5

AUDIO ELECTRONICS

5.1 INTRODUCTION

In the preceding lesson, you have studied the fundamentals of studio acoustics that include reverberation, sound isolation, noise level, basics of psychoacoustics. This lesson deals in basic electrical and electronic elements, used in sound equipments which include various types of electrical and electronic components and circuits commonly used in sound systems.

Emphasis will be given on resistors, thermistors and transistors.

5.2 OBJECTIVES

After going through this lesson, you should be able to:

- learn the basic concepts of voltage and current as applicable to recording equipments;
- identify various types of components used in electronic circuits;
- understand the functions of such components;
- identify the type, value and rating of components;
- learn some of the important points to be remembered while replacing these components;
- learn about the interference and methods to eliminate such problems;
- understand the importance of earthing and the problems that are likely to occur due to bad earthing;
- learn procedure to carry out adjustments of sound levels while using the equipments.

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5.3 CONCEPT OF VOLTAGE AND CURRENT

Consider a Water tank at the top of a multi storey building. It supplies water to all the floors of the building. You would have observed that the pressure with which water is supplied at the ground floor is more than at the top floor or terrace. This is because that water pressure is proportional to height difference between top level of water in tank and tap from which water is drawn. Further, water flow rate at the outlet (i.e., tap) is proportional to diameter of the pipe and tap.

Analogously, in electrical systems, CURRENT flow (a quantity similar to water flow rate) is proportional to pressure of the Direct Current (DC) source (e.g., 1.5 Volts Cell, mobile battery 4.5 VDC or car battery 12 VDC) or Alternating Current (AC) source (e.g., AC power supply 220VAC). Similarly, VOLTAGE is analogous to height difference of top of water level in tank and water tap.

Voltage

Before learning about voltage, let us learn Electric Field and Electric Potential. Electric Field is the region around a point charge, within which its effect can be experienced. Electric Potential of a point (say P) is the work done in bringing, unit positive charge, from infinity (beyond the electric field of P) to that point (P). Consider two points P1 and P2 with potentials V1 and V2, respectively. If there is potential difference between P1 and P2, this is termed as Potential Difference (PD), defined as V = V1 – V2. Another term for PD is Voltage. For the flow of electric current through an electrical element, voltage should exist across the terminals of the element. In simple words, voltage in electrical system is the ability of the energy source (cell, battery, generator, etc.) to produce a current. Voltage is measured in Volts and is represented by letter 'V' in electrical circuits and calculations.

Most of the modern day sound/recording equipments operate on DC voltage sources, obtained either from dry cells or by converting from AC mains voltage. Emphasis, in this lesson, has been limited to DC voltage sources for easy understanding.

Current

Current is analogous to water flow in the example. Before defining current let us know its genesis. We experience existence of electric charge many times in our daily life. If you rub surfaces of ebonite, glass or even a comb, it acquires electric charge. Try rubbing a comb for some time against your hair, the comb can pick up small pieces of paper. If you watch an aircraft landing in dark, a flash will be observed near the wheels. All these are examples of charge acquired on surfaces due to friction. The flash observed is due to the flow of charge. Thus, we can

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define the conventional Current as the rate of flow of charge (positive) per unit of time. 1 Ampere of current is flow of 1 Coulomb of charge per second. Unit of current is Ampere and is represented by letter ‘I’ in electrical circuits and calculations. Smaller units such as mA (1milli Ampere =1/1000 A) are most commonly used in electronic circuits.

The magnitude of the electric current depends not only upon the electromotive force but also upon the nature and dimensions of the path through which it circulates. The magnitude of current flowing through a simple circuit can be determined by use of a most important and basic law called as OHM’S LAW.

Ohm’s law states that the current in a DC circuit varies in direct proportion to the voltage and is inversely proportional to the resistance of the circuit. (The term resistance is analogous to the opposition offered to the movement of water flow by pipes, bends etc.) Resistance is represented by a letter ’R’ and its unit of measurement in electrical/electronic circuits is Ohm (Ω).

Mathematically, this law can be expressed as

Current = Electromotive force/Resistance

Using the symbols I, V and R to represent current, voltage and the resistance respectively, Ohm’s law can be written as:

$$I = V/R \text{ or } V = I \times R$$

Example: If 1volt is applied across a resistor of 1 ohm, a current of 1 Ampere will flow through this resistor.

Note that this law not only holds for a complete circuit, but can be applied for any part of a circuit provided care is taken to use the correct values for that part of the circuit.

Note:

1. Conventional current is considered to be in a direction opposite to the flow of electrons.

2. Electric current flows through a path if path is part of a closed loop with an independent supply source.

INTEXT QUESTION 5.1

1. A recording equipment operates on 12 V Battery. If the net resistance offered by the recording equipment is 300 ohms (resistive), how much current is likely to flow through the equipment. Answer briefly in the space provided for the purpose.

5.4 COMPONENTS USED IN ELECTRONIC CIRCUITS

Components used in electronic circuits can be broadly categorized in following two ways:

(a) Passive components – Resistors, Inductors, capacitors, diodes, thermistors, varistors and transformers are examples of passive components. Passive components are those which do not produce or amplify A.C. signals.

