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A Solar Cell Photo-luminescence Modulator for Optical Communications

A novel modulation technique uses solar cells for dual functionality as energy harvesters and high-speed optical wireless communication devices, reducing switching noise and enabling faster burst transmission.

Optical wireless communication (OWC) uses light for wireless data transmission, offering higher data rates, energy efficiency, and security as an alternative to radio frequency communication. Key components of traditional OWC systems include a light source, a photo-detector and electronic circuits for modulation and demodulation of information. High-efficiency solar cells made from GaAs or perovskite materials can be used as light sources and photo-detectors due to their luminescence and their ability to convert light into electricity.

Purdue researchers have created a novel technique for modulating a solar cell's photoluminescence, suitable for OWC and energy harvesting. This approach uses a modulator circuit with a MOSFET-controlled feedback loop to modulate the solar cell's voltage. Unlike traditional on-off modulators, which fully discharge the solar cell's internal capacitance and introduce switching noise, this technique supports higher-speed burst transmission. Researchers demonstrated that the technology is suitable for burst transmission and can achieve higher speeds than an on-off modulator, making it a promising solution for optical communication and energy harvesting devices. This technology also addresses limitations of traditional OWC with solar cells by providing higher transmission speeds, reducing switching noise, and offering dual functionality in solar cells. This improved performance can help to partially mitigate the impact of factors like atmospheric attenuation and interference and enhance the overall efficiency and effectiveness of OWC systems.

Technology Validation:

Modulator circuit was analyzed using a circuit model and experimentally validated with a proof-of-concept prototype. The proof-of-concept prototype demonstrated an optical communication link using a GaAs solar cell as the

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Authors
Walter Daniel Leon-Salas

Further information
Dipak Narula
dnarula@prf.org

View online

transmitter.

Advantages:

- Much higher transmission speeds than traditional on-off modulators, which allows for higher-speed burst transmission, improving communication capabilities

- Enables solar cells to serve as both energy harvesters and optical communication devices, increasing the efficiency and multi-functionality of these components

- Minimizes switching noise, enhancing signal quality and the overall performance of the optical wireless communication system

Applications:

- Indoor tracking of goods, people or animals

- Indoor, vehicular, underwater, and satellite communication

TRL: 4

Intellectual Property:

Provisional-Gov. Funding, 2023-03-05, United States | Utility-Gov. Funding, 2024-03-05, United States

Keywords: Optical wireless communication, OWC, solar cell photoluminescence modulator, energy harvesting, MOSFET, feedback loop modulation, high-speed burst transmission, communication devices, photodetector, light source, Chemical Engineering, Communications, Green Technology, Materials, Materials and Manufacturing, Modulators, Solar Cells, Solar energy, Wireless Communication