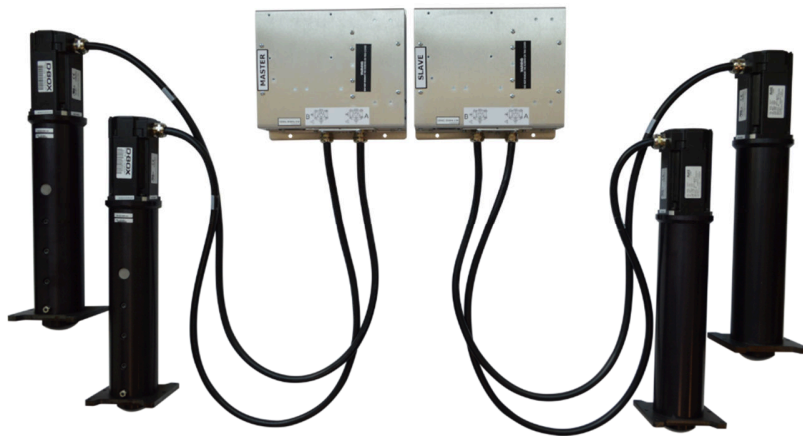




# G3 MOTION SYSTEM INSTALLATION MANUAL



**CONFIDENTIAL**

D-BOX – ACM\_G3\_INSTALLATION GUIDE - 209-914-0002-EN2

February 2020

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## IMPORTANT SAFETY INSTRUCTIONS

1. Read and follow these instructions step-by-step.
2. Keep them for future reference.
3. Install in accordance with the manufacturer's instructions and heed all warnings.
4. Do not use this apparatus near water.
5. Only clean with a dry cloth.
6. Do not block any ventilation openings.
7. Do not install near any heat sources such as radiators, heat registers, stoves, or other apparatus (including amplifiers) that produce heat.
8. Do not defeat the safety purpose of the polarized or grounding-type plug. A polarized plug has two blades with one wider than the other. A grounding-type plug has two blades and a third grounding prong. The wide blade or the third prongs are provided for your safety. If the provided plug does not fit into your outlet, consult an electrician for replacement of the obsolete outlet.
9. Protect the power cord from being walked on or pinched particularly at plugs, convenience receptacles, and the point where they exit from the apparatus.
10. Only use attaching hardware/accessories specified by the manufacturer.
11. Use only with the cart, stand, tripod, bracket, or table specified by the manufacturer, or sold with the apparatus. When a cart is used, use caution when moving the cart/apparatus combination to avoid injury from tip-over.
12. Unplug this apparatus during lightning storms or when unused for long periods of time.
13. Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way, including damage to power-supply cord or plug, liquid has been spilled or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.
14. Do not expose this apparatus to dripping or splashing and ensure that no objects filled with liquids, such as vases, are placed on the apparatus.
15. To completely disconnect this apparatus from the AC Mains, disconnect the power supply cord plug from the AC receptacle.
16. The mains plug of the power supply cord shall remain readily operable.
17. Do not expose batteries to excessive heat such as sunshine, fire or the like.



The lightning flash with arrowhead symbol within an equilateral triangle is intended to alert the user to the presence of uninsulated "dangerous voltage" within the product's enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons.



The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance (servicing) instructions in the literature accompanying the product.



This symbol indicates that you must communicate with the manufacturer for disposal of the equipment.

**WARNING:** To reduce the risk of fire or electric shock, do not expose this apparatus to rain or moisture.

Thank you for purchasing a D-BOX Motion System, the most immersive experience for the simulation and game markets. We strongly advise that you read the guidelines before assembling and using your Motion System.

Do not hesitate to contact us if you have questions.

## **D-BOX SUPPORT**

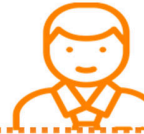
2172 rue de la Province, Longueuil, QC, Canada

BY EMAIL : [support@d-box.com](mailto:support@d-box.com)

BY PHONE - toll free CAN/US: 1-888-442-3269 ext.931  
- other regions: 1-450-442-3003 ext.931

### SUPPORT BUSINESS HOURS

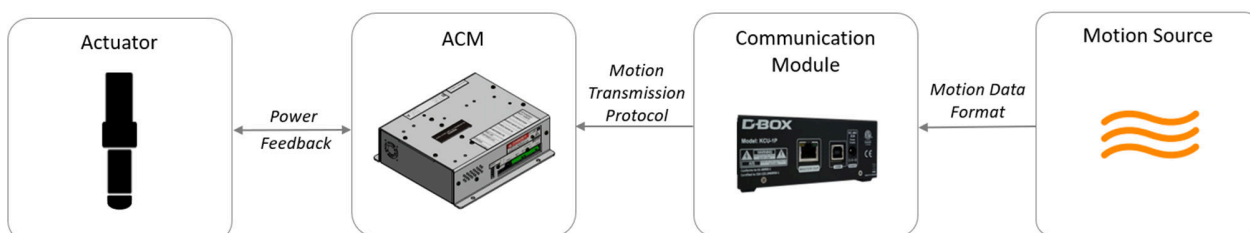
Monday to Friday	8h00 to 20h30 (UTC-5)
Saturday & Sunday	8h30 to 17h00 (UTC-5)



## INTRODUCTION

D-BOX Motion Systems are evolutive and scalable. Integrated into a seat, platform or simulator, they are designed to simulate a range of textures and scalable axes of movement. Whatever you require, D-BOX can help you select the best arrangement of actuators.

The following components are part of the D-BOX **Motion System**:



- **Motion System:** a complete architecture of hardware and software providing motion.
- **Actuator:** an assembly of motor and mechanic providing movements and vibrations.
- **Actuator Control Module (ACM):** provides power and control to the actuators. Controls the power sent to the motor and adjusts the precise rotation according to the feedback from an encoder within the actuator.
- **Communication Module:** electronic component used to transmit motion code, converting a signal format to another one.
- **Motion Source:** various applications generating motion data for the D-BOX Motion System.
- When integrating your D-BOX system, please comply with the following guidelines. If you must deviate from the guidelines, please contact us to make sure you are still using the system as prescribed.

## OPERATING CONDITIONS

The D-BOX Motion System shall be operated in controlled environmental conditions, per the following specifications:

- |                               |   |
|-------------------------------|---|
| ▪ Power Requirements          | 100 – 230VAC, 60Hz, 0.63A, Output: +48VDC, compatible with CAN – USA and EU power systems |
| ▪ Operating Temperature Range | 0 – 40°C  |
| ▪ Operating Hygrometry        | 10 – 50%  |
| ▪ Maximum Operating Altitude  | 2000 meters above sea level   |

## SOFTWARE - MOTION CORE

The D-BOX Motion System requires the installation of the Motion Core application on the host PC. The application is available for download on the D-BOX website ([www.d-box.com](http://www.d-box.com))

Please follow the Motion Core instructions for installation and use.

## SOFTWARE - MOTION SYSTEM CONFIGURATOR

**NOTE:** D-BOX upgrades the ACM firmware on a regular basis. D-BOX therefore recommends that you update your equipment to the latest firmware version, upon reception, with the Motion System Configurator<sup>1</sup>.

Each ACM comes with a default configuration based upon the Motion System architecture. Here is the list of the factory configurations. The letters describing the actuator position refers to the next table.

