Product Documentation
Damper Actuators and Accessories

Effective January 2004

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Retrofit applications
Replace virtually any Non-Direct coupled actuator with a high quality solution from Belimo.

- Solve any application - Widest range of mounting brackets and accessories
- Reduce installation cost – By resizing the damper you can select from 7 Belimo series of actuator types and torque ranges. 35 to 320 in-lb.

K4-2 US Universal clamp
Standard for all AF, NF and AM series actuators
- Eases installation – Only two nuts to tighten
- Increased flexibility – 1/2” to 1.05” capacity
- Centered on: 1/2”, 3/4” and 1.05” shafts
- Reduced cost - No need to purchase separate accessories

New products
Need a retrofit solution for your existing Staefa Controls Smart II controls?
Our retrofit solutions will accept the 0 to 20 V phasecut output allowing for simple installation without replacing the controller.

- AF24-PC US – Spring Return, 133 in-lb (see pages 18-19)
- AM24-PC US – Non-spring return, 160 in-lb (see pages 86-87)

Retrofit of non-direct coupled actuators
Our 0 to 135 ohm input actuators are a cost effective replacement for applications where the existing actuators have failed and the controller is still in good working condition.

- AF24-MFT95 US - Spring Return, 133 in-lb and
- AM24-MFT 95 US - Non-spring return, 160 in-lb
- We offer a complete line of mounting accessories for non-direct coupled applications (see pages 134-141)
- ZG-108 – replaces Honeywell, Johnson and Barber Colman non-direct coupled actuators. (see page 142)
Why Choose Belimo?

A CLOSER LOOK…

- Cut labor costs with simple direct coupling.
- True mechanical spring return – the most reliable failsafe.
- 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.
- Built-in or add on mechanical stops to adjust angle of rotation.
- By eliminating internal condensation Golden Point breather membrane optimizes performance in harsh airstream environments. (AF series)
- Built-in auxiliary switch is easy to use, offers feedback or signal for additional device. (-S models)
- Manual override crank speeds installation. (Not available with LF, NF and AFR… series)
- Need to change control direction? Do it easily with a simple switch on actuator housing.
- Microprocessor-controlled brushless DC motor increases actuator life span and reliability, provides constant running time. (modulating and (-SR) and floating point (-3) actuators)
- Rugged housings withstand rough handling in the mechanical room.
- 3 ft. appliance cable and conduit connector eases installation.
- Double insulated – no need for separate safety ground. A Belimo exclusive (on 120/230V models, and all models with built-in aux. switches).
- Automatically compensates for damper seal wear, ensuring tight close-off.

Brushless DC motor technology

The latest Belimo product with our Brushless DC motor technology is the 35 in-lb LM… series. With the increase in product lifespan and quality the LM series creates a new level of expectation for actuators installed in VAV applications.

- Only ONE moving part!
- No brushes to wear out
- Position feedback is generated by ASIC
- Overload proof; reduces power consumption in end position
- Running noise is reduced to absolute minimum

LM… Series actuators with Brushless motors

- LM24-3 (-T) US, Floating point or tri-state control, 35 in-lb
- LM24-SR-2.0 (-T) US, Proportional 2-10 VDC control, 35 in-lb

Our New LF24-SR-E US is a 2-10VDC controlled actuator with a built-in min position potentiometer specifically for Economizer applications.

Retrofit and Non-Direct coupled linkage solutions

Belimo offers the widest range of mechanical accessories for the replacement of competitive products as well as for the unique installation. Give us a call with your application problem.
The “10 questions” method for sizing and selection is recommended as the best method for your actuation requirements. Use the ‘Application Data’ column in this chart as a worksheet to help in the selection process. This data, along with the ‘Actuator Product Range’ charts on pages 2 and 3, allow for the best selection of a Belimo actuator.

### Typical damper requirements and sizing

**Damper with square shape: \( ft^2 = \frac{h \times w}{144}; \) (h = high, w = width)**

<table>
<thead>
<tr>
<th>Damper Area (8 ft²)</th>
<th>Rated Torque Loading of Damper (4 in-lb/ft²)</th>
<th>Total in-lb Required (32 in-lb)</th>
<th>Belimo LF/LM 35 in-lb</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 ft²</td>
<td>50 in-lb/ft²</td>
<td>320 in-lb</td>
<td>35 in-lb</td>
</tr>
</tbody>
</table>

#### Criteria

1. **What is the total area of the damper?**
   - Application Data: __________ sq. ft.

2. **Opposed blade or Parallel blade control construction?**
   - Opposed Blade
   - Parallel Blade

3. **Are there blade and edge seals on the damper?**
   - Yes
   - No

4. **For the damper in question. What does the manufacturer specify as the torque rating?**
   - In-lb/sq. ft.

5. **What is the air velocity, static pressure or design CFM?**
   - W.G.
   - CFM
   - FPM

6. **Is fail-safe required?**
   - Yes
   - No

7. **What is the supply voltage to the actuator?**
   - 24 VAC
   - 120 VAC
   - 230 VAC

8. **What is the control signal to the actuator?**
   - On/Off
   - Floating Point
   - 2-10 VDC
   - 0-10 VDC
   - 4-20 mA
   - PWM range

9. **Can you direct couple to a damper shaft?**
   - Yes
   - No, see accessories page

10. **Are there additional accessories required?**
    - Yes
    - No, see accessories section or actuator series for details

---

**Square**

<table>
<thead>
<tr>
<th>Damper Blade</th>
<th>Torque Loading in-lb/ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1000 FPM</td>
<td>FPM</td>
</tr>
<tr>
<td>2 inch water column</td>
<td>10.5</td>
</tr>
<tr>
<td>Parallel blade/edge seals</td>
<td>5</td>
</tr>
<tr>
<td>Opposed blade/edge seals</td>
<td>4</td>
</tr>
<tr>
<td>Parallel blade/no edge seals</td>
<td>3</td>
</tr>
</tbody>
</table>

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**BELIMO**

BELIMO Aircontrols (USA), Inc.

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4
Belimo actuators are compatible with many control inputs. There are many signals to select from with today’s controllers.

What does ‘on-off’, ‘open-close’, ‘3-point’, ‘tri-state’, ‘floating point’, ‘proportional modulation’, ‘phase cut’, ‘PWM’ or ‘MFT’ mean? Belimo will help you understand more on this control signal jungle with a quick overview:

On-Off or Open-Close: The actuator is able to drive either to its full open position, or to its full closed position. The same indication is used for Spring return type actuators. However the actuator will drive to its full open position and spring return to its zero position. This can also be reversed.

3-point, tri-state, floating point: The actuator has both clockwise (CW) and counter-clockwise (CCW) control inputs. One drives the actuator to its open, the other to its close position. If there is no signal (Null point) on either input the actuator simply stays in its last position.

Proportional control: The actuator drives proportional to its control input and modulates throughout its angle of rotation. This control type is usually a variation of VDC. Common values are:

- 0-10 VDC
- 2-10 VDC

It is common to also have a 0-20 mA output from a controller. This can be very easily converted to 0-10VDC or 2-10 VDC with a 500 ohm resistor.

Pulse Width Modulation (PWM): The actuator drives to a specified position according to a pulse duration, the “length” of signal. The pulse can originate from a dry contact closure or a triac sink or source controller. An example of PWM control.

- Time base: 0 to 10 seconds
- Output pulse: 5 seconds
- Actuator position: 50%

Phasecut: An actuator drives depending on the power result of a remaining wave. This signal type cuts the amplitude of the wave and the actuator recognizes this signal as a proportional movement.

Belimo developed multifunction Technology (MFT) with forward thinking. Today our MFT products are used to solve standard commercial HVAC control applications. Default MFT actuators are factory programmed to receive a standard 2-10 VDC control signal. In addition you can choose to program the actuator in the field for other standard VDC, PWM, Floating point and On-Off control.

Default actuator characteristics allow for 2-10 VDC control input with a 2-10 VDC position feedback and a runtime of 150 seconds. All Belimo actuators can be ordered with these operating characteristics.

Programmable capabilities of MFT:
- Control input: selectable, VDC, PWM, Floating point or On/Off
- Motion values: selectable running time torque adjustment
- Feedback: selectable feedback values
<table>
<thead>
<tr>
<th>Actuator Product Range</th>
<th>On-Off actuator application chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>Power Consumption</td>
</tr>
<tr>
<td>120 VAC, -20% to +10%</td>
<td>VA rating</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Airside Products</td>
<td></td>
</tr>
<tr>
<td>LF24 US</td>
<td>7</td>
</tr>
<tr>
<td>LF24-S US</td>
<td>7</td>
</tr>
<tr>
<td>LF120 US</td>
<td>7.5</td>
</tr>
<tr>
<td>LF120-S US</td>
<td>7.5</td>
</tr>
<tr>
<td>LF230 US</td>
<td>7</td>
</tr>
<tr>
<td>LF230-S US</td>
<td>7</td>
</tr>
<tr>
<td>NF24 US</td>
<td>8</td>
</tr>
<tr>
<td>NF24-S US</td>
<td>8</td>
</tr>
<tr>
<td>NF24-S2 US</td>
<td>8</td>
</tr>
<tr>
<td>NF24-S2 US</td>
<td>8</td>
</tr>
<tr>
<td>NF120 US</td>
<td>7</td>
</tr>
<tr>
<td>NF120-S US</td>
<td>7</td>
</tr>
<tr>
<td>NF230 US</td>
<td>7</td>
</tr>
<tr>
<td>NF230-S US</td>
<td>7</td>
</tr>
<tr>
<td>FSNF24 US</td>
<td>27</td>
</tr>
<tr>
<td>FSNF24-S US</td>
<td>27</td>
</tr>
<tr>
<td>FSNF120 US</td>
<td>27</td>
</tr>
<tr>
<td>FSNF120-S US</td>
<td>27</td>
</tr>
<tr>
<td>FSNF230 US</td>
<td>27</td>
</tr>
<tr>
<td>FSNF230-S US</td>
<td>27</td>
</tr>
<tr>
<td>AF24 US</td>
<td>10</td>
</tr>
<tr>
<td>AF24-S US</td>
<td>10</td>
</tr>
<tr>
<td>AF120 US</td>
<td>10</td>
</tr>
<tr>
<td>AF120-S US</td>
<td>10</td>
</tr>
<tr>
<td>AF230 US</td>
<td>11</td>
</tr>
<tr>
<td>AF230-S US</td>
<td>11</td>
</tr>
<tr>
<td>AFR24 US</td>
<td>10</td>
</tr>
<tr>
<td>AFR24-S US</td>
<td>10</td>
</tr>
<tr>
<td>AFR120 US</td>
<td>10</td>
</tr>
<tr>
<td>AFR120-S US</td>
<td>10</td>
</tr>
<tr>
<td>LM24 US</td>
<td>3</td>
</tr>
<tr>
<td>LM24.1 US</td>
<td>3</td>
</tr>
<tr>
<td>LM24-T US</td>
<td>3</td>
</tr>
<tr>
<td>LM24-T.1 US</td>
<td>3</td>
</tr>
<tr>
<td>LM24-S US</td>
<td>3</td>
</tr>
<tr>
<td>LM24-US† (fast running)</td>
<td>3</td>
</tr>
<tr>
<td>LM24-1OP US</td>
<td>3</td>
</tr>
<tr>
<td>LM24-5PO-US</td>
<td>3</td>
</tr>
<tr>
<td>LM24-5PO-T-US</td>
<td>3</td>
</tr>
<tr>
<td>NM24 US</td>
<td>3.5</td>
</tr>
<tr>
<td>NM24.1 US</td>
<td>3.5</td>
</tr>
<tr>
<td>AM24 US</td>
<td>4.5</td>
</tr>
<tr>
<td>AM24-S US</td>
<td>4.5</td>
</tr>
<tr>
<td>SM24-S US</td>
<td>4.5</td>
</tr>
<tr>
<td>GM24 US</td>
<td>6</td>
</tr>
</tbody>
</table>

Note: AFR... series: No manual override, 1 SPDT auxiliary switch (-S)  
† Torque 18 in-lb  
-60 sec. @ -22°F [-30°C]  
Δ All ...FSNF actuator details can be found in the Fire and Smoke documentation
AF Series Spring Return Direct Coupled Actuator

Minimum 133 in-lb torque

- For damper areas up to 35 sq-ft*
  (For lower torque, see NF or LF 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. (See Mounting Methods Guide and Mechanical Accessories Documentation page 132)

**AF Series - at a glance**

|-------------------|-------------------------|---------|---------|-------------------------|----------------|------------|-------------------|-------------------------|------------------------|----------------|-----------------------------|-----------------|-------------------------|----------------------|---------|-----------------------------|---------------------|-------------------|

**AF Series – at a glance**

* 4 in-lb/ft² damper torque loading. Parallel blade. No edge seals.
A CLOSER LOOK...

- Cut labor costs with simple direct coupling.
- True mechanical spring return – the most reliable failsafe.
- 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)
- Easy mechanical stop to adjust angle of rotation (add ZDB-AF2 accessory).
- By eliminating internal condensation Golden Point breather membrane optimizes performance in harsh airstream environments.
- Built-in auxiliary switch is easy to use, offers feedback or signal for additional device. (-S models)
- Manual override crank speeds installation (Not available with AFR... series)
- 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 housing withstands rough handling in the mechanical room.
- 3 ft. appliance cable and conduit connector eases installation.
- Double insulated – no need for separate safety ground. A Belimo exclusive. (-S,120V, 230V models)
- Automatically compensates for damper seal wear, ensuring tight close-off.

The Belimo Difference

- Customer Commitment.
  Extensive product range. Competitive project pricing. 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.
  20+ years direct coupled actuator design.
### Technical Data

<table>
<thead>
<tr>
<th>AF24 (-S) US</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 VAC ±20% 50/60 Hz 24 VDC ±10%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>running: 5 W  holding: 1.5 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>10 VA (class 2 power source)</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA appliance cable 1/2&quot; conduit connector</td>
</tr>
<tr>
<td>Electrical protection</td>
<td>auxiliary switches are double insulated</td>
</tr>
<tr>
<td>Overload protection</td>
<td>electronic throughout -5° to 90° rotation</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>95°, adjustable 30 to 90° with ZDB-AF2</td>
</tr>
<tr>
<td>Torque</td>
<td>133 in-lb [15 Nm] constant</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>spring return can be selected by CW/CCW mounting</td>
</tr>
<tr>
<td>Position indication</td>
<td>visual indicator, -5° to 90° (-5° is spring return position)</td>
</tr>
<tr>
<td>Manual override</td>
<td>3mm hex crank (shipped w/actuator)</td>
</tr>
<tr>
<td>Auxiliary switches</td>
<td>2 x SPDT 7A (2.5A) @ 250 VAC, UL listed one set at +5°, one adjustable 25° to 85°</td>
</tr>
<tr>
<td>Running time</td>
<td>150 sec. constant, independent of load, spring return &lt; 20 sec</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA type 2 / IP54</td>
</tr>
<tr>
<td>Housing material</td>
<td>zinc coated steel</td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No. 24 certified</td>
</tr>
<tr>
<td>Noise level</td>
<td>max. 45 dB (A)</td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Weight</td>
<td>6.0 lbs (2.7 kg.)</td>
</tr>
<tr>
<td><strong>AFR24 (-S) US</strong> (same as above except)</td>
<td></td>
</tr>
<tr>
<td>Position indication</td>
<td>-5° to 90° position indication</td>
</tr>
<tr>
<td>Manual override</td>
<td>Not available</td>
</tr>
<tr>
<td>Auxiliary switches</td>
<td>1 x SPDT 7A (2.5A) @ 250 VAC, UL listed adjustable 5° to 85°</td>
</tr>
</tbody>
</table>

---

**Operation**

The AF 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 consistent torque to the damper with, and without, power applied to the actuator.

The AF and AFR series provide 95° of rotation and are provided with a graduated position indicator showing -5° to 90°. The AF has a unique manual positioning mechanism which allows the setting of any damper position within its 95° of rotation. The AF and AFR series actuators are shipped in the zero position (5° from full fail-safe) to provide automatic compression against damper gaskets for tight shut-off. When power is applied to the AF series, the manual mechanism is released. When power is applied to the AFR series its “one time use” mechanism is released. The actuators will now try to close against the -5° position during its normal control operations. The manual override can also be released physically by the use of a crank supplied with the actuator (AF series).

The AF uses a brushless DC motor which is controlled by an Application Specific Integrated Circuit (ASIC). The ASIC monitors and controls the actuator’s rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

The AF24-S US version is provided with 2 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 +5°, the other switch function is adjustable between +25° to +85°. The AFR... series actuators are provided with 1 SPDT switch, adjustable between 5° to 85°.

### Dimensions (All numbers in brackets are metric.)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>K4-2 US (supplied)</th>
<th>K4-1 US (optional)</th>
<th>K4 US (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.66” [16.5]</td>
<td>0.38” [9.5]</td>
<td>0.39” [10]</td>
<td></td>
</tr>
<tr>
<td>0.19” [5]</td>
<td>0.31” [8]</td>
<td>0.31” [8]</td>
<td></td>
</tr>
<tr>
<td>3.96” [99]</td>
<td>1.97” [50]</td>
<td>2.64” [67]</td>
<td></td>
</tr>
<tr>
<td>0.08” [2]</td>
<td>0.26” [6.5]</td>
<td>0.08” [2]</td>
<td></td>
</tr>
<tr>
<td>10.59” [269]</td>
<td>5.85” [148.5]</td>
<td>0.8” [20]</td>
<td></td>
</tr>
<tr>
<td>0.39” [10]</td>
<td>0.39” [10]</td>
<td>0.39” [10]</td>
<td></td>
</tr>
<tr>
<td>0.39” [10]</td>
<td>0.39” [10]</td>
<td>0.39” [10]</td>
<td></td>
</tr>
<tr>
<td>0.39” [10]</td>
<td>0.39” [10]</td>
<td>0.39” [10]</td>
<td></td>
</tr>
</tbody>
</table>
On-off, spring return safety, 24 V

**Accessories**
- AV 10-18 Shaft extension
- IND-AF2 Damper position indicator
- K4 US Universal clamp for 3/8” to 3/4” shafts
- K4-1 US Universal clamp for up to 1.05” dia jackshafts
- K4-H Universal clamp for hexshafts 3/8” to 5/8”
- KH-AF Crankarm for up to 3/4” round shaft (Series 2)
- KH-AF-1 Crankarm for up to 1.05” jackshaft (Series 2)
- KH-AFV V-bolt kit for KH-AF and KH-AF-1
- Tool-01 10 mm wrench
- ZDB-AF2 Angle of rotation limiter
- ZG-100 Universal mounting bracket
- ZG-101 Universal mounting bracket
- ZG-102 Multiple actuator mounting bracket
- ZG-103 Universal mounting bracket
- ZG-104 Universal mounting bracket
- ZG-106 Mounting bracket for Honeywell® Mod IV replacement or new crankarm type installations
- ZG-107 Mounting bracket for Honeywell® Mod III or Johnson® Series 100 replacement or new crankarm type installations
- ZG-108 Mounting bracket for Barber Colman® MA 3/4., Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crankarm type installations
- ZG-AF US Crankarm adaptor kit for AF/NF
- ZG-AF108 Crankarm adaptor kit for AF/NF
- ZS-100 Weather shield (metal)
- ZS-150 Weather shield (polycarbonate)
- ZS-260 Explosion-proof housing
- ZS-300 NEMA 4X housing

For an overview of how to apply the accessories see pages 16 - 19. More detailed specifications can be found in our Mechanical Accessories section, page 132. Refer to our Mounting Methods Guide for application details.

**Note:** When using AF24 US and AF24-S US actuators, only use accessories listed on this page.

**Wiring diagrams**

**AF24 (-S) US, AFR24 (-S) US Typical Specification**

On-off spring return damper actuators shall be direct coupled type which require no crankarm 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 have a manual positioning mechanism accessible on its cover. AFR… will not. Actuators shall use a brushless DC motor and be protected from overload at all angles of rotation. Run time shall be constant and independent of torque. If required, 2 SPDT auxiliary switches shall be provided with one switch having the capability of being adjustable, AFR… 1 adjustable SPDT. Actuators with switches must be constructed to meet the requirement for Double Insulation so an electrical ground connection is not required to meet agency listings. Actuators shall be UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

**AF24 (-S) US, AFR24 (-S) US**

<table>
<thead>
<tr>
<th>Line Volts</th>
<th>1 Common</th>
<th>2 + Hot</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF24 US</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AFR24 US</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Provide overload protection and disconnect as required. Actuators may be connected in parallel. Power consumption must be observed.

Actuator may also be powered by 24 VDC.

For end position indication, interlock control, fan start-up, etc., AF24-S US incorporates two built-in auxiliary switches: 2 x SPDT, 7A (2.5A) @250 VAC, UL listed, one switch is fixed at +5°, one is adjustable 25° to 85°.

AFR24-S US 1 x SPDT, 7A (2.5A) @ 250 VAC, UL listed, 5° to 85°

Meets UL and CSA requirements without the need of an electrical ground connection.
AF120 (-S) US, AFR120 (-S) US / AF230 (-S) US
On-off, spring return safety, 120 or 230 VAC

Torque min. 133 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 crankarm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

Operation
The AF 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 consistent torque to the damper with, and without, power applied to the actuator.

The AF and AFR series provide 95° of rotation and are provided with a graduated position indicator showing -5° to 90°. The AF has a unique manual positioning mechanism which allows the setting of any damper position within its 95° of rotation. The AF and AFR series actuators are shipped in the zero position (5° from full fail-safe) to provide automatic compression against damper gaskets for tight shut-off. When power is applied to the AF series, the manual mechanism is released. When power is applied to the AFR series its “one time use” mechanism is released. The actuators will now try to close against the -5° position during its normal control operations. The manual override can also be released physically by the use of a crank supplied with the actuator (AF series).

The AF uses a brushless DC motor which is controlled by an Application Specific Integrated Circuit (ASIC). The ASIC monitors and controls the actuator’s rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches. The actuators are Double Insulated so a ground connection is not required.

The AF120/230-S US version is provided with 2 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 +5°, the other switch function is adjustable between +25° to +85°. The AFR… series actuators are provided with 1 SPDT switch, adjustable between 5° to 85°.

Dimensions (All numbers in brackets are metric.)

---

### Technical Data

<table>
<thead>
<tr>
<th>Parameters</th>
<th>AF120 (-S) US</th>
<th>AF230 (-S) US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>120 VAC ± 10%</td>
<td>230 VAC ±14%</td>
</tr>
<tr>
<td></td>
<td>50/60 Hz</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>running:  6 W</td>
<td>6.5 W</td>
</tr>
<tr>
<td></td>
<td>holding: 2.3 W</td>
<td>2.5 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>10 VA</td>
<td>11 VA</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA appliance cable</td>
<td>1/2&quot; conduit connector</td>
</tr>
<tr>
<td>Overload protection</td>
<td>actuators are double insulated</td>
<td></td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>95°, adjustable 30 to 90° w/ ZDB-AF2</td>
<td></td>
</tr>
<tr>
<td>Torque</td>
<td>133 in-lb [15 Nm] constant</td>
<td></td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>spring return can be selected by CW/CCW mounting</td>
<td></td>
</tr>
<tr>
<td>Position indication</td>
<td>visual indicator, -5° to 90° (-5° is spring return position)</td>
<td></td>
</tr>
<tr>
<td>Manual override</td>
<td>3mm hex crank (shipped w/actuator)</td>
<td></td>
</tr>
<tr>
<td>Auxiliary switches</td>
<td>2 x SPDT 7A (2.5A) @ 250 VAC, UL listed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(AF120/230-S) one set at +5°, one adjustable 25° to 85°</td>
<td></td>
</tr>
<tr>
<td>Running time</td>
<td>150 sec. constant, independent of load, spring return &lt; 20 sec</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
<td></td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA type 2 / IP54</td>
<td></td>
</tr>
<tr>
<td>Housing material</td>
<td>zinc coated steel</td>
<td></td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No. 24 certified</td>
<td></td>
</tr>
<tr>
<td>Noise level</td>
<td>max. 45 dB (A)</td>
<td></td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
<td></td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>6.9 lbs (3.1 kg.)</td>
<td></td>
</tr>
<tr>
<td>Manual override</td>
<td>Not available, when powered the actuator will drive to -5° for damper pre-tensioning</td>
<td></td>
</tr>
<tr>
<td>Auxiliary switches</td>
<td>1 x SPDT 7A (2.5A) @ 250 VAC, UL listed adjustable 5° to 85°</td>
<td></td>
</tr>
</tbody>
</table>
**AF120 (-S) US, AFR120 (-S) / AF230 (-S) US**

On-off, spring return safety, 120 or 230 VAC

### Accessories

- **AV 10-18** Shaft extension
- **IND-AF2** Damper position indicator
- **K4 US** Universal clamp for 3/8" to 3/4" shafts
- **K4-1 US** Universal clamp for up to 1.05" dia jackshafts
- **KH-AF** Crankarm for up to 3/4" round shaft (Series 2)
- **KH-AF-1** Crankarm for up to 1.05" jackshaft (Series 2)
- **KH-AFV** V-bolt kit for KH-AF and KH-AF-1
- **Tool-01** 10 mm wrench
- **ZDB-AF2** Angle of rotation limiter
- **ZG-100** Universal mounting bracket
- **ZG-101** Universal mounting bracket
- **ZG-102** Multiple actuator mounting bracket
- **ZG-103** Universal mounting bracket
- **ZG-104** Universal mounting bracket
- **ZG-106** Mounting bracket for Honeywell® Mod IV replacement or new crankarm type installations
- **ZG-107** Mounting bracket for Honeywell® Mod III or Johnson® Series 100 replacement or new crankarm type installations
- **ZG-108** Mounting bracket for Barber Colman® MA 3../4.., Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crankarm type installations
- **ZG-AF US** Crankarm adaptor kit for AF/NF
- **ZG-AF108** Crankarm adaptor kit for AF/NF
- **ZS-100** Weather shield (metal)
- **ZS-150** Weather shield (polycarbonate)
- **ZS-260** Explosion-proof housing
- **ZS-300** NEMA 4X housing

For an overview of how to apply the accessories see pages 16 - 19. More detailed specifications can be found in our Mechanical Accessories section, page 132. Refer to our Mounting Methods Guide for application details.

**Note:** When using AF120/230 US and AF120/230-S US actuators, only use accessories listed on this page.

### Wiring diagrams

#### 120 VAC (230 VAC for AF230 US)

- **L1 N**
- **L2 H**

**AF120 US**

**AFR120 US**

**AF230 US**

- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption must be observed.
- No ground connection is required.
- Meets UL and CSA requirements without the need of an electrical ground connection.

**AF120 US, AFR120 (-S) US/AF230 US Typical Specification**

On-off spring return damper actuators shall be direct coupled type which require no crankarm 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 have a manual positioning mechanism accessible on its cover. AFR... will not. Actuators shall use a brushless DC motor and be protected from overload at all angles of rotation. Run time shall be constant and independent of torque. If required, 2 SPDT auxiliary switches shall be provided with one switch having the capability of being adjustable, AFR... 1 adjustable SPDT. Actuators must be constructed to meet the requirement for Double Insulation so an electrical ground connection is not required to meet agency listings. Actuators shall be UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.
AFR24-3 (-S) US
On-off, spring return reversible, floating point, 24V

Torque min. 133 in-lb, for control of air dampers

Application
For modulating or on-off control of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications.

The actuator is mounted directly to a damper shaft up to 1.05” in diameter by means of its universal clamp. A crankarm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

Control is floating point from a triac or relay, or on-off from an auxiliary contact from a fan motor contactor, controller, or manual switch. The AFR24-3-S US is constructed to meet the requirements for Double Insulated devices. These units do not require a ground connection to meet electrical code requirements.

Operation
The AFR 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 consistent torque to the damper with, and without, power applied to the actuator.

The AFR series provides 95° of rotation and is provided with a graduated position indicator showing -5° to 90°. The AFR series actuators are shipped in the zero position (5° from full fail-safe) to provide automatic compression against damper gaskets for tight shut-off. When power is applied to the AFR series its “one time use” mechanism is released.

The AFR 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. The ASIC monitors and controls the brushless DC motor’s rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

The AFR24-3-S version is provided with 1 built-in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 5 to 85°.

The AF24-MFT (-S) US actuator with P-30... series configurations provides for floating point control, manual override and two auxiliary switches (-S). Please see the Multi-Function Technology® documentation 2.5 for more details

Dimensions (All numbers in brackets are metric.)

<table>
<thead>
<tr>
<th>Technical Data</th>
<th>AFR24-3 (-S) US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 VAC ± 20% 50/60 Hz, 24 VDC ± 10%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>running: 6 W; holding: 2 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>10 VA (class 2 power source)</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA appliance cable, 1/2” conduit connector</td>
</tr>
<tr>
<td>Electrical protection</td>
<td>auxiliary switches are double insulated</td>
</tr>
<tr>
<td>Overload protection</td>
<td>electronic throughout -5° to 90° rotation</td>
</tr>
<tr>
<td>Input impedance</td>
<td>1000 Ω (0.6w) control inputs</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>95°, adjustable 30 to 90° with ZDB-AF2</td>
</tr>
<tr>
<td>Torque</td>
<td>133 in-lb [15 Nm] constant</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>spring: reversible with CW/CCW mounting, motor: reversible with built-in switch</td>
</tr>
<tr>
<td>Position indication</td>
<td>visual indicator, -5° to 90°</td>
</tr>
<tr>
<td>Manual override</td>
<td>Not available</td>
</tr>
<tr>
<td>Auxiliary switches (AFR24-3-S)</td>
<td>1 x SPDT 7A (2.5A) @ 250 VAC, UL listed adjustable 5° to 85°</td>
</tr>
<tr>
<td>Running time</td>
<td>150 sec. constant, independent of load, spring return &lt; 20 sec</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA type 2/IP54</td>
</tr>
<tr>
<td>Housing material</td>
<td>zinc coated metal</td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No. 24 certified</td>
</tr>
<tr>
<td>Noise level</td>
<td>max. 45 dB (A)</td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Weight</td>
<td>6.0 lbs (2.7 kg.)</td>
</tr>
</tbody>
</table>

© Belimo Aircontrols (USA), Inc.
Accessory
AV-10-18 Shaft extension
IND-AF2 Damper position indicator
K4 US Universal clamp for 3/8" to 3/4" shafts
K4-1 US Universal clamp for up to 1.05" dia jacjshafts
K4-H Universal clamp for hexshafts 3/8" to 5/8"
KH-AF-20358 / 5 4 3 2 1 -01/04-10M-IG-Subject to change. © Belimo Aircontrols (USA), Inc.
KH-AF-1 Crankarm for up to 1.05" jackshaft (Series 2)
KH-AFV V-bolt kit for KH-AF and KH-AF-1
Tools-01 10 mm wrench
ZDB-AF2 Angle of rotation limiter
ZG-100 Universal mounting bracket
ZG-101 Universal mounting bracket
ZG-102 Multiple actuator mounting bracket
ZG-103 Universal mounting bracket
ZG-104 Universal mounting bracket
ZG-106 Mounting bracket for Honeywell® Mod IV replacement or new crankarm type installations
ZG-107 Mounting bracket for Honeywell® Mod III or Johnson® Series 100 replacement or new crankarm type installations
ZG-108 Mounting bracket for Barber Colman® MA 3...4...
ZG-AF US Crankarm adaptor kit for AF/NF
ZG-AF108 Crankarm adaptor kit for AF/NF
ZS-300 NEMA 4X housing
ZS-150 Weather shield (polycarbonate)
ZS-US Weather shield (metal)
ZS-100 Weather shield (polycarbonate)
ZS-200 Explosion-proof housing
ZS-300 NEMA 4X housing

For an overview of how to apply the accessories see pages 16 - 19. More detailed specifications can be found in our Mechanical Accessories section, page 132. Refer to our Mounting Methods Guide for application details.

Note: When using AFR24-3 (-S) US actuators, only use accessories listed on this page.

Wiring Diagrams

On-Off control of AFR24-3 (-S) US

Floating point control of AFR24-3 (-S) US

Auxiliary switches of AFR24-3-S US

AFR24-3 US, AFR24-3-S US Typical Specification
Floating point, on-off spring return damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a jack¬
shaft 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
have an external direction of rotation switch to reverse control logic. Actuators shall
use a brushless DC motor and be protected from overload at all angles of rotation.
Run time shall be constant and independent of torque. If required, 1 SPDT auxiliary
switch shall be provided with having the capability of being adjustable, AFR...1 adjustable SPDT. Actuators with auxiliary switches must be constructed to meet the
requirements for Double Insulation so an electrical ground connection is not required
to meet agency listings. Actuators shall be UL listed and CSA certified, have a 5
year warranty, and be manufactured under ISO 9001 International Quality Control
Standards. Actuators shall be as manufactured by Belimo.
**Technical Data**

<table>
<thead>
<tr>
<th>AF24-SR US</th>
<th>AFR24-SR US</th>
</tr>
</thead>
</table>
| **Power supply** | 24 VAC ± 20% 50/60 Hz  
               | 24 VDC ± 10% |
| **Power consumption** | running: 6 W  
                       | holding: 2 W |
| **Transformer sizing** | 10 VA (class 2 power source) |
| **Electrical connection** | 3 ft, 18 GA appliance cable  
                       | 1/2" conduit connector |
| **Overload protection** | electronic throughout 0 to 95° rotation |
| **Operating range Y** | 2 to 10 VDC, 4 to 20 mA |
| **Input impedance** | 100 kΩ (0.1 mA), 500Ω |
| **Feedback output U** | 2 to 10 VDC (max. 0.5 mA) for 95° |
| **Angle of rotation** | mechanically limited to 95° |
| **Torque** | 133 in-lb [15 Nm] constant |
| **Direction of rotation** | spring return reversible with CW/CCW mounting. Control direction selected by switch: CW=CCW with decrease in signal CCW=CCW with a decrease in signal |
| **Position indication** | visual indicator, -5° to 90° (-5° is spring return position) |
| **Manual override** | 3mm hex crank (shipped w/actuator) |
| **Running time** | 150 sec. constant, independent of load, spring return < 20 sec |
| **Humidity** | 5 to 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 type 2 / IP54 |
| **Housing material** | zinc coated metal |
| **Agency listings** | UL 873 listed, CSA C22.2 No. 24 certified |
| **Noise level** | max. 45 dBA (A) |
| **Servicing** | maintenance free |
| **Quality standard** | ISO 9001 |
| **Weight** | 6.0 lbs (2.7 kg.) |
| **AFR24-SR US** | (same as above except) |
| **Position indication** | -5° to 95° |
| **Manual override** | Not available |

---

**Torque min. 133 in-lb, for control of air dampers**

**Application**

For proportional modulation of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications.

The actuator is mounted directly to a damper shaft up to 1.05" in diameter by means of its universal clamp. A crankarm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

The actuator operates in response to a 2 to 10 VDC, with the addition of a 500Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner. A 2 to 10 VDC feedback signal is provided for position indication or master-slave applications.

**Operation**

The AF 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 AF series provides 95° of rotation and is provided with a graduated position indicator showing -5 to 90°. The AF has a unique manual positioning mechanism which allows the setting of any damper position within its 95° of rotation. When power is applied to the AFR series its "one time use" mechanism is released. The actuator is shipped in the zero position (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. The actuator will memorize the angle where it stops rotating and use this point for its zero position for its normal control operations. The manual override can also be released physically by the use of a crank supplied with the actuator.

The AF 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 zero position. The ASIC monitors and controls the brushless DC motor’s rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

**Dimensions**

(All numbers in brackets are metric.)

- **K4-2 US (supplied)**
  - 1/2" Centered (Default)
  - 3/4" Centered (Field Selectable)
  - 1.05" Centered (Field Selectable)
- **K4-1 US (optional)**
  - 3/4" to 1.05" Adjustable
- **K4 US (optional)**
  - 3/8" to 3/4" Adjustable
Proportional damper actuator, spring return safety, 24 V for 2 to 10 VDC and 4 to 20 mA control signal. Output signal of 2 to 10 VDC for position indication.

Accessories
- AV 10-18: Shaft extension
- IND-AF2: Damper position indicator
- K4 US: Universal clamp for 3/8" to 3/4" shafts
- K4-1 US: Universal clamp for up to 1.05" dia jackshafts
- K4-H: Universal clamp for hexshafts 3/8" to 5/8"
- KH-AF: Crankarm for up to 3/4" round shaft (Series 2)
- KH-AF-1: Crankarm for up to 1.05" jackshaft (Series 2)
- KH-AFV: V-bolt kit for KH-AF and KH-AF-1
- Tool-01: 10 mm wrench
- SGA24: Min. and/or man. positioner in NEMA 4 housing
- SGF24: Min. and/or man. positioner for flush panel mounting
- ZG-R01: 500Ω resistor for 0 to 20 mA control signal
- ZDB-AF2: Angle of rotation limiter
- ZG-100: Universal mounting bracket
- ZG-101: Universal mounting bracket
- ZG-102: Multiple actuator mounting bracket
- ZG-103: Universal mounting bracket
- ZG-104: Universal mounting bracket
- ZG-106: Mounting bracket for Honeywell® Mod IV replacement or new crankarm type installations
- ZG-107: Mounting bracket for Honeywell® Mod III or Johnson® Series 100 replacement or new crankarm type installations
- ZG-108: Mounting bracket for Barber Colman® MA 3../4../Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crankarm type installations
- ZG-AF US: Crankarm adaptor kit for AF/NF
- ZG-AF108: Crankarm adaptor kit for AF/NF
- ZS-100: Weather shield (metal)
- ZS-150: Weather shield (polycarbonate)
- ZS-260: Explosion-proof housing
- ZS-300: NEMA 4X housing

For an overview of how to apply the accessories see pages 16 - 19. More detailed specifications can be found in our Mechanical Accessories section, page 132. Refer to our Mounting Methods Guide for application details.

Note: When using AFR24-SR US actuators, only use accessories listed on this page.

AF(R)24-SR US Typical Specification
Spring return control damper actuators shall be direct coupled type which require no crankarm 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 counter-clockwise fail-safe operation. Actuators shall have control direction of rotation switch accessible on its cover. 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 or master-slave applications. Actuators shall be UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring diagrams

Provide overload protection and disconnect as required.
Actuators may be connected in parallel. Power consumption and input impedance must be observed.
Actuator may also be powered by 24 VDC.

Provide overload protection and disconnect as required.
Actuators may be connected in parallel. Power consumption and input impedance must be observed.
Actuator may also be powered by 24 VDC.
The ZG-R01 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.
Only connect common to neg. (—) leg of control circuits.
AF24-PC US

Proportional damper actuator, spring return safety, 24 V for 0 to 20 V phasecut control signal.
Output signal of 2 to 10 VDC for position indication

Torque min. 133 in-lb, for control of air dampers

Application
For proportional modulation of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications.

The actuator is mounted directly to a damper shaft up to 1.05” in diameter by means of its universal clamp. A crankarm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

The actuator operates in response to a 0-10 V phasecut control input from an electronic controller or positioner. A 2 to 10 VDC feedback signal is provided for position indication or master-slave applications.

Operation
The AF 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 AF series provides 95° of rotation and is provided with a graduated position indicator showing -5° to 90° (-5° is spring return position). When power is applied to the AFR series its "one time use" mechanism is released. The actuator is shipped in the zero position (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. The actuator will memorize the angle where it stops rotating and use this point for its zero position for its normal control operations. The manual override can also be released physically by the use of a crank supplied with the actuator.

The AF 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 constant rotation rate and to know the actuator’s exact zero position. The ASIC monitors and controls the brushless DC motor’s rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

Technical Data

<table>
<thead>
<tr>
<th>AF24-PC US</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 VAC ± 20% 50/60 Hz</td>
</tr>
<tr>
<td></td>
<td>24 VDC ± 10%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>running: 6 W; holding: 2.5 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>10 VA (class 2 power source)</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft. 18 GA appliance cable</td>
</tr>
<tr>
<td></td>
<td>1/2” conduit connector</td>
</tr>
<tr>
<td>Overload protection</td>
<td>electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td>Operating range Y</td>
<td>0 to 10 V phasecut</td>
</tr>
<tr>
<td>Input impedance</td>
<td>8 kΩ (0.1 mA), 50mW</td>
</tr>
<tr>
<td>Feedback output U</td>
<td>2 to 10 VDC (max. 0.5 mA) for 95°</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>mechanically limited to 95°</td>
</tr>
<tr>
<td>Torque</td>
<td>133 in-lb [15 Nm] constant</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>spring return reversible with CW/CCW mounting. Control direction selected by switch: CW=CCW with decrease in signal CCW=CCW with a decrease in signal</td>
</tr>
<tr>
<td>Position indication</td>
<td>visual indicator, -5° to 90° (-5° is spring return position)</td>
</tr>
<tr>
<td>Manual override</td>
<td>3mm hex crank (shipped w/actuator)</td>
</tr>
<tr>
<td>Running time</td>
<td>150 sec. constant, independent of load, spring return &lt; 20 sec</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA type 2 / IP54</td>
</tr>
<tr>
<td>Housing material</td>
<td>zinc coated metal</td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No. 24 certified</td>
</tr>
<tr>
<td>Noise level</td>
<td>max. 45 dB (A)</td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Weight</td>
<td>6.0 lbs (2.7 kg.)</td>
</tr>
</tbody>
</table>

Dimensions

(All numbers in brackets are metric.)

<table>
<thead>
<tr>
<th>K4-2 US (supplied)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2” Centered (Default)</td>
<td></td>
</tr>
<tr>
<td>3/4” Centered (Field Selectable)</td>
<td></td>
</tr>
<tr>
<td>1.05” Centered (Field Selectable)</td>
<td></td>
</tr>
<tr>
<td>K4-1 US (optional)</td>
<td></td>
</tr>
<tr>
<td>3/4” to 1.05” Adjustable</td>
<td></td>
</tr>
<tr>
<td>3/8” to 3/4” Adjustable</td>
<td></td>
</tr>
<tr>
<td>K4 US (optional)</td>
<td></td>
</tr>
</tbody>
</table>

Noise level max. 45 dB (A)
Servicing maintenance free
Quality standard ISO 9001
Weight 6.0 lbs (2.7 kg.)
**Proportional damper actuator, spring return safety, 24 V for 0 to 20 V phasecut control signal.**

**Output signal of 2 to 10 VDC for position indication**

**Accessories**
- AV 10-18 Shaft extension
- IND-AF2 Damper position indicator
- K4 US Universal clamp for 3/8” to 3/4” shafts
- K4-1 US Universal clamp for up to 1.05” dia jackshafts
- K4-H Universal clamp for hexshafts 3/8” to 5/8”
- KH-AF Crankarm for up to 3/4” round shaft (Series 2)
- KH-AF1 Crankarm for up to 1.05” jackshaft (Series 2)
- KH-AFV V-bolt kit for KH-AF and KH-AF-1
- Tool-01 10 mm wrench
- SGA24 Min. and/or man. positioner in NEMA 4 housing
- SGF24 Min. and/or man. positioner for flush panel mounting
- ZG-R01 500Ω resistor for 0 to 20 mA control signal
- ZDB-AF2 Angle of rotation limiter
- ZG-100 Universal mounting bracket
- ZG-101 Universal mounting bracket
- ZG-102 Multiple actuator mounting bracket
- ZG-103 Universal mounting bracket
- ZG-104 Universal mounting bracket
- ZG-106 Mounting bracket for Honeywell® Mod IV replacement or new crankarm type installations
- ZG-107 Mounting bracket for Honeywell® Mod III or Johnson® Series 100 replacement or new crankarm type installations
- ZG-108 Mounting bracket for Barber Colman® MA 3../4../ Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crankarm type installations
- ZG-AF US Crankarm adaptor kit for AF/NF
- ZG-AF108 Crankarm adaptor kit for AF/NF
- ZS-100 Weather shield (metal)
- ZS-150 Weather shield (polycarbonate)
- ZS-260 Explosion-proof housing
- ZS-300 NEMA 4X housing

For an overview of how to apply the accessories see pages 16 - 19. More detailed specifications can be found in our Mechanical Accessories section, page 132. Refer to our Mounting Methods Guide for application details.

**Note:** When using AFR24-SR US actuators, only use accessories listed on this page.

### AF24-PC US Typical Specification

Spring return control damper actuators shall be direct coupled type which require no crankarm 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 0 to 20 V phasecut control output 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 have control direction of rotation switch accessible on its cover. 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 or master-slave applications. Actuators shall be UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

### Wiring diagrams

- **Provide overload protection and disconnect as required.**
- **Actuators may be connected in parallel. Power consumption and input impedance must be observed.**
- **Actuator may also be powered by 24 VDC.**

0 to 20 V phasecut control of AF24-PC US
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, move it to 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.
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.

<table>
<thead>
<tr>
<th>Damper Type</th>
<th>Torque Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opposed blade, without edge seals, for non-tight close-off applications</td>
<td>3 in-lb/sq. ft.</td>
</tr>
<tr>
<td>Parallel blade, without edge seals, for non-tight close-off applications</td>
<td>4 in-lb/sq. ft.</td>
</tr>
<tr>
<td>Opposed blade, with edge seals, for tight close-off applications</td>
<td>5 in-lb/sq. ft.</td>
</tr>
<tr>
<td>Parallel blade, with edge seals, for tight close-off applications</td>
<td>7 in-lb/sq. ft.</td>
</tr>
</tbody>
</table>

The above torque loadings will work for most applications under 2 in. w.g. static pressure or 1000 FPM face velocity. For applications between this criteria and 3 in. w.g. or 2500 FPM, the torque loading should be increased by a multiplier of 1.5. If the application calls for higher criteria up to 4 in. w.g. or 3000 FPM, use a multiplier of 2.0.

