

## Model AEG2000B Robotic Arm Assembly Instructions

### Overview

This document has been taken in parts from the AEG industries, LLC AEG2000B RSS-Compatible Servo-Controlled Robotic Manipulator manual. The next few pages will help you get acquainted with your arm as you build it from scratch. Many of the tasks are independent and can be done in parallel, so we suggest that you split the work up. You can even split this handout up into four pieces for the four tasks. **PLEASE, if you take the wrong part, be careful when putting the part back.** It took a long time to organize all the hardware.

### Task 1: Shoulder and Upper Arm

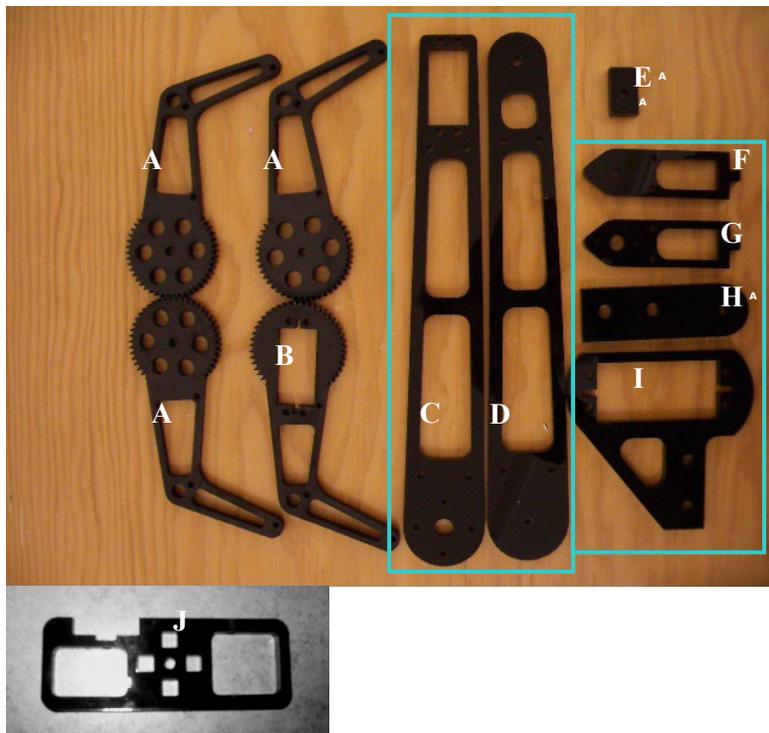


Figure 1: The laser-cut parts for the arm.

#### Parts:

- |                                   |  |
|-----------------------------------|--|
| 1 C                               | 9 8-32 x 7/16" socket head screws          |
| 1 D                               | 4 8-32 x 7/8" socket head screws           |
| 1 F                               | 4 8-32 lock nuts                           |
| 1 G                               | 4 4-40 x 1/2" or longer socket head screws |
| 1 H                               | 4 4-40 x 7/16" socket head screws          |
| 1 I                               | 2 4-40 x 1/2" circular standoffs           |
| 1 large white circular servo horn | 4 4-40 washers                             |
| 4 2-56 x 3/4" screws              | 4 4-40 lock nuts                           |
| 2 2-56 x 1/2" screws              | 4 1/4-20 x 7/8" socket head screws         |
| 6 2-56 lock nuts                  | 4 1/4-20 nuts                              |
| 8 8-32 x 1/2" set-screws          | 1 3/16" shoulder bolt                      |
| 4 8-32 x 3/4" standoffs           | 2 80/20 brackets                           |
| 8 8-32 x 1" standoffs             |  |