(b) Active Components – Active components are those components which can generate or amplify A.C. signals. It is important to note that power of amplified AC Signal at the output of an electronic amplifier is not generated in the device but is drawn from D.C. power supply. The example of active components are Bipolar Junction Transistors (BJTs), Field Effect Transistors (FETs) , Operational Amplifiers, Analogue ICs and Digital ICs. Integrated Circuits (ICs) are devices which integrate thousands of resistor, capacitors and transistors etc. to perform a desired function.

5.4.1 Passive Components

1. Resistors

Resistors provide means of controlling voltage and / or current in a circuit.

Resistors are typically used in electronic circuits to;

1. Establish bias potential and current for proper operation of transistors circuits.
2. Convert collector or emitter current of a transistor into corresponding output voltage.
3. To provide a preset level of attenuation.

Electrical characteristics of a resistor are determined largely by material used and its construction. While selecting a particular type of resistor following parameters need to be considered:

(i) Denomination of a resistor in terms of Ω (Ohm), kΩ (Kilo-ohms), or MΩ (Megaohms) etc.

(ii) Its desired accuracy or tolerance (i.e., maximum permissible percentage deviation from circuit design value). Resistors with tolerance of +/- 2% or less are termed as close tolerance resistors.

(iii) Its power rating (which must be equal to or greater than the maximum expected power dissipation)

(iv) Its temperature coefficient (expressed in ppm (parts per million) per unit change in temperature.)

(v) Its stability (expressed in terms of long or short term percentage variation of resistance value under specified physical and electrical conditions). Manufacturers usually specify it to be of "High Stability" if resistance is stable.

(vi) The noise performance (expressed as equivalent noise voltage generated by resistor under specified physical and electrical conditions). Manufacturers usually specify it to be of "Low Noise" if it is so.

High stability, low noise and close tolerance resistors are required in critical applications e.g. initial stages of amplifier dealing with very small level signals, input stage of Test and Measuring Instruments (TMIs) etc.

Though high performance (i.e. high stability, low noise, close tolerance) may be used in less or not so critical applications but it would be uneconomical to use, since such resistors are expensive.

Aluminium clad wire wound resistors rated for 25 Watts and above should be mounted on suitable heat sink. Its power rating should be de-rated by more than 50% if it is mounted in free air.

Value of Resistors

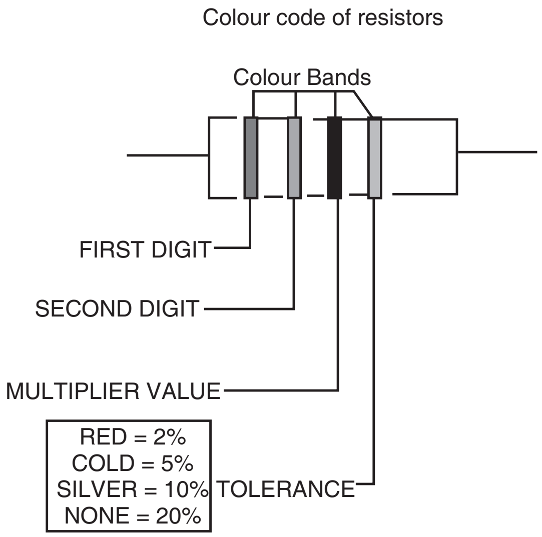
Resistance values marked on resistors are merely a guide to its actual value. A resistor marked 220 Ω with a tolerance of +/- 10% will have a value falling in range of 198 Ω to 242 Ω. In non critical application, where a resistor of say 230 Ω is needed, a 220 Ω with tolerance of +/- 10% will be satisfactory. However in critical applications, a close tolerance resistor of 220 Ω with 1% tolerance will be needed.

Resistors are also available in multiple series of fixed decade values (Decadic means in ratio of 1:10:100: 1000 etc.). However, each fixed decade value is governed by the tolerances involved.

Resistors are usually colour coded. These codes are available in terms of number of colour bands provided on the body of the resistor. Decoding the colour code helps in knowing the value of a resistor. In some of the specific cases the value of a resistor are directly marked on its body.

See Box: 5.1 below for details of the code along with a specific example to use the code.

Box 5.1: Colour code of resistors



DIGIT	COLOUR	MULTIPLIER
	Silver	0.01
	GOLD	0.1
0	BLACK	1
1	BROWN	10
2	RED	100
3	ORANGE	1k
4	YELLOW	10K
5	GREEN	100K
6	BLUE	1M
7	VIOLET	10M
8	GREY	
9	WHITE	

EXAMPLE:

BAND	COLOUR	VALUE
FIRST BAND	RED	2
SECOND BAND	GREEN	4
THIRD BAND	B;ACL	X1
FOURTH BAND	SILVER	10%

HENCE THE VALUE OF

INTEXT QUESTION 5.2

1. In a recording equipment, it is observed that one of the resistor is burnt. The colour bands provided on the burnt resistor are as given below:

   First band = Yellow,

   Second Band = Violet

   Third Band = Yellow

   Fourth Band = Red

   Using the Colour Code provided in the Box 1 above, find the value and tolerance of the resistor to be replaced.

