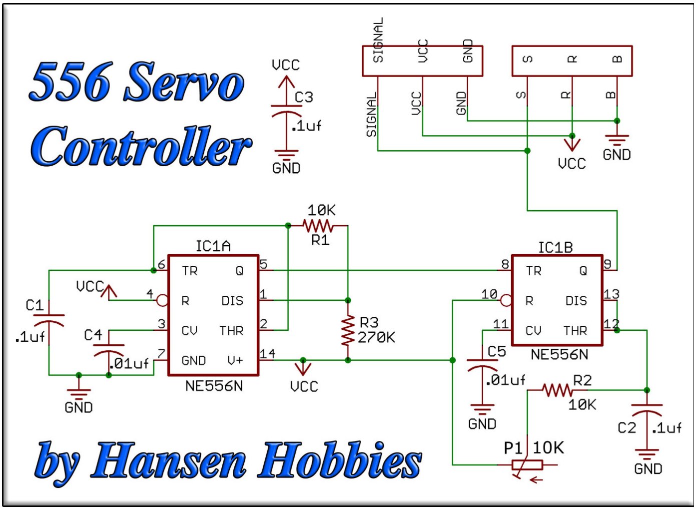
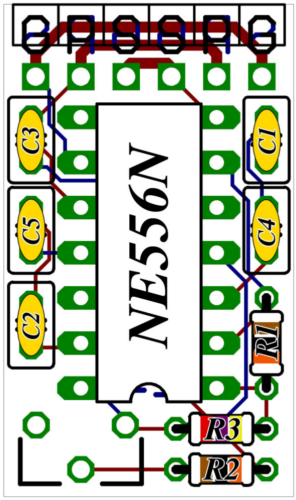




Thanks for purchasing this ***Servo Controller Kit by Hansen Hobbies***!

Please make sure you have everything:

- SCK pcb	(1)	- NE556N chip	(1)	- 0.1uF capacitor **C1**, **C2**, **C3**	(3)
- 0.01uF capacitor **C4**, **C5**	(2)	- 10KΩ resistor **R1**, **R2**	(2)	- 270KΩ resistor **R3**	(1)
- 10KΩ potentiometer	(1)	- 1x6 right angle header	(1)	- 14" solder	

Circuit explanation:

This circuit is based around the infamous **555** timer, but here, we use a **556** timer which is the same thing except is has two timers in one package. The goal is to make a controllable servo signal for testing/controlling servos. First, let's review what a servo signal looks like.

Servos are controlled using a **pulse width modulated** (**PWM**) signal. Fifty times a second your receiver sends a pulse to the servo, and the width of the pulse tells the servo where to go. For RC systems, the pulse comes every **20 milliseconds** (**50Hz**) and typically ranges in width from **1 to 2ms**.

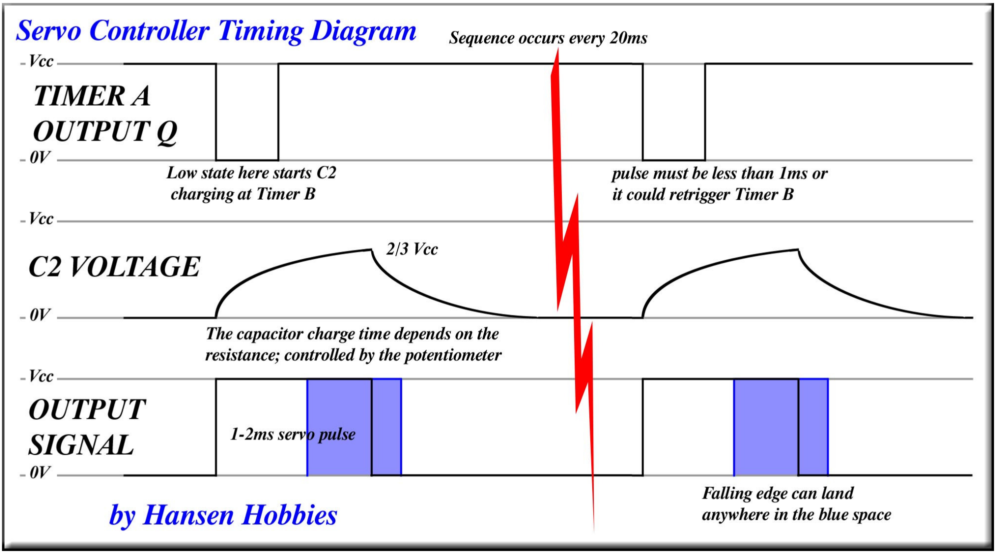
Using a **555** timer we can concoct all kinds of timing trickery. Each timer has two voltage comparators, a **reset pin**, a **discharge pin**, and an **output pin Q**. Pretty much all **555** timer circuits take advantage of the amount of time it takes to charge a capacitor through a resistor. The built-in comparators initiate actions when the capacitor voltage exceeds $2/3V_{CC}$ or drops below $1/3V_{CC}$. In this design, we use one timer (**Timer A**) to create a recurring **50Hz** pulse, then the second timer (**Timer B**) is used to create an adjustable **1-2ms** pulse. **Timer A** has to trigger **Timer B**. Note that in the schematic the timers are shown separately, but they are both built into a single chip. To makes things easier as you're looking at the schematic: **C3** is there simply to stabilize the voltage coming in from the battery, the two boxes in the top right represent the pins where the battery and servo plug in, and **C4** and **C5** are there simply to stabilize the internal voltage levels in the **556** timer (so just ignore them).

