A

Project Report on

"Maglev Wind Turbine"

Submitted in partial fulfillment of the requirements

of the degree of

Bachelor of Engineering In Electrical Engineering

Submitted by

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CERTIFICATE

This is to certify that the dissertation work entitled **"Maglev Wind Turbine"** is the work done by

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CERTIFICATE OF APPROVAL

The foregoing dissertation entitled “MAGLEV WIND TURBINE” is hereby approved as a creditable study of Electrical Engineering presented by

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DECLARATION

We declare that this written submission represents my ideas in my own words and where others ideas or words have been included; I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

As the world continues to grow and as cities continue to become more crowded and congested, our normal modes of transportation will not be able to handle these overpopulated areas. The answer to this transportation problem lies in the world of electro magnetism and superconducting magnets. Electromagnets and superconducting magnets have allowed us to create a magnetic levitating train nicknamed "Maglev" that floats on the track instead of being directly on it. This has a lot of potential to create trains that are super fast with low maintenance requirements. China is the first country in the world to commercially use MagLevs, and has already helped ease the congestion on the six lane highway leading from the Pudong Shanghai International Airport to Shanghai Lujiazui financial district. This new technology has already helped China in a short period of time and can certainly help other cities around the world that are just as congested as Shanghai.

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Introduction

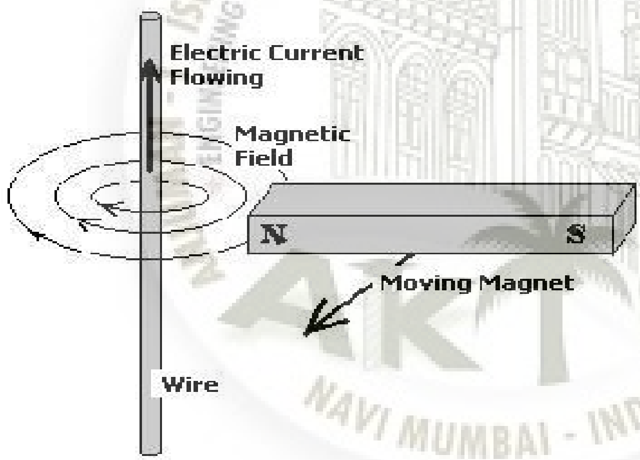
Energy is essential to our society to ensure our quality of life and to underpin all other elements of our economy. The escalation in cost and environmental concerns involving conventional electrical energy. Sources have increased interest in renewable energy sources. Many societies across the world in which we live have developed a large appetite for electrical energy. This appetite has been stimulated by the relative ease with which electricity can be generated, distributed, and utilized, and by the great variety of its applications. It is arguable whether the consumption of electricity should be allowed to grow unchecked, but the fact is that there is an ever-increasing demand for this energy form. Clearly, if this demand is to be met, then the world's electricity generating capacity will have to continue to grow. Presently almost all the electricity generation takes place at central power station which utilizes coal, oil, gas, water or fissile nuclear material as the primary fuel source. There are problem facing the further development of generating methods based on any of these ―conventional fuels‖. Hydro-power generation is restricted to geographically suitable areas, and reserves of coal, although presently plentiful, are not renewable. The possible hazards of nuclear power have been much publicized, particularly those concerning the storage and military use of nuclear waste material. Nevertheless, to assist in maintaining electrical supply in many of our societies its seems likely that an increasing nuclear power presence, involving breeder and possibly fusion reactors, will be tolerated. To achieve this and also to aid in management of the existing fossil-fuel resources, it is essential that some part and an increasing part, of future electrical energy research and development be concerned with so called —nonconventional —methods of generation Wind- solar power generations are visible options for future power generation. Besides being free, they are free of recurring costs. They also offer power supply solutions for remote areas, not accessible by grid power supply today around 30,000 wind turbines and more than 1,00,000 off-grid solar PV systems are installed all over the world. Wind and solar hybrid model with proper storage system have been keen interest for the last few years. In this paper a hybrid model of solar / wind is developed using the battery. The simulation circuit will include all realistic components of the system.

Wind Turbine Generator

A **wind turbine generator** is made up of two major components - the **turbine blades** which are spun by the wind, and an **alternator** which converts wind energy into **electricity**. While it is possible to purchase a sealed alternator unit, it is not particularly difficult to make your own alternator using **neodymium magnets** and **magnet wire**.

Generating Electricity

All **alternators** work because of the effects of moving magnets past wire. When electrons flow through a wire a magnetic field is created around it. Similarly when a magnetic field moves past a wire, electrons are *pushed* through it. Therefore, by moving magnets past a wire we make electrons move through it, thereby **generating electricity**.



