



Thank You for purchasing our TRI-Mode programmable DC Motor Controller. Our DC Motor Controller is the most flexible controller you will find. It is user-programmable and covers most applications. This Product has a limited warranty and as with any product, you must use it within the stated specifications and have a basic understanding of electricity and electronics. Before you start connecting the Servo Controller, please read the specs list below.

Features and specifications:

- Input 1: RC Pulse 0.9ms to 2.1ms. @ 6 Volts or less.
- Input 2: Potentiometer 5 to 25 K Ohm Linear, Position Feedback for servo loop.
- Motor Supply Voltage: 10 to 18 V DC (12V DC Recommended)
- 25 Amps Maximum Continuous Current - Absolute Search Peak Current is 40 Amps
- Efficient H-Bridge design using Four High-Power MOSFET transistors
- 3 Modes of operation: RC Servo, RC Speed, Manual Speed ** Programmable
- 3 Slope Tables ** Programmable
- Built-in soft-start feature. Up-Slope and Down-Slope. ** Programmable
- Motor Reversal Protection. ** Programmable.
- Power-Up safe start feature. Motor will only start if pulse of 1.5ms is detected. ** Programmable.

The controller has 2 parts.

Part 1 - The Motor Part

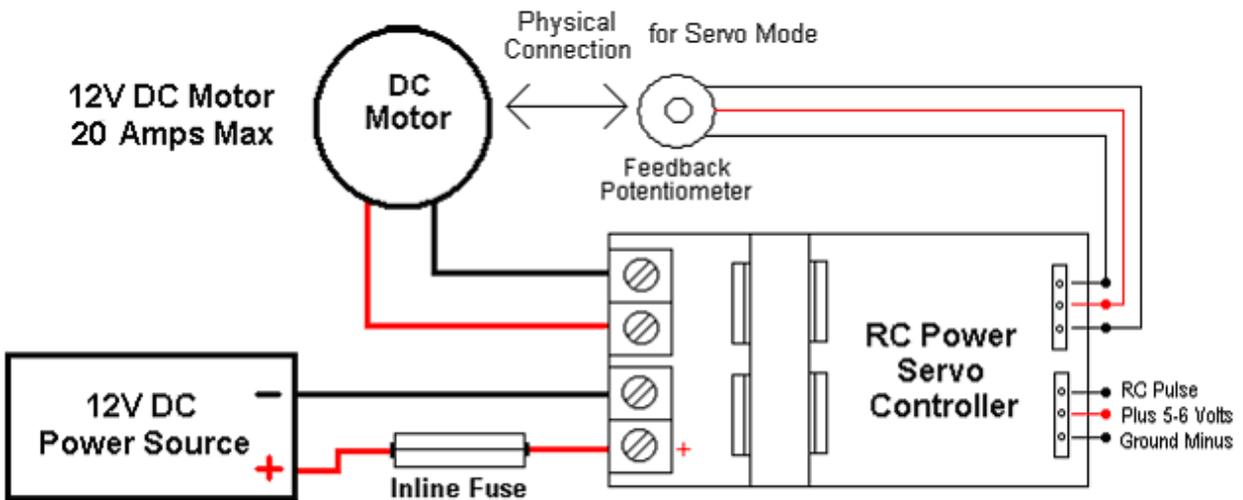
is were the motor is connected to 2 screw terminals. Power input for the Motor also has 2 screw terminals. The power for the Motor should be around 12 volts and supply enough current to the type of motor you are using. There are 4 high power transistors that switch the motor on and off and control the rotation direction.

- **The Motor part.:** You **must** use a power source of **no more than 18V** and never less than 9V. You **can not** run motors from a **6 Volt source**. There is no polarity and over current protection.
- Your Motor power source **must** be able to supply enough current (amperage) to your motor without a voltage breakdown under load. The voltage **must not go below 8 Volts** under load.
- If your Motor works continuously and draws more than 8 amps, we recommend a small cooling fan that runs on 12V. Using such a fan **is mandatory** if your motor current is continuous **10 amps or more**. For safe operating conditions check the temperature of the Heat Sink and decide for yourself.
- An Inline **30 A Fuse** to each controllers power input **is mandatory** as it will save your controller in case of any short circuit on the output to the motor.

