Electronics Department

MAINBOARD

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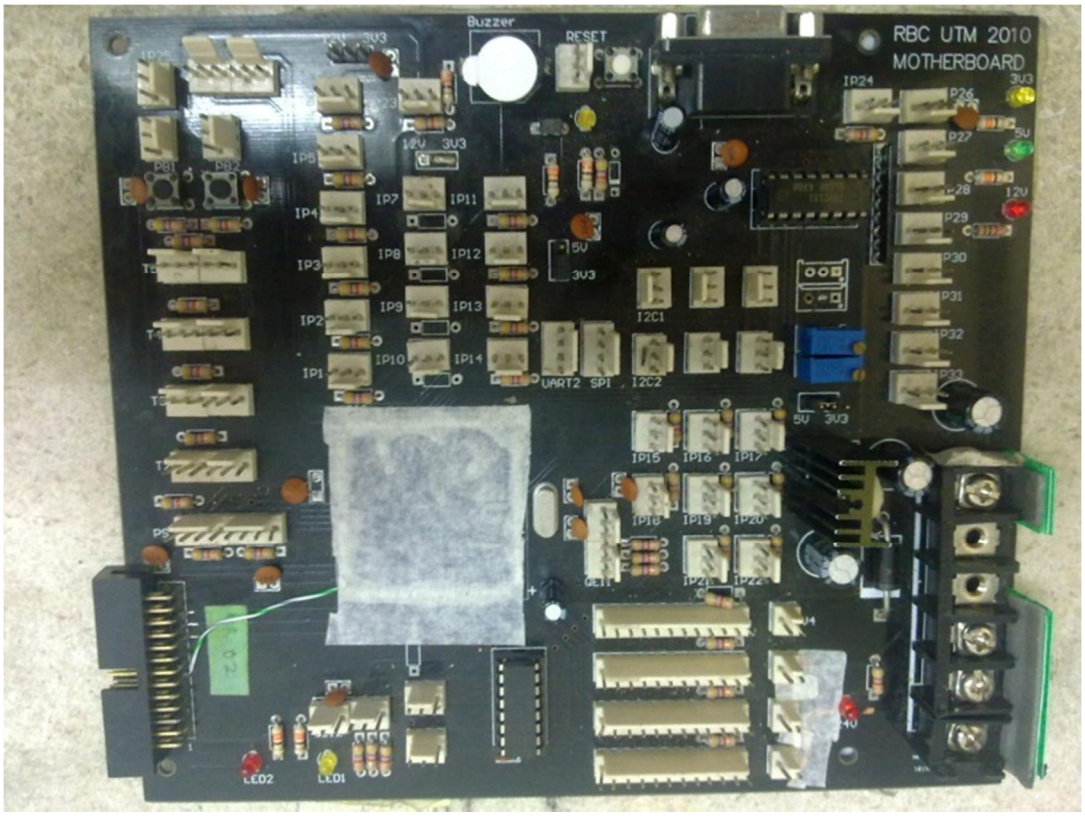
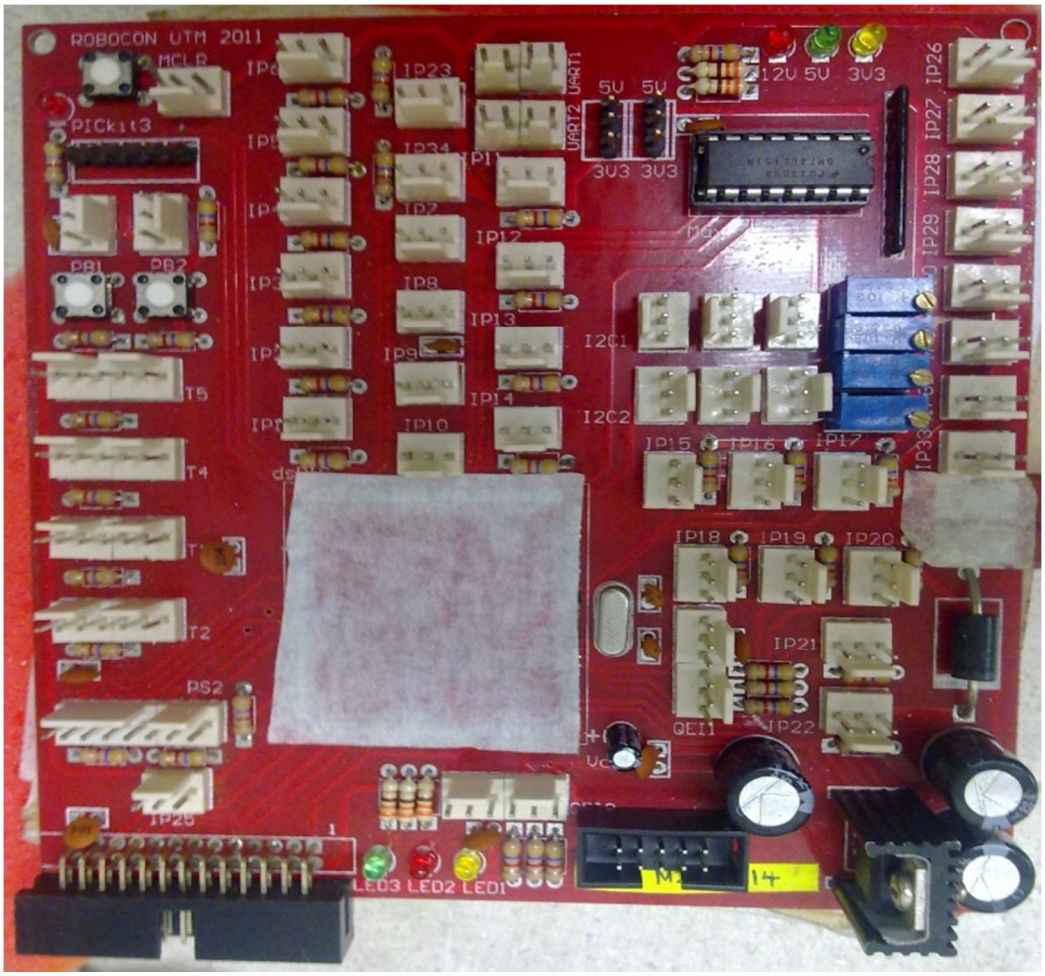
1.0 INTRODUCTION AND OVERVIEW

There are mainboard version 1.0 (black) and version 2.0 (red) in UTM ROBOCON. Mainboard, the server, is the most crucial board in a robot. It act as the body to connect with the hands and legs. It makes the wiring a lot more easier and advance. The mainboard provide the connectors for power, motors, switches and sensors. It also have a PICKIT3 and UART connector for connecting to a computer for programming. Also, for interface basically I2C is being used and for now the programmer still on the way developing the SPI and CAN which is better than I2C.



V1.0



V2.0

WHY WE GOT TWO VERSION OF MAINBOARD?

The mainboard was first born in the black(version 1.0) color and then was further upgrade and faced some changes until the next red(version 2.0) color mainboard came out. There were a few differences in between the black and red mainboard. Both have its own advantages and disadvantages.

