G2 MOTION SYSTEM INSTALLATION GUIDE

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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 Haptic System. We strongly advise that you read the guidelines before assembling and using your Haptic System.

Do not hesitate to contact us if you have questions.

D-BOX Support

2172 rue de la Province, Longueuil, Quebec, Canada

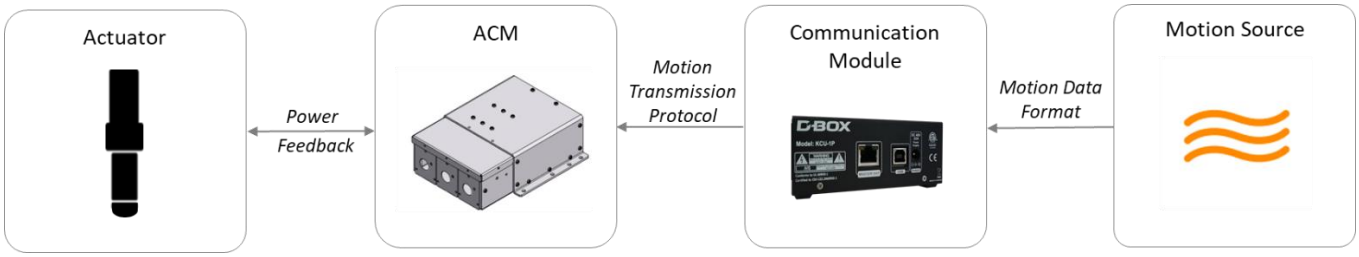
BY EMAIL : support@d-box.com

BY PHONE 1-800-442-3269; 931 (toll free CAN/US)
1-450-442-3003; 931 (other regions)

INTRODUCTION

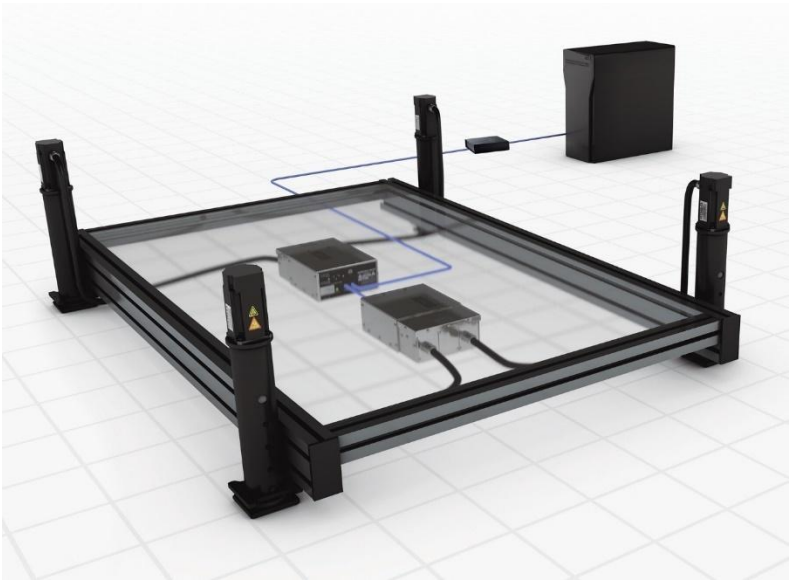
D-BOX Motion Systems are evolutive and scalable. Integrated into a seat, platform or simulator, they are designed to simulate a range of textures and scalable axes of movement. Whatever you require, D-BOX can help you select the best arrangement of actuators.

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 or sound, converting a signal format to another one.
- **Motion Source**: Various software developed by D-BOX to generate 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.



Typical D-BOX Platform

Mechanical Integration Phase

Here is a checklist to complete your mechanical integration phase:

1. **Consult all relevant documentation:** Installation guides contain important information on how to integrate and use our products. Make sure to respect all specifications and guidelines. This will help keep your product healthy and optimize its service lifetime. Most of our guides are available through our website but please do not hesitate to contact our team if you cannot find the information you are looking for.
2. **Share your design with us for review and recommendations:** Once your CAD integration is completed, our team will validate that the design respects our guidelines. All D-BOX products 3D files are available in *.stp* format upon request.
3. **Complete a finite element analysis (FEA):** Once the design is final, the FEA highlights potential design flaws and ensures the service lifetime is per your requirements.
4. **Complete life cycle tests with proper load and waves;** (motion code) so the tests are representative of typical usage.

NOTE: Weight detection is a special feature offered on a limited range of products. If weight detection is required for the system's activation, it is mandatory that our team perform a physical validation.

Software Integration Phase

Here is a checklist to complete your software integration phase:

1. **Install the *Motion Core* software**: Available for download on the D-BOX website. This software package includes the following components:
   - ***Control Panel***: An application allowing the configuration of several parameters such as global intensity level, latency, and output device priority.
   - ***Monitoring Service***: A service running in the background and constantly retrieving the status of all connected Motion Systems.
   - ***System Monitor***: An application leveraging the Monitoring Service API to display live health and operational data on all connected Motion Systems.
   - ***Motion Service*:** A core library required to generate the motion signal and address the Motion Controller (KAI, KCU). This library is automatically loaded by higher level software, enabling motion integration, such as Live Motion SDK and Motion Engine (covered below).
   - ***KAI and KCU Drivers*:** The lowest-level components of *Motion Core* that allow the proper detection and operation of the Motion Controller (KAI, KCU). The drivers are compatible with Microsoft Windows™.

2. **Integrate the monitoring and diagnostics API** (TCP XML API); this application provides live health and operational data for the Motion Systems. Default TCP communication port is 40001, but this value can be modified with the configuration file. Internal polling interval is 100ms so your application should poll at an equal or slower rate.

The following section applies only if you are playing with linear content (linear content playback).

3. **Install and configure the *Motion Engine* software:** This software runs in the background and analyzes the audio signal on the default capture device, allowing identification of motion-enabled linear content. It requires a specific audio path configuration so that both the default capture device and the VR HMD (if this is the case) receive the audio signal. Take good note of the following remarks:
   - Our experience indicates a high success rate with Realtek audio codecs and Oculus or HTC HMDs. However, due to the infinite number of computer layouts, we cannot guarantee the proper functioning of the audio path configuration.
   - Each computer running *Motion Engine* requires a license to receive and play Motion Codes. The authorization is given by executing a tool on the target computer and sending us the generated *.dlr* file, which D-BOX will ingest into its system.
   - Licenses are hardware-bound. Therefore, changing certain configurations such as network adapters will invalidate the license, which will need to be generated again.

4. **Set up your Jukebox account:** Jukebox is D-BOX Motion Code distribution and authorization service. You can reach this service here. Internally, our team will configure your account with the proper Motion Code to fulfill your needs.

For stations that support both linear and interactive experiences, note that *Motion Engine* must be turned off prior to launching an application with *Live Motion SDK* integrated. Both software modules acquire exclusively the connected D-BOX USB devices (KAI, KCU) and thus, both cannot simultaneously stream motion.

Motion Code Integration Phase

D-BOX Motion Code is readily compatible with many contents (2D, 3D, linear, interactive). Contact us for more information.

The following section applies only if you need to code a linear content.

1. **Send us your preliminary assets for evaluation.** Our team will evaluate the time required for the creation of the Motion Code. We will also provide recommendations to improve the global experience if possible.
2. **Send us final assets with your directives**. Our team will go through the creation process and send you the necessary files in the correct format.
3. **Test the experience and send us your comments.** If you feel like the experience needs to be improved.

