NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Electrical and Electronic Engineering

LASER LIGHT DETECTOR

Graduation Project
EE – 400

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ABSTRACT

Technology is growing quickly nowadays and everything is changing arround us. We need more and more things day by day. Alarm systems takes their place in security area and there are too many types.

This report discusses a laser light detector which is used in security sector. It can be used for home or shop security or museums. Laser light is not seen in the air and it is the most important advantage of this system. It is also possible to count some other advantages as an example. This system can also be improved by using correct devices which can work with the others without any problems.

The main goal of this report is, to show that we can create a simple,smaller and less costy alarm system by using laser light.

TABLE OF CONTENTS

INTRODUCTION

Alarm systems are the most important devices in the world that used for protecting a place. They have a widely usage area. There are too many types and people should know that for which reason they want to use it.

People can think on some questions if they want to buy an alarm system, such as, "what kind of an alarm system i should buy" , "how much efficiency i can get from this system" or "how much i pay". In this project it was tried to answer these kind of questios and was also tried to give some explanations and examples about a smaller, less costy, more easier and more efficiently system.

The project consists of introduction, three chapters and conclusion.

Chapter one describes the laser light, types, operating principles, uses and safety with some pictures.

Chapter two gives information about the features, types and applications of the devices.

Finally in chapter three, working principles and possible errors that can be occurred in the circuit were explained in details. Also possible errors were explained with examples and some pictures.

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Laser Light

A laser is an electronic-optical device that emits coherent light radiation. The term "laser" is an acronym for Light Amplification by Stimulated Emission of Radiation. A typical laser emits light in a narrow, low-divergence monochromatic (single-coloured, if the laser is operating in the visible spectrum), beam with a well-defined wavelength. In this respect, laser light is in sharp contrast with such light sources as the incandescent light bulb, which emits light over a wide area and over a wide spectrum of wavelengths.

The first working laser was demonstrated on May 16, 1960 by Theodore Maiman at Hughes Research Laboratories. Since then, lasers have become a multi-billion dollar industry. The most widesprea use of lasers is in optical storage devices such as compact disc and DVD players, in which the laser (a few millimeters in size) scans the surface of the disc. Other common applications of lasers are bar code readers, laser printers and laser pointers.

In industry, lasers are used for cutting steel and other metals and for inscribing patterns (such as the letters on computer keyboards). Lasers are also commonly used in various fields in science, especially spectroscopy, typically because of their well-defined wavelength or short pulse duration in the case of pulsed lasers. Lasers are used by the military for rangefinding, target identification and illumination for weapons delivery. Lasers used in medicine are used for internal surgery and cosmetic applications.

Figure 1.1 Laser Light

1.1.1 Design

A laser consists of a gain medium inside a highly reflective optical cavity, as well as a means to supply energy to the gain medium. The gain medium is a material with properties that allow it to amplify light by stimulated emission. In its simplest form, a cavity consists of two mirrors arranged such that light bounces back and forth, each time passing through the gain medium. Typically one of the two mirrors, the output coupler, is partially transparent. The output laser beam is emitted through this mirror.

Light of a specific wavelength that passes through the gain medium is amplified (increases in power); the surrounding mirrors ensure that most of the light makes many passes through the gain medium, being amplified repeatedly. Part of the light that is between the mirrors (that is, within the cavity) passes through the partially transparent mirror and escapes as a beam of light.

The process of supplying the energy required for the amplification is called pumping. The energy is typically supplied as an electrical current or as light at a different wavelength. Such light may be provided by a flash lamp or perhaps another laser. Most practical lasers contain additional elements that affect properties such as the wavelength of the emitted light and the shape of the beam.

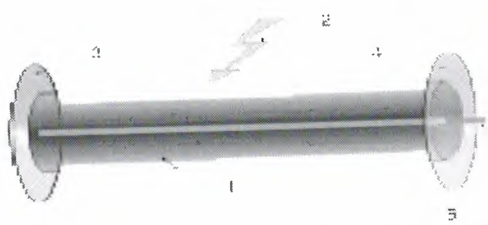

Figure 1.2 Laser Construction

1.1.2 Terminology

The word light in the acronym Light Amplification by Stimulated Emission of Radiation is typically used in the broader sense, as including photons of any electromagnetic energy, not just those in the visible spectrum. Hence there are infrared lasers, ultraviolet lasers, X-ray lasers, etc. Because the microwave equivalent of the laser, the maser, was developed first, devices that emit microwave and radio frequencies are usually called masers. In early literature, particularly from researchers at Bell Telephone Laboratories, the laser was often called the optical maser. This usage has since become uncommon, and as of 1998 even Bell Labs uses the term laser.

The back-formed verb to “lase” means "to produce laser light" or "to apply laser light to". The word "laser" is sometimes used to describe other non-light technologies. For example, a source of atoms in a coherent state is called an "atom laser".

1.1.3 Laser Physics

The gain medium of a laser is a material of controlled purity, size, concentration, and shape, which amplifies the beam by the process of stimulated emission. It can be of any state: gas, liquid, solid or plasma. The gain medium absorbs pump energy, which raises some electrons into higher-energy ("excited") quantum states. Particles can interact with light both by absorbing photons or by emitting photons. Emission can be spontaneous or stimulated. In the latter case, the photon is emitted in the same direction as the light that is passing by. When the number of particles in one excited state exceeds the number of particles in some lower-energy state, population inversion is achieved and the amount of stimulated emission due to light that passes through is larger than the amount of absorption. Hence, the light is amplified. By itself, this makes an optical amplifier. When an optical amplifier is placed inside a resonant optical cavity, one obtains a laser.

The light generated by stimulated emission is very similar to the input signal in terms of wavelength, phase, and polarization. This gives laser light its characteristic coherence, and allows it to maintain the uniform polarization and often monochromaticity established by the optical cavity design.

The optical cavity, a type of cavity resonator, contains a coherent beam of light between reflective surfaces so that the light passes through the gain medium more than once before it is emitted from the output aperture or lost to diffraction or absorption. As light circulates through the cavity, passing through the gain medium, if the gain (amplification) in the medium is stronger than the resonator losses, the power of the circulating light can rise exponentially. But each stimulated emission event returns a particle from its excited state to the ground state, reducing the capacity of the gain medium for further amplification. When this effect becomes strong, the gain is said to be *saturated.* The balance of pump power against gain saturation and cavity losses produces an equilibrium value of the laser power inside the cavity; this equilibrium determines the operating point of the laser. If the chosen pump power is too small, the gain is not sufficient to overcome the resonator losses, and the laser will emit only very small light powers. The minimum pump power needed to begin laser action is called the lasing threshold. The gain medium will amplify any photons passing through it, regardless of direction; but only the photons aligned with the cavity manage to pass more than once through the medium and so have significant amplification.

The beam in the cavity and the output beam of the laser, if they occur in free space rather than waveguides (as in an optical fiber laser), are, at best, low order Gaussian beams. However this is rarely the case with powerful lasers. If the beam is not a low-order Gaussian shape, the transverse modes of the beam can be described as a superposition of Hermite-Gaussian or Laguerre-Gaussian beams (for stable-cavity lasers). Unstable laser resonators on the other hand, have been shown to produce fractal shaped beams. The beam may be highly collimated, that is being parallel without diverging. However, a perfectly collimated beam cannot be created, due to diffraction. The beam remains collimated over a distance which varies with the square of the beam diameter, and eventually diverges at an angle which varies inversely with the beam diameter. Thus, a beam generated by a small laboratory laser such as a helium-neon laser spreads to about 1.6 kilometers (1 mile) diameter if shone from the Earth to the Moon. By comparison, the output of a typical semiconductor laser, due to its small diameter, diverges almost as soon as it leaves the aperture, at an angle of anything up to 50°. However, such a divergent beam can be transformed into a collimated beam by means of a lens. In contrast, the light from non-laser light sources cannot be collimated by optics as well.

Although the laser phenomenon was discovered with the help of quantum physics, it is not essentially more quantum mechanical than other light sources. The operation of a free electron laser can be explained without reference to quantum mechanics.