The black board was bigger in size if compared to the red board. So, after take up a few consideration include the placement and everything, the red board came out with the vexta was extend through bus cable by IDC connecter and a vexta converter is needed before it is to connect to the driver.

Also, the shift register that control the vexta also removed from the black board. Other than that, there's no more SPI and CAN in the red board as we did not used it for program the robots. But for now UTM ROBOCON are on the way to develop on SPI and CAN. So, the programmer can only use back the black board to test on it.

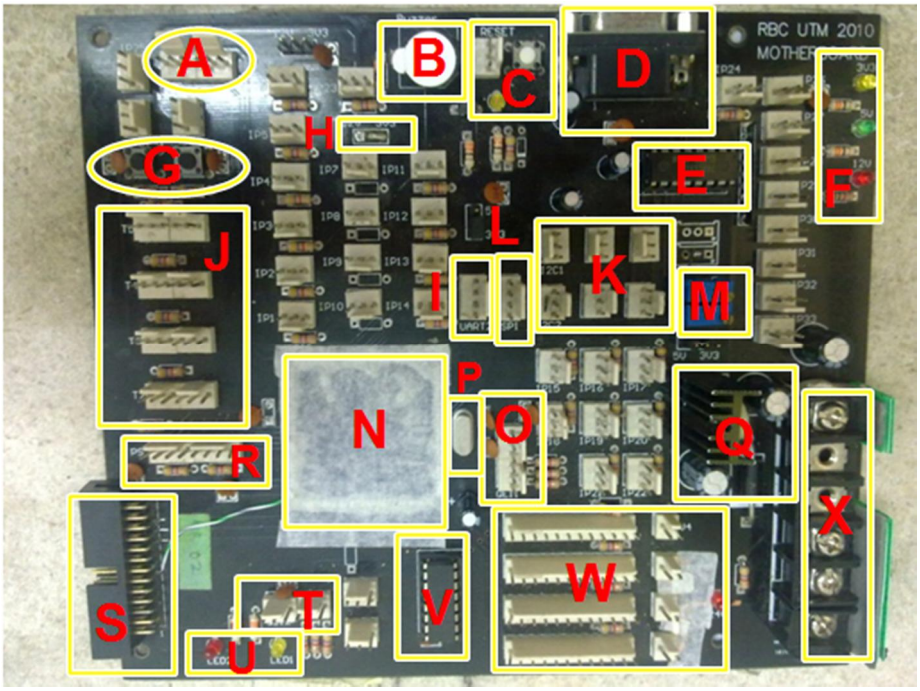
3.3V USE IN UART

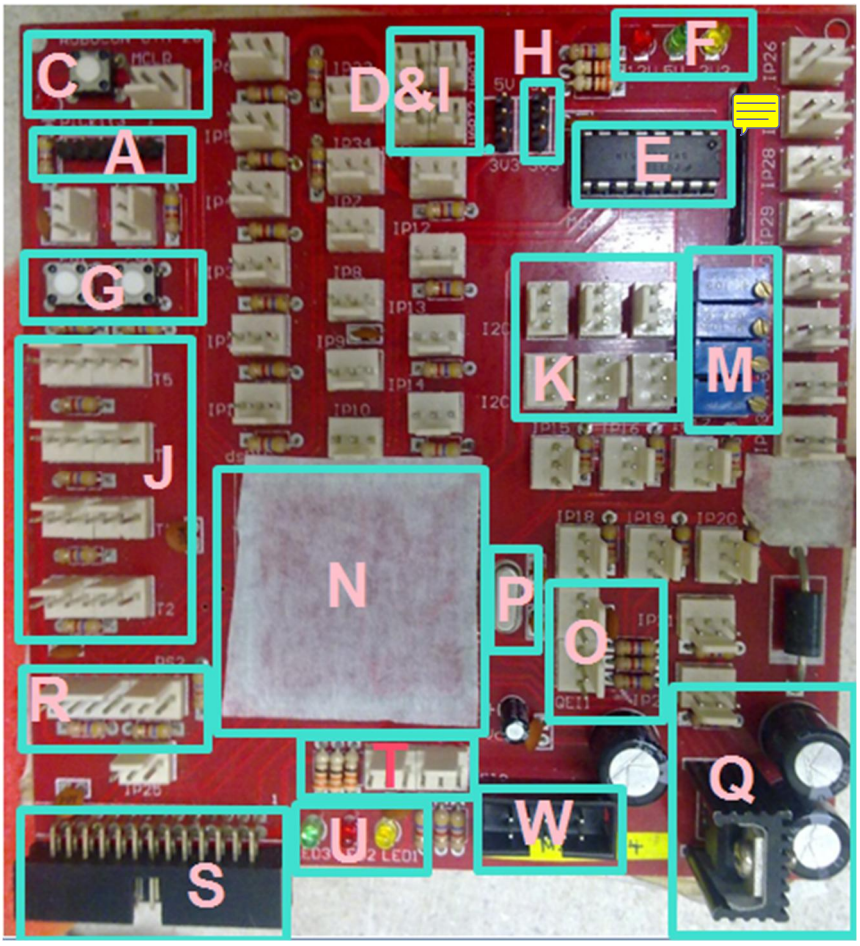
Moreover, the selectable voltage only left between 5v and 3.3v (basically we did not use 3.3v) where UART will use up 5v and same goes to I2C. The others I/O pins are standardize to 12v.

To ease in testing program, one more programmable LED was added in the red board. Since the vexta was removed from the board, the power supply to the board only need 12v which was connected with only one dean connector.

The buzzer also being taken out because it only a distraction to the board and programmer rarely use the buzzer for program purpose.

