipment that cannot be shut down - especially the transmitter. Inverters are also available in various capacities and ratings - the 650 VA, 1250 VA and 1500 VA are the most common. **VA** is analogous to **Wattage**, a term we are already familiar with.

Inverters can be acquired in **single battery** or **multiple battery** configurations for extra storage. They are charged from the mains electrical supply, so an important consideration, again, is whether there is enough continuous main electricity supply to keep the batteries charged against power cuts. It is also wise to remember that the storage capacity is linked to the cost of the unit, and that the battery units - usually 25 or 27 plate automotive or tubular batteries - need to be replaced roughly every two years. (Most of these batteries are of the **lead-acid type** and need a topping up with distilled water and/or acid at regular intervals. **Maintenance free** batteries, which need no topping up, are also available, but are more expensive.)

The more expensive - but more independent - backup is an **electrical generator set**, with a motor which runs on kerosene, diesel or petrol. Available in a variety of ratings from 650 VA to several KVA - the larger ones are run on diesel - they allow you to operate in areas with no power supply at all, or during extended power cuts, but require a **continuous fuel supply** and regular maintenance. The **noise** they make - even the sound insulated ones make some noise - and the **exhaust gases** can also be a concern.

For more on generators see **Section B: Generators** on Page 229

It's also a good idea to economize by using more **energy efficient lighting** fixtures (**compact fluorescent lamps** or **CFLs**). instead of standard tube-lights and tungsten incandescent bulbs, for instance), **natural ventilation systems** (better insulated walls for heat and cold protection instead of coolers, fans and heaters) and **alternative energy supply systems**.

A typical CFL bulb. CFLs consume very small quantities of electricity to provide as much or more light than equivalent incandescent (tungsten) bulbs.

Alternative energy systems like **solar power** (which converts sunshine into electrical energy) or **wind power** (which uses the wind to move turbines which generate electricity) can be a **great cost saving** in the long run - and are eco-friendly as well. Though the initial installation costs are often very high, if you can invest in these systems, they are more than likely to pay for themselves within a few years. In places where mains power is very intermittent or suffers frequent breakdowns, these can be very viable systems to consider, as they allow your station to operate without any interruptions of service.

A solar panel array. Typically, a smaller setup would need only a few panels (or a single medium sized panel) to fulfill some of its energy needs.

A good compromise with alternative energy systems is to use them to power only certain sections of the station - just the lights, say, or the transmitter and playout system - so that you can keep the load on the alternate supply low, and incur a lower initial cost. Keep in mind, though, that this may involve revisions of your wiring, though, to allow the alternate energy system to supply only select pieces of equipment.

The last, but not the least, thing we need to remember is to **ground** or **earth** the entire electrical supply and wiring of the station.

Practically, this means providing a **safe route** for the absorption of electricity leaking in the system, as well as a creating a **zero potential** against which reference electrical voltages in the system may be read. As we shall see later in the manual, this is of special significance for the antenna tower, which is often prone to lightning strikes. But where the station and studios are concerned, grounding is important for two reasons:

a. **To allow the ELCB to work**, since the ELCB breaks the circuit when it senses the sudden flow of current into the earth through the accidental contact;

b. To prevent **leaking currents** from damaging sensitive electronic equipment (the shock you sometimes feel from a television or the metal surfaces of any electric/electronic device is usually due to poor grounding); and

c. Poor grounding often leads to a **hum** that can be heard over the audio cables in the studio, caused by the cyclical nature of the a/c mains supply.

This is often accompanied by **electromagnetic interference** from the Earth's magnetic field and transmission lines, which can also be addressed by good grounding.

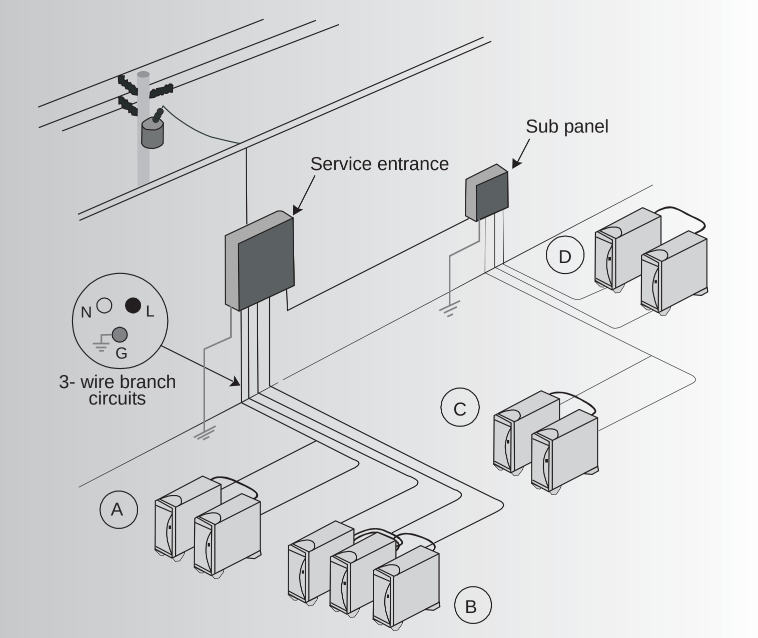


Fig 2-10. Grounding equipment is an important consideration for CR stations.
Most modern electronic systems are susceptible to faults caused by poor grounding.

Typically, in the absence of a formally wired ground, grounding can be achieved by simply running a wire connected to the ground points of all the power outlets and connecting it to any **buried water pipeline made of metal** (especially the galvanized iron or GI main water supply lines found in most places.)

A more through **professional grounding** is to be much preferred, however, and involves the connection of the ground wire to a **buried copper conductor plate**. The size of the plate is worked out on the basis of the total estimated load on the supply and the plate is buried at a depth which guarantees enough moisture to ensure good conductivity. This is often improved by burying the plate at that depth in a **bed of charcoal and salt**, which makes for better conductivity; and by leaving a channel or pipe buried alongside to allow the periodic addition of water to keep up the moisture levels.

Again, the importance of good grounding cannot be over-emphasized, as the safety of very costly electronic equipment in the station is dependent on this.

1. Routing Equipment wires and cabling

While designing the spaces and studio setups, it is also important to decide where and how you will route the numerous **cables** that connect the equipment together. Many of these wires and cables will actually connect different spaces together and we must think about how to organize and route them to **avoid tangles** and provide for **easy upkeep** and **maintenance** and to ensure that the cables are not accidentally damaged during general use, by rats or other vermin.

For more on cables and connectors see **Section B: Connectors (Power)** on Page 163 and **Section B: Connectors (Audio & Telecom)** on Page 166

The first requirement is **cable ties**, which are flexible binders made of nylon, and available in electrical and computer stores. There are reusable and single use varieties. Cable ties can be used to gather sets of related cables and tie them together; many cable ties have a space for you to attach the tie - and thereby the gathered cables held by the tie - to the wall or to the back or underside of furniture, which keeps things from getting messy and allows easy cleaning. In a pinch, these can be substituted with **twists of wire** cut to size or **stout twine**.

A selection of cable ties. The tip is looped around the cables that need to be tied together and through the box at the other end of the tie, which locks the loop in place

The second option is to fit plastic **cable channels** or **cable trays** to walls, just above the skirting, through which cables can be routed to keep them from coiling all over the floors. Cable trays have **perforations** around their entire length, and a sliding **plastic cover**, so that we can add and remove cables at will with very little effort.

Where cables pass from one room to another - between the recording floor and the control room, say - we must make special provisions, especially if acoustic treatment of one of the spaces must be respected: Cables must be routed through prepared **channels** or spaces designed in the partitions, preferably with a system of **baffles** or a **rubber diaphragm** around the cables to make an airtight seal.

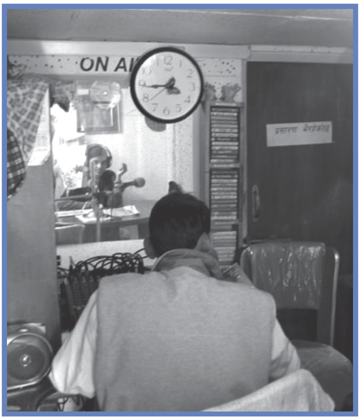
Professional studios and auditoria are designed with these cable routing exigencies in mind, and include under-floor channels and concealed wall panel fittings for connections and wires. If these are feasible in your spaces, they are excellent methods to keep cables out of the way.

Never let equipment and mains power supply wires overlap cables carrying audio between equipment. The electrical supplies may cause interference.

A short note on flexibility

While planning and designing your station, always think about how you can rearrange your setup to meet future needs: Accommodate new equipment, for instance; or even move the entire setup to a new location. All too often, CR stations have to upgrade or replace equipment, in which case a lack of planning means you are stuck with furniture or spaces which will now not go with the new equipment.

Keep the setups as modular and easy to dismantle as possible, to allow quick swaps and switches to be made. Some items, like soundproofing or partitions may be harder to change or shift - but that's unavoidable. The more you plan for this in advance, the easier it will be to make changes without seriously disrupting the station's activities.



A radio programme being broadcast by Radio Madanpokhara in Nepal. The studio dimensions are small, but the space has been utlilized creatively.

Chapter 3

Technology - II
Studio Equipment

In the previous section, we discussed the division of the station's studio work between the production studio and the broadcast studio. Continuing on the same theme, let's have a look at the kinds of equipment that go into the working of each of these studios.

There are many items which may be common to both studio setups: A two studio setup would need one each of these pieces of equipment, but a single studio setup would (obviously) require only one.

A second consideration is that modern computerized systems can often use different kinds of software to perform functions that would otherwise require a wide variety of studio equipment: For example, there are now different softwares available for editing, mixing, and mastering audio which can all run on a single computer. This may help you avoid acquiring some of the studio equipment outlined in this chapter.

For more on editing/mixing software, see **Section B:Computer Software** on Page 159

Relying on a single computer for all your studio functions could hinder your production and broadcast process if the computer fails or requires maintenance!

These descriptions do not include details of the cables and connectors required in the two studios, as that varies from equipment manufacturer to equipment manufacturer.

For more on cables and connectors see **Section B: Connectors (Power)** on Page 163 and **Section B: Connectors (Audio & Telecom)** on Page 166

Section I: The Broadcast studio

The **broadcast studio** typically has an equipment setup something like Fig 3-1.

Let's look at each piece of equipment step by step, to understand its function:

1. **Microphones:** Typically, the broadcast studio should have at least two high quality **voice mics** - one for the compere/host/presenter, and one for the guest. (A third would be good value if it is affordable, allowing a second

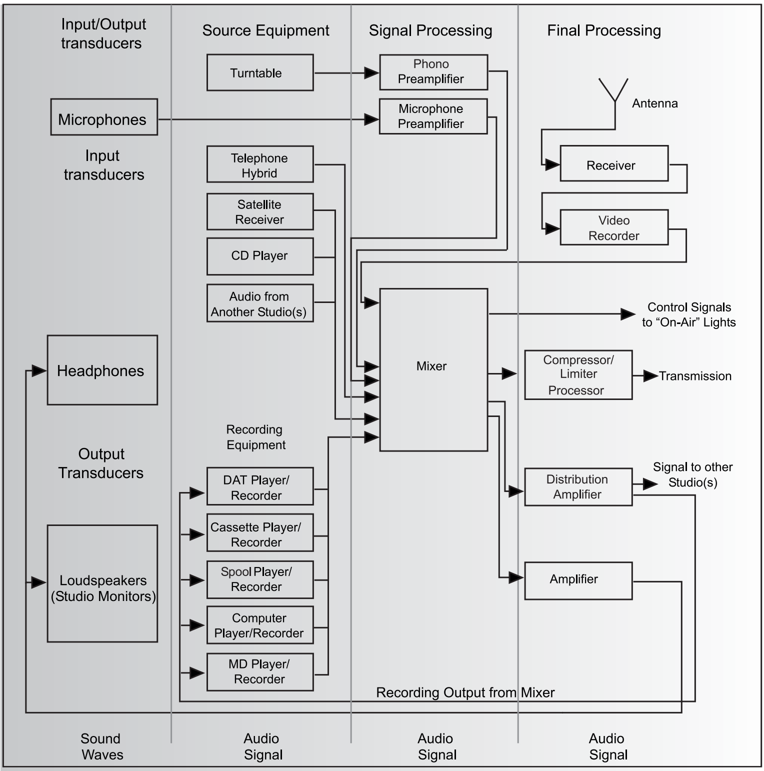


Fig 3-1. Schematic diagram of a broadcast Studio setup

guest to be 'miked' separately (and thereby, his/her audio levels controlled independently) as well as giving the studio a spare mic.

For more on microphones see **Section B: Microphones** on Page 198

The mics are typically not powerfully directional, as the studio already has controlled acoustics, and the speakers are quite close to the mics. In some cases, there may be a single mic which has a pickup on both sides, which is then shared by the people on either side of it.

Shure SM 58 dynamic microphone

The mics are also usually mounted on **adjustable stands** - in the case of the compere's mic, often on a **swinging armature** that allows for very precise adjustment of the mic position. This is so that so that the speakers do not need to hold the mics in hand, and also so that the mic stays at a constant distance. Speakers tend to have different speaking voices, and tend to be of different heights, so ease of stand adjustability is an important consideration.

Good studio mics include the **Shure SM 58**, the **Behringer TSM 87** and the **Rode NT-1A**. Very high end mics include the **Neumann U87** and the **Sennheiser MD 421**. Indian mics include those manufactured by **Ahuja Radio**, which supplies a variety of mics for different purposes. Nowadays, a number of very economical microphones made in China are also available in the market quite easily.

A Neumann U 87 condensor studio microphone. Note the suspension shock mount that holds the microphone and prevents accidental movements of the mic from causing a rumble in the audio.

Stands are available from a variety of suppliers, and in a pinch, even locally manufactured stands will do, as many of the mics come with appropriate grips that fit on top of the stands. Sometimes, but not often, mic manufacturers provide stands specific to their mics.

> It is important to select mics according to the function they must perform, and so that they meet the appropriate quality standards that are required for radio transmission. Select mics that have a reputation for sturdiness; and which will not fail at key times.

2. **CD players:** The current standard for playback sound sources - especially for music - is the CD player (though DVDs and their most recent cousins, the Blu-Ray disc and HD DVD, are the recent rage in the video world.) Two CD players would be very useful for a broadcast studio, allowing pre-recorded materials to be smoothly mixed with each other without gaps in transmission.

A mid range CD player from Denon, with a matched amplifier unit. Mid range home music CD units are often a good option for CR stations.

Studio CD players should have **large displays** so that they can be read from a distance, and should preferably be controllable from the mixer, which makes them easy to use (though this is not vital). Most importantly, they should allow you to connect them to a professional grade mixer unit with a balanced connector. They are one of the workhorses of any station setup.

Good studio CD player units are available from **Denon**, **Sony**, **Tascam** and **Pioneer**.

For more on CD players see **Section B: Compact Disc Players** on Page 141

3. **Studio cassette deck:** The cassette deck, which plays **audio cassettes**, is still a staple of many radio setups, since a lot of recorded material - especially music - is still available on cassette. Usually, any good home cassette deck - especially those from **Denon**, **Sony** or **Pioneer** - can perform this function, but a professional deck provides the advantage of **balanced outputs** for connection to a mixer. A **dual tape deck**, which allows you to use it as a dual cassette source for mix purposes is an added benefit. The **Tascam** pro units are of good grade and take heavy studio use.

The Tascam 322 dual cassette deck, a popular studio deck.
Note the flanged edges that allow it to be mounted in a rack mount.

For more on studio cassette decks see **Section B: Cassette Tapes & Cassette Recorders** on Page 134

For more on balanced connectors see **Section B: Balanced & Unbalanced Connectors** on Page 131

4. **Recorder unit(s):** There is actually a wide variety of studio recorder units now available to choose from. Till a few years ago the recorders of choice - and still popular in many places - were the **Digital Audio Tape (DAT)** recorder (which records digital audio on magnetic tape at very high quality) and the **MiniDisc (MD)** recorder (which used small magneto-optical disks somewhat like small CDs, and also records broadcast quality audio). Today, **flash memory** based recorders recording on solid state memory like **SD (Secure Digital)** cards and **CF (Compact Flash)** cards are rapidly becoming the norm. Two popular units, equally at home in a studio or in the field because they are so compact, are the **Marantz PMD 670** and the **Edirol R-09**. (There is a **Marantz PMD 660** as well, which is an even smaller version of the PMD 670.) A number of studios have also moved to purely computerized units where the audio is recorded digitally directly on the computer's hard disk.

Marantz PMD 670 solid state recorder.
The recorder records on Compact Flash (CF) cards.

For more on Flash recorders see **Section B: Flash Recorders** on Page 187

5. **Mixer :** A good mixer is the heart of the studio, allowing you to combine a variety of inputs and manage the audio levels of the various sources and mics. Each of the sources is connected to a **separate channel** for independent control, each of which has a **sliding fader** that allows you to raise or lower the level of the audio signal feeding through that channel.

A Mackie 4 channel mixer unit.
Note the four white channel faders
at the bottom left of the mixer.

The number of sources and mics you have in the studio usually decides the **number of channels** you need on the mixer - but 4 to 8 channels should be fine for most mid level stations. Prime considerations are the **quality of the sliders** (the moving resistors of the fader units); and the **options for controlling all the other studio equipment** - decks, CD players and mics - from the mixer itself. Good broadcast mixers are available from **Behringer, Mackie, Sony, Soundcraft** and **Tascam**. (In case a broadcast mixer with such controls is not available, a production mixer may be substituted instead, with the other sources and controls operated manually.)

For more on production mixers see **this chapter's Section II** on Page 54

6. **Headphones and monitors:** The usual rule is to have a pair of headphones for each speaker in the studio. The headphones are used to monitor the audio going on air and to preview a new source before its sound is actually mixed in.

Using headphones is especially important in the broadcast studio, because speakers would feed back sound into the mics, creating a loud whine or howl called **acoustic feedback noise** or **'howlround'**. (Some studios use speakers and a switching system where the on air audio is heard over the monitor speakers, which cut off the minute any of the mics become active.)

A pair of Sennheiser high quality headphones. Note the padded ear cups designed to fit snugly on and around the wearer's ears.

Good headphones are available from **Behringer**, **Sennheiser** and **Sony**. Good studio monitors are available from **Behringer**, **Sony**, **KRK**, **Denon**, and **Tannoy**, with the last three being very expensive pro studio options.

For more on Headphones see **Section B: Loudspeakers & Studio Monitors** on Page 190

7. **Distribution amplifier:** The Distribution Amplifier is another important piece of broadcast studio equipment. It boosts and amplifies audio from all the sources - audio players, mics - and feeds them to the recordings units and to other studios if necessary.

For more on Amplifiers see **Section B: Amplifiers** on Page 128

A Behringer 4-headphone audio amplifier. The unit is used specifically to distribute sound to upto 4 headphones with no loss of signal.

8. **Pre-amplifiers and amplifier units:** Several source units may have very low signal outputs which need to be amplified by pre-amplifier units that boost the signal to a level comparable o the remainder of the sources. Also, the outputs going to the headphones, the transmitter or - more usually - the studio monitor speakers may need to be boosted by an amplifier unit.

Whether these units are required or not depends on the precise configuration of your studio setup.

For more on Amplifiers see **Section B: Amplifiers** on Page 128

9. **Telephone hybrid or caller input:** One of the best ways to get your listeners involved in the programme is to give them an opportunity to call in during the programme, so that they can also participate in the programme. To get your callers on air, we require a **telephone hybrid unit** - there's usually a hybrid unit available to connect almost any type of telephone to the mixer unit, but it's important to first think about how many telephone lines you may have for callers to call in on: Large professional stations have dozens of lines for callers, but a smaller CRS may have only one, which considerably simplifies the job of selecting a hybrid unit. Some stations get around the need for having a multi line hybrid by connecting their office **EPABX intercom system** to their mixer, and using their dual or multi-line capabilities to enhance their call-in facility.

A Sonifex telephone hybrid unit

A simple way to connect callers to the studio setup is to use a phone line connected to a speaker phone unit: Incoming calls can be played over the speaker phone, with a mic placed close to the speaker phone to pick up this sound and feed it to the mixer unit. With this technique, it is important to avoid audio feedback, which could cause a whining noise in the audio.

For more on telephone lines, see **Chapter 6: Telecommunication & Other Ancillary Equipment** on Page 81

For more on Telephone Hybrids, see **Section B: Telephone Hybrids** on Page 220

10. **The On-Air light:** In order to effectively signal that the studio is in use and broadcasting ('live'), the usual system is to have a red 'On Air' light inside and outside the studio, that can be activated when work is going on. The inside light then tells guests that the broadcast is taking place, and the outside light tells people outside the office that the studio is busy. High grade on-air

lights are activated automatically when the mics are live, and are connected to the mixer unit.

The On-Air light can also be a simple switch operated light that can be turned on just before broadcast begins or when the stusio is in use. It just takes a bit of discipline to build this into the standard operating procedure for anyone working in the studio.

11. **Computerized playout system:** When we have a variety of live and pre-recorded programming being broadcast, it's often a little difficult to cue the programmes manually in a seamless and uninterrupted fashion. With computer systems becoming cheaper by the day, a number of small radio stations have increasingly begun to rely on **computer based playout systems**, which automatically play programmes in the correct sequence without human intervention. In some ways, this is a luxury for small station, but the potential savings of time and effort are enormous, as this would avoid having a variety of playback systems in the studio: The programmes, whether they are on cassette, CD or any other medium, are transferred onto the computer first, which then becomes the only 'source' unit in the studio. Professional playout systems like **Enco** often require specific hardware to work. There are also free alternatives like **Zara Radio** and **Campcaster**.

Several simple software meant to play back audio on a computer in a particular sequence can be substituted as basic playout systems: Just complete your programmes, compile them into a playlist using free software like WinAmp, and press 'play'!

For more on playout systems, see **Section B: Digital Playout Systems** on Page 173

12. **Broadcast recording devices (Audio Loggers):** As part of the monitoring and grievance redressal mechanism, many governments and adjudicating bodies make the recording and storage of all the programmes broadcast over a given period of time preceding any given date mandatory. In India, it is mandatory to record and store each programme for a 3 month period from the date it is broadcast: This is so that the programme may be produced before the adjudicating committee if someone files a complaint about the content.

For more on CR broadcast regulations in India, see **Chapter 9: CR Guidelines in India & their Implications** on Page 105

This means, naturally, that we have to record the programmes on a **continual basis**, and have enough **storage capacity** to store three months worth of programmes at any given time. This is not a very great problem if your station only broadcasts one or two hours in a day - which would add up to 90 days x 2 hours = 180 hours of programmes. But a station broadcasting 8 hours every day would have to store 8 x 90 = 720 hours worth or programmes!

The amount of programming you have to store to comply with the regulations really decides what kind of equipment you will store the broadcasts on: If it is comparatively little, you may decide to record the programmes on **cassette tapes** - it may take just a couple of cassettes to record two hours of programming a day. The cassette recorder can be connected to the broadcast chain in parallel with the transmitter, so that it receives the same signal that will finally go out over the antenna.

If the programming is greater than that in quantity, it is wise to set up a **dedicated computer** with a large hard disk based storage capacity to record the programmes in a suitable format. If space on the computer's internal hard disk is limited, the recordings can be regularly transferred to **CD**, **DVD** or an **external high capacity hard disk** from the computer's internal hard disk. (With memory and hard disk prices coming down so sharply over the last couple of years, it is now relatively inexpensive to install a suitably large hard disk within the system itself.) The programmes so recorded must be **clearly labeled** with the programme name and the date of broadcast, which should also be marked on any external media that are used - CDs or DVDs for example - so that there is a clear record of the broadcast content.

13. **Satellite receiver:** A new addition to the bank of source units is the satellite radio receiver, which receives radio signals directly from a satellite, like a **DTH (Direct to Home)** TV system. There are two or three satellite radio services providing a variety of music and programming available in South Asia, with the most prominent being the **Worldspace Radio** system. If you feel you can use the programming to pad out and fill in certain programming needs, it may be useful to acquire a satellite radio receiver, and work out a **rebroadcast deal** with the service provider. The upside is the availability of plentiful and CD quality programming. The downside is that the programming may not be relevant to your audience; may be mostly music based; and that your station will have no control over what's coming in and being rebroadcast.

A Hitachi Worldspace satellite radio receiver unit.
The line out socket can be connected to the mixer.

14. **Optional: Other playback source units (DAT, LP players, spool players)**
As noted before, CD players, solid state recorder/players and computerized playout and playback systems have made rapid strides in recent years, and

have all but replaced older warhorses like the **vinyl record** or **LP player**; the **spool (or reel-to-reel) player/recorder**; and even the comparatively recent **DAT recorder/player**. If you feel that any of your source materials may still be in any of these formats, you should consider whether you need to acquire any of this equipment for your station.

> Since most modern audio systems are digital, it makes sense to transfer older recordings on tape or LP records into a digital format that can be stored and played back on a computer or flash recorder unit in the long run.

Section II: The Production studio

The first thing to remember is that the basic setup of a production studio is not very dissimilar to a broadcast studio (and, in fact, that's the idea, because it gives us the flexibility of using it as a backup broadcast studio!) But the choices we make of the numerous options of each type of equipment may sometimes be a little different.

The primary difference is that it is not directly connected to the transmission system, and that it is generally equipped with equipment that allows you to

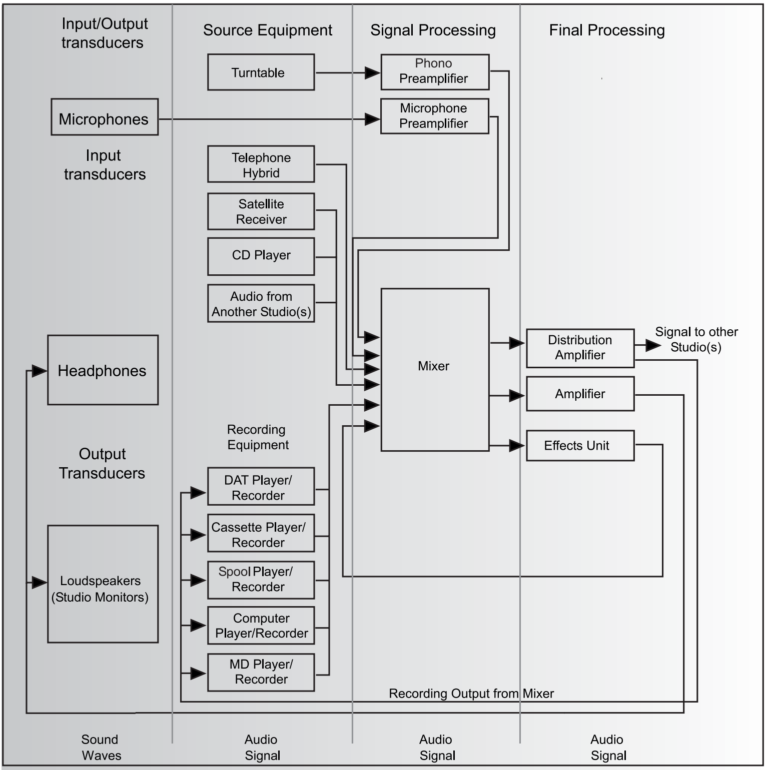


Fig 3-2. Schematic outline of a production studio setup

record and edit programmes for later broadcast. The second difference is - as we have seen - that the production studio is usually equipped with a formal control room and recording floor spaces.

The **production studio** typically has an equipment setup something like the one shown in Fig 3-2.

Once again, let's look at each piece of equipment step by step, to understand its function:

1. **Microphones:** Like the broadcast studio, microphones are an integral part of the production studio. They will usually be set up in the recording floor area, and the preference in production studios is often for mics that have a **bigger pickup area**, usually all around the mic itself, as we often use the production floor for discussions involving three or more people; or for radio drama that may mean several voices talking at once.

Unlike the broadcast studio mics, though, the mics in the production studio may not necessarily be on stands - often they are placed on the 'talk' table placed in the production floor, equidistant from all the speakers, or suspended from above in the middle of the recording floor, so as to enable people to stand or sit around the microphone. However, depending on what you are producing, there may be a variety of specialized mics used individually or simultaneously - including highly specialized mics that may be used to record individual musical instruments. But good mics, remember, are expensive - and while the temptation to equip yourself with a number of mics is always there, you must consider **what selection of mics is affordable** within your budget - and **what kind of recordings** you will be doing most of the time. (Obviously it makes no sense to buy an expensive professional mic that is designed to record a percussion instrument well if we will actually be recording panel discussions and human voice most of the time!)

The Samson C-01 condensor mic. This type of mic is especially useful where you have more than one performer around the mic, as in radio drama.

To our previous recommendation of the the **Shure SM 58**, the **Behringer TSM 87** and the **Rode NT-1A** - and the **Neumann U87** and the **Sennheiser MD 421** - we might add the **AKG C 414**, the **AKG C 3000** and the **Samson C01**.

For more on microphones, see **Section B: Microphones** on Page 198

2. **CD players:** Since prerecorded programs mean that you may be mixing a number of different sources into the final programme, a good broadcast CD player is an asset to the production studio. (However, this could be substituted with a more affordable home CD player as well, as reading the display of the unit from a distance is not a primary concern here. A home CD player would not have a balanced professional output, but that can be worked around if you are on a tight budget.)

Good studio CD player units are available from **Denon**, **Sony**, **Tascam** and **Pioneer**. Good combo drives (CD writer + DVD-ROM) or DVD-Burners (Superdrive) are made by **Sony**, **Liteon**, **Samsung** and **LG**.

An HP internal combo drive unit that plays DVDs and can read and write CDs

A useful solution is to have a good quality DVD writer, CD recorder or CD player built into the computerized editing and post production unit (see below), which will allow you to 'rip' tracks from CDs directly in digital format, thereby preserving their quality.

For more on CD players see **Section B: Compact Disc Players** on Page 141

3. **Studio cassette deck:** Once again, a good cassette deck is vital to the production studio. Cassettes are still the primary way to store pre-recorded materials in many portions of the country, especially the rural areas; and cassette players are therefore still in abundant use. CR setups that intend to distribute copies of their programmes to the listening public - and especially those that also have outreach projects where programmes are 'narrowcast' (played off portable cassette decks to small listening groups) - may pay

special attention to this need, and install more than one, to allow quick dubbing of programmes. As noted before, the **Tascam** pro units are of good grade and take heavy studio use.

A Tascam studio cassette deck. Note the VU meters at the top right which help you adjust audio levels while recording.

Smaller CRS with tighter budgets may also skip having a computerized (digital) setup altogether and use two cassette decks in the production studio - with or without a mixer - for cut-to-cut (start and stop) editing. This is the simplest and most basic way to edit - by dubbing the portions we require section by section onto a second tape.

For more on studio cassette decks see **Section B: Cassette Tapes & Cassette Recorders** on Page 134

4. **Recorder/audio storage unit(s):** Besides the studio cassette deck, you must decide what your final programmes will usually be stored on - that is, in what **format**. If they will be stored on CDs or DVDs, the **CD-burner** or **DVD-burner** unit which you will include as part of your computer editing system will do fine. On the other hand, you may decide to store or write your final programmes to **DAT** (in which case you will need a good studio DAT recorder from **Tascam**, **Denon** or **Sony**), or **MD** (in which case you will need a good MD recorder from **Sony** or **Sharp**). Studio MD models are hardly available anymore, but **Sony Hi-MD field recorders** - Hi-MD is the updated MD format - are still available at some outlets.

For more on MiniDisc recorders see **Section B: MiniDiscs & MiniDisc Recorders** on Page 204

Finally, you may also decide to store and write final programmes to the editing system's **hard disk drive (HDD)** itself, in which case you will probably need several high-capacity HDDs in your system, to store a lot of audio.

A large capacity external hard disk unit is a useful way to back up your files and your complete programmes. Such disk storage units may connect to the computer's USB port or Firewire port.

It is usually good practice to store the recorded 'raw audio' and the final version of the programmes on an external HDD of very high capacity: 750GB and higher external storage units are now quite common. Keeping these backups on an external HDD ensures that your DAW's internal memory is always available, and also that your finished programmes are always safe if your DAW fails for some reason.

Remember that storage technology changes every day, with newer audio formats and higher storage capacities emerging all the time!

A comparison of various audio storage media

Format	Medium	Capacity	Interoperability
Hi-MD	Hi-MD/MD disc	300 MB/1 GB (26 mins/ 125 mins)	Hi MD can record and playback in MD mode, but not vice versa.
CD	Compact Disc (CD-R, CD-RW)	700 MB/80 mins	CD-RW may not be read in all CD players
DVD	Digital Versatile Disc (DVD) (DVD-R/DVD+R/DVD-RW/DVD+RW)	4.7 GB	Writable DVDs may not be played back in all DVD players. Most DVD recorders can also record on CDs
Blu-Ray	Blue Ray disc	25 GB/50GB	Some Blu-Ray recorder/players may also play back DVDs. Not compatible with HD-DVD, though some newer players can play both formats.

Contd...

Format	Medium	Capacity	Interoperability
HD-DVD	HD-DVD disc	15 GB/30 GB	Some HD-DVD players will also play back DVDs. Not compatible with Blu-Ray, though some newer players will play both formats
HDD	Magnetic storage (magnetic platters inside HD casing)	Current highest: 1.5 TB	Can store all digital audio and video formats. Highest capacity. Only needs appropriate operating system and software to play back contents. Can only be used with a computer. (Some newer home video/audio recorders have HDDs built in for their higher storage capacity).

5. **Mixer :** Once again, a good mixer is the heart of the studio, allowing you to combine a variety of inputs and manage the audio levels of the various sources and mics. Each of the sources is connected to a separate channel for independent control, so the number of sources and mics you have in the studio usually decides the number of channels you need on the mixer - but a 4 - 6 channel mixer should be fine for most mid level stations. Prime considerations are the **equalizer controls** (which let you control the tone and quality of the audio); the **pan controls** (which allow you to mix in stereo); the **gain controls** (which let you boost the inputs and match them to each other; and the **sliders/faders**.

The Behringer UB 502 2-channel mixer. Decide the number of channels and controls that you will require on your mixer on the basis of the equipment you will connect to it.

Experienced recordists and sound engineers would also like the ability to **group** sets of inputs together to be controlled by a **master fader**. Good mixers, as mentioned before, are available from **Behringer**, **Mackie**, **Sony**, **Soundcraft** and **Tascam**.

Resist the temptation to acquire huge commercial or pro studio mixers with 24 or 60 channels - you probably won't need them, and they are fabulously expensive!

For more on mixers see **Section B: Mixers & Mixing Desks** on Page 207

5. **Headphones and monitors:** Production studio monitors usually need to be of better quality than those in the broadcast studio, because one tends to monitor the audio in the latter more over headphones. Good quality monitor speakers from **Behringer**, **Sony**, **KRK**, **Denon**, and **Tannoy** - especially the last three - can be very expensive, and it's okay to settle for a lower grade of monitor speaker as long it doesn't buzz or crackle at relatively higher volumes, and gives you an output that sounds reasonably close to the original sound.

Listen to a lot of speakers and choose them according to your budget and your own ability to distinguish between their quality. (In many cases, where the production studio is equipped with a computerized production and editing system, CR stations use good quality computer speakers from **Cambridge Soundworks**, **Logitech** or **Creative** as the studio monitor.)

A Creative Labs 2.1 computer speaker set with subwoofer. Good quality computer speakers can often be used as audio monitors in low cost CRS setups.

It is also wise to have three or four headphones - and the corresponding outputs from the mixer, which may require a separate **headphone amplifier** - in the control room; and two or three headphones in the recording floor area, to allow singers or performers to hear a beat track or instrumentals while they are singing. Headphones may also be used for the talk back system (see below.)

Remember that most of the programmes a CR station makes are likely to be heard in noisy situations on relatively inexpensive transistor sets - so even though it is always nice to make a programme that has very high production standards, very fine sounds and subtle mixing are probably never going to be a priority.

For more on headphones & studio monitors see **Section B: Loudspeakers & Studio Monitors** on Page 190

For more on headphone amplifiers, see **Section B: Amplifiers** on Page 128

6. **Distribution amplifier:** Ideally, the production studio needs a distribution amplifier as well, to feed the main output to the recording units (this may not be necessary if the entire process is oriented around a computerized editing system) and to the broadcast studio.

For more on Amplifiers see **Section B: Amplifiers** on Page 128

7. **Pre-amplifiers and amplifier units:** Once again, consider amplifier units if there are several source units, many of which may have very low signal outputs which need to be amplified by pre-amplifier units. Also, the outputs going to the headphones, and the studio monitor speakers may need to be boosted by an amplifier unit. (Some studio monitor speakers may have their own amplification systems built in, in which case they are likely to be very expensive indeed!). Whether these units are required at all - and if they are, what kind are required - is dependent on the precise combination of equipment in your studio.

M-Audio 'Audio Buddy' pre-amplifier, a low cost unit with two mic inputs

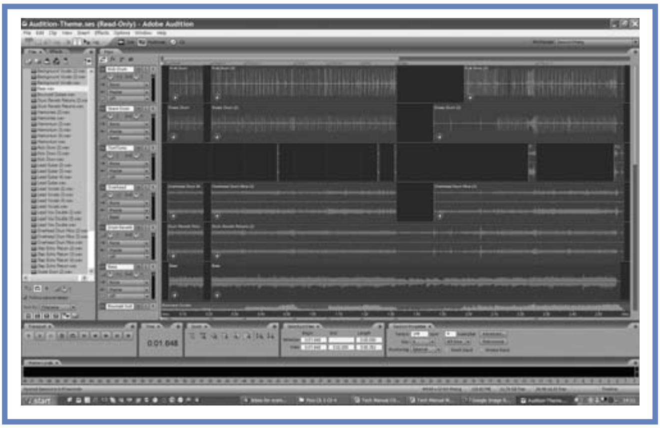
For more on Amplifiers see **Section B: Amplifiers** on Page 128

8. **Telephone hybrid or caller input:** It's also a good idea to have a telephone hybrid system that feeds into the mixer unit in the production studio - this allows you to **pre-record** telephone calls and edit them if necessary, an undeniable advantage over the live call. However, many CRS prefer to equip only their broadcast studios with telephone hybrids, as the immediacy of a live call is often seen as more vital to audience participation than a recorded and pre-edited phone call.

For more on telephone hybrids, see **Section B: Telephone Hybrids** on Page 220

9. **The On-Air light:** Production studios are also well advised to install an On Air light, with lights in the control room, outside the studio door and in the recording floor area, in order to advise guests in the studio and workers in the office outside that the studio is recording.

10. **The computerized editing system or Digital Audio Workstation (DAW):** Increasingly, production studios - and this applies to small CR setups as well - are oriented around a Digital Audio Workstation, which acts as a hard disk based recording system as well as an editing setup. When we say computerized editing system, we mean, of course, a computer equipped with the hardware to speedily and accurately process audio data, and store and retrieve several fairly long (30 minute and more) programmes simultaneously; and equipped with the software to access, play back and edit audio data. Very well equipped DAWs are no longer the preserve of expensive professional studios. A very good system that is more than adequate for any high grade work by a CRS can actually be assembled from components obtained from any reasonably equipped computer parts market, by someone with a fair knowledge of computers.



Modern audio workstations use software like Adobe Audition that let us perform audio edits and sound manipulation. Freeware and open source options have brought these costs down sharply of late.

The primary considerations for a DAW are:

- Processor speed
- Hard disk capacity
- Good motherboard with plenty of inputs and outputs
- High quality sound card, ideally with a 'breakout box' that lets you connect balanced outputs from the mixer
- A good quality monitor (as large as is reasonable: 17 inch is good, 15" will do in a pinch)
- As much Random Access Memory (RAM) as can be afforded (512 MB minimum)
- Audio editing software (proprietary or open source, freeware or paid, there are many excellent options)
- Ability to connect a variety of field recorders directly to the DAW for transfer of audio

For more on computer hardware and software, see **Section B: Computer Hardware** on Page 152 **and Section B: Computer Software** on Page 159

13. **Talkback system:** Since the production studio must interact with the people in the control room while recordings are going on - and it's not always feasible to keep opening and closing the access door in the partition between them - it's advisable to arrange a **talkback system** between the two spaces. This is usually setup with a dedicated 'talkback' box that is connected to a small mic near the mixer console on the control room side, and a small speaker or a headphone set on the recording floor side, so that the recordist or producer can give instructions to the people inside the recording floor area. (On the control room side, the recordist may use a **headset** unit that combines headphones with a small microphone before one's mouth,)

The Mackie Big Knob talkback unit allows you to 'talk back' to the people inside the recording areas, as well as choose between multiple audio inputs.

Many mixer units include a talkback section built in, which may help you avoid the need for a separate talkback setup.

14. **Optional 1: Patch-board or jackbox:** If there are lots of different pieces of equipment in the production studio, some recordists prefer to have a **patchboard** installed. This is essentially a unit with lots of **audio jack sockets** to which all the inputs and outputs of the equipment in the studio are wired. Instead of keeping them all connected with a jungle of cables, the recordist can now connect only the pieces of equipment he or she actually wants to use, with short connector leads. It's a good way to keep away from the nightmare of a tangle of cables, and from the need to plug and unplug connectors if there are limited inputs and outputs on the mixer or DAW.

An 8 jack modular patch panel from Hosa.
More such modules can be added to this one to expand the patch bay as the equipment increases.

For more on patchboards, see **Section B: Patchbays** on Page 121

15. **Optional 2: Additional players and recorders:** Since pre-recorded programmes may draw on a variety of different audio sources for their content - features and documentaries, especially, may tap into old archival recordings - it may be wise to have a spool recorder, a turntable/LP player and other player units as part of the production studio equipment. These, however, are comparatively infrequently used, so you may decide to have a single set that is shared between the broadcast and production studios - not a problem at all if you have a single studio setup - or dispense with them altogether, and arrange to rent or borrow them if required.

A brief note on the equipment suggested in this chapter

In this chapter, we have looked at ideal setups, and the types of equipment that are typically required by a well-equipped CRS. These suggestions must be adapted to your requirements: Feel free to mix and match, get double duty from single units of equipment, and avoid certain pieces of equipment wholesale.

Make the effort of finding out what other CR setups are using, as this will give you ideas on how you can develop your own setup.

Above all, plan for the future and plan to add equipment bit by bit as you go along: Starting with a very basic setup will still allow you to make quality programmes. It's the mind and the ear behind the equipment that make good programmes, not the equipment itself.

Don't get caught up in technolust and want a piece of equipment just because another CRS has it, or because you have a fixed idea of what a studio should be equipped with: Your decisions should be ruled by logic, rationale, an eye on your budget and common sense.

Chapter 4

TECHNOLOGY - III
FIELD RECORDING EQUIPMENT

Now that we've had a good look at the kind of equipment we need to equip our studios with, it's time to examine what kind of field recording equipment a community radio station needs.

Why do we need field recording equipment?

The simple answer to that is: Because we cannot gather all the audio we need for a programme within the confines of a community radio station or the studio. Sure, the studio may be connected to the outside world with telephones and other communication equipment; but the fact remains that some audio can only be recorded 'on location' or 'in the field', as it's called.

For instance, there may be people who cannot come to the studio to be recorded, or to participate in a discussion, but who may be important to the content of a programme. (A busy government officer, say, or a villager in a remote area, who has no means to travel to the studio.)

A field recording in progress by volunteers at Mandaakini Ki Awaaz Samudayik Radio in Uttarakhand.

There may also be audio which can only be recorded at the place where the sound is actually produced: Natural sounds like birdsong, or the sound of a waterfall, say; or the sounds made by a wedding procession.

What are the main considerations in selecting field recording equipment?

Since field recording equipment - unlike our carefully protected and shielded studio equipment - is exposed to **dust**, **humidity**, and **extremes of temperature**, it is important to consider the following factors while selecting field recording equipment:

1. **Ruggedness:** Any equipment we move around with should be able to take some basic knocks and bumps without malfunctioning: Climbing in and out of vehicles, travelling in crowded buses, and hiking some distances on foot are par for the course for CRS volunteers, and the equipment should be able to take that. (Note that this does not include rough handling or dropping the equipment - that's just plain carelessness, and there's no excuse for that.) You'll find that modern solid state recorders, in particular, fulfill this condition well, as they have very few moving parts.

The portable Marantz PMD 660 flash recorder. Designed for field use, the recorder is able to handle large variations in humidity and temeperature.

2. **Resistance to humidity and dust:** Many pieces of electronic equipment are so sensitive that they cannot withstand shifts in temperature - interior to exterior, for example, or from sunshine to shade. Others get easily fouled by the fine dust that pervades Indian cities and rural areas, and need multiple cleanings of their heads and other moving parts to stay in working order. Such pieces of equipment cannot be part of our field recording kit. While some maintenance is unavoidable, the ideal field equipment will not mind a bit of dust, and have a large operating temperature range.

For more on maintenance and protection of equipment, see **Chapter 7: Planning for Maintenance & Management** on Page 91

3. **Adaptability and portability:** While we are in the field, we do not have the luxury of carrying large varieties of equipment to suit different situations.

The recording equipment we carry has to give adequate or good results in all the situations and recording conditions we are likely to encounter. (This means the microphone has to be good for delicate as well as harsh sounds, voices as well as music, able to work in noisy conditions and in quiet.)

Similarly, this will be equipment we will be carrying on our persons most of the time, so it has to be reasonably **light**, or we will be weighed down and tired out by just the effort of carrying it around.

4. **Availability of spares and ancillaries:** While most modern electronic equipment is too complex for us to expect that there will be people capable of repairing faults wherever we go, always plan on acquiring field recording equipment for which supplies are available easily in the areas you work in. For example, choose equipment that uses standard **AA**, **AAA** or **D cells** over fancy proprietary batteries that may not be easily available: The standard batteries are usually available somewhere close by no matter where you are.

