NEAR EAST UNIVERSTY

Faculty of Engineering

Department of Electric and Electronic Engineering

SCHOOL ILLUMINATION

Graduation Project

EE-400

Student: C. Azmi Sakarya(20020620)

Supervisor: Assist. Prof. Dr. Özgür C. Özerdem

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Special thanks to Hasan who is an engineer in ELSİS LTD. with his help,I have learned autocad and and how to use my skills better.Thanks to facult of Engıneering for having such a good computational environment.

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Finally,I want to thanks m family,especially my brother and my fiancee.Without their endless support and love for me.I would never achive my current position.I wish my family lives happily always and my parents in the heaven be proud of me….

ABSTRACT

The make an illumination project is one of the important subject for an electric engineers.Because illumination of an area is the most important thing for us to continue our daily life.It should be perfect to take maximum efficiency

The main objective of this thesis is to provide perfect illumination for the area choosen.In order to do that I followed three main step at the beginning..The place where we shall do an illumination,the effective illumination and the environment after illumination

The first part in my project; is a primary school,so i have to use neither very high light intensity nor very low because the ages of students are small so their eyes are very sensitive.There must not be glazing..

The second part is more difficult;choosing the ideal armature type for the school.Because the place where I would make the project is shool so it must be good armature type for the kids.So I had choosed flourescent lamps while I was making the project.Flourescent lamps are very effective,convenient for lighting the school.They will give enough light for them and they would be esthetic for the place also their life time is long so their maintance woluld be easier..The third part is about after illumination .The environment after illumination is good and convenient for education and the health of the humans in the school.They will be in comfortable and esthetic places when they are in school.also for their usage I used many switch boxes so they can control the lightining easier ..

İn illumination projects one thing should not be forgotten;this was to make the business with the lowest cost price.If you dıd not make the project properly,the cost vill be higher than expected so no company would accept this.

In order to achieve this; I considered every detail and the step of the project very carefully...

INTRODUCTION

Illumination includes both artificial light sources such as lamps and natural illumination of interiors from daylight. Lighting represents a major component of energy consumption, accounting for a significant part of all energy consumed worldwide. Artificial lighting is provided today by electric lights, but previously by Gas lighting, candles or oil lamps. Proper lighting can enhance task performance or aesthetics, while there can be energy wastage and adverse health effects of lighting. Indoor lighting is a form of fixture or furnishing, and a key part of interior design. Lighting can also be an intrinsic component of landscaping.While we are making the illumination project ;choosing the ideal armatures (the lamp types) and the cost of the project that we have to give to the ones whom ordered to do...Both of those two things have to be perfect to make the bussines..This Thesis is aimed to provide the analysis and systemation of the illımination project.

The first chapter is consist on what iilumination is;the types of it and of illumination.İn this chapter I tried to explain the basic of illunination and the preparation of it.Chapter two is consist on the generalization of the illumination sources,wheather natural or human made..The general aim of the sources in illumination.Chapter three is about the natural sources that have been allways existed in the universe like the sun or stars..What they are and how they illuminate us.Chapter four is consist on the important illumination obejct,the flourescent lamps.The history,principles and the methods of flourescent lamps..Why they are so important and usefull for us in illumination.

Chapter five is about the normal lamps like incondescent and halogens lamps and the others.Their historical information,operation types,their efficiency in illumination for us.Chapter six to chapter nine is consist on the switches.the plugs,the cables ,mccb and the other objects that have to be known and used in electrical illunination project.Their aims,history and types ..Chapter ten is about the illumination calculations for preparing this project Chapter eleven and twelve is about the cost and voltage drop calculation while we were making this illumination project

CHAPTER ONE
ILLUMINATION

1.1 Overview

In this chapter i tried to explain what is illumination,the types of it,illumination methods and the general ideas about the illumination.

1.2 What Is Illumination

Illumination includes both artificial light sources such as lamps and natural illumination of interiors from daylight. Lighting represents a major component of energy consumption, accounting for a significant part of all energy consumed worldwide. Artificial lighting is provided today by electric lights, but previously by Gas lighting, candles or oil lamps. Proper lighting can enhance task performance or aesthetics, while there can be energy wastage and adverse health effects of lighting. Indoor lighting is a form of fixture or furnishing, and a key part of interior design. Lighting can also be an intrinsic component of landscaping.

Lighting fixtures come in a wide variety of styles for various functions. Some are very plain and functional, while some are pieces of art in themselves. Nearly any material can be used, so long as it can tolerate the heat and is in keeping with safety codes.

Proper selection of fixtures is complicated by the requirement to minimize the veiling reflections off of printed material. Since the exact orientation of printed material may not be closed controlled, a visual comfort probability can be calculated for a given set of lighting fixtures.

1.3 Types

Lighting types are classified by intended use as general, localized, or task lighting, depending largely on the distribution of the light produced by the fixture.General lighting fills in between the two and is intended for general illumination of an area. Indoors, this would be a basic lamp on a table or floor, or a fixture on the ceiling. Outdoors, general lighting for a parking lot may be as low as 10-20 lux (1-2 footcandles) since pedestrians and motorists already used to the dark will need little light for crossing the area.

Task lighting is mainly functional and is usually the most concentrated, for purposes such as reading or inspection of materials. For example, reading poor-quality reproductions may require task lighting levels up to 1500 lux (150 footcandles), and some inspection tasks or surgical procedures require even higher levels.

Figure 1.1 Illumination area

Accent lighting is mainly decorative, intended to highlight pictures, plants, or other elements of interior design or landscaping

1.4 Methods

Downlighting is most common, with fixtures on or recessed in the ceiling casting light downward. This tends to be the most used method, used in both offices and homes. Although it is easy to design it has dramatic problems with glare and excess energy consumption due to large number of fittings.

Uplighting is less common, often used to bounce indirect light off of the ceiling and back down. It is commonly used in lighting applications that require minimal glare and uniform general illuminance levels. Uplighting (indirect) uses a diffuse surface to reflect light in a space and can minimize disabling glare on computer displays and other dark glossy surfaces. It gives a more uniform presentation of the light output in operation.

Front lighting is also quite common, but tends to make the subject look flat as its casts almost no visible shadows. Lighting from the side is the less common, as it tends to produce glare near eye level. Backlighting either around or through an object is mainly for accent.

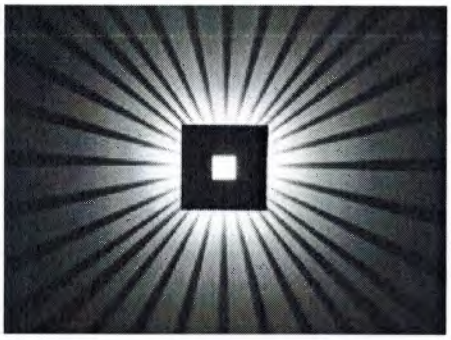


Figure 1.2 Wall-mounted light with shadows.

Forms of Lighting include alcove lighting, which like most other uplighting is indirect. This is often done with fluorescent lighting or rope light, or occasionally with neon lighting. It is a form of backlighting.
Soffit or close to wall lighting can be general or a decorative wall-wash, sometimes used to bring out texture (like stucco or plaster) on a wall, though this may also show its defects as well. The effect depends heavily on the exact type of lighting source used.

Recessed lighting (often called "pot lights" in Canada, "can lights" or 'high hats" in the U.S.) is popular, with fixtures mounted into the ceiling structure so as to appear flush with it. These downlights can use narrow beam spotlights, or wider-angle floodlights, both of which are bulbs having their own reflectors. There are also downlights with internal reflectors designed to accept common 'A' lamps (light bulbs) which are generally less costly than reflector lamps. Downlights can be incandescent, fluorescent, HID (high intensity discharge) or LED, though only reflector incandescent or HID lamps are available in spot configuration.

Track lighting, invented by Lightolier, was popular at one point because it was much easier to install then recessed lighting, and individual fixtures are decorative and can be easily aimed at a wall. It has regained some popularity recently in low-voltage tracks, which often look nothing like their predecessors because they do not have the safety issues that line-voltage systems have, and are therefore less bulky and more ornamental in themselves. A master transformer feeds all of the fixtures on the track or rod with 12 or 24 volts, instead of each light fixture having its own line-to-low voltage transformer. There are traditional spots and floods, as well as other small hanging fixtures. A modified version of this is cable lighting, where lights are hung from or clipped to bare metal cables under tension.

A sconce is a wall-mounted fixture, particularly one that shines up and sometimes down as well. A torchiere (tour-she-AIR or tour-SHARE) is an uplight intended for ambient lighting. It is typically a floor lamp but may be wall-mounted like a sconce.

The portable or table lamp is probably the most common fixture, found in every home and many offices. The standard lamp and shade that sits on a table is general lighting, while the desk lamp is considered task lighting. Magnifier lamps are also task lighting.

The illuminated ceiling was once popular in the 1960s and 1970s but fell out of favor after the 1980s. This uses diffuser panels hung like a suspended ceiling below fluorescent lights, and is considered general lighting. Other forms include neon, which is not usually intended to illuminate anything else, but to actually be an artwork in itself. This would probably fall under accent lighting, though in a dark nightclub it could be considered general lighting. Underwater accent lighting is also used for koi ponds , fountains, swimming pools and the like.

In a movie theater each step in the aisles is usually marked with a row of small lights, for convenience and safety when the film has started, hence the other lights are off. Traditionally made up of small low wattage, low voltage lamps in a track or translucent tube, these are rapidly being replaced with LED based versions.

1.5 Vehicle Use

Vehicles typically include headlights and tail lights. Headlights are white or yellow lights placed in the front of the vehicle, designed to illuminate the upcoming road and to make the vehicle more visible. Tail lights are always red and are placed in the rear to quickly alert other drivers about the vehicle's direction of travel. The white portion of the tail light is the back-up lamp, which when lit, is used to indicate that the vehicle's transmission has been placed in the reverse gear, warning anyone behind the vehicle that it is moving backwards, or about to do so.

In addition to lighting for useful purposes, and early 1970s, manufacturers would sometimes backlight their logos and or other translucent panelling. In the 1990s, a popular trend was to customize vehicles with neon lighting, especially underneath the body of a car. In the 2000s, neon lighting is increasingly yielding to digital vehicle lighting, in which bright LEDs are placed on the car and operated by a computer which can be customized and programmed to display a range of changing patterns and colors, a technology borrowed from Christmas lights.

Figure 1.3 Design

Lighting design as it applies to the built environment, also known as 'architectural lighting design', is both a science and an art. Comprehensive lighting design requires consideration of the amount of functional light provided, the energy consumed, as well as the aesthetic impact supplied by the lighting system. Some buildings, like surgical centers and sports facilities, are primarily concerned with providing the appropriate amount of light for the associated task. Some buildings, like warehouses and office buildings, are primarily concerned with saving money through the energy efficiency of the lighting system. Other buildings, like casinos and theatres, are primarily concerned with enhancing the appearance and emotional impact of architecture through lighting systems. Therefore, it is important that the sciences of light production and luminaire photometrics are balanced with the artistic application of light as a medium in our built environment. These electrical lighting systems should also consider the impacts of, and ideally be integrated with, daylighting systems. Factors involved in lighting design are essentially the same as those discussed above in energy conservation analysis.

Mathematical modeling is normally used for complex lighting design, whereas, for simple configurations, tables and simple hand calculations can be used. Based on the positions and mounting heights of the fixtures, and their photometric characteristics, the proposed lighting layout can be checked for uniformity and quantity of illumination. For larger projects or those with irregular floor plans, lighting design software can be used. Each fixture has its location entered, and the reflectance of walls, ceiling, and floors can be entered. The computer program will then produce a set of contour charts overlaid on the project floor plan, showing the light level to be expected at the working height. More advanced programs can include the effect of light from windows or skylights, allowing further optimization of the operating cost of the lighting installation.

The Zonal Cavity Method is used as a basis for both hand, tabulated, and computer calculations. This method uses the reflectance coefficients of room surfaces to model the contribution to useful illumination at the working level of the room due to light reflected from the walls and the ceiling. Simplified photometric values are usually given by fixture manufacturers for use in this method.

Computer modelling of outdoor flood lighting usually proceeds directly from photometric data. The total lighting power of a lamp is divided into small solid angular regions. Each region is extended to the surface which is to be lit and the area calculated, giving the light power per unit of area. Where multiple lamps are used to illuminate the same area, each one's contribution is summed. Again the tabulated light levels (in lux or foot-candles) can be presented as contour lines of constant lighting value, overlaid on the project plan drawing. Hand calculations might only be required at a few points, but computer calculations allow a better estimate of the uniformity and lighting level.

Practical lighting design must take into account the gradual decrease in light levels from each lamp owing to lamp aging, lamp burnout, and dirt accumulation on fixture and lamp surfaces. Empirically-established depreciation factors are listed in lighting design handbooks.

1.6 Energy Consumption

Artificial lighting consumes a significant part of all electrical energy consumed worldwide. In homes and offices from 20 to 50 percent of total energy consumed is due to lighting (Hawkin, 2000). Most importantly, for some buildings over 90 percent of lighting energy consumed can be an unnecessary expense through over-illumination (Hawken, 2000). Thus lighting represents a critical component of energy use today, especially in large office buildings where there are many alternatives for energy utilization in lighting. There are several strategies available to minimize energy requirements in any building:

Specification of illumination requirements for each given use area.
analysis of lighting quality to insure that adverse components of lighting (for example, glare or incorrect color spectrum) are not biasing the design.
Integration of space planning and interior architecture (including choice of interior surfaces and room geometries) to lighting design.
Design of time of day use that does not expend unnecessary energy.
Selection of fixture and lamp types that reflect best available technology for energy conservation.

Training of building occupants to utilize lighting equipment in most efficient manner. Maintenance of lighting systems to minimize energy wastage.

1.7 Health Effects

It is valuable to provide the correct light intensity and color spectrum for each task or environment. Otherwise, energy not only could be wasted but over-illumination can lead to adverse health and psychological effects.
Specification of illumination requirements is the basic concept of deciding how much illumination is required for a given task. Clearly, much less light is required to illuminate a hallway or bathroom compared to that needed for a word processing work station. Prior to 1970 (and too often even today), a lighting engineer would simply apply the same level of illumination design to all parts of the building without considering usage. Generally speaking, the

energy expended is proportional to the design illumination level. For example, a lighting level of 80 footcandles might be chosen for a work environment involving meeting rooms and conferences, whereas a level of 40 footcandles could be selected for building hallways. If the hallway standard simply emulates the conference room needs, then twice the amount of energy will be consumed as is needed for hallways. Unfortunately, most of the lighting standards even today have been specified by industrial groups who manufacture and sell lighting, so that a historical commercial bias exists in designing most building lighting, especially for office and industrial settings. Beyond the energy factors being considered, it is important not to over-design illumination, lest adverse health effects such as headache frequency, stress, and increased blood pressure be induced by the higher lighting levels. In addition, glare or excess light can decrease worker efficiency (DiLouie, 2006).

Analysis of lighting quality particularly emphasizes use of natural lighting, but also considers spectral content if artificial light is to be used. Not only will greater reliance on natural light reduce energy consumption, but will favorably impact human health and performance. For example, it is clear that student test scores are improved for children who learn in the presence of greater natural light (Bain, 1997). Artificial nightlighting has been associated with irregular menstrual cycles.

1.8 Timeline Of Lighting Technology

Since the world began, people used the sun as their main source of light.

70,000BC A whole rock or shell or other natural found objects was filled with moss or a similar material that was soaked in animal fat and then ignited

circa 3000 BC candles are invented.

circa 400 BC oil lamps

- 1780 Aimé Argand invents central draught fixed oil lamp
- 1784 Argand adds glass chimney to central draught lamp
- 1792 William Murdoch begins experimenting with gas lighting and probably produced the first gas light in this year.
- 1802 William Murdoch illuminated the exterior of the Soho Foundry with gas.

- 1805 Phillips and Lee's Cotton Mill, Manchester was the first industrial factory to be fully lit by gas.
- 1813 National Heat and Light Company formed by Fredrich Winzer (Winsor).
- 1802 Humphry Davy demonstrates arc-lighting in free air.
- 1815 Humphry Davy invents the miner's safety lamp.
- 1835 James Bowman Lindsay demonstrates a light bulb based electric lighting system to the citizens of Dundee.
- 1840 first kerosene lamps (oil lamps that burn fuel from petroleum)
- 1841 Arc-lighting used as experimental public lighting in Paris
- 1853 Ignacy Lukasiewicz invents petrol lamp
- 1854 Heinrich Göbel invents the first incandescent lamp by passing an electric current through a carbonized bamboo filament that was placed inside of a glass bulb
- 1856 glassblower Heinrich Geissler confines the electric arc in a tube.
- 1867 A. E. Becquerel demonstrates the first fluorescent lamp
- 1875 Henry Woodward patents the electric light bulb.
- 1876 Pavel Yablochkov invents the Yablochkov candle, the first practical carbon arc lamp, for public street lighting in Paris.
- 1879 Thomas Edison and Joseph Wilson Swan patent the carbon-thread incandescent lamp.
- 1880 Edison produced a 16 watt lightbulb that lasts 1500 hours.
- 1889 Incandescent gas mantle invented, revolutionises gas lighting.
- 1893 Nikola Tesla uses cordless low pressure gas discharge lamps, powered by a high frequency electric field, to light his laboratory. He displays fluorescent lamps and neon lamps at the World Columbian Exposition.
- 1894 D. McFarlane Moore creates the Moore tube, precursor of electric gas-discharge lamps.
- 1897 Walther Nernst invents and patents his incandescent lamp, based on solid state electrolytes.
- 1901 Peter Cooper Hewitt demonstrates the mercury-vapor lamp.

- 1911 Georges Claude develops the neon lamp.
- 1925 The first internal frosted lightbulbs were produced.
- 1926 Edmund Germer patents the fluorescent lamp.
- 1962 Nick Holonyak Jr. develops the first practical visible-spectrum light-emitting diode
- 1991 Philips invents a fluorescent lightbulb that lasts 60,000 hours. The bulb uses magnetic induction.
- 1994 First commercial sulfur lamp.

CHAPTER TW0
LIST OF LIGHT SOURCES

2.1 Overview

This is a list of sources of light, including both natural and artificial sources, and both processes and devices

2.2 Lightning spectacular source of illumination.

i. Astronomical objects

- Stars
- Star clusters
- Galaxies
- Nebulae
- Bioluminescence
- Glowworms
- Aequorea victoria (a type of jellyfish)
- Antarctic krill
- Lux operon
- Lightning
- Aurorae
- Sunlight
- Skylight
- Moonlight
- Triboluminescence

ii. Direct chemical

- Chemoluminescence (Lightsticks)
- Fluorescence
- Phosphorescence
- Combustion-based
- Argon flash
- Acetylene/Carbide lamps
- Betty lamp

- Butter lamp
- Candles

iii. Fire

- Gas lighting
- Kerosene lamps
- Lanterns
- Limelights
- Oil lamps
- Rushlights
- Safety lamps
- Davy lamps
- Geordie lamps
- Torches

iv. Electric

- Arc lamps
- Yablochkov candles
- Incandescent lamps
- Carbon button lamp
- Conventional incandescent light bulbs
- Flashlight
- Globar
- Nernst lamp
- Electroluminescent (EL) lamps
- Light-emitting diodes
- Organic light-emitting diodes
- Polymer light-emitting diodes
- Solid-state lighting
- LED lamp

v. A standard houshold Compact fluorescent lamp.

- Fluorescent lamps
- Compact fluorescent lamps
- Black light
- Inductive lighting
- Hollow cathode lamp
- Neon and argon lamps
- Plasma lamps
- Xenon flash lamps
- High-intensity discharge lamps
- Ceramic discharge metal halide lamps
- Hydrargyrum medium-arc iodide (HMI) lamps
- Mercury-vapor lamps
- Metal halide lamps
- Sodium vapor lamps

CHAPTER THREE
NEUTRAL LIGHT SOURCES

3.1 Overview

This chapter includes the neutral lighy sources,what they are,how does they effect our lifes.

