Solid State Economizer System

(CONSISTING OF: C7046C DISCHARGE AIR SENSOR OR C7150B MIXED AIR SENSOR, C7400A SOLID STATE ENTHALPY SENSOR OR C7650A SOLID STATE TEMPERATURE SENSOR, M7415 OR M8405 DAMPER ACTUATORS, T6031H THERMOSTAT AND W7459A,C, OR D SOLID STATE ECONOMIZER LOGIC MODULE)

PRODUCT DATA

APPLICATION

The Solid State Economizer System provides an economical method of providing cooling air by incorporating outdoor air in the first stage of cooling in heating, ventilating and air conditioning (HVAC) systems. The Solid State Economizer System consists of the C7046C Discharge Air Sensor, C7150B Mixed Air Sensor, C7400A Solid State Enthalpy Sensor or C7650A Solid State Temperature Sensor, M7415 and M8405 Damper Actuators, T6031H Thermostat, and W7459A,C,D Solid State Economizer Logic Module.

FEATURES

C7046C Discharge Air Sensors have probe lengths of 8 in. (203 mm) and nominal sensor resistance of 3000 ohms at 77°F (25°C).

- **No setting or calibration required.**
- **Solid state components not affected by dust or dirt.**
- **Fast reacting.**
- **Rugged aluminum insertion probe.**

C7150B Mixed Air Sensor is used with the M7415/M8405 Damper Actuator to sense mixed or discharged air in rooftop packaged air conditioning equipment.

- **No setting or calibration required.**

C7400A Solid State Enthalpy Sensor and C7650A Solid State Temperature Sensors are used with the W7459 Solid State Economizer Logic Module to allow using outdoor air as the first stage of cooling in HVAC systems.

- **C7400A senses and combines temperature and humidity of outdoor air (heat index).**
- **C7650A senses temperature only.**
- **Long-lasting, solid state sensing element is accurate and stable over time.**
- **When enthalpy/temperature of outdoor air increases, the outdoor air damper closes to a preset minimum position.**
- **When enthalpy/temperature of outdoor air is low, the outdoor air damper opens to reduce the building cooling load.**
- **Provides a 4 to 20 mA output signal to the W7459 Solid State Economizer Logic Module; setpoint is located on solid state economizer control.**
- **Maximum economizer savings is achieved when two C7400A Solid State Enthalpy Sensors are connected to one W7459 Solid State Economizer Logic Module for differential enthalpy changeover control.**

(Continued)

Contents

M7415 and M8405 Damper Actuators are 25 lb-in. spring return damper actuators that provide modulating or three-position control of economizer systems, ventilation dampers and combustion air dampers used in residential or commercial HVAC equipment.

- **M7415 Damper Actuator provides modulating control of economizer dampers from a thermistor mixed-air or discharge sensor to maintain 56°F (13°C) air temperature.**
- **M8405A Damper Actuator provides three-position control: closed, adjustable mid-position, and open.**
- **Quiet, high efficiency drive motor.**
- **High impact, glass-fiber reinforced, plastic case is rugged, lightweight and corrosion resistant.**

T6031H Thermostat acts as changeover thermostat.

- **Switches enclosed to resist effects of dust and moisture.**
- **Warmer-Cooler temperature scale.**
- **Sensing bulb installed in return air flow.**

W7459A,C,D Solid State Economizer Logic Module used with C7400 Solid State Enthalpy Sensors and M7415 or M8405 Damper Actuators to proportion outdoor and return air dampers for economizer control in commercial HVAC equipment.

- **Combine functions of solid state enthalpy changeover control, minimum damper position potentiometer (W7459A,D) and compressor staging relays.**
- **Optional differential enthalpy control provides greater economizer savings than single enthalpy control by selecting the most economical air for cooling. Differential enthalpy control utilizes two sensor inputs: one in return air and one in outdoor air; the economizer control then determines which air has the lower enthalpy.**
- **Solid state control package provides improved accuracy, reliability and stability.**
- **W7459A,D mounts on M7415 Damper Actuator and accepts inputs from C7150B Mixed Air Sensors, C7400 Solid State Enthalpy Sensors, C7046C Discharge Air Sensor, and optional remote minimum damper position potentiometer.**
- **W7459C mounts on M8405A Damper Actuator and accepts inputs from single pole single throw (spst) mixed or discharge air control and C7400 Solid State Enthalpy Sensors.**
- **Packages are designed to operate from the cooling space thermostat to provide a totally integrated control system.**
- **Housed in high-impact, glass-fiber reinforced plastic case that matches the lines of M7415 and M8405 Damper Actuators.**
- **Quick connect terminals.**
- **Enthalpy setpoint (A,B,C,D) located on W7459 Solid State Economizer Logic Module is used to select combination of air temperature and humidity that is suitable for free cooling.**
- **W7459A,D include built-in adjustable minimum damper position potentiometer that controls the amount of outdoor air admitted to meet minimum ventilation requirements; include terminals for connecting optional remote minimum position potentiometer.**
- **LED on W7459 indicates free cooling is available when there is a call for cooling from the thermostat.**

ORDERING INFORMATION

When purchasing replacement and modernization products from your TRADELINE® wholesaler or distributor, refer to the TRADELINE® Catalog or price sheets for complete ordering number.

If you have additional questions, need further information, or would like to comment on our products or services, please write or phone:

1. Your local Home and Building Control Sales Office (check white pages of your phone directory).
2. Home and Building Control Customer Relations
   Honeywell, 1885 Douglas Drive North
   Minneapolis, Minnesota 55422-4386

In Canada—Honeywell Limited/Honeywell Limitée, 35 Dynamic Drive, Scarborough, Ontario M1V 4Z9.
International Sales and Service Offices in all principal cities of the world. Manufacturing in Australia, Canada, Finland, France, Germany, Japan, Mexico, Netherlands, Spain, Taiwan, United Kingdom, U.S.A.

SPECIFICATIONS

IMPORTANT

The specifications given in this publication do not include normal manufacturing tolerances. Therefore, these units may not exactly match the specifications listed. Also, these products are tested and calibrated under closely controlled conditions and some minor differences in performance can be expected if these conditions are changed.

Models:
Specifications for each model are listed separately.

C7046 Discharge Air Sensors

Intended for use as a discharge sensor in rooftop applications.

Sensing Element:
Carbon type, thermistor-resistor element.

Performance Characteristics:
Reaction Time Constant with Air Approach Velocity of 8.33 ft/sec (2.54 m/sec): 60 seconds.

Resistance/Temperature (NTC):
Nominal Resistance: 3000 ohms at 77°F (24°C).
Nominal Sensitivity: 70 ohms per degree F (124 ohms per degree C) at midrange.

Mounting Arrangement:
Integral mounting flange that requires two no. 8 screws (not provided).

Maximum Ambient Temperature:
250°F (121°C).

Operating Temperature Range:
40°F to 150°F (4°C to 66°C).

Wiring Connections:
6 in. (152 mm) leadwires.

Dimensions:
See Fig. 1.

C7150B Mixed/Discharge Air Sensor

Used to sense mixed or discharged air in rooftop packaged air conditioning equipment.

Resistance/Temperature (NTC):
Nominal Resistance: 3000 ohms at 77°F (24°C).
Nominal Sensitivity: 70 ohms per degree F (124 ohms per degree C) at midrange.

Maximum Ambient Temperature:
250°F (121°C).

Operating Temperature Range:
-40°F to +110°F (-40°C to +44°C).

Dimensions:
See Fig. 2.

C7400A Solid State Enthalpy Sensor/C7650A Solid State Temperature Sensor

Permits use of outdoor air as the first stage of cooling in HVAC systems.

Temperature Sensing Element:
Thermistor.

Output Signal:
4 to 20 mA current signal; increases from 4 mA to 20 mA as enthalpy decreases.

Ambient Operating Temperature Range:
-40°F to +125°F (-40°C to +52°C).

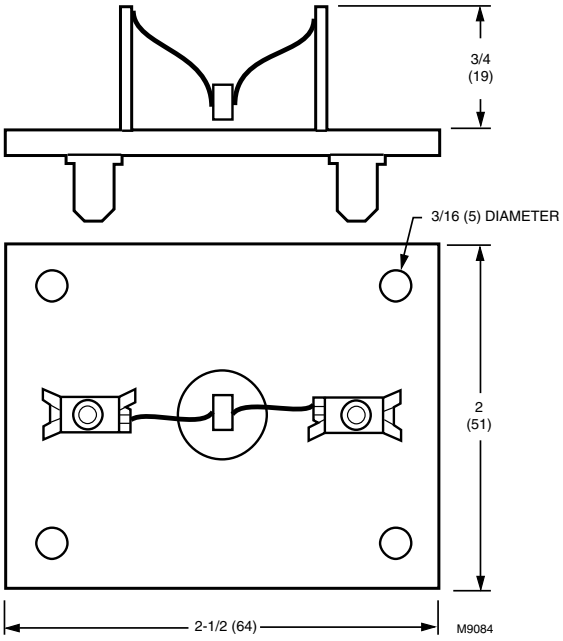


Fig. 2. Approximate dimensions of C7150B Mixed/ Discharge Air Sensor in in. (mm).

