Solutions Provided by BELIMO

Technical Documentation
Damper Actuators and Accessories

Effective October 2006

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Trane Technology Center, LaCrosse, Wisconsin

Actuator Product Range

Spring Return

TTF Series	TLF Series	TNF Series	TAF Series
18 in-lb [2 Nm] Approx. **4.5** sq. ft.	35 in-lb [4 Nm] Approx. **8** sq. ft.	60 in-lb [7 Nm] Approx. **15** sq. ft.	133 in-lb [15 Nm] Approx. **33** sq. ft.
			
Pg. 58	Pg 42	Pg 28	Pg 12
Control: On/Off Floating Point 2-10 VDC 4-20 mA w/500Ω resistor	**Control:** On/Off Floating Point 2-10 VDC 4-20 mA w/500Ω resistor	**Control:** On/Off Floating Point 2-10 VDC 4-20 mA w/500Ω resistor	**Control:** On/Off Floating Point 2-10 VDC 4-20 mA w/500Ω resistor
Power Supply: 24 VAC/DC	**Power Supply:** 24 VAC/DC	**Power Supply:** 24 VAC/DC	**Power Supply:** 24 VAC/DC
Options: Built-In Auxiliary Switch	**Options:** Built-In Auxiliary Switch	**Options:** Built-In Auxiliary Switch	**Options:** Built-In Auxiliary Switch

Actuator Product Range

Non-Spring Return

TLM Series	TNM Series	TAM Series	TGM Series
45 in-lb [5 Nm] Approx. **11** sq. ft.	90 in-lb [10 Nm] Approx. **22** sq. ft.	180 in-lb [20 Nm] Approx. **45** sq. ft.	360 in-lb [40 Nm] Approx. **90** sq. ft.
			
Pg 92	Pg 86	Pg 80	Pg 74
Control: Floating Point 2-10 VDC 4-20 mA w/500Ω resistor	**Control:** Floating Point 2-10 VDC 4-20 mA w/500Ω resistor	**Control:** Floating Point 2-10 VDC 4-20 mA w/500Ω resistor	**Control:** Floating Point 2-10 VDC 4-20 mA w/500Ω resistor
Power Supply: 24 VAC/DC	**Power Supply:** 24 VAC/DC	**Power Supply:** 24 VAC/DC	**Power Supply:** 24 VAC/DC
Basic Options: Terminal Strip Bulk Packs			

Why Belimo?
A CLOSER LOOK…

Damper Actuators

- Extensive product range.
- Specific retrofit offerings.
- Small dimensions in relation to torque.
- Microprocessor-controlled Brushless DC motor increases actuator life span and reliability & provides constant running time (most actuators).
- Cut labor costs with simple direct coupling.
- Check damper position easily with clear position indication.
- Overload-proof throughout rotation.
- Temporary restrictions in damper movement will not change actuator operation. Actuator returns to normal operation when restriction is remove.
- Built-in or add-on mechanical stops to adjust angle of rotation.
- Built-in auxiliary switch is easy to use, offers feedback or signal for additional device (-S models).
- Need to change control direction? Do it easily with a simple switch on actuator housing.
- Rugged housings withstand rough handling in the mechanical room.
- Automatically compensates for damper seal wear, ensuring tight close off.

Spring Return

- True mechanical spring return – the most reliable fail-safe.
- Reverse mount for clockwise or counterclockwise fail-safe.
- Manual override crank speeds installation (TAF Series).
- 3 ft. appliance cable and conduit connector eases installation.

Non-Spring Return

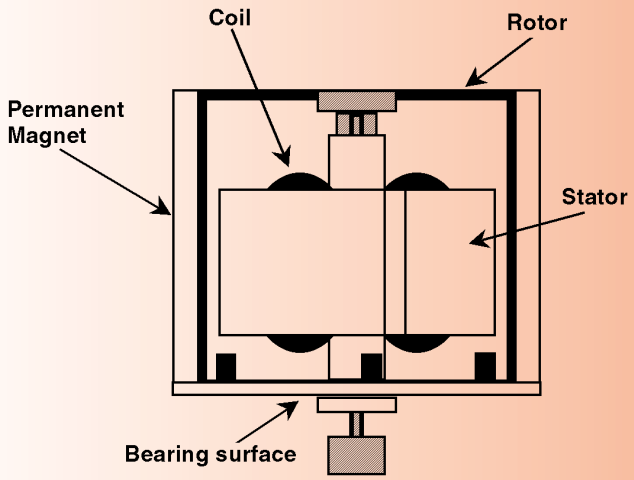
- Increased torque output by up to 28%
- More mounting flexibility – TLM accepts 3/4" dia. shafts, TNM, TAM & TGM mounts to 1.05" dia. jackshafts.
- New optional external auxiliary switch(es) or position feedback potentiometer modules – same modules for all non-spring return actuators!
- Manual override push button.
- Compatible to discontinued models.

Brushless DC Motor Technology

Belimo new generation actuators all employ state-of-the-art halomo sensorless, brushless DC motor technology. The halomo technology was developed exclusively by Belimo's Technology division and enables Trane to offer the high quality of brushless DC motor technology inside all actuator models in the new generation.

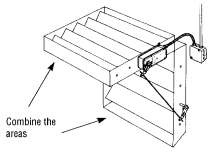
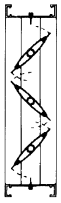
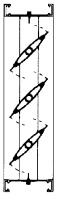
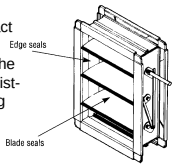
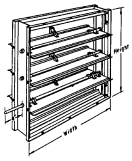
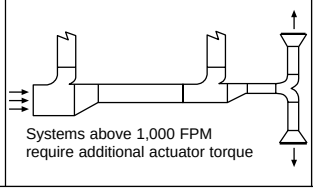
With the increase in product lifespan and quality the TLM series creates a new level of expectation for actuators installed in VAV applications.

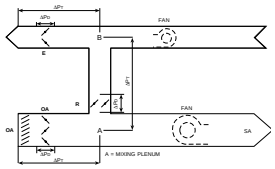
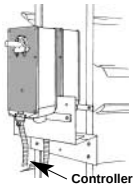
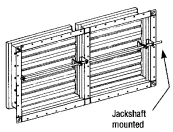
- Only **ONE** moving part!
- No brushes to wear out
- Position feedback is generated by ASIC
- Overload proof; uses integrated end stop filtering
- Running noise is reduced to absolute minimum



Sizing and Selecting Actuators

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 Trane actuator.

Criteria		Application Data
1 What is the total area of the damper?		_____ sq. ft.
2 Opposed blade or parallel blade control construction?	L” x W” = Total sq inches/144 = total sq feet **Opposed Blade w/o seals 3 in-lb/sq feet** **Opposed Blade w/ seals 5 in-lb/sq feet**  If unknown use a worst case scenario, parallel blade with seals. **Parallel Blade w/o seals 4 in-lb/sq feet** **Parallel Blade w/ seals 7 in-lb/sq feet** 	❑ Opposed Blade ❑ Parallel Blade
3 Are there blade and edge seals on the damper?	This will impact the proper selection as the seals add resistance requiring more torque. 	❑ YES ❑ NO
4 For the damper in question, what does the manufacturer specify as the torque rating?	 If this information is not available refer to the “typical damper requirements” chart.	_____ in-lb/sq. ft.
5 What is the air velocity, static pressure or design CFM?	 Systems above 1,000 FPM require additional actuator torque	_____W.G. _____CFM _____FPM

Criteria		Application Data
6 Is fail-safe required?	 Consider the application. Is the actuator/damper exposed to outside air? use spring return.	❑ YES ❑ NO
7 What is the supply voltage to the actuator? • 24 VAC/DC	 Do you need a step down transformer? If replacing an oil immersed gear train actuator. Is the transformer in the defective actuator? You may need to purchase one.	❑ 24 VAC
8 What is the control signal to the actuator?	 • Two position • Floating point • Modulating • Sequencing • “Non-standard” voltage signals This will be a critical component to the damper selection of an actuator.	❑ On/Off ❑ Floating Point ❑ 2-10 VDC ❑ 4-20 mA
9 Can you direct couple to a damper shaft?	 Direct coupling has become the industry standard. Some retrofit applications do not allow direct coupling.	❑ YES ❑ NO, see accessories page
10 Are there additional accessories required?	 Some applications require the additions of an auxiliary switch for proof of position. Or a retrofit application may require an additional mounting bracket and linkage kit. You must identify these needs prior to leaving the job site or ordering products.	❑ NO ❑ YES, see accessories section or actuator series for details

Typical Damper Requirements and Sizing

Damper with square shape: ft²= h x w /144; (h= high, w= width)

Damper Area (8 ft²) x Rated Torque Loading of Damper (4 in-lb/ft²) = Total in-lb Required (32 in-lb) *TLF/TLM 35 in-lb*

		Torque Loading in-lb/ft²		
		< 1000 FPM	FPM	FPM
SQUARE	**Damper Blade**	2 inch water column	1000-2500	2500-3500
	Parallel blade/edge seals	7	10.5	14
	Opposed blade/edge seals	5	7.5	10
	Parallel blade/no edge seals	4	6	8
	Opposed blade/no edge seals	3	4.5	6
	Round	10	14	20

Control Signal Overview

Trane 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', mean?

Trane 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 through-out 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 500Ω resistor.

Notes/Work Pad

Actuator Nomenclature

Spring Return

Spring Return Nomenclature

Example
TAF24-SR

Torque	133 in-lb
Actuator Type	Standard
Power Supply	24 VAC/DC
Control Signal	2 to 10 VDC
Auxiliary Switch	Not applicable
Clamp Size	1.05" standard clamp
Electrical Connection	3 ft, 18 GA appliance cable

TAF		24		-SR	
TORQUE STANDARD		**POWER SUPPLY**		**CONTROL**	
TAF	133 in-lb	**24**	24 VAC/DC	**Blank**	On/Off
TNF	60 in-lb			**3**	Floating Pt
TLF	35 in-lb			**SR**	2 to 10 VDC
TTF	18 in-lb				

Spring Return Actuator Product Range

Actuator Application Chart

	Airside Products	Torque Ⓑ (based on 4 in-lb per sq. ft)				Running Time		Power Supply	Power Consumption		Control Input			Position Feedback	Auxiliary Switches			See Page Number
		18 in-lb [2 Nm], Apprx. **4.5** sq. ft.	35 in-lb [4 Nm], Apprx. **8** sq. ft.	60 in-lb [7 Nm], Apprx. **15** sq. ft.	133 in-lb [15 Nm], Apprx. **33** sq. ft.	Motor Drive	Spring Return	24 VAC +/- 20%, VDC +/- 15%	VA rating	Wattage running (holding)	On/Off	Floating Point	2-10 VDC (Default) 4-20 mA* (w/500 ohm resistor)	2-10 VDC (Default)	1 SPDT, 3A (0.5A inductive) @250 V	1 SPDT, 6A (1.5A inductive) @250 V	2 SPDT, 7A (2.5A inductive) @250 V	
Spring Return	TAF24				●	150	<20	●	10	5 (1.5)	●							14
	TAF24-S				●	150	<20	●	10	5 (1.5)	●						●	14
	TAF24-SR				●	150	<20	●	10	6 (2)			●	●				16
	TNF24			●		<75	<60	●	8	5 (2.6)	●							30
	TNF24-S			●		<75	<60	●	8	5 (2.6)	●						●	30
	TNF24-SR			●		150	<60	●	6	3 (1)			●	●				32
	TLF24		●			< 40 to 75	<25♦	●	7	5 (2.5)	●							44
	TLF24-S		●			< 40 to 75	<25♦	●	7	5 (2.5)	●					●		44
	TLF24-SR		●			150	<25♦	●	5	2.5 (1)			●	●				48
	TLF24-3		●			150	<25♦	●	5	2.5 (1)		●						46
	TTF24	●				< 75	<25♦	●	4	2 (1.3)	●							60
	TTF24-S	●				< 75	<25♦	●	4	2 (1.3)	●				●			60
	TTF24-SR	●				95	<25♦	●	3	2 (1)			●					64
	TTF24-3	●				95	<25♦	●	5	2.5 (1)		●						62

♦<60 seconds @-22°F [-30°C]

Ⓑ For complete guide to sizing actuators see page 5.

Actuator Nomenclature

Non-Spring Return

Non-Spring Return Nomenclature

Example
TLMB24-3-T

Torque	45 in-lb
Actuator Type	Basic
Power Supply	24 VAC/DC
Control Signal	On/Off, Floating Pt.
Auxiliary Switch	Add-on
Clamp Size	5/8" LM standard
Electrical Connection	Terminal strip

TLM	B	24	-3	-T
Actuator Family Standard (95° Rotation)	**ACTUATOR TYPE**	**POWER SUPPLY**	**CONTROL**	*Terminal Screw Strip*
TGM 360 in-lb	**B** Basic	**24** 24 VAC/DC	**3** On/Off, Floating Point	
TAM 180 in-lb			**SR** 2 to 10 VDC	
TNM 90 in-lb				
TLM 45 in-lb				

Non-Spring Return Actuator Product Range

Actuator Application Chart

	Airside Products	Torque Ⓑ (based on 4 in-lb per sq. ft)				Running Time	Power Supply	Power Consumption		Control Input			Position Feedback	Auxiliary Switches	See Page Number
		45 in-lb [5 Nm], Apprx. **11** sq. ft.	90 in-lb [10 Nm], Apprx. **22** sq. ft.	180 in-lb [20 Nm], Apprx. **45** sq. ft.	360 in-lb [40 Nm], Apprx. **90** sq. ft.	Motor Drive	24 VAC +/- 20%, VDC +/- 15%	VA Rating	Wattage Running (holding)	On/Off	Floating Point	2-10 VDC 4-20 mA (w/500Ω resistor)	2-10 VDC	Add-on	
Non-Spring Return	TGMB24-3†				●	150	●	7	4.5 (2)	●	●			●	76
	TGMB24-SR†				●	150	●	7	4.5 (2)			●	●	●	78
	TAMB24-3			●		95	●	6	2.5 (0.5)	●	●			●	82
	TAMB24-SR			●		95	●	5	2.5 (0.5)			●	●	●	84
	TNMB24-3		●			95	●	4	2.5 (0.5)	●	●			●	88
	TNMB24-SR		●			95	●	4	2.5 (0.5)			●	●	●	90
	TLMB24-3	●				95	●	2	1.5 (0.2)	●	●			●	94
	TLMB24-3-T	●				95	●	2	1.5 (0.2)	●	●			●	94
	TLMB24-3-T.1	●				95	●	2	1.5 (0.2)	●	●			●	94
	TLMB24-SR	●				95	●	3	1.5 (0.5)			●	●	●	96
	TLMB24-SR-T	●				95	●	3	1.5 (0.5)			●		●	96
	TLMB24-SR-T.1	●				95	●	3	1.5 (0.5)			●		●	96

†For dual mounting on a single shaft the total sizing torque must not exceed 640 in-lbs (-3 and -SR wired in parallel).

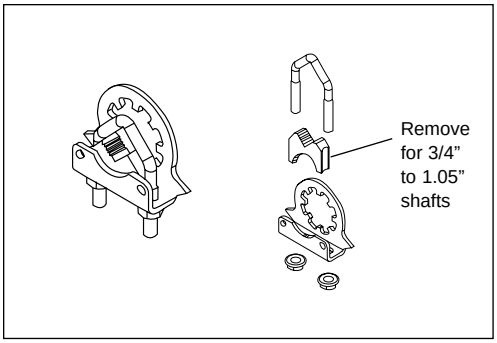
Ⓑ For complete guide to sizing actuators see page 5.

TAF Series Spring Return Direct Coupled Actuator

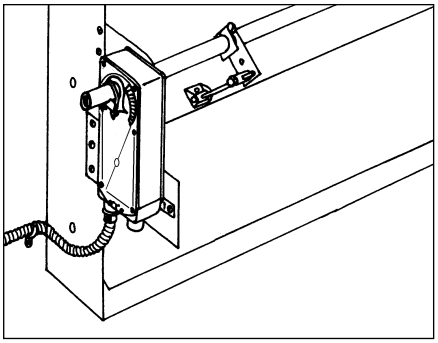
Minimum 133 in-lb Torque

- **For damper areas up to 35 sq-ft***
  (For lower torque, see TNF, TLF, or TTF series)

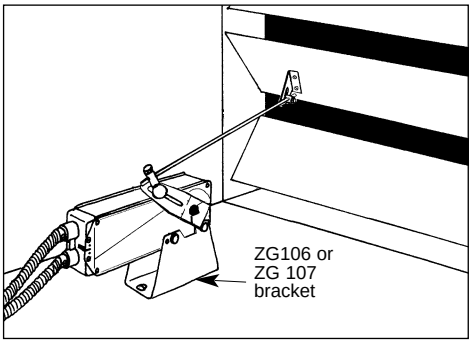
Applications



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.

TAF Series – AT A Glance

		TAF24 (p. 14)	TAF24-S (p. 14)	TAF24-SR (p. 16)
Torque:	133 in-lb	●	●	●
Power supply :	24 VAC/DC	●	●	●
Control signal:	on-off	●	●	●
proportional:	2 to 10 VDC			●
Feedback signal:	2 to 10 VDC			●
Running time motor:	150 sec constant	●	●	●
spring:	<20 sec	●	●	●
Brushless DC Motor		●	●	●
External direction of rotation switch				●
Manual override		●	●	●
Appliance rated cable, 18 GA		●	●	●
Built-in auxiliary switch 2 SPDT			●	

Installation instructions .....(p. 18–23)
Electrical operation .....(p. 24)
General wiring .....(p. 25)
Startup and checkout (p. 26)

*Based on 4 in-lb/ft^2 damper torque loading. Parallel blade. No edge seals.

A CLOSER LOOK...

LISTED 94D5 TEMP. IND & REG. EQUIP. UL | CSA | CE | ISO 9001

- Cut labor costs with simple direct coupling.
- True mechanical spring return – the most reliable fail-safe.
- Reverse mount for clockwise or counterclockwise fail-safe.
- Check damper position easily with clear position indicator.
- Overload-proof throughout rotation
- Temporary restrictions in damper movement will not change actuator operation. Actuator returns to normal operation when restriction is removed. (modulating actuators)
- 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
- 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. (-S models)
- Automatically compensates for damper seal wear, ensuring tight close-off.

BRUSHLESS dc motor ©

The Trane Difference

- *Low Installation and Life-Cycle Cost.*
  Easy installation. Accuracy and repeatability.
  Low power consumption. No maintenance.

- *Long Service Life.*
  Components tested before assembly. Every product tested before shipment.
  30+ years direct coupled actuator design.

TAF24 (-S)

On-off, Spring Return Fail-Safe, 24 V

Technical Data	TAF24 (-S)
Power supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power consumption	running: 5 W; holding: 1.5 W
Transformer sizing	10 VA (class 2 power source)
Electrical connection	3 ft, 18 GA appliance cable 1/2" conduit connector
Electrical protection	auxiliary switches are double insulated
Overload protection	electronic throughout 0° to 95° rotation
Angle of rotation	95°, adjustable 35° to 95° w/ ZDB-AF2
Torque	133 in-lb [15 Nm] constant
Direction of rotation	reversible with CW/CCW mounting
Position indication	visual indicator, 0° to 95° (0° is spring return position)
Manual override	3mm hex crank (shipped w/actuator)
Auxiliary switches	2 x SPDT 7A (2.5A) @ 250 VAC, UL listed one set at +5°, one adjustable 25° to 85°
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 steel
Agency listings	UL 873 listed, CSA C22.2 No. 24 certified
Noise level	max. 45 dB (A)
Servicing	maintenance free
Quality standard	ISO 9001
Weight	6.0 lbs (2.7 kg.)

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 TAF 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.

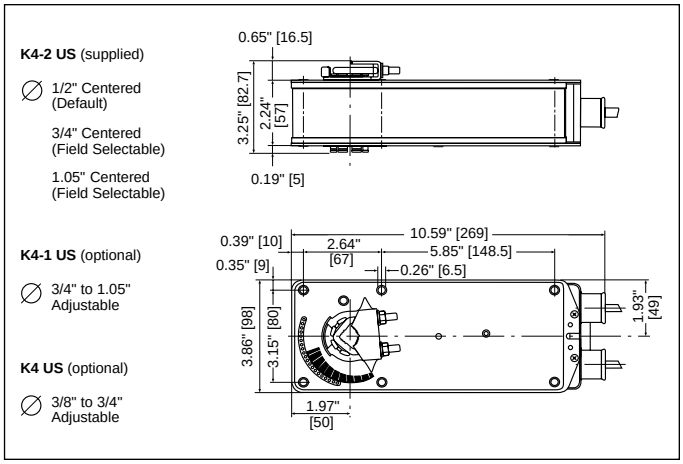
The TAF series provide 95° of rotation and are provided with a graduated position indicator showing 0° to 95°. The TAF has a unique manual positioning mechanism which allows the setting of any damper position within its 95° of rotation. The TAF series actuators are shipped at +5° (5° from full fail-safe) to provide automatic compression against damper gaskets for tight shut-off. When power is applied to the TAF series, the manual mechanism is released. The actuators will now try to close against the 0° position during its normal control operations. The manual override can also be released physically by the use of a crank supplied with the actuator.

The TAF 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 TAF24-S 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°.

For all accessories, see pages 110 and 132.

Dimensions [All numbers in brackets are in millimeters.]



I20683 - Subject to change.

CAUTION

△2 Equipment damage!
Actuators may be connected in parallel. Power consumption and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

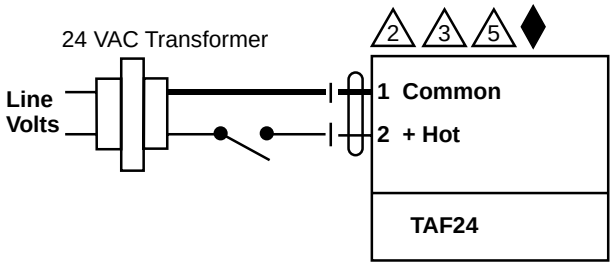
TAF24 (-S) Typical Specification

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. 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. 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 are UL listed and CSA certified, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

WARNING W450

Live Electrical Components!
During installation, testing, servicing and troubleshooting of this product, it maybe necessary to work with live electrical components. Have a qualified licensed electrician orother individual who has beenproperly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.



On-off wiring for TAF24

WARNING W451

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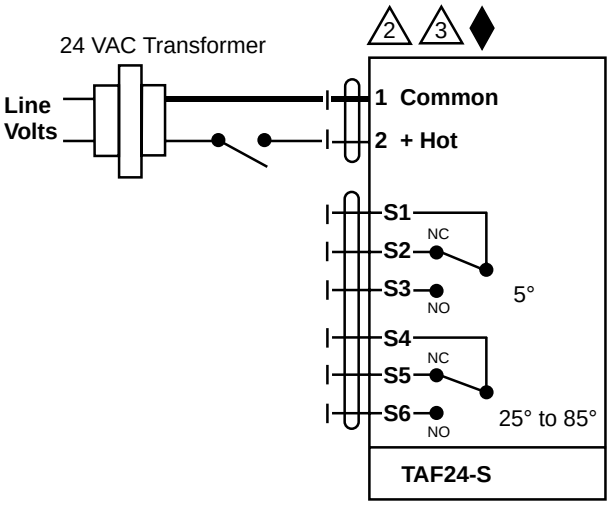
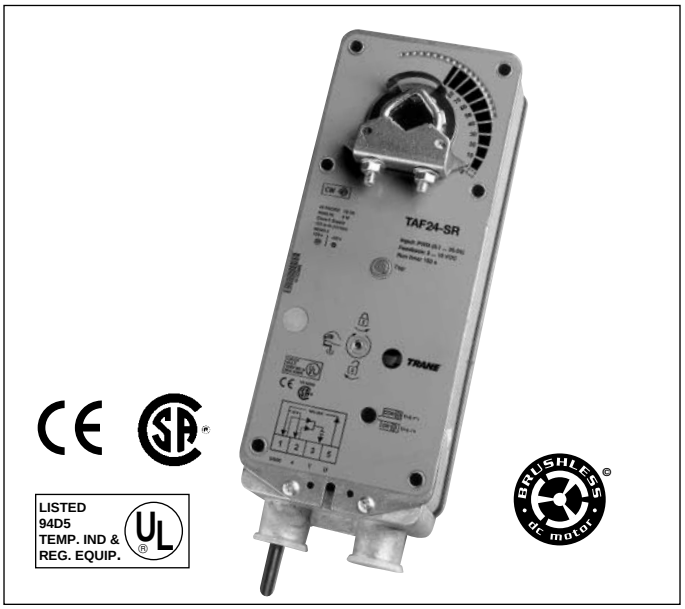


On-off wiring for TAF24-S

TAF24-SR

Proportional Damper Actuator, Spring Return Fail-Safe, 24 V for 2 to 10 VDC and 4 to 20 mA Control Signal. Output Signal of 2 to 10 VDC for Position Indication



Technical Data	TAF24-SR
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	100kΩ (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: reversible with cw/ccw mounting motor: reversible with built-in switch
Position indication	visual indicator, 0° to 95° (0° 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 dB (A)
Servicing	maintenance free
Quality standard	ISO 9001
Weight	6.0 lbs (2.7 kg.)

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.

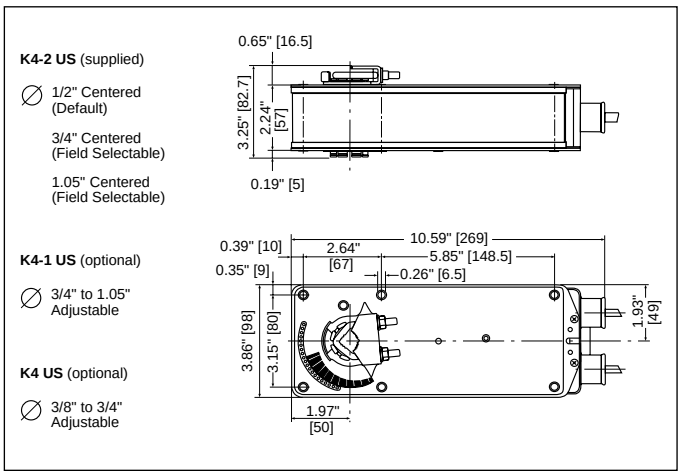
Operation
The TAF series actuators provide true spring return operation for reliable fail-safe application and positive close-off on air tight dampers. The spring return system provides constant torque to the damper with, and without, power applied to the actuator.

The TAF series provides 95° of rotation and is provided with a graduated position indicator showing 0 to 95°. The TAF has a unique manual positioning mechanism which allows the setting of any damper position within its 95° of rotation. The actuator is shipped at +5° 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 TAF 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.

For all accessories, see pages 110 and 132.

Dimensions [All numbers in brackets are in millimeters.]



I20683 - Subject to change.

CAUTION

△2 Equipment damage!
Actuators may be connected in parallel.
Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Only connect common to neg. (—) leg of control circuits

APPLICATION NOTES

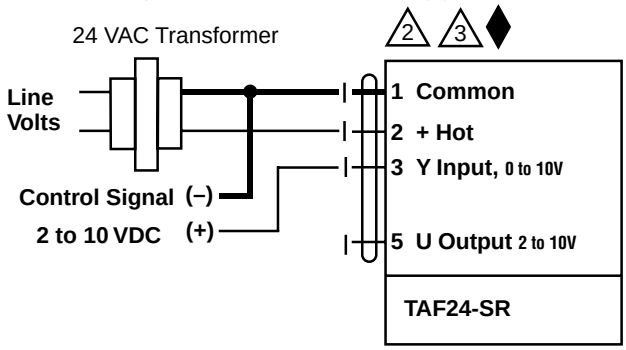
- Meets cULus or UL and CSA requirements without the need of an electrical ground connection.
- The ZG-R01 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

TAF24-SR 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 are UL listed and CSA certified and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

W452

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



W453

WARNING
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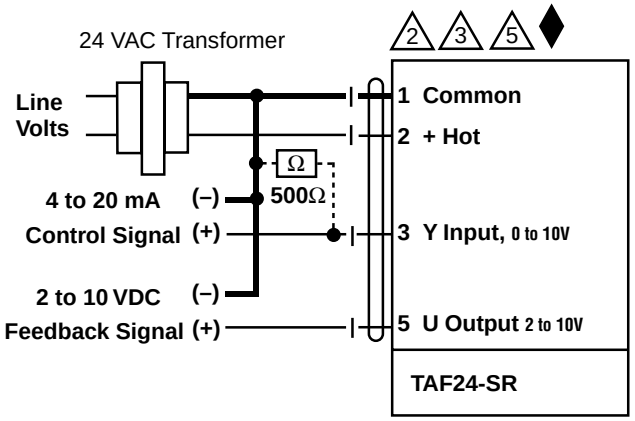
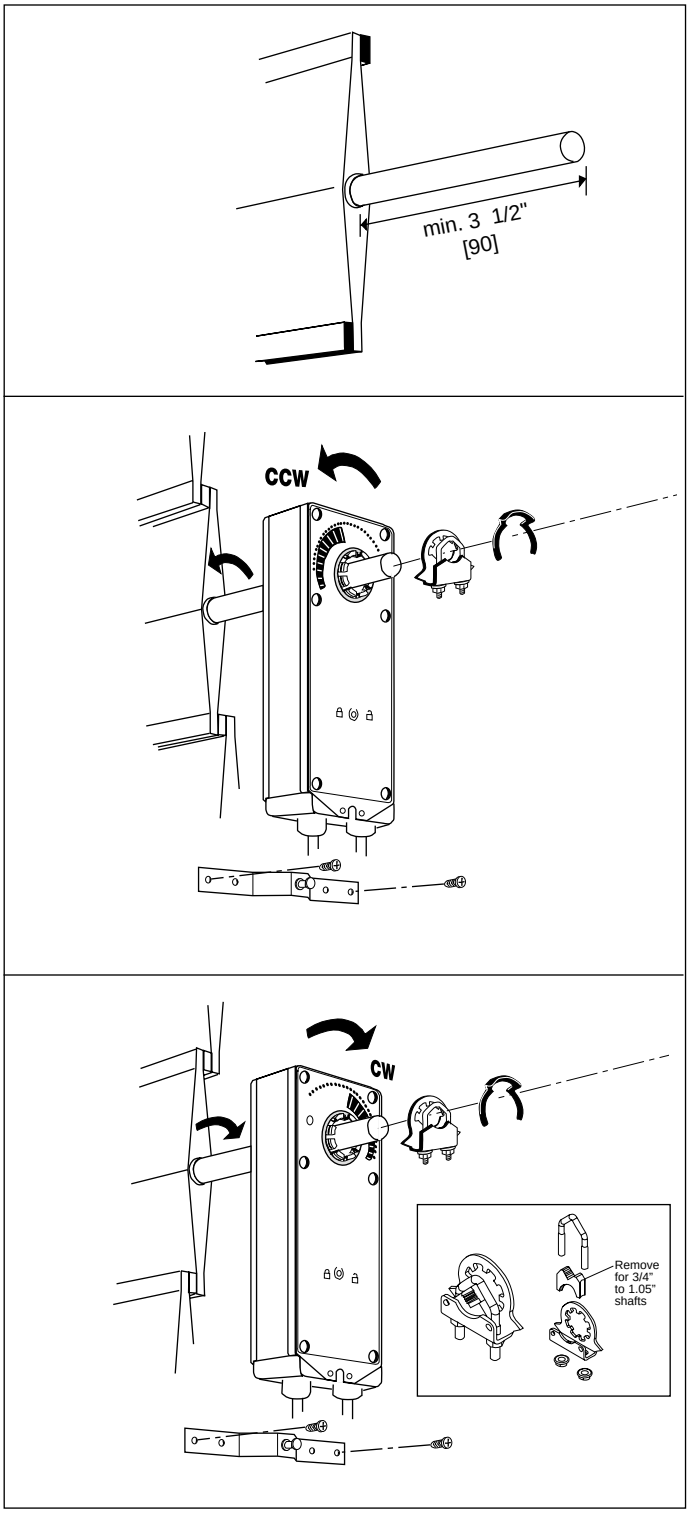


Installation Instructions

Quick-Mount Visual Instructions for Mechanical Installation

Dimensions (All numbers in brackets are in millimeters.)



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 10 mm 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.

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

The above torque loadings will work for most applications 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

Trane 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 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 accessory or the actuator may be mounted in its short shaft configuration.

Mechanical Operation

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

Automatic Airtight Dampers/Manual Override

The TAF series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°. The TAF 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 at +5° (5° from full fail-safe) to provide automatic compression against damper gaskets for tight shut-off. When power is applied, the manual mechanism is released and the actuator drives toward the full fail-safe position.

Standard Mounting

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

1. Manually move the damper to the fail-safe position (usually closed). If the shaft rotated counterclockwise ( ), this is a CCW installation. If the shaft rotated clockwise ( ), this is a CW installation. In a CCW installation, the actuator side marked “CCW” faces out, while in a CW installation, the side marked “CW” faces out. All other steps are identical.
2. The actuator is usually shipped with the universal clamp mounted to the “CCW” side of the actuator. To test for

adequate shaft length, slide the actuator over the shaft with the side marked “CCW” (or the “CW” side if this is the side with the clamp). If the shaft extends at least 1/8” through the clamp, mount the actuator as follows. If not, go to the *Short Shaft Installation* section.

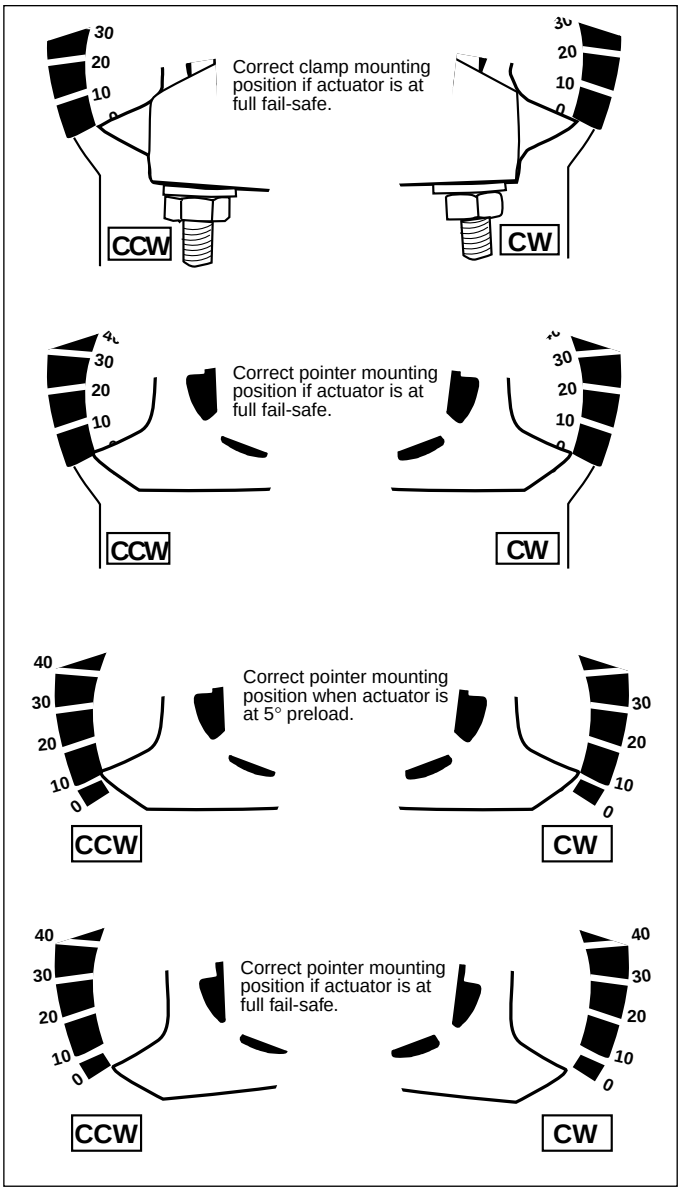


Figure A Universal Clamp and IND-AF2 Pointer (optional) Positions Indicating Fail-Safe and Pre-load Settings

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 Limiting, Mechanical Minimum Damper Position* section on page 21.
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

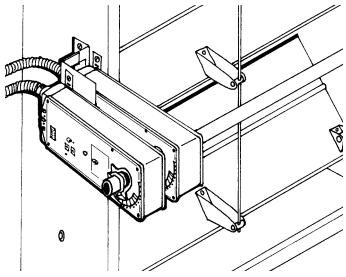
If the shaft extends at least 3/4” from the duct, follow these steps:

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 Figure A.

Jackshaft Installation

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

TAF actuators which may be used on one shaft:	
Model	**Max Quantity Per Shaft**
TAF24 (-S)	4
TAF24-SR	4



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 TAF actuator can provide, a second TAF 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 Figure 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 TAF 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 Figure C.

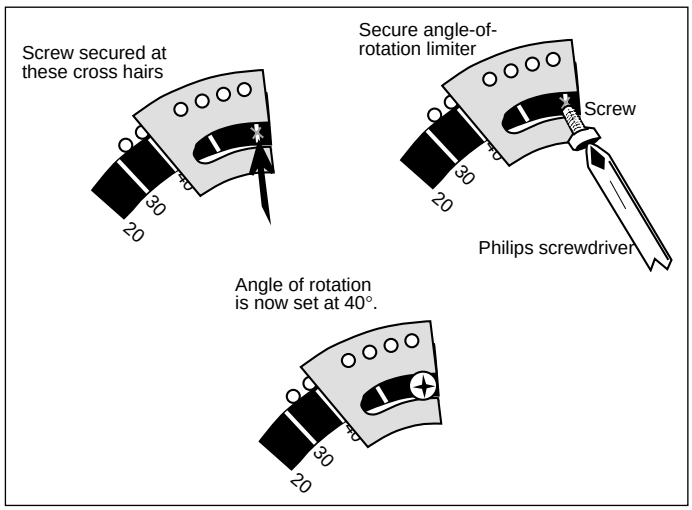


Figure C ZDB-AF2 Securing the Angle of Rotation Limiter

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 page 20.
1. Position the damper to its minimum position by using the manual crank or by providing the appropriate control signal to the TAF24… modulating type actuator.
2. Place the indicator on to the actuator spline in the approximate position shown in Figure D. Fasten it with the retaining clip. Note that the mounting orientation is different than the mounting used for *Damper Rotation Limiting*.

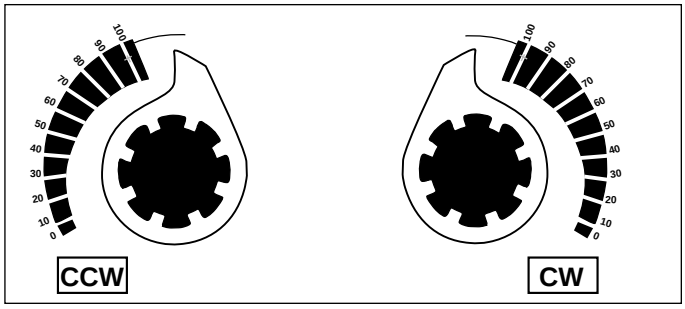


Figure D

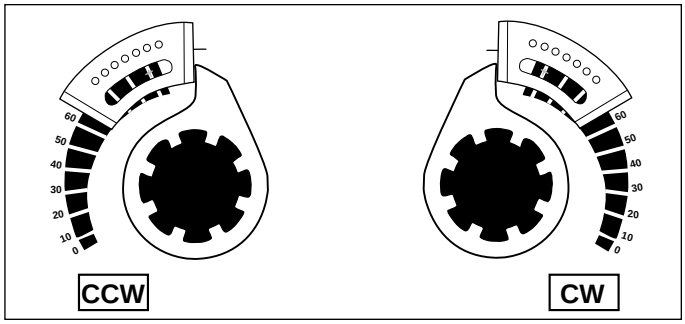
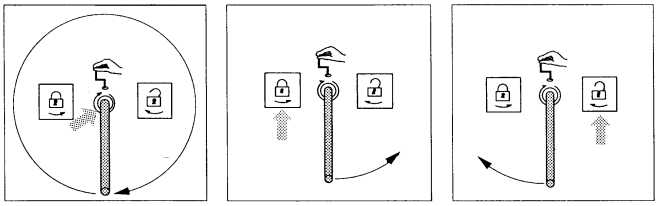


Figure E

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 Figure 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 TAF24-SR wired to either the SGA24 or SGF24 can be used for minimum position setting and still provide full close-off.

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



Winding the damper actuator
- insert crank handle
- turn handle in direction of arrow

Locking the damper actuator
- rotate crank handle 1/2 turn in the direction shown by the "locked" icon.

Unlocking the damper actuator
(2 options)
- rotate crank handle 1/4 turn in the direction shown by the "unlocked" icon.
- remote control by supplying power to the unit for > than 3 sec.

1. The manual override will only work if no power is available to the actuator.
2. Insert the manual crank (shipped with the actuator) into the hexagon hole located on either side of the actuator. An illustration, located on the label, shows the location.
3. Turn the crank in the direction shown on the label (clockwise on the "CW" side, counterclockwise on the "CCW" side). It will take approximately 19 revolutions to rotate the full 95° of rotation.
4. To lock the actuator in the required position, rotate the crank quickly in the opposite direction, 1/2 of a revolution. The "lock closed" icon on the label shows the correct direction.
5. The manual override may be disengaged in 2 ways.
   - Rotate the crank about a 1/4 revolution in the same direction as the initial winding. The "lock open" icon shows the correct direction.
   - Apply power to wire 1 and 2. The actuator will automatically disengage the override function and will go to the "on" position in the case of the on-off versions. Or, in the case of the proportional versions, go to the 0 signal position and then go to the position corresponding to the control signal. The actuator will now work normally.

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

Auxiliary Switches
The TAF series actuators may be ordered with 2 built-in SPDT auxiliary switches used for safety interfacing or signalling, for example, for fan start-up. The switch position near the fail-safe position is fixed at 5°. The other is adjustable between 25 and 85° of rotation. The crank, supplied with the actuator, or a 3mm allen wrench is used to adjust the switching position.

Switch Rating

Voltage	Resistive Load	Inductive Load
120 VAC	7A	5A
250 VAC	7A	2.5A

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

Method 1 - See Figure F
1 The actuator must be in its fail-safe position.
2. Insert the crank 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 Figure G
1. Position the damper to the point at which you want the switch to activate. This may be done by using the manual override or by providing the appropriate proportional signal to TAF24… 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.

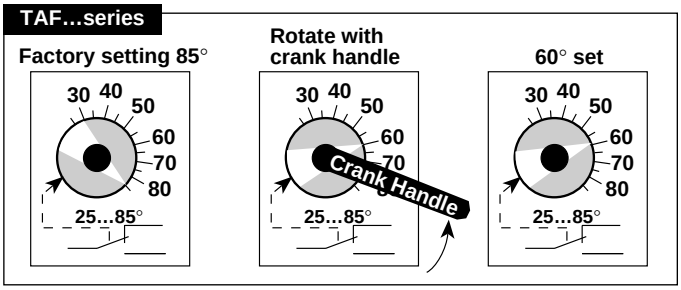


Figure F

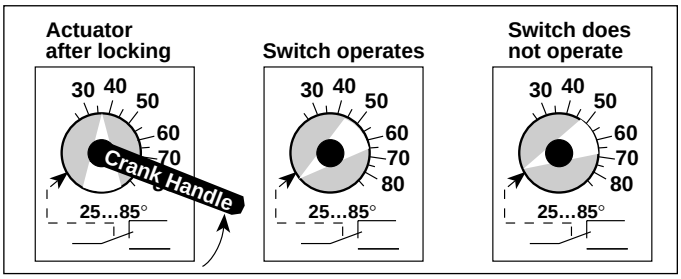


Figure G

Non-Direct Mounting Methods

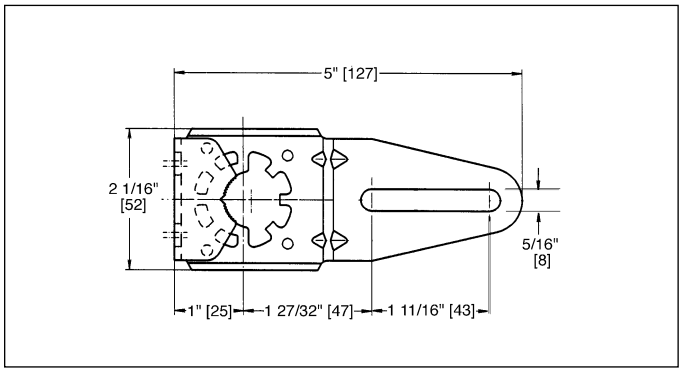
KH-AF Crankarm including Retaining Ring
Caution: the retaining clip supplied with the clamp is ***not*** used to mount the KH-AF crankarm.

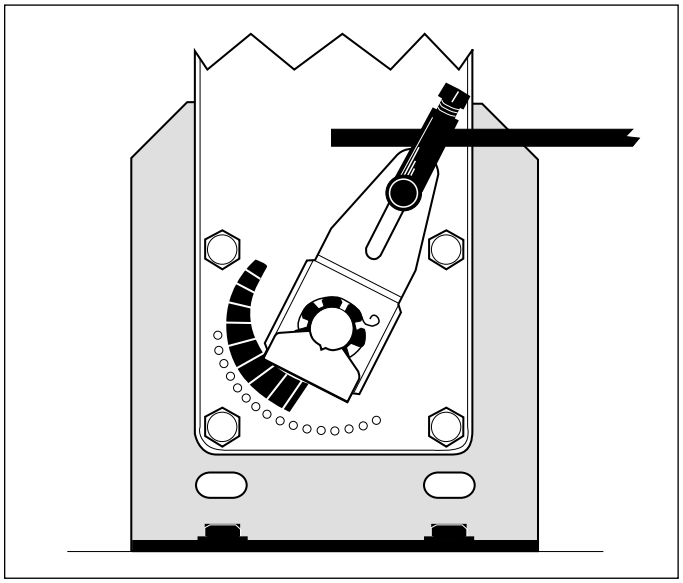
The KH-AF (-1) crankarm is used in non-direct coupled mounting applications. The KH-AF (-1) may also be used to simultaneously direct couple to a damper shaft and provide an additional crank arm connection to a second damper. The KH-AFV V-bolt kit must be used for this non-direct application (see illustration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

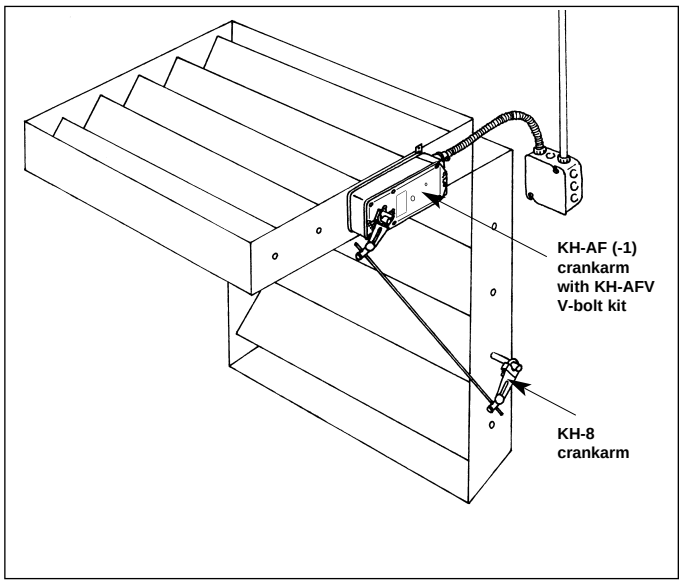
KH-AFV V-bolt kit for KH-AF(-1) crankarm

Dimensions (All numbers in brackets are in millimeters.)





KH-AF Non-direct mounting with ZG-108 mounting bracket



Multiple dampers direct coupled to one actuator with linkage to operate the other damper.

General

The TAF series actuators utilize brushless DC motor technology. The TAF uses this motor in conjunction with an Application Specific Integrated Circuit (ASIC). In the On-Off versions of the TAF, the ASIC monitors and controls the actuator's rotation and a digital rotation sensing function to prevent damage to the actuator. The TAF24… 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

A 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. Unlike the conventional DC motor, there are no brushes to wear or commutators to foul.

Overload Protection

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

Motor Position Detection

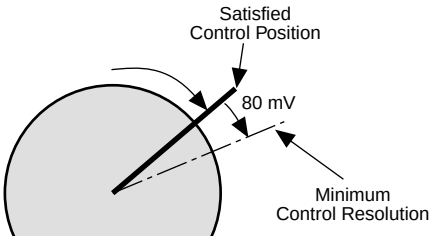
The brushless DC motors eliminate the need for potentiometers for positioning in modulating type actuators. Inside the motor are three "Hall Effect" sensors. These sensors detect the spinning rotor and send pulses to the microprocessor which counts the pulses and calculates the position to within 1/3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

Control Accuracy and Stability

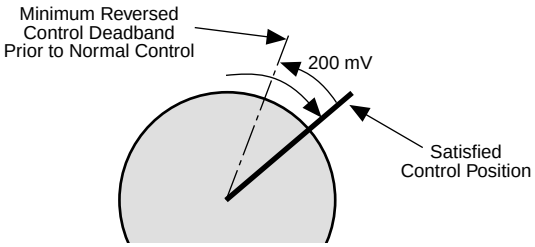
TAF24-SR actuators have built-in brushless DC motors which provide better accuracy and longer service life.

The TAF24-SR 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.

TAF actuator responds to a 80 mV signal when not changing direction from stop



TAF actuator responds to a 200 mV signal when reversing direction from stop position.



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.

Transformer(s)

The TAF24 . . actuators require a 24 VAC class 2 transformer and draws a maximum of 10 VA per actuator. The actuator enclosure cannot be opened in the field, there are no parts or components to be replaced or repaired.

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

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

Multiple Actuators, One Transformer

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

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

Multiple Actuators, Multiple Transformers

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

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

Wire Length for TAF… Actuators

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

Example: 3 actuators, 16 Ga wire
350 ft ÷ 3 Actuators = 117 ft. maximum wire run

Maximum Wire Length:

Wire Size	Max. Feet.		Wire Size	Max. Feet
12 Ga	900 Ft.		18 Ga	225 Ft.
14 Ga	550 Ft.		20 Ga	125 Ft.
16 Ga	350 Ft.		22 Ga	60 Ft.

Figure H

Wire Type and Wire Installation Tips

For most installations, 18 or 16 Ga. cable works well with the TAF24. . 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 TAF24… 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 TAF24-SR

When power is initially applied, the actuator will first release its manual preload position (This assumes a manual position has been set). The actuator will then rotate to the full fail-safe position. At this point the microprocessor recognizes that the actuator is at full fail-safe and uses this position as the base for all of its position calculations. The microprocessor will retain the initialized zero during short power failures of up to 20 seconds. 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.

TAF24-SR + P-100… Electrical Check-out Procedure

Step	Procedure	Expected Response	Gives Expected Response Go To Step…	Does Not Give Expected Response Go To Step…
1.	Control signal is applied to actuator.	Actuator will move to its "Control Signal" position.	Actuator operates properly. **Step 7**	No response at all. **Step 2** Operation is reversed. **Step 3** Does not drive toward "Control Signal Position". **Step 4**
2.	Check power wiring. Correct any problems. **See Note 1.**	Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.	Power wiring corrected, actuator begins to drive. **Step 1**	Power wiring corrected, actuator still does not drive. **Step 4**
3.	Turn reversing switch to the correct position. Make sure the switch is turned all the way left or right.	Actuator will move to its "Control Signal" position.	Actuator operates properly. **Step 7**	Does not drive toward "Control Signal Position". **Step 4**
4.	Make sure the control signal positive (+) is connected to Wire No 3 and control signal negative (-) is connected to wire No. 1. Most control problems are caused by reversing these two wires. Verify that the reversing switch is all the way CCW or CW.	Drives to "Control Signal" position.	Actuator operates properly. **Step 7**	**Step 5**
5.	Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For TAF24-SR 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.	Input voltage or current should be ±1% of what controller's adjustment or programming indicate.	Controller output (actuator input) is correct. Input Polarity Correct. **Step 6**	Reprogram, adjust repair or replace controller as needed. **Step 1**
6.	Loosen the nuts on the V-bolt and move the damper by hand from fully closed to fully open.	Damper will go from fully closed to fully open.	Damper moves properly. **Step 7**	Find cause of damper jam and repair. Move damper back to the fully closed position and tighten the nuts. **Step 1**
7.	Check damper torque requirement.	Torque requirement is ≤ actuator's minimum torque.	Defective Actuator. Replace Actuator.	Recalculate actuator requirement and correct installation.
8.	Actuator works properly. Test controller by following controller manufacturer's instructions.			

Note 1 Check that the transformer(s) are sized properly.

- If a common transformer is used, make sure that polarity is observed on the secondary. This means connect all No. 1 wires to one leg of the transformer and all No. 2 wires to the other leg of the transformer.
- If multiple transformers are used with one control signal, make sure all No. 1 wires are tied together and tied to control signal negative (-).
- Controllers and actuators must have separate 24 VAC/VDC power sources.

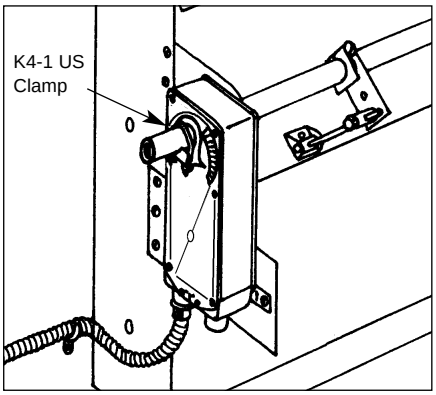
Notes/Work Pad

TNF Series Spring Return Direct Coupled Actuator

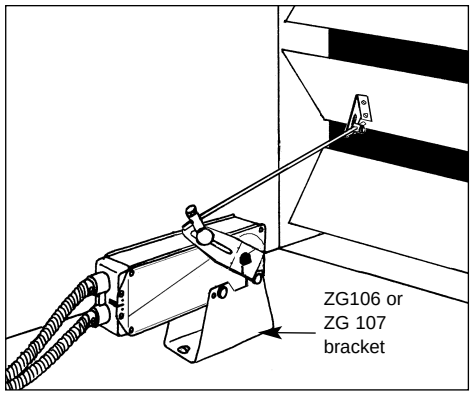
Minimum 60 in-lb Torque

- **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.

TNF Series – AT A Glance

		TNF24 (p. 30)	TNF24-S (p. 30)	TNF24-SR (p. 32)
Torque:	60 in-lb	●	●	●
Power supply :	24 VAC	●	●	●
Control signal:	on-off	●	●	
	proportional 2 to 10 VDC			●
Feedback signal:	2 to 10 VDC			●
Running time motor:	<75 sec	●	●	
	150 sec constant			●
spring:	<60 sec	●	●	●
Brushless DC Motor				●
External direction of rotation switch				●
Appliance rated cable, 18 GA		●	●	●
Built-in auxiliary switch	1SPDT		●	

Installation instructions .....(p. 34–39)
Startup and checkout .....(p. 41)
General wiring .....(p. 40)

*Based on 4 in-lb/ft^2 damper torque loading. Parallel blade. No edge seals.

I20683 - Subject to change.

A CLOSER LOOK...

LISTED 94D5 TEMP. IND & REG. EQUIP. UL | CSA | ISO 9001

- Cut labor costs with simple direct coupling.
- True mechanical spring return – the most reliable fail-safe.
- Mount for clockwise or counterclockwise fail-safe.
- Check damper position easily with clear position indicator.
- Don't worry about actuator burn-out, it 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. (modulating actuators).
- 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.
- 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 rated cable and conduit connector eases installation.

BRUSHLESS dc motor ©

The Trane Difference

- *Low Installation and Life-Cycle Cost.*
  Easy installation. Accuracy and repeatability.
  Low power consumption. No maintenance.
- *Long Service Life.*
  Components tested before assembly. Every product tested before shipment.
  30+ years direct coupled actuator design.

TNF24 (-S)

On-off, Spring Return Fail-Safe, 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 TNF 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.

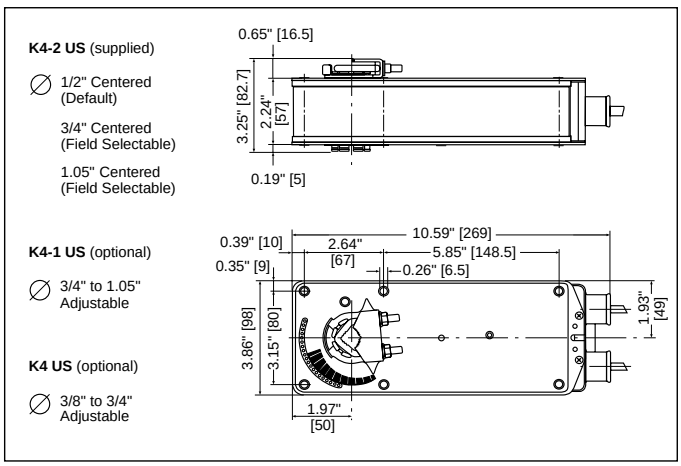
The TNF series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°.
The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

The TNF24-S version is provided with one 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°.

For all accessories, see pages 110 and 132.

Technical Data	TNF24 (-S)
Power supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power consumption	running: 5 W; holding: 2.6 W
Transformer sizing	8 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
Electrical protection	Auxiliary switches are double insulated
Angle of rotation	95°, adjustable 30 to 95° w/ accessories
Torque	60 in-lb [7 Nm] constant torque
Direction of rotation	reversible with CW/CCW mounting.
Position indication	visual indicator, 0° to 95° (0° is spring return position)
Auxiliary switches (TNF24-S)	1 x SPDT 7A (2.5A) @ 250 VAC, UL listed adjustable 5° to 85°
Running time (nominal)	motor: < 75 sec spring: < 60 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 steel
Agency listings	UL 873 listed, CSA C22.2 No.24 certified
Noise level	max. 45 dB (A)
Servicing	maintenance free
Quality standard	ISO 9001
Weight	6.6 lbs (3.0 kg.)

Dimensions [All numbers in brackets are in millimeters.]



I20683 - Subject to change.

CAUTION

△2 Equipment damage!
Actuators may be connected in parallel. Power consumption and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

TNF24 Typical Specification

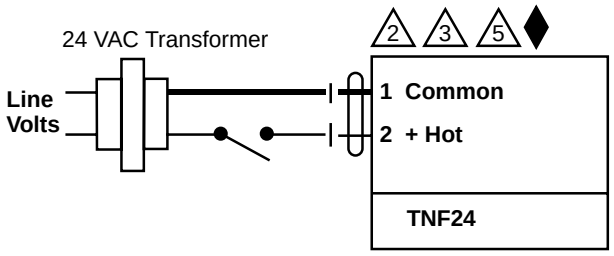
On-off spring return damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a jackshaft up to a 1.05" diameter. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall be protected from overload at all angles of rotation. If required, one 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 are UL listed and CSA certified and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

W454

WARNING

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



On-off wiring for TNF24

W455

WARNING

Live Electrical Components!
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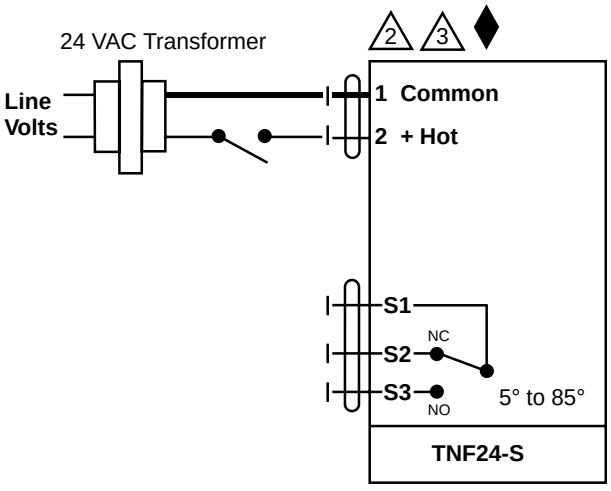


On-off wiring for TNF24-S

TNF24-SR

Proportional Damper Actuator, Spring Return Fail-Safe, 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.

