# CONESTOGA COLLEGE

# INSTITUTE OF TECHNOLOGY and ADVANCED LEARNING

Electronics Systems Engineering

**Engineering Project IV**

**Functional Specifications Document**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Document Title** | **Functional Specifications Document** | | | | |
| **Document Number** | 1 | | | **Revision** | B |
| **Date Issued** | 2015-01-16 |  |  | **Replaces** | NEW |

**Reviewer(s)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Name** | **Title/Expert Role** | **Signature** | **Date** |
| **Authors** | Michael Folz | Logistics, Research and Development. |  | 2015-02-06 |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| **Reviewed/ Approved By:** | Stefanauk, W. |  |  |  |
|  | Jarabek, M. |  |  |  |
|  | Roeser, P. |  |  |  |
|  |  |  |  |  |

**REVISION HISTORY**

|  |  |  |
| --- | --- | --- |
| **Revision** | **Description of Change** | **Effective Date** |
| NEW | Initial release of Concept Proposal Template | 2015-01-16 |
| B | Added Schematics. | 2015-01-30 |
| C | Added BOM | 2015-02-06 |

**Table of Contents:**

|  |  |  |
| --- | --- | --- |
| Section | Description of Section | Page |
| **1.0** | Introduction | 4 |
| **2.0** | Purpose | 4 |
| **3.0** | Scope | 4 |
| **4.0** | Goal | 4 |
| **5.0** | Objectives – Schedule | 4 |
| **6.0** | Constraints | 7 |
| **7.0** | Detailed Specifications | 7 |
| **8.0** | Configuration Options | 14 |
| **9.0** | Cost Targets | 15 |
| **10.0** | Related Documents and Publications | 16 |

1. **Introduction**

This document outlines the functional specifications for the IV project in the Electronics Systems Engineering program. This document will evolve with time as it is made during the development of the board itself.

1. **Purpose**

The purpose of this document is to serve as a reference point for the design and implantation of the final board.

1. **Scope**

This document is intended to satisfy in part, the specifications for the IV project in ESE.

1. **Goal**

The goal of this project is to design a four layer board responsible for hosting a process from the freescale S12C family. This board must be fully functional and have features that will make the board useful in later years. As this project will be used in project for later semesters.

1. **Objectives – Schedule**

The main objectives of this project are outlined below, they are split up into two groups the first being the hardware objectives the second software.

The software section will be empty for now as no concrete software tasks have been set for this project.

