

**Important**

**Requires ZeusPro  
V1.70 or later**

Build the FaceWalker  
Part 3, The Brain (v1.1)  
October 2006 of Servo Magazine

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In Parts 1 and 2 we built the base and the controller for the FaceWalker robot. Now it's time to add the brain. If you remember back in Part 1 of the series I told you that the face on the robot was one of the key components of the project. Without it you have just another walker, albeit a cool one. We will be using a Pocket PC for the brain. Let's look at a few requirements.

Pocket PC Requirements:

- 300Mhz or faster Processor, 500Mhz Recommended
- Windows Mobile 2003 or 2005
- .Net Compact Framework 1.- SP3 or 2.0
- RS232 Port
- 240 x 320 or better graphics
- ZeusPro Development Software

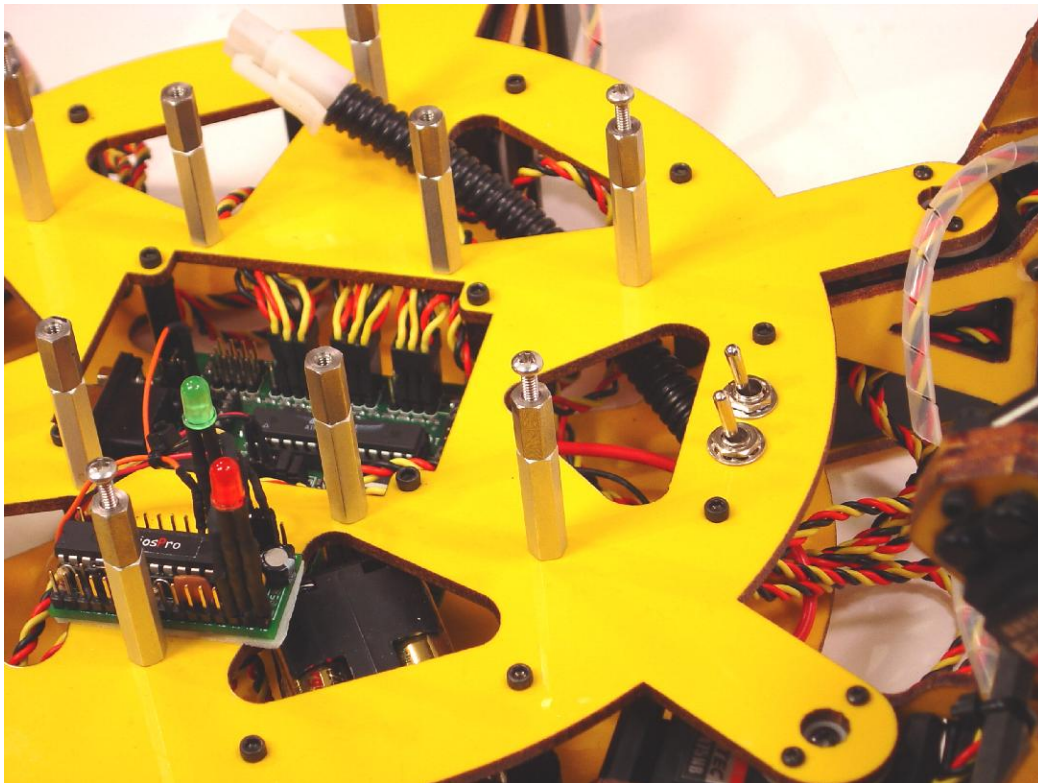
I understand that not everyone who wants to build the FaceWalker wants to use a Pocket PC. The good news is that the software that we create with the ZeusPro package will run on a Normal PC as well as a Pocket PC. ZeusPro is a very easy and inexpensive way to do windows development on the Desktop and Pocket PC. It is perfect for robotics as it was developed for interface to the outside world. You can do all your development, testing and debugging on the desktop and then simply create a Desktop or Pocket PC executable. For those Pocket PC purists there is even a full-blown Pocket PC development environment that allows you to do all the development, debugging and testing on the Pocket PC. The software portion of our brain is crucial, but we have a few finishing touches we need to make to our base first.