Similarly, if the availability of recording media is an issue for you, it makes better sense to choose an audio cassette based recording device than a MiniDisc or DAT recorder. (Of course, this is not always a problem - MDs and DATs, for example, are highly reusable media, and can be erased and reused several times, thereby increasing the gap before fresh supplies are needed.)

For more on maintenance and protection of equipment, see **Chapter 7: Planning for Maintenance & Management** on Page 91

What should a field recording kit consist of?

The components of a field recording kit are really very individual to the setting of the CRS and the preferences of the field reporters; but there are some broad components which we should include:

1. **Microphones(s) & accessories:** Ideally, the field recording kit should have a couple of microphones, one with a **wider pickup**, that can be used to record a group of people or a sound effect; and one that is highly **directional** and has a narrow area of pickup, for noisy situations or to isolate particular sounds. But this is usually a luxury, so it is more likely that you will have one multipurpose rugged microphone that will give you acceptable results in most conditions.

A basic digital audio recording kit. Note the case within which the recorder is carried to protect it from dust.

The mic should have a **good grip**, to allow it to be comfortably handheld; and should be accompanied by a **foam** or **fiber windshield** that prevents wind from hitting it and causing a rumbling noise. Most field mics use standard AA or AAA batteries. A **balanced output** is to be greatly preferred, as that assists us to get clean recordings even in areas with high electromagnetic disturbances.

Microphone cables matching the connectors, naturally, will also be part of the kit - unless the microphone connects to the recorder wirelessly. Cables should be of good quality and purchased readymade or made by someone who knows how to do it, to avoid problems in the field.

It's usually a good idea to carry one or more **spare microphone cables** as part of the kit, so that some spares are available if the main cable is damaged for some reason. The spare cables could also be of **different lengths**, to allow us to use the mic at varying distances from the recorder - 2 metre, 5 meter and 10 metre lengths should be fine. (But it is wise to remember that not all mics give a good quality signal over cables longer than 5 metres.)

For more on microphones, see **Section B: Microphones** on Page 198

2. **Recorder unit:** The field recorder should - besides being rugged and hard wearing - be **easy to use and set up**. A unit with very complex pre-recording processes will invariably cause you to miss important recordings which you otherwise should have managed to catch. It should have **balanced inputs**, for the reason stated above; but also allow you to connect a variety of different types of mics to it: Standard inputs could include professional (**XLR and large ¼" phono**) and semi-professional (**RCA, mini 1/8" phono**) inputs, if possible.

For more on connectors, see **Section B: Connectors (Audio & Telecom)** on Page 166

A **headphone socket**, to allow us to monitor what we are recording, is vital, as is the **ease of changing used media** for fresh media: There is nothing more irritating than having to struggle to insert a fresh cassette or MD in the middle of an interview. Ideally, you should not have to change the recording medium at all during a field recording trip.

The recorder should also run off **batteries**; and have a **low power draw**, allowing us to use fewer batteries in the field. To have **easily replaceable standard batteries** is a distinct plus.

The Zoom H2 Handy recorder. With a small form factor and built in stereo mics, this recorder works on two AA cells and records on SD flash memory.

A large and clear **display screen**, that lets you observe all the important parameters - **battery life**, the **amount of recording media left**, the **audio level** and the **track number** (if applicable) is a great plus.

A **digital recorder**, which allows us to sort and classify recordings as we go, as well as save time during the transfer process to our editing systems, is also a wise investment, especially if we have a DAW based editing process: It's usually possible to transfer the recording into the computer very quickly from a digital recorder. This is not possible if we use an analog recorder with a DAW, where the transfer process will be as long as the time it takes to physically play back each recording (i.e. 5 hours of recording = 5 hours of transfer time.)

For more on field recorders, see **Section B: Field Recorders** on Page 184

For more on digital recorders, see **Section B: Flash Recorders** on Page 187

3. **Recording media:** In case the recorder needs replaceable media for recording, there should be adequate supplies of blank media to cover all the recording planned for the day. (Estimating how much media is required is an acquired skill.) A good rule of thumb is to estimate the total recording time anticipated, estimate the blank media accordingly, and then add enough to cover a recording 1/3 rd longer than anticipated.

The **cost of the media** is a consideration, of course, with cheaper media often being kinder to you operating budget. But do factor in the reusability of the media as well - an MD which costs a lot more, but can be reused fifty times may actually prove more economical in the long run than a very low cost medium like the audio cassette, which is cheaper, but can only be used only a few times before the recording quality starts to drop.

Secure Digital (SD) and Compact Flash (CF) memory are solid state and have no moving parts. Very small cards can now give several hours of broadcast quality recording.

> Don't be stingy while carrying spare media - better to have a few unused cassettes and MDs at the end of the day than to travel miles to find that you've run out of media and have to miss out on the best interview of the day.

Modern flash based solid state recorders have much to commend them in this respect - memory is rapidly becoming cheaper, and vast amounts of recording can be made on one relatively inexpensive and reusable memory card.

For more on flash recorders, see **Section B: Flash Recorders** on Page 187

4. **Power supply:** Most good field recorders come with an a/c mains power adapter, but also run off batteries. The dual supply system allows you a longer recording time in the field, as we can plug in wherever we have access to mains power supplies. It's a good idea to carry at least one totally fresh set of spare batteries for the recorder and for the mic (if it is powered).

It is ideal to carry appropriately sized **Nickel Cadmium (NiCD)**, **NiMH (Nickel Metal Hydride)** or **LiIon (lithium Ion) rechargeable batteries** that are compatible with our equipment, along with **charger units** for each variety, so that we can recharge batteries along the way where possible. Many pieces of equipment come with internal rechargeable batteries in the first place, that are charged by the accompanying a/c adaptors.

A family of alkaline cells from Maplin. It is important to identify and carry the correct batteries for your equipment when in the field.

As a rule, rechargeable batteries have a longer life than standard dry cells. If rechargeables are not a part of your kit, try using **lithium** or **alkaline cells (Energizer, GP** or **Duracell)** - these are long life dry cells, but can be quite expensive on a recurring basis.

> All rechargeable batteries have a finite life, measured by the number of time they can undergo charges and recharges. (Each charge and discharge is called a 'charging cycle', and a given battery may be rated as good for a 1000 recharge cycles, or 20000 recharge cycles.) NiCd and NiMH rechargeable batteries are especially prone to losing their capacity to hold a charge after some time, a phenomenon called the 'memory effect'.

5. **Headphones:** A good pair of headphones to monitor the recording is an important part of the kit. Some recorder units come with a pair of high quality **in-ear earphones**, but a pair of over-ear headphones with comfortable padded earcups, and a long enough lead are to be preferred over this. **Noise canceling headphones**, which allow you to cut out environment noise, are also of great help, if you can afford them.

Yamaha's RHC headphones are low cost and affordable while remaining hifi enough for professional use.

A good pair of headphones, remember, can help you spot audio problems while you are still in a position to do something about them - so get the best pair you can afford.

For more on headphones see **Section B: Loudspeakers & Studio Monitors** on Page 190

6. **Carrying cases and covers:** Field recording equipment should always be carried in their carrying cases: There are a variety of cases, hard and soft, available for each piece of equipment, with many cases designed to allow operation of the equipment with the case still on. (This is especially true of the **soft rexine** or **plastic carry cases** that go with many field recorders.) The cases protect from jars and scratches, as well as dust; and most have straps and belts that allow you to sling the equipment around your waist or over your shoulder for easy carrying.

If standard cases are unavailable or too expensive, it's easy to stitch **cloth cases** with straps for the various pieces of equipment. A **stout kit bag** or **hard case** for the entire kit is also a good idea, both in terms of transporting the equipment safely, and in terms of keeping the kit organized.

7. **Optional 1: Cleaning kit:** A cleaning kit containing **cotton swabs**, **surgical alcohol** or **cleaning fluid** and an **antistatic duster** is a vital addition to your field recording kit if you are using a cassette recorder in the field, as they require frequent cleaning of the heads and pinch rollers. This is much less important with latter day digital recorders, where there are no magnetic heads that are exposed or even user accessible. A clean duster cloth is a good idea anyway.

8. **Optional 2: Boom rod/fishpole:** Many microphones can be fitted onto a long extensible rod called a **boom rod**, so that they can be held closer to a subject or sound source from a position several feet away. (This can be an important consideration while recording natural sounds in inaccessible places, for example.) There are also flexible versions of this called **fishpoles**. Depending on the kind of situations you record in, you might like to make one a standard part of your kit, or have one available for use as needed: They are especially useful in news situations, where a crowd of reporters may be jostling to use their recorders simultaneously!

9. **Optional 3: Accessories pouch:** Some field reporters like to be prepared for any eventuality and carry a simple **repair kit** - **soldering iron**, **solder wire**, **flux**, **miniature screw drivers**, **cutter** and **pliers** - as well as **marking chalk**, **rubber bands**, **cable ties** and **spare connectors**. This is a good idea, especially if you make the effort to learn how to do these basic repairs on the fly - it has saved more than one field recording trips from disaster!

For more on repairs and maintenance see **Chapter 7: Planning for Maintenance & Management** on Page 91

Chapter 5

Technology - IV
Transmission Equipment

The transmission process, as we have seen, is more or less the final step in getting the audio from our studio - live and pre-recorded - out to listeners.

Let's pick up the process at the point the final audio signal leaves the broadcast mixer, and see how it carries on from there:

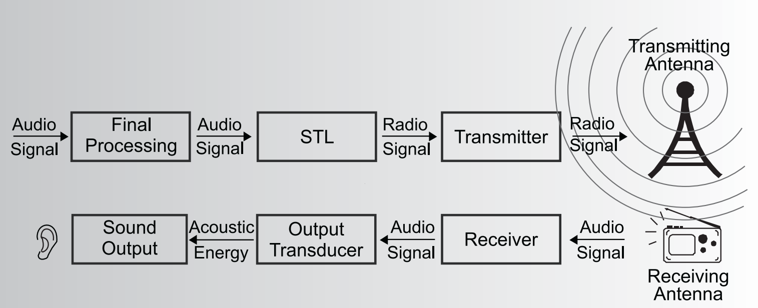


Fig 5-1. Schematic diagram of the transmission and reception process

1. **The Compressor/Limiter:** The incoming signal from the broadcast studio to the transmitter is (if we've done everything right so far) already somewhat controlled and corrected from the audio level point of view. But this still needs to be **processed** in order to keep it within a stricter range, so that the transmitter isn't **overloaded** by a signal that it cannot handle. That's where the compressor/limiter comes in: It controls the signal and keeps it within the range the transmitter can handle, so that the broadcast radio signal is **distortion free**, and so that the sensitive components of the transmitter are not damaged.

For more on Compressor/Limiters, see **Section B: Compressor/Limiters** on Page 149

2. **The Studio Transmitter link (STL):** The studios and the CR station are usually located in a place where people from the community can access the station easily. But that's not necessarily the best place to put the **antenna**, which has to be at a **vantage point** which overlooks the largest possible area for broadcast. And since the transmitter is usually placed in close physical proximity to the antenna, this means we have to find a way to get the audio

signal from the station/studio to the transmitter. This connection is called the **studio transmitter link** or **STL**. It can be a **physical (wired) connection**, using a tough armoured cable that can withstand the vagaries of weather and direct sunlight; or it can be an all weather **microwave radio link** that connects the two.

There are two key considerations where STLs are concerned: If it is a cabled connection, then there is the matter of **cable loss**: The reduction in signal strength due to the resistance offered by the cable itself. This can often be quite sharp, and may play a large part in the deciding what strength your transmitter has to be. The lower this loss, the better the cable - and the higher its cost. But it is generally wise to keep the studio to transmitter and the transmitter to antenna distance as short as possible: Many agencies advise keeping the studio to transmitter distance under 50 metres.

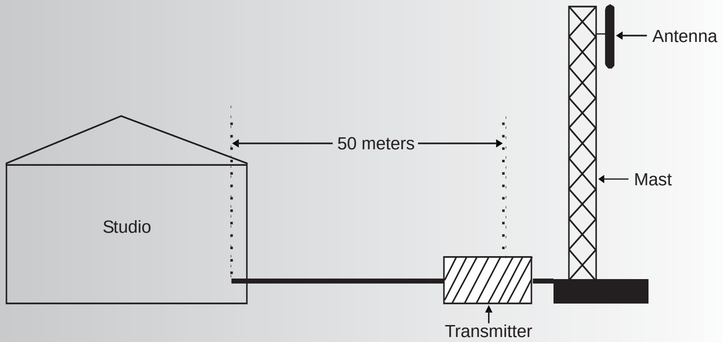
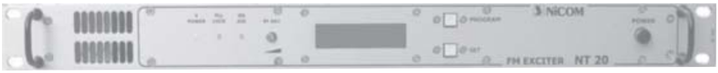


Fig 5-2. Keeping the STL cable as short as possible is a vital consideration. It is a good idea to install the antenna mast on the roof of the studio building itself in order to keep the distance to a minimum, and gain the added height offered by the building itself.

Wireless STLs, though not specifically banned under the guidelines governing CR broadcasting in India, invite a whole different set of issues: The microwave link will be treated by the Dept. of Telecommunications as a separate radio link, requiring a license from the Wireless Planning and Coordination (WPC) committee of the Dept. of Telecommunications. It will also involve a separate **spectrum fee**, which can be quite high. This is, of course, in addition to the cost of the link equipment itself, which is likely to add a few lakh rupees in the first place.

3. **The Transmitter:** The transmitter is the central component in the transmission process, and is a device that performs two functions: It generates a **radio frequency wave** that carries the audio signal (and is hence called the **carrier wave);** and it combines the audio signal that we input into it with the radio wave it generates (a process called **modulation**). The combined signal is very specific and precise, and is fed to the **antenna**.



A NICOM USA 30W FM transmitter. Note the LCD screen on the front which reads out the frequency setting of the transmitter.

The transmitter needs to be set up by an expert who can set it to a precise frequency, and test whether it is working well. During testing, the transmitter may be connected to a test or **dummy load,** instead of the antenna, to simulate transmission.

> The transmitter must never be run without either a dummy load or the antenna connected to its output, as that can damage the unit.

Depending on the size and complexity of the unit, it may have a **digital display** that shows the current frequency and the strength of the outgoing signal. There is usually a built in system that allows you to set the **frequency of the carrier wave** it generates to a specific value. (This is usually in steps of 1000 kHz, meaning we can set the unit to (say) 102.1, 102.2 or 102.3 MHz, with the 0.1 MHz differences corresponding to the 100 kHz steps. Practically, of course, stations are only allotted frequencies separated by at least 200 kHz on each side - that is, 92.0 MHz, 92.2. MHz, 92.4 MHz and so on-to prevent accidental transmission overlaps **('interference')** that could disturb transmissions over the two neighbouring frequencies.)

Small and medium range stereo and mono FM transmitters are manufactured by **West Bengal Electronics Corporation (WEBEL), and Bharat Electronics (BEL),** as well as several foreign companies like **Itel** and **Veronica**. Several other makes and varieties are available, including kits from organizations like the California, USA, based **Free Radio Berkeley**. With a moderate knowledge of electronics, one can build transmitters from pre-fabricated kits and from the basic electronic components on the basis of circuit designs available on the internet and elsewhere.

> It is illegal to make or own an unlicensed transmitter under Indian law. Indian regulations currently allow only transmitters meeting a set of stringent international broadcast specifications. If your transmitter is manufactured by a non-standard manufacturer - or you have assembled it yourself! - you can only use it if it is officially certified by a Bureau of Indian Standards recognized physical laboratory that can test its adherence to these parameters. The transmitter is expected to conform to the requisite International Telecommunication Union - Radio Communication (ITU-R) standards. For a list of NABL certified labs, go to: http://www.nabl-india.org/nabl/asp/users/labCatBrowsing.asp

Stereo or mono transmitter?

One of the important decisions to be taken by every CR station is whether the transmission should be in **mono**, or in **stereo**. FM radio technology inherently allows the transmission of CD quality stereo audio, so this is a decision that needs some thought.

For more on mono and stereo audio, see **Section B: Stereo & Mono** on Page 217

In order to take an informed decision, we should consider the following facts:

1. To get the full value out of stereo transmission, listeners require a **stereo receiver** as well to listen to the programming.Most potential listeners for an average CR station in this country are likely to be using low cost transistor receivers - where the absence of a second speaker makes stereo transmission pointless anyway.
2. Stereo transmission means mixing the audio in stereo to utilize its full effect. **Stereo mixing** is a comparatively difficult skill to learn, and needs considerable more practice than mixing in mono.
3. Stereo transmitters are more **expensive** than mono transmitters.
4. Stereo transmitters have a **shorter transmission range** than a mono transmitter of the same power rating. (i.e. A 30W stereo transmitter has a smaller range than a 30W mono transmitter.)

Of course, any decision we take on this matter also has to take into account future developments in our transmission area - technological developments like plentiful availability of cheap stereo receivers, for example, or FM enabled cell phones. So be careful and think ahead!

4. **The Antenna:** The antenna is a device made of metal, which radiates or sends out the modulated radio signal into the air all around it. Antennas, like microphones, can be **directional** (with much of the radiated energy sent in one primary direction); or, more usually, **omni directional**, with the energy being radiated evenly in all directions.

Siting or deciding the location of the antenna for best reception is an important consideration, with high vantage points overlooking the maximum possible area greatly preferred. This is why the antenna is usually fixed to a tall mast or tower that is carefully anchored to prevent it from falling over - the height gives it a greater vantage point.

For more on regulations regarding transmission power and antenna tower height, see **Chapter 9: CR Guidelines in India & their Implications** on Page 105

A simple homemade dipole antenna. This unit is mounted on a large bore metal post.

The antenna tower or mast can be of many varieties: The more complex ones are **self supporting tower** designs on three or four stilt legs, with built in ladders which can be used to access the antenna mounted at the top.

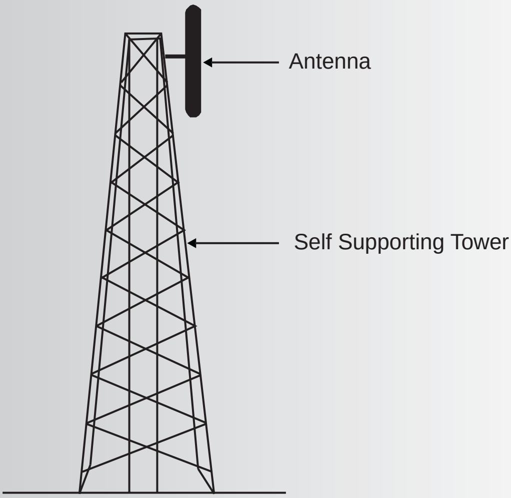


Fig 5-3. A basic self supporting tower design.

The simpler ones, which cost much less, are the **antenna masts**. Such masts are usually supported against wind by anchoring wires or guy ropes, in which case they are often referred to as **guyed masts.** (Of course, in a pinch, even a long bamboo pole that is suitably braced upright on a building's roof could provide a more than adequate height for the antenna - especially in a plains area.)

A guyed antenna mast, on the other hand, is quite easy to manufacture: All it requires is a good fabricator (iron worker) who has basic welding tools. You will require:

1. Angle iron (22 x 22 x 5 grade is quite adequate) in 10 or 15 foot sections;
2. Cross strut metal sections to provide the bracing between the three angles;
3. Nuts and bolts to attach the sections to each other, along with fish plate style punched metal sections.

The sections are manufactured by connecting the three metal angles in a triangular pattern, with equal sized cross-struts welded to the inner side of the angles. If constructed in 10 or 15 foot sections, these can be handled easily, and attached to each other with nuts and bolts holding the sections together.

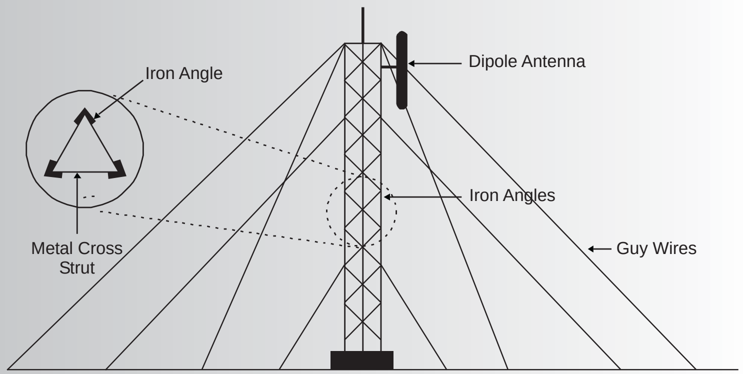


Fig 5-4. A simple guyed antenna mast design. The inset shows how the 3 angles used are interlinked and braced.

> Care should be taken that there are no large physical obstacles - mountains, hills or tall buildings - near the antenna that may block the radio signal emanating from it.

Grounding of the antenna is a very important consideration, as a tall metal tower is an open invitation to lightning strikes. The grounding of the antenna is distinct from the grounding we have already seen for the station electricals: This grounding is built to divert the millions of volts of energy from lightning into the ground, to protect the transmitter and other equipment in the studio from being jolted. If the electric charge gets back to them through the cables and link, they will all be destroyed and lakhs of rupees worth of equipment could be ruined.

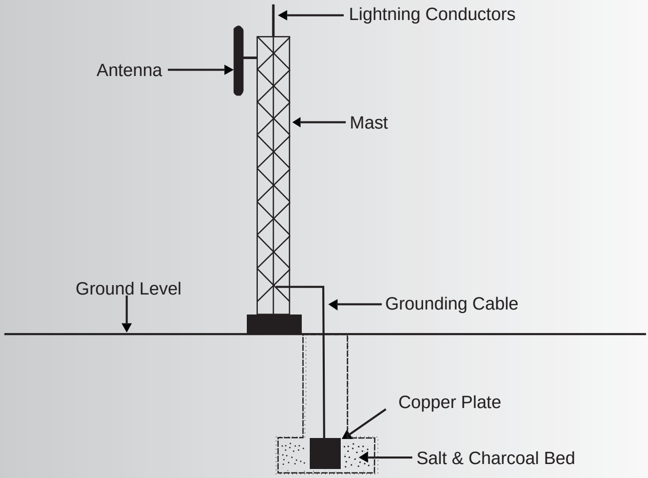


Fig 5-5. Grounding the antenna mast is vital, especially in hilly areas and storm prone areas.

The modulated radio wave emanating from the antenna can be received by radio sets at all the locations within a finite range of the antenna. The strength of the radio signal drops off with distance: Typically, for a 30 watt transmitter (which should give 100 Watt ERP with a correctly matched antenna), this is about 10 - 12 kms in the plains and 4 - 8 kms in the hills. The range refers to a distance of adequate reception: Any radio set within that range will pick up a strong signal that can be heard without the audio fading in and out, or with breaks in the signal.

A note on the regulation of FM transmission

In the modern world, we are surrounding by a plethora of radio signals used for telecommunications and data transfer, not to mention multiple radio and television broadcasts running simultaneously. It would lead to total chaos if anyone could broadcast any signal at any time: Think of ten stations in a given area all broadcasting at the same frequency! This is why there is a process of registration and allotment of frequencies. The transmission process in India is stringently regulated by official processes and government bodies.

Non-standard transmission equipment can also lead to spillovers of the signal into areas beyond the allotted frequency, and that that can also cause reception issues at the listener's end.

A live CR broadcast in progress. There is no way to rectify mistakes in production before a live programme is transmitted - so such programmes call for concentration, coordination and skill from the presenters and the producer.

Chapter 6

Telecommunications & Ancillary Equipment

While setting up and running a CR station, it is also important to plan the ways in which the station will connect to the world outside. Technology can play a major role in the way the community interacts and participates in the day-to-day functioning of the CRS.

Besides the transmitter and the broadcasting equipment itself, there are three primary technologies through which the CR station can be connected to the community and the world:

1. **Telephones;**
2. **Facsimile or fax;**
3. **The internet (and email)**

Section A: Telecommunications & telephony

1. Telephones

There are several types of telephone connections available nowadays: **(Wired) Landline**, **cellular (mobile)** and **WLL** phones. In some areas we may have access to all the three varieties, and in others to only one of the three. Some sections of the country still remain unconnected even today - but we can be hopeful that this will be remedied before long given the rate at which the telecom networks are expanding.

a. **Wired landline telephones:** The oldest kind of telephone connection, the wired landline connection involves the physical laying of a **copper wire telephone cable** to the place where the connection is installed. All the lines from all the phones in a given area are connected to local **telephone pillars** or **boxes**; and thereby, to a **telephone exchange**, through which they are connected to each other, and to phones in distant areas.

The biggest drawback of landline phones is the wire (or 'telephone pair') that actually covers the distance between the closest exchange or pillar, and the place where the telephone instrument is installed: Being a physical connection, it is subject to vagaries of weather; and also often gets snapped by strong winds, passing vehicles or even animals. In a remote area, a broken connection can take a long time to repair or

A modern landline phone instrument. The landline phone is increasingly losing out to the anywhere-anytime convenience of cellular telephony.

replace, which means the station's connectivity is compromised in the meantime. It is relatively easy for fixed line connection - especially in tropical weather conditions - to develop a disturbing crackle or noise that can make voices sound unclear.

b. **Wireless in Local Loop (WLL) phones:** A modern variation of the fixed line phone connection, WLL phones get over the problem of damaged pairs by using radio technology to connect the instrument to receiver/ transmitter units mounted on masts or towers in each area. The WLL instrument is usually characterized by a small **antenna** that projects out of the back of the instrument; and most units need a **power source** of some kind (usually a **battery**, or **mains power** through an electrical adaptor.) WLL phones can also be moved within a building as required, unlike fixed line phones where the entire wire may have to be uprooted and re-laid. Most phone companies also allow WLL instruments to operate within a limited range of the installed premises.

A WLL phone instrument. The antenna on the right side of the instrument links the phone to the closest transmitter/receiver unit.

c. **Cellular Telephones:** Like WLL phones, cellular phones use radio technology to connect the instrument to a transmitter/receiver mounted on a mast or tower close by. But unlike WLL phones, cellular phones are **mobile** - a factor also governed by the extremely small size of the instruments - with the signal reaching you wherever you are.

A Personal Digital Assistant (PDA) cellular phone instrument from HTC. Increasingly, internet enabled cellphones like this one are becoming all-in-one communication and entertainment devices.

Types of wireless telephone networks

WLL and cellular networks usually work on one of two popular standards: **GSM** (Global Standard for Mobile communications, more common among cellular networks) and **CDMA** (Code Division Multiple Access, available for both WLL and cellular networks).

GSM networks are more **widespread** globally, being an older technology. But CDMA networks offer **higher rates of data transfer**, as well as greater potential connectivity to internet and audio/video/multimedia services. Both types of networks are constantly being upgraded and new research being done to improve service quality - so both now offer a variety of value added services and higher speed connectivity, collectively now known as **3G** (third generation) services.

2. Facsimile (Fax)

The facsimile or fax machine is a device that allows you to scan documents and send them to a similar device over a standard telephone line, where the document can be printed out. Even though they are increasingly becoming obsolete in a world where the internet and email prevail (see below) they are still useful devices - a variety of organizations are still not totally computerized, and rely on fax machines for document transfers.

Fax machines need **electricity** to run; and also need a clear line for transmission or reception. If the line is damaged or unclear in any fashion, the received image tends to be distorted or incomplete.

A fax unit from HP. Though email is now rapidly replacing the fax machine, the device is still favoured by many government offices and by smaller organizations in the field.

Fax machines are of many varieties, notably those which **store numbers** in a memory, and those with **timers** that can automatically send pre-scheduled faxes at a specified time. Another important consideration is whether the fax machine uses **thermal paper** (more common) or **regular paper** (less common, also more expensive.)

> Thermal paper holds images only for a few days before the image starts fading. If you use a thermal paper fax, photocopy the fax as soon as possible.

Which type of phone and how many lines?

Which type of phone you select for your CR station is governed by what is available in your area most conveniently; and by how you want to equip the office, studio and staff.

Where phones for the office are concerned, you may want a line each for each of the following:

1. **The office line:** This connection will be for **administration**, **research** and other functions. If you have a large setup, with a number of rooms, this line may be connected to an **EPABX**, a device that allows you to connect multiple instruments to the same telephone line or lines. (The multiple instruments can then also connect to each other - forming an **intercom system** - with the outside line accessible from any of the instruments.)

2. **The studio line:** This line is for callers to call the studio for **phone-in programmes** and to participate in programme activities. The line is connected to a **telephone hybrid unit**, a device that lets you relay the sound coming over the telephone line into the mixer unit, and use it as an audio source. The caller's voice can then be incorporated into the programme, and - if the line is connected to the production studio - recorded for later editing. Phone hybrids can thus be used for:

- Conducting interviews with people who cannot be accessed directly for a recording
- Calls in by listeners who would like to request songs or programmes, or respond to questions
- 'Live' broadcasts by reporters in the field (including events)

3. **Feedback and listener response:** To let listeners call in with their opinions regarding the programmes the station is broadcasting, you might also consider having a separate line connected to an **answering machine**, a device to record incoming calls. Answering machines are available as standalone units which automatically record incoming calls on cassettes or (more lately) solid state memories. Software is also available to let you connect a phone line to a computer, in which case the computer records the calls directly onto its hard disk.

4. **Fax line:** If use is likely to be heavy, it makes sense to have a dedicated line for the fax machine. On the other hand, if you will be using the fax only sporadically, it could share the main office line, with the fax machine switched on or off as required.

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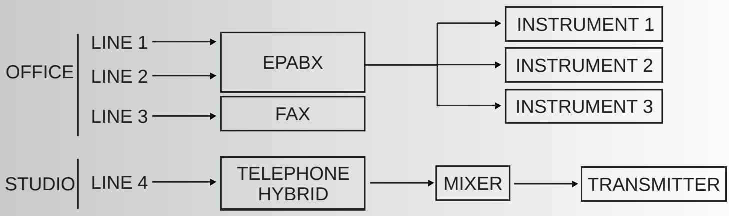

Fig 6-1. A typical distribution of telephone lines in a middle level CR station. Smaller CR stations often get multiple duty out of a single incoming line.

It's really up to you to choose which type of connection is best for your situation. It is a wise idea to not have WLL phones or cell phones for the studio line, as having a wireless unit close to audio equipment can mean disturbances in the audio that is being broadcast or recorded. (This is why all studio staff are generally advised to switch their cellular phones off when in the studio.) WLL phones are also usually not connectible to fax machines, so this should be a consideration when investing in a WLL phone for the office.

Any phone units or extensions installed in the studios should also have the facility to **mute** the unit - keep it from ringing - so that it doesn't actually sound when audio is being recorded or broadcast from the studio. Many specialized phone instruments are available for this purpose, with blinking lights indicating incoming calls instead of the standard ringtone.

If your radio station is constantly receiving more calls that one phone line can accommodate, it is a good idea to invest in more phone lines for the studio - there is nothing more frustrating for a listener than to be invited to call in and get an engaged tone. More than one line, while not a perfect solution, increases the chances that a caller will get through. Combined with a **hunting phone system,** which searches for the free line out of the ones connected to it, this can provide a much better connectivity experience for your listeners. (Multiple lines may also need **multi-line telephone hybrids** to connect to the mixer system, and this can be very expensive!)

For more on telephone hybrid units, see **Section B: Telephone Hybrids** on Page 220

Finally, you may like to consider the **value added services** available with a given choice of telephone line - WLL connections and cellular connections also offer you the ability to see incoming callers' numbers (**caller ID**) and send **SMSs** (Short Messaging Service, short text messages that can be transmitted to another phone working on the WLL or cellular system.) SMS, in particular, is increasingly being used by stations to ask listeners to make requests, vote for songs and/or send in their opinions.

When calculating approximate costs of operation, remember that fixed line and WLL phone connections generally charge a flat per month rental, along with a usage charge that is linked to the number of calls made. Cellular phone connections are either postpaid (with a rental and call charge structure like the one described above) or prepaid (where a predetermined amount is deposited in advance in exchange for a fixed amount of calling time.)

3. Internet & email

Most modern offices are connected to the **internet,** a worldwide network of computers and data relay systems that allows access to information stored on the network. The internet is a huge resource, with billions of **websites** - collections of electronic **web pages** - providing a variety of information on organizations, people, and events (and increasingly audio and video clips as well.)

Its ability to transcend geographical boundaries allows the creation of global **electronic groups** which can hold discussions on issues and information of common interest. It also allows individuals and organizations the ability to publicize themselves, their work and their ideas at relatively low cost. Most importantly, its value as a **repository of information** transcends traditional encyclopaediae, making it a hugely important component in research.

Connecting to the internet requires computers equipped with **browser software**, specialized software that can interpret data available on the internet in electronic language designed for fast and efficient data transfer over the **world wide web,** as it often called.

Most modern computer systems come pre-equipped with browser software: Internet Explorer is usually included as part of the Windows operating system, with free software like Mozilla Firefox, and Opera also widely available.

Websites follow a naming convention that uses **http:**// or **www** followed by a name and a **.com/.org/.net** suffix that identifies them uniquely. This must be entered in the browser window to access the page or site.

But perhaps the single greatest use of the internet is the ability it gives us to send **electronic mail** or **email** - electronic messages that travel over the internet almost instantaneously. Email communication is rapidly becoming the modern communication standard, especially since it now allows us to attach electronic computer files to mail messages. Many websites provide **free email services**, where you register to get a unique email address (xyz@mymail.com, for example) where others can send email to you. Many organizations tend to set up their own websites and their own coordinated email addresses that include the organization's name.

Internet connections are usually provided by an **Internet Service Provider (ISP),** who sells you a predetermined amount of connection time or data transfer against a set fee. As charges drop, many ISPs now provide an unlimited data and time connection against a per month flat fee. The ISP runs a computer called an **internet server** that can be connected to your computer in a number of ways:

a. **Through a regular phone connection:** Several ISPs are also telephone service providers and offer combination packages that combine internet access with phone calling. The fixed line phone cable, WLL instrument or cellular phone is connected to the computer, which then sends and receives data over the telephone connection. Many such ISPs offer a facility where the telephone continues to remain active even while the internet connection is on, though this is more common with **DSL** and **ADSL** connections (see below).

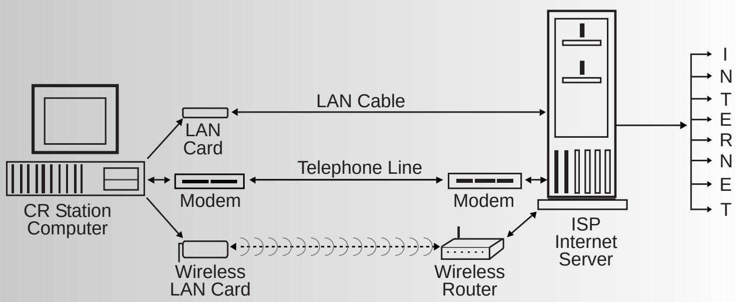

Fig 6-2. The computers in a CR station can connect to the internet in a variety of ways. Wireless Wi-Fi connections are rapidly becoming popular in offices.

b. **Through a dedicated internet connection:** Many ISPs also provide connections that are meant specifically for high speed internet data transfer. These could include **internet over LAN,** where the connection is provided over the type of cable that is used to connect Large Area computer networks (LANs); **ISDN** (Integrated Services Digital Network), a high quality copper wire telephone line usually provided for internet connections by telecom service providers; and **DSL** (Digital Subscriber Line) or **ADSL** (Asymmetric Digital Subscriber Line), which also uses a physical copper wire connection, but offers very high data transfer rates. ISPs providing DSL or ADSL line often bundle packages that include phone instruments and phone calling, as the DSL/ADSL line is capable of easily handling both phone and internet traffic simultaneously.

Depending on what type of internet connection is being used, the computer either needs a device called a **modem** (short for modulator-demodulator), which converts the computer's digital data into analog audio signals which are then transmitted over the network to the internet server; or a **network** or **LAN card**, a piece of equipment that allows computers to connect to each other. Discuss this with your ISP before acquiring an internet connection: They will let you know what the specifications and equipment you require will be.

More internet based communication opportunities

As the internet plays an increasingly larger role in our lives, it is also leading radio stations to leverage new technologies. Most popular among these technologies are:

1. **Blogs or web-logs:** These are online internet diaries maintained by individuals or members of a team or organizations, which offer an opportunity to share personal observations, experiences and memories. Many websites and ISPs offer visitors or users space on their internet servers to host blogs, which can then be accessed by anyone visiting a specific website. The newest variant of the blog is the **audio blog** or **video blog**, which offer the author of the blog facilities to present audio and video recordings respectively as part of the 'diary'. Almost any audio recording once converted to digital form can be used for this purpose. Popular blog sites include **www.blogger.com**, **www.blogspot.com** and **www.wordpress.com**.

2. **Podcasts:** Named after the popular Apple iPod music player, a podcast is an audio programme hosted on a website, which can be downloaded to one's computer or digital music player and heard by the listener. Though a good internet connection is called for - podcast files can be large in size for longer programmes - the advantage over broadcasting programmes is huge, as it allows one to listen to the programme at leisure. Many long-running prodcast series are now available over the internet, and many international media organizations like the BBC now regularly make their programming available as podcasts. Try **http://news.bbc.co.uk/2/hi/programmes/documentary_archive/** to hear some interesting podcast radio documentaries.

3. **Streaming audio and internet radio:** With comparatively inexpensive software and a good internet connection, it is now possible to schedule

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and play programmes over the internet to listeners who connect to your website or server. The audio - although in lower quality than broadcast level audio - can even be customized according to the listener's preferences, in terms of selecting which programmes to hear, or the order in which the programmes are played back. At the receivers' end, all that is required is a computer with some commonly available streaming multimedia players like **Windows Media Player** or **Real Audio player**; a good internet connection and a pair of speakers or headphones over which the audio can be heard. A large number of internet radio stations are now active, and may be accessed over the internet.

For CR stations, **podcasts** and **internet radio** present an additional opportunity to air programmes and expand their listenership beyond the local audience, as well as listen to other programmes from groups working in other geographical areas. Since both these technologies are **license-free** (or unregulated) and give the listener the ability to control their media consumption, they are seen as important changes in the traditional scheduled broadcast model in a globalizing world that now works across political boundaries and time zones.

Section B: Other office equipment

As we have seen in the previous section, the office requires a variety of telecommunications equipment for its functioning. In addition to all this - and as indicated by what we have already discussed - we must consider the following equipment for the office:

1. **Computers (for administration & research):** In today's world, computers are not only at the heart of broadcast systems, they are an ubiquitous part of the office as well. You should consider a at least one computer for the office - more than one, if you can find the funds for them! - as everything from documents to records to financial matters are now maintained on computers.

A modern branded desktop computer system from Lenovo. While branded desktops often carry extended warranties, assembled PCs often let you match components of your choice.

Office computers need to be of far simpler specifications than the DAWs we saw in a previous chapter, as they type of data they are expected to handle is primarily text and numeric. But they do need to be equipped with accessories that allow them to connect to the internet (modems) and/or to other computers (network or LAN cards). Of course, if you intend to use them for more demanding applications - like transferring audio programmes over the internet, or playing back audio or multimedia from internet sources - then the specifications will need to be higher. But a computer like this should usually be more than enough:

A basic configuration for an office computer

- Intel Pentium-4 3 GHz or Intel Core 2 Duo Processor 1.83 or higher (or) AMD Athlon 3000 dual core processor
- 120 GB hard disk drive (160 GB preferred)
- 512 MB RAM (1 GB preferred)
- 15" LCD or CRT monitor
- 56K modem
- 10/100 Ethernet (LAN) card or Wireless network card (if you have a wireless router)
- ATX cabinet with 300W SMPS power supply
- Appropriate motherboard for processor above (integrated audio and video are fine)
- At least 4 USB ports + serial port + Firewire port preferred
- Standard 101 keyboard and 3 button mouse
- 750 VA Uninterruptible Power Source (UPS)

You can buy pre-designed **branded computers**, or have one **assembled** to your specifications from components by an assembler. Discuss computers with your local computer supplier or with someone knowledgeable regarding computers and networks so that you can get a system appropriate for your needs.

For more on computer hardware and software, see **Section B: Computer Hardware** on Page 152 and **Computer Software (for Radio)** on Page 159

2. **Network hubs/Routers:** If you have multiple computers in the office, it is usually advisable to connect them together so that they can transfer files and data between them. The connection is usually achieved with a **network hub** or **router switch**. If each of the computers is equipped with a **network card**, and the network cards connected to the hub, the computers will be able to

share data. Some router equipment allows you to connect the internet connection to the router itself, so that it can be shared by all the office computers - though it must be remembered that the more the number of computers sharing the internet connection, the slower the data transfer speed that each experiences will be.

A Linksys WiFi (802.11g) wireless router.
Such a router allows WiFi enabled laptops and desktops to connect remotely to it within a given range.

Nowadays, routers and network hubs are also available in wireless versions, based around the 802.11 standard. This standard, known popularly as **WiFi**, allows computers equipped with the appropriate wireless network cards to connect to the router without cables. However, in a radio station, using wireless equipment of this sort could conceivably interfere with the audio studio's operations, so such equipment must be used with some care.

3. **UPS:** Every computer that you have in the office requires its own Uninterruptible Power Supply (UPS), a battery based unit that doubles as a device to correct variations in incoming AC mains voltages, as well as provide emergency power during a power failure. Depending on its capacity and the number and type of batteries attached to it, the UPS may provide enough time to shut down the system, or run it during an extended power cut.

UPS batteries need to be replaced at regular intervals, as batteries have finite ability to retain a charge - in regular use, this should be about every two or three years.

For more on UPS systems, see **Section B: Uninterrupted Power Supply** on Page 224

A note on the equipment mentioned in this chapter

It is important also to remember that though computerized offices are to be preferred, there is absolutely no reason why a CR station office cannot work with much more basic equipment - typewriters and manual records. A number of CR stations worldwide continue to operate effectively in this fashion, and do a very good job of it.

Remember that equipment is not the be all and end all of a CR station - and certainly not for the station office, even if it is important for the studio and production work. What is important is getting the work done and the broadcast running steadily - and within the limitations of the budget that you have.

An internet browsing programme being broadcast live by a CR station . The programme is interactive: Listeners call in with queries, which are then answered over the air by the show's hosts. The hosts find the answers to the queries on the internet.

Chapter 7

PLANNING FOR MAINTENANCE & MANAGEMENT

Since most CR stations run on stringent budgets and aim at serving the community with a not-for-profit motive, it becomes very important that its plans for the upkeep and maintenance of its equipment are up to the mark.

If done regularly and well, maintenance should:

1. **Prevent breakdowns before they happen;**
2. **Avoid unnecessary operational hassles and expenditure;**
3. **Ensure that the broadcast and production process is never interrupted, and that a good quality transmission goes out all the time.**

Setting rules and regulations in the studio

Maintenance starts *before* the breakdown happens! So start by creating some simple rules for studio access and use - and enforce them strictly. These include:

1. **Cleanliness:** Dust and dirt should not be allowed into the studio areas - that means no shoes or dirty clothes, or even food or drink in the studio areas. No pets should be allowed into the studio area either - animal hair is just as bad as dust! Ensure that the studio area is swept and mopped every day.

2. **Trained personnel only:** Put in place systems that allow for consistent **capacity building** of volunteers and producers on how to handle the equipment, and - as far as possible - allow only them to actually work in the studios. All too often damage occurs because someone is just fiddling with the equipment without really knowing how to use it. Of course, fiddling with equipment is part of learning how to use it as well - so the trick is working out a balance. (Strategic signs placed all around the office and within the studio may play a useful role in inspiring people to fiddle responsibly!)

3. **Report problems as they happen:** Instruct staff and volunteers and staff to report any problem, however small, as soon as they experience it. This will avoid the problem snowballing into a much greater issue. Computerized equipment, in particular, often signal when things are going wrong with a number of error messages. Instruct staff to note error messages whenever they appear so that the problem can be diagnosed.

Members of a CR group learn how to repair their field cassette player units. Field units need servicing on a regular basis to keep them in peak operating condition.

> Never force equipment to work - if a CD tray is stuck in the eject position and doesn't go back in, don't manhandle it into going back in! Your haste may damage an expensive piece of equipment and make it unusable!

Planning for maintenance

It is a good idea to incorporate a **regular inspection process** for all equipment into the management process - that way, equipment testing is done on a regular basis and possible trouble spotted early. Also, since radio and broadcast equipment is costly to repair - and given that repair facilities may not always be easy to access in your area - planning in advance for possible repairs allows you to manage the expenses in a way that is more convenient to you.

Planning includes:

1. Scheduling a system of equipment checks, and designating the people to carry them out;
2. Maintaining a log of equipment trouble faced and repairs carried out;
3. Maintaining a filing and documentation system where original equipment warranties and manuals are stored for reference;
4. Keeping a database of repair facilities and tech support persons accessible for ready reference;
5. Incorporating a maintenance budget into the yearly or monthly operational budget for the station;
6. Scheduling a regular training process that teaches station staff how to work on the equipment.

Maintaining the documentation and plans

It is very important to maintain an orderly system to file and keep accessible all the plans for the station - **layouts, wiring diagrams** and **equipment manuals.** If these are kept handy, then a number of problems can be sorted out very quickly when they arise.

Besides the fact that reading the **equipment manuals** allows the staff to learn the functions and correct operation of the equipment, manuals often have detailed instructions on procedures to be followed if the equipment gives trouble. Consult them first in case you are finding issues with any equipment - sometimes it can be as easy as switching the equipment off and then turning it back on!

Maintaining records and documentation for equipment - especially field equipment, which is often away from the station - is vital to keeping the technology in good order.

The **wiring layout** of the station - electricals and audio cables - will help you understand where a possible break or interruption may be happening. If you don't keep this filed away and accessible, as people change and time passes, the original layout will be forgotten and then you may have to painstakingly rip the floor and walls up to rediscover where the cables go. Update these diagrams and plans as you make alterations, corrections or upgrades - that way you always have a current picture of the setup.