3.2 Star

A star is a massive, luminous ball of plasma. Stars group together to form galaxies, and they dominate the visible universe. The nearest star to Earth is the Sun, which is the source of most of the energy on Earth, including daylight. Other stars are visible in the night sky, when they are not outshone by the Sun. A star shines because nuclear fusion in its core releases energy which traverses the star's interior and then radiates into outer space.

Figure 3.1 The Pleiades, an open cluster of stars in the constellation of Taurus. NASA photo

Almost all elements heavier than hydrogen and helium were created inside the cores of stars.Astronomers can determine the mass, age, chemical composition and many other properties of a star by observing its spectrum, luminosity and motion through space. The total mass of a star is the principal determinant in its evolution and eventual fate. Other characteristics of a star that are determined by its evolutionary history include the diameter, rotation, movement and temperature. A plot of the temperature of many stars against their luminosities, known as a Hertzsprung-Russell diagram (H-R diagram), allows the current age and evolutionary state of a particular star to be determined.

A star begins as a collapsing cloud of material that is composed primarily of hydrogen along with some helium and heavier trace elements. Once the stellar core is sufficiently dense, some of the hydrogen is steadily converted into helium through the process of nuclear fusion. The remainder of the star's interior carries energy away from the core through a combination of radiative and convective processes. These processes keep the star from collapsing upon itself and the energy generates a stellar wind at the surface and radiation into outer space.

Once the hydrogen fuel at the core is exhausted, a star of at least 0.4 times the mass of the Sun expands to become a red giant, fusing heavier elements at the core, or in shells around the core. It then evolves into a degenerate form, recycling a portion of the matter into the interstellar environment where it will form a new generation of stars with a higher proportion of heavy elements.

Binary and multi-star systems consist of two or more stars that are gravitationally bound, and generally move around each other in stable orbits. When two such stars have a relatively close [orbit], their gravitational interaction can have a significant impact on their evolution.

3.3 Sunlight

Sunlight in the broad sense is the total spectrum of the electromagnetic radiation given off by the Sun. On Earth, sunlight is filtered through the atmosphere, and the solar radiation is obvious as daylight when the Sun is above the horizon. This is usually during the hours known as day. Near the poles in summer, sunlight also occurs during the hours known as night and in the winter at the poles sunlight may not occur at any time

CHAPTER FOUR
FLOURESCENT LAMPS

4.1 Overview

This is about the flourescent lamps.The types of them,the history, principles of operation in flourescents, Mechanisms of lamp failure at end of life and their usage areas in life.

4.2 Flourescents

A fluorescent lamp is a gas-discharge lamp that uses electricity to excite mercury vapor in argon or neon gas, resulting in a plasma that produces short-wave ultraviolet light. This light then causes a phosphor to fluoresce, producing visible light.Unlike incandescent lamps, fluorescent lamps always require a ballast to regulate the flow of power through the lamp. In common tube fixtures (typically 4 ft (120 cm) or 8 ft (240 cm) in length), the ballast is enclosed in the fixture. Compact fluorescent light bulbs may have a conventional ballast located in the fixture or they may have ballasts integrated in the bulbs, allowing them to be used in lampholders normally used for incandescent lamps.

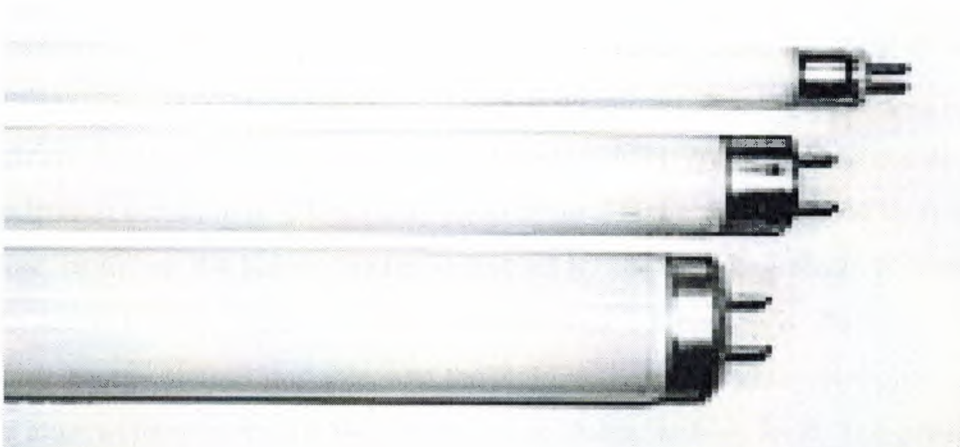


Figure 4.1 Flourescent lapms

4.3 History

The earliest ancestor of the fluorescent lamp is probably the device by Heinrich Geissler who, in 1856, obtained a bluish glow from a gas which was sealed in a tube and excited with an induction coil.At the 1893 World's Fair, the World Columbian Exposition in Chicago, Illinois displayed Nikola Tesla's fluorescent lights.In 1894, D. McFarlane Moore created the Moore lamp, a commercial gas discharge lamp meant to compete with the incandescent light bulb of his former boss Thomas Edison. The gases used were nitrogen and carbon dioxide emitting respectively pink and white light, and had moderate success.

In 1901, Peter Cooper Hewitt demonstrated the mercury-vapor lamp, which emitted light of a blue-green color, and thus was unfit for most practical purposes. It was, however, very close to the modern design, and had much higher efficiency than incandescent lamps.In 1926, Edmund Germer and coworkers proposed to increase the operating pressure within the tube and to coat the tube with fluorescent powder which converts ultraviolet light emitted by an excited plasma into more uniformly white-colored light. Germer is today recognized as the inventor of the fluorescent lamp.General Electric later bought Germer's patent and under the direction of George E. Inman brought the fluorescent lamp to wide commercial use by 1938.

4.4 Principles Of Operation

The main principle of fluorescent tube operation is based around inelastic scattering of electrons. An incident electron (emitted from the coils of wire forming the cathode electrode) collides with an atom in the gas (such as mercury, argon or krypton) used as the ultraviolet emitter. This causes an electron in the atom to temporarily jump up to a higher energy level to absorb some, or all, of the kinetic energy delivered by the colliding electron. This is why the collision is called 'inelastic' as some of the energy is absorbed. This higher energy state is unstable, and the atom will emit an ultraviolet photon as the atom's electron reverts to a lower, more stable, energy level. The photons that are released from the chosen gas mixtures tend to have a wavelength in the ultraviolet part of the spectrum. This is not visible to the human eye, so must be converted into visible light. This is done by making use of fluorescence. This fluorescent conversion occurs in the phosphor coating on the inner surface of the fluorescent tube, where the ultraviolet photons are absorbed by electrons in the phosphor's atoms, causing a similar energy jump, then drop, with emission of a further photon. The photon that is emitted from this second interaction has a lower energy than the one that caused it. The chemicals that make up the phosphor are specially chosen so that these emitted photons are at wavelengths visible to the human eye. The difference in energy between the absorbed ultra-violet photon and the emitted visible light photon goes to heat up the phosphor coatingClose-up of the cathodes and anodes of a germicidal lamp (an essentially-similar design that uses no fluorescent phosphor, allowing the electrodes to be seen.)The unfiltered ultraviolet glow of a germicidal lamp is produced by a low pressure mercury vapor discharge (identical to that in a fluorescent lamp) in an uncoated fused quartz envelope.A fluorescent lamp is filled with a gas containing low pressure mercury vapor and argon (or xenon), or more rarely argon-neon, or sometimes even krypton. The inner surface of the bulb is coated with a fluorescent (and often slightly phosphorescent) coating made of varying blends of metallic and rare-earth phosphor salts. The bulb's cathode is typically made of coiled tungsten which is coated with a mixture of barium, strontium and calcium oxides (chosen to have a relatively low thermionic emission temperature). When the light is turned on, the electric power heats up the cathode enough for it to emit electrons. These electrons collide with and ionize noble gas atoms in the bulb surrounding the filament to form a plasma by a process of impact ionization. As a result of avalanche ionization, the conductivity of the ionized gas rapidly rises, allowing higher currents to flow through the lamp. The mercury, which exists at a stable vapour pressure equilibrium point of about one part per thousand in the inside of the tube (with the noble gas pressure typically being about 0.3% of standard atmospheric pressure), is then likewise ionized, causing it to emit light in the ultraviolet (UV) region of the spectrum predominantly at wavelengths of 253.7 nm and 185 nm. The efficiency of fluorescent lighting owes much to the fact that low pressure mercury discharges emit about 65% of their total light at the 254 nm line (also about 10-20% of the light emitted in UV is at the 185 nm line). The UV light is absorbed by the bulb's fluorescent coating, which re-radiates the energy at lower frequencies (longer wavelengths: two intense lines of 440nm and 546nm wavelength appear on commercial fluorescent tubes) (see stokes shift) to emit visible light. The blend of phosphors controls the color of the light, and along with the bulb's glass prevents the harmful UV light from escaping

A fluorescent lamp is filled with a gas containing low pressure mercury vapor and argon (or xenon), or more rarely argon-neon, or sometimes even krypton. The inner surface of the bulb is coated with a fluorescent (and often slightly phosphorescent) coating made of varying blends of metallic and rare-earth phosphor salts. The bulb's cathode is typically made of coiled tungsten which is coated with a mixture of barium, strontium and calcium oxides

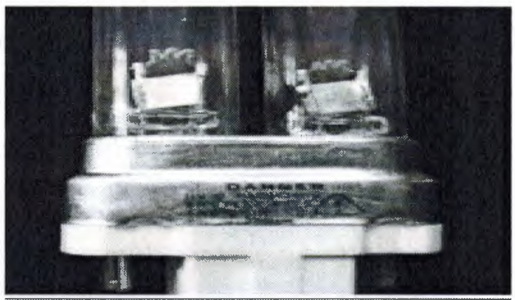


Figure 4.2 Close-up of the cathodes and anodes of a germicidal lamp (an essentially-similar design that uses no fluorescent phosphor, allowing the electrodes to be seen.)

When the light is turned on, the electric power heats up the cathode enough for it to emit electrons. These electrons collide with and ionize noble gas atoms in the bulb surrounding the filament to form a plasma by a process of impact ionization. As a result of avalanche ionization, the conductivity of the ionized gas rapidly rises, allowing higher currents to flow through the lamp. The mercury, which exists at a stable vapour pressure equilibrium point of about one part per thousand in the inside of the tube (with the noble gas pressure typically being about 0.3% of standard atmospheric pressure), is then likewise ionized, causing it to emit light in the ultraviolet (UV) region of the spectrum predominantly at wavelengths of 253.7 nm and 185 nm. The efficiency of fluorescent lighting owes much to the fact that low pressure mercury discharges emit about 65% of their total light at the 254 nm line (also about 10-20% of the light emitted in UV is at the 185 nm line). The UV light is absorbed by the bulb's fluorescent coating, which re-radiates the energy at lower frequencies (longer wavelengths: two intense lines of 440nm and 546nm wavelength appear on commercial fluorescent tubes) (see stokes shift) to emit visible light. The blend of phosphors controls the color of the light, and along with the bulb's glass prevents the harmful UV light from escaping.

4.5 Electrical Aspects Of Operation

Fluorescent lamps are negative resistance devices, so as more current flows through them (more gas ionized), the electrical resistance of the fluorescent lamp drops, allowing even more current to flow. Connected directly to a constant-voltage mains power line, a fluorescent lamp would rapidly self-destruct due to the uncontrolled current flow. To prevent this, fluorescent lamps must use an auxiliary device, commonly called a ballast, to regulate the current flow through the tube.

While the ballast could be (and occasionally is) as simple as a resistor, substantial power is wasted in a resistive ballast so ballasts usually use a reactance (inductor or capacitor) instead. For operation from AC mains voltage, the use of simple inductor (a so-called "magnetic ballast") is common. In countries that use 120 V AC mains, the mains voltage is insufficient to light large fluorescent lamps so the ballast for these larger fluorescent lamps is often a step-up autotransformer with substantial leakage inductance (so as to limit the current flow). Either form of inductive ballast may also include a capacitor for power factor correction.In the past, fluorescent lamps were occasionally run directly from a DC supply of sufficient voltage to strike an arc. In this case, there was no question that the ballast must have been resistive rather than reactive, leading to power losses in the ballast resistor. Also, when operated directly from DC, the polarity of the supply to the lamp must be reversed every time the lamp is started; otherwise, the mercury accumulates at one end of the tube. Nowadays, fluorescent lamps are essentially never operated directly from DC; instead, an inverter converts the DC into AC and provides the current-limiting function as described below for electronic ballasts.

More sophisticated ballasts may employ transistors or other semiconductor components to convert mains voltage into high-frequency AC while also regulating the current flow in the lamp. These are referred to as "electronic ballasts".

Fluorescent lamps which operate directly from mains frequency AC will flicker at twice the mains frequency, since the power being delivered to the lamp drops to zero twice per cycle. This means the light flickers at 120 times per second (Hz) in countries which use 60-cycle-per-second (60 Hz) AC, and 100 times per second in those which use 50 Hz. This same principle can also cause hum from fluorescent lamps, actually from its ballast. Both the annoying hum and flicker are eliminated in lamps which use a high-frequency electronic ballast, such as the increasingly popular compact fluorescent bulb.

Although most people cannot directly see 120 Hz flicker, some people[1][2] report that 120 Hz flicker causes eyestrain and headache. Dr. J. Veitch has found that people have better reading performance using high-frequency (20-60 kHz) electronic ballasts than magnetic ballasts (120 Hz).[3]

In some circumstances, fluorescent lamps operated at mains frequency can also produce flicker at the mains frequency (50 or 60 Hz) itself, which is noticeable by more people, especially in the presence of computer monitors with refresh rates set at 60Hz. This can happen in the last few hours of tube life when the cathode emission coating at one end is almost run out, and that cathode starts having difficulty emitting enough electrons into the gas fill, resulting in slight rectification and hence uneven light output in positive and negative going mains cycles. Mains frequency flicker can also sometimes be emitted from the very ends of the tubes, as a result of each tube electrode alternately operating as an anode and cathode each half mains cycle, and producing slightly different light output pattern in anode or cathode mode. (This was a more serious issue with tubes over 40 years ago, and many fittings of that era shielded the tube ends from view as a result.) Flicker at mains frequency is more noticeable in the peripheral vision than it is in the center of gaze.

4.6 Method Of 'Starting' A Fluorescent Lamp

The mercury atoms in the fluorescent tube must be ionized before the arc can "strike" within the tube. For small lamps, it does not take much voltage to strike the arc and starting the lamp presents no problem, but larger tubes require a substantial voltage (in the range of a thousand volts).

In some cases, that is exactly how it is done: instant start fluorescent tubes simply use a high enough voltage to break down the gas and mercury column and thereby start arc conduction. These tubes can be identified by the facts that they have a single pin at each end of the tube.

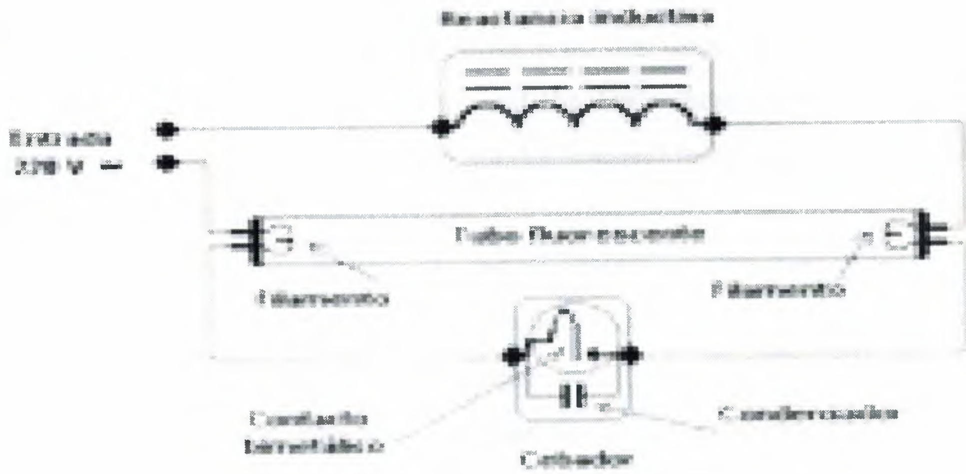


Figure 4.3 Starting of a flourescent lamp

the lampholders that they fit into have a "disconnect" socket at the low-voltage end to ensure that the mains current is automatically removed so that a person replacing the lamp cannot receive a high-voltage electric shock.

In other cases, a separate starting aid must be provided. Some fluorescent designs (preheat lamps) use a combination filament/cathode at each end of the lamp in conjunction with a mechanical or automatic switch (see photo) that initially connect the filaments in series with the ballast and thereby preheats the filaments prior to striking the arc.

These systems are standard equipment in 240v countries, and generally use a glowstarter. Before the 1960s, 4 pin thermal starters and manual switches were also used. Electronic starters are also sometimes used with these electromagnetic ballast fittings.

During preheating, the filaments emit electrons into the gas column by thermionic emission, creating a glow discharge around the filaments. Then, when the starting switch opens, the inductive ballast & a small value capacitor across the starting switch create a high voltage which strikes the arc. Tube strike is reliable in these systems, but glowstarters will often cycle a few times before letting the tube stay lit, which causes objectionable flashing during starting. The older thermal starters behaved better in this respect.

Once the tube is struck, the impinging main discharge then keeps the filament/cathode hot, permitting continued emission.

If the tube fails to strike, or strikes then extinguishes, the starting sequence is repeated. With automated starters such as glowstarters, a failing tube will thus cycle endlessly, flashing time and time again as the starter repeatedly starts the worn-out lamp, and the lamp then quickly goes out as emission is insufficient to keep the cathodes hot, and lamp current is too low to keep the glowstarter open. This causes visually unpleasant frequent bright flashing, and runs the ballast at above design temperature. Turning the glowstarter a quarter turn anticlockwise will disconnect it, opening the circuit.

Some more advanced starters time out in this situation, and do not attempt repeated starts until power is reset. Some older systems used a thermal overcurrent trip to detect repeated starting attempts. These require manual reset.

Newer rapid start ballast designs provide filament power windings within the ballast; these rapidly and continuously warm the filaments/cathodes using low-voltage AC. No inductive voltage spike is produced for starting, so the lamps must usually be mounted near a grounded (earthed) reflector to allow the glow discharge to propagate through the tube and initiate the arc discharge.

Electronic ballasts often revert to a style in-between the preheat and rapid-start styles: a capacitor (or sometimes an autodisconnecting circuit) may complete the circuit between the two filaments, providing filament preheating. When the tube lights, the voltage and frequency across the tube and capacitor typically both drop, thus capacitor current falls to a low but non-zero value. Generally this capacitor and the inductor that provides current limiting in normal operation form a resonant circuit, increasing the voltage across the lamp so that it can easily start.Some electronic ballasts use programmed start. The output AC frequency is started above the resonance frequency of the output circuit of the ballast, and after the filaments are heated the frequency is rapidly decreased. If the frequency approaches the resonant frequency of the ballast, the output voltage will increase so much that the lamp will ignite. If the lamp does not ignite an electronic circuit stops the operation of the ballast.

4.7 Mechanisms Of Lamp Failure At End Of Life

The end of life failure mode for fluorescent lamps varies depending how you use them and their control gear type. There are three main failure modes currently, and a fourth which is starting to appear:

Figure 4.2 Emission mix runs out

Closeup of the filament on a low pressure mercury gas discharge lamp showing white thermionic emission mix coating on the central portion of the coil. Typically made of a mixture of barium, strontium and calcium oxides, the coating is sputtered away through normal use, often eventually resulting in lamp failure.