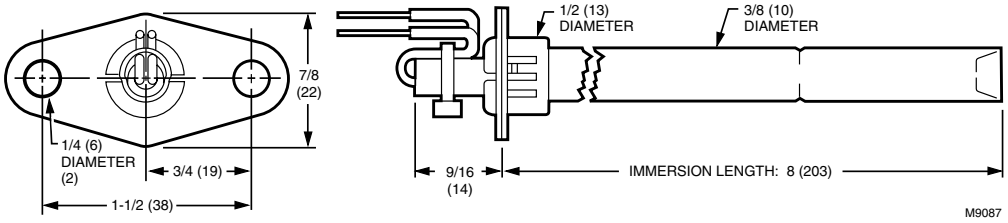


Fig. 1. Approximate dimensions of C7046C Air Temperature Sensor in in. (mm).

Approval:
Underwriters Laboratories Inc. Flammability Rating: UL94-5V.

Dimensions:
See Fig. 3.

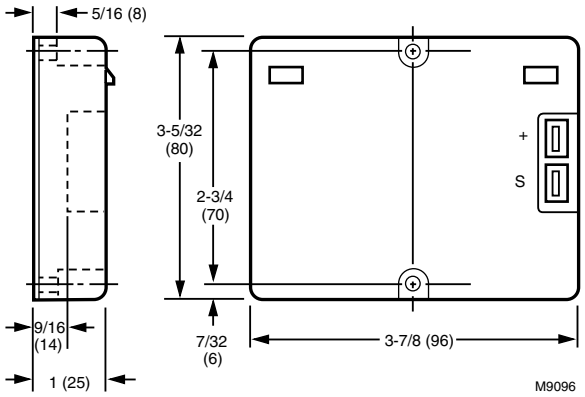


Fig. 3. Approximate dimensions of C7400A Solid State Enthalpy Sensor/C7650A Solid State Temperature Sensor in in. (mm).

M7415A, M8405A Damper Actuators

Provides control of economizer systems, ventilation dampers and combustion air dampers used in residential or commercial HVAC equipment.

Actuator Rotation:
Closed position is the limit of clockwise rotation; open position is the limit of counterclockwise rotation as viewed from the shaft end of the motor. These motors are shipped with the shaft in the closed position.

Auxiliary Switch Rating (M8405A only):
24 Vac, 20 VA inrush, 20 VA run (R8222 or equivalent load).

Terminal Connections:
1/4 in. (6 mm) male quick connect terminals mounted on actuator. Terminal arrangement is dependent on actuator model.

Ambient Operating Temperature Range:
-40°F to +125°F (-40°C to +52°C).

Voltage and Timing:
See Table 1.

Dimensions:
See Fig. 4.

Shaft:
Single-ended drive shaft with crank arm supplied.

Flammability Rating:
Underwriters Laboratories Inc. UL94-5V.

Approval:
Underwriters Laboratories Inc.
Component Recognized: File No. E4436, Guide No. XAPX2, Vol. 9, Section 1, 7-25-83.

Table 1. M7415A/M7405A Actuator Specifications.

Model Number	Voltage (Vac) 50/60 Hz	Power (Vac)		Timing (sec)[a]	Stroke (°)	Torque		Open Rotation (Shaft End View)	Spring Return (Shaft End View)
		(Drive)	(Hold)			(lb-in.)	(N•m)		
M7415A[b,c]	24	8	5	90	90	25	2.8	ccw	cw
M8405A[b,d]	24	7	3	90	90	25	2.8	ccw	cw

[a] Timing with 60 Hz power.
[b] Spring return.
[c] Modulating.
[d] Three-position with field adjustable minimum position control.

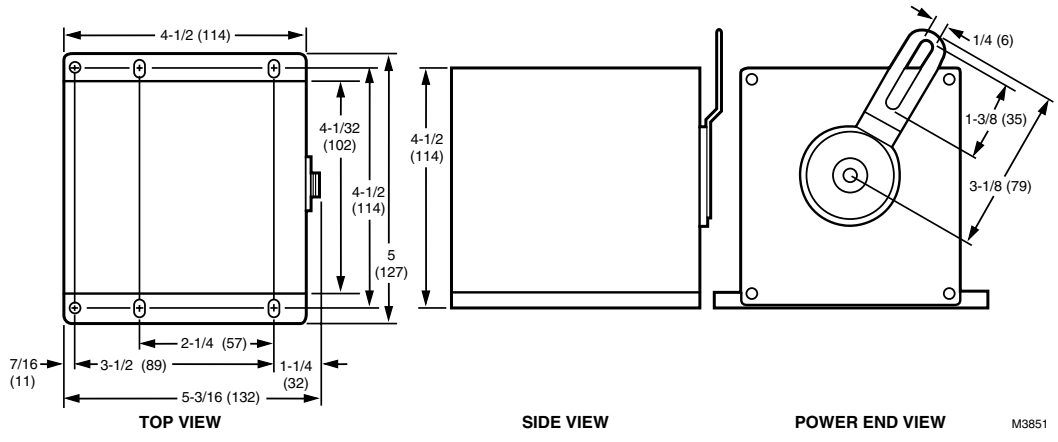


Fig. 4. Approximate dimensions of M7415A and M8405A in in. (mm).

T6031H Thermostat

A standard spdt switch, without a case, that acts as a changeover thermostat.

Electrical Rating:
0.25A at 1/.4V to 12 Vdc inductive load.

Control Range, Element Temperature and Differential:
See Table 2.

Approval:
Underwriters Laboratories Inc. Listed:
File E4436, Vol. 4, Guide No. XAPX2.

Dimensions:
See Fig. 5.

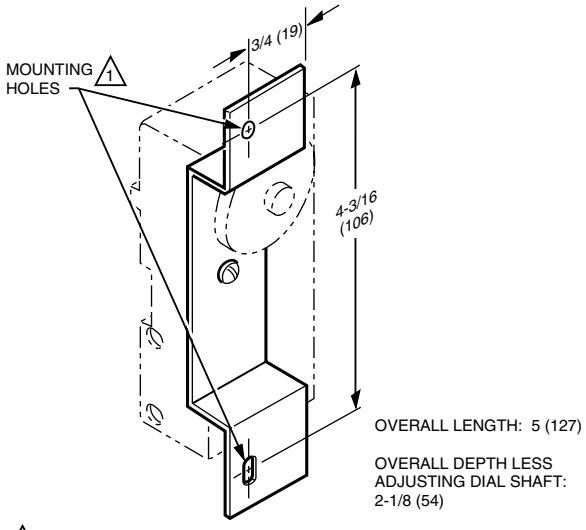


Fig. 5. Approximate dimensions of back mounting bracket for T6031H in in. (mm).

W7459A,C,D Solid State Economizer Logic Module

Used with C7400 Sensor or C7650A Sensor and M7415 or M8405 Actuator to proportion outdoor and return air dampers for economizer control in commercial HVAC equipment. Do *not* use C7650A Sensor with W7459D high enthalpy limit devices.

Electrical Ratings:
Input Voltage: 24 Vac, 50/60 Hz.
Power Consumption: 5.5 VA.
Relay Contact Rating at 24 Vac: 1.5A run, 3.5A inrush.

Temperature Ratings:
-25°F to +125°F (-32°C to +52°·C).

Approval:
Underwriters Laboratories Inc.:
Flammability Rating: UL94V-5V.

Specifications:
See Table 3.

Dimensions:
See Fig. 6.

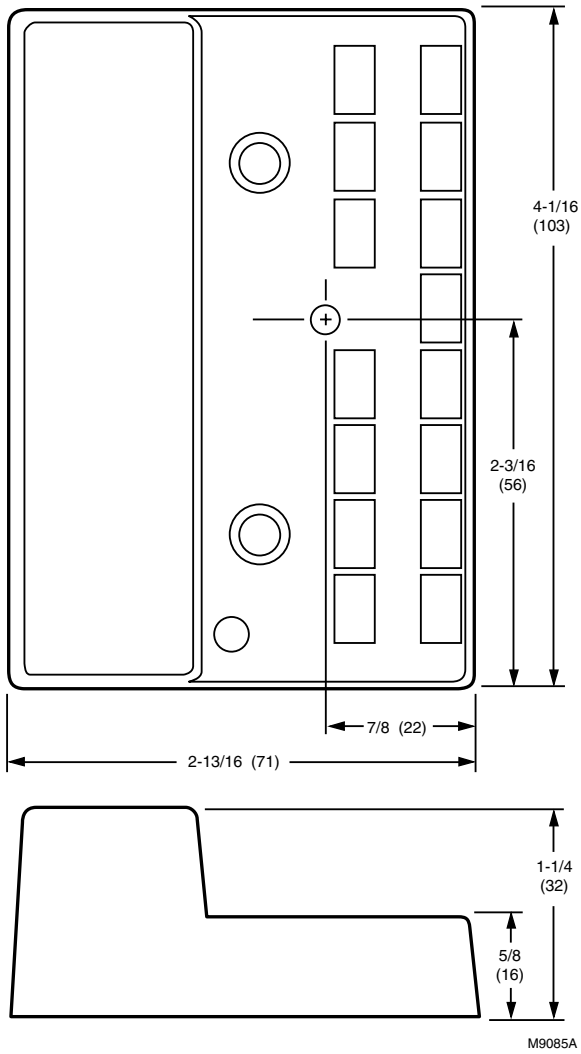


Fig. 6. Approximate dimensions of W7459 Solid State Economizer Logic Module in in. (mm).

Table 2. T6031H Thermostat Specifications.