MOTION SYSTEM ARCHITECTURE	FACTORY CONFIGURATION	ACTUATOR POSITION (See figure below)	DESCRIPTION
1 actuator	1 YAW	Y	1 ACM-MASTER with 1 horizontal actuator ensuring the YAW movement of the simulator.
2 actuators	2 BACK	BL - BR	1 ACM-MASTER with 2 actuators at the back of the pivot point on the simulator.
3 actuators	2 BACK/1 YAW	BL – BR - Y	1 ACM-MASTER with 2 actuators at the back of the pivot point on the simulator. 1 ACM-SLAVE with 1 horizontal actuator ensuring the YAW movement of the simulator.
4 actuators	2 BACK/2 FRONT	BL – BR –FL - FR	1 ACM-MASTER with 2 actuators at the front end of the simulator. 1 ACM-SLAVE with 2 actuators at the back end of the simulator.

<sup>1</sup> see the Motion System Configurator installation and user Manual, D-BOX document number 194-914-0010-EN3

You may have a configuration requirement different from the factory configuration. If this is the case, you need to change it using the Motion System Configurator<sup>1</sup> to modify the configuration BEFORE you install your Motion System. The D-BOX Motion System Configurator application attributes a specific ACM port to each actuator position.

A good practice is to replace the sticker on your ACM to reflect the new configuration.

## Motion System Configuration and Actuator Positioning

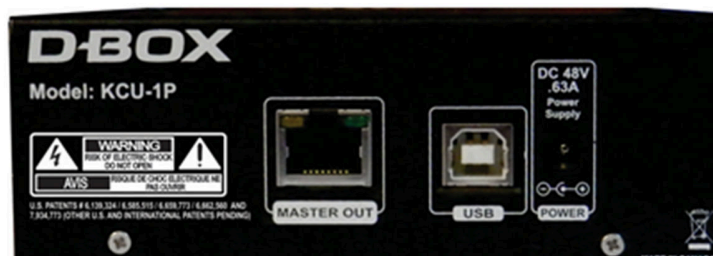
The letters represent the position of the actuators:

LEGEND	POSITION	PICTOGRAM REFERENCE
FL	Front-Left	
FC	Front-Center	
FR	Front-Right	
BL	Back-Left	
BC	Back-Center	
BR	Back-Right	
SU	Surge	
SW	Sway	
Y	Yaw	

For example: For a typical roll, pitch, heave configuration with 4 vertical actuators, actuators at positions 1 and 2 connect to the Master ACM and actuators at positions 3 and 4 connect to the Slave ACM. For additional details on the ACM configuration, please read the Motion System Configurator Guide.

## COMMUNICATION MODULE - KCU-1P

The KCU-1P is a communication module that transmits the data from the Motion Source to the first ACM in the chain.



**CAUTION:** avoid connecting the KCU-1P into the USB port of a Windows PC before the Motion Core application has been installed. Although the application installs itself as soon as the KCU-1P is connected to the computer, it requires driver files to complete the installation process.



**CAUTION: The KCU-1P works with a D-BOX G2 or G3 ACM. Never connect the KCU-1P to an ACM-I (G1).**

The KCU-1P comes with an installation bracket and a power supply. It has 2 ports and a power input jack.

PORTS / JACK	RECOMMENDED CABLE	COMMENTS
MASTER OUT	Use a shielded CAT.5e or CAT.6e cable to connect the KCU-1P to a D-BOX ACM G3 (Actuator Control Module).	<ul style="list-style-type: none"><li>• Make sure you use a shielded CAT.5e or CAT.6e cable and the RJ-45 at each end features a metal jacket.</li><li>• Connect one end of the cable to the MASTER OUT port of the KCU-1P.</li><li>• Connect the other end of the cable to the MASTER IN Port of the ACM G3.</li><li>• The total length should be 100 ft. (30.5m) or less – KCU-1P to last seat.</li></ul>
USB	Use a USB-A / USB-B cable to connect the KCU-1P to the Windows base computer.	<ul style="list-style-type: none"><li>• Connect the USB-B end of the cable to the USB port of the KCU-1P.</li><li>• Connect the USB-A end of the cable to the USB port of the computer.</li><li>• The total length of the USB cable should be 6 ft (1.8m) or less.</li></ul>
POWER	100 – 230VAC, 50 - 60Hz, 0.63A Output: +48VDC	<ul style="list-style-type: none"><li>• Always connect the power cable to a grounded receptacle.</li></ul>

## KCU-1P Power up

At power up, the front LED shows the status of the KCU-1P.

Power up sequence:

- RED: 48V power present but no USB connection.
- ORANGE: Connected to the PC USB port, drivers are installed. The unit is ready to operate.
- GREEN: Active Motion.

**NOTE:** One KCU-1P can provide the motion signal for a maximum of 20 daisy-chained ACM G3.

## ACTUATOR CONTROL MODULE

### ACM G3 families and compatibility

There exists multiple ACM in the G3 architecture. The following table outlines the ACM G3 compatibility with different actuator models.

ACM G3	TRAVEL	MODEL	MAX NUMBER OF ACTUATORS PER ACM
ACM G3 w DISCHARGE Master, Slave	1.5 in	250i	2
		400i	
		250HD	
		400HD	
	3 in	250i-3	2
		400i-3	
ACM G3 w DISCHARGE & FAN Master, Slave	6 in	500HD	2

**NOTE:** ACMs are programmed to work with a specific actuator model and at a specific place in the architecture (Master/Slave). Thus, ACMs are not interchangeable.

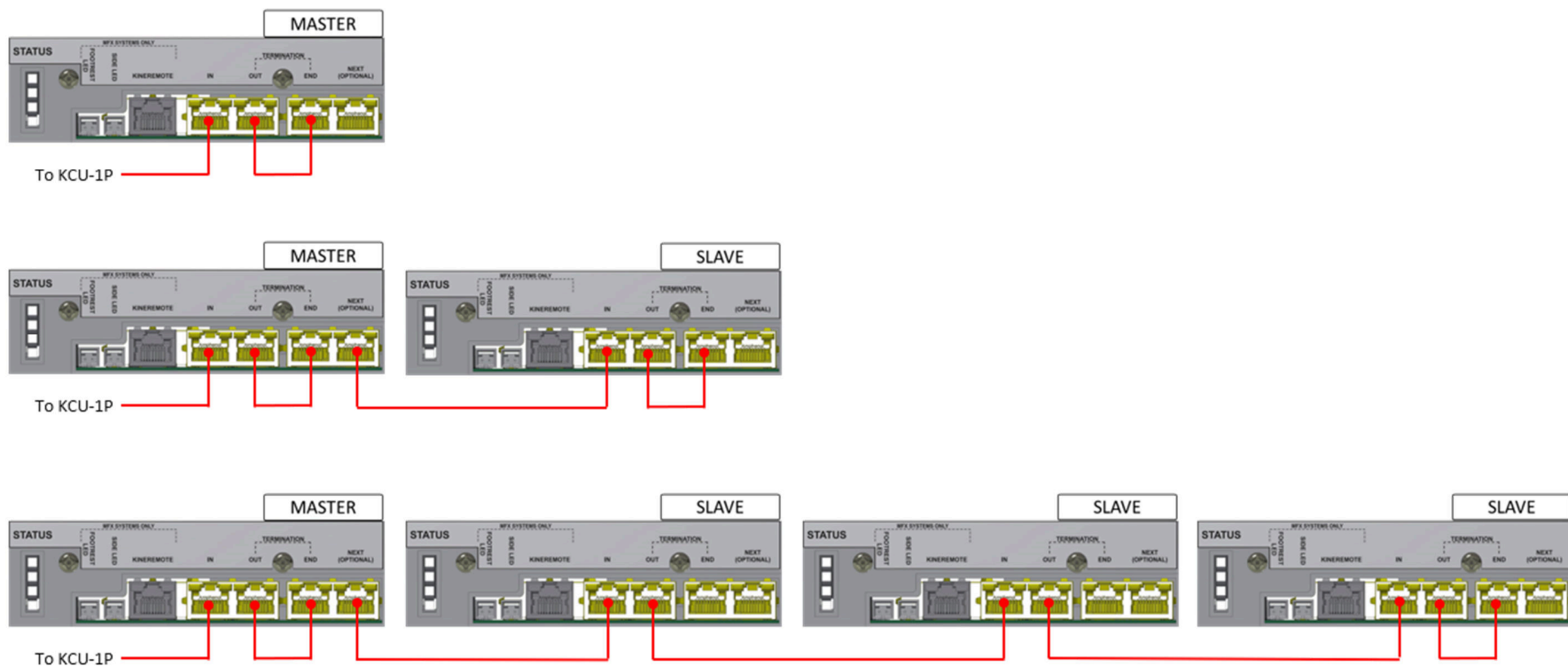
**NOTE:** In the G3 architecture, the ACMs are only compatible with a G3 actuator (motor and mechanics). Different generations of components are not compatible with each other.

