ULTRAMOTION **servo**cylinder	# Quick Start Guide: ## Command Line Interface (RS232 Serial) Mode

About Command Line Interface (RS232 Serial) Mode

The Servo Cylinder's Command Line Interface (CLI) offers the user complete control over all performance parameters, motion commands, and diagnostic information through a direct connection to a programmable logic controller (PLC), a computer with any terminal program such as PuTTY (using a serial-to-USB adapter), or any platform that operates an RS232 serial communication port such as LabVIEW, MATLAB, Python, Arduino, etc.

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 (≥180 W suggested, see PS-1X Series PSUs)
- A system to issue RS232 serial commands (such as a computer or PLC). For the purpose of this Quick Start Guide, our system will consist of:
  - o A PC running Windows 7
  - o An RS232-to-USB Converter (With an FTDI chipset and a minimum Baud rate of 115200)
  - o PuTTY, an open source windows-based terminal emulator

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 issuing serial commands (in this example, we will connect to a Windows 7 PC with an RS232-to-USB Converter).
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.

USB CONFIGURATION CABLE
8-36VDC POWER SUPPLY OR BATTERY
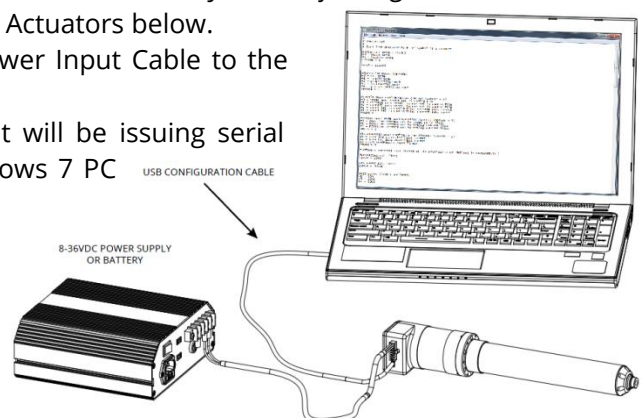
Additional Setup Information for A2-Series Actuators

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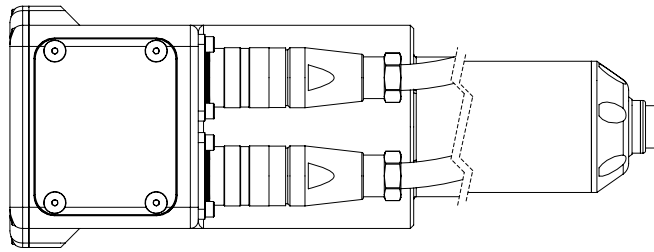
Torque each connector with at least 13.3 in lbf [1.5 N·m] of torque

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].

TORQUE
5.2 in-lb
(.588 Nm)
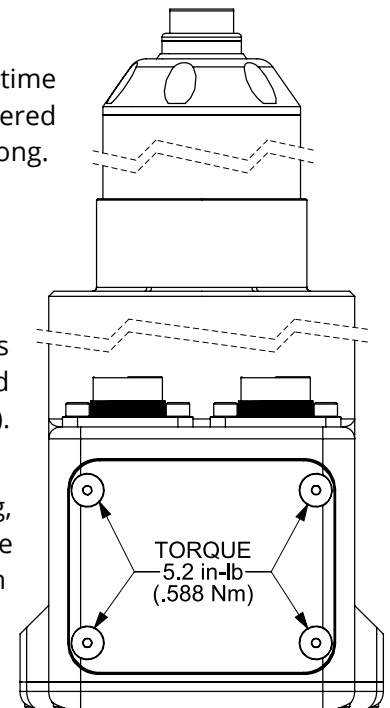
Configuration for Command Line Interface (RS232 Serial) Mode

How to Configure 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. 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).
2. Browse to "My Computer" and open the new storage drive labeled "Ultra Motion".
3. Locate the text file "CONFIG.TXT" and open it in a text editor.
4. Edit configuration parameters to set the actuator to behave as desired. Refer to Quick Start Settings for Command Line Interface (RS232 Serial) Mode below.
5. 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.

Quick Start Settings for Command Line Interface (RS232 Serial) Mode (Via CONFIG.TXT)

The table below contains a complete list of all variables that need to be configured in CONFIG.TXT to use Command Line Interface (RS232 Serial) Mode.

Note: Other unused variables in CONFIG.TXT:

While many other variables in CONFIG.TXT aren't necessarily used for Command Line Interface (RS232 Serial) Mode, the actuator will not successfully start up if these values are invalid or missing.