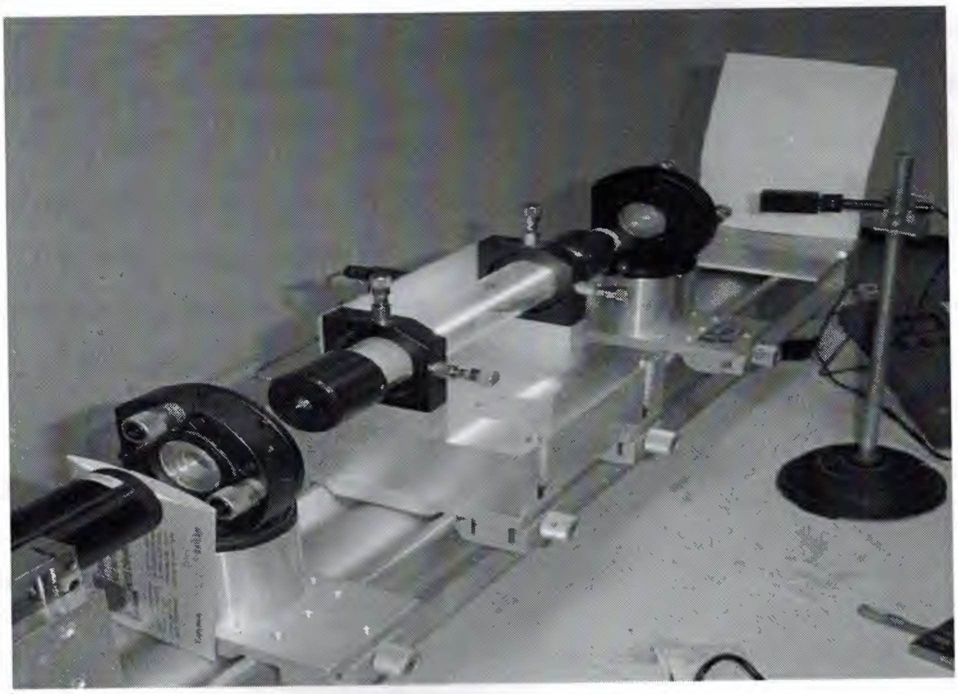

Figure 1.3 A Helium-Neon Laser

1.1.4 Modes Of Operations

The output of a laser may be a continuous constant-amplitude output (known as CW or continuous wave); or pulsed, by using the techniques of Q-switching, modelocking, or gain-switching. In pulsed operation, much higher peak powers can be achieved.

Some types of lasers, such as *dye lasers* and *vibronic solid-state lasers* can produce light over a broad range of wavelengths; this property makes them suitable for generating extremely short pulses of light, on the order of a few femtoseconds (10^{-15} s).

1.1.4.1 Continuous Wave Operation

In the continuous wave (CW) mode of operation, the output of a laser is relatively consistent with respect to time. The population inversion required for lasing is continually maintained by a steady pump source.

1.1.4.2 Pulsed Operation

In the pulsed mode of operation, the output of a laser varies with respect to time, typically taking the form of alternating 'on' and 'off' periods. In many applications one aims to deposit as much energy as possible at a given place in as short time as possible. In laser ablation for example, a small volume of material at the surface of a work piece might evaporate if it gets the energy required to heat it up far enough in very short time. If, however, the same energy is spread over a longer time, the heat may have time to disperse into the bulk of the piece, and less material evaporates. There are a number of methods to achieve this.

1.2 Types and Operating Principles

1.2.1 Gas Lasers

Gas lasers using many gases have been built and used for many purposes.

The helium-neon laser (HeNe) emits at a variety of wavelengths and units operating at 633 nm are very common in education because of its low cost.

Carbon dioxide lasers can emit hundreds of kilowatts at 9.6 μm and 10.6 μm, and are often used in industry for cutting and welding. The efficiency of a CO_2 laser is over 10%.

Argon-ion lasers emit light in the range 351-528.7 nm. Depending on the optics and the laser tube a different number of lines is usable but the most commonly used lines are 458 nm, 488 nm and 514.5 nm.

A nitrogen transverse electrical discharge in gas at atmospheric pressure (TEA) laser is an inexpensive gas laser producing UV Light at 337.1 nm.

Metal ion lasers are gas lasers that generate deep ultraviolet wavelengths. Helium-silver (HeAg) 224 nm and neon-copper (NeCu) 248 nm are two examples. These lasers have particularly narrow oscillation linewidths of less than 3 GHz (0.5 picometers), making them candidates for use in fluorescence suppressed Raman spectroscopy.

1.2.2 Chemical Lasers

Chemical lasers are powered by a chemical reaction, and can achieve high powers in continuous operation. For example, in the Hydrogen fluoride laser (2700-2900 nm) and the Deuterium fluoride laser (3800 nm) the reaction is the combination of hydrogen or deuterium gas with combustion products of ethylene in nitrogen trifluoride. They were invented by George C. Pimentel.

1.2.3 Excimer Lasers

Excimer lasers are powered by a chemical reaction involving an excited dimer, or excimer, which is a short-lived dimeric or heterodimeric molecule formed from two species (atoms), at least one of which is in an excited electronic state. They typically produce ultraviolet light, and are used in semiconductor photolithography and in LASIK eye surgery. Commonly used excimer molecules include F2 (fluorine, emitting at 157 nm), and noble gas compounds (ArF [193 nm], KrCl [222 nm], KrF [248 nm], XeCl [308 nm], and XeF [351 nm]).

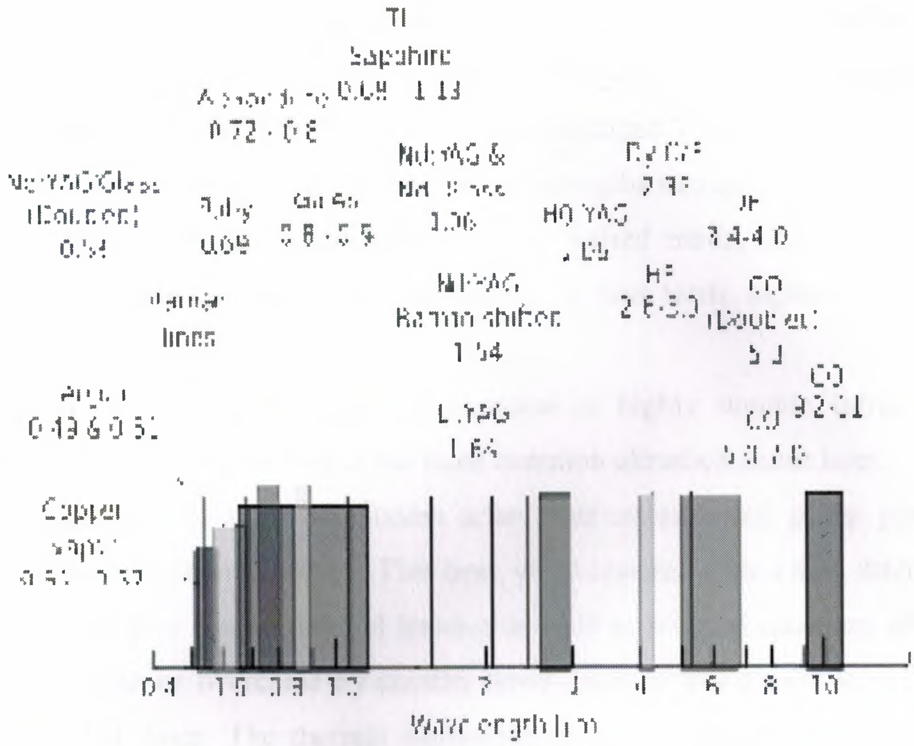

Figure 1.4 Spectral Output of Several Types of Lasers

1.3 Solid-State Lasers

Solid state laser materials are commonly made by doping a crystalline solid host with ions that provide the required energy states. For example, the first working laser was a ruby laser, made from ruby (chromium-doped corundum). Formally, the class of solid-state lasers includes also fiber laser, as the active medium (fiber) is in the solid state. Practically, in the scientific literature, solid-state laser usually means a laser with bulk active medium; while wave-guide lasers are caller fiber lasers.

Neodymium is a common dopant in various solid state laser crystals, including yttrium orthovanadate (Nd:YVO4), yttrium lithium fluoride (Nd:YLF) and yttrium aluminium garnet (Nd:YAG). All these lasers can produce high powers in the infrared spectrum at 1064 nm. They are used for cutting, welding and marking of metals and other materials, and also in spectroscopy and for pumping dye lasers. These lasers are also commonly frequency doubled, tripled or quadrupled to produce 532 nm (green, visible), 355 nm (UV) and 266 nm (UV) light when those wavelengths are needed.