Warranties, especially, are very important documents - within the warranty period, most equipment manufacturers will not charge labour or parts costs to fix equipment. File these away carefully, and see that they are duly completed when you acquire the equipment.

> Warranties are not always available if you acquire equipment from the unofficial market (often called the 'grey' market). So if you buy a really expensive piece of equipment in the grey market, you may save some money up front by buying it without a bill or at a discount from an unauthorized dealer - but be aware that equipment failure could cost you much more in repairs.

It is also a good idea to evolve and file your own **training manuals** and documents so that they can be accessed easily by staff - often manuals may give too many details regarding the equipment, and a simplified version may be useful to have for staff to use or train new volunteers with.

Maintaining inventories of equipment

It is also good practice to maintain an **inventory** or **equipment list** for all the equipment in the station, and to affix labels that correspond to the entry in the list to each piece of equipment. That way, it will be easy to find the details of any individual piece of equipment almost instantaneously by just referring to the appropriate entry in the list. The inventory should carry details like:

1. Name and model of the equipment
2. Serial number or unique ID
3. Function
4. Date of manufacture
5. Date of purchase
6. Name and contact address of the dealer
7. Warranty period
8. Situation (where is it located/installed)
9. Comments (a column where you can record remarks regarding the equipment, including complaints and repairs)

Many of these details will have to be gathered from the papers that accompany the equipment when it is acquired: **Bills of sale, warranties,** and so on. Some of the details - serial number, model and so on - may be read off the labels or printing that is usually affixed to the rear side of the equipment.

> Serial numbers, in particular, are very important during repairs, as this will be how you identify the equipment that has gone back to the repair shops: The repair shop may have many similar units with it at a given time. The serial number is also mentioned on the warranty, as it identifies the unit uniquely.

The serial number of the equipment is usually mentioned on a label on the side, back or underside of the equipment. Note that the label also gives information regarding power ratings.

Assessing (and investing in) maintenance skills building

It is also a good idea to see whether what the maintenance skills of various staff and community members is - there may be people among them who are adept at electric and electronic repair work, or who may even have experience in repairing some of the equipment. Maintain a list or **resource directory** of the people you identify.

Be careful while doing such an assessment - everyone enjoys being a source of information, and a lot of people like being tech gurus, but may actually not have much skill at all. If someone who only pretends to have experience sets about doing a repair job, you may end up with more problems that you started out with!

It is good to have some basic ability to repair equipment and clean and maintain it - and that includes the ability to make **running repairs** that keep the equipment functioning while more formal repair assistance can be called for - but too much experimentation can be detrimental to the equipment: Some parts can simply not be jury rigged, and being able to recognize where something can be done and where one should not take the risk is a very important ability.

It may also be a good idea to send staff out to equipment manufacturers' facilities and maintenance centers to learn some basic repair skills for the various kinds of equipment. Many manufacturers hold **workshops** and **preventive maintenance courses** for their equipment, which you may be able to access.

Assessing maintenance costs

When you run a CR station, the costs involved in repair and maintenance often run beyond the simple costs of repair and spare parts: Many CR stations are situated far away from the repair centers which can fix their equipment. Repair and maintenance costs may therefore have to include:

1. **Spare parts:** This includes the cost of any replacement parts that may be required to fix the equipment. Within the warranty period, this is generally not a concern, but outside warranty, it is definitely a cost. Note that warranties generally do not cover physical breakage, only normal wear-and-tear related breakdown.

2. **Labour:** The charges related to the time spent by the technician in fixing the equipment. Some suppliers will charge this as a flat fee as they already have an assessment of the average time it takes to fix common problems. These are also often covered by the warranty during the warranty period.

3. **Travel & boarding:** If the repair center is far away, you may also have to pay the repair technician's travel to and from your station, as well as the costs involved in putting him up if repairs take more than one day or travel

exigencies require him or her to stay overnight. This can add up to quite a lot, especially if the service center has rules regarding the kind of travel facilities that they require. Additionally, the service person may not be carrying all the spare parts required for a given repair job, as it is often impossible to prepared for every eventuality - and this may require more than one trip as a result.

> You can save yourself some bother by noting error messages carefully and reporting the problem faithfully and in detail when requesting repairs: This may help the technician identify the possible problems and come prepared with the appropriate tools and parts.

Even within the warranty period, travel and boarding for on-site repairs are unlikely to be covered by the service center unless expressly mentioned in the bill of sale or warranty. You may be able to convince the supplier to include this as a facility when you acquire the equipment, so try and bargain for it!

4. **Courier & postage:** Sometimes you may have to package and ship equipment to the manufacturer or supplier in order to get it fixed. This will require special packing, and shipping by courier, so that the equipment arrives safely and without further damage at its destination. A good courier company may charge you steeply for this service, especially since many pieces of equipment are heavy, and shipping is charged on a weight basis or a volume basis.

A CR volunteer discusses repair instructions over the phone as he checks an electrical point. Doing some basic preparatory work before calling in a technician can save time and money.

Annual Maintenance Contracts

Beyond the warranty period, many suppliers and repair centers offer **Annual Maintenance Contracts** or **AMCs** for the upkeep of the equipment. This usually involves a flat fee per annum for the equipment covered, which takes into account all the costs mentioned above. Under the AMC, the repair center usually does not charge you for every repair that they execute, as they will be paid the fee whether problems crop up or not: It is their responsibility to fix the problem, whatever it is, once the AMC is drawn up and agreed upon.

AMCs can often be **negotiated,** and it is up to you to work out the best deal for your station - try and get one or two **preventive maintenance visits** in a year included within the terms, and check for **loopholes** that force you to pay for specific portions of the repair and maintenance despite paying the annual fee.

A good AMC contract should cover all the possible costs involved in keeping the equipment running in good order, and also include a **timeframe** within which problems will be fixed.

> Many repair centers stop taking an active interest in your equipment once they have been paid the AMC fee - after which they put your work on hold while they attend to other paying customers. A punitive clause that forces time bound responses from the service provider is a good way to keep things in order!

General maintenance tips - A ready reckoner

1. **Read the Instruction manuals -** All the safety and operating instructions should be read before equipment is operated.
2. **Keep the Instruction manuals -** The safety and operating instructions must be kept for future reference.
3. **Heed Warnings -** All warnings on equipment and in the operating instructions should be obeyed.
4. **Follow Instructions -** All operating and use instructions should be followed.
5. **Cleaning -** Unplug equipment from the wall power outlet before cleaning. Do not use liquid cleaners or aerosol cleaners. Use a soft, damp cloth for cleaning the exterior of equipment.
6. **Attachments -** Do not use attachments not recommended by the equipment manufacturer, as they may be hazardous.
7. **Water and Moisture -** Do not use equipment near water - for example, near a bath tub, wash bowl, kitchen sink, or laundry tub; in a wet basement; or near a pool or any similar wet or damp place.
8. **Stability -** Do not place equipment on an unstable surface. The equipment may fall, causing serious injury to yourself or others,

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and serious damage to the equipment. Preferably all broadcast equipment should be mounted in a rack or stand, recommended by the supplier or sold with the equipment.

9. **Equipment should be moved and carried with care.** Rough handling, quick stops, excessive force, and moving over uneven surfaces may cause the equipment to be dropped or damaged.

10. **Ventilation -** Slots and openings in equipment cabinets are provided for ventilation and to ensure reliable operation of the equipment and to protect it from overheating. These openings must not be blocked or covered when the equipment is in operation, though you may be tempted to cover the equipment with a cloth or plastic sheet to protect it from dust. The openings should never be blocked by placing the equipment on a bed, sofa, rug or other soft surface. Equipment should not be placed in a built-in installation, such as a bookcase or rack, unless proper ventilation is provided or the manufacturer's instructions have been obeyed.

11. **Power Sources -** This product should be operated only from the type of power source indicated on the marking label. If you are not sure of the type of power supply you need for the equipment, consult the supplier or local power company. For products intended to operate from battery power or other sources, refer to the operating instructions.

12. **Power-Cord Protection -** Power-supply cords should be routed so that they are not likely to be walked on or pinched by items placed upon or against them, paying particular attention to cords at plugs, convenience receptacles and the point where they exit from the equipment.

13. **Outdoor Antenna Grounding -** If an outside antenna or cable system is connected to the equipment, be sure the antenna or cable system is grounded so as to provide some protection against voltage surges and built- up static charges.

14. **Lightning -** For added protection for your equipment during a lightning storm, or when it is left unattended and unused for long periods of time, unplug it from the wall outlet and disconnect any antenna or cable system. This will prevent damage to the equipment due to lightning and power-line surges.

15. **Power Lines -** An outside antenna system should not be located near overhead power lines or other electric light or power circuits, or where it can fall into such power lines or circuits. When installing an outside antenna system, extreme care should be taken to keep

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from touching such power lines or circuits, as contact with them can seriously injure or kill you.

16. **Overloading -** Do not overload wall sockets or extension cords, as this can result in fire or electric shock.
17. **Object and Liquid Entry -** Never push objects of any kind into equipment through openings as they may touch dangerous voltage points or short-out parts that could result in damaged equipment, fire or electric shock. Never spill liquid of any kind on the equipment.
18. **Servicing -** Do not attempt to service equipment yourself unless you are qualified to do so. Opening or removing covers may expose you to dangerous voltages or other hazards. Refer all servicing to qualified service personnel.
19. **Damage Requiring Service -** Unplug this product from the wall outlet and refer servicing to qualified service personnel under the following conditions:
    a) When the power-supply cord or plug is damaged.
    b) If liquid has been spilled, or objects have fallen into the equipment.
    c) If the equipment has been exposed to rain or water.
    d) If the equipment does not operate normally by following the operating instructions.
    e) If the equipment has been dropped or damaged in any way.
    f) When the equipment exhibits a distinct change in performance - this indicates a need for service.
20. **Adjust only those controls that are covered by the operating instructions.** Improper adjustment of other controls may result in damage and will often require extensive work by a qualified technician to restore the equipment to its normal operation.
21. **Replacement Parts -** When replacement parts are required be sure the service technician has used replacement parts specified by the manufacturer or that have the same characteristics as the original part. Unauthorised substitutions may result in fire, electric shock or other hazards.
22. **Safety Check -** Upon completion of any service or repairs to this product, ask the service technician to perform safety checks to determine that the equipment is in proper operating condition.
23. **Wall or Ceiling Mounting -** The equipment should be mounted to a wall or ceiling only as recommended by the manufacturer.
24. **Heat -** The equipment should be situated away from heat sources such as radiators, heat registers, stoves or other products (including amplifiers) that produce heat.

Keeping your audio recordings and reference materials neatly arranged and categorised is a very important part of the maintenance process. Libraries such as this one make locating archived programmes and raw recordings an easy process.

Chapter 8

ASSESSING TRAINING REQUIREMENTS

Now that we've had a look at the responsibilities involved in maintaining equipment in good order, it's time to ask ourselves an important question: What are the technology related **training requirements** required for our CR station?

(Of course, your station staff may require a variety of inputs and capacity building measures in terms of running/managing a station, mobilizing the local community whom the station addresses, and developing a feedback mechanism that allows the incorporation of listeners' opinions into the stations' programming. But for the moment, we will confine ourselves to the question of technology related training, as that is the primary focus of this manual.)

The first step to assessing your technological training requirements is, of course, to ask yourself what level the various members of your team are at (with reference to their ability to interact with technology):

1. **Absolute novice** (no idea regarding equipment, operation or repair)
2. **Trainee** (Has some understanding of practical usage of equipment, but must be accompanied by more experienced people)
3. **Operating level** (can operate equipment comfortably and competently);
4. **Expert operating level** (can operate equipment and can fix common operating issues and make fine adjustments to the equipment if required)
5. **Basic Repair level** (can fix most simple problems in equipment easily)
6. **Advanced repair level** (can handle advanced electronic repair equipment and has an excellent understanding of circuits, circuit diagrams, soldering, and electronic theory.)

A technical training in progress. CR volunteers learn how to install and setup software on their editing system.

Assessing training needs

Technical training can also be of different types: How to operate various kinds of equipment of software; how to make common repairs on studio or field equipment; or even electrical repairs and maintenance To assess the **type of technical training** that you and your team require, you will first have to answer the following questions:

1. Are there any community members who have any knowledge of electronics, electricals and/or equipment repair that we can access readily? (If so, what kind of skills do they have, and will they be willing to volunteer their expertise to the CR station?)
2. What kind of equipment are we going to install in the CR station? Will the station staff need any training to operate this equipment? Will this equipment have any simple components or pieces that we can maintain on our own within the staff?
3. Are there any equipment repair shops or service centers nearby which can undertake some of the simple maintenance responsibilities? If yes, can this service center/repair shop train some of the CR staff in basic repairs?
4. What kind of advisers and training facilities can we access outside the immediate community? (Are there any courses or service trainings offered by equipment suppliers which are relevant to our setup and equipment?)
5. Can we work out a training process with whoever installs the equipment and sets up the studio for us? What kind of trainings can these be? (Installation/Operation/maintenance/simple repairs/complex repairs?) How many such trainings can be arranged - and where?
6. What are the points to consider when we budget for trainings to address these needs?
7. Can we hire a specialist repair and maintenance technician to run the repair and maintenance process, or will this have to be an additional responsibility for management or an identified member within the staff?
8. Will we undertake the training of fresh volunteers and technical staff ourselves, or will we access outside resource persons or organizations for this? (That is: Will we become technical master trainers ourselves, or will we just learn what needs to be done and outsource the training process?)

It is important to remember that it is almost impossible to become experts at everything - being a service technician requires several years of training and an expert understanding of electronics, for instance.

It is also wise to recognize that your training requirements will be different at different points in time; and that training is likely to be a continuous part of the process of running a CR station: At the beginning, you may have to access training from outside the immediate community; and you might like to get the kind of training that lets you get the station off the ground and running quickly - an important consideration given that CR guidelines in India state that the station must be broadcasting within three months of obtaining the Grant of Permission agreement. (Given that you are unlikely to actually acquire equipment and set up the studios before your application crosses the first set of clearances from the various ministries - see the guidelines in next chapter - this actually doesn't leave you with very much time for the set of trainings!)

CR volunteers from Mandakini Ki Awaaz CR in Uttarkhand conduct an internal training for other members of the group. Technical and production training must be a continuous process.

Later in the process, you may establish a **sustained programme** that lets the senior members of the team take on some of the training processes themselves, as they will now be reasonably familiar with the equipment and operation. Building an internal training process also has the advantage of being **low cost**, from the station's perspective - outside trainers may charge you for their expertise - and **sustainable**, as skills acquired by staff can be passed on and preserved even if they leave.

It is important, therefore, to create a combination training plan that keeps in mind the available skills and the requirements of the CR station in the long term, in this fashion:

1. **Initial training:** The training of the core personnel/volunteers and producers of the CR station just before it commences operations;

2. **On-going training:** The continual training process of staff as new members join and old ones leave; and as equipment, technologies and content production techniques change.

Training resources

Many training resources in the form of **manuals** and **guides** (like the one you are reading, for instance) or **online internet based articles** are readily accessible if you are willing to do some research . Several organizations also run **online training courses** on various aspects of content production and equipment handling.

For a basic list of online web based resources on radio and community radio technology, see **Appendix 5: Useful Web-based Resources** on Page 265

Several organizations and individuals also provide training in radio, radio programming, radio technology and station setup. Some of them can provide an entire package of services that can help your team develop a CR station from scratch, and assist you through to your first few months on air.

For a list of organizations and individuals with experience in working on community radio, radio programming, station setup and equipment setup, see **Appendix 3: Index of Advisory Organizations & Individuals** on Page 254

It may be a good idea to discuss the trainings that staff from other CR stations have attended or been a part of, including the kind of advisers and trainers that they have had in the past. This may give you a few clues regarding where you can access training, and who from. Last but not least, it will probably give you an idea of whether the training the other station's staff received was any good - because it should reflect in the way that station runs its operations and produces programmes!

A CR group volunteer conducts a demonstration at a local school. Planning ahead often means grooming young people who can bring energy, dynamism and hard work to the station.

Chapter 9

Community Radio Guidelines in India and Their Implications

In this chapter, we'll see the entire CR guidelines issued by the Govt. of India when it permitted the setting up of CR stations in November 2006. While a large portion of the guidelines are not related specifically to the technology of community radio, there are a few clauses that do specify certain parameters that have to be followed. Use this entire text as a reference for the guidelines and for the application procedure. The sections that have technological implications have notes inserted to explain and clarify what the implications are.

Policy Guidelines for setting up Community Radio Stations in India

Foreword

In December 2002, the Government of India approved a policy for the grant of licenses for setting up of Community Radio Stations to well established educational institutions including IITs/IIMs.

The matter has been reconsidered and the Government has now decided to broad base the policy by bringing 'Non-profit' organisations like civil society and voluntary organisations etc under its ambit in order to allow greater participation by the civil society on issues relating to development & social change. The detailed policy guidelines in this regard is given below:

1. Basic Principles

An organisation desirous of operating a Community Radio Station (CRS) must be able to satisfy and adhere to the following principles:

a) 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.

b) The CRS to be operated by it should be designed to serve a specific well-defined local community.

c) It should have an ownership and management structure that is reflective of the community that the CRS seeks to serve.

d) Programmes for broadcast should be relevant to the educational, developmental, social and cultural needs of the community.

e) 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).

2. Eligibility Criteria

(i) The following types of organisations shall be eligible to apply for Community Radio licences:

a) Community based organisations, which satisfy the basic principles listed at para 1 above. These would include civil society and voluntary organisations, State Agriculture Universities (SAUs), ICAR institutions, Krishi Vigyan Kendras, Registered Societies and Autonomous Bodies and Public Trusts registered under Societies Act or any other such act relevant for the purpose. Registration at the time of application should at least be three years old.

b) Educational institutions

(ii) The following shall not be eligible to run a CRS:

a) Individuals;

b) Political Parties and their affiliate organisations; [including students, women's, trade unions and such other wings affiliated to these parties.]

c) Organisations operating with a motive to earn profit;

d) Organisations expressly banned by the Union and State Governments.

3. Selection Process & Processing of the applications

(a) Applications shall be invited by the Ministry of I&B once every year through a national advertisement for establishment of Community Radio Stations. However, eligible organisations and educational institutions can apply during the intervening period between the two advertisements also. The applicants shall be required to apply in the prescribed application form along with a processing fee of Rs.2500/- and the applications shall be processed in the following manner:

i) Universities, Deemed Universities and Government run educational institutions will have a single window clearance by putting up cases before an inter-ministerial committee chaired by Secretary (I&B) for approval. No separate clearance from MHA & MHRD shall be necessary. Once the WPC Wing of the Ministry of Communication & IT earmarks a frequency at the place requested by the institution, a Letter of Intent (LOI) shall be issued.

ii) In case of all other applicants, including private educational institutions, LOI shall be issued subject to receiving clearance from Ministries of Home Affairs, Defence & HRD (in case of private educational institutions) and frequency allocation by WPC wing of Ministry of Communication & IT.

Notes

The application for permission to set up a CRS is available on the Govt. of India's Ministry of Information & Broadcasting's website (**http://mib.nic.in/CRS/CRSmainpg.htm**). This is the CR related link, and contains detailed FAQs and guidelines, as well as the status of applications pending with the Ministry.

The application requires the attachment of a variety of background documents that prove the authenticity of your organization and its work within the community the CRS will address. It also requires the completion of some proposed site related data, and the attachment of a map on which you are expected to mark the site of the CR station and antenna mast/tower. This can be a simple map, even hand drawn, that gives a broad idea of the surrounding area and the location of your CRS.

The application must be filed with the office of the Under Secretary (FM) at the Ministry for Information & Broadcasting.

(b) A time schedule for obtaining clearances as below shall be prescribed:

i) Within one month of receipt of the application in the prescribed form, the Ministry of I&B shall process the application and either communicate to the applicant deficiencies, if any, or will send the copies of the application to the other Ministries for clearance as prescribed in para 3(a)(i) and 3(a)(ii) above, as the case may be.

ii) The Ministries concerned shall communicate their clearance within three months of receipt of the application. However, in the event of the failure of the concerned ministry to grant the clearance within the stipulated period of three months, the case shall be referred to the Committee constituted under the Chairmanship of Secretary (I&B) for a decision for issue of LOI.

Notes

The process of verification of the applicant's antecedents and background is conducted through an **Intelligence Bureau (IB)** enquiry ordered by the Ministry for Home Affairs, and through the local police department. This usually involves a visit by an IB person, who may inspect your records and ask for various background details regarding your operation, current projects and the details included in your application form.

Subsequently, the authorized representative of the applying organization will also be invited to make a presentation to a Community Radio **screening committee** at the Information & Broadcasting Ministry's offices in New Delhi. The presentation should give the background on the organization and the reasons for applying for a CR license. This is usually followed by an interview/question-and-answer

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session where you may be asked detailed questions regarding your application and the need for a CR station in your area for the proposed community. The panel for the screening committee is composed of civil society representatives as well as government representatives.

iii) In the event of more than one applicant for a single frequency at a given place, the successful applicant will be selected for issue of LOI from amongst the applicants by the Committee constituted under the Chairmanship of Secretary (I&B) on the basis of their standing in the community, the commitment shown, the objectives enunciated and resources likely to be mobilized by the applicant organisation as well as its credentials and number of years of community service rendered by the organisation.

iv) Within one month of the issue of the Letter of Intent (LOI) the eligible applicant will be required to apply, in the prescribed format and with the requisite fee, to the WPC Wing of the Ministry of Communication & IT, Sanchar Bhawan, New Delhi for frequency allocation & SACFA clearance.

Notes

One of the primary questions that CRS applicants need to ask themselves is - when do we actually buy the equipment we need and set up the physical station premises? The answer to that is: When you receive the **Letter of Intent**, because once you receive this, your application is on reasonably safe ground. There is still the chance that the WPC and SACFA clearance may not be forthcoming - see below - but this is primarily a greater issue for CR stations in urban areas. To buy equipment before the LoI is a distinct risk.

It also makes sense to start setting up your equipment and station at this point, because officially, you are just 6 - 8 months from here to going to air: You are expected to commence broadcast within 3 months of receiving the Grant of Permission Agreement that follows WPC and SACFA clearance. That's usually too short a period to set up, test and start using transmission equipment. Buying equipment at the LoI stage gives you the time to do this properly.

Of course, this discussion assumes that activities like mobilizing the community and establishing a volunteer based staff for the CRS are already complete or ongoing - that is something you definitely will not be able to complete even if you start those activities when you receive the LoI!

v) A time frame of six months from the date of application is prescribed for issue of SACFA clearance. In the event of non-receipt of such clearance from the Ministry of Communication & IT within the stipulated period of six months, the case will be referred to the Committee constituted under the Chairmanship of Secretary (I&B) for a decision.

Notes

The **WIRELESS PLANNING & COORDINATION (WPC)** Wing of the Ministry of Communications is the National Radio Regulatory Authority responsible for Frequency Spectrum Management, including licensing and caters to the needs of all wireless users (Government and Private) in the country. It exercises the statutory functions of the Central Government and issues licenses to establish, maintain and operate wireless stations. WPC is divided into major sections like Licensing and Regulation (LR), New Technology Group (NTG) and Standing Advisory Committee on Radio Frequency Allocation (SACFA). SACFA makes the recommendations on major frequency allocation issues, formulation of the frequency allocation plan, making recommendations on the various issues related to International Telecom Union (ITU), sorting out of problems referred to the committee by various wireless users, and issuing siting clearance of all wireless installations in the country.

Based on WPC records, official policy and existing stations and plans for future expansion, these bodies decide whether your application for a transmitter of a particular strength and a mast of a particular height can be permitted - especially in cases where more than one CRS may be set up to address different communities within overlapping or congruous geographical areas. WPC also decides whether your transmitter meets specifications as per the ITU-R broadcast guidelines and is responsible for the allocation of your station's frequency.

It may be wise to remember that the WPC can also decide to reduce the power of your station in order to prevent overlaps with other stations nearby, and to refuse frequency allocation altogether if too many stations have been set up already in your proposed geographical area of work. (This issue is set to become extremely acute in the near future in urban and peri-urban areas, where commercial and campus FM radio stations have already been allocated a number of stations and frequencies, leaving little space for new CR stations.)

SACFA clearance applications can ONLY be filed online on the WPC website - **www.wpc.dot.gov.in.** The process involves registering yourself as a user and logging in with your user identity and password; completing the form (which includes details regarding the fee that has to be paid by Demand Draft to WPC, so it's a good idea to make the DD before you sit down to apply!); getting an online application number; and submitting a hard copy of the completed application along with the fee demand draft to WPC. Details are given on the WPC website itself, including a step-by-step guide for applying parties. The website can also be used to track the status of your application at any given point in time.

The SACFA clearance application also involves the submission of a **second map** of the geographical area where the proposed station will be located, clearly indicating the station's own location within this area. The primary consideration for this map is that there should be latitude and longitude markings on it that help to identify the precise position of the CRS. While a Survey of India map is ideal for

Contd...

this purpose, it is likely to be expensive and may not be easy to access for everyone. The WPC is therefore willing to accept even commercially available maps in the 1:100,000 or better (1:50000) scale - the more the detail, the better - with latitude and longitude marked on the map by a qualified geographer or architect.

WPC is also responsible for deciding the spectrum usage fee for each station, a fee levied by the Govt. of India for the right to use specific bands of the radio spectrum for broadcasting. While there has been much debate on this with regard to CR stations, this is a necessary reality that you will have to plan for: A 100 Watt ERP transmission system in the plains area, with a reach of 5 - 12 kms is likely to pay an annual fee of Rs.19700 to the DoT for spectrum usage. Remember that just because the guidelines mention 100W ERP transmission - with a possibility of 250W ERP setups in certain geographical conditions - and a 30 metre mast, it doesn't necessarily mean you have to apply for the maximum possible: If your coverage area crosses the 25 km range, the annual spectrum fee becomes approximately Rs.36000!

vi) On receipt of SACFA clearance (a copy of which shall be submitted by the applicant), the LOI holder shall furnish a bank guarantee in the prescribed format for a sum of Rs.25, 000/-. Thereupon, the LOI holder will be invited to sign a Grant of Permission Agreement (GOPA) by Ministry of I&B, which will enable him to seek Wireless Operating License (WOL) from the WPC Wing of the Ministry of Communication & IT. The Community Radio Station can be made operational only after the receipt of WOL from the Ministry of Communication & IT.

vii) Within three months of receipt of all clearances i.e signing of GOPA, the Permission Holder shall set up the Community Radio Station and shall intimate the date of commissioning of the Community Radio Station to the Ministry of I&B.

viii) Failure to comply with time schedule prescribed above shall make the LOI/GOPA holder liable for cancellation of its LOI/GOPA and forfeiture of the Bank Guarantee.

4. Grant of Permission Agreement conditions

i) The Grant of Permission Agreement period shall be for five years.

ii) The Grant of Permission Agreement and the Permission letter will be non-transferable.

iii) No permission fee shall be levied on the Permission Holder. However, the Permission Holder will be required to pay the spectrum usage fee to WPC wing of Ministry of Communication & IT.

iv) In case the Permission Holder does not commence his broadcasting operations within three months of the receipt of all clearances or shuts down broadcasting activity for more than 3 months after commencement of operation, its Permission is liable to be cancelled and the frequency allotted to the next eligible applicant.

v) An applicant/organisation shall not be granted more than one Permission for CRS operation at one or more places.

vi) The LOI Holder shall furnish a bank guarantee for a sum of Rs.25,000/- (Rupees twenty five thousand) only to ensure timely performance of the Permission Agreement.

vii) If the Permission Holder fails to commission service within the stipulated period, he shall forfeit the amount of bank guarantee to the Government and the Government would be free to cancel the Permission issued to him.

5. Content regulation & monitoring

i) 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.

ii) At least 50% of content shall be generated with the participation of the local community, for which the station has been set up.

iii) Programmes should preferably be in the local language and dialect(s).

iv) The Permission Holder shall have to adhere to the provisions of the Programme and Advertising Code as prescribed for All India Radio.

v) The Permission Holder shall preserve all programmes broadcast by the CRS for three months from the date of broadcast.

Notes

As discussed previously in the manual, this clause refers to the mandatory requirement that every CRS preserve recordings of its broadcasts over the 3 months preceding any given day of operation.

This means we have to record our broadcasts on a continual basis, with recordings older than 3 months junked or erased simultaneously to make space for new recordings.

Thus, if today is the 1st of June, at this point in time, we will have to be in possession of broadcast recordings from the 1st of March onwards, so that we have three complete months of programmes - March, April and May - on file. Tomorrow, on the 2nd June, we can erase programmes recorded on the 1st of March, as the three month clause means we need to have recordings starting on the 2nd of March.

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The three month archiving system is mandated in order for the government - or any mandated authority vested with the power of investigating complaints against the programming generated by the CR station - to be able to call for and listen to a copy of the programme in question. (If programmes are not preserved, they would be broadcast and would then be lost forever, making such a process of investigation and adjudication impossible.) The implications for the CRS of this clause are that it has to set up an efficient archiving system that records the on air broadcast and preserves it on a storage medium that will not call for too much physical space.

At its simplest, the on-air programming can be recorded on cassette tape, clearly marked with day and date, and stored in a 'library' - which essentially needs to be no more than a cupboard that can store a reasonably large number of tapes. (At 60 minutes per tape, make an estimation of the number of tapes that will mean: Even two hours of programming a day means 2 hours/2 tapes x 30 days x 3 months = 180 tapes!)

Modern digital audio - if the CRS can afford it - can make this process less cumbersome, as digital storage essentially means recording on air programming directly onto a hard disk. Compression technology allows us to store good quality audio in relatively little space, and hard disks are becoming cheaper every day. So a single 500 Gigabyte hard disk should comfortably store nearly 500 x 1000 = 500000 minutes of broadcast quality programming: More than 8000 hours of programming!

Of course, the thing to remember with such a dedicated archiving computer is that there should be provisions to regularly back up the material that it is recording, so that a single system failure does not wipe out a large quantity of programming. This is especially significant assuming that you want to go beyond the three month regulation and store programming on an ongoing basis. (This is not required under the guidelines, but is good practice as a CRS, since you may reuse programming later, and be able to share it with other CR stations, with or without compensation.) It is therefore a good idea to equip such a system with a DVD writer, so that accumulated programming can be written to DVDs at intervals, and preserved off-system. DVDs don't take up much space in their slim cases, and if treated well, can be a long term storage method.

vi) The Permission Holder shall not broadcast any programmes, which relate to news and current affairs and are otherwise political in nature.

vii) The Permission Holder shall ensure that nothing is included in the programmes broadcast which:

a. Offends against good taste or decency;

b. Contains criticism of friendly countries;

c. 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;

d. Contains anything obscene, defamatory, deliberate, false and suggestive innuendoes and half truths;

e. Is likely to encourage or incite violence or contains anything against maintenance of law and order or which promote-anti-national attitudes;

f. Contains anything amounting to contempt of court or anything affecting the integrity of the Nation;

g. Contains aspersions against the dignity of the President/Vice President and the Judiciary;

h. Criticises, maligns or slanders any individual in person or certain groups, segments of social, public and moral life of the country;

i. Encourages superstition or blind belief;

j. Denigrates women;

k. Denigrates children.

l. 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.

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

a) Exploitation of religious susceptibilities; and

b) Committing offence to the religious views and beliefs of those belonging to a particular religion or religious denomination.

6. Imposition of penalty/revocation of Permission Agreement

(i) In case there is any violation of conditions cited in 5(i) to 5(viii), Government may suo motto or on basis of complaints take cognisance and place the matter before the **Inter-ministerial Committees on Programme and Advertising Codes** for recommending appropriate penalties. On the recommendation of the Committee a decision to impose penalties shall be taken. However, before the imposition of a penalty the Permission Holder shall be given an opportunity to represent its case.

(ii) The **penalty** shall comprise of:

(a) Temporary suspension of Permission for operating the CRS for a period up to one month in the case of the first violation

(b) Temporary suspension of Permission for operating the CRS for a period up to three months in the case of the second violation depending on the gravity of violation.

(c) Revocation of the Permission for any subsequent violation. Besides, the Permission Holder and its principal members shall be liable for all actions under IPC, CrPC and other laws.

(iii) In case of revocation of Permission, the Permission Holder will not be eligible to apply directly or indirectly for a fresh permission in future for a period of five years.

"Provided the penalty imposed as per above provision shall be without prejudice to any penal action under applicable laws including the Indian Telegraph Act 1885 and Indian Wireless Telegraphy Act 1933, as modified from time to time."

(iv) In the event of suspension of permission as mentioned in para 6 (ii) (a) & (b), the permission holder will continue to discharge its obligations under the Grant of Permission Agreement during the suspension period also.

7. Transmitter Power and Range

i) CRS shall be expected to cover a range of 5-10 km. For this, a transmitter having maximum Effective Radiated Power (ERP) of 100 W would be adequate. However, in case of a proven need 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 up to 250 Watts can be considered on a case-to-case basis, subject to availability of frequency and such other clearances as 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.

Notes

The strength of a transmitter, like the power in an electrical circuit, is measured in Watts. Essentially, this refers to the amount of electrical energy that it converts to radio wave (or electromagnetic) energy. Thus, a 30 Watt transmitter would consume a little more than 30 Watts of electricity - there is some internal loss in the system, and the conversion is not 100% efficient - and give an output of roughly 30 Watts worth of electromagnetic energy.

However, it is important to remember that just the transmitter's output does not tell us the station's output strength, because the actual strength - or Effective Radiated Power, ERP - is a combination of the transmitter's strength and the amount this is magnified by the antenna we use. (The magnification is called 'gain', and this is a natural property of the antenna based on the materials it is constructed out of and its physical structure and shape. It is also directional in nature, with the gain - and therefore the ERP - varying at different points with reference to the antenna.)

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Essentially, this means that the sum total of the two - the net strength of our station, as it were - must be a maximum of 100 Watts, with 250 Watts allowed in geographically difficult areas. Practically, this means if we select the correct combination of transmitter and antenna, our actual transmitter strength can be as low as 30 Watts, since gains of 3x (3 times the transmitter strength) are easily achievable through many antennae.

At the same time, we must factor in losses of signal strength caused by the cables connecting the studio to the transmitter, and the transmitter the antenna, which can also be an important consideration, especially if the transmitter has to be located at a little distance from the studio.

As noted earlier, please be aware that these are merely wattages and limits specified by the Govt. guidelines - whether you actually are allowed a transmitter of a specific output, or a mast of a particular height is dependent on WPC and SACFA clearance, as seen above.

ii) 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 RF radiation.

Notes

As discussed earlier in the manual, keeping the antenna high off the ground not only prevents it from being accidentally obstructed, but also gives the antenna a vantage point from which it can broadcast over a larger area.

This clause states that the metal pole or antenna tower on which the antenna is mounted for this purpose - the antenna unit itself is only a couple of feet long in most cases - can be a maximum of 30 metres high. It also states that the antenna must be at least 15 metres off the ground to safeguard against any radiation hazards caused by the electromagnetic energy emanating from it.

What you must remember is that this in no way restricts you from installing the antenna on a hillock or mountain overlooking your potential broadcast area as long as this falls within the space where your listener community resides, and considerations of equipment and studio location allow this (see the section on Studio Transmitter Links). Thus, even with the height restriction this clause imposes, you can actually get a much larger broadcast area if you can exploit some natural formations in your geographical area.

It is also a good idea to take advantage of building height if possible: If you install a 15 metre antenna on a 15 metre building, remember that you are actually getting the advantage of a 30 metre height with half the actual mast length.

iii) Universities, Deemed Universities and other educational institutions shall be permitted to locate their transmitters and antennae only within their main campuses

iv) 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.

Notes

Taking off from the point above, this clause specifies that you cannot install your antenna mast or tower on any convenient location just because it affords you a bigger broadcast area: It has to be in an area that falls within the space occupied by your potential listener community. In hilly regions, of course, the population may be sparse, and distributed up and down valleys or both sides of a hill or mountain. In such cases, we have relatively greater flexibility to decide the best placement of the antenna tower, as the definition of what constitutes the listener community's geographical area is rather hard to define exactly.

8. Funding & Sustenance

i) Applicants will be eligible to seek funding from multilateral aid agencies. Applicants seeking foreign funds for setting up the CRS will have to obtain FCRA clearance under Foreign Contribution Regulation Act, 1976.

Notes

Please remember that this means if you access funding from a donor agency to purchase equipment and/or set up your CR station, the wording of the policy suggests that funding can only be obtained through UN agencies or international aid agencies that are not part of the bilateral government-to-government aid system.

Also, this means that accessing funds - whether in cash or in equipment form - is governed by Foreign Currency Regulation Act norms. If your organization does not have permanent registration with the FCRA authorities, it may have to apply for 'prior permission' clearance for the funds or in kind assistance that it hopes to access. This process takes time, and must be factored in when planning the station setup and/or equipment purchases. Consult a good chartered accountant to figure out this process if you think you need help on this.

Note that United Nations funding is not governed by FCRA regulations.

ii) Transmission of sponsored programmes shall not be permitted except programmes sponsored by Central & State Governments and other organisations to broadcast public interest information. In addition, limited advertising and announcements relating to local events, local businesses and services and employment opportunities shall be allowed. The maximum duration of such limited advertising will be restricted to 5 (Five) minutes per hour of broadcast.

iii) Revenue generated from advertisement and announcements as per Para 8 (ii) shall be utilized only for the operational expenses and capital expenditure of the CRS. After meeting the full financial needs of the CRS, surplus may, with prior written permission of the Ministry of Information & Broadcasting, be ploughed into the primary activity of the organization i.e. for education in case of educational institutions and for furthering the primary objectives for which the NGO concerned was established.

9. Other Terms & Conditions

i) The basic objective of the Community Radio broadcasting would be to serve the cause of the community in the service area of the Permission Holder by involving members of the community in the broadcast of their programmes. For this purpose community shall mean people living in the zone of the coverage of the broadcasting service of the Permission Holder. Each applicant will have to specify the geographical community or the community of interest it wants to cover.

The Permission Holder shall provide the services of his CRS on free-to-air basis.

ii) Though the Permission Holder will operate the service under these guidelines and as per the terms and conditions of the Grant of Permission Agreement signed, the permission shall be subject to the condition that as and when any regulatory authority to regulate and monitor the broadcast services in the country is constituted, the permission holder will adhere to the norms, rules and regulations prescribed by such authority from time to time.

iv) The Permission Holder shall provide such information to the Government on such 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.

Notes

See notes on Clause 5 (V)

v) The Government or its authorized representative shall have the right to inspect the broadcast facilities of the Permission Holder and collect such information as considered necessary in public and community interest.

vi) The Government reserves the right to take over the entire services and networks of the Permission Holder or revoke/terminate/suspend the Permission in the interest of national security or in the event of national emergency/ war or low intensity conflict or under similar type of situations.

vii) All foreign personnel likely to be deployed by way of appointment, contract, consultancy etc by the Permission Holder for installation, maintenance and operation of the Permission Holder's services shall be required to obtain prior security clearance from Government of India.

viii) The Government reserves the right to modify, at any time, the terms and conditions if it is necessary to do so, in public interest or for the proper conduct of broadcasting or for security considerations.

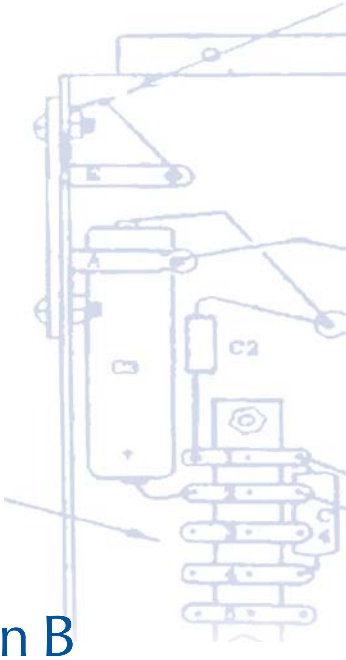
ix) Notwithstanding anything contained anywhere else in the Grant of Permission Agreement, the Government shall have the power to direct the permission holder to broadcast any special message as may be considered desirable to meet any contingency arising out of natural emergency, or public interest or natural disaster and the like, and the Permission holder shall be obliged to comply with such directions.

x) The permission holder shall be required to submit their audited annual accounts to the Government in respect of the organization/ division running the CRS. The accounts shall clearly show the income and expenditure incurred and the Assets and Liabilities in respect of the CRS.

xi) A Permission Agreement will be subject to such other conditions as may be determined by the Government.

xii) The Government shall make special arrangements for monitoring and enforcement of the ceiling on advertisements, particularly in those areas where private FM radio stations have been granted licenses.

NOTES



Section B

Detailed notes on equipment & audio concepts

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PART B: Detailed notes on equipment & audio concepts

Analog & Digital Audio

Sound travels as a series of **waves** - that is, as a continuous rise and fall in the pressure of the air at a given point in space. When we speak, our vocal chords vibrate at various frequencies, creating corresponding vibrations in the air around them. These vibrations - waves - are then transmitted by the particles that make up air, and the vibrations are passed along till they reach someone else's ears...or a microphone that is designed to pick up these vibrations.

For more on microphones, see **Section B: Microphones** on Page 198

Analog Audio

The microphone, in turn, converts these vibrations into an **electrical signal**, that rises and falls in exact correspondence with the rises and falls in the sound wave that is reaching the microphone. If the signal is then recorded on magnetic tape, what we have thus far is a process where a continuous wave or signal - even if it is changing from sound energy to electrical energy and stored as an arrangement of magnetic particles - is being preserved throughout the entire process. Since in each case, we have a signal that is analogous to the original sound wave that was produced, such signals are called **analog** signals.

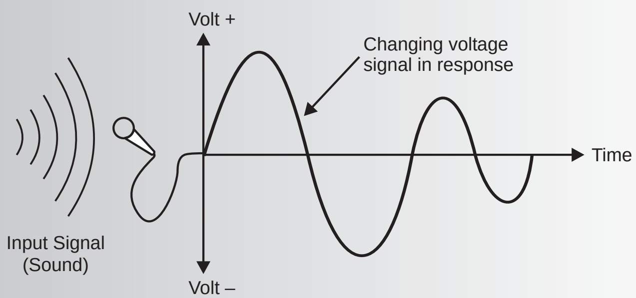

Fig 1: An analog signal produced by a microphone in response to a continuously changing sound

Digital audio

As technology progressed, however, new ways to store information became available. One such technology was **digital storage**, where information of any kind - visual, audio, or a combination of both - could be stored as a series of numbers, which together represented the original information. The information was stored usually in combinations of ones and zeros, a system of mathematics called **binary numbers.** (In fact, the fact that the storage was in the form of numeral digits was why it began to be called digital storage in the first place!)

Digital signals and storage offer us vast advantages over the older analog system:

1. Digital signals can be **stored more economically** than analog signals can. An LP or long playing record could store about a half hour's worth of music per side. Today, a small digital music player the size of a matchbox can store ten times as much.
2. Digital signals can also be **manipulated** more easily than analog signals, both in terms of clearing out unwanted components, and in terms of making changes to the signals.
3. Digital signals can also be **copied** and **duplicated** more easily: There is no deterioration of the signal across copies, unlike what used to happen with analog storage methods. This also applies to transmission of the signal through cables or broadcast, where analog signals invariably pick up some noise, but digital signals do not by virtue of the way the information is carried in both cases.

Where audio was concerned, this presents a plethora of options, with high quality audio becoming easily accessible to everyone: The first item of digital audio to make it to the market was the compact disc or CD, which stores digital data on a spinning disc of plastic encased metal.

For more on compact discs, see **Section B: Compact Discs** on Page 138 and **Section B: CD Writers** on Page 145

Increasingly, audio recording - professional or for personal use, large radio station or community radio station - relies on digital audio equipment. Computers store information digitally, as do CDs, VCDs and DVDs. However, there is a downside to using digital technology; and that has to do with the way analog sound is converted to a digital signal by the digital sound equipment we use.

A/D conversion

We have already seen that a sound, when it originates, is a continuously rising and falling wave, and hence analog in nature. To convert analog sound into a digital signal, there has to be a process where we convert the characteristics of the sound wave into a set of equivalent numbers that describes the wave. This process is called **Analog to Digital (or A/D) conversion**, and the first step in this is called **sampling.**

Sampling is essentially the process of dividing the original wave up into a series of smaller slices. Obviously, it is easier to describe each slice more accurately than one can describe the wave as a whole. And if we then have

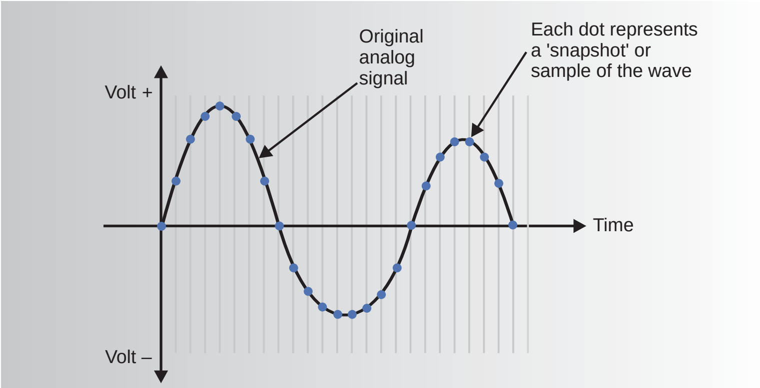

Fig 2: Analog to Digital sampling

a description of the **value** of each slice (as an equivalent number), and a description of that number's **position** in the overall list of numbers describing the wave, it is fairly straightforward to reconstruct the original wave from these descriptions.

The figure above shows the original wave, and slices we have made. We can reconstruct the wave by joining the samples (dots) that we have created. The reconstructed wave is not totally an accurate copy - it is more jagged than the original. This is the negative side of digital technology. A/D conversion is essentially a matter of **approximation**: The slices only give you an idea of what the original analog signal was like. However, this is becoming rapidly less of a drawback, as modern technology is using higher and higher sampling rates to make finer and finer slices of the original signal. If we can make the samples/slices much finer, the wave we can reconstruct from this information becomes closer and closer in shape to the original analog wave.

