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Wearable Shirt for Charging Mobile by Human Body Heat & Solar Power

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Abstract: **-- The following research considering proper usage of unused energy generated by humans in the form of heat and solar cells by making wearable shirt was designed and manufactured for charging the electronic devices such as mobile phone,laptop,etc.Integration of flexible solar cells and TEG into clothing can provide power for portable electronic devices. Photovoltaic is the most advanced way of providing electricity far from any mains supply, although it suffers from the limits of ambient light intensity. Alternatively human body heat is integrated for better outcomes, .The solar & TEG circuit consist of solar panel and thermoelectric generator; composed of two sources attached. Solar energy directly from sun radiation into electricity and TEG generate electricity from temperature difference. We introduced clothing-integrated photovoltaic and TEG their scope and limitations, the status of flexible solar Cells and TEG, charge controller and system design, as well as prototype solutions for various applications. The ability to harvest energy from the environment represents an important technology area that promises to eliminate wires and battery maintenance for many important applications and permits deploying self powered devices. This project paper suggests the use of a solar energy and body heat harvester to charge mobile phone devices proves its efficiency to charge the aimed batteries under sunlight and body heat separately. The wires and other accessories were attached inside the shirt, charging pins were placed inside the pockets of shirt. The designed shirt not only serves the purpose of wearing but also charges the electronic devices. It is cheap, easy to detach, washable and gives comfort to wearer.**

Keywords:**—TEG,Solar panel,Harvester, Shirt**

I. INTRODUCTION

The need for electronic devices that helps the human being in every day, now a days increasing features and possibility of modern mobile technology terminal devices. One last limitation is the demand for power supplies that allow unlimited operating and stand-by times. This project is based on energy producing from body heat and TEG. Extensive use of natural and renewable energy sources is needed to minimize the burden of fossil fuels. Burning of high levels of fossil fuels induce climate change, air and environmental pollution. Moreover, reason for switching from fossil fuels to renewable sources is their huge consumption and rapid reduction. A variety of renewable energy sources are readily available such as sun, wind, tides, and geothermal activity. An initial cost and maintenance cost of renewable energy is high but has no fluctuation in prices when in use as compared to the prices of electricity and gas.It is because renewable energies are fully dependent on natural energy sources, hence, eliminating the dependence on fossil fuels.

Though the years, technology has allowed the cellular phone to shrink not only the size of the ICs, but also the batteries. However, as technology has advanced and made our phone smaller and easier to use we still have one of the original problem that we must plug the phones into the walls in order to recharge the battery. Most people accept the reality as there is no other option to this problem so they carry extra batteries with them. Every time it is not possible to charge mobile batteries everywhere at any time so we design this mobile charger from which we can charge the mobile battery anywhere at any time.

II. TECHNOLOGY TRENDS IN MOBILE COMPUTING

Mobile phone companies often sell more batteries than phones to consumers. The phones sold to users include a rechargeable battery so that the device is immediately useful, but a certain number of consumers

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are expected to own more than one battery during the life of their phone. The same can probably be said for laptops and camcorders. Yet, there is little incentive for consumers to buy new batteries except for when they fail or when the consumer feels the need for a larger battery.

What is an energy harvester?

The term energy harvesting summarizes several different approaches which might lead us a step closer to such an ideal world. Instead of charging wearable with some sort of cable, new wearable could produce the energy they need from the light, heat or vibration in their surroundings.

