**[LASER BASED NON-INVASIVE GLUCOSE MONITORING](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3500977/) SYSTEM WITH AUTOMATIC INSULIN INJECTOR**

**AIM**

The primary aim of this research is to develop a non-invasive blood glucose monitoring system that utilizes red laser light to measure glucose levels in diabetic patients. The system aims to overcome the limitations of invasive techniques, reducing the risk of infection while providing an accurate and reliable means of monitoring blood glucose levels.

**OBJECTIVES**

1. To Develop a non-invasive blood glucose monitoring system that utilizes a 650nm wavelength of red laser light to measure glucose levels through human finger tissues.
2. To Address the risks associated with invasive blood glucose monitoring techniques, particularly the risk of infection, by providing a safer alternative for diabetic patients.
3. To Ensure the accuracy and reliability of the proposed monitoring system by analyzing transmitted and absorbed blood samples through the human finger and deriving a mathematical equation to calculate glucose levels.
4. To Derive a mathematical equation that correlates the obtained voltage levels from the red laser light with the glucose levels in blood. This equation will serve as the basis for accurate glucose level calculations.
5. To Design and implement the hardware necessary for the blood glucose monitoring device, incorporating the red laser light source and the associated components required for accurate measurement.

**ABSTRACT**

Blood glucose monitoring (BGM) techniques are invasive as they require a finger prick blood sample, a repetitively painful process that creates the risk of infection. BGM is essential to avoid complications arising due to abnormal blood glucose levels in diabetic patients. Laser light-based sensors have demonstrated a superior potential for BGM. Existing near-infrared (NIR)-based BGM techniques have shortcomings, such as the absorption of light in human tissue, higher signal-to-noise ratio, and lower accuracy, and these disadvantages have prevented NIR techniques from being employed for commercial BGM applications. A simple, compact, and cost-effective non-invasive device using visible red laser light of wavelength 650 nm for BGM (RL-BGM) is implemented in this paper. The RL-BGM monitoring device has three major technical advantages over NIR. Unlike NIR, red laser light has ~30 times better transmittance through human tissue. Furthermore, when compared with NIR, the refractive index of laser light is more sensitive to the variations in glucose level concentration resulting in faster response times ~7-10 s. Red laser light also demonstrates both higher linearity and accuracy for BGM.

**CHAPTER – 1**

**INTRODUCTION**

DIABETES or Diabetes Mellitus occurs when someone has abnormal blood sugar. There are two major types of diabetes in Type 1 diabetic patients, diabetes occurs due to the autoimmune destruction of the insulin-producing beta cells in the pancreas whereas in Type 2 diabetics the diabetes mellitus occurs from insulin resistance and relative insulin deficiency. Diabetes can cause many serious secondary health issues such as blindness, stroke, kidney failure, Ulcers, Infections, obesity and blood vessels damage, among other health complications. Approximately US $ 376 billion is spent annually in the US on the treatment and management of diabetes in diabetic patients and this amount is expected to rise to a projected US$ 490 billion by the end of 2030. Diabetes is a type a metabolic diseases in which the blood glucose (blood sugar) level in human body increases drastically from its normal level. The increase in sugar level is either due to inadequate production of insulin in blood cells or can be because of improper response of body cells to the insulin or can be because of both the reasons. Diabetes can lead to major complications like heart failure and blindness in the human body . Hence regular monitoring of glucose level is important. The World Health Organization (WHO) estimated that the number of people with diabetes is more than 200 million. Diabetes is a state of a body where it not able to produce the quantity of insulin sufficiently required to maintain normal level of blood glucose. So, diabetic patients regulate their blood glucose levels through proper diet as well as by injecting insulin. For the effective treatment of diabetes, patients have to measure the level of blood glucose periodically. At present, diabetic persons are using invasive figure pricking instrument knows as glucose meter to know the concentration of blood glucose.According to the International Diabetes Federation (IDF) the diabetes patients in 2011 are 366 million worldwide and this number is expected to rise to 552 million by 2030. Blood glucose concentration is currently measured using three broad categories of techniques which are invasive, minimally invasive and non-invasive. Invasive techniques require a blood sample which is currently extracted from the fingertip using a device known as a lancet. This method of determining blood glucose is currently the most commonly used technique and is a highly accurate method for blood glucose monitoring . Minimally invasive techniques involve attaching electrodes to the skin tissue. This method is not preferred due to its low accuracy and poor signal to noise ratio (SNR) even though this electronic method reduces the chances of infection and minimizes the pain.

**CHAPTER -2**

**LITERATURE SURVEYLITERATURER SURVEY**

1. **Haoran Ren, et al proposed “A Novel Cardiac Auscultation Monitoring System Based on Wireless Sensing for Healthcare” IEEE of Translational Engineering in Health and Medicine – 2018**

In this existing paper, a novel wireless sensing system to monitor and analyze cardiac condition is proposed, which sends the information to the caregiver as well as a medical practitioner with an application of the Internet of Things (IoT). An integrated system for heart sound acquisition, storage, asynchronous analysis has been developed, from scratch to information uploading through IoT and signal analysis. Cardiac auscultation sensing unit has been designed to monitor cardiovascular health of an individual. Bluetooth protocol is used to offer power efficiency and moderate data transmission rate. The Hilbert-Huang transform is used to eliminate interference signals and to help to extract the heart sound signal features. Subsequence segmentation algorithm based on double-threshold has been developed to extract physiological parameters

1. **Malcolm Clarke et al proposed “Interoperable End-to-End Remote Patient Monitoring Platform based on IEEE 11073 PHD and ZigBee Health Care Profile” - IEEE Transactions on Biomedical Engineering – 2018**

This existing paper described the implementation of an endto-end remote monitoring platform based on the IEEE 11073 standards for Personal Health Devices (PHD). It provides an overview of the concepts and approaches and describes how the standard has been optimized for small devices with limited resources of processor, memory and power and that use short range wireless technology. It explains aspects of IEEE 11073, including the Domain Information Model, state model and nomenclature, and how these support its plug-and-play architecture

1. **K. Nivetha, N. Ramya et al “BLOOD GLUCOSE MEASUREMENT BY SWEAT USING ARDUINO” – IESRA – 2017.**

This existing work investigated the effect of blood glucose measurement by conductivity measurement technique. Sweat contains dissolved ions, which contribute conduction between the two copper electrodes. As the concentration of ions in the sweat increases, conduction increases. The measured parameters such as voltage from the copper sensor is given to Arduino controller and then to the LCD display. Normal person have voltage range of 320 conductivity/sec and its corresponding glucose level is 80mg/dl. For diabetic person the voltage range is 377conductivity/sec and its corresponding glucose level is 141mg/dl. The responses are studied as salt content in the sweat is high, which results in high glucose level. If salt content in the sweat is low, it results in low glucose level. The correlation between salt content in sweat with its corresponding voltage and glucose level is done by interpolation equation. Non-invasive blood glucose estimation framework is utilized to quantify the blood glucose without taking the blood test.

1. **Ricardo A. de M. Valentim et al proposed “MP-HA: Multicycles Protocol for Hospital Automation over Multicast” – 2008.**

This paper presents a Multicycles Protocol for Hospital Automation (MP-HA) that works over multicast addressing and use a Master-Slave architecture. The protocol creates a segmented logical network based on multicast addressing associated with hospital beds. The objective of MP-HA is to ensure the determinism on network through medium access control mechanism increasing the transmission throughput. Thus, it creates a periodical environment making use of the parallel cycles which is called multicycles.

**DISADVANTAGES:** Glucose monitoring done by local area network.

1. **Gustavo H. P. Florentino et al proposed “Hospital Automation RFID-Based: Technology Stored In Smart Cards” – 2008.**

This system initially uses contactless smart cards to store patient’s data and for the authentication of hospital employees in the system. The proposed system also uses RFID tags stuck to containers containing patient’s collected samples for the correct identification of the patient who provided the samples. This work depicts a hospital laboratory workflow, presents the system’s modeling and deals with security matters related to information stored in the smart cards.

**DSIADVANTAGES: Direct RFID card is needed and there is no long distance data maintence**

1. **R.A. Buda et al proposed A Portable Non-Invasive Blood Glucose Monitoring Device – IEEE, 2014**

A portable non-invasive blood glucose monitoring device is developed using near infrared sensors. Besides being able to detect glucose concentration in blood, the device is also able to display the glucose level and the required insulin dose, corresponding to the body mass index (BMI) of the user. Several in vitro and in vivo experiments proved the reliability of the device. Results of the experiments proved that the device is reliable in glucose detection with 4% - 16% accuracy compared to the common invasive finger-prick method.

**DISADVANTAGES**: reliability test was less than 20%, which proved that the non-invasive technique implemented in the device is reliable to be used to measure glucose in blood

1. **M. A. Aizat Rahma et al “GluQo: IoT-Based Non-invasive Blood Glucose Monitoring” – JTECE, 2018**

The glucose level of a person was predicted based on the analyzed voltages received. The glucose readings were also sent to a phone via WiFi and displayed through an Android application. Validation and calibration were performed for the prototype.

**DISADVANTAGES:** percentage error of the glucose reading for the designed method was 7.20% compared to the prick method.

1. **SATHIYA DEVI et al proposed “BLOOD LEAKAGE MONITORING SYSTEM USING IR SENSOR IN HEMODIALYSIS THERAPY” IJASE – 2016.**

This paper described the application of IR sensor installed in a blood leakage monitoring system to detect blood leakage during hemodialysis treatment. The signal received by the sensor is calibrated for the output which sensing the blood’s color only. This system consists of an IR sensor, Microcontroller, Bluetooth wireless module and alert components. The red color sensing algorithm is simply evaluated on the microcontroller. The goal of this system is to give alarm when the sensor senses the red color only. So if blood leak occur on the arterio-venous fistula, it can be detected during hemodialysis treatment

**DISADVANTAGES: Nurse should stay within 10- 15 feet to know the blood leakage.**

**CHAPTER - 3**

**SYSTEM DESIGN**

**EXISTING SYSTEM**

This existing paper described the method of blood sugar measurement in the human blood noninvasively with various techniques. The measurement accuracy of the non-invasive measurement device plays vital role and with noise filtering techniques. When a light ray interact with human body tissues, it is attenuated by scattering as well as by absorption by the tissues. Due to the mismatch between the refraction index of extracellular fluid and the cell membrane, light scattering occurs in tissues. Refraction index of extracellular fluid varies with the glucose concentration whereas the cellular membrane index is assumed to be remain relatively constant. Beer-Lambert Law plays a major role in absorbance measurement which states that absorbance of light through any solution is in proportion with the concentration of the solution and the length path travelled by light ray.

* Reliable is less
* Requires understanding the physical and physiological factors that may affect blood glucose measurement

**PROPOSED SYSTEM**

In recent years, with the rise of global diabetes, a growing number of subjects are suffering from pain and infections caused by the invasive nature of mainstream commercial glucose meters. Non-invasive blood glucose monitoring technology has become an international research topic and a new method which could bring relief to a vast number of patients. In this proposed system using PIC16F877A microcontroller,the Laser light is used across the finger hose to measure glucose. Laser transmission involves a light source and a light detector positioned on either side of the finger hose. The amount of light passing through the fingerhose depends on the amount of blood glucose in that region. The finger hose was chosen due to the absence of bone tissues and also because of its relatively small thickness. The heartbeat sensor can be used to monitor the patient's heartbeat level, and the temperature sensor can be used to monitor the patient's body temperature. An insulin pump delivers precise doses of insulin, continuously allowing the user to program a pattern of insulin delivery tailored to their needs based on glucose level measurement. Automatically halts insulin infusion when glucose levels reach a predetermined threshold and the user is unresponsive to alarms. Provides increased protection against severe low blood glucose, even when patients are asleep. Then the sensor data is monitored for the Blynk application using IOT.

**BLOCK DIAGRAM**

**POWER SUPPLY FOR ALL UNITS**

**LASER TRANSMITTER**

**IOT**

**PIC(16F877A)**

**CONTOLLER**

**Finger Hose**

**RELAY**

**DRIVER**

**PHOTO DETECTOR**

**INSULIN INFUSION MECHANISM**

**SCU**

**TEMPERATURE SENSOR**

**HEART BEAT SENSOR**

**Methodology:**

**1. Design and Setup:**

Select PIC16F877A microcontroller for system control. Position a laser light source and a light detector on either side of the finger hose. Choose the finger hose due to its absence of bone tissues and small thickness.

**2. Glucose Measurement:**

Employ laser transmission through the finger hose.Measure the amount of light passing through the finger hose.Correlate the light transmission with blood glucose levels.

**3. Health Monitoring:**

Integrate a heartbeat sensor to monitor the patient's heart rate. Utilize a temperature sensor to monitor the patient's body temperature.

**4. Insulin Pump Control:**

Incorporate an insulin pump for precise insulin delivery. Allow users to program a tailored insulin delivery pattern based on glucose levels. Implement an automatic halt of insulin infusion when glucose levels reach a predetermined threshold. Include user responsiveness checks through alarms.

**5. Safety Measures:**

Ensure the system halts insulin infusion when predetermined glucose levels are reached, and the user is unresponsive.Provide increased protection against severe low blood glucose, especially during sleep.

**6. Sensor Data Transmission:**

Utilize the PIC16F877A microcontroller to gather data from the glucose, heartbeat, and temperature sensors.Establish an IoT connection, transmitting the sensor data to the Blynk application for monitoring.

**7. Blynk Application Integration:**

Develop an interface on the Blynk application to display real-time sensor data.Enable users to monitor glucose levels, heart rate, and body temperature remotely. Implement alerts and notifications for critical conditions.

**8. Testing:**

Conduct rigorous testing of the entire system, ensuring accuracy and reliability in glucose measurement and sensor data transmission.Verify the responsiveness of the insulin pump control system and safety measures.

**9. User Training and Documentation:**

Develop user-friendly documentation for system setup and usage.Provide training materials for users on interpreting sensor data and responding to alerts.

**10. Feedback and Iteration:**

Collect feedback from users to identify any issues or areas for improvement.Iterate on the system design and software based on user feedback to enhance overall performance and user experience.This methodology outlines the step-by-step process for designing, implementing, and testing the proposed non-invasive blood glucose monitoring system with integrated health monitoring and insulin pump control.