## ACM Connections

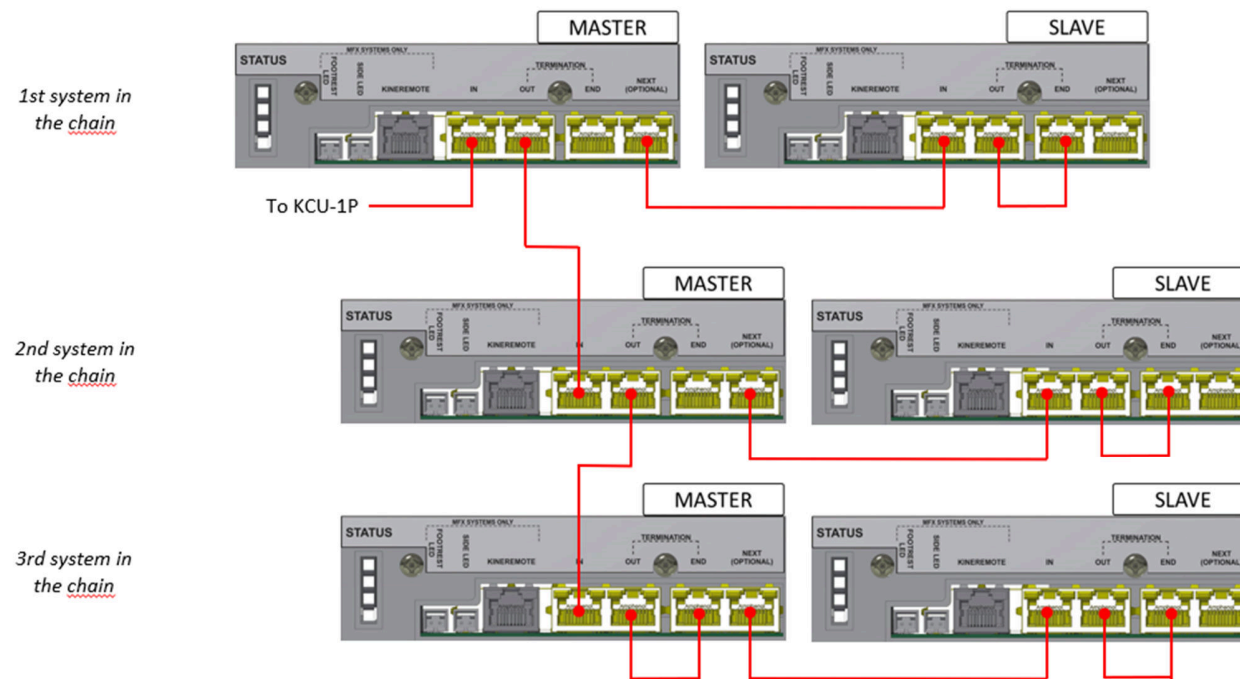
Depending on the ACM position in the system, it is programmed either as:

- MASTER: first ACM in a Motion System
- SLAVE: all following ACMs

Here are typical ACM configurations for the connection of a single Motion System:



The following example shows 3 Motion Systems using 2 ACMs each.



## ACM G3 LED Status

ACM G3 LED STATUS	
Off	ACM not powered
Green	No fault
Flashing green & flashing orange/red (MASTER)	Fault on one ACM
Red	Actuator fault. Manual re-initialization required.
Orange	Actuator fault. The unit will reinitialize by itself after a few minutes.

## ACTUATOR

### Maximum axial load

The following table shows the maximum axial load for each actuator.

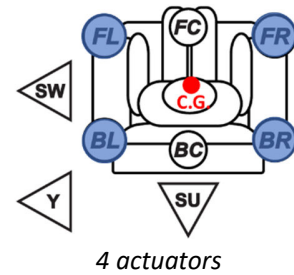
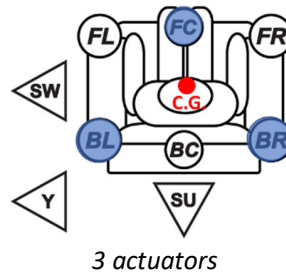
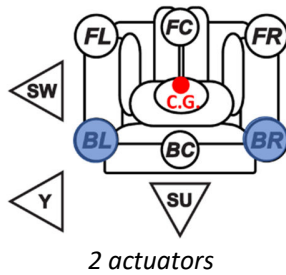
TRAVEL	ACTUATOR MODEL (mechanics name)	MAX AXIAL LOAD lb	MAX AXIAL LOAD <sup>1</sup> N <sub>D-BOX</sub> – System Monitor
1.5 in	250HD (AC10)	250	1900
	400HD (AC10)	400	2400
	250i (AC218)	250	1900
	400i (AC218)	400	2400
3.0 in	250i-3 (AC231)	250	1900
	400i-3 (AC231)	400	2400
6.0 in	500HD-6 (AC360)	500	2800

<sup>1</sup>You can find the reference to the maximal axial load in System Monitor - part of Motion Core. The Newton units are a reference to the load perceived by each motor but can't be converted into actual Newtons. Therefore D-BOX uses the eponym index.

- Make sure that the weight on the platform is no higher than the maximum supported weight.
- Make sure that the weight is evenly distributed among the actuators of the platform (as centered as possible).

