International Journal of Engineering Research
Volume No.7, Issue Special 4, pp : 364-365

ISSN:2319-6890 (online),2347-5013(print)
9,10 March 2018

Utilization of Piezoelectric Material for Energy Harvesting

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***Abstract*: Energy harvesting or the process of acquiring energy from surrounding environment has been a continuous endeavour throughout the history. Energy harvesting (also known as power harvesting or energy scavenging) is the process by which energy is derived from external sources (e.g. solar power, thermal energy, wind energy, salinity gradients, and kinetic energy), captured, and stored for small, wireless autonomous devices, like those used in wearable electronics and wireless sensor networks. Energy harvesting is such a broad topic, so we're going to specifically deal with piezoelectric energy harvesting.**

Key words: Energy harvesting, piezoelectric effect

Introduction

The piezoelectric effect converts mechanical strain into electric current or voltage. This strain can come from many different sources. Human motion, low-frequency seismic vibrations, and acoustic noise are everyday examples. Except in rare instances the piezoelectric effect operates in AC requiring time-varying inputs at mechanical resonance to be efficient. Peizoelectric materials such as lead zirconnatetitanate (PZT) are great candidate for energy harvesting using vibrations from the surrounding environment.

As piezo energy harvesting has been investigated only since the late 1990s, it remains an emerging technology. Piezoelectric materials are very good prospects for mechanical energy conversion because they have a good electromechanical coupling effect. Piezoelectric energy harvesting devices are also much simpler than, for example electromagnetic or electrostatic devices.[1]

Piezoelectric Effect

There are certain materials that generate electric potential or voltage when mechanical strain is applied to them; they tend to change their dimensions. This is called piezo electric effect. This effect was discovered in the year 1880 by Pierre and Jacques Curie.

The piezoelectric transducers work on the principle of piezoelectric effect. When mechanical stress or forces are applied to some materials along certain planes, they produce electric voltage. The voltage output obtained from these materials due to piezoelectric effect is proportional to the applied stress or force. Mechanism of effect is shown in figure 1,

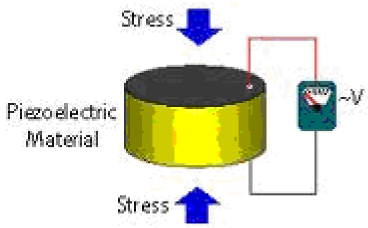
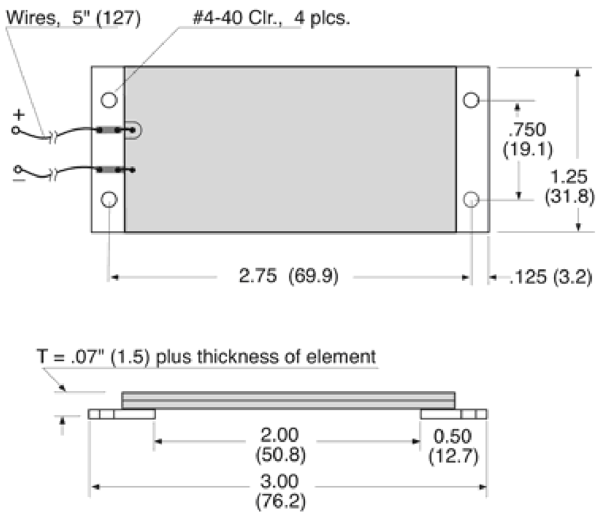


Figure 1. Piezoelectric effect

Piezo Energy Harvesting Circuit

The self powered Piezo Energy Harvesting Circuit collects intermittent or continuous energy input from the piezo generator and efficiently stores their associated energy in an onboard capacitor bank. During the charging process, the capacitor voltage is continuously monitored. When it reaches 5.2V the module output is enabled to supply power to an external (user) load. At this point 55 mJ of energy are available. When generator energy input is high, the output voltage remains ON continuously. Capacitor voltage is clamped at 6.8V. If external power demand exceeds generation, the output voltage decreases. When the output voltage drops to 3.1V, power to the load is switched OFF and is not turned on again until the capacitor bank has been recharged to 5.2V. The circuit accepts input voltages from 0V to ±500V AC or DC and input currents to 400 mA. Peizo energy harvesting generator – Double quick mount dimentions- 503 size is shown in figure 2. Energy Harvesting Circuit Specifications to be used as guidelines are given in table 1. [2]



ISSN:2319-6890 (online),2347-5013(print)
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Figure 2, Peizo energy harvesting generator – Double quick mount dimentions- 503 size

Table1.ENERGY HARVESTING CIRCUIT PECIFICATIONS

ELECTRICAL	
Maximum Instantaneous Input Voltage	± 500 V
Maximum Instantaneous Input Current	400 mA
Maximum Input Power	500 mW
Minimum Charging Input (Power Dissipation)	6.0 V @ 500nA (3μW)
Internal Voltage Clamp	7.0 V @ 10 nA
Maximum Output Current	1 Amp
Operating Life Cycles	Virtually unlimited
Logic Compatibility	CMOS
Supply Voltage Thresholds	VL = 3.1 V,
Useful Average Energy Output	55 mJ
Output On-Time Rating	88 msec @ 150 mA
ENVIRONMENTAL	
Operating Temperature Range	0 to 70° C
Maximum Average Operating Temperature	50° C
Storage Temperature	-40 to 85° C
Humidity	To 90%

APPLICATIONS: Application of this effect is mentioned below

- Cigarette Lighter
- Armed Forces
- Night Clubs
- Gyms
- Harvesting From Human Body
- Piezoelectric road harvests traffic energy to generate electricity
- Power Walking With Energy Floors
- Public Areas

Advantages Of Piezoelectric Energy Harvesting

Energy harvesting from light, thermal, magnetic or mechanical energy in the ambient environment is an important research topic. With recent progresses in wireless, sensor systems are being popularly used in various areas, including human body care, bridge or engine early health monitoring etc.

However, replacement of small power supplies and batteries in sensor systems would be a tedious task. Therefore, it is quite interesting to supply a small amount of power for sensor systems from environmental energy. [3]

•High frequency response: They offer very high frequency response that means the parameter changing at very high speeds can be sensed easily.

•High transient response: The piezoelectric transducers can detect the events of microseconds and also give the linear output.

•The piezoelectric transducers are small in size and have rugged construction.

Future Scope

The embedding of piezoelectric generators to create "smart roads" could eventually become an integral part of traffic management systems. Initially though, the system can be configured to generate and store energy from roads, airport runways and rail systems at the same time as delivering real-time data on the weight, frequency and spacing between passing vehicles. The harvested energy can be transferred back to the grid, or used for specific public infrastructure purposes such as lighting and widespread use of the system would enable far greater scrutiny and hence understanding of the behaviour of road vehicles. The harvested energy can be transferred back to the grid, or used for specific road infrastructure purposes. The infrastructure captures and stores energy for reuse. [4, 5, 6]

Conclusion

Flexible piezoelectric materials are attractive for power harvesting applications because of their ability to withstand large amount of strains. PZT materials that can convert ambient vibration energy surrounding them into electrical energy. This electric energy can then be used to power other devices or stored for later use. This technology has gained increasing attention due to recent advances in wireless and MEMS technology, allowing sensors to be placed in remote locations and operate at very low power. The ability of piezoelectric equipment to convert motion from human body into electrical power is remarkable. It is a great hope that energy harvesting will rule the next decade in the technical field. We thereby conclude upon the project by generating light out of the stress applied on the piezoelectric material. This can solve many problems regarding the dependency on batteries, also to harvest energy, since the world is in need of energy.

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