Photodiode operation

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October 28, 2015

1 Introduction

2 Calibration against solar cell

2.1 Introduction

In order to obtain the power being supplied by the solar cell from the current generated from the photodiode, the photodiode must be calibrated with the solar cell. The power management board of the CC5300, used here, sets the operating voltage of the solar cell to a constant voltage, roughly 1.1V, which is at or near the maximum power point of the solar cell for the levels of illumination expected. The current generated by the solar cell can then be measured using a picco-ammeter and calibrated against the output of the photodiode.

2.2 Setup

The photodiode may first be calibrated against the solar cell by directly measuring the photocurrent using a photodiode for a range of light levels. The photodiode is then subsequently connected to an op-amp within the MSP430 (usually OA0) configured as a trans-impedance amplier with a gain set by the value of the feedback resistor used. The output of the ti op-amp can then be routed to an ADC within the MSP430 and the digital output displayed through the serial port.

There are thus three different points that the calibration can be made. It would seem like a good idea to calibrate each in turn as they should all be related by known constants, e.g. the value of the gain in the op-amp, reference voltage and resolution of the ADC. Each are measured simultaneous to the photocurrent generated by the solar cell when connected to the power management board.

2.2.1 Direct current measurement

Here the photodiode is connected directly to an ammeter and the current measured. As there is no voltage across the ammeter it is in the same configuration as will be used when connected to the ti op-amp. The layout is shown in Figure 1

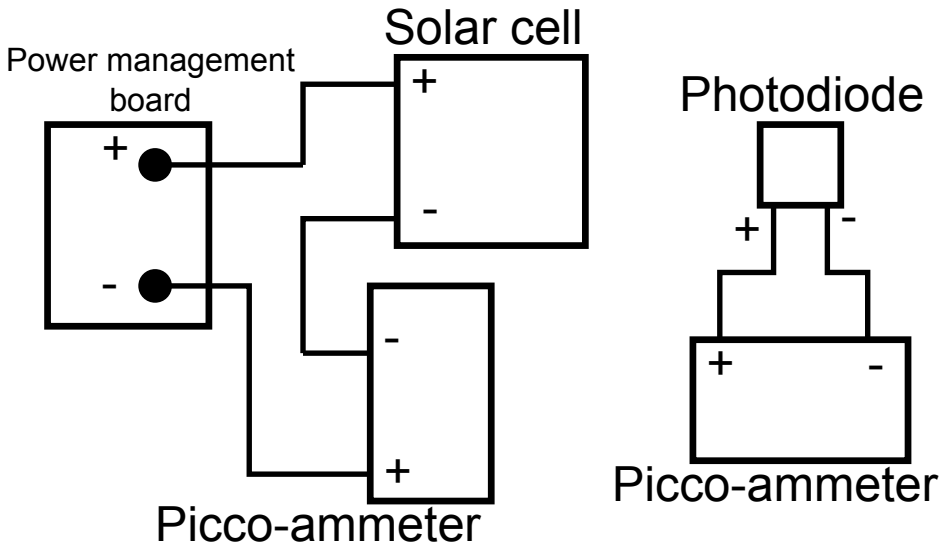

Figure 1: Layout of photodiode calibration with solar cell.

2.2.2 Trans-impedance op-amp voltage measurement

The setup fo the photodiode with a ti op-amp configured within the MSP430 is shown in Figure 2. The value of the feedback resistor used is 100 k. The firmware code is saved within
CCS
photodiode_calibrate.

2.2.3 ADC output comparison

The photodiode is connected to the op-amp and an ADC within the MSP430 as shown in Figure 3. The digital output from the ADC is then sent through a serial bus and displayed upon the PC. The value of the feedback resistor used is 100 k and the reference voltage for the ADC is 1.5V. The firmware code is saved within the *$PROJECT-ROOT$/CCS/photodiode_test* folder.

2.3 Results

2.3.1 Trans-impedance op-amp voltage measurement

The solar cell and photodiode were placed next to one-another and illuminated using a halogen lamp. The lamps was directed at a piece of white paper to create a diffuse

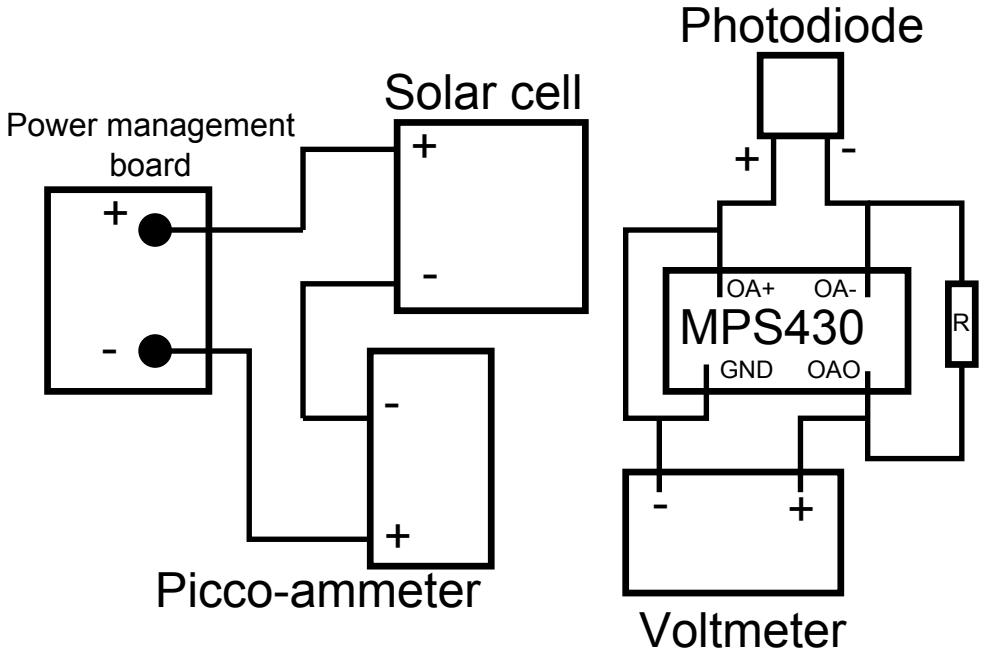

Figure 2: Layout of photodiode calibration with solar cell using ti op-amp within MSP430.