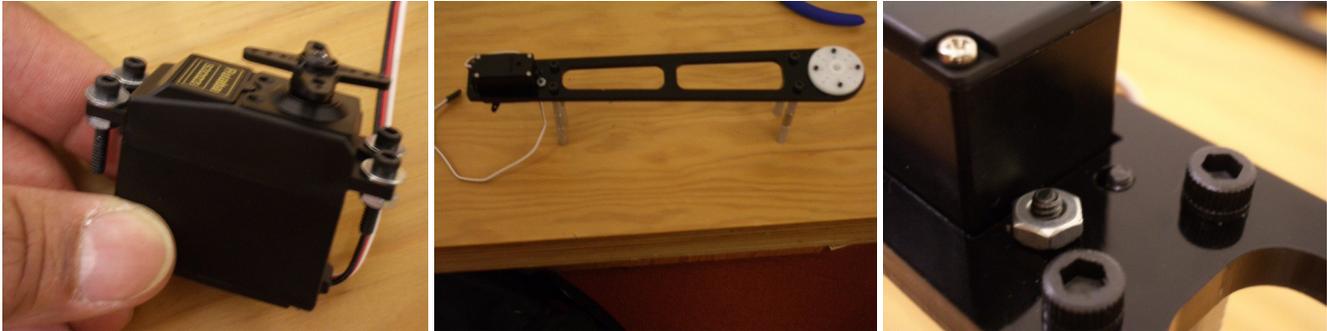
1.1. Mount a large white circular servo horn to C. Use 4 2-56 x  $\frac{3}{4}$ " screw and lock nuts.



1.2. Screw together three 8-32 standoffs ( $1'' + \frac{3}{4}'' + 1''$ ) to make one 1.75" mega-standoff. Use the 8-32 x  $\frac{1}{2}$ " set-screws. Lock them together tightly with pliers. Make 4 of these and install on C using 4 8-32 x  $\frac{7}{16}$ " socket head screws so that the white servo horn is on the **opposite side** of C from the standoffs.



1.3. Install the big servo into I. Make sure you get the servo-flange on the correct side (as seen above). You may have to push hard to pop the servo into place. Use 8-32 x  $\frac{7}{8}$ " screws and lock nuts to secure the servo.



- 1.4.** Use a 2-56 x 1/2" Phillips screw (servo horn screw) to attach the cross-shaped servo-horn to the S3003 servo. Then pop the servo into **C** as shown (servo horn and flange should be on the same side as standoffs). Next secure servo with 4 4-40 x 1/2" or longer socket head bolts, lock nuts and appropriately sized washers.



- 1.5.** Install the star-shaped servo horn on **G** as shown. Screw the arm into place with 2 2-56 x 1/2" socket head screws and lock nuts.



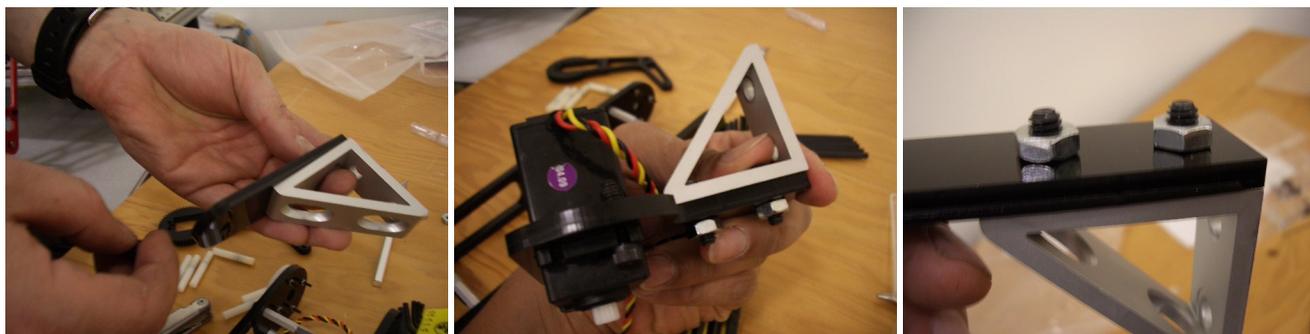
- 1.6.** Make sure you get at least 3.141592653589793238462643383279502 radians of travel on the arm as shown above.



**1.7.** Install the 2 4-40 x 1/2" circular standoffs with 4-40 x 7/16" socket head screws to **G**. On **F**, install an 8-32 x 3/4" metal standoff with an 8-32 x 7/16" socket head screw. Attach the **F** using 2 4-40 x 7/16" socket head screws.