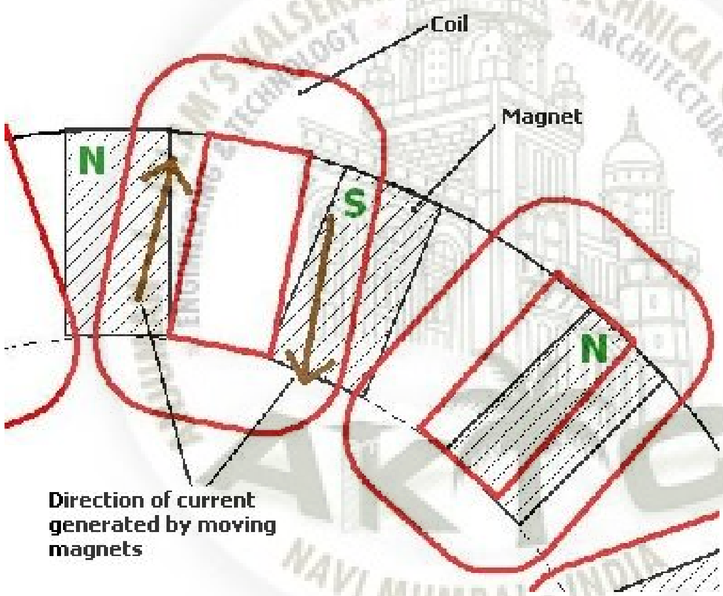
If instead of a single wire (pictured above), we have many individual wires, the same current of electricity will be generated in each wire. Since it is not practical to have lots of connected individual wires in an alternator, **coils of wire** are used instead.

Coils and Magnets

When the north pole of a magnet passes a coil, current flows in one direction around the coil. When the south pole of a magnet passes a coil, current flows in the opposite direction around the coil.

When the magnetic field is at 90 degrees to the coil windings, the most electric current is generated. When the magnetic field is parallel to the coil windings no electric current is generated.

Ideally you want each radial leg of a coil to be over a magnet at the same time - one leg over a north pole and one over a south pole - to maximum current generation.



In the diagram above you can see how electric current in the left radial leg of the coil is pushed upwards (clockwise) by the north pole of one magnet, and in the right radial leg it is pushed downwards (also clockwise) by the south pole of the next magnet.

If both radial legs were over magnets with the same polarity - i.e. both north poles, the generated currents would cancel one another out: the left side of the coil generating a current in the clockwise direction, and the right side of the coil generating a current in the anticlockwise direction resulting in no current flowing around the coil.

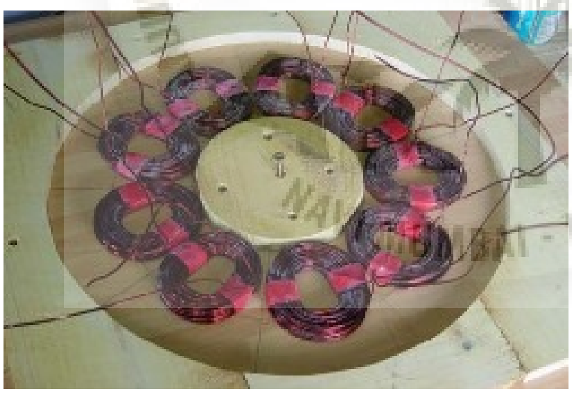
Therefore alternator **rotors** are made up of magnets with alternating polarities - **N S N S** and so on, and the coils are sized so that the distance between the two legs is equal to the distance between two side-by-side magnets.

Voltage and Current

The **voltage** and **current** generated depends on the strength of the magnets, the number of turns of wire in the coils, the distance between the coils and the magnets, and the speed of the magnets passing the coils. The polarity of the voltage - i.e. the direction the electricity flows depends on the polarity of the magnet - north or south.

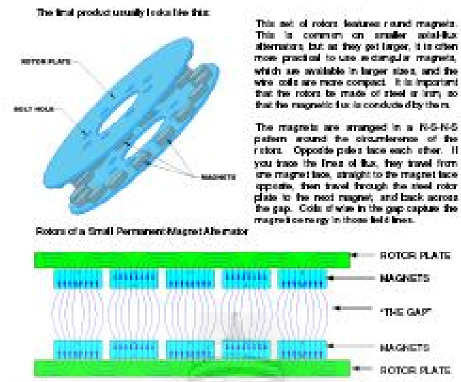
The voltage output by an *alternator* made of coils and magnets is therefore **Alterating Current** (AC), with the direction of the current changing every time the legs of the coils pass over a magnet.

Axial Flux Alternators for Wind Turbines



In our article **Wind Turbine Alternator Basics** we looked at how electricity is generated in a **wind turbine**as magnets rotate past fixed coils of copper wire.

The basic concepts behind axial flux alternator design are very simple, and it is well within the capabilities of any DIY enthusiast to put together their own alternator. To find out more we recommend you read the concise (free) guide to **axial flux alternator** basic principles linked to at the bottom of this article.



