WARNING!

Before replacing actuator, damper must be inspected and determined to be fully functional. See NFPA 80 &/or NFPA 105 for recommended check list.

Replacement of Old Gear Train Motors with Belimo FSxx Series

See **www.belimo.us/firesmoke** **Retrofits** for more replacement instructions.

Contents

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Mike Knipple 203 749-3170 Laure Pomianowski 775 355-2466
800 543-9038

WARNING!

Installer must be trained and experienced with repair of fire and smoke dampers and actuators.

UL®

In the “Marking & Application Guide, Dampers for Fire Barrier and Smoke Applications & Ceiling Dampers” April 2013 by Underwriters Laboratories Inc.®, page 6 they state:

DAMPER ACTUATORS

“… field mounting or substitution of actuators is not covered within the scope of the UL certification of the product. However, this does not necessarily preclude replacement of actuators in the field. Like any appliance, field servicing of these products is not covered under the scope of the UL certification and factory follow-up service program. As with any part of the damper, it is expected that replacement of actuators in the field be done in

Code and Standard Issues

In general, the administrative section of codes state that all mechanical and electrical systems must be kept in working order and an individual section may state that all life safety devices and systems must be operable. NFPA 80 (Fire) & NFPA 105 (Smoke) require periodic testing and repair of dampers as soon as possible after any deficiency is uncovered.

Chapter 7 IBC & IFC "Containment” Dampers	
Commissioning End of first year Every 4 years except in hospitals every 6 years	
Chapter 9 IFC "Smoke Control System” Dampers	
Dedicated Commissioning Semi-annually	**Non-dedicated** Commissioning Annually
Chapter 9 IBC & IFC **Fire detection & Smoke control systems**	
Dedicated Weekly self-test	**Non-dedicated** Not required

Fire & smoke dampers are appliances and field replacement of components is required when failure of any component occurs.

The Authority Having Jurisdiction (local Fire Marshal and/or Building Official) must be consulted if any blade or auxiliary switches are employed and are connected to the fire alarm system or to a Fire Fighters Smoke Control System (FSCS) panel. Retesting is required. A permit and inspection may be required since connections to an alarm system have been touched.

NFPA 80 (Fire) & NFPA 105 (Smoke)

NFPA requires damper inspection and repair of dampers.
See **www.nfpa.org**. for Standards. Details not covered here.

See NFPA 80 & NFPA 105 for details. The damper cleaning and examination check list here is based on them.

Damper installation shall meet code requirements. Fire stopping and drywall integrity shall be confirmed. Damper blades shall be in plane of wall. Duct shall be fall away with no fasteners connected to damper sleeve.

a. Dampers and ducts shall be cleaned of all foreign debris and dust build-up.
b. All exposed moving parts of the damper shall be dry lubricated as required by the manufacturer. Do not use oil as it draws dirt.
c. Damper shall be examined without defective old motor or new actuator to determine:
   i. The damper shall fully close from the open position.
   ii. Damper shall fully open from the closed position.
   iii. There are no obstructions to the operation of the damper. The damper shall not be blocked from closure in any way due to rusted, bent, misaligned, or damaged frame or blades. The damper shall not have defective hinges, side &/or blade seals, or other moving parts. The damper frame shall not be penetrated by any foreign objects that would affect operation.
d. If the damper is equipped with a fusible link, the link shall be removed for testing to ensure full closure and lock-in-place if so equipped. If the link is damaged or painted, it shall be replaced with a link of the same size, temperature, and load rating.
e. The fusible link shall be reinstalled after testing is complete.

After installation and wiring of new actuator it shall be tested.

a. The checklist may be customized using material here and in NFPA Standards. Multiple geometric configurations of springs, fusible link, thermal sensor(s), and actuation are possible. Confirm with AHJ if any additional requirements exist.
b. Electric thermal sensors, if present, must be tested and replaced if defective.
c. The test shall be conducted with normal HVAC airflow.
d. When equipped with smoke detection activation, the smoke detector shall be activated and damper operation observed.

Test voltage input to actuators and repair as necessary if voltage is not correct. Old breakers often deliver below 115V and failed actuators may be due to power supply problems.

For the Air Movement and Control Association damper maintainance manual go to:
http://www.amca.org/publications/damper_maintenance.aspx

Local Code Approval

While it is not detailed in codes, the following rules should be followed for selecting Belimo actuators for replacement:

Check the technical specifications to ensure an “equal or better” actuator is used.

- **Temperature** – the replacement actuator shall have been UL555S tested at the same or better temperature as the original actuator. 250˚F or 350˚F are standard.
- **Time** – the replacement actuator shall drive open and spring closed at a speed equal or faster than presently required by codes. (The AHJ may grant an exception and “grandfather” slower actuators where the original actuator was slower.)
- **Torque** – replacement actuator shall have equal or greater torque than the failed actuator.
- **Voltage** – replacement actuator shall have the same voltage rating as the original.
- **Amperage** – the replacement actuator(s) shall not draw more amperage than the original(s) and cause the total connected amp draw on a circuit breaker to be greater than allowed by electrical code.
- Final **Testing** – actuated damper and associated devices shall be tested for proper operation. See Acceptance testing details below.

(Mnemonic device: TTT-VAT)

WARNING!

In all cases, installation must comply with any and all local electrical and life safety codes. Operation of the system after installation must be performed to verify proper damper cycling. Final checkout requires verifying correct function.

WARNING!

Note that where any fire alarm wiring is touched, the fire department must be informed.

