A Project Report On

AUTOMATIC STREET LIGHT USING BUCK-BOOST RELAY AND SOALR PANELS

Submitted in fulfillment of the requirement For BE (EE)

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CERTIFICATE

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This is to certify that students have satisfactorily completed project work titled **"AUTOMATIC STREET LIGHTS USING BUCK-BOOST RELAY AND SOALR PANELS"**. Along with their batch mates in partial fulfillment for the final year project in Electrical Engineering. Under Mumbai University during academic year 2020 -2021.

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It is indeed a matter of great pleasure and proud privilege to be able to present this project on **"AUTOMATIC STREET LIGHT USING BUCK-BOOST REALS AND SOLAR PANELS"**. The completion of the project work is a millstone in student life and its execution is inevitable in the hands of guide. We are highly indebted the project guide Professor **SHRADDHA HULE SAWANT** for his invaluable guidance and appreciation for giving form and substance to this report. It is due to his enduring efforts, patience and enthusiasm, which has given a sense of direction and purposefulness to this project and ultimately made it a success.

We would like to tender our sincere thanks the staff members for their co-operation.

We would also like to express our deep regards and gratitude to the HOD: **RIZWAN FARADE**

PREFACE

We take an opportunity to present this project report on "AUTOMATIC STREET LIGHTS USING BUCK-BOOST RELAY AND SOLAR PANEL" and put before readers some useful information regarding our project.

We have made sincere attempts and taken every care to present this matter in precise and compact form, the language being as simple as possible.

We are sure that the information contained in this volume would certainly prove useful for better insight in the scope and dimension of this project in its true perspective.

The task of completion of the project though being difficulty was made quite simple, interesting and successful due to deep involvement and complete dedication of our group members.

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Introduction:

Did you ever think that how the street lights automatically turn ON in the night and turn OFF automatically at morning? Is there any person who comes to ON/OFF these lights? There are several ways to turn on the street lights but the following circuit describes an Automatic Street Light Controller Circuit that uses LDR and Relay to perform this job automatically.

The circuit employed here is an uncomplicated light/dark activated switch and contains a relay at its output, which simply turns ON/OFF a street light and further can be extended to control any electrical appliance in a household.

Many people have a phobia of darkness, so to assist them in such situations, we have explained a simple circuit that will automatically turn on the street light consisting of LEDs or bulb coupled with relay. It is lit well enough to see the objects nearby.

This circuit is very easy to work around and also it is battery operated. The power consumed by the circuit is very low because of the very few components used in the circuit.

The whole circuit is based on IC LM358, which is basically an operational amplifier that is configured in a voltage comparator. LDR (Light depending resistor), whose resistance is based upon the quantity of the light falling on it, is the main component for sensing the light. Along with these, a few more components are also used.

Importance of solar energy using on daily basis:

The Promise of Solar Energy:

All life on earth is supported by the sun. This amazing resource radiates energy and provides us both heat and light by fusing hydrogen into helium at its core. We call this solar radiation. Only about half of this solar radiation makes it to the Earth's surface. The rest is either absorbed or reflected by clouds and the atmosphere. Still, we receive enough power from the sun to meet the power demands of all mankind — millions of times over. Solar energy—power from the sun—is a vast, inexhaustible, and clean resource.

Sunlight, or solar energy, can be used directly for heating and lighting homes and businesses, for generating electricity, and for hot water heating, solar cooling, and a variety of other commercial and industrial uses. Most critical, given the growing concern over climate change, is the fact that solar electricity generation represents a clean alternative to electricity from fossil fuels, with no air and water pollution, no global warming pollution, no risks of electricity price spikes, and no threats to our public health.

The solar resource is enormous. According to the US Department of Energy, the amount of sunlight that strikes the earth's surface in an hour and a half is enough to handle the entire world's energy consumption for a full year. Just 18 days of sunshine on Earth contains the same amount of energy as is stored in all of the planet's reserves of coal, oil, and natural gas.

And, once a system is in place to harness the solar resource and convert it into useful energy, the fuel is free.

The Growth of Solar Energy:

Since 2008, U.S. installations have grown seventeen-fold from 1.2 gigawatts (GW) to an estimated 30 GW today, enough to power the equivalent of 5.7 million average American homes. Since 2010, the average cost of solar PV panels has dropped more than 60% and the cost of a solar electric system has dropped by about 50%. Solar electricity is now considered to be economically competitive with conventional energy sources in several states, including California, Hawaii, Texas, and Minnesota.

The Basics of Solar Energy:

So, what are the basics of solar energy systems? First of all, solar energy systems vary depending on application and size. Residential systems are found on rooftops across the United States, and businesses are beginning to install solar panels to offset their energy costs. Utilities, too, are building large solar power plants to provide cleaner energy to all customers connected to the grid.

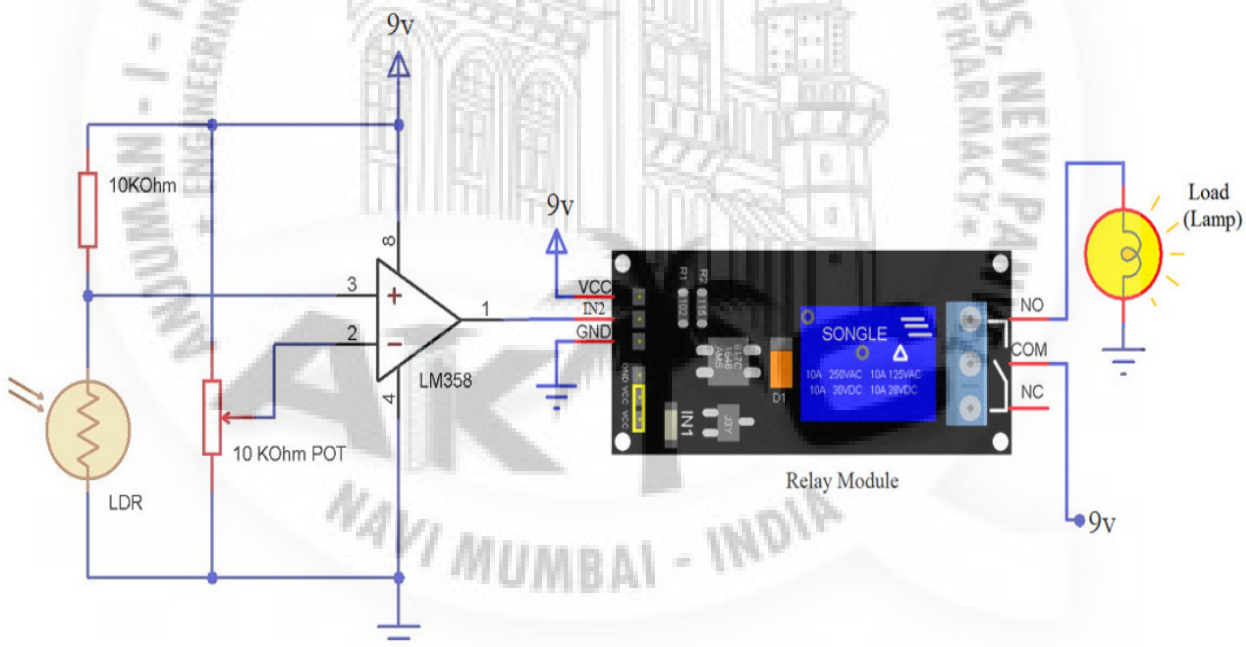
Regardless of the specifics of a given installation, there are two main types of solar energy technologies photovoltaic (PV) and concentrating solar power (CSP). Most people are familiar with PV technology because of the solar panels they see more and more on the tops of buildings or ones placed on the International Space Station.

When the sun shines onto one of those solar panels, photons from the sunlight are absorbed by the cells in the panel, which creates an electric field across the layers and causes electricity to flow. PV installations may be ground-mounted, rooftop mounted or wall mounted. They may be mounted in a permanent orientation to maximize production and value or they may be mounted on trackers that follow the sun across the sky. Rooftop PV panels make solar power viable in virtually every part of the United States. In a sunny location such as Los Angeles or Phoenix, a five-kilowatt residential system produces an average of 7,000 to 8,000 kilowatt-hours per year, roughly equivalent to the electricity usage of a typical U.S. household.

The second technology is concentrating solar power (also called concentrated solar thermal and CPS). It is used primarily in very large power plants and is not appropriate for residential use. This technology uses mirrors to reflect and concentrate sunlight onto receivers that collect solar energy and convert it to heat. The heat is used to drive a heat engine, usually a steam turbine, that is connected to an electrical power generator which is then used to produce electricity.

Our future clearly depends on our ability to utilize solar and other renewable sources of energy. Expanding technologies, tax incentives, and utility companies adapting to solar customers are all encouraging developments in the field of solar energy. Most important, however, is to remember that averaged over the entire surface of the planet, a square meter collects 4.2 kilowatt-hours of energy every day from the sun, or the approximate energy equivalent of nearly a barrel of oil per year.

Solar street lights are effective and efficient light sources in which power is fed with the help of Photo -voltaic Panels.
They are generally mounted on the lighting structure.
There is a Rechargeable battery, which is charged by photo voltaic panels.
Then the charge of that battery is used to powers a fluorescent or Led Lamp during the night.
There have sensors, through them solar panels turn on and turn off automatically by sensing outdoor light with the help of light source.
They are designed to work at night.



Circuit diagram of automatic street light control system.

