FCAPM Remote Mounting Kit for PKB and PMB Series Actuator

Application

The FCAPM is for high torque applications where the actuator is remote mounted or non-direct coupled to the damper shaft. The PKB and PMB series actuators install directly to the mounting flange of the bracket with the provided hardware. The form fit square shaft interlocks with the actuator's hollow axle creating a robust connection. The crank arm interlocks with the keyed shaft on the opposite side and is secured with cap screws. The FCAPM allows crank arm rotation according to the actuator's maximum angle, which is typically 95° of rotation. PKB and PMB series actuators allow for limiting rotation electronically as needed using the Belimo Assistant App.

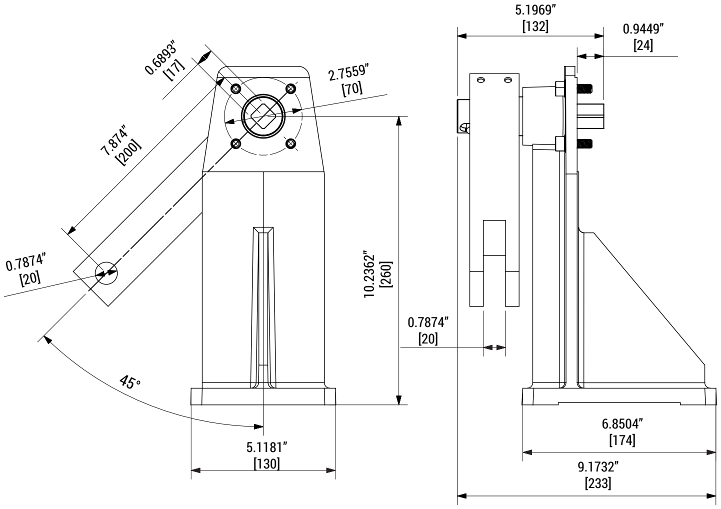
Safety Notes:

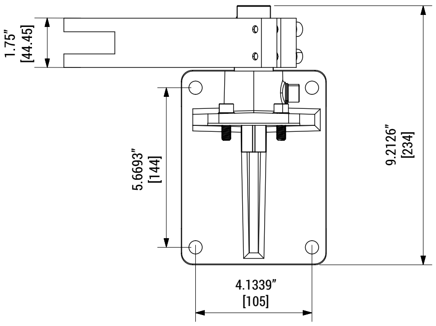
The combination of high actuator torque and linkage components can be hazardous. Always be aware of your surroundings and keep hands and fingers away from moving parts.

Due to the application's high torque requirement, the installed linkage should be tested MANUALLY by using the actuator's manual override crank without power to the actuator.

Ensure the linkage is not bound prior to servicing. Visually inspect the linkage condition and MANUALLY cycle the application prior to interacting with the linkage.

Dimensions





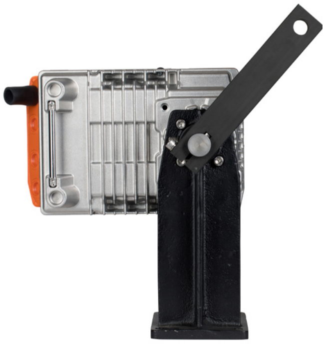
Weight:

24 lbs [10.9 kg]

Material:

Carbon steel

FCAPM with PKB / PMB



Installation

Evaluate the application space available for securing bracket to a sturdy surface. For example, a concrete floor or structural element of the building. A thin sheet of metal will not sufficiently support the weight of the assembly nor the dynamic forces generated by a crank arm delivering at least 1400 in-lbs of torque, or more depending on the linkage geometry selected. Foot mount bolts (not provided) should be fastened with use of four (4) 12 mm foot mount holes.

Align actuator in position with FCAPM. The PKB/PMB can be mounted fully horizontal to either side, or the vertical position. If mounted vertically, the actuator's orientation will be upside down. The drive shaft and actuator's 17x17 mm coupler must be aligned and fully inserted. If needed, the orientation of the crank arm and drive shaft can be adjusted by removing the crank arm. To do so, loosen the two (2) M8 x 45 mm hex socket head cap bolts with a 6 mm Allen wrench located on the crank arm. Then, untighten the M10 x 16 mm hex socket head cap bolt on drive shaft with an 8 mm Allen wrench. Place the drive shaft in desired position.

