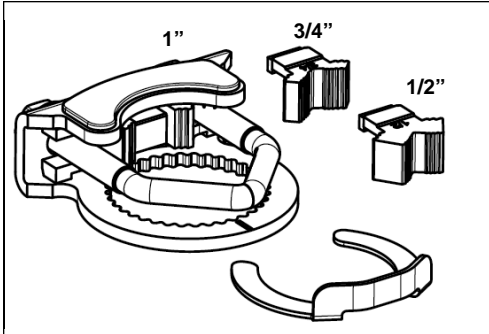


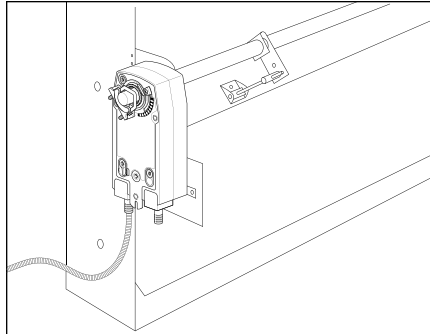
## Minimum 180 in-lb Torque

- For damper areas up to 45 sq-ft\* (For lower torque, see AF, NFB, NFX, LF, or TF series)

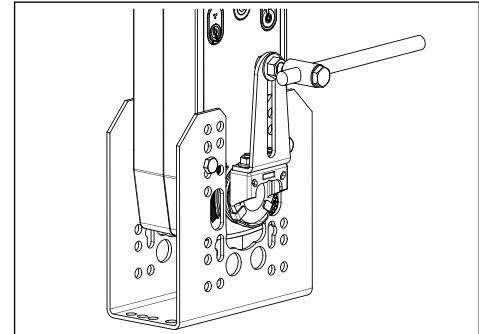
## Applications



New standard clamp fits standard 1/2" shafts to 1.05" jackshafts.



Mount directly to 1.05" jackshafts.



Linkage solutions are available when direct coupling is not possible.



All Actuators have BDCM

## AFB, AFX Series - At A Glance

		AFBUP AFXUP (p. 19)	AFBUP-S AFXUP-S (p. 19)	AFB24-MFT AFX24-MFT (p. 21)	AFB24-MFT-S AFX24-MFT-S (p. 21)	AFB24-MFT95 AFX24-MFT95 (p. 23)
Torque:	180 in-lb	●	●	●	●	●
Power supply:	24 VAC/DC	●	●	●	●	●
	120 VAC	●	●			
	230 VAC	●	●			
Control signal:	On/Off	●	●			
	Multi-function**			●	●	
	0 to 135 Ω					●
Feedback signal:	VDC variable**			●	●	●
	Running time motor:					
	<75 seconds	●	●			
Adj. 70 to 220 seconds***			●	●	●	
spring: <20 seconds		●	●	●	●	●
Brushless DC Motor		●	●	●	●	●
External direction of rotation switch				●	●	●
Manual override		●	●	●	●	●
Appliance rated cable, 18 GA†		●	●	●	●	
Plenum rated cable, 18 GA						●
Built-in auxiliary switch, Two SPDT			●		●	
Installation instructions.....(p. 31-36)	General wiring.....(p. 39)			Start-up and checkout.....(p. 40)	Electrical operations.....(p. 38)	

\*Based on 4 in-lb/ft² damper torque loading. Parallel blade. No edge seals. \*\*Default 2 to 10 VDC. \*\*\*Default 150 seconds. †Optional Plenum cable available for MFT models

## A CLOSER LOOK...

- Cut labor costs with simple direct coupling.
- True mechanical spring return – the most reliable fail-safe.
- Reverse mount for clockwise or counterclockwise fail-safe.
- Check damper position easily with clear position indicator.
- Overload-proof throughout rotation
- Temporary restrictions in damper movement will not change actuator operation. Actuator returns to normal operation when restriction is removed (modulating actuators).
- Built-in mechanical stop to adjust angle of rotation.
- By eliminating internal condensation incorporated breather membrane optimizes performance in harsh airstream environments.
- Built-in auxiliary switches is easy to use, offers feedback or signal for additional device (-S models).
- Manual override crank speeds installation
- Need to change control direction? Do it easily with a simple switch (modulating actuators).
- Microprocessor-controlled brushless DC motor increases actuator life span and reliability, provides constant running time (modulating actuators).
- Rugged metal on plastic housing withstands rough handling in the mechanical room.
- Standard 3 ft. appliance cable and conduit connector eases installation.
- Double insulated – no need for separate safety ground. A Belimo exclusive (-S models).
- Automatically compensates for damper seal wear, ensuring tight close-off.
- Added Flexibility to Select Clamp, Electrical Connection, and Running Time to fit your Specific Application with Belimo's Flexible Line of Actuators (AFX).



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### The Belimo Difference

- **Customer Commitment.**  
Extensive product range. Application assistance.  
Same-day shipments. Free technical support. Five year warranty.
- **Low Installation and Life-Cycle Cost.**  
Easy installation. Accuracy and repeatability.  
Low power consumption. No maintenance.
- **Long Service Life.**  
Components tested before assembly. Every product tested before shipment.  
30+ years direct coupled actuator design.

# AFBUP, AFBUP-S, AFXUP, AFXUP-S

On/Off, Spring Return, 24 to 240 VAC



Technical Data		AFBUP, AFBUP-S, AFXUP, AFXUP-S
Power supply		24...240 VAC -20% / +10%, 50/60 Hz 24...125 VDC ±10%
Power consumption	running	7 W
	holding	3.5 W
Transformer sizing		7 VA @ 24 VAC (class 2 power source) 8.5 VA @ 120 VAC 18 VA @ 240 VAC
Electrical connection	AFBUP...	3 ft, 18 GA appliance cable, 1/2" conduit connector <b>-S models:</b> Two 3 ft, 18 gauge appliance cables with 1/2" conduit connectors
	AFXUP...	3 ft [1m], 10 ft [3m] or 16 ft [5m] 18 GA appliance cable, with or without 1/2" conduit connector <b>-S models:</b> Two 3 ft [1m], 10 ft [3m] or 16 ft [5m] appliance cables with or without 1/2" conduit connectors
Overload protection		Electronic throughout 0 to 95° rotation
Control		On/Off
Torque		180 in-lb [20 Nm] minimum
Direction of rotation	spring	reversible with CW/CCW mounting
Mechanical angle of rotation		95° (adjustable with mechanical end stop, 35° to 95°)
Running time	motor	< 75 sec
	spring	20 sec @ -4°F to 122°F [-20°C to 50°C]; < 60 sec @ -22°F [-30°C]
Position indication		visual indicator, 0° to 95° (0° is full spring return position)
Manual override		5 mm hex crank (3/16" Allen), supplied
Humidity		max. 95% RH non-condensing
Ambient temperature		-22°F to 122°F [-30°C to 50°C]
Storage temperature		-40°F to 176°F [-40°C to 80°C]
Housing		Nema 2, IP54, Enclosure Type2
Housing material		Zinc coated metal and plastic casing
Agency listings †		cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC & 2006/95/EC
Noise level		<50dB(A) motor @ 75 seconds ≤62dB(A) spring return
Servicing		maintenance free
Quality standard		ISO 9001
Weight		4.6 lbs (2.1 kg), 4.9 lbs (2.25 kg) with switches
† Rated Impulse Voltage 4kV, Type of action 1.AA (1.AA.B for -S version), Control Pollution Degree 3.		
<b>AFBUP-S, AFXUP-S</b>		
Auxiliary switches		2 x SPDT 3A (0.5A) @ 250 VAC, UL Approved one set at +10°, one adjustable 10° to 90°

**Torque min. 180 in-lb, for control of air dampers**

## Application

For On/Off, fail-safe control of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer's specifications. Control is On/Off from an auxiliary contact, or a manual switch.

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.

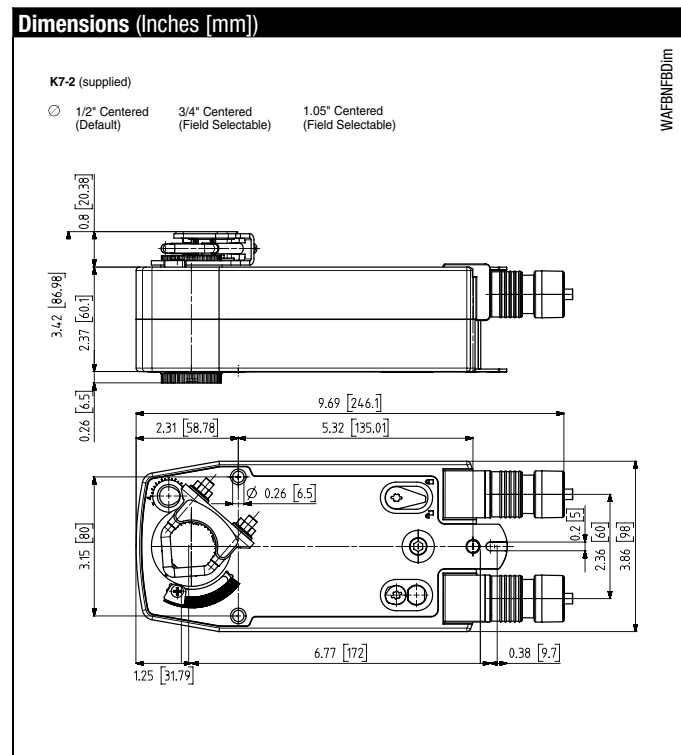
## Operation

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

The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

The AFBUP-S and AFXUP-S versions are provided with two built-in auxiliary switches. These SPDT switches provide 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°. The AFBUP, AFBUP-S, AFXUP and AFXUP-S actuator is shipped at +5° (5° from full fail-safe) to provide automatic compression against damper gaskets for tight shut-off.



