Conestoga College
Institute of Technology and Advanced Learning

Document Title	Project Functional Specification
Revision	3
Date Issued	January 23, 2015
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Department	School of Engineering and Information Technology
Program	Electronic Systems Engineering
Audience	ESE Semester 4 Faculty
Author	Marcin Czajkowski, Student
Reviewers	Mike Jarabek, Professor
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Revision History

Revision	Description of Change	Effective Date
1	New Document Release	Jan. 16, 2015
2	BOM, schematics and hardware spec updates	Jan. 23, 2015
3	Adding LCD, DAC, Accelerometer. Changes to encoder, BOM and HW reqs	Jan. 30, 2015

Contents

1. Introduction:

As part of the semester for year 2 for studies in Electronic Systems Engineering it is required to implement a project that will give students the opportunity to study and apply design principles for the creation of embedded systems hardware and software.

Additional tasks that a student will be learning through implementation of the project are:

- Populate and test PCB boards
- Design and simulate test diagnostic systems
- Use schematic capture as well as read specification of parts/systems vendors
- Create PCB manufacturing data
- Create a detailed documentation regarding project specifications and scheduling of the project

2. Scope of the Document:

The scope of the Project Functional Specification document is to present hardware specifications needed to implement the HCS12 embedded PCB. This document will be subjected to numerous revisions as the project progresses and the aspects of the project are added through the semester. This document shall include:

- List of related documents supporting the project
- Cost targets of the components and services needed to finish the project
- Configuration options of the embedded system
- Detailed specification such as:
    - Performance
    - Port usage
    - Communication options
    - External cabling details
    - Physical size and physical constraints
    - Power requirements
- Regulatory requirements
- Reliability and service

3. Chapter I – List of Related Documents

3.1. Purpose:

The purpose of this chapter is to attach documentation related to the project. The documentation will be attached as links. Some documents might require special access permissions to be viewed. Contact document author if issues persist.

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3.2. Documents list:

#	Document tile	Revision	Document purpose	Link
1	LM22675 Specs	L	To present specifications of LM22675	link
2	Project Charter	2.7	To present project IV requirements	link
3	Notes For Design Verification	5.0	MCU pin specifications	link
4	Port Mapping	6	Port mapping and pin outs of the MCU	link
5	PCB tolerances and design requirements	N/A	PCB design and tolerances	link
6	DC motor encoder connections	N/A	Pin out of the DC motor connector	link
7	Board outline	8	PCB outline and connector placements	link
8	Camera conx pinout	2	Camera connection pin out	link
9	Motor encoder	N/A	Motor speed feedback diagram	link
10	MAX3232	7	MAX3232 Data Sheet	link
11	Altium Resource/Documentation	N/A	Webpage for Altium Designer support	link
12	Absolute Maximum Ratings for Soldering SNOA549C	N/A	Soldering ratings for National Semiconductors	link
13	L293DD Driver	N/A	Stepper motor driver specifications	link
14	L6225 Driver	N/A	DC motor driver specifications	link

4. Chapter II – Cost Target

4.1. Purpose:

The purpose of the Cost Target chapter is to track the expenses of the parts and services required to finish the project. This chapter will keep an updated BOM as well as any quotes obtained from the vendors.

4.2. BOM

Comment	Footprint	LibRef	Quantity
Cap	CAPC2012X09M	CAP-X7R-47000pF-50V-±10%, CAP-X7R-.1uF-100V-±10%, CAP-X7R-5600pF-50V-±10%, CAP-X7R-5600pF-50V-±10%, CAP-X7R-.1uF-50V-±5%, CAP-X7R-.1uF-50V-±5%, CAP-COG-220pF-50V-±5%, Cap, CAP-X7R-.1uF-16V-±10%, Cap, CAP-COG-22pF-50V-±5%, CAP-COG-22pF-50V-±5%, CAP-X7R-2.2uF-16V-±10%, CAP-X7R-10000pF-50V-±10%, CAP-X7R-10000pF-50V-±10%, CAP-X7R-1uF-16V-±10%, CAP-X7R-1uF-16V-±10%, CAP-X5R-10uF-10V-±10%, CAP-X5R-10uF-10V-±10%	19
Cap Pol	CAPACITOR_3MM	Cap Polar-0.33uF-50V, Cap Polar-0.33uF-50V, Cap Polar-0.33uF-50V, Cap Polar-0.1uF-50V	4
Cap	C1210	CAP-X7R-2.2uF-16V-±10%	2
Cap Pol	CAPACITOR_6.3MM	Cap Polar-100uF-16V	1
TANT.		CAPACITOR POL	3
DIODE SCHOTTKY 40V 2A SMA	DIOM4326X23M	DIODE SCHOTTKY 40V 2A SMA	2
Diode 1N4148	zener_sod323	Diode 1N4148	2
H3x2	HDR2X3	Header 3X2	1
VRH_EN	HDR1X2	Header 2	1
VRL_EN	HDR1X2	Header 2	1
Header16_LCD_Header	HDR1X16_LCD	Header16_LCD	1

