



Mixing Box Model MBB

Installation, Operation and Maintenance Manual

(Fits HBB, BMB, HCA Series)

Magic Aire Mixing Box Accessory allows control of outdoor air and return air streams and provides optional factory controls for convenience and better IAQ. All hardware is included to allow operation as an economizer. Optional control package allows interface with stand-alone thermostats or building automation products. Capacities are available in nominal sizes from 400cfm to 8000cfm.

How to Use this Manual:

This manual gives instructions regarding installation, operation and maintenance for the Mixing Box Accessory for HBB, BMB, and HCA Series air handling units. For more information refer to:

Catalog brochure for unit dimensions, options, guide specifications and performance information.

New Magic 4 software for faster selection of new equipment.

Website www.magicaire.com for replacement parts guide, software downloads, product data and contact info for your local Magic Aire representative.

Replacement Parts – Identify parts needed using the replacement parts guide available at www.magicaire.com.

Use these instructions in conjunction with other appropriate instructions, including but not limited to those instructions supplied with the outdoor unit (if applicable). Installation must comply with all applicable local codes.



MBB shown with optional controls

GENERAL

Installation and maintenance are to be performed **only** by qualified personnel who are familiar with local codes and regulations and are experienced with HVAC equipment of this type.

WARNING: Sharp edges, coil surfaces and rotating fans are a potential injury hazard – avoid contact.

WARNING: Hazardous voltage – Disconnect and Lock Out all incoming power sources before servicing or installing unit. ELECTRIC SHOCK CAN CAUSE DEATH.

WARNING: This equipment may be installed well above finished floor—Use extreme caution when working at heights.

SAFETY WARNING:

Installer should pay particular attention to the following words:

NOTE—intended to clarify or make installation easier.

CAUTION—given to prevent equipment damage.

WARNING—to alert installer that personal injury and/or equipment damage may result if installation procedure is not properly followed.

UNPACKING-CHECK FOR DAMAGE!

Immediately inspect each unit for damage upon receipt.

- Inspect units for external and concealed damage immediately.
- File any damage claims in accordance with Magic Aire Freight Damage Policy and Terms and Conditions (available at www.magicaire.com).
- Do not repair damaged units without written authorization.
- Protect stored units from damage.

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Mixing Box Model MBB
Installation, Operation and Maintenance
Manual

Installation, Start-Up and Service Instructions

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DANGER

NEVER enter an enclosed fan cabinet or reach into a unit while the fan is running.
LOCK OPEN AND TAG the fan motor power disconnect switch before working on a fan. Take fuses with you and note removal on tag. Electric shock can cause personal injury or death.
LOCK OPEN AND TAG the electric heat coil power disconnect switch before working on or near heaters.
Failure to follow these warnings could lead to personal injury or death.

WARNING

CHECK the assembly and component weights to be sure that the rigging equipment can handle them safely.
Note also, the centers of gravity and any specific rigging instructions.
CHECK for adequate ventilation so that fumes will not migrate through ductwork to occupied spaces when welding or cutting inside air-handling unit cabinet or plenum.
WHEN STEAM CLEANING COILS be sure that the area is clear of personnel.
DO NOT attempt to handle access covers and removable panels on outdoor units when winds are strong or gusting until you have sufficient help to control them. Make sure panels are properly secured while repairs are being made to a unit.
DO NOT remove access panel fasteners or open access doors until fan is completely stopped. Pressure developed by a moving fan can cause excessive force against the panel which can injure personnel.
DO NOT work on dampers until their operators are disconnected.
BE SURE that fans are properly grounded before working on them.
Failure to follow these warnings could result in personal injury or equipment damage.

PREINSTALLATION

1. Check items received against packing list.
2. Do not stack unit components or accessories during storage. Stacking can cause damage or deformation.

Rigging — Do not remove shipping skids or protective covering until unit is ready for final placement. Use slings and spreader bars as applicable to lift unit. *Do not lift unit by coil connections, headers or damper shaft rods.*

INSTALLATION

Mixing Box

Contents: Mixing box with damper assembly, ready to install on air inlet of model HBB, HCA or BMB air handling unit.

Controls: Fully Modulating Economizer Controls—Single Enthalpy is **sold separately**. See instructions below.

Install mixing box according to suspension instructions (Figure 1). Alternately, the mixing box may be supported on a housekeeping pad or other field provided framing system.

To set dampers for economizer operation (dampers work opposite each other, install damper linkage hardware as indicated in the instructions. For other arrangements the dampers can be set up using factory hardware and field hardware as required for the application.

Controls Accessory Kit Fully Modulating Economizer —Single Enthalpy (SOLD SEPARATELY)

Contents (1ea except as noted):

1. Belimo ECON-ZIP-BASE Economizer Control Module
2. Belimo ECON-ZIP-EM Energy Module
3. Belimo ECON-ZIP-COM Communication Module
4. Belimo ECON-ZIP-TH Enthalpy Sensor
5. 110507 Dry Bulb Sensor
6. Belimo LF24-SR US Damper Actuator
7. 11ga wire dry bulb sensor mount and cable ties.

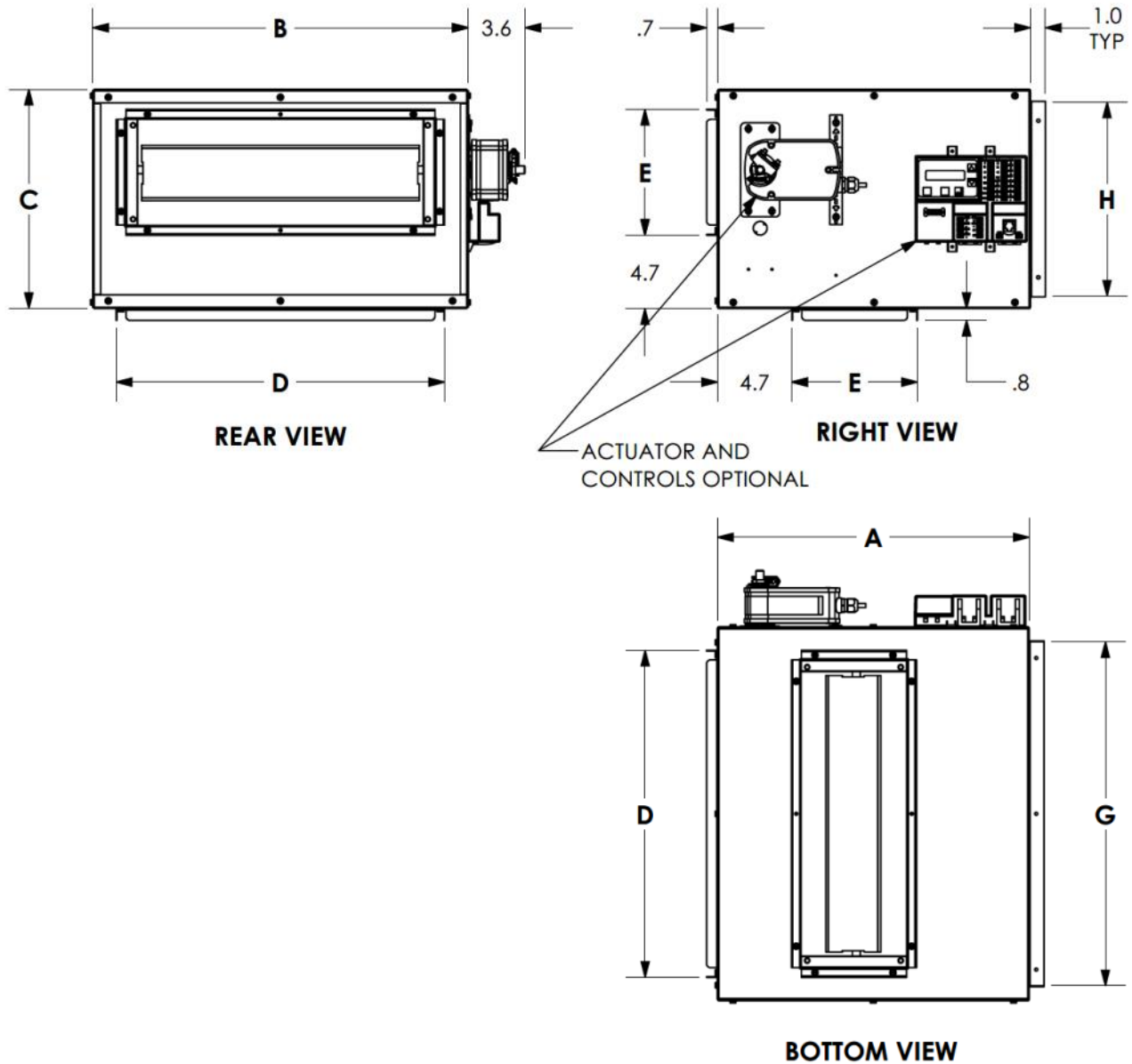


All mounting hardware and manuals are located in a plastic bag taped inside unit.



MIXING BOX ACCESSORY

BOTTOM O/A, RH CONTROLS
FITS MODELS BMB/HBB/HCA

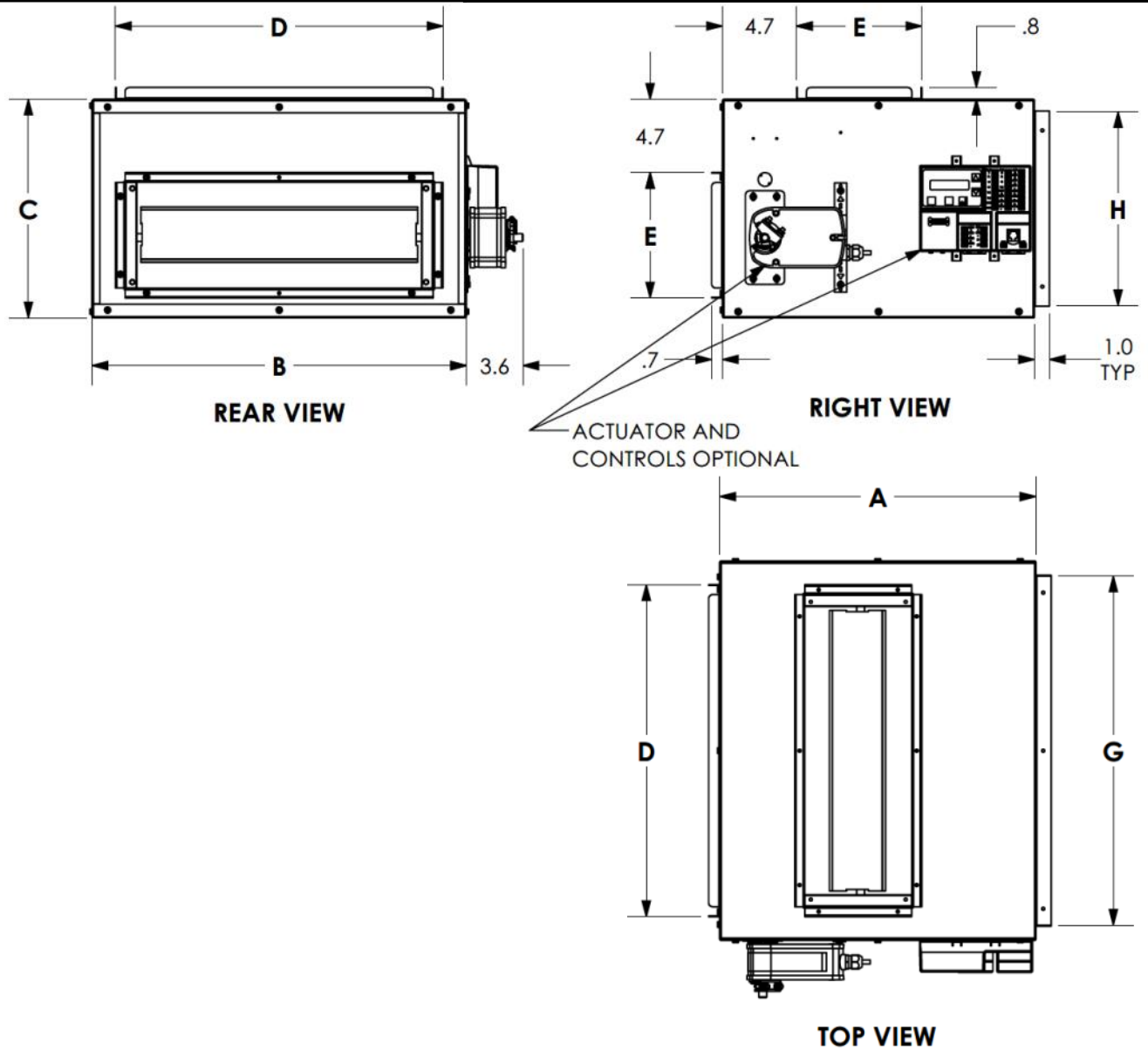


UNIT SIZE	MODEL	UNIT OUTLINE			DUCT DIMENSIONS		RETURN CONNECTION TO THE AHU UNIT		APPROX. SHIPPING WEIGHT (LBS)
		LENGTH	WIDTH	HEIGHT	WIDTH (Centered)	HEIGHT	WIDTH (Centered)	HEIGHT (Centered)	
		A	B	C	D	E	G	H	
04/06	MBB04H(M)/ MBB06H(M)	20.0	24.0	14.0	21.0	8.0	22.1	12.4	108
08/12	MBB08H(M)/ MBB12H(M)	24.0	26.5	17.7	24.0	12.0	27.7	16.4	141