Series and Parallel combination of resistors

In some of the cases, it is not possible to have an exact value of resistor that is required in the electronic circuit. Exact value is then obtained by use of series or parallel combination of resistors as shown in Fig. 5.1.

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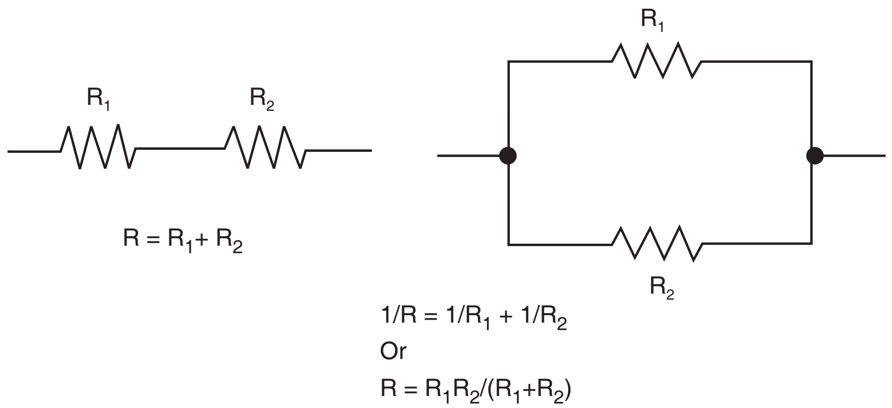

A. Series Combination B. Parallel combination

Fig. 5.1: Series and Parallel combination of resistors

In series combination (Fig. 5.1A), the resultant value of resistance is equal to the sum of value of individual resistors. Here $R = R_1 + R_2$

In parallel Combination (Fig. 5.1B), The resultant value of resistance is given as $1/R = 1/R_1 + 1/R_2$

Or $R = R_1R_2/(R_1 + R_2)$.

Example: A resistance of 4.9 KΩ is needed. What series combination will make it 4.9 KΩ.

Solution: Any of the a series combination of (2.2 KΩ & 2.7 KΩ) or (3.9 KΩ, 1 KΩ) or (4.7 KΩ & 0.2 KΩ) or or (3.3 KΩ & 1.6 KΩ) etc can be made. However, tolerance percentage has to be taken into account provided precise value is required.

Point To Remember

Care should be taken to ensure that power dissipated in each resistor does not exceed individual power rating of resistors.

Voltage Divider

A very common use of resistor is to provide fixed potential division of voltage as shown in Fig. 5.2.

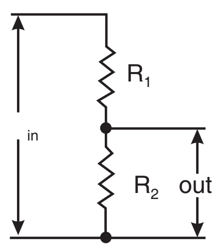

Fig. 5.2: Voltage Divider Circuit

Notes

Here

$$V_{out} = (R_2/R_1 + R_2) \times V_{in}$$

Points to Note

1. Close tolerance resistors (e.g. +/– 1%) should be used to obtain accurate value of voltage division.

2. A major disadvantage of such a simple voltage division is that output voltage will fall in case more current is drawn from the arrangement. The load resistance appears in parallel with R_2 and hence effective resistance of R_2 (i.e. R_2 in parallel with RL) decreases. This disturbs the voltage division ratio Vout/Vin. To ensure that voltage division ratio remain same, RL should be at least 10 times of the value of R_2. In precision applications, RL should at least 100 times of R_2.

3. It is important to note that current drawn by R_1 & R_2 in series from Vinput source is not excessive. In electronic circuit such input current will be of the order 1 to 10mA.

Current Divider

Another important application of resistors that is commonly used for measurement of high value of current is called current divider circuit. Here, a parallel combination of resistors is used to divert a portion of current to another branch of circuit. Figure 5.3 shows one such circuit.

