35E Single-Duct Terminal Units
Variable Volume System

Installation and Start-Up Instructions

CONTENTS

⚠ CAUTION

PERSONAL INJURY HAZARD

Air-handling equipment will provide safe and reliable service when operated within design specifications. The equipment should be operated and serviced only by authorized personnel who have a thorough knowledge of system operation, safety devices and emergency procedures.

Good judgment should be used in applying any manufacturer's instructions to avoid injury to personnel or damage to equipment and property.

SAFETY CONSIDERATIONS

Installation and servicing of air-conditioning equipment can be hazardous due to system pressure and electrical components. Only trained and qualified service personnel should install, repair, or service air-conditioning equipment.

Untrained personnel can perform basic maintenance functions of cleaning coils and filters and replacing filters. All other operations should be performed by trained service personnel. When working on air-conditioning equipment, observe precautions in the literature, tags and labels attached to the unit, and other safety precautions that may apply.

Follow all safety codes, including ANSI (American National Standards Institute) Z223.1. Wear safety glasses and work gloves. Use quenching cloth for unbrazing operations. Have fire extinguisher available for all brazing operations.

It is important to recognize safety information. This is the safety-alert symbol ⚠. When you see this symbol on the unit and in instructions or manuals, be alert to the potential for personal injury.

Understand the signal words DANGER, WARNING, CAUTION, and NOTE. These words are used with the safety-alert symbol.

DANGER identifies the most serious hazards which **will** result in severe personal injury or death. WARNING signifies hazards which **could** result in personal injury or death. CAUTION is used to identify unsafe practices, which **may** result in minor personal injury or product and property damage. NOTE is used to highlight suggestions which **will** result in enhanced installation, reliability, or operation.

⚠ WARNING

Disconnect all power to the unit before performing maintenance or service. Unit may automatically start if power is not disconnected. Electrical shock and personal injury could result.

⚠ CAUTION

If it is necessary to remove and dispose of mercury contactors in electric heat section, follow all local, state, and federal laws regarding disposal of equipment containing hazardous materials.

See Fig. 1 for the Proposition 65 Warning Label.

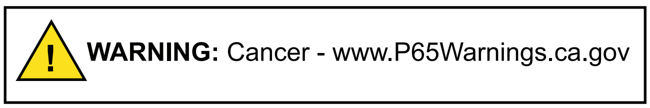

Fig. 1 — Proposition 65 Warning Label

PRE-INSTALLATION

General

The 35E unit is a single duct, variable volume terminal available with factory-installed pneumatic, analog electronic, Carrier Comfort Network® (CCN) or Carrier i-Vu® electronic controls options that can be used in conjunction with unit-mounted electric or hot water heat options. Figure 2 shows the basic box. Figure 3 is an example of a unit identification label.

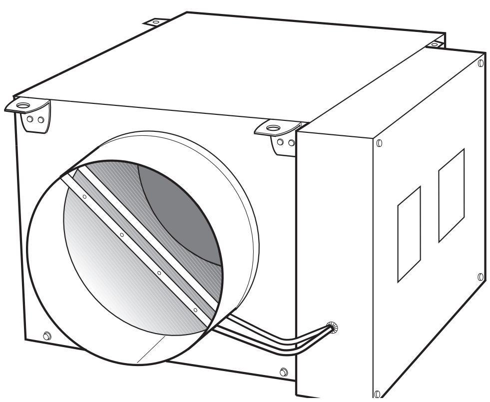

Fig. 2 — 35E Single Duct Box (Sizes 4-16)

