CHAPTER TWO

2.1 LITERATURE REVIEW

This chapter explains the literature review of the previous project work on electrical extension box, its relevance and the detailed explanation of each of the major components that is used to achieve the results.

2.2 HISTORY OF AN ELECTRICAL EXTENSION BOX

Sockets for portable appliances started becoming available in the 1880s. A proliferation of types developed to address the issues of convenience and protection from electric shock. Today there are approximately 20 types in common use around the world and many obsolete socket types are still found in older buildings. When electricity was introduced into houses in the 1880s, it was primarily used for lighting. One common approach for other appliances (such as vacuum cleaners, electric fans, smoothing irons and curling tong heaters) was to connect to light bulb sockets using lamp holder plugs.[1] However, in Britain, there were recognizable two pin plugs and wall sockets appearing on the market as early as 1885.

As electricity became a common method of operating labor-saving appliances, a safe means of connection to the electric system other than using a light socket was needed. Thomas Tayler Smith, of London, received British patent 4162 in 1882 for an "Electric-Circuit Connection" to "enable the electric conductors conveying the current to one or more lamps, or along a flexible cord, to be rapidly and safely brought into connection with the line or main wires". Smith subsequently received U.S. Patent 311,616 for the same device in 1885.

According to British Author [2] there were British patents for plug and sockets granted to T.T. Smith in 1883 (No. 3883) and W. B. Sayers & G. Hookham in 1884, (No. 16655). Mellanby also writes that there were two-pin designs by 1885, one of which appears in the General Electric Company catalogue of 1889. Gustav Binswanger, a German immigrant who founded the General Electric Company, obtained a patent (GB189516898) in 1895 for a plug and socket using a concentric (co-axial) contact system.

Harvey Hubbell, On 26 February 1903, invented several early American electrical plug and socket arrangements, he filed two patent applications featuring 2-pin plugs and adaptors for using his plugs with existing designs of lamp sockets and wall receptacles [3]. Hubbell's first plug design had two round pins which differed from those already in use in Europe in that the tips of the pins had annular detents similar to those of present-day jack plugs to positively retain a plug in its socket. In one patent, U.S. Patent 774,250 a plug was used with a socket which screwed into a lamp holder (like the early lamp holder plugs). In the other patent U.S. Patent 776,326 the same type of plug was used with various three-way adaptors that could be connected to lampholders or "a receptacle of any ordinary type".

Hubbell evidently soon found the round pin design unsatisfactory as a subsequent U.S. Patent 774,251 filed on May 27, 1904 shows lamp holder adaptors similar to those of his first patent for use with plugs having coplanar (tandem) flat pins. Hubbell's catalogue of 1906 includes various three-way adaptors similar to those shown in the US 776,326 patent, but modified for use with the coplanar flat pin plugs.[4] The Chapman receptacle must have been in general use at the time, as it was the only type of non-lamp holder receptacle for which adaptors were supplied. The 1906 catalogue says of the Chapman adaptor: "The device avoids fastening the cords together as is necessary with the ordinary Chapman plug when used for more than one purpose." This suggests that Hubbell's original invention was prompted by his observation of the problem that arose with the use of this sort of receptacle and plug. Gradually wall sockets were developed to supplement those that screwed into lampholders.[5]

In 1912, Hubbell rotated his tandem pins by 90 degrees to arrive at the parallel flat pin configuration still widely used today (NEMA 1-15). A feature common to all of Hubbell's patented designs is the provision of detents to retain a plug in its socket. This would have been a desirable feature in the days before wall receptacles became widespread and, for many consumers, the only source of electricity was an electric light socket. Despite Hubbel's objections, other manufacturers adopted the Hubbell pattern (omitting Hubbell's detents as these did not affect interchangeability) and by 1915 the use of Hubbell's configuration was widespread.

In 1919, Hubbell unsuccessfully attempted to get an injunction to prevent other manufacturers from making receptacles and plugs to the dimensions used by himself.

The report of the court proceedings [6] includes a comprehensive review of the development of the art in the US prior to 1919, based on evidence presented to the Court. Separable plugs had been available for more than a decade prior to Hubbell's 1904 design.