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 10-18 shaft extension 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 AF 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 AF—S versions are provided with 2 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 +5°, the other switch function is adjustable between +25 to +85°.

The AFR... series are provided with 1 x SPDT 7A (2.5A) @ 250 VAC, UL listed adjustable switch, 5° to 85°.

Automatic Airtight Dampers/Manual Override

The AF series provides 95° of rotation and is provided with a graduated position indicator showing -5 to 90°. The AF has a unique manual positioning mechanism which allows the setting of any damper position within its 95° of rotation. A pre-tensioned spring automatically tightens damper when power is applied to the actuator, compensating for damper seal deterioration. The actuator is shipped in the 0 position (5° from full fail-safe) to provide automatic compression against damper blade seals when the actuator is in use, providing tight shut-off. When power is applied, the manual mechanism is released and the actuator drives toward the full fail-safe position. While the AFR... series actuators do not have a manual override they do provide the -5° pre-tensioning feature.

Standard Mounting

Note: The AF...series actuator is shipped with the manual override adjusted for a 0° position at the universal clamp (not at full fail-safe, -5°). 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.

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-AF2 pointer. See Fig. A.

Jackshaft Installation
The AF… series actuator is designed for use with jackshafts up to 1.05” in diameter. In most applications, the AF actuator may be mounted in the same manner as a standard damper shaft application. If more torque is required than one AF actuator can provide, a second AF 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:

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Quantity Per Shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF24 (-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AFR24 (-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AF120 (-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AFR120 (-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AF230 (-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AF24-SR US</td>
<td>4</td>
</tr>
<tr>
<td>AFR24-SR US</td>
<td>4</td>
</tr>
<tr>
<td>AFR24-3 (-S) US</td>
<td>4</td>
</tr>
</tbody>
</table>

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 AF actuator can provide, a second AF actuator may be mounted to the shaft using the ZG-102 multiple mounting bracket.

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

Special Wiring and Additional Information: See wiring guide

Rotation Limitation
The angle of rotation limiter, ZDB-AF2, is used in conjunction with the tab on the universal clamp or IND-AF2 position indicator which comes with the ZDB-AF2. In order to function properly, the clamp or indicator must be mounted correctly. See Fig. A.

The ZDB-AF2 may not work in certain mounting orientations using the ZG-106 or ZG-107 mounting brackets. It will not work with the ZG-108 mounting bracket. Limiting the damper rotation must be accomplished by adjusting the crankarm linkage.

The ZDB-AF2 may be used in 2 ways to control the rotational output of the AF 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 (ZDB-AF2) on the actuator so that its edge lines up with the degree graduation on the actuator face which corresponds with the required rotation. See Fig. C.

3. Find the appropriate cross-hair location through the slot of the limiter. This is the screw mounting location.
4. Pierce through the label material to allow easy fastening of the retaining screw.
5. Position the limiter back to the desired position, making sure the locating “teeth” on the limiter are engaged into the locating holes on the actuator.
6. Fasten the limiter to the actuator using the self tapping screw provided.
7. Test the damper rotation either manually with the manual crank or apply power and if required, a control signal. Re-adjust if necessary.

Mechanical minimum damper position
In order to use this procedure, the actuator must be mounted for short shaft mounting. See pages 8 & 10.
1. Position the damper to its minimum position by using the manual crank or by providing the appropriate control signal to the AF24...modulating type actuator.
2. Place the indicator on to the actuator spline in the approximate position shown in Fig. D. Fasten it with the retaining clip. Note that the mounting orientation is different than the mounting used for Damper Rotation Limiting.

3. Place the ZDB-AF2 rotation limiter on the actuator so that it either makes contact with, or is as close as possible to, the edge of the indicator. See Fig. E. Make sure that the locating teeth are engaged into the locating holes on the actuator. If all of the mounting teeth do not align with the holes, the mounting location of the indicator to the spline may have to be moved. The limiter would then be remounted to get the best position match of both parts.
4. Find the cross-hair location through the slot of the limiter. This is the screw mounting location.
5. Pierce through the label material to allow easy fastening of the retaining screw.
6. Fasten the limiter to the actuator using the self tapping screw provided.
7. Test the damper operation either manually with the manual crank or apply power and if required, a control signal. Re-adjust if necessary.
This method should not be used for outside air damper applications. The damper will never go to the full close-off position. This may cause coils to freeze or other system problems. The AF24-SR (-S) US wired to either the SGA24 or SGP24 can be used for minimum position setting and still provide full close-off.

Manual override
The AF series actuators can be manually positioned to ease installation or for emergency positioning.

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

Method 1: See Fig. F
1. The actuator must be in its fail-safe position.
2. Insert the crank into the hexagon shaped hole located in the center of the adjustable switch pointer.
3. Rotate the crank until the switch pointer is at the desired switch point in degrees as shown.

Method 2: See Fig. 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 AF24...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. Rotate the switch pointer to just past the switch point indicating arrow as shown.
Installation Instructions

Non-direct mounting methods and electrical operation

Crankarm for AF Series Actuators

The KH-AF (-1) crankarm is used in non-direct coupled mounting applications. The KH-AF (-1) may also be used to simultaneously direct couple to a damper shaft and provide an additional crank arm connection to a second damper. The KH-AFV V-bolt kit must be used for this non-direct application (see illustration below).

Two sizes are available:
KH-AF  For round shafts up to 3/4” or square shafts up to 5/8”
KH-AF-1 For jackshafts up to 1.05”

Note: KH-AF (-1) crankarms cannot be used on AF Series 1 actuators.

Electrical Operation

General
The AF series actuators utilize brushless DC motor technology. The AF uses this motor in conjunction with an Application Specific Integrated Circuit (ASIC). In the On-Off versions of the AF, the ASIC monitors and controls the actuator’s rotation and a digital rotation sensing function to prevent damage to the actuator. The AF24…modulating 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 AF 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.

The AF… actuators are protected against overload by digital technology located in the ASIC. The ASIC circuit monitors the rotation of the brushless DC motor inside the actuator and stops the pulsing to the motor when it senses a stall condition. The motor remains energized and produces full rated torque during stall conditions.

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.
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.

**Transformer(s)**
The AF24 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 hot leg.* 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 AF24... actuators**
Keep power wire runs below the lengths listed in the Fig. 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:**

<table>
<thead>
<tr>
<th>Wire Size</th>
<th>Max. Feet</th>
<th>Wire Size</th>
<th>Max. Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Ga</td>
<td>350 Ft</td>
<td>18 Ga</td>
<td>225 Ft</td>
</tr>
<tr>
<td>14 Ga</td>
<td>200 Ft</td>
<td>20 Ga</td>
<td>125 Ft</td>
</tr>
<tr>
<td>16 Ga</td>
<td>350 Ft</td>
<td>22 Ga</td>
<td>60 Ft</td>
</tr>
</tbody>
</table>

**Fig. H**

**Wire Type and Wire Installation Tips**
For most installations, 18 or 16 Ga. cable works well with the AF24, 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 AF24... 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 AF24-SR US, AFR24-SR US**
When power is initially applied, the actuator will first release its preload position (This assumes a manual position has been set, the AFR... is pre set from the factory). 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. 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.
### AF24-SR US, AFR24-SR US  Electrical check-out procedure

<table>
<thead>
<tr>
<th>Step</th>
<th>Procedure</th>
<th>Expected Response</th>
<th>Gives Expected Response</th>
<th>Does Not Give Expected Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control signal is applied to actuator.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly</td>
<td>No response at all Step 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Operation is reversed Step 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Does not drive toward “Control Signal Position” Step 4</td>
</tr>
<tr>
<td>2.</td>
<td>Check power wiring. Correct any problems. See Note 1.</td>
<td>Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.</td>
<td>Power wiring corrected, actuator begins to drive Step 1</td>
<td>Power wiring corrected, actuator still does not drive Step 4</td>
</tr>
<tr>
<td>3.</td>
<td>Turn reversing switch to the correct position. Make sure the switch is turned all the way left or right.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly Step 7</td>
<td>Does not drive toward “Control Signal Position” Step 4</td>
</tr>
<tr>
<td>4.</td>
<td>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.</td>
<td>Drives to “Control Signal” position</td>
<td>Actuator operates properly Step 7</td>
<td>Step 5</td>
</tr>
<tr>
<td>5.</td>
<td>Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For AF24-SR US this is 2 to 10 VDC or 4 to 20 mA. Note: The input signal must be above the 2 VDC or 4 mA to have the actuator move.</td>
<td>Input voltage or current should be ±1% of what controller’s adjustment or programming indicate.</td>
<td>Controller output (actuator input) is correct. Input Polarity Correct Step 6</td>
<td>Reprogram, adjust repair or replace controller as needed Step 1</td>
</tr>
<tr>
<td>7.</td>
<td>Check damper torque requirement.</td>
<td>Torque requirement is ≤ actuator’s minimum torque.</td>
<td>Defective Actuator. Replace Actuator - See Note 2</td>
<td>Recalculate actuator requirement and correct installation.</td>
</tr>
<tr>
<td>8.</td>
<td>Actuator works properly. Test controller by following controller manufacturer’s instructions.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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 installation date, notify Belimo and give details of the application.
NF Series Spring Return Direct Coupled Actuator

Minimum 60 in-lb torque
- For damper areas up to 15 sq-ft*

Applications

Mount directly to 1.05" jackshafts with accessory clamp.

Linkage is available when direct coupling is not possible. (See Mounting Methods Guide 5.1 and Mechanical Accessories Doc 4.2)

**NF Series - at a glance**

<table>
<thead>
<tr>
<th>NF24 US (p. 30)</th>
<th>NF24-S US (p. 30)</th>
<th>NF24-S2 US (p. 30)</th>
<th>NF120 US (p. 32)</th>
<th>NF120-S US (p. 32)</th>
<th>NF230 US (p. 32)</th>
<th>NF230-S US (p. 32)</th>
<th>NF24-SR US (p. 34)</th>
<th>NF24-SR-S US (p. 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque: 60 in-lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power supply: 24 VAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120 VAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>230 VAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control signal: on-off</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control signal: proportional 2 to 10 VDC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback signal: 2 to 10 VDC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running time: motor &lt;75 sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>motor 150 sec constant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>spring &lt;60 sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External direction of rotation switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appliance rated cable, 18 GA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Built-in auxiliary switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two built-in auxiliary switches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation instructions ......(p. 36–41)</td>
<td>General wiring ..........(p. 41)</td>
<td>Start-up and checkout ......(p. 42)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 4 in-lb/ft² damper torque loading. Parallel blade. No edge seals.
A CLOSER LOOK…

- Cut labor costs with simple direct coupling.
- True mechanical spring return – the most reliable failsafe.
- Mount for clockwise or counterclockwise fail-safe.
- Check damper position easily with clear position indicator.
- Don’t worry about actuator burn-out. Belimo is overload-proof throughout rotation.
- Easy mechanical stop to adjust angle of rotation. (add ZDB-AF2 accessory).
- Need to change control direction? Do it easily with a simple switch. (NF24-SR US)
- Golden Point breather membrane optimizes performance in harsh airstream environments.
- Built-in auxiliary switch(s) is easy to use, offers feedback or signal for additional device. (NF24-S2 US has two switches, NF24-S US, NF120-S US, NF230-S US)
- Microprocessor-controlled brushless DC motor increases actuator life span and reliability, provides constant running time. (NF24-SR US)
- Rugged metal housing withstands rough handling in the mechanical room.
- 3 ft. appliance rated cable and conduit connector eases installation.

The Belimo Difference

- **Customer Commitment.**
  - Extensive product range. Competitive project pricing. 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.
  - 20+ years direct coupled actuator design.
NF24 (-S,-S2) US
On-off, spring return safety, 24 V

Torque min. 60 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 NF 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 NF 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 NF24-S US version is provided with 1 built in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 5° and 85°.

The NF24-S2 US version is provided with 2 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 +5°, the other switch function is adjustable between +25° to +85°.

Technical Data NF24 (-S) US

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 VAC ± 20% 50/60 Hz, 24 VDC ± 10%</td>
</tr>
<tr>
<td>Power consumption running</td>
<td>5 W</td>
</tr>
<tr>
<td></td>
<td>holding: 2.6 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>8 VA (class 2 power source)</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA appliance cable, 1/2” conduit connector</td>
</tr>
<tr>
<td>Overload protection</td>
<td>Electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td>Electrical protection</td>
<td>Auxiliary switches are double insulated</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>95°, adjustable 30 to 95° with accessories</td>
</tr>
<tr>
<td>Torque</td>
<td>60 in-lb [7 Nm] constant torque</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>Spring return can be selected by CW/CCW mounting</td>
</tr>
<tr>
<td>Position indication</td>
<td>Visual indicator, 0° to 95° (0° is spring return position)</td>
</tr>
<tr>
<td>Auxiliary switches (NF24-S)</td>
<td>1 x SPDT 7A (2.5A) @ 250 VAC, UL listed adjustable 5° to 85°</td>
</tr>
<tr>
<td>Running time (nominal) motor</td>
<td>&lt; 75 sec</td>
</tr>
<tr>
<td></td>
<td>spring: &lt; 60 sec</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA type 2 / IP54</td>
</tr>
<tr>
<td>Housing material</td>
<td>Zinc coated steel</td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No.24 certified</td>
</tr>
<tr>
<td>Noise level</td>
<td>Max. 45 dB (A)</td>
</tr>
<tr>
<td>Servicing</td>
<td>Maintenance free</td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Weight</td>
<td>6.6 lbs (3.0 kg.)</td>
</tr>
</tbody>
</table>

Technical Data NF24 (-S2) US

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auxiliary switches</td>
<td>2 x SPDT 7A (2.5A) @ 250 VAC, UL listed one set at +5°, one adjustable 25° to 85°</td>
</tr>
</tbody>
</table>

Dimensions (All ratings in brackets are metric.)

![Dimensions Diagram]
NF24 (-S,-S2) US
On-off, spring return safety, 24 V

Accessories
AV 10-18 Shaft extension
IND-AF2 Damper position indicator
K4-1 US Universal clamp for up to 1.05” dia jackshafts
K4-H Universal clamp for hexshafts 3/8” to 5/8”
KH-AF Crankarm for up to 3/4” round shaft
KH-AF-1 Crankarm for up to 1.05” jackshaft
KH-AFV V-bolt kit for KH-AF and KH-AF-1
Tool-01 10 mm wrench
ZDB-AF2 Angle of rotation limiter
ZG-100 Universal mounting bracket
ZG-101 Universal mounting bracket
ZG-102 Multiple actuator mounting bracket
ZG-103 Universal mounting bracket
ZG-104 Universal mounting bracket
ZG-106 Mounting bracket for Honeywell® Mod IV replacement or new crankarm type installations
ZG-107 Mounting bracket for Honeywell® Mod III or Johnson® Series 100 replacement or new crankarm type installations
ZG-108 Mounting bracket for Barber Colman® MA 3../4../
Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crankarm type installations
ZG-AF US Crankarm adaptor kit for AF/NF
ZG-AF108 Crankarm adaptor kit for AF/NF
ZS-100 Weather shield (metal)
ZS-150 Weather shield (polycarbonate)
ZS-260 Explosion-proof housing
ZS-300 NEMA 4X housing

Note: When using NF24 (-S,-S2) US actuators, only use accessories listed on this page.

Wiring diagrams

On-off wiring for NF24 US

NF24 US Typical Specification
On-off spring return damper actuators shall be direct coupled type which require no crankarm 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, 1 or 2 SPDT auxiliary switch shall be provided having the capability of 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 UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.
NF120 (-S) US / NF230 (-S) US

On-off, spring return safety, 120 or 230 VAC

Torque min. 60 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 NF 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 NF 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 NF120-S / NF230-S US versions are provided with 1 built-in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 5° and 85°.

Technical Data

<table>
<thead>
<tr>
<th>NF120 (-S) US</th>
<th>NF230 (-S) US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>120 VAC ± 10%</td>
</tr>
<tr>
<td></td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>running: 6 W</td>
</tr>
<tr>
<td></td>
<td>holding: 3.5 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>7 VA</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA appliance cable</td>
</tr>
<tr>
<td>Overload protection</td>
<td>Electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td>Electrical protection</td>
<td>Auxiliary switches are double insulated</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>95°, adjustable 30 to 95° w/ accessories</td>
</tr>
<tr>
<td>Torque</td>
<td>60 in-lb (7 Nm) constant torque</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>spring return can be selected by CW/CCW mounting</td>
</tr>
<tr>
<td>Position indication</td>
<td>visual indicator, 0° to 95° (0° is spring return position)</td>
</tr>
<tr>
<td>Auxiliary switches (-S models)</td>
<td>1 x SPDT 7A (2.5A) @ 250 VAC, UL listed, adjustable 5° to 85°</td>
</tr>
<tr>
<td>Running time (nominal)</td>
<td>motor: &lt; 75 sec</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td>Housing material</td>
<td>zinc coated steel</td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No.24 certified</td>
</tr>
<tr>
<td>Noise level</td>
<td>max. 45 dB (A)</td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Weight</td>
<td>7.3 lbs (3.3 kg.)</td>
</tr>
</tbody>
</table>

Dimensions (All ratings in brackets are metric.)

K4-2 US (supplied)
- 0.65” [16.5]

K4-1 US (optional)
- 0.5” [13]

K4 US (optional)
- 0.39” [10] Adjustable
On-off, spring return safety, 120 or 230 VAC

NF120 / NF230 Typical Specification
On-off spring return damper actuators shall be direct coupled type which require no crankarm 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, 1 SPDT auxiliary switch shall be provided having the capability of 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 UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring diagrams

On-off wiring for NF120 US / NF230 US

Note: When using NF120 US, NF120-S, NF230 US and NF230-S US actuators, only use accessories listed on this page.
NF24-SR (-S) US

Proportional damper actuator, spring return safety, 24 V for 2 to 10 VDC, or 4 to 20 mA control signal.
Output signal of 2 to 10 VDC for position indication

Torque min. 60 in-lb, for control of air dampers

**Application**
For proportional modulation of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications.

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 actuator operates 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. A 2 to 10 VDC feedback signal is provided for position indication or master-slave applications.

**Technical Data**

<table>
<thead>
<tr>
<th>NF24-SR US</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 VAC ± 20% 50/60 Hz 24 VDC ± 10%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>running: 3 W holding: 1 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>6 VA (class 2 power source)</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA appliance cable 1/2” conduit connector</td>
</tr>
<tr>
<td>Overload protection</td>
<td>Electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td>Operating range Y</td>
<td>2 to 10 VDC, 4 to 20mA</td>
</tr>
<tr>
<td>Input impedance</td>
<td>100 kΩ (0.1 mA), 500Ω</td>
</tr>
<tr>
<td>Feedback output U</td>
<td>2 to 10 VDC (max. 0.5 mA) for 95°</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>95°, adjustable 30° to 95° w/accessory</td>
</tr>
<tr>
<td>Torque</td>
<td>60 in-lb [7 Nm] constant torque</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>spring return reversible with CW/CCW mounting. Control direction selected by switch: CW=CW with decrease in signal CCW=CCW with a decrease in signal</td>
</tr>
<tr>
<td>Position indication</td>
<td>visual indicator, 0° to 95° (0° is spring return position)</td>
</tr>
<tr>
<td>Auxiliary switches</td>
<td>1 x SPDT 7A (2.5A) @ 250 VAC, UL listed adjustable 5° to 85°</td>
</tr>
<tr>
<td>Running time (nominal)</td>
<td>motor: 150 sec constant, independent of load spring: &lt; 60 sec</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA type 2 / IP54</td>
</tr>
<tr>
<td>Housing material</td>
<td>zinc coated metal</td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No.24 certified</td>
</tr>
<tr>
<td>Noise level</td>
<td>max. 45 dBA (A)</td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Weight</td>
<td>6.0 lbs (2.7 kg.)</td>
</tr>
</tbody>
</table>

**Dimensions** (All ratings in brackets are metric.)

<table>
<thead>
<tr>
<th>K4-2 US (supplied)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2” Centered (Default)</td>
<td>0.39” [10]</td>
</tr>
<tr>
<td>3/4” Centered (Field Selectable)</td>
<td>0.65” [16.5]</td>
</tr>
<tr>
<td>1.00” Centered (Field Selectable)</td>
<td>1.93” [49]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>K4-1 US (optional)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4” to 1.05” Adjustable</td>
<td>0.39” [10]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>K4 US (optional)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8” to 3/4” Adjustable</td>
<td>1.97” [50]</td>
</tr>
</tbody>
</table>
NF24-SR (-S) US

Proportional damper actuator, spring return safety, 24 V for 2 to 10 VDC, or 4 to 20 mA control signal. Output signal of 2 to 10 VDC for position indication

Accessories

- AV 10-18  Shaft extension
- IND-AF2  Damper position indicator
- K4-1 US  Universal clamp for up to 1.05” dia jackshafts
- K4-H  Universal clamp for hexshafts 3/8” to 5/8”
- KH-AF  Crankarm for up to 3/4” round shaft
- KH-AF-1  Crankarm for up to 1.05” jackshaft
- KH-AFV  V-bolt kit for KH-AF and KH-AF-1
- PTA-250  Pulse width modulation interface
- Tool-01  10 mm wrench
- SGA24  Min. and/or man. positioner in NEMA 4 housing
- SGF24  Min. and/or man. positioner for flush panel mounting
- ZDB-AF2  Angle of rotation limiter
- ZG-100  Universal mounting bracket
- ZG-101  Universal mounting bracket
- ZG-102  Multiple actuator mounting bracket
- ZG-103  Universal mounting bracket
- ZG-104  Universal mounting bracket
- ZG-106  Mounting bracket for Honeywell® Mod IV replacement or new crankarm type installations
- ZG-107  Mounting bracket for Honeywell® Mod III or Johnson® Series 100 replacement or new crankarm type installations
- ZG-108  Mounting bracket for Barber Colman® MA 3../4../5../6../7.., Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crankarm type installations
- ZG-AF US  Crankarm adaptor kit for AF/NF
- ZG-AF108  Crankarm adaptor kit for AF/NF
- ZS-100  Weather shield (metal)
- ZS-150  Weather shield (polycarbonate)
- ZS-260  Explosion-proof housing
- ZS-300  NEMA 4X housing

Note: When using NF24-SR US actuators, only use accessories listed on this page.

Wiring diagrams

- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption and input impedance must be observed.
- Actuator may also be powered by 24 VDC.

NF24-SR US Typical Specification

- Spring return control damper actuators shall be direct coupled type which require no crankarm 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 or master-slave applications. Actuators shall be UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

For end position indication, interlock control, fan start-up, etc., NF24-SR US incorporates a built-in auxiliary switch: 1 x SPDT, 7A (2.5A) @250 VAC, UL listed, adjustable 5° to 85°.
QUICK-MOUNT VISUAL INSTRUCTIONS

1. Rotate the damper to its failsafe 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, move it to the correct side for ease of installation.

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.
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.

<table>
<thead>
<tr>
<th>Damper Type</th>
<th>Torque Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opposed blade, without edge seals, for non-tight close-off applications</td>
<td>3 in-lb/sq. ft.</td>
</tr>
<tr>
<td>Parallel blade, without edge seals, for non-tight close-off applications</td>
<td>4 in-lb/sq. ft.</td>
</tr>
<tr>
<td>Opposed blade, with edge seals, for tight close-off applications</td>
<td>5 in-lb/sq. ft.</td>
</tr>
<tr>
<td>Parallel blade, with edge seals, for tight close-off applications</td>
<td>7 in-lb/sq. ft.</td>
</tr>
</tbody>
</table>

The above torque loadings will work for most applications under 2 in. w.g. static pressure or 1000 FPM face velocity. For applications between this criteria and 3 in. w.g. or 2500 FPM, the torque loading should be increased by a multiplier of 1.5. If the application calls for higher criteria up to 4 in. w.g. or 3000 FPM, use a multiplier of 2.0.

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 10-18 shaft extension 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 NF 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 consistent torque to the damper with, and without, power applied to the actuator.

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

The NF…-S versions are provided with 1 built-in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 5° and 85°. (NF24-S2, with 2 built-in switches, adjustable between +25° and +85°)

Standard Mounting

1. See Fig. B. Manually move the damper to the fail-safe position (a) (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, position the clamp so that the pointer section of the tab is pointing to 0° (see Fig. 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 Limitation section.

4. Lock the clamp to the actuator using the retaining clip.

5. Mount the spring return actuator to the shaft. Tighten the universal clamp, finger tight only.

6. Mount the anti-rotation strap at the base of the actuator. Do not tighten the screws.

7. Remove the screw from one end of the mounting bracket and pivot it away from the actuator.

8. Loosen the universal clamp and, making sure not to move the damper shaft, rotate the actuator approximately 5° in the direction which would open the damper.

9. Verify that the damper is still in its full fail-safe position.

10. Tighten the universal clamp to the shaft.

11. Rotate the actuator to apply pressure to the damper seals (b) and re-engage the anti-rotation strap (c).

12. Tighten all fasteners.

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

1. Move damper blades to the fail-safe position (a).

2. 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.

3. Engage the clamp to the actuator as close as possible to the determined location.

4. Lock the clamp to the actuator using the retainer clip.
Rotation Limitation
The angle of rotation limiter, ZDB-AF2, is used in conjunction with the tab on the universal clamp or IND-AF2 position indicator which comes with the ZDB-AF2. In order to function properly, the clamp or indicator must be mounted correctly. See Fig. A.

The ZDB-AF2 may not work in certain mounting orientations using the ZG-106 or ZG-107 mounting brackets. It will not work with the ZG-108 mounting bracket. Limiting the damper rotation must be accomplished by adjusting the crank arm linkage.

The ZDB-AF2 may be used to control the rotational output of the NF series actuator where a damper has a designed rotation less than 90°. An example would be a 45° or 60° rotating damper.

Damper rotation limiting
1. Determine the amount of damper rotation required.
2. Locate the Angle of Rotation Limiter (ZDB-AF2) on the actuator so that its edge lines up with the degree graduation on the actuator face which corresponds with the required rotation. See Fig. C.
3. Find the appropriate cross-hair location through the slot of the limiter. This is the screw mounting location.
4. Pierce through the label material to allow easy fastening of the retaining screw.
5. Position the limiter back to the desired position, making sure the locating “teeth” on the limiter are engaged into the locating holes on the actuator.
6. Fasten the limiter to the actuator using the self tapping screw provided.
7. Test the damper rotation before applying power and if required, a control signal. Re-adjust if necessary.

Auxiliary Switches
The NF series actuators may be ordered with 1 built-in SPDT auxiliary switch used for safety interfacing or signalling, for example, for fan start-up. The switch position is adjustable between 5° and 85° of rotation. The crank, supplied with the actuator, or a 3mm allen wrench (NF24-S2, with 2 built-in switches, adjustable between +25° and +85°) is used to adjust the switching position.

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

Figure C  ZDB-AF2  Securing the Angle of Rotation Limiter

Figure D
Installation Instructions
Non-direct mounting methods and additional information

Crankarm

The KH-AF (-1) crankarm is used in non-direct coupled mounting applications.

Two sizes are available:
- KH-AF For round shafts up to 3/4” or square shafts up to 5/8”
- KH-AF-1 For jackshafts up to 1.05”

Additional Operational Information for NF24-SR US Proportional Actuators

Initialization of the NF24-SR US

When power is initially applied, 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. 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. When power is applied again, the actuator will re-initialize the zero position. The microprocessor will keep count of these short power failures until 16 occur. At this point, the microprocessor will automatically drive the actuator to its zero position and re-initialize to correct for any possible error accumulation.

Motor position detection

Belimo brushless DC motors eliminate the need for potentiometers for positioning. 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.

Overload protection

The Belimo NF24-SR US actuator is protected from overload at all angles of rotation. The on board microprocessor constantly monitors the rotation of the DC drive 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.

Brushless DC motor operation

Belimo’s brushless DC motor spins by reversing the poles of stationary electromagnets housed inside rotating permanent magnets. The electromagnetic poles are switched by a microprocessor and a special ASIC (Application Specific Integrated Circuit) developed by Belimo. Unlike the conventional DC motor, there are no brushes to wear or commutators to foul.
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.

**Transformer(s)**
The NF24... actuator requires a 24 VAC class 2 transformer and draws a maximum of 8 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 hot leg. 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 page 19.

**Wire length for NF... actuators**
Keep power wire runs below the lengths listed in the table in Fig. E. 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 for NF24-SR US:**
3 actuators, 16 Ga wire
550 Ft ÷ 3 Actuators = 183 Ft. Maximum wire run

**Maximum wire length:**

<table>
<thead>
<tr>
<th>Transformer</th>
<th>Wire Size</th>
<th>Max. Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF24 (-S) US</td>
<td>12 Ga</td>
<td>1100 Ft</td>
</tr>
<tr>
<td></td>
<td>14 Ga</td>
<td>700 Ft</td>
</tr>
<tr>
<td></td>
<td>16 Ga</td>
<td>440 Ft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transformer</th>
<th>Wire Size</th>
<th>Max. Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF120 (-S) US / NF230 (-S) US</td>
<td>12 Ga</td>
<td>1250 Ft</td>
</tr>
<tr>
<td></td>
<td>14 Ga</td>
<td>800 Ft</td>
</tr>
<tr>
<td></td>
<td>16 Ga</td>
<td>500 Ft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transformer</th>
<th>Wire Size</th>
<th>Max. Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>NF24-SR (-S) US</td>
<td>12 Ga</td>
<td>1500 Ft</td>
</tr>
<tr>
<td></td>
<td>14 Ga</td>
<td>925 Ft</td>
</tr>
<tr>
<td></td>
<td>16 Ga</td>
<td>550 Ft</td>
</tr>
</tbody>
</table>

**Wire Type and Wire Installation Tips**
For most installations, 18 or 16 Ga. cable works well with the NF24... 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 NF24... 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.
## NF24-SR US Electrical check-out procedure

<table>
<thead>
<tr>
<th>Step</th>
<th>Procedure</th>
<th>Expected Response</th>
<th>Gives Expected Response Go To Step...</th>
<th>Does Not Give Expected Response Go To Step...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control signal is applied to actuator.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly Step 8</td>
<td>No response at all Step 2 Operation is reversed Step 3 Does not drive toward “Control Signal Position” Step 4</td>
</tr>
<tr>
<td>2.</td>
<td>Check power wiring. Correct any problems. <strong>See Note 1.</strong></td>
<td>Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.</td>
<td>Power wiring corrected, actuator begins to drive Step 1</td>
<td>Power wiring corrected, actuator still does not drive Step 4</td>
</tr>
<tr>
<td>3.</td>
<td>Turn reversing switch to the correct position. Make sure the switch is turned all the way left or right.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly Step 8</td>
<td>Does not drive toward “Control Signal Position” Step 4</td>
</tr>
<tr>
<td>4.</td>
<td>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.</td>
<td>Drives to “Control Signal” position</td>
<td>Actuator operates properly Step 8</td>
<td>Step 5</td>
</tr>
<tr>
<td>5.</td>
<td>Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For NF24-SR US this is 2 to 10 VDC or 4 to 20 mA. Note: The input signal must be above the 2 VDC or 4 mA to have the actuator move.</td>
<td>Input voltage or current should be ±1% of what controller’s adjustment or programming indicate.</td>
<td>Controller output (actuator input) is correct. Input Polarity Correct. Step 6</td>
<td>Reprogram, adjust repair or replace controller as needed. Step 1</td>
</tr>
<tr>
<td>6.</td>
<td>Loosen the nuts on the V-bolt and move the damper by hand from fully closed to fully open.</td>
<td>Damper will go from fully closed to fully open.</td>
<td>Damper moves properly Step 7</td>
<td>Find cause of damper jam and repair. Move damper back to the fully closed position and tighten the nuts. Step 1</td>
</tr>
<tr>
<td>7.</td>
<td>Check damper torque requirement.</td>
<td>Torque requirement is ≤ actuator’s minimum torque.</td>
<td>Defective Actuator. Replace Actuator - <strong>See Note 2</strong></td>
<td>Recalculate actuator requirement and correct installation.</td>
</tr>
<tr>
<td>8.</td>
<td>Actuator works properly. Test controller by following controller manufacturer’s instructions.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes

**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 installation date, notify Belimo and give details of the application.
Minimum 35 in-lb torque
- For damper areas up to 8 sq-ft*

Applications

Cost effective quality and performance for a range of applications including:
- Classroom Unit Ventilators
- Fan/Coil Units
- VAV Terminal Units
- Economizer Units
- Airhandlers
- Control Dampers

LF Series - at a glance

<table>
<thead>
<tr>
<th>Torque: 35 in-lb</th>
<th>Power supply: 24 VAC/DC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>120 VAC</td>
</tr>
<tr>
<td></td>
<td>230 VAC</td>
</tr>
<tr>
<td>Control signal: on-off</td>
<td>Control signal: floating point</td>
</tr>
<tr>
<td>Control signal: proportional 2 to 10 VDC</td>
<td>Control signal: 6 to 9 VDC</td>
</tr>
<tr>
<td>Feedback: 2 to 10 VDC</td>
<td>Auxiliary output, 20 VDC (to power controller)</td>
</tr>
<tr>
<td>Running time: motor &lt;75 sec</td>
<td>motor 150 sec constant</td>
</tr>
<tr>
<td></td>
<td>motor 90 sec constant</td>
</tr>
<tr>
<td></td>
<td>spring &lt;25 sec</td>
</tr>
<tr>
<td>External direction of rotation switch</td>
<td>Plenum rated cable, 18 GA</td>
</tr>
<tr>
<td>Conduit fitting</td>
<td>Appliance cable</td>
</tr>
<tr>
<td>Built-in auxiliary switch</td>
<td>LF24-SR US (p. 54)</td>
</tr>
</tbody>
</table>

Applications

Cost effective quality and performance for a range of applications including:
- Classroom Unit Ventilators
- Fan/Coil Units
- VAV Terminal Units
- Economizer Units
- Airhandlers
- Control Dampers

* 4 in-lb/ft² damper torque loading. Parallel blade. No edge seals.
Cut labor costs with (10 min. installation) simple direct coupling. Actuator Centers on 1/2” shaft. (K6-1, 3/4” clamp optional)

True mechanical spring return – the most reliable failsafe.

Mount for clockwise or counterclockwise fail-safe.

Easy-to-adjust mechanical stop to limit damper rotation.

Check damper position easily with clear position indicator.

Don’t worry about actuator burn-out. Belimo is overload-proof throughout rotation.

Need to change control direction? Do it easily with a simple switch. (modulating actuators)

Built-in auxiliary switch is easy to use, offers feedback or signal for additional device.

Microprocessor-controlled brushless DC motor increases actuator life span and reliability, provides constant running time. (modulating actuators)

Rugged metal housing withstands rough handling in the mechanical room.

3 ft. cable and conduit connector eases installation.

The Belimo Difference

Customer Commitment.
Extensive product range. Competitive project pricing. 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.
20+ years direct coupled actuator design.
**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, digital output, or a manual switch.

The actuator is mounted directly to a damper shaft from 3/8” up to 1/2” in diameter by means of its universal clamp. 1/2” shaft centered at delivery. For shafts up to 3/4” use K6-1 accessory. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

**Operation**

The LF 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 consistent torque to the damper with, and without, power applied to the actuator. The LF series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 90°. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches. Power consumption is reduced in holding mode.

The LF24-S US version is provided with 1 built in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 0° and 95°. The auxiliary switch in the LF24-S is double insulated so an electrical ground connection is not necessary.

**Technical Data LF24 (-S) US**

- **Power supply**: 24 VAC ± 20% 50/60 Hz, 24 VDC ± 10%
- **Power consumption**: running: 5 W, holding: 2.5 W
- **Transformer sizing**: 7 VA (class 2 power source)
- **Electrical connection**: 3 ft, 18 GA appliance cable (LF24-S US has 2 cables)
- **Overload protection**: electronic throughout 0 to 95° rotation
- **Angle of rotation**: max. 95°, adjust. with mechanical stop
- **Torque**: 35 in-lb [4 Nm]
- **Direction of rotation**: reversible with cw/ccw mounting
- **Position indication**: visual indicator, 0° to 90° (0° is spring return position)
- **Auxiliary switch (LF24-S)**: 1 x SPDT 6A (1.5) @ 250 VAC, UL listed adjustable 0° to 95° (double insulated)
- **Running time (nominal)**: motor: < 40 to 75 sec, spring: < 25 sec @ -4°F to +122°F [-20°C to +50°C], < 60 sec @ -22°F [-30°C]
- **Humidity**: 5 to 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 type 2 / IP54
- **Housing material**: zinc coated steel
- **Agency listings**: UL 873 listed, CSA C22.2 No.24 certified, CE
- **Noise level**: max: running < 50 db (A), spring return 62 db (A)
- **Servicing**: maintenance free
- **Quality standard**: ISO 9001
- **Weight**: LF24 3.1 lbs (1.40 kg.), LF24-S 3.2 lbs (1.45 kg.)

**Dimensions** (All numbers in brackets are metric.)

- **Standard**: 3/8” to 1/2” to 7/16”
- **Optional**: 1/2” to 3/4” with K6-1 accessory
**Accessories**

- AV 10-18 Shaft extension (K6-1 is required)
- IND-LF Damper position indicator
- K6-1 Universal clamp for up to 3/4" diameter shafts
- KH-LF Crankarm for up to 1/2" round shaft
- Tool-01 10 mm wrench
- ZG-LF2 Crankarm adaptor kit for LF
- ZG-112 Mounting bracket for Honeywell Mod IV, M6415 type actuators, and new installations
- ZG-LF112 Crankarm adaptor kit for Honeywell Mod IV, M6415 type actuators, and new installations
- ZS-100 Weather shield (metal)
- ZS-150 Weather shield (polycarbonate)
- ZS-260 Explosion-proof housing

**Note:** When using LF24 US and LF24-S US actuators, only use accessories listed on this page.

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**LF24 (-S) US Typical Specification**

On-off spring return damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a shaft up to a 3/4" diameter and center a 1/2" shaft. 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, 1 SPDT auxiliary switch shall be provided having the capability of being adjustable. Actuators with auxiliary switch must be constructed to meet the requirements for Double Insulation so an electrical ground is not required to meet agency listings. Actuators shall be UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

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**Wiring diagrams**

**On-off wiring for LF24 US**

1. Common
2. + Hot

**On-off wiring for LF24-S US**

1. Common
2. + Hot

- 1 SPDT auxiliary switch: 1 x SPDT, 6A (1.5A) @ 250 VAC, UL listed, adjustable 0° to 95°.
- Meets UL and CSA requirements without the need of an electrical ground connection.
**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 from 3/8” up to 1/2” in diameter by means of its universal clamp, 1/2” shaft centered at delivery. For shafts up to 3/4” use K6-1 accessory. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

**Operation**
The LF 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 consistent torque to the damper with, and without, power applied to the actuator. The LF series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 90°. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches. Power consumption is reduced in holding mode. The actuator is double insulated so an electrical ground connection is not necessary.

The LF120-S US and LF230-S US versions are provided with 1 built-in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 0° and 95°.

**Dimensions** (All numbers in brackets are metric.)

<table>
<thead>
<tr>
<th>Standard:</th>
<th>3/8” to 1/2”</th>
<th>3/8” to 7/16”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optional:</td>
<td>1/2” to 3/4” w/K6-1 accessory</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technical Data</th>
<th>LF120 (-S) US</th>
<th>LF230 (-S) US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>120 VAC ± 10% 50/60 Hz</td>
<td>230 VAC ± 10% 50/60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>running: 5.5 W</td>
<td>5 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>7.5 VA</td>
<td>7 VA</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA appliance cable (-S models have 2 cables) 1/2” conduit connector</td>
<td></td>
</tr>
<tr>
<td>Overload protection</td>
<td>electronic throughout 0 to 95° rotation</td>
<td></td>
</tr>
<tr>
<td>Electrical protection</td>
<td>actuators are double insulated</td>
<td></td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>max 95°, adjust. with mechanical stop</td>
<td></td>
</tr>
<tr>
<td>Torque</td>
<td>35 in-lb [4 Nm] constant torque</td>
<td></td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>reversible with cw/ccw mounting</td>
<td></td>
</tr>
<tr>
<td>Position indication</td>
<td>visual indicator, 0° to 90° (0° is spring return position)</td>
<td></td>
</tr>
<tr>
<td>Auxiliary switch (-S models)</td>
<td>1 x SPDT 6A (1.5A) @ 250 VAC, UL listed adjustable 0° to 95°</td>
<td></td>
</tr>
<tr>
<td>Electrical protection</td>
<td>actuators are double insulated</td>
<td></td>
</tr>
<tr>
<td>Running time (nominal)</td>
<td>motor: &lt; 40 to 75 sec  spring: &lt; 25 sec @ +4°F to +120°F [-20°C to +50°C]  &lt; 60 sec @ -22°F [-30°C]</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
<td></td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA type 2 / IP54</td>
<td></td>
</tr>
<tr>
<td>Housing material</td>
<td>zinc coated steel</td>
<td></td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873, CSA C22.2 No. 24 Certified, CE [LF230(-S) US]</td>
<td></td>
</tr>
<tr>
<td>Noise level</td>
<td>max: running &lt; 50 db (A)  spring return 62 db (A)</td>
<td></td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
<td></td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>LF120/230 3.4 lbs (1.54 kg.)  LF120/230-S 3.5 lbs (1.60 kg.)</td>
<td></td>
</tr>
</tbody>
</table>
Accessories
AV 10-18  Shaft extension (K6-1 is required)
IND-LF  Damper position indicator
K6-1  Universal clamp for up to 3/4” diameter shafts
KH-LF  Crankarm for up to 1/2” round shaft
Tool-01  10 mm wrench
ZG-LF2  Crankarm adaptor kit for LF
ZG-112  Mounting bracket for Honeywell Mod IV, M6415 type actuators, and new installations
ZG-LF112  Crankarm adaptor kit for Honeywell Mod IV, M6415 type actuators, and new installations
ZH-100  Weather shield (metal)
ZH-150  Weather shield (polycarbonate)
ZH-260  Explosion-proof housing

Note: When using LF120/230 US and LF120-S/230-S US actuators, only use accessories listed on this page.

LF120 (-S) US / LF230 (-S) US
On-off, spring return safety, 120/230 VAC

Typical Specification
On-off spring return damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a shaft up to a 3/4” diameter and center a 1/2” shaft. 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, 1 SPDT auxiliary switch shall be provided having the capability of being adjustable. Actuators must be constructed to meet the requirements for Double Insulation so an electrical ground is not required to meet agency listings. Actuators shall be UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring diagrams

On-off wiring for LF120 US / LF230 US

Provide overload protection and disconnect as required.
Actuators may be connected in parallel. Power consumption must be observed.
No ground connection is required.

On-off wiring for LF120-S US / LF230-S US

Provide overload protection and disconnect as required.
Actuators may be connected in parallel. Power consumption must be observed.
No ground connection is required.

For end position indication, interlock control, fan start-up, etc., LF120-S US and LF230-S US incorporate one built-in auxiliary switch: 1 x SPDT, 6A (1.5A) @250 VAC, UL listed, adjustable 0° to 95°.

Meets UL and CSA requirements without the need of an electrical ground connection.
**Technical Data**

**LF24-3 (-S) US**

**Power supply**
- 24 VAC ± 20% 50/60 Hz
- 24 VDC ± 10%

**Power consumption**
- running: 2.5 W; holding: 1 W

**Transformer sizing**
- 5 VA (class 2 power source)

**Electrical connection**
- LF24-3 US: 3 ft, plenum rated cable
- LF24-3-S US: 3 ft, 18 GA appliance cables (2)
- 1/2" conduit connector

**Overload protection**
- electronic throughout 0 to 95° rotation

**Input impedance**
- 1000 Ω (0.6w) control inputs

**Angle of rotation**
- max. 95°, adjust. with mechanical stop

**Torque**
- 35 in-lb [4 Nm]

**Direction of rotation**
- spring: reversible with cw/ccw mounting motor: reversible with built-in switch

**Position indication**
- visual indicator, 0° to 90° (0° is spring return position)

**Auxiliary switch**
- 1 x SPDT 6A (1.5A) @ 250 VAC, UL listed, adjustable 0° to 95° (double insulated)

**Running time**
- motor: 150 sec constant, independent of load
- spring: 25 sec @ -4°F to +122°F [20°C to +50°C]
- < 60 sec @ -22°F [-30°C]

**Humidity**
- 5 to 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 type 2/IP54

**Housing material**
- zinc coated metal

**Agency listings**
- UL 873 listed; CSA C22.2 No. 24 certified, CE

**Noise level**
- max: running < 30 db (A)
- spring return 62 db (A)

**Servicing**
- maintenance free

**Quality standard**
- ISO 9001

**Weight**
- LF24-3: 3.1 lbs (1.40 kg.)
- LF24-3-S: 3.6 lbs (1.45 kg.)

---

**Application**

For modulation or on-off control of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer's specifications.

The actuator is mounted directly to a damper shaft from 3/8" up to 1/2" in diameter by means of its universal clamp, 1/2" shaft centered at delivery. For shafts up to 3/4" use K6-1 accessory. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

Control is floating point from a triac or relay, or on-off from an auxiliary contact from a fan motor contactor, controller, or manual switch.

