CDR Presentation

Verification Subsystem

November 21, 2015

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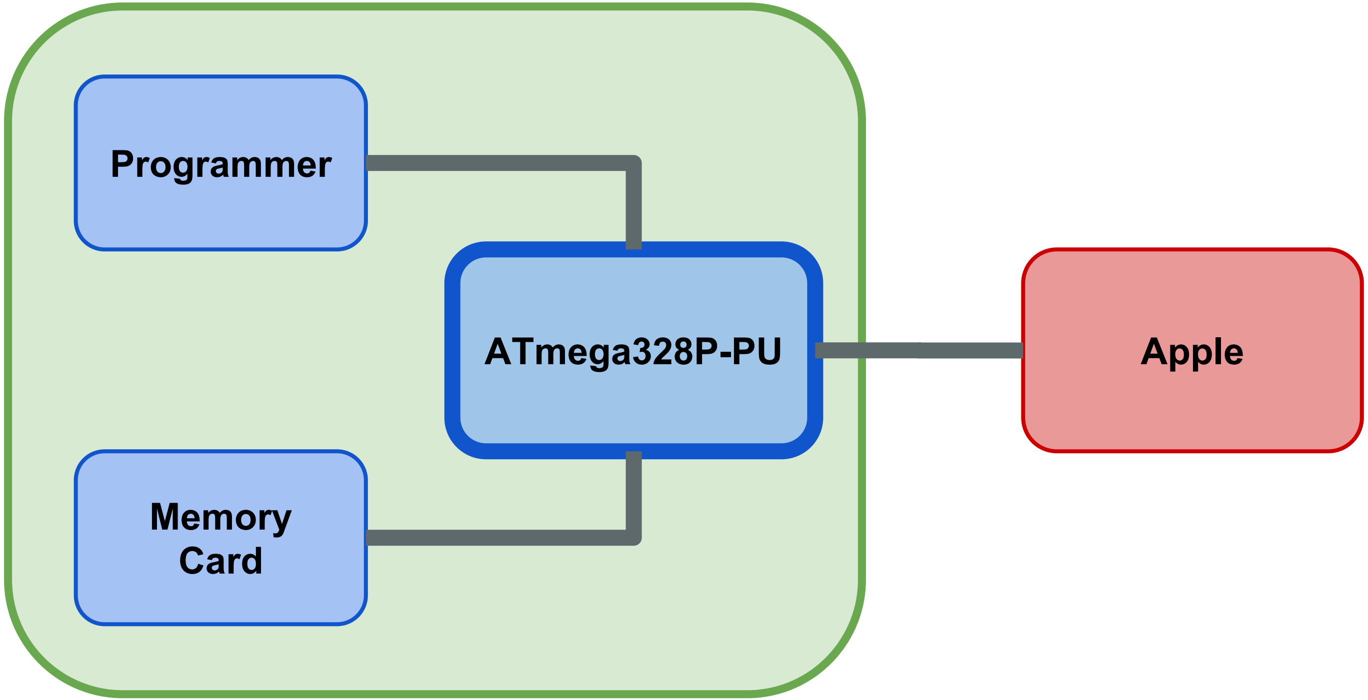
Overview

- Goals
- Block diagram
- Progress Overview
  - Verification Board
  - Other Progress
- Unfinished Business
- Questions & Problems for Feedback

