Thermoelectric Portable Mobile Charger Using LTC3108

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Abstract: ***This project focuses on the design and production of a compact and light universal thermoelectric charger capable of generating electric power through a thermoelectrical system. Using a thermo-energy converter, 5V power output can be produced directly from a thermoelectric module by translating heat energy to electricity where there is a different temperature on either side of the unit. The machine can be used anywhere and at any time, as electrical connections are not needed to operate.***

Keywords: Thermoelectric, Thermo, Electric, LTC3108, Electrical, Charger, Mobile, Portable, Cellular, Circuit, Charge, Voltage, Current

1. Introduction

Electrical power supplies are also one of the main components of human require-ments. One explanation is the mobile phone charging. In a person's daily life, mobile phones play a significant part. In our daily lives, therefore, electric power is necessary. Electricity is generated by a generator in remote areas, but it is too noisy to cost a lot of upkeep. The use of renewable energies, for example solar energy, is a further option, though, constrained by weather and topography. At night, the rest of us fill our smart watches, phones and exercise trackers with a jumble of wires and gadgets. It's a range that can not get smaller when wearable technology reaches our lives. Manufacturers and future-oriented workers expect that we will be energy independent soon and free from their uncertainty. But there is always a question: how? Solar chargers are actually the only key portable power sources, but they have major indoor and indoor drawbacks.

Kedar Hippalgaonkar, Jianwei Xu and their co-workers at IMRE think that, eventually, low waste heat – such as exhaust or body heat – will be used for energy equipment.

"Extensive excess heat in the atmosphere is spread," says Hippalgaonkar. "This means a large number. Converting this heat into energy is an outstanding resource.

The best method of producing electrical power is with thermoelectric. Heat can be turned into energy. In general, Universal Thermoelctric Charger can be defined as an instrument capable of generating 5V power through heat energy conversion into electrical energy. Body heat is superior to paws, when a different temperature occurs on either end of the unit, for generating and transferring heat straight to electrical energy through the thermo-electro-module.

The voltage increases steadily until the output voltage is 5V, and the output voltage stays constant and stable for USB service. Additional information on the thermoelectric universal charger is given in Chapters 2, and 3.

2. Problem Statement

Nowadays, as the world economy grows rapidly, more and more portable electronic products such as mobile telephones, smartphones, tablets, digital cameras, camcorders and more have been developed. All batteries have to be operated by batteries, but the battery capacity is restricted and not large enough to be used for a long time. For instance, it is typically difficult to locate a source of energy to reload these devices as people travel to remote areas like jungle or mountain. The battery is therefore always powerless. This type of problem, which is through portable electronic devices such as the power bank, can be solved alternative. The ability is nevertheless limited. This means that those devices can be charged by having a device that can utilize hand heat to produce electricity and DC voltage. This can be used particularly in case of an emergency.

2.1 Objective

The objectives of this project are:
1) To design a thermoelectric charger.
2) To design portable (small and light) equipment that's easy to carry.
3) To produce the 5V output voltage (USB port).

2.3 Scope of the Project

This project focuses on the design and production of a compact and light universal thermoelectric charger capable of generating electric power through a thermo-electrical system. Using a thermo-energy converter, 5V power output can be produced directly from a thermoelectric module by translating heat energy to electricity where there is a different temperature on either side of the unit. The machine can be used anywhere and at any time, as electrical connections are not needed to operate.

3. Literature Review

Today, the mobile usage is rising every day. The mobile battery drains easily, as multiple users use the mobile as their regular uses to browse the Internet and play games. The Power Bank is a common means of fast loading of the mobile without connecting to the grid. Power bank history begins in the years 2001-2003, when handheld energy batteries are supplied mostly with a battery. It was seen for the first time at the Las Vegas International Consumer Electronics Show, which took place in 2001. The birth of the external battery charger is assured by this event[1]. Power banks have the biggest benefit of being compact and easy to transport. But size and weight can vary based on the capacity. Light can also be used as a smaller power bank (2500mAh). Another value is that the potential of the power bank will now go up to 30,000mAh. This incredible ability allows the power bank to charge a standard smartphone like the iPhone 5s (1560mAh) up to 19 times. This huge number, though, results in bulky and bulky machines that are hard to carry for transport. Power banks can be a very valuable method to charge batteries of mobile devices while moving to remote areas such as the desert or camping at beaches. But after a time of use even a very large power bank can dry up. Therefore, it is vital to have a system that can produce energy needed to power electrical equipment batteries in an emergency using readily available material (usually taken together while travelling in remote areas).

