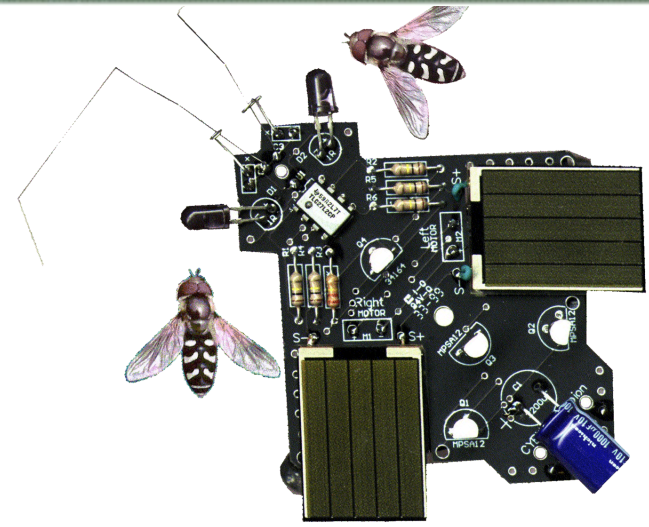
Cybug SolarFly Classic

Solar Powered Insectoid

BIO-MECH ROBOT KIT

HTTP://WWW.JCMEDUCATION.COM



The CYBUG Solarfly is a robotic lifeform whose energy source comes directly from the energy of the sun. Always in search of a better feeding area, this CYBUG will explore it's surroundings always heading toward the sunniest spot it can find. Sensitive feelers help it navigate its way around obstacles!

Inside this kit you'll find a step-by-step set of instructions on how to assemble this robot, and information on how it operates.

Made in Canada © 2024

Check your kit

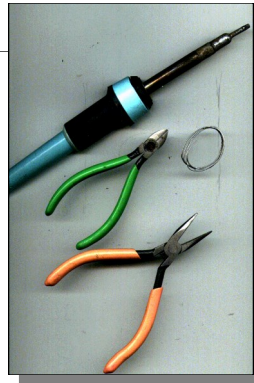
Before we begin assembly, it's a good idea that you inspect the kit's contents, and make sure you have the necessary tools to put this project together.

This kit should take a novice about 2 hours to assemble.

Tools

You will need the following tools not included in this kit...

- Soldering iron with fine point tip (electronics grade soldering pencil 35W, or solder station preferred. The better the iron, the easier the build.
- Needle nose pliers
- Side cutters
- Tape (Preferably black electrical tape)
- Solder
- Clean work surface in bright well ventilated area.
- **SAFETY GLASSES**



ASSEMBLY NOTES

Caution:

Building an electronic project is enjoyable, but please resist the temptation to hurry ahead and omit instruction steps. Please be sure that you:

- Read all instructions carefully.
- Read the entire step before you perform each operation.
- Be careful when handling hot soldering iron. Tip temperature may approach 700° F.
- Make certain that you **WEAR APPROPRIATE SAFETY GLASSES AT ALL TIMES** and work in a well ventilated area.

When cutting wires, make sure that the cut end is directed away from everyone.

PARTs

Check the following list to make sure your kit is complete

☐	1	Printed Circuit Board
☐	2	Solar Cells
☐	2	Infra-red LED
☐	1	Steel guitar string
☐	1	TLC27L2 operational amplifier
☐	1	MC34164P-3 voltage detector
☐	3	MPSA12 high speed darlington transistors
☐	1	2200 uF Capacitor
☐	2	1uF Capacitor
☐	2	DC Motors
☐	2	Plastic wheels
☐	4	Motor Mount Screws
☐	1	Motor bracket
☐	5	100K Resistors (Brown Black Yellow Gold)
☐	1	220K Resistors (Red Red Yellow Gold)
☐	1	6 inch length of wire
☐	1	Bracket Mount Screw/Nut
☐	1	length of brass wire

Safety notes

Please read the following information concerning safety...

