Build the Ultimate Remote Control
as seen in
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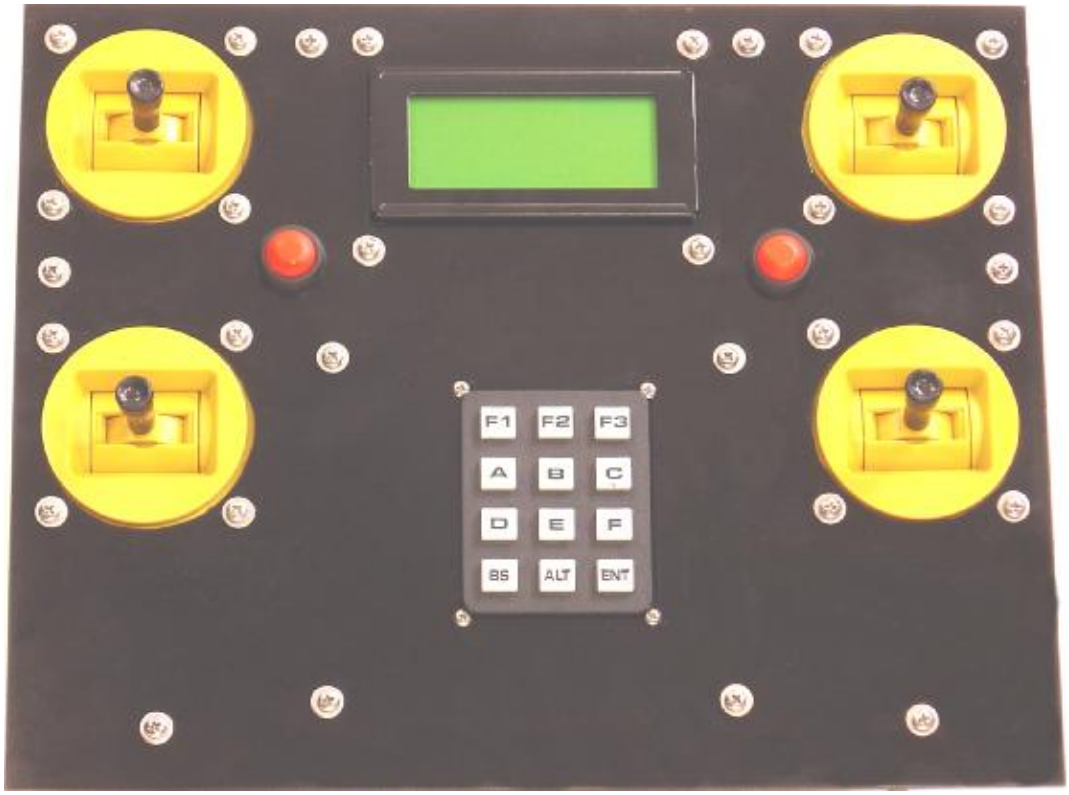
Last month we created a walking robot called the BioCrab. The problem with such a bot is that there are a great many control points and a remote control does not exist that will allow us to control all the aspects of the walker.

I am going to show you how to build a custom control system that has 4 dual axis joysticks as well as 6 buttons and a keypad. There is also a 4x16 LCD display for configuration and robot feedback. We will add a serial interface that can be connected directly to a robot via a wireless Zigbee module.



Kronos Robotics and Electronics
www.KronosRobotics.com

In order to build this remote you will need some controls like those shown in Figure 2. These will range from buttons to full action joysticks. The buttons weren't a issue but finding a joystick at a reasonable price was a real problem. A company called P3 America sells them but even the simplest dual axis joy stick was over $100 each. Since I wanted at least 4 joysticks my remote would probably cost me over $400 for the joysticks alone and over $500 for the completed remote. There just had to be another option.

Figure 2

VEX Radio Interface

What I really wanted was a joystick like you find in those 4 or 6 channel RC radios. They seemed to be very modular and rugged enough for the kind of remote I wanted to build. Many of you may have seen the VEX RC radio shown in Figure 3. When first released they sold for over $100. A while back Radio Shack dropped the VEX line and many of the radios have made there way to some of the mail order houses at a very reasonable price. At the time of this article, All Electronics was selling them for $29.95 each.

With a small screwdriver and a soldering iron you can retrieve the two joysticks shown in Figure 4 with about 10 minutes of effort. One real nice feature about these joysticks is that you may remove a small spring and the stick will remain where set and not return to the center position. You may do this with either or both axis. This makes them perfect for our remote.

Figure 3

Before I get into the details on building the remote, I thought I would show you how to use the VEX radio with the Bio Crab. The VEX radio is a 6 channel FM radio system. In addition to the two dual axis joysticks, there are 4 buttons on the back of the remote. While the Radio does not have the capacity to control every aspect of the BioCrab, it may be worth experimenting with before you take the radio apart for our project.

Figure 4

The VEX radios kit comes with a receiver that is unlike any other RC radio receiver you may have seen. The big difference is that the receiver does not contain the channel decoder circuitry for the individual servo channels. While this is not a good thing for RC enthusiasts it is perfect for those who want to interface the radio to a microcontroller. The receiver outputs all the pulses for the 6 channels one right after another. To handle this pulse train there is a library built into the DiosPro.

The radio does require a little bit of an interface to be able to plug it into one of the IO ports of the DiosPro. You need to supply power to the radio and pull the data pin high with a 22K resistor. To add the resistor and connections for this interface, remove the 4 screws from the back of the receiver and add three wires as shown in Figure 5. You may also add the 22K resistor as shown or connect it between the data port and 5v at the microcontroller.