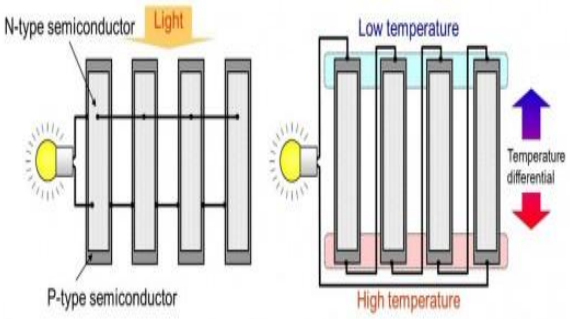


Fig (a) solar and body heat to generate electricity

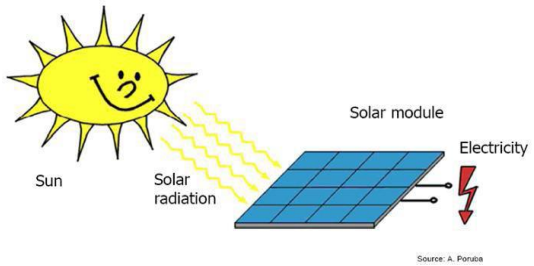
Heat from human body

The human body biological continuous produces heat shown in fig .1,These TEG Devices with direct contact to skin of the human body utilize this wasted energy into electricity by means of thermoelectric generators (TEGs). This important technology for self-produced power supplies consists of a TEG module that employs the temperature between the hot (body) and cold side of the thermo pair to generate electricity

III. SOLAR ENERGY

A) How electricity produces from solar panel

The principle used to generate electricity from the solarpanels is the same as that used to generate electricity fromthe chemical reaction using a standard battery. The basic working of solar panels depends on the semi conductor property of silicon. The silicon is a unique substance that has revolutionized the way electronic appliances work



Problem definition

Some developing countries and most populated industrialized countries (India china Mongolia Korea) etc. have average of 3 to 4 mobiles per family all are depending upon the grid supply .shortage of electric supply leads to reduces the production of electronic devices.

- In present there are solar power banks available but these all are not sufficient to charge mobile fully.
- Now a days without mobile we cant live in modern so that carrying mobile with charger and searching grid supply is difficult
- By researching areas like space and forest there is power required in the field so present power management is difficult by using batteries
- The last problem but not the least in present there is a daily power cut at village side even farmer cant able to charge the mobile .so communication problem occur village side

IV. OBJECTIVE

- The main aim of this project is to utilizing the human body heat and solar power for charging mobile electronics develop much cleaner noise less cost effective
- The entire system should be built indigenously built in order to provide jobs and a self-sustaining production system
- The product should be easy to visualize and should minimize design complexity, but should be durable and able to resist damage when handled on a daily basis
- It should be aesthetically appealing and easy to use so that the public can use it without assistance

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- ♣ The product should be able to charge a cell phone in a similar time frame to the current method, meaning within 6 hours for a complete charge cycle.
- ♣ The product should be versatile and charge the different cell phone brands available in the community
- ♣ Attractive wearable shirt with flexible solar and TEG design with charging option,
- ♣ Charge the mobile battery where ever requirement is needed
- ♣ Maintain the heat transfer from hot side to cold side because of uniform charging mobile battery
- ♣ By integrating solar panel & TEG to get sustainable required output maintaining properly

V. SCOPE OF THE STUDY

The scopes of project study are;

1) By integrating solar and body heat for continuous charge the portable equipment like laptop mobile any electronic equipments

2) by using thermoelectric generator connecting in series /parallel we can generate the power for maximum level not only body heat waste heat also possible to produce electricity

3) For the space research and satellite communication this type of mobile charging may helpful

4) By designing and implementing to clothing industries it leads to development of country and manufacturer clothing design increases the marketing

VI. DESIGN METHODOLOGY

For designing the solar shirt; solar cell, ICs, regulator and ready-made shirt were used. The solar cells (2 sets) each of 12 V were connected in series. And 6 TEG modules are attached in series and parallel to the shirt. Solar cell senses the sunlight and generates the DC voltage. And TEG senses a body heat Two ICs were used for charging the mobile, iPod, mp3 player and laptop and work as a charge controller. There were four rechargeable batteries (each of 4 V and 1.2 A) connected to store the electric charges and can be used to charge the devices in the absence of sunlight(exceptional case and easy to remove the storage battery). A reverse diode was also attached for one way passage of current

VII. LITRATURE SURVEY

a) Solar cell phone charger

Eligibath de regt,faun de diag,siddarth paiFollowing a research trip to Sabana Grande, Nicaragua during which we looked into a variety of different of cell phone owners in Sabana Grande with no access to grid electricity

b) Solar Mobile Charger

Rohit kamble, Sameer Yerolkar, Dinesh Shirsath, Bharat Kulkar

VIII.BLOCK DIAGRAM

A) Solar panel

The solar panel of 13*5 inches was sealed using glass sheet coating. Solar panel converts directly sun radiation into electrical energy