NOTE: Our team of motion designers have experience creating Motion Code for all sorts of contents. They will be helpful in the creation of an amazing experience. There are no autonomous methods of creating a Motion Code.

If you want to create a Motion Code for interactive content, refer to the following instructions:

1. **Integrate the D-BOX Live Motion SDK in your software:** Live Motion SDK allows you to submit live events that are processed by the matching Motion Code and turned into a corresponding immersive motion signal. Our SDK is well documented and available upon request.
2. **Send us logs and videos:** For us to start the motion code creation process. Our team would rather work with the real assets, but we understand this might be complex to achieve. The description of the required logs and video will be shared with you before the beginning of the process.
3. **Test the experience and send us your comments:** For iteration if you feel like the experience needs to be improved. Our team will also send you recommendations to improve the overall experience and will support the iteration until both parties are satisfied with the results.

NOTE: D-BOX motion integrators have experience creating Motion Code for various contents. Working with us will allow for an optimal experience. However, we offer different integration methods if you have a need for more autonomy. Contact our sales team for details.

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 SUITE

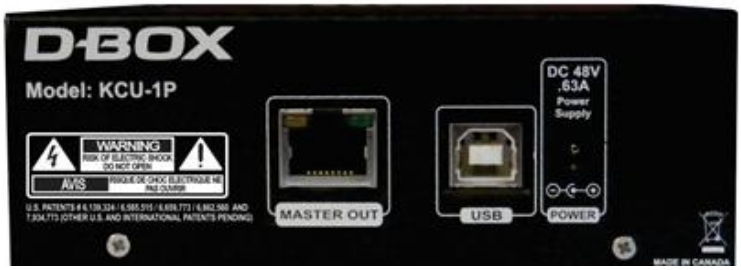
Motion Core

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.

Please follow the Motion Core instructions for installation and use.

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 some 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/MAIN OUT	Use a shielded CAT5E or CAT6E cable to connect the KCU-1P to a D-BOX ACM-II (Actuator Control Module).	• Make sure you use a shielded CAT5E or CAT6E cable and the RJ-45 at each end features a metal jacket. • Connect one end of the cable to the MASTER/ MAIN OUT port of the KCU-1P. • Connect the other end of the cable to the MASTER/MAIN IN Port of the ACM-II. • The total length should be 100 ft. (30.5m) or less – KCU-1P to last seat.

USB	Use a USB-A / USB-B cable to connect the KCU-1P to the Windows base computer.	• Connect the USB-B end of the cable to the USB port of the KCU-1P. • Connect the USB-A end of the cable to the USB port of the computer. • The total length of the USB cable should be 6 ft (1.8 m) or less.
POWER	100 – 230VAC, 50 - 60Hz, 0.63A Output: +48VDC	• Always connect the power cable to a grounded receptacle.

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-II.

ACTUATOR CONTROL MODULE

ACM-II families and compatibility

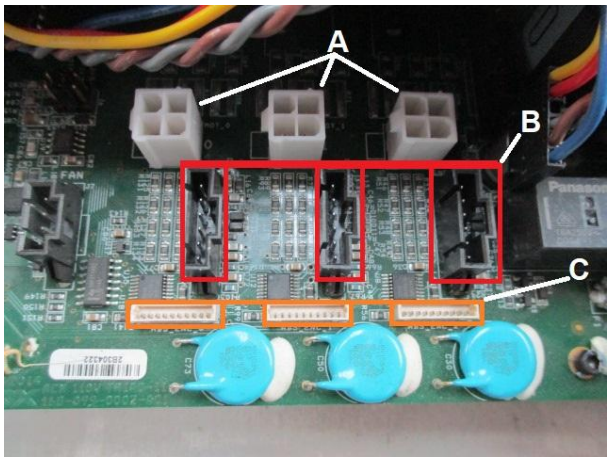
There exists multiple ACM in the G2 architecture. The following table outlines the ACM-II compatibility with different actuator models.

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

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

NOTE: In the G2 architecture, the ACMs are compatible with an **absolute encoder (ABS)**. To ensure transition with G1 architecture, D-BOX also provides ACMs compatible with a **NON-ABS encoder**. Those versions are different and **not compatible** with each other. A sticker on the ACM identifies its type.

The ACM-II has an access panel. Opening the access panel gives access to the motor wires. Each circuit board has three connector positions, and each position drives a specific actuator. Connector **B** is used with **NON-ABS** encoders. Connector **C** is used with **ABS** encoders. Motor connector **A** should always be connected.

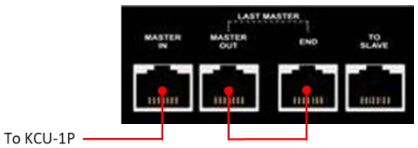
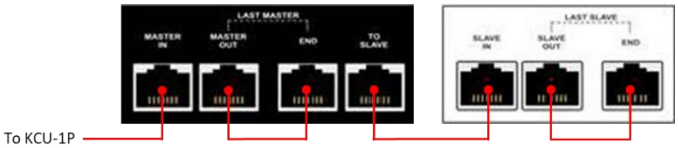
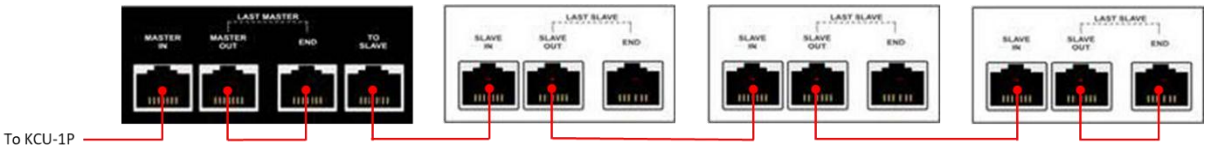


ACM Connections

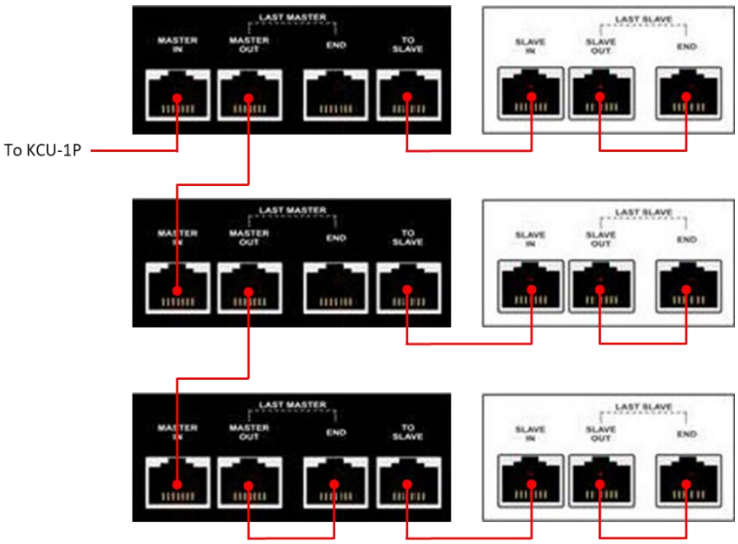
Depending on the ACM position in the system, it is programmed as either:

- "MASTER/MAIN": First ACM in a Motion System; or
- "SLAVE/SECONDARY": All following ACMs

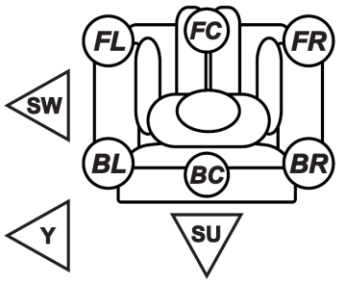
Here are typical ACM configurations for the connection of a single Motion System:

Number of ACM	**ACM Connection Diagram**
1 ACM	
2 ACM	
4 ACM	

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



Motion system configuration and actuator positioning



The letters represent the position of the actuators:

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

The ACM ports attributed to the positions are assigned by the D-BOX System Configurator, formerly known as Configuration Manager application.

