Chapter 1
Introduction and Literature Review

1.1 Introduction

One of the conventional techniques for food preservation is drying. Raisins and cashew nuts for use in other food processes are made when grapes are dried. In addition to requiring more space and having a chance of contamination from the outside environment, sun and shade drying methods. Currently, automatic solar fruit dryers, infrared radiation dryers, and microwave (MW) dehydration are used to dry cashew nets. It is suggested in this project to use IR radiation to modify the current grape drying technique. It differs significantly from traditional or natural drying. Infrared radiation speeds up the drying process and can be more precisely controlled to produce uniform drying and shorter drying times. By preserving the texture and color of the raisins, the proposed system improves quality and is weather-independent. The system is economical to operate because it uses non-traditional sources of energy. The Infrared Radiation and heat from the sun drying approach offers faster analysis times, making it a good choice for qualitative in-process use. Profit maximisation will result from the farmers' effective use of this technology.

1.2 Motivation of the work and Relevance

In India traditional drying methods are used for production of raisins. Around 20 days are required for drying process. Sun drying has a faster analysis time, making it a better methodology for qualitative in-process use. Profit maximisation will result from the farmers' effective use of this technology. Drying of the grapes will take about 22 hours [5].The modified system produces high quality raisins by taking advantage of system automation. The system monitors the sensor’s data and automatically controls different activities in drying process.

1.3 Objectives

Objectives of the proposed work are

1. Study of different dryer system available in market.
2. To design low cost solar hybrid dryer for industries which save electricity.
3. Dryer system will be use for multiple food drying as made portable.

1.4 Literature Review

Agriculture-related projects have surfaced in recent years. The relevant literature that was consulted for choosing various components of the suggested system is listed below.

Mr. O. N. Thigale and Mr. M. Patil [1] has created a solar vacuum dryer. They discovered that the vacuum dryer was productive and could complete the entire drying process without a power source. Mr. G. D. Lohar, Mr. A. G. Nandekar, Mrs. W. S. Kandlikar [2], have presented a modified natural method of infrared radiation for drying grapes. The aforementioned infrared radiation device is equipped with a number of sensors to monitor various drying process parameters. They have come to the *conclusion that infrared radiation exhibits a significant reduction in drying time when compared to natural drying. A. H. Utgikar, A. K. Shete, A. A. Aknurwar [3] has suggested IR heating as a method for drying grapes. Good quality raisins can be created by keeping a suitable distance between the IR source and the target. V. R. Thool, K. K. Narwade, A. B. Kokate, S.D. Khurjuleand , M.B. Pawar [4], have created a PLC-based grape drying system that can be used to make any type of raisin. The IR drying method is superior and results in no losses, according to the results. Mr. Onkar B. Kadam, Mr. Digvijay D. Shirke, Mr. Shantanu P. Kadam, Mr. Nilesh N. Desai, Mr. Suraj S. Pawar, Mr.Sujit S. Malgave [5], various grape drying methods have been described. They have discussed various drying techniques and found that infrared radiation drying dries the grapes more quickly than alternative techniques. Mr. Patil Kiran, Ms. Swami Sonam, Ms. Thorat Ashwini, Ms. Mane Pratidnya [6], have discussed an automatic fruit drying system that uses solar power. A grape experiment was examined one day. Grapes are dried using infrared radiation and a microcontroller for monitoring purposes. The suggested system is both space-efficient and cost-effective. Namani Rakesh, T. Santosh, Udugula Malavya, D. Rishikesh [7], have discussed the creation of the MPPT (Maximum Power Point Tracking) algorithm, which uses the incremental conductance method to draw the most power from solar panels. To prevent batteries from being overcharged and deeply discharged, they have devised a battery charge controller utilising a PIC microcontroller. They discovered that the system responds dynamically well under all circumstances. Nitesh Bhatnagar, Neetu Jangi, Megha Nagar, Rajkumar Saini, Manoj Krishnia [8], have presented a design for the Perturb and Observe algorithm-based Maximum Power Point Tracking (MPPT) for photovoltaic systems. The maximum power is made accessible in this case by controlling the PWM-generated signal with the help of the AVR controller.According to the literature assessment mentioned above, there is a lot of room for advancement in the methods used to produce raisins.

1.5 Thesis Organization

The report is divided into nine chapters. Each chapter serves the purpose of outlining different facets of the project, such as the fundamentals of the system, its need to be designed and flow of procedure to be done to complete with required purpose.

Chapter 1 contains introduction of the project. It gives general information about rasin making technique. Need and hence significance is described in detail.

Chapter 2 includes theoretical background contains the details and features about the available methodologies to obtain raisins.

Chapter 3 gives information about infrared radiation heating mechanism renewable energy Fruit Drying System Heating Mechanism it has detailed information about the framework of methodology and architecture, also contains block diagram for a system, specifications and characteristics.

Chapter 4 incorporates implementation of system has detailed information about the designing of system and development of system**.**

Chapter 5 An organizational structure's workflow can be effectively integrated with software-based services or components using a methodical, structured approach, according to the definition of software implementation.

Chapter 6 contains result and discussion has given the actual module of system and final result of developed system.

Gives advantages and applications from which information about advantages and disadvantages of proposed schema are got. It also explains various application areas where this idea can be implemented. Involves future scope it gives future scope related to proposed scheme. Derived from conclusion it gives final conclusion of proposed system.

Chapter 2

Theoretical Background of the Project

2.1 Raisin making techniques

In India, seedless Thompson grapes and its clones are used to make raisins. The most popular method involves dipping the berries in an Australian dip emulsion made of 2 point 4 percent potassium carbonate and 1 point 5 percent ethyloleate, then drying them in the shade using an open tier system. Water and sugar are the two key ingredients of ripening grapes and cashew nuts; as ripening progresses, the sugar content rises and the water content falls. Raisins almost entirely retain their sugar when drying but lose the majority of their water. There are various drying techniques used while manufacturing raisins.

2.1.1 Sun drying

This technique involves covering a sizable area of land with grape vines. They are made into raisins after being sun-dried. All of the grapes don't dry evenly using this method.

Figure 2.1 Sun drying

This approach completely depends on sunshine for drying. The drying process cannot be continued in poor weather conditions. The grapes must be manually monitored during this drying process to keep the birds away. It is a conventional technique for drying the grapes used in the production of raisins as shown in figure2.1.

2.1.2 Shade Drying

Grape bunches are spread out on racks and dried in the shade. The grapes are distributed over the racks, which are positioned beneath a sizable shade area. The sun dries them out.

Figure 2.2: Shade drying

The grapes are protected from birds using this method. Additionally, it is a manual process. It takes about 15 to 20 days to completely dry grapes so they may be made into raisins. Due to the open drying procedure, there is a danger that grapes will become infected as shown in figure 2.2

The drying process has evolved from these traditional methods in recent years as a result of technological advancements in the agriculture industry. Infrared, vacuum, microwave, and solar dryers are all frequently used.

2.1.3 Solar Drying

In this method, the raisins are made with solar energy. Solar panels in this area produce the electricity. It can be used at night as well. The grapes within the dryer are dried by the exhaust fans. Some sun dryers additionally have a chamber with AC convective heaters and DC converters, which aid in running fans as shown in figure 2.3

Figure2.3: **Solar drying**

2.1.4 Microwave Drying

Here, material is forced to heat up rather than having heat delivered to it. Microwave radiation is employed in this method to dry the grapes. Direct heat is applied to the grapes. Due to the high moisture content in the gaps, the temperature rises considerably during this drying. Phase controlling requires a separate mechanism. As a result of the microwave drying, the raisins' colour becomes darker.

2.1.5 Infrared Drying

Infrared drying penetrates the sample being dried as opposed to traditional ovens' use of convection and heat conductivity. The sample's required drying time may be reduced dramatically to 10–25 minutes by such heat penetration. The sample is heated using an infrared lamp to a filament temperature of 2000–2500 K. on the Kelvin scale. The sample thickness and the distance between the infrared source and the dried material are two variables that must be under control.

The analyst must take care to prevent burning or case hardening while the sample is drying. For infrared drying ovens, there are two methods of removing moisture from the air: a forced ventilation system, and an analytical balance.

Chapter 3
Infrared Radiation Heating Mechanism

3.1 Introduction

In India traditional drying methods are used for production of raisins. Around 20 days are required for drying process. By using infrared radiation to dry the grapes, the proposed system eliminates the shortcomings of conventional drying techniques. e. making of raisins. The required quality standards are not fulfilled in traditional open sun drying methods. Due to open sun drying contamination of grapes may occur because of dust from surrounding atmosphere. The system efficiently produces a quality raisin in a short drying period as compared to other drying methods

3.2 Block Diagram of Infrared Radiation Heating Mechanism

All agricultural crops only grow in a specific place and during specific seasons. Drying food products to preserve them has been a crucial process since ancient times. It's crucial to dry the fruits at a steady temperature. With the suggested system, infrared radiation technology is added to the conventional natural drying process. Figure 3.1 depicts the system's block diagram.

The automated drying system is the Intelligent Fruit Drying System. The system's beating heart is the vacuum chamber. In the chamber, various sensors are attached to track variables including weight, humidity, and temperature. To maintain the vacuum inside the chamber, a vacuum pump is linked to it.

The drying of grapes happens during the day using sunlight. An aperture plate that filters sunlight entering the chamber is present on top of the vacuum chamber. The batteries are charged by the solar panels, and the light intensity sensor measures the light's lumen output. Depending on how bright the light is, the switching mechanism adjusts the vacuum chamber's IR radiators. The resistance of the light intensity sensor increases throughout the day. The device runs at night on fully charged batteries and IR leds.

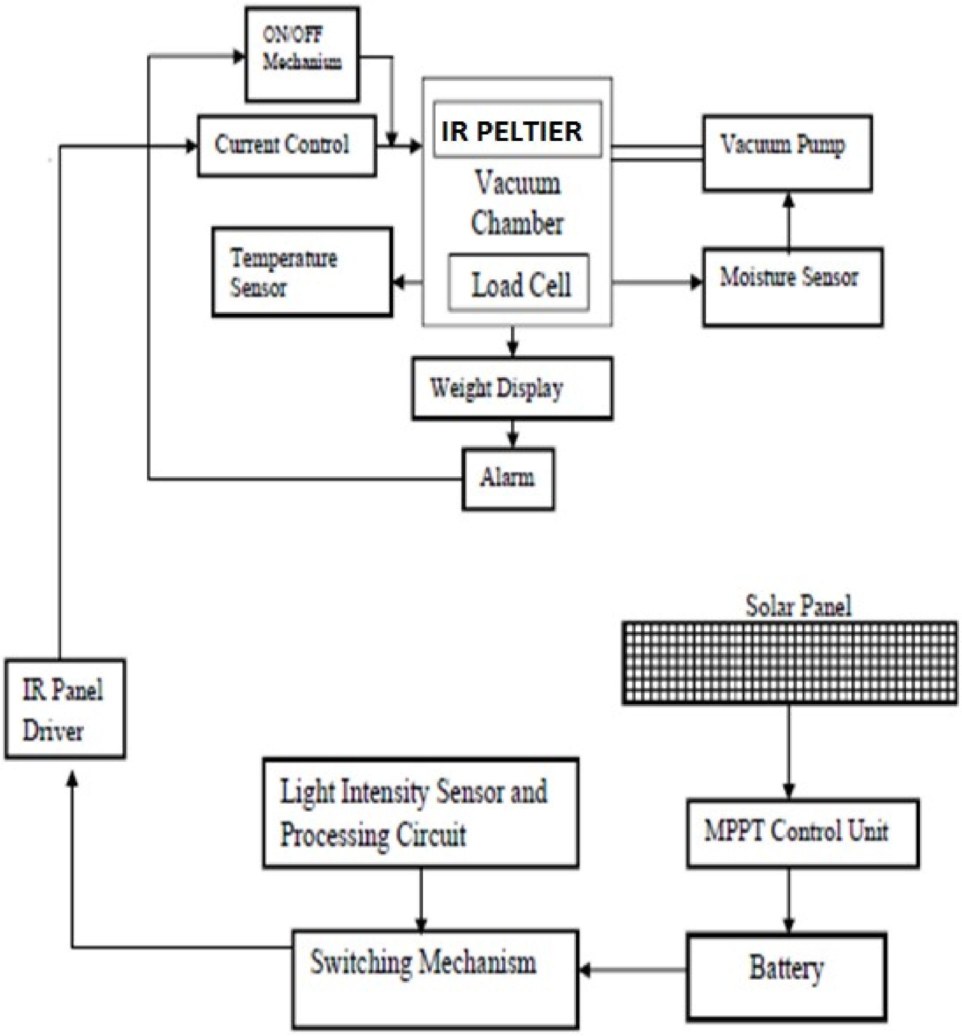


Figure 3.1: Intelligent Fruit Drying System

This allows for the drying process to take place both during the day and at night. An alarm is generated to indicate that the raisins are prepared for use once the moisture level of the raisins reaches the desired level. The technique offers dust-free drying, which helps to maintain both hygiene and raisin quality. There is far less manual intervention during the entire process of manufacturing raisins.

3.3 Component Details

3.3.2 Humidity Sensor

Water in the air is what causes humidity. The amount of water vapour in the air can have an impact on many industrial manufacturing processes as well as how comfortable people are. Multiple physical, chemical, and biological processes are affected by the presence of water vapour, as shown in figure 3.2.

