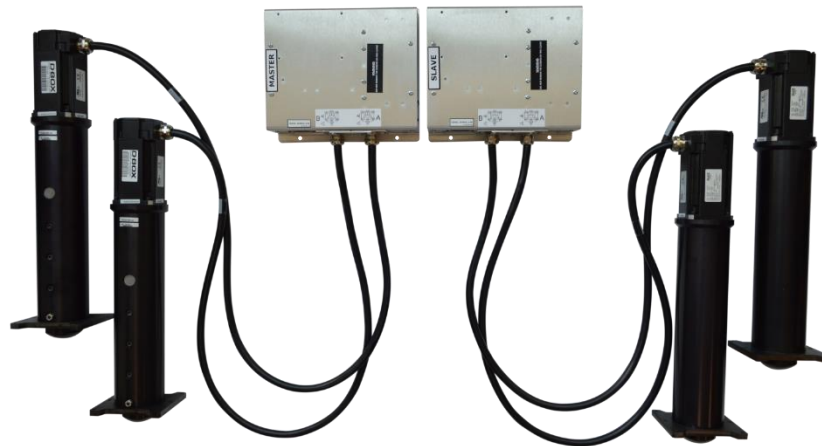


# **G3 HAPTIC SYSTEM INSTALLATION, USER AND TROUBLESHOOTING GUIDE**



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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.

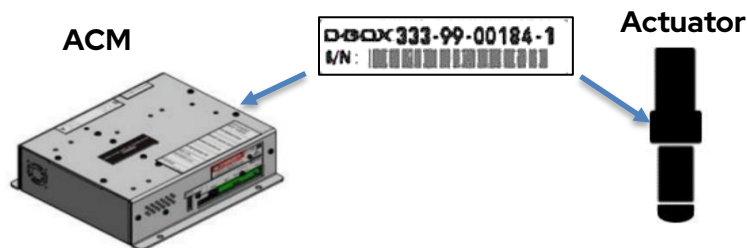
**WARNING:** To reduce the risk of fire or electric shock, do not expose this apparatus to rain or moisture.

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

Do not hesitate to contact us if you have questions.

Please make sure to provide the **serial numbers** (ACM & actuators) of your Haptic System when contacting the D-BOX Support. Note that for 3x and 4x actuators system, there may be more than 1 sequence of SN.

The serial number has the following format:



If remote assistance is required, you must have TeamViewer ([www.teamviewer.com](http://www.teamviewer.com)) installed on your PC.

## D-BOX Support

2172 rue de la Province, Longueuil, Quebec, Canada

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

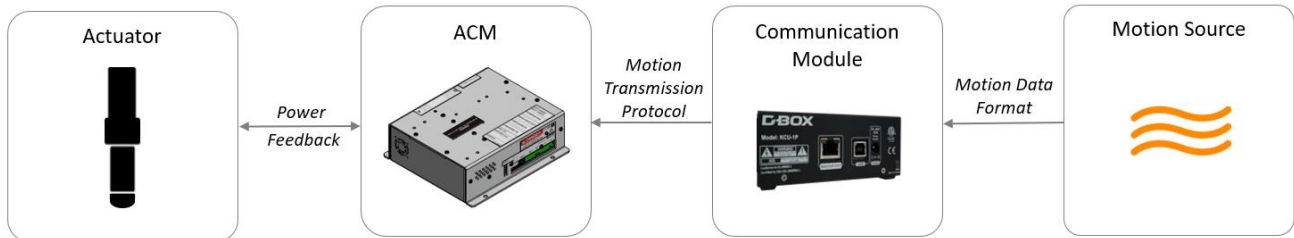
BY PHONE 1-800-442-3269; 931 (toll free CAN/US)  
1-450-442-3003; 931 (other regions)



## 1. INTRODUCTION

D-BOX Haptic 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 **Haptic System**:



- **Haptic 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 haptic code, converting a signal format to another one.
- **Haptic Source:** various applications generating Haptic data for the D-BOX Haptic 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.

### 1.1 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;** (haptic 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, a physical validation by our team is mandatory.

## 1.2 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 status of all connected Haptic Systems.
  - ***System Monitor***; an application leveraging the Monitoring Service API to display live health and operational data on all connected Haptic Systems.
  - ***Motion Service***; a core library required to generate the haptic signal and address the Haptic Controller (KAI, KCU). This library is automatically loaded by higher level software enabling the haptic integration, such as Live Motion SDK and Motion Engine, discussed below.
  - ***KAI and KCU Drivers***; the lowest-level components of *Motion Core* that allow the proper detection and operation of the Haptic 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 Haptic 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 a 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 Haptic 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 Haptic Code distribution and authorization service. You can reach this service [here](#). Internally, our team will configure your account with the proper Haptic 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 haptic.

### 1.3 Haptic Code Integration Phase

D-BOX Haptic 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 Haptic 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 haptic designers have experience creating Haptic 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 Haptic Code.

If you want to create a Haptic Code for an 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 Haptic Code and turned into a corresponding immersive haptic signal. Our SDK is well documented and available upon request.
2. **Send us logs and videos;** for us to start the haptic 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 haptic integrators have experience creating Haptic Code for various contents. Working with us will allow an optimal experience. However, we offer different integration methods if you have a need for more autonomy. Contact our sales team for details.

### 1.4 Operating Conditions

The D-BOX Haptic 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   |



## 2. SOFTWARE SUITE

### 2.1 Haptic Core

The D-BOX Haptic 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.

### 2.2 Motion System Configurator

See Motion System Configurator Guide and How-to videos for more details.

**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 Haptic System architecture. Here is the list of the factory configurations. The letters describing the actuator position refers to the next table.

HAPTIC 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	1 FRONT/2 BACK	FC - BL - BR	1 ACM-MASTER with 2 actuators at the back of the simulator. 1 ACM-SLAVE with 1 actuator at the front 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.

**NOTE:** If the configuration changes, it effects the actuator/ACM port.

---

<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 Haptic 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.

## 2.3 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.

## 3. COMMUNICATION MODULE - KCU-1P

The KCU-1P is a communication module that transmits the data from the Haptic 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>

### 3.1 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.

For more information on the LED status, refer to the Troubleshooting section.

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

## 4. ACTUATOR CONTROL MODULE

### 4.1 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.

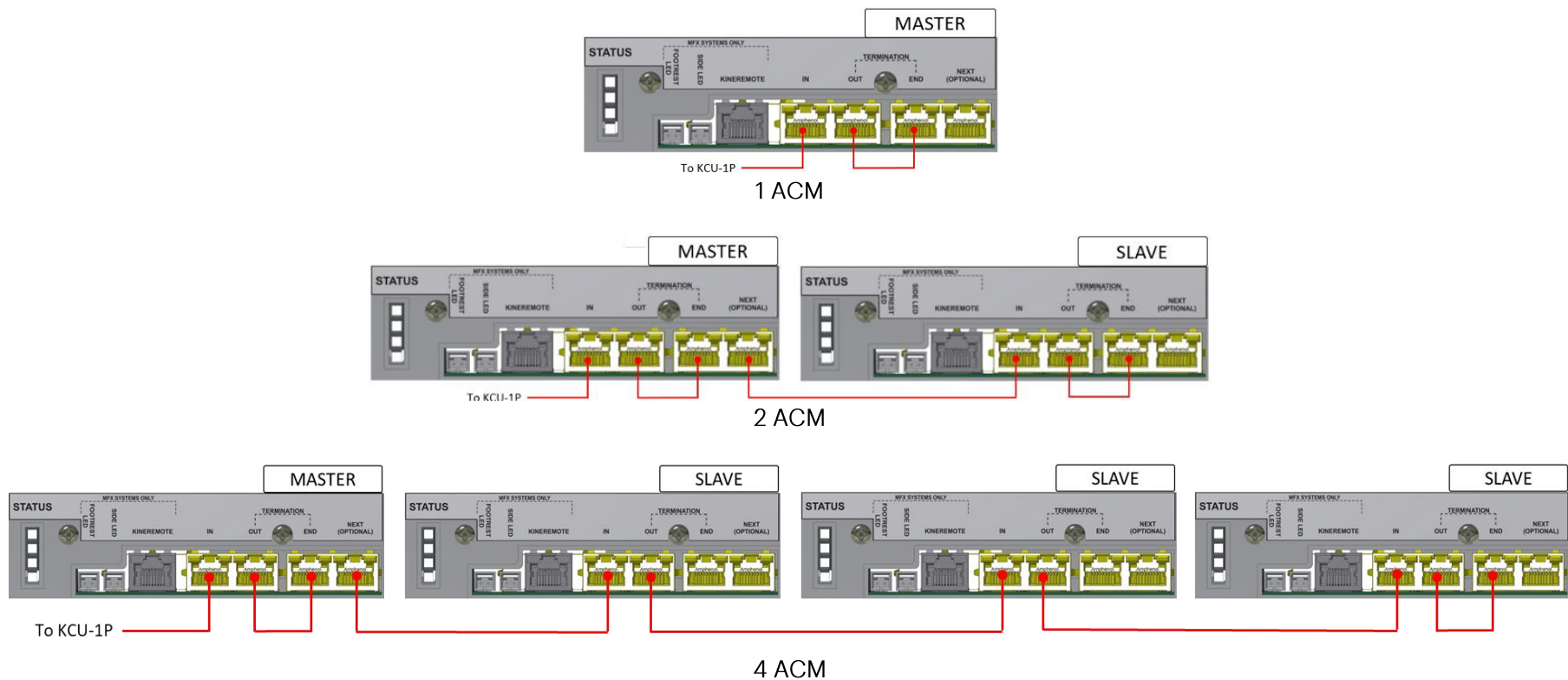
## 4.2 ACM Connections

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

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

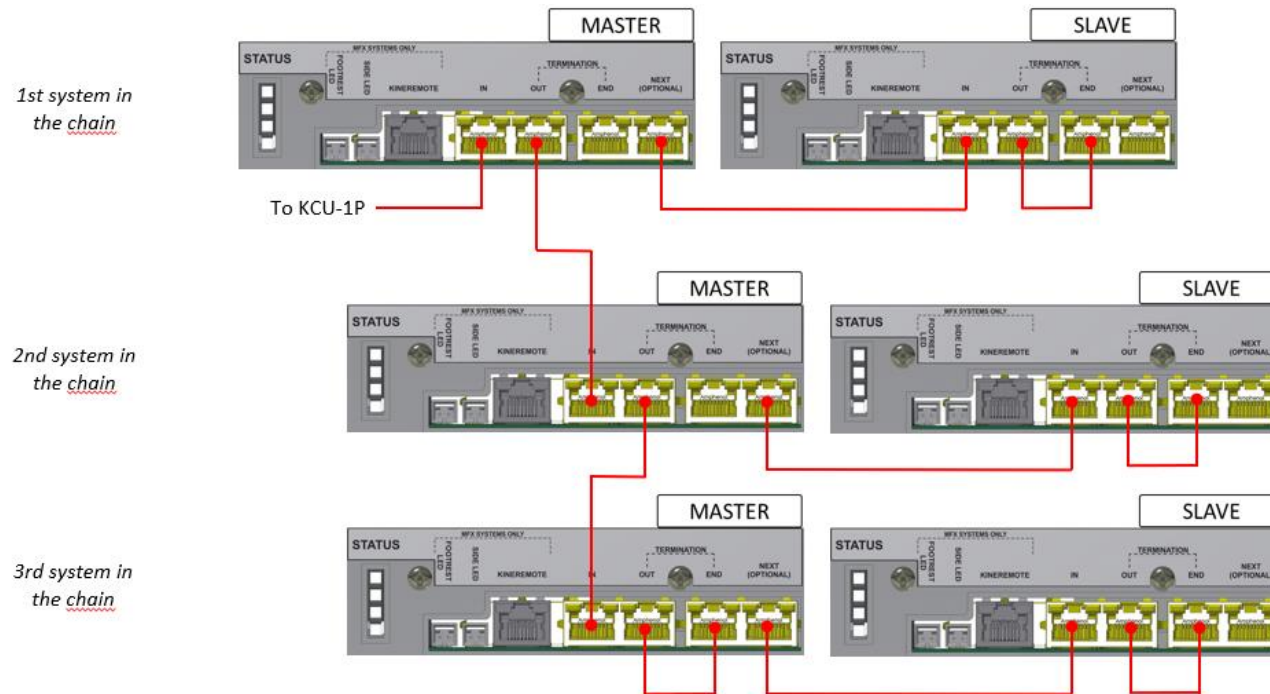
The last Master(s) and Slave(s) ACM(s) in the chain must always be terminated using a 1 feet shielded CAT5 cable, connecting from OUT to END ports of ACM.