It is generally accepted that if the sampling rate is twice the highest frequency wave in the audio signal, the results of sampling will be indistinguishable to the human ear from the original analog sound wave. This is why digital audio on CDs are sampled at 44100 Hertz (or 44100 samples per second, 44.1 KiloHertz or KHz) - because the highest frequency detectable by the human ear is 20000 Hz, and this is more than twice that. Digital video recordings record sound at 48000 Hz, so their audio is a little higher in quality. FM stations often sample the audio at 32 KHz, as the higher frequencies - 16000 Hz and above - often get lost in the broadcast process, and we need to be concerned with recording and reproducing audio only upto that limit.

Data/Bit Rate

The other factor that controls the quality and accuracy of the digital signal is the **amount of information** we can store about each of the samples/slices:

The more information we store about each sample, the greater the accuracy in reconstructing the original wave. In digital storage, each 1 or 0 that we use is called a **bit** of information. CDs usually use **16 bit sampling** - that is, 16 bits to describe each sample. More recent pro audio equipment uses 24, 32, 48 or 96 bit sampling, leading to ever more accurate storage and retrieval.

D/A Conversion

Once the audio is stored in a digital format, we need equipment and techniques to convert it back into the original analog sound as well. The CD players, DVD players and MP3 music players that we see all around us today - including the music players built into many mobile phones - perform just this function: They convert the digital signal back into the analog signal, a process known as **D/A conversion**. This is the exact reverse of the sampling process.

As noted previously, both the sampling and the D/A conversion process involve some loss of audio information. Some people can be sensitive to this loss, and can 'feel' the difference between the digital version and the analog version of the same audio recording. But increasingly, as digital audio equipment improves, even low cost consumer grade equipment can give you a high enough grade of storage and reproduction to satisfy the vast majority of listeners.

AMPLIFIERS

The first step in recording and storing audio - and in sending it over cables or any other kind of link between pieces of equipment - is to convert the sound waves into electrical energy.

The electrical signal that is generated by transduction devices like microphones is actually a very tiny current - so small, in fact, that you will not even notice it is there if it weren't for the sensitive instruments and devices we use to monitor, interpret and store it. In order to be able to effectively store and manipulate the sound, we need to be able to raise and lower its level - that is, make the electrical signal stronger or weaker, and thereby the sound louder or softer.

This is achieved with a device called the **amplifier**. The word 'amplify' means **to increase**; and this, indeed, is the primary function of an amplifier: To increase the magnitude or size of the signal.

Gain

Gain is a measure of the amount by which an amplifier increases the size of the electrical signal. It is measured as the ratio between the strength of the output signal to the strength of the input signal. (A gain of 2, for example, shows that the output signal is twice as strong as the input signal.)

The level or strength of an audio signal is measured in **deciBels (dB);** and looked at another way, a gain of 2 can also be seen as an increase of 3 decibels (3dB).

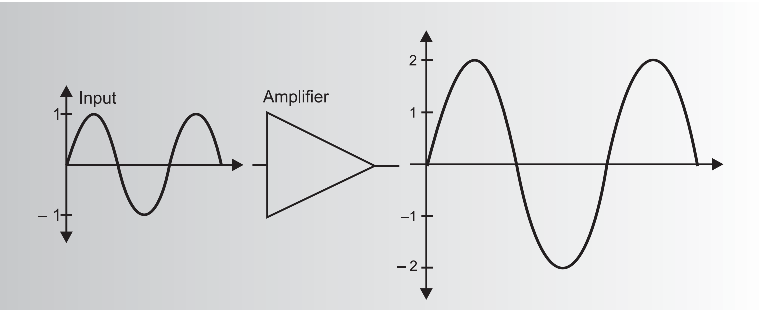

Fig 3: How an amplifier increases the level of an input signal.

Types of amplifiers

Amplifiers are one of the most essential components in a variety of audio processing situations, which makes them of special significance when we discuss their use in radio broadcasting.

1. Power amplifiers

Power amplifiers are used whenever we need to raise the **strength** of the signal high enough to drive a speaker: The larger the speaker, the larger the output required of the power amplifier...and consequently the greater the gain required of the power amplifier. Power amplifiers are often used in live sound situations - concerts, for instance - because the speakers required for the sound to reach a large gathering are very large.

Power amplifiers may or may not have controls of their own, though they commonly have a **knob** that allows you to control the gain (output). They also usually have connectors for a pair of speakers, and may accept a variety of connector types depending on the specific use they are meant for.

In the radio studio, the power amplifier is usually used to feed the **studio monitor speakers**. Most often, it is controlled from the mixing desk itself, with the faders of the mixer used to adjust the input (and thereby the output) of the amplifier.

2. Distribution amplifiers

The distribution amplifier (DA) is a type of amplifier used to keep the strength of the signal **constant across a large number of outputs** when a single source must feed multiple devices. Just as the pressure of water in a water pipe decreases if it is connected to too many taps, the strength of a signal in the system will fall if the same signal must be given to multiple outputs.

In the radio studio, there are usually a number of different pieces of equipment - and they may all need to be fed the output from a single mixer. (The same mixer may also give an output for the production studio, if the mixer in question is in the broadcast studio - and indeed, even to the voice booth or recording floor.) This means the signal will be greatly diminished if we just split it up electronically and try to feed it to all these devices. This is where the distribution amplifier comes in: The mixer output is fed to the DA, which boosts the strength of the input signal, and feeds it to a number of outputs - and thereby solving our problem of lowered signal strength.

In the radio studio, DAs typically have stereo inputs and a number of stereo outputs - often 8 outputs or more - which can then be connected to stereo recording devices and the transmission system. A low cost option would be to keep the entire system mono, and have a DA that has mono inputs and outputs; but these are comparatively rare as an option, since there is very little difference in price for such a setup.

3. Headphone amplifiers

A headphone amplifier is a specialized type of distribution amplifier that is used to connect more than one headphone to the same output.

When a programme is being made, or a transmission is taking place, more than one person will often need to listen to the audio output at the same time. Connecting multiple headphones to the same headphone socket would lead to the same situation we saw above: A weak signal that cannot be heard properly over any of the headphones. A headphone amplifier solves this by keeping the output to each pair of headphones constant.

Headphone amplifiers are often used in on air studios and on recording floors where each of the guests/speakers may be required to have a pair of headphones.

For more on headphones, see **Section B: Loudspeakers & Studio Monitors** on Page 190

4. Pre-amplifiers

Pre-amplifiers are used to boost the tiny output signals that emerge from many audio devices: Microphones, for instance, have outputs that are hardly a few microvolts strong. Pre-amplifiers boost these outputs to a level where they can be fed to other audio devices.

For more on microphones, see **Section B: Microphones** on Page 198

In many field recorders and mixers, the pre-amplifier is built into the input into which the microphone's output will be connected. It is important for the pre-amplifier to be of good quality, since it boosts the microphone's signal by a large amount (meaning it will also magnify any distortions by a large factor); and because it is the **first electronic signal processing unit** in the chain (and is therefore responsible for the quality of the signal that will be fed to all parts of the chain of electronics that follows it). A good microphone connected to a bad pre-amplifier can ruin any advantage and quality gained by the quality of the microphone.

It must be noted that among pre-amplifiers, the ones used for **LP players** (phonographs or turntables) are a specific subtype that cannot be connected to any other variety of equipment.

Balanced & Unbalanced Connections

One of the issues with transferring weak audio signals over wires is that the signals can be affected by any electromagnetic disturbances in the area. The powerful electromagnetic noise generated by overhead electrical cables, a nearby transformer field or even the Earth's own magnetic field can result in annoying distortions of the audio, or crackle, noise or hum in the circuit.

Engineers have found a number of ways to protect the signal from these disturbances, and chief among them is the concept of **balanced** and **unbalanced** connectors.

Balanced connectors

Balanced connectors constitute a system that allows us to **filter out** unwanted noise from the useful components of the signal.

The balanced connector system is composed of three wires: The **hot** and **cold** wires, which both carry the signal; and a common **screen wire**. The key to the entire system is that the hot and cold wires carry the same signal, but with the **polarity reversed** or 'out of phase' - that is, with the peaks and the troughs of the wave reversed, like this:

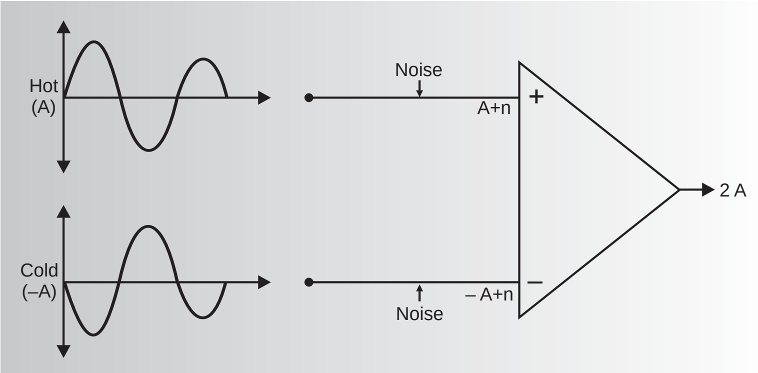

Fig 4: A balanced connector system.

As the figure shows us, the combination of the out of phase signals, and the fact that noise gets added to both wires equally allows us to output a signal that is **twice as strong** (2A) as the basic input audio (A), even while we manage to cancel out the noise (n).

Balanced connectors are found on all professional equipment - including semi professional equipment nowadays. For the system to work properly, the origin and receiving systems must both be balanced.

Unbalanced connectors

Unbalanced connectors use a two wire system where the inner **(hot)** conductor wire is surrounded by an outer wire, which is often in the form of a mesh or shield that is designed to absorb unwanted electrical disturbances. But since the system is not designed for a cancellation process like the balanced system is, the noise cannot be filtered out of the system.

Considerations

Owing to the effectives of the noise canceling system, balanced cables can be as long as 500 metres or more with no loss in the quality of the signal they carry. Unbalanced cables, on the other hand, have to be much shorter to keep the amount of noise they pick up to a moderate level. This is why balanced cables and connections are used in professional equipment, and unbalanced in consumer equipment, since the latter tends to require much shorter lengths of cable.

Balanced connections are also designed to carry a much higher signal level (usually +4 dBm) than unbalanced connections (usually - 7.8dBm). There are a number of equipment combinations and setups where we are required to connect balanced and unbalanced equipment; and when a balanced

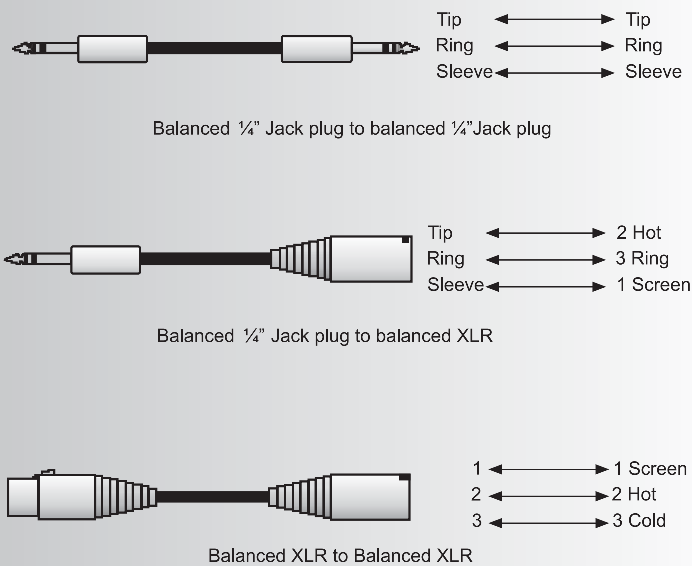

Fig 5 : Balanced connection wiring

input is connected to unbalanced equipment, we must be careful while **amplifying the signal**, since it is already at a level much higher than what the unbalanced system was designed for . Conversely, an unbalanced connector connected to a balanced input will actually be feeding it a signal that is too low for what it is designed for.

In such situations, the solution is to use a piece of equipment called a **balancing amplifier**, that converts balanced inputs to unbalanced and vice versa. The illustrations in this section show a variety of balanced and unbalanced connectors, and how the wires are connected.

For more on connectors, see **Section B: Connectors (Audio & Telecom)** on Page 166

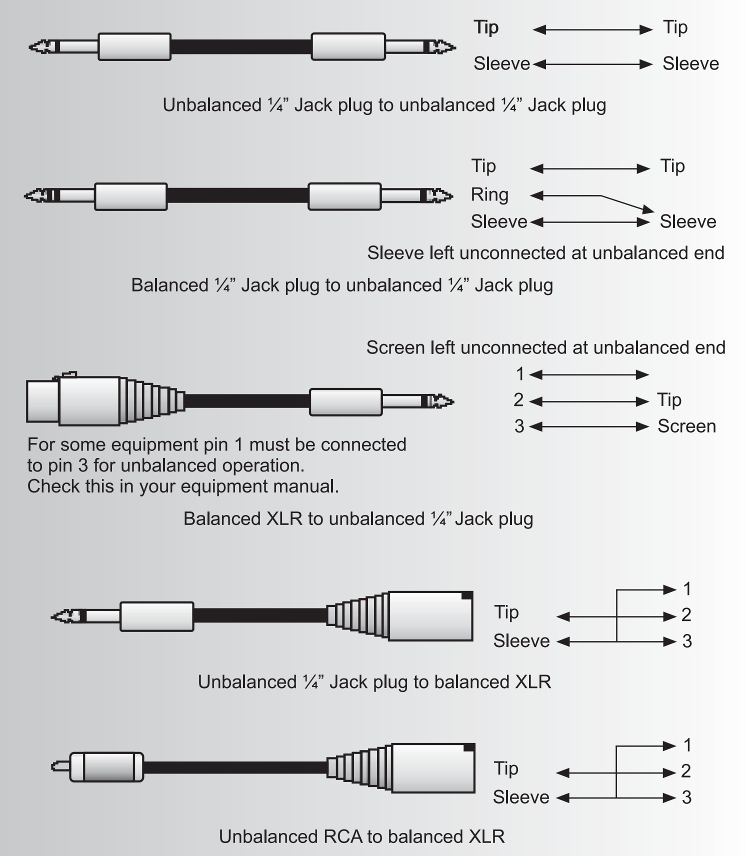

Fig 6 : Unbalanced connector wiring

Cassette Tapes & Cassette Recorders

Almost everyone, even in the relatively remote parts of the country, has heard audio played off a cassette player at some point in time. The cassette recorder has been the standard for small radio stations around the world for a long time; and though MiniDisc recorders and solid state flash memory recorders have increasingly begun to replace them, they still remain a useful part of the CR station's equipment list.

The cassette recorder is an **analog audio recording system**, and uses a recording system which we refer to as **magnetic recording**. There are two parts to any audio magnetic recording system:

- the tape it uses as the storage medium.
- the recorder, which also acts as the playback device

The Tape

Cassette tapes - and their predecessors, the spool or reel tape - are a typical example of the media used in magnetic audio recording systems. The three main features of the cassette tape are the **tape box**, the **tape ribbon** and the **plastic cassette**.

The box is a plastic case, usually with a hinged top that you open to remove the tape. The lid is often of clear plastic so that you can insert labels identifying the tape, which can then be read without opening the box.

A typical audio cassette, also known as a compact cassette. The tape ribbon is contained in a transparent plastic shell.

The tape (often also referred to as the ribbon) is essentially a long strip of plastic coated with a layer of **magnetic particles**. If you expose these magnetic particles to a magnetic field, they are permanently magnetized by the field until they are exposed to a fresh field. This is the property that magnetic recording utilizes to store the recording on the tape. This ability gives magnetic tape two of its most appealing features:

- Firstly you can record audio instantly and the tape will "remember" what was recorded for playback.
- Secondly you can erase the tape and record something else on it.

For more on magnetic recording, see **Section B: Magnetic Recording** on Page 193

Tape Type & Length

Cassettes are available in of various lengths. The ones most commonly sold in shops are **60-minute** or **90-minute** cassettes. A 90-minute cassette has 135 meters of tape inside it, which runs at 1 7/8th inches per second in the recorder.

Cassettes are also usually available in three types of coatings. In increasing order of audio quality, these are:

- **Ferric oxide**, where the magnetic particles are actually particles of an iron compound called ferric oxide. This is the most common type, and the kind most cassette recorders can record on
- **Chrome**, where particles of chromium dioxide are mixed in with the ferric oxide
- **Metal tape**, which uses particles of pure metal rather than an oxide compound

Metal tapes can be played back on all cassette players, but can only be recorded on recorders which have a special setting for metal tapes. Most professional cassette recorders will have a small switch that lets you shift between 'Normal' (Ferric Oxide), 'Chrome' and 'Metal' settings

The Cassette

The cassette is a fairly simple protective covering and case for the tape. In cassettes, the tape is usually attached to and wound around two **plastic cores**, two **rollers** and the plastic **outer shell** that protects the tape. (In spool tapes, the tape ribbon is loose, and is physically wound around the core of a plastic spool by the user.) There is also a small **felt pad** that keeps the tape pressed against the the record/playback head in the tape player.

The cassette also has two **protective tabs** on top. When these tabs are broken off, you can no longer record on the tape. Use a pen or something similar to gently break the tabs when necessary. If you have broken these tabs, but want to record onto the cassette again, you can cover the holes you have made by covering the tab slots with two small pieces of sticky tape. Be sure that the tape is securely stuck down, so that it cannot come loose while inside the cassette recorder.

Things to remember when using cassette tapes and recorders

The relatively poor quality compared to CD and reel-to-reel, and lack of editing facility, mean many broadcasters believe cassettes are not appropriate for regular use. Nevertheless, the cassette tape's small size and the almost universal access to cassette tape decks in studios make it a very useful medium.

Because the tape is contained inside the cassette, compact cassettes are very robust. However to protect your recordings, you should handle tapes with care.

- **Keep cassettes in their cases when not in use.**
- **Keep tapes away from magnetic fields.** The tape is a magnetic medium, so exposing the tape to a strong magnetic field will affect the stored sound. In the studio, computer screens and loudspeakers often have strong magnetic fields. So leaving tapes near the computer, or on top of a loudspeaker, is not good practice.
- **Always label the cassettes you are using.** A fresh blank tape usually includes a labelling sheet. People finding unlabelled cassettes lying around in the studio may record over them, and you may lose important sound that you will never be able to record again. Another reason is that you may lose your cassette and it will take time to listen to a whole lot of unmarked or poorly marked tapes to find the sound you need. Ensure that labels and stickers identifying tapes are not loose or peeling off. The labels can cause the tape to get stuck in the tape deck and will damage the machine.

Most tape decks have an **unbalanced stereo output**, although some more expensive broadcast tape decks have a balanced stereo output. **RCA connectors** are usually used for the unbalanced output. The left and right channels are usually colour coded, with **red** indicating right, and **white** left. These outputs are connected to the tape channel inputs on the mixing desk. In some instances these can be passed through a balancing amplifier before being connected to the mixer. In some studios they may also be connected to the studio patch panel.

Most cassette recorders and decks also have a stereo input for recording. Again this is most often through unbalanced RCA connectors or phono connectors. The tape deck is usually fed with audio directly from the recording bus of the mixing desk, or via a distribution amplifier connected to the recording bus. Some broadcast tape decks have a control input that allows the tape-deck to be controlled from the mixer.

Cleaning & Maintenance of cassette recorders

On the whole, however, tape recorders needs very little maintenance. The most important thing to remember is to clean tape heads and the compartment.

The tape heads should ideally be cleaned after every five hours of use. To clean the heads, take a cotton wool earbud and cleaning alcohol such as surgical spirits. Both earbuds and surgical spirit are available from most pharmacies. After shave lotion will work in an emergency.

Dip the earbud into the spirit so that it is moist but not dripping wet. Then gently rub the earbud over the heads in the tape deck. Avoid touching the plastic and rubber parts of the device with the spirit.

The main dirt that collects in the compartment will be dust and fluff. It is difficult to avoid getting dust in the compartment, but you can minimise the problem by keeping the compartment closed when not in use and by regularly cleaning the studio. If you see any bits of fluff or other dirt, gently pull them out using a pair of tweezers.

Most tape decks come with a noise reduction system to minimise unwanted noise during recording and playback. **Dolby Noise Reduction** is the most common system. Using the Dolby system properly will improve tape sound quality. For the best results, a recording made using a noise reduction system must be played back using the same system. If your station chooses to use noise reduction, then all the tape decks in the station need to be set to use the same noise reduction system.

Compact Discs

The compact disc is a **digital audio medium**. The disc stores stereo 16-bit audio sampled at 44.1 KHz. As an industry specification developed when CDs were invented, CDs can record 74 minutes 33 seconds of audio at this quality, although many newer CDs store up to 80 minutes. In terns of the amount of digital data that can be stored on a CD, this translates to 650 Megabytes (MBs) of information (700 MB for newer CDs).

Prerecorded audio CDs contain audio items such as songs organised into **tracks**, with each track identified by a track number. However, CDs can also contain **digital data** of other kinds, in which case they may be seen as files, much as you can see them on a computer's hard disk. If the CD contain audio in other digital audio formats like **mp3** or **wav**, this audio data will not be seen as tracks, but as data files.

A CD is only 120mm (millimetres) in diameter and about 1.2 mm thick. Most of a CD consists of a piece of **clear polycarbonate plastic**. During manufacturing, this plastic is impressed with microscopic bumps, arranged as a single, continuous, extremely long spiral track of data. These bumps mark the binary numbers, that is, the 1's and 0's (bits), which make up the digital audio on the disc. In the case of a data CD that is used in a computer, the bumps mark the bits that make up the data files stored on the CD. In all other respects it works in exactly the same way.

Once the clear piece of polycarbonate is formed, it is covered with a thin, **reflective aluminium layer**. A thin **acrylic layer** is then sprayed over the aluminium to protect it. The label and artwork is then printed on the acrylic.

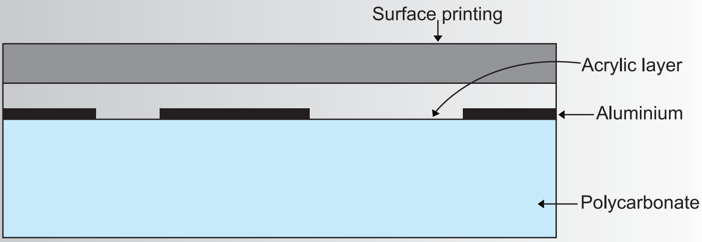

Fig 7 : Cross Section of a CD

The data track on the CD spirals outwards from the centre to the edge. The data tracks are extremely small and are measured in **microns**. A micron is a millionth of a metre. The data track is about 0.5 microns wide, and the gap separating one track from the next is only 1.6 microns wide. The bumps that make up the track are each only 0.5 microns wide, a minimum of 0.83 microns long and 125 nanometers high. (A **nanometer** is a billionth of a meter.) The microscopic sizes of the bumps make the spiral track on a CD extremely long. If you could lift the data track off a CD and stretch it out into a straight line, it would be 0.5 microns wide and over 5.5km long!

Reading the CD data

To read something this small requires an extremely accurate disc-reading mechanism. A CD player uses a **low power laser** to read the data track from the disc. A **laser** (Light Amplification by Stimulated Emission of Radiation) is a beam of intense light of a specific wavelength which can be focused and controlled very precisely. A motor unit spins the disc in the player and a sensitive tracking system keeps the laser beam focused on the spiral data track. The laser shines through the polycarbonate layer onto the aluminium backed data track. The shiny aluminium layer reflects the laser light back off the surface of the disc. The light is either reflected straight off the aluminium, or is deflected off a bump in the data track. The CD player detects these differences. It registers the light deflected off a bump as a 1, and light that is not deflected (the reflected light) as a 0. In this way, the CD player creates the stream of digital information that can be converted into an audio signal. The digital information on the CD is coded to ensure that as long as the CD is well looked after, it will work perfectly.

The CD also contains other digital data, called **sub-code**. The sub-code contains a **Table of Contents** that organises the data on the CD. The sub-code also contains information about the tracks on the CD, such as the number of tracks and their duration. The sub-code makes it possible to find different tracks on the CD easily, and allows the CD player to display things such as the **elapsed** and **remaining playback time** of a track.

Writable CDs

CD-Rs (compact disc-recordable) and **CD-RWs** (compact disc-rewritable) are increasing finding their way into many radio studios as the technology is becoming more affordable and easier to use. Some community stations have CD-Writers, and many are using them to distribute programming. This is especially important where CR stations share programming.

CD-Rs - writable CDs that can only be written once - can be read by almost any conventional CD player. CD-RWs - rewritable CDs that can be erased and reused several times - may not be read by some CD players (though this is changing rapidly). This is because CD-Rs are often "finalised" when they are written - that is, a Table of Contents is written into the sub-code when it is written. It may be worth investigating if your choice of CD player can play "unfinalised" CD-Rs, as this feature may become more useful in the future.

For more on writing CDs, see **Section B: CD Writers** on Page 145

Caring for CDs

The CD is a very delicate system, using the deflections of light off microscopic bumps to read audio. The CD is coded with a variety of error-correcting techniques to make it more reliable, but unless you look after your CDs, and handle them properly, they will be damaged and start "skipping" or not play at all. Being an optical based system, the usual problem is scratches and chips on the clear polycarbonate layer which prevent the laser from reading the data properly.

- To take a disc from its case, press down on the centre of the case and lift the disc out, holding it carefully by the edges.
- Fingermarks and dust should be carefully wiped off the disc's recorded surface (the silvered side) with a soft cloth. CDs do not have any grooves that can collect dirt and dust, so gently wiping the disc with a soft cloth should remove most dirt. To clean the disc, wipe in a straight line from the centre to the edge. Wiping in a circular motion will scratch a large part of the spiral data track and will cause the disc to "skip".
- Never use chemicals such as record sprays, anti-static sprays, benzene, methylated spirits or thinners to clean CD's. Such chemicals can do irreparable damage to the disc's plastic surface.
- Return discs to their cases after playing to avoid scratches that could cause the disc to "skip".
- Do not bend the disc.
- Do not leave the discs in the sun, or in areas of high temperature or humidity. Long periods in high temperatures can cause the disc to warp.
- Do not stick labels on the label side of the CD. If you need to write on the label side of the CD, write very gently with a permanent felt-tipped or other soft-tipped marker. Do not use a hard-tipped pencil or ballpoint pen. Never mark or write on the recorded side of the disc.

Compact Disc Players

A Compact Disc player is used to play CDs. The machine consists of a very sensitive reading mechanism that reads digital information from a CD. The CD player also contains **digital-to-analog conversion circuits**. These digital-to-analog conversion circuits convert the digital data stored on the CD into an analog audio signal that can be fed into a mixer or amplified for a loudspeaker.

For many community radio stations, CDs are the main source of audio other than the microphone. As a result, there is an enormous demand on the broadcast CD player. These machines are often in continuous use for up to 18 hours a day, and are opened and closed thousands of times each month.

A radio station environment demands ruggedness, reliability, and instant cueing from audio source equipment. This is why studio CD players are built differently, and have controls and other features that are different to those found on a domestic CD player. However, if you are familiar with domestic CD players, then a few minutes with the manual of a broadcast CD player will teach you all of the extra features.

For more on compact discs, see **Section B: Compact Discs** on Page 138

Playing CDs in a player

The basic operation of a CD player is straightforward. It involves putting a CD in the machine, choosing the track you want to play, and then pressing the play button to start playback. The CD is usually placed in a **tray** that slides out of the body of the player. In some players there may be a **slot** for the CD instead of a tray. Consult the user manual for your particular CD player for specific instructions on its features and operation.

An **open/close button** opens the CD player's disc tray. Press it to open the tray and insert the CD.

Always place the CD in the disc tray with the label facing upwards. CDs can only be played on one side, and putting a CD in the wrong way round will cause the CD player to "freeze up" as it tries to read the CD. It will eventually give up trying, and you will be able to open the tray and take out the CD, but this wastes precious time. When the CD is in the tray correctly, press the open/close button again to close the tray.

Many broadcast CD players disable the open/close button if a CD is playing in the machine. This stops presenters from accidentally ejecting the wrong CD.

Do not EVER push the tray closed, as this will damage the motor that opens the tray. Damaging the motor may cause the player to refuse to open or close at all. Avoid using special shaped CDs (heart shaped CDs, octagonal CDs etc.). Trying to play them may damage your CD player.

Choosing and playing tracks

Choosing tracks on the CD involves pressing the **TRACK** or **SEARCH** buttons. Some CD players use a **jog wheel** instead of a button to select tracks. A jog wheel is a control that is turned instead of pushed like a button. Turning it clockwise (to the right) will increase the track number. Turning it anti-clockwise (to the left) will decrease the track number.

Once you've selected a track, press the **PLAY** button to play that track. One of the marks of a good quality broadcast CD player is that when you press play, the machine starts playback instantly. There is no delay. These CD players "cue" the track when it is selected. This means the tracking mechanism in the machine immediately reads the sub-code on the disc and positions the read laser at the start of the track that is to be played ready for playback. These players often have a **CUE** button instead of a pause button, or an **AUTO CUE** control. This control flashes for the short time it takes the player to find the track. It then stays lit once the track is cued.

Some CD players may take a few seconds to start playback and do not start instantly once you've pressed PLAY. This short amount of time is taken by the CD player to look for the track you've chosen. To minimise the "dead air" created while the player locates the track, you can cue the player as follows:

- Use the track controls to select the track you want, and then press **PAUSE**.
- Make sure the pause indicator is showing, or that the elapsed time is shown as zero.
- When you are ready, press **PLAY** - and the track will play instantly.

Controlling CD players from an on-air mixer

Broadcast CD Players often use **fader start**, allowing them to be controlled from the studio mixing desk. In this case, the start button or the on-off buttons on the mixing desk can be used to play and pause the CD player. The mixing desk and the CD player have to be capable of using this feature if you want to use fader start.

Elapsed time and remaining time

The term **elapsed time** means the amount of time that has passed since the beginning of the track that is playing. The term **remaining time** means the amount of time left before the track comes to an end. Normally, the CD player's display shows elapsed time. That is, it counts up the seconds and minutes that have passed from the time the track started playing. A CD player used in a broadcast studio should also be able to display the remaining time, or the time left before the end of the track. This is an essential feature as it allows presenters to see how much time is left on a track, so that they can prepare the next item. Presenters don't want to be surprised when the track comes to an end. They must be prepared for the end of the track so that there is no dead air time while they set up the next item. You can choose whether elapsed time or remaining time is shown on the CD player's display by pressing a button marked **TIME** or **DISPLAY**.

One track at a time

Another important feature of broadcast CD players is that they should be able to play tracks one at time. Domestic players play tracks continuously from the beginning of the CD to the end. It is very rare that a station will play an entire CD from beginning to end. Normally stations play only one track from a CD and then an item from a different source - another CD player, or the MD, or a microphone. It makes your job much easier if you don't have to worry about stopping the CD player while starting the next item. This is why it is important that the CD player is capable of playing one track and then pausing itself. A button labelled **SINGLE/CONT**, or the **AUTO CUE** control, normally controls this. Pressing this button will put the player in **single play mode** - that is, it will play one track and then pause. Pressing the same button again make the machine continue with the next track. The play mode will be shown on the display.

Other functions

A **LOOP** function allows a part of a track to be looped - that is to be played over and over. The **REPEAT** function allows a track, or the whole CD, to be played repeatedly. A **PROGRAMME PLAY** function allows the running order of tracks on a CD to be programmed.

After the mixer and the microphones, the CD player is possibly the most important item in a community radio studio. So it is important to choose the right CD players for your station.

As we've said, your CD players need to be **rugged** and **reliable**. They must be chosen for their ability to play even dirty or scratched CDs. There are dramatic differences between CD players. There are many factors that are not easy to judge without experience. The experience of fellow broadcasters is valuable here. Ask around before buying CD players and see what other stations have to say.

Cleaning and maintaining CD players

Maintaining the CD player involves keeping the unit clean both externally and internally.

The lens used to focus the laser beam that reads the CD and the optical sensor that picks up the reflections off the CD can gather dirt and dust. Using a **Cleaning CD** approved by the player's manufacturer once a month should prevent this from becoming a problem.

Also, keeping the CD tray closed and your CDs clean (no sticky fingerprints and dust) will help prevent dirt getting into the machine.

Connectors and connections for the player

Typically, broadcast CD players have two stereo outputs, one balanced and one unbalanced. These usually use **male XLR connectors** for the balanced output, and **RCA connectors** for the unbalanced output. (Note that consumer grade CD players are often used in CR stations, and tend to have only the RCA outputs.) For RCA connectors, the left and right channels are usually colour coded, with red indicating right and white indicating left.

Most professional CD players also have **digital outputs**. These may be marked **OPTICAL** or **S/PDIF** (Sony-Philips Digital Interconnect Format). Using these outputs, the CD player feeds the digital information from the CD directly to a digital mixer or the digital input of a digital recording device, such as a computer, minidisc or DAT recorder. This avoids any loss of quality that may result from D/A conversion. Optical ouputs need a special **optical cable**.

Compact Disc Writers (CD Writers)

Today, writable CD drives (CD-Writers or CD-Burners) are standard equipment in most new computers. A CD-Writer allows you to take audio or data files from your computer and place them on CD. CDs containing audio can be played in a CD player, or if the CDs contain data, they can be used in a computer.

CD-Writers are relatively inexpensive, as are the blank CDs they use. CDs have rapidly begun to replace cassette tapes and floppy discs as the medium of choice for storing recordings and data.

Pre-recorded CDs are mass-produced through a complicated manufacturing process which is not practical to use unless producing hundreds, thousands or millions of CD copies. However as CDs became the standard medium for audio, the demand for a simple CD recording technique grew. At the same time, computer users needed a medium that could store more data than floppy discs. In response to this demand, electronics manufacturers introduced the CD-R and the CD-Writer.

For more on compact discs, see **Section B: Compact Discs** on Page 138

CD-Rs

CD-R stands for **CD-ROM Recordable**. A new CD-R does not have microscopic 'bumps' on its surface. That is, it contains no digital data. The CD-R is coated with a special chemical film coated with a **light sensitive dye** into which the 'bumps' can be burned using a CD Writer. When the disc is blank, the dye is translucent and light can shine through it and reflect off the metal surface. But when the dye layer is heated, it darkens so that light can't pass through it.

By darkening particular points along the CD track, and leaving other areas of dye translucent, you can create a digital pattern that a standard CD player can read. The light from the player's laser beam will only bounce back to the sensor when the dye is left translucent, in the same way that it will only bounce back from the flat areas of a conventional CD.

A CD-Writer is used to burn this digital pattern onto a blank CD-R. A CD Writer has two lasers: a standard **read laser** (like a normal CD player), and a **write laser**. The write laser is more powerful than the read laser and is intense enough to darken the dye material on the CD-R. The weaker read laser does not affect the dye. This means that information on the disc will not be affected by the read laser.

Advantages & Disadvantages of CD-Rs

The main advantage of CD-R discs is that they work in almost all CD players and computer CD-ROM drives. CD-Rs are also the cheapest media available. They are even cheaper than most high-quality cassette tapes.

The only drawback of CD-R is that once you've burned in the digital pattern, it can't be **erased** or **re-written**. It is possible to leave out some areas on the disc for later writing, but this creates a **multi-session CD**. A multi-session CD can not be read properly in a standard CD Player and some older CD-ROM drives.

CD-RW

To overcome the problem that the CD-R cannot be erased or rewritten, a new format was introduced in the mid-90s, called **CD-RW** (or **CD-ROM Rewritable**). The laser of a CD-RW writer, called a **CD-Rewriter**, can both burn bumps into the media and also melt the media back into its original state. In place of the dye layer in the CD-R, a CD-RW disc contains a chemical compound that can change its form when heated to certain temperatures. When the compound is heated above its melting temperature, to around 600 degrees Celsius, it becomes a liquid. At around 200 degrees Celsius, it turns into a solid.

The solid form of the compound is translucent (light can show through it), while the liquid is dark. On a new, blank CD-RW disc, all of the material in the writable area is in the solid form, so light will shine through this layer to the reflective metal above and bounce back to the light sensor. To write information on the disc, the CD-Burner uses its write laser, which is powerful enough to heat the compound to its melting temperature. As with CD-Rs, the weaker read laser does not change the state of the material in the recording layer.

Advantages & Disadvantages of CD-RWs

Due to the very flexibility of the medium, CD-RW discs do not reflect as much light as the other CD formats and cannot be read by many older CD players and drives. So these are not a good choice for music CDs. However, most new drives and players, including all CD-Rewriters, can work with all the different CD formats. For the most part, they are used to back-up computer files.

CD-Rewriters can write to both CD-R and CD-RW discs, whereas CD-R drives can't write to CD-RW discs. CD-RW discs are, however, about twice the price of CD-Rs. CD-Rs and CD-RWs are written using light and for this reason should be kept away from strong direct light, as this can corrupt the information stored on the disc.

Read & write speed

CD-Writers can read and create CDs at different speeds: This is usually expressed as a combination of two figures, a **read speed** and a **write speed**. Both are written as a **multiplication factor** (1x or 4x or 8x and so on). At 1x (1 times) writing speed, the CD spins at about the same rate as it does when the player is reading it. This means it would take you about 60 minutes to record 60 minutes of music. At 2x speed, it would take you about half an hour to record 60 minutes, and so on. Current CD-Writers operate at 24x writing speed or faster. Faster writing speeds need a faster connection between the computer and the writer; and a blank disc that is designed to record information at higher speed.

Like the CD writer, the CD-Rewriter also works at different speeds. In fact, the device is usually specified by its **write speed**, its **rewrite speed** and its **read speed**. (For example a CD-Rewriter would be specified as 16 x 8 x 32. This means it can write CDs at 16x speed; it can re-write CDs at 8x speed, and can read data from a CD at 32x speed.) The speed for re-writing is often slower than the write speed, as rewriting needs the extra step of first erasing the existing data on the CD.

Internal or external CD writers?

Most often the CD-Writer or Rewriter is part of a computer, and the information written to the CD comes from a file stored on the computer. The CD-Writer can be fitted into the case of the computer (an **internal writer**) or can be an external unit that connects to the computer via the USB, Firewire or PC Card connections.

Internal CD-Writers are relatively easy to install, and are about twice as fast and half the price of external writers. However external writers do have some advantages:

- Installing an external writer is much easier and you don't have to open up your computer's case.
- External writers are portable. This means that the writer is not tied to a particular computer and can be connected to any of the computers at your station. It is also a good solution if you want to use the CD-Writer with a laptop computer.
- External drives are usually compatible with different types of computers.

(Remember, though, that an external writer is likely to be about 50% more expensive than an internal one; so you should factor that in when making your choice.)

CD burning software

Using a CD-Writer attached to your computer requires **CD writing software**. Basic CD writing software will be supplied with the CD-Writer. The software allows you to decide what type of CD to make (audio or data) and choose the files you want to write to the CD. Programmes such as **Nero Burning Rom**, **Adaptec Easy CD Creator** and **Toast** (for Apple Macintosh computers) are very popular. In many cases, the software is supplied along with the writer device itself - but these versions may be limited in function.

Writing a CD places large demands on your computer and things can go wrong. Do not be surprised if some of the CDs you are burning don't come out right. CD-Rs cannot be overwritten. This means that when an error occurs while writing the disc, you have to throw away the whole disc. If you continually have problems burning CDs, try to reduce the write speed. The most common problem when writing CDs is called a **buffer underrun**. This happens when the computer is unable to send data to the CD-Writer fast enough. Reduction of the write speed can overcome this problem.

Not all CD-Writers are part of a computer. There are a number of stand-alone CD recorders available for both domestic and professional use. Often, these have two drives that allow you to record music tracks directly from one CD to another.

Remember that copying pre-recorded CDs raises very serious copyright issues. Breaking copyright laws can lead to legal action that could cost you a lot of money.

These stand-alone recorders can also have audio inputs, allowing them to record incoming signals, much like a cassette or minidisc recorder. These writers are usually fast and accurate, but typically can only be used to create music CDs. Professional models are also very expensive when compared to computer-based writers.

COMPRESSOR/LIMITERS

A compressor limiter (compressor) is a device used in most community radio station transmission systems. It is used to process the signal that comes from the broadcast studio before it is transmitted. The compressor/limiter keeps the level of your station's signal constant and at the best possible volume, both for your listeners and to compete with other stations.

In broadcast terms, we say the compressor is used to control the **dynamic range** of the station's sound. **Dynamic range** is the range between the loudest and quietest sounds that are broadcast. Reducing the dynamic range of the signal by using a compressor is called **compression**. The effect of compression is to make your station sound louder and clearer on air.

The **limiter,** on the other hand, sharply controls the audio output level at a predetermined level. This is often a much more harsh adjustment to the sound, and must be used with caution, as it can make your audio sound very bad if done improperly.

More usually, we use devices that combine both functions, allowing you to compress the signal to a certain extent, and limit it sharply after a certain point. Such devices are called **compressor/limiters.**

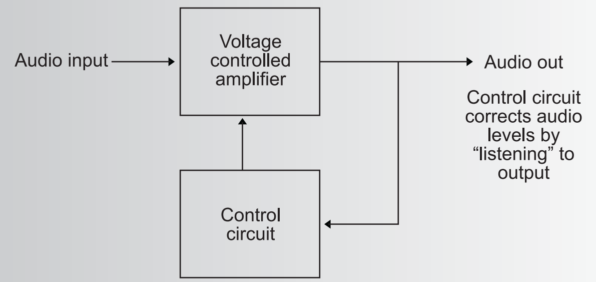

Fig 8 : A schematic view of how a compressor/limiter functions

Not all compressors work exactly as shown above. For example, some compressors monitor both the input and the output audio. Also, there is computer software to carry out the role of the compressor. However the underlying principle remains the same.

The compressor control panel generally has two meters:

- one meter indicates the amount of **gain reduction** or **compression**
- the other meter usually shows the **signal level** of the compressor's audio output.

The **threshold control** is used to set the signal level at which you want the compressor to begin reducing the level of the signal. The **ratio control** controls the change of output level for a given change in input. (For example a compression ratio of 2:1 means that for a 2dB (dB = decibel) increase in input signal level, the output signal will only increase by 1dB.)

The speed at which the gain is reduced in response to an increase in input signal level is called the **attack time.** This is usually specified in milliseconds, and is set using the **attack control**.

The speed at which the gain is restored to its original level after the input is removed is called the **release time.** This is set using the **release control**.

You need to listen to your signal very carefully in order to set these parameters. If the attack time is set too fast, the compressor will respond to even the shortest peaks (loudest sounds), causing the level to change very quickly. For example, the beats in a dance track often cause short peaks in the signal. If the attack time of the compressor is so short that it responds to the individual beats, the compressor will reduce the signal level on each beat, and produce a very unnatural sound. On the other hand if the attack time is too slow, the compressor's output may exceed the desired maximum before the compressor acts on the signal.

Too fast a release time causes "breathing" as the gain changes rapidly. If the release time is too short, quiet sections of music will be lost as the compressor will still be reducing the gain, even though the loud input signal is no longer there.

Many compressors have an **auto** (automatic) switch for the attack and release time. When the auto switch is on, the attack and release times are set dynamically, based on the input. This is often the best for CR stations, as the system is self adjusting to the needs of different kinds of audio and programming.

Some compressor/limiter units have an additional **gain knob** that can be used to match the final output gain to any of a variety of equipment. The output level resulting from using the gain control can be monitored on the output level meter.

Some compressors also have a **stereo link button,** which links the two channels of the compressor together so that both channels process their signals in the same way. If your compressor doesn't have a stereo link button, you will have to set controls for each channel to exactly the same level.

Pressing the **bypass** button bypasses the compression circuitry, and allows you to quickly compare the compressed and uncompressed output.

The compressor has a variety of possible settings. Small adjustments to any of them can make a considerable difference to your station's on-air sound. It is a good idea to document the compressor settings that work best for your station and compressor. Keep this record available for reference. Also, once the compressor has been set for your station, put a guard or protective covering on the front panel to prevent anyone from accidentally changing the settings.

The compressor settings you choose will depend very much on your preferred sound. However, many stations have been happy using:

- a threshold level of 0 dB
- compression ratio of between 1.5:1 and 4:1

Set the output gain so that the output level meter reads the ideal input signal level for subsequent equipment (often 0 dB).

Computer Hardware

Computers have become a vital tool in modern communication, both for office work and for the production of high quality audio and video with a considerable decrease in effort. Computers and digital technology have developed hand in hand over the last few decades, as digital storage was initially a system conceived for computer data.

There are two vital components to any computing system:

- **The hardware.** This is the wiring, electronic circuits, disc drives, monitors, keyboards and so on that make up the physical machine we call a computer.
- **The software.** This is the term used to describe the programmes that we use on the computer.

Hardware and software must work together if we are to get anything useful done with a computer.

For more on computer software, see **Section B: Computer Software (for Radio)** on Page 159

Your choice of computer hardware will differ according to your needs and according to the kind of software you are planning to use on your computer. In general, however, all computers share certain basic hardware:

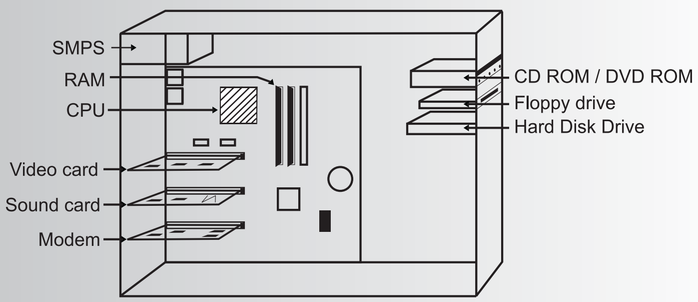

Fig 9: A schematic view of the average computer's innards.

