I. Project

Project Name: Photovoltaic Cells for Micro-Scale Wireless Sensor Nodes: Measurement and Modeling to Assist System Design

Micro-scale wireless sensor nodes can operate in normal situation after energy harvesting. As for the devices to harvest energy, the photovoltaic cells is preferred, because they can offer maximum power point, so in real applying situation, the WSN can work more efficiently with small size. The project sets up a characterization system to measure and model the performance of PV cell, which can help the WSN work more efficiently in applying scenario.

Keyword: Photovoltaic Cells, Micro-Scale Wireless Sensor Nodes, System Design, MPPT

II. Objectives

Objective:

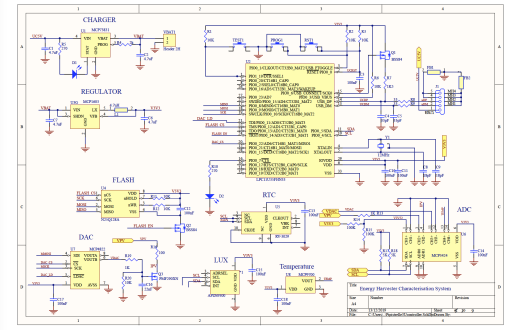
The project will measure conditions from environment, such as temperature and spectrum, to evaluate maximum power point and then optimize MPP by MPPT technique.

Research Background:

When we deploy the WSN in applying situation, the objective is to balance the energy consumption and energy generation, which is called neutral energy, so we can depend on energy less, which can help to reduce power consumption, greenhouse gas and pollution generation.

Hardware:

The hardware will refer to the picture as follows,



III. Method

1. The project will set up a characterization system, multiple CS will be manufactured to measure data, the elements can be listed as follows:

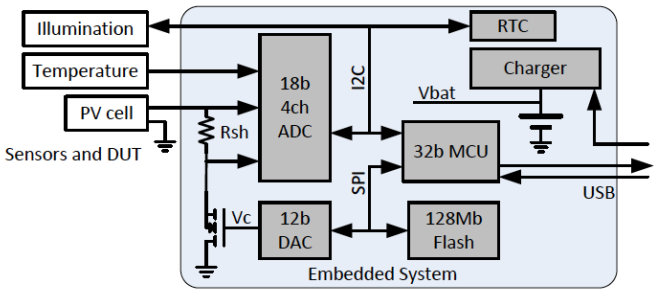


Figure 2: Characterization System.

- cm2-scale PV cells supply power with highest volumetric power output
- battery power supply recharged by USB
- memory storage considering data logging for long time
- 32b MCU converts data, PC interface allows PC to post processing data.
- light sensor collects spectrum, illumination levels
- temperature sensor collects temperature data
- 18bit 4channel ADC collects PV voltage and current and then calibrate I, V curves within a few milli-seconds, and limit current with 100's uA and voltage with 10's mV.
- 12bit DAC- control gate voltage of NFET
- flash memory- lossless compression, byte-packing
- shunt resistor- affect current measurement

All devices- low power sleep modes, no data is collected under extreme lo light conditions

2. The useful techniques can be listed as follows:

MPP is considered as ideal energy budget of WSN, so the point is considered as input to simulate switched capacitor(SC) converter design to evaluate conversion ratios and cold start voltages while the energy will be reduced in real state scenario. Because the low conversion effiency causes energy loss, so the parameters for harvester and converter is important. In the project, MPPT is done by FOCV(Fractional Open Circuit Volateg) technique, which provides low power and area with decoupling capacitance. Fraction Kopt is a challenge for laboratory, which is relevant to fill-factor of PV cells.The implementation will be done by simulation, to be specific, firstly measure IV curve in indoors, outdoors real world to get characteristics of PV cells, secondly replay data to repeat performance with time to perform long term continuous IV measurements on PV. Thirdly use SPICESimulation Program with Integrated Circuit to realize circuit simulation, analyse performance, optimize parameters, predicte circuit behaviours.

3. The project use standard conversion formula provided in the device datasheet to compute parameters (Rs, Rp, Is1, Is2) for iteration and arrive at a correction factor, which means voltage calibrated within

0.2%, current calibrated within 2% and below 5uA, light illumination with 20% and below or equal to 200Lux, 10% and greater or equal to 1000Lux.

IV. Project Plan

	June				July			
	1 week	2 week	3 week	4 week	1 week	2 week	3 week	4 week
Brief								
Method								

V. Reference

[1] Sebastian Bader, Xinyu Ma, and Bengt Oelmann. “Distributed Measurement of Light Conditions for Indoor Photovoltaic Applications”. In: 2020 IEEE SENSORS. IEEE. 2020, pp. 1–4.

[2] Lars Hanschke et al. “Light in the box: Reproducible lighting conditions for solar-powered sensor nodes”. In: Proceedings of the 15th ACM Conference on Embedded Network Sensor Systems. 2017, pp. 1–2.

[3] Anand Savanth et al. “Photovoltaic cells for micro-scale wireless sensor nodes: measurement and modeling to assist system design”. In: Proceedings of the 3rd International Workshop on Energy Harvesting & Energy Neutral Sensing Systems. 2015, pp. 15–20.