How To Build the P.A.R.T.S Mini-Sumo Robot Mark II

"You should be able to complete this robot in a weekend."

Portland Area Robotics Society
Portland, Oregon
May 27, 2001
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Legal Disclaimer

Whereas if we could afford a lawyer, this would be a nicely worded legal statement that would be as airtight as a hatchway on the Space Shuttle. But since we can’t, we can only warn you in writing to be careful.

If improperly handled, this thing can be dangerous! Please watch for sharp edges and don’t put any parts in your or anyone else’s mouth. And for gosh sakes, be real careful with the soldering iron! Grab it by the cool end because the other one gets hot enough to melt metal.

If you’re under 18, make sure your parents know what you’re doing. If you’re real young, you should have an adult help or at least supervise.

We are not responsible if you hurt yourself or anyone else while assembling or using this robot. We cannot assume any liability even if you act a fool and break something valuable. If you do, we can say we warned you and it’s your fault, OK?

While we’re disclaiming, we also need to say that we don’t guarantee this product will even work. We just know it worked for us after assembly and are pretty sure it will for you.
Introduction

Members of the Portland Area Robotics Society (PARTS) have worked hard to produce this Mini-Sumo robot kit for the Second Annual Competition to be held at OMSI on May 19th, 2001. Thanks are due to Marvin Green, Daryl Sandberg and Pete Skeggs for making this project happen.

The Mini-Sumo robot consists of 5 major components:

1. Parallax Inc.'s BASIC STAMP I computer chip programmable in BASIC using a PC.
2. A sensor board mounted on the top front of the robot.
3. Sandberg Unibody Frame with front scoop, back panel, and wheels.
4. Printed circuit board that ties all the components together.
5. Two R/C servos motors, available from hobby stores. NOTE: these are not included with the kit, and must be purchased separately.

Please read through the documentation before beginning this project. This will give you an idea of how all the pieces go together and how to make modifications. A basic knowledge of electronics, soldering, and programming is a good idea to be successful with this project.

Tools required:
✘ small tipped soldering iron
✘ solder
✘ solder wick or solder sucker - to remove solder
✘ wire cutters
✘ wire strippers
✘ small nosed pliers
✘ small tip Phillips screw driver
✘ small hand drill with 1/8 and 3/32 drill bits
✘ hot glue gun (optional)

The PARTS Mini-Sumo Robot is designed to be a starting point for your custom robot. Be inventive, be creative, create a winning Mini-Sumo by making modifications. Try different things, move things around, try different sensors, change the software.

The robot weighs about 320 grams when completed. The Mini-Sumo competition allows robots to weigh up to 500 grams. Add more weight to give the robot better traction.

You can make a practice ring by using thick black poster board and paint or tape a one inch white edge. The regulation Mini-Sumo ring is 77 cm in diameter and is covered with a layer of black rubber.

The official rules of the Mini-Sumo competition are maintained by Bill Harrison at: http://www.sinerobotics.com/sumo/
Here is the list of parts used in the PARTS M ini-Sumo robot.

**BASIC STAMP Chipset**
- 1 STAMP I PIC16C56-XT/P (Parallax PBASIC1/P)
- 1 4 MHz resonator (Parallax 250-04050)
- 1 EEPROM (Parallax 602-00005)

**Programming Cable**
- 1 DB25 housing
- 1 DB25 pin male connector
- 1 3 pin female Molex connector
- 1 3 pins for above
- 1 3 conductor unshielded cable 2-4ft

**Mechanical Parts**
- 1 Sandberg aluminum unibody chassis
- 2 wheels
- 1 CPU printed circuit board

**Electronics**
- 1 10uf capacitor
- 4 .1uf capacitor
- 4 330 ohm resistor
- 3 10 k resistor
- 2 4.7 k resistor
- 3 3 pin headers
- 1 slide switch
- 1 cds cell
- 4 leds
- 1 piezo speaker
- 1 12" length 4 conductor ribbon cable
- 1 battery pack for 4 AA’s
Proximity Sensor Subsystem