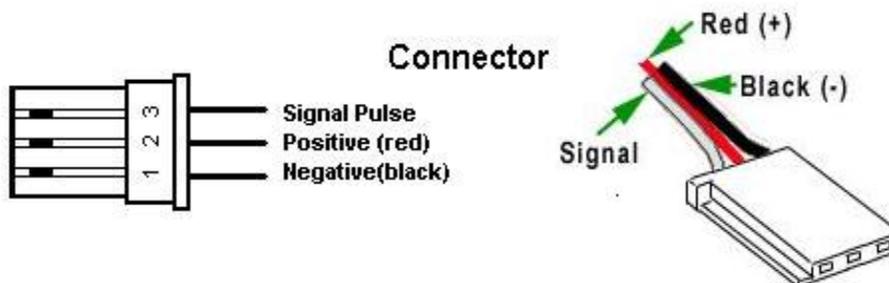
Part 2 - The Controller Part

The input voltage must never exceed 6 volts DC. You have to add a variable resistor (Potentiometer) of no less than 2.5 Kilo Ohm and no more than 25 Kilo Ohm and it must be a Linear type. If you use the controller in Servo Mode, the Feed-Back Potentiometer shaft must be coupled to the rotation axis of your end effector arm, either direct or via gears. If in speed mode, you can mount and control the potentiometer from anywhere.

The 3 pin Input of the Servo Controller is compatible with any standard RC Pulse generating device like a Rc Radio or a Micro-controller. The center wire supplies the Micro-controller with power and should **not exceed 6V**



RC Power Servo Connection Wiring

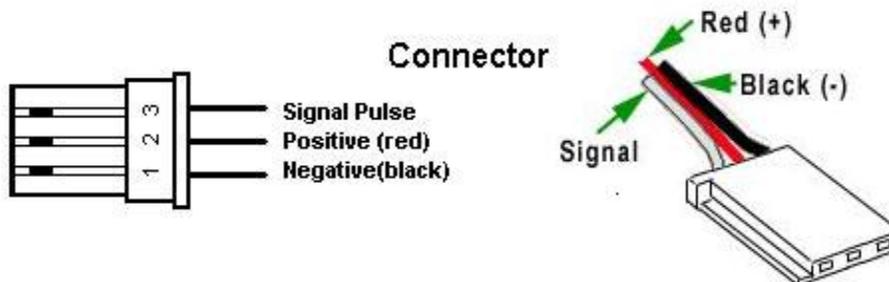
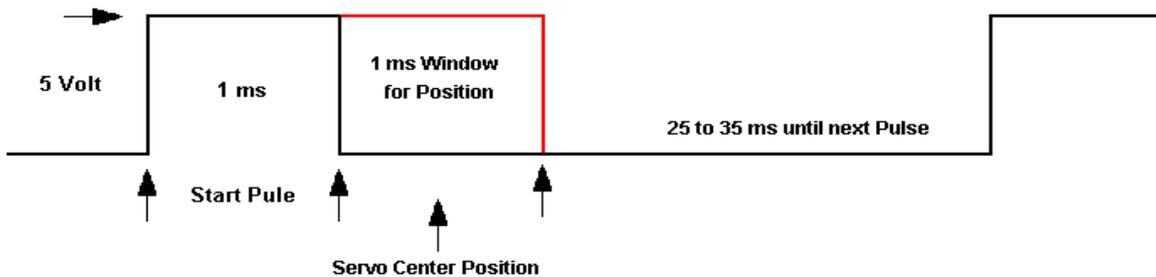


The RC Control Signal... How it works!

The RC Control Signal is a Pulse that is generated by an RC Radio Receiver or a Micro-Controller based circuit. This control protocol was developed back around 1957 and is still used today due to its popularity. The control signal is a pulse of varying width, called "Pulse-Width-Modulation". There is always a start pulse of 1 millisecond followed by a 1ms window that determines the position of the servo. The minimum pulse width is 1ms and the maximum is 2ms.

If in Servo Mode, a 1ms pulse would position your servo to one extreme end and a 2ms pulse to the other. Our Servo Controller will rotate the end-effector by 90 degrees for a 1ms pulse window. If the pulse width is 1.5 ms, then your servo would be at center position if in Servo Mode. Most servos of the Futaba variety will only turn 45 degrees for a 1 ms pulse window. This controller is designed to work at no less than 0.9 ms and no more than 2.1 ms. Any other value may destroy your feedback potentiometer

If in Speed Mode, the motor would be off at 1.5ms and at maximum speed at 1ms and 2 ms. There are 32 speed settings in either direction. You can also use our RC WIFI Controller that can control 8 RC Servos and 2 digital outputs from any WIFI enabled device like an iPad, iPhone or PC.



