Prince William Sound Profiler

Mid-semester Design Review

ECE 4873 Senior Design Project

Aquanauts

Introduction

- 1989 Exxon Valdez oil spill caused environmental damage
- Since 2013 an autonomous moored profiler (AMP) has collected data on PWS recovery
- Profiler needs modifications/updates
- Goals:
- Updated data storage and transmission capabilities for existing profiler
    - Module can send data from profiler sensors to scientists
    - Centralized data storage in module
- Relay system to supply power to sensors on-demand

Project Description and Goals

- Customer Requirements
  - Higher data transfer volume and speed
  - Updated central memory and processing
  - Automated system to turn sensors on/off on a schedule
- How we will address each
  - Revamp communications utilizing the nearby 3G/4G cell tower and updated data transfer rates vs. current 2G utilization
  - Direct FTP of data will provide full data transfer vs. the current direct UDP packetized transfer only representing 1/10th of collected data
  - Updated memory and processing unit to replace outdated/no longer manufactured Persistor
    - Raspberry Pi 3B
    - Samsung 870 EVO Solid State Drive
  - Custom-built MOSFET switching board to supply power to on-board sensors on a schedule
    - Conserves battery life

Technical Specification

Table 3. Technical Specifications

Specification	Min	Max
Functional Temperature	-5 C	30 C
Functional Depth	Sea level	60m
Total Power Consumption	9 Vdc, 1.01 A	14 Vdc, 1.67 A
Communication Range (Approx)	8000m (Nearest cell tower, approx. 5 miles)	N/A
Communication Protocol	3G & 4G SFTP (Direct to local server, or to cloud)	

Design Approach and Details

- Update Processor
  - Raspberry Pi 3B
    - Choice considerations:
      - Lowest power consumption of RPi models that support Linux
      - Linux required for ftp & ssh protocols
      - Arduino does not support Linux
      - USB bootable from SSD
    - Cons
      - Power consumption still not optimal (~210mA at idle)