The earliest presented to the court was the "Weston", (U.S. Patent 480,900 issued August 16, 1892, for which Hubbell had taken out a licence), another (unidentified) type following in 1897. Plugs per se with parallel flat pins, such as the "Fort Wayne" design were in common use by 1886, and flush receptacles, such as the "Bryant Electrical Company" design, by 1902. Hubbell had introduced its own parallel flat pin configuration in 1912. In 1915 there were from 15 to 20 different types of blades and from 15 to 30 different types of receptacles. The line of each was not interchangeable with competing lines. .... The existence of both "tandem" and parallel pin configurations had led to the introduction in 1914 of some receptacles having both configurations of slots and others having "T" slots. [7]

By 1915, Hubbell had sold about 13 million receptacles and plug bases/caps with tandem slots/pins, and about 1.25 million with parallel slots/pins, most of which were then still in active use, meaning that Hubbell's configurations were by far the most widely used.[citation needed]

Following the lead set by the lamp manufacturers in standardizing lamp bases, a conference of the plug and receptacle manufacturers, including Hubbell, was arranged with a view to agreeing a standard configuration. It was a time of great expansion in the use of electrical appliances such as fans, heaters, and cookers, as well as portable devices such as hair curlers and irons, and the public wanted interchangeability. Hubbell's parallel pin configuration was preferred, but Hubbell rebelled against standardization, and refused to agree, asserting that it had common law rights in the dimensions of its line. The other conference members pressed on regardless, and agreed to standardize on Hubbell's parallel flat pin configuration and dimensions. Hubbell's court action only served to confirm the legality of their activities, to the great benefit of the U.S. public.

In Britain, a 1911 book [8] dealing with the electrical products of A. P. Lundberg & Sons of London describes the "Tripin" earthed plug available in 2.5 amp and 5 amp models. The pin configuration of the "Tripin" appears virtually identical to modern BS 546 plugs. In her 1914 book electric cooking, heating, cleaning, etc. [8] Maud Lucas Lancaster mentions an earthed iron-clad plug and socket by the English firm of Reyrolle and Co.

The earliest American patent application for an earthed plug appears to be 11 January 1915 by George P. Knapp, on behalf of the Harvey Hubbell Company. U.S. Patent 1,179,728 covers the use of an earthing pin, which extends further than the other two contacts to ensure that it is engaged first. Knapp's design was obsoleted in the U.S. before the modern NEMA designations, but is still used in some other countries including China, Argentina and Australia.

The configuration of the socket was not operable with existing two-contact unearthed plugs. Other earthed sockets that are widely used in the U.S. today are operable with unearthed plugs. It is sometimes claimed (e.g., in Illumin) [9] that the modern American version of the earthed plug, was invented by Philip F. Labre who was issued a U.S. Patent 1,672,067 for an earthed socket and plug in 1928. However, Labre's design is no more similar to the modern version than Knapp's earlier design.

The German Schuko-system plug is believed to date from 1925 and is attributed to Albert Büttner.[10] As the need for safer installations became apparent, earthed three-contact systems were made mandatory in most industrial countries. During the first fifty years of commercial use of electric power, standards developed rapidly based on growing experience. Technical, safety, and economic factors influenced the development of all wiring devices and numerous varieties were invented. After the two-prong electric plug was introduced in the 1920s, the three-pin outlet was developed.

This format was introduced in order to mitigate the effect of a short circuit event, as the supply would be neutralized with earth.[11] Gradually the desire for trade eliminated some standards that had been used in only a few countries. Former colonies may retain the standards of the colonizing country. Sometimes offshore industrial plants or overseas military bases use the wiring practices of their controlling country instead of the surrounding region. Some countries have multiple voltages, frequencies and plug designs in use, which can create inconvenience and safety hazards. Hotels and airports may maintain sockets of foreign standards for the convenience of travelers.

By 2018, there were 15 plug and socket types around the world. [12] De facto standards became formalized as official national and international standards. The earliest was believed to be British Standard 73 Wall plugs and sockets (five ampere (5A) two-pin without earthing connection) which was first published in 1915. The International Electrotechnical Commission in 1934 established technical committee TC 23 for electrical fittings. Only two meetings were held before the outbreak of the Second World War.[13] In mainland Europe, since 1951 the International Commission on the Rules for the Approval of Electrical Equipment (CEE) has published a standard (CEE 7 Specification for Plugs and Socket-Outlets for Domestic and Similar Purposes[13]) describing the plugs and sockets used. In 1953 the CEE published Technical Report 83 (later 60083), which was a listing of plugs and sockets then in use. In North

America, the National Electrical Manufacturers Association (NEMA) publishes standards for plugs and sockets.