The guide covers **[neodymium magnets]** explaining clearly how **magnetic fields behave**, and how magnetic energy can be *concentrated* to maximise the electricity generation capability of an alternator.

next peak. Vibration is reduced not only by having peak currents 1/3 as intense, but also by having them 3 times more often. When rectifying the 3-phase power so that a DC battery can be charged, the current is also much smoother. The cost of extra rectifiers should not be considered an obstacle. They will last a long time if properly selected.

When the coils of wire are cast together into one plate, they are supported as a unit called a "stator" (it remains "static" while the rotor rotates). Builders usually arrange the coils in a star-shaped pattern in a flat mould. Into the mould they pour a polyester or epoxy resin. Then they close the mould, and when it has cured, the stator comes out as one big disk with the coils encapsulated inside. All of the internal electrical connections were made in advance. Either they selected one particular 3-phase connection arrangement, or they have enough wires coming out to allow some external connection changes. (See Appendix B for how it can be done)

It then looks at how coils of enamelled **magnet wire** can be positioned and connected to generate three phase AC electricity. By matching the coils (number, size, number of coils etc) to the magnets (number, size, shape), and matching the finished alternator to the **rotor** (diameter) a reliable and efficient **wind turbine generator** can be constructed.

View of the Axial Flux Alternator Guide

What is the Maglev?

Maglev (derived from magnetic levitation), is a system of transportation that suspends, guides and propels vehicles, predominantly trains, using magnetic levitation from a very large number of magnets for lift and propulsion. This method has the potential to be faster, quieter and smoother than wheeled mass transit systems. The power needed for levitation is usually not a particularly large percentage of the overall consumption; most of the power used is needed to overcome air drag, as with any other high speed train.

One such technology is Magnetic Levitation, or Maglev, which has the promise of becoming the largest development in transportation since the wheel. As a matter of fact, Maglev does away with the wheel and all the problems inherent with it (friction, noise, energy use, safety, and so forth) by using magnetism to levitate a vehicle above a track and to move it from one place to another. The greatest advantage to this is the absence of friction. Since Maglev vehicles float above tracks instead of riding on wheels, the vehicles do not come into contact with the track or roadbed; thus, they eliminate friction. Transportation systems that use Maglev have been implemented in airports for ground transportation and in major metropolitan cities for light rail systems.

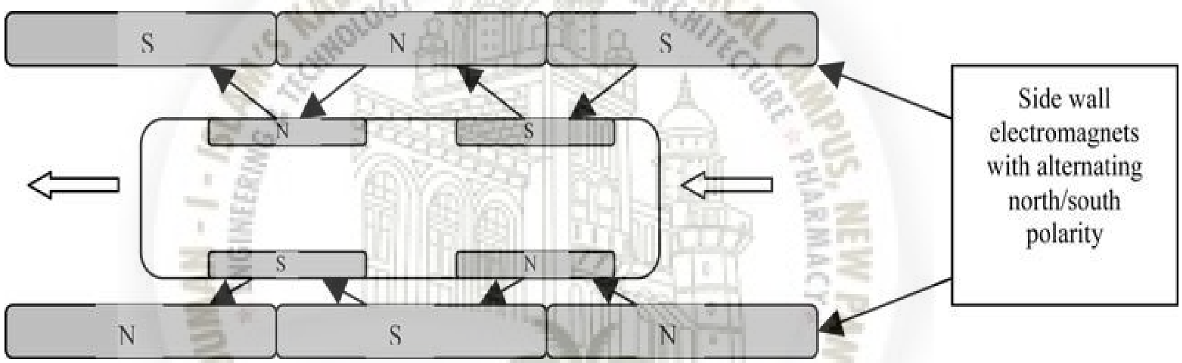
Magnetic Levitation

This phenomenon operates on the repulsion characteristics of permanent magnets. This technology has been predominantly utilized in the rail industry in the Far East to provide very fast and reliable transportation on maglev trains and with ongoing research its popularity is increasingly attaining new heights. Using a pair of permanent magnets like neodymium magnets and substantial support magnetic levitation can easily be experienced.

By placing these two magnets on top of each other with like polarities facing each other, the magnetic repulsion will be strong enough to keep both magnets at a distance away from each other. The force created as a result of this repulsion can be used for suspension purposes and is strong enough to balance the weight of an object depending on the threshold of the magnets . In this project, we expect to implement this technology for the purpose of achieving vertical orientation with our rotors as well as the axial flux generator.