|  |  |
| --- | --- |
| Hardware Schedule | |
| |  |  |  |  | | --- | --- | --- | --- | | Task Name | Duration | Start | Finish | | Board Design | **80 days** | **Mon 1/5/15** | **Fri 4/24/15** | | Week 1 - Project Plans | **4 days** | **Mon 1/5/15** | **Thu 1/8/15** | | Hardware functional Specifications | 4 days | Mon 1/5/15 | Thu 1/8/15 | | Project Schedule | 4 days | Mon 1/5/15 | Thu 1/8/15 | | Week 2 - Initial Schematic Design | **5 days** | **Fri 1/9/15** | **Thu 1/15/15** | | Schematic Design | 5 days | **Fri 1/9/15** | Thu 1/15/15 | | CPU Schematic | 3 days | Fri 1/9/15 | Tue 1/13/15 | | Power Schematic | 2 days | Tue 1/13/15 | Wed 1/14/15 | | RS232 Schematic | 2 days | Wed 1/14/15 | Thu 1/15/15 | | Order Parts | 1 day | Thu 1/15/15 | Thu 1/15/15 | | Order Generic Parts (resistors SMD | 1 day | Thu 1/15/15 | Thu 1/15/15 | | Week 3 - Motor Schematic Designs | **5 days** | **Fri 1/16/15** | **Thu 1/22/15** | | DC Motor | 2 days | Fri 1/16/15 | Mon 1/19/15 | | RC Servo | 2 days | Mon 1/19/15 | Tue 1/20/15 | | Stepper Motor | 3 days | Tue 1/20/15 | Thu 1/22/15 | | Week 4 - LCD and ACC Schematic Design | **5 days** | **Fri 1/23/15** | **Thu 1/29/15** | | LCD Schematic | 1 day | Fri 1/23/15 | Fri 1/23/15 | | Accelerometer | 3 days | Mon 1/26/15 | Wed 1/28/15 | | ADC | 2 days | Wed 1/28/15 | Thu 1/29/15 | | Week 5 - Design Files | **5 days** | **Fri 1/30/15** | **Thu 2/5/15** | | Submit Preliminary Placement | 3 days | Fri 1/30/15 | Tue 2/3/15 | | Generate Design Files | 3 days | Fri 1/30/15 | Tue 2/3/15 | | Verify Schematic Design | 3 days | Tue 2/3/15 | Thu 2/5/15 | | Week 6 - Manufacturing | **5 days** | **Fri 2/6/15** | **Thu 2/12/15** | | Board Suitable For Manufacturing | 4 days | Fri 2/6/15 | Wed 2/11/15 | | Submit Board | 1 day | Thu 2/12/15 | Thu 2/12/15 | | Week 7 - Study Week Catch Up | **5 days** | **Fri 2/13/15** | **Thu 2/19/15** | | Verify Board Design | 5 days | Fri 2/13/15 | Thu 2/19/15 | | Prepare for Debugging board Design | 5 days | Fri 2/13/15 | Thu 2/19/15 | | Week 8 - Board Assembly | **5 days** | **Fri 2/20/15** | **Thu 2/26/15** | | Solder Parts to board | 5 days | Fri 2/20/15 | Thu 2/26/15 | | Week 9 - Hello World | **6 days** | **Fri 2/27/15** | **Fri 3/6/15** | | Write LED flashing Code | 2 days | Fri 2/27/15 | Mon 3/2/15 | | Debug Hardware | 4 days | Tue 3/3/15 | Fri 3/6/15 | | Prepare for |  |  |  | | Week 9 - Hello World Software | **6 days** | **Fri 3/13/15** | **Fri 3/20/15** | | Led Blink | 1 day | Fri 3/13/15 | Fri 3/13/15 | | Drive Motor and LCD | 6 days | Fri 3/13/15 | Fri 3/20/15 | | Week 10 - SW Progress | **6 days** | **Fri 3/20/15** | **Fri 3/27/15** | | Tasks to be given | 6 days | Fri 3/20/15 | Fri 3/27/15 | | Week 11 - More Progress | **6 days** | **Fri 3/27/15** | **Fri 4/3/15** | | Tasks to be Given | 6 days | Fri 3/27/15 | Fri 4/3/15 | | Undefined | **16 days** | **Fri 4/3/15** | **Fri 4/24/15** | | Catch Up | 16 days | Fri 4/3/15 | Fri 4/24/15 | |

1. **Constraints**

Given the current standing, there are several concerns that must be addressed for the project to achieve some success.

6.1 Time

This will be the main constraint with the project as we must meet most of the requirements by the 2nd week of February, when we order the boards. This also includes the mastery of Altium.

6.2 Physical Constraints

Most of the physical constraints can be found in any of the following two documents which are hosted on eConestoga in the project IV folders.

|  |  |
| --- | --- |
| Physical Size / Board Dimensions | Board\_outline\_rev\_8.pdf |
| PCB Tolerances and Design Requirements | Pcb\_tollerances\_and\_design\_requirements\_2013 |

The board must match the board dimensions listed in the pdf document. There are board tolerances that must be met, this is to limit any noise and reduce cross talk between ports and pins.

**7.0 Detailed Specifications**

The detailed specifications section of the document will be split up into two larger groups with will be broken into smaller groups respectively.

This section will contain all details regarding the project not covered earlier.