Operation

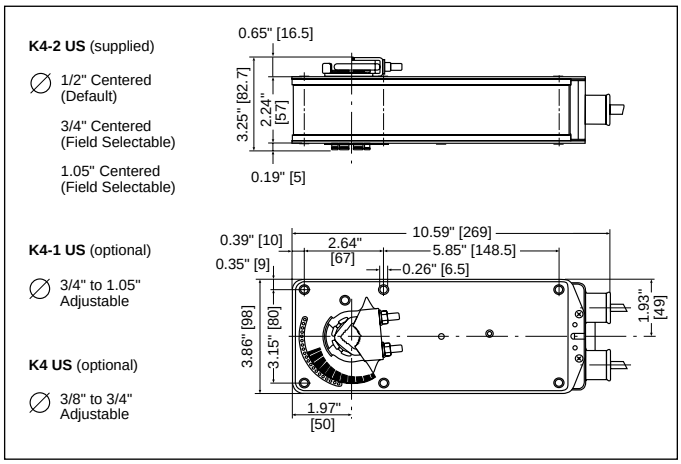
The TNF series actuators provide true spring return operation for reliable fail-safe application and positive close-off on air tight dampers. The spring return system provides constant torque to the damper with, and without, power applied to the actuator. The TNF series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°.

The TNF24-SR 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.

For all accessories, see pages 110 and 132.

Technical Data	TNF24-SR
Power supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power consumption	running: 3 W; holding: 1 W
Transformer sizing	6 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 20mA
Input impedance	100 kΩ (0.1 mA), 500Ω
Feedback output U	2 to 10 VDC (max. 0.5 mA) for 95°
Angle of rotation	95°, adjustable 30° to 95° w/accessory
Torque	60 in-lb [7 Nm] constant torque
Direction of rotation	spring: reversible with cw/ccw mounting motor: reversible with built-in switch
Position indication	visual indicator, 0° to 95° (0° is spring return position)
Running time (nominal)	motor: 150 sec constant, independent of load spring: < 60 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 dB (A)
Servicing	maintenance free
Quality standard	ISO 9001
Weight	6.0 lbs (2.7 kg.)

Dimensions [All numbers in brackets are in millimeters.]



I20683 - Subject to change.

Proportional Damper Actuator, Spring Return Fail-Safe, 24 V for 2 to 10 VDC, or 4 to 20 mA Control Signal. Output Signal of 2 to 10 VDC for Position Indication

CAUTION

△2 Equipment damage!
Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Only connect common to neg. (—) leg of control circuits

APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

♦ The ZG-R01 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

TNF24-SR Typical Specification

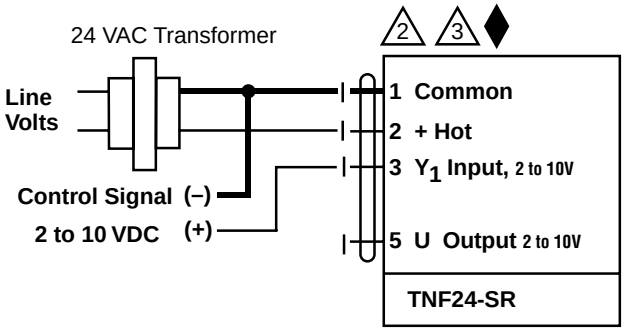
Spring return control damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a jackshaft up to a 1.05" diameter. The actuator must provide proportional damper control in response to a 2 to 10 VDC or, with the addition of a 500Ω resistor, 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 are UL listed and CSA certified and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

W456

WARNING

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

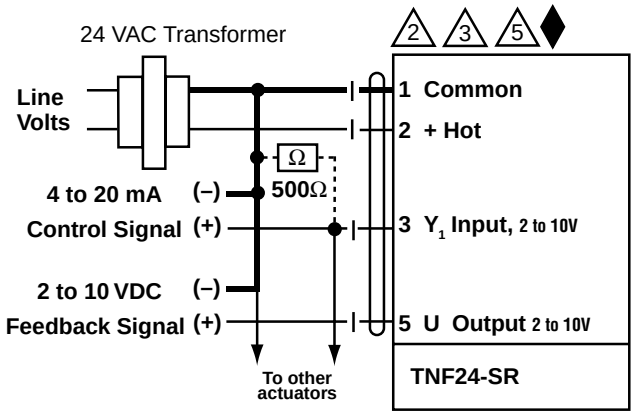


0 to 10 VDC control of TNF24-SR

W457

WARNING

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

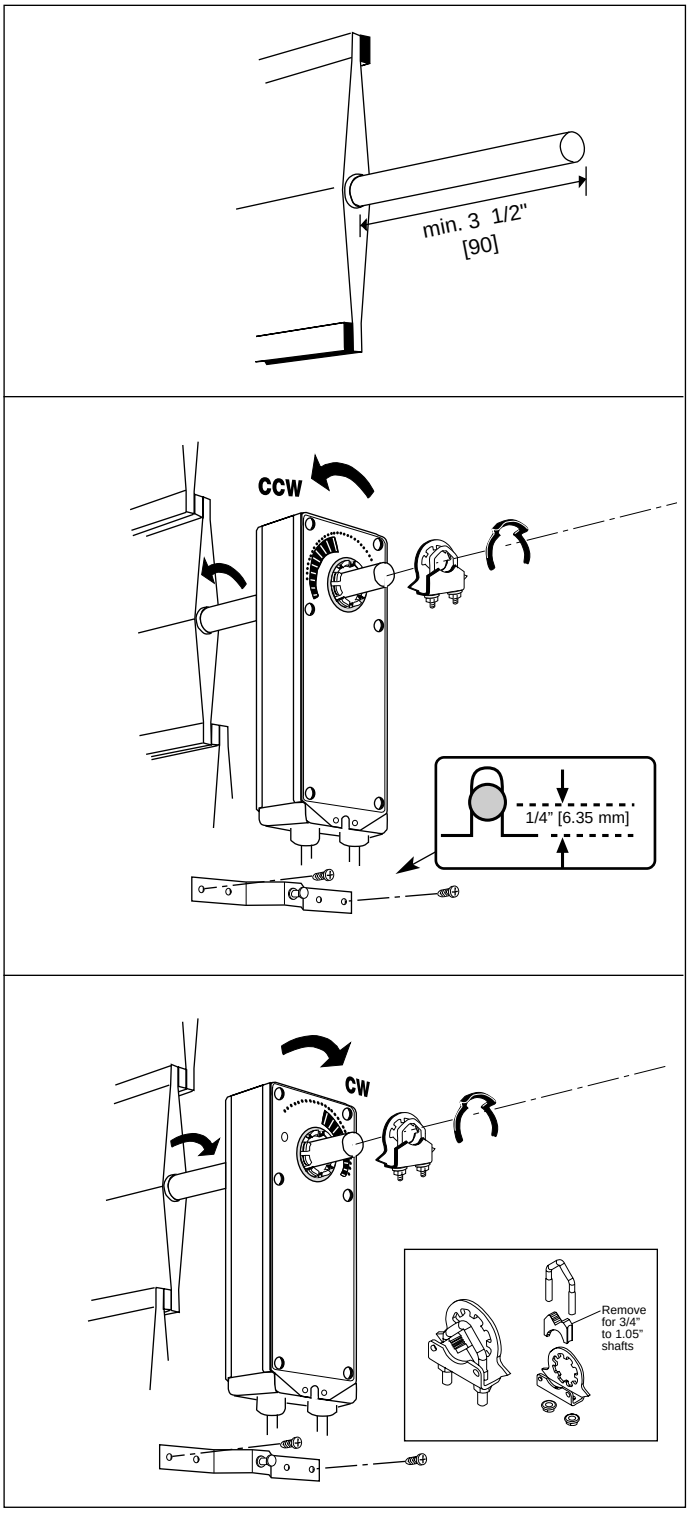


4 to 20 mA control of TNF24-SR with 2 to 10 VDC feedback output

Installation Instructions

Quick-Mount Visual Instructions for Mechanical Installation

Dimensions [All numbers in brackets are in millimeters.]



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 10 mm 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.

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

The above torque loadings will work for most applications 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

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

The TNF…-S versions are provided with one 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°.

Standard Mounting

1. See Fig. B. Manually move the damper to the fail-safe position (a) (usually closed). If the shaft rotated counter-clockwise ( ), 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.

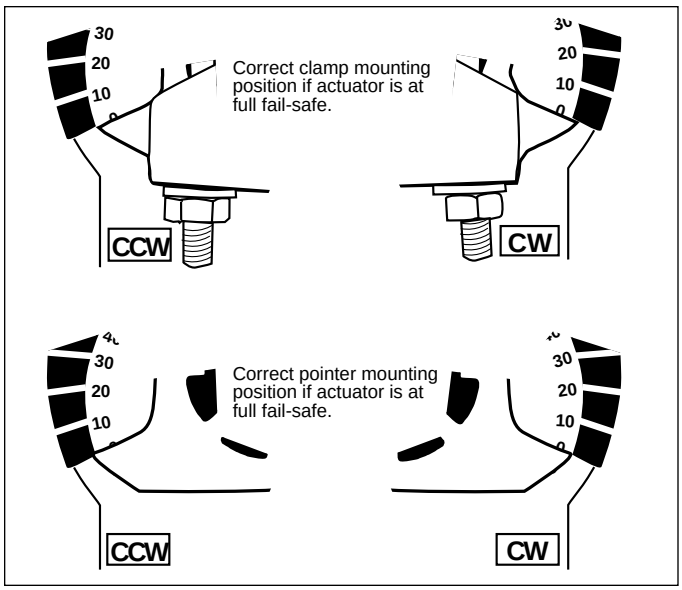


Figure A Universal Clamp and IND-AF2 Position Indicator (optional)

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. 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. Slip the stop of the anti-rotation strap in the slot of the base of the actuator. The stud should be centered approximately 1/4” from the end of the slot. 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 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.
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.

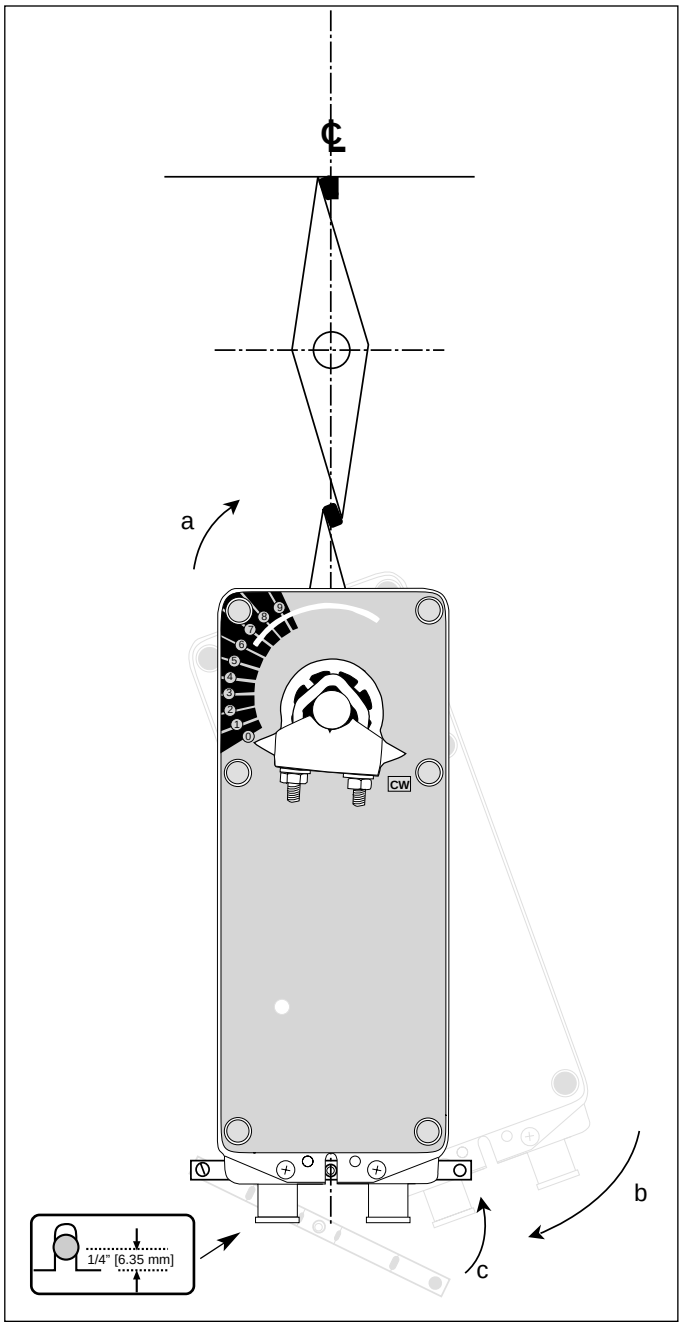


Figure B

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 TNF 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 Figure. C.

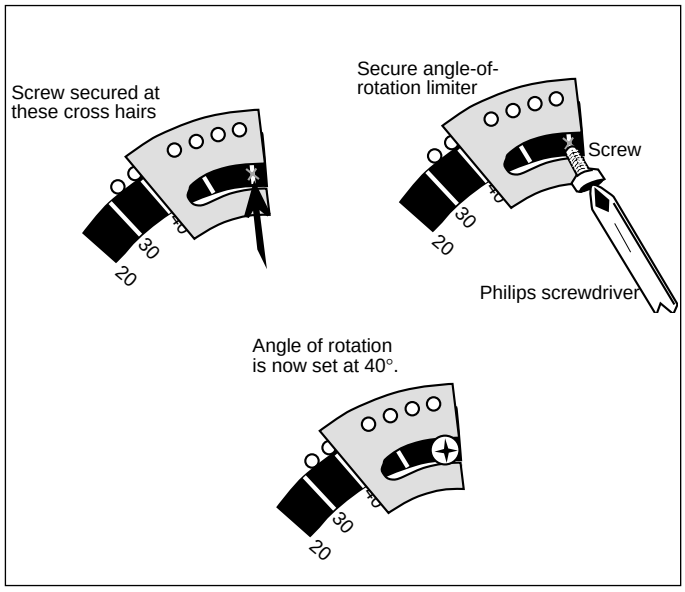


Figure C ZDB-AF2 Securing the Angle of Rotation Limiter

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 TNF series actuators may be ordered with one 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 is used to adjust the switching position. See Figure. D.

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.

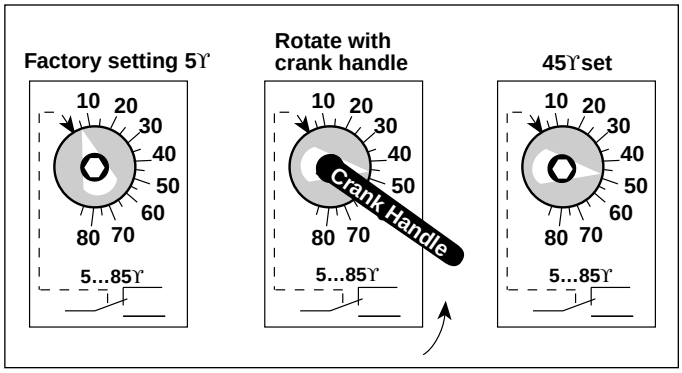


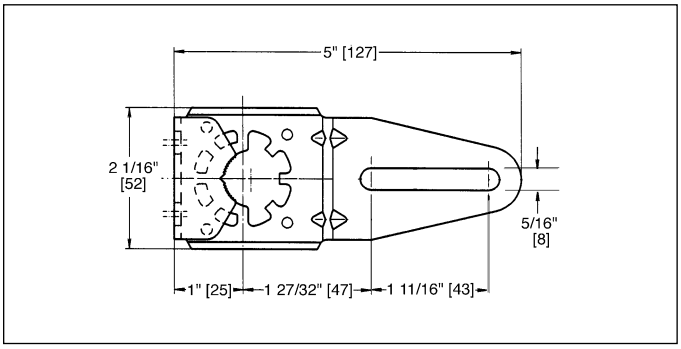
Figure D

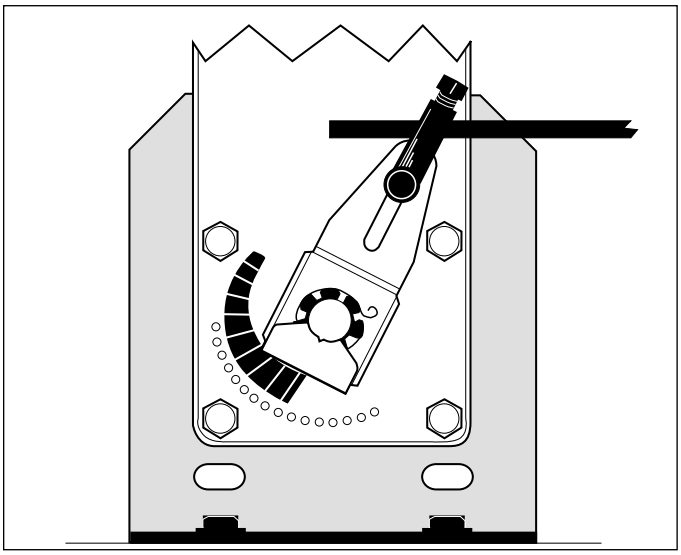
Non-direct Mounting Methods

KH-AF crankarm including retaining ring. ***Caution:*** the retaining clip supplied with the clamp is ***not*** used to mount the KH-AF crankarm.The KH-AF (-1) crankarm is used in non-direct coupled mounting applications.

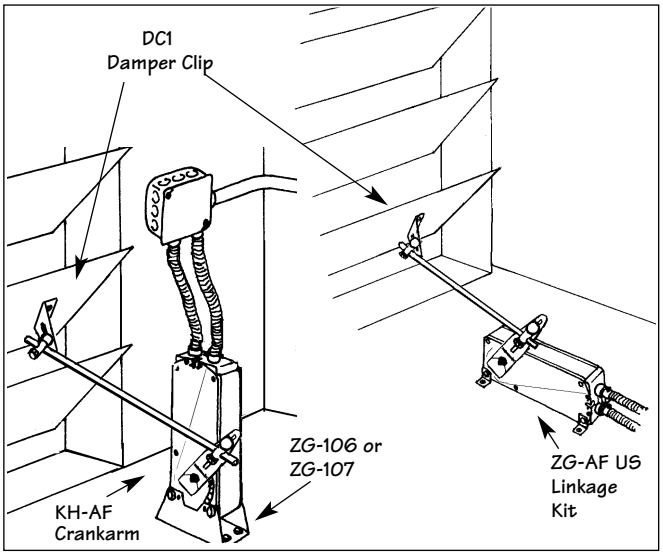
Two sizes are available:
KH-AF For round shafts up to 3/4” or square shafts up to 5/8”
KH-AF-1 For jackshafts up to 1.05”

Dimensions [All numbers in brackets are in millimeters.]





KH-AF Non-direct mounting with ZG-108 mounting bracket



Non-direct mounting using various accessories

Additional Operational Information for TNF24-SR Proportional Actuators

Initialization of the TNF24-SR

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 it 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

A 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 TNF24-SR actuators are 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

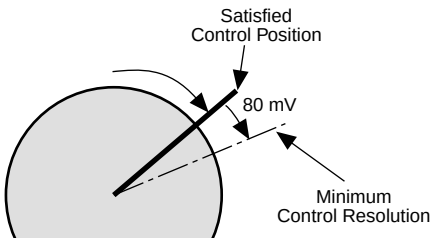
The brushless DC motor spins by reversing the poles of stationary electromagnets housed inside rotating permanent magnets. The electromagnetic poles are switched by a microprocessor and a special ASIC (Application Specific Integrated Circuit). Unlike the conventional DC motor, there are no brushes to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

Control Accuracy and Stability

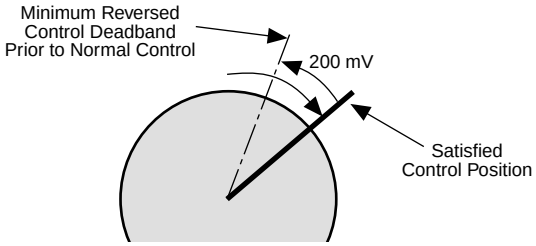
TNF24-SR actuators have built-in brushless DC motors which provide better accuracy and longer service life.

The TNF24-SR 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.

TNF actuator responds to a 80 mV signal when not changing direction from stop.



TNF actuator responds to a 200 mV signal when reversing direction from stop position.



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.

Transformer(s)

The TNF24 . . actuator requires a 24 VAC class 2 transformer and draws a maximum of 10 VA per actuator. The actuator enclosure cannot be opened in the field, there are no parts or components to be replaced or repaired.

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

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

Multiple Actuators, One Transformer

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

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

Multiple Actuators, Multiple Transformers

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

1. The transformers are properly sized.
2. All No. 1 wires from all actuators are tied together and tied to the negative leg of the control signal. See wiring diagram page 19.

Wire Length for TNF… Actuators

Keep power wire runs below the lengths listed in the table in Figure 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 TNF24-SR:

3 actuators, 16 Ga wire
550 ft ÷ 3 actuators = 183 ft. maximum wire run

Maximum wire length:

TNF24 (-S)

Wire Size	Max. Feet.		Wire Size	Max. Feet
12 Ga	1100 Ft.		18 Ga	260 Ft.
14 Ga	700 Ft.		20 Ga	140 Ft.
16 Ga	440 Ft.		22 Ga	75 Ft.

TNF24-SR

Wire Size	Max. Feet.		Wire Size	Max. Feet
12 Ga	1500 Ft.		18 Ga	375 Ft.
14 Ga	925 Ft.		20 Ga	200 Ft.
16 Ga	550 Ft.		22 Ga	100 Ft.

Figure E

Wire Type and Wire Installation Tips

For most installations, 18 or 16 Ga. cable works well with the TNF24… 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 TNF24… 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.

TNF24-SR + P-100… Electrical Check-out Procedure

Step	Procedure	Expected Response	Gives Expected Response Go To Step…	Does Not Give Expected Response Go To Step…
1.	Control signal is applied to actuator.	Actuator will move to its "Control Signal" position.	Actuator operates properly. **Step 8**	No response at all. **Step 2** Operation is reversed. **Step 3** Does not drive toward "Control Signal Position" . **Step 4**
2.	Check power wiring. Correct any problems. **See Note 1.**	Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.	Power wiring corrected, actuator begins to drive. **Step 1**	Power wiring corrected, actuator still does not drive. **Step 4**
3.	Turn reversing switch to the correct position. Make sure the switch is turned all the way left or right.	Actuator will move to its "Control Signal" position.	Actuator operates properly. **Step 8**	Does not drive toward "Control Signal Position". **Step 4**
4.	Make sure the control signal positive (+) is connected to Wire No 3 and control signal negative (-) is connected to wire No. 1. Most control problems are caused by reversing these two wires. Verify that the reversing switch is all the way CCW or CW.	Drives to "Control Signal" position.	Actuator operates properly. **Step 8**	**Step 5**
5.	Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For TNF24-SR 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.	Input voltage or current should be ±1% of what controller's adjustment or programming indicate.	Controller output (actuator input) is correct. Input Polarity Correct. **Step 6**	Reprogram, adjust repair or replace controller as needed. **Step 1**
6.	Loosen the nuts on the V-bolt and move the damper by hand from fully closed to fully open.	Damper will go from fully closed to fully open.	Damper moves properly. **Step 7**	Find cause of damper jam and repair. Move damper back to the fully closed position and tighten the nuts. **Step 1**
7.	Check damper torque requirement.	Torque requirement is ≤ actuator's minimum torque.	Defective Actuator. Replace Actuator.	Recalculate actuator requirement and correct installation.
8.	Actuator works properly. Test controller by following controller manufacturer's instructions.			

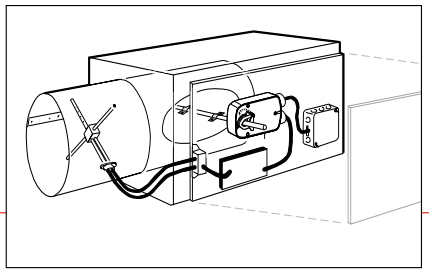
Note 1 Check that the transformer(s) are sized properly.

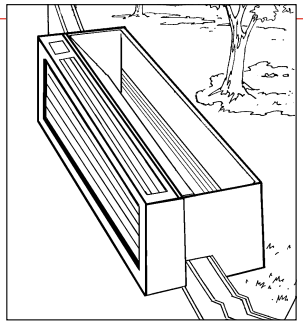
- If a common transformer is used, make sure that polarity is observed on the secondary. This means connect all No. 1 wires to one leg of the transformer and all No. 2 wires to the other leg of the transformer.
- If multiple transformers are used with one control signal, make sure all No. 1 wires are tied together and tied to control signal negative (-).
- Controllers and actuators must have separate 24 VAC/VDC power sources.

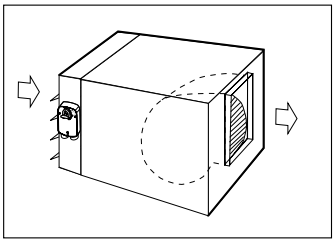
TLF Series Spring Return Direct Coupled Actuator

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

Actuators in bold have BDCM

TLF Series – AT A Glance

		TLF24 (p. 44)	*TLF24-S (p. 44)*	*TLF24-3 (p. 46)*	***TLF24-SR** (p. 48)*
Torque:	35 in-lb	●	●	●	●
Power supply:	24 VAC/DC	●	●	●	●
Control signal:	on-off	●	●		
	floating point			●	
	proportional 2 to 10 VDC				●
Feedback:	2 to 10 VDC				●
Running time motor:	<75 sec	●	●		
	150 sec constant			●	●
spring:	<25 sec	●	●	●	●
External direction of rotation switch				●	●
Plenum rated cable, 18 GA				●	●
Conduit fitting		●	●	●	●
Appliance cable		●	●		
Built-in auxiliary switch			●		

Installation instructions .....(p. 50–54)
Startup and checkout .....(p. 56)
General wiring .....(p. 55)

*Based on 4 in-lb/ft^2 damper torque loading. Parallel blade. No edge seals.

A CLOSER LOOK...

LISTED 94 D5 TEMP. IND. & REG. EQUIP. c UL us
LISTED 94D5 TEMP. IND & REG. EQUIP. UL
CSA CE ISO 9001

- 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, it 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.

BRUSHLESS dc motor ©

The Trane Difference

- *Low Installation and Life-Cycle Cost.*
  Easy installation. Accuracy and repeatability.
  Low power consumption. No maintenance.
- *Long Service Life.*
  Components tested before assembly. Every product tested before shipment.
  30+ years direct coupled actuator design.

TLF24 (-S)

On-off, Spring Return Fail-Safe, 24 V

Torque min. 35 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, 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

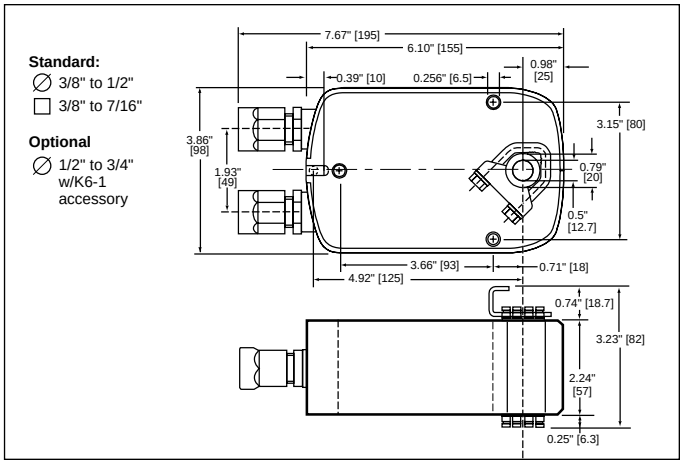
The TLF series actuators provide true spring return operation for reliable fail-safe application and positive close off on air tight dampers. The spring return system provides consistent torque to the damper with, and without, power applied to the actuator. The TLF series provides 95° of rotation and 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. Power consumption is reduced in holding mode.

The TLF24-S version is provided with one 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 TLF24-S is double insulated so an electrical ground connection is not necessary.

For all accessories, see pages 110 and 132.

Technical Data	TLF24 (-S)
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 (TLF24-S has 2 cables) 1/2" conduit connector
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 95° (0° is spring return position)
Auxiliary switch (TLF24-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	TLF24 3.1 lbs (1.40 kg.) TLF24-S 3.2 lbs (1.45 kg.)

Dimensions [All numbers in brackets are in millimeters.]



CAUTION

△2 Equipment damage!
Actuators may be connected in parallel.
Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead.
Actuators with appliance cables use numbers.

APPLICATION NOTES

◆ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

TLF24 (-S) 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, one 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 are UL listed and CSA certified and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

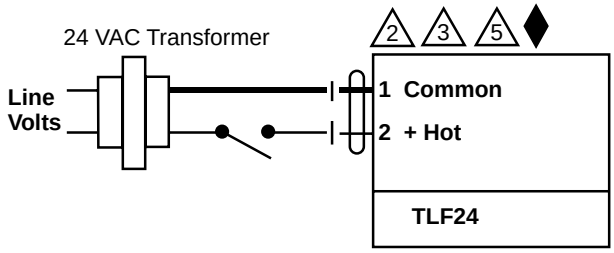
TLF

Wiring Diagrams

W458

WARNING

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

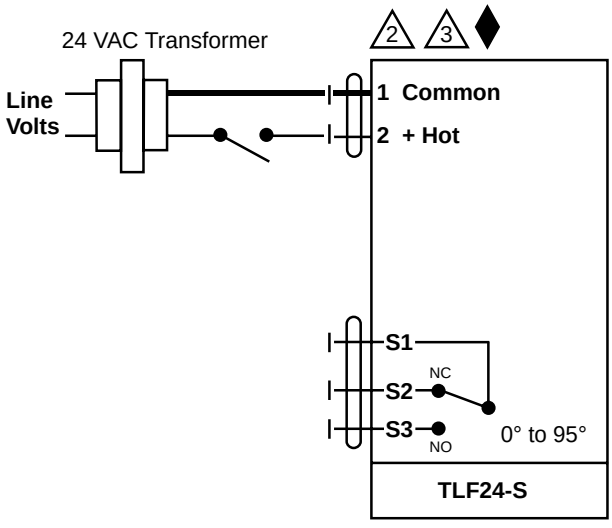


On-off wiring for TLF24

W459

WARNING

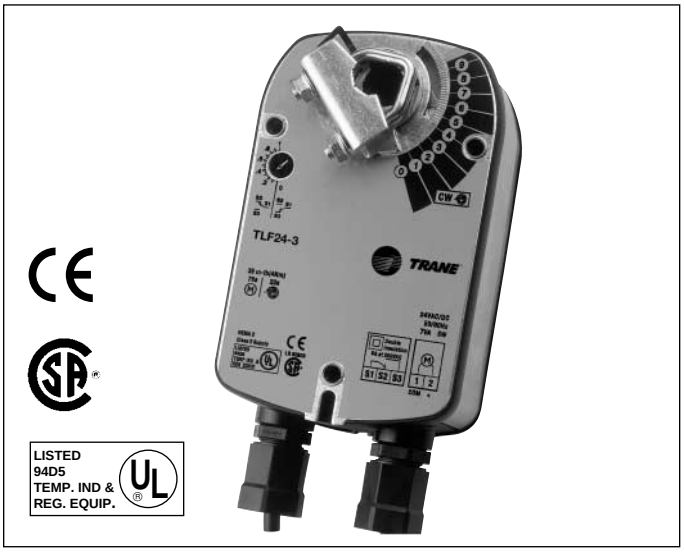
Live Electrical Components!
During installation, testing, servicing and troubleshooting of this product, it maybe necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these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



On-off wiring for TLF24-S

TLF24-3

On-off, Spring Return Fail-Safe, Reversible, Floating Point, 24V



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. 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 TLF 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.

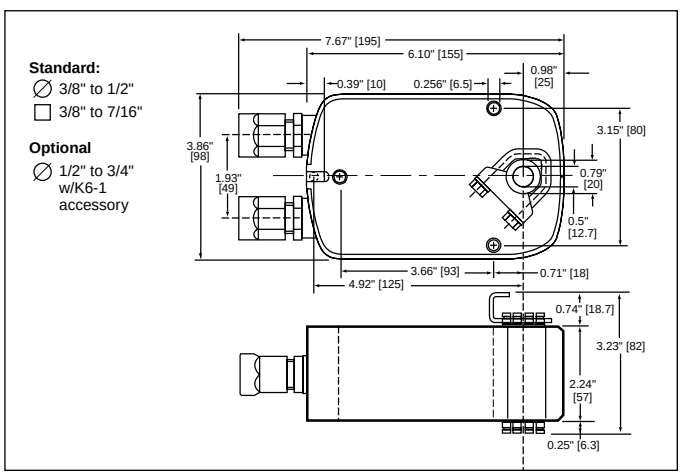
The TLF series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°.

The TLF24-3 uses a brushless DC motor which is controlled by an Application Specific Integrated Circuit (ASIC) and a micro-processor. 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.

For all accessories, see pages 110 and 132.

Technical Data	TLF24-3
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	TLF24-3 3 ft, plenum rated cable
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 95° (0° is spring return position)
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	TLF24-3 3.1 lbs (1.40 kg.)

Dimensions [All numbers in brackets are in millimeters.]



I20683 - Subject to change.

CAUTION

△2 Equipment damage!

Actuators may be connected in parallel. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

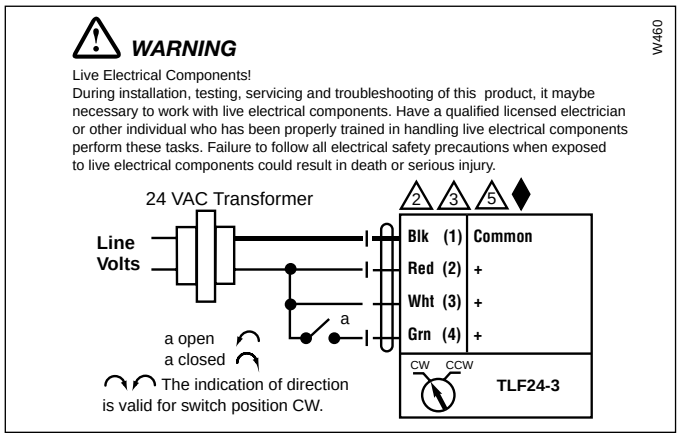
△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

△6 For triac sink the common connection from the actuator must be connected to the Hot connection of the controller. The actuator must be connected to the control board common.

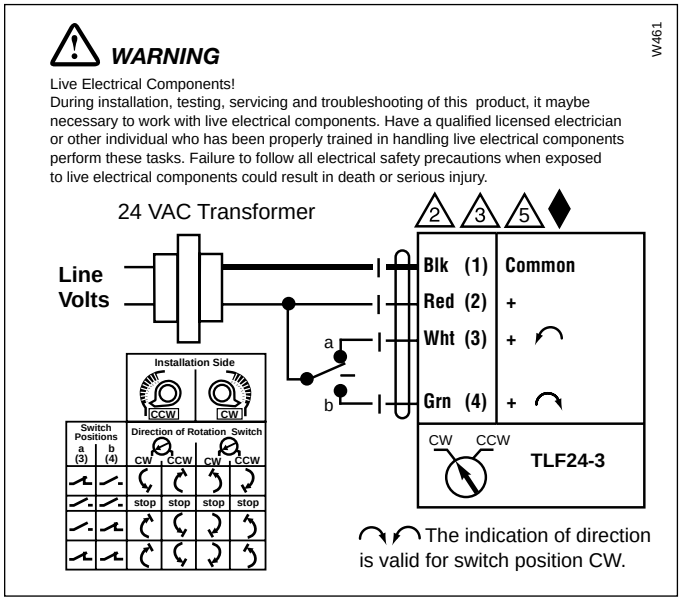
APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

Wiring Diagrams



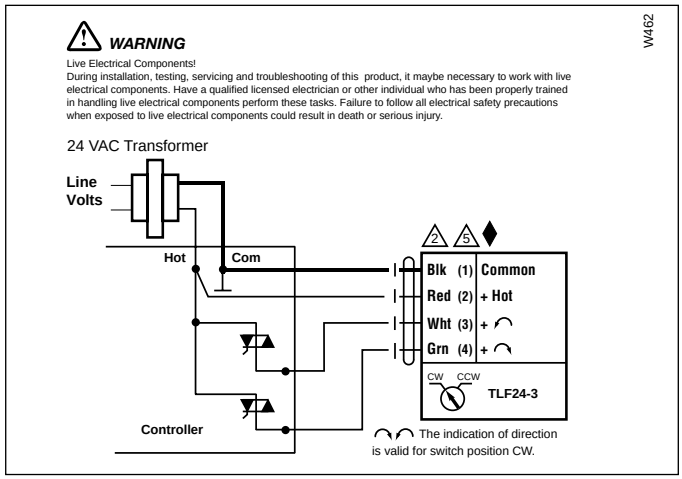
On-Off control of TLF24-3



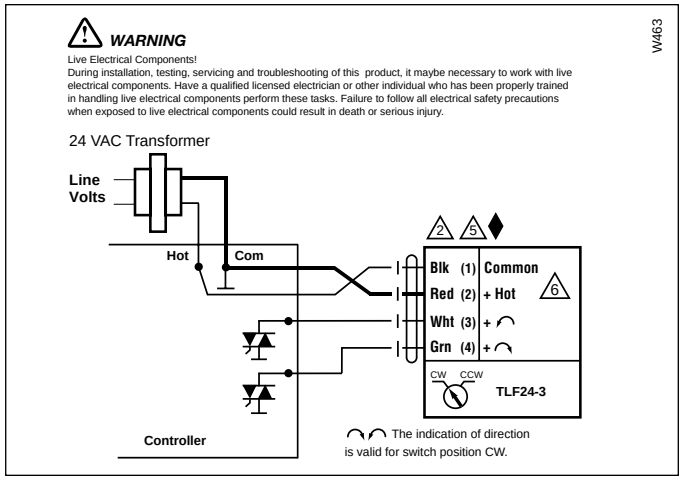
Floating point control of TLF24-3

TLF24-3 Typical Specification

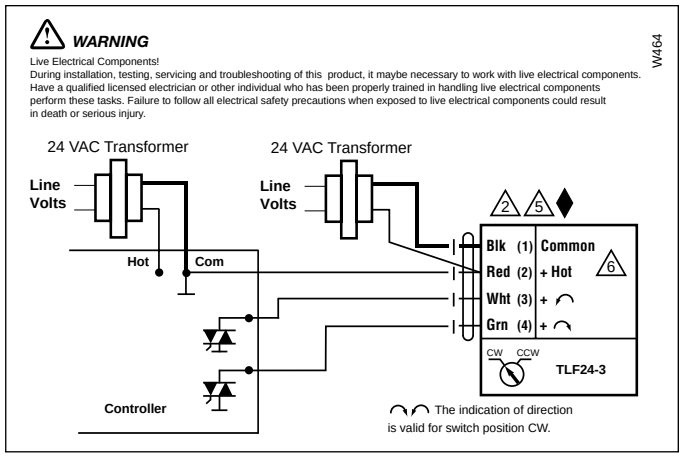
Floating point, on-off spring return damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a shaft up to a 3/4" diameter and center a 1/2" shaft. The actuators must be designed so that they may be used for either clockwise or counterclockwise 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. Run time shall be constant and independent of torque. Actuators are UL listed and CSA certified and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.



Triac source



Triac sink



Triac sink with separate transformers

TLF24-SR

Proportional Damper Actuator, Spring Return Fail-Safe, 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. 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 TLF 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.

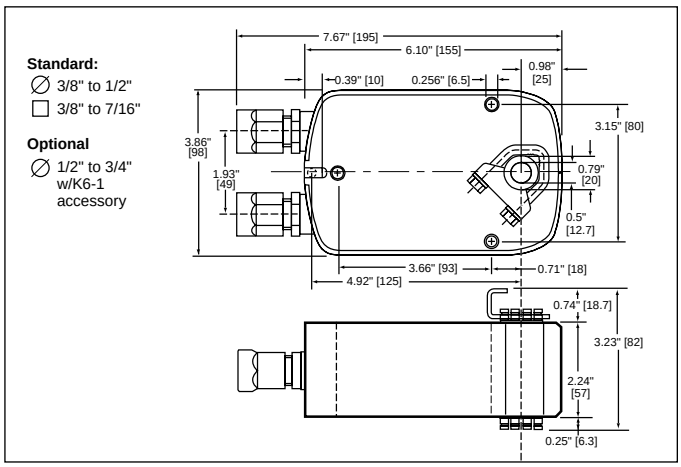
The TLF series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°.

The TLF24-SR 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.

For all accessories, see pages 110 and 132.

Technical Data	TLF24-SR
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	TLF24-SR 3 ft, plenum rated cable
Overload protection	electronic throughout 0° to 95° rotation
Operating range Y	2 to 10 VDC, 4 to 20mA
Input impedance	100 kΩ (0.1 mA), 500Ω
Feedback output U	2 to 10 VDC (max. 0.7 mA) for 95°
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 95° (0° is spring return position)
Running time (nominal)	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	TLF24-SR 3.1 lbs (1.40 kg.)

Dimensions [All numbers in brackets are in millimeters.]



I20683 - Subject to change.

CAUTION

△2 Equipment damage!
Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

△6 Only connect common to neg. (—) leg of control circuits. The TLF24-SR wire 5 is white.

APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

♦ The ZG-R01 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

TLF24-SR 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. 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 are UL listed and CSA certified and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

TLF

Wiring Diagrams

W465

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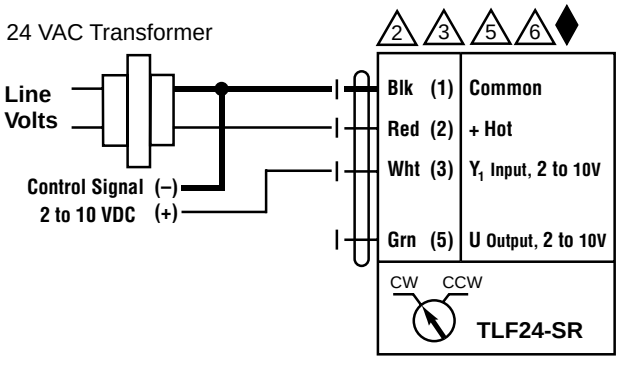

2 to 10 VDC control of TLF24-SR

W466

WARNING

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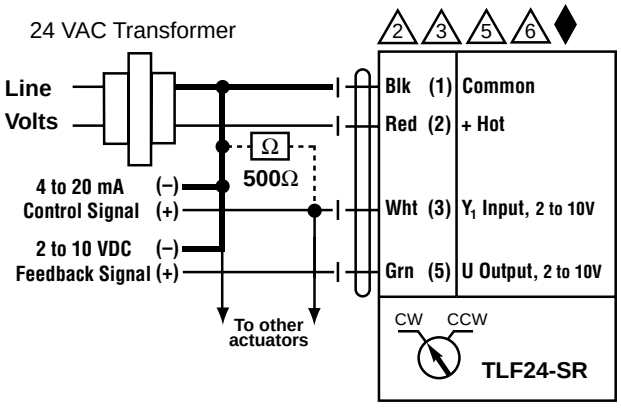
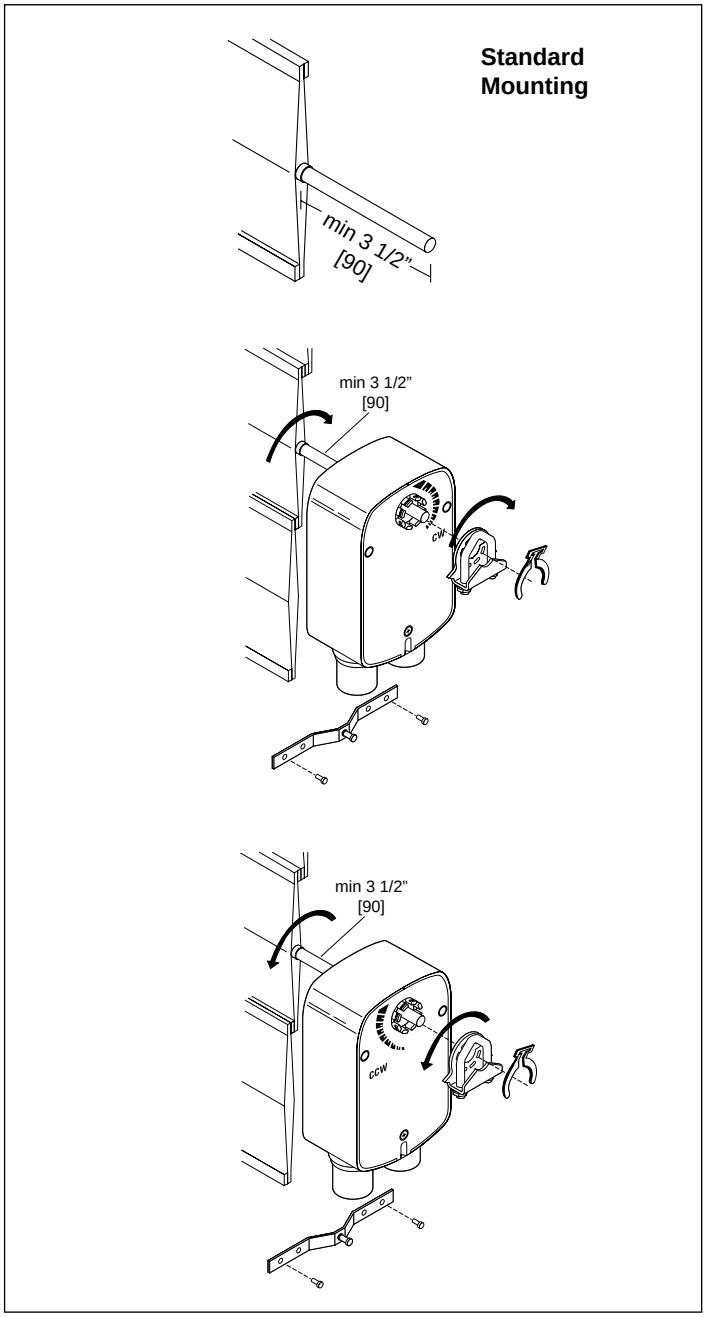


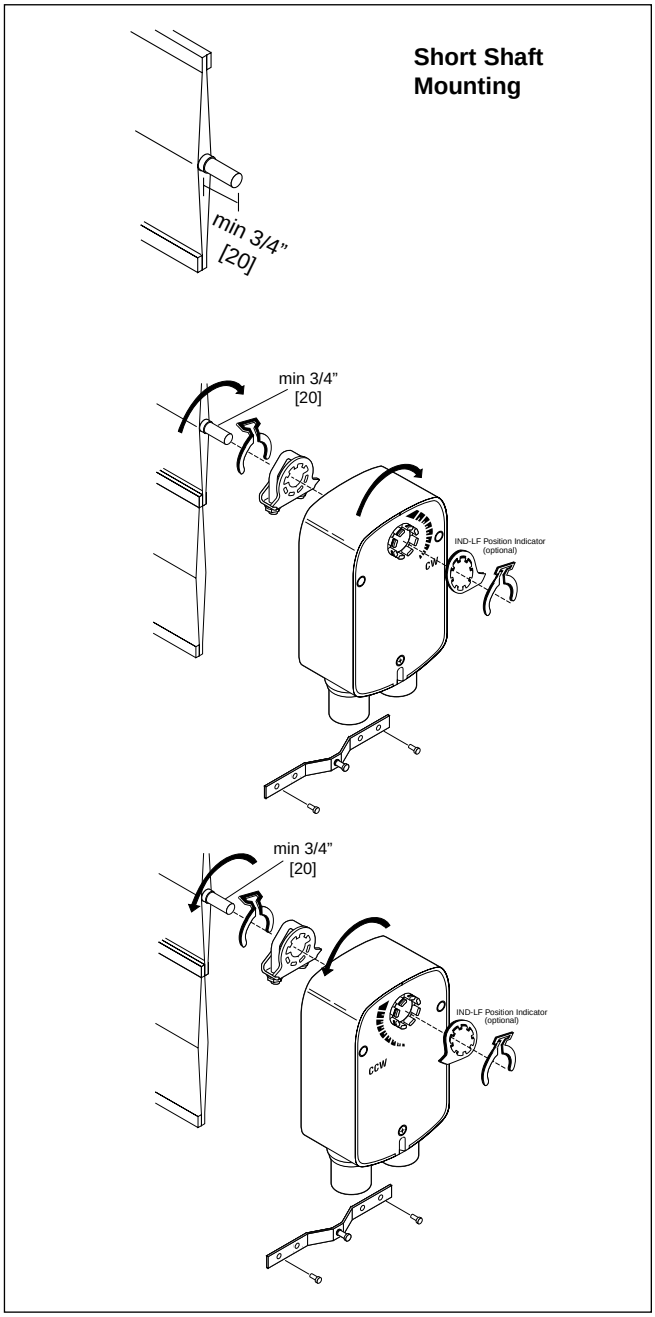
4 to 20 mA control of TLF24-SR with 2 to 10 VDC feedback output

Installation Instructions

Quick-Mount Visual Instructions

Dimensions [All numbers in brackets are in millimeters.]





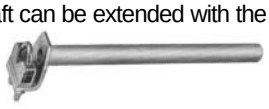
Quick-Mount Visual Instructions

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.
3. Slide the actuator onto the shaft and tighten the nuts on the V-bolt with a 10 mm 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.

Preliminary Steps

1. 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.
2. For new construction work, **order dampers with extended shafts**. Instruct the installing contractor to allow space for mounting and service of the 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 (K6-1 is required).



I20683 - Subject to change.

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.

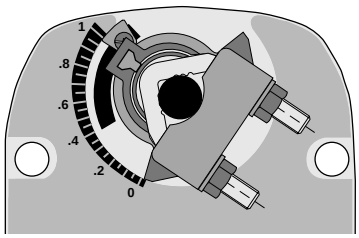
The TLF series actuators provide true spring return operation for reliable fail-safe application and positive close-off on air tight dampers. The spring return system provides consistent torque to the damper with, and without, power applied to the actuator.

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

The TLF…-S versions are provided with one 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°.

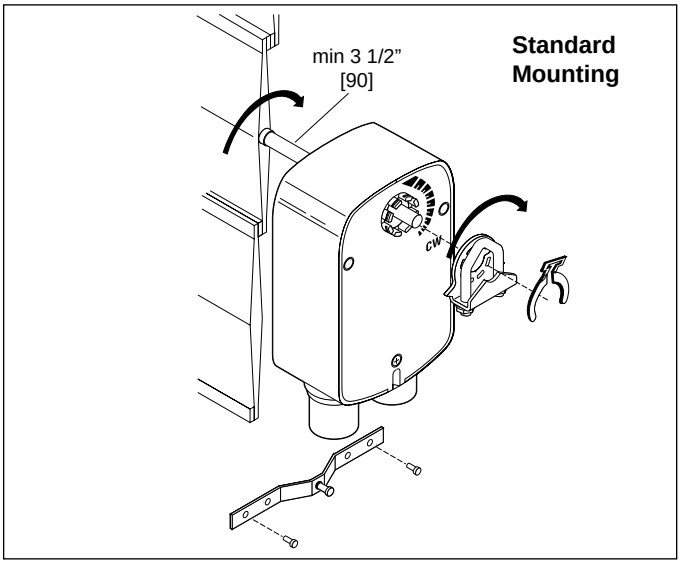
Standard Mounting / Airtight Damper Procedure

1. See Figue. B. Manually move the damper to the fail-safe position (a) (usually closed). If the shaft rotated counter-clockwise ( ), 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 Figure. C) and the spline pattern of the clamp mates with spline of the actuator. Slip the clamp over the spline. (Use the same procedure if the “CW” side is out.)
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.



Universal Clamp

Figure. C



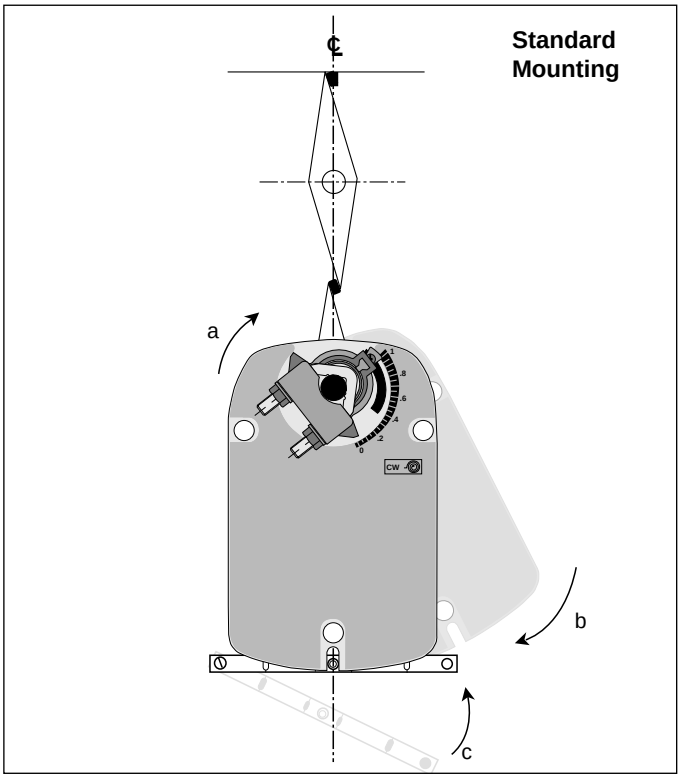
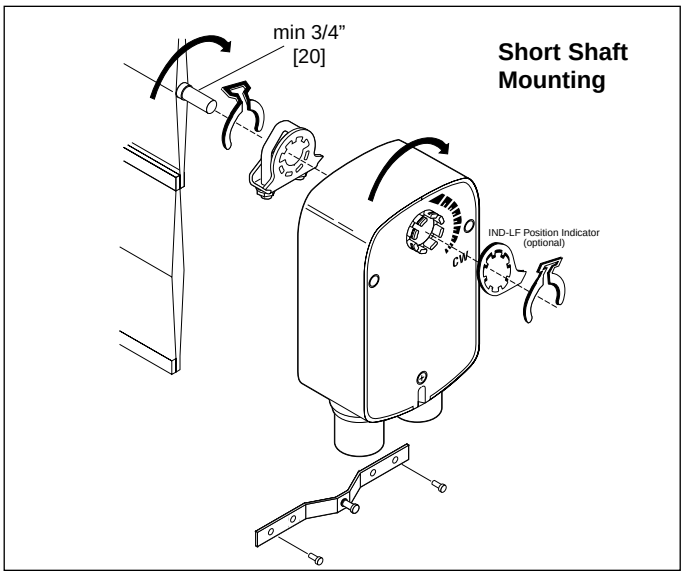


Figure. B

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 Figure 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.
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.
13. Use IND-LF accessory if position indication is needed.



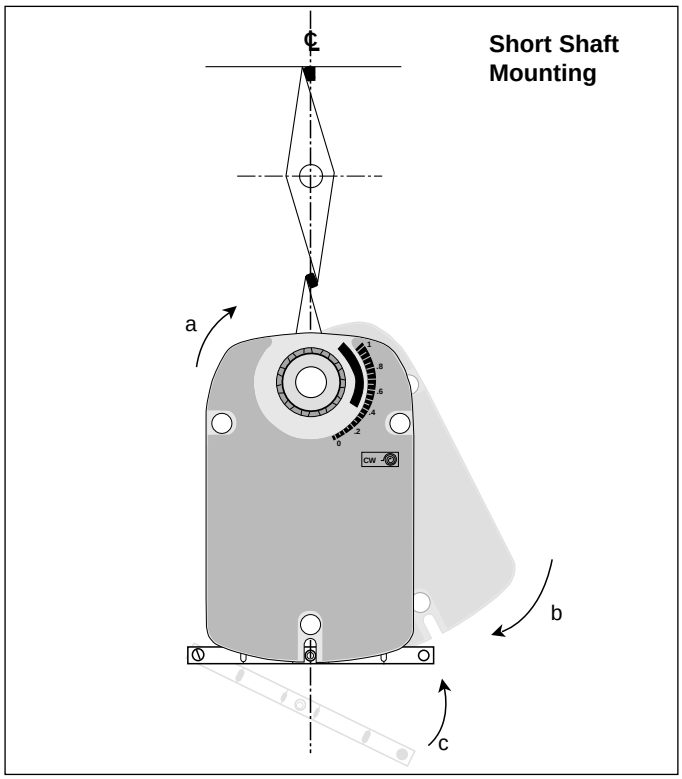


Figure D

Operational Information for TLF24-SR Actuators

Initialization of the TLF24-SR
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.

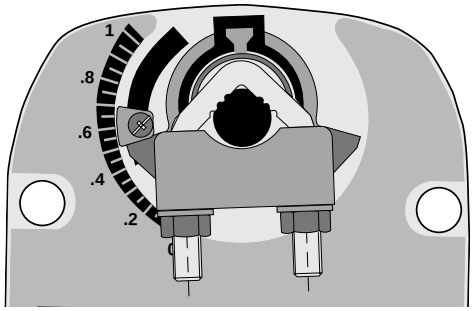
Motor Position Detection
A Brushless DC motors eliminate the need for potentiometers for positioning. Inside the motor are three “Hall Effect” sensors. These sensors detect the spinning rotor and send pulses to the microprocessor which counts the pulses and calculates the position to within 1/3 of a revolution of the motor.

Overload Protection
The TLF, on-off actuators are electronically protected against overload. The TLF, On-off actuators 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 TLF24, modulating actuators (TLF24-SR, TLF24-3) 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.

Mechanical Angle of Rotation Limiting

The TLF 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 TLF 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° 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

TLF24-3 and TLF24-SR actuators have a direction of rotation switch on the cover labeled “CW-CCW”. Switch position indicates start point. For the TLF24-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 counter-clockwise with a decrease in voltage or current.

The TLF24-3 and TLF24-SR 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 counter clockwise.

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

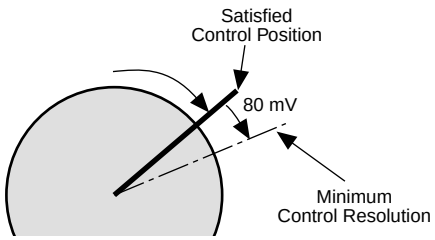
During checkout, the switch position can be temporarily reversed and the actuator will reverse its direction. This allows the technician a fast and easy way to check the actuator operation without having to switch wires or change settings on the controller. ***When the check-out is complete, make sure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

Control Accuracy and Stability

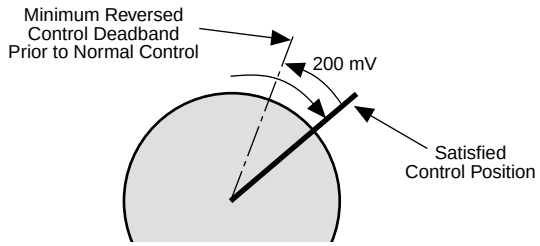
TLF24-SR actuators have built-in brushless DC motors which provide better accuracy and longer service life.

The TLF24-SR 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.