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### Accessories

AV 8-25	Shaft extension
IND-AFB	Damper position indicator
K7-2	Universal clamp for up to 1.05" dia jackshafts
KH-AFB	Crank arm
TF-CC US	Conduit fitting
Tool-06	8mm and 10 mm wrench
ZG-100	Universal mounting bracket
ZG-101	Universal mounting bracket
ZG-118	Mounting bracket for Barber Colman® MA 3../4.., Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crank arm type installations
ZG-AFB	Crank arm adaptor kit
ZG-AFB118	Crank arm adaptor kit
ZS-100	Weather shield (metal)
ZS-150	Weather shield (polycarbonate)
ZS-260	Explosion-proof housing
ZS-300	NEMA 4X housing

**Note:** When using AFBUP, AFBUP-S, AFXUP, AFXUP-S actuators, only use accessories listed on this page.

For actuator wiring information and diagrams, refer to Belimo Wiring Guide.

### Typical Specification

On/Off spring return damper actuators shall be direct coupled type which require no crank arm and linkage and be capable of direct mounting to a jackshaft up to a 1.05" diameter. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall be protected from overload at all angles of rotation. If required, two SPDT auxiliary switch shall be provided having the capability of one being adjustable. Actuators with auxiliary switches must be constructed to meet the requirements for Double Insulation so an electrical ground is not required to meet agency listings. Actuators shall be cULus approved and have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

### Wiring Diagrams

#### ✂️ INSTALLATION NOTES

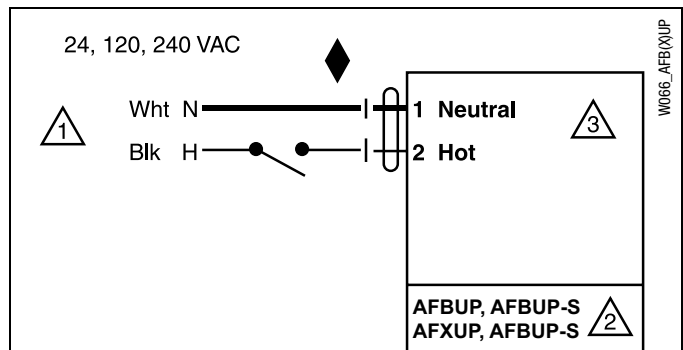
- 1 Provide overload protection and disconnect as required.
- 2 **CAUTION Equipment Damage!**  
Actuators may be connected in parallel. Power consumption and input impedance must be observed.
- 3 No ground connection is required.
- 4 For end position indication, interlock control, fan startup, etc., AFBUP-S and AFXUP-S incorporates two built-in auxiliary switches: 2 x SPDT, 3A (0.5A) @250 VAC, UL Approved, one switch is fixed at +10°, one is adjustable 10° to 90°.

#### 📄 APPLICATION NOTES

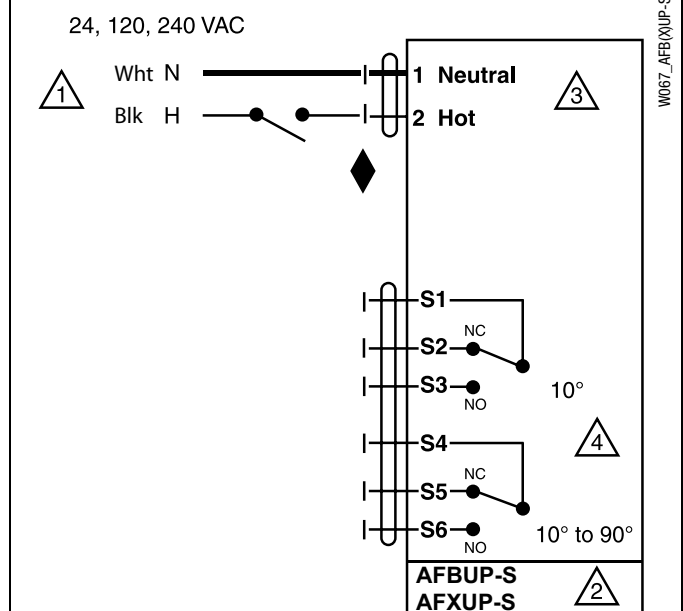
- ◆ Meets cULus requirements without the need of an electrical ground connection.

#### ⚠️ WARNING Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.



On/Off wiring for AFBUP, AFXUP



Auxiliary Switches for AFBUP-S, AFXUP-S

# AFB24-MFT, AFB24-MFT-S, AFX24-MFT, AFX24-MFT-S

Proportional, Spring Return, 24 V, Multi-Function Technology®



MFT



Technical Data		AFB24-MFT, AFB24-MFT-S, AFX24-MFT, AFX24-MFT-S
Power supply		24 VAC, +/- 20%, 50/60 Hz 24 VDC, +20% / -10%
Power consumption♦	running	7.5 W
	holding	3 W
Transformer sizing ♦		10 VA (Class 2 power source)
Electrical connection		
AFB...		3 ft, 18 GA appliance cable, 1/2" conduit connector -S models: two 3 ft, 18 gauge appliance cables with 1/2" conduit connectors
AFX...		3 ft [1m], 10 ft [3m] or 16 ft [5m] 18 GA appliance or plenum cables, with or without 1/2" conduit connector -S models: two 3 ft [1m], 10 ft [3m] or 16 ft [5m] appliance cables with or without 1/2" conduit connectors
Overload protection		electronic throughout 0 to 95° rotation
Operating range Y*		2 to 10 VDC, 4 to 20 mA (default) variable (VDC, PWM, floating point, on/off)
Input impedance		100 kΩ for 2 to 10 VDC (0.1 mA) 500 Ω for 4 to 20 mA 1500 Ω for PWM, floating point and on/off control
Feedback output U*		2 to 10 VDC, 0.5 mA max
Torque		minimum 180 in-lb (20 Nm)
Direction of rotation*	spring	reversible with cw/ccw mounting
	motor	reversible with built-in switch
Mechanical angle of rotation*		95° (adjustable with mechanical end stop, 35° to 95°)
Running time	spring	<20 sec @ -4°F to 122°F [-20° C to 50° C]; <60 sec @ -22°F [-30° C]
	motor*	150 seconds (default), variable (70 to 220 seconds)
Angle of Rotation adaptation		off (default)
Override control*		min position = 0% mid. position = 50% max. position = 100%
Position indication		visual indicator, 0° to 95° (0° is spring return position)
Manual override		5 mm hex crank (3/16" Allen), supplied
Humidity		max. 95% RH, non-condensing
Ambient temperature		-22 to 122° F (-30 to 50° C)
Storage temperature		-40 to 176° F (-40 to 80° C)
Housing		NEMA 2, IP54, Enclosure Type 2
Housing material		zinc coated metal and plastic casing
Noise level		≤40dB(A) motor @ 150 seconds, run time dependent ≤62dB(A) spring return
Agency listings †		cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC & 2006/95/EC
Quality standard		ISO 9001
Servicing		maintenance free
Weight		4.6 lbs. (1.9 kg), 4.9 lbs. (2 kg) with switch

\* Variable when configured with MFT options

† Rated Impulse Voltage 800V, Type of action 1.AA (1.AA.B for -S version), Control Pollution Degree 3.

♦ Programmed for 70 sec motor run time. At 150 sec motor run time, transformer sizing is 8.5 VA and power consumption is 6 W running / 3 W holding.

AFB24-MFT-S, AFX24-MFT-S	
Auxiliary switches	2 x SPDT 3A (0.5A) @ 250 VAC, UL approved one set at +10°, one adjustable 10° to 90°

- Torque min. 180 in-lb
- Control 2 to 10 VDC (DEFAULT)
- Feedback 2 to 10 VDC (DEFAULT)

## Application

For proportional modulation of dampers and control valves in HVAC systems. The AFB24-MFT, AFX24-MFT provides mechanical spring return operation for reliable fail-safe application.

## Default/Configuration

Default parameters for 2 to 10 VDC applications of the AFB24-MFT, AFX24-MFT actuator are assigned during manufacturing. If required, custom versions of the actuator can be ordered. The parameters noted in the Technical Data table are variable.

These parameters can be changed by three means:

- Pre-set configurations from Belimo
- Custom configurations from Belimo
- Configurations set by the customer using the MFT PC tool (version 3.4 or higher) software application.
- Handheld ZTH-GEN

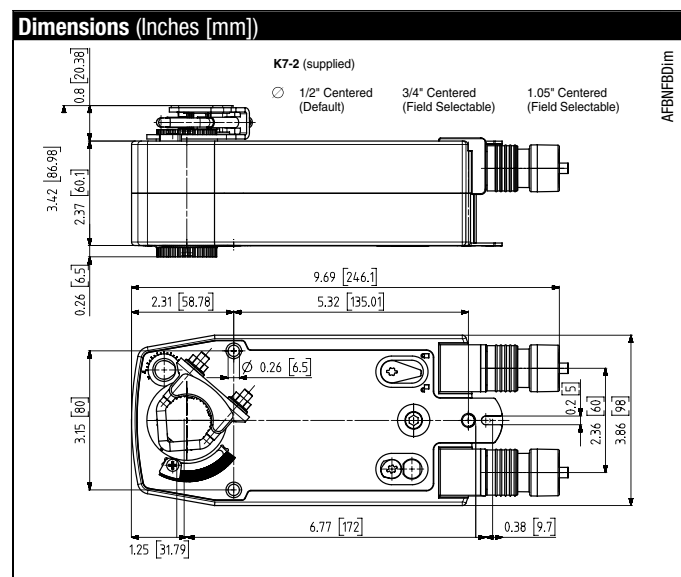
## Operation

The AFB24-MFT, AFX24-MFT actuator provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°. The actuator will synchronize the 0° mechanical stop or the physical damper or valve mechanical stop and use this point for its zero position during normal control operations. A unique manual override allows the setting of any actuator position within its 95° of rotation with no power applied. This mechanism can be released physically by the use of a crank supplied with the actuator. When power is applied the manual override is released and the actuator drives toward the fail-safe position.