**1.8.** Bolt **D** onto **C** with 8-32 x 7/16" socket head bolts. Use the 3/16" shoulder bolt to fasten **D** to the standoff of **F**.



**1.9.** Add the 80/20 mounting brackets to **I** and **H** using 1/4-20 x 7/8" socket head screws and nuts.

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## Task 2: Gripper and Elbow



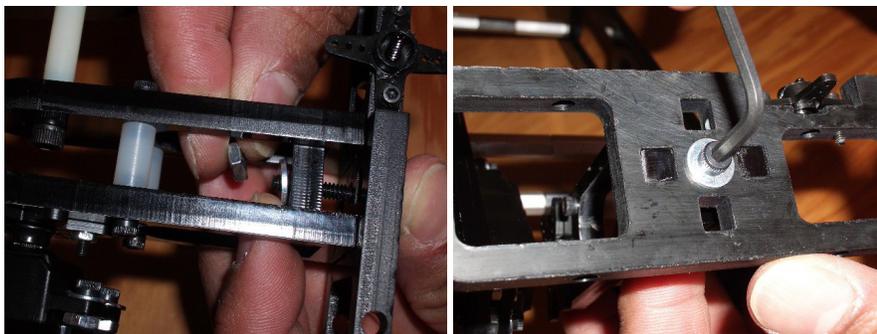
Figure 2: The laser-cut parts for the arm (Wrist mounting plate **J** also needed, but not pictured).



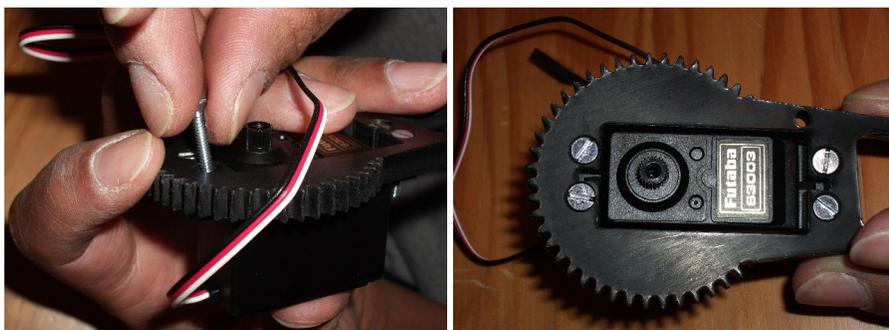
Install the small servo-horn onto the wrist plate, **J**, using short 2-56 socket screws. Note that you must first place the 2-56 x 1/2" servo-horn screw in the horn before mounting the horn to **J**.



Insert the wrist plate **J** onto the wrist made from **C**, **D**, **F**, and **G** in Part 1. Note that it can go on in two orientations, giving you a choice of kinematic configurations. You will want to place it so the notched end points up.



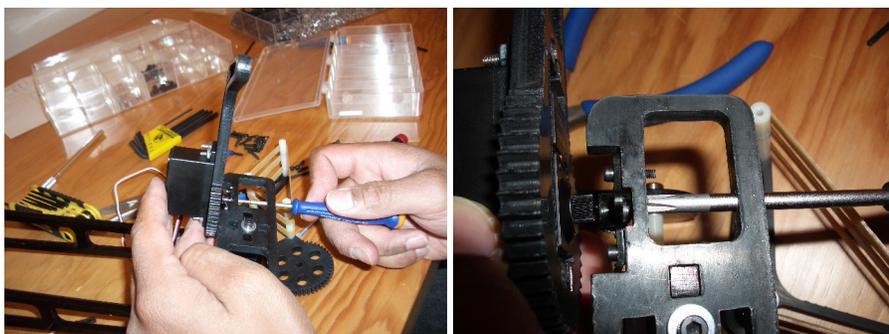
Insert the small square wrist-retaining-plate **E** into the wrist. Use the 6-32 x 7/8" bolt and lock nut to attach **E** to the wrist.