**Operation**

The LF 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 consistent torque to the damper with, and without, power applied to the actuator.

The LF series provides 95° of rotation and is provided with a graduated position indicator showing 0 to 90°.

The LF24-3 (-S) US 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. The ASIC monitors and controls the brushless DC motor's rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches. Power consumption is reduced in holding mode.

The LF24-3-S US version is provided with 1 built-in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 0° and 95°.

---

**Dimensions**

(All numbers in brackets are metric.)

**Standard:**
- 3/8" to 1/2"
- 3/8" to 7/16"

**Optional:**
- 1/2" to 3/4" w/K6-1 accessory

---

**Listed**

94D5
TEMP. IND & REG. EQUIP.
UL
®
**Accessories**

AV 10-18  Shaft extension (K6-1 is required)
IND-LF  Damper position indicator
K6-1  Universal clamp for up to 3/4" diameter shafts
KH-LF  Crankarm for up to 1/2" round shaft
Tool-01  10 mm wrench
ZG-LF2  Crankarm adaptor kit for LF
ZG-112  Mounting bracket for Honeywell Mod IV, M6415 type actuators, and new installations
ZG-LF112  Crankarm adaptor kit for Honeywell Mod IV, M6415 type actuators, and new installations
ZS-100  Weather shield (metal)
ZS-150  Weather shield (polycarbonate)
ZS-260  Explosion-proof housing

**Note:** When using LF24-3 (-S) US actuators, only use accessories listed on this page.

**Wire Diagrams**

**On-Off control of LF24-3 (-S) US**

![Wiring Diagram](image1)

**Floating point control of LF24-3 (-S) US**

![Wiring Diagram](image2)

**Auxiliary switch of LF24-3 (-S) US**

![Wiring Diagram](image3)

**LF24-3 (-S) US Typical Specification**

Floating point, on-off spring return damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a shaft up to a 3/4" diameter and center a 1/2" shaft. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall have an external direction of rotation switch to reverse control logic. Actuators shall use a brushless DC motor and be protected from overload at all angles of rotation. If required, 1 SPDT auxiliary switch shall be provided having the capability of being adjustable. Actuators with auxiliary switch must be constructed to meet the requirements for Double Insulation so an electrical ground is not required to meet agency listings. Run time shall be constant and independent of torque. Actuators shall have an external direction of rotation switch to reverse control logic. Actuators shall be as manufactured by Belimo.

**Notes:**
- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption must be observed.
- May also be powered by 24 VDC.
- The Common connection from the actuator must be connected to the Hot connection of the controller.
- The actuator Hot must be connected to the control board Common.
- For end position indication, interlock control, fan startup, etc., LF24-3-S US LF120-S US and LF230-S US incorporate one built-in auxiliary switch: 1 x SPDT, 6A (1.5A) @250 VAC, UL listed, adjustable 0° to 95°.
- Meets UL and CSA requirements without the need of an electrical ground connection.
- Actuators with plenum rated cable do not have numbers on wires; use color coded instead. Actuators with appliance rated cable use numbers.
LFC24-3-R (-S) US
On-off, spring return safety, reversible, floating point, 24V, Trane Voyager retrofit

Technical Data LFC24-3-R US

Power supply 24 VAC ± 20% 50/60 Hz
24 VDC ± 10%

Power consumption running: 2.5 W; holding: 1 W

Transformer sizing 5 VA (class 2 power source)

Electrical connection LFC24-3-R US 3 ft, plenum rated cable 4 male spade connectors

Overload protection electronic throughout 0 to 95° rotation

Input impedance 1000 Ω (0.6w) control inputs

Angle of rotation max. 95°, adjust. with mechanical stop

Torque 35 in-lb [4 Nm]

Direction of rotation spring: reversible with cw/ccw mounting motor: reversible with built-in switch

Position indication visual indicator, 0° to 90° (0° is spring return position)

Running time motor: 90 sec constant, independent of load
spring: < 25 sec @ -4°F to +122°F [-20°C to +50°C]
< 60 sec @ -22°F [-30°C]

Humidity 5 to 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 type 2/IP54

Housing material zinc coated metal

Agency listings UL 873 listed; CSA C22.2 No.24 certified, CE

Noise level max: running < 30 db (A)
spring return 62 db (A)

Servicing maintenance free

Quality standard ISO 9001

Weight LFC24-3-R US 3.1 lbs (1.40 kg.)

Technical Data LFC24-3-S US

Auxiliary switch 1 x SPDT 6A (1.5A) @ 250 VAC, UL listed adjustable 0° to 95° (double insulated)

Electrical Connection 3 ft, 18 GA appliance cables (2)
1/2” conduit connector

Weight LFC24-3-S US 3.6 lbs (1.45 kg.)

Torque min. 35 in-lb, for control of air dampers

Application
For modulation or on-off control of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications.

The actuator is mounted directly to a damper shaft from 3/8” up to 1/2” in diameter by means of its universal clamp, 1/2” shaft centered at delivery. For shafts up to 3/4” use K6-1 accessory. The ZG-LFC114 universal mounting kit can be used with the LFC24-3-R US actuator for retrofit of the economizer section of the Trane Voyager unit.

Control is floating point from a triac or relay, or on-off from an auxiliary contact from a fan motor contactor, controller, or manual switch.

Operation
The LF 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 consistent torque to the damper with, and without, power applied to the actuator.

The LF series provides 95° of rotation and is provided with a graduated position indicator showing 0 to 90°.

The LFC24-3-R (-S) US 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. The ASIC monitors and controls the brushless DC motor’s rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches. Power consumption is reduced in holding mode.

The LFC24-3-S US version is provided with 1 built-in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 0° and 95°. The auxiliary switch in the LFC24-3-S US is double insulated so an electrical ground is not necessary.

Dimensions (All numbers in brackets are metric.)

Standard:

- 3/8” to 1/2”
- 3/8” to 7/16”

Optional

- 1/2” to 3/4”
  w/K6-1 accessory

Electrical Connections LFC24-3-R US: 3 ft, plenum rated cable 4 male spade connectors
Accessories
AV 10-18 Shaft extension (K6-1 is required)
IND-LF Damper position indicator
K6-1 Universal clamp for up to 3/4” diameter shafts
KH-LF Crankarm for up to 1/2” round shaft
Tool-01 10 mm wrench
ZG-LF2 Crankarm adaptor kit for LF
ZG-112 Mounting bracket for Honeywell Mod IV, M6415 type actuators, and new installations
ZG-LF112 Crankarm adaptor kit for Honeywell Mod IV, M6415 type actuators, and new installations
ZG-LFC114 Used with LFC24-3-R US, mounting bracket kit for Trane Voyager economizer actuator retrofit. Kit includes mounting bracket and installation hardware.
ZS-100 Weather shield (metal)
ZS-150 Weather shield (polycarbonate)
ZS-260 Explosion-proof housing

Note: When using LFC24-3-R (-S) US actuators, only use accessories listed on this page.

Note: For On-Off control wiring please see LF24-3 US wiring diagram. “On-Off control of LF24-3 (-S) US” page 49.

Note: For Floating point control wiring, Triac source, sink or wiring with separate power supplies please page49 for correct wiring.

Note: Please consult equipment and/or controller manufacturers documentation to ensure compatibility. If you are unsure send controller specifications to Belimo Aircontrols for evaluation.

Wiring Diagrams

Floating point control of LF24-3... US

Notes:
- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption must be observed.
- No ground connection is required.
- For end position indication, interlock control, fan startup, etc., LFC24-3-S US, LF120-S US and LF230-S US incorporate one built-in auxiliary switch: 1 x SPDT, 6A (1.5A) @250 VAC, UL listed, adjustable 0° to 95°.
- Meets UL and CSA requirements without the need of an electrical ground connection.

LFC24-3-R (-S) US Typical Specification
Floating point, on-off spring return damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a shaft up to a 3/4” diameter and center a 1/2” shaft. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall have an external direction of rotation switch to reverse control logic. Actuators shall use a brushless DC motor and be protected from overload at all angles of rotation. If required, 1 SPDT auxiliary switch shall be provided having the capability of being adjustable. Actuators with auxiliary switch must be constructed to meet the requirements for Double Insulation so an electrical ground is not required to meet agency listings. Run time shall be constant and independent of torque. Actuators shall be UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring LFC24-3-R US

Field installed female connectors (provided)

Pre-installed male connectors on actuators

Auxiliary switch of LFC24-3-S US

Retrofit solution installation
LF24-SR (-S) US
Proportional damper actuator, spring return safety, 24 V for 2 to 10 VDC, or 4 to 20 mA control signal. Output signal of 2 to 10 VDC for position indication.

Technical Data LF24-SR (-S) US

<table>
<thead>
<tr>
<th>Power supply</th>
<th>24 VAC ± 20% 50/60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption</td>
<td>running: 2.5 W; holding: 1 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>5 VA (class 2 power source)</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>LF24-SR US 3 ft, plenum rated cable</td>
</tr>
<tr>
<td>Overload protection</td>
<td>electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td>Operating range Y</td>
<td>2 to 10 VDC, 4 to 20mA</td>
</tr>
<tr>
<td>Input impedance</td>
<td>100 kΩ (0.1 mA), 500Ω</td>
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<tr>
<td>Feedback output U</td>
<td>2 to 10 VDC (max. 0.7 mA) for 95°</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>max. 95°, adjust. with mechanical stop</td>
</tr>
<tr>
<td>Torque</td>
<td>35 in-lb [4 Nm]</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>spring return reversible with cw/ccw</td>
</tr>
<tr>
<td>Position indication</td>
<td>visual indicator, 0° to 95° (0° is spring return position)</td>
</tr>
<tr>
<td>Auxiliary switch (LF24-SR-S us)</td>
<td>1 x SPDT 6A (1.5A) @ 250 VAC, UL listed adjustable 0° to 95° (double insulated)</td>
</tr>
<tr>
<td>Running time (nominal)</td>
<td>motor: 150 sec constant, independent of load</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA type 2 / IP54</td>
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<tr>
<td>Housing material</td>
<td>zinc coated metal</td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No. 24 certified, CE</td>
</tr>
<tr>
<td>Noise level</td>
<td>max: running &lt; 30 db (A)</td>
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<tr>
<td>Servicing</td>
<td>maintenance free</td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Weight</td>
<td>LF24-SR 3.1 lbs (1.40 kg.)</td>
</tr>
<tr>
<td>LF24-SR-S 3.2 lbs (1.45 kg.)</td>
<td></td>
</tr>
</tbody>
</table>

Torque min. 35 in-lb, for control of air dampers

Application
For proportional modulation of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications.

The actuator is mounted directly to a damper shaft from 3/8” up to 1/2” in diameter by means of its universal clamp, 1/2” shaft centered at delivery. For shafts up to 3/4” use K6-1 accessory. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

The actuator operates 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. A 2 to 10 VDC feedback signal is provided for position indication or master-slave applications.

Operation
The LF 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 consistent torque to the damper with, and without, power applied to the actuator. The LF series provides 95° of rotation and is provided with a graduated position indicator showing 0 to 90°.

The LF24-SR (-S) US 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 fail-safe position. The ASIC monitors and controls the brushless DC motor’s rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches. Power consumption is reduced in holding mode.

The LF24-SR-S US version is provided with 1 built-in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 0° and 95°. The auxiliary switch in the LF24-SR-S US is double insulated so an electrical ground in not necessary.

Dimensions (All numbers in brackets are metric.)

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Note: The dimensions are subject to change. © Belimo Aircontrols (USA), Inc.
Proportional damper actuator, spring return safety, 24 V for 2 to 10 VDC, or 4 to 20 mA control signal.
Output signal of 2 to 10 VDC for position indication.

**Accessories**
- AV 10-18 Shaft extension (K6-1 is required)
- IND-LF Damper position indicator
- K6-1 Universal clamp for up to 3/4” diameter shafts
- KH-LF Crankarm for up to 1/2” round shaft
- SGA24 Min. and/or man. positioner in NEMA 4 housing
- SGF24 Min. and/or man. positioner for flush panel mounting
- Tool-01 10 mm wrench
- ZG-LF2 Crank arm kit for LF
- ZG-LF112 Crank arm kit for Honeywell Mod IV, M6415 type actuators, and new installations
- ZG-R01 500Ω resistor for 0 to 20 mA control signal
- ZG-112 Mounting bracket for Honeywell Mod IV, M6415 type actuators, and new installations
- ZS-100 Weather shield (metal)
- ZS-150 Weather shield (polycarbonate)
- ZS-260 Explosion-proof housing

Note: When using LF24-SR (-S) US actuators, only use accessories listed on this page.

**Wiring diagrams**

**24 VAC Transformer**

<table>
<thead>
<tr>
<th>Line Volts</th>
<th>Control Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blk (1) Common</td>
<td>Wht (3) Y, Input, 2 to 10V</td>
</tr>
<tr>
<td>Red (2) + Hot</td>
<td>Grn (5) U Output, 2 to 10V</td>
</tr>
</tbody>
</table>

**2 to 10 VDC control of LF24-SR (-S) US**

- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption and input impedance must be observed.
- Actuator may also be powered by 24 VDC.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead.
- The LF24-SR-S US wire 5 is white.

**Auxiliary switch of LF24-SR-S US**

For end position indication, interlock control, fan start-up, etc., LF24-SR-S us incorporates one built-in auxiliary switch: 1 x SPDT, 6A (1.5A) @250 VAC, UL listed, adjustable 0° to 95°.

Meets UL & CSA requirements without the need of an electrical ground connection.

**4 to 20 mA control of LF24-SR (-S) US with 2 to 10 VDC feedback output**

- Provide overload protection and disconnect as required.
- Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor, a +2% shift of control signal may be required. Power consumption must be observed.
- Actuator may also be powered by 24 VDC.
- A 500Ω resistor converts the 4…20 mA control signal to 2 to 10 VDC. (ZG-R01)
- Only connect common to neg. (——) leg of control circuits.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead.
LF24-SR-E US

Proportional damper actuator, 24 V for 2 to 10 VDC (or 4 to 20 mA) control signal or 3-position on/off control, with minimum position potentiometer. Output signal of 2 to 10 VDC for position indication.

• Torque min. 35 in-lb, for control of air dampers
• Built-in adjustable min-position for 3-position and proportional control

Application
For proportional control with minimum position setpoint, or three position control of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications.

The actuator is mounted directly to a damper shaft from 3/8" up to 1/2" in diameter by means of its universal clamp, 1/2" shaft centered at delivery. For shafts up to 3/4" use K6-1 accessory. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

The actuator operates in response to 24 VAC on wire 2 or 3, which allows the LF24-SR-E US to retrofit or replace Honeywell® M8405A actuators.

Operation
The LF 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 LF series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 90°.

The LF24-SR-E US 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 function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches. Power consumption is reduced in holding mode.

See wiring diagrams for LF24-SR-E US for more details on 3-position control.

Installation
Refer to LF Section of the Standard Actuation and Accessories, 2003 Product Documentation.

Honeywell® is a trademark of Honeywell Inc.

Dimensions (All numbers in brackets are metric.)

See diagram for dimensions.
Accessories
AV 10-18 Shaft extension (K6-1 is required)
IND-LF Damper position indicator
K6-1 Universal clamp for up to 3/4" diameter shafts
KH-LF Crankarm for up to 1/2" round shaft
Tool-01 10 mm wrench
ZG-LF2 Crankarm adaptor kit for LF
ZG-112 Mounting bracket for replacing Honeywell Mod IV, M6415 and M8405 type actuators, and new installations
ZG-LF112 Crankarm adaptor kit for replacing Honeywell Mod IV, M6415 and M8405 type actuators, and new installations
ZS-100 Weather shield (metal)
ZS-150 Weather shield (polycarbonate)

Note: When using LF24-SR-E US actuators, only use accessories listed on this page.

Wiring diagrams

Three-Position Control Signals

<table>
<thead>
<tr>
<th>Switch A</th>
<th>Wire 2-Red (x)</th>
<th>Wire 3-White (D)</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open**</td>
<td>Any</td>
<td>Any</td>
<td>Closed (via spring)</td>
</tr>
<tr>
<td>Closed</td>
<td>24 VAC</td>
<td>Open</td>
<td>Mid-position*</td>
</tr>
<tr>
<td>Closed</td>
<td>Open</td>
<td>24 VAC</td>
<td>Full Open*</td>
</tr>
<tr>
<td>Closed</td>
<td>24 VAC</td>
<td>24 VAC</td>
<td>Full Open*</td>
</tr>
</tbody>
</table>

* Desired position achieved by driving actuator with motor.
** An example would be to interlock the actuator power supply with the fan motor starter.

LF24-SR-E US Typical Specification
Spring return control damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a shaft up to a 3/4" diameter and center a 1/2" shaft. Actuator shall deliver a minimum output torque of 35 in-lbs. 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 20mA control input from an electronic controller. Actuator must have a built-in minimum position potentiometer. During 3-position control, the actuator shall drive to minimum position with 24 VAC on wire 2 and drive full open with 24 VAC on wire 3. 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 feedback signal shall be provided for position feedback or master-slave applications. The actuator must be designed so that they may be used for either clockwise or counterclockwise failsafe operation. Actuators shall be UL listed and CSA certified, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

2 to 10 VDC control of LF24-SR-E US

Notes:
- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption and input impedance must be observed.
- Actuator may also be powered by 24 VDC.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead.
- The ZG-R01 500Ω resistor converts the 4-20mA control signal to 2 to 10 VDC.

Wiring diagrams

3-position control with a SPDT switch or two contact closures (e.g. fan, cooling Y).

Min-position with Full Open override (with a single contact closure).

Notes:
- Provide overload protection and disconnect as required.
- Min-position is adjustable from 0 to 100% with a potentiometer on the actuator cover.
- Actuators with plenum rated cable do not have numbers on wires; use color codes instead.
- For 3-position control set direction of rotation to CW (Default).
- Switch A, actuator spring returns when open (e.g., fan interlock).
**Application of the LF24-SR-E US with minimum position potentiometer**

The LF24-SR-E US is the newest addition to the LF-series product range featuring dual functionality. A minimum position potentiometer has been built into the actuator for cost effective proportional and three position applications, e.g. economizer dampers in rooftop units.

**Proportional control with minimum position**

Minimum position is adjustable using the built-in potentiometer on the cover of the LF24-SR-E US. The minimum position can be adjusted anywhere over the full 0 to 95° range of the actuator. A 2 to 10 VDC input proportionally controls the actuator to the set-point position. The actuator electronics see both the 2 to 10 VDC input and the input signal from the potentiometer (minimum position setting). The actuator’s electronics select between the higher of these two signals. Therefore, the actuator moves to the position of the higher signal, which is the same operating characteristic the Belimo –SR actuators exhibit with the Belimo SGA24 and SGF24 positioners.

**LF24-SR-E US operates as follows:**

1. Set desired minimum position (Example 20%), while leaving the direction of rotation switch in the CW (default) position.
2. With power applied to wire 2 (red), the actuator will maintain the desired minimum position.
3. Applying a signal higher than that set by the minimum position potentiometer. In this example the input DC voltage must be greater than 3.6 VDC to move the actuator toward full open.
4. Changing the position of the direction of rotation switch to CCW will reverse the actuator’s control logic. If only the position of the direction of rotation switch is changed, then the actuator will move from 20% to 80%. The scale is now reverse from the default (e.g. 10VDC moves the actuator to 0).
5. Typically, power to the actuator is interlocked with the fan relay, which causes the actuator to spring return closed if the fan de-energizes.

**Control Accuracy and Stability**

LF24-SR-E US actuators have built-in brushless DC motors which provide better accuracy and longer service life.

The LF24-SR-E US 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 250 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.

**LF Actuator responds to a 80 mV signal when not changing direction from stop position.**

**LF Actuator responds to a 250 mV signal when reversing direction from stop position.**
Three-Position control using the LF24-SR-E US

By applying the LF24-SR override functionality and the new minimum position potentiometer, it is possible to achieve simple three-position control with the LF24-SR-E US.

1. Set desired minimum position (Example 20%), while leaving the direction of rotation switch in the CW (default) position. The direction of rotation switch does not need to be changed for three-position control, because direction of rotation can be changed by flipping the actuator.
2. With 24 VAC power applied across wire 1 (black) and 2 (red), the actuator will maintain minimum position.
3. Applying 24 VAC power across wire 1 (black) and 3 (white) overrides the minimum position and moves the actuator to Full Open.
4. With no power applied to actuator, it will spring return (fail-safe) closed.
5. Typically, power to the actuator is interlocked with the fan relay, which causes the actuator to spring return closed if the fan de-energizes.

Features of the Belimo Three-Position Solution

The LF24-SR-E US will:

- Direct couple to the damper shaft between 3/8” and 3/4” diameter for reduced installation cost.
- Spring return in either CW or CCW direction depending on mounting orientation of the actuator. This feature eliminates the need to select a specific model with correct spring return direction.
- Spring returns in <25 seconds @ -4° to +122°F.
- Increase minimum torque output to 35 in-lbs for 40% more torque than other 3-position actuator solutions.
- Drive to the adjustable minimum position from either the fully Open or Closed position using its brushless DC motor for improved reliability. Spring returns only during power loss.
- Drive full stroke in 150 seconds.
- Output a 2 to 10 VDC signal for position feedback.
- Control a damper proportionally between minimum position and full open (2 to 10 VDC input) for additional applications.
- Have dual (3-position and proportional control) wiring diagrams on actuator label for clear and easy wiring in the field.
- Consumes only 2.5 W driving to setpoint and 1 W to hold position, lower than actuators using AC motor technology.

Replacing an M8405 actuator

The three-position control functionality of the LF24-SR-E US allows direct replacement of a Honeywell M8405A foot mounted economizer actuator.

Mounting

For non-direct coupled applications use the ZG-LF112 HW accessory kit, which includes the KH-LF crankarm and ZG112 bracket and an accessory logic module mounting kit. The ZG-112 aligns the plane of the crankarm with that of the Honeywell M8405A. ZG-112 has at least two mounting holes that match the M805A foot pattern. The logic module mounting kit allows for attachment to the end of the LF24-SR-E US actuator. It provides for installation flexibility to place the module where space is available.

Wiring

For proper control logic wiring always refer to the controller manufactures documentation. See the 2003 Product Documentation Standard Actuation and Accessories for proper three position wiring diagram Belimo wiring diagram, page 55.
Preliminary steps

1. Belimo actuators should be mounted indoors in 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. (See Belimo Mechanical Accessories Doc. 5.2)
2. 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.
3. For standard mounting, the damper shaft must extend at least 3 1/2” from the duct. If the shaft extends less than 3 1/2”, the actuator may be mounted in its short shaft configuration. If an obstruction blocks access, the shaft can be extended with the AV 10-18 shaft extension. (KB-1 is required)

NOTE: Read the “Standard Mounting” instructions, on page 17, for more detailed information.

Dimensions (All numbers in brackets are metric.)

1. Rotate the damper to its failsafe 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, move it to 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.
**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.

**Transformer(s)**
The LF24... actuator requires a 24 VAC class 2 transformer and draws a maximum of 7 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 hot leg. 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 LF... actuators**
Keep power wire runs below the lengths listed in the table in Fig. A. 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 for LF24-SR US:
3 actuators, 16 Ga wire
550 Ft ÷ 3 Actuators = 183 Ft. Maximum wire run

**Maximum wire length:**

<table>
<thead>
<tr>
<th><strong>LF24 (-S) US</strong></th>
<th><strong>Wire Size</strong></th>
<th><strong>Max. Feet.</strong></th>
<th><strong>Wire Size</strong></th>
<th><strong>Max. Feet</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Ga</td>
<td>1100 Ft.</td>
<td>18 Ga</td>
<td>260 Ft.</td>
<td></td>
</tr>
<tr>
<td>14 Ga</td>
<td>700 Ft.</td>
<td>20 Ga</td>
<td>140 Ft.</td>
<td></td>
</tr>
<tr>
<td>16 Ga</td>
<td>440 Ft.</td>
<td>22 Ga</td>
<td>75 Ft.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>LF120 (-S) US / LF230 (-S) US</strong></th>
<th><strong>Wire Size</strong></th>
<th><strong>Max. Feet.</strong></th>
<th><strong>Wire Size</strong></th>
<th><strong>Max. Feet.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Ga</td>
<td>1250 Ft.</td>
<td>18 Ga</td>
<td>320 Ft.</td>
<td></td>
</tr>
<tr>
<td>14 Ga</td>
<td>800 Ft.</td>
<td>20 Ga</td>
<td>160 Ft.</td>
<td></td>
</tr>
<tr>
<td>16 Ga</td>
<td>500 Ft.</td>
<td>22 Ga</td>
<td>85 Ft.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>LF24-SR (-S) US / LF24-3 (-S) US / LFC24-3-R (-S) US</strong></th>
<th><strong>Wire Size</strong></th>
<th><strong>Max. Feet.</strong></th>
<th><strong>Wire Size</strong></th>
<th><strong>Max. Feet.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Ga</td>
<td>1500 Ft.</td>
<td>18 Ga</td>
<td>375 Ft.</td>
<td></td>
</tr>
<tr>
<td>14 Ga</td>
<td>925 Ft.</td>
<td>20 Ga</td>
<td>200 Ft.</td>
<td></td>
</tr>
<tr>
<td>16 Ga</td>
<td>550 Ft.</td>
<td>22 Ga</td>
<td>100 Ft.</td>
<td></td>
</tr>
</tbody>
</table>

**Wire Type and Wire Installation Tips**
For most installations, 18 or 16 Ga. cable works well with the LF24... 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 LF24... 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.

**Brushless DC motor operation**
Belimo’s brushless DC motor spins by reversing the poles of stationary electromagnets housed inside rotating permanent magnets. The electromagnetic poles are switched by a microprocessor and a special ASIC (Application Specific Integrated Circuit) developed by Belimo. Unlike the conventional DC motor, there are no brushes to wear or commutators to foul.
Mechanical Operation

The actuator is mounted directly to a damper shaft up to 1/2” in diameter by means of its universal clamp, or up to a 3/4” shaft with the optional K6-1 clamp. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

The LF 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 consistent torque to the damper with, and without, power applied to the actuator.

The LF series provides 95° of rotation and is provided with a graduated position indicator showing 0 to 90°.

The LF...S versions are provided with 1 built-in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 0° and 95°.

Standard Mounting / Airtight Damper Procedure

1. See Fig. B. Manually move the damper to the fail-safe position (a) (usually closed). If the shaft rotated counterclockwise (         ), this is a CCW installation. If the shaft rotated clockwise (         ), this is a CW installation. In a Left Hand installation, the actuator side marked “CW” faces out, while in a CW installation, the side marked “CCW” faces out. All other steps are identical.

2. The actuator is usually shipped with the universal clamp mounted to the “CW” side of the actuator. To test for adequate shaft length, slide the actuator over the shaft with the side marked “CW” (or the “CCW” 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, position the clamp so that the pointer section of the tab is pointing to 0° (see Fig. 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.)

4. Lock the clamp to the actuator using the retaining clip.

5. Verify that the damper is still in its full fail-safe position. (a)

6. Mount the spring return actuator to the shaft. Tighten the universal clamp, finger tight only.

7. Mount the anti-rotation strap at the base of the actuator. Do not tighten the screws.

8. Remove the screw from one end of the mounting bracket and pivot it away from the actuator.

9. Loosen the universal clamp and, making sure not to move the damper shaft, rotate the actuator approximately 5° in the direction which would open the damper.

10. Tighten the universal clamp to the shaft.

11. Rotate the actuator to apply pressure to the damper seals (b) and re-engage the anti-rotation strap (c).

12. Tighten all fasteners.
Short Shaft Mounting with IND-LF Position Indicator / Airtight Damper Procedure

If the shaft extends at least 3/4" from the duct, follow these steps:
1. (See Fig. D) Move damper blades to the fail-safe position (a).
2. 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.
3. Engage the clamp to the actuator as close as possible to the determined location.
4. Lock the clamp to the actuator using the retainer clip.
5. Mount the spring return actuator to the shaft. Tighten the universal clamp, finger tight only.
6. Mount the anti-rotation strap at the base of the actuator. Do not tighten the screws.
7. Remove the screw from one end of the mounting bracket and pivot it away from the actuator.

Operational Information for LF24-SR (-S) US Proportional Actuators

Initialization of the LF24-SR (-S) US
When power is applied, the internal microprocessor recognizes that the actuator is at its full fail-safe position and uses this position as the base for all of its position calculations. This procedure takes approximately 15 seconds. During this time you will see no response at the actuator. The microprocessor will retain the initialized zero during short power failures of up to 25 seconds. When power is applied during this period, the actuator will return to normal operation and proceed to the position corresponding to the input signal provided. For power failures over 25 seconds, the actuator will be at it fail-safe position and will go through the start up initialization again.

Motor position detection (LF24-SR (-S) US only)
Belimo brushless DC motors eliminate the need for potentiometers for positioning. 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.

Overload protection
The LF, on-off actuators are electronically protected against overload. The LF, On-off actuator have an internal current limiter which maintains the current at a safe level which will not damage the actuator while providing adequate holding torque.

The LF24, modulating, actuators (LF24-SR (-S) US, LF24-3 US) are protected against overload by digital technology located in the ASIC. The ASIC circuitry constantly monitors the rotation of the brushless DC motor inside the actuator and stops the pulsing to the motor when it senses a stall condition. The motor remains energized and produces full rated torque during stall conditions. The actuator will try to move in the direction of the stall every 2 minutes, for a period of 32 minutes. After this, the actuator will try again every 2 hours.
Installation Instructions
Quick-Mount Visual Instructions for Mechanical Installation

Mechanical Angle of Rotation Limiting

The LF actuators are provided with an adjustable stop to limit the rotation of the actuator. This function works in conjunction with the universal clamp or the optional position indicator. The adjustable stop is needed when rotation of less than 95° is required. The LF actuator can be indefinitely stalled, in any position, without harming the actuator.

Using the universal clamp:
1. Loosen the end stop fastening screw using a #2 Phillips screwdriver.
2. Move the stop block so the bottom edge of the block lines up with the number corresponding to the desired degrees of rotation. (example: 45 degrees of rotation = .5)
3. Lock the block in place with the fastening screw.
4. Check the actuator for proper rotation.

Using the IND-LF position indicator with adjustable stop:
Note: preferred method if short shaft mounting is used.
1. With the actuator in its fail-safe position, place the IND-LF Position Indicator so that it points to the 0 degree position.
2. Loosen the end stop fastening screw using a #2 Phillips screwdriver.
3. Move the stop block so the bottom edge of the block lines up with the number corresponding to the desired degrees of rotation. (example: 45 degrees of rotation = .5)
4. Lock the block in place with the fastening screw.
5. Check the actuator for proper rotation.

Direction of Rotation Switch

LF24-3 (-S) US and LF24-SR (-S) US actuators have a direction of rotation switch on the cover labeled “CW-CCW”. Switch position indicates start point. For the LF24-SR, with the switch in position “CW”, the actuator rotates clockwise with a decrease in voltage or current. With the switch in position “CCW”, the actuator rotates counterclockwise with a decrease in voltage or current.

The LF24-3 (-S) US and LF24-SR (-S) US actuators rotate clockwise when the switch is in the “CW” position and power is applied to wire #3. When power is applied to wire #4 the actuator rotates counterclockwise.

Rotating the direction of rotation switch to “CCW” reverses the control logic.

During checkout, the switch position can be temporarily reversed and the actuator will reverse its direction. This allows the technician a fast and easy way to check the actuator operation without having to switch wires or change settings on the controller. When the check-out is complete, make sure the switch is placed back to its original position.

Control Accuracy and Stability

LF24-SR US actuators have built-in brushless DC motors which provide better accuracy and longer service life.

The LF24-SR US 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.

LF Actuator responds to a 80 mV signal when not changing direction from stop position.

LF Actuator responds to a 200 mV signal when reversing direction from stop position.
Auxiliary Switches

The ...-S model actuators are equipped with an adjustable auxiliary switch used to indicate damper position or to interface additional controls or equipment. Switching positions can be set over the full 0 to 95° rotation simply by setting a switch on the actuator.

1. Set desired switch position. (Example 60%)
2. As the actuator rotates, the switch indicator moves from .6 (60%) toward 0 (0%). When the indicator passes 0 the switch contact between S1 and S2 is broken and the contact between S1 and S3 is made.

Switch Rating

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Resistive load</th>
<th>Inductive load</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 VAC</td>
<td>6 A</td>
<td>3 A</td>
</tr>
<tr>
<td>250 VAC</td>
<td>6 A</td>
<td>1.5 A</td>
</tr>
</tbody>
</table>

Non-direct Mounting Methods

KH-LF crankarm including retaining ring.

ZG-LF112 Crankarm adaptor kit

ZG-LF2 Crankarm adaptor kit

KG6 ball joint and universal crankarm (not included)
# Startup and Checkout

## Instructions For LF24-SR (-S) US

**LF24-SR (-S) US Electrical check-out procedure**

<table>
<thead>
<tr>
<th>Step</th>
<th>Procedure</th>
<th>Expected Response</th>
<th>Gives Expected Response</th>
<th>Does Not Give Expected Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Remove power to reset actuator. Re-apply power. Apply control signal to actuator.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly</td>
<td>Step 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No response at all</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Step 2 Operation is reversed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Step 3 Does not drive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>toward “Control Signal Position”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Step 4</td>
</tr>
<tr>
<td>2.</td>
<td>Check power wiring. Correct any problems. <strong>See Note 1.</strong></td>
<td>Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.</td>
<td>Power wiring correct-ed, actuator begins to drive</td>
<td>Step 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Power wiring corrected, actuator still does not drive</td>
</tr>
<tr>
<td>3.</td>
<td>Turn reversing switch to the correct position. Make sure the switch is turned all the way left or right.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly</td>
<td>Step 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Does not drive toward “Control Signal Position”</td>
</tr>
<tr>
<td>4.</td>
<td>Make sure the control signal positive (+) is connected to Wire No 3 and control signal negative (-) is connect-ed 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.</td>
<td>Drives to “Control Signal” position</td>
<td>Actuator operates properly</td>
<td>Step 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Step 5</td>
</tr>
<tr>
<td>5.</td>
<td>Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For LF24-SR US this is 2 to 10 VDC or 4 to 20 mA. Note: The input signal must be above the 2 VDC or 4 mA to have the actuator move.</td>
<td>Input voltage or current should be ±1% of what controller’s adjustment or programming indicate.</td>
<td>Controller output (actuator input) is correct. Input Polarity Correct.</td>
<td>Step 6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reprogram, adjust repair or replace controller as needed.</td>
</tr>
<tr>
<td>6.</td>
<td>Loosen the nuts on the V-bolt and move the damper by hand from fully closed to fully open.</td>
<td>Damper will go from fully closed to fully open.</td>
<td>Damper moves properly</td>
<td>Step 7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Find cause of damper jam and repair. Move damper back to the fully closed position and tighten the nuts.</td>
</tr>
<tr>
<td>7.</td>
<td>Check damper torque requirement.</td>
<td>Torque requirement is ≤ actuator’s minimum torque.</td>
<td>Defective Actuator. Replace Actuator - <strong>See Note 2</strong></td>
<td>Recalculate actuator requirement and correct installation.</td>
</tr>
<tr>
<td>8.</td>
<td>Actuator works properly. Test controller by following controller manu-facturer's instructions.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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 installation date, notify Belimo and give details of the application.
GM Series Direct Coupled Actuator

Minimum 320 in-lb torque**

- For damper areas up to 80 sq-ft*

Applications

Actuator is mounted to vortex frame and direct coupled to linkage shaft.

Linkage is part of inlet vane assembly supplied by manufacturer.

For large damper areas and inlet guide vanes.

GM Series - at a glance

<table>
<thead>
<tr>
<th>Feature</th>
<th>GM24 US (p. 70)</th>
<th>GM24-SR US (p. 72)</th>
<th>GM24-MF-T US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque:</td>
<td>320 in-lb</td>
<td>266 in-lb</td>
<td>320 in-lb</td>
</tr>
<tr>
<td>Power supply: 24 VAC</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Control signal: on-off</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control signal: proportional 2 to 10 VDC</td>
<td>●</td>
<td>●</td>
<td>●†</td>
</tr>
<tr>
<td>Feedback signal: 2 to 10 VDC</td>
<td>●</td>
<td>●</td>
<td>●†</td>
</tr>
<tr>
<td>Running time: 135 sec constant</td>
<td>●</td>
<td>●</td>
<td>●†</td>
</tr>
<tr>
<td>External direction of rotation switch</td>
<td>●</td>
<td>●</td>
<td>●†</td>
</tr>
<tr>
<td>18 GA appliance cable</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Installation instructions: (p. 74–78)</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>General wiring: ...............(p. 76)</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Start-up and checkout: (p. 79)</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

* 4 in-lb/ft² damper torque loading. Parallel blade. No edge seals. 320 in-lb of actuator torque.

**GM24-SR US Only is 266 in-lb

†Variable: Refer to Multi-Function Product Documentation for details.
A CLOSER LOOK...

- Cut labor costs with simple direct coupling – The Belimo Concept.
- Check damper position easily with clear indicator.
- Don’t worry about actuator burn-out. Belimo is overload-proof throughout rotation.
- Easy mechanical stop to adjust angle of rotation. (add ZDB-GM accessory).
- Push-button manual override speeds installation.
- Need to change control direction? Do it easily with a simple switch.
- Microprocessor-controlled brushless DC motor increases actuator life span and reliability, provides constant running time.
- Rugged NEMA 2 housing provides protection from splashing water.
- 3 ft. appliance cable and conduit connector eases installation.
- Microprocessor controlled.

The Belimo Difference

- **Customer Commitment.**

- **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. 20+ years direct coupled actuator design.
On-off, reversible, non-spring return, direct coupled, tri-state, 24 V

Torque min. 320 in-lb, for control of air dampers

Application
For modulating or on-off 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 of a fan motor contactor, or a manual switch. The direction of rotation is reversible, for use with a floating point type control. The actuator mounts directly to the damper operating shaft with a universal V-bolt clamp assembly.

Operation
The anti-rotation strap supplied with the actuator will prevent lateral movement of the actuator. The angle of rotation is mechanically limited to 95°. When reaching the damper or actuator end position, the motor stops automatically. The gears can be manually disengaged by simply pressing down the spring loaded button on the actuator cover. When this button is pressed down, the damper blades can be adjusted by hand. The position of the actuator is indicated by means of a scale reading 0 to 1.

The GM uses a brushless DC motor which is controlled by an Application Specific Integrated Circuit (ASIC). The ASIC monitors and controls the actuator’s rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

Technical Data

<table>
<thead>
<tr>
<th>Technical Data</th>
<th>GM24 US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 VAC ± 20% 50/60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>3 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>6 VA (class 2 power source)</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA appliance cable</td>
</tr>
<tr>
<td></td>
<td>1/2” conduit connector</td>
</tr>
<tr>
<td>Overload protection</td>
<td>Electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>mechanically limited to 95°</td>
</tr>
<tr>
<td>Torque</td>
<td>320 in-lb [36 Nm] starting in June 2002</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>reversible with switch A/B</td>
</tr>
<tr>
<td>Position indication</td>
<td>0 to 1 and reversible indicator</td>
</tr>
<tr>
<td>Running time</td>
<td>135 sec. independent of load</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA type 2</td>
</tr>
<tr>
<td>Housing rating</td>
<td>UL94V-0 (flammability rating)</td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No.24 certified, CE</td>
</tr>
<tr>
<td>Noise level</td>
<td>max. 45 dB (A)</td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Weight</td>
<td>4.0 lbs (1.8 kg.)</td>
</tr>
</tbody>
</table>

Dimensions (All numbers in brackets are metric.)

![Diagram](image)
GM24 US

On-off, reversible, non-spring return, direct coupled, tri-state, 24 V

**Accessories**
- KH8 Universal crankarm
- KG10 Ball joint
- NSV24 Battery back-up module
- P... Feedback potentiometer
- S2Z Mid-position switch
- S1,S2 Auxiliary switch
- Tool-01 10mm wrench
- ZDB-GM Angle of rotation limiter (Series 2)
- ZG-H2 Actuator operator handle
- ZG-GM2 Crankarm adaptor kit
- ZG-100 Universal mounting bracket
- ZG-101 Universal mounting bracket
- ZG-102 Multiple actuator mounting bracket
- ZG-103 Universal mounting bracket
- ZG-104 Universal mounting bracket
- ZS-100 Weather shield (metal)
- ZS-150 Weather shield (polycarbonate)
- ZS-260 Explosion-proof housing
- ZS-300 NEMA 4X housing

**NOTE:** When using GM24 US actuators, use only the accessories listed on this page.

**GM24 US - Typical Specification:**
Control damper actuators shall be electronic direct coupled type which require no crankarm and linkage. Actuators shall be UL listed and CSA certified, have a 2 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall have reversing switch and manual override on the cover. Actuators shall use a brushless DC motor and be protected from overload at all angles of rotation. Run time shall be constant and independent of torque. Actuators shall be as manufactured by Belimo.

**Wiring diagrams**

**On-Off control of GM24 US**

24 VAC Transformer

1  Common
2 +
3 +

A B GM24 US

The indication of direction is valid for switch position A.

Provide overload protection and disconnect as required.

Actuator may also be powered by 24 VDC.

**Tri-State control of GM24 US**

24 VAC Transformer

1  Common
2 +
3 +

A B GM24 US

The indication of direction is valid for switch position A.

Provide overload protection and disconnect as required.

Actuator may also be powered by 24 VDC.
GM24-SR US

Proportional damper actuator, non-spring return, direct coupled, 24 V for 2 to 10 VDC and 4 to 20 mA control signal.

Torque min. 266 in-lb, for control of air dampers

Application
For proportional modulation of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications.

The actuator mounts directly to the damper operating shaft with a universal V-bolt clamp assembly.

Operation
The actuator operates in response to a 2 to 10 VDC or, with the addition of a 500 Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner. A 2 to 10 VDC feedback signal is provided for position indication or master-slave applications.

The anti-rotation strap supplied with the actuator will prevent lateral movement of the actuator. The angle of rotation is mechanically limited to 95°. When reaching the damper or actuator end position, the motor stops automatically. The gears can be manually disengaged by simply pressing down the spring loaded button on the actuator cover. When this button is pressed down, the damper blades can be adjusted by hand. The position of the actuator is indicated by means of a scale reading 0 to 1.

The GM uses a brushless DC motor which is controlled by an Application Specific Integrated Circuit (ASIC). The ASIC monitors and controls the actuator’s rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

Technical Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 VAC ± 20% 50/60 Hz</td>
</tr>
<tr>
<td></td>
<td>24 VDC ± 10%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>3 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>7 VA (class 2 power source)</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA appliance cable</td>
</tr>
<tr>
<td></td>
<td>1/2” conduit connector</td>
</tr>
<tr>
<td>Overload protection</td>
<td>Electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td>Operating range Y</td>
<td>2 to 10 VDC, 4 to 20 mA</td>
</tr>
<tr>
<td>Input impedance</td>
<td>100 kΩ (0.1 mA), 500Ω</td>
</tr>
<tr>
<td>Feedback output U</td>
<td>2 to 10 VDC, 0.5 mA max</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>mechanically limited to 95°</td>
</tr>
<tr>
<td>Torque</td>
<td>min 266 in-lb [30 Nm]</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>reversible with switch A/B</td>
</tr>
<tr>
<td></td>
<td>A = CW with an increase in voltage</td>
</tr>
<tr>
<td></td>
<td>B = CCW with an increase in voltage</td>
</tr>
<tr>
<td>Position indication</td>
<td>0 to 1 and reversible indicator</td>
</tr>
<tr>
<td>Running time</td>
<td>135 sec. independent of load</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH, non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature</td>
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<tr>
<td>Housing</td>
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<td>Housing rating</td>
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<tr>
<td>Noise level</td>
<td>max. 45 dB (A)</td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Weight</td>
<td>4.2 lbs (1.9 kg.)</td>
</tr>
</tbody>
</table>

Dimensions (All numbers in brackets are metric.)

- 15/32” to 3/4” [12 to 20]
- 3/8” to 5/8” [9 to 16]
## GM24-SR US

Proportional damper actuator, non-spring return, direct coupled, 24 V for 2 to 10 VDC and 4 to 20 mA control signal.

### GM24-SR US - Typical Specification:

Control damper actuators shall be electronic direct coupled type which require no crankarm and linkage. Actuators shall be UL listed and CSA certified, have a 2 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall have reversing switch and gear disengagement button on the cover. Actuators shall use a brushless DC motor and be protected from overload at all angles of rotation. Run time shall be constant and independent of torque. 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. A 2 to 10 VDC feedback signal shall be provided for position indication or master-slave applications. Actuators shall be as manufactured by Belimo.