## Finishing up the Platform

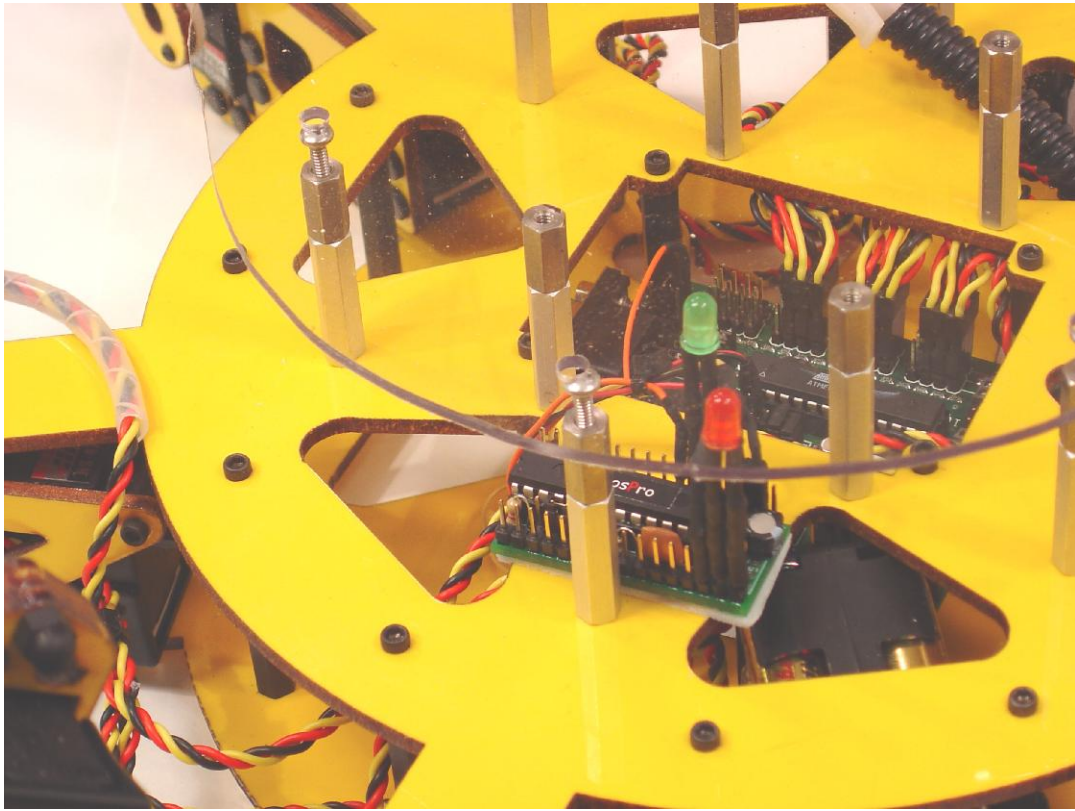
If you have not done so already you need to cut out your upper platform. This platform needs to be at least 7" in diameter but can assume any shape you wish to add a different effect to the FaceWalker. I am going to assume you are using clear Lexan for your platform but just about any smooth material will work. Most home centers sell 1/8" Lexan sheets and an 8" x 10" sheet will cost you under \$5.

The Lexan sheet will come with a protective plastic covering. Leave this in place while you cut out the platform. The covering makes a nice surface on which to draw your pattern and provides lubrication while you cut the sheet. If you have some scrap Lexan or plastic material without this covering you will need to add some masking tape. As you cut the plastic, the covering shreds and provides a lubricant that keeps your scroll saw or band saw from melting the plastic. This will yield you a much better edge.

Once the platform shape has been cut out you will need to mark out and drill the holes as outlined back in Part 1 of this series. We also need to create the holes for the two LEDs in our PS2 controller interface. This is done by inserting 6 #4 machine screws into the standoffs as shown in Figure 2.