**Hyperglycemia and Hypoglycemia**

Hyperglycemia and Hypoglycemia refer to medical conditions that exhibit abnormally high or low blood glucose/sugar levels. Diabetes is a condition in which the pancreas of the body ceases to produce insulin, which controls blood glucose levels. The causes of diabetes in humans are not yet fully understood, but the widely accepted hypothesis is that it may be genetic and may be caused by a high sugar intake as part of a daily meal serving. Once diabetes is diagnosed, the blood sugar level needs to be continuously monitored in order to facilitate medicinal insulin intake. Patients with hyperglycemia, in which continuously high blood glucose levels are exhibited, may require continuous blood glucose monitoring. This will require a continuous supply of blood from the patient as current measurement devices invasively monitor sugar levels, which sometimes leads to other complications such as hemorrhaging, blood loss, and other irritable conditions. Non-invasive techniques resolve blood requirement issues.

**CHALLENGES AHEAD FOR NON-INVASIVE GLUCOSE MONITORING**

Various non-invasive technologies have been discussed. Clearly, many research groups are exploring a wide variety of approaches, trying to develop a blood glucose measurement device that can provide stable and reliable results, conveniently and economically. One of the main reasons is that existing technologies, such as absorption spectroscopy, are relatively poor in signal-to-noise ratio in relation to blood glucose concentration and spectra response. Due to the huge anticipated market for a successful, non-invasive glucose monitoring device, the race for research teams to develop more precise and accurate spectroscopic equipment is heated. Moreover, multivariate training methods are often used in the quantitative analysis that the prediction model is data-dependent, whereas the specificity of measurement is not easy to tackle. Although an improved method is investigated for quantitative analysis that can enhance the correlation of the spectroscopic properties of the glucose molecule with glucose concentration in blood, more effort should be made to rigorously extend the technique to non-invasive blood glucose monitoring Moreover, calibration of spectroscopic devices is necessary, because of factors such as light intensity, which may affect the prediction model. As most of the non-invasive technologies are based on some type of optical sensing technique, a time lag may occur between measurements of blood glucose content from different parts of body, which could introduce calibration error. The absorption spectroscopy mainly detects the glucose molecule, and glucose can be found everywhere in the human body. Hence, it is difficult to have a universal prediction model instead of a The absorption spectroscopy mainly detects the glucose molecule, and glucose can be found everywhere in the human body. Hence, it is difficult to have a universal prediction model instead of a single user prediction model, which may need frequent self-calibration.single user prediction model, which may need frequent self-calibration.

**CHAPTER – 4**

**HARDWARE DESCRIPTION**

**POWER SUPPLY**

Power supply is a reference to a source of [electrical power](http://en.wikipedia.org/wiki/Electrical_power). A device or system that supplies [electrical](http://en.wikipedia.org/wiki/Electrical) or other types of [energy](http://en.wikipedia.org/wiki/Energy) to an output [load](http://en.wikipedia.org/wiki/External_electric_load) or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

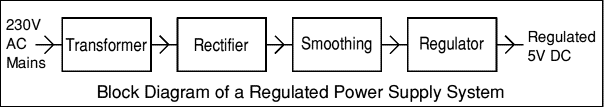
Power supplies for electronic devices can be broadly divided into linear and switching power supplies. The linear supply is a relatively simple design that becomes increasingly bulky and heavy for high current devices; voltage regulation in a linear supply can result in low efficiency. A switched-mode supply of the same rating as a linear supply will be smaller, is usually more efficient, but will be more complex.

**Linear Power supply:**

An [AC](http://en.wikipedia.org/wiki/Alternating_current) powered linear power supply usually uses a [transformer](http://en.wikipedia.org/wiki/Transformer) to convert the voltage from the wall outlet (mains) to a different, usually a lower voltage. If it is used to produce [DC](http://en.wikipedia.org/wiki/Direct_current), a [rectifier](http://en.wikipedia.org/wiki/Rectifier) is used. A [capacitor](http://en.wikipedia.org/wiki/Capacitor) is used to smooth the pulsating current from the rectifier. Some small periodic deviations from smooth direct current will remain, which is known as [ripple](http://en.wikipedia.org/wiki/Ripple_(electrical)). These pulsations occur at a frequency related to the AC [power frequency](http://en.wikipedia.org/wiki/Utility_frequency) (for example, a multiple of 50 or 60 Hz).

The voltage produced by an unregulated power supply will vary depending on the load and on variations in the AC supply voltage. For critical electronics applications a [linear regulator](http://en.wikipedia.org/wiki/Linear_regulator) will be used to stabilize and adjust the voltage. This regulator will also greatly reduce the ripple and noise in the output direct current. Linear regulators often provide current limiting, protecting the power supply and attached circuit from over current.

Adjustable linear power supplies are common laboratory and service shop test equipment, allowing the output voltage to be set over a wide range. For example, a bench power supply used by circuit designers may be adjustable up to 30 volts and up to 5 amperes output. Some can be driven by an external signal, for example, for applications requiring a pulsed output.



### Transformer:

### Description: transformer symbol

### Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC.

### Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage.

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core.

### Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The ratio of the number of turns on each coil, called the turn’s ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

Turns ratio=Vp/Vs=Nn/Ns and Power out=Power in

Vs\*Is=Vp \* Ip

|  |  |  |
| --- | --- | --- |
| Vp = primary (input) voltage Np = number of turns on primary coil Ip  = primary (input) current |  | Vs = secondary (output) voltage Ns = number of turns on secondary coil Is  = secondary (output) current |

### Description: AC power supply, transformer only

### The low voltage AC output is suitable for lamps, heaters and special AC motors. It is not suitable for electronic circuits unless they include a rectifier and a smoothing capacitor.

### Rectifier:

### There are several ways of connecting diodes to make a rectifier to convert AC to DC. The [bridge rectifier](http://www.kpsec.freeuk.com/powersup.htm#bridgerectifier) is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A [single diode](http://www.kpsec.freeuk.com/powersup.htm#singlediode) can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC.

### Description: DC power supply, transformer + rectifier

The varying DC output is suitable for lamps, heaters and standard motors. It is not suitable for electronic circuits unless they include a smoothing capacitor.

### Bridge rectifier:

### A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand (this must be at least three times the supply [RMS](http://www.kpsec.freeuk.com/acdc.htm#rms) voltage so the rectifier can withstand the peak voltages). Please see the [Diodes](http://www.kpsec.freeuk.com/components/diode.htm#bridge) page for more details, including pictures of ridge rectifiers.

### Description: Operation of a Bridge Rectifier

### Alternate pairs of diodes conduct, changing over the connections so the alternating directions of AC are converted to the one direction of DC.

### Output: full-wave varying DC: (using the entire AC wave):

### Description: Full-wave Varying DC

#### Single diode rectifier:

A single diode can be used as a rectifier but this produces **half-wave** varying DC which has gaps when the AC is negative. It is hard to smooth this sufficiently well to supply electronic circuits unless they require a very small current so the smoothing capacitor does not significantly discharge during the gaps. Please see the [Diodes](http://www.kpsec.freeuk.com/components/diode.htm#rectifier) page for some examples of rectifier diodes.

### Description: Single diode rectifier

### Output: half-wave varying DC (using only half the AC wave):

### Description: Half-wave Varying DC

### Smoothing:

### Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The diagram shows the unsmoothed varying DC (dotted line) and the smoothed DC (solid line). The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.

### Description: Smoothing

### Note that smoothing significantly increases the average DC voltage to almost the peak value (1.4 × [RMS](http://www.kpsec.freeuk.com/acdc.htm#rms) value). For example 6V RMS AC is rectified to full wave DC of about 4.6V RMS (1.4V is lost in the bridge rectifier), with smoothing this increases to almost the peak value giving 1.4 × 4.6 = 6.4V smooth DC.

### Smoothing is not perfect due to the capacitor voltage falling a little as it discharges, giving a small ripple voltage. For many circuits a ripple which is 10% of the supply voltage is satisfactory and the equation below gives the required value for the smoothing capacitor. A larger capacitor will give fewer ripples. The capacitor value must be doubled when smoothing half-wave DC.

### Smoothing Capacitor for 10% ripple, C=5\*10/vs.\*f

### C = smoothing capacitance in farads (F)

### Io = output current from the supply in amps (A)

### Vs = supply voltage in volts (V), this is the peak value of the unsmoothed DC

### f    = frequency of the AC supply in hertz (Hz), 50Hz in the UK.

### Description: Smooth DC power supply, transformer + rectifier + smoothing

The smooth DC output has a small ripple. It is suitable for most electronic circuits.

### Regulator:

### Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and current.

### Many of the fixed voltage regulator ICs has 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. They include a hole for attaching a [heat sink](http://www.kpsec.freeuk.com/components/heatsink.htm) if necessary.

1. Positive regulator
   1. input pin
   2. ground pin
   3. output pin

It regulates the positive voltage

1. Negative regulator
   1. ground pin
   2. input pin
   3. output pin

### It regulate the negative voltage

### Description: Voltage regulator

### Description: Regulated DC power supply, transformer + rectifier + smoothing + regulator

The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.

**TEMPERATURE SENSOR (LM35):**

* The temperature sensor is connected with the analog pin of the controller and we get the varying temperature levels of the vehicle.
* The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in oC).
* The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified.
* The temperature sensor will measure the temperature level of the vehicle

PIN DIAGRAM



DESCRIPTION

* It has an output voltage that is proportional to the Celsius temperature.
* The scale factor is .01V/oC
* The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4 oC at room temperature and +/- 0.8 oC over a range of 0 oC to +100 oC.
* Another important characteristic of the LM35DZ is that it draws only 60 micro amps from its supply and possesses a low self-heating capability. The sensor self-heating causes less than 0.1 oC temperature rise in still air.

Features:

* Calibrated directly in ° Celsius (Centigrade)
* Linear + 10.0 mV/°C scale factor
* 0.5°C accuracy guarantee able (at +25°C)
* Rated for full −55° to +150°C range
* Suitable for remote applications
* Low cost due to wafer-level trimming
* Operates from 4 to 30 volts
* Less than 60 μA current drain
* Low self-heating, 0.08°C in still air
* Nonlinearity only ±1⁄4°C typical
* Low impedance output, 0.1 W for 1 mA load

**HEART BEAT SENSOR**

* In this project we will detect the driver heart rate value using heart beat sensor
* Here the accurate heart rate value is obtained using the calculation which we loaded in the controller
* Some threshold values will be set to detect the abnormalities in heart rate value of the drivers
* Heart rate sensor is connected to the digital port (2) of the controller and some may have analog output
* HEART BEAT sensor is designed to give digital output of heat beat when a finger is placed on it.
* When the HEART BEAT detector is working, the beat LED flashes in unison with each heart beat.
* This digital output can be connected to microcontroller directly to measure the Beats Per Minute (BPM) rate.
* It works on the principle of light modulation by blood flow through finger at each pulse.
* HEART BEAT is sensed by using a high intensity type LED and LDR.
* The finger is placed between the LED and LDR.

**FEATURES**

Microcontroller based SMD design

* Heat beat indication by LED
* Instant output digital signal for directly connecting to microcontroller
* Compact Size
* Working Voltage +5V DC

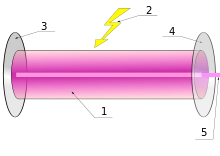
**LASER MODULE**

A **laser** is a device that emits [light](https://en.wikipedia.org/wiki/Light) through a process of [optical amplification](https://en.wikipedia.org/wiki/Optical_amplification) based on the [stimulated emission](https://en.wikipedia.org/wiki/Stimulated_emission) of [electromagnetic radiation](https://en.wikipedia.org/wiki/Electromagnetic_radiation). The term "laser" originated as an [acronym](https://en.wikipedia.org/wiki/Acronym) for "**light amplification by stimulated emission of radiation**".[[1]](https://en.wikipedia.org/wiki/Laser#cite_note-Gould1959-1)[[2]](https://en.wikipedia.org/wiki/Laser#cite_note-2) The first laser was built in 1960 by [Theodore H. Maiman](https://en.wikipedia.org/wiki/Theodore_H._Maiman) at [Hughes Research Laboratories](https://en.wikipedia.org/wiki/Hughes_Research_Laboratories), based on theoretical work by [Charles Hard Townes](https://en.wikipedia.org/wiki/Charles_Hard_Townes) and [Arthur Leonard Schawlow](https://en.wikipedia.org/wiki/Arthur_Leonard_Schawlow).

A laser differs from other sources of light in that it emits light [*coherently*](https://en.wikipedia.org/wiki/Coherence_(physics)), spatially and temporally. [Spatial coherence](https://en.wikipedia.org/wiki/Spatial_coherence) allows a laser to be focused to a tight spot, enabling applications such as [laser cutting](https://en.wikipedia.org/wiki/Laser_cutting) and [lithography](https://en.wikipedia.org/wiki/Photolithography#Light_sources). Spatial coherence also allows a laser beam to stay narrow over great distances ([collimation](https://en.wikipedia.org/wiki/Collimated_light)), enabling applications such as [laser pointers](https://en.wikipedia.org/wiki/Laser_pointer). Lasers can also have high [temporal coherence](https://en.wikipedia.org/wiki/Temporal_coherence), which allows them to emit light with a very narrow [spectrum](https://en.wikipedia.org/wiki/Frequency_spectrum), i.e., they can emit a single color of light. Temporal coherence can be used to produce [pulses](https://en.wikipedia.org/wiki/Ultrashort_pulse) of light as short as a [femtosecond](https://en.wikipedia.org/wiki/Femtosecond).

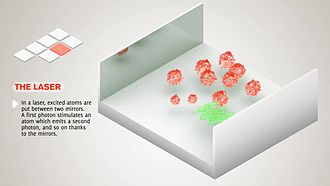
Among their many applications, lasers are used in [optical disk drives](https://en.wikipedia.org/wiki/Optical_disk_drive), [laser printers](https://en.wikipedia.org/wiki/Laser_printer), and [barcode scanners](https://en.wikipedia.org/wiki/Barcode_scanner); [DNA sequencing instruments](https://en.wikipedia.org/wiki/DNA_sequencer), [fiber-optic](https://en.wikipedia.org/wiki/Fiber-optic_communication) and [free-space optical communication](https://en.wikipedia.org/wiki/Free-space_optical_communication); [laser surgery](https://en.wikipedia.org/wiki/Laser_surgery) and skin treatments; cutting and [welding](https://en.wikipedia.org/wiki/Welding) materials; military and [law enforcement](https://en.wikipedia.org/wiki/Law_enforcement) devices for marking targets and [measuring range](https://en.wikipedia.org/wiki/Laser_rangefinder#Military) and speed; and [laser lighting displays](https://en.wikipedia.org/wiki/Laser_lighting_display) in entertainment.