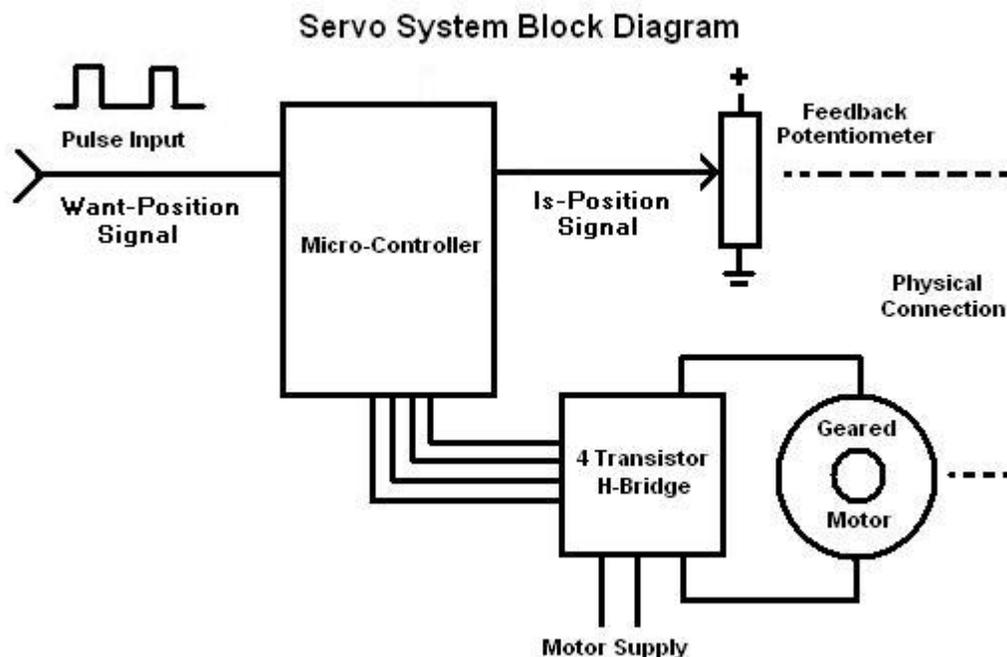
First the basics.... What is a Servo ?

A Servo is an Electro- Mechanical Positioning System and is the hearth of Automation and Robotics. The job of a Servo is to position some mechanical device or arm via a motor to a known position. To accomplish this, a Servos System needs to have one Output and two Inputs. The Output controls the Electric Motor that does the positioning. One Servo Input represents the “Want -Position”. RC Servos use a pulse of varying width. The second Servo Input measures the Present Position of this mechanical device, the “IsNowPosition” signal. This signal can be generated in many ways. RC Servos use a variable resistor (Potentiometer) that is in some fashion attached to the mechanical device and is known as the “Feedback Signal”. The resistance changes as the device changes position. A Micro-controller reads both of these Signals and compares them in order to decide which way the Motor has to turn to reach that “WantPosition”. It then switches the Motor on to turn in the correct direction. When the “WantPosition” signal and the “IsNowPosition” signal are equal in value the motor is instructed to stop. Whenever the “WantPosition” signal is different from the “IsNowPosition” signal, the controller will turn on the motor in the appropriate direction until both signals reach equilibrium.

An **H-Bridge** is an electronic switch that is controlled by the Micro-controller and switches the Motor to turn on forward, reverse or in the Off position.

Dynamic Breaking

We use this feature to prevent the Motor to continue spinning when the servo reaches it's target position. We simply short-circuit the motor leads when the off-position is reached. This feature is necessary to accurately position a servo. It prevents the motor from running past the target position



Tri-Mode motor controller

This controller can auto-detect the absence of an RC Pulse and automatically turn the controller into a motor speed controller instead of a RC Servo Controller.

Note: Always have your RC Receiver or other RC Pulse source powered up first or at the same time as the Motor Controller. If there is no RC Pulse detected during the first 250 ms after power-up, the controller assumes that only the feedback pot is present and turns the controller into a Speed Controller instead of a Servo Controller. The controller now switches to Table 1, the most linear algorithm by default, regardless of the setup programming

Mode1: A Servo Mode. The RC pulse sets the position of an arm, wheel or other mechanical device to a predetermined position. This mechanical device is known as an end-effector. The RC pulse is the WANT Position. The potentiometer is used to measure the IS NOW position of your end-effector and then tells the motor to turn in the proper direction and stop at that position. The POT must have a mechanical coupling to your end-effector, either direct or via gears.

Mode2: A Speed Mode. In RC speed controller mode, you can control the speed and direction of a Motor via the RC pulse. At 1.5 ms, usually the center position of a joy-stick on a Futaba radio, the motor will stop turning and come to a complete stop. Values between 1.5 and 2 ms will increase the motor speed in a linear fashion until it reaches maximum at 2ms. Anything less than 1.5 ms will increase the speed in the opposite direction in a linear fashion. Maximum speed is reached at 1 ms. The Potentiometer is used to calibrate the off-position of the motor. When your Joy-Stick on your Futaba Radio is in upright or center position, you would turn the Potentiometer to about center until the motor stops turning. This Mode will automatically use table1 and override any table setting.