Example of a configuration: 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 4 and 5 connect to the Slave ACM. For additional details on the ACM configuration, please read the instruction on the System Configurator.

ACM-II LED Status

ACM-II LED STATUS	
Off	ACM not powered
Green	No fault
Flashing green & flashing orange/red (MASTER/MAIN)	Fault on one ACM-II
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	MAX AXIAL LOAD
1.5 in	AC10, **250HD**	250 lbs
	AC10, **400i**	400 lbs
	AC211, **250i**	250 lbs
	AC211, **400i**	400 lbs
3.0 in	AC231, **250i**	250 lbs
	AC231, **400i**	400 lbs
6.0 in	AC360, **500HD**	500 lbs

Weight Limits

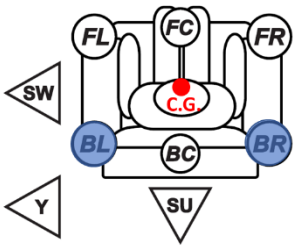
Motor Type	Weight Limit - N $_{D\text{-}BOX}$
JE – 250 lbs	1900
24D – 400 lbs	2400
32D – 500 lbs	2800

- Make sure that the weight on the platform is no higher than the maximum supported weight.

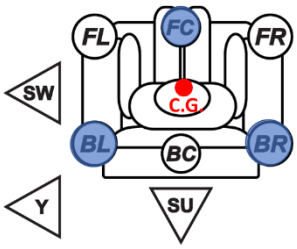
- Make sure that the weight is evenly distributed among the actuators of the platform (as centered as possible).

Weight Distribution

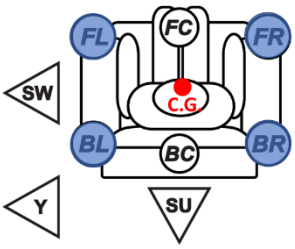
Each actuator has an individual maximal payload as previously mentioned. When integrating the Motion System on a platform, D-BOX recommends balancing the **center of gravity** (CG) of the platform to ensure **each actuator supports an equal load**. The following figures show equal distribution of weight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



2 actuators



3 actuators

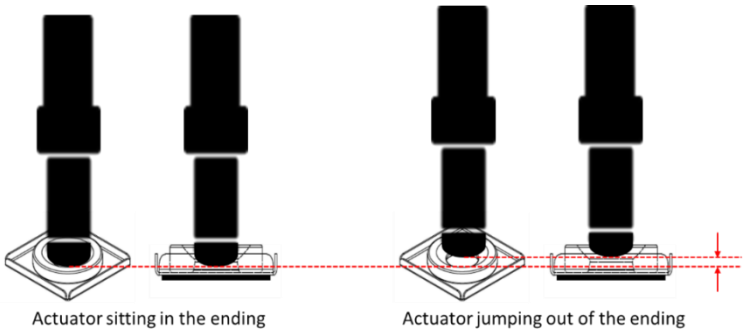


4 actuators

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.



Actuator sitting in the ending

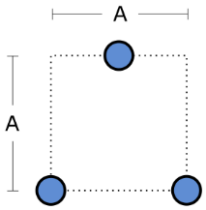
Actuator jumping out of the ending

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 actuator's position, the motion code, the simulator weight, simulator structure and weight distribution.

Distance between actuators

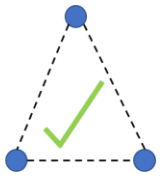
Respect the minimum distance between actuators for adequate movement of the platform. Measure the distance from a **square surface enclosing all actuators** (see example below). Respecting the spacing guidelines ensures proper interaction of the Motion System with the actuator endings, and proper lateral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



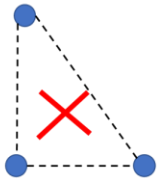
TRAVEL	MINIMUM SPACING BETWEEN ACTUATORS
1.5 in	14 in [356 mm]
3.0 in	24 in [610 mm]
6.0 in	36 in [914 mm]

Actuator alignment

When using 3 actuators, install them in the shape of an isosceles triangle. Avoid other patterns (e.g. scalene triangle).

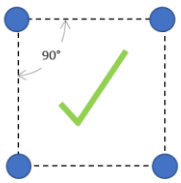


Adequate actuator integration

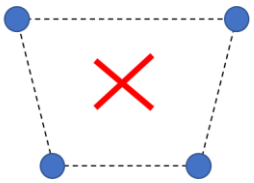


Inadequate actuator integration

When using a four (4) actuators system, install the actuators in a square or rectangular pattern. Avoid other patterns (e.g. trapezoid).



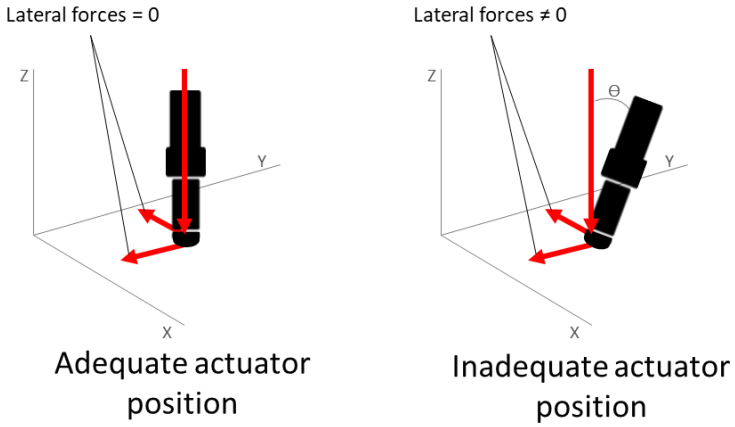
Adequate actuator integration (square/rectangular)



Inadequate actuator integration

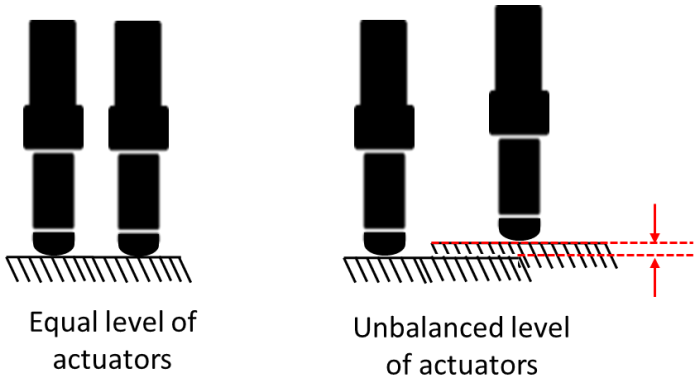
Actuator alignment

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.