Model Number	Control Range		Max Element Temperature		Differential		Type of Mounting	Capillary Length		Bulb Size	
	°F	°C	°F	°C	°F	°C		ft	m	in.	mm
T6031H	0° to 95°	-18° to +35°	150°	66°	3°	2°	Back	2	0.6	3/8 x 3-1/2	10 x 89

Table 3. W7459A,C,D Specifications.

Model	For Use with Actuator	Discharge Air Temperature Input	Minimum Position Potentiometer Adjustment	Terminals for Remote Minimum Damper Position	Output Relays
W7459A	M7415	Thermistor Sensor	Yes	Yes	2 spdt
W7459C	M8405	Spst control	No. Minimum position adjustment is built into M8405 Actuator	No	2 spdt
W7459D[a]	M7415	Thermistor Sensor C7150B or C7046A	Yes	Yes	2 spdt

[a] W7459D has a high enthalpy limit and defaults to mechanical cooling when the outdoor enthalpy reaches the preset limit. Do not use a dry bulb sensor for a high temperature limit.

INSTALLATION

When Installing these Products…

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and marked on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out the product operation as provided in these instructions.

⚠ CAUTION

CAN CAUSE ELECTRICAL SHOCK OR EQUIPMENT DAMAGE.

Disconnect power supply before connecting wiring.

C7046C Discharge Air Temperature Sensor

The sensor assembly consists of an aluminum sensor probe (element housed internally) with attached flange that can be mounted on a flat duct or plenum surface, or in a 2 in. by 4 in. (51 by 102 mm) junction box, using two no. 8 screws. Connections to the sensor are made through two 6 in. (152 mm) leadwires.

Location

Locate the sensor in the air duct or plenum where it can sample average air temperature. Avoid locations where air stratification can cause sensing errors.

Mounting

To mount the C7046C Sensor on a flat duct or plenum surface (see Fig. 7):

❶ Cut a 1/2 in (13 mm) hole in the duct or plenum surface at the desired location.
❷ Insert the sensor probe into the duct or plenum hole until the flange rests against the duct or plenum wall.
❸ If necessary, use the flange as a template to mark and drill two holes for no. 8 mounting screws.
❹ Fasten the sensor to the duct or plenum surface with the two no. 8 sheet metal screws (not provided).

To mount the C7046C Sensor in a junction box (see Fig. 8):

❶ Cut a 1/2 in (13 mm) hole in the duct or plenum surface at the desired location.
❷ Remove the center rear knockout from the junction box and insert the sensor probe through the knockout with the flange flat against the junction box.
❸ Using the flange as a template, mark and drill two holes in the junction box and the duct or plenum surface for no. 8 mounting screws.
❹ Insert the sensor probe through both the junction box knockout and the 1/2 in. (13 mm) hole drilled in the duct or plenum and fasten the junction box and sensor to the duct or plenum surface with the two no. 8 sheet metal screws (not provided).

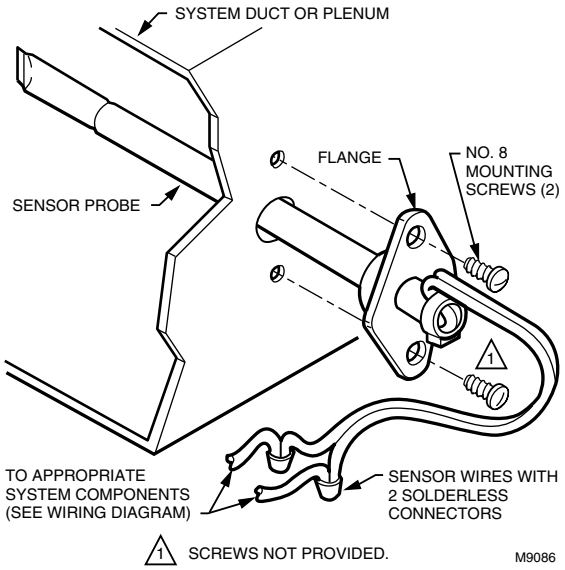


Fig. 7. Mounting C7046C Air Temperature Sensor on duct or plenum.

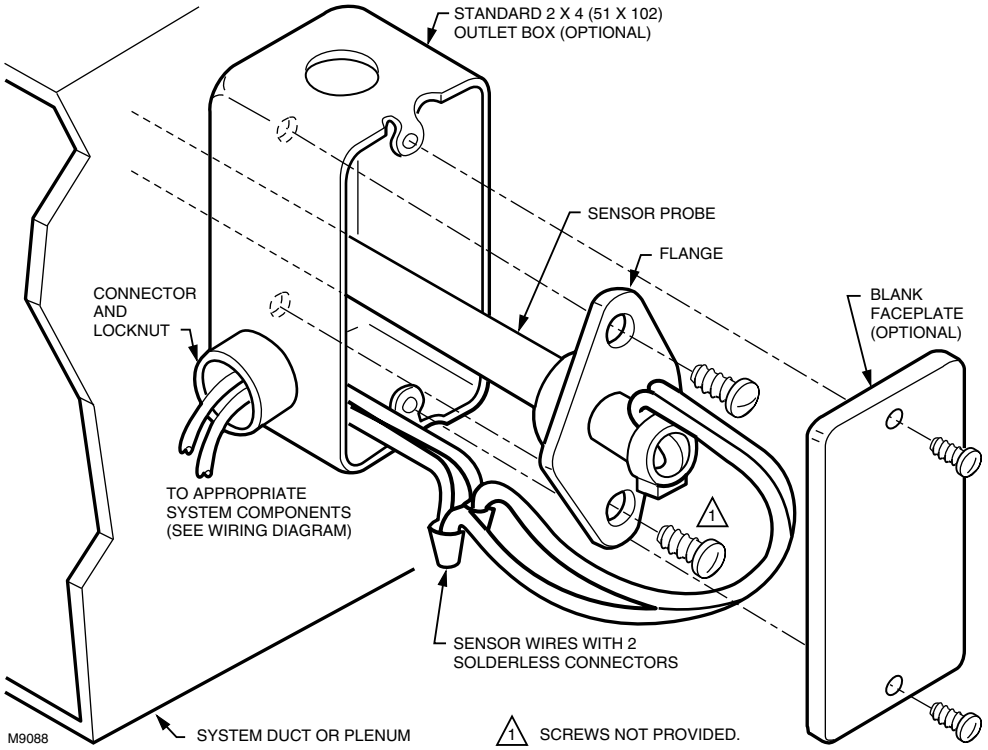


Fig. 8. Mounting C7046C Discharge Air Temperature Sensor in junction box.

Wiring

IMPORTANT

Failure to follow these wiring practices can introduce electrical interference (noise) that can cause erratic system operation:

a. Keep wiring at least one foot away from large inductive loads such as motors, line starters, lighting ballasts, and large power distribution panels.
b. Shielded cable is required in installations where these guidelines cannot be met.
c. Ground shield only to grounded controller case.

IMPORTANT

Minimize erratic temperature readings from a sensor to assure proper operation by following these wiring practices:

a. Route temperature sensor wiring away from building power wiring, control contactors and light dimming circuits, electric motors and welding equipment.
b. Make good physical wiring connections to assure good electrical connections.
c. Make sure that building earth ground connections are not intermittent or missing.
d. Mount sensor only in recommended environment.
e. Use shielded cable to reduce interference if rerouting of sensor wiring is not possible.

⚠ CAUTION

CAN CAUSE ELECTRICAL SHOCK OR EQUIPMENT DAMAGE.

Disconnect the power supply before connecting the wiring.

Make sure wiring complies with applicable local codes, ordinances and regulations.

Connect low voltage wiring from the sensor to the appropriate system component terminals using solderless connectors as shown in Fig. 7 and 8.

M7415A, M8405A Damper Actuators

⚠ CAUTION

CAN CAUSE ELECTRICAL SHOCK OR EQUIPMENT DAMAGE.

Disconnect power supply before connecting wiring.

⚠ WARNING

CAN CAUSE PERSONAL INJURY.

Do not remove end covers from actuator; spring return assembly can release to harm installer.

Location and Mounting

Location

Locate the actuator as close as possible to the equipment to be controlled. Refer to Fig. 4 for mounting dimensions.

Mounting

Mount the actuator with the shaft horizontal to assure maximum life; however, operation in other positions is possible when required in specific applications.

Remove the crank arm from the actuator (secured with two screws) and reposition to accommodate specific damper requirements. The crank arm position can be adjusted in 7.5-degree increments.

IMPORTANT

Position crank arm on actuator hub so that it does not strike the actuator mounting surface during any portion of the full stroke. See Fig. 9.

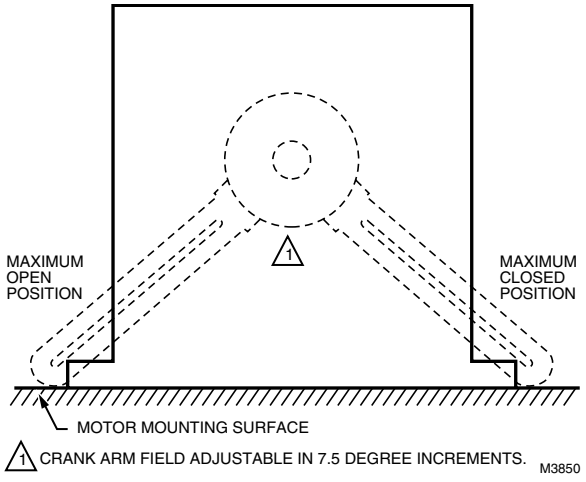


Fig. 9. Limits of crank arm rotation.

