Numerical Calculation of System Efficiency of Optical Wireless Power Transmission Using Silicon Photovoltaic Through Various Mediums

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Introduction

Wireless optical power transmission can be used to supply power for unmanned autonomous vehicle such as drone or underwater and even be used for charging implantable medical devices such as pacemaker. In power transmission, one of the most important objects of evaluation is efficiency. In this analysis, maximum system efficiency for optical power transmission is numerically calculated.

Results of Numerical Calculation

The efficiency of light source is assumed to be 40% and wavelength independent. For simplification, the incident light is assumed to be absorbed uniformly for the whole 200 μm thickness of silicon photovoltaic. Incident optical power for all mediums is assumed to be 1 W/cm^2. The maximum system efficiency around 22.1% at 940 nm and 1.4% at 960 nm wavelength for power transmission through air with 30 km visibility and air with 1 km visibility, respectively.

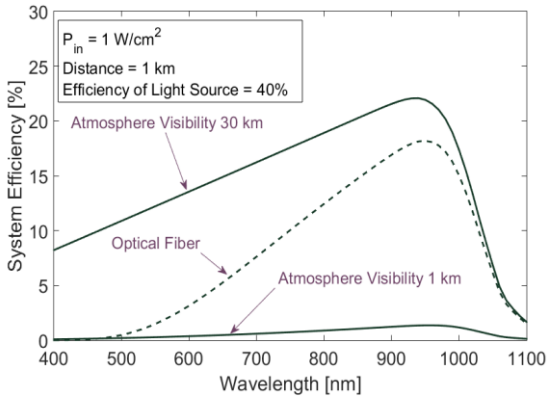

Figure 3. System Efficiency through Air and Optical Fiber

For optical power transmission through water, system efficiency around 17.0% at 700 nm and 810 nm wavelength for 10 cm depth of water, 13.4% at 570 nm wavelength for 1 m depth of water, 10.4% at 480 nm wavelength for 10 m depth of water and 5.6% at 400 nm for 100 m depth of water. For the optical power transmission through skin, the maximum system efficiency for 1 mm, 2 mm and 5 mm thickness of human skin are 18.2%, 14.5% and 7.3% at 910 nm wavelength, respectively.

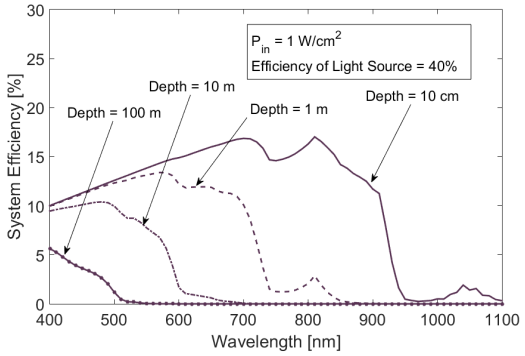

Figure 1. System Efficiency through Water

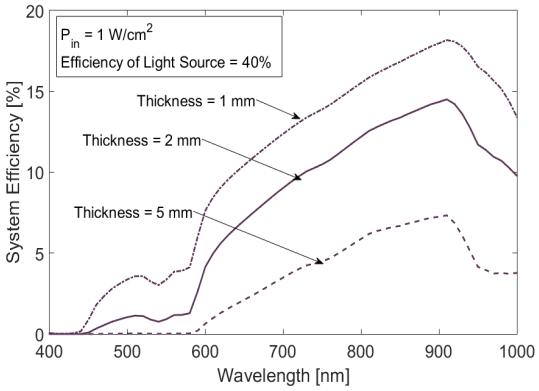

Figure 2. System Efficiency through Skin

References

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