MIXING BOX ACCESSORY

TOP O/A, RH CONTROLS
FITS MODELS BMB/HBB/HCA

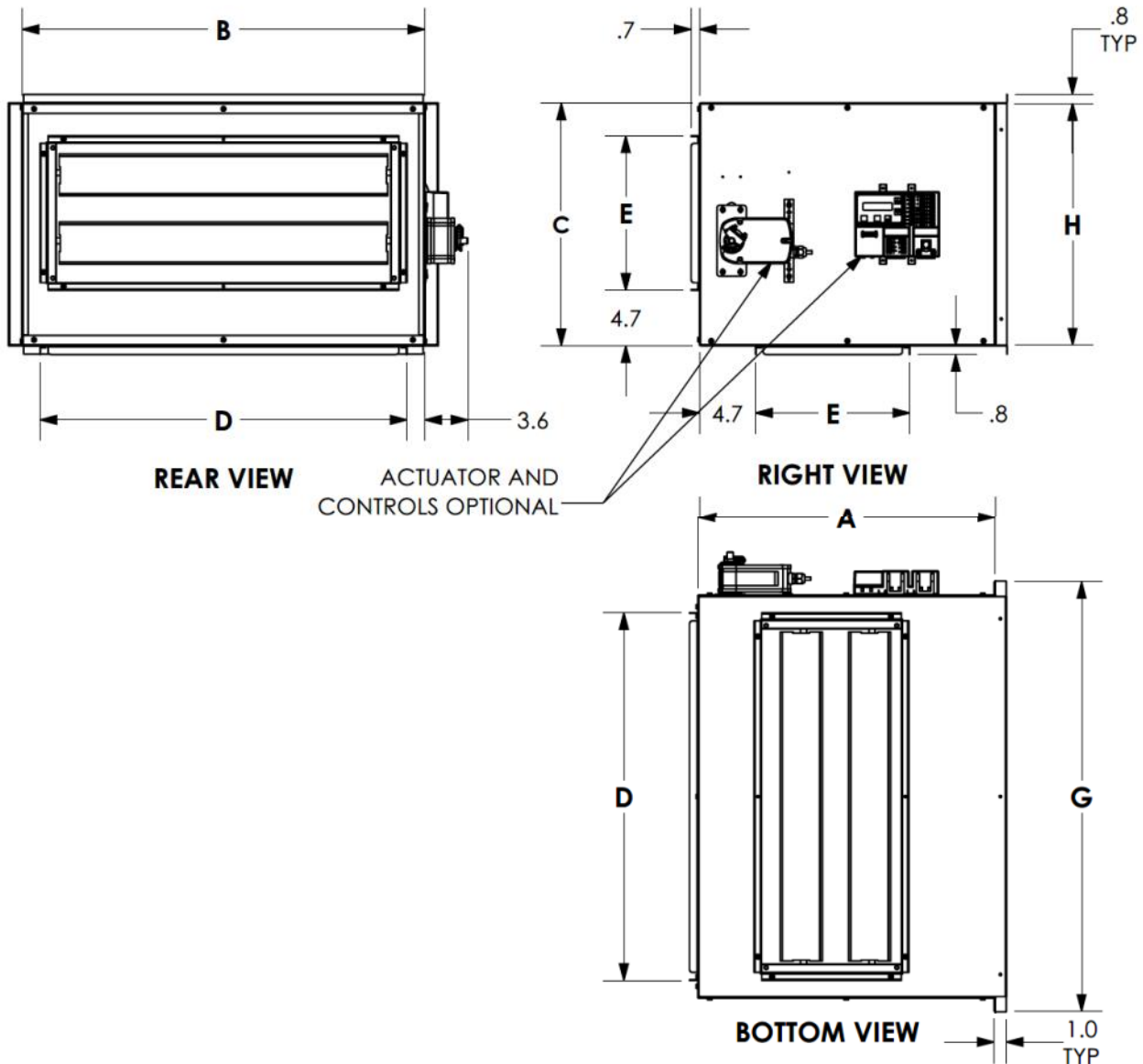


UNIT SIZE	MODEL	UNIT OUTLINE			DUCT DIMENSIONS		RETURN CONNECTION TO THE AHU UNIT		APPROX. SHIPPING WEIGHT (LBS)
		LENGTH	WIDTH	HEIGHT	WIDTH (Centered)	HEIGHT	WIDTH (Centered)	HEIGHT (Centered)	
		A	B	C	D	E	G	H	
04/06	MBB04H(M)/ MBB06H(M)	20.0	24.0	14.0	21.0	8.0	22.1	12.4	108
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MIXING BOX ACCESSORY

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FITS MODELS BMB/HBB/HCA

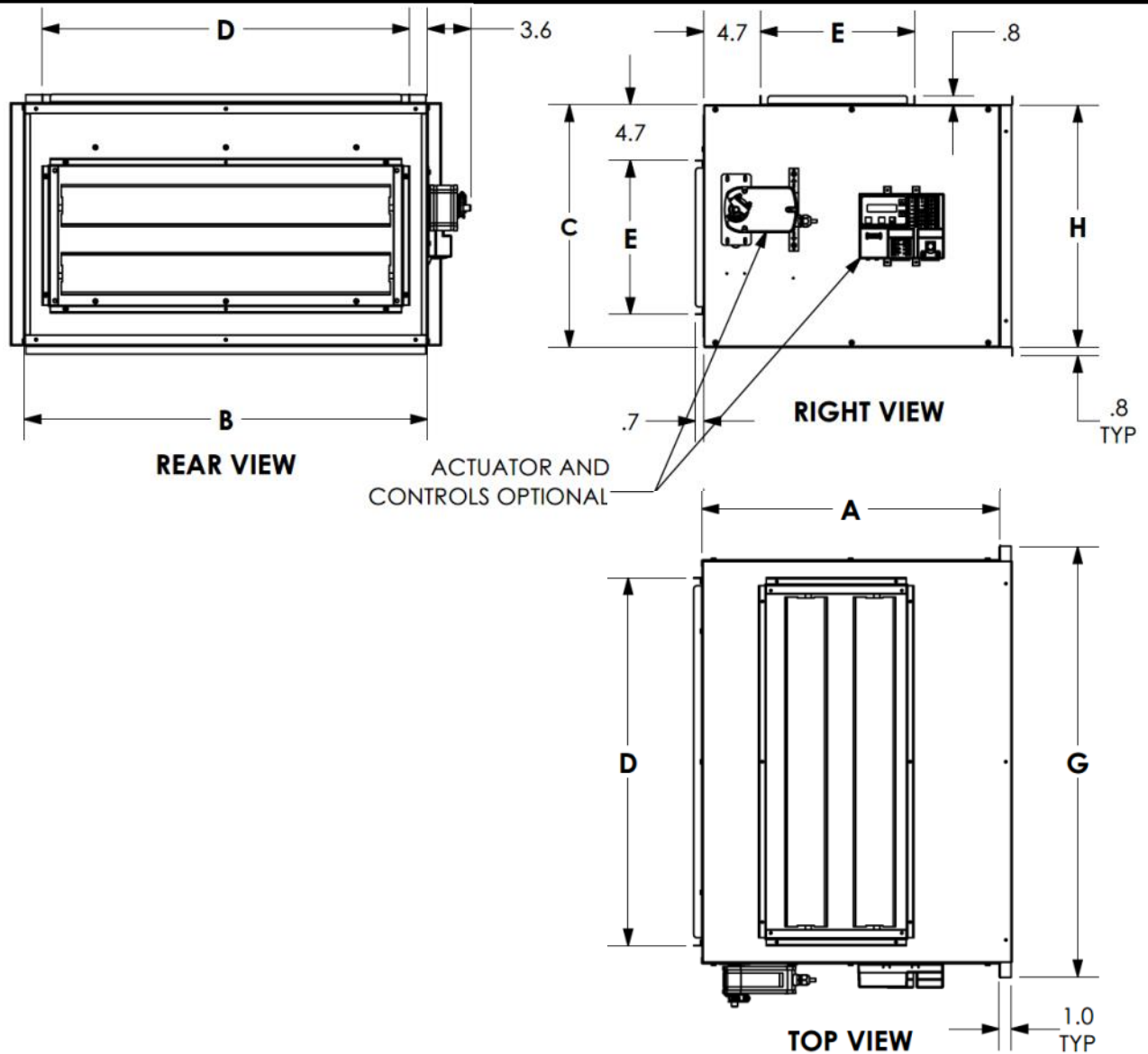


UNIT MODEL	UNIT SIZE	MIXING BOX MODEL	UNIT OUTLINE			DUCT DIMENSIONS		RETURN CONNECTION TO THE AHU UNIT		APPROX. SHIPPING WEIGHT (LBS)
			LENGTH	WIDTH	HEIGHT	WIDTH (Centered)	HEIGHT	WIDTH (Centered)	HEIGHT (Centered)	
			A	B	C	D	E	G	H	
HCA/HBB	16/20	MBB16H/MBB20H	25.0	34.0	20.5	31.0	13.0	36.2	20.4	179
BMB	16/20	MBB16M/MBB20M	25.0	34.0	25.5	31.0	13.0	36.2	25.4	185
	30/40	MBB30H(M)/MBB40H(M)	31.0	37.0	32.5	30.1	24.1	48.3	32.4	288
	60	MBB60H(M)	35.0	50.0	40.7	43.1	25.1	58.0	40.6	420
	80	MBB80H(M)	39.0	54.0	46.0	47.1	29.1	66.2	45.9	498



MIXING BOX ACCESSORY

TOP O/A, RH CONTROLS
FITS MODELS BMB/HBB/HCA



UNIT MODEL	UNIT SIZE	MIXING BOX MODEL	UNIT OUTLINE			DUCT DIMENSIONS		RETURN CONNECTION TO THE AHU UNIT		APPROX. SHIPPING WEIGHT (LBS)
			LENGTH	WIDTH	HEIGHT	WIDTH (Centered)	HEIGHT	WIDTH (Centered)	HEIGHT (Centered)	
			A	B	C	D	E	G	H	
HCA/HBB	16/20	MBB16H/MBB20H	25.0	34.0	20.5	31.0	13.0	36.2	20.4	179
BMB	16/20	MBB16M/MBB20M	25.0	34.0	25.5	31.0	13.0	36.2	25.4	185
	30/40	MBB30H(M)/MBB40H(M)	31.0	37.0	32.5	30.1	24.1	48.3	32.4	288
	60	MBB60H(M)	35.0	50.0	40.7	43.1	25.1	58.0	40.6	420
	80	MBB80H(M)	39.0	54.0	46.0	47.1	29.1	66.2	45.9	498

CONTROLS INSTALLATION

Control system installation:

1. Install controller in accessible location. Use factory provided mounting plate to mount to side of mixing box. See Figure 2a.
2. Attach energy and communications modules to Belimo Controller. See Figure 2b.
3. Drill 1" diameter hole in supply air (SA) duct. Attach SA dry bulb sensor on wire mount using two cable ties. Install sensor/mount in the duct using 1ea self-drilling screw (Figures 3, 4 and 5). Make sure SA sensor wires don't rub the edges of the sheet metal hole. Seal hole with HVAC



Figure 2a
Controller and Mounting Plate

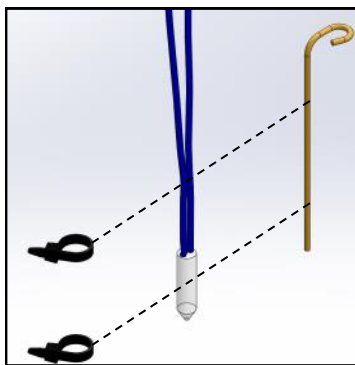


Figure 3
SA Sensor-
Attach to Sensor
Mount



Figure 2b
Energy and Comm Modules on Controller

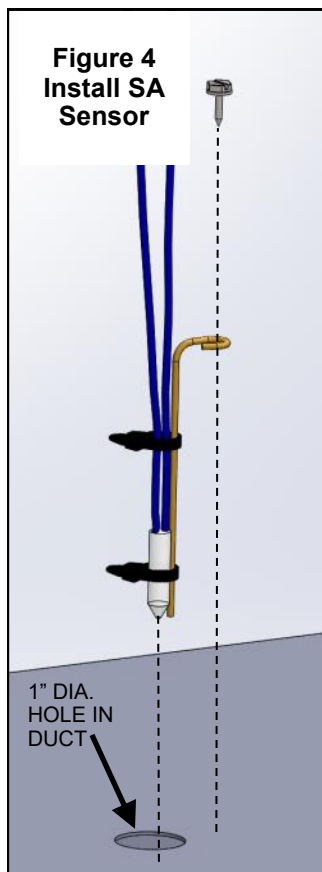


Figure 4
Install SA
Sensor

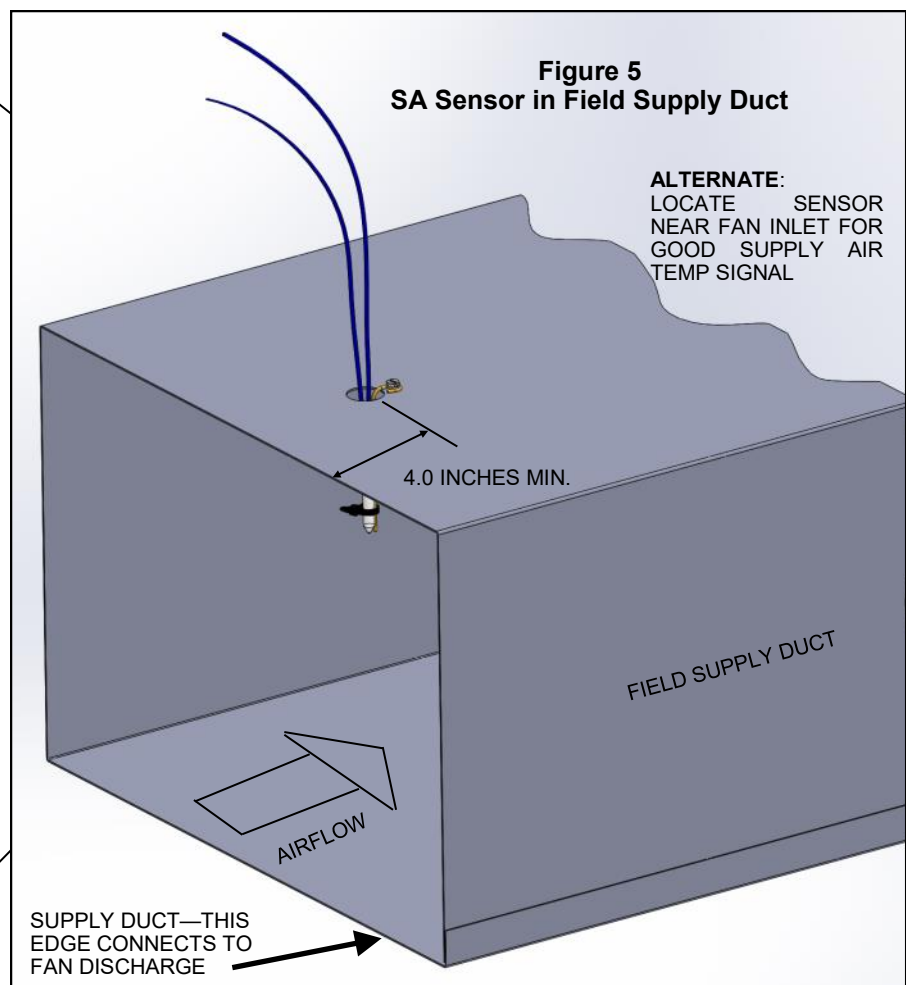


Figure 5
SA Sensor in Field Supply Duct

CONTROLS INSTALLATION (CONT'D)

