PiZ-Moto

(Pronounced “Pie-Zee Moto”)

Assembly Instructions (1.5)

Produced for the Cotswold Raspberry Jam (@CotswoldJam)

Latest instructions available at:

www.astro-designs.com/downloads/piz-moto/instructions/PiZ-Moto_Instructions.pdf

Contents

In your kit, you should find:

1) PiZ-Moto PCB (x1)
2) 100 Ohm Resistors (x3)
3) 1.8k Ohm Resistors (x2)
4) 3.3k Ohm Resistors (x2)
5) BA50BCT (or similar) Low-dropout Linear Regulator (x1)
6) L293DNE Quad Half-Bridge Driver I.C. (x1)
7) I.C. Socket (x1)
8) 2-way Screw Terminal (x3)
9) 3mm single-colour LED (x1)
10) 20-way Pin Header (x1)
11) 22uF 16V Aluminium Electrolytic Capacitors (x2)
12) 40-way Socket (x1)

Introduction

Firstly, thank-you for choosing the PiZ-Moto. The PiZ-Moto kit is based around the L293DNE quad half-bridge driver which can be used to control up to two motors in both directions. The L293DNE was chosen because it's pretty much the only driver you can find like this that's not surface-mount making it ideal for a kit like this. We wanted to make this motor driver a little different from others, after all there are quite a few available so what makes this one different? Firstly, it includes a built-in power supply so that the power source used to power the motors can also be used to power the Raspberry Pi Zero. Secondly, it includes interfaces for a photo-reflecting sensor, a proximity sensor and a couple of LEDs. For the power supply we chose a low drop-out linear regulator because they are cheap, easily assembled from a kit like this and because they are low drop-out, it means that the motor supply voltage only needs to be 0.3V greater than the 5V supply needed by the Raspberry Pi. So a 4-cell AA battery pack which produces 6V, makes an ideal power source for this motor driver kit. With the motor driver, regulator, and the extra interfaces on the board, you can build a intelligent line-following, object avoiding robot using with just a single add-on board for the Raspberry Pi Zero.

Tools Required

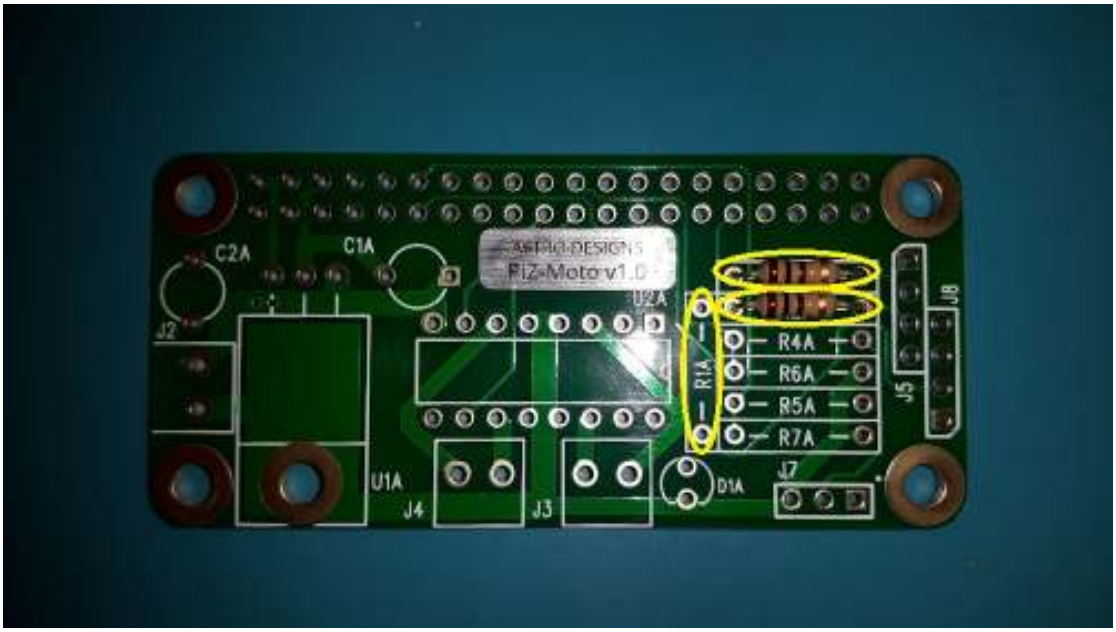
1) A reasonably decent soldering iron
2) Solder wire
3) A pair of snips
4) A pair of snipe-nosed Pliers

Assembly Instructions

Right, let's get stuck in…

1) It's always best to start with the smallest components so firstly we'll fit the resistors, then gradually move through the taller components. There are three different values of resistors used so let's fit these in turn.

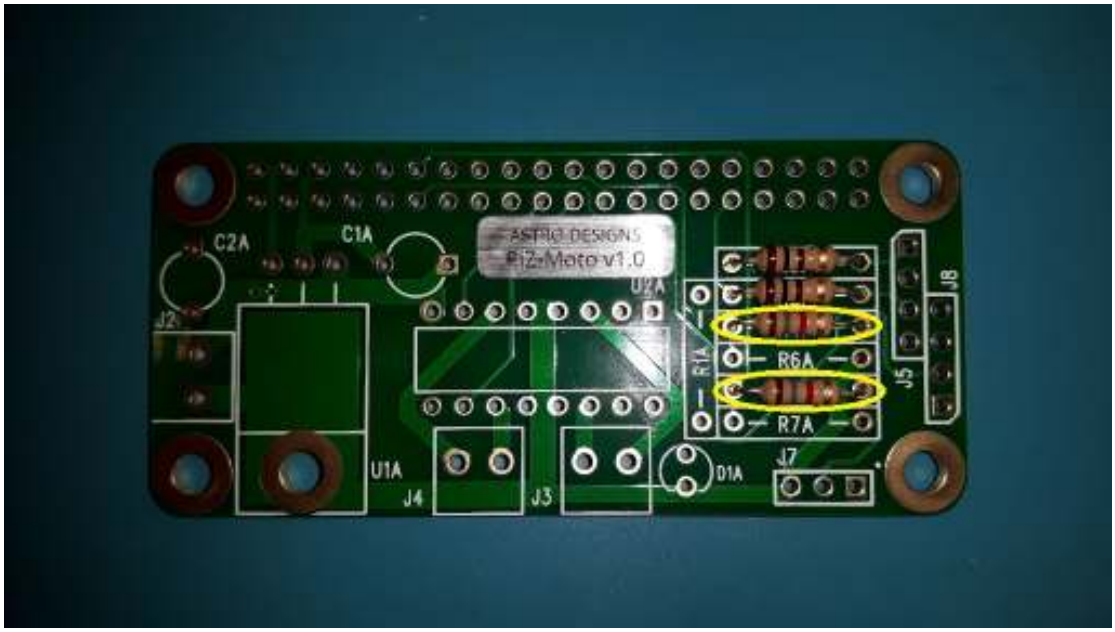
    a. Firstly, fit the three x 100 ohm resistors.
    These are colour-coded BROWN-BLACK-BROWN [GOLD]



