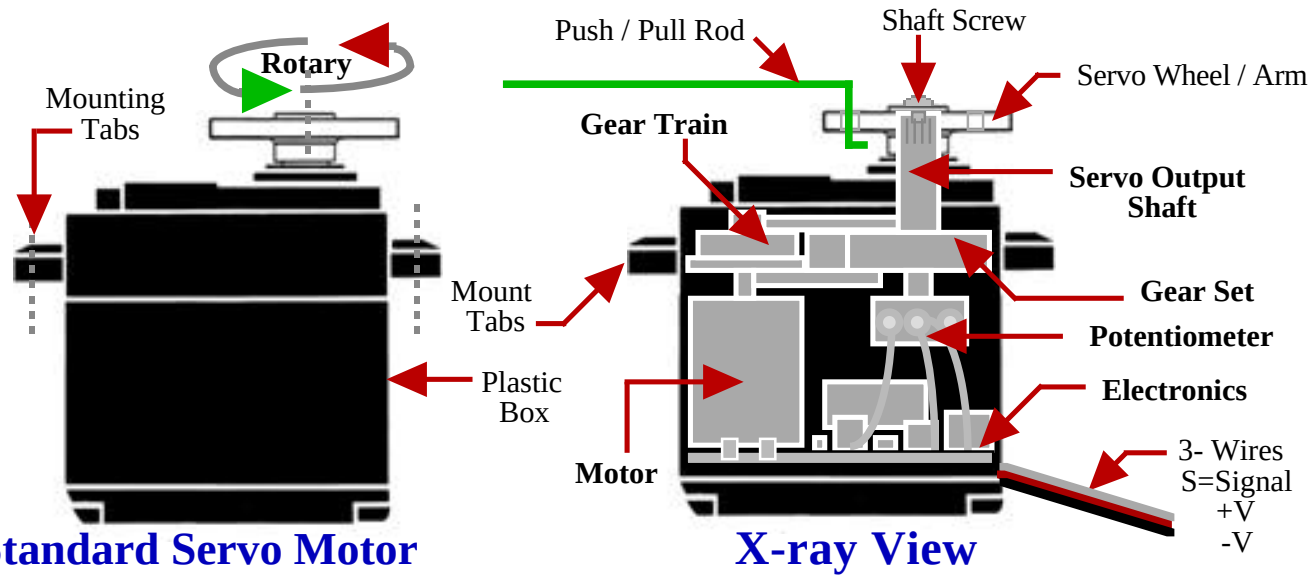
Servomotor Information

Technical **T**

Ver 3.1

A servo is a mechanical motorized device that can be instructed to move the output shaft attached to a servo wheel or arm to a specified position. Inside the servo box is a DC motor mechanically linked to a position feedback potentiometer, gearbox, electronic feedback control loop circuitry and motor drive electronic circuit.



Standard Servo Motor **X-ray View**

A typical R/C servo looks like a plastic rectangular box with a rotary shaft coming up and out the top of the box and three electrical wires out of the servo side to a plastic 3 pin connector. Attached to the output shaft out the top of the box is a servo wheel or Arm. These wheels or arms are usually a plastic part with holes in it for attaching push / pull rods, ball joints or other mechanical linkage devices to the servo. The three electrical connection wires out of the side are V- (Ground), V+ (Plus voltage) and S Control (Signal). The control S (Signal) wire receives Pulse Width Modulation (PWM) signals sent from an external controller and is converted by the servo on board circuitry to operate the servo.

R/C Servos are controlled by sending pulse width signals (PWM) from an external electronic device that generates the PWM signal values, such as a servo controller, servo driver module or R/C transmitter and receiver. Pulse Width Modulation or PWM signals sent to the servo are translated into position values by electronics inside the servo. When the servo is instructed to move (Received a PWM signal) the on board electronics convert the PWM signal to a electrical resistance value and the DC motor is powered on. As the motor moves and rotates the linked potentiometer also rotates. Electrical resistance value from the moving potentiometer are sent back to the servo electronics until the potentiometer value matches the position value sent by the on-board servo electronics that was converted from the PWM signal. Once the potentiometer value and servo electronic signals match, the motor stops and waits for the next PWM signal input signal for conversion.

A pulse width signal (PWM) of approximately 1.5 mS (1500 uS) is the "neutral" position for the servo. The servo, neutral is defined to be the point where the servomotor has exactly the same amount of potential rotation in the counter clockwise direction as it does in the clockwise direction. When the pulse width signal (PWM) sent to a servo is less than 1.5 mS. the servo moves some number of degrees counterclockwise from the neutral point. When the pulse is greater than 1.5mS the servo moves some number of degrees clockwise from the neutral point. Generally the minimum pulse will be about 1.0 mS and the maximum pulse will be 2.0 ms with neutral (Stop) movement at 1.5 mS

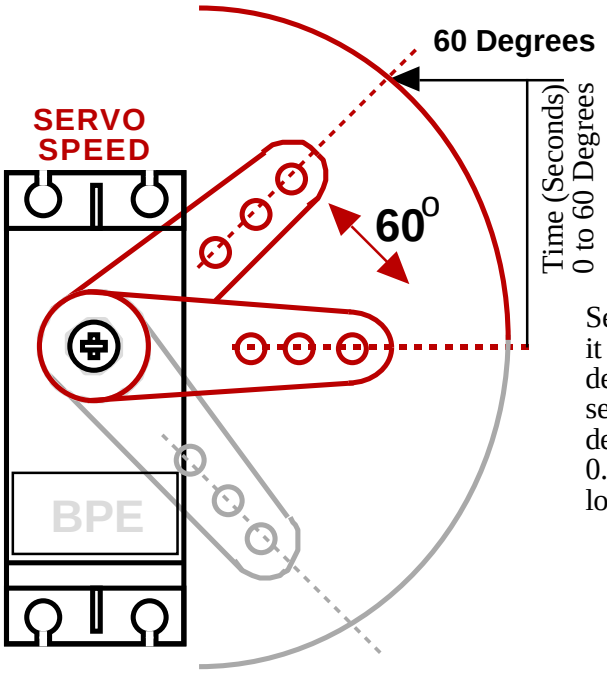
R/C servos run on 5 volts DC but they often work with voltages V-, V+ between 4 and 6 volts DC power, near 1 Amp of current. (Torque load on the servo arm determines amps and can be from 200 mA to 1 Amp depending on moving or holding force the servo needs for position)

Servo Information

Technical T

SERVO RATINGS

The most common details available on a servo are its speed and torque rating. Nearly all servo packages are listed with brand name, model name/ number, speed, and torque output at 4.8 volts and 6.0 volts. Some information about metal, plastic gears or ball bearings may also be listed.

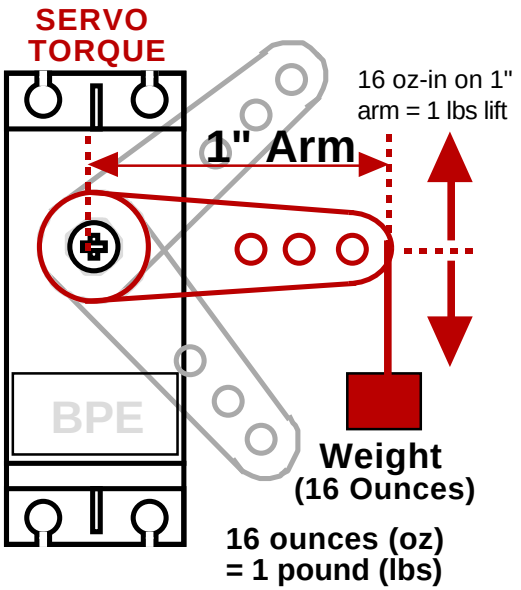


SERVO SPEED

Servo Speed is defined as the amount of time (in seconds) that a servo arm attached to the servo output shaft will move from 0 to 60 degrees.

Note: The lower the time (Seconds) the faster the servo can move an attached wheel or arm.

Servo Speed is measured by the amount of time (in seconds) it takes a 1 inch servo arm to sweep left or right through a 60 degree arc at either 4.8 or 6.0 volts. A servo rated at 0.22 seconds/60 degrees takes 0.22 seconds to sweep through a 60 degree arc. Some of the fastest servos available move in the 0.06 to 0.09 second range. In some servos, faster speeds may lower torque available.



SERVO TORQUE (Power)

Servo Torque is defined as ounce-inch (oz-in) The total push / pull power a servo can apply on a 1" servo arm when moving.

