RC BOAT POWER AND SIGNAL LEVEL INDICATOR

Mock Design Review Document
ECE 445

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Block Diagram

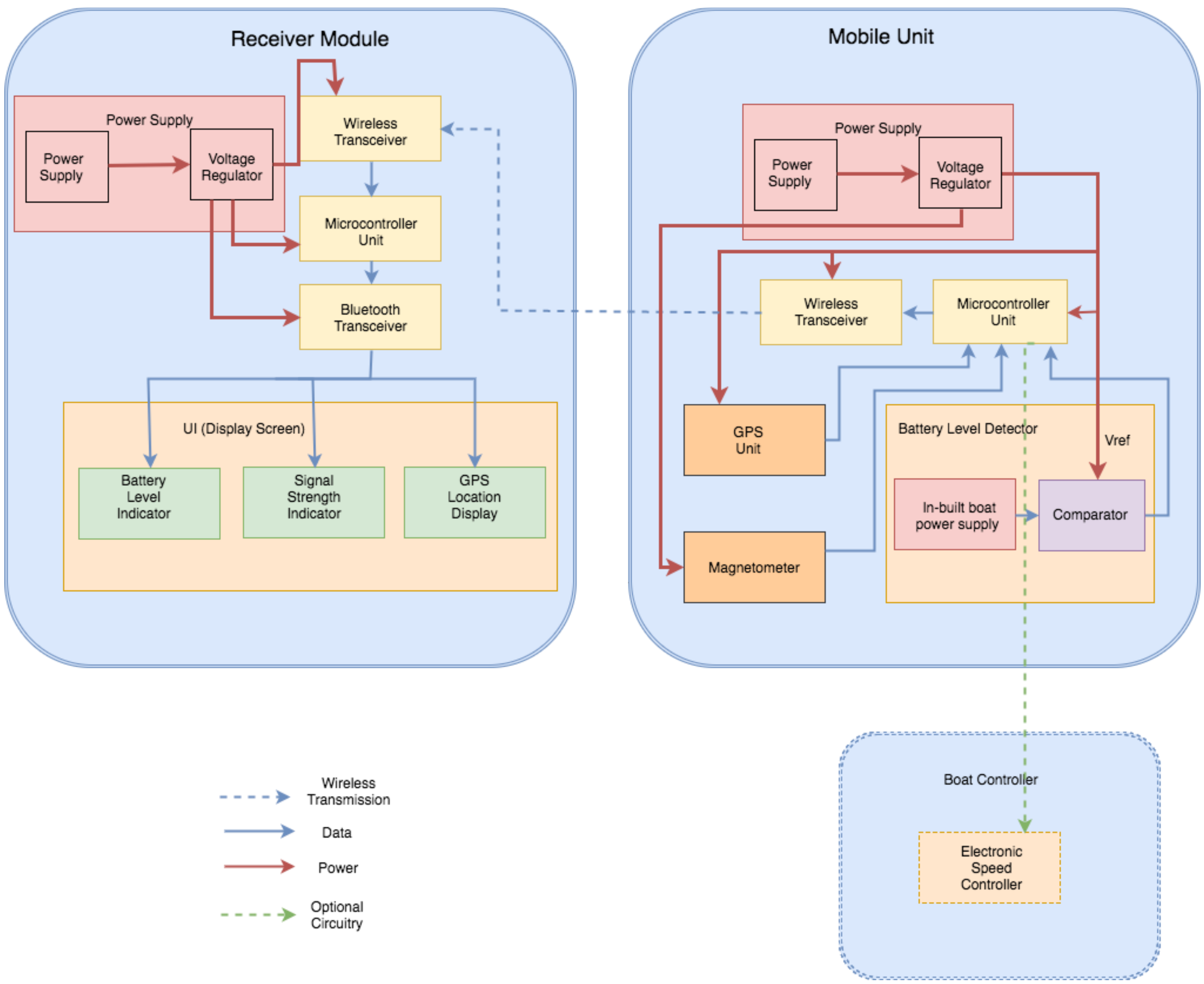

Figure 1. Block Diagram

Battery Level Detector

Measures the battery level of the onboard power supply. To implement this, we will use a simple comparator to compare a reference voltage with the voltage level of the boat inbuilt battery. We are planning to use LM339 quad comparator to accomplish this as it is readily available in the senior design lab.