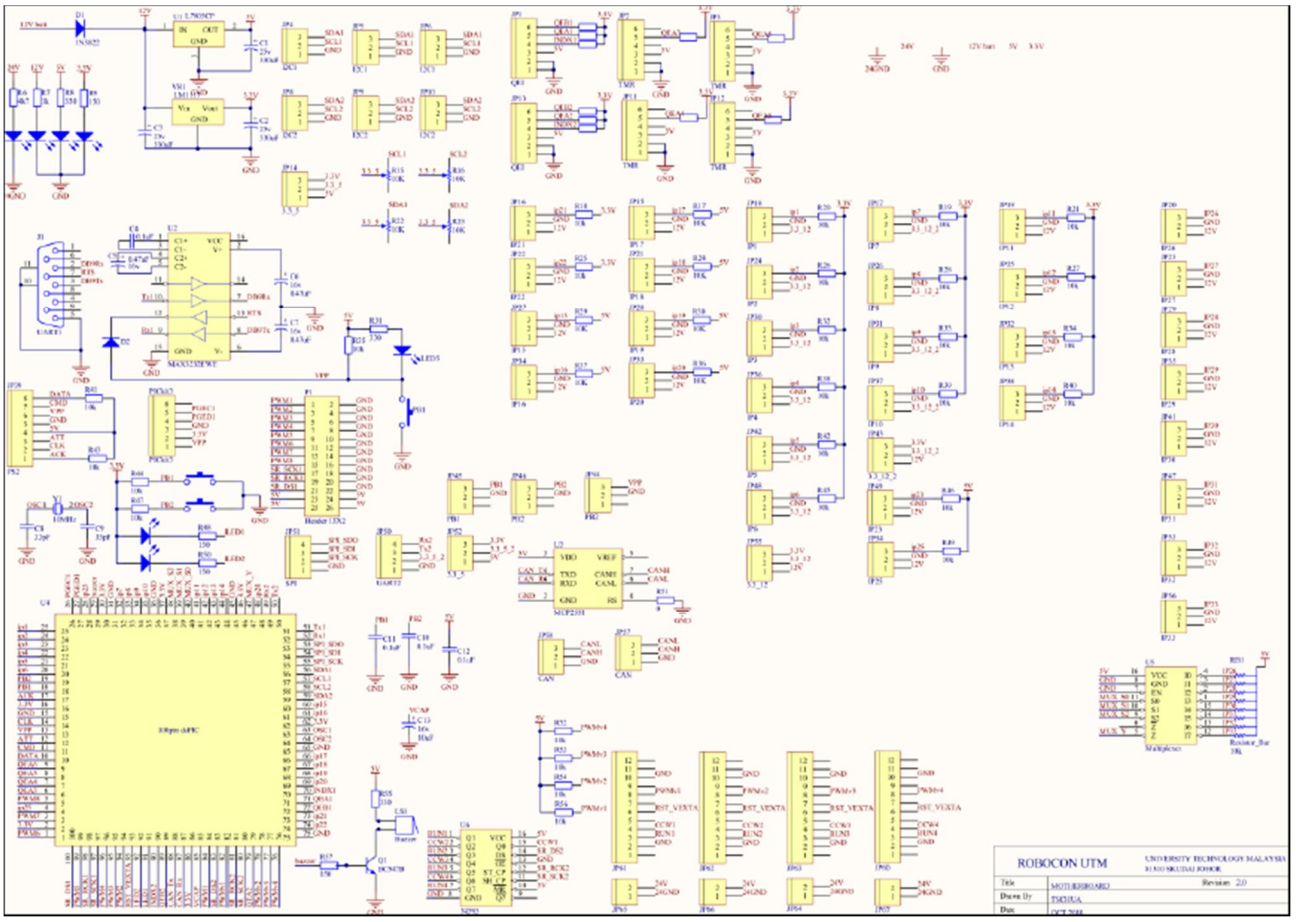
2.0 Board Layout



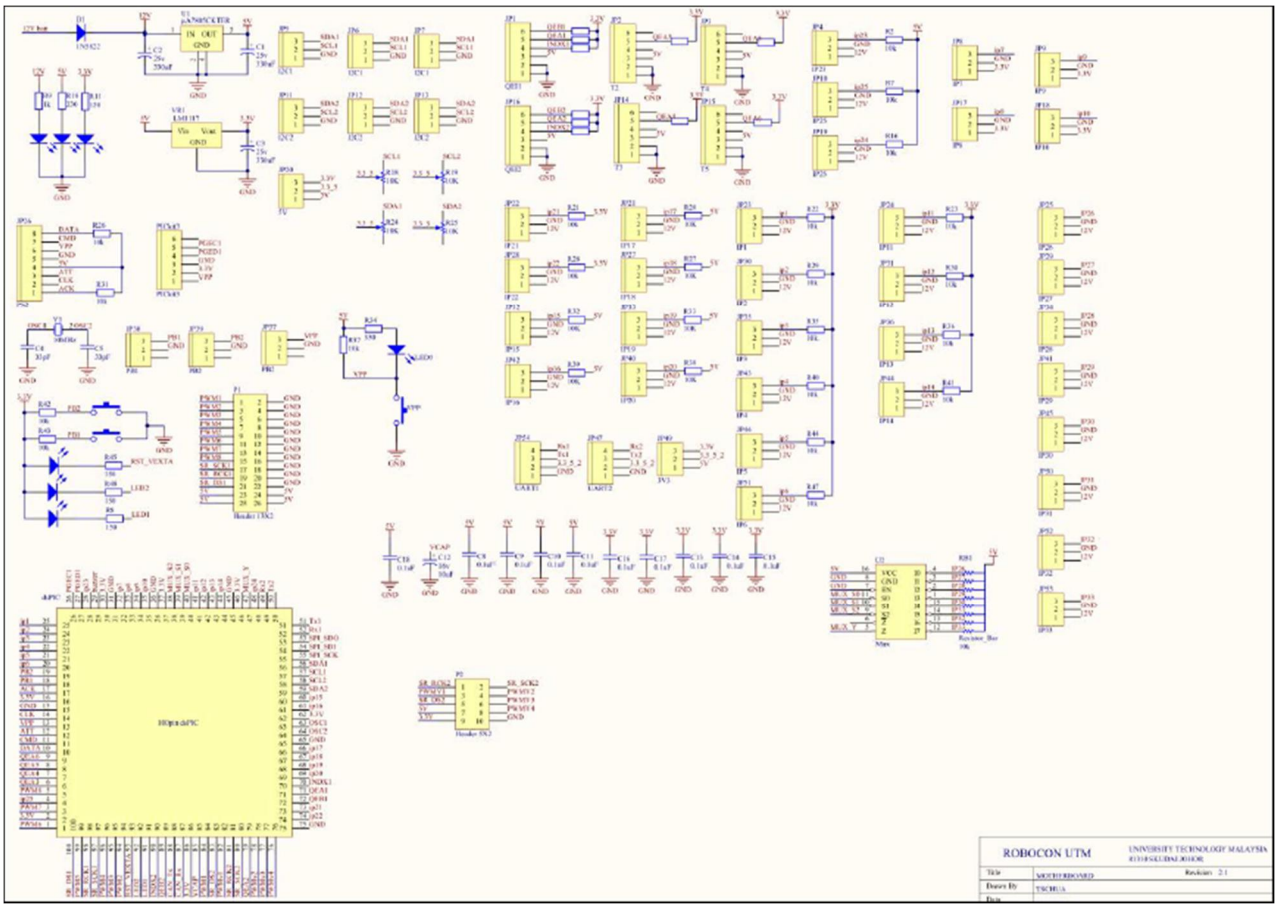


A	PICKIT3
B	Buzzer
C	RESET
D & I	UART1 & UART2
E	Multiplexer 74HC151
F	LED (indicator for voltage supply)
G & U	Programmable (Push Button & LED)
M	Multiturn(variable resistor)
H	Selectable voltage
J	TIMER
K	I2C1 & I2C2
L	SPI
Q	Voltage Regulator
O & T	QEI1 & QEI2
P	Oscillator (crystal)
N	dsPIC33FJ64G610 (100 Pin)
R	PS2 controller
S	IDC
V	~~MUX 74HC151~~
W	VEXTA
X	Power Supply
Male 3 pin (left over)	I/O PIN

3.0Schematics



1.0



S2.0

4.0 Specification

The mainboard come out with the dimension of 17.8cmX15.5cm for the version 1.0(black) and version 2.0 (red) with the dimension of 12.2cmX12.7cm in UTM ROBOCON.