Figure 3.2: Humidity sensor

Since it may have an impact on both employee health and safety and business costs associated with the product, humidity measurement in industries is crucial. In light of this, humidity sensing is crucial, particularly in systems that regulate industrial processes and human comfort. In many industrial and domestic applications, controlling or monitoring humidity is of utmost importance. During the processing of wafers in the semiconductor industry, humidity or moisture levels must be properly controlled and monitored. For respirators, sterilizers, incubators, pharmaceutical processing, and biological products in medical applications, humidity control is necessary. Controlling humidity is also important for the processing of food. For plantation protection (preventing dew), soil moisture monitoring, etc., humidity measurements are crucial in agriculture. Humidity control is necessary for domestic applications such as microwave cooking and living environments in buildings. Humidity sensors are used in all of these and many other situations to give a reading of the humidity levels in the surrounding area.

3.3.3 Temperature Sensor

Figure 3.3: Thermistor

For drying the fruits in chamber the temperature ranges from -55 to +150 degrees. Thermistors can also be used for voltage regulation, volume control, time delays, and circuit protection. This resistor can be used in a wide range of manufacturing and consumer goods, including rechargeable batteries, microwaves, circuit breakers, automotives, and digital thermometers. They are also utilised in commonplace applications including freezers, stoves, and fire alarms. Thermistor are thermally sensitive resistors, and their main job is to modify electrical resistance significantly, predictably, and precisely in response to changes in body temperature. When exposed to a rise in body temperature, the electrical resistance of the negative temperature coefficient (NTC) thermistors decreases. In figure 3.2 we can see the thermistor.

3.3.4 IC ATmega 328

Based on the AVR enhanced RISC architecture, the ATmega328/P is an 8-bit low-power CMOS microcontroller. The ATmega328/P achieves throughputs of about 1MIPS per MHz by processing powerful instructions in a single clock cycle. This strengthens a system created to balance the device's processing speed and power usage. 32 general purpose working registers are combined with a robust instruction set in the Atmel AVR core. Due to direct coupling between all 32 registers and the ALU, two different registers can be accessed simultaneously within a single clock cycle.

In comparison to traditional CISC microcontrollers, the resulting design is quicker and more code-efficient. The following capabilities are offered by the ATmega328/P:
In-System Programmable Flash having 32 kilobytes and Read/Write functionality, In addition, there are two flexible timer/counters with compare modes and PWM, a 6-channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages), an SPI serial port, six software-selectable power-saving modes, a Watchdog Timer with an internal oscillator, six general-purpose working registers, one serial programmable USART, and one byte-oriented 2-wire Serial Interface (I2C). The SRAM, Timer/Counters, SPI interface, and interrupt system continue to function even though the CPU is in idle mode and has been turned off. All other chip operations are stopped until the subsequent interrupt or hardware reset while the oscillator is stuck in the power-down state. The register's contents are nonetheless saved. The asynchronous timer continues to run, allowing the user to maintain a timer basis even though the rest of the device is sleeping in power-saving mode.

The ADC Noise Reduction mode turns off the CPU and all other I/O modules aside from the asynchronous timer and ADC to reduce switching noise during ADC conversions. The crystal/resonator oscillator is running while the rest of the device is in standby mode. As a result, highly quick startup and low power consumption are both possible. In Extended Standby mode, both the primary oscillator and the asynchronous timer are still in use. The library that Atmel provides enables AVR microcontrollers to include capacitive touch buttons, sliders, and wheels. In addition to offering reliable sensing, adjacent key suppression (AKSTM) technology, fully debouncing reporting of touch keys, and crystal-clear key event recognition, charge-transfer signal acquisition is unique.

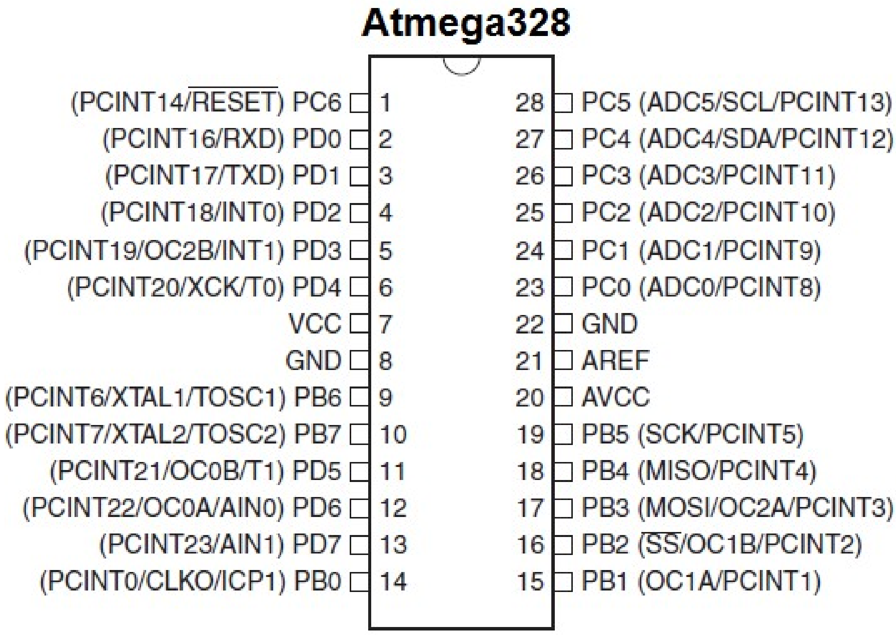


Figure 3.4: **Pin out of ATmega 328**

High density non-volatile memory technology from Atmel is used to create the product. The program memory can be modified In-System with the aid of the on-chip ISP Flash using an SPI serial interface, an AVR core-based on-chip Boot program, or a typical non-volatile memory programmer. Any interface can be used by the Boot program to download an application program into the Application Flash memory. The pin-out for the same is shown in figure 3.4.Thanks to the software in the Boot Flash section, true Read-While-Write operation will be feasible even as the Application Flash section is updated. The Atmel ATmega328/P is a powerful microcontroller that provides a very flexible and affordable solution for many embedded control applications. This is accomplished using a monolithic chip that combines an 8-bit RISC CPU with In-System Self-Programmable Flash. For the ATmega328/P, a full suite of system and program development tools is available, including C Compilers, Macro Assemblers, Program Debugger/Simulators, In-Circuit Emulators, and Evaluation Kits.

WORKING OF PELTIER MODULE

Because they must have different electron densities, n-type and p-type semiconductors are used to make up a peltier module. A thermally conducting plate, typically made of ceramic, is attached to each side of the alternating p and n-type semiconductor pillars, which are then arranged electrically in series and thermally in parallel. This eliminates the need for a separate insulator. A flow of DC current crosses the junction of the two semiconductors when a voltage is applied to their free ends, resulting in a change in temperature. When an electron transitions from a P type material to an N type material, it moves to a higher energy state and absorbs thermal energy (cold side). Following that, as the electrons move from N to P type materials, they drop to a lower energy state and release thermal energy (hot side) into the environment. The cooler the interior of the chamber (the cold side of the peltier plate) becomes, the more efficient the cooling module becomes. This is because heat dissipation increases with rate.

3.3.6 Solar Panel

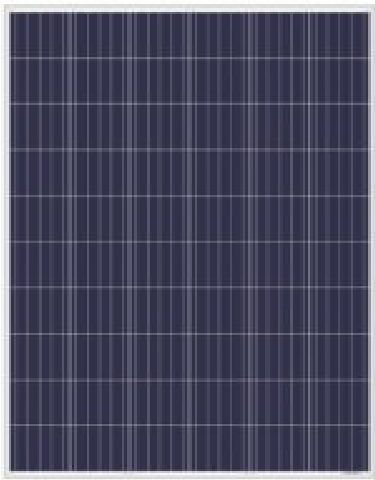


Figure 3.5: Solar panel

Photovoltaic solar panels use the energy they capture from the sun to produce electricity. A bundled, connected assembly of commonly 9x4 and 6x6 photovoltaic solar cells is called a photovoltaic (PV) module. The photovoltaic array of a photovoltaic system, which produces and supplies solar electricity for commercial and residential uses, is made up of photovoltaic modules. In our project, the highest voltage of the solar panels is 32V, and we use two solar panels connected in series to achieve this, as shown in figure 3.5.

1] MCU:

A microcontroller with eight 10-bit analog-to-digital (A/D) converters and two 4-PWM mode signals is used to implement the MPPT control circuit. The microprocessor manages the buck converter. It reads the voltage and current of the solar panels and determines their output power through the controller's A/D connection. Furthermore, it measures both the voltage and current on the battery side while calculating power, sending the proper control signals to the buck converter and modifying the duty cycle of the converter by sending a PWM signal through the controller to boost, lower, or disable the DC to DC converter as necessary. For this application, the avr offers the ideal balance of usability, performance, and low power usage. The control circuit compares the PV output power before and after modifying the duty ratio of the DC/DC converter control signal. The algorithm is predicted to cause the MPP to oscillate continuously.

2] DC-DC convertor:-

There are numerous DC-DC converter topologies available. One of these, the buck converter, is becoming a more common topology, since the output voltage level can be adjusted in relation to the input voltage, particularly in battery-powered applications. A DC/DC power converter is the converter that PV systems use the most. It ensures that the load receives the greatest possible electrical power transfer through a control action. Based on the amount of load that needs to be delivered, the converter's construction is chosen. We concentrate on the step-down DC/DC converter in this post (Buck converter). In order to maximise power transmission and regulate input voltage at the Maximum Power Point, MPPT makes use of the same converter in a different way.

3] MPPT:

Only 30 to 40 percent of the solar radiation that strikes a typical solar panel is converted into electrical energy. Utilizing maximum power point tracking technology improves the solar panel's efficiency. When the source and load impedances are in phase, a circuit's output power is at its highest, using the technique of maximum power transfer. The output voltage is increased by connecting a buck converter to a solar panel on the source side. By correctly adjusting the buck converter's duty cycle using a PWM signal, the source impedance and load impedance are matched. Numerous MPPT approaches have been proposed. The perturb and observe (PandO) and incremental conductance (INC) techniques are two of the most common, despite the fact that they have drawbacks like oscillations around MPP and confusion brought on by quickly changing atmospheric conditions.

In the suggested system, the perturb and observe MPPT algorithm is used. This technique entails the controller adjusting the voltage from the array just a little, measuring the power, and, If the power increases, continue to make adjustments in that direction until the power decreases. PandO method is employed here. It is the most popular MPPT method due to its simplicity and low cost.

The voltage of a cell is first raised; if the output power increases, the voltage is then raised again until the output power begins to decline. The voltage applied to the cell dropped as the output power started to rise until the maximum power was reached. Up until the MPPT is reached, this process is repeated repeatedly. Because of this, the output power varies slightly around the MPP. P-V curve for a PV module's output power at constant irradiance and module temperature, with the assumption that the PV module is operating far from the MPP.

This PandO method compares the power generated during the current cycle to the power generated during the previous cycle while periodically increasing or decreasing the PV cell's output terminal voltage. The operating point is assumed to have moved closer to the MPP if the power is increased. The operating point ought to logically move closer to the MPP as more voltage changes are made in the same direction. If the power fails, the operating point will have shifted away from the MPP, requiring a change in the perturbation's direction to bring it back toward the MPP.

4] Storage:

12 volt lead acid dry battery is a storage device.

In this thesis hardware is designed via SSSC unit
Observe and Perturb:

The primary goal of the maximum tracking power is to read the voltage or current coming from the solar panel, calculate the power, and then display the power at its highest level. Numerous algorithms are available to carry out this operation. Examples include the P&O (Observe and Perturb) method, incremental conductance, constant voltage, and parasitic capacitance method. P&O is the most popular algorithm among those that are accessible because of how simple it is to use. The incremental method's conductance is the most complicated. The advantage of this approach is that it might be more accurate than the P&O approach. The Parasitic Capacitance is much more difficult since the effect of solar cells is parasitic junction capacitance.

Types of DC/DC Converters

For this project, we require a product that can regulate and change one level of DC voltage into another. This situation can be achieved using a variety of DC/DC converters, such as the converter, buck converter, boost converter, buck-boost converter, and the converter. The buck converter, also referred to as a step down voltage converter because its output voltage is lower than its input voltage, is a switching converter that alternately opens and closes an electrical switch. A boost converter is comparable to a buck converter, with the exception that it performs step up conversion instead of step down. The voltage difference between the input and output is greater. The output voltage for buck-boost converters could be the same as or higher than the input voltage. In addition, the output voltage of a buck-boost converter and a converter can both be higher or lower than the input voltage. The converter output of buck-boost differs from buck-boost in that the polarity is reversed.

Because it has a simpler concept than the others, the converter of buck was selected for this project. Buck converters should, in general, have the following characteristics when they are in a steady state: the inductor current should be periodic and continuous; the average inductor voltage; the average capacitor current; and, most importantly, the power delivered to the effort should be similar to the power that an ideal source would provide for its constituent parts. It's important to take into account the power losses caused by imperfect components.

The MPPT method, or more specifically, how this algorithm was implemented on our system, was the single most important aspect in this project. As was previously noted, the maximum power tracking point was performed using either the observe or perturb method. This technique compared power to each moment and tracked the maximum power by altering the cycle of duty of the operation. Electrical power was computed with current or possibly voltage from a DC/DC converter. Matlab software is used to model the entire system and test the code in order to put this strategy into practice. Because Matlab software can simulate and code in the same file, it was chosen. Using the chart of flow the algorithm, the code was written step by step.