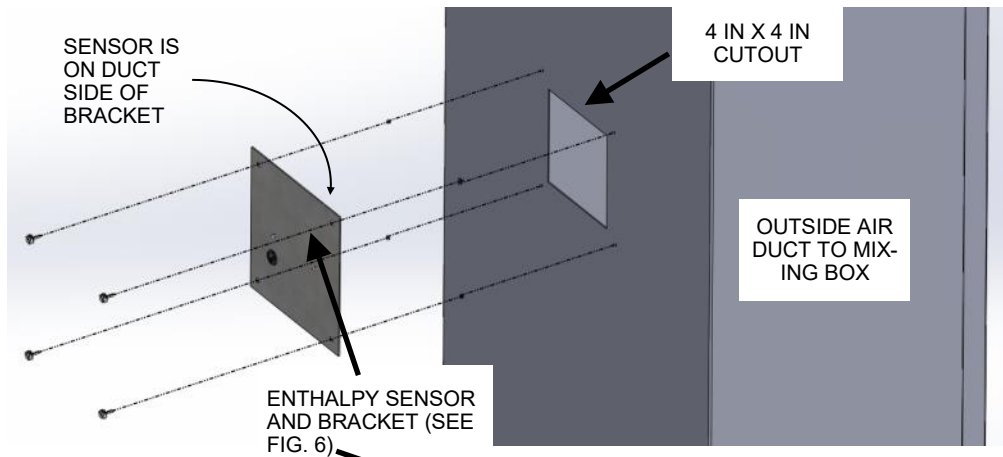
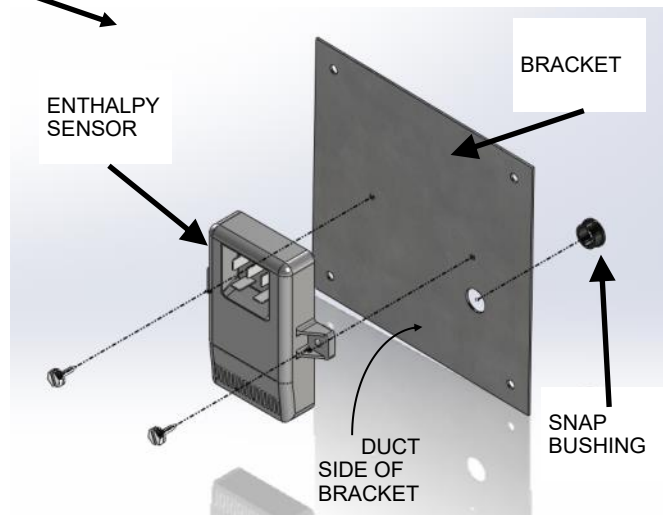


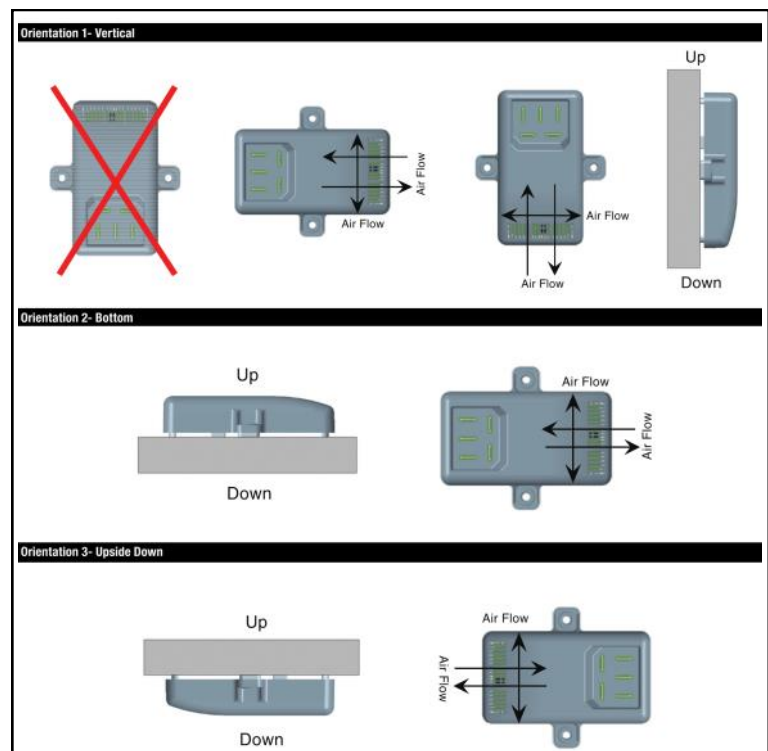
Figure 7
Enthalpy
Sensor In-
stallation in
OA Duct

Figure 6
Enthalpy Sensor and Bracket



- tape after installation.
4. Assemble bracket and OA Enthalpy Sensor. Pass sensor wiring through the snap bushing to protect from sharp edges (Figure 6).
 5. Install Bracket/OA Sensor assembly in field OA duct upstream of the mixing box (Figure 7) Be sure to install Enthalpy Sensor in acceptable orientation per Figure 8.
 6. Install actuator—refer to typical actuator installation guidelines on pages 29-32. **NOTE:** Be sure to install actuator anti-rotation bracket shown in Figure 9.
 7. Wire all components to controller (low voltage wire is field supplied). Refer to Figure 13 for single enthalpy control. 24VAC power is required and may be powered by the air handling unit's low voltage controls (motor start/stop station or MSS), if present. Otherwise, 24VAC power is

Figure 8
Enthalpy
Sensor
Orientation



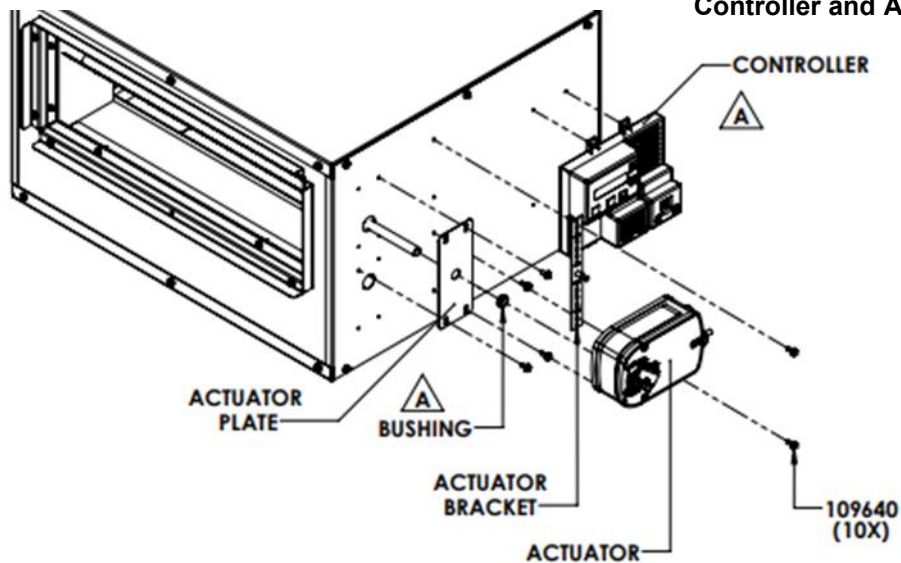
CONTROLS INSTALLATION (CONT'D)

- field provided.
8. Options: For differential enthalpy, see Figure 14. For CO2 demand controlled ventilation (DCV) and connection to power exhaust and other options, see Figure 15, Energy Module Wiring. For Title 24 alarm interconnections, see Figure 16.
 9. Start up controller and check out operation per the Quick Start guide (pages 17-18). Setup for DCV is on page 19. More detailed instructions are available on the Belimo website at