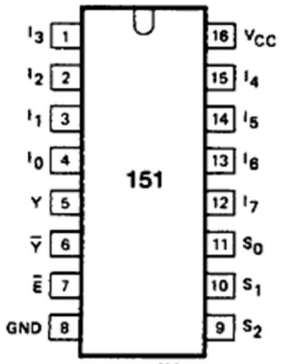
4.1 Operating Voltage

A voltage as high as 12v is needed to operate a mainboard. Then, the part in the mainboard can choose to whether used up to 12v, 5v or 3.3v. This can be done by put on the mini jumper at the selectable voltage.

4.2 Hardware

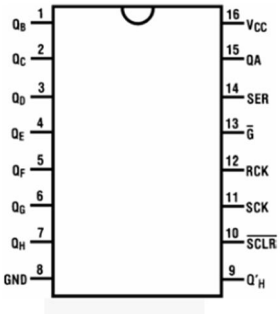
4.2.1 Inputs

4.2.1.1Multiplexer 74HC151 (MUX)



A multiplexer is a device that picks one of the analog or digital inputs signal and forward it onto single line. It makes possible for signals to share one device or resource.

4.2.1.2 Shift Register 74HC595



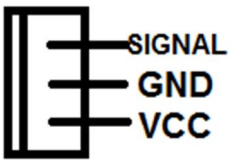
Shift register, like counters, are a form of sequential logic. It produces a discrete delay of a digital signal or waveform. “produce a discrete delay of a digital signal or waveform. A waveform synchronized to a *clock*, a repeating square wave, is delayed by "n" discrete clock times, where "n" is the number of shift register stages. Thus, a four stage shift register delays "data in" by four clocks to "data out". The stages in a shift register are *delay stages*, typically type"D" Flip-Flops or type "JK" Flip-flops.”

-possesses high noise immunity

-low power consumption

-8-bits serial in, parallel out shift register with storage

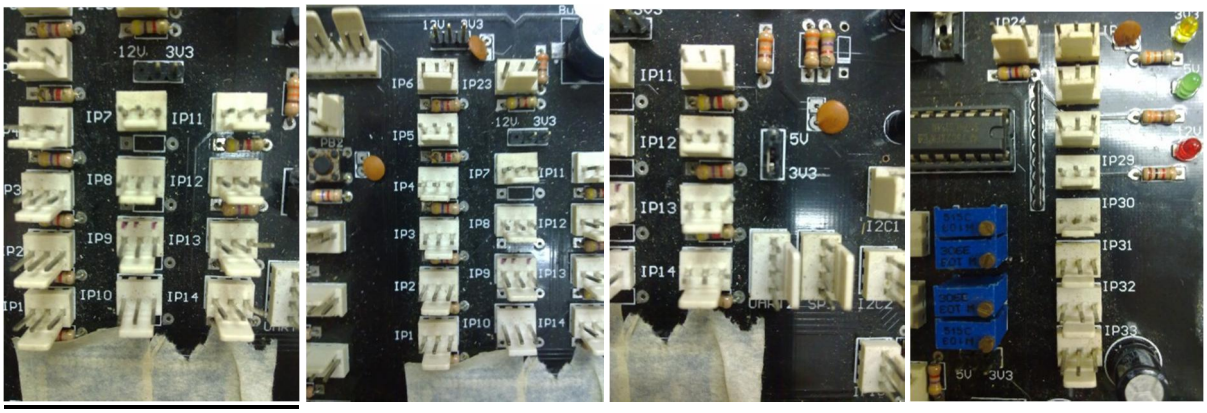
4.2.1.3 I/O pin (INPUT)



ROBOCON STANDARD

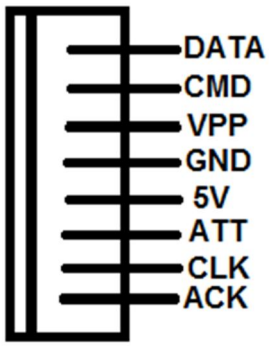
All the inputs pin are standardize into male 3 pins to make it easier to wiring. They are arranged mostly in a line and we can select the voltage to be either 3.3V, 5V or even 12V. Also, some parts of the I/O pins on the mainboard are connected to resistor or resistor bar. It is to make sure the voltage are always pull high and stable, specially for digital where the voltage is either 0v or 5v. So, if you did not want to pull high the voltage of the inputs, then you may choose those without the resistor such as the IP7, IP8, IP9 and IP10. Those without the resistor is specially for analog where the value of the voltage is floating from 0v-5v. As for the I/O pins, they are connected to limit switches (only connect the signal and ground), analog sensor and digital sensor.

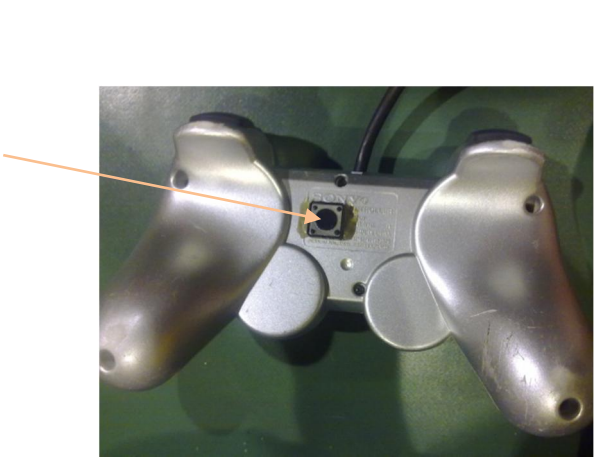
From the Figure below, you can choose the voltage that you prefer and suits with the connection needed. Others can be use randomly and the one that preferred by the programmer.



(A) (B) (C) (D)

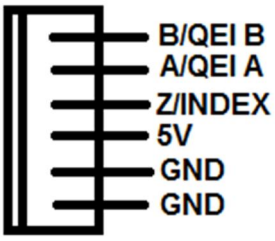
4.2.1.4 PS2 Controller



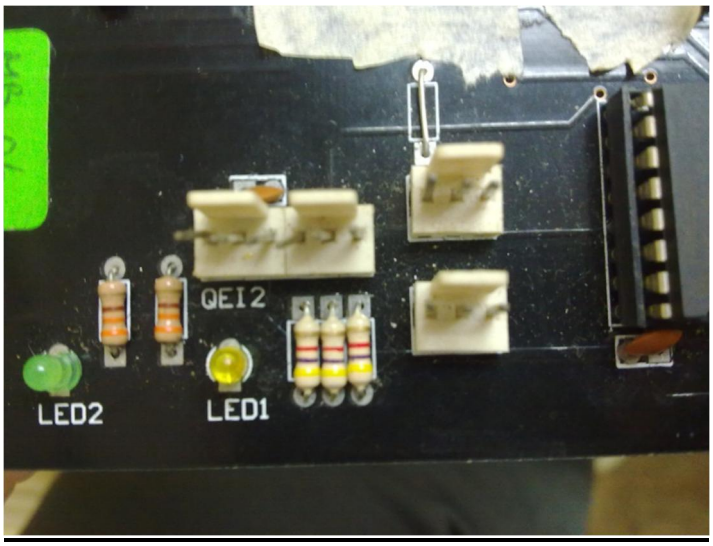


*modification: a reset button is added at the back (right side) of the PS2 controller.