## Design

[](https://en.wikipedia.org/wiki/File:Laser.svg)

Components of a typical laser:

1. Gain medium
2. Laser pumping energy
3. High reflector
4. [Output coupler](https://en.wikipedia.org/wiki/Output_coupler)
5. Laser beam



Animation explaining stimulated emission and the laser principle

A laser consists of a [gain medium](https://en.wikipedia.org/wiki/Active_laser_medium), a mechanism to energize it, and something to provide optical [feedback](https://en.wikipedia.org/wiki/Feedback). The gain medium is a material with properties that allow it to [amplify](https://en.wikipedia.org/wiki/Optical_amplifier) light by way of stimulated emission. Light of a specific wavelength that passes through the gain medium is amplified (increases in power).

For the gain medium to amplify light, it needs to be supplied with energy in a process called [pumping](https://en.wikipedia.org/wiki/Laser_pumping). The energy is typically supplied as an electric current or as light at a different wavelength. Pump light may be provided by a [flash lamp](https://en.wikipedia.org/wiki/Xenon_flash_lamp) or by another laser.

The most common type of laser uses feedback from an [optical cavity](https://en.wikipedia.org/wiki/Optical_cavity)—a pair of mirrors on either end of the gain medium. Light bounces back and forth between the mirrors, passing through the gain medium and being amplified each time. Typically one of the two mirrors, the [output coupler](https://en.wikipedia.org/wiki/Output_coupler), is partially transparent. Some of the light escapes through this mirror. Depending on the design of the cavity (whether the mirrors are flat or [curved](https://en.wikipedia.org/wiki/Curved_mirror)), the light coming out of the laser may spread out or form a narrow [beam](https://en.wikipedia.org/wiki/Light_beam). In analogy to [electronic oscillators](https://en.wikipedia.org/wiki/Electronic_oscillator), this device is sometimes called a *laser oscillator*.

Most practical lasers contain additional elements that affect properties of the emitted light, such as the polarization, wavelength, and shape of the beam.

**PIC MICROCONTROLLER:**

**MICRO CONTROLLER PIC16F877A**

* The below given details are general description of PIC16F877A controller.
* The controller is known as the heart of the entire system which will check for the input and operate the output accordingly.
* Here, temperature sensor, dust sensor and 2 motor unit is connected with the controller’s analog and digital pins
* The collected data of the system will be sent to IOT module through the controller’s TX pin
* These parameters are transferred over the cloud with the help of node MCU Esp8266
* The motor unit will be controlled using digital pins of the controller in order to spray and cleans the panel
* Thus, this will improve the efficiency of the panel and produces more voltage
* LCD interfaced will be connected with the digital pins of the controller

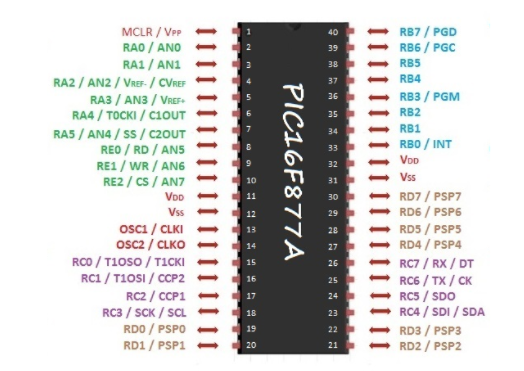
**ABOUT PIC16F877A**

**PIC Basic Properties:**

* It has 40 Pins.
* IT has 5 Ports in total. ( PortA, PortB, PortC, PortD and PortE).
* It supports Serial Communication for which it has 2 Pins TX and RX.
* You can receive data from RX and can transmit data from TX.
* It also supports SPI Protocol.
* We have to place a crystal oscillator ranging from 4MHz to 40MHz.
* We have to design its basic circuit first in order to use it.
* Moreover, we will also need some programmer or burner to upload hex file.
* I use PICKit3 in my projects.
* Here's an image of PIC16F877a:
* PIC is a family of [Harvard architecture](http://en.wikipedia.org/wiki/Harvard_architecture) [microcontrollers](http://en.wikipedia.org/wiki/Microcontroller) made by [Microchip Technology](http://en.wikipedia.org/wiki/Microchip_Technology), derived from the PIC1640.
* Originally developed by [General Instrument](http://en.wikipedia.org/wiki/General_Instrument)'s Microelectronics Division. The name PIC initially referred to "Programmable Interface Controller".
* Microcontroller is a general purpose device, which integrates a number of the components of a microprocessor system on to single chip.
* It has inbuilt CPU, memory and peripherals to make it as a mini computer.
* A microcontroller combines on to the same microchip:
* Memory (both ROM and RAM)

**Ports in PIC16F877a:**

* Port A has 8 Pins in total and it is an analogue Port. All Pins in Port A are analogue.
* Port B also has 8 Pins but these all are digital Pins.
* Port C is also a digital Port having 8 Pins.
* Port C Pins are also used for Serial Communication.
* Port D has 8 Pins and all are digital Pins.
* Port E has 3 Pins.



|  |  |
| --- | --- |
| **PIC16F877A –Detailed Features** | |
| CPU | 8-bit PIC |
| Architecture | 8 |
| Program Memory Size (Kbytes) | 14 |
| RAM (bytes) | 368 |
| EEPROM/HEF | 256/HEF |
| Pin Count | 40 |
| Max. CPU Speed (MHz) | 20 |
| Peripheral Pin select (PPS) | No |
| Internal Oscillator | No |
| No. Of comparators | 2 |
| No. Of  Operational Amplifier | 0 |
| No. Of ADC channels | 14 |
| Max ADC Resolution (bits) | 10 |
| ADC with Computation | No |
| Number of DAC Converter | 0 |
| Max DAC resolution | 0 |
| Internal Voltage Reference | Yes |
| Zero Cross Detect | No |
| No. Of 8-bit timers | 2 |
| No. Of 16-bit Timers | 1 |
| Signal Measurement Timer | 0 |
| Hardware Limit Timer | 0 |
| No. Of PWM outputs | 0 |
| Max PWM resolution | 10 |
| Angular Timer | No |
| Math Accelerator | No |
| No. Of  UART module | 1 |
| No. Of SPI Module | 1 |
| No. Of I2C module | 1 |
| No. Of USB Module | 0 |
| Windowed Watchdog Timer (WWDT) | No |
| CRC/Scan | No |
| Numerically Controlled Oscillator | 0 |
| Cap. Touch Channels | 11 |
| Segment LCD | 0 |
| Minimum Operating Temperature (\*C) | -40 |
| Maximum Operating Temperature (\*C) | 125 |
| Minimum Operating Voltage (V) | 2 |
| Maximum Operating Voltage (V) | 5.5 |
| High Voltage Capable | No |

**Applications**

* Multiple DIY Projects
* Projects requiring Multiple I/O interfaces and communications
* Ideal for more advanced level A/D applications in automotive, industrial, appliances and consumer applications.

The above given is general description of PIC16F877A controller.

**INTERNET OF THINGS (IoT)**

The Internet of things (IoT) is the network of physical devices, vehicles, home appliances and other items [embedded](https://en.wikipedia.org/wiki/Embedded_system) with [electronics](https://en.wikipedia.org/wiki/Electronics), [software](https://en.wikipedia.org/wiki/Software), [sensors](https://en.wikipedia.org/wiki/Sensor), [actuators](https://en.wikipedia.org/wiki/Actuator), and [connectivity](https://en.wikipedia.org/wiki/Internet_access) which enables these objects to connect and exchange [data](https://en.wikipedia.org/wiki/Data). Each thing is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing [Internet](https://en.wikipedia.org/wiki/Internet) infrastructure.

The figure of online capable devices increased 31% from 2016 to 8.4 billion in 2017. Experts estimate that the IoT will consist of about 30 billion objects by 2020. It is also estimated that the global market value of IoT will reach $7.1 trillion by 2020.

The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of [cyber-physical systems](https://en.wikipedia.org/wiki/Cyber-physical_system), which also encompasses technologies such as [smart grids](https://en.wikipedia.org/wiki/Smart_grid), [virtual power plants](https://en.wikipedia.org/wiki/Virtual_power_plant), [smart homes](https://en.wikipedia.org/wiki/Smart_home), [intelligent transportation](https://en.wikipedia.org/wiki/Intelligent_transportation) and [smart cities](https://en.wikipedia.org/wiki/Smart_city).

"Things", in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, [biochip](https://en.wikipedia.org/wiki/Biochip) transponders on farm animals, cameras streaming live feeds of wild animals in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring, or field operation devices that assist firefighters in [search and rescue](https://en.wikipedia.org/wiki/Search_and_rescue) operations. Legal scholars suggest regarding "things" as an "inextricable mixture of hardware, software, data and service".

These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices

As of 2016, the vision of the Internet of things has evolved due to a convergence of multiple technologies, including ubiquitous wireless communication, real-time [analytics](https://en.wikipedia.org/wiki/Analytics), [machine learning](https://en.wikipedia.org/wiki/Machine_learning), commodity sensors, and [embedded systems](https://en.wikipedia.org/wiki/Embedded_system). This means that the traditional fields of coil resistance), and others all contribute to enabling the Internet of things.

The concept of a network of smart devices was discussed as early as 1982, with a modified Coke machine at [Carnegie Mellon University](https://en.wikipedia.org/wiki/Carnegie_Mellon_University) becoming the first Internet-connected appliance, able to report its inventory and whether newly loaded drinks were cold. [Mark Weiser](https://en.wikipedia.org/wiki/Mark_Weiser)'s seminal 1991 paper on [ubiquitous computing](https://en.wikipedia.org/wiki/Ubiquitous_computing), "The Computer of the 21st Century", as well as academic venues such as Unicom and Parco produced the contemporary vision of IoT.  In 1994 Reza Raji described the concept in [IEEE Spectrum](https://en.wikipedia.org/wiki/IEEE_Spectrum) as "[moving] small packets of data to a large set of nodes, so as to integrate and automate everything from home appliances to entire factories". Between 1993 and 1996 several companies proposed solutions like [Microsoft](https://en.wikipedia.org/wiki/Microsoft)'s [at Work](https://en.wikipedia.org/wiki/At_Work) or [Novell](https://en.wikipedia.org/wiki/Novell)'s [NEST](https://en.wikipedia.org/wiki/Novell_Embedded_Systems_Technology). However, only in 1999 did the field start gathering momentum. [Bill Joy](https://en.wikipedia.org/wiki/Bill_Joy) envisioned [Device to Device (D2D)](https://en.wikipedia.org/wiki/Device-to-device)communication as part of his "Six Webs" framework, presented at the World Economic Forum at Davos in 1999.

The concept of the Internet of things became popular in 1999, through the [Auto-ID Center](https://en.wikipedia.org/wiki/Auto-ID_Labs) at [MIT](https://en.wikipedia.org/wiki/Massachusetts_Institute_of_Technology) and related market-analysis publications. Radio-frequency identification ([RFID](https://en.wikipedia.org/wiki/RFID)) was seen by [Kevin Ashton](https://en.wikipedia.org/wiki/Kevin_Ashton) (one of the founders of the original [Auto-ID Center](https://en.wikipedia.org/wiki/Auto-ID_Labs)) as a prerequisite for the Internet of things at that point. [Ashton](https://en.wikipedia.org/wiki/Kevin_Ashton) prefers the phrase "Internet for things." If all objects and people in daily life were equipped with identifiers, computers could manage and store them. Besides using RFID, the [tagging](https://en.wikipedia.org/wiki/Tag_(metadata)) of things may be achieved through such technologies as [near field communication](https://en.wikipedia.org/wiki/Near_field_communication), [barcodes](https://en.wikipedia.org/wiki/Barcodes), [QR codes](https://en.wikipedia.org/wiki/QR_codes) and [digital watermarking](https://en.wikipedia.org/wiki/Digital_watermarking).

In its original interpretation, one of the first consequences of implementing the Internet of things by equipping all objects in the world with minuscule identifying devices or machine-readable identifiers would be to transform daily life. For instance, instant and ceaseless [inventory control](https://en.wikipedia.org/wiki/Inventory_control) would become ubiquitous. A person's ability to interact with objects could be altered remotely based on immediate or present needs, in accordance with existing [end-user](https://en.wikipedia.org/wiki/End-user) agreements. For example, such technology could grant motion-picture publishers much more control over end-user private devices by remotely enforcing [copyright](https://en.wikipedia.org/wiki/Copyright) restrictions and [digital rights management](https://en.wikipedia.org/wiki/Digital_rights_management), so the ability of a customer who bought a [Blu-ray disc](https://en.wikipedia.org/wiki/Blu-ray_disc) to watch the movie could become dependent on the copyright holder's decision, similar to Circuit City's failed [DIVX](https://en.wikipedia.org/wiki/DIVX).

A significant transformation is to extend "things" from the data generated from devices to objects in the physical space. The thought-model for future interconnection environment was proposed in 2004. The model includes the notion of the ternary universe consists of the physical world, virtual world and mental world and a multi-level reference architecture with the nature and devices at the bottom level followed by the level of the Internet, sensor network, and mobile network, and intelligent human-machine communities at the top level, which supports geographically dispersed users to cooperatively accomplish tasks and solve problems by using the network to actively promote the flow of material, energy, techniques, information, knowledge, and services in this environment. This thought model envisioned the development trend of the Internet of things.

**APPLICATIONS**

* Consumer application
* Smart Home
* Media
* Infrastructure Management
* Manufacturing
* Agriculture
* Energy management
* Environmental monitoring
* Building and home automation
* Metropolitan scale deployments
* Medical and healthcare
* Transportation

**Consumer Applications**

A growing portion of IoT devices are created for consumer use. Examples of consumer applications include connected car, entertainment, [home automation](https://en.wikipedia.org/wiki/Home_automation) (also known as smart home devices), [wearable technology](https://en.wikipedia.org/wiki/Wearable_technology), [quantified self](https://en.wikipedia.org/wiki/Quantified_Self), connected health, and appliances such as washer/dryers, robotic vacuums, air purifiers, ovens, or refrigerators/freezers that use Wi-Fi for remote monitoring. Consumer IoT provides new opportunities for [user experience](https://en.wikipedia.org/wiki/User_experience) and [interfaces](https://en.wikipedia.org/wiki/User_interface).

