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Energy Harvesting Using Renewable Sources for Aeronautics Application

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Abstract: An effective energy generator deployed to the power conditioning for wireless sensor network adopted for aircraft health monitoring. This harvesting system captures energy from its environment. Here, two types of energy are used (thermal gradients and vibrations) and stores this energy in super capacitor. This paper presents recent developments in energy and these technologies for structural health monitoring applications. It also has a capability of harvest energy even when thermal gradients have disappeared and one of the major considerations is using of ultralow power converter. The simulation of the proposed system and validation of results is carried out in the MATLAB/SIMULINK software environment.

Index terms: Energy harvesting, Wireless sensor network, thermal gradients.

1. INTRODUCTION

To meet out the provocation in aircraft system and to energize the structural health monitoring this harvested energy is implemented. The energy synergy between harvesting and scavenging using renewable sources like thermal gradients, vibrations etc.., captured and stored for small wireless autonomous devices, and wireless sensor network [1]. Rapid advances in wireless technologies and low-power electronics have enabled the increased use of continuous systems for the monitoring of structural health. The use of wireless structural health monitoring (SHM) [3]. Wireless systems can provide continuous monitoring which, depending upon the size of the sensor network can be prohibitive. Since many wireless sensor nodes are powered by traditional batteries that must be replaced, recent research has focused on deploying systems that can be powered by harvesting ambient energy, such as mechanical vibrations, thermal gradients. One of the major advantage is using of super capacitor. Where, a power density is greater than conventional batteries. In this paper, we deployed an ultralow power converter for harvesting energy generator commitment to aeronautics applications that would enable infinite energy to a WSN node [4].

An advantage of a TEG compared to a vibration-based energy harvester is that it has no active device. One of the major drawbacks is that TEGs are relatively inefficient at very low thermal gradients are implicit were too large to integrate them with MEMS technologies. Aircrafts flying at high altitudes are related to large thermal gradients, the use of TEGs to power wireless SHM sensors.

2. AIRCRAFT ENERGY GENERATION

The generation in aircraft system is depending on two sources: energy harvesting and energy scavenging and the harvested system are larger than the cable the wireless power sensor network in a wired compensation. In aircraft energy generation, use of secondary batteries is strictly temperance which is worst conditions. Ultra capacitor also known as super capacitor they act as a storage device.

The above gradients can be converted into voltage through thermoelectric generator based on the See beck effect. These components are then fabricated into an assembly to function as one unit called a TEG Vibration sensor is sensed by piezo electric sensor. Vibration is a source of including energy commonly converted into usable electrical energy. Typically, the electrical energy is generated by using vibrations offered in the environment system through a piezoelectric material.

Depend on the storage in super capacitor level, power dissipated is energized which is not permanently utilized. At last PMOS is designed for low dropout (LDO) regulator. An appropriate energy efficiency with an energy management with proper maintenance and will save energy.

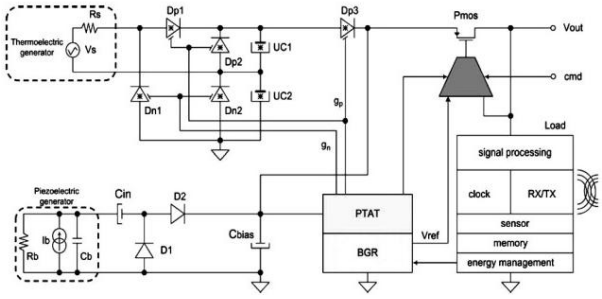

Fig: 1 proposed battery free energy harvested schematic diagram

3. SYSTEM DESCRIPTION

In this system consider two effective sensors, TEG as a main source and vibration as a secondary source.TEG is detected using a peltier sensor and vibrational energy sing piezo electric sensor. Filtered energy is stored in the super capacitor which will act as an energy density greater than batteries. The stored energy is given to the input of the boost converter. The Boost converters will step-up the output Voltage than the input voltage. The Boost converter output Voltage is given to the rechargeable battery for

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charging purpose. The battery output is given to the inverter and then the inverter will convert DC voltage into AC voltage. The Converted AC voltage is given to the high voltage load.

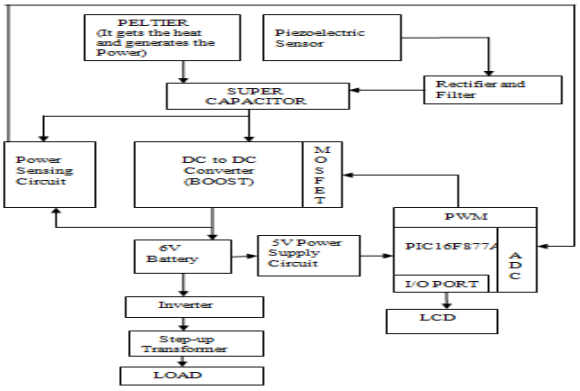

Fig: 2 Block diagram for battery free energy harvesting

Microcontrollers are used for more specific applications. Now a day's PIC16F877A PIC controller is most widely used device. The reasons for its wide usage and it have large memory capacity; it has adequate input /output ports.