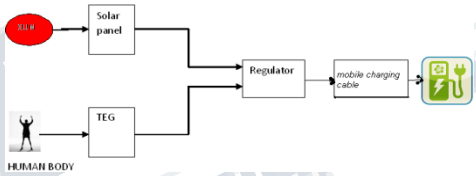
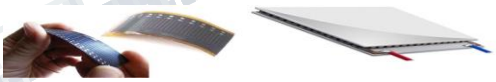


Figure (A);block diagram



Fig; solar panel and TEG

B) TEG (thermoelectric generator)

The waste heat can be used to generate electrical power using thermoelectric power generation (TEPG) TEC12706 devices shown in fig 3.2.1, the generated electrical power can supply the electronics and control systems or can be used for other purposes to increase the overall efficiency

When heat from human body of one side there will be a continuous electron or holes will flow continuously based on the temperature of heat. If the temperature is increases the voltage is also increases vice verse in such a way that the other side of thermoelectric generator is cold because heat transform is uniform then only electron will flow and voltage is developed at the output side of the thermoelectric generator

C)Voltage regulator (control circuit)

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In this part voltage from the TEG is regulated by required voltage for mobile charger hence the this involve capacitor , resistor, potentiometer ,and zener diode as a voltage regulator Normally voltage regulator can control the output voltage under the required condition and it helps to charge the mobile for different ratings

D)Mobile battery

After the regulated voltage is passed to the battery terminal to charge the mobile so that the required specification is 3.8 v li-ion batteries 5.70wh is required. Finally the mobile battery will charge under desired voltage condition

The basic structure of thermo electric generator

thermoelectric generator is a solid state flexible device that consists of a P-type and N-type semiconductor particle connected in series, shown in Figure

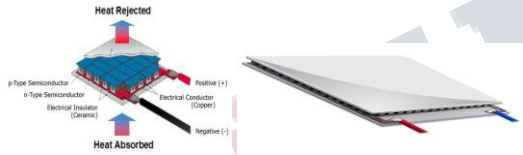


Fig (a); TEG module

Body heat to generate electricity using thermo electric generator

The basic technology behind the concept of turning body heat into electricity is a thermoelectric device. It is usually a thin conductive material that exploits the temperature difference between its two sides to generate electricity, known as the Seebeck effectA thermoelectric device placed on skin will generate power as long as the ambient air is at a lower temperature than the body is shown in fig 4.5.1, A patch of material one square centimeter in area can produce up to 30 microwatts. Place these generators side by side to multiply the amount of power being harvested.

A solar cell is a solid-state flexible electrical device (p-n junction) that converts the energy of light directly into electricity (DC) using the photovoltaic effect.

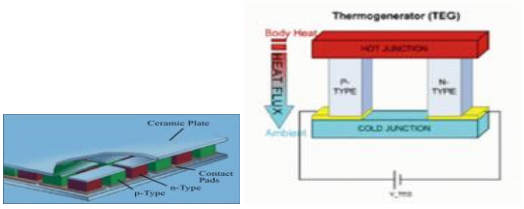
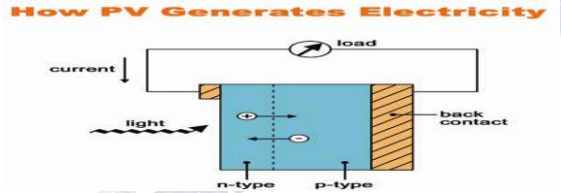


Fig (a); human body heat generate electricity

Flexible solar cells

A solar cell is a sandwich of n-type silicon (blue) and p-type silicon (red). It generates electricity by using sunlight to make electrons hop across the junction between the different flavors of silicon:.

Photovoltaic effect: The collection of light-generated carriers does not by itself give rise to power generation. In order to generate power, a voltage must be generated as well as a current. Voltage is generated in a solar cell by a process known as the "photovoltaic effect."



