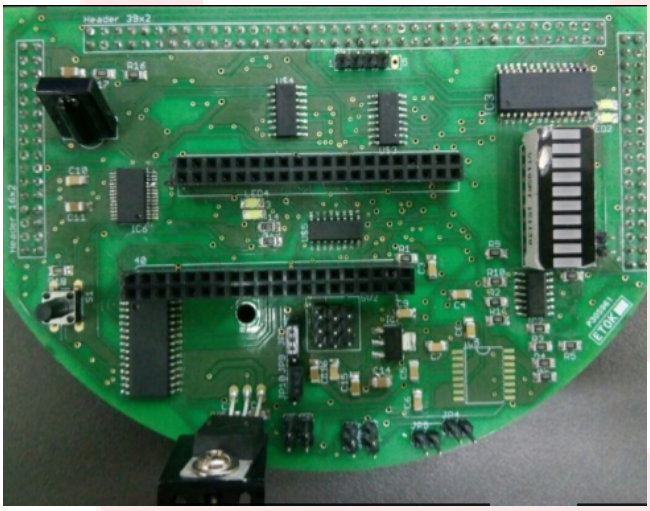
Fi-Pi

Adaptor Board for Firebird V Robot using Raspberry Pi 2

HARDWARE MANUAL



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Documentation author

Milan Preet Singh
Tejaswini A

Mentors

Rutuja
Deepa

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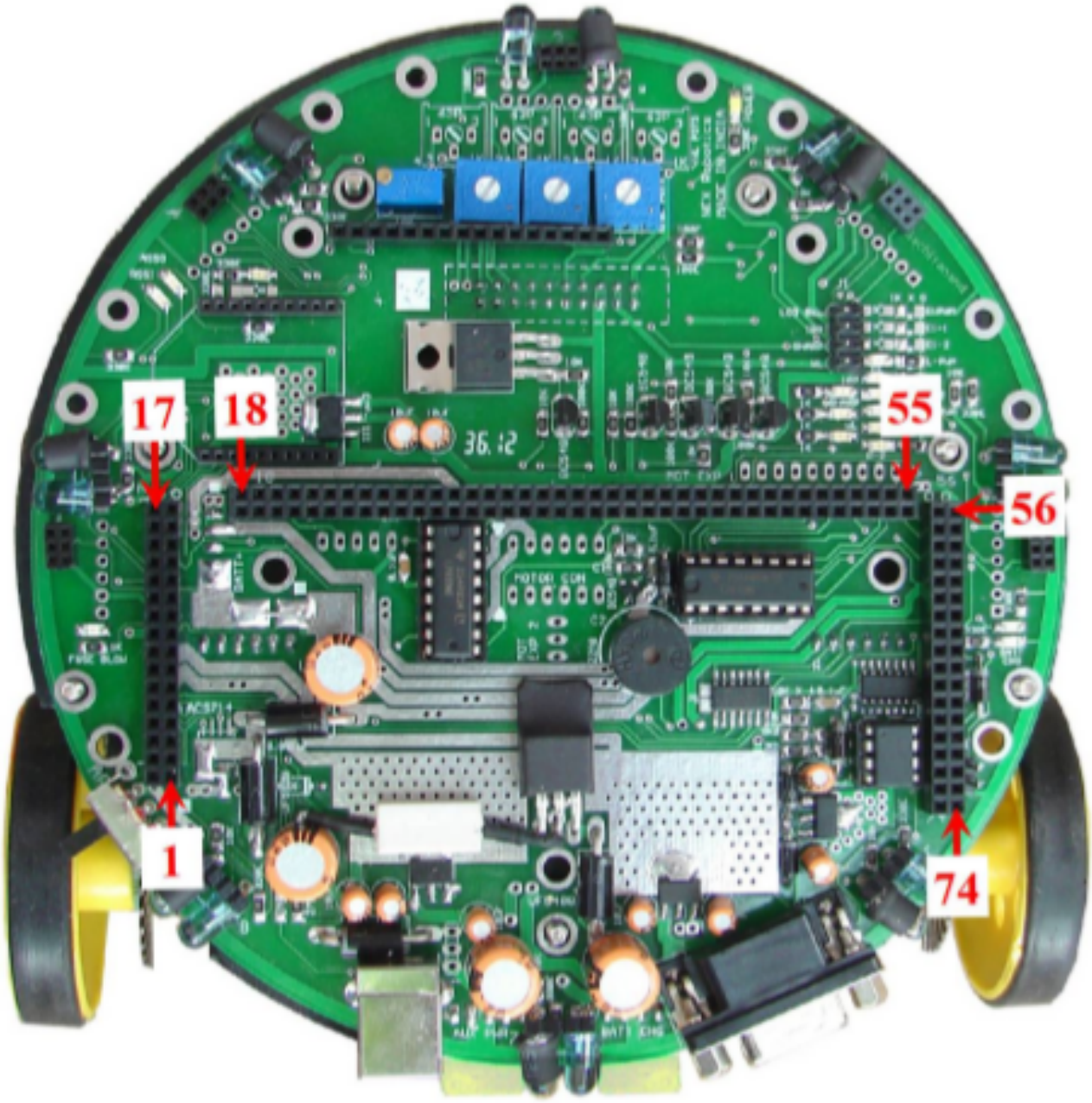
1.Introduction

Currently Firebird V robot comes with ATMEGA2560, 8051, ARM7 adaptor board. Using a raspberry pi based adaptor board would add to the functionality of the robot. The idea is to integrate the features of RPi to Firebird V robot.This would facilitate any on-board computations, image processing(Rpi supports PiCamera directly), the robot could even be used for IOT applications. Because of the presence of an operating system, Rpi is a mini computer.Adaptor board for Firebird V would definitely be an advantage.