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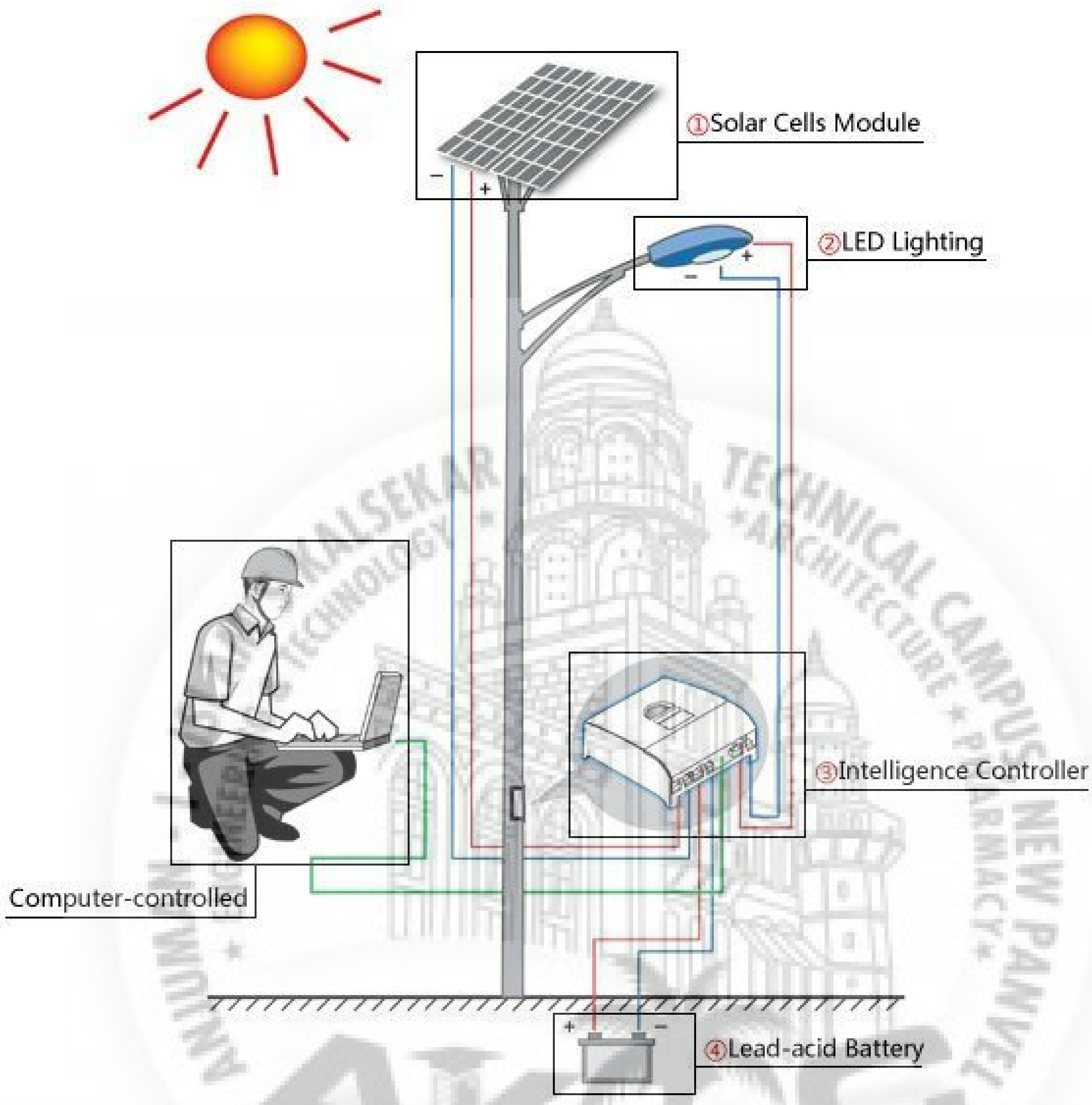


Upper diagram is automatic street lighting system.

Component used in automatic street light:

- IC LM358
- Resistor
- Potentiometer
- Relay Module
- Small LED Strip
- Battery
- LDR

Components Description:

LM358

It is an Operational Amplifier IC. It is available ib 8-pin DIP Package and can be used in several configurations like Amplifier, oscillator, comparator etc.

LDR

LDR is a device whose sensitivity depends upon the intensity of light falling on it. When the strength of the light falling on LDR increases the LDR resistance decreases, while if the strength of the light falls on LDR is decreased, its resistance increased.

In the time of darkness or when there is no light, the resistance of LDR is in the range of mega ohms, while in the presence of light or in brightness in decrease by few hundred ohms.

Testing of LDR

Before mounting any component in the circuit it is a good practice to check whether a component works properly or not so that you can avoid consumption of time in troubleshooting. For testing LDR set the range of multimeter in resistance measurement.

Measure the resistance of LDR in the light or brightness and the resistance must be low. Now, cover the LDR properly so that no light falls on it and once again measure the resistance. It must be high. If you got the satisfactory result, then your LDR is good.

Resistor

It is a passive component having two terminals that is used to manage the current flow in the circuit. A current that flows via a resistor is directly proportional to the voltage that appears across the resistor.

Resistors are of two types –

i) Fixed Resistor – having a fixed value of resistance
ii) Variable Resistor – whose value of resistance can be changed for example if we have a resistor of 5K then the value of resistance will vary from 0 to 5 k.

Value of resistance can be calculated with the help of multimeter or with the color code that is visible on the resistor.

Relay

It provides isolation between the controller and the device because as we know devices may work on AC as well as on DC but they receive signals from microcontroller which works on DC hence we require a relay to bridge the gap. The relay is extremely useful when you need to control a large amount of current or voltage with the small electrical signal.

Factors for Selecting an appropriate Relay

- The voltage and current required to strengthen the coil.
- The maximum voltage which we will acquire in the output.
- Amount of the armature.
- Amount of contacts for the armature.
- Number of electrical associates (N/O and N/C).

Working of Automatic Street Light Controller Switch Circuit:

The working of circuit is very much easy to understand. In this circuit, we used IC LM358, which is basically an operational amplifier. Pins 2 and 3 of these IC are used to compare the voltage and give us an output as high or low depending on the voltages at the input pins.

In this circuit, LDR and 10KΩ Resistor form one potential divider pair, which is used to provide a variable voltage at the non-inverting input (that is Pin 3). The second potential divider is built around inverting input (Pin 2) with the help of 10KΩ Potentiometer, which will supply half of the supply voltage to inverting pin.

As we know the property of LDR that during the day time, its resistance is low, the voltage at the non-inverting input (i.e. pin 3) is higher than the voltage at the inverting input (pin 2). Hence, the output at the pin 1 is high. As a result, the relay is OFF and the LED (or the bulb) will not glow.

But in dimness or at night time, we know that resistance of LDR is high. Hence, the voltage at non-inverting input pin 3 of the IC LM358 decreases than the inverting input pin 2. As a result, the output pin 1 moves to low state, which further makes the relay to activate and the LED or bulb associated to it will glow.

AUTOMATIC BIDIRECTIONAL POWER MANAGEMENT USING BUCK BOOST CONVERTER:

INTRODUCTION:

In recent years, shortage of petroleum is considered as one of the most critical world-wide issues, costly fuel becomes a major challenge for customers so we developed electric vehicles but the driving range is still too limited. In many remote or underdeveloped areas, direct access to an electric grid is impossible. A typical solution of this problem is renewable energies like photovoltaic inverter system would make life much simpler and more convenient. So we are proposes system to recharging with multi sources in an electric vehicle with constant voltage. That can improves battery performance and life. These electric vehicles help to keep the environment clean by reducing the amount of toxins emitted from standard exhaust systems and lower operating cost than the conventional internal combustion engine based vehicle.

Existing technologies:

Electric vehicle are operated by using batteries that are recharged through plug in from grid. In these processes, it can take lot of time to recharge the battery and also associates less power package so driving range is too limited. Then only customers are used to drive small distances, that batteries are not discharge fully. At this state, again it recharging the battery means electrons are affected in battery that causes reduce battery life and performance. There are proposed many ways to improve battery performance and life using converters, semiconducting devices, etc. Recently, research into the field of power management in battery has continued to receive much attention in academia.

a) A power converter for battery used in the Plug-in Hybrid Electric Vehicle is proposed, which could charge and discharge the battery effectively. The system is composed of two parts: a three phase full bridge PWM rectifier and a DC/DC converter. The PWM rectifier is utilized to rectify the three phase AC to DC voltage, which should be higher than the battery terminal voltage. The DC/DC converter is constructed by a buck-boost circuit, which is a buck circuit under charge mode and a boost circuit under discharge mode. The direct current control (DCC) algorithm is responsible for rectifying the AC output and diminishing the total harmonics distortion. The proportional-integral controller and bang- bang controller is to control the charging current and voltage.

b) The design and performance of a 6-kW, full-bridge, bidirectional isolated dc-dc converter using a 20-kHz transformer for a 53.2-V, 2-kWh lithium-ion (Li-ion) battery energy storage system. The dc voltage at the high-voltage side is controlled from 305 to 355 V as the battery voltage at the lowvoltage side varies from 50 to 59 V. The maximal efficiency of the dc-dc converter is measured to be 96.0% during battery charging, and 96.9% during battery discharging. Moreover, this paper analyzes the effect of unavoidable dc-bias currents on the magnetic-flux saturation of the transformer. Finally, it provides the dc-dc converter loss breakdown with more focus on the low- voltage-side converter.

c) The hybrid electric vehicle has come to the forefront as the leader for alternative fuel vehicles. With the increased demand for HEVs, more research has gone into the improvements of these vehicles. In order to achieve better performance in terms of miles per gallon, speed, and power, researchers have focused on many elements of the vehicle and how these elements affect the overall vehicle performance. One such element that has been a highly discussed topic has been the battery systems. Current battery technology has been a limiting factor when it comes to some aspects of the overall performance of the vehicle.

d) A new battery/ultra-capacitor hybrid energy storage system is proposed for electric drive vehicles including electric, hybrid electric and plug-in hybrid electric vehicles. Compared to the conventional hybrid energy storage system design, which uses a larger DC/DC converter to interface between the ultracapacitor and the battery/DC link to satisfy the real time peak power demands, these design uses a much smaller DC/DC converter working as a controlled energy pump to maintain the voltage of the ultra-capacitor at a value higher than the battery voltage for the most city driving conditions. The battery will only provide power directly when the ultra-capacitor voltage drops below the battery voltage. Therefore, a relatively constant load profile is created for the battery.

e) A single-phase bidirectional AC-DC converter and bidirectional DC-DC converter is proposed to transfer electrical power from the grid to an electrical vehicle (EV) and from an EV to the grid while keeping improved power factor of the grid. In first stage, a 230 V 50 Hz AC supply is converted in to 380V dc using a single-phase bidirectional AC-DC converter and in the second stage, a bidirectional buck–boost dc-dc converter is used to charge and discharge the battery of the PHEV (Plug-in Hybrid Electric Vehicle). In discharging mode, it delivers energy back to the grid at 230V, 50 Hz. A battery with the charging power of 1.2 kW at 120V is used in PHEV. The buckboost DC-DC converter is used in buck mode to charge and in a boost mode to discharge the battery. A proportional-integral (PI) controller is used to control the charging current and voltage.