Construction And Working Wearable Shirt To Charge Mobile

IX.EXPERIMENTAL TRIAL TO CHARGE MOBILE BATTERY BEFORE STITCHING TO SHIRT OR ATTACHING SOLAR PANEL

The prototype uses a simple hinged system which serves two purposes:

1) To angle the panel towards the sun so as to maintain a perpendicular planar angle. The panel is held in position by a notched wedge system

2) To protect the circuitry and phone from any light rain that may begin before the user has a chance to bring the system indoors.

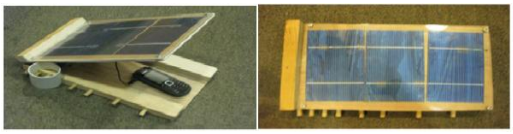


Fig (a);Experimental trial to charge mobile battery

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We designed our system and internal circuitry so that it could be easily reproduced given design schematics.

Testing ;Once the solar cell phone charger prototype was completed, it was necessary to test its real life performance.

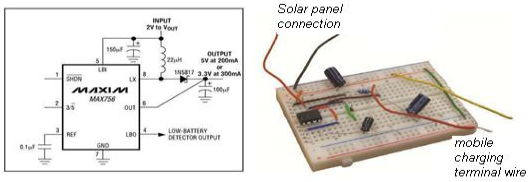
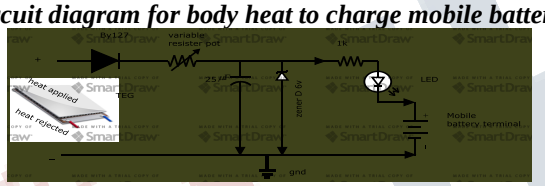


Fig ;Circuit diagram of solar to charge mobile battery

Our main goal at the beginning of this project was to have a cell phone charger that could charge a fully discharged cell phone in less than 6 hours. To test if our model could fulfill this task, we measured the power coming out of our circuit and into the cell phone and compared it to the energy capacity of the battery we were charging.

Circuit diagram for body heat to charge mobile battery



Fig(b);.circuit diagram for charging mobile battery

Figure (b) shows the circuit diagram to charge the mobile battery by using thermoelectric generator. In the thermoelectric module heat from body of one side of the module and heat is rejected on the other side. heat sink metal is fixed used to cold the other surface. As it is heat transfer take place from heat applied side to cold side. These thermoelectric generators of two terminals are to connected i.e. positive terminal is connected to diode side and the other terminal is connected to ground Circuit elements consist of Diode (BY127),Potentiometer (10kpot),Capacitor (50micro farad),Zener diode(6v),LED (3.5v),Mobile battery (3.8v)

When heat from body of one side under certain temperature (30 to 70 degree C)A thermoelectric produces electrical power from heat flow across a hot to cold side temperature gradient. order to reach the goal a few volts at the load, more thermoelectric generator need to be connected in series to make the maximum voltage. Thermoelectric device diode eliminates the reverse flow of electron to the thermo electric generator so that continuously electron will flow through diode when body heat to the TEG.Zener diode helps to eliminate the excess voltage flow to the battery because battery required to charge only bellow 6v range so that zener diode helps to maintain to battery charge safely and it reduces the over voltage .Zener diode range can be used as a 6 **Circuit diagram and working solar panel to charge mobile battery**

The MAX756/MAX757 are CMOS step-up DC-DC

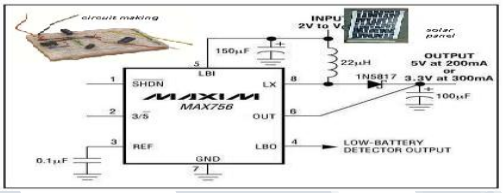


Figure (c);5 Volt From 1.5 Volt Circuit Schematicswitching regulators for small, low input voltage or battery-powered systems. The MAX756 accepts a positive input voltage down to 0.7V and converts it to a higher pin-selectable output voltage of 3.3V or 5V. The MAX757 is an adjustable version that accepts an input voltage down to 0.7V and generates a higher adjustable output voltage in the range from 2.7V to 5.5V. The circuit can be easily wired on a very small rectangular common PCB.All connections should be kept as short as possible.