Cross Reference

Siebe/Barber Coleman	Power	Torque	Aux Switches	Belimo	Notes
MA220	120 VAC	30		FSLF120 US	1, 2, 4
MA221	240 VAC	30		FSLF230 US	1, 2, 4
MA223	24 VAC	30		FSLF24 US	1, 2, 4
MA230	120 VAC	50		FSNF120 US	1, 2, 3
MA231	240 VAC	50		FSNF230 US	1, 2, 3
MA233	24 VAC	50		FSNF24 US	1, 2, 3
MA240	120 VAC	50			5,6
MA250	120 VAC	50		FSNF120 US	1, 2, 3, 4
MA251	230 VAC	50		FSNF230 US	1, 2, 3, 4
MA253	24 VAC	50		FSNF24 US	1, 2, 3, 4
MA-318	24 VAC	60		FSNF24 US	1, 3
MA-318-500	24 VAC	60	1	FSNF24 -S US	1, 3
MA-418	120 VAC	60		FSNF120 US	1, 3
MA-418-500	120 VAC	60	1	FSNF120-S US	1, 3
1	Direct couple the Belimo where shaft is available. Some were direct coupled.				
2	FSTF <1.5 sq.ft. FSLF <4 sq.ft.				
3	FSNF <12 sq.ft. FSAF*A <18 sq.ft.				
4	For Pottorff with shaft spring see: https://www.belimo.us/mam/americas/technical_documents/pdf-web/fire_and_smoke_doc/pottorff-ma2xx_to_belimo.pdf				
5	Motor was not 90 degree and pulley and cable were usually used. Some geometric changes are necessary to simplify.				
6	Provide photos. Motor, linkage, blades, fusible link, McCabe © Link, Typically direct couple to damper shaft if available. Otherwise, investigation necessary.				

Other Honeywell replacements are available.

M8xxx	24 VAC	Modulating	60		FSAFB24-SR
M8xxx w/ Switch	24 VAC	Modulating	60		FSAFB24-SR-S

See https://www.belimo.us/mam/americas/technical_documents/pdf-web/fire_and_smoke_doc/fire_smoke_competitive_replacement_data_reference.pdf for greater detail.

Honeywell	Voltage	Control	Torque	Aux	Replacement	
ML4105A1000	120 VAC	On/Off	30		FSLF120 US	*
ML4105B1009	120 VAC	On/Off	30		FSLF120 US	*
ML4105C1008	230 VAC	On/Off	30		FSLF230 US	*
ML4105D1007	230 VAC	On/Off	30		FSLF230 US	*
ML4115A1009	120 VAC	On/Off	30		FSLF120 US	*
ML4115A1017	120 VAC	On/Off	30		FSLF120 US	*
ML4115B1008	120 VAC	On/Off	30		FSLF120 US	*
ML4115B1016	120 VAC	On/Off	30		FSLF120 US	*
ML4115C1007	230 VAC	On/Off	30		FSLF230 US	*
ML4115C1015	230 VAC	On/Off	30		FSLF230 US	*
ML4115D1006	230 VAC	On/Off	30		FSLF230 US	*
ML4115D1014	230 VAC	On/Off	30		FSLF230 US	*
ML4115H1002	120 VAC	On/Off	30		FSLF120 US	*
ML4115J1019	120 VAC	On/Off	30		FSLF120 US	*
ML4202F1000	120 VAC	On/Off	20		FSLF120 US	*
ML4202F1000	120VAC	On/Off	20		FSLF120 US	*
ML4302F1008	120 VAC	On/Off	20		FSLF120 US	*
ML8105A1006	24 VAC	On/Off	30		FSLF24 US	*
ML8105B1005	24 VAC	On/Off	30		FSLF24 US	*
ML8115A1005	24 VAC	On/Off	30		FSLF24 US	*
ML8115A1013	24 VAC	On/Off	30		FSLF24 US	*
ML8115B1004	24 VAC	On/Off	30		FSLF24 US	*
ML8115B1012	24 VAC	On/Off	30		FSLF24 US	*
ML8115H	24 VAC	On/Off	30		FSLF24 US	*
ML8115J	24 VAC	On/Off	30		FSLF24 US	*
ML8202	24 VAC	On/Off	20		FSLF24 US	*
ML8302	24 VAC	On/Off	20		FSLF24 US	*
MS4104F1010	120 VAC	On/Off	30		FSLF120 US	*
MS4104F1210	120 VAC	On/Off	30	2	FSLF120-S US	*
MS4109F1010	120 VAC	On/Off	80		FSNF120 US	
MS4109F1210	120 VAC	On/Off	80	2	FSNF120-S	
MS4120F1006	120 VAC	On/Off	175		FSAFA120	
MS4120F1204	120 VAC	On/Off	175	2	FSAF120A-S	
MS4209F1007	120 VAC	On/Off	80		FSNF120 US	
MS4309F1005	120 VAC	On/Off	80		FSNF120 US	

MS4604F1010	230 VAC	On/Off	30		FSLF230	*
MS4604F1210	230 VAC	On/Off	30	2	FSLF230-S	*
MS4609F1010	230 VAC	On/Off	80		FSNF230	
MS4609F1210	230 VAC	On/Off	80	2	FSNF230-S	
MS4620F1005	230 VAC	On/Off	175		FSAF230A	
MS4620F1203	230 VAC	On/Off	175	2	FSAF230A-S	
MS4709F1014	230 VAC	On/Off	80		FSNF230 US	
MS4809F1012	230 VAC	On/Off	80		FSNF230 US	
MS7520A2015	24 VAC	2-10V, 4-20mA	175		FSAFB24-SR US	
MS8104F1010	24 VAC	On/Off	30		FSLF24	*
MS8104F1210	24 VAC	On/Off	30		FSLF24	*
MS8109F1010	24 VAC	On/Off	80		FSNF24	
MS8109F1210	24 VAC	On/Off	80	2	FSNF24-S	
MS8120F1002	24 VAC	On/Off	175		FSAF24A	
MS8120F1200	24 VAC	On/Off	175	2	FSAF24A-S	
MS8209F1003	24 VAC	On/Off	80		FSNF24 US	
MS8309F1001	24 VAC	On/Off	80		FSNF24 US	
S20230-F	230 VAC	On/Off	175		FSAF230A	
S20230-F-SW2	230 VAC	On/Off	175	2	FSAF230A-S	
S2024-F	24 VAC	On/Off	175		FSAF24A	
S2024-F-SW2	24 VAC	On/Off	175	2	FSAF24A-S	
SPH2 Aux Switch						**
32003532-002 Aux Switch						**

* Use FSNF series if damper is > 4 sq.ft.
** Use -S model of proper voltage.

Nominal sq.ft. per UL555S testing.	Temp	Actuator	
<4	350°F	FSLF	36” w x 24” h also.
<12	350°F	FSNF	Multisections also.
<16	250°F	FSNF	Multisections also.
<18	350°F	FSAF*A	Multisections also.