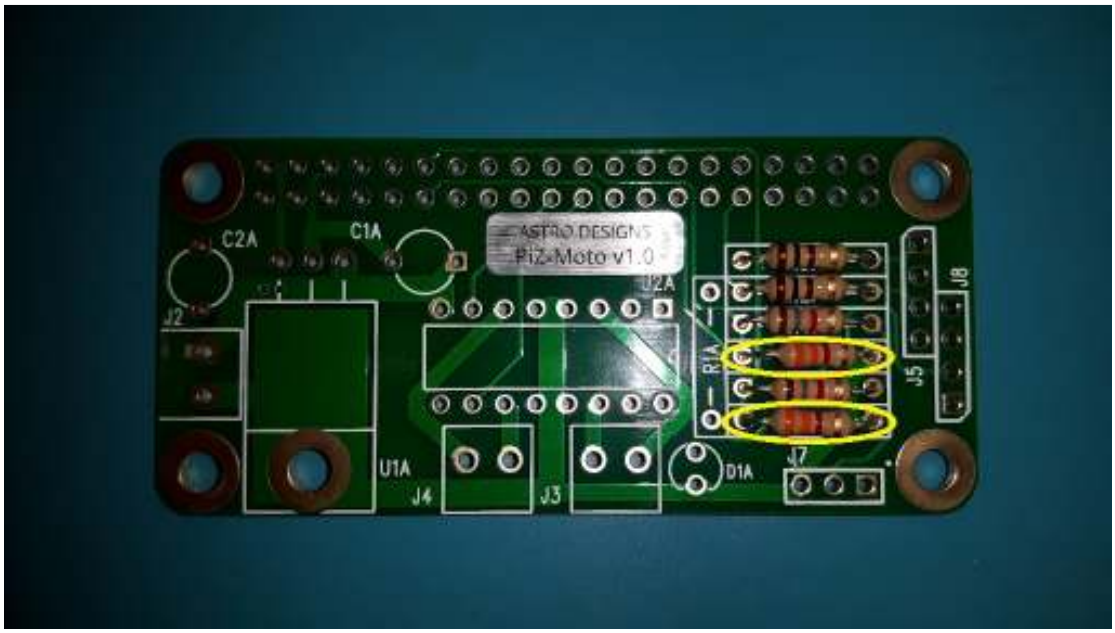
Note – Yes, I did actually forget to fit one of these before taking the picture. R1A must also be fitted (100 ohm) – if you don't fit it then the LED won't work.

Oh and just to make it look nice and neat, you might want to arrange the gold bands at the same end, or is that just me being finicky?

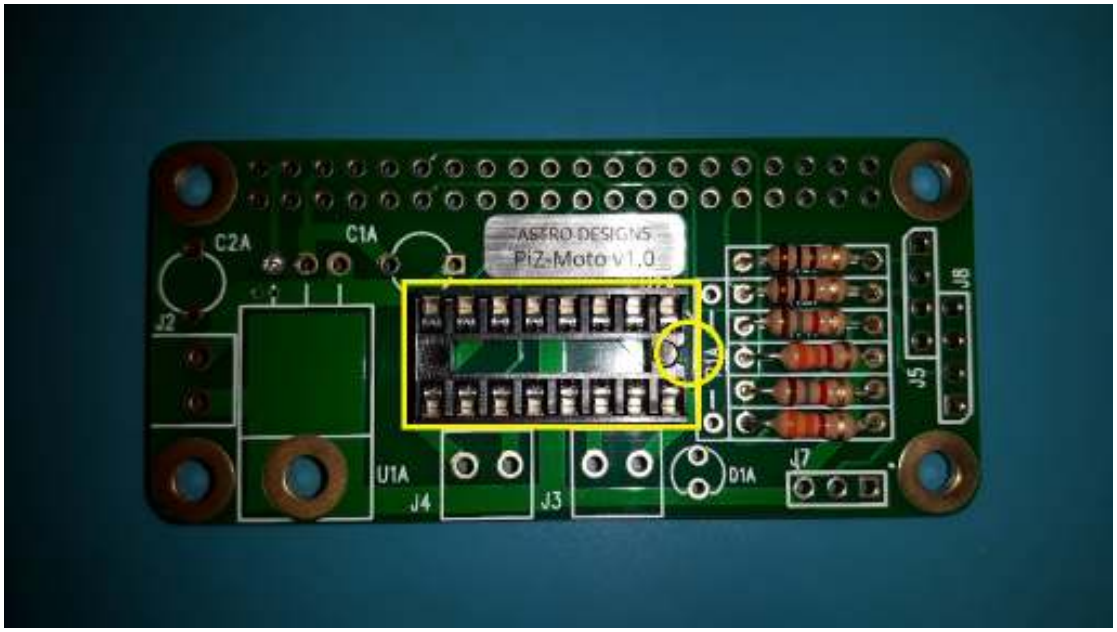
    b. Next, fit the two 1.8k ohm resistors.
    These are colour-coded BROWN-GREY-RED [GOLD]



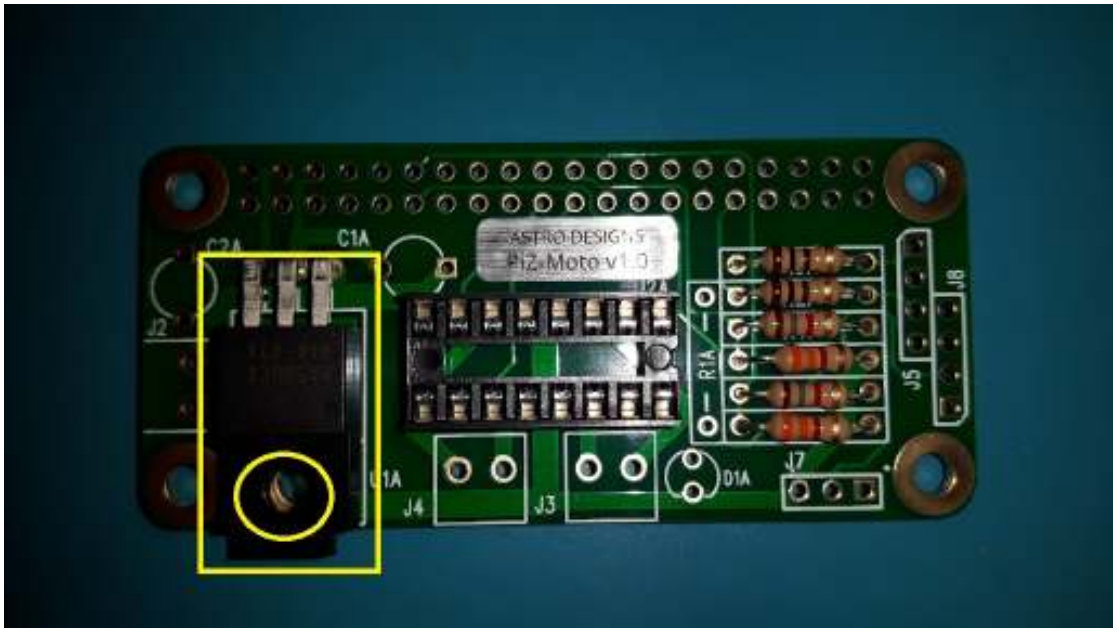
c. Next, fit the two 3.3k ohm resistors.
These are colour-coded ORANGE-ORANGE-RED [GOLD]