Note: Keyway insert located in drive shaft. Must align when installing crank arm. Take care to not lose piece.

Once the PKB/PMB is aligned and fully inserted, evenly tighten the four (4) M8 x 25 mm hex socket head cap bolts with washers using a 6 mm Allen wrench to secure actuator to FCAPM. Adjust PKB/PMB with manual handle crank to access bolts as needed. This can also be accomplished by loosening the two (2) M8 x 45 hex socket head cap screws on the crank arm with a 6 mm Allen wrench and uninstalling off the drive shaft.

When assembled and securely tightened, use manual override hand crank on PKB/PMB actuator to ensure desired range of motion. Cycle the actuator through its operational range to verify correct FCAPM set up with power and control signal.

Note: Through bolt and push rod (not provided) type will vary due to application.

Figure 1

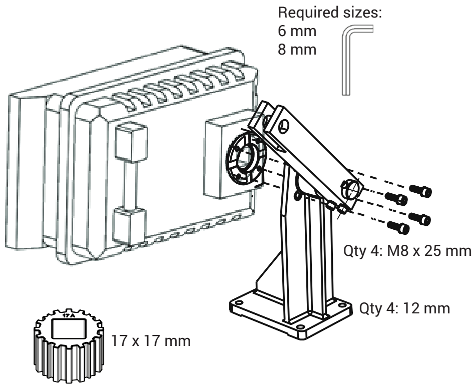
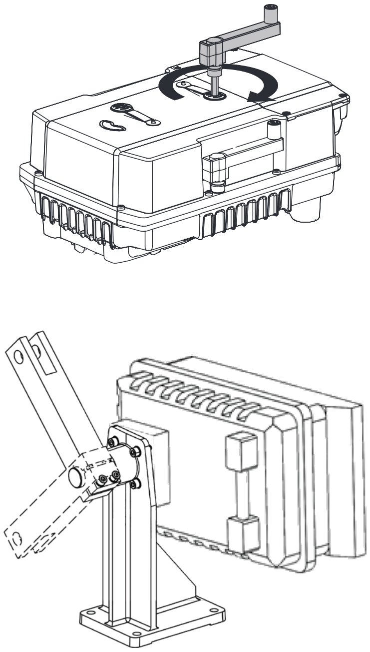


Figure 2

Figure 3



Basic Torque / Linkage Guide

The definition of torque is that it is a turning force. When talking about torque from an engineering standpoint we talk about a force (F), acting on the length of an arm (L), producing a turning force (T) given in a unit which incorporates both a unit of length and force in its description. Looking at this as an equation we would have:

T = L x F; where in common applications L would be in inches, F would be in pounds, and T would be shown as inch-pounds or pound-inches

Figure 4 shows a crank arm with a length between the pivot point to the ball joint attachment of 8”. At the ball joint it shows we are applying a force of 175 pounds. The resulting torque would be 1400 in-lb.

$$T = L \times F = 8 \text{ in} \times 175 \text{ lb} = 1400 \text{ in-lb}$$

When using this equation with actuators it is more common to see it in the following forms:

$$F = T/L \quad \text{or} \quad L = T/F$$

The rating of most electronic actuators is given in torque and it is usually required to find either the force from the crank arm or the length of the crank arm for the application. In Figure 4, if we said the actuator had a torque of 1400 in-lb, and needed a force of 350 lb, we would need a 8” crank arm.

$$L = T/F = 1400 \text{ in-lb}/175 \text{ lb} = 8 \text{ in}$$

Unfortunately, the equation T = L x F is only correct when the force acts upon the crank arm at a 90° angle. At any angle other than 90° the resultant torque or force is dependent on the crank arm effective radius. The effective radius (R), shown in Figure 5, is the distance between the point on the push rod which is perpendicular to the center of rotation of the crank arm and the center of rotation.

We now have to substitute the effective radius (R) in place of the crank arm length (L) in the torque equation.

$$T = R \times F \quad \text{or} \quad F = T/R$$

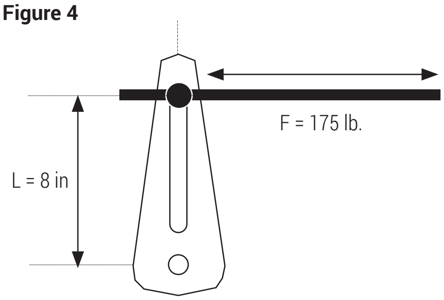
Note: R has its greatest value at the point where the crank arm is perpendicular to the push rod. At this point R equals L.