Requirements and Verification

<table>
<tr><th>Requirements</th><th>Verification</th></tr>
<tr><td>1. Must be able to determine the accurate ($\pm 5\%$) voltage level of the battery accurately when it goes below 3.5V.</td><td>1. The on-board battery is charged up to its full potential and the voltage is recorded using a DMM.
2. The batteries are plugged into the boat, and it used for up to 10 minutes after which the battery voltage is again measured using a DMM.</td></tr>
<tr><td>2. Must provide a low signal when the voltage level falls below the reference voltage and a high signal when the voltage is above the reference voltage .</td><td>Two exhaustive tests were conducted on the designed circuit which are explained as follows,

Test 1 -

1. The schematic shown in below (Figure 2) is set up on a breadboard.

2. V_{ref} is set to 3.5 V using a constant DC power supply. V_{cc} is set to 8 V using the constant DC power supply, with $I_{in} = .1\ mA$.

3. V_{in} is provided from a variable DC power supply. (Set to V_{in} = 5V).
4. As V_{ref} < V_{in}, the output of the comparator is high-Z and the LED is turned off.
5. V_{in} is reduced in steps of 0.5V and it was observed that the LED turns on when V_{in} < 3.5 V, as shown in Table 1.</td></tr>
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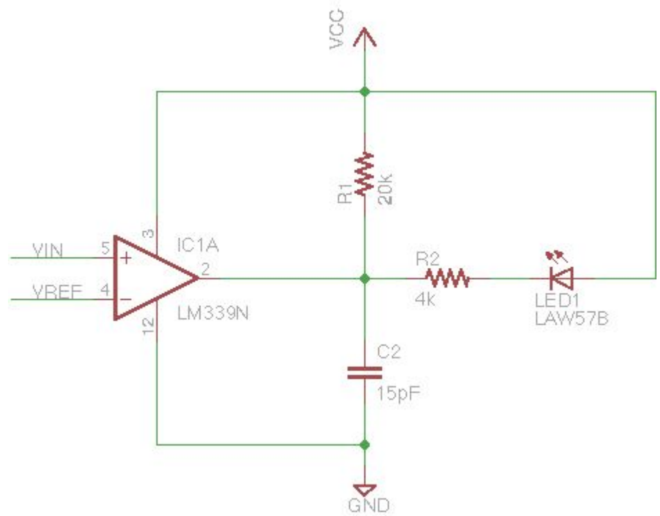

Figure 2. Schematic for Test 1

V_{Ref} (V)	V_{In} (V)	*LED State*
3.5	5	**OFF**
3.5	4.5	**OFF**
3.5	4	**OFF**
3.5	3.5	**OFF**
3.5	3	**ON**

Table 1

	Test 2 - 1. The schematic shown in figure 3 is set up on a breadboard. 2. V_{ref} is set to 3.5 V using a constant DC power supply. V_{cc} is set to 8 V using the constant DC power supply, with $I_{in} = .1\ mA$. 3. The signal generator is set up to provide a square wave output with a max amplitude of 5 V and an offset of 2 V and a duty cycle of 50%. The output is provided as V_{in} to the test circuit. 4. The output of the test circuit is observed on the oscilloscope alongside the input as shown in figure 4**.** 5. As is seen in the waveform, when the input is greater than the reference voltage R_{pullup} pulls the output high to V_{cc} providing a high output. Whereas when the input is lower than the reference voltage, the output is pulled to ground providing a low signal.