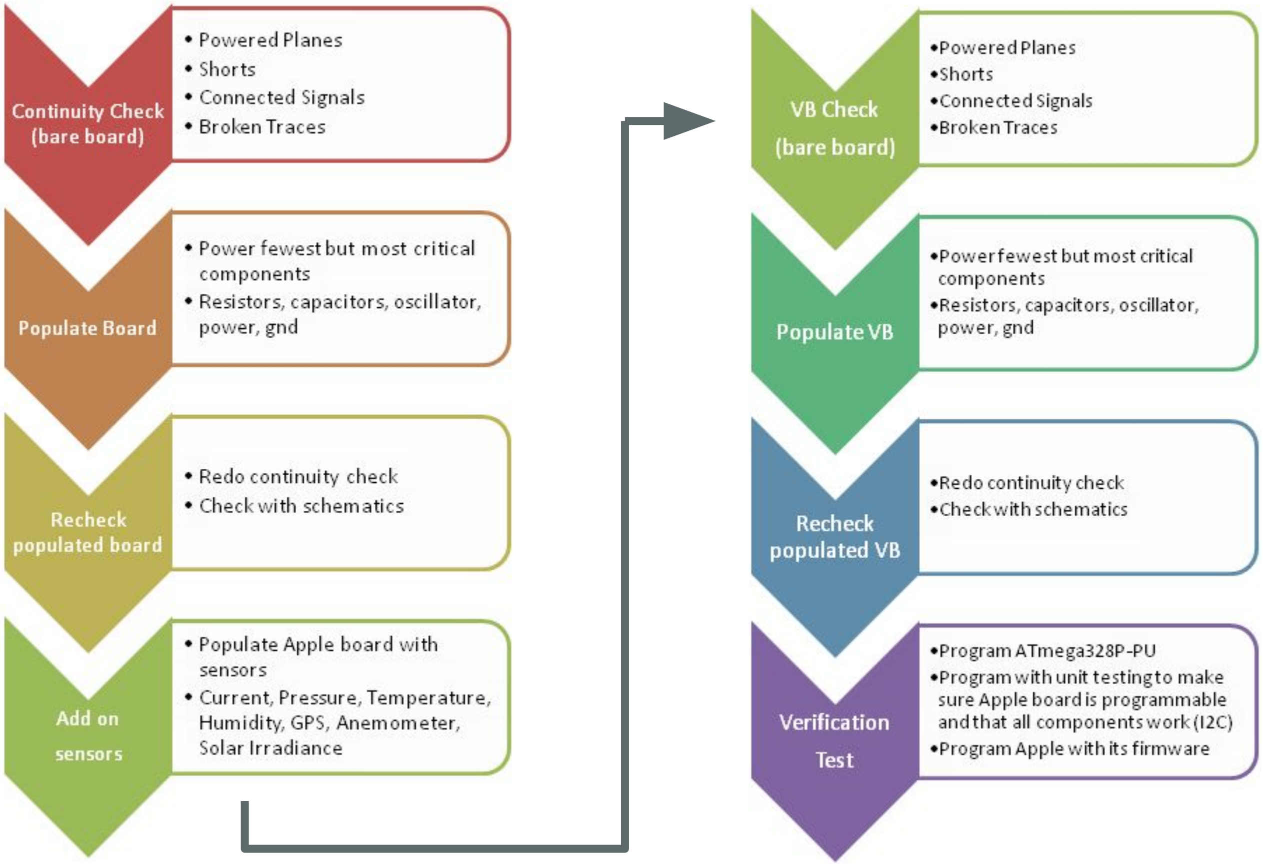
Goals

- Overall Goal:
  - Build verification board that can verify Apple Hardware
- Semester Goal:
  - Have a design ready to be sent out for fabrication
    - Min: Hardware
    - Max: Unit test hardware

Block Diagram - Verification Board (VB)