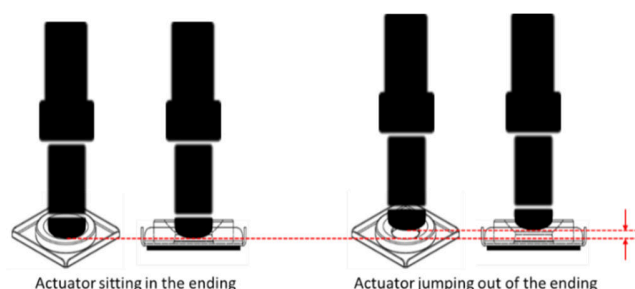
## Weight Distribution

Each actuator has an individual maximal payload as previously mentioned. When integrating the Motion System on a platform, D-BOX recommends balancing the **center of gravity** (CG) of the platform to ensure **each actuator supports an equal load**. The following figures show equal distribution of weight with 2, 3 or 4 actuators.



## Actuator Acceleration

The D-BOX Motion System can produce a 1G acceleration or greater. However, to avoid risks of injury for the user or damage to the equipment, D-BOX recommends calibrating the Motion System to produce a maximum of **1G**, using the control panel - see information on Motion Core. An acceleration above 1G can make the platform jump. Jumping can be observed when the actuator takes off from the ground. The following figures show a piston jumping in its cup.

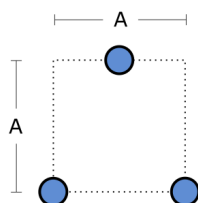


The shock of a piston falling back down in its cup reverberates on the top bearing of the piston, which takes the hit to protect the motor. As it progressively wears, the bearing also becomes noisier, reducing the service life of the ball nuts and screw. Avoid actuator jumping in the cup.

This behavior is typical when running the platform with no or light weight. There are no guidelines as to minimum weight; this is highly dependent on the actuators position, the motion code, the simulator weight, simulator structure and weight distribution.

## Distance between actuators

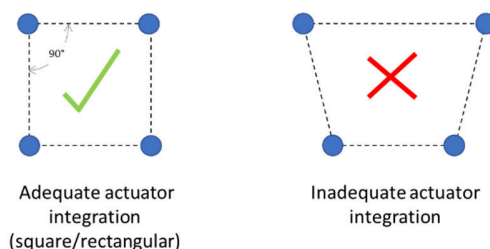
Respect the minimum distance between actuators for adequate movement of the platform. Measure the distance from a **square surface enclosing all actuators** - see example below. Respecting the spacing guidelines ensures proper interaction of the Motion System with the actuator endings, and proper lateral force transfer.



TRAVEL	MINIMUM SPACING BETWEEN ACTUATORS (A)
1.5 in	14 in [356 mm]
3.0 in	24 in [610 mm]
6.0 in	36 in [914 mm]

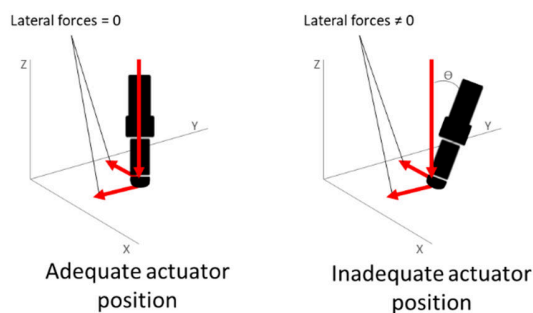
## Actuator alignment

When using 4 actuators, install them per a square or rectangular pattern. Avoid other patterns - e.g. trapezoid.



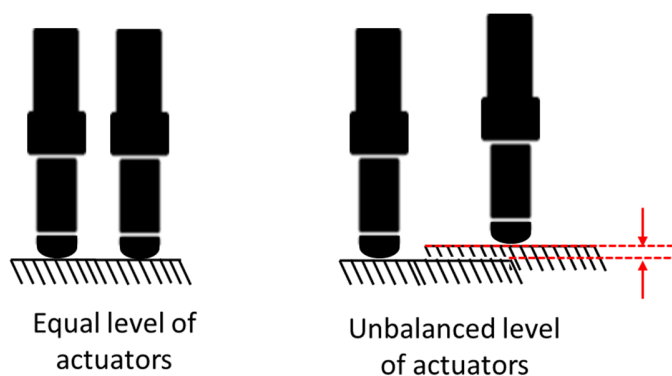
## Actuator straightness

During installation, the actuators should always remain straight to limit radial loading. Radial loading could result in premature wear of the actuators.



## Level surface

All actuators must be level on the same flat surface for optimal operations. Different levels could result in premature wear of the actuators.





## MOTION SYSTEM ACCESSORIES

Use only D-BOX certified accessories. Using accessories that are not D-BOX certified voids the warranty and can result in damages to the Motion System.

### Power converter

Past generation of D-BOX products were 120V native and to be used with a custom step-down transformer made specifically to respect certification requirements for 230V configurations. The G3 systems can be ordered in 120V or 230V version without an external step-down transformer.

**CAUTION: 120V and 230V ACM are NOT THE SAME PRODUCT. They need different internal components and need to be ordered from the factory for the right configuration.**

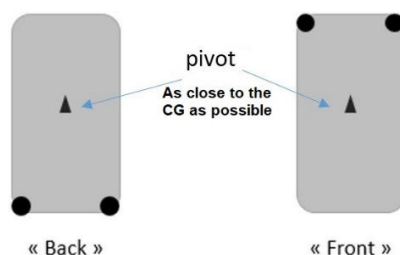
As D-BOX is not providing an external step-down transformer, you will need to assure power conversion by your own means if needed. To select your converter, please follow the power requirement listed in the spec sheets for your specific configuration.

Other than power requirement, D-BOX would like to suggest the use of an isolated converter to avoid risks of electrical shock. If a non-isolated converter is selected, please make sure to secure ground connection.

### Pivot

When using a 2-actuator Motion System, D-BOX provides a pivot as a third attachment point to ensure proper actuator movement. D-BOX suggests locating the pivot near the center of gravity, to support most weight and allow equal weight distribution on the actuators.

**NOTE:** the closer the actuators are to the CG, the larger the movement you get. A CG that's very close would create strong forces on actuators and might reduce stability. Make sure that actuators are always under charge.

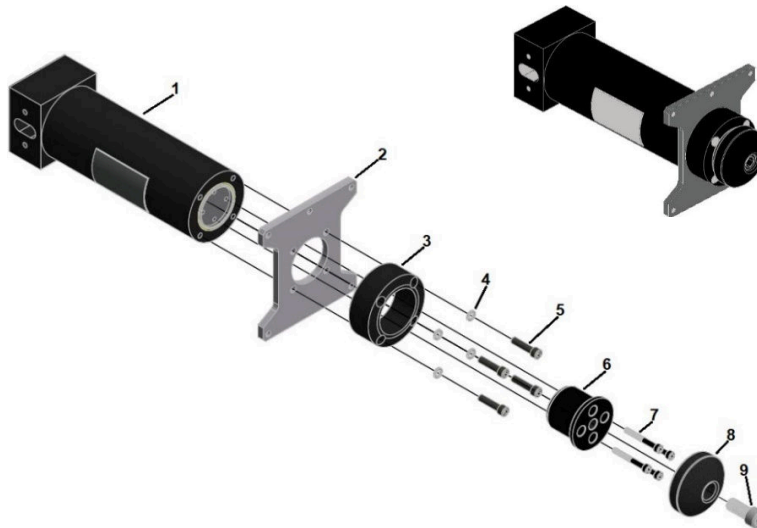


### Captive Endings

Go to the Removal/Installation section for details about the captive endings.