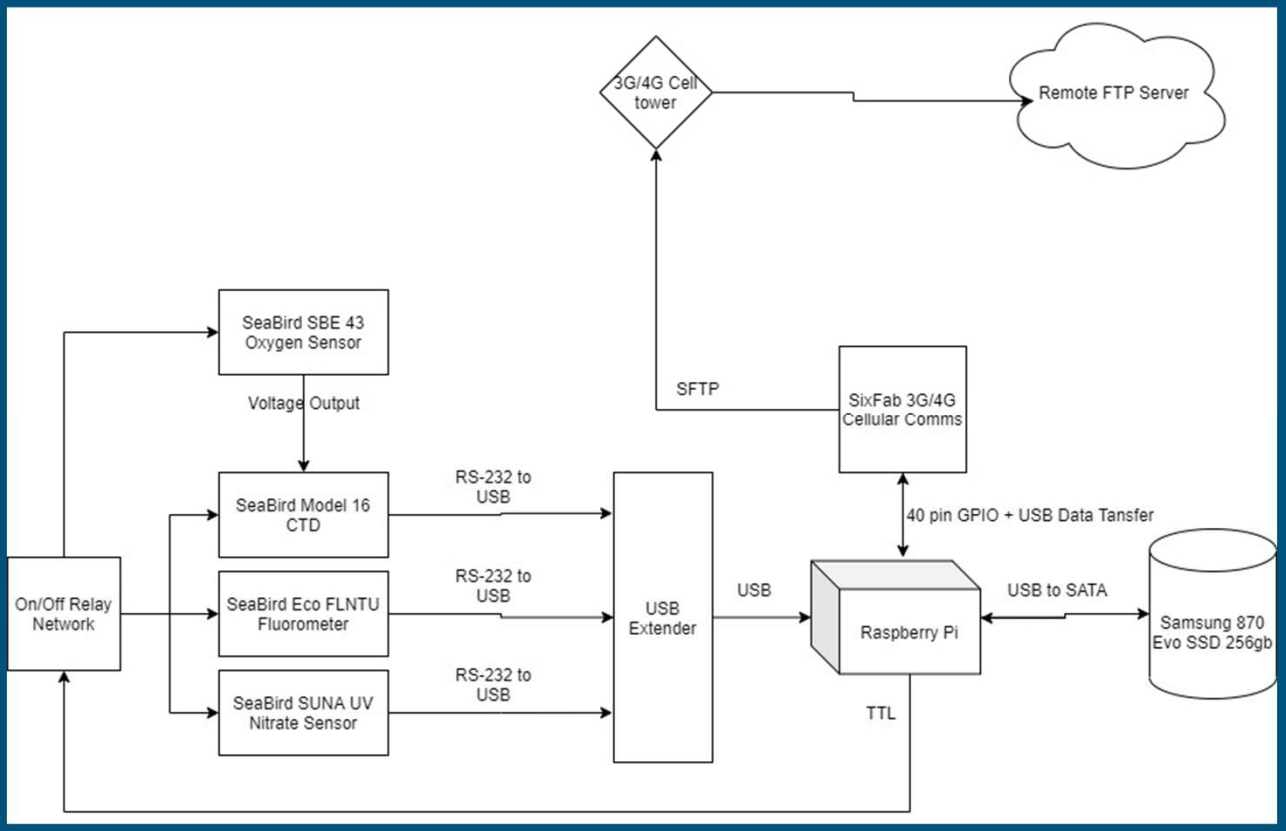
Design Approach and Details Cont'd

- Data Transmission
  - Raspberry Pi communicating with 3G/4G cell tower via SixFab Cellular Communications Module and antennas
  - SFTP to Cloud storage, or transmit direct to local server in Alaska
    - Cloud storage may require paid subscription, but not dependent on state of local server in Alaska, also will act as data backup
    - Local server in Alaska requires user setup/maintenance, data transmission success relies on state of local server
  - Cons:
    - Hard to test whether or not the signal in Alaska is strong enough

Design Approach and Details - SSD

- SSD is preferred over SD card for the following reasons:
  - Longevity -- SDs with DRAM cache last significantly longer than SD cards
    - They also have longer warranties
  - Size -- The system will have more storage to collect more data
    - Size also increases longevity
  - Performance -- SSDs have faster read and write speeds
    - This will help to run programs more efficiently
- Samsung 870 EVO (256 GB)
  - Has DRAM cache, good size, noted performance in user reviews, and 5 year warranty