### Multiple actuators mounted to shaft

<table>
<thead>
<tr>
<th>Model</th>
<th>Maximum quantity per shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM24 US</td>
<td>2</td>
</tr>
<tr>
<td>GM24-SR US</td>
<td>2</td>
</tr>
</tbody>
</table>

### Wiring diagrams

#### 0 to 10 VDC control of GM24-SR US

- **Provide overload protection and disconnect as required.**
- **Actuators may be connected in parallel. Power consumption and input impedance must be observed.**

#### 4 to 20 mA control of GM24-SR US with 2 to 10 VDC feedback output

- **Provide overload protection and disconnect as required.**
- **Connect actuator common (wire 1) to negative (−) leg of control circuits only.**
- **Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor, a +2% shift of control signal may be required. Power consumption must be observed.**
- **The 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.**
- **Actuator may also be powered by 24 VDC.**
Installation Instructions
Quick-Mount Visual Instructions for Mechanical Installation

Installation instruction for damper shafts with a minimum length of 2 1/2 inch [63 mm] for GM series actuators

1. Move the damper to closed position.
2. Position actuator onto damper shaft.
3. Hand tighten nuts on V-clamp.
4. If necessary, bend anti-rotation strap at both ends to fit between damper frame.
5. Fix anti-rotation strap to damper frame.
6. Disengage gears with manual release button on casing.
7. Turn motor clamp back to 5° before closed position and allow gears to re-engage.
8. Align the actuator at 90° to the damper shaft and verify that the damper is still in the fully closed position.
9. Tighten nuts on the V-clamp.

Installation instruction for damper shafts with a minimum length of 3/4 inch [20 mm] or bridging of damper frame

1. Disengage gears with manual release button on casing (Manual operation).
2. Turn actuator clamp back to 5° before closed position and allow gears to re-engage.
3. Pull out universal clamp after removing retaining clip.
5. Move damper into closed position.
7. Refit retaining clip.
8. If necessary bend or cut anti-rotation strap on either side to fit the damper frame.
9. Slide the stud of the anti-rotation strap into slot on actuator base and fix it with screws to damper frame.

Installation instruction for mounting GM actuators on inlet guide vanes.

1. Rotate vortex jackshaft fully counterclockwise.
2. Depress manual release button on actuator and rotate universal clamp fully counterclockwise.
3. Position the actuator on the jackshaft so that the actuator is in a position to mount to the anti-rotation strap.
4. Position and mount the anti-rotation strap to the vortex frame so that the mounting stud is one-sixteenth inch from the bottom of the mounting slot of the actuator.
5. Verify that rotation of the actuator is correct for full operation of the vortex blades. Adjust linkage if necessary. Fully tighten the V-bolt nuts.
6. If additional torque is required, add second actuator to the other end of the shaft assembly.
Installation Instructions

Mechanical Installation

1. Slip the actuator’s universal clamp over the damper shaft. Make sure that the bottom of the actuator (metal side) is toward the duct and the controls on the cover are accessible. Place the actuator in the desired mounting position.

2. Turn the damper shaft until the blades are fully closed.

3. Hand tighten the two nuts on the GM24 . . universal clamp.

4. Slide the stud of the anti-rotation bracket into the slot in the bottom of the actuator. Bend the strap as needed to support the rear of the actuator.

5. Fasten the strap to the duct with two screws. We recommend No. 8 self tapping sheet metal screws.

6. Loosen the two nuts on the universal clamp. Disengage the actuator gear train by pressing the “manual override button” (half round black button). Keeping the gears disengaged, and the damper fully closed, rotate the clamp until it is about 5° from the closed position.

7. Tighten the two nuts on the clamp with a 10 mm wrench (Belimo Tool-01). Use 9 to 11 ft-lb of torque.

The damper is now fully closed but the actuator is 5° from fully closed. This is called “pre-loading” the actuator. When the actuator is powered and sent to the closed position: it will put its full torque on the shaft compressing the edge and blade seals. This ensures that the damper will meet its leakage rating. The actuator is electronically protected from overload and will not be damaged.

Manual override
The Belimo GM24 . . actuators have a black, half round “manual override button” located on the top of the housing. Press this button and the gear train is disengaged so the damper shaft can be moved manually. Release the button and the gear train is re-engaged.

Testing the installation without power
1. Disengage the gear train with the manual override button and move the shaft from closed to open to closed. Ensure that there is no binding and that the damper goes fully open and closes with 5° of actuator stroke left.

2. Correct any problems and retest.

General Information

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

2. For new construction work, order dampers with extended shafts. Instruct the installing contractor to allow space for mounting the Belimo actuator on the shaft.

For replacement of existing gear train actuators, there are two options:

A. From a performance standpoint, it is best to mount the actuator directly onto the damper shaft.

B. If the damper shaft is not accessible, mount the GM24-. . actuator with a ZG-GM2 crankarm kit, and a mounting bracket (ZG-100, ZG-101, ZG-103, ZG-104)

Standard Mounting

1. Slip the actuator’s universal clamp over the damper shaft. Make sure that the bottom of the actuator (metal side) is toward the duct and the controls on the cover are accessible. Place the actuator in the desired mounting position.

2. Turn the damper shaft until the blades are fully closed.

3. Hand tighten the two nuts on the GM24 . . universal clamp.

4. Slide the stud of the anti-rotation bracket into the slot in the bottom of the actuator. Bend the strap as needed to support the rear of the actuator.

5. Fasten the strap to the duct with two screws. We recommend No. 8 self tapping sheet metal screws.

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Testing the installation without power
1. Disengage the gear train with the manual override button and move the shaft from closed to open to closed. Ensure that there is no binding and that the damper goes fully open and closes with 5° of actuator stroke left.

2. Correct any problems and retest.

Multiple Actuator Mounting

If more torque is required than one GM can provide, a second actuator may be installed on the same shaft. See page 78 for wiring details.
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.

Transformer(s)
The GM24... actuators require a 24 VAC class 2 transformer and draws a maximum of 6 VA for the GM24 US and 7 VA for the GM24-SR US. 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 subsequent 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 hot leg. 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 subsequent 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 on page 16.

Wire length for GM... actuators
Keep power wire runs below the limits listed in Fig. 1 or 2. 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 for GM24-SR US: 3 actuators, 16 Ga wire

Maximum wire length:

<table>
<thead>
<tr>
<th>Wire Size</th>
<th>Max. Feet.</th>
<th>Wire Size</th>
<th>Max. Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Ga</td>
<td>1500 Ft.</td>
<td>18 Ga</td>
<td>375 Ft.</td>
</tr>
<tr>
<td>14 Ga</td>
<td>925 Ft.</td>
<td>20 Ga</td>
<td>200 Ft.</td>
</tr>
<tr>
<td>16 Ga</td>
<td>550 Ft.</td>
<td>22 Ga</td>
<td>100 Ft.</td>
</tr>
</tbody>
</table>

Figure 1

<table>
<thead>
<tr>
<th>Wire Size</th>
<th>Max. Feet.</th>
<th>Wire Size</th>
<th>Max. Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Ga</td>
<td>1250 Ft.</td>
<td>18 Ga</td>
<td>300 Ft.</td>
</tr>
<tr>
<td>14 Ga</td>
<td>800 Ft.</td>
<td>20 Ga</td>
<td>160 Ft.</td>
</tr>
<tr>
<td>16 Ga</td>
<td>500 Ft.</td>
<td>22 Ga</td>
<td>85 Ft.</td>
</tr>
</tbody>
</table>

Figure 2

Wire Type and Wire Installation Tips

For most installations, 18 or 16 Ga cable works well with the GM24... 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 GM24... 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. Reroute the wiring away from the source of pickup.
3. Use shielded wire (Belden 8760 or equal). Ground the shield to an earth ground.

The GM24 US, on-off, tri-state actuators when set for switch position “A/B”, the actuator rotates clockwise with an increase in voltage or current. With the switch in Position “B”, the actuator rotates counterclockwise with an increase in voltage or current.

The GM24 US, on-off, tri-state actuators when set for switch position “A”, the actuator rotates clockwise when power is applied to wire #2, and counterclockwise when power is applied to wire #3.

The GM24 US, on-off, tri-state actuators when set for switch position “B”, the actuator rotates clockwise when power is applied to wire #2, and counterclockwise when power is applied to wire #3.
General Wiring Instructions (continued)

During checkout, the switch position can be temporarily reversed and the actuator will reverse its direction. This allows the technician a fast and easy way to check the actuator operation without having to switch wires or change settings on the thermostat. When the checkout is complete, make sure the switch is placed back to its original position.

The Position Indicator can be reversed depending on the desired direction of rotation of the damper.

1. Pull out the white pointer.
2. Turn the position indication card.
3. Replace the white pointer.

Control Accuracy and Stability

GM24 US Series actuators have built-in brushless DC motors which provide better accuracy and longer service life.

The GM24-SR US is designed with a unique non-symmetrical deadband. The actuator follows an increasing or decreasing control signal with a 40 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 the GM24-SR US 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.

Electrical Operation

General
The GM Series actuators utilize brushless DC motor technology. The GM uses this motor in conjunction with an Application Specific Integrated Circuit (ASIC). The ASIC monitors and controls the actuator’s rotation and a digital rotation sensing function to prevent damage to the actuator.

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 GM 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.
1. Disengage gears with manual release button on casing (Manual operation).
2. Turn actuator clamp back to the “0” position for CW operation when power is applied. “10” position for CCW operation
3. Pull out clamp after removing retaining clip. Note position indicator is at 0. (A)
4. Locate the angle of rotation limiter (ZDB-GM) on the actuator so that its mark sign lines up with the degree graduation on the actuator face which corresponds with the required rotation. (Every division represents approximately 10% of the angle of rotation). (B) Example: 3 divisions away from the end position means: 100% - (3 divisions x 10%) = 70%
5. Position clamp onto actuator and refit retaining clip. (C)

Non-Direct Mounting Methods

ZG-GM2 Kit contains:
① front fixing attachment
② rear fixing attachment
③ crankarm
④ 2 bolts M6x16
⑤ 7 sheet metal screws
2 KG10 ball joints

GM.. type actuator

Actuator is mounted to a universal mounting bracket or field-fabricated bracket. Connect to inlet vanes with linkage.

ZG-GM2 with ZG-100 Universal Mounting Bracket, using linkage to operate the damper blade.

Wall mounting
## GM24-SR US Electrical check-out procedure

<table>
<thead>
<tr>
<th>Step</th>
<th>Procedure</th>
<th>Expected Response</th>
<th>Gives Expected Response</th>
<th>Does Not Give Expected Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control signal is applied to actuator.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly</td>
<td><strong>Step 8</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No response at all</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Step 2</strong></td>
<td>Operation is reversed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Step 3</strong></td>
<td>Does not drive toward “Control Signal Position”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Step 4</strong></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Check power wiring. Correct any problems. <strong>See Note 1.</strong></td>
<td>Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.</td>
<td>Power wiring corrected, actuator begins to drive</td>
<td><strong>Step 1</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Power wiring corrected, actuator still does not drive</td>
<td><strong>Step 4</strong></td>
</tr>
<tr>
<td>3.</td>
<td>Turn reversing switch to the correct position.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly</td>
<td><strong>Step 8</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Does not drive toward “Control Signal Position”</td>
<td><strong>Step 4</strong></td>
</tr>
<tr>
<td>4.</td>
<td>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.</td>
<td>Drives to “Control Signal” position</td>
<td>Actuator operates properly</td>
<td><strong>Step 8</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Step 5</strong></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For GM24-SR US this is 0 to 10 VDC or 0 to 20 mA. Note: The input signal must be above the 2 VDC or 4 mA to have the actuator move.</td>
<td>Input voltage or current should be ±1% of what controller’s adjustment or programming indicate.</td>
<td>Controller output (actuator input) is correct. Input Polarity Correct.</td>
<td><strong>Step 6</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Step 1</strong></td>
<td>Reprogram, adjust repair or replace controller as needed.</td>
</tr>
<tr>
<td>6.</td>
<td>Use the manual override button to move the damper by hand from fully closed to fully open.</td>
<td>Damper will go from fully closed to fully open.</td>
<td>Damper moves properly</td>
<td><strong>Step 7</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Step 6</strong></td>
<td>Find cause of damper jam and repair.</td>
</tr>
<tr>
<td>7.</td>
<td>Check damper torque requirement.</td>
<td>Torque requirement is ≤ actuator’s minimum torque.</td>
<td>Defective Actuator. Replace Actuator - <strong>See Note 2</strong></td>
<td>Recalculate actuator requirement and correct installation.</td>
</tr>
<tr>
<td>8.</td>
<td>Actuator works properly. Test controller by following controller manufacturer’s instructions.</td>
<td></td>
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</tr>
</tbody>
</table>

### 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 installation date, notify Belimo and give details of the application.
AM Series Direct Coupled Actuator

Versatile and Powerful

- Minimum 160 in-lb torque in a compact package.
  For damper areas up to 40 sq-ft*.

Areas of Application

Direct Coupled
up to 3/4" standard shafts
or Jackshafts to 1.05"
(with K4-1 Clamp)

Mounting with
linkage (ZG-AM
accessory kit)

Short shaft
mounting (with
AV1 clamp)

Fits Jackshafts also.

AM Series - at a glance

<table>
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<tr>
<th></th>
<th>AM24 US (p. 82)</th>
<th>AM24 US (p. 82)</th>
<th>AM24 SR US (p. 84)</th>
<th>AM24-PC US (p. 86)</th>
<th>SM24 US (p. 88)</th>
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<tbody>
<tr>
<td>Torque</td>
<td>160 in-lb</td>
<td>160 in-lb</td>
<td>160 in-lb</td>
<td>133 in-lb</td>
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<td>Power supply</td>
<td>24 VAC/DC</td>
<td>24 VAC/DC</td>
<td>24 VAC/DC</td>
<td>24 VAC/DC</td>
<td>24 VAC/DC</td>
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<td>Control signal</td>
<td>on-off/ floating</td>
<td>on-off/ floating</td>
<td>On/Off</td>
<td>On/Off</td>
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</tr>
<tr>
<td>Control signal</td>
<td>proportional 2 to 10 VDC</td>
<td>proportional 2 to 10 VDC</td>
<td>0 to 20 V phasecut</td>
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<td></td>
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<tr>
<td>Control signal</td>
<td>0... 135Ω or Honeywell® Electronic Series 90</td>
<td>0... 135Ω or Honeywell® Electronic Series 90</td>
<td>0... 135Ω or Honeywell® Electronic Series 90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback</td>
<td>2 to 10 VDC</td>
<td>2 to 10 VDC</td>
<td>2 to 10 VDC</td>
<td>2 to 10 VDC</td>
<td></td>
</tr>
<tr>
<td>Running time</td>
<td>150 sec constant</td>
<td>110 to 150 sec</td>
<td>100 to 200 sec</td>
<td>16 to 19 sec</td>
<td></td>
</tr>
<tr>
<td></td>
<td>load dependent</td>
<td>load dependent</td>
<td>load dependent</td>
<td>load dependent</td>
<td></td>
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<tr>
<td>External direction of rotation switch</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Conduit fitting</td>
<td></td>
<td></td>
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<tr>
<td>Appliance cable</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Built-in auxiliary switches</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>UL listed, CSA certified, CE</td>
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</table>

Auxiliary switches and feedback potentiometer ...........................................(p. 88-90)
Installation instructions ......(p. 91–95) General wiring ..............(p. 93) Start-up and checkout (p. 96)

* 4 in-lb/ft² damper torque loading. Parallel blade. No edge seals.
20% more torque than SM.

Fits inside 4" damper frame.

Full stroke overload protection.

Electronic deadband for accuracy and stability (proportional models).

Easy direct coupled mounting, including jackshafts to 1.05".

Check damper position with clear position indicator.

Set actuator to compensate for damper seal wear and compression (proportional models).

Constant running time aids control loop tuning (proportional models).

Added flexibility with built-in mechanical stops.

Fully adjustable, built-in auxiliary switches (AM24-S US only).

Auxiliary switch add-on mounts on clamp, includes conduit fitting (SA1 US, SA2 US).

Push button manual override

Easily reverse control direction with switch on housing

3’ cable speeds installations

Micro processor controlled Brushless DC Motor

The Belimo Difference

Customer Commitment.

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. 20+ years direct coupled actuator design.
AM24 (-S) US
On-off/ floating point control, non-spring return, direct coupled, 24 V

Torque min. 160 in-lb, for control of air dampers.

AM24 US
AM24-S US

Application
For on-off and floating point control of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications.

The actuator is mounted directly to a damper shaft up to 3/4” in diameter by means of its universal clamp, or up to a 1.05” jackshaft with the optional K4-1 clamp. A crankarm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

Operation
The actuator is not provided with and does not require any limit switches, but is electronically protected against overload. The angle of rotation is mechanically limited to 95°. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged with a button on the actuator cover. The position of the actuator is indicated by a visual pointer. The anti-rotation strap supplied with the actuator will prevent lateral movement.

The AM24-S US version is provided with two built-in auxiliary switches. These SPDT switches are provided for safety interfacing or signaling. The switching function is adjustable between 0 and 95°.

Technical Data

<table>
<thead>
<tr>
<th>AM24 US, AM24-S US</th>
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</thead>
<tbody>
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<td>Power supply</td>
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<tr>
<td>Power consumption</td>
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<tr>
<td>Transformer sizing</td>
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<tr>
<td>Electrical connection</td>
</tr>
<tr>
<td>Overload protection</td>
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<tr>
<td>Angle of rotation</td>
</tr>
<tr>
<td>Torque</td>
</tr>
<tr>
<td>Direction of rotation</td>
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<tr>
<td>Position indication</td>
</tr>
<tr>
<td>Running time</td>
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<td>Manual override</td>
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<td>Humidity</td>
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<td>Ambient temperature</td>
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<td>Storage temperature</td>
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<tr>
<td>Housing type</td>
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<tr>
<td>Housing material rating</td>
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<tr>
<td>Noise level</td>
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<tr>
<td>Servicing</td>
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<tr>
<td>Agency listings</td>
</tr>
<tr>
<td>Quality standard</td>
</tr>
<tr>
<td>Weight</td>
</tr>
</tbody>
</table>

AM24-S US

| Auxiliary switches | adj. 0° to 95°, 2 x SPDT 3A (0.5A) @24 VAC |

Dimensions (All numbers in brackets are metric.)

K4-2 US (supplied)
- 1/2” Centered (Default)
- 1.05” Centered (Field Selectable)

K4-1 US (optional)
- 3/4” to 1.05” Adjustable

K4 US (optional)
- 3/8” to 3/4” Adjustable
The indication of direction is valid for switch position CW.

**AM24 (-S) US - Typical Specification:**

Control damper actuators shall be electronic 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. Actuators shall be UL and CSA listed, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall have reversing switch and manual override on the cover, and be protected from overload at all angles of rotation. If required, two adjustable SPDT auxiliary switches shall be provided (AM24-S US). Actuators shall be as manufactured by Belimo.

**Notes**

1. Provide overload protection and disconnect as required.
2. Actuators may also be powered by 24 VDC.
3. For end position indication, interlock control, fan startup, etc., AM24-S US incorporates two built-in auxiliary switches: 2 x SPDT, 3A (0.5A) @24 VAC, UL listed, adjustable between 0° and 95°.
4. Meets UL and CSA requirements without the need of an electrical ground connection.
AM24-SR US
Proportional damper actuator, non-spring return, direct coupled, 24 V, for 2 to 10 VDC and 4 to 20 mA control signal

Torque min. 160 in-lb, for control of air dampers.

Application
For proportional modulation of dampers in HVAC systems. Actual actuator sizing should be done in accordance with the damper manufacturer’s specifications.

The actuator is mounted directly to a damper shaft up to 3/4” in diameter by means of its universal clamp, or up to a 1.05” jackshaft with the optional K4-1 clamp. A crankarm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

Operation
The actuator operates 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. A 2 to 10 VDC feedback signal is provided for position indication or master-slave applications.

The actuator has a constant running time of 150 seconds. A functional test of the actuator-damper assembly may be done by pressing in the manual override button, this will activate the actuators test mode and cycle the actuator fully closed and back to control point. The microprocessor will correct for compression of tight close-off gaskets with age, providing the actuator is not on its mechanical stops.

A 2 to 10 VDC feedback (U) is provided with full 8 volt output range proportional to the operational rotation of the damper. A digital rotation sensing circuit protects the actuator in a stall anywhere in its 95° operating range without the need of limit switches. Add on auxiliary switches are easily fastened directly onto the actuator body for signalling and switching functions.

Technical Data AM24-SR US

Power supply 24 VAC, ± 20%, 50/60 Hz
24 VDC, ±10%

Power consumption 2.5 W running, 1.2 W holding

Transformer sizing 5 VA (Class 2 power source)

Operating range Y 2 to 10 VDC, 4 to 20 mA

Input impedance 100kΩ (0.1 mA), 500Ω for 4 to 20mA

Feedback output ‘U’ 2 to 10 VDC, 0.5 mA max

Electrical connection 3 ft, 18 GA, appliance cable, 1/2” conduit connector

Overload protection electronic throughout 0 to 95° rotation

Torque min 160 in-lb (18 Nm)

Direction of rotation reversible with switch "CCW-CW"
CW with a decrease in voltage
CCW with a decrease in voltage

Position indication clip on indicator

Manual override external push button

Angle of rotation 0-95° adjustable stops

Running time 150 secs. constant, independent of load

Run time stability ± 5%

Humidity 5 to 95% RH, non-condensing

Operating temperature -22 to +122° F (-30 to +50° C)

Storage temperature -40 to +176° F (-40 to +80° C)

Housing NEMA 2 (IP54 with cable entry down)

Housing material UL 94-5V (flammability rating)

Noise level less than 45 dB (A)

Agency listings UL 873 listed, CSA C22.2 No.24 certified, CE

Quality standard ISO 9001

Servicing maintenance free

Weight 2.8 lbs. (1.3kg.)

Dimensions (All numbers in brackets are metric.)

K4-2 US (supplied)
Ø 0.2” Centered
(1/8”)
(3.175 [76])

Ø 0.18” Centered
(1/8”)
(4.572 [116])

Ø 0.79” Centered
(20 mm)
(20.10 [51])

K4-1 US (optional)
2/3” to 1.05” adjustable
(1/8” to 26 mm)
(0.98 [25])

K4 US (optional)
3/8” to 3/4” adjustable
(9.53 [24])

(All dimensions in inches [mm].)
AM24-SR US
Proportional damper actuator, non-spring return, direct coupled,
24 V, for 2 to 10 VDC and 4 to 20 mA control signal

ACCESSORIES

AV 1 Damper shaft extension for AM
AV10-18 Universal shaft extension
K4-1 US Clamp for 3/4" to 1.05" jackshafts
K4-H Hex shaft clamp, for 3/8"-5/8" shafts
KH-AM Crankarm
SA11 US, SA2 US Auxiliary switches
PA... US 140 Ω, 500 Ω, 1000 Ω, 2800 Ω feedback potentiometers
PTA-250 Pulse width modulation interface
Tool-01 10 mm wrench
SGA24 Min. and/or man. positioner in NEMA 4 housing
SGF24 Min. and/or man. positioner for flush panel mounting
ZAD24 Digital position indication
ZG-R01 500Ω resistor for 0 to 20 mA control signal
ZG-AM Crank arm adaptor kit
ZG-100 Mounting bracket
ZG-101 Mounting bracket
ZG-103 Mounting bracket
ZG-104 Mounting bracket
ZS-100 Weather shield
ZS-150 Weather shield
ZS-260 Explosion-proof housing
ZS-300 NEMA 4X housing

WIRING DIAGRAMS

24 VAC Transformer

<table>
<thead>
<tr>
<th>Line Volts</th>
<th>Control Signal (-)</th>
<th>2 to 10 VDC (+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blk (1)</td>
<td>Common-</td>
<td></td>
</tr>
<tr>
<td>Red (2)</td>
<td>Hot +</td>
<td></td>
</tr>
<tr>
<td>Wht (3)</td>
<td>Y Input, 2 to 10V</td>
<td></td>
</tr>
<tr>
<td>Wht (5)</td>
<td>U Output, 2 to 10V</td>
<td></td>
</tr>
</tbody>
</table>

24 VAC Transformer

<table>
<thead>
<tr>
<th>Line Volts</th>
<th>4 to 20 mA Control Signal (-)</th>
<th>500Ω (+)</th>
<th>2 to 10 VDC Feedback Signal (-)</th>
<th>(+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blk (1)</td>
<td>Common-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red (2)</td>
<td>Hot +</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wht (3)</td>
<td>Y Input, 2 to 10V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wht (5)</td>
<td>U Output, 2 to 10V</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Provide overload protection and disconnect as required.
Actuators may be connected in parallel. Power consumption and input impedance must be observed.
Actuator may also be powered by 24 VDC.
The ZG-R01 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC, up to 2 actuators may be connected in parallel.
Only connect common to neg. (—) leg of control circuits.
AM24-PC US

Proportional damper actuator, non-spring return, direct coupled, 24 V, for 0 to 20 V phasecut control signal

Torque min. 160 in-lb, for control of air dampers.

Application
For proportional modulation of dampers in HVAC systems. Actual actuator sizing should be done in accordance with the damper manufacturer’s specifications.

The actuator is mounted directly to a damper shaft up to 3/4” in diameter by means of its universal clamp, or up to a 1.05” jackshaft with the optional K4-1 clamp. A crankarm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

Operation
The actuator operates in response to 0 to 10 V phasecut control input from an electronic controller or positioner. A 2 to 10 VDC feedback signal is provided for position indication or master-slave applications.

The actuator has a constant running time of 150 seconds. A functional test of the actuator-damper assembly may be done by pressing in the manual override button, this will activate the actuators test mode and cycle the actuator fully closed and back to control point. The microprocessor will correct for compression of tight close-off gaskets with age, providing the actuator is not on its mechanical stops.

A 2 to 10 VDC feedback (U) is provided with full 8 volt output range proportional to the operational rotation of the damper. A digital rotation sensing circuit protects the actuator in a stall anywhere in its 95° operating range without the need of limit switches. Add on auxiliary switches are easily fastened directly onto the actuator body for signalling and switching functions.

Technical Data AM24-PC US

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply 24 VAC</td>
<td>± 20%, 50/60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>2.5 W running, 1.2 W holding</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>5 VA (Class 2 power source)</td>
</tr>
<tr>
<td>Operating range Y</td>
<td>0 to 10 V, phasecut</td>
</tr>
<tr>
<td>Input impedance</td>
<td>8kΩ (50 mW)</td>
</tr>
<tr>
<td>Feedback output &quot;U&quot;</td>
<td>2 to 10 VDC, 0.5 mA max</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA, appliance cable, 1/2&quot; conduit connector</td>
</tr>
<tr>
<td>Overload protection</td>
<td>electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td>Torque</td>
<td>min 160 in-lb (18 Nm)</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>reversible with switch “CCW-CW”</td>
</tr>
<tr>
<td></td>
<td>CW with a decrease in voltage</td>
</tr>
<tr>
<td></td>
<td>CCW with a decrease in voltage</td>
</tr>
<tr>
<td>Position indication</td>
<td>clip on indicator</td>
</tr>
<tr>
<td>Manual override</td>
<td>external push button</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>0-95° adjustable stops</td>
</tr>
<tr>
<td>Running time</td>
<td>150 secs. constant, independent of load</td>
</tr>
<tr>
<td>Run time stability</td>
<td>± 5%</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH, non-condensing</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-22 to +122° F (-30 to +50° C)</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40 to +176° F (-40 to +80° C)</td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA 2 (IP54 with cable entry down)</td>
</tr>
<tr>
<td>Housing material</td>
<td>UL 94-5V (flammability rating)</td>
</tr>
<tr>
<td>Noise level</td>
<td>less than 45 dB (A)</td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No.24 certified, CE</td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
</tr>
<tr>
<td>Weight</td>
<td>2.8 lbs. (1.3kg.)</td>
</tr>
</tbody>
</table>

Dimensions
(All numbers in brackets are metric.)

K4-2 US (supplied)
- 1/2” Centered (Default)
- 3/4” Centered (Field Selectable)
- 1.05” Centered (Field Selectable)

K4-1 US (optional)
- 3/4” to 1.05” Adjustable

K4 US (optional)
- 3/8” to 3/4” Adjustable
AM24-PC US
Proportional damper actuator, non-spring return, direct coupled,
24 V, for 0 to 20 V phasecut control signal

Accessories
AV 1 Damper shaft extension for AM
AV10-18 Universal shaft extension
K4-1 US Clamp for 3/4" to 1.05" jackshafts
K4-H Hex shaft clamp, for 3/8"-5/8" shafts
KH-AM Crankarm
SA1 US, SA2 US Auxiliary switches
PA... US 140 Ω, 500 Ω, 1000 Ω, 2800 Ω feedback
PTA-250 Pulse width modulation interface
Tool-01 10 mm wrench
SGA24 Min. and/or man. positioner in NEMA 4 housing
SGF24 Min. and/or man. positioner for flush panel mounting
ZAD24 Digital position indication
ZG-R01 500Ω resistor for 0 to 20 mA control signal
ZG-AM Crank arm adaptor kit
ZG-100 Mounting bracket
ZG-101 Mounting bracket
ZG-103 Mounting bracket
ZG-104 Mounting bracket
ZS-100 Weather shield
ZS-150 Weather shield
ZS-260 Explosion-proof housing
ZS-300 NEMA 4X housing

AM24-PC US - Typical Specification:
Control damper actuators shall be electronic direct coupled
type which require no crank arm and linkage and be capable
direct mounting to a jackshaft up to a 1.05" diameter.
Actuators shall be UL and CSA listed, have a 5 year warranty,
and be manufactured under ISO 9001 International Quality
Control Standards. The actuator must provide proportional
damper control in response to a 0 to 10 V phasecut control
input from an electronic controller or positioner. Actuators
shall have reversing switch and gear disengagement button
on the cover, and be electronically protected from overload at
all angles of rotation. Actuators shall respond to 2 to 10 VDC
output relative to position regardless of the amount of damper
rotation. Run time shall be constant and independent of
torque. A 2 to 10 VDC feedback signal shall be provided for
position indication or master-slave applications. Actuators
shall be as manufactured by Belimo.

Wiring diagrams

Provide overload protection and disconnect as required.
Actuators may be connected in parallel. Power consumption
and input impedance must be observed.
Actuators may also be powered by 24 VDC.
SM24-S US
On-off, non-spring return, direct coupled, fast running, 24 V with built-in auxiliary switches

Technical Data

<table>
<thead>
<tr>
<th>SM24-S</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power supply</strong></td>
</tr>
<tr>
<td><strong>Power consumption AC</strong></td>
</tr>
<tr>
<td><strong>Transformer sizing</strong></td>
</tr>
<tr>
<td><strong>Electrical connection</strong></td>
</tr>
<tr>
<td><strong>Angle of rotation</strong></td>
</tr>
<tr>
<td><strong>Torque at rated voltage</strong></td>
</tr>
<tr>
<td><strong>Direction of rotation</strong></td>
</tr>
<tr>
<td><strong>Position indication</strong></td>
</tr>
<tr>
<td><strong>Running time</strong></td>
</tr>
<tr>
<td><strong>Auxiliary switch Open/Closed</strong></td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
</tr>
<tr>
<td><strong>Housing type</strong></td>
</tr>
<tr>
<td><strong>Housing material rating</strong></td>
</tr>
<tr>
<td><strong>Ambient temperature</strong></td>
</tr>
<tr>
<td><strong>Storage temperature</strong></td>
</tr>
<tr>
<td><strong>Noise level</strong></td>
</tr>
<tr>
<td><strong>Servicing</strong></td>
</tr>
<tr>
<td><strong>Service life</strong></td>
</tr>
<tr>
<td><strong>Weight</strong></td>
</tr>
</tbody>
</table>

Application

For on-off, fast-acting, control of dampers up to approximately 35 ft² [3 m²] (based on 4 in-lb per sq. ft.). Actual actuator sizing should be done in accordance with the damper manufacturer’s specifications.

Operation

The actuator is, by means of a special clamp, directly mounted onto the damper shaft.

The universal mounting bracket supplied with the actuator will prevent lateral movement of the actuator. The damper actuator is not provided with and does not require any limiting switches, but is protected against overloading.

The angle of rotation is mechanically limited to 95°. When reaching the damper or actuator end position, the motor stops automatically.

The gears can be manually disengaged by simply pressing down the spring loaded button on the actuator cover. When the button is pressed down, the damper blades can be adjusted by hand. The position of the actuator is indicated by means of a scale reading 0 . . . 10.

For end position indication, interlock control, etc., two built-in, non-adjustable auxiliary switches are provided with the actuator.

Accessories

ZG-SM2 Crank arm adaptor kit
ZDB Angle of rotation limiter
ZG-100 Universal mounting bracket
ZG-101 Universal mounting bracket
ZG-102 Multiple actuator mounting bracket
ZG-H2 Actuator operator handle
ZS-100 Weather shield, metal
ZG-150 Weather shield, polycarbonate

Dimensions

(All numbers in brackets are metric.)

- **Temperature and regulation equipment**: UL
- **Certification numbers**: 94D5

Wiring diagram

For end position indication, interlock control, etc., SM24-S incorporates 2 built-in auxiliary switches 2 x SPST (2A) 24 V UL listed

Parallel connection of several actuators is possible:

- The indication of direction is valid for switch position A

For end position indication, interlock control, etc., two built-in, non-adjustable auxiliary switches are provided with the actuator.

Operation

The actuator is, by means of a special clamp, directly mounted onto the damper shaft.

The universal mounting bracket supplied with the actuator will prevent lateral movement of the actuator. The damper actuator is not provided with and does not require any limiting switches, but is protected against overloading.

The angle of rotation is mechanically limited to 95°. When reaching the damper or actuator end position, the motor stops automatically.

The gears can be manually disengaged by simply pressing down the spring loaded button on the actuator cover. When the button is pressed down, the damper blades can be adjusted by hand. The position of the actuator is indicated by means of a scale reading 0 . . . 10.

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ZDB Angle of rotation limiter
ZG-100 Universal mounting bracket
ZG-101 Universal mounting bracket
ZG-102 Multiple actuator mounting bracket
ZG-H2 Actuator operator handle
ZS-100 Weather shield, metal
ZG-150 Weather shield, polycarbonate

Dimensions

(All numbers in brackets are metric.)

- **Temperature and regulation equipment**: UL
- **Certification numbers**: 94D5

Wiring diagram

For end position indication, interlock control, etc., SM24-S incorporates 2 built-in auxiliary switches 2 x SPST (2A) 24 V UL listed

Parallel connection of several actuators is possible:

- The indication of direction is valid for switch position A

For end position indication, interlock control, etc., two built-in, non-adjustable auxiliary switches are provided with the actuator.
Mounting Instructions
1. Remove pointer assembly from the actuator. Press down the manual override button and rotate the actuator fully counter-clockwise.
2. Invert SA... US switch and turn the driver disk fully clockwise as indicated.
4. Adjust switch dials as necessary
5. Remount the white plastic pointer only onto SA... US switch.

Operation
The SA1 US and SA2 US auxiliary switches are used to indicate when a desired position of a damper is reached or to interface additional controls for a specific control sequence. They are modular units that mount directly onto the AM type actuators and held in place with a prefitting screw. A driver disk is attached to the actuator clamp and offers direct transmission of the actuator position to the microswitch operating cams. The switching points can be set over the full scale of 0 to 1 simply by adjusting the slotted discs.

Wiring Diagrams

Technical Data

<table>
<thead>
<tr>
<th></th>
<th>SA1 US</th>
<th>SA2 US</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of switches</td>
<td>1xSPDT</td>
<td>2xSPDT</td>
</tr>
<tr>
<td>Switching capacity</td>
<td>6 A (2.5A) 250 VAC</td>
<td></td>
</tr>
<tr>
<td>Switching point</td>
<td>adjustable over full actuator rotation 0 to 1. Pre-setting with scale possible.</td>
<td></td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA appliance cable</td>
<td>1/2&quot; conduit connector</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22° F to +122° F [-30° C to +50° C]</td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40° F to +176° F [-40° C to +80° C]</td>
<td></td>
</tr>
<tr>
<td>Housing type</td>
<td>NEMA type 2</td>
<td></td>
</tr>
<tr>
<td>Housing material rating</td>
<td>UL 94-5VA (flammability rating)</td>
<td></td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No.24 certified, CE</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>8 oz [225 g]</td>
<td>9.3 oz [265 g]</td>
</tr>
<tr>
<td>Electrical protection</td>
<td>auxiliary switches are double insulated</td>
<td></td>
</tr>
</tbody>
</table>

Voltage Resistive Inductive

<table>
<thead>
<tr>
<th></th>
<th>120</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistive</td>
<td>6.0 A</td>
<td>6.0 A</td>
</tr>
<tr>
<td>Inductive</td>
<td>5.0 A</td>
<td>2.5 A</td>
</tr>
</tbody>
</table>
Feedback Potentiometer PA...US

For the direct coupled actuator AM2...

**Application**
The PA... US feedback potentiometers are used with AM actuators to provide a resistive signal which varies with damper position. The PA... US units are applied with commercial proportional temperature controllers to provide feedback of the damper position, or with electric or electronic meters to provide position indication. The signal can also be used as a positioner for parallel operation of multiple actuators.

**Operation**
The PA... US feedback potentiometer is mounted onto the damper actuator. A driver disk is attached to the actuator clamp and offers direct transmission of the actuator to the potentiometer.

**Mounting Instructions**

1. Remove pointer assembly from the actuator. Press down the manual override button and rotate the actuator fully counter-clockwise.

2. Invert PA... US and turn the driver disk fully clockwise as indicated.


4. Remount the white plastic pointer only, from the pointer assembly, onto PA... US.

<table>
<thead>
<tr>
<th>Types</th>
<th>PA500 US</th>
<th>Feedback potentiometer</th>
<th>500Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PA1000 US</td>
<td>Feedback potentiometer</td>
<td>1000Ω</td>
</tr>
<tr>
<td></td>
<td>PA2800 US</td>
<td>Feedback potentiometer</td>
<td>2800Ω</td>
</tr>
</tbody>
</table>

**Technical Data PA... US**

- Resistance values: as above
- Output: 1W
- Tolerance: ± 5%
- Linearity: ± 2%
- Resolution: min. 1%
- Residual resistance: max. 5% on both sides
- Electrical connection: 3 ft, 18 GA appliance cable, 1/2” conduit connector
- Humidity: 5 to 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 type 2
- Housing rating: UL94-5V (flammability rating)
- Servicing: maintenance free
- Agency listings: UL 873 listed, CSA C22.2 No.24 certified, CE
- Quality standard: ISO 9001
- Weight: 8.8 oz [250 g]
- Electrical protection: Class 2 circuits
1. Turn damper blade to its fully closed position. With manual override button depressed, rotate actuator clamp to about 1/16" - 1/8" between actuator stop and clamp, depending on damper seal design. Slide actuator over shaft and finger-tighten nuts.

2. Using a screwdriver, select clockwise or counterclockwise rotation. (Example shown is for clockwise closing damper). Slide anti-rotation bracket up under actuator engaging center cut-out on actuator back. Secure bracket with self-tapping screws.

3. Tighten the two nuts on the universal clamp with 10 mm wrench, 6-8 ft-lb torque. (On dampers with edge seals, actuator will compress damper blades when reaching end position for air-tight damper.)

4. Adjust end stops, if required.
Installation Instructions

Actuator sizing/preliminary steps

Preliminary steps
1. Belimo actuators should be mounted indoors in 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. (See Belimo Mechanical Accessories Doc. 5.2)
2. 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.
3. The AM Series actuator requires a minimum shaft length of 1.88". Use the AV1 for short shaft installations on 1/2" diameter shafts.

Replacement or mounting of optional mounting clamp
1. Squeeze tabs of retaining ring and lift off of actuator.
2. Remove clamp.
3. Replacement clamp has an alignment mark. Match this mark with the similar mark on the actuator and mount clamp.
4. Squeeze tabs of retaining ring and fit it into the retaining slot.

Note: If retaining ring is not fully seated, the clamp may come loose from the actuator.

AM actuators which may be used on one shaft:

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Quantity Per Shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM24 (-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AM24-SR US</td>
<td>4</td>
</tr>
</tbody>
</table>
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.

Transformer(s)
The AM Series actuators require a 24 VAC class 2 transformer and draw a maximum of 5 VA. 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 hot leg. 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 AM Series actuators
Keep power wire runs below the limits listed in the Fig. 1. 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.

Maximum wire length:

<table>
<thead>
<tr>
<th>Wire Size</th>
<th>Max. Feet</th>
<th>Wire Size</th>
<th>Max. Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Ga</td>
<td>1800 Ft.</td>
<td>18 Ga</td>
<td>450 Ft.</td>
</tr>
<tr>
<td>14 Ga</td>
<td>1100 Ft.</td>
<td>20 Ga</td>
<td>275 Ft.</td>
</tr>
<tr>
<td>16 Ga</td>
<td>700 Ft.</td>
<td>22 Ga</td>
<td>125 Ft.</td>
</tr>
</tbody>
</table>

Example for AM... US: 3 actuators, 18 Ga wire
450 Ft ÷ 3 Actuators = 150 Ft. Maximum wire run.

Wire Type and Wire Installation Tips
For most installations, 18 or 16 Ga. cable works well with the AM24 type 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.

Overload protection
All Belimo actuators are electronically protected against overload. In the AM series an electronic circuit maintains the current at a level which will not damage the motor while providing adequate holding torque.

Operational Information for AM Series Proportional Actuators (AM24-SR US)

Initialization
The proportional models of the AM series (AM24-SR US) must go through an initialization procedure to learn the zero signal position. When the power is first applied to the actuator, the gear release button is depressed, the actuator will move to its zero signal position. After the actuator learns this, it will drive to its control position.

Note: If power is lost to the actuator, and the actuator is moved by use of its manual override, the actuator must be re-initialized when power is returned, by pushing the override button.

Motor position detection
Belimo brushless DC motors eliminate the need for potentiometers for positioning. 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.
Installation Instructions

Feature operation

Manual Override

A button on the actuator cover disengages the gear train so the damper shaft can be moved manually. Release the button and the gear train is re-engaged.

Use the manual override to test the installation without power. For tight shut-off the damper should close with 5° of actuator stroke left.

Direction of Rotation Switch

AM actuators have a reversing switch on the cover labeled “CW-CCW”. Switch position indicates start point. For the AM24-SR US, with the switch in position “CW”, the actuator rotates clockwise with an increase in voltage or current. With the switch in position “CCW”, the actuator rotates counterclockwise with a decrease in voltage or current.

The AM24 (-S) US rotates clockwise when the switch is in the “CW” position and power is applied to wire #2. When power is applied to wire #3 the actuator rotates counterclockwise.

Rotating the “CW/CCW” switch to “CCW” reverses the control logic.

During checkout, the switch position can be temporarily reversed and the actuator will reverse its direction. This allows the technician a fast and easy way to check the actuator operation without having to switch wires or change settings on the thermostat. When the check-out is complete, make sure the switch is placed back to its original position.

Mechanical Angle of Rotation Limiting

The adjustable stops are needed when there is no damper stop or if you want the damper to stop rotating before it reaches its stops. The AM actuator can be indefinitely stalled in any position without harm.

1. Loosen the two end stops with a No. 2 Phillips head screwdriver being careful not to unscrew the captive nut under the slot.
2. Move the stops (in 2.5° steps) to the desired position and re-tighten the screws.

Control Accuracy and Stability

AM Series proportional actuators have built-in brushless DC motors which provide better accuracy and longer service life.

The AM Series 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.

AM Actuator responds to a 80 mV signal when not changing direction from stop position.

AM Actuator responds to a 200 mV signal when reversing direction from stop position.
Adjustable Auxiliary Switches

The AM24-S US actuator is equipped with two adjustable auxiliary switches used to indicate damper position or to interface additional controls or equipment. Switching positions can be set over the full scale of 0 to 95° simply by setting switch on the actuator cover.

Method A
1. Push the manual override button and rotate the clamp to the “0” position.
2. Set the desired switch position: example: 20% of rotation is “.2” on the setting scale.
3. Check the switch operation. As the indicator passes the “0” switch position, the contact between S1 and S2, or S4 and S5, is broken and the contact between S1 and S3, or S5 and S6 is made.

Switch Rating

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Resistive load</th>
<th>Inductive load</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 VAC</td>
<td>3 A</td>
<td>0.5 A</td>
</tr>
</tbody>
</table>

Method B
1. Use manual override to position universal clamp to desired switch position.
2. Turn switch pointer to “0”.

(switch function may also be monitored by a meter for precise setting)

Accessories

Mounting brackets

- ZG-100 Mounting bracket
- ZG-101 Mounting bracket
- ZG-103 Mounting bracket
- ZG-104 Mounting bracket

AV1 Short shaft adaptor

Used on 3/8” to 3/4” diameter shafts that are shorter than 1.875” and mounting space is minimal.

AV 10-18 Shaft extension

For damper shafts 3/8 to 11/16 in [10 to 18] dia or 3/8 to 9/16 in [10 to 14] square.

ZG-AM - Crank arm adaptor kit

For use when the actuator cannot be mounted directly to the damper shaft.