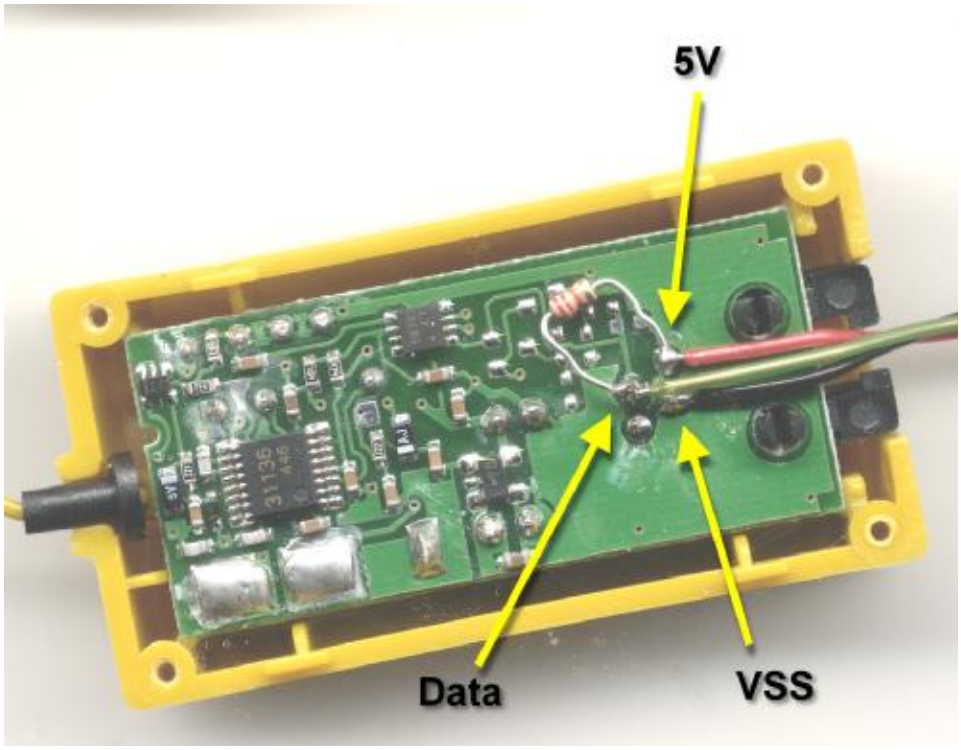
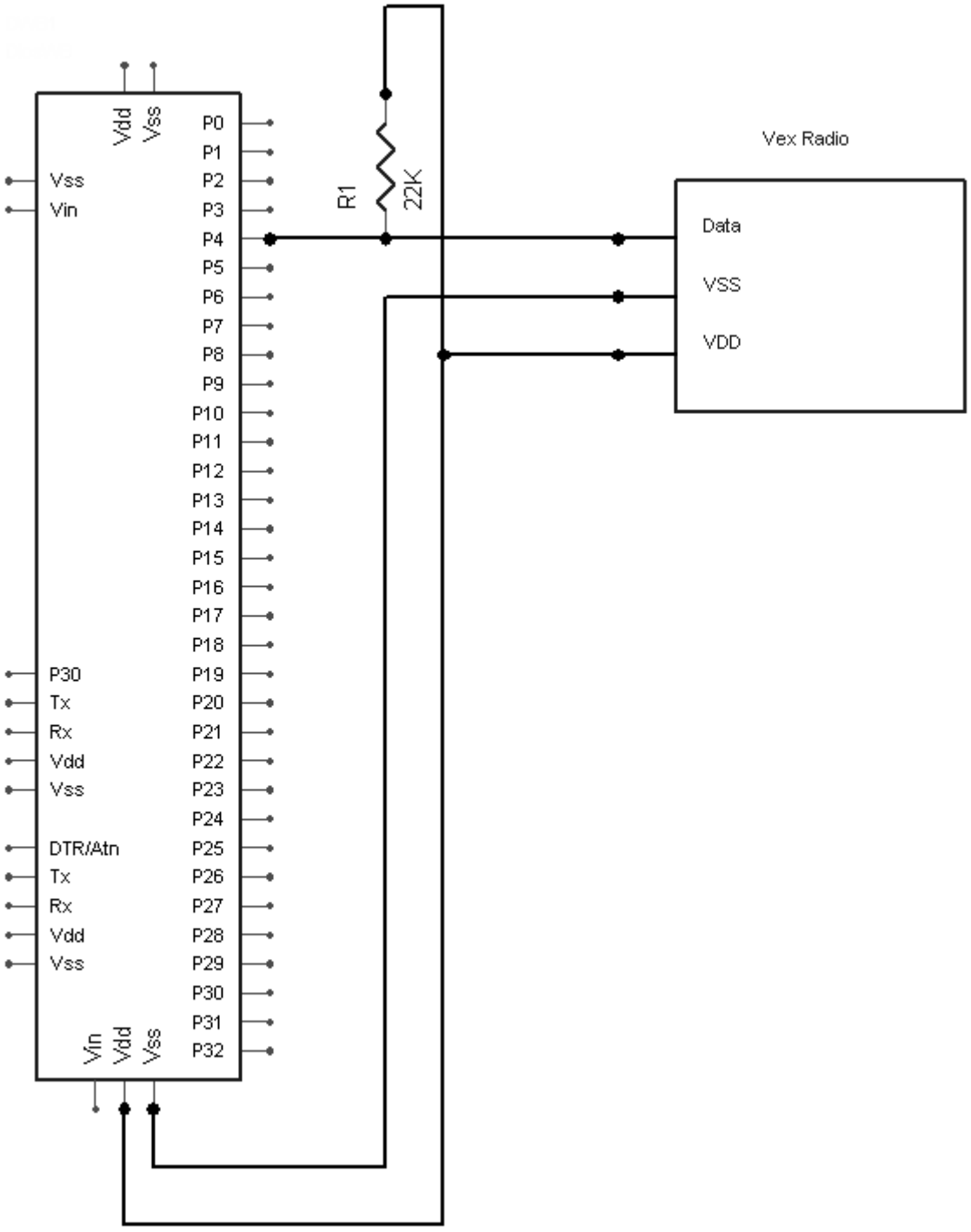


Figure 5

To use the radio, connect the radio to the DiosPro as shown in Schematic 1. If you hard-wired the 22K resistor inside the radio you may omit R1. As an option, the radio kit also comes with a small yellow cable with small modular connectors on each end. You can cut one of the connectors off and attach the small wires to a header. The red wire is VSS, the yellow is VDD, and green is the data lead.



Schematic 1

The heart of the interface is the single readvex function. Simply call this function, passing the port number and 6 global variables will be populated based on the joystick positions and the 4 buttons on the back of the receiver. The function will return 0 if the radio is not connected or off. To test the interface, run the Program 1.

```
DiosPro
'Vex Radio Interface Demo
func main()
  dim stat as integer
loop:
  stat=readvex(4)
  print stat,": ",VCH1," ",VCH2," ",VCH3," ",VCH4," ",VCH5," ",VCH6
  goto loop


endfunc

include \lib\vexradio.lib
```

Program 1

I have included a program called BioCrabVex.txt that will allow you to use the VEX radio to control the crab. Feel free to experiment.

Custom Remote Base Construction

I will be referencing various parts that I purchased for this project. A complete source for those items will be provided at the end of the article.

Joystick Removal

Before we start you will need to obtain the 4 joystick assemblies. On the back of the VEX radio there are 6 screws that must be removed. Under the battery holder are an additional 3. On the front of the radio there are 4 screws holding each joystick in place. Once these are removed lift the cover off the back of the receiver and expose the joysticks. There is a circuit board in the middle of the radio. Simply lift it off of its posts to gain access to the joysticks. You will have to use your soldering iron to remove the wires that are attached to the joysticks, but once done they can be removed by simply lifting them out of radio.