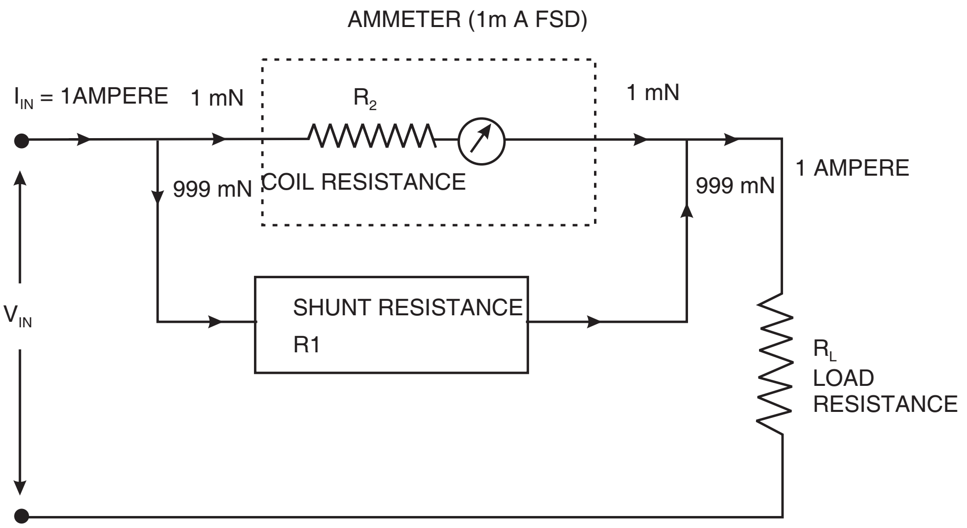

Fig. 5.3: Current Divider Circuit

Here, current through the Ammeter is given as

$$I_{out} = (R_1/R_1+R_2) \times I_{in}$$

Shunt provided in parallel with Ammeter, to provide higher measuring capacity, is an example of parallel combination of resistors.

Points to Remember:

1. Close tolerance resistance (+/- 1%) should be used to obtain accurate value of current division.
2. For precision applications, R2 should be at least 100 times value of R1.

Preset Resistors

Preset resistors enable adjustment of total resistance value without need to change the resistance which requires soldering & de-soldering. Preset resistors of following type are commonly available:

- Open track presets (for horizontal & vertical mounting on PCB)
- Encapsulated carbon & Multi turn cermet type

Variable Resistors

Variable resistors, like presets are commonly available in variety of forms.

1. Carbon track potentiometers.
2. Wire wound potentiometers.

Potentiometers are 3 terminal variable resistors. Carbon potentiometers are available in linear or semi-logarithmic law tracks. They may be in rotary or linear/slider form.

Sometimes, control of such potentiometers are mechanically linked together to make identical movement of rotary shaft or slider movement. Such resistors are called Ganged, tandem or stereo potentiometers. These are extensively used in Stereo Amplifiers.

Points to Remember

1. Open carrier track presets are relatively more noisy & unreliable. So cermet components should preferably be used.
2. Carbon track variable resistors suffer from track wear & noise. So these should not be used for critical application like low noise amplifier & for instruments amplifiers.

3. Logarithmic law potentiometers should be used in audio equipment for better controls. This is needed as our hearing is also logarithmic.

4. Carbon track controls should never be used for controlling regulated power supply voltage because intermittent contact on carbon slider may result in appearance of full input voltage at the output side of voltage regulator.

Thermistors

Thermistors are those resistors whose resistance changes considerably more with temperature than normal resistors. Thermistors are therefore, employed as temperature sensing & temperature compensating elements in electronic circuits. Thermistors are of following two types.

N.T.C. (Negative Temperature Coefficient) Thermistor

The resistance of Negative temperature Coefficient resistor decreases rapidly as temperature increases as shown in Fig. 5.4.

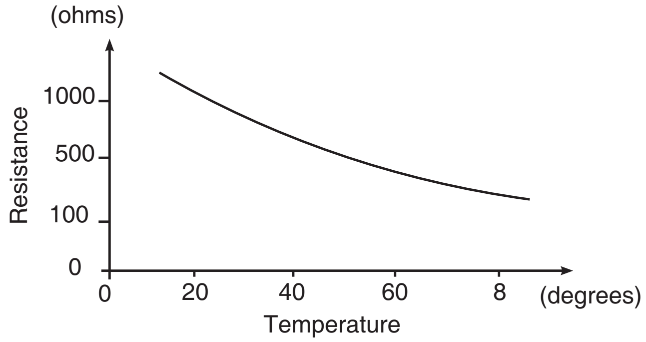

Fig. 5.4: Graph showing the characteristics of NTC Thermistor

P.T.C. (Positive Temperature Coefficient) Thermistors

PTC thermistors, on the other hand, exhibit a typically flat value say 100 Ohms over a range from low temperatures to say 80 deg C. As temperature rises further, their resistance increases rapidly to values more than 10k Ohms as shown in Fig. 5.5.

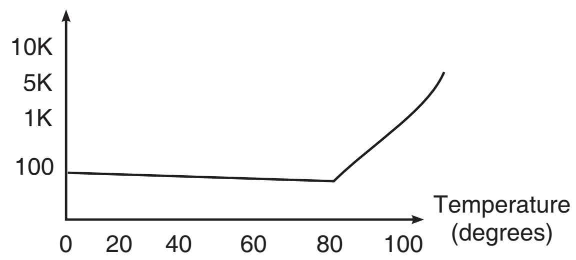

Fig. 5.5: Graph showing the characteristics of a PTC Thermistor

Voltage Dependent Resistors (Varistors)

Varistors are those resistors whose resistance decreases on applying increasing voltage. Fig. 5.6 shows typical characteristics of a varistor.