1 sensor printed circuit board
2 Sharp IS471F detectors
2 IR LEDs, 50 mA, 940 nm, +/-20 degree beam (DigiKey ey 67-1000-N D)
1 green LED (DigiKey ey HLM P-1719Q T-N D)
1 amber LED (DigiKey ey HLM P-1790Q T-N D)
1 1 uF bypass capacitor 2.5mm lead spacing
3 1K ohm, 1/8 watt resistors①
2 120 ohm 1/4 watt resistors
2 .5" len 1/8" diameter heatshrink

Optional
2 0 ohm, 1/8 watt resistors②
4 Vector miniwrap terminals, style T44
2 T1 LED spacers .5" (DigiKey RP502-N D)

Notes:

① The 1K resistors are for use with the special low current green and amber LEDs included. If you substitute regular LEDs, then you'll need to replace the 1K ohm resistors with 330 ohm resistors.

② The 0 ohm resistor is just a convenient and safe way of jumpering R1 and R2, which are otherwise not used. You can also use short lengths of wire, but beware that on the first runs of this board, there is no solder mask, so the jumper for R1 must be put on the bottom of the board.

Only Serial Numbers #1 thru #14 of the Mark II kits include both the Vector miniwrap terminals and the T1 LED standoffs / spacers (sorry). These optional parts are meant to provide an alternate way to attach the IR LEDs to the circuit board without having to bend the leads severely, thus reducing lead breakage.

If your kit included the miniwrap terminals, but did not include the LED standoffs, that's ok - you can either use the miniwrap terminals by themselves, or don't use them and bend the LED leads instead.
Schematics

CPU Board

Proximity Sensor

Serial #1-#26

Serial #27 and up
Circuit Board

Main PCB

Sensor PCB - Serial Numbers #1-#26

Sensor PCB - Version 2
Sensor Alternatives

A Mini-Sumo robot can work without any sensors other than the white-line sensor. However, by adding a proximity sensor, the robot can find his opponent and thus have a better chance of winning. Otherwise, the robot runs blind, and can only win by sheer luck.

A proximity sensor is a device which can detect the presence of another object nearby. There are many possible methods for performing such detection, including measuring reflected light (infrared), reflected sound (sonar), or reflected microwaves (radar).

The Mark II robot kit includes a low-cost proximity sensor board and all necessary parts, including the hard to find Sharp IS471F sensors, at half the cost of the proximity sensors in the Mark I kit.

Here are some other ideas for sensors for the kit:

- bumper switches
- IRPD board (from the Robot Store (http://www.robotstore.com), or build one using plans (Dallas Personal Robotics Group’s (http://www.dprg.org/irprox.html) or Dennis Clark’s (http://www.verinet.com/dlc/)). This sensor uses an infrared remote control module and two infrared LEDs to detect objects. Black or IR absorbing robots are hard to see.
- Sharp GP2D15 sensors; can detect when an object is 10" or closer fairly reliably. The data sheet for this can be downloaded from: http://www.portlandrobotics.org/download/gp2d12.pdf
- Polaroid Sonar modules are available from Acroname (http://www.acroname.com) and Mr. Robot (http://www.mrrobot.com). The advantage of this sensor is that it can see any robot, no matter what color. But they’re expensive!
Building the Main PCB

You will need the circuit board and all the electronics including the BASIC STAMP I chip set. These are located in one of the pink poly bags. The other pink poly bag contains the sensor board and its components, which are assembled separately, so to make life easier, don't mix the two.

Be sure to work in a ventilated, well lit area, with tile or thin carpeting on the floor; thick carpets like to eat little dropped parts!

Solder on the smallest electronic components first. Identify the resistors by its color code and solder them to their location.

R1, R7, R8, R9 - 330 ohm - orange orange brown
R4, R5 - 4.7k - yellow, purple, red
R2, R3, R6 - 10k resistors - brown black orange (R2 and R3 are optional if you use the sensor board included with the Mark II kit, but are used if you use Sharp GP2D15 sensors)

Next solder on capacitors C2, C3, C4, C5, these capacitors are marked with the number 104.

Solder in the BASIC STAMP I IC chip and the EEPROM chip paying close attention to the orientation of the notch in the IC.

The resonator RES can now be soldered in place. This provides the 4 MHz clock for the BASIC STAMP.

