M100E Economizer Series Actuator with R81EAA-2 Interface Board for Thermistor Sensor Applications

Installation

Parts Included

- M110EGA-1 or M130EGA-1 spring return actuator (R81EAA-2 electronics installed)
- five 1/4 in. female quick connect terminals
- LVR27A-602 crank arm

R81EAA-2:

- top cover electronics assembly
- terminal board
- insulating barrier
- two No. 6-32 x 5/16 in. Phillips-head recess screws

Note: An R81EAA-2 can be used with an M100X actuator. (See Ordering Information section, Table 1 in the M100E Economizer Series Actuator with R81EAA-2 Interface Board for Thermistor Sensor Applications Product Bulletin (LIT-2681114 in FAN 268.1 or 1628.3).

Tools Needed

- No. 2 Phillips screwdriver
- 1/8 in. (3 mm) flat-blade screwdriver
- punch and hammer

Precautions

IMPORTANT: All M100E Series actuators are intended to control equipment under normal operating conditions. Where failure or malfunction of M100E actuators could lead to an abnormal operating condition that could cause personal injury or damage to the equipment or other property, other devices (limit or safety controls) or systems (alarm or supervisory) intended to warn of, or protect against, failure or malfunction of M100E actuators must be incorporated into and maintained as part of the control system.

- Do not install the actuator in atmospheres where explosive vapors or gases could be present, or environments where substances corrosive to the device’s internal components could be present.
- Seal wiring into return air systems to prevent aspiration of corrosive air into the actuator.
Control Input

M100E Series actuators receive their input commands from a staged room thermostat and/or remote temperature sensor for accurate positioning of the output shaft. (Figure 1 illustrates sensor characteristics.)

![Thermistor Sensor Characteristics](image)

**Figure 1: Thermistor Sensor Characteristics**

Other inputs include:
- on-off command for changeover
- on-off command for cooling lockout
- thermistor temperature sensor input
- remote minimum position input
- remote setpoint potentiometer

Direction of Rotation

The actuators are factory set at the zero position and for 90° travel. The zero position is 10° Clockwise (CW) from vertical. (See Figure 2.) Spring return models always return Counterclockwise (CCW) to the zero position when power is removed.

Note: Direction of rotation is CW with temperature increase.

![Direction of Rotation](image)

**Figure 2: Direction of Rotation**

All reference to the direction of rotation is when viewing the load end stamped on the actuator housing as shown in Figure 2. From this view, the Counterclockwise (CCW) limit is the zero position.

Mounting

Actuator

Follow installation steps for the linkage kit used to couple the actuator and the controlled device. When not utilizing a damper linkage kit, use four 1/4 x 1 in. bolts to mount the actuator (not included).

Upright mounting of the actuator is preferred with the output shaft parallel to the floor. Locate the actuator where the shaft and wiring terminals are accessible.

**IMPORTANT:** For installations using the CVR83A-600R Weather Cover Kit, mount the actuator in an upright position to prevent water from entering the enclosure and damaging the actuator.

All linkage connections should be made to the drive shaft on the load end of the actuator, rated for up to 200 lb dead weight. Limit the load on the auxiliary end to 10 lb dead weight.

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R81E Installation

CAUTION: Equipment Damage Hazard. Disconnect all power supplies before removing the wiring connections and boards to avoid possible damage to the equipment.

Installing Boards

M100X base actuators are not provided with circuit boards. To install one, loosen the actuator’s cover screws, remove the cover, and proceed as follows:

1. Install the insulating barrier into the wiring compartment. Make sure all metal surfaces are covered. (See Figure 3.)

2. Install the terminal board by carefully placing the terminal receptacles onto the pin terminals.

3. Fasten the board with the No. 6-32 x 0.312 Phillips-head screws supplied.

4. Install the ribbon attached cover-mounted vertical board, carefully placing the terminal receptacles onto the two sets of pin terminals so all pins are aligned. (See Figure 4.)

5. Place the bracket, supplied with the actuator, over the vertical board and fasten it with the captive screw. (See Figure 5.)
6. Apply the adhesive-backed identification label provided to the actuator bracket. (See Figure 6.)

![Identification Label](image1)

**Figure 6: Identification Label**

### Removing Boards

To remove a circuit board, loosen the cover screws and remove the actuator cover. (The old cover will be replaced by the new furnished cover.)

1. Disconnect all wiring to the terminal board.
2. Loosen the captive screw, and remove the bracket. (See Figure 5.)
3. Pull the vertical board straight upward, being careful not to bend or damage the pin terminals.
4. Remove the two screws from the terminal board.
5. Grasp the receptacles and remove the terminal board by lifting upward, being careful not to bend or damage the pin terminals.