**Smart Home**

IoT devices are a part of the larger concept of [home automation](https://en.wikipedia.org/wiki/Home_automation), also known as [demotics](https://en.wikipedia.org/wiki/Domotics). Large smart home systems utilize a main hub or controller to provide users with a central control for all of their devices. These devices can include lighting, heating and air conditioning, media and security systems. Ease of usability is the most immediate benefit to connecting these functionalities. Long term benefits can include the ability to create a more environmentally friendly home by automating some functions such as ensuring lights and electronics are turned off. One of the major obstacles to obtaining smart home technology is the high initial cost.

**Home System Applications**

One key application of smart home is to provide [assistance for disabled and elderly individuals](https://en.wikipedia.org/wiki/Home_automation_for_the_elderly_and_disabled). These home systems utilize assistive technology to accommodate an owner's specific disabilities. Voice control can assist users with sight and mobility limitations while alert systems can be connected directly to Cochlear implants worn by hearing impaired users. They can also be equipped with additional safety features. These features can include sensors that monitor for medical emergencies such as falls or seizures. Smart home technology applied in this way can provide users with more freedom and a higher quality of life.

A second application of smart home is even more sophisticated. One can guide his or her connected device at home even from far away. If one for example leaves the office, it is possible to tell a connected air conditioner device via smart phone to cool down the house to a certain temperature.

**Agriculture**

The IoT contributes significantly towards innovating farming methods. Farming challenges caused by population growth and [climate change](https://en.wikipedia.org/wiki/Climate_change) have made it one of the first industries to utilize the IoT. The integration of wireless sensors with agricultural mobile apps and cloud platforms helps in collecting vital information pertaining to the environmental conditions – temperature, rainfall, humidity, wind speed, pest infestation, soil humus content or nutrients, besides others – linked with a farmland, can be used to improve and automate farming techniques, take informed decisions to improve quality and quantity, and minimize risks and wastes. The app-based field or crop monitoring also lowers the hassles of managing crops at multiple locations. For example, farmers can now detect which areas have been fertilized (or mistakenly missed), if the land is too dry and predict future yields.

**Medical and Healthcare**

IoT devices can be used to enable [remote health monitoring](https://en.wikipedia.org/wiki/Remote_patient_monitoring) and [emergency notification systems](https://en.wikipedia.org/wiki/Emergency_notification_system). These health monitoring devices can range from blood pressure and heart rate monitors to advanced devices capable of monitoring specialized implants, such as pacemakers, Fitbit electronic wristbands, or advanced hearing aids. Some hospitals have begun implementing "smart beds" that can detect when they are occupied and when a patient is attempting to get up. It can also adjust itself to ensure appropriate pressure and support is applied to the patient without the manual interaction of nurses. According to the latest research, US Department of Health plans to save up to USD 300 billion from the national budget due to medical innovations.

Specialized sensors can also be equipped within living spaces to monitor the health and general well-being of senior citizens, while also ensuring that proper treatment is being administered and assisting people regain lost mobility via therapy as well. Other consumer devices to encourage healthy living, such as, connected scales or [wearable heart monitors](https://en.wikipedia.org/wiki/Wearable_technology), are also a possibility with the IoT. More and more end-to-end health monitoring IoT platforms are coming up for antenatal and chronic patients, helping one manage health vitals and recurring medication requirements

The IoT can assist in the integration of communications, control, and information processing across various [transportation systems](https://en.wikipedia.org/wiki/Intelligent_transportation_system). Application of the IoT extends to all aspects of transportation systems the infrastructure, and the driver or user). Dynamic interaction between these components of a transport system enables inter and intra vehicular communication, [smart traffic control](https://en.wikipedia.org/wiki/Smart_traffic_light), smart parking, [electronic toll collection systems](https://en.wikipedia.org/wiki/Electronic_toll_collection), [logistic](https://en.wikipedia.org/wiki/Logistics_management) and [fleet management](https://en.wikipedia.org/wiki/Fleet_management), [vehicle control](https://en.wikipedia.org/wiki/Autonomous_cruise_control_system), and safety and road assistance. In Logistics and Fleet Management for example, The IoT platform can continuously monitor the location and conditions of cargo and assets via wireless sensors and send specific alerts when management exceptions occur (delays, damages, thefts, etc.).

**Building and Home Automation**

IoT devices can be used to monitor and control the mechanical, electrical and electronic systems used in various types of buildings (e.g., public and private, industrial, institutions, or residential) in [home automation](https://en.wikipedia.org/wiki/Home_automation) and [building automation](https://en.wikipedia.org/wiki/Building_automation) systems. In this context, three main areas are being covered in literature:

* The integration of the internet with building energy management systems in order to create energy efficient and IoT driven “smart buildings”.
* The possible means of real-time monitoring for reducing energy consumption and monitoring occupant behaviors.
* The integration of smart devices in the built environment and how they might be used in future applications

**Environmental Monitoring**

[Environmental monitoring](https://en.wikipedia.org/wiki/Environmental_monitoring) applications of the IoT typically use sensors to assist in environmental protection by monitoring air or [water quality](https://en.wikipedia.org/wiki/Water_quality), [atmospheric](https://en.wikipedia.org/wiki/Air_pollution) or [soil conditions](https://en.wikipedia.org/wiki/Soil_pollution) and can even include areas like monitoring the [movements of wildlife](https://en.wikipedia.org/wiki/Animal_migration_tracking) and their [habitats](https://en.wikipedia.org/wiki/Habitat).  Development of resource-constrained devices connected to the Internet also means that other applications like [earthquake](https://en.wikipedia.org/wiki/Earthquake_warning_system) or [tsunami early-warning systems](https://en.wikipedia.org/wiki/Tsunami_warning_system) can also be used by emergency services to provide more effective aid. IoT devices in this application typically span a large geographic area and can also be mobile. It has been argued that the standardization IoT brings to wireless sensing will revolutionize this area.

**ESP 8266- 12E NODE MCU (IoT MODULE)**

Node MCU is an open source [IoT](https://en.wikipedia.org/wiki/Internet_of_Things) platform. It includes firmware which runs on the [ESP8266](https://en.wikipedia.org/wiki/ESP8266) [Wi-Fi](https://en.wikipedia.org/wiki/Wi-Fi) [SoC](https://en.wikipedia.org/wiki/System_on_a_chip) from [Espressif Systems](https://en.wikipedia.org/w/index.php?title=Espressif_Systems&action=edit&redlink=1" \o "Espressif Systems (page does not exist)), and hardware which is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the dev kits. The firmware uses the [Lua](https://en.wikipedia.org/wiki/Lua_(programming_language)) scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson, and spiffs.

The Internet of things (IoT) is the network of everyday objects — physical things embedded with electronics, software, sensors, and connectivity enabling data exchange. Basically, a little networked computer is attached to a thing, allowing information exchange to and from that thing. Be it lightbulbs, toasters, refrigerators, flower pots, watches, fans, planes, trains, automobiles, or anything else around, a little networked computer can be combined with it to accept input (especially object control) or to gather and generate informational output (typically object status or other sensory data). This means computers will be permeating everything around us — ubiquitous embedded computing devices, uniquely identifiable, interconnected across the Internet. Because of low-cost, networkable microcontroller modules, the Internet of things is really starting to take off.

NodeMCU was created shortly after the [ESP8266](https://en.wikipedia.org/wiki/ESP8266) came out. On December 30, 2013, [Express if Systems](https://en.wikipedia.org/w/index.php?title=Espressif_Systems&action=edit&redlink=1) begin production of the ESP8266. The ESP8266 is a Wi-Fi SoC integrated with a TensilicaXtensa LX106 core, widely used in IoT applications. Node MCU started on 13 Oct 2014, when Hong committed the first file of node mcu-firmware to GitHub. Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the [gerber](https://en.wikipedia.org/wiki/Gerber_format" \o "Gerber format) file of an ESP8266 board, named devkit v0.9. Later that month, Tuan PM ported [MQTT](https://en.wikipedia.org/wiki/MQTT) client library from [Contain](https://en.wikipedia.org/wiki/Contiki) to the ESP8266 SoC platform, and committed to Node MCU project, then Node MCU was able to support the MQTT IoT protocol, using Lua to access the MQTT broker. Another important update was made on 30 Jan 2015, when Devsaurus ported the u8glib to Node MCU project, enabling Node MCU to easily drive LCD, Screen, OLED, even VGA displays.

**ESP8266 ARDUINO CORE**

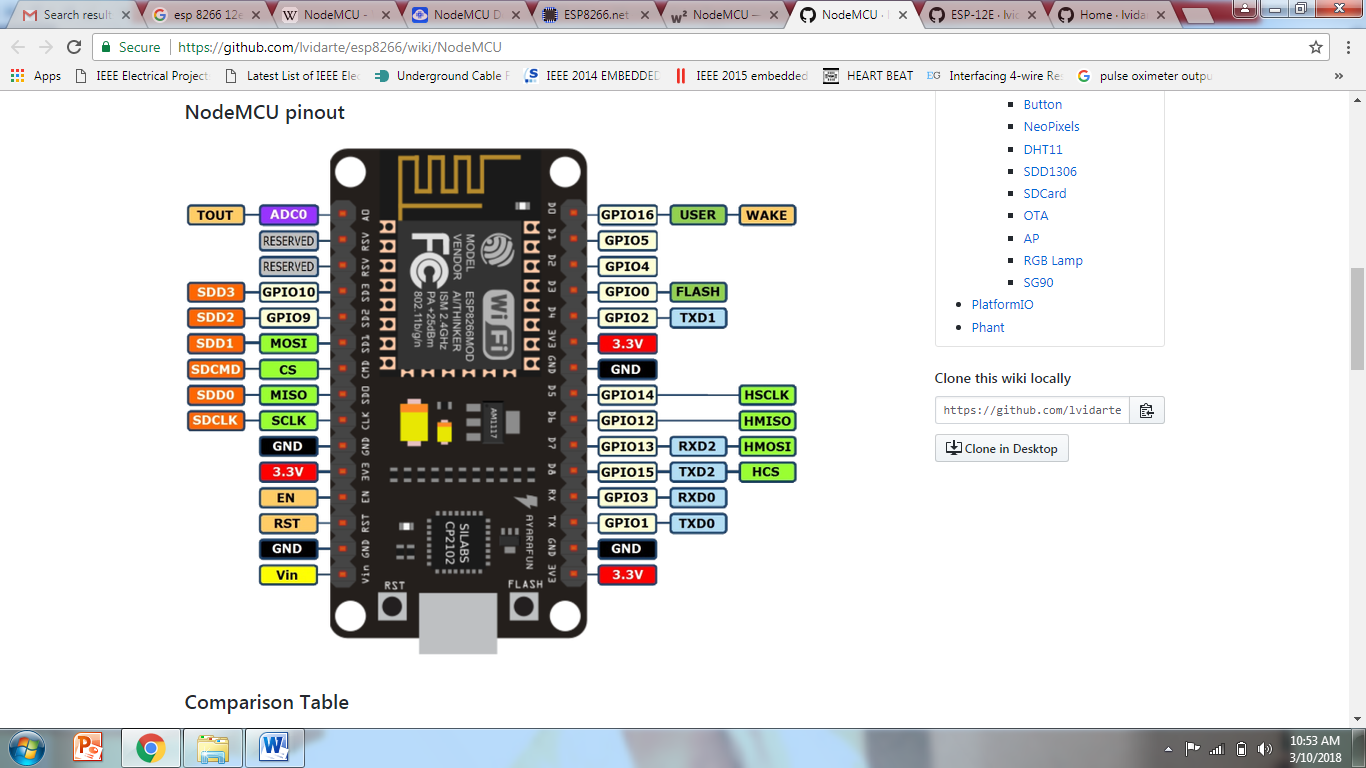
Arduino began developing new MCU boards based on non-AVR processors like the ARM/SAM MCU and used in the Arduino Due, they needed to modify the Arduino IDE so that it would be relatively easy to change the IDE to support alternate tool chains to allow Arduino C/C++ to be compiled down to these new processors. They did this with the introduction of the Board Manager and the SAM Core. A "core" is the collection of software components required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source file down to the target MCU's machine language. Some creative ESP8266 enthusiasts have developed an Arduino core for the ESP8266 WiFiSoC that is available at the GitHub ESP8266 Core webpage. This is what is popularly called the "ESP8266 Core for the Arduino IDE" and it has become one of the leading software development platforms for the various ESP8266 based modules and development boards, including Node MCUs.The Button is a Wi-Fi connected push button designed by [Peter R Jennings](https://en.wikipedia.org/wiki/Peter_R_Jennings). The Button is designed for single-purpose, internet-enabled functions. When the button is pressed, a connection is made to a web server which will perform the desired task. Applications include a doorbell or panic button.

**Node USB**

Node USB is an open IoT platform about the size of a standard USB stick. It was designed to leverage Node MCU ([Lua](https://en.wikipedia.org/wiki/Lua_(programming_language))) for easy programming and has the extra feature of [USB](https://en.wikipedia.org/wiki/USB) capability. It is ideal for Plug-n-Play solutions, allowing easy prototyping for developers Node MCU provides access to the [GPIO](https://en.wikipedia.org/wiki/General-purpose_input/output) (General Purpose Input/Output) and for developing purposes below pin mapping table should be referenced.

|  |  |  |  |
| --- | --- | --- | --- |
| **IO index** | **ESP8266 pin** | **IO index** | **ESP8266 pin** |
| **0 [\*]** | **GPIO16** | **7** | **GPIO13** |
| **1** | **GPIO5** | **8** | **GPIO15** |
| **2** | **GPIO4** | **9** | **GPIO3** |
| **3** | **GPIO0** | **10** | **GPIO1** |
| **4** | **GPIO2** | **11** | **GPIO9** |
| **5** | **GPIO14** | **12** | **GPIO10** |
| **6** | **GPIO12** |  |  |

Node MCU is an open source IoT platform based on the [ESP‐12E](https://github.com/lvidarte/esp8266/wiki/ESP%E2%80%9012E) module. The version 1.0 is the 5th design of NodeMCUdevkit. This uses [CP2102](https://www.amazon.co.uk/UART-CP2102-Module-Serial-Converter/dp/B00AFRXKFU) as UART bridge and can flash firmware automatically by using nodemcu-flasher. Also, it has a voltage regulator to convert from 5V to 3.3V which is the required by the esp21e module.



