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PARAMETER OPTIMIZATION OF A DC-DC BOOSTER CIRCUIT FOR LOW FREQUENCY VIBRATION-BASED ENERGY HARVESTING

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1. Introduction

Over the past decade, the use of portable electronics has grown steadily. Most of low power applications such as wearable devices power requirement had been steadily decreasing. In recent years, researchers growing interest in developing devices that are able to harvest energy from environment or ambient sources and convert it to electrical energy. Energy harvesting or known as energy scavenging is a process to seize the small amounts of energy from ambient sources. Harvestable source of energy includes solar power [1], [2], radio frequency [3], and mechanical vibration [4]. Solar power has a higher power density compared to mechanical vibration [5] and is consider as the most successful energy harvesting [6]. However, for indoor applications, the lighting is not adequate to generate sufficient power. Thus, studies on harvesting ambient energy is also viable and at an early stage of development [6]. Ambient energy has provided unlimited power sources for low-power electronic applications. It is one of the popular energy harvesting source for operating electronic devices mainly those which are intended to be isolated, embedded, or self-generated source applications. Among the harvestable ambient energy source, mechanical vibration is the most popular due to its higher power density and higher scalability [7]. Figure 10.1 shows energy harvesting's system. The system consists of three main blocks which are the harvesting device (energy transducer), the harvesting circuitry and the application system (load).

Figure 10.1. Basic block diagram of an energy harvesting booster.

A variety of harvesting circuitry are available for energy scavenging, namely DC-DC converter, AC-DC converter, Buck converter and Boost converter. DC-DC converters change a dc voltage to a different voltage level. There are several methods of conversion such as linear, electronic, magnetic, capacitive and switched mode. DC electrical power cannot be stepped up or down arbitrarily by transformers like AC electrical power. Thus, to change the voltage level of DC electrical power, DC-DC converter circuit is required. Furthermore, a DC-DC converter is the DC equivalent of transformer which convert the input energy into different impedance level. Meanwhile, Buck Converter is used to decrease the DC output voltage lower than the DC input voltage. Basically, it will step-down the output voltage and supply to further lower input voltage applications. Buck converter also able to have high input AC voltage directly from the AC supply and converted to DC as the output voltage. The advantage of using Buck Converter is its simplicity and low cost of production.

A boost converter also known as electronic circuit or electromechanical device converts a source of Direct Current (DC) from one voltage level to another. Boost converter is a type of electric power converter but converts power levels range from low input to high output. Basic circuit of boost converter is shown in Figure 10.2. The circuit consist of two semiconductors switches; diode and transistor, and one storage element. Capacitor and inductor which act as filter are added to the output of the converter to reduce output ripple voltage. A boost converter also known as step-up converter since it steps up the input voltage.