Ytterbium, holmium, thulium, and erbium are other common dopants in solid state lasers. Ytterbium is used in crystals such as Yb:YAG, Yb:KGW, Yb:KYW, Yb:SYS, Yb:BOYS, Yb:CaF2, typically operating around 1020-1050 nm. They are potentially very efficient and high powered due to a small quantum defect. Extremely high powers in ultrashort pulses can be achieved with Yb:YAG. Holmium-doped YAG crystals emit at 2097 nm and form an efficient laser operating at infrared wavelengths strongly absorbed by water-bearing tissues. The Ho-YAG is usually operated in a pulsed mode, and passed through optical fiber surgical devices to resurface joints, remove rot from teeth, vaporize cancers, and pulverize kidney and gall stones.

Titanium-doped sapphire (Ti:sapphire) produces a highly tunable infrared laser, commonly used for spectroscopy as well as the most common ultrashort pulse laser.

Thermal limitations in solid-state lasers arise from unconverted pump power that manifests itself as heat and phonon energy. This heat, when coupled with a high thermo-optic coefficient (d*n*/d*T*) can give rise to thermal lensing as well as reduced quantum efficiency. These types of issues can be overcome by another novel diode-pumped solid state laser, the diode-pumped thin disk laser. The thermal limitations in this laser type are mitigated by utilizing a laser medium geometry in which the thickness is much smaller than the diameter of the pump beam. This allows for a more even thermal gradient in the material. Thin disk lasers have been shown to produce up to kilowatt levels of power.

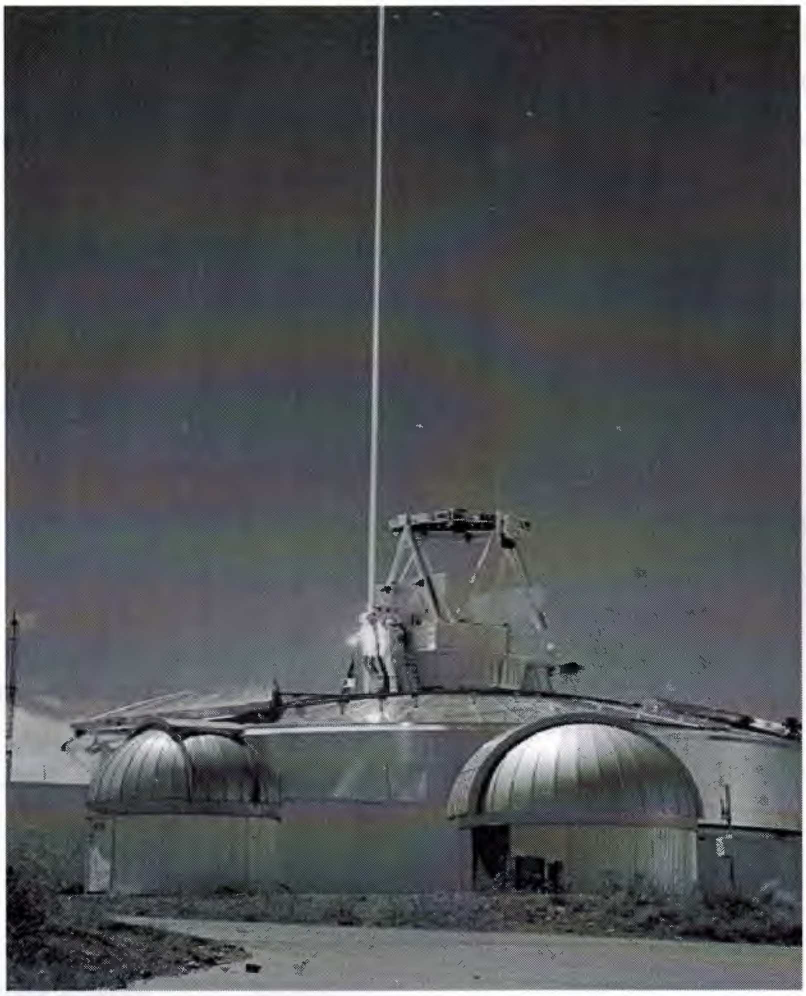

Figure 1.5 A 50 W FASOR, Based on a Nd: YAG Laser Used at The Startfire Optical Range

1.3.1 Fiber-Hosted Lasers

Solid-state lasers where the light is guided due to the total internal reflection in an optical fiber are called fiber lasers. Guiding of light allows extremely long gain regions providing good cooling conditions; fibers have high surface area to volume ratio which allows efficient cooling. In addition, the fiber's waveguiding properties tend to reduce thermal distortion of the beam. Erbium and ytterbium ions are common active species in such lasers.

Quite often, the fiber laser is designed as a double-clad fiber. This type of fiber consists of a fiber core, an inner cladding and an outer cladding. The index of the three concentric layers is chosen so that the fiber core acts as a single-mode fiber for the laser emission while the outer cladding acts as a highly multimode core for the pump laser. This have an active transition between energy sub-bands of an electron in a structure containing several quantum wells.

The development of a silicon laser is important in the field of optical computing, since it means that if silicon, the chief ingredient of computer chips, were able to produce lasers, it would allow the light to be manipulated like electrons are in normal integrated circuits. Thus, photons would replace electrons in the circuits, which dramatically increases the speed of the computer. Unfortunately, silicon is a difficult lasing material to deal with, since it has certain properties which block lasing. However, recently teams have produced silicon lasers through methods such as fabricating the lasing material from silicon and other semiconductor materials, such as indium(III) phosphide or gallium(III) arsenide, materials which allow coherent light to be produced from silicon. These are called hybrid silicon laser. Another type is a Raman laser, which takes advantage of Raman scattering to produce a laser from materials such as silicon.

1.4 Dye Lasers

Dye lasers use an organic dye as the gain medium. The wide gain spectrum of available dyes allows these lasers to be highly tunable, or to produce very short-duration pulses (on the order of a few femtoseconds).

1.4 Free Electron Lasers

Free electron lasers, or FELs, generate coherent, high power radiation, that is widely tunable, currently ranging in wavelength from microwaves, through terahertz radiation and infrared, to the visible spectrum, to soft X-rays. They have the widest frequency range of any laser type. While FEL beams share the same optical traits as other lasers, such as coherent radiation, FEL operation is quite different. Unlike gas, liquid, or solid-state lasers, which rely on bound atomic or molecular states, FELs use a relativistic electron beam as the lasing medium, hence the term free electron.

1.6 Exotic Laser Media

In September 2007, the BBC News reported that there was speculation about the possibility of using positronium annihilation to drive a very powerful gamma ray laser.Dr. David Cassidy of the University of California, Riverside proposed that a single such laser could be used to ignite a nuclear fusion reaction, replacing the hundreds of lasers used in typical inertial confinement fusion experiments.

1.7 Uses

When lasers were invented in 1960, they were called "a solution looking for a problem".Since then, they have become ubiquitous, finding utility in thousands of highly varied applications in every section of modern society, including consumer electronics, information technology, science, medicine, industry, law enforcement, entertainment, and the military.

The first application of lasers visible in the daily lives of the general population was the supermarket barcode scanner, introduced in 1974. The laserdisc player, introduced in 1978, was the first successful consumer product to include a laser, but the compact disc player was the first laser-equipped device to become truly common in consumers' homes, beginning in 1982, followed shortly by laser printers.

Some of the other applications include:

- Medicine: Bloodless surgery, laser healing, surgical treatment, kidney stone treatment, eye treatment, dentistry
- Industry: Cutting, welding, material heat treatment, marking parts
- Defense: Marking targets, guiding munitions, missile defence, electro-optical countermeasures (EOCM), alternative to radar
- Research: Spectroscopy, laser ablation, Laser annealing, laser scattering, laser interferometry, LIDAR
- Product development/commercial: laser printers, CDs, barcode scanners, thermometers, laser pointers, holograms, bubblegrams.

In 2004, excluding diode lasers, approximately 131,000 lasers were sold world-wide, with a value of US$2.19 billion. In the same year, approximately 733 million diode lasers, valued at $3.20 billion, were sold.

1.7.1 Examples By Power

Different uses need lasers with different output powers. Lasers that produce a continuous beam or a series of short pulses can be compared on the basis of their average power. Lasers that produce pulses can also be characterized based on the *peak* power of each pulse. The peak power of a pulsed laser is many orders of magnitude greater than its average power. The average output power is always less than the power consumed.