Usage of 6-in actuators for lateral motion

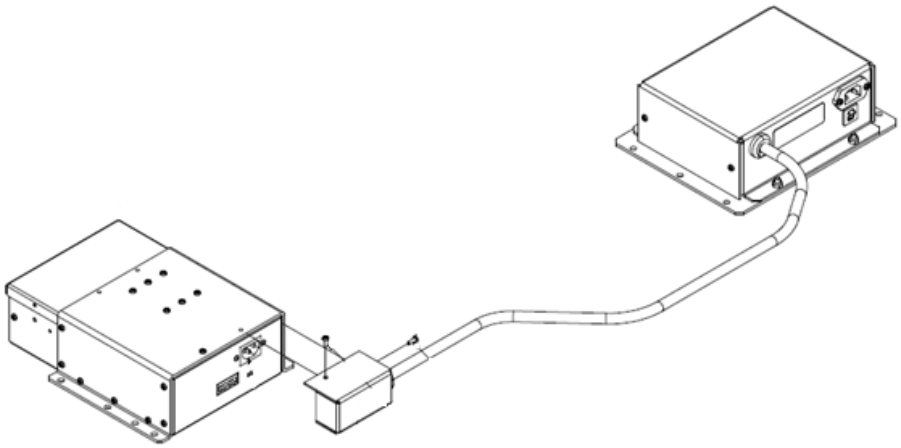
The 6-inch actuator has a play of approximately 1 mm, inherent to its design. This play can be felt when used in lateral motion (yaw, surge and sway) and impact the realism of the simulation. It is important to note that the play does not interfere with usage of such a system in general simulation; however, it has been reported as problematic by sim-racing professionals.

Motion System's Accessories

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

Power converter

All D-BOX Motion Systems are native 120V. Where AC power supply is 220V, D-BOX recommends using a D-BOX power converter to step-down power from 220V to 120V.

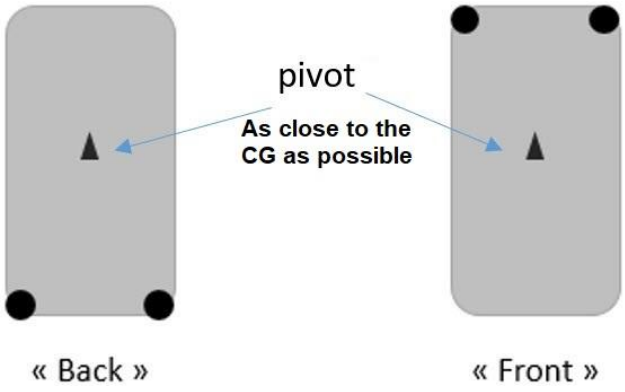


ACM 230S

Pivot - Best Practices

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

Captive endings are covered in the Installation/Removal section.

Quick Connect Connectors

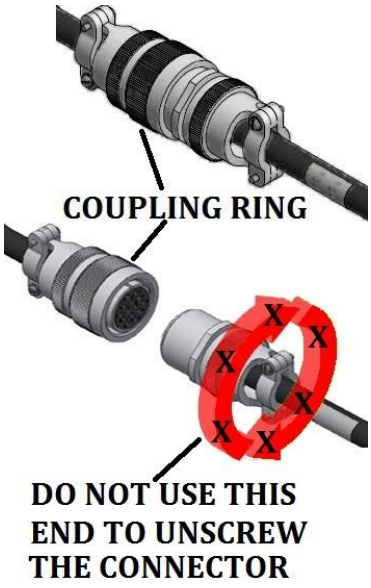
D-BOX offers "Quick-Connect" connectors as an option for ease of removal, installation and maintenance. The Quick Connect connector is part of the actuator power cable.

Quick Connect Connectors Best Practices

- Remove power before coupling/uncoupling.
- Avoid contact with foreign substances and moisture.

Installation / Removal

- Apply countertorque when screwing/unscrewing the quick connector.



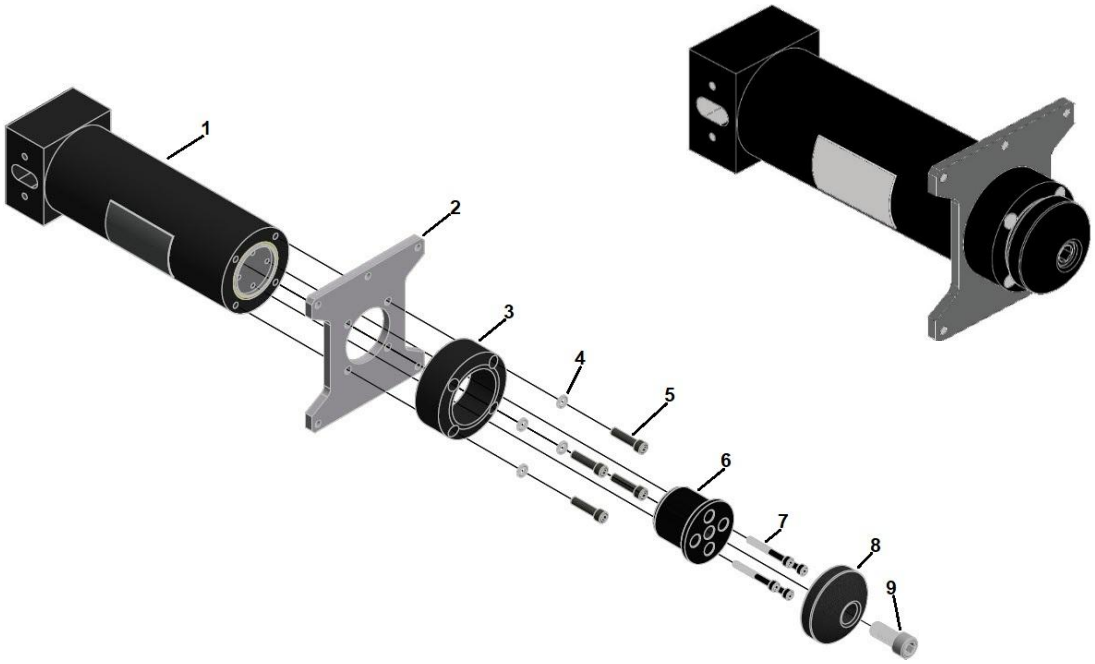
CAUTION: Always use the coupling ring to connect/disconnect the connector.

Maintenance, Cleaning and Lubrication

- Once mated, apply electrical tape around the connector.
- Clean and lubricate the receptacle contact pins.
- Wipe surfaces with a soft, clean, lint-free cloth or cotton swab. If corrosion is present, neutralize with a 5% solution of sodium bicarbonate in water, rinse with water, then wipe dry.
- To lubricate, apply a thin layer of light lubricating oil using a cotton swab. D-BOX recommends the following lubricating oils:
    - NATO Type O-190 per MIL-PRF-32033(2). Trade names include Aero Shell Fluid 18, Arpolube 800, and Royco 308A.
    - NATO Type O-156 per MIL-PRF-23699F. Trade names include Aero Shell Turbine Oil 500, Mobil Jet Oil II and Royco 500.
- Avoid using silicone-based lubricants for connector lubrication.

