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MULTIPLE CHARGERS WITH ADJUSTABLE VOLTAGE USING SOLAR PANEL

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Abstract- *The basic objective is to build a solar charger which charges multiple types of batteries simultaneously. The main purpose of this project is to use renewable energy source and reduce the electricity load. This type of charger is important to decrease the increasing electricity load with the increase of cellphone use in Bangladesh and to charge batteries during load shedding. It can charge cellphone batteries of 5V and 3.7V and pencil batteries of adjustable 3-9V. Solar energy is used as renewable energy to charge the batteries. This is a working multiple charger which is powerful enough to collect solar energy and using the solar energy it will charge different cell phone batteries and AAA rechargeable batteries as well. This charger might also come in handy to charge other type of batteries such as automotive batteries and IPS.*

Keywords: Renewable energy, solar energy, rechargeable batteries, adjustable voltage, electricity load

1. INTRODUCTION

1.1 General

1.1.1 Energy

Energy is one of the most fundamental parts of our universe. We use energy to do work. Energy lights our cities. Energy powers our vehicles, trains, planes and rockets. Energy warms our homes, cooks our food, plays our music, and gives us pictures on television. Energy powers machinery in factories and tractors on a farm. Everything we do is connected to energy in one form or another. Energy is defined as: "the ability to do work." There are many sources of energy. The forms of energy we will look at include:

- Electricity
- Biomass Energy - energy from plants
- Geothermal Energy
- Fossil Fuels - Coal, Oil and Natural Gas
- Hydro Power and Ocean Energy
- Nuclear Energy
- Solar Energy
- Wind Energy
- Transportation Energy

1.1.2 Solar Energy

Solar energy is quite simply the energy produced directly by the sun and collected elsewhere, normally the Earth. The sun creates its energy through a thermonuclear process that converts about 650,000,000 tons of hydrogen to helium every second. The process creates heat and electromagnetic radiation. The heat remains in the sun and is instrumental in maintaining the thermonuclear reaction. The electromagnetic radiation streams out into space in all directions.

Due to the nature of solar energy, two components are required to have a functional solar energy generator. These two components are a collector and a storage unit. The collector simply collects the radiation that falls on it and converts a fraction of it to other forms of energy. The storage unit is required because of the non-constant nature of solar energy; at certain times only a very small amount of radiation will be received. At night or during heavy cloud cover, for example, the amount of energy produced by the collector will be quite small. The storage unit can hold the excess energy produced during the periods of maximum productivity, and release it when the productivity drops. In practice, a backup power supply is usually added, too, for the situations when the amount of energy required is greater than both what is being produced and what is stored in the container. [1]

1.1.3 Rechargeable Battery

A rechargeable battery is a battery that can be recharged and used many times over. It is otherwise known as a storage battery because it is able to accumulate and store energy which then becomes available to the user when he puts the battery to use. A rechargeable battery is sometimes referred to as a secondary cell as well, which is opposed to the non-rechargeable variety which is a primary cell.

When a battery is discharged, it goes through

electrochemical changes. In a non-rechargeable battery, these changes are irreversible. A rechargeable battery, however, has the ability to efficiently reverse the chemical changes that occur during discharge when electrical energy is applied to it.

Today, many electronics use rechargeable batteries, among them cellular phones, laptops, MP3 players, video cameras, and cordless power tools. In fact, many modern products are designed to only use rechargeable batteries. Rechargeable batteries come in a variety of forms. Lead and sulfuric acid, as well as alkaline batteries can be rechargeable. Lithium ion (Li-ion) and lithium ion polymer (Li-ion polymer) batteries are two other types of rechargeable batteries. Furthermore, rechargeable NiMH or Li-on batteries work much longer on high-drain electronic equipment per charge than do single-use alkaline batteries.

There are also environmental benefits for using rechargeable batteries. Since one rechargeable battery can take the place of hundreds, even thousands, of single-use batteries, much less waste is generated. [2]

1.2 Objectives

- To build a device which charges multiple batteries.
- To use renewable energy.
- To decrease electricity load.