DC-DC converter model for simulation. Due to the peak current requirement of switching power supplies, the input capacitor is necessary to stabilize the input voltage. The most helpful inductor specification is determined by the equation below.

$$L_{MIN} = V_{IN} * \frac{V_{OUT} - V_{IN}}{\Delta I_L * f_s * V_{OUT}}$$

By measuring the output voltage or current of the solar panel at each instant and multiplying or dividing both values by the dc/cd converter, the instantaneous power produced by the solar panel at that instant was computed. P1, P2, and other power readings would be produced by repeating this function. Pn, Pn 1. An endless loop is used. In the event that the new power, Pn 1, exceeds the previous value, Pn, the operational voltage is compared. The duty cycle will be decreased or increased depending on whether the new voltage Vn 1 is greater than the old voltage Vn. The duty cycle will be increased if the new power is greater than the old power or decreased if the new voltage is greater than the old voltage. The maximum power point is always produced when the duty cycle is changed, which also changes the operating voltage or necessitates a new power calculation.

Inverters are the circuit which converting the DC to AC. We could easily say that the transfers of inverter power from the source of DC to an AC load. The goal is to create an AC voltage when only a DC source is available. By adjusting the dc of input voltage or also keeping the gain of the constant inverter, a output variable voltage could b obtained. Instead, if the DC voltage is fixed and not adjustable, changing the inverter's gain can produce a variable voltage output, which is typically done by modulating the pulse width of the inverter's output (PWM). This ratio of the voltages at the AC output and DC input is one way to define the gain inverter. A sine wave is simulated using a modified sine wave inverter. It adds a dead period to a typical square wave output. The wave is created by varying the DC source's three values at predetermined frequencies; as a result, it has less harmonics than a square wave. It offers a simple and affordable method of gadget powering using AC power. Its primary limitations are that not all devices, such as computers and medical equipment, can function correctly on it because of signal distortion. It should be noted that modified Sine wave inverters are not THD-rated (distortion of Total harmonic). It would be use less to rate a modified inverter of sine wave for distortion of harmonic, because its intendeduseisnotto reduced the introduced harmonicsto the device. Their aims is providing inexpensive or also AC power of portable. A efficiency topic is brought up to the harmonics discussion. Pure sinus wave of inverters are 5 percent low efficient, but the rating varies from the energy battery conversion to adjusted sinus wave of output. This doesn’t taking into the effect consideration of harmonics on battery to the instrument performance quality. In the sine wave of modified, the frequency of high harmonic contents producing the enhanced interference radio, more the heat effect in microwaves/ motors or also overload producing because to the reduction of capacitor impedance for the less frequency of capacitors/filters for the improvement of the factor of power. In terms of energy conservation of battery, a pure inverter of sine wave may be low efficiently, but this load uses more of energy output.

Battery:

Figure 3.6: Battery

To power electrical gadgets like torches, smartphones, and electric cars, One or more electrochemical cells with specific external connections make up an electric battery, which is a device. In our project, the battery will be charged using a solar charger at a constant voltage. The 12V 8AH battery from UP is what we use to store the solar energy. This battery has a cutoff voltage of 14.5V, and if it drops below that, the charging procedure will begin. Figure 3.6 shows battery.

State-of-Charge Estimation

Reading the battery voltage (V) and comparing it to a set of values kept in a lookup table (L0-L8) yield an estimate of the state of charge. Below, you can find the discharge curve and threshold voltages for the specific LG 18650 HE4 cells used in this.

The following formulas are used to determine the remaining capacity and charge time:

$Mah=cfull*(100-soc)*1.3$

$Tmax= 3600.cfull/icharge(90-soc)+45*60$

where icharge is the nominal charging current and cfull/cmax is the battery design capacitytmax is extended by 45 minutes, and cmax is raised by 30% to account for resistive losses and soc estimate error.

Safety

The charger incorporates a number of security measures. Among them are the detection of short circuits, open circuits, short voltages, and undervoltages. A Li-Ion battery typically operates safely in the range of vmin=2.5v/cell and vmax=4.2v/cell. Operating outside of this range could harm Li-Ion batteries permanently and could result in catastrophic failures like an explosion or fire.

A battery protection board also provides additional security for the battery pack, also known as the battery management system. The BMS keeps track of the voltages in each battery cell as well as the current used to charge and discharge the battery. If the voltage or current readings exceed the predefined limits, the BMS uses a solid-state switch to immediately disconnect the battery. The BMS is completely transparent and has no impact on charging, with the exception of the situation where it disconnects the exhausted battery to avoid over-discharge. In this case, the battery and a high value resistor connected in series maintain the battery's discharged voltage across the BMS terminals. The voltage value measured at the charger terminals is significantly lower as a result of this high value resistor. Chargers must start charging at much lower voltages than the vmin lower limit, like vstart=0.5v/cell, by ignoring the vmin lower limit.

The charger would begin charging a discharged battery at a lower safety current isafe=icharge/10 until the battery voltage reached vsafe=2.8v/cell, Then it would start using the full charging current. The voltage can no longer go below the vmin once it reaches this point. An "undervolt error" would be raised if the voltage fell below vmin. This error could be brought on by a battery open circuit or a short circuit.

If the charging current remains constant while the PWM duty cycle rises above a predetermined threshold, open circuit is also recognised. An "open circuit error" would result from this circumstance. Anytime the battery pack voltage suddenly surpasses vsurge=2.25v/cell, overvoltage is detected. An "overvolt error" would be raised if this value were exceeded.

Trickle Charging

The charger will stop charging when the end-of-charge (EoC) conditions are satisfied and go into an idle state where it will continuously check the battery voltage. The following parameters will be used to start a new charging cycle once the voltage falls below a predetermined threshold of vtrickle=4.10v/cell.:

Vtricklemax 4.15v-4.20v

Cmax=cfull*0.3+c

Tmax=20*60+t

The battery has a cmax design capacity. Since the battery was connected during both the initial charge and each subsequent trickle charge cycle, the values of c and t stand for the total charge capacity and charge duration, respectively. The trickle charge cycle uses a lower vmax and allows charging up to 3% of the battery's design capacity for a maximum of 20 minutes based on the aforementioned formulas.

Battery Protection Board

Despite the above-mentioned safety features, it is imperative to use a specific battery protection board for each of the battery packs. This adds an extra layer of security to guard against overcharging or over discharging caused by a software or hardware bug. Choice of battery ratings for thesis is 24v/10a

VOLTAGE CALIBRATION

1. Once the aforementioned preliminary step has been completed, please proceed as indicated below to calibrate the ADC values for the voltages v1, v2.
2. Start the serial monitor's serial monitor by entering the command cal start to engage the calibration mode. The serial monitor should display the message Calibration start.
3. Connect a steady voltage source of about 750 mV between the B-terminal and the power supply ground (0 V), and then determine the exact value of the voltage with a digital multimeter. It should be noted that 750 mV is used to pump 1.5 A through shunt resistors R8 and R9.

4. In the serial monitor, type the command "cal v2 value," where "value" denotes the mV value of the voltage measurement. Following the successful calibration of v2, the calibration constant v1,cal's value will be shown. If the calibration fails, the message "Out of range" will appear in the serial monitor.
5. Between the B terminal and the power supply ground (0 V), connect a source of constant voltage measuring roughly 16800 mV (4200 mV per cell), and then use a digital multimeter to measure the voltage precisely.
6. In the serial monitor, type the command cal v1 "value," where "value" denotes the millivolt (mV) reading of the voltage measurement (e. g. 16450). Following the successful calibration of v1, the calibration constant v1, cal's value will be displayed. The serial monitor will show the message "Out of range" if the calibration is unsuccessful".
7. You can confirm that the displayed values for v1 and v2 roughly match the observed voltages at B and B- by applying a known voltage (relative to 0V) to each of B and B-, then entering the. Instructions are enclosed in (dot).
8. In order to get accurate voltage readings, repeat steps 2, 3, 4, 5, and 6 as necessary.
9. For the voltage calibration mode to be ended, the command cal stop must be entered. On the serial monitor, the message "Calibration stop" ought to show up.

CURRENT CALIBRATION

Please carry out the actions listed below to calibrate the current reading:

1. Set a digital ammeter to the 10A range and connect the terminals B and B- of a lithium-ion battery that has been discharged in series.
2. Once it reaches a maximum of approximately 1 point 5A, the measured current value should start to gradually rise, and the serial monitor should indicate charging.
3. Enter the. (dot) command and confirm that the reported value for must as closely as possible match the measured current.

4. If the result of if the rshunt command is called and the value of rshunt is greater than the ammeter reading by 10 m.
5. Using the rshunt command, lower the value of rshunt by 10m if the output of the. command falls short of the amperemeter reading.
6. To get a precise reading of i, repeat steps 3, 4, and 5.

Despite one disadvantage, where designers must restrict the charging rate to prevent hazards and cell damage, As the go-to power source for portable electronics, lithium ion (Li-ion) batteries have cemented their position. Fortunately, modern Li-ion batteries are stronger and can charge much more quickly using "fast charging" methods. The best charging cycle for the electrochemistry and some fast-charging electronics are examined in greater detail in this article. In order to help engineers decide on their future charger design, the essay will also discuss the drawbacks of faster charging.

Lithium-ion (Li-ion) batteries have a straightforward concept, but it took four decades of research and significant funding to create the modern technology that reliably powers most portable electronics on the market. Early cells were brittle and prone to overheating during charging; however, research has improved them. To guarantee that maximum capacity is reached without overcharging and the associated risk of long-term harm, recharging must still follow a strict schedule that limits charge currents. The good news is that the ion mobility in the cell has increased recently thanks to developments in electrochemistry and materials science. The "constant current" phase of the charging cycle can be finished more quickly and with larger charge currents thanks to the increased mobility.

With these developments, it is now possible to charge the newest Li-ion battery-powered cellphones from 20 to 70 percent of their capacity in 20 to 30 minutes. Customers who value a quick battery refresh to three-quarter capacity have created a market niche for chargers that can safely allow quick charging. Chip producers have responded by offering designers ICs that enable variable charging rates to hasten the replenishment of Li-ion cell batteries. The end result is faster charging, but there is a cost.

Portable power enhancements

Li-ion batteries' foundation is made up of intercalation materials. Lithium ions can move between or within the layers of these materials thanks to their layered, crystalline structure. A lithium-ion battery discharges when ions pass through an electrolyte from the negative electrode to the positive electrode. As a result, the circuit's electrons move in the opposite direction, powering the load. Current stops flowing when the negative electrode's supply of ions is exhausted. The ion is forced to cross the electrolyte once more during the battery's charging process in order to settle in the negative electrode in preparation for the upcoming discharge cycle.

Modern batteries use lithium-based intercalation materials for the positive electrode because they are considerably safer than the highly reactive pure lithium, such as lithium cobalt oxide ($LiCoO_2$). Carbon-based graphite is used as the negative electrode in this system.

These resources are adequate but not flawless. Each time, some of the displaced ions interact with the electrode and change it into a different substance, losing some of the others to the electrochemical reaction. The free ion supply eventually runs out as a result, and battery life decreases. Even worse, every charging cycle results in the electrodes' volumetric increase. This puts strain on the crystalline structure and results in tiny degradation that reduces the electrodes' capacity to hold free ions. The total number of recharge cycles is thus limited.

The primary objective of current Li-ion battery research has been to address these drawbacks by squeezing more lithium ions into the electrodes to boost the energy density, which is determined by the amount of energy per unit volume or weight. This facilitates the ions' movement into and out of the electrodes as well as their transit through the electrolyte (i.e. enhancing ion mobility).

The amount of time it takes to charge a battery (for a specific current) ultimately depends on its capacity. For instance, when both batteries are charged at a current of 500 mA, a 3300 mAhr smartphone battery will take approximately twice as long to charge as a 1600 mAhr battery. The maximum amount of current the battery can generate in an hour is 1 C, so engineers specify charging rates in terms of "C" to account for this. C, for instance, equals 2 A for a battery with a 2000 mAh capacity. The charging procedure adheres to the same rules. When 1 A of charge current is applied to a 2000 mAhr battery, it will charge at a rate of 0.5C.

Therefore, it would seem that lowering the recharging time would result from increasing the charging current. This is accurate, but only to a point. First off, ions have a limited range of motion, Due to this, increasing the charging current past a certain point has no effect on how quickly ions move. Instead, the energy is lost as heat, which raises the internal temperature of the battery and increases the possibility of long-term damage. Second, unchecked charging at a high current eventually leads to the negative electrode embedding with too many ions for the electrode to support, and the battery is then obliterated.

The most recent Li-ion batteries can now use a higher charging current without risking dangerously rising internal temperature thanks to modern advancements that have significantly increased ion mobility. The most recent Li-ion batteries can now use a higher charging current without dangerously raising the internal temperature thanks to modern advancements that have significantly increased ion mobility. Manufacturers of Li-ion batteries advise a strict charging schedule to prevent damage to their products.

Carefully does it

Li-ion battery charging adheres to a schedule that was developed to ensure durability and safety without compromising performance. A small "pre-conditioning" charge of about 10% of the full charge current is applied to a lithium-ion battery when it is severely discharged (below 3 V, for example). This prevents the cell from overheating before it is able to handle the entire current of the constant-current phase. Most contemporary mobile devices are designed to shut down while there is still some charge because deep discharge, like overcharging, can harm the cell. As a result, this phase is actually not always necessary.

Depending on the specific electrochemistry, When the voltage reaches 4 or 4 and a half volts, the battery is typically charged at a constant current of 0 and a half volts or less. To avoid overcharging, when the battery voltage reaches 4 or 4 12 V, the charger switches into a "constant voltage" phase. Superior battery chargers smoothly transition from constant current to constant voltage to ensure that maximum capacity is reached without putting the battery in danger.

Charging stops once it reaches about 0.1 C while the current is gradually decreased and the voltage is maintained. The battery receives a recurrent "top up" charge to prevent self-discharge if the charger is left connected. When the battery's open-circuit voltage falls below 3 to 4 V, the top-up charge typically begins, and it ends when the full-charge voltage of 4 to 4 2 V is once again reached. As was already mentioned, overcharging shortens battery life and creates a risk. When the ions stop moving, the majority of the electrical energy that was delivered to the battery is converted to heat energy. The electrolyte has a tendency to explode due to outgassing, which leads to this overheating. Therefore, battery manufacturers encourage precise management and suitable charger safety measures.

