11. SERVO MODIFICATION FOR EXTENDED or 180 DEGREE ROTATION

Firstly some words of caution:

I take no responsibility for servos damaged by following procedures!
If you aren't comfortable around a soldering iron, it's probably better to find someone who is, and convince them to damage your servos ☺

The modification described has only been performed on ANALOG Servo's!
I have not attempted this modification on a Digital Servo, it may not work and may even damage the servo!

Any modifications to your Servo's will definitely void the warranty. So proceed at your own risk.

Perhaps a better phrase to apply to one of these "modified" Servos would be ***"Speciality"*** Servo, because this modification increases the output rotation to almost any amount from the original 60, 90 or 120 degrees all the way up to 180 degrees and maybe beyond!

Hitec do state the output shaft rotational range of their Servo's in datasheets, but looking at readily available data for other makes, this is not always the case.

The Servo's specifically modified here were purchased from Jaycar and have the catalogue numbers YM2763 and YM2765. The modification described herein can be applied to other makes of Servo although the methodology may differ as some Servo's have the motor mounted on the controller board.

Before endeavouring to go down this path, there are a couple of simple tests that you can first perform.

1. Check the existing rotational range of the output shaft. To do this, without power applied to the Servo and a horn/arm attached to the output shaft, slowly and carefully rotate the shaft until it stops at the mechanical stops at each end of rotation. This will give you, an indication of what is the maximum range determined by the mechanical stops. For some servos, the mechanical stops may limit the output shaft rotation to something less than 180 degrees. For the mentioned Jaycar Servo's the mechanical stops allow approximately 200 degrees of output shaft rotation.

2. Many of the servos on the market today give approx. 90 degrees of rotation when supplied with a PWM pulse with a width of between 1ms and 2ms. This is the standard pulse width range supplied by most radio control transmitters.

   Most modern Servo's have a pulse width of 1.5ms for the "neutral" point however, there are others still available from reputable retail stores and other sources which use an older standard of 1.3ms pulse for the "neutral point". The YM2763 and YM2765 sold by Jaycar, from the examples I have purchased, in the second category.

   By incrementing the pulse duration both shorter than 1ms and longer than 2.0ms it will be possible to identify what range can be achieved without internal modifications. The PICAXE Servo and SERVOPOS commands can provide durations from 0.01ms to 2.55ms.

   The internal electronic controllers for some Servo's may not accept pulse durations over the full range that the PICAXE Servo commands can provide.
   The YM2763 and YM2765 sold by Jaycar, from the examples I have purchased, are limited to approximately 0.64 to 2.00 ms pulse duration. Even theses limits can vary by around 0.01ms.

If you go even 0.1ms outside the range the electronics board can use then there is no movement at all **!** For example in PICAXE commands:

- to move to the neutral position use SERVOPOS 1, 130
- To then move to "lower" limit use SERVOPOS 1, 64 and the shaft moves to the limit
- But, from the neutral position using SERVOPOS 1, 60 and the shaft will **NOT** move from the neutral position.

This will give you the maximum range that the standard Servo you have will operate over with stretched pulse limits (that is shorter than 1ms and greater than 2ms).

3. You might also want to test the variation in rotation with different voltages as apparently some Servo's do vary the output shaft rotation with different supply voltages.
   The YM2763 and YM2765 sold by Jaycar, from the examples I have purchased, appear to be constant in terms of output shaft position irrespective of the applied voltage (in the range 4.5 to 7.2 volts.

   If you do find that the Servo output shaft position is supply voltage dependant, it is recommended that you set the extremities of shaft rotation based on the voltage (highest) that results in the greater shaft rotation. In this way you will not later have the shaft driven against the mechanical stops which is likley to damage the Servo.

From the above tests, the information is now available for the maximum mechanical rotation the shaft could turn. It is recommended that you back of your limits slightly so that the modified shaft travel is still slightly short of the mechanical limits.
The YM2763 and YM2765 sold by Jaycar, from the examples I have purchased, have 200 degrees of rotation and I seek to extend the operating range to 180 degrees so there is still some clearance from the mechanical limits at the end of controlled rotation.