X. CONSTRUCTION OF WEARABLE SHIRT FOR MOBILE CHARGING

The solar panel of 12*4 inches was sealed using glass sheet coating. For attaching the solar panel along with other accessories (circuit as shows in fig 1), a hole of 2* 1.5 inches was cut for solar panel and 8.5*8.5 inches was cut for wires inside the shirt. Through the hole, wires and ports were passed into the first layer of shirtt. Whereas, panel was attached at the back of the shirt using sticky gum.Other accessories of solar panel such as wires were attached using the small pins detachable ports were used to connect the charger pins; fig shown

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XI.CONSTRUCTION STEPS AND WORKING

Step1- trial;Step-2 –making,Step 3& 4-view

Working of wearable shirt

While stitching the wearable shirt we should checked properly weather the required circuit design is suitable or not for charging After checking the voltage and current level of the circuit mobile battery charging pin is connected By solar supply panel is connected to dc-dc step up converter this step up converter increase the voltage from 1.5 to 5 volt for required out put

XII.TESTING AND RESULT DISCUSSION

A) Testing solar mobile charger before attaching to the shirt

Once the solar cell phone charger prototype was completed, it was necessary to test its real life performance. Our main goal at the beginning of this project was to have a cell phone charger that could charge a fully discharged cell phone in less than 6 hours. To test if our model could fulfill this task, we measured the power coming out of our circuit and into the cell phone and compared it to the energy capacity of the battery we were charging.

Charging Time

The energy capacity of the cell phone batteries is 800 mAh. The test setup gives the required out puttocharge the mobile battery before stitching or attaching to the wearable shirt. so that we checked the trial for our project to reach the objective to charge mobile

Experimental set up:

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Figure(a)testing before attaching to wearable shirt

We attached two digital multimeters that measured the current and voltage output in real time from the leads coming out of the solar cells so that we could calculate the power input when the device was working. Moreover, we also attached two millimeters that measured the current and voltage output

B) Testing body heat to generate electricity to charge mobile battery

1) first we are using fully discharged mobile battery,
2) then heat from the body is measured by temperature sensor
3) The device is reported to produce an average power of 1mW when sitting in an office at 22ºC. As a result it could power health-monitoring devices such as electrocardiograms, which only require about 0.4mW. When body heat is less we are increasing the TEG module in series and parallel to charge the mobile battery.
4) battery will get charged 48% hence the output is obtained

Figure (B);Voltage And Current Indication By One Teg

C) Testing of Overall Circuit and Implementing to Wearable Shirt

Tested steps

- When the circuit design construction is over we go through the system weather the planed out put obtained or not.

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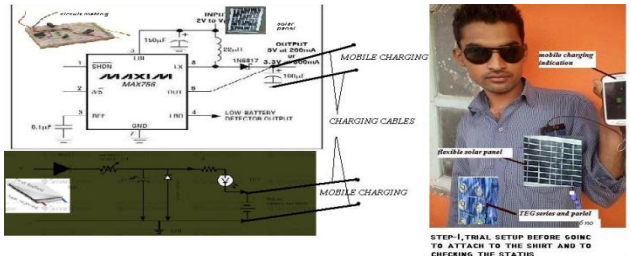


Figure (d); Power generation from solar and body heat circuit and implementing to the wearable shirt

- First we tested solar panel 12v 5watt 400mA 3 numbers output after experimental analysis over that panel is stitched to shirt for mobile charging.
- For charging mobile battery charger pin is provided from the circuit and battery get start charging slowly
- Charging Time ;The energy capacity of the cell phone batteries is 800 mAh. If we test the amperage output of our charger, we could figure out around how long it would take for the cell phone battery to charge completely.
- The mobile battery will charged completely after 3hrs approximately
- The body heat to charge mobile battery is constructed before we going to attach to the shirt first test the single thermo electric generator the specification are Operate from 0~15.2V DC and 0~6A,Operating Temperature 30to 220 degree C
- The connected circuit doesn't give required output so that number of TEG module is increased to charge the mobile battery (series and parallel) mobile get charged after 4 hours
- Finally both the module and circuit is attached to the shirt. the charging pin is available for charging every time so that mobile get charged fully so the experimental result achived