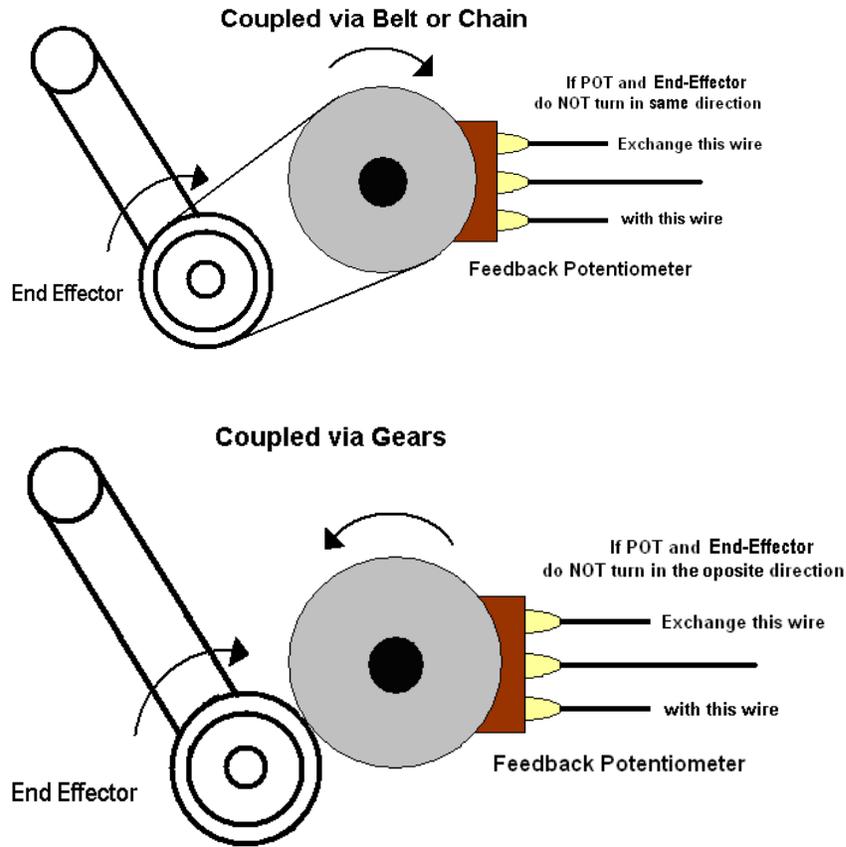
Mode3: A Speed Mode. In this mode the controller ignores any RC Pulse if present. Only the potentiometer is used to control the motor speed and direction. Whenever there is NO RC Pulse detected on power-up, the controller will switch to this mode automatically. No Radio or other Rc Pulse generator is needed. You only need the power for the controller (5 to 6 volts) and the power to the motor. The motor will stop turning at about center position of the Potentiometer and increase speed in a linear fashion when turned in either direction. This Mode will automatically use table1 and override any table setting.

Note: You can also run in the Manual Speed Mode, without setting it. You do not need any external power other than the motor power. On the left side of the PCB are 2 pins. When the jumper is plugged-in across the 2 pins, the controller now gets power from the Motor Power Source instead of the 3 pin connection from an RC Controller. With the jumper installed, the controller will switch to Manual Speed Mode automatically. **If you want to run the controller in Mode1 or 2, the jumper must be removed.**

The Feedback Potentiometer

This section deals with **Power Servo applications**. If you only want to use this controller for speed control you can ignore this section.

The RcPowerServo controller is the brain of the servo system. It is now your job to physically connect the Feedback Potentiometer to the End-Effector. The latter being the last pulley, gear or wheel after the Motor. Many 12 volt motors have a gearing mechanism built in, like a windshield wiper motor. The very first thing you must do before you mount the potentiometer is to establish the **direction** it has to turn. **Do NOT** attach the POT to the End-Effector until you are sure the end-effector turns in the correct direction. You can test this by first **placing your RC controller** to center. Then **center the POT** and hold it to your imaginary spot where you want to mount it. You then slowly turn the POT to the right or left and verify that the end-effector turns in the **same direction**. If it does turn in the **opposite direction** do the following. Remove the power from the RC Power Servo PCB. Then unplug the POT Connector. Turn the plug by 180 degrees and re-insert. Or exchange the 2 outside wires that lead to the pot by unsoldering and exchanging the 2 outside wires right on the POT. After re-applying the power and verifying the POT and End-effector turn in the **same direction**, you can mount your POT in a position where they will touch. When the 2 physically touch, the POT will turn in the opposite direction of the End-Effector.