The FSTF series actuators were introduced in 2013. They are 18 in-lb and designed for under 1.5 sq.ft. of fire and smoke damper. Use on larger dampers only when replacing an existing FSTF on a fire and smoke damper.

The FSLF is recommended for small dampers.

Belimo actuators pass UL555S at the same damper sizes as the Honeywell.	NOTE. Although an actuator may operate a larger sized damper use the UL listed sizing. Call for assistance.

Siemens

Make & Model	Power	Belimo Replacement	
GGD121	24	FSAF24	FSNF24
GGD221	120	FSAF120	FSNF120
GGD321	230	FSAF230	FSNF230

GND12x.1x	24V		FSLF24
GND22x.1x	120V		FSLF120
GND32x.1x	230V		FSLF230

Electronic Fuse Link (24 Vac)

ASK79.165 165°F (74°C)	BAE165 US
ASK79.212 212°F (100°F)	None. Call if needed.
ASK79.250 250°F (121°C)	None. Call if needed.
ASK79.350 350°F (177°C)	None. Call if needed.

Optional	Two Auxiliary Switches Fixed 5° and 85°

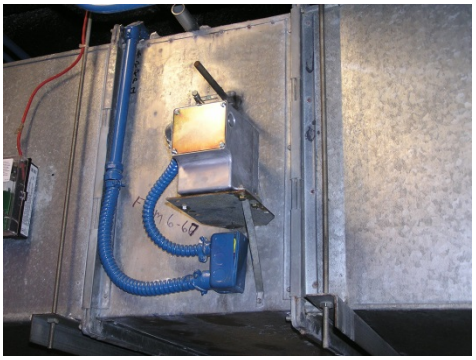
For more manufacturer specific instructions see Retrofit or Documentation Tabs in middle of page:
https://www.belimo.us/firesmoke

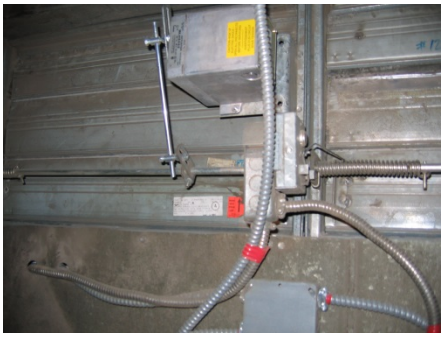
Belimo linkage kits:
https://www.belimo.com/pim/mam/americas/technical_documents/data_sheets/man-air-acc/Mechanical_Accessories.pdf

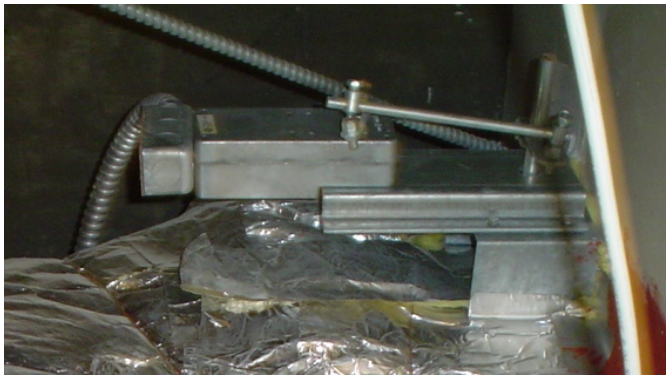
Mounting Methods Guide:
https://www.belimo.us/mam/americas/technical_documents/pdf-web/guides/mounting_methods.pdf

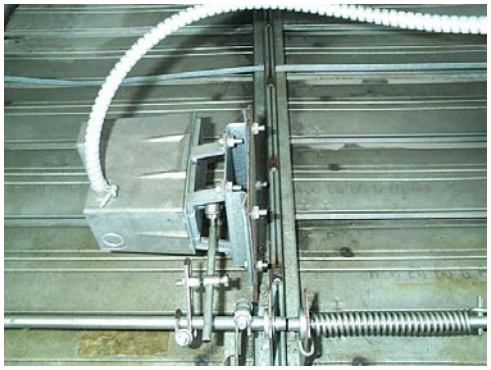
Examples of various gear train motors and mounting

In general, oil-filled spring return motors like the MA418 are straightforward replacements. In this case, the Belimo FSNF or FSAF may be direct coupled. The shaft spring should be examined and exercised to prove it is still operational. The fusible link cannot be seen, however it should release the shaft spring.

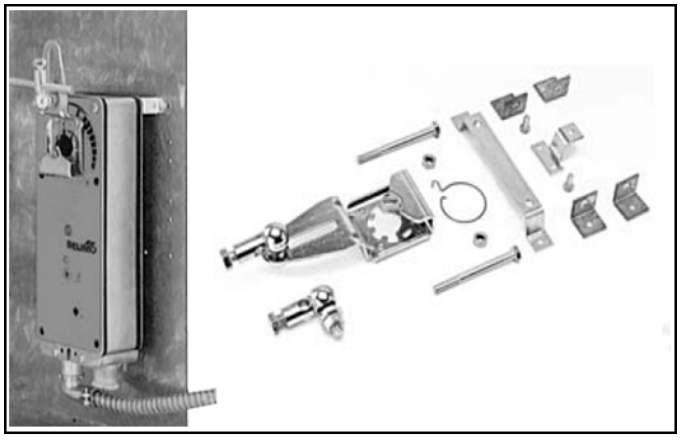








The above applications will need linkages due to space constraints or accessibility



ZG-AF US kit. This contains parts for several different ways to linkage the FSAF and FSNF series of actuators.