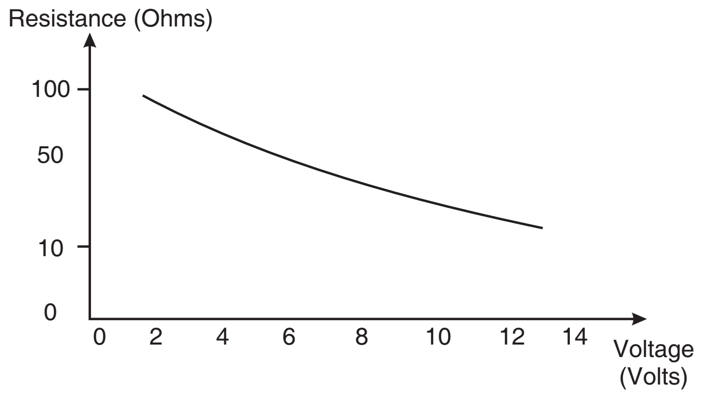

Fig. 5.6: Graph showing the characteristics of a Varistor

Varistors are used to suppress high voltage transients borne in AC mains due to switching On/OFF of inductive loads like motors ,transformers etc. VDRs are also used in D.C. Power supply to protect against application of high voltage to sensitive electronic circuits.

Capacitors

Capacitors are passive components which store energy in electric field (1/2 CV^2). These components do not dissipate energy like resistors. Typical applications of capacitors include:

1. Working as energy reservoir & smoothing circuits in DC power supply
2. Coupling AC signals between different stages of amplifier
3. Decoupling power supply from one stage of amplifier to another.

Electrical characteristics of capacitors are determined by physical dimension and type of dielectric material used in the capacitors. The capacitors are therefore, classified according to the type of dielectric used such as paper capacitors or ceramic capacitors. Both fixed and variable capacitors are commonly used in electronic circuits.

The capacitors are represented by a letter 'C' in circuit drawings. The actual measurement of capacity of a capacitor is termed as its 'capacitance'. The unit of capacitance is the 'Farad' and is expressed as C = Q/V, where C is in farads, Q is in the charge of coulombs and V is in volts. The farad is a rather large unit, so we use smaller units such as microfarad (=10^{-6} of a farad) or picofarad (=10^{-12} of a farad).

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Series and Parallel combination of capacitors

In order to get a required value of a capacitor as per circuit design, both series and parallel combinations are commonly used.

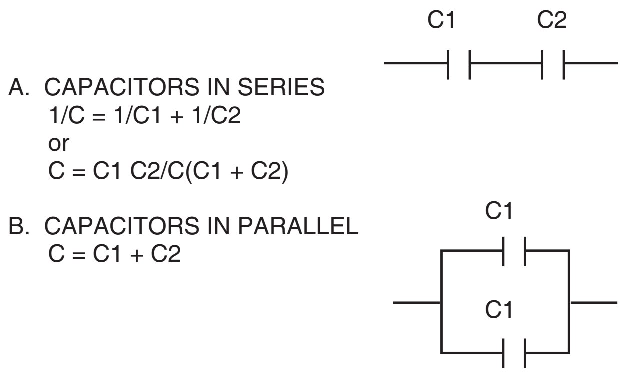

Fig. 5.7: Series and parallel combination of capacitors

As may be seen in Figure 5.7, the resultant capacitance of two capacitors C1and C2 in series is expressed as

$$1/C = 1/C1 + 1/C2 \quad \text{or } C = C1\ C2 / (C1 + C2)$$

In case of parallel combination, it is expressed as $C = C1 + C2$

Following factors should be considered, while selecting a capacitor, for a particular application:

(a) Required value of capacitor (in farad, micro farad, nanofarad, picofarad etc.)

(b) Required voltage rating (i.e. maximum voltage that can be applied without failing it)

(c) Accuracy or tolerance of capacitor (expressed as max. percentage variation from its specified value)

(d) Stability of capacitor (expressed in long term or short term %age variation of capacitive value under specified physical & electrical operating conditions)

(e) Temperature coefficient (expressed as variation in ppm per unit temp change)

(f) Leakage current (flowing in dielectric at rated DC voltage at a given temperature). Alternatively an insulation resistance (ideally infinite) is specified. This is resistance measured between capacitor plates under given set of physical & electrical conditions.

Notes

Points to Remember

Please keep in mind following points while selecting/using capacitors for different applications.

1. It is important that capacitor is operated at voltage well below their nominal maximum working voltage.
2. Since working voltage is a related to operating temperature, capacitor should be de-rated for working at higher temperatures.

5.4.2 ACTIVE COMPONENTS

1. Transistors

Transistors fall in two main categories i.e.

1. BJTs – Bipolar Junction Transistors
2. FETs – Field Effect transistors

They are also classified according to semiconductor material used i.e.

Silicon transistors and Germanium transistors

Transistors are also classified according to their field of application;

1. General purpose application
2. Audio frequency application
3. Radio frequency application
4. Switching application

Box: 5.2: Glossary used with transistors

Glossary generally used while referring to transistors:

Low Frequency	: for audio frequency applications typically below 100 kHz.
High frequency	: for RF applications (typically 100 kHz or higher)
Power	: Transistors operating at significant power levels. Such transistors are further sub divided into **AF power type** or **RF power type.**
Switching	: Transistors designed for switching applications.
Low noise	: Transistors which have low noise characteristics & are intended for low level signal applications.
High voltage	: High voltage transistors are designed for use with high voltage DC.
Drivers	: Transistors operating at medium power & voltage levels as penultimate stage of a power amplifier.