Header 3	HDR1X3	Header 3	1
Header 2	HDR1X2	Header 2	4
D Connector 9	DSUB1.385-2H9	D Connector 9	1
SRN8040	INDP8080X40M	SRN8040	2
10uH		INDUCTOR	1
Res3	RESC2112X05M	Resistor_10.0K, Resistor_10.0K, Resistor_10.0K, Resistor_10.0K, Resistor_10.0K, Resistor_10.0K, Resistor_10.0K, Resistor_100R, Resistor_100R, Resistor_5.11K, Resistor_475R, Resistor_5.11K, Resistor_475R, Resistor_221R, Resistor_4.75K, Resistor_10.0K, Resistor_10.0K, Resistor_1.00K, Resistor_1.00K, Resistor_2.87K, Resistor_2.87K, Resistor_100R	22
RPot	BOURNS_3386F	RPot	1
R_XLT1	RESC2112X05M	Resistor_10.0K	1
R_XLT2	RESC2112X05M	Resistor_1.02R	1
SWITCH_TACTILE		SWITCH_TACTILE	1
L293DD	SO20_N	L293DD	1
L6225	POWERSOP20	L6225	1
DS1813-10	SOT95P230X110-3M	DS1813-10	1
MC9S12C128MFUE	QUAD.65M/80/WG17.45 -HCS12	MC9S12C128MFUE	1
74ACT14_3	SOIC127P600X175-14M	74ACT14_3	2
LM22675MR-ADJ/NOPB	MRA08B_L	LM22675MR-ADJ/NOPB	2
MAX3232CSE	NSO16_N	MAX3232CSE	1
CRYSTAL/SM		CRYSTAL/SM	1
LM1117	TO261	Linear Voltage Regulator	1
LIS352ARTR	LP 14LGA	Accelerometer	1
MAX5513EUA	8-TSSOP	DAC	1
LMC6484IMX	14-SOIC	OPAMP	2
STM32F103	LQFP64	ARM microcontroller	1
		Current Total Cost: $69.54	

4.3. Total cost target

Currently the cost target of the finished product is approximately $200. The above estimate presents only the current known parts that must be acquired.

5. Chapter III - Specifications and Performance

5.1. Purpose:

The purpose of this chapter is to present detailed hardware and software specifications regarding configurations, ports usage, cabling details and system communications.

5.2. Hardware Specifications:

5.2.1. Ports:

Module	Port	MODE	Pin
Port T • Stepper Motor Coil Pair 2 In • Stepper Motor Coil Pair 2 Out • Stepper Motor Coil Pair 1 In • Stepper Motor Coil Pair 1 Out	 PT7 PT6 PT5 PT4	 GPIO OUT GPIO OUT GPIO OUT GPIO OUT	 14 13 12 11
Port T **Timer Module** • RC Servo 2 Out • RC Servo 1 Out • DC Motor Encoder 2 In • DC Motor Encoder 1 In	 PT3 PT2 PT1 PT0	 Timer Out Timer Out Input Capture Input Capture	 8 7 6 5
Port S • LED 2 (Green) • LED 1 (Green)	 PS3 PS2	 GPIO Out GPIO Out	 66 65
Port S **Serial Communications Interface (SCI)** • SCI Transmit • SCI Receive	 PS1 PS0	 SCI TX SCI RX	 64 63
Port M **Serial Peripheral Interface (SPI)** • SCK • MOSI • N_SS • MISO	 PM5 PM4 PM3 PM2	 SPI SCK SPI MOSI SPI N_SS SPI MISO	 70 71 72 73
Port M • CAN_TX • CAN_RX	 PM1 PM0	 GPIO Reserved GPIO Reserved	 74 75
Port J **Serial Peripheral Interface (SPI)** • SPI_CS2 • SPI_CS1	 PJ6 PJ7	 GPIO Out GPIO Out	 69 68
Port P • Keypad wake • ROMCTL (Pull up with 10K and connect to header pin for GPIO)	 PP7 PP6	 GPIO Reserved ROMCTL In	 78 67
Port P **PWM Module** • DC Motor 2 PWM • DC Motor 1 PWM	 PP5 PP4	 PWM Out PWM Out	 79 80
Port P • Unused • Unused • Unused • Unused	 PP3 PP2 PP1 PP0	 GPIO Unused GPIO Unused GPIO Unused GPIO Unused	 1 2 3 4
Port AD • Stepper Switch Right • Stepper Switch Left • Unused/Keyboard scan 5 • Unused/Keyboard scan 4 • Analog Input 3/Keyboard scan 3 • Analog Input 2 • Analog Input 1 • Analog Input 0	 PAD7 PAD6 PAD5 PAD4 PAD3 PAD2 PAD1 PAD0	 GPIO IN GPIO IN GPIO Reserved GPIO Reserved Analog In/GPIO Analog In Analog In Analog In	 58 57 56 55 54 53 52 51

Ports assignment cont…

Port A • Unused • LCD_RW • LCD_RS • LCD_E • LCD Data I/O 3 • LCD Data I/O 2 • LCD Data I/O 1 • LCD Data I/O 0	PA7 PA6 PA5 PA4 PA3 PA2 PA1 PA0	GPIO Unused GPIO Out GPIO Out GPIO Out GPIO I/O GPIO I/O GPIO I/O GPIO I/O	48 47 46 45 44 43 42 41
Port B • Unused • Unused • Unused • Unused • DC Motor 2 Direction B • DC Motor 2 Direction A • DC Motor 1 Direction B • DC Motor 1 Direction A	PB7 PB6 PB5 PB4 PB3 PB2 PB1 PB0	GPIO Unused GPIO Unused GPIO Unused GPIO Unused GPIO Out GPIO Out GPIO Out GPIO Out	23 22 21 20 19 18 17 16

5.2.2.Communication and cabling:

- TBD

5.2.3. Hardware configuration:

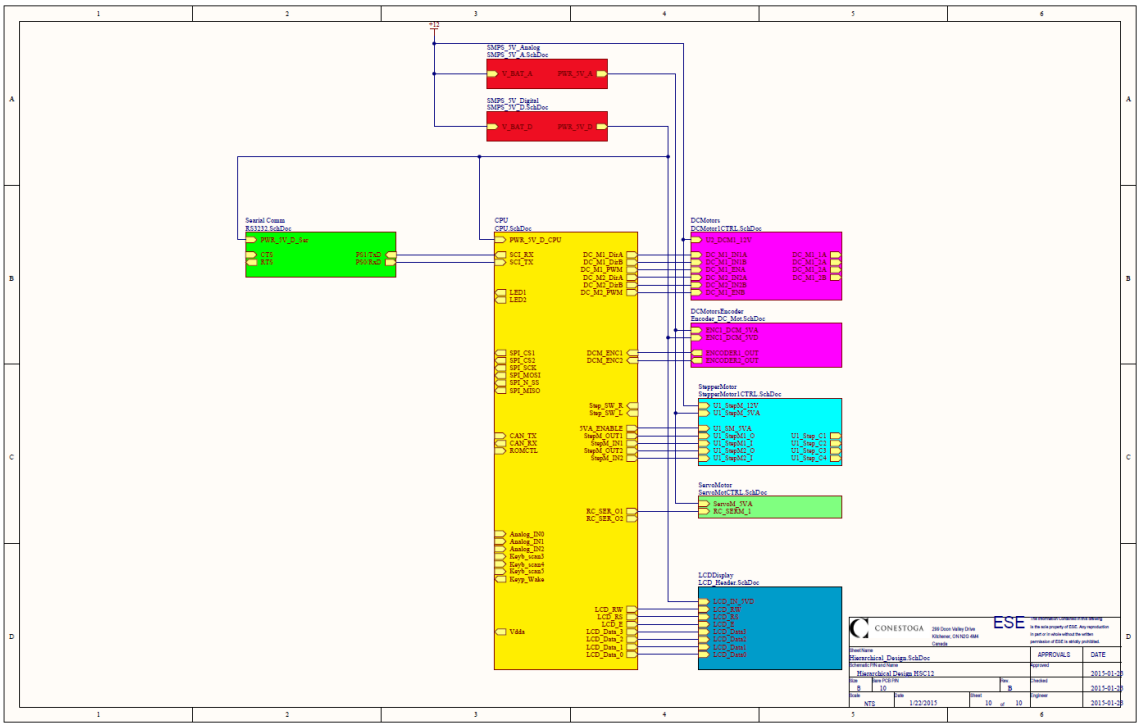
- Pierce oscillator (PE7/XCLKS pulled to ground)
- ModeC=1,ModeB=0,ModeA=0 → Normal single chip, BDM allowed
- UART connection to MAX3232 and ARM mictocontroller

5.2.4. Physical Constraints:

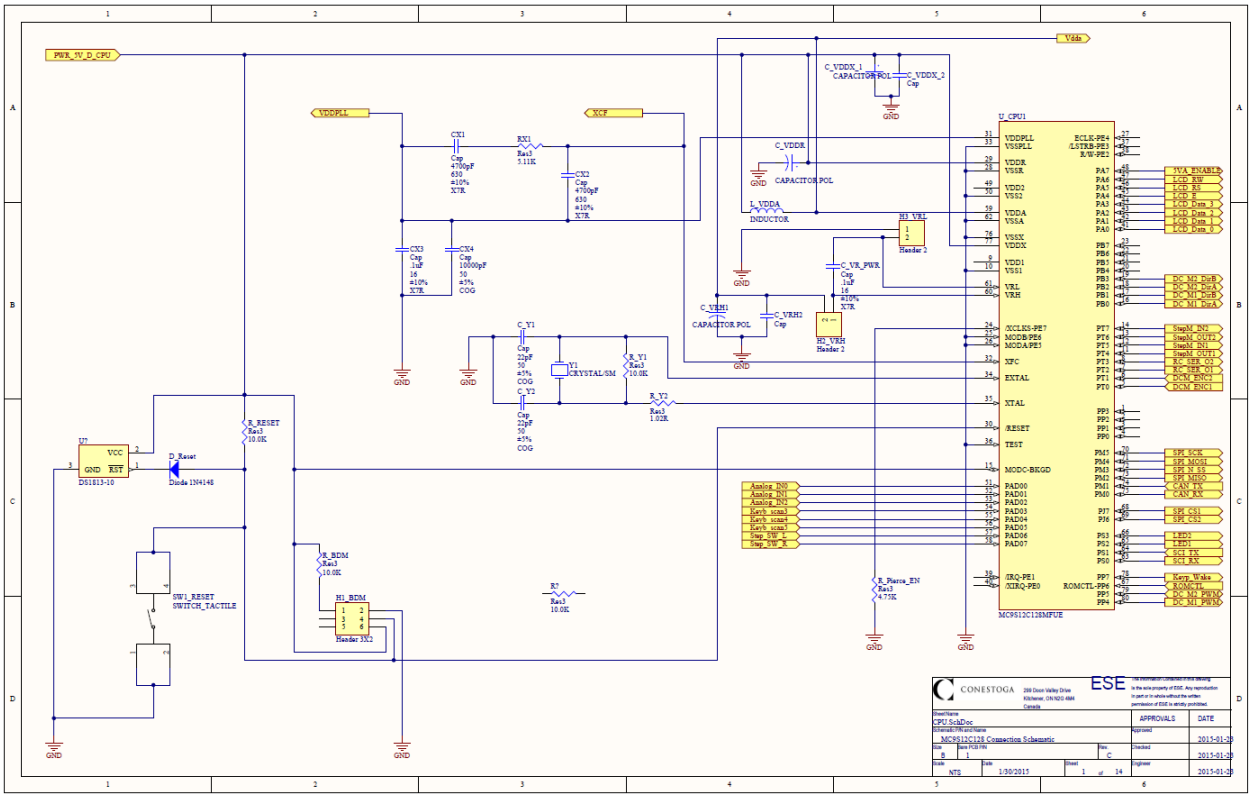
- Refer to refer to document 5 and 7 in 3.2 Documents List for the board physical constraints and layout options. Further details TBD
- Constraints regarding component placement – TBD