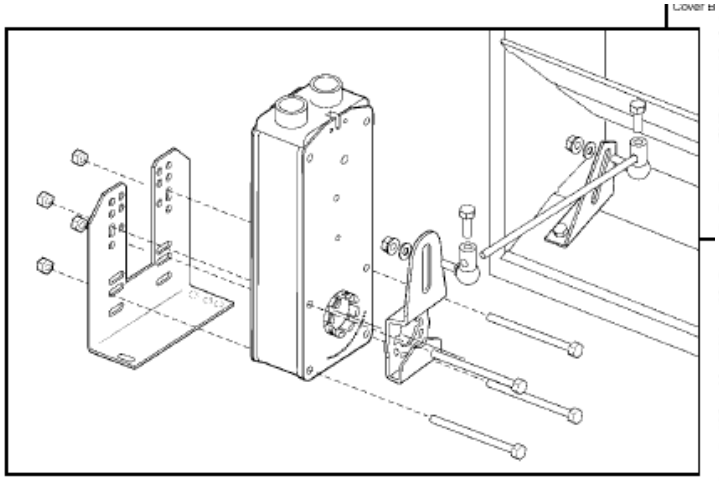
Linkage Mounting

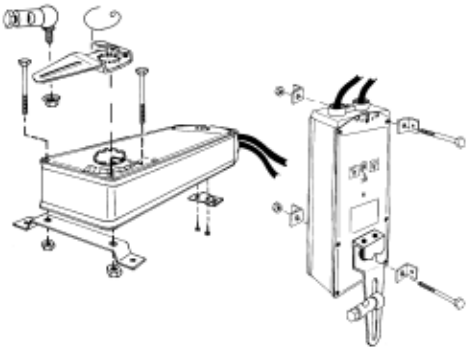
WARNING!

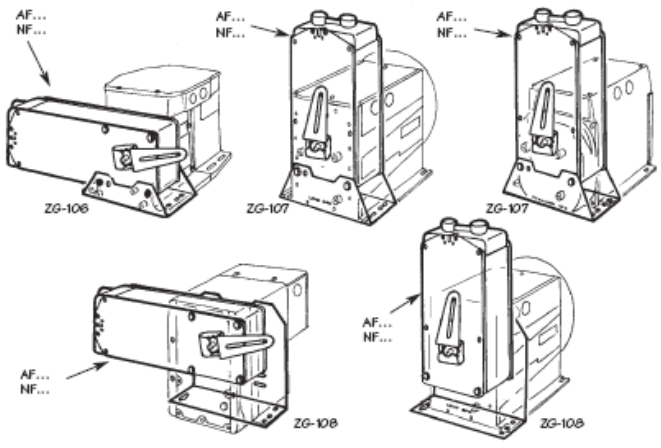
USE CAUTION!

Springs are under high torsion and may cause serious injury! If any external springs are present, exercise caution – wear face and hand protection.

Apply the most appropriate linkage mounting method for the geometric arrangement







Use of ZG-106 bracket with crank arm and ball joints to connect to two damper arms

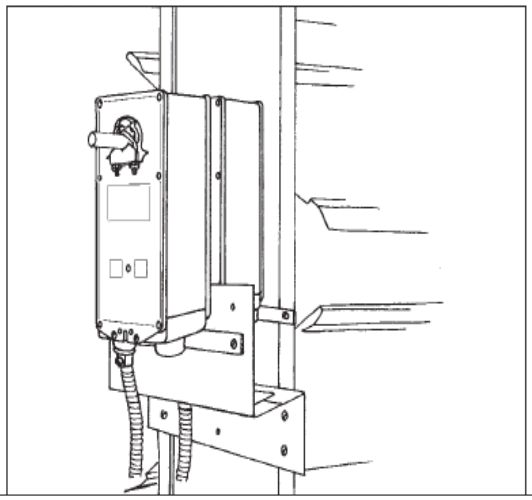
MA418 that was formerly linkaged, now direct coupled

These are very easy to replace. Simply remove the old motor and linkages. Then mount Belimo FSNF over shaft. Do not remove any bearings.

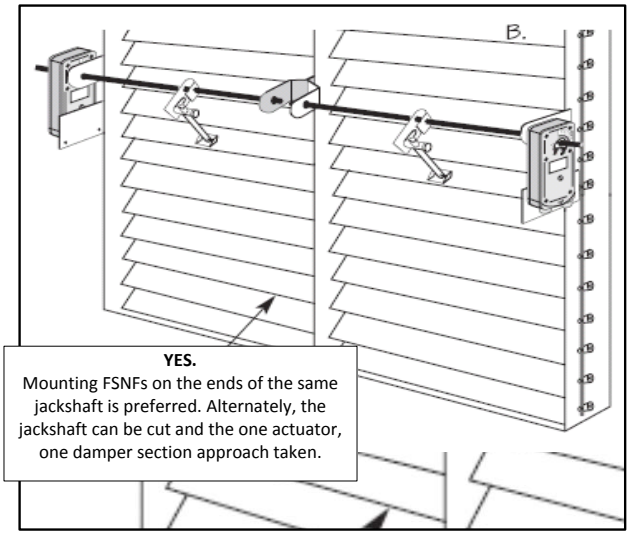
With no space to direct couple, the ZG-AF Leg kit has been used. Note the legs between actuator and duct

Above are some ways in which Belimo linkages are used. The lower right picture is of an FSTF with ZG-TF112. This actuator is not generally used for retrofits as it is only 18 in-lb of torque, but in special circumstances, it is quite useful.

The FSAF*A and FSNF series may be mounted using the ZG-102 (left). However, it is recommended that they be mounted on the ends of the jackshaft (right). Derate torque to 80% of the combination of multiple actuators.



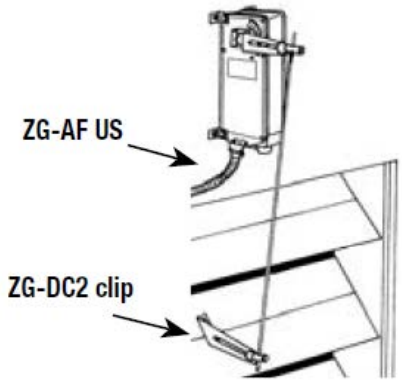
NO.
Use of the ZG-102 for mounting 2 FSNF is not recommended in general. The fast speed and high torque loads will damage gears if actuators are cycled more than once a day.