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



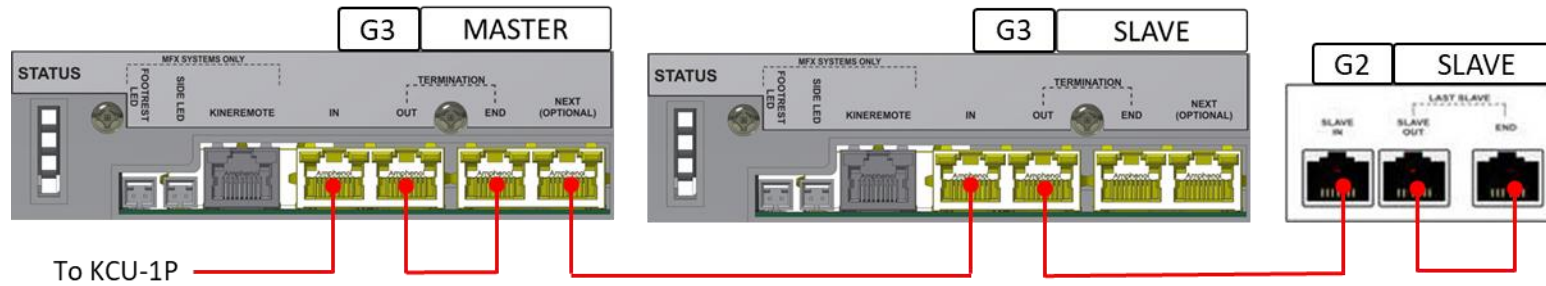


The following example shows 3 Haptic Systems using 2 ACMs each.



If you are connecting a G2 Slave ACM to a G3 haptic system, please refer to the following diagram and note the following:

- You will be able to use the Motion System Configurator to change the configuration. But you will not be able to change the actuator type or reorder the ACM.
- When contacting support, please make sure to mention your architecture is composed of a mix of both generations.





## 5. ACTUATOR

### 5.1 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

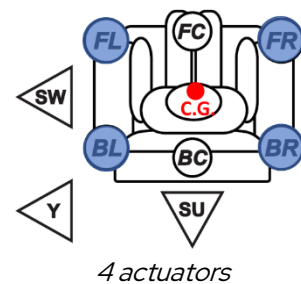
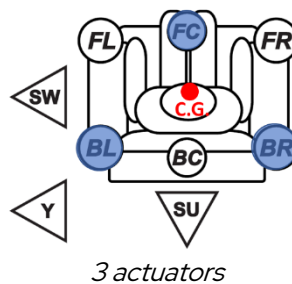
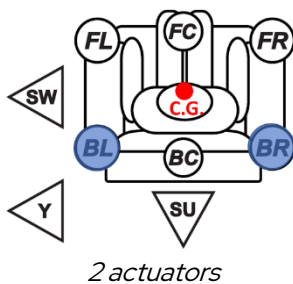
<sup>1</sup>You can find the reference to the maximal axial load in System Monitor – part of Motion Core.

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).

### 5.2 Weight Distribution

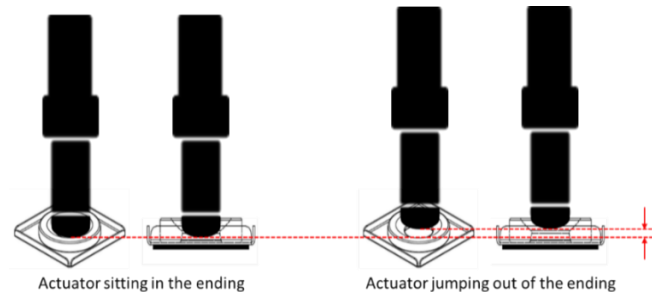
Each actuator has an individual maximal payload as previously mentioned. When integrating the Haptic System on a platform, D-BOX recommends balancing the **center of gravity** (CG) of the platform to ensure **each actuator supports an equal load**. The following figures show equal distribution of weight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



### 5.3 Actuator Acceleration

The D-BOX Haptic 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 Haptic 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.

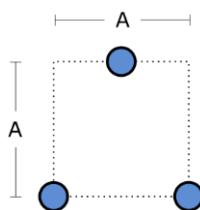


The shock of a piston falling back down in its cup reverberates on the top bearing of the piston, which takes the hit to protect the motor. As it progressively wears, the bearing also becomes noisier, reducing the service life of the ball nuts and screw. Avoid actuator jumping in the cup.

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 haptic code, the simulator weight, simulator structure and weight distribution.

## 5.4 Distance between actuators

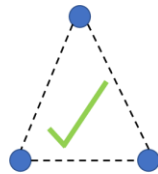
Respect the minimum distance between actuators for adequate movement of the platform. Measure the distance from a **square surface enclosing all actuators** – see example below. Respecting the spacing guidelines ensures proper interaction of the Haptic System with the actuator endings, and proper lateral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



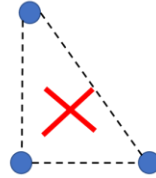
TRAVEL	MINIMUM SPACING BETWEEN ACTUATORS (A)
1.5 in	14 in [356 mm]
3.0 in	24 in [610 mm]
6.0 in	36 in [914 mm]

## 5.5 Actuator alignment

When using 3 actuators, install them per a isosceles triangle pattern, avoid other patterns – e.g. scalene triangle.

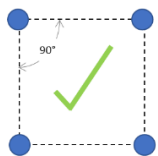


Adequate actuator integration

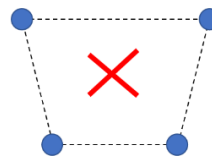


Inadequate actuator integration

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



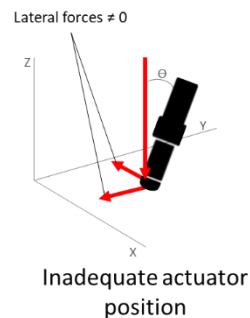
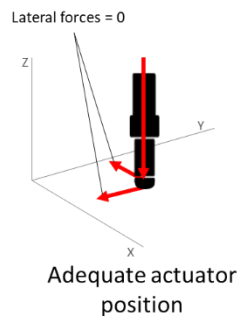
Adequate actuator integration  
(square/rectangular)



Inadequate actuator integration

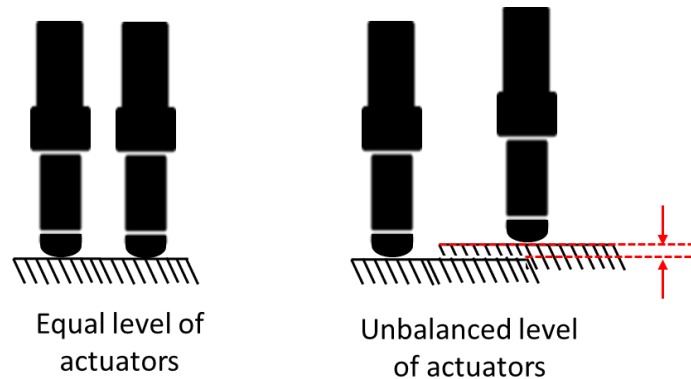
## 5.6 Actuator straightness

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



## 5.7 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.



## 5.8 Usage of 6-inch actuators for lateral motion

The 6-inch actuator has a play of approximately 1mm, 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 system in general simulation. But it has been reported as problematic by sim-racing professional.

## 6. HAPTIC 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 Haptic System.

### 6.1 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.**

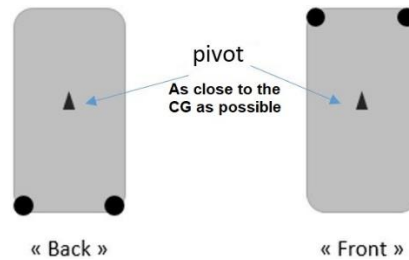
As D-BOX is not providing an external step-down transformer, you will need to assure power conversion by your own means if needed. To select your converter, please follow the power requirement listed in the spec sheets for your specific configuration.

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.

## 6.2 Pivot

When using a 2-actuator Haptic 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.



## 6.3 Captive Endings

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

## **7. HAPTIC SYSTEM OPERATION**

### **7.1 Power up**

#### Homing Sequence

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

### **7.2 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 fix position.

### **7.3 Shut down/Stand Still**

D-BOX does not offer a built in shutting off for its haptic 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.

## 8. TROUBLESHOOTING YOUR G3 HAPTIC SYSTEM

### 8.1 Initial Troubleshooting Steps

**Step 1:** Verify that the Haptic System, KCU-1P and computer are powered on. If you see an orange or red light on the equipment, refer to the LED status tables.

**Step 2:** The G3 ACM does not have a universal voltage input. Haptic Systems can be ordered 120V **or** 220V. Make sure your Haptic System suits country voltage.

**NOTE:** KCU-1P Controller has a universal power supply.

**Step 3:** Make sure your G3 Haptic System and KCU-1P Controller are connected to a grounded electrical outlet. Do not use adapter plugs or remove the grounding prong from cables. If you must use an extension cable, use a 3-wire cable with properly grounded plugs. Don't connect to a circuit with a GFI breaker.

**Step 4:** Verify that all cables (power & network) are firmly plugged in.

Always use the original USB cable supplied with the KCU-1P. Other USB cable might not be compatible.

All network cables must be CAT5e or 6 Shielded. We strongly suggest using the network cables supplied with your MS.

**Step 5:** Do a visual inspection of your system to make sure nothing prevents the MS from moving properly. Power cord(s) and network cable(s) must be secured and away from the actuators path.