Components on the adaptor board

- MCP3008 (8 channel 10-bit ADC)
- MCP23017 Port expander IC
- Header pins for interfacing adaptor board with main board, raspberry pi and for the expansion socket.
- FT232 for USB communication
- MAX202 for RS232 communication
- LM324 quad comparator IC
- Bar Graph LED
- L7805 IC for powering Rpi
- LM1117 IC for powering servo motors
- Switches
- Jumpers
- Resistors,capacitors,diodes,LEDs

2.Main board pin details

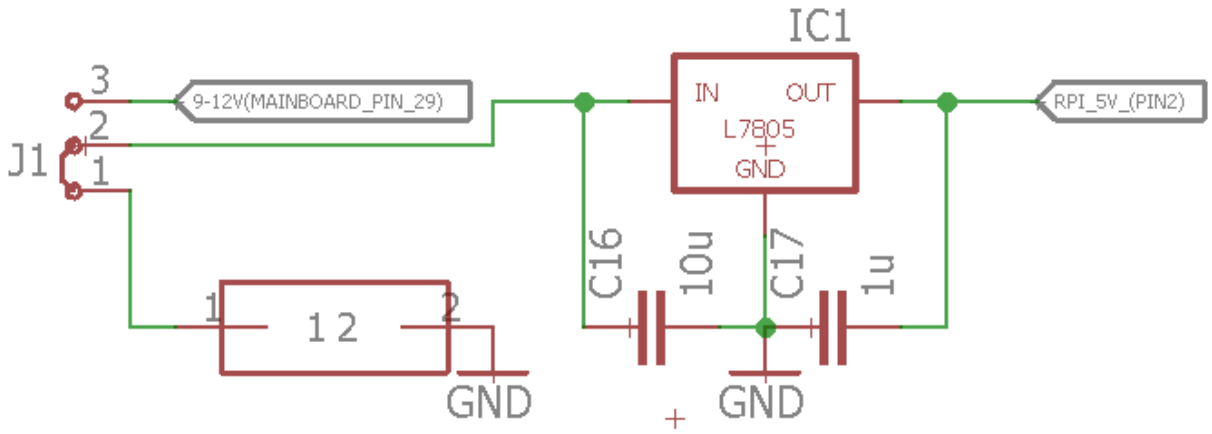


Pin No.	Pin Name	Function
1.	CS	Current sense analog value
2.	IR Proximity sensor 8	IR Proximity sensor 8 analog value
3.	Ground	Ground
4.	USB Data+	USB connection going to the raspberry pi via FT232 USB to serial converter.To enable USB communication set jumper as shown.
5.	USB Data-	USB connection going to the raspberry pi via FT232 USB to serial converter.To enable USB communication set jumper as shown.
6.	VUSB	Voltage source for FT232

7.	5V System	5V System Voltage. Can be used for powering up any digital device with current limit of 400mA
8.	5V Sensor	5V Sensor Voltage. Can be used for additional sensor interfacing with current limit 300mA.
9.	5V Sensor	5V Sensor Voltage. Can be used for additional sensor interfacing with current limit 300mA.
10.	5V System	5V System Voltage. Can be used for powering up any digital device with current limit of 400mA
11.	Sharp IR Range Sensor 1	Analog output of Sharp IR range Sensor 1
12.	IR Proximity Sensor 1	Analog output of IR Proximity Sensor 1.
13.	XBee RXD	XBee wireless module serial data in
14.	XBee TXD	XBee wireless module serial data out
15.	Sharp IR Range Sensor 2	Analog output of Sharp IR range Sensor 2
16.	IR Proximity Sensor 2	Analog output of IR Proximity Sensor 2.
17A.	RSSI	To capture the RSSI signal
17B.	Ultrasonic Trigger	To give trigger for Ultrasonic sensor
18.	MOSI	SPI Communication line for communicating with raspberry pi. Master Out Slave In.
19.	MISO	SPI Communication line for communicating with raspberry pi. Master In Slave Out.
20.	SCK	SPI Communication line for communicating with raspberry pi. Clock signal.
21.	SSI	SPI Communication line for communicating with raspberry pi.
22.	RS	LCD Register select pin(Command)
23.	RW	LCD Write pin(Command)
24.	EN	LCD Enable pin(Command)
25.	DB5	LCD Data bit 5
26.	DB4	LCD Data bit 4
27.	DB5	LCD Data bit 6
28.	DB5	LCD Data bit 7
29.	V Battery System	9-12V unregulated power supply for additional module interfacing.
30.	White Line sensor 1	Analog output of White Line sensor 1
31.	White Line sensor 2	Analog output of White Line sensor 2
32.	White Line sensor 3	Analog output of White Line sensor 3
33.	Sharp IR Sensor 1 to 5 Disable	TTL or CMOS input.Disable IR range Sensor
34.	IR Proximity Sensor Disable	TTL or CMOS input.Disable IR range Sensor
35.	5V System	5V System Voltage. Can be used for powering up any digital device with current limit of 400mA
36.	White Line sensor 4	Analog output of White Line sensor 4
37.	White Line sensor 5	Analog output of White Line sensor 5
38.	White Line sensor 6	Analog output of White Line sensor 6
39.	White Line sensor 7	Analog output of White Line sensor 7