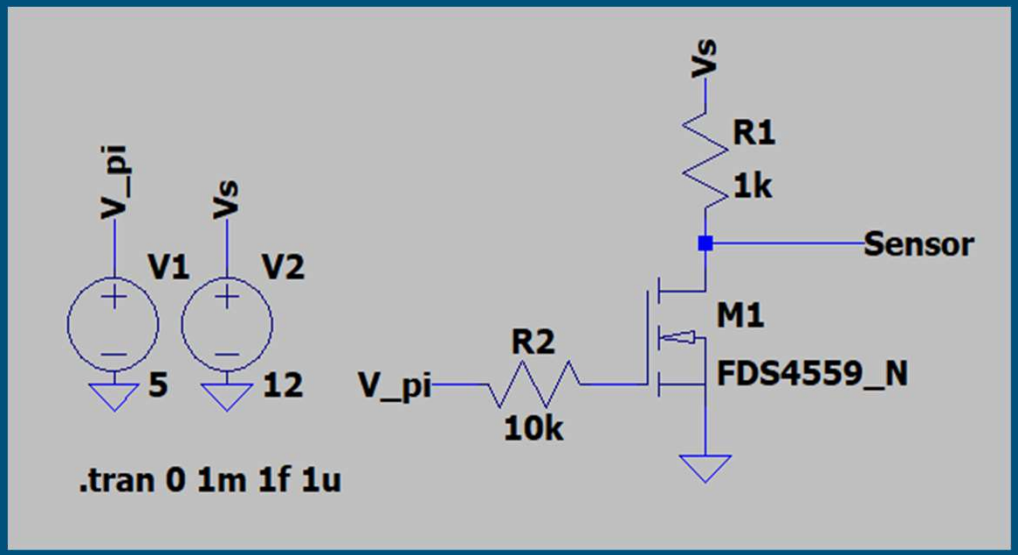
Communications Diagram



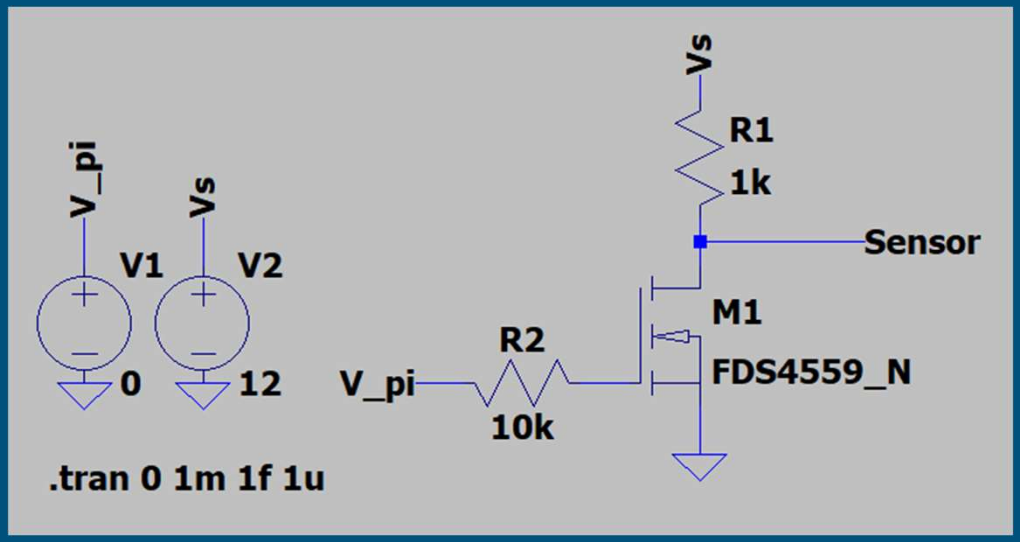
Design Approach and Details - MOSFET Board

- Buck converter to step down the voltage from the battery from 30V to 12V
  - Isolation capable buck converter with adjustable voltage
  - All sensors on the profiler can operate on 12V
- Individual MOSFETS will be used to turn individual sensors on and off
  - MOSFETs instead of relays
    - Since the battery voltage will be stepped down using an isolated buck converter, additional electric isolation is not required
    - The power MOSFETs can be simulated, but it was difficult to find spice models for SSRs
- MOSFET board will allow for new sensors to be added to the profiler in the future