Servos have a certain amount of torque (strength) that is generally proportional to their size. Servos come in all kinds of sizes, strengths and weight. Torque is the measurement of force given over a distance. For most servos in the USA, torque is measured in oz-in (force in ounces times inches, or ounce-inch). Servo Torque is measured by the amount of weight (in ounces) that a servo can hold at 1-inch out on the servo output arm in the horizontal plane, again at either 5.0 or 6.0 volts to see when the servo stalls as it tries to lift the weight horizontally. The reported result is a measurement like this: Servo XYZ = 100 oz/in. @ 6.0 V. That means that Servo XYZ is capable of holding 100 ounces using a 1 inch output arm without excessive deflection at 6.0 input volts. To convert oz-in to kilogram-centimeters (kg-cm) just divide by 13.9

Examples: Servo-A has 42 oz-in of torque
42 divided by 16 = 2.63 Lb-In. of force on a 1" servo arm

Servo-B has 2.5 oz-in of torque
2.5 divided by 2 = 1.25 Oz.-In. of force on a 2" servo arm

Servo-C has 36 oz-in of torque
36 divided by 4 = 9 Oz.-In. of force on a 4" servo arm

Note: If you need to know how many pounds a servo can push or lift on a 1" servo arm, divide the oz-in by the number 16. Different sized arms can be used. Use the length of the arm and divide the oz-in value by the arm length. Ounces divided by 16, for Pounds. Inches divided by 12 for Foot.

Servo Information

Technical T

SERVO RATINGS

4.5 to 6.0 Voltage

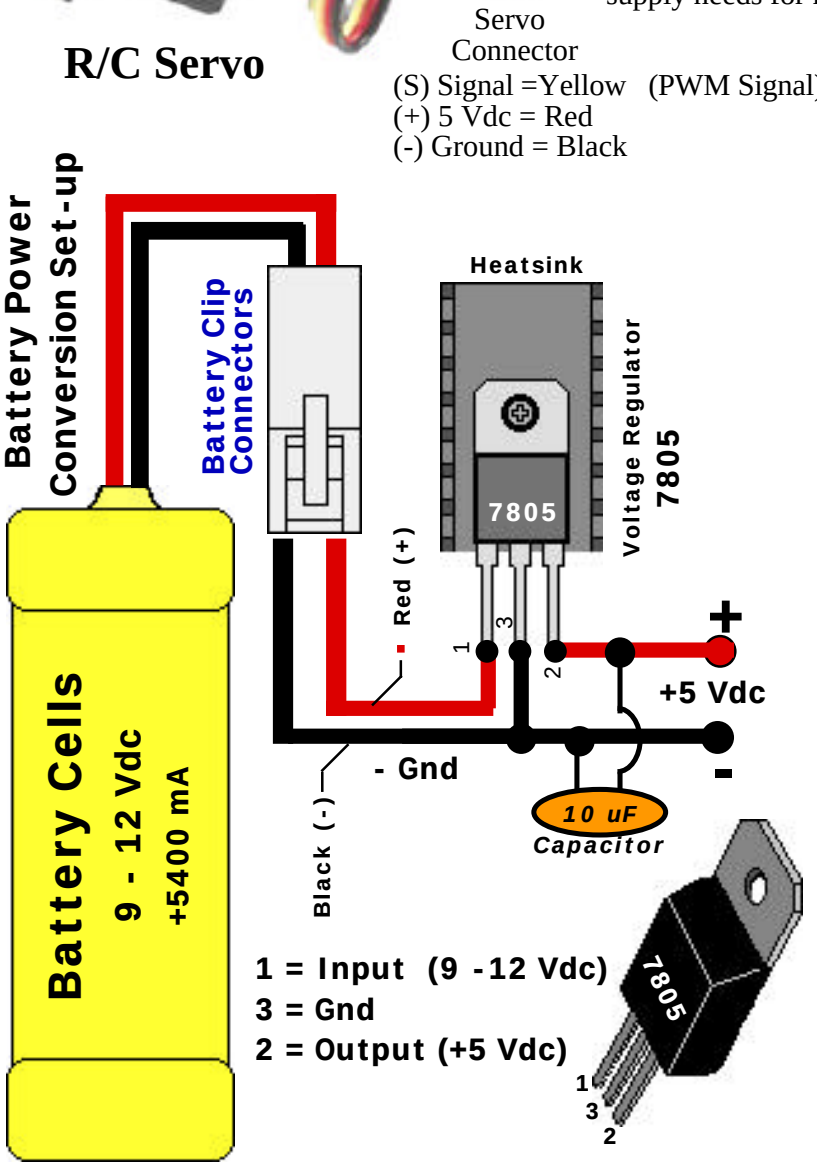
R/C Servo

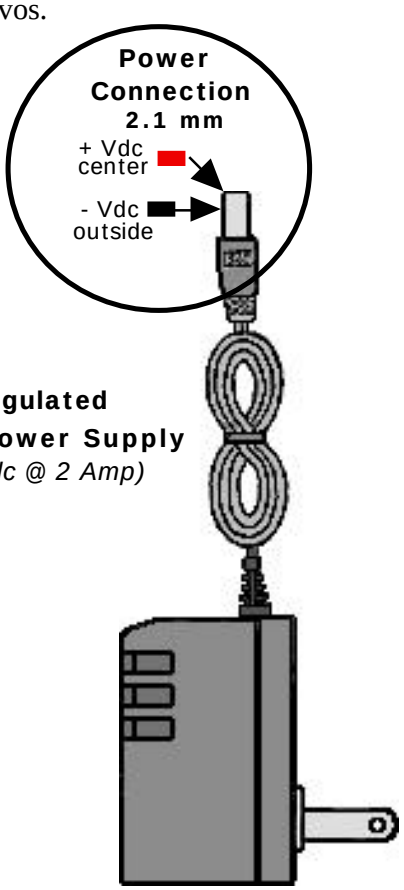
Servo Connector
(S) Signal =Yellow (PWM Signal)
(+) 5 Vdc = Red
(-) Ground = Black

SERVO POWER (4.5- 6.0 VDC)

Servo Power is defined as the amount of DC Voltage needed to operate a Servo without damage.

Servo operate from 4.5 to 6.0 volts DC. At the higher voltage servos tend to be faster and sometimes stronger, but can heat up faster when stalled or in a hold position with stress forces against the servo output shaft. Some servo controllers require a separate power source from the control source to deliver the higher 6.0 Vdc. The current drain (Amps required) depends on the torque being put out by the servo motor and can be in excess of one amp if the servo is stalled under load.
It is best to calculate 1 Amp per servo when figuring power supply needs for most servos.