TLF actuator responds to a 80 mV signal when not changing direction from stop position.



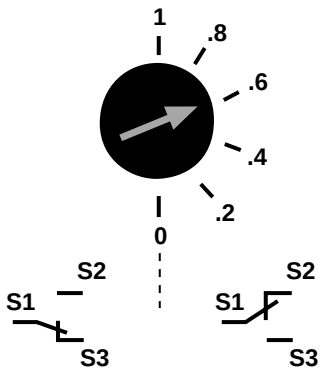
TLF actuator responds to a 200 mV signal when reversing direction from stop position.



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.



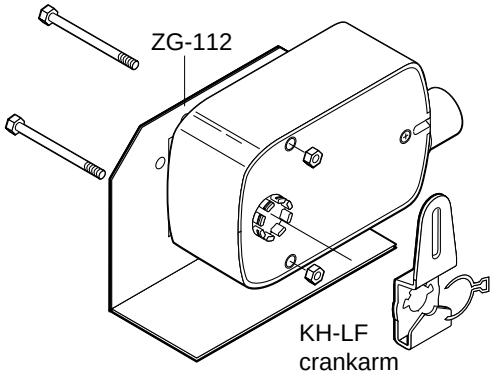
Switch Rating

Voltage	Resistive load	Inductive load
120 VAC	6 A	3 A
250 VAC	6 A	1.5 A

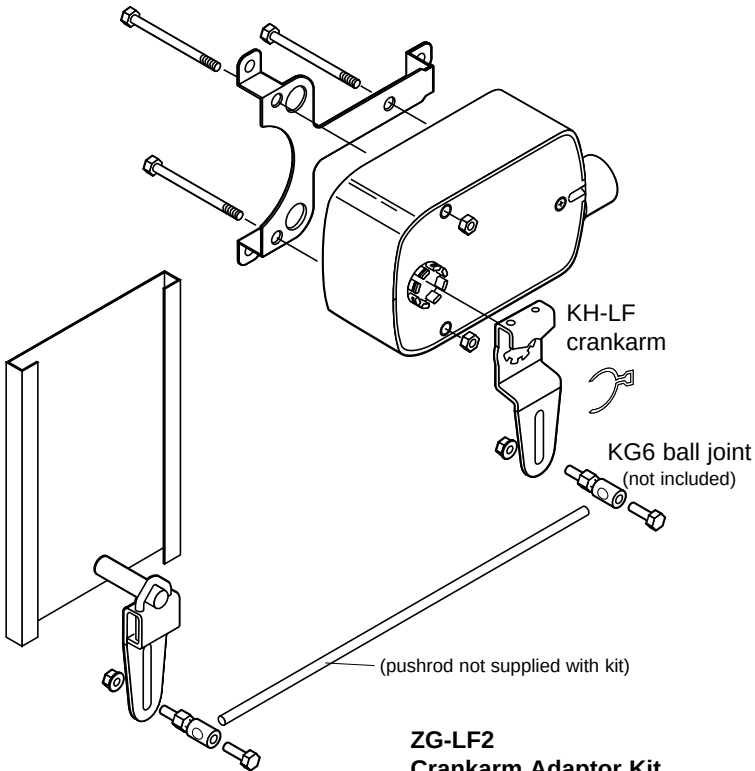
Non-Direct Mounting Methods

KH-LF
For shafts up to 1/2”

KH-LF Crankarm including retaining ring



ZG-LF112
Crankarm Adaptor Kit



ZG-LF2
Crankarm Adaptor Kit

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.

Transformer(s)

The TLF24 . . 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 TLF… Actuators

Keep power wire runs below the lengths listed in the table in Figure 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 TLF24-SR:

3 actuators, 16 Ga wire
550 ft ÷ 3 actuators = 183 ft. maximum wire run

Maximum Wire Length:

TLF24 (-S)

Wire Size	Max. Feet.		Wire Size	Max. Feet
12 Ga	1100 Ft.		18 Ga	260 Ft.
14 Ga	700 Ft.		20 Ga	140 Ft.
16 Ga	440 Ft.		22 Ga	75 Ft.

TLF24-SR / TLF24-3

Wire Size	Max. Feet.		Wire Size	Max. Feet
12 Ga	1500 Ft.		18 Ga	375 Ft.
14 Ga	925 Ft.		20 Ga	200 Ft.
16 Ga	550 Ft.		22 Ga	100 Ft.

Figure A

Wire Type and Wire Installation Tips

For most installations, 18 or 16 Ga. cable works well with the TLF24… 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 TLF24… 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

The 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). Unlike the conventional DC motor, there are no brushes to wear or commutators to foul.

Startup and Checkout

Instructions For TLF24-SR + P100

TLF24-SR + P100 Electrical Check-out Procedure

Step	Procedure	Expected Response	Gives Expected Response Go To Step…	Does Not Give Expected Response Go To Step…
1.	Remove power to reset actuator. Re-apply power. Apply control signal to actuator.	Actuator will move to its "Control Signal" position.	Actuator operates properly. **Step 8**	No response at all. **Step 2** Operation is reversed. **Step 3** Does not drive toward "Control Signal Position". **Step 4**
2.	Check power wiring. Correct any problems. **See Note 1.**	Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.	Power wiring corrected, actuator begins to drive. **Step 1**	Power wiring corrected, actuator still does not drive. **Step 4**
3.	Turn reversing switch to the correct position. Make sure the switch is turned all the way left or right.	Actuator will move to its "Control Signal" position.	Actuator operates properly. **Step 8**	Does not drive toward "Control Signal Position". **Step 4**
4.	Make sure the control signal positive (+) is connected to Wire No 3 and control signal negative (-) is connected to wire No. 1. Most control problems are caused by reversing these two wires. Verify that the reversing switch is all the way CCW or CW.	Drives to "Control Signal" position.	Actuator operates properly. **Step 8**	**Step 5**
5.	Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For TLF24-SR 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.	Input voltage or current should be ±1% of what controller's adjustment or programming indicate.	Controller output (actuator input) is correct. Input Polarity Correct. **Step 6**	Reprogram, adjust repair or replace controller as needed. **Step 1**
6.	Loosen the nuts on the V-bolt and move the damper by hand from fully closed to fully open.	Damper will go from fully closed to fully open.	Damper moves properly. **Step 7**	Find cause of damper jam and repair. Move damper back to the fully closed position and tighten the nuts. **Step 1**
7.	Check damper torque requirement.	Torque requirement is ≤ actuator's minimum torque.	Defective Actuator. Replace Actuator.	Recalculate actuator requirement and correct installation.
8.	Actuator works properly. Test controller by following controller manufacturer's instructions.			

Note 1 Check that the transformer(s) are sized properly.

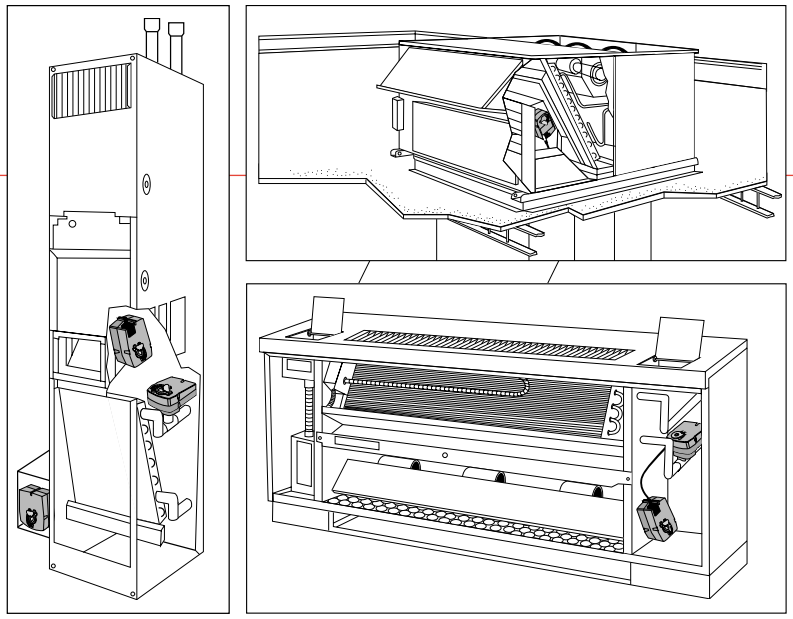
- If a common transformer is used, make sure that polarity is observed on the secondary. This means connect all No. 1 wires to one leg of the transformer and all No. 2 wires to the other leg of the transformer.
- If multiple transformers are used with one control signal, make sure all No. 1 wires are tied together and tied to control signal negative (-).
- Controllers and actuators must have separate 24 VAC/VDC power sources.

Notes/Work Pad

TTF Series Spring Return Direct Coupled Actuator

Minimum 18 in-lb Torque

- **For damper areas up to 4.5 sq-ft***



Applications

Cost effective quality and performance for a range of applications including:

- Classroom Unit Ventilators
- Fan/Coil Units
- Economizer Units
- Airhandlers
- Control Dampers
- VAV Terminal Units

Actuators in bold have BDCM

TTF Series – AT A Glance

		TTF24 (p. 60)	TTF24-S (p. 60)	TTF24-3 (p. 62)	TTF24-SR (p. 64)
Torque:	18 in-lb	●	●	●	●
Power supply:	24 VAC/DC	●	●	●	●
Control signal:	on-off	●	●		
	floating point			●	
	proportional 2 to 10 VDC				●
Running time motor:	<75 sec	●	●		
	95 sec constant			●	●
spring:	<25 sec	●	●	●	●
External direction of rotation switch				●	●
Plenum rated cable				●	●
Appliance cable		●	●		
Conduit fitting		●	●	●	●
Built-in auxiliary switch			●		

Installation instructions .....(p. 66-71)
Startup and checkout (p. 72)
General wiring.....(p. 70)

*Based on 4 in-lb/ft^2 damper torque loading. Parallel blade. No edge seals.

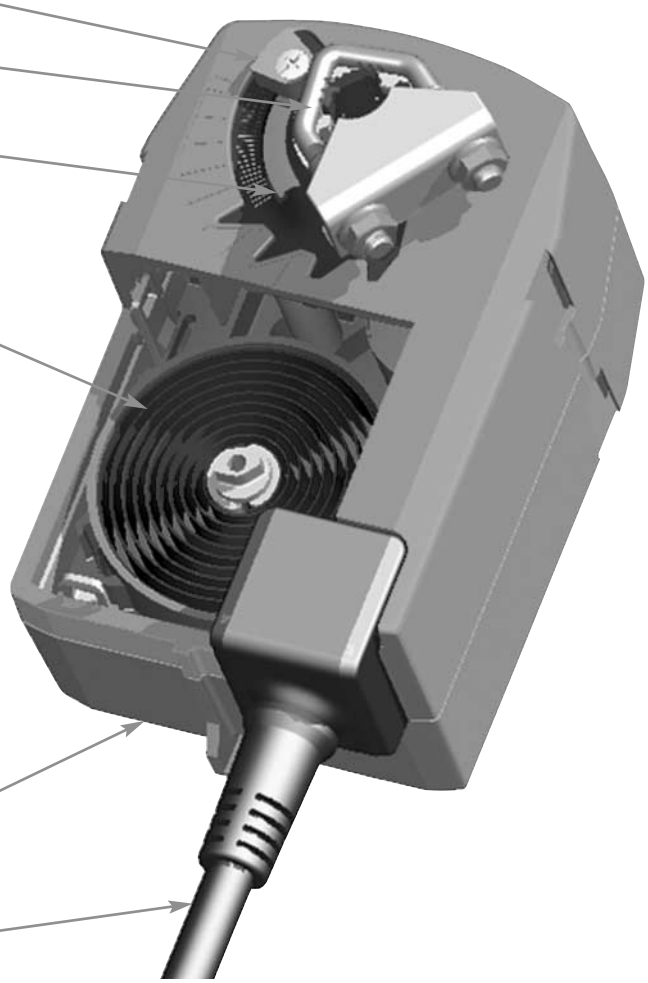
A CLOSER LOOK...

LISTED 94 D5 TEMP. IND. & REG. EQUIP. c UL us

CE

ISO 9001

- Easy-to-adjust mechanical stop to limit damper rotation.
- Cut labor costs with simple direct coupling. actuator centers on 1/2" shaft.
- Clockwise or counterclockwise fail-safe mounting for fail-safe.
- Compact size with the shortest shaft-center to edge distance in the industry - 0.77".
- True mechanical spring return – the most reliable fail-safe.
- Check damper position easily with clear position indicator.
- Don't worry about actuator burn-out. It 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 housing withstands rough handling in the mechanical room.
- 3 ft. standard cable and conduit connector (not shown) eases installation.



BRUSHLESS dc motor ©

The Trane Difference

- *Low Installation and Life-Cycle Cost.*
  Easy installation. Accuracy and repeatability.
  Low power consumption. No maintenance.
- *Long Service Life.*
  Components tested before assembly. Every product tested before shipment.
  30 years direct coupled actuator design.

TTF24 (-S)

On-off, Spring Return Fail-Safe, 24V

Technical Data	TTF24 (-S)
Power supply	24VAC ± 20%, 50/60Hz 24VDC ± 10%
Power consumption	running: 2.5 W holding: 1.3 W
Transformer sizing	5 VA (class 2 power source)
Electrical connection	3 ft, 18 GA appliance cable (-S models have 2 cables) 1/2" conduit connector
Overload protection	electronic throughout 0° to 95° rotation
Angle of rotation	max 95°, adjust. with mechanical stop
Torque	min. 18 in-lb [2 Nm]
Direction of rotation	reversible with cw/ccw mounting
Position indication	visual indicator, 0° to 95° (0° spring return position)
Auxiliary switch (-S models)	1 x SPDT 3A (0.5A) @ 250 VAC, UL listed adjustable 0° to 95°
Running time	motor: < 75 sec (0 to 18 in-lb) spring: < 25 sec @-4°F to +122°F [-20°C to +50°C] < 60 sec @-22°F [-30°C]
Humidity (nominal)	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 / IP42
Housing material	UL94 - 5VA
Agency listings	cULus listed acc. to UL 60730-1
Noise level	max: running < 50 db (A) spring return 62 dB (A)
Servicing	maintenance free
Quality standard	ISO 9001
Weight	TTF24 1.4 lbs (0.6 kg) TTF24-S 1.5 lbs (0.7 kg)

Torque min. 18 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 from 1/4" up to 1/2" in diameter by means of its universal clamp, 1/2" shaft centered at delivery. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

Operation

The TTF 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 TTF 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.

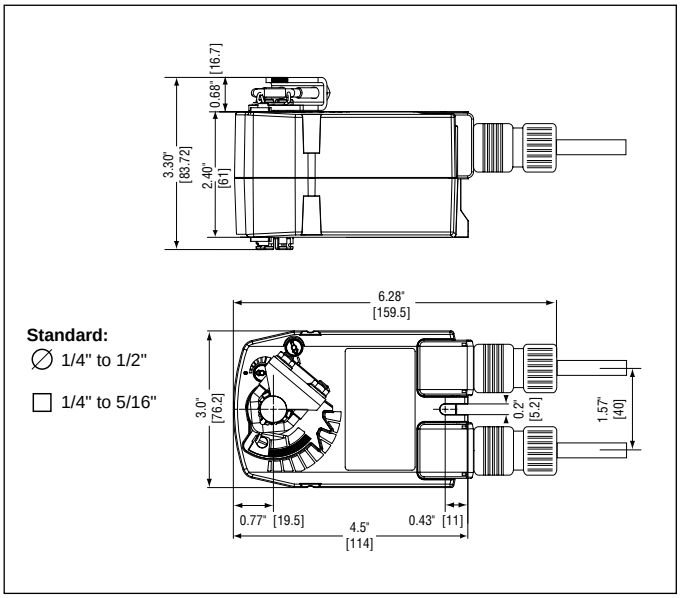
The TTF24-S versions are provided with one built-in auxiliary switch. This SPDT switch is provided for safety interfacing or signaling, for example, for fan start-up. The switching function is adjustable between 0° and 95°.

Safety Note

Screw a conduit fitting into the actuator's bushing. Jacket the actuator's input and output wiring with suitable flexible conduit. Properly terminate the conduit in a suitable junction box.

For all accessories, see pages 110 and 132.

Dimensions [All numbers in brackets are in millimeters.]



D096

I20683 - Subject to change.

CAUTION

△2 Equipment damage!
Actuators may be connected in parallel.
Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead.
Actuators with appliance cables use numbers.

APPLICATION NOTES

◆ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

TTF24 (-S) 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 1/2" 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, one 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 are cULus listed certified and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

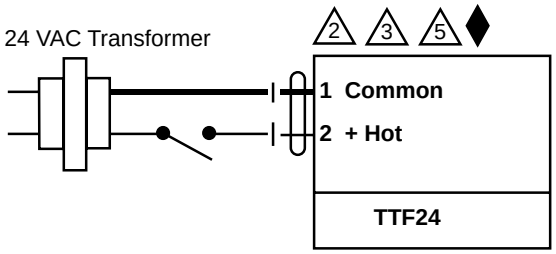
TTF

Wiring Diagrams

W467

WARNING

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

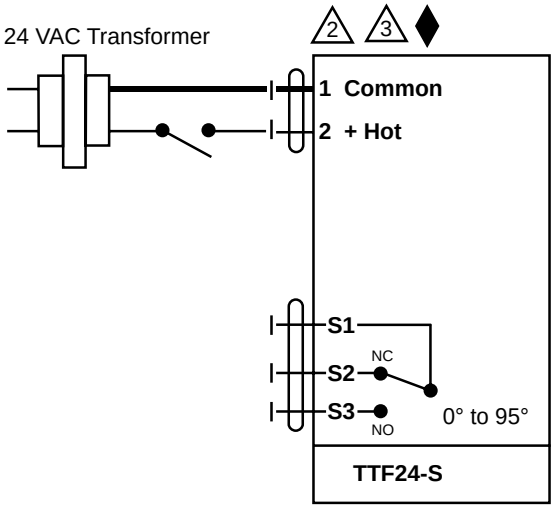


On-off wiring for TTF24

W468

WARNING

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



TTF24-3

On-off, Spring Return Fail-Safe, Reversible, Floating Point, 24V

Torque min. 18 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 1/4" up to 1/2" in diameter by means of its universal clamp, 1/2" shaft centered at delivery. 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 on a fan motor contactor, controller, or manual switch.

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

The TTF24-3 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.

For all accessories, see pages 110 and 132.

Technical Data	TTF24-3
Power supply	24 VAC ± 20% 50/60 Hz
Power consumption	running: 2.5 W ; holding: 1 W
Transformer sizing	4 VA (class 2 power source)
Electrical connection	TTF24-3 3 ft, 18 GA plenum rated cable
Overload protection	electronic throughout 0° to 95° rotation
Input impedance	1000Ω (0.6w) control inputs
Angle of rotation	max. 95°, adjust. with mechanical stop
Torque	18 in-lb [2 Nm]
Direction of rotation	spring: reversible with cw/ccw mounting motor: reversible with built-in switch
Position indication	visual indicator, 0° to 95° (0° is spring return position)
Running time	motor: 95 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 /IP42
Housing material	UL94-5VA
Agency listings	cULus listed acc. to UL 60730-1
Noise level	max: running < 35 db (A) spring return 62 dB (A)
Servicing	maintenance free
Quality standard	ISO 9001
Weight	TTF24-3 1.4 lbs (0.6 kg.)

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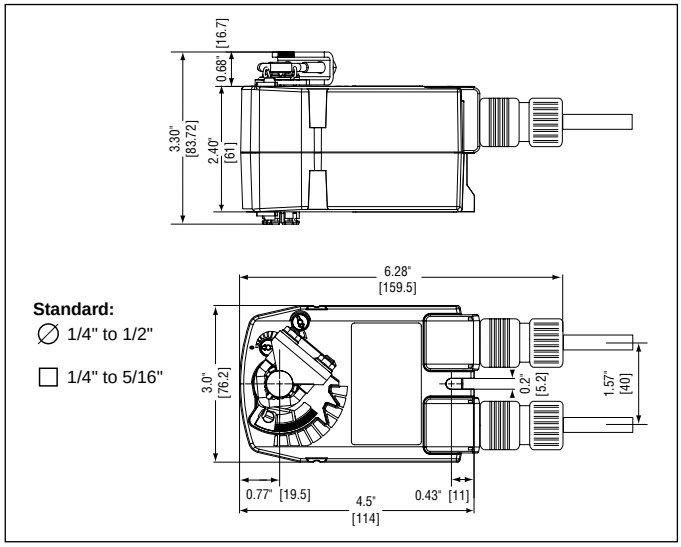
Dimensions [All numbers in brackets are in millimeters.]



D096

I20683 - Subject to change.

CAUTION

△2 Equipment damage!
Actuators may be connected in parallel.
Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

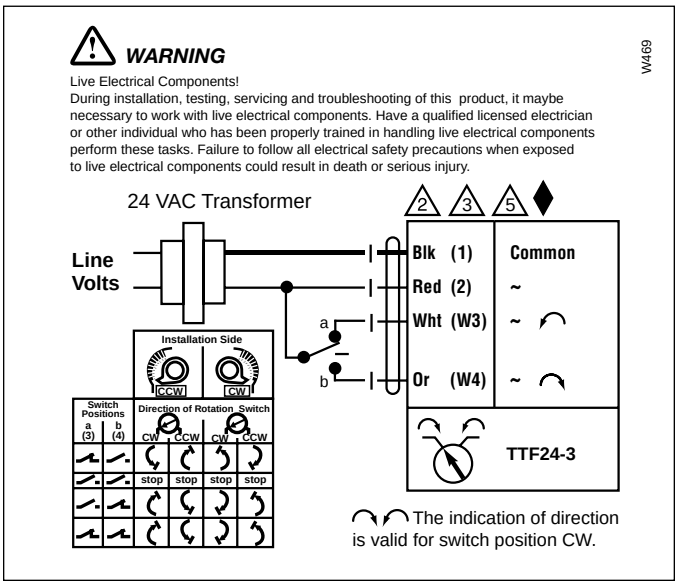
△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

△6 For triac sink the common connection from the actuator must be connected to the Hot connection of the controller. The actuator must be connected to the control board common.

APPLICATION NOTES

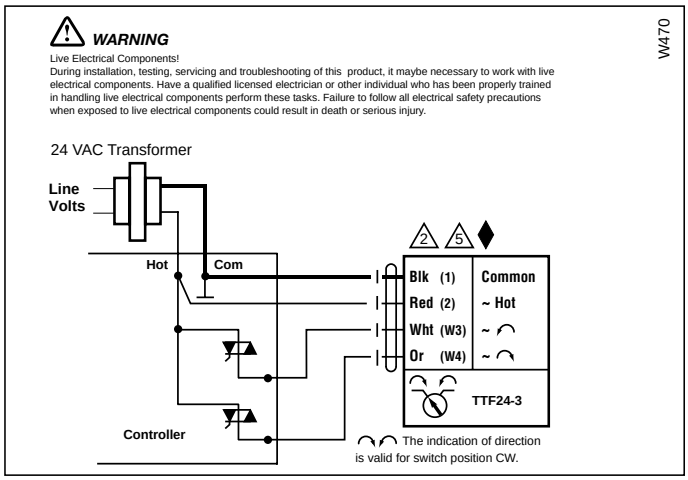
◆ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

Wiring Diagrams

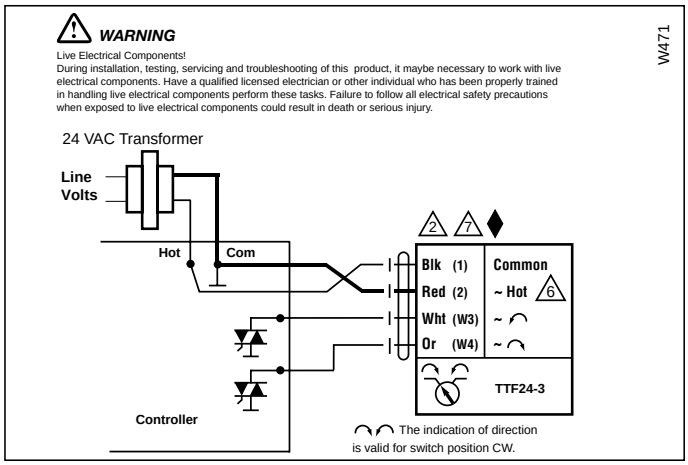


Floating point control of TTF24-3

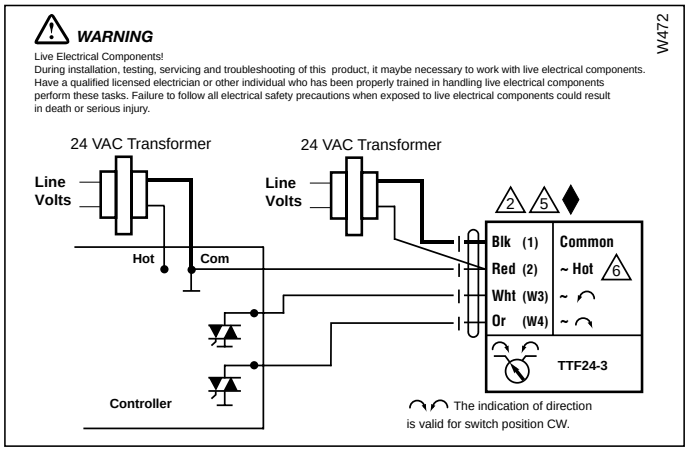
TF24-3 Typical Specification
Floating point, on-off spring return damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a shaft up to a 1/2" diameter and center a 1/2" shaft. The actuators must be designed so that they may be used for 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. Run time shall be constant and independent of torque. Actuators are cULus listed certified and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.



Triac source



Triac sink



Triac sink with separate transformers

TTF24-SR

Proportional damper actuator, Spring Return Fail-Safe, 24 V for 2 to 10 VDC, or 4 to 20 mA Control Signal.

Torque min. 18 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 1/4" up to 1/2" in diameter by means of its universal clamp, 1/2" shaft centered at delivery. 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.

Operation

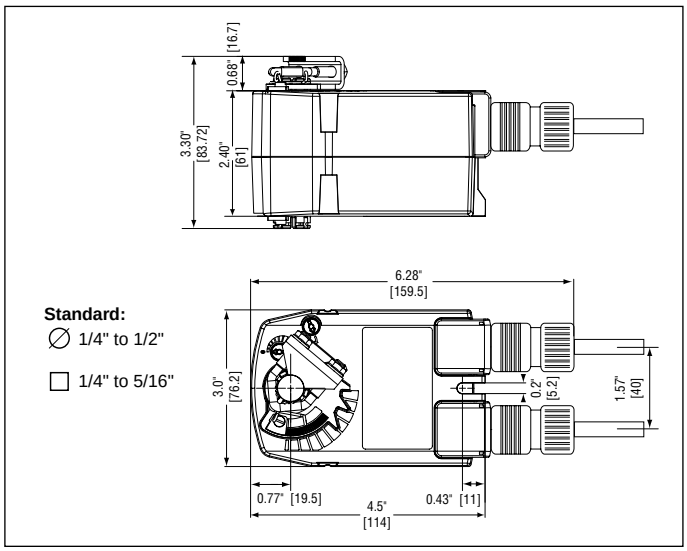
The TTF series actuators provide true spring return operation for reliable fail-safe application and positive close-off on air tight dampers. The spring return system provides consistent torque to the damper with, and without, power applied to the actuator. The TF series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°.

The TTF24-SR 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.

For all accessories, see pages 110 and 132.

Technical Data	TTF24-SR
Power supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power consumption	running: 2.5 W; holding: 1 W
Transformer sizing	4 VA (class 2 power source)
Electrical connection	TF24-SR 3 ft, 18 GA plenum rated cable
Overload protection	electronic throughout 0° to 95° rotation
Operating range Y	2 to 10 VDC, 4 to 20mA
Input impedance	100kΩ (0.1 mA), 500Ω
Angle of rotation	max. 95°, adjust. with mechanical stop
Torque	18 in-lb [2 Nm]
Direction of rotation	spring: reversible with cw/ccw mounting motor: reversible with built-in switch
Position indication	visual indicator, 0° to 95° (0° is spring return position)
Running time	motor: 95 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 / IP42
Housing material	UL94-5VA
Agency listings	cULus listed acc. to UL 60730-1
Noise level	max: running < 35 db (A) spring return 62 dB (A)
Servicing	maintenance free
Quality standard	ISO 9001
Weight	TTF24-SR 1.4 lbs (0.6 kg.)

Dimensions [All numbers in brackets are in millimeters.]



I20683 - Subject to change.

CAUTION

△2 Equipment damage!
Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

△6 Only connect common to neg. (—) leg of control circuits.

APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

♦ The ZG-R01 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

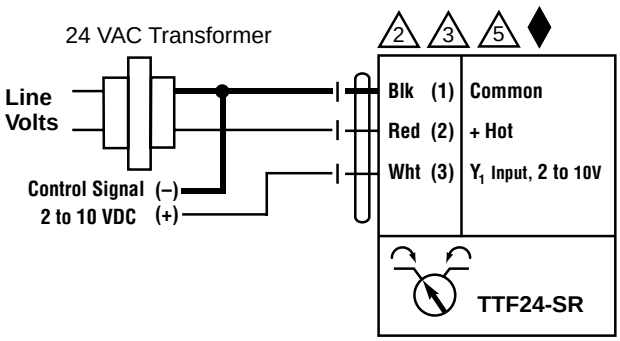
TTF24-SR Typical Specification
Spring return control damper actuators shall be direct coupled type which require no crankarm and linkage and be capable of direct mounting to a shaft up to a 1/2" diameter and center a 1/2" shaft. The actuator must provide proportional damper control in response to a 2 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 use a brushless DC motor controlled by a microprocessor and be protected from overload at all angles of rotation. Run time are constant, and independent of torque. Actuators are cULus listed certified and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

TTF

Wiring Diagrams

WARNING W473

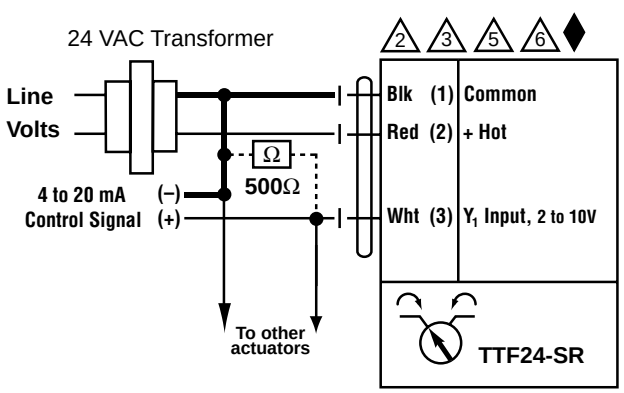
Live Electrical Components!
During installation, testing, servicing and troubleshooting of this product, it maybe necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these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



2 to 10 VDC control of TTF24-SR

WARNING W474

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



4 to 20 mA control of TTF24-SR

Mechanical Operation

The actuator is mounted directly to a damper shaft up to 1/2” 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.

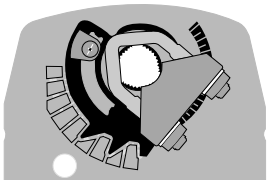
The TTF series actuators provide true spring return operation for reliable fail-safe application and positive close-off on air tight dampers. The spring return system provides consistent torque to the damper with, and without, power applied to the actuator.

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

The TTF…-S versions are provided with one 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

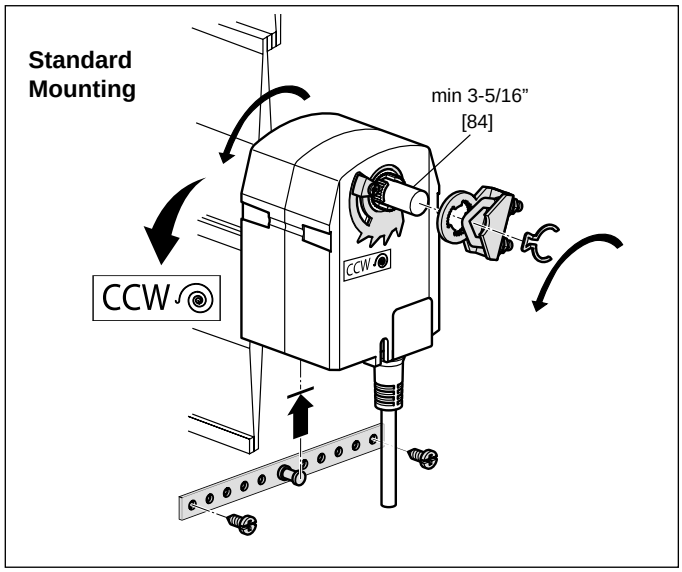
1. See Figure B. Manually move the damper to the fail-safe position (a) (usually closed). If the shaft rotated counterclockwise ( ), this is a CCW installation. If the shaft rotated clockwise ( ), this is a CW installation. In a left hand installation, the actuator side marked “CW” faces out, while in 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 Mounting* 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 Figure C) and the spline pattern of the clamp mates with spline of the actuator. Remount the stroke limiter to this side then slip the clamp over the spline. (Use the same procedure if the “CW” side is out.)
4. See *Remounting the Stroke Limiter*.
5. Lock the clamp to the actuator using the retaining clip.
6. Verify that the damper is still in its full fail-safe position (a).
7. Mount the spring return actuator to the shaft. Tighten the universal clamp, finger tight only.
8. Mount the anti-rotation strap at the base of the actuator. Do not tighten the screws.
9. Remove the screw from one end of the mounting bracket and pivot it away from the actuator.
10. Loosen the universal clamp making sure not to move the damper shaft, rotate the actuator approximately 5° in the direction which would open the damper.
11. Tighten the universal clamp to the shaft.
12. Rotate the actuator to apply pressure to the damper seals (b) and re-engage the anti-rotation strap (c).
13. Tighten all fasteners.



Universal Clamp

Figure C

Dimensions [All numbers in brackets are in millimeters.]



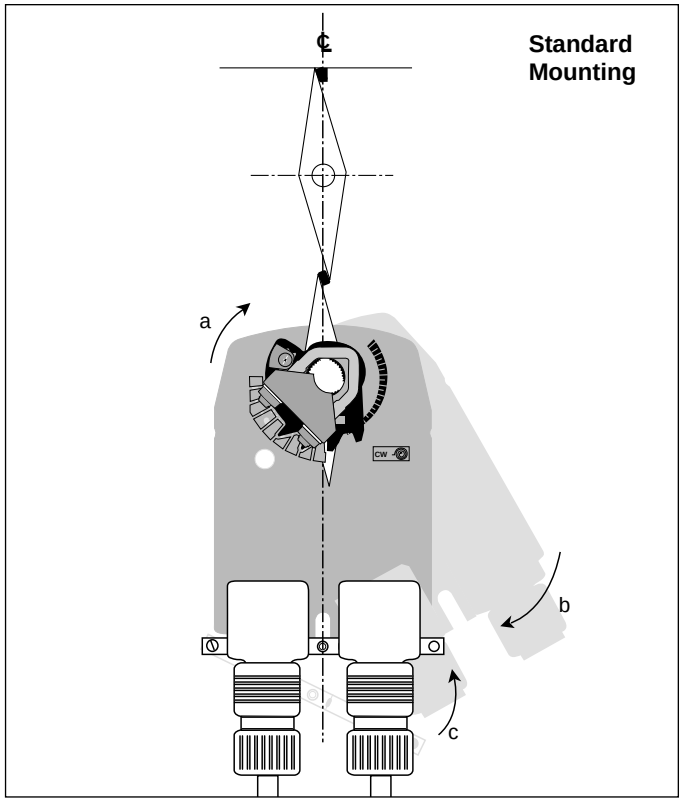


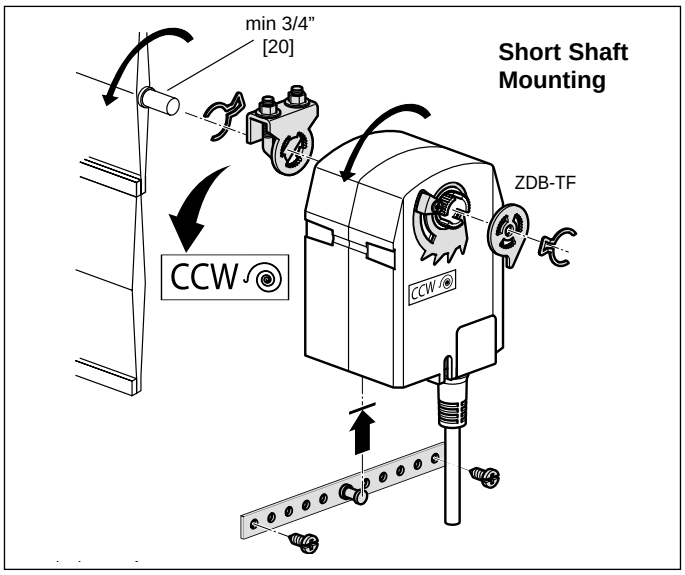
Figure B

Short Shaft Mounting with IND-TF Position Indicator / Airtight Damper Procedure

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

1. See Figure 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.
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.
13. Use IND-TF accessory if position indication is needed.

Dimensions [All numbers in brackets are in millimeters.]



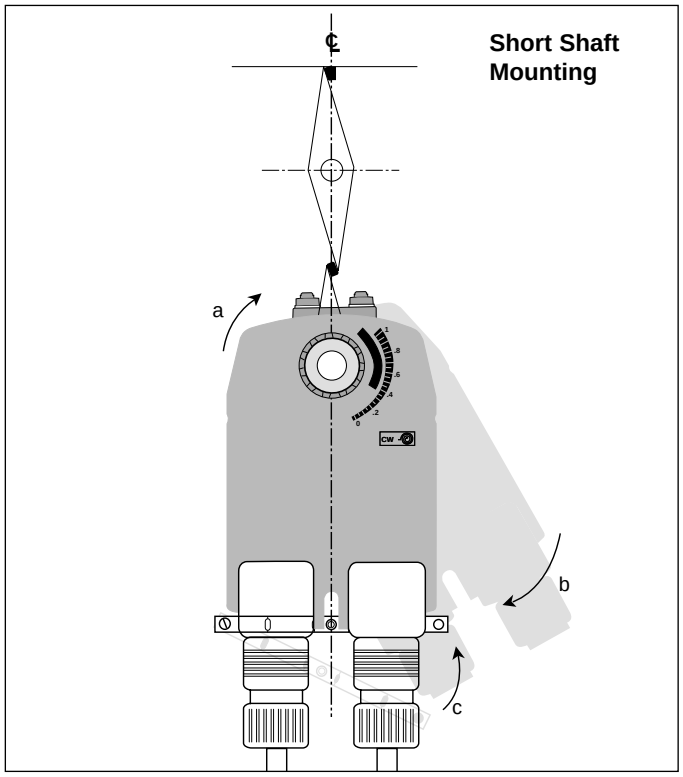
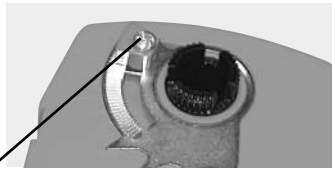


Figure D

TTF

Remounting the Stroke Limiter

1. Remove the stroke limiter by inserting a small screwdriver, like the one shown, and gently prying upward. This procedure takes very little force. See Figure 1.



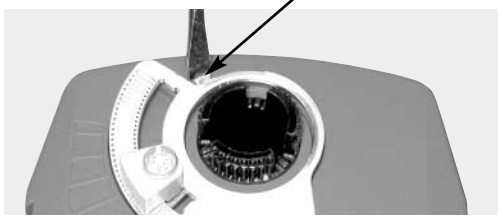
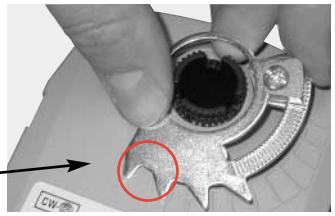
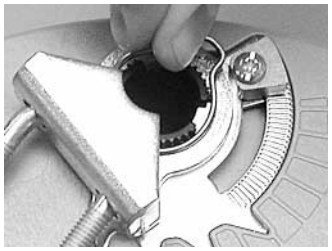


Figure 1.

2. While holding the back eye-let, unscrew the end-stop so that eye-let separates from the end-stop.
3. Flip the limiter over, so the teeth point the other direction. Replace the eye-let and end-stop.



4. Flip the actuator over to the opposite side (this reverses the spring return direction of the actuator). Replace the stroke limiter assembly by inserting the first two teeth as shown in the orange circle. Then press the stroke limiter into place by pushing downward on the adjustable stop.



5. Replace clamp and retaining clip.

Installation Instructions

Quick-Mount Visual Instructions for Mechanical Installation

Operational Information for TTF Actuators

Initialization of the TTF24-SR

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 its fail-safe position and will go through the start up initialization again.

Motor Position Detection (TTF24-SR)

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.

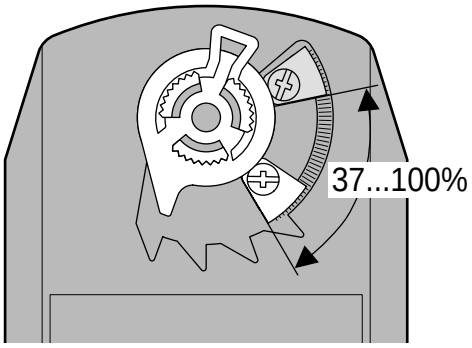
Overload Protection

The TTF, on-off actuators are electronically protected against overload. The TTF, 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 TTF24, modulating, actuators (TTF24-SR, TTF24-3) 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.

Mechanical Angle of Rotation Limiting

The TTF 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 TTF 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-TF 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-TF 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

TTF24-3 and TTF24-SR actuators have a direction of rotation switch on the cover labeled “CW-CCW”. Switch position indicates start point. For the TTF24-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 counter-clockwise with a decrease in voltage or current.

The TTF24-3 and TTF24-SR 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 counter clockwise.

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

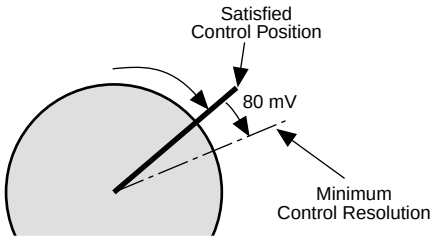
During checkout, the switch position can be temporarily reversed and the actuator will reverse its direction. This allows the technician a fast and easy way to check the actuator operation without having to switch wires or change settings on the controller. ***When the check-out is complete, make sure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

Control Accuracy and Stability

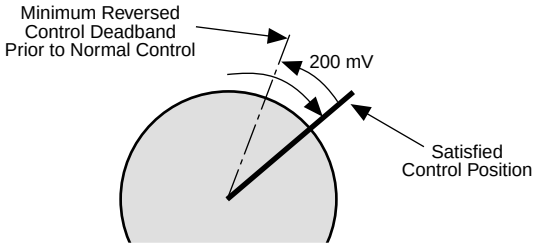
TTF24-SR actuators have built-in brushless DC motors which provide better accuracy and longer service life.

The TTF24-SR 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.

TTF actuator responds to a 80 mV signal when not changing direction from stop position.



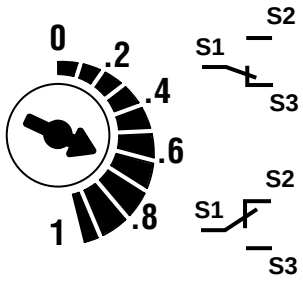
TTF actuator responds to a 200 mV signal when reversing direction from stop position.



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.

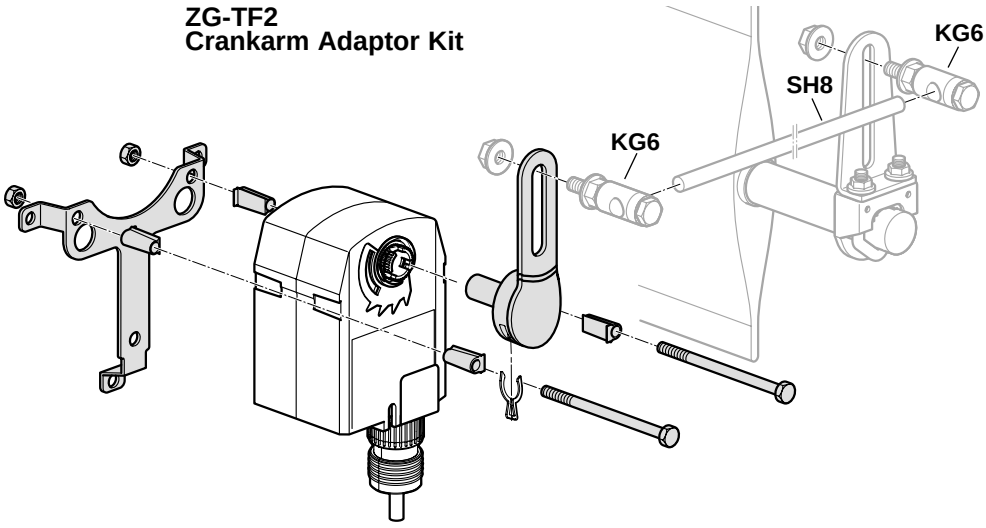
1. Set desired switch position (Example 60%).
2. As the actuator rotates, the switch indicator moves from .6 (60%) toward 0 (0%).



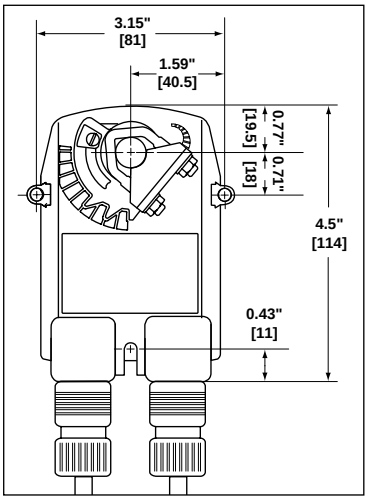
Switch Rating	
Voltage	250 VAC
Resistive load	3 A
Inductive load	0.5 A

Non-Direct Mounting Methods

ZG-TF2
Crankarm Adaptor Kit



Dimensions
[All numbers in brackets are in millimeters.]



Installation Instructions

General Wiring

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.

Transformer(s)

The TTF24 . . actuator requires a 24 VAC class 2 transformer and draws a maximum of 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 hotleg.* Mixing wire No. 1 & 2 on one leg of the transformer will result in erratic operation or failure of the actuator and/or controls.

Multiple Actuators, Multiple Transformers

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

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

Wire Length for TTF… Actuators

Keep power wire runs below the lengths listed in the table in Figure 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 TTF24-SR:

3 actuators, 16 Ga wire
550 ft ÷ 3 Actuators = 183 ft. maximum wire run

Maximum Wire Length:

TTF24 (-S)

Wire Size	Max. Feet.		Wire Size	Max. Feet
12 Ga	1300 Ft.		18 Ga	575 Ft.
14 Ga	1175 Ft.		20 Ga	300 Ft.
16 Ga	900 Ft.		22 Ga	150 Ft.

TTF24-3

Wire Size	Max. Feet.		Wire Size	Max. Feet
16 Ga	1125 Ft.		20 Ga	400 Ft.
18 Ga	725 Ft.		22 Ga	200 Ft.

TTF24-SR

Wire Size	Max. Feet.		Wire Size	Max. Feet
12 Ga	1800 Ft.		18 Ga	450 Ft.
14 Ga	1100 Ft.		20 Ga	275 Ft.
16 Ga	700 Ft.		22 Ga	125 Ft.

Figure A

Wire Type and Wire Installation Tips

For most installations, 18 or 16 Ga. cable works well with the TTF24… 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 TTF24… 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:

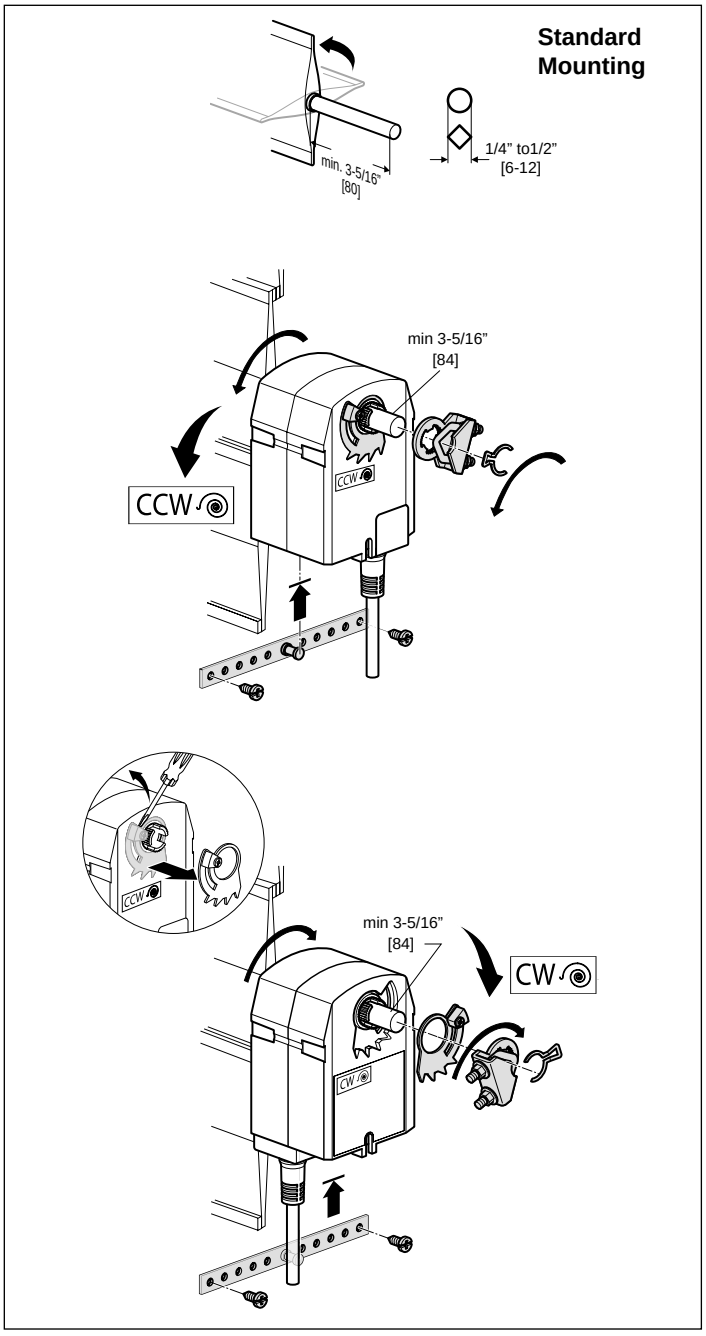
1. Run the wire in metallic conduit.
2. Re-route the wiring away from the source of pickup.
3. Use shielded wire (Belden 8760 or equal). Ground the shield to an earth ground. **Do not** connect it to the actuator common.

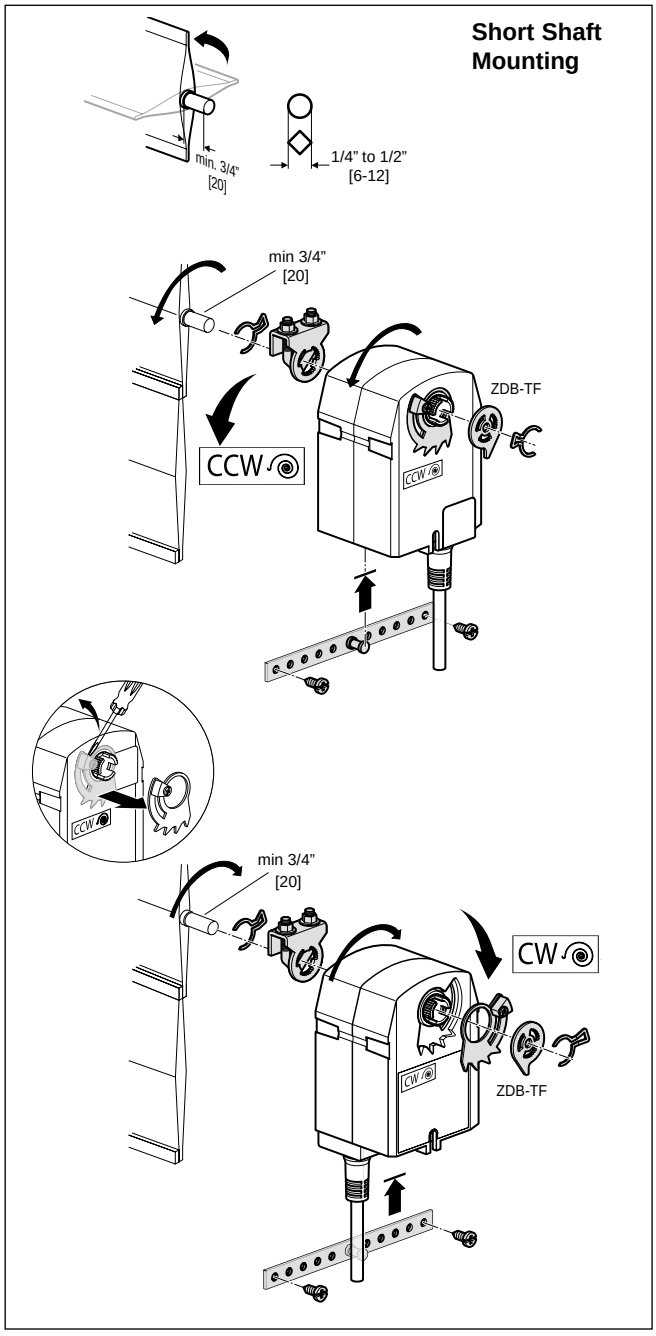
Brushless DC Motor Operation

The 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). Unlike the conventional DC motor, there are no brushes to wear or commutators to foul.

I20683 - Subject to change.

Dimensions [All numbers in brackets are in millimeters.]





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.
3. Slide the actuator onto the shaft and tighten the nuts on the V-bolt with an 8 mm 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 page 92, for more detailed information.

Preliminary Steps

1. 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 *Mechanical Accessories* Section)
2. For new construction work, **order dampers with extended shafts**. Instruct the installing contractor to allow space for mounting and service of the 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.

Startup and Checkout

Instructions For TTF24-SR

TTF24-SR Electrical Check-out Procedure

Step	Procedure	Expected Response	Gives Expected Response Go To Step…	Does Not Give Expected Response Go To Step…
1.	Remove power to reset actuator. Re-apply power. Apply control signal to actuator.	Actuator will move to its "Control Signal" position.	Actuator operates properly. **Step 8**	No response at all. **Step 2** Operation is reversed. **Step 3** Does not drive toward "Control Signal Position". **Step 4**
2.	Check power wiring. Correct any problems. **See Note 1.**	Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.	Power wiring corrected, actuator begins to drive. **Step 1**	Power wiring corrected, actuator still does not drive. **Step 4**
3.	Turn reversing switch to the correct position. Make sure the switch is turned all the way left or right.	Actuator will move to its "Control Signal" position.	Actuator operates properly. **Step 8**	Does not drive toward "Control Signal Position". **Step 4**
4.	Make sure the control signal positive (+) is connected to Wire No 3 and control signal negative (-) is connected to wire No. 1. Most control problems are caused by reversing these two wires. Verify that the reversing switch is all the way CCW or CW.	Drives to "Control Signal" position.	Actuator operates properly. **Step 8**	**Step 5**
5.	Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For TTF24-SR 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.	Input voltage or current should be ±1% of what controller's adjustment or programming indicate.	Controller output (actuator input) is correct. Input Polarity Correct. **Step 6**	Reprogram, adjust repair or replace controller as needed. **Step 1**
6.	Loosen the nuts on the V-bolt and move the damper by hand from fully closed to fully open.	Damper will go from fully closed to fully open.	Damper moves properly. **Step 7**	Find cause of damper jam and repair. Move damper back to the fully closed position and tighten the nuts. **Step 1**
7.	Check damper torque requirement.	Torque requirement is ≤ actuator's minimum torque.	Defective Actuator. Replace Actuator.	Recalculate actuator requirement and correct installation.
8.	Actuator works properly. Test controller by following controller manufacturer's instructions.			

Note 1 Check that the transformer(s) are sized properly.

- If a common transformer is used, make sure that polarity is observed on the secondary. This means connect all No. 1 wires to one leg of the transformer and all No. 2 wires to the other leg of the transformer.
- If multiple transformers are used with one control signal, make sure all No. 1 wires are tied together and tied to control signal negative (-).
- Controllers and actuators must have separate 24 VAC/VDC power sources.

Notes/Work Pad

TGMB Series Direct Coupled Actuator

Minimum 360 in-lb Torque

- **For damper areas up to 90 sq-ft***

All Actuators have BDCM

TGMB Series - At A Glance

		TGMB24-3	TGMB24-SR
Pages		76	78
Basic Product		●	●
Torque	360 in-lb [40 Nm]	●	●
Angle of Rotation	95 degrees	●	●
Power Supply	24 VAC/DC	●	●
Control Input	On/Off, Floating Point	●	
	2 to 10 VDC (4 to 20mA)		●
Feedback	None	●	
	2 to 10 VDC		●
Running Time	150 seconds	●	●
Wiring	Plenum Rated Cable	●	●
	Conduit Fitting	●	●
Auxiliary Switch	Add-on	●	●

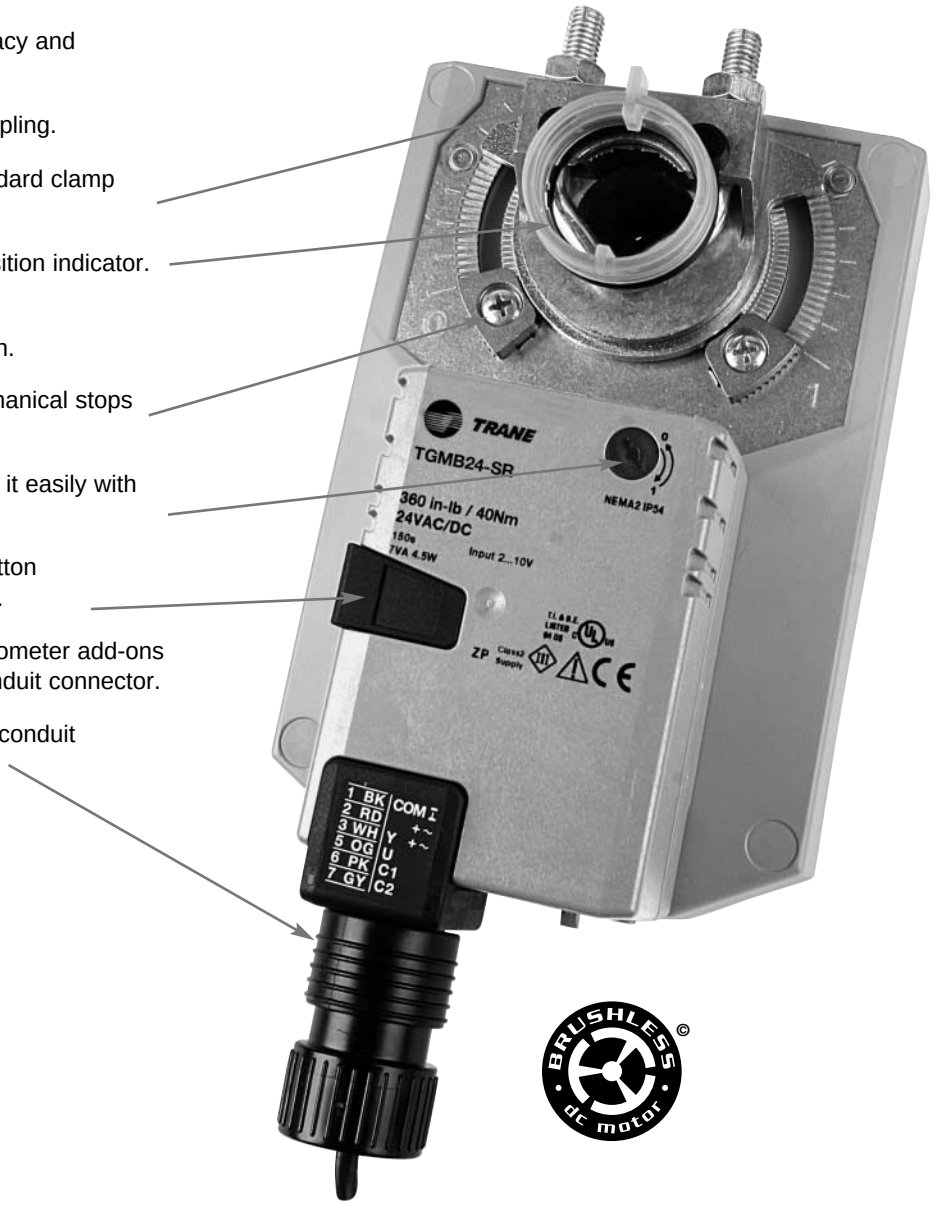
Installation and Operations…(page 99).