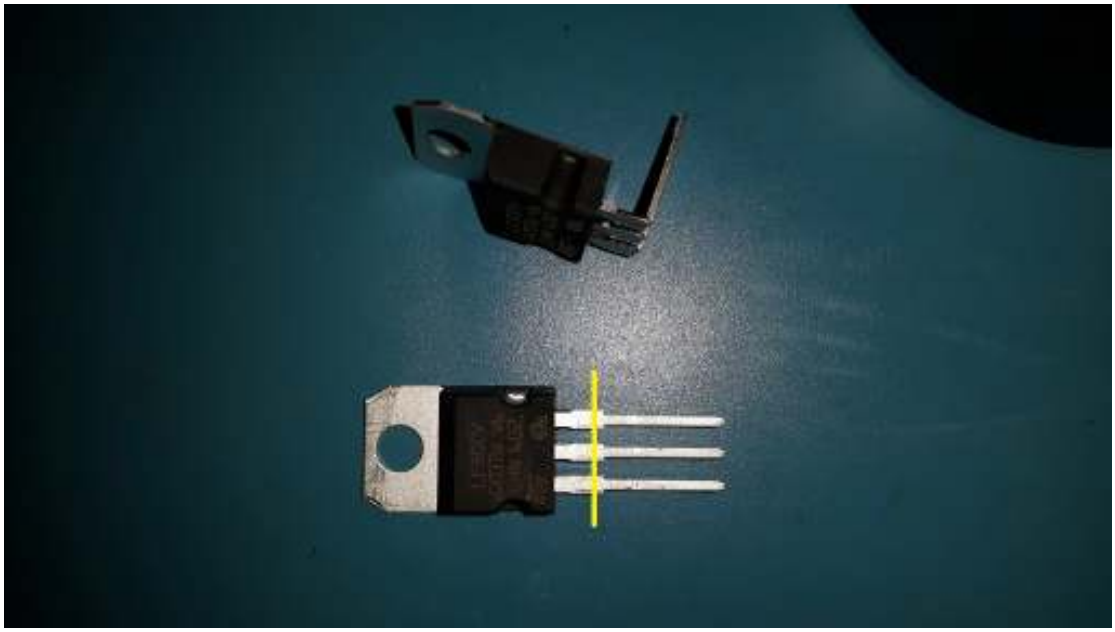
2) Next, fit the I.C. socket. Be sure to get the notch at the right end (see circle in yellow), while it makes no electrical difference it does help you to avoid plugging in the I.C. the wrong way around. Note: Don't plug the I.C. in just yet, we'll do that later.



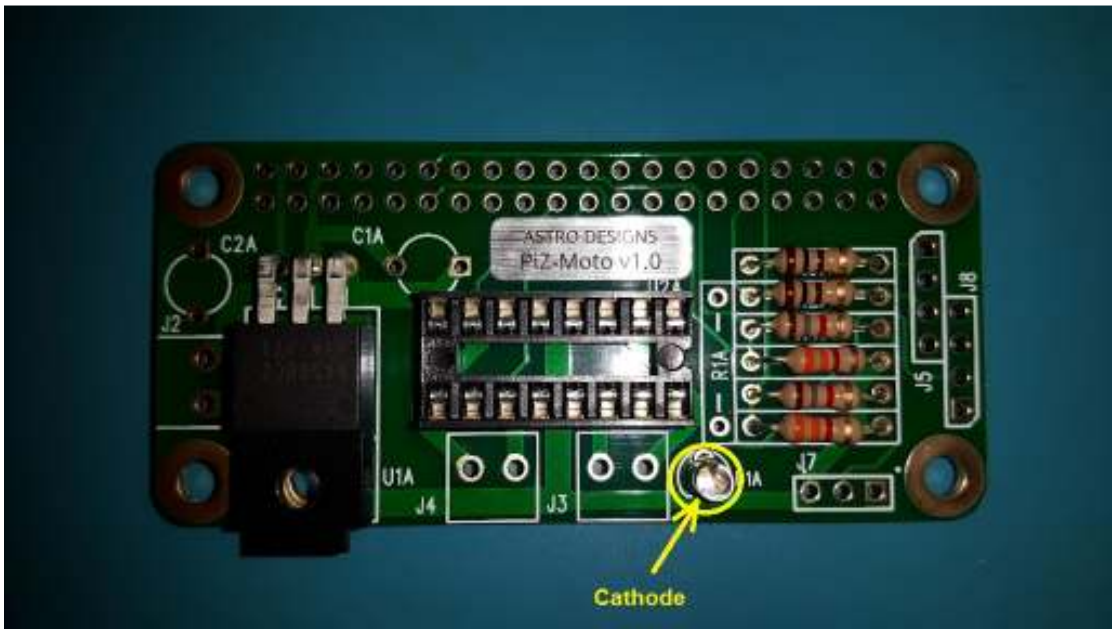
3) Next it's the turn of the linear regulator:



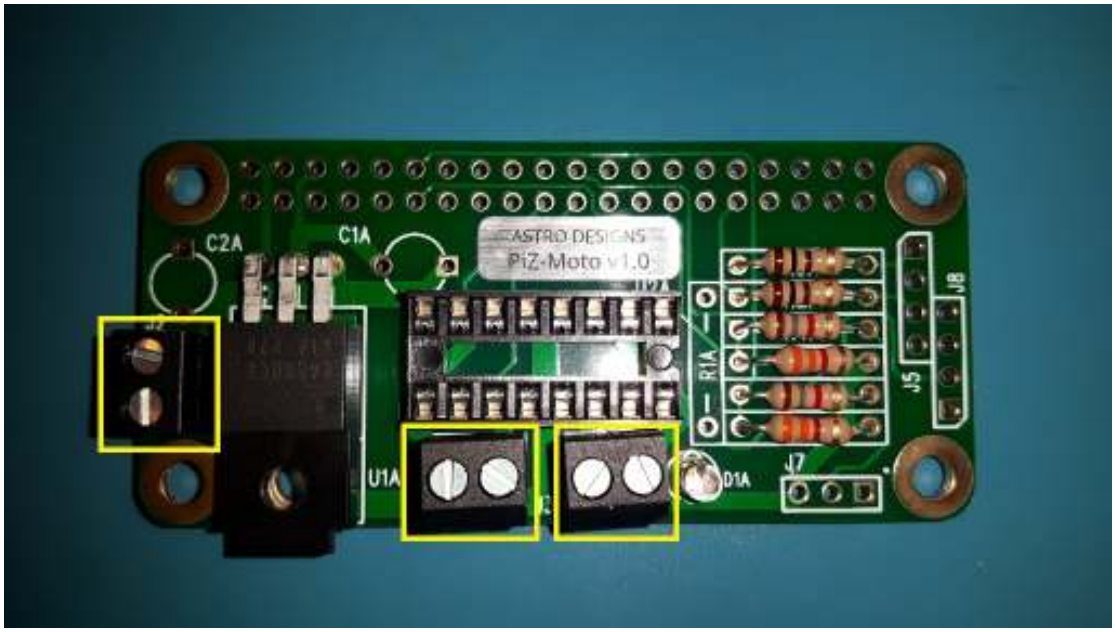
The linear regulator is supplied without the leads bent into position so these must be carefully bent. To get the mounting hole in the regulator to line up correctly, the leads must be bent just a fraction above the shoulder, where the leads get slightly wider (see picture below).