**Figure 2**

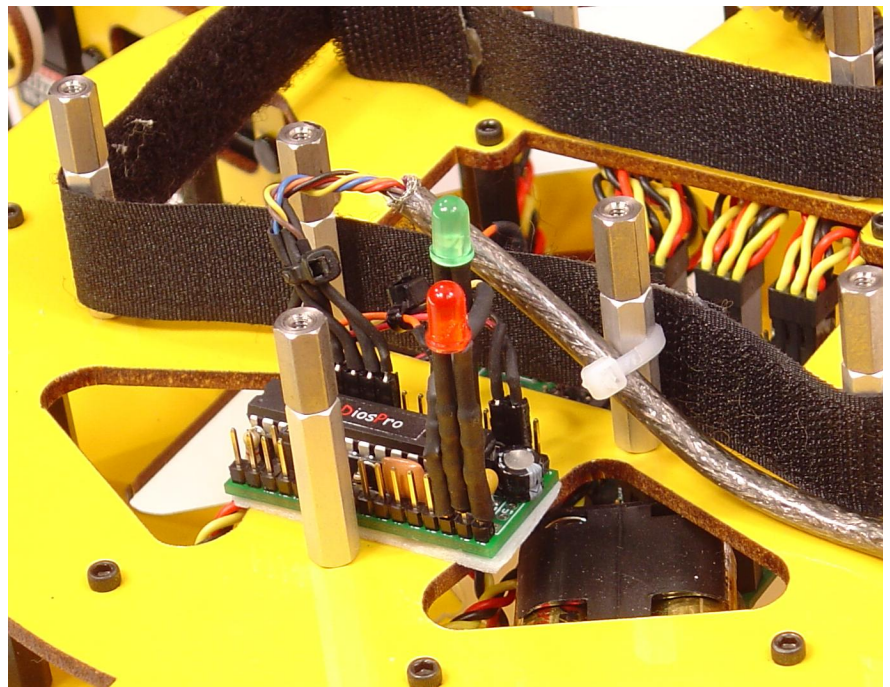


**Figure 3**

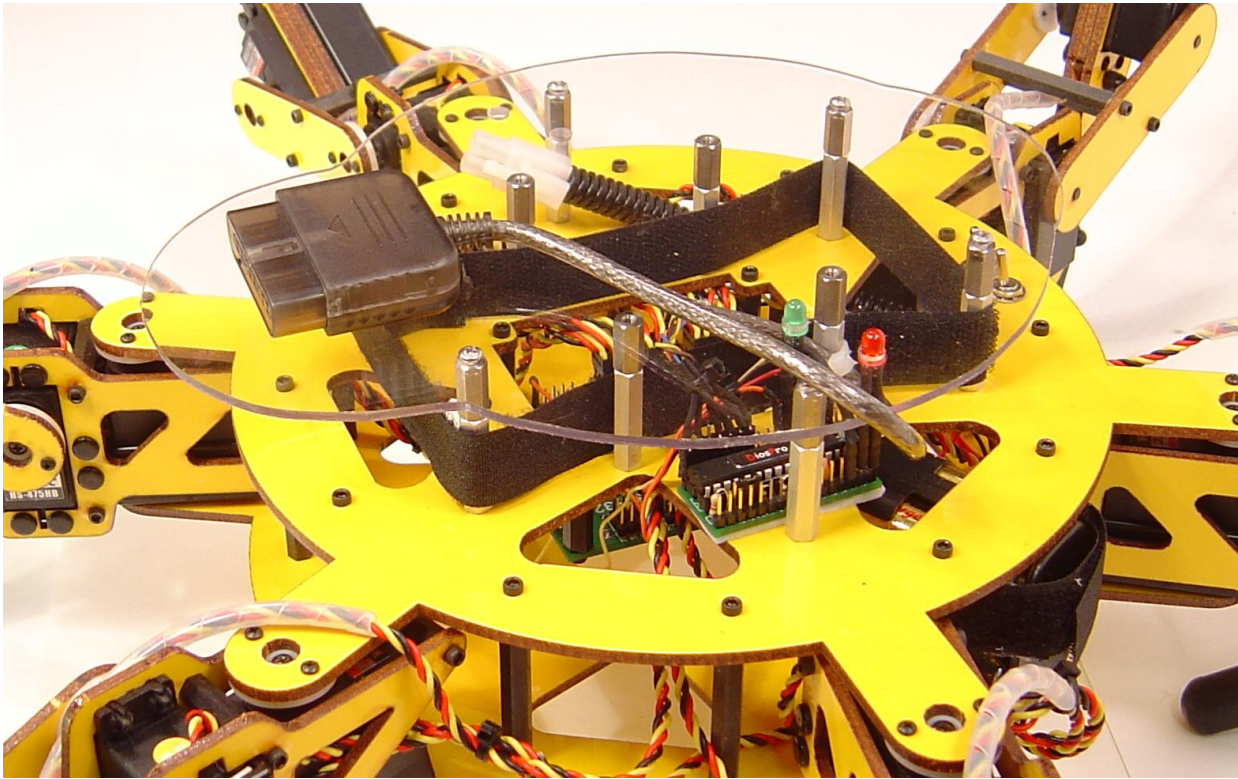
You then place the platform on top of these screws matching up the holes as shown in Figure 3. At this point you can place a small mark on the Lexan over each LED. For standard size LEDs a 7/32" drill bit is perfect but a 1/4" will do if you don't have that size. After this is done you can paint the underside of the platform. Use a paint that was designed for Lexan. You can get this from your local hobby shop as it is what they use to paint RC car bodies.

