EECE8010 - Embedded System Hardware Design

Milestone 1 – Project Document

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1-29-2020

Purpose of project:

This project is intended to design and implement a 2-layer PCB using Altium designer that controls 2 DC motors and a stepper motor using the STM32F303 microcontroller in conjunction with motor drivers. An LCD will be programmed to display a message corresponding to the outputs of the motors. The project includes design and manufacturing the PCB along with ordering and placing interfaces on the PCB. The STM32F303 microcontroller will be programmed to connect on board peripherals and perform data processing.

Scope of project:

To design a PCB that works as the intermediate stage between the STM3F03 microcontroller and interfaces. The PCB only provides the platform for which the interfaces will connect to the microcontroller, the hardware design of the microcontroller and interface components is outside the scope of this project and will be sourced from other vendors. Software for the microcontroller will programmed using the C language such that the dc and stepper motors can be controlled while information such as position and speed can be read and displayed.

This project solution ensures that all interfaces are connected to the appropriate ports on the microcontroller and that appropriate power signals are distributed throughout the board. The end goal of the project is to have a PCB with several interfaces that allows the STM3F03 microcontroller to effectively drive and read a stepper and dc motor.

Intended Audience:

This project document targets embedded systems development students and instructors; however, this document can easily be understood by any engineer in the embedded systems development field.

Description of solution:

The solution starts by defining the features to be included in the project. Following are the basic components and interfaces:

- PWM Constant Current Micro-Stepping Driver
- 2x H-Bridge driver
- Character LCD interface
- RS-232 level interface
- Analog inputs
- STM32F3 Nucleo-64 board interface

The microcontroller is the heart of the system as it communicates with the motor drivers, LCD, RS-232 and analog I/O interfaces. Two power sources are used. 5 V DC for the LCD and motor drivers, and 3.3 V DC for the RS-232 interface buffer and the micro-controller. The H-bridge is connected to 2 DC motors and controlled by the microcontroller.. Each DC motors has an encoder that feeds back to the microcontroller. The stepper motor driver receives an analog input from the microcontroller to set a

reference voltage to control the output current for the stepper motor. The stepper motor driver feeds back a monitor signal pulse to the microcontroller. Figure (1) below illustrates the block diagram for the main components of the project:

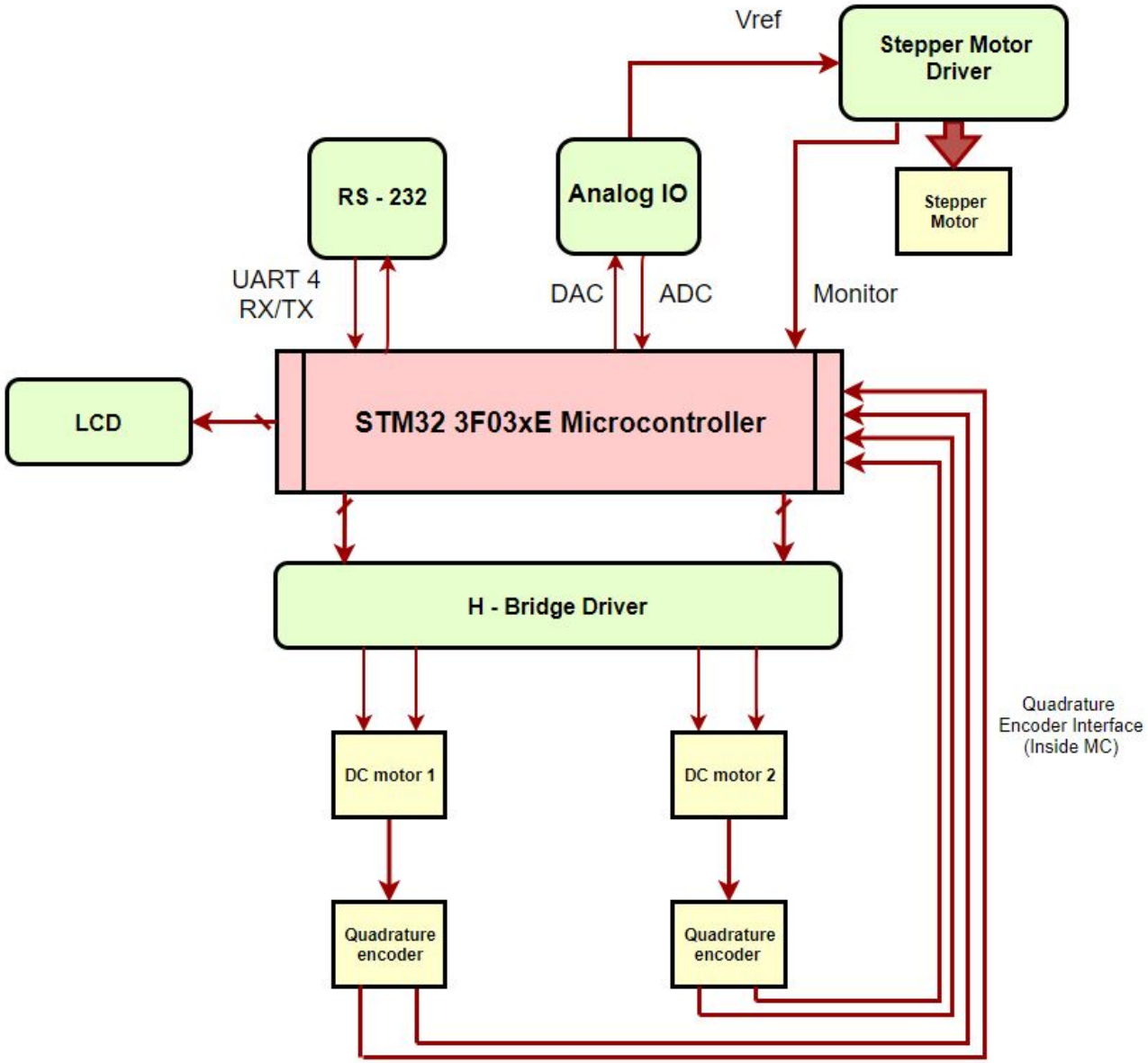

Figure 1: Block diagram of project solution

Component	Base Quantity	Spare Quantity	Cost of individual component (CAD)	Total Cost (CAD)	Links
Microcontroller STM32F303RE	1	0	$15.79	$15.79	Digikey
0.1 µF 50V ± 5% Capacitor	9	3	$0.27	$3.24	Digikey
10 µF 35V ±5% Polarized Capacitor	1	1	$0.42	$0.84	Digikey
220 pF 50V ± 10% Capacitor	1	1	$0.55	$1.10	Digikey
Power Connector	2	0	$0.57	$1.14	Digikey
Female Header 19x2	2	0	$3.25	$6.50	Digikey
Male Header 6x1	1	0	$0.63	$0.63	Digikey
Molex Connector 22-11-2062 (DC motors)	2	0	$1.31	$2.62	Digikey
Female Header 16x1 (LCD)	1	0	$1.47	$1.47	Digikey
Molex Connector 22-11-2042 (Stepper motors)	1	0	$0.83	$0.83	Digikey
Potentiometer 10 KΩ	1	0	$2.83	$2.83	Digikey
D connecter (RS - 232)	1	0	$1.11	$1.11	Digikey
Diode Schottky 40V 2A SMA	2	1	$0.60	$1.80	Digikey
Transistor BC846B	1	1	$0.20	$0.40	Digikey
10 KΩ Resistor	2	1	$0.15	$0.45	Digikey
3.32 KΩ Resistor	1	1	$0.15	$0.30	Digikey
0.47 Ω Resistor	2	1	$0.89	$2.67	Digikey
4.75 KΩ Resistor	1	1	$0.15	$0.30	Digikey
47.5 KΩ Resistor	1	1	$0.15	$0.30	Digikey
8.25 KΩ Resistor	1	1	$0.15	$0.30	Digikey
LCD HD44780	1	0	$16.97	$16.97	Mouser
MAX-3232 (RS -232 Driver)	1	0	$5.98	$5.98	Digikey
RS -232 Socket	1	0	$12.99	$12.99	Walmart
H-Bridge L293D	1	0	$6.65	$6.65	Digikey
PWM Micro-stepping Driver LV8712T-D	1	0	$4.28	$4.28	Digikey
DC motor	1	0	$2.44	$2.44	AliExpress
Bi-polar Stepper Motor	1	0	$15.49	$15.49	Amazon
PCB	1	0	$30.00	$30.00	Coordinator, M. Jarabek
Soldering Iron	1	0	$9.99	$9.99	CanadianTire
			Total cost of all parts	$149.41	

Background Information:

Stepper motors can be controlled using 555-timers. The PWM technique is used by controlling the width of the timer's output pulse. However, having a microcontroller on the board will definitely add more features and capabilities to the system.

Note: It has been noticed that 3 ADCs from the microcontroller have nothing connected to them.

We can add an external circuitry that passes an 8-bit command through the RS-232 to the microcontroller in order to control the DC/stepper motor. This external circuitry would consist of a ROM which will store the commands in a table. An 8-bit shift register buffer to temporarily hold the command before sending it. A decoder to select the desired command from the table and pass it to the buffer. An oscillator that produces a frequency that matches the baud rate of the microcontroller. Other associated hardware for voltage regulation, filtering and a controlled would be needed. Figure (2) below shows the block diagram of the external circuitry:

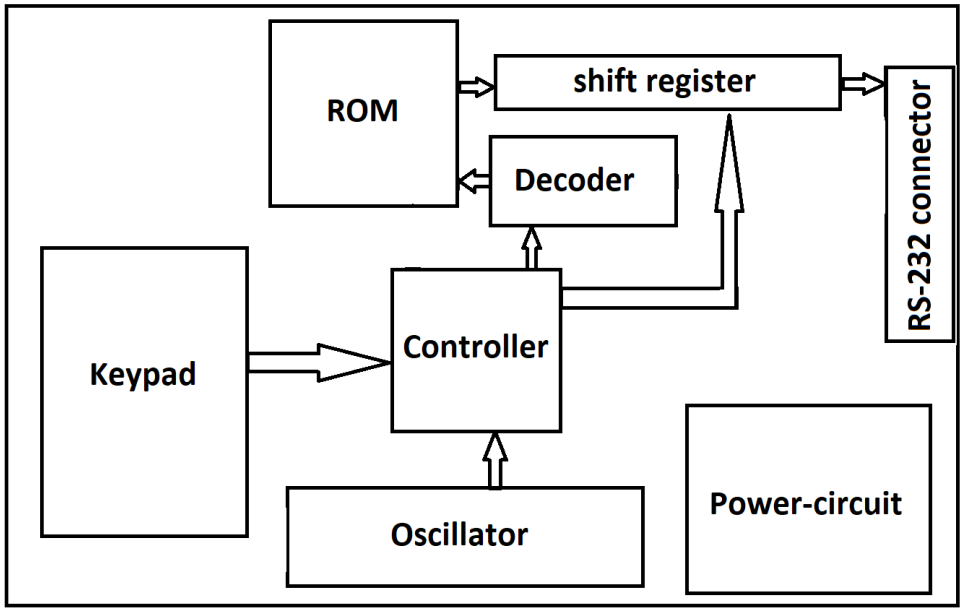

Figure 1: Block diagram of external circuitry