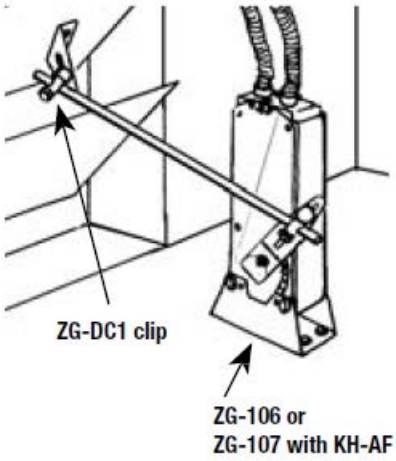


YES.
Mounting FSNFs on the ends of the same jackshaft is preferred. Alternately, the jackshaft can be cut and the one actuator, one damper section approach taken.

Example of linkage that can be replaced by direct coupling

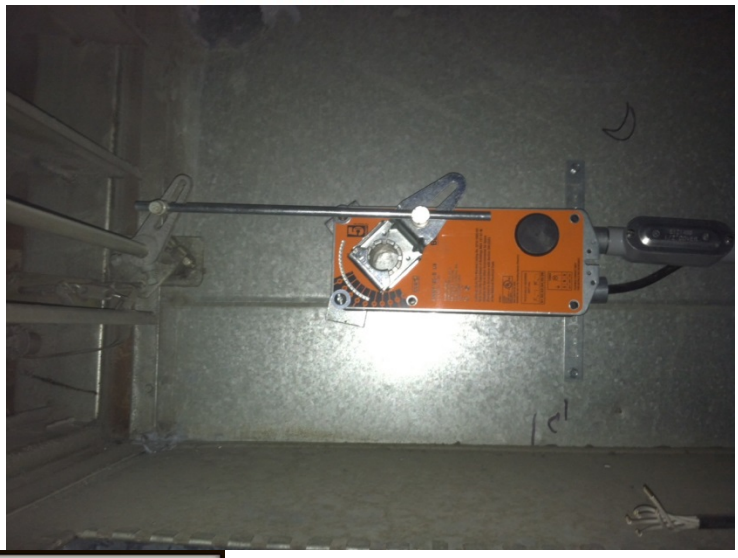
The motor to the right can be replaced by direct coupling over the shaft. Use of linkages is not needed.





Belimo linkage kits:
https://www.belimo.com/pim/mam/americas/technical_documents/data_sheets/man-air-acc/Mechanical_Accessories.pdf

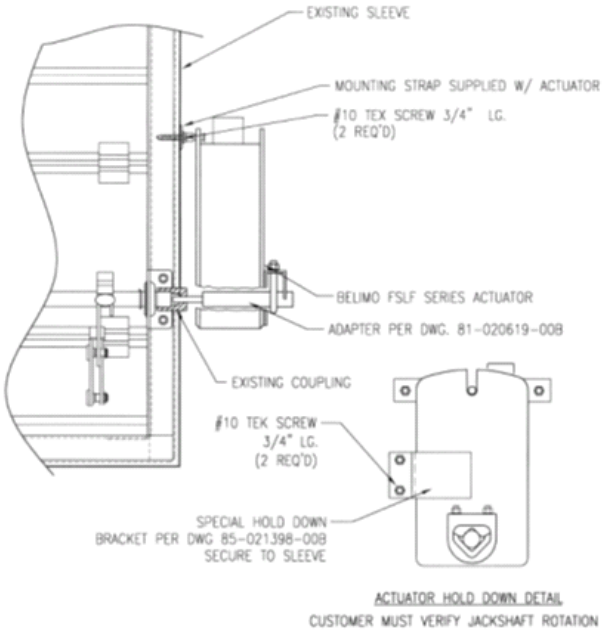
Mounting Methods Guide:
https://www.belimo.us/mam/americas/technical_documents/pdf-web/guides/mounting_methods.pdf




OPEN

FSLF

The FSLF has no linkages except for a custom one supplied in a kit by Ruskin.



Ruskin makes a kit with a shaft adaptor, hold down, and Belimo FSLF120 actuator.

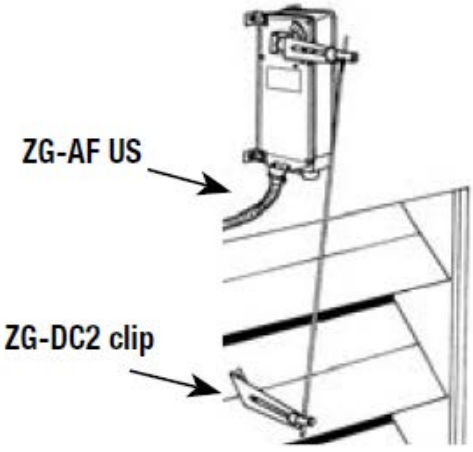
Fusible rods are no longer available from Ruskin.

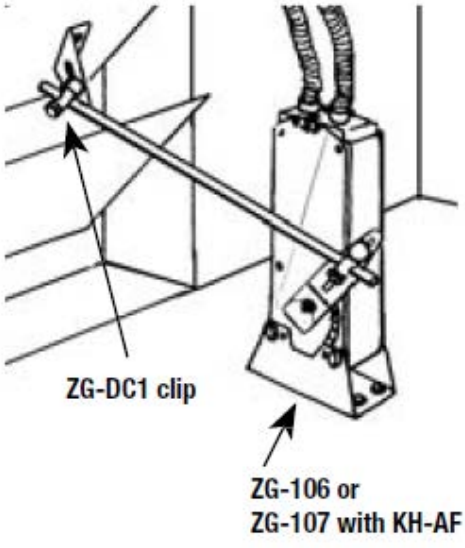
Where springs are defective, ball joints, rod, and a BAE 165 or Ruskin EFL are necessary.

Rewiring is necessary.

FSTF mounting

Given the typical space constraints of installed dampers, it is likely that all the actuator and linkage parts will need to be assembled as much as possible and then installed as an assembly.

