2019 Autonomous Car Prototype

Driving us into the Future

Team 5

Revision	Description
1A	Adam: Contributed to the scope of the document. Creatred the abbreviations area, the brief discription on 3.4 Motor, and inserted the diagrams for all of part 4.
2A	Reece: Added all of 6. Test Process.
3A	Maria: Contributed to the scope of the document, added descriptions to 3.1, 3.3, 3.2, made cosmetic changes and updated table of contents.
4A	Michael: Contributed to the scope of the document, created all of the diagrams for Section 3.
1B	Adam: Updated coverpage, abbrevations, descriptions in part 4, and fixed revisions.
2B	Reece: Contributed to the scope of the document. Added figure names/table of figures, edited 3.2. Power Supply. Added 6.4. Finger Test, adjusted formatting of the document.
3B	Maria: Added descriptions for 4.3, 4.4, and brief description of Section 6.
4B	Michael: Revised the diagrams in Section 3. Contributed to the descriptions of 4.2.

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1. Scope

The 2019 Autonomous Car Prototype is an innovative take on the modern car. In this revolution, the car can be programmed through a straight forward user interface to follow a specified path. Another feature that is built into the car is the black line detection to follow the road as the car drives itself along a route. The Autonomous Car Prototype has an intuitive design to detect nearby cars and appropriate the correct instructions for various situations which will bring the passengers safely to their destination. This revolutionary vehicle will change the way society travels from one place to another in the years to come.

2. Abbreviations

Abbreviation	Definition
LCD	Liquid Crystal Display
LED	Light Emitting Diode
RC	Remote Control
FRAM	Ferroelectric Random Access Memory
USB	Universal Serial Bus
I/O	Input / Output
ADC	Analog – to – Digital Converter
UI	User Interface

3. Overview

The 2019 Autonomous Car Prototype consists of a power supply, control board, MSP430FR2355 FRAM board, motor bridge, LCD display, and a user interface. See Figure 3.1 below.

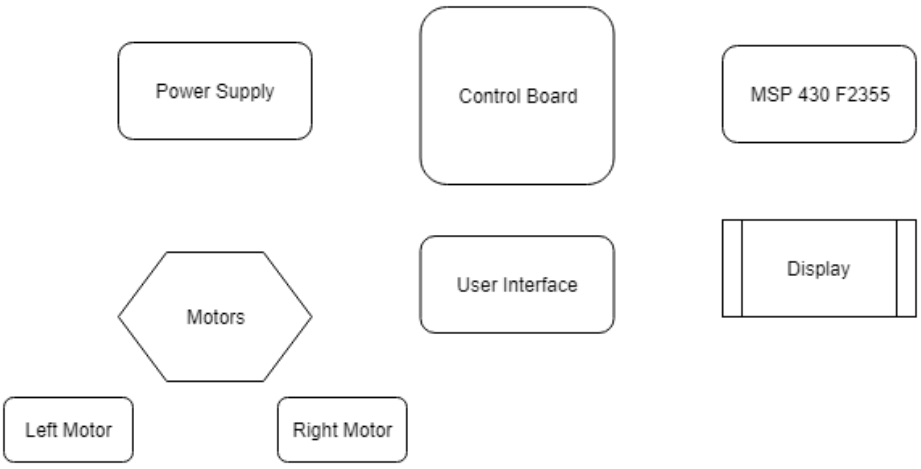


Figure 3.1 Overview Block Diagram

3.1. MSP430FR2355 FRAM Board

The MSP430FR2355 FRAM board features 2 switch buttons and 8 LEDs for user interface, an on-board ambient light sensor and connector for additional external analog sources, and a USB port for software input. Refer to Figure 3.1 below.