INSTALLATION/REMOVAL PROCEDURES

H-Bracket for 1.5in HD (AC10)



Removal

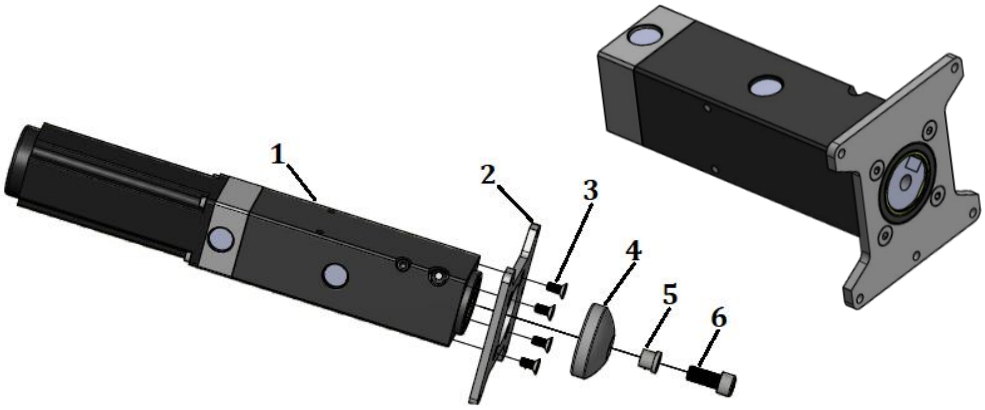
1. Remove bolt (9) and pivot (8).
2. Remove bolt (7) and end piston adapter (6).
3. Remove bolt (5), lockwasher (4), stop (3), and H-plate (2) from housing (1).

Installation

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

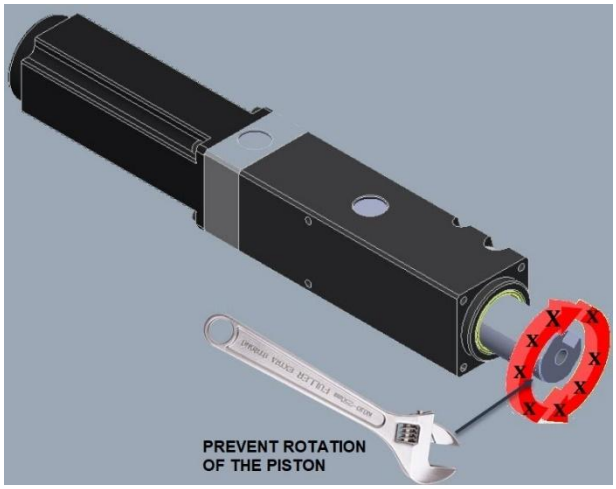
1. Align holes on H-plate (2) with holes on housing (1) and align holes on stop (3) with holes on H-plate (2) and then secure with lockwasher (4) and bolt (5). Torque bolt (5) to 98 lbf.in.
2. Align holes on the end piston adapter with the holes on piston end and secure the end piston adapter (6) with a 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 (AC231) actuators



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

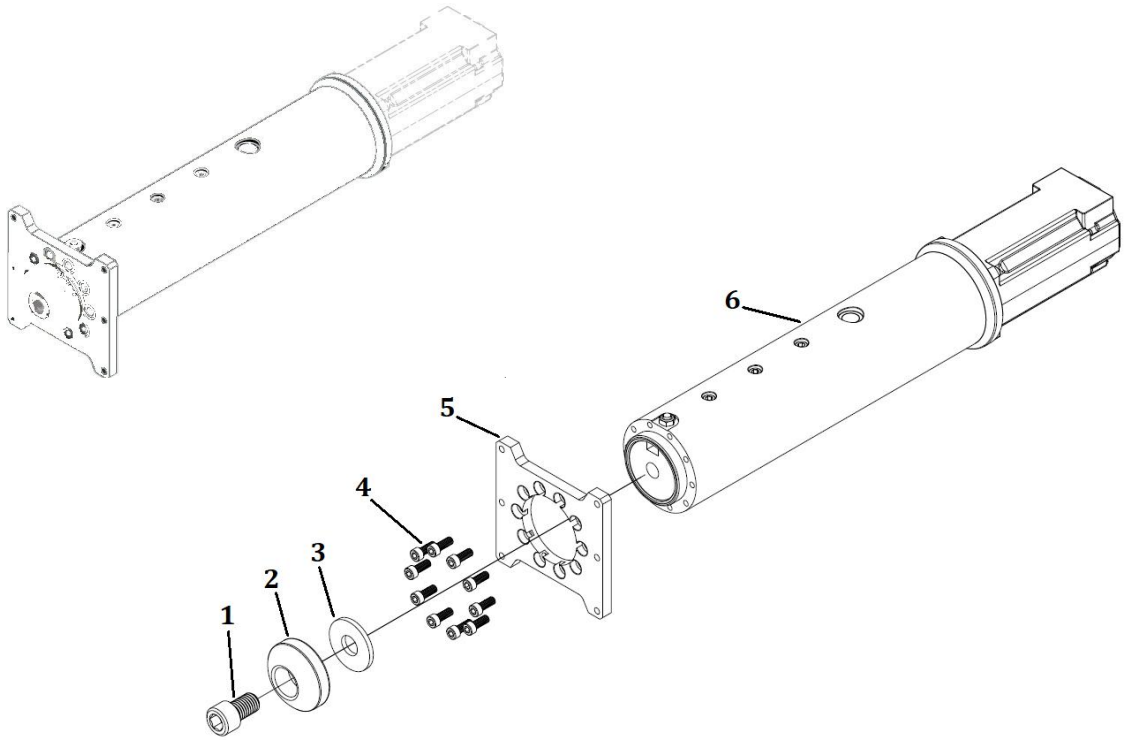
1. Place the H-bracket (3) on the end of the piston body (1) with the screw holes aligned.
2. Apply Loctite 243 (blue) thread locker in the four blind holes (2) on the piston body.

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

3. Use a 5mm 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 (AC360) actuator

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 as follows:

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 as follows:

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).

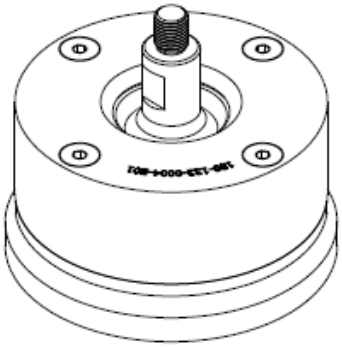
   NOTE: Apply the thread locker just before the bottom of the blind holes.

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).

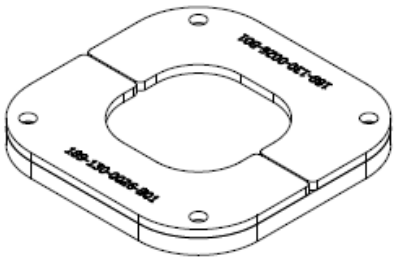
Captive ending

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 LITE: use with 1.5in (AC211, AC10) and 3in (AC231) actuators.
- OEM: use with 6in (AC360) actuators.

Spacer retainer

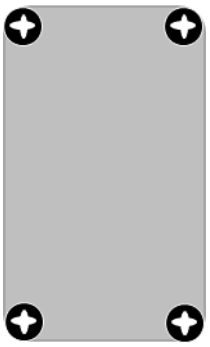
The spacer-retainer allows specific movements of the ball joint on both x and y axes, thus eliminating any constraints during the movement of the platform. There are 3 models of spacer retainer. All spacer retainers can be fitted on any model of ball joint.

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

The orientation of the spacer is critical and must be respected to prevent any damage to the components of the platform. Here are some spacer retainer configurations.

