

# Installation Instructions

## Quick-Mount Visual Instructions for Mechanical Installation

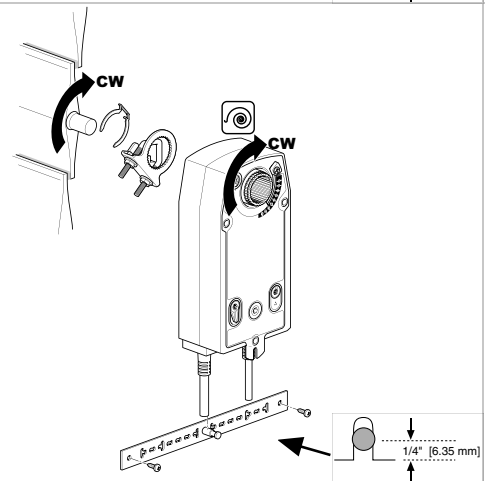
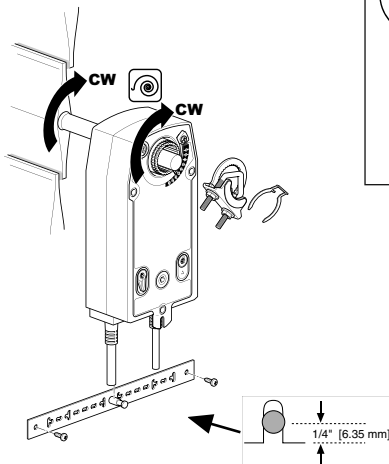
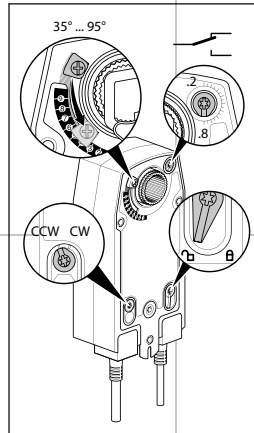
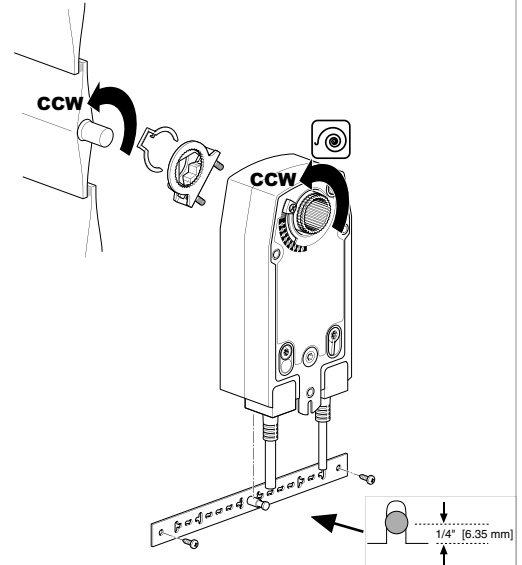
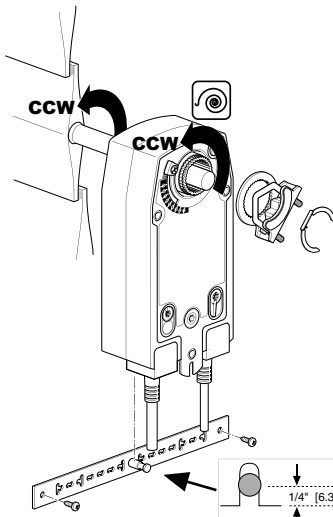
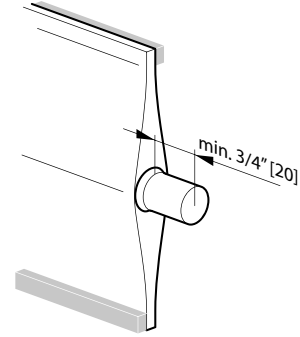
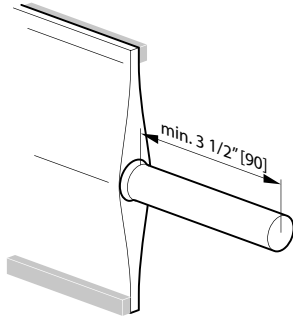