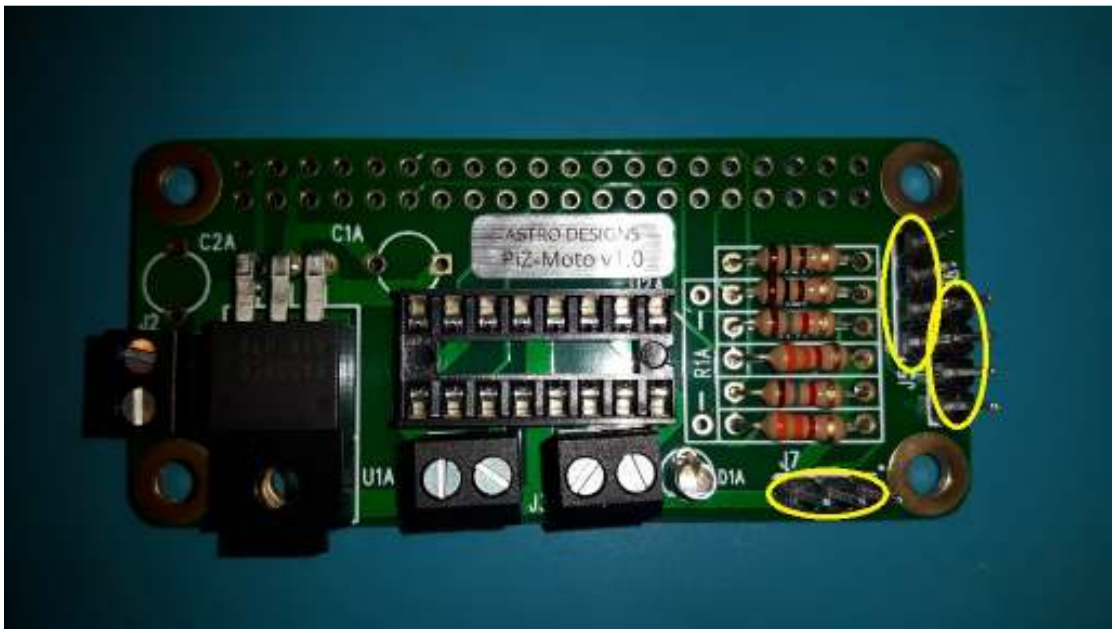
4) Fit the LED:
    a. Ensure that the LED is fitted the correct way around. The ‘cathode’ which is indicated by the shorter lead, must go at the bottom of the board. The circle outline for the LED has a flat section to mark the ‘cathode’, also marked with the yellow arrow in the picture below.



5) Next, fit the three 2-way screw-terminals:
    a. Try to keep them flat against the surface of the board as you solder them. It also helps when connecting the motor leads if the holes in the side for connecting the wires face outwards (yes, I did put one in the wrong way around once…);