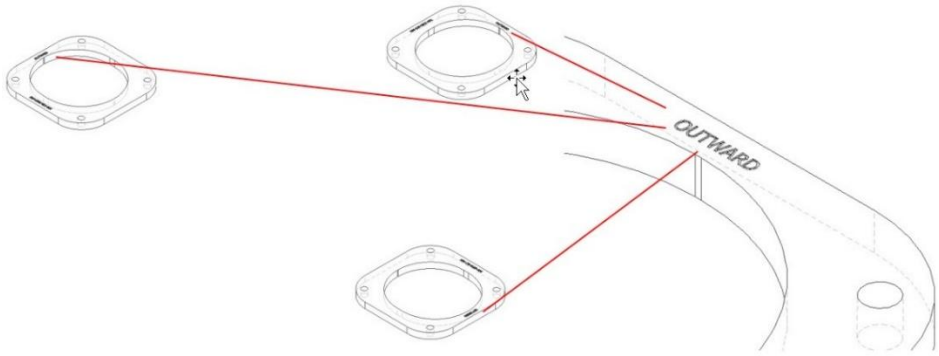
2 actuators and pivot

3 actuators



4 actuators

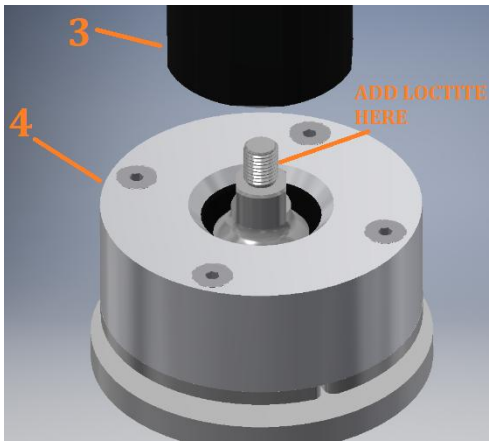
To help with positioning, the spacer retainer is marked with “OUTWARD” on the spacer.



Installation for 1.5-inch actuator

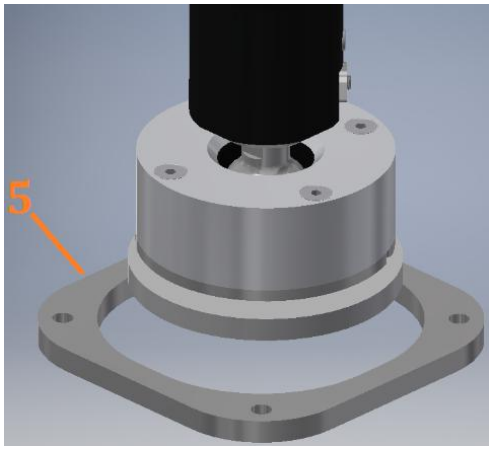
Here are installation instructions for the D-BOX ball joints. Make sure all the parts are clean before installation.

Unscrew bolt (1) with the ½ hex key and remove the pivot (2) from the actuator (3).



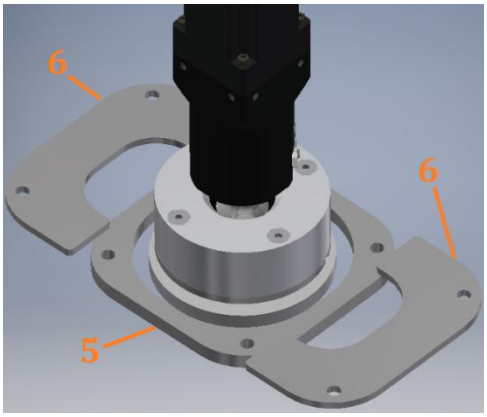
Apply Loctite 263 to the threaded section.

Screw the threaded section in the actuator (3). Use a torque wrench with a 5/8 crow foot socket to tighten the ball joint assembly (4) in the actuator. Torque to 170 lbf·in.

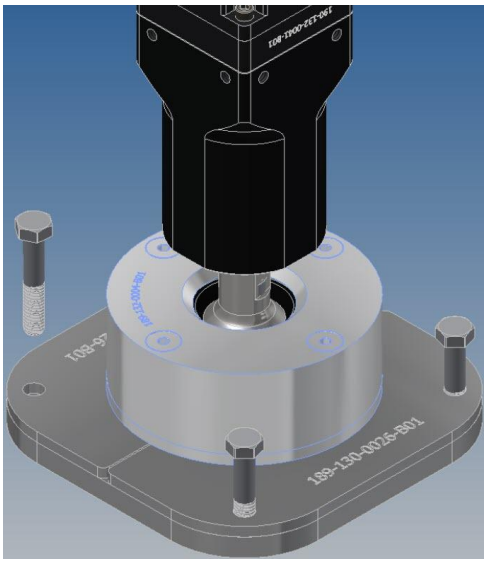


Place spacer (5) at its required location.

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).



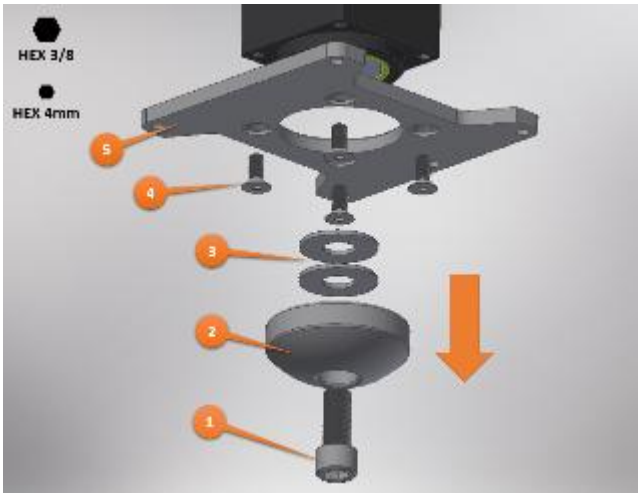
Slide retainers (6) on spacer (5) and in the slot on the ball joint.



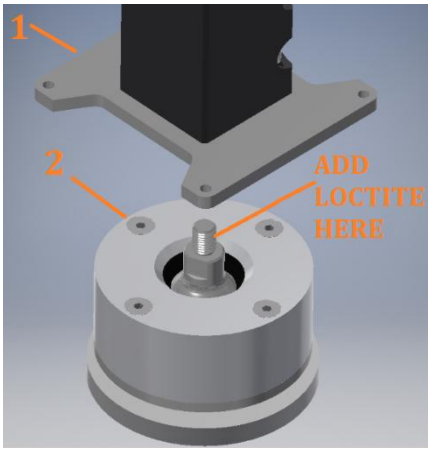
Align the holes in the retainers with the holes in the spacer. Use 5/16 bolts to tighten the spacer and retainers to the floor.

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

Installation for 3-inch actuator

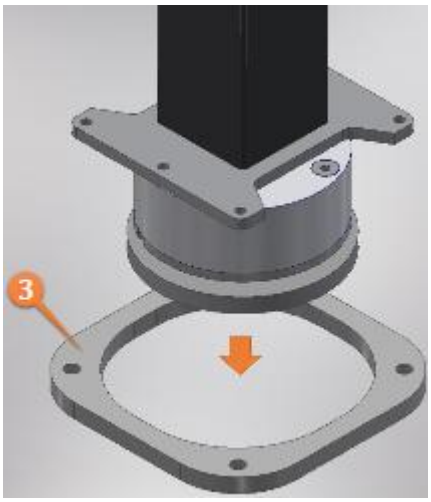


Unscrew bolt (1) with the 3/8 hex key and remove pivot (2) and spacers (3) from the actuator. Unscrew bolt (4) with the 4mm hex key and (optional) remove H-bracket (5) from the actuator.