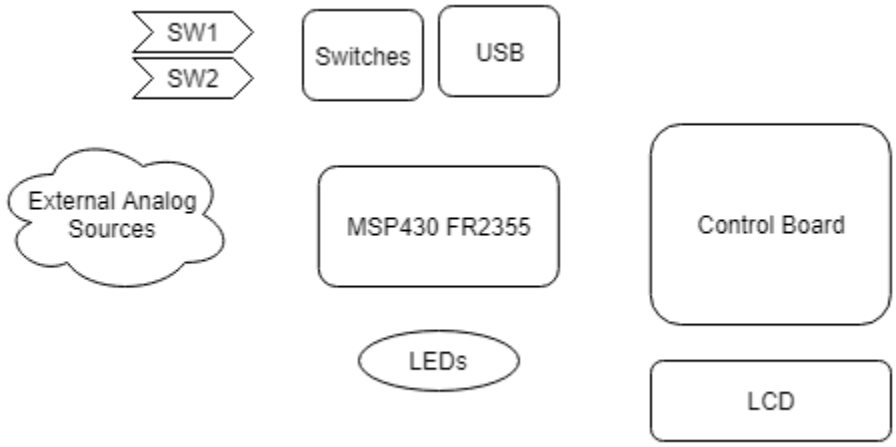


Figure 3.2 Block MSP430FR2355

3.2. Power Supply

The power supply is comprised of a set of 4 AA batteries which is connected to the power supply board through a buck boost converter providing the energy for all the Model T's necessary functions and equipment. The power system utilizes a switch to control the flow of energy in the system. Refer to Figure 3.3 below.

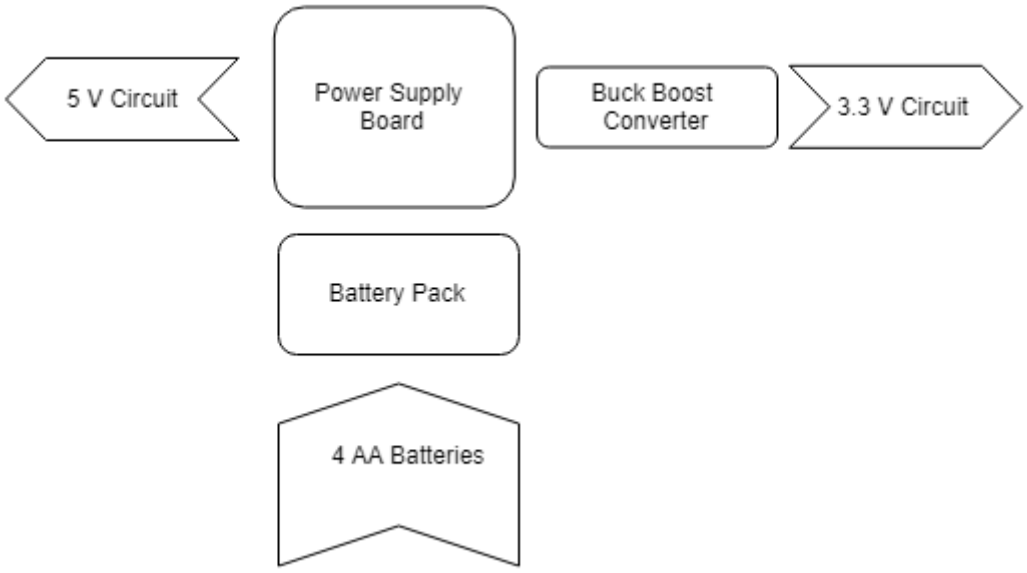


Figure 3.3 Power Supply Blocks

3.3. User Interface

The user interface block contains a LCD, 8 LEDs, Switch 1, Switch2, and a Thumb Wheel. Once powered, A working Model T should have LEDs blinking, LCD displaying messages to the user, and switches 1 and 2 that changes the display messages on the LCD. See Figure 3.3 below.