So now, it is time to start the modifications for extended output shaft rotation. What this modification will do is effectively "fool" the internal controller circuit so to make the motor run a little longer (hence the greater output shaft rotation) before the circuitry tells the motor to stop.

All that is necessary to accomplish this task is to add a resistor (of the proper value based on the amount of travel desired) to **each** outer terminal of the potentiometer. This will change the timing circuits delaying the motor turnoff.

Carefully open the servo case by removing the screws on each corner of the bottom. If you do not see what is depicted in Figure A, below, showing the two wires from the motor to the circuit board. (White in the Figure, but colour doesn't matter) STOP! Your servo might not be one that can easily be modified.

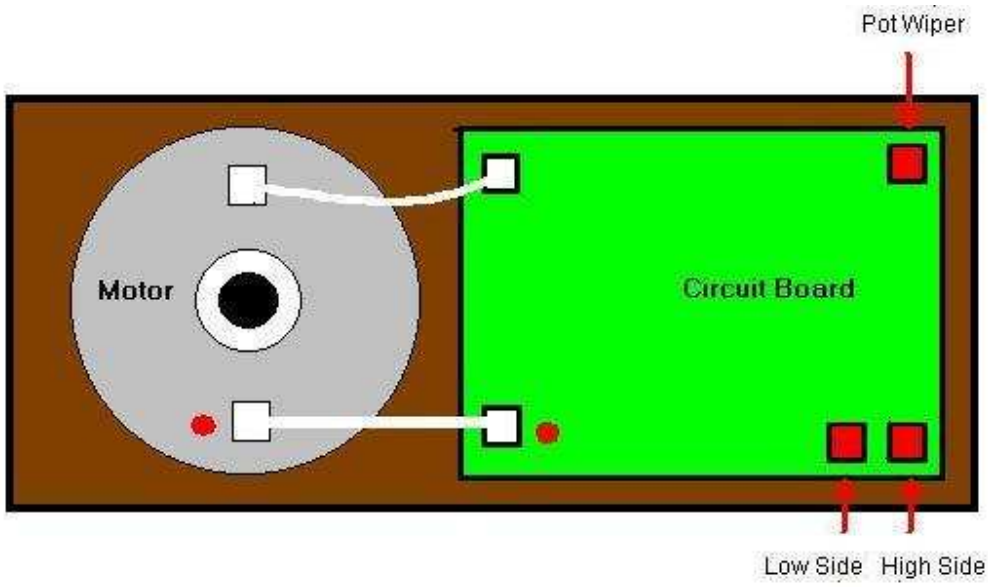

FIGURE A - ARRANGEMENT INSIDE
YM2763 / YM2765 SERVO-MOTOR

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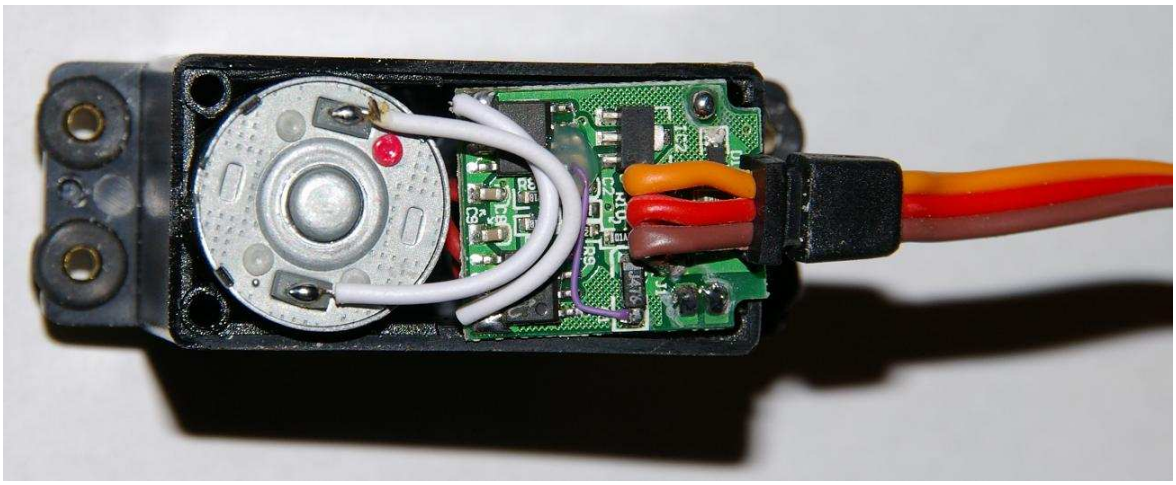