The CPU tower or cabinet

All computers need a case to house all the electronic components. Cases can come in a variety of colours and shapes, but all of them have the same purpose - that is, to hold and protect the electronic components. Modern CPU towers are usually of the **ATX** or **Micro-ATX** variety, which means they automatically switch the power off when the computer is shut down. It is a good idea to assess how large a case you need based on the number of **peripheral systems** (CD-ROM drives, CD-writers etc.) that you plan to install internally - these are usually accessed through configurable slots in the front of the system, and smaller cabinets have fewer slots.

The computer's power supply is normally supplied with the case. This power supply, called an **SMPS** (Switched Mode Power Supply), is basically an AC to DC convertor; and can come in a variety of ratings: 200 Watt, 300 Watt and 450 Watt are most common.

> Plan ahead and get a more powerful SMPS than you need if you intend to add more components later on to the system. (But remember that it will still consume its rated power whether you actually install those components or not!)

The SMPS usually has a fan fitted on it which is visible at the back of the cabinet: This is because the power conversion process generates a lot of heat which needs to be vented.

Motherboard

The motherboard is a large circuit board into which all the other components are plugged: The motherboard supplies power to all the components and connects them together, transporting data from one component to the other. The motherboard is mounted in the computer's case, and has slots and connectors for the other components

Motherboards vary in terms of speed and features. More expensive boards tend to be faster, more reliable and support more features and advanced components. It is important to match a motherboard to the processor unit that you install, as many of the features can be interdependent: A fast processor can be hampered by a poor motherboard, or a fast motherboard can be underused by a slow processor.

> Processor and peripheral manufacturers usually specify the best motherboard solutions for their equipment, so it's always worth having a look at those while deciding your configuration.

Last but not least, it is always worth considering how **futureproof** your motherboard is in terms of plugging newer peripherals into it: You may like to increase the RAM or plug a different card into one of the slots later on, and you should explore whether this will be possible at a later date.

The Central Processing Unit (CPU)

The CPU can be thought of as the **brain** of the computer. It is the part of the computer that does the actual computing, and co-ordinates the actions of the whole system. Software programs are written to give the CPU a set of instructions. The CPU will follow the instructions to accomplish a specific task. The two principal CPU manufacturers globally are **Intel Corporation** and **Advanced Micro Devices** (AMD).

Like all other components, the CPU is connected to the motherboard. It is easy to spot on the motherboard, as it usually the largest microchip on the board. This is why it is often called the **chip** for short. The CPU is covered by a **cooling fan**, as modern CPUs are very powerful and compact, and generate a lot of heat.

Computers are often differentiated by the type and speed of their CPU. For example, in terms of type, people may refer to a computer as a **Pentium III** or **Pentium IV** or as an **AMD Dual Core Turion**.: This means that the computer has a Intel Pentium III or IV series processor or an AMD Dual Core Turion processor installed.

The processor name also usually has a number and a frequency attached - like **Pentium IV 2.4 GHz**, for instance. The **2.4 GHz** refers to the **speed** of the CPU and indicates that it can operate at a speed of 2.4 GHz (or 2400 MHz). This means it is actually capable of doing 2400 million operations per second, which should indicate just how fast modern computers are.

The newest type of processors actually carry two processor chips in one casing - 4 and 8 chip versions are also beginning to make an appearance, but are still very expensive. These types of processors are called **Dual Core processors,** and are quickly becoming the modern standard for computer CPUs.

Random Access Memory (RAM)

The CPU has to process digital data to carry out instructions. This data has to be stored so that the CPU can quickly retrieve the data, process it and save it again for further processing. This storage space used to hold the data that the computer is working with at any time is referred to as the computer's **memory**. Memory is like the CPU's scrap paper - somewhere to write down notes and calculations as it works. It is referred to as **Random Access Memory (RAM)**. RAM is storage space that is available for short-term storage of data.

> RAM relies on a constant presence of electrical charges, and operates only when the computer is turned on. Data written to RAM vanishes when the system is powered off.

Computers are also differentiated by the amount of RAM they contain. The more RAM in the computer, the faster it works, but this is only applicable up to a point: For a slow processor or motherboard, increasing the RAM cannot push performance beyond a point. Most computers currently should come equipped with at least 512 Megabytes (512 million bytes of data) of RAM, though increasingly, advanced software has meant more should be preferred if it is possible. Computers can often take upto 4 Gigabytes of RAM in all, though this is dependent on the motherboard.

The computer has another kind of storage called **Read Only Memory (ROM)**. ROM contains data that is permanently etched onto a chip, and typically stores the commands necessary for a computer to **boot up**, or start.

Secondary storage devices: Hard disks (HDDs). Floppies and CD

In addition to RAM and ROM, computers have secondary storage devices such as **floppy discs**, **hard drives**, and **CD-ROMs**. These devices are responsible for long-term storage of data and software programmes. They can hold much more data than RAM and ROM, and are much less expensive. They are also much slower than the primary storage devices. Data stored in memory can be accessed by the CPU in **nanoseconds** (a nanosecond is a billionth of a second), while data on a hard drive is accessible in **microseconds** (a thousandth of a second). This means your hard drive is about a thousand times slower than RAM.

Most modern computers have hard discs capable of storing 120 gigabytes or more of data, with 250 and 500 GB becoming rapidly more common. (A **gigabyte** or **GB** equals a thousand megabytes.)

Floppy disc drives use an external storage medium called a floppy disc, which is a small 3.5" square plastic case that contains a magnetic surface. Though comparatively less used nowadays, they are still found on many older systems, especially in small towns and more remote areas.

The graphics/video card and the monitor

The video card and monitor allow us to communicate with the computer by seeing what it is actually doing to the data we are giving it. We need to give the computer instructions and data before it can do anything. We then need to see the results of the instructions displayed in a way that we can understand.

The monitor, or screen, works much like a television screen. Like a television, the computer monitor needs a **video signal** to display a picture. The video card creates this signal by interpreting the data the computer processes. The video card connects to the motherboard and converts the computer's digital output into text or pictures for display on the computer monitor.

> Demanding video applications like video editing may require specialized video cards that carry their own memory and execute this process quickly.

Monitors come in several varieties: **Cathode Ray Tube** (or **CRT)** monitors are most common - and cheaper - and work exactly the way your TV does. They come in **flat screen** and **normal screen** varieties, with flat screen to be preferred because the picture doesn't distort as much at the edges. The other type of monitor is the **LCD** or **Liquid Crystal Display,** which are thinner and lighter, but are somewhat poorer in colour rendition.

Monitors are usually 15" or 17" in **diagonal screen size** - the latter consumes more power - but larger monitors (21", 25") are also available for specific purposes.

Keyboard & Mouse

The keyboard and the mouse provide us with a way to input data into the computer, and interact with it. By **typing** on the keyboard - which is almost exactly like a typewriter keyboard - and **pointing and clicking** with a mouse, we are able to give instructions to the computer. The instructions are converted to digital data.

Keyboards are usually in English, though specific language keyboards are also available. In many cases, the same keyboard is adapted to type letters of various other languages, a function that is guided by the availability of the **font** (or typeface file) for that language on the computer.

Mice are available in **two button** and **three button** versions, with various functions being accessed by each of the two or three buttons - most functions can be achieved with two. Many modern mice also carry **scroll wheels,** a small wheel on top which you can use to quickly move up and down on a page displayed on the screen. Older mice have a **trackball** based design where a small rubber ball at the bottom moves as you move the mouse. Newer mice have an **optical input system** where a laser reads the surface the mouse is moving on to understand which direction it is moving in (and are hence known as **optical mice.**)

Sound or Audio cards

Adding a sound card to a computer makes it possible for the computer to play and record sound.

The card converts audio signals into a **digital format** that can be processed by the computer. The card also converts digital audio stored on a computer into a format that can be sent to other equipment such as loudspeakers and the mixing desk.

Sound cards vary enormously in quality and features. In the radio studio the primary purpose of a computer is to play and manipulate sound. Therefore, there are more demands on the studio sound card than on a standard office or home computer. The right choice of sound card used in a studio computer is vital. As the studio sound card tends to be more sophisticated than others, it is also often more expensive. Even basic sound cards today give very good quality audio; but if you intend to connect professional grade microphones directly to the computer, a sound card that has **balanced** and **unbalanced connectors** - on the card itself or on an attached **break out** box - may be a good choice.

For more on balanced and unbalanced connectors, see **Section B: Balanced and Unbalanced Connections** on Page 131

Modems and LAN cards

Computer communications are becoming a part of everyday life. More and more people are using the **internet** and **e-mail** as a resource and as a means of communication. By connecting our computer to a **phone line** or a **network connection**, we are able to communicate with other computer users. A modem makes it possible for a computer to communicate through phone lines. **Modem** is an acronym for **Modulator/Demodulator.** Modems translate digital computer information into analog signals used over phone lines. They can also work in reverse and translate the analog signal from a phone line into a digital signal used by a computer.

Modems are distinguished by the number of **bits per second** (**Bps**) of information that they can transmit. Nowadays, commonly used modems operate at 33 600 and 56 000 bits per second. However, older modems that work at lower speeds are still used in some places.

Like CD-writers, modems can also be **internal** or **external**, though it is more usual to find the internal ones today. They need to be connected to the telephone socket using a telephone cord, more usually known as an RJ-11 connector.

For more on RJ-11 conenctors, see **Section B: Connectors (Audio & Telecom)** on Page 166

If you have more than one computer in your station, you will probably want to share files and resources such as printers amongst them. To achieve this your computer needs **networking hardware**. This hardware is a **network interface card (NIC),** often just called a network card or **Large Area Network (LAN)** card. Most new computers are supplied with a network card. The network card allows the computer to talk with other computers on the network (that is transmit and receive data).

Modems and network cards are more important for the office systems than for any computers based DAWs that you may be installing: Most of the outputs from a DAW are likely to be through the mixer or on a CD, so networking the system is not a priority.

If you have more than two computers that you want to connect together, you may need a **network hub** to which you connect all of your computers. The hub switches information between the computers.

Other peripheral hardware

In addition to the hardware already listed, there is a wide variety of external hardware, often referred to as peripheral devices (or peripherals) that can be connected to a computer. The more common devices are **CD-Writers** used to make audio and data CDs; **printers** for printing information onto paper, and **scanners** to convert text or pictures on paper into a digital format for the computer. Many stations today use CD-Writers and store and distribute programmes they have produced.

It is also useful to have a printer for printing out text reports, letters and other information. Printers can be colour or black and white; and can be **inkjet** or **bubblejet** printers; or **laser printers.** Laser printers tend to be more expensive, but their toner (ink) cartridges tend to last a long time. Inkjet printers are intended for lighter work. They may cost less initially, but often have expensive ink cartridges that over time can cost more than the printer itself.

Computer Software (For Radio)

As we saw in the hardware section, there are two parts to any computer system: The hardware, and the software. Software is the term used to describe the programmes (or sections of computer code) that we use on the computer. The **programme** is a set of instructions that instructs the computer in how to execute a given task: This could be typing a word on the screen, or manipulating audio or anything that that you want the computer to do. Both hardware and software are very important, and we need the right hardware and software if we want to get anything useful done with a computer.

Different software for different uses

There are different software programmes or packages that perform different functions. For example to type and edit a script, or a letter, you need a word processing programme such as **Microsoft Word** or **Open Office Writer**. For accounts, budgets and spreadsheets, there is a wide variety of software you can use to make accounting easier, like **Microsoft Excel,** or **OpenOffice Calc.** Graphic designers use software packages for design and layout, like **Adobe InDesign**, or **CoreDraw**! or **OpenOffice Draw**. We also use internet browsing software such as **Mozilla Firefox** or **Internet Explorer** for accessing the Internet; and e-mail software such as **Outlook Express** or **Mozilla Thunderbird** for sending and receiving e-mail.

Proprietary, Freeware, Shareware and Open Source

Software can be **proprietary** (meaning it has to be purchased before use); **freeware** (meaning it is free to access and install); or **shareware** (where you can install it, but should pay for it if you continue to use it beyond a fixed amount of time). When software is purchased, you are basically **licensing** a copy of the software for use; and this license may limit the number of computers you can install the software on.

Over the last several years there has also been a worldwide movement to create and use software where anyone can access the basic code and make changes to suit their own purposes. This is called the **Open Source** movement, and it has resulted in a large variety of freely available and customizable software that perform nearly all the functions that proprietary software was once invariably required for - including audio editing and manipulation. Many open source software packages today are available for download directly from the Internet - but be careful while doing this, because people **pirate** or make illegal copies of proprietary software as well. This is not only illegal, it is unfair to all those who make a living by writing the software.

To go into all the kinds of software used on computers for various tasks is more than can be covered in this manual. So we'll focus first on the important software that we may use on a computer used for radio and audio related work.

1. Operating Systems (OSs)

The operating system controls all of the computer's hardware and provides a base upon which other software can be used. The operating system manages the hardware for the user, and provides onscreen images that you can understand when you are working on the computer. On PC based computers, the popular OSs are **Microsoft Windows** (**Windows XP SP2** is common, with **Windows Vista** now preinstalled on many computers), as well as many variants of the **GNU/Linux open source OS** (including variants like **Red Hat**, **Fedora** and **Ubuntu**, some of which must be paid for). On Apple Macintosh computers, often used for professional audio and video work, the current OS used is **Apple OS 10.5,** also popularly known as **Tiger**.

Many computers still use older variants of Windows, such as **Windows 95**, **Windows 98** or **Windows 2000** or **ME**. It's usually a good idea to get as new an edition of the OS you select as possible, as it will have updated controls and software for the hardware that you install on the system.

Some OSs are written specifically to facilitate multimedia and audio work on a computer. One such freely downloadable OS is **Ubuntu Linux Studio**, which comes bundled with audio processing and editing applications that work seamlessly in tandem with each other.

2. Audio editing and processing software

Audio editing and processing software is used to record, input, adjust, trim and refine audio from a variety of sources to make a programme. In the radio production studio, software programmes such as **ProTools, Cakewalk Pro, Peak, Nuendo, and Audition** are the common proprietary software choices. The open source preferred choice is usually SourceForge's **Audacity**. Other possible choices are **Solition II, Audioblast** and **Reaper**.

A screen capture of Nero Wave Editor, a simple audio editing software bundled with the Nero Ultra CD burning tools package.

These programmes let us **mix** and **edit** sounds, add **sound effects**, and **generate digital audio files** that can be sent to another computer for playout in the studio, or for writing onto a CD-R. Advanced audio editing programmes often demand more advanced sound hardware, and the soundcards used in audio production computers are usually more sophisticated than those on a standard computer. But CR stations often have less demanding requirements than professional studios, which require very high grade adjustments to music recordings for film and CD production. So simpler software and hardware can often be used, without the tremendous variety of functions that are often available in pro software.

As audio editing is usually **graphical based** - the software displays pictures of the sound waves you are working with - this often makes it easier to work with the sound, as opposed to the laborious manual work one had to do in studios once upon a time. Software can emulate most of the expensive hardware that audio studios once used to be equipped with, because the software can now manipulate the audio in exactly the same way - an important consideration in making radio more accessible to communities.

Most audio editing softwares also let you save the final version of the audio in a variety of audio file formats: **MP3**, **WAV**, **AIFF**, and so on.

3. Playout software

Stations that use computers in the broadcast studio will use **playout software**. Playout software provides a way for presenters to quickly access audio files stored on the computer and then to play them on the air. Programmes such as **Netia, On the Air, Wavecart, Radiohost** and many others have been especially designed for use in the radio studio.

There are free and open source counterparts like **ZaraRadio** that can be used for playout as well; and many small radio stations use simple audio player software like **WinAmp** to queue audio for playing.

> Using playout software may require more sophisticated sound and computer hardware, as well as considerably higher expense.

4. CD burning software

As noted in the section on CD writers, there are specialized softwares that can help you with the process of organizing and burning your files onto CDs for archiving or for playout. These include versions of **Nero Burning ROM, Alcohol, Toast** (for Macintosh), or **CD Burner XP**. Most will give you advanced functionality like leaving the disc unfinalized, or making a CD-R multisession.

5. Audio playback software

Most Windows OS based computers come equipped with a version of **Windows Media Player**, a playback software which you can use to play audio. But a variety of software is available to play audio on a computer: These range from **WinAmp** and **Realplayer** to **Quicktime Player** and **Jet Audio**.

Your choice of software depends on the scale you want to work at, how much you want to automate the process - and what kind of a budget you have. There may be differences in functionality between many of these softwares - but then again, you may not need much of the pro functionality or controls to achieve many of the things you require as a CR station.

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>
> Don't invest blindly in expensive software without exploring availability, support, usability, and functionality.

Connectors (Power)

While all radio equipment runs on electricity – DC or AC – the cables that connect all these varieties of equipment to their power sources are often different from each other – and so are the connectors at each end of the power cable. In most cases, the connectors will be of one of the following two types :

1. The standard power plug

The standard plug is the most common power connector, and is usually used to plug into **AC mains supply sockets**. AC mains power is of a very high voltage – 220 Volts in India – and can damage your equipment and cause fatal electric shocks if care is not paid to the way the plug is wired and plugged in.

Power plugs of this type come in two varieties: A larger variety with thicker cylindrical pins for heavier loads (often called a **power plug** or **15 Amp** plug), and a smaller variety with thinner cylindrical pins (often called **5 Amp** plugs) for lighter loads. Each of them requires a corresponding socket, as the pin spacing is different in each case – but modern socket fittings generally feature sockets which accept both varieties of plugs.

> Socket and plug fittings vary from country to country, as do the operating voltages of equipment. As most equipment used in a radio station is manufactured outside India, it is vital to check whether the plug supplied with the equipment will fit into sockets here: If it doesn't, it may be necessary to obtain adapter plugs that allow us to connect it to Indian standard sockets. If the operating voltage is also different – equipment from the United States operates at 110 Volts instead of 220 Volts, for example – then a power adapter may also be required to step down the voltage.

Plugs need to be wired as per existing international and domestic conventions for electrical wiring. This is done according to a **colour coding system** that identifies the correct wires to be connected to the **phase**, **neutral** and **earth** points of the socket.

- The **black wire** connects to the pin on the left as seen from the back of the plug. This pin is most often labelled **Neutral**, **Black** or just **N**.
- The **red wire** connects to the pin on the right as seen from the back of the plug. This pin is often labelled **Live**, **Red**, **L** or **Phase**.
- The **green earth wire** connects to the top pin of the plug. The earth pin is often labelled **Earth** or marked with the earth symbol.

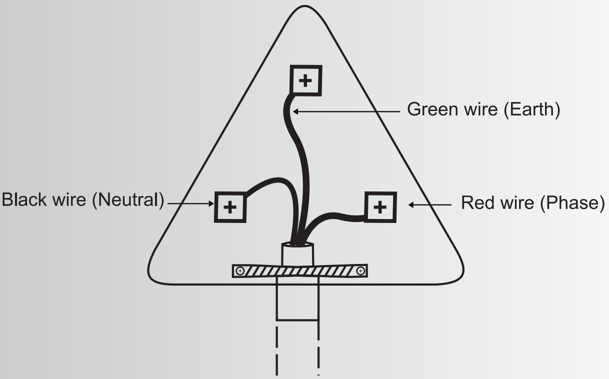


Fig 10: Standard wiring for a 3 pin plug in India.

Not all pieces of equipment use the earth wire, and you will have to read the wiring instructions to see whether or not 'earthing' is needed. Where there is a choice, always try to use a 3 pin plug instead of a two pin plug for the earth protection the third pin gives you.

Wiring a power plug correctly

Though it appears very simple – and it actually is, once you learn how to do it properly – there are some basic procedures that must be followed when wiring a plug.

The first thing is to note that the earth, live and neutral wires of a power cable each have their own **colour coded insulating plastic** or **rubber coating**. Together they are then surrounded by a second rubber or plastic coating (mostly white, grey or black) which keeps all three wires together.

To wire the plug, you will first have to remove a section of this outer coating, enough to expose the three individual wires, but without stripping the inner wires' own coatings. Also, when you do this, make sure you leave enough of the outer insulation jutting into the plug.

The earth, live and neutral wires are often stuck together. You may have to separate them by pulling them apart. When you do this, make sure the insulation (the blue, yellow / green and brown coating) surrounding the copper wire remains intact. Also, make sure that the three separated sections are just long enough to fit comfortably into the pins. Depending on the plug, you may have to leave the green wire a little longer and clip the other two wires slightly shorter so that they fit comfortably into the pins.

Contd...

Then remove a very short section of the green, red and black coatings to expose the copper wire within. Expose just enough so that the exposed copper portion fits into the holes in the three pins: If you expose too much, there is a risk that two of the wires may short circuit. Each of the wires may have several finer strands or filaments of copper wire. Twist these strands together so that they stay together. Then insert them into the holes on the pins.

Screw the screws that will hold the copper wire in the pins down firmly, making sure that they are holding the copper wire down. Tug gently on the wires once the screws are in to check. If the screws are not firm, or the pins wobble in their casings, or the screws that seal the plug casing are loose, change the plug at once.

2. The Kettle plug or IEC connector

The IEC connector is often called a "kettle plug", as they are often used on kettles. They are used to supply power to many pieces of studio equipment, and to computers. The formal name for this type of connector is the **IEC320/C-14 (male)** and the **IEC320/C-13 (female)**. The former usually receives the power, and the latter supplies the power. Commonly, the male connector will be found on the equipment body, and the female connector will be found on the end of the cable that is attached to it.

In most cases, equipment that uses IEC plugs and connectors are supplied with sealed molded plugs that do not have any joints and cannot be rewired by you. In these cases, if a plug shorts out ot malfunctions, the better option is to simply purchase the entire connector, with the wire/cable and the connectors.

A female IEC or kettle plug connector

Connectors (Audio & telecom)

There are a variety of connectors that are used to join pieces or groups of equipment together so that they can communicate with each other, and so that an audio signal may be passed among them. In some cases, this variety is the result of efforts by equipment manufacturers to develop proprietary connectors designed to fit only their own equipment. In other cases, newer connectors have been developed over time that have begun to coexist with older connectors.

1. The XLR connector

The three pin XLR connector is probably the most common 'pro' connector that one encounters on broadcast grade audio equipment. Typically, it has three pins, with Pin 1 used for the **shield** (or wire mesh) of the armoured cable, Pin 2 for the **phase** or '**hot**' **signal**, and pin 3 for the **cold** (or reversed phase) signal. The three pin arrangement – four and five are also possible, though less common – make this the connector of choice for balanced connections.

For more on balanced connections, see **Section B: Balanced & Unbalanced Connections** on Page 131

Since the XLR connector design includes a **locking tab** that clicks into place when attached - and which must be pressed to release the connector - it is a particularly safe connector. It is impossible to line the connector up the wrong way, or misconnect it.

By convention, the male XLR connector – with the pins – carries the signals out, and the female connector, with the sockets, takes in the signal.

A male and a female XLR connector. Note the tab on top that must be pressed to disconnect the connector.

2. ¼" phono plug and jack

The ¼" phono plug comes in two varieties: Two contact or three contact.

The three contact point version, with the two visible black bands, is also known as the **TRS** or **Tip-Ring-Sleeve** connector. The three contact points can be used for a stereo connection (tip = left, ring = right, sleeve = ground); or for balanced connections (Tip = hot, ring = cold, sleeve = shield). The two contact jacks only have a tip and a sleeve; and are used for mono or unbalanced connections.

A pair of ¼" phono jacks. Both are mono connectors, as indicated by the single black band.

3. 1/8" TRS plug or mini-phono plug and jack

The 1/8" phono plug – also known as the **mini-phono plug** – is the small cousin of the ¼" connector. On professional equipment, this is found only on portable equipment – notably field recorders – or on mid-range soundcards. They are, however, more common on consumer grade and home audio equipment.

The mini-phono jack is also available in two and three contact versions, though the latter is much more common. The three contact version is also the TRS variety (see above) and is most commonly used for unbalanced stereo connections.

A 1/8" mini phono jack. This one is a stereo TRS connector, as shown by the two black bands near the tip.

The small size and the (usually) flimsy construction means there are high failure rates with 1/8" connectors, and that they need constant checking when used in 'pro' work.

4. RCA jack and connector

The name RCA comes from the **Recording Corporation of America** (RCA) which was the first to develop this connector for their audio equipment. The RCA is an unbalanced connector, with the jack having a central pin surrounded by a flanged edge which acts as the other contact.

A pair of RCA jacks. Together, they make a stereo pair, with one carrying the L signal and the other the R signal.

Designed for domestic use, it may nevertheless be found on some studio equipment. The connector is prone to usage related wear and tear, as the outer ring often spreads due to careless handling and is then unable to make a clean connection.

5. D-Type connectors

The D-type multi-pin connector is available in male or female versions, and is often used where large amounts of data needs to be handled. The connectors range from 15 pin to 50 pin. They are common on digital equipment and are also often used on studio mixers.

A D-type connector.

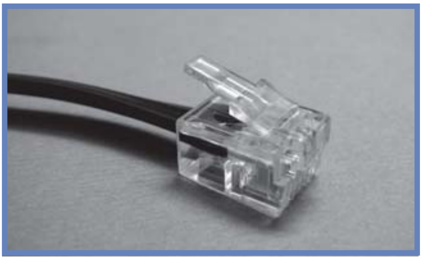
6. BNC connectors

The BNC connector is most often found on RF transmission equipment, and has a **locking ring** system that is similar to those found on a lightbulb. The **TNC connector** is also quite common, and is a screw type version of the BNC connector. A third variant, the **N-Type connector** is a larger version of the TNC connector. It is able to handle considerably higher RF powers, and is commonly found on transmission and RF test equipment.

Network, computer and telecom connectors

1. RJ-11 (telephone) connector

The RJ-11 clip connector is used for telephone connections. It is a small four-pin type connector; and is often found on modem and hybrid units. The plastic clip snaps into place, and must be pressed to withdraw the connector from its socket. The connector requires a special crimping tool to be attached to the telephone cable.



An RJ-11 connector. Note the clip on top which snaps into place when it is inserted in its socket.

2. RJ-45 network connector

The RJ-45 connector is a larger version of the RJ-11. It has eight pins and is used for data network cables such as ISDN cables and computer network cables. Standard computer network cards and network hubs have sockets for this connector, often known as an **Ethernet** or **LAN** (Large Area Network) connector. This connector needs to be crimped in place within the connector with a crimping tool as well.

An RJ-45 LAN connector. The 8 wires of the LAN cable need to be crimped in place.

3. USB connectors

USB or Universal Serial Bus connectors are found on computers and some audio devices like MDs and flash recorders. USB devices may be chained to each other to form a chain as long as 128 devices, all of which can be active simultaneously. Nowadays, USB is also used to power some devices like microphones: USB mics are often used on computers.

USB connectors may be classified on the basis of their data transfer standard (USB 1.0 and USB 2.0) or on the basis of their size (mini-USB and standard USB). Mini USB is often found on portable digital equipment and digital cameras. Standard USB is usually found on computers.

USB 1.0 offers data transfers at about 11 MBps (or Megabits per second). USB 2.0, the newer standard, can transfer at a thumping 480 MBps!

Regular size and mini-USB connectors, both male

A Female USB connector

4. Firewire connectors (IEEE 1394)

Originally developed exclusively for high speed digital audio and video transfer, Firewire or IEEE 1394 standard connectors come in two variants: **Firewire 400** (capable of 400 MBps transfers) and the newer **FireWire 800** (capable of a mind-boggling 800 MBps transfer speed.).

This connector comes in a larger and smaller variety as well.

A standard (left) and a mini firewire (right) connector

DECIBELS

When we work with audio equipment, it is important to keep track of the overall levels of the audio we are working with for two reasons:

1. So that we can compare the relative levels of various sounds and recordings, in order to adjust them relative to each other; and
2. So that we can keep the audio levels at a level where the equipment's circuitry can handle it.

In order to do this, however, it was important to develop a system of sound units which could mimic the human ear's way of distinguishing. The units which were developed became known as the **Bel** and the **deciBel (dB)**. The Bel was named after Alexander Graham Bell, the inventor of the telephone. A deciBel is one tenth of a Bel, and is the more commonly used of the two measures, as the Bel is a very large unit.

As a measure, the Bel and decibel are **logarithmic**. Logarithms are an arithmetic system where large numbers can be expressed as a system of smaller numbers, and where the progression of numbers is not linear in nature. (Our hearing is actually logarithmic in nature: A sound that we perceive as twice as loud is actually nearly four times as loud in absolute pressure terms, so it is easier to perceive this in relative terms. Additionally, 'loudness' is a very subjective quantity.)

What is important is to grasp that dB always represents a **ratio of two quantities**, and not a quantity itself. This can be the ratio of two powers, voltages, currents or sound intensities. Most often it is a ratio of power quantities. As we have seen, it is immaterial whether we talk about an audio signal in terms of the actual pressure wave that we hear or the change in electrical voltage that a microphone converts it into. Thus, if 0 dB is specified as some reference value then any number of dB above or below that zero reference can be used to describe a given quantity.

The standard dB term used for expressing input and output voltage is **dBu**. 0 dBu corresponds to a voltage of 0.775 volts. Another dB unit that is often used is the **dBv**, which is equivalent to the dBu. An older dB unit that is used is the **dBm**. 0 dBm is 1 milliwatt. **dBm** has no direct relationship to voltage.

DIGITAL PLAYOUT SYSTEMS

The advent of computers has not only made the process of editing and manipulating audio easier, it has also made the process of storing and accessing large quantities of audio data very convenient. Where radio was once a purely 'live' medium, today we can select and playback a huge variety of programming with the click of a few buttons.

At its most basic, a **digital playout system** is a computer set up to playback audio for broadcast. Most computers are capable of playing back audio with an appropriately installed sound card and audio playback software. What distinguishes a digital playout system from other such computers is the software used to organize, sort and search through the audio stored in its hard disk – and to 'queue' the audio so that it plays back in a specific sequence and without a pause.

For more on sound cards, see **Section B: Computer Hardware** on Page 152

For more on audio playback software, see **Section B: Computer Software (for Radio)** on Page 159

A large part of using a playout system is creating the sound files the system uses. For this, the audio must first be stored as digital audio files on the playout computer. If the original audio is on an analog medium like audio cassette or LP record, it will first have to be **digitized** or **captured**, and then transferred onto the playout system. On the other hand, if the audio is already on a digital medium like a CD, it will need to be **ripped** using a ripping software. Ripping is essentially a process of converting the audio from its original digital format to an audio format that is compatible with the playout software.

Most playout softwares are compatible with MP3 format files!

For more on digitization, see **Section B: Analog & Digital Audio** on Page 124

All the audio that will be broadcast ('played out') from the playout system has to be in the form of audio files on the playout computer – jingles, ads, programmes, music, teasers, everything. Since digitization may be a time consuming process, this generally means that one must have separate systems for the production work and the playout, because the playout system cannot be utilized for any other work while the broadcast is going on. If you do decide to share a single system for production and playout, remember that you must have large amounts of hard disk space and that you must plan in advance to share your time across these two functions.

Organising and managing the sound files in the playout system is the most demanding part of using the system. If sound files are not named according to a common convention and properly organized, the playout system becomes completely chaotic and it becomes impossible to find specific sound files. It is essential that everyone who uses the system knows how the sound files are organised. Since a number of people – community reporters, station manager, community volunteers – may be operating the system, this process must be set up when the system is first installed. Usually, the computer is set up with a folder where music sound files are saved, a folder for ads and jingles, a folder for finished productions such as interviews, one for sound effects and so on. Some systems already have folders for storing different items but will still rely on the user to label the item or save it in the right place.

> Folder systems and file naming conventions are sometimes dependent on the specific playout software being used.

Playout systems make the presenter's job much easier. At the same time, the station will need extra computer skills to maintain the playout system, and this can make the technical department's work more difficult. These skills can be difficult to learn and so it is important to have a good relationship with your supplier to talk through problems as they arise.

Digital automation systems – the next step

The digital automation systems are the next higher step beyond the audio playout systems, allowing us to **automate** the entire task of broadcasting programmes according to a pre-decided schedule. Once specific **time slots** have been set for various programmes to air, and for the programmes to be interrupted at specific points by advertisements, public service announcements and programme promos, the digital automation system allows us to simply line these up for several days in advance, for the programmes to play out completely without human interference.

Naturally for this system to work to its true potential, this means having a full time team to manage and organize the audio on the system, not to mention full time teams working on generating the programming and the advertising (especially if the programming team is also producing the advertisements on behalf of the advsertisers). It also means an enormous level of coordination and cooperation between these teams in terms of getting the relevant audio ready several days in advance of the play date.

> Given the scale of operation of a CR station, automation must be used with care. Extensive automation also means having a full time infotech team that can manage and maintain the computers involved at all times. This is only a viable option if your station is doing more than 8 hours of broadcasts a day.

(Audio) Effects

Audio effects can be of two kinds: The ones that are actually **recorded from a source** – a car passing, say, or a baby crying – and the kind that are **generated artificially** to change the audio quality of a recording or emphasize something (a whistle or bloop or thweep, for instance).

Properly used, effects can add a whole new dimension to recorded sound. Effects can make advertisements more appealing; dramas more dramatic; and jingles ear catching. Nearly all computer-based digital-editing systems now come equipped with a toolbox of effects – but it is often simplest to record the kind of sounds we want, unless we want something quite unnatural which can only be created artificially.

Of the many effects that one might use in radio work, the most common and popular are as follows:

1. Reverberation

Reverberation (or **reverb**) is the natural reflection of sound from walls and structures around us, which give a voice its 'presence' in an enclosed space. These reflections reach us so quickly after the original sound is made that we don't consciously perceive them as being separate from the main sound – but we can and do notice when they aren't there. (This is why a **padded room** or an **acoustically treated studio floor**, where reverb has been deliberately reduced through various techniques, sounds 'dead' to us, as if our voice has been swallowed up by the room.)

For audio recording purposes, we always try to record 'clean' sound – that is, sound without reverberations in a controlled studio environment. Later, during post-production, we add the 'reflections' electronically, to the exact degree that we require. Doing this well is an art, and calls for sharp ears and an understanding of what real reverb sounds like. Done properly, it can create the impression of a real room of a specific dimension.

2. Echo

When the reflection of the original sound reaches us after a distinct delay, we perceive the reflected sound as an echo. In electronic terms, we can add echo the same way we add reverb, but by increasing the **return time**.

3. Delay

Along with echo and reverb, we can also electronically create multiple reflections, and alter the **duration** and **volume** at which each of these echoes return after the original sound. This is achieved by using the delay effect controls. If the delay effect is used in combination with the **pan control** (see below), this can create spatial effects in stereo.

4. Modulation

Modulating the delay time creates modulation effects. If we use a low frequency oscillator to generate a signal that varies the delay time in accordance with the frequency of the oscillator signal we can create a **chorus effect**, like two or more voices singing the same part, but with slight differences in timing and tuning.

Using different length delays and different modulating frequencies can also create effects like:

Phasing: Very short delay time and mixing the delayed sound with the original creates a slightly flatter and 'treated' effect;

Flanging: A longer delay and feedback creates the effect that we hear when a guitar string is stretched sharply in the middle of a note;

Vibrato: When only the delayed sound is used, with a slight change in pitch, to create a wavering sound that is more tremulous than the original.

5. Pitch shifting

Pitch is a measure of the overall combination of frequencies in a sound or voice. (Hence: "She has a high-pitched voice" – that is, a voice where the shrill notes and higher frequencies predominate.) Before the advent of modern effects processors, pitch shifting was achieved by speeding up or slowing down the recording during playback – the former increased the pitch, and the latter decreased it. Unfortunately this technique also changed the overall length of the audio. Modern effects processors can **pitch shift** the sound – make it shriller or more bassy – without changing the speed of the audio.

6. Time stretching

Another sound effect that is possible with modern effects processors is the time stretch, where the length of the audio can be changed without affecting the pitch of the audio. (See **Pitch shifting** above.)

ELECTROMAGNETIC SPECTRUM

Radio waves are a form of electromagnetic radiation: **Electromagnetic radiation** is the transmission of energy in the form of waves that have electrical and magnetic components. Where scientists once thought magnetism and electricity were entirely unlinked phenomena, research over the last few centuries proved beyond a doubt that not only were the two linked, in many cases they were simply different expressions of the same energy.

The most familiar forms of electromagnetic radiation are **radio waves** and **visible light waves**. They differ primarily only in the frequency and wavelength of the radiation.

All electromagnetic waves travel through empty space at the same velocity (speed) – namely the speed of light. The speed of light (often denoted by the symbol **'c'**) is 2,99,792,458 metres per second. For most calculations the approximate value of 3,00,000 km/s is used. This is true whether we are talking about radio waves or visible light.

The electromagnetic spectrum

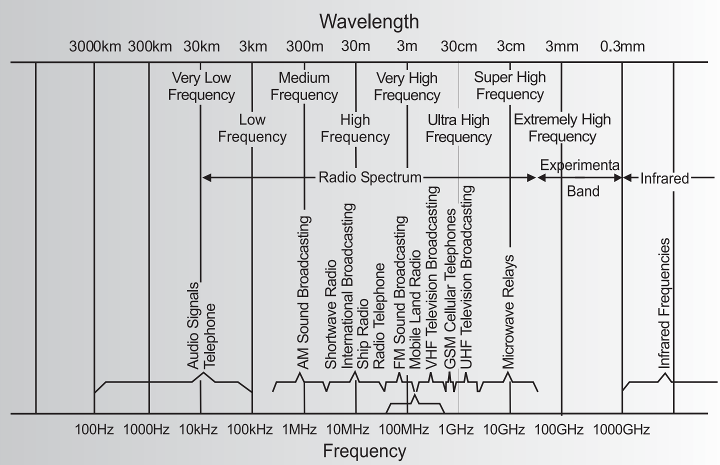


Fig 11. The Electromagnetic Spectrum

Mathematically, electromagnetic waves are represented by **sine waves**. The sine wave is a graphical representation of wave phenomena. As we have seen earlier, the wavelength and frequency of any electromagnetic wave are related to one another inversely; that is, when one increases, the other decreases.

We can now quantify this as an equation as:

Wavelength = Speed of light / frequency

Different forms of electromagnetic radiation are characterized by their wavelength and frequency. When electromagnetic waves are ordered by frequency or wavelength, this ordered array is called the **electromagnetic spectrum**. The electromagnetic spectrum represents all electromagnetic signals, from very low frequency (long wavelength) to very high frequency (low wavelength). Note that even visible light, the electromagnetic radiation that our eyes have evolved to perceive, is itself composed of a variety of frequencies of light: The colours of the rainbow that we see when sunlight is refracted or broken up by a glass prism are the different frequencies of light that together make up (white) sunlight.

EQUALIZERS

Many of us are already familiar with the **treble** and **bass** controls on our home stereos, that let us control whether the sound is higher or deeper in pitch.

For more on pitch, see **Section B: (Audio) Effects** on Page 175

Consumer grade equalization controls

The tone and bass controls are the most basic **equalisers**, allowing you to change the overall mix of frequencies in the audio to suit our listening experience, the listening area we are hearing the audio in - or to emphasize specific instruments or voices in the audio. Essentially, they act as a sort of **electronic filter**, allowing you to turn up certain frequencies in the audio, and turn down others.

A slightly more advanced version of the treble and bass knobs is the **graphic equalizer**, which is often found as a set of sliders on hi-fi consumer equipment. Each slider controls a specific band of frequencies, with the entire range from 50 Hz to 20000 Hz divided among 6 or 8 sliders. These are better than simple tone knobs or controls.

Professional grade equalizer controls

The equalizer controls on professional equipment are a lot more precise than the **band equalisers** found on home and consumer grade equipment. (Band equalizers are so named because they are not very precise, affecting a large group of frequencies together rather than a single frequency or a small range of frequencies.)

On studio mixers, one typically sees an **equalization section** that includes **HI**, **MID** and **LO** knobs, as well as an **EQ button**. Pressing the button activates the equalization section, and using the three knobs turns up or turns down the gain for the three equalization/filtration units.

The LO knob is a **high-pass filter**, which means it only low frequencies.

The HI knob is a **low-pass filter**, which means it cuts or boosts only high frequencies.

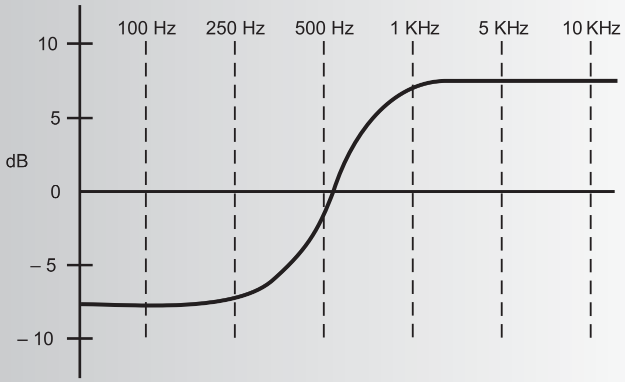


Fig 12. Effect of a low cut/hi pass filter

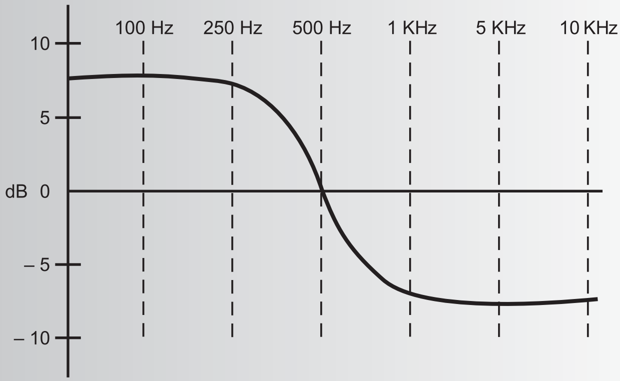


Fig 13. Effect of a hi cut/low pass filter

The MID knob is a **bandpass equalizer**. It typically affects frequencies between 500 Hz and 5000 Hz (the frequencies most commonly falling within the human vocal range). On many mixers the MID equalizer is also **tunable**, in that the **centre frequency** can be changed: This is the frequency in the exact middle of the range that this knob controls. This form of EQ is also known as a **sweep equaliser**.

Parametric equalization

The parametric EQ is very like the sweep equalizer in that it controls a band of frequencies. In addition, it has a third control that allows the **width** of the band to be adjusted. This is referred to as the '**Q**' of the control: A higher Q means a wider band of frequencies is being controlled, and a lower Q means a smaller band of frequencies is being controlled.

Software based equalization

Many audio editing and processing software now include equalization sections where you can perform the same function, sometimes in an even more precise way. Often these softwares have **graphical representations** of the equalization controls, to make them comfortable for those used to hardware mixers.

> Don't use equalization when recording audio unless there is no other way. Most of the time, audio is poor only because our microphone position or recording area is not up to scratch. Use equalization only at the post-production stage – and in moderate amounts.

(Acoustic) Feedback

Acoustic Feedback is most often experienced as the nasty screeching you sometimes hear coming out of speakers at a concert, or when someone is talking over a public address system. It is a high pitched sound that rises quickly to a shriek – and is not only unpleasant to hear, it can be downright dangerous for your equipment. Feedback is also known as **howlround**.

Feedback is produced when an unwanted sound output (or audio signal) from a loudspeaker or audio device is fed back to an earlier part of the sound reproduction system. The unwanted audio signal is picked up and amplified (made louder) by the electronic circuits in the system. The amplified sound is then output again over the speakers, and is picked up again by the inputs (microphone), making a **closed loop**. The system then quickly becomes **overloaded**, and this is heard as a nasty screeching sound through the loudspeakers.

Typically, feedback happens when the speakers in a public address system are placed behind the microphone, giving the speaker output a chance to go back to the input and be amplified. To stop feedback, you have to break the feedback loop. In the example described above, you will have to move the mic to a place where sound coming from the speakers is not picked up by the mic. Or you can move the loudspeakers so that their output cannot reach the mic. Moving either the speakers or the mic will break the feedback loop, and the system will work properly.

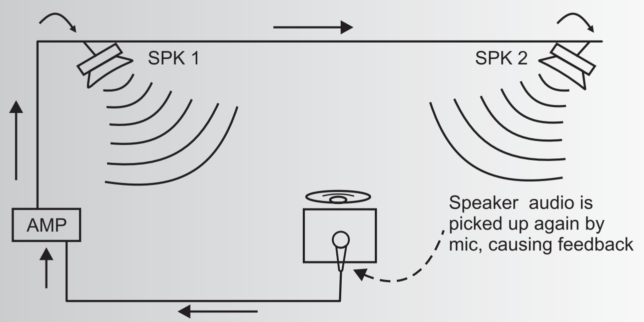


Fig 14. Poor speaker placement leading to 'howlround' – the speakers should have been placed between the mic and the audience.

Avoid situations that will lead to acoustic feedback for two reasons:

Firstly, it always affects your sound output. The noise is horrible and it will make your sound unlistenable. Even a small amount of feedback can cause echoes or boosting or cutting of certain frequencies.

Secondly the very high signal levels associated with feedback can destroy or damage loudspeakers and other equipment that are part of the feedback loop.

Acoustic feedback is not acceptable at all in the broadcast studio. To make sure feedback from the mic to the loudspeakers doesn't happen, broadcast studios have special switching units. These units, often incorporated into the mixer, turn off the studio loudspeakers whenever a microphone is turned on. The same switching unit also normally triggers the RAG lights or On-air lights. These are indicator lights placed inside and outside the studio to show that a microphone is switched on, and that someone is ON AIR. It is good practice never to enter or leave the studio when the on-air light is on.

Another kind of in-studio feedback relates to recording equipment. For example, let us assume a recording device is being used to record a signal from the recording output of a mixing desk. If the recorder's output is added to the mix on the mixer's recording bus, and you lift the fader of the channel feeding the recorder, feedback will occur. The audio is feeding back into the system, and the same kind of noise will result.