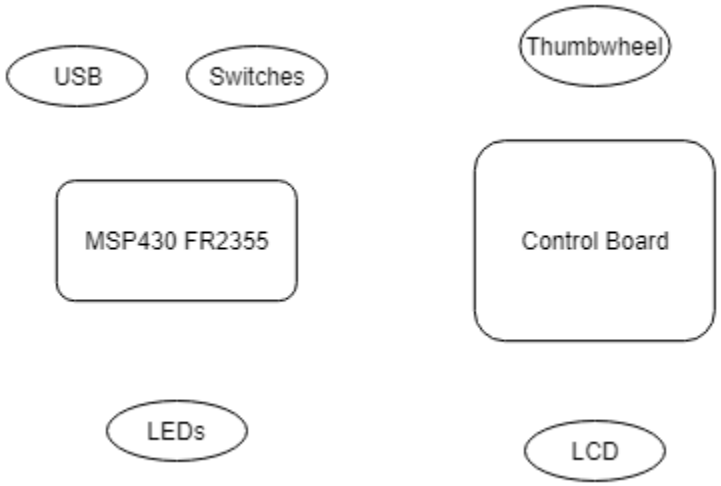


Figure 3.4 User Interface Blocks

3.4. Motor

The Model T contains two DC motors configured with an H–bridge control for forward command of the wheels. The H-bridge is connected through pins J21 and J43, for the right and left respectively. See Figure 3.4 below.

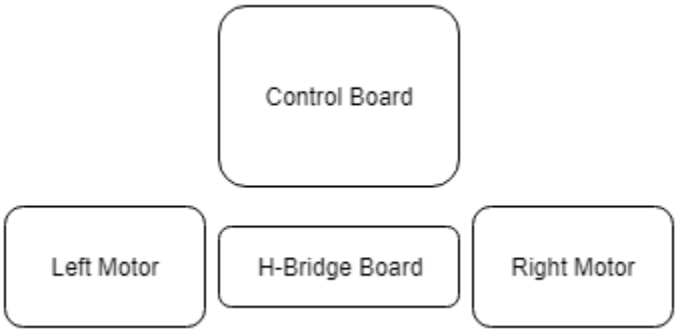


Figure 3.5 Motor Blocks

4. Hardware

Hardware for the project is made up of four major components - the MSP430FR2355 FRAM Board, Power System Board, User Interface devices, and two Motors. Below describes how each component should work according to the most recent project made based on the block diagrams shown above.

4.1. MSP430FR2355 FRAM Board

The MSP430FR2355 FRAM board is an embedded microcontroller that is focused on sensing and measurement. This FRAM board is ultra-low-power and includes 2 switch buttons and 8 LEDs for user interface, an on-board ambient light sensor and connector for additional external analog sources, and a USB

port for software input. The MSP430FR2355 takes advantage of a 16-bit RISC CPU, a constant generator, and 16-bit registers.

	MSP430FR2355
Non-volatile memory (kB)	32
RAM (KB)	4
ADC	12-bit SAR
ADC: channels (#)	12
GPIO pins (#)	44
I2C	2
SPI	4
UART	2
Comparator channels (#)	2
Package Group	LQFP | 48 TSSOP | 38 VQFN | 40
Approx. price (US$)	2.40 | 1ku
Timers - 16-bit	4
Bootloader (BSL)	UART
Operating temperature range (C)	-40 to 105
Package size: mm2:W x L (PKG)	48LQFP: 81 mm2: 9 x 9 (LQFP | 48) 38TSSOP: 62 mm2: 6.4 x 9.7 (TSSOP | 38) 40VQFN: 36 mm2: 6 x 6 (VQFN | 40)
Features	DAC OpAmp PGA Real-Time Clock