- Where **safety glasses** at all times.
- When clipping wires, **do not direct clippings toward any person.**
- Be careful when handling steel guitar string: the ends are quite sharp.
- Exercise caution at all times when handling soldering iron. The end is very hot.
- Work in a well ventilated area: avoid breathing solder fumes.
- Wash hands after each session. (Solder has a lead content)

Soldering

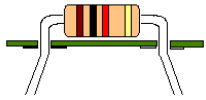
Soldering is the most important operation you will perform while constructing this kit. A good solder connection will ensure a solid electrical connection between the part and the circuit board. A bad solder joint can prevent an otherwise well assembled kit from functioning properly.

It is simple to make a good solder connection if you follow a ***few simple rules:***

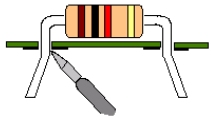
1. Use the right type of soldering iron. A 25 to 40 Watt pencil type iron intended for electronic work with a 1/8" pointed tip works best. Use a rosin-core solder on diameter approximately .0.081 mm and a 60/40 lead/tin ratio.
2. Keep the soldering tip clean by wiping it frequently on a wet sponge or cloth: then apply solder to the tip to give the entire tip a *wet* look. (Tinning the tip) When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and re-tinned.

How to Solder

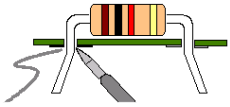
- Install the component on the board, flaring the leads on bottom side slightly (so the part does not fall out when the board is flipped!) Flip the board upside down.
- Touch the freshly tinned solder to the point where the component wire meets the board. Hold for 1 second!
- Touch the solder to the opposite side of the component wire/board junction and allow solder to melt and surround pad entirely.



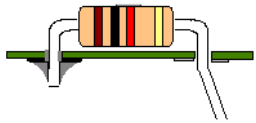
- Remove solder and soldering iron by dragging iron up the component wire.
- Clip off excess component wire



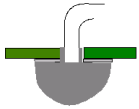
Getting the perfect amount of solder is key to An effective solder joint!



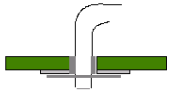
How do you know when you made a good connection?



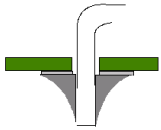
Too much Solder? You get an "igloo"



Too Little Solder? Solder will lie flat like a pancake.



Just the right amount? Solder will look like a volcano!



Always be on the watch for solder splashes or sloppy connections which can short against it's neighbor. These will certainly effect the operation of your kit

Please follow all instructions carefully, and be very careful that you use safety glasses at all times when building your kit! Be careful when handling your soldering iron… the tip is very hot!

Start here...

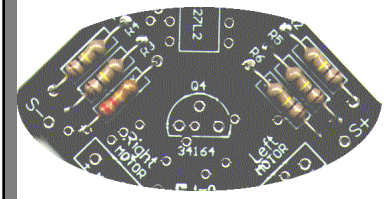
It's time to start putting together your new kit! Please follow all instructions carefully, and in sequence. Remember: Soldering irons are **hot**! Work in a well ventilated area and avoid breathing fumes. Wear **safety glasses** at all times to avoid eye injury by flying clippings or solder splashes. Take your time, and have fun. Once built, your CYBUG Solarfly will last for years!

1

Insert Resistors R1 through R6.

- R1,R2,R4,R5,R6 = 100K ohm (Brown, Black, Yellow, Gold)
- R3 = 220K ohm (Red, Red, Yellow, Gold)

Gently bend leads 90 degree's with needle-nose pliers and insert in hole. (There is no polarity) Solder leads and clip excess leads off.



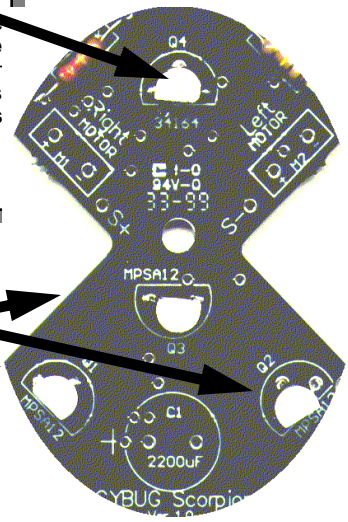
2

Caution: Polarity Sensitive Device

NOTE: This transistor looks just like the MPSA12 !