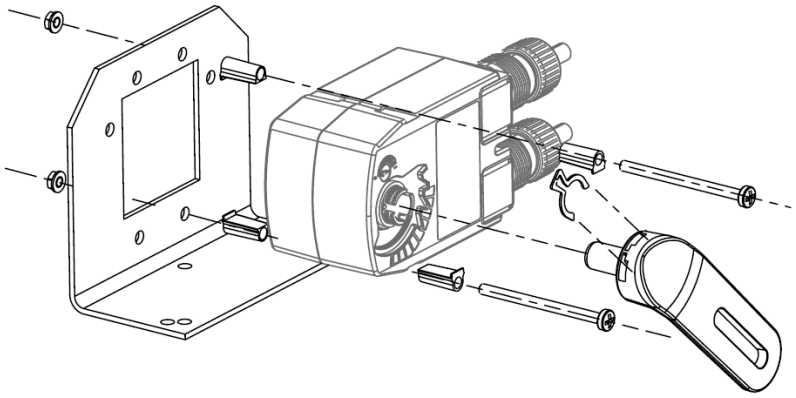




Possible alternate arrangements for damper clip. (FSNF, FSAF actuators shown.)

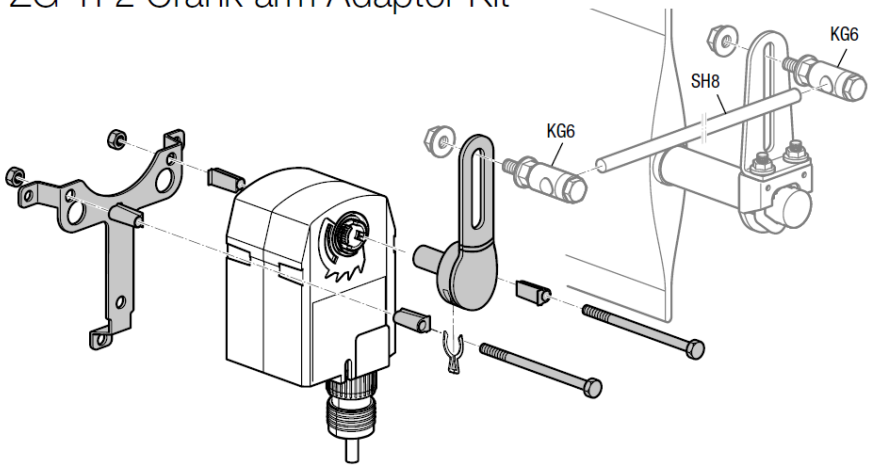
FSTF linkage kit mounting

The crank arm material is Duroplast Vyncolit® (phenolic compound similar to Bakelite). Smoldering temp is 500°F; auto-ignition temp is 900°F.



The ZG-TF112 Crank Arm Adaptor Kit includes:
1 ZG-113 Mounting Bracket
1 KH-TF-1 Crank arm with Retaining Clip
2 Bolts with Nuts
Ball joints and 5/16” Rod not included

ZG-TF2 Crank arm Adaptor Kit



The ZG-TF2 Crank Arm Adaptor Kit includes:
1 Mounting Bracket
1 KH-TF-1 Crank Arm with Retaining Clip
3 Bolts with Nuts
Ball joints and 5/16” Rod not included

It is assumed that the bracket here will be installed on an existing sleeve or the Prefco mounting plate shown in the full damper pictures below. Belimo brackets and parts are shown in our Mechanical Accessories Guide:
https://www.belimo.com/pim/mam/americas/technical_documents/data_sheets/man-air-acc/Mechanical_Accessories.pdf

Direct Coupling

This is the preferred method for mounting

-

FSLF

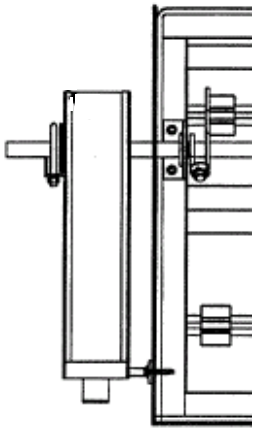
FSLF mounted on the damper shaft. Two sheet metal screws hold the anti-rotation strap. Two nuts secure cold-weld clamp onto shaft.

Note that actuator floats freely. Clamp cold welds when teeth dig into the damper shaft and the anti-rotation strap stud allows the actuator to move if shaft is not perfectly concentric. Rigid mounting by jamming the stud into the U-slot of actuator is NOT usually best.

FSNF & FSAF

FSNF mounted on the damper shaft. Two screws hold the anti-rotation strap. Two nuts secure cold-weld clamp onto shaft.

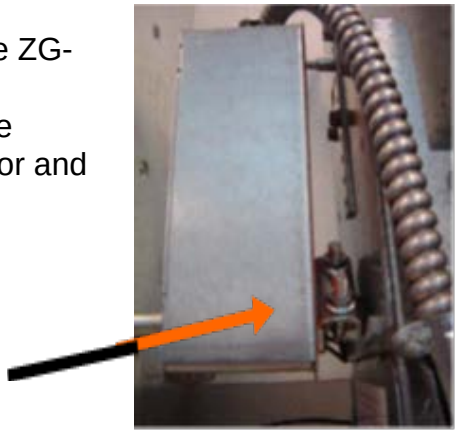
FSAF mounts the same.



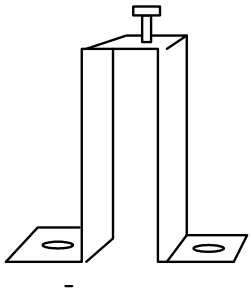
Side view

For short shaft mounting, the ZG-LMSA-1/2-5 can be used. Alternately, the clamp can be installed between the actuator and sheet metal.

Clamp



The geometry of linkages changes the torque translation between the actuator and the damper. See Belimo's Mounting Methods Guide for a description of the mathematics.



As long as it is mechanically solid, the anti-rotation strap may be bent to fit height.

