

**IOM A-0984E – IP68 - 420DC**  
**AUTOMATED PILOT ACTUATOR**  
Installation and Operation Manual



Please ensure to read and understand the contents of this manual.

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# 1 HEALTH AND SAFETY: READ FIRST

Read the health and safety information before using the 420DC Automated Pilot Actuator.

Specific warning and caution statements, where they apply, will be found throughout the manual.

- “Warning” statements identify conditions and actions that pose hazard(s) to the user.
- “Caution” statements identify conditions and actions that may damage the 420DC Automated Pilot Actuator.

This manual is produced to enable a competent user to install, operate, program, and calibrate the 420DC Automated Pilot Actuator. The electrical installation and use of these actuators should be carried out in accordance with the National Legislation and Statutory Provisions relating to the safe use of this equipment, applicable to the site of installation.

Only persons competent by virtue of their training or experience should be allowed to install, program, and/or operate the product. Work undertaken must be carried out according to the instructions in this manual. Users working on this equipment should be familiar with their responsibilities under any statutory provisions relating to the health and safety of their workplace.

Where appropriate, the user must ensure that the actuator is suitably protected against its operating environment.

## **Caution!**

**If your actuator cannot be installed immediately, store it in a clean, dry place until you are ready to connect incoming cables. If the actuator is installed but cannot be cabled, it is recommended that the pilot assembly and actuator be removed from the valve until the actuator is ready to be cabled and/or commissioned.**

## 2 GENERAL INFORMATION

The 420DC Motorized Pilot Actuators are electro-mechanical, bi-directional rotary actuators that are designed to actuate the adjusting screw of a pilot manufactured by Singer Valve Inc. These actuators can provide up to 40 inch-pounds of torque with output shaft turns between 1/20<sup>th</sup> to 10.

The actuator is a closed-loop system where the output shaft is positioned using a position feedback from a 5,000 ohm potentiometer. Using a 4-20mA command signal, the actuator positions the shaft within a programmable control range. A programming software and communication cable are required to program the actuator control range.

### ACTUATOR SPECIFICATION – VA250

<b>Input Voltage</b>	24 VDC/ 50 Watts Minimum
<b>Command Signal Input</b>	4-20 mA
<b>Input Impedance</b>	220 ohms
<b>RPM</b>	1
<b>Torque Limiter</b>	Programmable
<b>Feedback</b>	4-20 mA
<b>Programming</b>	USB RS232 Protocol

### ENVIRONMENTAL SPECIFICATION

<b>Operating Temperature</b>	-30°C to 85 °C
<b>Insulation Resistance</b>	100 MΩ at 500VDC
<b>Dielectric Strength</b>	500VAC
<b>Weight</b>	5.5lbs Approx.
<b>Enclosure Rating</b>	IP68 (7ft immersion for up to 24 hours)

### MATERIAL SPECIFICATION

<b>Enclosure</b>	Satin blue anodized aluminum
<b>Base</b>	Anodized aluminum
<b>Output Shaft</b>	Stainless steel
<b>Cable</b>	22 gauge, Vinyl Sleeve
<b>Screws</b>	Stainless Steel

### STORAGE

If your actuator cannot be installed immediately, store it in a clean, dry place until you are ready to connect incoming cables. If the actuator is installed but cannot be cabled, it is recommended that the pilot assembly and actuator be removed from the valve until the actuator is ready to be cabled and/or commissioned.

### 3 ACTUATOR INSTALLATION

**NOTE:**

The pilot and actuator assembly is normally factory calibrated for standard pilot ranges in proportion to the 4-20 mA input signal, unless otherwise specified. Refer to pilot tags for details. No further adjustments are necessary. Contact the factory for further information.

**CAUTION!**

The 420DC Motorized Actuator is a low-speed, high-torque device which requires precise mounting and positioning in order to ensure proper operation and long term reliability. Please follow these instructions carefully.

Figure 1 shows the materials needed to mount the actuator.



**Figure 1 – Clockwise from left: pilot, 420DC coupling, 420DC actuator, 3/32” Allen wrench, 1/4” Allen wrench**

Note: The pilot and actuator shown in Figure 1 may be different from those included.

Refer to the Installation and Operation Manual for the included pilot or test inline to ensure that the pilot screw has been adjusted to its minimum pressure setpoint.