DON'T MIX THEM UP!

The MC34164 (Q4) voltage monitor is placed here!. **Note the direction of the flat side corresponds to the flat side of the silkscreen.** (The top of this part has been painted white for clarity). Leave 5mm of lead length between the bottom of this part and the printed circuit board. (**Use the three large holes in the triangle shape**) Solder and clip off excess lead.



3

Caution: Polarity Sensitive Device

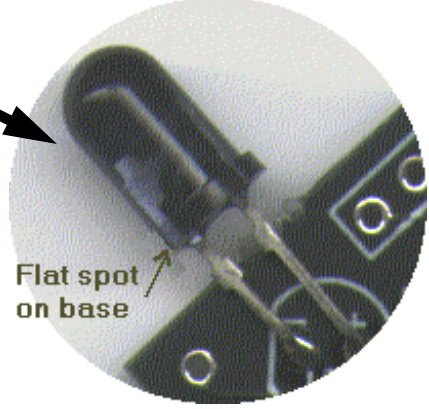
Insert the three MPSA12 transistors (Q1, Q2 and Q3) in the locations marked on the PCB. Again, lead a 5mm gap between the parts body and the circuit board.

Solder and cut off excess leads

4

Caution: Polarity Sensitive Device

Insert both IR (Infra-red) receivers with the camphor (flat spot) on the base to the left as shown. Leave 1 cm of lead remaining and bend these IR receivers to face forward and outward at a 45 degree angle as shown. Solder and clip excess leads.

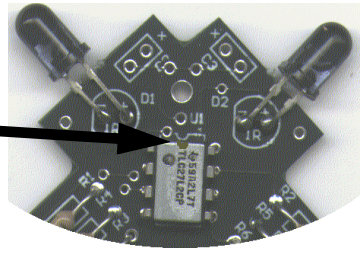


5

Caution: Polarity Sensitive Device

Install U1: The 8 pin operational amplifier and socket (TLC27L2).

BE CAREFUL. The notch at the top of the silkscreen must match the notch at the top of the chip. Solder. *If there is no notch, then it should have a small circular mold mark by pin 1... This should go to the upper left .*



6

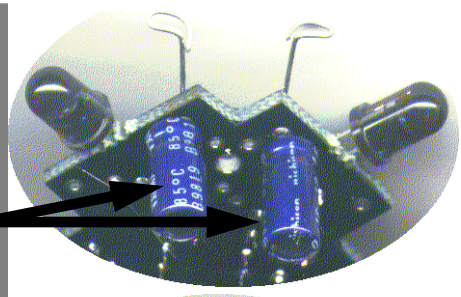
Caution: Polarity Sensitive Device

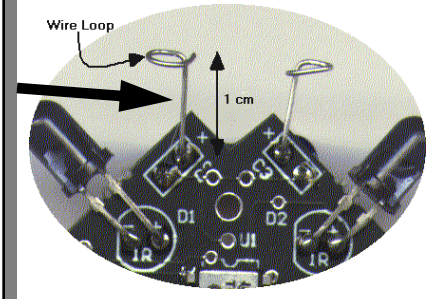
Insert the two 1uF capacitors (C2, C3) with the positive side of the capacitor in the holes marked with the + sign. (The capacitor clearly identifies the negative lead. The **other one** is the positive lead!)

These components are to be installed on the **bottom side** of the circuit board! Solder. (**Do NOT CUT**)

Bend the **inside excess lead** (the lead closest to the + symbol on the silkscreen) of each capacitor so it is facing straight forward. Use pliers to create a small loop about 1cm from the bend as shown in the graphic. This loop will be used with the touch sensors in your Solarfly.