Configuration Variable	Set to...	Notes
opMode	0	Sets the actuator to Command Line Interface (RS232 Serial) Mode. _This is the default setting._
spMin	2048	This sets the actuator to retract to a minimum position that has safe headroom before the physical stop. _This is the default setting._
spMax	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. _This is the default setting._
maxTorq	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. _This is the default setting._
kp	1200	Stable generic value for proportional gain. This value can be tuned for increased performance and responsiveness. _This is the default setting._
ki	250000	Stable generic value for integral gain. This value can be tuned for increased performance and responsiveness. _This is the default setting._

kd	10000	Stable generic value for derivative gain. This value can be tuned for increased performance and responsiveness. *This is the default setting.*
errMode	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 **strongly recommended** using this setting (in mode 6 or 7) to protect the motor. *This is the default setting.*
baud	115200	This sets the RS232 Serial baud rate to 115200. *This is the default setting.*
maxSpeed	2000000	This safely limits the speed to ~20% of maximum speed. *This is the default setting.*
Accel	5000	This safely limits the acceleration to a moderate value. *This is the default setting.*
ifMode	0	Sets the RS232 Serial communication to work in "Human Mode"

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 torqueing 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 Command Line Interface (CLI)

To use the command line interface, connect via the RS232 serial port and open a serial terminal.

Setting up a PuTTY Terminal (in Windows)

1. (If not done already) Install VCP (Virtual COM Port) drivers, which can be found on the FTDI website.
2. (If not done already) Install PuTTY, which can be found on the PuTTY website.
3. (If not done already) Follow the wiring procedure outlined in Setting up the Servo Cylinder Hardware on page 1. The micro-USB cable is not necessary if the Servo Cylinder is already configured.
4. In Windows, determine which COM port number was assigned to the Servo Cylinder. This can be done by opening Device Manager (Right click My Computer, Under System Tools click Device manager). In Device manager, expand the "Ports (COM & LPT)" menu, and make a note of the number of the COM port for the USB Serial Port (COM4 in the window below)
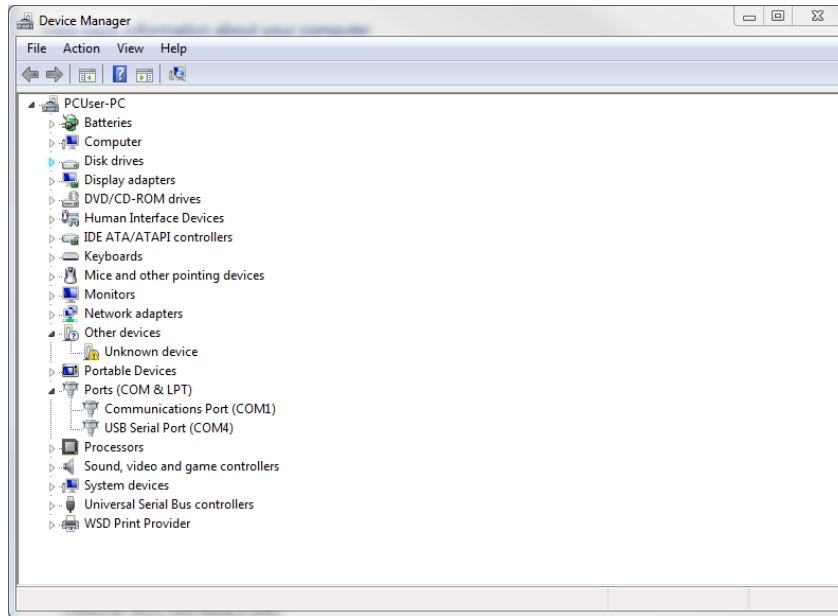
5. Open PuTTY.
6. Set up PuTTY to run a serial command line interface. To do this, click the "Serial" Radio Button. Under Serial Line, enter the correct COM port for the Servo Cylinder (COM4 in this example). Under "Speed", enter the Baud Rate set up in CONFIG.TXT, which is 115200. You may now save these as default settings for PuTTY.
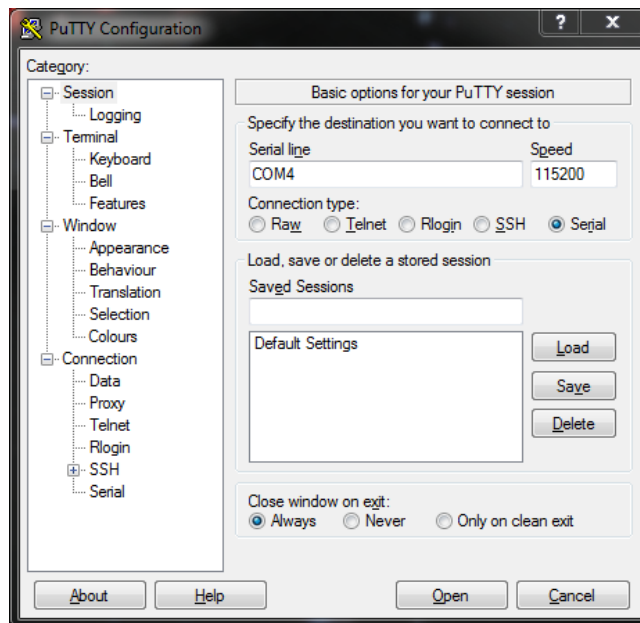
7. Click "Open" to open the command line interface. A blank terminal window will open.
8. As a test, issue the Help command (HE) by typing HE and pressing enter. If correctly set up, the Servo Cylinder should return a table of serial commands (as seen in the screenshot below).

```
|   |          |   17 = Filtered analog voltage input          |
|   |          |   18 = Analog current input                   |
|   |          |   19 = Filtered analog current input          |
|   |          |   20 = Temperature sensor input               |
|   |          |   21 = Position error                         |
|   |          |   22 = Quadrature input errors                |
|   |          |   23 = 1-2ms pulse input errors               |
|   |          |   23 = 32-bit counter with 100us increments   |
|XC |none      |Clear timer                                    |
|ZC |integer   |Calibrate actuator, write HARDWARE.TXT, restart CPU (321) |
|ZU |integer   |Jump to rs232 firmware update, exit CLI (321)  |
|ZR |integer   |Reset actuator (321)                           |
|ZD |none      |Read bridge driver DIAG register, display results |
|ZF |none      |Clear latching fault flags in status register  |
|ZW |none      |Overwrite CONFIG.TXT with current config variables (321) |
|ZI |none      |Clear PID filter I-term and D-term             |
|HE |none      |Display this table                             |
|   |          |                                               |
    *Running this command without an argument will display the current value
     without setting it.
    **Running this command without an argument will display all values.

OK
>
```