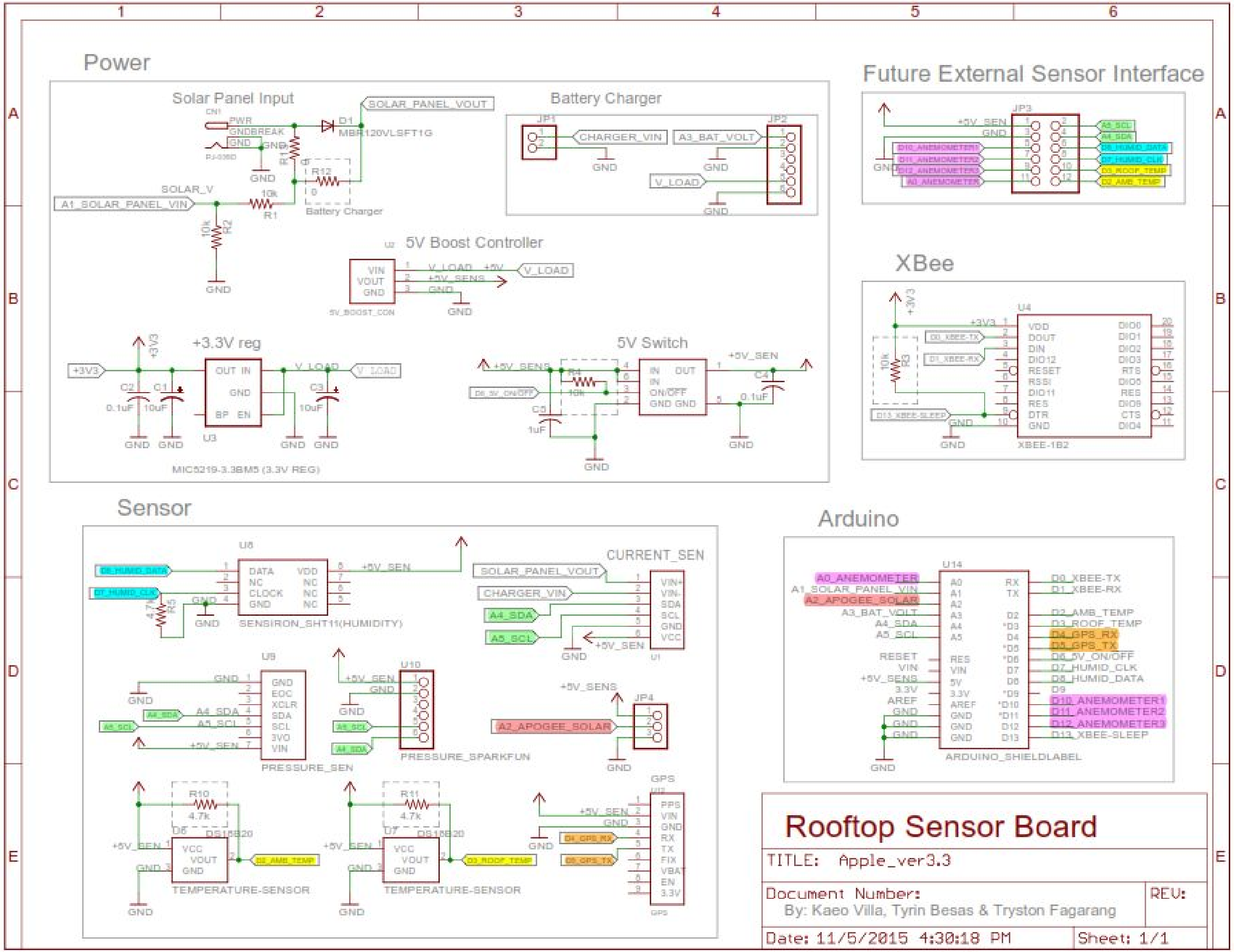
Block Diagram - Apple Verification Procedure