Principles of Magnetic Levitation

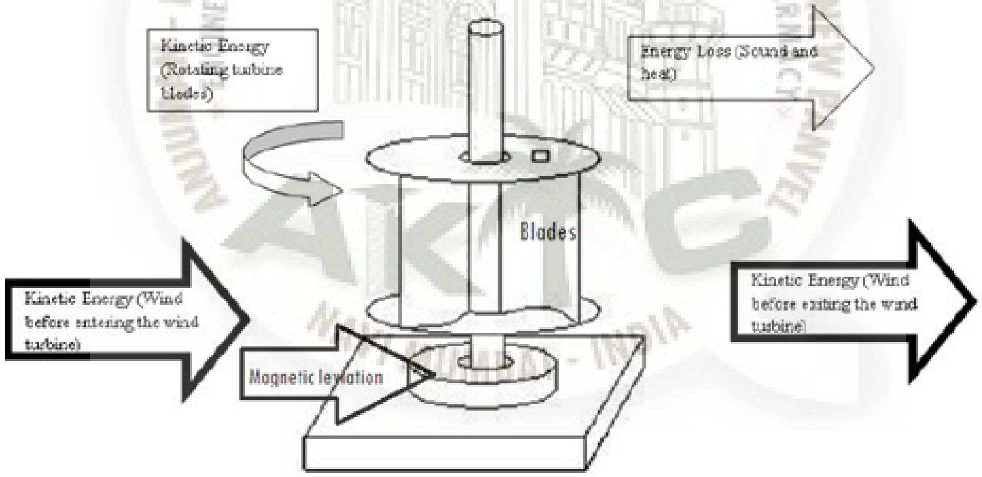
As students explore the principles of magnetic levitation, they identify how these concepts may be used in vehicle design. The role of magnets, electromagnets, and electrical current as used in Maglev propulsion help to solidify students' understanding of how the properties of attraction and repulsion result in levitation



During this process, the vehicle is placed on a track with alternating north and south polarity magnets. Electrical current passes through a coil of wire that touches the magnet, thus creating an electromagnet. Reversing the electrical current changes the polarity of each electromagnet.

Overview and working principle

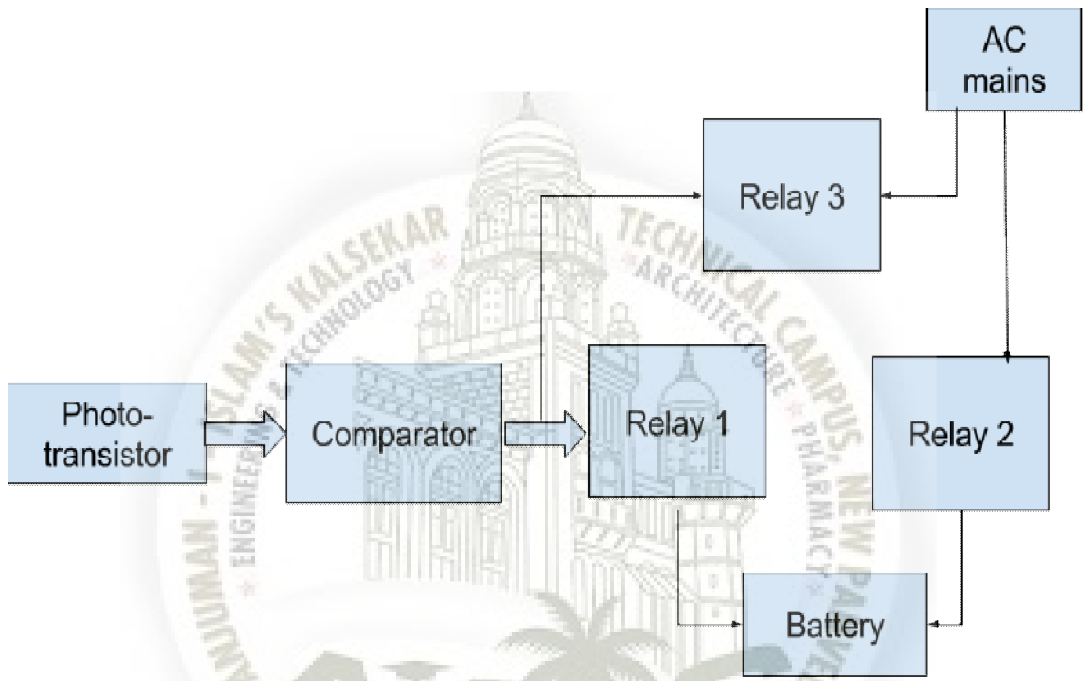
This section introduces and provides a brief description of the major components and factors that will contribute to an efficiently functioning wind turbine. These factors are wind power, the generator, magnet levitation and the DC-DC converter. Later sections will provide an in-depth look into the essence of each factor and its function and importance to the overall operation of the vertical axis wind turbine.



