Powering Wireless Alarm Sensors with Solar Cells

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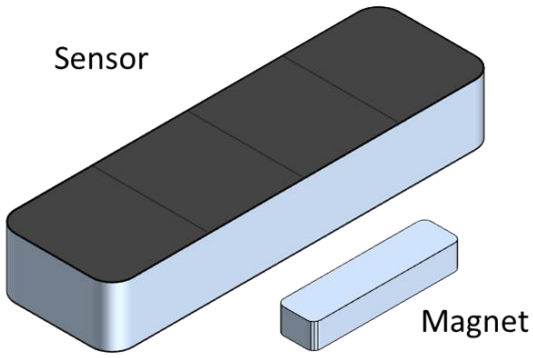
Solar cells are becoming better and cheaper while the power consumption of small electronic products is decreasing. These advancements can be utilized for future home alarm systems to reduce or potentially eliminate the need for batteries.

You may have noticed that pocket calculators sometimes have a dark rectangular window with a few vertical lines in it. These are solar cells which are used to harvest energy from the ambient light to reduce the need for batteries. Solar powered calculators have existed since the 1970s, and now wireless alarm systems powered by solar cells may be next in line. The combination of low power consumption and well-lit placement of window sensors makes it interesting to investigate if they can be powered by solar cells.

When designing a system for harvesting energy using solar cells there are a number of decisions which need to be made.

First of all you need to decide which type of solar cells to use. Silicon is the traditional material of which the majority of solar cells are based on. It can be treated in different ways to create either crystalline silicon or amorphous silicon. The latter is used to make cheaper solar cells at the cost of lower performance, the type that is traditionally found in pocket calculators. New types of solar cells, referred to as third generation solar cells, have recently started to appear commercially. Organic- and dye-sensitized solar cells are two third generation solar cells which challenge amorphous silicon solar cells by also promising low costs.



Concept drawing of a window sensor with solar cells.

The next decision that needs to be made is which type of energy storage to use. For the alarm sensors to keep functioning during the night when there is no natural light, they need to store energy during the day or rely on a backup battery during the night. Two types of devices suitable for storing energy include supercapacitors and rechargeable batteries. Each type has its pros and cons that need to be considered with the specific alarm sensor in mind.

The third decision which needs to be made is regarding the electrical solution. To extract maximum energy from the solar cells it is required that they work at the optimal voltage level at every instant. This can be achieved with a power converter controlled according to a MPPT scheme (maximum power point tracking). The choice is between using a MPPT chip to achieve a high efficiency but at an increased cost, or accepting that the solar cells will work at a lower efficiency maintaining a low cost.

In my master thesis I investigate these subjects and apply them to wireless alarm sensors [1]. My work also includes measurements made in both a home environment and in a lab environment to estimate the amount of energy that can be harvested in natural and artificial light. Finally I demonstrate the concept of a solar cell driven window alarm sensor by building a prototype.

[1] T. Olofsson, “Energy Harvesting with Solar Cells for Wireless Alarm Nodes”, Division of Industrial Electrical Engineering and Automation, Faculty of Engineering, Lund University, 2018.