4.2.1.5 QEI (Quadrature Encoder Interface)

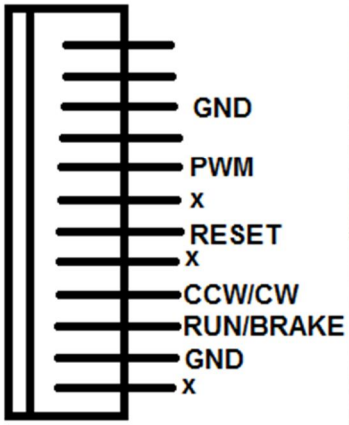


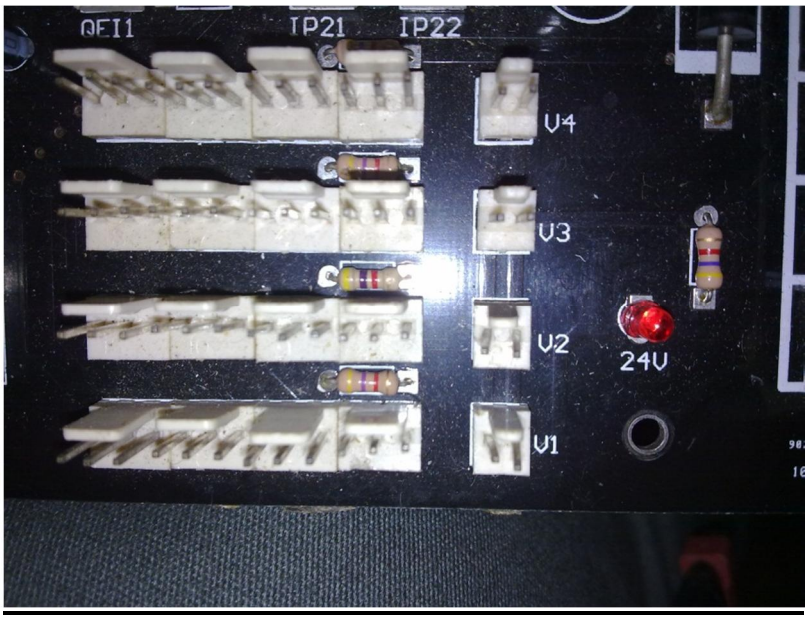
QEI (Quadrature Encoder Interface)- the encoder are to connect to this 6 pin. It provide the interface for obtaining mechanical position data. Quadrature Encoder are used for position and speed detection for a rotating system. The two channel, Phase A(QEI A) and phase B(QEI B), have a unique relationship. If phase A leads Phase B, then the direction of the motor is deemed positive or forward. If Phase A lags Phase B, then the direction of the motor deemed negative or reverse. In UTM ROBOCON, we do not use the INDEX pin.

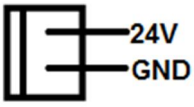


The picture shows the QEI2 on the black board which there are 3 resistors connect to the signal pin to pull up the voltage. *For your information, the two male 3-pin connector at the right side is the CAN.

4.2.1.6 VEXTA motor







To run a motor, power supply up to 24v is needed. The LED acts as an indicator to show there is 24v power supplied to the VEXTA.

GND-0v

RUN/BRAKE- stop immediately or naturally control. (when it was short to GND, if motor comes from ON to OFF condition, the motor will stop immediately. When it was opened to GND, if motor comes from ON to OFF condition, the motor will stop naturally.)

CCW/CW-when CCW short to GND, the motor will rotate in CW direction. When CW short to GND, the motor will rotate in CCW direction. It also does the ON/OFF control.

PWM-it can accept 0-5v to do the speed control.

*To increase the PWM speed, connect the v1 and v2 9th pin respectively to 5v and 3.3v.

4.2.2 Outputs

4.2.2.1 LEDs

(A) (B)

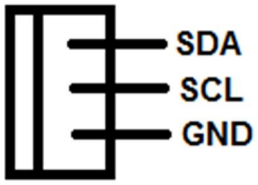
The Figure (A) and (B) shows that the LED act as the indicator for the mainboard. Figure(A) is to show that there is power supply up to 3.3v, 5v, and 12v. If one of the LEDs did not light up, it means there is something wrong with the mainboard. Do check for the connection. Besides that, the Figure (B) is programmable LEDs. This is to ease the programmer to test the mainboard and other circuits that is connected to the mainboard whether it can run the program or not.

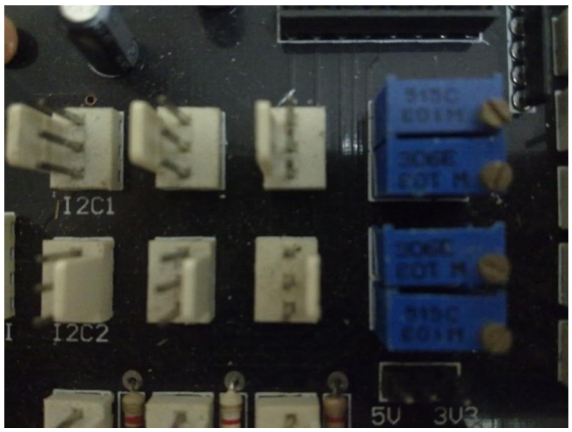
4.2.3 Communications

4.2.3.1 I2C

Three bus line are needed; ground (GND), serial data line(SDA) and serial clock line(SCL). Each device is recognize by an unique address and can be receiver or transmitter depends on the function of the device.

-Simple master and slave relationship exist all the time.





4.2.3.2 SPI (Serial Peripheral Interface)

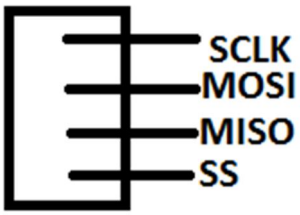
SPI is a single-master communication protocol.

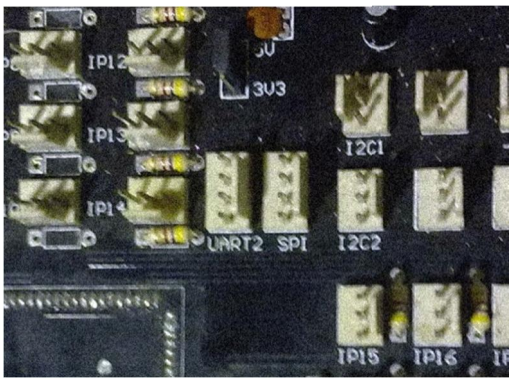
-A clock signal named SCLK, sent from the bus master to all slaves; all the SPI signals are synchronous to this clock signal;

-A slave select signal for each slave, SSn, used to select the slave the master communicates with;

-A data linen from the master to the slaves, named MOSI (Master Out – Slave In)

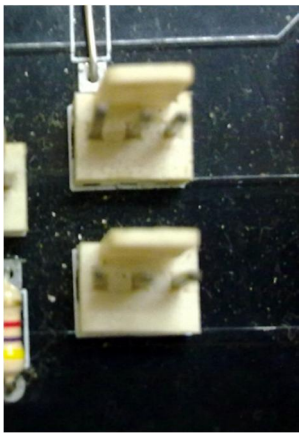
-A data line from the slaves to the master, named MISO (Master In-Slave Out)





4.2.3.3CAN (Controller Area Network)

CAN is a message-based protocol. CAN is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other without a host computer.