B. Proposed system:

In the proposed system consists of two main components, one is positive buck boost converter (i.e. DC to DC converter) and another one is PIC16F877A. Converter is used to managing the input sources from renewable energies or grid, then controller is used to monitoring the system and displaying the status for user reference. This system overcomes the drawbacks of previous system like battery efficiency and life, driving range, recharging battery, etc. this method greatly simplifies the recharging system in electric vehicle. The proposed system will be presented and verified in detail in this paper

II. SYSTEM ARCHITECTURE:

This section describes the conceptual design of a flexible and low cost electric vehicle infrastructure is follows below

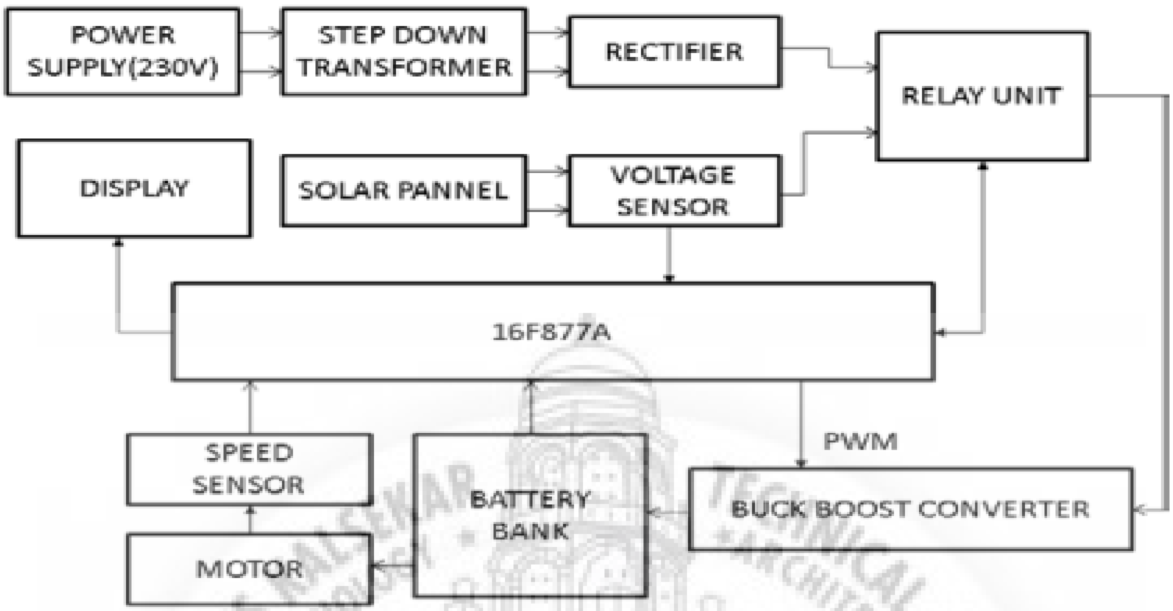


Figure 1. Power Management Block Diagram

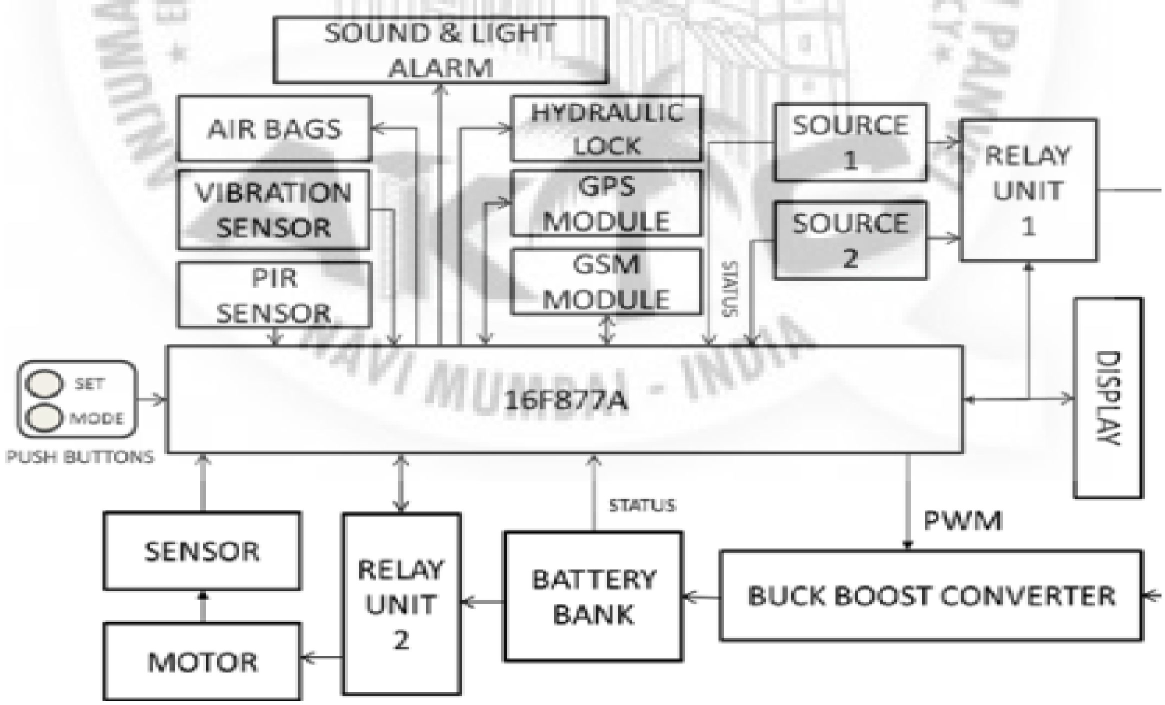


Figure 2. Monitoring System Block Diagram

Fig. 1 and Fig. 2 describes the process of the electric vehicle power management and monitoring system. The detailed description of the proposed system is as follows:

• Normally electric vehicle are operated by using battery (i.e. lithium ion battery). In a proposed system, that is recharged in frequent manner by using grid and also from solar energy. These are operated as like previous method electric vehicle.

• Both input source are interfaced into the relay, that relay unit is controlled by controller.

• Then relay unit is connected into converter, because the outputs of photovoltaic systems are varied if the battery is directly recharged means that causes reduce battery life.

• Converter is used to produce constant output voltages that will help to improve battery performance. The output of the buck boost converter is the input of battery bank.

• Each device in the block diagram is connected to the controller, because the controller is used to monitoring the process of system and displaying the status of the system through display (i.e. like liquid crystal display).

• In Fig. 2 consist of air bag, PIR sensor, GPS module, GSM module, etc.

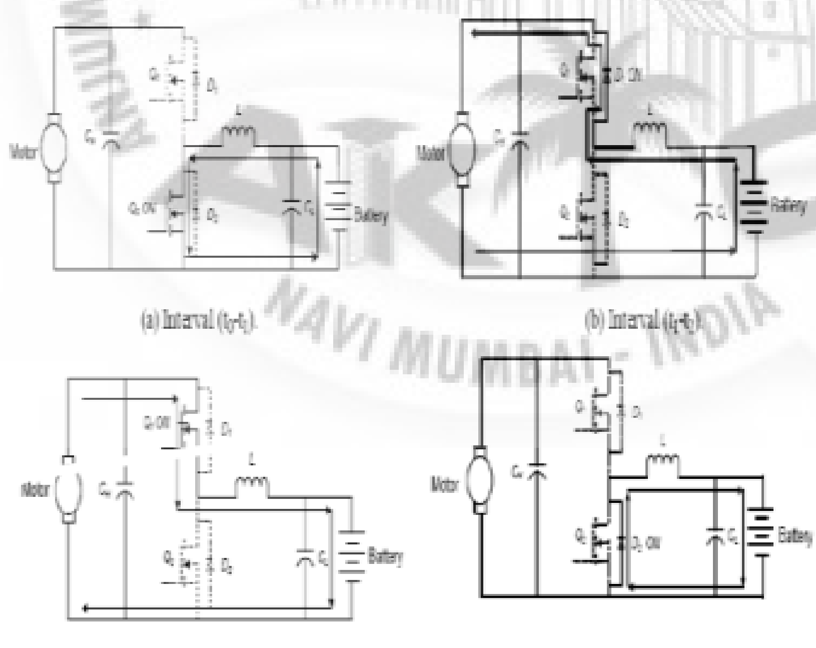
• The user gives inputs through mobile to module.

• Then it should response as per the input conditions.

• So these systems prevents from theft also.

CIRCUIT DESCRIPTION 2.1 Converter operation:

The bidirectional dc-dc converter shown in Figure1 is operated in continuous conduction mode for forward motoring and regenerative braking of the dc motor. The MOSFETs Q1 and Q2 are switched in such a way that the converter operates in steady state with four sub intervals namely interval 1(t0-t1), interval 2(t1-t2), interval 3(t2-t3) and interval 4(t3-t4). It should be noted that the low voltage battery side voltage is taken as V1 and high voltage load side is taken as V2. The gate drives of switches Q1 and Q2 are shown in Figure 3. The circuit operations in steady state for different intervals are elaborated below.



(a) Interval (t_0-t_1). (b) Interval (t_1-t_2).

(c) Interval (t_2-t_3). (d) Interval (t_3-t_4).

Converter operating modes.

Interval 1(t0-t1): At time t0, the lower switch Q2 is turned ON and the upper switch Q1 is turned OFF with diode D1, D2 reverse biased as shown in Figure 2(a). During this time interval the converter operates in boost mode and the inductor is charged and current through the inductor increases.