Figure 4.1 MSP430FR2355

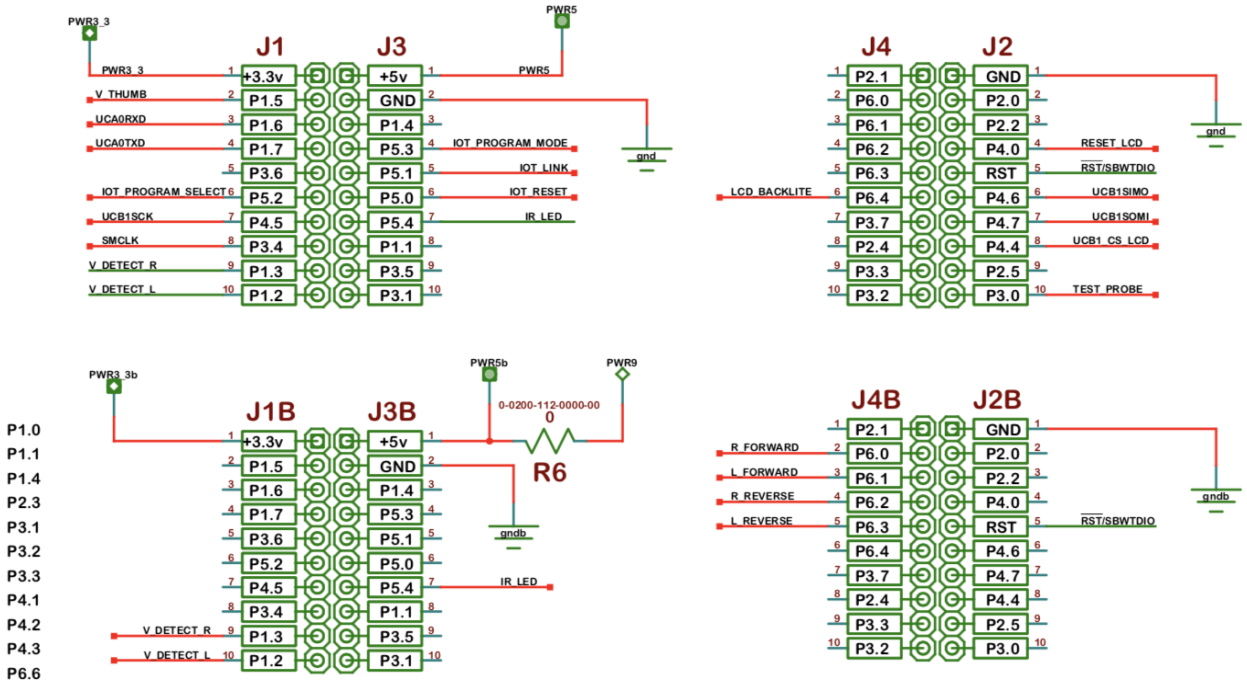


Figure 4.1 MSP430 FRAM Board

4.2. Power System

The power system block diagram takes in 4 AA batteries (aprox.6V). Using a Buck Boost Converter, the 6V is diminished to a 3.3V circuit. The result is a 5V circuit and a 3.3V circuit which are outputted through the respective pins and can be used by the control board for the rest of the system.