## REMOVAL/INSTALLATION PROCEDURES

### H-Bracket for 1.5 in HD Actuator - AC10



#### Removal

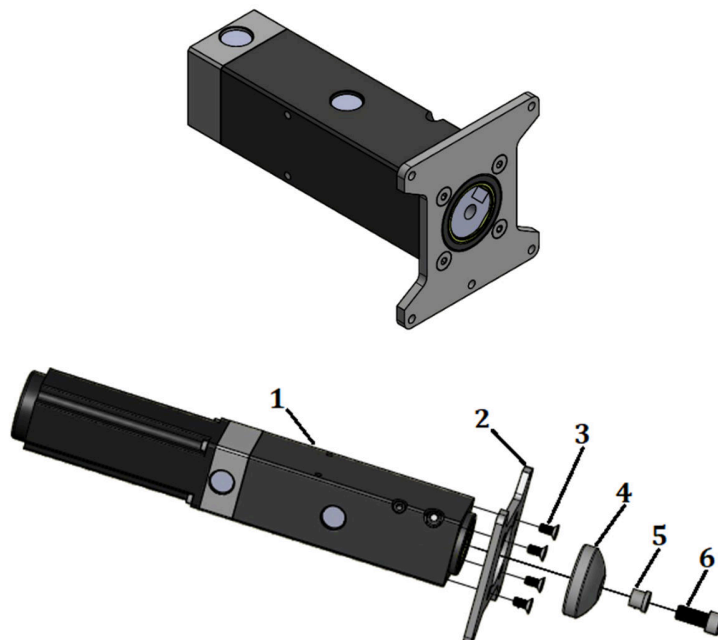
1. Remove bolt (9) and pivot (8).
2. Remove bolt (7) and end piston adapter (6).
3. Remove bolt (5), lockwasher (4), stop (3), and H-plate (2) from housing (1).

#### Installation

**NOTE:** Apply one drop of Loctite 243 blue threadlocker on bolts (5), (7) and (9) before installation.

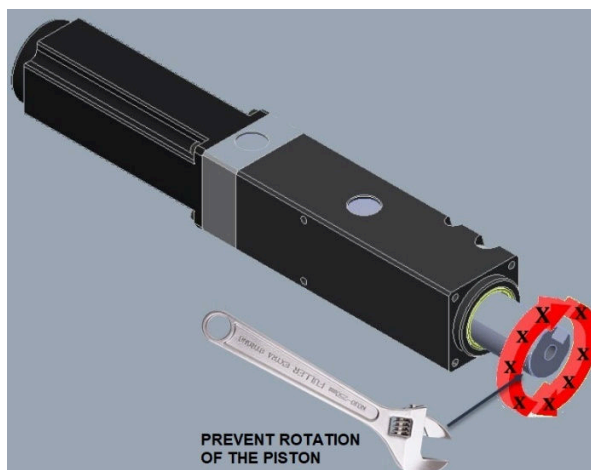
1. Align holes on H-plate (2) with holes on housing (1) and align holes on stop (3) with holes on H-plate (2), and then secure with lockwasher (4) and bolt (5). Torque bolt (5) to 98 lbf.in.
2. Align holes on end piston adapter with holes on piston end and secure end piston adapter (6) with bolt (7). Torque bolt (7) to 40 lbf.in.
3. Secure pivot (8) on end piston (6) with bolt (9). Torque bolt (9) to 130 lbf.in.

## H-Bracket for 3in Actuator - AC231



### Removal

**CAUTION:** extend the piston and lock with a wrench to avoid breaking the cam follower.



1. Remove bolt (6) with a 3/8" hex bit, spacer (5) and pivot (4).
2. Remove bolt (3) and H-bracket (2).

### Installation

1. Place the H-bracket (3) on the end of the piston body (1) with the screw holes aligned.

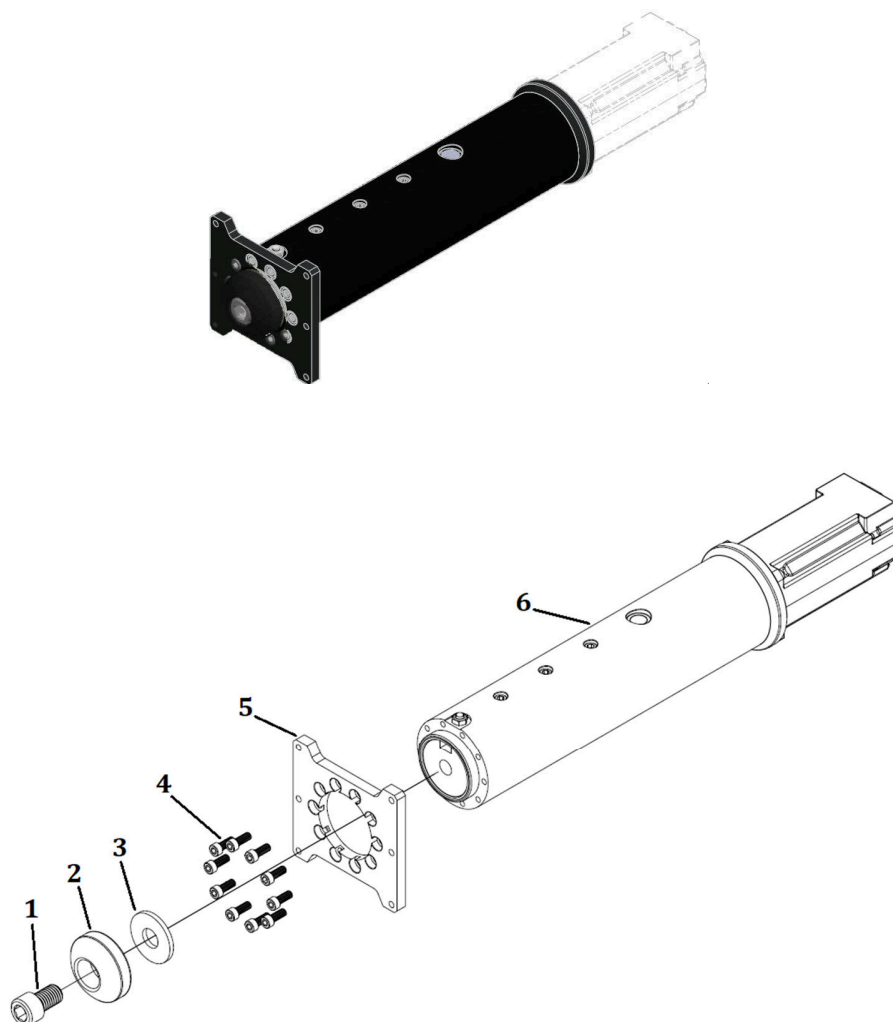
2. Apply Loctite 243 (blue) thread locker in the four blind holes (2) on the piston body.

**NOTE:** Apply the thread locker just before the bottom of the blind holes.

3. Use a 5 mm bit to secure the H-bracket plate to the piston body with 4 screws (item 4, M6 X 1.0 X 14 mm), then tighten the 4 screws to a torque of 133 N m (98 lbf in).
4. Install pivot (4) with spacer (5) and bolt (6).

### H-Bracket for 6in actuator - AC360

**NOTE:** there are 2 models of H-brackets; one with seven mounting holes, one with 10 mounting holes. The procedures are the same for both models. Only the ten holes model is shown here.