The continuous or average power required for some uses:

- 5 mW – CD-ROM drive
- 5–10 mW – DVD player or DVD-ROM drive
- 100 mW – CD-RW drive
- 250 mW – High-speed CD-R burner
- 500 mW – Consumer DVD-R burner
- 1 W – green laser in current Holographic Versatile Disc prototype development
- 1–20 W – output of the majority of commercially available solid-state lasers used for micro machining
- 30–100 W – typical sealed CO_2 surgical lasers
- 100–3000 W (peak output 1.5 kW) – typical sealed CO_2 lasers used in industrial laser cutting
- 1 kW – Output power expected to be achieved by a prototype 1 cm diode laser bar

Examples of pulsed systems with high peak power:

- 700 TW (700x1012 W) – The National Ignition Facility is working on a system that, when complete, will contain a 192-beam, 1.8-megajoule laser system adjoining a 10-meter-diameter target chamber. The system is expected to be completed in April of 2009.

- PW (1.3×10^{15} W) – world's most powerful laser as of 1998, located at the Lawrence Livermore Laboratory.

1.7.2 Hobby Uses

In recent years, some hobbyists have taken interests in lasers. Lasers used by hobbyists are generally of class IIIa or IIIb, although some have made their own class IV types.However, compared to other hobbyists, laser hobbyists are far less common, due to the cost and potential dangers involved. Due to the cost of lasers, some hobbyists use inexpensive means to obtain lasers, such as extracting diodes from DVD burners.

Hobbyists also have been taking surplus pulsed lasers from retired military applications and modifying them for pulsed holography. Pulsed Ruby and Pulsed YAG lasers have been used.

1.8 Laser Safety

Even the first laser was recognized as being potentially dangerous. Theodore Maiman characterized the first laser as having a power of one "Gillette"; as it could burn through one Gillette razor blade. Today, it is accepted that even low-power lasers with only a few milliwatts of output power can be hazardous to human eyesight.

At wavelengths which the cornea and the lens can focus well, the coherence and low divergence of laser light means that it can be focused by the eye into an extremely small spot on the retina, resulting in localized burning and permanent damage in seconds or even less time. Lasers are classified into safety classes numbered I (inherently safe) to IV (even scattered light can cause eye and/or skin damage). Laser products available for consumers, such as CD players and laser pointers are usually in class I, II, or III. Certain infrared lasers with wavelengths beyond about 1.4 micrometres are often referred to as being "eye-safe". This is because the intrinsic molecular vibrations of water molecules very strongly absorb light in this part of the spectrum, and thus a laser beam at these wavelengths is attenuated so completely as it passes through the eye's cornea that no light remains to be focused by the lens onto the retina. The label "eye-safe" can be misleading, however, as it only applies to relatively low power continuous wave beams and any high power or q-switched laser at these wavelengths can burn the cornea, causing severe eye damage.

'High Powered' green handheld 125milliwatt lasers (considered 'High Power' compared to a normal laser pointer) have recently been used in attacks on aircraft pilots landing at Australian airports. The risk is that if the laser hit the pilots eyes it could cause temporary blindness at a critical point in the flight. In 2007 penalties under the Australian Civil Aviation Act for shining laser beams at aircraft were increased to two years' jail and fines of up to $30,000.

Figure 1.6 Warning Symbol For Lasers

CHAPTER TWO

CIRCUIT DEVICES

2.1 Light Dependent Resistor (LDR)

A photoresistor or Light Dependent Resistor or CDS Cell is an electronic component whose resistance decreases with increasing incident light intensity. It can also be referred to as a photoconductor.

A photoresistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, eg. silicon. In intrinsic devices, the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire bandgap. Extrinsic devices have impurities added, which have a ground state energy closer to the conduction band — since the electrons don't have as far to jump, lower energy photons (i.e. longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by phosphorus atoms(impurities), there will be extra electrons available for conduction.

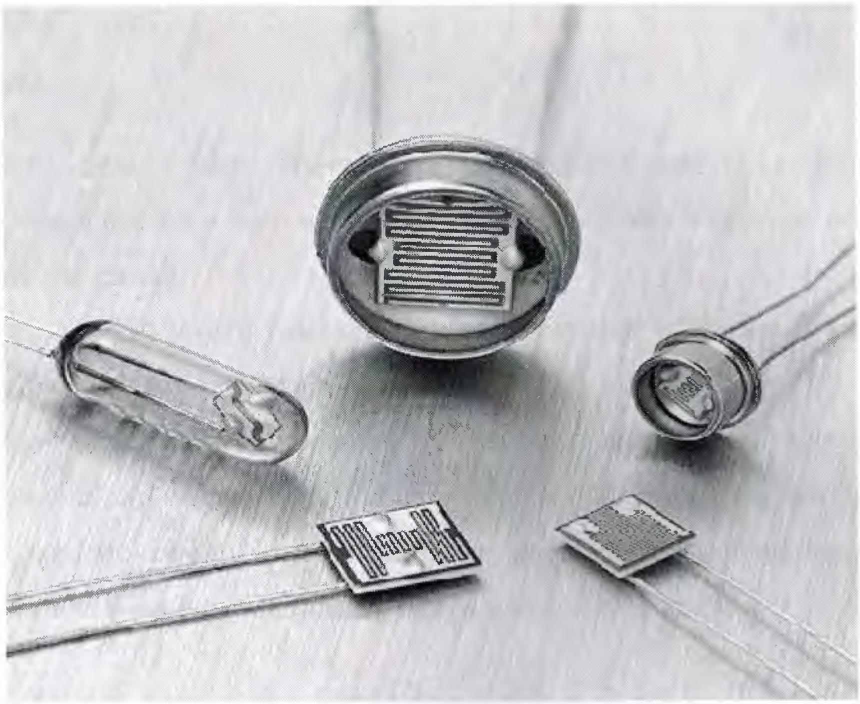

Figure 2.1 Light Dependent Resistors

2.1.1 Cadmium Sulfide Cells

Cadmium sulfide (CdS) cells rely on the material's ability to vary its resistance according to the amount of light striking the cell. The more light that strikes the cell, the lower the resistance. Although not accurate, even a simple CdS cell can have a wide range of resistance from less than 100 Ω in bright light to in excess of 10 MΩ in darkness. Many commercially available CdS cells have a peak sensitivity in the region of 500nm - 600nm (green light). The cells are also capable of reacting to a broad range of frequencies, including infrared (IR), visible light, and ultraviolet (UV). They are often found on street lights as automatic on/off switches. They were once even used in heat-seeking missiles to sense for targets.

Standard cadmium based LDRs have a frequency response that varies according to light level, but is routinely below 1Hz, so they are unsuitable for data links and picture scanning. Silicon based photodiodes and phototransistors are orders of magnitude faster.

2.1.2 Applications

Photoresistors come in many different types. Inexpensive cadmium sulfide cells can be found in many consumer items such as camera light meters, clock radios, security alarms, street lights and outdoor clocks.

They are also used in some dynamic compressors together with a small incandescent lamp or light emitting diode to control gain reduction.

Lead sulfide- and indium antimonide-LDR are used for the mid infrared spectral region. At the other end of the scale, Ge:Cu photoconductors are among the best far-infrared detectors available, and are used for infrared astronomy and infrared spectroscopy. Continues power dissipation is 80mW and the Maximum voltage which can be applied to its 100V.

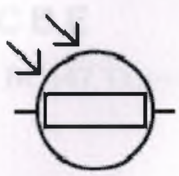

Figure 2.2 Circuit Symbol of Light Dependent Resistors

2.2 BC547 Transistor

An electrical signal can be amplified by using a device that allows a small current or voltage to control the flow of a much larger current. Transistors are the basic devices providing control of this kind. Modern transistors are divided into two main categories: bipolar junction transistors (BJTs) and field effect transistors (FETs). Applying current in BJTs and voltage in FETs between the input and common terminals increases the conductivity between the common and output terminals, thereby controlling current flow between them. The characteristics of a transistor depend on its type.

The term "transistor" originally referred to the point contact type, which saw very limited commercial application, being replaced by the much more practical bipolar junction types in the early 1950s.Today's most widely used schematic symbol, like the term "transistor", originally referred to these long-obsolete devices.

In analog circuits, transistors are used in amplifiers, (direct current amplifiers, audio amplifiers, radio frequency amplifiers), and linear regulated power supplies. Transistors are also used in digital circuits where they function as electronic switches, but rarely as discrete devices, almost always being incorporated in monolithic integrated circuits. Digital circuits include logic gates, random access memory (RAM), microprocessors, and digital signal processors (DSPs).