The "emission mix" on the tube filaments/cathodes is necessary to enable electrons to pass into the gas via thermionic emission at the tube operating voltages used. The mix is slowly sputtered off by bombardment with electrons and mercury ions during operation, but a larger amount is sputtered off each time the tube is started with cold cathodes. (The method of starting the lamp and hence the control gear type has a significant impact on this.) Lamps operated for typically less than 3 hours each switch-on will normally run out of the emission mix before other parts of the lamp fail. The sputtered emission mix forms the dark marks at the tube ends seen in old tubes. When all the emission mix is gone, the cathode cannot pass sufficient electrons into the gas fill to maintain the discharge at the designed tube operating voltage. Ideally, the control gear should shut down the tube when this happens. However, some control gear will provide sufficient increased voltage to continue operating the tube in cold cathode mode, which will cause overheating of the tube end and rapid disintegration of the electrodes and their support wires until they are completely gone or the glass cracks, wrecking the low pressure gas fill and stopping the gas discharge.

4.7.1 failure of integral ballast electronics

This is only relevant to compact fluorescent lamps with integral electrical ballasts. Ballast electronics failure is a somewhat random process which follows the standard failure profile for any electronic devices. There is an initial small peak of early failures, followed by a drop and steady increase over lamp life. Life of electronics is heavily dependent on operating temperature—it typically halves for each 10C temperature rise. The quoted average life of a lamp is usually at 25C ambient (this may vary by country). The average life of the electronics at this temperature is normally greater than this, so at this temperature, not many lamps will fail due to failure of the electronics. In some fittings, the ambient temperature could be well above this, in which case failure of the electronics may become the predominant failure mechanism. Similarly, running a compact fluorescent lamp base-up will result in hotter electronics and shorter average life (particularly with higher power rated ones). Electronic ballasts should be designed to shut down the tube when the emission mix runs out as described above. In the case of integral electronic ballasts, since they never have to work again, this is sometimes done by having them deliberately burn out some component to permanently cease operation.

4.7.2 failure of the phosphor

The phosphor drops off in efficiency during use. By around 25,000 operating hours, it will typically be half the brightness of a new lamp (although some manufacturers claim much longer half-lives for their lamps). Lamps which do not suffer failures of the emission mix or integral ballast electronics will eventually develop this failure mode. They still work, but have become dim and inefficient. The process is slow, and often only becomes obvious when a new lamp is operating next to an old lamp.

4.7.3 tube runs out of mercury

Mercury is lost from the gas fill throughout the lamp life, as it is slowly absorbed into glass, phosphor, and tube electrodes, where it can no longer function. Historically this hasn't been a problem because tubes have had an excess of mercury. However, environmental concerns are now resulting in low mercury content tubes which are much more accurately dosed with just enough mercury to last the expected life of the lamp. This means that loss of mercury will take over from failure of the phosphor in some lamps. The failure symptom is similar, except loss of mercury initially causes an extended run-up time (time to reach full light output), and finally causes the lamp to glow a dim pink when the mercury runs out and the argon base gas takes over as the primary discharge.This claim is unsupported by any reference.

4.7.4 phosphors and the spectrum of emitted light

Many people find the color spectrum produced by some fluorescent tubes to be harsh and displeasing. A healthy person can sometimes appear to have a sickly looking washed out skin tone under fluorescent lighting. This is due to two things.

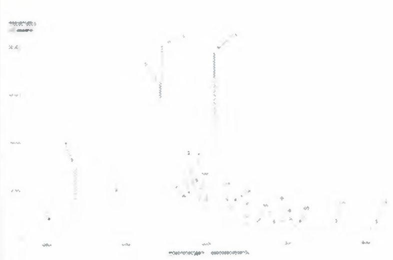
The first cause is the use of poor light quality low CRI high CCT tubes, such as 'cool white'. These have poor light quality, producing a lower than ideal proportion of red light, hence skin appears to have less pink coloration than it would under better lighting.

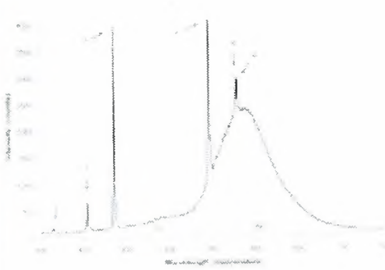
The second cause is due to the characteristics of the eye and tube type. High CCT natural daylight looks a natural color at daylight illumination levels, but as light level is reduced it appears progressively colder to the eye. At lower illumination levels, the human eye perceives lower color temperatures as normal and natural. Most fluorescent tubes are higher color temperature than 2700K filament lighting, and cooler tubes don't look natural to the eye at far below daylight illumination levels. This effect depends on the tube phosphor, and only applies to the higher CCT tubes at well below natural daylight levels.

Many pigments appear a slightly different color when viewed under some fluorescent tubes versus incandescent. This is due to a difference in two properties, CCT and CRI.

The CCT, Color Temperature, of GLS filament lighting is 2700K, and that of halogen lighting 3000K, whereas fluorescent tubes are popularly available in the range from 2700K to 6800K, which represents a fair variation perceptually.CRI, Color Rendition Index, is a measure of how well balanced the different color components of the white light are. A lamp spectrum with the same proportions of R,G,B as a black body radiator has a CRI of 100%, but real life fluorescent tubes achieve CRIs of anywhere from 50% to 99%. The lower CRI tubes have a visually low quality unbalanced color spectrum, and this produces some change in perceived color. For example a low CRI 6800K halophosphate tube, which is about as visually unpleasant as they get, will make reds appear dull red or brown.

Some of the least pleasant light comes from tubes containing the older halophosphate type phosphors (chemical formula $Ca_5(PO_4)_3(F,Cl):Sb^{3+},Mn^{2+}$), usually labelled as "cool white". The bad color reproduction is due to the fact that this phosphor mainly emits yellow and blue light, and relatively little green and red. To the eye, this mixture appears white, but the light has an incomplete spectrum. Better quality fluorescent lamps use either a higher CRI halophosphate coating, or a triphosphor mixture, based on europium and terbium ions, that have emission bands more evenly distributed over the spectrum of visible light. High CRI halophosphate and triphosphor tubes give a more natural color reproduction to the human eye.

Fluorescent lamp spectra		
Typical fluorescent lamp with "rare earth" phosphor		A typical "cool white" fluorescent lamp utilizing two rare earth doped phosphors, Tb^{3+}, $Ce^{3+}:LaPO_4$ for green and blue emission and $Eu:Y_2O_3$ for red. For an explanation of the origin of the individual peaks click on the image. Note that several of the spectral peaks are directly

		generated from the mercury arc. This is likely the most common type of fluorescent lamp in use today.
An older style halophosphate phosphor fluorescent lamp		Halophosphate phosphors in these lamps usually consist of trivalent antimony and divalent manganese doped calcium halophosphate ($Ca_5(PO_4)_3(Cl,F):Sb^{3+}, Mn^{2+}$). The color of the light output can be adjusted by altering the ratio of the blue emitting antimony dopant and orange emitting manganese dopant. The color rendering ability of these older style lamps is quite poor. Halophosphate phosphors were invented by A.H. McKeag et al. in 1942.
"Natural sunshine" fluorescent light		An explanation of the origin of the peaks is on the image page.
Yellow fluorescent lights		The spectrum is nearly identical to a normal fluorescent bulb except for a near total lack of light below 500 nanometers. This effect can be achieved through either

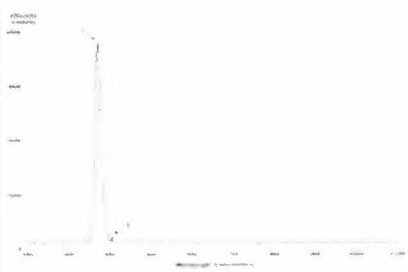
		specialized phosphor use or more commonly by the use of a simple yellow light filter. These lamps are commonly used as lighting for photolithography work in cleanrooms and as "bug repellant" outdoor lighting (the efficacy of which is questionable).
Spectrum of a "blacklight" bulb		There is typically only one phosphor present in a blacklight bulb, usually consisting of europium-doped strontium fluoroborate which is contained in an envelope of Wood's glass.

Figure 4.3 Usage

Fluorescent light bulbs come in many shapes and sizes. An increasingly popular one is the compact fluorescent light bulb (CF). Many compact fluorescent lamps integrate the auxiliary electronics into the base of the lamp, allowing them to fit into a regular light bulb socket.In the US, residential use of fluorescent lighting remains low (generally limited to kitchens, basements, hallways and other areas), but schools and businesses find the cost savings of fluorescents to be significant and only rarely use incandescent lights.Lighting arrangements often use fluorescent tubes in an assortment of tints of white. Sometimes this is done due to failure to appreciate the difference or importance of differing tube types. Mixing tube types within fittings is also sometimes done to improve the color reproduction of lower quality tubes.In other countries, residential use of fluorescent lighting varies depending on the price of energy, financial and environmental concerns of the local population, and acceptability of the light output.In February 2007, Australia enacted a law that will ban most sales of incandescent light bulbs by 2010 . While the law does not specify which alternative Australians are to use, compact fluorescents are likely to be the primary replacements. InApril 2007, Canada announced a similar plan to phase out the sale of incandescent bulbs by 2012.

CHAPTER FİVE

LAMPS

5.1 Overview

This chapter is about the lamps that we will use while we are making the illumination projects.Their types,usage areas,their historical informations.

5.2 Incandescent Light Bulb

The incandescent light bulb or incandescent lamp is a source of artificial light that works by incandescence. An electrical current passes through a thin filament, heating it and causing it to become excited, releasing thermally equilibrated photons in the process. The enclosing glass bulb prevents the oxygen in air from reaching the hot filament, which otherwise would be destroyed rapidly by oxidation.

Figure 5.1 An incandescent light bulb and its glowing filament.

Incandescent bulbs are also called electric lamps, extending the use of a term applied to the original arc lamps, and in Australia they are also called light globes, or more commonly in Anglophone countries light bulbs. A benefit of the incandescent bulbs is that they can be produced for a wide range of voltages, from just a few volts up to several hundred volts. Because of their relatively poor luminous efficacy, incandescent light bulbs are gradually being replaced in many applications by (compact) fluorescent lights, high-intensity discharge lamps, LEDs, and other devices.

Brazil and Venezuela were the first countries to attempt to phase out the use of incandescent light bulbs in 2005. Australia has announced it will phase out incandescent light bulbs in favour of compact fluorescent lights by 2010. Politicians in other countries have proposed similar measures (see the Proposals to outlaw section). These proposals have met criticism due to shortcomings of CFLs including consumer safety, environmental issues (CFLs contain the toxic element mercury), the emission spectrum of fluorescent lamps, the costs of replacement and technological limitations such as non-dimmable fluorescent lamps.

5.3 History Of The Light Bulb

Incandescent lamps were developed from early experiments in which electrical current was passed through filaments of noble metals such as platinum. The problem of the filament burning out after a few minutes, and the low resistance and high current draw made incandescent lamps a failure in practical terms until the developments by Edison and Swan in the 1870s.[2] In 1802 Sir Humphry Davy had the most powerful battery in the world at the Royal Institution of Great Britain. In that year he created the first incandescent light by passing the current through a thin strip of platinum, chosen because the metal had an extremely high melting point. It was not bright enough nor did it last long enough to be practical, but it was the precedent behind the efforts of scores of experimenters over the next 75 years until Thomas Edison's creation of the first practical incandescent lamp in 1879.[3] In 1809 Davy created the first arc lamp by making a small but blinding electrical connection between two charcoal rods connected to a 2000 cell battery. Demonstrated to the Royal Institution in 1810, the invention came to be known as the Arc lamp.

In 1835 James Bowman Lindsay demonstrated a constant electric light at a public meeting in Dundee, Scotland. He stated that he could "read a book at a distance of one and a half feet". However, having perfected the device to his own satisfaction, he turned to the problem of wireless telegraphy and did not develop the electric light any further. His claims are not well documented.

In 1840, British scientist Warren de la Rue enclosed a platinum coil in a vacuum tube and passed an electric current through it. The design was based on the concept that the high melting point of platinum would allow it to operate at high temperatures and that the evacuated chamber would contain fewer gas molecules to react with the platinum, improving its longevity. Although an efficient design, the cost of the platinum made it impractical for commercial use.

- In 1841 Frederick de Moleyns of England was granted the first patent for an incandescent lamp, with a design using powdered charcoal heated between two platinum wires contained within a vacuum bulb.
- In 1845 American John Wellington Starr acquired a patent for his own incandescent light bulb involving the use of carbon filaments.[6] He died shortly after obtaining the patent. Aside from the information contained in the patent itself, little else is known about him.
- In 1851 Jean Eugène Robert-Houdin publicly demonstrated incandescent light bulbs on his estate in Blois, France. His light bulbs are on permanent display in the museum of the Chateau of Blois.
- In 1872 Alexander Nikolayevich Lodygin invented an incandescent light bulb. In 1874 he got a patent for his invention.

In a suit filed by rivals seeking to get around Edison's lightbulb patent, the German-American inventor Heinrich Göbel claimed he had developed the first light bulb in 1854: a carbonized bamboo filament, in a vacuum bottle to prevent oxidation, and that in the following five years he developed what many call the first practical light bulb. Lewis Latimer demonstrated that the bulbs Göbel had purportedly built in the 1850's had actually been built much later, and actually found the glassblower who had constructed the fradulent exhibits for Göbel. In a patent interference suit in 1893, the judge ruled that Göbel's claim was "extremely improbable."

Figure 5.2 Carbon filament lamp E27 socket, 220 volts, approx. 30 watts, left side: running with 100 volts

Joseph Wilson Swan (1828–1914) was a physicist and chemist born in Sunderland, England. In 1850 he began working with carbonized paper filaments in an evacuated glass bulb. By 1860 he was able to demonstrate a working device but the lack of a good vacuum and an adequate supply of electricity resulted in a short lifetime for the bulb and an inefficient source of light. By the mid-1870s better pumps became available, and Swan returned to his experiments. Swan received a British patent for his device in 1878. Swan reported success to the Newcastle Chemical Society, and at a lecture in Newcastle in February 1873 he demonstrated a working lamp that utilized a carbon fiber filament, but by 1877 he had turned to slender rods of carbon. The most significant feature of Swan's lamp was that there was little residual oxygen in the vacuum tube to ignite the filament, thus allowing the filament to glow almost white-hot without catching fire. From this year he began installing light bulbs in homes and landmarks in England, and by the early 1880s he had started his own company.

In North America, parallel developments were also taking place. On July 24, 1874 a Canadian patent was filed for the Woodward and Evans Light by a Toronto medical electrician named Henry Woodward and a colleague Mathew Evans. They built their lamps with different sizes and shapes of carbon filaments held between electrodes in glass globes filled with nitrogen. Woodward and Evans attempted to commercialize their bulb, but were unsuccessful. Nonetheless, Thomas Edison considered their approach sufficiently promising that he bought the rights to both their Canadian and US patents for $5000USD before embarking on his own light bulb development program.[citation needed] To get enough grant money, Edison told the press that he had already invented the light bulb and that he needed money to produce it. Edison filed his first patent application for "Improvement In Electric Lights" on October 14, 1878 (U.S. Patent 0,214,636).

After many experiments with platinum and other metal filaments, Edison returned to a carbon filament. The first successful test was on October 22, 1879;[8] and lasted 13.5 hours. Edison continued to improve this design and by Nov 4, 1879, filed for a U.S. patent (granted as U.S. Patent 0,223,898 on Jan 27, 1880) for an electric lamp using "a carbon filament or strip coiled and connected ... to platina contact wires."[9] Although the patent described several ways of creating the carbon filament including using "cotton and linen thread, wood splints, papers coiled in various ways,"[9] it was not until several months after the patent was granted that Edison and his team discoverd that a carbonized bamboo filament could last over 1200 hours.

Hiram S. Maxim started a lightbulb company in 1878 to exploit his patents and those of William Sawyer. His United States Electric Lighting Company was the second company to sell practical incandescent electric lamps, after Edison. They made their first commercial installation of incandescent lamps at the Mercantile Safe Deposit Company in New York City in the fall of 1880, about six months after the Edison incandescent lamps had been installed on the steamer Columbia. Maxim in October 1880 patented a method of coating carbon filaments with hydrocarbons to extend their life. Lewis Latimer, his employee at the time, developed an improved method of heat treating them which reduced breakage and allowed them to be molded into novel shapes, such as the characteristic "M" shape of Maxim filaments. On January 17, 1882, Latimer received a patent for the "Process of Manufacturing Carbons", an improved method for the production of light bulb filaments which was purchased by the United States Electric Light Company. Latimer patented other improvements such as a better way of attaching filaments to their wire supports.

In Britain, the Edison and Swan companies merged into the Edison and Swan United Electric Company (later known as Ediswan, which was then incorporated into Thorn Lighting Ltd). Edison was initially against this combination, but after Swan sued him and won, Edison was eventually forced to cooperate, and the merger was made. Eventually, Edison acquired all of Swan's interest in the company. Swan sold his United States patent rights to the Brush Electric Company in June 1882. Swan later wrote that Edison had a greater claim to the light than he, in order to protect Edison's patents from claims against them in the US.

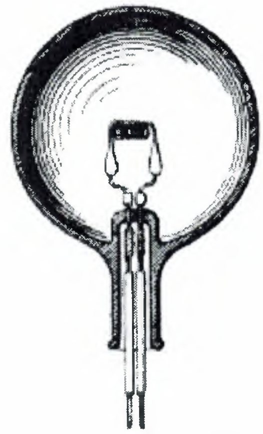


Figure 5.3 U.S. Patent 0,223,898 by Thomas Edison for an improved electric lamp

The United States Patent Office gave a ruling October 8, 1883 that Edison's patents were based on the prior art of William Sawyer and were invalid. Litigation continued for a number of years. Eventually on October 6, 1889, a judge ruled that Edison's electric light improvement claim for "a filament of carbon of high resistance" was valid.

In addressing the question "Who invented the incandescent lamp?" historians Robert Friedel and Paul Israel (1987, 115-117) list 22 inventors of incandescent lamps prior to Swan and Edison. They conclude that Edison's version was able to outstrip the others because of a combination of factors: an effective incandescent material, a higher vacuum than others were able to achieve and a high resistance lamp that made power distribution from a centralized source economically viable. Another historian, Thomas Hughes, has attributed Edison's success to the fact that he invented an entire, integrated system of electric lighting. "The lamp was a small component in his system of electric lighting, and no more critical to its effective functioning than the Edison Jumbo generator, the Edison main and feeder, and the parallel-distribution system. Other inventors with generators and incandescent lamps, and with comparable ingenuity and excellence, have long been forgotten because their creators did not preside over their introduction in a system of lighting." (Hughes 1977, 9)

In the 1890s, the Austrian inventor Carl Auer von Welsbach worked on metal-filament mantles, first with platinum wiring, and then osmium, and produced an operative version in 1898.

In 1897, German physicist and chemist Walther Nernst developed the Nernst lamp, a form of incandescent lamp that used a ceramic globar and did not require enclosure in a vacuum or inert gas. Twice as efficient as carbon filament lamps, Nernst lamps were briefly popular until overtaken by lamps using metal filaments.

In 1903, Willis Whitnew invented a filament that would not blacken the inside of a light bulb. (Some of Edison's experiments to stop this blackening led to the invention of the electronic vacuum tube.) It was a metal-coated carbon filament. In 1906, the General Electric Company was the first to patent a method of making tungsten filaments for use in incandescent light bulbs. In the same year Franjo Hannaman, a Croatian from Zagreb, invented a tungsten (wolfram) filament lamp, which lasted longer and gave a brighter light than the carbon filament. Tungsten filaments were costly, but by 1910 William David Coolidge (1873–1975) had invented an improved method of making tungsten filaments. The tungsten filament outlasted all other types of filaments and Coolidge made the costs practical. Marvin Pipkin, an American chemist, in 1924 patented a process for frosting the inside of lamp bulbs without weakening them, and in 1947 patented a process for coating the inside of lamps with silica.