In Part 2 you added a connector to a PS2 extension cable. It is time to once again connect that connector to the DiosPro. We need to take a small tie wrap and attach the cable to the standoff shown in Figure 4.

This provides some strain relief to the connector that we made back in Part 2. Place a small 1" piece of double stick foam tape on the bottom of the PS2 connector and attach it to the platform as shown in Figure 5.



**Figure 4**



**Figure 5**

To attach the Pocket PC to the platform we need a universal PDA mount like the one shown in Figure 6.



**Figure 6**

These have a flexible ball joint behind the head and the neck can be positioned at any angle. They use a suction cup to hold the mount in place. I have had one of these in my car for years. The connection is quite strong and will last a long time as long as the surface is smooth and clean.

You can find one of these mounts for under \$25 by searching for "Universal PDA Mount" on Amazon. You can also find them in some auto supply stores.

You are not restricted to this mount alone. The main head can be removed and mounted any number of ways. In truth I mounted the head on a shorter cell phone mount on my first FaceWalker. I do recommend, however, that you use the cup for a while until you get your FaceWalker tricked out the way you want. This allows you to remove and reposition the mount as needed.

The actual PDA mount position is a matter of preference, but I placed mine as far back as it would go so that the Pocket PC would be somewhat centered as shown in Figure 7.



**Figure 7**

## Pocket PC Serial Interface Cable

You are going to need a cable that connects your Pocket PC to the Face Walker. Each and every Pocket PC is different and you will have to research your particular model in order to purchase the correct one. Most Pocket PC cables like the one shown in Figure 8 were designed to connect the PDA to the PC. This sets the Pocket PC as a DCE device and will not work when connected to the SSC-32. So for most purchased cables you will need a gender changer and 9-pin null modem.

I attempted to use Bluetooth and a Bluetooth RS232 adapter and had little success. While Bluetooth has some good throughput speeds, I found that it has too much latency when used in an application such as this. Now I'm not saying it can't be done. The other problem that Bluetooth has with operations like this is that if the Pocket PC gets turned off you have to manually go back and reset all the connections making it a pain to set up each time you changed the batteries in the FaceWalker. I also tried IRDA and Zigbee and neither panned out. With all the bad press that RS232 serial IO gets, it provides a very reliable and rock solid interface in applications like this. If you decide to go with a cable like this wrap the excess cable around the neck of the mount and route the cable through the inside of the base along the side of the SCC-32.

## Make Your Own Pocket PC Cable

Another option is to build a cable. If you have a IPAQ Pocket PC then you are in luck. The Kronos Robotics website has a step by step project showing you how to build the cable shown in Figure 9. The advantage to a custom made cable is that it can be made to the exact length and you won't need any gender changers or null modems. You can find the instructions on how to make one of these cables at:

<http://www.kronosrobotics.com/Zeus/IPAQcon.shtml>



**Figure 8**



**Figure 9**

## Some Finishing Touches

Take a look at Figure 10. I added some split loom tubing to the serial cable and the PS2 connector cable. Walkers are notorious for destroying servo cables so I have added thin plastic wrap to all of mine. You can also use thin split loom tubing for this as well.



You may have also noticed in Figure 10 that I am using the shorter cell phone mount. You will still need the standard sized PDA head as the cell phone head is too small to hold a Pocket PC.

## First Test

Before I get into the details of the software let's test the completed FaceWalker from the PC. The FaceWalker Desktop software requires you to have .Net installed on your computer. It will not run without it.

- Install the FaceWalkerDT\_Setup software on your Desktop Computer
- Place the FaceWalker on some sort of stand so that the legs are free to articulate.
- Connect a 9-pin serial cable between the FaceWalker SSC-32 board and the PC.
- Connect a wired or wireless controller to the FaceWalker PS2 connector.
- Power up the logic using the logic power switch.