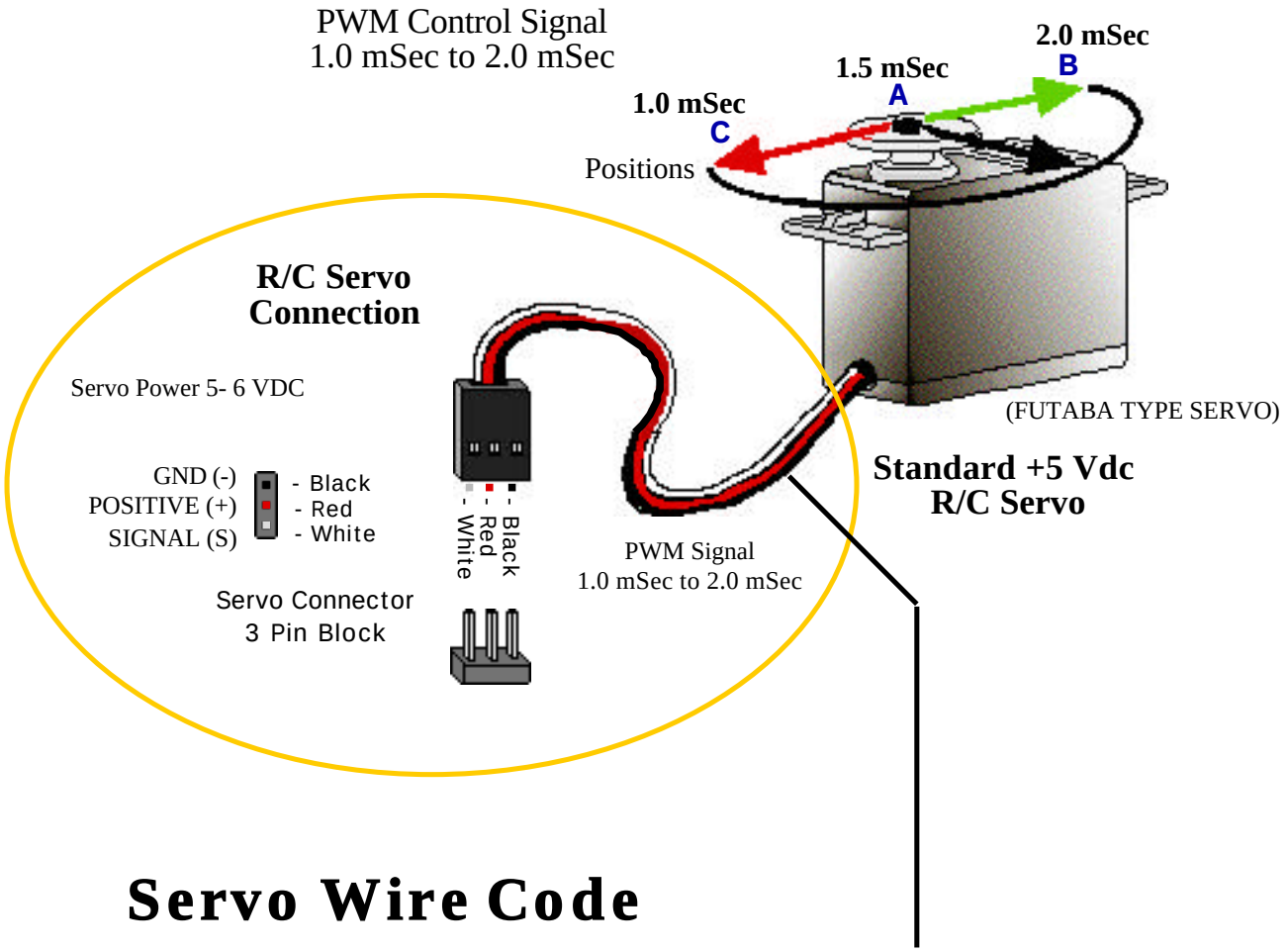




9-12 Vdc to +5 Vdc Converter	
7805	Voltage Regulator
10 uF	Capacitor
9-12 Vdc Supply	Battery Supply
Heatsink	

Servo Wire Information

Technical T

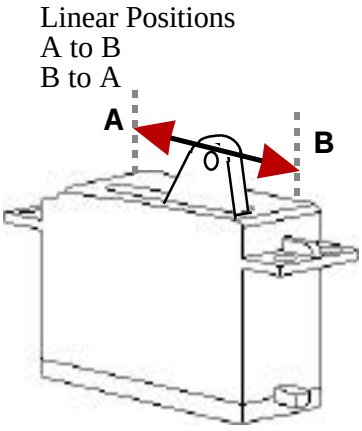


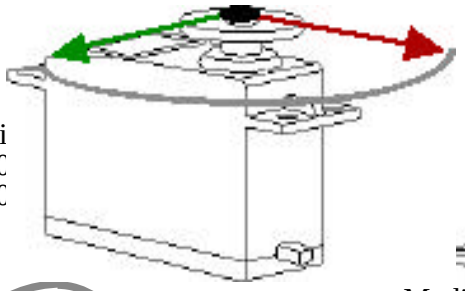
Servo Wire Code

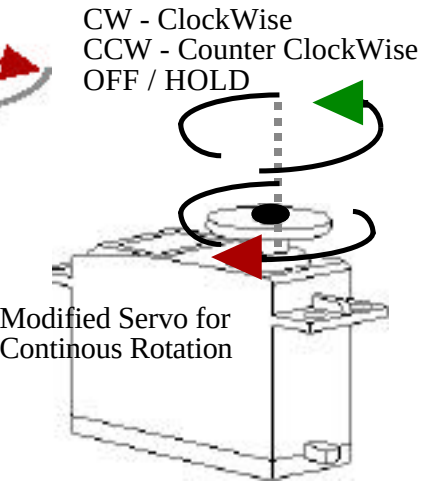
Servo Type	Positive (+)	Signal (S)	Negative (-)
Cirrus	Red	White	Black
Futaba - J	Red	White	Black
JR	Red	Orange	Brown
Hitec	Red	Yellow	Black
Airtronics	Red	Orange	Black
	Red	White	Black
	Red	Black	Black
Airtronics - Z	Red	Blue	Black
Fleet	Red	White	Black
GW	Red	Orange	Brown