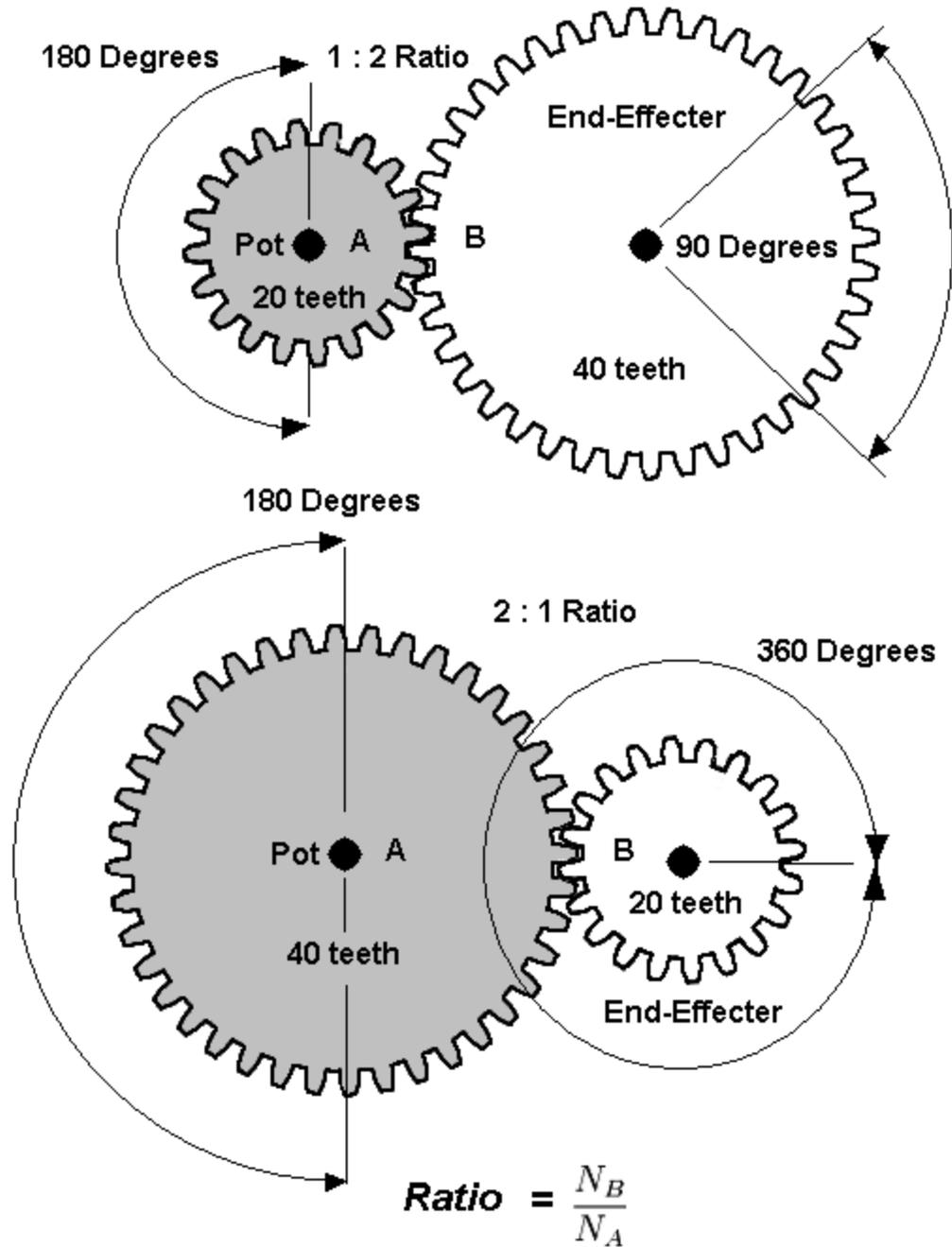
You also have to establish the degree of movement that your End-Effector needs. The End-Effector is the part of your design that does the actual work, either an arm, a pulley or a linear motion shaft. It is this Travel Range of the End-Effector you must establish first. It is the **ratio** between your **Feedback POT** and your **End-Effector** we need to calculate. Your Feedback POT represents a Fixed Parameter. A 1 ms Pulse Range will turn the POT 180 Degrees regardless of where your End-Effector is positioned. Therefore you have to establish the gearing ratio between your End-Effector and the Feedback POT. The degree of movement of the End-Effector is used for the calculation.

Controlling your End Effector

If you are making a Robot Arm and you attach the Feedback POT directly to the rotation axis of your arm without any gears, then your arm will have a 180 degree travel. Remember, **the POT will always turn 180 degrees**. If you want an arm to travel 90 Degrees, then you must use 2 Gear Wheels with a 1:2 Ratio. From the examples below, you should be able to calculate the gear ratio you need for your project. The actual number of gear teeth in the gears is not critical, only the teeth ratio between the POT gear and the END-EFFECTER is important.

The END-EFFECTER is the last wheel or linkage in your design that does the actual work.

For 1 ms range Feedback POT always turns 180 Degrees



How to mount the Feedback Potentiometer....