### Quick-Mount Visual Instructions

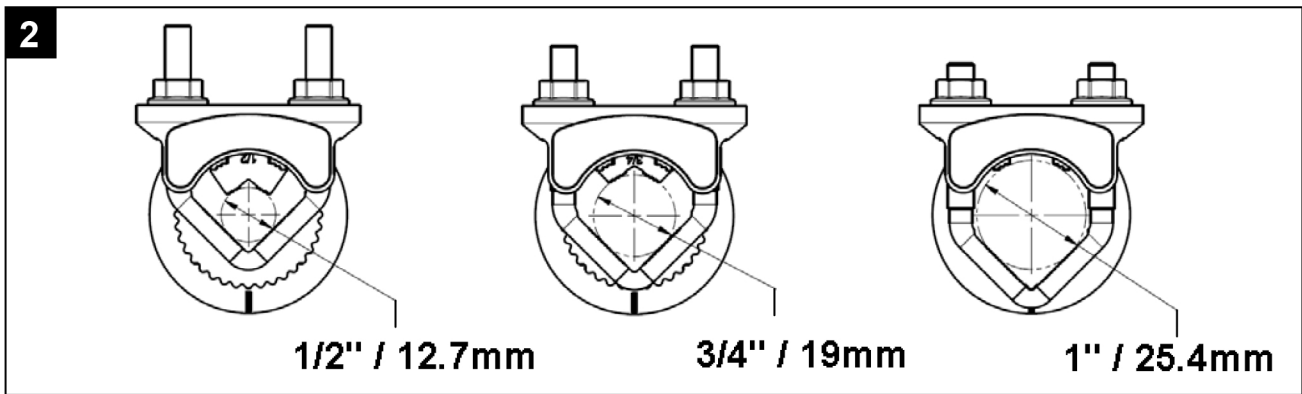
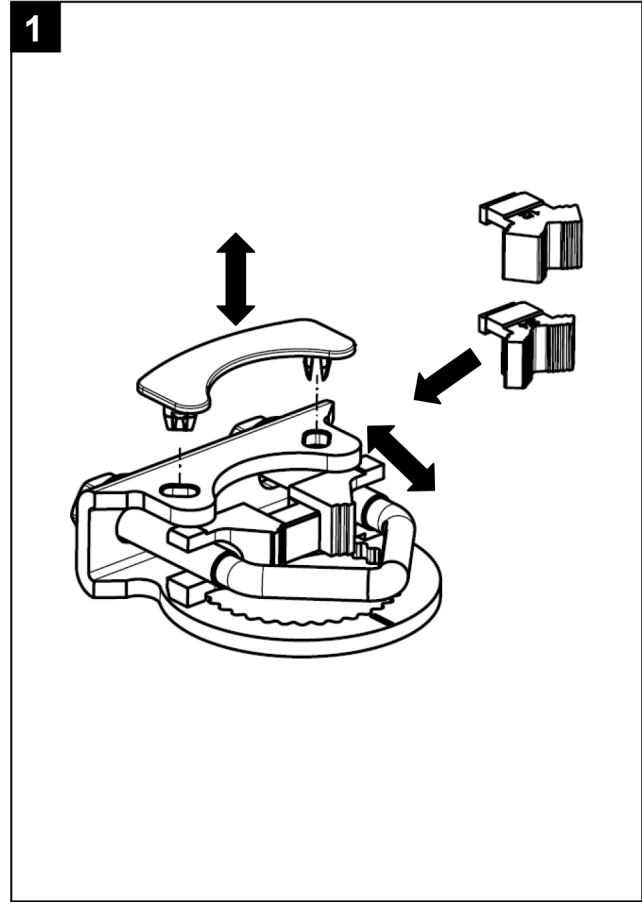
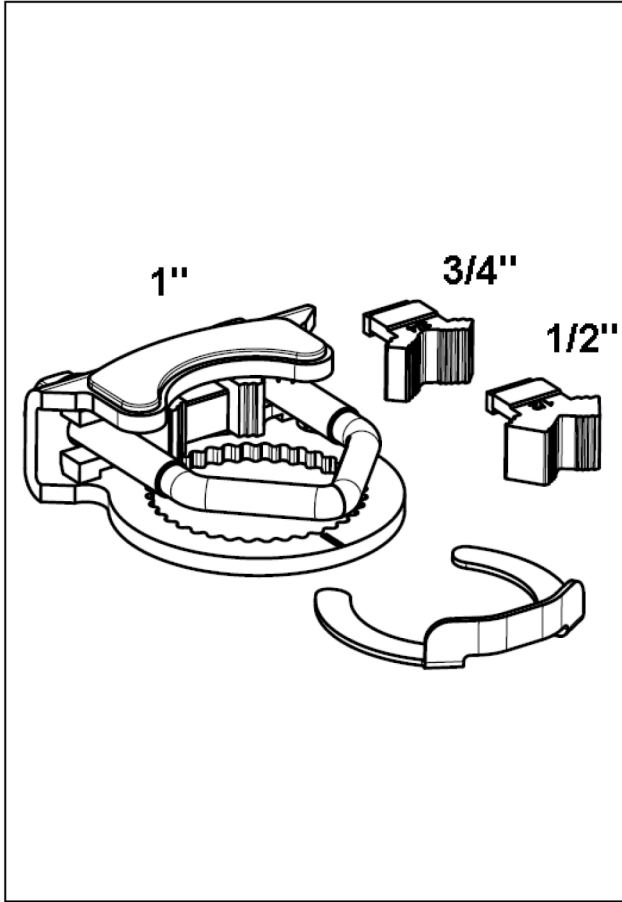
1. Rotate the damper to its fail-safe position.  
If the shaft rotates counterclockwise, mount the "CCW" side of the actuator out.  
If it rotates clockwise, mount the actuator with the "CW" side out.
2. If the universal clamp is not on the correct side of the actuator, mount it onto the correct side.
3. Slide the actuator onto the shaft and tighten the nuts on the V-bolt with a 10mm wrench to 6-8 ft-lb of torque.
4. Slide the anti-rotation strap under the actuator so that it engages the slot at the base of the actuator. Secure the strap to the duct work with #8 self-tapping screws.






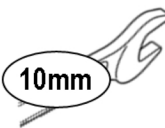
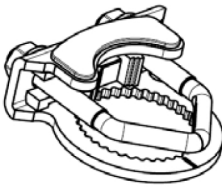
NOTE: Read the "Standard Mounting" instructions, on the next page, for more detailed information.

### Dimensions (Inches [mm])



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|  |             |  |  |  |  |  <b>10mm</b> |  |
|---|-------------|---|---|---|---|--|---|
| <b>1/2"</b>   | <b>mm</b>   | <b>12.7</b>   | <b>10 ... 19</b>  | ---   | <b>14 ... 20</b>  |  |   |
|   | <b>inch</b> | <b>1/2</b>  | <b>3/8 ... 3/4</b>  | ---   | <b>9/16 ... 3/4</b>   |  |   |
| <b>3/4"</b>   | <b>mm</b>   | <b>19</b>   | <b>10 ... 22</b>  | <b>10</b>   | <b>14 ... 25.4</b>  |  |   |
|   | <b>inch</b> | <b>3/4</b>  | <b>3/8 ... 3/4</b>  | <b>3/8</b>  | <b>9/16 ... 1</b>   |  |   |
| <b>1"</b>   | <b>mm</b>   | <b>25.4</b>   | <b>19 ... 26.7</b>  | <b>12 ... 18</b>  | ---   |  |   |
|   | <b>inch</b> | <b>1</b>  | <b>3/4 ... 1.05</b>   | <b>1/2 ... 11/16</b>  | ---   |  |   |