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**Wiring**

- **CAUTION:** **Equipment Damage Hazard.** Disconnect all power supplies before wiring connections are made. Check all wiring connections before applying power to the system. Short-circuited or improperly connected wires will result in permanent damage to the equipment.

- Make all wiring connections using copper conductors only. Wire in accordance with the National Electrical Code and local regulations.

- Use separate transformers on each M100 actuator to avoid potential miswiring or control signal problems.

- Locate all splicing and excess wiring outside the actuator wiring compartment. If desired, add a standard electrical box to the actuator’s wiring compartment. (See Figure 7.)

![Wiring Compartment](image2)

**Figure 7: Wiring the Junction Box**

The M100E does not require shielded cable on runs shorter than 50 ft (15 m). Avoid running low voltage sensor wiring in the same conduit as line voltage wiring, 24 VAC wiring, or other conductors that supply highly inductive loads (contactors, coils, motors, generators, etc.).
Use shielded cable if the control wiring is longer than 50 ft (15 m), run in a common conduit, or located near inductive loads. Use 22 AWG, Beldfoil 8761, or an equivalent for runs up to 250 ft (76 m). For runs between 250 to 500 ft (76 to 152 m), use 18 AWG, Beldfoil 8760, or an equivalent. Connect the shield to Terminal T1 (Common) only. To connect the wiring:

1. Use a hammer and punch to push the plug out of one of the access holes.
2. Install the conduit connector (not provided) to the actuator, and secure it using the conduit nut provided with the connector.
3. Connect the sensor to S1 and S2 located in the wiring compartment. (See Figure 8.)

4. Connect isolated 24 VAC to Terminals T1 and T2.

Figure 8 shows a wiring configuration, and Table 1 shows the location of the wiring terminals. Refer to the M100E Economizer Series Actuator with R81EAA-2 Interface Board for Thermistor Sensor Applications Application Note (LIT-2681130 in FAN 268.1 and 1628.3) for examples of slave actuator wiring configurations.

Table 1: Wiring Terminals

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Power Common</td>
</tr>
<tr>
<td>T2</td>
<td>24 VAC Power</td>
</tr>
<tr>
<td>S1</td>
<td>Thermistor Sensor (Common)</td>
</tr>
<tr>
<td>S2</td>
<td>Thermistor Sensor</td>
</tr>
<tr>
<td>A</td>
<td>Changeover Relay Coil (24 VAC)</td>
</tr>
<tr>
<td>B</td>
<td>Refrigeration Programming Relay Coil (24 VAC)</td>
</tr>
<tr>
<td>C</td>
<td>Relay Coil Common</td>
</tr>
<tr>
<td>X</td>
<td>Do Not Connect</td>
</tr>
<tr>
<td>8</td>
<td>Remote</td>
</tr>
<tr>
<td>9</td>
<td>Minimum</td>
</tr>
<tr>
<td>10</td>
<td>Position</td>
</tr>
<tr>
<td>8</td>
<td>Slave Actuator</td>
</tr>
<tr>
<td>9</td>
<td>Not Used</td>
</tr>
<tr>
<td>10</td>
<td>Slave Actuator</td>
</tr>
</tbody>
</table>

Refrigeration Programming Relay Contacts

| B1       | N.O. (Normally Open)             |
| B2       | COM (Common)                     |
| B3       | N.C. (Normally Closed)           |

Note: The changeover relay contacts are internally connected to the circuit.

Slave Actuators

A maximum of nine M100J Series actuators may be slaved from an M100E actuator. Refer to the M100E Economizer Series Actuator with R81EAA-2 Interface Board for Thermistor Sensor Applications Application Note (LIT-2681130 in FAN 268.1 and 1628.3) for more specific wiring information.
Adjustments

Travel
Travel is field adjustable from 65 to 270° by turning the travel potentiometer located on the R81E terminal board. (See Figure 9.) Adjusting the potentiometer affects the CW limit of the actuator’s rotation. (The CCW limit is not adjustable.) Refer to the appropriate damper linkage literature for more information on travel adjustment.

1. Apply 24 VAC to Terminals T1 (Common) and T2.
2. Run the actuator to its CW limit by jumpering Terminals 8 and T1.
3. Turn the travel potentiometer CW to increase the travel and CCW to decrease travel.