**IoT Module**

| **S.No.** | **Components** | **Node MCU v1.0** | **Arduino MKR1000** |
| --- | --- | --- | --- |
| **1** | **Microcontroller** | **ESP-12E module, with Espressif ESP8266 32bits** | **ARM Cortex M0+ 32bits** |
| **2** | **Clock Speed** | **80/160MHz** | **48MHz** |
| **3** | **Board Power Supply** | **5V** | **5V** |
| **4** | **Circuit Operating Voltage** | **3.3V** | **3.3V** |
| **5** | **Flash Memory** | **4MB** | **256KB** |
| **6** | **SRAM** | **64KB** | **32KB** |
| **7** | **EEPROM** | **No** | **No** |
| **8** | **Digital I/O Pins** | **10** | **8** |
| **9** | **PWM Pins** | **10** | **12** |
| **10** | **Analog Input Pins** | **1 (ADC 10 bit)** | **7 (ADC 8/10/12 bit)** |
| **11** | **Analog Output Pins** |  | **1 (DAC 10 bit)** |
| **12** | **Connectivity** | **IEEE 802.11 b/g/n Wi-Fi** | **IEEE 802.11 b/g/n Wi-Fi** |
| **13** | **Antenna Type** | **PCB** | **PCB** |
| **14** | **Supported Battery** | **No** | **Li-Po single cell, 3.7V, 700mAh minimum** |
| **15** | **UART** | **1 (+ TX only on pin GPIO2)** | **1** |
| **16** | **SPI** | **2** | **1** |
| **17** | **I2C** | **1** | **1** |
| **18** | **LED built in** | **D0 / GPIO 16** | **GPIO 6** |
| **19** | **Programming Languages** | **C++ / Python / Lua / Javascript** | **C++** |
| **20** | **Flashing** | **Locally / OTA** | **Locally / OTA** |

**CHIP**

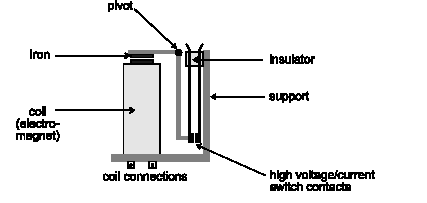
The ESP8266 series, or family, of Wi-Fi chips is produced by Espressif Systems, a fabless semiconductor company operating out of Shanghai, China. The ESP8266 series presently includes the ESP8266EX and ESP8285 chips.

ESP8266EX (simply referred to as ESP8266) is a system-on-chip (SoC) which integrates a 32-bit Tensilica microcontroller, standard digital peripheral interfaces, antenna switches, RF balun, power amplifier, low noise receive amplifier, filters and power management modules into a small package. It provides capabilities for 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2), general-purpose input/output (16 GPIO), Inter-Integrated Circuit (I²C), analog-to-digital conversion (10-bit ADC), Serial Peripheral Interface (SPI), I²S interfaces with DMA (sharing pins with GPIO), UART (on dedicated pins, plus a transmit-only UART can be enabled on GPIO2), and pulse-width modulation (PWM). The processor core, called "L106" by Espressif, is based on Tensilica's Diamond Standard 106Micro 32-bit processor controller core and runs at 80 MHz (or overclocked to 160 MHz). It has a 64 KB boot ROM, 32 KB instruction RAM and 80 KB user data RAM. (Also, 32 KB instruction cache RAM and 16 KB ETS system data RAM.) External flash memory can be accessed through SPI. The silicon chip itself is housed within a 5 mm × 5 mm Quad Flat No-Leads package with 33 connection pads — 8 pads along each side and one large thermal/ground pad in the centre.

**Relay Driver:**

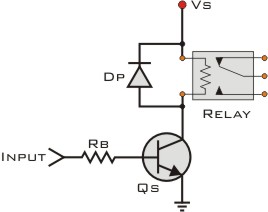
A relay is an electro-magnetic switch which is useful if you want to use a low voltage circuit to switch on and off a light bulb (or anything else) connected to the 220v mains supply.

The diagram below shows a typical relay (with “normally-open” contacts).



The current needed to operate the relay coil is more than can be supplied by most chips (op. amps etc), so a transistor is usually needed.

**Relay Driver using single transistor:**

[](http://pcbheaven.com/wikipages/images/transistorcircuits_1234707497.jpg)

This circuit will drive a relay coil from a low power output, usually from an IC like 555 or a TTL/CMOS. It is used to switch high loads or loads that needs AC current to operate. The relay will be actuated when the input of the circuit goes high. The protection diode Dp is used to protect the transistor from the reverse current generated from the coil of the relay during the switch off time. The values for Rb and Qs vary accordingly. The way to calculate them is:

First we calculate the load current:

**IL = VS / RL**

Then we calculate the transistor hFE. It must be at least 5 times the load current IL divided by the maximum output current from the Input to the base of the transistor

|  |  |
| --- | --- |
| **hFE(min) > 5 X** | **IL** |
| **IINPUT** |

Now you can choose the transistor Qs. You must select it according to it'sIc that must be greater than IL and it's current gain hFE.

Then you calculate the base resistor RB, If the input is taken from a component (possible an IC) that uses the same power supply as the transistor (that is Vs), then the form is:

**RB = 0.2 X RL X hFE**

Otherwise, if the component uses another power source (like VCC) then the form is:

|  |  |
| --- | --- |
| **RB =** | **VCC X hFE** |
| **5 X IL** |

The protective diode could be the 1N4001 or any general purpose diode.

**An example:**

The output from a 74LS series TTL IC is required to operate a relay with a 160 Ohm coil. The supply voltage is 12V for the transistor and 5V for the IC. The IC can supply a maximum current of 2mA.

**IL = Vs / RL => IL = 12 / 160 = 75mA**

The transistor must have an hFE greater than 5 X 75 / 2 =>**hFE> 187.5**. So we choose a transistor with hFE = 200 and IC = 100mA.

Now for the RB resistor. Because the power supplies of transistor and IC are different, we use the second formula:

|  |  |
| --- | --- |
| **RB =** | **VCC X hFE** |
| **5 X IL** |

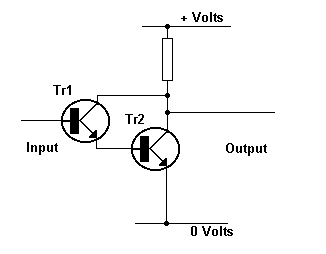
With the use of some basic maths, this will produce **RB = 2666.6 Ohm**. You choose the closest resistor possible to this value.

**Darlington Pair**

A Darlington pair is two transistors that act as a single transistor but with a much higher current gain.

The **Darlington transistor** (often called a **Darlington pair**) is a compound structure consisting of two bipolar transistors (either integrated or separated devices) connected in such a way that the current amplified by the first transistor is amplified further by the second one. This configuration gives a much higher [current](http://en.wikipedia.org/wiki/Electric_current)[gain](http://en.wikipedia.org/wiki/Gain) (written β, hfe, or hFE) than each transistor taken separately and, in the case of integrated devices, can take less space than two individual transistors because they can use a *shared* collector. Integrated Darlington pairs come packaged in transistor-like [integrated circuit](http://en.wikipedia.org/wiki/Integrated_circuit) packages.

The Darlington configuration was invented by [Bell Laboratories](http://en.wikipedia.org/wiki/Bell_Laboratories) engineer [Sidney Darlington](http://en.wikipedia.org/wiki/Sidney_Darlington) in 1953. He [patented](http://en.wikipedia.org/wiki/Patent) the idea of having two or three transistors on a single chip (and *sharing* a ***single*** *collector*), but not that of an arbitrary number (which might have covered all modern integrated circuits.

****

The circuit shows ‘Darlington Pair’ driver. The first transistor’s emitter feeds into the second transistor’s base and as a result the input signal is amplified by the time it reaches the output.

This circuit is used for amplifying currents, i.e., the amplified current from the first transistor is further amplified by the second transistor. Needless to say, this transistor combination exhibits a much higher current gain than if only one transistor was used.

The important point to remember is that the Darlington Pair is made up of two transistors and when they are arranged as shown in the circuit they are used to amplify weak signals.

**Use of Darlington Pair**

In some application the amount of input current available to switch on a transistor is very low. This may mean that a single transistor may not be able to pass sufficient current required by the load.

As stated earlier this equals the **input current** x **the gain of the transistor (hFE)**. If it is not be possible to increase the input current then we need to increase the gain of the transistor. This can be achieved by using a Darlington Pair.

A Darlington Pair acts as one transistor but with a current gain that equals:

Total current gain **(hFE total)** = current gain of transistor 1 **(hFE t1) x** current gain of transistor 2**(hFE t2)**

So for example if you had two transistors with a current gain **(hFE)** = 100:

**(hFE total)** = 100 **x** 100

**(hFE total)** = 10,000

You can see that this gives a vastly increased current gain when compared to a single transistor.

Therefore this will allow a very low input current to switch a much bigger load current.

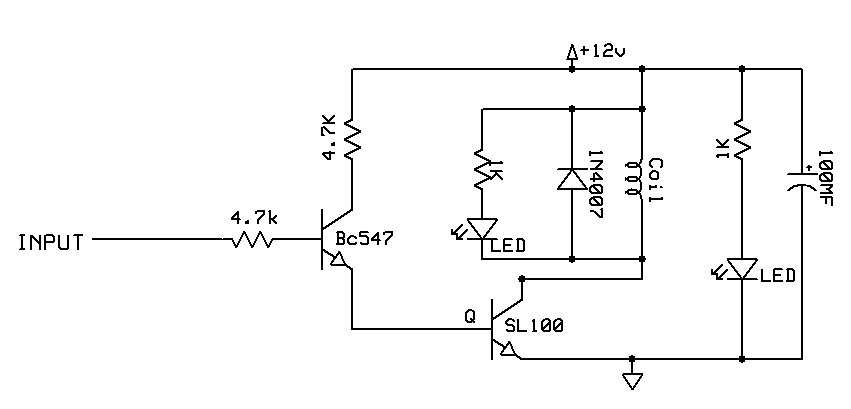
**Base Activation Voltage**

Normally to turn on a transistor the base input voltage of the transistor will need to be greater than 0.7V. As two transistors are used in a Darlington Pair this value is doubled.

Therefore the base voltage will need to be greater than 0.7V x 2 = 1.4V.

It is also worth noting that the voltage drop across collector and emitter pins of the Darlington Pair when the turn on will be around 0.9V Therefore if the supply voltage is 5V (as above) the voltage across the load will be will be around 4.1V (5V – 0.9V)

Circuit Diagram:



A Darlington pair behaves like a single transistor with a high current gain (approximately the product of the gains of the two transistors). In fact, integrated devices have three leads (B, C and E) broadly equivalent to those of a standard transistor.

A general relation between the compound current gain and the individual gains is given by:

If *β1* and *β2* are high enough (hundreds), this relation can be approximated with:

A typical modern device has a current gain of 1000 or more, so that only a small base current is needed to make the pair switch on. However, this high current gain comes with several drawbacks.

One drawback is an approximate doubling of base-emitter voltage. Since there are two junctions between the base and emitter of the Darlington transistor, the equivalent base-emitter voltage is the sum of both base-emitter voltages:

For silicon-based technology, where each VBEi is about 0.65 V when the device is operating in the active or saturated region, the necessary base-emitter voltage of the pair is 1.3 V.

Another drawback of the Darlington pair is its increased saturation voltage. The output transistor is not allowed to saturate (i.e. its base-collector junction must remain reverse-biased) because its collector-emitter voltage is now equal to the sum of its own base-emitter voltage and the collector-emitter voltage of the first transistor, both positive quantities in normal operation. (In symbols, VCE2 = VBE2 + VCE1, so VC2> VB2 always.) Thus the saturation voltage of a Darlington transistor is one VBE (about 0.65 V in silicon) higher than a single transistor saturation voltage, which is typically 0.1 - 0.2 V in silicon. For equal collector currents, this drawback translates to an increase in the dissipated power for the Darlington transistor over a single transistor.

Another problem is a reduction in switching speed, because the first transistor cannot actively inhibit the base current of the second one, making the device slow to switch off. To alleviate this, the second transistor often has a resistor of a few hundred ohms connected between its base and emitter terminal. This resistor provides a low impedance discharge path for the charge accumulated on the base emitter junction, allowing a faster transistor turn-off.

The Darlington pair has more phase shift at high frequencies than a single transistor and hence can more easily become unstable with negative feedback.

A Darlington pair can be sensitive enough to respond to the current passed by skin contact even at safe voltages. Thus it can form the input stage of a touch-sensitive switch.

When current to the coil is switched off the magnetic field around the coil collapses very quickly. This can cause a phenomenon called "**Back emf**" where a very high voltage

Specification:

BC 547

1. Current - 100 mA
2. Voltage - max. 65 V

SL 100

1. Current – 500mA
2. Voltage – max. 50V

**SPECIFICATION**

**45RPM 12V DC** geared motors for robotics applications. Very easy to use and available in standard size. Nut and threads on shaft to easily connect and internal threaded shaft for easily connecting it to wheel.

Features

* 45RPM 12V DC motors with Gearbox
* 6mm shaft diameter with internal hole
* 125gm weight
* Same size motor available in various rpm
* 2kgcm torque
* No-load current = 60 mA(Max), Load current = 300 mA(Max)

**RELAYS**

|  |
| --- |
| relay symbol |
| Circuit symbol for a relay |
| Relay, photograph © Rapid Electronics |
| Relay, photograph © Rapid Electronics |
| Relays |
|  |
|  |

A relay is an **electrically operated switch**. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and most have **double throw** (**changeover**) switch contacts as shown in the diagram.

Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits, the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a [transistor](http://www.kpsec.freeuk.com/trancirc.htm#ic) is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

Relays are usuallly SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available.

The coil will be obvious and it may be connected either way round. Relay coils produce brief high voltage 'spikes' when they are switched off and this can destroy transistors and ICs in the circuit. To prevent damage you must connect a [protection diode](http://www.kpsec.freeuk.com/components/relay.htm#protect) across the relay coil.

The relay's switch connections are usually labeled COM, NC and NO:

* **COM** = Common, always connect to this, it is the moving part of the switch.
* **NC** = Normally Closed, COM is connected to this when the relay coil is **off**.
* **NO** = Normally Open, COM is connected to this when the relay coil is **on**.
* Connect to COM and NO if you want the switched circuit to be **on when the relay coil is on**.
* Connect to COM and NC if you want the switched circuit to be **on when the relay coil is off**.

**Choosing a relay**

You need to consider several features when choosing a relay:

1. Physical size and pin arrangement

If you are choosing a relay for an existing PCB you will need to ensure that its dimensions and pin arrangement are suitable. You should find this information in the supplier's catalogue.

1. Coil voltage

The relay's coil voltage rating and resistance must suit the circuit powering the relay coil. Many relays have a coil rated for a 12V supply but 5V and 24V relays are also readily available. Some relays operate perfectly well with a supply voltage which is a little lower than their rated value.