The actuator uses a brushless DC motor which is controlled by an Application Specific Integrated Circuit (ASIC) and a microprocessor. The microprocessor provides the intelligence to the ASIC to provide a constant rotation rate and to know the actuator's exact position. The ASIC monitors and controls the brushless DC motor's rotation and provides a Digital Rotation Sensing (DRS) function to prevent damage to the actuator in a stall condition. The position feedback signal is generated without the need for mechanical feedback potentiometers using DRS. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

The AFB24-MFT, AFX24-MFT is mounted directly to control shafts up to 1.05" diameter by means of its universal clamp and anti-rotation bracket. A crank arm and several mounting brackets are available for damper applications where the actuator cannot be direct coupled to the damper shaft. The spring return system provides minimum specified torque to the application during a power interruption. The AFB24-MFT, AFX24-MFT actuator is shipped at +5° (5° from full fail-safe) to provide automatic compression against damper gaskets for tight shut-off.

**NOTE: Please see documentation on Multi-Function Technology.**



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### Accessories

AV 8-25	Shaft extension
IND-AFB	Damper position indicator
KH-AFB	Crank arm
K7-2	Universal clamp for up to 1.05" dia jackshafts
TF-CC US	Conduit fitting
Tool-06	8mm and 10 mm wrench
ZG-100	Universal mounting bracket
ZG-101	Universal mounting bracket
ZG-102	Multiple actuator mounting bracket
ZG-118	Mounting bracket for Barber Colman® MA 3../4..., Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crank arm type installations
ZG-AFB	Crank arm adaptor kit
ZG-AFB118	Crank arm adaptor kit
ZS-100	Weather shield (metal)
ZS-150	Weather shield (polycarbonate)
ZS-260	Explosion-proof housing
ZS-300	NEMA 4X housing

**NOTE:** When using AFB24-MFT, AFB24-MFT-S, AFX24-MFT and AFX24-MFT-S actuators, only use accessories listed on this page.

For actuator wiring information and diagrams, refer to Belimo Wiring Guide.

### Typical Specification

Spring return control damper actuators shall be direct coupled type which require no crank arm and linkage and be capable of direct mounting to a jackshaft up to a 1.05" diameter. The actuator must provide proportional damper control in response to a 2 to 10 VDC or, with the addition of a 500Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall use a brushless DC motor controlled by a microprocessor and be protected from overload at all angles of rotation. Run time shall be constant, and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position feedback. Actuators shall be cULus Approved and have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

### Wiring Diagrams

#### ✂️ INSTALLATION NOTES

- 1 Provide overload protection and disconnect as required.
- 2 **CAUTION Equipment Damage!** Actuators may be connected in parallel if not mechanically mounted to the same shaft. Power consumption and input impedance must be observed.
- 3 Actuators may also be powered by 24 VDC.
- 4 Position feedback cannot be used with Triac sink controller. The actuator internal common reference is not compatible.
- 5 Control signal may be pulsed from either the Hot (source) or the Common (sink) 24 VAC line.
- 8 Contact closures A & B also can be triacs.
- 9 For triac sink the common connection from the actuator must be connected to the hot connection of the controller.

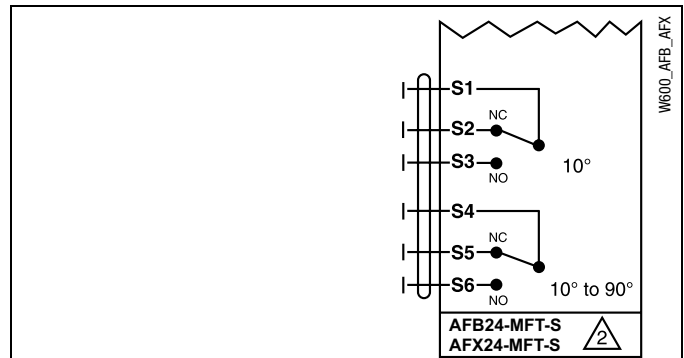
#### 📄 APPLICATION NOTES

- ◆ Meets UL requirements without the need of an electrical ground connection.
- ◆ The ZG-R01 500 Ω resistor may be used.

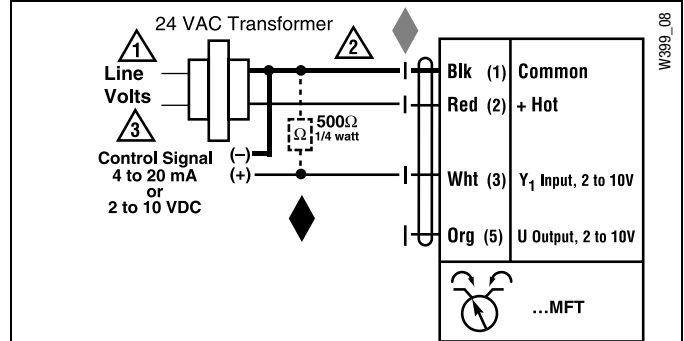
#### ⚠️ WARNING Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

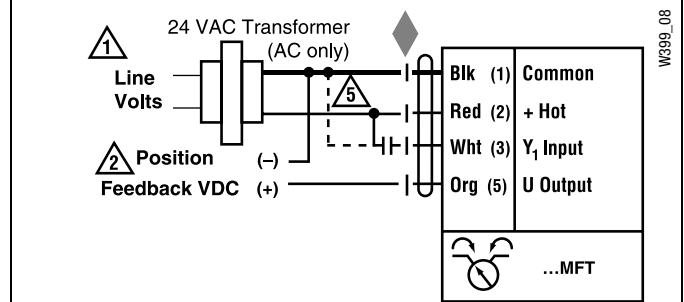
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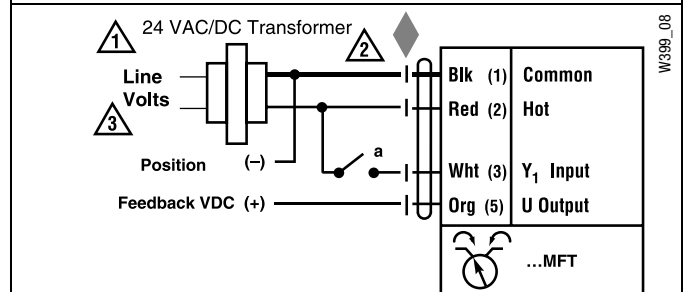
Auxiliary Switches for AFB24-MFT-S, AFX24-MFT-S



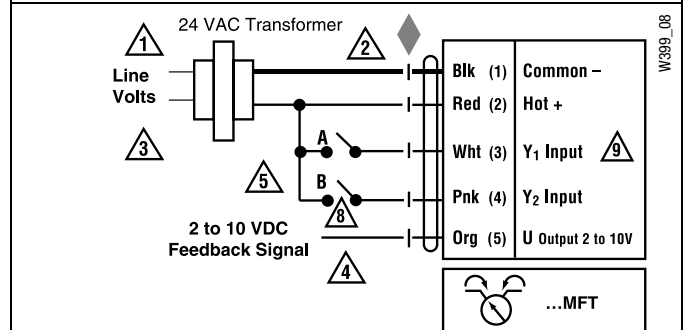
VDC/4-20 mA



PWM



On/Off control



Floating Point control

# AFB24-MFT95, AFX24-MFT95

Proportional, Spring Return, 24 V, for Use with Honeywell® Electronic Series 90 or a 0 to 135 Ω Input



MFT



Technical Data		AFB24-MFT95, AFX24-MFT95
Power supply		24 VAC, +/- 20%, 50/60 Hz 24 VDC, +20% / -10%
Power consumption♦	running holding	7.5 W 3 W
Transformer sizing♠		10 VA (Class 2 power source)
Electrical connection		
	AFB24-MFT95	3 ft, 18 GA plenum cable, with 1/2" conduit connector
	AFX24-MFT95	3 ft [1m], 18 GA plenum cable, with or without 1/2" conduit connector
Overload protection		electronic throughout 0 to 95° rotation
Operating range Y		0 to 135 Ω Honeywell Electronic Series 90, 0 to 135 Ω input
Feedback output U*		2 to 10 VDC, 0.5 mA max
Torque		minimum 180 in-lb (20 Nm)
Direction of rotation*	spring motor	reversible with cw/ccw mounting reversible with built-in switch
Mechanical angle of rotation*		95° (adjustable with mechanical end stop, 35° to 95°)
Running time	spring motor*	<20 seconds @ -4°F to 122°F [-20° C to 50° C]; <60 seconds @ -22°F [-30° C] 150 seconds (default), variable (70 to 220 seconds)
Angle of Rotation adaptation		off (default)
Position indication		visual indicator, 0° to 95° (0° is spring return position)
Manual override		5 mm hex crank (3/16" Allen), supplied
Humidity		max. 95% RH, non-condensing
Ambient temperature		-22 to 122° F (-30 to 50° C)
Storage temperature		-40 to 176° F (-40 to 80° C)
Housing		NEMA 2, IP54, Enclosure Type 2
Housing material		zinc coated metal and plastic casing
Noise level		≤40dB(A) motor @ 150 seconds, run time dependent ≤62dB(A) spring return
Agency listings †		cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC & 2006/95/EC
Quality standard		ISO 9001
Servicing		maintenance free
Weight		4.6 lbs. (1.9 kg)

\* Variable when configured with MFT options

† Rated Impulse Voltage 800V, Type of action 1.AA (1.AA.B for -S version), Control Pollution Degree 3.

♠ Programmed for 70 seconds motor run time. At 150 sec motor run time, transformer sizing is 8.5 VA and power consumption is 6 W running / 3 W holding.

- Torque min. 180 in-lb
- Control fixed, 0 to 135 Ω input, or Honeywell series 90 (fixed)
- Feedback 2 to 10 VDC (DEFAULT)

## Application

For proportional modulation of dampers and control valves in HVAC systems. The AFB24-MFT95, AFX24-MFT95 provides mechanical spring return operation for reliable fail-safe application.