Even though it's not harmful, undercharging still has the potential to reduce battery capacity. For instance, an undercharge of 1% can cause a 8% reduction in battery capacity. As a result of these elements, the battery should be able to be fully charged by the charger, which should also be able to control the final voltage to within 50 mV of 4 V or 4 V 2. Simpler chargers use charging for a predetermined period of time while assuming the battery is fully charged as one of their detection techniques. Another is keeping track of the moment during the constant-voltage stage when the current reaches 0.1 C. numerous chargers also include capabilities to gauge battery temperature in order to avoid overcharging.

Thermal control:

AVR atmega 328p-pu ic is used as heart of system which will sense temperature via inbuilt ADC and generate PWM signal to control supply of peltier plate w. r. to temperature and charge the battery. Proposed design uses peltier plate to control the thermal heat of of system to 70 degree when sunlight is not available. Temperature sensor measures initial temperature, which microcontroller unit then converts from analog to digital. The microcontroller will also compare the battery temperature before generating the actuator signal in pwm form to control the voltage and current of the peltier plate, which will produce heat. With a low-cost design, the design compiles a very small size that is easily fitted in any vehicle.

3.4.7 Arduino Uno

The Arduino Uno is a microcontroller board that has the ATmega328P as its core. It has a USB port, a power jack, an ICSP header, six analog inputs, a 16 MHz quartz crystal, and reset and ICSP header buttons. It also has 14 digital input/output pins, 6 of which can be used as PWM outputs. It comes with everything required to support the microcontroller; Simply connect it to a computer with a USB cable, or power it with an AC-to-DC adapter or battery, to get things going. Figure 3.7 shows the Arduino Uno

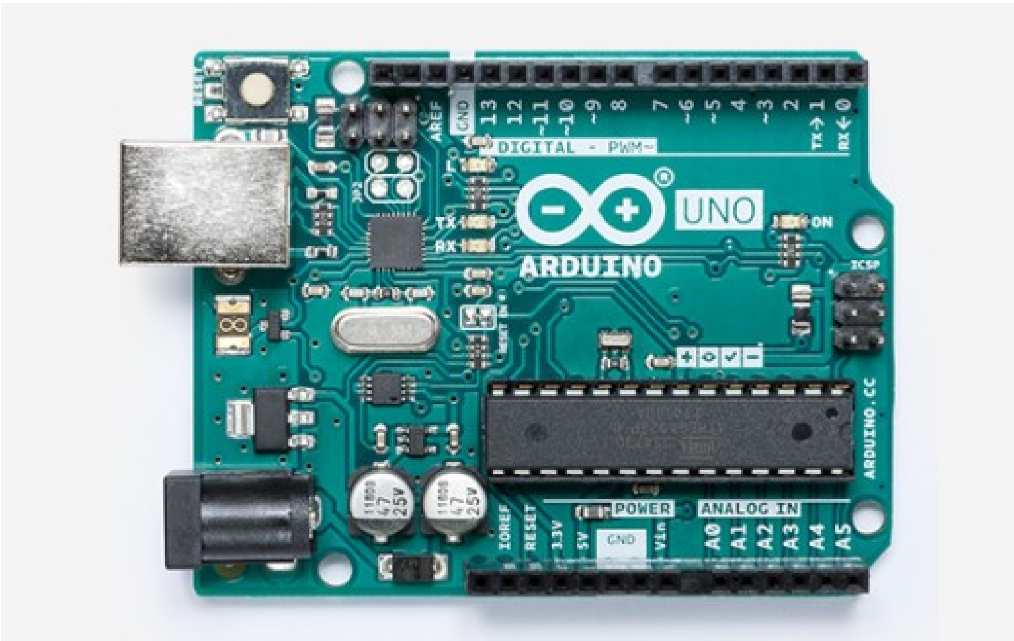


Figure 3.7: Arduino Uno board

3.4.8 IR LED

Infrared signals are produced by IRLEDs, a special kind of LED. It is a semiconductor device specifically, and it emits infrared rays when it is exposed to electrical current. There is no lighting produced by IR LEDs. Instead, they are most frequently utilized in a variety of signal transfer systems, including those found in night-vision cameras, remote controls for televisions, and other devices. To control the object, an IR LED projects light and data signals. Additionally, cameras, security systems, and other types of technology use IR LEDs. Due to their low heat production and energy consumption, they are advantageous.

A diode or straightforward semiconductor is what an IR LED is. In diodes, electric current is restricted to one direction of flow. As the current flows, electrons from one diode component fall into holes on a different component. In order to fall into these holes, the electrons must release energy in the form of photons that produce light.

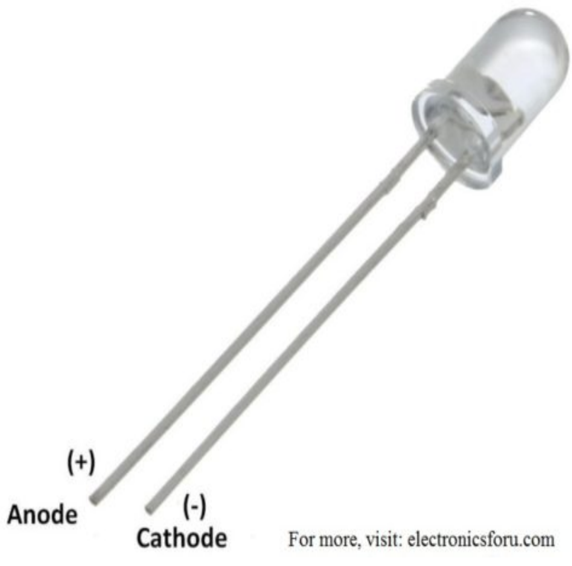


Figure 3.8: IR LED

When using an IR diode in an electronic application, the emission must be modulated to avoid erroneous triggering. The IR LED signal can be distinguished from background noise thanks to modulation. Figure 3.8 shows the IR LED. The package of an infrared diode is transparent to infrared light but opaque to visible light.

3.4.9 LCD Display

In the project the display of the moisture is given on an LCD. In LCD displays, a liquid crystal solution is sandwiched between two sheets of polarizing material, as shown in figure 3.9. The crystals align so that light cannot pass through them as a result of an electric current being passed through the liquid. Therefore, each crystal functions like a shutter, either letting light through or blocking it. Alphanumeric displays are used by a wide range of gadgets, including word processors, copiers, point-of-sale terminals, medical equipment, mobile phones, and palmtop computers. On the 16 x 2 intelligent alphanumeric matrix displays, there are 224 different characters and symbols that can be displayed. A complete list of the symbols and characters is provided on pages 7 and 8. (note these symbols can vary between brand of LCD used). This manual contains all the technical information needed to connect the device, which only needs one power source (+5V).

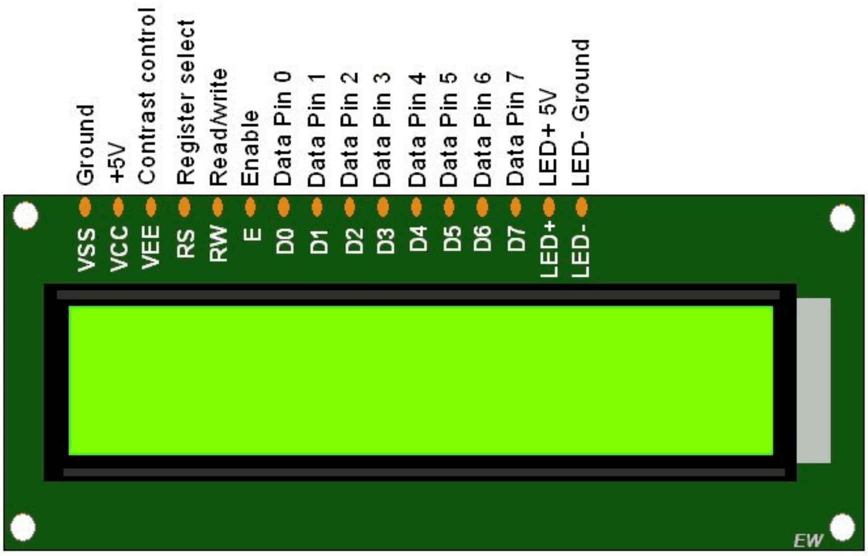


Figure 3.9: Pin diagram of LCD 16*2

Pin-out Description-

<table>
<tr><th>Pin No</th><th>Symbol</th><th>Details</th></tr>
<tr><td>1</td><td>Vss</td><td>ground</td></tr>
<tr><td>2</td><td>Vcc</td><td>supply voltage+5V</td></tr>
<tr><td>3</td><td>Vee</td><td>power Supply to Control contrast</td></tr>
<tr><td>4</td><td>Rs</td><td>register Select</td></tr>
<tr><td>5</td><td>R/W</td><td>Read/Write
R/W=0 Write To Register
R/W=1 Read from Register</td></tr>
<tr><td>6</td><td>EN</td><td>High to low pulse is given when data is sent to print</td></tr>
<tr><td>7</td><td>DB0</td><td rowspan="8">8-bit data pins. To display number or letters their ASCII code is sent to data pins

Instruction command codes are sent to these pins.</td></tr>
<tr><td>8</td><td>DB1</td></tr>
<tr><td>9</td><td>DB2</td></tr>
<tr><td>10</td><td>DB3</td></tr>
<tr><td>11</td><td>DB4</td></tr>
<tr><td>12</td><td>DB5</td></tr>
<tr><td>13</td><td>DB6</td></tr>
<tr><td>14</td><td>DB7</td></tr>
<tr><td>15</td><td>LED +</td><td>Backlight +5v</td></tr>
<tr><td>16</td><td>LED -</td><td>Backlight ground</td></tr>
</table>

Figure 3.10: Pinout

Features:-

1. Easy interface with 4 bit or 8 bit MPU or mc
2. Built in LCD controller with font 5*7 or 5*10 dots
3. Internal automatic reset circuit at power on.
4. Display data RAM for 80 char.(80*8 bits)
5. 16 X 2 LCD display

6. 5 X7 Pixel matrix
7. Two register
8. 16 Characters *2lines display.
9. Display mode and backlights variations

In the project, the LCD is connected to port 0 (D0-D7). e. to and including pins 32 and 39. This means that the data-bus D0-D7 is connected to port 0 of IC 89s52. The controller's pin 14 and pin 11, as well as another crucial pin called EN (LCD enable), are directly connected. Meanwhile, the LCD's pins R and W are grounded. Here, the LCD is interfaced to provide the user with a variety of display messages, as shown in figure 3.10.

The interfacing is given in detail which is as follows:

A 16x2 type LCD is utilized in this apparatus. i. e. two rows of 16 characters each. An LCD's function is to display any resultant parameters that must be displayed on the screen in accordance with user requirements or to display the status of actions taken by the relevant circuit.

1. Basics of LCD:-LCD has 8 Bit data (D0-D7). Basically LCD requires three control signals which are-

a. **R/W**: - Read/Write signal when low it is configuring as write function.

b. **RS: -** The display has two internal bytes-wide registers: a command register (RS=0) and a character register (RS=1).

2. Command: - Commands are character size, rows and columns, cursor movement, blink cursor etc. Basically LCD can be configured in the two modes, which are nothing but Slave mode and Handshake mode. In the slave mode a command is transferred to LCD and wait for some delay for the specific time that is normally 6msec. On the other hand i.e. in the handshake mode the ‘D7’ bit is used. After the completion of the task the D7 bit is set high by the display. LCD screens, which are electronic display modules, have a wide range of applications. A very fundamental module that is frequently used in many different devices and circuits is a 16x2 LCD display. These modules are preferred over multi-segment LEDs with seven segments and other segments. For instance, a 16x2 LCD has two of these lines and can display 16 characters per line. Additionally, LCDs are inexpensive, simple to program, and have no limitations when it comes to displaying unique or even customized characters, animations, or other features. On this LCD, a 5x7 pixel matrix represents each character. On this LCD, there are two registers: Command and Data. The command register stores the LCD's command instructions. A command is a directive given to an LCD that instructs it to carry out a specific task, such as initializing it, clearing its screen, putting the cursor in a specific location, controlling the display, etc. The data that will be shown on the LCD is kept in the data register. The character's ASCII value, which will be displayed on the LCD, is contained in the data. Click to read more about an LCD's internal structure.