5.4 Operation

An SEM image (75x) of a 60 W line voltage light bulb filament. In order to increase the filament length while keeping its physical size small, the filament takes the form of a coiled coil. By comparison, low voltage lamp filaments usually take the form of a single coil. Incandescent light bulbs consist of a glass enclosure (the envelope, or bulb) which the bulb with an inert gas reduces evaporation of the filament and reduces the required strength of the glass. Inside of the bulb is a filament of tungsten wire, through which an electrical current is passed. The current heats the filament to an extremely high temperature (typically 2000K to 3300K depending on the filament type, shape, size, and amount of current passed through).

Heated atoms within the filament intensely vibrate. The electrons, which are charged particles now strongly oscilating, radiate excess energy in the form of black body radiation, according to Maxwell's equations. This spectrum, unlike those caused by non-equilibrium atomic or molecular transitions such as in a mercury-vapor lamp, is continuous, typically peaking in the visible light but also containing significant energy in the near-infrared wavelengths.

Figure 5.4 Filament microscop seen

Incandescent light bulbs usually also contain a glass mount on the inside, which supports the filament and allows the electrical contacts to run through the envelope without gas/air leaks. Many arrangements of electrical contacts are used, such as a screw base (one or more contacts at the tip, one at the shell), a bayonet base (one or more contacts on the base, shell used as a contact or only used as a mechanical support), and for some lamps an electrical contact at either end of a tubular lamp. Contacts in the lamp socket allow the electrical current to pass through the filament. Power ratings range from about 0.1 watt to about 10,000 watts, and up. To improve the efficacy of the lamp, the filament usually consists of coils of fine wire, also known as a 'coiled coil'. For a 60 watt 120-volt lamp, the length of the filament is usually 6.5 feet or 2 meters.

One of the smallest problems of the standard electric light bulb is evaporation of the filament. The largest problem is that the inevitable variations in resistivity along the filament cause non-uniform heating, with "hot spots" forming at points of higher resistivity. Thinning by evaporation increases resistance in places. But hot spots evaporate faster, increasing their resistance faster—a positive feedback which ends in the familiar tiny gap in an otherwise healthy-looking filament. Irving Langmuir suggested that an inert gas, instead of vacuum, would retard evaporation and still avoid combustion, and so ordinary incandescent light bulbs are now filled with nitrogen, argon, or krypton. However, a filament breaking in a gas-filled bulb can pull an electric arc, which may spread between the terminals and cause very heavy current flow; intentionally thin lead-in wires or more elaborate protection devices are therefore often used as fuses built into the light bulb.[10]

During ordinary operation, the tungsten of the filament evaporates; hotter, more-efficient filaments evaporate faster. Because of this, the lifetime of a filament lamp is a trade-off between efficiency and longevity. The trade-off is typically set to provide a lifetime of hours for ordinary lamps. See the section below, Voltage, light output, and lifetime, for a discussion of the trade-offs involved in setting a lamp life specification.

In a conventional (not halogen) lamp, the evaporated tungsten eventually condenses on the inner surface of the glass envelope, darkening it. For bulbs that contain a vacuum, the darkening is uniform across the entire surface of the envelope. When a filling of inert gas is used, the evaporated tungsten is carried in the thermal convection currents of the gas, depositing preferentially on the uppermost part of the envelope and blackening just that portion of the envelope.

Some old, high-powered lamps used in theater, projection, searchlight, and lighthouse service with heavy, sturdy filaments contained loose tungsten powder within the envelope. From time to time, the operator would remove the bulb and shake it, allowing the tungsten powder to scrub off most of the tungsten that had condensed on the interior of the envelope, removing the blackening and brightening the lamp again.

When a light bulb envelope breaks while the lamp is on or if air leaks into the envelope, the hot tungsten filament reacts with the air, yielding an aerosol of brown tungsten nitride, brown tungsten dioxide, violet-blue tungsten pentoxide, and yellow tungsten trioxide which then deposits on the nearby surfaces or the bulb interior.

5.5 The Halogen Lamp

A separate lens is included with some halogen light fixtures to filter out UV lightOne invention that addressed the problem of short lamp life was the halogen lamp, also called the tungsten-halogen lamp, the quartz-halogen lamp or the quartz-iodine lamp, wherein a tungsten filament is sealed into a small envelope filled with a halogen gas such as iodine or bromine

Figure 5.5 Halogen lamp behind a round UV filter.

In an ordinary incandescent lamp, the thickness of the filament may vary slightly. The resistance of the filament is higher at the thinner portions which causes the thin areas to be hotter than the thicker parts of the filament. The rate of tungsten evaporation will be higher at these points due to the increased temperature, causing the thin areas to become even thinner, creating a runaway effect until the filament fails. A tungsten-halogen lamp creates an equilibrium reaction in which the tungsten that evaporates when giving off light is preferentially re-deposited at the hot-spots, preventing the early failure of the lamp. This also allows halogen lamps to be run at higher temperatures which would cause unacceptably short lamp lifetimes in ordinary incandescent lamps, allowing for higher luminous efficacy, apparent brightness, and whiter color temperature. Because the lamp must be very hot to create this reaction, the halogen lamp's envelope must be made of hard glass or fused quartz, instead of ordinary soft glass which would soften and flow too much at these temperatures.

The envelope material can be selected and modified (by means of optical coating) to achieve whatever lamp characteristics are required. Halogen bulbs are widely used in automobile headlamps, for example, and because headlamps often contain plastic parts, halogen headlamp bulbs' envelopes are made out of hard glass, or out of quartz 'doped' with additives to block most of the UV output (hard glass blocks UV without need of dopants).

Conversely, some applications require ultraviolet radiation, and in such cases, the lamp envelope is made out of undoped quartz. Thus, the lamp becomes a source of UV-B radiation. Undoped quartz halogen lamps are used in some scientific, medical and dental instruments as a UV-B source.

A typical halogen lamp is designed to run for about 2000 hours, twice as long as a typical incandescent lamp.

5.5.1 halogen infrared

A further development that has added to halogen lamp efficacy is an infrared-reflective coating (IRC). The quartz envelope is coated with a multi-layered dichroic coating which allows visible light to be emitted while reflecting a portion of the infrared radiation back onto the filament. Such lamps are called halogen-infrared lamps, and they require less power than standard halogen lamps to produce any given light output. The efficiency increase can be as much as 40% when compared to its standard equivalent. Harison Toshiba Lighting Corporation (Imabari, Japan) manufactures a halogen infrared bulb called HIR-1 for automotive headlamp use that achieves 2,500 lumens out of 65 watts input power (38 lumens per watt); this bulb uses IR-reflective coatings licensed from General Electric[12].

5.5.2 safety

Because the halogen lamp operates at very high temperatures, it can pose fire and burn hazards. Additionally, it is possible to get a sunburn from excess exposure to the UV emitted by an undoped quartz halogen lamp. To mitigate the negative effects of unintentional UV exposure, and to contain hot bulb fragments in the event of explosive bulb failure, manufacturers of lamps intended for general-purpose usage usually install UV-absorbing glass filters over or around the bulb. Alternatively, they may add a coating of UV inhibitors on the bulb envelope that effectively filters UV radiation. When this is done correctly, a halogen lamp with UV inhibitors will produce less UV than its standard incandescent counterpart.

5.5.3handling precautions

Any surface contamination, notably fingerprints, can damage the quartz envelope when it is heated. Contaminants, such as oil and other skin residue naturally deposited by fingerprints will, unless removed, create a hot spot on the bulb surface when the bulb is turned on. This extreme, localized heat causes the quartz to change from its vitreous form into a weaker, crystalline form which leaks gas. This weakening may also cause the bulb to rapidly form a bubble, thereby weakening the bulb and leading to its failure or explosion, and creating a serious safety hazard. Consequently, quartz lamps should be handled without ever touching the clear quartz, either by using a clean paper towel or carefully holding the porcelain base. If the quartz is contaminated in any way, it must be thoroughly cleaned with rubbing alcohol and dried before use.

5.5.4 applications and popularity

The incandescent lamp is widely used in domestic applications, and is the basis of most portable lighting, such as table lamps, some car headlamps and electric flashlights. Halogen lamps have become more common in auto headlamps and domestic situations, particularly where light is to be concentrated on a particular point. Some applications of the incandescent bulb make use of the heat generated. Some examples of this use include some models of incubator (for hatching eggs), brooding boxes for young poultry, heat lights for reptile tanks, and the Easy-Bake Oven toy. The fluorescent light has, however, replaced some applications of the incandescent lamp with its superior life and energy efficiency. It cannot reproduce the heat required for some applications. LED lights are beginning to see increased home and auto use, replacing incandescent lamps. However, the spectrum emitted by fluorescent bulbs includes UV light, which can damage paintings and textiles. They are also slow to respond when switched on, raising safety concerns, especially for the elderly and infirm. Another concern is that for people suffering from sensory issues (like those who have autism) the flickering of fluorescent lights can be very distracting and make concentration difficult[citation needed]. With the rise of autism, this is a factor to consider when planning what kind of lighting a particular facility or home needs. One special problem concerns residents of highly insulated homes, especially in Scandinavia, where the heat emitted by incandescent bulbs is used to heat the home. Some lights are left on permanently, increasing their life.

5.6 Efficiency And Alternatives

Approximately 95% of the power consumed by an incandescent light bulb is emitted as heat, rather than as visible light. [13] An incandescent light bulb, with 5% efficiency, is less efficient than fluorescent lamp (7%-15% efficiency), and thus produces more heat with the same amounts of light from both sources. (See Luminous efficacy table.) One reason why incandescent lamps are unpopular in commercial spaces is that the heat output results in the need for more air conditioning in the summer. Proponents claim that the heat that incandescent bulbs emit may remove some of the burden of heating a room from a thermostatically-controlled system, particularly at night and during cold periods of the year. However, dedicated heating systems usually achieve the same results more efficiently

Incandescent lamps can usually be replaced by self-ballasted compact fluorescent light bulbs, which fit directly into standard sockets (but contain mercury, and thus should not be disposed of in a regular trash can). This lets a 100 W incandescent lamp be replaced by a 23-watt fluorescent bulb, while still producing the same amount of light.

Quality halogen incandescents are closer to 9% efficiency, which will allow a 60 W bulb to provide nearly as much light as a non-halogen 100 W. Also, the lower wattage halogen lamp can be designed to produce the same amount of light as a 60 W non-halogen lamp, but with much longer life. However, small halogen lamps are often still high-power, causing them to get extremely hot. This is both because the heat is more concentrated on the smaller envelope surface, and because the surface is closer to the filament. This high temperature is essential to their long life (see the section on halogen lamps above). Left unprotected, these can cause fires much more easily than a regular incandescent, which may only scorch easily flammable objects such as drapery. Most safety codes now require halogen bulbs to be protected by a grid or grille, or by the glass and metal housing of the fixture. Similarly, in some areas halogen bulbs over a certain power are banned from residential use.

LED-based lighting is becoming more common,[citation needed] because it can offer very high efficiency. A 3 W, 120 VAC LED bulb could replace at least a 15 W incandescent bulb and would last 60 times longer than the incandescent bulb. In the long run, LED bulbs would save money when they become available for general lighting uses, despite costing more up front than incandescents. Compared to fluorescent bulbs, they will contain smaller quantities of harmful metals such as mercury.

One problem with wholesale replacement of incandescent bulbs with compact fluorescents is the poor tolerance for extreme cold by the compact fluorescents, which may fail to operate properly at low temperatures. Light output drop at low temperatures, and they may not light at all below zero degrees C (32 degrees F). They also have unacceptably short life when switched on and off frequently. Incandescent bulbs operate well with no loss of brightness at extremely low or high temperatures and can better withstand frequent turning on and off, as in security light applications. Manufacturers of compact fluorescents warn against using ordinary CFLs to replace incandescent bulbs in enclosed fixtures or those which are controlled by dimmers.. Another major disadvantage is the lack of ability to dim a fluorescent lamp. According to BC Hydro, and Environmental Defense, new dimmable screw-in fluorescent bulbs are now available, however, these models only dim to a certain percentage such as 10 or 20 percent before turning off completely.

5.7 Proposals To Outlaw

5.7.1 the united states

In January of 2007, California State Assembly member Lloyd E. Levine (D-Van Nuys) announced that he would introduce the "How Many Legislators does it take to Change a Light Bulb Act" (a reference to light bulb joke), which would ban the sale of incandescent light bulbs in California starting in 2012.

A few days later, Connecticut state Representative Mary M. Mushinsky (D-Wallingford) proposed a similar ban for the state of Connecticut.[19][20]

On February 8 2007, New Jersey Assemblyman Larry Chatzidakis introduced a bill that calls for the state to switch to fluorescent lighting in government buildings over the next three years. "The light bulb was invented a long time ago and a lot of things have changed since then," said Chatzidakis. "I obviously respect the memory of Thomas Edison, but what we're looking at here is using less energy.

5.7.2 australia and new zealand

On February 20, 2007, Prime Minister John Howard and Environment Minister Malcolm Turnbull announced that by 2010, incandescent light bulbs would be banned in Australia.[22] It is estimated greenhouse gas emissions will by cut by 800,000 tonnes (Australias current emission total is 564.7 million tonnes), a saving of approximate 0.14%[23]

In response, New Zealand is considering similar measures. Climate Change Minister David Parker said: "The Australians are talking about looking at banning ordinary lightbulbs in three years' time...I think by the time that is implemented in Australia - if it is - we will be doing something very similar".

5.7.3 canada

In April 2007, Ontario's Minister of Energy Dwight Duncan announced the provincial government's intention to ban incandescent light bulbs by 2012. The plan would ban the sale of incandescent light bulbs, but not the use.[25]

The Provincial government of Nova Scotia, Canada would also like to move towards phasing out incandescent light bulbs in the province. However, Energy Minister Bill Dooks said he expects it would be four or five years before a ban is in place.

Federal Environment Minister John Baird has announced a plan to phase-out incandescent light bulbs in Canada by 2012. According to the minister Canada will save $3- to $4-billion Canadian dollars over the lifetime of the new bulbs.

5.7.4 europe

The European Union has proposed a ban on incandescent light bulbs, planned to come into effect in the near future, but this will not affect existing incandescent bulbs, only the production of new bulbs.[28] However, the proposal has yet to be approved by all member states or the European Parliament. The decision appears to have been made without consulting either the industry, consumer groups or technical experts.[citation needed] There are substantial problems involving consumer safety, the high cost of CFLs and disposal of toxic mercury within the fluorescent bulbs.[citation needed] None of these issues have been tackled by EU leaders.

Germany's Environment Minister Sigmar Gabriel has urged the European Commission to ban inefficient light bulbs in the EU in the fight against global warming. The EU could reduce carbon dioxide emissions by 25 million tonnes a year if energy saving light bulbs were used in both the domestic and services sectors

Belgium's Minister of the Environment Bruno Tobback is intent on banning old-fashioned incandescent light-bulbs, and thinks the ban on incandescent light-bulbs should be included in the list of measures under the Kyoto Protocol. Energy Minister Kris Peeters supports this position as well. The Netherlands is moving ahead with plans to ban incandescent light bulbs as well

5.8 Standard Fittings

Most domestic and industrial light bulbs have a metal fitting (or lamp base) compatible with standard threaded sockets. The most common types of fitting are:

Figure 5.6 A light bulb with a standard E26 Edison screw base

Candelabra screw base, used in nightlights and Christmas lights, and by some halogen bulbs.

MES or medium Edison screw (E26 - one inch), used in North America and Japan for most 120 and 100-volt lamps. A slight variant of this base, E27, is used in Europe and elsewhere in the world with 220-240V household voltage.

BC or B22 or double-contact bayonet cap, used in Australia, Ireland, New Zealand and the UK for most 220–240V mains lamps and is used in the US for certain 120V lamps in appliances such as sewing machines and vacuum cleaners. (E27 also common in Australia and the UK.)

G4 or GY4 for dualpin/bipin (looks like a miniature wall connector) halogen lamps with the number being the centre-to-centre distance in millimeters.

R7S-75 for halogen lamptubes, in this case a 7 mm diameter socket with 75 mm tube length.

In each designation, the E stands for Edison, who created the screw-base lamp, and the number is the diameter in millimeters. (This is even true in North America, where designations for the actual bulb glass diameter are in eighths of an inch.) There are four standard sizes of screw-in sockets used for line-voltage lamps:

- candelabra: E12 North America, E10 & E11 in Europe
- intermediate: E17 North America, E14 (SmallES) in Europe
- medium or standard: E26 (MES) in North America, E27 (ES) in Europe
- mogul: E39 North America, E40 (GoliathES) in Europe).

There is also a rare "admedium" size (E29), incompatible with standard and used to frustrate thieves of bulbs used in public places; and a very miniature size (E5) generally used only for low-voltage applications such as with a battery.

The largest size is now only used in large street lights, however a few high-wattage household lamps (such as a 100/200/300-watt three-way) used this at one point. MES bulbs for 12 volts are also produced for recreational vehicles. Large outdoor Christmas lights use an intermediate base, as do some desk lamps and many microwave ovens. Emergency exit signs also tend to use the intermediate base.

Bulbs with a bayonet (push-twist) base, for use with sockets having spring-loaded base plates, are produced in similar sizes and are given a B or BA designation. These are also extremely common in 12-volt automobile lighting worldwide, in addition to wedge-base ones which have a partial plastic or even completely glass base. In this case, the wires wrap around to the outside of the bulb, where they press against the contacts in the socket. Miniature Christmas bulbs use a plastic wedge base as well.

Halogen bulbs are available with a standard fitting, but also come with a pin base, with two contacts on the underside of the bulb. These are given a G or GY designation, with the number being the centre-to-centre distance in millimeters. For example, a 4 mm pin base would be indicated as G4 (or GY4). Some common sizes include G4 (4 mm), G6.35 (6.35 mm), G8 (8 mm), GY8.6 (8.6 mm), G9 (9 mm), and GY9.5 (9.5 mm). The second letter (or lack thereof) indicates pin diameter. Some spotlights or floodlights have pins that are broader at the tips, in order to lock into a socket with a twist. Other halogen bulbs come in a tube, with blades or dimples at either end.

Fluorescent tubes use a different set of pins, but self-ballasted compact fluorescents are available in both medium and candelabra-base bulbs, intended to replace incandescents.

There are also various odd fittings for projectors and stage lighting instruments. Projectors, in particular, may run on odd voltages (such as 82), perhaps intended as a vendor lock-in.

General Electric introduced standard fitting sizes for tungsten incandescent lamps under the Mazda trademark in 1909. This standard was soon adopted across the United States, and the Mazda name was used by many manufacturers under license through 1945.

Incandescent light bulbs are usually marketed according to the electrical power consumed. This is measured in watts and depends mainly on the resistance of the filament, which in turn depends mainly on the filament's length, thickness and material. It is difficult for the average consumer to predict the light output of a bulb given the power consumed but it can be safely assumed, for two bulbs of the same type, colour, and clarity, that the higher-powered bulb is brighter.

5.9 Comparison Of Electricity Cost

A kilowatt-hour is a unit of energy, and this is the unit in which electricity is purchased. (The cost of electricity in the United States normally ranges from $0.05 to $0.13 per kilowatt-hour (kWh), but can be as high as $0.26 per kWh in certain areas such as Alaska and Hawaii, where Compact Fluorescent light bulbs are particularly popular.)

The following shows how to calculate total cost of electricity for using an incandescent light bulb vs. a compact fluorescent light bulb [33]. (Also note that 1 kWh = 1000 Wh).

The average lifetime of incandescent light bulbs is about 750–1000 hours. It would take at least 6-11 incandescent bulbs to last as long as one compact fluorescent, which have an average lifetime between 11,250 and 15,000 hours.[34] This causes an additional total cost of using incandescent bulbs. Another additional (potential) cost may be incurred if the bulbs are not in a readily accessible location and special equipment (e.g., cherry picker) and/or personnel are needed to replace it.

