An Energy Harvesting System for In-tire TPMS


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Main Objective
Development of a highly miniaturized Tire Pressure Monitoring System for in-tire assembly with $V < 1\text{ cm}^3$ and $m < 5\text{ g}$.

Today's rim-mounted TPMS:
$60\text{ cm}^3$

Future self-sufficient tire-mounted TPMS:
$< 1\text{ cm}^3$

Application Background
Tire monitored parameters – information for comfort and safety

TPMS Supply Requirements
- Mechanical reliability to shocks and vibration up to 2000g
- Operating temperature range from -40°C to 125°C
- Life time > 10 Years
- High efficiency of Energy Scavenger even at low vehicle speed
- Low-leakage energy storage device
- Competitive costs to rim-mounted supply unit

MEMS Energy Harvester Device
- Electrostatic transduction principle
- Electret as bias for the transducer
- In-plane motion
- High aspect ratio micromachining
- Simulations show that a few $\mu$W of in-tire harvested power is possible at driving speeds down to 50km/h
- Measurement of first prototype confirms the workability of our design concept

Energy Conversion Unit
- Compatible to MEMS- or piezoelectric-harvester
- On-chip handling of AC input voltage up to 36V_{pp}
- Total current consumption < 50nA
- Measurements on first test chips prove feasibility

TPMS Blockdiagram
- Load
- Pressure
- Wheel speed
- Road condition
- Wear
- Side slip
- Friction

TPMS current profile
- Typ. current consumption
- RF transmission
- Wakeup, sensors, measurement, application program
- Standby current, leakage
- ~2mA
- ~300µA
- <200nA
- ~30s period
- Tyre endurance

Energy Storage
- Large Battery
- Tiny Energy Harvester

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