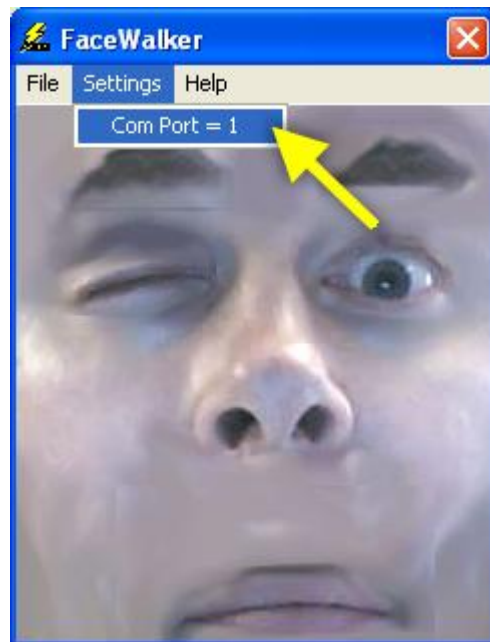
At this point the two LED's should blink then go green.

- Start the FaceWalker\_DT application.

The Red LED should start to flash. If it does not you may need to change the com port as shown in Figure 11. The FaceWalker will wink continuously (Nervous twitch) if it does not have a connection to the PS2 Controller.

- Power up the servos using the servo power switch.

Move the right joystick forward slightly until the legs start to move. Once they do let the joystick move back to the center position. The legs should stop moving. The more you move the joystick the further the leg stride. Try all joystick directions.



**Figure 11**

## Final Pocket PC Hookup

Now its time to connect your Pocket PC to the FaceWalker.

- Install the FaceWalkerPPC\_Setup software. You will need to have your Pocket PC attached to the PC when you run this install.
- Once installed, disconnect the Pocket PC from your Desktop and place it in the PDA Mount on the FaceWalker.
- Connect the Serial cable and any needed adapters to the Pocket PC and SSC-32 board.
- Connect a wired or wireless controller to the FaceWalker PS2 connector.
- Power up the logic using the logic power switch.

At this point the two LED's should blink then go green.

- Start the FaceWalker\_PPC application on your Pocket PC.

The Red LED should start to flash. If it does not you may need to change the com port as shown in Figure 11.

- Power up the servos using the servo power switch.

Move the right joystick forward slightly until the legs start to move. Once they do let the joystick move back to the center position. The legs should stop moving. The more you move the joystick the further the leg stride. Try all joystick directions.

That's it !!!!! Construction is complete. Let's take a look at the software.

## The Software

The FaceWalker brain software is broken down into 4 sections.

- FaceWalker.txt
- WakjerIKLib.txt
- WalkerAnimationLib.txt
- WalkerActionLib.txt

Lets take a look at each section in detail.

### FaceWalker.txt

This is the entry point into the program. It contains the main loop and makes calls to various routines that allow the FaceWalker to operate.

When started, the program initializes various segments of the program and starts the com port. Once done it enters a loop where all the processing in the program is taken care of.

- The first task in the loop is to check the menu to see if we need to change the com port.
- Next we make a call to the animation routines to handle any face changes that were triggered.
- The program then calls the PS2 routines that pulse the DTR lead that singles the DiosPro chip to send us a reading taken from the PS2 controller. A set of 6 global variables called DualShock1-DualShock6 are populated with the current PS2 readings.
- After the buttons are checked and handled, a call to the IK routines are made to process the leg movements.
- The button settings are saved and we start all over and do it again.

## WalkerIKLib.txt

This is the heart of the FaceWalker walking commands. IK stands for Inverse Kinetics. Here is what they do. Instead of using a state machine like many walker programs do, the position of each leg target position is calculated based on the command you have given it. In other words if you are telling the FaceWalker to spin, a mathematical calculation is made to calculate the new position of the leg from its current position.

What this all means is that you can give the face walker the commands to move forward, sideways and spin all at the same time and it will respond. It also means that from just about any position we can go to another position without having to return to a home position. This is not true of most state based walker programs.

And a big thank you to Laurent Gay for originally implementing the IK mathematics behind these walker routines. I simply ported the code to the Zeus language and encapsulated it into the ProIK() subroutine.

## WalkerAnimationLib.txt

This is an animation engine that handles all the sounds and face animations based on tiny lists that are controlled by a state machine.