**Figure 2 – Adjust pilot screw to minimum position**

Loosen the set screws on the 420DC coupling using the 3/32" Allen Wrench, as shown in Figure 3.



**Figure 3 – Loosen 420DC coupling set screws**



Mount 420DC coupling to the pilot screw – some force may be required to ensure a proper fit, but take care not to upset the current position of the screw. Inspect the assembly and make sure the coupling sits flat on the pilot screw head as shown in Figure 5.



**Figure 5 – Mount 420DC coupling to pilot adjustment screw**



**Figure 4 – Inspect assembly to ensure coupling sits flat**

## COUPLING THE ADJUSTING SCREW

### CAUTION!

Before installing the coupling to the adjusting screw of the pilot, ensure that the actuator and pilot is at the minimum of its control range. This ensures that if a 4mA signal is applied, the actuator output shaft and the coupling will not come in contact which can potentially damage the motor and the output shaft.

Refer to Chapter 4 and onwards on wiring and software configuration of the actuator.

**Before installing the actuator to the pilot, power and apply a 4mA signal to the actuator.**

Slip the 420DC actuator over the pilot/coupling assembly. Rotate the actuator on the pilot so that the keyed actuator shaft slides securely inside the hole at the top of the coupling.



**Figure 6 – Slip 420DC Actuator over pilot/coupling assembly and adjust orientation such that output shaft fits in top hole of coupling**

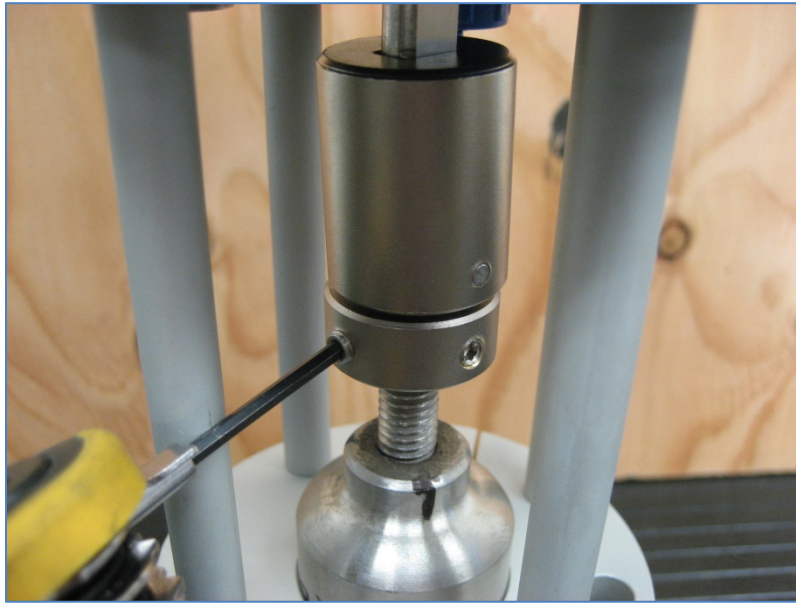


Use the ¼" Allen wrench to tighten actuator spring casings simultaneously, alternating between each screw one turn at a time. Tightening both screws concurrently maximizes the strength of the fit and helps to prevent slippage.



**Figure 7 – Tighten spring casing set screws simultaneously**

Tighten the set screws on the 420DC coupling to secure the pilot set screw to the 420DC actuator.



**Figure 8 – Tighten 420DC coupling set screws**

The 420DC/pilot assembly is now ready for operation! Refer to Chapter 7 for Set-up and Programming.



**Figure 9 – Mounted 420DC actuator and pilot**

## 4 ELECTRICAL REQUIREMENTS

### WARNING!

**SHOCK HAZARD – REMOVE ALL SOURCES OF POWER BEFORE WIRING THE ACTUATOR. FAILURE TO FOLLOW MAY RESULT IN SERIOUS INJURY OR DEATH. INSTALLATION AND SERVICING MUST BE PERFORMED BY QUALIFIED PERSONNEL.**

### CAUTION!

Fusing is not provided within the actuator.

- Power supply line fusing must be provided and should not exceed 2 amperes. Use motor-type fuses.
- Command signal line fusing must be provided and should not exceed 100mA. Use fast-blow fuses.