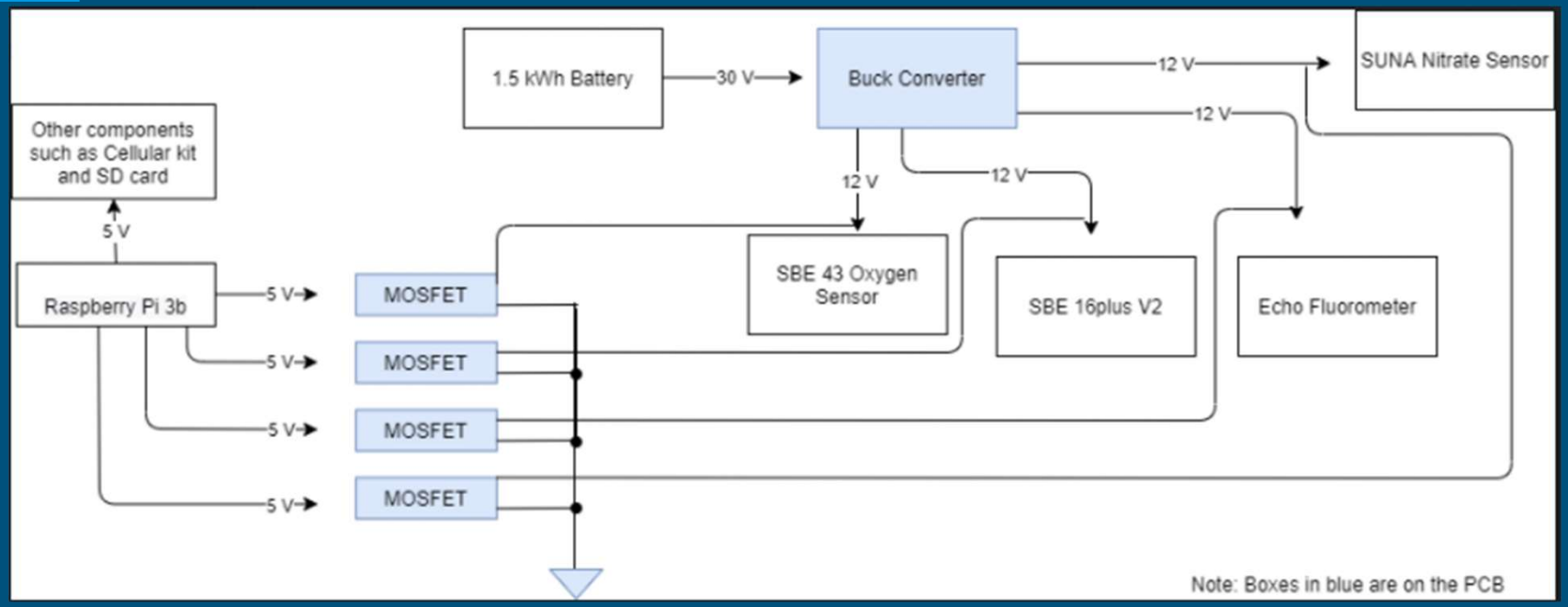
MOSFET Switching Simulation



MOSFET Switching Simulation (Continued)



Power Diagram



Codes and Standards

- 802.15.4-2020 - IEEE Standard for Low-Rate Wireless Networks: The standard provides for ultra low complexity, ultra low cost, ultra low power consumption, and low data rate wireless connectivity among inexpensive devices.
- IMT-2000: Offers the capability of providing value-added services and applications for frequencies between 400 MHz and 3 GHz.
  - Makes 3G systems affordable
  - Adds compatibility feature with existing systems such as 2G

Project Demonstration

- Verification and Validation
  - Software simulation and physical testing with the final prototype (Inspect, Demonstrate, Test)
- Expo
  - Poster, Video, Prototype Demo
    - Present simulation results in a descriptive manner
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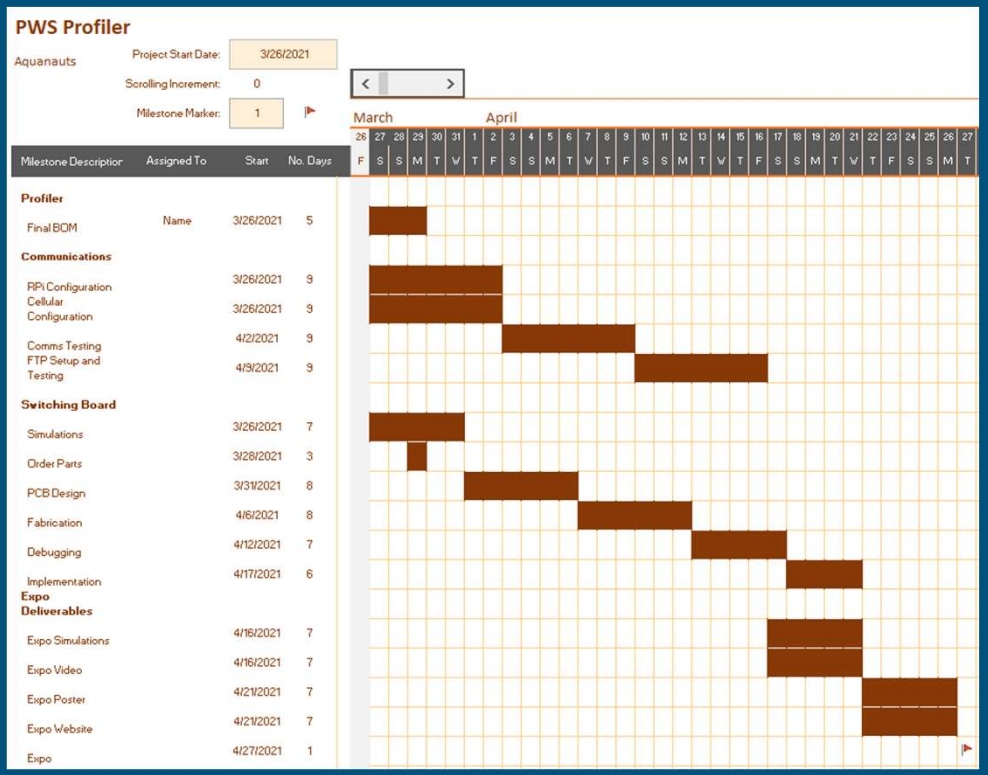
    - Physical prototype

