A Cubic-Millimeter Energy-Autonomous Wireless Intraocular Pressure Monitor
Gregory Chen, Hassan Ghaed, Razi Haque, Michael Wieckowski, Yejoong Kim, Gyouho Kim, David Fick, Daeyeon Kim, Mingoo Seok, Ken D. Wise, David Blaauw, and Dennis Sylvester

The 1.5 cubic-mm IOP monitor is implanted in the anterior chamber of the eye as part of a treatment for glaucoma.

Continuous monitoring of intraocular pressure (IOP) aids in the treatment of glaucoma and can be achieved with an implanted microsystem. Constraints from the device location and implantation limit the size to roughly one cubic millimeter. These size constraints in turn limit the energy the microsystem can harvest from the environment, store in a secondary power source, and consume in load circuits. We present a 1.5 mm³ 5.3 nW wireless IOP monitor that achieves energy-autonomous operation through a combination of energy harvesting and ultra-low-power circuit techniques. A MEMS capacitive sensor and ΣΔ capacitance-to-digital converter measure IOP with 0.5 mmHg accuracy. A microcontroller processes and saves IOP data and stores it in a 2.4 fW/bitcell SRAM. A 4.7 nJ/bit fully-integrated wireless transceiver transmits the data to an external device placed 10 cm from the eye with a bit error rate of $10^{-6}$. The microsystem harvests 80 nW from an integrated 0.07 mm² solar cell to recharge a 1 mm² 1 µAh thin-film battery and power the load circuits. The design achieves zero-net-energy operation with 1.5 hours of sunlight or 10 hours of bright indoor lighting daily.

Research Thrust: Micropower Circuits
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