Let's start with **Timer B**, detailed in the right side of the schematic. The goal is simple: make a pulse that we can control between **1 and 2ms**. **C2** starts out with no charge, but slowly charges through **P1** and **R3**. When it reaches $2/3V_{CC}$ the **threshold pin** 'senses' this and two things happen: the **output pin Q** goes low, and the **discharge pin** discharges **C2** completely. Now nothing happens in this part of the circuit until a voltage of less than $1/3V_{CC}$ is applied to the **trigger pin** of **Timer B**; the timer is stuck. When the **trigger pin** does get a low pulse, then **Timer B** sets the **output pin Q** high and releases **C2** from discharge, allowing it to once again charge through **P1** and **R3**. This cycle will take place anytime we pulse the **trigger pin** of **Timer B** low. For a capacitor to charge to $2/3V_{CC}$ through a resistor it takes a certain amount of time, known as the "**RC time constant**" represented by the Greek letter pronounced "tao". The time constant is calculated as:

$$\tau = R \times C$$

Or in this case:

$$\tau = (P1 + R3) \times C2$$



P1 is a **10KΩ** potentiometer that can be anything from **0 to 10KΩ**. When you plug in values of **0-10KΩ**, **10KΩ**, and **0.1uF** for **P1**, **R3**, and **C2**, respectively, we get results of **.001 through .002**, exactly the **1-2ms** needed for the **PWM**.

Now if we can just signal **Timer B** to do it's thing every **20ms** we'll be set. The concept is simple: charge a capacitor through a resistor(s) until it gets to **2/3** V_{CC}, then discharge it until it gets to **1/3**V_{CC}, then do the same thing over and over again. This is called an **astable multivibrator** and is made up of the parts shown in the left side of the schematic. **C1** has to charge up through **R1** and **R2**, and when it reaches **2/3**V_{CC} the **threshold pin** (which is connected to a comparator inside) 'senses' this. **Timer A** then does two things: it sets the **output pin Q** low, and it pulls the **discharge pin** low to discharge **C1** through **R1**. As **C1** discharges the voltage at the **trigger pin** gets lower and eventually reaches **1/3**V_{CC} and the process starts over again; the **output pin Q** is set high, and the timer stops discharging **C1** so it can start charging through **R1** and **R2** again. The frequency can be calculated as:

$$f = \frac{1.44}{(R1 + 2R2) \times C1}$$

Plugging in values of **10KΩ**, **270KΩ**, and **0.1uF** a frequency of **49.66Hz** is returned; very close to our goal of **50Hz**. Note that **R1** is much smaller than **R2**. This was done so that **Timer A** outputs a very short low pulse every **20ms**. If the **trigger pin** of **Timer B** were still held low after **C2** reached **2/3Vcc** then it would retrigger the timer. The output of **Timer A** connects to the **trigger pin** of **Timer B**, so every time it goes low it makes **Timer B** discharge **C2**.