1.3 Limitations

- The used Solar panel is slightly larger than expected.
- The circuit board is not fully portable
- The solar panel is not directly connected to the circuit board rather it is connected to a pair of 6V batteries.

1.4 Future Plan

- To get rid of the 6V batteries.
- To charge automotive batteries if necessary.
- To control current flow.

2. METHODOLOGY

2.1 Circuit Diagram

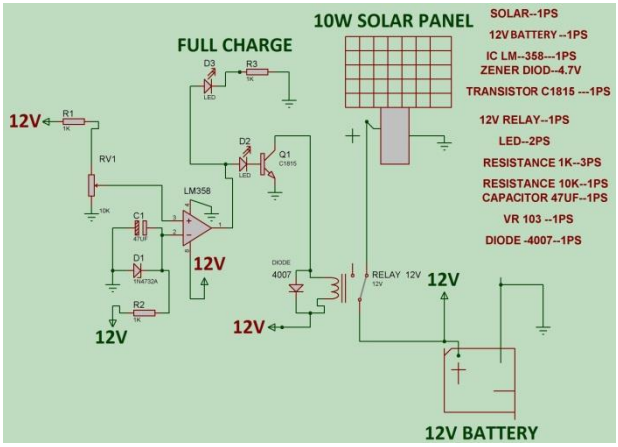


Fig.1: Schematic circuit diagram for transmitting power from solar panel to 12V battery

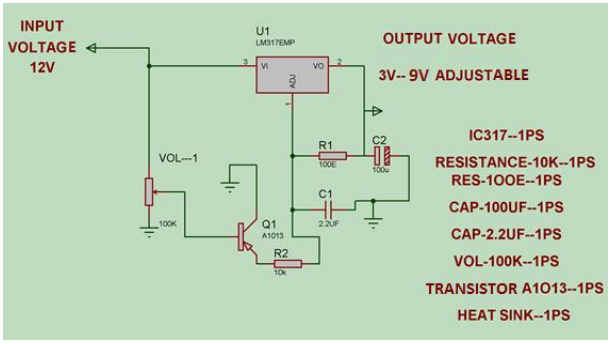


Fig.2: Schematic circuit diagram for transmitting power from 12V battery to AAA battery

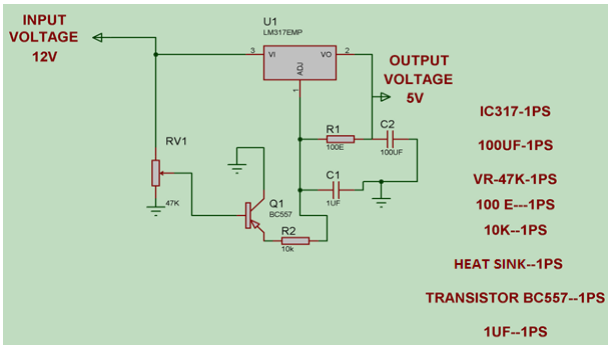


Fig.3: Schematic circuit diagram for transmitting power from 12V battery to 5V and 3.7V cellphone battery

2.2 Tools Required

1. Solar panel (10 Watt)
2. Breadboard
3. Relay
4. Capacitor
5. Zener diode
6. Two 6V Batteries
7. Regulator IC
8. Operational Amplifier IC
9. Transistor
10. LED
11. Diode
12. Resistor
13. Variable resistor
14. Heat Sink
15. Connecting wire
16. Box etc.