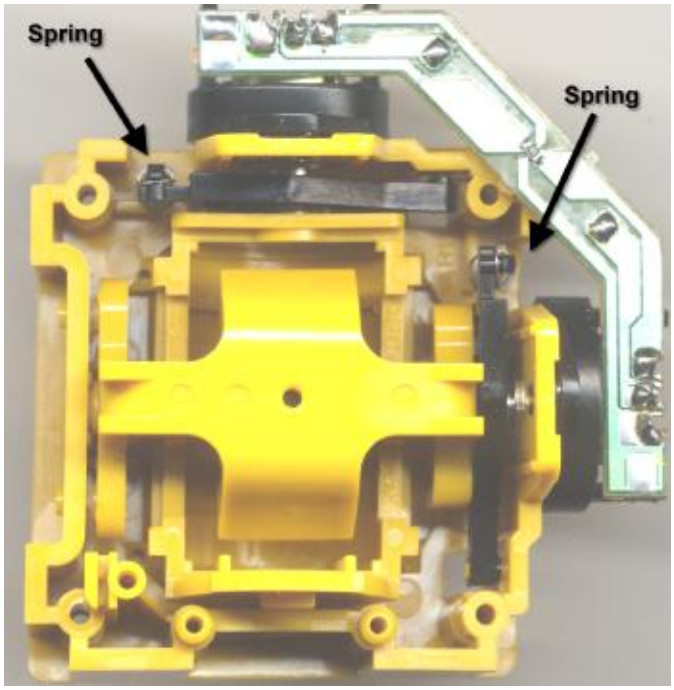
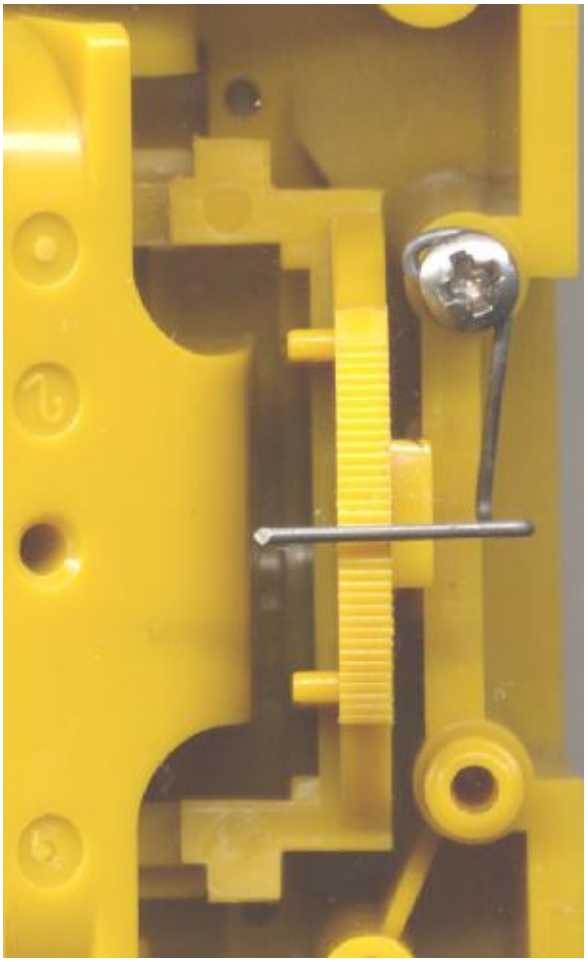


Figure 6

The right and left joysticks are the same except for layout of the small circuit board that is attached to the stick shown in Figure 6. As I mentioned earlier you may remove the small springs on one of the axis. There is also a small detent aria on the vertical axis, and by adding a small bent wire you can add a cool click detent to that axis as shown in Figure 7.



On my control I removed the spring on all the axis of the bottom two joysticks and added the detent wire to the vertical axis on them as well.

Base Construction

You will need to select some sort of material to use for your base. In my case I used a piece of 1/8" x 8" x 10" clear acrylic shown in Figure 8. I like the acrylic because it comes with a protective coating and its transparency allows you to easily mark the holes for the various boards and controls that you will need to attach. You can purchase this material from your local home center in various sizes.

The joysticks need a 2" hole cut out in order to mount them. I used a scroll saw, but a 2" hole saw could also be used. Use Figure 9 as a rough guide to layout. I recommend you lay out your components to get a feel for placement. The LCD needs to be mounted between the top two joysticks. Keep this in mind if you use a different LCD or set of joysticks. Once the holes are cut you will need to insert the joysticks then mark the 4 mounting holes for each. Attach the joysticks using some 1/2" machine screws. The original screws may be used, but must be cut short as they are too long. This is just a dry fit to aid in assembly; you will have to remove the sticks in order to add the additional cutouts as needed.

We are going to use a Kronos Robotics Serial LCD. This is a 4 line by 16 character LCD with a LED backlight. To mount the LCD simply place the LCD in place and mark the 4 mounting holes and the outline of the LCD to create a cutout. If you plan on keeping the base clear you don't need to add a cutout for the LCD, simply mark the 4 mounting holes.

Figure 8

The key pad can be mounted under the base with a cutout or on top with a slot cut for the header. The keypad was purchased from All Electronics and is a row/column matrix of keys. Other types will work as well but you may need to make changes to the software.

Figure 9 shows all the cut-outs and holes in my base. Your layout may be slightly different. Note the two small 1/2" holes. These are for two buttons. You may want to place them in different positions. There will also be four buttons mounted on the bottom base.