SA...us Auxiliary switches, PA...us Feedback potentiometers

SGA24/SGF24

Minimum and/or manual positioner (electronic), SGA24 is enclosed in a NEMA 4 housing. The SGF24 is for flush panel mounting.
## AM24SR US Electrical check-out procedure

<table>
<thead>
<tr>
<th>Step</th>
<th>Procedure</th>
<th>Expected Response</th>
<th>Gives Expected Response Go To Step…</th>
<th>Does Not Give Expected Response Go To Step…</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control signal is applied to actuator.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly Step 9</td>
<td>No response at all Step 2 Operation is reversed Step 3 Does not drive toward “Control Signal Position” Step 4</td>
</tr>
<tr>
<td>2.</td>
<td>Check power wiring. Correct any problems. <strong>See Note 1.</strong></td>
<td>Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.</td>
<td>Power wiring corrected, actuator begins to drive Step 1</td>
<td>Power wiring corrected, actuator still does not drive Step 4</td>
</tr>
<tr>
<td>3.</td>
<td>Turn reversing switch to the correct position.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly Step 9</td>
<td>Does not drive toward “Control Signal Position” Step 4</td>
</tr>
<tr>
<td>4.</td>
<td>Push manual override button. (If clamp is at min signal position, move damper to fully closed position)</td>
<td>Actuator will drive to 0 position and back to control position</td>
<td>Actuator operates properly Step 9</td>
<td>Step 5</td>
</tr>
<tr>
<td>5.</td>
<td>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.</td>
<td>Drives to “Control Signal” position</td>
<td>Actuator operates properly Step 9</td>
<td>Step 6</td>
</tr>
<tr>
<td>6.</td>
<td>Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For AM24SR US this is 0 to 10 VDC or 0 to 20 mA. Note: The input signal must be above the 2 VDC or 4 mA to have the actuator move.</td>
<td>Input voltage or current should be ±1% of what controller’s adjustment or programming indicate.</td>
<td>Controller output (actuator input) is correct. Input Polarity Correct Step 7</td>
<td>Reprogram, adjust repair or replace controller as needed Step 1</td>
</tr>
<tr>
<td>7.</td>
<td>Use the manual override button to move the damper by hand from fully closed to fully open.</td>
<td>Damper will go from fully closed to fully open.</td>
<td>Damper moves properly Step 8</td>
<td>Find cause of damper jam and repair Step 1</td>
</tr>
<tr>
<td>8.</td>
<td>Check damper torque requirement.</td>
<td>Torque requirement is ≤ actuator’s minimum torque.</td>
<td>Defective Actuator. Replace Actuator - <strong>See Note 2</strong></td>
<td>Recalculate actuator requirement and correct installation.</td>
</tr>
<tr>
<td>9.</td>
<td>Actuator works properly. Test controller by following controller manufacturer’s instructions.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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 installation date, notify Belimo and give details of the application.
NM Series Direct Coupled Actuator

Minimum 70 in-lb torque
- For damper areas up to 18 sq-ft*

Application Methods
Medium Volume Control Dampers.

KH-8 Crankarm - final position must be vertical when damper is fully open.

Mount actuator at a 45° angle to allow for full 90° crankarm rotation.

Damper is mounted through a wall with control shaft exposed, but space too tight to direct couple.

Actuator mounted on field-fabricated plate to control a cone-type VAV damper.

NM Series - at a glance

<table>
<thead>
<tr>
<th>Feature</th>
<th>NM24 US (p. 100)</th>
<th>NM24-SR US (p. 102)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque</td>
<td>70 in-lb</td>
<td></td>
</tr>
<tr>
<td>Power supply</td>
<td>24 VAC</td>
<td></td>
</tr>
<tr>
<td>Control signal</td>
<td>on-off/floating point</td>
<td></td>
</tr>
<tr>
<td>Control signal</td>
<td>modulating - 2 to 10 VDC</td>
<td></td>
</tr>
<tr>
<td>Control signal</td>
<td>pulse width modulating</td>
<td></td>
</tr>
<tr>
<td>Control signal</td>
<td>start/span adjustable</td>
<td></td>
</tr>
<tr>
<td>Running time</td>
<td>75 to 150 sec for 0 to 70 in-lb</td>
<td></td>
</tr>
<tr>
<td>Running time</td>
<td>150 sec independent of load.</td>
<td></td>
</tr>
<tr>
<td>External direction of rotation switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angle of rotation limiting (mechanical)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External manual override</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary switches</td>
<td>(p. 104)</td>
<td>Installation instructions (p. 105–110)</td>
</tr>
<tr>
<td>General wiring</td>
<td>(p. 107)</td>
<td>Start-up and checkout (p. 111)</td>
</tr>
</tbody>
</table>

* 4 in-lb/ft² damper torque loading. Parallel blade. No edge seals.
**A CLOSER LOOK...**

- Cut labor costs with simple direct coupling.
- Check damper position from a distance with clear position indicator.
- Don’t worry about actuator burn-out. Belimo is overload-proof throughout rotation.
- Enjoy added flexibility with easy mechanical stop to adjust angle of rotation.
- Need to change control direction? Do it easily with a simple switch.
- Simple manual override button helps you get up and running faster.
- Auxiliary switch accessory (SN1, SN2) is easy to use, offers feedback or signal for additional device.
- 3 ft. plenum rated cable eases installation. Conduit connector provided: one less detail to worry about.
- Microprocessor-controlled brushless DC motor increases actuator life span and reliability, provides constant running time independent of load. (Proportional actuators)

**The Belimo Difference**

- **Customer Commitment.**

- **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. 20+ years direct coupled actuator design.
NM24 US
On-off, reversible, non-spring return, direct coupled, floating point, 24 V

Torque min. 70 in-lb, for control of air dampers surfaces up to 18 sq. ft.

Application
For modulating or on-off control of dampers in HVAC systems. Actual actuator sizing should be done in accordance with the damper manufacturer’s specifications. Control is on-off from an auxiliary contact of a fan motor contactor, or a manual switch. The direction of rotation is reversible, for use with a floating point type control. The actuator mounts directly to the damper operating shaft with a universal V-bolt clamp assembly.

Operation
The universal mounting bracket supplied with the actuator will prevent lateral movement of the actuator. The damper actuator is not provided with and does not require any limit switches, but is protected against overloading. The angle of rotation is mechanically limited to 95°. When reaching the damper or actuator end position, the motor stops automatically. The gears can be manually disengaged by simply pressing down the spring loaded button on the actuator cover. When this button is pressed down, the damper blades can be adjusted by hand. The position of the actuator is indicated by a visual pointer. Auxiliary switches are easily fastened directly onto the actuator body for signalling and switching functions.

Accessories
AV 10-18 Damper shaft Extension
SN1,SN2 Auxiliary switches
ZG-H2 Actuator operator handle
ZG-NM3 Crank arm adaptor kit for ZG-105
ZG-NM4 Crank arm adaptor kit
ZG-NMSA-1 Shaft adaptor for short shafts
ZG-105 Mounting Bracket

Technical Data NM24 US

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 VAC ± 20% 50/60 Hz</td>
</tr>
<tr>
<td>Power consumption</td>
<td>2 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>3.5 VA (Class 2 power source)</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 FT, 18 GA plenum rated (UL CL2P)</td>
</tr>
<tr>
<td>Overload protection</td>
<td>electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>0 to 95°, adjustable stops</td>
</tr>
<tr>
<td>Torque</td>
<td>min 70 in-lb [8 Nm]</td>
</tr>
<tr>
<td>Damper area (Note 1)</td>
<td>18 Sq Ft</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>reversible with switch L/R</td>
</tr>
<tr>
<td>Position indication</td>
<td>clip-on indicator</td>
</tr>
<tr>
<td>Manual override button</td>
<td>on actuator</td>
</tr>
<tr>
<td>Running time</td>
<td>75 to 150 sec for 0 to 75 in-lb [0 to 8Nm] (0 to 90°)</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH, non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-4°F to +122°F [-20°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA type 2</td>
</tr>
<tr>
<td>Housing material</td>
<td>UL 94-5V (flammability rating)</td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA C22.2 No.24 certified, CE</td>
</tr>
<tr>
<td>Noise level</td>
<td>less than 35 db (A)</td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
</tr>
<tr>
<td>Quality Standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Weight</td>
<td>1.8 lbs [0.8 kg]</td>
</tr>
</tbody>
</table>

Note 1: Damper area is calculated using approximately 4 in-lb/sq ft of damper area. This is an average torque requirement for good quality dampers operating under a 1" WC pressure drop. Check damper specifications for exact torque requirements.
On-off, reversible, non-spring return, direct coupled, floating point, 24 V

Wiring Diagrams

On-Off control of NM24 US

Tri-State control of NM24 US

Notes:

1. Provide overload protection and disconnect as required.
2. Actuators are provided with color coded wires. Wire numbers are provided for reference.
3. May also be powered by 24 VDC.

Bulk packaging - NM24.1 US

The bulk packaging option for the NM... series has been discontinued as of October 2003

T-Type bracket
These are included in the single-actuator packages.

Part # 11333 (UOM:1)

L-Type bracket 21731

Part #: 12503-00001 (UOM:24)
(includes 21731) shipped separately upon request.

NM24 US - Typical Specification:
Control damper actuators shall be electronic direct coupled type which require no crank arm and linkage. Actuators shall be UL and CSA listed, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall have reversing switch and manual override on the cover, and be protected from overload at all angles of rotation. Actuators shall be as manufactured by Belimo.
NM24-SR US
Proportional damper actuator, non-spring return, direct coupled, 24 V, for 2 to 10 VDC and 4 to 20 mA control signal

Technical Data  NM24-SR US
Power supply  24 VAC, ± 20%, 50/60 Hz  24 VDC, ±10%
Power consumption  1.3 W
Transformer sizing  3.5 VA (Class 2 power source)
Operating range Y  2 to 10 VDC, 4 to 20 mA
Input impedance  100kΩ (0.1 mA), 500Ω
Feedback output 'U'  2 to 10 VDC, 0.7 mA max
Electrical connection  3 ft, 18 GA plenum rated (UL CL2P) cable, 1/2" conduit connector
Overload protection  electronic throughout 0 to 95° rotation
Torque (Note 1)  min 70 in-lb (8 Nm)
Damper area (Note 2)  18 sq ft
Direction of rotation  reversible with Switch “L-R”
L = CW with an increase in voltage
R = CCW with an increase in voltage
Position indication  clip on indicator
Manual override  button on actuator
Angle of rotation  0-95° adjustable stops
Running time (35-95°)  150 seconds independent of max. angle of rotation or torque
Running time (0-35°)  0-150 seconds proportional to max. angle of rotation (Note 3)
Run time stability  ± 5%
Humidity  5 to 95% RH, non-condensing
Ambient temperature  -4 to +122° F (-20 to +50° C)
Storage temperature  -40 to +176° F (-40 to +80° C)
Mounting position  not sensitive to position
Housing  NEMA 2
Housing material  UL 94-5V (flammability rating)
Noise level  less than 35 dB (A)
Agency listings  UL 873 listed, CSA C22.2 No.24 certified, CE
Quality standard  ISO 9001
Servicing  maintenance free
Weight  1.8 lbs. (0.8kg.)

Note 1  Minimum torque is produced at minimum voltage, minimum temperature.
Note 2  Damper area is calculated using approximately 4 in-lb/sq ft of damper area. This is an average torque requirement for good quality dampers operating under a 1" WC pressure drop. Check damper specifications for exact torque requirements.
Note 3  The on board microprocessor measures the actuators full stroke on startup. It then adjusts the actuator speed to ensure 150 second run time for 35°-95°. Below 35° stroke, the speed is constant and run time varies with rotation angle.

Application
For proportional modulation of dampers in HVAC systems. Actual actuator sizing should be done in accordance with the damper manufacturer’s specifications. The actuator mounts directly to the damper operating shaft with a universal V-bolt clamp assembly.

Operation
The actuator operates in response to a 2 to 10 VDC, 2 to 10 V phasecut or, with the addition of a 500Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner. A 2 to 10 VDC feedback signal is provided for position indication or master-slave applications. A built-in microprocessor automatically tests for the amount of rotation required to modulate the damper fully closed to fully open. The actuator will self-adjust to run at a consistent running time of 150 seconds, and rescale the input signal so the entire 8 volt control range is used to provide maximum resolution of the control system. The microprocessor will also correct for compression of tight close-off gaskets with age, providing the actuator is not on its mechanical stops. A functional test of the actuator-damper assembly may be done by pressing in the manual override button, this will activate the actuators test mode and cycle the actuator fully open and closed. A 2 to 10 VDC feedback (U) is provided with full 8 volt output range proportional to the operational rotation of the damper.

A digital rotation sensing circuit protects the actuator in a stall anywhere in its 95° working range without the need of limit switches. Auxiliary switches are easily fastened directly onto the actuator body for signalling and switching functions.

Accessories
AV10-18 Damper shaft extension
SN1,SN2 Auxiliary switches
ZG-H2 Actuator operator handle
ZG-NM3 Crank arm adaptor kit for ZG-105
ZG-NM4 Crank arm adaptor kit
ZG-NMSA-1 Shaft adaptor for short shafts
ZG-105 Mounting bracket

Dimensions (All numbers in brackets are metric.)

<table>
<thead>
<tr>
<th>3/8&quot; to 3/4&quot;</th>
<th>3/8&quot; to 5/8&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 3/32&quot; [58]</td>
<td>2 3/32&quot; [58]</td>
</tr>
<tr>
<td>5 1/2&quot; [140]</td>
<td>5 1/2&quot; [140]</td>
</tr>
<tr>
<td>6 13/32&quot; [163]</td>
<td>6 13/32&quot; [163]</td>
</tr>
<tr>
<td>3 3/16&quot; [5.2]</td>
<td>3 3/16&quot; [5.2]</td>
</tr>
<tr>
<td>7/8&quot; [22]</td>
<td>7/8&quot; [22]</td>
</tr>
</tbody>
</table>

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Wiring diagrams

Typical Specification:
Control damper actuators shall be electronic direct coupled type which require no crank arm and linkage. Actuators shall be UL and CSA listed, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall have reversing switch and gear disengagement button on the cover, and be electronically protected from overload at all angles of rotation. Actuators shall respond to 2 to 10VDC output relative to position regardless of the amount of damper rotation. Actuators shall have brushless DC motor. Run time shall be constant and independent of torque and angular rotation between 35° and 95°. A 2 to 10 VDC feedback signal shall be provided for position indication or master-slave applications. Actuators shall be as manufactured by Belimo.

Bulk packaging - NM24-SR.1 US
The bulk packaging option for the NM... series has been discontinued as of October 2003

T-Type bracket
These are included in the single-actuator packages.

Part #: 11533 (UOM:1)

L-Type bracket 21731

Part #: 12503-00001 (UOM:24)
(includes 21731) shipped separately upon request.
SN1, SN2 Auxiliary Switches

For the direct coupled actuator NM 2...

**Mounting Instructions**

1. Remove pointer assembly from the actuator. Press down the manual override button and rotate the actuator fully counter-clockwise.

2. Invert SN . switch and turn the driver disk fully clockwise as indicated.


4. Adjust switch dials as necessary

5. Remount the white plastic pointer only onto SN . switch.

**Operation**

The SN1 and SN2 auxiliary switches are used to indicate when a desired position of a damper is reached or to interface additional controls for a specific control sequence. They are modular units that mount directly onto the NM type actuators and held in place with a prefitted screw. A driver disk is attached to the actuator clamp and offers direct transmission of the actuator position to the microswitch operating cams. The switching points can be set over the full scale of 0 to 10 simply by adjusting the slotted discs.

**NOTE:** will not mount to NM actuators manufactured prior to May 1994

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Resistive</th>
<th>Inductive</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>6.0 A</td>
<td>5.0 A</td>
</tr>
<tr>
<td>250</td>
<td>6.0 A</td>
<td>2.5 A</td>
</tr>
</tbody>
</table>

**Wiring Diagrams**

**Technical Data**

<table>
<thead>
<tr>
<th>SN1</th>
<th>SN2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of switches</td>
<td>1xSPDT</td>
</tr>
<tr>
<td>Switching capacity</td>
<td>6 A (2.5A) 250 VAC</td>
</tr>
<tr>
<td>Switching point</td>
<td>adjustable over full actuator rotation 0 to 10. Pre-setting with scale possible.</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft. 18 GA cable [1 m long 0.75mm²]</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>0° F to +122° F [-30° C to +50° C]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40° F to +176° F [-40° C to +80° C]</td>
</tr>
<tr>
<td>Housing type</td>
<td>NEMA type 2</td>
</tr>
<tr>
<td>Housing material rating</td>
<td>UL 94-V0 (flammability rating)</td>
</tr>
<tr>
<td>Weight</td>
<td>4 oz [125 g] 5.6 oz [175 g]</td>
</tr>
</tbody>
</table>
Quick-Mount Visual Instructions for Mechanical Installation

1. Turn damper blades to their fully closed position. Slide actuator onto damper shaft. Tighten the nuts on the universal clamp only finger-tight at this time.

2. Slide anti-rotation mounting strap up under actuator so that it engages actuator at the center cut-out. Secure to ductwork with self-tapping screws.

3. Loosen nuts on clamp. Press manual override button. Rotate the clamp to about 5° from the closed position (1/16 to 1/8" between stop and clamp). Tighten the two nuts on the universal clamp with a 10 mm wrench using 4 to 6 ft-lb of torque.

4. Adjust end stops, if required.

5. Mount actuator indoors. If mounted outdoors, use approved protective enclosure.
Installation Instructions

Mechanical Installation

General Information

Preliminary steps
1. 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.

2. 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 2” from the duct. If the shaft extends less than 2” or if an obstruction blocks access, the shaft can be extended with the AV 10-18 shaft extension or the ZG NMSA-1 for applications with minimal mounting area.

For replacement of existing gear train actuators, there are two options:
   A. From a performance standpoint, it is best to mount the actuator on the damper shaft.
   B. If the damper shaft is not accessible, mount the NM24-. . actuator with a ZG-NM4 linkage kit, to convert to a crankarm style application or the ZG-105 mounting bracket with the ZG-NM3.

Standard Mounting

1. Remove the plastic position indicator from the actuator. Slip the actuator’s universal clamp over the damper shaft. Make sure that the bottom of the actuator (metal side) is toward the duct and the controls on the cover are accessible.

Place the actuator in the desired mounting position.
2. Turn the damper shaft until the blades are fully closed.
3. Hand tighten the two nuts on the NM24-. . universal clamp.
4. Slide the stud of the anti-rotation bracket into the slot in the bottom of the actuator. Bend the strap as needed to support the rear of the actuator.
5. Fasten the strap to the duct with two screws. We recommend No. 8 self tapping sheet metal screws.
6. Loosen the two nuts on the universal clamp. Disengage the actuator gear train by pressing the “manual override button” (half round black button near the cable entry). Keeping the gears disengaged, and the damper fully closed, rotate the clamp until it is about 5° from the closed position or approximately 1/16 to 1/8 of an inch between the mechanical stop and the universal clamp.
7. Tighten the two nuts on the clamp with an 10 mm wrench (Belimo Tool-01). Use 4…6 ft-lb of torque.

The damper is now fully closed but the actuator is 5° from fully closed. This is called “pre-loading” the actuator. When the actuator is powered and sent to the closed position it will put its full torque on the shaft compressing the edge and blade seals. This ensures that the damper will meet its leakage rating. The actuator is electronically protected from overload and will not be damaged.

Adjustable stops
The adjustable stops are needed when there is no damper stop or if you want the damper to halt rotating before it reaches its stops. The NM24-. . actuator can be indefinitely stalled in any position without harm.
1. Loosen the two end stops with a No. 2 Phillips head screwdriver being careful not to unscrew the captive nut under the slot.
2. Move the stops to the desired position and re-tighten the screws.

Manual override
The Belimo NM24-. . actuators have a black, half round “manual override button” located next to the cable entry. Press this button and the gear train is disengaged so the damper shaft can be moved manually. Release the button and the gear train is re-engaged.

Testing the installation without power
1. Disengage the gear train with the manual override button and move the shaft from closed to open to closed. Ensure that there is no binding and that the damper goes fully open and closes with 5° of actuator stroke left.
2. Correct any problems and retest.
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 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.

**Transformer(s)**
The NM24 type actuator requires a 24 VAC class 2 transformer and draws a maximum of 3.5 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 hot leg.** 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 NM type actuators**
Keep power wire runs below the limits listed in the Fig. 1. 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

\[
1000 \text{ Ft} \div 3 \text{ Actuators} = 333 \text{ Ft. Maximum wire run.}
\]

**Maximum wire length:**

<table>
<thead>
<tr>
<th>Wire Size</th>
<th>Max. Feet</th>
<th>Wire Size</th>
<th>Max. Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Ga</td>
<td>2500 Ft</td>
<td>18 Ga</td>
<td>600 Ft</td>
</tr>
<tr>
<td>14 Ga</td>
<td>1600 Ft</td>
<td>20 Ga</td>
<td>350 Ft</td>
</tr>
<tr>
<td>16 Ga</td>
<td>1000 Ft</td>
<td>22 Ga</td>
<td>175 Ft</td>
</tr>
</tbody>
</table>

**Wire Type and Wire Installation Tips**
For most installations, 18 or 16 Ga. cable works well with the NM24 type 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 NM24 proportion al 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. Reroute the wiring away from the source of pickup.
3. Use shielded wire (Belden 8760 or equal). Ground the shield to an earth ground.

**Reversing switch, “L-R”**
The NM24/SR US actuators have a reversing switch on the cover labeled “L-R”. With the switch in position “L”, the actuator rotates clockwise with an increase in voltage or current. With the switch in Position “R”, the actuator rotates counterclockwise with an increase in voltage or current.

The NM24 US, on-off, tri-state actuators when set for switch position “R”, rotate clockwise when power is applied to wire #3, and counterclockwise when power is applied to wire #2.

During checkout, the switch position can be temporarily reversed and the actuator will reverse its direction. This allows the technician a fast and easy way to check the actuator operation without having to switch wires or change settings on the thermostat. **When the check-out is complete, make sure the switch is placed back to its original position.**
Controller types
Belimo NM24-SR US actuator is compatible with virtually all electronic controllers using a 2 to 10 VDC control signal. And will work with a 4 to 20 mA signal with the addition of a 500Ω resistor.

Microprocessor controlled brushless DC motor
An on board microprocessor monitors operation and controls a brushless DC motor. It also performs a self test upon power up.

Overload protection
The Belimo NM24-SR US actuator is protected from overload at all angles of rotation. The on board microprocessor constantly monitors the rotation of the DC drive 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.

Brushless DC motor operation
Belimo’s brushless DC motor spins by reversing the poles of stationary electromagnets housed inside rotating permanent magnets. The electromagnetic poles are switched by a microprocessor and a special ASIC (Application Specific Integrated Circuit) developed by Belimo. Unlike the conventional DC motor, there are no brushes to wear or commutators to foul.

Motor position detection
Belimo Brushless DC motors do not use potentiometers for positioning. 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.

Initialization or function check
When a power source is applied to terminal 1 and 2 the motor carries out an initialization of the actuator. If required, a function check can also be made after connection of the supply voltage by pressing in the manual override button and then releasing it. The purpose of this initialization is to determine the mechanical angle of rotation and to adapt the running time to the angle of rotation. The function check can also be used to verify that the damper, and linkage (if mounted) are running free and are correctly adjusted.

The function check makes the motor run first to the clockwise or counter-clockwise stop, depending on the selector switch position. Thereafter it runs to the opposite stop. During this operation the output (U5) supplies 2 VDC.

Re-initialization
Whenever the “manual override button” is pressed and released and the actuator is powered, the microprocessor will “re-initialize”. See “Initialization or function check” above.

Motor speed and run time
The microprocessor also controls the speed of the motor. In a conventional DC motor, increased torque slows the motor speed. Since the microprocessor determines the total rotation during initialization, it can calculate how fast to turn the motor to insure a 150 second run time independent of the total rotation over a range of 35-95°. Below 35°, the motor runs at a constant speed and the run time is proportional to the angle.

Input Resolution
During initialization the microprocessor determines the maximum rotation angle. It then divides this angle by the working span of the input signal and calculates how many degrees to travel for each volt change in control signal or pulse length. This means that the working span (Example: 8 V for a 2 to 10 VDC Signal) is consistent for any angle of maximum rotation down to as low as 35°. This greatly simplifies engineering and checkout when dampers have differing maximum rotations.

# Table: Total Rotation Run Time

<table>
<thead>
<tr>
<th>Total Rotation</th>
<th>Run Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>95°</td>
<td>150 Sec.</td>
</tr>
<tr>
<td>75°</td>
<td>150 Sec.</td>
</tr>
<tr>
<td>55°</td>
<td>150 Sec.</td>
</tr>
</tbody>
</table>

Monitoring and self-adjustment of close-off position
The purpose of this function is to correct the mechanical tolerances within 4% which can change over time. It assures that the actuator always presses the damper blade with maximum pressure onto the seal. The end positions are automatically checked as soon as the actuator position comes within 3% of the total angle of rotation, at full open or full closed.

The actuator will self-adjust until it reaches its mechanical stops.

Accessories
AV 10-18 Shaft extension
Tool-01 10 mm wrench for tightening the universal clamp’s nuts.
Tool-03 #10 tamper proof Torx screwdriver required for installation of ZG-NM3 or ZG-NM4 linkage kits.
SGA24 Minimum and/or manual positioner (electronic) In NEMA 4 enclosure for surface mounting.
SGF24 Minimum and/or manual positioner (electronic) For flush panel mounting.
SN1 Auxiliary Switch, 1 x SPDT
SN2 Auxiliary Switch, 2 x SPDT
ZG-NM4 Linkage kit. Includes 1 crank arm for the actuator, 2 ball joints and 1 mounting plate for the actuator. Customer needs to supply 5/16” connecting rod and a crank arm for the damper.
ZG-NM3 Linkage kit for use with the ZG-105 mounting bracket. Includes 1 crank arm for the actuator and 2 ball joints.
ZG-NMSA-1 Shaft adaptor for short shafts
ZG-H2 Actuator operator handle A heavy gauge steel handle which attaches to the universal clamp. For use where frequent manual positioning of dampers is required.
ZG-105 Mounting bracket, when direct coupled mounting is not possible.
ZG-NM3 - Crank arm adaptor kit

For use when the actuator cannot be mounted directly to the damper shaft. Similar to ZG-NM4 (below) but without mounting plate. To be used with ZG-105 (right).

ZG-NM4 - Crank arm adaptor kit

For use when the actuator cannot be mounted directly to the damper shaft.

Mounting Instructions for ZG-NM4 Linkage Kit

1. Remove the four retaining screws ➀ in the base of the actuator.
   **Note:** A #10 tamper-proof Torx screwdriver is required.
2. Install the mounting plate ➁ to the base of the actuator using the four retaining screws from step #3.
3. Mount the actuator assembly in a convenient location by the damper.
4. Insert the crankarm assembly ➂ into the universal clamp and tighten in the desired position.
5. Adjust the crank arm linkage for proper damper operation

ZG-105 Mounting Bracket

ZG-NMSA-1 Shaft adaptor

Used on 1/2" diameter shafts that are shorter than 3/4" and mounting space is minimal.

AV 10-18 Shaft Extension

For damper shafts 3/8 to 11/16 in [10 to 18] dia or 3/8 to 9/16 in [10 to 14] square.

SGA24/SGF24

Minimum and/or manual positioner (electronic), SGA24 is enclosed in a NEMA 4 housing. The SGF24 is for flush panel mounting.

ZG-H2 Actuator Operator Handle

Used when it is desirable to move or adjust damper by hand. Increases leverage and precision during set-up and testing.
Non-Direct Mounting Methods

**Universal mounting bracket or a field-fabricated 16 ga. angle iron or plate.** Used when there is little clearance between the damper shaft and the wall.

**KH-8 Crankarm - final position must be vertical when damper is fully open.**

**Mount actuator at a 45° angle to allow for full 90° crankarm rotation.**

**Damper is mounted through a wall with control shaft exposed, but space too tight to direct couple.**

Use this method when there is little clearance between the damper shaft and the wall.
**Startup and Checkout**

**Instructions For NM24-SR US**

<table>
<thead>
<tr>
<th>Step</th>
<th>Procedure</th>
<th>Expected Response</th>
<th>Actuator Responds</th>
<th>No Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Connect signal Input to wires 1 &amp; 3. Connect signal output (if used) to wires 1 &amp; 4. Connect 24 VAC/VDC power to Wires 1 &amp; 2</td>
<td>Actuator drives to the “No Signal” position (usually closed), then to the “Maximum Signal” position (usually open) then to the “Control Signal” position.</td>
<td>Actuator operates properly <strong>Step 9</strong></td>
<td>No response at all <strong>Step 2</strong> Operation is reversed <strong>Step 3</strong> Does not drive toward “Control Signal Position” <strong>Step 4</strong></td>
</tr>
<tr>
<td>2.</td>
<td>Check power wiring. Correct any problems. Note 1</td>
<td>Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.</td>
<td>Power wiring corrected, actuator begins to drive <strong>Step 1</strong></td>
<td>Power wiring corrected, actuator still does not drive <strong>Step 4</strong></td>
</tr>
<tr>
<td>3.</td>
<td>Turn reversing switch to the correct position. Make sure the switch is turned all the way left or right. Press “Override Button” all the way down and release</td>
<td>Actuator drives to the “No Signal” position (usually closed), then to the “Maximum Signal” position (usually open) then to the “Control Signal” position.</td>
<td>Actuator operates properly <strong>Step 9</strong></td>
<td>Does not drive toward “Control Signal Position” <strong>Step 4</strong></td>
</tr>
<tr>
<td>4.</td>
<td>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.</td>
<td>Drives to “Control Signal” position</td>
<td>Actuator operates properly <strong>Step 9</strong></td>
<td><strong>Step 5</strong></td>
</tr>
<tr>
<td>5.</td>
<td>Disconnect signal input from Wires No. 1 &amp; 3</td>
<td>Actuator drives to the “No Signal” position</td>
<td><strong>Step 6</strong></td>
<td><strong>Step 8</strong></td>
</tr>
<tr>
<td>6.</td>
<td>Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For NM24-SR this is 2 to 10 VDC or 4 to 20 mA (with 500Ω resistor).</td>
<td>Input voltage or current should be ±1% of what controller’s adjustment or programming indicate.</td>
<td>Controller output (actuator input) is correct. Input Polarity Correct. <strong>Step 7</strong></td>
<td>Reprogram, adjust repair or replace controller as needed. <strong>Step 7</strong></td>
</tr>
<tr>
<td>7.</td>
<td>Disconnect power from Wire No. 2. Reconnect signal input to Wires No. 1 &amp; 3. Reconnect power to Wire No. 2</td>
<td>Actuator drives to the “No Signal” position (usually closed), then to the “Maximum Signal” position (usually open) then to the “Control Signal” position.</td>
<td>Actuator operates properly <strong>Step 9</strong></td>
<td><strong>Step 8</strong></td>
</tr>
<tr>
<td>8.</td>
<td>Actuator does not drive</td>
<td>Defective actuator</td>
<td></td>
<td>Replace actuator</td>
</tr>
<tr>
<td>9.</td>
<td>Actuator works properly. Test controller by following controller manufacturer’s instructions.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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.
**LM Series Direct Coupled Actuator**

**Small Yet Powerful**
- Minimum 35 in-lb torque in a compact package.
  For damper areas up to 8 sq-ft*.

**Areas of Application**

**VAV Units and Small Zone Dampers**

- Rack and pinion type actuator replaced by direct coupled LM.
- Replacement LM24 compatible with existing control system.
- Existing pneumatic actuator requires linkage.
- Quiet Plus® VAV terminal unit by Warren Technology

---

**LM Series - at a glance**

<table>
<thead>
<tr>
<th>Torque: 35 in-lb</th>
<th>Power supply: 24 VAC/DC</th>
<th>Brushless DC motor:</th>
<th>Control signal: on-off</th>
<th>Feedback signal: 2 to 10 VDC</th>
<th>10kΩ feedback potentiometer</th>
<th>5kΩ feedback potentiometer</th>
<th>Run time, 95 sec</th>
<th>Run time, 80 to 110 sec for 0 to 35 in-lb</th>
<th>Run time, 25 to 35 sec for 0 to 18 in-lb</th>
<th>Left/Right rotation switch</th>
<th>Angle of rotation limiting (mechanical)</th>
<th>Angle of rotation limiting (electronic)</th>
<th>Plenum rated cable, 18 GA</th>
<th>Screw terminal strip</th>
<th>Manual override push-button</th>
<th>Built-in auxiliary switch</th>
</tr>
</thead>
</table>

---

* 4 in-lb/ft² damper torque loading. Parallel blade. No edge seals.
A CLOSER LOOK...

- Brushless DC Motor for added accuracy and controllability.
- Cut labor costs with simple direct coupling.
- Check damper position from a distance with clear position indication.
- Don’t worry about actuator burn-out. Belimo is overload-proof throughout rotation.
- Enjoy added flexibility with easy mechanical stops to adjust angle of rotation. (LM24-SR-2.0 US has electronic rotation limiting.)
- Consistent running time independent of load.
- Easily accessible manual override push-button helps you pre-tension damper blades.
- Need to change control direction? Do it easily with a simple switch.
- 3 ft. plenum rated cable eases installation (external terminal strip also available)

The Belimo Difference

- Customer Commitment.
  Extensive product range. Competitive project pricing. 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.
  20+ years direct coupled actuator design.

Bulk Packaging Offers Big Value for Large Jobs, Stocking Orders.
Application

For on-off and floating point control of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications. The actuator mounts directly to the damper operating shaft with a universal V-bolt clamp assembly.

Operation

The actuator is not provided with and does not require any limit switches, but is electronically protected against overload. The angle of rotation is mechanically limited to 95°. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged with a button on the actuator cover. The position of the actuator is indicated by a visual pointer. The anti-rotation strap supplied with the actuator will prevent lateral movement.

The LM24-3 US and LM24-3-T US actuators use a Brushless DC motor, which is controlled by an Application Specific Integrated Circuit (ASIC). The ASIC monitors and controls the actuator’s rotation and provides a digital rotation sensing (DRS) function to prevent damage to the actuator in a stall condition.

Technical Data

<table>
<thead>
<tr>
<th>LM24-3 US</th>
<th>LM24-3-T US</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power supply</strong></td>
<td>24 VAC ± 20% 50/60 Hz</td>
</tr>
<tr>
<td><strong>Transformer sizing</strong></td>
<td>3 VA (Class 2 power source)</td>
</tr>
<tr>
<td><strong>Electrical connection</strong></td>
<td>3 ft, 18 GA, UL CL2P plenum cable</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>On-off/Floating point</td>
</tr>
<tr>
<td><strong>Overload protection</strong></td>
<td>Electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td><strong>Input impedance</strong></td>
<td>3900Ω</td>
</tr>
<tr>
<td><strong>Angle of rotation</strong></td>
<td>max 95°, adjust. with mechanical stops</td>
</tr>
<tr>
<td><strong>Torque</strong></td>
<td>min 35 in-lb [4 Nm], Independent of load</td>
</tr>
<tr>
<td><strong>Direction of rotation</strong></td>
<td>reversible w/switch CW/CCW (not on “-T” models)</td>
</tr>
<tr>
<td><strong>Position indication</strong></td>
<td>clip-on indicator (not on “-T” models)</td>
</tr>
<tr>
<td><strong>Running time</strong></td>
<td>95 seconds</td>
</tr>
<tr>
<td><strong>Manual override</strong></td>
<td>external push button</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>5 to 95% RH, non-condensing</td>
</tr>
<tr>
<td><strong>Ambient temperature</strong></td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td><strong>Storage temperature</strong></td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td><strong>Housing type</strong></td>
<td>NEMA type 2 (-T models NEMA 1)</td>
</tr>
<tr>
<td><strong>Housing material rating</strong></td>
<td>UL94-5V</td>
</tr>
<tr>
<td><strong>Noise level</strong></td>
<td>less than 35 dB (A)</td>
</tr>
<tr>
<td><strong>Servicing</strong></td>
<td>maintenance free</td>
</tr>
<tr>
<td><strong>Agency listings</strong></td>
<td>UL873 listed, CSA 22.2 No. 24 certified, CE</td>
</tr>
<tr>
<td><strong>Quality standard</strong></td>
<td>ISO 9001</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>1.2 lbs [0.55 kg]</td>
</tr>
</tbody>
</table>

LM24-3-T US

| **Electrical connection** | Screw terminal (for 26 to 14 GA wire) |    |
| **Housing**               | NEMA type 1                     |    |
| **Direction of rotation** | Reverse wires terminals 2 and 3 |    |

Accessories

| 11533 | T-type anti-rotation bracket |
| 22065 | L-type anti-rotation bracket (included) |
| ZG-LMSA | Shaft adaptor for short shafts |
| Tool-02 | 8 mm wrench |

Dimensions

<table>
<thead>
<tr>
<th>All numbers in brackets are metric.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4” to 5/8” [8 to 16]</td>
</tr>
<tr>
<td>1/4” to 7/16” [6 to 11]</td>
</tr>
<tr>
<td>3.47” [88]</td>
</tr>
<tr>
<td>3.32” [84.9]</td>
</tr>
<tr>
<td>2.56” [65]</td>
</tr>
<tr>
<td>3.68” [93.5]</td>
</tr>
<tr>
<td>4.53” [115]</td>
</tr>
<tr>
<td>4.32” [109.2]</td>
</tr>
<tr>
<td>1.28” [32.5]</td>
</tr>
<tr>
<td>1/4” to 5/8” [8 to 16]</td>
</tr>
<tr>
<td>1/4” to 7/16” [6 to 11]</td>
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<tr>
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<tr>
<td>4.32” [109.2]</td>
</tr>
<tr>
<td>1.28” [32.5]</td>
</tr>
</tbody>
</table>

Specifications are subject to change.

© Belimo Aircontrols (USA), Inc.
**LM24-3 (-T) US**

**On-off/ floating point control, non-spring return, direct coupled, 24 V**

**On-off control**

```
24 VAC Transformer
Line Volts

<table>
<thead>
<tr>
<th>Blk (1)</th>
<th>Common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red (2)</td>
<td>+</td>
</tr>
<tr>
<td>Wht (3)</td>
<td>+</td>
</tr>
</tbody>
</table>

LM24-3 (-T) US

The indication of direction is valid for switch position R.
```

**Floating point or on-off control**

```
24 VAC Transformer
Line Volts

<table>
<thead>
<tr>
<th>Blk (1)</th>
<th>Common</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red (2)</td>
<td>+</td>
</tr>
<tr>
<td>Wht (3)</td>
<td>+</td>
</tr>
</tbody>
</table>

CCW CW
LM24-3 US

The indication of direction is valid for switch position CW.
```

**Notes**

- Provide overload protection and disconnect as required.
- Actuators may also be powered by 24 VDC.
- Actuators are provided with color coded wires. Wire numbers are provided for reference.
- The LM24-3-T US actuators are provided with a numbered screw terminal strip instead of cable.
- Switch wires 2 and 3 to change rotation direction of LM24-3-T US (does not have CW/CCW external switch).

**T-Type bracket**

These are included in the single-actuator packages and are available at no extra cost in the bulk packages upon request.

Part # 11533 (UOM:1)

**L-Type anti-rotation bracket.**

Included with each bulk packaged actuator.

Part #: 22065 (UOM:1)

12502-00002 (includes 22065: UOM:16) shipped with bulk pack option.

**Bulk packaging**

<table>
<thead>
<tr>
<th>Bulk Pack No.</th>
<th>Actuator Type</th>
<th>Quantity/Pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM24-3.1 US</td>
<td>LM24-3 US</td>
<td>32</td>
</tr>
<tr>
<td>LM24-3-T.1 US</td>
<td>LM24-3-T US</td>
<td>48</td>
</tr>
</tbody>
</table>

To have better control of job site inventory and reduce the environmental impact of unnecessary packing material.

**LM24... on-off/floating - Typical Specification:**

Control damper actuators shall be electronic direct coupled type which require no crank arm and linkage. Actuators shall be UL and CSA listed, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall have Brushless DC motor technology. Actuators shall have reversing switch and manual override on the cover, and be protected from overload at all angles of rotation. If required, actuator will be provided with screw terminal strip for electrical connections (LM24-3-T US). Actuators shall be as manufactured by Belimo.
**Technical Data**

<table>
<thead>
<tr>
<th>LM24-SR-2.0 US</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 VAC ± 20% 50/60 Hz</td>
</tr>
<tr>
<td></td>
<td>24 VDC ± 10%</td>
</tr>
<tr>
<td>Power consumption</td>
<td>2 W</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>4 VA (Class 2 power source)</td>
</tr>
<tr>
<td>Electrical connection</td>
<td>LM24-SR-2.0 US: 3 ft, 18 GA, UL CL2P plenum cable</td>
</tr>
<tr>
<td>Overload protection</td>
<td>Electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td>Operating range</td>
<td>2 to 10 VDC, 4 to 20 mA</td>
</tr>
<tr>
<td>Input impedance</td>
<td>100 kΩ (0.1 mA), 500Ω</td>
</tr>
<tr>
<td>Feedback output ‘U’</td>
<td>2 to 10 VDC (max. 0.7 mA)</td>
</tr>
<tr>
<td>Angle of rotation</td>
<td>max 95°, electronically adjustable</td>
</tr>
<tr>
<td>Torque</td>
<td>min 35 in-lb, Independent of load</td>
</tr>
<tr>
<td>Direction of rotation</td>
<td>reversible with switch CW/CCW</td>
</tr>
<tr>
<td>Position indication</td>
<td>clip-on indicator (not on “-T” models)</td>
</tr>
<tr>
<td>Running time</td>
<td>95 seconds</td>
</tr>
<tr>
<td>Manual override</td>
<td>external push button</td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH, non-condensing</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td>Housing type</td>
<td>NEMA type 2 (-T models Nema type1)</td>
</tr>
<tr>
<td>Housing material rating</td>
<td>UL 94-5V</td>
</tr>
<tr>
<td>Noise level</td>
<td>less than 35 dB (A)</td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
</tr>
<tr>
<td>Agency listings</td>
<td>UL 873 listed, CSA 22.2 No. 24 certified, CE</td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>Weight</td>
<td>1.2 lbs [0.55 kg]</td>
</tr>
</tbody>
</table>

**LM24-SR-2.0 US**

- **Power supply**: 24 VAC ± 20% 50/60 Hz
- **Power consumption**: 2 W
- **Transformer sizing**: 4 VA (Class 2 power source)
- **Input impedance**: 100 kΩ (0.1 mA), 500Ω
- **Feedback output ‘U’**: 2 to 10 VDC (max. 0.7 mA)
- **Input impedance**: 100 kΩ (0.1 mA), 500Ω
- **Angle of rotation**: max 95°, electronically adjustable
- **Torque**: min 35 in-lb, Independent of load
- **Direction of rotation**: reversible with switch CW/CCW
- **Position indication**: clip-on indicator (not on “-T” models)
- **Running time**: 95 seconds
- **Manual override**: external push button
- **Humidity**: 5 to 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 type**: NEMA type 2 (-T models Nema type1)
- **Housing material rating**: UL 94-5V
- **Noise level**: less than 35 dB (A)
- **Servicing**: maintenance free
- **Agency listings**: UL 873 listed, CSA 22.2 No. 24 certified, CE
- **Quality standard**: ISO 9001
- **Weight**: 1.2 lbs [0.55 kg]

**Application**

For proportional modulation of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications. The actuator mounts directly to the damper operating shaft with a universal V-bolt clamp assembly. The actuator operates in response to a 2 to 10 VDC or, with the addition of a 500 Ω resistor, a 4 to 20 mA input signal from an electronic controller or positioner. A 2 to 10 VDC feedback signal is provided for position indication or master slave applications. (Not available on “-T” versions)

The LM24-SR-2.0 US provides an electronic angle of rotation adjustment to limit the actuators rotation 20% to 100% while still using the full input signal and feedback control range. (Not available on LM24-SR-T-2.0 US)

**Operation**

The anti-rotation strap supplied with the actuator will prevent lateral movement of the actuator. The damper actuator is not provided with and does not require any limit switches, but is protected electronically against overload. The angle of rotation is mechanically limited to 95°. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged by pressing a button on the actuator cover. The position of the actuator is indicated by a visual pointer.

The LM24-SR-2.0 US and LM24-SR-T-2.0 US actuators use a Brushless DC motor, which is controlled by an Application Specific Integrated Circuit (ASIC). The ASIC monitors and controls the actuator’s rotation and provides a digital rotation sensing (DRS) function to prevent damage to the actuator in a stall condition.

**Accessories**

- 11533 T-type anti-rotation bracket
- 22065 L-type anti-rotation bracket (included)
- ZG-LMSA Shaft adaptor for short shafts
- Tool-02 8 mm wrench
- ZG-R01 500 Ω resistor for 4 to 20 mA

**Dimensions**

(All numbers in brackets are metric.)

- 1/4” to 5/8” [6 to 16]
- 1/4” to 7/16” [6 to 11]
Proportional control, non-spring return, direct coupled, 24 V, for 2 to 10 VDC and 4 to 20 mA control signal

T-Type bracket
These are included in the single-actuator packages and are available at no extra cost in the bulk packages upon request.

Part # 11533 (UOM:1)

L-Type anti-rotation bracket.
Included with each bulk packaged actuator.

Part #: 22065 (UOM:1)
12502-00002
(includes 22065: UOM:16)
shipped with bulk pack option.


<table>
<thead>
<tr>
<th>Bulk Pack No.</th>
<th>Actuator Type</th>
<th>Quantity/Pack</th>
</tr>
</thead>
</table>

To have better control of job site inventory and reduce the environmental impact of unnecessary packing material.

Notes
- Provide overload protection and disconnect as required.
- Actuators are provided with color coded wires. Wire numbers are provided for reference.
- The LM24-SR-T-2.0 US is provided a screw terminal instead of cable.
- The LM24-SR-T-2.0 US does not have feedback.
- Connect actuator common (Wire 1) to Negative (–) leg of control circuits only.
- Actuators may also be powered by 24 VDC.
- A 500Ω resistor (ZG-R01) must be added for 4 to 20 mA control.
Application
For on-off control of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer’s specifications. The actuator mounts directly to the damper operating shaft with a universal V-bolt clamp assembly.

