Power Management and Communication for Remotely Powered Sensor Nodes

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Introduction

This research focuses on development of wirelessly powered integrated circuits (ICs). The circuits should be able to wirelessly communicate with the base station and read the data from various sensors or control different actuators.

The Main Challenges:

- Implementing the internal circuits of the sensor node with low power consumption.
- Increasing the efficiency of wireless power transmission.

Example Applications

- Blood Pressure Monitoring System
- ECG Monitoring System
- Intracochlear Pressure & Temperature Monitor
- Cardiac Pacemaker
- Cochlear Implants

System Building Blocks

Remote Powering

Main Blocks for Wireless Power Transfer:

- PA
- L1 & L2
- Rectifier

PA is converting the DC power from the battery to AC power for coupling.
L1 & L2 are coupling energy from base station to remotely powered side.
Rectifier is converting coupled AC voltage to DC voltage.

Regulator is stabilizing the voltage for processing blocks.

Wireless Voltage Regulation can be used to compensate the variation of the coupling between the inductors.

Performance of the Fabricated Rectifier:

- Output Power: 100 mW
- Output Voltage: 1.65 V
- Peak Input Voltage: 2.1 V
- PCE (Simulated): 85%

Low Power Communication

Standard Transmitter:

- Class E PA
- Frequency: 13.56 MHz
- Power Consumption: 370 mW

Performance of the Fabricated Transmitter:

- Oscillator Performance:
  - Technology: 0.18 um
  - External Inductor: 27 nH
  - Frequency: 27 MHz
  - Supply Voltage: 1 V
  - Supply Current: 65 – 176 uA

Low Power Transmitter:

- Low data rate of biomedical signals and short communication range make it possible to use low precision transmitter by directly modulating the free running oscillator.

Low Power Communication

Performance of Different Blocks:

Class E PA

- Operation Frequency: 13.56 MHz
- Power Consumption: 370 mW

Data Receiver

- Operation Frequency: 806 MHz
- Data Rate: 12 Kbps
- Power Consumption: 152 mW

Expected Contributions

- Intelligent usage of the harvested power by modifying the system level design.
- Extending the system operation to multiple implants.