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# Installation Instructions

## Mechanical Installation



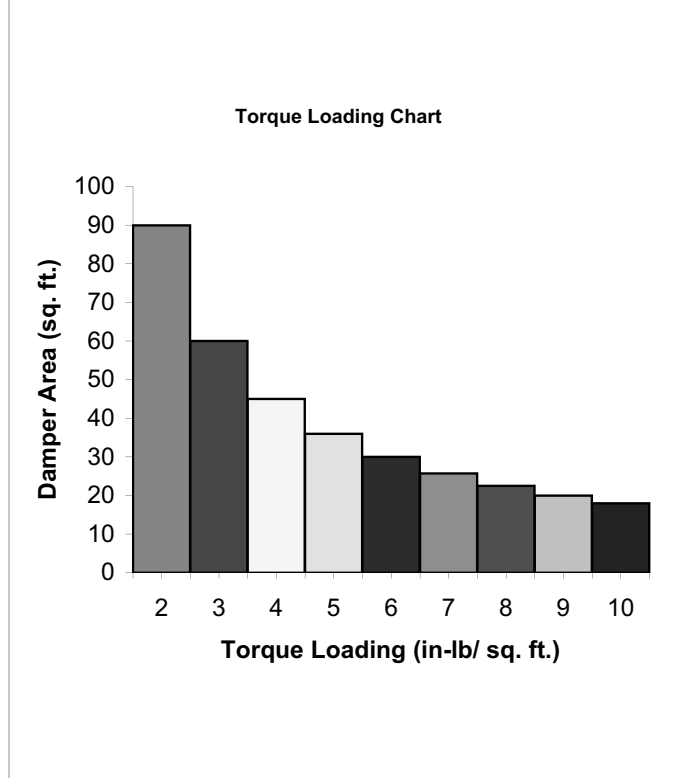
### Determining Torque Loading and Actuator Sizing

Damper torque loadings, used in selecting the correct size actuator, should be provided by the damper manufacturer. If this information is not available, the following general selection guidelines can be used.

| Damper Type  | Torque Loading  |
|--|-----------------|
| Opposed blade, without edge seals, for non-tight close-off applications  | 3 in-lb/sq. ft. |
| Parallel blade, without edge seals, for non-tight close-off applications | 4 in-lb/sq. ft. |
| Opposed blade, with edge seals, for tight close-off applications         | 5 in-lb/sq. ft. |
| Parallel blade, with edge seals, for tight close-off applications        | 7 in-lb/sq. ft. |

The above torque loadings will work for most applications with 1000 FPM face velocity. For applications between this criteria and 2500 FPM, the torque loading should be increased by a multiplier of 1.5. If the application calls for higher criteria up to 3000 FPM, use a multiplier of 2.0.

### Torque Loading Chart



### General Information

Belimo actuators should be mounted indoors in a dry, relatively clean environment free from corrosive fumes. If the actuator is to be mounted outdoors, a protective enclosure must be used to shield the actuator.

For new construction work, **order dampers with extended shafts**. Instruct the installing contractor to allow space for mounting and service of the Belimo actuator on the shaft. The damper shaft must extend at least 3 1/2" from the duct. If the shaft extends less than 3-1/2" or if an obstruction blocks access, the shaft can be extended with the AV 8-25 shaft extension accessory or the actuator may be mounted in its short shaft configuration.

### Mechanical Operation

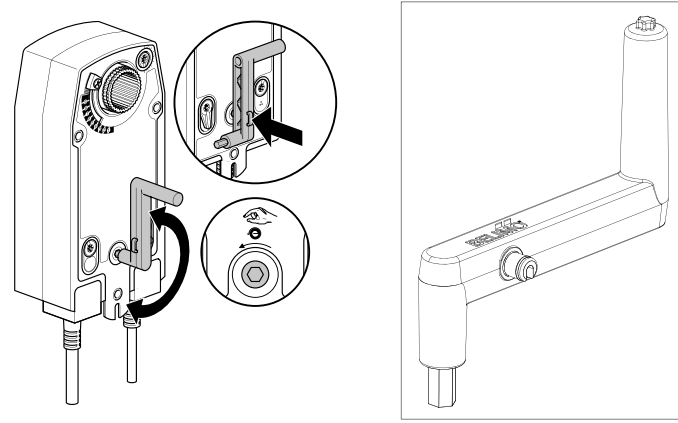
The actuator is mounted directly to a damper shaft up to 1.05" in diameter by means of its universal clamp. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft. The AFB, AFX series actuators provide true spring return operation for reliable fail-safe application and positive close-off on air tight dampers. The spring return system provides constant torque to the damper with, and without, power applied to the actuator. The AFB...-S, AFX...-S versions are provided with two built-in auxiliary switches. These SPDT switches are provided for safety interfacing or signaling, for example, for fan start-up. The switching function at the fail-safe position is fixed at +10°, the other switch function is adjustable between +10° to +90°.

### Automatic Airtight Dampers/Manual Override

The AFB, AFX series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°.

The AFB, AFX has a unique built in manual positioning mechanism which allows the setting of any damper position within its 95° of rotation. A pre-tensioned spring automatically tightens the damper when power is applied to the actuator, compensating for damper seal deterioration..

The actuator is shipped at +5° (5° from full fail-safe) to provide automatic compression against damper gaskets for tight shut-off. When power is applied, the manual mechanism is released and the actuator drives toward the full fail-safe position.



### Standard Mounting

**NOTE:** The AFB, AFX...series actuator is shipped with the manual override adjusted for a +5° position at the universal clamp (not at full fail-safe, 0°). This allows for automatic compression of damper blade seals when the actuator is in use, providing tight shut-off. This assumes that the damper is to have tight shut-off at the fail-safe position. If tight close-off is desired at the opposite direction from fail-safe, the manual override should be released so the actuator can go to the full fail-safe position. See the manual override instructions.