Operation
The actuator is not provided with and does not require any limit switches, but is electronically protected against overload. The angle of rotation is mechanically limited to 95°. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged with a button on the actuator cover. The position of the actuator is indicated by a visual pointer. The anti-rotation strap supplied with the actuator will prevent lateral movement.

Accessories
LM-P T-type anti-rotation bracket
ZG-LMSA Shaft adaptor for short shafts
Tool-02 8 mm wrench

Technical Data

<table>
<thead>
<tr>
<th>LM24… on-off/floating point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply 24 VAC ± 20% 50/60 Hz</td>
</tr>
<tr>
<td>Power consumption 2 W</td>
</tr>
<tr>
<td>Transformer sizing 3 VA (Class 2 power source)</td>
</tr>
<tr>
<td>Electrical connection 3 ft, 18 GA, UL CL2P plenum cable</td>
</tr>
<tr>
<td>Control On-off</td>
</tr>
<tr>
<td>Overload protection Electronic throughout 0 to 95° rotation</td>
</tr>
<tr>
<td>Angle of rotation max 95°, adjust. with mechanical stops</td>
</tr>
<tr>
<td>Torque min 35 in-lb [4 Nm]</td>
</tr>
<tr>
<td>Direction of rotation reversible w/switch L/R (not on ~T models)</td>
</tr>
<tr>
<td>Position indication clip-on indicator (not on ~T models)</td>
</tr>
<tr>
<td>Running time 80 to 110 sec. for 0 to 35 in-lb</td>
</tr>
<tr>
<td>Manual override external push button</td>
</tr>
<tr>
<td>Humidity 5 to 95% RH, non-condensing</td>
</tr>
<tr>
<td>Ambient temperature -22°F to +122°F [-30°C to +50°C]</td>
</tr>
<tr>
<td>Storage temperature -40°F to +176°F [-40°C to +80°C]</td>
</tr>
<tr>
<td>Housing type NEMA type 2 (-T models NEMA 1)</td>
</tr>
<tr>
<td>Housing material rating UL94-5V</td>
</tr>
<tr>
<td>Noise level less than 35 dB (A)</td>
</tr>
<tr>
<td>Servicing maintenance free</td>
</tr>
<tr>
<td>Agency listings UL 873 listed, CSA C22.2 No.24 certified, CE</td>
</tr>
<tr>
<td>Quality standard ISO 9001</td>
</tr>
<tr>
<td>Weight 1.2 lbs [0.55 kg]</td>
</tr>
</tbody>
</table>

LM24-US

Control On-off

Auxiliary switch Adj. 0° to 95°, SPDT 6 A (2.5A) @ 24 VAC

LM24-10P-US

Control On-off/Floating point

Feedback 10 kΩ, 1W potentiometer

LM24-5P0-T.1 US (bulk pack only)

Control On-off/Floating point

Feedback 5 kΩ, 1W potentiometer

Housing NEMA type 1

Direction of rotation Reverse wires terminals 2 and 3

Dimensions (All numbers in brackets are metric.)

1/4" to 5/8" [6 to 16]
1/4" to 7/16" [6 to 11]

LM24-T-US (bulk pack only)

Control On-off

Electrical connection Screw terminal (for 26 to 14 GA wire)

Housing NEMA type 1

Direction of rotation Reverse wires terminals 2 and 3
**LM24 (-T) US**

On-off control, non-spring return, direct coupled, 24 V

---

**On-off control**

- 24 VAC Transformer
  - Blk (1) Common
  - Red (2) +
  - Wht (3) +

The indication of direction is valid for switch position R.

**Floating point or on-off control**

- 24 VAC Transformer
  - Blk (1) Common
  - Red (2) +
  - Wht (3) +

The indication of direction is valid for switch position R.

**Feedback potentiometer wiring for LM24-10P US and LM24-5P0-T US**

- Org (P1)
- Blue (P2)
- Yel (P3)

**Auxiliary switch wiring for LM24-S US**

- S1
- S2 NC
- S3 NO 0° to 95°

**Notes**

1. Provide overload protection and disconnect as required.
2. Actuators may also be powered by 24 VDC.
3. Actuators are provided with color coded wires. Wire numbers are provided for reference.
4. For position indication, the LM24-10P US is provided with a 10 kΩ feedback potentiometer and the LM24-5P0-T US is provided with a 5 kΩ feedback potentiometer.
5. The LM24-T US and LM24-5P0-T US are provided with a numbered screw terminal strip instead of cable.
6. Switch wires 2 and 3 to change rotation direction of LM24-T US and LM24-5P0-T US (does not have L/R external switch).
7. Value based on resistance between (P1) and (P2). Indicates direction of rotation of actuator.

---

**L-Type anti-rotation bracket.** Included with each actuator.

**Part #: 22065**

**Bulk packaging LM24 on-off/floating**

<table>
<thead>
<tr>
<th>Bulk Pack No.</th>
<th>Actuator Type</th>
<th>Quantity/Pack</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM24.1 US</td>
<td>LM24 US</td>
<td>32</td>
</tr>
<tr>
<td>LM24-T.1 US</td>
<td>LM24-T US</td>
<td>48</td>
</tr>
<tr>
<td>LM24-5P0-T.1 US</td>
<td>LM24-5P0-T US</td>
<td>48</td>
</tr>
</tbody>
</table>
Technical Data  LMC24 (-SR) US...

Power supply 24 VAC ± 20% 50/60 Hz  24 VDC ± 10%

Power consumption LMC24 US  2.0 W
LMC24-SR (-T) US  2.5 W

Transformer sizing LMC24 US  3 VA
LMC24-SR (-T) US  4 VA

Electrical connection 3 ft, 18 GA, UL CL2P plenum cable

Control On-off (LMC24 US)

Overload protection Electronic throughout 0 to 95° rotation

Angle of rotation max 95°, adjust. with mechanical stops (LMC24 US), electronically adjustable
between 20 to 100% on LMC24-SR US only

Torque min 18 in-lb [2 Nm]

Operating range Y 2 to 10 VDC, 4 to 20 mA (LMC24-SR (-T) US)

Input impedance 100 kΩ (0.1 mA), 500Ω (LMC24-SR (-T) US)

Feedback output ‘U’ 2 to 10 VDC (max. 0.7 mA ) (LMC24-SR-T US)

Direction of rotation reversible with switch “CCW-CW”
LMC24-SR-T US:  CW with a decrease in voltage
CCW with a decrease in voltage

Position indication clip-on indicator

Running time 25 to 35 sec. for 0 to 18 in-lb

Manual override external push button

Humidity 5 to 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 type NEMA type 2

Housing material rating UL94-5V

Noise level less than 35 dB (A)

Servicing maintenance free

Agency listings UL 873 listed, CSA C22.2 No.24 certified, CE

Quality standard ISO 9001

Weight 1.2 lbs [0.55 kg]

LMC24-SR-T US

Electrical connection Screw terminals (for 26 to 14 GA wire)

Angle of rotation max 95°, adjust. with mechanical stops

Housing NEMA type 1

Feedback No feedback with the LMC24-SR-T US

Note: Actuators do not have Brushless DC Motor

Torque min. 18 in-lb, for control of damper surfaces up to 4.5 sq ft.

LMC24 US (on/off)
LMC24-SR US (proportional)
LMC24-SR-T US (proportional)

Application
For on-off control of dampers in HVAC systems (LMC24 US). For proportional modulation of dampers in HVAC systems (LMC24-SR-T US). Actuator sizing should be done in accordance with the damper manufacturer’s specifications. The actuator mounts directly to the damper operating shaft with a universal V-bolt clamp assembly.

The LMC24-SR-T US actuator operates in response to a 2 to 10 VDC or, with the addition of a 500 Ω resistor, a 4 to 20 mA input signal from an electronic controller or positioner. A 2 to 10 VDC feedback signal is provided for position indication or master slave applications. The LMC24-SR US provides an electronic angle of rotation adjustment (not available in the LMC24-SR-T US) to limit the actuators rotation 20% to 100% while still using the full input signal and feedback control range.

Operation
The actuator is not provided with and does not require any limit switches, but is electronically protected against overload. The angle of rotation is mechanically limited to 95°. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged with a button on the actuator cover. The position of the actuator is indicated by a visual pointer. The anti-rotation strap supplied with the actuator will prevent lateral movement.

Accessories
LM-P  T-type anti-rotation bracket
IRM-100 Input scaling module (For LMC24-SR-T US only)
ZG-LMSA Shaft adaptor for short shafts
PTA-250 Pulse width modulating interface (For LMC24-SR-T US only)
SGA24 Min. and/or manual positioner in NEMA 4 housing (For LMC24-SR-T US only)
SGF24 Min. and/or manual positioner for flush panel mount (For LMC24-SR-T US only)
Tool-02 8 mm wrench
ZAD24 Digital position indication (For LMC24-SR-T US only)

ZG-R01 500Ω resistor for 4 to 20 mA (For LMC24-SR-T US only)

Dimensions (All numbers in brackets are metric.)
Non-spring return, direct coupled, 24 V, 25 to 35 sec. running time

Notes

1. Provide overload protection and disconnect as required.
2. Actuators may also be powered by 24 VDC
3. Actuators are provided with color coded wires. Wire numbers are provided for reference.
4. Connect actuator common (Wire 1) to Negative (−) leg of control circuits only.
5. A 500Ω resistor (ZG-R01) must be added for 4 to 20 mA control.
6. LMC24-SR-T US does not have a cable. Numbers shown are terminal numbers.

LMC24... - Typical Specification:
Control damper actuators shall be electronic direct coupled type which require no crank arm and linkage. Actuators shall be UL and CSA listed, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall have reversing switch and manual override on the cover, and be protected from overload at all angles of rotation. Actuator shall have a nominal running time of 30 seconds for 95° rotation. Proportional actuators shall respond to 2 to 10VDC output relative to position regardless of the amount of damper rotation. A 2 to 10 VDC feedback signal shall be provided for position indication or master-slave applications. An electronic angle of rotation adjustment (LMC24-SR US only) shall be provided to reduce the actuators rotation from 100 to 20% while still using the full input signal and feedback control range. Actuators shall be as manufactured by Belimo.

L-Type anti-rotation bracket. Included with each actuator.

Part #: 22065
**Preliminary steps**

1. Belimo actuators should be mounted indoors in 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. (See Belimo Mechanical Accessories Doc. 5.2)

2. 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.

3. The LM Series actuator requires a minimum shaft length of 1.5". Use the ZG-LMSA for short shaft installations on 1/2" diameter shafts.

**Installation Instructions**

**Quick-mount visual instructions**

1. Turn damper blade to its fully closed position.

2. With manual override button depressed, rotate actuator clamp to about 1/16" - 1/8" between actuator stop and clamp, depending on damper seal design. Slide actuator over shaft and finger-tighten nuts.

3. Slide anti-rotation bracket up under actuator engaging center cut-out on actuator back. Secure bracket with self-tapping screws. Tighten the two nuts on the universal clamp with 8 mm wrench, 3-5 ft-lb torque. (On dampers with edge seals, actuator will compress damper blades when reaching end position for air-tight damper.)

4. Adjust end stops, if required.

**Dimensions** (All numbers in brackets are metric.)
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.

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.

Transformer(s)
The LM Series actuators require a 24 VAC class 2 transformer and draw a maximum of 4 VA. 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 hot leg. 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 LM Series actuators
Keep power wire runs below the limits listed in the Fig. 1. 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.

Maximum wire length:

<table>
<thead>
<tr>
<th>Wire Size</th>
<th>Max. Feet</th>
<th>Wire Size</th>
<th>Max. Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Ga</td>
<td>1225 Ft.</td>
<td>20 Ga</td>
<td>400 Ft.</td>
</tr>
<tr>
<td>18 Ga</td>
<td>725 Ft.</td>
<td>22 Ga</td>
<td>200 Ft.</td>
</tr>
</tbody>
</table>

Example for LM... US: 3 actuators, 18 Ga wire
725 Ft ÷ 3 Actuators = 241.6 Ft. Maximum wire run.

Wire Type and Wire Installation Tips
For most installations, 18 or 16 Ga. cable works well with the LM24 type 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.

LM Series Actuators with Terminal Strip
LM...-T actuators feature an external screw terminal strip on the top of the actuator housing (instead of cable). Connections are numbered and a wiring schematic is shown next to the terminal strip. The terminals are designed for 26 to 14 GA wire.

Overload protection
All Belimo actuators are electronically protected against overload. In the LM series an electronic circuit maintains the current at a level which will not damage the motor while providing adequate holding torque.

Manual Override
A button on the actuator cover disengages the gear train so the damper shaft can be moved manually. Release the button and the gear train is re-engaged.

Use the manual override to test the installation without power. For tight shut-off the damper should close with 5° of actuator stroke left.
Installation Instructions

Feature Operation

Direction of Rotation Switch (All LM except LM24-3-T US)

LM actuators have a reversing switch on the cover labeled “CW-CCW”. Switch position indicates start point. For the LM24-SR (-T) 2.0 US, with the switch in position “CW”, the actuator rotates clockwise with an increase in voltage or current. With the switch in position “CCW”, the actuator rotates counterclockwise with an increase in voltage or current.

The LM24-3-T US does not have a switch. They rotate clockwise when power is applied to wire #3, and counterclockwise when power is applied to wire #2.

During checkout, the switch position can be temporarily reversed and the actuator will reverse its direction. This allows the technician a fast and easy way to check the actuator operation without having to switch wires or change settings on the thermostat. When the check-out is complete, make sure the switch is placed back to its original position.


The adjustable stops are needed when there is no damper stop or if you want the damper to halt rotating before it reaches its stops. The LM actuator can be indefinitely stalled in any position without harm.

1. Loosen the two end stops with a No. 2 Phillips head screwdriver being careful not to unscrew the captive nut under the slot.
2. Move the stops (in 2.5° steps) to the desired position and re-tighten the screws.

Electronic Angle of Rotation Limiting (LM24-SR-2.0 US)

With the LM24-SR-2.0 US proportional actuator, you can adjust the angle of rotation (95°) anywhere between 20% and 100% using an external adjustment. A potentiometer limits rotation while allowing the full control input and feedback range (2 to 10 VDC), providing higher control resolution within the limited angle of rotation.
## LM24-SR (-T) 2.0 US Electrical check-out procedure

<table>
<thead>
<tr>
<th>Step</th>
<th>Procedure</th>
<th>Expected Response</th>
<th>Gives Expected Response</th>
<th>Does Not Give Expected Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control signal is applied to actuator.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly Step 8</td>
<td>No response at all Step 2 Operation is reversed Step 3 Does not drive toward &quot;Control Signal Position&quot; Step 4</td>
</tr>
<tr>
<td>2.</td>
<td>Check power wiring. Correct any problems. <strong>See Note 1.</strong></td>
<td>Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.</td>
<td>Power wiring corrected, actuator begins to drive Step 1</td>
<td>Power wiring corrected, actuator still does not drive Step 4</td>
</tr>
<tr>
<td>3.</td>
<td>Turn reversing switch to the correct position.</td>
<td>Actuator will move to its “Control Signal” position.</td>
<td>Actuator operates properly Step 8</td>
<td>Does not drive toward “Control Signal Position” Step 4</td>
</tr>
<tr>
<td>4.</td>
<td>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.</td>
<td>Drives to “Control Signal” position</td>
<td>Actuator operates properly. Step 8</td>
<td>Step 5</td>
</tr>
<tr>
<td>5.</td>
<td>Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For LM24SR (-T) US this is 0 to 10 VDC or 0 to 20 mA. Note: The input signal must be above the 2 VDC or 4 mA to have the actuator move.</td>
<td>Input voltage or current should be ±1% of what controller’s adjustment or programming indicate.</td>
<td>Controller output (actuator input) is correct. Input Polarity Correct. Step 6</td>
<td>Reprogram, adjust repair or replace controller as needed. Step 1</td>
</tr>
<tr>
<td>6.</td>
<td>Use the manual override button to move the damper by hand from fully closed to fully open.</td>
<td>Damper will go from fully closed to fully open.</td>
<td>Damper moves properly Step 7</td>
<td>Find cause of damper jam and repair. Step 1</td>
</tr>
<tr>
<td>7.</td>
<td>Check damper torque requirement.</td>
<td>Torque requirement is ≤ actuator’s minimum torque.</td>
<td>Defective Actuator. Replace Actuator - <strong>See Note 2</strong></td>
<td>Recalculate actuator requirement and correct installation.</td>
</tr>
<tr>
<td>8.</td>
<td>Actuator works properly. Test controller by following controller manufacturer’s instructions.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 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 installation date, notify Belimo and give details of the application.
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For detailed installation instructions call 800-543-9038 • See the Belimo MOUNTING METHODS GUIDE for application information.
A CLOSER LOOK...

We’ll help solve any application problem with a wide range of accessories and unparalleled customer service.

The Belimo Difference

- **Customer Commitment.**
  - Extensive product range. Competitive project pricing. 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.
  - 20+ years direct coupled actuator design.
Special Clamps / Position Indicator

K4-1 US
K4-1 US Jackshaft Clamp
For AF, NF and AM Series Actuators
Fits jackshafts up to 1.05". Retaining ring fixes clamp to actuator teeth.

K4-H
K4-H Hex Shaft clamp
For AF, NF and AM Series Actuators
Fits hex shafts 3/8" to 5/8". Retaining ring fixes clamp to actuator teeth.

IND-AF2
IND-AF2 Damper Position Indicator
For AF and NF Series Actuators
For damper position indication in short-shaft installations.

IND-LF
IND-LF Damper Position Indicator
For LF Series Actuators. Similar to IND-AF2

Linkage accessories
When the actuator is not mounted to the damper shaft

KH-AF / KH-AF-1
KH-AF Crankarm
For AF and NF Series Actuators
Fits round shafts to 3/4". Retaining clip fixes clamp to actuator teeth.

KH-AF-1 Crankarm for Jackshaft Applications
For AF and NF Series Actuators
Fits round shafts to 1.05". Retaining clip fixes clamp to actuator teeth.

KH-AFV
KH-AFV V-Bolt Kit
For AF/NF Crankarms

KH-LFV
KH-LFV V-Bolt Kit
For LF Crankarms
Allows direct coupling with KH-LF. Contains V-bolt and 2 nuts.

KH-LF
KH-LF Crankarm
For LF Series Actuators
Fits shafts to 1/2". Retaining clip fixes clamp to actuator teeth.
KH6 Universal Crankarm

Zinc plated steel, for damper shafts 3/8” to 11/16” dia. (10 to 18mm) or 3/8” to 9/16” square (10 to 14mm). Slot width 1/4” (6.2mm). Uses KG6 or KG10 ball joint.

KH6/ KH8

KH8 Universal Crankarm

Zinc plated steel, suitable for damper shafts 3/8” to 11/16” dia. (10 to 18mm) or 3/8” to 9/16” square (10 to 14mm). Slot width 21/64” (8.2mm). Uses KG8 or KG10 ball joint.

KH8

KG6 Ball Joint

For KH6 Universal Crankarm

Zinc plated steel. For 5/16” dia. rod (8mm).

KG6

The KG6 ball joint is only recommended up to 70 in-lbs.

KG8

KG8 90° Ball Joint

For KH8 Universal Crankarms

Zinc plated steel. For 5/16” dia. rod (8mm). 90° angle.

KG10

KG10 Ball Joint

Used with the following Crankarms:

KH6 = 1/4”
KH8 = 5/16”

The bolt portion of the KG10 fits both a 5/16” slot and 1/4” slot.

SH8

SH8 Push Rod

For KG6 and KG8 Ball Joints

36” length. 5/16” dia.

SH10

SH10 Push Rod

For KG10 Ball joints

36” length. 3/8” dia.
Linkage Accessories

ZG-DC1 Damper Clip
Mounts to damper blade - 3.5"

ZG-DC2 Damper Clip
Mounts to damper blade - 6"

The ZG-DC1 and ZG-DC2 damper clips are designed to mount to damper blades and work as crankarms in damper linkage applications. The ZG-DC1 is designed to be used in applications where the actuator is located in front of the damper. The ZG-DC2 is designed to be used when the actuator is located above or below the damper.

Crankarm adaptor kits

When the actuator is not mounted to the damper shaft

ZG-AF Crankarm Adaptor Kit
For AF and NF Series Actuators

Kit contains: 1 KH-AF crankarm with retaining ring
2 stand-off brackets
4 mounting feet
2 bolts with nuts
2 self-tapping metal screws
2 KG8 ball joints
Instructions

Note: May require crankarm and balljoints.

ZG-AF108 Crankarm Adaptor Kit
For AF and NF Series Actuators

Kit contains: 1 KH-AF crankarm with retaining ring
1 ZG-108 mounting bracket (see page 10)
4 bolts with nuts

Note: May require crankarm and balljoints.

ZG-LF112 Crankarm Adaptor Kit
For LF Series Actuators

Kit contains: 1 KH-LF crankarm with retaining ring
1 ZG-112 mounting bracket (see page 63)
2 bolts with nuts

Note: May require crankarm and balljoints.

ZG-LF2 Crankarm Adaptor Kit
For LF Series Actuators

Kit contains: 1 KH-LF crankarm with retaining clip
1 mounting bracket
3 bolts with nuts
Instructions

Note: May require crankarm and balljoints.
Shaft Adaptors

ZG-LFC114 Mounting Kit
Specifically for Trane Voyager unit retrofit
Kit contains: 1-Mounting bracket
1-Shaft adaptor
2-Actuator mounting bolts and nuts
4-Mounting bracket screws

AV10-18 Universal Shaft Extension
For damper operating shafts
Approx. 9 1/2” (240mm) extension for shafts 3/8” to 11/16” dia. (10 to 18mm), or 3/8” to 9/16” square (10 to 14mm).

AV1 Shaft Extension for AM Series Actuators
Approx. 3” (75mm) extension for shafts 3/8” to 3/4” dia. (10 to 20mm), or 3/8” to 9/16” square (10 to 14mm).

ZG-NMSA-1 Shaft Adaptor
For NM Series Actuators
For 1/2” dia. shafts shorter than 3/4”. 3” long, 13/16” outside dia. 2 set screws. Shaft extends 1” inside ZG-NMSA-1.

ZG-LMSA Shaft Adaptor
For LM, LF Series Actuators
For 1/2” dia. shafts shorter than 3/4”. 3” long, 5/8” outside dia. 2 set screws. Shaft extends 3/4” inside ZG-LMSA.

Rotation limiters

ZDB Angle of Rotation Limiter
For SM Series Actuators
Remove nuts on V-bolt and install ZDB to clamp assembly with indicator in 0 position. Remove clip holding clamp assembly to actuator. Pull out clamp assembly and rotate to the number of graduations you would like to limit rotation by. Each graduation is 9°. Reinstall clamp assembly.

ZDB-GM Angle of Rotation Limiter
For GM Series Actuators
Disengage gears with manual release and turn clamp indicator to 0 position. Pull out retaining clip and remove clamp. Locate ZDB-GM at desired graduation (each approx. 10°). Reinstall clamp.
**Rotation Limiters**

**ZDB-AF2**

Rotation Limiting with ZDB-AF2 in standard shaft mounting.

Rotation Limiting with ZDB-AF2 in short shaft mounting requires IND-AF2 Position Indicator. Actuator's standard clamp faces damper.

**ZDB-AF2 Angle of Rotation Limiter**

For AF and NF Series Actuators

The ZDB-AF2 is used in conjunction with the tab on the universal clamp or IND-AF2 position indicator which comes with the ZDB-AF2. In order to function properly, the clamp or indicator must be mounted correctly. The ZDB-AF2 may not work in certain mounting orientations using the ZG-106 or ZG-107 mounting brackets. It will not work with the ZG-108 mounting bracket. Limiting the damper rotation must be accomplished by adjusting the crankarm linkage.

1. Determine damper rotation required.
2. Locate the ZDB-AF2 on the actuator so that its edge lines up with the degree graduation on the actuator face which corresponds with the required rotation.
3. Make sure the locating “teeth” on the ZDB-AF2 are engaged into the locating holes on the actuator.
4. Pierce the actuator label at the cross hair showing through the slot on the ZDB-AF2. Fasten to the actuator using the self tapping screw provided.

**Miscellaneous**

**ZG-H2 Actuator Operator Handle**

For SM, AM (with 3/4” clamp), GM and NM Series Actuators
Application
The ZG-JSA jack shaft adaptors are designed to be inserted into hollow jack shafts which have an outside diameter greater than 3/4 inch and provide a 3/4 inch shaft for mounting Belimo actuators.

Installation
1. Check the inside edge of the jack shaft for burrs. Use a file if necessary to remove any burr which would prevent the ZG-JSA from being inserted into the jack shaft.
2. The inside surface of the jack shaft should be clean. If necessary, clean the jack shaft to remove any oil, grease, or dirt.
3. Loosen the tension nut on the ZG-JSA enough to allow the diameter of the holding wedge to be in line with the two other sections of the adaptor.
4. Insert the ZG-JSA into the jack shaft. Care must be taken to make sure that the wedge section of the adaptor is a minimum of 1 1/2 inches from any jack shaft holding bushing. If the holding wedge section is too close to a bushing, the adaptor may lock the jack shaft to the bushing or the bushing may be damaged.
5. Tighten the tension nut on the ZG-JSA to expand the holding wedge section, fixing the adaptor to the jack shaft.
6. Mount the specified actuator to the 3/4 inch section of the adaptor.

### Technical Data

<table>
<thead>
<tr>
<th>Jack shaft size</th>
<th>ZG-JSA-1</th>
<th>ZG-JSA-2</th>
<th>ZG-JSA-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside dia.</td>
<td>1.00”</td>
<td>1 5/16”</td>
<td>1.05”</td>
</tr>
<tr>
<td>Inside dia.</td>
<td>3/4”</td>
<td>1 3/32”</td>
<td>27/32”</td>
</tr>
<tr>
<td>Weight</td>
<td>1.3 lbs.</td>
<td>2.3 lbs.</td>
<td>1.6 lbs.</td>
</tr>
<tr>
<td>Material</td>
<td>Cold rolled steel, nickel plated</td>
<td></td>
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</tr>
</tbody>
</table>

### Dimensions

<table>
<thead>
<tr>
<th>ZG-JSA-</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3/4</td>
<td>3/4</td>
<td>–</td>
<td>10 3/4</td>
</tr>
<tr>
<td>2</td>
<td>1 1/16</td>
<td>3/4</td>
<td>6</td>
<td>12 1/2</td>
</tr>
<tr>
<td>3</td>
<td>13/16</td>
<td>3/4</td>
<td>6</td>
<td>12 1/4</td>
</tr>
</tbody>
</table>
ZG-100 Universal Mounting Bracket

For SM, AM, GM, NF, and AF series actuators

Application
The ZG-100 universal mounting bracket is designed for applications where the actuator cannot be mounted directly to the damper shaft, and no proper mounting surface is available. It may be used for outside or inside the duct mounting, fastened to the ductwork or directly to the damper assembly. It may also be used to mount to other surfaces rather than the duct.

The ZG-100 is provided with prepped hole patterns for the SM, GM, NF and AF series actuators and their associated crankarm adaptor brackets. The hole pattern layout allows mounting these actuators in three different, mounting orientations. The ZG-100 may also be field drilled for special or more exact mounting of linkage components.

Installation
1. Mount the appropriate set of crankarm adaptor kit brackets and crankarm to the actuator to be used. When using spring return actuators, care must be taken to select the proper mounting orientation for the correct fail-safe operation.

2. Position the ZG-100 mounting bracket in the planned mounting location. If possible, do not fasten at this time. The ZG-100 can be mounted by using either the four 1/4 inch diameter holes on its base or five 1/4 x 5/8 inch oval holes on its edge. Additional holes may be drilled if necessary.

3. Position the actuator/adaptor assembly in the desired mounting location against the ZG-100 and see if one of the existing hole patterns can be used for the actuator mounting. If the existing hole patterns cannot be used, mark the correct hole positions and drill the desired holes. Do not mount.

4. With the actuator mounting position established, position the ZG-100 bracket in the best position for proper crankarm/linkage alignment. Fasten the ZG-100 to the mounting surface.

5. Mount the actuator/adaptor assembly to the ZG-100.

6. Install the crankarm linkage between the actuator and damper.

7. Cycle the actuator through its operational range to verify correct linkage setup. The SM, GM, and AF actuator series may be manually operated without power available.

Other Universal Mounting Brackets

<table>
<thead>
<tr>
<th>Model</th>
<th>Actuator Used With</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZG-101</td>
<td>SM, AM, GM, NF, AF</td>
</tr>
<tr>
<td>ZG-103</td>
<td>SM, AM, GM</td>
</tr>
<tr>
<td>ZG-104</td>
<td>SM, AM, GM</td>
</tr>
<tr>
<td>ZG-105</td>
<td>NM</td>
</tr>
<tr>
<td>ZG-106</td>
<td>NF, AF</td>
</tr>
<tr>
<td>ZG-107</td>
<td>NF, AF</td>
</tr>
<tr>
<td>ZG-108</td>
<td>NF, AF</td>
</tr>
</tbody>
</table>

Note: Follow the instructions for mounting the adaptor kits to the actuator or the actuator may be damaged.
ZG-101 Universal Mounting Bracket
For SM, AM, GM, NF, and AF series actuators

Application
The ZG-101 universal mounting bracket is designed for applications where the actuator cannot be mounted directly to the damper shaft, and no proper mounting surface is available. It may be used for outside or inside the duct mounting. The bracket is designed to mount to the damper base, providing greater strength than mounting to the sheet metal or fiberglass duct only. It may also be used as a standard right angle mounting bracket where more contact area is desired. The larger contact area spreads the torsional load created by the actuator/damper operation over a wider area.

The ZG-101 is provided with prepunched hole patterns for the SM, GM, NF and AF series actuators and their associated crankarm adaptor brackets. The hole pattern layout allows mounting these actuators in two, different, mounting orientations.

Installation
1. Mount the appropriate set of crankarm adaptor kit brackets and crankarm to the actuator to be used. When using spring return actuators, care must be taken to select the proper mounting orientation for the correct fail-safe operation.

<table>
<thead>
<tr>
<th>ACTUATOR SERIES</th>
<th>CRANKARM KIT FOR ZG-101</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM</td>
<td>ZG-SM2</td>
</tr>
<tr>
<td>AM</td>
<td>ZG-AM</td>
</tr>
<tr>
<td>GM</td>
<td>ZG-GM2</td>
</tr>
<tr>
<td>NF</td>
<td>ZG-AF</td>
</tr>
<tr>
<td>AF</td>
<td>ZG-AF</td>
</tr>
</tbody>
</table>

Note: Follow the instructions for mounting the adaptor kits to the actuator or the actuator may be damaged.

2. Position the ZG-101 mounting bracket in the planned mounting location. If possible, do not fasten at this time. The ZG-101 can be mounted by using at least three of the nine 1/4 x 5/8 inch oval holes. Additional holes may be drilled if necessary.

3. Position the actuator/adaptor assembly in the desired mounting location against the ZG-101 and see if one of the existing hole patterns can be used for the actuator mounting. If the existing hole patterns cannot be used, mark the correct hole positions and drill the desired holes. Do not mount.

4. With the actuator mounting position established, position the ZG-101 bracket in the best position for proper crankarm/linkage alignment. Fasten the ZG-101 to the mounting surface.

5. Mount the actuator/adaptor assembly to the ZG-101.

6. Install the crankarm linkage between the actuator and damper.

7. Cycle the actuator through its operational range to verify correct linkage setup. The SM, GM, and AF actuator series may be manually operated without power available.

OTHER UNIVERSAL MOUNTING BRACKETS

<table>
<thead>
<tr>
<th>MODEL</th>
<th>ACTUATOR USED WITH</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZG-100</td>
<td>SM, AM, GM, NF, AF</td>
</tr>
<tr>
<td>ZG-103</td>
<td>SM, AM, GM</td>
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<tr>
<td>ZG-104</td>
<td>SM, AM, GM</td>
</tr>
<tr>
<td>ZG-105</td>
<td>NM</td>
</tr>
<tr>
<td>ZG-106</td>
<td>NF, AF</td>
</tr>
<tr>
<td>ZG-107</td>
<td>NF, AF</td>
</tr>
<tr>
<td>ZG-108</td>
<td>NF, AF</td>
</tr>
</tbody>
</table>
Application
The multiple actuator mounting bracket is designed for cases where it is necessary to mount two actuators to one shaft to provide extra torque. The dual mounting bracket is typically used with the AF and GM series actuators. This is due to the fact that each of these series are the highest torque range available.

Installation
1. Determine if the second actuator will mount on top of (Figure A) or 180° opposed to (Figure B) the first actuator.
2. Mount the first actuator as you would normally; but, do not wire at this time. Make sure the shaft clamp assembly on the actuator is positioned correctly for proper damper operation.
3. Mount the actuator rear mounting bracket to the top of the multiple actuator mounting bracket. There are two locations for the mounting of this bracket. Hole set A is the preferred location. Hole set B is to be used if additional clearances are required to route flexible conduit to the actuators.
4. Loosen the three locking screws located in the slots of the mounting bracket.
5. Adjust the top section of the bracket to a height which clears the top of the first actuator by approximately 1/8". Tighten the three locking screws.
6. Mount the second actuator on the shaft and slide the mounting bracket under the second actuator so the rear mounting bracket stud engages the slot at the rear of the actuator.
7. Transfer the thru hole locations from the multiple actuator mounting bracket base to the mounting surface.
8. Drill the three holes. (Use a No. 2 drill if you are using the No. 8 sheet metal screws provided.)
9. Fasten the multiple mounting bracket.
10. After verifying the correct orientation of the shaft clamp assembly of the second actuator, tighten the fastening nuts on the clamp.
11. Wire the actuators in parallel to the controller.
12. Power the actuators and check for proper operation.

Accessory
AV10 - 18 Universal shaft extension

Figure A
Note: The major advantage with this method is it requires less mounting area. The manual override, if available, cannot be used in this configuration.

Figure B
Note: The major advantages are that a shorter shaft is required and a lower profile is achieved.
ZG-103 Universal Mounting Bracket

For SM and GM series actuators

Application
The ZG-103 universal mounting bracket is designed for applications where the actuator cannot be mounted directly to the damper shaft, and no proper mounting surface is available. It may be used for outside or inside the duct mounting. The ZG-103 is designed to mount the SM and GM series actuators in the same mounting locations as common foot mounted, crankarm style actuators.

The ZG-103 is provided with prepunched hole patterns for the SM, and GM series actuators and their associated crank-arm adaptor brackets. The hole pattern layout allows mounting these actuators in two, different, mounting orientations.

Installation
1. Mount the appropriate set of crankarm adaptor kit brackets and crankarm to the actuator to be used. When using spring return actuators, care must be taken to select the proper mounting orientation for the correct fail-safe operation.

   ACTUATOR CRANKARM SERIES KIT FOR ZG-103
   SM ZG-SM2
   AM ZG-AM
   GM ZG-GM2

   Note: Follow the instructions for mounting the adaptor kits to the actuator or the actuator may be damaged.

2. Position the ZG-103 mounting bracket in the planned mounting location. If possible, do not fasten at this time. The ZG-103 can be mounted by using at least two of the six 1/4 inch diameter holes in its base. Additional holes may be drilled if necessary.

3. Position the actuator/adaptor assembly in the desired mounting location against the ZG-103 and locate the existing hole pattern for the actuator mounting. If the existing hole patterns cannot be used, mark the correct hole positions and drill the desired holes. Do not mount.

4. With the actuator mounting position established, position the ZG-103 bracket in the best position for proper crankarm/linkage alignment. Fasten the the ZG-103 to the mounting surface.

5. Mount the actuator/adaptor assembly to the ZG-103.

6. Install the crankarm linkage between the actuator and damper.

7. Cycle the actuator through its operational range to verify correct linkage setup. The SM, and GM actuator series may be manually operated without power available.

OTHER UNIVERSAL MOUNTING BRACKETS

<table>
<thead>
<tr>
<th>MODEL</th>
<th>ACTUATOR USED WITH</th>
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</thead>
<tbody>
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<td>ZG-104</td>
<td>SM, AM, GM</td>
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<tr>
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<td>NM</td>
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<tr>
<td>ZG-106</td>
<td>NF, AF</td>
</tr>
<tr>
<td>ZG-107</td>
<td>NF, AF</td>
</tr>
<tr>
<td>ZG-108</td>
<td>NF, AF</td>
</tr>
</tbody>
</table>

Material: 12 GA Galvanized
Weight: 2.9 lbs.
ZG-104 Universal Mounting Bracket
For SM, AM and GM series actuators

Application
The ZG-104 universal mounting bracket is designed for applications where the actuator cannot be mounted directly to the damper shaft, and no proper mounting surface is available. It may be used for outside or inside the duct mounting. The ZG-104 is designed to mount the SM, and GM series actuators in the same mounting locations as common foot mounted, crankarm style actuators.

The ZG-104 is provided with prepunched hole patterns for the SM and GM series actuators and their associated crankarm adaptor brackets. The hole pattern layout allows mounting these actuators in 2, different, mounting orientations.

Installation
1. Mount the appropriate set of crankarm adaptor kit brackets and crankarm to the actuator to be used. When using spring return actuators, care must be taken to select the proper mounting orientation for the correct fail-safe operation.

2. Position the ZG-104 mounting bracket in the planned mounting location. If possible, do not fasten at this time. The ZG-104 can be mounted by using at least three of the nine 1/4 inch diameter holes in it base. Additional holes may be drilled if necessary.

3. Position the actuator/adaptor assembly in the desired mounting location against the ZG-104 and locate the existing hole pattern for the actuator mounting. If the existing hole patterns cannot be used, mark the correct hole positions and drill the desired holes. Do not mount.

4. With the actuator mounting position established, position the ZG-104 bracket in the best position for proper crankarm/linkage alignment. Fasten the ZG-104 to the mounting surface.

5. Mount the actuator/adaptor assembly to the ZG-104.

6. Install the crankarm linkage between the actuator and damper.

7. Cycle the actuator through its operational range to verify correct linkage setup. The SM, and GM actuator series may be manually operated without power available.

OTHER UNIVERSAL MOUNTING BRACKETS

<table>
<thead>
<tr>
<th>MODEL</th>
<th>ACTUATOR USED WITH</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZG-100</td>
<td>SM, AM, GM, NF, AF</td>
</tr>
<tr>
<td>ZG-101</td>
<td>SM, AM, GM, NF, AF</td>
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<td>NF, AF</td>
</tr>
<tr>
<td>ZG-108</td>
<td>NF, AF</td>
</tr>
</tbody>
</table>

Material: 12 GA Galvanized
Weight: 3.0 lbs.
**ZG-105 Universal Mounting Bracket**  
For NM series actuators

**Application**
The ZG-105 universal mounting bracket is designed for applications where the actuator cannot be mounted directly to the damper shaft, and no proper mounting surface is available. It may be used for outside or inside the duct mounting. The ZG-105 is designed to mount the NM series actuators in the same mounting locations as common foot mounted, crankarm style actuators.

The ZG-105 is provided with prepunched hole patterns for use with the NM series actuators with the ZG-NM3 crankarm adaptor kit. The hole pattern layout allows mounting these actuators in two, different, mounting orientations.

**Installation**
1. Position the ZG-105 mounting bracket in the planned mounting location. If possible, do not fasten at this time. The ZG-105 can be mounted by using the three 9/64 inch diameter holes in its base. Additional holes may be drilled if necessary.

2. Using a number 10 tamper-proof torx screwdriver, remove the four torx head screws on the base of the actuator.

3. Position the actuator in the desired mounting location against the ZG-105 and locate the existing hole pattern for the actuator mounting.

4. Align the screw holes in the base of the actuator to the selected hole set in the ZG-105 and fasten the actuator to the bracket using the four screws removed in step 2.

5. Mount the NM crankarm into the universal mounting clamp at the desired starting angle. Fasten the ZG-105 to the mounting surface.

6. Install the crankarm linkage between the actuator and damper.

7. Cycle the actuator through its operational range to verify correct linkage setup. The NM actuator series may be manually operated without power available.

**OTHER UNIVERSAL MOUNTING BRACKETS**

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<th>MODEL</th>
<th>ACTUATOR USED WITH</th>
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</table>

**Accessory**
TOOL-03 #10, Tamper-proof TORX screwdriver
ZG-106 / ZG-107 Universal Mounting Bracket

For AF and NF series actuators

Application

The ZG-106 and ZG-107 universal mounting brackets are designed for applications where the actuator cannot be mounted directly to the damper shaft. They may be used for outside or inside the duct mounting. The ZG-106 and ZG-107 are designed to mount the NF and AF series actuators in the same mounting locations as common foot mounted, crankarm style actuators. Hole patterns in the base match common Honeywell™ and Johnson Controls™ actuators for easy retrofit. The ZG-106 and ZG-107 are designed with different actuator mounting heights. The ZG-106 is designed to place the KH-AF crankarm in the same relative position as the Honeywell™ Mod IV actuators. The ZG-107 will place the crankarm in the same relative position as the Honeywell™ Mod III actuators.

The ZG-106 and ZG-107 are provided with hole patterns to mount the NF and AF series actuators in either a horizontal or vertical position to meet space requirements. The KH-AF crankarm is required to fully convert the NF or AF for crankarm operation.

Installation

1. When using spring return actuators, care must be taken to select the proper mounting orientation for the correct fail-safe operation.

2. If this is a new installation, position the ZG-106 or ZG-107 mounting bracket in the planned mounting location. Do not fasten at this time.

   If this a retrofit installation replacing common Honeywell™ or Johnson Controls™ actuators, and the bolt pattern of the bracket matches the pattern of the previous actuator, fasten the bracket to the mounting surface. Mount the KH-AF crankarm to the actuator. Proceed to step 6.

3. Position the actuator in the desired mounting position (horizontal or vertical) in the ZG-106 or ZG-107. Slide in the mounting bolts to temporarily hold the actuator to the bracket.

4. Mount the KH-AF crankarm to the actuator in the required operating position.

5. Position the bracket/actuator assembly in the best position for proper crankarm/linkage alignment. Mark the bracket position. Remove the actuator. Fasten the bracket to the mounting surface.

6. Mount the actuator to the bracket using the 2 mounting bolts and lock nuts.

7. Install the linkage assembly between the damper and actuator.

8. Cycle the actuator through its operational range to verify correct linkage setup. The AF actuator series may be manually operated without power available.

OTHER UNIVERSAL MOUNTING BRACKETS

<table>
<thead>
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<th>ACTUATOR USED WITH</th>
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<tr>
<td>ZG-108</td>
<td>NF, AF</td>
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</table>

Material: 12 GA Galvanized

Weight: ZG-106 0.7 lbs.  ZG-107 0.9 lbs.
Application
The ZG-108 universal mounting bracket is designed for applications where the actuator cannot be mounted directly to the damper shaft. It may be used for outside or inside the duct mounting. The ZG-108 is designed to mount the NF and AF series actuators in the same mounting locations as common foot mounted, crankarm style actuators. Hole patterns in the base match common Honeywell™, Siebe™ (Barber Colman™) and Johnson Controls™ actuators for easy retrofit.

The ZG-108 is provided with hole patterns to mount the NF and AF series actuators in either a horizontal or vertical position to meet space requirements. The KH-AF crankarm is required to fully convert the NF or AF for crankarm operation.

Installation
1. When using spring return actuators, care must be taken to select the proper mounting orientation for the correct fail-safe operation.

2. If this is a new installation, position the ZG-108 mounting bracket in the planned mounting location. Do not fasten at this time.

If this is a retrofit installation replacing common Honeywell™, Siebe™ (Barber Colman™) or Johnson Control™ actuators, and the bolt pattern of the bracket matches the pattern of the previous actuator, fasten the bracket to the mounting surface. Mount the KH-AF crankarm to the actuator. Proceed to step 6.

3. Position the actuator in the desired mounting position (horizontal or vertical) on the ZG-108. Slide in two of the mounting bolts and loosely tighten the lock nuts to temporarily hold the actuator to the bracket.

Note: The ZG-108 has hole patterns for three mounting heights for the crankarm location, choose the best height for the application.

4. Mount the KH-AF crankarm to the actuator in the required operating position.

5. Position the bracket/actuator assembly in the best position for proper crankarm/linkage alignment. Mark the bracket position. Remove the actuator. Fasten the bracket to the mounting surface.

6. Mount the actuator to the bracket using the four mounting bolts and lock nuts at the same height location as determined in step 3. Or, if a retrofit application, select the correct hole set so the crankarm location matches the crankarm of the actuator being replaced.

7. Install the linkage assembly between the damper and actuator.

8. Cycle the actuator through its operational range to verify correct linkage setup. The AF actuator series may be manually operated without power available.

OTHER UNIVERSAL MOUNTING BRACKETS

<table>
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<th>MODEL</th>
<th>ACTUATOR USED WITH</th>
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<td>NF, AF</td>
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<tr>
<td>ZG-107</td>
<td>NF, AF</td>
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</tbody>
</table>
ZG-108 Universal Mounting Bracket
Mounting Positions for Typical Replacements

Barber Colman™ MA Type - Vertical
Barber Colman™ MA Type - Horizontal (left)
Barber Colman™ MA Type - Horizontal (right)

Black holes represent correct bolt locations.