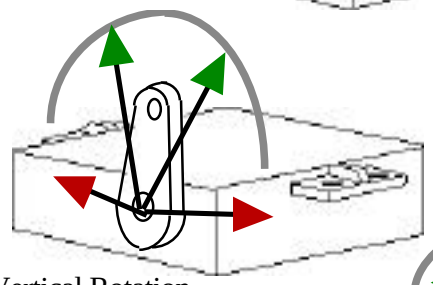
R/C Servo Function

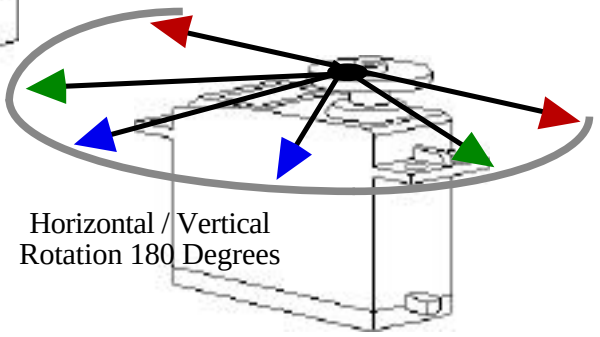
Technical T

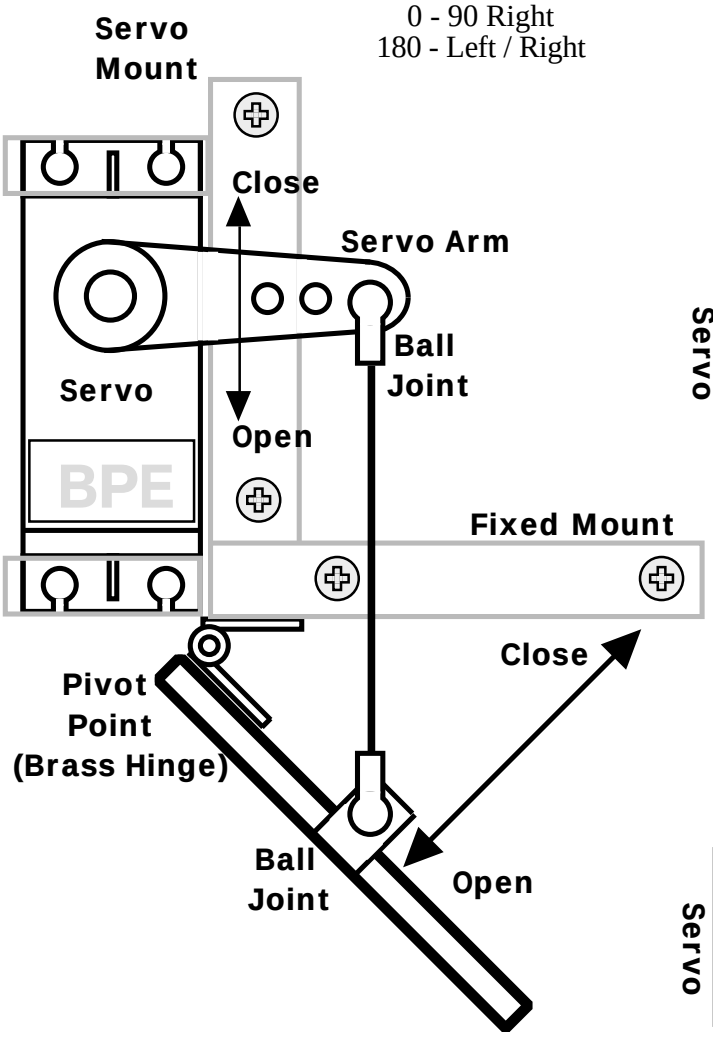


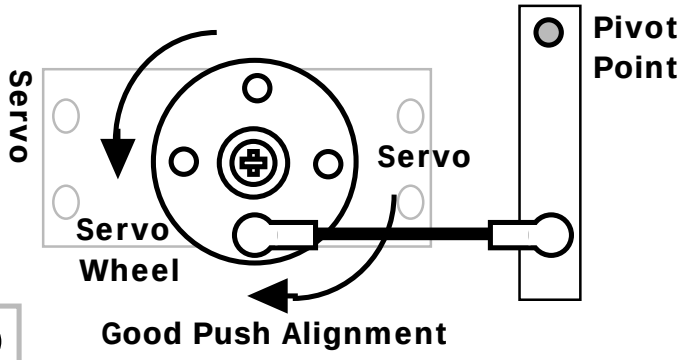


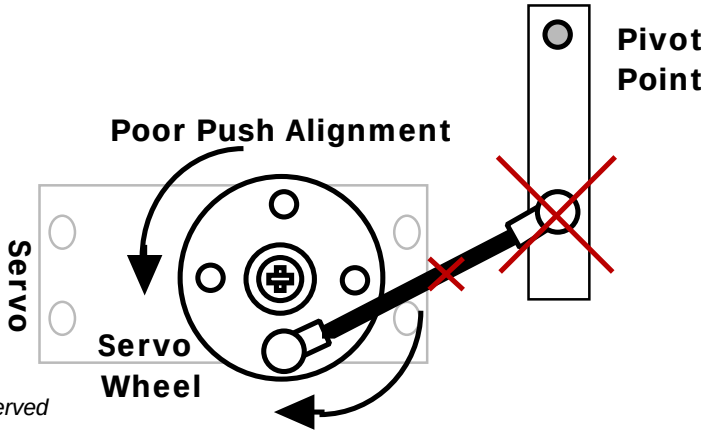






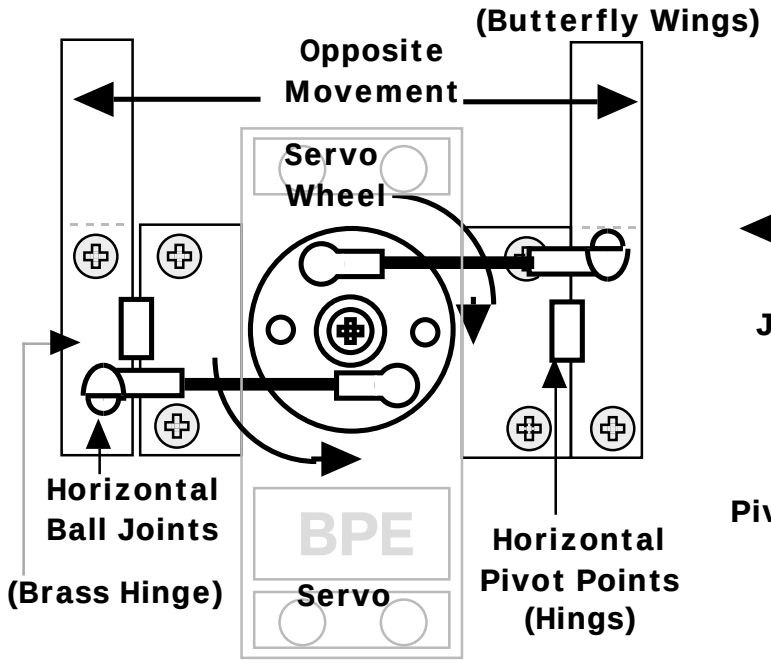


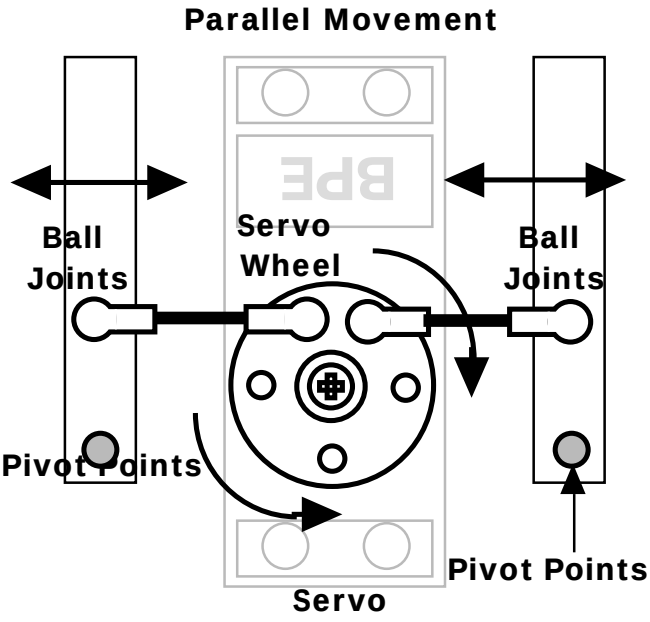


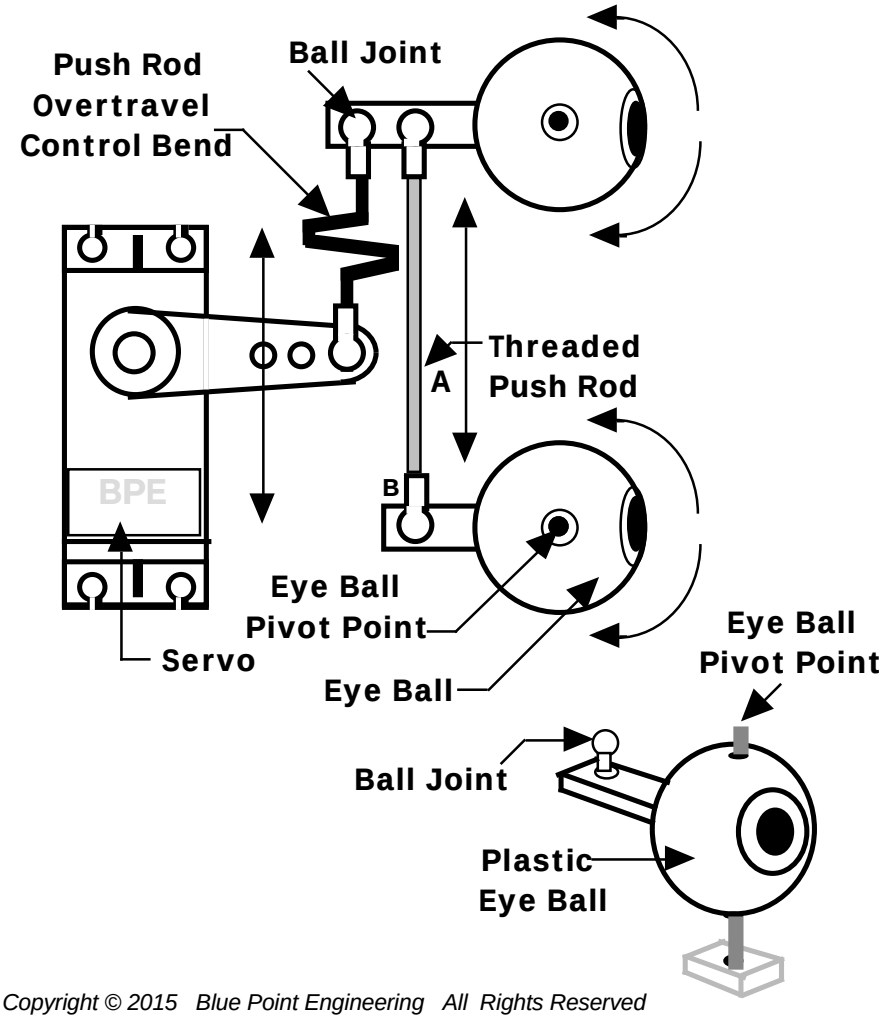


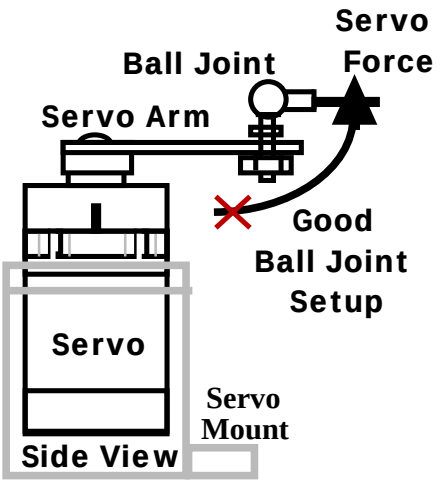
Servo Mechanics

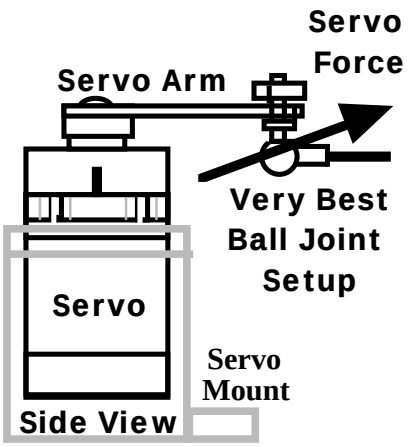
Technical T











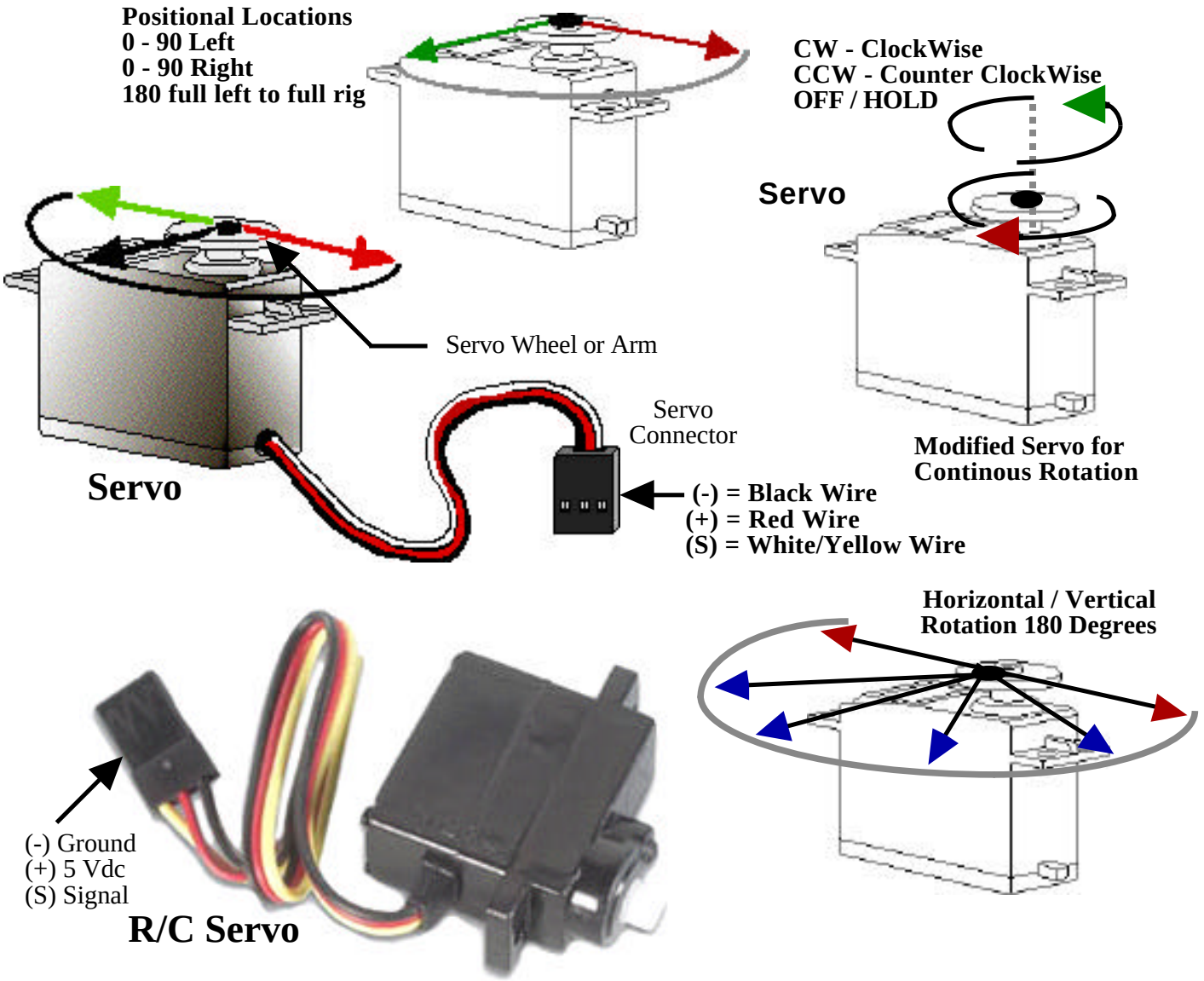
Servo Centering

Technical **T**

R/C servos are usually mechanically stopped from moving at full rotation. They have limited rotation through a mechanical, plastic block on the internal gearing and can rotate about 90 to 180 degrees or less only. Servos are unable to continually rotate and usually can't be used for driving rotating wheels. A servos precision positioning makes them ideal for robotics and animatronics, since servos are self contained with control loop circuitry, drive circuits, servo position, speed control, and are very easy to control by an external device such as a electronic servo controller board used in animatronic character and robotic applications.

Servos are dynamic devices that when instructed to move position, will actively move to hold the position, If for example a servo is instructed to move in the clockwise position and an external force is present and pushing against the servo such as a mechanical linkage, the servo will resist being moved out of that position or continue to try and move to the instructed position, even if the servo arm is incorrectly placed on the motor shaft, until powered off. It is for this reason that every **servo output arm or servo wheel used should be placed into the neutral position before instillation into your project.**

Setting the servo arm or wheel to the neutral position prevents stress to the servo motor, damages to the electronics and provides wider movement ranges and angles for operating the mechanical linkages connected to the servo arm or servo wheel.



Servo Info and Centering

Technical T

How to Determine the Center Position of a R/C Servo

Automated Servo Center Position

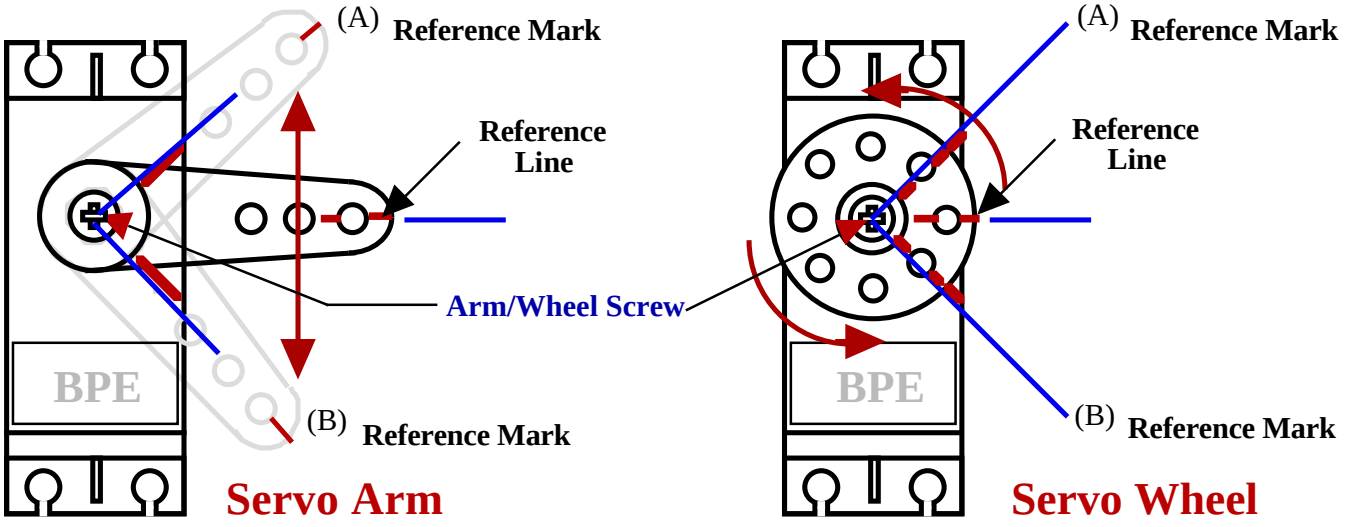