2.3 Flow Chart

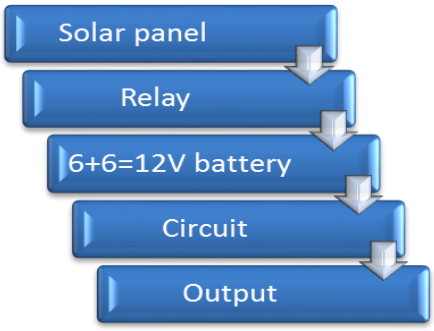


Fig.4: flow chart of the full system

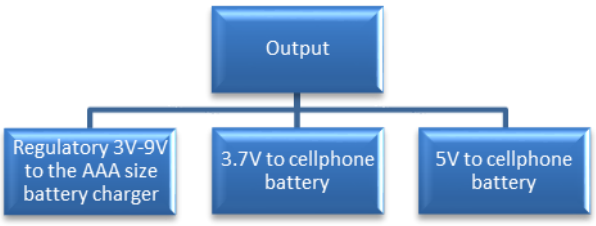
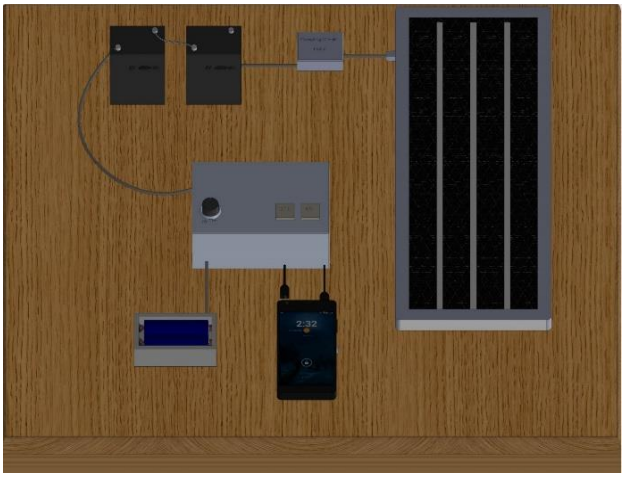


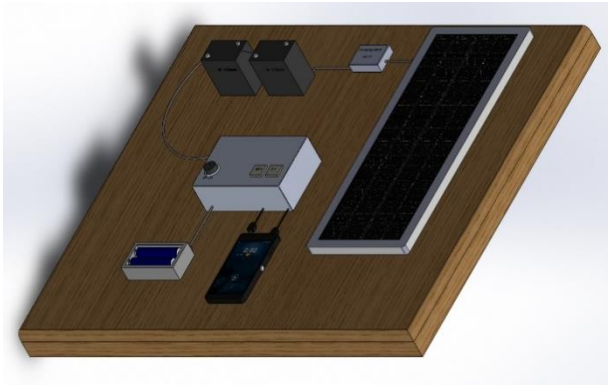
Fig.5: flow chart of output voltage

3. DESIGN AND FABRICATION OF MULTIPLE CHARGER

3.1 Simplified setup designed by SolidWorks



View (a)



View (b)

Fig.6: Diagram of the system (a) and (b)

3.2 Tools

3.2.1 Solar Panel

A poly-10W solar panel by Generic Solar is used. The rated voltage is 17.2V and rated current is 0.58A. The open circuit voltage is 21.6V and short circuit current is 0.68A. Maximum system voltage is 600V.

3.2.2 Breadboard

A breadboard is a construction base for prototyping of electronics. One small breadboard is used. Capacitors, relay, regulator IC, transistor etc. are placed on it. Some of these equipment are soldered and some are kept without soldering. [3]

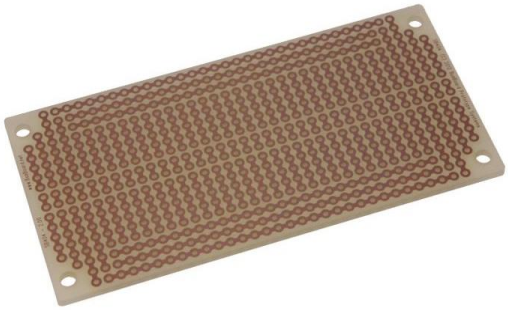


Fig.7: Breadboard

3.2.3 Relay

Relays are switches which are operated both electrically and mechanically. Relays consist of an electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. [4] A 12V relay is used here to limit the incoming power from the solar panel to 12V. It receives power up to 12V and goes to off position if it exceeds 12V.

Fig.8: Relay

3.2.4 Capacitor

Capacitor is an electronic component that stores electric charge. The capacitor is made of two close conductors that are separated by a dielectric material. [5] Seven capacitors are used. The model numbers are 47uf, 100uf and 2.2uf.

Fig.9: Capacitor

3.2.5 Zener Diode

Zener diode is a special kind of diode which permits

current to flow in the forward direction. Zener diodes allow current to flow in the reverse direction when the voltage is above a certain value. [6] One zener diode is used to fix the incoming voltage.