Notes

Transistor Codes

Transistor codes have either

(a) 2 letters & 3 figures for general purpose transistors OR

(b) 3 letters & 2 figures for special purpose transistors

First letter denotes type of semiconductor material used

A – indicates Germanium semiconductor material

B – indicates Silicon semiconductor material

Second letter denotes application i.e.

C – for Low power, low frequency applications

D – for High power, low frequency applications

F – for Low power, high frequency applications

L – for High power, high frequency applications

The third letter does not have a particular significance in case of transistors for special applications. For example

Transistor AF 115 is a general purpose Germanium transistor for low power & high frequency applications.

Transistor BC 108 is a general purpose Silicon transistor for low power & low frequency applications

Transistor BFY 50 is a special purpose Silicon transistor for low power high frequency applications.

Bipolar Junction Transistors (BJTs)

Bipolar Junction Transistors (BJTs) comprise of PNP or NPN junctions made up of either doped Germanium or doped Silicon material. In both cases, electrodes are labelled as collector, base & emitter. Silicon transistors are much more widely used than Germanium transistors in majority of applications. This is because Silicon transistors do not suffer from the problem of "thermal run away" (see note1) as much as Germanium transistors. Therefore you may find very few Germanium transistors being used now-a-days.

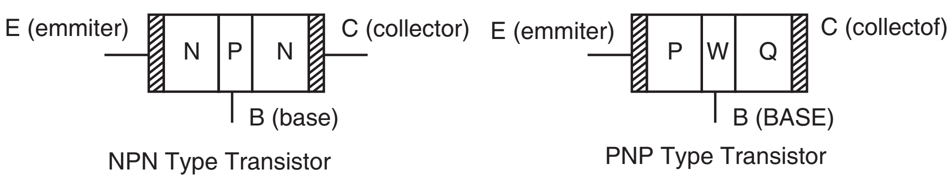

Fig. 5.8: Basic junction design configuration of NPN and PNP type of Transistors

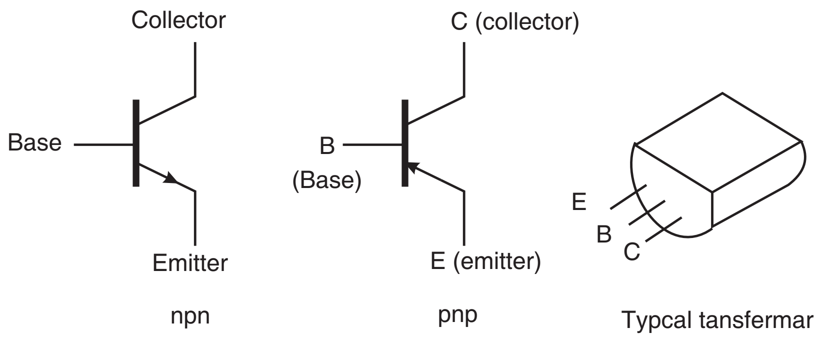

Fig. 5.9: Symbolic representation of NPN and PNP Transistors

Figures 5.8 and 5.9 show basic construction & symbolic representation of NPN & PNP transistors. Base region of both types of transistors (i.e. NPN & PNP) is made very thin so that electrons or holes are swept away across the base region resulting in very small base current. Therefore base current is very small (say 1/100 of emitter current). Thus small base current controls 100 times more current in emitter or collector circuit. This forms the basis of control or amplification of a larger current (emitter current or collector current) by a much smaller base current (say 1/100 of emitter current).

Please note that flow of current (conventional) is from collector to emitter in cased of NPN transistor & from emitter to collector in case of PNP transistors. This is in opposition to the flow of electrons

Note 1: In transistors reverse leakage current increases as temperature rises. The increased reverse leakage current results in more heat dissipation & still higher temperature. This cycle continues & results in phenomenon known as "thermal run away". This results in improper operation of transistors circuit & may result in damage of the transistor device itself.

2. Field Effect Transistors

Field effect transistors (FET) may be divided into two main categories, namely junction and insulated gate. Basically a junction FET is a slice of silicon whose conductance is controlled by an electric field acting perpendicularly to current path. This electric field results from a reversed-bias pn junction and because of the importance of this transverse field the device is named as Field Effect Transistor. FETs are basically of two types namely MOSFET (Metal Oxide Semiconductor Field Effect Transistor) and JFET (Junction Field Effect Transistors). Because of difference in their performance characteristics they are used for different specific circuits.

One of the main differences between a junction FET and a conventional transistor is that for the former current is carried by only one type of carrier, the majority carriers. In the case of a latter both majority and minority carriers are involved. Hence the FET is sometimes referred to as a Unipolar Transistor while the conventional type is called a Bipolar Transistor.

Another important difference is that the FET has high input impedance, while ordinary transistors have low input impedance. Because of this, FETs are voltage operated as opposed to current operated bipolar transistor.

The electrodes of FET are named as 'Source', 'Gate' and 'Drain'. The symbolic circuit representation of FET is shown in Figure 5.10 below.