There are several ways to do this:
(See Servo Checker Operation Guide)
The best and easiest way to set a servo's center position is to connect the servo to a servo checker or tester. There are several low cost servo checkers worth purchasing and having in your toolbox if you plan to work with servos. To use a Servo Checker simple set the Servo Checker to its automated center position and let the controller move the connected servo to center. If the servo arm is pre-attached, you may have to remove the servo arm on top of the servo shaft and re-position it back onto the servo shaft center point. The servo is now ready for instillation. Once centered place the servo arm on top of the servo shaft, secure it with servo screw and install the servo as needed or carefully remove the servo arm from the servo if not needed for instillation. Do not move the shaft at this point, if it moves, simply repeat the above procedure to find the servo center again.

Manual Servo Center Position - Steps:

Carefully place one of the servo arms or wheel onto the servo shaft, mark a reference line through (across) the servo arm or wheel center point.
Slowly and carefully rotate the servo arm or wheel by hand as far to one side as it will go, do not force servo arm / wheel.
Mark a line on the servo base where the servo arm or wheel reference line stops.
Slowly and carefully rotate the servo arm or wheel by hand to the opposite position, as far to one side as it will go, do not force servo arm / wheel. Should travel about 180 degrees.
Mark a line on the servo base where the servo arm reference line stops.

Rotate the servo arm back to 90 degrees between the two end reference line positions (A,B) marked on the servo base. You may have to remove the servo arm on top of the servo shaft and re-position it back onto the output shaft to get the center point if the arm is off center position. This should put the servo arm close to center position.
Carefully remove the servo arm from the servo if not needed for instillation or place the servo arms on top of the servo shaft, secure it with servo screw and install the servo as needed. Do not move the shaft at this point. If it moves, simply repeat the above steps to find the servo center again.