If your servo is similar to that shown Figure A, then gently lift the circuit board to gain access to the feedback potentiometer. This should be easily done because the wires should be long enough to permit this. When the circuit board has been lifted out of the Servo case, you should see the potentiometer with three wires (similar to than shown in Figure B). With the Jaycar YM2763/5 Servo's both motor wires are white and there is a red dot on the motor adjacent to the terminal which connect to the circuit board terminal at the same side as the pot wiper (there is no red dot on the circuit board).

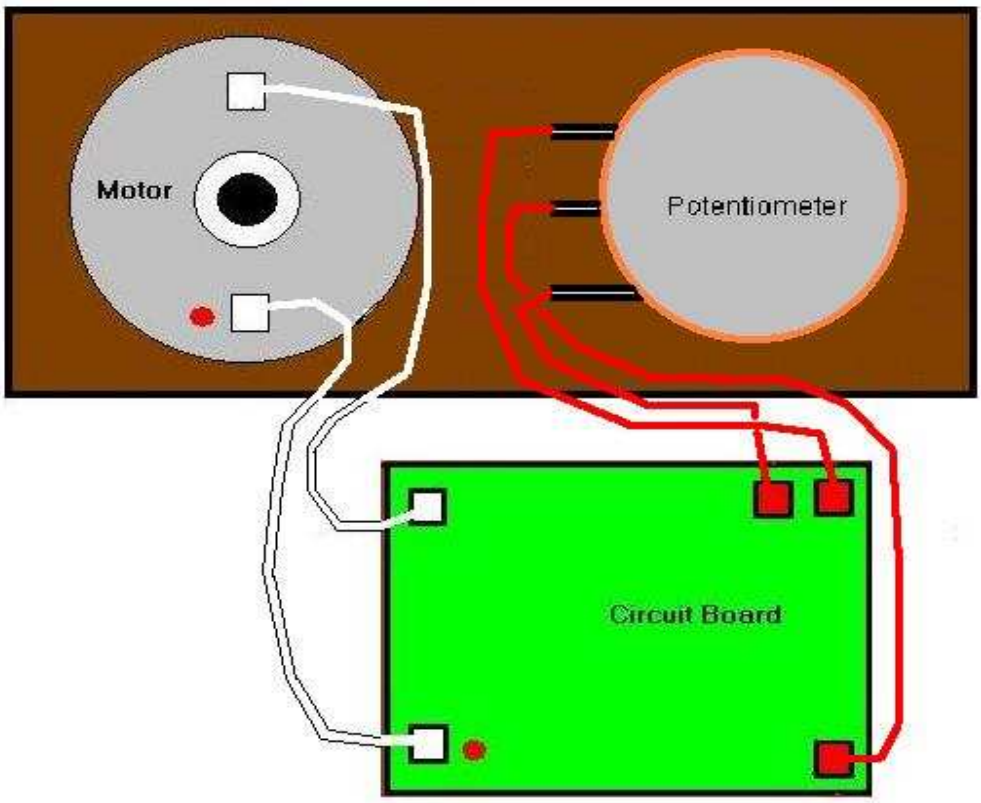

FIGURE B - ARRANGEMENT INSIDE CIRCUIT BOARD LIFTED TO SHOW POT

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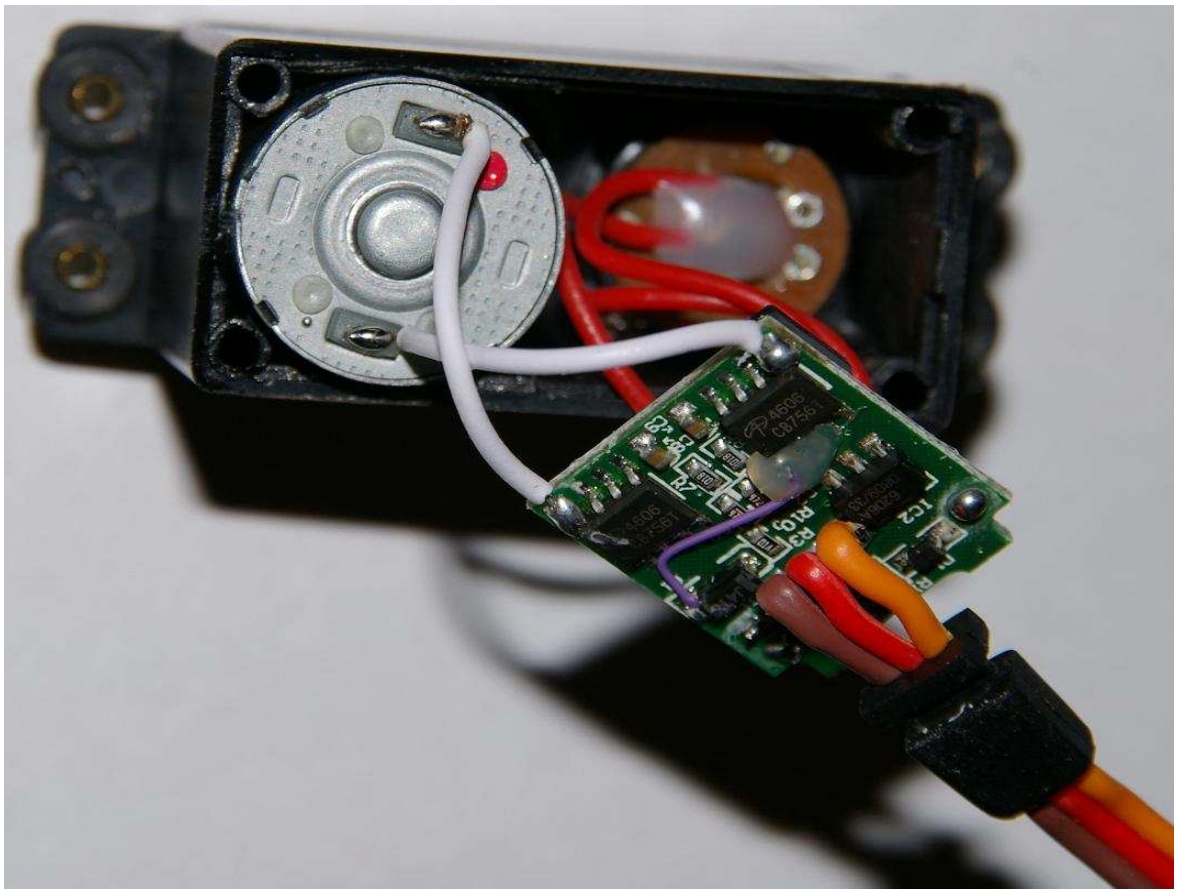
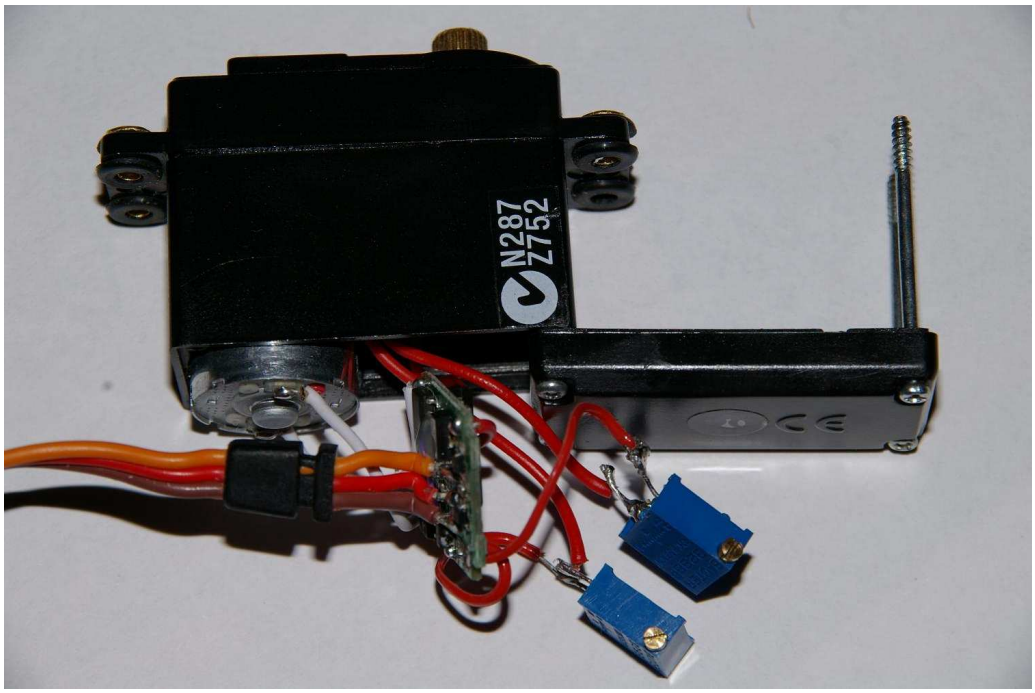
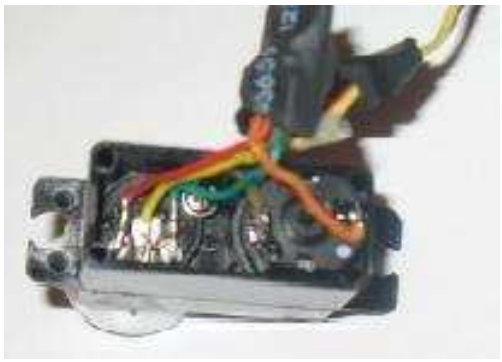