Field Recorders

The term field recorder refers to any portable recording device that allows reporters to go into the field with the means to capture sound. Because there are so many different kinds of field recorders you can buy, it is impossible to enumerate every type that is available in the market. But we can quickly list the most popular varieties.

1. Cassette recorders

Cassette recorders are the most common field recording devices available in many places even today. The cassettes that we use in them are readily available almost everywhere, and are quite cheap. They are relatively **rugged**, **easy to repair** – cassette recorders are plentiful enough for even the average electronics repairmen to fix the common problems – and are **relatively cheap**. Good cassette field recorder models are the **Sony Recording Walkman** series, and (a little more expensive, but with far more controls for professional grade work) the **Sony TCD-5M recorders**.

For more on cassette recorders, see **Section B: Cassette Tapes & Cassette Recorders** on Page 134

2. Minidisc recorders

The minidisc or MD was originally invented by Sony as a replacement for its cassette walkman players – that is, as a handy portable recorder that could carry high quality audio. It never found acceptance in the home consumer market, as it was an expensive device. Instead, it became popular with filmmakers and journalists as a way to record high quality digital stereo audio. MDs have been the staple recorder for a number of CR stations across the globe for some time. The newer Sony **HiMD models** – an upgraded version with higher capacity media and the ability to record **PCM WAV** uncompressed audio – are still quite popular. The recorders are priced quite reasonably for the quality of recording; and the HiMD recorders offer the additional option of **digital USB transfers** for editing on a DAW, making them an attractive option.

For more on MD recorders, see **Section B: Minidiscs & Minidisc Recorders** on Page 204

3. Flash recorders

The most recent type of field recorder – and by far the ones gaining greatest ground today - are the solid state flash recorders that record on **Compact Flash (CF)** media or **Secure Digital (SD)** cards. As digital memory has improved in tandem with the increasing roles computers play in our lives, flash recorders – which use the same kind of solid state memory used in computer BIOS memory – have also improved by leaps and bounds. The most recent versions – like **Zoom's H-2 recorder** or the **Edirol R-09** – are very high quality instruments, with the ability to record several hours of high quality audio on media that are rapidly becoming cheaper by the day. (SD cards are available in 8 GB versions today, enough for over 10 hours of non stop recording in uncompressed WAV format; and CF cards are available in as high a capacity as 64GB.)

For more on flash recorders, see **Section B: Flash Recorders** on Page 187

Conducting a field recording

A field recording normally involves the following steps:

1. **Connect the microphone to the recorder.** The microphone cable usually has a female XLR or connector at the microphone end, or it may be built into the recorder. The recorder end of the cable could use a variety of input connectors, including male XLRs and ¼" mini-phono plugs. Make these connections gently and correctly, and never force the connectors to go in. Remember to press down the tab on XLR connectors. Field recorders are often made of lightweight materials, and force may crack the case or break the connector mount.

2. **Connect headphones to the recorder.** Smaller field recorders come with earbud style headphones. Pro models often need to be matched with full size headphones. Gently push the ¼" plug or minijack plug into the jack for the headphones. If your full size headphones need a plug adapter to make them fit, be sure to attach this first.

3. **Insert the media.** Follow the operating instructions of your recorder and gently insert a recordable tape, MD, flash memory chip (or other appropriate blank medium) into the recorder. Always ensure that the inserted medium is fresh/blank. If there is already a recording on it, ensure that you will not accidentally erase it while doing the new recording.

4. **Switch on the recorder and check your levels**. Start by conducting a short test recording to check your recording levels. Switch on and hold the microphone in the position that you expect to work with it. Say a few words, and ask your guest to speak as well. Keep your eyes on the audio level meter. (Some recorders may require you to put them in REC-PAUSE mode to do this.) Change the record levels on the recorder, or adjust the mic position till you are happy with the levels. Check audio quality on

Contd...

the headphones as well, so that you know there are no unnecessary crackles or loose connections.

5. **Make the recording.** Different recorders require you to press different combinations of buttons to start the recording process. Confirm the exact process to start and stop recordings before you commence your recording.

6. **Complete your recording, and label your media or identify it in some fashion.** Many reporters/recordists use sticky notes or insert labels that can be written on to identify tapes/MDs/CDs. It's a good idea to also keep a notebook or pad close to hand to note good takes and pre-select sections of recordings at this stage itself.

7. **Pack your equipment in their cases.** Carry a checklist to ensure that all the bits and pieces have been packed up and not left on location. Coil all the cables neatly and stow them so that the connectors do not get accidentally damaged. Make a note of any equipment that has been malfunctioning. Pack your used media separately.

Flash Recorders

Till a few years ago, the first choice of field recorders for CR stations used to be **cassette recorders** and **minidisc recorders**. But with computers and cheaper memory becoming rapidly available – and therefore increasingly becoming a part of even smaller stations – the stage was set for a new type of device that could give very high quality digital recordings, and yet be very compact and rugged.

This new type of recorder was the device that is now popularly called the **flash recorder**, as it records on various types of **flash** or **solid state memory**. Many of us are familiar with flash memory in the form of the **thumb** or **USB drives** that have increasingly replaced the use of floppy discs over the last few years.

Flash memory

Flash memory is a comparatively new type of data storage system, and is a considerable improvement on hard disk and tape based digital storage systems (like that used in the **Digital Audio Tape, DAT**) as it has no moving parts. It uses an electronic chip that is essentially the same as the BIOS memory in your computer. Each of the chips contains thousands of electronic transistors, tiny 'gates' that allow electrons and charges to move from one part of the chip to the other.

In flash memory - more correctly known as **EEPROM memory** - the data is stored as a change in the conducting parameters of the electronic chip itself: That is, as a property of these individual transistor 'gates'. To change the state of each gate takes an electronic input – but the best part is that though it takes power to change the state of the transistor, once the power is withdrawn, the state of the transistor remains static. This means the chip does not forget the information once the power is withdrawn. This type of memory is also known as **non-volatile memory** i.e. memory that does not vanish when the power source shuts down. (Contrast this with the fact that computer RAM, which also stores information while the computer is on and running, 'forgets' all the data when the computer is shut down – this is called **volatile memory**, and means that a computer has to automatically write all the data in the RAM onto the hard disk for later retrieval before it shuts down.) Since the amount of power required to operate with flash memory is also very small, and since writing information to flash memory involves no moving mechanical parts, this also means a very small power source can go a long way.

Types of flash memory

Flash memory is available in an incredible variety of shapes, sizes and capacities: You see **MMC** cards in mobile phones, **SD** and **Micro SD** cards in cameras, and **CF** cards in a variety of instruments. For audio, the two most common recording media are **SD (Secure Digital) cards** and **CF (Compact Flash) cards**, with the former rapidly outdistancing the latter.

1. Secure Digital cards (SD)

SD cards are available in capacities ranging from 16MB to 4 GB (though commonly the maximum used in many recorders is 2 GB, which gives approximately 3.5 hours of uncompressed professional grade audio). By convention, they are small blue chips about twice the size of your thumb nail, with the golden electronic contacts exposed at one end.

SD cards have a small **notch** at one corner: This helps you identify how to orient and insert them into the slot that is provided for them on audio recorders and cameras.

2. Compact Flash cards (CF)

CF cards are an earlier development in flash memory, and are slightly bulkier, being about the width and breadth of a box of matches – but the extra dimensions also mean a staggering amount of information can be stored on them. The most recent types of CF can store as much as 64 GB of data, though 4 GB and 8 GB are more commonly used in audio recorders.

CF cards are also thicker than SD cards – which actually means a couple of millimetres, so don't go imagining something very thick! – and have a series of slots across one edge: This is for the connector, which usually has 50 pins.

Flash recorders

Given the type of memory it uses, the flash recorder has several things to recommend it over other types of recorders:

1. It is noiseless
2. It has no moving parts, and therefore fails less
3. It allows faster access to your data, and in a non-linear way (more like a computer does)
4. It is lighter and smaller
5. It consumes very little power
6. It can be connected directly to a computer via USB for direct digital file transfers with a minimum of fuss and complexity

All these together make the average flash recorder very small, compact, rugged and battery conserving – all very important factors for field recorders.

Selecting a flash recorder

Flash recorders range from the basic dictaphone varieties (with an inbuilt mic, meant mainly to record voice for notes and in field dictation, like the **Samsung Voice Pen** or the **Olympus DS-2200**); to the higher end dictaphone units (still meant for dictation, but often with provision for external mics, like the **Sony ICD-B 500** or the **ICD-MX20**); the middle end professional units (like the **Edirol R-09** or the **M-Audio Microtrack 24/96**); and the high end professional units (like the **Marantz PMD 670** and **660** or the **Tascam HD-P2**, with XLR inputs and advanced controls).

There are flash recorders today to suit every pocket and budget, so you will have to consider the key features one by one when you purchase a flash recorder. Important considerations include:

1. What is the maximum memory it can take? (in case you upgrade it later)
2. What kind of VU meters does it have?
3. What kind of batteries does it use, and how many?
4. What kind of memory does it take (SD cards are rapidly becoming cheaper than CF)
5. What kind of connectors does it have? (XLR or mini phono?)
6. Can it be powered externally if required? (Most middle and high end recorders come with power adapter provisions)
7. Does it have an internal mic and a built in speaker? (Depending on the kind of field recordings you do, you may want to operate without an additional mic, or even listen to the audio without headphones.)
8. What kind of audio file formats can it record in, and at what sampling rates? (Higher end units offer WAV and MP3 recordings at a variety of settings – lower end units may not offer uncompressed audio at all, as they may have smaller memories. This is especially true of the Dictaphone varieties, which have non-removable memories, and which are optimized for long recordings in the field rather than high quality audio).

Loudspeakers And Studio Monitors

In a sound studio, we don't just listen to sound – we **monitor** it, with attention and focus, so that we can perceive small distortions, issues with diction, or small changes in tonality. Naturally, this is a process that calls for a high quality pair of speakers, so we can hear the audio that's coming off the mic or off our recording system.

From a mechanical/electronic point of view, the speaker is the exact reverse of the microphone – it is a **transducer** that converts the electrical audio signal into physical movements of a surface which then generates pressure (sound) waves that we can hear with our ears. A good speaker, like a good microphone, should conduct this conversion process with a minimum of distortion or change in audio quality.

For more on microphones, see **Section B: Microphones** on Page 198

The electrical signal from a mic or a recorder is too weak, of course, to drive a large surface back and forth, so speakers are generally used in conjunction with an amplifier, which can boost the signal to a strength where it can 'drive' the speaker.

For more on amplifiers see **Section B: Amplifiers** on Page 128

The speaker consists of three main sections: **drivers**, a **cross over network** and an **enclosure** (the speaker box).

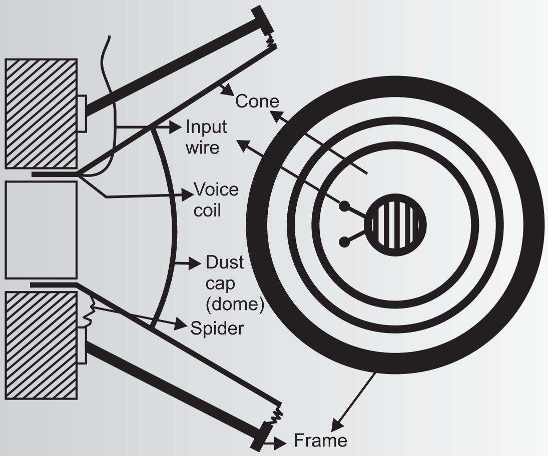


Fig 15. Cross section of a speaker unit

The **input wires** for the speaker carry the audio signal to the **driver unit**, which is essentially a cone of stiff cardboard (in consumer end speakers) and Kevlar plastic (in higher end speakers). The narrow end of the cone is connected to a coil of wire (**the voice coil**) that is wrapped around a permanent magnet. The amplified audio signal is fed to this coil, which then acts as an electromagnet, and alternately is repulsed by the other magnet and attracted by it. These movements are dependent on the frequency and strength of the electrical (audio) signal fed to it, which – of course – corresponds to the frequency and strength of the original audio.

The movements of the voice coil are transferred to the cone, to which it is attached; and the vibrations of the cone make the air in front of it vibrate as well, which is what we perceive as sound.

Woofers and tweeters

We have already seen that the audio signal must be amplified in order to drive the speaker cone back and forth. It stands to reason that if the cone is large, the amplification must correspondingly be greater. Most good speakers, therefore, use a combination of two driver units, a smaller cone handling higher frequencies (**tweeter**) and a larger cone (**woofer**) handling low frequencies.

Such speakers need a **crossover circuit** to channel specific frequencies to the two driver units

The enclosure

Usually, the drivers and all the related circuitry, including the surface on which they are mounted, are encased in a heavy box or enclosure, often made of wood. This not only serves to keep all the components together, it also keeps them all in the correct position relative to each other. Additionally, since the drivers are moving quite fast, and set up powerful vibrations, the enclosure is heavy in order to be able to absorb the vibrations.

Enclosures are carefully designed and calibrated to provide the best sound experience: The hollow space serves as a **resonator** – that means the column of the air inside it vibrates at the same rate as the sound produced by the speaker drivers, increasing the sound output. This is also supported by the design of the vents surrounding the main driver cones, which are designed to direct the backward reflections to the front.

Passive & Active monitors

Most studio monitors are **passive monitors**: That is, they are connected to power amplifiers, that in turn are connected to the mixer. The levels of the audio signal reaching such monitors are generally controlled from the mixer itself. Some monitors, however, have power amplifiers built in. Such monitors are called **active speakers**, and they're considerably more expensive.

With passive monitors, there is a possibility that we will **overdrive** the speaker drivers – that is, give them a signal input that is beyond their capacity, thereby damaging them. With active monitors this is not a worry, since the amplifier and the driver are a matched set. (Having matched amplifiers often makes active speakers sound better as well!)

Speaker cones must be protected from dust and direct sunlight – and most of all from curious pokes by people!

Headphones & Earphones

Headphones are small **paired speaker units** fitted in a plastic or leather casing which is designed to be worn over the user's head. (The headphone's smaller cousin, **the earphone**, has two small speaker units enclosed in small plastic holders designed to fit within your ears.)

Headphones can be used in both studio and outdoor situations. In studio situations, headphones are often used to prevent **acoustic feedback** when there are live microphones around. In field situations, headphones prevent extraneous **ambient noise** from disturbing your concentration on the audio that is being recorded.

The primary sections of a headphone unit are:

1. **The Head strap/headband:** An elasticized band that holds both speaker units together and allows the user to fit them over his or her head.
2. **The Ear cups:** Made of plastic or leather, the ear cups enclose the speaker units and have a covering of soft felt, vinyl or leather that allows the speakers to fit snugly over or against the user's ears.
3. **The Lead:** Headphones are generally designed to monitor stereo audio. This is why there are two speaker units, and the input cables are paired: A main stereo cable usually splits into two independent left and right wires that feed each speaker unit.
4. **The Jack/connector:** Headphones and earphones are generally equipped with stereo connectors, usually 1/4th inch or 1/8th inch miniphono stereo jacks, as headphones are inherently intended to be monitor stereo audio. (Correspondingly, most smaller field recorder units are equipped with miniphono sockets, and most pro field recorders with regular phono sockets: The assumption is that pro recorders will be used with full scale headphones, and smaller recorders with earphones.)

Magnetic Recording

Magnetic recording is an **analog recording process**, and works on the principle of **electromagnetism**. Magnetism and electricity are linked phenomena, which means that an electrical current passing through a conductor like a wire or a piece of metal generates a magnetic force that is in proportion to the strength of the current. (Similarly, if a conductor is placed in a moving magnetic field, an electric current is generated within the conductor.)

In magnetic recorders – typical examples are the **cassette** and the **spool recorder** - the input electrical signal from the microphone (or any other audio signal source) is fed to a **recording head**, which is essentially a soft iron core with a wire coil wrapped around it. A **motor unit** moves a rubber or plastic **capstan** and **pinch roller** system that grips the tape surface and moves it under the head at a constant pace (usually 4.76 cm/second). As the input current varies according to the changes in the audio, so does the magnetic force generated in the iron core of the head. This varying magnetic force is recorded onto the tape as a rearrangement of the magnetic particles on the tape surface.

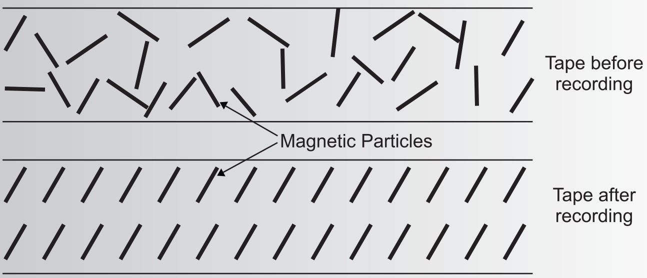


Fig 16. Recording on a magnetic tape organizes the magnetic particles on the tape in response to the input signal

When the recorded tape is then played back, the tape is moved across a second head – **the playback head** – where the reverse process takes place: The magnetic field generated by the particles on the tape generate a corresponding current in the iron core of the head, which is drawn off by the wire coil and can then be amplified and played back over speakers, recreating the original sound. In professional magnetic recorders, the recording and playback heads are often separate, but in most consumer grade equipment, the same head performs both functions.

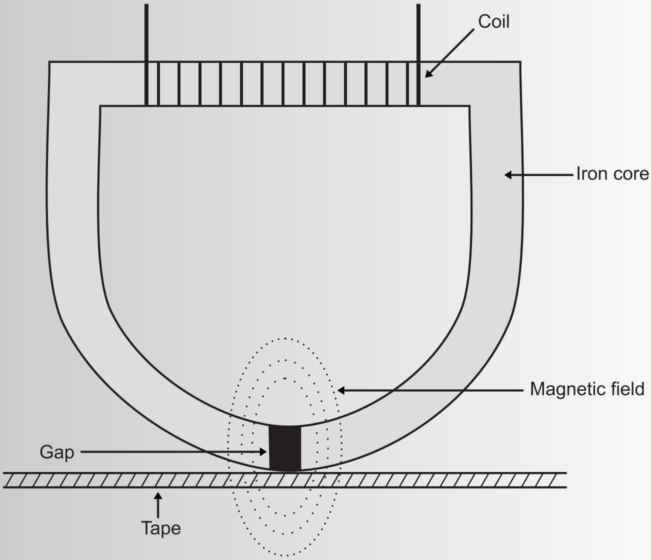


Fig 17. The magnetic recording head

The primary issue with the media - tapes, floppy discs - used in magnetic recording is that they can be easily damaged by heat, or any stray elecromagnetic fields in the vicinity.

Tapes and floppies can be damaged if they are left near computer screens, speaker sets, any powerful magnets - or even, sometimes, if they are locked up in a metal drawer or almirah!

Additionally, the tape base is actually an emulsion containing magnetic particles; and this often attracts mildew and fungus if the tapes are not used or aired out a bit on a regular basis.

Meters And Audio Level Measurement

Almost all audio equipment used in a radio station has an **audio level meter** of one kind or the other. Maintaining audio levels is important: The circuitry in every audio equipment has a capacity beyond which it will not be able to handle the voltages and currents involved. If we feed the equipment a signal beyond its capacity, at best the audio will be **distorted** – and at worst, it will damage the equipment. Similarly, if the audio levels are too low, then the system's own noise will drown out the usable signal.

For more on Signal to Noise Ratio, see **Section B: Signal to Noise Ratio** on Page 214

Audio meters are also necessary so that we can **match levels** across pieces of equipment, keeping the quality of the audio high.

Different pieces of equipment carry different types of meters, and it is vital to know how to use each of these to gauge the audio levels properly:

1. The VU meter

The VU or **Volume Unit** meter is the most common analog meter type for audio equipment. Typically, it has a graded meter with markings ranging from around -20 VU to +3 VU. Till 0 VU, the meter is generally marked in green or black, and beyond this, it is usually marked in red. A needle moves across the meter to indicate the level of the audio that is being input into the equipment.

0 VU indicates the maximum distortion free level that the equipment can handle. In practice, there is some scope for going beyond this: It is okay if most of the programme is around 0 VU, with the occasional peak reaching + 2 VU.

For more on dBu units, see **Section B: Decibels** on Page 172

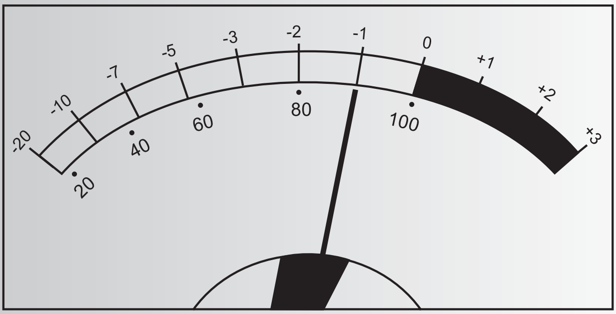


Fig 18. The VU meter

Lining up VU meters

VU meters on various pieces of equipment are often used to align the equipment to a reference signal. For this, we use a source that plays back a 1000 Hz (1 KHz) test tone at 0 dBu, and feed the source to all the equipment that needs to be aligned.

The faders on the equipment to be aligned are then set to a standard reference point (usually -10) and the channel gain turned up or down till the VU meters on all the pieces of equipment reach -4 VU.

When all the equipment that we are using has been so aligned, it is good practice to mark the gain setting at which this alignment has been achieved on each of them – this way we can be sure that all the equipment is reflecting the correct levels.

2. The PPM meter

In some equipment, it is more important to measure the highest levels of the audio signal – the **peak**. Since the VU meter needle is in constant movement, and doesn't stop at the peaks, it is hard to note the peaks of the signal.

This is why some pieces of equipment – especially the master broadcast mixer in large studios – are equipped with **PPM meters** or **Peak Programme Meters**, which are designed and graduated specifically to measure the peak levels of the programme.

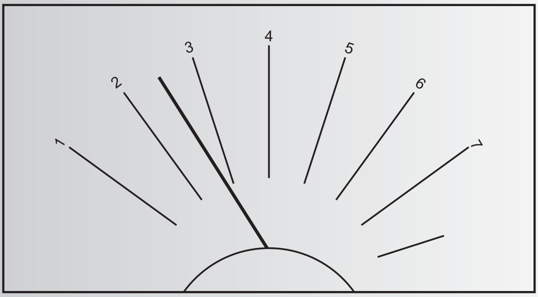


Fig 19. The PPM meter

In the PPM meter, the graduations are generally marked from 1 to 7. The reference 0 dBu is equivalent to the 4 mark. The signal should be controlled to not exceed the 6 mark

3. Digital meters (LCD or LED)

Modern digital audio equipment often carry a third type of meter called a digital meter. These are often a part of the **Light Emitting Diode (LED)** display on the casing of the machine; or are carried as part of the remainder of the display on a **Liquid Crystal Display (LCD)** display built into the unit.

Unlike the analog VU and PPM meters, digital meters give no headroom – that is, we cannot exceed the 0 mark on these meters. If we do, distortion of the sound will almost certainly result.

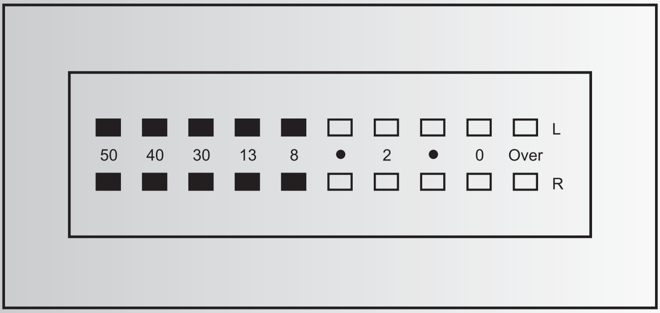


Fig 20. The digital meter

Many sound recordists today tend to use the -12 dBu mark on the meter in the same way as the 0 dBU reference on the older analog meters: That way, the audio can exceed the reference level somewhat without still reaching the 0 dBu mark, giving the same headroom as the analog meters. If we record using this standard, it is wise to keep the softest sounds around -18 dBU to – 20 dBu, and the loudest sounds around – 6 dBu. When we finally mix and master the sound, we can bring the whole programme further up towards the 0 dBu mark.

LCD digital meters are composed of a series of dots or black boxes that appear and disappear in response to the input signal. The only permanent markings are two dots marked towards the right end of the meter, and corresponding roughly to the 4 and 1 marks. Try and keep recording levels on or around the first dot, with the peaks touching the second dot (to the right) only occasionally.

MICROPHONES

A microphone is a **transducer**, a device that converts one form of energy to another. In the case of the microphone, the acoustic energy of sounds as they travel through air get converted to a corresponding electrical signal whose voltage varies in direct correspondence to the original sound waves. This electrical signal can then be fed to a recording device or other audio devices so that it can be stored for later playback.

Microphones are popularly referred to as **mics** (pronounced **mikes**). Today, there are several varieties available, with specific functions and purposes. We can understand how a mic works by looking at the simplest type of mic there is: The **dynamic** or **moving coil** microphone.

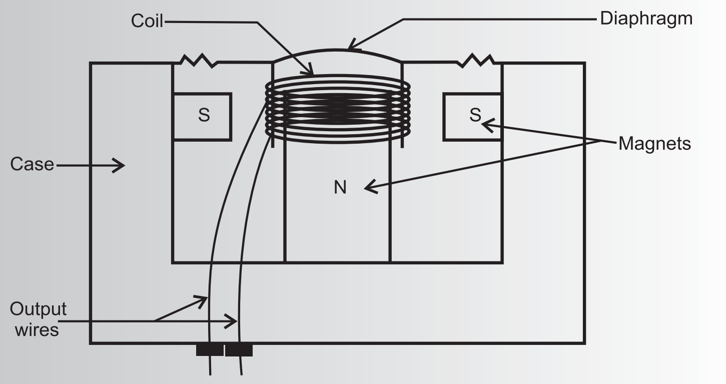


Fig 21. The moving coil microphone

At its very basic, the dynamic microphone is made up of a thin plastic or metal film attached to a fine coil of wire. The film – known as a **diaphragm** – is usually stretched across the open end of the microphone, and the coil hangs below it, suspended between the North and South poles of a powerful magnet. When someone speaks in front of the diaphragm, their voices reach the diaphragm as a series of pressure waves – changes in the pressure of the air between their mouths and the diaphragm. The pressure waves make the diaphragm vibrate back and forth, moving the attached wire coil across the magnet. When the wire moves in the magnetic field, a small current is generated in the wire. This phenomenon is called **electromagnetic induction**.

The important thing is that the current varies in direct proportion to the movement of the diaphragm-coil combination – and since *that* is dependent on the strength and frequency of the original sound waves striking the diaphragm, the current is actual in direct correspondence to the original sound. This small signal, only a few microvolts strong, can then be drawn off and amplified by a **pre-amplifier,** so that we can record or manipulate it further.

For more on pre-amplifiers, see **Section B: Amplifiers** on Page 128

I. Mics classified by construction

1. Dynamic mics

Dynamic mics are of the **moving coil** or the **ribbon** type. The dynamic coil type is decribed in the example above. The ribbon mic also works on the principle of electromagnetic induction, but the transduction in this case takes place because of the vibrations caused in a thin aluminium ribbon suspended in a magnetic field.

Dynamics mics are especially good for field recordings, as they require no external source of power.

Examples: **Shure SM 57** and **58**

2. Condensor or capacitor mics

Just as dynamic mics make use of the principle of electromagnetic induction, capacitor mics make use of the principle of capacitance.

Capacitors – also known as **condensers** - are electrical components where two metal plates are separated by an insulating material. If a voltage is applied across the two plates, the two plates get charged. If the distance between the two plates now changes, the voltage across the two plates will change correspondingly.

In capacitor mics, one plate of the capacitor is fixed, while the other plate acts as the **diaphragm**, and can move freely in response to the sound energy striking it. The change in the voltage caused by the movement of the free plate – and the consequent change in the distance between the two plates – is read as the audio signal.

Capacitor mics need a power supply to keep the capacitor charged. This may either be supplied by an internal battery fitted in the mic; or through a power supply provided through the same wires which carry the audio signal away from the mic. If the latter system is used, the power supply is known as a **Phantom power supply**. This is usually a 48V supply; and mics which require such a supply usually include **P48** within the mic name.

Capacitor mics are highly sensitive, and give very accurate sound reproduction. This is why they are used extensively for broadcast.

Examples: **Rode NT-1A**, **Sennheiser MKH 416 P48**

3. Electret condenser mics

Electret condenser mics are a variety of condenser mic where the capacitor plates are permanently charged instead of requiring a continuous electrical charge to maintain their voltage.

As they do not require a power supply, this means these mics can be very small in size, allowing them to be used as built-in mics in several types of devices. However, their audio quality is also poorer than powered condenser mics.

Electret condenser mics are usually found as the built in mics on consumer grade home audio and portable audio equipment, especially smaller two-in-one cassette recorders.

4. Carbon mics

Carbon mics are one of the oldest types of mics, and are used in old style telephone handsets. They can only handle a frequency response of about 300 Hz to 3000 Hz, making them useless for broadcast audio.

5. Piezoelectric mics

The modern replacement for the carbon mic in telephone and mobile phone handsets, these mics make use of the **piezeoletric effect** - the ability of certain crystals to generate a small voltage when distorted mechanically in a particular direction – to generate an audio signal. Their frequency response, though better than carbon mics, is still not perfectly suited for broadcast – but is often adequate for phone in programmes and on-location reporting in the absence of other equipment.

II. Microphones classified by directionality

Microphones can also be classified on the basis of their **directionality** – that is their ability to pick up sound from specific directions around the mic. This is generally represented on a **polar diagram**, a 360 degree chart that shows the **pick up pattern** of the mic.

The polar pattern or diagram generally shows the pick up of the mic at various frequencies. Naturally, a mic that has the same or similar pick up pattern at every frequency is to be much preferred.

Thus, on the basis of their pick-up pattern, mics are classified as **omnidirectional** (where the mic picks up sound from all around it); or **directional** (where the mic only picks up sound from specific directions).

Directional microphones can be subclassified into several types, based on how directional they are. Among these, the most common variety is the simple **cardioid mic**, so called because its pick up is mildly directional, and looks roughly like a heart shape.

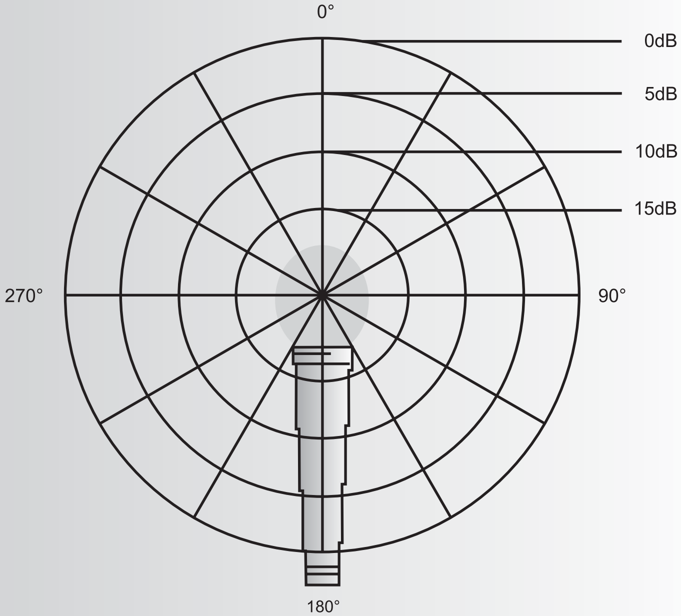


Fig 22. Omnidirectional polar pattern

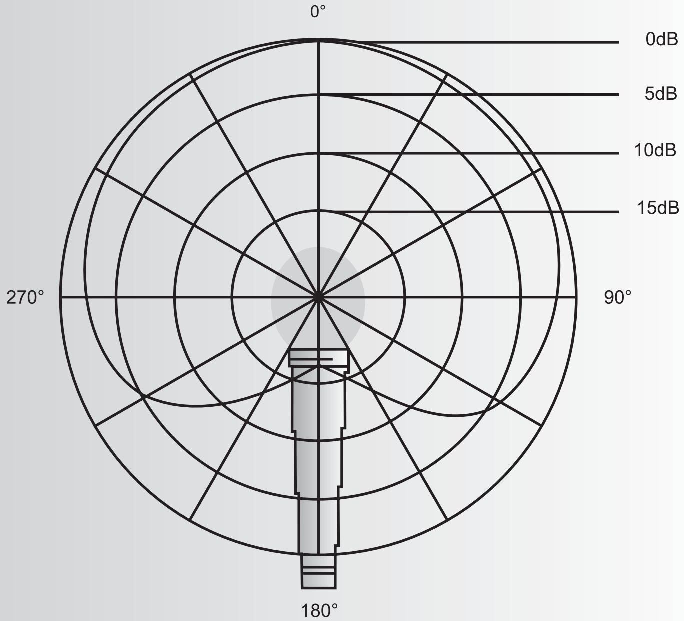


Fig 23. Basic cardioid mic polar pattern

Most cardioid mics tend to pick up sound best in the direction that they point to directly, with the highest rejection of sound being at the sides. There are variations of the cardioid mic which are even more directional, and whose pick up is limited to a very narrow area in front of the mic. These mics are known as **supercardiod** and **hypercardioid** mics.

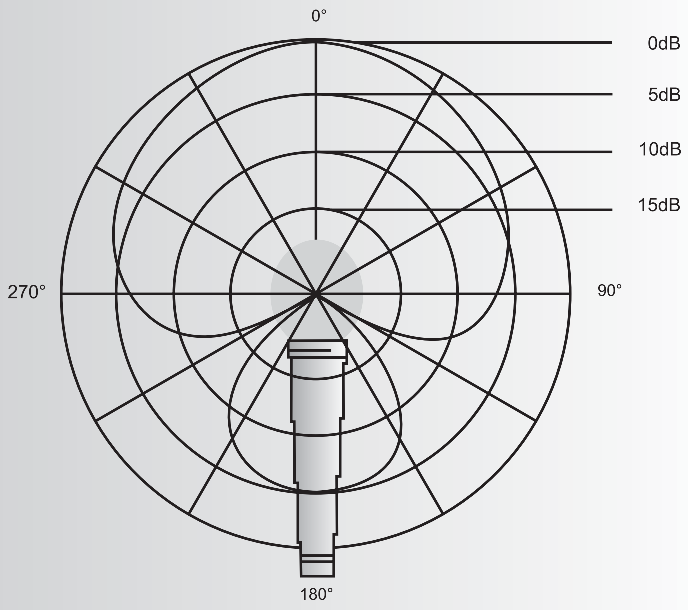


Fig 24. Hypercardioid polar pattern

Hypercardiod mics often use additional accessories like a **slotted interference tube** to heighten the directional effect. The long tube attached to the front gives them an elongated appearance that suggests their other name: **Tube** or **shotgun microphones**, since they often look like gun barrels.

The last kind of directional mic is the **figure of eight** or **bidirectional microphone**, which is only sensitive to sound coming from the two sides of the microphone.

The figure of eight microphone is usually only used for situations where one mic may be used between guest and presenter, or where two singers share a mic.

> Nowadays, many manufacturers use advanced electronics to make mics that have switchable polar patterns. This lets the mic be used as cardioid, bidirectional or omnidirectional mic depending on the situation. (For example: The **Sennheiser MKH 800**)

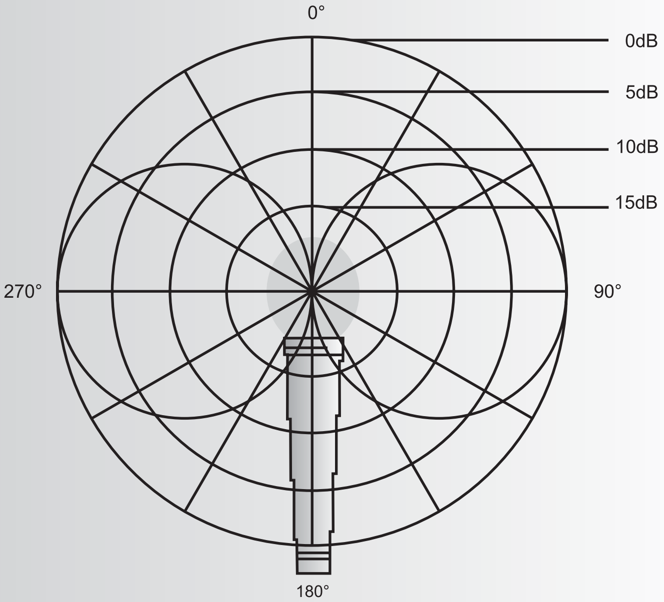


Fig 25. Figure of Eight Polar pattern

The proximity effect

An important consideration when using bidirectional and cardioid mics is their response when the source of sound is very close to the mic. This causes the boost of low frequencies in the mic's pickup, an effect called the **proximity effect**.

Used well by an expert and trained presented, this can result in a full and throaty larger-than-life radio voice. But used poorly, this can mean muddied and dull audio.

Guarding against pop

Many sounds used as part of normal speech are **plosive** – that is, the sounds involve the expulsion of gusts of air from the mouth. When these sounds are made in front of a mic, the gusts of air can strike the mic diaphragm, and cause a rumble that can distort the audio. (The letters P and B, in particular are responsible for this.) The effect is called **pop** or **popping** noise.

This effect may be reduced with **voice training** (which teaches the presenter to say the plosive sounds without large pops of air); and by using a **pop filter** in front of the mic. Pop filters are fine screens of fabric or metal mounted on a small stand which may be attached in front of the mic. The mesh breaks up the blast of air, and prevents it from hitting the sensitive portions of the mic, thereby reducing the pop.

Minidiscs And Minidisc Recorders

The Minidisc (MD) format was introduced in 1992, by Sony. MDs were intended to replace cassette tape as a new portable digital audio playback and recording system. This meant it had to be small and able to withstand vibrations and rough treatment outside the safety of the home or studio. Unfortunately it never quite reached the same level of popularity as the compact cassette – though its quality and compactness made it the de facto standard for community radio and journalists till the advent of flash based recorders.

For more on flash recorders, see **Section B: Flash Recorders** on Page 187

The Minidisc

The Minidisc or MD is actually a small silvered disc contained in a plastic case. In some ways it looks like a computer floppy disc, only much smaller. The disc stores up to 16 bit, 44.1 KHz sampled digital audio through a process called **magneto-optical storage**, which combines some aspects of magnetic recording with the optical storage processes used in CDs. This also makes MDs erasable and reusable with no loss of quality, which contributes greatly to their use in the field.

For more on sampling, see **Section B: Analog & Digital Audio** on Page 124

For more on magnetic recording, see **Section B: Magnetic Recording** on Page 193

For more on CDs, see **Section B: Compact Discs** on Page 138

Being a digital storage medium, MDs can store audio as **tracks**, which means we can search through them in a non-linear fashion: We can skip tracks we don't want to hear, and jump straight through to the recordings made at the end. Information regarding the tracks is stored – like CDs – in a **table of contents** file that is updated each time we record or erase a track.

A standard MD disc. The shutter moves aside during recording to let the recorder access the actual disc surface.

MDs can record in both stereo and mono. At its basic **short play** (SP) setting, a normal MD recorder can store up to 74 minutes of stereo audio on a single 300 MB capacity disc. This is doubled to 148 minutes if we record in mono. Audio is recorded on standard MDs in a digital compression mode called **ATRAC**. This means that audio from a standard MD cannot be heard on a computer without special software that can play back ATRAC compressed audio

For more on stereo and mono audio, see **Section B: Stereo & Mono** on Page 217

In recent times, a higher capacity 1 GB disc has become available which is meant specifically for use with the new generation **HiMD recorders** (see MD & HiMD, below).

MD recorders

MD recorders are available in both **studio models** and **portable field recording units**, though the latter are in more common use. Most of the field units are very compact, having dimesnsions not much larger than the disc itself. Nearly all of the models – primarily from **Sony, Sharp** and **Tascam** – have menu based operations, with many of the settings and features accessible only through a customizable computer-type menu.

MD recorders were built to be used in tough field situations, and have acquitted themselves well in a variety of conditions with minimal care. Most accept a mini-phono jack based external microphone, and contain an internal rechargeable battery. Some can accept an additional external battery – usually AA size – in an attachable external case.

MD and Hi-MD

To remedy the compression that was placed on the audio in MD recorders, Sony came up with a variant of the MD called the **Hi-MD** a few yars ago. Hi-MD recorders allow one the choice of recording in **Hi-SP**, **Hi-LP** or uncompressed **PCM WAV** formats: All three modes record audio in a proprietary Sony file format called **OMG**, which is then converted to uncompressed WAV when transferred to a computer. (HiMD recorders can also record in the older MD mode, in which case the PCM WAV option is not available.)

Hi-MD recorders can play older MD discs; but discs recorded on the HiMDs in PCM WAV cannot be played back on the older recorders.

Hi-MD recorders also offer the option of avoiding D/A conversion when transferring or dubbing the audio onto another recorder: Where regular MDs could do this only through the line out jacks (that needed a mini-phono plug and cable to be plugged in), HiMD recorders allow transfer of the audio as a digital file through the USB port built in to the recorder.

This is highly useful, as it avoids D/A conversion related losses, and saves transfer time.

For more on D/A conversion, see **Section B: Analog & Digital Audio** on Page 124

HiMDs recording in PCM WAV format give about 27 minutes of recording on the standard MD disc, which is 300 MB in capacity. Newer 1 GB Hi-MD discs allow one to record approximately 124 minutes of uncompressed audio on a single disc.

Hi-MD is a recording mode, and is not related to the disc itself. Any MD disc can be formatted to Hi-MD mode and used in a Hi-MD recorder.

Taking care of MD discs

- Do not touch the disc by opening the shutter on the cartridge. The shutter and disc will be damaged if the shutter is forced open.
- Do not place MDs in direct sunlight, areas of high temperature, or high humidity.
- If dust gets into the MD cartridge, wipe it with a soft DRY cloth. Do not use any liquids to clean MDs.
- When putting a label on a MD, make sure it is fixed to the correct position for labels on the disc. If the label is not properly fixed it may roll up or come loose and could cause the cartridge to get stuck in the MD player.

Mixers And Mixing Desks

At first sight, the mixer is a daunting sight. Even a comparatively small mixer with only 4 channels on it seems to have way too many buttons and faders for one to understand them all. But if one looks a little closely, one will realize that the mixer is actually divided into sections, and that each plays its own specific part in the overall process of controlling and managing audio. Whether in the studio or the field, the mixer is the heart of the system.

At its most basic, the mixer is used to **mix audio** – that is, combine different sources, adjust their individual and relative levels, and give us one combined output which can then be fed to a recorder or a transmitter. Each source is connected to a different **channel**, so that it can be controlled independently; and all the channels feed the **master channel**, which controls the final output.

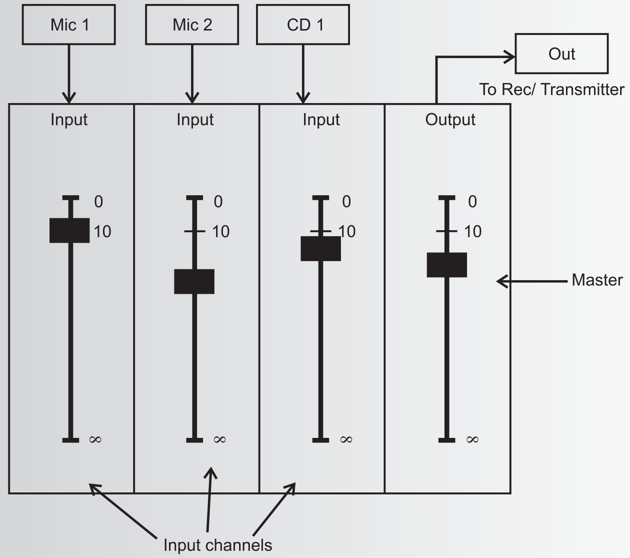


Fig 26. A basic mixer shown in schematic form

Note that in this diagram, the **sliders** or **faders** on each channel – which we use to control the level of the input – are set to different points. Depending on how loudly or softly the person in front of the mic is speaking, the fader is moved up **(boost)** or down **(cut)**. Levels may be seen on most mixers on **VU meters**. There may be one or several meters, which may show individual input levels or the final programme output level.

In this case, the three input channels form one **mixing bus**: One pathway down which the combined audio will go before it reaches the **master fader**.

Larger mixers with more channels may have more than one mixing bus, letting us **gang** or **group** channels. This lets us select the inputs that will be sent to a particular output. For example, during a live programme, which is being transmitted directly from the studio, we may have two speakers and a music source like a CD playing underneath their voices. For the live transmission, we may have all three sources being channeled to a **programme (mixing) bus**, from where the output goes to the transmitter. But we may want only the voices to be recorded to a recording system - without the music - for archive purposes...in which case we might also direct the two mic channels to a **second (recording) mixing bus**, which sends its output to a recorder unit.

Many mixers will also feature some stereo and some mono channels, to allow us to connect stereo sources and mono sources separately to the mixer. Channels may also feature a **PAN-POT knob**, which allows us to 'pan' the input audio left or right when we are mixing stereo audio.

Mixers may also have an **equalization section**, where there may be an **EQ button** along with **LO**, **MID** and **HI** knobs to control the relative mix of frequencies in the input audio.

For more on equalization, see **Section B: Equalizers** on Page 179

Other features to remember when selecting a mixer

The illustration given on the previous page illustrates a 3 channel mixer. In practice one should get a mixer with as many channels as one can afford. This will allow you to add more pieces of equipment to the studio without upgrading the mixer.

Additionally, many mixers come with **A/B switches** on each channel, allowing you to keep more than one piece of equipment connected to the same channel, but use the appropriate one as required.

Ideally, the mixer you select should offer more than one **mixing bus,** allowing different mixes of signals to be sent to different equipment. A broadcast mixer would also have **stereo channels**. These allow you to control the left and right signals from a piece of stereo source equipment with one fader.