These characteristics are of great practical and economic importance. For a supply voltage V,

- Light output is approximately proportional to V 3.4
- Power consumption is approximately proportional to V 1.6
- Lifetime is approximately inversely proportional to V 16
- Color temperature is approximately proportional to V 0.42

This means that a 5% reduction in operating voltage will more than double the life of the bulb, at the expense of reducing its light output by about 20%. This may be a very acceptable trade off for a light bulb that is a difficult-to-access location (for example, traffic lights or fixtures hung from high ceilings). So-called "long-life" bulbs are simply bulbs that take advantage of this trade off.

According to the relationships above (which are probably not accurate for such extreme departures from nominal ratings), operating a 100-watt, 1000-hour, 1700-lumen bulb at half voltage would extend its life to about 65,000,000 hours or over 7000 years – while reducing light output to 160 lumens, about the equivalent of a normal 15 watt bulb. The Centennial Light is a light bulb which is accepted by the Guinness Book of World Records as having been burning almost continuously at a fire station in Livermore, California since 1901. However, the bulb is powered by only 4 watts. A similar story can be told of a 40-watt bulb in Texas which has been illuminated since September 21, 1908. It once resided in an opera house where notable celebrities stopped to take in its glow, but is now in an area museum.[35]

In flood lamps used for photographic lighting, the trade-off is made in the other direction. Compared to general service bulbs, for the same power, these bulbs produce far more light, and (more importantly) light at a higher color temperature, at the expense of greatly reduced life (which may be as short as 2 hours for a type P1 lamp). The upper limit to the temperature at which metal incandescent bulbs can operate is the melting point of the metal. Tungsten is the metal with the highest melting point. A 50-hour-life projection bulb, for instance, is designed to operate only 50 °C (90 °F) below that melting point.

Lamps also vary in the number of support wires used for the tungsten filament. Each additional support wire makes the filament mechanically stronger, but removes heat from the filament, creating another trade-off between efficiency and long life. Many modern 120 volt lamps use no additional support wires, but lamps designed for "rough service" often have several support wires and lamps designed for "vibration service" may have as many as five. Lamps designed for low voltages (for example, 12 volts) generally have filaments made of much heavier wire and do not require any additional support wires.

5.10 Luminous Efficacy And Efficiency

A light can waste power by emitting too much light outside of the visible spectrum. Only visible light is useful for illumination, and some wavelengths are perceived as brighter than others. Taking this into account, luminous efficacy is a ratio of the useful power emitted to the total radiant flux (power).

It is measured in lumens per watt (lm/W). The maximum efficacy possible is 683 lm/W. Luminous efficiency is the ratio of the luminous efficacy to this maximum possible value. It is expressed as a number between 0 and 1, or as a percentage.[36] However, the term luminous efficiency is often used for both quantities.

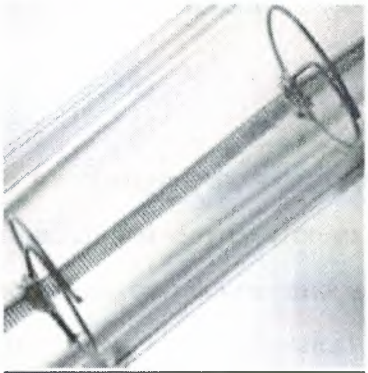


Figure 5.7 Closeup of a tungsten filament inside a halogen lamp

Two related measures are the overall luminous efficacy and overall luminous efficiency, which divide by the total power input rather than the total radiant flux. This takes into account more ways that energy might be wasted and so they are never greater than the standard luminous efficacy and efficiency. The term "luminous efficiency" is often misused, and in practice can refer to any of these four measures.

The chart below lists values of overall luminous efficacy and efficiency for several types of incandescent bulb, and several idealised light sources. A similar chart in the article on luminous efficacy compares a broader array of light sources to one another.

Thus a typical 100 W bulb for 120 V systems, with a rated light output of 1750 lumens, has an overall efficacy of 17.5 lumens per watt, compared to an "ideal" of 242.5 lumens per watt for one type of white light. Unfortunately, tungsten filaments radiate mostly infrared radiation at temperatures where they remain solid (below 3683 kelvins). Donald L. Klipstein explains it this way: "An ideal thermal radiator produces visible light most efficiently at temperatures around 6300 °C (6600 K or 11,500 °F). Even at this high temperature, a lot of the radiation is either infrared or ultraviolet

CHAPTER SİX
SWITCHES

6.1 Overview

This chapter is about the switches that we are using in the illumination projects.The types of switches.the controling mechanism and methods of switching

6.2 What Is Switch

A switch is a device for changing the course (or flow) of a circuit. The prototypical model is a mechanical device (for example a railroad switch) which can be disconnected from one course and connected to another. The term "switch" typically refers to electrical power or electronic telecommunication circuits. In applications where multiple switching options are required (e.g., a telephone service), mechanical switches have long been replaced by electronic variants which can be intelligently controlled and automated.The switch is referred to as a "gate" when abstracted to mathematical form. In the philosophy of logic, operational arguments are represented as logic gates. The use of electronic gates to function as a system of logical gates is the fundamental basis for the computer—i.e. a computer is a system of electronic switches which function as logical gates.

Figure 6.1 A simple electrical switch

In the simplest case, a switch has two pieces of metal called contacts that touch to make a circuit, and separate to break the circuit. The contact material is chosen for its resistance to corrosion, because most metals form insulating oxides that would prevent the switch from working. Contact materials are also chosen on the basis of electrical conductivity, hardness (resistance to abrasive wear), mechanical strength, low cost and low toxicity.

Sometimes the contacts are plated with noble metals. They may be designed to wipe against each other to clean off any contamination. Nonmetallic conductors, such as conductive plastic, are sometimes used.

6.3 Contact Arrangements

A pair of contacts is said to be 'closed' when there is no space between them, allowing electricity to flow from one to the other. When the contacts are separated by a space, they are said to be 'open', and no electricity can flow.Switches can be classified according to the arrangement of their contacts. Some contacts are normally open until closed by operation of the switch, while others are normally closed and opened by the switch action. A switch with both types of contact is called a changeover switch.

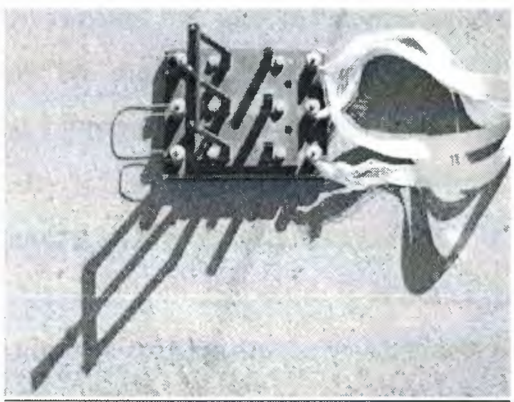


Figure 6.2 Triple Pole Single Throw (TPST or 3PST) knife switch used to short the windings of a 3 phase wind turbine for braking purposes. Here the switch is shown in the open position.

The terms pole and throw are used to describe switch contacts. A pole is a set of contacts that belong to a single circuit. A throw is one of two or more positions that the switch can adopt. These terms give rise to abbreviations for the types of switch which are used in the electronics industry. In mains wiring names generally involving the word way are used; however, these terms differ between British and American English and the terms two way and three way are used in both with different meanings.Switches with larger numbers of poles or throws can be described by replacing the "S" or "D" with a number or in some cases the letter T (for triple). In the rest of this article the terms SPST SPDT and intermediate will be used to avoid the ambiguity in the use of the word "way".

6.4 Multiway Switching

Multiway switching is a method of connecting switches in groups so that any switch can be used to connect or disconnect the load. This is most commonly done with lighting.

Switching a load on or off from two locations (for instance, turning a light on or off from either end of a flight of stairs) requires two SPDT switches. There are two basic methods of wiring to achieve this.

In the first method, mains is fed into the common terminal of one of the switches; the switches are then connected through the L1 and L2 terminals (swapping the L1 and L2 terminals will just make the switches work the other way round), and finally a feed to the light is taken from the common of the second switch. A connects to B or C, D connects to B or C; the light is on if A connects to D, i.e. if A and D both connect to B or both connect to C.

The second method is to join the three terminals of one switch to the corresponding terminals on the other switch and take the incoming supply and the wire out to the light to the L1 and L2 terminals. Through one switch A connects to B or C, through the other also to B or C; the light is on if B connects to C, i.e. if A connects to B with one switch and to C with the other.

Wiring needed in addition to the mains network (not including protective earths):

1. **First method:**

- double wire between both switches
- single wire from one switch to the mains
- single wire from the other switch to the load

- single wire from the load to the mains

2. **second method:**

- triple wire between both switches
- single wire from any position between the two switches, to the mains
- single wire from any position between the two switches, to the load
- single wire from the load to the mains

If the mains and the load are connected to the system of switches at one of them, then in both methods we need three wires between the two switches. In the first method one of the three wires just has to pass through the switch, which tends to be less convenient than being connected. When multiple wires come to a terminal they can often all be put directly in the terminal. When wires need to be joined without going to a terminal a crimped joint, piece of terminal block, wirenut or similar device must be used and the bulk

CHAPTER SEVEN
DOMESTİC AC POWER PLUGS AND SOCKETS

7.1 Overview

This chapter includes the domestic AC power plugs.their usage areas in real life.the types used in illumination projects,their historical information and also the general informations about the plugs

7.2 Plugs

This article covers only plugs and sockets intended for common domestic use. For plugs and sockets used for industrial applications, or with more than two current carrying conductors, see Industrial & multiphase power plugs & sockets. For less common plugs and sockets see unusual and obsolete plugs and sockets.

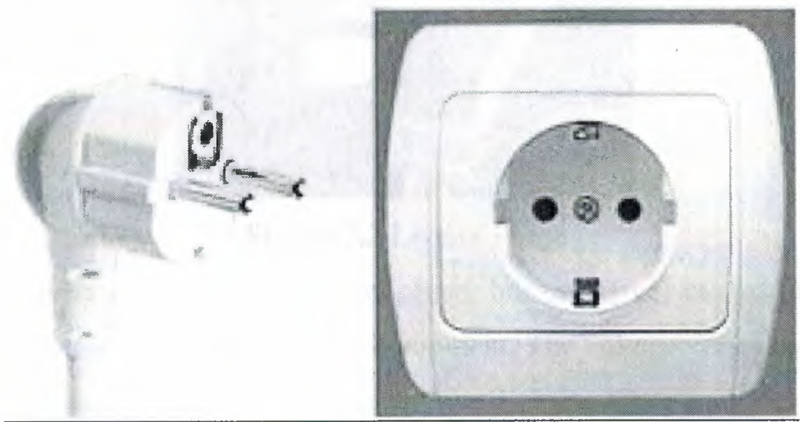


Figure 7.1 CEE 7/7 plug and socket

Domestic AC power plugs and sockets are devices that connect the home appliances and portable light fixtures commonly used in homes to the commercial power supply so that AC electric power can flow to them.
Power plugs are male electrical connectors that fit into female electrical sockets. They have contacts that are pins or blades which connect mechanically and electrically to holes or slots in the socket. Plugs usually have a live or hot contact, a neutral contact, and an optional earth or ground contact. Many plugs make no distinction between the live and neutral contacts, and in some cases they have two live contacts. The contacts may be brass, tin or nickel plated.Power sockets are female electrical connectors that have slots or holes

which accept the pins or blades of power plugs inserted into them and deliver electricity to the plugs. Sockets are usually designed to reject any plug which is not built to the same electrical standard. Some sockets have one or more pins that connect to holes in the plug.

7.3 The Three Contacts

In most countries, household power is single-phase electric power, in which a single live conductor brings alternating current into a house, and a neutral returns it to the power supply. Many plugs and sockets include a third contact used for a protective earth ground, which only carries current in case of a fault in the connected equipment.

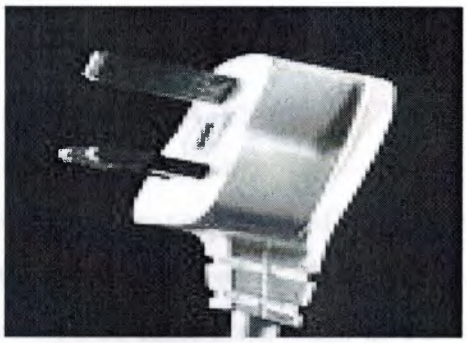


Figure 7.2 Live or Phase

The livecontact (also known as phase, hot or active) carries alternating current from the power source to the equipment. The voltage varies by country, as set by national standards. In some installations, there may be two live conductors, either being two phases from a three-phase system or being both phases from a split phase system. Some plug/socket combinations are designed in a way that a plug can be inserted only one possible way — this is referred to as a polarized plug (not to be confused with positive and negative polarity). Others allow the plug to be inserted with live and neutral either way round — this is referred to as an unpolarized plug.

- **neutral**

The neutral contact returns current from the equipment back to the power source or distribution panel. It is in most (but not all) cases referenced to the earth. Except under fault conditions it does not pose a danger because the voltage between the neutral contact and the earth is close to zero, but is nevertheless treated as live in most installation practices because it can develop a high voltage under fault conditions.

The main danger posed by the neutral is the voltage can rise as high as the voltage on the live conductor if a broken neutral cable in the wiring disconnects the neutral but leaves the live conductor connected. Another possibility is that the live and neutral may be reversed or crossed by improper installation.

Neutral and earth (ground) are closely related and are usually connected at some point. However, extra connections between the neutral and the earth should be avoided unless the relevant jurisdiction's regulations allow it. Connecting neutral and earth at more than one point can sometimes create a dangerous ground loop in the system.

- **earth/ground**

The earth contact (known as ground in American English) is only intended to carry electric current when connected to equipment that has developed an insulation fault (except for EMI/RFI filters which do cause a small current down the earth). The earth connection was added to modern plugs because, if a live wire or other component in a device touches the metal casing, anybody touching the device may receive a dangerous electric shock. In many countries devices with metal cases must have the case connected to the earth contact. This reduces but does not eliminate the possibility of the case developing a high voltage relative to the earth and grounded metalwork.

It is a common misconception that the purpose of the earth connection is to take fault currents safely to earth. The primary purpose of the earthing system is to cause a fuse to blow or a breaker or a residual-current device (RCD) to trip to automatically disconnect the power supply to any device or cable which develops a wiring fault. The secondary purpose is to hold all touchable metal in a house to the same voltage to prevent electrical shocks when touching two metal objects at the same time. In addition, some equipment such as surge protectors require an earth connection to function properly because they operate by shorting the excess current to the earth.

There are two main approaches to the problem of how to disconnect power when a live wire comes into contact with metalwork attached to the earthing system. One way is to get the resistance through the fault path and back to the supply very low by having a metallic connection from the earth back to the supply transformer (a TN system). Then when a fault happens a very high current will flow rapidly blowing a fuse (or tripping a circuit breaker).

Where such a direct connection is not used (a TT system) the resistance of the fault path back to the supply is almost invariably far higher and as a result the fault current is generally too low to reliably blow fuses (or trip circuit breakers). Therefore an RCD must normally be used to disconnect the fault.

The neutral core could in theory be used as a ground, but this would be dangerous if the core broke, so this is not normally used in building wiring or portable appliances. It is, however, used in some other situations with special precautions. For instance, in Switzerland, sockets in houses with the old two wire installation have the ground and neutral contacts connected together, probably supposing that the professionally maintained house installation is much more reliable than plugged-in device. Also using the neutral as a ground prevents the use of RCDs.

7.4 History Of Plugs And Sockets

When electricity was first introduced into the household, it was primarily used for lighting. At that time, many electricity companies operated a split-tariff system where the cost of electricity for lighting was lower than that for other purposes. This led to low-power appliances (such as vacuum cleaners and hair driers) being connected to the light fitting. The picture to the right shows a 1909 electric toaster with a light bulb socket plug.

However, as electricity became a common method of heating houses and operating labour-saving appliances, a means of connection to the electric system other than using a light socket was needed. The original two prong electrical plug and socket were invented by Harvey Hubbell and patented in 1904.

The three prong plug was invented in 1928 by Philip F. Labre, while he was going to school at the Milwaukee School of Engineering (MSOE). It is said that his landlady had a cat which would knock over her fan when it came in the window. When she plugged the fan back in, she would get an electric shock. Philip figured out that if the plug was grounded, the electricity would go to earth through the plug rather than his landlady. He applied for and was issued a patent for grounding receptacle and plug on June 5, 1928.[2] As the need for safer installations became apparent, earthed three-contact systems were made mandatory in most industrial countries.

7.5 Proliferation Of Standards

The reason that there are now over a dozen different styles of plugs and wall outlets is that when European countries adopted 220-240V electricity, for nationalistic reasons they developed their own unique national plug designs instead of agreeing on a European standard plug. In contrast, the 38 different countries which adopted the American 110-120V standard electricity also adopted the U.S. type A and B plugs. Most countries elsewhere in the world were once colonies of European nations and usually adopted the standards of their colonial governments at the time electricity was introduced. In many other countries there is no single national standard and multiple voltages, frequencies and plug designs are in use, creating extra complexity and potential safety problems for users.

However, in recent years most countries have settled on one of a few de facto standards, although there are legacy installations of obsolete wiring in most countries of the world. Some buildings have wiring that has been in use for almost a century and which pre-dates all modern standards.To minimize the difficulty of designing for different national standards, many manufacturers of electrical devices like personal computers have adopted the practice of putting a single world-standard IEC connector on the device, and supplying for each country a power cord equipped with a standard IEC connector on one end and a national power plug at the other. The device itself is designed to adapt to a wide range of voltage and frequency standards.

7.6 World Maps By Plug/Socket And Voltage/Frequency

There are two basic standards for voltage and frequency in the world. One is the North American standard of 110-120 volts at 60 Hz, which uses plugs A and B, and the other is the European standard of 220-240 volts at 50 Hz, which uses plugs C through M. The differences arose for historical reasons.

In the United States, Thomas Edison insisted on using 110 volts direct current (DC) rather than alternating current (AC) for his electric system in New York City. However, George Westinghouse, who built the first large hydro-electric plants at Niagara Falls, decided to use AC instead of DC because it could be stepped up or stepped down in voltage using transformers. The electrical genius Nicola Tesla advised him that 240 V at 60 Hz was optimal (According to some sources 60 Hz was chosen because it made for more convenient gearing ratios in AC electric clocks), but authorities would not let him use more than 110 V for distribution. Eventually Edison switched his 110 V DC system over to AC as well, and so 110 V at 60 Hz became the American electrical standard, despite the fact it required conductors twice as large to carry the same amount of power as 240 V.

In Europe, the German company AEG built the first generating facilities, and chose 50 Hz because it fitted better into the metric system of powers of ten (1, 10, 100). AEG had a virtual monopoly in Europe so their standard spread to the rest of the continent and eventually to Britain. Originally parts of Europe were electrified at 110-120 V like North America, but after World War II, regulators decided to increase it to 220-240 V to reduce the amount of copper used for wiring[citation needed], although many European countries had adopted 220-240V long before WW2. In Britain, for example, 240 volts @ 50 Hz was officially adopted as a standard early in the 20th century, although there were local systems in some towns supplying power at non-standard voltages and frequencies (25Hz, 40 Hz and even DC) right up until the 1950s.

American regulators would have liked to double the voltage as well, but there were far more household electrical appliances than in Europe. They compromised by adopting a split phase 240 V system, supplying 120 V on two live conductors going into each household with a single neutral. Small appliances ran on 120 V, big ones on 240 V. It was more complicated, but saved copper and was backward-compatible with existing appliances. Also, the original plugs could be used with the revised system.

Countries on other continents have adopted one of these two voltage standards, although some countries use variations or a mixture of standards. The outline maps show the different plug types, voltages and frequencies used around the world, colour-coded for easy reference.