The LED's can be soldered in place now. The LED's are polarized, and will only work if soldered in the correct orientation. Make sure the cathode (negative) side of the LED faces the right hand side of the circuit board. The silk screen image of the LED shows the cathode as the flat side in the image.
Solder in capacitor C1 and orient the negative and positive pins correctly, the positive pin is marked on the circuit board.

The three 3 pin headers can be soldered into positions SL, SR and PC connector locations. The pins shipped with the Mark II kits stick out too long under the circuit board once they are soldered in. You should clip them off on the underside of the board, being careful to aim them away from yourself and others, as they will shoot off rapidly when clipped.

The ON/OFF switch can now be soldered to the circuit board, followed by the piezo speaker. Note: some of the piezo's leads don't quite fit in the holes provided on the circuit board. You might have to ream the holes out a bit (but not too much) to make them fit.
The sensor board for the PARTS Mini-Sumo Robot Mark II uses 2 Sharp IS471Fs, 2 Infrared LEDs, and a few other parts. It can sense objects up to 8-10 inches away, depending on reflectivity.

**Assembly**

The resistors indicated on the sensor board below are labeled differently for the first run of sensor boards (Serial Numbers #1-#26) and the later revision.

<table>
<thead>
<tr>
<th>SN 1-26</th>
<th>SN 27 &amp; up</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS1, IS2</td>
<td>Sharp IS471F sensors; the flat side faces forward</td>
</tr>
<tr>
<td>LED1</td>
<td>green LED; cathode in square pad</td>
</tr>
<tr>
<td>LED2</td>
<td>amber LED; cathode in square pad</td>
</tr>
<tr>
<td>IR1, IR2</td>
<td>infrared LEDs; cathodes in square pads</td>
</tr>
<tr>
<td>R1, R2</td>
<td>R1, R6 0 ohm resistors or jumpers ①</td>
</tr>
<tr>
<td>R3, R4</td>
<td>R3, R4 1K ohm resistors ②</td>
</tr>
<tr>
<td>R5, R6</td>
<td>R2, R5 120 ohm resistors</td>
</tr>
<tr>
<td>C1</td>
<td>high-frequency bypass capacitor (preferably multilayer ceramic)</td>
</tr>
<tr>
<td></td>
<td>2.5mm radial lead spacing, 0.68 uF or higher</td>
</tr>
<tr>
<td>P1</td>
<td>connection to main PCB via 4 conductor ribbon cable</td>
</tr>
</tbody>
</table>

① if you use a wire for a jumper, place it on the back of the board to avoid shorting out IR1

② if regular LEDs are used instead of the low current ones supplied, use 330 ohm resistors

First, solder in the capacitor C1.

Next, solder in R3 and R4, the 1K ohm resistors (brown, black, red).
INSTRUCTIONS FOR SERIAL NUMBERS 1-26

Solder in R1 and R2. Solder resistors R5 and R6 which are current limit resistors that must be added in series with the L and R output pins of P1, before the signals get to the main board. The original 25 kits do not have places for these resistors on the circuit board. Instead, this can be done by soldering one end of each 120 ohm resistor into the respective L and R holes on the sensor PCB, and allowing the other ends of the two resistors to hang loose until later.

When the ribbon cable is added to connect the sensor board to the main board during final assembly, solder the L and R wires from the main PCB to the loose ends of the two resistors, then protect their ends from shorting on the main PCB's prototype area using 1/2" lengths of heat shrink. Tip: peel the L and R wires away from each other and from the + and - wires for about 2", then slide the two heat shrink tubes down the wires as far as you can from the solder joint. Then, solder the stripped ends of the L and R wires to the resistors, let cool, then slide the heatshrink back over the exposed ends of the resistors. Now rub the heatshrink briefly with the tip of the soldering iron to shrink it. If the heat shrink is too close to the solder joint during soldering, it will shrink too soon and won't be able to be slid over the solder joints.

INSTRUCTIONS FOR SERIAL NUMBERS 27 AND LATER

Solder in R1 and R6. Solder in R2, R5 the 120 ohm resistors (brown, red, brown).

Installing Infrared Sensors (all models)

Now you can add the IS471Fs. The bumpy side goes towards the back of the board, facing R3 and R4, while the flat side faces forward. Insert an IS471F into the four pads, all the way down to where the pins straighten out, then solder them in.