Setpoint
An internal setpoint adjustment for the remote sensor is located on the R81E terminal board and has a calibrated dial adjustable from 40 to 90°F (5 to 30°C). (See Figure 9.) When a remote setpoint control is used, turn the R81E setpoint knob CCW to its limit at the low temperature end of the dial, and adjust the setpoint at the remote location.

Proportional Band

| IMPORTANT: | If the actuator cannot maintain a stable position, increase the proportional band. Do not allow the actuator to oscillate, which could shorten the actuator’s life. |

The proportional band potentiometer (shown in Figure 9) controls the amount of change in the sensor temperature required to drive the actuator between the zero position and full stroke. (See Figure 10.) The proportional band is adjustable between 2 and 20°F (1.1 and 11°C).
Minimum Position

To increase the minimum position, turn the minimum position potentiometer CCW through the cover or CW from underneath the cover on the circuit board.

The minimum position potentiometer controls the CCW travel limit that the actuator will drive to when powered. The minimum position is CW from the zero position. When power is removed, the actuator will spring return to the zero position. The minimum position is adjustable between 0 and 70% of full travel, and is affected by the full travel adjustment. Set the minimum position after linkage and full travel adjustments are complete.

Manual Override

Use the following procedures to manually override the actuator. Refer to Figure 9 for terminal locations.

![CAUTION: Equipment Damage Hazard. This procedure is for checkout of the actuator only, and not for continuous operation. Ensure that overriding the actuator will not damage the system or components connected to the actuator.]

1. Disconnect all inputs before manually overriding the actuator.
2. With 24 VAC applied to Terminals T1 (Common) and T2:
   • Jumper Terminals T1 and 8 to drive the actuator in the CW direction to the full travel limit.
   • Jumper Terminals 8 and 10 to drive the actuator in the CCW direction to the zero position (overrides the minimum position setting.)
3. With 24 VAC applied to Terminals T1 (Common) and T2, and with 24 VAC applied to Terminals A and C (Common), which energizes the changeover relay:
   • Jumper sensor Terminals S1 and S2 to drive the actuator in the CW direction to the full travel limit.
   • Open sensor Terminal S1 or S2 to drive the actuator in the CCW direction to the minimum position.
4. Restore all original connections.
Checkout Procedure Changeover

Relay “A”

Apply 24 VAC to Terminals T1 (Common) and T2, and proceed:

1. Turn the minimum position potentiometer fully CCW from the board side of the cover or CW through the cover.
2. Energize the changeover relay by applying 24 VAC between Terminals A and C (Common). (This simulates the availability of outside air for natural cooling.)
3. Adjust the setpoint to approximately midrange, 65°F (18°C).
4. Jumper sensor Terminals S1 and S2, which will simulate a rise in mixed air temperature. (The actuator will rotate CW, and the outdoor air dampers will open.)
5. Remove the jumper and open sensor Terminal S2, which will now simulate a drop in mixed air temperature. (The actuator will rotate CCW and the outdoor air dampers will close.)
6. Restore all original connections and settings.

Minimum Position

Apply 24 VAC to Terminals T1 (Common) and T2, and continue as follows:

1. De-energize the changeover relay by removing power from Terminals A and C. (This simulates that outside air is no longer available for natural cooling.)
2. Turn the minimum position potentiometer CW on the board side or CCW through the cover to increase the minimum position. (The actuator will rotate CW, and the outdoor air damper minimum position will increase.)
3. Turn the minimum position potentiometer CCW on the board side or CW through cover to decrease the minimum position. (The actuator will rotate CCW and the outdoor air damper minimum position will decrease.)
4. Restore all original connections and settings.

Refrigeration Relay “B”

Remove connections from Terminals B, B1, B2, and B3, and perform the following:

1. Apply 24 VAC between Terminals B2 and C.
2. Use an AC voltmeter to verify that there is 24 VAC across Terminals B3 and C and 0 VAC across Terminals B1 and C.
3. Energize the refrigeration programming relay by applying 24 VAC between Terminals B and C.
4. Use an AC voltmeter to verify that there is 24 VAC across Terminals B1 and C, and 0 VAC across Terminals B3 and C.
5. Remove the 24 VAC from Terminals B2 and C, and from Terminals B and C.
6. Restore all original connections.
**Troubleshooting**

Verify that the M100 is powered by an isolated 24 VAC supply, and proceed as follows:

1. Cycle the actuator manually as described in the *Manual Override* section.
2. Perform the steps described in the *Checkout Procedure* section.
3. Verify that the voltage at Terminal 10, with reference to Terminal T1, is approximately +12 VDC.
4. Verify that the voltage at Terminal 9, with reference to Terminal T1, is approximately +10 VDC.
5. Verify that the voltage at Terminal 8, with reference to Terminal 10, is between 0 and approximately -2 VDC as the actuator drives from zero to full travel.