*Based on 4 in-lb/ft^2 damper torque loading. Parallel blade. No edge seals.

A CLOSER LOOK...

LISTED 94 D5 TEMP. IND. & REG. EQUIP. c UL us CE ISO 9001

- Brushless DC motor for added accuracy and controllability.
- Cut labor costs with simple direct coupling.
- Self-centers on 1" jackshaft with standard clamp or 3/4" with accessory clamp.
- Check damper position with clear position indicator.
- Don't worry about actuator burn-out; It is overload proof throughout rotation.
- Enjoy added flexibility with easy mechanical stops to adjust angle of rotation.
- Need to change control direction? Do it easily with a simple switch.
- Easily accessible manual override button helps you pre-tension damper blades.
- Auxiliary switch and feedback potentiometer add-ons mount directly on clamp, includes conduit connector.
- Standard 3ft plenum rated cable and conduit connector provided.



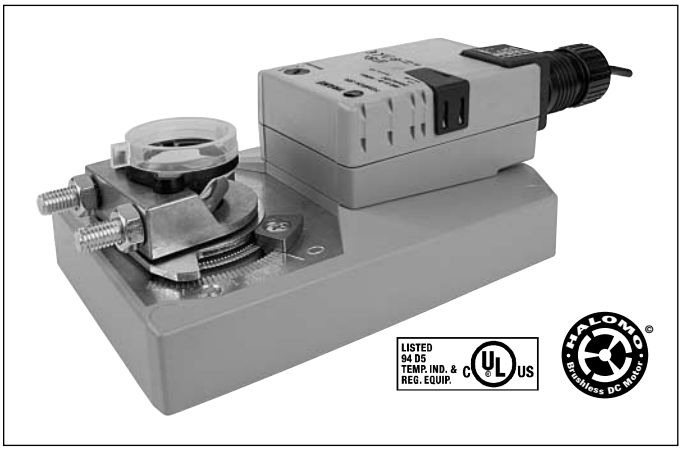
The Trane Difference

- *Low Installation and Life-Cycle Cost.*
  Easy installation. Accuracy and repeatability.
  Low power consumption. No maintenance.

- *Long Service Life.*
  Components tested before assembly. Every product tested before shipment.
  30+ years direct coupled actuator design.

TGMB24-3

On/off-Floating Point Control, Non-Spring Return, Direct Coupled, 24 V



Technical Data	TGMB24-3
Power Supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power Consumption	4 W (2 W)
Transformer Sizing	6 VA (Class 2 power source)
Electrical Connection	3 ft, 18 GA plenum rated cable 1/2" conduit connector
Overload Protection	electronic throughout 0° to 95° rotation
Control	on/off, floating point
Input Impedance	600Ω
Angle of Rotation	max. 95°, adjust. with mechanical stop
Torque	360 in-lb [40 Nm]
Direction of Rotation	reversible with ↷/↶ switch
Position Indication	reflective visual indicator (snap-on)
Manual Override	external push button
Running Time	150 seconds, constant independent of load
Humidity	5 to 95% RH non condensing (EN 60730-1)
Ambient Temperature	-22°F to +122°F [-30°C to +50°C]
Storage Temperature	-40°F to +176°F [-40°C to +80°C]
Housing	NEMA 2/IP54
Housing Material	UL94-5VA
Agency Listings	cULus acc. to UL 60730-1/-2-14 and CAN/CSA C22.2 No.24, CE according to 73 / 23 / EEC
Noise Level	<45dB(A)
Servicing	maintenance free
Quality Standard	ISO 9001
Weight	3.4 lbs [1.55 Kg]

Torque min. 360 in-lb for control of damper surfaces up to 90 sq ft.

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 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 actuator is not provided with and does not require any limit switches, but is electronically protected against overload. The anti-rotation strap supplied with the actuator will prevent lateral movement.

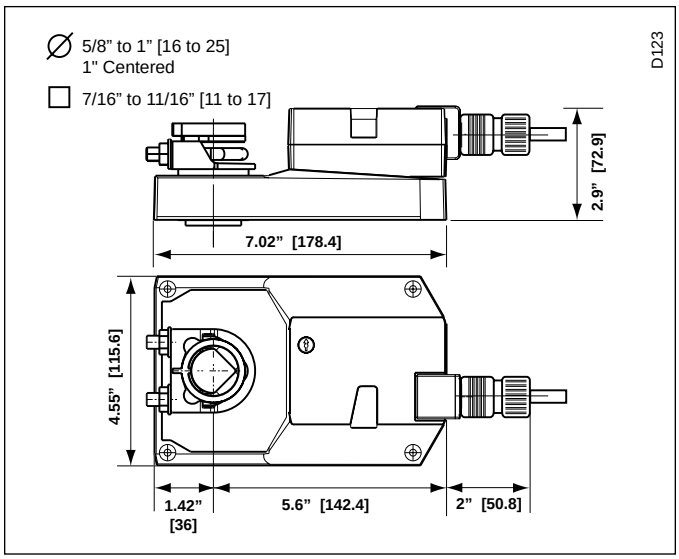
The TGMB series provides 95° of rotation and a visual indicator indicates position of the actuator. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged with a button on the actuator cover.

The TGMB24-3… 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. Power consumption is reduced in holding mode.

Add on auxiliary switches or feedback potentiometers are easily fastened directly onto the actuator body for signaling and switching functions.

For all accessories, see pages 110 and 132.

Dimensions (All numbers in brackets are in millimeters.)



CAUTION

△2 Equipment damage!
Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

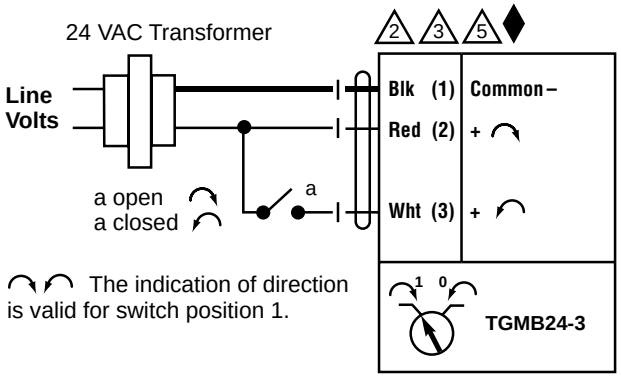
TGMB24-3 - Typical Specification:
Floating point, on/off control damper actuators shall be electronic direct-coupled type, which require no crankarm and linkage and be capable of direct mounting to a shaft up to 1.05" diameter. Actuators shall have brushless DC motor technology and be protected from overload at all angles of rotation. Actuators shall have reversing switch and manual override on the cover. Run time shall be constant and independent of torque. Actuators are cULus listed, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

W478

WARNING

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



On/Off

W479

WARNING

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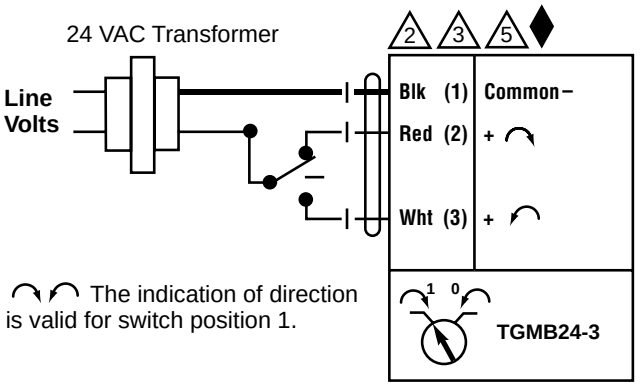
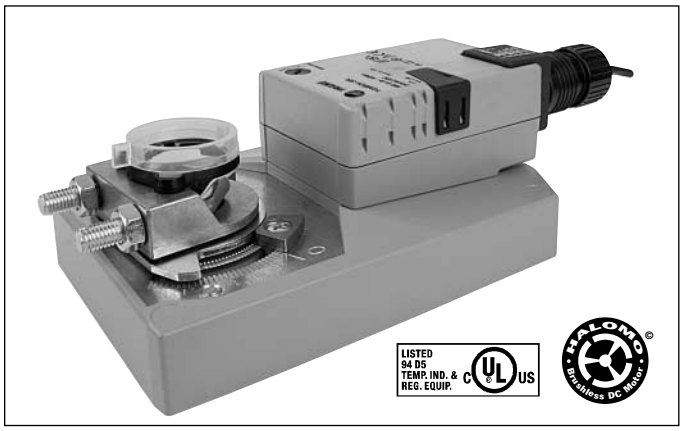


Floating point or On/Off control

TGMB24-SR

Proportional Control, Non-Spring Return, Direct Coupled, 24V, for 2 to 10 VDC and 4 to 20 mA



Technical Data	TGMB24-SR
Power Supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power Consumption	4.5 W (2W)
Transformer Sizing	6.5 VA (Class 2 power source)
Electrical Connection	3 ft, 18 GA plenum rated 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	100kΩ (0.1 mA), 500Ω
Feedback Output U	2 to 10 VDC (max 0.5 mA)
Angle of Rotation	max. 95°, adjust. with mechanical stop
Torque	360 in-lb [40 Nm]
Direction of Rotation	reversible with ↷/↶ switch. Actuator will move: ↶ =CCW with decreasing control signal (10→2V) ↷ =CW with decreasing control signal (10→2V)
Position Indication	reflective visual indicator (snap-on)
Manual Override	external push button
Running Time	150 seconds, constant independent of load
Humidity	5 to 95% RH non condensing (EN 60730-1)
Ambient Temperature	-22°F to +122°F [-30°C to +50°C]
Storage Temperature	-40°F to +176°F [-40°C to +80°C]
Housing	NEMA 2/IP54
Housing Material	UL94-5VA
Agency Listings	cULus acc. to UL 60730-1/-2-14 and CAN/CSA C22.2 No.24, CE according to 73 / 23 / EEC
Noise Level	<45dB(A)
Servicing	maintenance free
Quality Standard	ISO 9001
Weight	3.4 lbs [1.55 Kg]

Torque min. 360 in-lb for control of damper surfaces up to 90 sq ft.

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, 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 actuator is not provided with and does not require any limit switches, but is electronically protected against overload. The anti-rotation strap supplied with the actuator will prevent lateral movement.

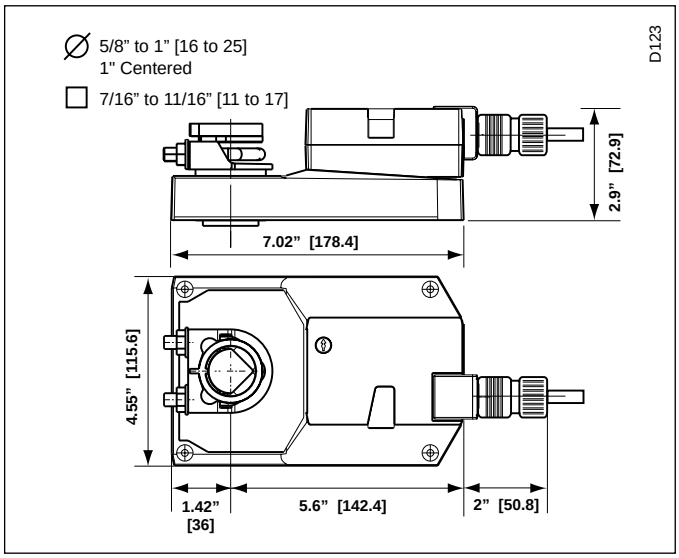
The TGMB series provides 95° of rotation and a visual indicator indicates position of the actuator. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged with a button on the actuator cover.

The TGMB24-SR… actuators use a sensorless 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. Power consumption is reduced in holding mode.

Add on auxiliary switches or feedback potentiometers are easily fastened directly onto the actuator body for signaling and switching functions

For all accessories, see pages 110 and 132.

Dimensions (All numbers in brackets are in millimeters.)



CAUTION

△2 Equipment damage!
Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

△6 Only connect common to neg. (—) leg of control circuits.

APPLICATION NOTES

◆ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

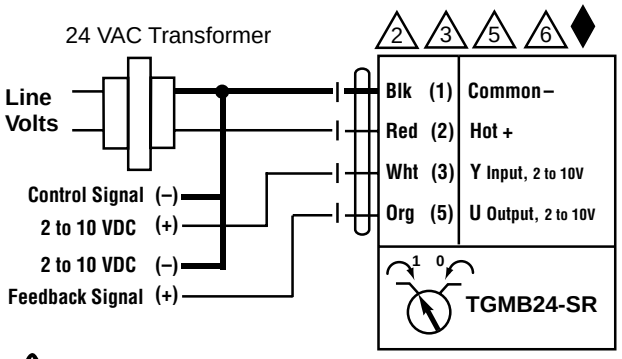
◆ The ZG-R01 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

TGMB24-SR - Typical Specification:
Proportional control damper actuators shall be electronic direct-coupled type, which require no crankarm and linkage and be capable of direct mounting to a shaft up to 1.05" diameter. Actuators 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. Actuators shall have brushless DC motor technology and be protected from overload at all angles of rotation. Actuators shall have reversing switch and manual override on the cover. Run time shall be constant and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position indication. Actuators are cULus listed, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

W480

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



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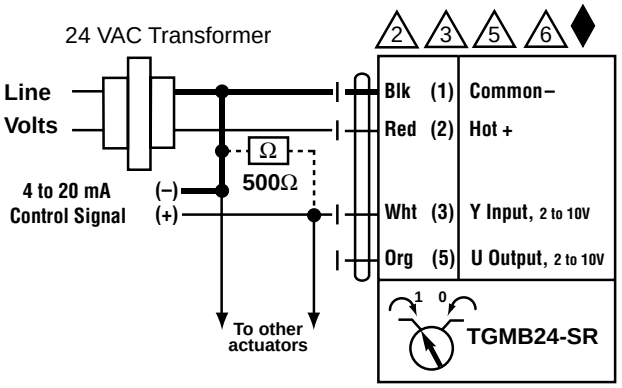


2 to 10 VDC and 4 to 20 mA control of TGMB24-SR

TGMB

TAMB Series Direct Coupled Actuator

Versatile and Powerful

- Minimum 180 in-lb torque in a compact package.
  For damper areas up to 45 sq-ft*

All Actuators have BDCM

TAMB Series - At A Glance

		TAMB24-3	TAMB24-SR
Pages		82	84
Basic Product		●	●
Torque	180 in-lb [20 Nm]	●	●
Angle of Rotation	95 degrees	●	●
Power Supply	24 VAC/DC	●	●
Control Input	On/Off, Floating Point	●	
	2 to 10 VDC (4 to 20mA)		●
Feedback	None	●	
	2 to 10 VDC		●
Running Time	95 seconds	●	●
Wiring	Plenum Rated Cable	●	●
	Conduit Fitting	●	●
Auxiliary Switch	Add-on	●	●

Installation and Operation… (page 99).

*Based on 4 in-lb/ft^2 damper torque loading. Parallel blade. No edge seals.

A CLOSER LOOK...

LISTED 94 D5 TEMP. IND. & REG. EQUIP. c UL us CE ISO 9001

- Brushless DC motor for added accuracy and controllability.
- Cut labor costs with simple direct coupling.
- Self-centers on 1/2", 3/4", and 1.05" jackshafts with standard clamp.
- Check damper position with clear position indicator.
- Don't worry about actuator burn-out; It is overload proof throughout rotation.
- Enjoy added flexibility with easy mechanical stops to adjust angle of rotation.
- Need to change control direction? Do it easily with a simple switch.
- Easily accessible manual override button helps you pre-tension damper blades.
- Auxiliary switch and feedback potentiometer add-ons mount directly on clamp, includes conduit connector.
- Standard 3ft plenum rated cable and conduit connector provided.

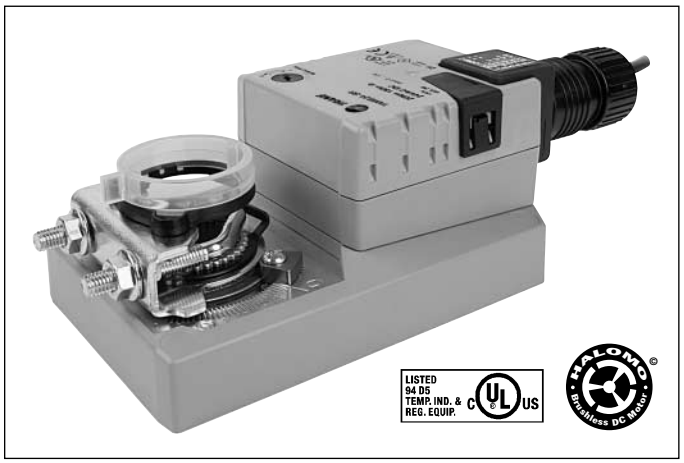
The Trane Difference

- *Low Installation and Life-Cycle Cost.*
  Easy installation. Accuracy and repeatability.
  Low power consumption. No maintenance.
- *Long Service Life.*
  Components tested before assembly. Every product tested before shipment.
  30+ years direct coupled actuator design.

TAMB

TAMB24-3

On/Off-Floating Point Control, Non-Spring Return, Direct Coupled, 24 V



Technical Data	TAMB24-3
Power Supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power Consumption	2.5 W (0.2 W)
Transformer Sizing	5.5 VA (Class 2 power source)
Electrical Connection	3 ft, 18 GA plenum rated cable 1/2" conduit connector
Overload Protection	electronic throughout 0° to 95° rotation
Control	on/off, floating point
Input Impedance	600Ω
Angle of Rotation	max. 95°, adjust. with mechanical stop
Torque	180 in-lb [20 Nm]
Direction of Rotation	reversible with ↷/↶ switch
Position Indication	reflective visual indicator (snap-on)
Manual Override	external push button
Running Time	95 seconds, constant independent of load
Humidity	5 to 95% RH non condensing (EN 60730-1)
Ambient Temperature	-22°F to +122°F [-30°C to +50°C]
Storage Temperature	-40°F to +176°F [-40°C to +80°C]
Housing	NEMA 2/IP54
Housing Material	UL94-5VA
Agency Listings	cULus acc. to UL 60730-1/-2-14 and CAN/CSA C22.2 No.24, CE according to 73 / 23 / EEC
Noise Level	<45dB(A)
Servicing	maintenance free
Quality Standard	ISO 9001
Weight	2.2 lbs [1000 Kg] TAMB24-3

Torque min. 180 in-lb for control of damper surfaces up to 45 sq ft.

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 1.05" in diameter by means of its universal clamp, self-centered default. 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 anti-rotation strap supplied with the actuator will prevent lateral movement.

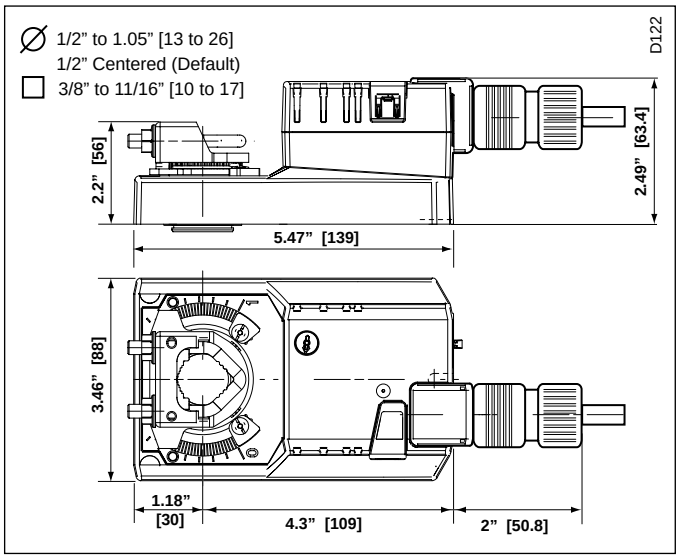
The TAMB series provides 95° of rotation and a visual indicator indicates position of the actuator. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged with a button on the actuator cover.

The TAMB24-3… actuators use a sensorless 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. Power consumption is reduced in holding mode.

Add on auxiliary switches or feedback potentiometers are easily fastened directly onto the actuator body for signaling and switching functions.

For all accessories, see pages 110 and 132.

Dimensions (All numbers in brackets are in millimeters.)



CAUTION

△2 Equipment damage!
Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

APPLICATION NOTES

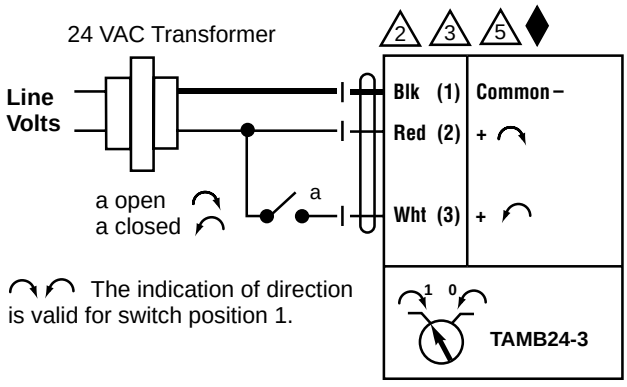
♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

TAMB24-3 - Typical Specification:
Floating point, on/off control damper actuators shall be electronic direct-coupled type, which require no crankarm and linkage and be capable of direct mounting to a shaft up to 1.05" diameter. Actuators shall have brushless DC motor technology and be protected from overload at all angles of rotation. Actuators shall have reversing switch and manual override on the cover. Run time shall be constant and independent of torque. Actuators are cULus listed, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

W481

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



On/Off

W482

WARNING
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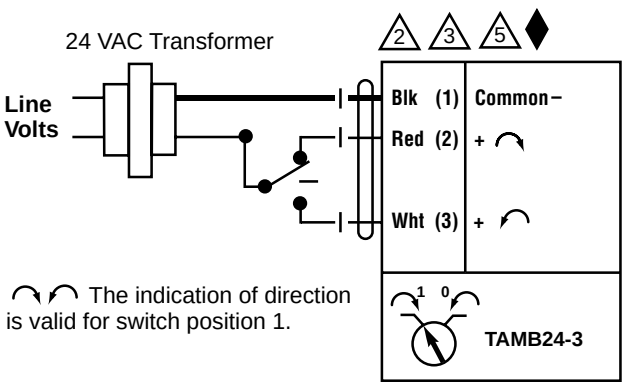
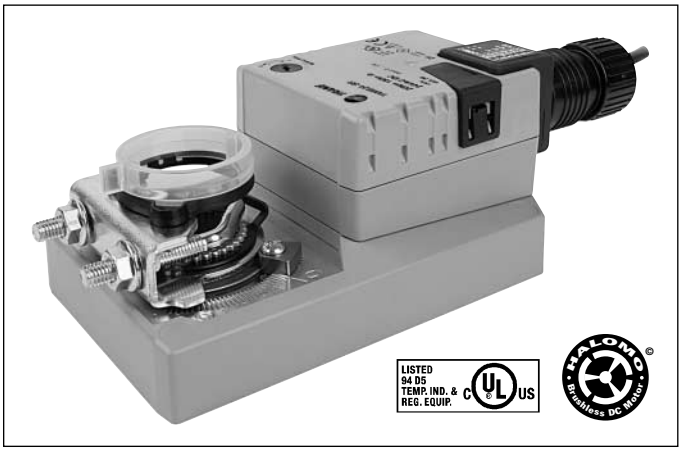


Floating Point or On/Off control

TAMB24-SR

Proportional Control, Non-Spring Return, Direct Coupled, 24V, for 2 to 10 VDC and 4 to 20 mA



Technical Data	TAMB24-SR
Power Supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power Consumption	2.5 W (0.4 W)
Transformer Sizing	5 VA (Class 2 power source)
Electrical Connection	3 ft, 18 GA plenum rated 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	100kΩ (0.1 mA), 500Ω
Feedback Output U	2 to 10 VDC (max 0.5 mA)
Angle of Rotation	max. 95°, adjust. with mechanical stop
Torque	180 in-lb [20 Nm]
Direction of Rotation	reversible with ↷/↶ switch. Actuator will move: ↶ =CCW with decreasing control signal (10→2V) ↷ =CW with decreasing control signal (10→2V)
Position Indication	reflective visual indicator (snap-on)
Manual Override	external push button
Running Time	95 seconds, constant independent of load
Humidity	5 to 95% RH non condensing (EN 60730-1)
Ambient Temperature	-22°F to +122°F [-30°C to +50°C]
Storage Temperature	-40°F to +176°F [-40°C to +80°C]
Housing	NEMA 2/IP54
Housing Material	UL94-5VA
Agency Listings	cULus acc. to UL 60730-1/-2-14 and CAN/CSA C22.2 No.24, CE according to 73 / 23 / EEC
Noise Level	<45dB(A)
Servicing	maintenance free
Quality Standard	ISO 9001
Weight	2.2 lbs [1000 Kg]

Torque min. 180 in-lb for control of damper surfaces up to 45 sq ft.

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, 1/2" self-centered default. 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, 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 actuator is not provided with and does not require any limit switches, but is electronically protected against overload. The anti-rotation strap supplied with the actuator will prevent lateral movement.

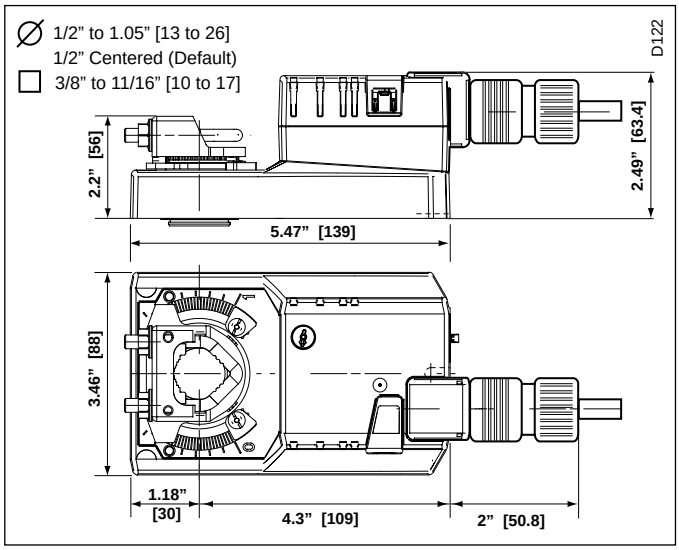
The TAMB series provides 95° of rotation and a visual indicator indicates position of the actuator. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged with a button on the actuator cover.

The TAMB24-SR… actuators use a sensorless 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. Power consumption is reduced in holding mode.

Add on auxiliary switches or feedback potentiometers are easily fastened directly onto the actuator body for signaling and switching functions

For all accessories, see pages 110 and 132.

Dimensions (All numbers in brackets are in millimeters.)



I20683 - Subject to change.

CAUTION

△2 Equipment damage!
Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

△6 Only connect common to neg. (—) leg of control circuits.

APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

♦ The ZG-R01 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

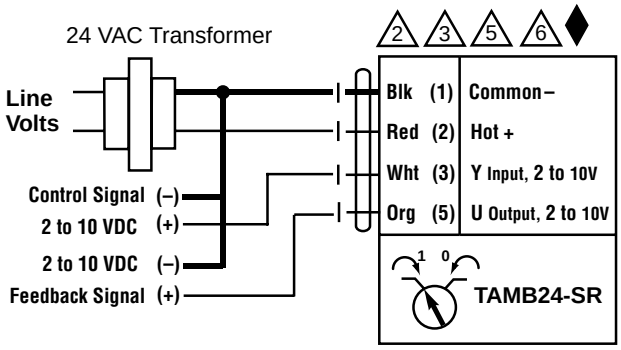
TAMB24-SR - Typical Specification:
Proportional control damper actuators shall be electronic direct-coupled type, which require no crankarm and linkage and be capable of direct mounting to a shaft up to 1.05" diameter. Actuators must provide proportional damper control in response to a 2 to 10 VDC or, with the addition of a 500Ω resistor, a 4 to 20 mA control input from an electronic controller or positioner. Actuators shall have brushless DC motor technology and be protected from overload at all angles of rotation. Actuators shall have reversing switch and manual override on the cover. Run time shall be constant and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position indication. Actuators are cULus listed, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

WARNING

W483

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



WARNING

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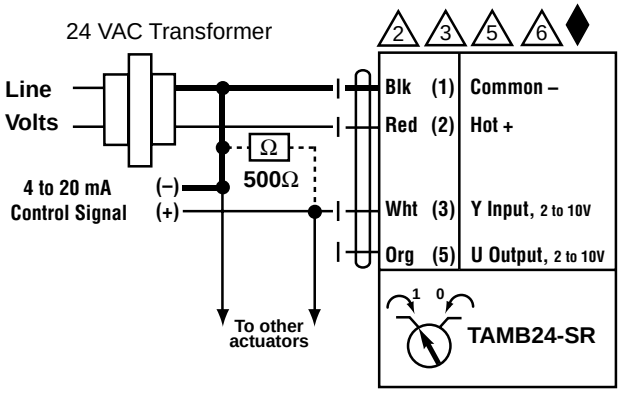


2 to 10 VDC and 4 to 20 mA control of TAMB24-SR

TAMB

TNMB Series Direct Coupled Actuator

Minimum 90 in-lb Torque

- For damper areas up to 22 sq-ft*

All Actuators have BDCM

TNMB Series - At A Glance

		TNMB24-3	TNMB24-SR
Pages		88	90
Basic Product		●	●
Torque	90 in-lb [10 Nm]	●	●
Angle of Rotation	95 degrees	●	●
Power Supply	24 VAC/DC	●	●
Control Input	On/Off, Floating Point	●	
	2 to 10 VDC (4 to 20mA)		●
Feedback	None	●	
	2 to 10 VDC		●
Running Time	95 seconds	●	●
Wiring	Plenum Rated Cable	●	●
	Conduit Fitting	●	●
Auxiliary Switch	Add-on	●	●

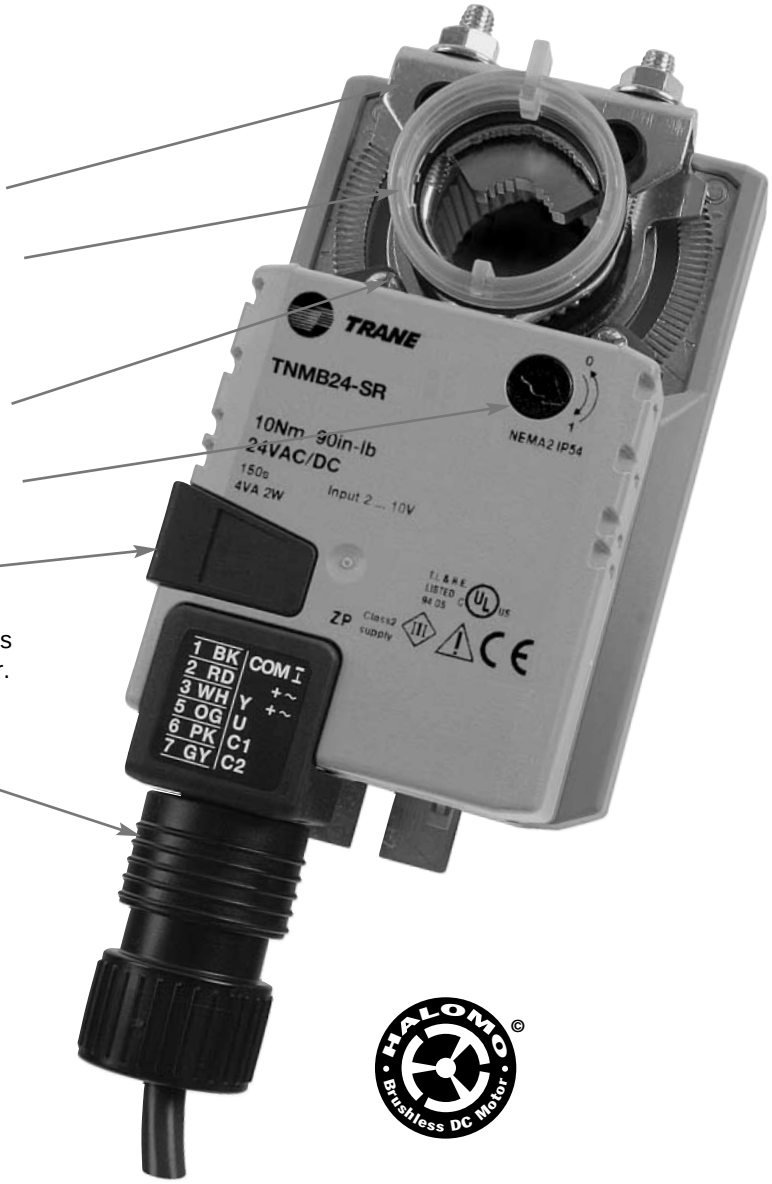
Installation and Operation… (page 99).

*Based on 4 in-lb/ft^2 damper torque loading. Parallel blade. No edge seals.

A CLOSER LOOK...

LISTED 94 D5 TEMP. IND. & REG. EQUIP. c UL us
CE
ISO 9001

- Brushless DC motor for added accuracy and controllability.
- Cut labor costs with simple direct coupling.
- Self-centers on 1/2", 3/4", and 1.05" jackshafts with standard clamp.
- Check damper position with clear position indicator.
- Don't worry about actuator burn-out; It is overload proof throughout rotation.
- Enjoy added flexibility with easy mechanical stops to adjust angle of rotation.
- Need to change control direction? Do it easily with a simple switch.
- Easily accessible manual override button helps you pre-tension damper blades.
- Auxiliary switch and feedback potentiometer add-ons mount directly on clamp, Includes conduit connector.
- Standard 3ft plenum rated cable and conduit connector provided.



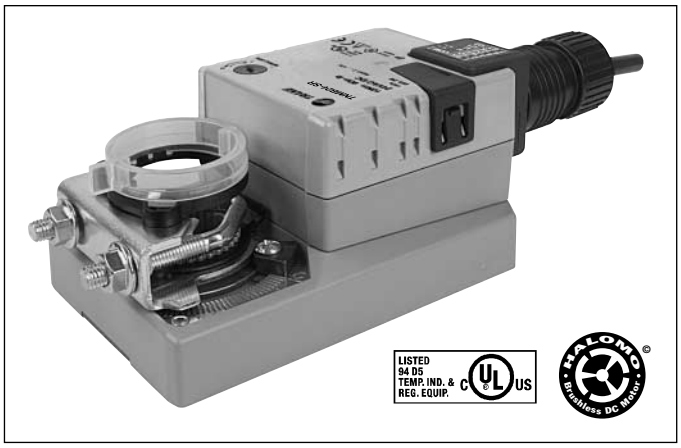
The Trane Difference

- *Low Installation and Life-Cycle Cost.*
  Easy installation. Accuracy and repeatability.
  Low power consumption. No maintenance.

- *Long Service Life.*
  Components tested before assembly. Every product tested before shipment.
  30+ years direct coupled actuator design.

TNMB24-3

On/Off-Floating Point Control, Non-Spring Return, Direct Coupled, 24 V



Technical Data	TNMB24-3
Power Supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power Consumption	2 W (0.2 W)
Transformer Sizing	4 VA (Class 2 power source)
Electrical Connection	3 ft, 18 GA plenum rated cable 1/2” conduit connector
Overload Protection	electronic throughout 0° to 95° rotation
Control	on/off, floating point
Input Impedance	600Ω
Angle of Rotation	max. 95°, adjust. with mechanical stop
Torque	90 in-lb [10 Nm]
Direction of Rotation	reversible with ↷/↶ switch
Position Indication	reflective visual Indicator (snap-on)
Manual Override	external push button
Running Time	95 seconds, constant independent of load
Humidity	5 to 95% RH non condensing (EN 60730-1)
Ambient Temperature	-22°F to +122°F [-30°C to +50°C]
Storage Temperature	-40°F to +176°F [-40°C to +80°C]
Housing	NEMA 2/IP54
Housing Material	UL94-5VA
Agency Listings	cULus acc. to UL 60730-1/-2-14 and CAN/CSA C22.2 No.24, CE according to 73 / 23 / EEC
Noise Level	<45dB(A)
Servicing	maintenance free
Quality Standard	ISO 9001
Weight	1.7 lbs [0.75 Kg]

Torque min. 90 in-lb for control of damper surfaces up to 22 sq ft.

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 1.05" in diameter by means of its universal clamp, 1/2” self-centered default. 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 anti-rotation strap supplied with the actuator will prevent lateral movement.

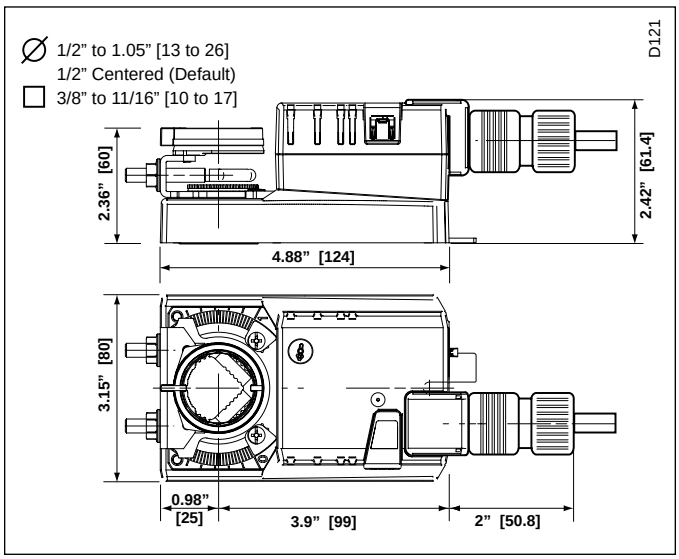
The TNMB series provides 95° of rotation and a visual indicator indicates position of the actuator. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged with a button on the actuator cover.

The TNMB24-3… actuators use a sensorless 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. Power consumption is reduced in holding mode.

Add on auxiliary switches or feedback potentiometers are easily fastened directly onto the actuator body for signaling and switching functions.

For all accessories, see pages 110 and 132.

Dimensions (All numbers in brackets are in millimeters.)



I20683 - Subject to change.

CAUTION

△2 Equipment damage!

Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

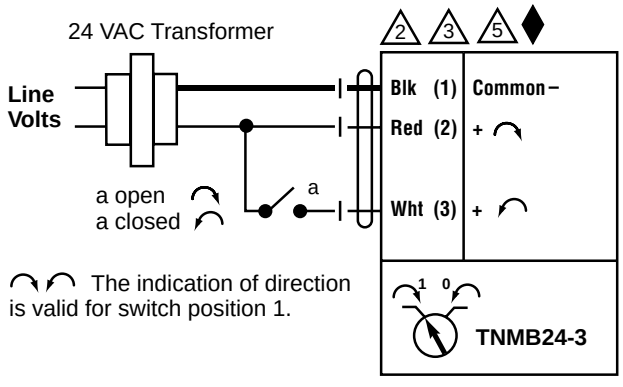
TNMB24-3 - Typical Specification:
Floating point, on/off control damper actuators shall be electronic direct-coupled type, which require no crankarm and linkage and be capable of direct mounting to a shaft up to 1.05” diameter. Actuators shall have brushless DC motor technology and be protected from overload at all angles of rotation. Actuators shall have reversing switch and manual override on the cover. Run time are constant and independent of torque. Actuators are cULus listed, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

W497

WARNING

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



On/Off

W498

WARNING

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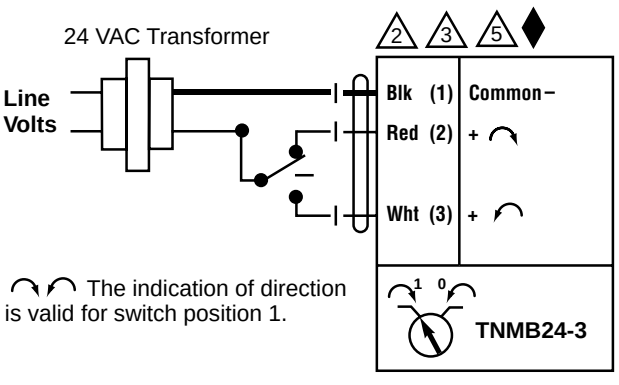
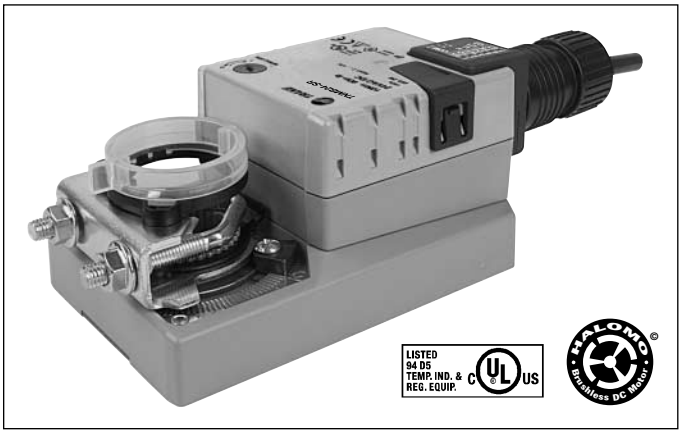


Floating point or On/Off control

TNMB24-SR

Proportional Control, Non-Spring Return, Direct Coupled, 24V, for 2 to 10 VDC and 4 to 20 mA



Technical Data	TNMB24-SR
Power Supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power Consumption	2.5 W (0.4 W)
Transformer Sizing	5 VA (Class 2 power source)
Electrical Connection	3 ft, 18 GA plenum rated 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)
Angle of Rotation	max. 95°, adjust. with mechanical stop
Torque	90 in-lb [10 Nm]
Direction of Rotation	reversible with ↷/↶ switch. Actuator will move: ↶ =CCW with decreasing control signal (10→2V) ↷ =CW with decreasing control signal (10→2V)
Position Indication	reflective visual Indicator (snap-on)
Manual Override	external push button
Running Time	95 seconds, constant independent of load
Humidity	5 to 95% RH non condensing (EN 60730-1)
Ambient Temperature	-22°F to +122°F [-30°C to +50°C]
Storage Temperature	-40°F to +176°F [-40°C to +80°C]
Housing	NEMA 2/IP54
Housing Material	UL94-5VA
Agency Listings	cULus acc. to UL 60730-1/-2-14 and CAN/CSA C22.2 No.24, CE according to 73 / 23 / EEC
Noise Level	<45dB(A)
Servicing	maintenance free
Quality Standard	ISO 9001
Weight	1.7 lbs [0.75 Kg]

Torque min. 90 in-lb for control of damper surfaces up to 22 sq ft.

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, 1/2” self centered default. 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, 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 actuator is not provided with and does not require any limit switches, but is electronically protected against overload. The anti-rotation strap supplied with the actuator will prevent lateral movement.

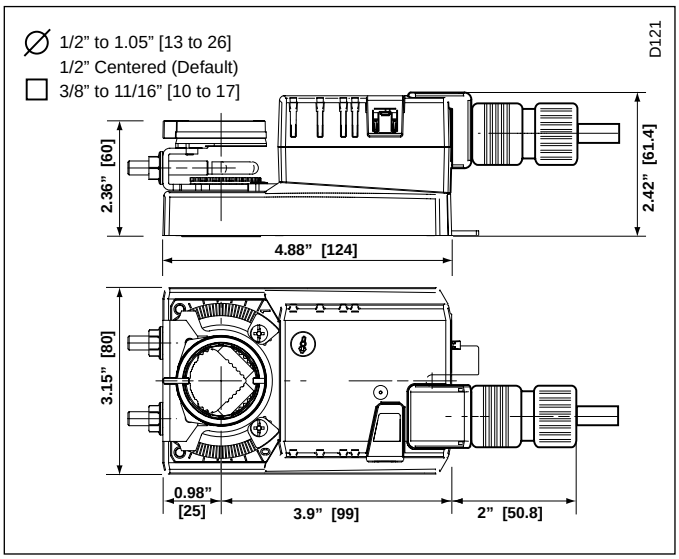
The TNMB series provides 95° of rotation and a visual indicator indicates position of the actuator. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged with a button on the actuator cover.

The TNMB24-SR… actuators use a sensorless 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.Power consumption is reduced in holding mode.

Add on auxiliary switches or feedback potentiometers are easily fastened directly onto the actuator body for signaling and switching functions

For all accessories, see pages 110 and 132.

Dimensions (All numbers in brackets are in millimeters.)



I20683 - Subject to change.

CAUTION

△2 Equipment damage!
Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

△6 Only connect common to neg. (—) leg of control circuits.

APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

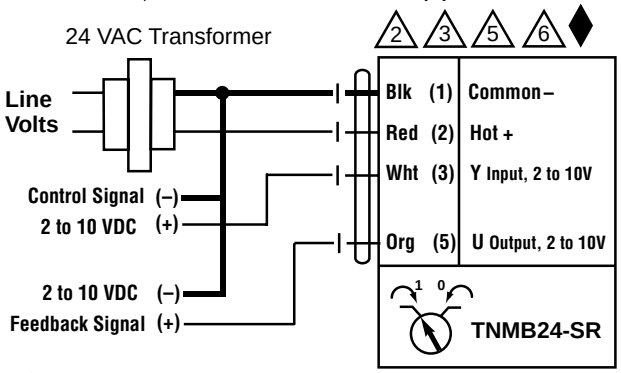
♦ The ZG-R01 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

TNMB24-SR - Typical Specification:
Proportional control damper actuators shall be electronic direct-coupled type, which require no crankarm and linkage and be capable of direct mounting to a shaft up to 1.05" diameter. Actuators 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. Actuators shall have brushless DC motor technology and be protected from overload at all angles of rotation. Actuators shall have reversing switch and manual override on the cover. Run time shall be constant and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position indication. Actuators are cULus listed, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

W499

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



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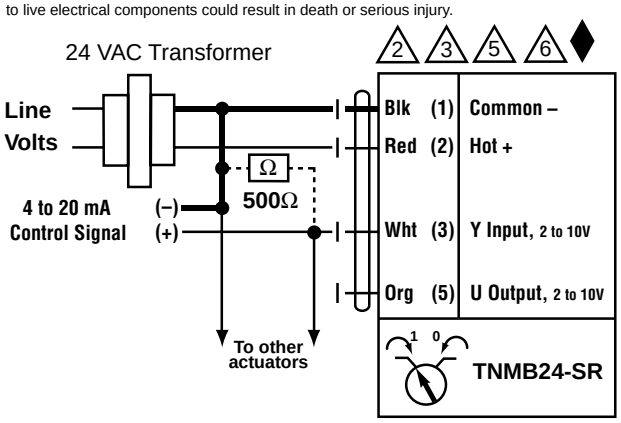


2 to 10 VDC and 4 to 20 mA control of TNMB24-SR

TNMB

TLMB Series Direct Coupled Actuator

Versatile and Powerful

- Minimum 45 in-lb torque in a compact package.
  For damper areas up to 11 sq-ft*

All Actuators have BDCM

TLMB Series - At A Glance

		TLMB24-3	TLMB24-3-T	TLMB24-SR	TLMB24-SR-T
Pages		94	94	96	96
Basic Product		●	●	●	●
Torque	45 in-lb [5 Nm]	●	●	●	●
Angle of Rotation	95 degrees	●	●	●	●
Power Supply	24 VAC/DC	●	●	●	●
Control Input	On/Off, Floating Point	●	●		
	2 to 10 VDC (4 to 20mA)			●	●
Feedback	None	●	●		●
	2 to 10 VDC			●	
Running Time	95 seconds	●	●	●	●
Wiring	Plenum Rated Cable	●		●	
	Terminal Strip		●		●
	Conduit Fitting	●		●	
Auxiliary Switch	Add-on	●	●	●	●

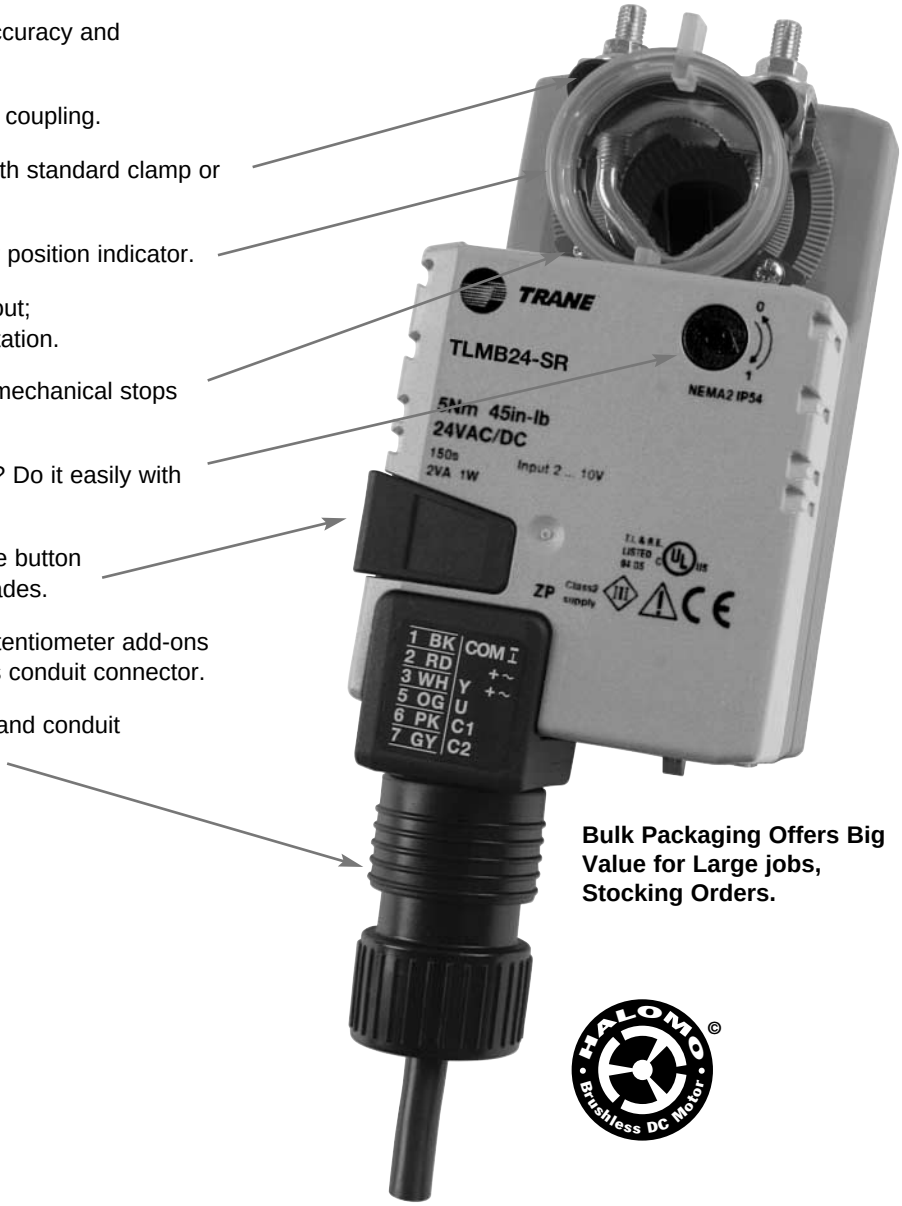
Installation and Operation… (page 99).

*Based on 4 in-lb/ft^2 damper torque loading. Parallel blade. No edge seals.

A CLOSER LOOK...

LISTED 94 D5 TEMP. IND. & REG. EQUIP. c UL us CE ISO 9001

- Brushless DC motor for added accuracy and controllability.
- Cut labor costs with simple direct coupling.
- Self-centers on 5/8" jackshafts with standard clamp or 3/4" with accessory clamp.
- Check damper position with clear position indicator.
- Don't worry about actuator burn-out; It is overload proof throughout rotation.
- Enjoy added flexibility with easy mechanical stops to adjust angle of rotation.
- Need to change control direction? Do it easily with a simple switch.
- Easily accessible manual override button helps you pre-tension damper blades.
- Auxiliary switch and feedback potentiometer add-ons mount directly on clamp, includes conduit connector.
- Standard 3ft plenum rated cable and conduit connector provided.



Bulk Packaging Offers Big Value for Large jobs, Stocking Orders.

HALOMO Brushless DC Motor

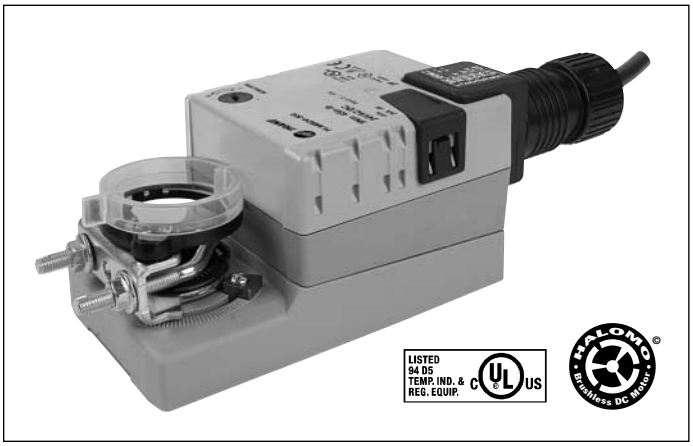
The Trane Difference

- *Low Installation and Life-Cycle Cost.*
  Easy installation. Accuracy and repeatability.
  Low power consumption. No maintenance.
- *Long Service Life.*
  Components tested before assembly. Every product tested before shipment.
  30+ years direct coupled actuator design.

TLMB

TLMB24-3 (-T)

On/Off-Floating Point Control, Non-Spring Return, Direct Coupled, 24 V



Technical Data	TLMB24-3… on/off-floating
Power Supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power Consumption	1.5 W (0.2 W)
Transformer Sizing	3 VA (Class 2 power source)
Electrical Connection	3 ft, 18 GA plenum rated cable 1/2" conduit connector
Overload Protection	electronic throughout 0° to 95° rotation
Control	on/off, floating point
Input Impedance	600Ω
Angle of Rotation	max. 95°, adjust. with mechanical stop
Torque	45 in-lb [5 Nm]
Direction of Rotation	reversible with ↷/↶ switch
Position Indication	reflective visual indicator (snap-on)
Manual Override	external push button
Running Time	95 seconds, constant independent of load
Humidity	5 to 95% RH non condensing (EN 60730-1)
Ambient Temperature	-22°F to +122°F [-30°C to +50°C]
Storage Temperature	-40°F to +176°F [-40°C to +80°C]
Housing	NEMA 2/IP54
Housing Material	UL94-5VA
Agency Listings	cULus acc. to UL 60730-1/-2-14 and CAN/CSA C22.2 No.24, CE according to 73 / 23 / EEC
Noise Level	<35dB(A)
Servicing	maintenance free
Quality Standard	ISO 9001
Weight	1.1lbs [0.5 Kg],
TLMB24-3-T	
Electrical connection	Screw terminal (for 26 to 14 GA wire)
Housing	NEMA 1/IP20

Torque min. 45 in-lb for control of damper surfaces up to 11 sq ft.

TLMB24-3
TLMB24-3-T
TLMB24-3-T.1 (bulk)

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 from 1/4" up to 5/8" in diameter by means of its standard universal clamp. Shafts up to 3/4" diameter can be accommodated by an accessory clamp.

Operation
The actuator is not provided with and does not require any limit switches, but is electronically protected against overload. The anti-rotation strap supplied with the actuator will prevent lateral movement.

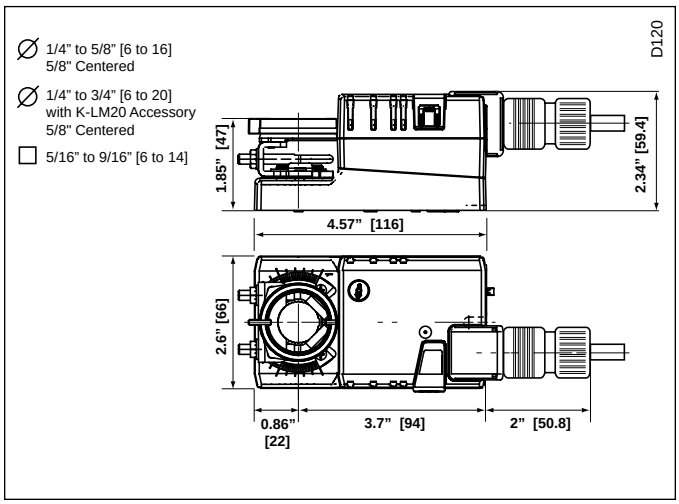
The TLMB series provides 95° of rotation and a visual indicator which indicates position of the actuator. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be disengaged with manual release on the actuator cover.

The TLMB24-3… actuators use a sensorless 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. Power consumption is reduced in holding mode.

Add on auxiliary switches or feedback potentiometers are easily fastened directly onto the actuator body for signaling and switching functions.

For all accessories, see pages 110 and 132.

Dimensions (All numbers in brackets are in millimeters.)



I20683 - Subject to change.

CAUTION

△2 Equipment damage!

Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

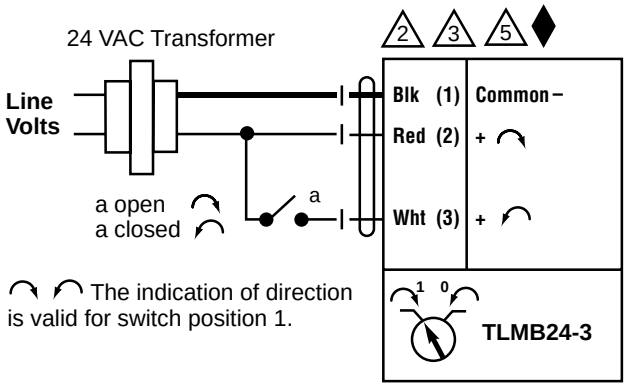
TLMB24-3 - Typical Specification:
Floating point, on/off control damper actuators shall be electronic direct-coupled type, which require no crankarm and linkage and be capable of direct mounting to a shaft from 1/4" to 5/8". Shafts up to 3/4" diameter can be accommodate with an accessory clamp. Actuators shall have brushless DC motor technology and be protected from overload at all angles of rotation. Actuators shall have reversing switch and manual override on the cover. If required, actuator will be provided with screw terminal strip for electrical connections (TLMB24-3-T). Run time shall be constant and independent of torque. Actuators are cULus listed, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

W500

WARNING

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



On/Off

W501

WARNING

Live Electrical Components!
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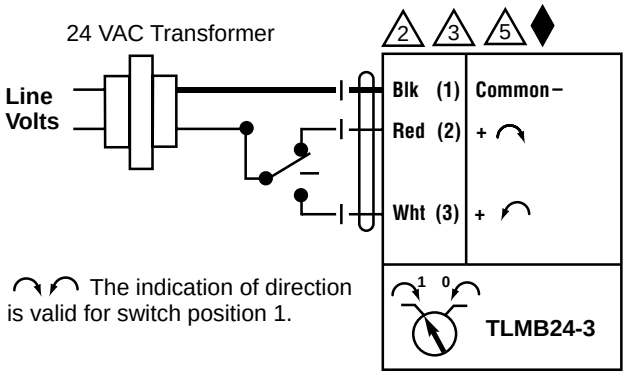
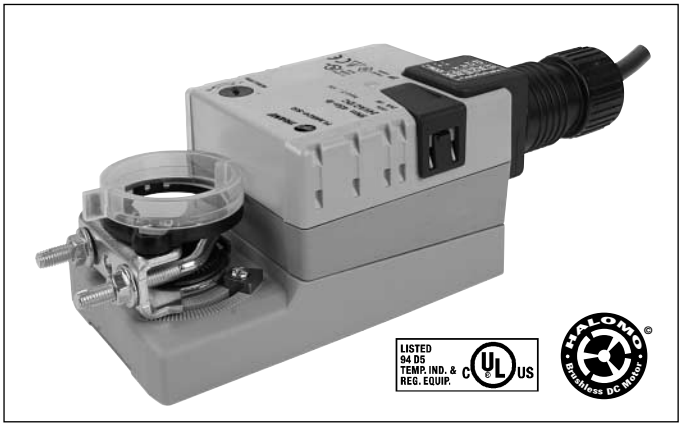


Floating point or On/Off control

TLMB24-SR (-T)

Proportional Control, Non-Spring Return, Direct Coupled, 24V, for 2 to 10 VDC and 4 to 20 mA



Technical Data	TLMB24-SR
Power Supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Power Consumption	1.5 W (0.4 W)
Transformer Sizing	3 VA (Class 2 power source)
Electrical Connection	3 ft, 18 GA plenum rated 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	100kΩ (0.1 mA), 500Ω
Feedback Output U	2 to 10 VDC (max 0.5 mA)
Angle of Rotation	max. 95°, adjust. with mechanical stop
Torque	45 in-lb [5 Nm]
Direction of Rotation	reversible with ↷/↶ switch. Actuator will move: ↶ =CCW with decreasing control signal (10→2V) ↷ =CW with decreasing control signal (10→2V)
Position Indication	reflective visual Indicator (snap-on)
Manual Override	external push button
Running Time	95 seconds, constant independent of load
Humidity	5 to 95% RH non condensing (EN 60730-1)
Ambient Temperature	-22°F to +122°F [-30°C to +50°C]
Storage Temperature	-40°F to +176°F [-40°C to +80°C]
Housing	NEMA 2/IP54
Housing Material	UL94-5VA
Agency Listings	cULus acc. to UL 60730-1/-2-14 and CAN/CSA C22.2 No.24, CE according to 73 / 23 / EEC
Noise Level	<35dB(A)
Servicing	maintenance free
Quality Standard	ISO 9001
Weight	1.1 lbs [0.5 Kg]
TLMB24-SR-T	
Electrical connection	Screw terminal (for 26 to 14 GA wire)
Housing	NEMA 1/IP20

Torque min. 45 in-lb for control of damper surfaces up to 11 sq ft.

TLMB24-SR
TLMB24-SR-T
TLMB24-SR-T.1 (bulk)

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 1/4" up to 5/8" in diameter by means of its universal clamp. Shafts up to 3/4" diameter can be accommodated by an accessory clamp.

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 actuator is not provided with and does not require any limit switches, but is electronically protected against overload. The anti-rotation strap supplied with the actuator will prevent lateral movement.

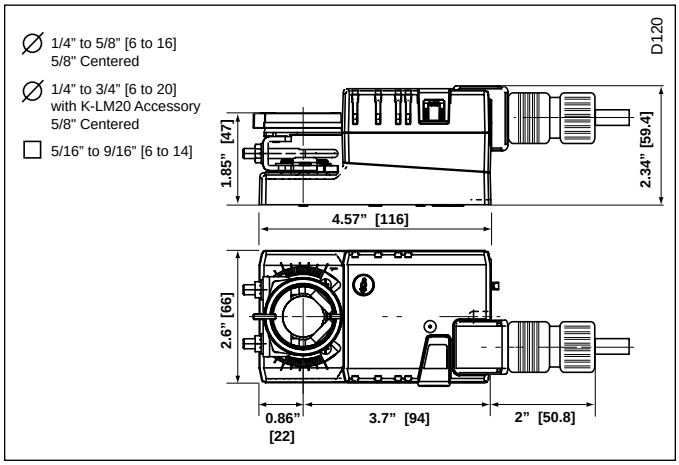
The TLMB series provides 95° of rotation and a visual indicator indicates position of the actuator. When reaching the damper or actuator end position, the actuator automatically stops. The gears can be manually disengaged with a button on the actuator cover.

The TLMB24-SR… actuators use a sensorless 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. Power consumption is reduced in holding mode.

Add on auxiliary switches or feedback potentiometers are easily fastened directly onto the actuator body for signaling and switching functions

For all accessories, see pages 110 and 132.

Dimensions (All numbers in brackets are in millimeters.)



CAUTION

△2 Equipment damage!
Up to 4 actuators may be connected in parallel. With 4 actuators wired to one 500Ω resistor. Power consumption must be observed and input impedance must be observed.

INSTALLATION NOTES

△3 Actuator may also be powered by 24 VDC.

△5 Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables use numbers.

△6 Only connect common to neg. (—) leg of control circuits.

APPLICATION NOTES

♦ Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

♦ The ZG-R01 500Ω resistor converts the 4 to 20 mA control signal to 2 to 10 VDC.

TLMB24-SR... - Typical Specification:
Proportional control damper actuators shall be electronic direct-coupled type, which require no crankarm and linkage and be capable of direct mounting to a shaft from 1/4" to 5/8". Shafts up to 3/4" diameter can be accommodate with an accessory clamp. Actuators 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. Actuators shall have brushless DC motor technology and be protected from overload at all angles of rotation. Actuators shall have reversing switch and manual override on the cover. If required, actuator will be provided with screw terminal strip for electrical connections (TLMB24-SR-T). Run time shall be constant and independent of torque. A 2 to 10 VDC feedback signal shall be provided for position indication. Actuators are cULus listed, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

W502

WARNING
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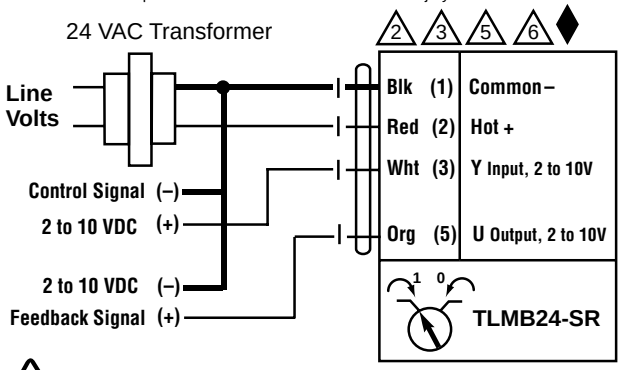

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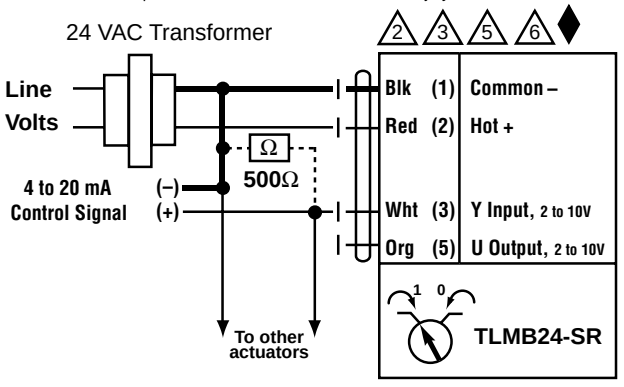


2 to 10 VDC and 4 to 20 mA control of TLMB24-SR

Notes/Work Pad

Table of Contents **Page**

General Information

Preliminary Steps

1. Belimo actuators with NEMA 1 or NEMA 2 ratings 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 non-spring return actuator with a ZG-NMA or ZG-GMA crankarm kit, and a mounting bracket (ZG-100, ZG-101, ZG-103, ZG-104)

Determining Torque Loading and Actuator Sizing

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

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

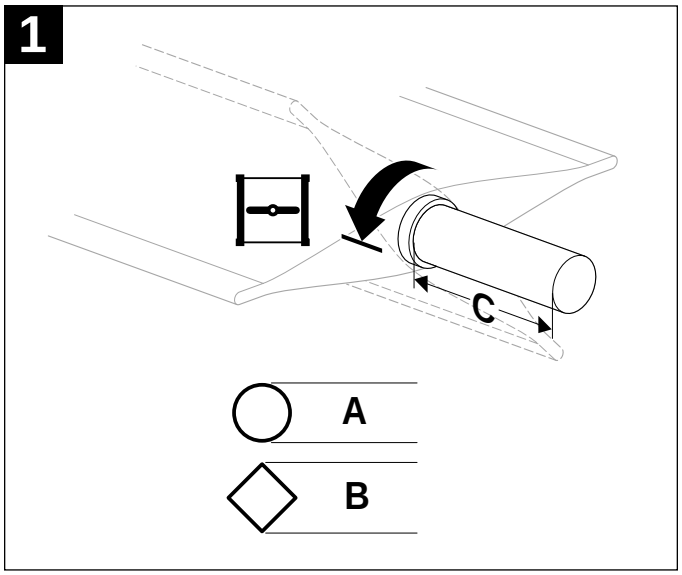
The above torque loadings will work for most applications under 2 in. w.g. static pressure or 1000 FPM face velocity. For applications between this criteria and 3 in. w.g. or 2500 FPM, the torque loading should be increased by a multiplier of 1.5. If the application calls for higher criteria up to 4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

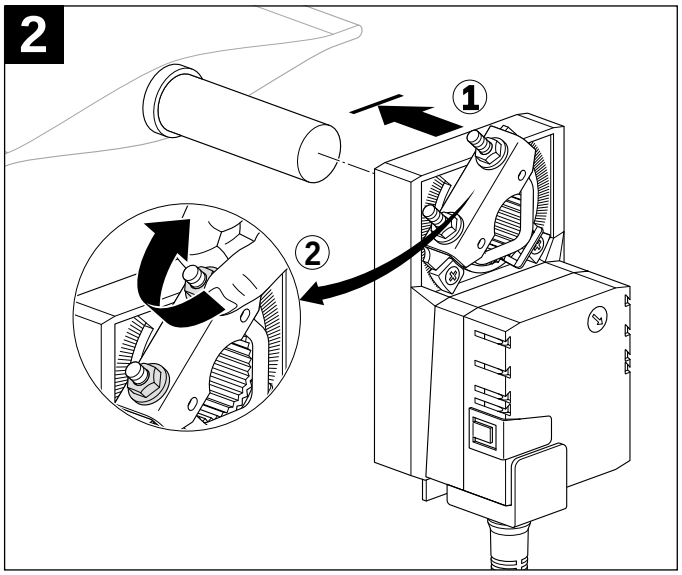
Multiple Actuator Mounting

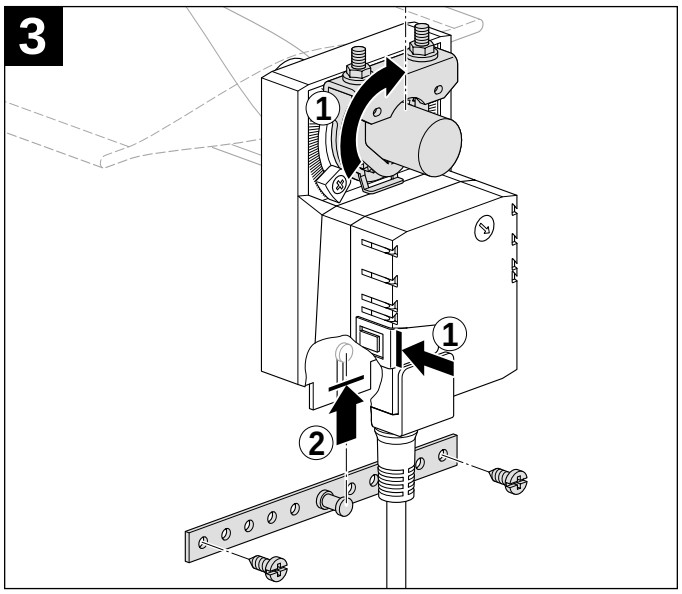
If more torque is required than one TGMB can provide, TGMB24-SR may be installed on the same shaft.

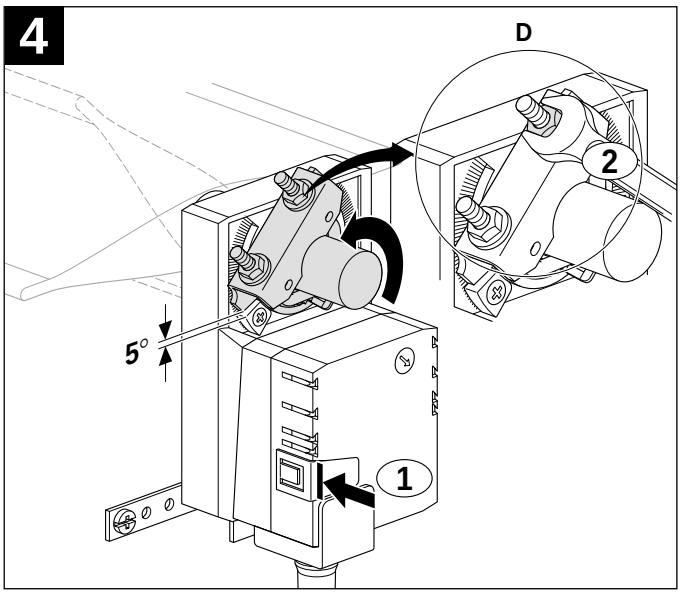
Installation Instructions

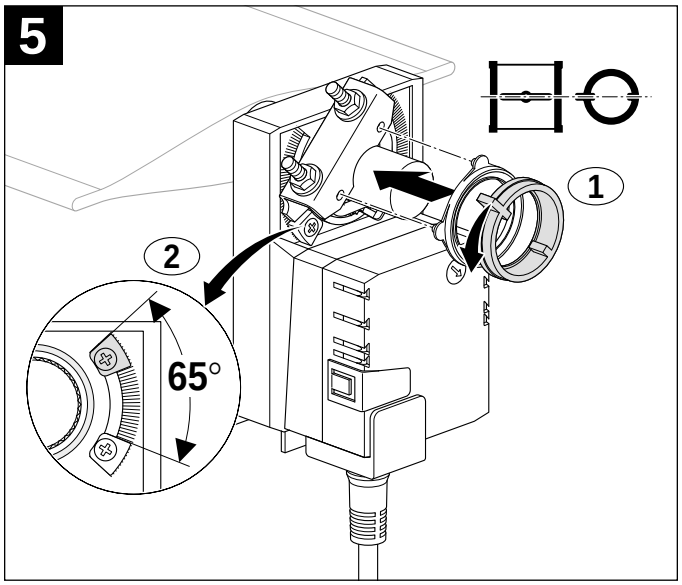
Quick-Mount Visual Instructions for Mechanical Installation











See next page for Standard Mounting Instructions.

	A*	B	C**	D
TLMB	1/4” to 3/4”	5/16” to 3/4”	1.5”	4 to 5 ft-lb
TNMB	5/16” to 1.05”	2/5” to 1.05”	1.5”	6 to 7 ft-lb
TAMB	5/16” to 1.05”	2/5” to 1.05”	1.5”	6 to 7 ft-lb
TGMB	5/16” to 1.05”	2/5” to 1.05”	1.5”	6 to 7 ft-lb

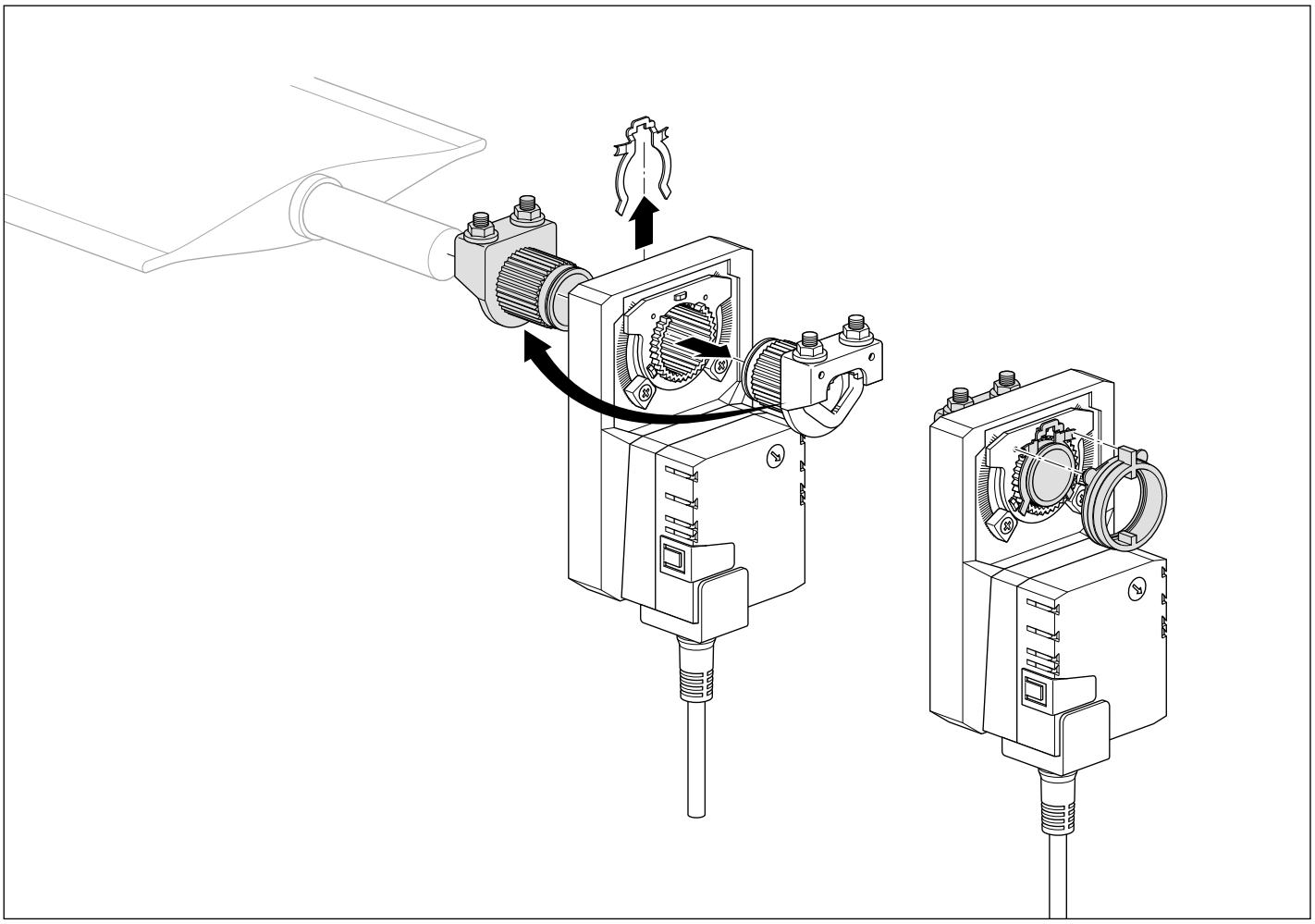
*TLMB standard clamp has max 5/8” diameter. Accessory clamp K-LM20 can be mounted for sizes up to 3/4” diameter. TNMB and TAMB clamps have an insert that self-centers on the following diameter shafts: 1/2” (default), 3/4” and 1.05”.

**Shorter with reversible clamp for TNMB, TAMB, and TGMB

I20683 - Subject to change.

Mounting Installation

Reversible Clamp Quick Mount (TNMB, TAMB, TGMB)



Standard Mounting

1. Turn the damper shaft until the blades are fully closed.
2. ① Slip the actuator's universal clamp over the damper shaft. Make sure that the duct and the controls on the cover are accessible. Place the actuator in the desired mounting position.
   ② Hand tighten the two nuts on the actuators universal clamp.
3. ① Disengage the actuator gear train by pressing the manual override button and rotate the clamp until centered.
   ② Slide the anti-rotation strap up under the actuator so it engages the actuator at the center cutout. Bend the bracket as needed to support the rear of the actuator. Secure to ductwork with self-tapping screws (No. 8 recommended).
4. ① Loosen the nuts on the universal clamp. Press the manual override button and rotate the clamp to about 5° from the closed position (1/16 to 1/8" between stop and clamp).
   ② Tighten the two nuts on the universal clamp with a 10 mm wrench (see table for required torque).
5. ① Snap on the reflective position indicator.
   ② Adjust end-stops, if required
6. Mount actuators indoors. If mounted outdoors, use approved protective enclosure.

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.

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.

Mounting Instructions

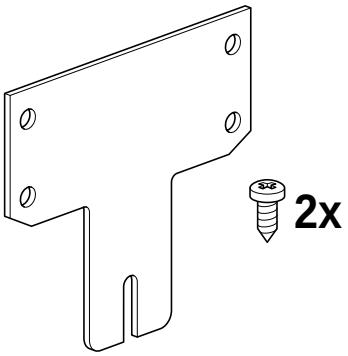
Retrofit Brackets [Z-SMA and Z-GMA]

Replacing Discontinued Belimo

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. Example would be a Belimo AM24 US mounted to a valve linkage. The direct replacement of the actuator is TAMB24-3. However, the TAM24 US and the AMB24-3 are different lengths, the linkage would need to be replaced as well.

Instead of replacing the linkage the retrofit bracket Z-SMA and Z-GMA can be used to extend the location of the anti-rotation bracket to match the location of the anti-rotation bracket of discontinued Belimo actuators.
These brackets can be ordered directly from Belimo.
Please refer to Belimo's product guide and price list, or visit **www.belimo.com**.

Z-SMA for replacing AM and SM actuators
Z-GMA for replacing GM actuators



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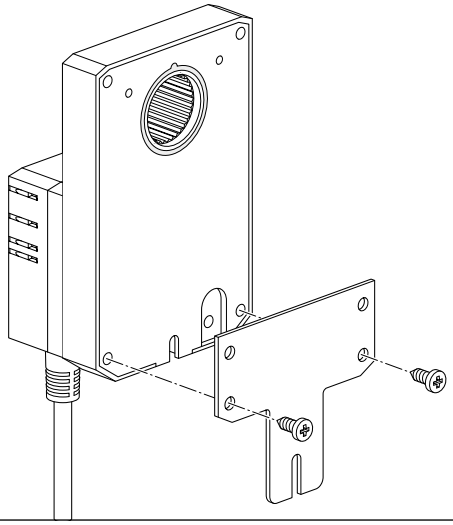
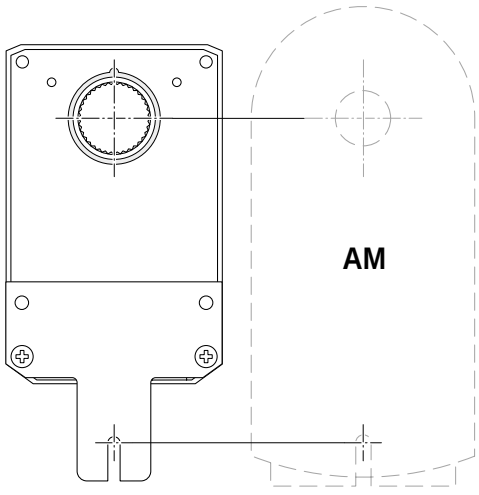


A



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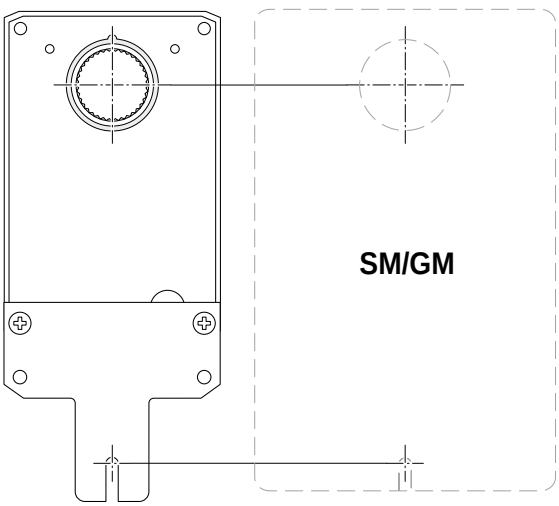


Electrical Operation

General

All non-spring return actuators utilize Halomo sensorless Brushless DC motor technology developed by Belimo. The non-spring return actuators use this motor in conjunction with an Application Specific Integrated Circuit (ASIC). The Halomo ASIC provides the intelligence to provide a constant rotation rate to prevent damage to the actuator.

Initialization

When a power source is applied the motor carries out an initialization of the actuator. The purpose of this initialization is to determine the mechanical angle of rotation and to adapt the running time to the angle of rotation. When power is applied, the internal microprocessor recognizes that the actuator is at its full-safe position and uses this position as the base for all of its calculations.

Brushless DC Motor Operation

The Halomo sensorless brushless DC motor spins by reversing the poles of stationary electromagnets housed inside rotation permanent magnets. The electromagnetic poles are switched by a special ASIC. Unlike the conventional DC motor, there are no brushes to wear or commutators to foul.

Motor Position Detection

Halomo motor technology is a sensorless, brushless DC motor. The Halomo technology eliminates the need for potentiometers for positioning. The Halomo ASIC detects the spinning rotor by monitoring the back EMF of the motor poles. The ASIC counts these pulses and calculates position within 1/3 of a motor revolution.

Overload Protection

The non-spring return actuators are electronically protected from overload at all angles of rotation by digital technology 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 an overload. The motor remains energized and produces full rated torque when in overload.

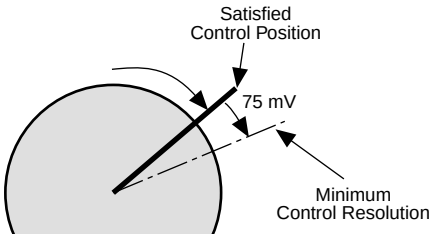
The overload filtration helps increase the actuators installed life expectancy by filtering out unnecessary control signal changes or end-stop pulsing while in overload. This helps ensure that dampers are fully closed and that edge and blade seals are always properly compressed.

Control Accuracy and Stability

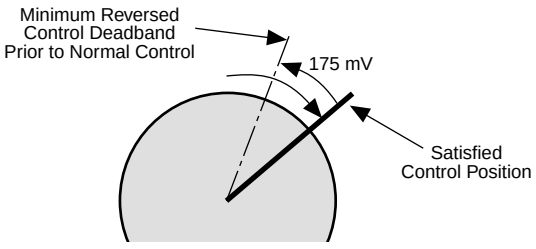
All actuators have built-in brushless DC motors which provide better accuracy and longer service life.

Non-spring return actuators are designed with a unique non-symmetrical deadband. The actuator follows an increasing or decreasing control signal with a 75 mV resolution. If the signal changes in the opposite direction, the actuator will not respond until the control signal changes by 175 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.

Actuator responds to a 75 mV signal when not changing direction from stop position.



Actuator responds to a 175 mV signal when reversing direction from stop position.



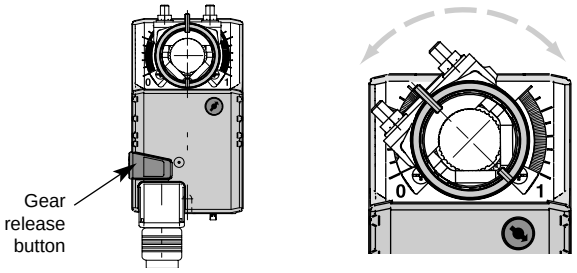
Operation

Mechanical Features

Manual Override

The non-spring return actuators have a black, “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.

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

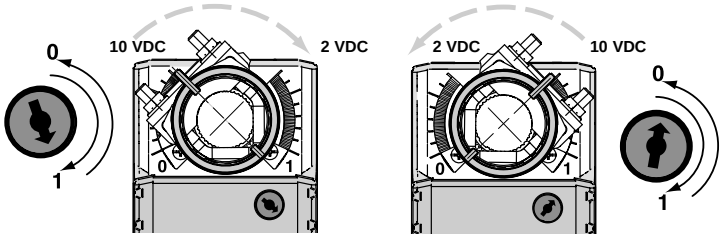


Direction of Rotation Switch

Non-spring return actuators have a reversing switch on the cover. Switch position indicates start point. For the non-spring return, with the switch in position 1, the actuator rotates clockwise with an decrease in voltage or current. With the switch in position 0, the actuator rotates counterclockwise with an decrease in voltage or current.

The non-spring return rotates clockwise when the switch is in the 1 position and power is applied to wire #2. When power is applied to wire #3 the actuator rotates counter clockwise.
Rotating the switch to 0 reverses the control logic.

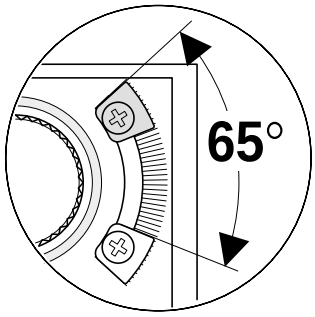
During checkout, the switch position can be temporarily reversed and the actuator will reverse its direction. This allows the technician a fast and easy way to check the actuator operation without having to switch wires or change settings on the thermostat. ***When the check-out is complete, make sure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



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.

Transformer(s)

The non-spring return actuators require a 24 VAC class 2 transformer and draws a maximum of 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 hotleg.* Mixing wire No. 1 & 2 on one leg of the transformer will result in erratic operation or failure of the actuator and/or controls.

Multiple Actuators, Multiple Transformers

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

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

Wire Length for Actuators

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

Example: 3 actuators, 16 Ga wire
350 ft ÷ 3 actuators = 117 ft. maximum wire run

Maximum Wire Length:

TGMB-24…

Wire Size	Max. Feet.
12 Ga	1125 ft.
14 Ga	800 ft.
16 Ga	500 ft.
18 Ga	325 ft.
20 Ga	175 ft.
22 Ga	90 ft.

TAMB-24…

Wire Size	Max. Feet
12 Ga	1150 ft.
12 Ga	925 ft.
16 Ga	550 ft.
18 Ga	375 ft.
20 Ga	200 ft.
22 Ga	100 ft.

TNMB-24…

Wire Size	Max. Feet.
12 Ga	1250 ft.
14 Ga	1130 ft.
16 Ga	900 ft.
18 Ga	575 ft.
20 Ga	300 ft.
22 Ga	150 ft.

TLMB-24…

Wire Size	Max. Feet
16 Ga	1125 ft.
18 Ga	750 ft.
20 Ga	400 ft.
22 Ga	200 ft.

Figure H

Wire Type and Wire Installation Tips

For most installations, 18 or 16 Ga. cable works well with the non-spring return 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 non-spring return 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:

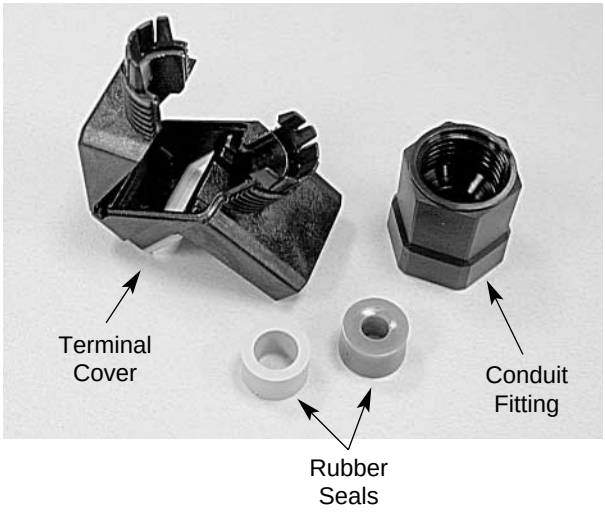
1. Run the wire in metallic conduit.
2. Re-route the wiring away from the source of pickup.
3. Use shielded wire (Belden 8760 or equal). Ground the shield to an earth ground. **Do not** connect it to the actuator common.

Protective Terminal Cover

Belimo non-spring return actuators with terminal strips are can be converted from NEMA 1/IP20 to NEMA 2/IP54 using the protective terminal cover **ZS-T**.

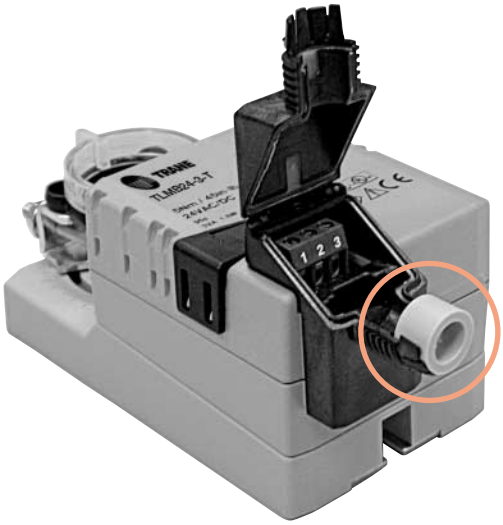
The ZS-T terminal cover accessory consists of:

- Terminal Cover
- Conduit Fitting
- Rubber Seal for Wire Diameter 4-6
- Rubber Seal for Wire Diameter 6-8

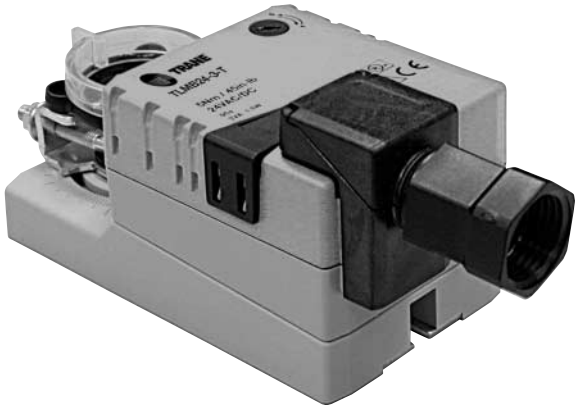


Mounting the Terminal Cover

1. Attach terminal cover to actuator, if not done already.
2. Slide the conduit fitting and correct size rubber seal onto wire.
3. Wire up actuator using the terminal strips.
4. Fit rubber seal into slot of terminal cover.

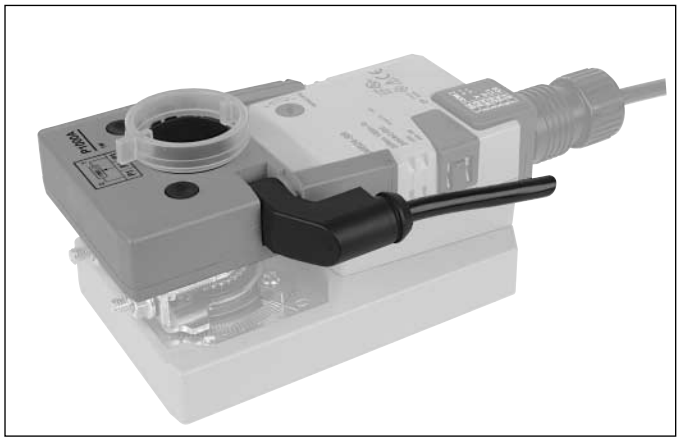


5. Shut terminal top and screw on conduit connector.



Feedback Potentiometer P...A GR

For the Non-Spring Direct-Coupled Actuators



Types		
P140A GR	Feedback Potentiometer	140Ω
P200A GR	Feedback Potentiometer	200Ω
P500A GR	Feedback Potentiometer	500Ω
P1000A GR	Feedback Potentiometer	1000Ω
P2800A GR	Feedback Potentiometer	2800Ω
P5000A GR	Feedback Potentiometer	5000Ω
P10000A GR	Feedback Potentiometer	10000Ω

Technical Data	P...A GR
Resistance Values	As Above
Output	1 W
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 2 / IP54
Housing Rating	UL94-5VA
Servicing	Maintenance Free
Agency Listings	cULus acc. to UL 60730-1/-2-14 and CAN/CSA C22.2 No.24 CE according to 73 / 23 / EEC
Quality Standard	ISO 9001
Weight	4.6 oz [130 g]

Application

The P…A GR feedback potentiometers are used with TLM, TNM, TAM, and TGM actuators to provide a resistive signal which varies with damper position.

The P…A GR 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 P…A GR feedback potentiometers are mounted onto the direct coupled actuator. The switches are modular units that mount directly onto TLM, TNM, TAM, and TGM type actuators and are locked into place by guiding grooves on the sides of the actuator.

A driver disk is attached to the actuator clamp and offers direct transmission of the actuator position to the micro switch cams.

Mounting Instructions

1. Remove position indicator from actuator.

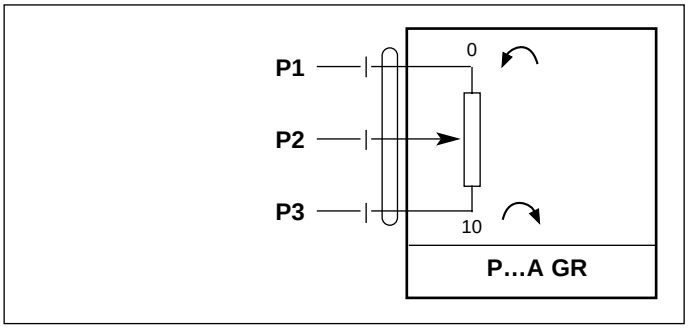
2. Press down the manual override button and rotate the actuator fully counter-clockwise.

3. Turn the driver disk on the potentiometer fully counterclockwise.

4. Slide potentiometer onto the actuator using the actuator guiding grooves on the sides of the actuator.

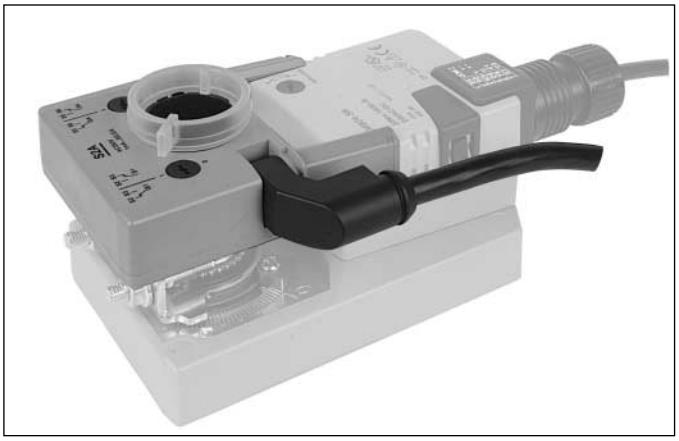
5. Check for correct mating of the driver disk to the universal clamp.

Wiring Diagram



Auxiliary Switches S1A GR, S2A GR

For the Non-Spring Return Direct-Coupled Actuators



Types		
S1A GR	1 SPDT	3 ft, 18 GA Appliance Cable
S1A/300 GR	1 SPDT	6 ft, 18 GA Appliance Cable
S1A/500 GR	1 SPDT	10 ft, 18 GA Appliance Cable
S2A GR	2 SPDT	3 ft, 18 GA Appliance Cable
S2A/300 GR	2 SPDT	6 ft, 18 GA Appliance Cable
S2A/500 GR	2 SPDT	10 ft, 18 GA Appliance Cable

Technical Data	S1A GR	S2A GR
Number of Switches	1 SPDT	2 SPDT
Switching Capacity	3A (0.5A), 250 VAC	
Switching Point	Adjustable over Full Rotation (0° to 95°).	
Pre-Setting with Scale Possible.		
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 2 / IP54	
Housing Rating	UL94-5VA	
Servicing	Maintenance Free	
Agency Listings	cULus acc. to UL 60730-1/-2-14 and CAN/CSA C22.2 No.24 CE according to 73 / 23 / EEC	
Quality Standard	ISO 9001	
Weight	4.6 oz [130 g]	6.0 oz [170 g]

Application

The S1A GR and S2A GR 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

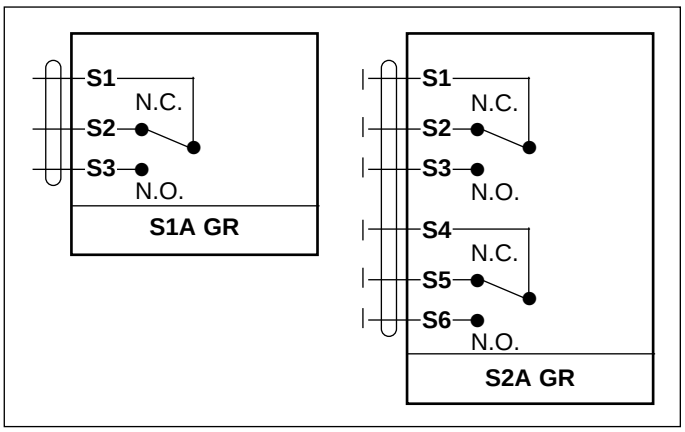
The S1A GR and S2A GR auxiliary switches are mounted onto the direct coupled actuator. The switches are modular units that mount directly onto TLM, TNM, TAM, and TGM type actuators and are locked into place by guiding grooves on the sides of the actuator.

A driver disk is attached to the actuator clamp and offers direct transmission of the actuator position to the micro switch cams. The switching points can be set over the full scale of 0 to 1 simply by adjusting the slotted discs.

Mounting Instructions

1. Remove position indicator from actuator.
2. Press down the manual override button and rotate the actuator fully counter-clockwise.
3. Turn the driver disk on the switch fully counterclockwise.
4. Slide switch onto the actuator using the actuator guiding grooves on the sides of the actuator.
5. Check for correct mating of the driver disk to the universal clamp.
6. Adjust switch dials as necessary.

Wiring Diagrams



Electrical Check-out Procedure for (-SR) Actuators

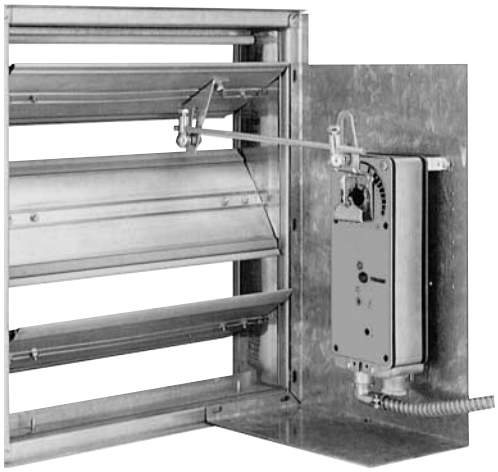
Step	Procedure	Expected Response	Actuator Responds Go To Step ...	No Response Go To Step
1.	Connect signal Input to wires 1 & 3. Connect signal output (if used) to wires 1 & 4. Connect 24 VAC/VDC power to Wires 1 & 2.	Actuator drives to the “No Signal” position (usually closed), then to the “Maximum Signal” position (usually open) then to the “Control Signal” position.	Actuator operates properly. **Step 9**	No response at all. **Step 2** Operation is reversed. **Step 3** Does not drive toward "Control Signal Position". **Step 4**
2.	Check power wiring. Correct any problems. **Note 1**	Power supply rating should be ≥ the total power requirement of the actuator(s). Minimum voltage of 19.2 VAC or 21.6 VDC.	Power wiring corrected, actuator begins to drive. **Step 1**	Power wiring corrected, actuator still does not drive. **Step 8**
3.	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.	Actuator drives to the “No Signal” position (usually closed), then to the “Maximum Signal” position (usually open) then to the “Control Signal” position.	Actuator operates properly. **Step 9**	Does not drive toward “Control Signal Position”. **Step 4**
4.	Make sure the control signal positive (+) is connected to Wire No 3 and control signal negative (-) is connected to wire No. 1. Most control problems are caused by reversing these two wires. Verify that the reversing switch is all the way CCW or CW.	Drives to “Control Signal” position.	Actuator operates properly. **Step 9**	**Step 5**
5.	Disconnect signal input from Wires No. 1 & 3.	Actuator drives to the “No Signal” position.	**Step 6**	**Step 8**
6.	Check input signal with a digital volt meter (DVM). Make sure the input is within the range of the actuator. For (-SR) actuators this is 2 to 10 VDC or 4 to 20 mA (with 500Ω resistor).	Input voltage or current should be ±1% of what controller's adjustment or programming indicate.	Controller output (actuator input) is correct. Input Polarity Correct. **Step 7**	Reprogram, adjust repair or replace controller as needed. **Step 7**
7.	Disconnect power from Wire No. 2. Reconnect signal input to Wires No. 1 & 3. Reconnect power to Wire No. 2.	Actuator drives to the “No Signal” position (usually closed), then to the “Maximum Signal” position (usually open) then to the “Control Signal” position.	Actuator operates properly. **Step 9**	**Step 8**
8.	Actuator does not drive	Defective actuator.		Replace actuator.
9.	Actuator works properly. Test controller by following controller manufacturer's instructions.			

Note 1 Check that the transformer(s) are sized properly.

- If a common transformer is used, make sure that polarity is observed on the secondary. This means connect all No. 1 wires to one leg of the transformer and all No. 2 wires to the other leg of the transformer.
- If multiple transformers are used with one control signal, make sure all No. 1 wires are tied together and tied to control signal negative (-).
- Controllers and actuators must have separate 24 VAC/VDC power sources.

Mechanical Accessories

We'll help solve any application problem with a wide range of accessories and unparalleled customer service.



The Trane Difference

- *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.

	Part Number	Description	TAF	TNF	TLF	TTF	TGM	TAM	TNM	TLM	Page
Clamp / Positioner Indicators	IND-AF2	Damper Position Indicator	●	●							112
	IND-LF	Damper Position Indicator			●						113
	IND-TF	Damper Position Indicator				●					114
	K4-2 US	Standard TAF/TNF Clamp (1/2" to 1.05")	●	●							112
	K4-1 US	Jackshaft Clamp (Up to 1.05')	●	●							112
	K4-H US	Hex Shaft Clamp (3/8" to 5/8")	●	●							112
	K6 US	Standard TLF Clamp (3/8" to 1/2")			●						113
	K6-1 US	Jackshaft Clamp (1/2" to 3/4")			●						113
	K8 US	Standard TTF Clamp				●					114
	K-GM25	Standard Reversible Clamp (1")					●				115
	K-GM20	Reversible Clamp (3/4")					●				115
	K-AM25	Standard Clamp (1/2" to 1")						●			116
	K-SA	Reversible AM Clamp (2/5" to 3/4")						●			116
	K-NA	Reversible NM Clamp (5/16" to 3/4")							●		117
	K-LM20	Clamp (3/4")								●	118
	K-LM16	Standard Clamp (5/8")								●	118
	K-LM13	Clamp (1/2")								●	118
	K-LM10	Clamp (3/8")								●	118
	K-LU	Spindle Clamp (5/16" to 1/2")									119
Linkage Accessories	KH-AF US	Crankarm	●	●							112
	KH-AF-1	Crankarm for Jackshaft Applications	●	●							112
	KH-AFV	V-Bolt Kit for KH-AF (-1) Crarnkarms			●						112
	KH-LF	Crankarm			●						113
	KH-LFV	V-Bolt Kit for KH-LF Crankarms			●						113
	KH-TF US	Crankarm				●					114
	AH-GMA	GMB Crankarm					●				115
	AH-25	AMB and NMB Crankarm						●	●		116
	KH6	Universal Crankarm (For KG6 Balljoint)	●	●	●	●	●	●	●		119
	KH8	Universal Crankarm (For KG8 Balljoint)	●	●	●	●	●	●	●		119
	KG6	Ball Joint (5/16")	●	●	●	●	●	●	●		119
	KG8	Ball Joint (5/16", 90)	●	●	●	●	●	●		●	119
	KG10	Ball Joint for KH6 (3/8")	●	●	●	●	●	●	●		119
	SH8	Push Rod for KG6 & KG8 Ball Joints (36", 5/16" Dia.)	●	●	●	●	●	●	●		119
	SH10	Push Rod for KG10 Ball Joints (36", 3/8" Dia.)	●	●	●	●	●	●	●		119
	ZG-DC1	Damper Clip for Damper Blade	●	●	●	●	●	●	●		119
	ZG-DC2	Damper Clip for Damper Blade	●	●	●	●	●	●	●		119
Brackets	ZG-100	Universal Mounting Bracket	●	●			●	●			127
	ZG-101	Universal Mounting Bracket	●	●			●	●			127
	ZG-102	Multiple Actuator Mounting Bracket	●				●				120
	ZG-103	Universal Mounting Bracket					●	●	●		127
	ZG-104	Universal Mounting Bracket					●	●	●		127
	ZG-106	Universal Mounting Bracket	●	●							123
	ZG-107	Universal Mounting Bracket	●	●							123
	ZG-108	Universal Mounting Bracket	●	●							121
	ZG-112	Universal Mounting Bracket			●						128
Crankarm Adaptor Kits	ZG-AF US	Crankarm Adaptor Kit (includes mounting hardware)	●	●							124
	ZG-AF108	Crankarm Adaptor Kit (includes ZG-108 & KH-AF US)	●	●							121
	ZG-LF112	Crankarm Adaptor Kit (includes ZG-112 & KH-LF)			●						128
	ZG-LF2	Crankarm Adaptor Kit (includes mounting hardware)			●						129
	ZG-LFC114	Trane Voyager Retrofit Kit (includes retrofit bracket)			●						130
	ZG-TF112	Crankarm Adaptor Kit (includes ZG-112 & KH-TF US)				●					128
	ZG-TF2	Crankarm Adaptor Kit (includes mounting hardware)				●					129
	ZG-GMA	Crankarm Adaptor Kit (includes mounting hardware)					●				125
	ZG-NMA	Crankarm Adaptor Kit (includes mounting hardware)						●	●		126
Shaft Adaptors	AV6-20	Shaft Extension fits 1/4' to 3/4" Diameter Shafts			●	●				●	118
	AV8-25	Shaft Extension fits 5/16" to 1" Diameter Shafts	●	●	●		●	●	●		112
	ZG-JSA (-1,2,3)	Jackshaft Adaptors for Hollow Jackshafts	●	●			●	●	●		131
	ZG-LMSA(-1)	Shaft Adaptor								●	118
	ZG-NMSA-1	Shaft Adaptor							●		117
Rotation Limiters	ZDB-AF2 US	Angle of Rotation Limiter for TAF/TNF	●	●							112
	ZDB-LF	Angle of Rotation Limiter for TLF			●						113
	ZDB-TF	Angle of Rotation Limiter for TTF				●					114
Housings	ZS-T	Protective Terminal Strip Cover (-T Models Only)					●	●	●	●	106
Miscellaneous	AF-CC US	Conduit Connector	●	●							112
	TF-CC US	Conduit Connector				●	●	●	●	●	114
	AF-P	Anti-Rotation Bracket (11414)	●	●							112
	LF-P	Anti-Rotation Bracket (11695)			●						113
	TF-P	Anti-Rotation Bracket (11533)				●				●	114
	Tool-06	8 mm and 10 mm Wrench	●	●	●	●		●	●	●	–

TAF/TNF Accessories

Clamps / Position Indicators / Rotation Limiters

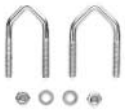
K4 US	Clamp. Fits shafts 3/8" to 3/4".
K4-1 US	Jackshaft Clamp. Fits jackshafts up to 1.05".
K4-2 US	Standard Clamp. Fits shafts 1/2" to 1.05".

K4-H	Hex Shaft Clamp. Fits hex shafts 3/8” to 5/8”.

IND-AF2	Damper Position Indicator. For damper position indication in short shaft installations.

ZDB-AF2	Angle of Rotation Limiter for TAF/TNF actuators.

KH-AFV	V-Bolt Kit allows for direct coupling with KH-LF. Contains V-Bolt and 2 nuts.



Shaft Adaptors / Extensions

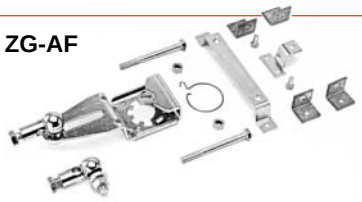
AV8-25	Shaft Extension. For damper operating shafts. Approx. 6-5/8" [170 mm] extension for shafts 1/4" to 3/4" [6 to 20 mm].

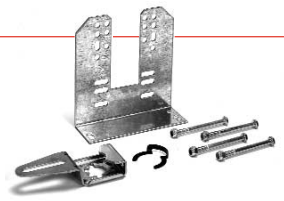
The shaft adaptors listed below may be used with TAF/TNF actuators. For more information see page 131.
ZG-JSA-1 ZG-JSA-2 ZG-JSA-3

Non-Direct Mounting

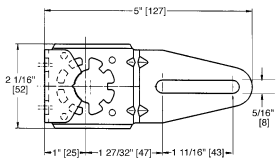
ZG-AF US	Crankarm Adaptor Kit. For more information see page 124.
ZG-AF108	Crankarm Adaptor Kit. For more information see page 121.

ZG-AF





KH-AF US	Crankarm Fits round shafts up to 3/4”.
KH-AF-1	Crankarm for Jackshaft Applications Fits round shafts up to 1.05".



Mounting Brackets

The mounting brackets listed below may be used with TAF/TNF actuators. For more information see pages 123 to 127.
ZG-100 ZG-101 ZG-102 ZG-106 ZG-107

Miscellaneous

AF-P Anti-Rotation T-Bracket for TAF/TNF.

Clamps / Position Indicators / Rotation Limiters

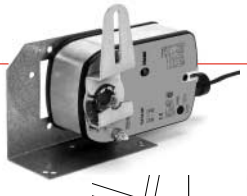
K6 US	Clamp. Fits shafts 3/8" to 1/2".
K6-1 US	Clamp. Fits shafts 1/2" to 3/4".
IND-LF	Damper Position Indicator.
ZDB-LF	Angle of Rotation Limiter for TLF actuators
KH-LFV	V-Bolt Kit allows direct coupling with KH-LF. Contains V-Bolt and 2 nuts.

Shaft Adaptors / Extensions

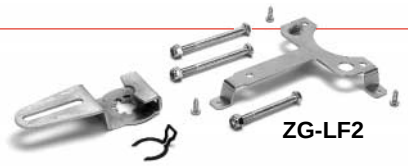
ZG-LMSA-1	Shaft Adaptor (See TLM Accessories).
AV6-20	Shaft Extension. (See TLM Accessories).
AV8-25	Shaft Extension. For damper operating shafts. Approx. 6-5/8" [170 mm] extension for shafts 1/4" to 3/4" [6 to 20 mm].

Non-Direct Mounting

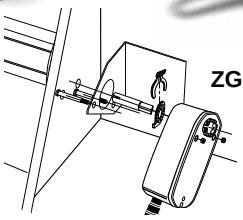
ZG-LF112	Crankarm Adaptor Kit. For more information see page 128.
ZG-LF2	Crankarm Adaptor Kit. For more information see page 129.
ZG-LFC114	Crankarm Adaptor Kit. Specially for Trane Voyager Unit Retrofit. For more information see page 130.



ZG-LF112

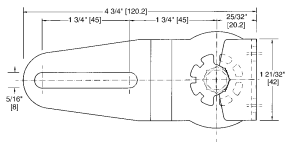


ZG-LF2



ZG-LFC114

KH-LF	Crankarm.



Mounting Brackets

The mounting brackets listed below may be used with TLF actuators. For more information see pages 128 to 129.
ZG-112

Miscellaneous

LF-P	Anti-Rotation T-Bracket for TLF.

TTF Accessories

Clamps / Position Indicators / Rotation Limiters

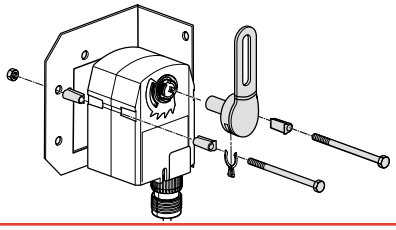
IND-TF	Damper Position Indicator.
ZDB-TF	Angle of Rotation Limiter for TTF actuators.

Shaft Adaptors / Extensions

AV6-20	Shaft Extension. For damper operating shafts. Approx. 6-5/8" [170 mm] extension for shafts 1/4" to 3/4" [6 to 20 mm].

Non-Direct Mounting

ZG-TF112	Crankarm Adaptor Kit. For more information see page 128.
ZG-TF2	Crankarm Adaptor Kit. For more information see page 129.
KH-TF	Crankarm. Fits shafts up to 1/2".



Miscellaneous

TF-CC US	Conduit Connector for TTF / TGM / TAM / TNM / TLM
TF-P	Anti-Rotation T-Bracket for TTF / TLM.

Clamps / Position Indicators / Rotation Limiters

K-GM25	Standard Reversible Clamp. Fits shafts up to 1.05".
K-GM20	Reversible Clamp. Fits shafts up to 3/4".

Shaft Adaptors

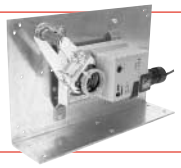
AV8-25	Shaft Extension. For damper operating shafts. Approx. 6-5/8" [170 mm] extension for shafts 1/4" to 3/4" [6 to 20 mm].

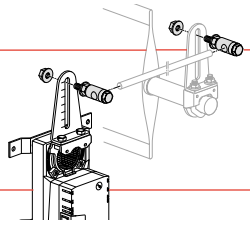
The shaft adaptors listed below may be used with TGM actuators. For more information see page 131.

ZG-JSA-1 ZG-JSA-2 ZG-JSA-3

Non-Direct Mounting

ZG-GMA	Crankarm Adaptor Kit. For more information see page 125.
AH-GMA	Crankarm.





Mounting Brackets

The mounting brackets listed below may be used with TGM actuators. For more information see pages 120 to 127.

ZG-100 ZG-101 ZG-102 ZG-103 ZG-104

Miscellaneous

TF-CC US	Conduit Connector for TTF / TGM / TAM / TNM / TLM

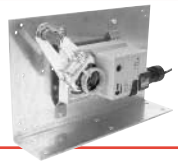
TAM Accessories

Clamps / Position Indicators / Rotation Limiters

K-AM25	Standard Reversible Clamp. Fits shafts up to 1.05".
K-SA	Reversible Clamp. Fits shafts up to 3/4".

Non-Direct Mounting

ZG-NMA	Crankarm Adaptor Kit. For more information see page 126.
AH-25	Crankarm.



Shaft Adaptors / Extensions

AV8-25	Shaft Extension. For damper operating shafts. Approx. 6-5/8" [170 mm] extension for shafts 1/4" to 3/4" [6 to 20 mm].

The shaft adaptors listed below may be used with TAM actuators. For more information see page 131.

ZG-JSA-1 ZG-JSA-2 ZG-JSA-3

Mounting Brackets

The mounting brackets listed below may be used with TAM actuators. For more information see page 127.

ZG-100 ZG-101 ZG-103 ZG-104

Miscellaneous

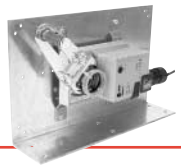
TF-CC US	Conduit Connector for TTF / TGM / TAM / TNM / TLM.

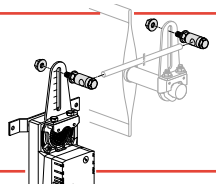
Clamps / Position Indicators / Rotation Limiters

K-AM25	Standard Reversible Clamp. Fits shafts up to 1.05".
K-NA	Reversible Clamp. Fits shafts up to 3/4".