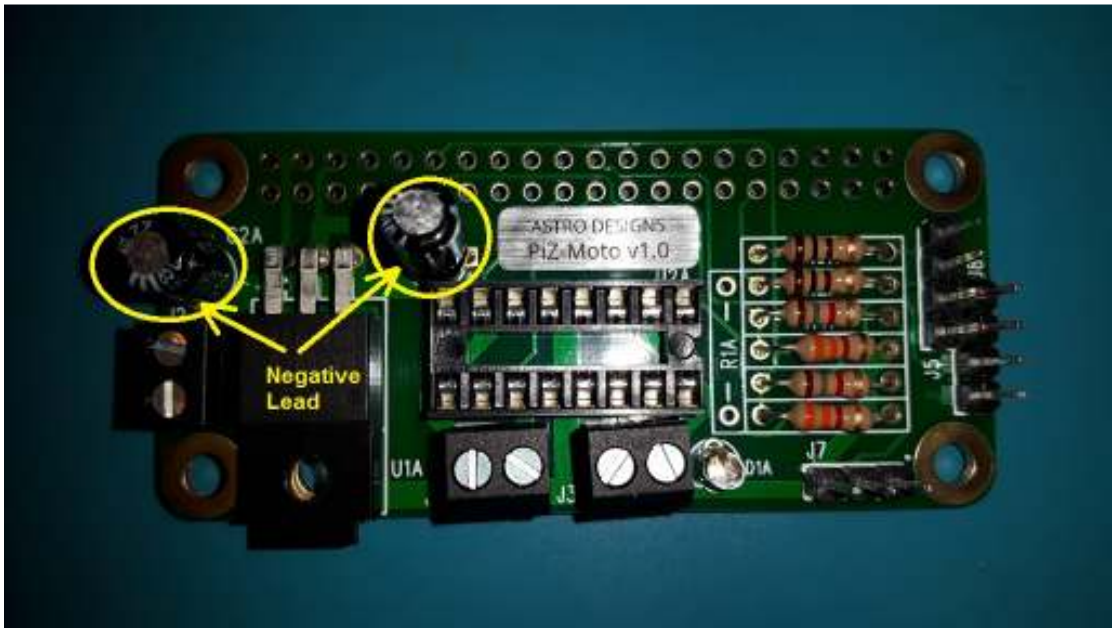


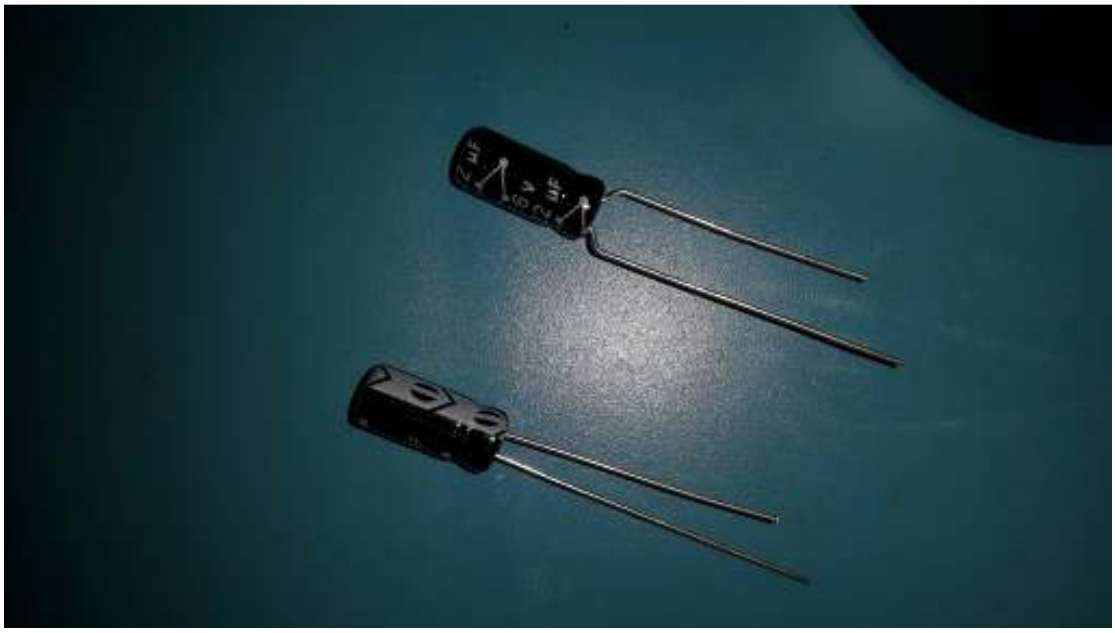
6) Next, fit the three pin-headers. Two of these are four-pin, the third is three-pin. These need to be carefully broken off the 20-pin strip provided. This will leave a few spare which are not needed for this project.



7) Next, fit the two large capacitors. Firstly, these need to have the pins ‘formed’ slightly to match the separation of the holes on the board. The pins should be separated by about the same amount as the diameter of the capacitor. See the additional picture below illustrating how they should look. Secondly, it’s important to note that these are polarised capacitors so

they MUST be fitted the correct way around. The negative terminal is marked on the capacitor with a stripe and "-" symbols. The arrows on the picture below point to where the negative terminal should go. One of the terminals for the capacitor shape on the PCB has a square pad, this corresponds to the positive lead on the capacitor.

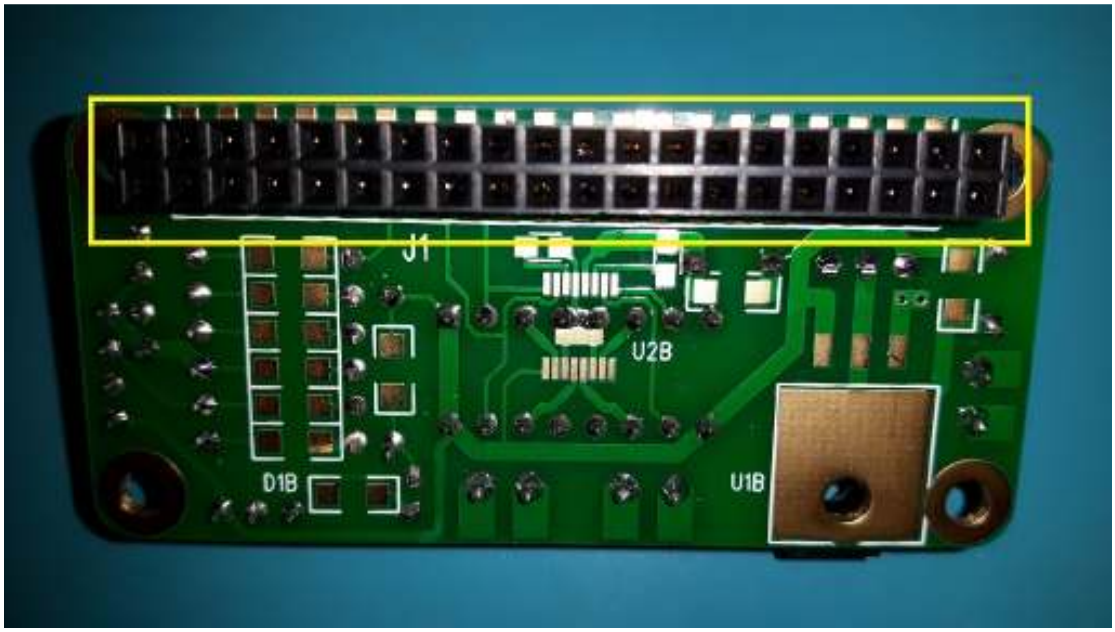


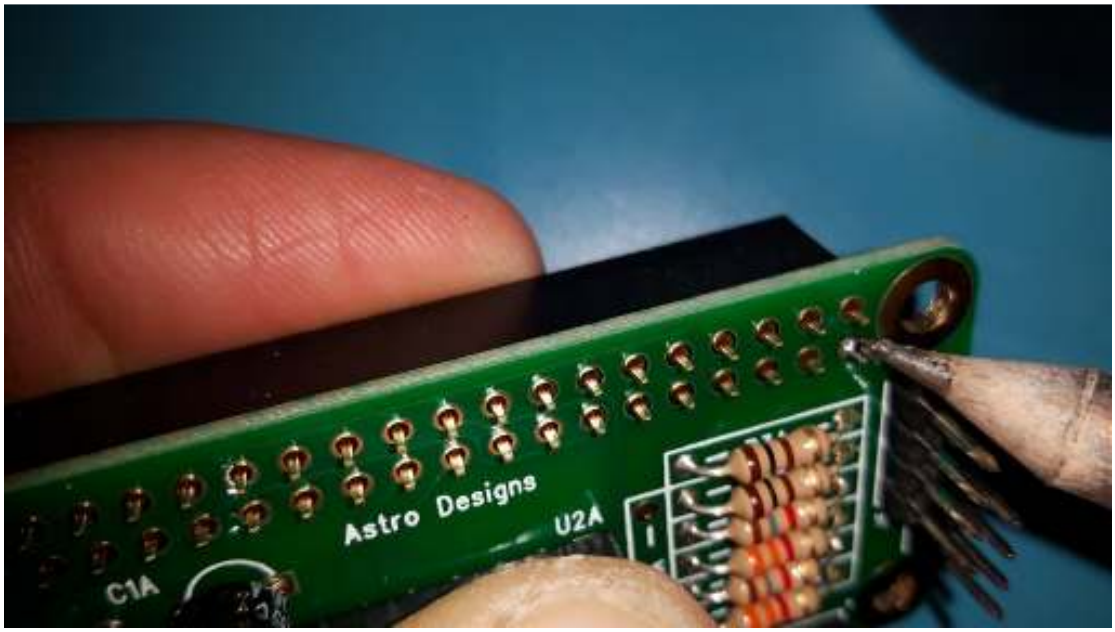


8) Next, fit the 40-way socket. Note this needs to be assembled onto the opposite side of the board with the pins coming through to the top side.