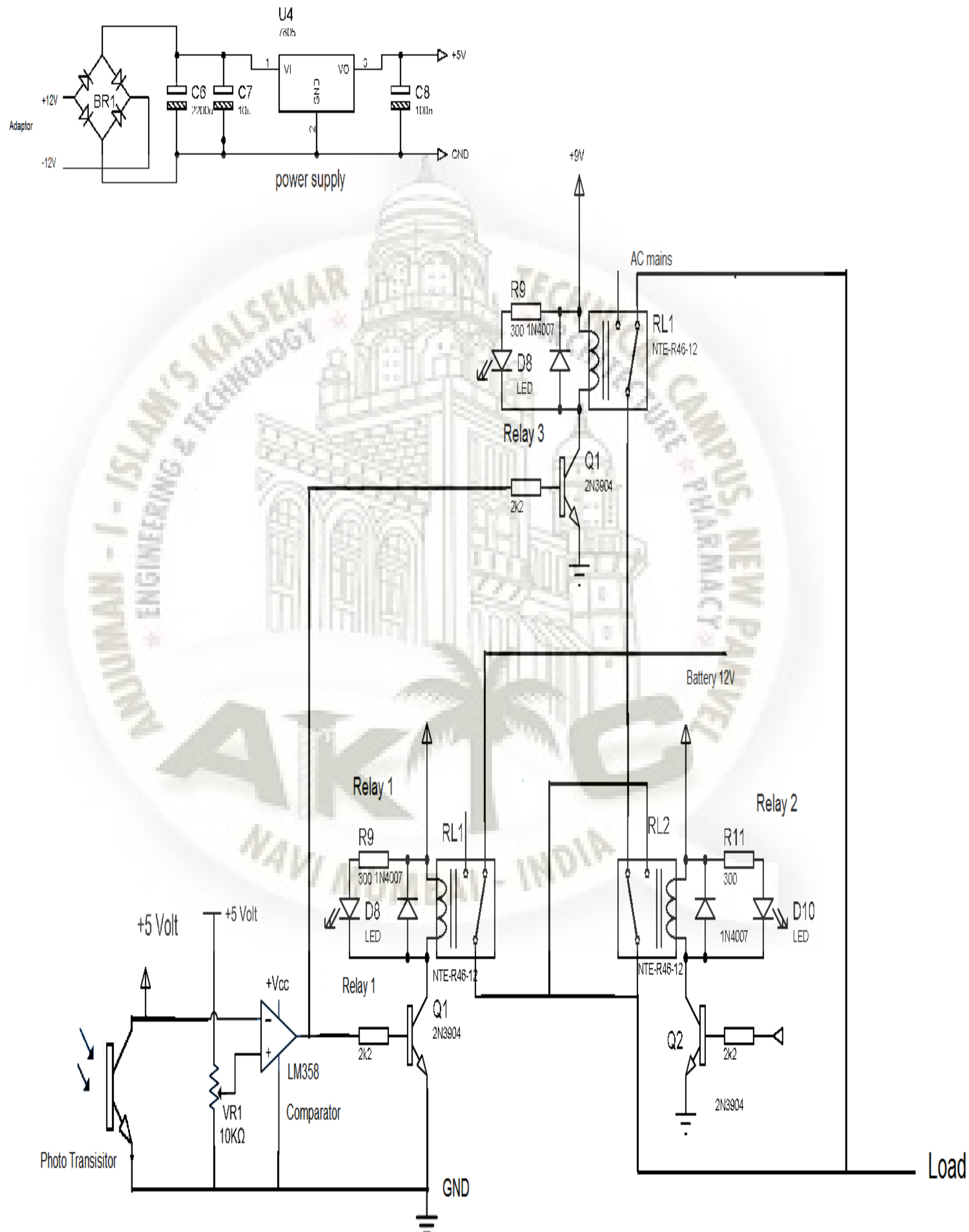
Features

- Maglev structure
- 100 voltapprox. voltage
- Led o/p and multimeter o/p
- Switching - When natural (battery) off then auto switch to any mains supply
- Natural energy storing concept we are showing in Battery- 12-volt battery
- Charging circuitry at the output of Maglev
- Multimeter and Blower from student side
- Maglev structure
- Daylight sensor (photo transistor)
- Without controller.

Block Diagram



Circuit Diagram



- POWER SUPPLY:

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can be broken down into a series of blocks, each of which performs a particular function. For example a 5V regulated supply.

- Optical Sensor (daylight sensor)

It consists of just two major components. The first is a phototransistor (a photo receiver) and the second is a comparator.

The reflected signal falls on the photo transistor. This ray excites the base of the transistor and switches the transistor on.

A comparator is a device which compares two voltages and switches its output to indicate which is larger.