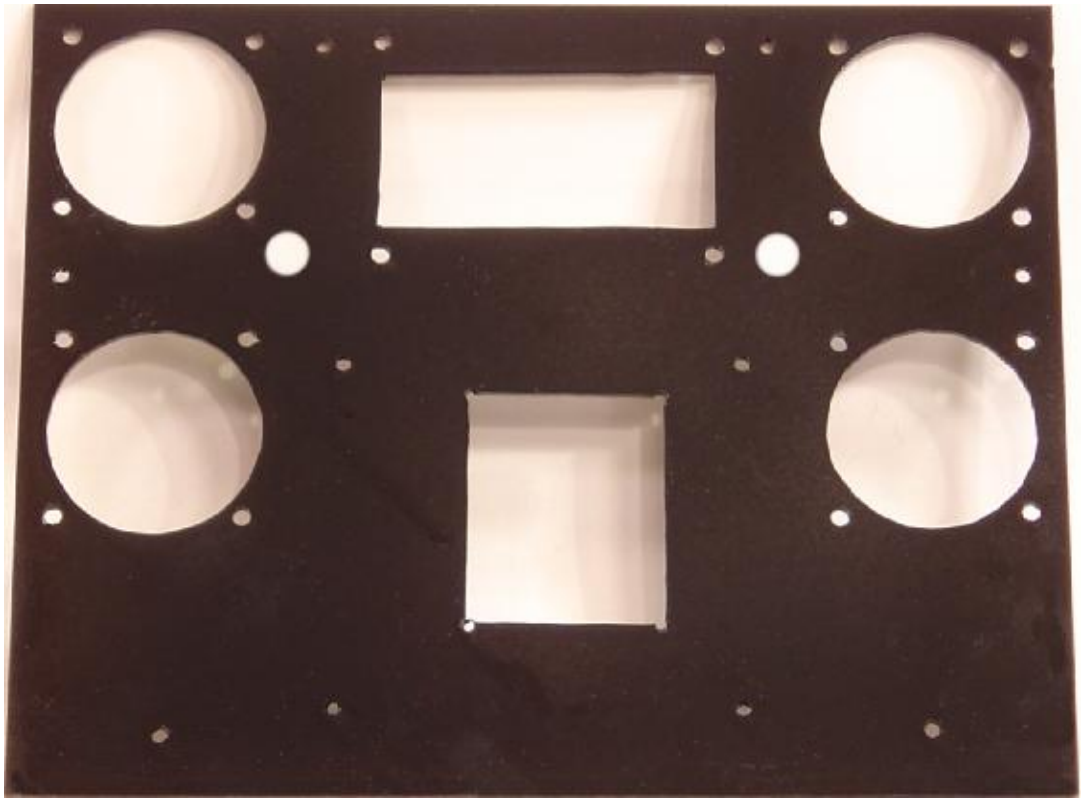


Figure 9

Figure 10 shows all the components mounted on the base. It also shows the lower base attached as well. I used a 2" standoff that I created by connecting a 1" M/F standoff to 1" F/F standoff. These are #4 standoffs purchased from Jameco. You may have also noticed that I attached the metal handle from the VEX radio to the lower base.

The top two buttons and the lower four buttons were purchased from All Electronics. You will need to drill a 1/2" hole for these. Place the lower button in a position that you fingers can reach while you are manipulating the joysticks.

The Dios WorkBoard Deluxe is mounted to the upper base using four 1" standoffs. These standoffs keep it above the header connected to the keypad. Notice that the breadboard is being used for this project. I recommend its use until you have your remote configured to your satisfaction. It will be very simple to make hardware changes, and once you get the remote operating the way you want you, can remove the breadboard and solder the wires directly to the prototyping area under the breadboard.

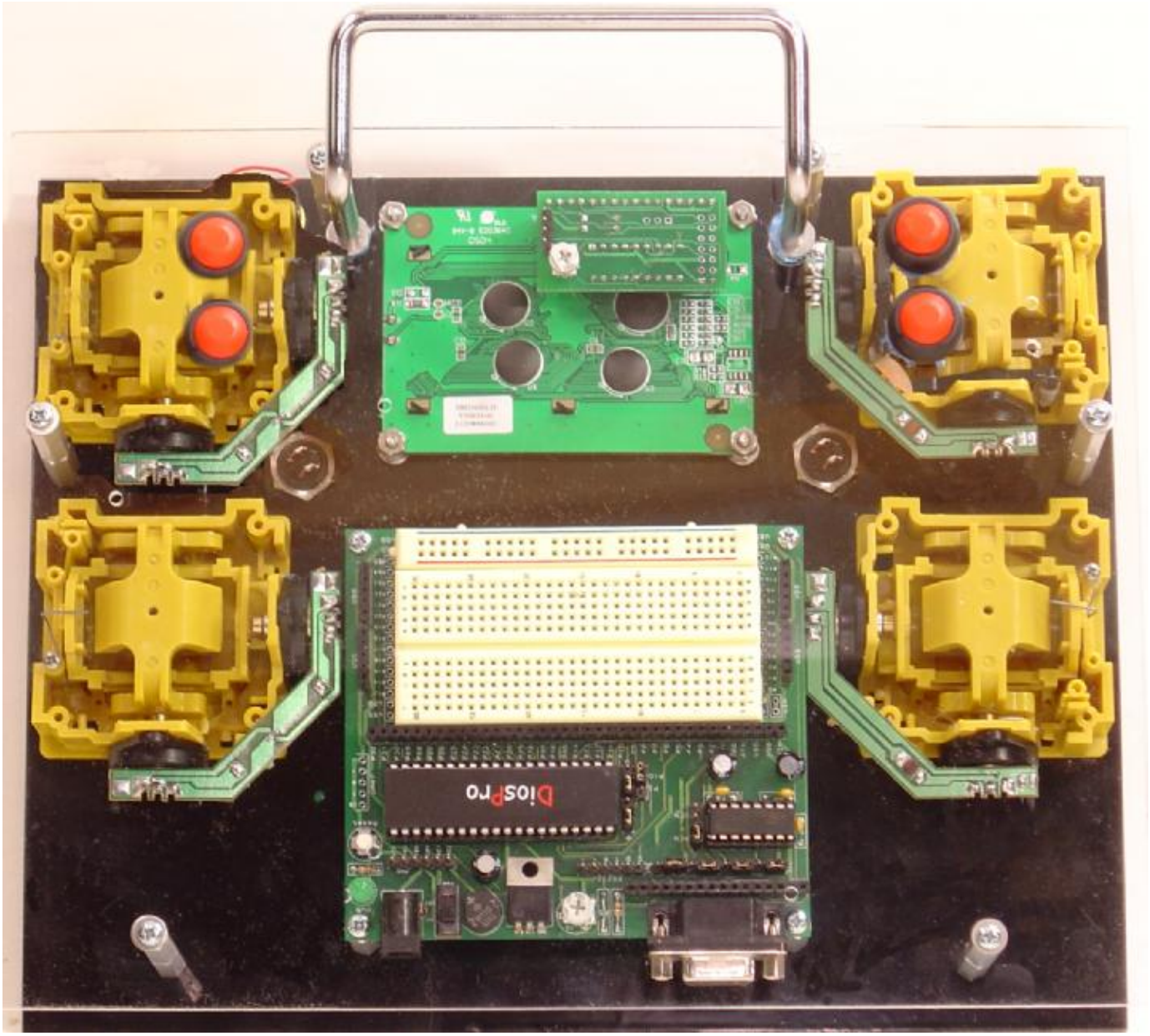


Figure 10

At this point it is important to note that the two joysticks that you removed from the VEX radio are slightly different. The difference is in the thin PCB attached to the two potentiometers. One has a small crisscross design. You should mount them as shown in Figures 10 and 12.