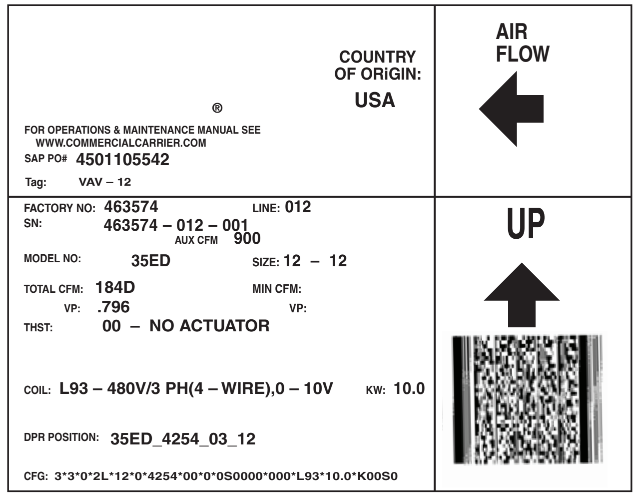

Fig. 3 — Unit Identification Label

STORAGE AND HANDLING

Inspect the unit for damage upon receipt. Shipping damage claims should be filed with shipper at time of delivery. Store in a clean, dry, and covered location. Do not stack cartons. When unpacking units, care should be taken that the inlet collars and externally mounted components do not become damaged. Do not lift units using collars, sensors or externally mounted components as handles. If a unit is supplied with electric or hot water heat, care should be taken to prevent damage to these devices. Do not lay uncrated units on end or sides. Do not stack uncrated units over 6 ft high. Do not manhandle. Do not handle control boxes by tubing connections or other external attachments. Table 1 shows component weights.

INITIAL INSPECTION

Once items have been removed from the carton, carefully check for damage to duct connections, coils or controls. File damage claim immediately with transportation agency and notify Carrier.

UNIT IDENTIFICATION

Each unit is supplied with a shipping label and an identification label. See Fig. 3.

INSTALLATION PRECAUTION

Check that construction debris does not enter the unit or ductwork. Do not operate the central-station air-handling fan without final or construction filters in place. Accumulated dust and construction debris distributed through the ductwork can adversely affect unit operation.

SERVICE ACCESS

Provide service clearance for unit access.

CODES

Install units in compliance with all applicable code requirements.

UNIT SUSPENSION

See Fig. 4 for unit suspension details.

Warranty

All Carrier furnished items carry the standard Carrier warranty.

No periodic preventative maintenance is required, unless called for in specific control sequence.

1. Third-party trademarks and logos are the property of their respective owners.

Table 1 — 35E Unit Weights[a]

35E SIZE	UNIT ONLY (lb)	WITH PNEUMATIC CONTROLS (lb)	WITH DDC OR ANALOG CONTROLS (lb)	WITH ELECTRIC HEAT CONTROLS (lb)	WITH HOT WATER (1 row/2 row) (lb)
04, 05, 06	14	18	23	32	19/20
07, 08	16	20	25	39	21/23
09, 10	21	25	30	44	28/30
12	26	30	35	56	35/38
14	34	38	43	65	44/49
16	38	42	47	75	50/55
22	65	69	74	91	82/90

NOTE(S):

a. Data is based on unit casing is 22 gauge, unit insulation is 1/2 in. thick, 1.5-lb Tuf-Skin Rx[1] with dual density, and units rated with standard linear flow sensor.