High level commands like; PlayHello, PlayHey, PlayGetback, PlayMean, PlayCommandAttack are called to load a series of arrays called, Eyecommands, Mouthcommands, and Soundcommands.

These are then played back and choreographed based on the times loaded in their corresponding time arrays. The dofacer() subroutine is used at the gateway into this engine and is called on a regular bases from the main program loop.

## WalkerActionLib.txt

The IK routines are used solely for making the FaceWalker walk. If we want to place the FaceWalker in a defensive stance we need to make a call to the action library. The action library is where any action outside normal walking movement is done. This is done in a couple of ways.

One way is that we simply call a ComOutput command to place the servos in predetermined positions with various delays between the calls. The ACT\_ATTACK command is an example of this type action.

The other way is to use a set of low level action segments. I have added commands like HipV, HipV, and Knee as well as higher level commands like LegUp, LegDown and LegFWD. By calling these commands you can perform movements in loops. The Shy command is an example of this. You could use these commands to place FaceWalkers, belly on the ground then use the legs to create a wave.

The action library is also where we trigger face animations and sound to be played by the animation library.

## FaceWalker Operation

Since we are using a PS2 controller there are quite a few commands you can give the FaceWalker:

### Right Analog Stick

- Left and right cause the FaceWalker to strafe left or right.
- Up and down cause the FaceWalker to move forward and backwards.

The amount of movement is determined by how far you push the stick.

### Left Analog Stick

- Left and right cause the Face Walker to rotate.
- Up and Down set the height of the Face Walker.

### Select Button

- Locks the current height in place. Hitting it again releases it.

### Digital KeyPad

- Left and right set the number of steps needed to make a leg movement. The lower the number the faster the legs will get to their positions. For Pocket PCs this is set to 4, and for Desktop machines this is set to 8 at program startup.
- Up and down set the amount of leg lift, the Face walker uses. By adjusting this value and slowing down the Face Walkers speed you could make him tip toe.

### Triangle Button

- Slows down the overall servo speed.

### X Button

- Speeds up the overall servos speed.

### Square Button

- Face says "Hey"

### Circle Button

- Face says "Hello"

### R1 Button

- Attack Mode

### R2 button

- Shy Mode

### L1 Button

- Cycle through commands. FaceWalker Face will say the command.

### L2 Button

- Do the command.

Many of these commands were created for the Robot Fest. Feel free to modify them for your own needs.

## Final Thoughts

The FaceWalker has performed flawlessly. It has proven the attention getter it was designed to be. I have even taken it to non robotic shows and it has never failed at stealing the show.

## Going Further

The Action and Animation libraries were designed with expansion in mind. Take a look at the code and start playing around.

The DiosPro microcontroller's power has barely been tapped. It would be very easy to add some sensors to this interface such as a Sonar. Once done you could start to add automation to your FaceWalker. It is absolutely feasible to make the FaceWalker totally automated.

I have also created a project called the DiosWalker. This version uses DiosPro chips only.

<http://www.kronosrobotics.com/Projects/DiosWalker.shtml>

## Parts

All the source as well as the exe files can be found for this project on the kronosrobotics website at:

<http://www.kronosrobotics.com/Projects/FaceWalkerP3Files.zip>

### **KRMicros [www.krmicros.com](http://www.krmicros.com)**

- ZeusPro <http://www.krmicros.com/Development/ZeusPro/ZeusPro.htm>

### **Other**

- Double stick foam tape. 1, 1" piece should do it. Any department store or home center will carry this. A popular brand name is 3M.
- Tie Wraps. You may need a couple of these to anchor some of the cables. You can pick these up at most home centers.
- 8" x 10" Sheet of 1/8" Lexan. You can pick up cut sheets at most home centers.
- Universal PDA Mount. Perform a search on Amazon.com for 'Universal PDA Mount'
- Pocket PC Serial Cable. You will have to check with your Pocket PC manufacture.
- 9-pin Null Modem. You will need this if you purchase a serial cable designed to connect your Pocket PC to a Desktop PC. Check [www.jameco.com](http://www.jameco.com) for this.
- 9-pin Female to Female Gender Changer. You will need this if you purchase a serial cable designed to connect your Pocket PC to a Desktop PC. Check [www.jameco.com](http://www.jameco.com) for this.
- Split loom tubing. This is needed only if you want to hide or protect some of the cables. Most home centers carry this in the electrical section.