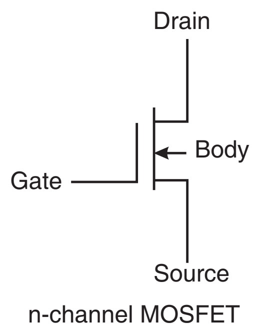

Fig. 5.10: Symbolic representation of a Field Effect Transistor (FET)

INTEXT QUESTION 5.3

State whether the following statements are True or False. Write T or F in the box provided against each statement.

(a) Resistance of a material always decreases if the temperature of the material is decreased. [ ]

(b) In an electric circuit electrons flow from a point of lower potential to a point of higher potential. [ ]

(c) Any amount of current can be passed through a fuse wire provided that the heat is dissipated before the wire melts. [ ]

(d) In both NPN and PNP transistors, current flowing through the base is very small as compared to Collector or Emitter. [ ]

(e) FET is a Unipolar device. [ ]

5.5 INTERFERENCE

While listening to radio programmes, you might have observed that the quality of the recorded message/song you are listening may not be good. It may be noisy or may even be suffering from unwanted interfering signals. Sometimes it may be so annoying that you may be forced to change the radio channel. Any interfering signal or stray pick up constitutes a form of noise. Here the spectrum and amplitude characteristics depend on the interfering signal. For example, 50 Hz pickup from power supply circuit has a sharp spectrum and constant amplitude where as car ignition noise, lightning, and other impulsive interferences are broad in spectrum and spiky in amplitude. Other sources of interference are radio and television stations, electrical equipment, motors, fans and switching regulators etc. Many circuits, as well as detectors and even cables, are sensitive to vibration and sound. These are called microphonic noises.

Sources of Interference

- In electronic circuits, the noise can be due to thermal noise produced by resistors, transistors and other components.
- Carbon potentiometers after a long use may give crackling noise.
- The transistors used in amplifiers may not be of low noise characteristics.
- Interfering signals can enter an electronic instrument (for example, a tape recorder) through the power- line inputs or through signal input and output lines.
- Bad or loose connections, especially at the connector points usually pick up the radio frequencies.
- Use of unshielded cables and unbalanced circuits are common sources, for picking up interfering signals.
- Sometimes, even the crosstalk, between Left and Right channels of the stereo system, is also a source of interference.

Eliminating interference

Numerous effective tricks have been evolved to handle most of these commonly occurring interference problems. Many of these noise sources can be controlled by careful design, selecting of proper components, shielding and filtering.

5.6 EARTHING PROBLEMS

In the preceding section, you have learnt that the interfering signals, 50 Hz pickup (power supply hum), and signal coupling via power supplies and ground paths can turn out to be far greater practical importance than the noise sources generated by discrete components like resistors and transistors. All these problems are due to bad earthing and are commonly referred as ‘earthing’ problems.

Eliminating of Earthing Problems

- These interfering signals can all be reduced to an insignificant level with proper layout and construction, earthing and extensive electrostatic and magnetic shielding.
- A good low resistance separate earth electrode (Earth Pit) may be provided for Audio equipments as close to the building as possible.
- All the audio equipments should be connected to this earth pit by copper straps of sufficient thickness to have low resistance path.
- The lengths of these copper straps should be as small as possible.
- Separate earth straps should be used for each equipment.
- Ensure good and permanent connection at all the junction points.
- Audio earths should not be looped with power and RF earths.
- Use good quality shielded cables for audio interconnection between various equipments.
- Ensure the connections at the connectors are well soldered and not loose.

5.7 CARRY OUT ADJUSTMENTS

Recording of programmes by use of recording equipments is a highly skilled job which is mastered only by practice. Controls provided on various types of equipments are to be adjusted for proper alignment of audio signals. Manufacturers of equipments usually specify certain controls and commands for initial alignment and calibration. Such instructions and guidelines must be followed. For example, a digital recorder may require a low level input signal than an analogue recorder. Every equipment is specified for its minimum and maximum input level. Deviations from these minimum and maximum input levels may deteriorate the quality of programmes.

The feeding of audio signals from one equipment to the next is usually controlled by volume controls (faders commonly called in audio consoles). This arrangement is shown in Fig. 5.11.

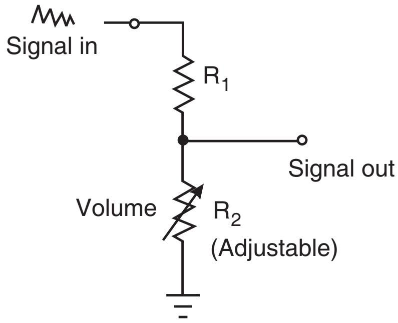

Fig. 5.11: Schematic drawing for audio signal level control

As may be seen in Figure 5.11, output signal to next stage is controlled by variable resistor R2. In case of stereo recordings, volume controls of both left and right channels are ganged to have equal alignment levels of both lines.

Similarly VU (volume Units) meters or PPM (Peak Programme Meters) are provided on consoles and recorders to know the exact input/output levels.