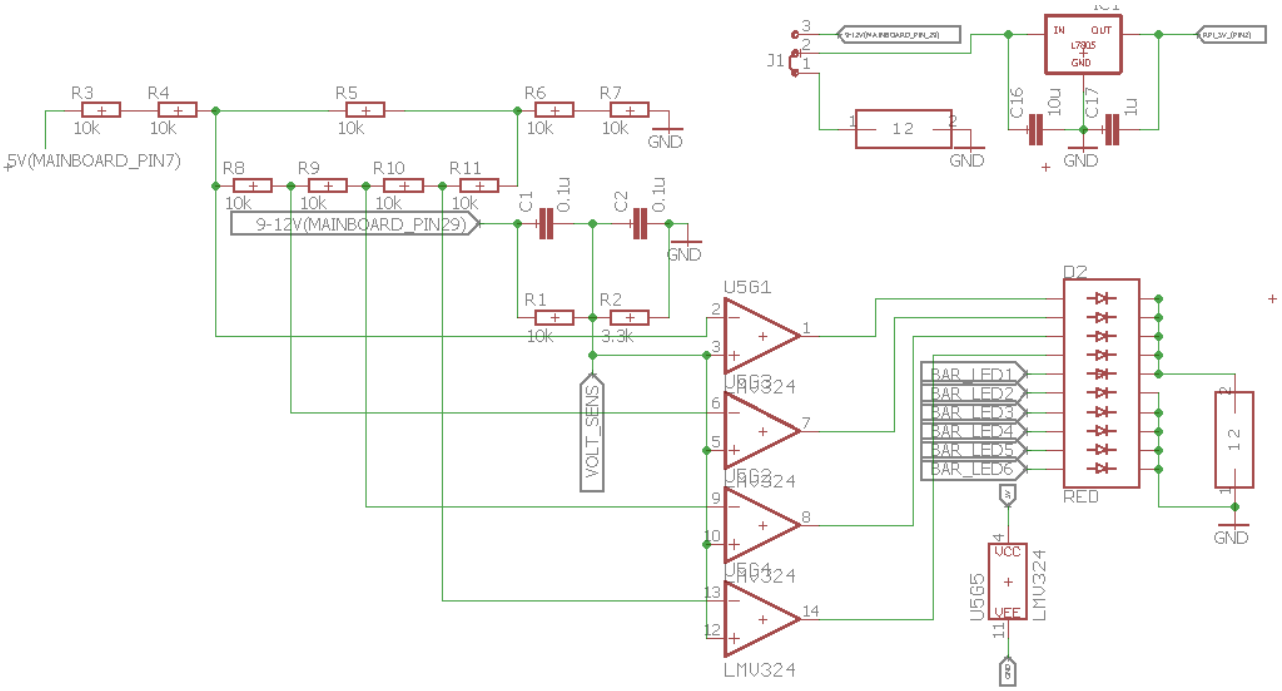
40.	White Line Sensor Disable	TTL or CMOS input.Disable White Line Sensor
41.	Sharp IR Range Sensor 3	Analog output of Sharp IR range Sensor 3
42.	IR Proximity Sensor 3	Analog output of IR Proximity Sensor 3.
43.	IR Proximity Sensor 4	Analog output of IR Proximity Sensor 4.
44.	Sharp IR Range Sensor 4	Analog output of Sharp IR range Sensor 4
45.	Sharp IR Range Sensor 5	Analog output of Sharp IR range Sensor 5
46.	IR Proximity Sensor 5	Analog output of IR Proximity Sensor 5.
47.	C1 1	Logic input 1 for C1 Motor Drive
48.	C1 PWM	PWM input for C1 Motor Drive
49.	C1 2	Logic input 2 for C1 Motor Drive
50.	PWML	PWM input for Left Motor Drive
51.	L1	Logic input 1 for Left Motor Drive
52.	L2	Logic input 2 for Left Motor Drive
53.	R1	Logic input 1 for Right Motor Drive
54.	PWMR	PWM input for Right Motor Drive
55.	R2	Logic input 2 for Right Motor Drive
56.		Not Used
57.		Not Used
58.		Not Used
59.		Not Used
60.		Not Used
61.		Not Used
62.	Position Encoder Left	Output of Left Position Encoder (0-5V)
63.	Position Encoder Right	Output of Right Position Encoder (0-5V)
64.	Position Encoder C2	Output of C2 Position Encoder (0-5V)
65.	Position Encoder C1	Output of C1 Position Encoder (0-5V)
66.	C2 2	Logic input 2 for C2 Motor Drive
67.	C2 1	Logic input 1 for C2 Motor Drive
68.	C2 PWM	PWM input for C2 Motor Drive
69.	IR Proximity Sensor 6	Analog output of IR Proximity Sensor 6.
70.	IR Proximity Sensor 7	Analog output of IR Proximity Sensor 7.
71.	Buzzer	Input, V¿0.65V turns on the buzzer
72.	DAC OUT	Not Connected
73.	RS232 TXD	RS232 Transmit, connected to DB9 serial connector on main board
74.	RS232 RXD	RS232 Receive, connected to DB9 serial connector on main board