1. Manually move the damper to the fail-safe position (usually closed). If the shaft rotated counterclockwise (↺), this is a CCW installation. If the shaft rotated clockwise (↻), this is a CW installation. In a CCW installation, the actuator side marked "CCW" faces out, while in a CW installation, the side marked "CW" faces out. All other steps are identical.
2. The actuator is usually shipped with the universal clamp mounted to the "CCW" side of the actuator. To test for adequate shaft length, slide the actuator over the shaft with the side marked "CCW" (or the "CW" side if this is the side with the clamp). If the shaft extends at least 1/8" through the clamp, mount the actuator as follows. If not, go to the *Short Shaft Installation* section.
3. If the clamp is not on the correct side as determined in step #1, re-mount the clamp as follows. If it is on the correct side, proceed to step #5. Look at the universal clamp. If you are mounting the actuator with the "CCW" side out,

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position the clamp so that the pointer section of the tab is pointing to 0° (see Figure C) and the spline pattern of the clamp mates with spline of the actuator. Slip the clamp over the spline. (Use the same procedure if the “CW” side is out.) If your application requires a mechanical minimum position, read the *Rotation Limiting, Mechanical Minimum Damper Position* section.

4. Lock the clamp to the actuator using the retaining clip.
5. Verify that the damper is still in its full fail-safe position.
6. Slide the actuator over the shaft.
7. Position the actuator in the desired location.
8. Tighten the two nuts on the clamp using a 10mm wrench or socket using 6-8 ft-lb of torque.
9. Slip the stud of the anti rotation strap into the slot at the base of the actuator. The stud should be positioned approximately 1/16 of an inch from the closed end of the slot. Bend the strap as needed to reach the duct. Attach the strap to the duct with #8 self tapping screws.

### Short Shaft Installation

If the shaft extends at least 3/4” from the duct, follow these steps:

1. Determine the best orientation for the universal clamp on the back of the actuator. The best location would be where you have the easiest access to the V bolt nuts on the clamp.
2. Engage the clamp to the actuator as close as possible to the determined location.
3. Lock the clamp in place using the remaining retainer clip.
4. Verify that the damper is still in its full fail-safe position.
5. Slide the actuator over the shaft.
6. Position the actuator in the desired location.
7. Tighten the two nuts on the clamp using a 10mm wrench or socket using 6-8 ft-lb of torque.
8. Slip the stud of the anti-rotation strap into the slot at the base of the actuator. The stud should be positioned approximately 1/16 of an inch from the closed end of the slot. Bend the strap as needed to reach the duct. Attach the strap to the duct with #8 self tapping screws.
9. If damper position indication is required, use the optional IND-AFB pointer. See **Figure A**.

### Jackshaft Installation

The AFB, AFX... series actuator is designed for use with jackshafts up to 1.05” in diameter. In most applications, the AFB, AFX actuator may be mounted in the same manner as a standard damper shaft application. If more torque is required than one AFB, AFX actuator can provide, a second AFB, AFX actuator may be mounted to the jackshaft using the ZG-102 multiple actuator mounting bracket. *See wiring guide for wiring details.*

#### AF ACTUATORS WHICH MAY BE USED ON ONE SHAFT

| Model                         | Maximum Quantity Per Shaft |
|-------------------------------|----------------------------|
| AFB24-MFT(-S), AFX24-MFT (-S) | 3                          |
| AFBUP(-S), AFXUP(-S)          | 2                          |

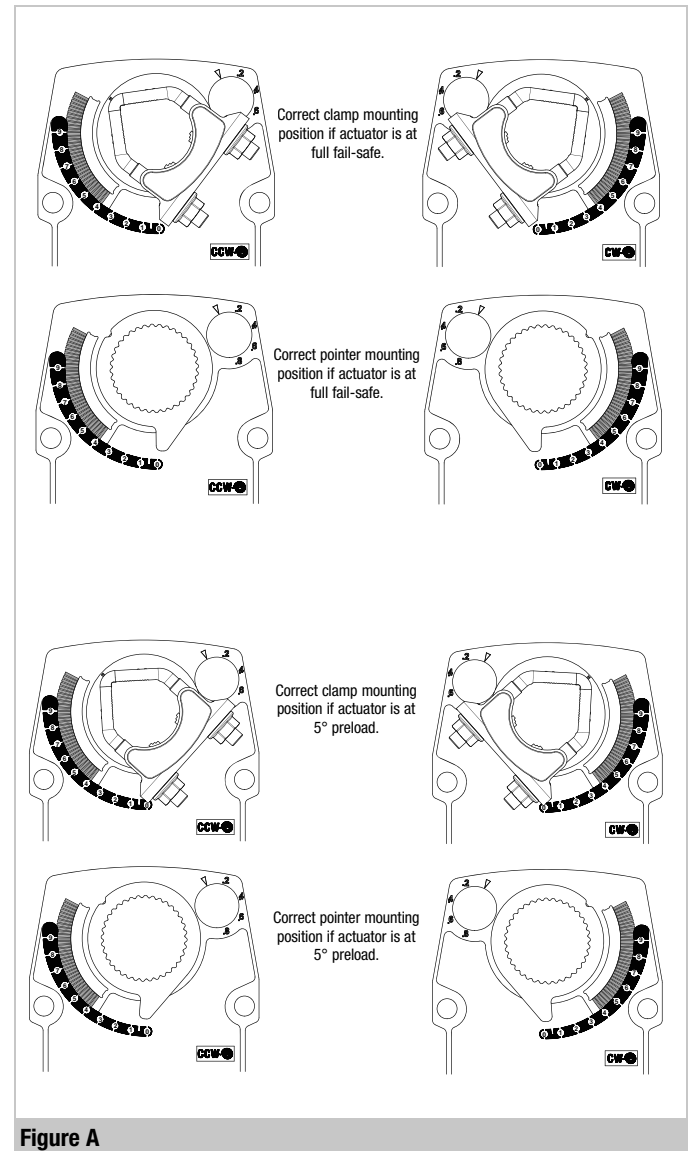
**MOUNTING:** If the actuators are mounted on the opposed ends of the shaft, the actuator direction must be selected carefully. Usually, the direction of rotation is reversed.