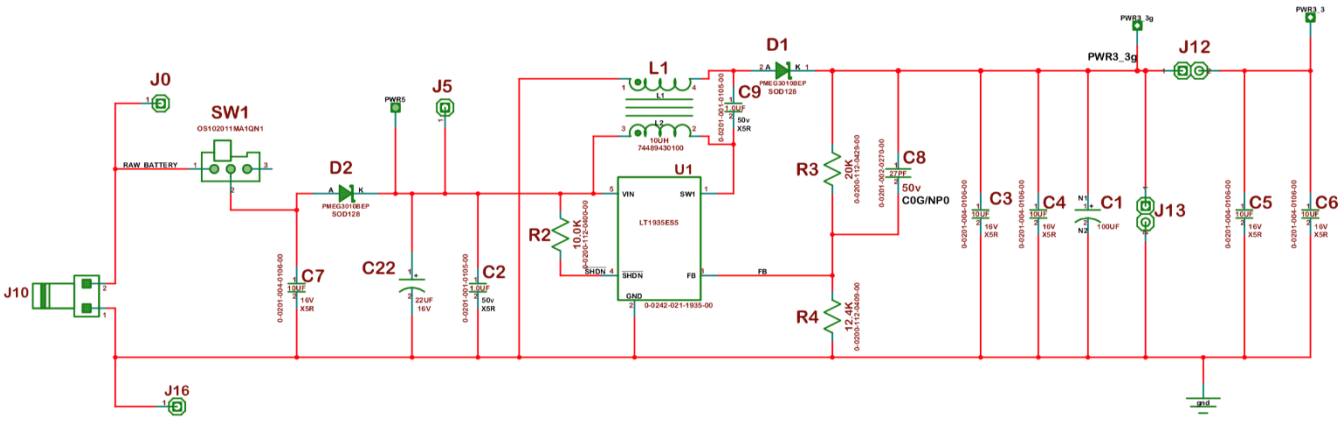


Figure 4.2 Buck Boost Converter/General Power Systems

4.3. User Interface

The user interface block contains a LCD, 8 LEDs, Switch 1, Switch2, and a Thumb Wheel. Once powered, a working Model T should have LEDs blinking, switches 1 and 2 that prompts the Model T to create circle, triangle, or infinity shapes and display messages on the LCD screen to the appropriate shape made. See Figure 4.4 and 4.5 below.

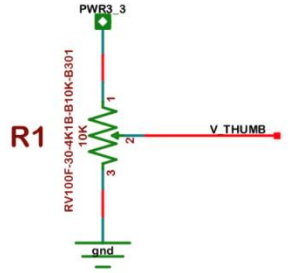


Figure 4.3 Potentiometer

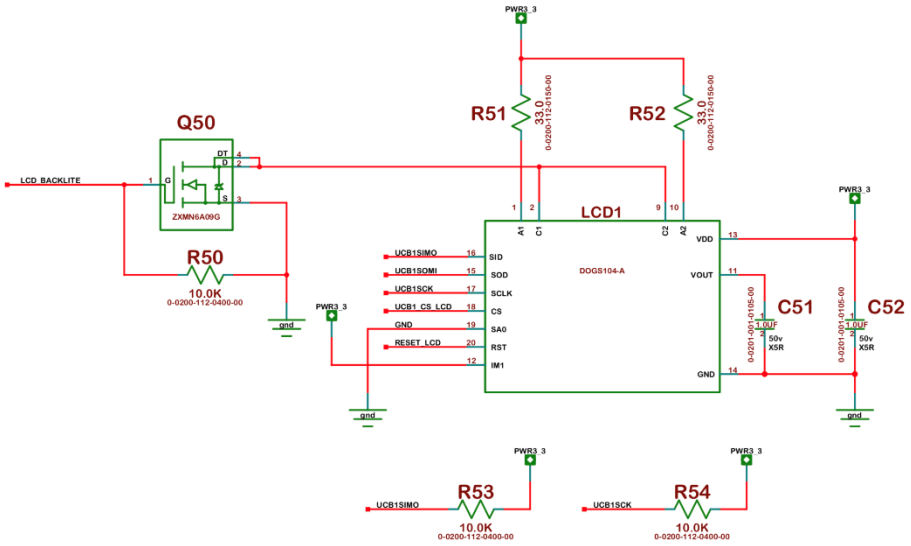


Figure 4.4 Buttons and LCD

4.4. Motor

The Model T contains two DC motors configured with an H–bridge control of the forward command of the wheels. The H-bridge is connected through pins J21 and J43, for the right and left controls respectively. A working motor should create the necessary shaped by turning off or on the forward command of either left or right wheels. See Figure 4.5 and 4.6 for left and right figure below.