The international standard IEC 60884-1 defines the general requirements for plugs and sockets intended for household and similar purposes, IEC 60884-1 does not define specific plug and socket types, which are the subject of national standards in each country. IEC 60884-1 para 9.2 does stipulate "it shall not be possible, within a given system, to engage a plug with a socket-outlet having a higher voltage rating or a lower current rating". IEC 60884-1 para 6.1 defines the preferred voltage ratings for single-phase plugs and sockets as 130 V or 250 V. The foreword of IEC 60884-1 states: in order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.[14]

Consolidation of standards eases international trade and travel. For example, the CEE 7/7 plug has been adopted in several European countries and is compatible with both CEE 7/3 and CEE 7/5 sockets, while the unearthed and unpolarised CEE 7/16 Europlug is compatible with even more European and other socket types. In response to a suggestion that the European Commission introduce a common system across the whole of the European Union, the Commission's Regulatory Fitness and Performance (REFIT) programme issued a report in 2017. The report found that "the harmonisation of plug and socket outlet systems in Europe, by introducing changes in national wiring legislations (would have) important transitional periods (above 75 years)", and that the cost to "replace the old socket-outlets (and the corresponding plugs of the appliances being used)" was estimated at 100 billion Euro, "generating a huge environmental impact, producing some 700 000 tons of electrical waste".[15] The report does not recommend harmonising the plugs and socket-outlet systems in Europe.

IEC 60906-1 was originally published in 1986 as a common standard for plugs and sockets in countries using 230 V that could be accepted by many countries as their national standard, now or in the near future.[15] A modified version is used in Brazil, but IEC 60906-1 has been adopted only in South Africa (in 1993) becoming the "preferred configuration for new installations" in 2013. A statement released by the South African Bureau of Standards in 2016 said that the roll-out of the new standard would be gradual and that the implementation of a new standard could take "[up to] 50 years".[15]

IEC 60906-2 is based on the NEMA 5-15 and NEMA 5-20 plug and socket systems and was originally published in 1992. The object of this part of IEC 60906 is to provide a standard for a safe, compact and practical IEC 125 V system of plugs and socket-outlets that could be accepted by many countries as their national standard, now or in the near future. It is therefore recommended that any country in need of a new or replacement system for the nominal voltage range 100V to 130V a.c. adopt this standard as its only national standard.[15]

Some older industrial buildings in Spain used sockets that took a plug rated for higher current and had two flat contacts and a round earth pin, somewhat similar in design to the ones found on American plugs but larger in size. The two flat contacts are spaced further apart than on an American plug. No domestic appliances were ever sold with these plugs. The line and neutral measure 9 by 2 mm (0.354 by 0.079 in), and are 30 mm (1.181 in) apart. All three pins are 19 mm (0.748 in) long, and the earth pin is a cylinder of 4.8 mm (0.189 in) diameter.

Many older North American sockets have two different current and voltage ratings, most commonly 10 A 250 V/15 A 125 V. This has to do with a peculiarity of the National Electrical Code from 1923 to the 1950s. Originally, sockets were rated at 10 A 250 V, because the NEC limited lighting circuits to 10 A. In 1923, the code changed to allow lighting circuits to be fused at 15 A, but the previous 10 A rule still applied to circuits over 125 V.[15] The higher voltages were rarely used for lighting and appliances. Most sockets with this rating are of the "T-slot" type. Another obsolete socket, made by Bryant, 125 V 15 A and 250 V 10 A rating. A NEMA 5-20 125 V 20 A or 6-20 250 V 20 A plug with a missing earth pin would fit this socket, but a NEMA 2-20 plug is slightly too big to fit.

In Australia, the same or similar T-configuration sockets are used for DC power sockets, such as in stand-alone power systems (SAPS), on boats and in police vehicles. Polarity is inconsistent. In the former Soviet Union, this socket was and still is commonly used for wiring in places where the voltage is lowered for safety purposes, like in schools, filling stations or in wet areas, and is rated 42 V at 10 A AC. Such an unusual connection is intended specifically to make the connection of standard higher-voltage equipment impossible.