**7.1 Hardware Specifications**

Hardware Requirements:

|  |  |
| --- | --- |
| The finished product will have the following modules installed: | |
| * Use HCS12-family processor as specified * Include a BDM port for debugging and programming * Include RS-232 communication to host * Include hardware to drive 2 permanent magnet DC motors * Include hardware to read 2 incremental optical encoders for position/speed feedback * Include hardware to drive 1 RC servo * Include hardware to drive 1 stepper motor with 2 limit switches to support homing of the motor * Include hardware to drive a character LCD module * Include hardware to accept analog inputs and produce analog outputs * Include an on-board accelerometer * Include a unique extension to the design functionality (e.g. communication interface, supported I/O device, etc) chosen by the student and approved by faculty Draw DC power from supplied batteries (2 x 12V available) or bench supply * Include a monitor program (written by you, using C and assembler) to: * perform diagnostics on all components * communicate with a host computer via the RS232 link * operate all motors and actuators on command * read and report all sensors on command * be able to display information on the LCD as required by the application | |
| Dedicated Packages:  Some functions will require embedded processors/packages to run; the chips listed below are responsible for performing specific tasks. Please note that there are a few chips needed to be added, at this time we have yet to discuss all the proper hardware requirements. | |

|  |  |
| --- | --- |
| **Functions** | **Microprocessor/ Package** |
| **RS232 Logic Level Conversion** | MAX3232ECDBR |
| **Switch mode power supply Buck (12v – 5V** | LM2675MRE – ADJ |
| **Motor Driver / Bridge Driver** | L6205D013TR |
| **Linear Power Supply (5v -3.3v)** | LM1175 |
| **Accelerometer (Analog Out)** | MMA7361 or MMA7360 |
| **LCD Display ( 320x240 –SPI) includes SD and touch interface** | ILI9341 & touch driver TBD |
| **Ultrasonic Module** | HC-SR04 |
| **Further HW Modules** | TBT |

7.2 Port Usage

There are several ports open on the module it will be ideal if these pins were used by an additional device or at the very least be connected to a male or female header for external control/configuration