Wiring

CAUTION

CAN CAUSE ELECTRICAL SHOCK OR EQUIPMENT DAMAGE.

Disconnect power supply before connecting wiring.

Disconnect power supply before connecting wiring to prevent electrical shock or equipment damage. All wiring must comply with applicable local codes and ordinances. See Fig. 10 and 13 for typical hookup diagrams.

T6031H Thermostat

Location and Mounting

The T6031H Thermostat mounts either vertically or horizontally on a wall or panel. Locate the remote bulb as far from the controller as capillary tubing allows. Locate the bulb where it can sense the average temperature of the controlled medium.

Mounting Sensing Elements

T6031H: Install the bulb in the return airflow where air of average temperature can circulate around it.

IMPORTANT

Do not overtighten clamps to the point of distorting the sensor bulb because overtightening causes a significant shift in bulb calibration.

Mounting Thermostat

Mount the thermostat using the back mounting plate as shown in Fig. 5.

Wiring

CAUTION

CAN CAUSE ELECTRICAL SHOCK OR EQUIPMENT DAMAGE.

Disconnect power supply before connecting wiring.

Disconnect the power supply before connecting wiring to prevent electrical shock and equipment damage. All wiring must comply with applicable local codes and ordinances.

Refer to Fig. 11 and the wiring diagrams furnished with the system equipment to complete the wiring.

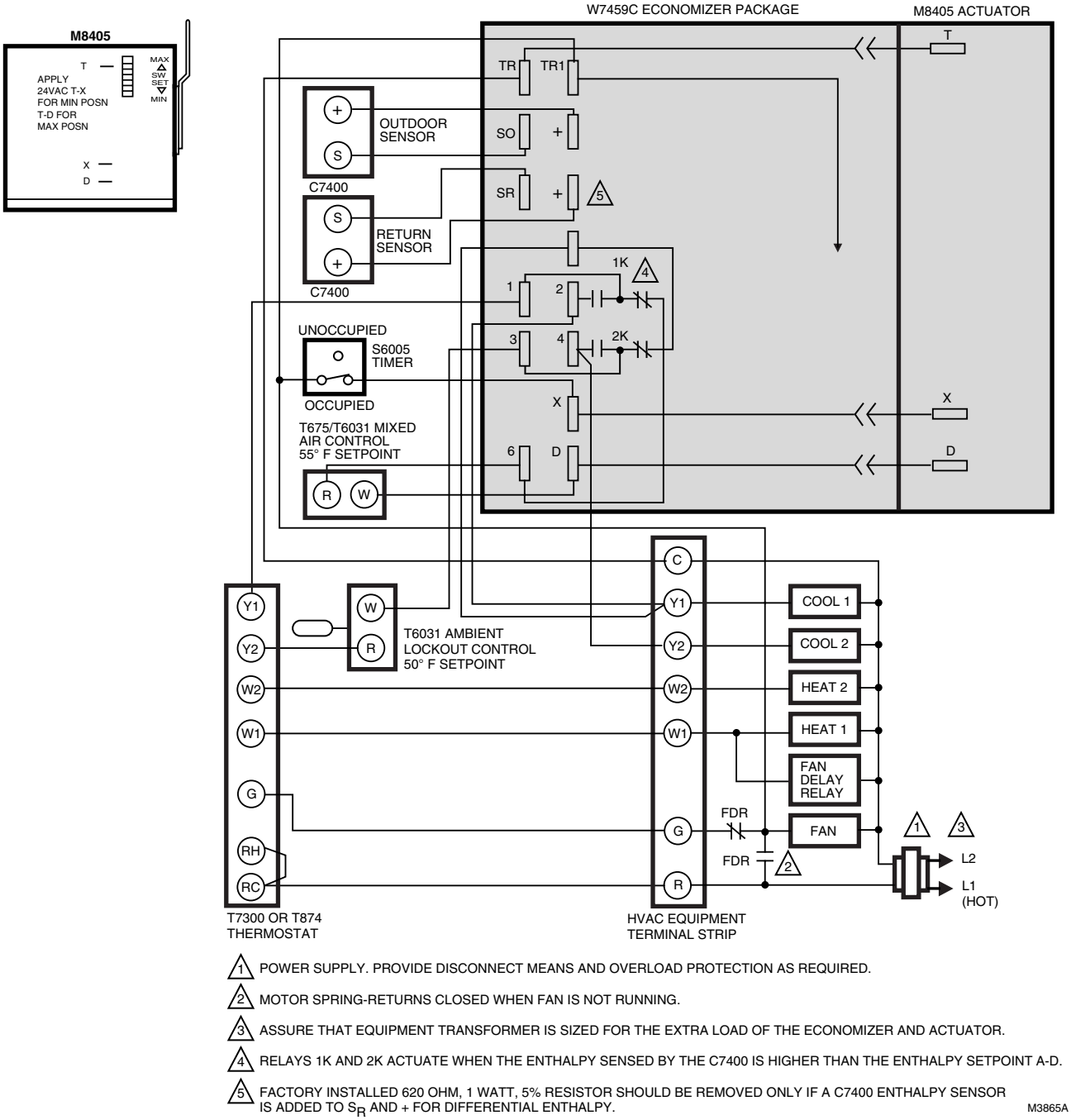


Fig. 10. M8405A Damper Actuator used in two-stage cooling system with differential enthalpy changeover and W7459C Economizer.

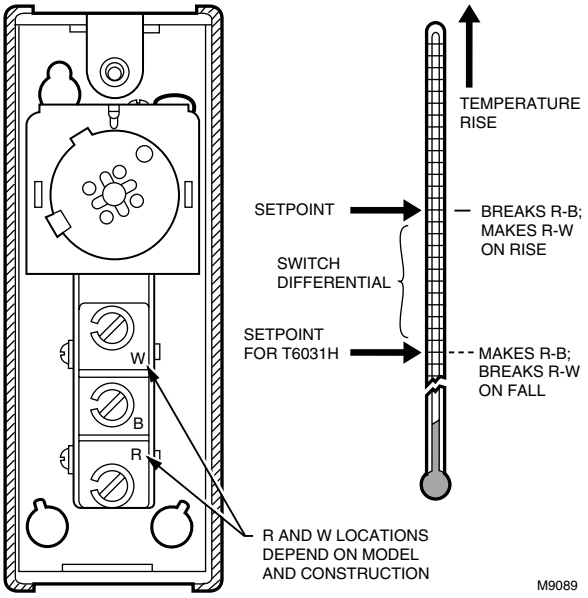


Fig. 11. T6031H switch terminal arrangement and switching.

W7459A,C,D Solid State Economizer Logic Module

CAUTION

CAN CAUSE ELECTRICAL SHOCK OR EQUIPMENT DAMAGE.

Disconnect power supply before connecting wiring.

Location and Mounting

W7459 Economizer Logic Module

Mount the W7459 Economizer Logic Module on the side of the M7415 or M8405 Damper Actuator. When planning the installation, allow enough clearance for maintenance and service. Install the W7459 Economizer Logic Module where it is protected from rain and snow. One mounting screw is supplied to secure the W7459 to the actuator (after the actuator is mounted). See Fig. 12.

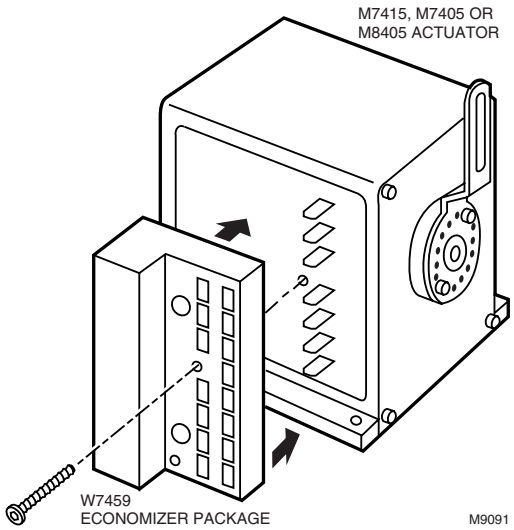


Fig. 12. Mounting W7459 on M7415 or M8405 Damper Actuator.

C7400 Enthalpy Sensor and C7650 A Temperature Sensor

Location and Mounting

Outdoor air sensing: Mount the C7400 Enthalpy Sensor or C7650A Temperature Sensor in any orientation where it is exposed to freely circulating air but protected from rain, snow and direct sunlight.

Return air sensing: For differential enthalpy or temperature control, a second C7400 Enthalpy Sensor or C7650A Temperature Sensor is connected to the W7459. Mount the second sensor in the return air duct as far as possible from the outdoor air sensor.