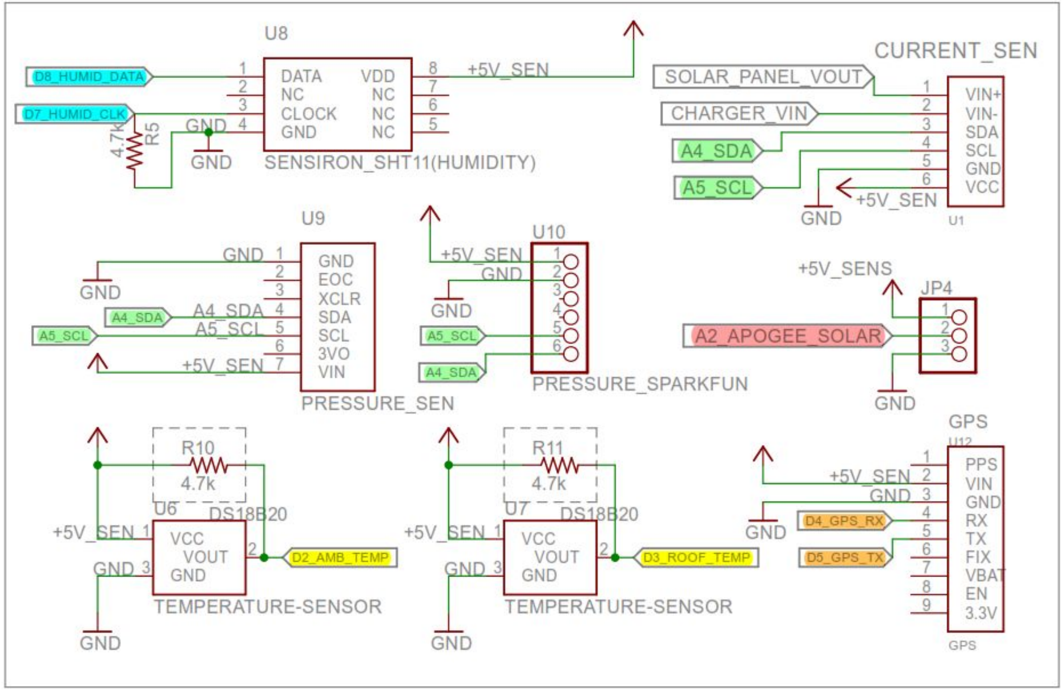
Progress Overview

- Updated short term goals
  - End of semester: EAGLE design completed
- Bare bones implementation of ATmega on breadboard
  - Bootloaded ATmega
  - Blinking LED
- Verification board test specifications

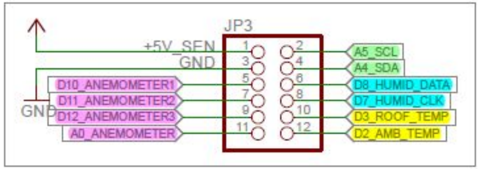
Verification Board Test Specifications


Power
Solar Panel Input
Battery Charger
5V Boost Controller
+3.3V reg
5V Switch
Future External Sensor Interface
XBee
Sensor
Arduino
Rooftop Sensor Board
TITLE: Apple_ver3.3
Document Number:
By: Kaeo Villa, Tyrin Besas & Tryston Fagarang
REV:
Date: 11/5/2015 4:30:18 PM
Sheet: 1/1