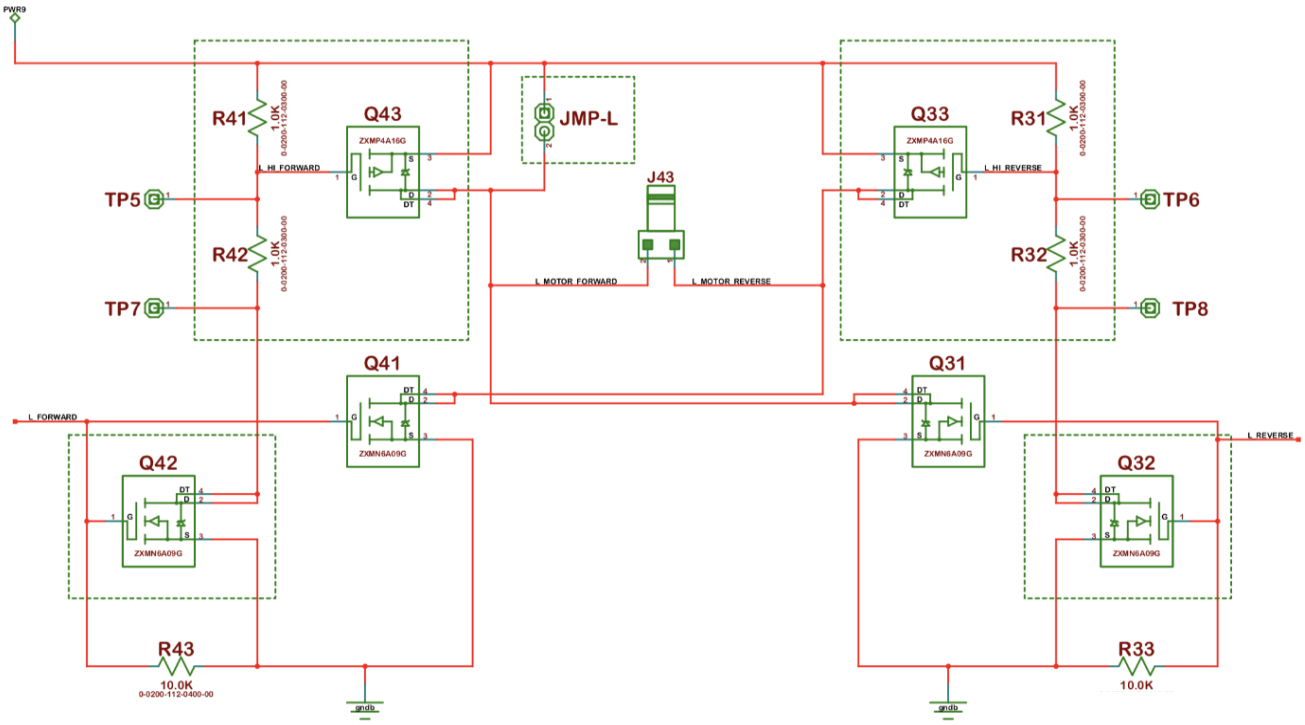


Figure 4.5 Left Motor Schematic

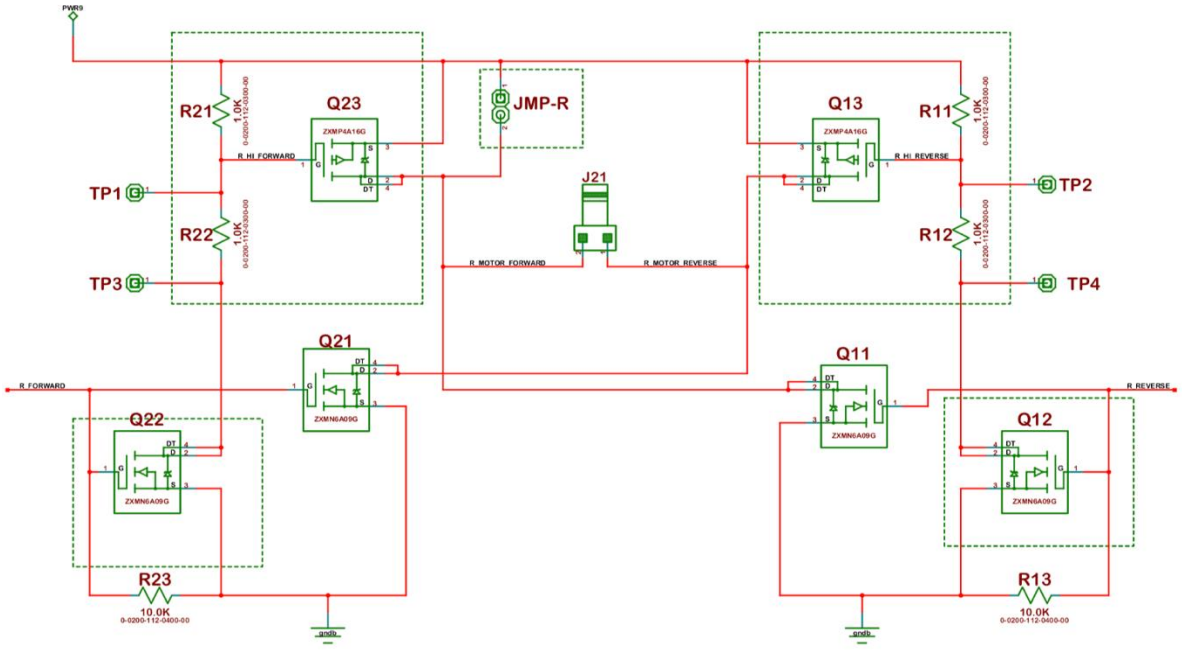


Figure 4.6 Right Motor Schematic

5. Power Analysis

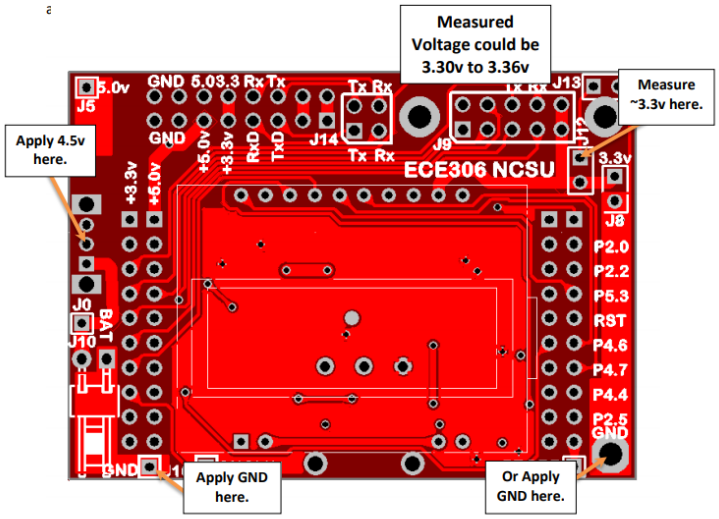
Provide a description of the power consumption of each part. How long will it last running off of a battery(s).

6. Test Process

Section 6 is a compilation of all the hardware tests done to ensure a perfectly working Model T. Most of the test process is done to check that the correct voltage is distributed on the board and the LCD is powered correctly.

6.1. Power Supply Test

Test the power supply with at least a 5 Volt Power Supply and an oscilloscope. First, test the power supply with the oscilloscope to make sure the output is correct. After that, follow the instructions on the diagram below.



If the tested numbers are incorrect, inspect the parts with a magnifying device to ensure your components are properly soldered to the board.

Figure 6.1 Power Board Test

6.2. Power Connector Test

To test this, you will need a Volt Meter with a Diode setting. Using the diagram and images below, measure with the positive probe on J0 and negative probe on J5; you should read an open circuit. After this, flip the probes and you should get around 165 ohms.