Chapter 4

Implementation of the System

4.1 System Design

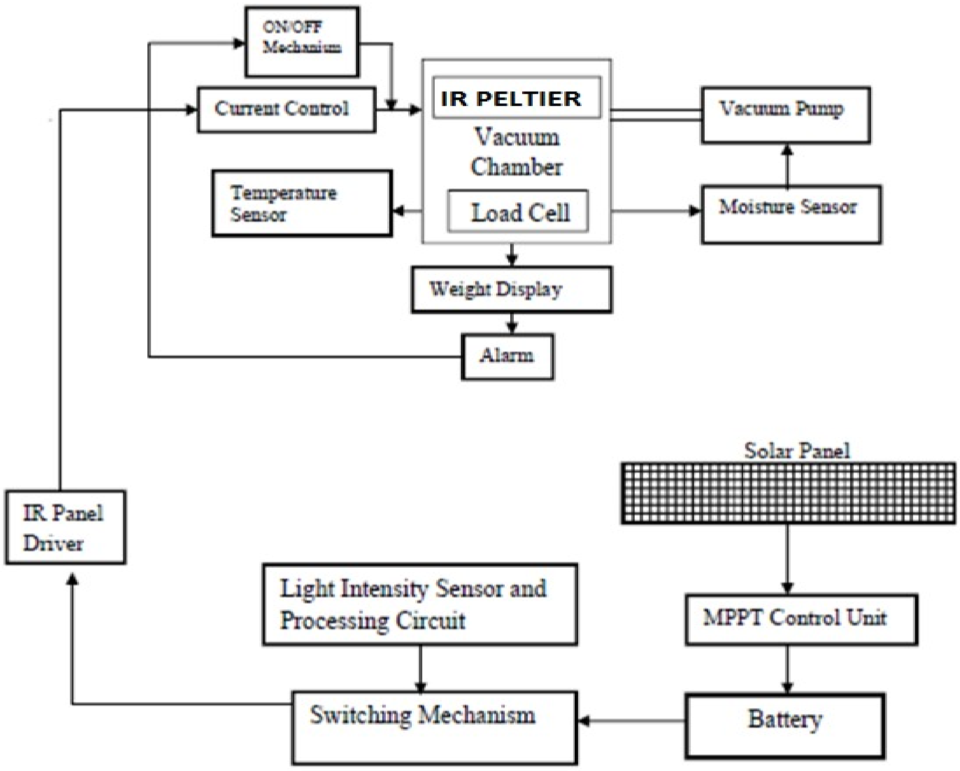


Figure 4.1: solar infrared radiation and a peltier heating mechanism are used in a fruit drying system.

4.2 Vacuum Chamber Unit

The vacuum chamber consists of load cell and moisture sensor. The tray is placed inside the chamber. The grapes to be dried are kept in the tray. The weighing sensor is connected at the bottom of tray to sense the weight of cashew nut/grapes during drying process. An aperture plate is mounted on the top of the chamber. Only IR radiation is allowed to enter the chamber due to an aperture plate and IR filter on top of the vacuum chamber. Only IR radiations are able to enter the chamber when sunlight enters due to light filtering. The grapes' moisture is evaporatively removed by heat energy produced by infrared rays that penetrate the vacuum chamber [6]. The drying process is sped up by the vacuum pump's removal of the moisture from the vacuum chamber. Grape moisture content evaporates, causing weight loss. When the weight of the grapes reaches 30% of its initial value, a load cell and associated electronics will sound an alarm. The ON/OFF mechanism stops IR radiation from entering the vacuum chamber once an alarm is activated.

The electrical signals formed by the moisture sensor are further passed to ADC for calculating the actual moisture by referring the food object placed in chamber using sensor. after passing signal to signal conditioner these signals are amplified and converted to digital form with help of a 24 bit ADC (HX711).

Sensor detects % moisture and displays it on LCD. User can see amount of %moisture present in the chamber. Amount of moisture is continuously displayed on the LCD display during this whole process.

4.3 Light Intensity Sensing Mechanism

The light intensity sensor tracks the amount of light continually. Infrared radiators' power is turned on by an automatic switching mechanism when there is no light. Batteries that power the IR radiators at night are charged separately using a solar panel (absence of sunlight). Solar battery charging is completed using the Maximum Power Point Tracking (MPPT) control algorithm. The battery won't be overcharged or charged in-depth thanks to this algorithm [7]. To develop battery charge control, the Arduino controller is utilized [8].

4.4 MPPT Unit

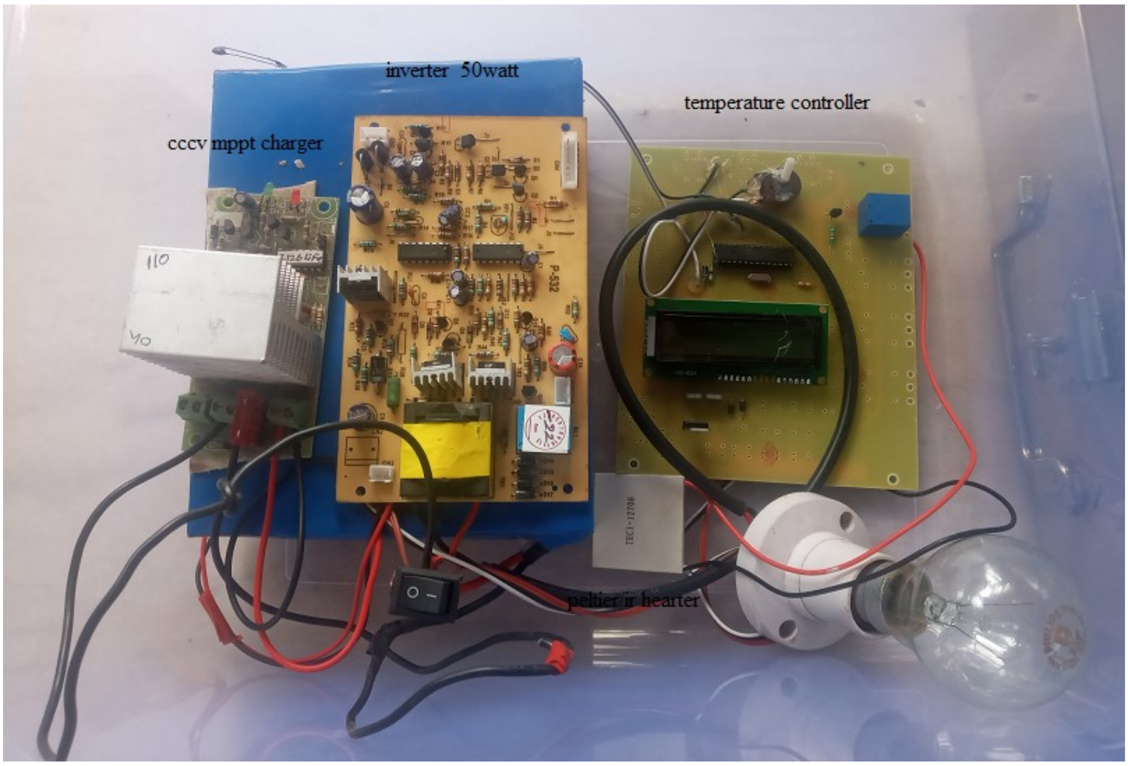


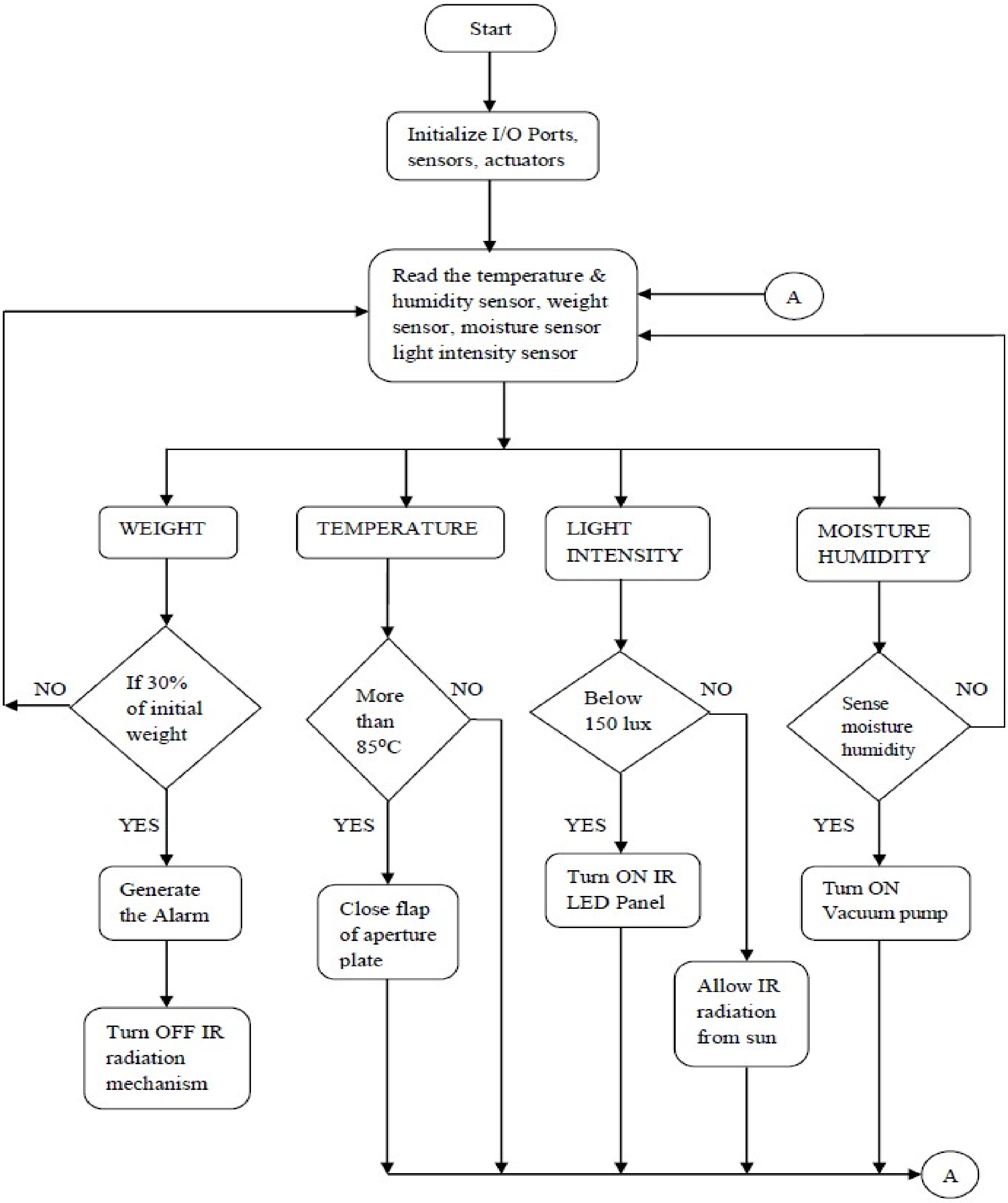
Figure 4.2: **MPPT battery charger unit**

The compatibility of the PV array (solar panels) with the battery bank or utility grid is optimized by an electronic DC to DC converter known as an MPPT, or maximum power point tracker. Simply put, they reduce the greater DC output voltage from solar panels (and a few wind turbines) to the lower voltage required to charge batteries. The majority of contemporary MPPTs have conversion efficiencies of 93–97%. In the winter, you normally gain 20 to 45% more power, and in the summer, 10-15% more. The actual gain can differ significantly based on the weather, temperature, battery charge, and other variables. By using an MPPT charger circuit, a battery can be fully charged. We employ a MOSFET 3205 switching mechanism through an optocoupler in the charger circuit. Optocouplers are used to isolate gate pulses. As input from the solar panel and battery in this circuit, two voltage dividers with a 100 kOhm resistance are used, as shown in figure 4.2.

Chapter 5

Software Implementation

5.1 Flow chart



1. The whole hardware system cannot accomplish the task on its own unless real-time program instructions are flashed into the hardware.
2. For the system to work, the peripheral devices must be set up and initialized in accordance with software instructions. The software element is crucial for coordinating and controlling all of the peripherals connected to the controller.
3. At the beginning, all of the sensors, controllers, and individual parts are initialized. Initially, a tray with a weighing sensor attached is where the grapes are put.
4. Weight is calculated by the sensor and displayed on the LCD. A warning is given when the weight drops below 30% of its starting weight, and the weight is continuously monitored.

5. A temperature sensor keeps track of the chamber's temperature. The aperture plate closes and the amount of solar energy entering the earth is decreased when the temperature reaches the predetermined point.
6. The solar light lux is tracked by the light intensity sensor. The vacuum chamber's IR panel is turned ON as the sun's brightness decreases.
7. The vacuum chamber's moisture is detected using moisture humidity sensors. The vacuum pump maintains the chamber's vacuum while removing moisture.