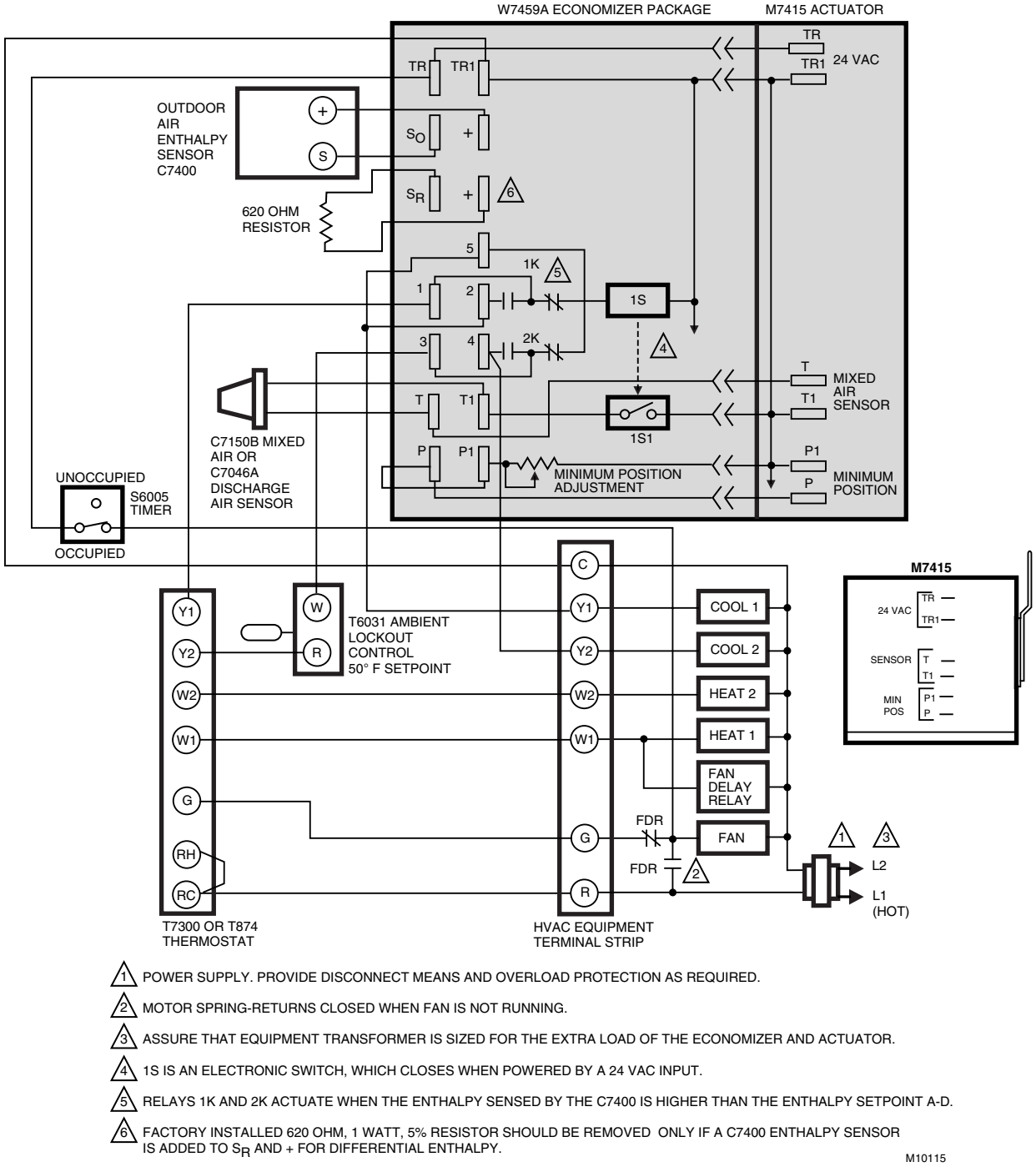
Wiring

CAUTION

CAN CAUSE ELECTRICAL SHOCK OR EQUIPMENT DAMAGE.

Disconnect power supply before connecting wiring.

Disconnect the power supply before connecting wiring to prevent electrical shock or equipment damage. All wiring must comply with applicable local codes, ordinances and regulations. See Fig. 13 for a typical wiring diagram.



1. POWER SUPPLY. PROVIDE DISCONNECT MEANS AND OVERLOAD PROTECTION AS REQUIRED.
2. MOTOR SPRING-RETURNS CLOSED WHEN FAN IS NOT RUNNING.
3. ASSURE THAT EQUIPMENT TRANSFORMER IS SIZED FOR THE EXTRA LOAD OF THE ECONOMIZER AND ACTUATOR.
4. 1S IS AN ELECTRONIC SWITCH, WHICH CLOSES WHEN POWERED BY A 24 VAC INPUT.
5. RELAYS 1K AND 2K ACTUATE WHEN THE ENTHALPY SENSED BY THE C7400 IS HIGHER THAN THE ENTHALPY SETPOINT A-D.
6. FACTORY INSTALLED 620 OHM, 1 WATT, 5% RESISTOR SHOULD BE REMOVED ONLY IF A C7400 ENTHALPY SENSOR IS ADDED TO S_R AND + FOR DIFFERENTIAL ENTHALPY.

M10115

Fig. 13. W7459A,D/C7400 used in two-stage cooling system with single enthalpy changeover and with M7415 Actuator.

OPERATION AND CHECKOUT

Operation

Controller Dial Setting

Control setpoint scale is located on the W7459 Solid State Economizer Logic Module. Control points A, B, C, and D are field selectable; A, B, C, D control points are used for single enthalpy or temperature sensing. One enthalpy or temperature sensor is connected to the solid state economizer control for single enthalpy or temperature. Turn D (fully clockwise ↷) when the differential enthalpy or temperature control is desired. Two enthalpy or temperature sensors are connected to the solid state economizer control for differential enthalpy control. See Fig. 10 and 13.

IMPORTANT

Do not use C7650A Solid State Temperature Sensors with W7459D high enthalpy limit devices.

C7046C and C7150B Mixed/Discharge Air Sensors

The C7046C and C7150B Mixed Air Sensors consist of a thermistor sensing element mounted in a tubular probe. The sensors are applied at various locations throughout single zone and multizone duct systems. The negative temperature coefficient (NTC) characteristic of the thermistor element causes its resistance to decrease as the sampled air temperature increases. See Fig 14. To stabilize system control, the resistance shift is balanced with other system sensor signals by appropriate system logic panels.

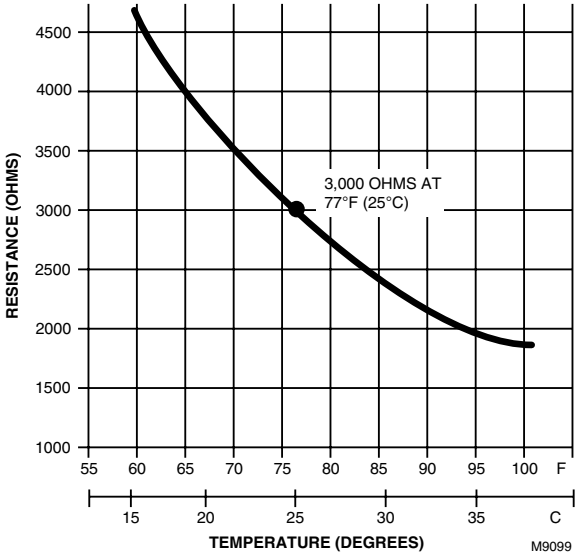


Fig. 14. C7046C and C7150B Air Temperature Sensors resistance versus temperature.

C7400A Solid State Enthalpy Sensor

The C7400A Solid State Enthalpy Sensor is used with a solid state economizer control and damper actuator to proportion an outdoor air damper in a ventilation system.

Figure 15 is a partial psychometric chart with single C7400A Sensor and W7459A Economizer Logic Module performance curves. The curves illustrate the reset in the temperature control point due to changes in relative humidity.

The enthalpy control setpoint A,B,C, or D combines temperature and humidity conditions, resulting in the control curve shown in Fig. 15. When the enthalpy or outdoor air is below (left of) the appropriate curve, the outdoor air damper can proportion open on a call for cooling. If outdoor air enthalpy rises above (to the right of) the control curve, the outdoor air damper closes to the minimum position.

For differential enthalpy, turn the control setpoint to D (fully clockwise). If outdoor air enthalpy is lower than return air enthalpy, the outdoor air damper proportions open on a call for cooling.

If outdoor air enthalpy is higher than return air enthalpy, the outdoor air damper closes to minimum position. Differential enthalpy control provides energy savings and increased comfort by using the air with the lowest enthalpy.

If outdoor air enthalpy and return air enthalpy are equal, the outdoor air damper proportions open on a call for cooling.

The relationship between the C7400A Sensor output current and relative humidity is shown in Fig. 16.

C7650A Solid State Temperature Sensor

The C7650A Solid State Temperature Sensor is used with a solid state economizer control and damper actuator to proportion an outdoor air damper in a ventilation system.

When outdoor air temperature is higher than return air temperature, the outdoor air damper closes to the minimum position. When the outdoor air temperature and the return air temperature are equal, the outdoor air damper proportions open on a call for cooling.

The relationship between the C7650A Sensor output current and the air temperature is shown in Fig. 17.

