ScoutWalker 2.2/SunSeeker Adaption

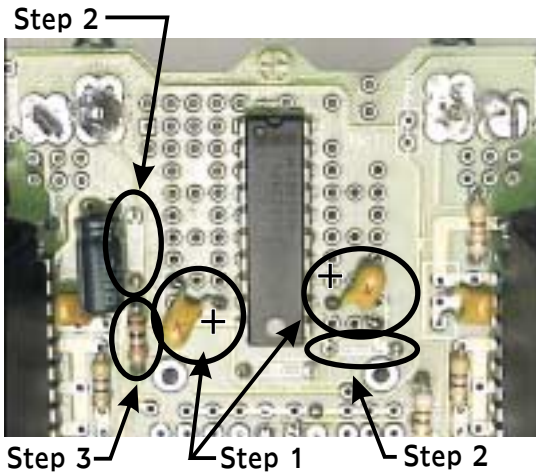
October 29, 2001

The ScoutWalker is essentially a blind robot with touch sensors, capable of bumping into things, and moving out the way to carry on its mission to....walk. The SunSeeker Head is a device that loves to look around, and lock onto the brightest thing it can find. What happens when we join these two separate robots together? A walking robot with a very interesting personality; something that moves around its environment, stopping occasionally to soak in the scenery!

We will be using the built-in capabilities of the ScoutWalker 2.2 to mount the SunSeeker on its back, give it power, and translate the signals from the head into information the robot can use to hunt out sources of light. By design, it will walk for several seconds, stop, look around for several seconds, then continue on its way. If you have ever watched crawling insects, you will notice that they follow a similar pattern of behavior. The stop/look/continue strategy allows it to analyse its environment without the additional "noise" that the walking motion introduces. Ever try to read a book while sitting at the back of the bus? Lot harder than while sitting at your desk!

Parts List:

3 x diodes	2 x 240kOhm (Red/Yel/Yel)	1 x 1.0M Ohm (Br/Blk/Grn)	2 x 1-1/2" Length Solid Core Wire
4 x nylon standoffs	1 x 2.2M Ohm (Red/Red/Grn)	1 x 1k Ohm (Brn/Blk/Red)	
4 x #2-56 x 3/4" Bolts	1 x 100 Ohm (Br/Blk/Br)	1 x 6" Length 4 Conductor Wire	2 x 6.8μF capacitors
4 x #2 Nuts	1 x 2.0M Ohm (Red/Blk/Grn)	1 x 1-1/4" Length Rod	4 x Socket Pins



1 ☐

Start by removing the forward battery pack, revealing the 74AC240 underneath. Solder the 6.8uF tantalum capacitors onto the pads shown ('C2'), but BE CAREFUL of the polarity. Make sure they go in as shown, with the '+' mark on the capacitor going where labeled.

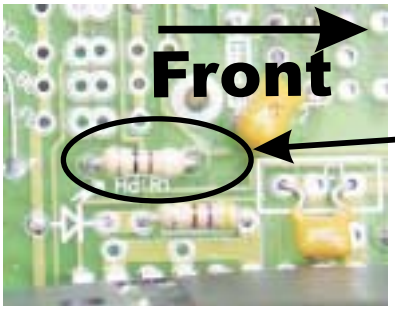
2 ☐

Add socket pins at the locations labeled 'Head R' and 'Walk R', **on the other side.** You'll be adding resistors to these locations later.

These capacitors and resistors set the amount of time the robot spends between looking around and walking. Reducing the value of the resistor makes it spend an accordingly smaller amount of time doing that particular activity.

3 ☐

Add the 1K resistor at the place labeled "R11". This resistor connects the head/body oscillator Bicore to the enable lines of each motor Bicore. When the oscillator goes "high" (+) through this resistor, it shuts off the motors.