**Connecting 24VDC to the Command Signal line will permanently damage the control system electronics and render the actuator inoperable.**

### ELECTRICAL REQUIREMENTS

- All installation must be in accordance with the national electric code requirements as well as state and local codes.
- A fuse or circuit breaker must be placed near the actuator and it must be marked as the disconnecting means for the equipment.
- The 4-20 mA control signal should be stable, meaning that the quality of the signal should not vary more than +/- 0.025mA.

### OPTIONAL ELECTRICAL REQUIREMENTS

- Install surge suppression devices in the distribution panel if the installation site is prone to surge or transient voltages.

## 5 WIRING DIAGRAM

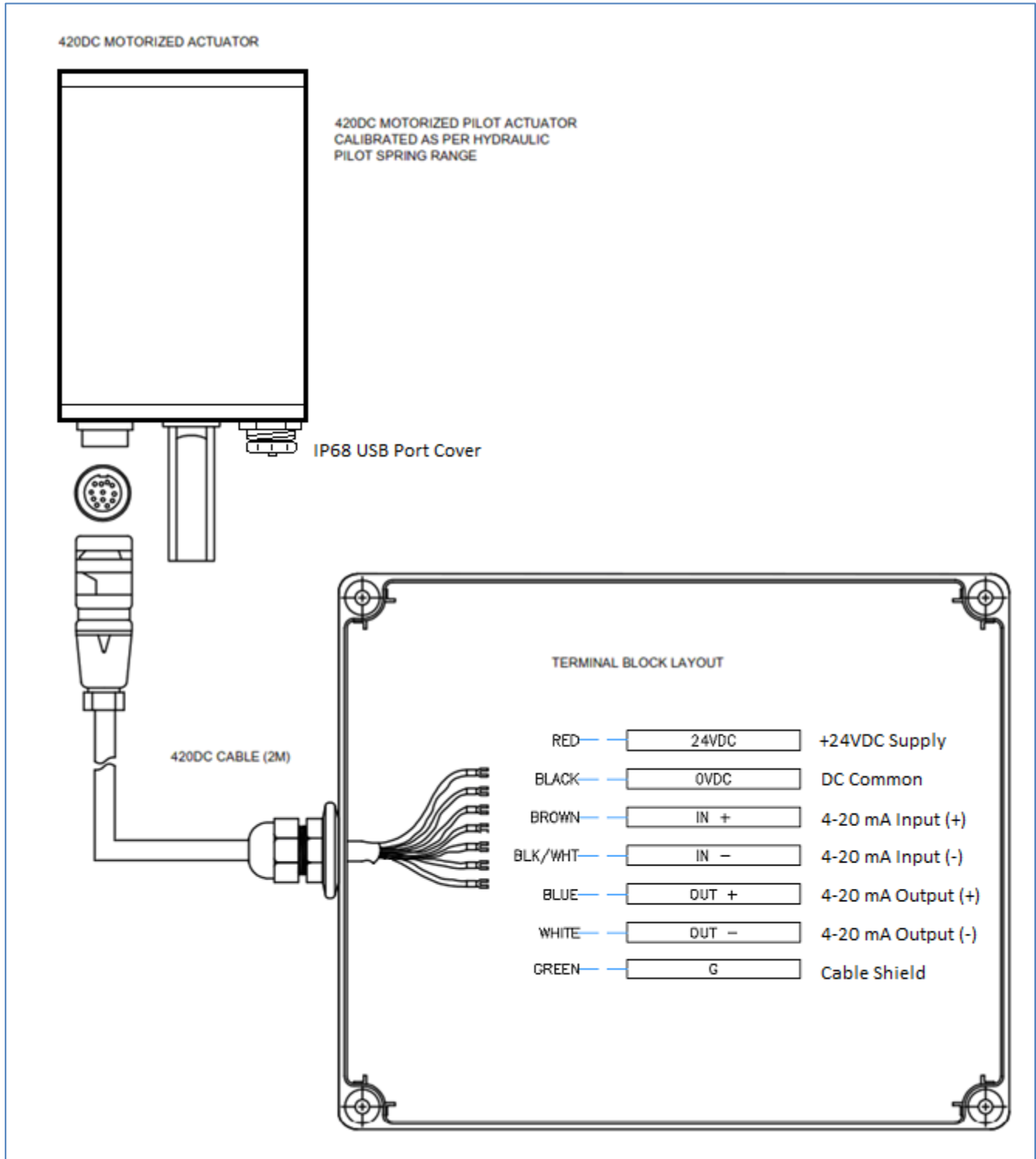


Figure 10 –Wiring Diagram

**Note:** Watertight junction boxes are not watertight until the junction box conduit connections are sealed by the customer after wiring.

