KNOO
Keeping the Nuclear Option Open

Bristol University Wireless Sensor Node

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Introduction

The design and development of a remote sensing node for monitoring quantities such as temperature, corrosion and strain is presented. Principal features are that the system is to be low-cost, autonomous, have a high life expectancy and be able to withstand harsh environments, particularly high temperatures. The IEEE 802.15.4 wireless communications standard is used and the power management scheme used to energise the transmitter at the sensing node is addressed. Particular challenges in this application include the efficient management of energy at very low power levels and voltages, and also circuit design for high temperatures. Energy may be supplied from storage elements (batteries, capacitors or by mechanical means) or derived from the ambient environment (solar cells, thermoelectric elements). Figure 1 outlines the configurable hardware arrangement built for evaluating these alternative schemes. Power is derived from one or more sources and stored in a common element.

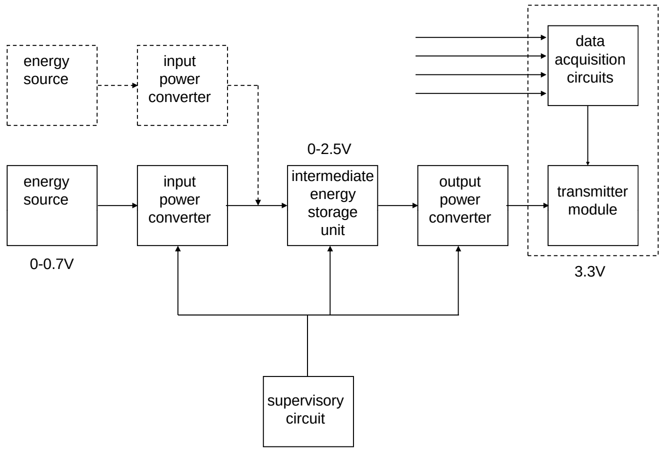

Figure 1. Outline of system

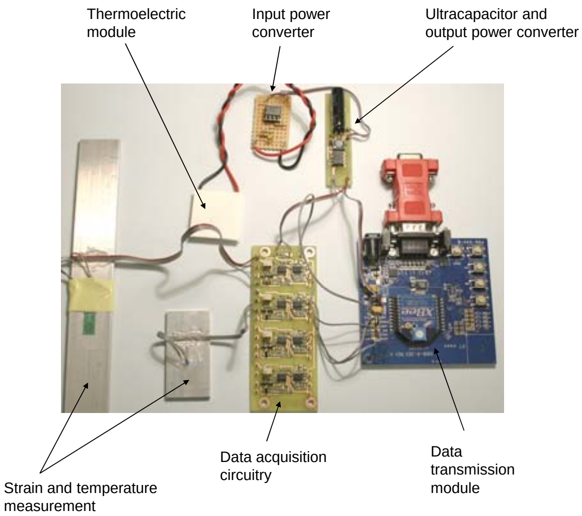

Figure 2. Experimental rig

Power management

The power harvested is intermittent in nature and is also insufficient to run the data acquisition and transmission circuitry continuously. This energy is therefore stored and the system is periodically "chirped" to transmit data back to the "base" station. The multi-channel input power converter in Figure 1 draws power from the source and places this in the storage element. An "ultracapacitor" is used for energy storage. When sufficient charge has been accumulated, the output power converter energises the data acquisition and transmitter circuits. Although having a much lower energy density than a battery (by a factor of approximately 10), the ultracapacitor exhibits virtually zero degradation with charge cycling, an essential consideration here where a high life expectancy is required. Figure 2 shows the experimental rig.

Challenges are minimising standby power losses and conditioning the power at low voltage and low power levels. At input voltages below one volt, "start-up" is particularly problematic. However, a hybrid power converter and charge-pump circuit may be used (Figure 3). The charge pump is inefficient, but can start up at low voltages and is only used transiently.

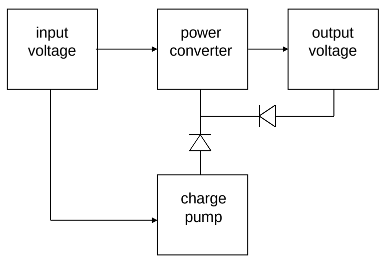

Figure 3. Hybrid power converter and charge pump circuit

Future work

Power has been derived from both a thermoelectric element and solar cell. However, a sufficient temperature gradient or ambient light level is not available in every application and a mechanical storage system is being designed.

"Hardening" of the circuitry to operate in high-temperature environments is being undertaken.

Acknowledgement

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