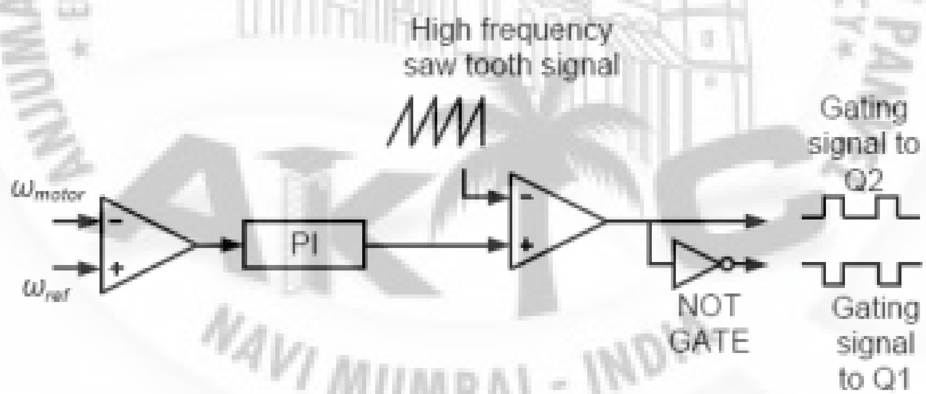
Interval 2(t1-t2): During this interval both switches Q1 and Q2 is turned OFF. The body diode D1 of upper switch Q1 starts conducting as shown in Figure 2(b). The converter output voltage is applied across the motor. As this converter operates in boost mode is capable of increasing the battery voltage to run the motor in forward direction.

Interval 3(t2-t3): At time t3, the upper switch Q1 is turned ON and the lower switch Q2 is turned OFF with diode D1, D2 reverse biased as shown in Figure 2(c). During this time interval the converter operates in buck mode.

Interval 4(t3-t4): During this interval both switches Q1 and Q2 is turned OFF. The body diode D2 of lower switch Q2 starts conducting as shown in Figure 2(d). 2.2 Converter design: The bi-directional converter is designed based on the input supply voltage and output voltage requirement to drive the electric vehicle at desired speed. The converter power topology is based on a half bridge circuit to control the dc motor.

CONTROL STRATEGY:

The control circuit of the bidirectional converter is shown in Figure 4.To control the speed of the dc drive; one possible control option is to control the output voltage of the bidirectional converter. To control the output voltage of the bidirectional converter for driving the vehicle at desired speed and to provide fast response without oscillations to rapid speed changes a PI controller is used and it shows satisfactory result. In this control technique the motor speed ωm is sensed and compared with a reference speed ωref. The error signal is processed through the PI controller. The signal thus obtained is compared with a high frequency saw tooth signal equal to switching frequency to generate pulse width modulated (PWM) control signals.



Control of the bidirectional dc-dc converter.

Battery requirement for automotive application:

Mainly Nickel-Metal hydride (NiMH) and Lithiumion batteries are used in vehicular application due to their characteristics in terms of high energy density, compact size and reliability. The battery is being recharged by the regenerative capabilities of the electric motors which are providing resistance during braking helping to slow down the vehicle. The lithium-ion battery has been proven to have excellent performance in portable electronics and medical devices .The lithium-ion battery has high energy density, has good high temperature performance, and is recyclable. The promising aspects of the Li-ion batteries include low memory effect, high specific power of 300 W/kg, high specific energy of 100 Wh/kg, and long battery life of 1000 cycles. These excellent characteristics give the lithium-ion battery a high possibility of replacing NiMH as next-generation batteries for vehicles.

SIMULATION RESULTS:

Performance of the dc motor drive with the above battery model and bidirectional converter is simulated under different speed command. The simulations are carried out using MATLAB/SIMULINK. The inductor parasitic resistance and MOSFET turn-on resistance are not considered in this case. For the test condition of the proposed drive topology the following values of the different components of the converter are considered. A separately excited DC motor model is used as load to the bidirectional dc-dc converter. The motor rated at 5 hp, 240 V, and 1750 rpm. Principal parameters of the bidirectional converter are: L = 1600 μH, CH=470 μF, CL = 470 μF, fSW =20 kHz Battery voltage=48 V. Battery capacity=16 Ah, SOC=88%.

CONCLUSION:

In this work we demonstrate the performance of a battery operated electric vehicle system and it shows satisfactory performance at different driving condition. The proposed control technique with PI controller find suitable for this electric drive. The overall cost and volume of the battery operated electric vehicle is less with the least number of components used in the system.

About Buck-Boost Transformer:

Sometimes used as push-pull transformers, are a type of transformer that is used to supply power to electrical equipment in cases when the voltage requirements of that equipment are different from the available line or supply voltage. The need to raise the supply voltage might result from a drop in line voltage due to equipment demand on the power distribution system, or from line losses. Should the supply voltage to equipment be unstable, the performance of that equipment may be impacted, causing it to not operate at peak efficiency, or in extreme cases, premature equipment failure may result. For example, a motor that is operated at a level of voltage which is significantly below its rated value may run constantly on its starter windings, resulting in overheating and possible burnout.

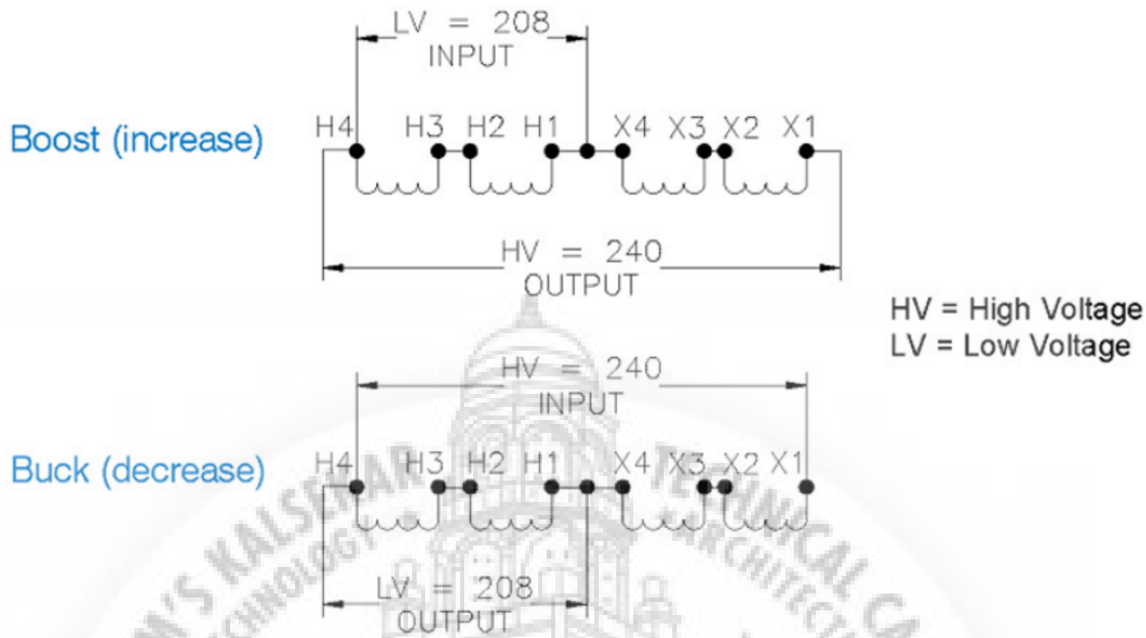
The 2008 National Electric Code (NEC) Handbook Section 210.9 defines a buck-boost transformer as one that provides a means of raising (boosting) or lowering (bucking) a supply line voltage by a small amount (usually no more than 20 percent). While standard transformers alter the input voltage to a value of output voltage that may be substantially different from the input, buck-boost transformers are designed to make more modest changes to voltage levels, usually less than +/- 30 percent.

Buck-boost transformers consist of two primary windings and two secondary windings. In standard transformer designs, the primary and secondary windings are typically isolated from each other electrically, meaning that they are only coupled magnetically through mutual induction. With buck-boost transformers, however, the design configuration is altered to one in which the windings are connected to allow the input or supply-side voltage to be altered as needed to suit the specific application. Using this approach, the output voltage of the transformer can be a value that has been bucked (lowered) or boosted (raised) from that of the supply voltage.

For the operation of equipment that is running on single-phase AC power, one buck-boost transformer may be used. Several units are needed to adjust the input voltage for three-phase AC powered equipment, depending on the type of three-phase connection employed, open delta or wye. Four-wire wye configurations will require three buck-boost transformers; 3-wire wye configurations will need two buck-boost transformers.

Single phase Buck-Boost transformer connection diagram:

Below figure shows an example of an electrical connection diagram that illustrates the connection configuration for single-phase power to boost and buck a supply voltage. To obtain a boost in output over the supply voltage, the input voltage is applied across two of the four windings and the output is drawn from terminals that are across all four windings. The opposite is done when the goal is to buck a supply voltage down to a lower voltage output.



Buck-boost transformers are built as isolation transformers, meaning they have separate primary and secondary coils. Once the unit is ready to be installed on-site, the installation team or end-user can connect the primary to the secondary to change the device's electrical characteristics. By wiring together the primary and secondary windings, the buck-boost transformer functions as a single-winding autotransformer. Using additive and subtractive polarity, small changes to voltage can be achieved in an electrical distribution circuit. Manufacturers provide specific connection diagrams applicable to their different transformer models to achieve the desired output voltage buck or boost. The use of four windings in buck-boost transformers permits the device to be wired in eight different ways or configurations, making buck-boost transformers flexible enough to meet a variety of application conditions.

Buck-Boost transformer application:

Common uses of buck-boost transformers are as follows:

- to boost 110 VAC to 120 VAC
- to boost 240 VAC to 277 VAC for lighting applications
- to provide low voltage outputs of 12, 16, 24, 32, or 48 VAC from a high voltage input

Buck-boost transformers are used in applications such as powering:

- Air conditioners
- AC motors
- Pumps
- Tanning beds
- Control circuits
- Industrial lighting systems
- Telecommunications applications
- Uninterruptable Power Supply (UPS) for computer systems

Buck-boost transformers are generally highly efficient, have a smaller footprint, are lighter, weigh less, and are less expensive than other transformer solutions such as a distribution transformer. A few of the limitations of these devices are that they do not offer circuit isolation, they cannot provide a neutral, and they cannot be used with a closed delta three-phase wiring configuration, It should be noted as well that buck-boost transformers do not provide any voltage stabilization, so if the supply side voltage fluctuates, the output voltage will change by the same percentage.

