# Hacking a Servo

Now that you understand how a servo works, the first thing that a eager engineering type will want to do is take it apart! Don't worry, this is completely acceptable behaviour in robotics. This section is going to describe how to take a R/C servo and make it into an excellent gearhead motor. The changes are quite easy to do, once you have seen the insides. This modification is known to work quite well on Futaba S-148 servos, which are commonly available.

The theory behind this hack is to make the servo think that the output shaft is always at the 90 degree mark. This is done by removing the feedback sensor, and replacing it with an equivalent circuit that creates the same readings as the sensor being at 90 degrees. Thus, giving it the signal for 0 degrees will cause the motor to turn on full speed in one direction. The signal for 180 degrees will cause the motor to go the other direction. Since the feedback from the output shaft is disconnected, the servo will continue in the appropriate direction as long as the signal remains.

The result of this is a really nice compact gearhead motor with built in electronics. The interface to this motor unit is a 1 wire control line, +5 volts for power, and a ground. All of this for around $15, which is an outstanding deal.

As for the details, there are actually only two modifications to make to the servo.

1. Replace the position sensing potentiometer with an equivalent resistor network
2. Remove the mechanical stop from the output shaft

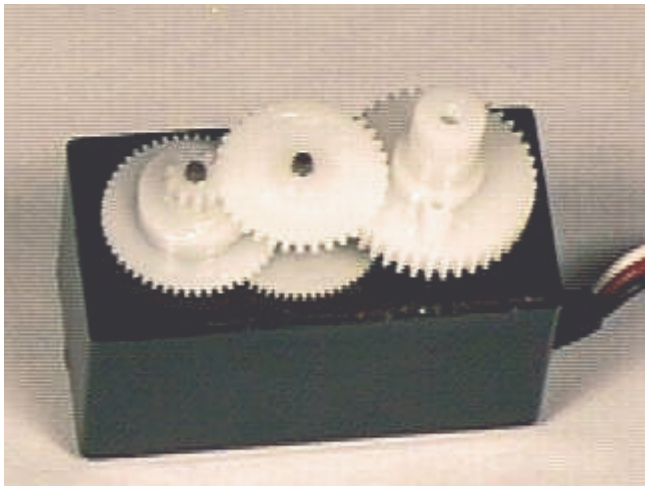
Here are the steps. You will need a few supplies

- small philips screwdriver for opening the case
- a soldering iron
- a desoldering pump or solder wick for removing the potentiometer
- a sharp knife or wire cutters for removing the mechanical stop
- Two 2.2k resistors (actually, anything between 2.2k and 3.3k will work, as long as they are equal values)

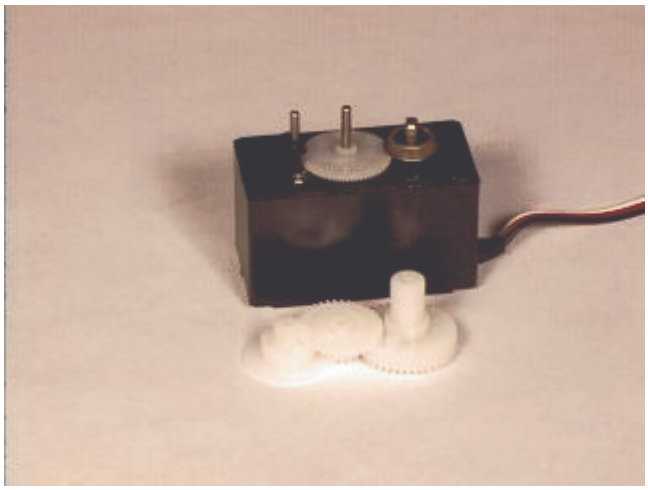
The following steps will help you make the modifications.

- Open the case by removing the 4 screws located at the bottom of the servo. The bottom plate should come off easily. Remove the top of the case. You will find a set of gears under the top case, a several blobs of white grease. Try hard to save the grease by leaving it on the

gears.



- Be careful to note how the gears are arranged, and remove them from the top of the servo. I usually place them as the are supposed to sit. The large fine tooth gear in the middle does not need to be removed. See the picture below.