Now mount the small S3003 servo into the gripper-arm using the flat-head 4-40 x 1/2" screws. Potential gotcha: **Make sure the servo-flange is on the outside of the gripper-arm**, where the bulk of the servo is.



Install the 1.5" standoffs onto the gripper arms **A** and **B** using 6 4-40 x 7/16" bolts. Add three or more rubber bands to each gripper arm.



Attach **B** to **J** by screwing the small servo on **B** into its servo horn on **J**.



Install each **A** piece onto **J** using a nylon bushing. The bushing should slip through the gripper plate but require some insertion force to push into the wrist-plate. We used the flat side of a closed set of pliers to push with. Secure the bushing with a 2-56 x  $\frac{3}{4}$ " socket head screw and lock nut.



Mount the two gripper-arms together using 6 more 4-40 x  $\frac{7}{16}$ " bolts/

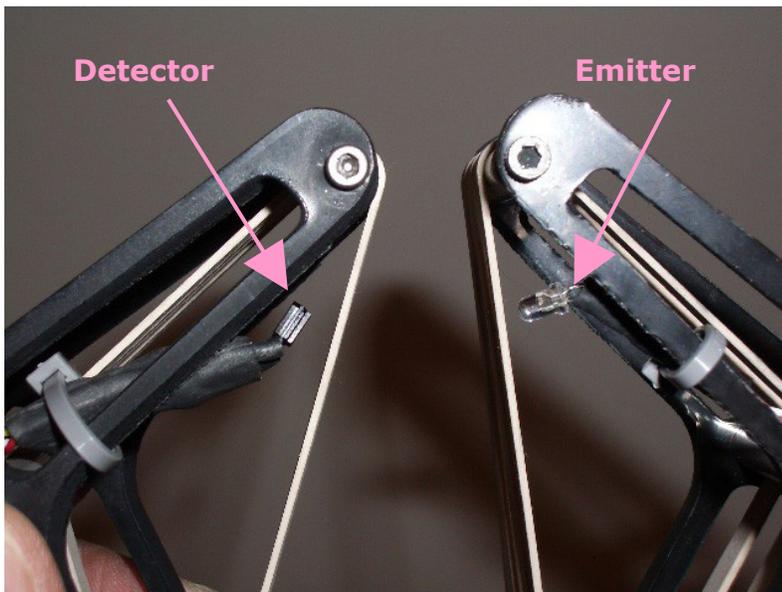
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### Task 3: Break-beam Object Detector

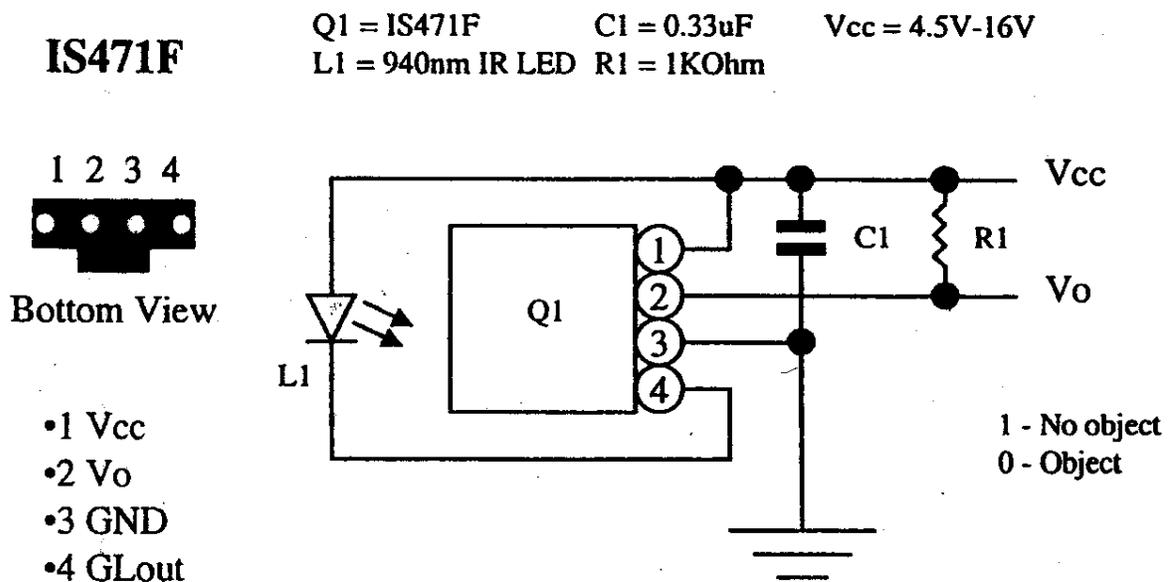
The break-beam sensor requires that the LED emitter and detector be mounted on opposing gripper-arms facing each other when the gripper is open. If the sensors are not facing each other or are too far apart ( $>4''$ ) they will not see each other.