4.2.4 Programmer

4.2.4.1 PICKIT3

It is intended to provide enough information so the target board can be designed that compatible to the debugger for both emulation and programming operation. The basic theory in-circuit emulation and programming is described so that if problems encountered, are quickly resolved. PICKIT3 connected to the PC via USB. The system is capable of reloading the firmware via the USB interface.

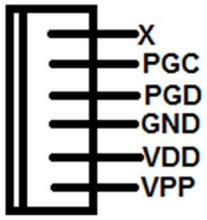
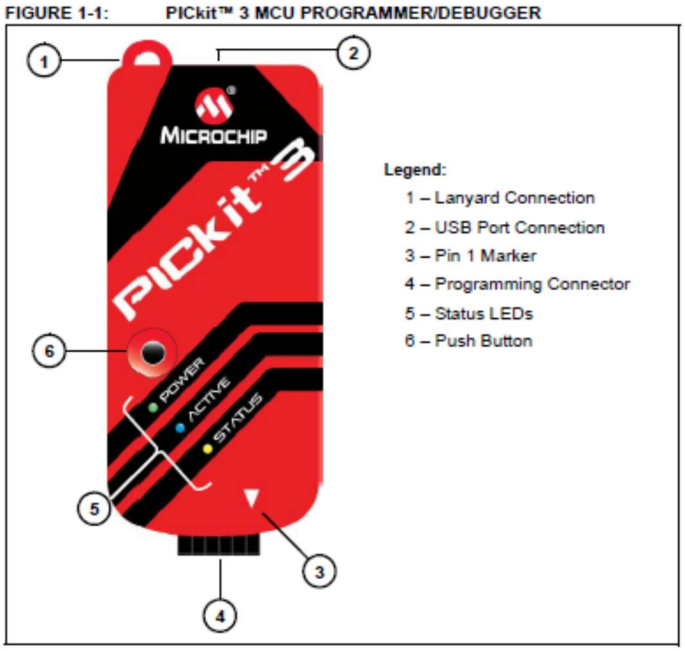


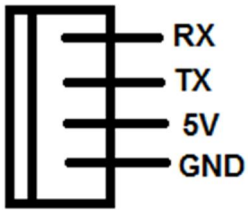
FIGURE 1-1: PICkit™ 3 MCU PROGRAMMER/DEBUGGER

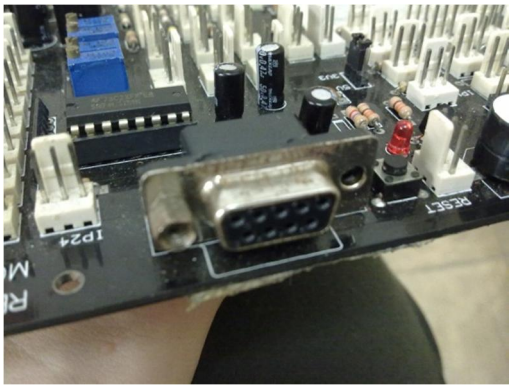


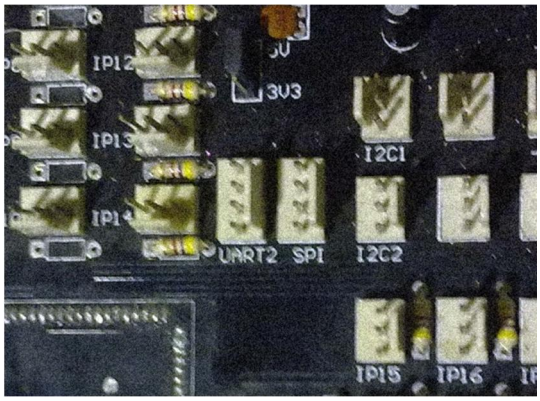
4.5 UART1 & UART2

(Universal Asynchronous Receiver/Transmitter)

-A UART is an individual integrated circuit that use for serial interface over a computer or peripheral devices serial port.







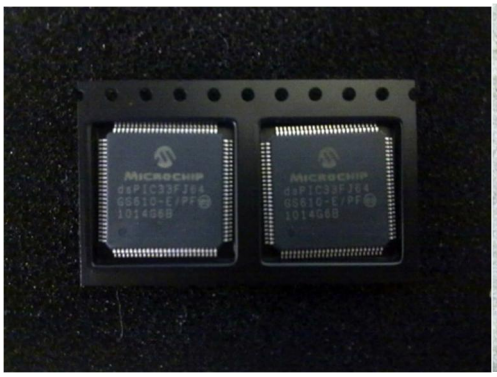
UART 1 UART2

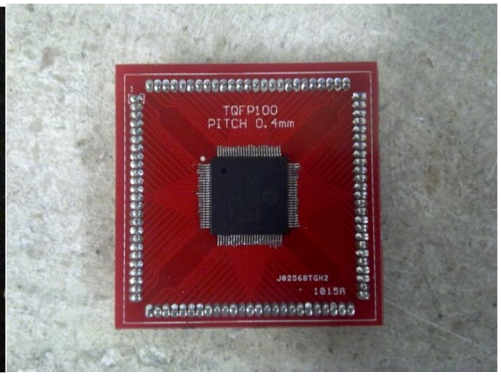
Figure above shows the UART1 and UART2 for the black board. For the UART1, it already has a built in boot loader and if you look under the board you can see the MAX232 connected to it. As for the RED board, the UART1 and UART2 are all standardize to the male 4-pin as in UART2 in the black board. In that case, we will need to always use external boot loader.

4.2.5 Microcontroller

4.2.5.1 dsPIC33FJ64GS610

WHY WE CHOOSE dsPIC33FJ64GS610?