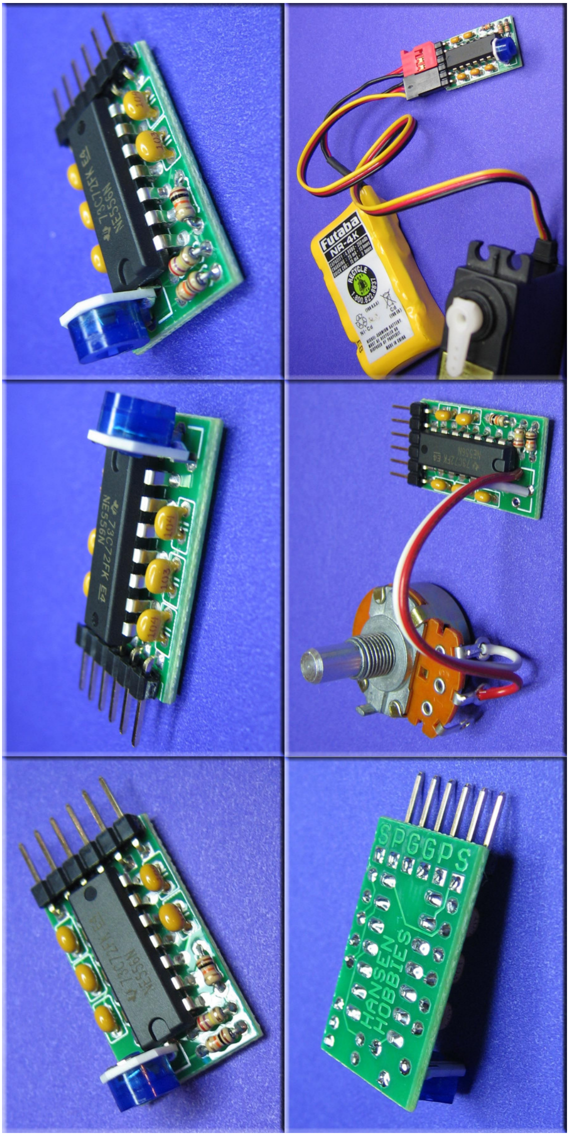
Assembly instructions:

Use the **printed circuit board** (**pcb**) layout diagram above as well as the images below to place and solder your components. The solder in this kit has a **water soluble flux** that can be cleaned off with **hot water and a brush**; this results in a very clean looking solder job. Cleaning the flux off is not optional. If you prefer, use a standard rosin flux solder or no-clean solder instead that doesn't need to be cleaned. If you're new to soldering, many good tutorials can be found online.

It is recommended that you solder the **NE556N** chip first, and then move on to the resistors and capacitors. Neither the resistors nor the capacitors have any special orientation/polarity. Make sure the **0.1uF** capacitors (reads "**104**" on the side) are placed where **C1**, **C2**, and **C3** are indicated, and the **0.01uF** capacitors (reads "**103**" on the side) are placed where **C4** and **C5** are indicated. Place the resistors taking note of the color codes, and then the potentiometer and right-angle header. Clip off the component leads as you go.

After all the components are soldered in place (and leads clipped flush to the board) check over your circuit to make sure there aren't any bridged connections or misplaced components. If you're using the included solder wash the board in hot water and scrub with a brush. If available, do a final rinse with distilled water or isopropyl alcohol. Dry the board with a towel and let air dry, or use a heat gun/hair dryer. Water will not damage the circuit, but moisture in the potentiometer could cause it to malfunction.

Depending on your application, you may prefer to replace the small potentiometer with a larger panel-mount potentiometer. This can easily be done as shown in the images to the right.



Operating Instructions:

The header pins are marked on the pcb as "*G*", "**P**", and "**S**" for **ground**, **power**, and **signal**, respectively. The three pins on one side are a mirror of the other side; it doesn't matter which side you plug in your battery and servo, just make sure the black wire goes to ground, the red to power, and the white/yellow to signal. Turn the potentiometer to make the servo turn (can be turned by hand or with a small screwdriver).

Attention: The "G", "P" and "S" markings on the component side of the circuit board, printed in white silkscreen (which normally gets covered by the right angle header anyways), are incorrect. The lettering was inadvertently flipped in the design process. Please follow the lettering on the bottom/solder side of the board. We will correct the problem on our next batch.

If you have any questions or comments about this kit please email chris@hansenhobbies.com.