**Additional Information**

See Table 2 for accessories, and contact your nearest Johnson Controls representative. Refer to Table 3 for product specifications.
<table>
<thead>
<tr>
<th>Product Code Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y68AA-1</td>
<td>Transformer, 120/24 VAC, 40 VA, 60 Hz, Class 2</td>
</tr>
<tr>
<td>Y68DA-1</td>
<td>Transformer, 240/24 VAC, 40 VA, 60 Hz, Class 2</td>
</tr>
<tr>
<td>Y68HA-1</td>
<td>Transformer, 24/24 VAC, 40 VA, 60 Hz, Class 2</td>
</tr>
<tr>
<td>S91DJ-1</td>
<td>Auxiliary switch kit with one Single-Pole, Double-Throw (SPDT) switch</td>
</tr>
<tr>
<td>S91EJ-1</td>
<td>Auxiliary switch kit with two SPDT switches</td>
</tr>
<tr>
<td>S91PT-1</td>
<td>Auxiliary potentiometer kit, 1000 ohm, 1/3 watt</td>
</tr>
<tr>
<td>CVR83A-600R</td>
<td>Weather cover kit</td>
</tr>
<tr>
<td>Y20DAA-2</td>
<td>Mounts the actuator to the top of a duct or any flat surface. Contains the LVR27A-602, LVR27A-600, ROD16-3, and SWL10A-603Y (2).</td>
</tr>
<tr>
<td>Y20DAB-2</td>
<td>Mounts the actuator to the side of a duct or wall. Contains all items in the Y20DAA-2 plus one BKT22A-602.</td>
</tr>
<tr>
<td>Y20EBA-1</td>
<td>Valve linkage kit for mounting Honeywell® valves with 1/4-28 stem connection to M120 or M130 actuators</td>
</tr>
<tr>
<td>Y20EBA-2</td>
<td>Valve linkage kit for mounting Honeywell® valves with 1/4-28 stem connection to M150 actuators</td>
</tr>
<tr>
<td>Y20EBA-3</td>
<td>Valve linkage kit for mounting Barber-Colman® valves with 1/4-28 stem connection to M120 or M130 actuators</td>
</tr>
<tr>
<td>Y20EBA-4</td>
<td>Valve linkage kit for mounting Barber-Colman® valves with 1/4-28 stem connection to M150 actuators</td>
</tr>
<tr>
<td>Y20EBD-1</td>
<td>Linkage kit for M120 or M130 actuators and 1-1/4 in. (DN 32) valves, produces 75 lb (334 N) seating force</td>
</tr>
<tr>
<td>Y20EBD-2</td>
<td>Linkage kit for M140 actuators and 1-1/4 in. (DN 32) valves, produces 150 lb (607 N) seating force</td>
</tr>
<tr>
<td>Y20EBD-3</td>
<td>Linkage kit for M150 actuators and 1-1/4 in. (DN 32) valves, produces 270 lb (1202 N) seating force</td>
</tr>
<tr>
<td>Y20EBD-5</td>
<td>Linkage kit for M110 actuators and 1-1/4 in. (DN 32) valves, produces 40 lb (178 N) seating force</td>
</tr>
<tr>
<td>Y20EBD-6</td>
<td>Linkage kit for M120 or M130 actuators and 1-1/4 in. (DN 32) valves, produces 100 lb (449 N) seating force</td>
</tr>
<tr>
<td>Y20EBC-1</td>
<td>Coupling adaptor to convert valves with a 5/16 in. stem and a hold down nut for Johnson Controls 1/2 to 3 in. valves manufactured prior to March 1969.</td>
</tr>
<tr>
<td>Y20EBE-2</td>
<td>Stem adaptor and centerpiece collar to adapt VT Series valves with slotted stems. (Y20EBD-5 also required.)</td>
</tr>
<tr>
<td>Y20EBE-3</td>
<td>Hold down nut for cast iron and VB Series 2-1/2 to 4 in. valves and yoke nut for Barber-Colman 1/2 to 2 in. valves</td>
</tr>
<tr>
<td>Y20EBC-1</td>
<td>Stem connector for Barber-Colman 2-1/2 to 4 in. valves, 5 per package. (Use with Y20EBD-3 or -6.)</td>
</tr>
<tr>
<td>Y20EBC-11</td>
<td>Valve Linkage Adaptor Kit for VG7000 valves. (Y20EBC Series kit also required.)</td>
</tr>
<tr>
<td>VG7000-M110</td>
<td>Mounting Kit for M110 actuator and 1/2 through 2 in. (DN15 through DN50) valves</td>
</tr>
<tr>
<td>VG7000-M130</td>
<td>Mounting Kit for M130 actuator and 1/2 through 2 in. (DN15 through DN50) valves</td>