Chapter 6

Results and Discussion

Hardware details are as given below

Solar panel 150w.
Lamp LED load -12v x 1A=12w x 2.
Max charging AMPS=20A
Battery lithium Ferro phosphate 12v 30AH .4cells
Current sensor =max 20A
Kit sensor voltage capacity=32v
Display 16x2 LCD.
Max charging current =10A
Max charging voltage cutoff
Overcharge cutoff=14.6v
Low battery cutoff = 11.5v
Back up time for DC grid.
12v=12w=12hrs-without solar
24w=6hrs-after battery
48w=3hrs-full charge battery mode.
Peltier plate 12v 92watt

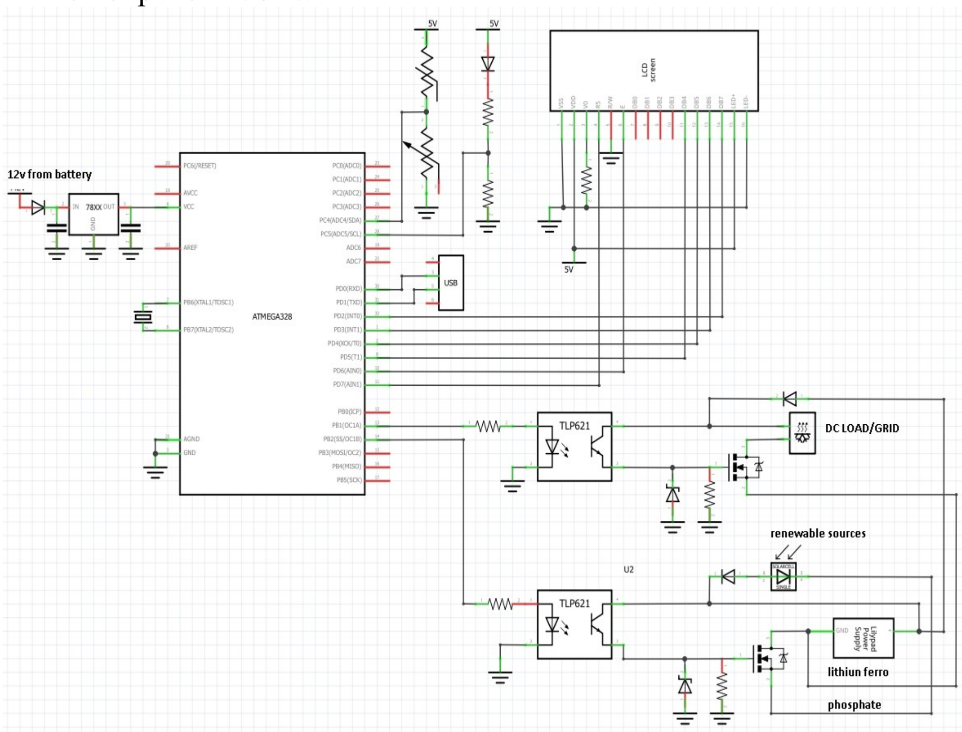


Figure 6.1: Control circuit

Table 6.1

Time	Battery charging voltage pv connected	Charging current
7am	13v	1A
8am	13.6v	2A
9am	13.9v	3A
10am	14.0v	5A
11am	14.34v	5.5A
12pm	14.65v	0A (Cutoff)

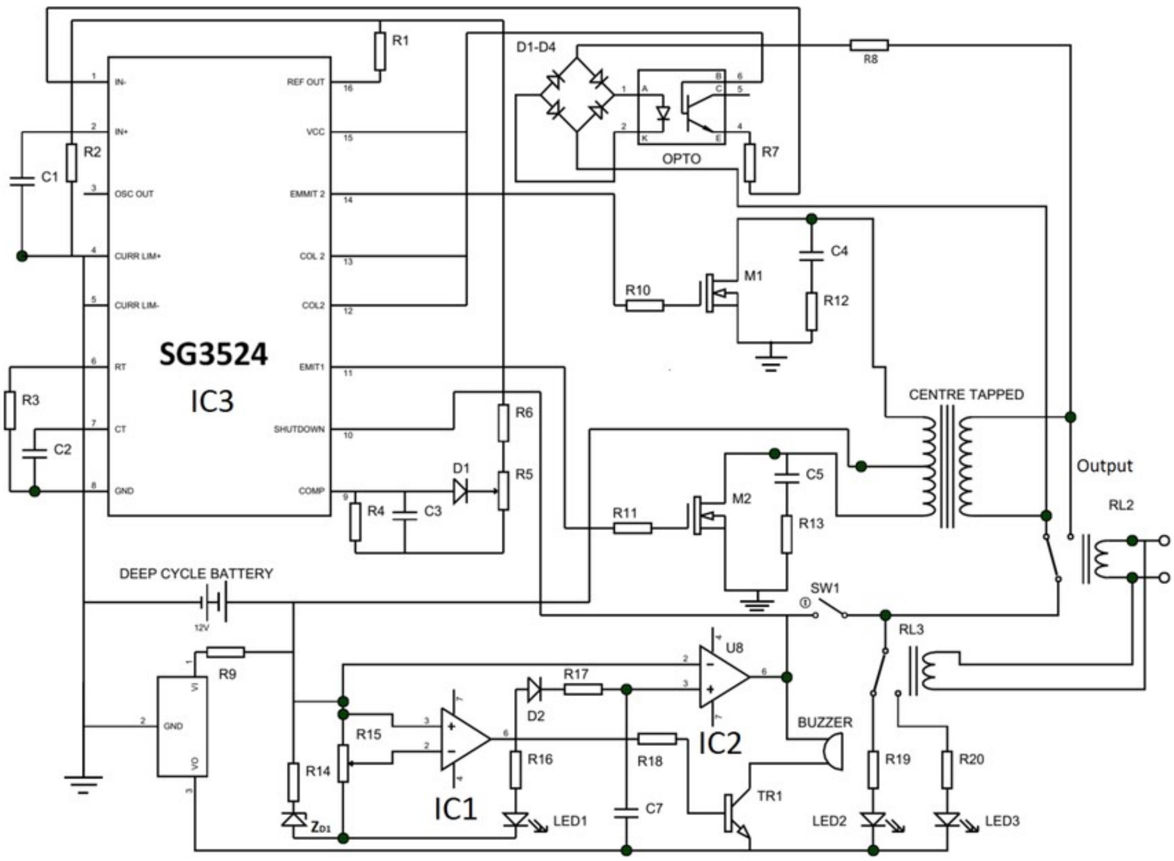


Figure 6.2: DC to AC converter

Circuits called inverters change dc into ac. It is simple to state that inverters convert power from a dc source to an ac load. When there is only a dc voltage source available, the goal is to generate an ac voltage. As shown in figure 6.2. By adjusting the input dc voltage while keeping the inverter's gain constant, a variable output voltage can be achieved. On the other hand, if the dc voltage is fixed and uncontrollable, a variable output voltage can be obtained by altering the inverter's gain, which is typically done by controlling the inverter's pulse-width modulation (PWM) control. The inverter gain can be defined as the ratio of the ac output voltage to dc input voltage. A sine wave is simulated using a modified sine wave inverter. It adds a dead period to a typical square wave output. The wave is created by varying the DC source between three values at predetermined frequencies, which results in fewer harmonics. Than a square wave, harmonics It offers a simple and affordable way to power gadgets that require AC power. Its main limitations are that not all devices, including as computers and medical equipment, can be used with it since they are not immune to signal distortion. It should be noted that modified-sine wave inverters do not have a THD rating (THD). Since its intended usage is not to lessen the harmonics introduced to devices, rating a modified-sine wave inverter for harmonic distortion would be meaningless. Their goal is to offer portable, inexpensive AC power. The examination of harmonics raises the issue of efficiency. Although this rating is based on the conversion of battery energy to modified sine wave output, pure sine wave inverters are 5% less efficient. The efficiency of the output from the battery to the gadget is not taken into account here. The high frequency harmonic content of a modified sine wave increases radio interference, amplifies the heating effect on microwaves and motors, and results in overloading by reducing the impedance of low frequency filter capacitors and capacitors for power factor enhancement. Although a pure-sine-wave inverter may convert battery energy less effectively, the load uses more of the output energy.

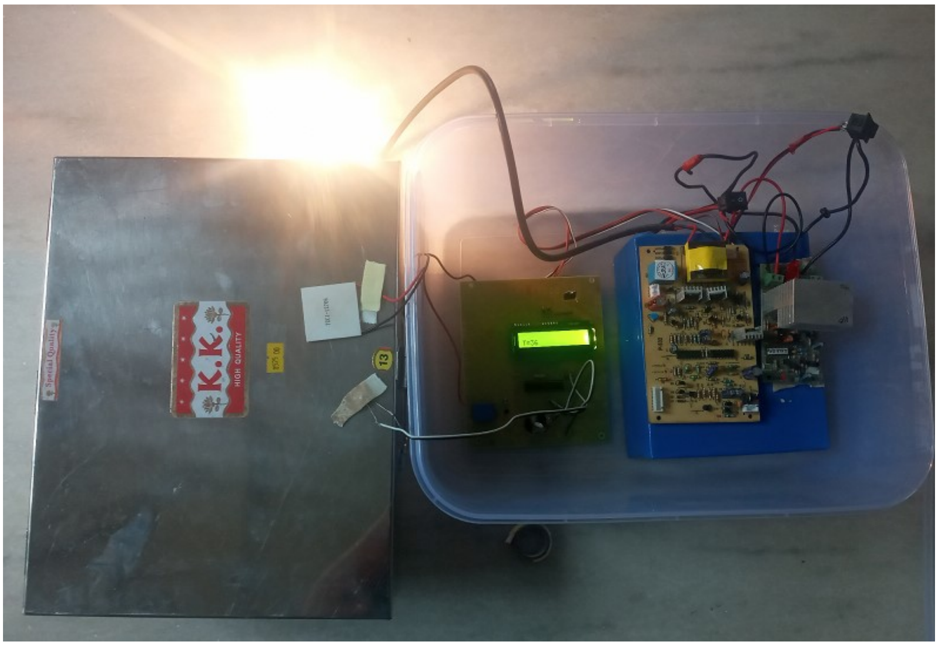


Figure 6.3

Inverter output 230v ac 50 hz supply

Figure 6.4

Cold Side Temperature (°C)	Hot Side Temperature (°C)	Temperature Difference (°C)	Voltage (V)
18	18	0	0
23	38	15	0.05
26	51	25	0.1
30	59	29	0.14
33	67	34	0.2
37	74	37	0.22
43	84	41	0.24
43	87	44	0.25
44	105	56	0.4
53	118	65	0.55

Table 6.2:Peltier plate temperature vs voltage measured

Peltier output temperature 70 degree celcius maintained at 12v input for heating of cashew nut at night mode on battery back up.

Figure 6.5: Output after drying 6hrs

Advantages and Applications

Advantages of Using an infrared heating mechanism, an intelligent fruit drying system.

1. Natural nutrients preserved

The grapes' original nutritional value is retained. The raisins retain their high standards and golden colour. Food goods in greater quantities can be dried.

2. Anytime drying

The suggested system is capable of operating without sunlight. The drying procedure can also be done at night using IR radiators. The batteries are charged by the sun during the day, and at night, charged batteries provide power to IR radiators.

3. Good stability

The suggested approach aids in providing a uniform drying. It offers decent stability

.

4. Cost effective

The system operates efficiently because it uses non-traditional sources of energy. Profit maximisation will result from the farmers' effective use of this technology.

Conclusion

In this proposal, the already used natural procedure for drying grapes is modified with an appropriate enclosure that contains IR radiators and related equipment. The right sensors are utilised to measure variables such as humidity, temperature, and sample weight. The grapes are dried uniformly with the use of infrared radiation, according to experimental examination carried out with the aid of a dryer. Due to the low temperature at which the grapes are dried, the original colour is better preserved. Comparing the drying process to the natural drying method, the drying time is significantly shortened. Vacuum solar dryers are effective and time-saving, and they should be used whenever good results and little time are needed. The suggested system runs automatically. Both accuracy and user comfort are improved. The entire process of manufacturing is done without human intervention.

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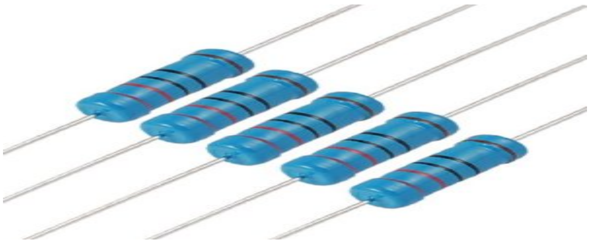
APPENDIX

GENERAL COMPONENTS

- **RESISTORS :**



The resistance is the fundamental component of the circuit in many electronic circuit applications. The resistance is introduced to either decrease current or produce the desired voltage drop. The parts that provide resistance values are referred to as resistors. Resistors can have a fixed value, such as i. e., which are referred to as fixed resistors because their value cannot be altered. Variable resistors are those whose value can be altered or changed.

There are two different varieties of resistors. These exist:

- Carbon resistors.
- Wire wound resistors.

Carbon resistors are used when the power dissipation is less than 2W because they are smaller and cost less. Wire wound resistors are used where the power dissipation is more than 5W. In electronic equipments carbon resistors are widely used because of their smaller size

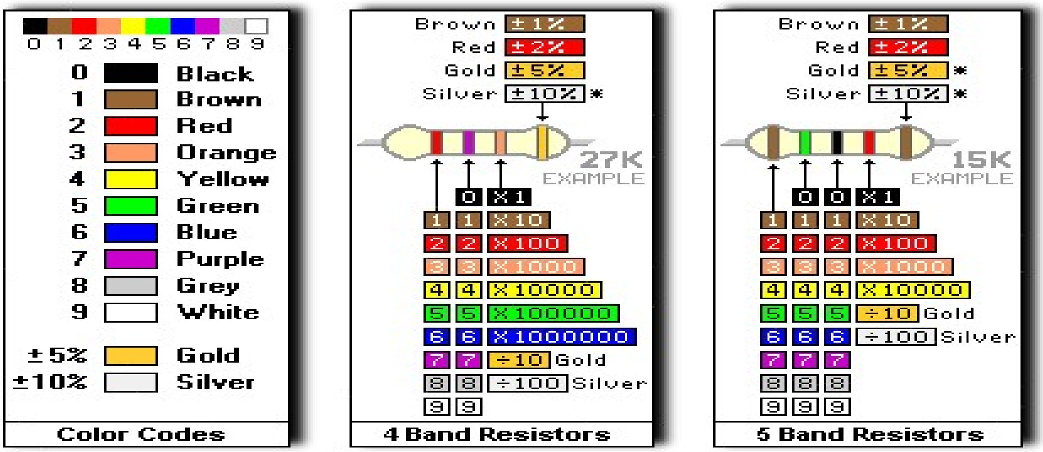
All resistors have three main characteristics:

- Its resistance R in ohms (from 1 ohm to many mega ohms).
- Power rating (from several 0.1W to 10 W).
- Tolerance (in percentage).

RESISTOR COLOR CODING:

Small and color-coded to show their resistance value in ohms, the carbon resistors are small in size. Different colors are used to indicate the numeric values. The dark colors represent lower values and the lighter colors represent the higher values. The color code has been standardized by the electronic industries association.

The resistors have printed color bands that are read from left to right and are located at one end. The first color band closed to the edge indicates the first digit in the value of resistance. The second digit is provided by the second band. The third band displays the number of zeroes following the second digit. The resulting number is the resistance in ohms. A fourth band indicates the tolerance i.e., to indicate how accurate the resistance value is, the bands are shown in the figure 1.