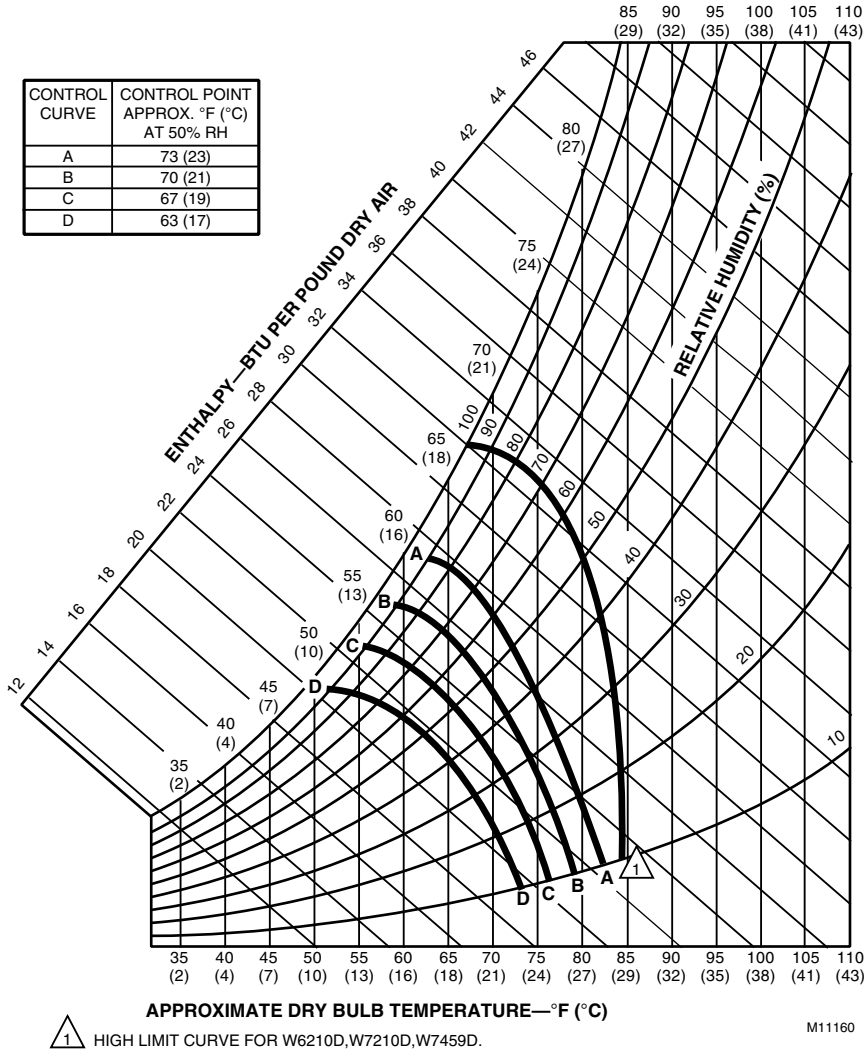


Fig. 15. Partial psychrometric chart with single C7400A Solid State Enthalpy Sensor and W7459 Solid State Economizer Logic Module performance curves.

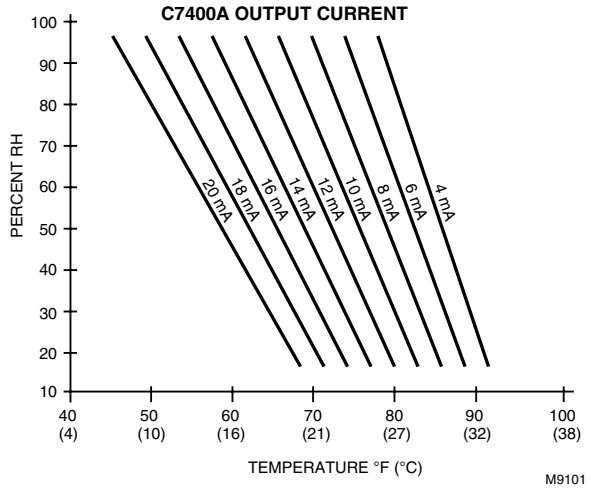


Fig. 16. C7400A Sensor output current vs. relative humidity.

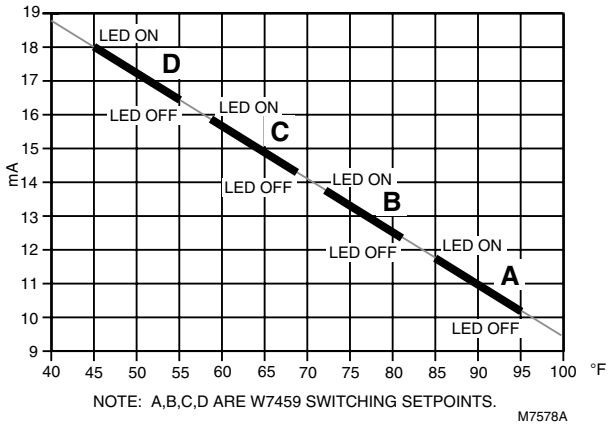


Fig. 17. C7650A Solid State Temperature Sensor output current vs. temperature.

M7415 Damper Actuator

Single M7415 Damper Actuator accepts thermistor sensor input from a C7046A or a C7150B Mixed Air Sensor mounted in discharge or mixed air duct. See Fig. 13.

During the occupied period, on a call for cooling, when outdoor air temperature or enthalpy conditions are low, the M7415 Actuator proportions to maintain between 50°F (10°C) and 56°F (13°C) at the thermistor sensor.

If the mixed or discharge temperature is above 56°F (13°C), the M7415 Actuator opens to admit additional outdoor air until the temperature returns to the 50°F (10°C) to 56°F (13°C) range. If the mixed or discharge air temperature is below 50°F (10°C), the actuator proportions closed, shutting the outdoor air damper until the temperature returns to the 50°F (10°C) to 56°F (13°C) range. During the occupied period, the actuator does not close past the minimum position.

If the fully open M7415 Actuator cannot satisfy the space demand, mechanical cooling is sequenced on.

During the unoccupied period, the M7415 Actuator overrides the minimum position setting and drives fully closed. On a loss of power, the actuator spring-returns fully closed.

The M7415 Actuator can also accept the Q769A 6- to 9-volt Adapter. The Q769A is factory calibrated so that the motor drives open from the closed position at 6.2 Vdc. A nominal M7415 Actuator drives closed from the open position at 8.8 Vdc.

If terminals P and P1 are jumpered, the M7415 drives fully open; however, if terminals P and P1 are left open, the M7415 drives fully closed. The M7415 minimum position adjustment drives the motor open when the resistance across P and P1 is minimal. Increasing the amount of resistance across these terminals drives the actuator closed.

M8405 Damper Actuator

An spst low voltage controller is used to control the M8405 Actuator as follows:

a. Fully open—when the controller circuit closes to provide 24 Vac to terminals D and T, the actuator is energized and runs fully open.
b. Fully closed—when the controller circuit opens, power is removed from terminals D and T, and the actuator spring returns to the fully closed position.
c. Mid-position—when the controller circuit closes to provide 24 Vac to terminals T and X, the actuator is energized to run to the adjustable mid-position (minimum position).

Adjustable minimum position can be reached from either the fully closed or fully open position. From fully closed, the actuator drives open to the minimum position; from fully open, the actuator spring-returns to minimum position.

W7459A,C,D Solid State Economizer Logic Module

The purpose of an economizer is to use outdoor air for cooling, whenever possible, to reduce air conditioner compressor operation. The W7459 Economizer System, when wired as shown in Fig. 10 or 13, responds to a signal from the cooling thermostat. This system uses a C7400 Solid State Enthalpy Sensor or a C7650A Solid State Temperature Sensor. It responds to both dry bulb temperature and humidity, allowing the use of outdoor air at higher temperatures for free cooling when the humidity is low.

The economizer functions as a true first stage of cooling and provides maximum fuel economy during the cooling cycle. The economizer is automatically locked out during heating. It holds the outdoor air damper at the minimum position setting. On a call for cooling by the space thermostat, the system operates as follows:

When the enthalpy or temperature of the outdoor air is below the setpoint, the outdoor air damper is proportioned open (and the return air damper is proportioned closed) to maintain between 50°F and 56°F (10°C and 13°C) at the mixed/discharge air sensor. During economizer operation, the mechanical cooling is operated by stage 2 cooling on the space thermostat.

When the enthalpy or temperature of the outdoor air is above the setpoint, the outdoor air damper closes to its minimum position. A call for cooling from the space thermostat turns on the mechanical cooling.

During the unoccupied period, the M7415 Damper Actuator spring-returns the outdoor air damper to the fully closed position.

SETTINGS AND ADJUSTMENTS

Adjusting Minimum Damper Position

The minimum position potentiometer keeps the outdoor air damper from completely closing during system operation to allow ventilation.

M7415 and M8405 Damper Actuators Adjusting Minimum Position (Ventilation)

The M7415 Damper Actuator is adjusted for desired minimum position using a Q709 Actuator Mounted Minimum Position Potentiometer and/or a remote S963B1136 Manual Potentiometer. The M8405 Damper Actuator has an integral thumbwheel for minimum position adjustment.

M7415 Minimum Position Adjustment

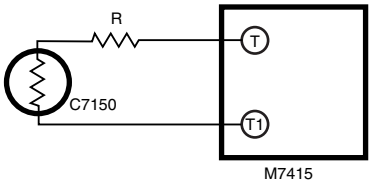
1. Run actuator to fully closed position and disconnect 24 Vac from terminals TR and TR1.
2. Connect minimum position potentiometer to terminals P and P1 (T and T1 are disconnected).
3. Reconnect 24 Vac to terminals TR and TR1 and adjust the potentiometer for the desired minimum position.
4. When the Q709 Actuator Mounted Minimum Position Potentiometer is used and a remote potentiometer is not connected in series, jumper terminals P and P1 on the Q709A.

M8405 Minimum Position Adjustment

1. Connect the 24 Vac to the actuator at terminals T and X (D is not connected).
2. Adjust the thumbwheel on the actuator for desired minimum position.