|  |
| --- |
|  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **PORT** | **Module** | **Port** | **Pin Functions** |  | **Mode** | **Pin** | | PORT-A | Unused | PA7 | ADDR15 | H\_BKL | GPIO Reserved | 48 | |  | LCD\_RW | PA6 | ADDR14 | H\_RW | GPIO Reserved | 47 | |  | LCD\_RS | PA5 | ADDR13 | H\_RS | GPIO Reserved | 46 | | GPIO and Address | LCD\_E | PA4 | ADDR12 | H\_E | GPIO Reserved | 45 | |  | LCD Data 3 | PA3 | ADDR11 | ILI\_D3/H\_3 | GPIO Reserved | 44 | |  | LCD Data 2 | PA2 | ADDR10 | ILI\_D2/H\_2 | GPIO Reserved | 43 | |  | LCD Data 1 | PA1 | ADDR9 | ILI\_D1/H\_1 | GPIO Reserved | 42 | |  | LCD Data 0 | PA0 | ADDR8/DATA8 | ILI\_D0/H\_0 | GPIO Reserved | 41 | | PORT-B | LCD\_D7 | PB7 | ADDR0 | ILI\_D7 | GPIO Reserved | 23 | |  | LCD\_D6 | PB6 | ADDR1 | ILI\_D6 | GPIO Reserved | 22 | | GPIO and Address | LCD\_D5 | PB5 | ADDR2 | ILI\_D5 | GPIO Reserved | 21 | |  | LCD\_D4 | PB4 | ADDR3 | ILI\_D4 | GPIO Reserved | 20 | |  | DC Motor 2 Direction B | PB3 | ADDR4 | L6225\_2B | GPIO Reserved | 19 | |  | DC Motor 2 Direction A | PB2 | ADDR5 | L6225\_2A | GPIO Reserved | 18 | |  | DC Motor 1 Direction B | PB1 | ADDR6 | L6225\_1B | GPIO Reserved | 17 | |  | DC Motor 1 Direction A | PB0 | ADDR7 | L6225\_1A | GPIO Reserved | 16 | | PORT-AD | Stepper Switch Right | PAD7 | AN7 |  | GPIO Reserved | 58 | | Analog Input | Stepper Switch Left | PAD6 | AN6 |  | GPIO Reserved | 57 | |  | ACC\_OUTPUT | PAD5 | AN5 |  | GPIO Reserved | 56 | |  | LCD\_RD | PAD4 | AN4 | ILI\_RD | GPIO Reserved | 55 | |  | LCD\_WR | PAD3 | AN3 | ILI\_WR | GPIO Reserved | 54 | |  | LCD\_RS | PAD2 | AN2 | ILI\_RS | GPIO Reserved | 53 | |  | LCD\_CS | PAD1 | AN1 | ILI\_CS | GPIO Reserved | 52 | |  | LCD\_RST | PAD0 | AN0 | ILI\_RST | GPIO Reserved | 51 | | PORT-E | GPIO Reserved | PE7 | XCLKS/NOACC |  | GPIO Reserved | 27 | | External Clock | GPIO Reserved | PE6 | MODEB/IPIPE1 |  | GPIO Reserved | 27 | |  | GPIO Reserved | PE5 | MODA/IPIPE0 |  | GPIO Reserved | 27 | |  | GPIO Reserved | PE4 | ECLK |  | GPIO Reserved | 27 | |  | LCD\_WR | PE3 | LSTRB/TAGLO |  | GPIO Reserved | 37 | |  | LCD\_RS | PE2 | RW |  | GPIO Reserved | 38 | |  | IRQ | PE1 | IRQ | MASK | GPIO Reserved | 39 | |  | XIRQ | PE0 | XIRQ | NO MASK | GPIO Reserved | 40 | | PORT-J | SPI\_SC2 | PJ6 | KWJ6 |  | GPIO UNUSED | 69 | |  | SPI\_SC1 | PJ7 | KWJ7 |  | GPIO UNUSED | 68 | | PORT-M | SPI-SCK | PM5 | SCK | SD CARD | GPIO Reserved | 70 | |  | SPI-MOSI | PM4 | MOSI | SD CARD | GPIO Reserved | 71 | | SPI and CAN Bus | SPI-SS | PM3 | SS | SD CARD | GPIO Reserved | 72 | |  | SPI-MISO | PM2 | MISO | SD CARD | GPIO Reserved | 73 | |  | CAN\_TX | PM1 | TXCAN | Canbus | GPIO Reserved | 74 | |  | CAN\_RX | PM0 | RXCAN | Canbus | GPIO Reserved | 75 | | PORT-P | Keypad Wake | PP7 | KWP7 | ????? | GPIO Reserved | 78 | |  | ROMCTL | PP6 | KWP6 | ????? | GPIO Reserved | 67 | |  | DC Motor 2 PWM | PP5 | KWP5 |  | GPIO Reserved | 79 | | PWM | DC Motor 1 PWM | PP4 | KWP4 |  | GPIO Reserved | 80 | |  | ACCELEROMETER- CSEL | PP3 | KWP3 | LIS342 | GPIO Reserved | 1 | |  | ACC- INPUT | PP2 | KWP2 | OP FROM CHIP | GPIO Reserved | 2 | |  | ACC – S0 | PP1 | KWP1 | LIS342 | GPIO Reserved | 3 | |  | ACC – S1 | PP0 | KWP0 | LIS342 | GPIO Reserved | 4 | | PORT-S | I2C SCL | PS3 | GPIO |  | GPIO Reserved | 66 | |  | I2C SDA | PS2 | GPIO |  | GPIO Reserved | 65 | | Serial TX/RX | SCI Transmit | PS1 | TXD |  | GPIO Reserved | 64 | |  | SCI Receive | PS0 | RXD |  | GPIO Reserved | 63 | | PORT-T | Stepper Motor Coil Pair 2 In | PT7 | PW7 |  | GPIO Reserved | 14 | |  | Stepper Motor Coil Pair 2 Out | PT6 | PW6 |  | GPIO Reserved | 13 | | PWM | Stepper Motor Coil Pair 1 In | PT5 | PW5 |  | GPIO Reserved | 12 | |  | Stepper Motor Coil Pair 1 Out | PT4 | PW4 |  | GPIO Reserved | 11 | |  | RC Servo 2 Out | PT3 | PW3 |  | GPIO Reserved | 8 | |  | RC Servo 1 Out | PT2 | PW2 |  | GPIO Reserved | 7 | |  | DC Motor Encoder 2 | PT1 | PW1 |  | GPIO Reserved | 6 | |  | DC Motor Encoder 1 | PT0 | PW0 |  | GPIO Reserved | 5 | |