1. Coil resistance

The circuit must be able to supply the current required by the relay coil. You can use [Ohm's law](http://www.kpsec.freeuk.com/ohmslaw.htm) to calculate the current:

|  |  |
| --- | --- |
| Relay coil current   = | supply voltage |
| coil resistance |

For example: A 12V supply relay with a coil resistance of 400 Ohm passes a current of 30mA. This is OK for a 555 timer IC (maximum output current 200mA), but it is too much for most ICs and they will require a [transistor](http://www.kpsec.freeuk.com/trancirc.htm#ic) to amplify the current.

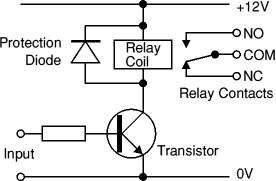
1. Switch ratings(voltage and current)

The relay's switch contacts must be suitable for the circuit they are to control. You will need to check the voltage and current ratings. Note that the voltage rating is usually higher for AC, for example: "5A at 24V DC or 125V AC".

1. Switch contact arrangement(SPDT,DPDT etc)

Most relays are SPDT or DPDT which are often described as "single pole changeover" (SPCO) or "double pole changeover" (DPCO).

**Protection diodes for relays**

Transistors and ICs must be protected from the brief high voltage produced when a relay coil is switched off. The diagram shows how a signal [diode](http://www.kpsec.freeuk.com/components/diode.htm) (eg 1N4148) is connected 'backwards' across the relay coil to provide this protection.

Current flowing through a relay coil creates a magnetic field which collapses suddenly when the current is switched off. The sudden collapse of the magnetic field induces a brief high voltage across the relay coil which is very likely to damage transistors and ICs. The protection diode allows the induced voltage to drive a brief current through the coil (and diode) so the magnetic field dies away quickly rather than instantly. This prevents the induced voltage becoming high enough to cause damage to transistors and ICs.

**Relays and transistors compared**

Like relays, [transistors](http://www.kpsec.freeuk.com/components/tran.htm) can be used as an electrically operated switch. For switching small DC currents (< 1A) at low voltage they are usually a better choice than a relay. However, transistors cannot switch AC (such as mains electricity) and in simple circuits they are not usually a good choice for switching large currents (> 5A). In these cases a relay will be needed, but note that a low power transistor may still be needed to switch the current for the relay's coil! The main advantages and disadvantages of relays are listed below:

**Advantages of relays:**

* Relays can switch **AC and DC**, transistors can only switch DC.
* Relays can switch **higher voltages** than standard transistors.
* Relays are often a better choice for switching **large currents** (> 5A).
* Relays can switch **many contacts** at once.

**Disadvantages of relays:**

* Relays are **bulkier** than transistors for switching small currents.
* Relays **cannot switch rapidly** (except reed relays), transistors can switch many times per second.
* Relays **use more power** due to the current flowing through their coil.
* Relays **require more current than many ICs can provide**, so a low power transistor may be needed to switch the current for the relay's coil.

**DC MOTOR**

DC motors are part of the electric motors using DC power as energy source. These devices transform electrical energy into mechanical energy. The basic principle of DC motors is same as electric motors in general, the magnetic interaction between the rotor and the stator that will generate spin.

**Simple motor has six parts:**

1. Armature or rotor
2. Commutator
3. Brushes
4. Axle
5. Field magnet
6. DC power supplyof some sort

**Working Principle of DC motor**  
  
Graphically, the working principles of DC motors can be seen in Figure 1 below.

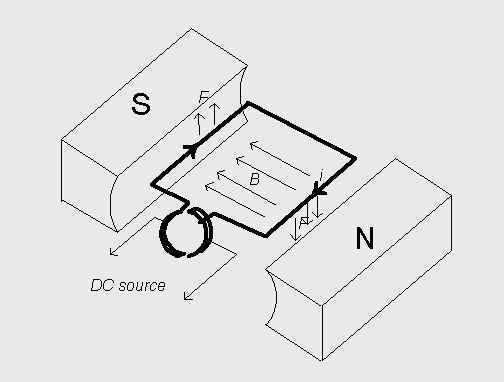


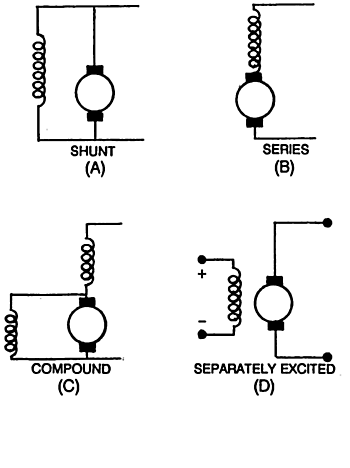
Figure 1. Principle of DC motor

When DC electric current flowing in the coil in accordance with the direction of the arrow, while the direction of the magnetic field B is from north to south pole, the coil will be driven by the force F in the direction as shown in Figure 1. This condition occurs continuously so will result in rotation on the axis of the coil. The direction of the electric current in the coil is fixed, because of the split ring on the end of the coil.

**The major classes of DC motors are**

* Shunt wound.
* Series wound.
* Compound wound.
* Separately excited.

These types of motors differ only in the connection of the field circuits The armatures, commutators, and so forth are nearly identical with each other and with those of the generators. All four major classes of motors are widely used. This is in contrast to the generators, in which the compound wound type is used for nearly all general power applications.