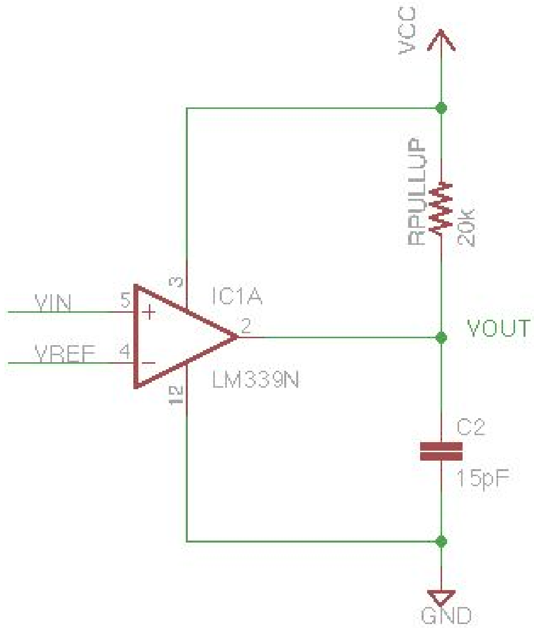

Figure 3.Schematic for Test 2

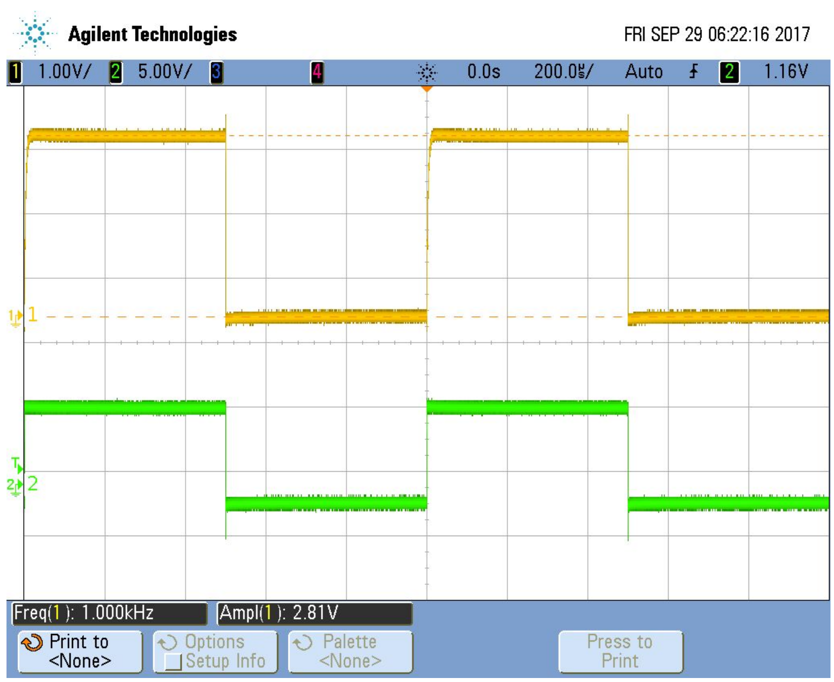

Figure 4. Input(Green) and Output(Yellow) for Test 2

Power Supply (Mobile Unit)

Voltage regulator supplies the necessary power to individual components on the Mobile Unit. We need the regulator provide 3.3V to the circuitry. The total current consumption can be estimated using following numbers obtained from the datasheets[3],

Element	Approx Current Consumption
Comparator	≃ 50 nA
Magnetometer	≃ 10 mA (normal operation)
GPS Unit	≃ 10 mA
Wireless Transceiver (HC-12)	≃ 50 mA (normal operation), 200 mA(during data transmission)

All the above units function on a 3.3 V - 3.5 V supply and adding up their current consumption and keeping in mind rough margins we can estimate the total current consumption during normal operation of the design to be around 100 mA whereas for peak operation during data transmission it is ≃ 200 mA. We are planning to use LM1117 IC as our voltage regulator. It has variable fixed voltages of 2.5V, 3.3V and 5V and also has a current capacity of 800 mA which gives us a lot of wiggle room in case HC-12 (our major current sink) goes above the rated value during data transmission.