   It's best to solder just two pins in opposite corners to start with, then while pressing the connector into the board, re-melt the solder on those two pins just to ensure the connector

is properly flush with the board. Once this is done then the rest of the pins can then be soldered.

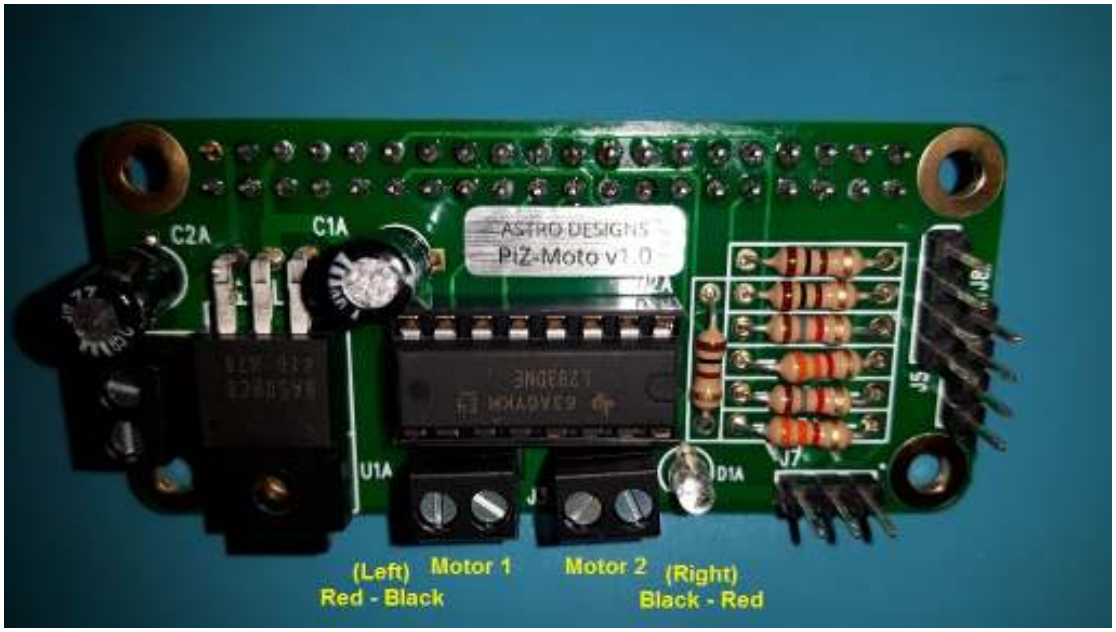




9) That's it! Ok, you should now do a quick check to ensure that all components are fitted and are fitted correctly. Check:
    a. All components are fitted;
    b. All pins are soldered cleanly;
    c. All long-leads have been snipped-off;
    d. The I.C. socket is fitted the correct way around with the notch close to the resistors;
    e. Capacitors are fitted the correct way around;
    f. The LED is fitted the correct way around;

10) Finally, plug the L293DNE motor driver I.C. into the I.C. socket. Make sure it's fitted the correct way around, with the notch towards the resistor-end of the board.

Connecting the motors



Each pair of screw terminals above connects to a single motor. In theory you could connect two motors in parallel, with two motors on a single screw terminal but start with one motor per screw terminal pair. The motor driver is rated to 600mA per motor.

Connecting the battery:

It's important to get the polarity correct when connecting the battery. Getting this wrong could damage the board. The ground / black / 0V wire from the battery should connect to the battery screw terminal that's closest to the corner of the board (marked in yellow as "-" in the picture below). The positive / red wire from the battery should connect to the other screw terminal, marked below in yellow as "+".

It's best to have a switch in line with your battery so that it's easy to turn things off. Make sure the switch is off when connecting the battery to the board.

Important note: The PiZ-Moto is designed to be powered through the screw-terminal power connector. The PiZ-Moto uses an on-board 5V regulator to provide a 5V regulated power supply to the Raspberry Pi Zero through the Pi's +5V & GND pins on the Pi's GPIO connector. Please do not power the Pi through the Pi's USB power connector while connected to the PiZ-Moto. While this is unlikely to result in any damage, you will not be able to provide power to the motors using the Pi's USB power connector so it recommended that you don't use that connector when using the PiZ-Moto.

It’s designed to run off four “AA” cells which would provide approximately 6V. But it will work on as little as 5.3V. The recommended upper limit is 6.5V although it will tolerate more. How much it can tolerate comes down to how much current is needed by the Pi Zero. If you connect a USB WiFi dongle or a camera then I wouldn’t recommend anything more than 6V. Also check the temperature of the regulator (U1A) as this gets hot as the Pi Zero draws more current.

It’s really best suited to minimal applications where the loading on the Pi Zero is very little. A Bluetooth dongle or Wireless Keyboard Dongle consumes very little power so these are ideal.

One final note on the battery side of things, you don’t need to (& shouldn’t) power the Pi Zero separately. The Pi Zero is powered from the regulator on the PiZ-Moto.

Connecting the Photo Sensor

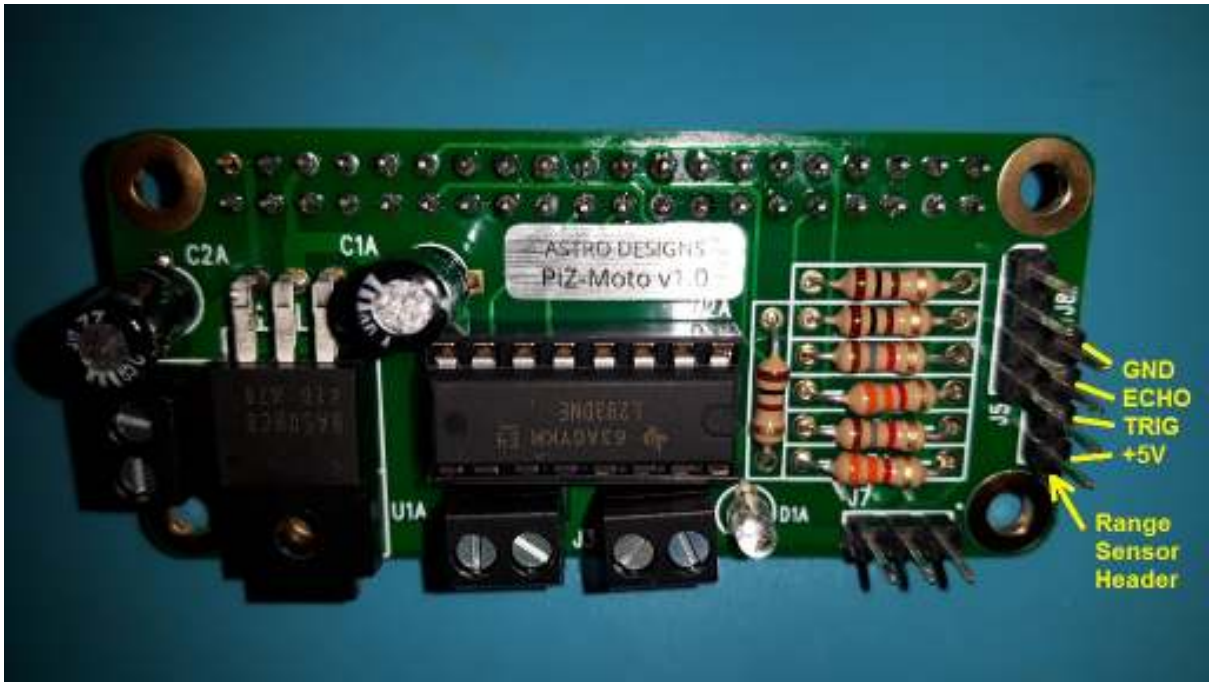
The Photo Sensor Header is designed to connect directly to a photo-reflector / line sensor like the one found in the CamJam EduKit #3. Simply connect the three pins on the PiZ-Moto Photo Sensor Header to the three pins on the photo-reflector / line sensor, making sure you get the pins connected to the right terminals on the photo-reflector board and you’ll be ready to test.