**Step 6:** Check your haptic system's connection and make sure you are connected on the right ports. Then, verify that all termination loops are closed when applicable. The last ACM Master and ACM Slave must be terminated with a CAT.5e or 6 Shielded cable. Please refer to the G3 Installation Guide for more details.

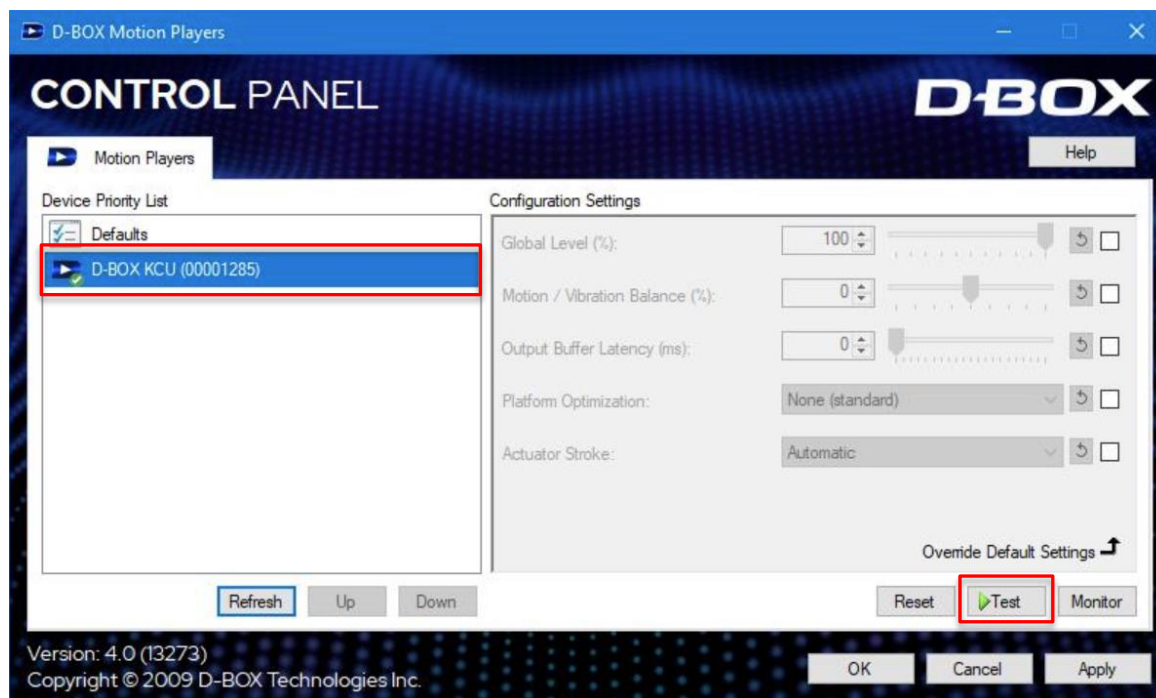
**If the system is not operational, try the following:**

**Step 7:** reset the entire system:

- A) Reboot your computer
- B) Power off the Haptic System and the KCU-1P Haptic Controller by unplugging the power cords. Wait for at least 60 seconds then restore the power to the equipment. The platform should do its homing sequence by going up, down then middle position. If the system does not go through its homing sequence, open System Monitor and check if there are some alarms. Then, refer to the "Faults and Corrective Actions" section.

**NOTE:** If the actuators move up and down continuously, there might be a cable or a foreign object preventing the actuators from functioning properly.

**Step 8:** Proceed with a motion & communication test using the D-BOX Control Panel application. Select your KCU device (on the left) then press the "Test" button:



If the MS is moving following the preprogrammed pattern, it means the computer can communicate with the MS correctly. You can now perform a full test using your D-BOX compatible software.

If the system can't perform the communication test, open System Monitor and check if there are some alarms. Then, refer to the "Faults and Corrective Actions" section. If there are no alarms, you may need to update the firmware of the system (**see section 8.2**).



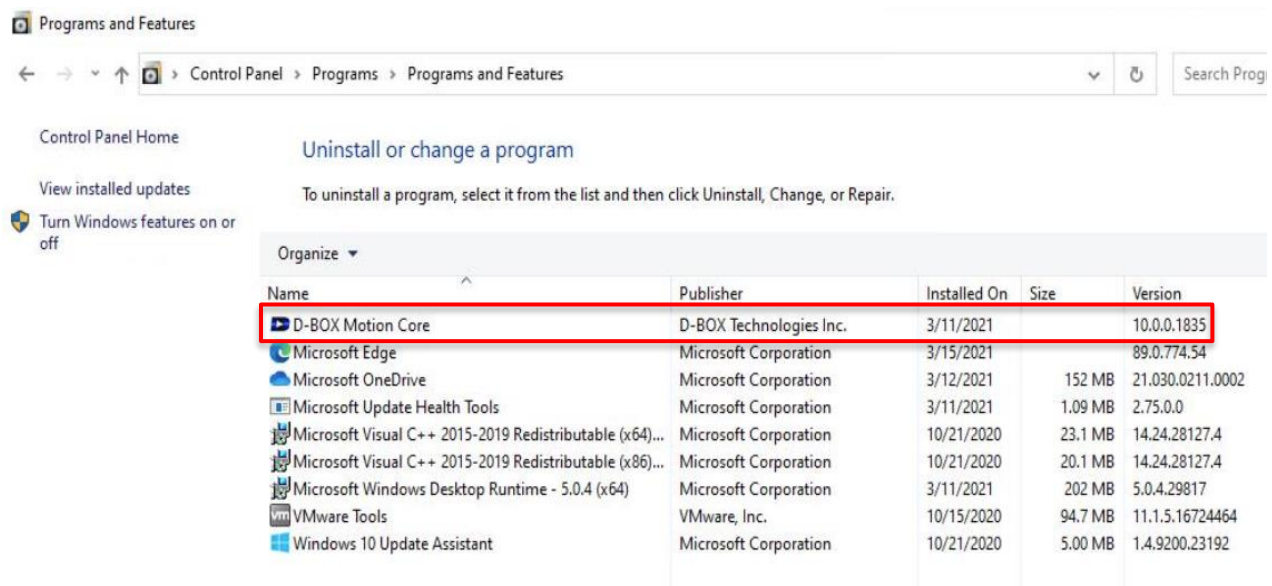
## 8.2 Update Software and Firmware

**Step 9:** Make sure you have the latest version of the D-BOX Motion Core installed on your computer.

You can verify which version is currently installed on your computer:

### Windows Control Panel > Programs > Programs and Features

Find an item called “D-BOX Motion Core” then check the version number:



**Step 10:** Verify your D-BOX equipment firmware and configuration (refer to the Motion System Configurator section of this guide for more information):

1. Download and install the latest version of Motion System Configurator available on the D-BOX website ([www.d-box.com](http://www.d-box.com)) under the download section. Documentation is also available in the package.
2. Make sure that all of your equipment is properly connected to the computer, then start Motion System Configurator.
3. Follow the instructions in the software to do a firmware update.
4. Verify that the physical system configuration equals the software configuration. Follow the instructions in the software to change the configuration if required. A good practice is to replace the sticker on your ACM to reflect the new configuration to avoid confusion.

**NOTE:** Reprogram your haptic system BEFORE you install your Haptic System.

### 8.3 Troubleshooting with KCU-1P LED Status

This section covers the status LED located on your KCU-1P:



Once you plug the KCU-1P, the controller draws 48V from its power supply. The front STATUS LED illuminates as follow:

LED STATUS	STATUS	SOLUTION
Off	KCU-1P is not powered	Make sure the power supply is properly connected.
Red	No USB connection is detected	<p>Check that the USB cable is properly connected.</p> <p>Make sure you have the latest version of Motion Core installed.</p> <p>Make sure you are using the original USB cable provided with your controller.</p>
Orange	Connected to the PC USB port. The unit is ready to operate.	Start your D-BOX compatible software or game.
Green	The device s operational and receiving motion data (or silence data).	

**NOTE:** One (1) KCU-1P can provide the haptic signal for a maximum of twenty (20) daisy-chained ACM G3

If the LED stays off or red, contact D-BOX Support.

## 8.4 Troubleshooting with ACM LED Status

This section covers the status LEDs located on your ACM:

- ACM Mode
- Actuator Status
- Actuator Fault
- KC Command



LED	LED STATUS	STATUS	SOLUTION
ACM Mode	Off	ACM not powered	Make sure your ACM fits your country voltage.  Make sure the power cord is firmly connected.
	Green	Platform servo active (platform is in control mode) System is applying power to the motors	
	Orange	Platform servo deactivated (standby mode) System is parked and actuators are free	Can be a normal behavior during certain system states (error recovery).
	Red	Missing communication (cannot assert mode)	Can be a normal behavior during certain system states (park mode).  Make sure all network cables are firmly connected.  Make sure the KCU-1P is properly connected to the PC.
Actuator Status	Off	n/a	
	Green	No fault. Platform is ready for haptic playback All actuators have completed their homing sequence	
	Orange	Platform is verifying the actuators stroke (actuator verification: homing sequence)	Normal behavior during the homing sequence.
	Red	Platform not ready for playback – error present	See System Monitor for more details.

LED	LED STATUS	STATUS	SOLUTION
Actuator Fault	Off	n/a	
	Green	No fault	
	Orange	Actuator fault. The unit will reinitialize by itself after a few minutes. A delay of 30 sec before the system tries to recover	Make sure there is no foreign objects blocking the actuators.  See System Monitor for more details.
	Red	Actuator fault. Manual re-initialization required.	
KC Command	Off	No command	
	Green	Will blink to indicate that the ACM is answering a unicast command.	
	Orange	Will blink to indicate the ACM is answering a broadcast command.	
	Red	n/a	

## 8.5 Troubleshooting with D-BOX System Monitor

The D-BOX System Monitor software gives you the ability to test and diagnostic your MS. The software is accessible from your Windows program menu under the D-BOX software:



**Taking screenshot will help support with resolving your issues.**

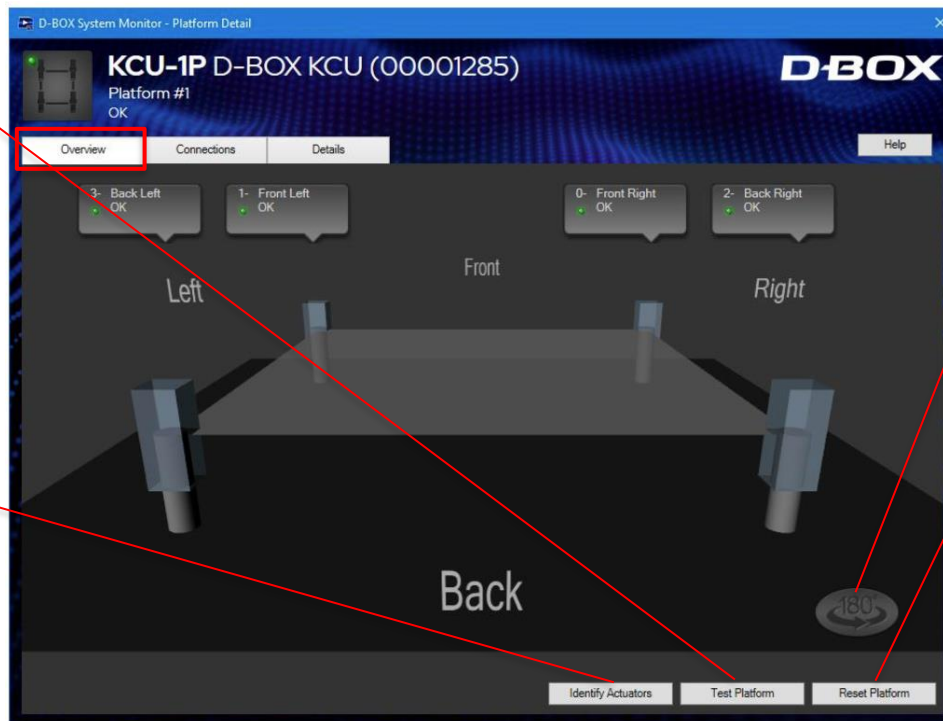
**Overview Tab:** The overview tab shows status for each actuator. Other functions are available by clicking the buttons located at the right bottom of the screen:

### Test Platform

generates movements and vibrations following a preprogrammed pattern. Useful to test communication between HW and SW.