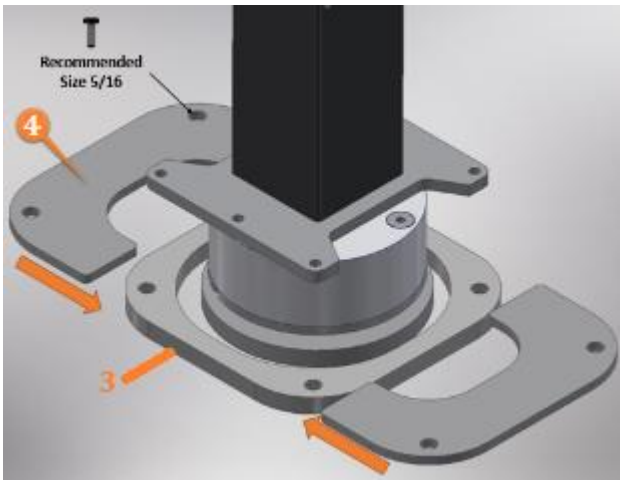
Add Loctite 263 to the threaded section.

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.

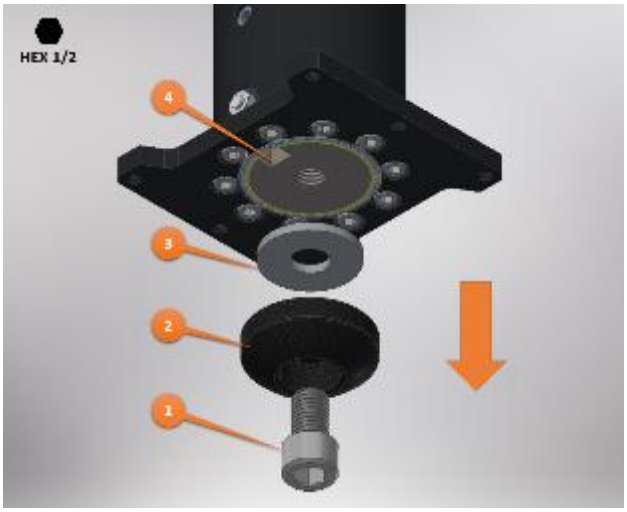
Make sure the holes in the spacer are aligned with the holes in the floor and place the actuator and ball joint assembly in spacer (3).



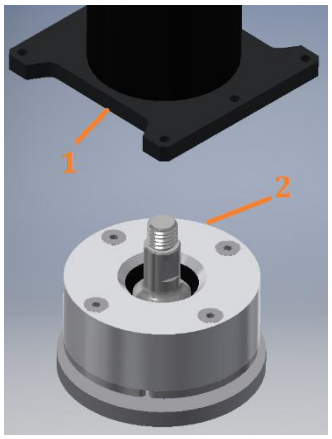
Slide retainers (4) on spacer (3) and in the slot on the ball joint.

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.

Installation for 6-inch actuator

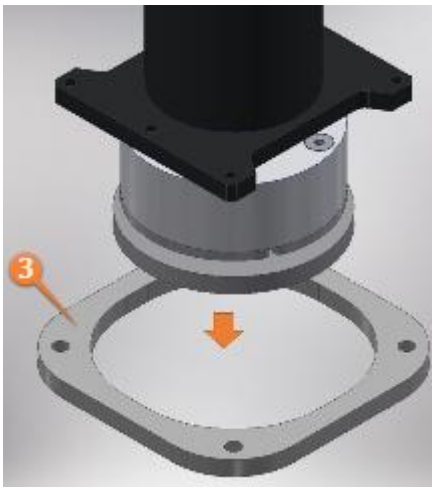


Unscrew bolt (1) with the ½ hex key and remove pivot (2) and spacer (3) from actuator (4).



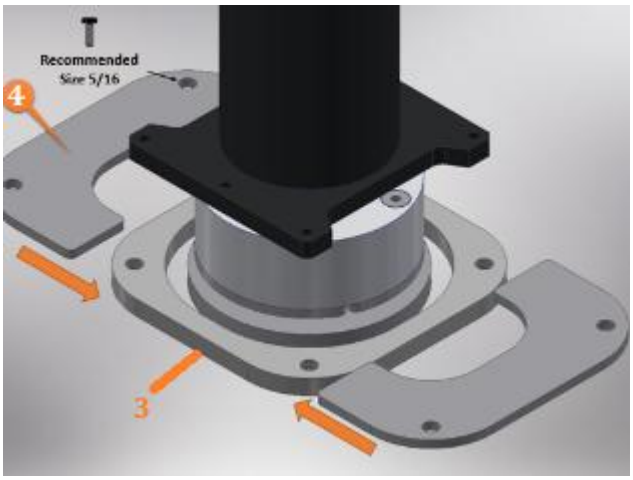
Add Loctite 263 to the threaded section.

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

1. 

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).



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

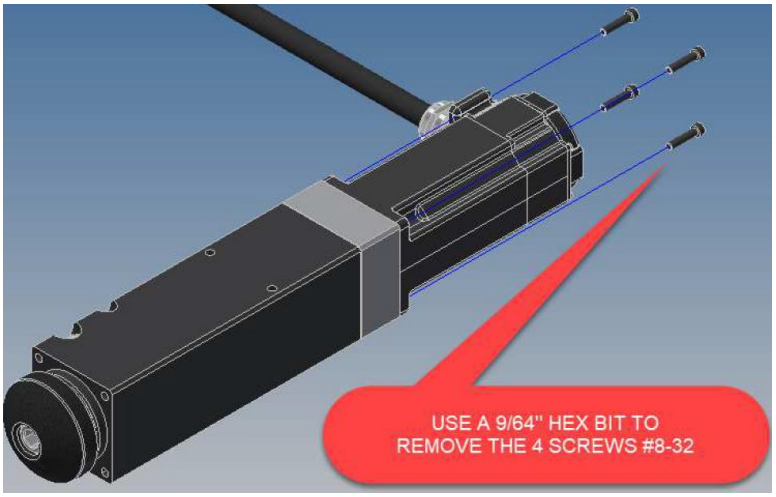
Align the holes in the retainers with the holes in the spacer. Use 5/16 bolts to tighten the spacer and retainers to the floor.