XIII. RESULT

The wearable charging shirt charges the cell phone in the same time as the normal charger does i.e. 3 to 3.5 hours., the wearer need not to stand under the sun continuously. Also checked the result There are body heat charge mobile battery at night. For charging the mobile battery according to the circuit design solar to mobile battery charged and it takes time of charging about 3 to 5 hours and the efficiency after connecting the circuit we got 65%

The graph below plots the power data in Watts for the input power, or power that was measured out of the solar cells and TEG, and output

The experimental result both solar and body heat the required output,. From the tested data, after attaching that if a cell phone battery were fully discharged, it would take about 3 to 5 hours for it to fully charge (the battery has an energy capacity of 800mAh). Realistically, some cell phone batteries are charged from half charge, based on rating of battery

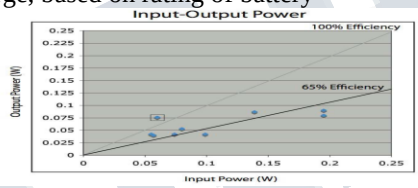
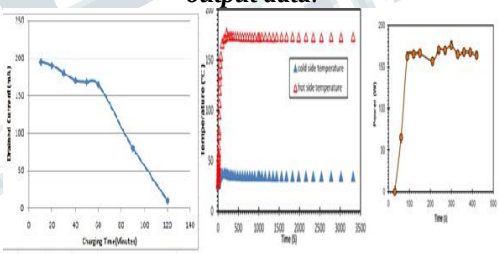


Figure (a);Input-Output Data Graph. Figure above shows the input and output data for the solar cell phone charger. Note the linear fit on the input over output data.



Fig;A charging mobile battery I vs time

Fig;B Temperatures on the hot and cold sides of the
Fig;c Power generated from the TEG p/t
The mobile battery charged fully by using solar and body heat .in the solar circuit and TEG circuit design we got required amount of charging the mobile battery by using voltage controller

XIV. CONCLUSION

Wearable shirt –integrated with PV cells and TEG are an interesting option for powering mobile electronic devices. Among various technologies for flexible solar and TEG modules.We consider the project to be a successful attempt at supplementing their energy

requirements while maintaining economic viability. Our initial goal was only to develop the economically viable circuitry required to step up the 1.5V to 5V to charge mobile battery . On developing the circuitry, we decided to prototype the entire system and did so successfully. The system gives the best economical pollution free, required energy solution to the people. The required voltage to charge the mobile is 3.7v that can be achieved. In the design of mobile electronics, power is one of the most difficult restrictions to overcome, and current trends indicate this will continue to be an issue in the future. Current technology innovation,CPU speed, and other functionality versus battery life in the creation of any mobile device. Power generation from the user may alleviate such design restrictions and may enable new products such as anywhere we can charge ,by manufacturing this suitable for our country and development

Acknowledgment

We gratefully acknowledge the indispensible contributions of many coworkersand students and co-operation of my Mother for his guidance in designing of project.To the memory of my BCET student " Bangalore breaks".

Scope Of The Future Work

- Manufacturing this type of wearable shirt that leads to improve the cloth marketing
- Eliminating the present circuit to small circuit to increase the beauty of shirt
- By adding efficient and flexible solar module and TEG module leads to increase the power production for other electronic component

Advantages

- Clean, Noise less #, Cost is less #This is a Non-conventional system # #No fuel is require #Easy maintenance # portable# Charging time is less (maximum temp)
- Promising technology for solving power crisis to an affordable extent.# Simple in construction.
- Pollution free.# Reduces transmission losses.
- Wide areas of application# Required less space
- It can be use at any time when it necessary.
- Less number of parts required. # we can charge any electronic devices
- Electricity can used for many purposes # efficient and eliminate the grid searching
- Attractive look for the wearer

Disadvantages

- Complex circuit design,not applicable for high voltage

APPLICATIONS

- Electronic equipment like mobile,laptops,ipod,etc can charge by using this design
- TEG module can be used for generate electricity from waste heat
- Self charging battery by fixing the TEG at radiator or two wheeler silencers pipe
- Power for satellite communication
- Space research and defense application
- Implemented to fores animals security

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