Broadcast mixers should also be capable of controlling the operation of source equipment: To start a CD player from the mixer itself, from example. This is sometimes called **fader start**. Fader start means you must also have playback and recording equipment that accept fader starts.

Mixer design and circuitry is a very specialized part of audio equipment design. A good mixer with dependable and distortion free circuitry is a very complex item, and very expensive. The mixer is often the most expensive single piece of equipment in the studio.

Modulation

Modulation, at its most basic, means the **combination** of different waves. This is a very important concept for radio transmission, because the whole principle of broadcasting is based on the concept of modulating the audio that we would like to broadcast.

Human ears are capable of hearing sounds between 20 Hz and 20000 Hz. The average human voice ranges between 500 Hz and 5000 Hz, which is directly in the middle of this hearing band. Our ears are tuned to listen primarily to other human voices.

Now, let's assume that we want to record and transmit a voice that is about 3000 Hz in frequency. A wave with a frequency of 3 KHz has a wavelength of about 100000 metres. It is a principle of physics that we need an antenna at least a quarter of the wavelength to effectively transmit the wave. This means we need an antenna 25 km long to transmit our 3 KHz signal – which is impractical, to say the least! The only way around this is to find a way to raise the frequency of the audio in a way that allows us to use a more conveniently sized antenna system. And this where modulation comes in.

For more on frequency and wavelength, see **Chapter 1: So What is Radio & How does it work?** on Page 8

For more on antennas, see **Chapter 5: Transmission Equipment** on Page 72

We use modulation to 'add' the audio signal that we want to broadcast to a high frequency (radio frequency) electromagnetic wave. The combined wave then acquires the properties of both component waves. The audio signal 'piggybacks' on the radio wave, which is then called a **carrier wave.**

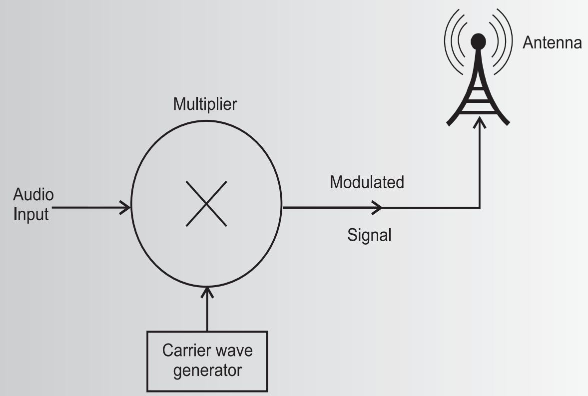


Fig 27: The modulation chain during transmission

In radio broadcasting, modulation can occur in one of two ways:

- The **amplitude** of the carrier wave can be modulated to carry the audio signal. This technique is called a**mplitude modulation (AM)**.
- The **frequency** of the carrier wave can be modulated to carry the audio signal. This technique is called **frequency modulation (FM)**.

Amplitude Modulation

Amplitude Modulation is the older form of modulation for radio. Depending on the wavelength of the carrier wave, AM can be classified as **Long Wave (LW), Medium Wave (MW)** and **Short Wave (SW)**. Today, MW is the most common form of AM transmission – **All India Radio's Akashvani** and **Vividh Bharati** stations broadcast on MW. Most MW stations broadcast on frequencies between 535 KHz and 1605 KHz which correspond to wavelengths of 560 to 187 metres. AM stations are usually spaced about 100 KHz apart.

In AM, audio information is combined with a carrier wave by varying the **amplitude** of the carrier wave above and below its unmodulated value: The changes in amplitude reflect the variations of the audio signal.

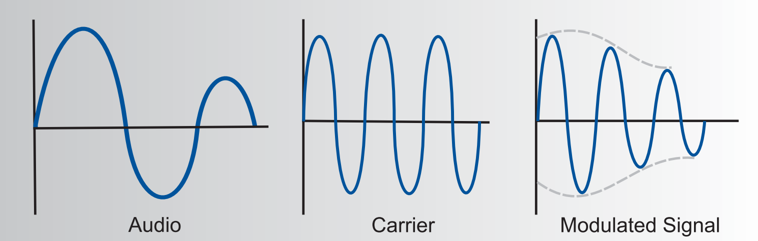


Fig 28: Amplitude Modulation

The biggest advantage of AM is that relatively modest output powers can reach very long distances, often hundreds of kilometres. Shortwave (SW) broadcasts can go even further – thousands of kilometers – and reflections off the electrically charged ionosphere of the Earth's atmosphere can increase that distance further.

AM broadcasts can carry audio information ranging from about 200 Hz to about 5 KHz. This means the broadcasts are fine for voice, but often make music sound scratchy, since many instruments have frequency ranges higher than 5 KHz.

> The ionosphere layer of the atmosphere is more diffuse when the sun's radiation is striking it directly. It is denser on the night side of the planet, when it is in shadow. Ionospheric reflection of SW broadcasts, correspondingly, improves at night time.

Frequency Modulation

Frequency Modulation involves modulating the audio signal with a **Very High Frequency (VHF)** radio carrier wave in a way that the resultant wave retains the amplitude of the carrier wave, but has a frequency that varies according to the audio signal.

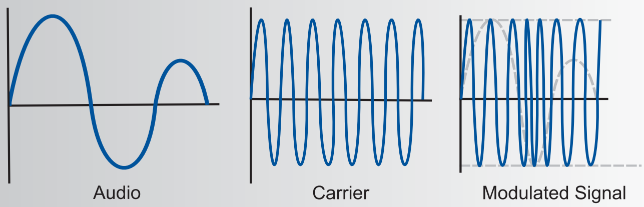


Fig 29: Frequency Modulation

This form of modulation makes broadcasts **less susceptible to interference** from storms and stray electrical and magnetic influences – but it also means a **more limited transmission range** for the same output power. FM transmission is **line of sight**, meaning the broadcast antenna has to be electronically visible to the receiving antenna. This is why FM stations are typically local stations, and why FM is the modulation technique of choice for CR stations.

Placing FM antennas at high vantage points can increase this range, as can increasing the transmitter strength - but there may be physical limitations to doing this, especially with reference to the technical guidelines covering community radio stations in India.

For more technical parameters for CR in India, see **Chapter 9: Community Radio Guidelines in India and their Implications** on Page 105

Commercial radio broadcasting is globally assigned frequencies between 88 and 108 MHz, at 200 KHz intervals. The extra bandwidth (200 KHz on each side of the base frequency) means FM can carry **higher quality audio** (20 Hz to 16000 Hz), as well as **stereo signals**. For digital audio, FM is generally rated as being able to carry nearly CD quality audio, at about 96 Kbps/44.1 KHz sampling.

PATCHBAYS

A patchbay, also called a **jackfield**, is one of the most useful items in a studio. Anypne who has ever connected and disconnected any audio equipment - especially a modern multi-component hi-fi system - will agree that it can be a really painful process, especially if it has to be done multiple times in a day.

We make the process of connecting and disconnecting inputs and outputs to each other easier by using a patchbay, which is essentially a series of electric contacts enclosed in a single housing. Different pieces of equipment are permanently wired to one or more of the contacts (two contacts if we want to keep the stereo inputs and outputs separate, one contact if we're only working with mono). As per our requirements, we can then connect any combination of contacts with short patch leads, which are short connectors designed to connect patchbay contacts.

The most commonly available patchbays normally have 2 rows of 26 sockets, with each socket on the top row paired with the socket below it. The top row of sockets is for **source equipment**; the bottom row is for **inputs to the mixer** or other recording or transmission equipment. For a small CR station, it may be advisable to invest in modular patchbays, which are available in 4 + 4 sections: This means we can add more contacts as we require them and our studio expands.

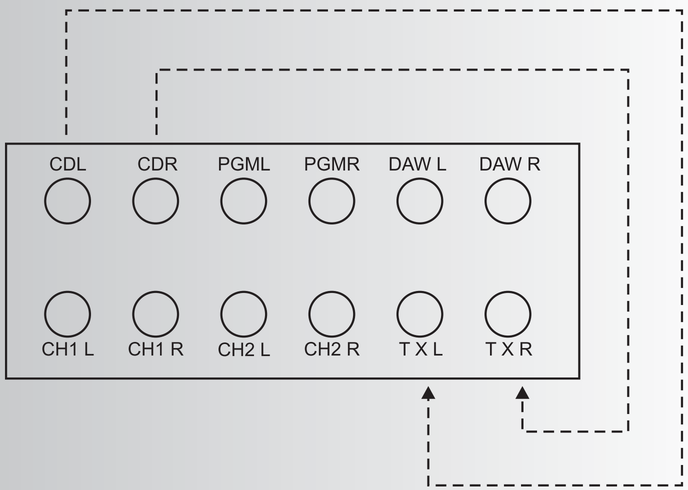


Fig 30: A schematic of a small patchbay

This diagram shows a small patchbay, labeled as per the inputs and outputs connected to it.

The top row of jacks are outputs, and are labelled as follows:

CD L and **CD1 R**: These are the Left and Right outputs from the CD Player

PGM L and **PGM R**: These are the broadcast mixer's Left and Right programme outputs.

DAW L and **DAW R**: These are the Left and Right outputs from the Digital Audio Workstation in the production studio.

The bottom row of jacks are inputs, and are labelled as follows:

CH 1 L and **CH 1 R**: These are inputs to the Left and Right inputs of Channel 1 on the mixer.

CH 2 L and **CH 2 R**: These are inputs to the Left and Right inputs of Channel 1 on the mixer.

TX L and **TX R**: These connect to the Left and Right inputs of the compressor limiter.

Thus, while the CD Left and Right outputs on the top row might generally be connected to the Ch1 L and Ch1 R inputs on the bottom row (that is, the stereo inputs on Channel 1 of the mixer), in an emergency - when we need to maintain or service the mixer, say - we can connect the CD player outputs directly to the transmitter input, as illustrated.

A patch cord must always run from an output to an input: That is, opposite ends must be connected on different rows. This is very important - a small mistake in plugging together circuits can severely damage equipment!

Signal to Noise Ratio

All through this manual, we have used the word **signal** whenever we have wanted to indicate an electrical current that carries information. To this, we will now add the word **noise**, which can then be defined as electrical currents which carry no useful information.

Every electronic circuit that carries a signal inherently has some **internal noise**. These are basically stray electric currents that are generated by the machinery itself. In audio terms, you hear this noise as a hiss or as a crackle or background pop under the main audio. (If we cut off the audio feed and simply boost the output of the equipment to a monitor, the **static noise** we hear is the internal noise generated by the equipment.)

One of the reasons we keep the signal level as high as we can - without reaching the distortion or overload point, of course - is so that the signal (useful) audio can be distinguished clearly against whatever background noise the system generates: If the signal level is too low, it will be drowned out by the system noise.

Given the variety of audio equipment available, and the number of manufacturers, it would obviously be good to have an objective measure of this difference between the signal level and the noise levels of the system. This is why the signal to noise ratio was evolved as an evaluative reference: To develop standards for the level of noise in a system. A high signal to noise ratio means there is always a large separation between the signal and the background noise. A low signal to noise ratio means a small separation between the two, and therefore the risk that the signal and the noise may not be clearly distinguished from each other.

Signal to Noise ratio - often denoted as **S/N ratio** in short - is measured in decibels (dB). Thus, if the maximum signal level the equipment can handle without distortion is 80 db, and the level of the inherent system noise is 20dB, the S/N ratio for that equipment is 80 - 20 = 60 dB. (In practice, of course, the measurement is not as simple as this!)

> The better the components and the grade of manufacture of an equipment, the lesser the internal noise that it generates - and the higher its S/N ratio. Given two pieces of equivalent equipment, the piece with the higher S/N ratios will be distinctly more expensive!

Sound & Audio

Sound

Sound is the effect perceived by the brain when vibrations travelling through the air stimulate the ears. These vibrations are conveyed through the air as changes in the pressure of the air.

Anything that vibrates and is in contact with the air can create sound pressure waves. These vibrations disturb air molecules causing waves of alternating high and low pressure. The ear is a sensitive transducer that responds to the changes in pressure. The pressure waves strike a sensitive membrane of tissue inside our ears called the **eardrum** - which, as its name suggests, is like a drum skin. The eardrum vibrates when the waves strike it, and pass the vibrations on through three small bones to the inner ear. The inner ear contains two chambers full of fluid, which are lined with fine hairs and particles of calcium. When the vibrations reach these hairs, they are converted into electrical signals which are passed on through nerves to the part of the brain which processes these signals into the sensation we know as sound.

Sounds that we hear as being **louder** are caused by greater changes in air pressure, which means the eardrum vibrates to a greater degree back and forth **(higher amplitude)**. Softer (or quieter) sounds are caused by lesser changes in air pressure, which means the eardrum vibrates to a lesser degree back and forth **(lower amplitude)**. Loudness is a subjective measure and the same sound may be perceived differently by different individuals.

For more on properties of sound waves, see **Chapter 1: So What is Radio, and How does it work?** on Page 8

When we say human beings can hear sound in the range 20 Hz to 20000 Hz, we are saying the pressure wave changes at a rate between 20 times a second and 20000 times a second. Looked at in another way, this is the definition of sound, since only pressure waves between these two limits will result in the sensation we call sound.

Sound waves travel through air at a speed of 344 metres per second (1238.4km/h). This is measured at sea level at a temperature of 15 °C. The speed of sound is independent of frequency.

Audio

Audio is the word used to signify the electrical equivalent of a sound wave, which we create through a process of **electro-acoustic transduction**. The **audio signal**, as we should correctly call it, takes the form of a changing electronic voltage in the circuit, that rises and falls in exact correspondence with the changes in the original pressure wave.

For more on transduction and microphones, see **Section B: Microphones** on Page 198

We convert sound to audio in order to be able to manipulate and/or store it for later playback. A microphone is used to convert sound to audio, whereas a loudspeaker or headphone is used to convert the recorded audio back into sound so that we ca hear it with our ears.

Most of the equipment in the radio studio works with audio signals rather than directly with sound - so most of the equipment should correctly be termed audio devices.

Stereo & Mono

When we hear a sound, we tend to forget that we are actually hearing it with both our ears. The purpose of two ears placed on opposite sides of our heads is not, as widely assumed, for redundancy - 'one ear will continue working if something happens to the other one!' - but in order to give us a sense of **spatial separation** between different sounds.

We are able to create this spatial separation because of an interesting phenomenon called **phase difference**. Sound, as we know, travels as a series of waves, with higher pressure sections alternating with lower pressure sections. When a sound is generated by a source on one side of us, it reaches the ear closer to it by a shorter path, and the ear farther from it by a longer path. What this results in is that though both ears hear the same set of waves, there is a miniscule difference in the time it takes for specific parts of the wave to reach each ear. Our brains use this to calculate the **angularity** of the sound - that is, its position in front of us - and its **distance** from us. (This allows us to create a mental picture of the **soundscape** in front of us that is quite independent of what we see - this is why we can still tell the direction of the sound when our eyes are closed!)

This is what **stereo** means - the ability to create a spatial perspective to sounds we hear. When working with audio, we can create this effect artificially by recording audio on two separate channels, and feeding the respective channels to two separate speakers. By distributing signals between the two channels, we can make the sound appear to emanate purely from one speaker; from both to equal extents; or both, but with a slightly greater emphasis on one of the speakers.

The effect is to create the phase difference we perceive when hearing naturally with our ears. Naturally, to use this effect best, the ideal listening position should be at a position exactly between and equidistant from each of the speakers.

If on the other hand, we used a single speaker - or fed the same signal to both speakers - we would not be able to get this sense of spatial separation. When we have only one channel of audio, we call the signal a **mono signal**.

Stereo & Mono connectors

As we need two channels of audio for stereo, we have to keep both channels separated from each other when conveying the signal from one piece of equipment to another. This is why all stereo equipment has two connectors,

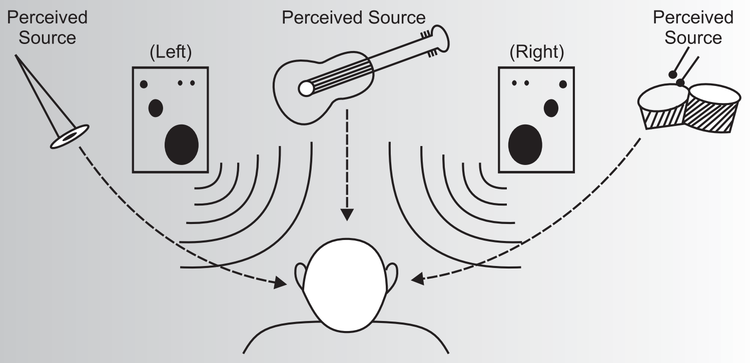


Fig 31: Stereo perception of sound. The various instruments sound as if they are spread out in front of the listener even though we actually only have two sound sources - the two speaker units.

usually labeled **Left (or L)** and **Right (or R)**. Often the connectors are also colour coded, with **red** connectors for the right channel, and **white** or **black** for the left channel. It is important to make these connections properly, so that the stereo image does not accidentally get mixed up.

Stereo connectors can be clearly indetified just by looking at them. RCA stereo connectors, for example, come in a colour coded pair. Stereo phono jacks are always of the TRS variety (Tip-Ring-Sleeve) with the three contacts defined by two black bands near the tip of the jack.

Mono connectors usually use a single connector, or a phono jack with a single black band near the tip. It is usually possible to make or purchase cables that will let you feed a stereo output to a mono input, or a mono output to both stereo inputs.

Mics: Mono and stereo

Unless you are using a **stereo microphone** - which actually combines two microphones in a single body, and gives two discrete outputs - all mics are mono, and give a single channel output. The stereo image that you see in the final programme that is broadcast is built during the post production process. This is what the **Pan-Pot knob** on the mixer is used for - to distribute the so und between both audio channels.

For more on the Pan-Pot knob, see **Section B: Mixers & Mixing Desks** on Page 207

Remember, mixing in stereo or working with stereo sound automatically assumes that the listener has equipment that will allow him or her to recreate the spatial separation that you are building. If all your stereo programmes will be heard on small single speaker transistor radios, it is pointless to spend time, money and effort on doing stereo programmes in the first place.

Mixing audio in stereo is not only more time consuming, it requires more powerful equipment - in the sense of higher end computers and speakers. Digital stereo audio also means larger audio file sizes than mono. Finally, stereo transmitters give a smaller transmission range than mono transmitters of the same power output rating.

Telephone Hybrids

A telephone hybrid makes it possible to talk to callers on-air - that is, it allows people calling the studio 'live' to participate in a discussion with the presenter over the phone that goes out as part of the transmission. Essentially, this means the caller's voice is added to the mixer's output; and that the studio sound - the presenter's voice - reaches the caller over the phone line.

Having a telephone hybrid system allows you to create greater interaction with your listeners, and involve them in the programmes the station generates in a much more active way.

What the hybrid does

There are two important considerations when connecting a phone line to our audio systems:

1. The telephone system works on the basis of a continuous power voltage supplied to the telephone instrument - we have to see to it that this does not interact with our audio systems in any way, as this can cause damage to our equipment (not to mention a nasty hum in the audio!)
2. The telephone carries both received audio (caller's voice) and sent audio (presenter's voice) over the same wires. We need to use a system where these two audio feeds can be handled independently and sent independently of each other to their respective destinations: The caller's voice to the mixed mixer programme output, and the presenter's voice to the caller over the phone - but keeping both audio feeds at a balanced level.

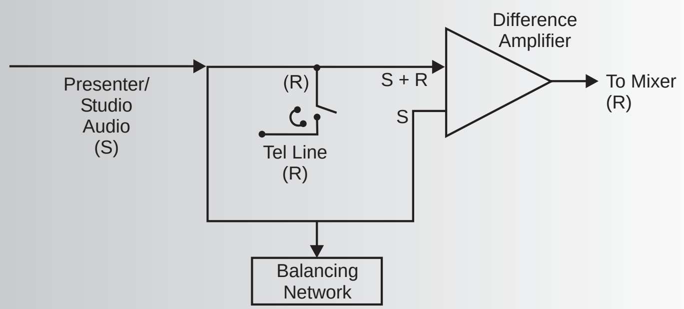


Fig 32: A schematic view of the telephone hybrid

For this the hybrid uses three types of circuitry:

1. A **difference amplifier** that performs the task of separating the caller's voice and sending this to the mixer;

2. An **isolation element** , which is actually a transformer that prevents the telephone line power supply from being transferred into your audio equipment;
3. **A balancing network** that balances the level of the presenter's voice against the voice of the caller, and helps the difference amplifier subtract the send audio. If the balancing network is not very accurate, then the subtraction operation will not completely remove the send audio, and the audio may be distorted.

The separation is noted in the hybrid specs as a negative figure in decibels: The higher this number, the better the hybrid - and the more expensive it is likely to be.

The signal that is sent from the mixing desk to the hybrid send input is called a **mix minus** or **cleanfeed** signal. This is because it contains all the on-air audio that you want the caller to hear, less the output of the phone hybrid (which is the caller's voice itself.)

Most broadcast mixers already have a dedicated channel for the phone hybrid to be plugged in, and have a dedicated mix minus already set for this channel. If it doesn't, you will have to direct all the sources except the hybrid output into one auxiliary mix bus, and use the output of this mix bus as the mix minus to feed back to the phone line.

Using the hybrid

Most hybrids are rather straightforward to use - they may handle one line or multiple lines, with lights that generally come on to indicate which line the incoming call is on. Once things are set up, operation is as easy as pressing the correct line button to connect the line to the audio feed. Most hybrids also allow you to connect a standard telephone instrument to them in order to make calls.

> A good multiline hybrid should allow you to queue callers, and switch between them easily.

In the case of some older (analog) hybrids, there is generally a **null adjustment** that lets you tune the circuit for best audio quality. Modern digital hybrids are excellent at signal separation, and do not need such tuning at all.

Transmitters

The transmission system is the final step in getting a broadcast signal on air and out to its listeners. And the heart of the transmission system is the **transmitter**, the combination of circuits that turns an audio signal into a frequency or amplitude modulated radio wave that can be broadcast.

Let's take a good look at the FM transmission system to understand what a transmitter unit does.

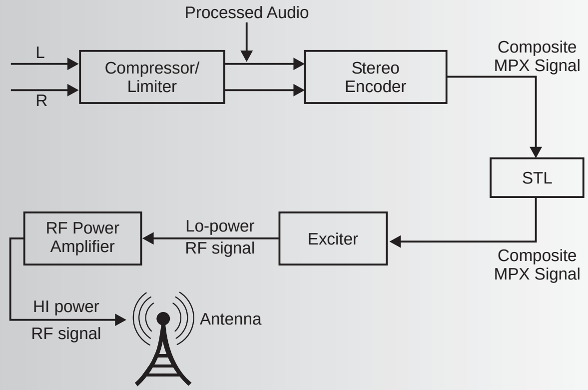


Fig 33: Schematic view of FM transmission system

The process starts with the final programme output from the studio or playout system. For our discussion here, and because FM has the capability to handle stereo broadcasts, we will assume this is a stereo signal with left and right channels.

The final programme is by now, hopefully, mixed and the levels corrected properly already. But this is fed to a **compressor/limiter** unit anyway to ensure that the signal is properly corrected to transmission parameters. This unit applies compression and limiting to prevent the transmitter from being overdriven, and to control the dynamic range of the audio.

For more on Compressor/Limiters, see **Section B: Compressor/Limiters** on Page 149

The processed audio signal is then fed to a **stereo encoder**. The encoder combines the two channels of audio - left and right - and also generates a **19 KHz pilot tone** that is used by receivers to detect a stereo broadcast. The output is said to be **multiplexed**, as it now consists of several elements. (This often shortened to **MPX,** a labeling that you may find marked on the outputs of encoders.)

The multiplexed signal is now forwarded to the **exciter unit**, which generates the **radio frequency carrier wave**. (As we have seen, for FM, this carrier must be between 88 MHz and 108 MhZ in frequency.) The exciter also **modulates** the carrier with the encoder's MPX signal, thereby creating a **low power radio frequency (RF) signal** that can be transmitted by an FM antenna.

Exciters generally have an inherent power output of 30 - 50 Watts. For most community radio stations - and especially those in India - this may be more than enough as per the guidelines and the signal gain one is likely to get from an appropriately matched antenna.

For more on transmitter strength parameters, see **Chapter 9: CR Guidelines in India and their Implications** on Page 105

If more power than the exciter's inherent power is required, then one or more **power amplifiers** may be added between the exciter unit and the antenna, to boost the strength of the signal. (Commercial broadcasters often boost the signal to several kilowatts.)

The final modulated and boosted signal is then sent to the **transmitting antenna unit**, which radiates the modulated multiplex signal into space. AM antennae are designed to be a quarter the wavelength of the station's broadcast wavelength, which - given the high wavelengths used for AM broadcast - mean the antenna unit and the tower on which it is mounted on can often be very large.

FM antennae, on the other hand, can be much smaller. The high frequencies used for FM transmission mean the wavelengths are considerably smaller, and antennae can be about half the wavelength of the station's carrier frequency. Typically, this means an antenna of 2 metres' width or less. The most common antenna used is a **dipole antenna**, which is omnidirectional, and radiates equally in all directions.

When the multiplexed and modulated signal reaches the antenna what happens is this: The RF signal flowing into the antenna creates a corresponding change in the **electromagnetic field** around the antenna, which moves away from the antenna at the speed of light. Since the RF signal flowing into the antenna is changing constantly in response to the audio signal, the electromagnetic field being radiated is also changing constantly. The antenna on at the listener's end picks up this varying electromagnetic field and the radio receiver's circuitry extracts the original audio from it through a series of **RF filtration circuits**. The extracted audio can then be amplified and played back over the transistor's speaker.

UNINTERRUPTED POWER SUPPLY (UPS)

All of the studio and transmission equipment at your radio station requires a source of electrical power to work. This is usually supplied by the AC mains power supply provided by the local power company, which in India is usually run by the government. (Though power distribution in some areas has been privatized.)

However, many stations are located in areas where mains power supply is unreliable. Unless you have back-up, a mains power failure will interrupt your broadcast. This is a serious problem - remember, your listeners will also be affected by the electricity failure, and will want to rely on their radio station to keep them informed about it!

This is the purpose of an **uninterrupted power supply (UPS)**. As the name suggests, a UPS provides uninterrupted power to the station even when the mains supply is disturbed.

There are many different UPS systems that supply varying degrees of back-up protection. The choice of system for your station should be made after considering the quality of the power supply in your area. For example, stations located in areas that suffer from constant power disturbances will need a more complete power back-up system than stations located in areas where the power supply is more stable.

What can disturb the mains electrical supply?

The mains supply is meant to be a stable AC voltage of 220 volts at 50 Hz, but there are several kinds of power line disturbances that affect the mains supply:

Lightning, power network switching and the operation of other high power equipment in your building, such as elevators, spot welders and so on will cause **spikes** in the mains voltage. A power spike or a power surge is when the mains voltage jumps to well over 220 volts for a short time. The mains voltage can also can dip below 220V, providing an **undervoltage** supply. This can be caused by faults in the power network and sharp load changes. This kind of condition is often seen in light bulbs that dim in intensity, a condition known as **brownout**.

The mains supply can also be noisy when signals at frequencies other than 50 Hz find their way onto the power lines.

Lastly, the supply can **black out**. In this case there is a total voltage loss and all electrical equipment is left without power. Blackouts can last for a few moments, or sometimes they can last for a number of days - a common condition especially in the remote parts of the country.

A UPS counters power disturbances in two ways:

- **By acting as a buffer** between the sensitive studio equipment and the fluctuating mains power supply, providing protection from power surges, dips and line noise.
- **By providing back-up power** in the event of a complete power failure. The duration of the availability of back-up power is dependent on the batteries used as part of the UPS.

Types of UPS

There are three main types of UPS: **off-line**, **line interactive** and **online** UPS. Each one has different features:

1. Offline UPS

Off-line UPSs only supply equipment with back up power when the mains supply is not available; and are generally used on equipment which can accept a momentary loss of power.

Offline UPSs be used in conjunction with **surge protection** devices - often known as **spikeguards**, which may be built into the power supply points themselves. Offline UPSs provide no inherent protection from spikes and brownouts, both of which can be dangerous for electronic equipment. In this sense, they are most appropriate for areas with minimal power problems, though they are the cheapest of the three types in terms of cost.

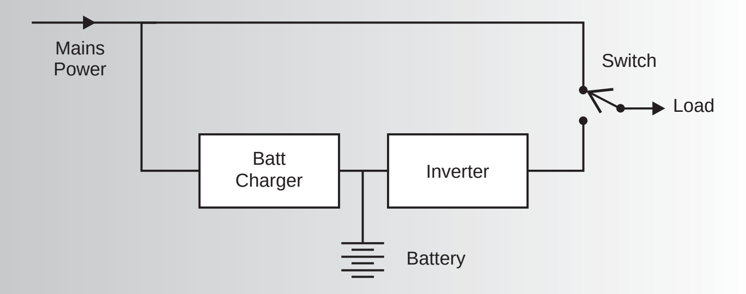


Fig 34: Offline UPS system

2. Line interactive UPS

Line-interactive UPSs are used when mains voltage fluctuations (dips and spikes) are a problem. Like the offline UPS, in the line-interactive system, battery power is only utilized when the mains supply is not available. But in addition, the mains power itself is fed to the equipment through a transformer; and a monitoring circuit watches the main supply for dips and spikes.

Thus, it is **line interactive** because it corrects the voltage, or switches to backup power, based on a constant assessment of the mains supply.

Though line interactive UPSs respond to spikes and drops in voltage, there is still a distinct response time within which the change in voltage could affect your electronic devices.

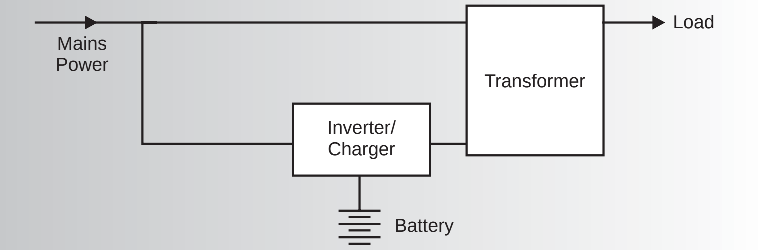


Fig 35: Line interactive UPS

3. Online UPS

The on-line UPS provides the greatest safety and the highest equipment protection.

In the on-line UPS, mains power is converted to DC through a **rectifier**, removing any chance of surges and dips. This is then converted through an **inverter** to a completely back-up based AC supply. When mains power fails completely, the system runs off the backup batteries.

Strictly speaking, these are the best UPSs for sensitive electronic equipment - but they are the most expenive kind as well, often being more than twice the cost of an offline UPS of similar rating.

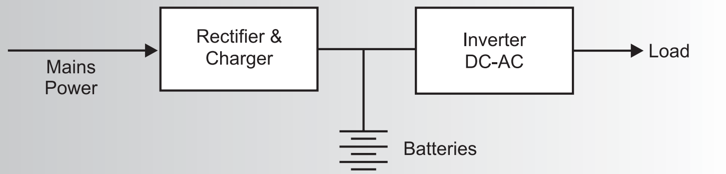


Fig 36: Online UPS

UPS systems are only **back up** power supplies! Having a UPS system is pointless if you have frequent interruptions of your mains power supply, as the UPS batteries will only charge as long as it is plugged into the mains supply

Power rating and back up duration

There are two specifications for UPSs that you have to keep in mind beyond the types specified above.

The first consideration is its **power rating** - that is, the maximum power consumption that it can support. Each piece of equipment that you run off any power supply will consume some power. The UPS you acquire must be able to comfortably support all the equipment that you wish to connect to it. UPS power ratings are usually given in **Volt Amperes (VA)** or **Kilo-Volt Amperes (KVA).** Standard ratings include:

650 VA (about enough to support one computer with a 15" monitor)

1 KVA (enough for one computer with 15" monitors, along with a CD player, 6 channel mixer, a cassette deck, studio audio monitors)

1.5 KVA (enough for two computers with 15" monitors, along with two CD players, mixer, a cassette deck, powered studio monitors, amplifiers)

2 KVA (enough for all of the above, plus MD or flash based recorder units, studio lights)

Large **5 KVA** units and higher are used to back up entire offices.

A good rule of thumb is to get a UPS that can support about 30% more than the maximum load that you will place on it. Another rule of thumb for small and medium CR stations is to assume a minimum of 1.5 KVA per studio, not including transmission equipment and lights.

The second consideration is the **amount of back up time** that the UPS will give you at the power rating it can support: This is dependent on the **quality** and **storage capacity** of the batteries that the UPS system utilizes. In the examples given above, the 650 VA UPS with a single battery can give about 15 minutes backup for the single computer it supports, with a simple two wheeler automotive battery. But the 1.5 KVA UPS may be attached to two 25 plate truck batteries, and may give 3 - 4 hours backup for the entire load it handles. UPSs can often be matched to a larger battery setup in order to prolong the backup time.

Inverter batteries are a consumable: Whether you use it or not, batteries have a limited life based on the number of charge-discharge cycles they can handle. You must therefore count on changing the UPS batteries every two years or thereabouts.

Remember that old batteries can be returned to dealers in exchange for a discount on the price of a fresh battery!

What kind of batteries?

Older battery technology involved the use of **lead-acid batteries**, which remain the most easily available type of large rechargeable battery anywhere in the country.

In lead acid batteries, the lead plates which form the cells of the battery are bathed in sulphuric acid, which acts as the **electrolyte**, the charge transporting chemical. In such batteries, it is important to maintain the dilution of the acid at a specific level, which involves the **topping up** of the liquid inside the battery with **distilled water** at regular intervals. The distilled water is poured in through several rubber or plastic caps on the top of the battery: Unscrewing the caps lets you access the insides of the battery.

Though standard lead acid batteries are cheaper, and easy to obtain., an additional concern is that they should not be placed indoors or in enclosed spaces, because the acid tends to give out fumes which are harmful when breathed and corrosive to electronic equipment.

Modern rechargeable automotive and inverter batteries, however, are **maintenance** free and need no topping up. They use a different combination of chemicals to retain the charge; can be placed indoors; and often last longer in regular use than the lead acid type (not least because we often forget to top up the lead acid ones at the correct point in time!). However, maintenance free batteries are much more expensive.

Nearly all major battery manufacturers provide both kinds of batteries. Ask the UPS supplier which ones he recommends - in most cases, he will be able to get you a good deal as a mass supply agent. But remember to check the market price of the batteries he suggests anyway!

GENERATORS

In essence, a generator is the reverse of an electric motor: Where the motor consumes electricity in order to move, the generator uses a fuel source in order to move a magnet and generate electricity. Thus where a UPS simply stores existing power, the generator manufactures power. This means generators can be used in places where electricity supply is erratic - as long as fuel is available.

Generators also work on the principle of **electric induction**: A motor running on kerosene, diesel, petrol or LPG (Liquefied Petroleum Gas) is used to spin a powerful magnet within a coil of conducting wire. The movement of the magnetic field around the coil generates an electric current in the coil that can then be drawn off, corrected ('rectified') and supplied to devices.

Portable generators nowadays come in a range of capacities. Like UPSs, they are usually rated in **VA** or **KVA** (Volt Amperes or Kilo Volt Amperes). **650 VA, 1250 VA, 1600 VA** and **2400 VA** generally fall into the **portable category**. These usually run off **petrol**, **kerosene** or **LPG**. Larger generators (**5 KVA, 10 KVA** and so on) are usually run off **diesel**.

Like any other fuel driven motor - a car engine, say, or a grain thresher - generator engines need **regular maintenance**. Their engine oil (which lubricates the moving parts of the motor) needs to be replaced, the sparkplugs (which ignite the fuel mixture in petrol, kerosene or LPG units) cleaned - and the fuel filters and tanks serviced. The additional maintenance can be a hassle for a small CR station; but weigh this against the potential need for continuous electricity supplies.

Generators are most often used in situations where power cuts are a norm, or where power supply can be seriously interrupted for a long period of time. A CR station cannot broadcast only when the power permits! So though a good generator from a reputed company may cost a lot initially to install, it should be factored in during the planning process itself if power is a potential logistical problem.

Generators generate **high voltages** and need **cabling** to be connected to the power supply of the station. They also give out **exhaust fumes** from the internal combustion process they use. This can represent a potential hazard to the people who work there if the cables are poorly managed or the generator is installed in a place where the fumes cannot be vented properly. Follow a safety code when using generators, and ensure that everyone knows and follows this code when starting or operating the generator.

Many generators are also attached to **changeover circuits** which let you connect the generator to the power supply in parallel to your existing mains supply. These changeover circuits often come in the form of a box, and are often built to automatically cut off the generator when the power comes back, so that both supplies do not add up and fry your electronics.

> The installation of the generator and the disconnect and transfer switches MUST be performed by a qualified electrical contractor. This is not a job for the station's technical department. Do not attempt to install these devices yourself or make repairs without adequate knowledge of the devices and eletricals!

Safety code for generator operation

1. NEVER run an electric generator inside a building.
2. ALWAYS store the generator fuel (petrol, kerosene or diesel) in proper containers, in a safe and secure place.
3. NEVER fuel an electric generator while the generator is running!
4. DO NOT smoke or bring naked flames near the generator, or when handling fuel.
5. ENSURE proper ventilation around the generator.
6. ALWAYS have a fully charged, approved fire extinguisher located near the generator.
7. ALWAYS disconnect from the mains supply BEFORE starting your backup generator. The generator should normally be installed so that this happens automatically: That is, you should have a changeover switch so the generator cuts off automatically when the mains power comes back. (Otherwise the circuits will suddenly be charged with 220 + 220 = 440 Volts of electricity, and everything in your studio will be destroyed! Automatic changeovers are the best choice, failing which one can manually switch the mains isolator off. Manual switching requires discipline and a systematic approach - we may sometimes not know when the power comes back and use the generator unnecessarily. Besides, forgetfulness can be disastrous.)
8. NEVER remove or tamper with safety devices - they are there to protect you.
9. NEVER attempt to repair an electric generator yourself. ALWAYS refer repairs to your supplier or other qualified serviceman.
10. Many engine parts are very HOT during operation. Don't touch them as you could get severely burnt.

Section C

Appendices

APPENDIX 1

SUGGESTED SETUPS FOR CR STATIONS

On the next few pages, you will see some suggested combinations of equipment for CR stations of varying scales and scope. The tables present an outline ready-reckoner that you can use to work out a list that will suit your purposes and your CR station. There are three different suggestions designed by three professionals working in the field of community radio in India, and each is based on their individual experience and understanding of the needs and imperatives of CR technology.

Remember that equipment models and technology change all the time: This means the suggested models and prices indicated are subject to regular revision. To get an up to date version of this table, you may have to spend some time researching new models and prices.

Additionally, these are only suggested combinations of equipment. Ask friends, professional acquaintances and colleagues from other CR stations about their experiences with equipment – and for their recommendations on what might work for your setup. Once you have a basic list of equipment, get comparative estimates from a number of suppliers. Select the supplier with the best reputation and the one who offers you a maintenance related deal.

All prices and estimates included here are estimated street prices in India. There may be huge variations between official billed prices from importers and retail agents and the 'grey' (unofficial) market. Please treat these costs as indicative only.