## Default/Configuration

Default parameters for 0 to 135 Ω Input applications of the AFB24-MFT95 and AFX24-MFT95 actuator are assigned during manufacturing. If required, custom versions of the actuator can be ordered. However the control input cannot be modified via MFT PC tool software. The parameters noted in the Technical Data table are variable.

These parameters can be changed by three means:

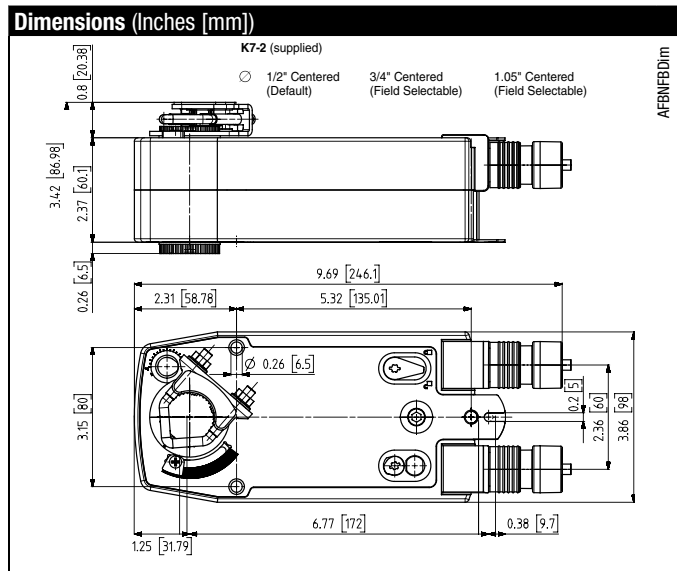
- Pre-set configurations from Belimo
- Custom configurations from Belimo
- Configurations set by the customer using the MFT PC tool (version 3.4 or higher) software application.

## Operation

The AFB24-MFT95, AFX24-MFT95 actuator provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°. The actuator will synchronize the 0° mechanical stop or the physical damper or valve mechanical stop and use this point for its zero position during normal control operations. A unique manual override allows the setting of any actuator position within its 95° of rotation with no power applied. This mechanism can be released physically by the use of a crank supplied with the actuator. When power is applied the manual override is released and the actuator drives toward the fail-safe position.

The actuator uses a brushless DC motor which is controlled by an Application Specific Integrated Circuit (ASIC) and a microprocessor. The microprocessor provides the intelligence to the ASIC to provide a constant rotation rate and to know the actuator's exact position. The ASIC monitors and controls the brushless DC motor's rotation and provides a Digital Rotation Sensing (DRS) function to prevent damage to the actuator in a stall condition. The position feedback signal is generated without the need for mechanical feedback potentiometers using DRS. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

The AFB24-MFT95, AFX24-MFT95 is mounted directly to control shafts up to 1.05" diameter by means of its universal clamp and anti-rotation bracket. A crank arm and several mounting brackets are available for damper applications where the actuator cannot be direct coupled to the damper shaft. The spring return system provides minimum specified torque to the application during a power interruption. The AFB24-MFT95, AFX24-MFT95 actuator is shipped at +5° (5° from full fail-safe) to provide automatic compression against damper gaskets for tight shut-off.



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### Proportional Potentiometric Control - Wiring Diagrams

#### INSTALLATION NOTES

- 5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables are numbered.
- 21 Provide overload protection and disconnect as required.
- 22 Actuators and controller must have separate transformers.
- 23 Consult controller instruction data for more detailed information.
- 24 Resistor value depends on the type of controller and the number of actuators.
- 24 No resistor is used for one actuator. Honeywell® resistor kits may also be used.
- 25 To reverse control rotation, use the reversing switch.

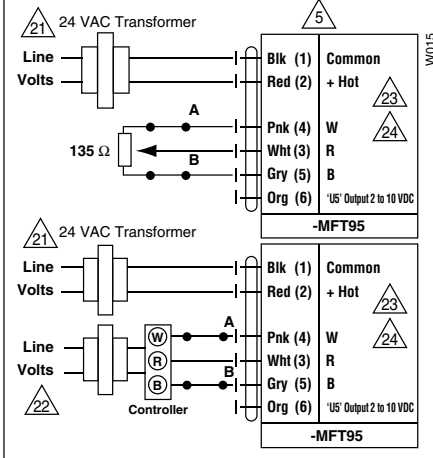
#### Wire Colors

1 = Black	3 = White	5 = Gray
2 = Red	4 = Pink	6 = Orange

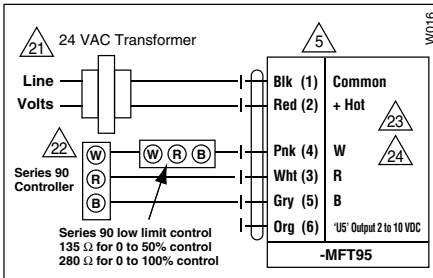
#### Override

Switch A	Switch B	Damper Position
		Damper Open
		Damper Closed

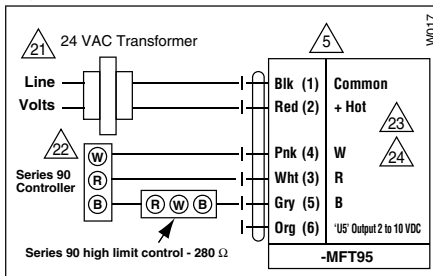
The direction of rotation switch is set so that the fail safe position and the position of the damper is closed with no signal at wire R.



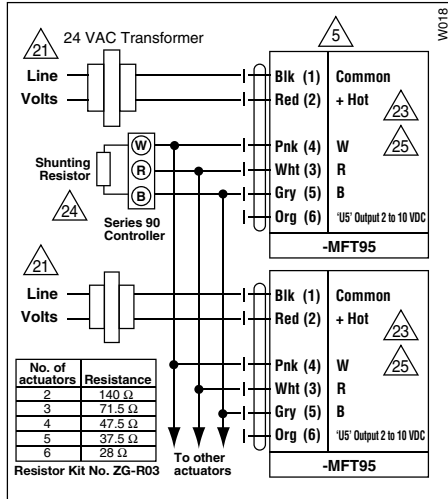
#### Low Limit Control



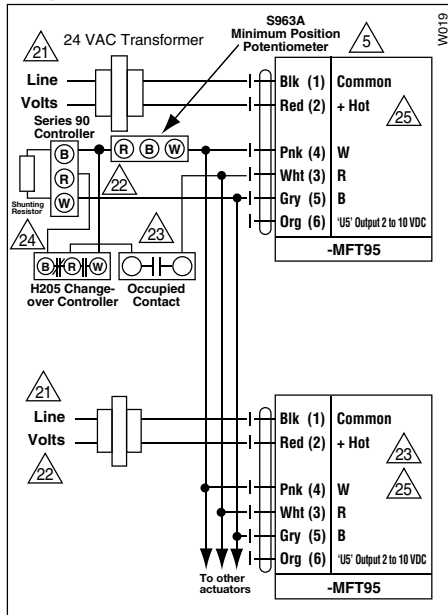
#### High Limit Control



#### Wiring Multiple Actuators to a Series 90 Controller



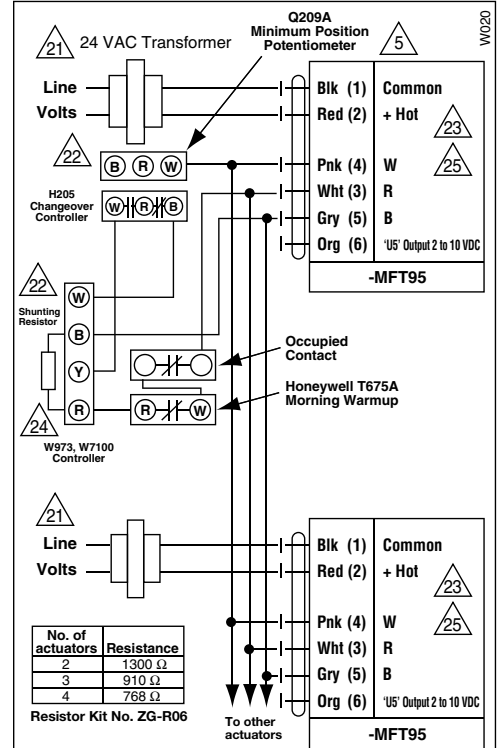
#### Wiring Multiple Actuators to a Series 90 Controller using a Minimum Position Potentiometer



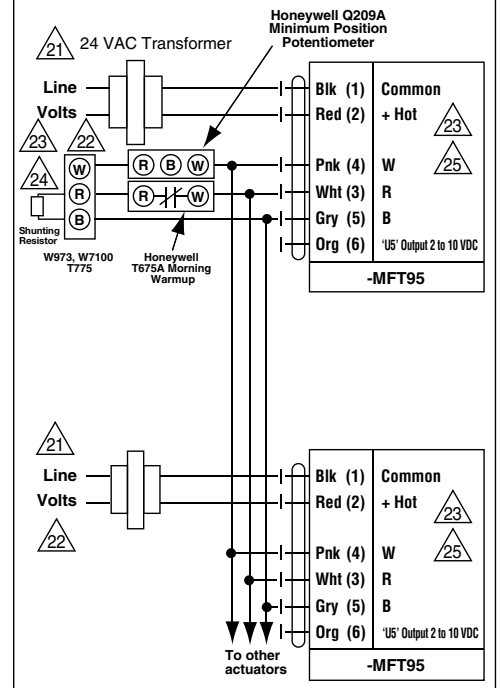
#### WARNING Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

