



# Quick Start Guide: 1-2ms Pulse (PWM) RC Servo Control Mode

## About 1-2ms Pulse (PWM) RC Servo Control Mode

In 1 to 2 ms Pulse (PWM) mode, the actuator can be easily configured to respond to a standard RC PWM signal with 50 Hz or 333 Hz update rate.

## About this Guide

This quick start guide is an abbreviated version of the [Servo Cylinder Manual](#) meant for users to safely get started. You may need the information in the full manual to get the most out of the Servo Cylinder.

## Getting Started

### You will need:

- Servo Cylinder (A-series) Actuator
- Command/Signal Cable (Combined with Power Input Cable for A1-series actuators)
- Power Input Cable (Combined with Command/Signal Cable for A1-series actuators)
- Mini-USB Cable (only if configuring using USB Mass-Storage)
- Power Supply Unit (PSU) capable of 8-36 VDC ( $\geq 180$  W suggested, see [PS-1X Series PSUs](#))
- A system to issue an RC Servo PWM signal with a pulse width between 1ms and 2ms at a 50 to 333 hz pulse frequency, such as an Arduino or RC Controller. In this example, we will be using an RC controller that will pulse at 50hz, and the servo cylinder will be set up to operate with the following parameters:
  - Full retraction (spMin = 2048) at 1ms pulse input.
  - Full extension (spMax = ePos - 1024) at 2ms pulse input.
  - Analog Signal Input/Output relationship: An input pulse width between 1ms and 2ms will command the actuator to move to a position between spMin and spMax that is proportional to the pulse width's respective position between 1ms and 2ms.

## Setting up the Servo Cylinder Hardware

### Note: Setting up A2-Series Servo Cylinders

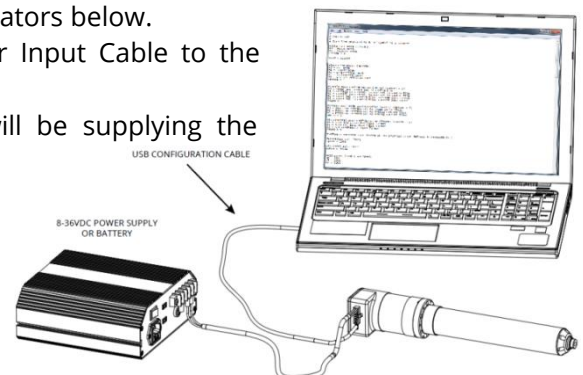
Setup of the A2 Servo Cylinder requires additional setup and precautions to maintain IP65 integrity. Please see Additional Setup Information for A2-Series Actuators on page 2 for more information.



**WARNING:** Never "Hot Plug" or power the Servo Cylinder until all wiring and connectors are in place.

Begin by connecting all of the wires and cables first, and then turning on the power. To do this:

1. Connect the Power Input and Command/Signal Cable to the Servo Cylinder. *If using an A2-Series Servo Cylinder*, read Additional Setup Information for A2-Series Actuators below.
2. Ensure the Power Supply is off, and then connect the Power Input Cable to the Power Supply.
3. Connect the Command/Signal cable to the system that will be supplying the control signal.
4. *(If configuring using USB Mass-Storage)* Connect the Mini-USB Cable between the Servo Cylinder and your computer. *If using an A2-Series Servo Cylinder*, read Configuring A2 Series Servo Cylinders over USB below.
5. Turn on the Power Supply.



## Additional Setup Information for A2-Series Actuators

This section pertains to A2-series actuators only. If you have an A1-series actuator, skip to Page 3

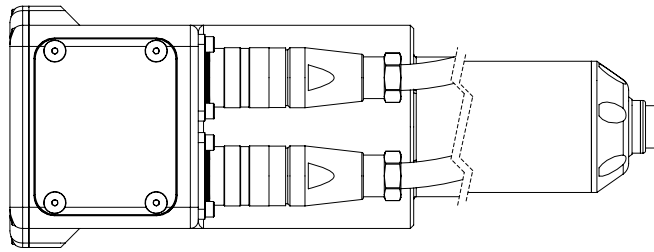
Initial setup is critical to preserve the Ingress Protection (IP) rating of the A2 series Servo Cylinder actuators. The IP65 rating only applies when connectors are correctly installed, and the Access Port Cover is correctly in place. While accessing these features, take special care to protect the actuator from potentially damaging environmental effects.