Honeywell™ Mod. IV Type- Vertical
Honeywell™ Mod. IV Type - Horizontal (left)
Honeywell™ Mod. IV Type - Horizontal (right)

Johnson Control™ 100 Series Type and Honeywell™ Mod. III Type Vertical
Johnson Control™ 100 Series Type and Honeywell™ Mod. III Type Horizontal (left)
Johnson Control™ 100 Series Type and Honeywell™ Mod. III Type Horizontal (right)
ZS-100 Weather Shield
For all damper actuators

Application
The ZS-100 weather shield provides moderate protection to actuators which are mounted outdoors. This product is not designed as a water tight enclosure. The weather shield will work with all damper actuators.

Installation
The ZS-100 weather shield is supplied disassembled. Supplying it in this manner makes it applicable to a wider range of field applications. It may be assembled with 2 sides, 2 ends and the cover to completely conceal the actuator. A hole punch can be used to provide a hole to mount a wire conduit. A foam gasket is also provided to achieve a better seal between the cover and sides or from the base to the mounting surface. If desired, a side or end can be deleted from the assembly to provide easy access from the bottom of the enclosure.

General Instructions:
1. The actuator mounting strap must be shortened by 1 1/8 inches on both ends. (At the closest oblong slot to the end).
2. Install the actuator following the instructions for the actuator used.
3. Determine which side of the enclosure requires holes for wiring. To ease installation, holes should be made in the housing prior to assembly.
4. Assemble the ends and sides together first, then attach the cover.
5. If using the gasket, peel off the backing from the gasket and lay it onto the surface without stretching it. If stretched, it may pull loose with age.
6. Thread the wiring temporarily through the wiring hole(s).
7. Center the housing over the actuator and mount the housing to the mounting surface with self-drilling screws.
8. Remove the cover from the housing and install conduit/fittings to the housing.
9. Check the operation of the actuator prior to re-installing the cover.
10. Re-install the cover.

Accessories
ZS-101 Base mounting plate

Material: 16 GA Galvanized
Weight: 3.5 lbs.
Note: The ZS-100 is supplied disassembled
**ZS-150 Weather Shield**

For all damper actuators

**Application**
The ZS-150 weather shield provides moderate protection to actuators which are mounted outdoors. This product is not designed as a water tight enclosure. The one piece, smoke tinted, polycarbonate housing allows easy mounting over all damper actuators. The tinted, clear housing allows easy viewing of the actuator in operation.

**Installation**
The ZS-150 weather shield is supplied as a one piece enclosure. Two 7/8 inch wiring holes are pre-drilled to allow easy connections of conduit to the housing. If connections must be made to a different spot on the enclosure or only one hole is required, two plastic plugs are provided to seal the holes. A foam gasket is also provided to achieve a better seal between the base of the enclosure to the mounting surface.

**General Instructions:**
1. The actuator anti-rotation strap must be shortened by 2 inches on both ends.
2. Install the actuator following the instructions for the actuator used.
3. If using the gasket, peel off the backing and lay it onto the housings flange surface without stretching it. If stretched, it may pull away with age.
4. Attach the conduit fitting(s), if used, to the housing and thread the cable(s) through the fitting(s).
5. Center the housing over the actuator and fasten the housing to the mounting surface with self-drilling screws.

**Material:**
- **Polycarbonate**
- **Color:** Clear, smoke tinted
- **Weight:** .8 lbs [.4 kg]
Application

The ZS-260 explosion-proof housing may be used with the GM..., AM..., SM..., AF..., NF..., LF... series actuators. This housing is not designed for direct coupling. It is for use in Class I, II and III hazardous locations, and to meet the requirements for NEMA 4, 7 & 9 type enclosures.

Operation

The ZS-260 enclosure is designed so that the required actuator may be easily field mounted into the enclosure. The actuator is fastened on to the internal portion of the operating shaft and secured at the end with an anti-rotation strap. A crank-arm, such as the KH8, is mounted to the external portion of the operating shaft for connection to connection to the damper linkage. ZG-109 right angle, and ZG-110 stand-off mounting brackets may be used (see back).

The ZS-260 is designed so that the operating shaft can be mounted on either the front or rear side of the housing.

Accessories

KH8 Universal crankarm
KG8 Universal ball joint
KG10 Universal ball joint
ZG-109 Right angle mounting bracket
ZG-110 Stand-off mounting bracket

Technical Data

<table>
<thead>
<tr>
<th>Technical Data</th>
<th>ZS-260</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Housing: cast, copper-free, aluminum, Cover bolts: stainless steel Operating shaft: stainless steel</td>
</tr>
<tr>
<td>Conduit holes</td>
<td>3/4”–14 NPT (2 supplied) see Note 1</td>
</tr>
<tr>
<td>Operating shaft diameter</td>
<td>1/2 inch</td>
</tr>
<tr>
<td>Operating shaft location</td>
<td>Front or rear side of housing (Field selected)</td>
</tr>
<tr>
<td>Approved applications</td>
<td>UL &amp; CSA, Class I, II &amp; III; Group B, C, D, E, F &amp; G NEMA 7, Class I, Groups B, C &amp; D NEMA 9, Class II, Groups E, F &amp; G NEMA 4</td>
</tr>
<tr>
<td>Weight</td>
<td>31.0 lb. (14.0 kg) without actuator</td>
</tr>
</tbody>
</table>

Note 1: Fittings that meet the requirements of the hazardous location must be used. All applications must comply with applicable local and/or national electric code.

Note: Since conditions of use of this product are outside the control of Belimo, the purchaser should determine suitability of the product for their intended use, and assumes all risk and liability in connection therewith.
ZS-260 Mounting Instructions

1. Determine proper operating shaft location.
2. Remove threaded plug from the hole in which the operating shaft will be mounted.
3. Install the anti-rotation strap, mounting plate, to the side of the housing where the operating shaft will be mounted.
4. From the inside surface of the housing, insert the operating shaft, short length first, into the mounting hole.
5. Hand tighten the shaft bushing into the housing until the star nut/seal is in contact with the face of the housing.
6. Using a screw driver blade, drive the star nut/seal clockwise until the bushing is locked into place.
7. Install the anti-rotation strap into the mounting plate at the designated holes for the actuator to be used.
8. Install actuator
9. Wire actuator (per electrical code).
10. Bolt housing together
ZS-300 Protective Housing

Technical Data ZS-300 (-1) (-5)

- **Material**: All 304 stainless steel housing, door, (with neoprene gasket), shaft, coupling, universal mounting plate, and hardware.

- **Conduit holes**: Field drilled as required. U.L. listed electrical fittings for NEMA 4X conditions must be used.

- **Operating shaft**: 1/2" by 5 15/16" long 304 stainless steel with integral coupling for direct mounting to 1/2" round or hexagonal drive shafts. Square head set screws are 304 stainless steel.

- **Optional shafts (Ordered separately)**:
  - ZS-300-C1: 1/2" shaft adaptor (standard with housing)
  - ZS-300-C2: 3/4" shaft adaptor
  - ZS-300-C3: 1" shaft adaptor

- **Rotating shaft seal**: Machined PVC hub, bronze oilite bearings, 10 PSI, Nitrile, bi-rotational, hydrodynamic, radial lip Wave seal.

- **Industry standards**: The Belimo ZS-300 NEMA 4X enclosure and Belimo model SM, GM, AM, AF, NF and LF are U.L. listed as an assembly. These enclosures conform to the NEMA standard for Type 4X (water-, dust-tight and corrosion resistant).

- **Weight**: 11 lbs. [5 kg] without actuator or mounting brackets.

ZS-300 NEMA 4X Housing

For AM, SM, GM, AF, NF, LF Series Actuators

**Application**
The ZS-300 (-1) NEMA 4X enclosures may be used with SM, GM, AM, AF, NF and LF Belimo actuators. They are intended for use primarily to provide protection against corrosion, windblown dust and rain, splashing water, hose-directed water; undamaged by the formation of ice on the enclosure. Type 304 stainless steel enclosures resist moisture, dust, salt, and corrosive chemicals, and are easy to keep clean for sanitary applications.

**Operation**
The ZS-300 enclosures are designed so that the required actuator may be easily mounted in the enclosure. The operating shaft and coupling are inserted from the backside through the rotating shaft seal. The actuator is fastened on the end of the operating shaft and secured at the end with an anti-rotation strap. Adjustable mounting brackets, if supplied, are assembled to the fixed mounting holes at the top and bottom of the enclosure with stainless steel nuts, bolts and lock washers. The direct drive coupling is designed for a 1/2" round or hexagonal shaft and secured with two square head set screws. Mounting brackets are adjusted and secured in place.

**Ordering Information**
- ZS-300: Housing with mounting brackets
- ZS-300-1: Housing without mounting brackets
- ZS-300-5: 316L enclosures, custom mounting brackets and operating shaft/couplings are available. Consult Belimo.

**Accessories**
- ZS-300-BK: Mounting bracket set
- ZS-300-C1: 1/2" shaft adaptor (standard with housing)
- ZS-300-C2: 3/4" shaft adaptor
- ZS-300-C3: 1" shaft adaptor
ZS-300 Mounting instructions

1. The damper operating shaft should extend approximately 1 1/2 inches from the damper assembly or duct side. Mount the drive shaft/coupler to the damper operating shaft. Fasten the coupler to the damper operating shaft by tightening the two 3/8 inch square head set screws.

2. Determine the housing mounting orientation for the application.

3. Locate the housing hole position(s) for the control wiring of the actuator.

4. Make the necessary holes in the housing for the electrical fittings. All fittings must be rated for use in NEMA 4X applications.

5. Install (if ordered with) the 2 mounting brackets to the housing using the four 1/4-20 screws, washers, and nuts. Do not tighten.

6. Carefully slide the housing over the drive shaft.

7. Place the housing in the desired mounting position. Transfer the mounting hole locations from the mounting bracket to the mounting surface.

8. Drill the 4 holes and fasten the brackets to the surface.

9. Install the anti-rotation strap to the housing in the correct location for the actuator which is being used.

10. Mount the actuator to the drive shaft using the instructions for the actuator being used. Finger tighten the nuts of the universal clamp. Make sure the back of the actuator is parallel to the back of the housing.

11. The operating shaft must pass through the mounting clamp at least 3/8 of an inch. It must not extend beyond the front of the housing. Slide the actuator/housing assembly in the mounting brackets to obtain the proper position.

12. Tighten the mounting brackets to the housing. Verify that the back of the actuator is still parallel to the back of the housing. Tighten the nuts on the universal clamp.

13. Make all of the required electrical connections.

14. Test the actuator/damper operation.

15. Fasten the housing cover using the 6 swivel clamps.
## Electronic Accessory Usage Chart

<table>
<thead>
<tr>
<th>BELIMO ACTUATOR</th>
<th>S1, S2 Auxiliary Switch</th>
<th>P... Feedback Potentiometer</th>
<th>SGA24, SGF24 Positioners</th>
<th>PTA-250 Pulse Width Modulation Interface</th>
<th>IRM-100 Input Rescaling Module</th>
<th>ADS-100 Analog to Digital Switch</th>
<th>NSY24 Battery Back-up Module</th>
<th>ZG-R01 Resistor For 4 to 20 mA Conversion</th>
<th>ZG-R02 50% Voltage Divider</th>
<th>ZG-R03, ZG-R05, ZG-R06 Resistor Kits (For multiple actuators with Honeywell Series 90 controllers)</th>
<th>ZG-X40 Transformer</th>
<th>ZG-HTR Thermostat/Heater Kit</th>
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<td>●</td>
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</tr>
<tr>
<td>LF24-3 (-S) US</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
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<td>●</td>
<td>●</td>
<td>●</td>
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<td>●</td>
</tr>
<tr>
<td>LF24-MFT US</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
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</tr>
<tr>
<td>NF24 (-S) US</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
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<td>●</td>
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</tr>
<tr>
<td>NF24-SR US</td>
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<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>NF120 (-S) US</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>NF24-MFT US</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>AF24 (-S) US</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
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<td>●</td>
<td>●</td>
</tr>
<tr>
<td>AF24-SR (-S) US</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>AF24-MFT US</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>AF24-MFT95 US</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>AF120 (-S) US</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>AF230 (-S) US</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

**Notes:**
- BELIMO ACTUATOR
- BELIMO ELECTRONIC ACCESSORY
- See Page No.
A CLOSER LOOK...

We’ll help solve any application problem with a wide range of accessories and unparalleled customer service.

The Belimo Difference

- **Customer Commitment.**
  - Extensive product range. Competitive project pricing. 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.
  - 20+ years direct coupled actuator design.
**S1, S2 Auxiliary Switches**

For the direct coupled actuator SM2.../ GM2...

**Application**
The S1 and S2 auxiliary switches are used to indicate when a desired position of a damper is reached or to interface additional controls for a specific control sequence.

**Operation**
The S1 and S2 auxiliary switches are mounted onto the direct coupled actuator. A spindle transmits the rotary motion of the actuator positively to the switching segments. Any switching point on the micro-switches over the full scale of 0 to 10 can be selected by means of the slotted disc, which can be locked by the fixing screw in the hub of the disc. The position of the switch can be read at any time.

If required, the S1 and S2 can also be mounted on a P... feedback potentiometer, but 2 auxiliary switch units cannot be mounted on top of each other.

**Assembly**
Use the 4 long bolts, where a S1, S2 auxiliary switch is mounted on top of a P... potentiometer.

**Switch setting**
1. Turn actuator by hand to the 0 setting.
2. Loosen fixing screw in the center of the slotted disc.
3. Select the desired switching point on the scale marked 0 to 10 by rotating the slotted disc.
4. Re-lock the fixing screws.
5. Check the switching points by turning the actuator by hand. The slotted disc follows rotation. The micro-switches operate when the arrow passed the positions 0 or 10 (white line). The switching symbols indicate the actual switching positions.

**Note:** with the S1, S2 auxiliary switches, the reversible indicator cannot be used. Use the 4 long bolts when the S1, S2 auxiliary switches are used with the SM24-SR US or GM24-SR US.

---

**Technical Data S1 | S2**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>S1</th>
<th>S2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of switches</td>
<td>1 SPDT</td>
<td>2 SPDT</td>
</tr>
<tr>
<td>Switching capacity</td>
<td>7A (2.5 A) 250 VAC</td>
<td></td>
</tr>
<tr>
<td>Switching point</td>
<td>adjustable over full actuator rotation 0 to 10. Pre-setting with scale possible. Set switching points lockable.</td>
<td></td>
</tr>
<tr>
<td>Electrical connection</td>
<td>3 ft, 18 GA appliance cable</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>5 to 95% RH non-condensing</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>-22°F to +122°F [-30°C to +50°C]</td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°F to +176°F [-40°C to +80°C]</td>
<td></td>
</tr>
<tr>
<td>Housing</td>
<td>NEMA type 2</td>
<td></td>
</tr>
<tr>
<td>Housing rating</td>
<td>UL94V-0 (flammability rating)</td>
<td></td>
</tr>
<tr>
<td>Servicing</td>
<td>maintenance free</td>
<td></td>
</tr>
<tr>
<td>Agency listings</td>
<td>CE</td>
<td></td>
</tr>
<tr>
<td>Quality standard</td>
<td>ISO 9001</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>5.3 oz [150 g]</td>
<td>7.4 oz [210 g]</td>
</tr>
</tbody>
</table>
Application
The P... feedback potentiometers are used for continuous damper control in conjunction with normal commercial P-controllers with feedback signals. The P... units can also be used in conjunction with moving coil instruments for position indication, or they can serve as a positioner for parallel operating actuators when used with normal commercial controllers.

Operation
The P... feedback potentiometer is mounted onto the damper actuators. A spindle transmits the rotary motion of the motor positively to the potentiometer, and no adjustments whatsoever are necessary. If required, 2 potentiometer units P... can be mounted on top of each other.

Assembly
Use the 4 long bolts, where 2 P... units are mounted on top of each other.

Types

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>P500</td>
<td>Feedback potentiometer</td>
<td>500Ω</td>
</tr>
<tr>
<td>P1000</td>
<td>Feedback potentiometer</td>
<td>1000Ω</td>
</tr>
<tr>
<td>P2800</td>
<td>Feedback potentiometer</td>
<td>2800Ω</td>
</tr>
</tbody>
</table>

Technical Data

- **Resistance values**: as above
- **Output**: 1W
- **Tolerance**: ± 5%
- **Linearity**: ± 2%
- **Resolution**: min. 1%
- **Residual resistance**: max. 5% on both sides
- **Electrical connection**: 3 ft, 18 GA appliance cable 1/2” conduit connector
- **Humidity**: 5 to 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 type 2
- **Housing rating**: UL94V-0 (flammability rating)
- **Servicing**: maintenance free
- **Quality standard**: ISO 9001
- **Weight**: 5.3 oz [150 g]
SGA24, SGF24 Positioners

For proportional actuators with a working range of 0 to 10 VDC or 2 to 10 VDC

Application
These positioners are intended for the remote control of modulating actuators or for use as a minimum positioner (providing a minimum limit for the output signal from a modulating controller). The control range is 0 to 100% of the angle of rotation of the actuator.

Positioner SGA24 is for surface mounting with a NEMA 4 housing included. Positioner SGF24 is for flush mounting.

Operation
The positioner receives its supply voltage through terminals 1 and 2. A rotary knob is turned, producing a proportional control signal (Y) at the output (terminal 3) of either .5 to 10 VDC or 2 to 10 VDC and therefore a proportional change in the position of the actuator between 0 and 100%. When used for a minimum limit, the positioner works as a higher of 2 signal selector. This function allows only the signal from the controller or positioner, whichever is greater, to go to the actuator.

Function
The changeover from 2 to 10 V to 0 to 10 V is selected by means of a slide switch on the printed circuit board. The angle of rotation of the knob can be limited mechanically, by moving the adjustable stops under the knob.

Accessory
ZG-SGF Mounting plate for single gang wiring box

Changeover switch

Drilling template for SGF24 (flush mount)

Dimensions
All ratings in brackets are metric.
Pulse Width Modulation Interface PTA-250

To convert a pulse width modulated signal to a 2 to 10 VDC signal for Belimo proportional actuators. (Series 3)

Application
The PTA-250 converts a single pulse-width modulated input to an analog, 2 to 10 VDC, output to modulate a Belimo-SR actuator. The PTA-250 is available for replacement of existing installations. The ...MFT product can replace 100% of the PTA-250 applications, more effectively.

Operation
A timed contact or solid state closure from the controlling microprocessor controller is converted to a linear analog output with 256 steps of resolution. The last output is held until the PTA-250 receives the end of the next pulsed output. The PTA-250’s output will not wrap around if an excessively long input pulse is received. Four input pulse clock rates are jumper selectable. Normal/Triac input positions are also jumper selectable. The input signal can be optically isolated from the PTA-250 circuit and can accept either positive or negative polarity. A red LED indicator is provided to indicate that power is applied to the PTA-250 and that the microprocessor is functioning. A green LED indicator is provided to indicate the presence of a pulse from the controller.

Note: The onboard zero and span adjustments are not for field use.

Pulse timing selection

<table>
<thead>
<tr>
<th>Range 1</th>
<th>Range 2</th>
<th>Range 3</th>
<th>Range 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0235</td>
<td>0.0235</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>0.0235</td>
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<tr>
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<td>0.1</td>
</tr>
<tr>
<td>0</td>
<td>0.0196</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>0.0235</td>
<td>0.0235</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>0</td>
<td>0.0196</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Normal/Triac input selection

Control interface drawings

Dimensions

PTA-250

- Weight: 1.5 oz
- Dimensions: 2 3/16" x 2 1/4" x 9/16"
IRM-100 Input Rescaling Module

To adjust the zero start point and working span of Belimo proportional (. . . –SR) actuators.
(Series 3)

Application
The IRM-100 input rescaling module is designed to change non-standard voltage or current signal levels into a 2 to 10 VDC output to modulate Belimo -SR type actuators. The IRM-100 is available for replacement of existing installations. The . . . MFT product can replace 100% of the IRM-100 applications, more effectively.

Operation
The IRM-100 is installed between a controller and a Belimo ...-SR actuator. The module can be adjusted to work with a zero offset of 0 to 18 VDC and a span range of 2.6 to 17 VDC. The IRM-100 has a 2 pin jumper mounted to the circuit board. When the jumper is connected between these 2 pins, a 4 to 20 mA signal can be fed directly into the IRM. The result being the conversion of a wide range of analog control signals to a 2 to 10 VDC range.

The IRM-100 may also be used to sequence several actuators from one signal source. This is done by adjusting the IRM units to work at different input ranges. (Example: 2 to 5 VDC, 5 to 8 VDC, 8 to 11 VDC, etc.)

Calibration
1. Attach a variable signal source to the input and power wires to the IRM-100.
2. Apply power.
3. Input the minimum signal level.
4. Adjust the offset potentiometer to produce a 2 VDC signal at the output. A clockwise rotation of the potentiometer screw will increase the output signal.
5. Input the maximum signal level.
6. Adjust the span adjustment to produce a 10 VDC signal at the output. A clockwise rotation of the potentiometer screw will increase the output signal.
7. Double check the input-output calibration and install.

Technical Data

| IRM-100  |
|-----------------|-----------------|
| Power supply   | supply voltage: 24 VAC ± 15% |
| Power consumption | < 1 watt          |
| Transformer sizing | 1 VA               |
| Input voltage:  | max voltage: 25 VDC |
| zero (starting point): 0 to 18 VDC |
| span adjustment: 2.6 to 17 VDC |
| impedance: 400 KΩ |
| current: 0 to 20 mA |
| impedance: 500 Ω |
| Output voltage: | 2 to 10 VDC |
| current: 15 mA max |

Electrical connection wire terminals, 14 gauge max

Ambient temperature -20°F to +150°F [-30°C to +65°C]

Humidity 5 to 95% RH non-condensing

Mounting Snap-Track (provided)

Dimensions board: 1 3/16” x 2 3/16” x 9/16”

w/Snap-Track: 1 7/8” x 2 3/8” x 15/16”

Weight .9 oz.

Dimensions

2 3/8”

-1 7/8”

15/16”
**Application**
To control reheat coils and/or a fan stage in a fan-powered terminal unit. The ADS-100 is controlled by a 2 to 10 VDC reheat output of a temperature controller. (TRS-M)

**Operation**
The ADS-100 is designed to switch up to three independent stages of reheat on and off, according to a 2 to 10 VDC signal. The three output stages are furnished with a triac output. Each stage can be adjusted independently from each other over the 0 to 2.4° F throttling range of the TRS-M temperature controller.

The ADS-100 is shipped pre-adjusted, as shown in the following table. (Based on differential from setpoint)

<table>
<thead>
<tr>
<th>Stage</th>
<th>1st. stage</th>
<th>2nd. stage</th>
<th>3rd. stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switch ON</td>
<td>-0.45°F</td>
<td>-1.35°F</td>
<td>-2.25°F</td>
</tr>
<tr>
<td>Switch OFF</td>
<td>-0.15°F</td>
<td>-1.05°F</td>
<td>-1.95°F</td>
</tr>
<tr>
<td>Switch ON</td>
<td>2.8V</td>
<td>5.8V</td>
<td>8.8V</td>
</tr>
<tr>
<td>Switch OFF</td>
<td>0.4V</td>
<td>0.2V</td>
<td>0.4V</td>
</tr>
</tbody>
</table>

If desired, each stage may be field readjusted for special requirements. Three red LED indicators are provided to verify when the stages are energized.

**Setpoint readjustment**
Tools required: small screwdriver, voltmeter.
To readjust the output stages, the following procedure is used: Connect the voltmeter to the desired switchpoint reference signal output and terminal 1 (COM). Readjust the switch point reference signal output with the corresponding potentiometer to your desired switch point. The adjustment range is 2.5 to 9.5 VDC. If you go below or above these values the ADS-100 may not switch off or on properly.

If this occurs you have to increase or decrease your switching level until the ADS-100 works correctly.

**Technical Data**

<table>
<thead>
<tr>
<th>ADS-100</th>
<th>Power supply</th>
<th>24 VAC ± 20% 50/60 HZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption</td>
<td>1.5 W</td>
<td></td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>3 VA (not including contactors)</td>
<td></td>
</tr>
<tr>
<td>Electrical connection</td>
<td>9 pole wire-terminal</td>
<td></td>
</tr>
<tr>
<td>Control input</td>
<td>2 to 10 VDC</td>
<td></td>
</tr>
<tr>
<td>Input impedance</td>
<td>100 K Ω</td>
<td></td>
</tr>
<tr>
<td>Adjusting range</td>
<td>2.5 to 9.5 VDC</td>
<td></td>
</tr>
<tr>
<td>Dead band</td>
<td>.3°F fixed</td>
<td></td>
</tr>
<tr>
<td>Switching capacity</td>
<td>24 VAC 10 VA max. (voltage sinking triac)</td>
<td></td>
</tr>
<tr>
<td>Mounting</td>
<td>Snap-Track (provided)</td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td>3 1/4” x 2” (3 7/16” x 2” w/snap-track)</td>
<td></td>
</tr>
</tbody>
</table>

**Dimensions**

![Dimensions Diagram]
Application
Several Belimo damper actuators can be used either with 24 VAC or 24 VDC.
In case of a power failure, the NSV24 battery back-up unit switches the damper actuator from its main AC power supply over to the 24 VDC battery to drive the actuators to their safety position.
For easy maintenance, the battery back-up system is placed in the control panel, not in the actuator.
Several actuators may be powered by one back-up module.
The batteries are separate from the NSV24.

Operation
The NSV24 is connected to the same 24 VAC power source as the damper actuators. It also charges the 24 V (2-12 volt batteries) storage battery. Its charge current is limited to 150 mA maximum, and the maximum charge voltage is temperature compensated.
In case of a power failure, the NSV24 switches immediately over to the battery power source, and according to the control function, the actuators will move to their safety position.
After 250 seconds, the batteries are disconnected from the actuators to prolong battery life. Because of this, a safe battery back-up can be provided for several short-term failures.
The main power source operation is indicated by a green LED, and the battery power source by a red LED.

Connectable Actuators

<table>
<thead>
<tr>
<th>Model</th>
<th>Maximum per module</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM24 US</td>
<td>20</td>
</tr>
<tr>
<td>GM24-MFT US</td>
<td>15</td>
</tr>
<tr>
<td>GM24-SR US</td>
<td>15</td>
</tr>
<tr>
<td>AM24 US</td>
<td>30</td>
</tr>
<tr>
<td>AM24-MFT US</td>
<td>30</td>
</tr>
<tr>
<td>AM24-SR US</td>
<td>30</td>
</tr>
<tr>
<td>NM24 US</td>
<td>30</td>
</tr>
<tr>
<td>NM24-MFT US</td>
<td>30</td>
</tr>
<tr>
<td>NM24-SR US</td>
<td>30</td>
</tr>
<tr>
<td>LM24-3 US</td>
<td>30</td>
</tr>
<tr>
<td>LM24-MFT US</td>
<td>30</td>
</tr>
<tr>
<td>LM24-SR-2.0 US</td>
<td>30</td>
</tr>
</tbody>
</table>

Accessories
NSV-BAT 12 VDC 1.3 Ah battery (2 required)

Dimensions

Technical Data

- **NSV24**
  - **Power supply**: 24 VAC ± 20% 50/60 Hz
  - **Fusing**: 4A slow blow fuse
  - **Power consumption**: Min. 5W (without actuator load)
  - **Transformer**: 8 VA
  - **Batteries**: 24 V Nominal 1.2 Ah (2-12 volt lead-acid batteries; batteries not supplied with module)
  - **Maintenance**: The batteries should be checked annually (approximate life is 6 years)
  - **Charging circuit**: Charge current max. 150 mA
  - **Battery back-up operation**: 24 V nominal 1.2 Ah, max. 60 W auto shut off after 250 seconds
  - **Indication LED**: Green - Main power source operation (battery will be charged) Red - Battery back-up operation
  - **Mounting**: Mounted in the control panel with an 11 terminal plug-in base (not supplied with module)
  - **Ambient temperature**: 14°F to +122°F [-10°C . . . +50°C]

Note:
Fail-safe direction must have normally closed contact.

This diagram is shown in the “failed” mode and prior to the 250 sec time-out function.
**Application**
The NSV-BAT battery is for use with the NSV24 battery back-up module. It is a sealed, maintenance free, lead-acid battery. Two NSV-BAT batteries are required for one NSV24.

**Dimensions**

The NSV-BAT battery dimensions are as follows:

- **Height**: 2.13" [54 mm]
- **Width**: 3.82" [97 mm]
- **Depth**: 1.65" [42 mm]

**Technical Data**

<table>
<thead>
<tr>
<th>NSV-BAT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery type</td>
<td>Lead-acid</td>
</tr>
<tr>
<td>Voltage</td>
<td>12VDC</td>
</tr>
<tr>
<td>Nominal capacity</td>
<td>1.2 AH</td>
</tr>
<tr>
<td>Connections</td>
<td>.187 male spade</td>
</tr>
<tr>
<td>Weight</td>
<td>1.32 lb [.6 kg]</td>
</tr>
</tbody>
</table>

**ZG-R01 Resistor for 4 to 20 mA conversions**

The ZG-R01 is a 499 Ω Resistor which has been encased in a section of heat shrink tubing with short sections of hook up wire. The ZG-R01 is used to convert a 4 to 20 mA signal into a 2 to 10 VDC control signal.

**Dimensions**

- **Approx. 9"**

**ZG-R02 50% voltage divider**

The ZG-R02 is a voltage divider designed so that when connected to a 100 KΩ input impedance, the output signal is 50% if the input signal. The voltage divider circuit is encased in a short section of heat shrink tubing with three short sections of hook up wire.

**Dimensions**

- **Approx. 10"**

**The impedance of the device attached must be 100kΩ.**

**Resistor kits for multiple actuator applications**

<table>
<thead>
<tr>
<th>Number of Actuators</th>
<th>Resistance Ω</th>
<th>Number of Actuators</th>
<th>Resistance Ω</th>
<th>Number of Actuators</th>
<th>Resistance Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>140</td>
<td>2</td>
<td>150</td>
<td>2</td>
<td>1300</td>
</tr>
<tr>
<td>3</td>
<td>71.5</td>
<td>3</td>
<td>124</td>
<td>3</td>
<td>910</td>
</tr>
<tr>
<td>4</td>
<td>47.5</td>
<td>4</td>
<td>113</td>
<td>4</td>
<td>768</td>
</tr>
<tr>
<td>5</td>
<td>37.5</td>
<td>5</td>
<td>105</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>28</td>
<td>6</td>
<td>97.6</td>
<td>6</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Resistor Kit No.</th>
<th>ZG-R03</th>
<th>Resistor Kit No.</th>
<th>ZG-R05</th>
<th>Resistor Kit No.</th>
<th>ZG-R06</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td>3</td>
<td></td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

**Application**

For use with the AF24-MFT95 US or SM24-SR94 US actuators and Honeywell® controllers

- ZG-R03 - see table to left
- ZG-R05 - see table to left
- ZG-R06 - see table to left
Application
The ZG-CBNS US accessory is used when the application requires the wiring terminations to be made at the actuator.

Operation
The ZG-CBNS US serves as an electrical junction box. The products that can be used with this accessory are as follows:

NF24 US, NF24-S US, 
NF120 US, NF120-S US, 
NF24-SR US, NF24-MFT US, 
NF24-S2 US, 
AF24 US, AFR24 US, AFR24-S US, 
AF120 US, AFR120 US, AFR120-S US, 
AF230 US, 
AF24-SR US, AFR24-SR US, AFR24-MFT US

Due to the internal volume of this junction box, according to UL requirements, The ZG-CBNS US CANNOT be used with the following products:

NF24-S2 US, 
AF24-S US, 
AF120-S US, 
AF230-S US

Assembly and Installation
1. Remove supply voltage from the actuator and/or the auxiliary switch.
2. Remove the plastic insert from the actuator conduit fitting (1).
3. Cut the actuator cable(s) to approximately 6 inches. Remove approximately 4 inches of the black cable insulation. Be sure not to damage the insulation of the conductors inside. This will void the actuators warranty.
4. Insert the actuator cable(s) into the junction box holes (A and B). Slide the housing towards the actuator.
5. Insert the cable(s) through strain relief assembly (3), thread strain relief assembly to the actuator conduit fitting (1) and tighten. Thread the nut (4) over the cable and tighten. Repeat process for the second cable. If no second cable is present, use the plug (5) with the nut (4). The second strain relief assembly is required to properly secure the housing to the actuator.
6. Assemble the cover and gasket: Knock out the appropriate conduit hole in the junction box cover (7). Pull field wiring through the hole in the cover and install the field supplied conduit fitting. Optional, knockouts are available at the sides of the junction box.
7. When wiring connections are completed, secure the box cover in place with the supplied screws (8).
8. Install the actuator.
Power supply, signal simulator PS-100

Application
The PS-100 power supply and signal simulator is designed to operate most proportional, floating, and on-off style actuators without the presence of a controller. The PS-100 can produce 24 VAC on-off and floating control signal along with a 0 to 10 VDC and 135Ω proportional signal. A multi-function digital display is provided which can read either the 0 to 10 VDC output or a 0 to 10 VDC feedback signal either as voltage or percentage of control. The PS-100 comes with a 120 to 24 VAC, plug into the wall transformer for power. Both the PS-100 and transformer are supplied in a black fabric carrying case.

Replacement Power Supply: PS-XFMR

Technical Data

<table>
<thead>
<tr>
<th>PS-100</th>
<th>120 VAC 50/60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply:</td>
<td>Primary: 120 VAC, 35 W</td>
</tr>
<tr>
<td>Transformer:</td>
<td>PN: PS-XFMR</td>
</tr>
<tr>
<td>Terminal outputs:</td>
<td>Push-button, wire terminals (12)</td>
</tr>
<tr>
<td>Input:</td>
<td>On-off, Floating Point</td>
</tr>
<tr>
<td>135Ω, 0 to 10 VDC:</td>
<td>Input: 0 to 10 VDC</td>
</tr>
<tr>
<td>Display:</td>
<td>LCD</td>
</tr>
<tr>
<td>Readouts, Output:</td>
<td>0 to 10 VDC in volts or percentage based on a 2 to 10 VDC control span</td>
</tr>
<tr>
<td>Readouts, Input:</td>
<td>0 to 10 VDC in volts or percentage based on a 2 to 10 VDC control span</td>
</tr>
<tr>
<td>Weight:</td>
<td>3 lbs [1.4 kg] with case</td>
</tr>
</tbody>
</table>

Dimensions

Refers to appropriate actuator documentation for specific VA ratings.
ZG-HTR NF/AF Thermostat/heater Kit

For NF/AF Series actuators

Application
The ZG-HTR Thermostat/Heater kit is designed to be field installed to the NF and AF series actuators. The ZG-HTR provides a thermostatically controlled heater which allows the NF/AF actuators to be used below their normal low ambient temperature rating. At approximately 10°F [-12°C] the heater energizes to maintain the actuators internal temperature to within working limits. The rubberized heating element has an adhesive back which attaches to the side of the actuator housing. The thermostat assembly mounts to the rear of the actuator and provides for the connection of the 24 VAC supply voltage. The actuator/heater assembly should be contained in a housing, similar to the ZS-100 Weather Shield, to achieve best results.

Instructions
1. Determine which side of the NF/AF actuator the heater element will be fastened to.
2. Clean the mounting surface to remove any dust, oil film, etc. which may prevent the heater from attaching securely. A cleaning solvent which leaves no residue is recommended.
3. Carefully peel back the clear plastic backing from the heater element. Care must be taken not to handle the adhesive back or have it make contact with any surface prior to mounting it to the actuator side.
4. Without making contact between the actuator and heater, position the heater element so that the wire end is towards the rear of the actuator. The edge by the wire should line up with the center of the 1/4 bolt hole on the top of the actuator as indicated in the drawing at the left. Center the heater element so it is equally spaced from top to bottom on the actuator side.

   Warning: Once the adhesive back makes contact with the actuator surface, it should not be removed.

5. Carefully make contact with the top side of the heater and gradually roll the heater element to make full contact with the actuator side.

Dimensions (All numbers in brackets are metric.)

<table>
<thead>
<tr>
<th>Technical Data</th>
<th>ZG-HTR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply</td>
<td>24 VAC ± 20% 50/60 Hz</td>
</tr>
<tr>
<td>Transformer sizing</td>
<td>35 VA</td>
</tr>
<tr>
<td>Heater output</td>
<td>35 watts</td>
</tr>
<tr>
<td>Actuator low ambient rating with enclosure:</td>
<td>-40°F [-40°C]</td>
</tr>
<tr>
<td></td>
<td>enclosure with 1&quot; insulation:</td>
</tr>
<tr>
<td>Weight</td>
<td>11 oz [320 g]</td>
</tr>
</tbody>
</table>

*with K4-1 US clamp
6. If a conduit fitting is supplied with the actuator, on the side of the actuator which will have the wiring box, remove and discard the 2 screws which fasten the conduit fitting to the actuator.

7. Position the wiring box at the rear of the actuator. Mount the wiring box to the rear of the actuator using only the left screw, the one shown without a washer.

   **Note:** If the conduit fitting is not provided on the model actuator being used, use the nuts provided to secure the wiring box to the actuator.

8. Feed the cable from the heater element through the slot at the rear of the actuator into the hole in the bottom of the wiring box.

9. Slip the cable through the wire clamp removing any slack in the wire from the heater to the fastening point in the wiring box. Fasten the clamp to the actuator using the remaining screw and washer.

10. Determine which conduit fitting hole in the wiring box will be used to provide the power source to the heater circuit.

11. Remove the desired knock-out in the wiring box and, if used, fasten the conduit fitting.

12. Install the actuator following the actuator installation instructions.

13. Fasten one of the red heater wires to one of the black thermostat wires using the wire nut supplied.

14. Connect 24 VAC power to the remaining wires.

15. Fasten the thermostat/cover assembly to the wiring box.
### Application Information

#### Special Control Range Applications

<table>
<thead>
<tr>
<th>Control Signal</th>
<th>Belimo Actuator</th>
<th>Accessory</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 5 VDC</td>
<td>LM24-MFT US</td>
<td>None</td>
<td>Preset at factory or use MFT Handy device Set start point for 1 VDC, span for 4 VDC</td>
</tr>
<tr>
<td></td>
<td>NM24-MFT US</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AM24-MFT US</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GM24-MFT US</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NF24-MFT US</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AF24-MFT US</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>LF24-MFT US</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 to 20 mA</td>
<td>Any -MFT,-SR Actuator</td>
<td>ZG-R01, or 500Ω, 1/2 w resistor</td>
<td>Wire the ZG-R01 across the wires #1 and #3</td>
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<tr>
<td>10.5 to 13.5 VDC</td>
<td>LM24-MFT US</td>
<td>None</td>
<td>Preset at factory or use MFT Handy device Set start point for 10.5 VDC, span for 3 VDC</td>
</tr>
<tr>
<td></td>
<td>NM24-MFT US</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AM24-MFT US</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>14 to 17 VDC</td>
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<tr>
<td>Pulse Width Modulation</td>
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</tr>
<tr>
<td></td>
<td>LF24-MFT US</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Preset at factory or use MFT Handy device

IRM-100 Calibrate the IRM-100 for an input range of 1 to 5 VDC. Calibrate IRM-100 2-10 in 2 to 10 out for signal amplification.

### Sequencing Two or More Actuators With One Control Signal using the IRM-100

![Diagram showing sequencing of actuators with one control signal using the IRM-100](image)

- Provide overload protection and disconnect as required.
- Actuator and controller must have separate transformers.
- Consult controller instruction data for more detailed installation information.
- 500Ω resistor if signal provided is 4 to 20 mA
**IRM-100 used as a current amplifier**

In some applications, the capacity of a controller output may not have current available to control multiple end devices. An example would be a controller which has an output current of .5 mA maximum. If 10 AFR24-SR US actuators have to be driven from the same output, the current requirement would be \( I = \frac{E}{R} = \frac{10 \text{ volts}}{100000 \Omega} = .1 \text{ mA} \) for each actuator. For the 10 actuators, 1 mA of current would be necessary to properly control the actuators.

The IRM-100 may be used as an interface to provide a higher current capacity to the system. The IRM-100 has an output capacity of 15 mA. This higher level output can handle a greater number of actuators. By calibrating the IRM-100 for a 2 to 10 VDC input to achieve a 2 to 10 VDC output, IRM-100 provides this added capacity for the system.

The same circuit will also work if a 4 to 20 mA signal is used. A 500 Ω resistor is placed across terminal #1 and #3 which converts the 4 to 20 mA to 2 to 10 VDC.

---

**ADS-100 used as an auxiliary switch**

The ADS-100 was originally designed as an accessory to switch on stages of electric reheat from an electronic thermostat. However, it can also function as an electronic auxiliary switch from any device which can provide 0 to 10 VDC signal, such as any feedback wire 5 from any …SR or …MFT type actuator.

The ADS-100 has 3 triac outputs rated at 10 VA maximum each which will turn on, in sequence, with an increasing voltage.
A CLOSER LOOK...

Application Information and Wiring Diagrams for Belimo Products.

The Belimo Difference

- Basic Electricity
- Understanding Wiring Diagrams
- Analog Outputs
- Wiring Diagrams for Belimo Products
- Applications
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I. BASIC ELECTRICITY

I-A. Abbreviations

DC = Direct Current
AC = Alternating Current
VDC = Direct Current Voltage
VAC = Alternating Current Voltage

I-B. Current

A = Ampere
mA = Milliampere = Thousandths of an ampere.  (Example: 12mA = 12/1000 = .012A)
I = The symbol for current in mathematical formulas.

I-C. Voltage

V = Volt*
mV = Millivolt = Thousandths of a volt.  (Example: 5mV = 5/1000 = .005V)
E = The symbol for voltage in mathematical formulas.

I-D. Resistance

Ω = Ohm = Resistance
kΩ = Kilo ohm = Thousands of ohms.  1kΩ = 1,000Ω
MΩ = Megohm = Millions of ohms.  1MΩ = 1,000kΩ = 1,000,000Ω
R = The symbol for resistance in mathematical formulas.

I-E. OHM’s Law

E = Voltage  I = Current  R = Resistance

E = I x R  Example:  I = 20mA,  R = 500Ω  Therefore, E = .020 x 500 = 10V
R = E/I  Example:  E = 1.35V,  I = 10mA  Therefore, R = 1.35/.010 = 135Ω
I = E/R  Example:  E = 120V,  R = 50Ω  Therefore, 120/50 = 2.4A

I-F. Power

W = Watt*
mW = Milliwatt = Thousandths of a watt  (Example: 7mW = 7/1000 = .007W)
kW = Kilowatt = Thousands of watts  (Example: 1kW = 1,000W)

I-G. Power Calculations

W = E x I  Example:  V = 24V,  I = 260mA  Therefore, W = 24 x .260 = 6.24W
W = R x I²  Example 1:  R = 100Ω,  I = 3A  
W = 100 x 3² = 100 x 3 x 3 = 900W
Example 2:  R = 500Ω,  I = 20mA = .020A
W = 500 x .020² = 500 x .020 x .020 = 500 x .0004 = .2W or 200mW.
W = E²/R  Example:  V = 24V,  R = 100,  Therefore, W = 24²/100 = 24 x 24/100 = 5.76W

* I.S.O. standard indicates “U” be used for voltage and “P” for power.
I-H. Series Connection of Resistors

Resistors that are connected in series have a total resistance value that is equal to the sum of all the resistance values of the resistors.

\[ R_{\text{Total}} = R_1 + R_2 + R_3 = 200\,\Omega + 250\,\Omega + 1.0k\,\Omega = 1.45k\,\Omega \]

The total resistance is always larger than the largest single resistor!

I-I. Parallel Connection of Resistors

If all the resistors have the same resistance value, the total resistance will be equal to the resistance value of one resistor divided by the number of resistors.

\[ R_{\text{Total}} = \frac{R}{5} = \frac{100k}{5} = 20k \]

Example: Five equal resistors \( R = 100k \) are connected in parallel. The total resistance \( R_{\text{Total}} = \frac{R}{5} = \frac{100}{5} = 20k \)

If the resistors that are connected in parallel have different values, the following formula must be used:

\[ \frac{1}{R_{\text{Total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \]

\[ \frac{1}{R_{\text{Total}}} = \frac{1}{200} + \frac{1}{250} + \frac{1}{1000} = .005 + .004 + .001 = .01 \]

\[ R_{\text{Total}} = 100\,\Omega \]

I-J. Impedance

The expression “impedance” is used in the BELIMO literature in the following way:

- **Input impedance:** The input circuit of a control device, based on its circuitry, has a certain electrical resistance. The value of this resistance determines how much current the device will draw from the controller. This value must be taken into consideration when connecting any device to a controller output. Example: “Input impedance 100 kΩ.” This means that the DC resistance between the input (Y or Y1) and common (COM) is 100 kΩ (100,000 ohm). When the signal is 10 VDC, using Ohm’s Law (I=E/R), the current draw on the output of the controller will be (10V/100,000 Ω) = .0001A = .1 mA for each actuator that is connected to the signal. The combined input impedance must be higher than the controller output impedance.

Example I: “Input impedance 1000 Ω minimum.” This means that the combined input impedance of the devices being controlled must be greater than 1000Ω.

Example II: “Maximum output current .2 mA.” Based on a 0 to 10 VDC control signal, the output impedance would be equal to R=E/I or (10V)/(.0002A) = 50kΩ

In general, the higher the input impedance, the lower the current draw, therefore less strain on the controller output. The lower the output impedance, the more current available; the more current available, the more devices can be controlled.