## Removal

Remove the H-bracket per the following instructions.

1. Remove bolt (1) - 3/8" hex bit - pivot (2), and flat washer (3).
2. Remove bolt (4) and H-bracket (5).

## Installation

Install the H-bracket per the following instructions.

1. Place the H-bracket (5) on the end of the piston body (6) with the screw holes aligned.
2. Apply Loctite 243 (blue) thread locker in the ten blind holes on the piston body (6).

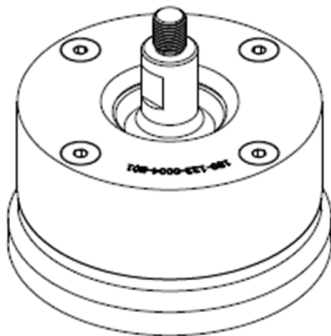
**NOTE:** Apply the thread locker just before the bottom of the blind holes.

3. Use a 5 mm bit to secure the H-bracket to the piston body with screws (item 4, M6 X 1.0 X 14 mm), then tighten the screws to a torque of 133 N m (98 lbf in).
4. Install pivot (2) with washer (3) and bolt (1).

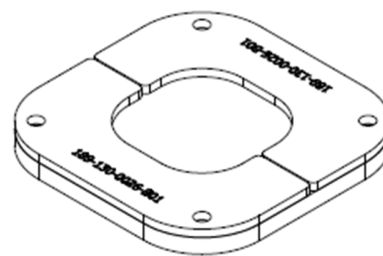
## Captive ending

Some platforms may require the use of an actuator ending that binds the actuator to the floor or a frame. The D-BOX captive ending (ball joint) allows proper actuator movements.

The D-BOX captive ending is a 2 components assembly:



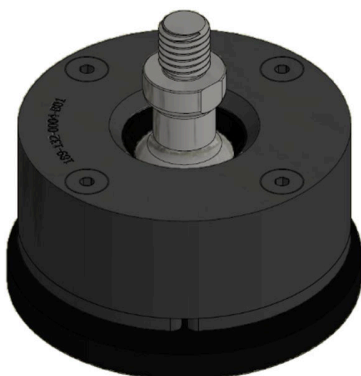
**Ball joint**



**Spacer Retainer**

### Ball joint

There are 2 models of ball joints.






**OEM:** use with 6in - AC360 - actuators.



**OEM LITE:** use with 1.5in - AC211, AC10 - and 3in - AC231 actuators.

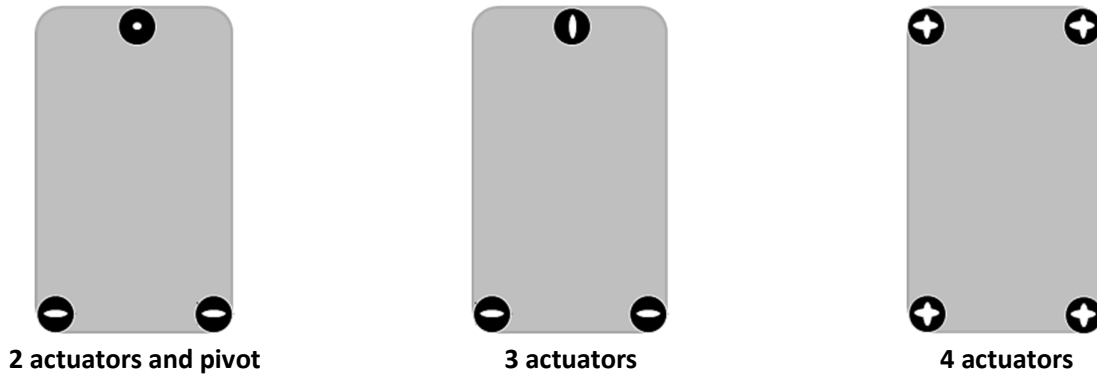
### Spacer retainer

The spacer-retainer allows specific movements of the ball joint on both x and y axes, thus eliminating any constraints during the movement of the platform. There are 3 models of spacer retainer. All spacer retainers can be fitted on any model of ball joint.

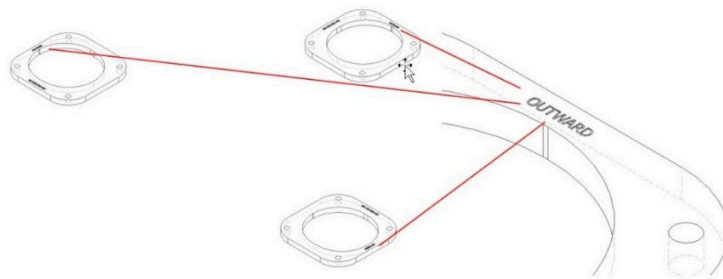
-  0 axis allowing no movement in x and y axis.
-  1 axis allowing movement only on 1 axis (x or y).
-  2axes allowing movement on 2 axes (x and y).

**CAUTION:** Respect the orientation to avoid any damage to the components of the platform.

Here are some spacer retainer configurations.



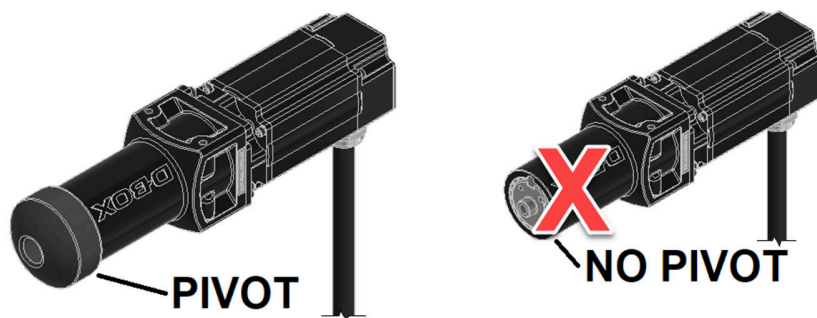
To help with positioning, the spacer retainer is marked **OUTWARD** on its top surface.



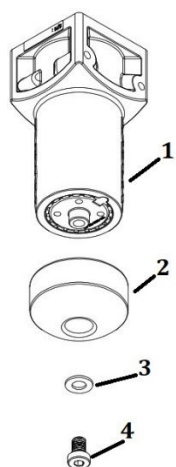
## 1.5-inch actuator - AC218

Here are installation instructions for the D-BOX ball joints. Make sure all the parts are clean before installation.

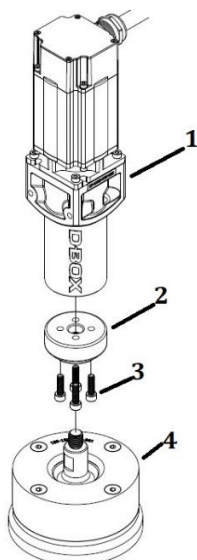
**CAUTION:** Never operate the AC218 actuator without the pivot installed. Operating the AC218 actuator without the pivot leads to irreparable damages to the actuator.