#### Typical wiring diagrams for multiple actuators used with the W973, W7100 and T775 controllers



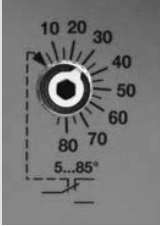

#### Used with the W973 and W7100 controllers





		AF120 US, AF120-S US AF230 US, AF230-S US	AFBUP, AFBUP-S, AFXUP, AFXUP-S	
OPERATION	Torque	133 in-lb [15 Nm] minimum	180 in-lb. [20 Nm] minimum	
	Running Time	Motor	< 75 seconds	<75 seconds
		Spring	< 60 seconds	20 seconds @ -4°F to 122°F [-20°C to 50°C]; <60 seconds @ -22°F [-30°C]
	Noise Level	Max. 45 dB (A)	<50dB(A) motor @ 75 seconds; ≤62dB(A) Spring Return	
	Motor Technology	DC Motor	DC Motor	
	Overload Protection	Electronic throughout 0° to 95° rotation	Electronic throughout 0° to 95° rotation	
	Operating Temperature	-22°F to 122°F [-30°C to 50°C]	-22°F to 122°F [-30°C to 50°C]	
Operating Humidity	5 to 95% RH non-condensing	5 to 95% RH, non-condensing		
CONTROL	Control Signal	On/Off	On/Off	
MOUNTING & COMMISSIONING	Dimensions (L x W x H)			
	With Conduit Fitting	10.47" [266] x 3.86" [98] x 3.25" [82.7]	9.69" [246] x 3.86" [98] x 3.42" [87]	
	Shaft Dimensions	Up to 1.05"	Up to 1.05"	
	Direction of Rotation	Reversible with CW/CCW mounting	Reversible with CW/CCW mounting	
	Manual Override	3 mm hex crank supplied	5 mm hex crank (3/16" Allen), supplied	
	Position Indication	Visual indicator, 0° to 95° (0° is Spring Return position)	Visual indicator, 0° to 95° (0° is Spring Return position)	
	Angle of Rotation	95°, adjustable 30 to 95° w/ ZDB-AF2 US accessory	95° (adjustable with mechanical end stop, 35° to 95°)	



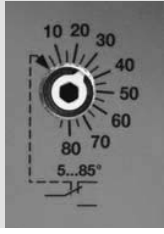



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		AF120 US, AF120-S US AF230 US, AF230-S US	AFBUP, AFBUP-S, AFXUP, AFXUP-S	
ELECTRICAL WIRING	Power Supply	AF120: 120 VAC ± 10% 50/60 Hz AF230: 230 VAC ± 15% 50/60 Hz	24...240 VAC -20 %/+10%, 50/60 Hz; 24...125 VDC +/- 10 %	
	Power Consumption	Running	AF120: 8 W AF230: 8.5 W	7 W
		Holding	AF120, AF230: 3 W	3.5 W
	Transformer Sizing / VA Rating	AF120, AF230: 11 VA	7 VA @ 24 VAC 8.5 VA @ 120 VAC 18 VA @ 240 VAC	
	Auxiliary Switches	<b>(-S Models):</b> 2 x SPDT 7A (2.5A) @ 250 VAC, UL Approved, one set at +5°, one adjustable 5° to 85°		<b>(-S Models):</b> Two SPDT 3A (0.5A inductive) @ 250V UL Approved, one set at +10°, one adjustable 10° to 90°
Electrical Connection	3 ft, 18 GA appliance cable 1/2" conduit connector, <b>(-S Models):</b> Two 3 ft, 18 GA, appliance cables, 1/2" conduit connectors		3 ft, 18 GA, appliance cable, 1/2" conduit connector, <b>(-S Models):</b> Two 3 ft, 18 GA, appliance cables, 1/2" conduit connectors; Optional 10 or 16 ft cables with X types	
CONSTRUCTION	Housing Rating	NEMA 2, IP54	NEMA 2, IP54, Enclosure Type2	
	Housing Material	Zinc coated steel	Zinc coated metal and plastic casing	
	Agency Listings	cULus acc. to UL 873 and CAN/CSA C22.2 No. 24-93	cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC & 2006/95/EC	
	Storage Temperature	-40°F to 176°F [-40°C to 80°C]	-40°F to 176°F [-40°C to 80°C]	
	Weight	7.3 lbs (3.3 kg)	4.6 lbs (2.1 kg), <b>(-S Models):</b> 4.9 lbs (2.25 kg)	

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		AF24-MFT US, AF24-MFT-S US	AFB24-MFT, AFB24-MFT-S, AFX24-MFT, AFX24-MFT-S	
OPERATION	<b>Torque</b>	133 in.-lb. [15 Nm] minimum	180 in.-lb. [20 Nm] minimum	
	<b>Running Time</b>	<b>Motor</b>	150 seconds (default), variable (75 to 300 seconds)	150 seconds (default), variable (70 to 220 seconds)
		<b>Spring</b>	<20 sec spring return fail safe position	<20 seconds @ -4°F to 122°F [-20°C to 50°C]; <60 seconds @ -22°F [-30°C]
	<b>Noise Level</b>	<45 dB (A)	≤40dB(A) motor @ 150 seconds, run time dependant; ≤62dB(A) spring return	
	<b>Motor Technology</b>	Brushless DC motor	Brushless DC motor	
	<b>Overload Protection</b>	Electronic throughout 0 to 95° rotation	Electronic throughout 0 to 95° rotation	
	<b>Operating Temperature</b>	-22 to 122° F (-30 to 50° C)	-22 to 122°F (-30 to 50°C)	
	<b>Operating Humidity</b>	5 to 95% RH, non-condensing	Max. 95% RH, non-condensing	
CONTROL	<b>Operating Range 'Y'</b>	2 to 10 VDC, 4 to 20 mA w/500 Ω resistor; Programmable Variable	2 to 10 VDC, 4 to 20 mA w/500 Ω resistor; Variable (VDC, PWM, Floating Point, On/Off)	
	<b>Input Impedance</b>	100 kΩ for 2 to 10 VDC (0.1 mA); 500 Ω for 4 to 20 mA; 1500 Ω for PWM, Floating Point and On/Off	100 kΩ for 2 to 10 VDC (0.1 mA); 500 Ω for 4 to 20 mA; 1500 Ω for PWM, Floating Point, On/Off	
	<b>Feedback Output 'U'</b>	2 to 10 VDC, 0.5 mA max, variable when configured with MFT options	2 to 10 VDC, 0.5mA max, variable when configured with MFT options	
MOUNTING & COMMISSIONING	<b>Dimensions (L x W x H)</b>			
	<b>With Conduit Fitting</b>	10.47" [266] x 3.86" [98] x 3.25" [82.7]	9.69" [246] x 3.86" [98] x 3.42" [87]	
	<b>Shaft Dimensions</b>	Up to 1.05"	Up to 1.05"	
	<b>Direction of Rotation</b>	<b>Motor</b>	Reversible with built-in switch 	Reversible with built-in switch 
		<b>Spring</b>	Reversible with CW/CCW mounting	Reversible with CW/CCW mounting
<b>Manual Override</b>	3 mm hex crank (supplied)	5 mm hex crank (3/16" Allen), supplied 		
<b>Position Indication</b>	Visual indicator, 0° to 95° (0° is Spring Return position) 	Visual indicator, 0° to 95° (0° is Spring Return position) 		

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		AF24-MFT US, AF24-MFT-S US	AFB24-MFT, AFB24-MFT-S, AFX24-MFT, AFX24-MFT-S	
MOUNTING & COMMISSIONING	Angle of Rotation	95°, adjustable 30 to 95° w/ ZDB-AF2 US accessory 	95° (adjustable with mechanical end stop, 35° to 95°) 	
	Power Supply	24 VAC, ± 20%, 50/60 Hz; 24 VDC, ±10%	24 VAC, ± 20%, 50/60 Hz; 24 VDC, +20/-10%	
ELECTRICAL WIRING	Power Consumption	Running	6 W	7.5 W
		Holding	2.5 W	3 W
	Transformer Sizing	10 VA (Class 2 power source)	10 VA (Class 2 power source)*	
	Auxiliary Switches	<b>(-S Models):</b> 2 x SPDT 7A (2.5A) @ 250 VAC, UL Approved, one set at +5°, one adjustable 25° to 85° 	<b>(-S Models):</b> Two SPDT 3A (0.5A inductive) @ 250V UL Approved, one set at + 10°, one adjustable 10° to 90° 	
Electrical Connection	3 ft, 18 GA appliance cable 1/2" conduit connector, <b>(-S Models):</b> Two 3 ft, 18 GA, appliance cables, 1/2" conduit connectors 	3 ft, 18 GA, appliance cable, 1/2" conduit connector, <b>(-S Models):</b> Two 3 ft, 18 GA, appliance cables, 1/2" conduit connectors; Optional 10 or 16 ft cables and plenum rated cables (non -S models only) with X types 		
CONSTRUCTION	Housing Rating	NEMA 2, IP54	NEMA 2, IP54, Enclosure Type2	
	Housing Material	Zinc coated metal	Zinc coated metal and plastic casing	
	Agency Listings	cULus acc. to UL 873 and CAN/CSA C22.2 No. 24-93	cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC & 2006/95/EC	
	Storage Temperature	-40 to 176° F (-40 to 80° C)	-40 to 176°F (-40 to 80°C)	
	Weight	6.0 lbs. (2.7 kg)	4.6 lbs. (2.1 kg), <b>(-S Models):</b> 4.9 lbs.(2.25 kg)	

\*10 VA @ 70 second run time  
 8.5 VA @ 150 second run time  
 8 VA @ 220 second run time