LEGEND

DDC — Direct Digital Controls

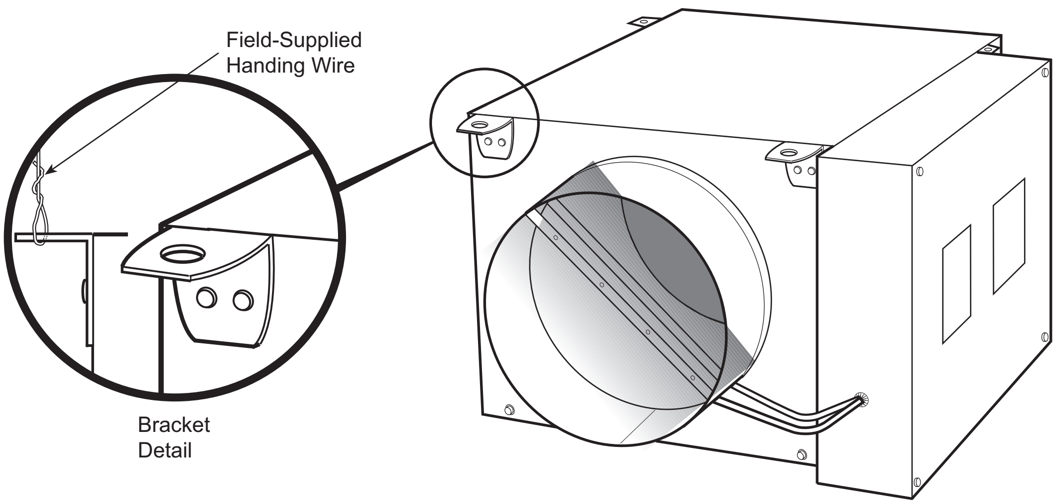

Fig. 4 — Typical Unit Suspension with Brackets

CONTROL ARRANGEMENTS

The 35E single-duct unit is offered with a wide variety of factory-mounted controls that regulate the volume of air delivery from the unit and respond to cooling and heating load requirements of the conditioned space. Stand-alone controls will fulfill the thermal requirements of a given control space. These devices are available in both pneumatic and electronic arrangements. Carrier Comfort Network® (CCN), Carrier i-Vu® Open DDC (Direct Digital Controls), and Carrier i-Vu® TruVu™ DDC controllers are communicating controls which are integrated with the building system. A number of DDC control packages by others are available for consignment mounting, as indicated.

Control offerings are:

- 35EA (Analog Control)
- 35EB (Open BACnet®[1] VVT Electronic Controls)
- 35EC (Carrier Comfort Network® [CCN] Variable Air Volume [VAV] Electronic Control)
- 35ED (BACnet® VAV Electronic Controls)
- 35EN (No control or direct digital controls [DDC] by others)
- 35EP (Pneumatic Control)
- 35ET (TruVu BACnet® VAV Electronic Controls)
- 35EV (CCN Variable Volume and Temperature [VVT] Electronic Control)
- 35EW (TruVu BACnet® VVT Electronic Controls)

Each control approach offers a variety of operating functions; a control package number identifies combinations of control functions. The following listings contain the basic function arrangements for each control offering. Because of the variety of functions available, circuit diagrams, operating sequences, and function descriptions are contained in separate Application Data publications. Refer to the specific control publication for details.

VAV Control Arrangements

The VAV units are furnished with factory-installed PICs for integration into either the Carrier Comfort Network (CCN) or Carrier i-Vu® Open and TruVu™ Digital Control Systems. Room temperature sensors are not included.

VVT Control Arrangement

The VVT units are furnished with factory-installed PICs for integration into either the Carrier Comfort Network (CCN) or Carrier i-Vu® Open and TruVu™ Digital Control Systems. Room temperature sensors are not included.

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Analog Electronic Control Arrangement

Pressure-independent control packages are available without supplemental heat, with on/off hot water or electric heat, proportional hot water heat, or with cooling/heating automatic changeover control.

All analog control arrangements include a standard linear inlet flow sensor, 24-v transformer (optional), control enclosure and wall thermostat to match the control type.

2100: Heating control

2101: Cooling control

2102: Cooling with on/off electric heat control

2103: Cooling with on/off hot water heat control

2104: Cooling/heating automatic changeover control

2105: Cooling with proportional hot water heat control

2110: Cooling with proportional (SSR) electric heat

2111: Cooling with electric heat (up to 3 Stages) and automatic changeover

2113: Cooling with proportional (SSR) electric heat and automatic changeover

Pneumatic Control Arrangement

All control packages are pressure independent (unless otherwise noted) and available with or without hot water heat, dual maximum airflow, heating and cooling maximum airflow and dual minimum airflow. All control arrangements include a standard linear inlet flow sensor.

1100 (Actuator only): DA-NC pressure dependent control

1101 (Actuator only): RA-NO pressure dependent control

1104 (Multi-function controller): DA-NO with or without hot water or electric heat

1105 (Multi-function controller): DA-NC with or without hot water or electric heat

1106 (Multi-function controller): RA-NO with or without hot water or electric heat

1107 (Multi-function controller): RA-NC with or without hot water or electric heat

1108 (Dual Maximum Control): DA-NO with or without hot water or electric heat

1109 (Heating/cooling maximum control): DA-NO with or without hot water or electric heat

1110 (Dual minimum control): DA-NO with or without hot water or electric heat

PNEUMATIC CONTROL LEGEND

DA: Direct-acting thermostat

RA: Reverse-acting thermostat

NO: Normally open damper position

NC: Normally closed damper position

The single function controller provides single functions, i.e., DA-NO. Multi-function controllers are capable of providing DA-NO, DA-NC, RA-NC or RA-NO functions.