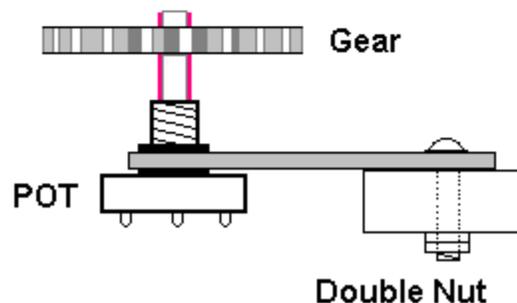
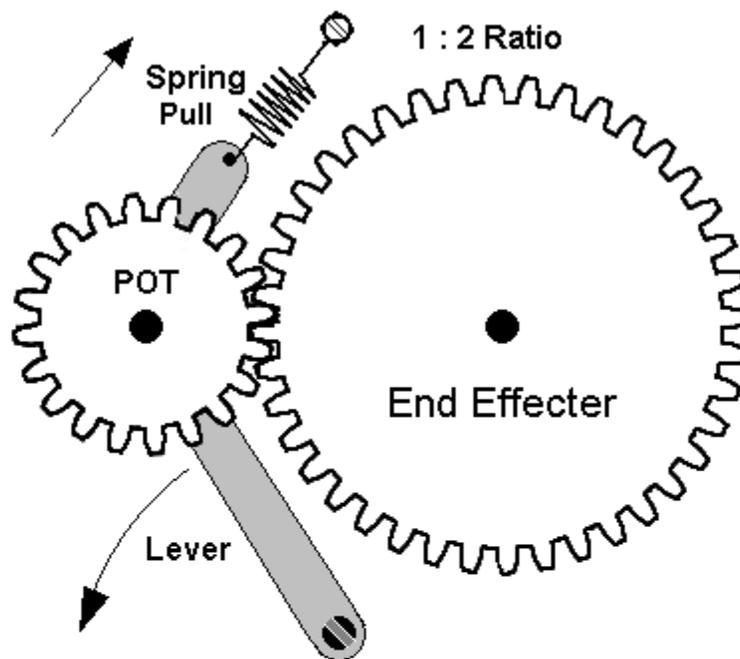
From experience, we strongly recommend NOT to mount the Feedback POT rigidly in a fixed position.

Reason 1:

If you accidentally reverse the plug to the Feedback POT into the controller, the end effector will run past the POT limit and likely damage it. If you use this spring pulling system, the gear will simply slip and cause no damage to the POT.

Reason 2:

To set your end effector to a physical position in relation to your joy stick or other controller, you don't have to loosen any screws. Simply pull the lever back and align the POT gear wheel to a different teeth position on the end effector gear.



Programming the Tri-Mode Controller

Has

The 13 parameters are saved in non-volatile memory and take effect next time you power-up the controller. Before you start making changes, look at the setting choices below.

The 13 Program selections

=====			
1.	Mode 1	RC Power Servo	
2.	Mode 2	RC Speed Controller	(Linear Table Only)
3.	Mode 3	Manual Speed Controller	(Linear Table Only)

4.	Ramp Delay =	16 Steps	
5.	Ramp Delay =	8 Steps	
6.	Ramp Delay =	6 Steps	
7.	Ramp Delay =	4 Steps	
8.	Ramp Delay =	0 = OFF	Default

9.	Slope Table =1	Long decay	
10	Slope Table =2	Linear Decay	Default
11	Slope Table =3	Short Decay	

12	RC Pulse checking	ON	
13	RC Pulse checking	OFF	Default

As you may notice, the program choices are numbered and are in groups. You can only select or change one parameter in each group. You can select 1 of the 3 Mode choices.

----- 3 Settings for Mode Selection -----

1: Mode1: A Servo Mode. The RC pulse sets the position of an arm, wheel or other mechanical device. The potentiometer is attached to your end-effector and is used to measure the IS NOW position and then tells the motor to turn in the proper direction and stop at that position. The POT must have a mechanical coupling to your end-effector, either direct or via gears. This Mode only works if there is a RC Pulse detected within 250ms after power-up. If the RC Pulse is absent on power-up, the Mode will then default to Mode3

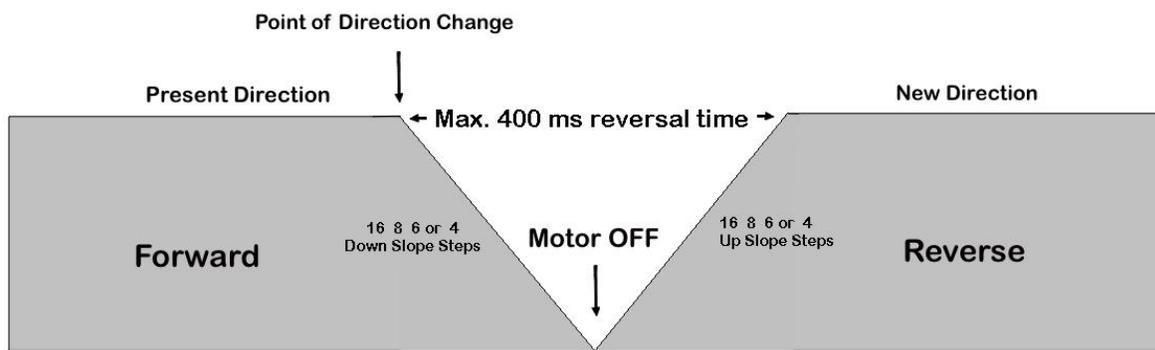
2: Mode2: A Speed Mode. On power-up, when the controller detects an RC Pulse and the controller is programmed for Mode2. The potentiometer is NOT attached to your end-effector The RC Pulse is now used to control the speed and direction of your motor, The controller will now act as a Bidirectional Speed Controller. The POT is used as a fine trim to stop the motor when your RC joystick is in the center position. This Mode only works if there is a RC Pulse detected within 250ms after power-up. If the RC Pulse is absent on power-up, the Mode will then default to Mode3