While there is definitely space between the circuit board and the rear of the potentiometer inside the Jaycar YM2763/5 Servo's to add some resistors, you would need to locate some very small trim pots to permanently mount trim pots internally.

The simplest way to determine the required resistance is a fairly simple technique which can be applied to most Servos. Two 2 kΩ or 5 kΩ trimpots are placed inline with the high and low side wires to the Servo feedback potentiometer. For the Jaycar Servos, all the feedback pot wires are red.
A suggestion is to use the bottom cover and screws to at least partially hold the Servo together while performing these tests and adjustments (see photo below).



With Hitec Servo's the feedback wires are red, yellow and green wires and the red and green wires are the one to add resistance to (see photo below).



Set for two potentiometers to minimum resistance initially.

Connect the Servo to PICAXE, and use a program to drive the Servo to each end of its travel.

Such a program might be like this:

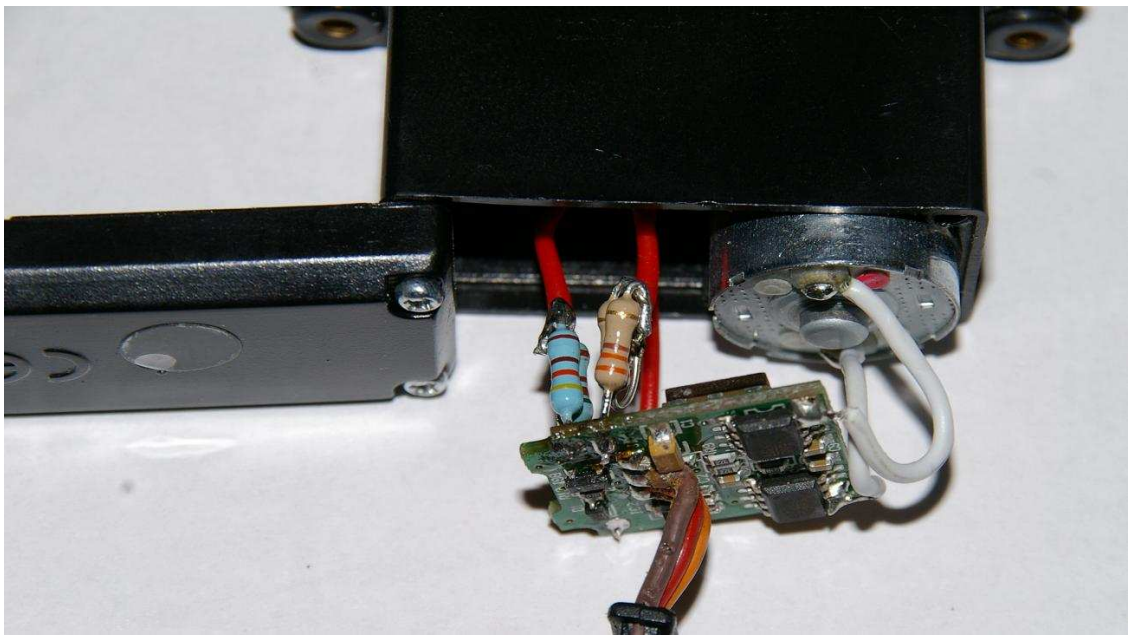
```
SYMBOL lowest = 64
SYMBOL highest = 199
SYMBOL neutral = 130
SYMBOL servpin = 1

Init: SERVO servpin, neutral
      PAUSE 5000 ; wait 5 seconds
Main:
      SERVOPOS servpin, lowest
      PAUSE 5000 ; 5 seconds is sufficient for each adjustment
      SERVOPOS servpin, neutral
      PAUSE 2000
      SERVOPOS servpin, highest
      PAUSE 5000 ; 5 seconds is sufficient for each adjustment
      SERVOPOS servpin, neutral
      PAUSE 2000
      GOTO Main
```