5.2.5. PCB Design

- Top Down Representation

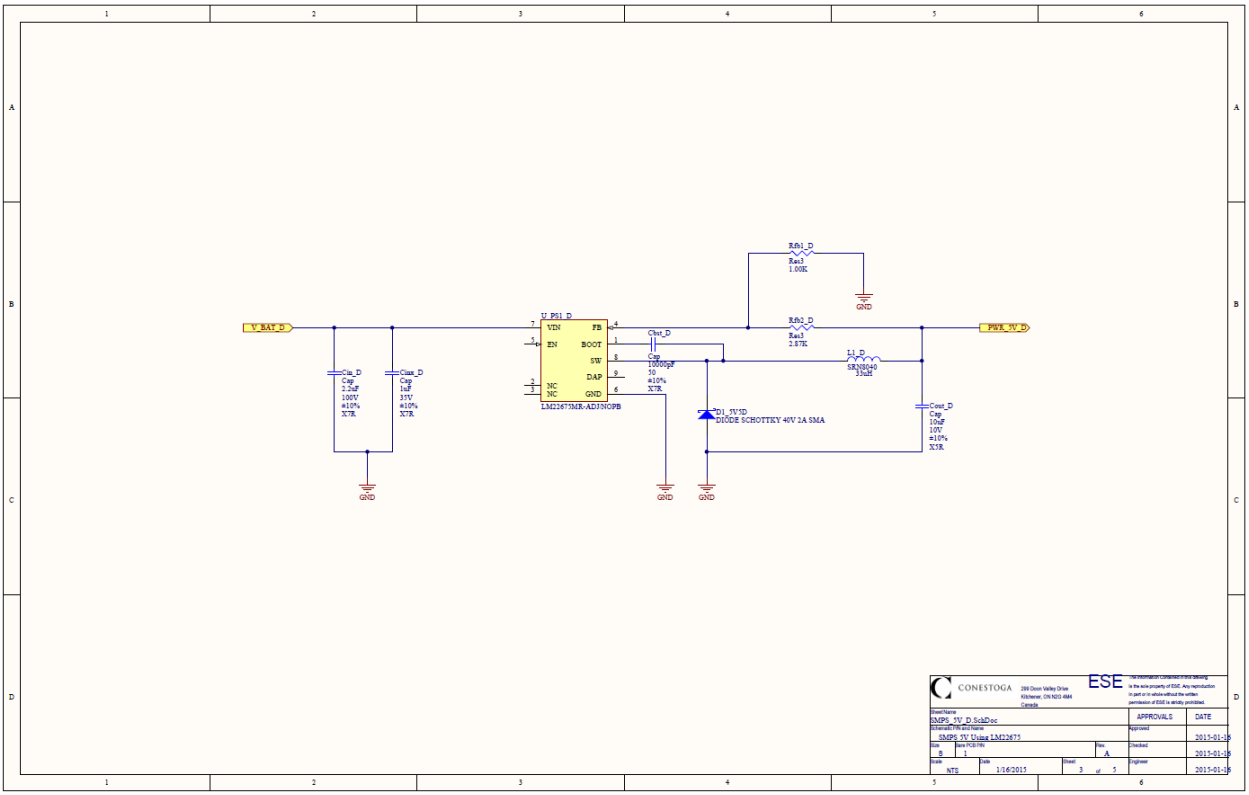


- MCU connections

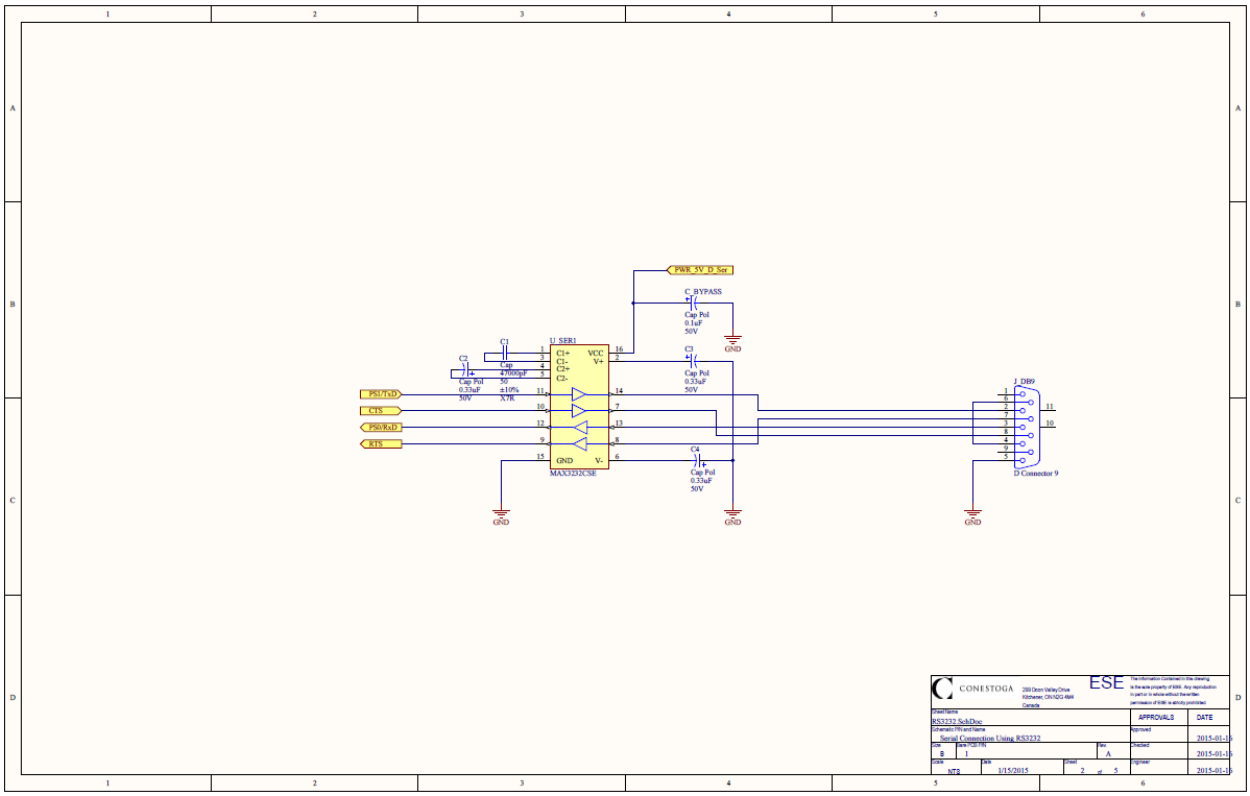


- MOD C = 1 ; MOD B = 0 ; MOD A = 0 -> operation type: Normal single chip, BDM allowed