Equipment and component

The following equipment and components are used for this project. Their description and details are briefly described.

Thermoelectric cooler (TEC) Module

The temperature differential can be rendered on both sides by the TEC module shown in Figure 2.1. There would be hot on one side and cold on the other. It can be used to warm up or cool down stuff, depending on which side we choose to use. Depending on its varying temperature, this TEC can produce electricity. This will continue as long as heat is adequately collected from the machines. This will continue. If the system is turned on, both sides are acting as heat quicker, although colder sooner on the cold side.

Figure 2.1: TEC 1-12706 [2].

Resistor (470Ω, 10kΩ, 470kΩ)

A resistor has two terminals on its part. It generates a voltage on its terminal equal to the electrical current that flow through it. In electrical networking and electrical circuit, Resistor is an important element. Tolerance, stiffness, power rating and maximum work voltage are the key features of the resistor. It functions as a noise, inductance and coefficient of temperature.

Capacitor (150µF, 100µF, 0.1µF, 1µF)

A condenser is one of a passive component, consisting of a pair of dialectally separated conductors, and is known as a condenser. Figure below displays the standard condenser. In this case, the dielectricity that holds an energy creates a mechanical force between the conductor, since voltage is on both conductors. An perfect capacitor, a single constant value can be defined and calculated in farad.

Light Emitting Diode (LED)

The semiconductor light source is a light-emitting diode (LED). It is used in many applications for illumination and indication lighting. It initially emitted as a low intensity red light when it was introduced as a practical electronic device in 1962, but nowadays, it has ultraviolet, high emission infrared wavelengths. If the LED is on, the electron is recombined with a hole in the system, releasing a photon energy. An LED can also be used to form the radiation pattern with tiny and optimized optical components.

Voltage Regulator

There is a three end positive control system available in the 78XX / KA78XXA series that is included in the TO-220 / D-PAK packet. In this unit, the output voltage is severally set and used in a wide variety of applications. Each type requires a small internal current, a safe working area and a thermal shut-down. It allows it to kill ultimately. If adequate heat sink is supplied, 1A output current can be supplied.

Universal Serial Bus (USB)

USB is intended to standardize the connexion to personal computer equipment (including keyboards, digital cameras, printers, disc drives and network adapters). It functions also as a source of electricity. Today, USB currently provides a range of serial and parallel port interfaces and distinguishes power loaders on the handheld devices.

Hardware Layout

4. Research Methodology

It has been mentioned from the previous chapter that the power bank has limited capacity. A system that has constant electrical energy saving capacity is suggested in order to solve this problem. It needs to be easy to ship and lightweight. This chapter will therefore explain the procedure or process used in the undertaking of this mission. In this area, students can all understand the features of the material selected and the proper way of doing this activity. The therapeutic charger is developed requiring multiple steps to be taken. This project focuses on the battery charger for the road. It helps people in charging devices that have no electrical power source using manual heat when travelling away. This project is aimed at developing a small, lightweight system to generate 5V output voltage. The mission was divided into two parts, hardware and software development, to accomplish the goal of this project. Livewire and Proteus to design the circuit are the applications used. Made with Sketch Up programme, the 3-dimensional paintings. There is a hybrid circuit used, including the voltage diverter and the voltage controller. In hardware inventions, product procurement, device acquisition and project execution are included. More on the project will be presented with the project flow map in Figures 3.1 and 3.2.