Figure 5 shows the same torque and crank arm as Figure 4; however, the crank arm is now not perpendicular to the push rod. At this point in the crank arm rotation we show an R of 4”. With the output torque of 1400 in-lb, the resulting force at this point is 350 lb.

$$F = T/R = 1400 \text{ in-lb}/4 \text{ in} = 350 \text{ lb}$$

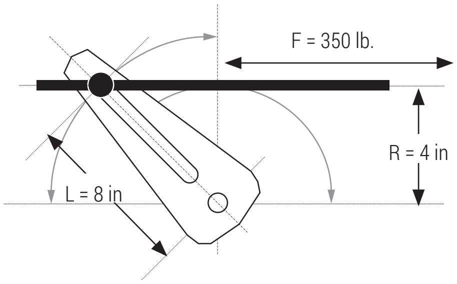
As the effective radius (R) changes during the crank arm rotation, the relationship between torque, force, and even rotational speed changes. By analyzing the crank arm orientation between the actuator and damper, special set ups can be made to optimize certain damper applications.

Figure 4



$$T = L \times F = 8 \text{ in} \times 175 \text{ lb} = 1400 \text{ in-lb}$$

Figure 5



Special Applications

High Close-off Torque

Low leakage dampers with blade seals require a greater close-off torque than the normal operating torque. By setting up the linkage correctly, the torque provided to the damper at close-off can be multiplied.

Figure 6 shows a linkage arrangement where, when the damper is in the closed position, the angle between the actuator crank arm and push rod is relatively large. This angle makes the resulting effective radius at the actuator (Ra) small; this in turn causes a higher force to act on the push rod. When the damper is at close-off, the damper crank arm is adjusted so it is at an angle creating a relatively large effective radius (Rd) at the damper. The large force from the push rod is multiplied by the effective radius (Rd) at the damper and the result is a higher torque at the close off position. The torque from the actuator is actually multiplied at this point by a factor M which is equal to Rd/Ra.

$$M = Rd/Ra$$

One important thing to remember is that at the opposite end of rotation the torque can be reduced to a point where minor binding or friction could lock up the damper.

Faster Response Time at Damper

Figure 7 shows an application where the actuator crank arm is approximately twice as long as the damper crank arm. This results in a rotation at the damper shaft of 90° with only 45° of rotation at the actuator. Using only 45° of the actuator's rotation gives the advantage of the damper operating at twice the actuator's normal speed. A draw back is that the actuator torque is cut in half. It is recommended that the actuator be limited to only 45° of rotation either mechanically (preferred) or electrically. If this is not done, it is possible that the linkage or the damper may be damaged as the actuator continues to rotate.

Limiting Damper Rotation

Figure 8 shows an application where we are limiting the degree of rotation while still using the full 90° rotation of the actuator. The crank arm shown of the actuator is shorter than the arm on the damper. Because of the smaller arc produced at the actuator arm, the push rod travel cannot rotate the damper arm through a full 90° rotation.

General Comments

The use of a linkage assembly can be advantageous if a solution to a special need is required. However, great care must be taken in planning the linkage geometry. Any change made to the linkage has an effect on more than one condition. As an example, if you adjust the linkage for more torque, you will at the same time effect the damper rotational speed and the angle of the damper rotation. In any special application it is necessary to use a trial-and-error, back-and-forth method to set the required parameters. This can be a very time consuming process, but it should be done.

Figure 6

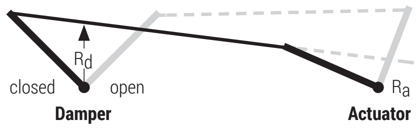


Figure 7

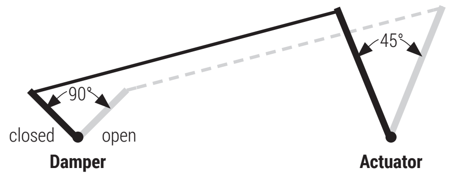


Figure 8