7.7 Types Of Plug And Sockets

Electrical plugs and their sockets differ by country in shape, size and type of connectors. The type used in each country is set by national standards legislation. In this article each type is designated by a letter designation from a U.S. government publication, plus a short comment in parentheses giving its country of origin and number of contacts. Subsections then detail the subtypes of each type as used in different parts of the world.

Note that IEC Class I refers to earthed equipment. IEC Class II refers to unearthed equipment protected by double insulation. See Appliance classes.

7.7.1 type a (north american/japanese 2-pin)

Standardized by the U.S. National Electrical Manufacturers Association[5] and adopted by 38 other countries, this simple plug with two flat parallel pins, or blades, is used in most of North America and on the west coast of South America on devices not requiring a ground connection, such as lamps and "double-insulated" small appliances. NEMA 1-15 sockets have been prohibited in new construction in the United States and Canada since 1962, but remain in many older homes and are still sold "for replacement use only". Type A plugs are still very common because they are compatible with type B sockets.

Early designs could be inserted either way, but some modern ones prevent the neutral pin from being inserted into the live socket by making it wider than the live one, referred to as a polarized plug. (Note that this is not the same as positive/negative polarization in a direct current system.) New polarized plugs will not fit in old type A sockets, but both old and new type A plugs will fit in new type A and type B sockets. Some devices that do not distinguish between neutral and live, such as sealed electronic power supplies, are still sold with both pins narrow. When attaching a new polarized plug to a cord, it is useful to remember that the most common type of two-conductor cord for low-power use in North America has smooth insulation on the "hot" side and ribbed insulation on the "neutral" side.The Japanese plug and socket are identical to NEMA 1-15. However, the Japanese system incorporates stricter dimensional requirements for the plug housing, different marking requirements, and mandatory testing and approval by MITI or JIS.

Some older Japanese outlets and multiplug adapters are non-polarized -- the slots in the sockets are the same size - and will only accept non-polarized plugs. Japanese plugs should be able to fit into modern North American outlets without trouble, but North American appliances with polarized plugs may require adapters or replacement non-polarized plugs to connect to older Japanese outlets; or even replacement of the wall socket itself.

Japanese standard wire sizes and the resulting current ratings are somewhat different from those used elsewhere in the world. Japanese voltage is only 100 volts - lower than American voltage - and the frequency in eastern Japan is only 50 hertz instead of 60, so even if a North American plug can be inserted into a Japanese socket, it does not always mean the device will work properly.

7.7.2 type b (american 3-pin)

An American grounded (earthed) plug. Note that the receptacle will also accept an ungrounded (two prong) plug whether polarized or unpolarized.

NEMA 5-15 (North American 15 A/125 V grounded)The type B plug has two flat parallel blades like type A, but has a round ground or earthing pin (American standard NEMA 5-15/Canadian standard CSA 22.2, N°42).[5] It is rated for 15 amperes at 125 volts. The ground pin is longer than the live and neutral blades, so the device is grounded before the power is connected. The neutral blade in the type B socket is wider than the live one to prevent type A plugs being inserted upside-down, but type B plugs often have both pins narrow since the ground pin enforces polarity.

The 5-15 socket is standard in all of North America (Canada, the United States and Mexico). It is also used in Central America, the Caribbean, northern South America (Colombia, Ecuador, Venezuela and part of Brazil), Japan, parts of South Korea; and Taiwan.With type B outlets, if you look directly at the outlet with the ground at the bottom, the neutral slot is on the left, and the live slot is on the right. They may also be installed with the ground at the top or on either side, but the pinout going clockwise, starting with the ground, are always ground, neutral, live. If the plug is polarized, the widest pin is the neutral connector.

Due to the low power (1.8KW) available from a 120 V 15A socket a number of other NEMA connectors for higher currents and 240 V supplies are also commonly encountered in North American homes.

JIS C 8303, Class I (Japanese 15 A/100 V grounded)

Japan also uses a Type B plug similar to the North American one.[6] However it is less common than its Type A equivalent.

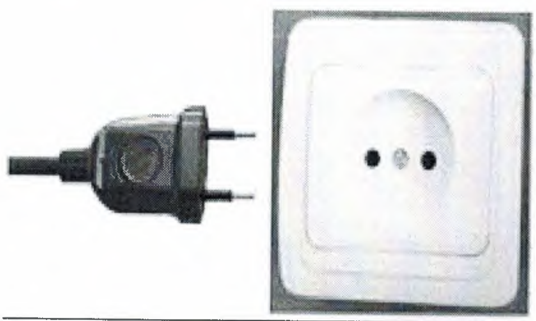


Figure 7.3 CEE 7/16 plug and socket

7.7.3 type c (european 2-pin)

This two-pin plug is probably the single most widely used international plug, popularly known as the Europlug. The plug is unearthed and has two round, 4 mm pins, which usually converge slightly. It can be inserted into any socket that accepts 4 mm round contacts spaced 19 mm apart. It is described in CEE 7/16.[7] and is also defined in Italian standard CEI 23-5 and Russian standard GOST 7396

The Europlug is used in Class II applications throughout continental Europe (Germany, Austria, Switzerland, Italy, Greece, the Netherlands, Belgium, France, Spain, Portugal, Denmark, Norway, Sweden, Finland, Iceland, Slovenia, Poland, The Czech Republic, Slovakia, Hungary, Romania, Bulgaria, Lithuania). It is also used in Turkey, the Middle East, most of Africa, Peru, Bolivia, Chile, Brazil, Uruguay, as well as the former Soviet republics, and many developing nations.

This plug is intended for use with devices that require 2.5 A or less. Because it can be inserted in either direction into the socket, live and neutral are connected at random.

CHAPTER EIGHT
MCCB-MCB

8.1 Overview

In this chapter i tried to explain mccb and mcb.I gave general information of the mccb.its usage areas and the application styles.

8.2 Mccb

A circuit breaker is an automatically-operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city.

Figure 8.1 Operation

Magnetic circuit breakers are implemented using a solenoid (electromagnet) whose pulling force increases with the current. The circuit breaker's contacts are held closed by a latch and, as the current in the solenoid increases beyond the rating of the circuit breaker, the solenoid's pull releases the latch which then allows the contacts to open by spring action. Some types of magnetic breakers incorporate a hydraulic time delay feature wherein the solenoid core is located in a tube containing a viscous fluid. The core is restrained by a spring until the current exceeds the breaker rating. During an overload, the solenoid pulls the core through the fluid to close the magnetic circuit, which then provides sufficient force to release the latch. The delay permits brief current surges beyond normal running current for motor starting, energizing equipment, etc. Short circuit currents provide sufficient solenoid force to release the latch regardless of core position thus bypassing the delay feature. Ambient temperature affects the time delay but does not affect the current rating of a magnetic breaker.

Thermal breakers use a bimetallic strip, which heats and bends with increased current, and is similarly arranged to release the latch. This type is commonly used with motor control circuits. Thermal breakers often have a compensation element to reduce the effect of ambient temperature on the device rating.Thermomagnetic circuit breakers, which are the type found in most distribution boards, incorporate both techniques with the electromagnet responding instantaneously to large surges in current (short circuits) and the bimetallic strip responding to less extreme but longer-term overcurrent conditions.

Circuit breakers for larger currents are usually arranged with pilot devices to sense a fault current and to operate the trip opening mechanism.

Under short-circuit conditions, a current many times greater than normal can flow (see maximum prospective short circuit current). When electrical contacts open to interrupt a large current, there is a tendency for an arc to form between the opened contacts, which would allow the flow of current to continue. Therefore, circuit breakers must incorporate various features to divide and extinguish the arc. In air-insulated and miniature breakers an arc chute structure consisting (often) of metal plates or ceramic ridges cools the arc, and blowout coils deflect the arc into the arc chute. Larger circuit breakers such as those used in electrical power distribution may use vacuum, an inert gas such as sulfur hexafluoride or have contacts immersed in oil to suppress the arc.

The maximum short-circuit current that a breaker can interrupt is determined by testing. Application of a breaker in a circuit with a prospective short-circuit current higher than the breaker's interrupting capacity rating may result in failure of the breaker to safely interrupt a fault. In a worst-case scenario the breaker may successfully interrupt the fault, only to explode when reset, injuring the technician.

Small circuit breakers are either installed directly in equipment, or are arranged in a breaker panel. Power circuit breakers are built into switchgear cabinets. High-voltage breakers may be free-standing outdoor equipment or a component of a gas-insulated switchgear line-up.

8.3 Low Voltage Thermal Magnetic Circuit Breaker

Below is a photograph of the internal details of a 10 ampere European DIN rail mounted thermal-magnetic miniature circuit breaker. Circuit breakers such as this are the most common style in modern domestic consumer units and commercial electrical distribution boards throughout Europe. Unfortunately, while the size and shape of the opening in the front and its elevation from the rail are standardised, the arrangements for busbar connections are not, so installers need to take care that the chosen breaker fits the bus bar in a particular board.

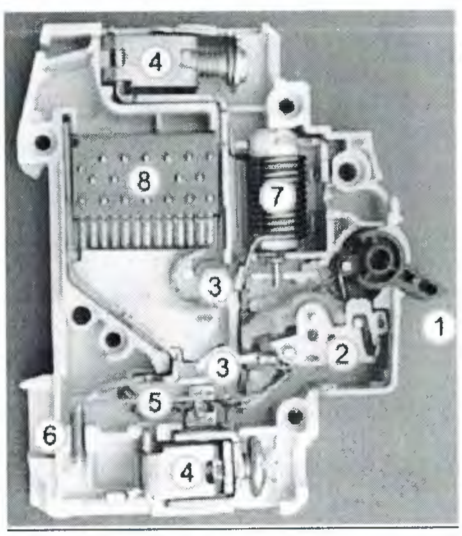


Figure 8.2 Actuator lever-used to manually trip and reset the circuit breaker

Indicates the status of the circuit breaker (On or Off/tripped). Most breakers are designed so they can still trip even if the lever is held or locked in the on position. This is sometimes referred to as "free trip" or "positive trip" operation.

Actuator mechanism - forces the contacts together or apart.

- Contacts - Allow current to flow when touching and break the flow of current when moved apart.
- Terminals
- Bimetallic strip
- Calibration screw - allows the manufacturer to precisely adjust the trip current of the device after assembly.
- Solenoid
- Arc divider / extinguisher

8.4 COMMON TRİP BREAKERS

When supplying a branch circuit with more than one live conductor, each live conductor must be protected by a breaker pole. To ensure that all live conductors are interrupted when any pole trips, a "common trip" breaker must be used. These may either contain two or three tripping mechanisms within one case, or for small breakers, may externally tie the poles together via their operating handles.

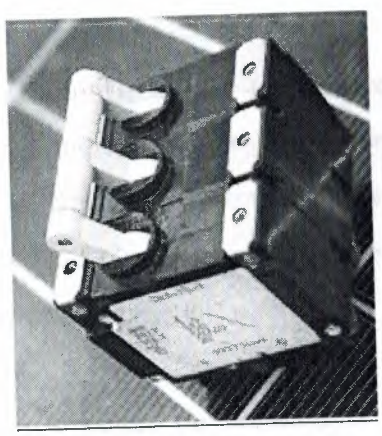


Figure 8.3 Three pole common trip breaker for supplying a three-phase device. This breaker has a 2 A rating

Two pole common trip breakers are common on 120/240 volt systems where 240 volt loads (including major appliances or further distribution boards) span the two live wires. Three pole common trip breakers are typically used to supply three phase power to large motors or further distribution boards.

8.5 Types Of Circuit Breaker

There are many different technologies used in circuit breakers and they do not always fall into distinct categories. Types that are common in domestic, commercial and light industrial applications at low voltage (less than 1000 V) include:

Figure 8.4 Front panel of a 1250 A air circuit breaker manufactured by ABB. The breaker can be withdrawn from its housing for servicing. Trip characteristics are configurable via DIP switches on the front panel.

- MCB (Miniature Circuit Breaker)—rated current not more than 100 A. Trip characteristics normally not adjustable. Thermal or thermal-magnetic operation. Breakers illustrated above are in this category.
- MCCB (Moulded Case Circuit Breaker)—rated current up to 1000 A. Thermal or thermal-magnetic operation. Trip current may be adjustable.

Electric power systems require the breaking of higher currents at higher voltages. Examples of high-voltage AC circuit breakers are:

Vacuum circuit breaker—With rated current up to 3000 A, these breakers interrupt the current by creating and extinguishing the arc in a vacuum container. These can only be practically applied for voltages up to about 35,000

V, which corresponds roughly to the medium-voltage range of power systems. Vacuum circuit breakers tend to have longer life expectancies between overhaul than do air circuit breakers.

Air circuit breaker—Rated current up to 10,000 A. Trip characteristics are often fully adjustable including configurable trip thresholds and delays. Usually electronically controlled, though some models are microprocessor controlled via an integral electronic trip unit. Often used for main power distribution in large industrial plant, where the breakers are arranged in draw-out enclosures for ease of maintenance.

8.6 Other Breakers

The following types are described in separate articles.

Breakers for protections against earth faults too small to trip an overcurrent device:

- RCD—Residual Current Device (formerly known as a Residual Current Circuit Breaker) - detects current imbalance. Does NOT provide overcurrent protection.
- RCBO—Residual Current Breaker with Overcurrent protection - combines the functions of an RCD and an MCB in one package. In the United States and Canada, panel-mounted devices that combine ground(earth) fault detection and overcurrent protection are called Ground Fault Circuit Interrupter (GFCI) breakers; a wall mounted outlet device providing ground fault detection only is called a GFI.
- ELCB—Earth leakage circuit breaker. This detects earth current directly rather than detecting imbalance. They are no longer seen in new installations for various reasons.
- Autorecloser: A type of circuit breaker which closes again after a delay. These are used on overhead power distribution systems, to prevent short duration faults from causing sustained outages.
- Polyswitch (polyfuse): A small device commonly described as an automatically-resetting fuse rather than a circuit breaker.

CHAPTER NINE
CABLES

9.1 Overview

This chapter is about the cables which we are using while we are making the illumination project.The types of the cables,the areas where we use which types of cables.Their inside view.

9.2 Modern Cables

- T&E
    1. L&N are PVC insulated, earth conductor is bare
    2. All 3 are sheathed with PVC
    3. Most domestic cable is T&E
    4. $1mm^2$ $1.5mm^2$ & $2.5mm^2$ have non-stranded conductors
    5. $4mm^2$, $6mm^2$, $10mm^2$ & $16mm^2$ are stranded
- Singles

1. PVC insulated single conductors
2. Used for a minority of domestic work
3. For earth & equipotential bonding
4. Standard cable for use in conduit

- LSF

1. Low Smoke & Fume
2. Available in pretty purple

- Armoured

For outdoor & garden use

- MICC

1. aka pyro
2. Copper tube sheath with magnesium oxide insulation
3. Fireproof
4. Rigid
5. Occasionally seen in domestic premises, mainly in blocks of flats
6. Widely used for fire alarm systems in commerce
7. Prone to absorbing moisture from the air

8. Hence does not always combine well with RCDs
9. Special cable terminations required
10. Ideal for flammability risk areas, eg traversing a thatched roof.

9.3 Historic Cables

- Paper

1. Paper insulation
2. From the WW1 era
3. Very rare now

- PBJ

i. PolyButyl Jute
ii. Common mains incomer insulation,
iii. Lots of old PBJ is still in service

- Lead sheathed

i. Common in 1930s for socket circuits
ii. Used as exterior farm cable well after that
iii. Lead sheath does not make good earth connections
iv. Rubber interior insulation

- VIR

i. Rubber insulated wiring
ii. The most common historic wiring
iii. Twisted pair cotton/rubber was very common
iv. Rubber wiring uses thinner conductors than PVC, since the rubber is higher temperature rated
v. Rubber insulation perishes, cracks & falls off
vi. Most VIR wiring is now in a very bad way
vii. If you have a VIR instalation in use you have a safety problem.

- Aluminium

i. Cheaper alternative to copper

ii. Used at one time until its risks were realised
iii. Aluminium cable creeps, oxidises & fractures.
iv. Fire risk
v. Requires special connections, do not connect to old ali cable using connectors intended for copper.
vi. Al requires a larger conductor size than Cu for the same current rating

- Copper clad aluminium

i. An attempt to improve the properties of ali cable
ii. Significantly better than al, surface oxidation is eliminated, creep reduced & the cracking risk more or less eliminated

- T&E

i. 7/.029 T&E
ii. imperial stranded version of 2.5mm² T&E
iii. Ashathene T&E
iv. Precursor to PVC T&E
v. PVC outer VIR inner
vi. an early T&E cable
vii. 2 core T&E
viii. no earth, used for lighting circuits

9.4 POWER CABLES

A power cable is an assembly of two or more electrical conductors, usually held together with an overall sheath. The assembly is used for transmission of electrical power.

9.4.1 history

Early telegraph systems were the first forms of electrical cabling but transmitted only small amounts of power. Gutta-percha insulation used for the first transatlantic cables was unsuitable for building wiring use since gutta-percha deteriorated rapidly when exposed to air. The first power distribution system developed by Thomas Edison used copper rods, wrapped in jute and placed in rigid pipes filled with a bituminous compound. Although vulcanized rubber had been patented by Charles Goodyear in 1844, it was not applied to cable insulation until the 1880s, when it was used for lighting circuits. Rubber-insulated cable was used for 11,000 volt circuits in 1897 installed for the Niagara Falls power project. Oil-impregenated paper-insulated high voltage cables were commercially practical by 1895. During World War II several varieties of synthetic rubber, and polyethylene insulation was applied to cables.

9.4.2 construction

Modern power cables come in a variety of sizes, materials, and types, each particularly adapted to its uses. Large single insulated conductors are also called power cables in the trade.

Conductors are usually made of copper or aluminum wires, or may be composite conductors with steel strands at their core. Conductors are usually stranded for flexibility, but small cables may use solid conductors.

Conductors in a cable may be different sizes. Each conductor has its own electrical insulation. The cable may include uninsulated conductors used for the circuit neutral or for ground (earth) connection.

The overall assembly may be round or flat. Filler strands may be added to the assembly to maintain its shape. Special purpose power cables for overhead or vertical use may have additional elements such as steel or Kevlar structural supports.

For circuits operating at 2400 volts between conductors or more, a conductive shield may surround each conductor. This equalizes electrical stress on the cable insulation. This technique was patented by Martin Hochstadter in 1916, and so the shield is sometimes called a Hochstadter shield. The individual conductor shields of a cable are connected to earth ground at one or both ends of each length of cable.Some power cables for outdoor overhead use may have no overall sheath. Other cables may have a plastic or metal sheath enclosing all the conductors. The materials for the sheath will be selected for the intended application, and may be specially resistant to water, oil, sunlight, underground conditions, chemical vapors, impact, or high temperatures. Cables intended for underground use or direct burial in earth will have heavy plastic sheaths, may be protected by a lead sheath, or may require special direct-buried construction. Where cables must run where exposed to impact damage, they are protected with flexible steel tape or wire armor, which may also be covered by a water resistant jacket.

Cables for high-voltage (more than 65,000 volts) power distribution may be insulated with oil and paper, and are run in a rigid steel pipe, semi-rigid aluminium or lead jacket/sheath. The oil is kept under pressure to prevent formation of voids that would allow partial discharges within the cable insulation. Newer cables use cross link polyethylene (XLPE) for insulation.

A hybrid cable will include conductors for control signals or may also include optical fibers for data. Besides data transmission, these optical fibres are used for distributed temperature monitoring in order to optimize the load/ampacity of the cable.

