# Active Implants for Managing Hydrocephalus

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## Hydrocephalus

Hydrocephalus is a lifetime condition where excess fluid is produced in the brain and must be drained through a ventricular shunt.

A valuable clinical indicator of the shunt's status is intracranial pressure (ICP).Wireless transfer of power to an implantable pressure sensor could provide lifetime shunt monitoring.

Size is an important factor for a sensor system located on the head.

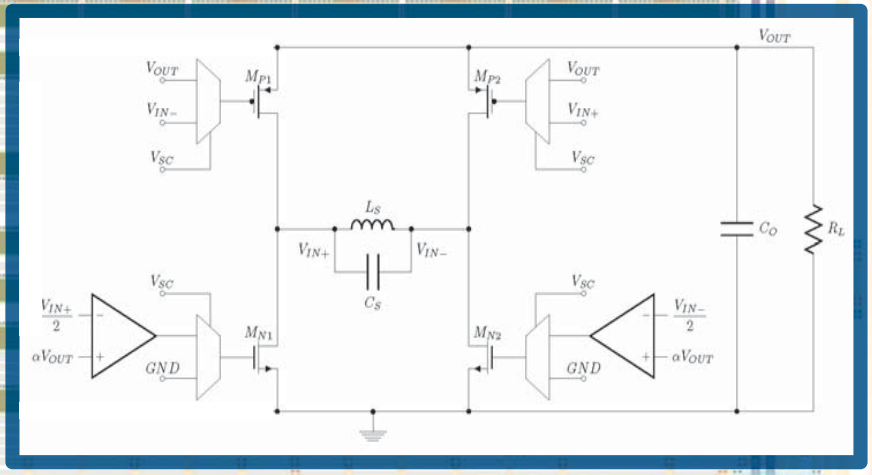
## Wireless Power

A time varying magnetic field generated by an external coil can propagate through the skin and induce an alternating current in an implanted pickup coil.

The strength of this current depends on the relative positions of the coils. Position can vary creating variations in supply current and hence output voltage.

The AC current must be rectified into a DC supply to power the implant.

An integrated circuit (IC) can be used to make a small yet highly efficient rectifier that also regulates the output voltage within save operating limits.

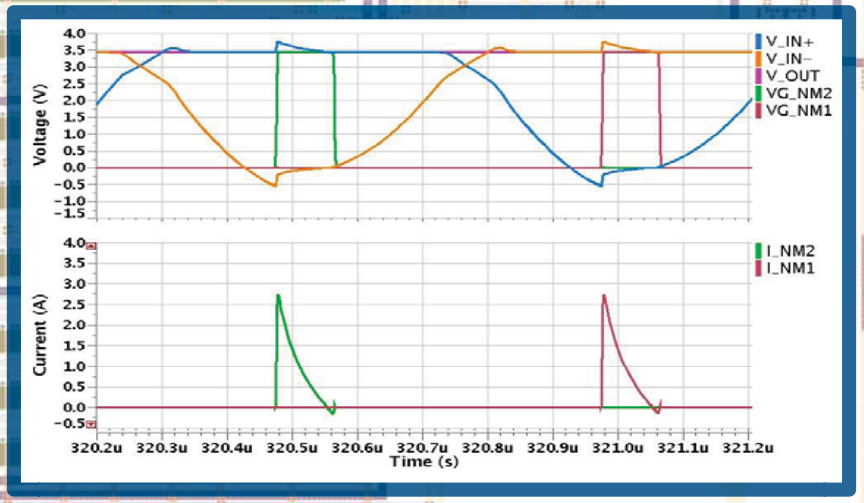



**Top: Schematic of synchronous rectifier (SR) and pickup circuit.**

**Middle: Table of MOS states with different pickup voltages and SC input.**

**Bottom: Graph of SR operation.**

| $V_{SC}$ | $V_{in-}$ | $M_{P1}$ | $M_{N2}$ | $M_{P2}$ | $M_{N1}$ |
|---|---|---|---|---|---|
| *low* | $V_{OUT}$ | *off* | *off* | *on* | *on* |
| | $V_{OUT} - \lvert V_{tp} \rvert$ | *on* | *off* | *off* | *off* |
| | $-V_{th}$ | *on* | *on* | *off* | *off* |
| *high* | *GND* | *off* | *on* | *off* | *on* |




## Synchronous Rectifier Design

The rectifier has two PMOS transistors, two NMOS transistors and two comparators. The comparators turn the NMOS transistors on and off at the correct moments to achieve rectification.

Cross coupled PMOS transistors are controlled by the amplitude of the AC pickup voltage.

The zero forward voltage of the transistors allow smaller voltage drops than diodes and hence higher efficiency's.

By shorting the pickup with the NMOS transistors $V_{OUT}$ can be regulated.

## Results

The frequency of the wireless power transfer is up to 1MHz.

The designed comparators and their bias circuits each draw 42μA and have a 20nS delay.

The rectifier IC has been sent for fabrication. It will be 97% efficient when outputting 100mA at 3.3V. The size of the IC will be 2.5mm by 1.2mm.

Shorting control has been integrated into the rectifier for voltage regulation.