3.Powering Raspberry Pi



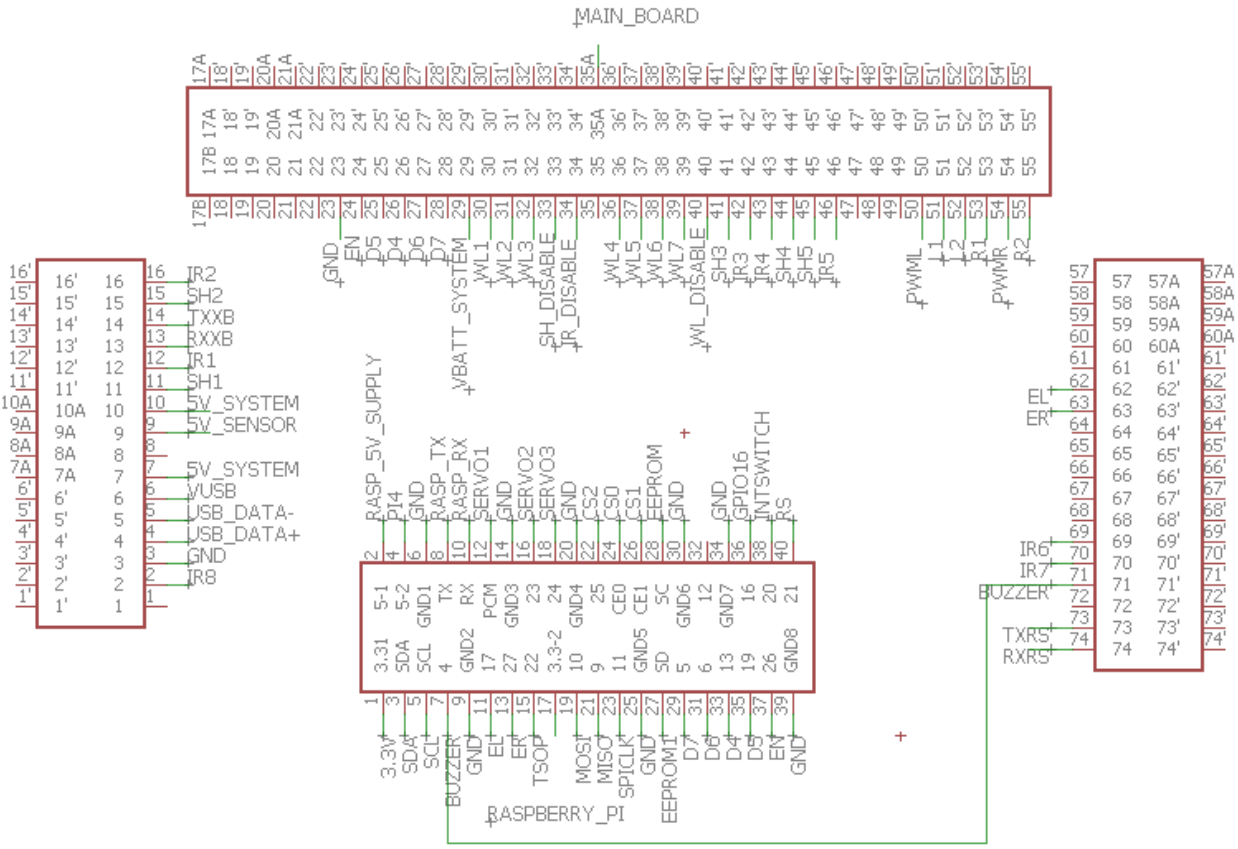
- Raspberry pi needs a constant 5v and more than 1A power supply. L7805 voltage regulator is used to serve this purpose.
- The battery voltage of Firebird V robot is directly obtained by using pin 29 of main board.
- The output of 29th pin on the main board is in the range of 9-12v. Either this or any external battery can be used as an input for the 7805 IC. The selection between the two is facilitated by a jumper.
- The output of 7805 is the regulated 5v output, which is given to 5v pin of raspberry pi.
- Two header pins are provided for the connection with external battery.