- **PRESET:**

There are two general categories of variable resistors:

- General purpose resistors.
- Precision resistors.

The general purpose type can again be wire wound type and carbon type .These follows either linear or logarithmic law. The precision type are always wire wound and follow a linear law .The variable resistors can be broadly classified as potentiometer , rheostats , presets and decade resistance boxes.

The general purpose wire wound potentiometers are available in 1, 2, 3 and 4 watts. The usual tolerances ratings 10 % and 20% are available. The widely used potentiometers are of the standard diameters 19mm, 31mm, and 44mm. The temperature coefficient depends on the wire used and on the resistors values. The resolution of these wire wound resistors is proper than carbon resistors because the wiper has to move from one winding to the other, where as in carbon potentiometers it is continuous. These resistors are highly linear, the linearity falling with 1%.

➢ CAPACITORS:

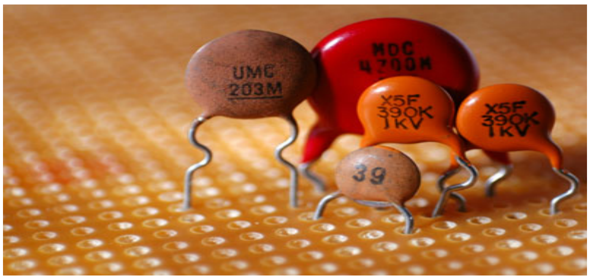
Capacitors are objects capable of storing electrical charge. A dielectric's capacity to store electric charges can be used to understand capacitance. Its component, Farad, is named after Michael Faraday. According to the dielectric used, the capacitors are given names. The most typical ones are electrolytic, air, paper, mica, and ceramic capacitors.

A capacitor's conducting plates are physically separated from one another by an insulator or dielectric. The plates of the capacitor have opposite charge, this gives rise to an electric field. The dielectric between the plates of a capacitor is where the electric field is concentrated.

Similar to resistors, capacitors are essential for the proper operation of almost every electronic circuit and give us a way to store electrical energy in the form of an electric field. Storage capacitors in power supplies and coupling of A are just two examples of the many uses for capacitors. C. signals between amplifier stages and decoupling power supply rails to allow, as far as A. C. Insofar as the signal components are concerned, the supply rails are identical to zero volts.

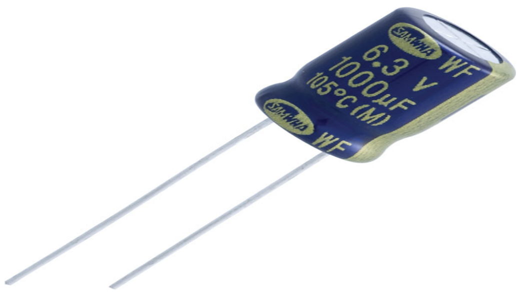
- **TYPES OF CAPACITORS**:

- **DISC CAPACITORS :**



The conductor plates are created in the disk form by firing silver onto the ceramic's two surfaces. The sheets are then baked, shaped and sized appropriately, and attached using pressure contacts and solders. These are extremely affordable and have a high capacitance per unit volume. The disks are lacquered or encapsulated in plastic or Phenolic molding. Round disk are used at high voltages the capacitance of values upto 0.01F can be obtained. They have tolerance of +20% or –20%. In general these capacitors have voltage ratings up to 750 V D.C.

- **ELECTROLYTIC CAPACITORS :**



The name of these capacitors refers to the electrolyte that is employed as a medium to produce high dielectric constants. These capacitors are inexpensive despite having high capacitances and low operating voltages.

There are two types of Electrolytic capacitors:

- ❖ Aluminum Electrolytic capacitors.
- ❖ Tantalum electrolytic capacitors

In circuits that combine D.C, electrolytic capacitors are used. volts and amps. C. The D.C. voltage maintains the polarity . They are used as ‘ripple filter ‘ where large capacitance are required at low cost in small space . They are also used as ‘biased capacitors ‘ and ‘decoupling capacitors ‘ and even as ‘coupling capacitors ‘ in R- C amplifier.

➢ COLOR CODING :

Capacitance values are denoted by color on mica and tubular ceramic capacitors. Color coded capacitors have a value in pF as well because coding is only required for very small sizes. From black for "0" to white for "9," the colors are the same as for resistor coding. Mica capacitors use ‘six dot code system’.

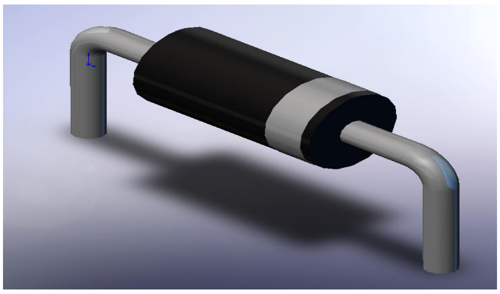
❖ SIX DOT CODE :

The top row is read in this example from left to right, and the bottom row is read from right to left.

(1) White . (2) Digit . (3) Digit. (4) Multiplier. (5) Tolerance . (6) Class.

The first .'s color, white, denotes coding. The next three .s are read to determine the capacitance value; if the first one is silver, a paper capacitor is present. The left is indicated by the white colored band, which also contains the temperature coefficient. The next three colors represent the capacitance value. Brown, Black, Brown, for instance, equals 100 pF.

- **DIODES:**

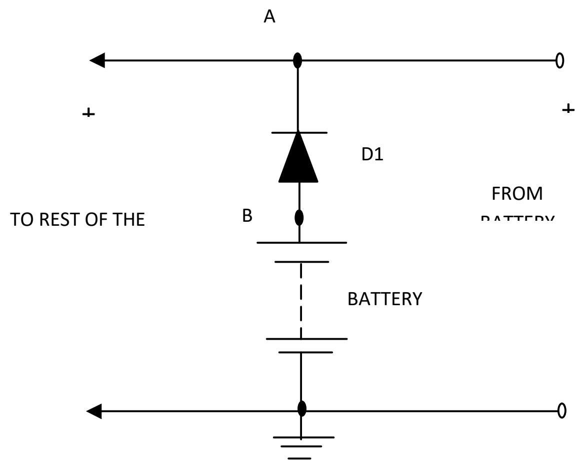


We place mechanical valves in the liquid's path to ensure that the flow is unidirectional. We can create useful machines like pumps and locomotives by properly arranging these valves in a system. A semiconductor diode, which is a type of electronic valve similar to a thermionic valve, can be used to regulate the flow of electric current in one direction. However, we only use these diodes in circuits for specific purposes like, among other things, passing EMF or converting AC to DC. When a diode is forward biased and its forward voltage drop (potential barrier) is greater than the biasing voltage, current can flow through it.

- **AUTOMATIC SWITCHOVER TO BATTERY:**

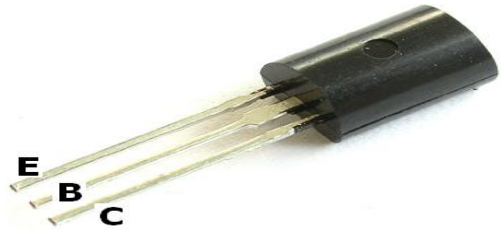
An uninterrupted power supply (UPS) is necessary for a main operated clock. This facility is very useful in transistors and two in ones for recording or listening to news programs. A relay can do this job with a battery backup. But the relay takes several milliseconds before it makes contact. Moreover, it is costly and occupies space.

The same task can be achieved with a single diode. Just connect a germanium diode DR50 (D1) as shown in fig 1.when the power is available form the eliminator or the external power source, the gadget will use the power from it. As points A and B are at same potential, the external power is remove, point B will be at higher potential that point A i.e. D1 is forward biased and current flows from the battery. In no case the voltage of the eliminator or the external power source should be less than the voltage of the battery. Otherwise, the current will flow from the battery during mains operation also and the battery will be drained quickly.



Automatic switchover to battery

- **TRANSISTOR:**



The ability to amplify weak signals by the transistor, a brand-new class of electronic device, is comparable to and frequently superior to that of vacuum tubes. Transistors operate in any position, are significantly smaller than vacuum tubes, lack filaments, and therefore require no heating power. They have a nearly infinite lifespan due to their mechanical strength and can perform some tasks more effectively than vacuum tubes.

J. Invented it in 1948. In addition to W. H. A transistor, invented by Robert Brattain of Bell Telephone Laboratories, is now the brains behind the majority of electronic devices. Despite being only a little over 45 years old, vacuum tubes are quickly being replaced by transistors in almost all applications.

By sandwiching either p-type or n-type semiconductors between two pairs of the opposing types, two pn junctions are formed, which are the building blocks of a transistor. Thus, there are only two different kinds of transistors:

- p-n-p transistor

Two n-type semiconductors are joined by a thin p-type section to form an n-p-n. A p-n-p, on the other hand, is made up of two p-sections that are divided by a thin n-type section.

- Here, we observe two p-n junctions. A transistor can therefore be conceptualized as a pair of diodes coupled back to back.
- Each type of semiconductor has three terminals.

- There is a very thin layer in the middle. This is the component that affects a transistor's performance the most.

Scientists frequently try to come up with a name for newly created devices that will adequately describe the invention. This is where the word "transistor" first appeared. The two pn junctions in a transistor. As will be discussed later, one junction has a forward bias, and the other a reverse bias. While the reverse biased junction and the forward biased junction both have low resistance paths, the forward biased junction has a high resistance path. The low resistance circuit receives the weak signal, and the high resistance circuit produces the output. To transfer a signal from a low resistance to a high resistance, a transistor is therefore used. The prefix "tans" refers to the device's ability to transfer signals, while the suffix "istor" designates it as a solid element belonging to the same general family as resistors.

- **NAMING THE TRANSISTOR TERMINALS:**

Three doped semiconductor sections make up a transistor (p-n-p or n-p-n). The emitter is located on one side, and the collector is located on the other. The base, which connects the emitter and collector at two points, is the middle portion.

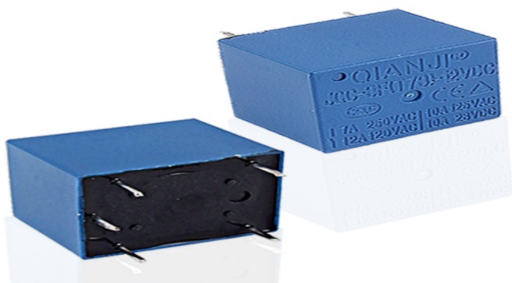
- Emitter: - Charge carriers (electrons or holes) are produced in the region on one side known as the emitter. To provide a large number of majority carriers, the emitter is always forward biased with respect to the base.
- Collector: - On the other side, where the fee is collected, is the collector. Every time the collector reverses its bias. Its job is to take charges away from the base junction where it meets.
- Base: - The pn junctions between the emitter and collector are formed in the center region, also referred to as the base. The emitter circuit may have low resistance because the base emitter junction is forward biased. Due to the base-collector junction's reverse bias, the collector circuit has high resistance.

- **CHARACTERISTICS OF TRANSISTORS**

Whenever we have to decide about the applications of a transistor certain question arises. Some of these are – how much amplification gets from it? What is the highest frequency upto which it can be used? How much power output could we get from it? And what should be the values of different components used in the circuits? The answers to these entire questions lie in the electrical properties of the transistor. These properties depend on the size, manufacturing techniques and materials used in the manufacturer of transistor and are known as characteristics. Transistor manufacturers give these characteristics in the data sheets published by them.

- Current gain factor ‘alpha’ (α)
- Current gain factor ‘beta’ (β)
- Input resistance (Rin)
- Output resistance (Rout)
- Cut-off frequency (F α and Fβ)
- Leakage current (I ‘co)

- **RELAY:**



Relays are switches that are controlled by electricity. Other operating principles are also used, but electromagnets are commonly used in relays to mechanically operate a switching mechanism. When a circuit needs to be controlled by a low-power signal (while maintaining total electrical isolation between the control and controlled circuits) or when several circuits need to be controlled by a single signal, relays are used. The first relays were employed in long-distance telegraph circuits to repeat signals from one circuit and send them again to another. For logical operations, relays were widely used in early computers and telephone exchanges.

A specific type of relay called a contactor is capable of handling the sizable power required to directly drive an electric motor. By switching electrical current through a semiconductor device, solid-state relays control power circuits devoid of moving parts. Relays with calibrated operating characteristics and, on occasion, multiple operating coils guard electrical circuits against overload or faults. in contemporary electric power systems, digital instruments still carry out these functions and are referred to as "protective relays."

➢ BASIC DESIGN AND OPERATION:

A coil of wire encircling a soft iron core, or an iron yoke, is the basic construction of an electromagnetic relay , a movable iron armature, and one or more sets of contacts (there are two in the relay shown) that serve as a low-resistance path for magnetic flux. The yoke is mechanically connected to the armature, which is hinged to it, along with one or more sets of moving contacts. The magnetic circuit is broken when the relay is de-energized because a spring holds it in place. One of the two sets of contacts on the relay is currently closed, while the other set is open. Other relays may have a greater or lesser number of contact sets depending on how they are used. In addition, a wire connects the relay's armature and yoke in the illustration. The circuit between the Moving contacts on the armature and the circuit track on the printed circuit board (PCB) is kept open through the yoke, which is soldered to the pc.

A connection between a movable contact and a fixed contact is made or broken (depending on the design) when a magnetic field created by an electric current flowing through the coil pulls the armature. If the relay's set of contacts were closed when it was de-energized, the movement opens the contacts and breaks the connection; if they were open, the reverse is true. When the current to the coil is cut off, the armature is pushed back into its relaxed position by a force that is roughly half as strong as the magnetic force. Although a spring typically provides this force, gravity is also frequently used in industrial motor starters. Relays are typically made to operate quickly. This lessens noise in low-voltage applications and arcing in high-voltage or current applications.