We have provided you with pre-soldered break-beam sensors from a previous year's class, but you should consult the provided schematic to ensure that yours is wired correctly.

Here is how the assembly mounts on the gripper. It will take some fine adjustment to get just right; you should use orcspsy to ensure that they are aligned correctly. Make sure the detector window faces in the correct direction].



The schematic below shows the break-beam sensor wiring:



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R132-IS471F Sharp IR Detector Kit Parts List		
Qty.	Part #	Description
1	K34-RES1.0K	R1 1.0K Ohm resistor
1	K179-IR-LED	L1 940nm IR LED
1	K180-IS471F	Q1 Sharp IS471F Detector
1	K181-CAP-P4959	C1 0.33uf capacitor

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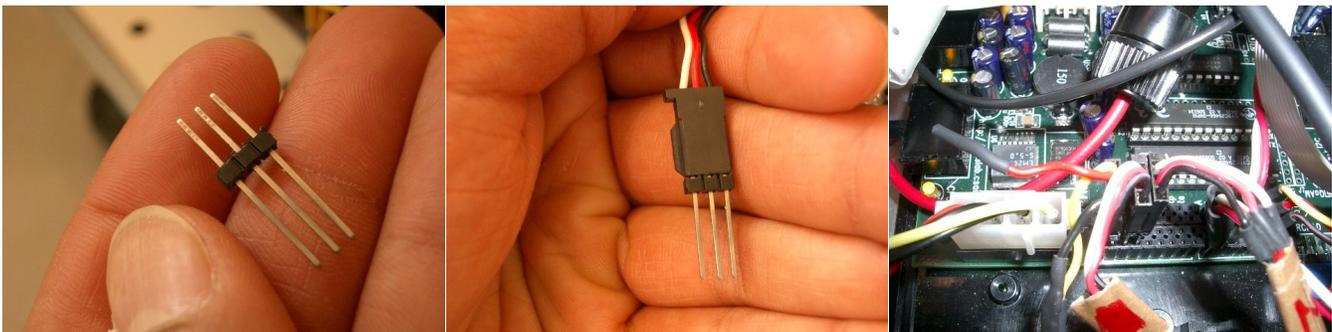
The break beam sensor connects to port 12 of the Orboard. Make your header the same way you built up the light sensor connectors. Connect **Vcc** to the pin labeled “+” on the ORC board, **Gnd** to “-“, and **Vo** to the input pin (the only one left).

Run orcsy to verify the operation of the sensor.

## Task 4: Cabling and Final Integration



String the wires through the gripper and arm and back to the Orcboard. Use the provided servo extension cables and wire ties to make a clean install. The shoulder must mount to the robot such that the arm clears the camera when it is fully up.



Break off three 3-pin sections of header. Slide the plastic down so that both sides of each pin are the same length. Plug these into the gripper and wrist servo leads, and into the correct ports on the ORC board. The gripper plugs in to port 1, and the elbow plugs into port 2. The red wire connects to the row of the port labeled “+” the black connects to “-“ and the white wire connects to the other pin. (Closest to the SBC) Look at the exemplar robot for details.

The Godzilla shoulder servo is gigantic and thus needs a giant amount of power, so it needs to be powered by the Servo Power Supply board. Connect the shoulder servo to the output of the servo power supply board. Connect the input of the servo power supply board to ORC board port 0. Look at the ORC board schematics if you need to.