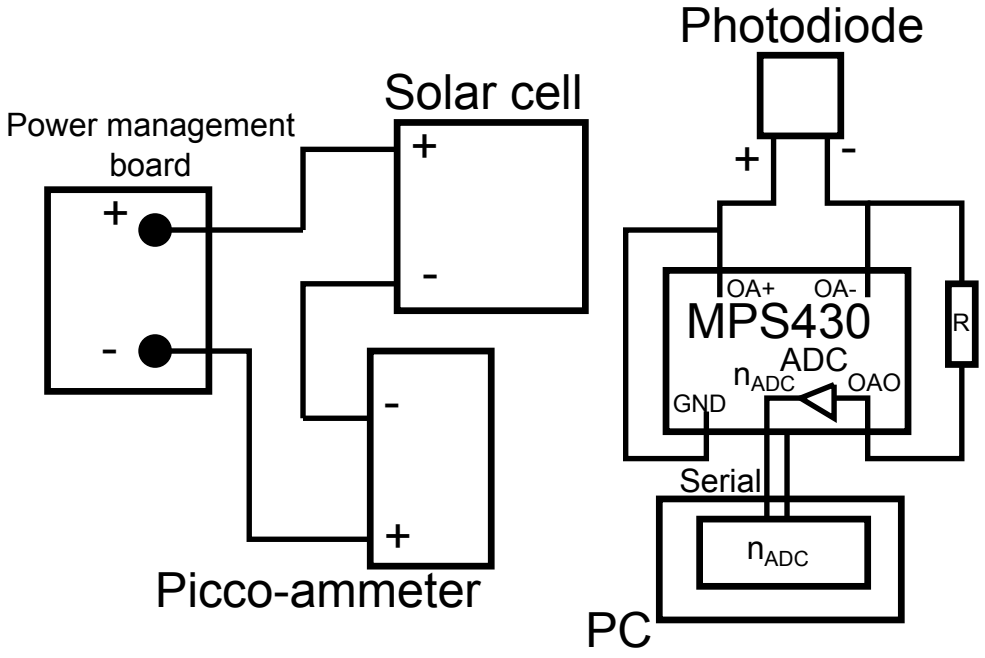

Figure 3: Layout of photodiode calibration with solar cell using ti op-amp and ADC within MSP430.

light uniform over the area of the solar cell and photodiode. Data is saved within the file *data_2015_10_27.csv* within the *data* folder. The data is shown in Figure 4.

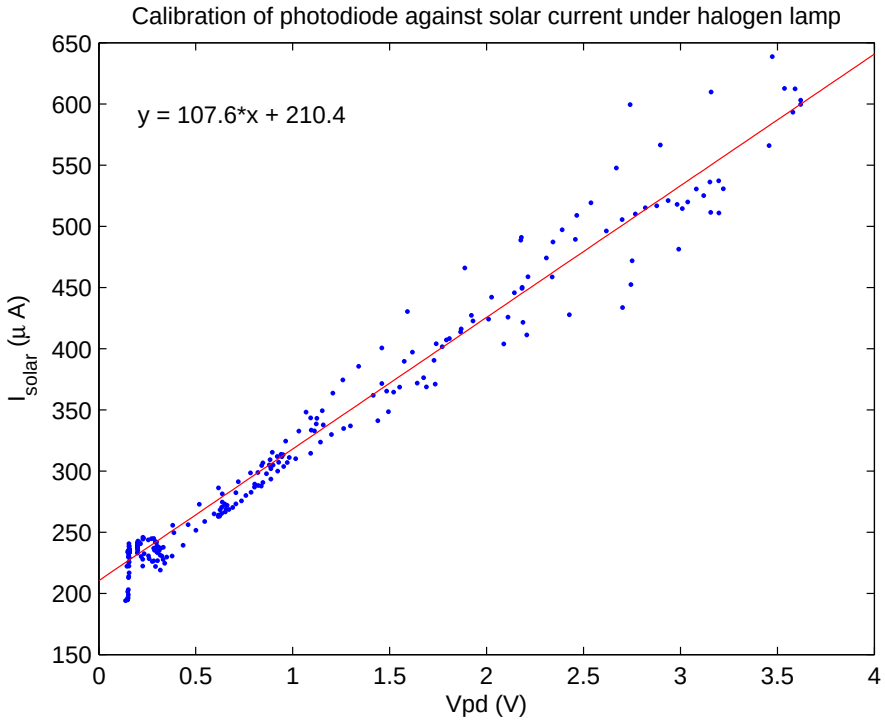

Figure 4: Photocurrent as a function of op-amp voltage.

2.4 Analysis

- Why is there a y-offset when calibrated against the op-amp voltage (Figure 4)?