4 ☐

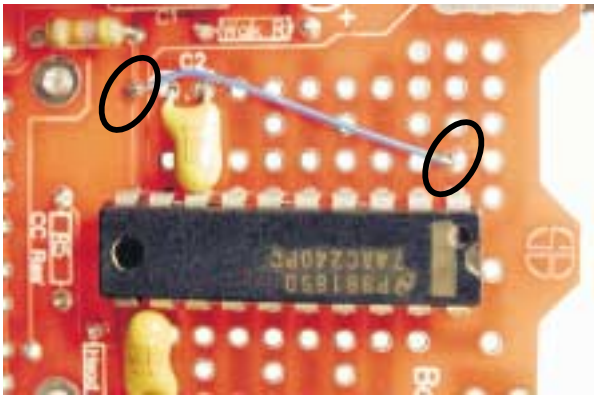
Remove the forward battery pack.

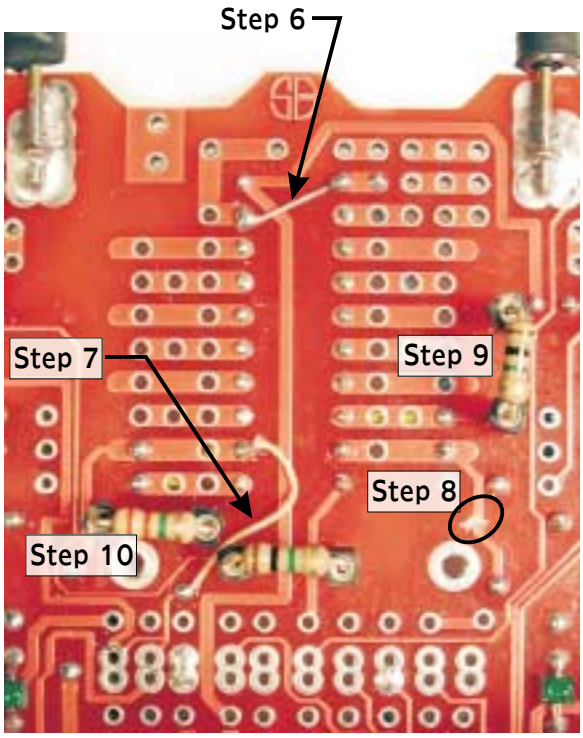
Install the 100 ohm resistor in the location marked 'Hd R1'. This will provide power to the SunSeeker in regular intervals.

ScoutWalker 2.2/SunSeeker Adaption

5 ☐

Add the jumper wire shown to the pads circled. This is the first step in "enabling" the chip. It already has power, but it still has to be told to "turn on".





6 ☐

Take a bit of wire (one of the extra bits of resistor leg works well) and solder it across the two points shown. The 74AC240 has two "enable" inputs, so this activates both at the same time.

7 ☐

Run another piece of wire (not resistor leg - something with insulation on it, please) across the two pads shown. This sets up the circuit for alternately activating the head, then the walker.

8 ☐

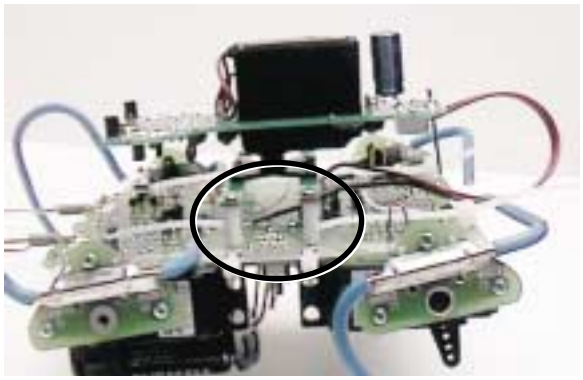
Using a sharp knife, cut the trace shown right through. Make sure you can see the dull yellow of the circuit board substrate underneath. This fixes a production error that made both the head *and* the walker turn on at the same times (fixed in the previous step

9 ☐

Install the socket pins and add the 2.2Meg resistor (Rd/Rd/Gn). The one on the right side controls how long the ScoutWalker will stay in walking mode.