Clip off outside leads of each capacitor at the circuit board

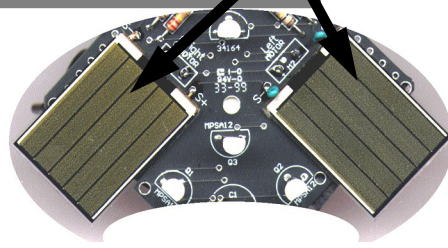




7 Attach Solar Cells...

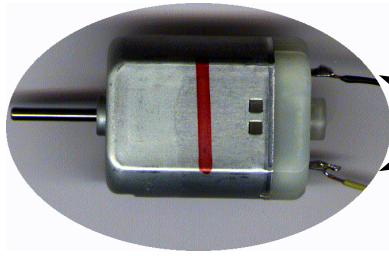
Strip the insulation off four 1 cm lengths of wire. Carefully solder the wire to the solar cells + and - solder pads.

Place the two solar cells on the circuit board, with the wires going into the holes marked S- and S+. Solder wires onto circuit board. Attach the solar cells to the PCB using tape along the underside of each panel to the underside of the printed circuit board



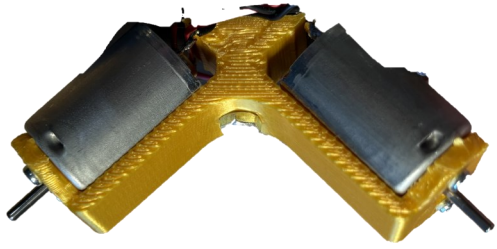
8 Installing the motors...

Solder two 8 cm lengths of wire to each of the terminals on the two motors. *Note which terminal has the red dot beside it.* (This is the positive terminal)



Installing the motors...

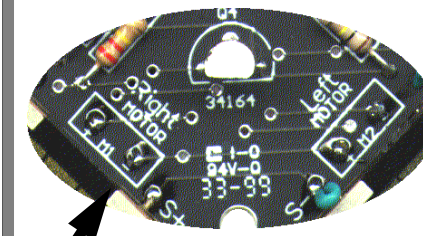
Using the four screws provided, attach the motors to the plastic motor bracket.



Polarity Sensitive! Remember that the motor terminal with the RED dot is positive (+).

Solder the other end of the 8 cm motor wires to the circuit board pads marked M1 and M2. The pad with the + must go to the side of the motor with the RED DOT. The - pad goes to the other motor terminal

*Note: There must be **a crossover**... The leads from the right side motor are to be contacted to M1 (on the left side of the board) and the leads from the left side motor are connected to M2 (on the right side of the board).*



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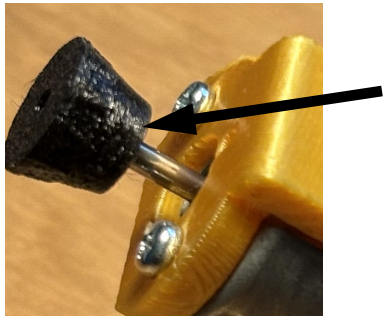
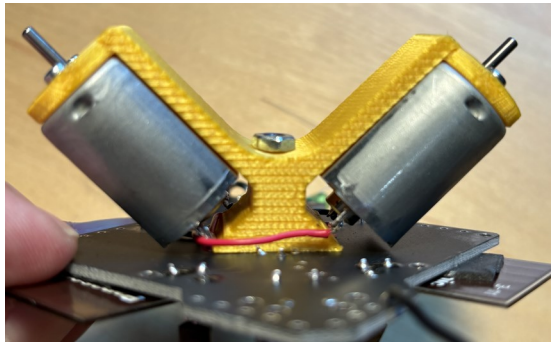


Attach the wheels...

Press the small black plastic wheels onto the motor shafts. If you want a faster action, put them on with the larger diameter to the outside!



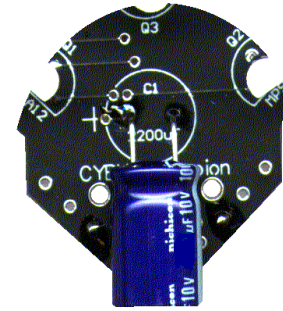
Attach the mounting bracket...

Using the nut and long bolt, attach the motor bracket to the underside of the Solarfly. Remember that the motors are crossed over, so the left motor wires go to the right motor connector on the PCB!