- Relay Driver Circuit:

The Relay driver circuit consists of the “transistor relay driver”. Using this circuit one relay can be driven in one direction at a time. So as per the data provided to the Relay driver circuit, the relay will switch on/off. The device which is to be control is connected to the NO NC contacts of relay. The relay contacts will in turn act as Comparator output goes high.

Hardware requirements:

1. Neodymium magnets
2. Coils
3. Relay x 2
4. Phototransistor
5. Comparator- LM358
6. Battery - 12V, 1Amp

Component Description

Phototransistor L14G2

L14G2 is an NPN phototransistor. It acts as a photodetector in the sense that it can convert the incident light into electric response. They are commonly used as sensors usually paired with a light source like LED.

These are the bipolar transistors having a transparent case. This transparent case exposes the base collector region of transistor to external light. When light incidents on this junction, electrons are generated by the photons. These electrons are injected in the base of phototransistor. The current gain of the transistor amplifies the resulting photocurrent at the base collector junction. Thus a phototransistor conducts in the presence of light and remains in off mode in absence of light. The maximum dark current is 100nA; while in light its current is 500µA.

A phototransistor is different from a simple transistor in the way that in the latter, voltage applied to the base is replaced by light striking it. Simply put, a phototransistor amplifies variations in the light striking it.

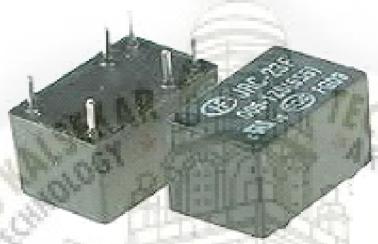
*Phototransistors may or may not have a base terminal. If a base terminal is available, it is used to bias its light response.

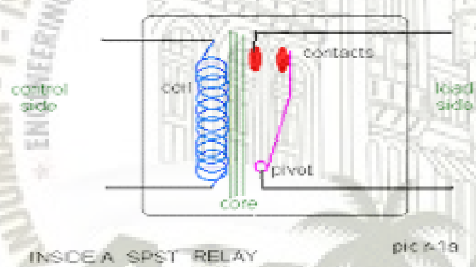
Photodiodes can also be used for similar function as phototransistors, but they have much lower gain and thus lower photocurrent. Phototransistors cannot detect low intensities of light but are more responsive to the exposed light. Also, the transistor response lasts for a longer period as compared to a photodiode.

The required light source is a gallium arsenide LED with peak wavelength is 940 nm. The emitter lead is indicated by a protruding edge in the transistor case. The base is nearest to the emitter. The collector is at the other extreme side of the casing.

Relay

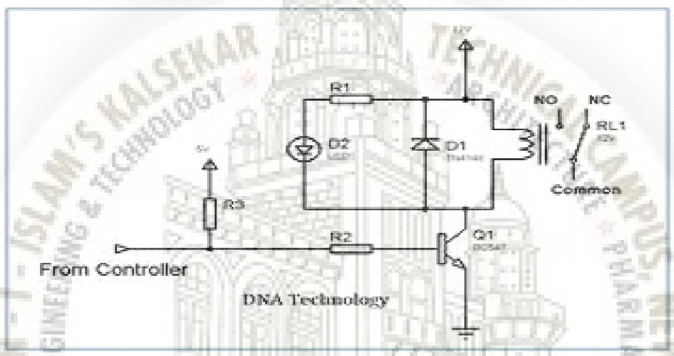
- BLOCK: Output
- TYPE: Electromagnetic/Electromechanical Relay
- ANALOG/DIGITAL: Digital
- PINS FOR INTERFACE: 1Pin
- PHOTO/CIRCUIT SYMBOL:





A relay is an electrical switch that uses an electromagnet to move the switch from the off to on position instead of a person moving the switch. It takes a relatively small amount of power to turn on a relay but the relay can control something that draws much more power. A relay is used to control the air conditioner in your home. The AC unit probably runs off of 220VAC at around 30A. That's 6600 Watts! The coil that controls the relay may only need a few watts to pull the contacts together.

A relay switch can be divided into two parts: input and output. The input section has a coil which generates magnetic field when a small voltage from an electronic circuit is applied to it. This voltage is called the operating voltage. Commonly used relays are available in different configuration of operating voltages like 6V, 9V, 12V, 24V etc. The output section consists of contactors which connect or disconnect mechanically. In a basic relay there are three contactors: normally open (NO), normally closed (NC) and common (COM). At no input state, the COM is connected to NC. When the operating voltage is applied the relay coil gets energized and the COM changes contact to NO. Different relay configurations are available like SPST, SPDT, DPDT etc, which have different number of changeover contacts. By using proper combination of contactors, the electrical circuit can be switched on and off.