The lower standoffs used to attach the upper base to the lower base are positioned in such a way that they hold a 6-cell battery pack snugly in place as shown in Figure 11. Here I used a 9v battery clip attached to a 2.1 coax to plug into the board, but you could also use the onboard power header as well.

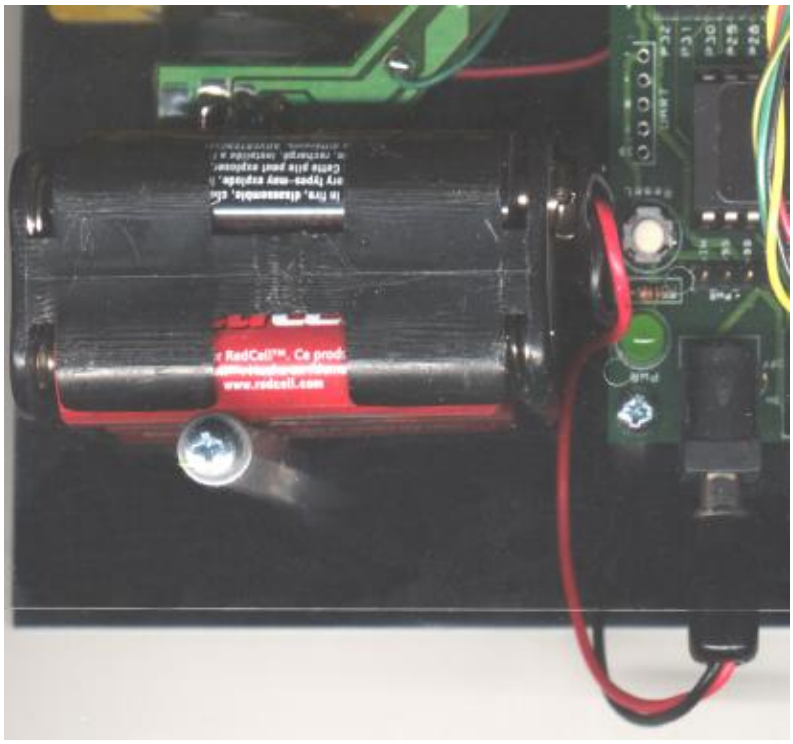


Figure 11

Hookup

Let's take a look at each sub section in detail. This will allow us to test each section as we add it to the system.

Joystick Hookup

Each joystick has a small PCB that you will make the connections shown in Schematic 1. Figure 12 shows the joystick placement when viewing from the bottom of the control. The yellow wire is connected to the Y axis of each joystick. The green is connected to the X axis. Red is VDD (5v) and Black is VSS.

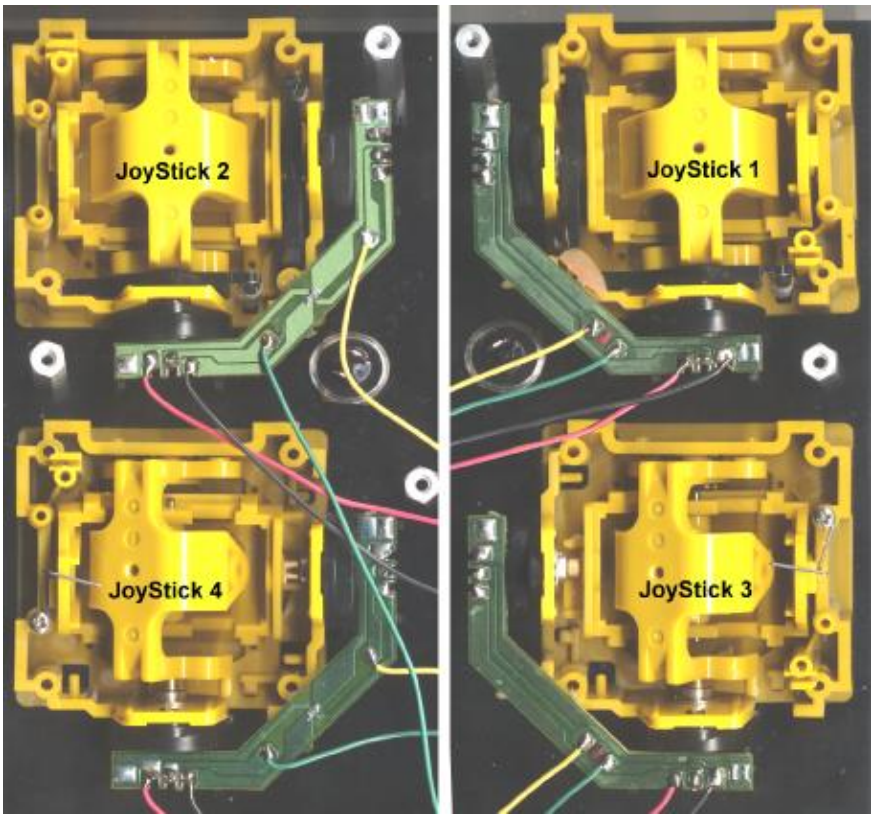
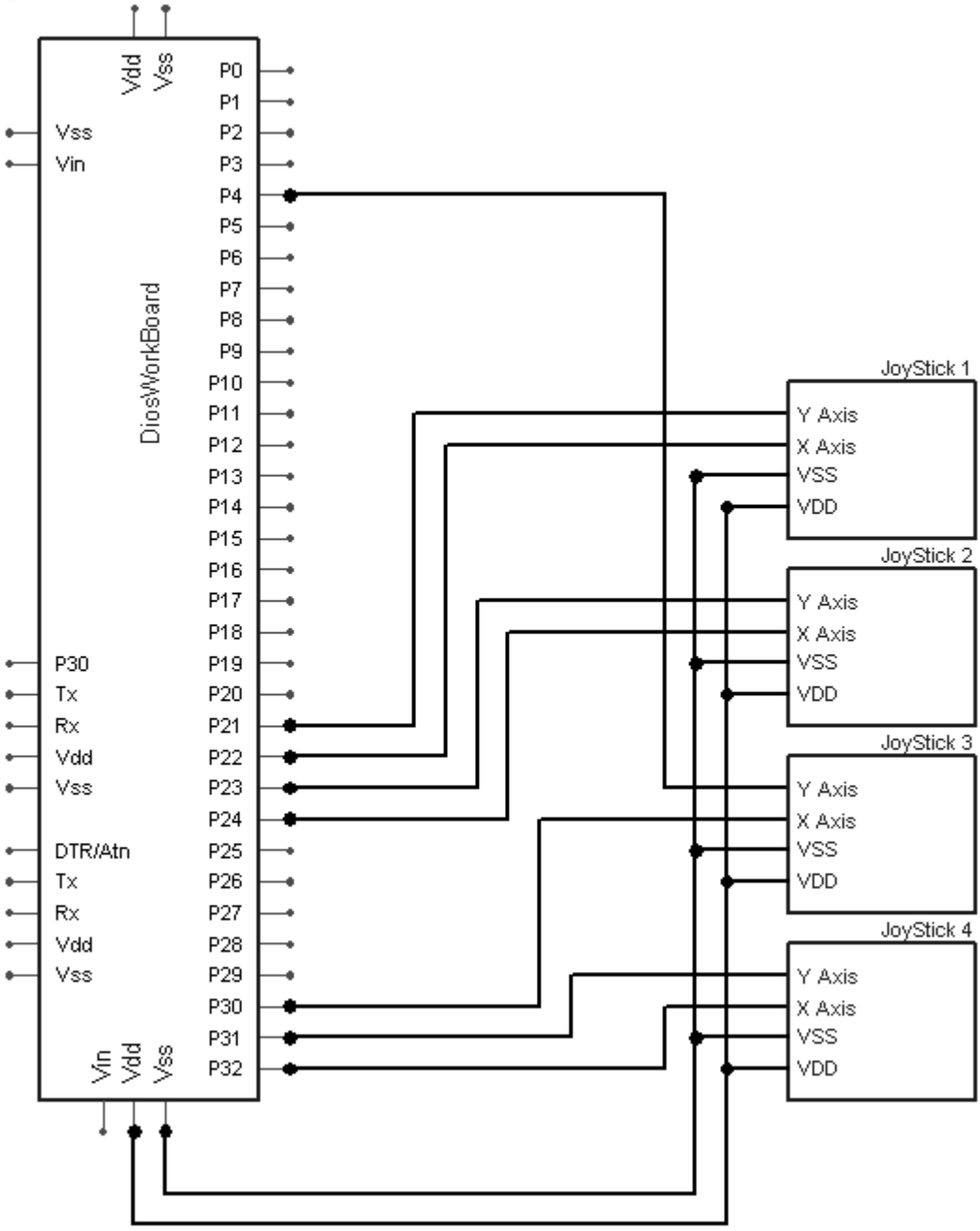