Non-Direct Mounting

ZG-NMA	Crankarm Adaptor Kit. For more information see page 126.
AH-25	Crankarm.





Shaft Adaptors / Extensions

ZG-NMSA-1	Short Shaft Extension.
AV8-25	Shaft Extension. For damper operating shafts. Approx. 6-5/8" [170 mm] extension for shafts 1/4" to 3/4" [6 to 20 mm].

The shaft adaptors listed below may be used with TNM actuators. For more information see page 131.
ZG-JSA-1 ZG-JSA-2 ZG-JSA-3

Mounting Brackets

The mounting brackets listed below may be used with TNM actuators. For more information see page 127.
ZG-103 ZG-104

Miscellaneous

TF-CC US	Conduit Connector for TTF / TGM / TAM / TNM / TLM.

TLM Accessories

Clamps / Position Indicators / Rotation Limiters

K-LM20	Clamp. Fits shafts up to 3/4".
K-LM16	Standard Clamp. Fits shafts up to 5/8".
K-LM13	Clamp. Fits shafts up to 1/2".
K-LM10	Clamp. Fits shafts up to 3/8".

Shaft Adaptors / Extensions

ZG-LMSA	Shaft Extension.
ZG-LMSA-1	Shaft Extension.
AV6-20	Shaft Extension. For damper operating shafts. Approx. 6-5/8" [170 mm] extension for shafts 1/4" to 3/4" [6 to 20 mm].

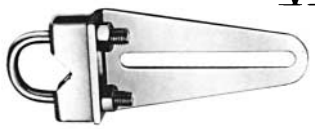
Miscellaneous

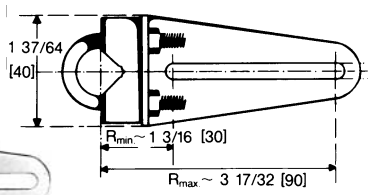
TF-CC US	Conduit Connector for TTF / TGM / TAM / TNM / TLM.
TF-P	Anti-Rotation T-Bracket for TTF / TLM.

Universal Crankarms

Dimensions [All numbers in brackets are in millimeters.]

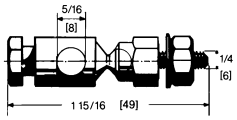
KH6	Zinc plated steel. Slot width 1/4" (6.2 mm). For damper shafts: 3/8" to 11/16" dia. (10 to 18 mm) or 3/8" to 9/16" sq. (10 to 14 mm). Uses KG6 or KG10 Ball Joint.
KH8	Zinc plated steel. Slot width 21/64" (8.2 mm). For damper shafts: 3/8" to 11/16" dia. (10 to 18 mm) or 3/8" to 9/16" sq. (10 to 14 mm). Uses KG8 or KG10 Ball Joint.



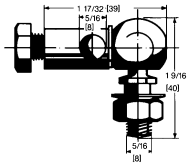


Ball Joints

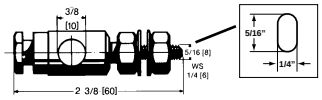
KG6	For KH6 Universal Crankarm. Zinc plated steel. For 5/16" dia. rod (8mm). The KG6 ball joint is only recommended up to 70 in-lbs (8 Nm).



KG8	For KH8 Universal Crankarm. Zinc plated steel. 90° angle. For 5/16" dia. rod (8 mm).



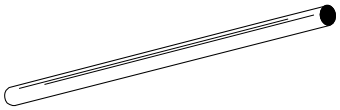
KG10	Used with following crankarms: KH6 = 1/4" (6.2 mm) KH8 = 5/16" (8 mm)



The bolt portion of the KG10 fits both a 5/16" slot and 1/4" slot.

Push Rods

SH8	For KG6 and KG8 Ball Joints. 36" length, 5/16" dia.
SH10	For KG10 Ball Joints. 36" length, 3/8" dia.

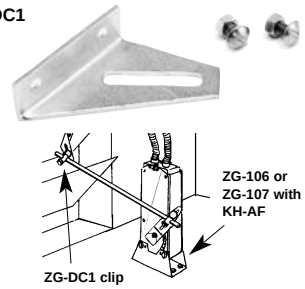


Damper Clips

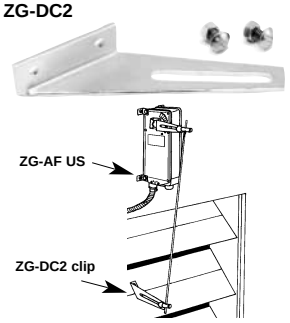
ZG-DC1	Mounts to Damper Blades – 3.5"
ZG-DC2	Mounts to Damper Blades – 6"

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.

ZG-DC1



ZG-DC2



ZG-102 Multiple Actuator Mounting Bracket

For TGM and TAF Series Actuators

Application

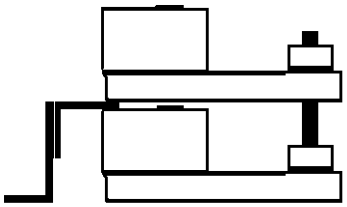
The ZG-102 multiple actuator mounting bracket is designed for cases where it is necessary to mount two actuators to one shaft to provide extra torque.

The dual mounting bracket is typically used with the TAF and TGM series actuators. This is due to the fact that each of these series are the highest torque range available.

Figures A and B demonstrates two different mounting configurations using the ZG-102 mounting bracket.

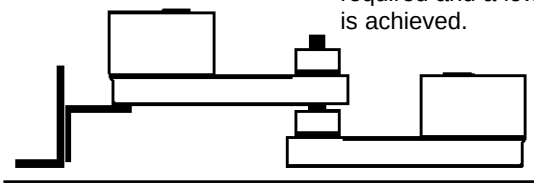
Accessory

AV10 - 25 Universal shaft extension.



Note: The major advantage with this method is it requires less mounting area. The manual override, if available, cannot be used in this configuration.

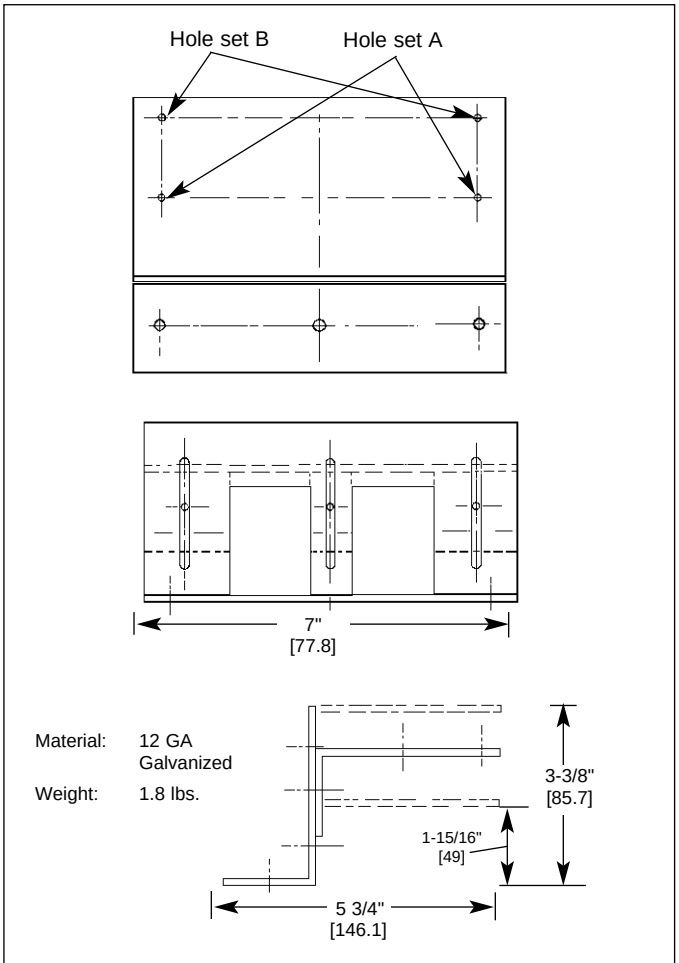
Figure A



Note: The major advantages are that a shorter shaft is required and a lower profile is achieved.

Figure B

Dimensions [All numbers in brackets are in millimeters.]



OTHER CRANKARM ADAPTOR KITS AND UNIVERSAL MOUNTING BRACKETS

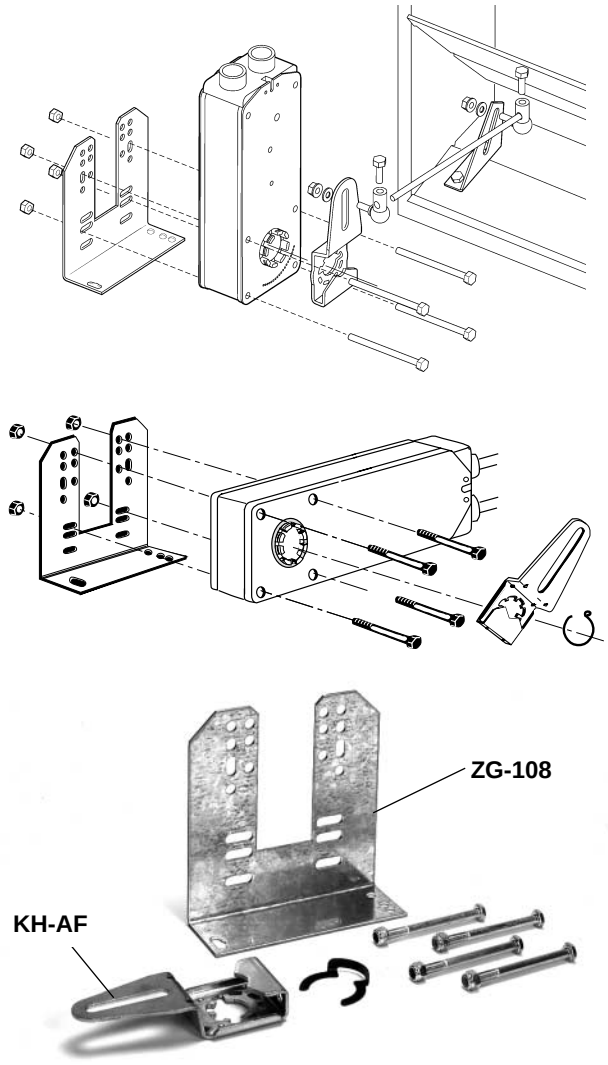
KIT	MOUNTING BRACKET*	ACTUATOR USED WITH
ZG-AF108	ZG-108 (Included)	TNF, TAF
ZG-AF US	ZG-100, ZG-101	TNF, TAF
ZG-LF112	ZG-112 (Included)	TLF
ZG-LF2	NA	TLF
ZG-LFC114	NA	TLF
ZG-TF112	ZG-112 (Included)	TTF
ZG-TF2	NA	TTF
ZG-GMA	ZG-101, ZG-101, ZG-103, ZG-104	TGM
ZG-NMA	ZG-101, ZG-101, ZG-103, ZG-104	TNM, TAM
NA	ZG-106	TNF, TAF
NA	ZG-107	TNF, TAF

*Unless otherwise noted, mounting brackets are not included in crankarm adaptor kits.

I20683 - Subject to change.

ZG-AF108 Crankarm Adaptor Kit

For TAF and TNF Series Actuators



Application

The ZG-AF108 Crankarm Adaptor Kit 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-AF108 Crankarm Adaptor Kit includes:

1 ZG-108 Mounting Bracket
1 KH-AF Crankarm with Retaining Ring
4 Bolts with Nuts

Note: May require crankarm and ball joints.

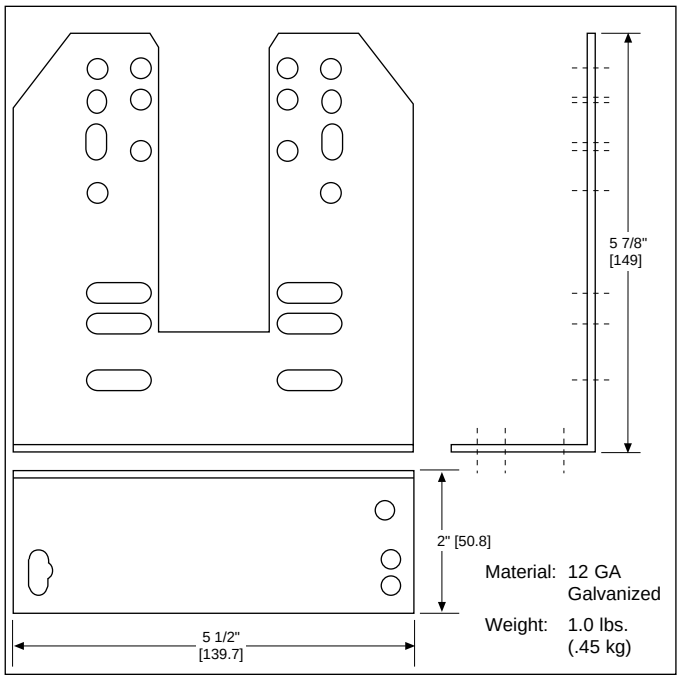
The ZG-108 is provided with hole patterns to mount the TNF and TAF series actuators in either a horizontal or vertical position to meet space requirements.

The ZG-108 Mounting Bracket is designed to mount the TNF and TAF series actuator in the same mounting locations as common foot mounted, crankarm style actuators. Hole patterns in the base match common Honeywell™, Siebe™ (Barber Coleman™), and Johnson Controls™ actuators for easy retrofit.

Use when replacing these actuators:

Honeywell	**M91…**	**M945…**
	M955…	**M965…**
	M975…	**M8…**
Johnson	**M110…**	**M140…**
	M120…	**M150…**
	M130…	
Barber Coleman	**MA3…**	**MA4…**
	MA5…	

Dimensions [All numbers in brackets are in millimeters.]



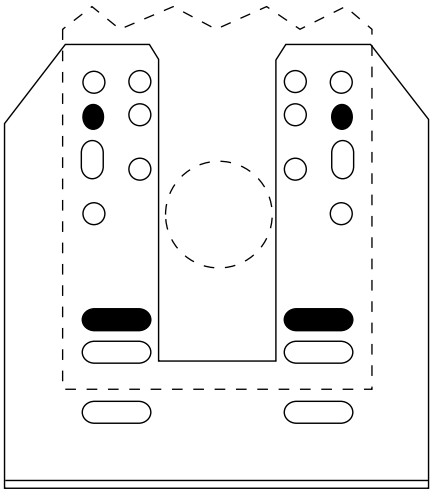
OTHER CRANKARM ADAPTOR KITS AND UNIVERSAL MOUNTING BRACKETS

KIT	MOUNTING BRACKET*	ACTUATOR USED WITH
ZG-AF108	ZG-108 (Included)	TNF, TAF
ZG-AF US	ZG-100, ZG-101	TNF, TAF
ZG-LF112	ZG-112 (Included)	TLF
ZG-LF2	NA	TLF
ZG-LFC114	NA	TLF
ZG-TF112	ZG-112 (Included)	TTF
ZG-TF2	NA	TTF
ZG-GMA	ZG-101, ZG-101, ZG-103, ZG-104	TGM
ZG-NMA	ZG-101, ZG-101, ZG-103, ZG-104	TNM, TAM
NA	ZG-106	TNF, TAF
NA	ZG-107	TNF, TAF

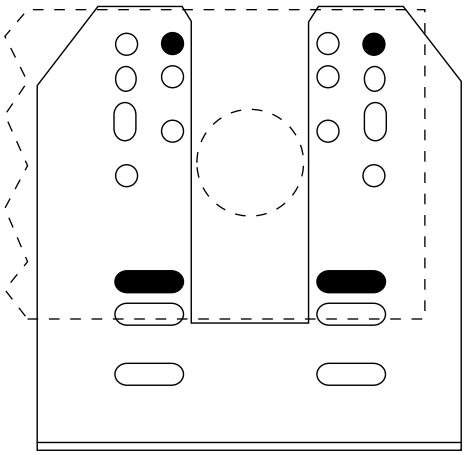
*Unless otherwise noted, mounting brackets are not included in crankarm adaptor kits.

ZG-AF108 Crankarm Adaptor Kit

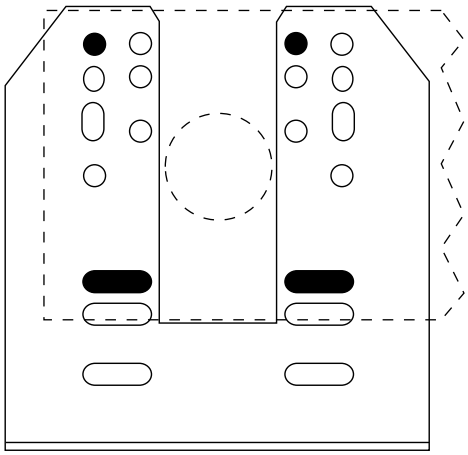
Mounting Positions for Typical Replacements



Barber Colman™ MA Type - Vertical

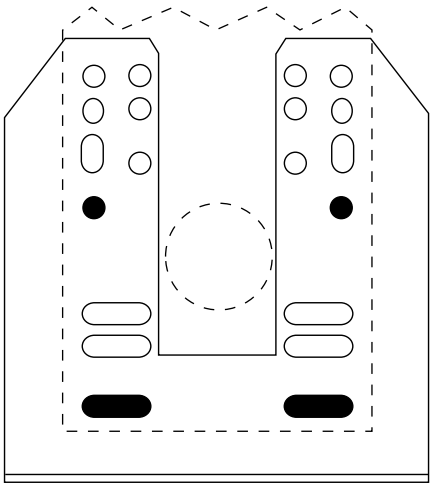


Barber Colman™ MA Type - Horizontal (left)

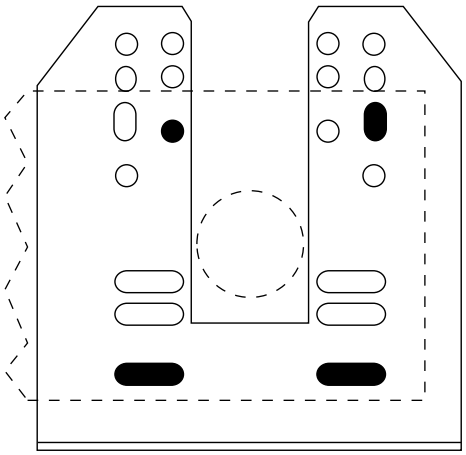


Barber Colman™ MAT ype - Horizontal (right)

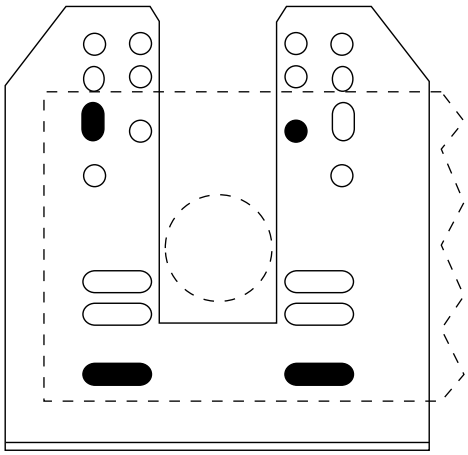
Black holes represent correct bolt locations.



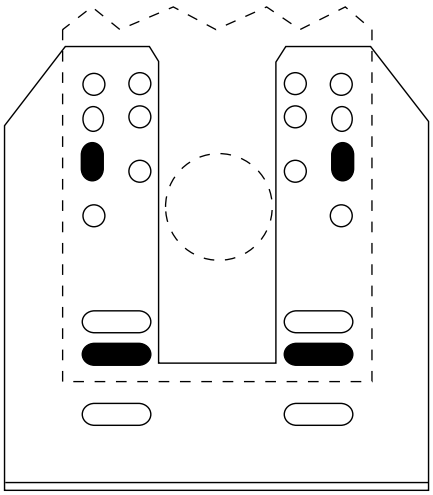
Honeywell™ Mod. IV Type- Vertical



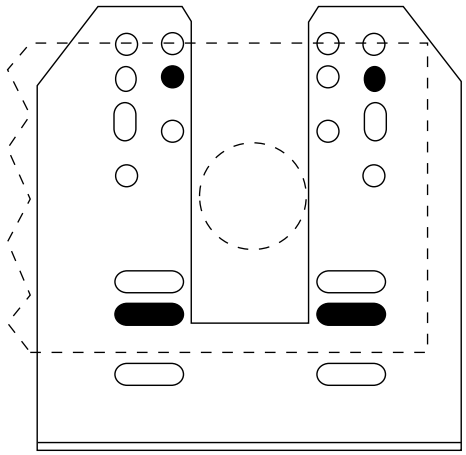
Honeywell™ Mod. IV Type - Horizontal (left)



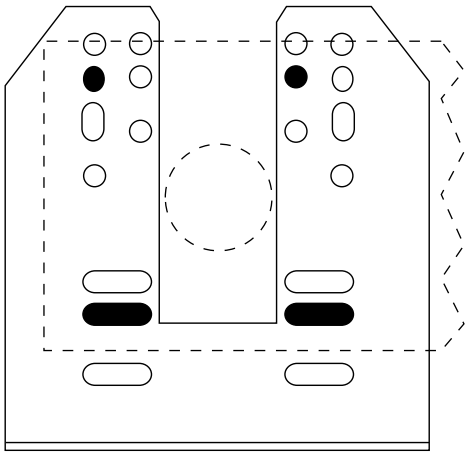
Honeywell™ Mod. IV Type - Horizontal (right)



Johnson Control™ 100 Series Type and Honeywell™ Mod. III Type Vertical



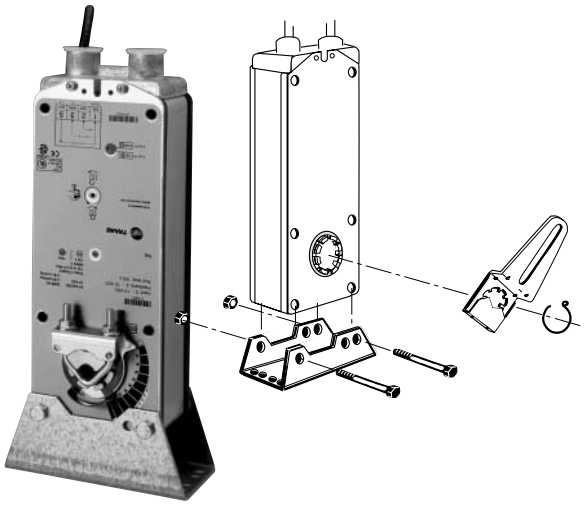
Johnson Control™ 100 Series Type and Honeywell™ Mod. III Type Horizontal (left)

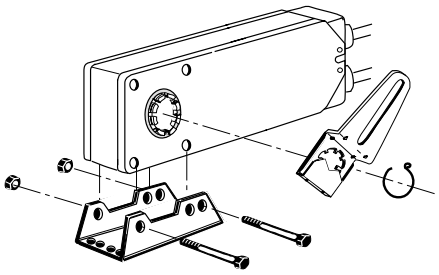


Johnson Control™ 100 Series Type and Honeywell™ Mod. III Type Horizontal (right)

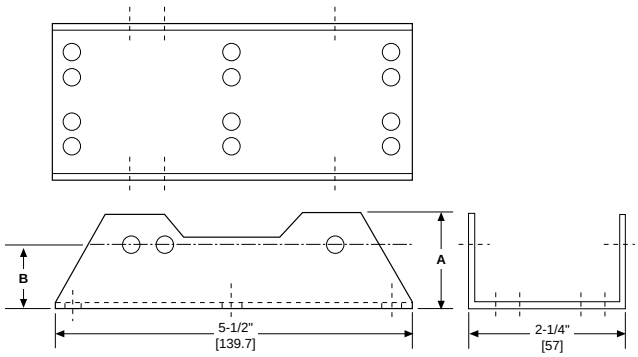
ZG-106 and ZG-107 Universal Mounting Brackets

For TAF and TNF Series Actuators





Dimensions [All numbers in brackets are in millimeters.]



MODEL NO.	A	B
ZG-106	1.50"	1.02"
ZG-107	2.25"	1.77"

Material: 12 GA Galvanized

Weight: ZG-106 0.7 lbs.
ZG-107 0.9 lbs.

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 is provided with hole patterns to mount the TNF and TAF series actuators in either a horizontal or vertical position to meet space requirements.

The KH-AF crankarm is required to fully convert the TNF and TAF for crankarm operation.

The ZG-106 and ZG-107 are designed to mount the TNF 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 Coleman™), and Johnson Controls™ actuators for easy retrofit.

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 is designed to place the crankarm in the same relative position as the Honeywell™ Mod III actuators.

Use the ZG-106 when replacing these actuators:

Honeywell	Mod IV	
	M91…	M945…
	M955…	M965…
	M975…	M8…

Use the ZG-107 when replacing these actuators:

Honeywell	Mod III

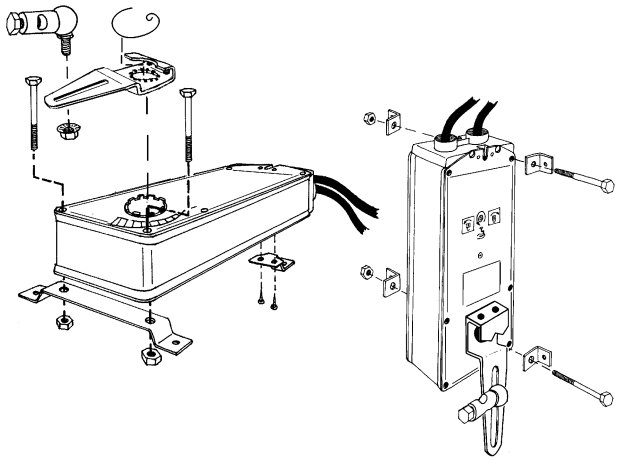
OTHER CRANKARM ADAPTOR KITS AND UNIVERSAL MOUNTING BRACKETS

KIT	MOUNTING BRACKET*	ACTUATOR USED WITH
ZG-AF108	ZG-108 (Included)	TNF, TAF
ZG-AF US	ZG-100, ZG-101	TNF, TAF
ZG-LF112	ZG-112 (Included)	TLF
ZG-LF2	NA	TLF
ZG-LFC114	NA	TLF
ZG-TF112	ZG-112 (Included)	TTF
ZG-TF2	NA	TTF
ZG-GMA	ZG-101, ZG-101, ZG-103, ZG-104	TGM
ZG-NMA	ZG-101, ZG-101, ZG-103, ZG-104	TNM, TAM
NA	ZG-106	TNF, TAF
NA	ZG-107	TNF, TAF

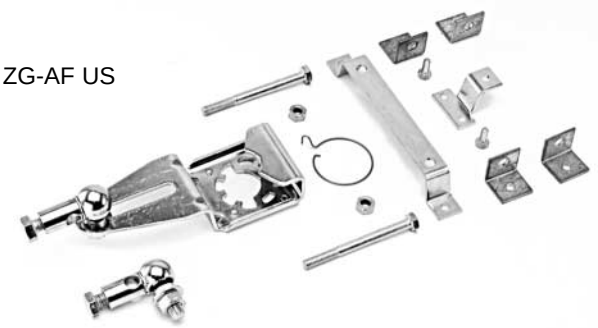
*Unless otherwise noted, mounting brackets are not included in crankarm adaptor kits.

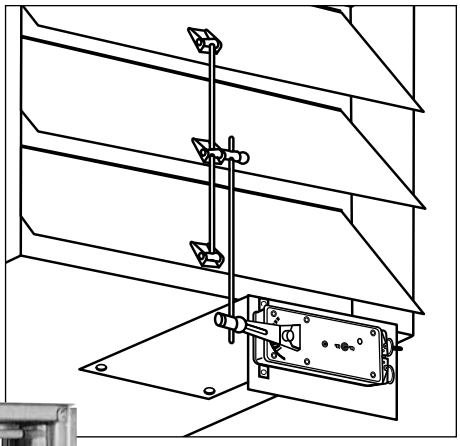
ZG-AF US Crankarm Adaptor Kit

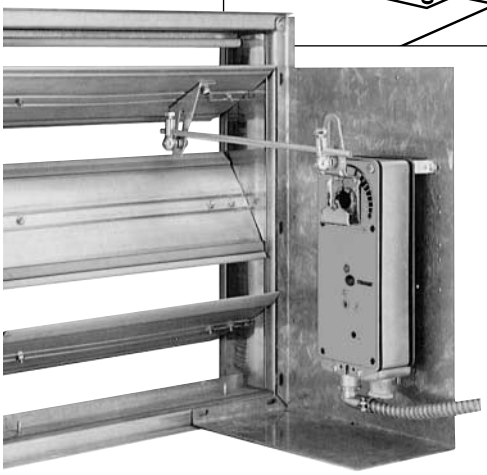
For TAF and TNF Series Actuators



ZG-AF US







Application

The ZG-AF US Crankarm Adaptor Kit is designed for applications where the actuator cannot be mounted directly to the damper shaft.

The ZG-AF US Crankarm Adaptor Kit includes:

- 1 KH-AF Crankarm with Retaining Ring
- 2 Standoff Brackets
- 4 Mounting Feet
- 2 Bolts with Nuts
- 2 Self-Tapping Screws
- 2 KG8 Ball Joints Instructions

The following Universal Mounting Brackets are needed to fully convert to crankarm operation:

- ZG-100
- ZG-101

The ZG-100 and ZG-101 Universal Mounting Brackets are designed for applications where the actuator cannot be mounted directly to the 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 and ZG-101 are provided with pre-punched hole patterns for the TAM, TGM, TNF, and TAF series actuators. The ZG-100 hole pattern layout allows mounting these actuators in three different, mounting orientations. The ZG-101 hole pattern layout allows mounting these actuators in two different, mounting orientations. The ZG-100 and ZG-101 may also be field drilled for special or more exact mounting of linkage components.

For technical data and dimensions on ZG-100 and ZG-101 Universal Mounting Brackets, see page 300.

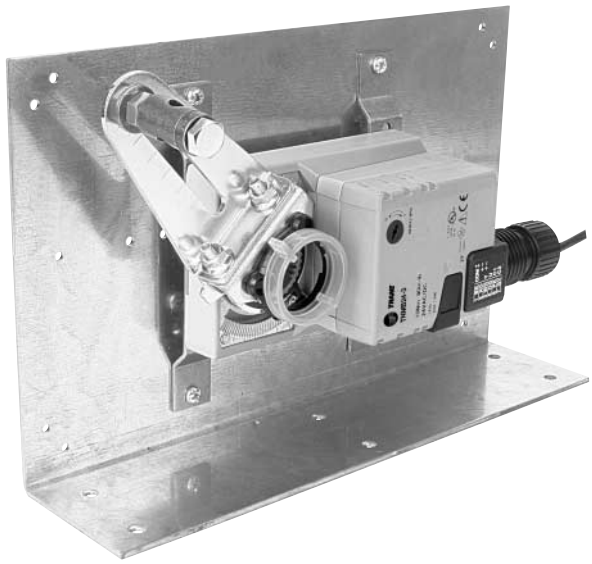
OTHER CRANKARM ADAPTOR KITS AND UNIVERSAL MOUNTING BRACKETS

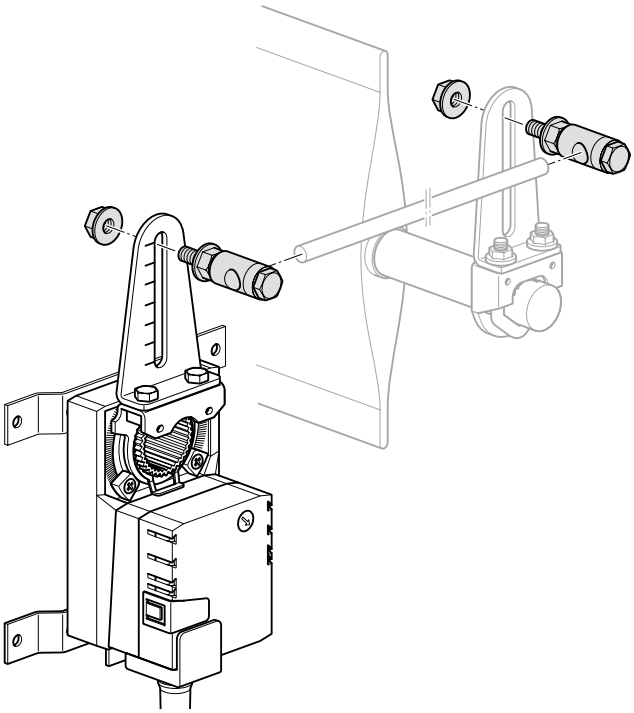
KIT	MOUNTING BRACKET*	ACTUATOR USED WITH
ZG-AF108	ZG-108 Included)	TNF, TAF
ZG-AF US	ZG-100, ZG-101	TNF, TAF
ZG-LF112	ZG-112 (Included)	TLF
ZG-LF2	NA	TLF
ZG-LFC114	NA	TLF
ZG-TF112	ZG-112 (Included)	TTF
ZG-TF2	NA	TTF
ZG-GM2	ZG-101, ZG-101, ZG-103, ZG-104	TGM
ZG-NMA	ZG-101, ZG-101, ZG-103, ZG-104	TNM, TAM
NA	ZG-106	TNF, TAF
NA	ZG-107	TNF, TAF

*Unless otherwise noted, mounting brackets are not included in crankarm adaptor kits.

ZG-GMA Crankarm Adaptor Kit

For TGM Series Actuators





Application

The ZG-NMA Crankarm Adaptor Kit is designed for applications where the actuator cannot be mounted directly to the damper shaft.

The ZG-NMA Crankarm Adaptor Kit includes:

- 1 AH-25 Crankarm
- 2 KG10 Ball Joints
- 2 Mounting Brackets
- 1 Spacer
- Mounting Hardware

The following Universal Mounting Brackets are needed to fully convert to crankarm operation:

- ZG-100
- ZG-101
- ZG-103
- ZG-104

The ZG-100, ZG-101, ZG-103, and ZG-104 Universal Mounting Brackets are designed for applications where the actuator cannot be mounted directly to the 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, ZG-101, ZG-103, ZG-104 are provided with pre-punched hole patterns for the TNM, TAM, TGM, TNF, and TAF series actuators. The ZG-100 hole pattern layout allows mounting these actuators in three different, mounting orientations. The ZG-101, ZG-103, and ZG-104 hole pattern layout allows mounting these actuators in two different, mounting orientations. The ZG-100 and ZG-101 may also be field drilled for special or more exact mounting of linkage components.

For technical data and dimensions on ZG-100 , ZG-101, ZG-103, and ZG-104 Universal Mounting Brackets, see page 300.

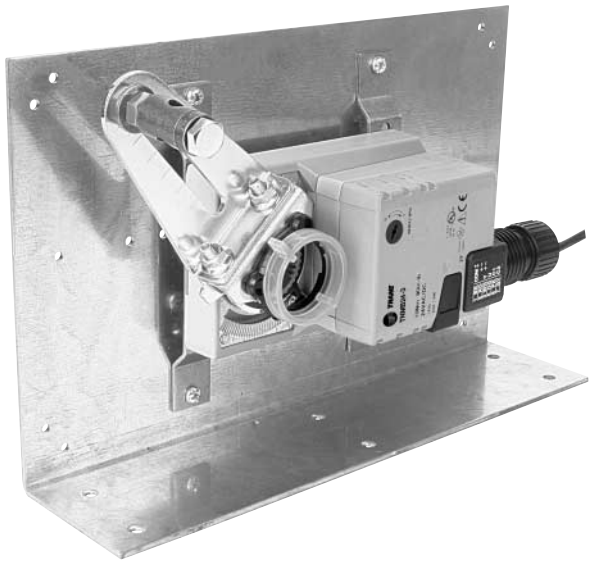
OTHER CRANKARM ADAPTOR KITS AND UNIVERSAL MOUNTING BRACKETS

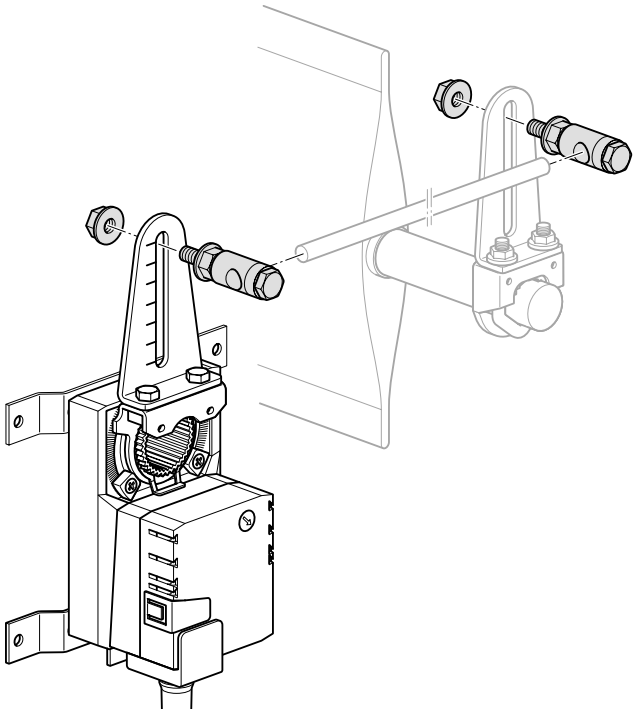
KIT	MOUNTING BRACKET*	ACTUATOR USED WITH
ZG-AF108	ZG-108 (Included)	TNF, TAF
ZG-AF US	ZG-100, ZG-101	TNF, TAF
ZG-LF112	ZG-112 (Included)	TLF
ZG-LF2	NA	TLF
ZG-LFC114	NA	TLF
ZG-TF112	ZG-112 (Included)	TTF
ZG-TF2	NA	TTF
ZG-GMA	ZG-101, ZG-101, ZG-103, ZG-104	TGM
ZG-NMA	ZG-101, ZG-101, ZG-103, ZG-104	TNM, TAM
NA	ZG-102	TAF, TGM
NA	ZG-106	TNF, TAF
NA	ZG-107	TNF, TAF

*Unless otherwise noted, mounting brackets are not included in crankarm adaptor kits.

ZG-NMA Crankarm Adaptor Kit

For TAM and TNM Series Actuators





Application

The ZG-NMA Crankarm Adaptor Kit is designed for applications where the actuator cannot be mounted directly to the damper shaft.

The ZG-NMA Crankarm Adaptor Kit includes:

- 1 Crankarm
- 2 KG10 Ball Joints
- 2 Mounting Brackets
- 1 Spacer
- Mounting Hardware

The following Universal Mounting Brackets are needed to fully convert to crankarm operation:

- ZG-100
- ZG-101
- ZG-103
- ZG-104

The ZG-100, ZG-101, ZG-103, and ZG-104 Universal Mounting Brackets are designed for applications where the actuator cannot be mounted directly to the 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, ZG-101, ZG-103, ZG-104 are provided with pre-punched hole patterns for the TNM, TAM, TGM, TNF, and TAF series actuators. The ZG-100 hole pattern layout allows mounting these actuators in three different, mounting orientations. The ZG-101, ZG-103, and ZG-104 hole pattern layout allows mounting these actuators in two different, mounting orientations. The ZG-100 and ZG-101 may also be field drilled for special or more exact mounting of linkage components.

For technical data and dimensions on ZG-100 , ZG-101, ZG-103, and ZG-104 Universal Mounting Brackets, see page 300.

OTHER CRANKARM ADAPTOR KITS AND UNIVERSAL MOUNTING BRACKETS

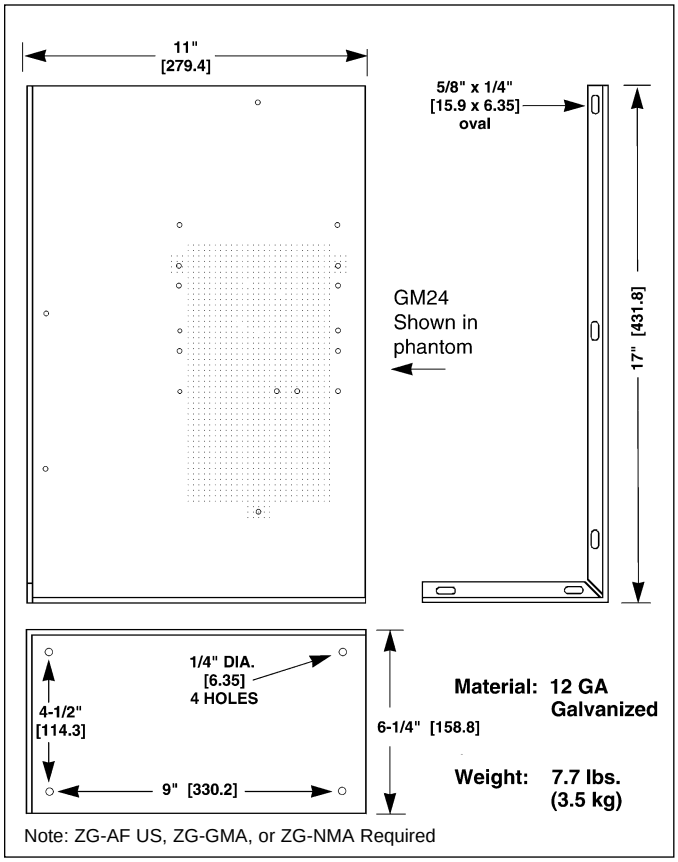
KIT	MOUNTING BRACKET*	ACTUATOR USED WITH
ZG-AF108	ZG-108 (Included)	TNF, TAF
ZG-AF US	ZG-100, ZG-101	TNF, TAF
ZG-LF112	ZG-112 (Included)	TLF
ZG-LF2	NA	TLF
ZG-LFC114	NA	TLF
ZG-TF112	ZG-112 (Included)	TTF
ZG-TF2	NA	TTF
ZG-GMA	ZG-101, ZG-101, ZG-103, ZG-104	TGM
ZG-NMA	ZG-101, ZG-101, ZG-103, ZG-104	TNM, TAM
NA	ZG-102	TAF, TGM
NA	ZG-106	TNF, TAF
NA	ZG-107	TNF, TAF

*Unless otherwise noted, mounting brackets are not included in crankarm adaptor kits.

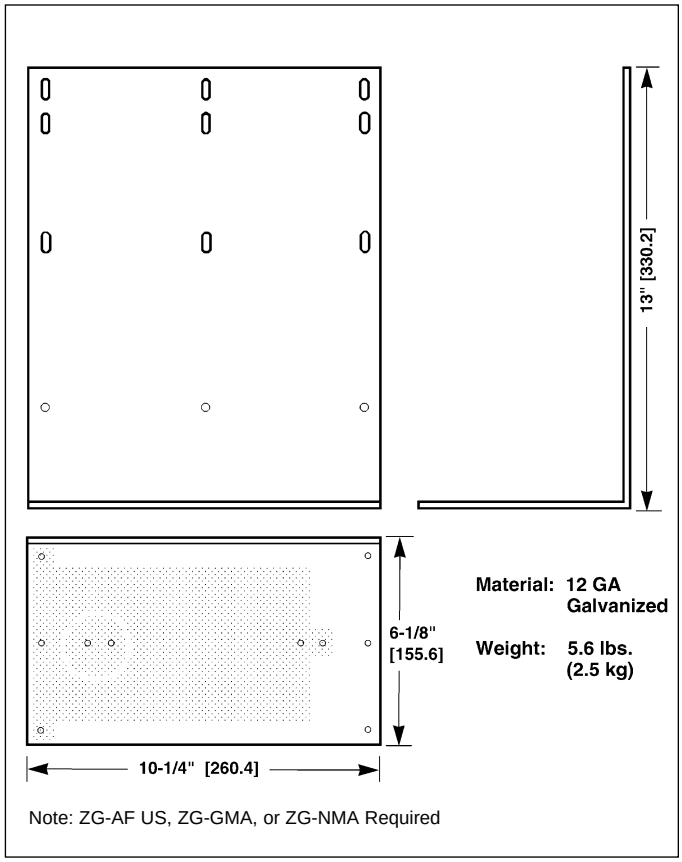
ZG-100, ZG-101, ZG-103, ZG-104 Universal Mounting Brackets

For TAM, TGM, TNF, and TAF Series Actuators

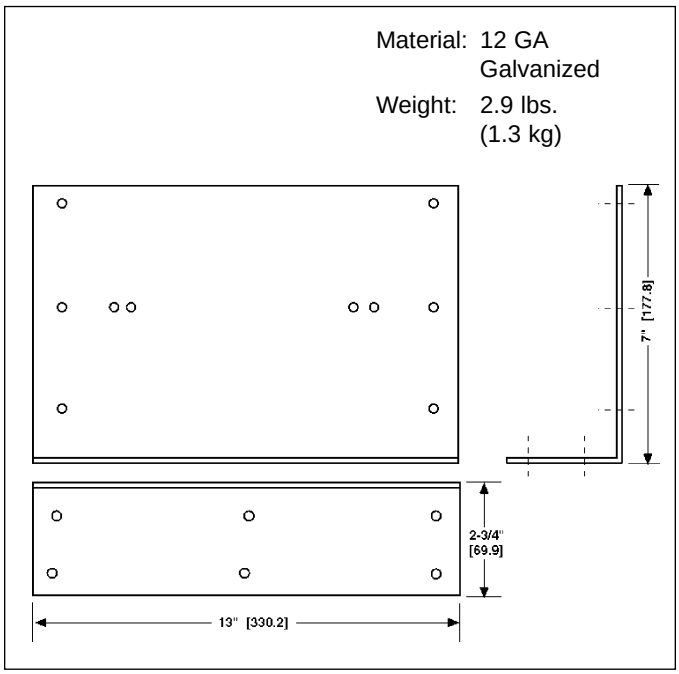
Dimensions [All numbers in brackets are in millimeters.]



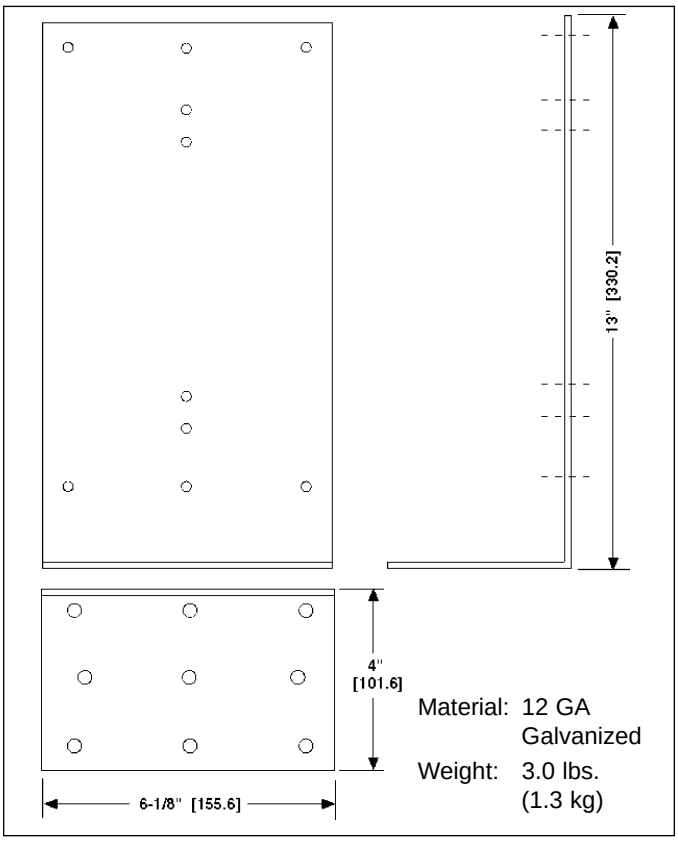
ZG-100 Universal Mounting Bracket



ZG-101 Universal Mounting Bracket



ZG-103 Universal Mounting Bracket



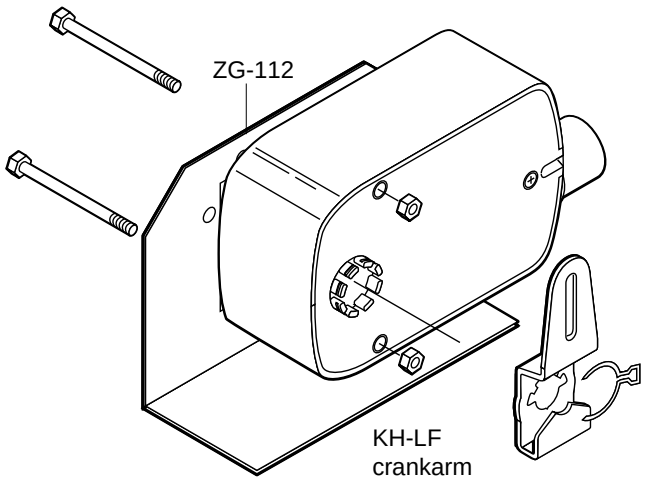
ZG-104 Universal Mounting Bracket

ZG-LF112 and ZG-TF112 Crankarm Adaptor Kits

For TLF and TTF Series Actuators

ZG-LF112 Crankarm Adaptor Kit

For TLF Series Actuators



Application

The ZG-LF112 Crankarm Adaptor Kit 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-LF112 Crankarm Adaptor Kit includes:
1 ZG-112 Mounting Bracket
1 KH-LF Crankarm with Retaining Ring
2 Bolts with Nuts

Note: May require crankarm and ball joints.

The ZG-112 is provided with hole patterns to mount the TLF series actuators in either a horizontal or vertical position to meet space requirements.

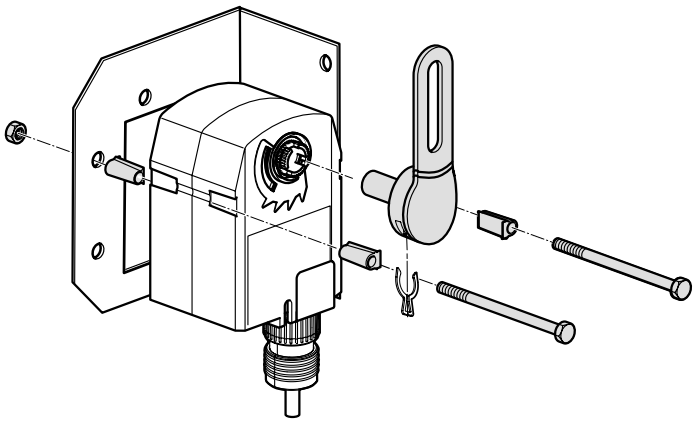
The ZG-112 Mounting Bracket is designed to mount the TLF and TTF series actuator in the same mounting locations as common foot mounted, crankarm style actuators. Hole patterns in the base match common Honeywell™, Siebe™ (Barber Coleman™), and Johnson Controls™ actuators for easy retrofit.

Use when replacing these actuators:

Honeywell	M84… M7

ZG-TF112 Crankarm Adaptor Kit

For TTF Series Actuators



Application

The ZG-TF112 Crankarm Adaptor Kit 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-TF112 Crankarm Adaptor Kit includes:
1 ZG-112 Mounting Bracket
1 KH-TF Crankarm with Retaining Ring
2 Bolts with Nuts

Note: May require crankarm and ball joints

The ZG-112 is provided with hole patterns to mount the TTF and TLF series actuators in either a horizontal or vertical position to meet space requirements.

The ZG-112 Mounting Bracket is designed to mount the TTF and TLF series actuator in the same mounting locations as common foot mounted, crankarm style actuators. Hole patterns in the base match common Honeywell™, Siebe™ (Barber Coleman™), and Johnson Controls™ actuators for easy retrofit.

Use when replacing these actuators:

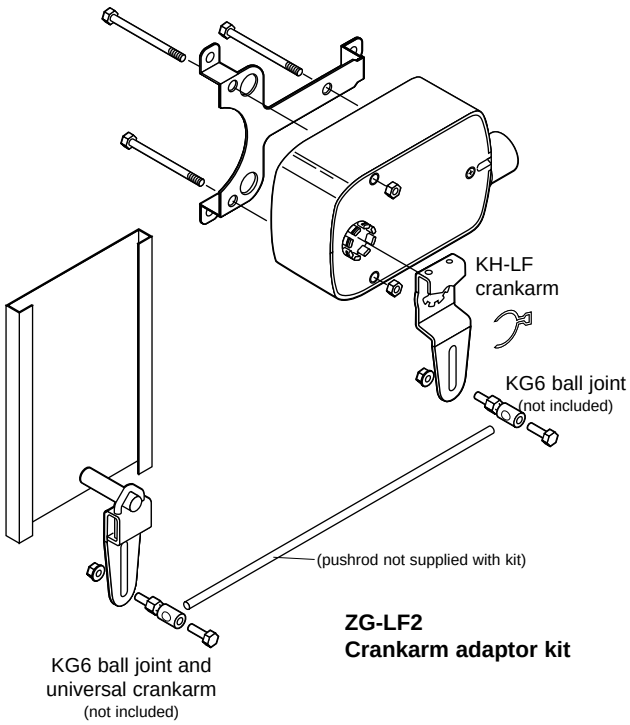
Honeywell	M84… M7…

ZG-LF2 and ZG-TF2 Crankarm Adaptor Kits

For TLF and TTF Series Actuators

ZG-LF2 Crankarm Adaptor Kit

For TLF Series Actuators



ZG-LF2
Crankarm adaptor kit

Application

The ZG-LF2 Crankarm Adaptor Kit 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-LF2 Crankarm Adaptor Kit includes:
1 Mounting Bracket
1 KH-LF Crankarm with Retaining Ring
3 Bolts with Nuts

Note: May require crankarm and ball joints.

The ZG-LF2 Crankarm Adaptor Kit can be used to replace foot mounted, crankarm style actuators. The ZG-LF2 allows for easy retrofit of Honeywell™, Siebe™ (Barber Coleman™), and Johnson Controls™ actuators.

ZG-TF2 Crankarm Adaptor Kit

For TTF Series Actuators

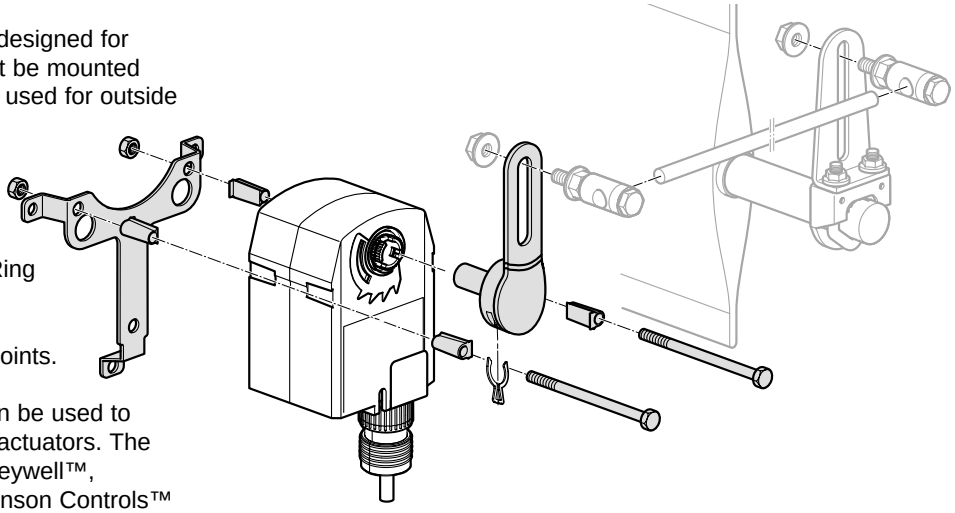
Application

The ZG-TF2 Crankarm Adaptor Kit 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-TF2 Crankarm Adaptor Kit includes:
1 Mounting Bracket
1 KH-TF Crankarm with Retaining Ring
3 Bolts with Nuts

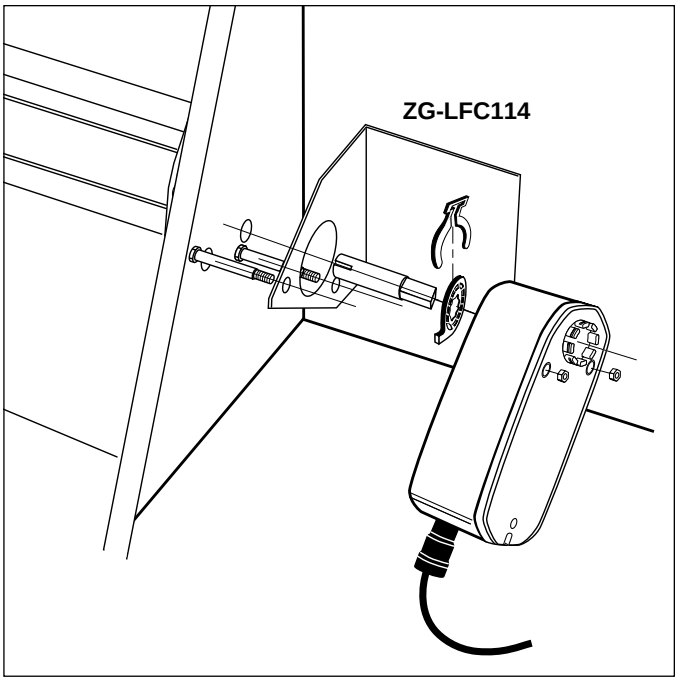
Note: May require crankarm and ball joints.

The ZG-TF2 Crankarm Adaptor Kit can be used to replace foot mounted, crankarm style actuators. The ZG-TF2 allows for easy retrofit of Honeywell™, Siebe™ (Barber Coleman™), and Johnson Controls™ actuators.



ZG-LFC114 Crankarm Adaptor Kits

For TLF Series Actuators



Application

The ZG-LFC114 Crankarm Adaptor Kit is designed for Trane voyager economizer actuator retrofit.

The ZG-LFC114 Crankarm Adaptor Kit includes:

1 Mounting Bracket
1 Shaft Adaptor
2 Bolts with Nuts

Note: May require crankarm and ball joints

Use when replacing these actuators:

Honeywell	M84…
	M7…

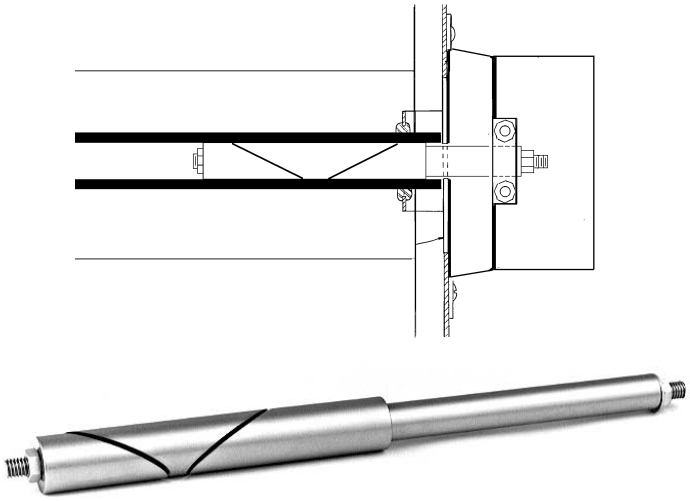
OTHER CRANKARM ADAPTOR KITS AND UNIVERSAL MOUNTING BRACKETS

KIT	MOUNTING BRACKET*	ACTUATOR USED WITH
ZG-AF108	ZG-108 (Included)	TNF, TAF
ZG-AF US	ZG-100, ZG-101	TNF, TAF
ZG-LF112	ZG-112 (Included)	TLF
ZG-LF2	NA	TLF
ZG-LFC114	NA	TLF
ZG-TF112	ZG-112 (Included)	TTF
ZG-TF2	NA	TTF
ZG-GMA	ZG-101, ZG-101, ZG-103, ZG-104	TGM
ZG-NMA	ZG-101, ZG-101, ZG-103, ZG-104	TNM, TAM
NA	ZG-102	TAF, TGM
NA	ZG-106	TNF, TAF
NA	ZG-107	TNF, TAF

*Unless otherwise noted, mounting brackets are not included in crankarm adaptor kits.