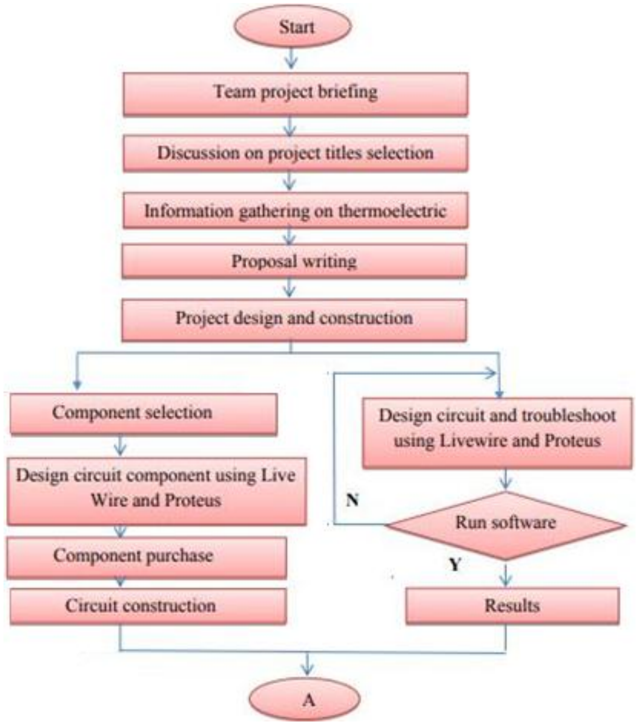

Figure 3.1: The flow chart for the Universal Thermoelectric charger project (1)

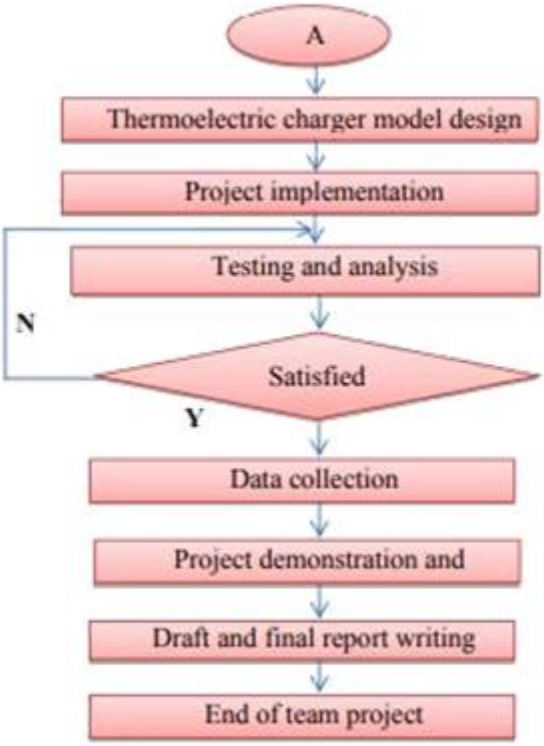

Figure 3.2: The flow chart for the Universal Thermoelectric charger project (2)

Circuit Design

In this section, the component parts that are used in this project are specified and the circuits that have been designed are presented.

Component Part

Bil.	Component	Types	Total [RM]
1	Teg	TEC-12706-1.5	140
	Module		
2	IC	L7850CV	18
3	Resistor	470ohm	0.8
		2kohm	0.8
		1kohm	0.8
4	Capacitor	0.33uF	1.6
		0.1uF	1.6
5	LEDs	Red	0.8
		Green	0.8
6	Accessories	PCB Board	15
		Stand Kits	10
		Jumper/Wire	10
		I/O Terminal	8
		Female USB Type A	8
		Heat Sink	10
		Multi USB Output	25
		Hand holder	20
		Candle	10
		Thermal Paste	11
7	Other	Acid	10
		Glossily Paper	9
		Box	2
		Double sided tape	2.8
	Total		316.00*