### Identify Actuators

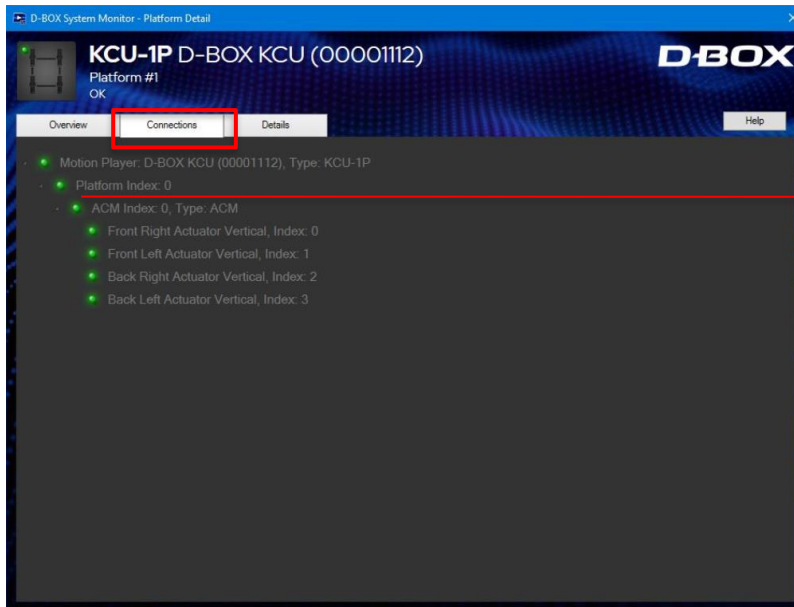
sends a haptic "toc" to each actuator one at the time with an onscreen identification. Useful to determine if your actuators are installed to the right position.



The overview image can be turned using this button.

**Reset Platform** will reset all your actuator to neutral, and the platform will go through a homing sequence

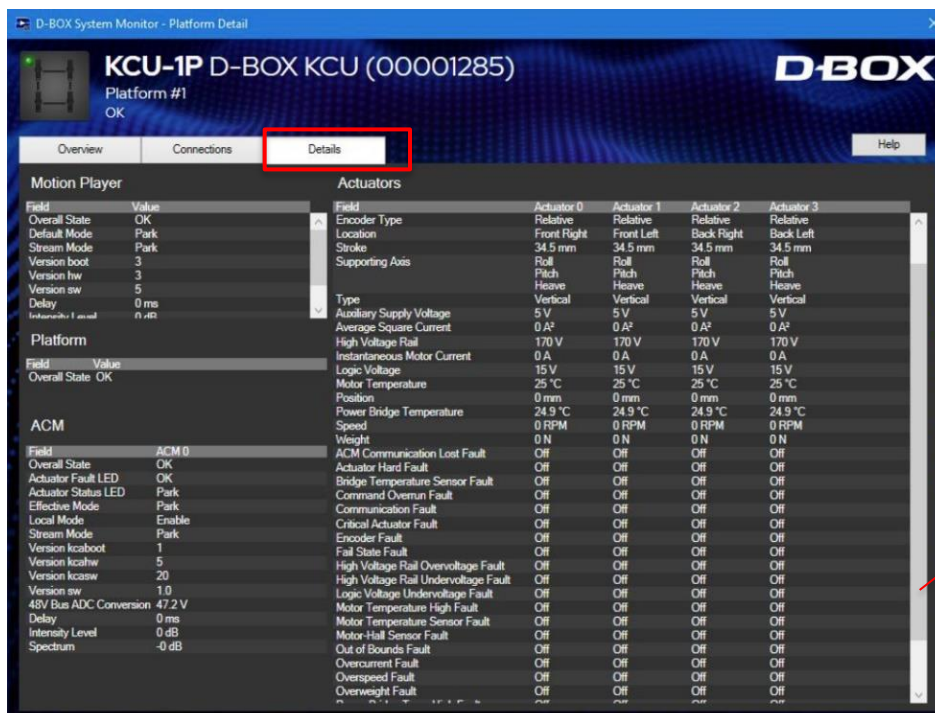
**Connections Tab:** Displays the status for each components of your MS. All dots should be green. A red indicator means faulty component. Go to the Detail Tab to investigate further.



**Dots** shows the status of the D-BOX equipment.

**Red dots** indicate a failure.

**Details Tab:** This section displays in real time the health of your system. If a component fails, the information related to the failure will be shown in red. **See section 9 for a complete list of faults, possible causes and corrective actions:**



Scroll down for more information

## 8.6 Faults and Corrective Actions

**Make sure to follow these safety rules in the case you need to open the ACM for troubleshooting or to replace an actuator or an ACM:**

You must ask D-BOX Support authorization prior opening the main cover of an AMC. Opening the main cover of an ACM without formal authorization voids the warranty.



**WARNING:** HANDLING ACTUATOR CABLES AND CONNECTIONS WHILE THE ACM IS POWERED COULD CAUSE INJURY OR DEATH. THESE EQUIPMENT OPERATE UNDER EXTREMELY HIGH VOLTAGE. ALWAYS TURN OFF THE SYSTEM POWER BY UNPLUGGING ACM POWER CORD BEFORE.

FAULT	CAUSE	CORRECTIVE ACTION
ACM Communication Lost Fault	The power cable is disconnected from the ACM(s).	<p>Visually inspect the entire length of the power cable for obvious signs of damage. Replace them in case of doubts.</p> <p>Make sure the ACM power cable is securely plugged in.</p> <p>Make sure you are connected to a grounded electrical outlet. Do not use adapter plugs or remove the grounding prong from cables. If you must use an extension cable, use a 3-wire cable with properly grounded plugs.</p> <p>Inside the ACM, check that the white 4 pins power connector is properly connected.</p> <p>Check the power coming out of the outlet and make sure it respects the specified operating conditions. In case of doubt, connect the haptic system to another circuit.</p>
	Defective or disconnected CAT 5e cable.	<p>Visually inspect the entire length of the communication cables for obvious signs of damage. Replace them in case of doubts.</p> <p>Make sure that all communication cables are Cat.5e shielded cables.</p> <p>Make sure the communication cable is no longer than 100 feet (30m).</p> <p>Make sure the communication cables are properly connected and that the last Master and Slave ACMs are terminated (see section 2).</p>

FAULT	CAUSE	CORRECTIVE ACTION
<b>Actuator Hard Fault</b>	This is a Hard fault; the faulty actuator is immediately deactivated to prevent damage to the ACM, and all other actuators go to their lowest position.	<p>Do a visual inspection to make sure nothing is blocking the actuator travel.</p> <p>Power off the haptic system, support the platform in order to gain access to the actuator piston and pull it out of its body slowly until the entire piston is out of the body and then slowly push it back in.</p> <p>If error persists, replace/repair the faulty actuator.</p>
<b>Bridge Temperature Sensor Fault</b>	The error can be triggered by starting the system when the temperature is too low.	<p>Make sure your system is running in a temperature range of 0 to 40°C.</p> <p>Check if the fan is working.</p>
	The internal power bridge sensor is defective.	<p>Make sure there is enough ventilation around the ACM.</p> <p>If the problem persists, replace/repair the faulty ACM.</p>
<b>Command Overrun Fault</b>	<p>A new command was received by the actuator while the previous command was not completed.</p> <p>This should not be a permanent fault and should clear after a while.</p>	<p>From system Monitor, reset the haptic system.</p> <p>Power off the haptic system, wait for a minute, then try again.</p> <p>From System Monitor, check if there is any other fault and follow the solution recommended.</p> <p>If error persists, contact D-BOX Support.</p>
<b>Critical Actuator Fault</b>	This is a Hard fault; the faulty actuator is immediately deactivated to prevent damage to the ACM, and all other actuators go to the lowest position.	<p>Do a visual inspection to make sure nothing is blocking the actuator travel.</p> <p>Power off the haptic system, support the platform in order to gain access to the actuator piston and pull it out of its body slowly until the entire piston is out of the body and then slowly push it back in.</p> <p>If error persists, replace/repair the faulty actuator.</p> <p>If error persists, proceed with ACM replacement.</p>



FAULT	CAUSE	CORRECTIVE ACTION
<b>Encoder Fault</b>	<p>There is a problem associated to the motor encoder.</p> <p>Could be a defective motor encoder, a defective motor cable or ACM.</p>	<p>Power off the haptic system, wait for a minute, then try again.</p> <p>Inside the ACM, check that the white 4 pins power connector is properly connected.</p> <p>Power off the haptic system and interchange the actuator connection in the ACM. This manoeuvre helps isolate the problem.</p> <p>– If the fault persists on the same port after the swap, problem is related to the ACM. Replace/repair the faulty ACM.</p> <p>– If the fault follows the faulty actuator, the problem is related to this actuator. Replace/repair the faulty actuator.</p>
<b>Fail State Fault</b>	Will not occur for G3 system.	n/a
<b>High Voltage Rail Overvoltage Fault</b>	<p>Too high voltage detected.</p> <p>Voltage from the wall outlet is too high for the Haptic System</p>	<p>Make sure your system matches your country voltage.</p> <p>Make sure you are not connected to a GFI breaker.</p> <p>Check the power coming out of the outlet and make sure it respects the specified operating conditions. In case of doubt, connect the haptic system to another circuit.</p>
<b>High Voltage Rail Undervoltage Fault</b>	<p>Too low voltage detected.</p> <p>Defective or disconnected power cable.</p>	<p>Visually inspect the entire length of the power cable for obvious signs of damage. Replace them in case of doubts.</p> <p>Make sure the ACM power cable is securely plugged in.</p> <p>Make sure you are connected to a grounded electrical outlet. Do not use adapter plugs or remove the grounding prong from cables. If you must use an extension cable, use a 3-wire cable with properly grounded plugs.</p>
<b>Logic Voltage Undervoltage Fault</b>	Low-voltage rail is too low	<p>If you are using an extension cable, try without.</p> <p>If error persists, replace/repair the faulty ACM.</p>