An NPN transistor is being used to control the relay. The transistor is driven into saturation (turned ON) when a LOGIC 1 is written on the PORT PIN thus turning ON the relay. The relay is turned OFF by writing LOGIC 0 on the port pin. A diode (1N4007/1N4148) is connected across the relay coil; this is done so as to protect the transistor from damage due to the BACK EMF generated in the relay's inductive coil when the transistor is turned OFF. When the transistor is switched OFF the energy stored in the inductor is dissipated through the diode & the internal resistance of the relay coil. Normally 1N4148 can be used as it is fast switching diode with a maximum forward current of 300ma. This diode is also called as free-wheeling diode.

The LED is used to indicate that the RELAY has been turned ON. The resistor R1 defines the current flowing through the LED thereby defining the LED's intensity.

Resistor R2 is used as a Series Base Resistor to set the base current. When working with 8051 controllers that it's not compulsory to use this resistor as the controller has internal 10k resistor which acts as a base resistor.

Possibilities:

- Logic operation
- ON/OFF Control
- Limit control

COMPARATOR

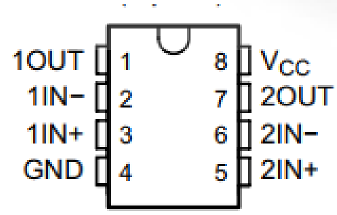
BLOCK: Input

TYPE: LM 358

ANALOG/DIGITAL: Analog

PINS FOR INTERFACE: 8Pins

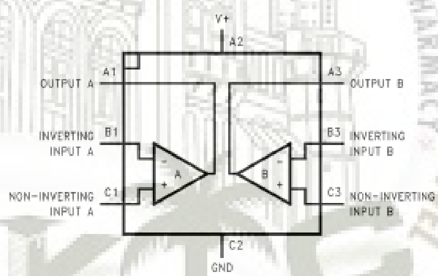
PHOTO/CIRCUIT SYMBOL:



These devices consist of two independent, high-gain frequency-compensated operational amplifiers designed to operate from a single supply or split supply over a wide range of voltages.

Features

- Wide Supply Ranges – Single Supply: 3 V to 32 V (26 V for LM2904) – Dual Supplies: ±1.5 V to ±16 V (±13 V for LM2904)
- Low Supply-Current Drain, Independent of Supply Voltage: 0.7 mA Typical
- Wide Unity Gain Bandwidth: 0.7 MHz
- Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground
- Low Input Bias and Offset Parameters – Input Offset Voltage: 3 mV Typical A Versions: 2 mV Typical – Input Offset Current: 2 nA Typical – Input Bias Current: 20 nA Typical A Versions: 15 nA Typical
- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage: 32 V (26 V for LM2904)
- Open-Loop Differential Voltage Gain: 100 dB Typical
- Internal Frequency Compensation



Pin Functions

PIN			TYPE	DESCRIPTION
D/P/LMC NO.	DSBGA NO.	NAME		
1	A1	OUTA	O	Output , Channel A
2	B1	-INA	I	Inverting Input, Channel A
3	C1	+INA	I	Non-Inverting Input, Channel A
4	C2	GND / V-	P	Ground for Single supply configurations. negative supply for dual supply configurations
5	C3	+INB	I	Output, Channel B
6	B3	-INB	I	Inverting Input, Channel B
7	A3	OUTB	O	Non-Inverting Input, Channel B
8	A2	V+	P	Positive Supply

Flow of Project

- Using Maglev concept we will generate an energy and which will be stored in Battery.
- We are using daylight sensor for automation purpose, according to data received from the daylight sensor light will on and off automatically.
- Firstly the light (Bulb) will be connected to battery and if the power is not sufficient then light will be switched to AC mains.

ADVANTAGES

- It is cheaper, faster, not congested, and has a much longer service life.
- It is very energy efficient. Unlike autos, trucks and airplanes, it does not burn oil, but instead consumes electricity, which can be produced by coil-fired, nuclear, hydro, fusion, wind, or solar power plants.
- It emits no pollution and less weather dependent.
- Maglev train cars are less expensive to build and are relatively quiet in comparison to conventional trains.
- The maglev tracks take up a lot less land, because they are elevated. This also reduces the amount of collisions and accidents.
- Maglev trains use far less energy than other types of transportation.
- Maglev trains are much faster, because they float over the track eliminating rolling resistance and potentially improving the power efficiency.
- Maglev trains require Less maintenance (no wear because they float over the track).

Limitations

- Cost is major issue when considering maglev trains, especially since they cannot operate on the existing, conventional rails. Guide ways would need to be built in order to make use of this new technology.
- The weight of the electromagnets in the EMS and EDS systems are also an issue. A very strong magnetic field is required to levitate the heavy trains, (the trans rapid TRO7 weighs 45 tons) and maintaining the field constant requires a lot of energy which is expensive.