7.4 Schematics

|  |  |
| --- | --- |
| **Schematic Function/Name** | **Schematic Design** |
| Project Board Schematic |  |
|  | This is the main board , the ILI LCD schematic shares the port B with the Hatachi LCD. |
| Accelerometer\_3Axis |  |
|  | The accelerometer has only one buffered output, this is the V OUT, output. VOUTX, Y and Z are connected directly to a header. |
| RS232 |  |
|  | The leds are connected to a transistor via emitter follower. The CTS and RTS pins are connected to a header, these should be shorted. |
| MC9S12C (Main Processor) |  |
|  | Pay close attention to the SPI connections, the clock has 2 resistors these are used to make the clock line a pull up or pull down. Slave select on all lines should be pulled up, to prevent stray lows from starting up the slave. |
| LCD\_Schematic  HD44780 |  |
|  | The backlight is controlled by an external port, the LCD is completely controlled by PORTA |
| Can\_Bus\_Tranciever |  |
|  | The canbus is using the AC termination method for filtration, the resistor method via between canH and canL lines however quality tends to be lost. |
| DAC\_8Bit |  |
|  | This schematic is fairly basic, it is not necessary for the outputs to be voltage followed as the output from the MAX chip has an internal voltage follower. |
| DC Motor & Encoder |  |
|  | The encoder input must be limited(10mA max- to drive internal led) and the output from the encoder needs a voltage follower (buffer). |
| SMPS 5V 1A |  |
|  | SMPS power supply, this same schematic is used for both the analog and digital versions. |
| Liner 3.3V Digital |  |
|  | Both Caps are used for noise isolation. |
| Stepper Motor |  |
|  | The stepper motor has internal isolation. The pull downs are to prevent the motors from being turned on during non operation. VIN = 12V this drives the motor. |
| RC Servo |  |
|  | The RC Servo motor has internal isolation and motor control, it can be driven without any problems using the input from the UC. This Collector follower circuit will limit the output current from the UC to the RC servo motor. |
| GRAPICAL LCD  Ili9327 (400x240) |  |
|  | The LCD uses the same pin spacing as the arduino, this will be necessary to replicate. |

7.3 Software Driving the Board

The software requirements have yet to be completely defined; however there are a few goals that must be met

* Drive motors connected to external pins, Drivers written for both of the LCD modules HD44780 & ILI9341, Write software capable of taking input from the RS232 port on the board.
* Further software requirements To Be determined

1. **Configuration Options**

Each board must meet certain minimum specifications however we have been given the freedom to choose and some cloud’s and should for our project.

There are several options open to the students, it is highly recommended we implement the shouldn’t and cloud’s as well as a few other modules.

**Modules that are Encouraged (Should be implemented)**

|  |  |
| --- | --- |
| Functions | Microprocessor/ Package |
| **LEDS and dip switches** | Implement a small array of switches and a few LEDS. |
| **Expansion Connectors** | Important! – Female headers will be implemented for future expansion. In particular the ports with SPI, I2C and RS232. |
| **Prototyping Area** | Given the size constraints this feature will not be added. It is to be assumed the female headers will be enough to allow external boards connection to the processor. |

**Modules that are a Must**

|  |  |
| --- | --- |
| Functions | Microprocessor/ Package |
| **Can Bus Transceiver** | SPI- MCP2515  RS232- MCP2551 |
| **SPI Interface** | Implemented in the should. |

**Extra Implementation:**

|  |  |
| --- | --- |
| Functions | Microprocessor/ Package |
| **320x240 Display** | ILI9341 – useful for debugging and User interface. |
| **SPI SD Card Slot** | Highly useful for external data storage, if implemented and the FATFS libraries are supported, the external card will act as a connected file system. |
| **Touch Screen** | The touch screen interface will allow for more sophisticated user interface. |

Ideally all ports and pins will have female headers, however given the size of the board there might be some limitations in implementing that onto the final product.