11

Caution: Polarity sensitive component

Insert the large capacitor in the rear of the CYBUG at the location marked as C1. The side of the capacitor with the white bar is the negative side, and should go in the right-most hole. You may either install the capacitor standing vertically or lay it horizontally.



Working with steel wire...

The feeler and antennae wires in the CYBUG Solarfly are made from spring-steel guitar string wire (0.010mil) and is very tough and resilient.

It will probably nick your pliers when you cut this wire, so you might want to find a less desirable pair when working with this material. (You might also try cutting the wire by bending it sharply many times in the same spot until it breaks.) Always keep track of cut pieces since this wire can also be rather sharp on the ends. Never direct cuttings toward anybody including yourself. The flying pieces can move very quickly.

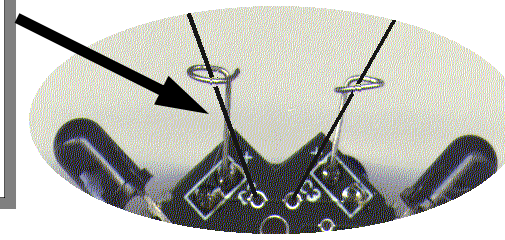
Bends may be made and corrected by using pliers.

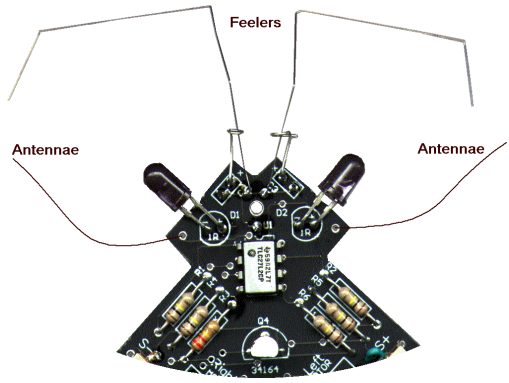
12

Create a sharp 90 degree bend (5mm long) in the end of a 12 cm piece of steel guitar string.

Thread that end through the left feeler loop and solder it to the pad beside the marking C2 on the printed circuit board.

Repeat the process for a right feeler, this time using the pad by the C3 designator.





13

Bend the feeler wires in a fashion similar to the above graphic. It is recommended that the feelers extend forward about 5 cm before bending left or right. You may choose to put a downward bend about 3cm from the front of the robot so the Solarfly can detect obstacles closer to the ground.

Carefully adjust the position of the feeler loops so that the feeler wires pass directly through them without actually touching them. When the feelers bump an object, they should touch the loops, alerting our robot.

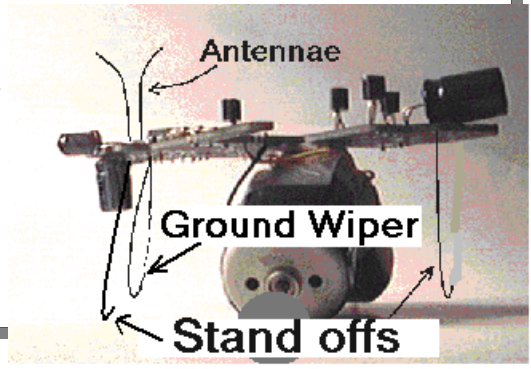
Solder two 7 cm pieces of steel wire into the left and rightmost pads of the head and allow them to extend straight up. These are the power pickup antennae which allows the Solarfly to energize from the Sunflower Power Plant (Optional)

14

Install the stand-offs

Using two 8 cm lengths of brass wire, build a front and rear stand-off to prevent the robot from tipping forward and backward. Use the large pad in the middle of the Scorpion head and the two small pads at the very end of the Scorpion to secure the loops of brass wire.

Using a 5cm length of steel guitar string wire, solder a ground wiper from the small pad just above U1 and extending vertically downward. This will be used if you wish to create a feeding station for your robot.



All done!

Your CYBUG Solarfly is completed now, and is ready to roll! If everything went well, it should look similar to this Solarfly. Like real Solarflys, this robot is attracted to sunlight or bright objects... the brighter the better. It's infra-red sensitive eyes should keep the robot running toward any bright object it encounters, and the feelers will signal the robot to turn away from any object it should encounter.