## Removal



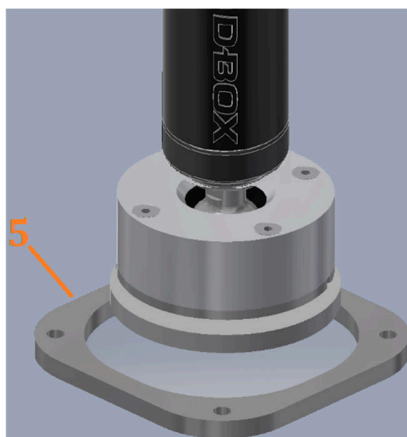
Unscrew bolt (4) with the  $\frac{1}{2}$  hex key and remove washer (3) and pivot (2) from the actuator (1).



Apply threadlocker Loctite 263 to the threaded section of bolts (3) and ball joint (4).

Install pivot (2) on actuator (1) with bolts (3). Torque bolts to 50 lbf in.

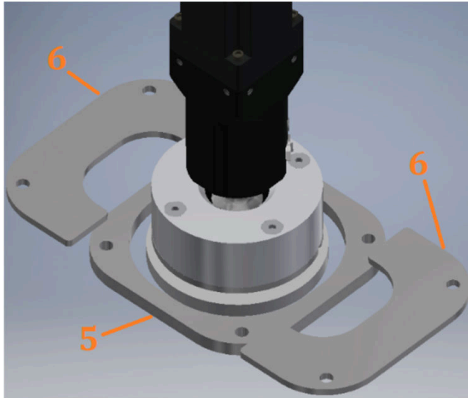
Screw the threaded section of ball joint (4) in the actuator (3). Use a torque wrench with a  $\frac{5}{8}$  crow foot socket to tighten the ball joint (4) in the actuator. Torque to 170 lbf in.



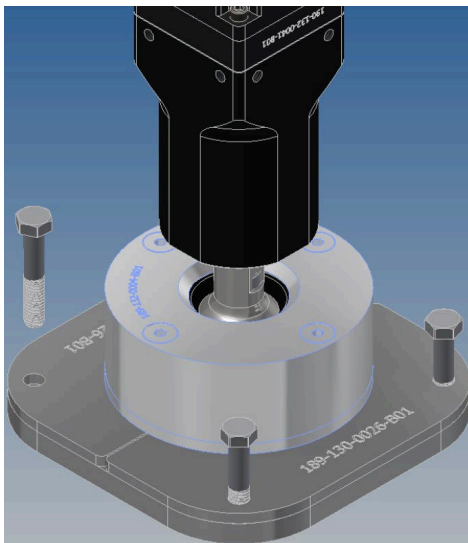
Place spacer (5) at its required location.

Make sure the holes in the spacer are aligned with the holes in the floor and place the actuator and ball joint assembly in spacer (5).





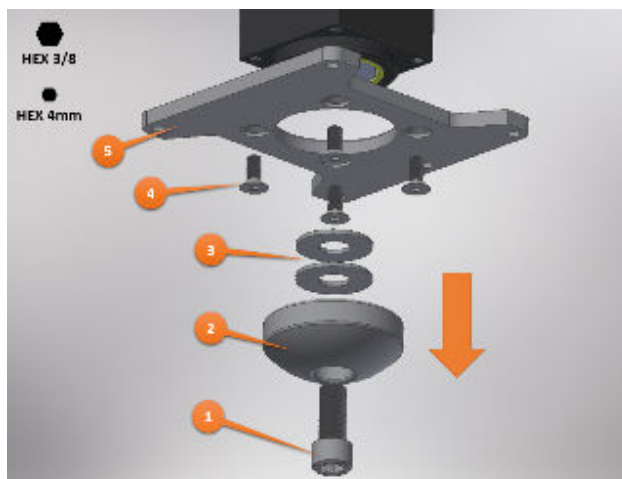
Slide retainers (6) on spacer (5) and in the slot on the ball joint.



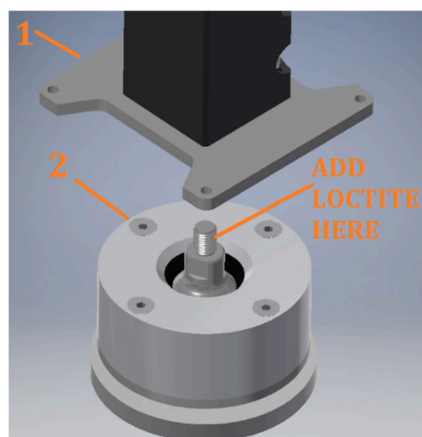
Align the holes in the retainers with the holes in the spacer. Use 5/16 bolts to tighten the spacer and retainers to the floor.

**NOTE:** the way the ball joint is anchored to the floor is the same for all actuators – 1.5", 3", and 6".

## 3-inch actuator - AC231

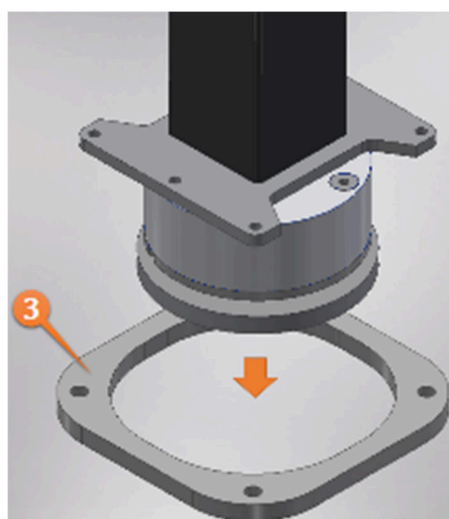


Unscrew bolt (1) with the 3/8 hex key and remove pivot (2) and spacers (3) from the actuator. Unscrew bolt (4) with the 4mm hex key and (optional) remove H-bracket (5) from the actuator.



Add Loctite 263 to the threaded section.

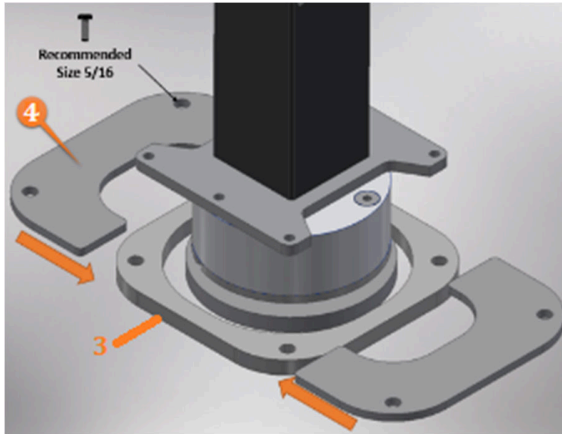
Screw the threaded section in the actuator (1). Use a torque wrench with a 5/8 crow foot socket to tighten the ball joint assembly (2) in the actuator. Torque to 170 lbf in.



Place spacer (3) at its required location.

Make sure the holes in the spacer are aligned with the holes in the floor and place the actuator and ball joint assembly in spacer (3).