10 ☐

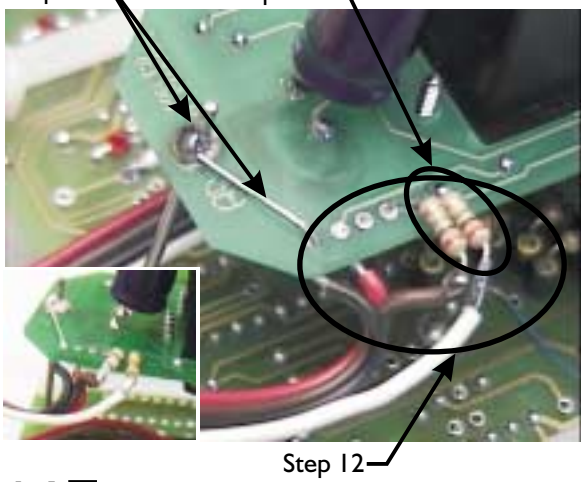
Install the socket pins and add the 1.0 Meg resistor (Br/Bl/Gn). This resistor controls how long the head is active. The whole point of including the socket pins for these resistors is so you can easily modify the tine durations - use them! Experiment! See what varying these resistor values do for the overall performance o f the robot.



11 ☐

Use the included 2-56 x 3/4" screws with the nylon standoffs and nuts to mount the SunSeeker to the ScoutWalker body. You will find four small holes very close to the servo ziptie holes - this is where the mounting bolts go through. You may find them to be somewhat tight, so if you want, you can just screw the bolts directly into these holes without the nuts. This isn't as secure as *with* the nuts, but do what you have to do!

ScoutWalker 2.2/SunSeeker Adaption



12 ☐

Now that you have your two robots bolted together, your next task is to get them to talk to each other. The first thing to do is to take the rod and solder it into the large hole at the rear of the SunSeeker. Locate it so that about 3mm (1/8") sticks out of the top of the SunSeeker PCB. Then use a resistor clipping to electrically connect it to the ground pad to its right.

13 ☐

Solder the two 240k resistors on the top two interface pads as shown. Yes, it looks strange. Solder only *one* of the resistor to each pad, and clip **most** of the other end off so you can solder wires to the stubs.

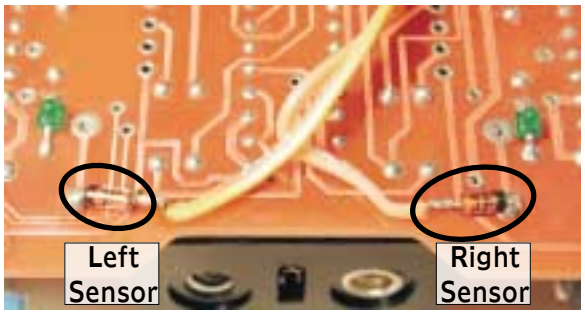
14 ☐

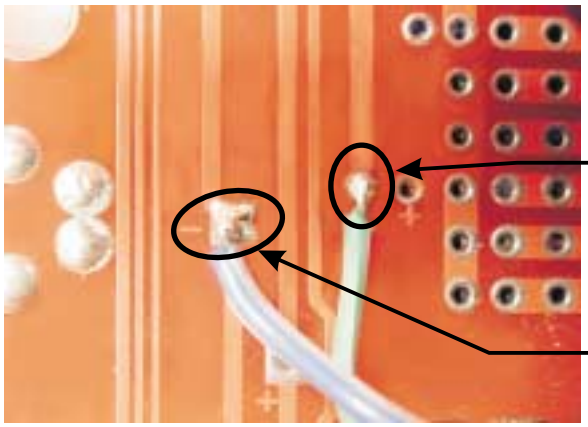
Take your 4-conductor ribbon cable and split the individual strands off in 10mm (3/8") stubs. Pick which colors you want to represent negative, positive, left, and right, and solder them to the interface pads. The top pad is the right signal line, the second is the left signal line. The **bottom** pad is negative, and the next one up is positive.

(Optional) You may want to remove the solarcell off the front of your SunSeeker, as it *consumes* a small amount of power when being powered by the ScoutWalker's battery.

15 ☐

It is *very important* to not to forget the diodes in this step. Solder each diode in place, each on a pad for that side's "turn gate" pad. Note the orientation of the diode, with the cathode (stripe) being closest to the pad. The other side of the diode is soldered to the signal line going to the SunSeeker.