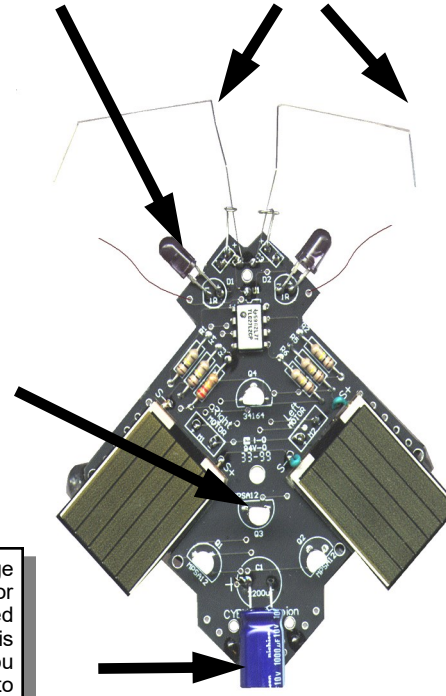
Here's a breakdown of your artificial lifeforms anatomy, and how it compares with a real bug.

Touch

These long touch sensors detect an object when they are pushed against the sensor loops. This discharges the memory capacitor on that side, causing the robot to move in the opposite direction

Sight

The Solarflys sense of sight is provided by a pair of Infra-red (heat) transmitters. These components produce a tiny voltage which is proportional to the amount of infra-red light received. You can find transmitters like these in any remote control!



Nerves

These devices are called darlington transistors and are responsible for channeling the energy from the Solarflys stomach to one of the motors (as directed by the "brain")

Stomach

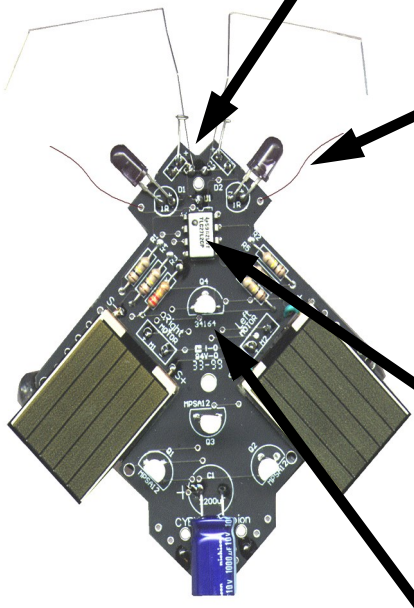
The stomach of this robot is this large capacitor. It is a storage reservoir for electrons, and holds the charge provided by the solar cells until the brain decides there is enough power to send it to one of the motors. You can double or triple the size of this capacitor to increase the size of the motor steps, but time between steps will increase too!

Memory

The capacitors C1 and C2 (underside) are charged by the IR “eyes” and will temporarily hold the last voltage level if the light should momentarily go away. When the touch sensor makes contact, this capacitor will discharge to zero volts, and very slowly charge back up when the feeler is released. This will keep the Solarfly turning away from the obstacle for a while after the touch sensor is released.

Antennae

The antennae on the Solarfly are used to couple external power (from the optional Sunflower Power-plant) to the Solarfly’s stomach (storage capacitor). This provides extra energy for more activity.



Brains

The “brain” of the Solarfly is a special kind of operational amplifier called a “comparator”. It compares the voltage level of each eye/memory element to the other, and instructs the darlingtons (see nerves) to power the motor opposite the brightest source. This causes the robot to move in that direction.

Heart

The heart of the Solarfly is based on the “Chloroplast Solar Engine”. This circuit monitors the voltage across the capacitor C1 as it charges from the solar cells. When the voltage reaches a sufficient level (around 7V) the circuit will discharge the capacitors voltage across the motor until the voltage drops to 5V. At 5V the Chloroplast will stop discharge, and resume charging the capacitor.

Theory of operation

For those of you more technically inclined, here's how your Solarfly works!