Direct Digital Electronic Control Arrangements (Field-Supplied)

Control packages are field-supplied for factory mounting, unless otherwise noted. All DDC control arrangements include a standard inlet flow sensor, optional 24-v transformer and control enclosure.

Contact Carrier for detail about mounting field-supplied controls.

NO CONTROL

D001: 35E box with control box and 24-v transformer. Also used for control enclosure and electric heat.

DXX0: Field-supplied, Factory-Installed Controls (FMA) with control enclosure.

DXX1: Field-supplied, Factory-Installed Controls (FMA) with control enclosure when electric heat is selected.

INSTALLATION

⚠ WARNING

LOCK OUT AND TAG heater electrical disconnect before working on this equipment. Otherwise, one leg of the 3-leg heater remains energized. Electrical shock or personal injury could result.

Step 1 — Install Volume Control Box

1. Move unit to installation area. Remove unit from shipping package. Do not handle by controls or damper extension rod.
2. Optionally, the unit may have factory-installed hanger brackets (as shown in Fig. 4).
3. Suspend units from building structure with straps, rods, or hanger wires. Secure the unit and level it in each direction. Note that reheat coil is in the heavy end of unit.

Step 2 — Make Duct Connections

1. Install supply ductwork on unit inlet collar. Check that air-supply duct connections are airtight and follow all accepted medium-pressure duct installation procedures. Refer to Table 2 for pressure data.

   NOTE: To ensure proper equipment performance, it is recommended that a length of rigid straight duct equal to 3 times the duct diameter be provided to the inlet.
2. Install the discharge duct. Fully open all balancing dampers.

   NOTE: Ninety degree elbows or tight radius flexible duct immediately upstream of inlet collar should be avoided as these can affect the balancing of the unit.

Table 2 — 35E Basic Pressure Data[a,b,c,d]