Schedule, Tasks, and Milestones



Chance of Success: 95%

BOM

Part	Manufacturer	Retailer	Price per Item	Quantity	Part Total
Raspberry Pi 3B	Raspberry Pi	Digi-Key	35	1	35
Raspberry Pi 4G/LTE Cellular Modem Kit	Sixfab	Sixfab	109	1	109
Sixfab Connect Sim	Sixfab	Sixfab	2	1	2
SAMSUNG PRO Plus SDHC Full Size SD Card 32GB	Samsung	Amazon	9.99	1	9.99
MKR SD PROTO SHIELD	Arduino	Arduino	13.8	1	13.8
USB 3.0 SATA III Hard Drive Adapter Cable, SATA to USB Adapter Cable	SKL Tech	Amazon	7.99	1	7.99
SAMSUNG 870 EVO 250GB 2.5 Inch SATA III Internal SSD	Samsung	Amazon	39.99	1	39.99
DC-DC Converter	Mean Well USA	Digi-Key	26.71	1	26.71
Power MOSFET FQP30N06L	ON Semiconductor	Digi-Key	1.22	4	4.88
USB to Serial RS232 Adapter	SIIG	Amazon	49.85	1	49.85

Total
299.21

Current Status

a. Full analysis of power requirements - COMPLETE
b. PCB design - IN PROGRESS
c. Communication Design - COMPLETE
    i. Testing phase - IN PROGRESS
d. Software & processing - IN PROGRESS
e. Creating a full BOM - NEARLY COMPLETE
    i. Order parts - NEARLY COMPLETE (Need RS-232 hub & buck converters)

Leadership Roles

- Group Leader: Jim O’Donnell
- Expo Coordinator: Shayna Seidel
- Financial Advisor: Seungju Jason Lee
- Webmaster: Ruben Quiros
- Documentation Coordinator: Timothy Pierce
- Tech lead: Shelby Crisp