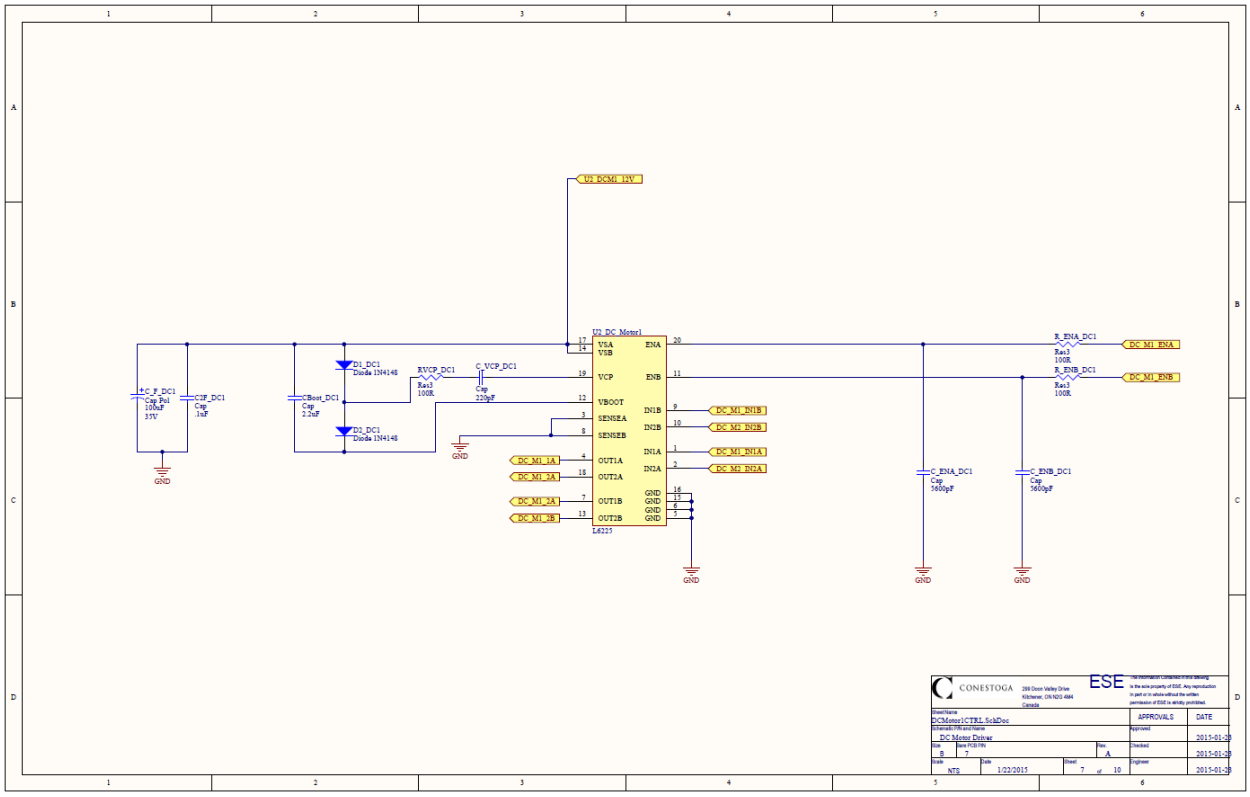
- SMPS 5V power supply



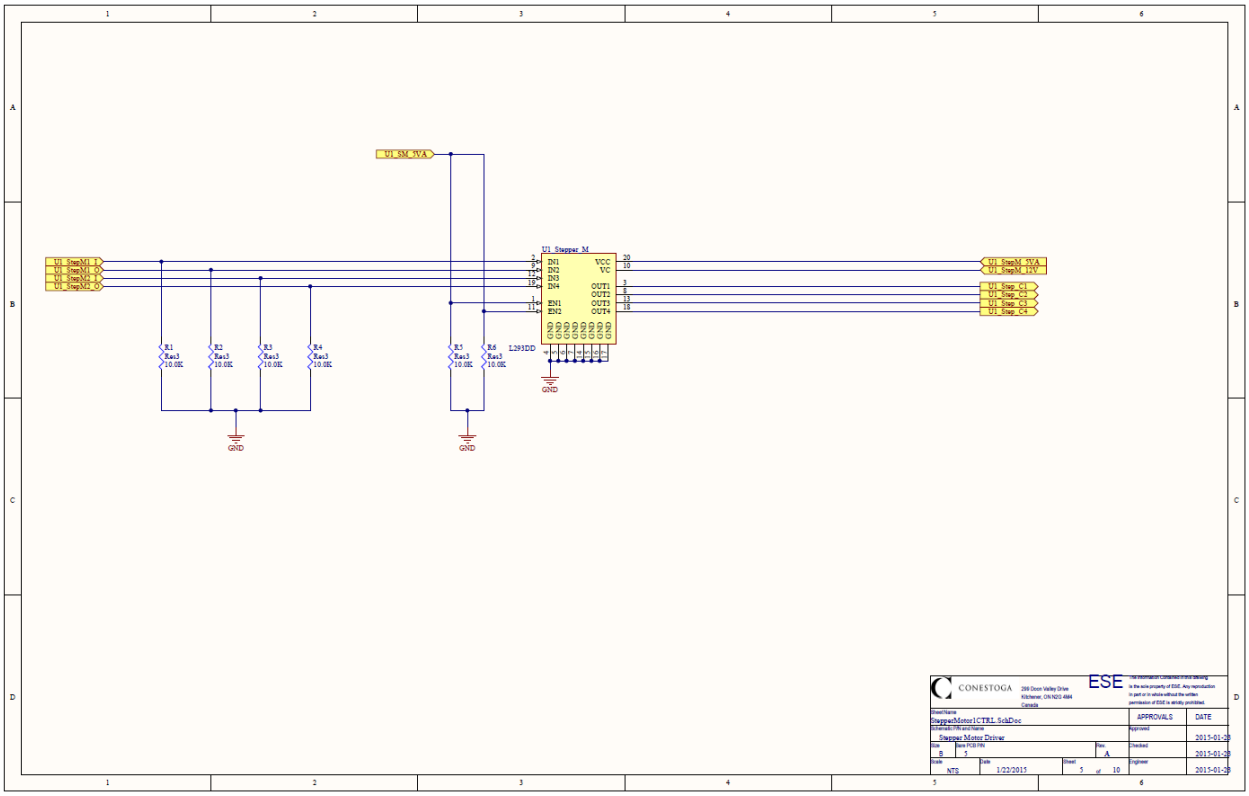
- RS3232 connections



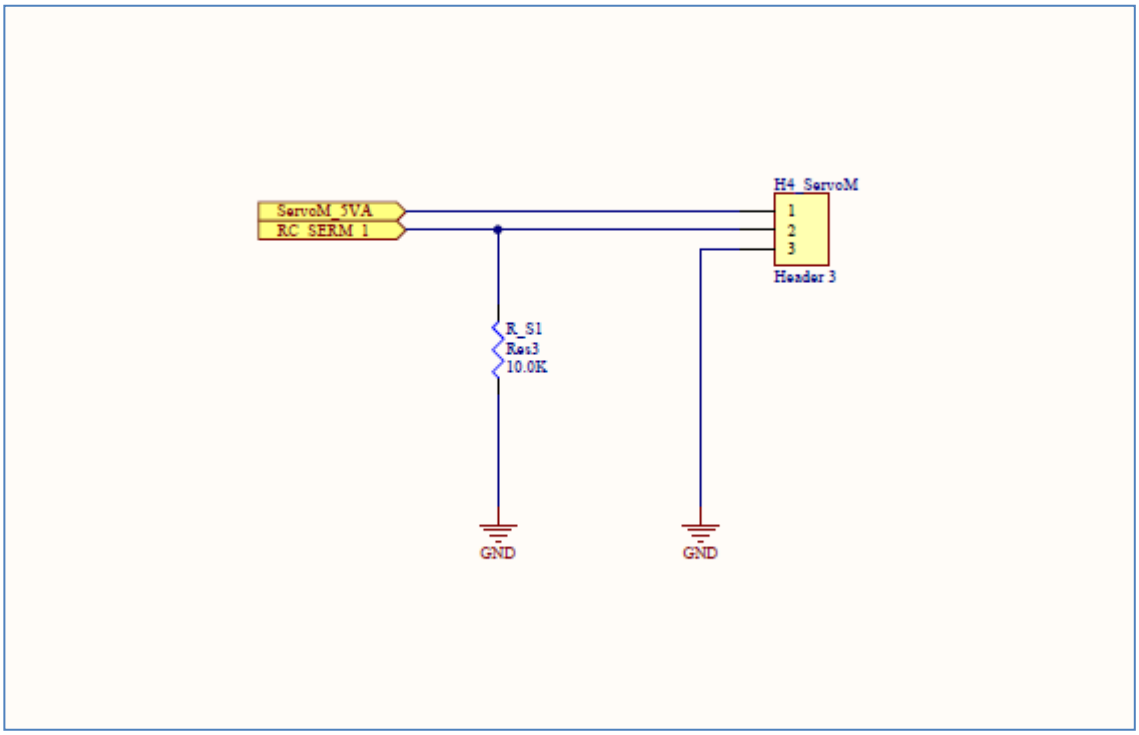
- DC motor driver



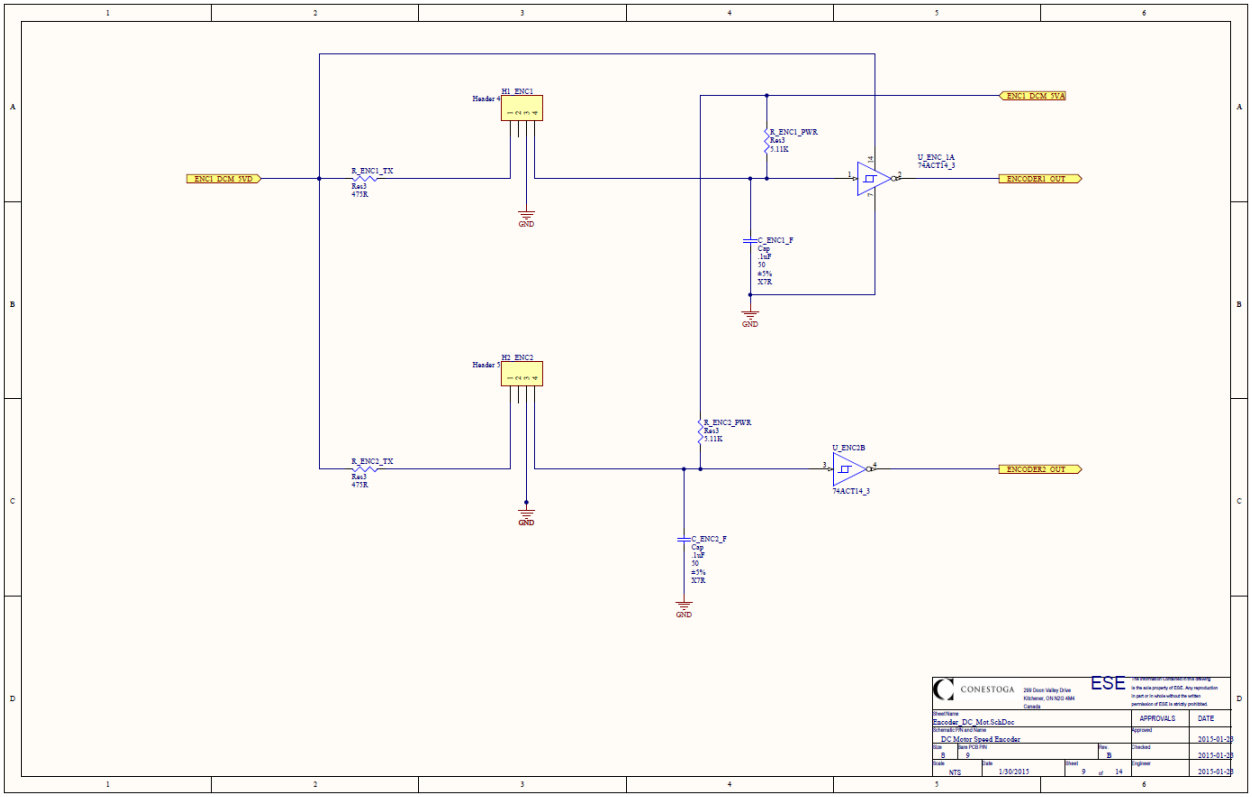
- Stepper motor driver



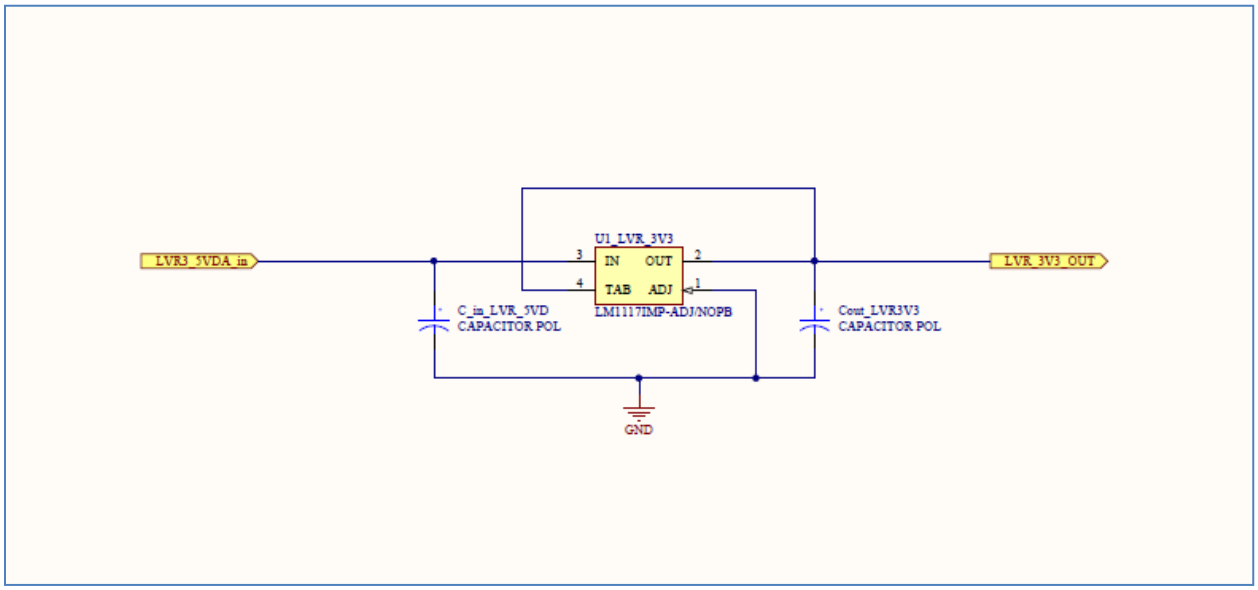
- Servo motor connections



- DC motor encoder

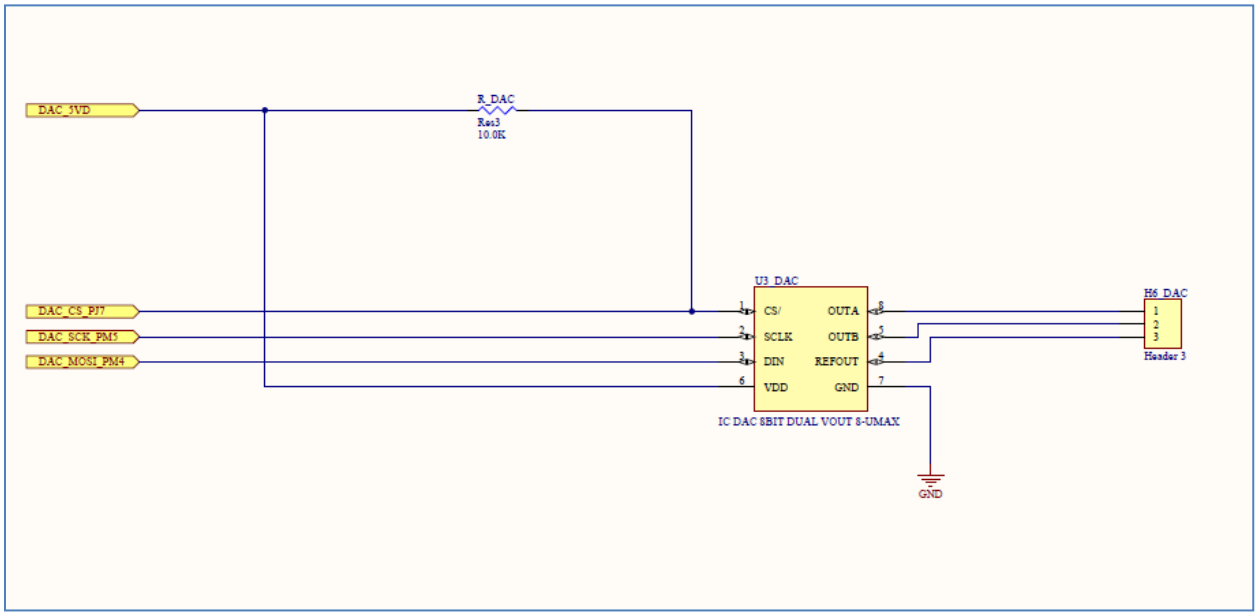


- Linear Voltage Regulator

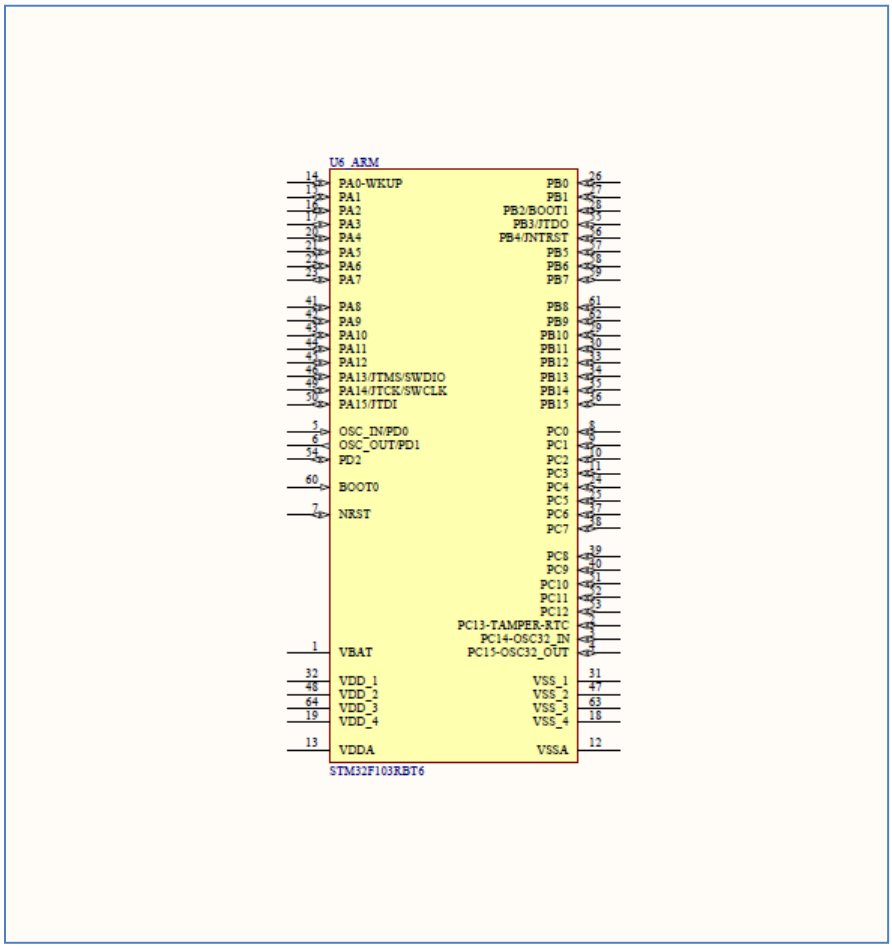


- Output = 3.3V powering accelerometer

- DAC



- ARM microcontroller



  - Connected to SCM12 through UART (MAX3232)
  - Used for additional GPIO pins

5.2.6.Power requirements

- Power supplies requirements:
  - Two 5V SMPS and one linear 3.3V power supplies are required
- Main power connection driving the 5V power supplies and motors is 12V
- Maximum power consumption per chipset – TBD and tested (it varies on configuration)

5.3. Software Specifications

5.3.1. Programming environment

- The programming development environment for the HSC12 will be Code Warrior suite (refer to document 11 in 3.2 Documents List for software documentation)
- Other software specifications TBD

6. Chapter IV – Regulatory Requirements

6.1. Purpose:

The purpose of this chapter is track regulatory requirements that shall be kept during the design phase.

6.2. ESD Requirements

- Design for LM22675 require to comply with JEDEC document JEP155 500-V HBM
- Other requirements TBD

6.3. Soldering Requirements

- Refer to document 12 in 3.2 Documents List for National Semiconductor products soldering specs
- IPC standard that will be applied for this project – TBD

7. Reliability and Service

- The main reliability requirement is for the system to be able to run from 12V (current consumption is to be determined – dependent on configuration).