## 6 SOFTWARE BASICS

### 1) Initialization

Connect the 420DC actuator to a 24VDC power source via the supplied Singer 420DC Junction Box, as shown in Figures 11 and 12.



Figure 11 – Connect Actuator to Junction Box

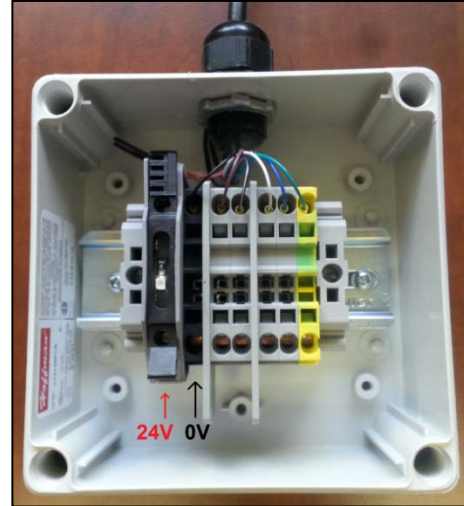


Figure 12 – Connect DC Power to Box

Start the Singer Valve 420DC Programming software; ensure the main console window opens as shown in Figure 13.

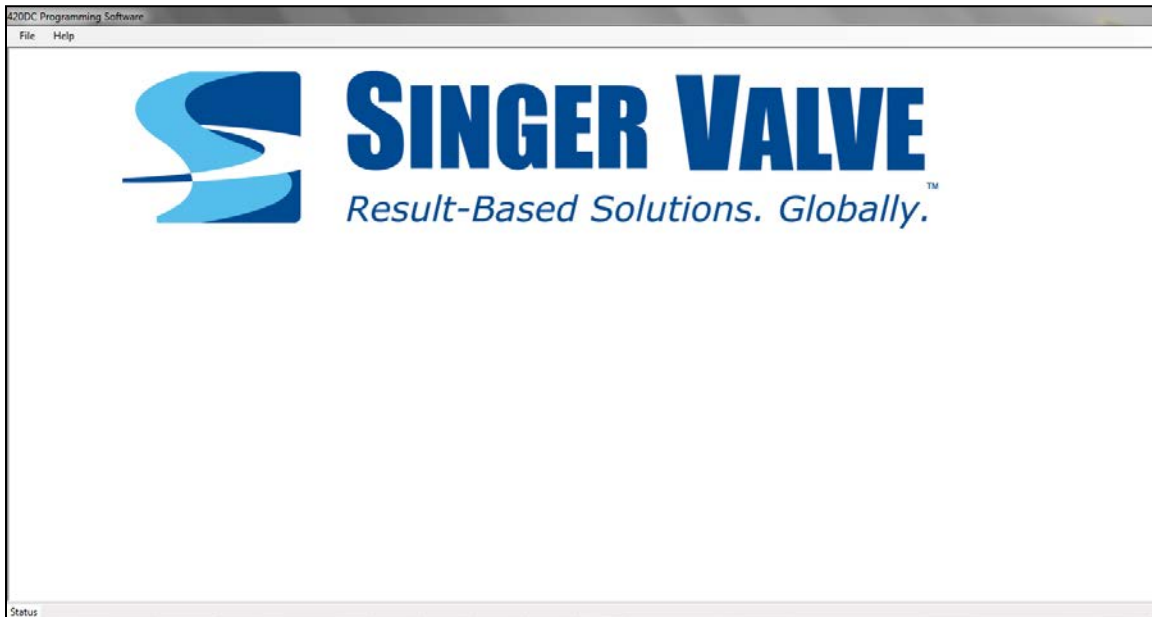


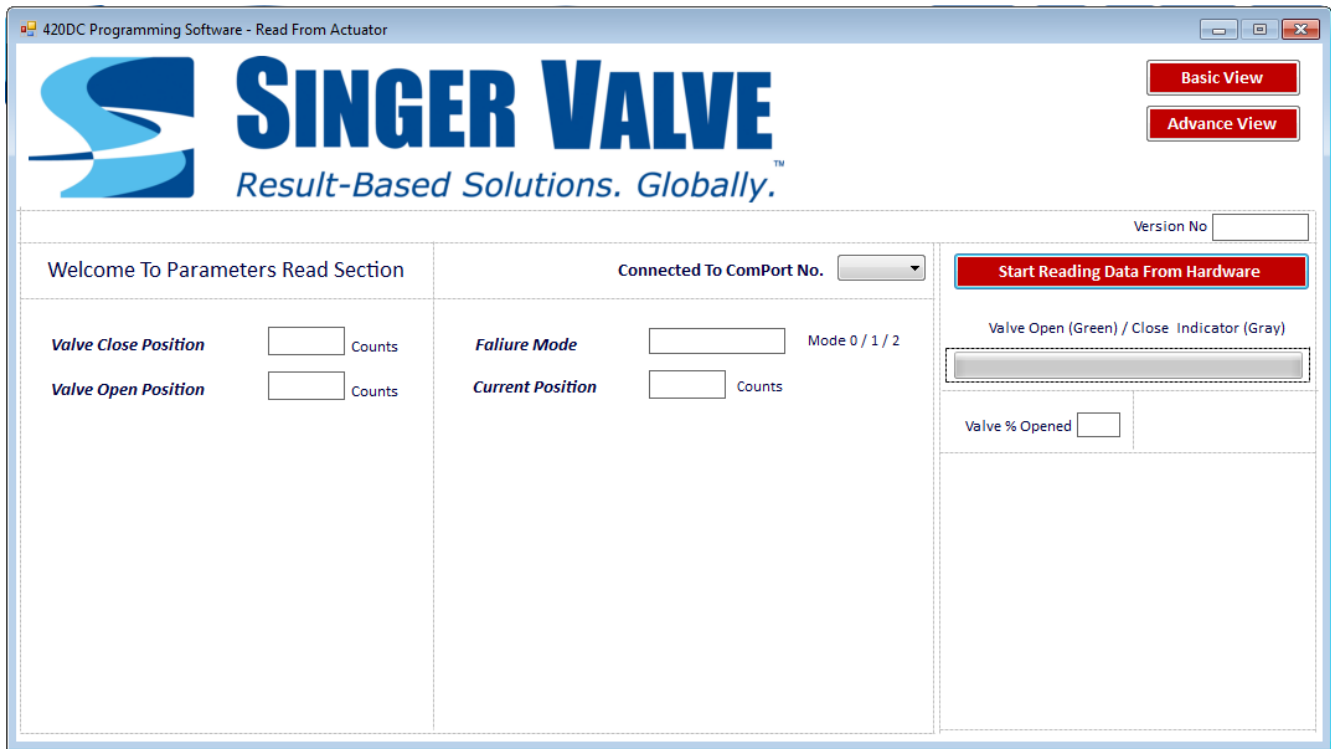
Figure 13 – Main Console Window

Unscrew the waterproof USB port cover and connect the actuator to the working computer with the supplied USB cable; allow Windows Update to install the necessary drivers.



