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BATTERY LESS WIRELESS SENSOR NETWORKS

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ABSTRACT **-This paper describes about power management in battery less wireless sensor nodes using solar harvesting. In recent years research in wireless sensor networks is increasing rapidly due to their self-powered nature, wireless sensors which are able to detect and transmit events to a base station. These wireless sensor networks are mainly used in monitoring of volcanic eruptions ,climatic conditions etc. in this paper we are going to analyze the bq25505 circuit and also we are going to design a solar harvesting circuit and measures variations of Voc and Vmpp by varying different photovoltaic cells by this we estimate the performance of the circuit based on varied characteristics of different photovoltaic cells in the circuit. MPPT (Maximum-Power-Point-Tracking) method is used when the conditions are not suitable such as climatic conditions. Super capacitor is used for storage of power for performing perpetual cycle. Even the circuit can work without using a battery.**

Index Terms**: solar harvesting, photovoltaic cells, Maximum power point tracking(MPPT), super capacitor.**

I. INTRODUCTION

The interest in promoting ambient energy sources became more beneficial to wireless sensor networks because the main shortcoming of wireless sensor nodes is bounded battery lifetime. Real world appliances of wireless sensor networks include monitoring of climatic conditions such as temperature, humidity and also other type of monitoring networks are volcanic eruption monitoring, glacier movement monitoring, habitat monitoring, carbon dioxide level. For the past few years fostering ambient energy harvesting circuits given a ray of hope to the shortcomings of the wireless sensor networks. However the utilized energy may not be regular it is challenging task to use the energy for perpetual cycle. Considering these constraints in this paper we propose solar based energy harvesting circuit using maximum power point tracking method (MPPT) which could work even when conditions are unsuitable. It also helps to maintain maximum operating point to produce maximum power. This maximum power point technique [MPPT] uses two or more solar panels to produce maximum power under various loads and different temperature levels. The operating point at which this solar panel is producing is the maximum power point (MPP). The current, voltage at which these are producing at the MPP are called maximum power point current IMPP, voltage VMPP.[3] .Comparing to other ambient energy resources harvesting solar power is more helpful to extract maximum power. There are many power point tracking methods such as hill-climbing which directly calculates the MPP by calculating the inclination of the power generated at output with dependence to voltage at the output. The fractional open-circuit voltage (FVoc) methodology utilizes the linear relationship between VMPP and the open circuit voltage Voc under various temperature levels. This methodology is simple and easy to execute. In this paper we are going to use energy harvesting Nano-Power management circuit i.e., bq25505 it is well needed for ultra low power applications. This product is particularly designed for meeting the wattage demands of various power sources such as wireless sensor networks (WSN). The main features of this are it provides high efficiency, maximum storage. It is used in various applications such as entertainment System remote controls, portable and wearable health devices, industrial monitoring. Here in this paper we presented as follows :the section 1 consists of the related work in the section 2 the methodology of the work in

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next section we presented the circuit of bq25505 and description of the circuit and its results.

II. RELATED WORK

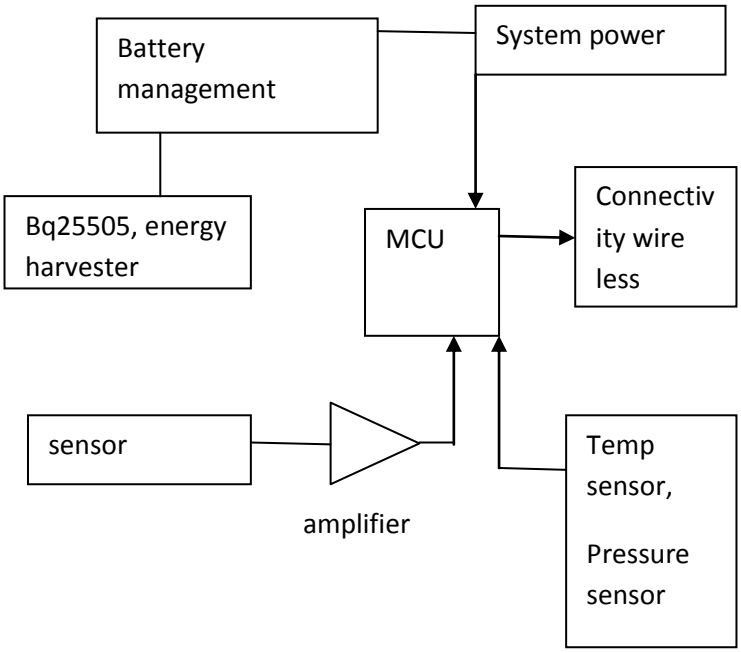
Many theories and techniques were proposed on energy harvesting methods for low power sensor networks. These methodologies vary on various constraints such as cost, efficiency. In Reference[1] author proposed on battery less embedded system based on solar harvesting. it mainly focuses on MPPT methodology they constructed an energy harvesting circuit which could work without battery. In reference [7] author proposed on indoor light energy to provide long term power to solve building management appliances for distributed wireless sensor networks. They constructed a prototype and varied under various light conditions at indoor whether it worked practically. In reference [1] they presented various communication systems with various energy harvesting transmitters. While constructing the energy harvesting circuit the circuit has to consider various constraints such as the power consumed may not be sufficient to the embedded system, the voltage and current characteristics of storage devices and solar panels have to work together to maximize the power point under various conditions these are provided in reference [6]. Though energy consumption is reduced but the limitation of lifetime on battery less wireless sensor networks is still remains so in the reference they had presented two harvesting circuits that could show the leakage energy and also working in places where limited solar radiation is present[4]. Even when we switch off the electrical appliances there will some power dissipation such a power is called passive power. In this paper they presented various challenges faced by wireless sensor networks and they have provided a choice to the consumers to choose devices based on the energy outlet. In reference[8] the author described the historic and current developments on energy harvesting methods for wireless sensor networks and mobile charges .and also stated that batteries are the primary source or many devices.