A diode is frequently placed across the coil when the coil is energized with direct current in order to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise produce a voltage spike risky to semiconductor circuit components. A diode may be found inside the relay case of some automotive relays. Number circuits, which combine a capacitor and a resistor in series, are another option for contact protection networks that can tame surges. If the coil is intended to be powered by alternating current (AC), a tiny copper "shading ring" can be crimped to the end of the solenoid to increase the minimum pull on the armature throughout the AC cycle.

Instead of using a solenoid to switch the controlled load, Thyristors or other solid-state switching components are used in solid-state relays, and the control signal activates them. To separate control and controlled circuits, use an optocoupler, which is an LED connected to a photo transistor.

- **DC Motor:**

One of the first devices to turn electrical power into mechanical power was the direct current (DC) motor. Two magnetic fields interact in a permanent magnet direct current (PMDC) to transform electrical energy into mechanical energy. A motor's windings and a permanent magnet assembly produce one field each, while a current running through them produces the other. The rotor usually rotates as a result of the torque these two fields produce. By commutating the current in the windings as the rotor rotates, continuous torque is produced. Permanent magnet (PM) motors are without a doubt the most popular type of DC motor, but there are other types as well (including those that create the permanent magnetic field using coils).

Direct current power sources are used to power DC motors. By varying the current flowing through the motor's coils, the magnetic field may be adjusted. "Commutation" is the term for this action. In a large number of DC motors (brush-type), mechanical brushes automatically commutate the rotor's coils as the motor turns.

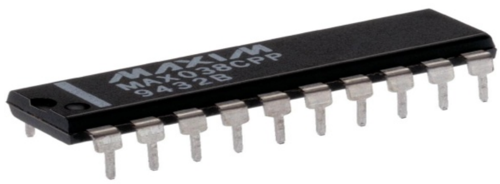
It's nothing new to manage the motor speed of a DC motor. The simplest way to regulate a DC motor's rotational speed is to alter the voltage that drives it. The motor strives to run at a higher speed the higher the voltage is. Because a straightforward voltage regulation would cause a sizable power loss on the control circuit, pulse width modulation (PWM) is used in many applications to drive DC motors. In order to control the current going to the motors, the operating power is turned on and off using the basic Pulse Width Modulation (PWM) technique. The motor's speed is determined by the ratio of "on" to "off" time.

Sometimes it's necessary to switch up the rotation's direction. By switching the polarity of the operating power (for example, by going from a negative to a positive power supply or by switching the power terminals going to the power supply), this spin can be altered in conventional permanent magnet motors. Relay or a H bridge circuit is commonly used to implement this direction change.

DC motors that lack brushes are an alternative to "brush-type" DC motors. In order to commutate the stator's stationary copper winding, brushless DC motors rely on an external power source. The constant manager rotor rotates as a result of this changing stator field. In terms of torque/vs. A brushless permanent magnet motor is the best performing motor in terms of weight or efficiency. Brushless motors are typically the most expensive type of motor. Brushless DC motor systems with electronic commutation are frequently utilised as blower and fan drives in electronic, telecommunications, and industrial equipment applications. Brush-less motors come in a variety of designs that can be used in a variety of applications. Others can have their speed changed by varying the voltage applied to them (typically the motors used in fans), while some are designed to rotate at a fixed speed (like those found in disc drives). Some brushless DC motors (including some computer fans and disc drive motors) have an integrated tachometer that emits pulses as the motor rotates.

Customers typically pick brush-type DC motors when a low system cost is desired and brushless motors to fulfill specific requirements (such as maintenance-free operation, high speeds, and explosive environments where sparking could be dangerous). Many battery-powered appliances employ brush type DC motors. Brushless DC motors are frequently used in applications like DC-driven fans and disc drive rotation motors.

- **Introduction to Integrated Circuits:**



All current digital systems rely on integrated circuits, which are constructed from a single silicon chip with hundreds of thousands of components. A chip's "scale of integration" offers a comparative measurement of the number of unique semiconductor devices that are present on it. The following phrases are frequently used.

Scale of integration	Abbreviation	Number of logic gates
Small	SSI	1 to 10
Medium	MSI	10 to 100
Large	LSI	100 to 1000
Very large	VLSI	1000 to 10,000
Super large	SLSI	10,000 to 100,000

- **Encapsulation:**

The plastic dual-in-line (DIL) type package is the most popular and one that most readers will be familiar with when it comes to encasing integrated circuits. Depending on the complexity of the integrated circuit in question and, in particular, the requirement to provide external connections to the device, these are offered with varying numbers of pinsWhile microprocessors (and their more complex support devices) frequently require 40 pins or more, conventional logic gates, for instance, are frequently supplied in 14-pin or 16-pin DIL packages.

- **Identification:**

Finding the integrated circuit devices when investigating an unfamiliar piece of equipment is one of the most frequent issues. The upper surface of each chip is coded by the manufacturers to assist us in this task. A typical example of such coding would be the type number of the chip (which might also include some generic coding), the manufacturer's name (typically in the form of prefix letters), and the device classification (typically in the form of a prefix, infix, or suffix).

- **Logic Families:**

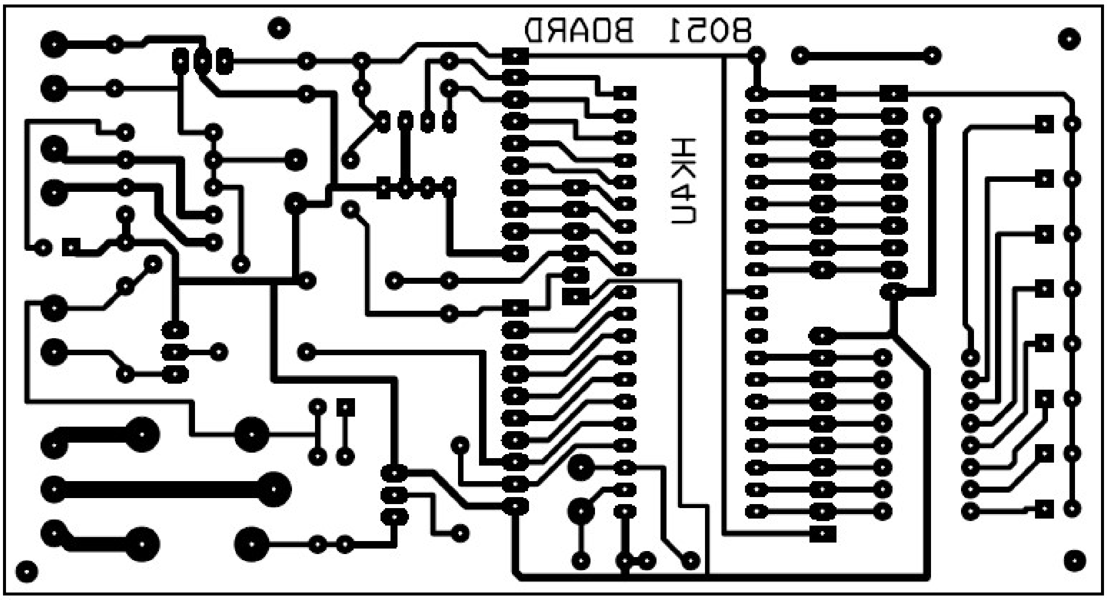
A variety of "logic families" make up the integrated circuits that make up modern digital circuitry. The term merely describes the kind of semiconductor technology used to create the integrated circuit. This technology is instrumental in determining the characteristics of a particular device. It encompasses crucial factors like supply voltage, power dissipation, switching speed, and noise immunity, which makes it quite different from its characteristics.

The two most popular logic families, at least for the more fundamental general purpose devices, are complementary metal oxide semiconductor (CMOS) and transistor transistor logic (TTL). The well-known low power Schottky (LS-TTL) variations are one of the many sub-families that make up the TTL family. The '74' series is the most widely used subset of traditional TTL logic devices. Unsurprisingly, these devices can be identified by their coding's prefix number 74. Therefore, devices coded with the digits 7400, 7408, 7432, and 74121 are all members of this family, which is also known as "Standard TTL." These devices' low power Schottky variations can be identified by the LS infix. Following that, the coding would be 74LS00, 74LS08, 74LS32, and 74LS121.

Popular CMOS devices are coded with a 4 as the first prefix and are a part of the "4000" series. Thus, the following devices are all CMOS: 4001, 4174, 4501, and 4574. The "original" (now-obsolete) unbuffered series of CMOS devices is sometimes also identified by a suffix letter: A; the improved (buffered) series is identified by a suffix letter: B. An unbuffered B-series device is one with an UB suffix.

Infix letters	Meaning
C	an equivalent TTL device's CMOS variant.
F	‘Fast’ – a high speed version of the device
H	High speed version
S	Schottky (a name derived from the configuration of the input circuit).
HC	High-speed CMOS version (with CMOS-compatible inputs).
HCT	High speed CMOS version (with TTL compatible inputs)

PCB DESIGNING:

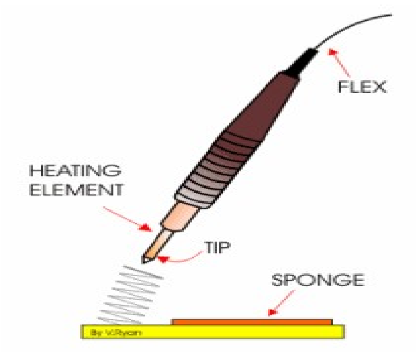


1. Create your circuit board first. Your circuit board should be designed using PCB computer-aided design (CAD) software. To help you see how the components on your circuit board would be arranged and operate in practise, you can alternatively use a perforated board with already-drilled holes in it.
2. Purchase a plain board from a retailer that has a thin layer of copper plated on one side.
3. Scrub the board to make sure the copper is clean using a scouring pad and water. Launder the board.
4. On a piece of blue transfer paper, print the pattern of your circuit board on the dull side. Verify that the design is placed properly for transfer.
5. Place the printed pattern from the circuit board on the blue transfer paper so that it is in contact with the copper.
6. Place a standard white sheet of paper on top of the blue one. Iron over the white and blue paper as directed on the transfer paper to transfer the design to the copper board. Use the iron's tip to iron each design element that appears close to a board edge or corner.

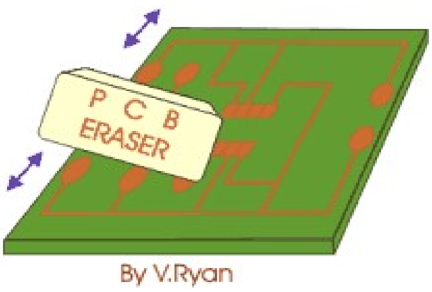
7. Allow the blue paper and board to cool. Peel the blue paper from the board slowly so you can see the transferred design.
8. Ink that did not transfer from the printed design to the copper board in black should be looked for on the transfer paper. Ensure that the design of the board is oriented properly.
9. Use the ink from a black permanent marker to fill in any toner that is missing from the board. Give the ink some time to dry.
10. Use ferric chloride to etch the board's exposed copper by removing it from the board.
11. Don old clothing, safety goggles, and gloves.
12. Put the ferric chloride in a non-corrosive container with a non-corrosive lid, and warm it in a bucket of warm water. Never heat it above 115 F (46 C) to prevent the release of dangerous gases.
13. Use just enough ferric chloride to fill a plastic tray with plastic risers and allow space for the circuit board to be affixed on top. Do this in a well-ventilated area, please.
14. Using a pair of plastic tongs, set the circuit board face down on the risers of the tray. Depending on the size of your circuit board, give the exposed copper 5 to 20 minutes to fall off the board as it etches. If necessary, stir the board and tray with the plastic tongs to enable quicker etching.
15. Use lots of flowing water to properly wash the circuit board and all the etching equipment.
16. Use high-speed steel or carbide drill bits to drill holes in your circuit board for 0.03 inch (0.8 mm) lead component spacing. To safeguard your eyes and lungs while drilling, put on safety goggles and a respirator.
17. Use a scouring pad and running water to thoroughly clean the board. Electrical parts for your board should be added and soldered in place.

SOLDERING TECHNIQUES

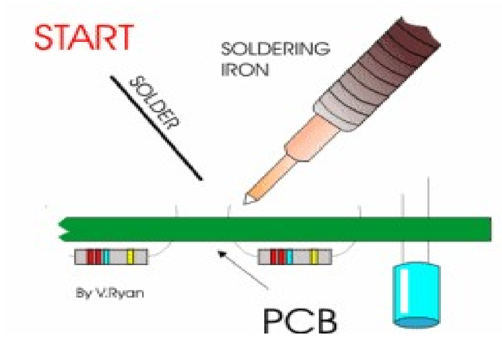
Soldering is the only permanent "fix" for joining components to a circuit. Even so, soldering requires a lot of practice because it is easy to "destroy" hours of preparation and design. If you follow the advice provided below, you will be successful.



Make use of a sturdy soldering iron. Make sure the tip is in good working order by inspecting it. It won't help you solder a good joint if it looks damaged. The tips of soldering irons can vary in shape, but they should generally be clear and unburned.



Film from the tracks is eliminated using a pc eraser. Because the film will prevent the components from being soldered to the computer properly, caution must be exercised. An optical magnifier can be used to inspect the track. Sometimes wire can be used to close gaps in the tracks, but more often than not, a new pc. needs to be etched.



The track and the component should then be brought into contact with the heated soldering iron, which should be left to heat them up. Solder can be used once they have been heated. The component, the track, and the solder should all be able to move freely. The extended legs on the components need to be cut off with wire clippers after the circuit has been soldered. At this point, testing of the circuit is ready.