4.Battery voltage indication



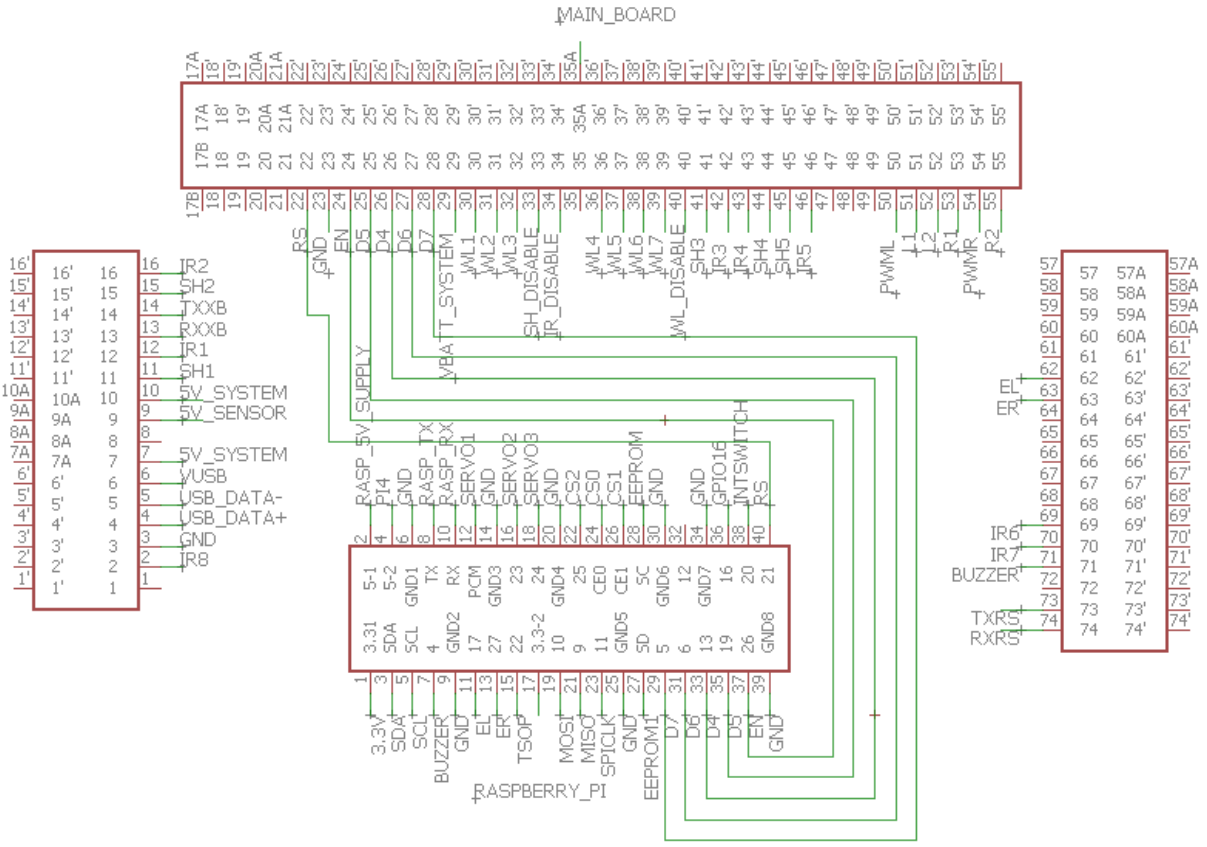
- The battery voltage of the Firebird V robot can be detected by the battery voltage sensing circuit.
- It could be sensed either by connecting the volt_sens pin to ADC and reading its value or by seeing the indications from the bottom 5 LEDs of bargraph LEDs
- First of all, the 9-12v output from mainboard pin 29 is mapped to value less than 5V by using the voltage divider circuit.This circuit apprx divides the voltage by 4 and henceforth mapping 12V to 3V, 11V to 2.75V, 10V to 2.5V and 9V to 2.25V.This output is given to all 4 input+ pins of the quad comparator IC LM324.
- The input for input- pins are given as 3V, 2.75V, 2.5V, 2.25V resp by the simple circuit as given above.
- So, whenever voltage is greater than 12V all the bottom 5 LEDs glow, when greater than 11V and less than 12V bottom 4 LEDs glow, when greater than 10V and less than 11V bottom 3 LEDs glow and when greater than 9V and less than 10V bottom 2 LEDs glow.
- In order to see the battery status, jumper has to be inserted into the two header pins provided at te right of the bargraph LED.

5.Buzzer interface



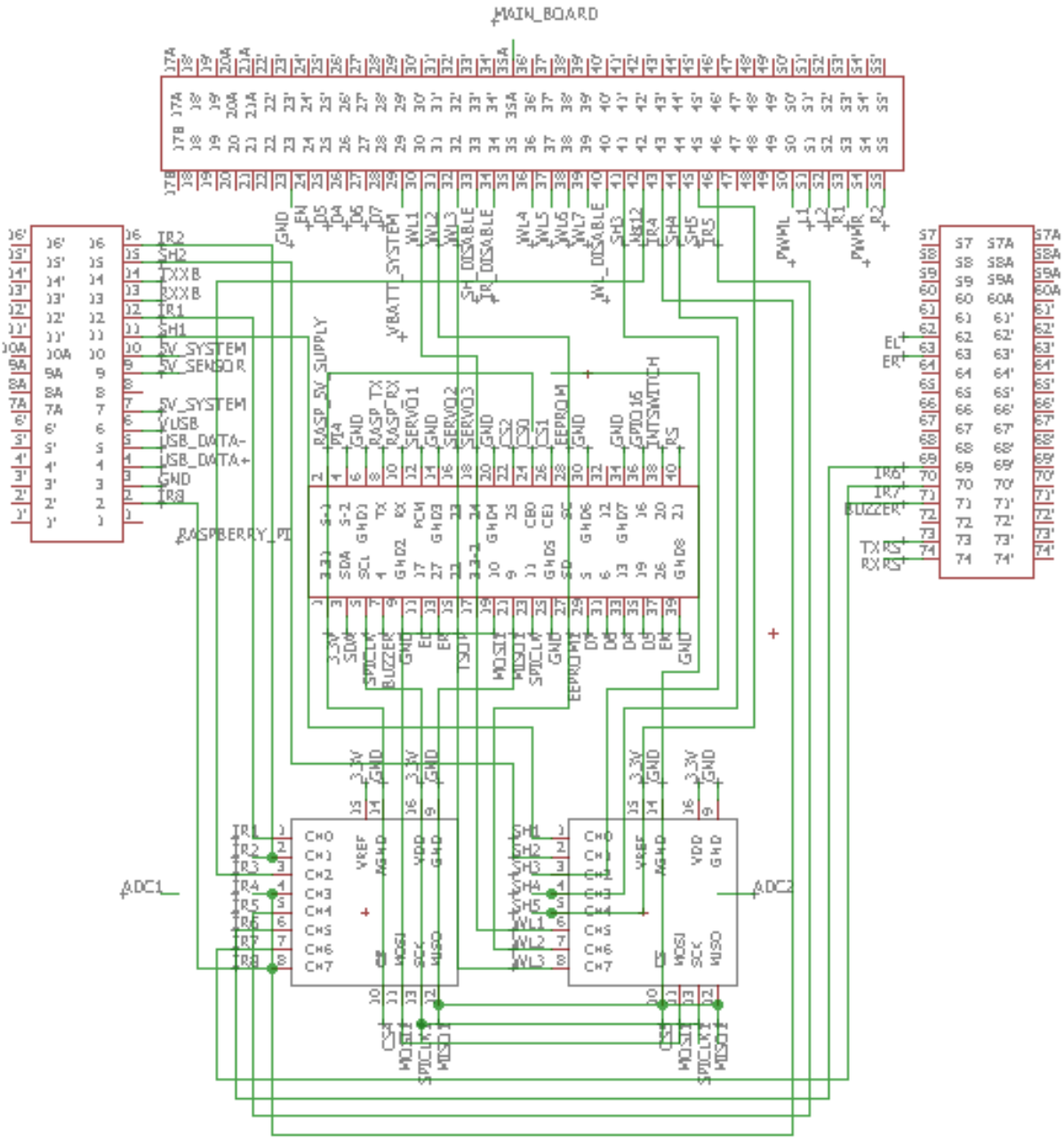
- Input for buzzer is available at pin 71 of main board.
- This input is given to GPA6 of port expander 1.
- In order to program it, this pin should be used.