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  | | --- | | **Brushless motor**  A DC Brushless Motor uses a permanent magnet [**external** rotor](http://www.dynetic.com/brushless%20terminology.htm#rotor), three phases of driving coils, one or more [Hall effect devices](http://www.dynetic.com/brushless%20terminology.htm#hall effect) to sense the position of the rotor, and the associated drive electronics. The coils are activated, one phase after the other, by the drive electronics as cued by the signals from the Hall effect sensors, they act as three-phase synchronous motors containing their own [variable frequency drive electronics](http://www.dynetic.com/brushless%20terminology.htm#VFD). | | |  | | --- | | **BLDC Motor Advantages**   * Electronic commutation based on Hall position sensors * Less required maintenance due to absence of brushes * Speed/Torque- flat, enables operation at all speeds with rated load * High efficiency, no voltage drop across brushes * High output power/frame size. Reduced size due to superior thermal characteristics. Because BLDC has the windings on the stator, which is connected to the case, the heat disipation is better * Higher speed range - no mechanical limitation imposed by brushes/commutator * Low electric noise generation | | **BLDC Motor Disadvantages**   * Higher cost of construction * Control is complex and expensive * Electric Controller is required to keep the motor running. It offers double the price of the motor.  |  | | --- | | **Brushed Motor**  A Brushed Motor has a rotating set of wound wire coils called an armature which acts as an electromagnet with two poles. A mechanical rotary switch called a [commutator](http://www.dynetic.com/brushless%20terminology.htm#commutation) reverses the direction of the electric current twice every cycle, to flow through the armature so that the poles of the electromagnet push and pull against the permanent magnets on the outside of the motor. As the poles of the armature electromagnet pass the poles of the permanent magnets, the commutator reverses the polarity of the armature electromagnet. During the instant of switching polarity, inertia keeps the classical motor going in the proper direction.  **Brushed motor Advantages**   * Two wire control * Replaceable brushes for extended life * Low cost of construction * Simple and inexpensive control * No controller is required for fixed speeds * Operates in extreme environments due to lack of electronics   **Brushed motor disadvantages**   * Periodic maintenance is required * Speed/torque is moderately flat. At higher speeds, brush friction increases, thus reducing useful torque * Poor heat dissipation due to internal rotor construction * Higher rotor inertia which limits the dynamic characteristics * Lower speed range due to mechanical limitations on the brushes * Brush Arcing will generate noise causing EMI. | |  | |   **SPECIFICATION**  **10RPM 12V DC** geared motors for robotics applications. Very easy to use and available in standard size. Nut and threads on shaft to easily connect and internal threaded shaft for easily connecting it to wheel.  Features   * 10RPM 12V DC motors with Gearbox * 6mm shaft diameter with internal hole * 125gm weight * Same size motor available in various rpm * 5kgcm torque * No-load current = 60 mA(Max), Load current = 300 mA(Max)   **LCD DISPLAY**  **INTRODUCTION:**  Liquid crystal cell displays (LCDs) are used in similar applications where LEDs are used. These applications are display of display of numeric and alphanumeric characters in dot matrix and segmental displays.  LCDs are of two types:   1. Dynamic scattering type 2. Field effect type   **The construction of a dynamic scattering liquid crystal cell:**  The liquid crystal material may be one of the several components, which exhibit optical properties of a crystal though they remain in liquid form. Liquid crystal is layered between glass sheets with transparent electrodes deposited on the inside faces.  When a potential is applied across the cell, charge carriers flowing through the liquid disrupt the molecular alignment and produce turbulence. When the liquid is not activated, it is transparent. When the liquid is activated the molecular turbulence causes light to be scattered in all directions and the cell appear to be bright.  This phenomenon is called dynamic scattering.  The construction of a field effect liquid crystal display is similar to that of the dynamic scattering type, with the exception that two thin polarizing optical filters are placed at the inside of each glass sheet. The liquid crystal material in the field effect cell is also of different type from employed in the dynamic scattering cell. The material used is twisted numeric type and actually twists the light passing through the cell when the latter is not energised.  A liquid crystal display (LCD) is an electronically-modulated optical device shaped into a thin, flat panel made up of any number of color or monochrome pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power. LCD has material, which continues the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered from similar to a crystal.  LCD consists of two glass panels, with the liquid crystal materials sandwiched in between them. The inner surface of the glass plates is coated with transparent electrodes which define in between the electrodes and the crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. When a potential is applied across the cell, charge carriers flowing through the liquid will disrupt the molecular alignment and produce turbulence.  When the liquid is not activated, it is transparent. When the liquid is activated the molecular turbulence causes light to be scattered in all directions and the cell appears to be bright. Thus the required message is displayed. When the LCD is in the off state, the two polarizer’s and the liquid crystal rotate the light rays, such that they come out of the LCD without any orientation, and hence the LCD appears transparent.  **Working:**  When sufficient voltage is applied to the electrodes the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarizer, which would result in activating/highlighting the desired characters. The power supply should be of +5v, with maximum allowable transients of 10mv. To achieve a better/suitable contrast for the display the voltage (VL) at pin 3 should be adjusted properly. A module should not be removed from a live circuit.  The ground terminal of the power supply must be isolated properly so that voltage is induced in it. The module should be isolated properly so that stray voltages are not induced, which could cause a flicking display. LCD is lightweight with only a few, millimeters thickness since the LCD consumes less power, they are compatible with low power electronic circuits, and can be powered for long durations. LCD does not generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. LCDs have long life and a wide operating temperature range. Before LCD is used for displaying proper initialization should be done.  LCDs with a small number of segments, such as those used in digital watches and pocket calculators, have individual electrical contacts for each segment. An external dedicated circuit supplies an electric charge to control each segment. This display structure is unwieldy for more than a few display elements. Small monochrome displays such as those found in personal organizers, or older laptop screens have a passive-matrix structure employing super-twisted nematic (STN) or double-layer STN (DSTN) technology—the latter of which addresses a color-shifting problem with the former—and color-STN (CSTN)— wherein color is added by using an internal filter. Each row or column of the display has a single electrical circuit.  The pixels are addressed one at a time by row and column addresses. This type of display is called passive-matrix addressed because the pixel must retain its state between refreshes without the benefit of a steady electrical charge. As the number of pixels (and, correspondingly, columns and rows) increases, this type of display becomes less feasible.  Very slow response times and poor contrast are typical of passive matrix addressed LCDs. High-resolution color displays such as modern LCD computer monitors and televisions use an active matrix structure. A matrix of thin-film transistors (TFTs) is added to the polarizing and color filters. Each pixel has its own dedicated transistor, allowing each column line to access one pixel. When a row line is activated, all of the column lines are connected to a row of pixels and the correct voltage is driven onto all of the column lines.  The row line is then deactivated and the next row line is activated. All of the row lines are activated in sequence during a refresh operation. Active-matrix addressed displays look "brighter" and "sharper" than passive-matrix addressed displays of the same size, and generally have quicker response times, producing much better images. A general purpose alphanumeric LCD, with two lines of 16 characters. So the type of LCD used in this project is16 characters \* 2 lines with 5\*7 dots with cursor, built in controller, +5v power supply, 1/16 duty cycle.    **PIN DESCRIPTION FOR LCD:**   |  |  |  | | --- | --- | --- | | PIN NO | SYMBOL | FUNCTION | | 1 | Vss | Ground terminal of Module | | 2 | Vdd | Supply terminal of Module, +  5v | | 3 | Vo | Power supply for liquid crystal drive | | 4 | RS | Register select  RS=0…Instruction register  RS=1…Data register | | 5 | R/W | Read/Write  R/W=1…Read  R/W=0…Write | | 6 | EN | Enable | | 7-14 | DB0-DB7 | Bi-directional Data Bus.  Data Transfer is performed once ,thru DB0-DB7,incase of interface data length is 8-bits;and twice, thru DB4-DB7 in the case of interface data length is 4-bits.Upper four bits first then lower four bits. | | 15 | LAMP-(L-) | LED or EL lamp power supply terminals | | 16 | LAMP+(L+)  (E2) | Enable |   **LCD PIN DESCRIPTIONS:**  The function of each pins of LCD is described below **VCC, VSS and VEE** while v and v provide +5v and ground, respectively, v is used for controlling LCD contrast.  **RS, register select**  There are two very important registers inside the LCD. The RS pin is used for their selection as follows. If RS=0, the instruction code register is selected, allowing the user to send a command such as clear display, cursor at home,etc.if RS=1 the data register is selected, allowing the user to send data to be displayed on the LCD.  **R/W, read/write**  R/W input allows the user to write information to the LCD or read information from it. R/W=1 when reading; R/W=0 when writing.  **E, enable**  The enable pin is used by the LCD to latch information presented on its data pins. When data is supplied to data pins, a high to low pulse must be applied to this pin in order for the LCD to latch in the data present at the data pins.  **D0 - D7**  The 8-bit data pins, D0 – D7, are used to send information to the LCD or read contents of the LCD’S internal registers. There are also instruction codes that can be sent to the LCD to clear the display or force the cursor to the home position or blink the cursor. RS=0 is used to check the busy flag bit to see if the LCD is ready to receive information. The busy flag is D7 and can be read when R/W=1 and RS=0, as follows: if R/W=1, RS=0.when D7=1, the LCD is busy taking care of internal operation and will not accept any new information, when D7=0, the LCD is ready to receive new information.  **LCD INTERFACING WITH MICROCONTROLLER:**    **ADVANTAGES:**   1. Consume much lesser energy (i.e. low power) when compared to LEDs. 2. Utilizes the light available outside and no generation of light. 3. Since very thin layer of liquid crystal is used, more suitable to act as display elements (in digital watches, pocket calculators, ect.) 4. Since reflectivity is highly sensitive to temperature, used as temperature measuring sensor. 5. Very cheap.  DISADVANTAGES:  1. Angle of viewing is very limited. 2. External light is a must for display. 3. Since not generating its own light and makes use of external light for display, contrast is poor. 4. Cannot be used under wide range of temperature.   **APPLICATIONS:**  1. Watches  2. Fax & Copy machines & Calculators.  **CIRCUIT DIAGRAM** | |  |  | | --- | |  | |  |   **CHAPTER – 5**  **SOFTAWRE DESCRIPTION**  **SOFTWARE DESIGN** MPLAB IDE  * + Free integrated development environment (IDE) from Microchip to implement code for PICs   + Latest version 8.60(recommended), In Lab 7.6   + IDE and documentation (user guide) can be downloaded from the Microchip website   + To open MPLAB IDE   + **Start**🡪**All Programs**🡪**Microchip**🡪**MPLAB IDE v8.60**🡪**MPLAB IDE**  PROJECT CREATION  * A project must be created for implementation   + Specify your device   + Create and edit your files   + Compile and link your project   + Program the device * To create a project   + Project🡪Project Wizard…   + Begin project and specify device   + Select Microchip MPASM Tool suite   + Create New Project File   + Add project files   + Finish project creation and return to IDE  UPDATING SOURCE CODE  * + - Modify .asm files     - Under ‘Source Files’ folder in project window     - Open and edit files to implement new functionality     - Additional files can be created and added  BUILDING PROJECTS  * + - * Project🡪Build All (or Ctrl+F10)       * Output window indicates success or failure       * HEX file generated when project is built  PROGRAMMING THE PIC Directly Downloading Hex files to the PIC Memory   * Used to transfer HEX file to the PIC and begin program execution * Two methods (HEX file must be generated)   + MPLAB IDE     - Programmer🡪Select Programmer🡪PICKit3   + PICkit3     - Separate program     - Start🡪All Programs🡪Microchip🡪PICkit 3  Arduino Software (IDE) Get the latest version from the download page. You can choose between the Installer (.exe) and the Zip packages. We suggest you use the first one that installs directly everything you need to use the Arduino Software (IDE), including the drivers. With the Zip package you need to install the drivers manually. The Zip file is also useful if you want to create a [portable installation](https://www.arduino.cc/en/Guide/PortableIDE).  When the download finishes, proceed with the installation and please allow the driver installation process when you get a warning from the operating system.  Description: https://www.arduino.cc/en/uploads/Guide/DRV_Capture1.png  Choose the components to install  Description: https://www.arduino.cc/en/uploads/Guide/DRV_Capture2.png  Choose the installation directory (we suggest to keep the default one)  Description: https://www.arduino.cc/en/uploads/Guide/DRV_Capture3.png The process will extract and install all the required files to execute properly the Arduino Software (IDE)  **Arduino Boot loader Issue**  The current boot loader burned onto the Arduino UNO is not compatible with ROBOTC. In its current form, you will be able to download the ROBOTC Firmware to the ArduinoUNO, but you will not able to download any user programs.  The reason for this is because there is a bug in the Arduino UNO firmware that does not allow flash write commands to start at anywhere but the beginning of flash memory (0x000000). See the bottom of this page for more technical details.  Because ROBOTC is not able to burn a new bootloader as of today, you will need to use the Arduino's Open Source language with a modified bootloader file to re-burn your bootloader on your Arduino UNO boards. The enhanced bootloader is backwards compatible with the original one. That means you'll still be able to program it through the Arduino programming environment as before, in addition to ROBOTC for Arduino.  **Hardware Needed**  To burn a new version of the Arduino boot loader to your UNO, you'll need an AVR ISP Compatible downloader.  **Using an AVR ISP (In System Programmer)**   * Your Arduino UNO (to program) * An AVR Programmer such as the [AVR Pocket Programmer](http://www.sparkfun.com/products/9825) * An AVR Programming Cable (the pocket programmer comes with one)   If you have extra Arduino boards, but no ISP programmer, SparkFun.com has a cool tutorial on how to flash a bootloader using an Arduino as an ISP.  **Using another Arduino as an ISP**   * Your Arduino UNO (to program) * A Working Arduino (doesn't matter what kind) * Some Male-to-Male Jumper Cables   For instructions on this method, take a look at the SparkFun.com website: <http://www.sparkfun.com/tutorials/247>  **Software Needed**  ROBOTC is not currently able to burn a bootloader onto an Arduino board, so you'll need to download a copy of the latest version of the Arduino Open-Source programming language.   * Arduino Official Programming Language - [Download Page](http://arduino.cc/en/Main/Software%7CArduino)   In addition, you'll need the ROBOTC modified bootloader. You can download that here:   * ROBOTC Modified UNO Bootloader - [Modified Bootloader](http://cdn.robotc.net/downloads/arduino/stk500boot_v2_mega2560.hex)   **Bootload Download Instructions**   * Download the [Arduino Open Source Software](http://arduino.cc/en/Main/Software) and a copy of the [Modified Bootloader](http://cdn.robotc.net/downloads/arduino/stk500boot_v2_mega2560.hex) File * Copy the Modified Bootloader File into the /Arduino-1.0/hardware/arduino/bootloaders/stk500v2/ and overwrite the existing bootloader.   [Description: CopyBootloader.png](http://www.robotc.net/wikiarchive/File:CopyBootloader.png)   * Power up your Arduino UNO (either via USB or external power) * Plug in your AVR ISP Programmer to your computer (make sure you have any required drivers installed) * Connect your AVR ISP Programmer into your Arduino UNO Board via the ISP Header (the 2x3 header pins right above the Arduino Logo) * Launch the Arduino Open Source Software   [Description: ArduinoLaunch.png](http://www.robotc.net/wikiarchive/File:ArduinoLaunch.png)   * Change your settings in the Arduino Software to look for an Arduino UNO * Change your settings in the Arduino Software to select your ISP Programmer Type (Check your programmer's documentation for the exact model)   [Description: ArduinoSelectProgrammer.png](http://www.robotc.net/wikiarchive/File:ArduinoSelectProgrammer.png)   * Select the "Burn Bootloader" option under the "Tools" menu. The modified bootloader will now be sent to your Arduino. This typically take a minute or so.   [Description: BurnBootloader.png](http://www.robotc.net/wikiarchive/File:BurnBootloader.png)   * You should be all set to download ROBOTC firmware and start using your Arduino UNO with ROBOTC.   **Technical Details**  The Arduino Boot loader sets the "erase Address" to zero every time the boot loader is called. ROBOTC called the "Load Address" command to set the address in which we want to write/verify when downloading program.  When writing a page of memory to the arduino, the Arduino boot loader will erase the existing page and write a whole new page.  In the scenario of downloading firmware, everything is great because the Erase Address and the Loaded Address both start at zero.  In the scenario of writing a user program, we start writing at memory location 0x7000, but the Boot loader erases information starting at location zero because the "Load Address" command doesn't update where to erase.  Our modification is to set both the Load Address and the Erase Address so the activity of writing a user program doesn't cause the firmware to be accidentally erased.  **Summary** Microcontroller Arduino UNO Operating Voltage 5V Input Voltage (recommended)  Input Voltage (limits) 6-20V  Digital I/O Pins 54 (of which 14 provide PWM output)  Analog Input Pins 16  DC Current per I/O Pin 40mA  DC Current for3.3VPin 50mA  Flash Memory 256 KB of which 8 KB used by bootloader  SRAM 8KB  EEPROM 4KB  Lock Speed 16MHz  The Arduino UNO can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.  The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.  They differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the programmed as a USB-to-serial converter.  **The power pins are as follows:**   * **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. * **5V.** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via a non-board regulator, or be supplied by USB or another regulated 5V supply. * **3V3.**A3.3voltsupplygeneratedbytheon-boardregulator.Maximumcurrentdrawis50mA. * **GND.** Ground pins.   The ATMEGA has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the [EEPROM library](http://www.arduino.cc/en/Reference/EEPROM)).  Each of the 54 digital pins on the Mega can be used as an input or output, using [pinMode()](http://arduino.cc/en/Reference/PinMode), [digitalWrite()](http://arduino.cc/en/Reference/DigitalWrite), and [digitalRead()](http://arduino.cc/en/Reference/DigitalRead) functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50k Ohms. In addition, some pins have specialized functions:   * **Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX).** Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATMEGA USB-to-TTL Serial chip. * **External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2).** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a changing value. See the [attach Interrupt()](http://arduino.cc/en/Reference/AttachInterrupt) function for details. * **PWM: 0to13.** Provide 8-bit PWM output with the [analogWrite()](http://arduino.cc/en/Reference/AnalogWrite) function. * **SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS).** These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Duemilanove and Diecimila. * **LED: 13.** There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off. * **I2C: 20 (SDA) and 21 (SCL).** Support I2C (TWI) communication using the [Wire library](http://wiring.org.co/reference/libraries/Wire/index.html) (documentation on the Wiring website). Note that these pins are not in the same location as the I2C pins on the Duemilanove.   The Arduino UNO has 16 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and analog Reference() function.  There are a couple of other pins on the board:   * **AREF.** Reference voltage for the analog inputs. Used with [analog Reference](http://arduino.cc/en/Reference/AnalogReference)(). * **eset.** Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.   **Communication**  The Arduino UNO has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The Arduino UNO provides four hardware UARTs for TTL (5V) serial communication.  An ATMEGA on the board channels one of these over USB and provides a virtual comport to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2 chip and USB connection to the computer (but not for serial communication on pins 0 and1).  A [SoftwareSerial library](http://www.arduino.cc/en/Reference/SoftwareSerial) allows for serial communication on any of the digital pins.  The Arduino UNO also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the [documentation on the Wiring website](http://wiring.org.co/reference/libraries/Wire/index.html) for details. To use the SPI communication, please see the Arduino UNO datasheet.  **Programming**  The Arduino UNO can be programmed with the Arduino software ([download](http://arduino.cc/en/Main/Software)). For details, see the [reference](http://arduino.cc/en/Reference/HomePage) and [tutorials](http://arduino.cc/en/Tutorial/HomePage).  