Next, attach the green LED, in the LED1 spot. The cathode is the short pin on the LED, and goes in the hole with the square pad. The cathode is also marked by the flat side of the LED. Then, attach the amber LED in the LED2 spot, again with the cathode in the square pad hole. If they are backwards, they will not light.
Now it's time to add the IR LEDs - the two clear ones. There are three methods for mounting them, not all of which are possible with some kits (only kits #1-14 include the LED spacers).

Just do ONE of the following:

1. bend the leads of the LEDs in the right shape, and solder them in
2. use 2 Vector miniwrap terminals (included in the kit), snap the LED leads into the forks in the top of the terminals, then solder the connections
3. use 2 Vector miniwrap terminals on either side of the LED spacer, then attach the LEDs to the terminals as in 2.

The method you use depends on the parts present in your kit, as well as your comfort level in serverly bending LED leads. Method 1 is the normal method used in boards like this, but due to the placement of the LEDs compared to the sensors, the leads must be bent even sharper than normal. The metal used in LED leads is brittle, and must be bent slowly and carefully or it will snap, often right at the base of the LED, rendering it useless.

Note the position of the front of the IR LEDs compared to the front of the sensors
Testing the Proximity Sensor Board

The sensor board is easy to test. As explained in the final assembly page, solder in a length of the 4 conductor ribbon cable to the P1 area. Then, temporarily connect the battery case's wires to the ribbon cable by twisting the ends together:

<table>
<thead>
<tr>
<th>P1</th>
<th>ribbon cable</th>
<th>battery cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>green</td>
<td>black</td>
</tr>
<tr>
<td>+</td>
<td>red</td>
<td>red</td>
</tr>
</tbody>
</table>

Make sure the red and black wires don't short together. And even though they're not connected to anything yet, don't let the white and black wires cause a short.

Hey, it works!

Insert some fresh batteries in the holder. If neither colored LED lights, hold a white piece of paper or your hand in front of the sensor board, about 4 inches away. One or both of the green and amber LEDs should light up, if they are not already. If neither lights up, remove at least one battery from the holder, then check the board.

If the green and amber LEDs work, it's time to attach the IR shields.
Installing the IR Shields

Place a shield around the back side of an IS471F, with the bottom edge of the shield flush against the PCB. Using your thumb and forefinger, gently squeeze the shield onto the sensor until it feels engaged, with the shield rotated vertically slightly so that the edge of the IS471F is blocked from view of the IR LED. Don't rotate the shield too far, or else it won't stay on and it will be blocking the front surface of the sensor from valid IR reflections.

At this point, you should be able to shake the board and the shield will not fall off. Hold the PCB pointed away from any objects (towards a non-reflective wall at least 3 feet away), see if the LED on that side of the board has gone out. If not, gently remove the shield and rotate it slightly, then try again. Do the same for the other IS471F.

You may need to use a tiny drop of super glue on the bottom of each sensor shield to prevent them from dropping off – especially during a competition! Just be careful, and don't get any super glue on the LED or the fronts of the sensors.

Notice that the shields are slightly bowed-out away from the IR LEDs to block direct light from reaching the detectors.

Finally, remove the batteries from the holder, untwist the wires, then go on to the next step.
Fun Experiment (if you have a webcam)

This is what IR looks like! The blue-ish beams are from the IR LEDs, as detected by a 3Com BigPicture webcam with the room lights off. The CCD element of a digital camera can see in infrared.

You can try using this when you are done assembling your robot to fine-tune the aiming of the IR LEDs.
The line sensor that is mounted under the scoop uses an LED to provide light and a CdS sensor to measure the amount of reflected light. Solder two 6.5 inch wires to the CdS sensor and solder the wires to the CdS location on the circuit board.

Solder two 6.5 inch wires to the LED. The LED is polarized. Make note of the cathode side (refer to the diagram in the main PCB assembly instructions to determine the cathode side of the LED) and make sure that it gets connected to the '-' side of the LED connector on the circuit board.