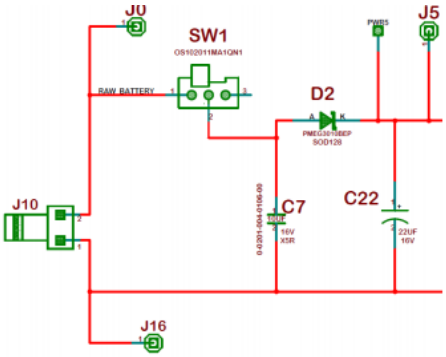


Figure 6.3 Switch Power Schematic

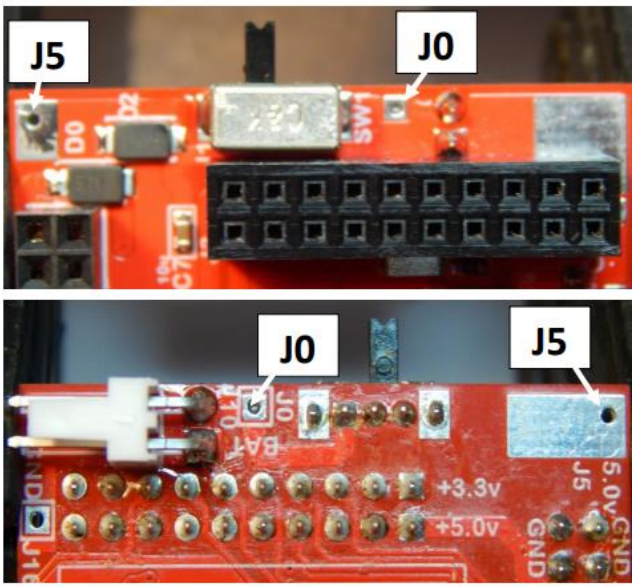


Figure 6.2 Switch Power Test

6.3. LCD Test

Power the board with the battery pack and the backlight should be on and working with readable characters. Press S1 and S2 to ensure the LCD changes.

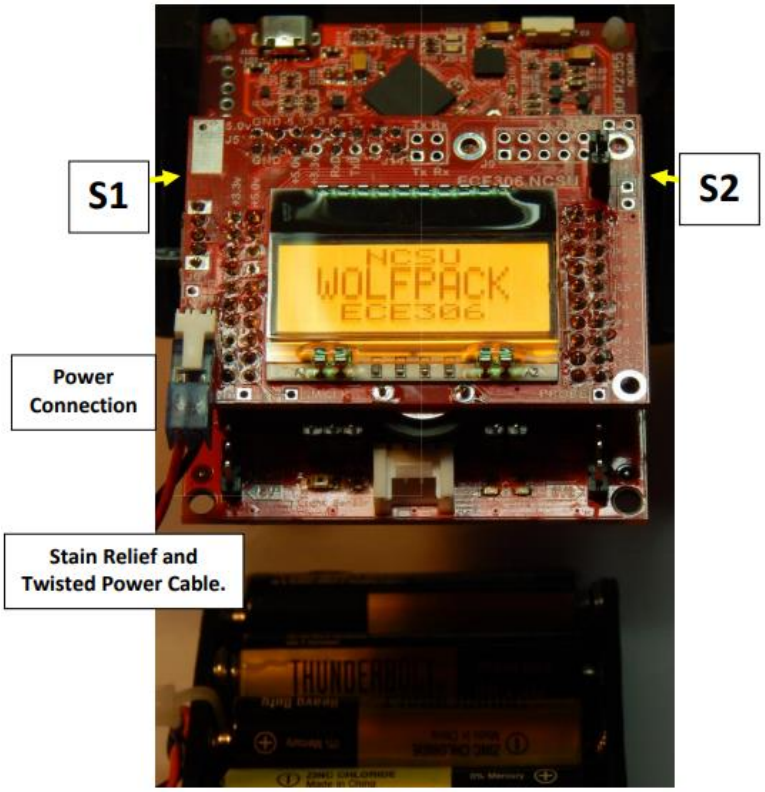


Figure 6.4 LCD Test

6.4. Finger Test

Any time software/hardware is modified, hold your finger on important components (FETs, Inductors, etc) to feel for heat. You should not be able to feel any heat coming from the part. If you do, turn off the board and do further tests with an oscilloscope, volt-ohm meter, and your test code to diagnose and fix the problem.

7. Software

The software is configured using a modular approach. Describe the code structure. Remember to identify the various functions and what operates when. This is a description of how your software is configured. You should be able to give this to one of your class mates and they would understand what you tried to do.

8. Flow Chart

The following is the flow chat for your code.

8.1. Main Blocks

Each function should have its own section and be on a separate page. Insert page breaks when necessary. This describes the software. What calls the function? Etc. Do not just put C code statements in blocks. Also do not write novels. Be reasonable.

8.2. Initialization Blocks

8.3. Interrupt Blocks

9. Software Listing

This is just a printout of the actual code, with each file in its own section.

9.1. Main.c

9.2. System_Init.c

9.3. Interrupt.c

10. Conclusion

What did you learn? If something did not work what went wrong.