### Installing A2 Series Cables

In order to achieve an IP65 rated seal, the connectors on both Power Input and Command & Signal Cables must be installed with 13.3 in·lbs [1.5 N·m] of torque.

#### You will need:

- A 16mm spanner-type torque wrench capable of 13.3 in·lbs [1.5 N·m] of torque.



Torque each connector with at least 13.3 in lbf [1.5 N·m] of torque

### Configuring A2 Series Servo Cylinders over USB

#### Note: Configuration using Serial Commands

Configuration of the all Servo Cylinders can be performed using specific RS232 serial commands. Alternatively, you may remove the rear access cover on the end of the actuator to configure over USB mass storage. We recommend configuration over serial to eliminate the risk of compromising the cover seal O-ring during removal.

To access the Mini-USB port on A2-Series actuators, you must first remove the Access Port Cover, and replace it after you have finished configuration. *Cleanliness is critical*, and care must be taken to not compromise the seal in access port installation and removal.



**IMPORTANT:** Never remove the access port cover for an excessive period of time (more than 1-2 Hours). The A2 contains a desiccant which will be rendered ineffective for protecting the actuator if left exposed to atmosphere for too long.

#### You will need:

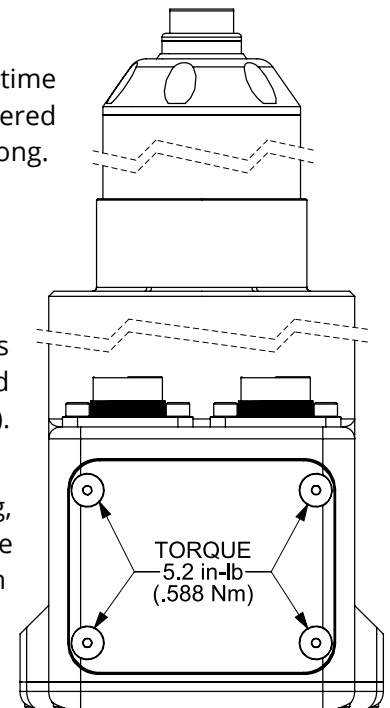
- A 1/16" hex torque wrench capable of 5.2 in·lbs [1.5 N·m] of torque

#### To Remove the Access Port Cover:

1. Ensure that the O-ring is kept clean of dust and debris while the panel is removed. Also ensure that the cover or connector covers are not removed for too long. The O-ring should have a light coat of grease on it (from factory).

#### To Re-Install the Access Port Cover:

1. Inspect the O-ring, ensuring it is clean and intact. If dirty, clean the O-ring, groove, and the faying surface on the cover with acetone. Then re-grease the O-ring with nitrile/Buna-N compatible grease such as Super Lube® High Temperature, Extreme Pressure Grease.
2. Put the access port cover in place, and install all four screws finger tight. *Do not apply significant torque yet.*
3. In a cross pattern (e.g. top left, than bottom right), carefully torque each screw to 5.2 in-lb [0.588 Nm].



# Configuration for 1-2ms Pulse (PWM) RC Servo Control Mode

## Configuring Servo Cylinder with USB Mass Storage

The Servo Cylinder has a small 10kB section of non-volatile flash memory that is used to store configuration data. Do not use this memory to store backup copies of CONFIG.TXT and HARDWARE.TXT. Storing any files other than CONFIG.TXT and HARDWARE.TXT will exceed available storage space.

### Note: Hardware Specific Parameters (within HARDWARE.TXT)

This file contains hardware specific information (such as FOC gains, sensor calibration information, etc.), and is not intended for editing without consultation with Ultra Motion engineers. Read the [full manual](#) for more information.