Mount the CdS sensor and LED to the underside center on the front scoop, making sure that the bare wires do not touch the metal scoop, and that the CdS and LED do not rub on the table when the robot is running. A hot glue gun is perfect for this. The line sensor will not work well if the CdS and LED are too far away from each other, are pointing away from each other, or are pointing so much towards each other that the CdS is seeing the LED directly.
Motors

The robot uses two R/C servo motors. These servos are designed to rotate about 180 degrees and need to be modified to rotate continuously. These servos are ideal for small robot use because they contain a motor, gearbox and motor drive electronics. Servo's can be controlled with only one I/O pin.

Servos are not included in the kit. You must purchase them separately.

At least one vendor, MrRobot, sells pre-modified, continuously rotating servos, which is a much easier route for beginners. However, this is not an endorsement of MrRobot or its products.

Modifying the Servos for Continuous Rotation

Note: These instructions are for Futaba FP148 servos. These instructions will work with some other servos, but not all [this works with the Futaba S3003]. They will not work with Hitec and Cirrus servos. The Futaba FP148 has a drawing of all of the servo parts that will aid you in performing this modification.

1. Remove the four screws that hold the servo together.

2. Take the upper case off the servo by holding the upper case with your thumb and middle finger and pressing down on the final gear with your index finger. The cover should come off easily and all of the gears should remain in place.

3. Remove the third gear and set it aside. Remove the final gear.
4. Using a #6 sheet metal screw, remove the potentiometer drive plate that is inside the bottom of the final gear. Twist the screw into the drive plate about one turn and pull it out. The metal bearing will come out with the drive plate. Put the metal bearing back into the final gear. [Note for Futaba S3003: the final gear in this servo has a molded-in flat that engages the potentiometer shaft; you will need to round it off using a Dremel tool so that the pot shaft no longer turns at all when the gear turns]

5. Cut off the small protrusion that sticks up from the flat surface of the final gear. Trim it flush with the gear.

6. Drill out the screw hole in the final gear. Use a 5/64" drill bit to make the hole go completely through the gear. Be careful not to damage the threads.
7. Punch a small hole in a piece of heavy paper (like a business card). Place the card over the servo gears with the shaft of the potentiometer poking through the hole. This will protect the gears from metal filings in the next step.

8. Using a razor or coping saw, cut a 1mm groove in the end of the potentiometer shaft. This will be used as screwdriver slot when the servos are calibrated.

9. Optional: You can shorten the wires that go to the servo at this point. Do not attempt this unless you are very good at soldering in very tight places. This doesn’t improve the performance of the robot, it just tidies things up a bit. Make them at least 100 mm long.

10. Clean up all the parts and reassemble the servo. Put the final gear in place and spin it to make certain that it turns freely. Put the third gear in place. Put the cover on and screw it all together.

11. Later, once the main circuit board is assembled and ready to be programmed, load the program SERVADJ.BAS, then, using a small jeweler’s screwdriver (a nice set is available at Radio Shack), adjust the pot in each servo (through the hole you drilled in step 6) by engaging the tip of the screwdriver in the slot you cut in the top of the pot shaft (in step 8), then turning slowly back and forth until the servo stops moving. The servos are now ready for use.
Optional Additional Servo Modification

Note: if this is not done, be sure to use the version of the program for unrotated servos!

One servo should be modified to rotate the opposite direction of the other servo. This is because the servos are placed facing opposite directions of each other on the robot base.

This will make programming the software easier because using the same pulse width value for both servo's, will drive one servo clockwise and the other servo counter clockwise. This will move the robot forward or reverse.

To perform this modification on one servo you will need to remove the motor and circuit board from the case. The motor is attached to the circuit board by two solder tabs. To remove the motors, remove the solder from the solder tabs using a solder sucker, solder wick, or tapping the circuit board until the heated solder falls off.

Once the solder is removed and the motor is separated from the circuit board rotate the motor 180 degrees and reinsert the motor and solder it back into place.

Motors

PARTS Mini-Sumo Robot Mark II
Mechanics

Assembling the Wheels

1. Match the two small holes in the wheels with two of the holes in the servo horn that came with your servos.

2. Enlarge the matching holes in the servo horn by drilling them out with a 3/32 inch drill bit.

3. Attach the wheel to the servo horn with two 4-40 countersunk screws. You will have to push the screws as you turn them and they will thread themselves into the plastic of the horn.