Figure 12

Load and run the program called Joy1.txt. This program will display the X and Y axis from each of the four joysticks.



Schematic 2

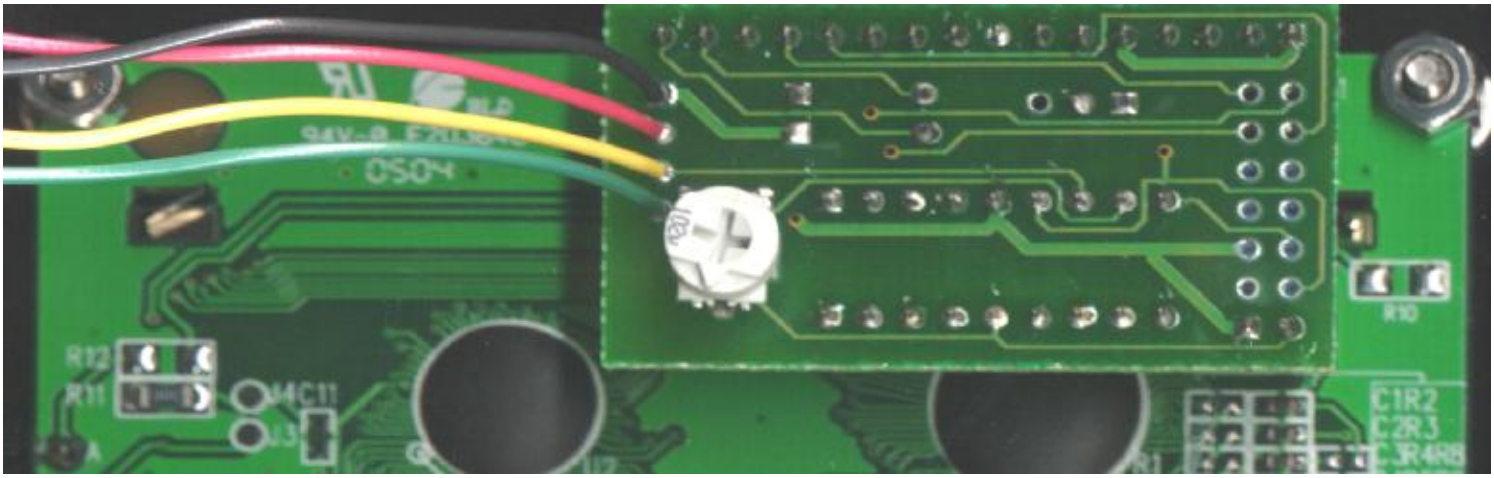


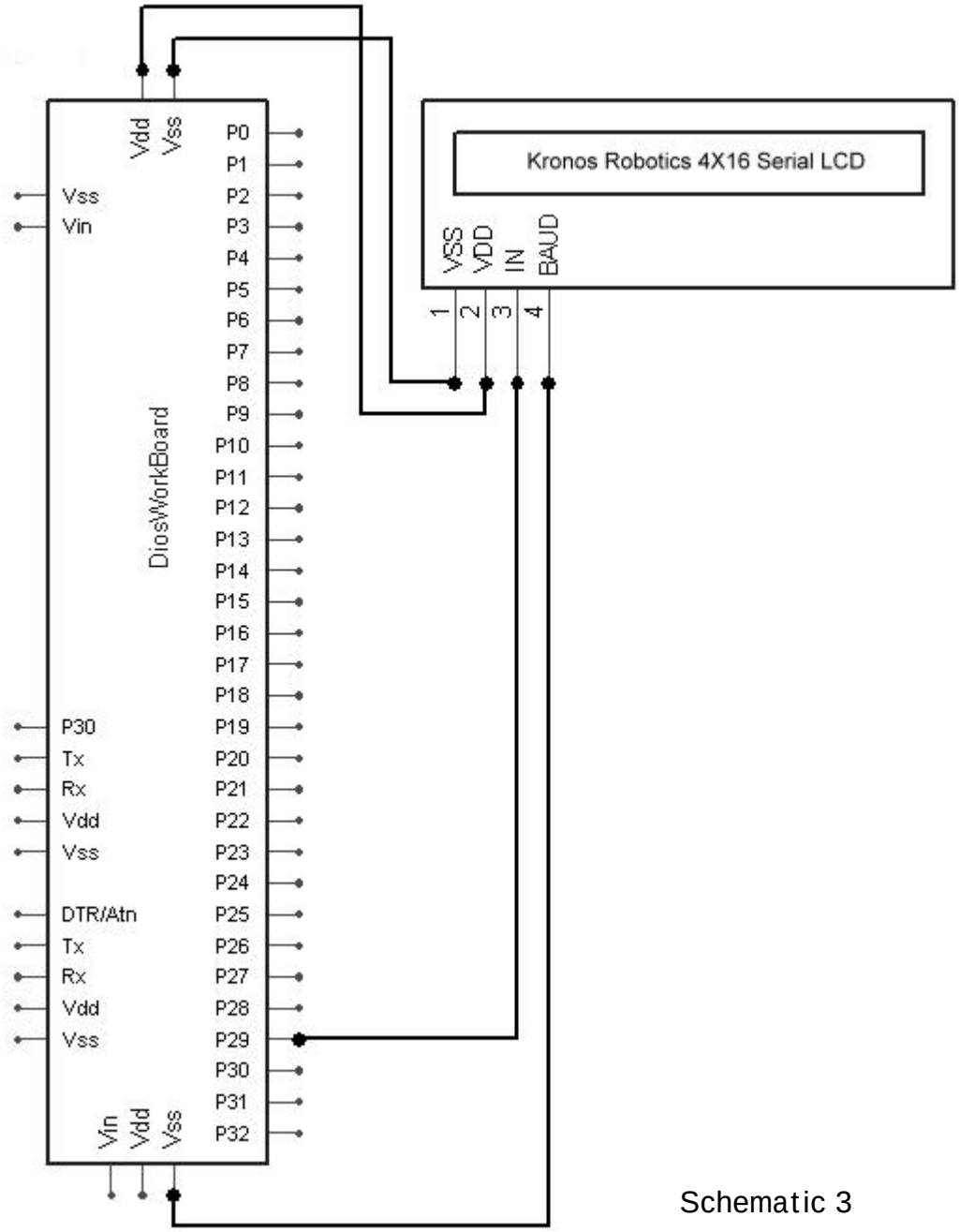
Figure 13

LCD Hookup

The Serial LCD comes with a small 4-pin header that you may mount as needed, but we won't be using it. Simply attach 4 wires as shown in Figure 13.

The last pin on the Serial LCD interface is optional and can be used to set the baud rate to 19200 when tied to VSS. In this application we are going to use the 19200 baud interface as shown in Schematic 3.