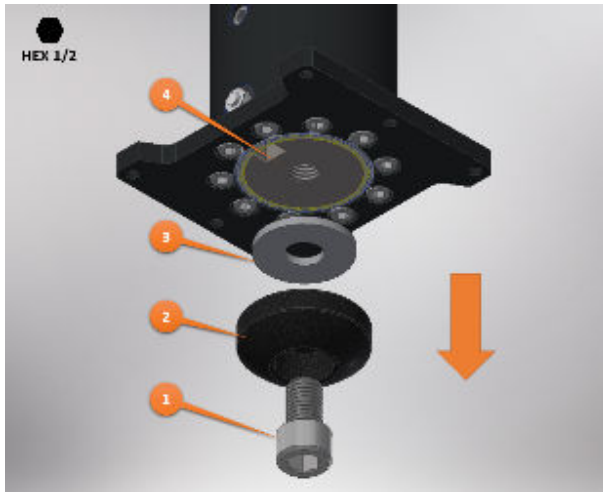
### 3-inch actuator - AC231



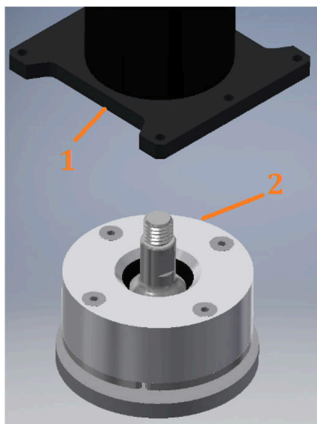
Slide retainers (4) on spacer (3) and in the slot on the ball joint.

Align the holes in the retainers with the holes in the spacer. Use 5/16 bolts to tighten the spacer and retainers to the floor.

## 6-inch actuator - AC360

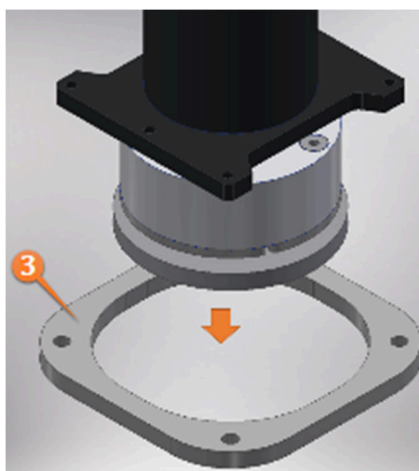


Unscrew bolt (1) with the  $\frac{1}{2}$  hex key and remove pivot (2) and spacer (3) from actuator (4).



Add Loctite 263 to the threaded section.

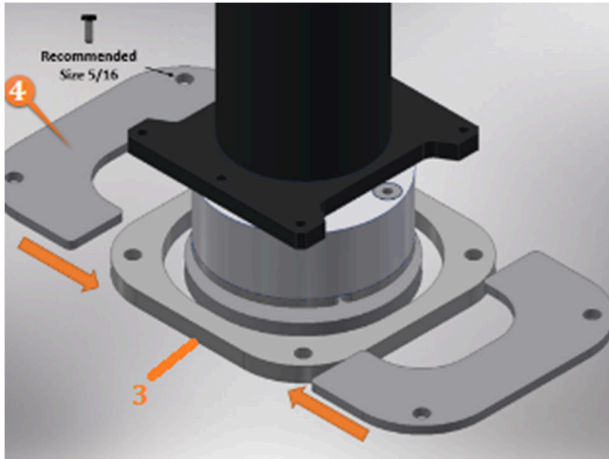
Screw the threaded section in the actuator (1). Use a torque wrench with a  $\frac{5}{8}$  crow foot socket to tighten the ball joint assembly (2) in the actuator. Torque to 170 lbf in.



Place spacer (3) at its required location.

Make sure the holes in the spacer are aligned with the holes in the floor and place the actuator and ball joint assembly in spacer (3).

### 6-inch actuator - AC360

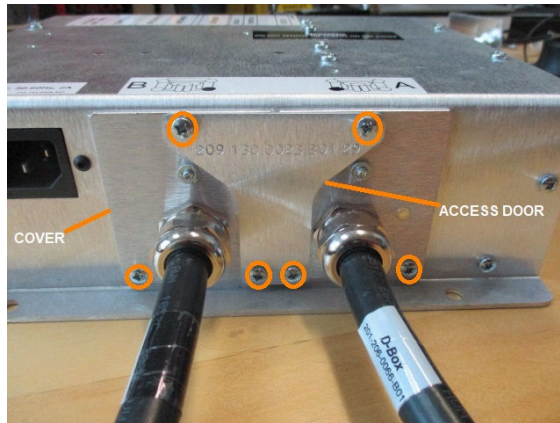


Slide retainers (4) on spacer (3) and in the slot on the ball joint.

Align the holes in the retainers with the holes in the spacer. Use 5/16 bolts to tighten the spacer and retainers to the floor.

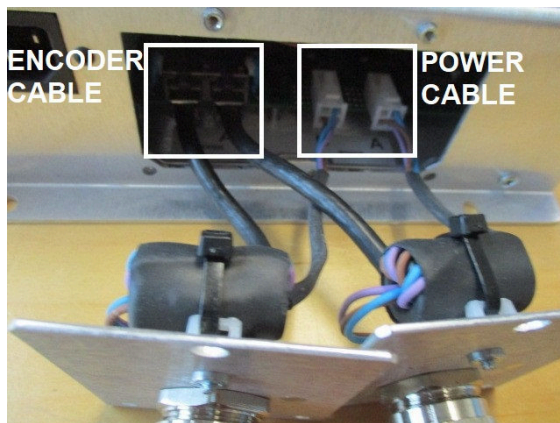
## AC218 ACTUATOR REPLACEMENT

### Removal



Remove the screws holding the center ACM cover.

Then remove the remaining screws from the actuator cover and gently pull the actuator cover from the ACM.

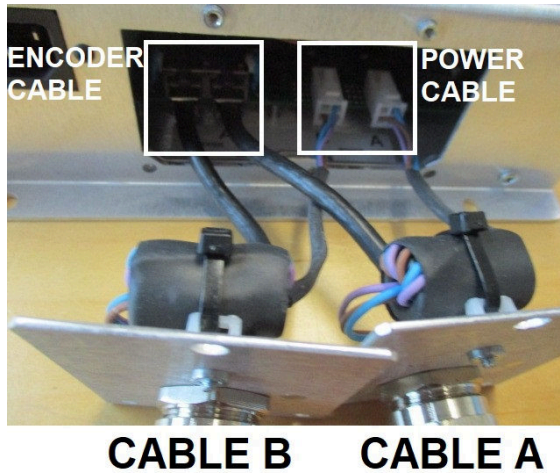


Each actuator is identified by a letter. Each actuator has two cables: a power cable and an encoder cable.

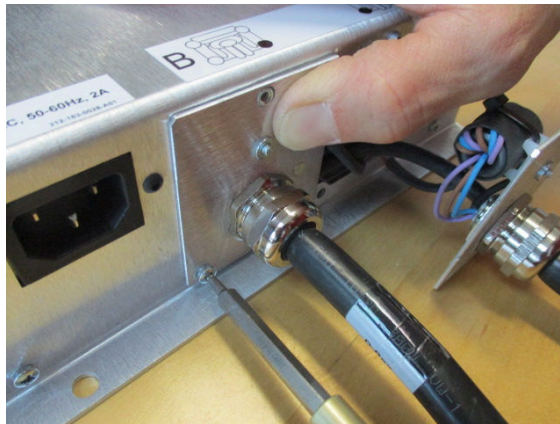
Identify both cables related to the actuator you wish to remove. Unplug both cables.

**CABLE B      CABLE A**

## Installation



Plug both power and encoder cables in the ACM.



Install the actuator cover with screw.



Install the center ACM cover with screw.