4. Tighten a 4-40 nut onto each of the screws to lock everything in place.

5. Stretch the rubber O-ring onto the wheel.
Mounting the Servos and Assembling the Chassis

The servos must be mounted very accurately on the chassis. If not, there will not be enough space for the nuts that hold the wheels to the horns to clear the chassis. Also, if the servos are mounted too far toward the rear of the chassis, the robot will be too long to qualify in competition (100 MM limit). Too far toward the front and the robot will not be able to push its opponent effectively.

1. Clean the chassis and servos with Windex or rubbing alcohol to make certain the tape sticks well.

2. Using the smallest piece of double stick tape, stick the two servos together, back to back. Keep the servos on a flat surface to make certain that they line up exactly with each other.

3. Attach the wheels to the servos with the screws that came with the servos.

4. With the front of the chassis (the part with the 45 degree bend) pointing straight up, tape the back of the chassis (the part with the 90' bend) to the work surface with masking tape or Scotch tape. Don't use the tape that came with the robot kit.

5. With the wheels sitting on the work surface, place the servos against the chassis with the servo wires toward the back of the robot chassis. Using a sharp tipped marker, mark where the forward edge of the servos lines up with the chassis.

6. Remove the servos and untape the chassis from the work surface. Mark a line lengthwise down the middle of the chassis. The chassis is 80mm wide, so the mark is 40 mm from either edge.
7. Set the servo and wheel assembly on the chassis, lining up the gap between the servos with the center line, and the front of the servos with the line that you made in step 5. Check to make certain that everything is centered and square, the tires do not stick out past the back of the robot chassis, and the wheel nuts do not hit the edge of the chassis.

8. If everything lines up, clean the servos with Windex or alcohol and apply one piece of double stick tape to each of the servos.

9. Very carefully, attach the servos to the chassis, using the marker lines for alignment. Remember, you only get one chance with the tape. Take your time, this step is very important.

10. Attach the four 7/8 inch aluminum stand-offs to the chassis with four 4-40 pan head screws. Do not tighten the screws yet, just put them in loosely.
Assemble Cables

Programming Cable

A 3 wire connector cable is needed to connect the BASIC STAMP I to the parallel printer port of a PC. A male DB25 is wired up as shown to a three female pin connector. Solder three wires to the 3 pin connector, then to the DB25 as shown above.

Plug the DB25 into the PC parallel port one and the three pin connector into the circuit board. Align the 3 pin connector's edge labelled "PC edge" above (the GND wire) with the "PC" label on the circuit board.

The PC label indicates the GND connection, which is the pin with the square copper pad; the other two pins have round pads.

3 Pin Connector

The 3 pin connector consists of the 3 pin connector housing and 3 female crimp-on pins. Remove about 1.5" of the outer insulation from the programming cable. Remove about 3/16" of insulation from the ends of each of the 3 wires. Using needle nosed pliers or a crimping tool, crimp the pins one at a time to the ends of the wire, making sure that the bare wire does not stick down into the bottom hole of the pin. If it does stick down too far, it will prevent the pin from sliding over the corresponding male pin on the circuit board. Solder the wires to the pins to ensure a reliable connection, then slide each one into the 3 pin connector housing so that they lock in place.
Connect the Proximity Sensors

Cut a 4" length of the 4 conductor ribbon cable:

Note: the wire in your kit may have different colors; just use the colors to keep track of which wire goes where.

Separate the wires for approximately 0.5" in from each end, and strip off approximately 1/8" of insulation from the ends of each wire. Solder the wire in place as follows:

INSTRUCTIONS FOR SERIAL NUMBERS 1-26

Solder one end of a 120 ohm resistor to the end of the black wire in the ribbon cable. Solder the other 120 ohm resistor to the white wire. Place the green heatshrink wrap over each resistor and solder the the resistors to the L and R holes on the sensor board (enter the holes on the board from underneath). The L is unlabeled on some boards - it's between + and R). Solder the green wire to the - hole and red to the + one, again with the wires entering from underneath.

INSTRUCTIONS FOR SERIAL NUMBERS 27 AND UP

Solder the black wire to L, white to R, green to -, and red to +.