### Multiple Actuator Mounting

If more torque is required than one AFB, AFX actuator can provide, a second AFB, AFX actuator may be mounted to the shaft using the ZG-102 multiple mounting bracket.

**NOTE:** The manual positioning mechanism cannot be used in multiple actuator applications.

**Special Wiring and Additional Information:** See wiring guide



**Figure A**

### Rotation Limitation

The angle of rotation limiter, which is built into the actuator, is used in conjunction with the tab on the universal clamp or IND-AFB position indicator. In order to function properly, the clamp or indicator must be mounted correctly.

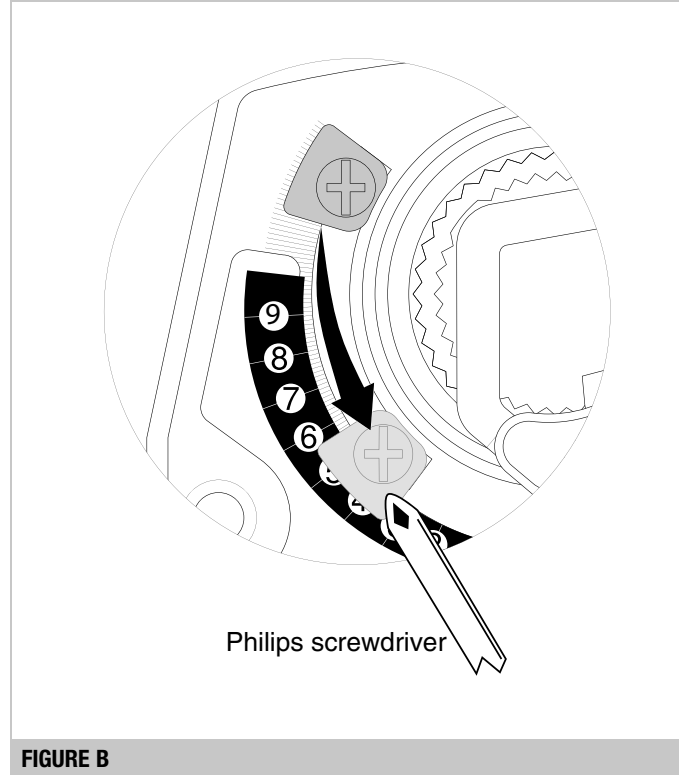
See **Figure A**.

The rotation limiter may not work in certain mounting orientations using the ZG-118 mounting bracket. Limiting the damper rotation must be accomplished by adjusting the crank arm linkage.

The built-in rotation limiter may be used in 2 ways to control the rotational output of the AFB, AFX series actuator. One use is in the application where a damper has a designed rotation less than 90°. An example would be a 45° or 60° rotating damper. The other application would be to set a minimum damper position which can be easily set or changed without having to remove the actuator from the damper.

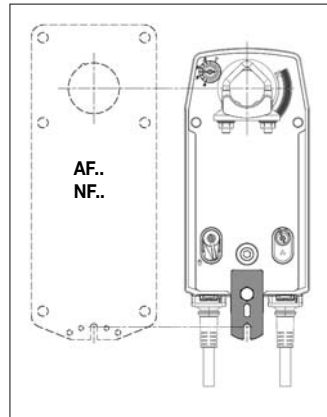
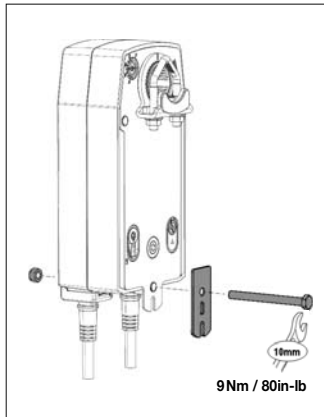
### Damper Rotation Limiting

1. Determine the amount of damper rotation required.
2. Locate the Angle of Rotation Limiter on the actuator **Figure B**.
3. Position the limiter to the desired position, making sure the locating “teeth” on the limiter are engaged into the locating holes on the actuator.
4. Fasten the limiter by screwing the attached screw.
5. Test the damper rotation either manually with the manual crank or apply power and if required, a control signal. Re-adjust if necessary.



**FIGURE B**

### Z-AF For Replacing AF and NF Actuators

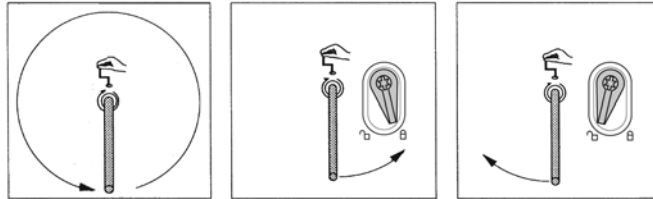


### Manual Override

The AFB, AFX series actuators can be manually positioned to ease installation or for emergency positioning.

1. The manual override will only work if no power is available to the actuator.
2. Insert the manual crank (shipped with the actuator) into the hexagon hole located on either side of the actuator. An illustration, located on the label, shows the location.
3. Turn the crank in the direction shown on the label (clockwise on the "CW" side, counterclockwise on the "CCW" side). It will take approximately 23 revolutions to rotate the full 95° of rotation.
4. To lock the actuator in the required position, flip the switch to the locked position that is located to the right of the crank on the CCW side of the actuator (left of the crank on the CW side).
5. The manual override may be disengaged in 2 ways.
  - Flip the switch to the unlocked position and the actuator will go to its fail-safe position.
  - Apply power to wire 1 and 2. The actuator will automatically disengage the override function and will go to the "on" position in the case of the On/Off versions. Or, in the case of the proportional versions, go to the 0 signal position and then go to the position corresponding to the control signal. The actuator will now work normally.

