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Design and Implementation of Solar Charging Helmet-Indian Perspective

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Abstract : *Charging of mobile phone is a difficult task especially while undertaking a long ride and power supply is not easily available. This paper proposes Designing of SOLAR CHARGING HELMET in view of Indian perspective [1]. The solar charging unit fitted in a helmet is weather proof, highly efficient, economical, eco-friendly as it uses non-conventional energy sources. The proposed appliance has important tangible positive effect in Indian perspective towards lowering of CO2 emission, bringing down mortality & morbidity in road-related accidents.*

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Keywords: *Mobile Phones, Safety Helmets, Solar Mobile Charger, Solar Panels.*

INTRODUCTION

We spend a great deal of our time using smart phones for communication, social networking, games, business and whatnot. This puts a great strain on the battery life of the device. It is impractical to carry a charger everywhere you go. Wish your arduous morning bike commute to work/college could charge up your cell phone that too using completely renewable source of energy? A handy **SOLAR CHARGING HELMET** that lets the user do just it is proposed in the paper. The helmet provides clean power and encourages more bikers to protect themselves by wearing it. In India, many bikers face fines violating rules, face fatal accidents resulting in death/prolonged hospital stay. So the proposed appliance will help in preventing such situations.
Solar panels are simply solar cells lined up together in series and parallel so as get sufficient voltage and are p-n junction semiconductor devices with pure silicon wafer doped with 'n' type phosphorous on the top and 'p' type boron on the base [2]. If the PV cell is placed in the sun, **photons** of light strike the electrons in the p-n junction and energize them, knocking them free of their atoms. These electrons are attracted to the positive charge in the
n-type silicon and repelled by the negative charge in the p-type silicon [3]. Connecting wires across the junction will have a current in them.
We need to understand **solar panels** so as to understand their applications. Today, we have mono crystalline, polycrystalline and amorphous thin film panels. Mono crystalline is so far the most efficient, given that they have the maximum silicon in a unit area so more current for the same number of photons. They are made out of a single silicon crystal as a continuous lattice [4].

Solar panels are really useful in broad daylight but we need energy when the Sun isn't shining above our rooftops. That's why we need solar chargers which will store energy in rechargeable batteries. This project aims to make a solar charger using a voltage regulating IC L7805 with the constant output voltage obtained through it so as to charge 2 Lead Acid Batteries.

A. Abbreviations and Acronyms
IC-Integrated Circuit
PV-Photovoltaic
Si-Silicon

COMPONENTS DESCRIPTION

A. Solar Panel

Figure 1. *Solar Panel*

Features:
•High efficiency and monocrystalline
• Water resistant
• Light weight
•Maximum Power (Pm):0.5W
•Open Circuit Voltage (Voc):2.4V
• Short Circuit Current (Isc):32mA
• Weight: 20g
• Material: Polycrystalline Silicon
• Dimension: 80x38mm
• Power Tolerance:-5% to +5%
• Encapsulation Methods: Epoxy Resin Lamination
• No frame, with solder wire

B. IC LM7805

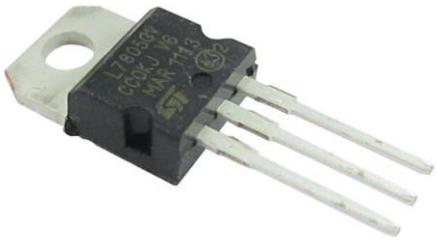

Figure 2. *IC LM7805*

Member of 78xx series of fixed linear voltage regulator ICs are used to maintain the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage. 7805 provides +5V regulated power supply. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible [5]

C. Battery: (Sealed lead acid battery)

Figure 3. *Lead Acid Battery*

This circuit is designed for two 4V, 0.5 Ah battery. This means a 0.5A current will charge the battery in 1hour. Lead acid batteries are not the best available options in rechargeable batteries (unlike portable and easy to use Li-ion batteries). But for small applications they are good enough. Secondary (rechargeable batteries) can be discharged and recharged multiple times i.e. the original composition of the electrodes can be restored by reverse current.

D. Diode IN4007

Figure 4. *Diode IN4007*

A diode is a two-terminal electronic component with asymmetric conductance which means it has low (ideally zero) resistance to current flow in one direction, and high (ideally infinite) resistance in the other. These are simply blocking diodes which ensure that the current flows only in one way so that the battery doesn't discharge when the output from solar panel is low.

E. 1kΩ Resistor

Figure 5. 1kΩ Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits, resistors are used to limit current flow, to adjust signal levels, bias active elements, and terminate transmission lines among other uses.