SERVO CENTERING

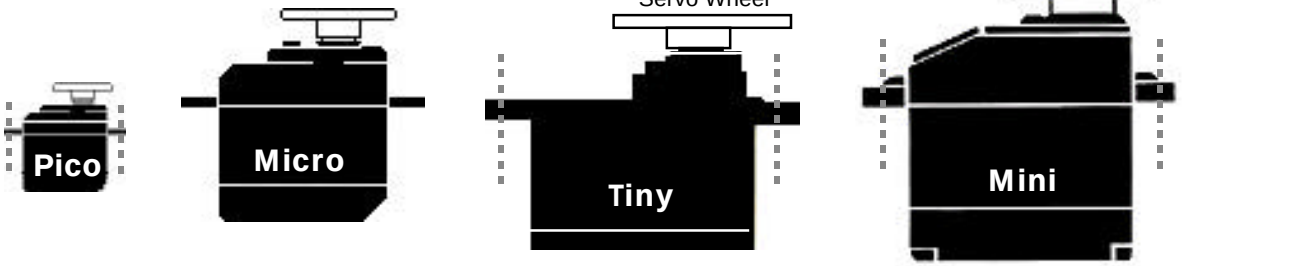


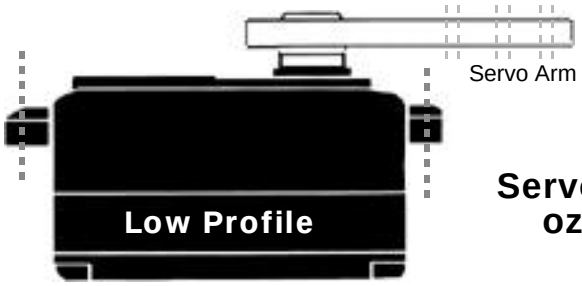
R/C Servo Sizes / Types

Technical T

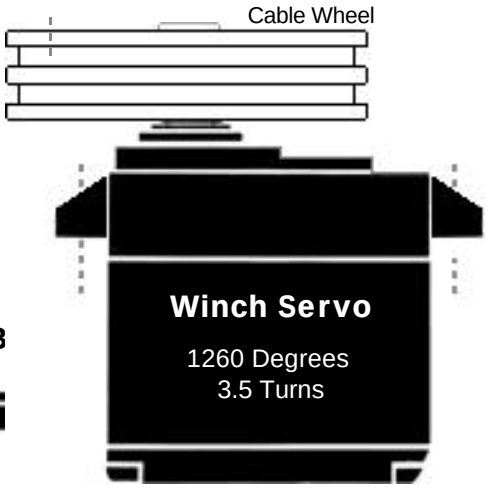
Ver 2.5

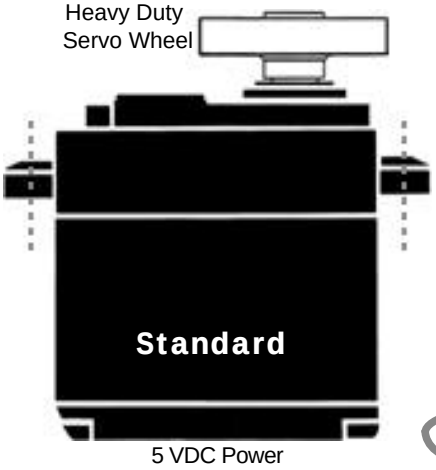
Servo's Shown Actual Size

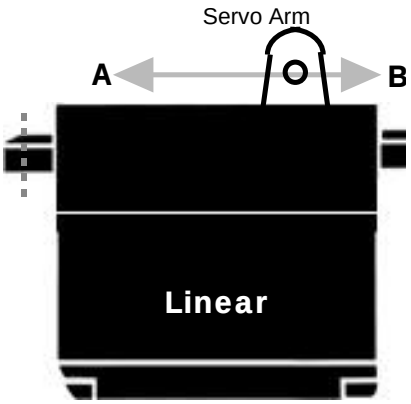


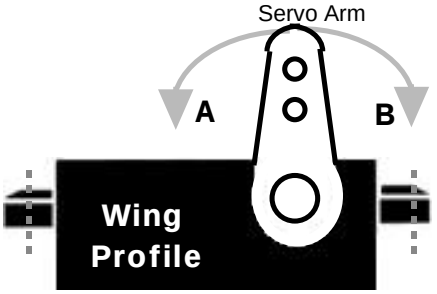


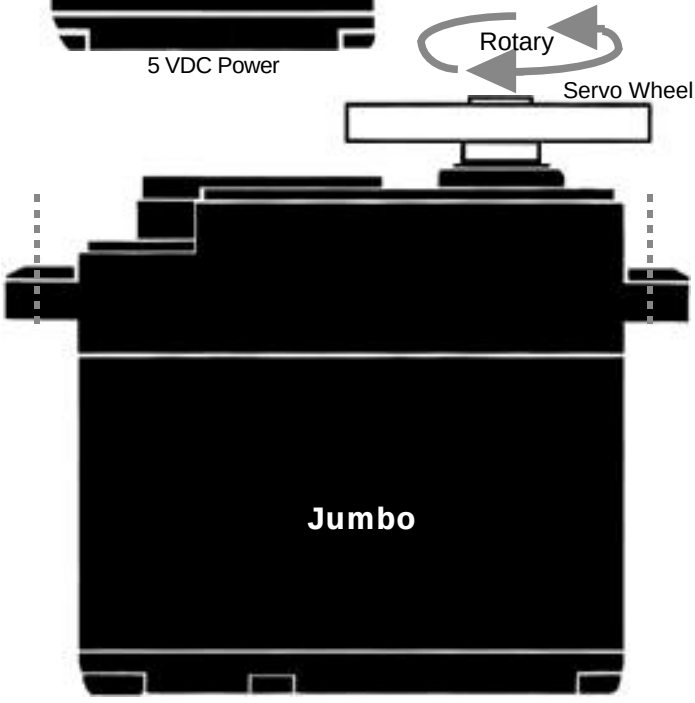
Servos Measured in oz-in of Torque

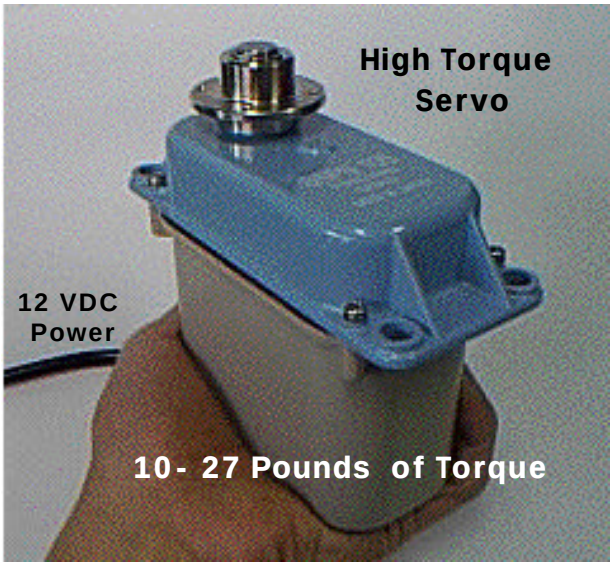








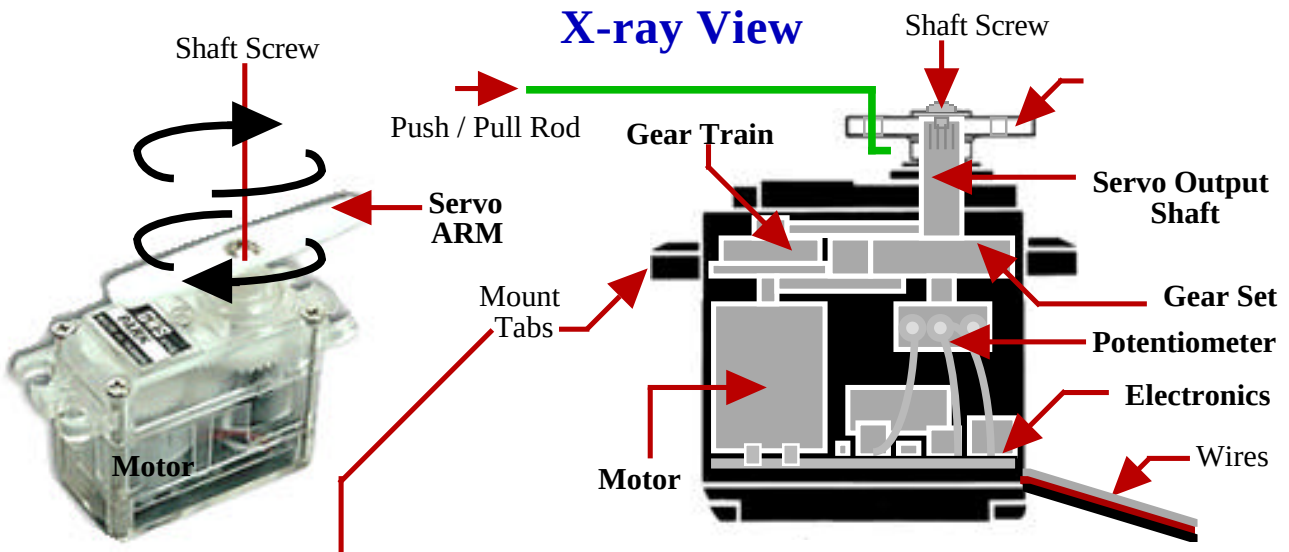




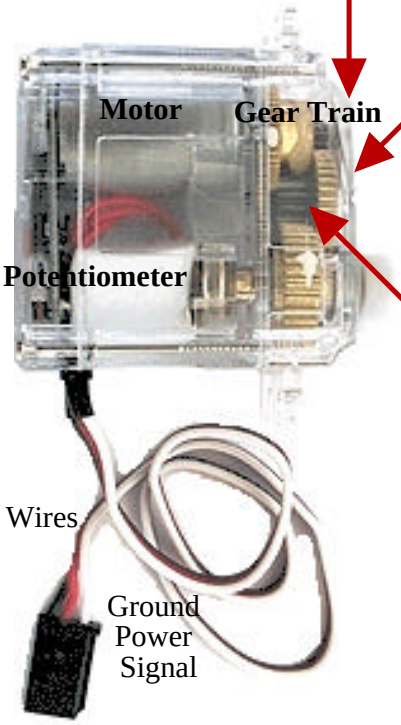
Servomotor Information

Technical T

Ver 2.5



Note: A Servo stability and longevity is determined by the quality of the electronics, mechanical parts. Any servo under stress in pushing or pulling a mechanical device will fail eventually.
Never let a servo Hum, shake, or push / pull beyond its limits.