Suggested Setup 1A (Courtesy: N. Ramakrishnan, Ideosync Media Combine)

Setup IA: Basic Community Radio Station (digital)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
	Studio Equipment					**67000**	
1	Mixing Console, 1 mono mic 4/3 stereo line	Behringer	Eurorack UB502	1	10000	10000	www.behringer.com
2	Microphone (dynamic)	Shure	SM 58	1	8000	8000	www.shure.com
3	Professional headphones	Behringer	HPM 1000	4	1000	4000	www.behringer.com
4	PC Computer as DAW - Intel Core 2 Duo 2.16/ 512 MB RAM/160 GB HDD/Combo drive/ 17" CRT monitor/Creative Audigy 256 Sound card/Intel motherboard/ATX cabinet/Creative speakers/Windows XP SP2	Assembled	Mixed	1	45000	45000	—
	Field recording Equipment					**81600**	
5	Microphone (condensor)	Sony	ECM MS 907	3	6000	18000	www.sony.com
6	Compact Digital field recorder	Zoom	H 2	4	15000	60000	www.zoom.co.jp
7	Memory (SD cards: 2 GB)	Transcend	Transcend SD	3	1200	3600	www.transcend.com
	Transmission equipment					**350000**	
8	50W VHF FM transmitter	BEL	LVB 206	1		—	www.belindia.com
9	Dummy Load					—	
10	5/8 Vertical omni directional antenna	Veronica	5/8S Vertical	1		—	www.veronica.co.uk

(Contd...)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
11	RF Cable (RG 213)	Various		50 m		—	Local manufacturers
12	Compressor limiter D&R	Behringer/				—	www.behringer.com www.d-r.nl
	Miscellaneous					**60000**	
13	UPS system with maintenance free batteries	Microtek	1250 VA	1	30000	30000	www.microtek.com
14	Guyed mast system/antenna tower	—	15 m – 30m	1	20000	20000	Local fabrication
15	Miscellaneous connectors/cables + low cost acoustic treatment	—	As reqd		15000	10000	
					TOTAL	**558600**	**~560000**

Suggested Setup 1B (Courtesy: N.Ramakrishnan, Ideosync Media Combine)

Setup IB: Middle level Community Radio Station (digital)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
	Studio Equipment					**192500**	
1	Mixing console 4/5 Mono 4/3 stereo line	Yamaha	MG 12/4	1	20000	20000	www.yamaha-mg.com
2	Microphone, condensor 1" capsule	Behringer	TSM 87	2	6500	13000	www.behringer.com
3	Microphone (dynamic)	Shure	SM 58	2	8000	16000	www.shure.com
4	Professional headphones	Behringer	HPM 1000	5	1000	5000	www.behringer.com
5	Studio Monitors	Behringer	Truth B 2031	1	15000	15000	www.behringer.com
6	4-way headphone amplifier	Alto Pro	—	1	9000	9000	www.altoproaudio.com
7	Telephone hybrid	D & R	TH 1	1	22000	22000	www.d-r.nl
8	Sound card	M-Audio	Revolution 7.1	1	7500	7500	www.m-audio.com
9	4 way line box	Behringer	Ultra Di-pro	1	8000	8000	www.behringer.com
10	Mic stands	Proel	—	4	2500	10000	www.proelgroup.com
11	100 m Shielded audio cable with 30 pieces each of XLR female & male, and 30 pieces RCA	Proel	—	Set	10000	10000	www.proelgroup.com
12	Studio Compressor Limiter	Alto Pro	2 channel	1	12000	12000	www.altoproaudio.com
13	PC Computer as DAW - Intel Core 2 Duo 2.16/ 1 GB RAM/160 GB HDD/Combo drive/ 17" CRT monitor/M-audio Sound card/Intel motherboard/ATX cabinet/ /Windows XP SP2	Assembled	Mixed	1	45000	45000	—

(Contd...)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
	Field Recording Equipment					**133200**	
14	Microphone (condensor)	Sony	ECM MS 907	6	6000	36000	www.sony.com
15	Compact Digital field recorder	Zoom	H 2	6	15000	90000	www.zoom.co.jp
16	Memory (SD cards: 2 GB)	Transcend	Transcend SD	6	1200	7200	www.transcend.com
	Transmission Equipment					**450000**	
17	50W VHF FM transmitter	BEL	LVB 206	1		—	www.belindia.com
18	Dummy Load					—	
19	Stacked dipole antenna	Veronica	Stacked dipole	1		—	www.veronica.co.uk
20	RF Cable (RG 213)	Various		50 m		—	Local manufacturers
21	Compressor limiter	Behringer/ D&R				—	www.behringer.com www.d-r.nl
	Miscellaneous					**165000**	
22	UPS system with maintenance free batt	Nexus/Microtek	1250 VA	1	30000	30000	www.microtek.com
23	Guyed mast system/antenna tower	—	15 m – 30m	1	20000	20000	
24	Generator	Honda Siel	EXK 2000 S	1	60000	60000	
25	Carpentry + office furniture + racks	Miscellaneous	—	Set	30000	30000	
26	Office computer system Intel Core 2 Duo 2.16/256 MB RAM/120 GB HDD/Combo drive/15" CRT monitor/ Intel motherboard/ ATX cabinet/Windows XP SP2	Assembled	—	—	25000	25000	
					Total	**940700**	**~ 950000**

Suggested Setup 1C (Courtesy N.Ramakrishnan, Ideosync Media Combine)

Setup III: Large Community Radio Station (digital)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
	On air studio Equipment					**572500**	
1	On AIR mixer/4-2-6 control room/studio monitoring	AEQ	BC-500	1	300000	300000	www.aeqbroadcast.com
2	Rode Condensor Studio Microphone	Rode	NT 1A	4	18000	72000	www.rodemic.com
3	CD player	Denon	DNC 630F	1	10000	10000	www.denon.com
4	Double tape deck	Denon	DN770R	1	10000	10000	www.denon.com
5	Telephone Hybrid	Telos	Telos 1	2	32000	64000	www.telos-systems.com
6	Mic stands	Proel	ST232, 23850	4	1500	6000	www.proelgroup.com
7	Professional headphones	Behringer	HPM 1000	6	1000	6000	www.behringer.com
8	Headphones Amplifier	Behringer	HA 8000	1	9000	9000	www.behringer.com
9	Studio & Control Room Monitors (Pair)	Behringer	Truth B2031	1 (pair)	22000	22000	www.behringer.com
10	Patch Bay	Neutrik	—	2	6500	13000	www.neutrik.com
11	Patch Cords	Proel	—	24	250	6000	www.proelgroup.com
12	19" rack	Proel	—	2	10000	20000	www.proelgroup.com
13	Assorted studio cables/Multi cable/Plugs	Proel	—	Set	20000	20000	www.proelgroup.com
14	UPS 1250 VA double battery	El Nova	—	1	3500	3500	www.elnova.com
15	Studio Compressor Limiter	Alto Pro	2 channel	1	12000	12000	www.altoproaudio.com

(Contd...)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
	Production studio Equipment					**392500**	
1	Production Digital Mixer	Yamaha	01V96	1	165000	165000	www.yamaha.com
2	Rode Condensor Studio Microphone	Rode	NT 1A	2	18000	36000	www.rodemic.com
3	CD player	Denon	DNC 630F	1	10000	10000	www.denon.com
4	Double tape deck	Denon	DN770R	1	10000	10000	www.denon.com
5	Telephone Hybrid	Telos	Telos 1	1	32000	32000	www.telos-systems.com
6	Mic stands	Proel	ST232, 23850	2	1500	3000	www.proelgroup.com
7	Professional headphones	Behringer	HPM 1000	2	1000	2000	www.behringer.com
8	Studio & Control Room Monitors (Pair)	Behringer	Truth B2031	1 (pair)	22000	22000	www.behringer.com
9	Patch Bay	Neutrik	—	2	6500	13000	www.neutrik.com
10	Patch Cords	Proel	—	24	250	6000	www.proelgroup.com
11	19" rack	Proel	—	2	10000	20000	www.proelgroup.com
12	Assorted studio cables/Multi cable/Plugs	Proel	—	Set	20000	20000	www.proelgroup.com
13	UPS 1250 VA double battery	El Nova	—	1	3500	3500	www.elnova.com
14	PC Computer as DAW - Intel Core 2 Duo 2.16/ 1 GB RAM/160 GB HDD/Combo drive/17" CRT monitor/M-audio Sound card/Intel motherboard/ATX cabinet/ /Windows XP SP2	Assembled	Mixed	1	50000	50000	—

(Contd...)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
	Field Recording Equipment					**177600**	
1	Microphone (condensor)	Sony	ECM MS 907	8	6000	48000	www.sony.com
2	Compact Digital field recorder	Zoom	H 2	8	15000	120000	www.zoom.co.jp
3	Memory (SD cards: 2 GB)	Transcend	Transcend SD	8	1200	9600	www.transcend.com
	Audio Editing Setup (3 editing systems)					**159600**	
1	PC Computer - Intel Core 2 Duo 2.16/1 GB RAM/160 GB HDD/Combo drive/17" CRT monitor/Creative Audigy 256 sound card/Intel motherboard/ATX cabinet/ /Windows XP SP2	Assembled	—	3	45000	135000	—
2	UPS 650 VA double battery	El Nova	—	3	2700	8100	www.elnova.com
3	Speaker units for editing units	Creative	SBS 380	3	4500	13500	www.creative.com
4	Headphones for editing units	Behringer	HPM 1000	3	1000	3000	www.behringer.com
	Transmission equipment					**450000**	
1	50W VHF FM transmitter	BEL	LVB 206	1		—	www.belindia.com
2	Dummy Load					—	
3	Stacked dipole antenna	Veronica	Stacked dipole	1		—	www.veronica.co.uk
4	RF Cable (RG 213)	Various		50 m		—	Local manufacturers
5	Transmission Compressor limiter	Behringer/ D&R		1		—	www.behringer.com www.d-r.nl

(Contd...)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
	Office Equipment					**143600**	
1	Office computer systems Intel Core 2 Duo 1.83/ 256 MB RAM/120 GB HDD/Combo drive/15" CRT monitor/ Intel motherboard/ATX cabinet/ Windows XP SP2	Assembled	—	3	25000	75000	
2	Carpentry + office furniture + racks	Miscellaneous	—	Set	40000	40000	
3	UPS 650 VA double battery	El Nova	—	3	2700	8100	www.elnova.com
4	Fax machine	Canon	—	1	7500	7500	www.canon.com
5	Flatbed Scanner	Canon	—	1	5000	5000	www.canon.com
6	Telephone connection + Internet	Installation	—	1	3000	3000	—
7	Network hub + cabling	Micronet	—	1	5000	5000	www.micronet.info
	Miscellaneous					**170000**	
1	Generator 5 KVA soundproof	Greaves	5 KVA	1	150000	150000	
2	Guyed mast system/antenna tower	—	15 m – 30m	1	20000	20000	Local manufacturers
					Total	**2065800**	~ 2066000

Suggested Setup 2 (Courtesy Ramnath Bhatt, VOICES - with additional inputs from Abhijit Shylanath, consultant)

Setup II: Basic Community Radio Station (digital)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
	Studio Equipment					**62000**	
1	Mixing Console, 1 mono mic 4/3 stereo line	Behringer	Eurorack UB502	1	10000	10000	www.behringer.com
2	Microphone (Condensor)	Behringer	C-1	1	6000	6000	www.behringer.com
3	Professional headphones	Behringer	HPM 1000	2	1000	2000	www.behringer.com
4	PC Computer as DAW - Intel Core 2 Duo 2.16/ 512 MB RAM/160 GB HDD/Combo drive/17" CRT monitor/Creative Audigy 256 Sound card/ Intel motherboard/ATX cabinet/Creative speakers/Windows XP SP2	Assembled	Mixed	1	20000	20000	—
5	External Hard Drive (500 GB)	Toshiba, any other		1	8000	8000	
6	Sound proofing basic	Local resources	Using foam, and heavy curtains (for roughly a 10x10 room)		10000	10000	
7	Studio amp and monitoring speakers	Local Resources	Local resources		6000	6000	

(Contd...)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
	Field recording Equipment					**32000**	
8	Microphone (condensor)	Sony	ECM MS 907	2	6000	12000	www.sony.com
9	Compact Digital field recorder	Sony	IC Recorder	2	10000	20000	www.sony.com
	Transmission equipment					**190000**	
10	50W VHF FM transmitter	WEBEL		1		—	ww.webel-india.com
11	100/200 watt VHF antenna					—	
12	RF Cable (RG 213 or 7/8)	Various		50 m		—	
	Miscellaneous					**40000**	
13	UPS system with maintenance free batteries	Microtek	1250 VA	1	30000	30000	www.microtek.com
14	Guyed mast system/antenna tower *(If this can be obtained through private telecom operator)*	—	15 m – 30m	1	Private telecom/ BSNL	—	—
15	Miscellaneous connectors/cables	—	As reqd		15000	10000	
					Total	**324000**	

Suggested Setup 3 (Courtesy: Ashish Bhatnagar, Prasar Bharti)

Very Basic Community Radio Station (digital)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
	Studio Equipment					**72000**	
1	Mixing Console, 1 mono mic 4/3 stereo line	Behringer Yamaha Mackie	Eurorack UB502	1	10000	10000	www.behringer.com www.yamaha-mg.com www.mackie.com
2	Microphone (dynamic)	Shure Studio Projects Sennheiser	SM 58 B2	2	2000 3000	6000	www.shure.com www.studioprojects.com www.sennheiser.com
3	Professional headphones	Behringer Sony	HPM 1000 MDR- V150	4	1000 1250	4000	www.behringer.com www.sony.com
4	C Computer as DAW - Intel Core 2 Duo 2.16/ 512 MB RAM/160 GB HDD/Combo drive/ 17" CRT monitor/Creative Audigy 256 Sound card/Intel motherboard/ATX cabinet/Creative speakers/Windows XP SP2	Assembled	Mixed	1	45000	45000	
5	DVD / CD player			2	3500	7000	

(Contd...)

S.No.	Equipment Description	Brand	Model	Quantity	Approx. Price	Total	Internet resource
	Field recording Equipment					**18000**	
6	Compact Digital field recorder	Cenix Edirol R1 Zoom H1 Sony USB Rec	With external mic	3	3500/ 6000	18000	www.edirol.net www.zoom.co.jp www.sony.com
	Transmission equipment					**190000**	
8	50W VHF FM transmitter	WEBEL		1		—	www.webel-india.com
10	100/200 watt VHF antenna					—	
11	RF Cable (RG 213 or 7/8)	Various		50 m		—	Local manufacturers
	Miscellaneous						
13	Inverter/ UPS with maintenance free batteries (150 AH)	Microtek	600 VA	1	15000	15000	www.microtek.com
14	Guyed mast system/antenna tower	—	15 m – 30m	1	20000	20000	
15	Miscellaneous connectors/cables + low cost acoustic treatment	—	As reqd		15000	15000	
16.	Misc. (wiring /furniture/ earthing etc)				50000	50000	
					Total	**380000**	

APPENDIX 2

AUDIO & RADIO EQUIPMENT MANUFACTURERS (GLOBAL LIST)

The list below contains the details of the principal audio equipment manufacturers globally, sorted by the type of equipment they specialize in. Additional specifications and descriptions of the models of equipment they manufacture are available at their respective websites.

1. Mixing consoles

www.altoproaudio.com	**Alto**	Standard Allround
www.behringer.com	**Behringer**	Standard Allround
www.alesis.com	**Alesis**	Standard Allround
www.mackie.com	**Mackie/Onyx**	Standard Allround
www.behringer.com	**Soundcraft**	Professional On Air and Production
www.aeq.es	**AEQ**	Professional On Air and Production
www.commsandsound.com	**Alice**	Professional On Air and Production
www.d-r.nl	**D&R**	Professional On Air and Production
www.sonifex.com	**Sonifex**	PProfessional On Air and Production
www.wheatstone.com	**Audioarts**	Professional On Air and Production
www.autogram-crl.com	**Autogram**	Professional On Air and Production
www.arrakis-systems.com	**Arrakis**	Professional On Air and Production
www.studer.ch	**Studer**	Professional On Air and Production
www.yamaha.com	**Yamaha**	Professional On Air and Production with PC Multitrack control 200
www.fostex.com	**Fostex**	Production mixer and 4-8 Track digital recorder
www.tascam.com	**Tascam**	Standard all round, Production with PC Multitrack control 200
www.roland.com	**Roland**	Production mixer and 4-8 Track digital recorder

www.axeldigital.com	**Axel Tech**	Mixer semi and Pro
www.aev.net	**AEV**	Professional On Air and Production
www.axeltechnology.ru	**Oxygen 4**	Professional On Air and Production
www.klotzdigital.com	**Vadis/ D.Cennium**	Professional On Air - and Production

2. Monitor Loudspeakers

www.behringer.com	**Behringer**	Studio, OB, PC
www.jbl.com	**JBL**	Studio, OB, PC
www.fostex.com	**Fostex**	Studio, OB, PC
www.yamaha.com	**Yamaha**	Studio, OB, PC
www.mackie.com	**Mackie**	Studio, OB, PC
www.creative.com	**Creative**	PC
www.tannoy.com	**Tannoy**	Studio, OB, PC
www.m-audio.com	**M-Audio**	Studio, OB, PC
www.krksys.com	**KRK**	Studio, OB, PC
www.tapcoworld.com	**Tapco**	Studio, OB, PC
www.genelec.com	**Genelec**	Studio,OB, PC

3. PA Systems

www.califone.com	**Califone**	30 watt highly mobile very small "one box"
www.bswusa.com	**Mackie**	Mixer, speakers, 1200 watts, 4 mic, stands, cables
www.fender.com	**Fender**	Portable sound systems 12 volt
www.fender.com	**Fender**	12 volt battery pack based
www.proelgroup.com	**Proel**	PA Live
www.fbt.uk.com	**FBT**	PA Live
www.bswusa.com	**JBL**	JBL speakers, Soundcraft mixer, AKG Mics
www.ahujaradios.com	**Ahuja**	PA systems, mics, amplifiers for PA

4. Telephone Hybrids

www.d-r.nl	**D&R**	Passive analogue and digital
www.telos.com	**Telos**	Analogue and digital
www.sonifex.com	**Sonifex**	Analogue and digital
www.comconindustries.com	**Comcon**	Analogue
www.jk-audio.com	**JK Audio**	Digital

5. Microphones

www.akg.com	**AKG**	All types
www.shure.com	**Shure**	Dynamic, Electret condenser
www.rode.com	**Rode**	Condenser Large diaphragm
www.behringer.com	**Behringer**	Condenser, Dynamic
www.audiotechnica.com	**Audio Technica**	All types
www.sennheiser.com	**Sennheiser**	All types
www.electrovoice.com	**Electrovoice**	Dynamic, Electret condenser
www.sony.com	**Sony**	Dynamic, Electret condenser
www.heilsound.com	**Heil**	Dynamic, Condensor
www.studioprojectsusa.com	**Studio Projects**	Condensor
www.neumann.com	**Neumann**	Condensor, Dynamic
www.coleselectroacoustics .com	**Coles Electroacoustics**	Ribbon commentator mics
www.beyerdynamic.de	**Beyer**	Dynamic, Electret condenser

6. Headphones

www.akg.com	**AKG**
www.sennheiser.com	**Sennheiser**
www.denon.com	**Denon**
www.sony.com	**Sony**
www.behringer.com	**Behringer**
www.koss.com	**Koss**
www.beyerdynamic.de	**Beyer Dynamics**
www.shure.com	**Shure**

7. Processors, Compressors and Limiters

www.behringer.com	**Behringer**
www.tcelectronics.com	**TC Electronics**
www.altoproaudio.com	**Alto Pro Audio**
www.innovonics.com.au	**Innovonics**
www.ramseykits.com	**Ramsey**
www.veronica.co.uk	**Veronica**
www.orban.com	**Orban**

8. Computers (Branded)

www.apple.com	**Apple Computers**	Macintosh OS based systems
www.dell.com	**Dell Corp.**	Windows OS based systems
www.hp.com	**Hewlett Packard**	Windows OS based systems / servers
www.compaq.com	**Compaq Corp.**	Windows OS based systems
www.creative.com	**Creative**	Windows OS based systems
www.lenovo.com	**Lenovo**	Windows OS based systems, servers
www.asus.com	**Asus Tech**	Windows OS based systems
www.msicomputer.com	**MSI**	Windows OS based systems
www.acer.com	**Acer**	Windows OS based systems

9. DVD,CD, MD, DAT, Cassette tape Player / Recorders

www.sony.com	**Sony**	CD, Minidisc, DAT Cassette
www.d-mproasia.com	**Denon**	CD, Minidisc, DAT, Cassette
www.tascam.com	**Tascam**	CD, Minidisc, DAT, Cassette
www.panasonic.com	**Panasonic**	CD, DAT
www.fostex.com	**Fostex**	CD, Minidisc, Dat, Cassette
www.superscope-marantzpro.com	**Superscope**	CD, Casette

10. Reel to reel 1/4" tape recorders

www.studer.ch	**Studer**	
www.revox.com	**Revox**	
www.akai.com	**Akai**	
www.tascam.com	**Tascam**	

11. Turntables

www.stantondj.com	**Stanton**	Analogue with stylus
www.denon.com	**Denon**	Analogue and Digital output, with stylus
www.panasonic.com	**Technics**	Analogue with stylus, instant start

12. Digital Portable & Studio Recorders

www.maycom.nl	**Maycom**	Flash recorders
www.marantz.com	**Marantz**	FlashDisc
www.hhb.co.uk	**HHB**	DAT, Minidisc. HDD and flash recorders
www.fostex.com	**Fostex**	Muiltitrack
www.sony.com	**Sony**	Minidisc, flash recorders
www.sharpusa.com	**Sharp**	Minidisc
www.zoom.co.jp	**Zoom**	Flash recorders
www.motu.com	**Mark of the Unicorn**	HDD recorders and processing hardware
www.nagraaudio.com	**Nagra**	Hi-quality pro recorders
www.edirol.net	**Edirol**	Professional flash field recorder units
www.aeq.es	**AEQ**	Portable flash field recorder
www.hhb.co.uk	**HHB**	Microphone with integrated flash recorder
www.sonifex.co.uk	**Sonifex**	PCM CIR HD

13. Operating systems and basic PC

www.microsoft.com	**Microsoft**	Windows OS (XP, Vista)
www.apple.com	**Apple OS**	Apple OS 10.5
www.linux.com	**LINUX**	Links to Linux based OS variants

14. Broadcast Software

www.winamp.com	**Winamp**	Sound playback, conversion, Play list (free)
www.radiohost.com	**Radiohost**	On Air playout automation
www.jazler.com	**Jazler**	On Air playout automation
www.audioenhance	**Audioenhance**	On Air playout automation(Non commercial special price)
www.bdcast.com	**Broadcast Electronics**	On Air playout automation
www.arrakis-systems.com	**Arrakis**	On air playout automation (Some down loads are free)
www.creamware.com	**Creamware**	On air playout automation
www.bsiusa.com	**Simian**	On air playout automation
www.aeqbroadcast.com	**AEQ**	On air playout automation
www.studer.ch	**Studer**	On air playout automation linked to Studer hardware
www.dalet.com	**Dalet**	On air playout automation
www.rcsuk.com	**RCS**	On air playout automation
www.enco.com	**ENCO**	On air playout automation
www.echolab.com	**Echolab Conductor**	Professional automation

15. Sound edit and processing software

www.steinberg.net	**Steinberg**	Cubase, Nuendo software
www.digidesign.com	**Digi Design**	Pro Tools
www.adobe.com	**Adobe**	Audition software
www.cakewalk.com	**Cakewalk**	Cakewalk software
www.sourceforge.net	**Audacity**	Audacity (Free)
www.wavosaur.com	**Wavosaur**	Wavosaur (Free)
www.baxtrom.com	**Soliton**	Soliton 2 (Free)
www.sonycreative software.com	**Sony Creative**	Soundforge
www.nero.com	**Nero**	Nero Wave Editor (Bundled with CD burner)

16. Soundcards

www.soundblaster.com	**Creative**
www.terratec.com	**Terratec**
www.creamware.com	**Creamware**
www.steinberg.net	**Steinberg**
www.rme.com	**RME**
www.digigram.com	**Digigram**
www.yamaha.com	**Yamaha**
www.turtlebeach.com	**Turtle Beach**
www.motu.com	**Mark of the Unicorn**

17. XLR Plugs, cables and patch bays

www.proelgroup.com	**Proel**
www.neutrik.com	**Neutrik**
www.switchcraft.com	**Switchcraft**
www.deltron-emcon.com	**Deltron**

18. Microphone stands

www.proelproaudio.com	**Proel**
www.k-m.de	**Konig Meyer**
www.ahujaradio.com	**Ahuja**

19. FM Transmitters

www.ramseykits.com	**Ramsey Kits**	Low Power and building kits, low cost.
www.itelcast.com	**Itel**	All types, low to medium cost transmitters
www.dbbroadcast.com	**DB Elettronica**	All types, low to medium cost transmitters
www.rvrusa.com	**RVR**	All types, low to medium cost transmitters
www.crownbroadcast.com	**Crown Broadcast**	Low - medium power. Plug and Play transmitters
www.telefunken.com	**Telefunken**	All powers, Analogue and Digital, Expensive Pro.
www.martielectronics.com	**Marti**	Plug and Play transmitters; STL Link systems

www.broadcast electronics.com	**BE**	Heavy duty medium and High power Transmitters.
www.bext.com	**Bext Corp**.	All types, low to medium cost Transmitters
www.rohde-schwarz.com/	**Rohde Schwartz**	All powers, Analogue and Digital, Expensive Pro
www.veronica.co.uk	**Veronica Co.**	Low power, Low cost.
www.pcs-electronics.com	**PCS Electronics**	FM PCI card
www.sbsfm	**SBS**	Medium cost transmitters
www.webelmediatronics.in	**Webel**	Low cost Indian transmitters
www.bel-india.com	**BEL**	Low cost Indian transmitters
www.nautel.com	**Nautel**	All types of transmitters, including digital radio
www.audemat-aztec.com	**Audemat-Aztec**	All types of transmitters, including digital radio
www.harris.com	**Harris Corp.**	High End transmitters

20. FM Transmitting Antennas

www.ramseykits.com	**Ramsey Kits**	Building instructions for "do it yourself people"
www.aldena.tv	**Aldena**	Low to medium power, medium cost
www.itelcast.com	**Itel**	Low to medium power, medium cost
www.armstrongtx.com	**Armstrong**	Low to High Power
www.dbbroadcast.com	**DB Elettronica**	Low to medium power, medium cost
www.vhfteknik.se	**VHF Teknik**	Low to medium power, medium cost
www.andrew.com	**Andrew Corporation**	Low to High Power
www.dielectric.com	**Dielectric**	Low to High Power
www.rfsworld.com	**RFS**	Low to High Power, all types
www.radiostructures.co.uk	**Radio Structures Ltd.**	Various low power

21. Masts and towers

www.clarkmasts.com	**Clark Masts Teksam Ltd.**	Pump up masts for mobile use
www.racal-antennas.com	**Racal Antennas**	Pump-up
www.radiostructures.co.uk	**Radio Structures Ltd.**	Different wind- and pump-up masts

22. Satellite Receivers

www.worldspace.com	**WorldSpace**	Digital reception equipment (needs subscription)

23. Cases and furniture

www.proelgroup.com		Carry cases, packs
www.skbcases.com		Airtight, Waterproof: Foam/ ABS/stainless steel
www.portabrace.com		World leading designer of blue nylon cases

APPENDIX 3

LIST OF ADVISORY ORGANIZATIONS & INDIVIDUALS

Beyond the basic information contained within this manual, and the information you may be able to research on your own, there are several individuals and organizations that you can contact for additional information, advice or assistance in setting up your own community radio station. This list gives the names and contact details of several of these organizations and individuals. Please note that though their primary office locations are in specific cities, many of these agencies and advisers have experience working across the entire country.

Note: This is not a list of funding organizations!

Community Radio setup, community mobilization, content and technical training, setup

1. United Nations Educational Scientific & Cultural Organization (UNESCO)

Address: UNESCO House, B-5/29, Safdarjung Enclave, New Delhi 110029
Telephone: +91-011-36713000
Telfax: +91-11-26713001/02
Web: www.unesco.org/delhi
Email: newdelhi@unesco.org

2. United Nations Children's Fund (UNICEF)

Address: India Country Office, UNICEF House, 73, Lodhi Estate,
New Delhi - 110003
Telephone: +91-011-24690401
Telfax: +91-11-24691410/24627521
Web: www.unicef.org/india
Email: smukherji@unicef.org (Supriya Mukherji, Programme Communications Officer)

3. United Nations Development Fund (UNDP)

Address: India Country Office, 55, Lodhi Estate, New Delhi – 110 003
Telephone: +91-011-24628877
Telfax: +91-11-46532333, 24627612
Web: www.undp.org.in
Email: john.borgoyary@undp.org (John Borgoyary, Programme Officer)

4. Community Radio Forum - India (CRF)

Address: C/o Drishti Media Collective, 103, Anand Hari Tower, New Sandesh Press Road, Opp. Chanakya Tower, Bodakdev, Ahmedabad , Gujarat - 380 054
Telephone: +91-79-26851235, 66614235
Web: www.drishtimedia.org
Email: stalink123@gmail.com (K.Stalin, Convenor)

5. Ideosync Media Combine

Address: 177, Ashoka Enclave III, Sector 35, Faridabad – 121 003 – Haryana
Telephone: +91-0129-4131883, 6510156 (Prefix 95129-from Delhi)
Telfax: +91-0129-2254395 (Prefix 95129- from Delhi)
Web: www.ideosyncmedia.org
Email: info@ideosyncmedia.org

6. Panos Institute South Asia (India Country Office)

Address: D-302, 2nd Floor, Defence Colony, New Delhi - 110024
Telephone: +91-011-24615217, 24615219
Fax: +91-011-24615218
Web: www.panossouthasia.org/india
Email: panos@panosindia.org

7. Mysore Resettlement and Development Agency (MYRADA)

Address: No.2, Service Road, Domlur Layout, Bangalore 560071, Karnataka
Telephone: +91-080-25352028/3166
Fax: +91- 080-25350982
Web: www.myrada.org
Email: myrada@vsnl.com

8. Alternative for India Development (AID India)

Address: Plot No.1 V.G.N. Nagar, Iyyapanthangal, Chennai - 600 056 - Tamil Nadu
Telephone: +91-044-26272336, 26490014
Fax: +91-044-26272340
Web: www.aidindia.net
Email: aidindia1@vsnl.com

9. Drishti Media Collective

Address: 103, Anand Hari Tower, New Sandesh Press Road, Opp. Chanakya Tower, Bodakdev, Ahmedabad - 380 054 - Gujarat
Telephone: +91-79-26851235, 66614235
Web: www.drishtimedia.org
Email: drishtiad1@gmail.com

10. Deccan Development Society (DDS)

Address: 101, Kishan Residency, 1-11-242/1, Street No. 5, Shyamlal Buildings Area, Begumpet, Hyderabad - 500 016 – Andhra Pradesh
Telephone: +91-040-27764577, 27764744
Telfax: +91-040-27764722
Web: www.ddsindia.com
Email: hyd1_ddshyd@sancharnet.in, hyd2_ddsppvr1@sancharnet.in, ddshyderabad@gmail.com

11. VOICES

Address: No. 165, First Floor, 9th Cross, Indiranagar Ist Stage, Bangalore-560038 - Karnataka
Telephone: +91-080-25213902, 25213903
Fax: +91-080-25213901
Web: www.voicesindia.org, www.voices4all.org
Email: ram@voicesindia.org (Ramnath Bhatt)

12. One World South Asia (OWSA)

Address: C-5 Qutab Institutional Area, New Delhi – 110016
Telephone: +91-011-41689000
Fax: +91-011-41689001
Web: http://southasia.oneworld.net
Email: southasia@oneworld.net

13. Commonwealth Educational Media Center for Asia (CEMCA)

Address: C-5/4, Safderjung Development Area, New Delhi – 110016
Telephone: +91-011-26537146
Fax: +91-011-26537147
Web: www.cemca.org
Email: r.sreedher@gmail.com (Dr.R.Sreedher, Director)

14. Mahila Samakhya, Karnataka (MSK)

Address: No 68, 1st Cross, 2nd Main, HAL 3rd Stage, Near New Thippasandra Main Road, Bangalore 560 075, Karnataka, India
Telephone: +91-80-25727471, 25262988
Web: www.mahilasamakhyakarnataka.com (under construction)
Email: samakhya@vsnl.net

15. Mandaakini Ki Awaaz Samudayik Radio

Address: Kendra Bhanaj, P.O. Machkandi via Chandrapuri, Tehsil Ukhimath, Distt. Rudraprayag, Uttarakhand - 246 425
Telephone: +91-01364-213114, 9411389062

16. Hevalvaani Samudayik Radio

Address: Kendra Chamba, Mussoorie Road, Chamba, Distt. Tehri Garhwal, Uttarakhand - 249145
Telephone: +91-01376-256159

17. DHAN Foundation

Address: 18, Pillaiyar Koil Street, S.S. Colony, Madurai - 625 016 - TamilNadu
Telephone: +91-0452-2610794, 2610805
Fax: +91-0452-2602247
Web: www.dhan.org
Email: dhan@md3.vsnl.net.in

18. Digital Empowerment Foundation

Address: D-307, 1st Floor, Sarvodaya Enclave, New Delhi – 110 017
Telephone: +91-11-51829729
Web: www.defindia.org
Email: osama_manzar@yahoo.com (Osama Manzar)

19. Knowledge Networking for Rural Development in Asia/ Pacific Region (ENRAP)

Address: IDRC Regional Office for South Asia, 208, Jor Bagh,
New Delhi 110003
Telephone: +91-11-24619411 (Ext. 102)
Fax: +91-11-24622707
Web: www.nomadindia.net
Email: michelle@nomadindia.net (Michelle Chawla)

20. Nomad India

Address: 1, Sapote building, Irani Road, Dahanu – 401602 – Maharashtra
Telephone: +91-02528-222241, 9860030888/9890150999
Fax: None
Web: www.nomadindia.net
Email: michelle@nomadindia.net (Michelle Chawla)

21. Kutch Mahila Vikas Sangathan (KMVS)

Address: Media Cell, C/o Kutch Mahila Vikas Sangathan, 15-A, "Midhara",
Himmat Nagar, Revenue Colony, Bhuj - 370 001 - Kutch District,
Gujarat
Telephone: +91-02832-222124, 223311
Email: ujjasradio@gmail.com, preetikutch@yahoo.co.in

22. Auroville Radio

Address: Auroville Radio – TV, Town Hall Complex, Auroville – 605101
- Tamil Nadu
Telephone: +91- 0413-2622250, 2622170
Fax: +91-0413-2622055
Web: www.aurovilleradio.org
Email: info@aurovilleradio.org (Andrea Tazzarri)

23. Anna FM 90.4, Chennai

Address: C/o EMRC, Anna University, Guindy, Chennai - 600025
Telephone: +91-044-22300106
Telefax: +91-044-22300105
Web: http://collinfo.annauniv.edu:6060/emrc/annafm/annafm.htm
Email: p_lakshmi@annuniv.edu (Dr.P.Lakshmi, Director-in-charge, EMRC)

24. IT for Change

Address: No.393, 17th Main, Jayanagar 4th 'T' Block, Bangalore - 560041 - Karnataka
Telephone: +91-080-26654134, 26536890
Fax: +91-080-41461055
Web: www.ITforChange.net
Email: itfc@ITforChange.net

25. Charkha

Address: Ground Floor, G-15/11-12, G - Block, Malviya Nagar, New Delhi – 110 017
Telephone: + 91-11-26680688, 26680816
telfax: +91-11-26680816
Web: www.charkha.org
Email: charkha@bol.net.in

26. Aga Khan Foundation

Address: Sarojini House II Floor, 6 Bhagwan Dass Road, New Delhi -110001
Telephone: +91-011-23782173
Fax: +91-011-23782174
Web: www.akdn.org/india
Email: general@akfindia.org

27. World Development Foundation (WDF)

Address: Plot 5, Sector 3, Karuna Kunj, Dwarka (Behind DPS, in front of BSES), New Delhi – 110 075
Telephone: +91-011-25082764
Telfax: +91-011-25082764
Web: www.wdfindia.org
Email: mail@wdfindia.org

Independent Consultants

1. Ashish Bhatnagar (Technical) (Honorary Advisor)

Address: 313, Asia House, Kasturba Gandhi Marg, New Delhi - 110001
Telephone: +91-011-23073881
Mobile: +91-9868183881
Email: abroadcaster@gmail.com

2. Jean Parker (Content Creation & Recording)

Address: A703 Supreme Green Woods, NIBM Road., Kondhwa, Pune - 411048 - Maharashtra
Telephone: +91-020-4005582
Mobile: +91-9890436033
Email: radioforever@gmail.com

3. Mahesh Acharya (Technical)

Address: No.307. B Block, Manjunatha Residency,
Opp. SCT College, Vigyan Nagar, Bangalore - 560 075 -
Karnataka
Telephone: +91-80-41709551
Mobile: +91-9886303077
Email:mahesh.aacharya@gmail.com. cr_4_agriculture@yahoo.com

4. Dr. Arun Mehta (Technical)

Address: B-69, Lajpat Nagar - I, New Delhi-110024
Telephone: +91-011-29817007
Email: arun.mehta@gmail.com

5. Vickram Crishna (Technical)

Address: A31/32 Queens Apts, Pali Hill, Bandra, Mumbai – 400050 -
Maharashtra
Telephone: (Available on request)
Email: vvcrishna@radiophony.com
Web: www.radiophony.com

APPENDIX 4

AUDIO & RADIO EQUIPMENT VENDORS IN INDIA

The list below contains the details of the key suppliers and vendors of audio and radio related equipment in India. This is by no means an exhaustive list, and is based on the agencies and vendors that many people who have participated in the development of this manual have recommended. This should provide you a starting point for your enquiries when you begin the process of acquiring equipment.

A. Acoustics & Studio setup consultants

Broadcast Engineering Consultants India Ltd. (BECIL)
14-B, Ring Road, I.P. Estate,
New Delhi 110002
Tel: +91-11-23378823
Fax: +91-11-23379885
E-Mail: becil@vsnl.com
Web: www.becil.com

Technomedia Solutions Pvt. Ltd.
1001, Kailash Building
26, Kasturba Gandhi Marg
New Delhi 110001, INDIA
Tel: +91-11-23765169/70/7
Fax: +91-11-23765152
E-Mail: kc@technomediaindia.com, s.nigam@technomediaindia.com
Web: www.technomediaindia.com

All India Radio (AIR) Resources Unit
DG, AIR, Akashwani Bhawan
Parliament Street, New Delhi - 110001
Tel: +91-11-23421187, 23421221
E-Mail: ismehla@air.org.in, neeraj@air.org.in
Web: www.resourcesair.com

Noori Broadcast Solutions Pvt. Ltd.
99-National Park,
Lajpat Nagar-IV,
New Delhi-110024 (India)
Tel: +91-11-65636876
Mob: +91-9811983404, 98891070243
Fax : +91-11-65636876
E-Mail: akhtarma@yahoo.com

Electro Dynamics
58/46, Birhana Road
Kanpur 208 001.
Tel: +91-11-41622014
Fax: +91-11-26430947
E-Mail: eledyne@vsnl.net

Rivera International
397/A, Mangaldas House,
Naaz Cinema Compound Lamington Road, Mumbai 400 004
Tel: +91-22-2200555/777
Fax: : +91-22-23862342
E-Mail: anam@bom2.vsnl.net.in

B. Multi-equipment providers

Advanced Telemedia Pvt. Ltd.
12 A Kalkaji
New Delhi -110019
Tel: +91-11-41675452-4
Fax: +91-11-41675451
Email: sales@atmpl.com
Web: www.atmpl.com

Falcon Technologies
102 Empire Apartments
98 M. G. Road, Sultan Pur
New Delhi 110 030
Tel: +91-11-26804631, 32 / 26804640, 51
Fax: +91-11-26806966
E-Mail: falcontech@eagle-grp.com

Trimurti Instruments
13, Sopariwala house No. 5,
1st floor, Chunam lane,
Lamington Road,
Mumbai - 400007 - Maharashtra.
Tel: +91-22-23858704, 25379253
Mob: +91-9869164174
Email: pankajath@gmail.com, pankajath@hotmail.com

Shaf Broadcast Pvt. Ltd.
B-4/142, IInd Floor
Safdarjung Enclave
New Delhi - 110029
Tel : +91-11-26169902, 03
Fax : +91-11-26169904
Email : sales@shafindia.com

Asia Pacific Broadcasting Union
PO Box 1164,
59700 Kuala Lumpur,
Malaysia
E-mail: info@abu.org.my
Tel: +60-3-22823592
Fax: +60-3-2282-5292

Sony India
A-31, Mohan Cooperative Estate,
Mathura Road,
New Delhi 110044
Tel: +91-11-66006600
Fax: +91-11-26959141
E-Mail: bppmktg@ap.sony.com

CMS-NVL
"NVL House", 198/2,
Garhi, East of Kailash,
Opp. Sapna Cinema,
New Delhi-110065
Tel. : +91-11-26218527
Fax : +91-11-26225955
E-mail : ashokksehgal@yahoo.com

Ahuja Radios
215, Okhla Industrial Estate
New Delhi - 110 020 - INDIA
Tel.: +91-11-26831549, 41612475
Fax: +91-11-26847287, 41616563
Email: admin@ahujaradios.com, ahuja@ahujaradios.com

Hytech India
18, Poorvi Marg, Vasant Vihar,
New Delhi-110 057.
Tel: +91-11-41661709, 26140652
Fax: +91-11-26142084
E-Mail: hytech@vsnl.com, hytech_del@airtelbroadband

Telerad (A Division of ASE Ltd)
Head Office: 89-92, G.I.D.C Naroda Industrial Area,
Ahmedabad - 382 330 - Gujarat
Delhi: 408-810,
Vishwa Sadan, District Center,
Janakpuri - New Delhi - 110 058
Tel: (Ahmedabad) +91-79-22813017/3117
(Delhi) +91-11-25541731/9330
Fax: (Ahmedabad) +91-79-22821592 (Delhi) +91-11- 2554 8507
Email : telsales@icenet.net, tlrddel@airtelbroadband.in

Promedia
R-31, Laxmi Industrial Estate
Link Road,
Andheri (W)
Mumbai - 400 053
Tel: +91-022-67021711, 26354891
Fax: +91-22-67021714, 26354819
Mob: +91-9820023077
E-Mail: info@promediain.net, nikhil@promediain.net

AGP Broadcast Infrastructure Pvt. Ltd.
226-A, Pocket B, Mayur Vihar Phase II
New Delhi
Tel: +91-11-22783543, 22785668
Telfax: +91-11-22783543
Mob: +91-9811143367
Email: info@agpbroadcast.com

Sonodyne
98, NB Block E, New Alipore
Kolkata - 700 053
Tel: +91-33-24570418, 24583406
Fax: +91-33-24787243
Mob: +91-9811143367
Email: response@sonodyne.com

Visual Technologies India Pvt. Ltd.
370-371/2, First Floor,
Hospital Road,
Jangpura, New Delhi - 110 014.
Tel: +91-11-24379961-64, 24378592-94, 24373965
Fax: +91-11-24378591, 2437 5843
E-Mail: vtidel@vtipl.com, vtihyd@vtipl.com

Setron India Private Limited
E-2, Greater Kailash Enclave -1,
New Delhi - 110048.
Tel: +91-11-26242250, 26241150/601
Fax: +91-11-26242150
E-Mail: sales@setronindia.com

Deepjyot Electronics
B-4/228, Safdarjung Enclave
(Behind Safdarjung Club)
New Delhi - 110 029
Tel: +91-11-26187495, 2617 7791
Fax: +91-11-4135 4357
E-Mail: deepjyot.electronics@gmail.com

C. Radio Automation and IT

ENCO India
A-238, 2 Floor
Defence Colony
New Delhi-110023
Tel: +91-9871580444
E-Mail: arjun@enco.com
Contact Person : Arjun Srivastav

HCL Infinet Ltd.
E-4, 5, 6 ; Sector 11,
Noida 201301
Tel: +91-120-2552973
Fax: +91-120-2552973
E-Mail: anuragku@hcl.in

D. FM Transmitter equipment

Bharat Electronics Ltd. (BEL)
Outer Ring Road
Nagavara
Bangalore - 560045 - Karnataka
Tel: +91-080-28303280 (Broadcast systems Division)
Fax: +91-080-25039305
Email: mohanda@bel.co.in (D.A.Mohan, GM Broadcast & Telecom)

West Bengal Electronics Industry Development Corp. (WEBEL)
Webel Bhavan,
Block - EP & GP,
Sector - V, Salt Lake
Kolkata - 700 091 - West Bengal
Tel: +91-33-23578392
Fax: +91-33-23571708/23571739
Email: contact@webel-india.com

Rohde & Schwarz India Pvt. Ltd.
A-27 First Floor,
Mohan Co-operative Industrial Estate
Mathura Road, New Delhi 110 044
Tel: +91-11-42535400
Fax: +91-11-42535433
E-Mail: Nidhi.sharma@rohde-schwarz

Broadcast Electronics
A-238, Defence Colony,
New Delhi-110024
Tel: +91-11-24333340
Fax: +91-11-24333339
E-Mail: sm@btgroup.co.in

APPENDIX 5

USEFUL WEB BASED RESOURCES

One of the most useful resources available to any CR station or CR practitioner is the internet, that worldwide network of computers and databases that offers us the largest collection of information ever created. The list below highlights a few of the most useful websites that will add and expand on the information contained in this manual.

1. www.communityradiotoolkit.net

A website for CR practitioners and information seekers, run by Radio Regen (Wales), and supported by the UK Dept. for Culture, Media and Sport (DCMS). The website is a mine of information on CR - including the **CRT Handbook** - and offers access to several online discussion fora for registered users, to discuss various aspects of their experiences with CR. It is also a source of information and news on CR related events in Europe and the UK area.

2. CR India (http://mail.sarai.net/mailman/listinfo/cr-india)

A mailing list/discussion forum on community radio in India, with a rapidly growing membership. A very useful platform for the exchange of queries and information on CR regulations, technology and setup, the list includes most of the organizations and individuals active in the CR movement in India.

3. http://www.mib.nic.in

The website of the Govt. of India's Ministry of Information and Broadcasting. It carries all the background to the current CR (FM) policy, including the application documents and guidelines described in Section A, as well as a very detailed FAQ on the application and licensing process, and the technical parameters that have to be followed (see **http://mib.nic.in/CRS/FAQ.htm**). The site also gives details on the current commercial FM rollout.

4. http://www.unesco.org + http://www.undp.org

The United Nations Educational, Scientific and Cultural Organization (UNESCO) and the United Nations Development Programme (UNDP) websites. Both organizations are involved with development of community radio worldwide, and have supported the establishment of CRS across the globe. Both have also worked on the extensive documentation of CR best practices and experiences. The websites need to be explored a bit to find information relevant to Indian practitioners of CR – it is wise to narrow the search in both cases to the sub-sites for India and South Asia – but there are a huge number of links to documents and information on CR around the world in the main sites.

5. www.freeradio.org

The website of the Free Radio Berkeley movement, dedicated to international radio action training. The FRB movement works on the 'airwaves are free' principle, and encourages the sharing of DIY radio information that removes restrictions on access to technology and broadcasting controls. Focused primarily on democratizing radio access in the United States – and consequently, opposition to FCC control – the website contains information on training courses run by the organization, as well as resources like circuit diagrams and online ordering processes for radio related circuitry and DIY kits. Also contains a numbetr of useful 'how to' pages.

6. www.radiophony.org

Radiphony is an Indian company dedicated to the free airwaves principle, that works to provide easy to use audio and radio technology solutions for Indian users. The site allows access to resources like the **eLocutor**, a software that allows severely physically challenged individuals to work on a computer. The site also contains detailed FAQs on low power radio and the CR process and setup in India. Also includes – like Free Radio Berkeley – access to information on a DIY simple radio transmitter circuit which can be constructed by most amateur enthusiasts.

7. http://prometheusradio.org

The Prometheus Radio Project is a US based initiative to democratise media access by promoting low power FM. While its events calendar is primarily US-centric, the tech resources are exhaustive, with a number of pages devoted to concepts around low power broadcasting, and galleries of photos illustrating simple solutions and field radio techniques. The International section includes their experiences is supporting and developing low power FM stations in Tanzania. The project can also be contacted for radio station setup consultancies.

8. http://www.resourcesair.com

The website of the All India Radio Resources Unit, which offers technical consultancies to set up CRS. The website details the consultancy work they undertake, and is an especially useful reference to understand the steps involved in designing, setting up and testing a new FM station.

9. http://www.developingradiopartners.org

The website of Developing Radio Partners, a US based not-for-profit that works towards empowering communities worldwide with access to low cost radio technology. While there are no tech resources on the site, their detailed case studies based on their experiences in Sierra Leone, Mongolia and Southern Africa are interesting for the perspective they offer new CR practitioners.

10. http://www.becil.com

The website of Broadcast Engineering Consultants India Ltd. (BECIL). BECIL has been one of the primary consultant agencies for broadcast setups in India, especially where commercial radio and television have been concerned. A Govt. of India enterprise, the website is a source for all kinds of technical and broadcast event related news and information, and contains links to CR application, licensing and guideline related information. The CR link on the site explains BECIL's consultancy work and the services it provides.

11. www.communityradionetwork.org

A website developed by VOICES (Bangalore, India) with UNDP support as part of the same project under which the **Community Radio Step by Step** manual was developed (See **Bibliography**). The website offers members a discussion forum on various aspects of CR in India, as well as information regarding setup, sustainability, technical know-how and equipment setups.

12. http://southasia.oneworld.net

The website of OneWorld South Asia (OWSA), the South Asian arm of the international development organization OneWorld. The website offers networking opportunities to grassroot agencies, and includes an extensive events listing that covers grassroot communication initiatives like CR, one of OWSA's focus areas. OWSA produces and disseminates radio programming, and conducts capacity building programmes on radio and readio technology for field level organizations.

13. www.itrainonline.org/itrainonline/english/community_radio.shtml

iTrainonline provides online training resources on a number of media related subjects, ranging from audio and video to community radio. The community radio page has links to an extensive list of documents and websites that give information on CR, content development for CR, standard stylesheets from professional media organizations, story ideas, and journalism tips. The resources are catalogued under the heads Basics, General, Technical, and Content Development.

14. http://www.transom.org/tools/index.php

Transom.org is an online resource site developed by Atlantic Public Media to allow sharing and discussion on public media access. The site includes several informative articles on recording and editing, selecting equipment, and setting up a studio; as well as useful links to a variety of resources.

15. www.bbctraining.com

Though not directly a CR resource, the BBC Online training website is an enormous resource for learning the technology of radio per se, and the content production techniques that have made the BBC one of the most well known and respected broadcasting organizations in the world. The website also includes online training courses on a variety of recording and production techniques for radio.

16. http://www.apc.org/english/capacity/training community_radio.shtml

The website for the Association for Progressive Communication, an international association that works on internet and ICTs for social justice and development. The website offers a number of resources – shared with the iTrainonline website mentioned above – on community radio, as well as resources on networking civil society organizations.

17. http://www.apnic.net/services/index.html

The Asia Pacific Network Information Center is a resource sharing online organization that facilitates discussion on a variety of ICT and media related subjects amng civil society organizations in the Asia-Pacific. It has a large resources section that, while not directly referring to community radio practitioners, has a lot of ICT related guidelines, resources and information.

18. http://en.wikipedia.org/wiki/Category:Radio_technology

The online contributory resource Wikipedia has a very interesting section on radio terminology and history. This resource provides simple definitions and a number of links to other resources, and changes very rapidly to reflect new media inputs.

19. http://www.cdt21.com/

Website of Circuit Design, Inc., a manufacturer of low cost radio solutions. Includes an RF design guide with a discussion of circuit diagrams, and an online resource for calculations, and online articles on low power FM applications

20. http://www.radioactive.org.uk/home.htm

Website of Radioactive, a UK based organization that works to help communities set up low cost CRS. Radioactive's website offers a number of turnkey CRS packages and setup diagrams that offer CR practitioners and NGOs a point of reference for deciding their equipment combinations and setups. Many of the packages offered have attached costings that allow an assessment of the overall costs involved.

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Comunica (2002)

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Radio Regen (2006)

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Community Radio Manual
Open Society Foundation for Southern Africa/National Community Radio Forum/CAF-SCO (2002)

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Ministry of Information & Broadcasting, Govt. of India (2006)

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