FAULT	CAUSE	CORRECTIVE ACTION
<b>Motor Temperature High Fault</b>	The motor temperature detector has failed or disconnected, or that the temperature is too low.	Make sure that the weight on the platform is not heavier than the maximum supported weight.
<b>Motor Temperature Sensor Fault</b>	If the temperature shown is around 561 degrees, it may be a defective motor cable or temperature sensor.	Make sure that the weight is evenly distributed among the actuators of the platform (as centered as possible).  In System Monitor, weight limits in "D-BOX Newton": <ul style="list-style-type: none"> <li>250lb model: <b>1900N</b></li> <li>400lb model: <b>2400N</b></li> <li>500lb model: <b>2800N</b></li> </ul> Make sure the haptic system is operating in normal operating conditions (room temperature).  If error persists, replace/repair the faulty actuator.
<b>Motor Hall Sensor Fault</b>	Will not occur for G3 system.	n/a
<b>Out of bounds Fault</b>	When the position of the actuator is over its limits. Should never occur in normal operation conditions.  Might comes from Haptic Code.	Verify that you are running a D-BOX certified haptic code. Call D-BOX for validation if necessary.  Make a test using the D-BOX Control Panel.
<b>Overcurrent Fault</b>	ACM could have the wrong configuration (ex: 250lbs motor instead of 400lbs).  Could be a defective motor.	From Motion System Configurator, verify that the physical system configuration equals the software configuration. Follow the instructions in the software to change the configuration if required.  If error persists, contact D-BOX Support.
<b>Overspeed Fault</b>	Will not occur for G3 system.	n/a
<b>Overweight Fault</b>	There's too much weight on the platform.  The weight is unbalanced on the platform.	Make sure that the weight on the platform is not heavier than the maximum supported weight.  Make sure that the weight is evenly distributed among the actuators of the platform (as centered as possible).  Weight limits in "D-BOX Newton": <ul style="list-style-type: none"> <li>250lb model: <b>1900N</b></li> <li>400lb model: <b>2400N</b></li> <li>500lb model: <b>2800N</b></li> </ul> If error persists, contact D-BOX Support.

FAULT	CAUSE	CORRECTIVE ACTION
<b>Power Bridge Temperature High</b>	The ACM power bridge has overheated, or the sensor is defective.	<p>Removing the power, wait for a minute then try again.</p> <p>Let the system cool down for a while and see if the temperature cools within normal limits.</p> <p>If error persists, contact D-BOX Support</p>
<b>Soft Actuator Fault</b>	This fault is always accompanied with another fault (called "main fault").	Check solution for the main fault.
<b>Temporary Actuator Fault</b>	This fault is always accompanied with another fault (called "main fault").	Check solution for the main fault.
<b>Travel Fault</b>	<p>Travel measure during the search-stop procedure is too large or too small.</p> <p>Normally caused by an external body preventing the actuator to move.</p> <p>Alternative causes of this fault are :</p> <ul style="list-style-type: none"> <li>• Actuator mechanics extreme wear (check if actuators are "jumping in their cups" or platform is pulled on the ground when moved around);</li> <li>• Broken actuator c-clip because actuator has receive an anormal choc (pulling on the actuator, bad tying-down of the system during transport);</li> <li>• Wear on actuator bearing (check if actuators are "jumping in their cups" or platform is pulled on the ground when moved around);</li> <li>• Bad communication with encoder.</li> </ul>	<p>Do a visual inspection to make sure nothing is blocking the actuator travel.</p> <p>Power off the haptic system, support the platform in order to gain access to the actuator piston and pull it out of its body slowly until the entire piston is out of the body and than slowly push it back in.</p> <p>If error persists, replace/repair the faulty actuator.</p>

## 8.7 Troubleshooting Software Issues (Game Center)

This section covers common software issues you may experience from the Game Center:

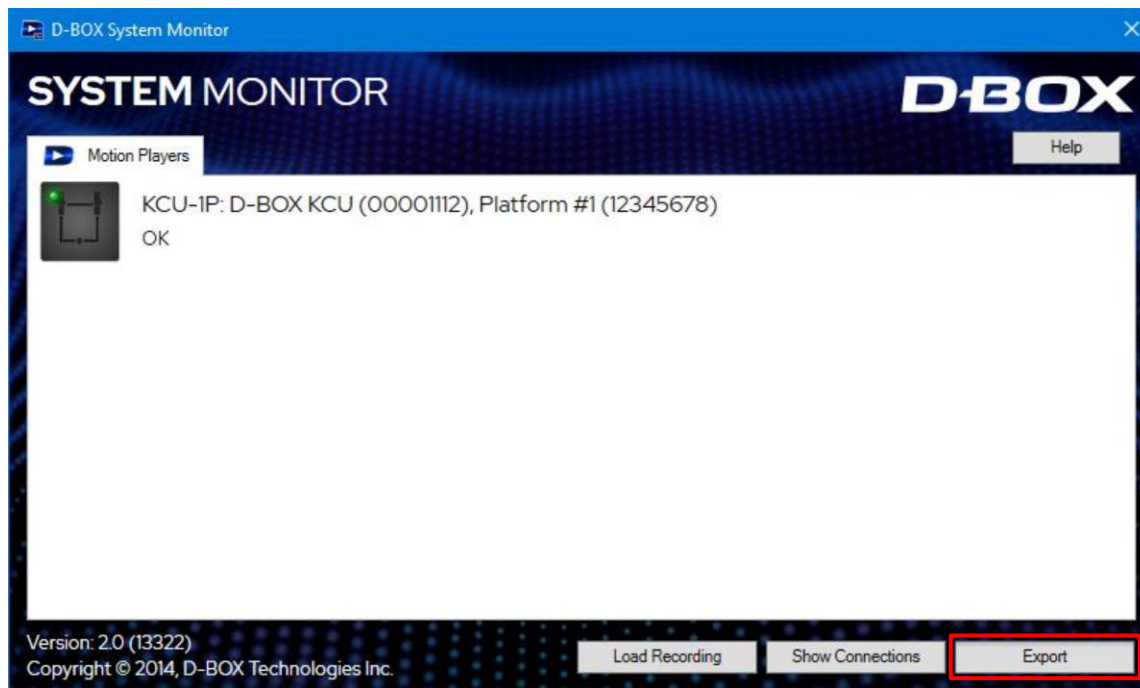
FAULT	CAUSE	CORRECTIVE ACTION
Game not found	The game version is not the same one D-BOX has coded.	<p>The integration could have been done on another version of the game. Try starting the game; movement should still work.</p> <p>Verify the game version to make sure it's matching the one compatible with your D-BOX system. Upgrade the game version to the latest one available.</p>
Haptic Code status "disable"	Configuration is incorrect.	Open the settings for this Haptic Code and select automatically start with game.
Haptic Code not working / No movement	There was a problem during the installation	<p>Uninstall all version of the game and D-BOX software.</p> <p>Reinstall game, start the game, play once and exit.</p> <p>Install the latest version of the D-BOX Motion Core available on the D-BOX website (Download section).</p>
Error in game center: «Game not installed»	Problem during the game or haptic code installation.	<p>The Haptic Code of the game should be installed where the installer is suggesting.</p> <p>For older game (before 2010), it should be in the game folder.</p> <p>For newer games (after 2010) it should be under "C:\Program Files\D-BOX\Gaming\" folder.</p> <p>The problem could be related to the version of the game used: DVD version / online download version. The supported version is specified on the D-BOX website.</p>
Error message: «dbxMotionPanel.exe - Fatal error CLR error: 80004005. The program will now terminate»	The software package .NET Vx is not installed.	Install the latest version of the D-BOX Motion Core available on the D-BOX website (Download section).

## 8.8 Exporting MS Logs

If the Haptic System is still not working properly after updating the firmware and the D-BOX Motion Core software, proceed by exporting the logs of your MS. The log file can be exported directly from the D-BOX System Monitor software.

**Please follow the steps below:**

1. Power off all ACMs of the platform by disconnecting the power cords.
2. Open the D-BOX System Monitor and let it run in the background.
3. Power on the ACMs.
4. Run your simulation or game software until the issue is reproduced.
5. Once the issue is reproduced, choose "Export", save the recording, and send it by e-mail to D-BOX Support.



## 9. REMOVAL/INSTALLATION PROCEDURES

Please follow instructions below if you need to replace an actuator and/or an ACM.

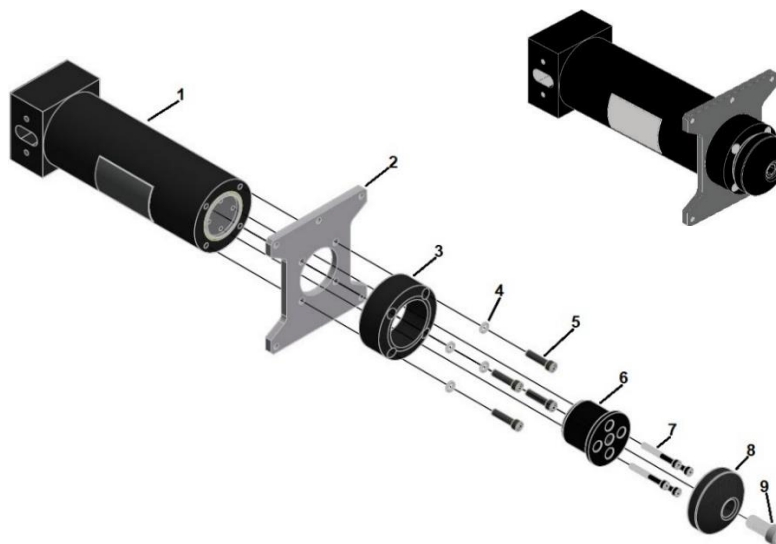


**WARNING:** USE CAUTION WHEN HANDLING ACTUATOR CABLES AND CONNECTIONS INSIDE THE ACM. THESE EQUIPMENT OPERATE UNDER EXTREMELY HIGH VOLTAGE. SERIOUS INJURY OR DEATH COULD OCCUR IF HANDLED WHILE OPERATING.

**Make sure to disconnect all ACM power cables and the Cat.5E cable coming from the KCU-1P Controller.**

### 9.1 H-Bracket installation/removal

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



#### Removal

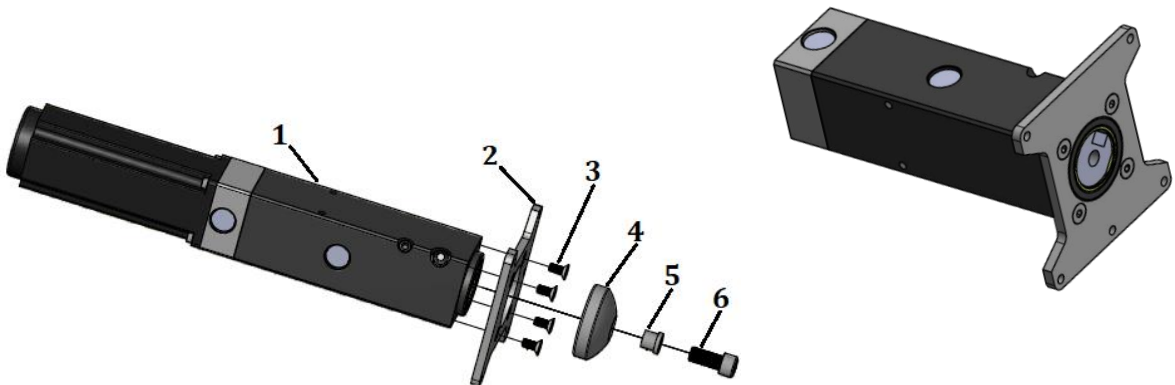
1. Remove bolt (9) and pivot (8).
2. Remove bolt (7) and end piston adapter (6).
3. Remove bolt (5), lockwasher (4), stop (3), and H-plate (2) from housing (1).