The following calculations drive the design choice for the LM1117 circuit. According to the datasheet [2],

$$V_{OUT} = V_{REF}(1 + \frac{R_2}{R_1})$$

LM1117 has an internal V_{REF} of 1.25 V and for our design we need V_{OUT} = 3.3V. Substituting these numbers, we get

$$R_2 = 1.64\, R_1$$

Therefore we choose R_1 = 121 Ω and R_2 ≃ 200 Ω.

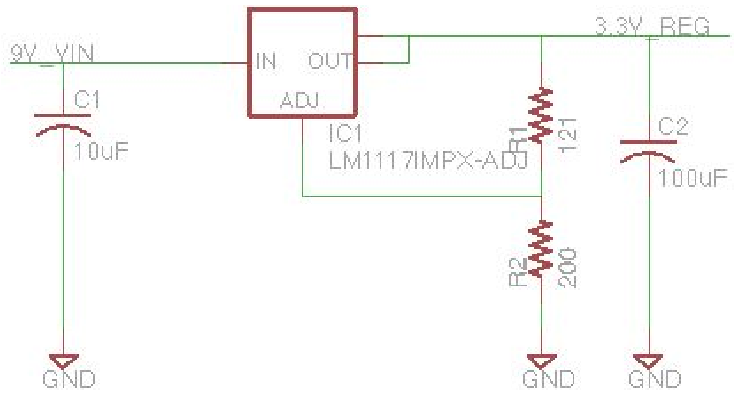

Figure 4.Schematic for voltage regulator

Requirement	Verification
1. Must be able to provide a stable 3.3 V with a tolerance of $\pm 5\%$.	1. Circuit shown in the figure above is set up on a breadboard. 2. A variable load is hooked up at the output of the regulator and the voltage at the output is checked using a DMM.
2. Must be able to provide at least 100 mA current to the load at all times.	1. Circuit shown in the figure above is set up on a breadboard. 2. A variable load is hooked up at the output of the regulator and the current through the load is checked using a DMM.

Ethics and Safety

There are several cases that can run into potential hazards with our project, according to IEEE Code of Ethics: “to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitation” [1]. Our built-in battery uses Lithium ion battery which can explode if overcharged or bought to extreme temperatures. We must monitor the power supply, and ensure that the voltage and current are within reasonable limits to avoid any meltdown or explosions.

Voltage regulator serves as a heat sink for many connected components that can prevent them from overheating and meltdown. However, if the regulator keeps serving power for a long time, regulator itself will encounter overheating and meltdown. Therefore, we must come up with a method to monitor the temperature of the regulator and keep its thermal stable.

Since our boat is an outside electrical device, we must make our device waterproof to prevent any kind of moisture that can damage to our module leading to short-circuits. We will make our design follow IP66 or higher guidelines that can keep the internals of the boat dry for playing period.

One of main concerns during the project, according to IEEE Code of Ethics [1], is "to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment". First, special precautions must be taken for the mobile unit. In case water enters the sealed container, it should not be unsafe for handling, or provide any risk of electrocution.

During the development procedure, technical issues may occur, and need the TA to help us out. We want to make sure that we "seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others"[1], and give proper credit to any help that is offered not only from TAs, professors but also others.

Finally, all team members should "assist colleagues and co-workers in their professional development and to support them in following this code of ethics" [1]. We will make sure that we respect each other, offer and accept criticism within our team, and support each other when in need.

References:

[1] - "IEEE IEEE Code of Ethics." IEEE - IEEE Code of Ethics, www.ieee.org/about/corporate/governance/p7-8.html. Accessed 1 Oct. 2017.

[2] - "LM1117 Datasheet." TI.com, www.ti.com/lit/ds/symlink/lm1117.pdf.

[3] - "LM339 Datasheet." TI.com,http://www.ti.com/lit/ds/symlink/lm2901v.pdf.