Self-Powered Adaptive Switched Architecture Storage for Ultra-Capacitors
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Objectives
- Coupling energy harvesting & storage on supercapacitor (SC)
- Adaptive storage for early startup at charging (low capacitance value) and maximization of stored energy (high capacitance).
- Autonomy of the system and maximum energy usage rate.

Self-powered and adaptive storage system

Experimental results
Energy harvester simulated by a Thévenin generator
- Epp=5V, Rpp=140Ω, Rload=16Ω, C=100mF, Cpp=400mF, Vpp=2V, Vpp=1V
- Forward/Reverse: 1.2mA, 0.8mA

Charge profile:
- The S configuration allows for a fast charging and startup (low Ceq).
- The P configuration allows for the storage of a large amount of energy (high Ceq).

Discharge profile:
- The S configuration allows a maximum energy usage rate in the case of a system powered by an energy harvesting source.

Measurement and calculation of losses
Source and load modeled by a constant current source

Perspectives
Silicon integration of the self-powered and adaptive storage.

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CONTEXT: Autonomous battery-free wireless sensor node

Self-adaptive Architecture
The principle of this structure is to change the value of the total storage capacity according to the state of charge/discharge, to satisfy the objectives: fast charging time with a low capacitance (Ceq=C/N series configuration), maximization of stored energy with Ceq=C/N (parallel configuration).

Self-adaptive architectures under study
Each of the two types of adaptive structures consists of 4 identical supercapacitors (SC) + 9 switches + 3 Schottky diodes for structure B, allowing three possible configurations: Series (S), series-parallel (SP) and parallel (P) (The diodes allow a default serial structure).

Analysis of the two self-adaptive architectures
Both structures are identical; they have the same number of SCs, switches and configurations (S, SP, P). However, they differ in the SP configuration.

Impact of the dispersion in capacitance values on losses (worst case)
Input | Output
| Tolerance range | C1=100mF±20% | C2=100mF±20% |
| Structure A | 0.12 | 0.08 | 0.08 | 0.12 | 2.08% |
| Structure B | 0.08 | 0.08 | 0.12 | 0.12 | 2.16% |

Low losses ⇒ balancing circuit not necessary
Structure B exhibits lower balancing currents

Summary
- Low losses ⇒ balancing circuit not necessary
- Structure B exhibits lower balancing currents