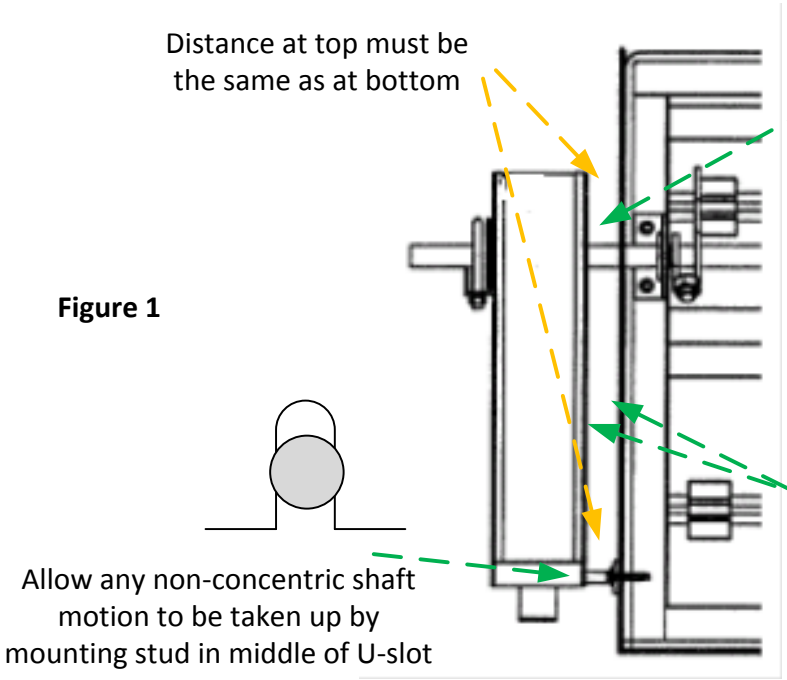
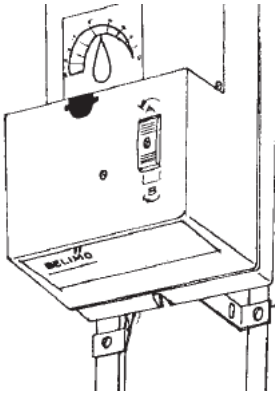


Figure 1

Note how the pin of the anti-rotation strap is mounted in middle of actuator U-slot.

Figure 2



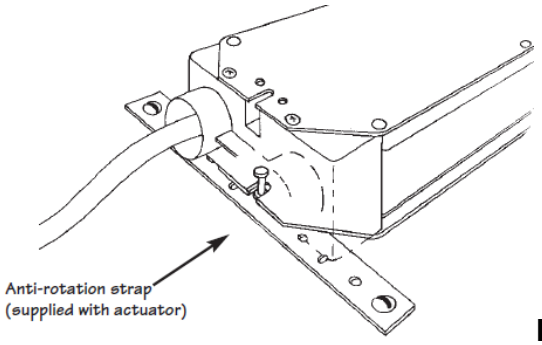
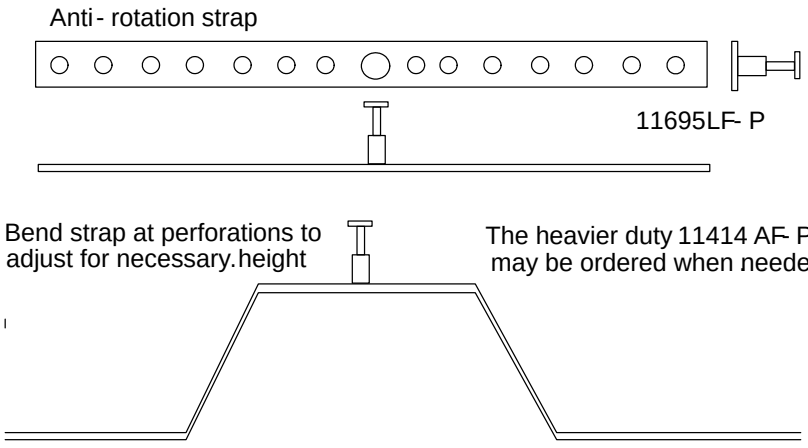
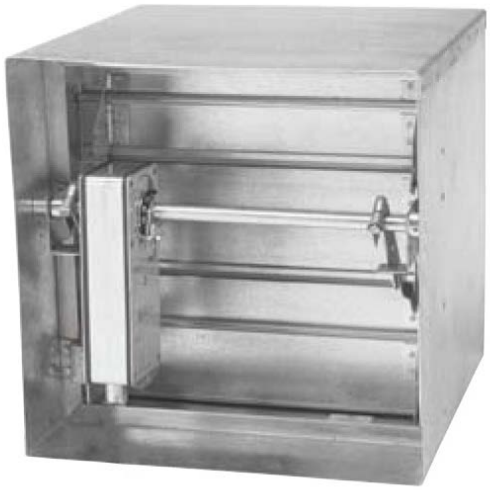


Figure 3





FSNF mounted on the damper shaft. Two sheet metal screws hold the anti-rotation strap. Two nuts secure cold-weld clamp onto shaft.

Depending on the geometry, any number of mounting arrangements are correct.

Alternately, the anti-rotation strap can be attached to any Belimo linkage, an electrical J-box cover plate, or to a pieced of U-channel.

It is important to remember that the ducts are fall-away. The actuator mounting cannot interfere with the ability of the duct to fall from the damper. The damper must continue to protect the wall.

See Belimo Mounting Methods Guide for more mounting drawings.

Best to mount the Belimo anti-rotation strap perpendicular to the actuator to allow for movement on non-concentric shaft.

WARNING!

Actuator anti-rotation strap may not be screwed to the duct. It must attach to either the sleeve or to the mounting bracket. The duct must be able to fall away from the damper in case of ceiling collapse in a fire.

WARNING!

Read entire actuator data sheet before installation.

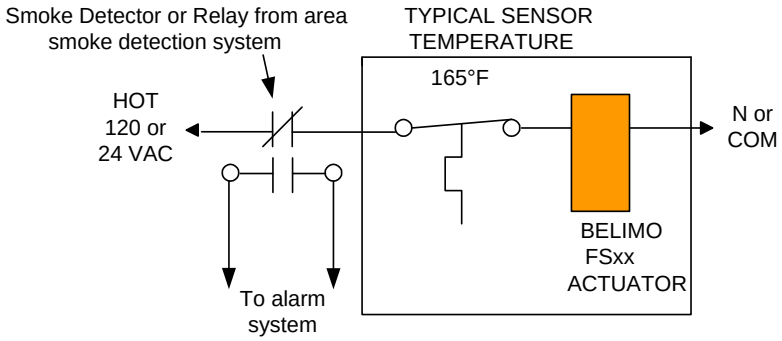
Wiring

> *WARNING!*
>
> **Disconnect and lock out power before starting to disconnect old motor.**

There are three wiring schemes that describe all applications. While the geometry of the wire runs may vary, the connections are straightforward.