16 ☐ (Left side of center breadboarding space)

Solder the third wire (positive power) to the square pad on the right side as located here. MAKE SURE it isn't the pad directly above the "+", otherwise your SunSeeker will be waaaay overpowered. The pad show here is the one connected to the 100 ohm resistor you previously installed.

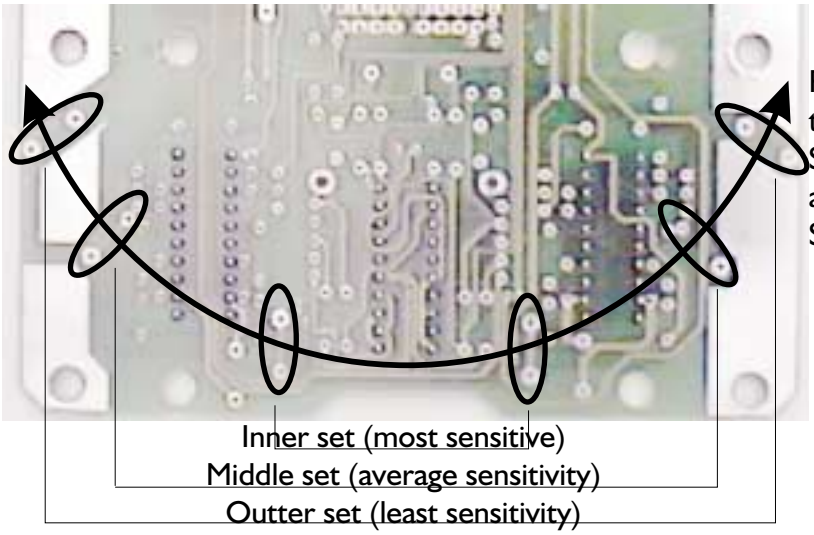
Solder the fourth wire (negative / ground) to this pad located here.

17 ☐

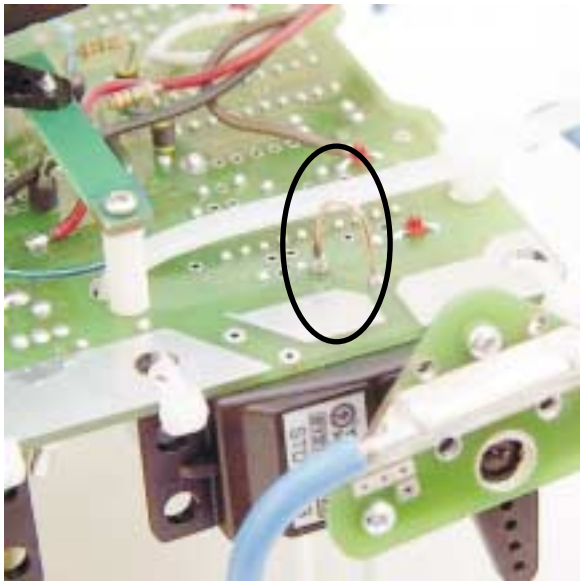
Now to the crux of the matter - exactly *how do you* get the SunSeeker Head to tell the ScoutWalker body when to turn?

That pin you soldered onto the rear of the SunSeeker is going to close a circuit on the ScoutWalker which is the same as activating the appropriate touch sensor, which in turn makes the robot turn. You can select how sensitive your head will be to imbalances in light by where you mount the 'limit gates' on the ScoutWalker body. These are loops of stiff wire you mount on the appropriate pair of attachment points at the rear of the ScoutWalker body.

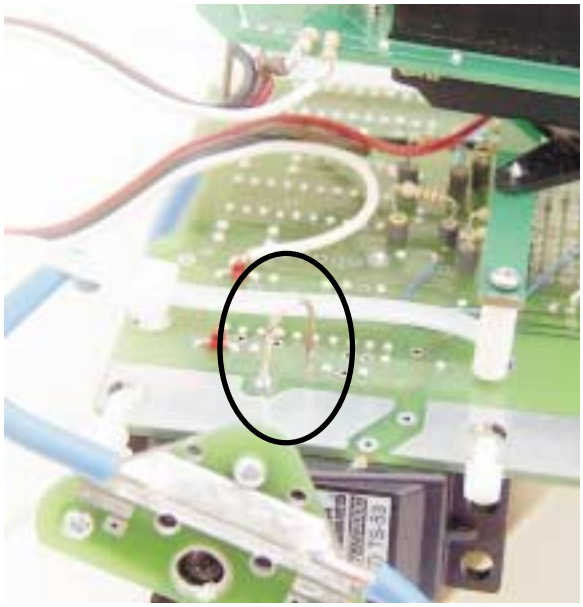
We have made three ranges of sensitivity available to you at this point. You may want to start with the default position of using the middle set of gates, as we have found them to be quite effective at making the ScoutWalker go towards light, but still allow some leeway for general exploration. But do feel free to experiment with the other gate positions.