Figure 2.3 BC547 Transistor

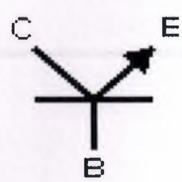

Figure 2.4 Classic Drawing of a BC547 Transistor

2.3 Single Bipolar Timer (NE555)

2.3.1 Features

- High Current Drive Capability (200mA)
- Adjustable Duty Cycle
- Temperature Stability of 0.005%/πC
- Timing From µSec to Hours
- Turn off Time Less Than 2µSec

2.3.2 Applications

- Precision Timing
- Pulse Generation
- Time Delay Generation
- Sequential Timing

2.3.3 Description

TheNE555 monolithic timing circuit is a highly stable controller capable of producing accurate time delays or oscillation. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors an done capacitor. The circuit may be triggeredand reset on falling waveforms, and the output structure can source or sink up to 200 mA. The NE55 is avaliable in plastic and ceramic minidip package and in a 8-lead micropackage and in metal can package version.

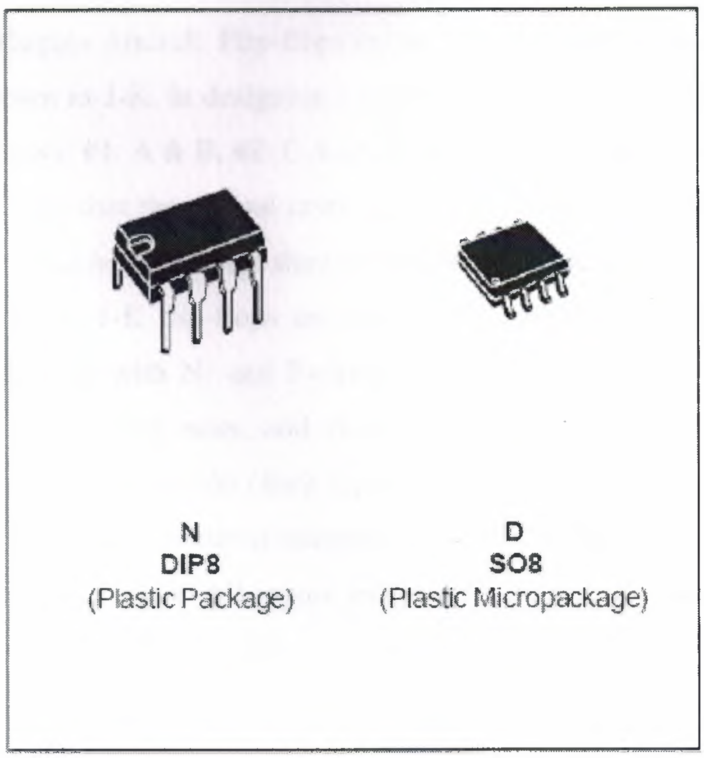

Figure 2.5 NE555 Package Types

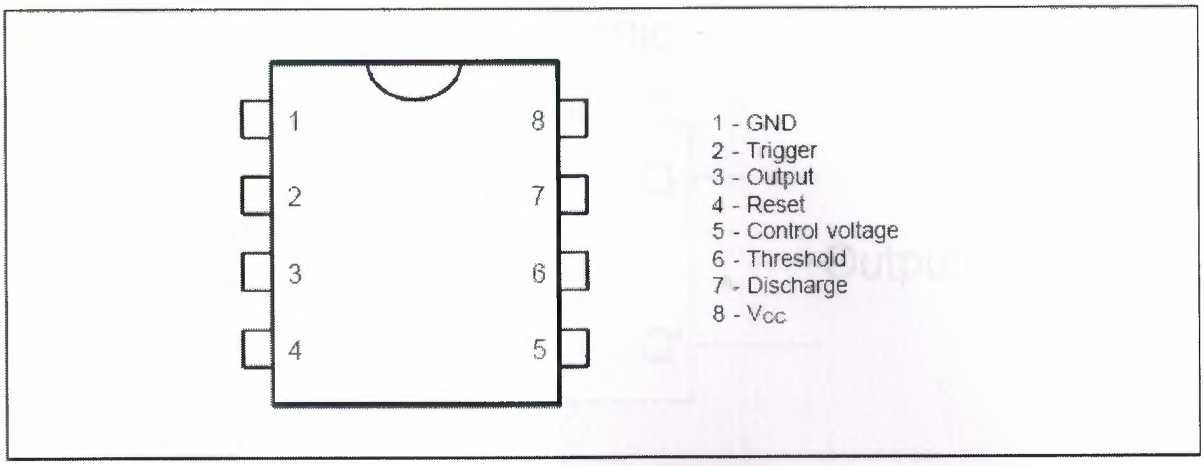

Figure 2.6 Pin Connections of NE555

2.4 Dual J-K Flip-Flop (CD4027BC)

The origin of the name for the JK flip-flop is detailed by P. L. Lindley, a JPL engineer, in a letter to EDN, an electronics design magazine. The letter is dated June 13, 1968, and was published in the August edition of the newsletter. In the letter, Mr. Lindley explains that he heard the story of the JK flip-flop from Dr. Eldred Nelson, who is responsible for coining the term while working at Hughes Aircraft. Flip-flops in use at Hughes at the time were all of the type that came to be known as J-K. In designing a logical system, Dr. Nelson assigned letters to flip-flop inputs as follows: #1: A & B, #2: C & D, #3: E & F, #4: G & H, #5: J & K.

Another theory holds that the set and reset inputs were given the symbols "J" and "K" after one of the engineers that helped design the J-K flip-flop, Jack Kilby.

The CD4027BC dual J-K flip-flops are monolithic complementary MOS (CMOS) integrated circuits constructed with N- and P-channel enhancement mode transistors. Each flip-flop has independent J, K, set, reset, and clock inputs and buffered Q and Q outputs. These flip-flops are edge sensitive to the clock input and change state on the positive-going transition of the clock pulses. Set or reset is independent of the clock and is accomplished by a high level on the respective input. All inputs are protected against damage due to static discharge by diode clamps to VDD and VSS.

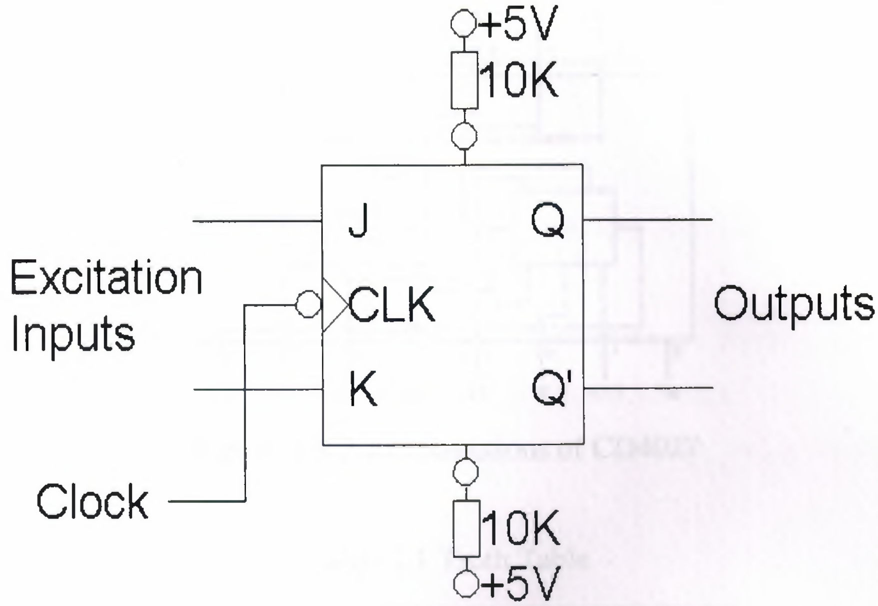

Figure 2.7 Circuit Symbol of a JK Flip Flop

2.4.1 Features

- Wide supply voltage range: 3.0V to 15V
- High noise immunity: 0.45 VDD (typ.)
- Low power TTL compatibility: Fan out of 2 driving 74L or 1 driving 74LS
- Low power: 50 nW (typ.)
- Medium speed operation: 12 MHz (typ.) with 10V supply.