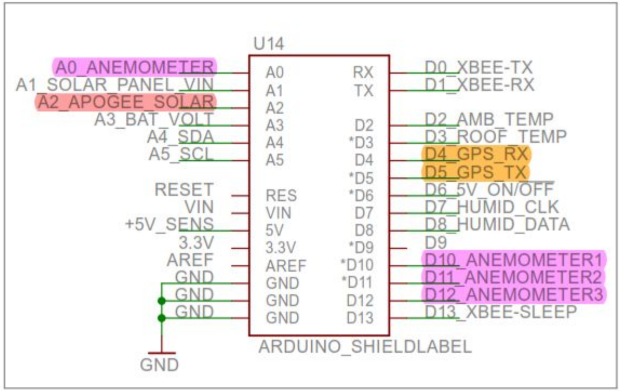
Sensor



Future External Sensor Interface



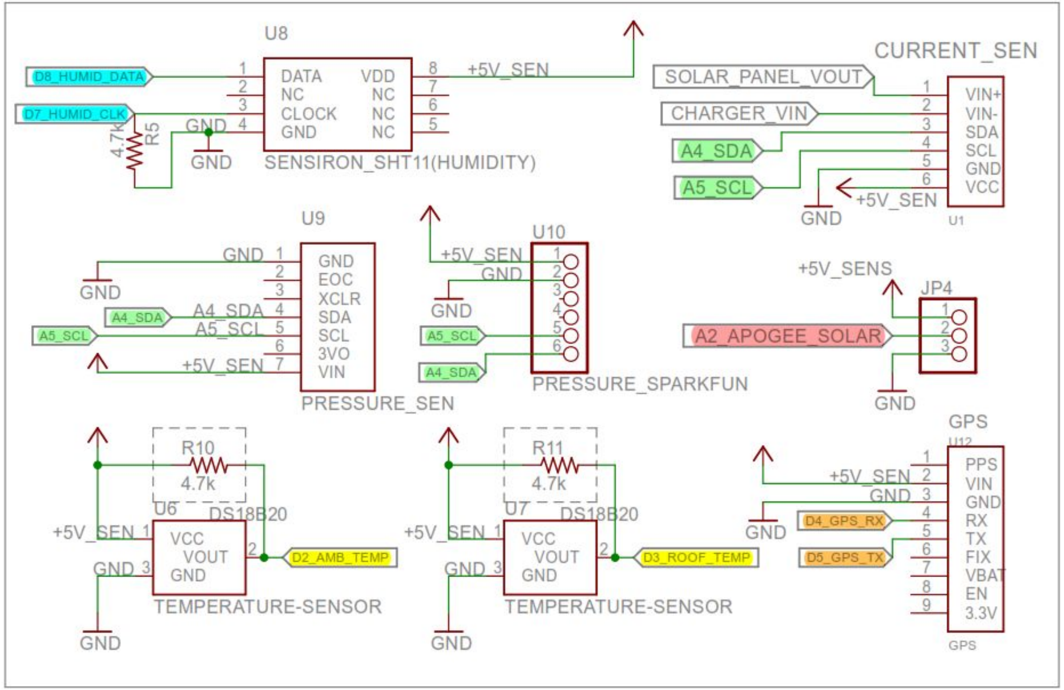
Arduino



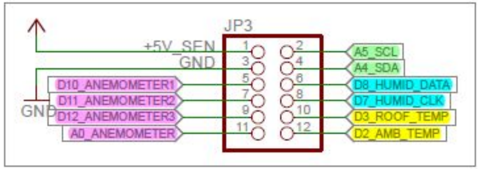
Interfacing with Apple Sensors

- Data Readings:
  - Current
  - Pressure
  - Temperature
  - Humidity
- Power and GND Check:
  - Anemometer
  - Solar Irradiance
  - GPS

