



# Quick Start Guide: Analog Voltage (-10 to +10V) Mode

## About Analog Voltage (-10 to +10V) Mode

In Analog Voltage mode, the actuator extends to a position proportional to a range of input voltages. The limits of the input voltage are from -10 to +10V, however these values may be configured to any desired voltage range within -10 to +10V.

## 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 issuing an analog voltage signal range between -10 and 10V, such as a DAC (Digital to Analog Converter). In this example, we will be using a programmable voltage supply that we will set up to operate with the following parameters:
  - Full retraction (spMin = 2048) at 0V input.
  - Full extension (spMax = 28520) at +10V input.
  - Linear relationship to move between spMin and spMax for voltage values between 0 and +10 volts.

## Setting up the Servo Cylinder Hardware

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

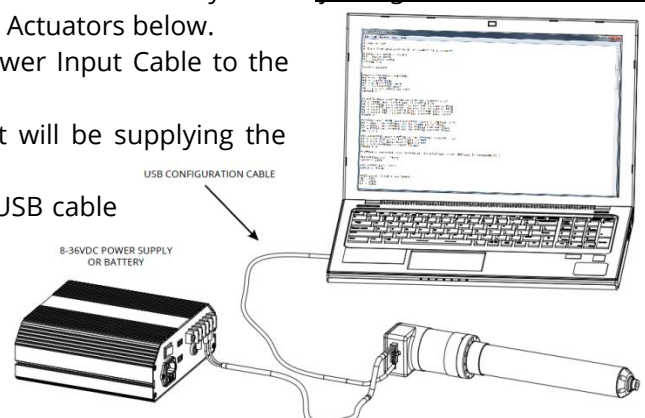
Setup of the A2 Servo Cylinder requires additional setup and precautions to maintain IP65 integrity. Please see Additional Setup Information for A2-Series Actuators on page 2 for more information.



**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 analog voltage 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

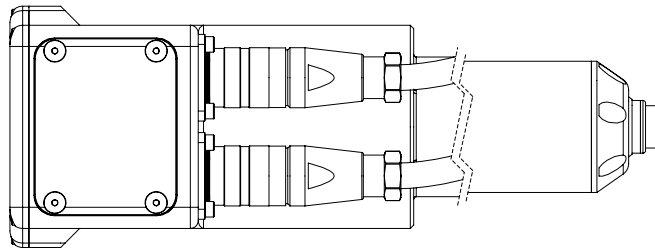
Initial setup is critical to preserve the Ingress Protection (IP) rating of the A2 series Servo Cylinder actuators. The IP65 rating only applies when connectors are correctly installed, and the Access Port Cover is correctly in place. While accessing these features, take special care to protect the actuator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

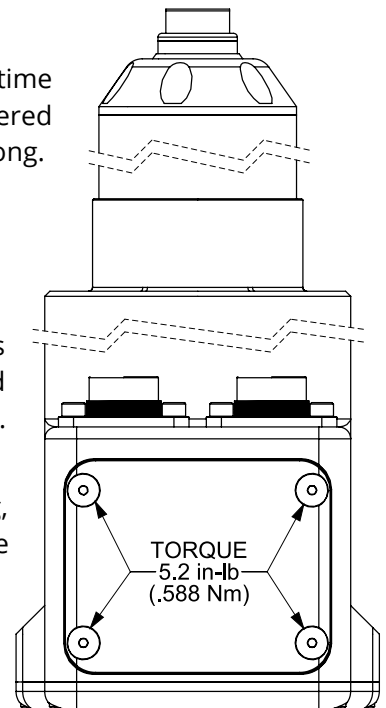
- A 1/16" hex torque wrench capable of 5.2 in·lbs [1.5 N·m] of torque

#### 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 Analog Voltage (-10 to +10V) 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 Analog Voltage (-10 to +10V) Mode (Via CONFIG.TXT) 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.

## Establishing the Relationship between Input Signal and Output Position

In proportional mode, the Servo Cylinder moves proportionally to an input signal. Specifically for Analog Voltage Mode, the output linear position is proportional to an input voltage, which in this example is between 0V and +10V. The configuration variables vMin and vMax are used to define the upper and lower limits of the range of input voltage signals. The voltage defined by the variable vMin will command actuator to move to the position defined by the variable spMin. Likewise, the voltage defined by the variable vMax will command actuator to move to the position defined by the variable spMax. An input voltage between vMin and vMax will command the actuator to move to a position between spMin and spMax which is proportionally related to the input voltage’s respective position between vMin and vMax.

In this quick start guide, we will be setting the actuator to move between full retraction and full extension at voltages between 0V and +10V.

## Converting between Voltage Input and Servo Cylinder Sensor Count Units

### Note: Defining Analog Voltage Input

Due to small variations in input impedance and sensor characteristics, we recommend you set vMin and vMax individually for each actuator to get the optimal performance.

For rapid unit conversions, use our [Ultra Motion Servo Cylinder Unit Converter](#), or use the below relationship:

$$V_{sc}[\text{count}] = V[\text{volts}] \times 3029 - 33112$$

## Quick Start Settings for Analog Voltage (-10 to +10V) Mode (Via CONFIG.TXT)

The table below contains a complete list of all variables that need to be configured in CONFIG.TXT to use Analog Voltage (-10 to +10V) Mode.

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

While many other variables in CONFIG.TXT aren't necessarily used for Analog Voltage (-10 to +10V) 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>	1	Sets the actuator to Analog Voltage (-10 to +10V) Mode.
<b>vMin</b>	33114	This sets the input voltage (measured in ADC encoder counts) at which the actuator will have moved to the position defined by <b>spMin</b> . For optimal results the user should calibrate the minimum and maximum voltage range to each actuator, due to small differences in each actuator and signal system. The value vMin = 33114 corresponds to approximately 0 volts.
<b>vMax</b>	63402	This sets the input voltage (measured in ADC encoder counts) at which the actuator will have moved to the position defined by <b>spMax</b> . For optimal results the user should calibrate the minimum and maximum voltage range to each actuator, due to small differences in each actuator and signal system. The value vMax = 63402 corresponds to approximately +10 Volts.
<b>vFilter</b>	10000	Defines the analog voltage input 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 Analog Voltage (-10 to +10V) 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) Establish the desired relationship between input voltage signal and output motion. Read the section Establishing the Relationship between Input Signal and Output Position on page 3.
3. (If not done already) Configure the actuator by following the instructions in Configuration for Analog Voltage (-10 to +10V) Mode on page 3.
4. Feed the analog voltage signal to the actuator to control the actuator. The actuator should now operate with respect to the input signal.