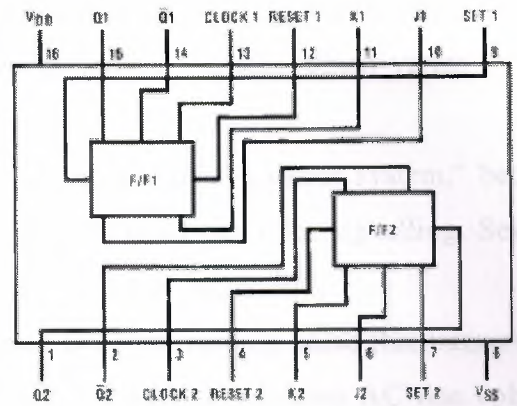

Figure 2.8 Pin Connections of CD4027

Table 2.1 Truth Table

Inputs t_{n-1} (Note 1)						Outputs t_n (Note 2)	
CL (Note 3)	J	K	S	R	Q	Q	$\overline{Q}$
↗	I	X	O	O	O	I	O
↗	X	O	O	O	I	I	O
↗	O	X	O	O	O	O	I
↗	X	I	O	O	I	O	I
↘	X	X	O	O	X	(No Change)	
X	X	X	I	O	X	I	O
X	X	X	O	I	X	O	I
X	X	X	I	I	X	I	I

2.5 Buzzer

A buzzer or beeper is a signalling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows.

It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Sonalert which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulsed the sound on and off.

In game shows it is also known as a "lockout system," because when one person signals ("buzzes in"), all others are locked out from signalling. Several game shows have large buzzer buttons which are identified as "plungers".

The word "buzzer" comes from the rasping noise that buzzers made when they were electromechanical devices, operated from stepped-down AC line voltage at 50 or 60 cycles. Other sounds commonly used to indicate that a button has been pressed are a ring or a beep.

Figure 2.9 Buzzer

2.6 Capacitor

2.6.1 History

In October 1745, Ewald Georg von Kleist of Pomerania in Germany invented the first recorded capacitor: a glass jar with water inside as one plate was held on the hand as the other plate. A wire in the mouth of the bottle received charge from an electric machine, and released it as a spark.

In the same year, Dutch physicist Pieter van Musschenbroek independently invented a very similar capacitor. It was named the Leyden jar, after the University of Leyden where van Musschenbroek worked. Daniel Gralath was the first to combine several jars in parallel into a "battery" to increase the charge storage capacity.

Benjamin Franklin investigated the Leyden jar, and proved that the charge was stored on the glass, not in the water as others had assumed. The earliest unit of capacitance was the 'jar', equivalent to about 1 nanofarad.

Early capacitors were also known as condensers, a term that is still occasionally used today. It was coined by Alessandro Volta in 1782 (derived from the Italian condensatore), with reference to the device's ability to store a higher density of electric charge than a normal isolated conductor. Most non-English European languages still use a word derived from "condensatore"

.

2.6.2 Capacitor Types

There are very many different capacitor types that can be bought and used in electronics circuits. While the list below gives some of the major capacitor types, noot all can be listed and described and there are some less well used or less common types that can be seen. However it does include most of the major capacitor types.

2.6.2.1 Ceramic

As the name indicates, ceramic capacitors gains their name from the fact that they use a ceramic dielectric. This gives the many properties including a low loss factor, and a reasonable level of stability, but this depends upon the exact type of ceramic used. Ceramic dielectrics do not give as high a level of capacitance per unit volume as some types and as a result ceramic capacitors typically range in value from a few picofarads up to values around 0.1 uF.

Figure 2.10 Ceramic Capacitor

2.6.2.2 Electrolytic

The electrolytic capacitor is the most popular type for values greater than about 1 microfarad, having the one of the highest levels of capacitance for a given volume. It is constructed using two thin films of aluminium foil, one layer being covered with an oxide layer as an insulator. An electrolyte-soaked paper sheet is placed between them and then the two plates are wound around on one another and then placed into a can.

These capacitors are polarised, i.e. they can only be placed one way round in the circuit. If they are connected incorrectly they can be damaged, and in some extreme instances they can explode. Care should also be taken not to exceed the rated working voltage. Normally they should be operated well below this value.

These capacitors have a wide tolerance. Typically the value of the component may be stated with a tolerance of -50% +100%. Despite this they are widely used in audio applications as coupling capacitors, and in smoothing applications for power supplies. They do not operate well at high frequencies and are typically not used for frequencies above 50 - 100 kHz.

Figure 2.11 Electrolytic Capacitor

2.6.2.3 Plastic Film Capacitors

There is a number of different types of plastic film capacitors. Polycarbonate, polyester and polystyrene are some of the most common. Each has its own properties, allowing them to be used in specific applications. Their values may range anywhere from several picofarads to a few microfarads dependent upon the actual type. Normally they are non-polar. In general they are good general-purpose capacitors that may be used for a variety of purposes, although their high frequency performance is not usually as good as that of the ceramic types.

2.6.2.5 Tantalum

Ordinary aluminium electrolytic capacitors are rather large for many uses. In applications where size is of importance tantalum capacitors may be used. These are much smaller than the aluminium electrolytics and instead of using a film of oxide on aluminium they us a film of oxide on tantalum. They do not normally have high working voltages, 35V is normally the maximum, and some even have values of only a volt or so.

Like electrolytic capacitors, tantalums are also polarised and they are very intolerant of being reverse biased, often exploding when placed under stress. However their small size makes them very attractive for many applications.

Figure 2.14 Tantalum Capacitors

2.7 Resistors

Most axial resistors use a pattern of colored stripes to indicate resistance. Surface-mount resistors are marked numerically. Cases are usually brown, blue, or green, though other colors are occasionally found such as dark red or dark grey.

One can also use a multimeter or ohmmeter to test the values of a resistor.

Figure 2.15 Resistors

2.7.1 Four-Band Axial Resistors

Four-band identification is the most commonly used color coding scheme on all resistors. It consists of four colored bands that are painted around the body of the resistor. The scheme is simple: The first two numbers are the first two significant digits of the resistance value, the third is a multiplier, and the fourth is the tolerance of the value (e.g. green-blue-yellow red : 56 x (10^4) ohms = 56 x 10000 ohms = 560 kohms ±2%). Each color corresponds to a certain number, shown in the chart below. The tolerance for a 4-band resistor will be 1%, 5%, or 10%.

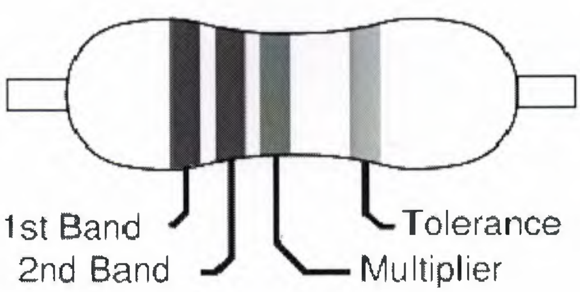

Figure 2.16 Four-Band Axial Resistors

2.7.2 Preferred Values

Resistors are manufactured in values from a few milliohms to about a gigaohm; only a limited range of values from the IEC 60063 preferred number series are commonly available. These series are called E6, E12, E24, E96 and E192. The number tells how many standardized values exist in each decade (e.g. between 10 and 100, or between 100 and 1000). So resistors conforming to the E12 series, can have 12 distinct values between 10 and 100, whereas those confirming to the E24 series would have 24 distinct values. In practice, the discrete component sold as a "resistor" is not a perfect resistance, as defined above. Resistors are often marked with their tolerance (maximum expected variation from the marked resistance). These E numbers correspond to the formula R= 10^(N/E), So for an 1.21 ohm E96 series resistor, N=8 and 10^(8/96)=1.21 ohm. Each multiple of 96 added to the remainder gives the next decade. So a 12.1 ohm resistor would have a N= 8+96 = 104. N can also be found by using the formula E*LOG10(R) = N.

Table 2.2 Resistor Colour Codes

Color	1st band	2nd band	3rd band (multiplier)	4th band (tolerance)	Temp. Coefficient
Black	0	0	$\times10^{0}$		
Brown	1	1	$\times10^{1}$	±1% (F)	100 ppm
Red	2	2	$\times10^{2}$	±2% (G)	50 ppm
Orange	3	3	$\times10^{3}$		15 ppm
Yellow	4	4	$\times10^{4}$		25 ppm
Green	5	5	$\times10^{5}$	±0.5% (D)	
Blue	6	6	$\times10^{6}$	±0.25% (C)	
Violet	7	7	$\times10^{7}$	±0.1% (B)	
Gray	8	8	$\times10^{8}$	±0.05% (A)	
White	9	9	$\times10^{9}$		
Gold			$\times10^{-1}$	±5% (J)	
Silver			$\times10^{-2}$	±10% (K)	
None				±20% (M)	

2.7.3 Five-Band Axial Resistors

5-band identification is used for higher precision (lower tolerance) resistors (1%, 0.5%, 0.25%, 0.1%), to notate the extra digit. The first three bands represent the significant digits, the fourth is the multiplier, and the fifth is the tolerance. 5-band standard tolerance resistors are sometimes encountered, generally on older or specialized resistors. They can be identified by noting a standard tolerance color in the 4th band. The 5th band in this case is the temperature coefficient.