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		AF24-MFT95 US	AFB24-MFT95, AFX24-MFT95	
OPERATION	Torque	133 in-lb. [15 Nm] minimum	180 in-lb. [20 Nm] minimum	
	Running Time	Motor	150 seconds (default), variable (75 to 300 seconds)	150 seconds (default), variable (70 to 220 seconds)
		Spring	<20 sec spring return fail safe position	<20 sec @ -4°F to 122°F [-20°C to 50°C]; <60 sec @ -22°F [-30°C]
	Noise Level	<45 dB (A)	≤40dB(A) motor @ 150 seconds, run time dependant; ≤62dB(A) spring return	
	Motor Technology	Brushless DC motor	Brushless DC motor	
	Overload Protection	electronic throughout 0 to 95° rotation	Electronic throughout 0 to 95° rotation	
	Operating Temperature	-22 to 122° F (-30 to 50° C)	-22 to 122°F (-30 to 50°C)	
	Operating Humidity	5 to 95% RH, non-condensing	Max. 95% RH, non-condensing	
CONTROL	Operating Range 'WRB'	0 to 135 Ω Honeywell electronic series 90, or a 0 to 135 Ω input	0 to 135 Ω Honeywell electronic series 90, or a 0 to 135 Ω input	
	Feedback Output 'U'	2 to 10 VDC, 0.5mA max, Variable when configured with MFT options	2 to 10 VDC, 0.5mA max, Variable when configured with MFT options	
MOUNTING & COMMISSIONING	Dimensions (L x W x H) [mm]			
	With Conduit Fitting	10.47" [266] x 3.86" [98] x 3.25" [82.7]	9.69" [246] x 3.86" [98] x 3.42" [87]	
	Shaft Dimensions	up to 1.05"	up to 1.05"	
	Direction of Rotation	Motor	Reversible with built-in switch 	Reversible with built-in switch 
		Spring	Reversible with CW/CCW mounting	Reversible with CW/CCW mounting
	Manual Override	3 mm hex crank (supplied)	5 mm hex crank (3/16" Allen), supplied 	
Position Indication	Visual indicator, 0° to 95° 	Visual indicator, 0° to 95° (0° is Spring Return position) 		

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		AF24-MFT95 US	AFB24-MFT95, AFX24-MFT95
<b>MOUNTING &amp; COMMISSIONING</b>	<b>Angle of Rotation</b>	95°, adjustable 30 to 95° w/ ZDB-AF2 US accessory 	95° (adjustable with mechanical end stop, 35° to 95°) 
	<b>Power Supply</b>	24 VAC, ± 20%, 50/60 Hz; 24 VDC, ±10%	24 VAC, ± 20%, 50/60 Hz; 24 VDC, +20/-10%
<b>ELECTRICAL WIRING</b>	<b>Power Consumption</b>		
	<b>Running</b>	6 W	7.5 W
	<b>Holding</b>	2 W	3 W
	<b>Transformer Sizing</b>	10 VA (Class 2 power source)	10 VA (Class 2 power source)*
	<b>Auxiliary Switches</b>	N/A	N/A
	<b>Electrical Connection</b>	3 ft, 18 GA appliance cable, 1/2" conduit connector 	3 ft, 18 GA, plenum cable, 1/2" conduit connector; AFX Model: 3 ft, 18 GA, plenum rated cable with or without 1/2" conduit connector 
<b>CONSTRUCTION</b>	<b>Housing Rating</b>	NEMA 2, IP54	NEMA 2, IP54, Enclosure Type2
	<b>Housing Material</b>	Zinc coated metal	Zinc coated metal and plastic casing
	<b>Agency Listings</b>	cULus acc. to UL 873 and CAN/CSA C22.2 No. 24-93	cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC & 2006/95/EC
	<b>Storage Temperature</b>	-40 to 176° F (-40 to 80° C)	-40 to 176°F (-40 to 80°C)
	<b>Weight</b>	6.0 lbs. (2.7 kg)	4.6 lbs. (2.1 kg)

\* 10 VA @ 70 second run time  
8.5 VA @ 150 second run time  
8 VA @ 220 second run time

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# Installation Instructions

## Quick-Mount Visual Instructions for Mechanical Installation

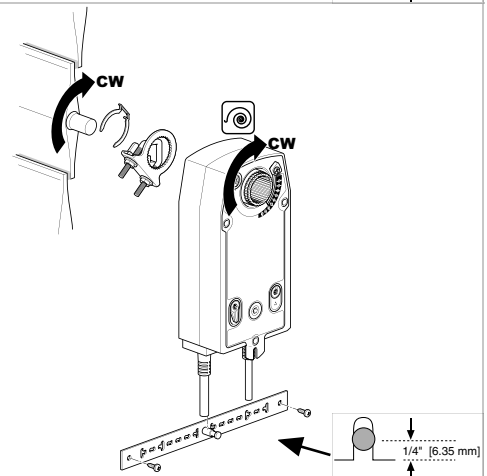
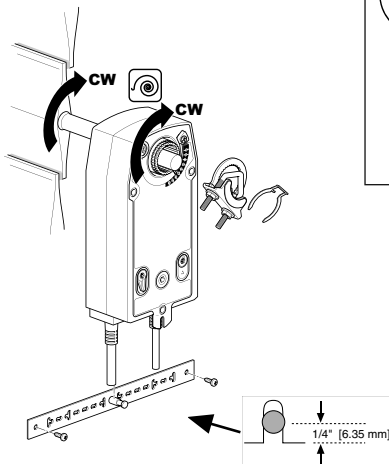
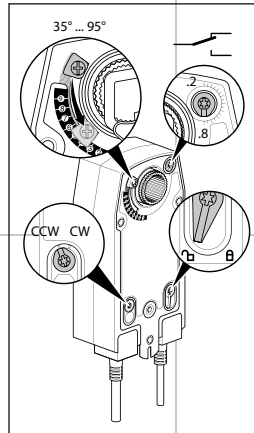
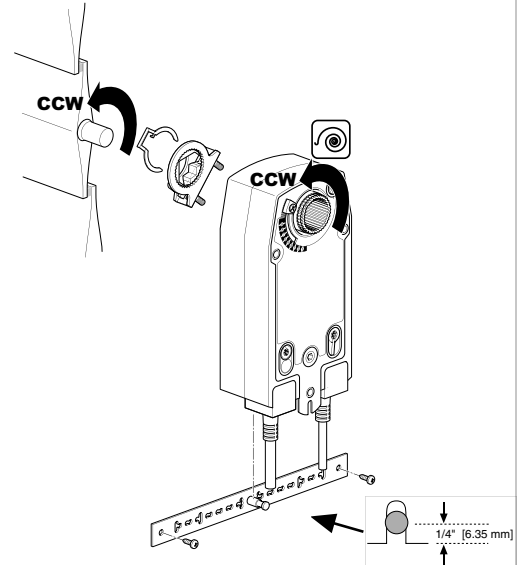
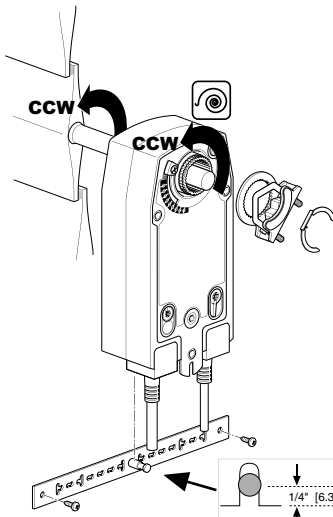
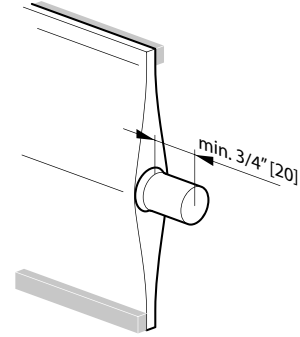
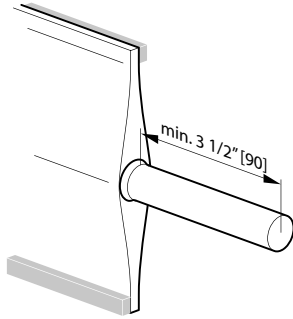