Fig.10: Zener diode

3.2.6 Two 6V Batteries

Two 4.5Ah, 6V-RB640CS batteries are used. They receive power from the solar panel via relay, store it and send it to the system.

3.2.7 Regulator IC

Three LM 317 regulator ICs are used. The LM317 is used in DC to DC converter applications. It is used to regulate voltage and current if needed. The LM317 has three pins: input, output, and adjustment. A resistive voltage divider between the output and ground configures the op amp as a non-inverting amplifier so that the voltage of the output pin is continuously adjusted to be a fixed amount.

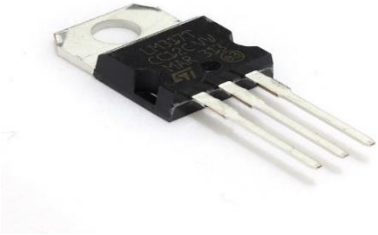


Fig.11: Regulator IC

3.2.8 Operational Amplifier IC

An Operational Amplifier **(**op-amp) is fundamentally a voltage amplifying device designed to be used with external feedback components such as resistors and capacitors between its output and input terminals. [7] One LM 358 OP AMP IC is used.

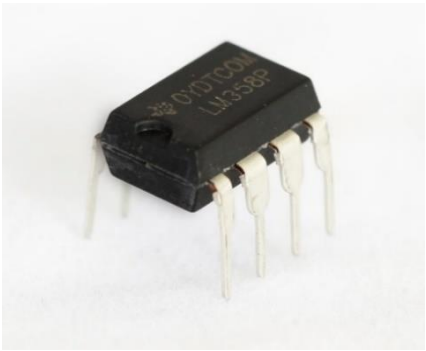


Fig.12: Operational amplifier IC

3.2.9 Transistor

A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current through another pair of terminals. [8] Four transistors are used. The types of transistors are C1815 and A1013.

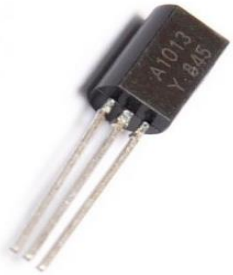


Fig.13: Transistor

3.2.10 LED

A light-emitting diode (LED) is a semiconductor device that emits visible light when an electric current passes through it. The light is not particularly bright, but in most LEDs it is monochromatic, occurring at a single wavelength. [9] When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. Three LEDs are used. One LED indicates the activation of the incoming power. Other LEDs are used to indicate full charge state of 12V battery.

Fig.14: LED

3.2.11 Diode

A diode is a two-terminal electronic component with asymmetric conductance; it has low (ideally zero) resistance to current in one direction, and high (ideally infinite) resistance in the other. Two diode 4007 are used. These are used to convert AC voltage to DC voltage and to keep the required voltage on the relay steady.

Fig.15: Diode

3.2.12 Resistor

A piece of conducting material of a particular resistance meant for use in a circuit is called a 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. Twelve resistors of 1K and 10k are used.

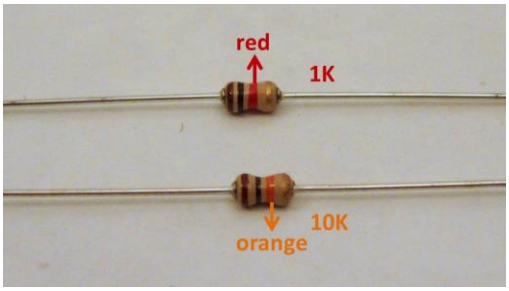


Fig.16: Resistor

3.2.13 Variable Resistor

A variable resistor is a potentiometer with only two connecting wires instead of three. However, although the actual component is the same, it does a very different job. The pot allows us to control the potential passed through a circuit. The variable resistance lets us adjust the resistance between two points in a circuit. Two variable resistors of model number VR103 are used to control the resistance.