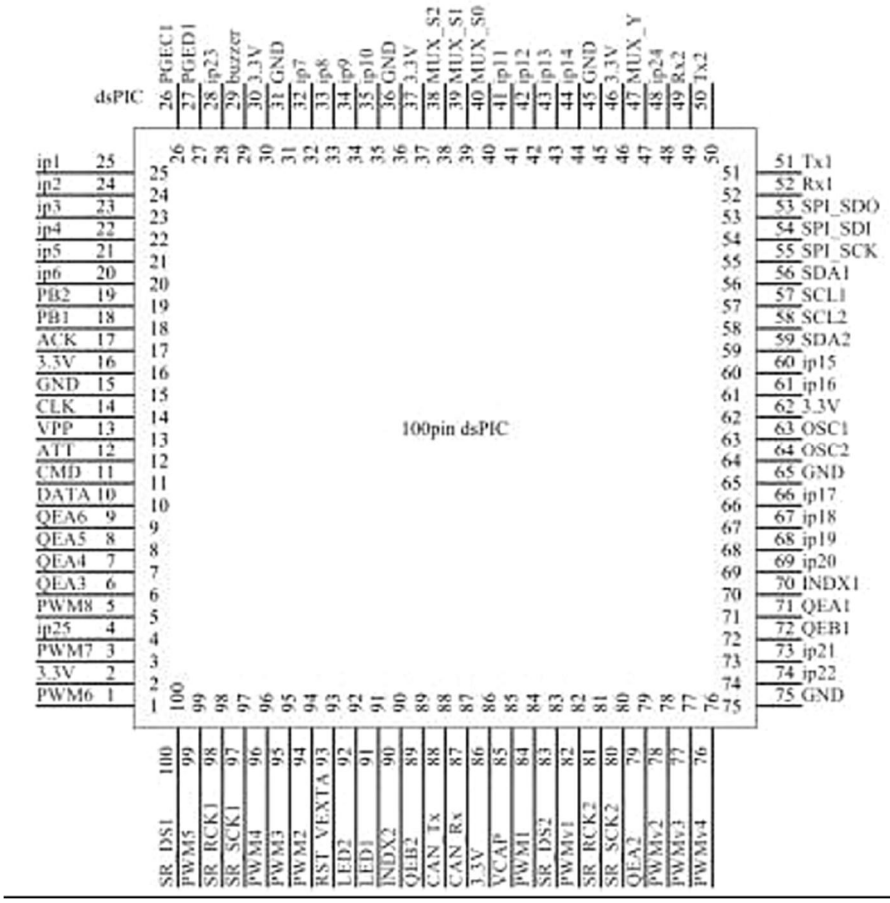




Parameter Name	Value
Architecture	16-bit
Pin count	100
Digital Communication Peripherals	2-UART, 2-SPI, 2I2C
Capture/compare/PWM peripherals	4/4
CAN (#,type)	1 ECAN
PWM Resolution bits	16
Motor Control PWM Channels	18
Quadrature Encoder Interface (QEI)	2
Timers	4x16 bit x 32-bit

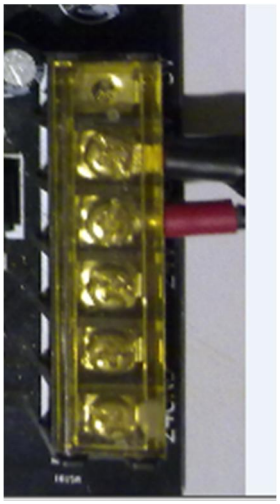
Advanced analog Features	-High speed ADC module: 10-bit resolution with up to two Successive Approximation Register(SAR) converters(up to 4 Msps) -Up to four High-Speed Comparators with direct connection to the PWM module:10-bit Digital to Analog Converter(DAC) for each comparator; DAC reference output

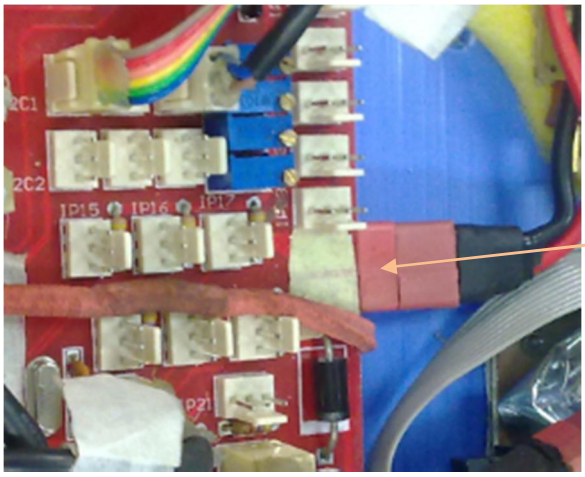
High-speed PWM	-Up to 9 PWM pairs with independent timing -PWM support for: DC/DC, AC/DC, inverters -flexible trigger configurations for ADC conversions
Timers/Output Compare/Input Capture	-QEI module configure as timer/counter -6 general purpose timer: five 16-bits and up to two 32-bit timers/counters -Four Output Compare(OC) modules act as timers/counters -Four Input Capture(IC) modules
Communication Interface	-2 UART modules(12.5Mbps):with support for LIN 2.0 protocols and IrDA -two 4-wire SPI modules (15Mbps) -two I2C modules (up tp 1 Mbaud) with SMBus support -PPS to allow function remap -Programmable Cyclic Redundancy Check (CRC)
Direct Memory Access (DMA)	-4-channel DMA with user-selectable priority arbitration -UART, SPI, ECAN, IC, OC and timers



4.2.6 Power Supply

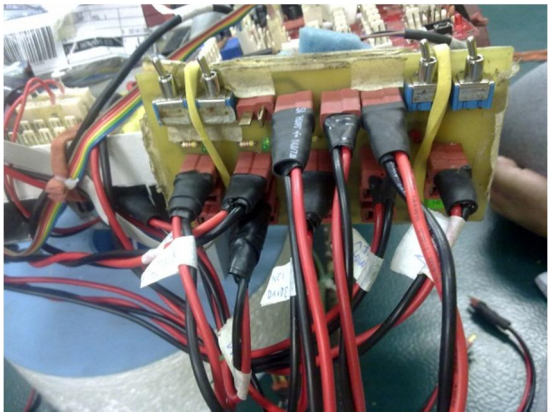
To use the mainboard, after connect all the circuits and I/O pins, power supply from Lithium Polymer (LiPo) or acid battery are connected through the power supply case for black board and direct male dean connector for red board.

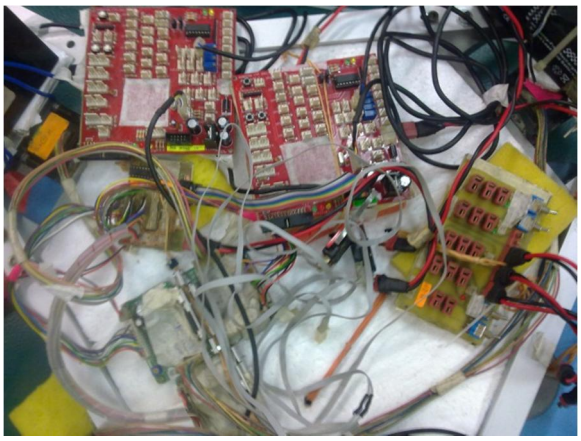




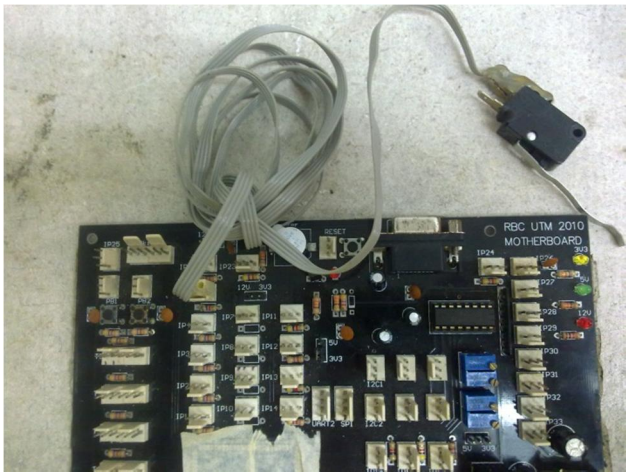
5.0 Installation

Batteries are connected to power distributor before extend and supply to the mainboard.