Key specification to select Buck-Boost transformer:

Buck-boost transformers are available in many standard catalog items with defined low and high voltage levels and kVA ratings. Manufacturers and suppliers provide selection charts that can be used to choose an appropriate buck-boost transformer to suit specific application needs and conditions. The general process for the selection of a buck-boost transformer begins with defining the application conditions. This includes specifying the following parameters:

- The system phase – single or three-phase operation, which must be the same for the load as for the supply.
- The system frequency – the frequency of the operating load which must be the same as that of the supply or line, e.g. 50 Hz, 60 Hz.
- The line or supply voltage – the measured value of supply voltage which is desired to be bucked (decrease) or boosted (increased)
- The load voltage – the voltage level that the equipment being powered is designed to operate.
- The electrical configuration - delta or wye.
- The load kVA, load current, or horsepower – only one of these values is needed and can usually be found on the nameplate of the equipment being operated.

Buck-boost transformers typically consist of series-multiple windings, meaning that there are two similar coils in each of the windings that can be connected either in series or in parallel. Units that have series-multiple windings will show their ratings in terms of two values separated by a slash (e.g. 120/240 VAC Primary, 12/24 VAC Secondary).

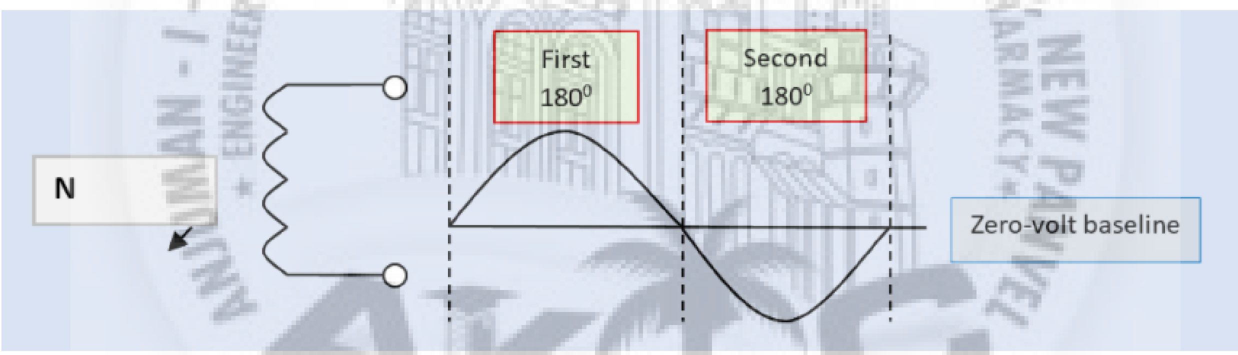
Once the use conditions are specified, the appropriate device can be selected from the manufacturer's selection chart and the reference wiring diagram can also be accessed to define the configuration and the terminal connections for the installation of the transformer.

Buck-Boost Transformer Working Principle:

A buck-boost transformer is a type of transformer which is primarily used to adjust the voltage level applied to various electric equipment. Buck-boost transformers are utilized in in several applications such as uninterruptible power supplies (UPS) units for computers.
When an existing AC electrical circuit suffers from excessive voltage drop along the length of the conductors, a conventional transformer, given the correct primary and secondary voltage ratings, can be wired as an autotransformer to boost the sagging voltage. The polarities of the two series-connected windings would have to be configured in additive polarity to add the lower secondary winding voltage to the primary-winding / line voltage.
When the AC distribution voltage within a building or other structure is of higher voltage rating than the voltage rating of a unit of electrical utilization equipment, a conventional transformer, given the correct primary and secondary voltage ratings, can be wired as an autotransformer to buck the too-high system voltage. The polarities of the two series-connected windings would have to be configured in subtractive polarity to subtract the lower secondary winding voltage from the primary winding/line voltage.

Transformer Polarities (The Dots):

To understand what is meant by transformer polarities, you must consider the voltage produced across a winding by a single-phase 2-wire AC sine waveform at some point in time. When a building or other structure electrical-power distribution circuit operates at 60-Hz AC. The voltage as indicated in figure below, changes polarity a total of 120 times per second. **Transformer polarity** involves the relationship between the different windings at the same point in time. When investigating winding polarity, it is assumed that this point in time occurs when the peak positive voltage is being produced across both windings in question.



Generation of a single-phase 2-wire AC sine waveform electrical supply from a rotating magnetic field.

On a wiring diagram (whether an electrical drawing or on the nameplate of a buck or boost transformer), it is common practice to indicate the polarity of the transformer windings by placing a **solid black dot** beside one end of each winding as shown in figure below. These dots (bullets) signify that the polarity is at the same point in time for each winding. Another way to describe winding polarity is to say the two winding-voltage waveforms are in phase. This same type of polarity notation is also used for transformers that have more than one primary or more than one secondary winding.

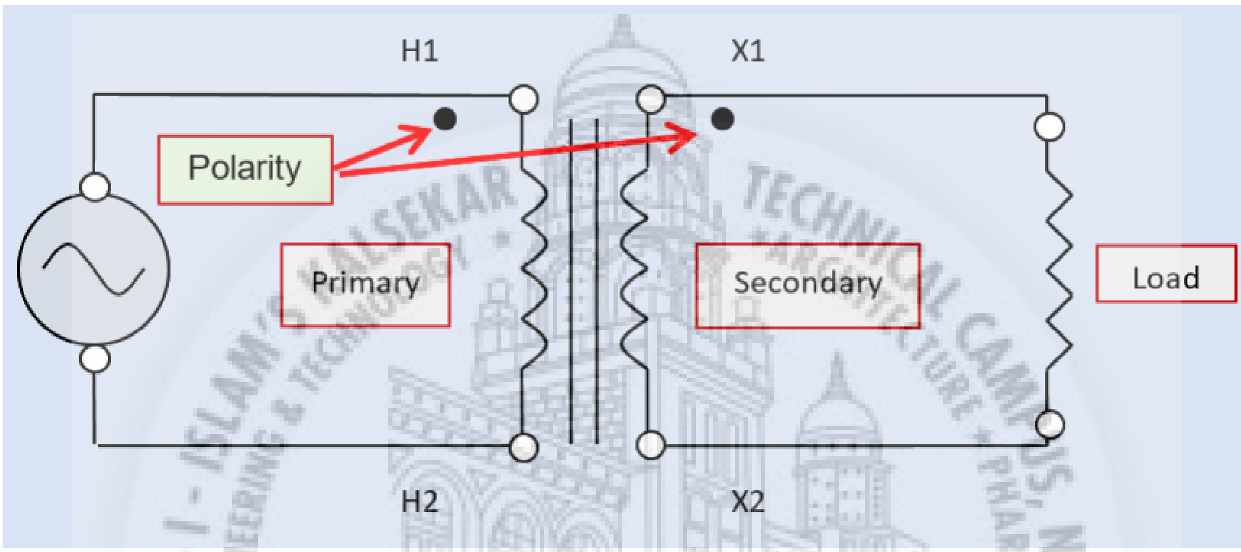


Diagram of the single-phase AC transformer circuits with dots indicating winding polarity.

The windings of a conventional (isolating) transformer can be tested for the buck or boost wiring configuration by connecting the primary and secondary windings as an autotransformer as shown in *Figure 3*, and testing for either additive or subtractive polarity.

When additive-polarity connections are used to increase a too-low circuit voltage, the circuit is normally referred to as a boost configuration, because the secondary winding voltage is added to the line or supply voltage (to “boost” the primary winding voltage).

When subtractive-polarity connections are used to decrease a too

-high circuit voltage, the circuit is normally referred to as a buck configuration, because the secondary winding voltage is subtracted from the line or supply voltage (to “buck” the primary winding voltage). Either boosting or bucking the supply voltage is accomplished by connecting one lead of the secondary winding to one lead of the primary winding and applying the voltage across both windings to the connected load.

The transformer shown in figure has a primary voltage rating of 120 volts and a secondary voltage rating of 30 volts. Notice that neither the primary nor secondary windings are lead or polarity identified and that the secondary winding has been connected in series with the connected load. The transformer now contains only one winding and is, therefore, an autotransformer.

When the 120-volt supply is applied to the primary winding, the voltmeter connected across the load will indicate either the sum of the two winding voltages (boost configuration) or the difference between the two winding voltages (buck configuration). If the voltmeter readout is 150 volts, the primary and secondary windings are connected in additive polarity (120V + 30V = 150V). If the voltmeter readout is 90 volts, the primary and secondary windings are connected in subtractive polarity (120V – 30V = 90V).

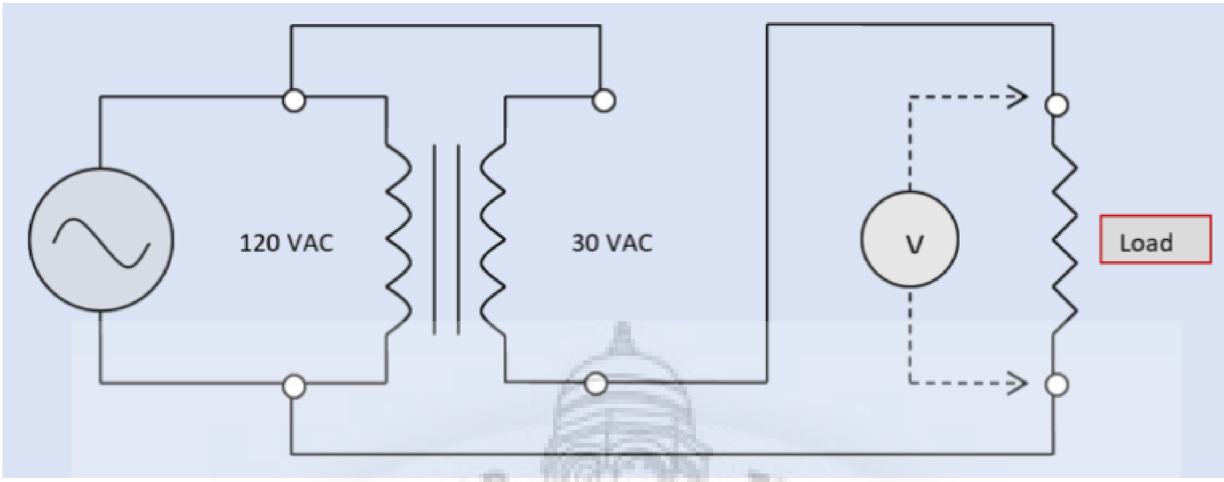


Diagram of a single-phase AC transformer connected as an autotransformer for either buck or boost configuration.