#### Installation

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

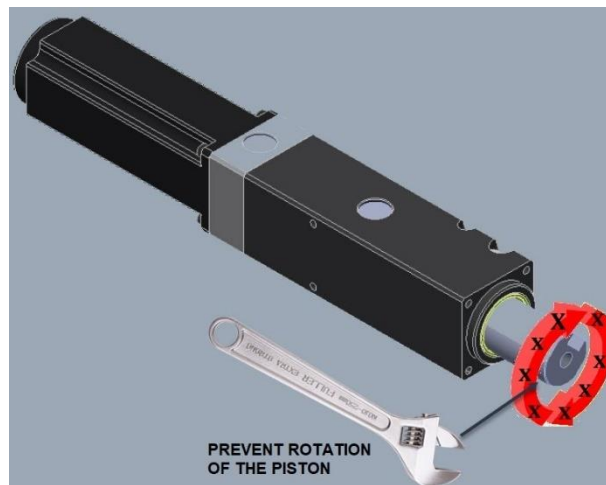
1. Align holes on H-plate (2) with holes on housing (1) and align holes on stop (3) with holes on H-plate (2), and then secure with lockwasher (4) and bolt (5). Torque bolt (5) to 98 lbf.in.
2. Align holes on end piston adapter with holes on piston end and secure end piston adapter (6) with bolt (7).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

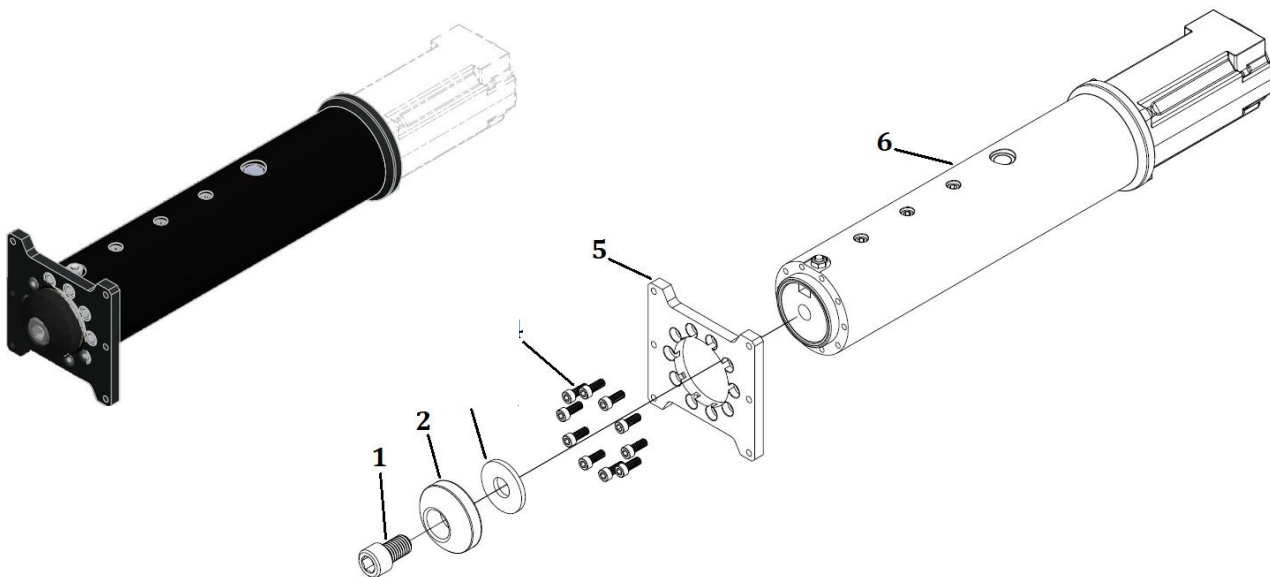
1. Place the H-bracket (3) on the end of the piston body (1) with the screw holes aligned.
2. Apply Loctite 243 (blue) thread locker in the four blind holes (2) on the piston body.

**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.

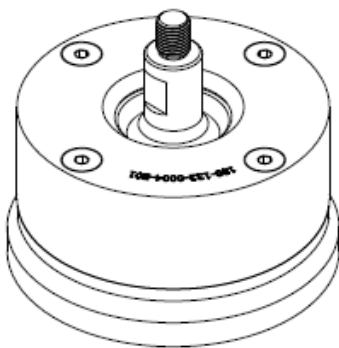


3. Use a 5 mm bit to secure the H-bracket to the piston body with screws (item 4, M6 X 1.0 X 14 mm), then tighten the screws to a torque of 133 N m (98 lbf in).
4. Install pivot (2) with washer (3) and bolt (1).

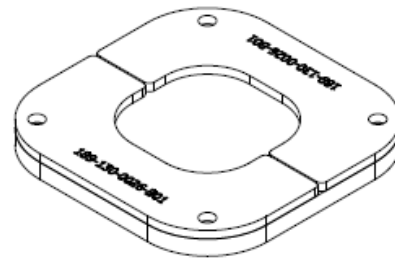
## 9.2 Captive ending

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

There are 2 models of captive endings:

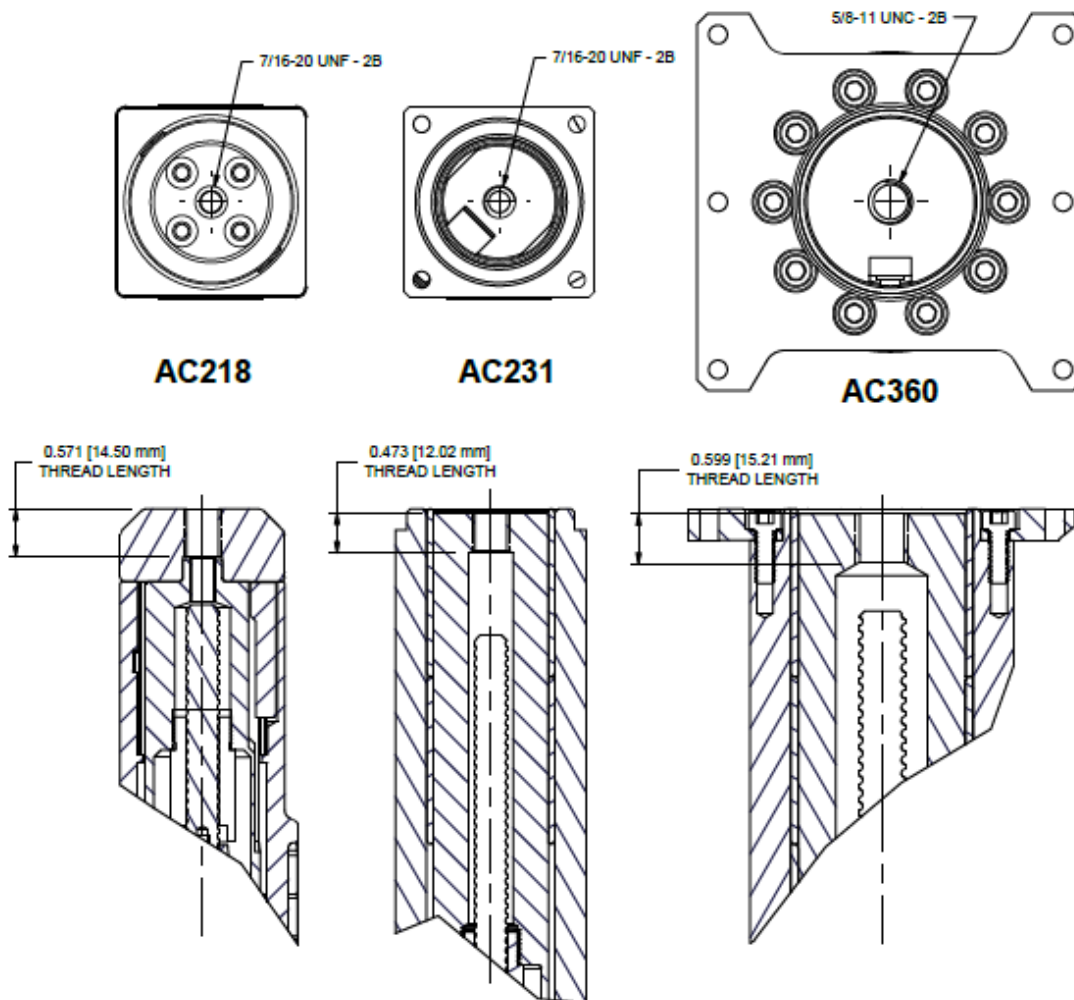


**OEM:** use with 6in - AC360 - actuators.






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

The thread of the captive endings for each actuator is as follow:



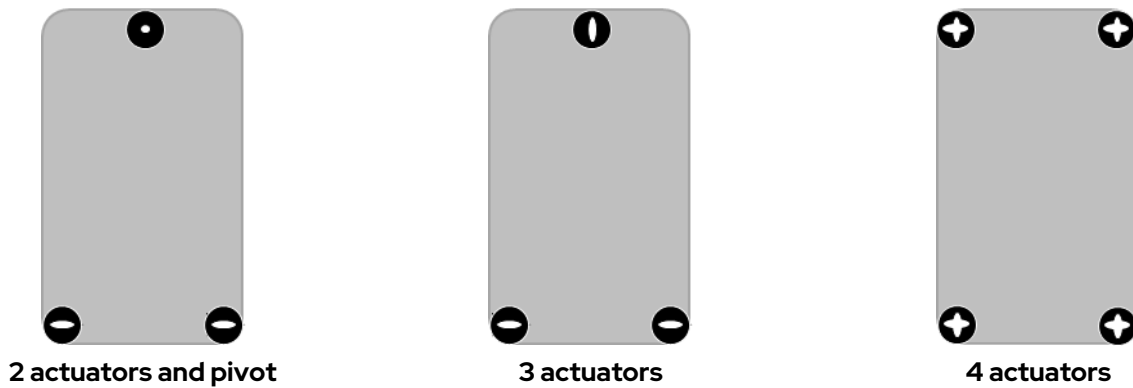
## Spacer retainer

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.