### How to configure variables within CONFIG.TXT (Windows)

1. (If not done already) Follow setup instructions in Setting up the Servo Cylinder Hardware on page 1.
2. Once the Servo Cylinder is connected via Mini-USB and powered, the computer will automatically recognize the Servo Cylinder as a Mass Storage device (similar to a flash drive).
3. Browse to “My Computer” and open the new storage drive labeled “Ultra Motion”.
4. Locate the text file “CONFIG.TXT” and open it in a text editor.
5. Edit configuration parameters to set the actuator to behave as desired. Refer to Quick Start Settings for 1-2ms Pulse (PWM) RC Servo Control Mode on page 4.
6. Save the file locally to your windows machine, and then copy it to the Ultra Motion drive to OVERWRITE the CONFIG.TXT file currently on the Servo Cylinder. If there is no existing CONFIG.TXT file, simply copy this new file onto the drive. Alternatively, you can download and save the website generated CONFIG.TXT directly to the “Ultra Motion” drive.

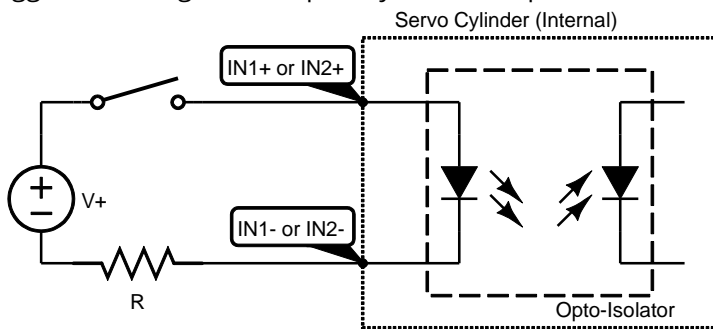
## Setting up the Input Signal Voltage

The optically isolated digital inputs need to be energized with between 5mA and 15mA of forward current to be activated. This can be achieved with a voltage between 3.3 and 7 volts (DC). A voltage in excess of 7 volts can be used if it is in conjunction with an appropriately sized current limiting resistor. The range of resistor sizes can be calculated as a function of voltage below:

$$R_{min}[\text{ohms}] = \frac{V[\text{volts}] - 1.8}{.015} - 285, \quad R_{max}[\text{ohms}] = \frac{V[\text{volts}] - 2}{.005} - 315$$

A voltage of +5V and/or a ground for use by the optically isolated input can be supplied externally (fully isolated from Servo Cylinder hardware), or by one or both of the Servo Cylinder’s on-board GPIO pins. *For maximum noise rejection*, the input signal should be isolated from the Servo Cylinder, but this is not a requirement.

Suggested wiring for the optically isolated inputs is shown below.



Schematic for Digital Inputs

Forward Voltage [VDC]	9	12	24	28	36
Resistor size [ohms]	400	700	1900	2300	3100

Current limiting resistor sizes for common DC voltages.

## Establishing the Relationship between Input Signal and Output Position

In proportional mode, the Servo Cylinder moves proportionally to an input signal. Specifically for 1-2ms Pulse (PWM) RC Servo Control Mode, the output linear position is proportional to the width of a voltage pulse, which in this example is between 1ms and 2ms. The configuration variables pMin and pMax are used to define the upper and lower limits of the range of input pulse widths. The pulse width defined by the variable pMin will command actuator

to move to the position defined by the variable spMin. Likewise, the pulse width defined by the variable pMax will command actuator to move to the position defined by the variable spMax. An input pulse time between pMin and pMax will command the actuator to move to a position between spMin and spMax which is proportionally related to the input pulse width's respective position between pMin and pMax.

In this quick start guide, we will be setting the actuator to move between full retraction and full extension at pulses between 1ms and 2ms.

## Converting between Pulse width input and Servo Cylinder Sensor Count Units

For rapid unit conversions, use our [Ultra Motion Servo Cylinder Unit Converter](#). Servo cylinder uses units of 1/60,000 of a millisecond. The relationship is as follows:

$$t_{sc}[count] = t[ms] \times 60,000$$

## Quick Start Settings for 1-2ms Pulse (PWM) RC Servo Control Mode

The table below contains a complete list of all variables that need to be configured in CONFIG.TXT to use 1-2ms Pulse (PWM) RC Servo Control Mode.

### Note: Other unused variables in CONFIG.TXT:

While many other variables in CONFIG.TXT aren't necessarily used for 1-2ms Pulse (PWM) RC Servo Control Mode, the actuator will not successfully start up if these values are invalid or missing.