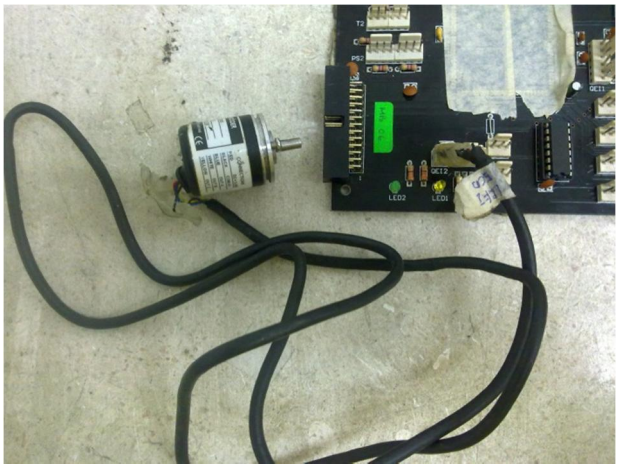




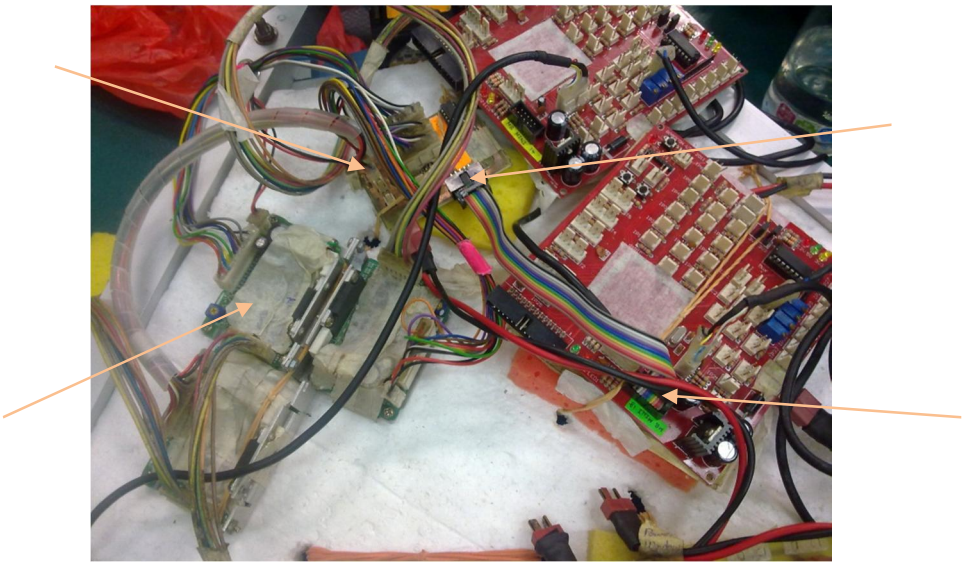
Limit switch connects to I/O pin.



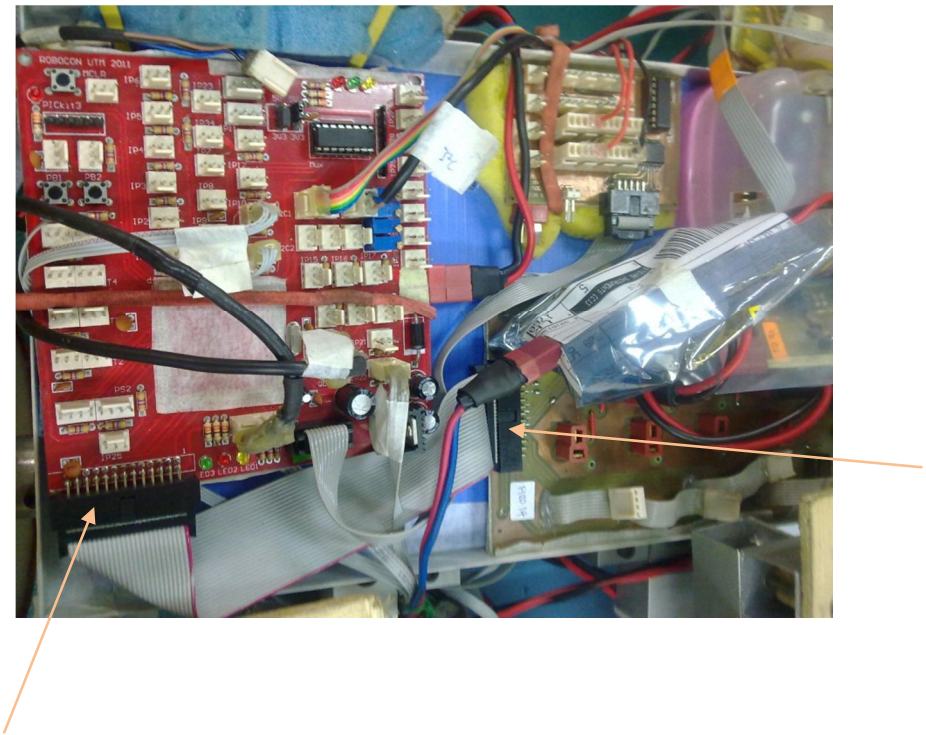
Encoders are to connect to the QEI.



For red board, the vexta extend out and a vexta converter is used before it is connected to the vexta driver and then to the motor.



BUS cable is used to connect the mainboard and H bridge.



6.0 Troubleshooting & Precaution

6.1 Troubleshoot

What did you do when u saw the LEDs indicators for power supply did not light up?

Immediately switch off the switch at power distributor or quickly unplug the dean connectors at mainboard.

Why do you need to do so?

It is because the mainboard may be short circuited.

How can you know the mainboard is short circuit?

The LEDs, indicator for power supply did not light up. If only 3.3v did not light up, there is high probability 3.3v short; 5v did not light up, probably 3.3v or 5v short; if all did not light up then somewhere short circuit.

What you can do to make sure the board is short circuit or not?

Take out the main PIC and check the pin. Then, you can use the multimeter and check for 3.3v,5v, 12v respectively with ground whether they are short circuit. Other than that, do check for the shift register and multiplexer. Lastly, check if there is track spoilt. If there is track break, fix it by soldering or you can use jumper to connect it back.

When I2C is not able to interface well, what should you put on priority?

First, check out with the programming before refer to the electronics. Second, if it's not the programming matter then you can check whether the mini jumper is connected to the 5v and tune the variable resistor (multiturn) up to 2K. Third, make sure the connector you used is in good condition.

UNSOLVED QUESTION

*I2C HANG

*IC RESET

6.2 Precaution

Every time after finish wiring the robot, please make sure there is no excess aluminium powder or debris on top of the mainboard.

Other than that, the wiring also needs to put in consideration to not let any connectors to hang on top of the mainboard and touch any of the pins.

This is to make sure the mainboard did not short circuit and spoilt the mainboard when there is power supplied.

Do check the RESET button on the mainboard whether capacitor is connected to it. If there is none, then you may face the problem where the mainboard will keep on auto reset and you cannot run your program. So, it is better to connect the capacitor to the reset button.

7.0 Reference

-http://picmania.garcia-cuervo.net/recursos/redpictutorials/microchip_-_dspic33f_ref_manual/section_15._quadrature_encoder_interface_-_dspic33f_frm_70208a.pdf

-http://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus

-http://www.microchip.com/wwwproducts/Devices.aspx?dDocName=en547034