</tr>
<tr>
<td>VG7000-M140</td>
<td>Mounting Kit for M140 actuator and 1/2 through 2 in. (DN15 through DN50) valves</td>
</tr>
<tr>
<td>VG7000-M150</td>
<td>Mounting Kit for M150 actuator and 1/2 through 2 in. (DN15 through DN50) valves</td>
</tr>
<tr>
<td>Y20DFC-1</td>
<td>Damper linkage kit for mounting the actuator to CD-1300 dampers only (includes a universal mounting bracket for inside or outside damper frame mounting)</td>
</tr>
<tr>
<td>Table 3: Specifications</td>
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<td>------------------------</td>
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<tr>
<td><strong>Product</strong></td>
<td>M100E Economizer Series Actuator with R81EAA-2 Interface Board</td>
</tr>
<tr>
<td><strong>Power Requirements</strong></td>
<td>24 VAC, Class 2, (20 to 30 VAC) at 50/60 Hz, 25 VA spring return, 20 VA non-spring return</td>
</tr>
<tr>
<td><strong>Input Signal</strong></td>
<td>Proportional control, thermistor sensor input using A91 or T91 sensors</td>
</tr>
</tbody>
</table>
| **Input Signal Adjustments** | Mixed air setpoint 40 to 90°F (5 to 32°C)  
Adjusted proportional band 2 to 20°F° (1.1 to 11°C°)  
Adjusted minimum position 0 to 70% of full travel |
| **Mechanical Connection** | 3/8 in. (9.5 mm) square shaft (both ends)  
Maximum dead weight on output shaft: 200 lb (91 kg) on load end; 10 lb (4.5 kg) on auxiliary end |
| **Mechanical Output**  | Running Torque  
Breakaway and Stall (minimum)  
M110: 25 lb-in (2.8 N-m) spring return, 100 lb-in (11 N-m)  
M120: 35 lb-in (4.0 N-m)  
M130: 50 lb-in (5.6 N-m) spring return, 200 lb-in (23 N-m)  
M140: 75 lb-in (8.5 N-m)  
M150: 150 lb-in (17 N-m)  
300 lb-in (34 N-m) |
| **Rotation Range**     | Fixed zero, adjustable full travel 65 to 270°, factory set at 90° |
| **Rotation Timing**    | 60 seconds for 160° travel nominal, 60 Hz  
38 seconds for 90° travel nominal, 60 Hz  
75 seconds for 90° spring return |
| **Cycle Life**         | M110EGA-1, M130EGA-1: 150,000 cycles at rated load. Duty cycle, 25% |
| **Electrical Connection** | 1/4 in. spade terminals |
| **Action**             | CW rotation on temperature increase (fixed) |
| **Factory Settings**   | Setpoint 65°F (18°C); Proportional band 2°F° (1.1°C°); Minimum position 0% |
| **Programming Relay**  | Contacts: SPDT, Class 2 circuit  
Coil: 24 VAC, 1 VA, Class 2 circuit |
| **Changeover Relay**   | 24 VAC, 1 VA, Class 2 circuit (contacts connected internally) |
| **Ambient Operating Conditions** | Non-spring Return: -40 to 125°F (-40 to 52°C), 90% RH  
Spring Return: -35 to 125°F (-37 to 52°C), 90% RH |
| **Ambient Storage Conditions** | -40 to 140°F (-40 to 60°C), 90% RH |
| **Enclosure**          | NEMA 2, IP32 |
| **Dimensions (H x W x D)** | Spring Return: 6.23 x 5.64 x 7.68 in. (158 x 143 x 195 mm)  
Non-spring Return: 6.23 x 5.64 x 4.94 in. (158 x 143 x 125 mm) |
| **Shipping Weight**    | Spring Return: 9 lb (4.1 kg)  
Non-spring Return: 6.5 lb (2.9 kg) |
| **Agency Compliance**  | UL: M110EGA-1, M130EGA-1: UL 916 Listed, File 107041, CCN PAZX  
UL 873 Recognized, File E27734, CCN XAPX2  
M100X and R81: No UL Listing |
| **EU Directive Compliance** | 89/336/EEC (CE Mark) |

The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, consult the local Johnson Controls office. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.