6. The Servo Cylinder is now set up and ready to take commands.

Executing Commands in Command Line Interface (RS232 Serial) Mode

The Servo Cylinder will respond to single line commands. All commands consist of two letter characters (not case sensitive) and may or may not be followed by a parameter (also known as an argument) and/or a checksum. Command is executed when followed by a carriage-return (CR) character (newline characters are ignored).

A list of Command Line Interface (CLI) language commands is as follows. For more information on each command, read the full Servo Cylinder Manual.

	Command	Function
Read	AN	Read Analog Inputs
	AP	Read Actuator Position
	BV	Read Bus Voltage
	DI	Read Digital Input
	FS	Read Firmware Version and Serial Number
	HE	Display the Help Table
	QP	Read Position Setpoint
	RC	Read 1 to 2ms Pulse (PWM) Input
	SR	Read Status Register
	TQ	Read Motor Torque
	VL	Read Actuator Velocity
Set	AC	Set Acceleration for Trajectory Moves
	CG	Coast On
	CS	Coast Off
	D1, D2	Set Mode for DIO1 and DIO2 (Respectively)
	H1, H2	Set the PWM Output Signal Type on DIO1 and DIO2 (Respectively)
	IM	Set Serial Interface Mode
	KD	Set Derivative Gain for Position PID Filter
	KI	Set Integral Gain for Position PID Filter
	KP	Set Proportional Gain for Position PID Filter
	MT	Set Limit for Maximum Commanded Torque
	PA	Set Absolute Target Position
	PC	Set Target Position to Current Position
	PO	Set Target Position Offset
	SP	Set Maximum Speed for Trajectory Moves
	W1, W2	Set Status Register Bit Mask for GPIOs DIO1 and DIO2 (Respectively)

	Command	Function
System	ZC	Run Calibration Routine
	ZD	Read Bridge Driver DIAG Register
	ZF	Clear Latching Fault Flags in Status Register
	ZR	Reset Actuator
	ZU	Jump to RS232 Firmware Updater
Trajectory	T1, T2, T3, T4	Trajectory Move to User Defined Position Pos1, Pos2, Pos3, and Pos4 (Respectively)
	TA	Trajectory Move to Absolute Position
	TE	Trajectory Move to Fully Extended Position (spMax)
	TK	Interrupt the current trajectory
	TM	Trajectory Move to Midpoint
	TO	Trajectory Move to Offset (incremental trajectory move)
	TR	Trajectory Move to Fully Retracted Position (spMin)
Streaming	X1, X2, X3	Set Data Stream for Columns 1, 2, and 3 (respectively)
	XC	Clear Timer
	XG	Turn Data Streaming On
	XR	Display Data Stream Setup
	XS	Turn Data Streaming Off
	XT	Set Data Stream Time Interval