TERMINAL QUESTIONS

1. A moving coil meter, with 1 mA FSD (Full Scale Deflection) and 200 Ω coil resistance is required to read 1A. Determine the value of shunt resistance required. (Refer Fig. 5.3 for circuit drawing)
2. With reference to Figure 5.12, calculate the following values:
   - (i) Resistance between terminals B& C
   - (ii) Resistance between terminals A&C
   - (iii) Total current flowing through the circuit
   - (iv) Voltage drop from A to B point
   - (v) Voltage drop across B & C
   - (vi) Current in 3 Ohm resistor

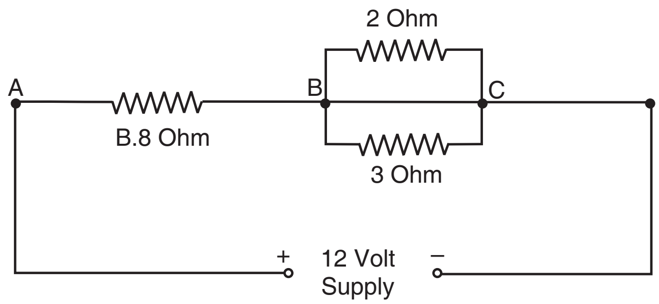

Fig. 5.12

5.8 WHAT HAVE YOU LEARNT

In this lesson, on basic electronics, you have learnt the basic concepts of voltages and currents as applicable to recording equipment. Modern day recording equipments operate on DC voltage sources, obtained either from dry cells or DC supplies obtained from AC mains voltage (220 VAC). Rate of flow of positive charge per unit of time is called conventional current. Magnitude of current through a circuit or part of it, can be determined by use of Ohm's law. According to this law, current in a DC circuit is directly proportional to its applied voltage and inversely proportional to the resistance of the circuit.

All electronic circuits are made up of passive components (resistors, capacitors, diodes and thermistors etc.) and active components (transistors, ICs etc.). These circuits can be analysed if the properties and functions of components are understood. Method of series and parallel combination of resistors and capacitors helps us in finding a suitable combination if the exact replacement of a desired value is not available. By use of colour code, the value of a resistor can be determined easily. Some circuits operate on different supplies. Voltage divider circuits help in providing the desired voltages from the available DC supply source.

Any unwanted signal, getting mixed with wanted signal, is termed as interfering signal. This interfering signal can be due to circuit noise generated by components, RF pickup from a radio transmitter or power hum from AC mains. Many of these noise sources can be controlled by careful design, selecting of proper components, shielding and filtering. By taking necessary steps, like earthing of equipments by providing low resistance paths to nearest earth electrode and use of good quality shielded cables, the problems due to bad earthing can be solved. Necessary precautions and steps to be taken while carrying out adjustments and alignments have also been described.

5.9 ANSWERS TO IN-TEXT QUESTIONS

5.1

According to Ohm's law current flowing through the circuit = Voltage Applied / Resistance of the circuit. Therefore, Current I = 12/300 Ampere = 12X1000/300 m A = **40 m A**

5.2

Using the colour code we can find its value as follows:

First band = Yellow = 4

Second Band =Violet = 7

Third Band (multiplier) = Yellow = X 10 K

Fourth Band (Tolerance) = Red = 2%

Hence the Value of Resistor is = 47 × 10K= **470 K with tolerance of +/- 2%**

5.3

(a) [F] (b) [T] (c) [T] (d) [T] (e) [T]

5.10 ANSWERS TO TERMINAL QUESTIONS

1. (Refer Figure 5.3 for circuit drawing)

Let shunt resistance value be R1Ω. Since coil resistance is 200 Ω. Therefore R2 is 200 Ω. Since Full Scale Deflection of meter is 1mA, therefore Iout = 1mA.

Now, Since

Iout= $(R_1/R_1+R_2) \times I_{in}$

Therefore, 1mA = $(R_1/R_1+200) \times 1000$mA

Therefore, R1+200 = 1000 R1

Therefore 999R1 = 200

Therefore R1 (Shunt Resistance) = 200/999 = **0.2 Ω** (approx).

You must note that, R2 is coil resistance and not some individual discrete component.

2.

(i) Resistance between B& C. Using the formula 1/R = !/R1 +1/R2, we get 1/R = ½ +1/3 = (2+3)/6 = 5/6 or R = 6/5 = **1.2 Ohm**

(ii) Resistance between A& C = Resistance between A&B +Resistance between B&C = 3.8 +1.2 = **5 Ohm**

(iii) Total current in circuit = Voltage between A &C / Resistance between A &C = 12V/5 Ohm = **2.4 Ampere**

(iv) Voltage drop from A to B = Current flowing between A&B x Resistance between A&B = 2.4x 3.8 = **9.12 V**

(v) Voltage drop across B&C = Voltage across A&C – Voltage across A& B = 12V-9.12V = **2.88 V**

(vi) Current in 3 Ohm resistor = Voltage across B&C /Resistance =2.88/ 3 **=0.96 Ampere**