9.4.3 named cable types

Common types of general-purpose cables used by electricians are defined by national or international regulations or codes. Commonly-used types of power cables are often known by a "shorthand" name. For example, NEC type NM-B (Non-Metallic, variant B), often referred to as RomexTM (named by the Rome Wire Company, now a trademark of Southwire Company [1]), is a cable with a nonmetallic jacket. UF (underground feeder) is also nonmetallic but uses a moisture- and sunlight-resistant construction suitable for direct burial in the earth or where exposed to sunlight, or in wet, dry, or corrosive locations. Type AC is a fabricated assembly of insulated conductors in a flexible metallic armor, made by twisting an interlocking metal strip around the conductors. BX, an early genericized trademark of the General Electric company was used before and during WWII, designating a particular design of armored cable.

In Canada, type TECK cable, with a flexible aluminum or steel armour and overall flame-retardant PVC jacket, is used in industry for wet or dry locations, run in trays or attached to building structure, above grade or buried in earth. A similar type of cable is designated type MC in the United States.

Electrical power cables are often installed in raceways including electrical conduit, and cable trays, which may contain one or more conductors. Conduit may also be rigid or flexible, metallic or nonmetallic, and differentiation from cable may require some investigation of the contents at their termination.

Mineral Insulated Copper Clad cable (type MI) is a fire-resistant cable using magnesium oxide as an insulator. It is used in demanding applications such as fire alarms and oil refineries.

- Flexible cables

All cables are flexible, which allows them to be shipped to installation sites on reels or drums. Where applications require a cable to be moved repeatedly, more flexible cables are used. Small cables are called "cords" or "flex". Flexible cords contain finer stranded conductors, rather than solid, and have insulation and sheaths that are engineered to withstand the forces of repeated flexing. Heavy duty flexible power cords such as feeding a mine face cutting machine are carefully engineered -- since their life is measurable in (6) weeks! See "Power cord" and "Extension cable" for further description of flexible power cables. Other types of flexible cable include twisted pair, extensible, coaxial, shielded, and communication cable.

- Power cord

A power cord or mains cable is a cable that temporarily connects an electrical appliance to an electrical power source. The term is generally used for cables using a power plug to connect to a single-phase alternating current power source at "mains voltage" (100 to 240 volts, depending on the location). The terms power cable, mains lead or flex are also used. The term cord set is also used to distinguish those cords that include connectors molded to the cord at each end.

Power cords from those countries that use 110 V mains supply (chiefly the United States, Canada, parts of South America and Japan) tend to be bulkier than the mains cables used in the rest of the world, because of the higher currents required to deliver the same power (watts) at 110 V compared with 230 V.

Power cables may be either fixed or detachable from the appliance. In the case of detachable leads, the appliance end of the power cord has a socket (female connector) rather than a plug (male connector) to link it to the appliance, to avoid the dangers from having a live protruding pin. Cords may also have twist-locking features, or other attachments to prevent accidental disconnection at one or both ends.

Common types of detachable power cable have appliance-side connectors such as the IEC 60320 C13 sometimes colloquially known as an "IEC connector", "Kettle lead" or "IBM plug" (commonly used for higher current appliances where an earth or ground connection is required) and IEC 60320 C7 commonly used for low-current applications such as an power supply inlet for use with a laptop computer. The IEC C7 is also known as a "figure-of-eight lead" (connecting by two small round pins, with round insulating bushings; the connector has a figure-of-eight cross section). The polarised IEC 60320 C5 connector is now commonly used on the AC side of laptop computer power supplies. The IEC C5 is commonly known as "cloverleaf plug" or "Mickey Mouse plug" because of the shape of its cross section.

IEC power cables come in high-temperature and low-temperature variants, as well as various current capacities. The connectors have slightly different shapes to ensure that it is not possible to substitute a cable with a lower temperature or current rating, but that it is possible to use an over-rated cable. Cords also have different types of exterior jackets available to accommodate environmental variables such as moisture, temperature, oils, sunlight, flexibility, and heavy wear. For example, a heating appliance may come with a cord designed to withstand accidental contact with heated surfaces.

Note that the same types of connectors are used with both 110 V and 230 V power cables, so care must be used when moving appliances between countries with different voltage standards — substituting a power cord that matches local power outlets will result in an incorrect voltage being applied to the appliance or equipment. Unless explicitly labelled as capable of handling local voltages, this is very likely to damage or destroy the appliance.

An extension cord (also known as a power extender, or an extension lead, sometimes known as an extension cable, but that has a distinct meaning from extension cord for many people) is a length of flexible electrical power cable (flex) with a plug on one end and one or more sockets on the other end (usually of the same type as the plug). The term usually refers to mains (household AC) extensions but is also used to refer to extensions for other types of cabling. If the plug and receptacle are of different types, the term "adapter cord" may be used.

Other countries also regulate the use of extension cables but the specific conditions and the nature of the regulation varies. In Europe and elsewhere where the normal domestic voltage is around 230 V, there is less risk of causing fire through overheating of cables for any given power due to the lower current. However most European extension cables now include an automatic current cut-out to avoid misuse of the cable. This requires manual re-

- Twisted pair

Twisted pair cabling is a form of wiring in which two conductors are wound together for the purposes of canceling out electromagnetic interference (EMI) from external sources and crosstalk from neighboring wires.
Twisting wires decreases interference because the loop area between the wires (which determines the magnetic coupling into the signal) is reduced. In balanced pair operation, the two wires typically carry equal and opposite signals (differential mode) which are combined by subtraction at the destination. The noise from the two wires cancel each other in this subtraction because the two wires have been exposed to similar EMI.

The twist rate (usually defined in twists per metre) makes up part of the specification for a given type of cable. The greater the number of twists, the greater the attenuation of crosstalk. Where pairs are not twisted, as in most residential interior telephone wiring, one member of the pair may be closer to the source than the other, and thus exposed to slightly different induced EMF.

In contrast to FTP and STP cabling, UTP cable is not surrounded by any shielding. It is the primary wire type for telephone usage and is very common for computer networking, especially as patch cables or temporary network connections due to the high flexibility of the cables.

- Coaxial Cable

Coaxial cable is an electrical cable consisting of a round conducting wire, surrounded by an insulating spacer, surrounded by a cylindrical conducting sheath, usually surrounded by a final insulating layer (jacket). It is used as a high-frequency transmission line to carry a high-frequency or broadband signal. Because the electromagnetic field carrying the signal exists (ideally) only in the space between the inner and outer conductors, it cannot interfere with or suffer interference from external electromagnetic fields.Four-conductor shielded cable with metal foil shield and drain wire

A shielded cable is an electrical cable of one or more insulated conductors enclosed by a common conductive layer. The shield may be composed of braided strands of copper (or other metal), a non-braided spiral winding of copper tape, or a layer of conducting polymer. Usually, this shield is covered with a jacket. The shield acts as a Faraday cage to reduce electrical noise from affecting the signals, and to reduce electromagnetic radiation that may interfere with other devices. The shield minimizes capacitively coupled noise from other electrical sources.

In single conductor signal cables the shield may act as the return path for the signal and is usually connected only at the signal source. In multiconductor cables the shield should be grounded only at the source end, and will not carry circuit current.

High voltage power cables with solid insulation are shielded to protect the cable insulation and also people and equipment.

- Signal cables

By twisting two conductors of a signal circuit, some cancellation of inductively coupled noise is obtained. However, a metallic shield layer over the twisted pair provides better suppression of noise. Coaxial cable is used at higher frequencies to provide controlled circuit impedance, but the outer tubular conductor is also effective at reducing coupling of noise into a circuit.

Applications

The use of shielded cables in security systems protects them from power frequency and radio frequency interference, reducing the number of false alarms being generated.

Microphone or "signal" cable used in setting up PA is usually shielded twisted pair cable, terminated in XLR connectors. The twisted pair carries the signal in a balanced audio configuration.

The cable laid from the stage to the mixer is often multicore cable carrying several pairs of conductors.

CHAPTER TEN
ILLUMINATION CALCULATIONS

10.1 Overview

This chapter is about the illumination calculations of the thesis that i have done.

10.2 FİRST FLOOR:

- Man Wc

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(6.25*4.25)/2.2(6.25+4.25)=1.25

η=0.38

d=1.25

A=6.25*4.25=26.56m

qt=(E*A*d)/ η=13993

Z=qt/ql=13993/2350=6

N/2=6/2=3

E0=(qlx*Z*η)/(d*A)=162 lux

- Dressing Room

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(6.25*3.3)/2.2(6.25+3.3)=1

η=0.33

d=1.25

A=20.625

qt=(E*A*d)/ η=15621

Z =6

N/2=3

E0=(qlx* Z *η)/(d*A)=180.48lux

- Dressing Room

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(6.25*3.2)/2.2(6.25+3.2)=1

η=0.38

d=1.25

A=20m

qt=(E*A*d)/ η=15151

Z=7

N/2=3

E0=(qlx*Z*η)/(d*A)=183 lux

- Woman Wc

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(6.25*4.35)/2.2(6.25+4.35)=1.25

η=0.38

d=1.25

A=27.18

qt=(E*A*d)/ η=17881

Z=7

N/2=3

E0=(qlx*Z*η)/(d*A)=183 lux

- Dınnıng Hall

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(42.19*11.83)/2.2(42.19+11.83)=4

η=0.55

d=1.25

A=499.1

qt=(E*A*d)/ η=2283

Z =97

N/2=48

E0=(qlx*Z*η)/(d*A)=201 lux

- Corrıdors(E=150)

i. Corridor1

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(18.15*1.5)/2.2(18.15+1.5)=0.6

η=0.23

d=1.25

A=27.22

qt=(E*A*d)/ η=22190

Z =10

N/2=5

E0=(qlx*Z*η)/(d*A)=158 lux

ii. Corridor2

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(6.3*2.35)/2.2(6.3+2.35)=0.8

η=0.29

d=1.25

A=14.8

qt=(E*A*d)/ η=9569

Z =4

N/2=2

E0=(qlx*Z*η)/(d*A)=147 lux

iii. Corridor3

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(32*1.35)/2.2(32+1.35)=0.6

η=0.23

d=1.25

A=43.2

qt=(E*A*d)/ η=35217

Z =15

N/2=8

E0=(qlx*Z*η)/(d*A)=150 lux

iv. Corridor4

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(14.8*2.6)/2.2(14.8+2.6)=1

η=0.33

d=1.25

A=38.48

qt=(E*A*d)/η=2183

Z =9

N/2=4

E0=(qlx*Z*η)/(d*A)=14lux

v. Corridor5

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(38.29*2.41)/2.2(38.29+2.41)=1

η=0.33

d=1.25

A=92m

qt=(E*A*d)/ η=52272

Z =22

N/2=11

E0=(qlx*Z*η)/(d*A)=95lux

10.3 SECOND FLOOR;

- Teachers Room

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(5.85*4.1)/2.2(5.85+4.1)=1

η=0.33

d=1.25

A=23.98

qt=(E*A*d) η/=181667

Z =7

N/2=3

E0=(qlx*Z*η)/(d*A)=181lux

- Supplies Room(E=100)

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(4.25*1.9)/2.2(4.25+1.9)=0.6

η=0.23

d=1.25

A=8

qt=(E*A*d)/ η=4347.8

Z =2

N/2=1

E0=(qlx Z*η)/(d*A)=108lux

- Medical Room(E=100)

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(3.79*3.2)/2.2(3.79+3.2)=0.8

η=0.29

d=1.25

A=12.35

qt=(E*A*d)/m=5323.2

Z =3

N/2=2

E0=(qlx*Z*η)/(d*A)=132lux

- Classroom 9

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(7.55*5.8)/2.2(7.55+5.8)=1.5

η=0.41

d=1.25

A=43.79

qt=(E*A*d)/ η=26701

Z =11

N/2=4

E0=(qlx*Z*η)/(d*A)=194lux

- Classroom 8

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(4.9*10.9)/2.2(4.9+10.9)=1.5

η=0.41

d=1.25

A=53.41

qt=(E*A*d)/ η=32567

Z =13

N/2=6

E0=(qlx*Z*η)/(d*A)=188lux

- Classroom 7

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(4.9*6.39)/2.2(4.9+6.39)=1.25

η=0.38

d=1.25

A=31.3

qt=(E*A*d)/ η=20592

Z =8

N/2=4

E0=(qlx*Z*η)/(d*A)=183lux

- Classroom 6

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(4.9*6.8)/2.2(4.9+6.8)=1.25

η=0.38

d=1.25

A=33.32

qt=(E*A*d)/ η=21921

Z =9

N/2=4

E0=(qlx*Z*η)/(d*A)=193lux

- Classroom 5

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(6.9*10.2)/2.2(6.9+10.2)=1.5

η=0.41

d=1.25

A=70.38

qt=(E*A*d)/ η=42914

Z =18

N/2=9

E0=(qlx*Z*η)/(d*A)=197lux

- Classroom 4

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(11.8*6.89)/2.2(11.8+6.89)=1.5

η=0.41

d=1.25

A=75.4

qt=(E*A*d)/ η=45976

Z =20

N/2=10

E0=(qlx*Z*η)/(d*A)=205lux

- Classroom 3

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(6.78*6.8)/2.2(6.78+6.8)=1.5

η=0.41

d=1.25

A=46.1

qt=(E*A*d)/ η=28102

Z =12

N/2=6E0=(qlx*Z*η)/(d*A)=200lux

- Classroom 2

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(6.8*7)/2.2(6.8+7)=1.5

η=0.41

d=1.25

A=47.6

qt=(E*A*d)/ η=29024

Z =12

N/2=6

E0=(qlx*Z*η)/(d*A)=195lux

- Classroom 1

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(6.8*6.75)/2.2(6.8+6.75)=1.5

η=0.41

d=1.25

A=45.9

qt=(E*A*d)/ η=27988

Z =12

N/2=6

E0=(qlx*Z*η)/(d*A)=202lux

- Security Room

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(3.8*2.8)/2.2(3.8+2.8)=0.8

η=0.29

d=1.25

A=10.4

qt=(E*A*d)/ η=9172

Z =4

N/2=2

E0=(qlx*Z*η)/(d*A)=209lux

- Corrıdors(E=100)

vi. Corridor1

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(15.7*1.4)/2.2(15.7+1.4)=0.6

η=0.23

d=1.25

A=21.98

qt=(E*A*d)/ η= 17918

Z =8

N/2=4

E0=(qlx*Z*η)/(d*A)=157lux

vii. Corridor2

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(6.3*2.35)/2.2(6.3+2.35)=0.8

η=0.29

d=1.25

A=14.8

qt=(E*A*d)/η=9569

Z =4

N/2=2

E0=(qlx*Z*η)/(d*A)=148lux

viii. Corridor3

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(4.9*2.84)/2.2(4.9+2.84)=1.5

η=0.41

d=1.25

A=13.91

qt=(E*A*d)/η=6361

Z =3

N/2=1

E0=(qlx*Z*η)/(d*A)=164lux

ix. Corridor4

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(32*1.24)/2.2(32+1.24)=0.

η=0.23

d=1.25

A=39.8

qt=(E*A*d)/ η=32445

Z =14

N/2=7

E0=(qlx*Z*η)/(d*A)=152lux

x. Corridor5

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(14.8*2.6)/2.2(14.8+2.6)=1

η=0.33

d=1.25

A=38.48

qt=(E*A*d)/ η=21863

Z =9

N/2=4

E0=(qlx*Z*η)/(d*A)=146lux

xi. Corridor6

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(2.41*38.29)/2.2(2.41+38.29)=1

η=0.33

d=1.25

A=92.27

qt=(E*A*d)/ η=524266

Z =22

N/2=11

E0=(qlx*Z*η)/(d*A)=148lux

- Spor Hall

h=H-h1=6.1-0.85=5.25 m

K=(a*b)/h(a+b)=(34.3*18.6)/2.2(34.3+18.6)=2.5

η=0.49

d=1.25

A=637.9

qt=(E*A*d)/ η=3825

Z =137

N/2=66

E0=(qlx*Z*η)/(d*A)=198lux

- Stairs

h=H-h1=3.05-0.85=2.2 m

K=(a*b)/h(a+b)=(3.81*6.1)/2.2(3.81+6.1)=1

η=0.33

d=1.25

A=23.32

qt=(E*A*d)/ η=8833

$Z = 4$

$N/2 = 2$

$E0 = (qlx * Z * \eta) / (d * A) = 106 lux$

* PS: WHILE I WAS MAKING THE PROJECT; I USED THE TL'D 36/84 W FLOURESCENT, 2360 LM AS AN ARMATURE TYPE

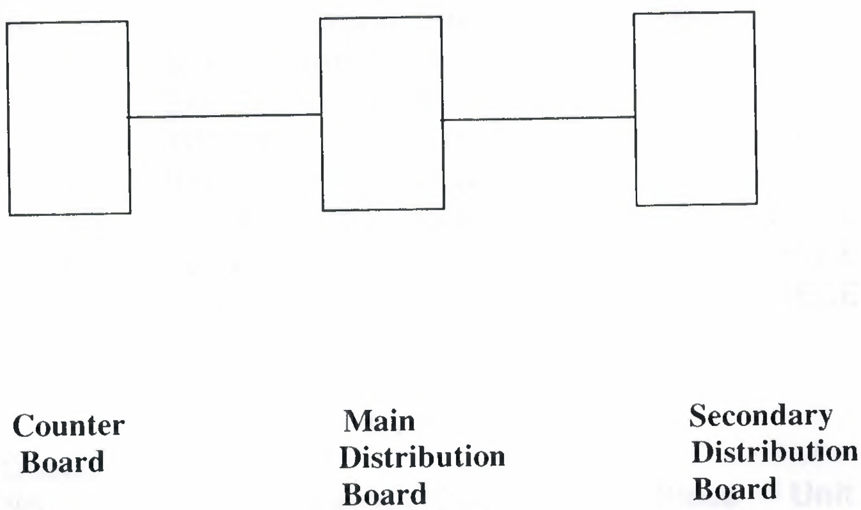
CHAPTER ELEVEN

VOLTAGE DROP CALCULATIONS

11.1 Overview

This capter includes the voltage drop calculations that are needed for my illumination project

11.2 Calculation



$$g1 = 0.42mV / Am$$
$$\Delta Ucm = g1 \times L1 \times I1$$
$$\Delta Ucm = 0.42 \times 25 \times 166.8$$
$$\Delta Ucm \cong 1752$$

$$g2 = 1mV / Am$$
$$\Delta Ums = g2 \times L2 \times I2$$
$$\Delta Ums = 1 \times 60 \times 62.55$$
$$\Delta Ums = 3753$$

$$\Delta Usm = \Delta Ucm + \Delta Ums$$
$$\Delta Usm = 1752 + 3753$$
$$\Delta Usm = 5506 \leq \%2.5$$

CHAPTER TWELVE
COST CALCULATIONS

12.1. OVERVIEW

In this chapter did the calculations of the cost.The cost calculations are very important because no manager and a company would except the high prices if there are cheaper volues

12.2. Calculatıons

DTK

Queue No	Explanation	Piece	Unit	Unit piece	Total
1	3x95+50mm2 SWA	25	METRE		0,00
2	3X6 way MCCB DB	1	PİECE		0,00
3	4x250A MCCB İnput	1	PİECE		0,00
4	3x100A MCCB Output	2	PİECE		0,00
5	3x63A MCCB Output	1	PİECE		0,00
6	Tel box	1	PİECE		0,00
7	TV box	1	PİECE		0,00
				Total	**0,00**

DTY

Queue No	Explanation	Piece	Unit	Unit piece	Total
1	3x35+16 mm2 ECC-PVC	60	METRE		0,00
2	3x100A MCCB İnput	1	PİECE		0,00
3	3x12 ways DB	1	PİECE		0,00
4	2x36W Flourescent İnstallation	113	PİECE		0,00
5	double plug İnstallation	14	PİECE		0,00
6	heater İnstallation	1	PİECE		0,00
7	Phone Plug İnstallation	1	PİECE		0,00
8	Tv. Plug İnstallation	3	PİECE		0,00
9	Clima İnstallation	9	PİECE		0,00
				Total	**0,00**