The parallel and tandem socket accepts normal parallel NEMA 1-15 plugs and tandem NEMA 2-15 plugs. Both pairs of sockets are fed internally by the same supply. A more recent and common version of this type is the T-slot socket, in which the locations of the tandem and the parallel slots were combined to create T-shaped slots. This version also accepts normal parallel NEMA 1-15 plugs and tandem NEMA 2-15 plugs. Incidentally, a NEMA 5-20, NEMA 6-15, or NEMA 6-20 plug with a missing earth pin would fit this socket. This receptacle type has been unavailable at retail since the 1960s but still available from the manufacturer Leviton (model 5000-I) for replacement only and not for new installations.

Harvey Hubbell had patented the parallel blade plug in 1913, and patented a polarized version in 1916. He also patented the T-slot single outlet in 1915, and a duplex T-slot outlet in 1916 both meant to take his older 1904 tandem and newer parallel plug design. (Single: U.S. Patent 1,146,938; Duplex: U.S. Patent 1,210,176). Prior to the 1930s, when Hubbell's parallel blade plug received its official rating of 125v (and became the United States' general service electrical plug standard), all of his electrical connectors were used interchangeably on either 120 V or 240 V. The two blade tandem configuration plug received its official rating of 250 V in the 1950s but has been "banned" from use since the 1960s because of its lack of a ground or neutral.[citation needed]

The Tripoliki was virtually abandoned by the 1980s, but can still be found in unrenovated houses constructed before 1980. Previous to the large-scale adoption of Schuko plugs, this was the only way to use an earthed appliance in Greece. It can accept Europlugs, and also (but with no earth connection possible) French and German types.

2.3 COMPONENTS USED FOR THE PROJECT

For this project to be complete, there is a need to know the components used in the design. In electronics, the power system is designed in such a way that the equipment always has power so that it can function effectively. These components include:

- Resistor
- Transistor
- Transformer
- Switch
- Fuse
- Liquid crystal display (LCD)

- 13A sockets
- Rectifier
- Capacitor

2.3.1 CAPACITORS

Capacitor is a passive component that consists of two conducting surfaces separated by a layer of an insulating medium called di-electric. They are usually used to store electric charges.

2.3.2 CERAMIC CAPACITORS

Ceramic capacitor are the common types of capacitors used in most of the electrical instruments, as they are more reliable and cheaper manufacture.

These capacitors consist of ceramic or porcelain discs and are said to exist in a non-polarized from which is used in various types of industries. Ceramic material is known to be an excellent dielectric because of its poor conductivity and an efficient of the electrostatic fields.

2.3.3 ELECTROLYTIC CAPACITOR

An electrolytic capacitor is a type of capacitor that uses an electrolyte to achieve a larger capacitance than capacitor other capacitor types. An electrolyte is a liquid or gel containing a high concentration. Almost all-electrolytic capacitor are polarized, which means that the voltage on the positive terminal must always be greater than the voltage on the negative terminal.

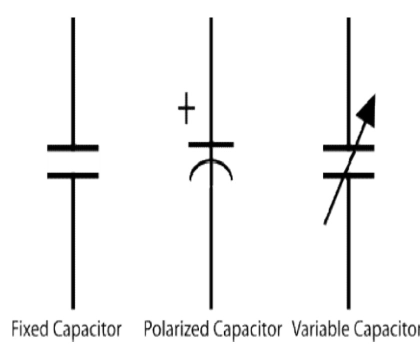

Fig.2.1 symbols of a capacitor

2.3.4 REGULATORS

A LM79805 regulator is a three terminal positive regulator with 5V fixed output voltage. The fixed regulator provides a local regulation, internal current limiting, thermal shut-down control, and safe area protection. Atypical diagram of a Regulator is shown in Fig. 2.3.

Fig. 2.2 A Regulator

2.3.5 RESISTORS

Resistors are passive elements used to oppose the flow of electricity in a circuit. The resistance of a resistor is measured in ohms. They are used to limit the current in the circuit and as a potential divider to achieve a specific value of voltage across a terminal. Resistors are either fixed or variable. A typical symbol of a resistor is shown in Fig. 2.3