### Quick-Mount Visual Instructions

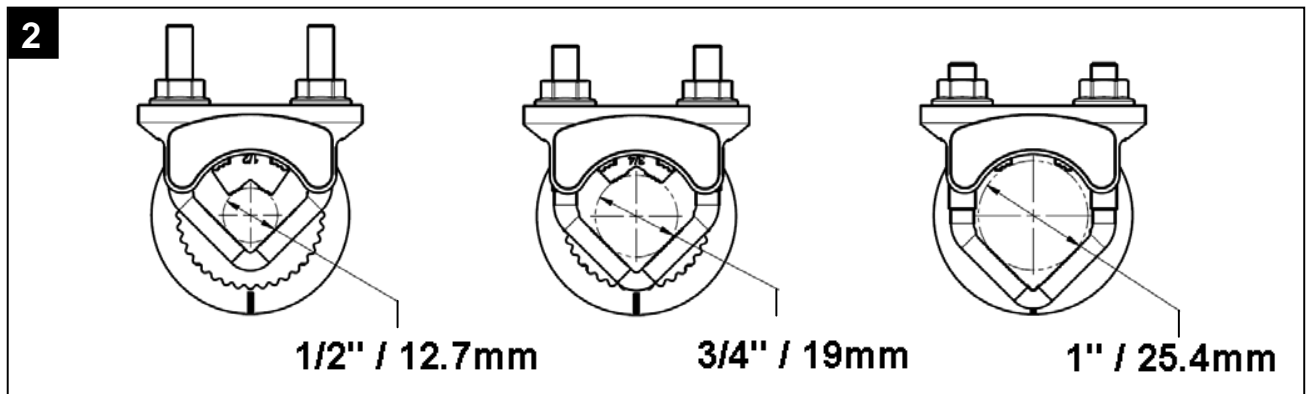
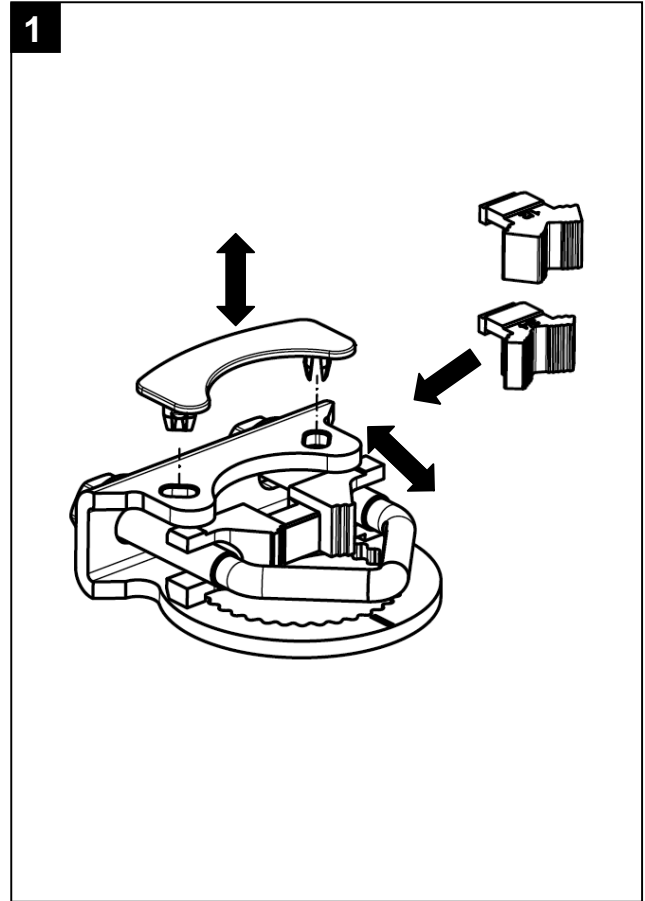
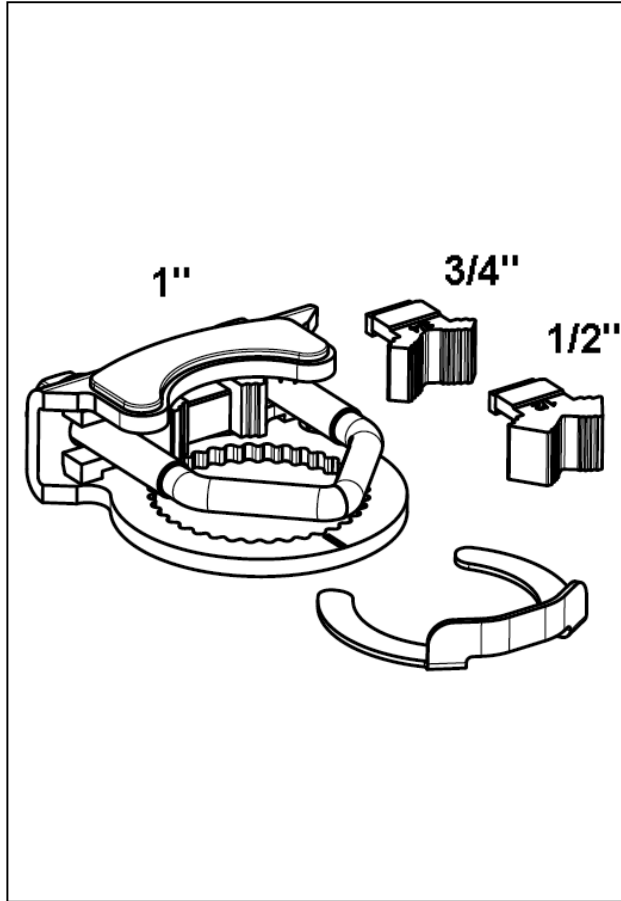
1. Rotate the damper to its fail-safe position.  
If the shaft rotates counterclockwise, mount the "CCW" side of the actuator out.  
If it rotates clockwise, mount the actuator with the "CW" side out.
2. If the universal clamp is not on the correct side of the actuator, mount it onto the correct side.
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.






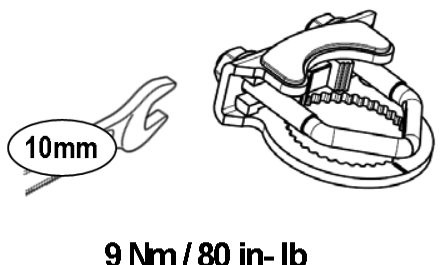
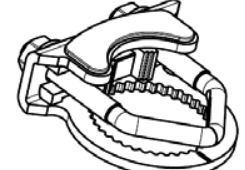
### Dimensions (Inches [mm])



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						 10mm	
1/2"	mm	12.7	10 ... 19	---	14 ... 20		
	inch	1/2	2/5 ... 3/4	---	9/16 ... 3/4		
3/4"	mm	19	10 ... 22	10	14 ... 25.4		
	inch	3/4	2/5 ... 3/4	3/8	9/16 ... 1		
1"	mm	25.4	19 ... 26.7	12 ... 18	---		
	inch	1	3/4 ... 1.05	1/2 ... 11/16	---		



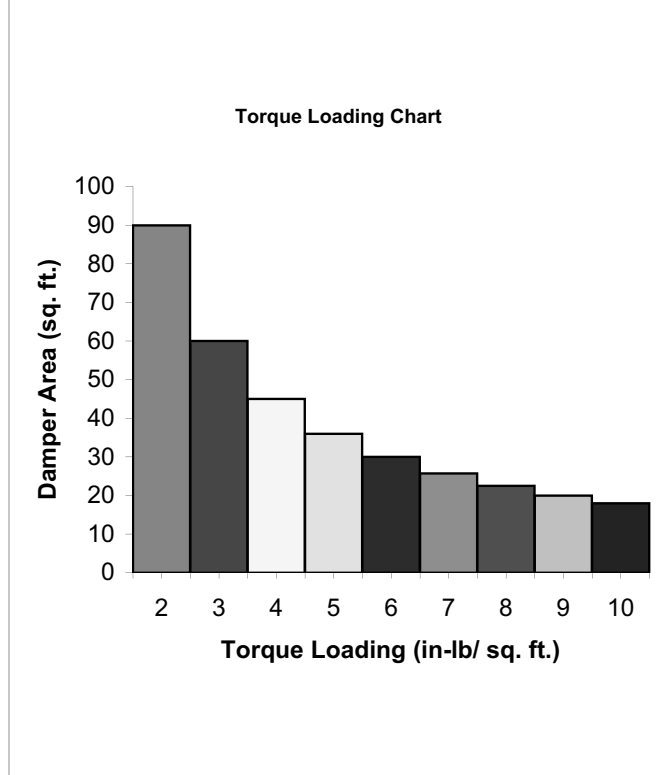
### Determining Torque Loading and Actuator Sizing

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

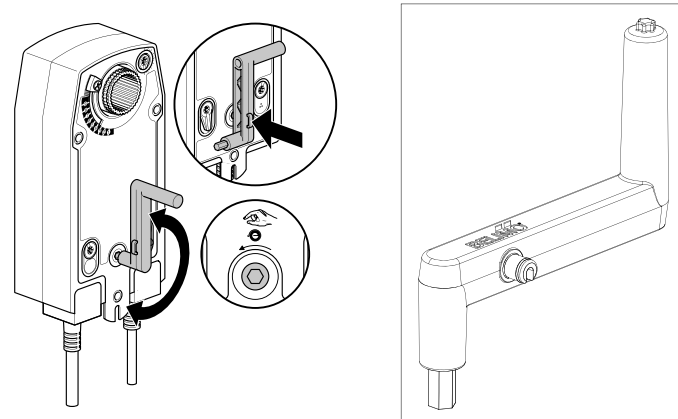
The actuator is mounted directly to a damper shaft up to 1.05" in diameter by means of its universal clamp. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft. The AFB, AFX series actuators provide true spring return 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.

- Lock the clamp to the actuator using the retaining clip.
- Verify that the damper is still in its full fail-safe position.
- Slide the actuator over the shaft.
- Position the actuator in the desired location.
- Tighten the two nuts on the clamp using a 10mm wrench or socket using 6-8 ft-lb of torque.
- 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:

- 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.
- Engage the clamp to the actuator as close as possible to the determined location.
- Lock the clamp in place using the remaining retainer clip.
- Verify that the damper is still in its full fail-safe position.
- Slide the actuator over the shaft.
- Position the actuator in the desired location.
- Tighten the two nuts on the clamp using a 10mm wrench or socket using 6-8 ft-lb of torque.
- 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.
- 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

