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Conditioning Circuit for the Energy Harvest System

Introduction

Energy harvesting is a process by which the energy is derived from external resources, captured, and then stored for small, wireless, and autonomous devices. However, because most of the energy resources are unpredictable, the voltage and the current coming from the energy harvest system are not always stable [1]. As a solution, a conditioning circuit is implemented to provide a stable output voltage to support the performance of a load from the harvesting system [2].

Commercial Application of the Conditioning Circuit

LTC 3331: Buck-boost DC/DC with Energy Harvesting Battery Charger

This chip at a cost of $5.07 from the Linear Technology Company integrates a high voltage power supply with a buck-boost DC/DC converter to create a single output supply. Simultaneously, the chip charges its rechargeable battery with a 10mA shunt current. A supercapacitor is also integrated into the chip, allowing for increased output storage. Voltage and current settings for both inputs and outputs are programmable. Whereas, the drawback of the chip is the low output current. The maximum output current is 50mA, which does not satisfy the design requirement of high power consumption device [3].

Underlying technology of the conditioning circuit

DC-DC Converter:

A DC-DC converter converts a source of direct circuit from one voltage level to another. In the current market, three different types of DC/DC converters are commonly used:

a. Buck Converter: the output voltage is lower than the input voltage and of the same polarity.
b. Boost Converter: the output voltage is higher than the input and of the same polarity.
c. Inverting (Buck-Boost) Converter: the output voltage is of the opposite polarity as the input [4].

Power Buffer:

The mostly commonly used power buffers are rechargeable batteries and supercapacitors. Supercapacitors have greater life cycles compared to rechargeable batteries. Like batteries, they store charge, but they can maintain their capacitance for more than half a million charge cycles and have a 10-year life operational lifetime. However, the supercapacitor's terminal voltage changes as it discharges while rechargeable batteries have a stable output voltage [5].

Building Blocks of the Conditioning Circuit

Implementation of the conditioning circuit is not as simple as connecting existing DC-DC converters between the energy harvester and the load. A control system is required to switch the power buffer between charge and discharge modes. Calculations are also required to choose specific resistors, capacitors, and inductors to provide a specific output voltage and current to meet the design requirements.

Most of the hardware chips, including the DC-DC converter and power buffer, are available in the current market. Power consumption is another critical requirement. Due to the limitation and the unpredictability of the natural energy resources, it is beneficial for the energy harvest system to have a conditioning circuit with minimum power consumption [6].

Reference

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