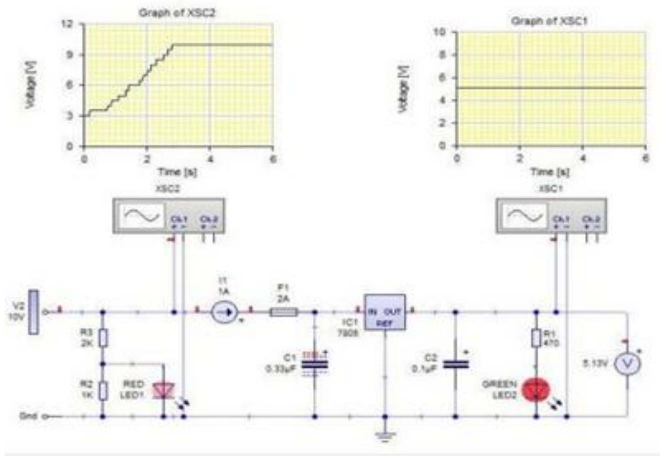

Figure 3.3: Circuit Design using LIVEwire software.

The main power source for space experiments already are high-temperature thermoelectric generators. The Mars rover, Curiosity and Voyager 2 are using long-lasting nuclear radiation. The interstellar space probe. The latter has worked for more than 40 years on this type of power. Hippalgaonkar clarified that "the production of thermoelectric electricity is not a new idea. "The research has been conducted since the 1950's and progress on new materials has been extensive, but most of the work in the past was focused on hazardous, inorganic materials and applications with high operating temperatures."

Hippalgaonkar believes that the explosion of Things' internet provides a market for small, non-toxic power sources. If they used body heat to make energy efficient, potential body sensors and portable devices could continuously be used. "We do need to develop appropriate new, non-toxic, and cost-effective thermo-electrical materials at lower temperatures"

Any waste heat that is escaping by exhaust from cars, aeroplanes or ships is another major opportunity to be used, he says. The generated electricity can then be recycled into the vehicle and its environmental impact reduced.

The PHAROS project by A*STAR concentrates on materials to create these heat generators. The five-year project, started in 2016, seeks to find a non-toxic and preferably Earth-rich material composition (which makes it cheap), efficient and easy. In this sense, less toxic hybrid materials are being developed, mixing organic and inorganic materials, and those with a thermoelectric power generation potential at a low temperature.

The project involves Hippalgaonkar, a solid-state physicist with an expertise in nano and 2D nanoscale and electron behavior, and Jianwei Xu, a physicist with extensive research experience in organic materials, especially semiconductor polymers. The project is an international research organization.

Turning down the heat on thermal power

A generator uses the Seebeck effect for the charging of personal devices using thermoelectric materials in which a temperature differential induces electric tanning at the junction of two materials (often p- and n-doped semiconductors, however). You can use this voltage to drive or load a system.

To date, the most popular thermoelectric compounds, including plumbing tel-luride and bismuth counteruride, have been focused on metal counterparts. These are commercially available and are used to manufacture energy from satellites and space probes locally as a power source. But at high temperatures they are only efficient, and an onboard nuclear isotope is used in space to create this heat to produce a high temperature difference. The solution can serve as a long-term, local power source, but the likely health hazards presented by nuclear radiation do not make it ideal for many terrestrial use.

"With the PHAROS plant, there is a lack of efficient material working at room temperature," says Xu. It is however difficult to recognize, manufacture and understand the events of new candidates' thermoelectric materials.

To date PHAROS 'team is studying a broad number, combined with an inorganic portion consisting from, say, tellurium nanowires, silicone nanoparticles or 2-D materials including, MoS2, a conjugated semiconducting polymer for the organic component of its hybrids (such as polyaniline, P3HT or: PSS). With these, the use of carbon nanotubes as a substitute was explored.

The team also discusses methyl ammonium lead iodide perovskites1's thermo-electric potentials, an inorganic-organic hybrid material system which has been known for its active use in solar cells in recent years. In terms of power transfer performance, this hybrid material beats silicon. The main advantage of the use of a partial organic system is that it is ideal for processing solutions that create wide-ranging, thin, flexible materials that can be printed in a cheap way.

In order for a thermoelectric material to perform properly, a high Seebeck coefficient preferably needs to be usable, which means the amount of voltage produced for a given difference in temperature. And the material must also have high electrical conductivity to allow a charge to move easily, and low thermal conductivity to sustain the temperature gradient.