6.LCD interface



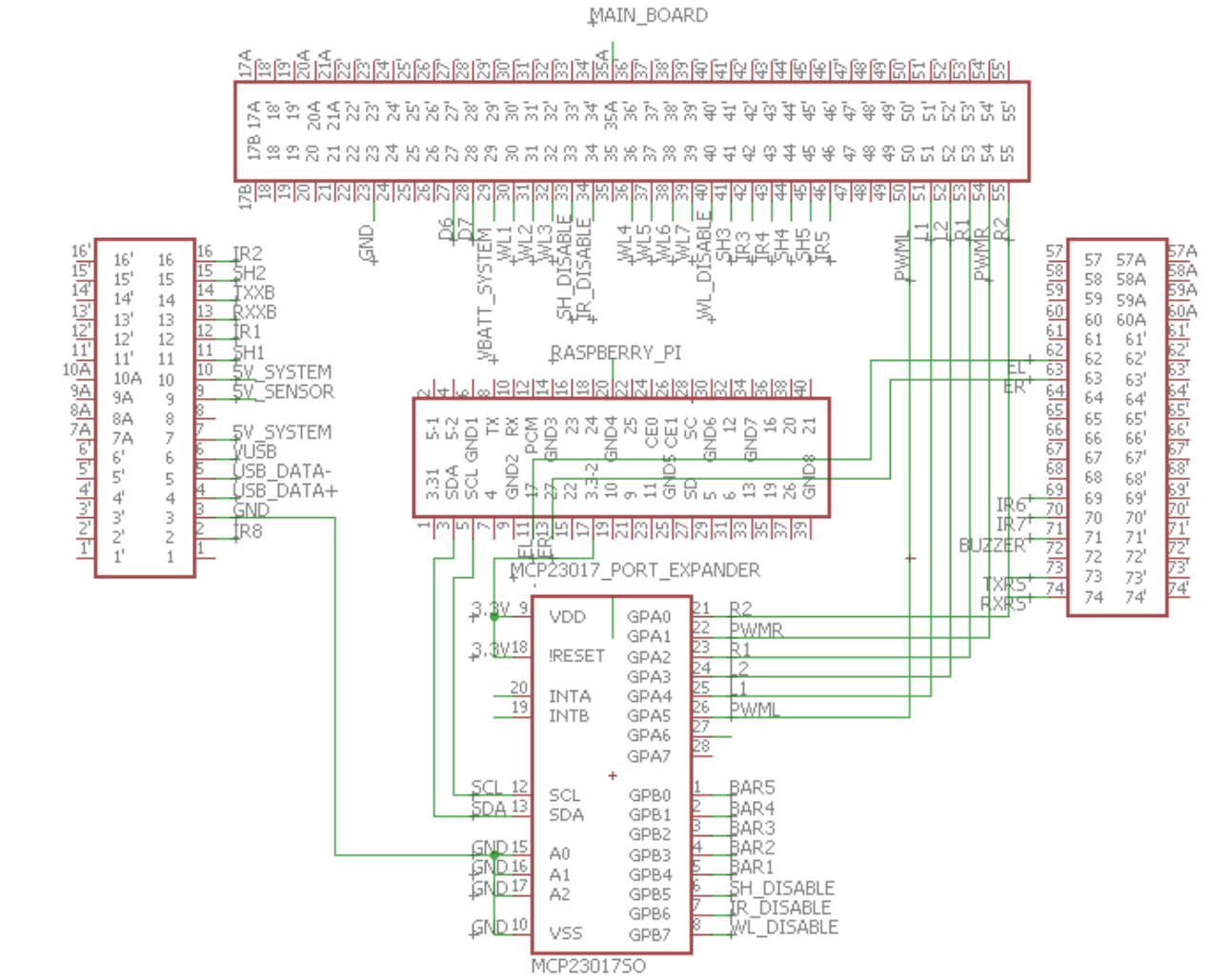
- LCD pins RS, EN, DB5, DB4, DB6 and DB7 are available on pins 22, 24, 25, 26, 27 and 28 resp. on the mainboard.
- These are give to pins 26, GND, 19, 13, 6, 5 and 21 gpio pins of raspberry pi resp.
- In order to program the LCD, these pins should be used.