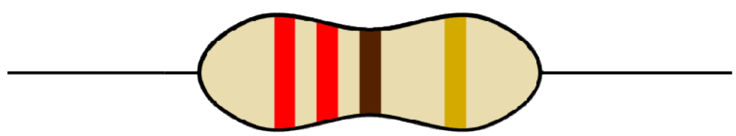

Fig. 2.3 Resistor

2.3.7 CRYSTAL OSCILLATOR

A crystal oscillator is an electronic circuit that uses the mechanical resonance vibrating crystal of piezoelectric material to create an electric signal with a precise frequency. This is often used to stabilize frequencies for radio transmitters and receivers. A typical diagram of crystal oscillator is shown in Fig. 2.4

Fig. 2.4 Crystal Oscillator

2.3.8 TRANSFORMER

A current is a passive component that transfers electrical energy from one electrical circuit to another circuit, or multiple circuit. A varying current in any one coil of the transformer produces a varying magnetic flux in the transformer's core, which induces a varying electromotive force across any other coils wound around the same core.

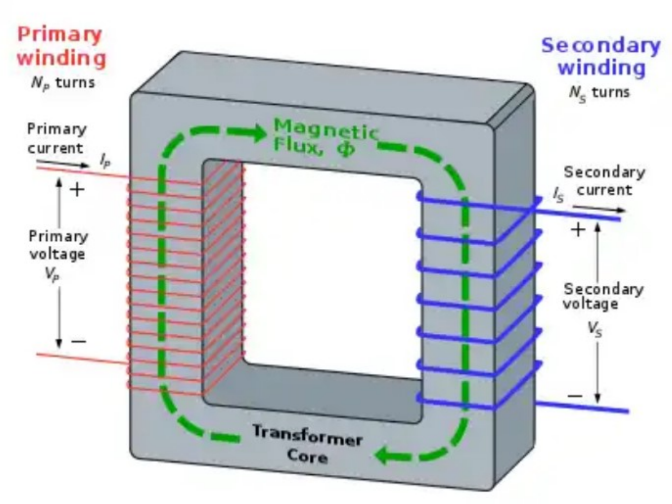

Fig. 2.5 Transformer winding

2.3.9 SWITCH

This electrical component can disconnect or connect the conducting path in an electrical circuit interrupting the electric current or diverting it from one conductor to another. The most common type of switch is an electromechanically device consisting of one or more sets of movable electrical contacts connected t external circuits, when a pair of contacts is touching current can pass between them, while when the contacts are separated, no current flow.

Fig.2.6   A typical switched socket

2.3.10 FUSE

This is an electrical safety device that operates to provide overcurrent protection of an electrical circuit. Its essential component is a metal wire or strip that melts when too much current flows through it, thereby stopping or interrupting the current.

Fig.2.7   A fuse

2.3.11 LIQUID CRYSTAL DISPLAY

This is a flat panel display or electronically modulate optical device that uses the light – modulating properties of a liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour or monochrome.

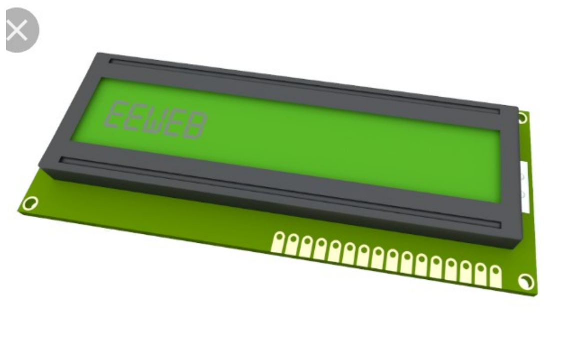

Fig.2.8 Liquid crystal display

2.3.12 13A SOCKET

This is a three (3) outlet with a (live, Neutral and Earth), it accommodates different electrical devices and aid their connections to the electricity before they can function properly. It helps in the connection of appliances rated between 700W and 3000W e.g dishwasher, micro wave, kettle, toaster machine, Iron e.t.c

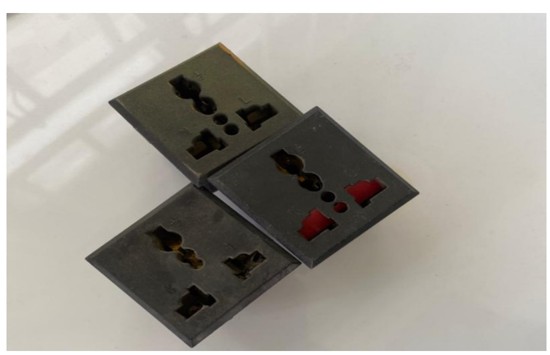

Fig.2.9 A typical 13A sockets

2.3.13 UNIVERSAL SERIAL BUS (PORT)

USB connectors have become the standard connection method for devices such as keyboards, game pads & joysticks, scanners, digital cameras, printers and external hard drives.
Although designed for personal computers USB has become commonplace on other devices such as mobile phones, tablets, video game consoles, AC power adaptors, memory sticks and mobile internet access dongles

