Wireless Power and Data Acquisition System for Large Detectors
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Motivation
To develop a wireless data acquisition system with the intended application to read-out instrumentation systems having thousands of channels. Our study focuses on a specific application, the read-out of a detector having photomultiplier tubes. This project is to develop a photomultiplier tube base that is powered wirelessly and transfers data wirelessly.

Approach
- With the detectors increasing in its size and complexity, it is complication to use traditional approach where the power and data are transferred with electric cables.
- Cabling may represent a significant cost and complication in the experiment.
- Two components of the project: Power transfer (RF and optical beam), Data transfer (RF)
- The goal is to elimination of all cables: no physical connection to the detector.

Radio Frequency Option
- $P_x = G_x G_r \left( \frac{\lambda}{4\pi R^2} \right)^2$
  
  (Friis transmission: free space propagation under ideal condition)
- $G_{dB} = 20 \log_{10} \left( \frac{\lambda}{4\pi R} \right)$
  
  (RMS voltage measured by the oscilloscope)

20 dB power loss at a distance of five meters from the transmitter

We need to transmit 10 Watts of power with 14 dBi Yagi antenna in order to receive 100 mW power with 11 dBi Yagi antenna at a distance of five meters. Again, we loose 30% in converting RF to DC power output.

Optical Option
(Purpose: transfer power wirelessly using optical source and receiver)

Nearly 250 mW D.C. power is received up to a distance of five meter from the source of power 3.5 Watts.

Solar Panel IV Characteristics
IV curve of a solar cell is the IV curve of a diode in dark with a light generated current source.

Prototype Design
Design of the prototype module we are currently testing.

- The prototype front-end utilizes and 802.11n module whose wired interface is a single interrupt line and a serial peripheral interface bus.
- To achieve the full 35 Mbit/s payload transfer rate capability of the module/802.11n, the SPI bus must run at a 50 MHz clock rate.
- The current prototype necessitates an FPGA, which is used to interface to an ADC, DAC, ping-ponged RAM chips and to the 801.11n wireless radio.
- To accomplish the communication with the radio and to handle the TCP/IP stack, an ARM Cortex M1 soft processor is implemented.

Conclusion
We have developed the two options (RF and optical) for wireless power transfer up to a point where a decision could be made based on their relevant merits for the intended application. The optical system is more advantageous for small scale prototype system.

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