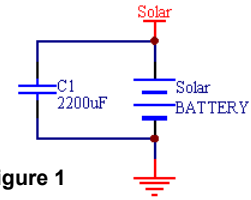


Figure 1

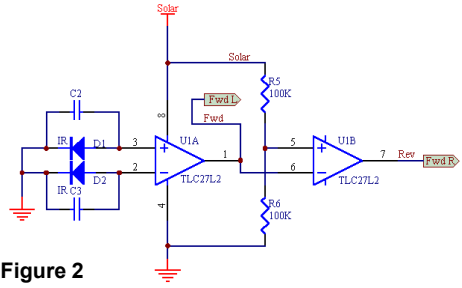


Figure 2

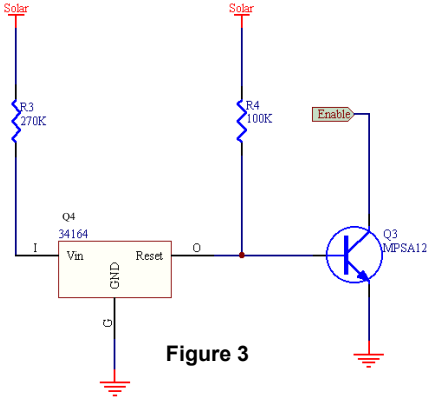


Figure 3

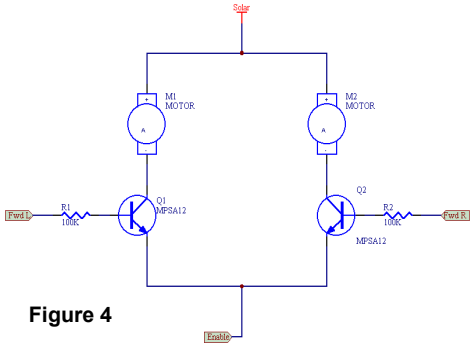


Figure 4

The solar cell in **figure 1** charges the capacitor in parallel with it. As the voltage across that capacitor reaches nearly 7V, the output of the voltage detector circuit in **figure 3** opens, which permits Q3 to be turned on by the pull up resistor R4. This Q3 provides a path to ground for the motor, which is also connected to the charged capacitor C1. One of the motors runs and discharges the capacitor. The capacitor C1 will continue to discharge until the voltage detector (Q4) detects 5V across C1. At that point the output of Q8 will go low, turning off Q3, and disabling the motor. This is the basic chloroplast circuit.

Meanwhile, in **figure 2**, the comparator circuit is monitoring the voltage of each of the IR diodes at it's input (the higher the light level at the diodes input, the higher the voltage.) The capacitors C2 and C3 function to decrease the response speed of the voltage change, and provide a bit of "memory" for each light sensor. The output of the comparator will either turn on Q1 or Q2 (**figure 4**), which determines which motor will receive the solar energy which the "chloroplast" discharges.

If you wish more complete description of the Solarflys operation, please contact JCM Electronic Services at the address on this booklets last page, or visit...

http://www.jcmeducation.com

Turning it loose!

It's time to turn your Solarfly loose on the world! Place it on a smooth surface outside in the brightest sunlight you can find for best response. You robot should begin moving within a few seconds, and explore it's new environment, looking for the brightest thing it can see.

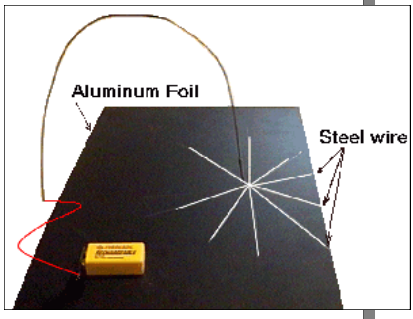
If you touch one of the feelers (so it touches against the feeler loop) you should see the motor on the opposite side disabled and the robot turn away from the object. Remember, the smaller the feeler loop, the more sensitive the touch!

If the robot doesn't seem to operate correctly, take the following steps...
Remember the Solarfly is optimized for direct sunlight, and won't work under normal room light.
Make sure the touch feelers passes directly through the middle of the feeler loops, and does not touch the loop itself unless the robot bumps into something.
Make sure both solar panels are totally illuminated, and that a shadow is not covering part of either of the solar panels.
Check your solder joints carefully to make sure that there are no shorts or solder splashes.