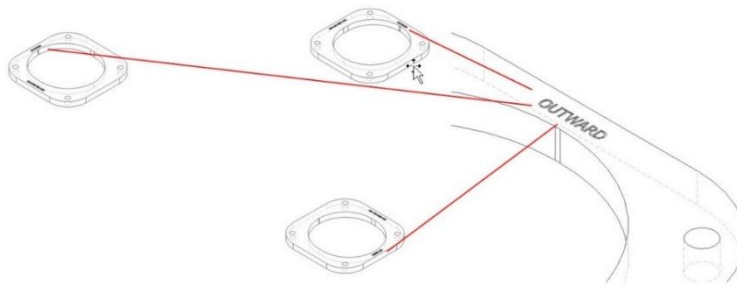
- 
**0 axis** allowing no movement in x and y axis.
- 
**1 axis** allowing movement only on 1 axis (x or y).
- 
**2 axes** allowing movement on 2 axes (x and y).

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

Here are some spacer retainer configurations.



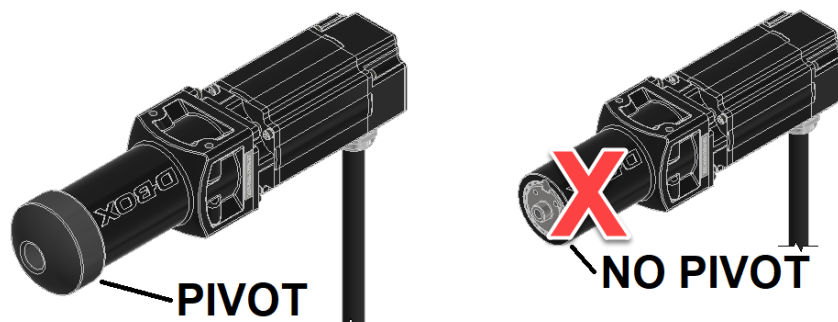
To help with positioning, the spacer retainer is marked **OUTWARD** on its top surface.



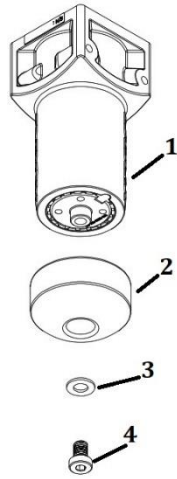
### 1.5-inch actuator - AC218

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

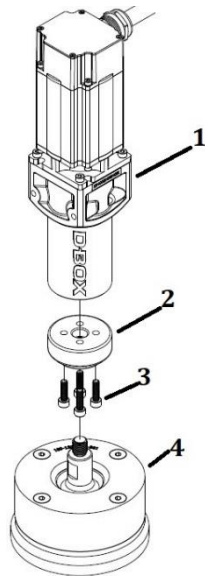
**CAUTION: Never operate the AC218 actuator without the pivot installed. Operating the AC218 actuator without the pivot leads to irreparable damages to the actuator.**



## Removal



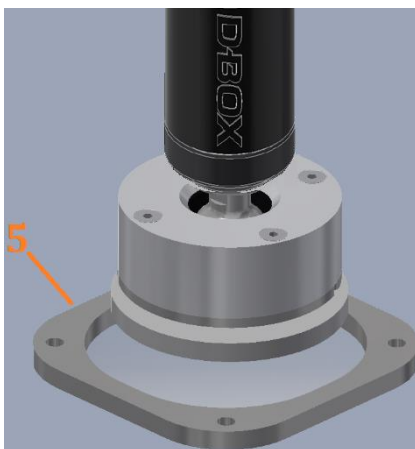
Unscrew bolt (4) with the  $\frac{1}{2}$  hex key and remove washer (3) and pivot (2) from the actuator (1).



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

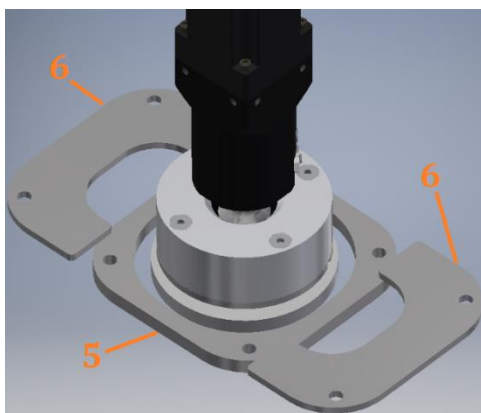
Install pivot (2) on actuator (1) with bolts (3). Torque bolts to 50 lbf in.

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.

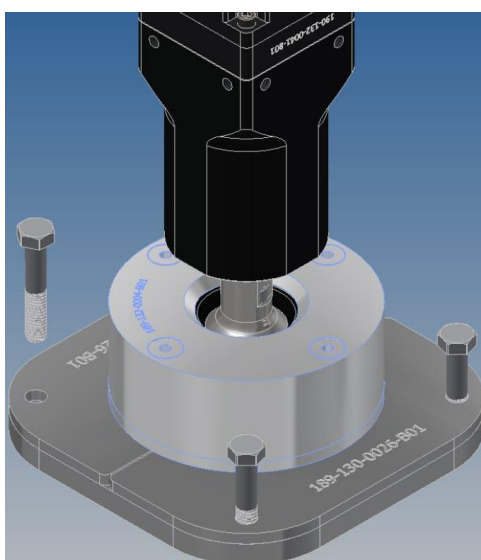


Place spacer (5) at its required location.

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).



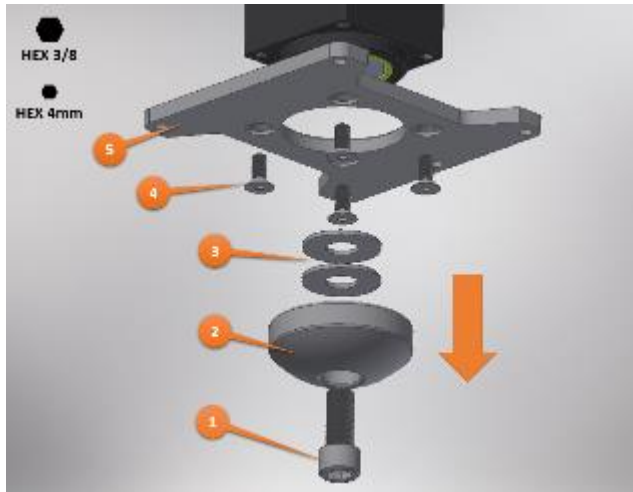
Slide retainers (6) on spacer (5) and in the slot on the ball joint.



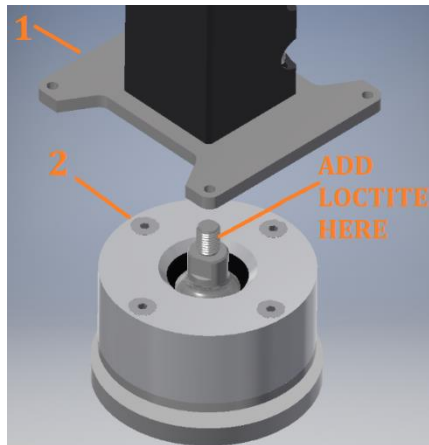
Align the holes in the retainers with the holes in the spacer. Use 5/16 bolts to tighten the spacer and retainers to the floor.

**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

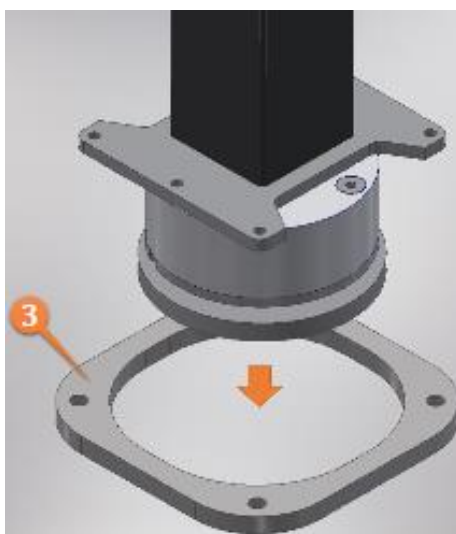


Unscrew bolt (1) with the 3/8 hex key and remove pivot (2) and spacers (3) from the actuator. Unscrew bolt (4) with the 4mm hex key and (optional) remove H-bracket (5) from the actuator.



Add Threadlocker Loctite 263 to the threaded section.

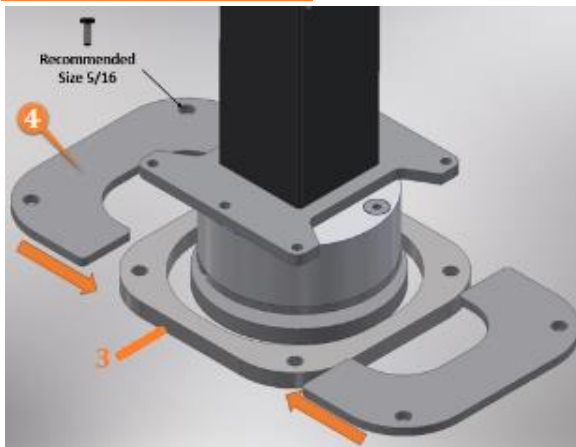
Screw the threaded section in the actuator (1). Use a torque wrench with a 5/8 crow foot socket to tighten the ball joint assembly (2) in the actuator. Torque to 170 lbf in.



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).

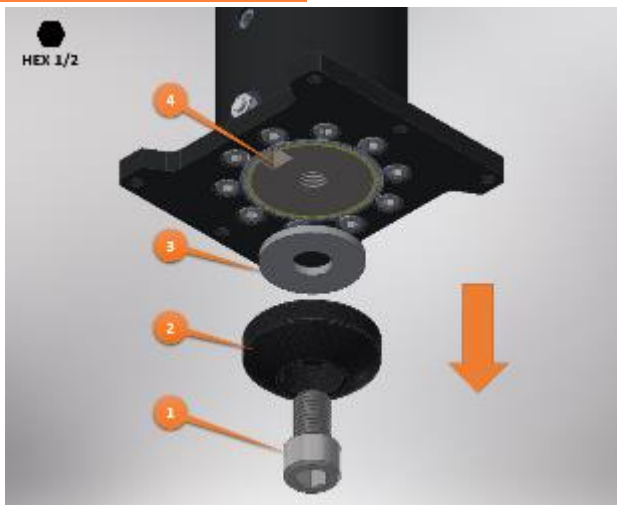
### 3-inch actuator - AC231



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

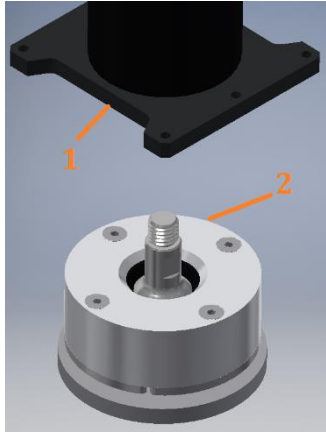
Align the holes in the retainers with the holes in the spacer. Use 5/16 bolts to tighten the spacer and retainers to the floor.