1. **Cost Targets**

As stated in the documents provided our target cost is 200$ per board manufactured. With the given parts so far I should be able to meet that target provided the board manufacturing costs less than 80$. As the individual parts collectively should run around 100-130$

|  |  |  |  |
| --- | --- | --- | --- |
| **Number** | **Part Name** | **Quantity** | **Total Cost** |
| 1 | ILI9341 | 1 | 9.79$ |
| 2 | Touch Screen | 1 |  |
| 3 | SD Card Reader | 1 |  |
| 4 | Ultrasonic - SR04 |  | 2.50$ |
| 5 | MC9S12C64MFUE-ND | 2 | [33.84](http://www.digikey.ca/product-detail/en/MC9S12C64MFUE/MC9S12C64MFUE-ND/1167764) |
| 6 | MAX3232CSE | 1 | [4.1](http://www.digikey.ca/product-detail/en/MAX3232CSE%2B/MAX3232CSE%2B-ND/947902) |
| 7 | LM22675MRE-ADJ | 2 | [11.58](http://www.digikey.ca/product-detail/en/LM22675MRE-ADJ%2FNOPB/LM22675MRE-ADJ%2FNOPBCT-ND) |
| 8 | PCB Board Manufacturing | 1 | 0 |
| 9 | Not Determined | ? | 0 |
| Total |  |  | 49.52 |

All other costs not listed are at this time unknown or to be determined.