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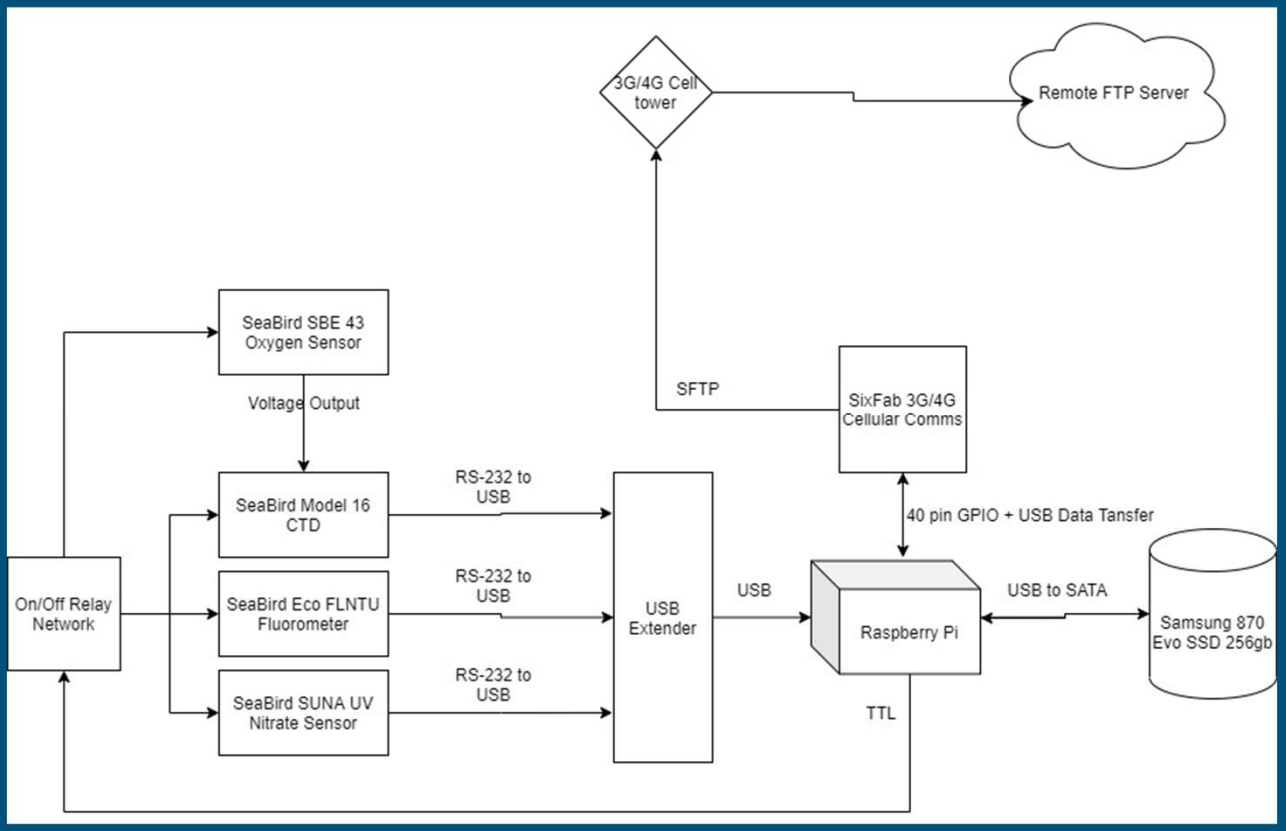

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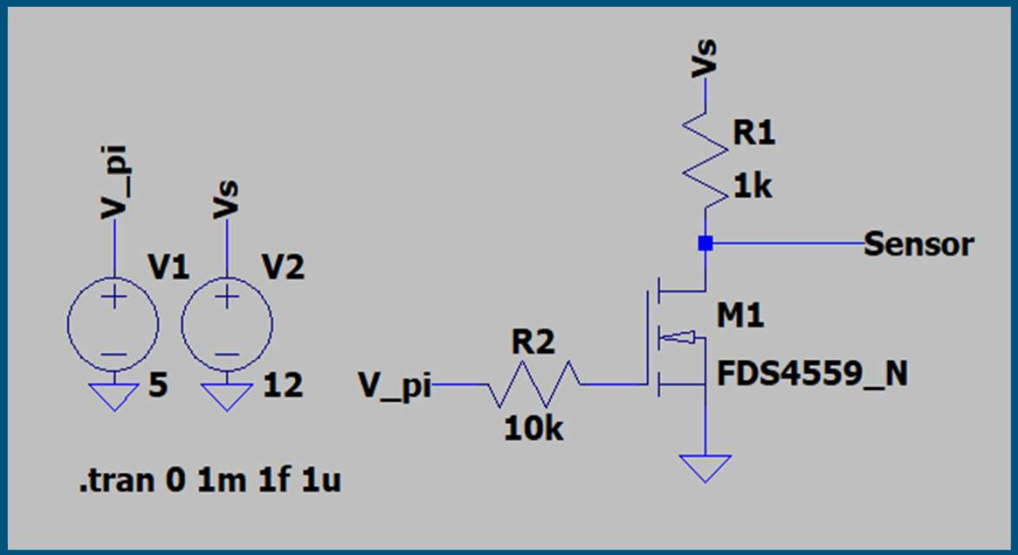