APPLICATIONS

- The principal application for maglev has always been considered to be the high speed transport of passengers between major centers of population. Maglev is often viewed as a sort of super-speed train that competes with airplanes for inter-city passengers. Moreover, potential maglev systems are generally examined in the context of routes between major population centers in a country or a region.
- Maglev has many other applications, however, where it offers great advantages and benefits, and where systems can payback their construction cost in a much shorter time than an intercity passenger route.
- NASA and private aerospace entities are looking at maglev technology for another kind of travel. A maglev line, tilted upward, could accelerate a rocket to give it an extra boost of speed to get the vehicle into low Earth orbit. A kind of maglev line could be used to accelerate payload entirely from the surface of the Moon, further cutting launch costs, thus granting easier access to the Moon's natural resources.
- It is used in factories and companies where traveling path is fixed.
- It is used in IIT companies which has very large area and fixed path.
- Transportation engineering (magnetically levitated trains, flying cars, or personal rapid transit (PRT), etc.)
- Environmental engineering (small and huge wind turbines: at home, office, industry, etc.)
- Military weapons engineering (rocket, gun, etc.)
- Nuclear engineering (the centrifuge of nuclear reactor)
- Civil engineering including building facilities and air conditioning systems (magnetic bearing, elevator, lift, fan, compressor, chiller, pump, gas pump, geothermal heat pumps, etc.)

Conclusion

Over all, the magnetically levitated vertical axis wind turbine was a success. The rotors that were designed harnessed enough air to rotate the stator at low and high wind speeds while keeping the center of mass closer to the base yielding stability. The wind turbine rotors and stator levitated properly using permanent magnets which allowed for a smooth rotation with negligible friction. At moderate wind speeds the power output of the generator satisfied the specifications needed to supply the LED load. After testing the project as an overall system we found that it functioned properly but there are many things that can be improved upon. The generator itself had some design flaws which we feel limited the amount of power it could output. These flaws start at the coils which were initially made too thick and limited how close the magnets attached to the stator could be positioned from each other. If the magnets were pulled in closer to one another, the magnetic field density would be much greater allowing for more power to be induced into the coils. Another setback was that the wire that was used to wrap the coils as 30AWG and because of its small cross section it restricted the amount of current that could be drawn from the generator. Lastly, the plexi-glass that was used for the frame of the wind turbine was too elastic. Due to the fact it was not as strong as we had hoped, there was some sag in frame about the central axis where the majority of the weight and force was located. If a more heavy duty material was used in future design then it would allow for more precision in magnet placement.

Future Scope

The home for the magnetically levitated vertical axis wind turbine would be in residential areas. Here it can be mounted to a roof and be very efficient and practical. A homeowner would be able to extract free clean energy thus experiencing a reduction in their utility cost and also contribute to the "Green Energy" awareness that is increasingly gaining popularity. The maglev windmill can be designed for using in a moderate scale power generation ranging from 400 Watts to 1 KW. Also it is suitable for integrating with the hybrid power generation units consisting of solar and other natural resources.

At present, there are several countries such as USA, Germany and China that are in the forefront of producing green energy from renewable and non polluting resources such as solar and wind energy. In terms of wind energy, we will have a look at a super wind turbine called MagLev which is the key to building stronger and more efficient turbines in the future. MagLev was first unveiled in the Wind Power Exhibition in Asia in Beijing. This turbine is surely going to take wind power technology to a whole new level with the help of magnetic levitation.

The turbine makes use of magnetic levitation in the following way. The turbine has vertically oriented blades and these are suspended in the air above the base of the machine. Hence there is no use of ball bearings to support the blades. The turbines make use of permanent magnets instead of electromagnets. Hence there is no use of electricity to run the turbines. The magnet employs the practicality of neodymium magnets and hence there is no energy wasted in terms of friction.

Hence there are no maintenance costs to be shelled out and the life of the generator is increased manifold.
The MagLev turbine has several benefits over the conventional wind turbines. MagLev is able to make use of low intensity winds that blow at 1.5 meters per second. And the turbine can also operate well in high intensity winds of 40 m/s. MagLev is today the largest conventional wind turbine in the world producing 5 watts of power. Today one MagLev can produce total power of one gigawatt of power which is enough to provide electricity to 750,000 homes.

Hence you can imagine how important a MagLev can be to produce clean and green electricity to sustain our environment.
The MagLev has also increased wind generation capacity by 20% over the conventional wind turbines. The operational costs on the other hand have decreased by 50%. The wind turbines will be made operational for at least the next 500 years.
Construction of the MagLev was started in China in November, 2007.

The private firm, ZhongkeHengyuan Energy Technology has invested close to 400 million yuan in building the facility. In the US, the Arizona based firm, MagLev Wind Turbine Technologies will be manufacturing these wind turbines commercially. The company says that it will deliver 1 kilowatt of clean power at less than 1 cent per watt.

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