A. Maximum energy transfer

In thermal gradients, energy harvested through two voltage polarities and as considered one polarity we are need to connect rectifier before storage capacitors. Active diodes are connected across the super capacitor and these diodes control over the require voltage regulator to the PTAT block circuit shown in fig 1.

Ultralow power consumption are energize with requirement of a low quiescent current of the full converter. It is as low as possible for threshold MOS transistor which can be dismantled during process variation. The main issue could be provided by the operational amplifier to the gate of the MOS switch and high d.c gain. Once this voltage is reached, the threshold voltage of the active diode is provided by the source to drain voltage of the MOSFET switch.

B. Energy profitable

The energy consumption for a minimum current energization, the active diodes is design for the threshold voltage in the range of 10 mV with a consumption of few hundreds of nA. For implementing of low bias current, we modeled a voltage and current at a nano watt reference. To precede MOS transistor device is used in the linear region with the absence of resistor.

The main purpose of this modeling is to enhance the power management in the harvesting system. But implementing of power consumption cannot be checked using a device, simply we are checking the current reference by using transistors and simulation with measured value of 20 nA .For a single source, 3V power supply the total power consumption can be estimated in the range of 300 nW ,the perfect multisource power consumption will be 600 nW. Thus the value is two times smaller than the 300 nW power and to empower current of 20 nA and for suitable condition we use dummy transistors.

As already discussed energy dissipating circuit with the combination of TEG with vibrational sensor to energize energy synergy between harvesting and scavenging during demand in power consumption. This is demonstrated using simulink shown in fig 3.

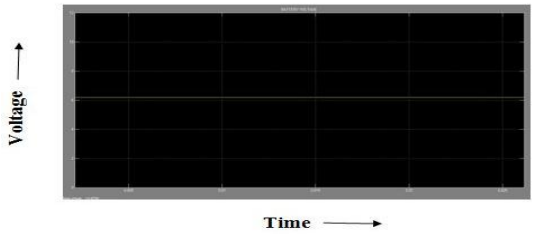

Fig: 3 Battery output

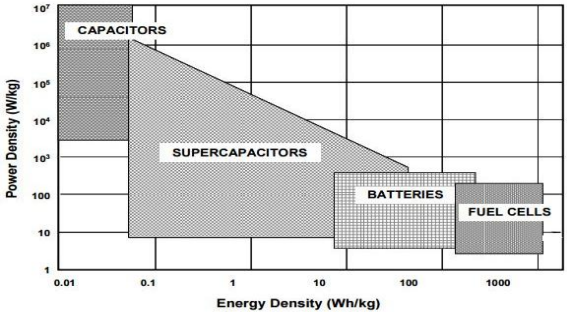

Fig 4: Energization of super capacitor or Ultra capacitors.

Emerging of signal processing regulates supply voltage and this would provide more advantage to increase the efficiency.

4. FABRICATION

In this system, the control processing is generated using PIC controller powered by pulse generator advantage of using 16F877A is wide usage device. The reasons for its wide usage are it has large memory capacity; it has adequate input /output ports. Where energy generated from the sensors stored in Cin shown in fig: 1 capacitor, filtered after rectification process. The circuit generates the Cbias current that biases voltage reference (PTAT/BGR) block and to minimize the cost and circuit complexity we are not implementing a maximum power point tracking (MPPT).

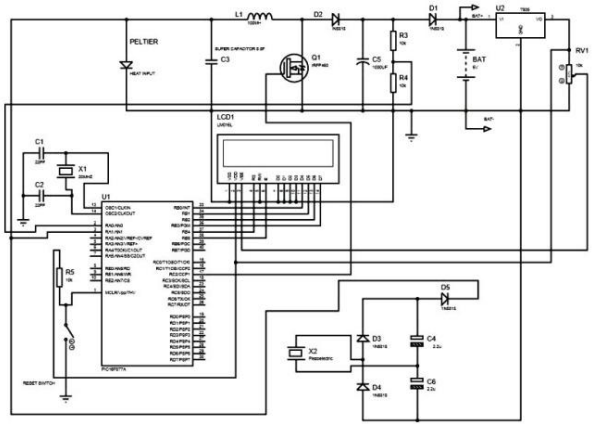

Fig: 5 Microprocessor circuit with piezo electric and peltier sensor

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PMOS power transistor is used for a voltage regulation and this is implementing by rectifiers and active diode in the circuit .The energy generator is to supply a wireless sensor node. These vibration energized from aircraft engine are not enough to generate by WSN node. Where if energy dissipated from the sensor is more, it is stored in UCs and when it is reduction in power originates from UCs. In which super capacitor act as a storage device have a capability of discharging charge at low power consuming. To avoid power loss we use Graetz circuit using active diodes.