Finally, on the main board, solder the green wire to the center hole on IOD R, the red in the + hole of IOD R, the black in the square hole of IOD L, and the white in the square hole of IOD R.

Sharp GP2D15 Option

The IOD L and IOD R connectors are soldered to the circuit board in the IOD L and IOD R holes. The red wire is positive, the black wire is ground, and the yellow wire is the signal. The signal wire goes in the square hole, the ground goes in the center hole, and the positive goes in the + hole.
Final Assembly

Attach the Main Board

If you are using the sensor board, attach the circuit board to the four stand-offs with two 4-40 pan head screws in the back and two 3/16" male-female stand-offs in the front. Tighten the four screws on the bottom and the two screws and two stand-offs on the top.

If you are using Sharp GP2D15 sensors, attach the circuit board to the four stand-offs using the four 4-40 pan head screws in all four corners. The two 3/16" female stand-offs are not needed.

Using the last piece of double stick tape, attach the battery holder to the bottom of the chassis. The wires should be at the right rear corner of the robot, looking at it as if you were driving a car. The front edge of the battery holder should be 1/8" behind the bend in front of the chassis. Tape the wires to the right rear aluminum stand-off with electrical tape.

Attach the Sensor Board

If you are using the sensor board, attach the sensor board with the two 4-40 pan head screws to the top of the 3/16" standoffs. The IS471F sensors and IR LEDs should be pointing forward.
Initial Testing

Smoke Test

Verify that the power connector and sensor connectors are correct. It is possible to destroy the BASIC STAMP and other electronics if the power leads are reversed or there is a wiring error, so check your work. With the power switch in the off position, install four AA batteries in the battery holder.

Turn the power switch on and the power LED and LED P should light. Also, the sensor board's amber and green LEDs should respond to your hand when held in front of the robot about 4 inches away. Move your hand back and forth to verify proper left (green), right (amber), center (green and amber) object detection.

The robot will not do anything else yet because it doesn't have any software code to run. This is done next.
Programming the BASIC STAMP I

The PARTS M ini-Sumo Robot is programmed in a language called PBASIC. PBASIC is quite flexible and easy to use. Information can be found at:

http://www.parallaxinc.com/

The BASIC STAMP Editor to write and download programs can be found at:

http://www.portlandrobotics.com/download/stamp1.exe

Note: The STAMP .EXE editor may not work well under Window's 95/NT. Exit Windows and run the editor from the DOS prompt.

Three BASIC STAMP programs have been written for the mini-sumo robot. Use them to get started. But you should use your own ideas to fine tune your robot and gain a competitive edge in your matches.

Servo Adjust - generates 1.50ms pulses for calibration
http://www.portlandrobotics.com/download/servadj.bas

PARTS M ini Sumo Mark II - for non-rotated servos and PARTS IR sensor board
http://www.portlandrobotics.com/download/PARTS_mini_sumo_MkII.bas

PARTS M ini Sumo Mark II - for rotated servos and Sharp GP2D15 sensors
http://www.portlandrobotics.com/download/omsisumo.bas

Comments and technical questions can be posted to the PARTS discussion newslist at:
http://www.yahoogroups.com/group/PARTS
## APPENDIX: BASIC STAMP I/O Pinout

There are 8 input/output pins on the BASIC STAMP I. Each of the 8 pins can be designated as an input or an output. This robot uses thr 8 input/output pins as follows:

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>PIEZO Speaker = output</td>
</tr>
<tr>
<td>1</td>
<td>LED1 = output</td>
</tr>
<tr>
<td>2</td>
<td>LED2 = output</td>
</tr>
<tr>
<td>3</td>
<td>SR Right Servo Connector (- = black wire) = output</td>
</tr>
<tr>
<td>4</td>
<td>SL Left Servo Connector (- = black wire) = output</td>
</tr>
<tr>
<td>5</td>
<td>IODR Right IR. Object Detector (+ = red wire) = input</td>
</tr>
<tr>
<td>6</td>
<td>IODL Left IR. Object Detector (+ = red wire) = input</td>
</tr>
<tr>
<td>7</td>
<td>CdS resistor detects light level = input</td>
</tr>
</tbody>
</table>