7.Sensors and ADC interface



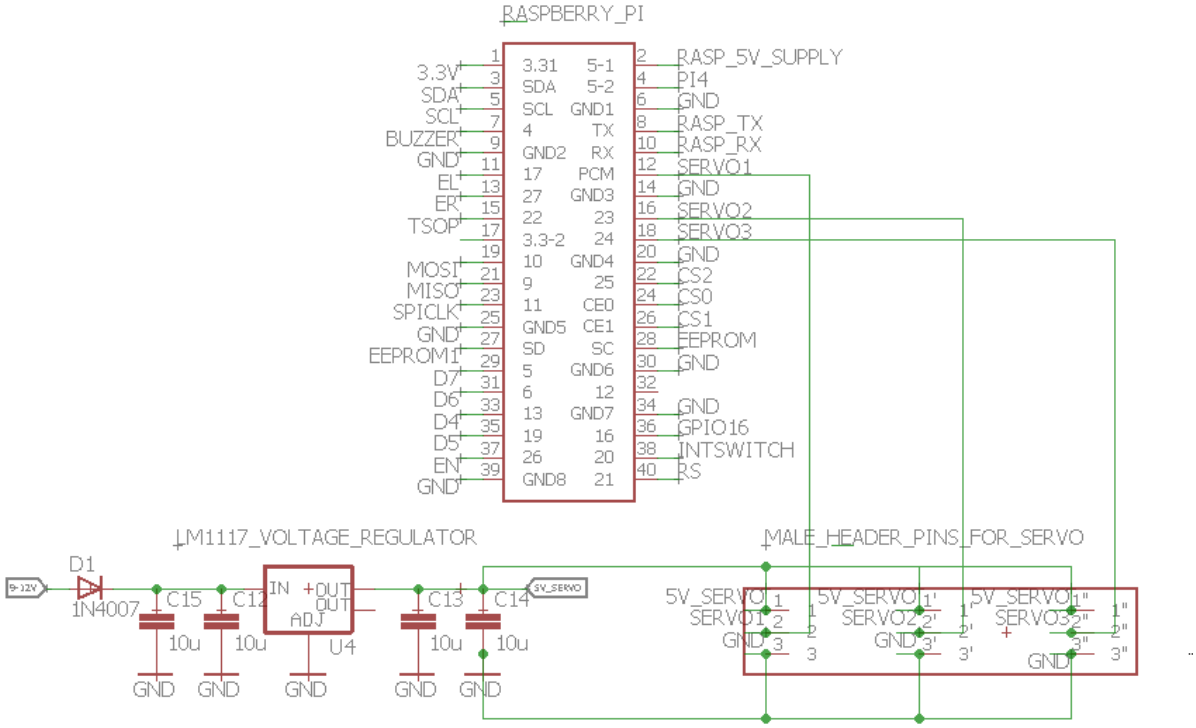
- Sensors values are read by raspberry pi via external ADC. Raspberry pi communicates to ADC MCP3008 with SPI communication protocol.
- The communication between raspberry pi and MCP3008 happens with 3 lines, which are MISO, MOSI and SCLK. The appropriate device is chosen by its chip select pin which is unique for every device.
- All the 8 IR proximity sensors are connected to ADC1, White line sensors and sharp IR sensors are given to ADC2.