I-K. Power Consumption (W) / Volt Amperes (VA)

When a device is powered with direct current (DC), or alternating current (AC) into a pure resistive load (bulb, heater, etc.), the rated power consumption is watts (W) and is the product of the current (I) and voltage (E), \( W = E \times I \).
When an actuator is powered with alternating current (AC), the actual power consumption in watts (W) inside the actuator will remain the same. However, due to the inductive and capacitive character of the load, a shift between current and voltage occurs (phase shift). This results in an “apparent” power consumption, which is higher than the actual power consumption. The “apparent” power consumption is expressed in volt-amperes (VA), which is the product of AC volts and the current (VA = V x I x efficiency.)

The size of a transformer is expressed in volt-amperes (VA) and not in watts (W). **The VA rating of a transformer must be at least as large as the combined VA rating of all the actuators connected to the transformer.**

*Example:* Actuator AM24 US.
Power consumption: 2.5 W. Transformer sizing: 4.5 VA

If five (5) AM24 US are connected to one transformer, the VA rating of the transformer must be 5 x 4.5 VA = 22.5 VA, or larger.

It is better to use a number of small transformers than one large one.

The Belimo products are designed to be powered from Class II transformers for UL applications. These transformers have internal power limitation. A Class II transformer must not provide more than 30 V and no more than 100 VA output. **Do not use a Class I transformer and fuse, because it does not constitute a Class II power source!**

**I-L . Wire Sizing**

Using the correct wire size is important when long wire runs are used. Using too small of a wire increases the resistive losses of the run. The result of this may be too low of a voltage at the actuator to operate correctly. The above chart can be used to determine the correct wire size to use for an application.

*Example I:* Three AM24-SR US actuators are powered from the same wire. The wire run is 100 feet.

Step #1. Calculate the total power required. The AM24-SR US requires 5 VA, 3 actuators are being used. 3 x 5 = 15 VA Total.

Step #2. Locate 15 VA on the vertical axis of the chart and 100 feet on the horizontal axis.

Step #3. Find the intersection of 15 VA and 100 Ft (Point “A”)

Step #4. Read the diagonal line to the right of point “A”. It is the 18 ga. wire gauge line. Use 18 ga. or larger wire.

**Chart 1**

*Note:* A low gauge number = a thicker wire; A high gauge number = a thinner wire.

*Example II:* The maximum wire length for a 10 VA power consumption using different wire gauges.

<table>
<thead>
<tr>
<th>Point</th>
<th>Gauge</th>
<th>Max. Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>“B”</td>
<td>22 Ga</td>
<td>60 FT</td>
</tr>
<tr>
<td>“C”</td>
<td>20 Ga</td>
<td>120 FT</td>
</tr>
<tr>
<td>“D”</td>
<td>18 Ga</td>
<td>220 FT</td>
</tr>
<tr>
<td>“E”</td>
<td>16 Ga</td>
<td>350 FT</td>
</tr>
<tr>
<td>“F”</td>
<td>14 Ga</td>
<td>550 FT</td>
</tr>
<tr>
<td>“G”</td>
<td>12 Ga</td>
<td>900 FT</td>
</tr>
</tbody>
</table>
I-M. Multi-Conductor Wire Types

- “BELLS WIRE” has parallel wires, which may act as an antenna and is therefore sensitive to electrical noise. This type of wire should not be used for control circuits.

- “TWISTED PAIR” cancels out most of the electrical noise because the wires alternate their positions. This is the type of wire that is used for most control circuits.

- “SHIELDED WIRE” is twisted pair that is surrounded by a metal foil or wire mesh which acts as a shield and prevents electrical noise from reaching the wires inside.

Shielded wires are used for the BELIMO actuators only if the electrical noise is very severe. Normally twisted pairs are sufficient. Remember! The shield must be grounded in one point only!

I-N. Ground Loops

If a shield is grounded at both ends of a shielded wire, a ground loop is created. Ground loops will defeat the purpose of shielding, and aggravate the electrical noise problem.

Ground loops can also be created by using more than one wire for signal common (COM ⊥). The (-) signal common terminals on the controller are usually interconnected. Therefore, a ground loop is formed when two or more signal common terminals of the controller are wired to the same transformer. (See Fig. 11-5 and 11-6, page 175.)

Signal common (COM ⊥) is necessary, as a reference, but only one connection should be used.

Redundant signal common terminals should not be connected.

A ground loop acts as an antenna and will pick up electrical noise. This should be avoided, by using the correct wiring practice.
II. UNDERSTANDING WIRING DIAGRAMS

II-A. Electrical Symbols

U.S. Electrical Symbols for Contacts

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N.O. (NORMALLY OPEN)</td>
<td></td>
</tr>
<tr>
<td>N.C. (NORMALLY CLOSED)</td>
<td></td>
</tr>
<tr>
<td>N.O.</td>
<td>N.C.</td>
</tr>
</tbody>
</table>

International Symbols for Contacts

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMALLY OPEN</td>
<td></td>
</tr>
<tr>
<td>NORMALLY CLOSED</td>
<td></td>
</tr>
<tr>
<td>SWITCHING</td>
<td></td>
</tr>
</tbody>
</table>

Traditional Electronic Symbols for Contacts

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORMALLY OPEN</td>
<td></td>
</tr>
<tr>
<td>NORMALLY CLOSED</td>
<td></td>
</tr>
<tr>
<td>SWITCHING</td>
<td></td>
</tr>
<tr>
<td>TRI-STATE FLOATING CENTER OFF</td>
<td></td>
</tr>
</tbody>
</table>

Belimo Proportional Actuators- Wire Symbols and Numbers

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMON</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>24 VAC POWER</td>
<td></td>
</tr>
<tr>
<td>0...10VDC SIGNAL</td>
<td></td>
</tr>
<tr>
<td>0...20V Phase-cut Signal</td>
<td></td>
</tr>
<tr>
<td>2...10VDC Feedback Signal</td>
<td></td>
</tr>
</tbody>
</table>

Belimo
BELIMO ACTUATOR
1
2
3
4
5
Not applicable for NM24 SR and NM24 SRS
If a feedback is available at the actuator, we recommend that this signal be brought back to the control panel. Even if it is not required for the control sequence, it is a useful signal to have available for possible troubleshooting in the future.

II-B. Compatibility of Different Power Supplies

Power Supply with Half-Wave Rectifier

Half-wave rectifiers offer the advantage of using the same connection for the AC common and DC common. Therefore, the common of different devices using half-wave rectifiers can be interconnected and use the same power source.

Some devices, typically DDC controllers, have full-wave rectifiers. In this case, always use a separate transformer for the controller.

Power Supply with Full-Wave Rectifier

Full-wave rectifiers provide more current capacity. Their disadvantage is that the AC and DC sides cannot be interconnected.

Every device which has a full-wave rectifier must be powered from its own separate transformer, if the COM ⊥ wire is connected to the Common of other devices.

Note: If a device with a full-wave rectifier is powered from the same transformer as a device with a half-wave rectifier, a short circuit will result if the commons (COM ⊥) are interconnected.

The Belimo products use half-wave rectifiers. Therefore, they may be connected to the same transformer as long as all commons (COM ⊥) are connected to the same leg of the transformer. However, anytime actuators are connected to a controller a separate transformer should be used for the controller power supply unless you know that the controller also uses a half-wave rectifier.
II-C. Connection of Actuators

0 to 10 V Control Signals

Signal Loss

Due to the high input impedance (100kΩ) of the actuators, the current through the signal wire is very low. Therefore, the loss of signal will be negligible, even if with long wire runs.

Example: Three actuators are connected via a 330 ft. (100 meters) long pair of 22 Ga. wires. Each wire has a resistance of 5Ω.

The current draw from each actuator is \( I = \frac{E}{R} = \frac{10}{100,000} = 0.1 \text{ mA} \), when the signal is 10 VDC.

The current in the wire will be \( 3 \times 0.1 = 0.3 \text{ mA} \). Because 2 wires, the Common and the Source, go to the actuator, the resistance in the wires is \( 2 \times 5\Omega = 10\Omega \). The loss of signal will be \( E = R \times I = 10 \times 0.3 = 3 \text{ mV} = 0.003\text{V} \).

4 to 20 mA Control Signals

The controller will regulate the output current (signal) to the desired value, regardless of the resistance (up to a specified value) in the wires and the load resistor.

The resistance in the wires will only cause the output voltage of the controller to be slightly higher than the input of the actuators. The advantage with a 4 to 20 mA output signal to the actuators is that wire resistance does not cause any error to the control signal, and that electrical interference is rejected.

The input impedance of the actuators will reduce the resulting resistance of the load resistor. However, the error is so small that there is no need to compensate for this by using a slightly higher resistance value. A 500Ω load resistor will give an adequate accuracy. Use a 499Ω, 1%, 1/2w resistor or two 1kΩ, 1%, 1/4 w resistors in parallel.
Modulating Control Signal Wiring

**Fig. II-1** Single Output to Single Actuator

**Fig. II-2** Multiple Outputs to Multiple Actuators Using 1 Transformer for Actuators

**Fig. II-3** Multiple Outputs to Multiple Actuators Using 2 Transformers for Actuators
II-D. Long Distance Wiring

Fig. II-4

II-E. Wiring Mistakes

Fig. II-5 A Common Wiring Problem

Fig. II-6 Correct Wiring
### III. ANALOG OUTPUTS

#### III-A. 2 to 10 Volt Analog Output

The controller produces a variable voltage between signal common and the analog output.

The signal common (wire #1) of the actuator must be connected to the signal common of the controller, and the output of the controller is connected to actuator signal input (wire #3).

#### III-B. Sourcing 4 to 20 mA Analog Output

A sourcing 4 to 20mA analog output sends out a current to the actuator, and receives it at the signal common terminal.

It is similar to a 0 to 10 V output. The only difference is that one 500Ω resistor has to be installed between wires #3 and #1 at the actuator. The resistor converts the current (4 to 20 mA) to a 2 to 10 V signal. The resistor should be located at the actuator.

![Fig III-1](image)

#### III-C. Sinking 4 to 20 mA Analog Output

A sinking 4 to 20 mA output uses a different logic to create a control signal. In both a 0 to 10 VDC and sourcing 4 to 20 mA application, the signal is regulated at the positive (+) source of the signal. In a sinking application the signal is regulated between the device being controlled and common. For this reason, the term “Output” in a sinking application is sometimes confusing.

The controller has one terminal that supplies a constant DC voltage (often +24V). The input of the actuators (wire #3) are connected to the constant voltage. A 500Ω resistor is connected between wires #1 and #3 on one actuator connected to each output. (One resistor for each output.) Terminal #1 on the actuator is connected to the output of the controller.

The current will run from the constant voltage on the controller, to wire #3 on the actuator, through the 500 Ω resistor, to wire #1, and back to the input of the controller.

From the controllers point of view, all the #3 terminals of the actuators are at a “common” constant +24VDC. The signal common, wire #1, of the actuators will vary with the control signal.

Because the signal common of the actuators is variable, each output requires a separate transformer. The signal common of actuators connected to different outputs must never be interconnected. (See note ** in the wiring diagram)

![Fig III-2 Sinking 4 to 20 mA](image)
### III-D. Parallel Operation

![Diagram for Parallel Operation]

**Note:** If multiple actuators are on one shaft, see Section V-A.

### III-E. Master-Slave operation

![Diagram for Master-Slave Operation]

**Note:** Master-Slave operation should be used when it is important that one damper tracks the movement of another.

### III-F. Monitoring feedback with a remote indicator

![Diagram for Monitoring Feedback]

**Note:** If multiple actuators are on one shaft, see Section V-A.

### III-G. One Output/Multiple Transformers

![Diagram for One Output/Multiple Transformers]

**Note:** If multiple actuators are on one shaft, see Section V-A.

---

Belimo Types
- AM, LF, LM, SM, GM, AF, NF, -SR Proportional

**Input (+)**
- 2 to 10 V

**Output (+)**
- 2 to 10 V

**COM (-)**
- Always use a separate transformer for the controller unless you know a half-wave rectifier is used!
IV. WIRING DIAGRAMS FOR BELIMO PRODUCTS

IV-A. Spring Return On/Off Control

24 V

- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption must be observed.
- Actuator may also be powered by 24 VDC.

120/230 V

- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption must be observed.
- Actuator may also be powered by 24 VDC.
- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption must be observed.
- No ground connection is required.
- Provides UL and CSA requirements without the need of an electrical ground connection.
- Provides UL and CSA requirements without the need of an electrical ground connection.

- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption must be observed.
- No ground connection is required.
- For end position indication, interlock control, fan start-up, etc., AF230-S incorporates a built-in auxiliary switch: 1 x SPDT, 7A (2.5A) @250 VAC, UL listed, adjustable 5° to 85°.
- For end position indication, interlock control, fan start-up, etc., AF24-S incorporates two built-in auxiliary switches: 2 x SPDT, 7A (2.5A) @250 VAC, UL listed, one switch is fixed at +5°, one is adjustable 25° to 85°.
- Provides UL and CSA requirements without the need of an electrical ground connection.
- Provides UL and CSA requirements without the need of an electrical ground connection.
IV-B. Non-Spring-Return On/Off Control

On/Off Control GM, SM, NM, LM

Provide overload protection and disconnect as required.

Actuators may also be powered by 24 VDC

For end position indication, interlock control, fan startup, etc., LM24-S US incorporates a built-in auxiliary switch: 1 x SPDT, 6A (1.5A) @24 VAC, UL listed, adjustable 0° to 95°.

Meets UL and CSA requirements without the need of an electrical ground connection.

IV-C. Floating Point Control, Spring Return and Non-Spring-Return

Spring Return

Provide overload protection and disconnect as required.

Actuators may also be powered by 24 VDC.

May also be powered by 24 VDC.

Floating point control of AF24-3 (-S) US

Floating point control of LF24-3 (-S) US

Auxiliary switches of AF24-3-S US

Auxiliary switches of LF24-3-S US
Floating point control of AF24-3(-S) us and LF24-3(-S) us from triac

Non-Spring Return

Floating Point Control of LM24-3-T us

Standard Floating Point Control
IV-D. Proportional Control

Standard Wiring

2 to 10 VDC Feedback signal

Override to zero position

4 to 20 mA Control Signal

Override to 10 V position

Override control to min, mid, max, positions

4 to 20 mA Control Signal

<table>
<thead>
<tr>
<th>Functions</th>
<th>a</th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min*</td>
<td>0%</td>
<td>&lt;</td>
<td>&lt;</td>
</tr>
<tr>
<td>Mid*</td>
<td>50%</td>
<td>&lt;</td>
<td>&lt;</td>
</tr>
<tr>
<td>Max*</td>
<td>100%</td>
<td>&lt;</td>
<td>&lt;</td>
</tr>
<tr>
<td>Normal**</td>
<td>Control mode acc. to Y</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Default selectable 0-100%. See Configuration Data Sheet.
**Customizable. See Configuration Data Sheet.

Notes

- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption and input impedance must be observed.
- Actuator may also be powered by 24 VDC.
- ZG-R01 may be used.
IV-F. Auxiliary Switch Wiring

Auxiliary switch wiring for AM...-S us

Auxiliary switch wiring for AF...-S us

Auxiliary switch wiring for NF...-S us

Auxiliary switch wiring for AM...-S us

Auxiliary switch wiring for LF...-S us and LM24-S us

Auxiliary switch wiring for P-370 us

Auxiliary Switches
S1/S2 for SM, GM; SN1/SN2 for NM
SA1/SA2 for AM

Note:
SA1, SA2, AM...24-S us, AF...24-S us, NF...-S us auxiliary switches are double insulated and meet UL and CSA requirements without an electrical ground.

<table>
<thead>
<tr>
<th>Product</th>
<th>Voltage</th>
<th>Resistive load</th>
<th>Inductive load</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1, S2</td>
<td>250</td>
<td>7.0 A</td>
<td>2.5 A</td>
</tr>
<tr>
<td>SA1, SA2</td>
<td>250</td>
<td>6.0 A</td>
<td>2.5 A</td>
</tr>
<tr>
<td>SN1, SN2</td>
<td>250</td>
<td>6.0 A</td>
<td>2.5 A</td>
</tr>
<tr>
<td>AF...-S us</td>
<td>250</td>
<td>7.0 A</td>
<td>2.5 A</td>
</tr>
<tr>
<td>AM...-S us</td>
<td>24</td>
<td>3.0 A</td>
<td>1.5 A</td>
</tr>
<tr>
<td>LF...-S us</td>
<td>250</td>
<td>6.0 A</td>
<td>1.5 A</td>
</tr>
<tr>
<td>LM24-S us</td>
<td>24</td>
<td>6.0 A</td>
<td>2.5 A</td>
</tr>
<tr>
<td>NF...-S us</td>
<td>250</td>
<td>7.0 A</td>
<td>2.5 A</td>
</tr>
<tr>
<td>P-370</td>
<td>120</td>
<td>1.0 A</td>
<td>1.0 A</td>
</tr>
<tr>
<td></td>
<td>240</td>
<td>0.7 A</td>
<td>0.7 A</td>
</tr>
</tbody>
</table>
### IV-G. Accessories

#### Feedback Potentiometer

- **P...** used with SM/GM
- **PA...** used with AM

#### Szs Mid Position Switch

- The direction of rotation switch on the actuator must be in position "A" for the Szs to function correctly.
- Reverse A and C connections to the actuator to change direction of rotation.

#### Szs Mid Position Switch

- Used with the SM and GM Series actuators

#### Feedback Potentiometer

- **P...** used with SM/GM
- **PA...** used with AM

#### Sga, Sgf Positioners

- Override switches are optional.
- Provide overload protection and disconnect as required.

#### Irm-100 Input Rescaling Module

- Provide overload protection and disconnect as required.
- The controller should be powered from a separate transformer.
- The actuator and Irm-100 may be powered from the same transformer.
- Consult controller instruction data for more detailed installation information.
- To reverse control rotation, use the reversing switch.

#### Sbg 24 Range Controller

- Override control
- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption and input impedance must be observed.
- The actuator and SBG-24 may be powered from the same transformer.
- The controller should be powered from a separate transformer.
- Wire No. 4 on the NM24-SR US is used for feedback.

#### Ads-100 Analog to Digital Switch

- 5.7.9 = Switch point reference signal for manual adjustment of stages 1, 2, & 3 respectively.
- Actuator and controller must have separate transformers.
IV-F. Accessories (continued)

Control interface diagrams

PTA-250 Pulse Width Modulation Interface

Failsafe direction must have a normally closed contact.

NSV 24 Battery Back-up Module

ZAD24 Digital Position Indicator

ZG-X40 Transformer

ZG-R01, ZG-R02 Resistor Kits
V. APPLICATION INFORMATION

V-A. Wiring for Multiple Actuators on One Shaft (AF/GM, for other actuators use next higher torque actuator)

### Actuators which may be used on one shaft:

<table>
<thead>
<tr>
<th>Model</th>
<th>Max Quantity Per Shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF24(-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AF120(-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AF230(-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AF24-SR(-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AF24-3(-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AF24-SR95 US</td>
<td>1</td>
</tr>
<tr>
<td>GM24 US</td>
<td>2</td>
</tr>
<tr>
<td>GM24-SR US</td>
<td>2</td>
</tr>
<tr>
<td>AM24(-S) US</td>
<td>4</td>
</tr>
<tr>
<td>AM24-SR US</td>
<td>4</td>
</tr>
</tbody>
</table>

### Notes:

- Provide overload protection and disconnect as required.
- Actuators may be connected in parallel. Power consumption must be observed.
- May also be powered by 24 VDC.
- Set reversing switch (CCW-CW)(A-B) as required by control logic and control range.
- Actuator and controller must have separate transformers.

### Notes:

- See page 185 for ladder diagram wiring of 2 to 10 VDC actuators.

<table>
<thead>
<tr>
<th>Line Volts</th>
<th>Control Signal</th>
<th>2 to 10 VDC</th>
<th>Output 2 to 10 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Common</td>
<td>Y 1 Input, 0 to 10 V</td>
<td>1 Common</td>
<td>Y 1 Input, 0 to 10 V</td>
</tr>
<tr>
<td>2 + Hot</td>
<td>Y 2</td>
<td>2 + Hot</td>
<td>Y 2</td>
</tr>
<tr>
<td>3 U</td>
<td>Y 5</td>
<td>3 Y, Input, 0 to 10 V</td>
<td>Y 5</td>
</tr>
</tbody>
</table>

![Diagram of wiring connections showing actuators and transformers](image_url)
V-A. (continued) Wiring for Multiple Actuators on One Shaft (AF/GM, for other actuators use next higher torque actuator)

All actuators except AF24-SR us

AF24-SR us

Typical wiring of multiple dampers with more than one AF24-SR us mounted on a single shaft.
**Application Information**

**V-E. Floating Control Using a 2-wire DC Control Signal**

- Note: Direction of rotation shown for the R or A position.
- IN4001, IN4003 diode or equivalent, observe polarity.

**V-F. Operating two 0 to 10 VDC Controllers with the Higher of Two Control Signals**

- IN4001, IN4003 diode or equivalent, observe polarity.

**Explanation:** The diode allows the positive (+) signal to pass through it and does not allow a higher level positive signal to back feed to the other controller. Only the highest controller signal is seen by the actuator. There is a .7 VDC voltage loss across the diode. This makes the actual voltage range 2.7 to 10.7 VDC.

**V-G. Minimum Position with 0 to 10 VDC Actuators**

- Provide overload protection and disconnect as required.
- Override switches are optional.

**V-H Wiring to Johnson Controls A350P Controller**

- Power polarity must be correct.

**V-J. Minimum Position Setting**

- Provide overload protection and disconnect as required.
- Override switches are optional.

**Note:** Direction of rotation shown for the R or A position.
V-I. Wiring to Honeywell T775 Controller

**0 to 18 VDC Output Models**

- **T775E1089 / T775F1089**

   Use separate transformer for T775 if powering from 24 VAC.

   **Note:** The T775 Controllers have an adjustable control range of 0 to 18 VDC. Use the T775 Calibration instructions to calibrate a 2 to 10 VDC range.

**4 to 20 mA Output Models**

- **T775E1056 / T775F1055**

   Use separate transformer for T775 if powering from 24 VAC.

   **Resistor:** 500 Ω 0.5 W (ZG-R01)
I. GENERAL
A. Warranty all actuators for a period of five years from the production date as stated in the Terms and Conditions of Sale and Warranty.
B. Electronic valve and damper actuators shall be as manufactured, brand labeled, or distributed by Belimo.
C. Electronic control valves, as specified, shall be Belimo or other brands manufactured, brand labeled or distributed by Belimo.
D. Other manufacturers must be approved, in writing, 10 days prior to the bid date.

II. PRODUCTS

A. Electronic Damper Actuators
1. Electronic actuators, less than 600 in-lb. of rated torque, shall have ISO 9001 quality certification and be UL listed under standard 873, CSA C22.2 No. 24 and have CE certification.
2. Electronic actuators used on valves or dampers shall be designed to directly couple and mount to a stem, shaft or ISO style-mounting pad. Actuator mounting clamps shall be a V-bolt with a toothed V-clamp creating a cold weld, positive grip effect. Single point, bolt, or single screw actuator type fastening techniques or direct-coupled actuators requiring field assembly of the universal clamp is not acceptable.
3. Actuators shall be fully modulating/proportional, pulse width, floating/tri-state, or two position as required and be factory or field selectable. Actuators shall have visual position indicators and shall operate in sequence with other devices if required.
4. Optional auxiliary switches shall be available.
5. Actuators shall have an operating range of –22° to 122°F.
6. Proportional actuators shall accept a 0-10 VDC or 0-20 mA input signal and provide a 2-10 VDC or 4-20 mA (with a load resistor) operating range.
7. Actuators shall be capable of operating on 24, 120 or 230VAC, or 24VDC and Class 2 wiring as dictated by the application. Power consumption shall not exceed 10 VA for AC, including 120VAC actuators, and 8 watts per actuator for DC applications.
8. NEMA 2 rated actuators shall be provided with a three foot (minimum), pre-wired, electrical cable. Actuators requiring removal of the actuator cover for access to wiring terminals, exposing electronic, printed circuit boards to damage, are unacceptable.
9. Actuators using “on-board” chemical storage systems, capacitors, or other “on-board” non-mechanical forms of fail-safe operation are unacceptable.
10. Upon loss of control signal, a proportional actuator shall fail open or closed based on the minimum control signal. Upon loss of power, a non-spring return actuator shall maintain the last position.
11. Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required. Valves requiring greater torque or higher close off may be assembled with multiple low torque actuators.
12. Dual mounted actuators using additional anti-rotation strap mechanical linkages, or special factory wiring to function are not acceptable. Actuators in a tandem pair must be “off the shelf,” standard actuators ready for field wiring.
13. Valve actuators will not produce more than 62 dB (A) when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise rating of 45 dB(A) with power on or in the running or driving mode.

B. Electronic Valve Actuators
1. Electronic actuators, less than 600 in-lb. of rated torque, shall have ISO 9001 quality certification and be UL listed under standard 873, CSA C22.2 No. 24 and have CE certification.
2. Electronic actuators used on valves shall be designed to directly couple and mount to a stem, shaft or ISO style-mounting pad.
3. Actuators shall be fully modulating/proportional, pulse width, floating/tri-state, or two position as required and be factory or field selectable. Actuators shall have visual position indicators and shall operate in sequence with other devices if required.
4. Optional auxiliary switches shall be available.
5. Actuators shall have an operating range of –22° to 122°F except NR series with range of -22° to 160°F.
6. Proportional actuators shall accept 0-10 VDC or 0-20 mA input signal and provide a 2-10 VDC or 4-20 mA (with a load resistor) operating range.
7. Actuators shall be capable of operating on 24, 120 or 230VAC, or 24VDC and Class 2 wiring as dictated by the application. Power consumption shall not exceed 10 VA for AC, including 120VAC actuators, and 8 watts per actuator for DC applications.
8. NEMA 2 rated actuators shall be provided with a three foot (minimum), pre-wired, electrical cable. Actuators requiring removal of the actuator cover for access to wiring terminals, exposing electronic, printed circuit boards to damage, are unacceptable.
9. For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Spring return actuators shall be capable of CW or CCW mounting orientation. Spring return actuators with more than 60 in-lb. of torque shall have a metal, manual override crank.
10. Actuators using “on-board” chemical storage systems, capacitors, or other “on-board” non-mechanical forms of fail-safe operation are unacceptable.
11. Upon loss of control signal, a proportional actuator shall fail open or closed based on the minimum control signal. Upon loss of power, a non-spring return actuator shall maintain the last position.
12. Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required. Valves requiring greater torque or higher close off may be assembled with multiple low torque actuators.
13. Dual mounted actuators using additional anti-rotation strap mechanical linkages, or special factory wiring to function are not acceptable. Actuators in a tandem pair must be “off the shelf,” standard actuators ready for field wiring.
14. Valve actuators will not produce more than 62 dB (A) when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise rating of 45 dB(A) with power on or in the running or driving mode.
15. Proportional actuators shall be fully programmable. Control input, position feedback and running time shall be factory or field programmable. Diagnostic feedback shall provide indications of hunting or oscillation, mechanical overload, mechanical travel and mechanical load limit. The actuators shall also provide actuator service data, at minimum, number of hours powered and number of hours in motion.
16. Proportional actuators shall be capable of digital communication, as built.
C. Industrial Actuators

1. Belimo SY Series Industrial Electric Actuators
   a. The valve actuator shall consist of a thermally protected capacitor-type reversible electric motor, a patented planarom planetary worm combination drive, heater, limit switches and wiring termination blocks, all contained in a die cast aluminum enclosure. The drive system will provide continuous, smooth torque transmission throughout a 90 degree travel. Adjustable stops provide mechanical adjustment of end-of-travel. The transmission shall allow continuous duty operation of a manual override handwheel without the need to remove power, or de-clutch the manual system.
   b. Enclosure shall be designed to meet NEMA 4, 4X (weatherproof) requirements, or CSA approved for non-hazardous locations.
   c. The actuator shall employ ISO5211 mounting standards to provide for a wide range of international applications.
   d. The enclosure will have an industrial quality coating.
   e. Actuator shall have a motor rated for a minimum of 25% duty cycle in modulating applications.
   f. Actuator shall be suitable for operation in ambient temperature ranging from 22°F to +150°F [-5°C to +65°C].
   g. The motor shall be fractional horsepower; permanent split capacitor type designed to operate on 24 VAC, 110 VAC or 220 VAC, 1 pH, 50/60 Hz supply. A self resetting thermal switch shall be imbedded in the motor for overload protection.
   h. Internal terminal blocks shall be clearly marked for field wiring. A wiring diagram shall be permanently attached to the OUTSIDE of the actuator housing.
   i. Actuator will have a suitable sized NPT entry for external connections.
   j. Gears shall be hardened alloy steel, permanently lubricated. The worm drive system negates the need for a brake.
   k. Two adjustable cam actuated end travel limit switches shall be provided to control electrical movement of the actuator.
   l. 2 SPDT auxiliary switches, rated at 250 VAC shall be included. The switches are factory pre-set at 3 degrees and 87 degrees rotation, and may be field adjusted.
   m. Actuator shall be equipped with a hand wheel or shaft for manual override to permit operation of the actuator in the event of electrical power failure or system malfunction. Hand wheel, where applicable, must be permanently attached to the actuator. (SY2 and larger)
   n. The handwheel override shall be continuously operational regardless of the powered state of the actuator, without the need to remove electrical power if present during the override phase. (SY2 and larger)
   o. The hand wheel will not rotate while the actuator is electrically driven.
   p. The actuator shall provide a visual indicator beacon on the top of the housing for position status of the actuator and attached devices.
   q. Actuator shall have an internal heater and thermostat to minimize the build-up of moisture inside the sealed enclosure.
   r. Modulating units shall operate under 2-10 VDC, 2-10 VDC, 4-20mA, and 1-5 VDC control modes. The default shall be 2-10 VDC control.

2. Industrial Type Actuators (Manufactured by RCS)
   For Butterfly Valves
   a. The valve actuator shall consist of a capacitor-type reversible electric motor, gear train, limit switches and terminal block, all contained in a die cast aluminum enclosure.
   b. Enclosure shall be designed to meet NEMA 4 (weatherproof) requirements, or CSA approved for non-hazardous or hazardous locations.
   c. Output shaft shall be electroless nickel plated to prevent corrosion.
   d. The enclosure will have an industrial quality coating.
   e. Actuator shall have a motor rated for continuous duty.
   f. Actuator shall be suitable for operation in ambient temperature ranging from -22°F to +150°F [-30°C to +65°C].
   g. The motor shall be fractional horsepower; permanent split capacitor type designed to operate on a 120 VAC, 1 pH, 60 Hz supply. A self resetting thermal switch shall be imbedded in the motor for overload protection.
   h. A 6 ft wiring harness shall be provided for ease in field wiring (Above 1500 in.-lbs).
   i. Actuator will have a suitable sized NPT entry for external connections.
   j. Reduction gearing shall be designed to withstand the actual motor stall torque.
   k. Gears shall be hardened alloy steel, permanently lubricated. A self-locking gear assembly or a brake shall be supplied.
   l. Two adjustable cam actuated end travel limit switches shall be provided to control direction of travel.
   m. 2 SPDT auxiliary switches, rated at 250 VAC shall be included.
   n. Actuator shall be equipped with a hand wheel or shaft for manual override to permit operation of the valve in the event of electrical power failure or system malfunction. Hand wheel, where applicable, must be permanently attached to the actuator.
   o. When in manual operation electrical power to the actuator will be permanently interrupted.
   p. The hand wheel will not rotate while the actuator is electrically driven.
   q. Actuator shall have heater and thermostat to minimize condensation within the actuator housing.
   r. Modulating units shall include programmable card capable of 0-10 VDC, 2-10 VDC, 4-20mA, and 1-5 VDC default settings.

D. Electronic Control Valves

1. General
   a. The manufacturer shall be capable of providing individual valve identification tagging on each printed valve label. Valve tag identification shall be documented on the approved, submitted valve schedule.
   b. Valve actuator(s) shall provide the minimum torque, based on the manufacturers’ calculations, required for the rated valve close off.

2. Zone Valves
   a. Zone valves, as specified, shall be by Belimo.
   b. Zone valves with brass bodies shall be used in terminal unit water applications where sizing or physical limitations prohibit the use of characterized control valves, or in terminal equipment, where water sizing dictates a 2 or Three-way, diverting electronic control valve 3/4" or smaller.
   c. Zone valve actuators shall have a minimum of 30 psi close-off rating.

3. Characterized Control Valves™
   a. Control valves shall be of the Characterized Control Valve™ type provided by Belimo.
   b. Characterized Control Valves™ shall be used for all water applications where sizing permits.
   c. A TEFZEL flow-characterizing disc shall be installed in the inlet of Two-way characterized control valves and in the control port of Three-way valves. The valve trim shall utilize a stainless steel ball and stem for all water or glycol solutions up to 60%. For water applications, an optional chrome plated brass ball and brass stem can be used.
   d. Valve bodies shall be nickel-plated, forged brass with female NPT threads. Bodies to 1-1/4" shall be rated at 600 psi and sizes 1-1/2" to 3" at 400 psi.
   e. Characterized Control Valves™ shall have a self-aligning, blowout proof, brass stem with a dual EPDM O-ring packing design. Fiberglass reinforced Teflon seats shall be used.
   f. The valves shall have a four bolt mounting flange to provide a 4 position, field changeable, electronic actuator mounting arrangement.
   g. A non-metallic construction, bonded of high temperature, continual use material shall provide a direct, mechanical connection between the valve body and actuator. The coupling shall be designed to provide thermal isolation and eliminate lateral and rotational stem forces. Vent hole shall be provided to reduce condensation build-up.
4. **Globe Valves:**
   a. Globe valves, as specified, shall be by Belimo.
   b. Two-way and Three-way globe valves may be used only if characterized control valves do not fit the sizing criteria or application.
   c. Globe valves may be used for chilled or hot water, steam, or glycol solutions to 60%. Screwed and flanged water valves shall have equal percentage or linear flow characteristics for Two-way or Three-way valves, respectively. All stems shall be stainless steel.
   d. Screwed globe valves 1/2” through 2” shall have bronze bodies rated at ANSI Class 250. For water or steam up to 35 psi, trim shall include a brass plug, a spring-loaded TFE packing, and a bronze seat. The maximum differential shall be 35 psi for water and 20 psi for steam.
   e. Two-way and Three-way flanged globe valves 2-1/2” to 6” shall have cast iron bodies rated for ANSI Class 125 or ANSI 250. The maximum differential shall be 25 psi for water and 10 psi for steam. Trim shall include stainless steel stems, bronze plugs, bronze seats, and a TFE V-ring packing.
   f. For steam inlet pressures higher than those stated above, furnish globe valves with stainless steel trim specifically rated for the application.

5. **Direct Coupled Globe Valve Actuator and Adaptor Bracket:**
   a. Actuator shall be designed with an integrated adaptor bracket that will direct mount to the valve.
   b. Actuator shall provide a linear force capable of fulfilling the required close-off of the valve.
   c. Actuator shall include an automatic valve coupling device that shall lock securely to the valve stem.
   d. Proportional and spring return actuators shall adapt upon powering the actuator. This adaptation will determine stroke length and enable the actuator to set the minimum and maximum limits of the supplied control signal, thereby utilizing the entire control signal range. Feedback, running time and other parameters are automatically adjusted to the effective stroke.
   e. Actuator shall have a manual override equipped with an interlocking device to protect the actuator from over-torque of the manual override.

6. **Butterfly Valves**
   a. Butterfly valves, as specified, shall be by Belimo.
   b. Butterfly valves 2” to 12” shall have a fully lugged, drilled and tapped, cast iron body, rated to 200 psi body pressure, with 14” and larger valves having a body pressure rating of 150 psi. Flanges shall meet ANSI 125/150 standards. The one-piece body shall feature an extended neck allowing sufficient clearance for flanges and 2” of piping insulation. The disc shall be stainless steel and provide bi-directional bubble-tight close off in either direction for water or 60% glycol applications. The disc shall be polished and contoured to minimize torque and wear. The flow characteristic shall be modified equal percentage for Two-way valves and linear for Three-way valves. Valves 2” through 12” shall be rated for standard HVAC service of up to 50 psi close-off, or for heavy commercial service of up to 200 psi close-off. Valves 14” and larger shall be rated for up to 150 psi close-off.
   c. The disc shall have full 360-degree concentric seating. Valves up through 12” shall utilize an internal spline for the disc-to-stem connection. External mechanical methods to achieve this mechanical connection, such as pins or screws, shall not be employed. Valves 14” and larger will utilize a dual-pin method to prevent the heavy disc from settling onto the liner, causing distortion. A phenolic backed, non-collapsing, EPDM seat shall be field replaceable and shall create a positive seal between flange face and valve body. No gaskets shall be required between the valve and flange faces. The shaft shall be supported at four locations by RPTFE bushings.
   d. Butterfly valves may be used in all two-position applications and modulating applications larger than 2”, or where the close off rating of other valve styles does not meet the design requirements.
   e. Butterfly valves shall be sized primarily by using velocity calculations to prevent fluid velocities from exceeding 12 feet per second. For modulating applications, CV factors at sixty (60) degrees shall be used for determining delta P once size has been determined by the velocity calculations.
   f. High torque industrial valve actuators, >300 in-lb. of rated torque, may be used where low torque actuators are not suitable. High torque actuators shall be as manufactured or provided by Belimo.
I. GENERAL
Until otherwise arranged, in writing, the following conditions are valid. The Seller as referred to in the terms of sale is Belimo Aircontrols (USA) Inc. or Belimo Aircontrols (CAN) Inc.

II. PRICE
1. Our prices are net, FOB Point of Origin in US currency for sales made by Belimo Aircontrols (USA), Inc. and CAN currency for sales made by Belimo Aircontrols (CAN) Inc.
2. Freight and packaging (wooden crates, pallets etc) will be charged at cost for each shipment.
3. Orders with a net value of less than US$300 (CAN$450) will be subject to a US$20 (CAN$35) handling fee.
4. No handling fee will be applied to orders placed through the Belimo Internet ordering system (www.belimo.com).
5. We reserve the right to make partial deliveries which can be invoiced separately.
6. Wiring diagrams, installation, and commissioning are not included in our prices.

III. PAYMENT
1. Invoices are payable in US currency for sales made by Belimo Aircontrols (USA), Inc. and in CAN currency for sales made by Belimo Aircontrols (CAN) Inc. within 30 days from the date of invoice without any deductions.
2. Accounts with balances exceeding 60 days will be subject to an interest charge of 2% per month.
3. Accounts with balances exceeding 45 days will be subject to re-stocking charges.

IV. TITLE
Title in and property to the goods shall not pass to the Buyer until the Seller has received payment in full.

V. DAMAGE OR LOSS IN TRANSIT
Seller assumes no liability for damage or loss of shipment. All shipments should be unpacked and examined immediately upon receipt. Any external evidence or loss or damage must be noted on the freight bill or carrier’s receipt and signed by the carrier’s agent at the time of delivery. Failure to do so will result in the carrier’s refusal to honor the claim. Buyer then should notify Seller with copy of freight bill or damage report so that Seller then can file claim for loss or damage in transit with the carrier. If damage does not become apparent until shipment is unpacked, customer must make a request for inspection by the carrier’s agent and file with the carrier within 15 days after receipt of product and notify Seller. Seller is not liable for consequential damages resulting from the installation of damaged product.

VI. DELIVERY
We undertake to make every attempt to adhere to our delivery promise(s), but do not accept cancellation of contract or liability for any direct or indirect losses which may arise, for any reason whatsoever, due to our failure to adhere to such promise(s).

VII. RETURN OF GOODS
1. Goods received by the Buyer cannot be returned unless previously agreed upon with Seller. Buyer must acquire Return Material Authorization (RMA) number from Belimo prior to return of the goods. At this time, Buyer will also receive instructions to where product is to be returned. Only products returned to proper location with RMA number will be considered for credit.
2. Only goods in original packaging can be accepted. Goods returned must be in condition for resale as new equipment to qualify for credit. A minimum restocking charge of 10% for actuators and 15% for valve products and valve assemblies of the invoice value will be applied. Return material must be shipped prepaid.
3. Returns resulting from errors by the Seller will not be subject to re-stocking charges.

VIII. WARRANTY
1. Belimo offers a five-year warranty for product listed in our literature and shipped after May 1, 2000 for product shipped to locations within the USA and Canada. Some products may carry less than a 5-year warranty. Please see documentation for specific reference to products with a warranty of less than five years.
2. The Belimo warranty is unconditional for the first two years from the date of production. For the following three years, a conditional warranty applies. Under this conditional warranty, the consequences of ordinary wear and tear, damage due to negligence or improper use, or other causes beyond our control are excluded from warranty coverage. Product specific terms of warranty with regard to warranty period or conditions of warranty may apply to certain specified products as stated in the documentation for those products.
3. The warranty shall be null and void should the Buyer or any other persons modify or repair any part of our equipment.
4. Buyer must acquire a Return Material Authorization (RMA) number from Belimo prior to receiving warranty replacement or credit for product. Product return is not required in all cases to complete the warranty process. Ask our Customer Service department for detailed information.
5. Products found to be defective for which warranty is applicable will be replaced or repaired at Seller’s discretion. Seller is not responsible for charges resulting from the removal and/or replacement of product.

IX. NONSTOCK AND NONCATALOG ITEMS
Products not listed in the current price list or catalogs are considered to be special order items and subject to minimum order quantities, special handling charges, and/or other conditions stipulated to us by suppliers. Such items normally are subject to longer delivery times. Special order items may carry cancellation charges once an order is placed and may also be subject to a restricted return policy.

X. PROPER LAW AND JURISDICTION
For sales made by Belimo Aircontrols (USA) Inc., this contract is and shall be deemed to have been made in the United States, shall in all respects be governed by the laws of the State of CT. For sales made by Belimo Aircontrols (CAN) Inc., this contract is and shall be deemed to have been made in Canada, shall in all respects be governed by the laws of the Province of Ontario.
Discontinued Products

Replacement of discontinued Belimo products

When replacing an actuator, whether Belimo or other, be sure to consider the application parameters before selecting the replacement. The new product may not be the best fit for the application. An example would be an existing SM24-SR US mounted to a valve linkage. The direct replacement of the actuator is the AM24-MFT US. However the SM... and AM... are different lengths, the linkage would need to be replaced as well. When retrofitting or replacing actuators, it is always best to select the new product based on application parameters. This ensures the selected actuator is fit for the application. Never only use a part number cross-reference when replacing defective actuators.

*Please review our MFT Product Documentation for more information.

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With branch in VA

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San Antonio, TX 78216
Phone: 210-349-6161

Applied Automation
3186 South Washington Street, #230
Salt Lake City, UT 84115
Phone: 801-486-6454

Boston Aircontrols, Inc.
1 Garfield Circle
Burlington, MA 01803
Phone: 781-272-5800

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Denver, CO 80204-4800
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Phone: 773-763-1300

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Timonium, MD 21093
Phone: 410-252-1221

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Seattle, WA 98124
Phone: 800-877-8026
With branches in WA, OR

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Phone: 952-920-0131

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Lake Forest, CA 92630
Phone: 949-380-7878
With branches in CA, NV, OR, AK, AZ, ID, UT, WA

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Chicago, IL 60610-3923
Phone: 312-226-4900
With branches in IL, IN

Stromquist and Company
4620 Atlanta Rd.
Smyrna, GA 30080
Phone: 404-794-3440
With branch in FL

Temperature Control Systems
10315 Brockwood Road
Dallas, TX 75238
Phone: 214-343-1444
With branches: Temperature Controls-
Dallas, Climate Control Systems, Tulsa Controls, Austin Controls.

Tower Equipment Co., Inc.
1320 West Broad Street
Stratford, CT 06615
Phone: 800-346-4647

Twinco Supply Corporation
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Huntington Station, NY 11746-2143
Phone: 800-794-3188
With branches in NY

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Brampton, ON, L6T 5J5
Phone: 905-790-8667

Baymar Supply Co.
3200 Jefferson Blvd.
Windsor, ON N8T 2W8
Phone: 519-974-5800

Controls Depot
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Ottawa, ON K1G 5T9
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Saskatoon, SK, S7K 5J1
Phone: 306-242-3333
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O’Dell Associates Inc.
#3 - 1038 Cooke Blvd.
Burlington, ON L7T 4A8
Phone: 905-681-3901

Prokontrol
1989 Michelin
Laval, QC, H7L 5B7
Phone: 450-973-7765
With branches in Ville Vanier and Ontario

Refrigerative Supply
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Alberta, Saskatchewan, Manitoba

Regal Controls
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Vancouver, BC, V5V 3C8
Phone: 604-879-6357
With branches in Langley

Regulvar Laval
1985 Boul Industriel Laval Q.C
H7S-1P6
Phone: 450-629-0435
With branches in Hull, Sherbrooke,
St. Hubert, Lachine, Quebec City

Regulvar Ottawa Inc.
170 Laurier Ax West Suite 714
Ottawa, Ontario, K1P-5V6
Phone: 613-565-2129

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Phone: 780-452-3110
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Alberta, Saskatchewan

Southern Supplies
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Oshawa, ON, L1J 6X4
Phone: 905-728-6216
With branch in Belleville

SCI
3311 Boul Industriel
Laval, QC, H7L 4S3
Phone: 450-668-8866

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