DTK1

Queue No	Explanation	Piece	Unit	Unit piece	Total

1	4x16+6 mm2 ECC-PVC	10	METRE		0,00
2	3x63A MCCB İnput	1	PİECE		0,00
3	3x6 way DB	1	PİECE		0,00
5	2x36W Flourescent İnstallation	37	PİECE		0,00
6	Double Plug İnstallation	10	PİECE		0,00
7	Heater İnstallation	6	PİECE		0,00
8	İnside Grounded İnstallation	24	PİECE		0,00
9	Phone Plug İnstallation	1	PİECE		0,00
10	Tv. Plug İnstallation	3	PİECE		0,00
				Total	**0,00**

DTUK

Queue No	**Explanation**	**Piece**	**Unit**	**Unit piece**	**Total**
1	3x35+16 mm2 ECC-PVC	10	METRE		0,00
2	3x100A MCCB İnput	1	PİECE		0,00
3	3x6 way DB	1	PİECE		0,00
				Total	**0,00**

DTO

Queue No	**Explanation**	**Piece**	**Unit**	**Unit piece**	**Total**
1	2x16+6 mm2 ECC-PVC	25	METRE		0,00
2	1x6 way DB 2x63A 300mA C/O	1	PİECE		0,00
3	2x36W Flourescent installation	5	PİECE		0,00
4	Double Plug İnstallation	11	PİECE		0,00
5	Heater İnstallation	1	PİECE		0,00
6	Clima İnstallation	2	PİECE		0,00
7	Data İnstallation	1	PİECE		0,00
8	Phone Plug İnstallation	2	PİECE		0,00
9	Tv. Plug İnstallation	4	PİECE		0,00
				Total	**0,00**

DTU1

Queue No	**Explanation**	**Piece**	**Unit**	**Unit piece**	**Total**
1	2x35+16 mm2 ECC-PVC	10	METRE		0,00
2	1x8 way DB 2x63A 300mA C/O	1	PİECE		0,00
3	2x36W Flourescent İnstallation	35	PİECE		0,00
4	Double Plug İnstallation	11	PİECE		0,00
5	Vavien Switch İnstallation	1	PİECE		0,00

DTGO

Queue No	Explanation	Piece	Unit	Unit piece	Total
1	2x16+6 mm2 ECC-PVC	25	METRE		0,00
2	1x6 yollu DT 2x63A 300mA C/O	1	PİECE		0,00
3	2x36W Flourescent İnstallation	2	PİECE		0,00
4	Double Plug İnstallation	4	PİECE		0,00
5	Heater İnstallation	1	PİECE		0,00
6	Clima İnstallation	1	PİECE		0,00
7	Data İnstallation	2	PİECE		0,00
8	Phone Plug İnstallation	1	PİECE		0,00
9	Tv. Plug İnstallation	1	PİECE		0,00
				Total	**0,00**

DTS6=DTS7=DTS9

Queue No	Explanation	Piece	Unit	Unit piece	Total
1	2x16+6 mm2 ECC-PVC	26	METRE		0,00
2	1x6 way DB 2x63A 300mA C/O	1	PİECE		0,00
3	2x36W Flourescent İnstallation	14	PİECE		0,00
4	Double Plug İnstallation	6	PİECE		0,00
6	Clima İnstallation	1	PİECE		0,00
7	Data İnstallation	2	PİECE		0,00
8	Phone Plug İnstallation	2	PİECE		0,00
9	Tv. Plug İnstallation	2	PİECE		0,00
				Total	**0,00**
	DTS6=DTS7=DTS9	3	PİECE		**0,00**

DTS4

Queue No	Explanation	Piece	Unit	Unit piece	Total
1	2x16+6 mm2 ECC-PVC	42	METRE		0,00
2	1x6 way DB 2x63A 300mA C/O	1	PİECE		0,00
3	2x36W Flourescent İnstallation	11	PİECE		0,00
4	Double Plug İnstallation	6	PİECE		0,00
6	Clima İnstallation	1	PİECE		0,00
7	Data İnstallation	2	PİECE		0,00
8	Phone Plug İnstallation	2	PİECE		0,00
9	Tv. Plug İnstallation	2	PİECE		0,00
				Total	**0,00**

DTS5

Queue No	Explanation	Piece	Unit	Unit piece	Total
1	2x16+6 mm2 ECC-PVC	58	METRE		0,00
2	1x6 way DB 2x63A 300mA C/O	1	PİECE		0,00
3	2x36W Flourescent İnstallation	6	PİECE		0,00
4	Double Plug İnstallation	6	PİECE		0,00
6	Clima İnstallation	1	PİECE		0,00
7	Data İnstallation	2	PİECE		0,00
8	Phone Plug İnstallation	2	PİECE		0,00
9	Tv. Plug İnstallation	2	PİECE		0,00
				Total	**0,00**

DTS1=DTS2=DTS3=DTS8

Queue No	Explanation	Piece	Unit	Unit piece	Total
1	2x16+6 mm2 ECC-PVC	36	METRE		0,00
2	1x6 way DB 2x63A 300mA C/O	1	PİECE		0,00
3	2x36W Flourescent İnstallation	24	PİECE		0,00
4	Double Plug İnstallation	6	PİECE		0,00
6	Clima İnstallation	1	PİECE		0,00
7	Data İnstallation	2	PİECE		0,00
8	Phone Plug İnstallation	2	PİECE		0,00
9	Tv. Plug İnstallation	2	PİECE		0,00
				Total	**0,00**
	DTS1=DTS2=DTS3=DTS8	4	PİECE	0,00	**0,00**

Queue No	Explanation	Piece	Unit	Unit piece	Total

1	3x95+50mm2 SWA	25	METRE	155,00	3875,00
2	3X6 way MCCB DB	1	PİECE	3834,00	3834,00
3	4x250A MCCB İnput	1	PİECE	680,00	680,00
4	3x100A MCCB Output	4	PİECE	189,00	756,00
5	3x63A MCCB Output	2	PİECE	181,00	362,00
6	Phone Box	1	PİECE	93,00	93,00
7	TV Box	1	PİECE	95,00	95,00
1	3x35+16 mm2 ECC-PVC	70	PİECE	58,00	4060,00
3	3x12 way DB	1	PİECE	4509,00	4509,00
4	2x36W Flourescent İnstallation	247	PİECE	127,00	31369,00
5	Double Plug İnstallation	74	PİECE	80,00	5920,00
6	Heater İnstallation	9	PİECE	164,00	1476,00
7	Phone Plug İnstallation	13	PİECE	88,00	1144,00
8	Tv. Plug İnstallation	19	PİECE	90,00	1710,00
9	Clima İnstallation	16	PİECE	109,00	1744,00
1	4x16+6 mm2 ECC-PVC	10	PİECE	30,00	300,00
3	3x6 way MCCB DB	2	PİECE	3834,00	7668,00
8	İnside Grounded İnstallation	24	PİECE	50,00	1200,00
1	2x16+6 mm2 ECC-PVC	212	METRE	18,00	3816,00
2	1x6 way DB 2x63A 300mA C/O	6	PİECE	84,00	504,00
7	Data İnstallation	11	PİECE	88,00	968,00
1	2x35+16 mm2 ECC-PVC	10	METRE	59,00	590,00
2	1x8 way DB 2x63A 300mA C/O	1	PİECE	173,00	173,00
5	Vavien Switch İnstallation	1	PİECE	88,00	88,00
				Total:	76934,00

CONCLUSION

As an electric and electronic engineer,the importantan of the illumination projects increases every day in every country.Because every day the population of the human beings increases so the needee of houses and buildings increas.The most comfortable and the most usefull illumination of the buildings are needed day by day.To achieve that the engineers must be clever while prepating the electrical project to manage the best.

While we are doing the illumination projects like my thesis,we must be very very carefull because any mıstakes that era done in the project would couses so many results in the future period.So at first we have to know and recognize the place very well.And than start to think how we should do the illumination.What armature types we have to use to achieve best illumination,where we should put plugs and armature or electrical devices to cost the minimum for us.Any engineer in the real life as an electrical project engiineer should make the unnecessary cost for the company..

In future i am sure that every thing about the illumination project will change lots of.Because the development and the researches about the illumination will increase day by day in order to new technologies.New types of armature will apppear,the buildings and their structures will change so the way off illumination we are doing will change.As it started the intelligenct houses,every thing will be computurized so the lightining of the houses will be different in future time

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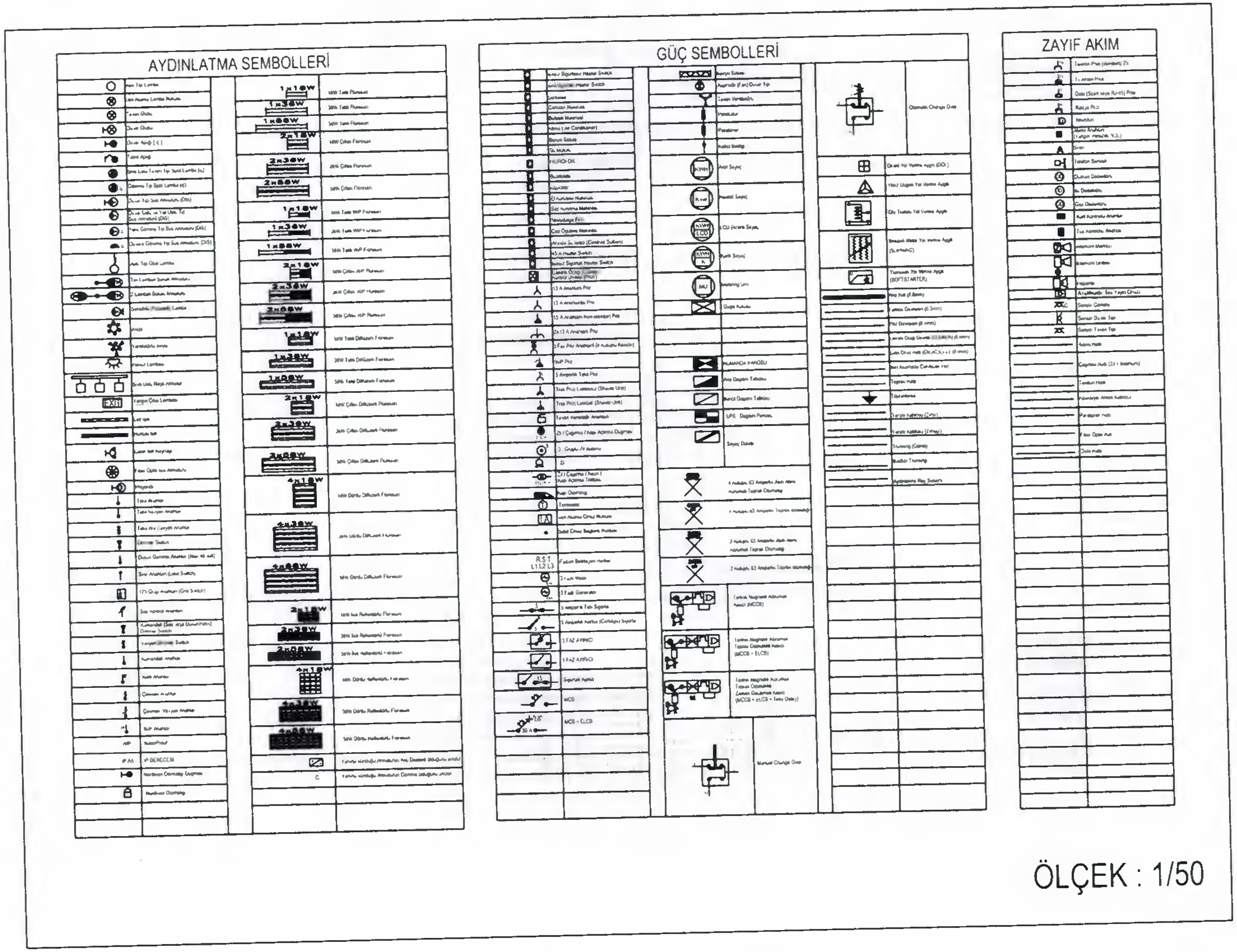
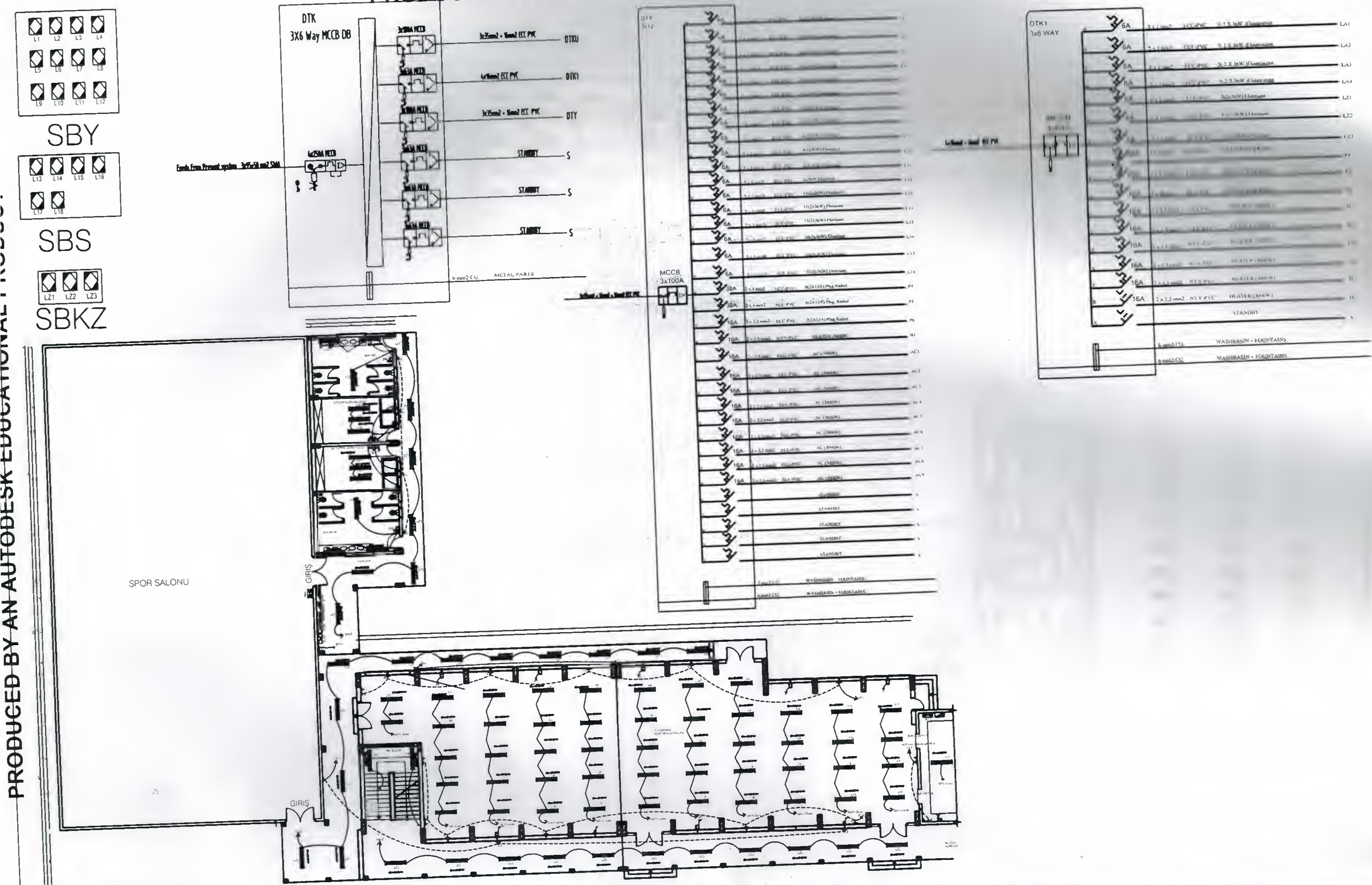
ILLUMINATION SYMBOLS





ZEMIN KAT YEMEKHANE PLANI - Alan : 620m2 - Ölçek 1/100

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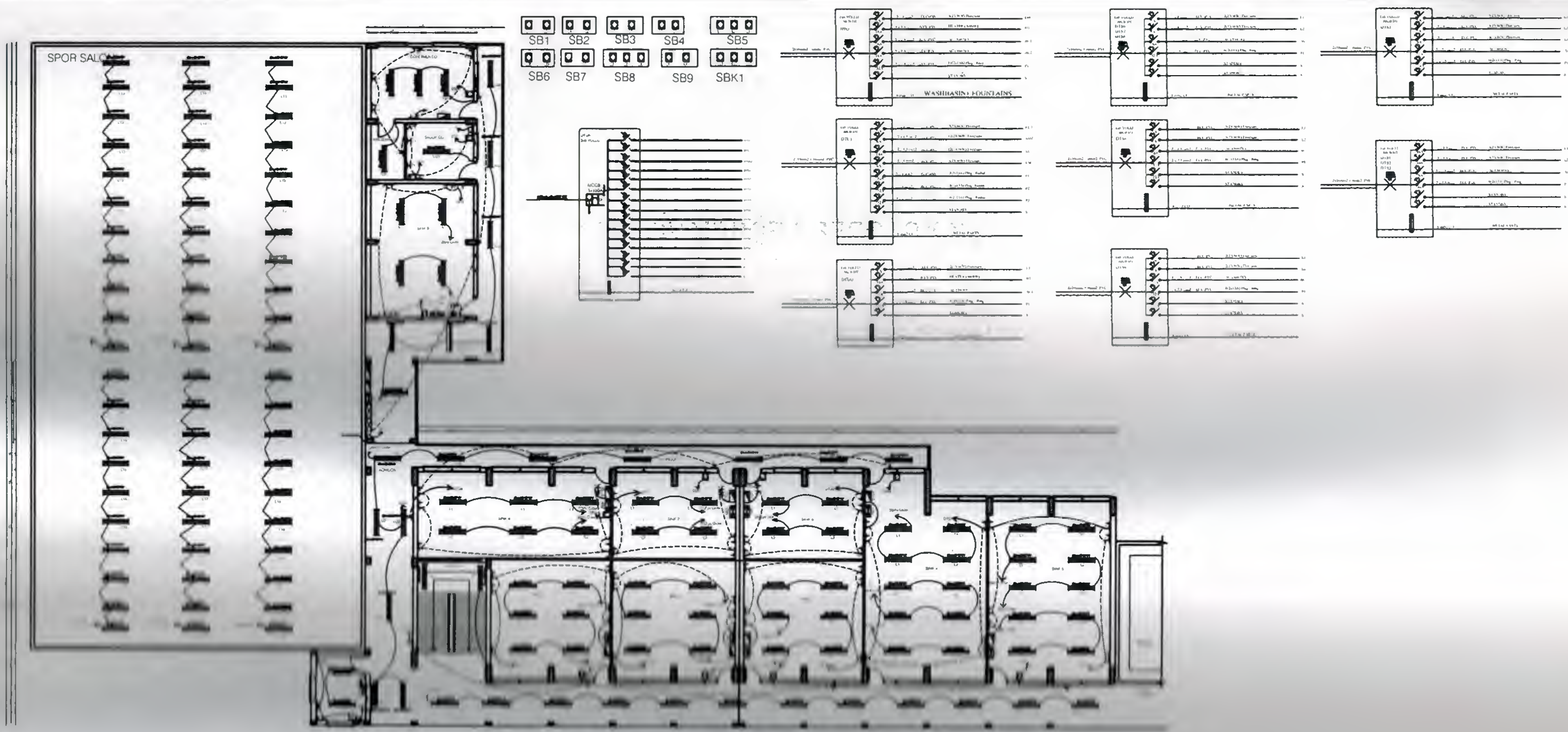

- 1. KAT AKILLI SINIFLAR - Alan :610 m2 -

-SOYUNMA SAĞLIK VE ÖĞRETMEN ODASI+GÜVENLİK - Alan : 210m2

Ölçek : 1/100