2.7.4 Surface Mount Technology Resistors (SMT)

Surface mounted resistors are printed with numerical values in a code related to that used on axial resistors. Standard-tolerance Surface Mount Technology (SMT) resistors are marked with a three-digit code, in which the first two digits are the first two significant digits of the value and the third digit is the power of ten (the number of zeroes). For example:

Table 2.3 Reading of SMT Resistors

"334"	= 33 × 10,000 ohms = 330 kilohms
"222"	= 22 × 100 ohms = 2.2 kilohms
"473"	= 47 × 1,000 ohms = 47 kilohms
"105"	= 10 × 100,000 ohms = 1 megohm

2.7.5 Industrial Type Designation

Table 2.4 Power Rating at 70 Degree

Type No.	Power rating (watts)	MIL-R-11 Style	MIL-R-39008 Style
BB	1/8	RC05	RCR05
CB	¼	RC07	RCR07
EB	½	RC20	RCR20
GB	1	RC32	RCR32
HB	2	RC42	RCR42
GM	3	-	-
HM	4	-	-

Table 2.5 Tolerance Code

Industrial type designation	Tolerance	MIL Designation
5	±5%	J
2	±20%	-
1	±10%	K
-	±2%	G
-	±1%	F
-	±0.5%	D
-	±0.25%	C
-	±0.1%	B

The operational temperature range distinguishes commercial grade, industrial grade and military grade components.

- Commercial grade: 0 °C to 70 °C
- Industrial grade: −40 °C to 85 °C (sometimes −25 °C to 85 °C)
- Military grade: −55 °C to 125 °C (sometimes -65 °C to 275 °C)
- Standard Grade -5°C to 60°C

2.7.6 Laser Pointer

A laser pointer is a portable, pen-sized laser designed to be held in the hand, and most commonly used to project a point of light to highlight items of interest during a presentation. Most laser pointers have low enough power that the projected beam presents a minimal hazard to eyes for incidental exposure. Consequently, beams from laser pointers are generally not visible from the side in normal clear air, but only visible as a point of light where the beam strikes a diffusely reflective surface. Some higher powered laser pointers are faintly visible via Rayleigh scattering when viewed from the side in moderately to dimly lit conditions.

Figure 2.17 Laser Pointer

2.7.7 Types of Laser Pointer

The early laser pointers were helium-neon (HeNe) gas lasers and generated laser radiation at 633 nanometer (nm). Usually designed to produce a laser beam with an output power no greater than 1 milliwatt (mW). The least expensive laser pointers use a deep red laser diode near the 670/650 nanometers (nm) wavelength. Slightly more expensive ones use a red-orange 635 nm diode, making them more easily visible than their 670 nm counterparts due to the greater sensitivity of the human eye at 635 nm. Other colors are possible too, with the 532 nm green laser being the most common alternative. In the past few years, yellow-orange laser pointers, at 593.5 nm, have been made available. Recently (September 2005), handheld blue laser pointers at 473 nm have also become available.

The apparent brightness of a spot from a laser beam depends not only on the optical power of the laser and the reflectivity of the surface, but also on the color response of the human eye. For the same optical power, the green laser will seem brighter than other colors because the human eye is most sensitive at low light levels in the green region of the spectrum (wavelength 520 - 570 nm. Sensitivity decreases for redder or bluer wavelengths.

The output power of a laser pointer is measured in milliwatts (mW). In the US lasers are classified by the American National Standards Institute and by the Food and Drug Administration (FDA). Visible laser pointers (400-700 nm) operating at less than 1 mW power are Class II and visible laser pointers operating with 1-5 mW power are Class IIIa. Class IIIb lasers emit power between 5 mW and 500 mW (0.5 watt) and are not allowed for laser pointers. Class IIIb lasers can present a variety of hazards to personnel through ocular exposure to direct beams.

2.7.7.1 Green Laser Pointer

Green laser pointers appeared on the market circa 2000, and are the most common type of DPSS lasers (also called DPSSFD, diode pumped solid state frequency-doubled). They are much more complicated than standard red laser pointers, because laser diodes are not commonly available in this wavelength range. The green light is generated in an indirect process, beginning with a high-power (typically 100-300 mW) infrared AlGaAs laser diode operating at 808 nm. The 808 nm light pumps a crystal of neodymium-doped vanadate (ND:YVO4) (or Nd:YAG or less common Nd:YLF), which lases deeper in the infrared at 1064 nm. The vanadate crystal is coated on the diode side with a dielectric mirror that reflects at 1064 nm and transmits at 808 nm. The crystal is mounted on a copper block, acting as a heatsink; its 1064 nm output is fed into a crystal of potassium titanyl phosphate (KTP), mounted on a heatsink in the laser cavity resonator. The orientation of the crystals must be matched, as they are both anisotropic and the Nd:YVO4 outputs polarized light. This unit acts as a frequency doubler, and halves the wavelength to the desired 532 nm. The resonant cavity is terminated by a dielectric mirror that reflects at 1064 nm and transmits at 532 nm. An infrared filter behind the mirror removes IR radiation from the output beam, and the assembly ends in a collimator lens. The output power of most green laser pointers is on the scale of 5 mW.

Nd:YVO_4 is replacing Nd:YAG and Nd:YLF due to lower dependency on the exact parameters of the pump diode (therefore allowing for higher tolerances), wider absorption band, lower lasing threshold, higher slope efficiency, linear polarization of output light, and single mode output. For frequency doubling of higher power lasers, LBO is used instead of KTP. Newer lasers use a composite Nd:YVO4/KTP crystal instead of two discrete ones.

Some green lasers operate in pulse or quasi-continuous wave (QCW) mode, to reduce cooling problems and prolong battery life.

Figure 2.18 Green Laser Pointer

2.7.7.2 Blue Laser

Blue laser pointers, which became available around 2006, have the same basic construction as green lasers. They most commonly lase at 473 nm, which is produced by frequency doubling of 946 nm laser radiation from a diode-pumped Nd:YAG or Nd:YVO4 crystal. For high output power BBO crystals are used as frequency doublers, for lower powers KTP is used.

Blue lasers can also be fabricated with InGaN semiconductors, although the light is more violet than blue (405nm). In this case, no frequency doubler is needed. The Japanese company Nichia controls (in 2006) 80% of the market.

2.7.8 Applications

Laser pointers are often used in school and business presentations and visual demonstrations as an eye-catching pointing device. Red laser pointers can be used in almost any indoor or low-light situation where pointing out details by hand may be inconvenient, such as in construction work or interior decorating. Green laser pointers can be used for similar purposes as well as outdoors in daylight or for longer distances.

In pointing applications such as these, natural hand tremor may cause unwanted jittery motion of the laser dot. Future laser pointers may solve this problem by stabilizing the laser beam from unwanted hand tremor.

Laser pointers can be used as toys for pets, especially for cats in play. Some offer a selection of designs for the laser beam to project (e.g. images of butterflies, mice, or flowers), to provide variety. Opinions are divided on the safety of laser pointers used in this way. Some consider laser pointers to be a healthier alternative to the more traditional string for cats because they reduce the risk of choking on the string. Others are concerned that the laser beam may damage pets' eyes, or that the pet will develop frustration problems from not being able to catch the prey.

Green laser pointers can also be used for skygazing. On a moonless night, a green laser pointer beam can often be clearly seen, allowing someone to accurately point out individual stars to others nearby.

Figure 2.19 Laser Pointer In Operation

CHAPTER THREE

GENERAL INFORMATION ABOUT THE CIRCUIT

3.1 Working Principle of the Circuit

Suppose that there is a laser beam and it falls to a LDR with a distance. This distance can be a few centimeters or it can be longer such as 10 or more meters. We put the LDR in a black pipe because we don't want it to effect of day light. Resistivity of the LDR is less during the laser beam touches the LDR. If we put anything between the laser and the LDR, the resistivity of the LDR increases. So we can easily understand if the light is cut or not by using this simple mechanism.