**BOM**

|  |  |  |  |
| --- | --- | --- | --- |
| *Comment* | Description | Quantity | Price |
|  |  |  |  |
| *CON6* | CONN HEADER BRKWAY 6POS DL .100 | 1 |  |
| *Cap* | CAP CER .22uF 50v X7R 0805 | 3 |  |
| *Cap* | CAP CER .1uF 50v X7R 0805 | 7 |  |
| *p, p, p, p, Cap, Cap, Cap, Cap, C1, Cap, Cap* | CAP CER .1uF 16v X7R 0805 | 11 |  |
| *Cap* | CAP CER 100pF 500v COG 0805 | 2 |  |
| *p* | CAP CER 4700pF 50v X7R 0805 | 1 |  |
| *ap* | CAP CER 470pF 50v X7R 0805 | 1 |  |
| *Cap* | CAP CER 10000pF 50v Z5U 0805 | 1 |  |
| *Cap Pol* | CAP 85C 10uF ±20% 16V WX Series Aluminum Electrolytic | 3 |  |
| *Cap* | CAP CER 22pF 630v X7R 0805 | 2 |  |
| *Cap* | CAP CER 10000pF 100v X7R 0805 | 3 |  |
| *Cap* | CAP CER .1uF 50v X7R 0805 | 5 |  |
| *Cap* | CAP CER 5600pF 50v X7R 0805 | 2 |  |
| *Cap Pol* | CAP 85C 100uF ±20% 16V WX Series Aluminum Electrolytic | 1 |  |
| *Cap* | CAP CER .1uF 100v X7R 0805 | 1 |  |
| *Cap* | CAP CER 1uF 16v X7R 0805 | 2 |  |
| *MCP2551* | IC TRANSCEIVER CAN HI-SPD 8-SOIC | 1 |  |
| *Cap* | CAP CER 2.2uF 16v X7R 0805 | 1 |  |
| *Cap* | CAP CER 10000pF 50v Z5U 0805 | 1 |  |
| *Cap* | CAP CER 10uF 6.3v X5R 0805 | 1 |  |
| *Header 2, Header 2, Header 2, Header 2, Header 2, Header 2, eader 2, Header 2* | Header, 2-Pin | 8 |  |
| *MM3Z3V3ST1G* | 3.3V, 200mw Zener | 4 |  |
| *1N4148, Diode 1N4148, Diode 1N4148* | High Conductance Fast Diode | 3 |  |
| *DIODE SCHOTTKY 40V 2A SMA* | Schottky Rectifier | 2 |  |
| *DS1813-10* | 5V EconoReset with Pushbutton | 1 |  |
| *MC9S12C128MFUE* | IC MCU 16BIT 128KB FLASH 80QFP | 1 |  |
| *Header16\_LCD* | Header, 16-Pin Female | 1 |  |
| *SRN8040-33uH* | FIXED IND 22UH 2.2A 100 MOHM SMD | 2 |  |
| *IC DAC 8BIT DUAL VOUT 8-UMAX* | IC DAC 8BIT DUAL VOUT 8-UMAX | 1 |  |
| *MAX3232CSE* | 3.0V TO 5.5V, Low-Power, up to 1Mbps, True RS-232 Transceiver Using Four 0.1µF External Capacitor | 1 |  |
| *RPot* | Potentiometer | 1 |  |
| *Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, RFb1, RFb1* | RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 10.0K OHM 1% 1/8W 0805, RES SMD 1.00K OHM 1% 1/8W 0805, RES SMD 1.00K OHM 1% 1/8W 0805 | 17 |  |
| *Res3* | RES SMD 13.7K OHM 1% 1/8W 0805 | 1 |  |
| *Res3* | RES SMD 3.09K OHM 1% 1/8W 0805 | 3 |  |
| *Res3* | RES SMD 102R OHM 1% 1/8W 0805 | 2 |  |
| *Res3* | RES SMD 4.75K OHM 1% 1/8W 0805 | 2 |  |
| *Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, Res3, R2\_B* | RES SMD 10.0K OHM 1% 1/8W 0805 | 17 |  |
| *Res3* | RES SMD 649R OHM 1% 1/8W 0805 | 1 |  |
| *Res3* | RES SMD 1.00K OHM 1% 1/8W 0805 | 5 |  |
| *Res3* | RES SMD 9.76M OHM 1% 1/8W 0805 | 3 |  |
| *Res3* | RES SMD 698R OHM 1% 1/8W 0805 | 2 |  |
| *Res3* | RES SMD 4.75K OHM 1% 1/8W 0805 | 3 |  |
| *Res3* | RES SMD 100R OHM 1% 1/8W 0805 | 3 |  |
| *Res3* | RES SMD 2.87K OHM 1% 1/8W 0805 | 4 |  |
| *BC846B* | NPN General Purpose Amplifier | 5 |  |
| *SWITCH\_TACTILE* | SWITCH TACTILE SPST-NO 0.05A 12V | 1 |  |
| *D Connector 9* | Receptacle Assembly, 9 Position, Right Angle | 1 |  |
| *LM22675MR-ADJ/NOPB* | 1A SIMPLE SWITCHER®, Step-Down Voltage Regulator with Precision Enable, 8-pin PSOP, Pb-Free | 2 |  |
| *L293DD* | Push-Pull Four Channel Driver With Diode | 1 |  |
| *LIS352ARTR* | IC ACCELEROMETER 3AXIS LP 14LGA | 1 |  |
| *LMC6484\_0* | IC OPAMP GP 1.5MHZ RRO 14SOIC | 1 |  |
| *L6225* | IC MOTOR DRIVER PAR 20POWERSO | 1 |  |
| *74ACT14\_3* | IC INVERTER HEX SCHMITT 14SOIC | 1 |  |
| *LM1117IMP-ADJ/NOPB* | 800mA Low-Dropout Linear Regulator, 4-pin SOT-223, Pb-Free | 1 |  |
| *Cap* | CAP CER 220pF 50v COG 0805 | 1 |  |

**10.0 References**

[1] freescale.com, (2015). MC9S12C Family MC9S12GC Family Reference Manual. [online] Available at: http://www.freescale.com/files/microcontrollers/doc/data\_sheet/MC9S12C128V1.pdf [Accessed 16 Jan. 2015].