When the polarity dots are not shown on a given transformer-wiring diagram with the respective-circuit lead identification, it is normally assumed that H1 in the primary (or the higher-voltage winding for step-down configuration) and X1 in the secondary (or the lower-voltage winding for step-down configuration) are in phase (have the same transformer winding polarity). Some schematics shown the H1 and X1 lead with the accompanying polarity dots. Polarity dots are always used when the H1 and X1 leads are not of the same polarity — to show which identified winding leads are of the same polarity.

The basic boost or buck circuit of figure above is drawn expanded in figure below and *5* to show the polarity aspects of the primary and secondary windings.

Single Phase Boost Transformer:

A voltage-boost situation could arise when a 230-volt, single-phase AC induction motor is installed on a 200-volt power supply.

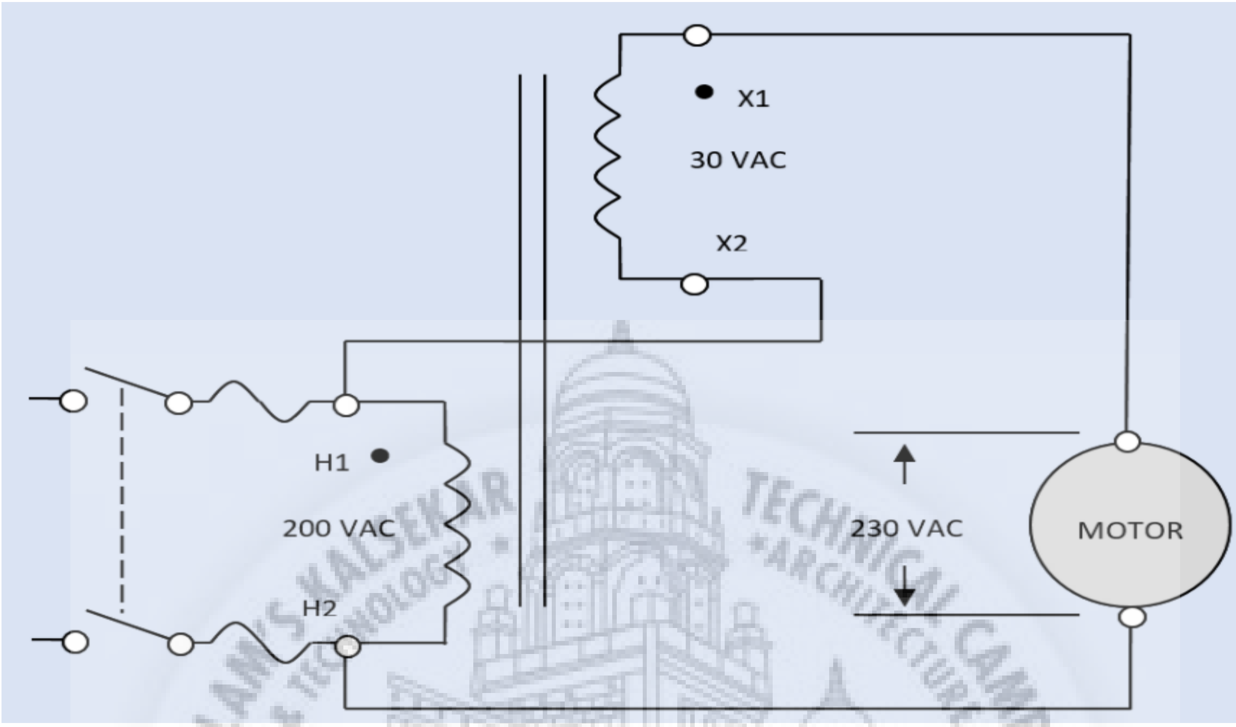
At the lower-voltage rating, the motor would overheat, even under light-loading conditions.

As shown in figure above an isolation transformer with a 200-volt primary and a 30-volt secondary can be wired to deliver 230 volts to the motor. The boost operation occurs when the 30-volt secondary winding is wired in additive polarity with the 200-volt primary winding.

The 30-volt secondary voltage is effectively added to the 200-volt primary voltage. The motor load receives 230 volts.
Another typical application of this boost configuration is to correct for voltage drop on a distant motor load, such as a rural well pump, where both the circuit supply and the motor are rated at 230 volts, but the circuit conductors were not sized correctly to compensate for the voltage drop on initial installation, and replacement of the circuit conductors is cost prohibitive. The circuit current in this boost application will increase the existing load current drawn from the branch-circuit supply.

The increase in the supply-circuit load current will equal the current drawn by the primary winding of the transformer. The boost operation of the transformer will convert the current in the primary winding operating at the lower supply-line voltage, to the secondary winding voltage that will add to the lower supply-line voltage at the original motor-load current value in the secondary circuit.

If the full-load current rating of the AC electric motor in figure below is 8 amps, this 8 amps flows through the 30-volt winding of the transformer which is in series with the motor.



An isolation transformer can be wired as an autotransformer in a boost configuration.

Projected into the primary winding circuit by the inverse of the voltage ratio:

(30 volts ÷ 200 volts) × 8 amps = 1.2 amps

The primary winding full-load current, to provide an increase in the secondary circuit of 30 volts, requires 1.2 amps. From the branch -circuit supply, the two currents add:

8 amps + 1.2 amps = 9.2 amps

Both the AC electric motor and the transformer are allowed to operate in a 125% overload condition:

125% of 9.2 amps = 11.5 amps

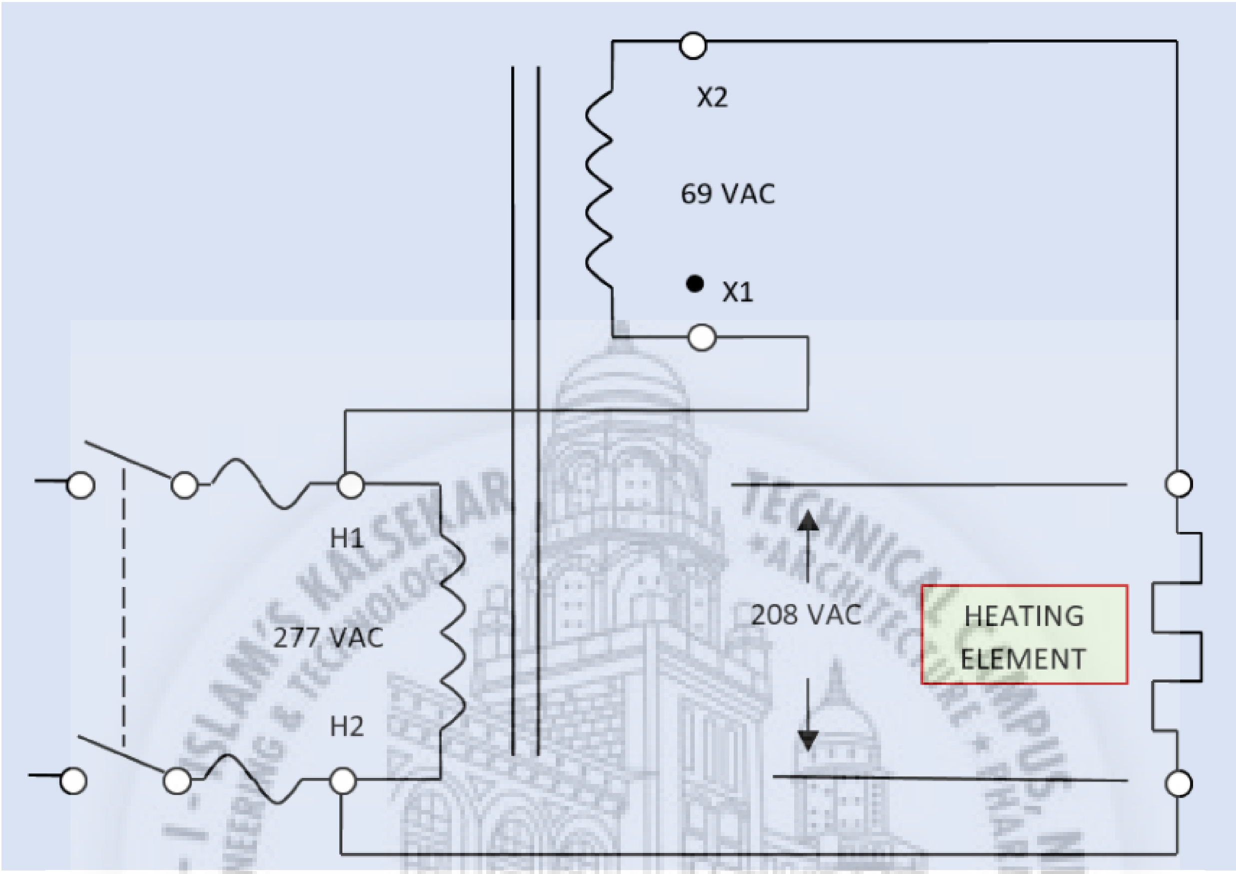
Using the next higher standard size, the boost transformer and the motor circuit would both be protected by a fuse or circuit breaker rated at 15 amps. The transformer's minimum power rating would be based on the motor's full-load current rating and the secondary voltage rating of 30 volts:

30 volts × 8 amps = 240 volt-amps

In figure above, the secondary winding has been connected in series with the connected load with secondary (or lower-voltage) lead X2 connected to one side of the transformer/load power supply and the primary (or higher-voltage) lead H1. Leads H1 and X1 are polarity dotted, indicating these two points in the transformer circuit are in phase. The H1 – X2 connection is a dot – to – no-dot connection, which should yield additive polarity. The load voltage, indicated by the voltmeter readout, is the sum of the 200-volt branch-circuit supply / primary voltage rating and the 30-volt secondary voltage rating: 230 volts.