ANTI-ROTATION
BRACKET

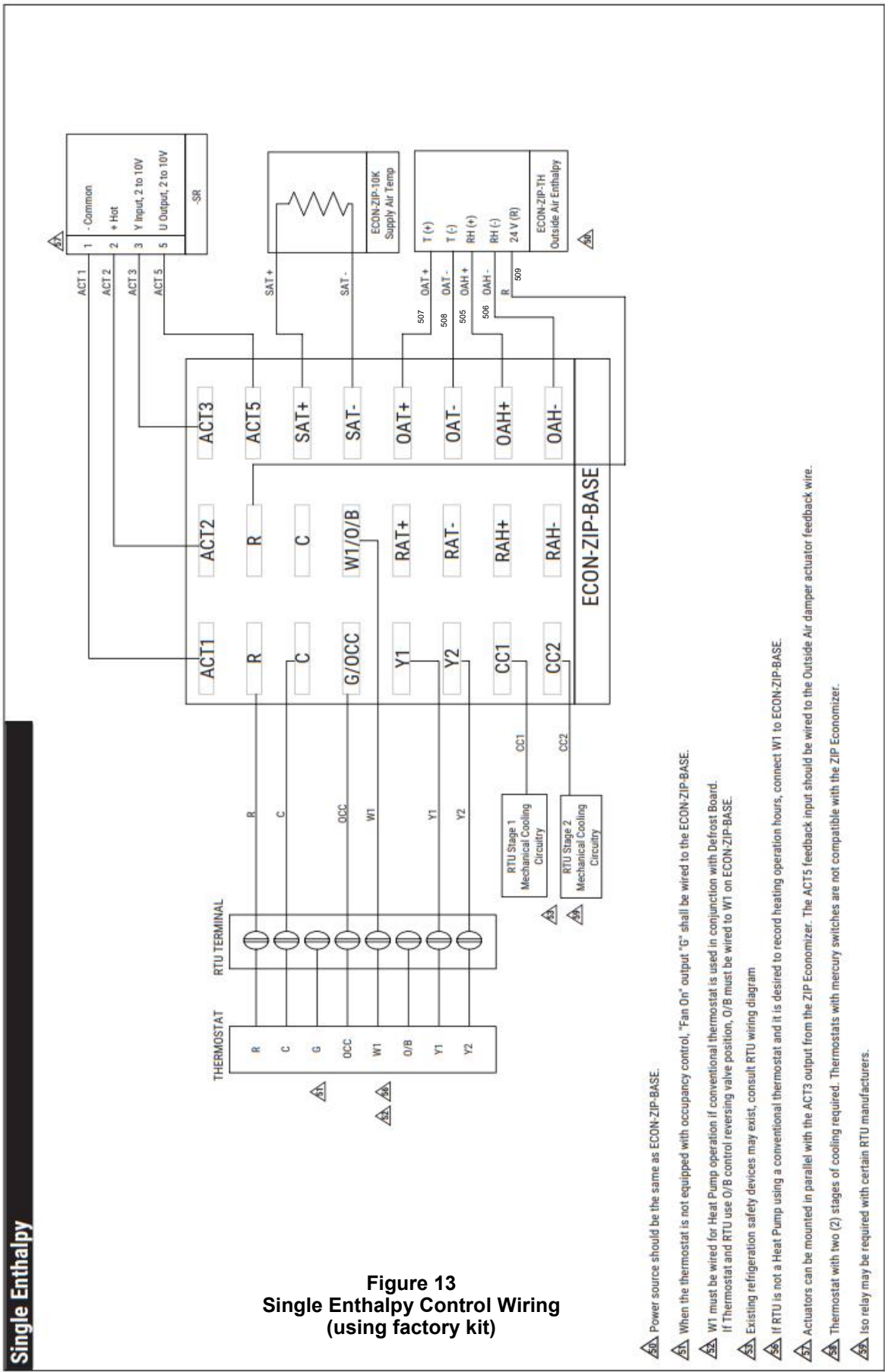


Figure 9
Controller and Actuator Installation

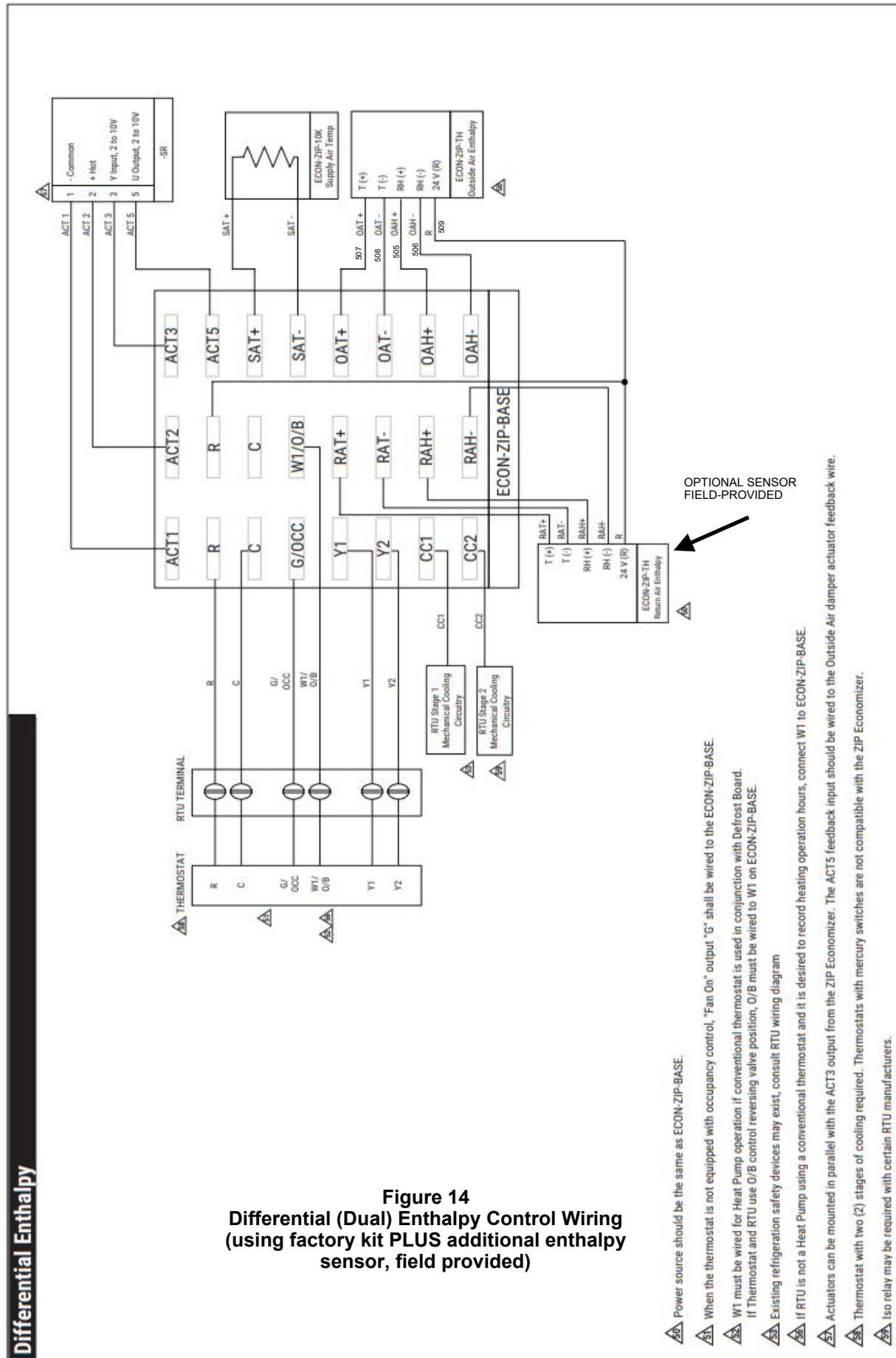


TYPICAL WIRING SCHEMATIC

Single Enthalpy



TYPICAL WIRING SCHEMATIC



TYPICAL WIRING SCHEMATIC

Figure 15
Energy Module Wiring

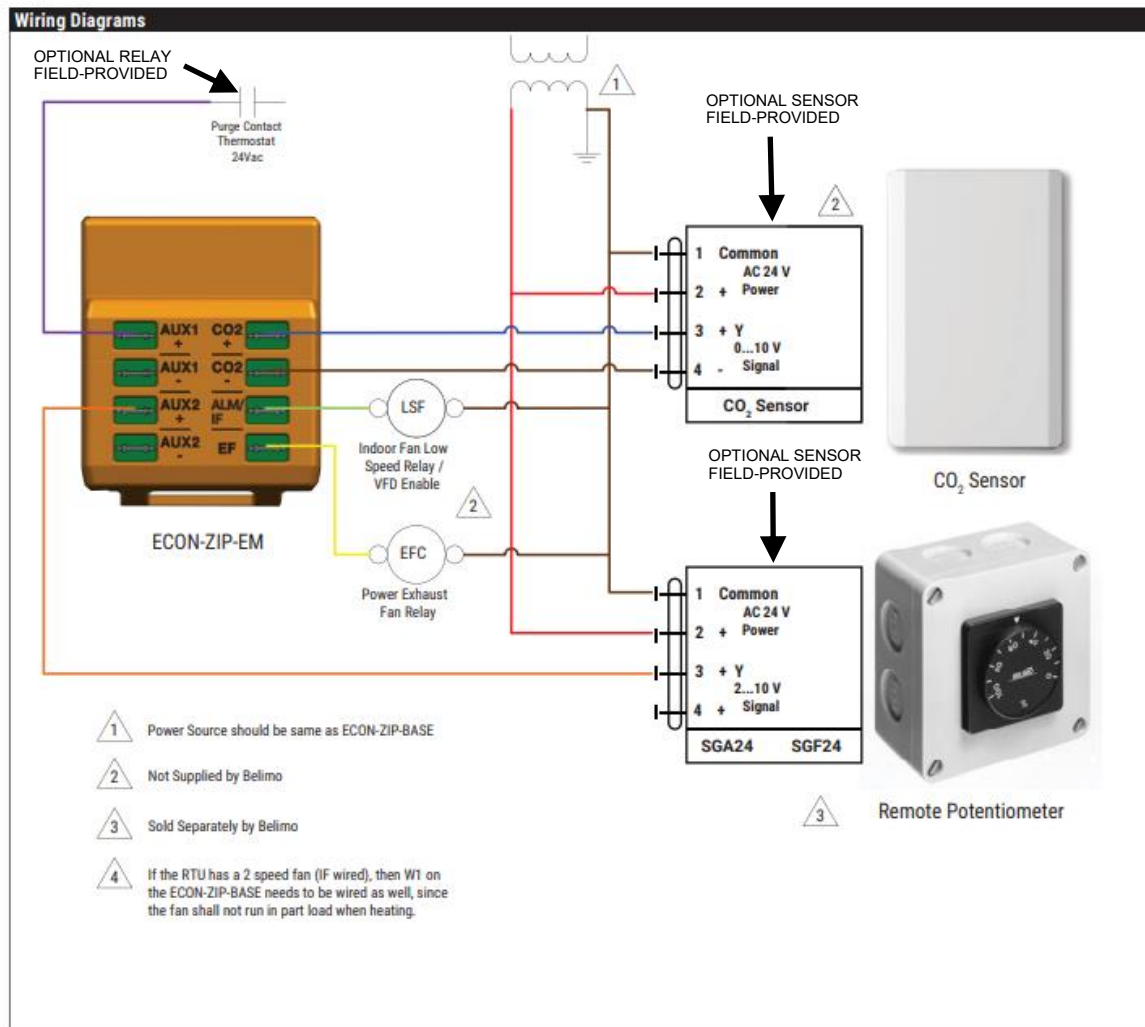
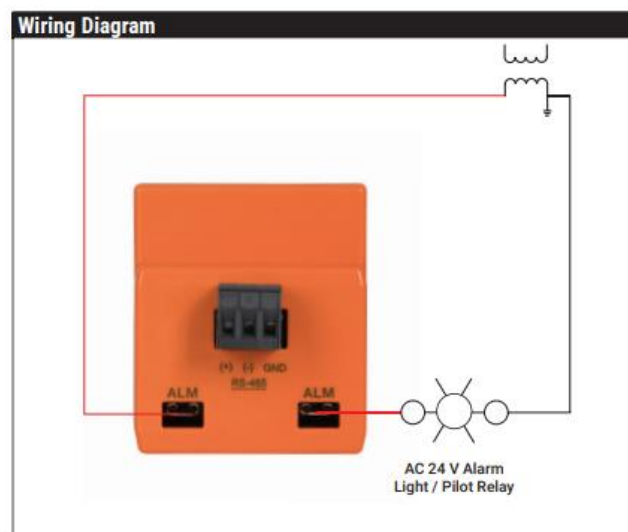


Figure 16
Communication Module Wiring



QUICK SETUP GUIDE

ZIP Economizer Quick Setup



WARNING Live Electrical Components!

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

Installation

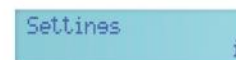
1. Shut off power to RTU before beginning installation.
2. Note orientation, opening rotation, and spring return rotation of damper assembly. Mount Actuator to Outside Air and Return Damper assembly. To ensure tight outside air shutoff; while tightening actuator clamp push damper closed.
3. Terminate required Inputs and Outputs(I/O): For the ZIP Economizer to function correctly, the following I/O, at a minimum, are required to be terminated, wired, and functioning (R, C, Y1, Y2, G, CC1, OAT, SAT, ACT1, ACT2, ACT3, ACT5). See wiring diagrams.
4. Sensor configuration: The ZIP Economizer automatically detects sensors attached and automatically configures for single dry bulb, single enthalpy, differential dry bulb and differential enthalpy.

MMI Keypad

Moves up through the menu on the same level. Will increase values by one increment at a time. When setting values holding key down will fast scroll	Moves down through the menu on the same level. Will decrease values by one increment at a time. When setting values holding key down will fast scroll.	
Enter sub menu level. Start editing a setting. Store an entered value.	Escape sub menu to next higher level. Cancel current actions.	Show additional information on the current menu Item when "i" appears in lower right of display.

Settings

"Settings" is the menu displayed when the ZIP Economizer is first powered. Press "OK" to parameterize required settings. Reference above Keypad Key definition instructions and navigate as needed.



Functions

1. "Monitor Live Conditions" is used to display settings and live values.
2. "Settings" is used to parameterize the ZIP Economizer. (Note: Devices 1 is for CC1, CC2, EF, IF; Devices 2 is for OAH, RAH)
3. "Present Devices" is used to verify that the ZIP Economizer's Auto Detected connections are terminated properly. If connected device is not shown, verify wiring. If wiring has continuity and device is verified operational re-enter "Settings" and enable missing device by changing from "Auto" to "Available" or "Installed".
4. "Alarms" is used to view current and historical alarms and delete inadvertently caused alarms.
5. "Service and Commissioning" submenu is used to manually override the "Devices" of the RTU or to manually override the modes of the RTU ("Forced Modes"). "Settings" must be completed to access.
6. "Status" is a display of the current operating mode. It can be accessed by pressing "esc". The action of pressing any key will drop the user down from Status to the next level, so repeatedly pressing "esc" will toggle the display between Status and Monitor Live Conditions. **(Note: If status "Setup incomplete" is displayed the RTU cooling operation will be disabled and additional parameters must be set to achieve "Setup complete".)**

Setup incomplete

QUICK SETUP GUIDE



ZIP Economizer Quick Setup

Required "Settings" Parameters for All Configurations

Note: you may enter parameters in any order - eg: Vent min Pos before ZIP Code - If the RTU is a heat pump or uses a 2 speed indoor fan, these parameters should be enabled first, otherwise the logic may go to Setup Complete prematurely.

1. ZIP Code US or Canada (sets the free cooling changeover high limit and temperature units F/C)
 - a. When the Zip Code submenu is displayed enter "OK" to begin "US" Zip Code parameterization. If "Canada" Postal Code is desired press the up/down arrow to access.
 - i. Press OK to access digit 1 (flashing) then use the up/down arrow to parameterize; enter OK when complete. Repeat until all digits are complete. If a mistake is made press "esc" and repeat from beginning.

US
89436

- ii. When all Zip Code or Postal Code digits are entered press "esc" to move up a level then press the up/down arrow to access next settings parameter.
2. Vent Min Pos (Outdoor Air Damper Ventilation Minimum Position)
 - a. When the "Vent Min Pos" submenu is displayed press "OK" to parameterize (flashing).

Vent Min Pos
--% i

- b. Use the up/down arrow to parameterize, press "OK" when complete. The actuator will immediately drive the damper to the minimum position.

3. Additional Parameters may require setting. The ZIP Economizer will auto-detect added Devices such as a CO2 sensor etc. When the ZIP Economizer detects a new device, it will prompt the user in the Status level; navigate to Settings and parameterize blank fields. If the devices are connected upon first start up their settings will require parameterization then.
4. When all parameters have been set, the ZIP Economizer will show "Setup Complete" if there are still parameters to set, there will be no action. You can verify by pushing esc until status level is reached and it will display "Setup Incomplete". If this is the case, re-enter settings menu and use up down arrows to find the parameter with blank fields and parameterize as described above.

Setup Complete - Initializing Automatic Mode

1. When all entries have been completed, the ZIP Economizer will switch to Status display and show "Setup Complete", and will immediately show a "Damper scaling starts in 10secs" and will countdown to 0 (**be aware, at 0 the damper will start to move at high speed**). A message will scroll saying "Damper scaling for better operation if obstruction is present rescale damper in commissioning menu". (For detailed instructions on this – please see the section "Service and Commissioning" below. This will open damper to 100% (re-scale control signal if needed). (Note: failure to identify obstructions or improper setup of damper assembly may result in an improper scaling and operation of the damper.)

Once scaling is complete, a message will appear saying "Damper scaling successful". The ZIP will then show "maximum at 80° = 100%" That message will show maximum rotation of the damper. This process ensures the damper is always operating and displayed from 0...100%.

2. Once the message has appeared, the actuator immediately closes the damper and a countdown begins, until the unit starts to operate in Automatic Mode (**be aware, when countdown complete, the RTU will respond to thermostat calls which may enable mechanical cooling**).

Service and Commissioning (Manual Override 1 & 2)

The ZIP Economizer has built in commissioning processes found in "Manual Override1 - Devices" & "Manual Override2- Forced Modes".

1. **Devices.** Use "Manual Override1- Devices" to verify RTU integrated components in manual operation. Navigate to "Services and Commissioning" menu, press "OK"; press the down arrow to access "Manual Override1- Devices". Press "ok" again to select a desired "Timeout" duration. Press down arrow for selectable devices. The device options are "Damper Pos", "Compressor 1", "Compressor 2", "Exhaust Fan", and "Fan Speed". Devices will only appear if they are connected. Return to automatic for normal functioning of the ZIP Economizer.
2. **Forced Modes.** Use "Manual Override2- Forced Modes" to override outputs. Navigate to "Service and Commissioning menu, press "OK"; press the down arrow twice to access "Manual Override2- Forced Modes". Press "ok" again to select a desired "Timeout" duration". The forced mode options are "Free Cooling", "Integrated Cooling", "Mechanical Cooling", "DCV", and "Unoccupied". Depending on the mode (see "Menu Sequence" section for notes), there will be the option to change or simulate the following: Y1 and Y2 stages, "OAT simulation", "SAT Simulation", "Fan Speed", and "CO2 Simulation". Selections will appear depending on what devices are connected. Return to automatic for normal functionality of the ZIP Economizer.
3. **Damper Scaling.** The test will re-scale the control signal range to maximum resolution (0...100%) over the calibrated (reduced) angle. When using a Belimo actuator, the actuator will speed up to reduce test time.