The signal connection on the PiZ-Moto Photo Sensor Header can also be used as a general-purpose 5V input and is connected to the Pi Zero’s GPIO-25.

Connecting the Range Sensor

The Range Sensor header is designed to connect directly to an SR-04 range sensor, as found in the CamJam EduKit #3. The SR-04 is also available separately from several suppliers. Simply connect the four pins on the PiZ-Moto Range Sensor Header to the four pins on the SR-04, making sure you get the pins connected to the right terminals on the SR-04 and you'll be ready to test.

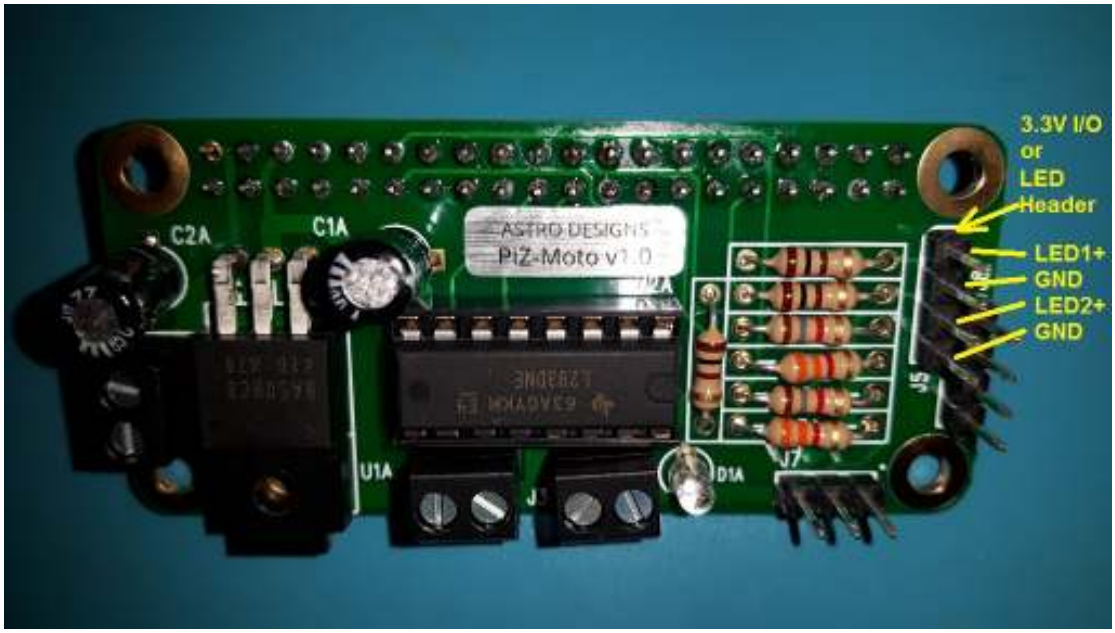
he Echo connection on the PiZ-Moto Photo Sensor Header can also be used as a general-purpose 5V input and is connected to the Pi Zero's GPIO-18 via a 5V to 3.3V level shifting network. The Trig connection can be used as a general-purpose 3.3V input or output and is connected directly to the Pi Zero's GPIO-17



Connecting the LEDs

The LED header is really a couple of general purpose I/O pins, each provided paired with it's own 'GND'. The two LED pins have a 100 ohm resistor in series with it's connection the header on the Pi Zero. This both protects the I/O on the Pi Zero as well as allowing an LED to be connected directly across the two pins. No external resistor is necessary. In our examples here, we just connect a couple of LEDs directly but you could use these pins as inputs or outputs.

The LED1+ connection on the LED Header is connected to the Pi Zero's GPIO-5 via a 100 ohm resistor. The LED2+ connection is connected to the Pi Zero's GPIO-6 via a 100 ohm resistor.



That's it, you're now ready to run some quick tests and start using your PiZ-Moto

Testing

1) Firstly, connect the battery and switch it on (if there's a switch).
2) Check that the LED comes on;
3) Measure the voltage on the "+5V" terminals of the 40-way socket. These should be very close to 5.0V;
4) Disconnect the battery and check that the LED goes off;
5) Connect the PiZ-Moto to a Raspberry Pi Zero. Take care to ensure that the connector lines up correctly and is not offset by (say) one pin. (Yes, I've done that too and now have a PiZero that's minus a GPIO output ☹)
6) The Python script PiZ-Moto_test.py is the best way to test the board. If you connect the battery, motors, LEDs, line sensor & proximity sensor and run the script, it'll quickly exercise all functions on the PiZ-Moto allowing you to check it all works. You'll need a Pi Zero with HDMI display & USB keyboard connected.
    a. Plug a small DC brushed motor into each motor terminal;
    b. Connect the 3-pin photo sensor header to a photo-reflector / line detector;
    c. Connect the 4-pin range sensor header to a SR-04 ultrasonic range sensor;
    d. Connect the 4-pin LED / 3.3V I/O header to a couple of LEDs
7) Connect the battery again and switch it on.
8) Run the Python script [piz-moto_test.py], following the instructions on-screen or over a terminal;

    www.astro-designs.com/downloads/piz-moto/examples/piz-moto_test.py

If you encounter any problems, maybe a motor only works one way, one or more of the sensors doesn't work, one or both LEDs doesn't work, then double check all soldering, re-flowing any joints that you're not sure about.

