Live Demonstration: A Wireless Sensor Using a Solar Cell Optical Transceiver

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I. Introduction

A new wireless communication approach that employs solar cells as receivers and transmitters of information has been recently proposed [1,2]. This approach, which has been dubbed Optical Frequency Identification (OFID) for its analogy with Radio Frequency Identification (RFID), exploits the infrared luminescent radiation emitted by high-efficiency solar cells, such as GaAs solar cells, when excited by light (photo-luminescence or PL) or an electrical current (electro-luminescence or EL). In OFID, the luminescent emissions of a solar cell are modulated by varying the voltage across the solar cell. Binary On-Off as well as multi-level modulations are possible in this scheme. The solar cell can also be used to receive information encoded optically by virtue of its photo-transduction property. Finally, in an OFID system the solar cell is also used for its intended purpose, which is to harvest radiant optical energy.

Some of the advantages of using light over radio to transmit information are: 1) light can be collimated in narrow beams with lenses and mirrors. As a result optical transmitters can have very large antenna gains; 2) imaging receivers can be used to receive transmissions from multiple devices simplifying the need for collision avoidance mechanisms; 3) unlike passive RFID tags, OFID devices can be activated without a nearby reader as long as there is sufficient ambient light. OFID devices can also work in low-light or dark environments by stimulating EL emissions of their solar cells; 4) OFID devices can be placed on or near metallic surfaces without affecting their performance. OFID technology has exciting applications in the areas of smart homes and buildings, environmental monitoring and supply chain.

II. Demonstration Setup

The setup of this live demonstration will consist of a portable OFID reader and multiple OFID tags. The reader comprises a blue laser diode that is employed to stimulate a PL response from the solar cell. The power radiated by the laser diode is kept below 5 mW for eye safety. The reader also contains an optical receiver, an LCD screen and a user interface. Each OFID tags will include a GaAs solar cell, a battery charger, an FPGA, a receiver circuit, a temperature sensor and power management circuits. Fig. 1 shows a diagram of the system that will be demonstrated. The setup will also include a full-spectrum camera that visitors can use to observe the infrared radiation emitted by the solar cells.

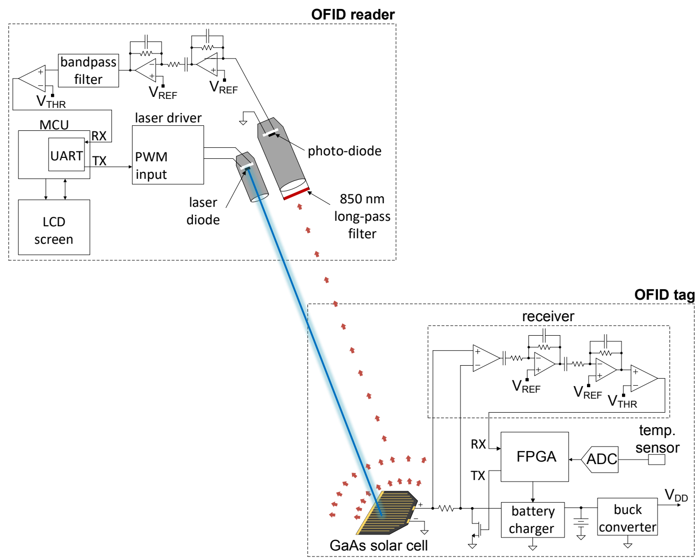

Fig. 1: Block diagram of an OFID bi-directional optical communication system using a solar cell.

III. Visitor Experience

Visitors will be able to interact with the OFID communication system by handling the optical tags and using the reader. Visitors will be encouraged to touch the temperature sensor on the tag and point the reader in the direction of the tag to get a reading of their temperature. Visitors will be asked to experiment with different distances and angles between the reader and the tags to find out what is the maximum reading range of the system at a given angle.

IV. Related Previous Published Work

This demonstration is based on our previous work [1,2].

References

[1] W. D. Leon-Salas and X. Fan, “Exploiting luminescence emissions of solar cells for Optical Frequency Identification (OFID),” *IEEE Int. Symp. Circ. and Syst. (ISCAS)*, May 2018.

[2] W. D. Leon-Salas and X. Fan, “Solar cell photo-luminescence modulation for optical frequency identification devices” *IEEE Trans. on Circuits and Systems I*, pp. 1-12, 2018.