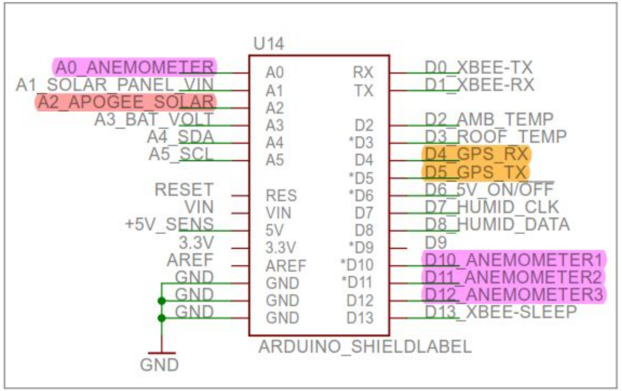
Sensor



Future External Sensor Interface

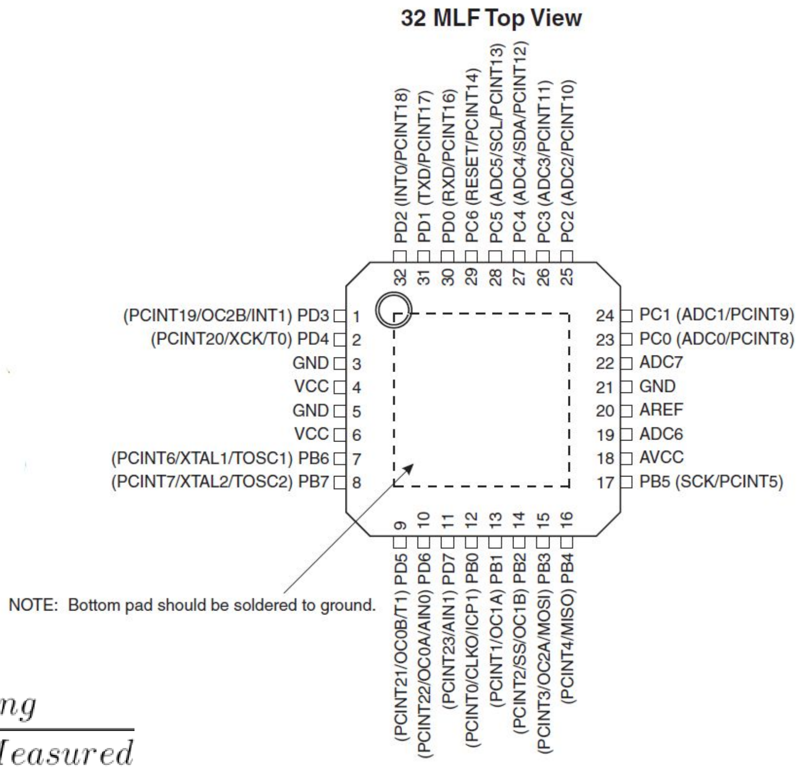


Arduino



MCU: ATmega328P-PU

- I/O pins
  - Digital
  - ADC - 23:29, 19, 22
    - Use ADC value to check if sensor is powered correctly
    - $$\frac{Resolution\ of\ the\ ADC}{System\ Voltage} = \frac{ADC\ Reading}{Analog\ Voltage\ Measured}$$



Other Progress

Quality Assurance Checklist

	Quality Assurance Checklist						
	Evaluator Names:						
	Date of Assessment:						
Section	**Topics**	**Check Date**	**Operator Initals**	**Yes/No**	**N/A**	**Date Fixed**	**Comments**
A	**Unpopulated PCB Check**						
A.1	Did you do a continuity check?						
A.2	Are all the necessary planes powered?						
A.3	Are there no shorts?						
A.4	Are the signals properly connected?						
A.5	Are there any broken traces?						
B	**Populated PCB Check**						
B.1	Did you obtain the Apple circuit schematics?						
B.2	Is the PCB populated with the fewest but most critical components?						
B.3	Do all the voltages fall in the correct voltage ranges?						
B.4	Are all the reference planes correct and grounded properly?						
C	**Compeletely populated PCB Check**						
C.1							

Apple Documentation

WeatherBox Project

Purpose of Weatherbox Project:

Objective of Weatherbox Project:
The objective of this project is to design and develop low-cost, accurate, and reliable environmental sensor modules that can easily be reproduced for mass deployment on rooftops across the University of Hawaii at Manoa campus. The meteorological data collected from these modules will assist in planning future renewable energy installations as well as providing risk mitigation for electricity generation through the development of renewable resource prediction and forecasting algorithms.

Apple Weather Sensor Module

The Apple weatherbox design is the first stable platform in the weatherbox lineage.

Purpose
The meteorological data collected from these modules will assist in planning future renewable energy installations as well as providing risk mitigation for electricity generation through the development of renewable resource prediction and forecasting algorithms.

Objective
To design and develop low-cost, accurate, and reliable environmental sensor modules that can easily be reproduced for mass deployment on rooftops across the University of Hawaii at Manoa campus.