Note: Failure to identify obstructions or improper setup of damper assembly may result in an improper scaling and operation of the damper.)

Additional manual overrides can be found later in this document.

QUICK SETUP GUIDE

ZIP Economizer

Demand Control Ventilation Setup



Before Getting Started

ECON-ZIP-EM and CO₂ sensor can be added during or after initial set up.

1. A CO₂ sensor is needed with the following characteristics:
 - a. Output that is DC 0...10 V
 - b. Range of 0-2000 ppm
2. Attach the Energy Module ECON-ZIP-EM to the ZIP Economizer ECON-ZIP-BASE.



3. Setting PPM range (only required if sensor is configurable for other ranges).

Type of Output	Ventilation Rate (cfm/Person)	Analog Output	CO ₂ Control Range (ppm)
Proportional	Any	0...10 V	0...2000

4. Power RTU and enter Settings Menu.

Note: When the CO₂ sensor is powered and DC 0...10 V is available at CO₂+ and CO₂-, the ZIP Economizer will recognize the CO₂ presence and the prompt to set up CO₂ settings.

5. Setting DCV settings.

- a. With single speed indoor fan, only 2 DCV settings are required.

- i. DCV Min Pos – This is the minimum occupied or zero occupancy ventilation rate expressed in damper percent open (Title 24 2013 section 120.1(b)2; ASHRAE 62.1 Section 6.2.7).

DCV Min Pos
--% i

- ii. CO₂ PPM Set Pnt – This is the CO₂ concentration that is desired in the space (Title 24 2013 section 120.1(c)4. prescribed as 600 ppm plus outdoor air CO₂ concentration assumed to be 400 ppm = a set point of 1000ppm).

DCV PPM Set Pnt
--PPM i

Wiring CO₂ Sensor to ZIP Economizer

1. Wire CO₂ sensor DC 0...10 V output to ECON-ZIP-EM CO₂ sensor input.

- | | |
|---|-------------------|
| 1 | Not Used |
| 2 | Not Used |
| 3 | Relay Norm Open |
| 4 | Relay Common |
| 5 | Relay Norm Closed |
| 6 | 4-20mA Output |
| 7 | Signal Ground |
| 8 | 0-10V Output |

- | | |
|---|-----------|
| 1 | AC+ / C+ |
| 2 | AC- / GND |

Example CO₂ Sensor Diagram



2. Wire CO₂ sensor power.

Note: If RTU terminal VA is sufficient R/C terminals may be used on ZIP Economizer.

- | | |
|---|-------------------|
| 1 | Not Used |
| 2 | Not Used |
| 3 | Relay Norm Open |
| 4 | Relay Common |
| 5 | Relay Norm Closed |
| 6 | 4-20mA Output |
| 7 | Signal Ground |
| 8 | 0-10V Output |

- | | |
|---|-----------|
| 1 | AC+ / C+ |
| 2 | AC- / GND |

Example CO₂ Sensor Diagram



Operation

The ZIP Economizer logic will control the outside air damper position based on space CO₂ dilution needs. If the CO₂ value is low, the damper shall remain at DCV Min Pos when not in free cooling. When the CO₂ concentration rises above the CO₂ PPM Set Pnt (as the space becomes more populated), then the damper will start to modulate towards Vent Min Pos to maintain level at CO₂ PPM set Pnt. When the CO₂ concentration drops in the space (the space population decreases) the damper will start to modulate back towards DCV Min Pos.

WARNING Live Electrical Components!

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QUICK SETUP GUIDE



ZIP Economizer 2-Speed Fan Setup

Before Getting Started

Setting up the ZIP Economizer with Variable Frequency Drive.

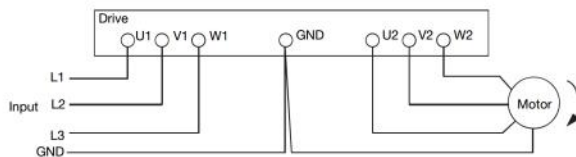
1. You will need a VFD rated for supply fan HP.
2. You will need to have a ZIP Economizer ECON-ZIP-BASE and an Energy Module ECON-ZIP-EM.
3. You will also need a separate SPDT relay for integration, and SPST for fan enabling.

Note: You will need to set Energy Module I/O Configuration to "IF" under Settings.



Wiring VFD to ZIP Economizer

Wire the VFD according to the manufacturer's instructions. Ensuring line voltage to the drive, and wiring the output of the VFD to motor per diagram below.



Verify that the motor rotation is correct. If not, switch 2 of 3 wires from VFD to motor.

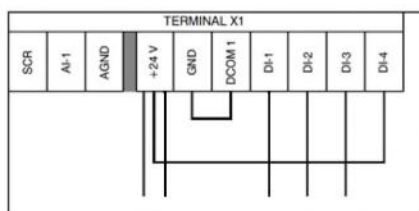
1. Locate the VFD Digital Inputs, as well as any pertinent High, Low Speed Designation.

Example VFD Terminal Designations

Reference	Drive Control Terminal Description
+24V	Auxiliary voltage output DC 24 V / 250 mA (reference to GND), short circuit protected.
GND	Auxiliary voltage output common
DCOM	Digital input common. Jumper to GND.
DI1	Start/stop. Jumper to +24 V.
DI2	Program to 40 Hz. Wire to SPDT NO contact.
DI3	Program to 60 Hz. Wire to SPDT NC contact.
DI4	Safety interlock. Jumper to +24 V.

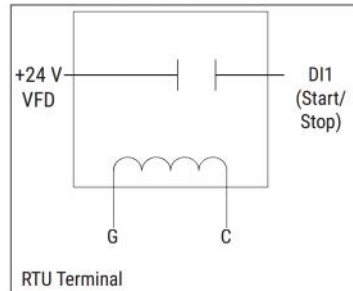
The control circuit inputs to the VFD are DC 24 V signals. This voltage is sourced from the VFD at its terminal strip X1, +24 V. The speed inputs are received at X1 terminals (DI-2) for low speed (40 HZ) motor operation and (DI-3) for high speed (60 HZ) motor operation. When neither input is present, the VFD will shut the fan motor off.

Utilizing the nomenclature from the example VFD Terminal Designations table, pull the following items from the terminal block for Digital Inputs.

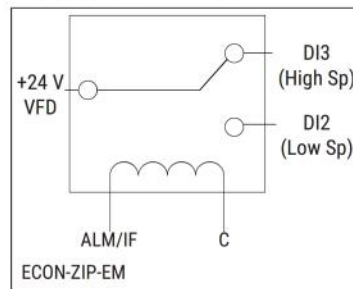


2. Connecting them into the following, utilizing the ALM/IF connection at the ECON-ZIP-EM.

Fan enable relay; single pole, single throw



Single pole, double throw relay



3. Power RTU and enter Settings menu.

Programming Indoor Fan Settings

When a VFD is added, up to three (3) additional settings will be required.

- a. Low Sp Vent Min - When a 2 Speed strategy is used to save energy, an additional Vent Min Pos needs to be entered for low speed operation due to less available static pressure from the fan. This position will be greater than Vent Min Pos, however equal the same measured airflow rate value.
- b. Low Sp DCV Min - When a 2 Speed strategy is used to save energy, an additional DCV Min Pos needs to be entered for low speed operation due to less available static pressure from the fan. This position will be greater than DCV Min Pos, however equal the same measured airflow rate value.
- c. Low Exh Fan Pos - When a 2 speed strategy is used to save energy, an additional Exh Fan On Pos needs to be entered for low speed operation due to less available static pressure from the fan. This position will be greater than Exh Fan On Pos, however equal the same measured airflow rate value.

These values should be set to provide the same airflow of outside air (OA) and exhaust as when fan is operating at full speed. Due to less pressure generated by the fan, this value is typically a higher percentage open value.

WARNING Live Electrical Components!

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

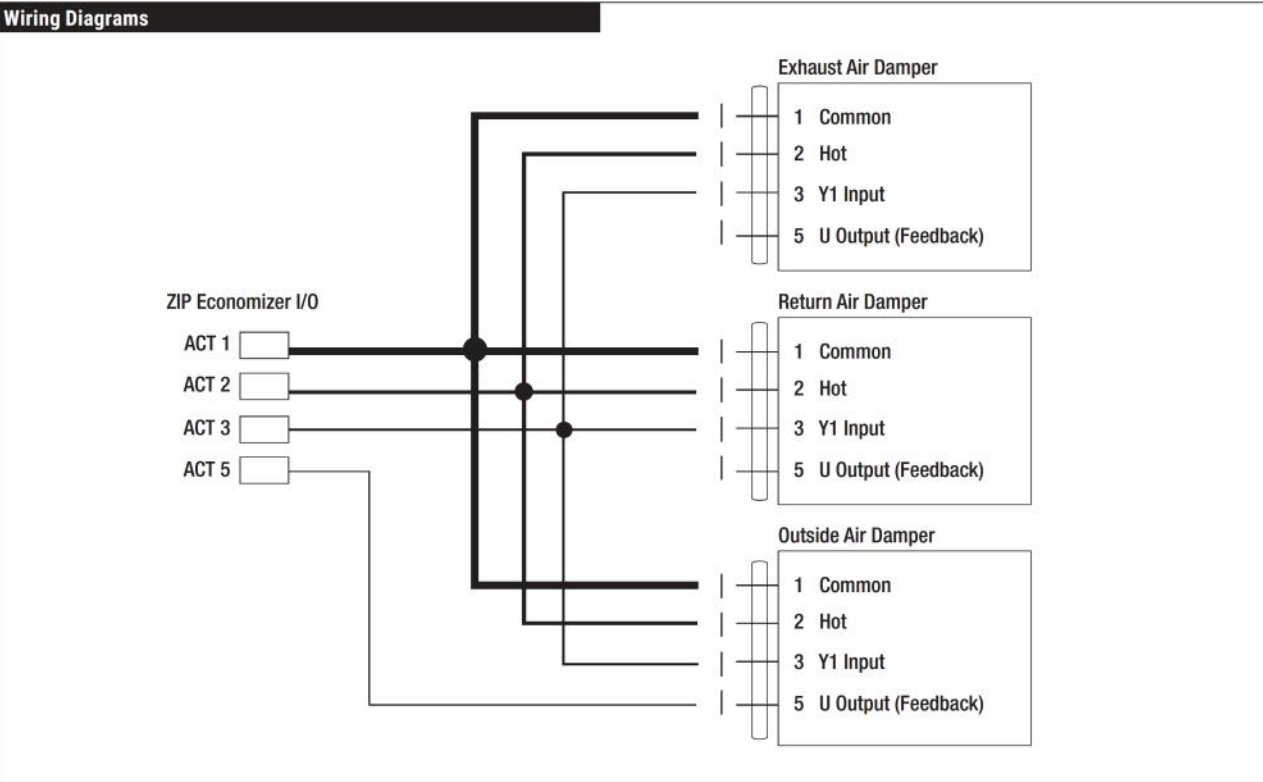
QUICK SETUP GUIDE

ZIP Economizer
Multiple Actuator Configuration



When using the ZIP Economizer on a Rooftop Unit (RTU) that has more than one damper that is not mechanically linked, the ZIP Economizer can drive a maximum of (3) -SR actuators. The actuators must be wired in parallel with the ACT3 output from the ZIP Economizer. The ACT5 feedback input on the ZIP Economizer should be wired to the Outside Air Damper actuator feedback wire.

Wiring for the multiple actuator configuration is shown in the illustration below; please ensure to follow all warnings and cautions listed in the actuator mounting instructions. Any combination of TFB24-SR, LF24-SR, NFB24-SR, and AFB24-SR can be mounted in this arrangement.



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COMPONENT DATA SHEETS



ECON-ZIP-BASE ZIP Economizer™ Base Module

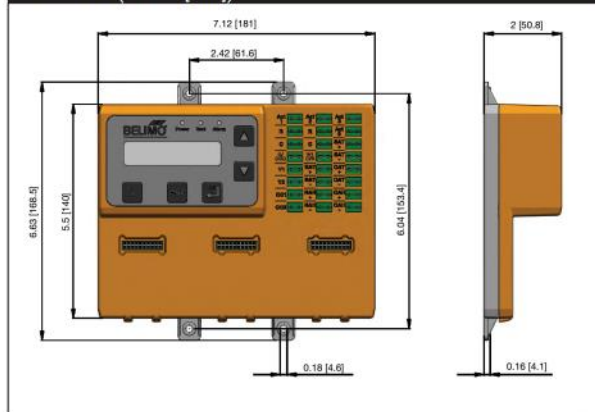


5-year warranty

Technical Data

Power supply	AC 24 V $\pm$ 20%, 50/60 Hz; Class 2 power source
	4 VA base control (ECON-ZIP-BASE)
	5.5 VA base control with Energy Module (ECON-ZIP-BASE + ECON-ZIP-EM)
Power consumption rating*	5 VA base control with Communication Module (ECON-ZIP-BASE + ECON-ZIP-COM)
	6.5 VA base with Energy Module and Communication Module. (ECON-ZIP-BASE + ECON-ZIP-EM + ECON-ZIP-COM)
Rated impulse voltage	330 V
Connectors	1/4" male spade connectors
Environmental	RoHS, conformally coated
Software class	A
Control pollution degree	3
Temperature input signal	NTC 10k Ω , Type II
Humidity	5 to 95% RH non-condensing
Humidity input signal	DC 0...10 V; corresponds to 0...100%
Housing	NEMA 1
Housing material	UL94-5VA
Ambient temperature range	-40...+158°F [-40...+70°C]
Storage temperature range	-40...+176°F [-40...+80°C]
Display	2x16 character LCD; LED backlight; transfective
Display op. range**	-22...+176°F [-30...+80°C]
Agency listing	cULus acc. to UL873, CAN/CSA C22.2, No. 24-93
Energy code compliant	ASHRAE 90.1, CA Title 24, NECB

Dimensions (Inches [mm])



Installation

You can mount the ZIP Economizer in any orientation; it is recommended that you mount it in a position that will allow full utilization of the LCD and key pad and proper clearance for installation, servicing, wiring, and removal.