3: Mode3: A Speed Mode. The controller will now act as a Bidirectional Motor Speed Controller. The potentiometer is NOT attached to your end-effector. This Mode is also the default if there is NO RC Pulse detected within 250ms after power-up. The POT is now used to control the speed and direction of your motor. The motor will stop running when the POT is in center position and increase speed when the POT is turned away from center position.

5 Settings for Reverse-Protection Feature: Ramp Delay

We also have to prevent the motor from instantaneously reversing direction. When the motor runs at full speed in the forward direction and we tell it to go to a position in the opposite direction, we must first slow the motor down. Only when the servo motor comes to a stop can we reverse direction and process the Up-Slope. This is necessary to allow robots to move fluidly and avoid stress or damage to gears, levers and pulleys. For some applications, like power steering, these features are not wanted or not necessary. Settings #4 to #7 lets you set the number of Slope Steps that effect the reversal protection. The #8 setting turns this feature Off and is the default setting. If you like to test this feature start with # 7.

A Power Servo needs to have an Instantaneous Motor Direction Reversal Protection



----- 5 Program Parameters for Motor Reversal Steps -----

4: Both Velocity Slopes, up and down, have **16 steps**. This produces the longest slope.

Usage: Very slow moving arms, servos that have lots of torque and lift heavy weights.

5: Both Velocity Slopes, up and down, have **8 steps**. Slope count is divided by 2.

Usage: Same as above but with high torque gearing.

6: Both Velocity Slopes, up and down, have **6 steps**. Slope count is divided by 3..

Usage: For medium speed servos.

7: Both Velocity Slopes, up and down, have **4 steps**. Slope count is divided by 4. This is the shortest slope but still useful.

Usage: use if the servo starts to have signs of overshooting.

8: Both Velocity Slopes, up and down, are **completely disabled**.

Default Setting

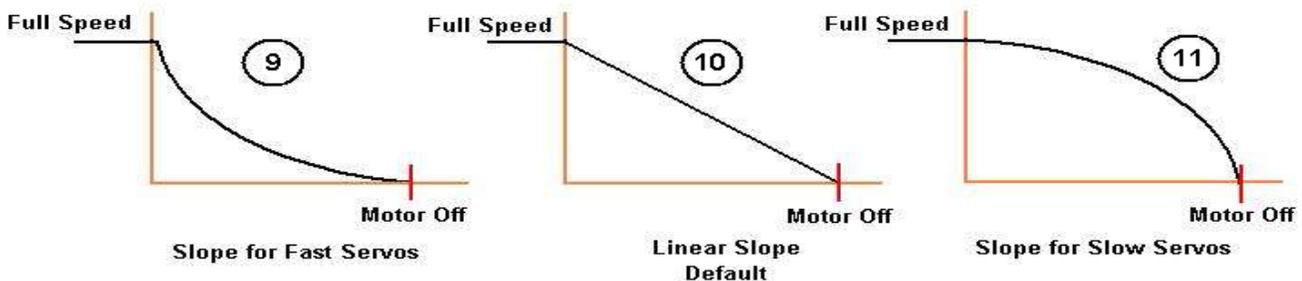
Usage: For fast moving servos with low torque. Use if any of the above settings still cause overshooting the target position. Also best when instant response is needed like for a steering servo.

3 Settings for Speed Slope Selection

Using more powerful motors necessitates the use of velocity ramping. If we were to apply full power to our Servo Motor that has a 1 or 2 pounds of lift load, we would first get a very jerky motion, and second, our hardware may not survive the stress of this instantaneous force. To bring a large weight into motion, we must match motor torque to weight load. Our RC Power Servo Controller will do this by slowly increasing the speed of the motor, which is known as Up-Ramping or Soft-Start, and do the same to slow it down by Down-Ramping.. Basically we need to control the Speed when we want to go from one servo position to another.

Not all Servo Applications are equal. Some are for moving large weights, torque being the main criteria. Others are for quick responding applications like Power Steering, Velocity being the main criteria. If your end-effector arm takes less than 3 seconds for a 180 degree turn, then the feedback signal is faster than what we can process and your effector arm would overshoot the target position. For this reason, we have to slow our motor down before we reach the target position.

For fast moving servos we need to use a quick decaying slope to prevent the servo from overshooting the target position. Use program #9 for this purpose. The #10 slope is the default setting and will work for most applications. For slow and very slow servos use #11 setting.