Use
To respond to the current weather conditions (shut off power sources/turn on power sources)

- Reorganizing the board layout and taking out the op amp
- cleaning up the schematic

1 System Design

Block diagram

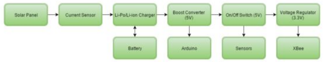
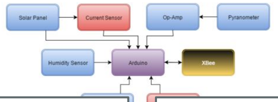


Figure 1.1 (a): Power system block diagram of Apple



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2 Communication System

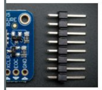
GPS Sensor (GlobalTop Technology MTK3339 GPS)

- Provides location and current time
- Powered by 5V supply
- Consumes an average of 22.5mA
- Can track up to 22 satellites
- Update ranges are (1 - 10) Hz
- Position accuracy ± 1.8m
- Easily finds specific Weatherbox in a network of Weatherboxes

Figure 2.1: MTK3339

Pressure Sensor (Bosch BMP085 barometric pressure sensor) - RECENTLY DISCONTINUED

- I2C data transfer
- Measurement ranges from (300 - 1,100)hPa ± 1.0hPa with a resolution of 0.01hPa
- Incorporated temperature sensor has a range of (-40 to 85)℃ ± 1℃
- **NEW MODEL: BMP180 - smaller, cheaper, more efficient**
  - connected the same way



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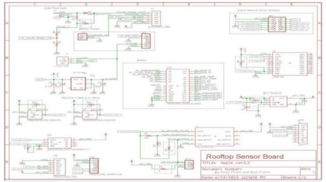

Parts Notes:

- Boost converter
  - boosts 3.7V to 5V (its red)
- Xbee
  - runs at 3.3V
  - There is a separate regulator to convert that
- I2C:
  - uses temp, humid, and current sensor (these are tied to the I2C bus)

splar irradiance does not use opamp

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3 Power System

Battery

- 3.7V - 6,600 mAh rechargeable Li-ion
- Fully charges around midday from dual solar panels
- Switch cuts off power when <30% (1.11V)

Charger

- Li/Li-Ion
- 3.7/4.2V MCP 73871

Solar Panel

- Large 6V 3.4W
- Never directly powers the circuit
- Only powers the charging circuit to charge the battery

Power Budget

- 130mA current draw at full operation mode
- 70mA current draw when sensors are off

4 Control System:

Arduino Uno R3

- Brain of the system
- Microcontroller board based
- Open-source prototyping platform

Problems with 2013 Apple Design

- Power distribution
- Programming Arduino
- Overall Box Structure/Housing

Improvements in 2015 Apple Design

- design that supports "remote" programming
- easier to assemble and disassemble
- implement parent module data retrieving

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Table 1. Apple module cost breakdown

Description	Quantity	Unit cost (USD)
Arduino UNO - R3	1	29.95
XBEE Pro 63mW RPSMA - Series 2B	1	44.95
INA219 High Side DC Current Sensor Breakout	1	9.95
Sensirion Temperature/Humidity Sensor	1	35.00
BMP085 Barometric Pressure/Temperature/Altitude Sensor	1	19.95
NCP1402-5V Step-Up Breakout	1	5.95
Op Amp - Dual Rail-to-Rail - 2.7-12V power @ 80mA output	1	2.95
Pyranometer Apogee SP-110	1	169.00
Large 6V 3.4W Solar panel	2	69.00
USB/DC/Solar Lithium Ion/Polymer charger - v1.0	1	24.95
Lithium Ion Battery Pack - 3.7V 6600mAh	1	39.50
Housing	1	15.00
Clamps	1	50.00
PCB	1	7.00
	Total	524.05

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ATmega328P-PU Documentation

- For other teams to use in the future

ATmega328P-PU Microcontroller

Abstract: The ATmega328P-PU is a high performance, low power 8-bit microcontroller with 4/8/16/32K Bytes In-System Programmable Flash. This microcontroller is used on the Arduino Uno.