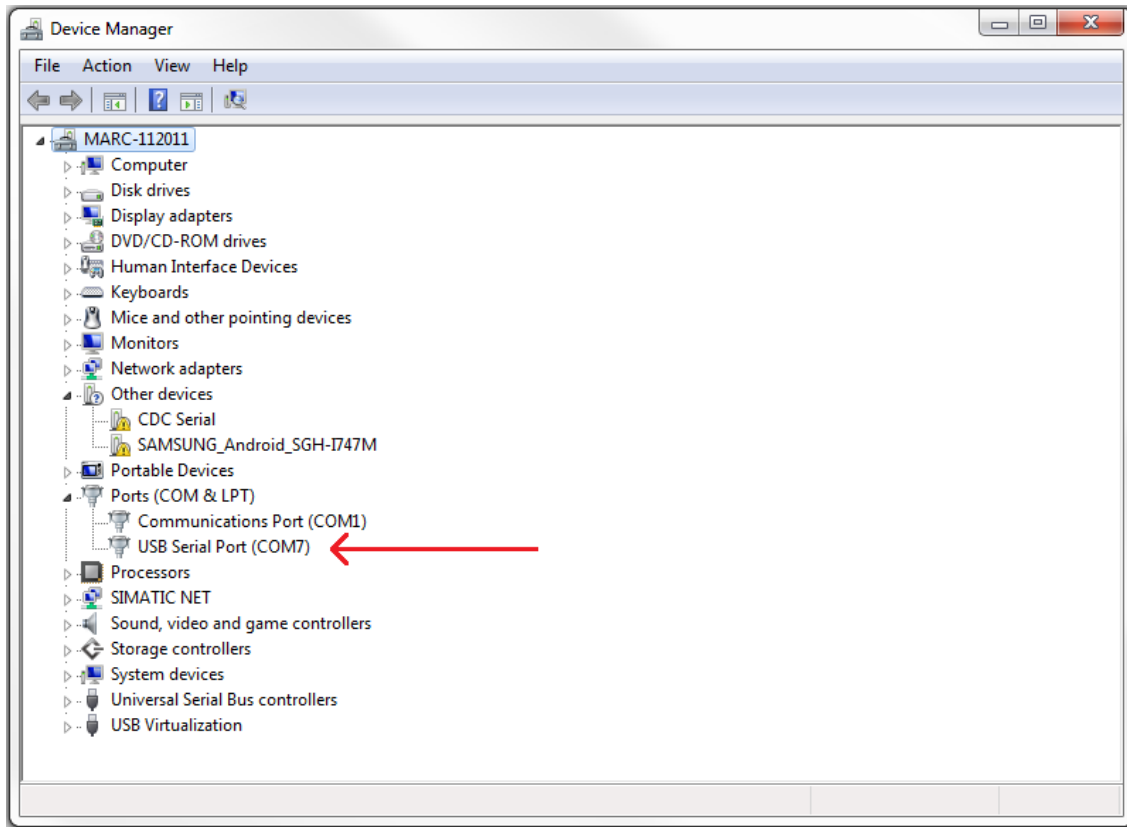
## 2) Read Actuator Parameters

In order to read the parameters programmed to the actuator, click File → Read and ensure the Read Window opens over the main console window as shown in Figure 14.



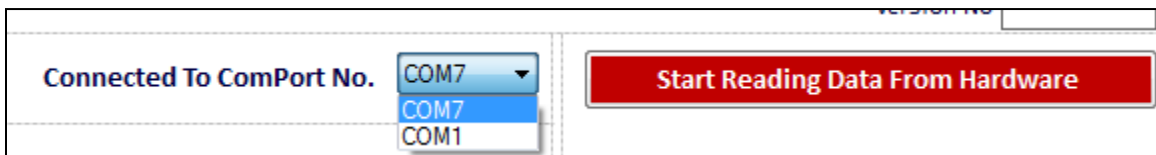
**Figure 14 – Read Parameters Window**

To determine the port actuator has connected to, start Windows Device Manager (shown in Figure 15) by opening the start menu and typing “Device Manager”; alternatively the Device Manager can be found in the Windows Control Panel.



**Figure 15 – Windows Device Manager**

In the 'Read' Window, use the dropdown menu to select the Communications Port connected to the actuator, then click "Start Reading Data from Hardware".



**Figure 16 – Connecting to Actuator**

The 'Read' Window shows four fields in the Basic View:

- **Valve Close Position:** Indicates the lowest digital setpoint position of the pilot, generally set between 700 and 850. This is the position the actuator will move to when a 4mA control signal is applied.
- **Valve Open Position:** Indicates the highest digital setpoint position of the pilot; this value will vary between pilots but may go up to 3500. This is the position the actuator will move to when a 20mA signal is applied.
- **Failure Mode:** Indicates the response of the actuator in the event of losing communication with the command signal. The *STOP* Failure Mode locks the position of the actuator; *CLOSE* forces the pilot closed; and *OPEN* forces the pilot open.
- **Current Position:** Indicates the current position of the actuator's shaft between 0 and 4095

The Advanced View shows technical parameters solely for troubleshooting by Singer Valve personnel – **DO NOT USE THE ADVANCED VIEW UNLESS REQUESTED BY SINGER STAFF WHILE TROUBLESHOOTING.**

### 3) Write Actuator Parameters

The Write Parameters Window is used to change settings loaded to the actuator. Click File → Write to open the window shown in Figure 17.



**Figure 17 – Write Parameters Window**

Use the dropdown menu to select the Communications Port connected to the actuator, then click “Read Values”.