Path that the pin on the rear of the SunSeeker head takes across the body of the ScoutWalker



Rear left gate installation



Rear right gate installation

Here are some close-ups of the installation of the gate wires. Note that they have to be tall enough to contact the pin on the rear of the SunSeeker head, otherwise the pin may have to be lengthened.

Where do I go from here?

Now that you have all the necessary components mounted as to make your robot light-seeking, you have a very interesting base to start performing experiments on.

When you first turn it on, you will see that it first looks around before starting to move. Use this opportunity to make sure that your SunSeeker head is still tracking true, and make any minor adjustments (if any) to make it look for sources of light.

When it does start turning towards a light source, you will see the rear pin contact a gate, and one of the front tactile sensor lights will come on. When this happens, the head is designed to 'back off' from the gait momentarily, so it doesn't send a continuous signal to the ScoutWalker body even when the head is in the "off" state. This 'back-off' behavior is governed by the two 240k resistors that are soldered to the head and the ribbon cable - try using different values if you want to adjust the 'back-off' distance.

Feel free to adjust the 'Walk R' and 'Head R' resistor values. These will let you change how long your robot spends walking versus looking around. The larger the resistor value, the longer it spends doing that particular activity. In fact, if you wish to lock your new robot into only one of the modes (looking or walking), just remove the associated resistor, and it will never progress to the other state. Ie.: Remove the 'Walk R' resistor to make it walk continuously, without stopping and activating the head ever again. This is useful for diagnosing leg problems, or for tuning the head light-seeking ability.

Other projects you may want to think about adding to your new light-seeking ScoutWalker include:

1) Keep the solarcell on the SunSeeker head, and figure out a way to route the power from the head indicator LEDs to the main walker storage batteries (assuming you've put in Nicads). This will make a robot with a light-tracking head that will try to keep the batteries automatically charged up all the time.

2) Relocate the optical sensors on the head to the underside of the head PCB, or build little light-shades around them so they aren't sensitive to overhead lighting. Or try twisting the eyes in different directions.

3) Figure out a way to mount your own little 'headlights' on the top of the SunSeeker, and turn them on when the light level falls below a certain threshold. Then it will be able to see and chase objects it sees at night! If you want to avoid hitting these objects, figure out a way to swap the 'left' and 'right' sensor connections from the head to the body.

(Other general robot modification ideas)
4) Use the general breadboard area in the middle of the robot body to build a circuit with a mercury switch so that the ScoutWalker automatically goes into reverse if it climbs too steep of a hill.

5) Try adding additional touch sensors to the leg-mounting pads right on the servos. There are extra pads there to facilitate experimentation.

6) Build a 'look-down' sensor that will keep the ScoutWalker from walking off the edge of a table.

7) Add 'active' light-seeking sensors to the SunSeeker, so it uses modulated IR emitters and detectors to scan it's environment for obstacles it can't see with the standard passive IR detectors.

The breadboard in the middle of the ScoutWalker body is designed to easily facilitate at most another 20-pin chip of some sort (ie: like the other 74AC240's on the board). Power and ground connections are near to where they need to be to give such a chip power. Additionally, you have the extra logic gates on the 74AC240 chip at the top middle of the board - perhaps these can be used in some sort of clever manner. Come up with a new an clever idea, and let us know - we'd love to hear how you've hacked your ScoutWalker/SunSeeker combination!

Solarbotics Ltd.

ScoutWalker 2.2/SunSeeker Adaption