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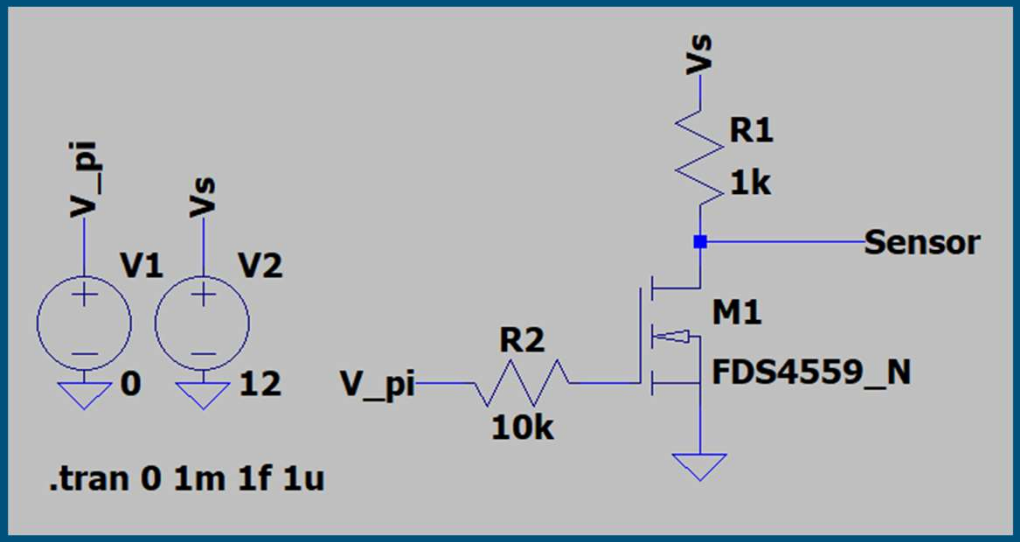

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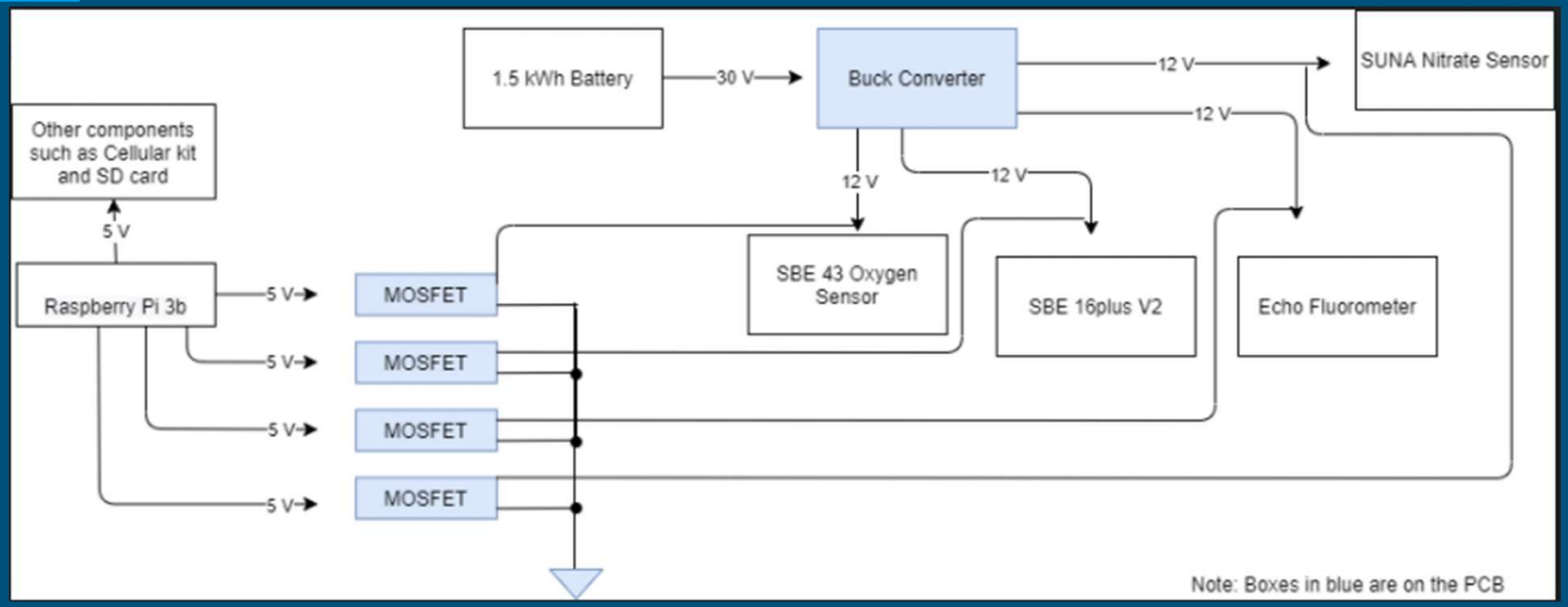