Servo Components: Best -vs- Good Parts

METAL BALL BEARING

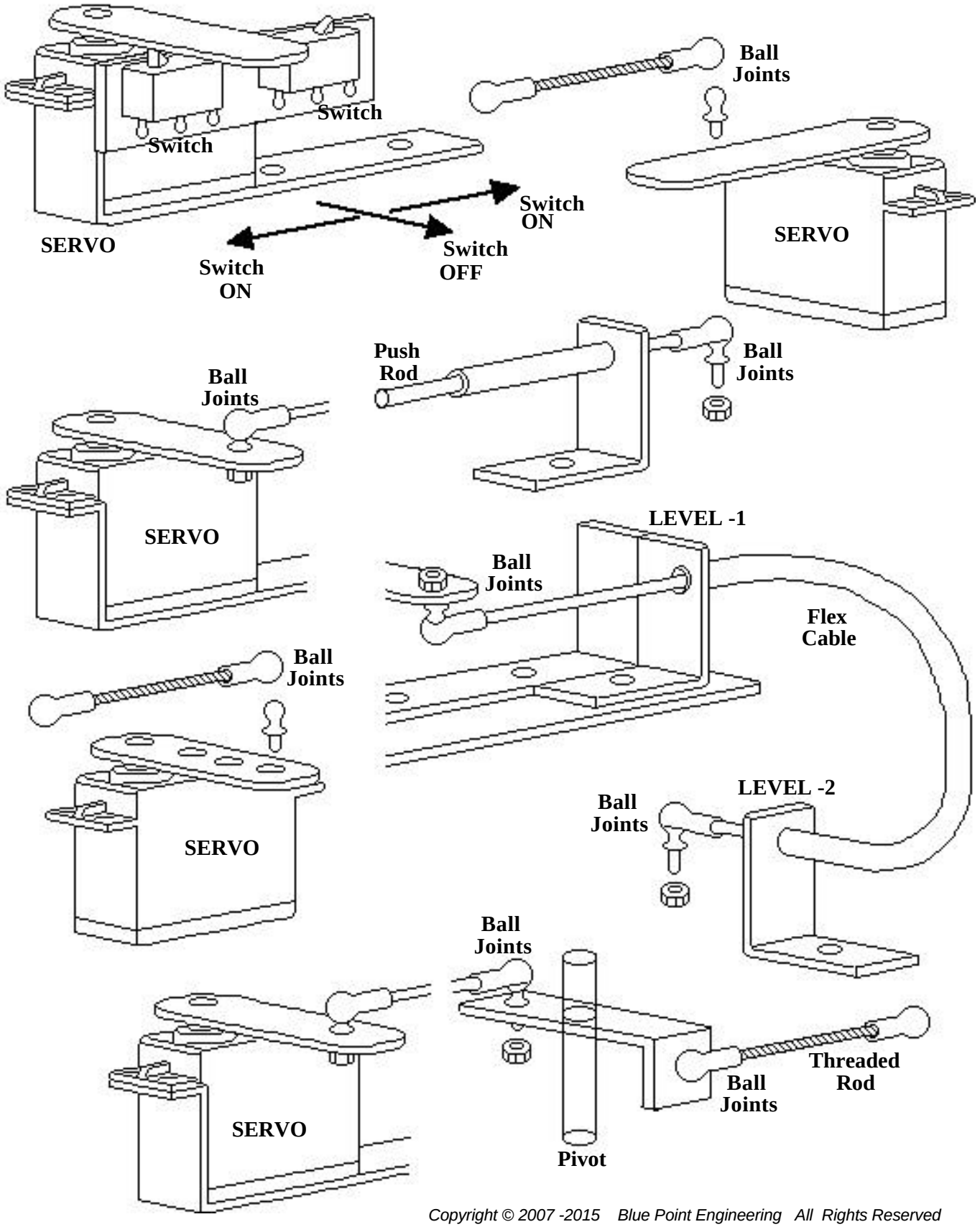
BRONZ / PLASTIC INSERT BUSHING

METAL GEARS

PLASTIC GEARS

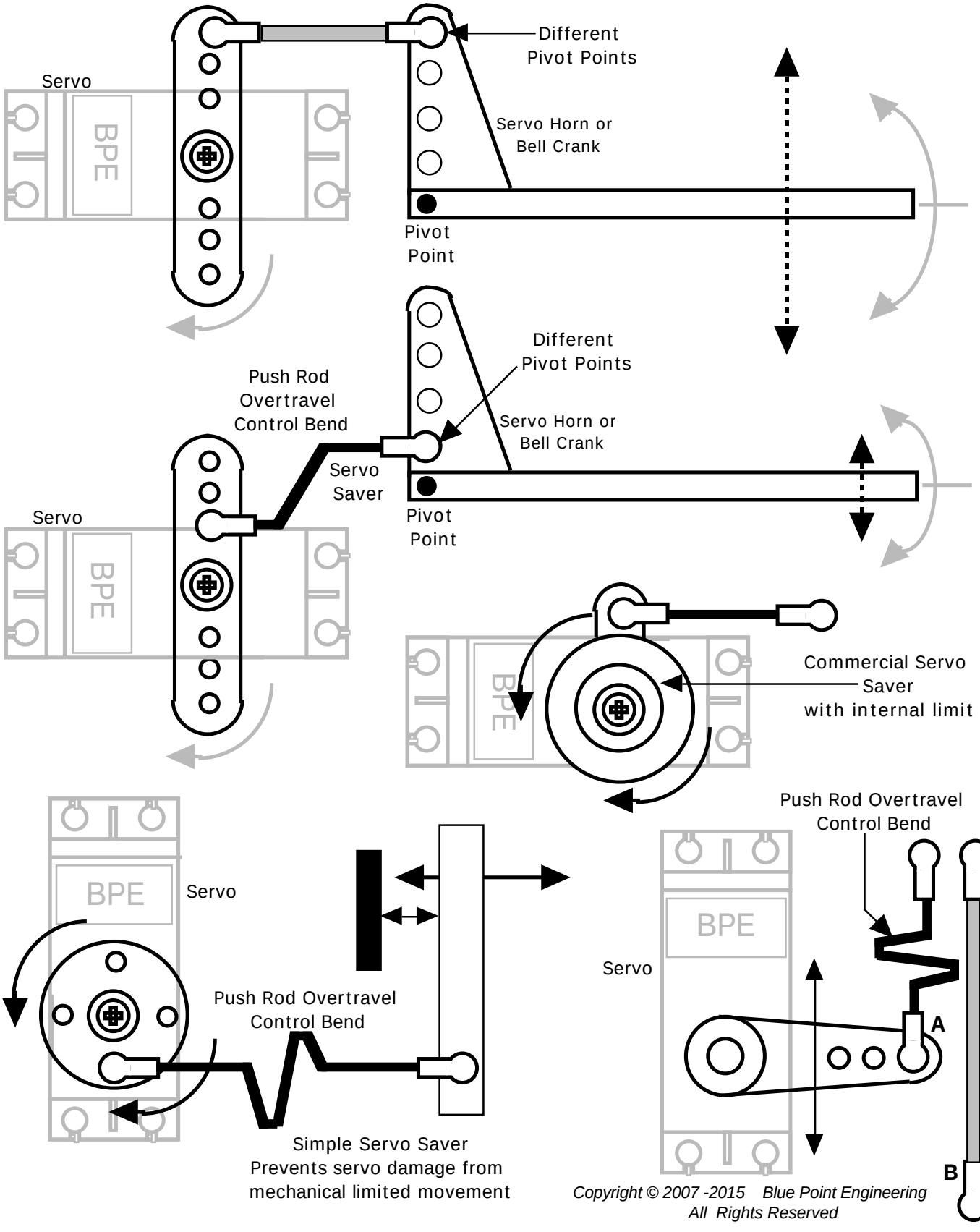
Servo Setup Mechanics

Technical T