The ‘Write’ Window shows four fields in Basic View:

- **Valve Close Position:** Indicates the lowest digital setpoint position of the pilot, generally set between 700 and 850. This is the position the actuator will move to when a 4mA control signal is applied.
- **Valve Open Position:** Indicates the highest digital setpoint position of the pilot; this value will vary between pilots but may go up to 3500. This is the position the actuator will move to when a 20mA signal is applied.
- **Failure Mode:** Indicates the response of the actuator in the event of losing communication with the command signal. The *STOP* Failure Mode locks the position of the actuator; *CLOSE* forces the pilot closed; and *OPEN* forces the pilot open.
- **Motor Trip Current:** Indicates the maximum allowable current draw by the actuator before a failure mode is triggered. **This value should not be changed from its default value.**

After changing the desired parameters, click “Start Write” and wait until a prompt appears saying ‘Writing Completed’.

The Advanced View shows technical parameters solely for troubleshooting by Singer Valve personnel – **DO NOT USE THE ADVANCED VIEW UNLESS REQUESTED BY SINGER STAFF WHILE TROUBLESHOOTING.**

#### 4) Manual Motion Control

In order to control the 420DC actuator manually without the use of a 4-20mA control signal, the Motion Control Window shown in Figure 18 can be used. To open the window click File → Motion Control.



**Figure 18 – Motion control Window**

Use the dropdown menu to select the Communications Port connected to the actuator, then click “Read Values from Hardware”. If the connection is successful, the “Valve Position” and “Position Counts” fields will be populated. The definition of these fields is as follows:

- **Valve Position:** Shows the position of the 420DC actuator on a percentage scale, as defined by the Valve Open and Close positions specified in the Read and Write menus
- **Position Counts:** Shows the position of the valve on a 0-4096 scale

Use the “Move Forward” and “Reverse” buttons to manually control the position of the valve. Click the “Stop” button to brake the actuator once the desired position is reached.

To control the actuator using a 4-20mA command signal after using the Motion Control Window, click the “Auto” button – failure to do so will disable control of the actuator and will require the unit to be depowered and repowered before further use.

## 7 SET-UP AND PROGRAMMING

**NOTE:** Unless specified at time of order, the control range of the actuator will be factory calibrated to the pilot spring range and will be set to the minimum pilot setting.

### **CAUTION!**

Before installing the coupling to the adjusting screw of the pilot, ensure that the actuator and pilot is at the minimum of its control range. This ensures that if a 4mA signal is applied, the actuator output shaft and the coupling will not come in contact which can potentially damage the motor and the output shaft. Allow at least 3mm space between the coupling and the output shaft.

### **Installation Technique # 1: Field Set-up**

- Ensure that the actuator is wired and installed on the pilot correctly. Apply power to the actuator.
- Ensure that the actuator is communicating with the software.
- Follow the **Read Actuator Parameters** step in Section 6 of this manual to view the current parameters
- Ensure **Failure Mode** is set to **STOP**.
- Open the **Manual Control** window to enable manual control.
- Manually move the actuator to the minimum desired setpoint of the process variable. (i.e. downstream pressure setpoint).

### **CAUTION:**

**If manually closing the valve, ensure that the output shaft does not come in contact with the bottom of the coupling. Contact increases torque and may cause motor and shaft damage.**

**If contact is possible, remove the actuator, and set the adjusting screw to the minimum setpoint. Re-install as per guidelines in Chapter 3.**

**The Manual Control window allows the actuator to move above and below the installed open and closed positions of the actuator, and will only stop with the Stop button is pressed.**

- Note the closed position of the valve in the “Position Counts” field.  
**Note: This will be the pilot setpoint at 4 mA.**
- Manually move the actuator to the maximum desired setpoint of the process variable; note the open position of the valve in the “Position Counts” field.  
**Note: This will be the pilot setpoint at 20mA.**
- Click on **Auto** to enable automatic control.
- Open the **Write to Actuator** window and change the “Valve Open Position” and “Valve Closed Position” parameters to those noted in the previous steps, then write the values to the actuator
- Remove communication cable and apply control signal.

### **Recommended Practice**

- Do not operate the actuator at the minimum output shaft position. Recommended ‘Closed Valve Position’ Value: > 700.



## Installation Technique # 2: Calculation

Use this method if the maximum desired setpoint of the pilot cannot be set in the field.