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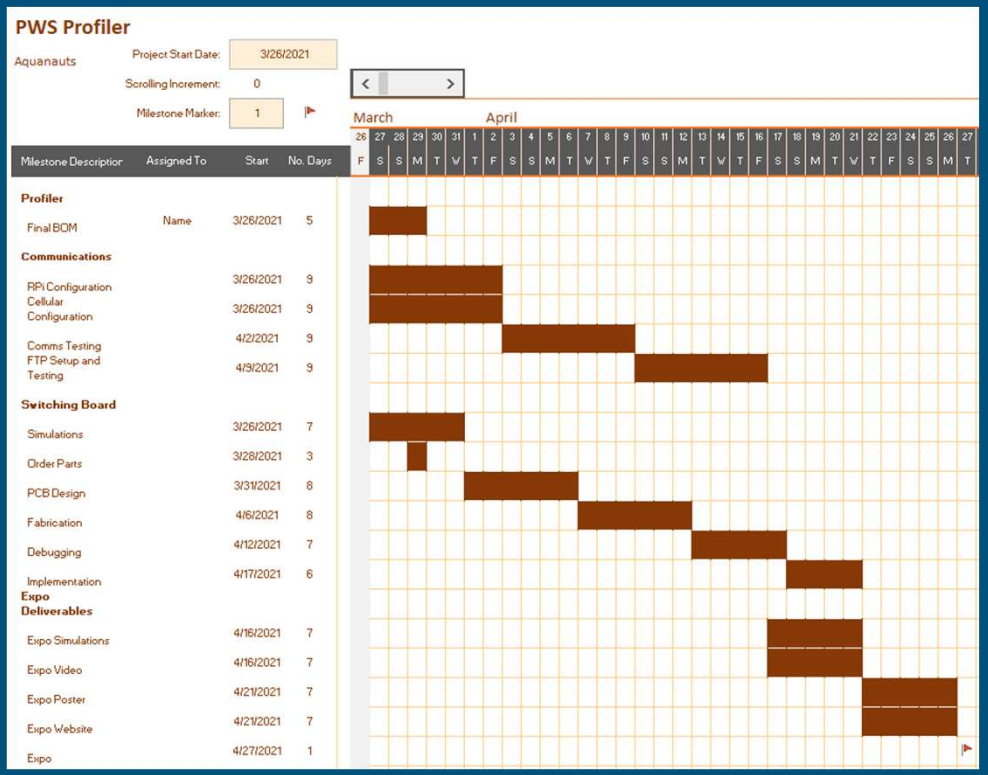

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