Advanced Sports Timer

ECE 445 MDR

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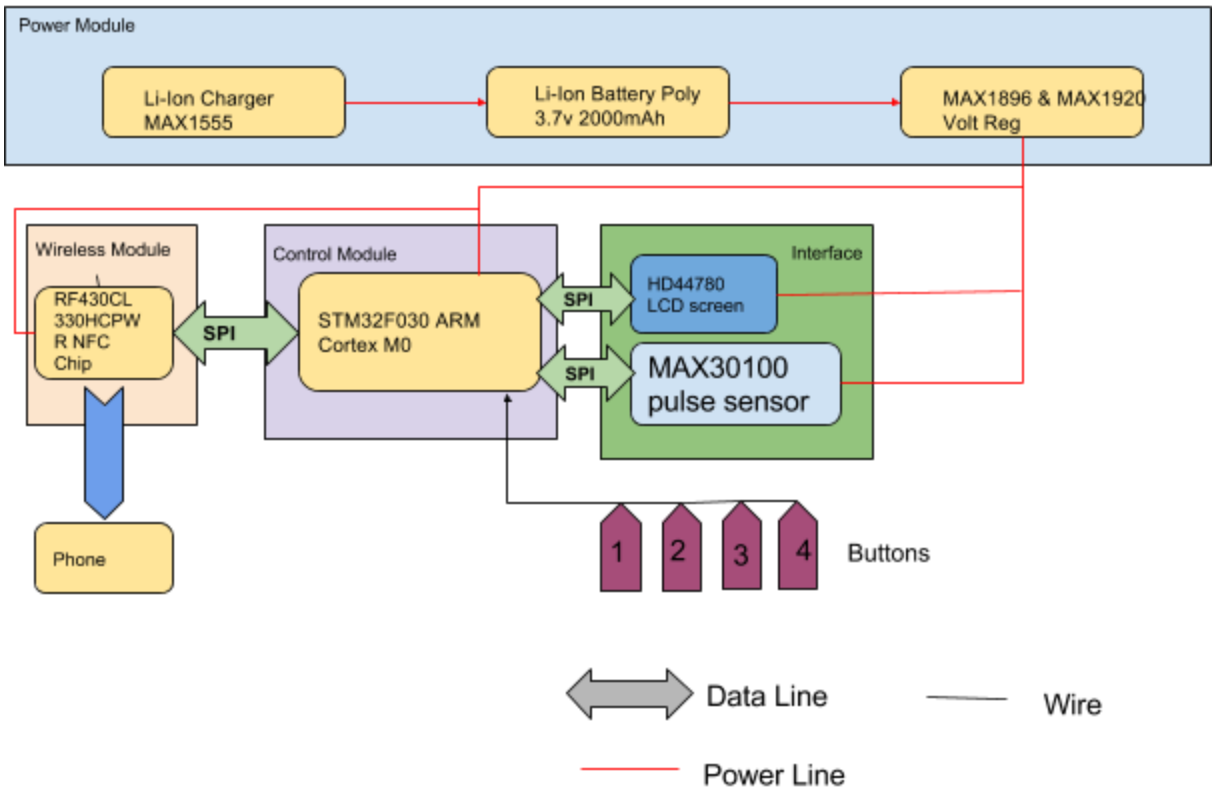
1 Block Diagram



2 Circuit Schematic

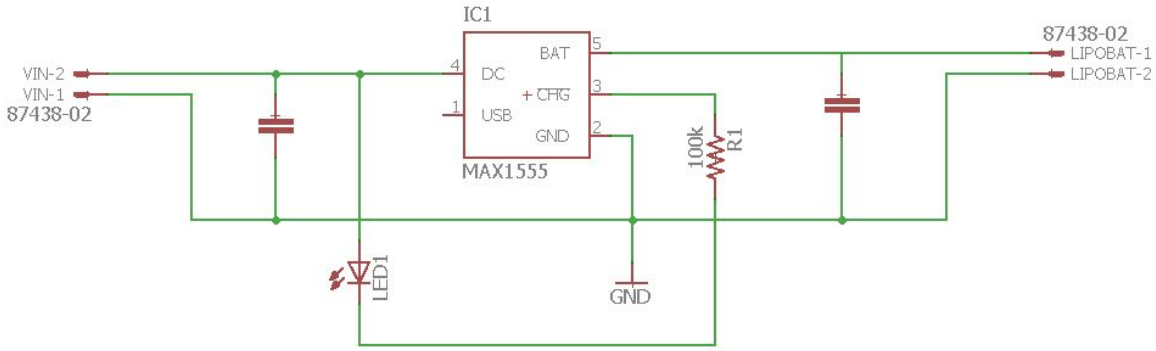


Figure: Schematic of the Li-ion Charger Circuit

3 Calculation

Wireless RF chip RF430CL330H has internal capacitance between [31.5pF, 38.5pF] between its two antenna output pins. The resonant frequency that we need the chip to transmit at is 13.7MHz for optimum performance. In order to solve for the inductance ranges that we might need we solve the following equation:

$$fres = \frac{1}{2*\pi*\sqrt{L*C}}$$

If the internal capacitance is not within the range specified by the manufacturer then additional capacitors will be needed in parallel at the output pins in order to achieve desired capacitance range. The next step is to calculate the passive quality factor, Q. Q needs to be between [30, 40] in order to optimize performance. The following equation is used to calculate Q:

$$Q = \frac{fres}{BW}$$

4 Plot

Parts are on order for testing

5 Block Description

The wireless transmission module is responsible for communicating the data to an accompanying phone. The NFC chip operates at a frequency of about 13.56 MHz, with an operating range of <=10cm. At max range we would want the transmission rate to be about 2kB/sec, so as to transmit the running times of the athletes. The running times would most likely take up about 2-3kB of data. The NFC chip consumes about 0.5 mW of power (Max operating voltage is 3.6 and draws 160 microA of current at peak operation). We will use the SPI interface present on the chip to write data to the SRAM on the chip then the phone will read it with the RF interface present.

6 Requirements and Verifications for Wireless Module

Requirements:

1. Use SPI protocol to receive data from microprocessor
2. RF430 needs to be able to transmit the data wirelessly at a frequency of 13.7MHz
3. Design an antenna with an inductance between [3.57uH,4.28uH]
4. Antenna has Q factor Between [30,40]
5. Internal capacitance of RF430CL330H needs to be between [31.5pF, 38.5pF]

Verification

1. Program the STM32F030K6T6 Microprocessor in SPI in order to communicate with RF430 chip
2. Use a network analyzer to view the frequency the RF430 is transmitting at
3. Order a specific inductor within acceptable range once capacitance is measured and verified
4. Use network analyzer to view bandwidth of frequency transmission and solve the Q equation. If Q is too large then use a larger inductance, if Q is too small use smaller inductance value to increase quality factor.
5. Use a digital multimeter to measure the intrinsic capacitance of RF430

7 Safety Statement

Being a wearable device we are making sure that the currents and voltages that we are using are kept at a level that does not harm any person using it. The largest voltage we are utilizing in the power module is 5v and the largest current is under 100mA. We also want to make sure to make the device waterproof so as not to cause unnecessary shorts in the circuit that can potentially harm the user and destroy the device. The housing of the device has to be durable enough to protect the battery (because it can leak and cause harm to the skin), as well as fragile components, but not hard enough to accidently hurt the wearer of the device. It must also be small and discreet so as not to be cumbersome to the athlete.

8 Citations

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