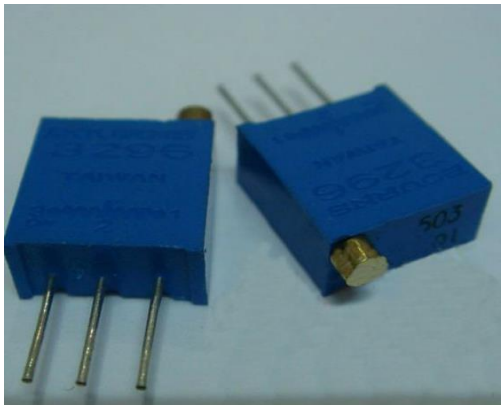


Fig.17: Variable resistor

3.2.14 Heat Sink

A heat sink is a passive heat exchanger that cools a device by dissipating heat into the surrounding medium. In computers, heat sinks are used to cool central processing units or graphics processors. Heat sinks are used with high-power semiconductor devices such as power transistors and optoelectronics such as lasers and light emitting diodes (LEDs), where the heat dissipation ability of the basic device is insufficient to moderate its temperature.

A heat sink is designed to maximize its surface area in contact with the cooling medium surrounding it, such as the air. Air velocity, choice of material, protrusion design and surface treatment are factors that affect the performance of a heat sink.

3.2.15 Connecting Wire

A short length of electric cable fitted with connectors at both ends, connected across a device in an electrical circuit so that the current bypasses the device. So Connecting wire is a piece of wire used to attach two circuits or components together. The gauge or size of the wire must be large enough to support the amount of current flow.

Fig.18: Connecting wire

3.3 Construction Procedure

Relay, capacitor, regulator ICs, transistor, zener diode, resistor etc. have been planted on the breadboard. There are LEDs boarded on to indicate proper functionality. This breadboard is connected to a pair of 6V batteries. These batteries are connected to a 10W solar panel.

3.4 Working Procedure

Solar panel absorbs solar energy and sends it to the relay. The relay limits the incoming voltage within 12V and cuts off receiving energy if it is over 12V. The relay is connected with a pair of 6V batteries which stores energy and sends it to the system. There are three regulator ICs. One of those adjusts output power to 3-9V which is connected with the rechargeable pencil battery charger. This 3-9V adjustable voltage can be regulated from 3V to 9V as per the battery model requires. The other two regulator ICs power up one 3.7V and another 5V output line which can charge two cell phone batteries at a time via micro USB cord.

3.5 Final Figure

Fig.19: Whole Implementation of the system

4. RESULT AND DISCUSSION

4.1 Experimental results

Table 1: Output voltage of equipment

Equipment	Output Voltage
Solar panel	6-20V (Depending on the intensity of sunlight)
6+6=12V battery (Although the solar panel can supply up to 18V, but the maximum allowable voltage is 12V and if more voltage is incoming then the input will be cut off automatically)	6-12V
Rechargeable AAA battery	3-9V (Depending on the regulator)
5V cellphone battery	5V
3.7V cellphone battery	3.7V

4.2 Discussion

With several tests done with voltmeter and ammeter the apparatus showed the output voltage was accurate as per requirement of the objective as well as the output current did not exceed the maximum current flow limit that might harm the batteries that would be charged.

5. CONCLUSION

The use of cellphones has become a part and parcel of day to day life. As well as pencil batteries are used massively in clocks, TV & AC remotes, calculators, toys etc. The global population is tremendously large. Everyone needs to use at least one cell phone for communication and also to get access to internet.

We need electricity in every purpose of our life. Most of this electricity is produced by using non-renewable natural resources of earth which is very limited and will run out in near future. So we need to preserve this natural resources for future by limiting its use. Hence we should start using renewable energy. Sun is the largest resource of energy of our solar system. We should start using the solar energy to charge these batteries to save a massive amount of non-renewable natural resources of energy.

We should also consider that people are starting to use tablet PCs in a large number and these devices can be with the same apparatus.

So this experiment has great value and potential. This apparatus should be produced vastly and people should be encouraged to use this effective environment friendly apparatus which will preserve non-renewable natural resources for future use.

6. ACKNOWLEDGMENT

The authors are grateful to all the teachers and staffs of the Department of Mechanical Engineering, CUET.

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8. NOMENCLATURE

Symbol	Meaning	Unit
V	Voltage	(V)