"These qualities are very difficult to hit at the same time," Hippalgaonkar notes. "Ideally, you want to find the stuff that balances wood's low thermal conductivity with metal's high electric conduction and that's not easy to achieve."

Materials with a perfect score

The so-called 'TZ value' was created to take Seebeck's coefficient, thermal conductivity, electrical conductivity and temperature into account to further promote comparisons between materials. "We want to have something that has a ZT of approximately 1," says Xu. But, for many implementations, a high ZT number is not required. A 1 can now be manufactured in bismuth telluride and lead telluride, however both materials are poisonous, costly and rigid to process.

In recent days, a healthy, 10-20% route to a perfect thermoelectric scorecard is developed by the PHAROS team. They achieved this by refining a materials system that combines a carefully designed conjugated polymer with a tellurium nanowire in conjunction with researchers from the US-based Lawrence Berkeley National Laboratory (LBNL). ZT values were recommended to be approximately 0.1–0.22.

This finding has been supportive of the interactions between the organic and the inorganic constituents of material made by the LBNL Jeff Urban team by Shuo-Wang Yange of the Center for High Performance Computing at A*Star. The dynamics of how charging flows into these complex materials was outlined for the first time by the experimental and theoretical work done by the Hippalgaonkar team and laid a strong foundation for future development.

"It is very important to investigate the interaction between organic and inorganic interfaces," states Hippalgaonkar. "It is incredibly difficult to understand the mechanics of how load passes through such a complex landscape.

"Thermoelectric will provide you with the opportunity to make your own sensors as quickly as possible," says Hippalgaonkar. For example, heart rate monitoring with a few hundred microwatts have very modest power requirements. A material with a ZT of 1 working at room temperature of approximately 10 ° C produces roughly 50 microwatts per centimeter and the new material from PHAROS could, in principle, produce 10 microwatts per square centimeter at room temperature. Hippalgaonkar says that small-scale thematic electricity is already attractively close to reality. And once their commercial commitment begins, they just speed up their work.

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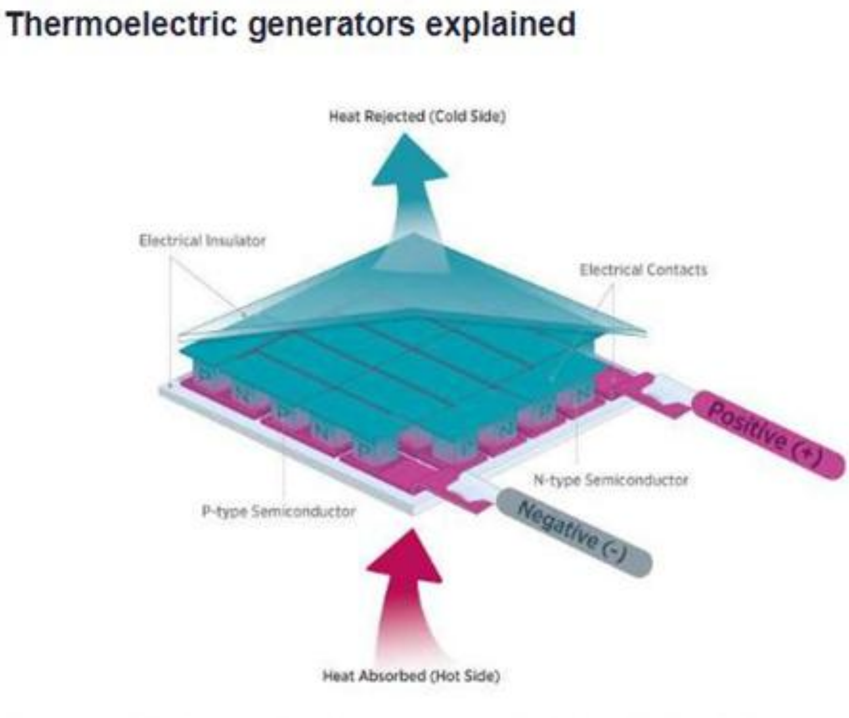