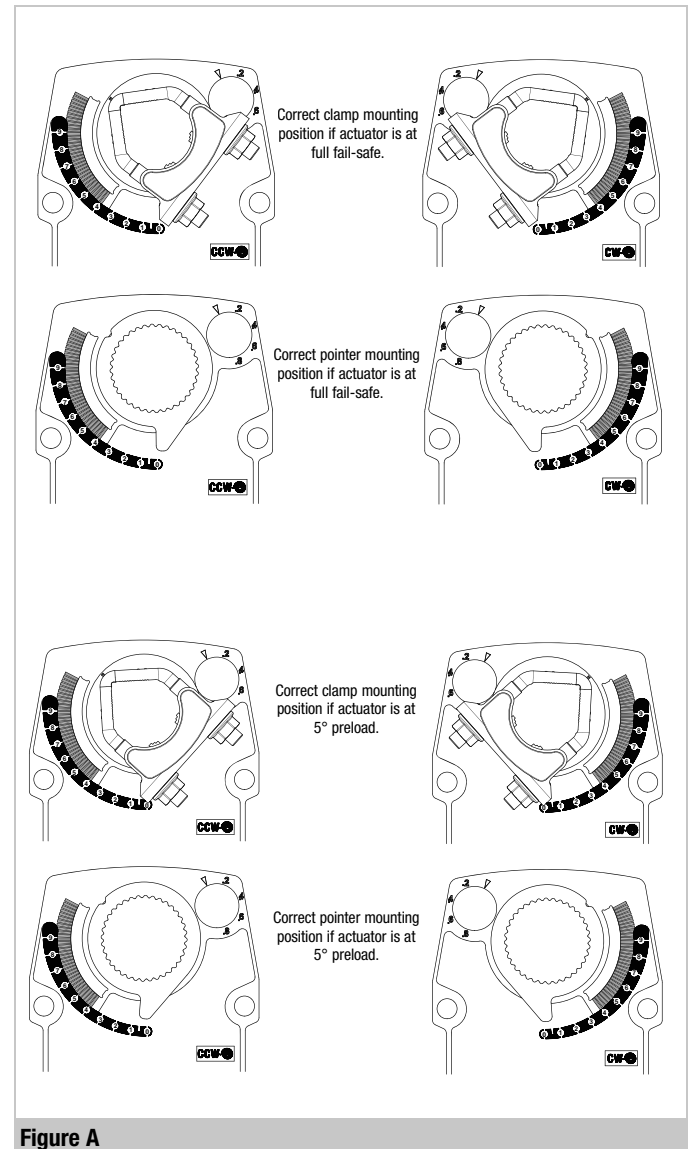


Figure A

### 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.

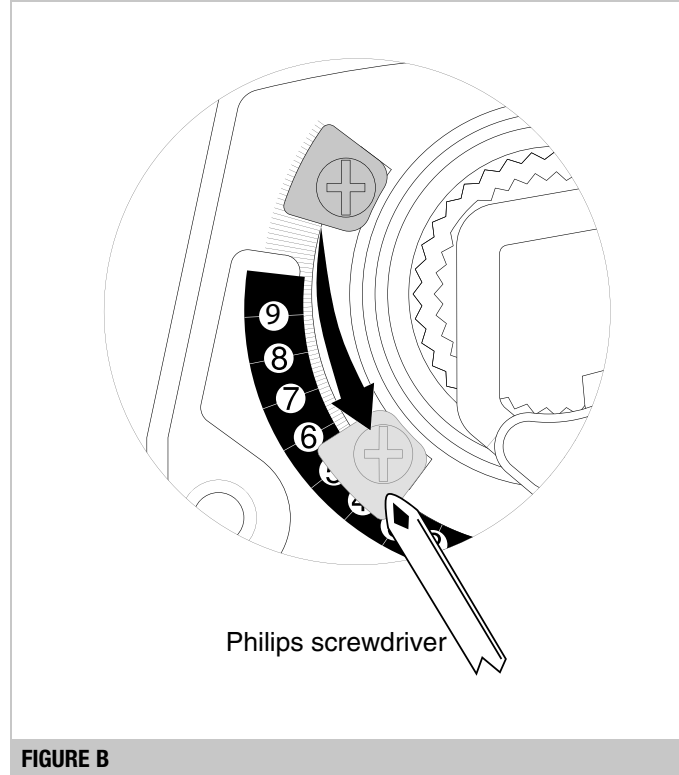
See **Figure A**.

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.

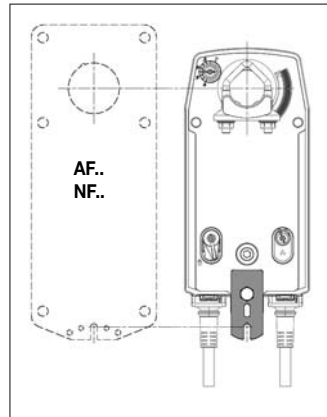
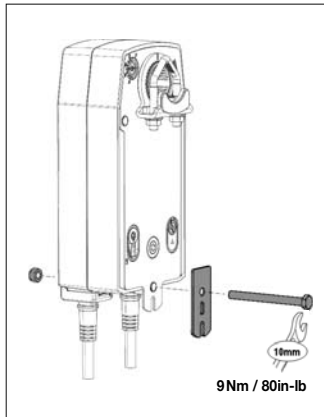
### Damper Rotation Limiting

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

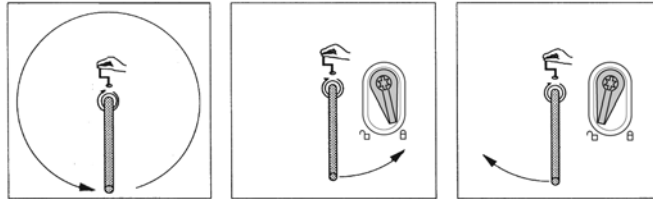


### Manual Override

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

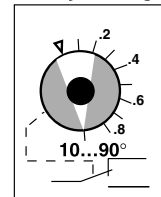
Two methods may be used to adjust the switching point of the adjustable switch.

#### Method 1 - See Figure F

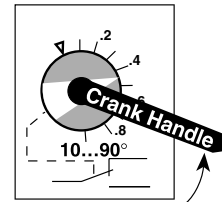
1. The actuator must be in its fail-safe position.
2. Insert the crank handle into the torx shaped hole located in the center of the adjustable switch pointer.
3. Gently rotate the crank until the switch pointer is at the desired switch point in degrees as shown.

#### AFB, AFX... Series

##### Factory setting 90°



##### Rotate with crank handle



##### 60° set

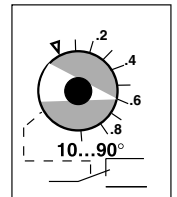


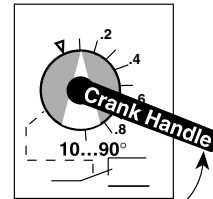
FIGURE F

#### Method 2 - See Figure G

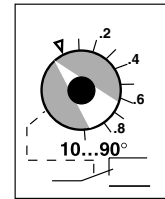
1. Position the damper to the point at which you want the switch to activate. This may be done by using the manual override or by providing the appropriate proportional signal to AFB24, AFX24... modulating type actuator. The position of the switch pointer is not important during this step
2. Insert the 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

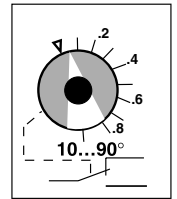


FIGURE G

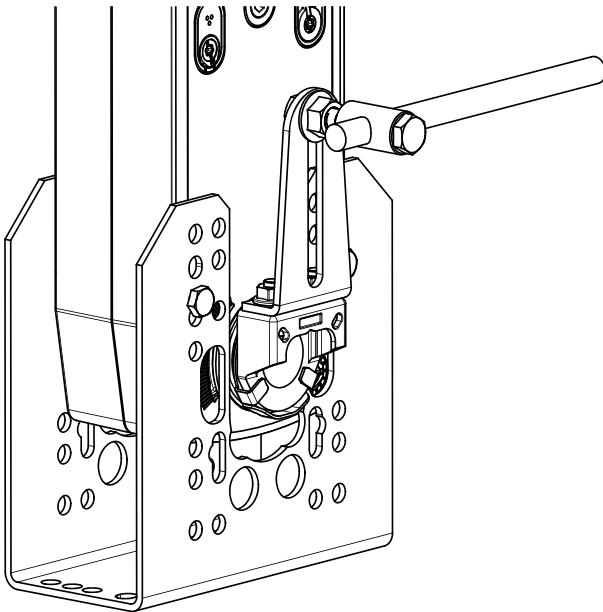
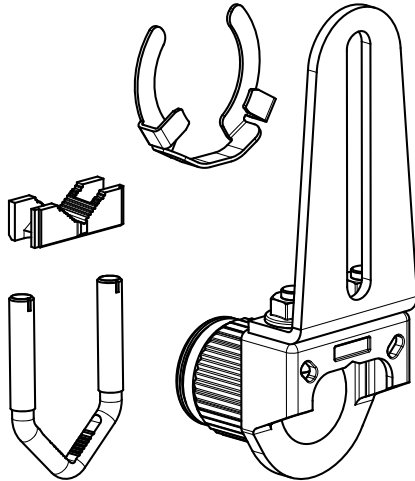
# KH-AFB Crank arm

## Including Retaining Ring

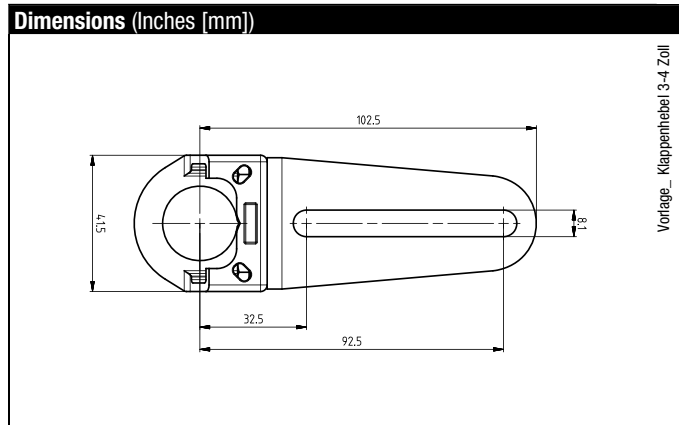
**CAUTION:** The retaining clip supplied with the clamp is **not** used to mount the KH-AFB crank arm.

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

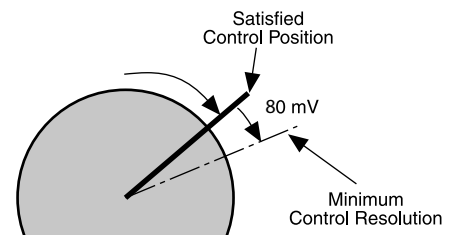
Belimo brushless DC motors eliminate the need for potentiometers for positioning in modulating type actuators. Inside the motor are three "Hall Effect" sensors. These sensors detect the spinning rotor and send pulses to the microprocessor which counts the pulses and calculates the position to within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

### Control Accuracy and Stability

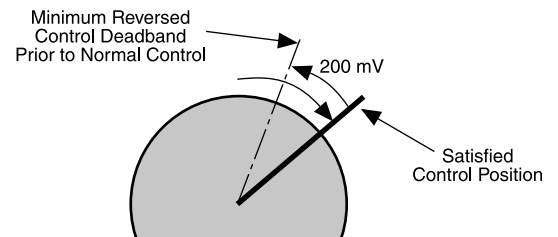
AFB24-MFT, AFX24-MFT actuators have built-in brushless DC motors which provide better accuracy and longer service life.

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.

# Installation Instructions

## General Wiring Instructions



**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 Go To Step...	Does Not Give Expected Response 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> Operation is reversed <b>Step 3.</b> Does not drive toward "Control Signal Position" <b>Step 4.</b>
2.	Check power wiring. Correct any problems. <b>See Note 1.</b>	Power supply rating should be the total power requirement of the actuator(s). 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. <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. 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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