Take the overall dimensions of 6.63" [168.5] x 7.12" [181] x 2" [50.8] and mount in the interior of the RTU in a convenient location that you can access. Secure the ZIP utilizing #8 self-tapping screws (included). A minimum of two tabs need to be secured, one which is a top tab. Ideally secure all four tabs. Wire the electrical connection using 1/4" female insulated spade connectors to prevent corrosion.

Input/Output Specifications

Type	Name	Description	Electrical Specification
Input	R	Supply Hot	AC 24 V, $\pm$ 20%, 50/60Hz
Input	G/ OCC	Fan Signal (occupied)	On/Off, AC 24 V, $\pm$ 20%, 50/60Hz
Input	C	Supply Common	Common
Input	Y1	Cooling requirement Stage 1	On/Off, AC 24 V, $\pm$ 20%, 50/60Hz
Input	Y2	Cooling requirement Stage 2	On/Off, AC 24 V, $\pm$ 20%, 50/60Hz
Input	W1/ O/B	Heating requirement Stage 1	On/Off, AC 24 V, $\pm$ 20%, 50/60Hz
Input	SAT $\pm$	Supply Air Temperature Sensor	Type: 10K NTC (Type II thermistor)
Input	OAT $\pm$	Outdoor Air Temperature	Type: 10K NTC (Type II thermistor)
Input	OAH $\pm$	Outdoor Air Humidity	DC 0...10 V Auto Detection: Sensor present if voltage 0.5...10 V
Input	RAT $\pm$	Return Air Temperature	Type: 10K NTC (Type II thermistor)
Input	RAH $\pm$	Return Air Humidity	DC 0...10 V Auto Detection: Sensor present if voltage 0.5...10V
Output	CC1	Compressor 1 RTU Stage 1 Mechanical Cooling Circuitry	100'000 cycles @ inrush current of 3A, normal current 1.5A Impedance for Auto detection @ 24 V: <600 Ω @ 60Hz <800 Ω @ 50Hz
Output	CC2	Compressor 2 RTU Stage 2 Mechanical Cooling Circuitry	100'000 cycles @ inrush current of 3A, normal current 1.5A Impedance for Auto detection @ 24 V: <600 Ω @ 60Hz <800 Ω @ 50Hz
Output	Act 1	Actuator supply common	Common
Output	Act 2	Actuator supply hot	AC 24 V, 50/60Hz
Output	Act 3	Actuator control output	DC 2...10 V
Input	Act 5	Actuator feedback signal	DC 2...10 V

* The power consumption is for the control only and does not include connected loads such as actuator, compressors, fans, and sensors. For transformer sizing, the power consumption of these attached components must be included.

** At low temperature the display has decreased response time. Below -22°F [-30°C] it will not function.

COMPONENT DATA SHEETS

ECON-ZIP-EM

ZIP Economizer™ Energy Module



5-year warranty

Technical Data

Power supply	AC 24 V ± 20%, 50/60Hz, class 2 power source
Power consumption rating*	1.5 VA (ECON-ZIP-EM), 5.5 VA (ECON-ZIP-BASE + ECON-ZIP-EM)
Connectors	1/4" male spade connectors
Environmental	RoHS, conformally coated
Indoor fan speed selection	100'000 cycles @ inrush current of 3A, normal current 1.5A
Exhaust fan selection	100'000 cycles @ inrush current of 3A, normal current 1.5A
Supported CO2 sensor	DC 0...10 V, sensor auto-detection, 0-2000 ppm
Auxiliary input - purge contact	on/off - AC 24 V, 50/60HZ - current load min 10 mA
Auxiliary input - remote potentiometer	DC 2...10 V
Humidity	5...95% RH non-condensing
Housing	NEMA 1
Housing material	UL94-5VA
Ambient temperature range	-40...+158°F [-40...+70°C]
Storage temperature range	-40...+176°F [-40...+80°C]
Agency listing	cULus acc. to UL873, CAN/CSA C22.2, No. 24-93

*The power consumption is for the control only and does not include connected loads such as actuator, compressors, fans, and sensors. For transformer sizing, the power consumption of these attached components must be included.

Product Features

The ZIP Economizer™ Energy Module provides additional I/Os to offer higher control functionalities that will save energy and will meet new and future minimum code requirements. The Energy Module is needed for CO2 sensors, Indoor Fan, 2 Speed Fan, Exhaust Fan, Remote Potentiometer for Damper Positioning, as well as purge control. The auto-detection and plug and play capability offers quick set up.

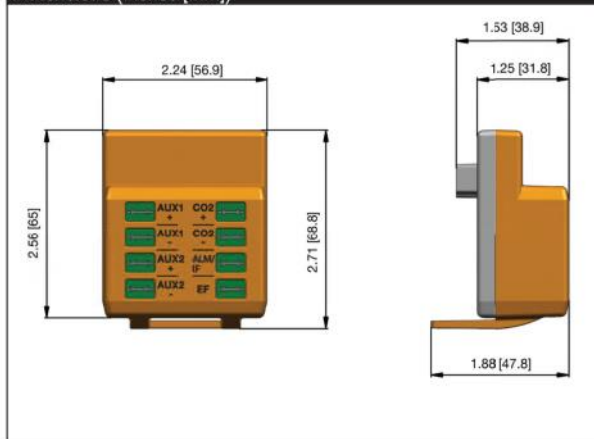
Application

The ZIP Economizer™ Energy Module offers demand control ventilation for high occupancy areas. (A third party CO2 sensor required). Pre-occupancy purge input for VOC removal (requires thermostat with purge contact). Power exhaust for building pressure control (requires power exhaust fan) Remote damper override (requires remote potentiometer installed). 2 speed fan control (requires supply fan to be equipped with multi speed fan or VFD).

I/O Specifications

Type	Name	Description	Electrical Specification
Input	CO2 +/-	CO2 sensor input	DC 0...10 V Sensor auto-detection
Output	ALM/IF	Alarm relay or Indoor fan low speed relay	100'000 cycles @ inrush current of 3A, normal current 1.5A Impedance for Auto detection @24 V: <600 Ω @ 60Hz <800 Ω @ 50Hz
Output	EF	Exhaust fan enable	100'000 cycles @ inrush current of 3A, normal current 1.5A Impedance for Auto detection @ 24 V: <600 Ω @ 60Hz <800 Ω @ 50Hz
Input	AUX1 ±	Auxiliary input Purge contact input	On/Off, AC 24 V, 50/60 Hz Current load min. 10 mA
Input	AUX2 ±	Auxiliary input Remote Potentiometer Input	DC 2...10 V

Dimensions (Inches [mm])



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COMPONENT DATA SHEETS

ECON-ZIP-COM

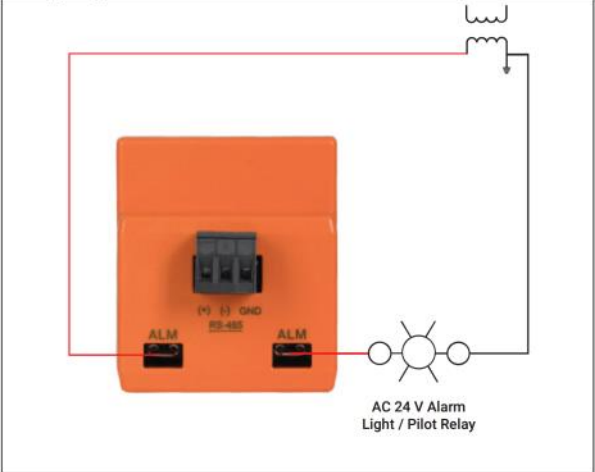
ZIP Economizer™ Communication Module



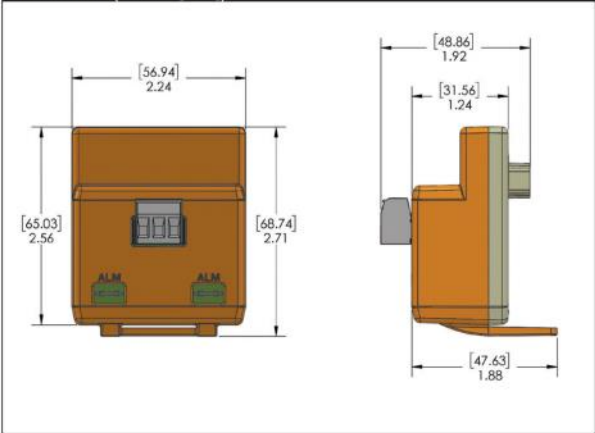
Technical Data	
Power supply	AC 24 V ± 20%, 50/60 Hz, class 2 power source
Power consumption rating*	2.5 VA (ECON-ZIP-COM), 6.5 VA (ECON-ZIP-BASE + ECON-ZIP-COM)
Connectors	1/4" male spade connectors
Environmental	RoHS, conformally coated
Communication interface	RS485 interface, optical isolation max. 1k VDC (for max. 1 min), Pin 4: RS485 Com Gnd, Pin 7: RS485 Com A, Pin 8: RS485 Com B
Supported remote alarm	normal current: 0.5A, inrush current: 1A
Humidity	5...95% RH non-condensing
Housing	NEMA 1
Housing material	UL94-5VA
Ambient temperature range	-40...+158°F [-40...+70°C]
Storage temperature range	-40...+176°F [-40...+80°C]
Agency listing	cULus acc. to UL873, CAN/CSA C22.2, No. 24-93

*The power consumption is for the control only and does not include connected loads such as actuator, compressors, fans, and sensors. For transformer sizing, the power consumption of these attached components must be included.

Wiring Diagram



Dimensions (Inches [mm])



I/O Specifications

Type	Name	Description	Electrical Specification
I/O	Comm	Communication Interface	RS485 Interface Optical Isolation max. 1k VDC (for max. 1min) Terminal Assignments: (+) Data B (-) Data A GND Ground
Relay	ALM	Diagnostic Alarm	Relay contact 24 V Normal current: 0.5A Inrush current: 1A

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COMPONENT DATA SHEETS

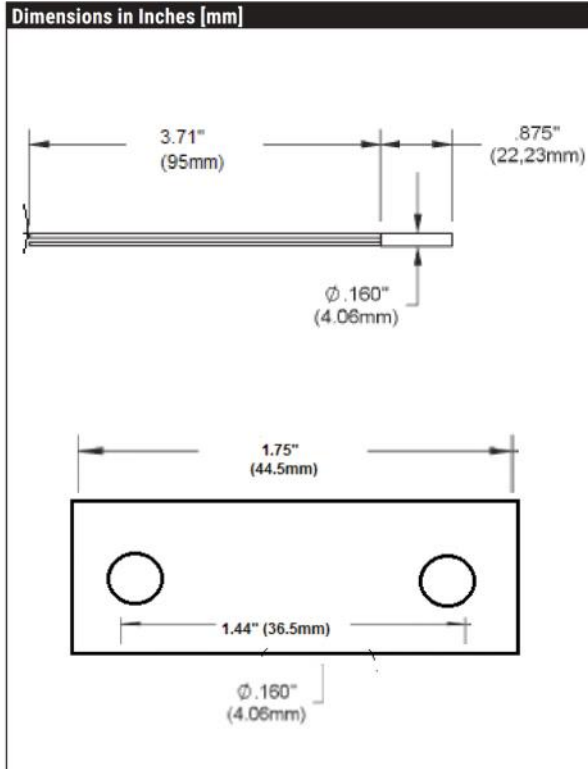


ECON-ZIP-10K

ZIP Economizer™ Temperature Sensor



Technical Data	
Temperature output signal	NTC 10k Ohm, Type II
Connectors	1/4" female spade insulated connectors, 3 ft. cable
Accuracy	$\pm 0.36^{\circ}\text{F}$ ($\pm 0.2^{\circ}\text{C}$)
Stability drift	less than $0.036^{\circ}\text{F}/\text{yr}$ [$0.02^{\circ}\text{C}/\text{yr}$]
Material	etched Teflon, plenum-rated & FEP jacketed cable; galvanized t-bracket
Ambient temperature range	$-67^{\circ}\text{F} \dots +176^{\circ}\text{F}$ [$-55 \dots +80^{\circ}\text{C}$]



Installation

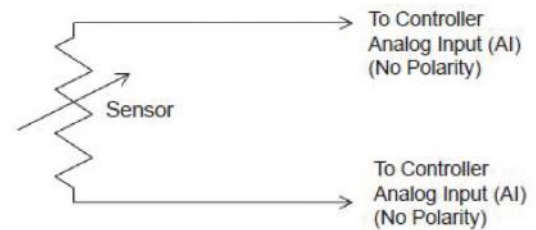
Avoid mounting in areas where acid fumes or other deteriorating vapors can attack the metal parts, or in areas where escaping gas or other explosive vapors are present.

Mount the sensor in a position that will allow for proper clearance for installation, servicing, wiring, and removal.

Using the dimensions as a reference, mount the 10K Sensor on the outside of the dampers to measure outside temperature, or inside the return air duct to measure the return temperature. If mounted outside, the sensor must be placed within hood behind the outdoor air filter. It needs to be protected from direct exposure to water (snow/rain) and direct exposure to sunlight (UV radiation).

Secure the sensor with #8 self-tapping screws (included in kit) using a size 16 or 18 drill.