When the Servo shaft rotates to one end adjust the trimpot which causes the servo to keep moving in the same direction that was initially. Keep rotating the trimpot slowly until the mechanical end stop is hit, and then back off a little.
When the Servo shaft rotates to the other end, do the same with the other trimpot.
Repeat as necessary and then verify that the servo now rotates close to 180 degrees. This might require a bit of 'tweaking' with each trimpot, to ensure that each end stop is approached, but not hit.

Once you are happy with the amount of Servo output shaft rotation, unsolder the trimpots, taking care not to rotate them while doing it. Measure the resistance of each using a DVM (they will generally be different), and note it, remembering which side of the Servo feedback potentiometer the trimpot came from. Now, the values will probably not correspond to a standard resistor value. In this case it is safer to pick a resistor value lower than that measured, rather than one higher (reducing slightly the throw). This ensures that the mechanical end-stops are not hit, and protects the servo.

With the tolerance in carbon and metal film resistors I have found that by carefully selecting two nominal standard resistors and soldering them in series I can get very close to the desired resistance values for each resistance to be added on each side of the feedback potentiometer.
For example, one resistance required was 665 Ohms which was achieved using two 330 Ohm resistors one of which had a value of 333 Ohms and a second had a value of 332 Ohms.

You only need 1/4 watt resistors as there is very little current here. Keep the leads of the resistor as short as possible. If using two resistors to attain the desired resistance, solder then in a "Z" formation. With the Jaycar YM2763/65 Servo's the resistors can be mounted directly onto the electronic controller board. For other Servos it may be easier to mount the resistors to the feedback pot terminals.



Remember, all of this has to go back together without the resistors touching something else. In fact I have placed a layer of electrical insulation tape over the top of the adjoining surface mounted ICs on the circuit board to prevent any shorts between the added resistors and the existing circuit board components.

Finally, solder the wires removed from the board to potentiometer terminals to the other lead of each resistor that you have added. **Be sure to connect the wires correctly or your Servo output shaft will accelerate into the end stop and likely damage the Servo !**

Now reassemble the Servo using insulation tape or "spaghetti" tubing to insulate the leads where necessary. Figure 4 shows the placement of the added resistors before re-assembling the unit. Nothing can be above the level of the potentiometer and the leads of the resistors must not touch the circuit board when it is replaced.

Depending on how close the value of the added resistance is relative to the value determined from the trimpots, the Servo output shaft will now rotate a greater number of degrees for a specified pulse duration than it did before. The value of the resistors will vary depending on the value of the potentiometer inside of your servo. For example, one Servo that I modified had a 4530 Ω potentiometer and required a high side resistor of 945 Ω whereas a second Servo had a 4950 Ω potentiometer and required a 846 Ω high side resistor.

In each case, the high side resistor for the Jaycar Servos required a higher value than the low side resistor.