Load and run the program called Joy2.txt. This program will display the X and Y axis from each of the four joysticks on the LCD. Note that you may need to adjust the contrast trimmer in order for the characters to be visible.

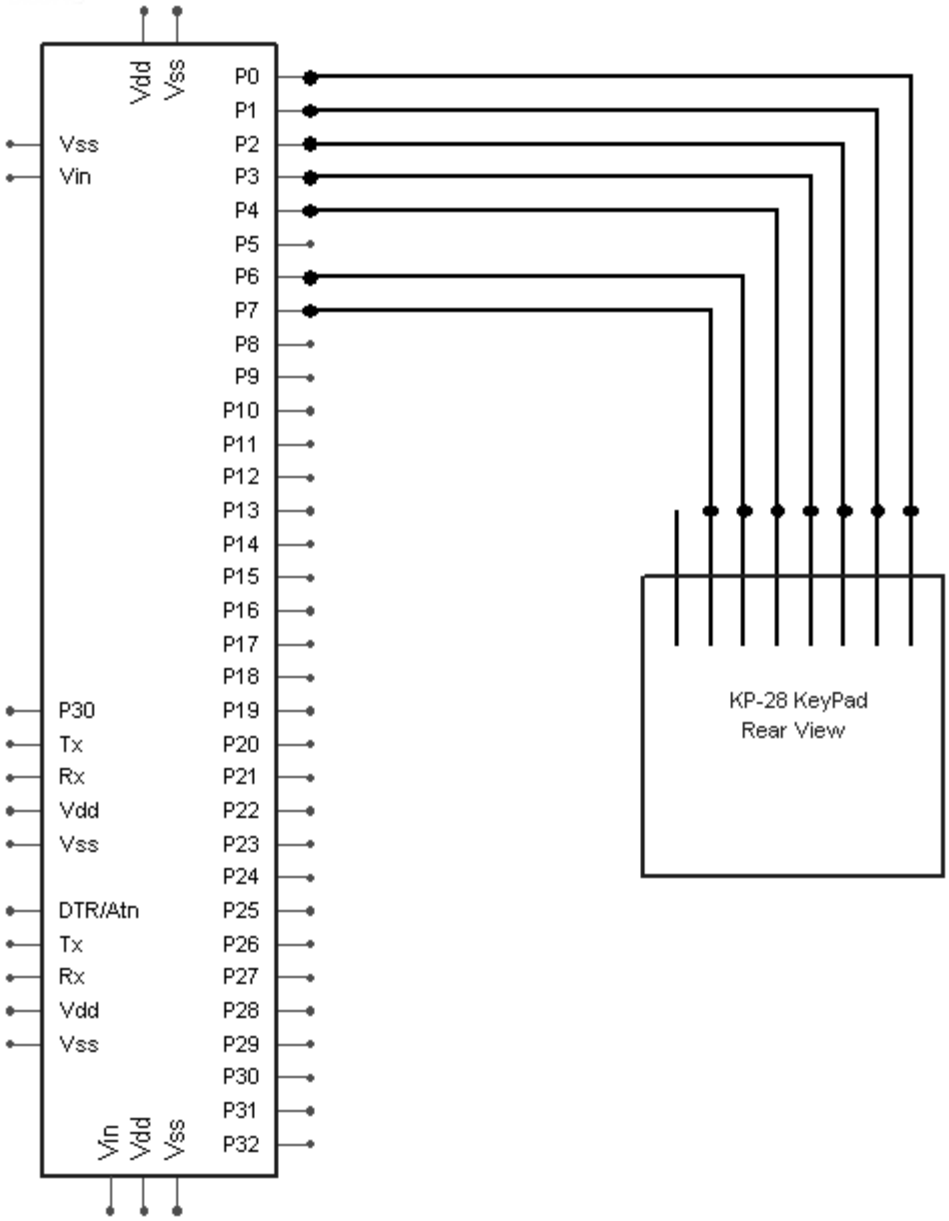


Schematic 3

Keypad Hookup

The keypad is very easy to hookup. You need only connect 7 wires to the header on the keypad as shown. Note that the schematic shows the rear view of the keypad. This is the view of the header that you see on the underside of the base. I cut off a 7-pin section from a female header and soldered 7 wires. This allowed me to slip the header onto the keypad even while the Dios Workboard is installed. Once the header is attached to the keypad, plug the wires into the ports shown in Schematic 4.