Microcontroller Pin Configuration

Pin	Port	Description
1-2, 9-11, 30-32	Port D (PD7:0)	8-bit bi-directional I/O port with internal pull-up resistors (Selected for each bit) [1]
3, 5, 21	Vcc	Digital Supply Voltage
4, 6	GND	Ground
7-8, 12-17	Port B (PB7:0)	- 8-bit bi-directional I/O port with internal pull-up resistors - Can be used as input to the inverting oscillator amplifier and input to the internal clock operating circuit - PB7 can be used as output from the inverting oscillator amplifier
18	AVcc	- supply voltage pin for A/D converter, PC3:0 and ADC7:6 - should be external connected to Vcc even if ADC not used - if ADC used, it should be connected to Vcc through low-pass filter - PC6:4 uses a digital supply voltage, Vcc
19, 22	ADC7:6	A/D Converter
20	AREF	Analog Reference pin for the A/D Converter
23-28	Port C (PC5:0)	- 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit)
29	PC6/RESET	- PC6 used as I/O pin - electrical characteristics of PC6 differ from other Port C pins

[1] What is a Pull-up Resistor
Let's say you have an MCU with one pin configured as an input. If there is nothing connected to the pin and your program reads the state of the pin, will it be high (pulled to VCC) or low (pulled to ground)? It is difficult to tell. This phenomena is referred to as *floating*. To prevent this unknown state, a pull-up or pull-down resistor will ensure that the pin is in either a high or low state, while also using a low amount of current.
For simplicity, we will focus on pull-ups since they are more common than pull-downs. They operate using the same concepts, except the pull-up resistor is connected to the high voltage (this is usually 3.3V or 5V and is often refereed to as VCC) and the pull-down resistor is connected to ground.
Pull-ups are often used with buttons and switches.

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Microcontroller application
Bootloading and Mounting

- Making sure the chip has a bootloader on it (a bootloader allows the chip to be programmed, without it, you cannot program anything on it and it won't work)

http://www.instructables.com/id/Bootloading-and-Mounting-Arduino-Atmega328/

- Download Arduino Uno
- For required parts you will need:

Atmega328 Bootloading
- 1 - Arduino Uno with a bootloaded Atmega328
- 1 - Atmega328, Atmega328p or Atmega328p-pu
- 1 - 16MHz crystal
- 2 - 22pF Capacitor
- 1 - 10k ohm resistor
- 1 - breadboard
- wires

Mounting Flashed Atmega328
- 1 - Atmega328, Atmega328p or Atmega328p-pu
- 1 - 16MHz crystal
- 2 - 22pF Capacitor
- 1 - 10k ohm resistor
- 1 - breadboard
- 5v DC power source or
- DC power source above 5v with voltage regulator (Step 6)
- wires

(optional parts)
- 1 - LED
- 1 - 220 ohm resistor
- 1 - pushbutton
- 1 - 10k ohm resistor
- 1 - 0.1uF capacitor

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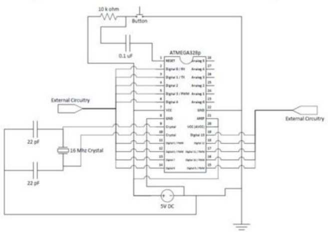
Atmega328p-pu Mounting Schematic



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Unfinished Business

- Verification board
  - Go over data sheets & understand pin outputs
  - Selecting parts
  - EAGLE PCB layout
  - Manually measure voltages of Apple for ADC data
- Documentation

Questions & Problems for Feedback

- What can be measured from SDA and SCL?
- Temperature sensor:
    - Where is the temperature data? Converted to voltage (Vout)?
- Which temperature sensor is being used for humidity sensor?
- What can we see from the digital pins (Since it won't work with ADC)?
- Other input/feedback

Thank you!