Discharge Air Temperature Setpoint Adjustment—M7415 Only

This temperature range can be adjusted either up or down by wiring a resistor in series (to increase the setpoint) or in parallel (to decrease the setpoint) with the C7150B, depending on the application. See Fig. 18 and 19 for explanation.

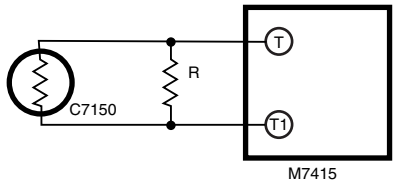


RESISTOR VALUE (OHMS)	C7150B SETPOINT °F (°C)
681	54.5—61.5 (12.5—16.4)
2760	68.4—80.1 (20.3—26.8)
3650	87.4—110.3 (30.8—45.5)
4420	104.7—150 (40.4—65.5)
4750	116—194 (46.7—90)
4870	120—300 (49—149)
NO RESISTOR	50—56 (10—13.3)

USE 1%, 1/8 W OR HIGHER RESISTOR

M1544C

Fig. 18. Increasing C7150B setpoint.



RESISTOR VALUE (OHMS)	C7150B SETPOINT °F (°C)
18.2K	36—44 (2.2—6.7)
24K	39.5—47 (4.0—8.3)
30K	42—49 (5.6—9.4)
NO RESISTOR	50—56 (10—13.3)

USE 1%, 1/8 W OR HIGHER RESISTOR

M1545C

Fig. 19. Decreasing C7150B setpoint.

W7459A,C,D Solid State Economizer Logic Module

Two potentiometers with screwdriver slots for adjustment are located on the face of the module.

Minimum Position Adjustment

W7459A,D Economizer Logic Module

1. Make sure the factory-installed jumper is in place across terminals P and P1 (terminals T and T1 are disconnected.
2. Connect 24 Vac at terminals TR and TR1 and adjust the potentiometer on the face of the W7459A,D with a screwdriver for desired minimum position.

W7459C Economizer Logic Module

1. Connect 24 Vac at terminals TR and X (D is not connected).
2. Adjust thumbwheel on motor for desired minimum position.

Enthalpy Changeover Setpoint

Single enthalpy: the enthalpy changeover setpoint is set to return the outdoor air damper to the minimum position when the enthalpy rises above its setpoint. The enthalpy setpoint scale markings, located on the W7459, are A, B, C, D; see Fig. 15 for the corresponding control point. The factory-installed 620-ohm jumper must be in place across terminals + and S_R.

Differential Enthalpy Changeover Setting

(Use this option only with two-stage cooling thermostats.)

Differential enthalpy control uses two C7400 Enthalpy Sensors or two C7650A Temperature Sensors connected to one W7459 Solid State Economizer Logic Module.

The setpoint scale markings, located on the W7459, are A,B,C, and D. Turn the setpoint potentiometer fully clockwise to the D setting. The economizer selects the air that has lower enthalpy or temperature for cooling; for example, if outdoor air has lower enthalpy or temperature than return air, the outdoor air damper is opened to bring in outdoor air for free cooling.

IMPORTANT

Do not use C7650A Solid State Temperature Sensors with W7459D high enthalpy limit devices.

SEQUENCE OF OPERATION

Economizer Sequence of Operation

(With and Without Differential Enthalpy)

The economizer operating sequence for both the modulating and the three-position control systems are identical when the outdoor enthalpy temperature is above the mixed air setpoint of 55°F (13°C). The operating sequence for both, using a standard two-stage thermostat is:

1. The first stage of the thermostat signals a need for cooling.
2. The W7459 Solid State Economizer Logic Module begins to make decisions regarding the unit/ economizer operation.
3. a. On the standard (non-differential) economizers, the logic module checks the outdoor air C7400 Enthalpy Sensor or C7650 Temperature Sensor to determine if the enthalpy or temperature is below the setpoint.
   b. On the differential economizers, the logic module checks to determine if the outdoor air temperature is below the return air temperature.

❹ a. On the standard economizers, the damper motor is energized if the outside air temperature is below the enthalpy setpoint, thereby opening the damper and introducing outside air to cool the conditioned space.
b. On differential economizers, the damper motor is energized if the outside air temperature is below the return air temperature, thereby introducing outside air to cool the conditioned space.

❺ If the logic module uses the outside air for cooling, the mixed air sensor prevents the entering air from going below 55°F (13°C).
a. On the modulating system, the control closes the outside air damper and opens the return air damper to mix the outside air and return air to maintain 55°F (13°C).
b. On the three-position system, the mixed air sensor switch opens, closing the fresh air damper until the mixed air sensor temperature returns above 55°F (13°C), closing the switch and opening the outside air damper.

❻ a. If the logic module senses that the outside air is not suitable for cooling, the air conditioning unit compressor is energized and the space is cooled with refrigerated air.
b. On the two-stage thermostat, the economizer is the first stage if the outside air temperature is suitable for cooling. The compressor on the unit is energized if the second stage of the thermostat is energized, thereby creating an integrated economizer.

❼ Refer to Table 4 for further information on outside air damper positions.

❽ The W7459D has a high enthalpy limit and defaults to mechanical cooling when the outdoor enthalpy reaches the preset limit. Do not use a dry-bulb sensor for a high temperature limit. Refer to Table 5 for further information on outdoor air damper positions.

Table 4. Outdoor air damper positions.

Outside Temperature[1]	Standard Economizer Damper Position		Return Temperature[1]	Differential Enthalpy Damper Position	
	Modulating [2]	3-Position[2]		Modulating[2,3]	3-Position[2,3]
80	Closed	Closed	80	Closed	Closed
			85	Open	Open
75	Closed	Closed	75	Closed	Closed
			80	Open	Open
70	Open	Open	75	Open	Open
65	Open	Open			
60	Open	Open	75	Open	Open
55	Open	Open	75	Open	Open
54 and down	Modulating	Opening/Closing	75	Modulating	Opening/Closing

1 Standard economizer position based on enthalpy control set on the A setting and 50% relative humidity.
2 Closed position is either the minimum position or fully closed, depending on the job setting.
3 Opening/closing is dependent on the mixed air temperature.

Table 5. W7459D maximum outdoor enthalpy switching.

Outdoor RH (Percent)	Free Cooling Mode Switching	
	Into Free Cooling (LED ON) on Decreasing Outdoor Enthalpy	Out of Free Cooling (LED OFF) onIncreasing Outdoor Enthalpy
25	83° ±0.5°F	85° ±0.5°F
50	78° ±0.5°F	80° ±0.5°F
60	76° ±0.5°F	78° ±0.5°F
75	73° ±0.5°F	75° ±0.5°F

CHECKOUT AND TROUBLESHOOTING

Tables 6 through 9 provide step-by-step economizer checkout and troubleshooting steps. See Fig. 19 and 20 for enthalpy setpoint potentiometer, minimum position potentiometer and LED and meter locations.

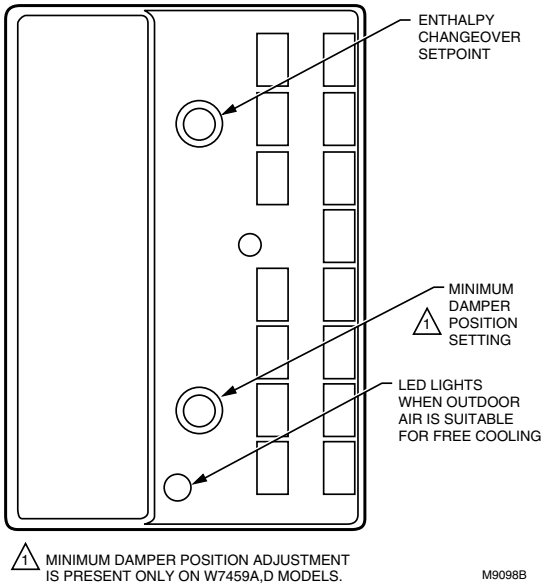


Fig. 20. Location of enthalpy setpoint potentiometer, minimum position potentiometer and LED.

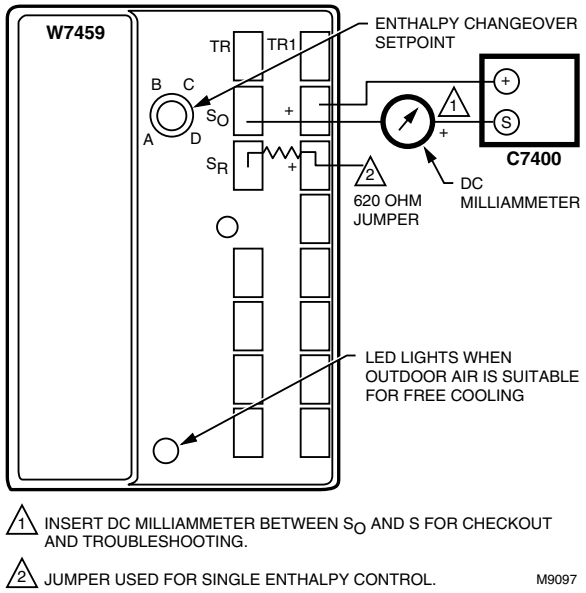


Fig. 21. Meter location for checkout and troubleshooting.

Table 6. Troubleshooting modulating economizer—outdoor enthalpy above setpoint.