### 6-inch actuator - AC360



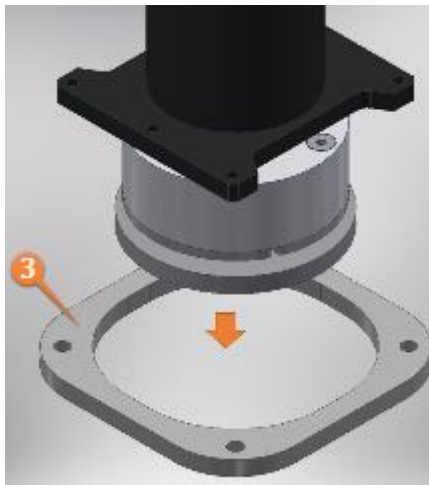
Unscrew bolt (1) with the 1/2 hex key and remove pivot (2) and spacer (3) from actuator (4).

### 3-inch actuator - AC231



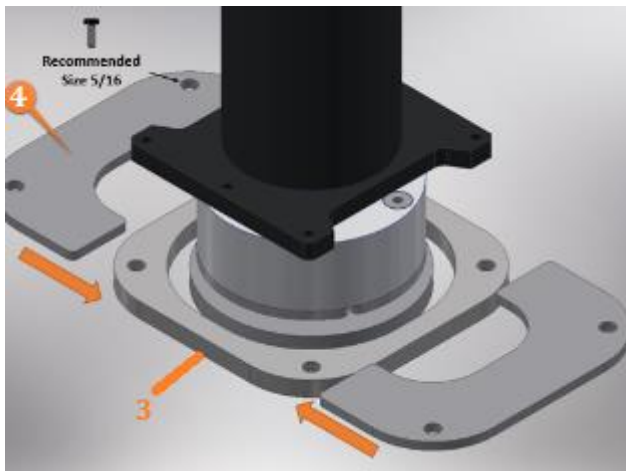
Add Threadlocker Loctite 263 to the threaded section.

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).



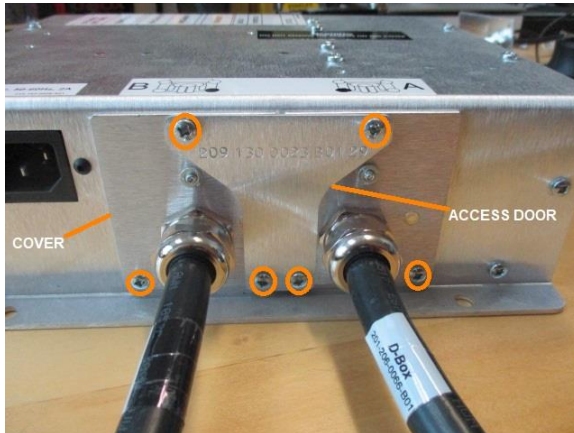
Slide retainers (4) on spacer (3) and in the slot on the ball joint.

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.



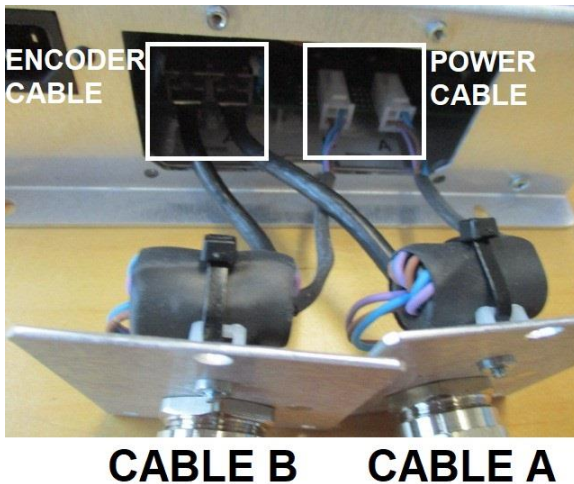
## 9.3 Actuator Installation/Removal from ACM

### Removal



Remove the screws holding the center ACM cover.

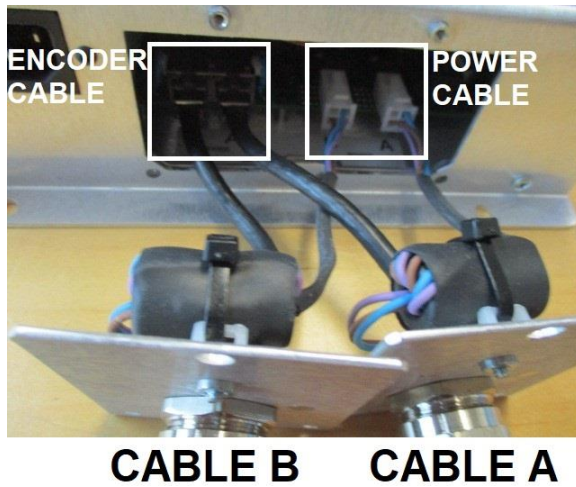
Then remove the remaining screws from the actuator cover and gently pull the actuator cover from the ACM.



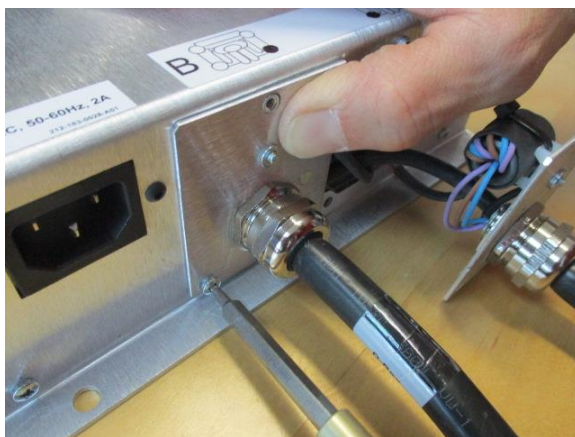
Each actuator is identified by a letter. Each actuator has two cables: a power cable and an encoder cable.

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

## Installation



Plug both power and encoder cables in the ACM.



Install the actuator cover with screw TBD.



Install the center ACM cover with screw TBD.

## 9.4 3-inch Actuator - Mechanic replacement

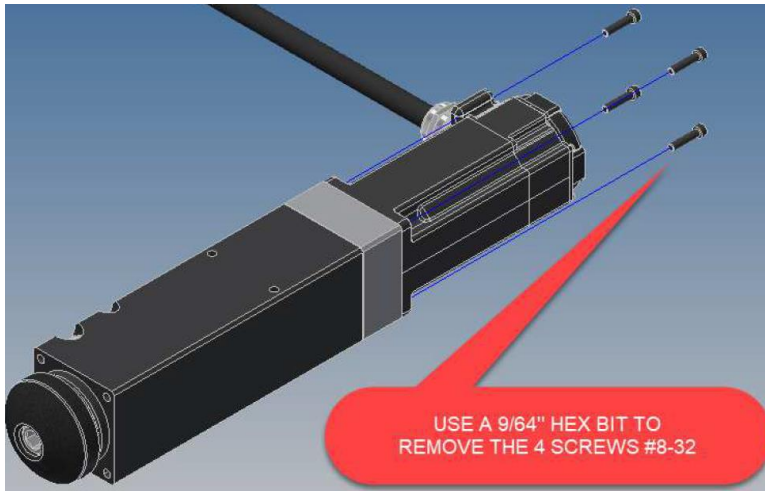
The following tool will be needed:



9/64 in hexagonal screwdriver

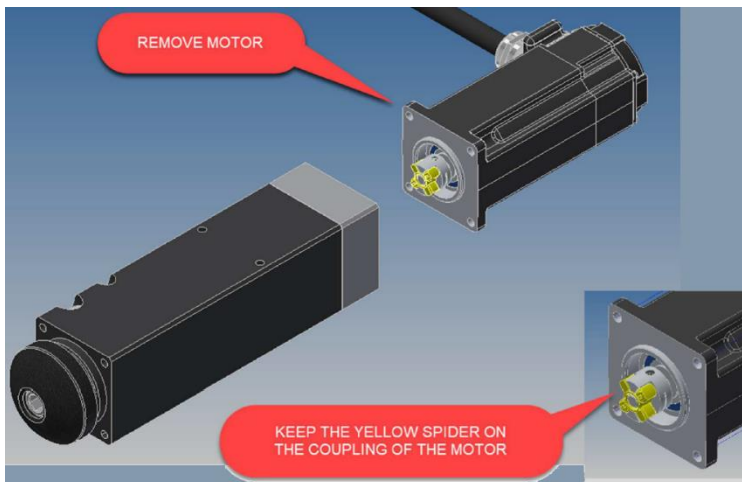
**NOTE:** T-handle will ease the procedure

### Removal of the old mechanic



- 1) Remove the 4 Allen screws #8-32 with the 9/64 hex bit screwdriver.

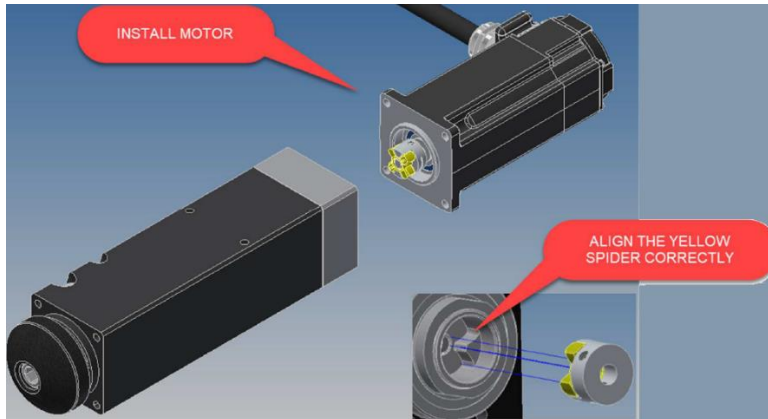
**NOTE:** Keep the screws for reinstallation of the new mechanic.



- 2) Split motor from mechanic.

**NOTE:** Keep the yellow spider on the coupling of the motor.

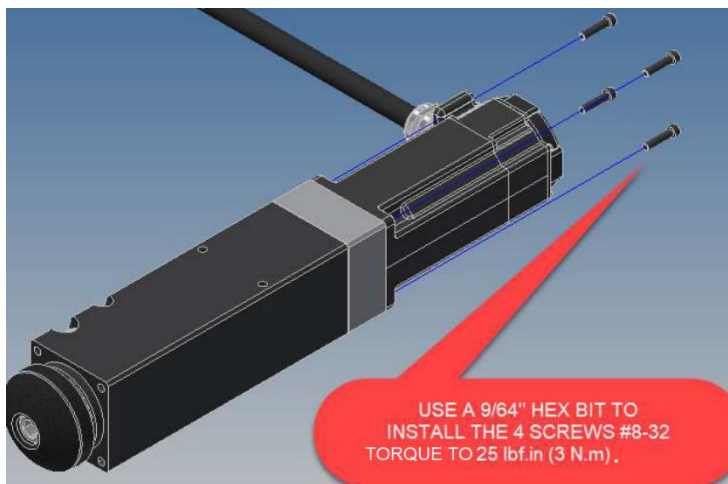
### Installation of the new mechanic



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

**NOTE:** Hold 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 4 screws.
- 3) Check correct operation of the actuator by extending and compressing the piston with your hand.

## 10. RISK ASSESSMENT CRITERIA FOR PRODUCT CERTIFICATION

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