Prerequisites of the example code

If you're going to use the Bluetooth based "Wii-Mote" controller then you'll need to install the CWiid module so that Python can talk to the Wiimote.

Install cwiid using

sudo apt-get install python-cwiid

Examples

1) The Python script PiZ-Moto_Wii.py is designed to control a 2-motor wheeled robot with line-following and object avoidance functions. It's also primarily designed to work with a BlueTooth based "Wiimote" controller.

    www.astro-designs.com/downloads/piz-moto/examples/piz-moto_wii.py

2) The Python script PiZ-Moto_ kb.py is designed to control a 2-motor wheeled robot with line-following and object avoidance functions. This version is primarily designed to work with a wireless USB keyboard.

Note: the PiZiMoto_kb.py script isn't ready yet but we'll hope to get it ready early July 2016.

www.astro-designs.com/downloads/piz-moto/examples/piz-moto_kb.py

3) The board is designed to be 100% compatible with the CamJam EduKit #3 so the worksheets designed for the EduKit #3, and the sensors that come as part of that kit, will all run on the PiZ-Moto. We highly recommend getting hold of the EduKit #3 if you want to get going playing with motors with the Raspberry Pi.

The Alternative & Adventurous Kit, Possibly…

You may have noticed that there are some surface mount pads on the bottom side of the board. Why are these there? Well we thought we'd do something slightly different to other kits and offer the option of a surface mount kit for those of you feeling a little more adventurous with your soldering iron and who might want to venture into the world of surface mount technology. The majority of the surface mount components designed into this board are relatively easy to fit, the surface mount motor driver on this version on the other hand, isn't so easy and really needs a fine-tipped iron, microscope and some extra-fine solder. A steady hand helps too. So we may change that one. But by one way or another we'll hope to offer a surface mount kit soon.

Frequently Asked Questions

Q) What's the recommended power supply?

A) It was designed to run from 6V. It can handle more and has been tested at 9V, but only with minimum loading on the 5V supply rail. And it can take less, as little as 5.3V. But the recommended supply is 6V. 4 x AA cells are an ideal supply.

Q) Can it support a WiFi dongle on the Raspberry Pi?

A) Yes. They can be a little power-hungry and can cause the 5V regulator to run quite hot but it can work. We would recommend that you run off a power supply voltage of no more that 6V when using WiFi to help keep the temperature of the 5V regulator down.

Q) Will it work with the Raspberry Pi A, B, B+, 2 or 3?

A) It's designed for the Pi Zero, because the Pi Zero has a lower power consumption than other versions of the Raspberry Pi. It's not designed to supply much current on the 5V power rail, that's how we get away with using an easy to assemble & low-cost 5V regulator. However, depending on what you connect to the 5V supply, yes it can possibly work with other versions of the Raspberry Pi. The 5V regulator is rated to supply up to 1A so the total current draw on the 5V supply, including the Pi, any USB dongles and anything loading the 5V pins on the Pi's GPIO connector must be less than

1A. However, since the 5V regulator is a 'linear regulator' it's not as efficient as a 'switching regulator' and it can get quite hot, especially when the supply voltage is greater than 6V. If you're going to load up the 5V supply rail with current-thirsty USB dongles (e.g. WiFi) or plug heavy loads into the GPIO connector then you should try to keep the supply voltage to around 6V. Also, keep an eye on the temperature of the regulator. If it gets hot then you probably need a heatsink to help keep the temperature down or you need to reduce the load on the 5V supply.

Q) How much can I connect to the 5V supply.

A) Please see the previous answers.

Q) Can I power the Raspberry Pi from the 5V USB power or data connectors?

A) It is not recommended but it does work. If you're connecting a USB power supply to the Pi Zero while it's plugged into the PiZ-Moto, disconnect the power supply to the PiZ-Moto.

Q) Can I run the camera on the Pi Zero when it's powered from the PiZ-Moto?

A) We've not tested this at the time of writing this document but we believe this is probably ok. The current consumption of the camera is around 200 – 400mA (TBC) which should be fine. We'd recommend using a power supply voltage of no more than a 6V supply for this. If you try using the camera, or any extra load on the 5V supply, keep an eye on the temperature of the regulator.

Q) Which motor terminal is for the left motor & which terminal is for the right motor?

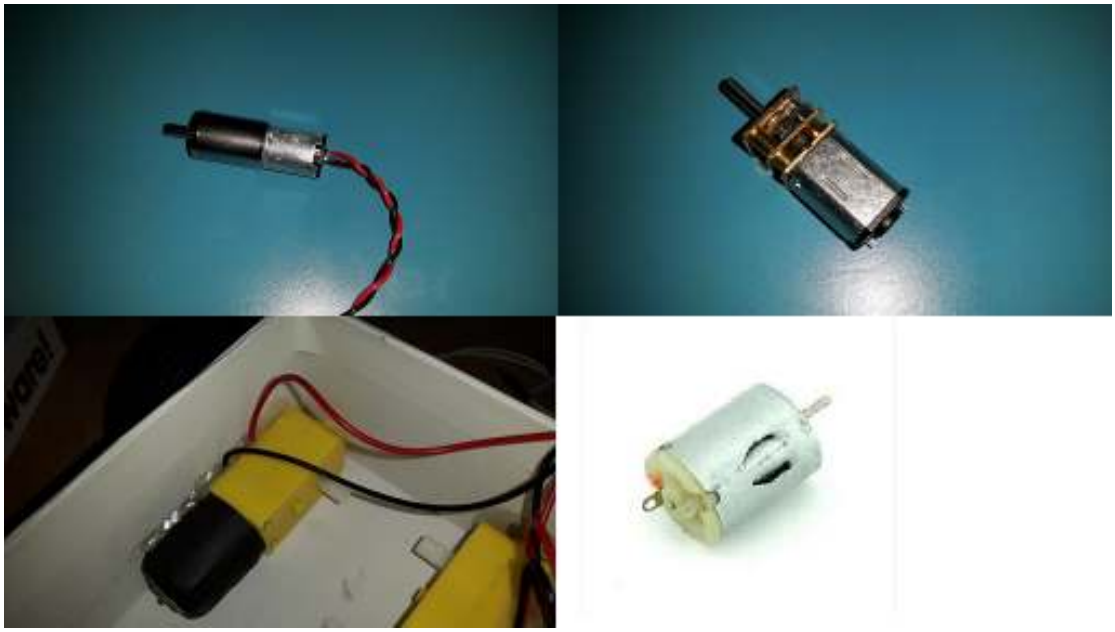
A) J3 should connect to the right motor, J4 should connect to the left motor.

Q) Which way round should I connect the red & black leads from the motors?

A) This really depends on how your motors are wired. The motors from the CamJam EduKit 3 seem to work fine when connected as described in the picture in the earlier section on Connecting The Motors.

Q) What kind of motors can I use?

A) Small, low-current DC brushed motors. Here's a few examples:



Have fun with your Astro Designs PiZ-Moto

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