Condition on Logic Module *Should Be*	Condition Not Met
1. Red LED not lighted.	1. If the LED glows, the Logic Module *thinks* it is in the Economizer mode. Verify that conditions are above the enthalpy setpoint, see Note 2. Check wiring to Enthalpy Control for a short from {SO} and {+}.
2. 24 Vac to terminals {TR} and {TR1}.	2. Check the wiring from [G] and [C] on the unit low voltage terminal strip. {TR} and {TR1} power the actuator.
3. 24 Vac to terminals {1} and {TR1}.	3. Verify that there is a call for cooling from the thermostat. Without a call for cooling, the compressor can not be in the normal air conditioning mode.
4. 24 Vac to terminals {2} and {TR1}.	4. If 24 Vac is not on {2} and {TR1}, the internal switch is not set correctly. Remove the {SO} wire from the module. If 24 Vac is on {2} and {TR1}, the enthalpy control is bad or the {SO} and {+} wires are shorted together. If no voltage to {2} and {TR1}, the module is bad.
5. Continuity on terminals {1} and {2}, {3} and {4}.	5. If there is not continuity for terminals {1} and {2}, the internal switch is not in the correct position and either the module or the enthalpy control is defective. If there is continuity from terminals {1} and {2}, the red LED should not be lighted. If there is continuity on terminals {3} and {5}, the internal switch is correctly energized. The damper actuator should be in a modulating mode.
6. Compressor does not operate with all above conditions correct.	6. Check the wiring from {2} to Y1 on the unit low voltage control board. Verify that 24 Vac is not on Y1 and C.
Second Stage	
7. 24 Vac to terminals {3} and {TR1}.	7. Verify that you have a two-stage thermostat. Check for a call for a second stage cooling. If 24 Vac is not on {3} and {TR1}, check wiring from Y2 on the thermostat to the module.
8. 24 Vac to terminals {4} and {TR1}.	8. If {4} and {TR1} do not have 24 Vac, and {3} and {TR1} have 24 Vac, the internal switch is not in the correct position. The module is defective.
9. Compressor does not operate with second stage conditions met.	9. If all other functions are correct, check wiring from {4} to Y2 on the unit low voltage terminal board.

{ } Terminals on the logic module.
[ ] Low voltage input from unit or thermostat.

NOTES:
1. Standard economizer position based on enthalpy control set on the A setting and 50 percent relative humidity.
2. Closed position is either the minimum position or fully closed, depending on the job setting.
3. Opening/closing is dependent on the mixed air temperature.

Table 7. Troubleshooting modulating economizer—outdoor enthalpy below setpoint.

Condition on Logic Module *Should Be*	Conditions Not Met
1. Red LED lighted.	1. Jumper terminals {SO} and {+}. If the LED lights, the module is okay, see Note 2. Check wiring to enthalpy control.
2. 24 Vac to terminals {TR} and {TR1}.	2. Check the wiring from [G] and [C] on the unit low voltage terminal strip. {TR} and {TR1} power the actuator.
3. 24 Vac to terminals {1} and {TR1}.	3. Verify there is a call for cooling from the thermostat. Without a call for cooling, the motor can not be in the economizer mode.
4. No continuity on terminals {1} and {2}.	4. If there is continuity from terminals {1} and {2}, the red LED should not be lighted. If there is continuity and the LED glows, the module is defective.
5. Continuity on terminals {3} and {5}.	5. If there is continuity on terminals {3} and {5}, the internal switch is correctly energized. Damper motor should be in a modulating mode.
6. Motor does not operate with all above conditions met.	6. Jumper the mixed air sensor terminals {T} and {T1}. If the motor begins to operate, check the wiring to the sensor. If correct, the temperature is below the sensor setpoint or it is defective. If the motor does not operate, and the wiring is correct and the temperature is above the sensor setpoint, the motor is bad.
Second Stage	
7. 24 Vac to terminals {3} and {TR1}.	7. Verify that you have a two-stage thermostat. Check for a call for a second stage cooling. If 24 Vac is not on terminals {3} and {TR1}, check wiring from terminal Y2 on the thermostat to the module.
8. 24 Vac to terminals {5} and {TR1}.	8. If terminals {5} and {TR1} do not have 24 Vac, the intermal switch is not in the correct position, assuming that terminals {3} and {TR1} do have 24 Vac. The module is defective.
9. Compressor does not operate with second stage conditions met.	9. If all other functions are correct, check the wiring from terminal {5} to Y2 on the unit low voltage terminal board.

{ } Terminals on the logic module.
[ ] Low voltage input from unit or thermostat.

NOTES:
1. Standard economizer position based on enthalpy control set on the A setting and 50 percent relative humidity.
2. Closed position is either the minimum position or fully closed, depending on the job setting.
3. Opening/closing is dependent on the mixed air temperature.

Table 8. Troubleshooting three-position economizer—outdoor enthalpy above setpoint.

Condition on Logic Module *Should Be*	Conditions Not Met
1. Red LED not lighted.	1. If the LED glows, the module *thinks* it is in the economizer mode. Verify the conditions are above the enthalpy setpoint, see Note 2. Check wiring to Enthalpy Control for a short from {SO} and {+}.
2. 24 Vac to terminals {TR} and {TR1}, {X} and {TR}.	2. Check the wiring from [G] and [C] on the unit low voltage terminal strip. {TR} and {TR1} power the actuator. {X} and {TR} provide power for minimum position.
3. 24 Vac to terminals {1} and {TR}.	3. Verify that there is a call for cooling from the thermostat. Without a call for cooling the compressor can not be in the normal air conditioning mode.
4. 24 Vac to terminals {2} and {TR}.	4. If 24 Vac is not on {2} and {TR}, the internal contacts are not set correctly. Remove the {SO} wire from the module. If 24 Vac is on {2} and {TR}, the enthalpy control is bad or the {SO} and + wiring are shorted together. If no voltage to {2} and {TR}, the module is bad.
5. Continuity on terminals {1} and {2}, {3} and {4}.	5. If there is not continuity for {1} to {2}, the internal contacts are not in the correct position, and either the module or the enthalpy control is defective. If there is continuity from terminals {1} and {2}, the red LED should not be lighted. If there is continuity and the LED glows, the module is defective. If there is continuity on terminals {3} and {5}, the internal contacts are correctly energized. Damper motor should be in the economizer mode.
6. Compressor does not operate with all above conditions correct.	6. Check the wiring from {2} to Y1 on the unit low voltage control board. Verify that there are not 24 Vac to Y1 and C on the unit.
Second Stage	
7. 24 Vac to terminals {3} and {TR}.	7. Verify that the thermostat is two-stage. Check for a call for a second stage cooling. If there are not 24 Vac on {3} and {TR}, check wiring from Y2 on the thermostat to the module.
8. 24 Vac to terminals {5} and {TR}.	8. If {4} and {TR} do not have 24 Vac and {3} and {TR} have 24 Vac, the internal switch 1S is not in the correct position. The module is defective.
9. Compressor does not operate with second stage conditions met.	9. If all other functions are correct, check the wiring from {4} to Y2 on the unit low voltage terminal board.

{ } Terminals on the logic module.
[ ] Low voltage input from unit or thermostat.

NOTES:
1. Standard economizer position based on enthalpy control set on the A setting and 50 percent relative humidity.
2. Closed position is either the minimum position or fully closed, depending on the job setting.
3. Opening/closing is dependent on the mixed air temperature.

Table 9. Troubleshooting three position economizer—outdoor enthalpy below setpoint.

Condition on Logic Module *Should Be*	Conditions Not Met
1. Red LED lighted.	1. Jumper terminals {SO} and {+}. If the LED glows, the module is okay, see Note 2. Check wiring to enthalpy control.
2. 24 Vac to terminals {TR} and {TR1}.	2. Check the wiring from [G] and [C] on the unit low voltage terminal strip. {TR} and {TR1} power the actuator.
3. 24 Vac to terminals {1} and {TR1}.	3. Verify there is a call for cooling from the thermostat. Without a call for cooling, the motor can not be in the economizer mode.
4. No continuity on terminals {1} and {2}.	4. If there is continuity from terminals {1} and {2}, then the red LED cannot be lighted. If there is continuity and the LED glows, the module is defective.
5. Continuity on terminals {3} and {5}.	5. If there is continuity on terminals {3} and {5}, the internal switch 1S is correctly energized. Damper motor should be in a modulating mode.
6. Motor does not operate with all above conditions met.	6. Jumper the mixed air sensor terminals {6} and {D}. If the motor begins to operate, check the wiring to the sensor. If it is correct, the temperature is below the sensor setpoint or the sensor is defective. If the motor does not operate, the wiring is correct, and the temperature is above the sensor setpoint, the motor is bad.
Second Stage	
7. 24 Vac to terminals {3} and {TR}.	7. Verify that the thermostat is two-stage. Check for a call for a second stage cooling. If 24 Vac is not on {3} and {TR}, check wiring from Y2 on the thermostat to the module.
8. 24 Vac to terminals {5} and {TR}.	8. If {5} and {TR} do not have 24 Vac, and {3} and {TR} do have 24 Vac, then the internal switch 1S is not in the correct position. The module is defective.
9. Compressor does not operate with second stage conditions met.	9. If all other functions are correct, check the wiring from {5} to Y2 on the unit low voltage terminal board.

{ } Terminals on the logic module.
[ ] Low voltage input from unit or thermostat.

NOTES:
1. Standard economizer position based on enthalpy control set on the A setting and 50 percent relative humidity.
2. Closed position is either the minimum position or fully closed, depending on the job setting.
3. Opening/closing is dependent on the mixed air temperature.

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