The Arduino UNO on the Arduino UNO comes preburned with a [bootloader](http://arduino.cc/en/Tutorial/Bootloader) that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol ([reference](http://www.atmel.com/dyn/resources/prod_documents/doc2525.pdf), [C header files](http://www.atmel.com/dyn/resources/prod_documents/avr061.zip)).  You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see [these instructions](http://arduino.cc/en/Hacking/Programmer) for details.  **Automatic (Software) Reset**  Rather than requiring a physical press of the reset button before an upload, the Arduino UNO is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the Arduino UNO via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.  This setup has other implications. When the Arduino UNO is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the UNO. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.  The Mega contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.  **USB Over current Protection**  **Physical Characteristics and Shield Compatibility**  The Arduino UNO has a resettable poly fuse that protects your computer's USB ports from shorts and over current. Although most computers provide their own internal protection, the fuse provides an extra layer ofprotection.Ifmorethan500mAisappliedtotheUSBport, the fuse will automatically break the connection until the short or overload is removed.  The maximum length and width of the UNO PCB are 4 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.  The UNO is designed to be compatible with most shields designed for the Diecimila or Duemilanove. Digital pins 0 to 13 (and the adjacent AREF and GND pins), analog inputs 0 to 5, the power header, and ICSP header are all in equivalent locations. Further the main UART (serial port) is located on the same pins (0 and 1), as are external interrupts 0 and 1 (pins 2 and 3 respectively). SPI is available through the ICSP header on both the Mega and Duemilanove / Diecimila.  **Please note that I2C is not located on the same pins on the Mega (20and21) as the Duemilanove / Diecimila (analog inputs 4 and 5).**  **How to use Arduino**  Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the [Arduino programming language](http://arduino.cc/en/Reference/HomePage) (based on [Wiring](http://wiring.org.co/)) and the Arduino development environment (based on [Processing](http://www.processing.org/)). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP).  Arduino is a cross-platoform program. You’ll have to follow different instructions for your personal OS. Check on the [Arduino site](http://arduino.cc/en/Guide/HomePage) for the latest instructions. [*http://arduino.cc/en/Guide/HomePage*](http://arduino.cc/en/Guide/HomePage)  Once you have downloaded/unzipped the arduino IDE, you can plug the Arduino to your PC via USB cable.  **MODULES DESCRIPTION**   * DATASET COLLECTION * DATASET PREPROCESSING * FEATURE SELECTION * MODEL TRANING * RISK PREDICTION * DATA STORAGE   **DATASET COLLECTION**  This module is responsible for collecting and inputting clinical and demographic data from the patient, such as maternal age, blood pressure, protein levels in the urine, weight gain, and medical history. The data is collected through various sources, such as electronic health records, wearable devices, or manual input from healthcare providers.  **DATASET PREPROCESSING**  This module prepares the data for analysis by removing any missing or irrelevant data, normalizing the data, and transforming the data into a suitable format for analysis. This is an important step in ensuring that the data is clean and ready for use by the machine learning algorithms. Data preprocessing is the process of cleaning, transforming, and organizing raw data into a format that is suitable for analysis, modeling, or use in machine learning algorithms. The goal of data preprocessing is to prepare the data for further analysis by removing any inconsistencies, errors, or inaccuracies that may negatively impact the results of the analysis.  **FEATURE SELECTION**  This module identifies the most relevant features for predicting preeclampsia. This is done using various feature selection algorithms, such as correlation analysis or recursive feature elimination. The selected features are used as input to the machine learning model. Feature selection is the process of selecting a subset of relevant and informative features from a larger set of features in order to build a more effective and efficient machine learning model. The goal of feature selection is to improve the performance of the model, reduce overfitting, increase the interpretability of the model, and decrease the computational complexity of the analysis.  **MODEL TRAINING**  Model training is the process of learning the parameters of a machine learning algorithm from a set of labeled data. The goal of model training is to build a model that can make accurate predictions on new, unseen data. The model training process involves presenting the algorithm with a set of inputs and corresponding outputs, and adjusting the parameters of the model so that the predictions of the model are as close as possible to the actual outputs.  **RISK PREDICTION**  The goal of risk prediction is to provide organizations with a quantitative assessment of the risk associated with a particular event or decision, and to help them make informed decisions about how to manage that risk. For example, in finance, risk prediction can be used to estimate the likelihood of a loan default, and to make decisions about how much capital to allocate to a particular loan. It's important to note that risk prediction is not an exact science, and that the accuracy of risk predictions can be influenced by a variety of factors, including the quality of the data used to make the prediction, the complexity of the models used, and the assumptions made about the underlying relationships between the inputs and the outcome. As such, risk prediction should be seen as one tool in an overall risk management strategy, rather than a definitive answer in and of itself.  **DATA STORAGE**  This module stores the collected data, along with the predictions and alerts generated by the system, in a secure database for future reference and analysis. Data storage is an important component of data management, and is used to ensure that information can be retrieved and used at a later time. It is important to choose the appropriate data storage system based on the specific needs of the data being stored, including the size of the data, the rate at which it is generated, and the required level of access and availability.  **CHAPTER 5**  **SOFTWARE DESCRIPTION**  **PYTHON**  **NUMPY**  **PANDAS**  **SCKIT-LEARN**  **K-NEAREST NIGHBOUR**  **PYTHON**  Python is a popular programming language. It was created by Guido van Rossum, and released in 1991.  It is used for:  • Web development (server-side),  • Software development,  • Mathematics,  • System scripting.  There are two attributes that make development time in Python faster than in other programming languages:  1. Python is an interpreted language, which precludes the need to compile code before executing a program because Python does the compilation in the background. Because Python is a high-level programming language, it abstracts many sophisticated details from the programming code. Python focuses so much on this abstraction that its code can be understood by most novice programmers.  2. Python code tends to be shorter than comparable codes. Although Python offers fast development times, it lags slightly in terms of execution time. Compared to fully compiling languages like C and C++, Python programs execute slower. Of course, with the processing speeds of computers these days, the speed differences are usually only observed in benchmarking tests, not in real-world operations. In most cases, Python is already included in Linux distributions and Mac OS X machines.  3. Python is a dynamic, high level, free open source and interpreted programming language. It supports object –oriented programming as well as procedural oriented programming. Python is a very easy to code as compared to other language like c , c ++, java etc.. It is also a developerfriendly language. Python is also an Integrated language because we can easily integrated python with other language like c, c ++, etc.  **NUMPY**  Our Python NumPy Tutorial provides the basic and advanced concepts of the NumPy. Our NumPy tutorial is designed for beginners and professionals.  NumPy stands for numeric python which is a python package for the computation and processing of the multidimensional and single dimensional array elements.  NumPy Tutorial  What is NumPy stands for numeric python which is a python package for the computation and processing of the multidimensional and single dimensional array elements. Travis Oliphant created NumPy package in 2005 by injecting the features of the ancestor module Numeric into another module Numarray.  It is an extension module of Python which is mostly written in C. It provides various functions which are capable of performing the numeric computations with a high speed. NumPy provides various powerful data structures, implementing multi-dimensional arrays and matrices. These data structures are used for the optimal computations regarding arrays and matrices.  In this tutorial, we will go through the numeric python library NumPy. The need of NumPy With the revolution of data science, data analysis libraries like NumPy, SciPy, Pandas, etc. have seen a lot of growth. With a much easier syntax than other programming languages, python is the first choice language for the data scientist.  NumPy provides a convenient and efficient way to handle the vast amount of data. NumPy is also very convenient with Matrix multiplication and data reshaping. NumPy is fast which makes it reasonable to work with a large set of data. There are the following advantages of using NumPy for data analysis.   1. NumPy performs array-oriented computing. 2. It efficiently implements the multidimensional arrays. 3. It performs scientific computations. 4. It is capable of performing Fourier Transform and reshaping the data stored in multidimensional arrays. 5. NumPy provides the in-built functions for linear algebra and random number generation.   Nowadays, NumPy in combination with SciPy and Mat-plotlib is used as the replacement to MATLAB as Python is more complete and easier programming language than MATLAB. Prerequisite Before learning Python Numpy, you must have the basic knowledge of Python concepts.  **PANDAS:**  IMG_256  pandas are a [software library](https://en.wikipedia.org/wiki/Software_library) written for the [Python programming language](https://en.wikipedia.org/wiki/Python_(programming_language)) for data manipulation and analysis. In particular, it offers data structures and operations for manipulating numerical tables and [time series](https://en.wikipedia.org/wiki/Time_series). It is [free software](https://en.wikipedia.org/wiki/Free_software) released under the [three-clause BSD license](https://en.wikipedia.org/wiki/3-clause_BSD_license).[[2]](https://en.wikipedia.org/wiki/Pandas_(software)#cite_note-2) The name is derived from the term "[panel data](https://en.wikipedia.org/wiki/Panel_data)", an [econometrics](https://en.wikipedia.org/wiki/Econometrics) term for data sets that include observations over multiple time periods for the same individuals.  **SCKIT-LEARN:**  IMG_256  Scikit-learn is probably the most useful library for machine learning in Python. It is on NumPy, SciPy and matplotlib, this library contains a lot of effiecient tools for machine learning and statistical modeling including classification, regression, clustering and dimensionality reduction. Scikit-learn is an open source Python library that has powerful tools for data analysis and data mining. It's available under the BSD license and is built on the following machine learning libraries: ... SciPy, an ecosystem consisting of various libraries for completing technical computing tasks. Scikit-Learn has a good number of ML algorithms which can be readily deployed in our models. It doesn't require the programmer to be a pro in machine learning concepts. It just needs us to specify what needs to be done. Not to mention, it is a high level library with brutal abstractions.  Scikit-learn is a free machine learning library for Python. It features various algorithms like support vector machine, random forests, and k-neighbours, and it also supports Python numerical and scientific libraries like NumPy and SciPy. The scikit-learn project started as scikits. learn, a Google Summer of Code project by David Cournapeau. Its name stems from the notion that it is a "SciKit" (SciPy Toolkit), a separately-developed and distributed third-party extension to SciPy. The original codebase was later rewritten by other developers.  **K-Nearest Neighbours (KNN)**   * K-Nearest Neighbour is one of the simplest Machine Learning algorithms based on Supervised Learning technique. * K-NN algorithm assumes the similarity between the new case/data and available cases and put the new case into the category that is most similar to the available categories. * K-NN algorithm stores all the available data and classifies a new data point based on the similarity. This means when new data appears then it can be easily classified into a well suite category by using K- NN algorithm. * K-NN algorithm can be used for Regression as well as for Classification but mostly it is used for the Classification problems. * K-NN is a **non-parametric algorithm**, which means it does not make any assumption on underlying data. * It is also called a **lazy learner algorithm** because it does not learn from the training set immediately instead it stores the dataset and at the time of classification, it performs an action on the dataset. * KNN algorithm at the training phase just stores the dataset and when it gets new data, then it classifies that data into a category that is much similar to the new data.   **Why do we need a K-NN Algorithm?**  Suppose there are two categories, i.e., Category A and Category B, and we have a new data point x1, so this data point will lie in which of these categories. To solve this type of problem, we need a K-NN algorithm. With the help of K-NN, we can easily identify the category or class of a particular dataset. Consider the below diagram  K-Nearest Neighbor(KNN) Algorithm for Machine Learning  **How does K-NN work?**  The K-NN working can be explained on the basis of the below algorithm:   * **Step-1:** Select the number K of the neighbors * **Step-2:** Calculate the Euclidean distance of **K number of neighbors** * **Step-3:** Take the K nearest neighbors as per the calculated Euclidean distance. * **Step-4:** Among these k neighbors, count the number of the data points in each category. * **Step-5:** Assign the new data points to that category for which the number of the neighbor is maximum. * **Step-6:** Our model is ready.   Suppose we have a new data point and we need to put it in the required category. Consider the below image  K-Nearest Neighbor(KNN) Algorithm for Machine Learning   * Firstly, we will choose the number of neighbors, so we will choose the k=5. * Next, we will calculate the **Euclidean distance** between the data points. The Euclidean distance is the distance between two points, which we have already studied in geometry. It can be calculated as   K-Nearest Neighbor(KNN) Algorithm for Machine Learning   * By calculating the Euclidean distance we got the nearest neighbors, as three nearest neighbors in category A and two nearest neighbors in category B. Consider the below image   K-Nearest Neighbor(KNN) Algorithm for Machine Learning   * As we can see the 3 nearest neighbors are from category A, hence this new data point must belong to category A.   **How to select the value of K in the K-NN Algorithm**   * There is no particular way to determine the best value for "K", so we need to try some values to find the best out of them. The most preferred value for K is 5. * A very low value for K such as K=1 or K=2, can be noisy and lead to the effects of outliers in the model. * Large values for K are good, but it may find some difficulties.   **Advantages of KNN Algorithm:**   * It is simple to implement. * It is robust to the noisy training data * It can be more effective if the training data is large.   **Disadvantages of KNN Algorithm:**   * Always needs to determine the value of K which may be complex some time. * The computation cost is high because of calculating the distance between the data points for all the training samples.   **CHAPTER 6**  **ADVANTAGES AND APPLICATIONS**  **Advantages:**   1. **Non-Invasive Monitoring:** The use of laser light for glucose measurement eliminates the need for frequent, painful finger-prick blood tests, making glucose monitoring less invasive and more tolerable for patients. 2. **Continuous and Real-Time Tracking:** Continuous monitoring allows for the detection of glucose level fluctuations in real-time, providing a more comprehensive understanding of the patient's glucose trends throughout the day. 3. **Automated Insulin Delivery:** Integrating glucose monitoring with an insulin pump facilitates automated insulin delivery based on real-time data, reducing the risk of human error in insulin administration. 4. **Increased Safety**: The system's ability to halt insulin infusion automatically when glucose levels drop too low, especially if the user is unresponsive to alarms, significantly increases patient safety, particularly during sleep. 5. **Personalized Diabetes Management**: The system allows for the programming of personalized insulin delivery patterns, offering a tailored approach to diabetes management based on individual needs. 6. **Remote Monitoring**: IoT connectivity enables the transmission of glucose data to healthcare providers and caregivers in real-time, allowing for remote monitoring and timely intervention if necessary.   Applications:   1. **Type 1 Diabetes Management:** This technology is particularly beneficial for individuals with Type 1 diabetes, requiring continuous monitoring and regular insulin administration. 2. **Type 2 Diabetes Management**: Patients with Type 2 diabetes who require insulin therapy can also benefit from this integrated approach, particularly those with poorly controlled glucose levels. 3. **Pediatric Diabetes Care:** The non-invasive and automated nature of this system can significantly improve diabetes management in children, making it less traumatic and more manageable for both children and their parents. 4. **Geriatric Care:** Older adults with diabetes, who may have difficulty managing complex treatment regimens, can benefit from the automated and remote monitoring features. 5. **Research and Development:** This technology can be used in clinical research to gather comprehensive data on glucose patterns under various conditions, contributing to the development of more effective diabetes management strategies. 6. **Emergency Medical Services:** In emergency situations, first responders can quickly assess a diabetic patient's glucose levels using this technology, allowing for immediate and appropriate treatment. 7. **Healthcare Data Analytics:** The data collected through this system can be used for big data analytics in healthcare, leading to improved treatment protocols and personalized diabetes management plans.   **CHAPTER 7**  **RESULT AND DISCUSSION**  The innovative integration of non-invasive glucose monitoring with automated insulin delivery exemplifies a significant advancement in diabetes management, potentially revolutionizing patient care. Utilizing laser light transmittance through the finger for glucose measurement offers a less invasive and more patient-friendly alternative to traditional methods, enhancing patient compliance and comfort. The strategic selection of the finger hose, devoid of bone tissue and with its minimal thickness, ensures accurate and efficient light penetration, making it an ideal site for such measurements. Central to this system is a highly advanced insulin pump that not only delivers precise doses of insulin based on real-time glucose readings but also incorporates critical safety mechanisms. These mechanisms are designed to prevent hypoglycemic events by automatically halting insulin delivery when glucose levels fall below a safe threshold, a feature especially crucial during periods of sleep. The seamless integration of a laser module and photodiode translates optical properties into actionable data, subsequently analyzed and processed by an PIC16F877A microcontroller. This process culminates in the display of glucose levels on an LCD screen and the transmission of this data to healthcare providers via IoT technology, enabling timely interventions. This holistic approach not only promises to improve the quality of life for individuals living with diabetes by offering a more natural and less intrusive method of managing their condition but also enhances safety with built-in protections against severe low blood glucose levels. As this technology matures, it has the potential to set a new standard in diabetes care, prioritizing both efficacy and patient well-being.  **CHAPTER 8**  **CONCLUSION**  The integration of laser-based glucose monitoring, automated insulin delivery, and IoT connectivity represents a significant advancement in diabetes management technology. This system offers a more accurate, efficient, and user-friendly alternative to traditional diabetes management methods, addressing many of the challenges faced by individuals with diabetes.The non-invasive nature of the glucose monitoring, combined with the precision and personalization of the insulin delivery system, significantly enhances the quality of life for users. It minimizes the risks associated with diabetes, such as severe hypoglycemia, and provides a foundation for more consistent and effective diabetes control.Furthermore, the capability for remote monitoring by healthcare providers ensures that patients receive timely care, making this system a powerful tool in the management of diabetes. It not only supports the individual needs of patients but also contributes to the broader goals of healthcare systems to deliver patient-centered, efficient, and effective care.  In conclusion, this technology heralds a new era in diabetes management, offering promising prospects for improving patient outcomes, reducing healthcare costs associated with diabetes complications, and ultimately, enhancing the overall well-being of individuals living with diabetes.  **CHAPTER 9**  **REFERENCES**  [1] Yadav, J., Rani, A., Singh, V., Murari, B.M., Near-infrared LED based non-invasive blood glucose sensor , IEEE International Conference on Signal Processing and Integrated Networks (SPIN), 2014 Feb , pp. 591-594.  [2] UnnikrishnaMenon, K.A., Hemachandran, D , Abhishek, T.K., A survey on non-invasive blood glucose monitoring using NIR, IEEE International Conference on Communications and Signal Processing (ICCSP), 2013 Apr , pp. 1069-1072.  [3] Anas, M.N., Nurun, N.K., Norali, A.N., Normahira, M., Noninvasive blood glucose measurement. IEEE EMBS Conference on Biomedical Engineering and Sciences (IECBES), 2012 Dec , pp. 503-507.  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