#### CCW Side Example:



#### Winding the damper actuator

- insert crank handle
- turn handle in direction of arrow

#### Locking the damper actuator

- Flip the lock switch to the position pointing to the "locked" symbol

#### Unlocking the damper actuator (2 options)

- Flip the lock switch to the position pointing to the "unlocked" symbol.
- Remote control by supplying power to the unit for > than 3 sec.

### Testing the installation Without Power

The actuator/damper installation may be tested without power at the actuator. Refer to the manual positioning section of the instructions. Move the damper to its full non-fail-safe position using the manual crank. Disengage the manual position mechanism and have the damper go to full fail-safe position. Correct any mechanical problems and retest.

### Auxiliary Switches

The AFB, AFX series actuators may be ordered with two built-in SPDT auxiliary switches used for safety interfacing or signaling, for example, for fan start-up. The switch position near the fail-safe position is fixed at 10°. The other is adjustable between 10° and 90° of rotation. The crank that is supplied with the actuator is used to change the switch position.

#### SWITCH RATING

| Voltage | Resistive Load | Inductive Load |
|---------|----------------|----------------|
| 120 VAC | 3A             | 1.03A          |
| 250 VAC | 3A             | 0.5A           |

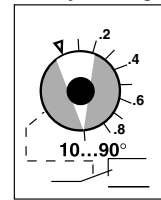
Two methods may be used to adjust the switching point of the adjustable switch.

#### Method 1 - See Figure F

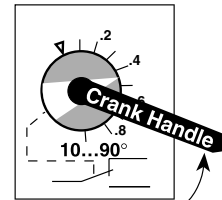
1. The actuator must be in its fail-safe position.
2. Insert the crank handle into the torx shaped hole located in the center of the adjustable switch pointer.
3. Gently rotate the crank until the switch pointer is at the desired switch point in degrees as shown.

#### AFB, AFX... Series

##### Factory setting 90°



##### Rotate with crank handle



##### 60° set

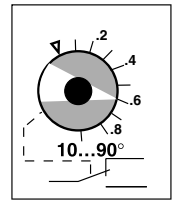


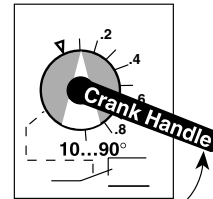
FIGURE F

#### Method 2 - See Figure G

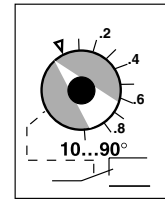
1. Position the damper to the point at which you want the switch to activate. This may be done by using the manual override or by providing the appropriate proportional signal to AFB24, AFX24... modulating type actuator. The position of the switch pointer is not important during this step
2. Insert the crank into the hexagon shaped hole located in the center of the adjustable switch pointer.
3. Gently rotate the switch pointer to just past the switch point indicating arrow as shown.

#### AFB, AFX... Series

##### Actuator after locking



##### Switch operates



##### Switch does not operate

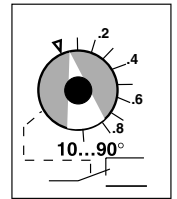


FIGURE G

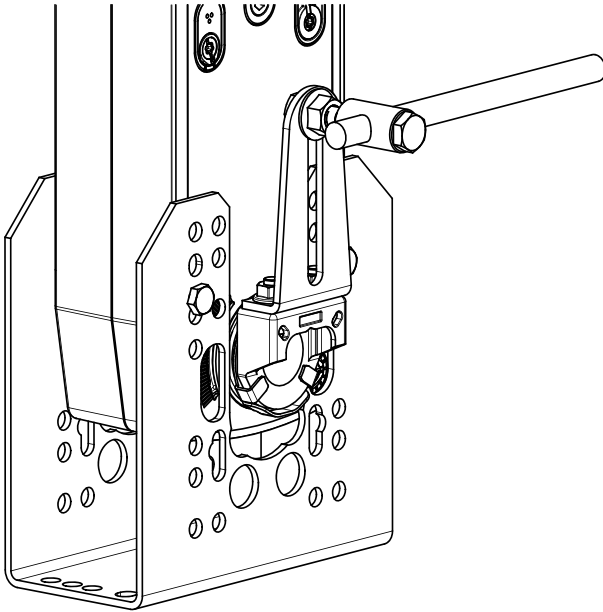
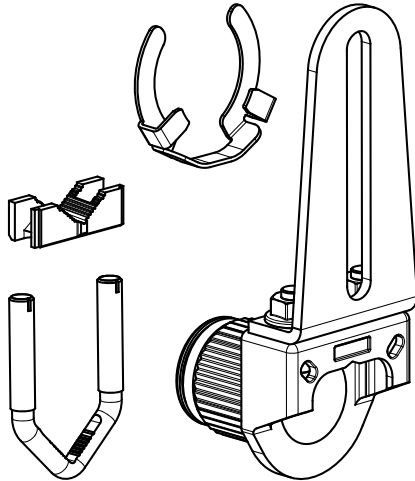
# KH-AFB Crank arm

## Including Retaining Ring

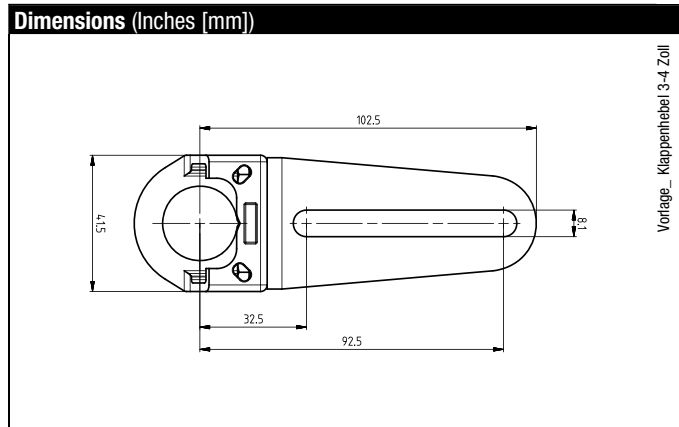
**CAUTION:** The retaining clip supplied with the clamp is **not** used to mount the KH-AFB crank arm.