F. Electrolytic Capacitor 47 uF

Figure 6. 47uF Electrolytic Capacitor

Aluminium electrolytic capacitors are used in huge quantities. They are very cost effective and able to provide a larger capacitance per volume than other types of capacitor. This gives them very many uses in circuits where high currents or low frequencies are involved. These are typically used most in applications such as audio amplifiers of all types and in power supply circuits

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G. Ceramic Capacitor 100 nF

Figure 7. *100nF Ceramic Capacitor*

A Multi-layer ceramic capacitor (MLCC) uses a ceramic material as the dielectric. Ceramic capacitors are also very small in size and have a low maximum rated voltage. They are not polarized, which means that they may be safely connected to an AC source. Ceramic capacitors have a great frequency response due to low parasitic effects such as resistance or inductance.

SIMULATION

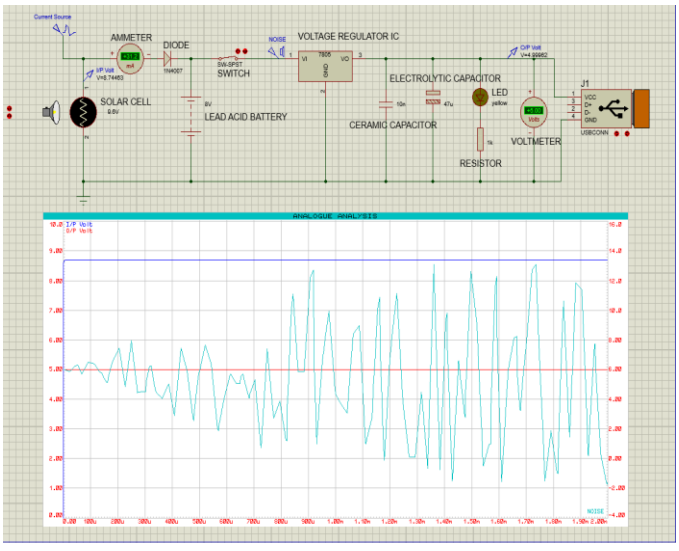

Figure 8. *Simulation of Solar Charging Circuit in Proteus Software*

EXPERIMENTS & GRAPHS

A. Behavior of solar panels with varying intensities of ligh

Conditions	Open circuit voltage across the panel
Covered with cardboard	0.117 V
Covered with Paper	1.12 V
At the window (11 am)	6.59 V
In the lab	3.41 V
Using a torchlight at distance 15 cm	5.02 V
At the terrace (12 noon)	9.13 V

Observations: Solar panels are heavily dependent on the intensity and the nature of light falling on them to produce any kind of voltage. The output varies right from 0.11 V to 9.2 V.

Conclusions: Sunlight matters a lot. So to make the best out of a fixed solar panel, we need to have some kind of power tracking which will always allow the panel to produce a maximum power by impedance matching.

B. The working of IC LM7805 (using power supply)

Vin	Vref	Vout	Vin-Vout
2.12V	0V	0.87V	1.25V
3.35V	0 V	2.25V	1.10V
4.02V	0 V	2.85V	1.17V
4.87v	0 V	3.77V	1.10v
5.02V	0 V	3.98V	1.04V
5.88V	0 V	4.651V	1.229V
6.52V	0V	5.01V	1.51
7.32V	0V	5.02V	2.3
8.41V	0V	5.01V	3.4

Observation: The output voltage from the IC is observed to be nearly constant.

Results: IC LM7805 gives a constant output voltage for a particular range of input voltage.

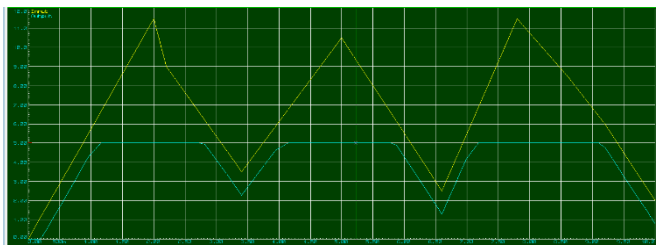

Figure 9. IC 7805 Input-Output Voltage Characteristics

the I-V Characteristics of the Solar Panel

C. ***To plot the I-V Characteristics of the Solar Panel***

Voltage (Volts)	Current (Milli Amperes)
0.1045	31.30
0.1551	31.02
0.3118	31.18
0.6320	31.60
6.5556	29.53
8.5536	25.92
9.1993	20.58
9.0150	18.03
8.8278	12.21

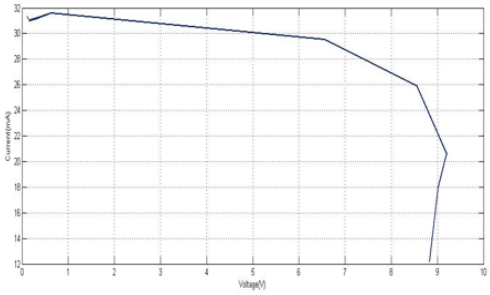

Figure 10. I-V Characteristics of the Solar Panel

C. Output Current vs Load curve

Current (Milli Amperes)	Load (Ohms)
842	3
640	5
440	10
210	22
152	32.4
132	42.6
117	52.3
103	58.5