Configuration Variable	Set to...	Notes
<b>opMode</b>	2	Sets the actuator to Proportional Mode.
<b>spMin</b>	2048	This sets the actuator to retract to a minimum position that has safe headroom before the physical stop. <i>This is the default setting.</i>
<b>spMax</b>	Result of: "ePos - 1024"	Look up the value of "ePos" in HARDWARE.TXT and subtract 1024 from it, and use this starting value. This will set the actuator to extend to a minimum position that has safe headroom before the physical stop. <i>This is the default setting.</i>
<b>maxTorq</b>	10000	This sets the actuator to a safe max torque that will not burn out motor windings if continuously bearing a load (under ordinary circumstances). The actuator is capable of torque exceeding this value, but care must be taken to avoid damage due to overheating. <i>This is the default setting.</i>
<b>kp</b>	1200	Stable generic value for proportional gain. This value can be tuned for increased performance and responsiveness. <i>This is the default setting.</i>
<b>ki</b>	250000	Stable generic value for integral gain. This value can be tuned for increased performance and responsiveness. <i>This is the default setting.</i>
<b>kd</b>	10000	Stable generic value for derivative gain. This value can be tuned for increased performance and responsiveness. <i>This is the default setting.</i>
<b>errMode</b>	0	In this setting, the Error mode is disabled and not providing any protection from the motor winding burning out (which is acceptable if maxTorq ≤ 10000). If increasing maxTorq from default settings, we <b>strongly recommend</b> using this setting (in mode 6 or 7) to protect the motor. <i>This is the default setting.</i>
<b>pmCFG</b>	0	Sets the actuator to 1-2ms Pulse (PWM) RC Servo Control Mode.
<b>pMin</b>	60000	This sets the pulse width (measured 1/60,000 of a millisecond) at which the actuator will have moved to the position defined by <b>spMin</b> . The value pMin = 60000 corresponds to a pulse width of 1 ms.

<b>pMax</b>	120000	This sets the pulse width (measured 1/60,000 of a millisecond) at which the actuator will have moved to the position defined by <b>spMax</b> . The value pMin = 120000 corresponds to a pulse width of 1ms.
<b>pFilter</b>	3000	Defines the pulse width filter to a typical level. Reduce number for more filtering.

## Installation and Use

### Note: For first time users...

We *highly* recommend running the Servo Cylinder unloaded on a benchtop to gain familiarity with the system before using it to drive a load. Consider using Error Mode until the system is fully understood to protect the hardware and prevent motor burn outs.

## Integrating Servo Cylinder into Your System



**WARNING:** Do not apply torque down to actuator rod when torquing hardware into the actuator rod. Use the rod-end wrench flats to apply torque here.

### Note: Understanding “Hard-stop” Behaviour

If a Servo Cylinder is commanded to run into a “Hard-stop” such as a machine element, physical body, or an excessive exerted force which disallows movement, the controller will attempt to obey the command and power through the hard-stop, which will very likely overheat and cause damage to the motor windings.

With the settings described in this document, the Servo Cylinder will be unable to be commanded to hit its own internal physical “hard-stop” travel limits. However, it will still be possible to hit these limits with either excessive force or motion while the actuator is unpowered. Additionally, it is important to understand that if you have installed the Servo Cylinder into a system with its own hard-stop (such as a machine element or other travel limit), you should configure spMin and spMax accordingly to prevent running into the hard-stops of your mechanism.

## Using the Servo Cylinder in 1-2ms Pulse (PWM) RC Servo Control Mode

1. (If not done already) Set up the Servo Cylinder by following the instructions in Setting up the Servo Cylinder Hardware on page 1 of this document.
2. (If not done already) Set up the input signal such that the voltage is within acceptable bounds. This may require the use of a voltage limiting resistor per Setting up the Input Signal Voltage section on page 3.
3. (If not done already) Establish the desired relationship between input pulse signal and output motion. Read the section Establishing the Relationship between Input Signal and Output Position on page 3.
4. (If not done already) Configure the actuator by following the instructions in Configuration for 1-2ms Pulse (PWM) RC Servo Control Mode on page 3.
5. Feed the control signal to the actuator to control the actuator. The actuator should now operate with respect to the input signal.