Single Phase Buck Transformer:

A buck situation could arise when a 208-volt, single-phase AC resistive load must be installed on a 277-volt power source (branch circuit). At the higher-voltage rating, the resistive load would overheat to the point of destruction or at least damage to the heating elements. As shown in figure below, an isolation transformer with a 277-volt primary and a 69-volt secondary can be wired in a buck configuration to deliver 208 volts to the resistive load. The buck operation occurs when the secondary winding is wired in subtractive or reverse polarity to the primary winding. The 69-volt secondary voltage is effectively subtracted from the 277-volt primary voltage. The resistive load receives 208 volts.



An isolation transformer can be wired as an autotransformer in a buck configuration.

If the resistive heating load in figure above is rated at 10 kW, the full-load current is calculated as:

[1000 (/k) x 10 kW] ÷ 208 volts = 48.1 amps

The 48.1 amp heater current will flow through the 69-volt winding that is in series with the heater assembly. Projected into the primary circuit by the inverse of the voltage ratio:

(69 volts ÷ 277 volts) × 48.1 amps = 12.0 amps

The primary full-load current, to provide a decrease in the secondary circuit of 69 volts, requires 12.0 amps. Since the secondary winding is wired in subtractive polarity (indicated by the winding jumper being interconnected between H1 and X1), the

12-amp primary is effectively subtracted from the secondary load amperage to calculate the branch-circuit supply current:

48.1 amps – 12 amps = 36.1 amps

The power ratings of the two transformer circuits are equal:

277 volts × 36.1 amps = 208 volts × 48.1 amps = 10,000 volt-amps

The circuit for both the resistive heating load and the transformer are sized at 125% of these calculated full-load current ratings. The calculated branch-circuit OCPD rating is:

125% of 36 amps = 45 amps

The calculated primary-circuit current is:

125% of 12 amps = 15 amps

The calculated secondary-circuit current, which includes both the secondary winding and the heating assembly, is:

125% of 48 amps = 60 amps

In figure above the secondary winding has been connected in series with the connected load with secondary (or lower-voltage) lead X1 connected to one side of the transformer/load power supply and the primary (or higher-voltage) lead H1. Leads H1 and X1 are polarity dotted, indicating these two points in the transformer circuit are in phase. The H1 – X1 connection is a dot-to-dot connection, which should yield subtractive polarity. The load voltage, indicated by the voltmeter readout, is the difference of the 277-volt supply/primary voltage rating and the 69-volt secondary voltage rating: 208 volts.

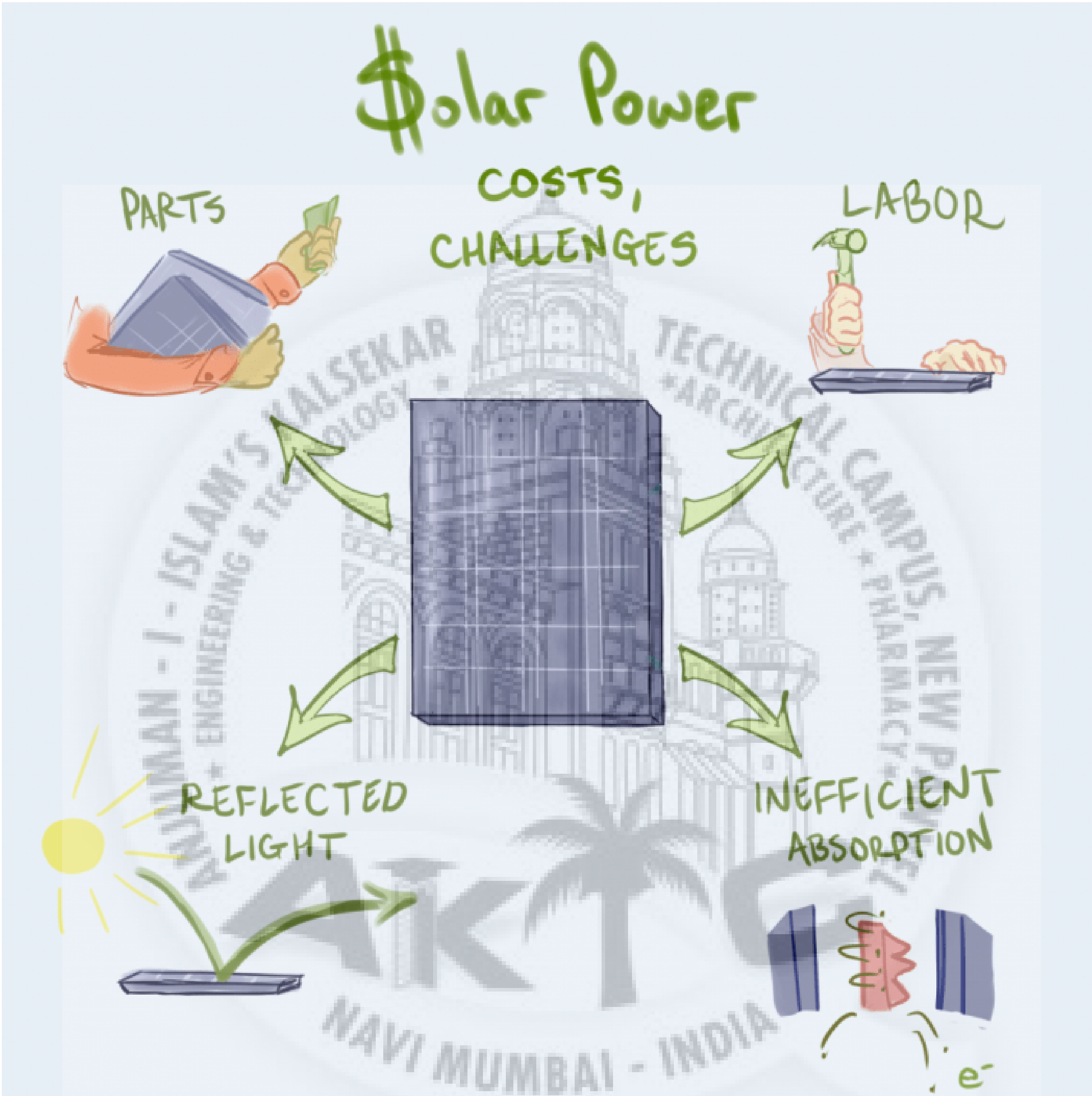
As a general rule, autotransformers cannot be used to supply individual branch or feeder circuits, unless the common lead connection is to the grounded-circuit conductor in a 2-wire branch circuit.

Future With Solar Power:

The Sun emits enough power onto Earth each second to satisfy the entire human energy demand for over two hours. Given that it is readily available and renewable, solar power is an attractive source of energy. However, as of 2018, less than two percent of the world's energy came from solar. Historically, solar energy harvesting has been expensive and relatively inefficient. Even this meager solar usage, though, is an improvement over the previous two decades, as the amount of power collected from solar energy worldwide increased over 300-fold from 2000 to 2019. New technological advances over the last twenty years have driven this increased reliance on solar by decreasing costs, and new technological developments promise to augment this solar usage by further decreasing costs and increasing solar panel efficiency.

Solar Cells:

Over the past 20 years, the costs associated with solar cells, the structures capable of converting light energy into electricity, have been steadily decreasing. The National Renewable Energy Laboratory, a US government lab that studies solar cell technology, estimates contributors to the increasing affordability of solar. They estimate that hard costs, the costs of the physical solar cell hardware, and soft costs, which include labor or costs to obtain required government permits, are about equal. Soft costs have decreased because there are more potential consumers and more installation experts for new solar cells, so companies can produce solar cells in bulk and install them easily. Hard costs are less than half of what they were in the year 2000, mostly due to decreasing material costs and an increased ability of cells to capture light. Engineering more cost-effective and efficient solar cells has required careful consideration of the physics involved in solar capture in addition to innovative design.



Solar cells become less expensive when the cost of the labor and materials use to build them go down, or when they become better at turning incoming light into electricity.

Because solar cells are used to convert light into electricity, they need to be composed of some material that's good at capturing energy from light. This material can be sandwiched between two metal plates which carry the electricity captured from light energy to where it is needed, like the lights of a home or machines of a factory.

Choosing the right material to capture light involves measuring the difference between two energy levels called the valence band and the conduction band. The lower-energy valence band is filled with many small negatively charged particles called electrons, but the higher-energy conduction band is mostly empty. When electrons are hit with particles of light, called photons, they can absorb enough energy to jump from the low-energy conduction band into the high-energy valence band.