Wiring Diagram



ECON-ZIP-10K

ZIP Economizer Terminal inputs

SAT (+/-)
OAT (+/-)
RAT (+/-)

COMPONENT DATA SHEETS

ECON-ZIP-TH

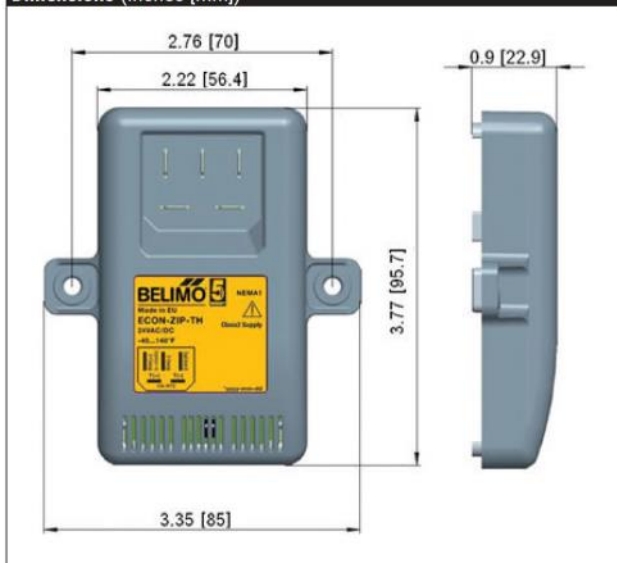
ZIP Economizer™ Temperature and Humidity Sensor



Technical Data

Power Supply	AC 24 V $\pm$ 20%, 50/60Hz, Class 2 power source
Current Consumption	Max. 5mA
Rated Impulse Voltage	800 V
Connectors	1/4" male spade connectors
Environmental	RoHS conformally coated
Software Class	A
Control Pollution Degree	3
Temperature Sensor Type	NTC 10kOhm
Humidity	0...100% RH
Humidity Sensor Type	DC 0...10 V (0...100% RH) max load 10k Ohm, Class 2 limited energy
Housing	NEMA 1
Ambient Temperature Range	-40...+140°F [-40...+60°C]
Storage Temperature Range	-40...+158°F [-40...+70°C]
Accuracy	$\pm$ 3% 35...65% rH @ 75°F $\pm$ 5% 0...34%, 66...100% rH @ 75°F
Response Time	<45 seconds @ 40 FPM, 75°F
Hysteresis	<2.5% rH
Long Term Stability	<1% rH/year
Agency Listing	UL60730-1,-2-9,-2-13. UL2043 compliant, CE 2004/108/EC "Electromagnetic compatibility (EMC)", EN60730-1,-2-9 and-2-13

Dimensions (Inches [mm])



Installation

Avoid mounting in areas where acid fumes or other deteriorating vapors can disintegrate the metal parts of the module's circuit board, or in areas where escaping gas or other explosive vapors are present.

You must mount the sensor in a position that will allow for proper clearance for installation, servicing, wiring, and removal.

Using the dimensions as a reference, mount the Temperature and Humidity Sensor on the outside of the dampers to measure outside temperature and humidity, or inside the return air duct to measure the return temperature and humidity. If mounted outside, the sensor must be placed within hood behind the outdoor air filter. It needs to be protected from direct exposure to water (snow/rain) and direct exposure to sunlight (UV radiation).

The orientation of the sensor is critical to ensure optimal performance. (Please see figures on recommended orientation.)

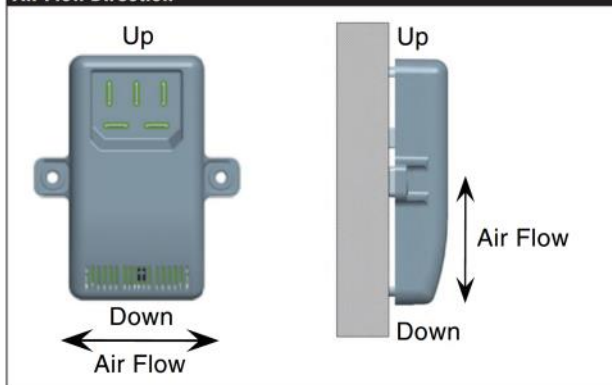
Ensure installation matches an approved orientation before securing with #8 self-tapping screws (included in kit).

The electrical connection needs to be wired using appropriate insulated spade connectors, 1/4" female, according to the wiring diagram.

Wiring



Air Flow Direction



I/O Specifications

Type	Name	Description	Electrical Specification	ZIP Terminal
Input	24 V	Supply Hot	AC 24 V, $\pm$ 20%, 50/60 Hz	Same Power Supply
Output	T(+/-)	Temperature	Type: 10K NTC (Type II thermistor)	OAT (+/-), RAT (+/-), SAT (+/-)
Output	RH (+/-)	Relative Humidity	DC 0...10 V	OAH (+/-), RAH (+/-)

COMPONENT DATA SHEETS



Modulating, Spring Return, AC 24 V/DC, for
DC 2...10 V or 4...20 mA Control Signal

Proportional, Spring Return, 24 V for 2 to 10
VDC or 4 to 20 mA Control Signal, Torque min.
35 in-lb, for control of air dampers

Technical data sheet

LF24-SR US



5-year warranty



Technical data

Electrical data	Nominal voltage	AC/DC 24 V
	Nominal voltage frequency	50/60 Hz
	Power consumption in operation	2.5 W
	Power consumption in rest position	1 W
	Transformer sizing	5 VA (class 2 power source)
	Electrical Connection	18 GA plenum cable, 3 ft [1 m], with 1/2" conduit connector
	Overload Protection	electronic throughout 0...95° rotation
	Electrical Protection	actuators are double insulated
Functional data	Torque motor	35 in-lb [4 Nm]
	Direction of motion motor	selectable with switch 0/1
	Direction of motion fail-safe	reversible with cw/ccw mounting
	Angle of rotation	Max. 95°
	Running Time (Motor)	150 s constant, independent of load
	Running time motor note	constant, independent of load
	Running time fail-safe	<25 s @ -4...122°F [-20...50°C], <60 s @ -22°F [-30°C]
	Noise level, motor	30 dB(A)
	Noise level, fail-safe	62 dB(A)
	Shaft Diameter	3/8...1/2" round, centers on 1/2"
Safety data	Position indication	Mechanical
	Degree of protection IEC/EN	IP54
	Degree of protection NEMA/UL	NEMA 2
	Enclosure	UL Enclosure Type 2
	Agency Listing	cULus acc. To UL 873 and CAN/CSA C22.2 No. 24-93; Listed to UL 2043 - suitable for use in air plenums per Section 300.22(c) of the NEC and Section 602.2 of the IMC
	Quality Standard	ISO 9001
	Ambient temperature	-22...122°F [-30...50°C]
	Storage temperature	-40...176°F [-40...80°C]
	Ambient humidity	Max. 95% RH, non-condensing
	Servicing	maintenance-free
Weight	Weight	3.4 lb [1.5 kg]
Materials	Housing material	galvanized steel

Product features

- Application** For fail-safe, modulating control of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer's specifications. The actuator is mounted directly to a damper shaft from 3/8" up to 1/2" in diameter by means of its universal clamp, 1/2" shaft centered at delivery. For shafts up to 3/4" use K6-1 accessory. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft. The actuator operates in response to a 2...10 V, or with the addition of a 500Ω resistor, a 4...20 mA control input from an electronic controller or positioner. A 2...10 V feedback signal is provided for position indication.
- Operation** The LF series actuators provide true spring return operation for reliable fail-safe application and positive close-off on air tight dampers. The spring return system provides consistent torque to the damper with, and without, power applied to the actuator. The LF series provides 95° of rotation and is provided with a graduated position indicator showing 0 to 95°. The LF24-SR US uses a brushless DC motor which is controlled by an Application Specific Integrated Circuit (ASIC) and a microprocessor. The microprocessor provides the intelligence to the ASIC to provide a constant rotation rate and to know the actuator's exact fail-safe position. The ASIC monitors and controls the brushless DC motor's rotation and provides a digital rotation sensing function to prevent damage to the actuator in a stall condition. The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches. Power consumption is reduced in holding mode.
- Typical specification** Spring return control damper actuators shall be direct coupled type which require no crank arm and linkage and be capable of direct mounting to a shaft up to a 3/4" diameter and center on a 1/2" shaft (default). Actuator shall deliver a minimum output torque of 35 in-lbs. The actuator must provide modulating 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. Actuators shall use a brushless DC motor controlled by a microprocessor and be protected from overload at all angles of rotation. Run time shall be constant, and independent of torque. A 2 to 10 feedback signal shall be provided for position feedback. The actuator must be designed so that they may be used for either clockwise or counter clockwise failsafe operation. Actuators shall be cULus listed, have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Accessories

Electrical accessories	Description	Type
	DC Voltage Input Rescaling Module	IRM-100
	Auxiliary switch, mercury-free	P475
	Auxiliary switch, mercury-free	P475-1
	Signal simulator, Power supply AC 120 V	PS-100
	Convert Pulse Width Modulated Signal to a 2...10 V Signal for Belimo Proportional Actuators	PTA-250
	Positioner for wall mounting	SGA24
	Positioner for front-panel mounting	SGF24
	Resistor, 500 Ω, 1/4" wire resistor with 6" pigtail wires	ZG-R01
	Resistor kit, 50% voltage divider	ZG-R02
	Transformer, AC 120 V to AC 24 V, 40 VA	ZG-X40

Mechanical accessories	Description	Type
	Shaft extension 170 mm Ø10 mm for damper shaft Ø 6...16 mm	AV6-20
	End stop indicator	IND-LF
	Shaft clamp for LF..	K6 US
	Shaft clamp reversible, clamping range Ø16...20 mm	K6-1
	Ball joint suitable for damper crank arm KH8 / KH10	KG10A
	Ball joint suitable for damper crank arm KH8	KG6
	Ball joint suitable for damper crank arm KH8	KG8
	Actuator arm, clamping range Ø8...16 mm, Slot width 8.2 mm	KH-LF
	V-bolt Kit for KH-LF.	KH-LFV
	Damper crank arm Slot width 8.2 mm, for Ø1.05"	KH12
	Damper crank arm Slot width 6.2 mm, clamping range Ø10...18 mm	KH6
	Damper crank arm Slot width 8.2 mm, clamping range Ø10...18 mm	KH8
	Anti-rotation bracket LF.	LF-P
	Push rod for KG10A ball joint 36" L, 3/8" diameter	SH10
	Push rod for KG6 & KG8 ball joints (36" L, 5/16" diameter).	SH8
	Wrench 0.32 in and 0.39 in [8 mm and 10 mm]	TOOL-06
	Angle of rotation limiter, with end stop	ZDB-LF
	Form fit adapter 8x8 mm	ZF8-LF
	Mounting Bracket: ZS-260 Right Angle	ZG-109
	Linkage kit	ZG-110
	Mounting bracket for LF..	ZG-112
	Damper clip for damper blade, 3.5" width.	ZG-DC1
	Damper clip for damper blade, 6" width.	ZG-DC2
	LF crankarm adaptor kit (includes ZG-112).	ZG-LF112
	LF crankarm adaptor kit (T bracket included).	ZG-LF2
	Shaft extension for 3/8" diameter shafts (4" L).	ZG-LMSA-1
	Shaft extension for 1/2" diameter shafts (5" L).	ZG-LMSA-1/2-5
	Weather shield 330x203x152 mm [13x8x6"] (LxBxH)	ZS-100
	Base plate, for ZS-100	ZS-101
	Weather shield 406x213x102 mm [16x8-3/8x4"] (LxWxH)	ZS-150
	Explosion proof housing 406x254x164 mm [16x10x6.435"] (LxBxH), UL and CSA, Class I, Zone 1&2, Groups B, C, D, (NEMA 7), Class III, Hazardous (classified) Locations	ZS-260
	Weather shield 438x222x140 mm [17-1/4x8-3/4x5-1/2"] (LxBxH), NEMA 4X, with mounting brackets	ZS-300
	Weather shield 438x222x140 mm [17-1/4x8-3/4x5-1/2"] (LxBxH), NEMA 4X, with mounting brackets	ZS-300-5
	Shaft extension 1/2"	ZS-300-C1
	Shaft extension 3/4"	ZS-300-C2
	Shaft extension 1"	ZS-300-C3

Electrical installation

 Warning! Live electrical components!

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

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

 Provide overload protection and disconnect as required.

 Actuators may also be powered by DC 24 V.

 Only connect common to negative (-) leg of control circuits.

 A 500 Ω resistor (ZG-R01) converts the 4...20 mA control signal to 2...10 V.

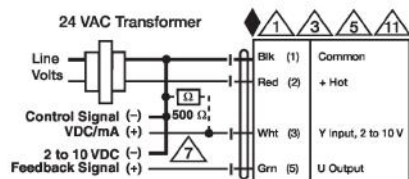
 Actuators may be connected in parallel if not mechanically linked. Power consumption and input impedance must be observed.

COMPONENT DATA SHEETS



Technical data sheet

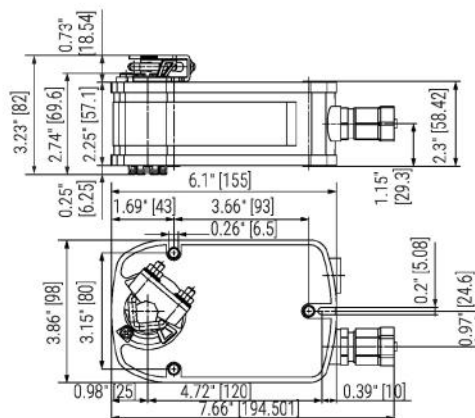
LF24-SR US



2...10 V / 4...20 mA Control

Dimensions

Dimensional drawings



COMPONENT DATA SHEETS

Installation Instructions

Quick-Mount Visual Instructions for Mechanical Installation



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 10mm wrench to 6-8 ft-lb of torque.
4. Slide the anti-rotation strap under the actuator so that it engages the slot at the base of the actuator. Secure the strap to the duct work with #8 self-tapping screws.