Required Data:

- Pilot Pressure Change per turn: please see pilot datasheet. ( $\Delta PV/\text{turn}$ )
- Minimum Desired Process Variable Setpoint (PVmin)
- Maximum Desired Process Variable Setpoint (PVmax)

Equation:

a.  $PV_{\text{range}} = PV_{\text{max}} - PV_{\text{min}}$

b.  $PV_{\text{range}} / (\Delta PV/\text{turn}) = \text{Output Shaft Turn Range}$

c.  $\text{Output Shaft Turn Range} * 410 = \text{Actuator Control Range}$

d.  $\text{Open Valve Position value} = \text{Closed Valve Position value} + \text{Actuator Control Range}$

### Sample Calculation:

Given:

Closed Valve Position Value: 700

Pilot Pressure Change per turn: 31psi/turn

Minimum Desired Process Variable Setpoint: 40 psi

Maximum Desired Process Variable Setpoint: 80 psi

Solve for: Open Valve Position Value

a. Solve for PV range:

$$80 \text{ psi} - 40 \text{ psi} = 40 \text{ psi}$$

b. Solve for Output Shaft Turn Range

$$40 \text{ psi} / (31 \text{ psi/turn}) = 1.29 \text{ turns}$$

c. Solve for Actuator Control Range

$$1.29 \text{ turn} * 410 \text{ counts/turn} = 529 \text{ counts}$$

d. Solve for Open Valve Position Value

$$700 + 529 = 1229$$

e. Enter 1229 as the Open Valve Position

Program the actuator as per Installation Technique # 1, but enter the calculated value as the Open Valve Position.

## 8 OPERATION GUIDELINES

The 420DC Motorized Pilot Actuators are electro-mechanical, bi-directional rotary actuators that have a low-speed, high torque output suitable for rotary positioning. They are designed to actuate the adjusting screw of a pilot manufactured by Singer Valve Inc.

The actuator is a closed-loop system where the output shaft is positioned using a position feedback from a 500 ohm potentiometer. Using a 4-20mA command signal, the actuator positions the shaft within a programmable control range.

**Limit this actuator to a maximum of 200 set point changes per day.** The precision potentiometer will wear with use, operating the actuator intermittently will extend the maintenance cycle/life of the actuator.

**CAUTION:**

**Do not operate the actuator until the adjusting screw of the pilot bottoms out.**

**Do not operate the actuator until the output shaft comes in contact with the bottom of the coupling.**

**Due to the actuator's high torque output, stalling the actuator will burn out the dc motor.**

**NOTE:**

The pilot and actuator assembly is normally factory calibrated for standard pilot ranges in proportion to the 4-20 mA input signal, unless otherwise specified. To estimate the pressure setpoint, use the linear equation below:

**LINEAR EQUATION (Slope):**

$$PRESSURE OUTPUT = (INPUT SIGNAL - 4mA) \left( \frac{PRESSURE RANGE}{CURRENT SIGNAL RANGE} \right) + MINIMUM PRESSURE$$

where,

Pressure Range =	Maximum Pressure – Minimum Pressure
Current Signal Range =	(20mA – 4 mA) = 16mA
Input Signal =	Current control signal

## 9 TROUBLESHOOTING GUIDE

ISSUES	POSSIBLE CAUSE	REMEDY
Actuator does not communicate with software	<ul style="list-style-type: none"> <li>a. Communication port not configured properly.</li> <li>b. Software version not compatible.</li> <li>c. No power to actuator</li> </ul>	<ul style="list-style-type: none"> <li>a. Make sure software com port is the same as laptop/pc com port.</li> <li>b. Contact factory for with actuator serial number for current software version.</li> <li>c. Check power supply, fuses, and wiring</li> </ul>
Actuator does not operate	<ul style="list-style-type: none"> <li>a. No power to actuator</li> <li>b. No control signal to actuator</li> <li>c. Motor burned out</li> <li>d. Actuator shaft stalled</li> <li>e. 24VDC source applied to control signal line (short)</li> </ul>	<ul style="list-style-type: none"> <li>a. Check power supply, fuses, and wiring</li> <li>b. Check source, fuses, and wiring</li> <li>c. Replace motor and determine cause.</li> <li>d. Check for a mechanical jam and correct</li> <li>e. Replace control board and/or fuse</li> </ul>