Fig.2.10 USB port

2.3.14 LITHIUM BATTERY

A lithium battery or a Li-ion battery is a type of rechargeable battery composed of cells in which lithium ions move from the negative electrode through an electrolyte to the positive electrode during discharge and when charging. The figure below shows a lithium battery

Fig.2.11 A lithium battery

2.3.15 RELAY

A relay is an electrically operated or electromechanical switch composed of an electromagnet, an armature, a spring and a set of electrical constants. The electromagnetic switch is operated by a small electrical current that turns a larger current on or off by either releasing or retracting the armature constant, thereby cutting or completing the circuit.

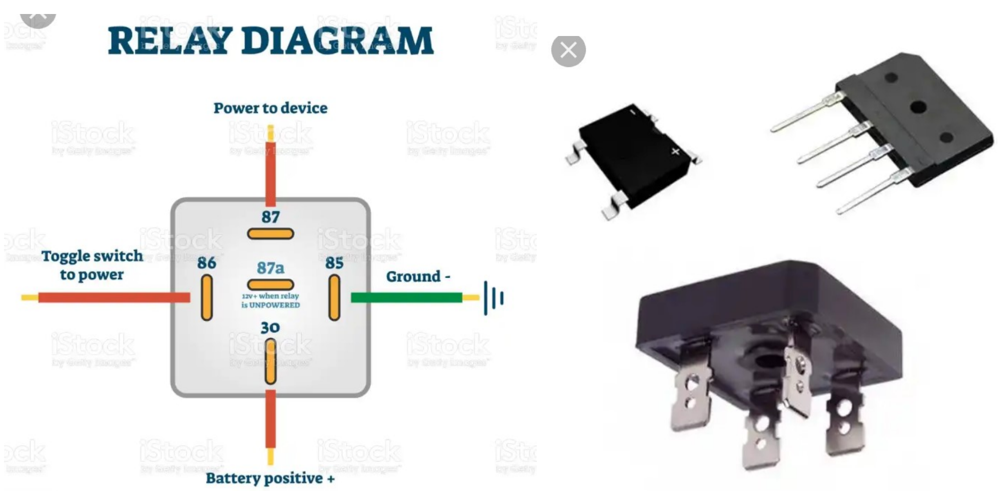

Fig.2.12 Relay

2.3.16 TRANSISTOR

Transistor are active component of integrated circuits, or ‘microchips,’ which often contain billions of these minuscule devices etched into their shiny surfaces. Deeply embedded in almost everything electronic, transistors have become the nerve cells of the information Age.

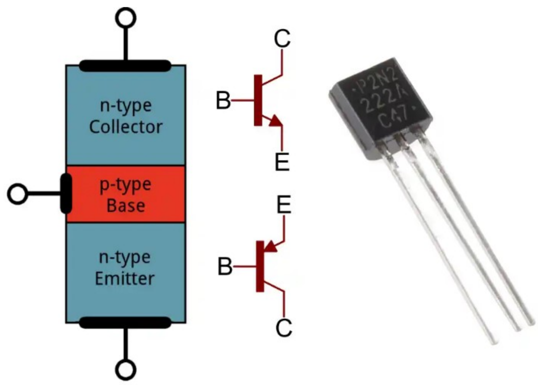

Fig.2.13 Transistor

2.3.17. RECTIFIER

A rectifier is a device that converts an oscillating two-directional alternating current (AC) into a single-directional direct current (DC). AC power is available at low cost. DC power is more expensive to produce. Therefore, a method of changing ac to dc is needed as an inexpensive dc source. AC power can be converted to DC power using rectifiers When ac power is converted to dc power using rectifiers, dc output contains un wanted alternating current components known as ripple. Many rectifier applications need that the ripple do not exceed a specified value. If the ripple exceeds the specified value, different unwanted effects appear in the system. Some of the unwanted effects are stray heating and audible noise. The ripple can be reduced using an output filter.

Fig.2.15 Rectifier