8.Motors and wheel encoders interface



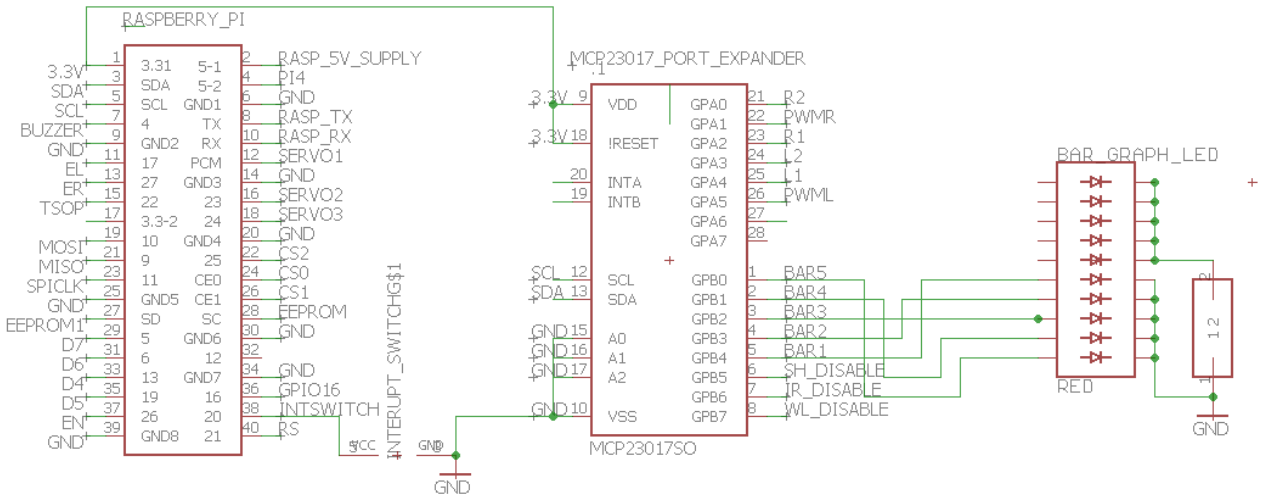
- Left motor control pins(L1,L2), Right motor control pins(R1,R2)and PWM motor control pins(PWMl, PWMR) are available on pins 51, 52, 53, 55, 50 and 54 pins of main board resp.
- The above mentioned pins are connected to MCP23017 Port expander with I2C communication.This would facilitate the usage of more GPIO pins since raspberry pi does'nt have many.
- Data and clk signals flow through SDA and SCL lines resp between Raspberry pi and MCP23017 port expander.
- The address of this Port expander as shown in fig. is 000 and that of 2nd is 001 which is specified by voltage levels at A0, A1, A2 pins resp.
- R2, PWMR, R1, L2, L1 and PWML pins are available on GPA0, GPA1, GPA2, GPA3, GPA4, GPA5 and GPA6 resp. of the Port expander.
- The Left and Right wheel encoders are connected to the GPIO 17 and 27 pins of raspberry pi.

9.Powering servo motors and Servo pod connections



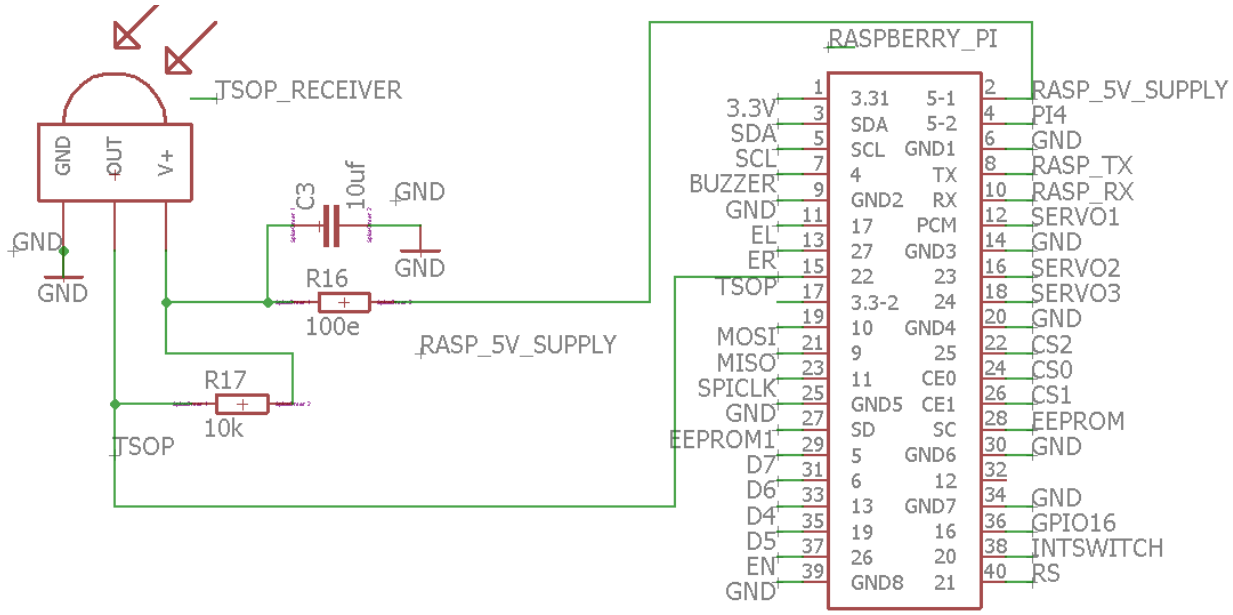
- Servo motors need 5V and more than 500mA current to run efficiently. In order to meet these requirements, the +ve of servo motors is given to the output of LM1117 Voltage regulator IC. The input to which is given by 9-12V (pin 29) from main board.
- A set of 9 male header pins are given on the Adaptor board for interfacing upto 3 servo motors.
- Three of which are for Vcc (5V), three for ground and three for controlling th motion of servo motors 1,2 and 3 resp.
- The servo motor control pins are given to GPIO 5, 23 and 24 pins of raspberry pi resp.

10.Interrupt switch and controlling bargraph leds



- Sudden power cut to raspberry pi may lead to spoiling of the Raspbian OS. Hence, whenever the interrupt switch is pressed on the adaptor board, a python script could be written such that the raspberry pi shuts down systematically.
- The bottom 5 LEDs of bargraph LED can be controlled by the GPB0, GPB1, GPB2, GPB3 and GPB4 pins of MCP23017 port Expander.

11.TSOP1738 RC5 IR receiver and decoder



- The Firebird V robot can run according to the commands of TV remote, by decoding the IR signals which it receives from the TSOP receiver.
- It has Vcc(3.3V), ground and the output pin, which is connected to GPIO 22 pin rsapberry pi.
- By decoding the data obtained from the IR signals of TV remote, the robot could run accordingly.