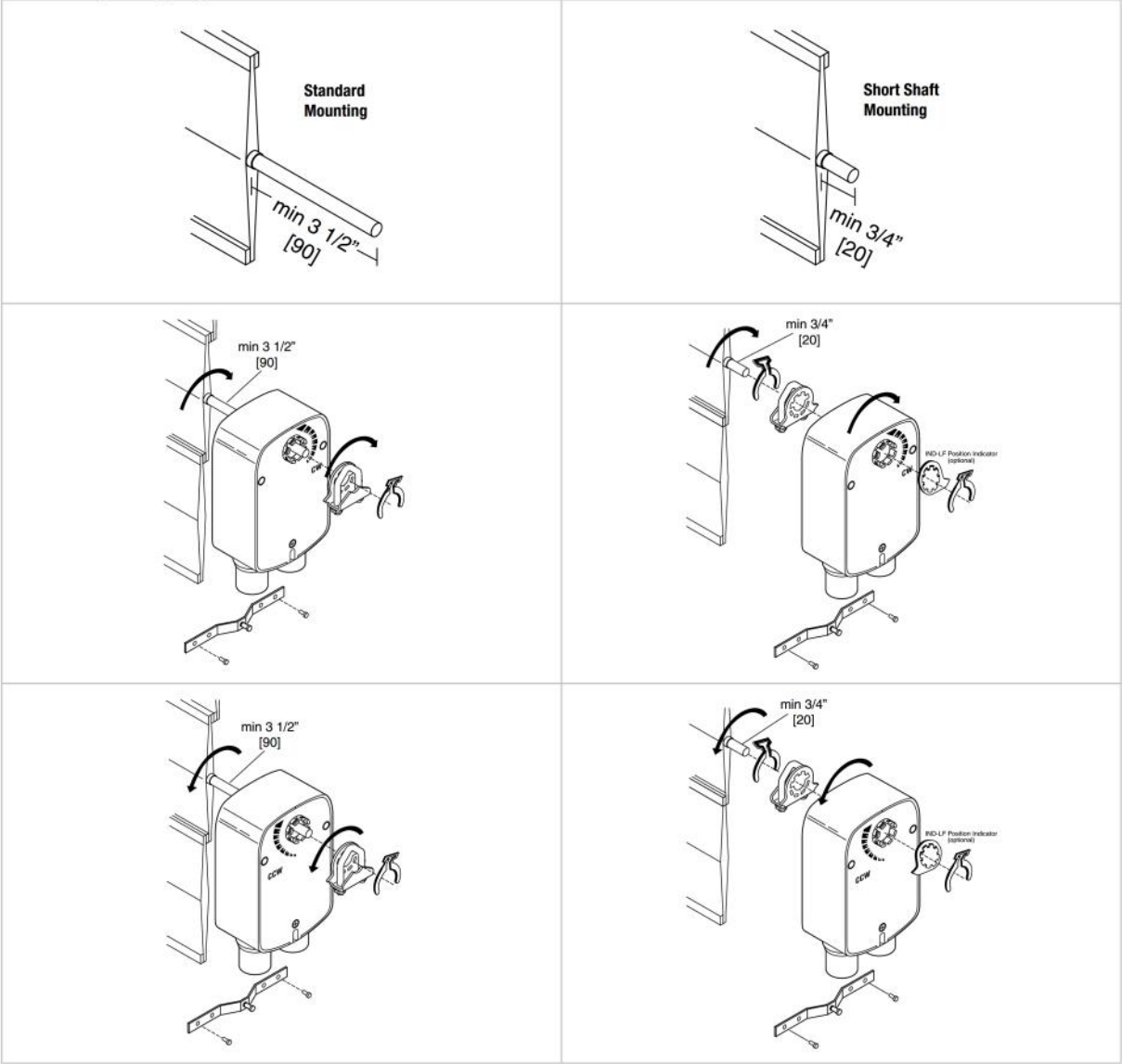
NOTE: Read the "Standard Mounting" instructions, on the next page, for more detailed information.

Preliminary Steps

1. Belimo actuators should be mounted indoors in dry, relatively clean environment free from corrosive fumes. If the actuator is to be mounted outdoors, a protective enclosure must be used to shield the actuator (See *Belimo Mechanical Accessories*).
2. For new construction work, **order dampers with extended shafts**. Instruct the installing contractor to allow space for mounting and service of the Belimo actuator on the shaft.
3. For standard mounting, the damper shaft must extend at least 3 1/2" from the duct. If the shaft extends less than 3 1/2", the actuator may be mounted in its short shaft configuration. If an obstruction blocks access, the shaft can be extended with the AV 10-18 shaft extension. (K6-1 is required)



Dimensions (Inches [mm])



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Installation Instructions

Mechanical Installation

Mechanical Operation

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

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

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

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

Standard Mounting / Airtight Damper Procedure

1. See **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 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.

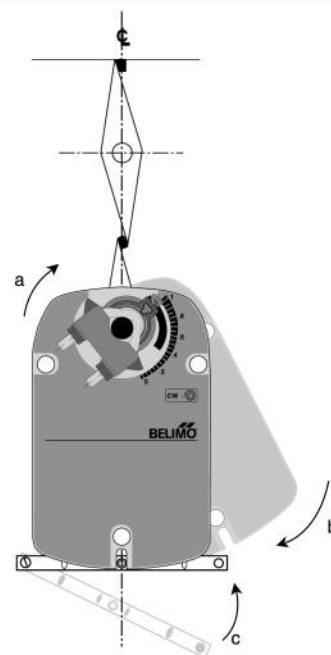
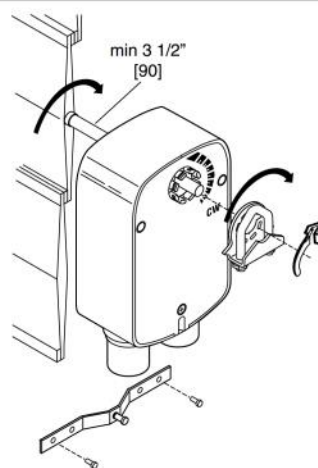


FIGURE B – Standard Mounting (Dimensions in Inches [mm])

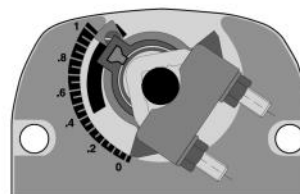


FIGURE C – Universal Clamp

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COMPONENT DATA SHEETS

Installation Instructions

Mechanical Installation



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.

Operational Information for LF24-SR US and LF24-MFT... US Actuators

Initialization of the LF24-SR US and LF24-MFT... US

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

Motor position detection

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

Overload protection

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

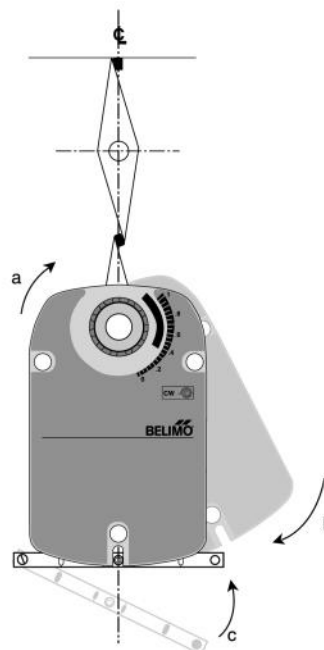
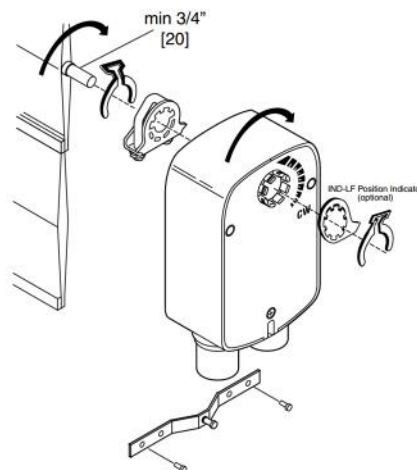


FIGURE D – Standard Mounting (Dimensions in Inches [mm])

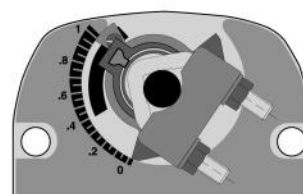


FIGURE C – Universal Clamp

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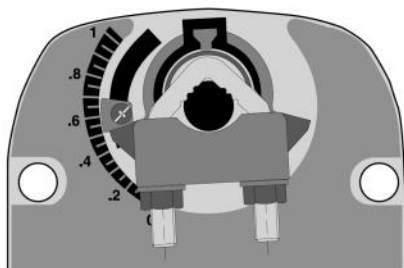


Installation Instructions

Mechanical Installation

Mechanical Angle of Rotation Limiting

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



Using the Universal Clamp

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

Using the IND-LF Position Indicator with Adjustable Stop

NOTE: preferred method if short shaft mounting is used.

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

Direction of Rotation Switch

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

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

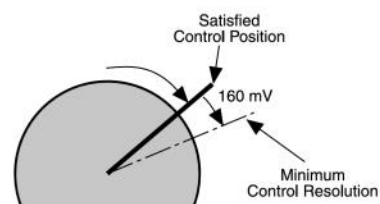
Rotating the direction of rotation switch to "CCW" reverses the control logic. During checkout, the switch position can be temporarily reversed and the actuator will reverse its direction. This allows the technician a fast and easy way to check the actuator operation without having to switch wires or 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

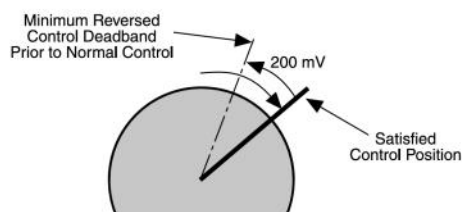
LF24-SR US actuators have built-in brushless DC motors which provide better accuracy and longer service life.

The LF24-SR US actuators are designed with a unique non-symmetrical deadband. The actuator follows an increasing or decreasing control signal with a 160 mV resolution. If the signal changes in the opposite direction, the actuator will not respond until the control signal changes by 200 mV. This allows these actuators to track even the slightest deviation very accurately, yet allowing the actuator to "wait" for a much larger change in control signal due to control signal instability.

LF Actuator responds to a 160 mV signal when not changing direction from stop position.



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



The LF24-MFT(-S) US control accuracy and stability can be found in the MFT technical documentation.

Installation Instructions

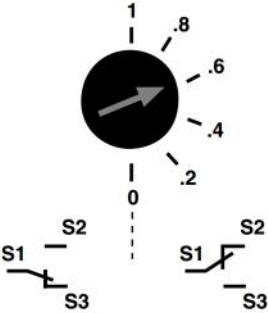
Auxiliary Switches and Non-Direct Mounting Methods



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.



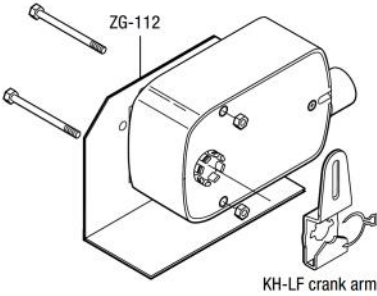
Switch Rating		
Voltage	Resistive load	Inductive load
120 VAC	3 A	1.03 A
250 VAC	3 A	0.5 A

Non-Direct Mounting Methods

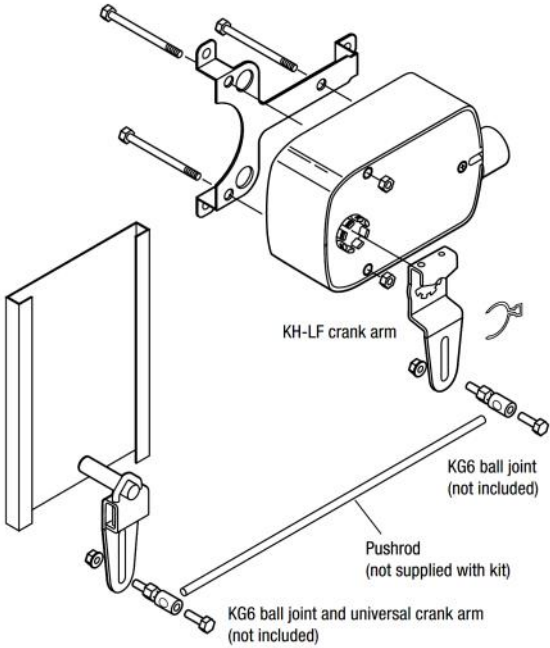
KH-LF Crank arm
Including Retaining Ring



ZG-LF112 Crank arm Adaptor Kit



ZG-LF2 Crank arm Adaptor Kit



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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 and/or Belimo.

Transformers

The LF24... actuator requires a 24 VAC class 2 transformer and draws a maximum of 7 VA per actuator. The actuator enclosure cannot be opened in the field, there are no parts or components to be replaced or repaired.

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

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

Multiple Actuators, One Transformer

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

1. The TOTAL current draw of the actuators (VA rating) is less than or equal to the rating of the transformer.
2. Polarity on the secondary of the transformer is strictly followed. This means that all No. 1 wires from all actuators are connected to the common leg on the transformer and all No. 2 wires from all actuators are connected to the 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 LF... 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 LF24-SR US: 3 actuators, 16 Ga wire
 $550 \text{ Ft} \div 3 \text{ Actuators} = 183 \text{ Ft}$. Maximum wire run

LF24(-S) US Maximum Wire Length

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.

LF120(-S) US / LF230(-S) Maximum Wire Length

Wire Size	Max. Feet.	Wire Size	Max. Feet
12 Ga	1250 Ft.	18 Ga	320 Ft.
14 Ga	800 Ft.	20 Ga	160 Ft.
16 Ga	500 Ft.	22 Ga	85 Ft.

LF24-SR(-S) US / LF24-3(-S) US LFC24-3-R(-S) US / LF24-MFT... US Maximum Wire Length

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 LF24... actuators. Use code-approved wire nuts, terminal strips or solderless connectors where wires are joined. It is good practice to run control wires unspliced from the actuator to the controller. If splices are unavoidable, make sure the splice can be reached for possible maintenance. Tape and/or wire-tie the splice to reduce the possibility of the splice being inadvertently pulled apart.

The LF24... proportional actuators have a digital circuit that is designed to ignore most unwanted input signals (pickup). In some situations the pickup may be severe enough to cause erratic running of the actuator. For example, a large inductive load (high voltage AC wires, motors, etc.) running near the power or control wiring may cause excessive pickup. To solve this problem, make one or more of the following changes:

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

Brushless DC Motor Operation

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

COMPONENT DATA SHEETS

Startup and Checkout

Instructions For LF24-SR (-S) US and LF24-MFT...US + P100



LF24-SR (-S) US and LF24-MFT...US + 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 LF24-SR US this is 2 to 10 VDC or 4 to 20 mA. Note: The input signal must be above the 2 VDC or 4 mA to have the actuator move.	Input voltage or current should be $\pm 1\%$ 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. - See Note 2.	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.
- NOTE 2** If failure occurs within 5 years from original installation date, notify Belimo and give details of the application.

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Mixing Box Accessory
Installation, Operation and Maintenance
Manual



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