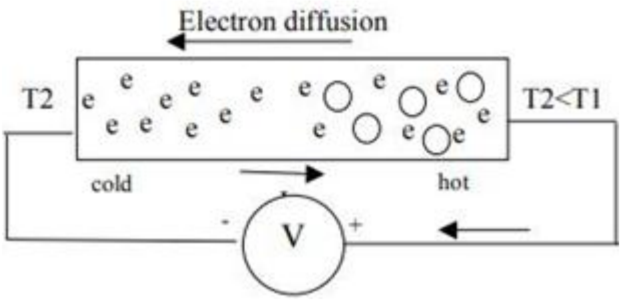
A diagram of a thermoelectric power generator. Credit: Nature Research

A TEG is a system that transforms a temperature differential into one voltage and controls the transfer of electricity through a circuit. It is a way to transform waste heat into fuel. The Seebeck effect, noticed by the German physicist, Thomas Johann Seebeck, in 1821, is responsible for such instruments.

A TEG is normally created using doped semiconductors p- and n-type to create two routes that bind with separate temperature metallic electrodes, one hot cold. The Seebeck effect means that the holes in the p-type materials, the electrons in the n-type material diffuse from the hot electrode to the cold electrode, resulting in voltage and current leakage. The mechanism can also be performed reverse where the Peltier effect is known, and cooling at the material junction is triggered by the injection of an electric current. Particularly in small-scale machines, thermoelectric coolers, also known as Peltier coolers, regulate the temperature of sensitive electronic and optoelectronic equipment including laser diodes and photodetectors.

Seebeck effect

Thermal energy typically is a byproduct of other energy forms such as chemical, mechanical and electrical energy. The process of transforming electrical energy into thermal energy is called play heating. heating. Hence, when the current passes in, the wires heat up, and the foundation for electric stoves, toasters, etc.

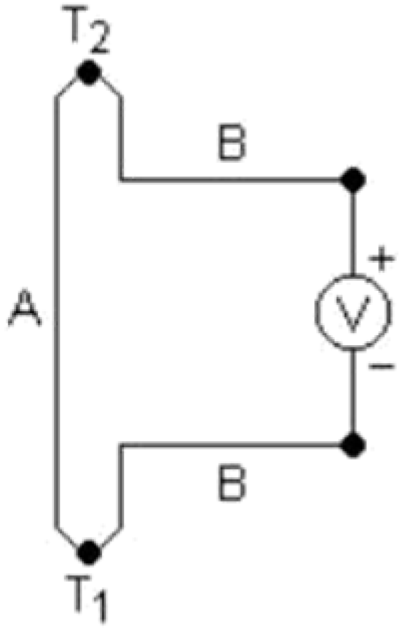


Electrons diffuse from the hot to cold side of the metal (Thompson EMF) or semiconductor leaving holes on the cold side.

As two ends of a driver are kept at various temperatures, electrons migrate to cold at a heat crossing at higher thermal speeds. Seebeck observed that the output of an energy exchange between the two ends was hotter or colder for one end of a metal strip. He experimented with crossovers between various conductive materials (simple mechanical connexions). He noticed that the wire linking the two junctions would allow a compass needle to deflect if he created a temperature differential between two electrically linked junctions (e.g. heating one of the junctions and cooling the other). He claimed he had found a way for thermal control to be converted into a magnetic field. Later, the magnetic field in the circuit of the increasing emf V (Lenz 's Law) was created by the electron diffusion current. The size of the emf V formed between these two interfaces depends on the material and on the temperature of the emf T12 by means of a linear relation describing the Seebeck S ratio of the material.

V=S T12

The Seebeck coefficient can be measured Figure 2, by connecting wire-A in a circuit with 2 wire-Bs. The two junctions (ends of wire-A) are held at two temperatures, and V measured as T1 or T2 is varied, Diagram of.



Experimental setup for measuring the Seebeck coefficient S

Only terminals 1 and 2 need be considered if the B-leads at the voltmeter are kept at the same temperature. If T1>T2 electrons flow to T1 leaving T2 more positive.

