Timpdon Electronics

Technical Note - No. 17

How to Convert a Standard RC Servo to a Working Model Boat Radar Aerial Rotator

Introduction

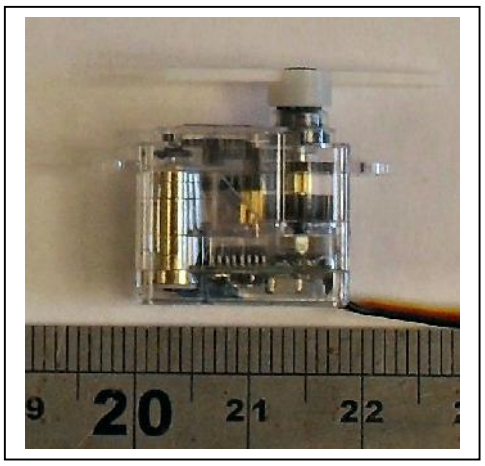
In order to build a working radar aerial rotator for your boat, you need a [very small] slow speed motor and gearbox. Ideally, you want a shaft rotation speed in the order of 20 rev/min.

The easiest and cheapest way of generating such low speeds is to use a standard RC servo modified for continuous rotation, and with the internal servo electronics removed so that the motor can be controlled directly by an external voltage supply.

In addition, you will almost certainly need some form of speed controller to reduce the motor voltage [to about 1 V], in order to reduce the rotation speed to the required level.

This Technical Note describes how to set about modifying a standard RC servo to create a low speed motor gearbox, and how to build a very simple speed controller which will allow the motor speed to be controlled down to zero.

Choice of Servo



The procedure described here will work with any RC servo. However, for a radar rotator, space is likely to be at a premium and you will probably want to use the smallest servo you can find. Quoted servo torque is irrelevant, as for a radar rotator almost zero torque is required.

I used the HITEC HS-35HD servo, which is the smallest I have been able to source easily.

This servo has dimensions of 18.6 mm x 7.6 mm x 15.5 mm, and is described as an Ultra-Nano servo. It is not cheap [about £15], but it works brilliantly

Similar sized Chinese made servos are advertised on EBay and elsewhere, down to about £5 each which will probably work just as well, but I have not tried them.

Conversion Procedure

Step 1 Mechanical Modifications to the Servo

The first step of the conversion is to ensure that the servo output shaft can rotate continuously, and is not constrained to approximately 180 degree rotation by mechanical end stops and limits on the position feedback potentiometer connected to the output shaft.

On the HS-35HD, the shaft has no stops and will already rotate freely, so you can omit this step. The same is likely to be true for most very small servos, but not for larger models.

You can easily check by fitted a servo horn and carefully attempting to rotate the output shaft manually. If it will rotate continuously without forcing, you should be OK.

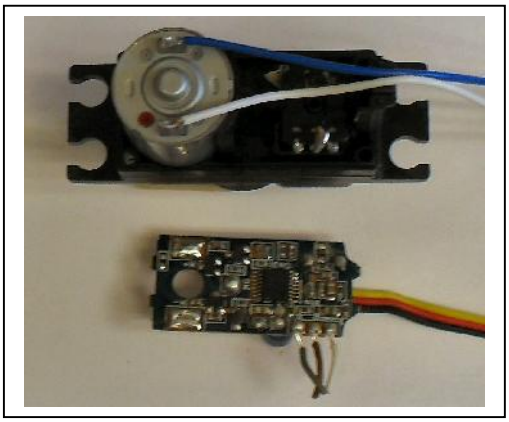
If not, mechanical modifications will be required to remove the end stops. In this case, refer to *Timpdon Electronics* Technical Note No 16 - How to Convert a Standard RC Servo to a Bi-directional RC Controlled Low Speed Motor Gearbox.

In this conversion, we will not be using the existing servo radio control electronics, only the motor and the gearbox, so they can be discarded or disconnected and left in-situ unused.

Step 2 Electrical Modifications to the Servo

For a radar rotator, none of the inbuilt servo electronics will be used, and the motor leads will be brought out of the servo for direct connection to an external voltage source. You will therefore need to gain access to the internal connections of the servo to disconnect the motor wiring.

Before Conversion



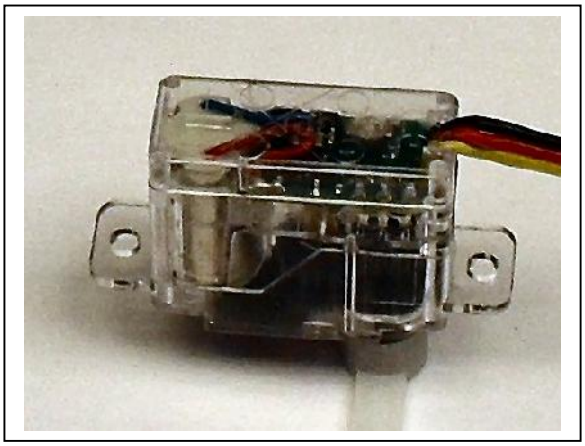
After Conversion

If you are using a larger model of servo, where the case is held together by fixing screws, simply remove the screws and slide the rear of the case off the main body of the servo.

Then carefully unsolder the connections to the motor terminals, probably fastened directly to the main control printed circuit board, and unsolder or cut the three wires connected to the position feedback potentiometer.

Remove and discard the printed circuit board, together with the 3 way cable which connected to the RC receiver. You can leave the position feedback potentiometer in place.