The KH-AFB crank arm is used in non-direct coupled mounting applications. The KH-AFB may also be used to simultaneously direct couple to a damper shaft and provide an additional crank arm connection to a second damper.

**KH-AFB** For round shafts up to 3/4" or square shafts up to 5/8"



**KH-AFB non-direct mounting with ZG-118 mounting bracket**



### General

The AFB, AFX series actuators utilize both DC Motors and brushless DC motor technology. The AFB, AFX uses this motor in conjunction with an Application Specific Integrated Circuit (ASIC). In the On/Off versions of the AFB and AFX, the ASIC monitors and controls the actuator's rotation and a digital rotation sensing function to prevent damage to the actuator. The AFB24, AFX24... modulates type actuators incorporate a built in microprocessor. The microprocessor provides the intelligence to the ASIC to provide a constant rotation rate and knows the actuator's exact zero position.

### Brushless DC Motor Operation

Belimo's brushless DC motor spins by reversing the poles of stationary electromagnets housed inside of a rotating permanent magnet. The electromagnetic poles are switched by a special ASIC circuit developed by Belimo. Unlike the conventional DC motor, there are no brushes to wear or commutators to foul.

### Overload Protection

The AFB, AFX series actuators are protected from overload at all angles of rotation. The ASIC circuit constantly monitors the rotation of the DC motor inside the actuator and stops the pulses to the motor when it senses a stall condition. The DC motor remains energized and produces full rated torque to the load. This helps ensure that dampers are fully closed and that edge and blade seals are always properly compressed.

### Motor Position Detection

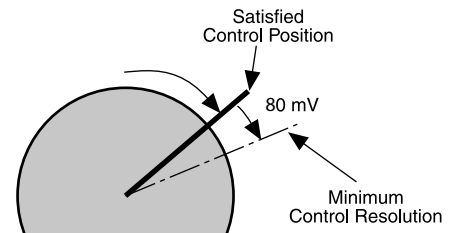
Belimo brushless DC motors eliminate the need for potentiometers for positioning in modulating type actuators. Inside the motor are three "Hall Effect" sensors. These sensors detect the spinning rotor and send pulses to the microprocessor which counts the pulses and calculates the position to within 1/3 of a revolution of the motor.

### Control Accuracy and Stability

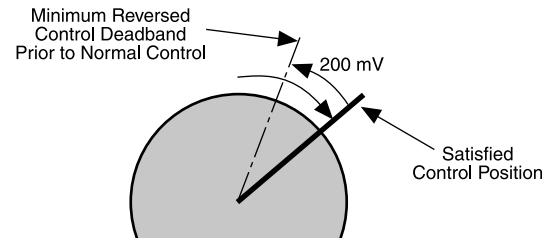
AFB24-MFT, AFX24-MFT actuators have built-in brushless DC motors which provide better accuracy and longer service life.

The AFB24-MFT, AFX24-MFT actuators are designed with a unique non-symmetrical deadband. The actuator follows an increasing or decreasing control signal with a 80 mV resolution. If the signal changes in the opposite direction, the actuator will not respond until the control signal changes by 200 mV. This allows these actuators to track even the slightest deviation very accurately, yet allowing the actuator to "wait" for a much larger change in control signal due to control signal instability.

#### AF Actuator responds to an 80 mV signal when not changing direction from stop



#### AF Actuator responds to a 200 mV signal when reversing direction from stop position.



**Note:** Resolution is a percentage of operating range. 1% in one direction, 2.5% when changing direction. 2-10 VDC control example shown above.



**WARNING** The wiring technician must be trained and experienced with electronic circuits. Disconnect power supply before attempting any wiring connections or changes. Make all connections in accordance with wiring diagrams and follow all applicable local and national codes. Provide disconnect and overload protection as required. Use copper, twisted pair, conductors only. If using electrical conduit, the attachment to the actuator must be made with flexible conduit.

**Always read the controller manufacturer's installation literature carefully before making any connections.** Follow all instructions in this literature. If you have any questions, contact the controller manufacturer and/or Belimo.

### Transformers

The AFB24, AFX24...actuators require a 24 VAC class 2 transformer and draws a maximum of 10 VA per actuator. The actuator enclosure cannot be opened in the field, there are no parts or components to be replaced or repaired.

- EMC directive: 89/336/EEC
- Software class A: Mode of operation type 1
- Low voltage directive: 73/23/EEC

**CAUTION:** It is good practice to power electronic or digital controllers from a separate power transformer than that used for actuators or other end devices. The power supply design in our actuators and other end devices use half wave rectification. Some controllers use full wave rectification. When these two different types of power supplies are connected to the same power transformer and the DC commons are connected together, a short circuit is created across one of the diodes in the full wave power supply, damaging the controller. Only use a single power transformer to power the controller and actuator if you know the controller power supply uses half wave rectification.

### Multiple Actuators, One Transformer

Multiple actuators may be powered from one transformer provided the following rules are followed:

1. The TOTAL current draw of the actuators (VA rating) is less than or equal to the rating of the transformer.
2. Polarity on the secondary of the transformer is strictly followed. *This means that all No. 1 wires from all actuators are connected to the common leg on the transformer and all No. 2 wires from all actuators are connected to the hotleg.* Mixing wire No. 1 & 2 on one leg of the transformer will result in erratic operation or failure of the actuator and/or controls.