Vb-Va = SA(T2-T) Vc-Vb= SB(T1-T2) Vd-Vc= SA(T-T1)

V = (Vb-Va)+ (Vc-Vb) + (Vd-Vc)

V=SAT2–SAT+SBT1–SBT2+SAT–SAT1

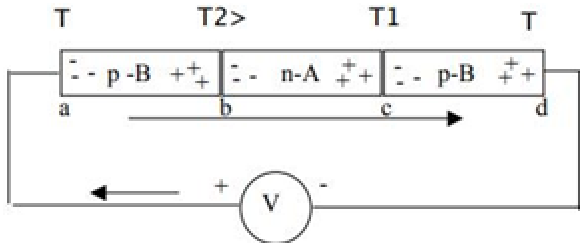
V = SA(T2-T1) - SB(T2-T1) = (SA-SB)(T2-T1)

Q = q V = q (SA-SB)(T2-T1)

dQ/dt = I (SA-SB)(T2-T1) = I Π12

Peltier Effect (1834)

The Seebeck effect can also be reversed: you can create a temperature differential by moving a stream through two junction points. In 1834, the scientist Peltier discovered this phenomenon and it is therefore known as the Peltier effect. This might sound like the above mentioned Joule sun, but it doesn't actually happen. In Joule heating, the temperature of the fluid in which it passes raises the current. A temperature differential is produced in Peltier effect devices: one intersection is cooler and one link is colder. While Peltier refrigerators are not as powerful as some other kind of refrigerators, they are reliable, easy to manage and easy to modify. Micro-electronic equipment including micro-controllers and computer CPUs are used for coolers of the Peltier effect system. Software hobbyists often use it to help them to get mi-croprocessors overclocked for more power without allowing the Chip to overheat or fail.



Two dissimilar metals or semiconductors connected at b and c.

The junction at T1 heats up while the junction at T3 cools.

Vb-Va = SA(T2-T) Vc-Vb= SB(T1-T2) Vd-Vc= SA(T-T1)

V = (Vb-Va)+ (Vc-Vb) + (Vd-Vc)

V=SAT2–SAT+SBT1–SBT2+SAT–SAT1

V = SA(T2-T1) - SB(T2-T1) = (SA-SB)(T2-T1)

Q = q V = q (SA-SB)(T2-T1)

dQ/dt = I (SA-SB)(T2-T1) = I Π12

LTC3108-1

The highly integrated DC / DC converter LTC3108-1 is suitable for capturing and monitoring excess power from very low voltage sources like TEGs, thermopiles or small solar panels. Input voltages of 20mV are used for the stepping-up topology. The LTC3108-1 offers a complete power management solution for wireless data sensing and processing through a simple step-up transformer. The LDO 2.2V powers the outer microprocessor, while the main output is designed to control a wireless transmitter or sensors at one of four fixed voltages. The strong indicator indicates that the main output voltage is regulated. The host will trigger a second display. When a source of input voltage is not usable, a storage condenser provides power. Extremely low relaxing current and high performance construction provide the condenser with the highest charging times available. Without its special VOUT set options, the LTC3108-1 practically matches the LTC3108. A slim thermally strengthened 12-lead (3 mm / 4 mm) DFN kit and a 16-lead SSOP package is also available for the LTC3108-1.

Pin Functions (DFN/SSOP)

VAUX (Stick 1 / Step 2): Internal Circuit Rectifier and IC VCC output. VAUX bypass with a capacitance of minimal 1μF. VAUX is clamped to 5.25 V (typical). An active shunt regulator.

VSTORE (Storage Capacitor or Battery output) (Pin 2 / Pin 3). In case of a loss of the input voltage, a broad condenser may be attached from this pin to GND. The full VAUX clamp stress is compensated. This pin should be left open or attached to VAUX if not used.

VOUT (Pin 3 / Pin 4): Converter 's primary output. The voltage of this pin is set to the VS1 and VS2 voltage. Attach this pin to a condenser or rechargeable battery.