3 Program Parameters for Slope Selection

	Slope Type	Usage	
9:	Fast Decay	for fast moving servos, like a steering servo.	
10:	Linear Slope	for medium speed servos.	Default Setting
11:	Slow Decay	for slow moving servos.	

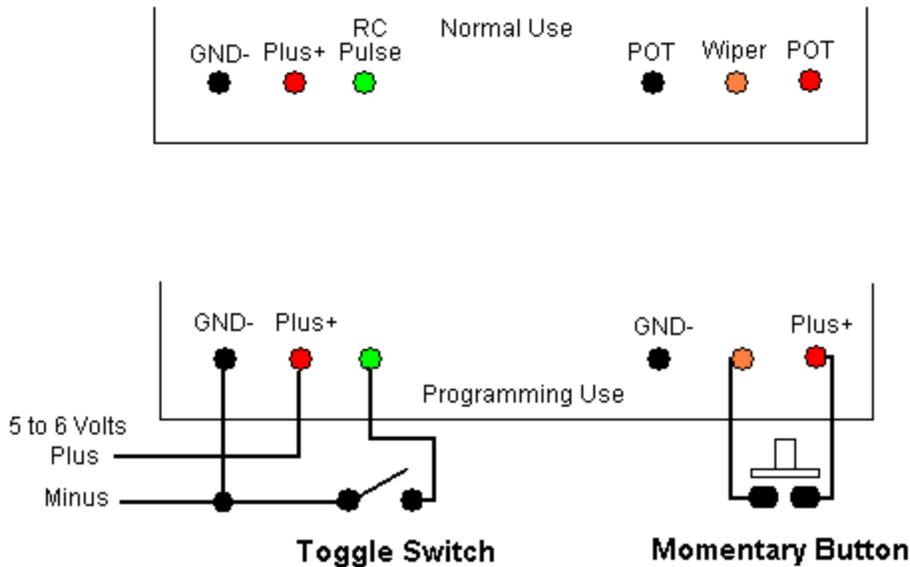
2 Settings for Start Up Safety Protection:

In order to prevent your robotics going a mock and cause serious damage, we need a Start Up Safety Protection that will not arm the motor until it receives at least **one valid RC Pulse of 1.5 ms**. This prevents your Robotics from moving randomly and cause serious damage. This can occur if you apply Motor Power before you activate your RC Controller. Your Joystick or the POT, depending on the application, has to be in the center position to enable the motor to turn. When this feature is enabled, you have to move your controller to the center OFF position before the Motor gets power.

----- 2 Settings for Power-Up safe start feature. 1.5ms Rc Pulse detection. -----

12:	1.5ms pulse detection	= ON	
13:	1.5ms pulse detection	= OFF	Default Setting

Programming Instructions for the Tri-mode Controller



And finally, a simple programmer you have to build yourself. You only need 1 **single pole switch** and 1 **normally open pushbutton** to program any of the 13 settings.

Before you start any programming activity, please do the following....

Disconnect the Power Source for the Motor. This is for safety reasons.

Your motor could start turning when you disconnect the Feedback Potentiometer.

Disconnect the Feedback-Potentiometer

Remove the 3 pin plug that comes from your RC-Controller Board or RC Radio Receiver or other power source for the Micro-Controller

Connect the Programmer circuit as shown above. This must be done when the controller has NO power.

Now you can program any of the 13 settings

- 1.) **Close the Toggle Switch.** When the controller detects that this pin is on ground when you apply power and it boots, it goes into **programming mode**.
- 2.) **Connect the power source**, 5 to 6 volts. Now in programming mode.
- 3.) **Now press the Pushbutton** the number of times that matches the parameter you like to set. The maximum # is 13
- 4.) When you have completed pressing the button X times, **Open the Toggle Switch.**
The Micro-Controller will now save your Setting in Flash-Memory.
This must be done before you disconnect the power.
- 5.) You must now **disconnect the power**, the cable that comes from your RC Controller or RC Radio. Your controller is now programmed to a new setting.
- 6.) To change another setting, go to step # 1.

Here is a summary of the programming sequence :

Disconnect the Motor Power and follow these steps in sequence

**Disconnect the 5-6 volt Controller Power
Connect Switch and Button**

AA

Close Toggle Switch
Apply the 5-6 volt Power now in program mode
Push button as many times as the Setting number
Open Toggle Switch now in save setting mode
Disconnect the 5-6 volt Power

To program more settings -- go to AA

To test your new setting, re-connect your motor and your feedback potentiometer and the power source for the motor, and last the cable to your RC Controller or RC Radio.

Be careful when trying out your new settings. Unexpected results may appear.

We like to thank you for purchasing this product. Please report any errors you may find. We are also open to suggestions to make this a better product . You can contact us @

support@rcpowerservo.com