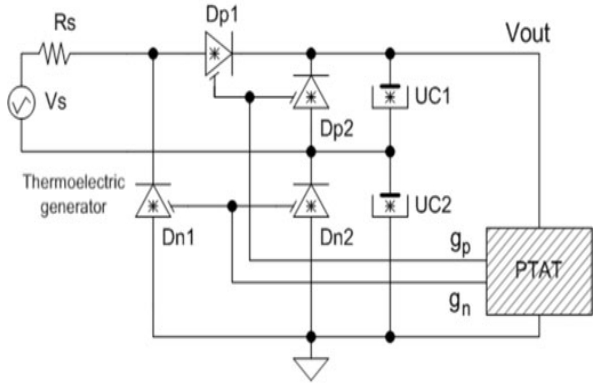

Fig: 6 Graetz bridge with active diodes and two UC storage devices.

Dimensioning of DC power supply with stabilized output and full wave rectifier with Graetz bridge and leveling capacitive filter. The stabilizer can be any of the linear IC stabilizers with fixed or regular output voltage or also a circuit made by discrete components shown in fig: 6.
PTAT act as a voltage reference with active diodes allow harvesting energy from the TEG and storing it in UCs (UC1 and UC2) to be chosen optimizing leakage currents to minimum losses. To proceed with this problem two implementing two UCs storage, UC1 for positive alteration and UC2 for negative alteration. The second drawback of the Graetz circuit is that two diode thresholds are lost for the rectification with each voltage reference circuit to bias the amplifier

5. RESULT & OUTCOME

This energy harvesting using renewable sources for aeronautics based on two technologies: CMOS technology and SOI technology. The advantage of SOI technology is the better of the device and it has a potential to work up to 200 °C. This will be the better choice for aeronautics application. These would allow active diodes and long channel transistors. The SOI technology has additional advantage that could be triggered even on worse environment.

To generate the active diodes, a minimum voltage around 0.9v is required. Once this voltage is reached, the drawn voltage of the active diode is providing to the source to drain voltage of the MOSFET switch. With a high dc gain, this voltage is equal to the offset of the operational amplifier. The MOSFET switch allows starting the rectifier with a standard diode threshold (~ 0.7 V). In the case of totally discharged UCs and a single energy source called, TEG several minutes are needed to reach 0.9 V.

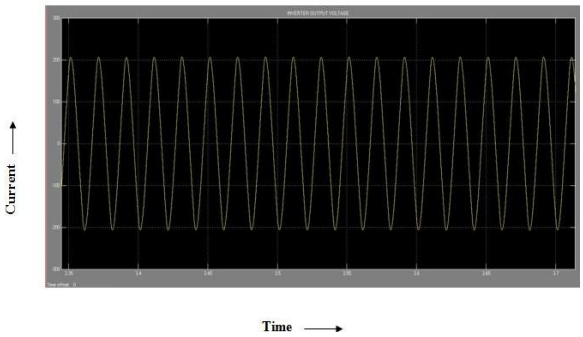

Fig: 7 Output current for harvested system

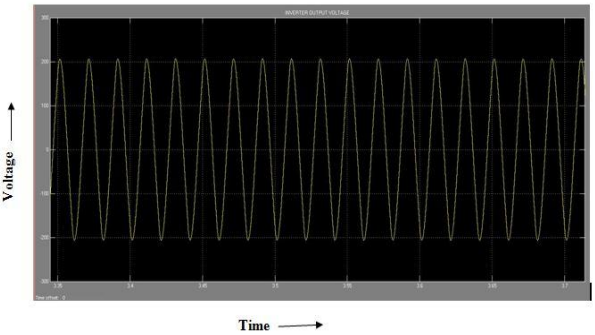

Fig: 8 Stimulant output voltage for harvested system

Thus with an appropriate power management it can be energized to a greater extend of generating energy and that will greatly reduce the power consumption.

6. CONCLUSION

The renewable energy source generator deployed in this paper exhibits two advantages compared to available commercial solutions. It allows using two sources of energy, which is an advantage for the concept of energy harvesting since the availability of a single energy source in a given environment is not fixed. The next advantage is its ultralow power consumption that is critical for the autonomy of a battery-free wireless sensor node. This circuit was designed for a specific SHM aeronautics application where transient gradients and permanent mechanical vibrations are used as energy sources. Vibrations provide a secondary source mainly used to self-bias the circuit, which does not include any battery and stores energy into UCs. The developed model is employed with two advantageous technologies: CMOS technology and SOI technology that could be well suited for commercial products.

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BIOGRAPHIES

R.S. Dhivya Bachelor Engineer with major of Electrical and Electronics Engineering. This paper is awarded as 'BEST PAPER AWARD' in conference ELCON'16.

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