VOUT2 (Pin 4 / Pin 5): Converter Switching Output. Attach this pin to a load that has been modified. This output is available before VOUT2 EN is powered up and linked to VOUT via a 1.3 to P-channel transfer. This pin should be left open or attached to VOUT if not used. The peak flow is typical of 0.3A in this stream.

VLDO (Pin 5 and 6): 2.2V LDO performance. Attach the GND to this pin with a 2.2 μF or larger ceramic condenser. This pin should be added to VAUX if not used.

PGD (Pin 6): Good power output. Power Output. If VOUT is within 7.5 percent of its size, a 1 M digit resistor will pull the PGD to the VLDO. If VOUT goes below its scheduled PGD value by 9%, it will fall below. Up to 100μA this pin will sink.

VS2: VOUT Pick Pin 2 (Pin 7 / Pin 10). To set the output voltage, connect this pin to the floor or VAUX.

VS1 (Pin 8/Pin 11): VOUT Select Pin 1. Connect this pin to ground or VAUX to program the output voltage.

VOUT2_EN (Pin 9/Pin 12): Enable VOUT2 data. If this pin is pushed strong,

VOUT2 is enabled. An inner 5 M pull-down resistor is accessible on this board.

This pin will stay open or grounded if not used.

C1 (Pin 10/Pin 13): Input to the preparing and changing device. Attach a condenser from this pin with the step-up transformer's secondary winding.

C2 (Pin 11/Pin 14): Enter to the drive mechanism of the N-Channel Doors. Connects a condenser to the side winding of the step-up transformer from this pin.

SW (Pin 12/Pin 15): Interior N-Channel Drain Turn. Link the pin to the transformer 's main winding.

GND (Pins 1, 8, 9, 16) SSOP Only: Ground

GND (Exposed Pad Pin 13) DFN Only: Ground.

The exposed DFN pad has to be soldered to the floor level of the PCB. It serves as the relation between the ground and heat from the die.

L7805 Voltage Regulator

This series is designed for a wide variety of applications with an integrated voltage controller with fixed voltage. These implementations cover on-card noise-removal control and single-point propagation concerns. Up to 1,5 A of output current could be provided by each of these regulators. These regulators are effectively resistant to overload because of their intrinsic current restricting and heat shutdown functions. In addition to being used as fixed voltage controllers, they can also be used as a power-pass element in precision regulation, using external components to obtain adjustable output voltage and streams.

5. Conclusion

This project was a rather good version of the Universal Thermoelectric Charger, which performed well for the entire system. Our project is basically based on the thermoelectric technology that transforms heat energy into electricity for chargers and coolers. The adapter is for the storage of the hand phone. The goods recharge the battery using a great deal of electricity. But our initiative will also save a lot of money, and will not only conserve energy from gas. Thermoelectric power generation may be used in combination with DC and DC voltages that transform to autonomy and self-support without the usage of a power source. UTC can be a suitable device to generate energy in space, especially when other power sources are unable to work.

The water tank is used to guarantee that the temperature does not reach the thresholds, and the extra USB port is required to connect to a multi-USB network. In the case that the voltage is exceeded the cap, priority should be given to shielding all device components from harm by utilising the fuse on a step-down control circuit.

Our group hopes, as a student, that this idea will be distributed domestically and internationally. The computer developed by our community is compact, mobile and user friendly, and smaller. Just USB multi-charge cables need to be plugged in at the USB socket, and then attached to the computer compliant handset. The projects are configured to use the water tank and the USB port to ensure that energy can be supplied through the system due to previous experiments. The project is In order to improve this prototype for future work, the system can be rendered water-resistant by using another content. Moreover, it will produce smoke when the cause heats the thermal sink, causing air pollution. So it is a safer option to create a cover that covers the vent, ensuring that the exhaust valve is sealed shut and mounted to keep the smoke out. Besides, once the framework has been built, this project is viable and marketing strategies for this project can be made. The selling advantage of this project is really strong because of the expense and energy use reduction and is flexible on distance travel.

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