III. METHODOLOGY

The block diagram described below is an energy harvesting block diagram . energy harvesting is method of extracting energy from ambient energy sources.

BQ25505

The figure reference [2] given below is circuitry of bq25505. Bq25505 design starts from dc dc boost charger that requires a low voltage of microwatts of power to start operating.



IV. DESCRIPTION OF THE CIRCUIT

The boost charger is meant to be powered from a high impedance DC source, such as solar panel so that it can regulate the input voltage in order to prevent the input source from collapsing. This boost charger uses pulse frequency modulation to maintain the circuit even the light conditions are not favorable. This boost charger provides capacitors so that these are used as energy storage elements. The boost charger once is starts working with an input voltage of as low as 330mv it can continue to harvest energy to vin =100mv. The transformation of power in to the device is improved by implementing the sampling network of the programmable maximum power point tracking. Using external resistors the sampling of the vin_dc of open circuit voltage is done and this sampling voltage is stored in the external capacitor.

Bq25505 is designed in such a way that it can support a variety of elements that

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store energy. Generally system need some type of storage element as the harvesters that extract energy from the sources is time varying so often storage elements such as rechargeable battery or super capacitors are required bq25505 has an internal programmable circuitry which prevents the damage to the storage element against the over voltages and under voltages. Bq25505 is also having a autonomous power multiplexer gate drive. In order to provide a single power rail to the system load the gate driver allows two storage elements autonomously. When the system is powered by harvester energy the user can set level this is possible due to multiplexer which depends on the vbat threshold which is resistor programmable.

a. ENABLE PIN:

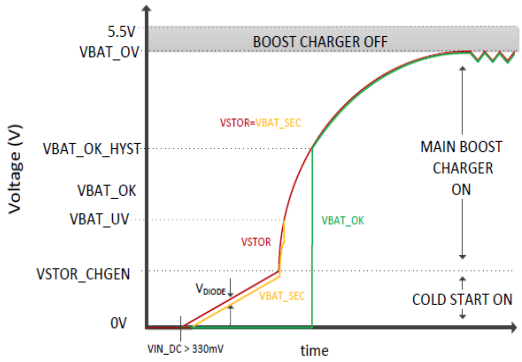
In order to maximize the flexibility for the control of the system an enable pin is implemented when taken high the en pin it completely shut down the ic along with boost charger and battery management. It also makes the pfet which is connected vstor turnoff it is described as ship mode because it puts the ic in" the lowest leakage state" and gives a very long storage period without any discharging of the battery on vbat_sec. this pin is connected to vss or system ground if en is no need to control.

b. ***MAXIMUM POWER POINT TRACKING***:

In order to extract maximum power from energy harvester source maximum power point technique is implemented (MPPT). The impedance of the main boost charger by regulating the input voltage based on the vin_dc to the reference sample voltage. The maximum power point is 70-80% for solar harvesters. By using the external resistors the MPPT is optimized to meet the needs of the input source.

c. ***Storage element***:

The operation of the storage element is described here. Here ic has a internal circuitry to control voltage across the storage element and also Optimization of storage element. The figure2, figure3 reference [2] below describe the analysis of the storage element which when depleted storage element is stored and partially charged storage element is stored. The given figure[2] below



Fig[2]: charge operation after a depleted element is attached

V. CONCLUSION

In this paper we presented energy management circuit of bq25505 extracted from texas instruments. It is first of the family of nano power management circuitry which is suited for the needs of low power applications. It has an internal circuitry which protects the storage element from damage of low and over voltages. It extracts maximum power from harvesting source and it provides an programmable MPPT.

VI. REFERENCES

[1] **A Survey of Recent Work on Energy Harvesting Networks -H. Erkal, F. M. Ozcelik, M. A. Antepli, B. T. Bacinoglu and E. Uysal-Biyikoglu**
Dept. of Electrical and Electronics Eng., METU, Ankara 06531 Turkey.

[2] Texas instruments –bq25505 data sheet

[3] Power management in energy harvesting embedded systems-presented by
Clemens Moser Dipl.-Ing. B.Sc. TU Munich

[4] Energy Harvesting for Wireless Sensor Networks by Vincent lee

[5] Energy harvesting powers industrial wireless sensor networks.

[6] Design considerations for solar energy harvesting wireless embedded systems-Vijay Raghunathan, Aman Kansal, Jason Hsu, Jonathan Friedman, and Mani Srivastava
Networked and Embedded Systems Lab (NESL)

[7] Design considerations of sub-mW indoor light energy harvesting for
wireless sensor systems- Wang, Wensi S.; O'Donnell, Terence; Wang, Ningning; Hayes, Michael; O'Flynn, Brendan; Ó Mathúna, S. Cian.

ISSN: 2278 – 909X

[8] Energy scavenging for mobile and wireless electronics.- Joseph A. Paradiso
Massachusetts Institute of Technology Media Laboratory

[9] design of solar harvesting circuit for battery less embedded system-Davide Brunelli, Clemens Moser, Lothar Thiele, Member, IEEE, and Luca Benini, Fellow, IEEE.

[10] A new MPPT method for low power solar energy harvesting- Oscar López-Lapeña, Maria Teresa Penella, Student Member, IEEE, and Manel Gasulla, Member, IEEE.

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