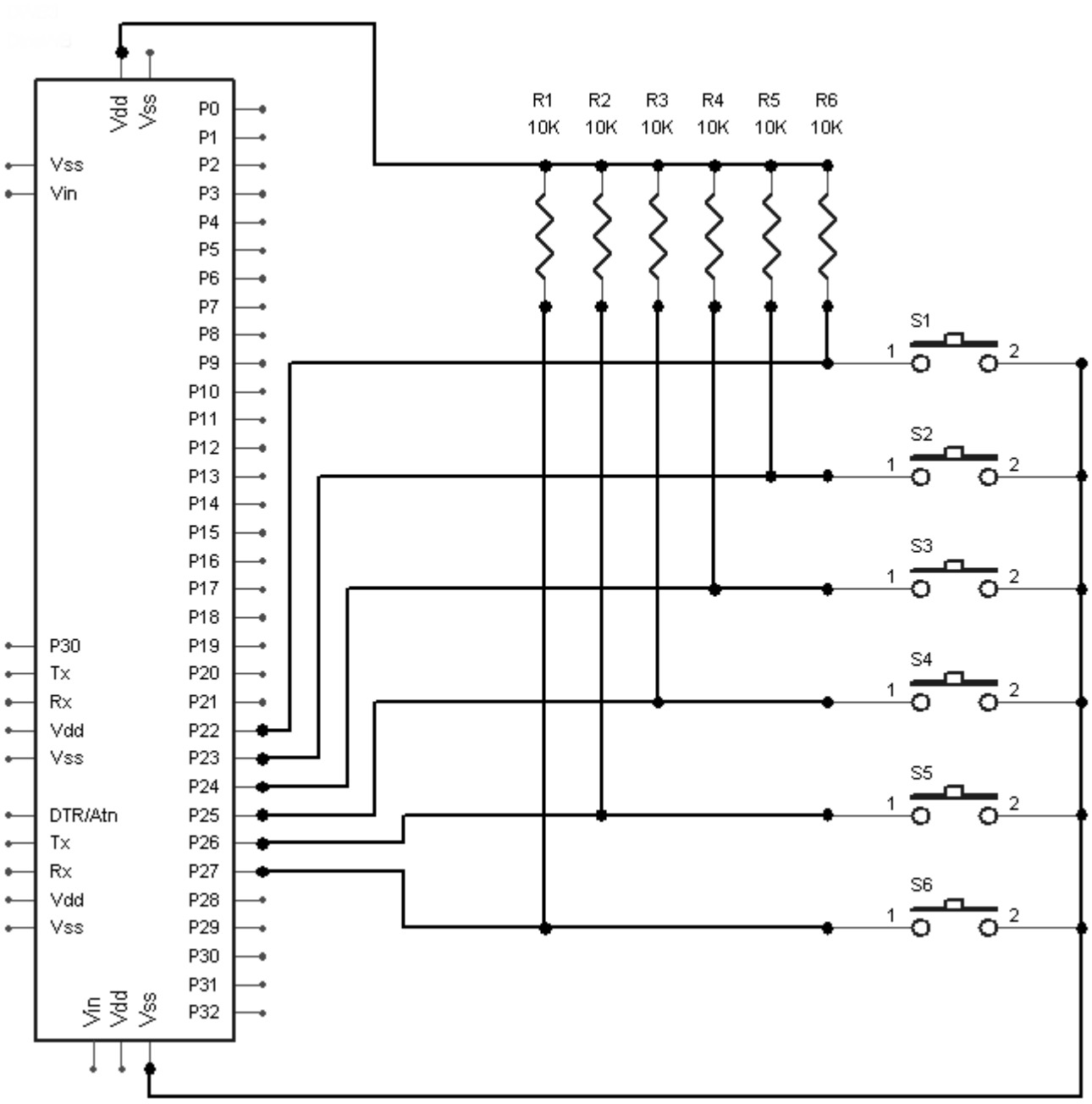
Load and run the program called **Joy3.txt**. This program will display the joystick information as well as the keypad key number 1-12.



Button Hookup

One pin of all the buttons is tied to VSS as shown in Schematic 5. The other pin is connected to an IO port on the DiosPro. The ports are held high with a 10K resistor. When the button is pressed, the corresponding IO port will go from a high state to a low state.

First solder and connect the two buttons mounted on the top of the base. Then connect wires to the 4 buttons on the lower base. I used 10" wires held together with small tie wraps. This will give you a good deal of room to wire the lower base to the mounted components on the upper base.



Schematic 5

Load and run the program called **Joy4.txt.** This program will display the joystick, keypad and button information on the LCD. Push each button to make sure the display goes from 1 when idle to 0 when pressed.

What's Next?

I had to cram quite a bit into this article. Next month I will add a bit of software to create a tethered serial interface that can be used to talk to robots. Then we will add a Zigbee interface to complete our remote.

All the example programs as well as the source are available for download at:
http://www.kronosrobotics.com/Projects/remote.shtml

Parts

Available from Kronos Robotics - www.kronosrobotics.com

- DiosPro Chip #16428
- Dios Workboard Deluxe #16452
- DiosCompiler Free Download from www.kronosrobotics.com
- 4x16 Serial LCD #16531
- 36-pin snap able female header #16291 (used to make header sockets)
- 9-Pin Serial cable #16259. (needed to program the DiosPro)
- 6 Cell Battery Pack #16321
- 9v Battery Clip #16264

Jameco

- Eight 3/8" #4 machine screws, Jameco #40969
- Four #4 washers, Jameco #106826
- Eight #4,1" Standoffs F/F, Jameco #139206
- Six #4,1" Standoffs M/F, Jameco #139231
- 50 #4, 1/2" Machine Screws, Jameco #106810
- 50 #4, Washers, Jameco #211131

All Electronics

- Two 6-Channel Transmitter Receivers #JS-6
- Six Pushbuttons #PB-138
- KeyPad #KP-28

Other
- Two 8x10 1/8" Plexiglass or similar. Available at most home centers.

Jameco Electronics can be found at www.jameco.com
All Electronics can be found at www.allelectronics.com
Kronos Robotics can be found at www.kronosrobotics.com