3in Actuator – Mechanic replacement

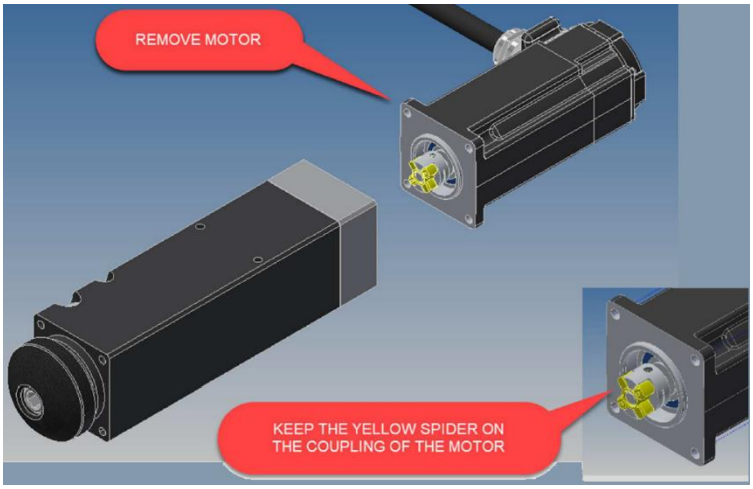
The following tool will be needed:

9/64-in hexagonal screwdriver
NOTE: T-handle will ease the procedure

Removal of the old mechanic

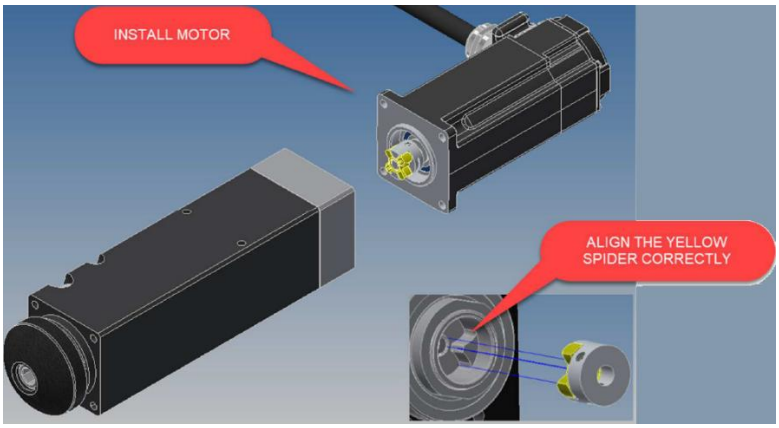


1) Remove the 4 Allen screws #8-32 with the 9/64 hex bit screwdriver.
   NOTE: Keep the screws for the re-installation of the new mechanic.



2) Split motor from mechanic.
   NOTE: Keep the yellow spider on the coupling of the motor.

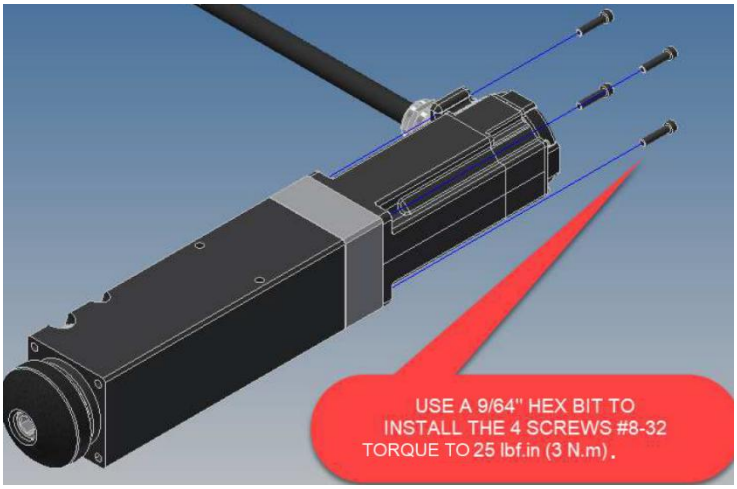
Installation of the new mechanic



1) Install the new motor on the mechanic and align the yellow spider correctly.

   NOTE: Hold the anchor with your finger to prevent ballscrew from turning while mating the motor to the housing; this will ensure the couplings stay aligned.

   NOTE: Make sure the holes on the body align with the ones on the actuator bracket.



2) Use the T-handle hexagonal screwdriver to install the mechanic on the motor with the four (4) screws.
3) Check for proper operation of the actuator by extending and compressing the piston with your hand.

MOTION SYSTEM OPERATION

Power up

Homing Sequence

Note that after powering up or exiting the Park mode, or upon an ACM fault, the motion system does a homing sequence; it goes all the way up, all the way down, and then centers before returning to service.

During Operation

The motors are always energized in any of the ACM operating modes. There are subtle differences between the different modes of operation, as explained below. Take note that those differences are inherent to the ACM software (firmware) and not related to any hardware interlock.

Park Mode

The motors are energized, but the servo loop torque is set to zero by the ACM software. The servo loop does not try to compensate for position error, even though it maintains the motors powered. This explains why the user experiences a certain motor drag when trying to move the seat.

Hold Low/Hold Center Mode

The motors are energized. The ACM software applies full nominal torque to the motor servo loop. The servo loop then maintains the commanded position (center or low) by modulating the current to the motors as required.

Enabled mode

Similar as Hold Low/Hold Center modes but the motors follow the position stream received by the drive instead of a fixed position.

Shut down/Stand Still

D-BOX does not offer a built-in shutting off for its motion systems. There is a way to settle the actuator to the ground with software. However, if the shut off must be physical, the best way is to cut the power to the ACM or the USB Controller. When there is no power, the actuators settle to the ground by gravity, with a controlled speed. As Disconnecting the D-BOX power cords would void the warranty, D-BOX recommends adding a power cord external to our products.

RISK ASSESSMENT CRITERIA FOR PRODUCT CERTIFICATION

Risks	Description	Probability	Severity	Risk Mitigation Action
Internal Risks				
Overweight Fault on an actuator	The weight on an actuator exceeds the limit of the motor (Limit in the model Firmware of the ACM). When an Overweight Fault occurs, the actuators settle to the ground and the system does a home sequence if the error is cleared.	**Moderate**	**Minor**	The design should take into consideration the worst case with a margin for the weight on each actuator.
Motor temperature too high on an actuator	The temperature of a motor exceeds the limit of the motor (Limit in the model Firmware of the ACM). When a Motor temperature too high Fault occurs, the actuators settle to the ground and the system does a home sequence if the error is cleared.	**Unlikely**	**Minor**	If the actuator is used in an enclosed area, make sure that the temperature will be below the maximum rating.
OverCurrent Fault on an ACM (Drive)	If the motion exceeds the acceleration limit (Limit in the model Firmware of the ACM). When a Current Fault occurs, the actuators settle to the ground and the system does a home sequence if the error is cleared.	**Unlikely**	**Minor**	During the motion code design, it is important to respect the limitation about the acceleration/speed of the system.
Overspeed Fault on an ACM (Drive)	If the motion exceeds the speed limit (Limit in the model Firmware of the ACM). When a speed Fault occurs, the actuators settle to the ground and the system does a home sequence if the error is cleared.	**Unlikely**	**Minor**	During the motion code design, it is important to respect the limitation about the acceleration/speed of the system.
External Risks				
ACM (drive) unplug during motion	If a person accidentally unplugs the power cord, or an electrical failure occurs. When there is no power, the actuators settle to the ground, by gravity, with a controlled speed.	**Moderate**	**Minor**	The moving part of the system should not be accessible by the guest and all cables need to be secured and not accessible.
External blocking (Travel Fault) on an actuator	If an object blocks the motion of an actuator, a Travel fail occurs. When a Travel Fault occurs, the actuators settle to the ground and the system does a home sequence if the error is cleared.	**Moderate**	**Minor**	The moving part of the system should not be accessible by the guest.
Disconnection of the communication cable (RJ45)	If a person accidentally unplugs the RJ45 communication. When the cable is unplugged, the actuators settle to the ground with a control speed.	**Unlikely**	**Minor**	The moving part of the system should not be accessible by the guest and all cables need to be secured and not accessible.