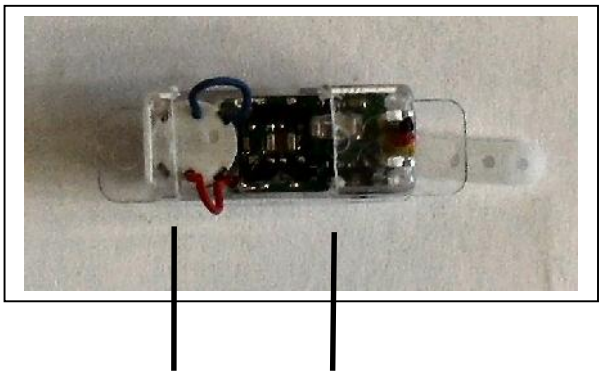
Then, solder two new wires to the motor terminals, lead them out of the case through the slot originally used by the RC receiver cable, and refit the case and fixing screws.



If you are using a very small servo, such as the HS-35HD, the case is unlikely to be assembled with screws, but glued together. Bitter experience has shown that attempting to break the glued bond is likely to cause irreparable damage, so the access technique described below is strongly recommended.

On the HS-35HD Servo, the case is transparent, and the position of the motor and control electronics is easily discernable on the underside of the servo case.

First, cut off and discard the original cable to the RC receiver as close to the body of the servo as possible.

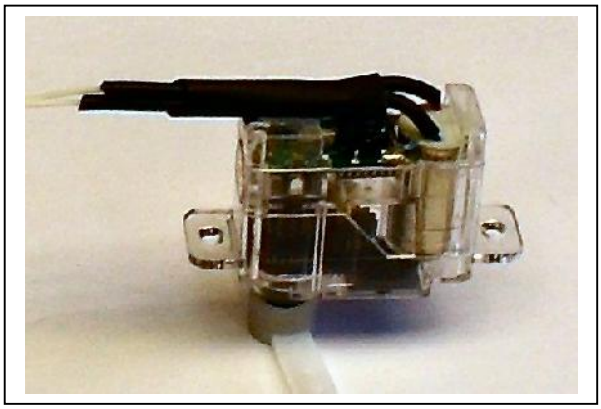


Cut Here .. and Here

Then locate the position where the two wires from the motor join the electronics PCB.

Carefully cut through the bottom of the servo case, on either side of this position, making sure you do not damage the motor wires.

Also, ensure that at least some of the case remains to hold the motor in position. Remove the cut portion of the case bottom using a craft knife or similar.



Carefully cut the two motor wires as close to the PCB as possible. Take Care !! - they are very thin and not very strong. Strip back about 3 mm of insulation from each wire and solder an extension wire to each. Use very thin wire. Insulate each joint using fine heat shrink tubing, or similar.

Fix the extension wires to the case in some way, to ensure that any force on the external wiring does not reach the actual motor wires. I use heat shrink sleeving and super glue.

The unused original servo electronics are left inside the case.

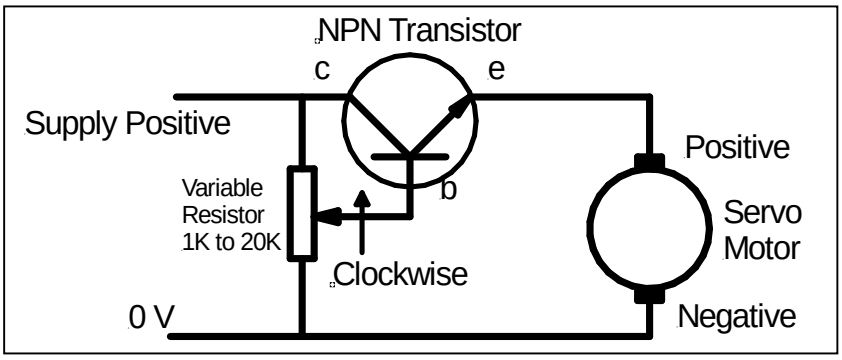
Step 3 Initial Electrical Tests

Connect a 5V or 6V supply [battery] to the new motor wires, and check that the output shaft rotates continuously, and smoothly. Note that with a 5 V supply, it will rotate far too fast for use as a radar rotator [About 120 rev/min for the HS-35HD], but this will be reduced using the speed controller described below.

Note the direction of rotation. If it is opposite to what you want, reverse the supply polarity. Mark the positive wire, for future reference.

Step 4 Speed Controller

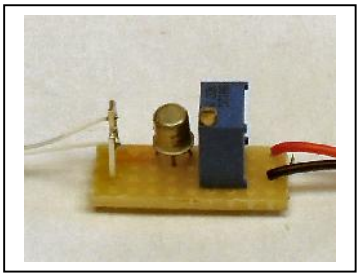
A simple speed controller to permit accurate control of the motor speed from zero upwards, can be made simply using two electronic components, a variable resistor and an NPN transistor. The circuit diagram is shown below.



The transistor can be almost any NPN type, as long as it has a current capacity of at least twice the motor current. For the HS-35HD, the motor current was about 30 mA at the final set speed. I used a BC107 transistor.

The variable resistor should have a value of between 1 kilohm and 20 kilohm. I used a 10 Kilohm, 10 turn miniature potentiometer to give me accurate control over the speed setting.

The supply voltage can be anything you like, within reason, say 5V to 12 V.



Simply solder up the circuit as shown, ideally on a small piece of stripboard.

Connect the supply and adjust the variable resistor setting to give the required shaft speed - about 20 to 30 rev/min is ideal.

A shaft can be glued directly into the screw hole in the output shaft normally used to secure the servo horn, and the other end glued to the radar aerial.

There you have it !! - A working radar rotator, constructed in less than an hour [after a bit of practice].

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