Mock design review

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Block diagram:

120v 60Hz → charger → Li Polymer batteries

relay

voltage regulator 12v → solenoid

voltage regulator 3.3v → microcontroller

voltage regulator 5v → camera and sensors

3.7v

Circuit Schematic: Power circuit

Calculations:

sum of V and I for the various components to get power/I rating for battery
microcontroller+solenoid+camera
3.3*0.05+12*0.5+5*.07=6.515 W
At 3.7 V for battery, assuming 75% efficiency in conversion
6.515/3.7*4/3=2.34 A rating, at least. Add another .5 A for misc power drawn from other parts
Voltage of zener diode is 3.9v
Secondary coil has voltage around 12v.
Voltage after rectifier = 12 * 2/pi = 7.63v
Zener diode has Iz= 200mA. Thus the resistor R2 need to be (7.63-3.9)/0.2 =18.65 Ohms

Assume the current of load is around 2.35A and current of zener diode is 200mA. We get total current after rectifier is 2.55A.

Block Description: Power circuit

It integrates an uninterrupted power supply (UPS) with an integrated battery capable of powering the device when the external power supply is cut off. It will draw power from a standard outlet (120 V, 60 Hz), transform it into 3.7 V DC [battery voltage], and convert that into the 3.3 V DC [microprocessor voltage] for the microcontroller, camera, and digital components. It will be able to switch between drawing power from the battery and the outlet without the voltage to the microcontroller going outside of its tolerances. It will also be upconvert the voltage to about 12 Volts at 500 mA for the locking solenoid. The battery would likely have to be rated for a maximal output current of at least 3 A. An additional 5 V DC would be needed to power the camera, sensors, and the other parts of the circuit.

Safety statement:

1. We should make sure all parts are discharged after testing.
2. The camera has a temperature range between -10C to 55C so we have to be cautious about it.
3. We should always work in groups of at least two in the lab.
4. Make sure the circuit is properly grounded.
5. In case of a mishap or emergency contact the lab teaching assistant.
6. Do not bring food and drinks to the lab.
7. Li polymer battery need to be treated carefully. Also voltage should not be discharged below 3v.

Requirements:

To determine the current rating of the battery, we must find the power drawn by the various components. The an Arduino should provide a good analog for the power drawn by the
microcontroller, and it draws 50 mA at 3.3 V [1]. A camera module similar to what we would use draws about 70 mA at 5 V [2], while a solenoid may require something in the range of 500 mA at 12 V [4]. Assuming an efficiency of 75% in power conversion from battery to the components:

Total $P = \Sigma IV$

$$P = (0.050 \times 3.3 + 0.070 \times 5 + 0.500 \times 12) \times 1/0.75 = 8.69 \text{ W}$$

$$I = P/V$$

$$8.69/3.7 = 2.35 \text{ A}$$

This would be an underestimate, since it does not take into consideration the various sensors, LEDs, and other devices. A battery of at least 3 A rating would likely be sufficient.

- It is able to safely charge a 3.7 V battery using a standard 120 V AC wall outlet.
- Output 12 V DC within 10% at least 500 mA for at least 10 seconds continuously, without the 3.3 V output deviating by more than 5% voltage and 20% current.
- Be able to transition between a powered wall outlet, and an unpowered one without the 3.3 V output deviating by more than 5% voltage and 20% current.

Verification:

- Plug the device into a standard wall outlet, and measure the voltage across the battery, as well as the current being drawn. It should be within the battery manufacturer's specifications.
- Measure the voltage and current with a 66Ω on the 3.3 V output.
- Load the 12 V output with a 24Ω load. Measure the voltage and current through the load, as well as that to the 66Ω load on the 3.3 V output for 10 seconds. Switch the outlet on and off, while measuring the voltage and current using an oscilloscope on the 3.3 V output.

Safety Statement:

This device will involve dangerous wall outlet voltage/current levels. It is important to ensure that all of the voltage transformers and regulators are properly designed, especially when they involve a LiPoly battery. Overcharging, pulling or pushing too much current through them may cause them to overheat, damaging them, or even causing a fire.

Citations