If it still acts up, contact JCM Electronic Services and we'd be pleased to help!

Try building a **feeding station** for your Solarfly as follows...

1 Lay down an aluminum foil sheet on the floor of it's habitat to act as a ground plane.
2 Cut four 18 cm lengths of steel guitar string wire and solder them all together in the middle. Spread out the wires until they form a star shape as shown in the graphic. This will be the **feeding array**.
3 Use a long stiff copper wire (or coat hanger) bent in an large inverted "J" to support a star shaped feeding array horizontally 10 cm over the foil sheet as shown in the graphic.
4 Attach the positive pole of a small 9V battery to the feeding array, and the negative pole to the aluminum ground plane. **Never let the J shaped wire or the positive star-shaped feeding array make electrical contact with the ground plane foil or you will short out your battery**.
5 Hang a small strip of white tissue from the middle of the feeding array to attract the Solarfly toward the center.



When your Solarfly touches it's antennae to the feeding stations star it will move considerably faster.

Try increasing the size of C1. Larger sizes will produce longer delays between each step for the Solarfly, but the steps themselves will be much larger.

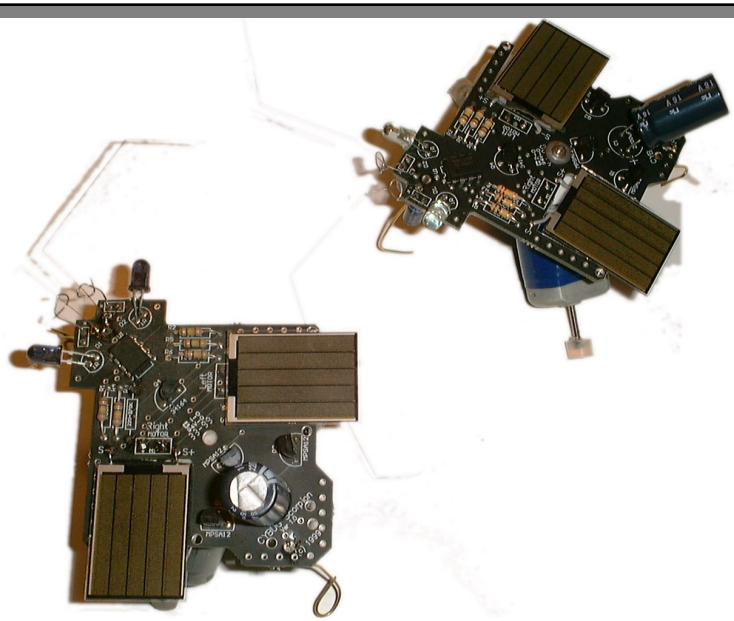
If you increase the size to 47,000uF (.047F, 5.5Volts) then your robot will take about 4 seconds to charge in direct sunlight, but will move for 2-3 seconds per step.

These larger capacitors are often called memory backup capacitors or Gold Capacitors, and are available through most electronics component distributors.

What's in this bag?

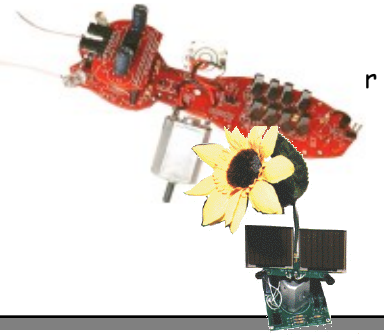
This kit contains detailed instructions with photographs, all components (over 40 parts), quality double sided circuit board, and theory of operation. You'll need an electronics grade soldering pencil, and some basic handtools to complete this project!

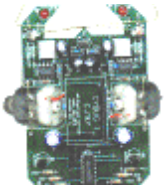
No prior knowledge of electronic fabrication required!



Other CYBUG kits…

Your Sunflower will enjoy the company of other robotic lifeforms including the new Q Scarab , and the SunFlower (solar powered separately)





For questions or support please contact:

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Ver 2e