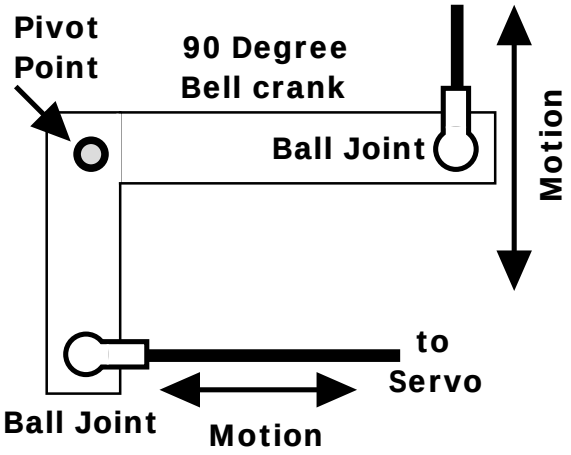
Servo Mechanics

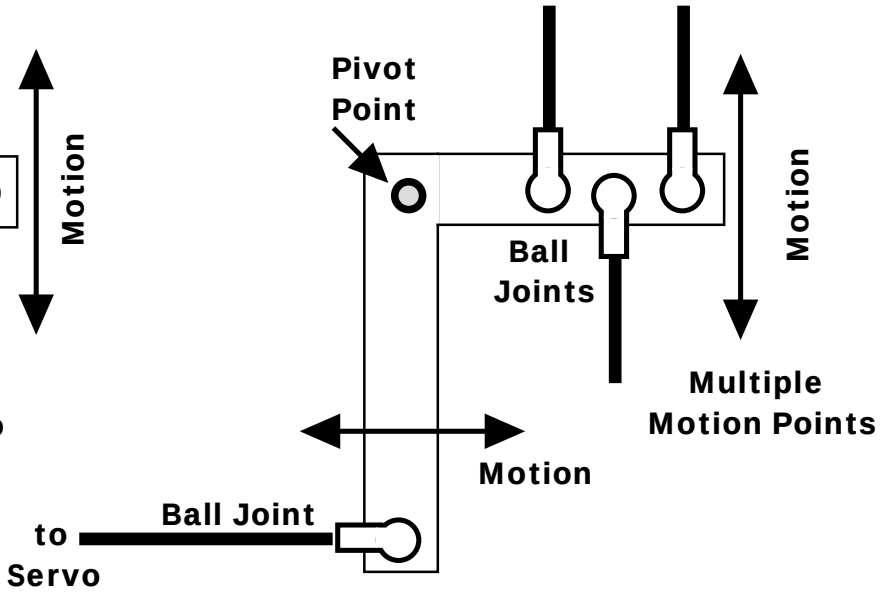
Technical T

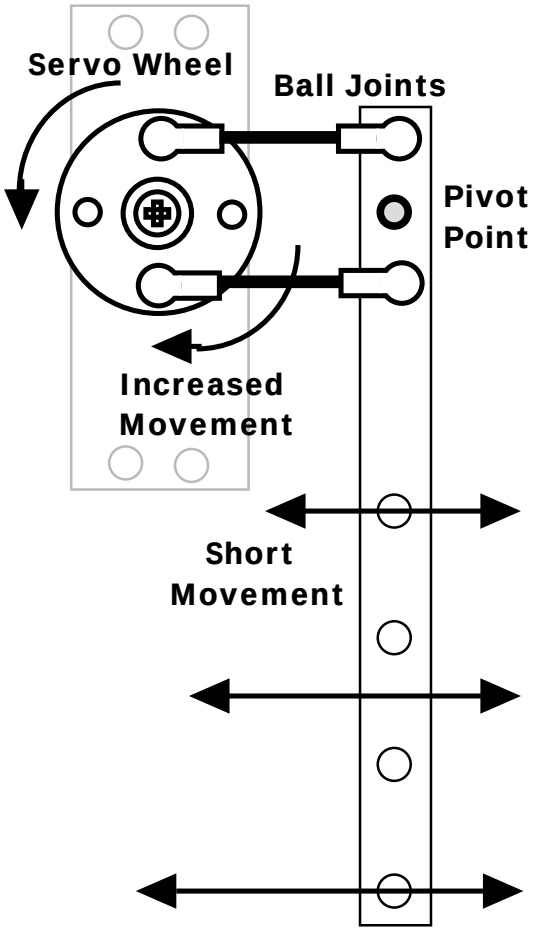


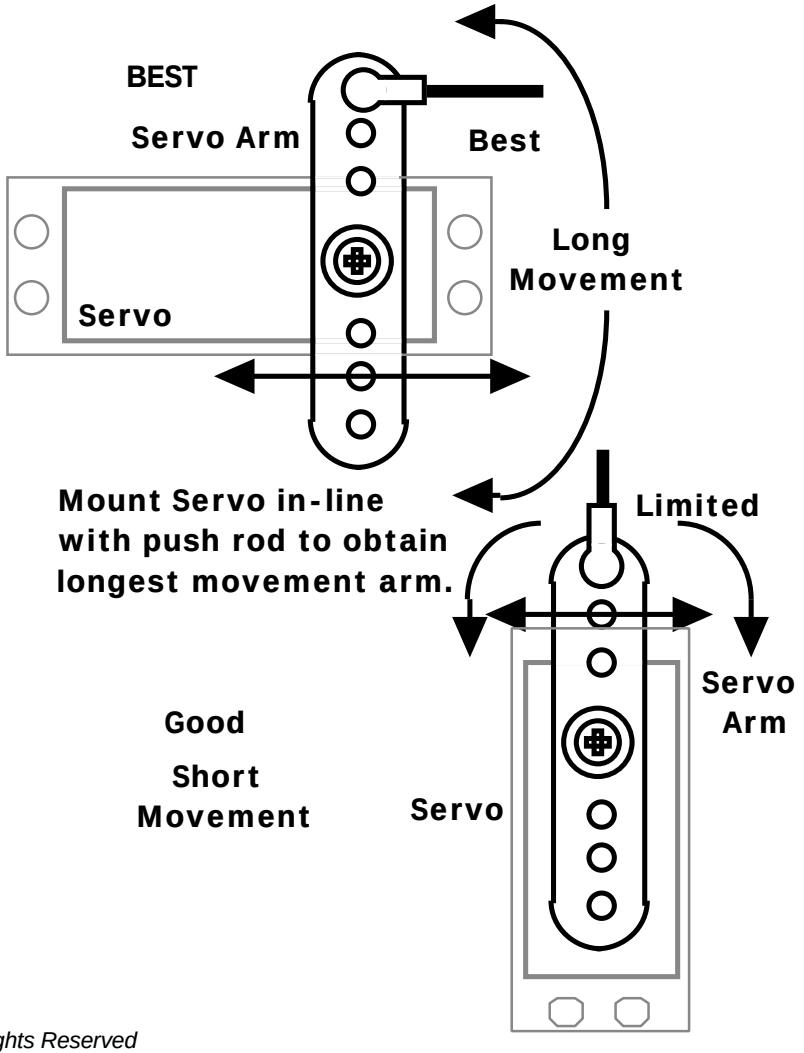
Servo Mechanics

Technical T









Animatronic Mechanics

Technical T