Jack Shaft Adaptors ZG-JSA- .

To Adapt Hollow Jack Shafts to fit Actuators



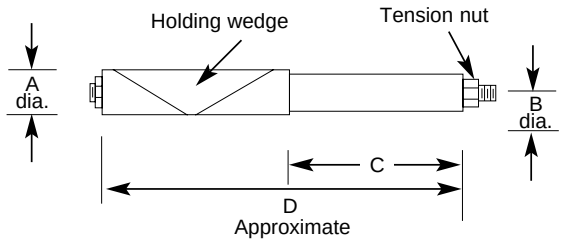
Application

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 actuators.

Technical Data	ZG-JSA-1	ZG-JSA-2	ZG-JSA-3
Jack shaft size			
Outside dia.	1.00 "	1 5/16"	1.05"
Inside dia.	3/4 "	1 3/32"	27/32"
Weight	1.3 lbs.	2.3 lbs.	1.6 lbs.
Material	Cold rolled steel, nickel plated		

Dimensions

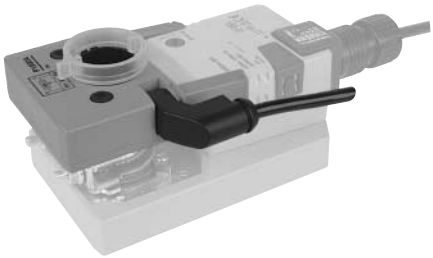
ZG-JSA-.

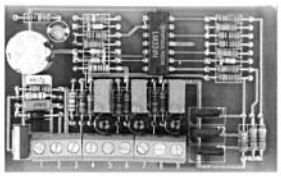


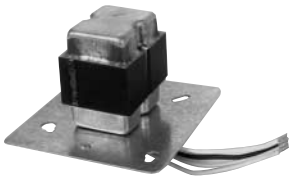
	A	B	C	D
ZG-JSA-1	3/4”	3/4”	–	10-3/4”
ZG-JSA-2	1-1/16”	3/4”	6”	12-1/2”
ZG-JSA-3	13/16”	3/4”	6”	12-1/4”

Electronic Accessories

We'll help solve any application problem with a wide range of accessories and unparalleled customer service.







The Trane Difference

- *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.

Electronic Accessory Usage Chart

See Page No.		140	108	—	107	134	135	136	138	138	137	140	141
TRANE ACTUATOR	Description	Actuator Power Supply Simulator	Auxiliary Switch(es)	Shaft Mount Auxiliary Switch	Feedback Potentiometer	Positioners	Input Rescaling Module	Analog to Digital Switch	Resistor for 4 to 20 mA Conversion 50%	Voltage Divider	Battery Back-Up Module	Transformer	Thermostat / Heater Kit
	Part Number	PS-100	S1A GR, S2A GR	P370	P... A GR	SGA24, SGF24	IRM-100	ADS-100	ZG-R01	ZG-R02	NSV24 US	ZG-X40	ZG-HTR
TAF24 (-S)		•		•								•	•
TAF24-SR		•		•		•		•	•	•		•	•
TNF24 (-S)		•		•								•	•
TNF24-SR		•		•		•		•	•	•		•	•
TLF24 (-S)		•		•								•	
TLF120		•		•									
TLF24-3...		•		•								•	
TLF24-SR...		•		•		•	•	•	•	•		•	
TTF24 (-S)		•										•	
TTF120		•											
TTF24-3		•										•	
TTF24-SR		•				•	•	•	•	•		•	
TGMB24-3		•	•	•	•						•	•	
TGMB24-SR		•	•	•	•	•	•	•	•	•	•	•	
TAMB24-3		•	•	•	•						•	•	
TAMB24-SR		•	•	•	•	•	•	•	•	•	•	•	
TNMB24-3		•	•	•	•						•	•	
TNMB24-SR		•	•	•	•	•	•	•	•	•	•	•	
TLMB24-3 (-T)		•	•	•	•						•	•	
TLMB24-SR (-T)		•	•	•	•	•	•	•	•	•	•	•	

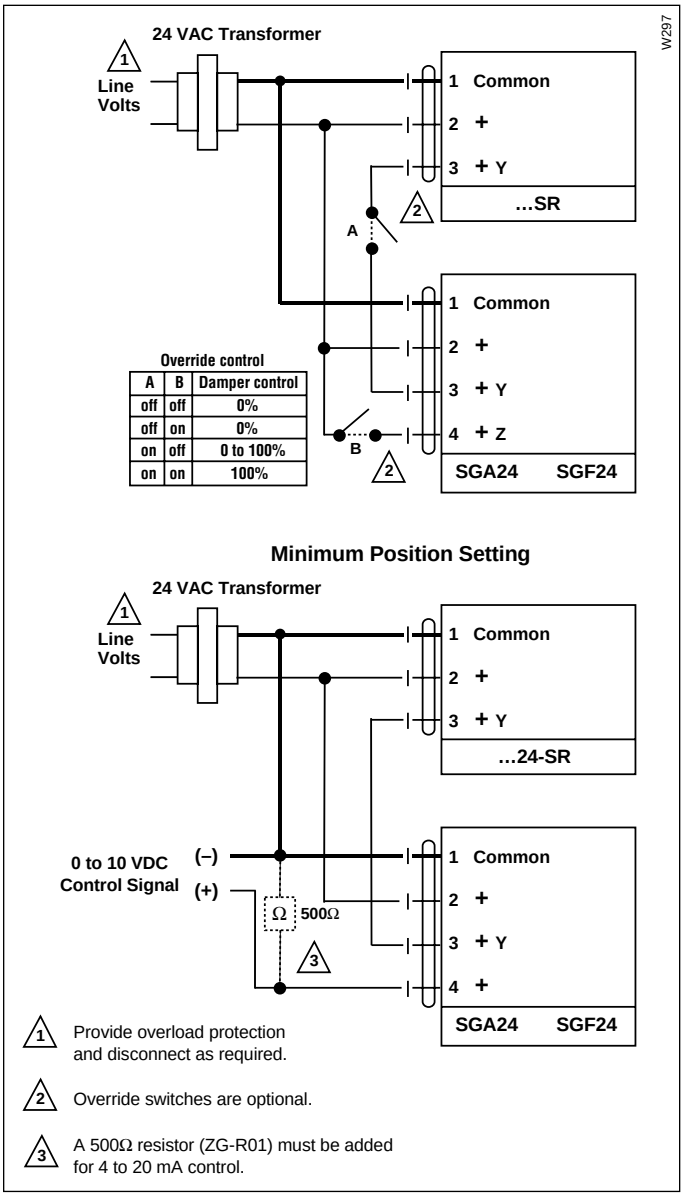
SGA24, SGF24 Positioners

For Proportional Actuators with a Working Range of 0 to 10 VDC or 2 to 10 VDC


SGA24


SGF24

Wiring Diagram



1 Provide overload protection and disconnect as required.

2 Override switches are optional.

3 A 500Ω resistor (ZG-R01) must be added for 4 to 20 mA control.

Technical Data	SGA24, SGF24
Power supply	24 VAC ± 20% 50/60 Hz 24 VDC ± 10%
Transformer sizing	1 VA
Control signal Y	0.5 to 10 VDC; 2 to 10 VDC (switchable)
Power output	up to 10 actuators (1 mA max)
Degree of protection	(SGA24 only NEMA 4 [1P54])
Connection	Terminals (14 ga. wire max)
Humidity	5 to 95% RH non-condensing

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 0.5 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.

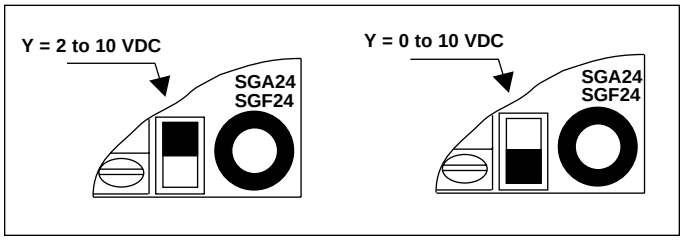
Function

The changeover from 2 to10 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.

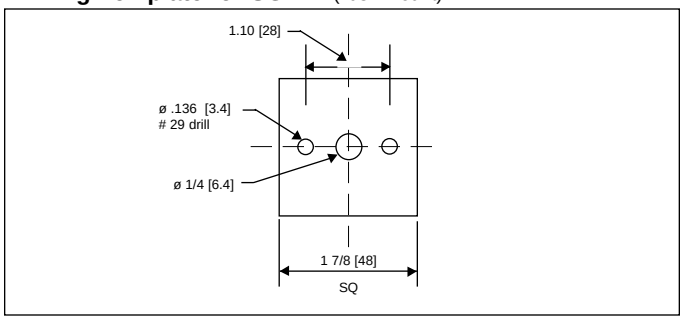
Accessory

ZG-SGF Mounting plate for single gang wiring box

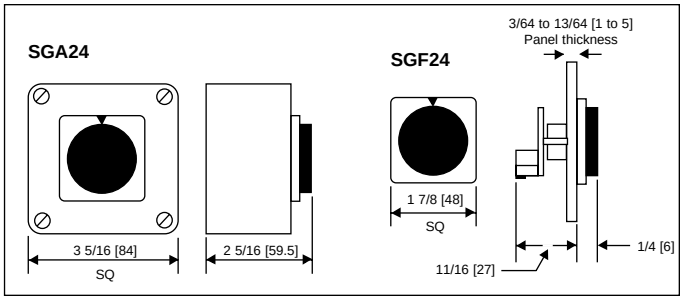
Changeover Switch



Drilling Template for SGF24 (flush mount)

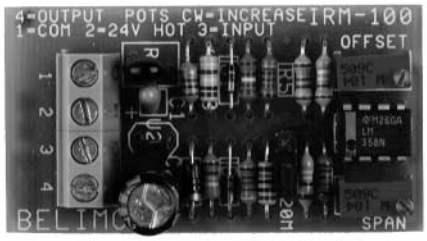


Dimensions [All numbers in brackets are in millimeters.]

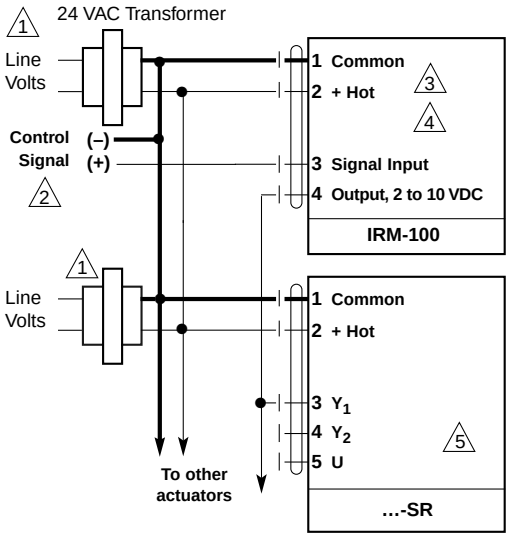


IRM-100 Input Rescaling Module

To Adjust the Zero Start Point and Working Span of Proportional (. . –SR) Actuators. (Series 3)



Wiring Diagram



1. Provide overload protection and disconnect as required.
2. The controller should be powered from a separate transformer.
3. The actuator and IRM-100 may be powered from the same transformer.
4. Consult controller instruction data for more detailed installation information.
5. To reverse control rotation, use the reversing switch.

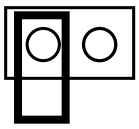
Technical Data	IRM-100	
Power supply	supply voltage:	24 VAC ± 15% 24 VDC ± 15%
Power consumption	< 1 watt	
Transformer sizing	1 VA	
Input voltage:	max voltage:	25 VDC
	zero (starting point):	0 to 18 VDC
	span adjustment:	2.6 to 17 VDC
	impedance:	400KΩ
current:	0 to 20 mA	
	impedance:	500Ω
Output	voltage:	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.	

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 -SR type actuators. The IRM-100 is available for replacement of existing installations.

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.



Jumper not connected to both pins for voltage applications (as shipped)

Jumper on both pins for 4 to 20 mA applications

The IRM may also be used to sequence several actuators from one signal source. This is done by adjusting the IRM units to work at different in put ranges.

IRM-100 used as a current amplifier

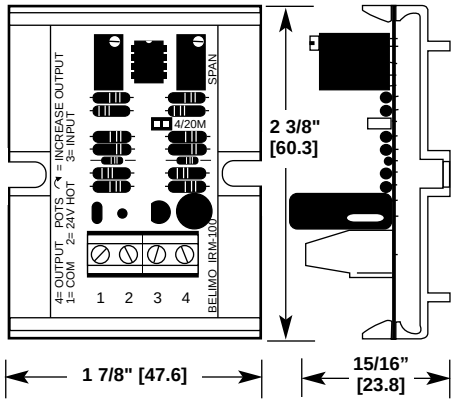
In some applications, the capacity of a controller output may not have current available to control multiple end devices. An example would be a controller which has an output current of .5 mA maximum. If 10 TAF24-SR actuators have to be driven from the same output, the current requirement would be I = E/R = (10 volts)/(100000Ω) = .1 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 500Ω resistor is placed across terminal #1 and #3 which converts the 4 to 20 mA to 2 to 10 VDC.

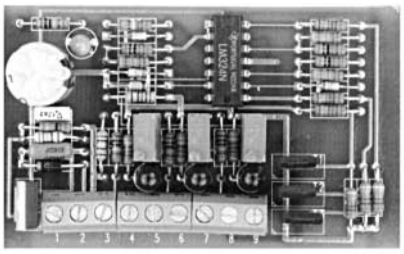
Dimensions [All numbers in brackets are in millimeters.]

IRM-100

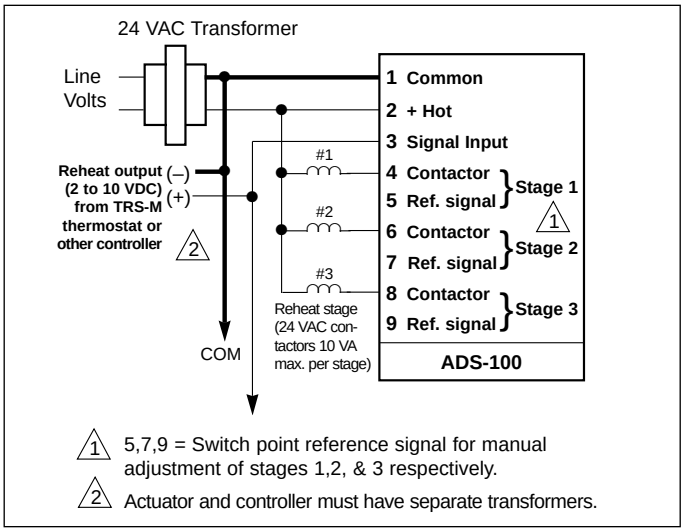


Analog to Digital Switch ADS-100

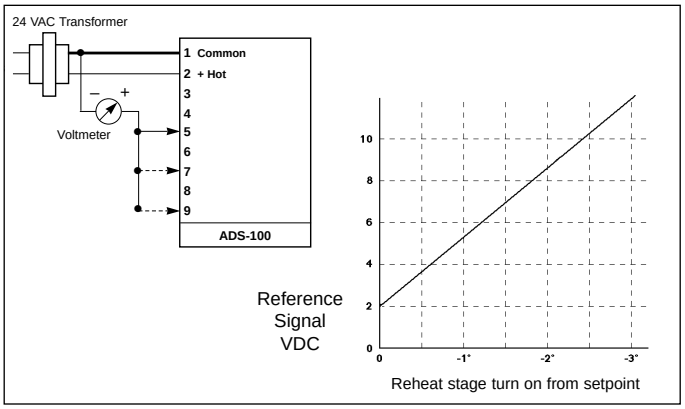
For Proportional (. . –SR) Actuators.



Wiring Diagram



Switchpoint Adjustment Drawings



Technical Data	ADS-100
Power supply	24 VAC ± 20% 50/60 HZ
Power consumption	1.5 W
Transformer sizing	3 VA (not including contactors)
Electrical connection	9 pole wire-terminal
Control input	2 to 10 VDC
Input impedance	100KΩ
Adjusting range	2.5 to 9.5 VDC
Dead band	0.3°F fixed
Switching capacity	24 VAC 10 VA max. (voltage sinking triac)
Mounting	Snap-Track (provided)
Dimensions	3 1/4" x 2" (3 7/16" x 2" w/snap-track)

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)

	1st. stage	2nd. stage	3rd. stage
Switch ON	-0.45°F	-1.35°F	-2.25°F
Switch OFF	-0.15°F	-1.05°F	-1.95°F
Switch ON	2.8V	5.8V	8.8V
Switch OFF	0.4V	0.2V	0.4V

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.

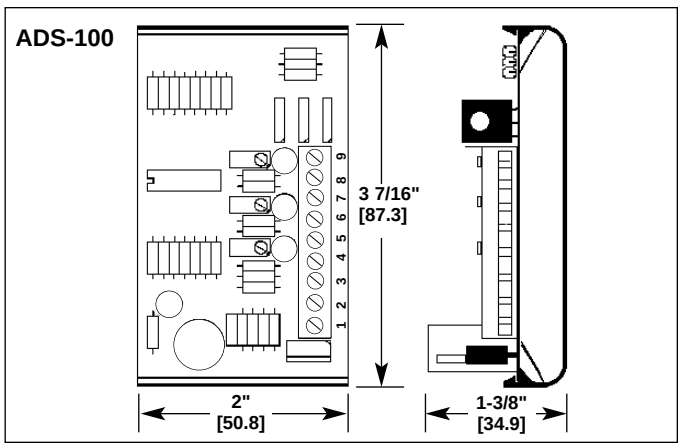
To readjust the output stages, the following procedure is used: Connect the voltmeter to the desired switchpoint reference signal output and terminal 1 (COM). Readjust the switch point reference signal output with the corresponding potentiometer to your desired switch point. The adjustment range is 2.5 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.

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 type actuator.

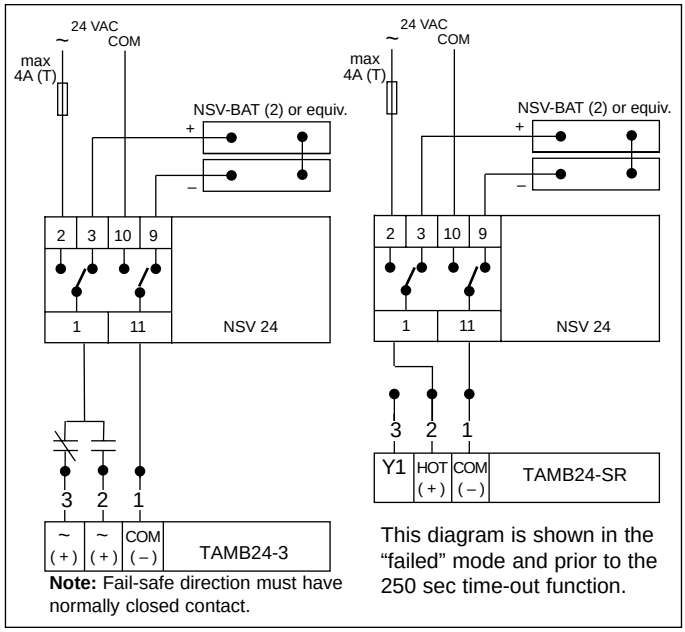
The ADS-100 has 3 triac outputs rated at 10 VA maximum each which will turn on, in sequence, with an increasing voltage.

Dimensions [All numbers in brackets are in millimeters.]



Battery Back-up Module NSV24

Wiring Diagram



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.

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 Charge voltage 24-27 V, temperature compensated
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]

Application

Several 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 f ailures. The main power source operation is indicated by a green LED, and the battery power source by a red LED.

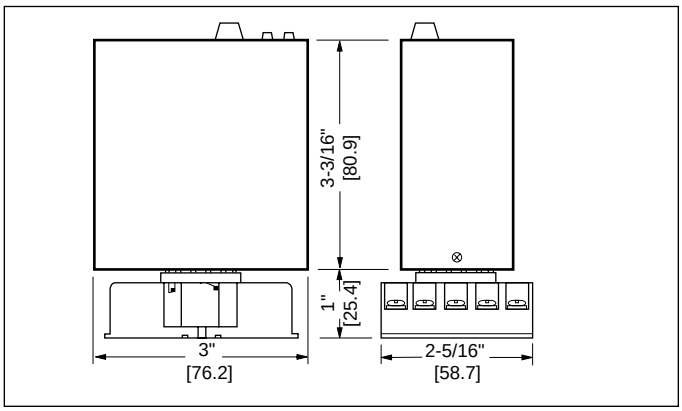
Connectable Actuators

Model	Maximum per module
TGMB24-3	20
TGMB24-SR	15
TAMB24-3	30
TAMB24-SR	30
TNMB24-3	30
TNMB24-SR	30
TLMB24-3	30
TLMB24-SR	30

Accessories

NSV-BAT 12 VDC 1.2 Ah battery (2 required).

Dimensions [All numbers in brackets are in millimeters.]

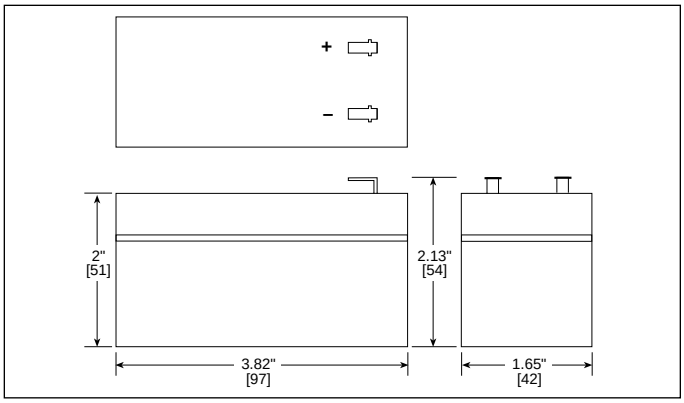


NSV-BAT 12 V Battery

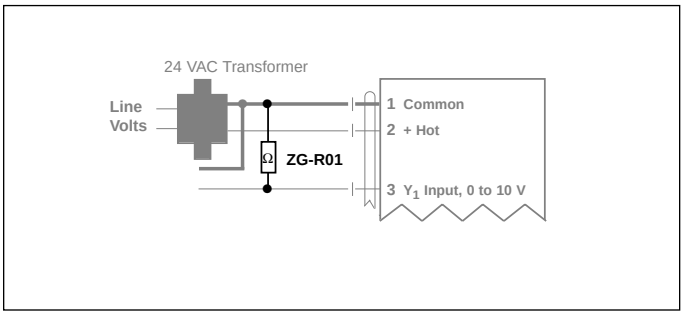
Technical Data	NSV-BAT
Battery type	Lead-acid
Voltage	12VDC
Nominal capacity	1.2 AH
Connections	.187 male spade
Weight	1.32 lb [.6 kg]

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 [All numbers in brackets are in millimeters.]

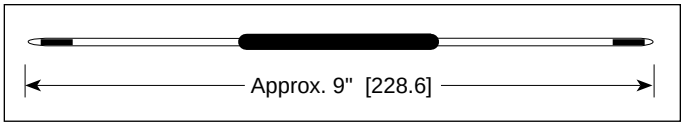


ZG-R01 Resistor for 4 to 20 mA Conversions

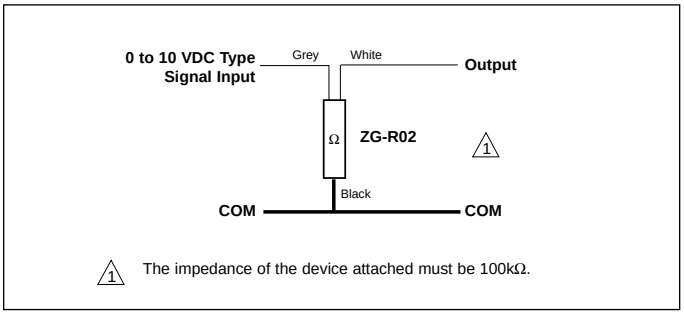


Application
The ZG-R01 is a 499Ω Resistor which has been encased in a section of heat shrink tubing with short sections of hook up wire.The ZG-R01 is used to convert a 4 to 20mA signal into a 2 to 10 VDC control signal.

Dimensions [All numbers in brackets are in millimeters.]

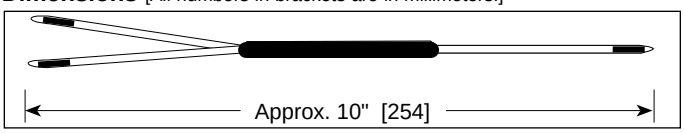


ZG-R02 50% Voltage Divider



Application
The ZG-R02 is a voltage divider designed so that when connected to a 100KΩ 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 [All numbers in brackets are in millimeters.]



ZG-CBNS / ZG-CBLS

Junction Box for TLF…(-S), TNF…(-S) and TAF…(-S)* Actuators

ZG-CBNS Junction box

ZG-CBLS Junction box

Application
The ZG-CBNS accessory is used when the application requires the wiring terminations to be made at the actuator.

Operation
The ZG-CBNS serves as an electrical junction box. The products that can be used with this accessory are as follows:

TNF24, TNF24-S
TNF24-SR

TAF24
TAF24-SR

*Due to the internal volume of this junction box, according to UL requirements, The ZG-CBNS **CANNOT** be used with the following products:

TAF24-S

Application
The ZG-CBLS accessory is used when the application requires the wiring terminations to be made at the actuator.

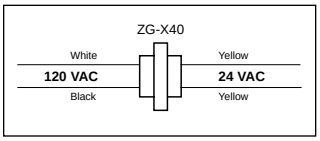
Operation
The ZG-CBLS serves as an electrical junction box. This product can be used with any standard LF product.

Technical Data	ZG-CBNS / ZG-CBLS
Voltage rating	250 VAC
Electrical connection	Maximum 5 line voltage connection
Housing rating	UL94 5V
Material type	FR/ABS CYCOLAC KJW4051
Ambient temperature	-22°F to+122°F [-30°C to +50°C]
Storage temperature	-40°F to +176°F [-40°C to +80°C]
Agency listing	UL 873 (pending)
Quality standards	ISO 9001
Weight	<0.5 lbs

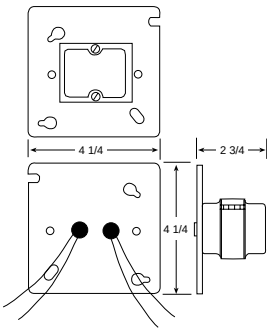
Transformer ZG-X40

40 VA, 120 to 24 VAC Transformer

Wiring Diagram



Dimensions



Application

The ZG-X40 is a 40 VA, 120 to 24 VAC transformer. It is designed so that both the primary and secondary leads exit through the same side of a 4 1/4" square outlet box cover. With this design, all wiring can be done inside a standard J-box with a minimum amount of labor.

Wire Specification

No. 18 AWG leads, 6 1/2" length	
Termination	**Color**
Primary	White-Black
Secondary	Yellow-Yellow

Technical Data	**ZG-X40**
Primary Voltage	120 VAC 50/60 Hz
Secondary Voltage	24 VAC
Max VA Rating	40 VA
Connections	6 1/2" leads with stripped ends
Type	Class 2
Mounting Method	4 1/4" square outlet box cover
Agency Approvals	UL 1585, CSA 22.2 #66

Maximum Number of Like Actuators per Transformer

Model #	**Qty**	**Model #**	**Qty**
TNMB24-3	11	TAF24. .	4
TNMB24-SR	13	TNF24 (-S)	5
TAMB24-3	8	TNF 120 (-S)	5
TAMB24-SR	8	TNF24-SR	6
TGMB24-3	6	TLF24	8
TGMB24-SR	5	TLF24-SR	8

Refers to appropriate actuator documentation for specific VA ratings.

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.

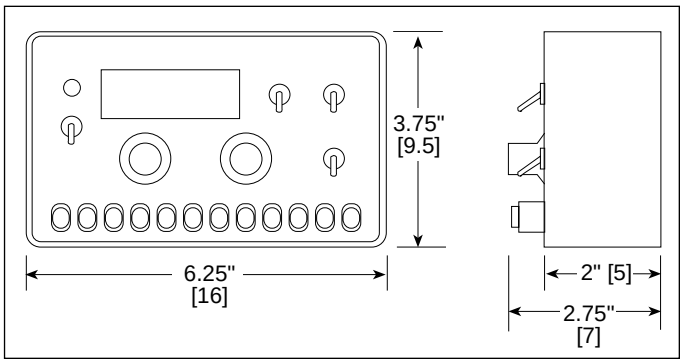
The PS-100 can produce 24 VAC on-off and floating control signal along with a 0 to 10 VDC and 135Ω proportional signal. A multi-function digital display is provided which can read either the 0 to 10 VDC output or a 0 to 10 VDC feedback signal either as voltage or percentage of control.

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

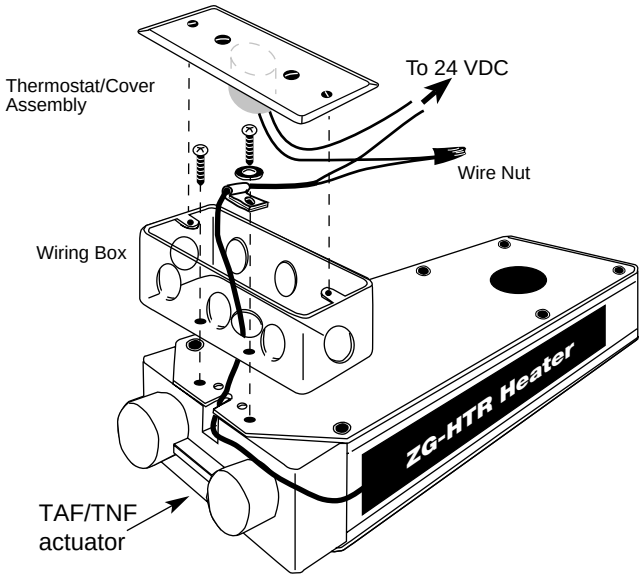
Technical Data	**PS-100**
Power supply	120 VAC 50/60 Hz
Power consumption	< 4 W without actuator
Transformer	Primary: 120 VAC, 35 W Secondary: 24 VAC, Class 2 trans. PN: PS-XFMR
Terminal outputs	Push-button, wire terminals (12) On-off, Floating Point 135Ω, 0 to 10 VDC
Input	0 to 10 VDC
Display	LCD
Readouts, Output	0 to 10 VDC in volts or percentage based on a 2 to 10 VDC control span
Readouts, Input	0 to 10 VDC in volts or percentage based on a 2 to 10 VDC control span
Weight	3 lbs [1.4 kg] with case

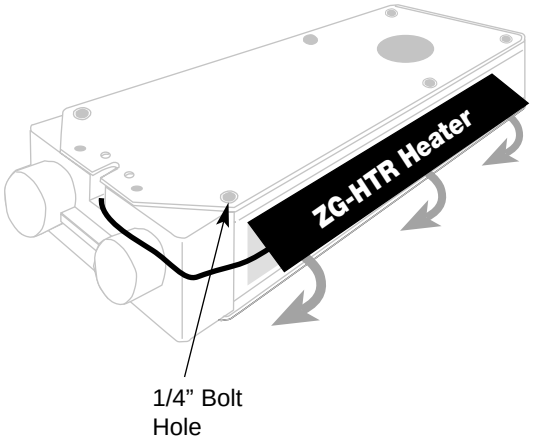
Dimensions [All numbers in brackets are in millimeters.]



ZG-HTR TNF/TAF Thermostat/heater Kit

For TNF/TAF Series Actuators

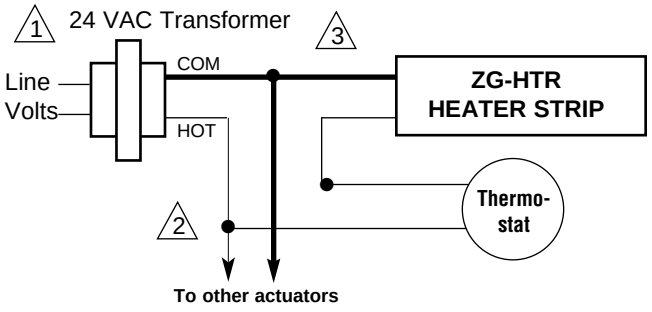




Application

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.

Wiring Diagram



1. Provide overload protection and disconnect as required.
2. The ZG-HTR may be wired to the same transformer as the actuator. Total VA ratings must be observed.
3. Power to the ZG-HTR must be applied continuously during the heating season. Do not wire the ZG-HTR to the on-off control signal when on-off type actuators are being used.

Dimensions [All numbers in brackets are in millimeters.]

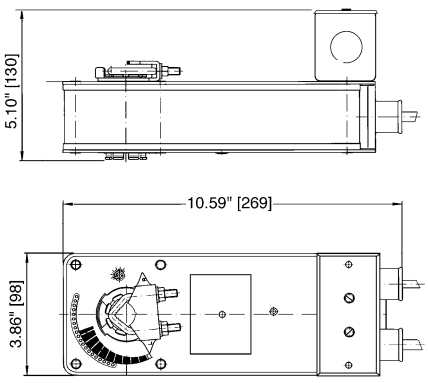
Standard:

∅ 3/8" to 3/4"

□ 3/8" to 5/8"

Optional*

∅ 3/4" to 1.05"



*with K4-1 US clamp

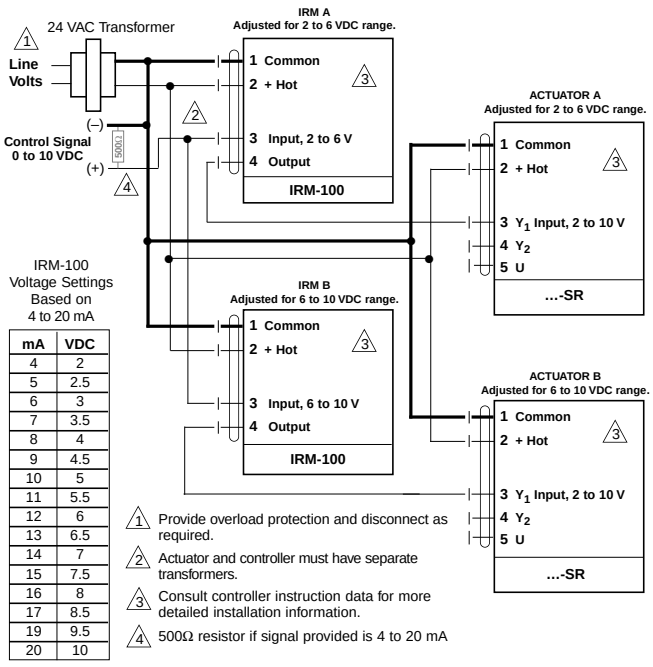
Technical Data	ZG-HTR
Power supply	24 VAC ± 20% 50/60 Hz
Transformer sizing	35 VA
Heater output	35 watts
Actuator low ambient rating	with enclosure: -40° F [-40° C] enclosure with 1" insulation: -58° F [-50° C]
Weight	11 oz [320 g]

Special Control Range Applications

Control Signal	Belimo Actuator	Accessory	Notes
1 to 5 VDC	AF24-MFT US NF24-MFT US LF24-MFT US GMX24-MFT AMX24-MFT NMX24-MFT LMX24-MFT	None	Preset at factory or use PC Tool Software Set start point for 1 VDC, span for 4 VDC
4 to 20 mA	Any -MFT,-SR Actuator (Including Trane)	ZG-R01, or 500Ω, 1/2 w resistor	Wire the ZG-R01 across the wires #1 and #3
10.5 to 13.5 VDC	AF24-MFT US NF24-MFT US LF24-MFT US GMX24-MFT AMX24-MFT NMX24-MFT LMX24-MFT	None	Preset at factory or use PC Tool Software Set start point for 10.5 VDC, span for 3 VDC
14 to 17 VDC	AF24-MFT US NF24-MFT US LF24-MFT US GMX24-MFT AMX24-MFT NMX24-MFT LMX24-MFT	None	Preset at factory or use PC Tool Software Set start point for 14 VDC, span for 3 VDC
Pulse Width Modulation	AF24-MFT US NF24-MFT US LF24-MFT US GMX24-MFT AMX24-MFT NMX24-MFT LMX24-MFT	None	Preset at factory or use PC Tool Software

*Preset at factory or use PC Tool Software
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

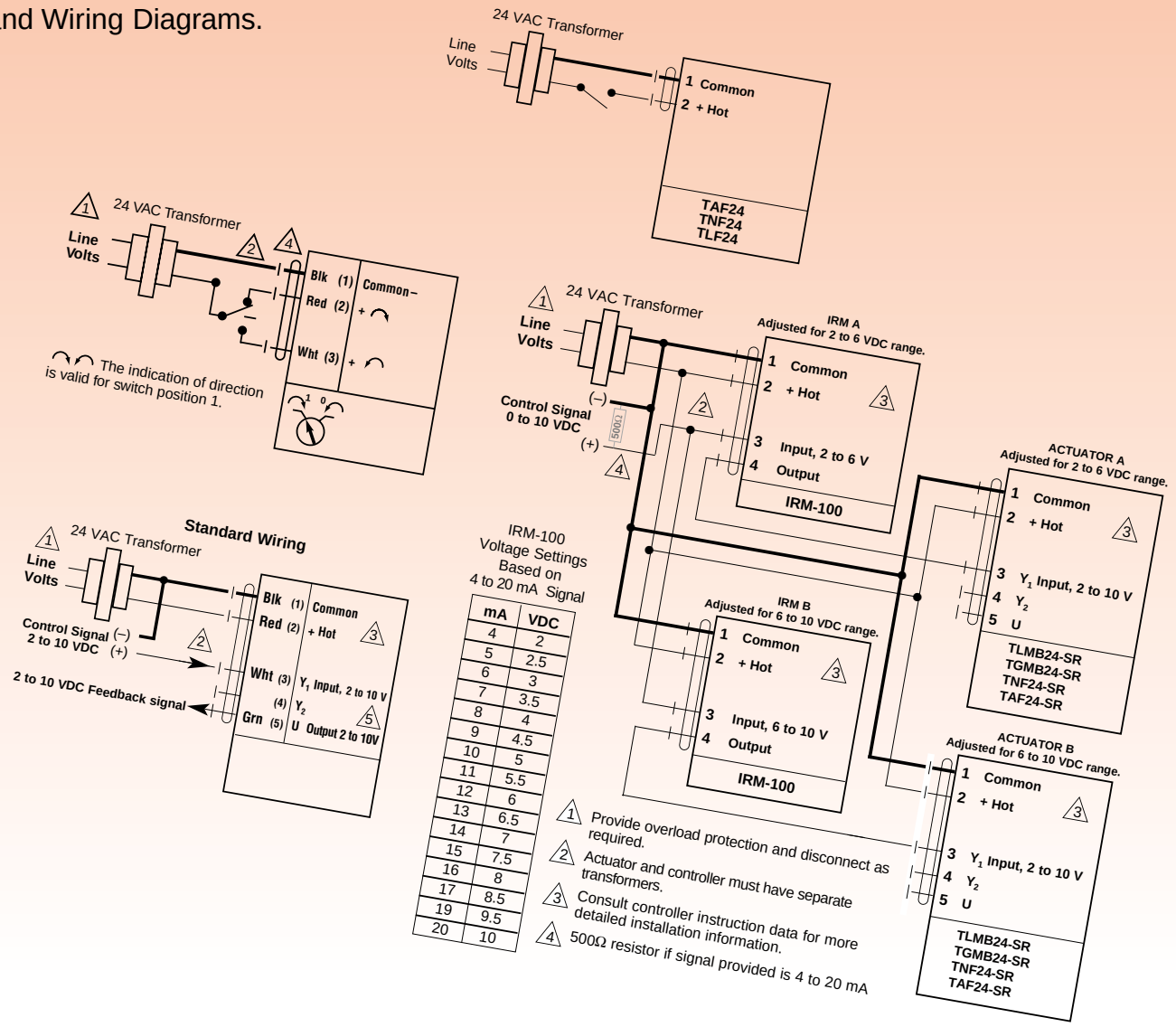


IRM-100 Voltage Settings Based on 4 to 20 mA

mA	VDC
4	2
5	2.5
6	3
7	3.5
8	4
9	4.5
10	5
11	5.5
12	6
13	6.5
14	7
15	7.5
16	8
17	8.5
19	9.5
20	10

A CLOSER LOOK...

Application Information and Wiring Diagrams.



- *Basic Electricity*
- *Understanding Wiring Diagrams*
- *Analog Outputs*
- *Wiring Diagrams*
- *Applications*

INDEX

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 = Mega ohm = 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

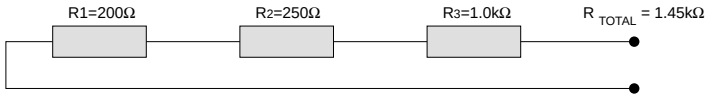
W = E x I	*Example:*	V = 24V, I = 260mA Therefore, W = 24 x .260 = 6.24W
$W = R \times I^2$	*Example 1:*	R = 100Ω, I = 3A $W = 100 \times 3^2 = 100 \times 3 \times 3 = 900W$
	Example 2:	R = 500Ω, I = 20mA = .020A $W = 500 \times .020^2 = 500 \times .020 \times .020 = 500 \times .0004 = .2W$ or 200mW.
$W = E^2/R$	*Example:*	V = 24V, R = 100, Therefore, $W = 24^2/100 = 24 \times 24/100 = 5.76W$

*** 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.

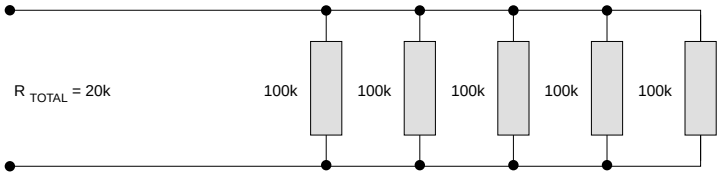
Example: $R_1 = 200\Omega$ $R_2 = 250\Omega$ $R_3 = 1.0k\Omega$ $R_{Total} = R_1 + R_2 + R_3 = 200\Omega + 250\Omega + 1.0K\Omega = 1.45k\Omega$



The total resistance is always larger than the largest single resistor!

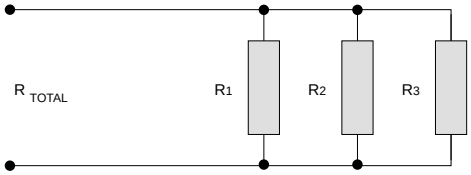
I-I. Parallel Connection of Resistors

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.



Example: Five equal resistors R = 100k are connected in parallel.
The total resistance $R_{Total} = R/5 = 100/5 = 20k$

If the resistors that are connected in parallel have different values, the following formula must be used:



The total resistance is always smaller than the smallest single resistor!

Example: R1 = 200 R2 = 250 R3 = 1.0k

$$\frac{1}{R_{TOTAL}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{TOTAL}} = \frac{1}{200} + \frac{1}{250} + \frac{1}{1000} = .005 + .004 + .001 = .01$$

$$R_{TOTAL} = \frac{1}{.01} = 100\Omega$$

$R_{TOTAL} = 100\Omega$

I-J. Impedance

The expression “impedance” is used in the 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.**

- **Output impedance:** The output of a controller has a limited amount of current capacity to supply to the devices it is controlling. The capacity can be given in one of 2 ways. One way is by stating it as “Maximum output current .2 mA.” The other is by giving its output impedance. The output impedance must always be lower than the combined input impedance of the devices being controlled.
  Example I: “Output impedance 1000Ω 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 x 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 TAMB24.
Power consumption: 2.5 W. Transformer sizing: 4.5 VA

If five (5) TAMB24 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.

These 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 TAMB24-SR actuators are powered from the same wire. The wire run is 100 feet.**

Step #1. Calculate the total power required.
The TAMB24-SR 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 15VA 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.

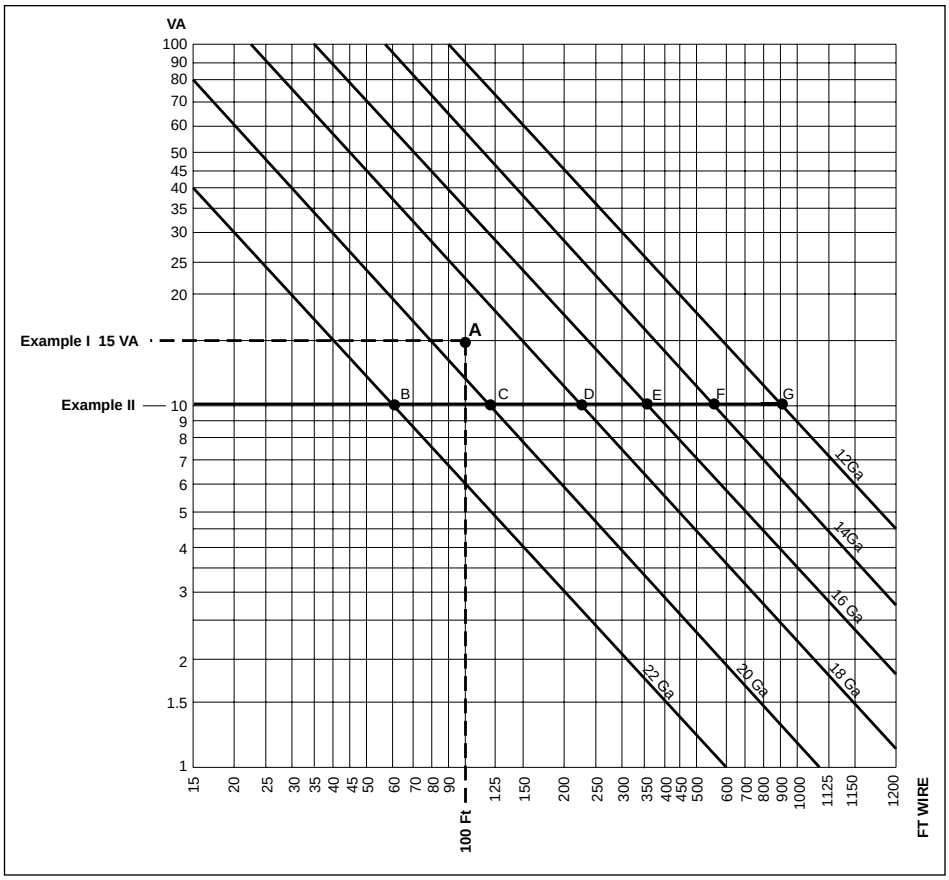


Chart 1

Note: A low gauge number = a thicker wire; A high gauge number = a thinner wire.

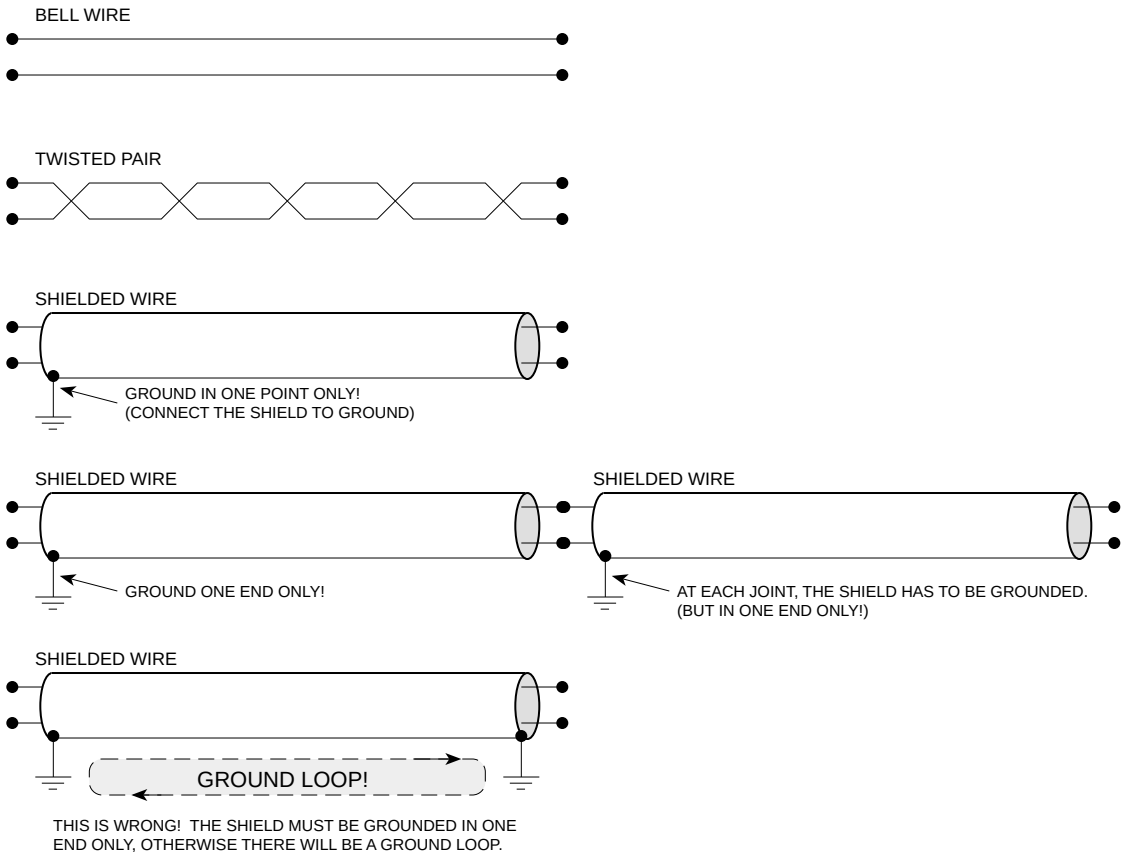
Example II: **The maximum wire length for a 10 VA power consumption using different wire gauges.**

Point "B"	22 Ga	Max. 60 FT
Point "C"	20 Ga	Max. 120 FT
Point "D"	18 Ga	Max. 220 FT
Point "E"	16 Ga	Max. 350 FT
Point "F"	14 Ga	Max. 550 FT
Point "G"	12 Ga	Max. 900 FT

I-M. Multi-Conductor Wire Types

- *"BELL 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 a 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 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 Figure 11-5 and 11-6, page 175.)

Signal common (COM ⊥) is necessary, as a reference, but only one connection should be used.

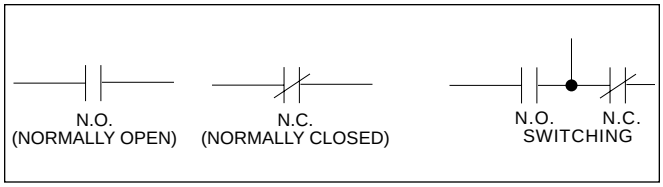
Redundant signal common terminals should not be connected.

A ground loop acts as an antenna and will pick up electrical noise. This should be avoided, by using the correct wiring practice.

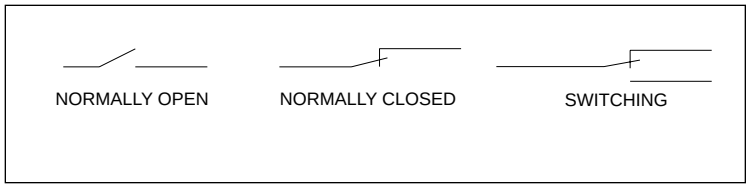
II. UNDERSTANDING WIRING DIAGRAMS

II-A. Electrical Symbols

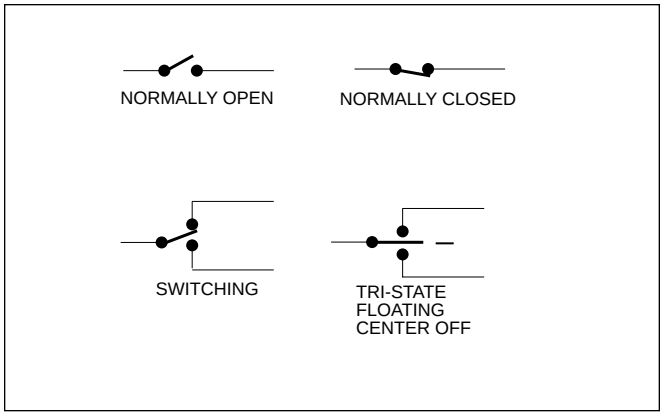
U.S. Electrical Symbols for Contacts



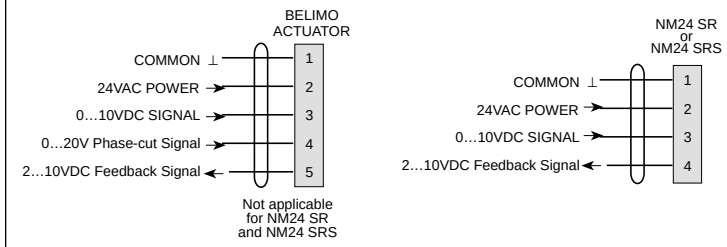
International Symbols for Contacts



Traditional Electronic Symbols for Contacts



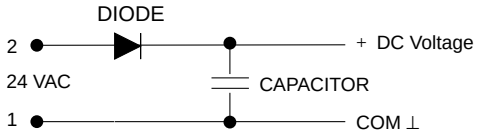
Proportional Actuators- Wire Symbols and Numbers



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

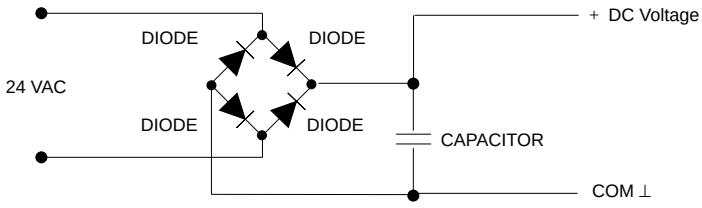
Power Supply with Half-Wave Rectifier



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.

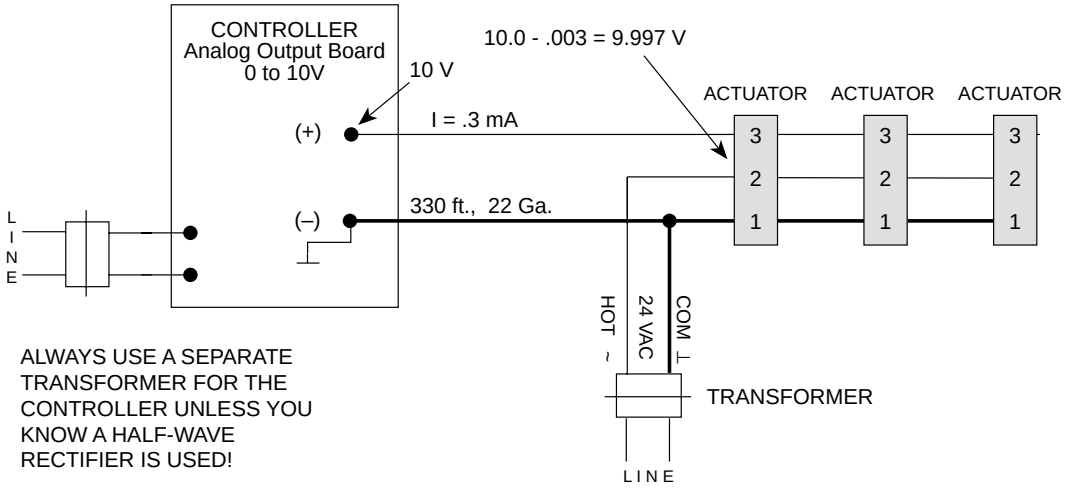
These products use half-wave rectifiers. Therefore, they may be connected to the same transformer as long as all commons (COM ⊥) are connected to the same leg of the transformer. However, anytime actuators are connected to a controller a separate transformer should be used for the controller power supply 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

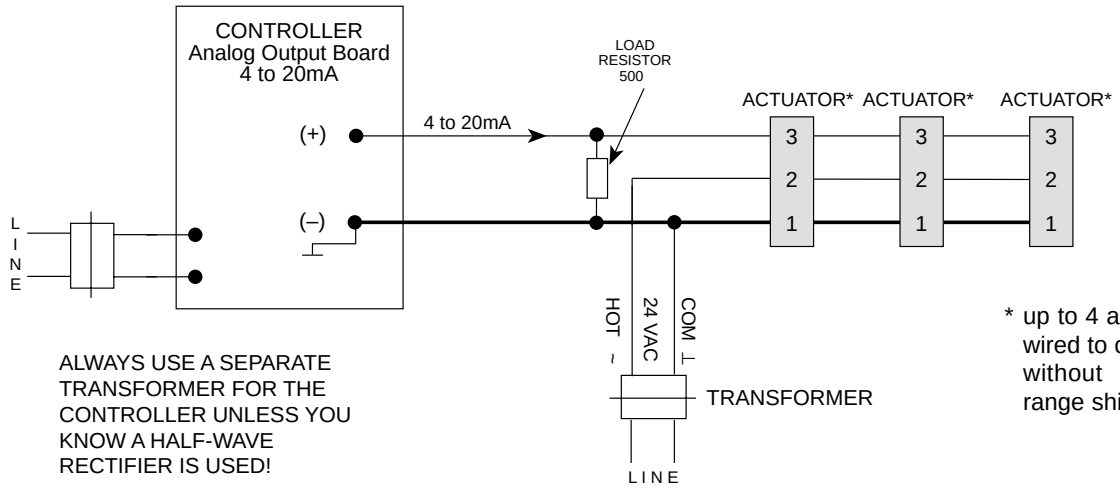
Due to the high input impedance (100kΩ) of the actuators, the current through the signal wire is very low. Therefore, the loss of signal will be negligible, even if with long wire runs.
Example: Three actuators are connected via a 330 ft. (100 meters) long pair of 22 Ga. wires. Each wire has a resistance of 5Ω.
The current draw from each actuator is (I = E/R) 10/100,000 = 0.1 mA, when the signal is 10 VDC.
The current in the wire will be 3 x 0.1 = 0.3 mA. Because 2 wires, the Common and the Source, go to the actuator, the resistance in the wires is 2 x 5Ω = 10Ω. The loss of signal will be (E = R x I) 10 x 0.3 = 3 mV = -.003V.



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.



* up to 4 actuators may be wired to one load resistor without a significant range shift.