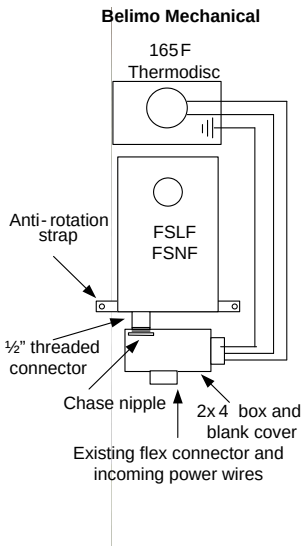
TYPICAL FIRE - SMOKE COMBINATION DAMPER WIRING

Electric thermal disc



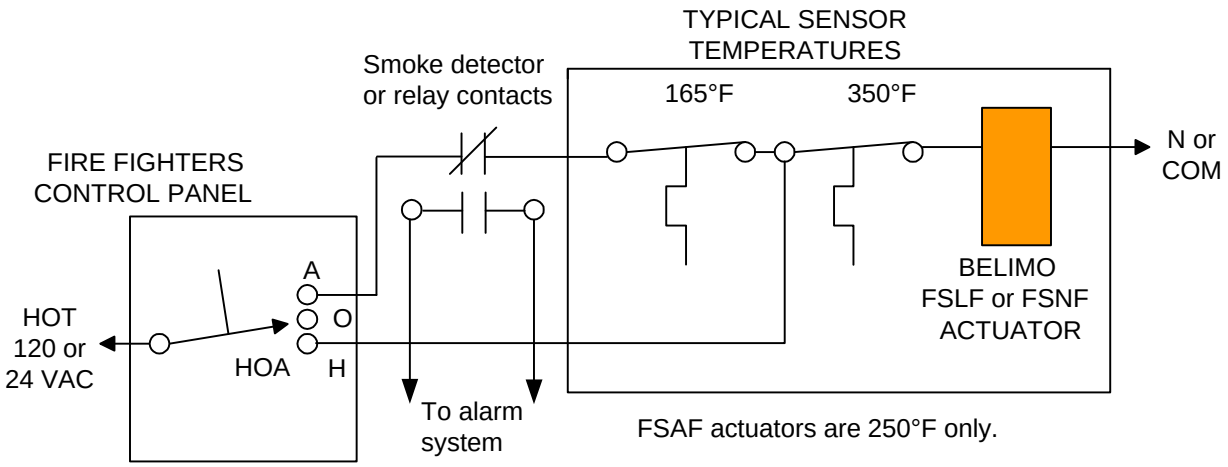
Regardless of the wiring routes used, this drawing shows the wiring necessary for a UL555S damper and actuator. Use it as a basis for any of the other wiring schematics. Note that the alarm connections are not touched when replacing an actuator. This is a major concern for Fire Marshals.

Where a wiring compartment is needed for junctions, a 2 x 4 box can be attached with a chase nipple.



The wiring below is commonly connected to alarm or smoke control electronic modules in modern systems. The functional sequence is the same.

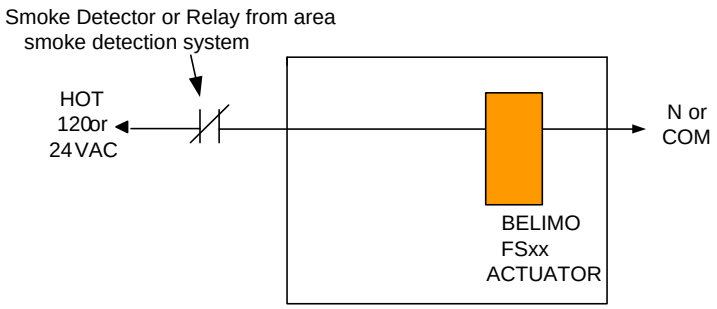
TYPICAL REOPENABLE DAMPER with FSCS



In some cases the gear train motor was installed for smoke only functions. The fire closing was achieved using fusible links. There is no electric sensor in the damper in that case as there is typically a shaft spring performing the fire function. Wiring is shown below.

Fusible link DAMPER ACTUATOR WIRING

SMOKE DAMPER



Building Official / Fire Marshal Notification Form

Retain this portion of checklist at premises for Fire Marshal inspection. See local AHJ or Fire Marshal for other information and requirements regarding conformance with NFPA 80 & NFPA 105.

☐ Test Checklist (Smoke dampers do not have sensors. Only steps a & b apply.)

1. **Single Sensor Combination Damper**
   a. □ Open smoke detector or relay wire or contact to cut power. *Damper springs closed.*
   b. □ Reconnect power. *Damper drives open.*
   c. □ Open thermal sensor using heat gun. *Damper springs closed.*
   d. □ Press thermal sensor manual reset. *Damper drives open.*

   Repeat 3 times to ensure operation. This imitates UL555S test.

2. **Reopenable Two Sensor Fire-Smoke Combination Damper**
   (Since this system involves the Firefighters' Smoke Control System, inform fire department.)

With FSCS switch in Auto position:
   a. □ Disconnect power from smoke detector or relay contacts. *Actuator springs damper closed.*
   b. □ Reconnect power. *Actuator drives damper open.*
   c. □ Trip thermal sensor. *Actuator springs damper fully closed.*
   d. □ Press manual reset. *Actuator drives damper open.*

Test FSCS switch functions:
   a. □ Move FSCS switch to Off position. *Actuator springs damper fully closed.*
   b. □ Move FSCS switch to Hand position. *Actuator drives damper open.*
   c. □ Trip secondary (higher temperature) thermal sensor. *Actuator springs damper fully closed.*
   d. □ Press manual reset of secondary sensor. *Actuator drives damper open.*

Move FSCS switch back to Auto position:
   a. □ Actuator springs damper closed if Primary sensor is still open.
   b. □ Actuator stays open if Primary sensor has re-closed.

☐ **When completed, ensure sensors are reset and smoke detector is in normal state and FSCS switch is in Auto. Damper is normally Open; check sequence of operation.**

Damper Numbers or Location Identifying Numbers……

Date……-……-……

Contractor……

Service Technician (Print)……

Service Technician (Signed)……

Phone Number (……)……

Notes……

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