(Click on picture for larger view)

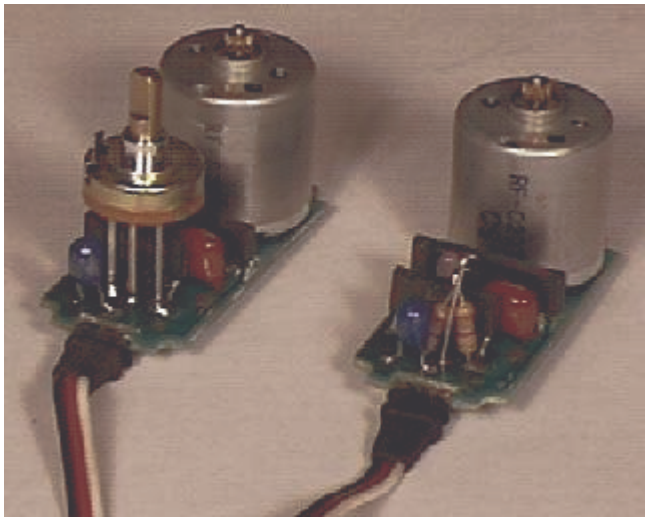
Servo with top and gears removed

- Locate and remove the two small philips head screws on the left shaft in the picture above. These screws go through the top case and into the drive motor.
- Next, you need to remove the circuit board from the case. To do this, you will probably need to press down hard on the brass shaft on the right side. This is the top of the position potentiometer. I find that pressing that brass shaft against the edge of the workbench helps push it through.
- From the bottom, very carefully pry up on opposing corners of the circuit board. The board should slide out with the motor and potentiometer attached. You should end up with the following parts on the table.

(Click on picture for larger view)

Disassembled servo motor.

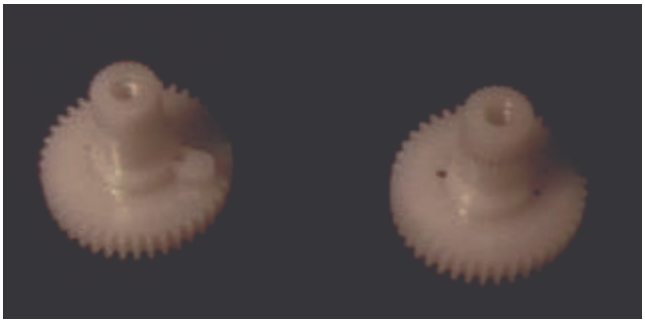
- Now for the actual modifications. You will need to desolder the potentiometer from the board. I usually cut the long leads off a quarter inch or so from the bottom. I then use solder wick on the back side of the board.
- Once the pot has been removed, you need to wire in the resistor network in its place. To do this, place the resistors side by side and twist one pair of leads. Solder them together, but leave one of the leads long enough to make a 3 wire part. Then replace the pot with this 3 wire pot. As seen in the picture below, the pot has been replaced by the resistor network.



(Click on picture for larger view)

An unmodified (left) and modified circuit board.

- Now, reassemble the circuit board into the case. Note that the pot is now missing, so only the motor will protrude through the top of the case.
- Before reinstalling the gears, you will need to modify the gear with the output shaft so the mechanical stop is removed. The mechanical stop is a small tab of plastic on the lower gear surface. In the picture below, you can see the tab on the left gear. This should be cut down flush with the surface. Try to get all of the tab removed, as is shown with the gear on the right side.



(Click on picture for larger view)

An unmodified (left) and modified output shaft gear

- Replace the gears as they were when you took the motor apart, replace the top of the case, the bottom plate, and the two screws.
- Your done!

The motor should now be able to turn all the way around. Connect a control horn, and carefully apply enough pressure to make the horn turn around. Feel for any mechanical problems, such as a gear catching on the cut off section of the tab. You should not feel any catching or resistance. It would be best not to play with turning the servo by hand too much. This device is not intended to be driven from the output shaft, and it may cause undo wear and tear on the servo motor.

---