An Enabling a Battery-Less Sensor Node Using Dedicated Radio Frequency Energy Harvesting for Complete Off-Grid Applications

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Abstract :

The large-scale deployment of sensor nodes in difficult-to-reach locations makes powering of sensor nodes via batteries impractical. Besides, battery-powered WSNs require the periodic replacement of batteries. Wireless, battery-less sensor nodes represent a less maintenance-intensive, more environmentally friendly and compact alternative to battery powered

sensor nodes. Moreover, such nodes are powered through wireless energy harvesting. In this research, we propose a novel battery-less wireless sensor node which is powered by a dedicated 4 W EIRP 920 MHz radio frequency (RF) energy device. The system is designed to provide complete off-grid Internet of Things (IoT) applications. To this end we have designed a power base station which derives its power from solar PV panels to radiate the RF energy used to power the sensor node. We use a PIC32MX220F32 microcontroller to implement a CC-CV battery charging algorithm to control the

step-down DC-DC converter which charges lithium-ion batteries that power the RF transmitter and amplifier, respectively. A 12 element Yagi antenna was designed and optimized using the FEKO electromagnetic software. We design a step-up converter to step the voltage output from a single stage fully cross-coupled RF-DC converter circuit up to 3.3 V. Finally, we use the power requirements of the sensor node to size the storage capacity of the capacitor of the energy harvesting circuit. The results obtained from the experiments performed showed that enough RF energy was harvested over a distance of 15 m to allow the sensor node complete one sense-transmit operation for a duration of 156 min. The Yagi antenna achieved a gain of 12.62 dBi and a return loss of −14.11 dB at 920 MHz, while the battery was correctly charged according to the CC-CV algorithm through the control of the DC-DC converter.

Biography:

Timothy James Miller received his electrical engineering degree from the University of Pretoria. His research interests are energy harvesting, control systems and wireless sensor networks. His current focus is on building resilient distributed computing systems. He works as a consulting engineer at a bank in South Africa.