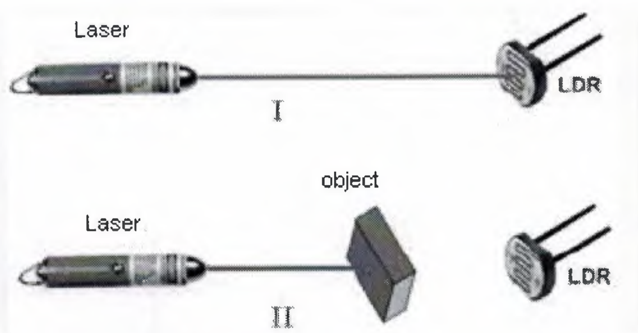

Figure 3.1 Laser and LDR

The variety of magnitude of the light changes the resistivity of the LDR and it caues to change the voltage on the node between the 100k resistor and LDR. This voltage is compared with the reference voltage and an avaliable signal produced. When the laser beam falls on the LDR, the voltage on the node, between the LDR and 100k resistor is greater than the reference voltage. The output voltage of op-amp (NE555) is logical 0 at the same time. When the light cut, resistivity of LDR increased and the voltage on the node between LDR and 100k resistor decreased. Then the output voltage increases to logical 1 position and alarm position is occurred.

This circuit works without any problem but there is something missing which is very important for the circuit. If we test the circuit carefully, we can see that alarm position is "on" only when the light cut by an object. This kind of system is not prefered for a secutiry system.

Because it is desired to continoue of the alarm position even the effect disappears for the circuit that causes the light cut. The circuit needs an extra device. An itegrated circuit that contains a flip flop can be used to fix this problem. This IC (integrated circuit) provides to continoue of the signal. This IC contains two kinds of flip flop. When the energy applied to the circuit, IC is resetted and the Q output waits at logical 0 position. Transistor is on the cut position. If the connection cut between the laser and the LDR, the flip flop comes set position and Q output is logical 1 positon. If the light comes on LDR, logical level of Q does not change. Then transistor becaomes active and provides to apply 9V to the buzzer. Buzzer gives a low voice. This alarm position keeps working until someone pushes the reset button. As an example we can replace three mirrors by 45 degree angle and provide to fall laser light on the LDR like figure 3.1.

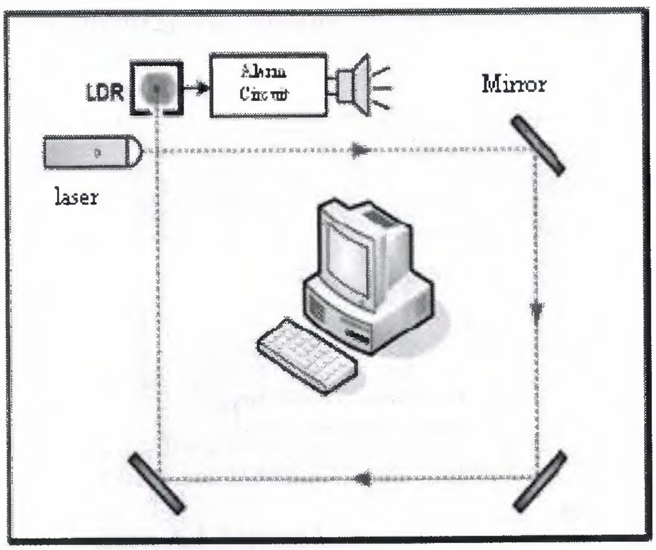

Figure 3.2 A Simple Security System With Laser

We also can make changes with its protection area by using mirrors. The only thing that we should pay attention is to adjust the mirrors by correct angles.

3.2 Possible Errors of the Circuit

3.2.1 Using LDR Without a Dark Cover

LDR (Light Dependent Resistor) is the one of the most important device of this circuit. As I explained before, it works according to magnitude of the light. But there is some important points when we use LDR in a circuit. Because its resistivity changes according to medium. When we measure its resistivity in a dark medium and a light medium, we can see a high difference. Because in a dark medium its resistivity is high and free transporters' denisty inside materials are higher. But in a light medium it can take both light that we try to send on it and the other light which is in the medium. So its resistivity can be less and it causes that the circuit does not work as we exactly want. The best solution is to keep the LDR in a dark cover, like a balck pipe. This black pipe prevents receiving the medium light by LDR. So that we can use it better and our circuit works without any medium effects.

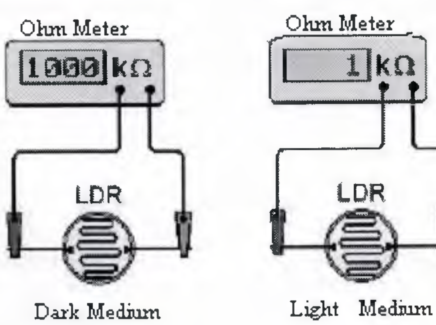

Figure 3.3 Test of LDR in Different Mediums

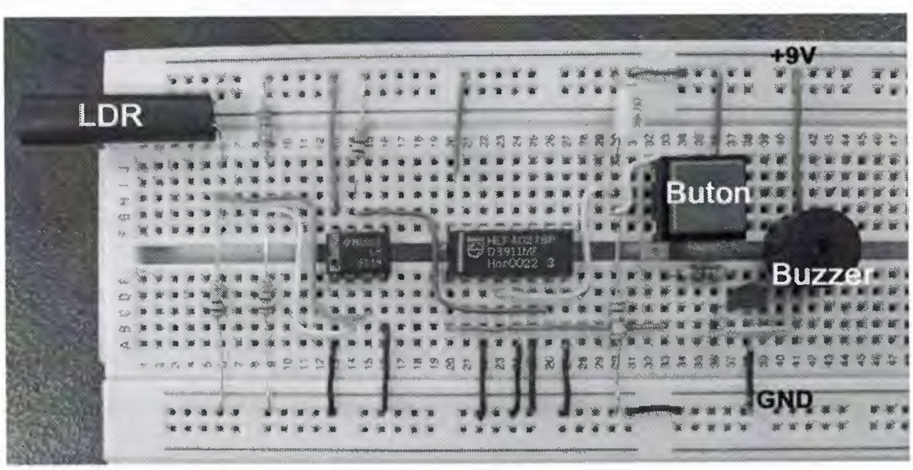

Figure 3.4 LDR With a Dark Cover

3.2.2 Connecting the Circuit Without Using a Flip Flop Integrated

It is also possible to connect the circuit without using a flip flop. But it has a big disadvantage. Because if we do not use flip flop in the circuit, signal time becomes shorter when the circuit is in alarm position. It is not prefered for a security system. It is desired to continoue the alarm position even the effect disappears that causes to cut the light. So a flip flop should be used for a better protection.

Figure 3.5 Circuit and the Signal Without Using a Flip Flop

3.2.3 Endurance of Cables

When we connect a circuit, there are some steps that we should check and one of these steps is checking cable connections. Because it is very important to know that the current fows or not from a device to another or there is how much voltage on a device. These informations help us in calculations and connecting the circuit. If there is any broken cable on the circuit, it does not work correctly. Number of the cables that used in a circuit is also important to connect a circuit. Because error is directly proportional to the number of the cables that are used in a circuit. It means, how many cables, that much possibilities for an error.

3.2.4 Wrong Angle Between the Mirrors

Mirrors have an important rol in this system. Because we can increase or decrease the protection area by using the mirrors. That is why the mirrors have to be put in correct angles. For example if we use three mirrors in our system we should put the mirrors by 45 degree. Because the mirrors are the members which reflect the laser light between themself and finally to the LDR. If there is a mistake in replacing the mirrors, laser light does not fallen on the LDR and the system does not work.

Figure 3.6 Replacing the Mirrors in a Correct Position

3.2.5 Sensitivity of Devices

In this circuit there are some devices which have high sensitivity such as the capacitor. Actually it is the poorest device of the circuit. If there is an error in the capacitor, the circuit keeps the alarm position till someone realises and turns the circuit off or the battery finishes. To fix this problem, the only way is changing the capacitor with a new one.

Figure 3.7 The Capacitor That is Used in This Circuit

CONCLUSION

Alarm systems are very important with their widely usage area in this century. There are some properties that are desired from a good alarm system. Such as;

- Good and wide protection area
- High sensitivity
- Devices with high quality
- Easy to use
- Hard to touch or make the system out of service from outside
- Less cost

These kind of alarm systems, (with laser) are used in museums to protect valuable things, like diamond in a glass or old materials which has a value from the past, in homes and shopes, as a simple burglar alarm system and etc. This system has more advantages than the other simple systems. Because it is working with laser and laser can not be seen in the air and it is more difficult to realise. Another advantage of this system is having a smaller circuit. We can say that it is easier to hide that an alarm system is used in an area.

This system can be improved by adding some devices which are well-matched with the devices in the circuit. It can also be improved by using programmable integrated circuits but the cost will increase and the circuit of the system will be bigger.

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