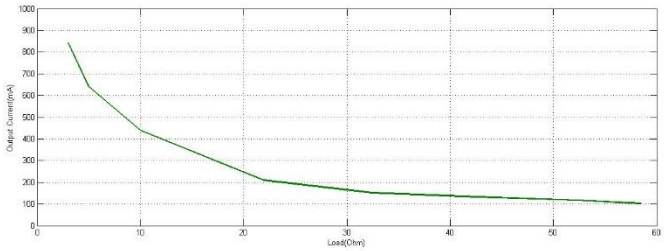

Figure 11. Output Current vs Load curve

COST ANALYSIS

S.No	COMPONENT	QTY	SPECIFICATIONS	PRICE PER UNIT(₹)
1	Voltage Regulating IC	1	LM7805	10
2	Capacitors	2	100 nF & 47 uF	2
3	USB jack	1	-	10
4	Push Switch	1	Toggle Type	5
5	Resistor	1	1KΩ	2
6	Diode	1	IN4007	1
7	LED	1	Yellow	1
8	Solar Panel	4	2.4 V	200
9	Lead Acid Battery	2	4V,0.5 Ah	40
10	Helmet	1	ISI certified	700

NET COST = ₹1613

CONCLUSIONS

- Solar panels are as good as power supplies of an average of 9.6 V in bright sunlight. The only problem is unregulated voltage due to variation in intensity of light.
- IC LM7805 solves the problem by regulating the output voltage but it again dissipates 2V across it which makes the system less efficient.
- Solar charger circuits need voltage regulators so as to charge the batteries at constant voltage.
- The Helmet with Solar Charging Kit is cost effective.
- The charger circuit is a simple, ready to use lead acid battery charger and is a good way to tap Sun's energy on the go.

FURTHER RESEARCH

The scope of imagination is large as solar power can run anything on DC voltage. Specifically, we want to explore solar chargers in greater detail and understand how to increase efficiency of power generation (IC LM7805 drops the precious 2V across it thus wasting energy). An area of interest is exploring different technologies available in making solar cells (Mono-crystalline, Polycrystalline, Thin Films) and be able to explain why their efficiency changes so much by understanding their crystal structures.

A team of scientists has come up with a new research that could revolutionize flexible electronics and solar cells. Researchers have demonstrated an eco-friendly process that enables unprecedented spatial control over the electrical properties of graphene oxide. This two-dimensional nanomaterial has the potential to revolutionize flexible electronics, solar cells and biomedical instruments [6].

Their approach makes it possible to draw nanoscale electrically-conductive features in atomically-thin insulating sheets with the highest spatial control reported so far. This process can be implemented under ambient conditions and is environmentally-benign, making it a promising step towards the practical integration of graphene oxide into future technologies [7].

Another area of concern is the low efficiency of the IC 7805 which is around 40%. We can improve it considerably by using MC34063A whose efficiency is about 75%. The MC34063 is a monolithic control circuit containing all the active functions required for switching dc-to-dc converters. The MC34063 was designed to be incorporated in buck, boost, or voltage-inverter converter applications.

The following figure shows the basic buck switching regulator. Q1 interrupts the input voltage and provides a

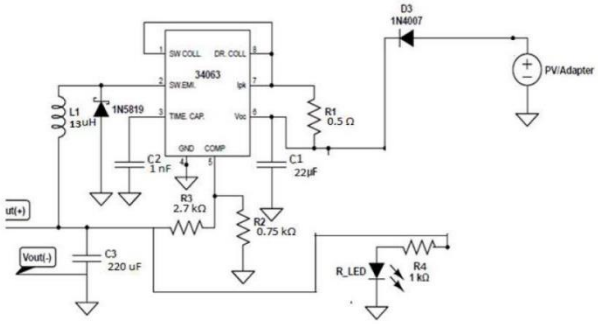

Figure 12. Diagram of Charging Circuit using MC34063A

variable duty-cycle square wave to an LC filter. The filter averages the square wave and produces a dc output voltage that can be set to any level less than the input by controlling the percent conduction time of Q1 to that of the total switching cycle time.

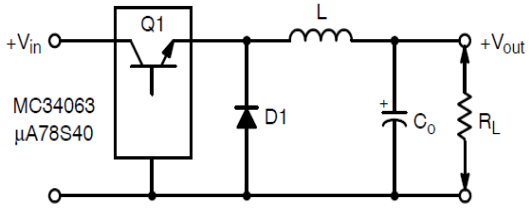

Figure 13. ***Buck Regulator Configuration***

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Working Model

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