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

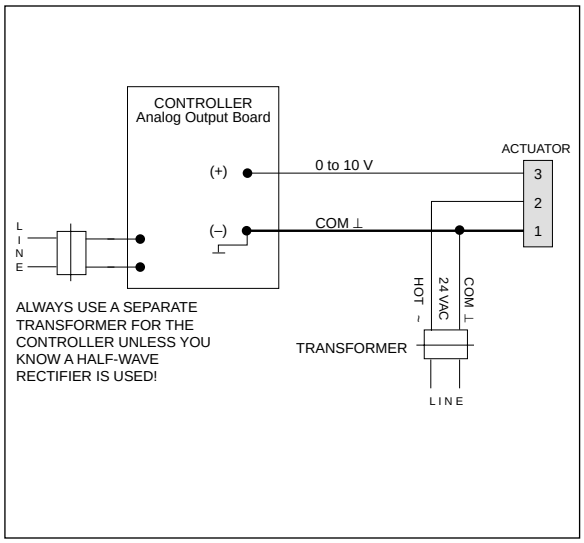


Fig. II-1 Single Output to Single Actuator

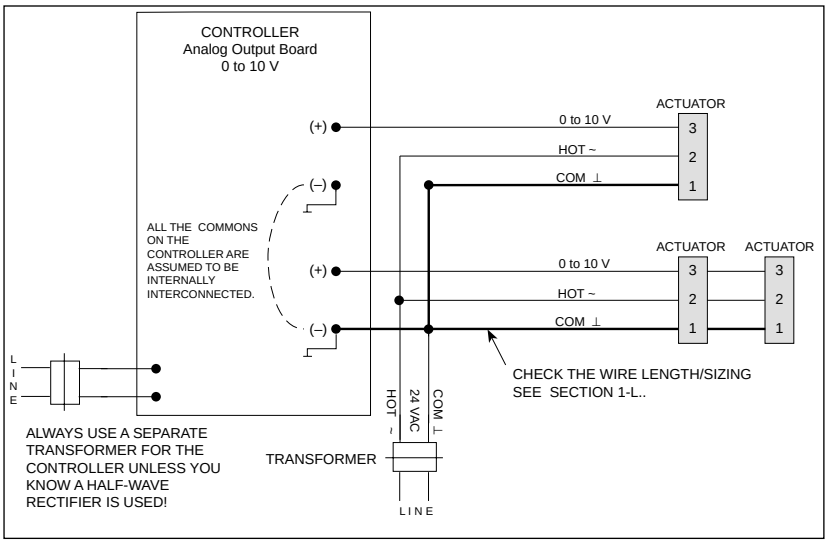


Fig. II-2 Multiple Outputs to Multiple Actuators Using 1 Transformer for Actuators

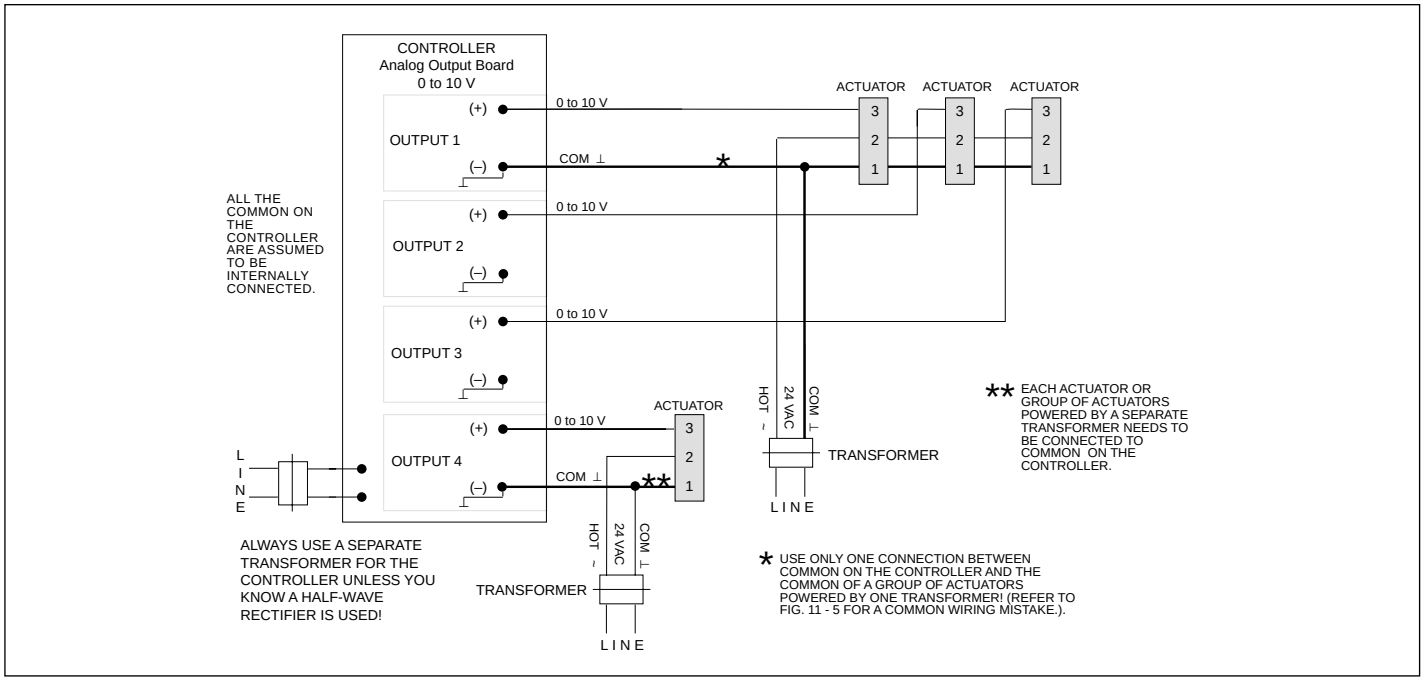


Fig. II-3 Multiple Outputs to Multiple Actuators Using 2 Transformers for Actuators

II-D. Long Distance Wiring

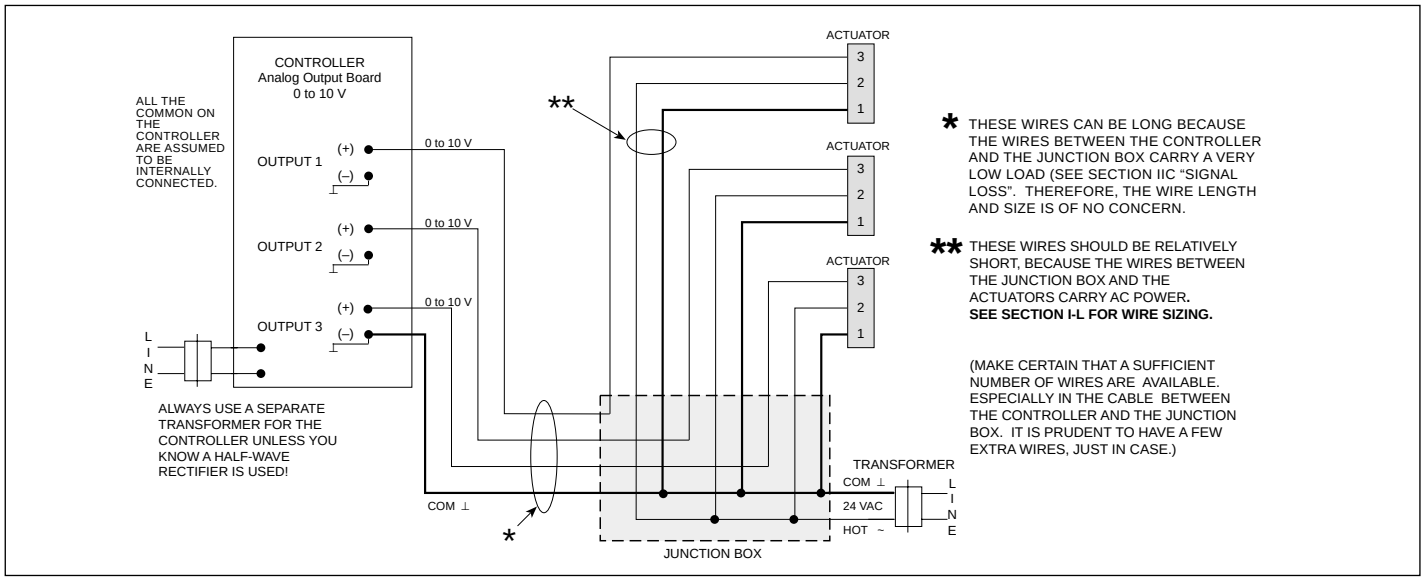


Fig. II-4

II-E. Wiring Mistakes

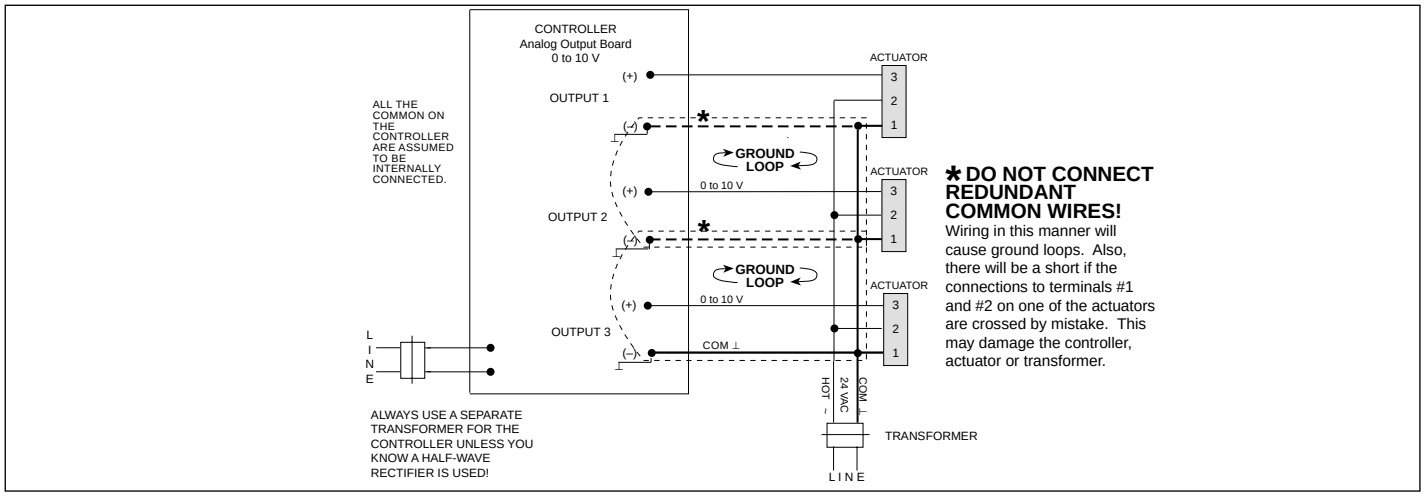


Fig. II-5 A Common Wiring Problem

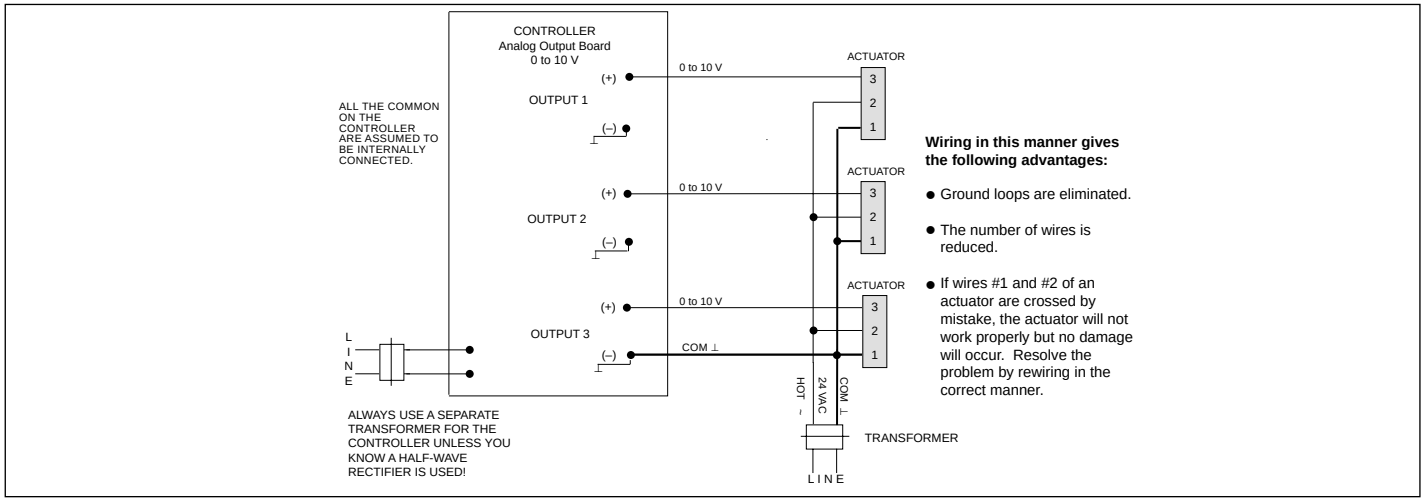


Fig. II-6 Correct Wiring

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.

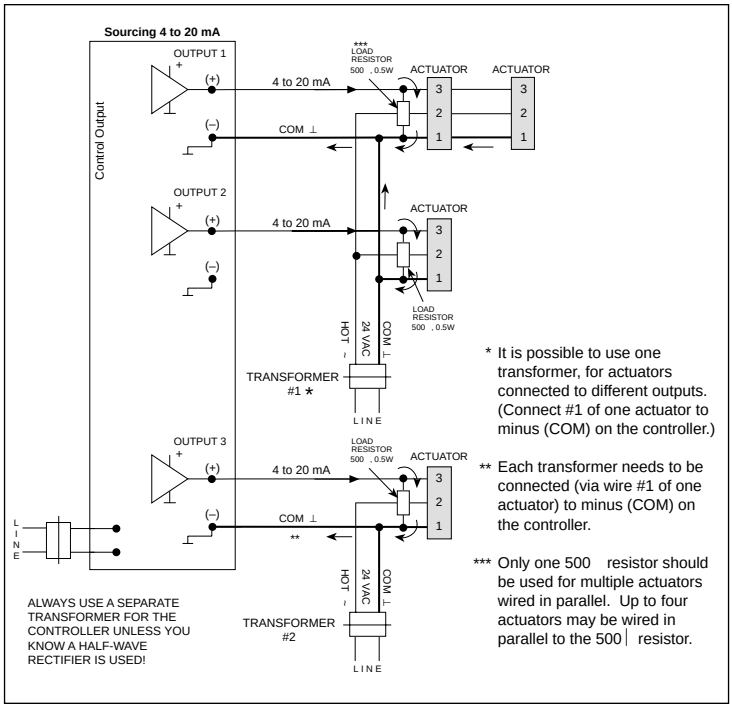


Fig III-1

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)

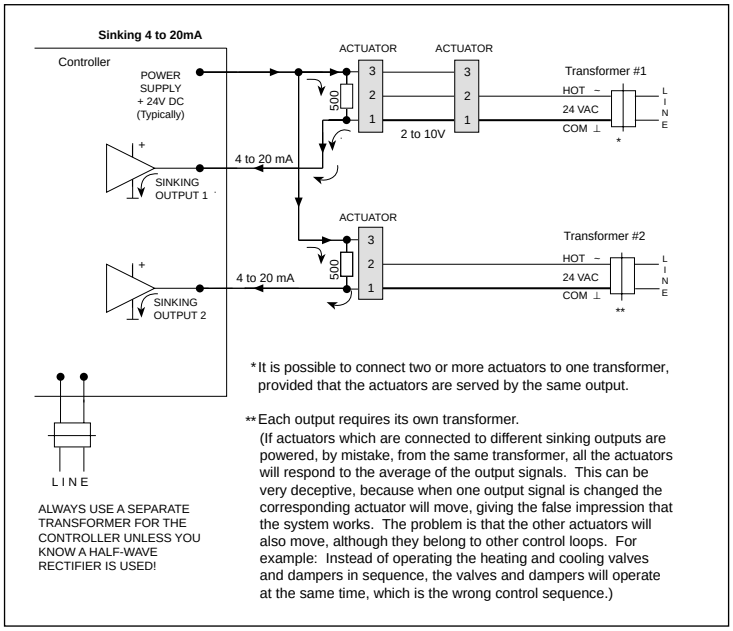


Fig. III-2 Sinking 4 to 20 mA

III-D. Parallel Operation

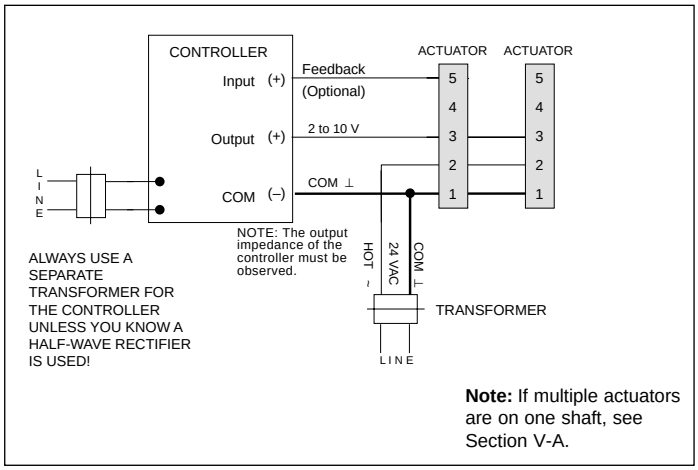


Fig III-3

III-E. Master-Slave operation

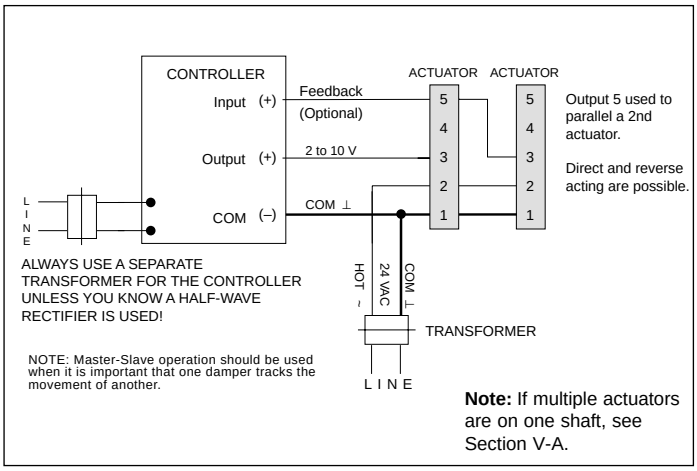


Fig III-4

III-F. Monitoring feedback with a remote indicator

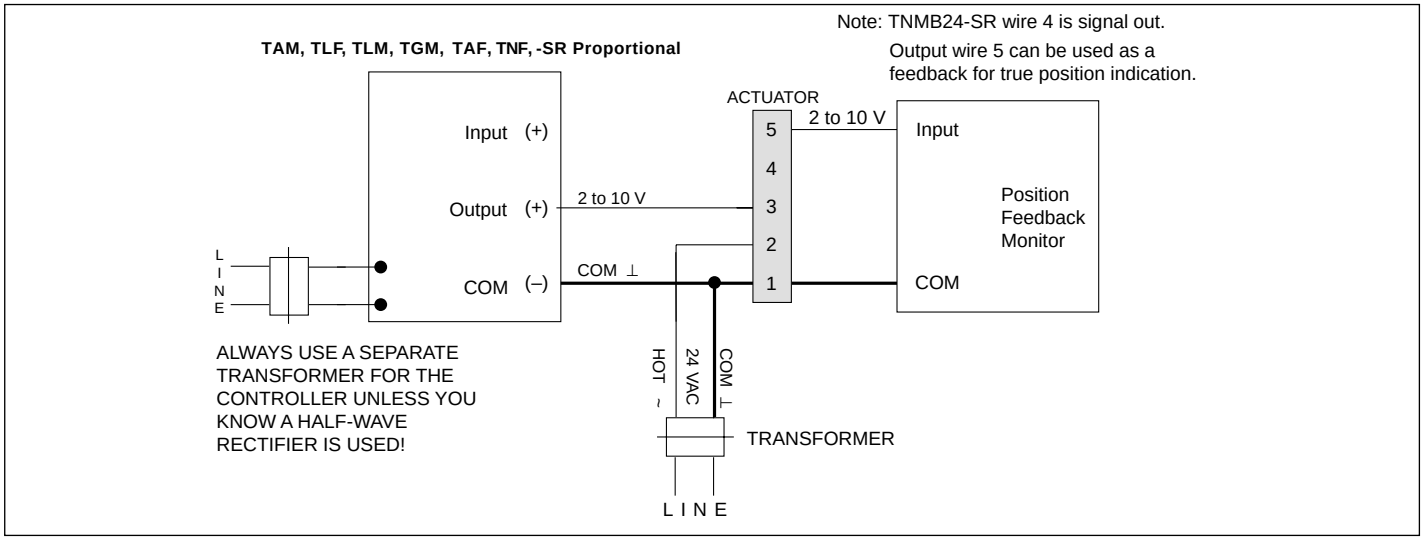


Fig. III-5

III-G. One Output/Multiple Transformers

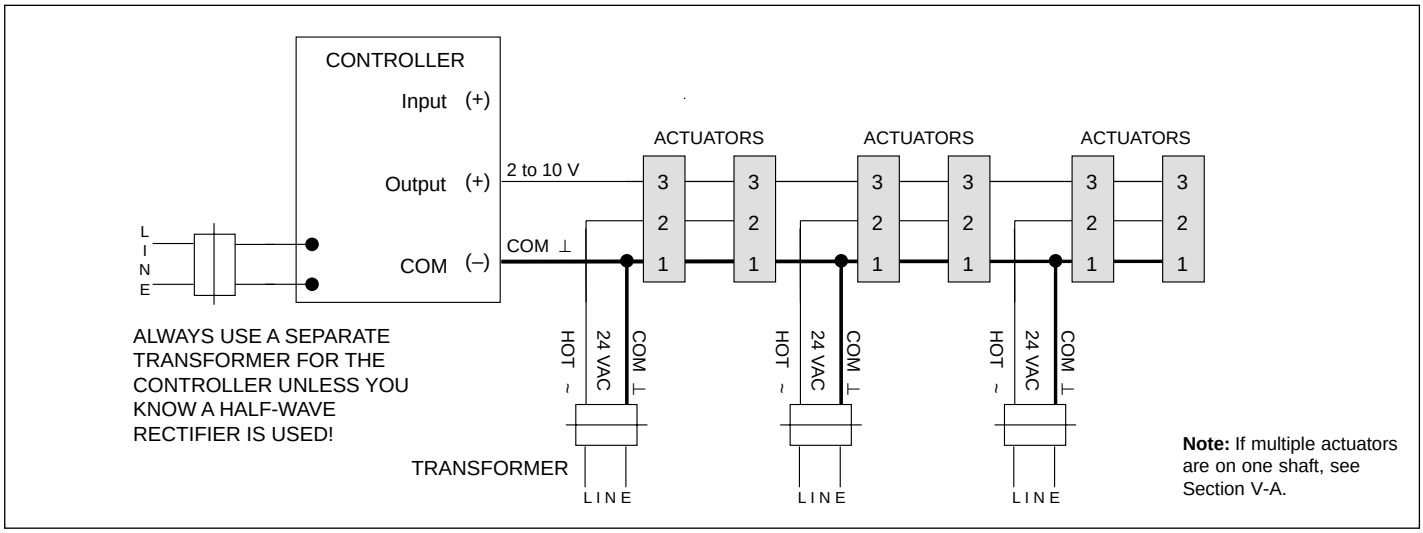
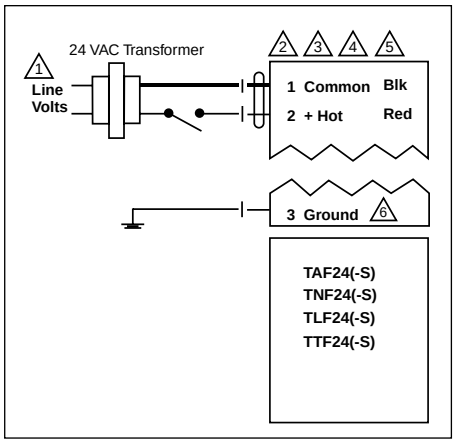


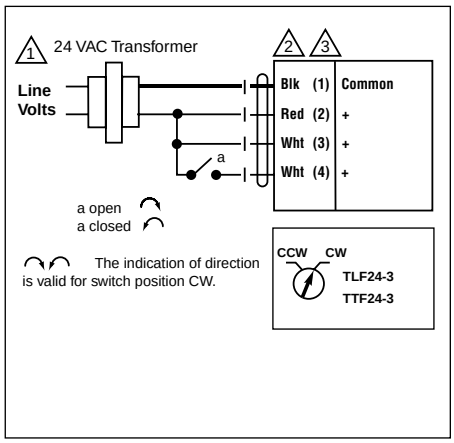
Fig. III-6

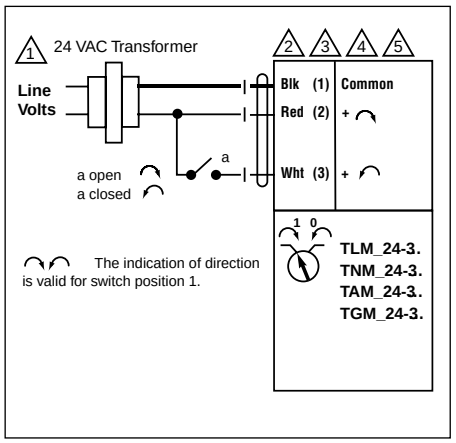
IV. Wiring Diagrams

IV-A. IV-A. On/Off Control, 24V

W419





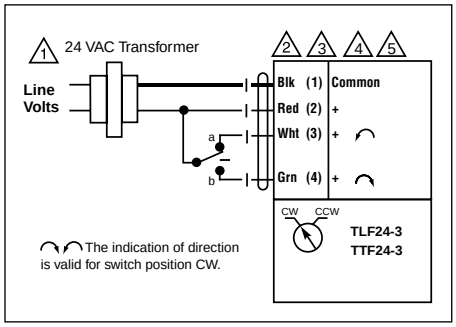


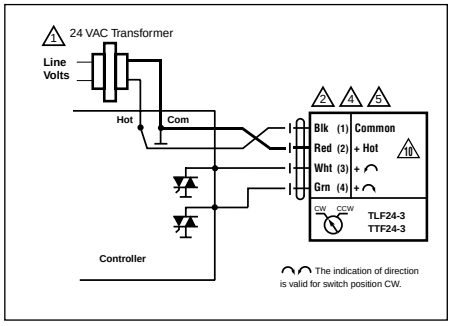
Notes:

1. Provide overload protection and disconnect as required.
2. Actuators may be connected in parallel. Power consumption and input impedance must be observed.
3. Actuators may also be powered by 24 VDC.
4. Meets cULus or UL and CSA requirements without the need of an electrical ground connection.
5. Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables are numbered.
6. Ground connection required only for Fire and Smoke actuators.

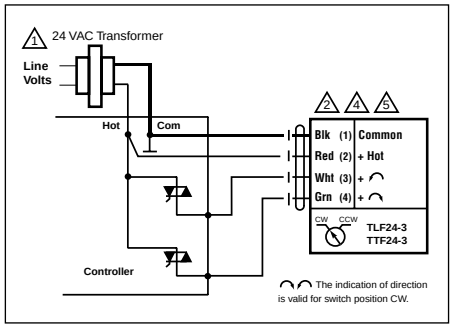
IV-B. Floating Point Control, 24V

W488

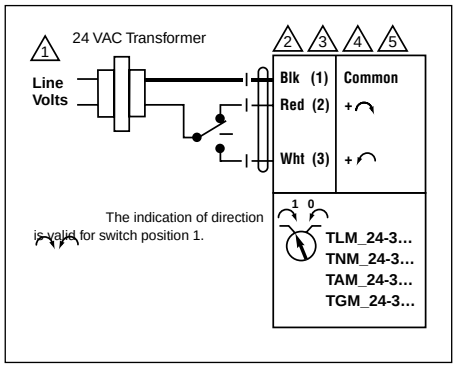


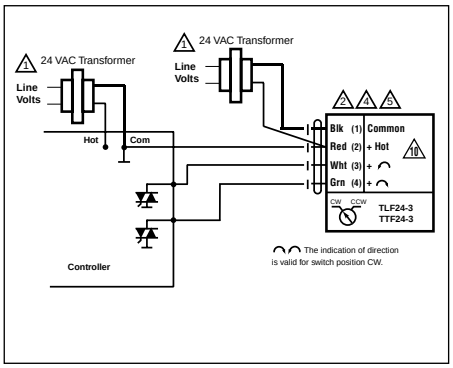


Triac sink



Triac source





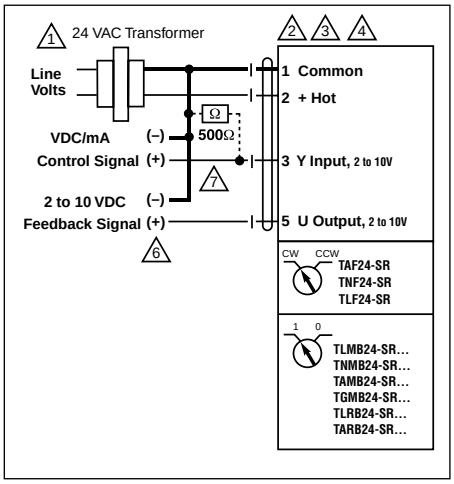
Triac sink with separate transformer

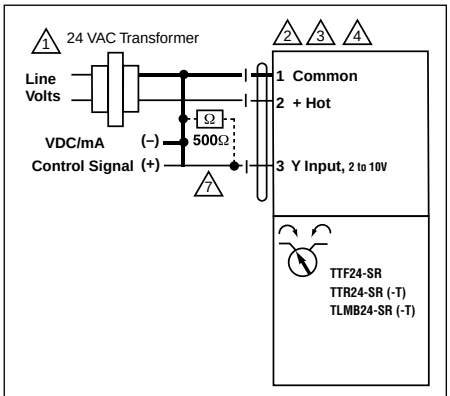
Notes:

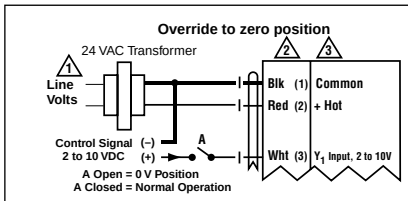
1. Provide overload protection and disconnect as required.
2. Actuators may be connected in parallel. Power consumption and input impedance must be observed.
3. Actuators may also be powered by 24 VDC.
4. Meets cULus, or UL or CSA requirements without the need of an electrical ground connection.
5. Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance rated cable use numbers.
10. For triac sink the Common connection from the actuator must be connected to the Hot connection of the controller. The actuator must be connected to the control board common.

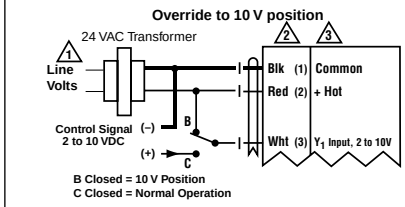
IV-C. Proportional Control, 24V

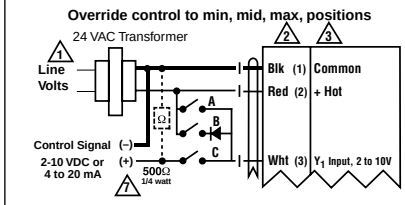
W489











	Functions	a	b	c
Min*	0%			
Mid*	50%			
Max*	100%			
Normal**	Control mode acc. to Y			

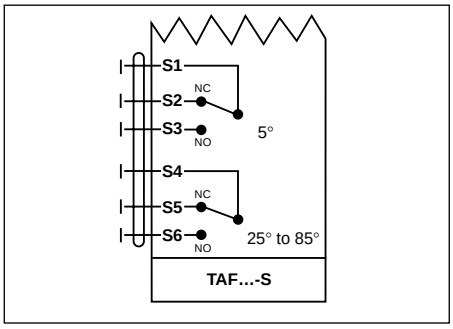
* Default selectable 0-100%. See Configuration Data Sheet.
** Customizable. See Configuration Data Sheet.

Notes:

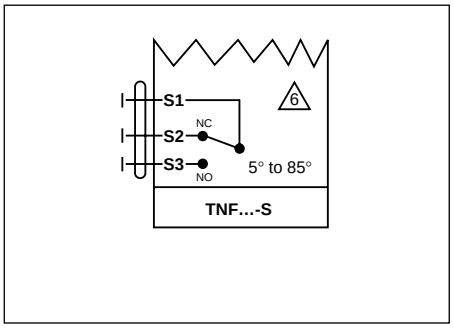
1. Provide overload protection and disconnect as required.
2. Up to Four Actuators may be connected in parallel
   Power consumption and input impedance must be observed.
3. Actuator may also be powered by 24 VDC.
4. Meets cULus or UL and CSA requirements without the need of electrical ground connection.
5. Actuators with plenum rated cable do not have numbers on wires; use color codes instead. Actuators with appliance cables are numbered.
6. Only connect common to neg. (—) leg of control circuits.
7. A 500Ω resistor converts the 4 to 20mA control signal to 2 to 10 VDC.)

IV-D. Auxiliary Switch Wiring

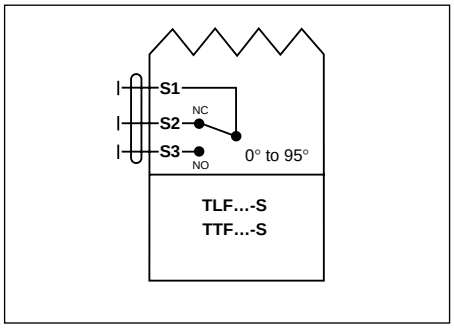
W490



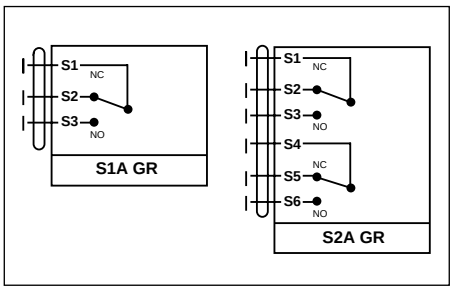
Auxiliary Switch Wiring for TAF… -S



Auxiliary Switch Wiring for TNF…-S



Auxiliary Switch Wiring for TLF…-S, TTF…-S



Add on Auxiliary Switches S1A/S2A GR for TGM, TAM, TNM and TLM

Product	Voltage	Resistive Load	Inductive Load
TAF…-S	250	7.0 A	2.5 A
TNF…-S	250	7.0 A	2.5 A
TLF…-S	250	6.0 A	1.5 A
TTF…-S	250	3.0 A	0.5 A
S1A, S2A GR	250	3.0 A	0.5 A

Auxiliary Switch Ratings

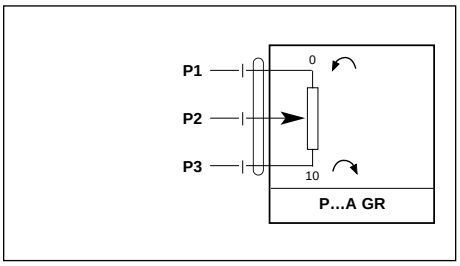
Notes:

Two built-in auxiliary switches (2xSPDT), for end position indication, interlock control, fan startup, etc.

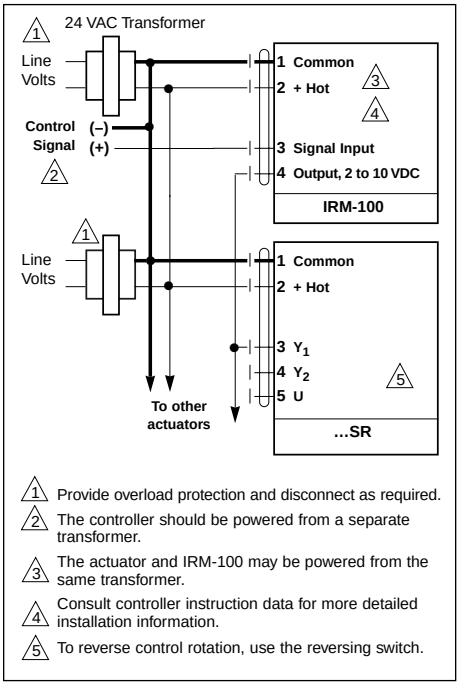
One built-in auxiliary switch (1xSPDT), for end position indication, interlock control, fan startup, etc.

Meets cULus or UL and CSA requirements without the need of an electrical ground connection.

IV-E. Accessories

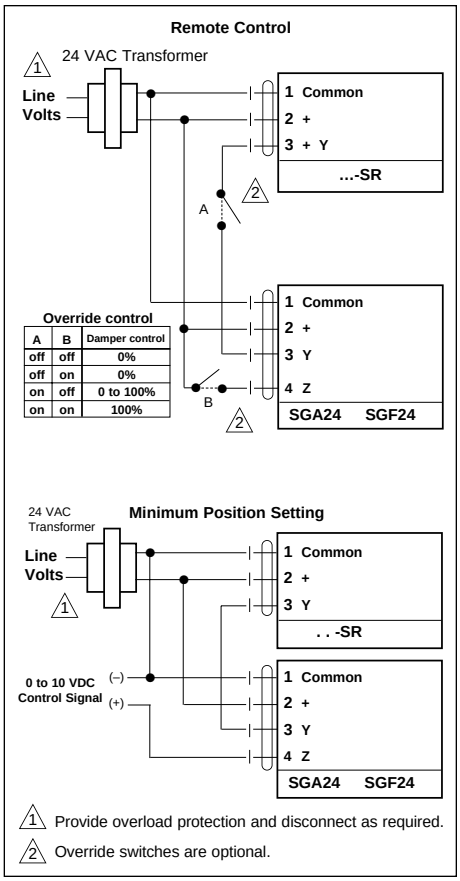


Feedback Potentiometer
P…A GR used with TGM / TAM / TNM / TLM



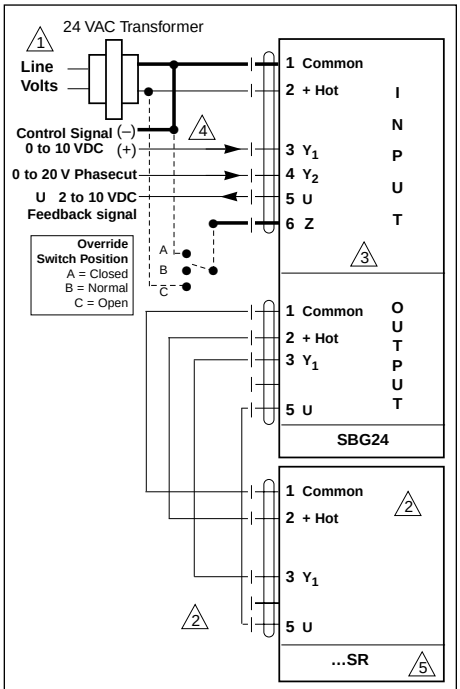
1 Provide overload protection and disconnect as required.
2 The controller should be powered from a separate transformer.
3 The actuator and IRM-100 may be powered from the same transformer.
4 Consult controller instruction data for more detailed installation information.
5 To reverse control rotation, use the reversing switch.

IRM-100 Input Rescaling Module



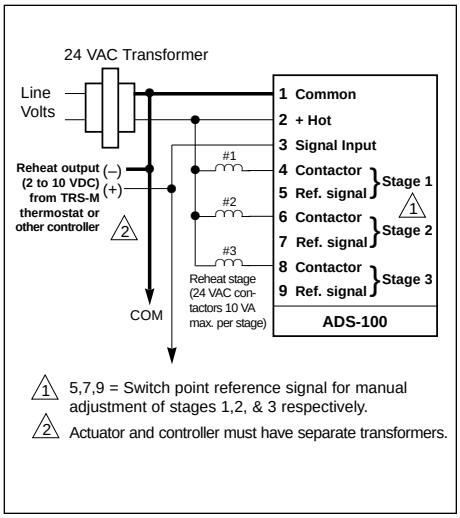
1 Provide overload protection and disconnect as required.
2 Override switches are optional.

SGA, SGF Positioners



1 Provide overload protection and disconnect as required.
2 Actuators may be connected in parallel. Power consumption and input impedance must be observed.
3 The actuator and SBG-24 may be powered from the same transformer.
4 The controller should be powered from a separate transformer.
5 Wire No. 4 on the TNM24-SR is used for feedback.

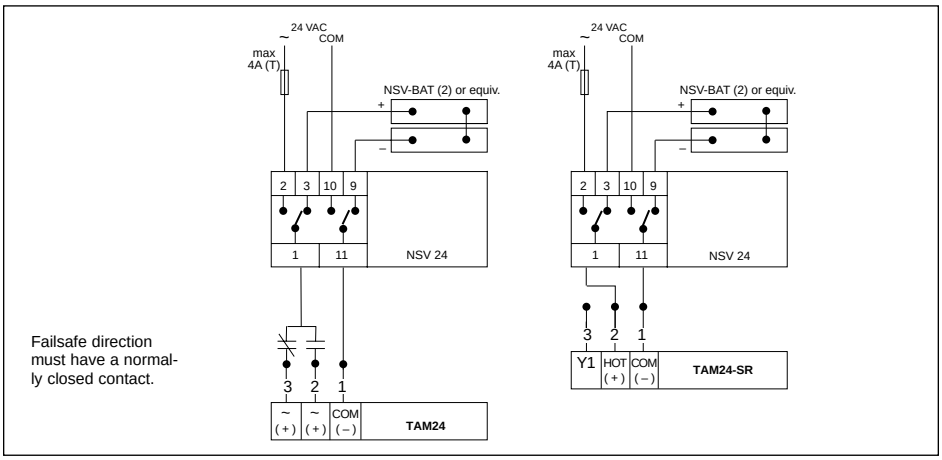
SBG 24 Range Controller



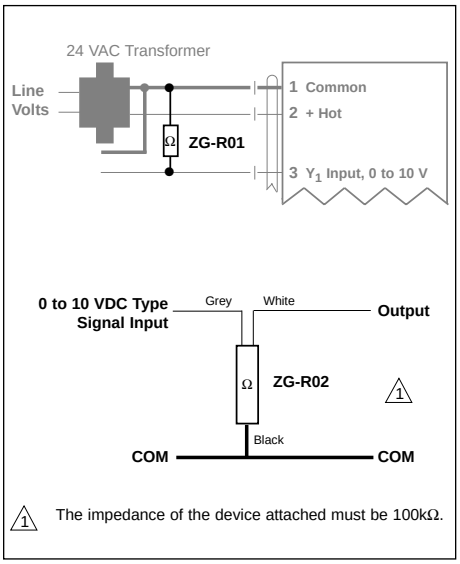
1 5,7,9 = Switch point reference signal for manual adjustment of stages 1,2, & 3 respectively.
2 Actuator and controller must have separate transformers.

ADS-100 Analog to Digital Switch

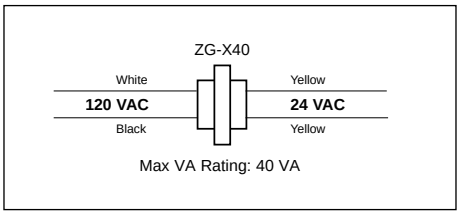
IV-E. Accessories (continued)



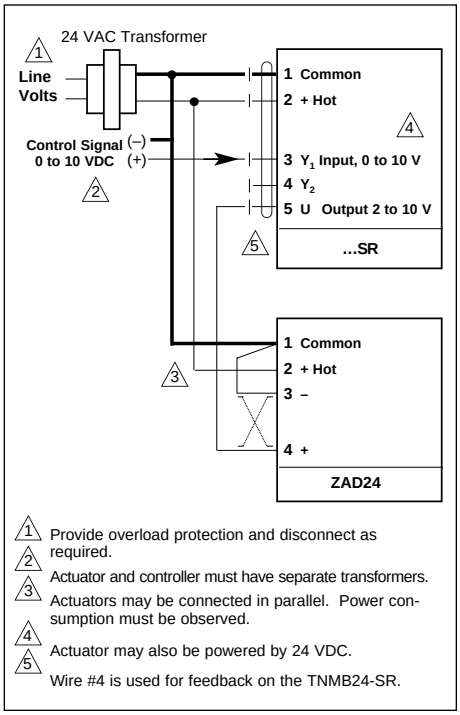
NSV 24 Battery Back-up Module



ZG-R01, ZG-R02 Resistor Kits



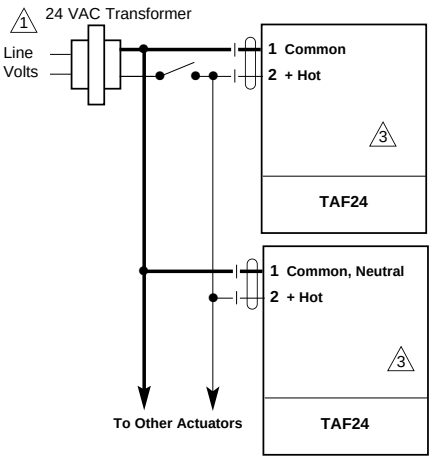
ZG-X40 Transformer

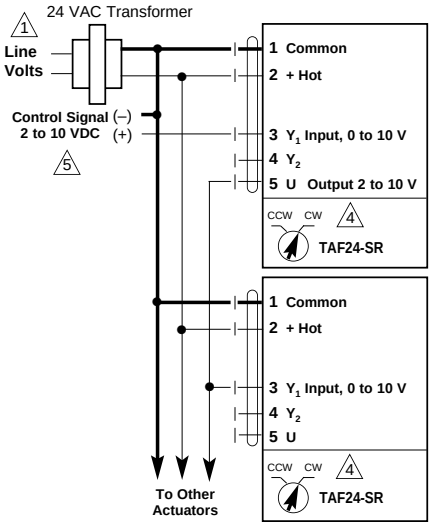


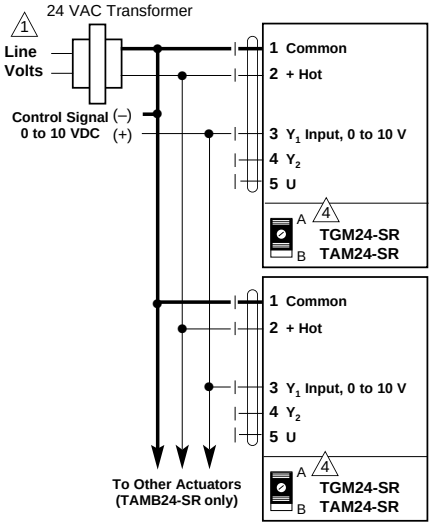
ZAD24 Digital Position Indicator

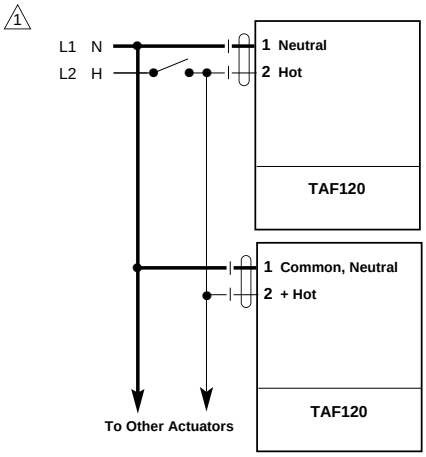
V. Application Information

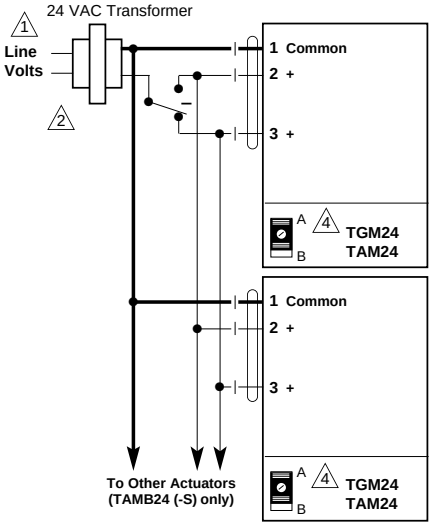
V-A. Wiring for Multiple Actuators on One Shaft (TAF/TGM, for other actuators use next higher torque actuator)









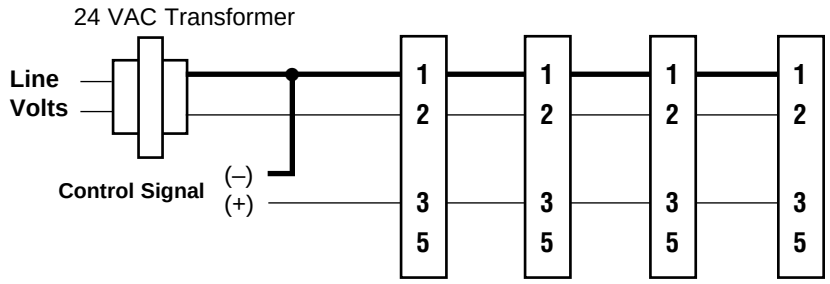


Actuators which may be used on one shaft:	
Model	**Max Quantity Per Shaft**
TAF24(-S)	4
TAF24-SR	4
TGM24-SR	2
TAM24-SR	4

Notes:

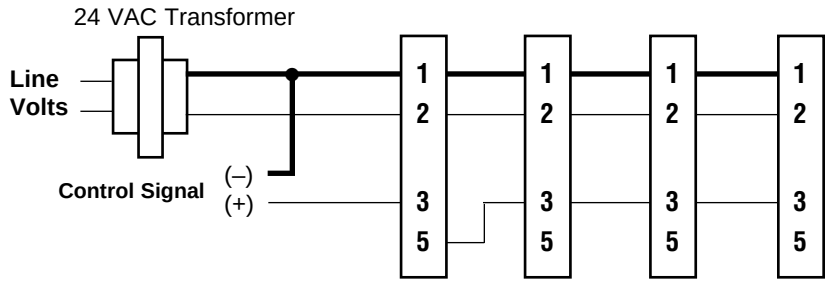
1. Provide overload protection and disconnect as required.
2. Actuators may be connected in parallel. Power consumption must be observed.
3. May also be powered by 24 VDC.
4. Set reversing switch (CCW-CW)(A-B) as required by control logic and control range.

V-A. (continued) Wiring for Multiple Actuators on One Shaft (TAF/TGM, for other actuators use next higher torque actuator)



Note:
See table on page 161 for maximum number of actuators allowed.

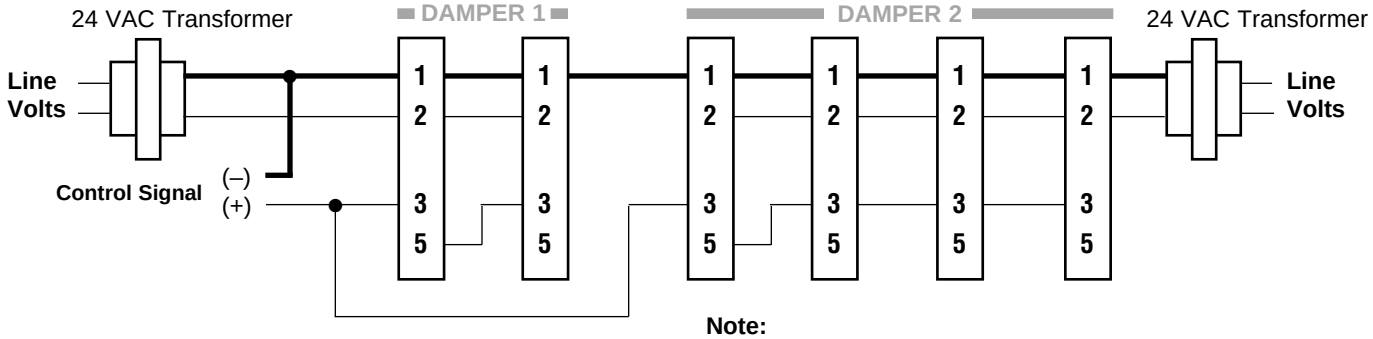
All actuators except TAF24-SR



Note:
TAF24-SR must be wired in this manner when more than one actuator is mounted on a single shaft.

A **maximum** of 4 actuators may be mounted to a single shaft.

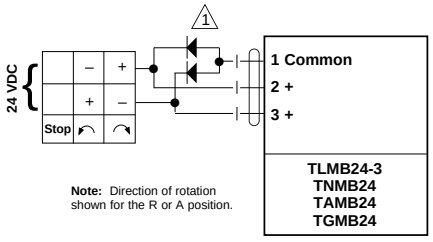
TAF24-SR



Note:
Shown with typical 2 transformer wiring, if one transformer does not have enough capacity for 6 actuators.

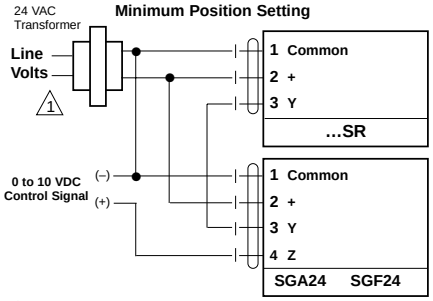
Typical wiring of multiple dampers with more than one TAF24-SR mounted on a single shaft.

V-E. Floating Control Using a 2-wire DC Control Signal



1 IN4001, IN4003 diode or equivalent, observe polarity.

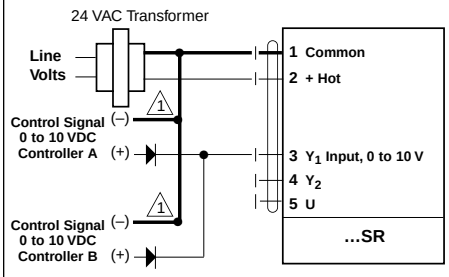
V-G. Minimum Position with 0 to 10 VDC Actuators



1 Provide overload protection and disconnect as required.

2 Override switches are optional.

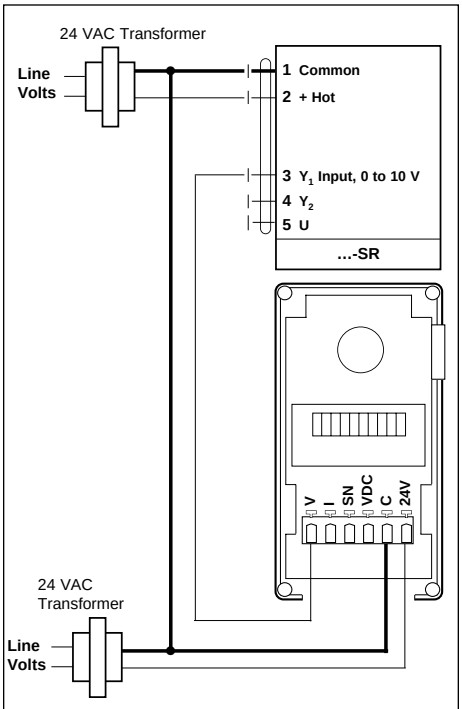
V-F. Operating two 0 to 10 VDC Controllers with the Higher of Two Control Signals



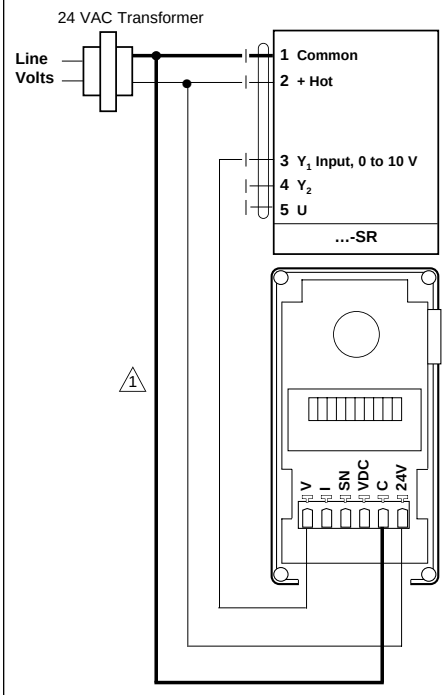
1 IN4001, IN4003 diode or equivalent, observe polarity.

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-H Wiring to Johnson Controls A350P Controller



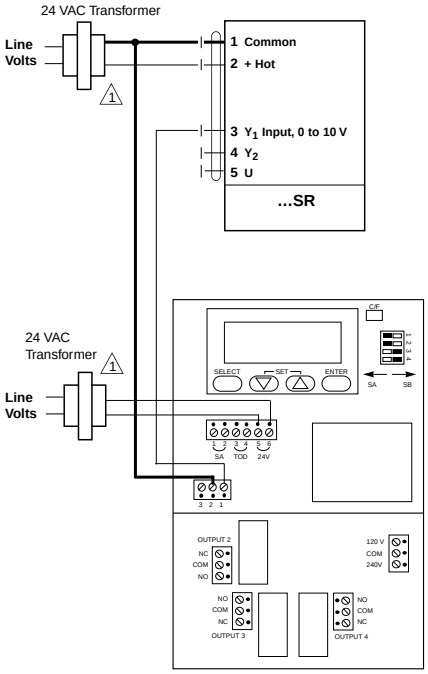
Johnson Controls A350P Controller
Multiple Power Source Wiring



Johnson Controls A350P Controller
Single Transformer Wiring

1 Power polarity must be correct

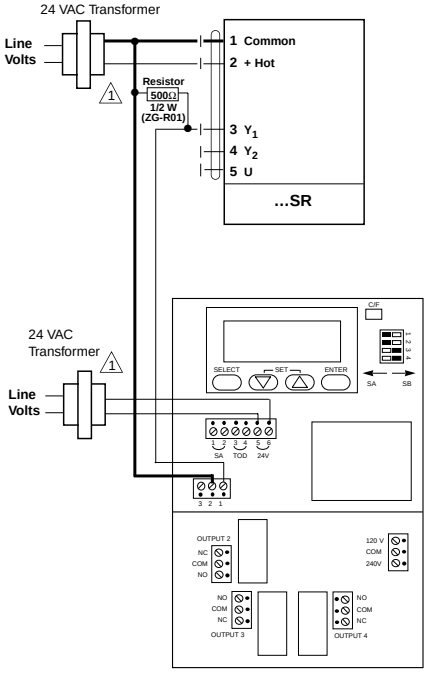
V-I. Wiring to Honeywell T775 Controller



T775E1098 / T775F1089
0 to 18 VDC Output Models

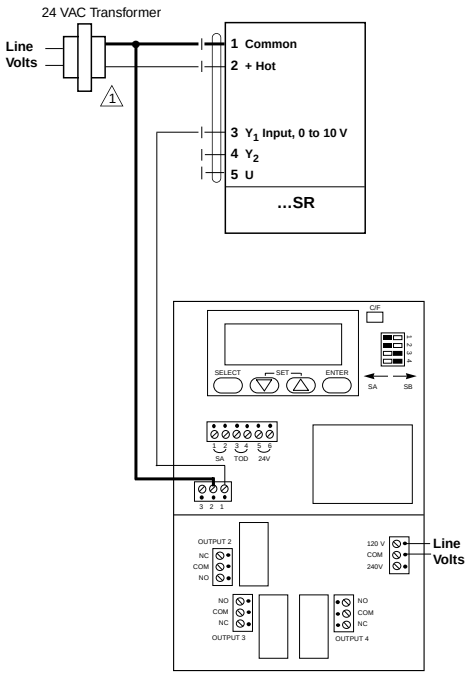
1 Use separate transformer for T775 if powering from 24 VAC.

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.



T775E1056 / T775F1055
4 to 20 mA Output Models

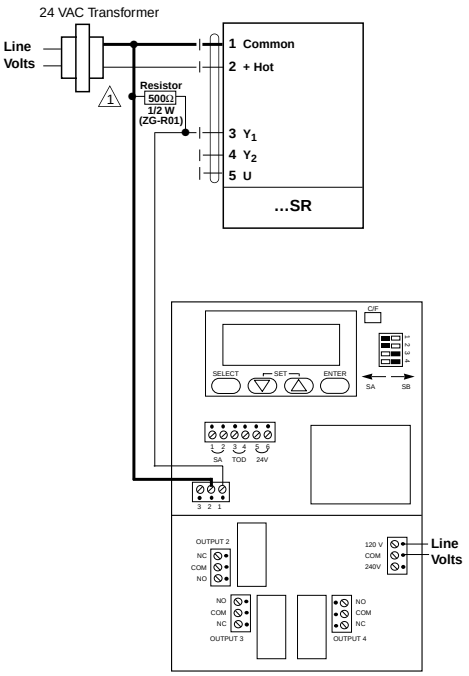
1 Use separate transformer for T775 if powering from 24 VAC.



T775E1098 / T775F1089
0 to 18 VDC Output Models

1 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.



T775E1056 / T775F1055
4 to 20 mA Output Models

1 Use separate transformer for T775 if powering from 24 VAC.

Notes/Work Pad

Notes/Work Pad

Notes/Work Pad

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