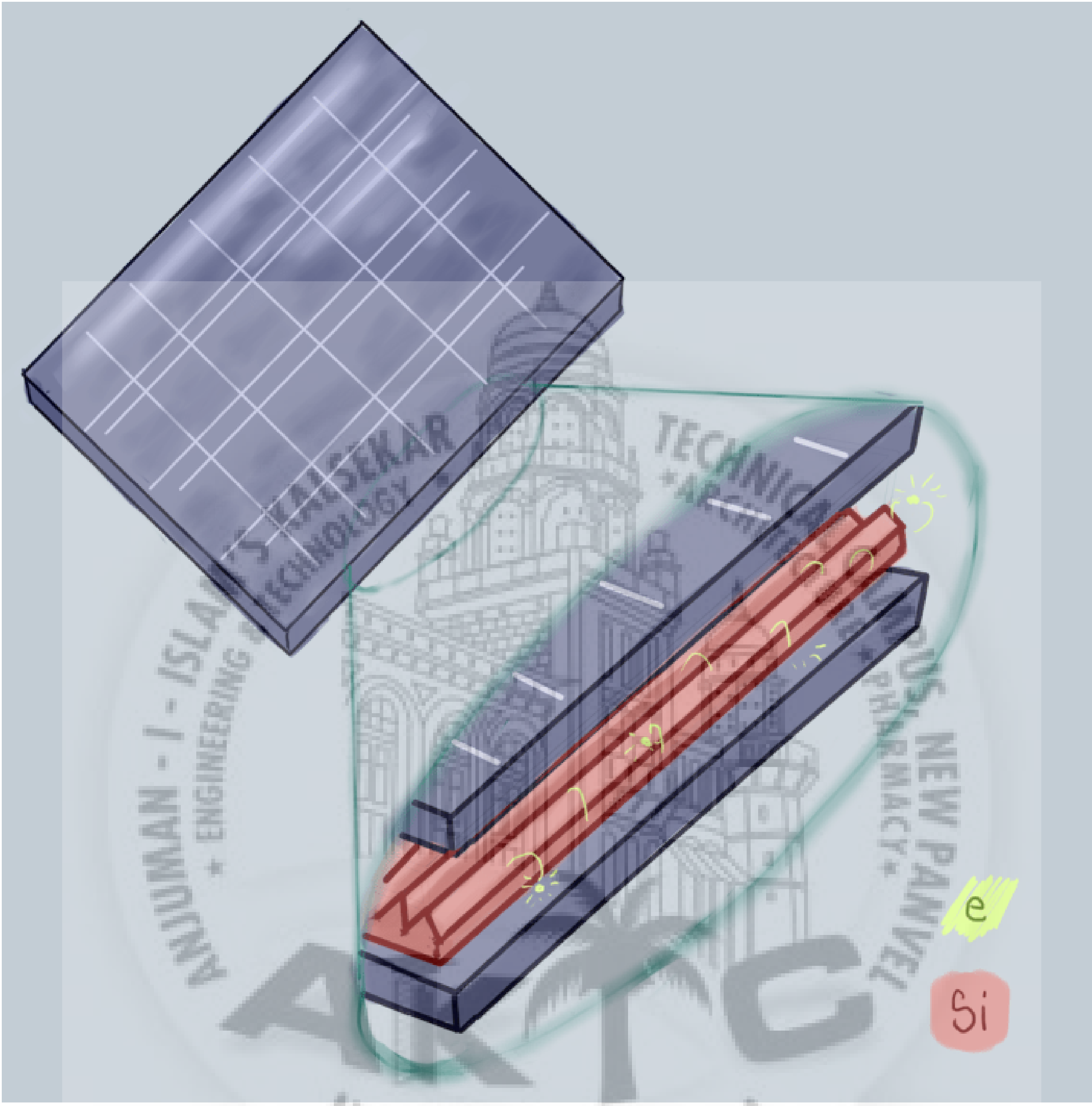
Once in the valence band, the extra energy in the electron can be harvested as electricity. It's as if the electrons are sitting at the bottom of a hill (the conduction band) and being hit by a photon that gives them the energy to leap to the top (the valance band).

The amount of energy needed for electrons to jump into the valence band depends on the type of material. Essentially, the size of the metaphorical hill varies based on the properties of a given material. The size of this energy gap matters because it impacts how efficiently solar cells convert light into electricity.

Specifically, if photons hit the electrons with less energy than the electron needs to jump from the valence band to the conduction band, none of the light's energy is captured. Alternatively, If the light has more energy than is needed to overcome that gap, then the electron captures the precise energy it needs and wastes the remainder. Both of these scenarios lead to inefficiencies in solar harvesting, making the choice of solar cell material an important one.

Historically, silicon has been the most popular material for solar cells. One reason for this popularity lies in the size of the gap between silicon's conduction and valence bands, as the energy of most light particles is very close to the energy needed by silicon's electrons to jump the energy gap. Theoretically, about 32% of light energy could be converted into electric energy with a silicon solar cell.

This may not seem like a lot, but it is significantly more efficient than most other materials. Additionally, silicon is also inexpensive. It is one of the most abundant elements on earth, and the cost of refining it has decreased dramatically since 1980. The solar cell and electronics industries have driven the decrease in purification cost as they have learned better bulk purification techniques to drive the demand of solar cells and consumer electronics.



When light hits a solar cell, it causes it causes electrons to jump into a conduction band, allowing the light energy to be harvested. Here yellow electrons (labeled e) move through the silicon atoms (labeled Si) in the solar cell when hit by a photon.

In addition to decreasing material costs, clever engineering tricks are pushing the efficiency of silicon solar cells closer to their theoretical maximum. In order for photons to be converted into energy, they must first collide with an electron. One trick to increase the likelihood of a photon/electron collision involves patterning the silicon in solar cells in microscopic pyramid shapes. When light is absorbed into a pyramid, it travels further, increasing the probability that the light will collide with the electrons in the silicon before escaping the cell.

In a similar tactic, chemists and material scientists have designed anti-reflective coatings to put on the front of solar cells to prevent useful light from being reflected back into space without ever hitting an electron in the solar cell. Likewise, putting a reflector on the back of the solar cell also allows more light to be harvested. The light that reaches the solar cell and makes it all the way through to the back without hitting an electron gets bounced to the front of the cell, giving the cell another chance of collecting the light.

Currently, the cost of silicon-based solar cells continues to decrease, and, despite predictions to the contrary, the cost of silicon itself continues to decrease. Silicon solar cells are likely to remain popular for the next few years. Alternatives to silicon solar cells have been developed but aren't far enough along to be commercially viable.

The Future of Solar Cells:

To outpace current solar cells, a new design would need to be able to capture more light, transform light energy to electricity more efficiently, and/or be less expensive to build than current designs. Energy producers and consumers are more likely to adopt solar power if the energy it produces is equally or less expensive than other, often non-renewable, forms of electricity, so any improvement to current solar cell designs must bring down overall costs to become widely used.

The first option, adding hardware that allows the solar cells to capture more light, does not actually require that we abandon current solar cell designs. Electronics can be installed with the solar cell that let the cell track the sun as it moves through the daytime sky. If the solar cell is always pointing at the sun, it will be hit by many more photons than if it was only pointing towards the sun around midday. Currently, designing electronics that can track the position of the sun accurately and consistently for several decades at a reasonable cost is an ongoing challenge, but innovation on this front continues. An alternative to making the solar cell itself move is to use mirrors to focus light on a smaller, and therefore cheaper solar cell.

Another route to improving the performance of solar cells is to target their efficiency so they are better at converting energy in sunlight to electricity. Solar cells with more than one layer of light-capturing material can capture more photons than solar cells with only a single layer. Recently, lab-tested solar cells with four layers can capture 46% of the incoming light energy that hit them. These cells are still mostly too expensive and difficult to make for commercial use, but ongoing research may one day make implementing these super-efficient cells possible.

The alternative to improving the efficiency of solar cells is simply decreasing their cost. Even though processing silicon has become cheaper over the past few decades, it still contributes significantly to the cost of solar cell installation. By using thinner solar cells, material costs decrease. These “thin-film solar cells” use a layer of material to harvest light energy that is only 2 to 8 micrometers thick, only about 1% of what is used to make a traditional solar cell. Much like cells with multiple layers, thin-film solar cells are a bit tricky to manufacture, which limits their application, but research is ongoing.

In the immediate future, silicon solar cells are likely to continue to decrease in cost and be installed in large numbers. In the United States, these cost decreases are anticipated to increase the solar power produced by at least 700% by 2050. Meanwhile, research on alternative designs for more efficient and less expensive solar cells will continue. Years from now, we are likely to see alternatives to silicon appearing on our solar farms and rooftops, helping to provide clean and renewable sources of energy. These improvements have and will continue to be made possible by increasing bulk manufacturing of solar cells and new technologies that make the cells cheaper and more efficient.

Application Of Automatic Solar Street Lighting System:

Government Units & Municipalities:

Government organizations can save large sums of money by using an automatic solar street light system for outdoor lighting. It is forecasted that we will have 359 million street lights by 2026.

Corporate & Big Businesses:
Many companies nowadays are applying green energy technologies & practices to reduce their carbon footprint. Installing automatic street light system can prove to be a step in this direction.

Great Way to Light Up Streets:
Apart from lighting up streets automatic solar street light system along with CCTV can also provide us additional security. Smart solar street lights are wireless & one of the street lighting solutions.

Along Roads & Highways:
High quality automatic street light systems can enhance night-time visibility on rural roads, main roads & highways. These are also very easy to install & are affordably priced.

Parks & Recreational Areas:
Areas which are mainly donned by children can make good use of automatic street light systems. They are safe & secure & provide uniform lighting & the right amount of luminosity to parks.

Schools & Universities:
Automatic solar street light system is an excellent choice for schools, colleges & universities. With plenty of accessible areas, ranging from bus shelters to parking lots institutions can install them throughout the campus.

Advantages of Automatic Solar Street Lights:

Since automatic street light systems feature no moving parts, they require less maintenance than conventional street lights.

The automatic solar street light system is a stand-alone arrangement & therefore requires no external wiring or having to connect with the grid.

There are lower chances of the automatic street light system overheating & risk of accidents is also minimized.

Cost of operating automatic solar street lights is far less when compared to the conventional street lights.
The automatic street light system is eco-friendly & hence helps in reducing the carbon footprint.

Smart solar street lights can be put up in remote areas even in places that are not accessible to the grid.

Disadvantages of Automatic Solar Street Lights:

The automatic street light system requires a higher initial investment in comparison to conventional street lights.

Generation of energy for solar street light entirely depends upon the climatic conditions.

Risk of theft of the automatic street light system is relatively higher since they are non-wired & are much expensive.

Rechargeable batteries of the automatic street light system are required to be replaced a few times.

Snow, dust or moisture can accumulate of PV panels which can hinder energy production.

Conclusion:

So, we concluded from our project Automatic Street Lights using Buck-Boost relay and solar panels that;

- Solar energy is one of the important and major renewable energy source of energy and has also proven it useful in functioning of applications like street lights.

- Solar powered automatic street light controller is one of the applications of electronics to increase the facilities of life. The use of new electronic theories has been put down by expertise to increase the facilities given by the existing appliance. Here the facility of ordinary street light is increased by the making it controlled automatically.

- The charge control is necessary in order to achieve safety and increase the capacity of the battery. In cities, currently thousands of street lights are operated and the yearly electricity maintenance cost is very high.

- The initial cost and maintenance can be the draw backs of this project. With the advances in technology and good resource planning the cost of the project can be cut down and also with the use of good equipment the maintenance can also be reduced in terms of periodic checks.

- It saves around 40% of electricity from per street light. So throughout the world if we use this concept then it will eliminate the energy crisis to a larger extent.

- It is eco-friendly and utilizes the renewable source of energy very well.
- The Solar Powered LED Streetlight with Auto Intensity

Control can control the electric charge and intensity of lights.

- This project can be enhanced by using with timer based products and photo sensor based products.
- We can use solar tracking system for fast charging.
- In monsoon season solar light is more difficult so that we use extra batteries in series to save more power.