### Multiple Actuators, Multiple Transformers

Multiple actuators positioned by the same control signal may be powered from multiple transformers provided the following rules are followed:

1. The transformers are properly sized.
2. All No. 1 wires from all actuators are tied together and tied to the negative leg of the control signal. See wiring diagram.

### Wire Length for AFB..., AFX... Actuators

Keep power wire runs below the lengths listed in the **Figure H**. If more than one actuator is powered from the same wire run, divide the allowable wire length by the number of actuators to determine the maximum run to any single actuator.

Example: 3 actuators, 16 Ga wire  
 $350 \text{ Ft} \div 3 \text{ Actuators} = 117 \text{ Ft. Maximum wire run}$

| MAXIMUM WIRE LENGTH FOR 10VA |            |           |           |
|------------------------------|------------|-----------|-----------|
| Wire Size                    | Max. Feet. | Wire Size | Max. Feet |
| 12 Ga                        | 900 Ft.    | 18 Ga     | 220 Ft.   |
| 14 Ga                        | 550 Ft.    | 20 Ga     | 120 Ft.   |
| 16 Ga                        | 350 Ft.    | 22 Ga     | 60 Ft.    |

**FIGURE H**

### Wire Type and Wire Installation Tips

For most installations, 18 or 16 Ga. cable works well with the AFB24, AFX24...actuators. Use code-approved wire nuts, terminal strips or solderless connectors where wires are joined. It is good practice to run control wires unspliced from the actuator to the controller. If splices are unavoidable, make sure the splice can be reached for possible maintenance. Tape and/or wire-tie the splice to reduce the possibility of the splice being inadvertently pulled apart.

The AFB24, AFX24... proportional actuators have a digital circuit that is designed to ignore most unwanted input signals (pickup). In some situations the pickup may be severe enough to cause erratic running of the actuator. For example, a large inductive load (high voltage AC wires, motors, etc.) running near the power or control wiring may cause excessive pickup. To solve this problem, make one or more of the following changes:

1. Run the wire in metallic conduit.
2. Re-route the wiring away from the source of pickup.
3. Use shielded wire (Belden 8760 or equal). Ground the shield to an earth ground. **Do not** connect it to the actuator common.

### Initialization of the AFB24-MFT, AFX24-MFT

When power is initially applied, the actuator will first release its manual preload position (This assumes a manual position has been set). The actuator will then rotate to the full fail-safe position. At this point the microprocessor recognizes that the actuator is at full fail-safe and uses this position as the base for all of its position calculations. The microprocessor will retain the initialized zero during short power failures of up to 20 seconds. The AFB24-MFT and AFX24-MFT will also return to its position prior to the 20-second-or-less power loss. For power failures greater than 20 seconds, the actuator would naturally return to its full fail-safe position prior to the microprocessor losing its memory. The actuator will also re-initialize if the manual position mechanism is used.

| AFB24-MFT, AFX24-MFT + P-100... Electrical Check-Out Procedure |  |   |  |   |
|--|--|---|--|---|
| STEP   | Procedure  | Expected Response   | Gives Expected Response<br>Go To Step...   | Does Not Give<br>Expected Response<br>Go To Step...   |
| 1.   | Control signal is applied to actuator.   | Actuator will move to its "Control Signal" position.  | Actuator operates properly <b>Step 7.</b>  | No response at all <b>Step 2.</b><br>Operation is reversed <b>Step 3.</b><br>Does not drive toward "Control Signal Position" <b>Step 4.</b> |
| 2.   | Check power wiring.<br>Correct any problems.<br><b>See Note 1.</b>   | Power supply rating should be the total power requirement of the actuator(s).<br>Minimum voltage of 19.2 VAC or 21.6 VDC. | Power wiring corrected, actuator begins to drive <b>Step 1.</b>                      | Power wiring corrected, actuator still does not drive <b>Step 4.</b>  |
| 3.   | Turn reversing switch to the correct position. Make sure the switch is turned all the way left or right.   | Actuator will move to its "Control Signal" position.  | Actuator operates properly <b>Step 7.</b>  | Does not drive toward "Control Signal Position" <b>Step 4.</b>  |
| 4.   | Make sure the control signal positive (+) is connected to Wire No. 3 and control signal negative (-) is connected to wire No. 1. Most control problems are caused by reversing these two wires. Verify that the reversing switch is all the way CCW or CW. | Drives to "Control Signal" position.  | Actuator operates properly <b>Step 7.</b>  | <b>Step 5.</b>  |
| 5.   | Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator.<br><b>NOTE:</b> The input signal must be above the 2 VDC or 4 mA to have the actuator move.   | Input voltage or current should be $\pm 1\%$ of what controller's adjustment or programming indicates.                    | Controller output (actuator input) is correct. Input Polarity Correct <b>Step 6.</b> | Reprogram, adjust repair or replace controller as needed <b>Step 1.</b>   |
| 6.   | Check damper torque requirement.   | Torque requirement is actuator's minimum torque.  | Defective Actuator.<br>Replace Actuator - <b>See Note 2.</b>                         | Recalculate actuator requirement and correct installation.  |
| 7.   | Actuator works properly. Test controller by following controller manufacturer's instructions.  |   |  |   |

- NOTE 1** Check that the transformer(s) are sized properly.
- If a common transformer is used, make sure that polarity is observed on the secondary. This means connect all No. 1 wires to one leg of the transformer and all No. 2 wires to the other leg of the transformer.
  - If multiple transformers are used with one control signal, make sure all No. 1 wires are tied together and tied to control signal negative (-).
  - Controllers and actuators must have separate 24 VAC/VDC power sources.
- NOTE 2** If failure occurs within 5 years from original purchase date, notify Belimo and give details of the application.

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