INLET SIZE (in.) (area in sq ft)	MAXIMUM AIRFLOW (cfm)	MINIMUM AIRFLOW (cfm)		ELECTRIC HEAT[e] MAX kW vs. CFM at 55 F EAT		MINIMUM INLET STATIC PRESSURE (unit and heat pressure drop)						
		Cooling Only or with Hot Water	Electric Heat			Velocity Press. (ΔV_{PS})	Basic Unit (ΔP_S)	Basic + 1-Row Coil (ΔP_S)	Basic + 2-Row Coil (ΔP_S)	Basic + 3-Row Coil (ΔP_S)	Basic + 4-Row Coil (ΔP_S)	Basic + Heater[f] (ΔP_S)
4 (0.09)	230	40	55	55	1.1	0.02	0.01	0.02	0.02	0.02	0.02	0.01
				110	2.2	0.10	0.05	0.06	0.07	0.08	0.09	0.05
				150	3.0[g]	0.18	0.10	0.12	0.13	0.15	0.16	0.10
				230	3.0[g]	0.43	0.24	0.28	0.31	0.35	0.39	0.24
5 (0.14)	360	62	85	85	1.7	0.02	0.01	0.02	0.02	0.03	0.03	0.01
				140	2.8	0.06	0.03	0.05	0.06	0.07	0.09	0.03
				250	5.0[g]	0.21	0.10	0.15	0.19	0.24	0.28	0.10
				360	5.0[g]	0.43	0.21	0.31	0.40	0.49	0.58	0.21
6 (0.20)	515	90	110	110	2.0	0.02	0.01	0.01	0.02	0.03	0.03	0.01
				250	5.1	0.10	0.04	0.09	0.13	0.17	0.22	0.04
				400	7.5[g]	0.25	0.10	0.22	0.34	0.45	0.56	0.10
				520	7.5[g]	0.42	0.17	0.38	0.57	0.75	0.94	0.17
7 (0.27)	700	121	140	140	2.9	0.02	0.01	0.01	0.02	0.03	0.04	0.01
				330	6.7	0.09	0.04	0.08	0.12	0.16	0.20	0.04
				550	9.5[g]	0.25	0.10	0.22	0.33	0.44	0.54	0.10
				700	9.5[g]	0.40	0.16	0.36	0.53	0.71	0.88	0.16
8 (0.35)	920	160	190	190	3.9	0.02	0.01	0.02	0.03	0.05	0.06	0.01
				440	9.1	0.09	0.04	0.12	0.19	0.25	0.32	0.04
				700	13.0[g]	0.23	0.10	0.29	0.47	0.64	0.82	0.10
				920	13.0[g]	0.39	0.17	0.51	0.81	1.11	1.42	0.17
9 (0.44)	1160	201	240	240	4.9	0.02	0.01	0.02	0.03	0.04	0.05	0.01
				550	11.3	0.08	0.04	0.09	0.14	0.19	0.24	0.04
				900	16.0[g]	0.23	0.10	0.25	0.38	0.52	0.66	0.10
				1160	16.0[g]	0.38	0.17	0.42	0.64	0.86	1.09	0.17
10 (0.55)	1430	248	300	300	5.1	0.01	0.01	0.02	0.03	0.04	0.05	0.01
				700	14.3	0.08	0.04	0.13	0.21	0.29	0.38	0.04
				1100	21.0[g]	0.21	0.10	0.32	0.53	0.73	0.93	0.10
				1450	21.0[g]	0.36	0.17	0.56	0.91	1.26	1.62	0.17
12 (0.78)	2060	357	425	425	8.7	0.01	0.01	0.02	0.04	0.06	0.07	0.01
				1000	20.6	0.08	0.04	0.14	0.22	0.31	0.40	0.04
				1600	30.0[g]	0.20	0.10	0.35	0.57	0.80	1.02	0.10
				2060	30.0[g]	0.33	0.17	0.58	0.95	1.32	1.69	0.17
14 (1.07)	2800	486	580	580	11.9	0.01	0.01	0.02	0.04	0.05	0.06	0.01
				1375	28.2	0.07	0.04	0.13	0.21	0.28	0.36	0.04
				2100	36.0[g]	0.16	0.10	0.30	0.48	0.66	0.84	0.10
				2800	36.0[g]	0.29	0.18	0.53	0.85	1.17	1.49	0.18
16 (1.40)	3660	634	750	750	15.4[g]	0.01	0.01	0.02	0.04	0.06	0.07	0.01
				1775	36.0[g]	0.06	0.04	0.14	0.22	0.31	0.40	0.04
				2800	36.0[g]	0.14	0.10	0.34	0.56	0.77	0.99	0.10
				3660	36.0[g]	0.24	0.17	0.58	0.95	1.32	1.69	0.17
22 (2.63)	7000	1212	1800	1800	36.0[g]	0.02	0.01	0.05	0.09	0.13	0.16	0.01
				3300	36.0[g]	0.07	0.04	0.18	0.30	0.42	0.55	0.04
				5300	36.0[g]	0.17	0.10	0.45	0.77	1.09	1.14	0.10

NOTE(S):

a. To obtain Total Pressure (P_t), add the Velocity Pressure for a given cfm to the Static Pressure drop (ΔP_S) of the desired configuration, e.g., P_t for a Size 8 Basic Unit at 920 cfm = 0.39 + 0.17 = 0.56
b. Maximum discharge temperatures with electric heat are set at 120°F by the National Electric Code.
c. Max kW shown assumes 55°F entering air and is limited by unit's selected voltage, phase, max capacity and design. Min cfm for electric heat is based on UL/ETL listings. (Diffuser performance will likely be poor at this low flow rate).
d. Minimums for DDC by others are the responsibility of the controls provider.
e. The ASHRAE Handbook of Fundamentals does not recommend a discharge temperature exceeding 90°F for satisfactory air mixing and comfort.
f. A minimum of 0.10-in. discharge static pressure is required to ensure steady operation for the airflow switch in the electric heater.
g. Max kW is limited by design.

LEGEND

DDC — Direct Digital Controls
EAT — Entering Air Temperature
UL — Underwriters Laboratories
ΔP_S — The difference in static pressure from inlet to discharge
ΔV_{PS} — Change in velocity pressure

Step 3 — Install Sensors and Make Field Wiring Connections — Electric Analog or DDC (Direct Digital Controls)

Refer to specific unit dimensional submittals and control application diagrams for control specifications. All field wiring must comply with National Electrical Code (NEC) and local requirements. Refer to the wiring diagram on the unit for specific wiring connections.

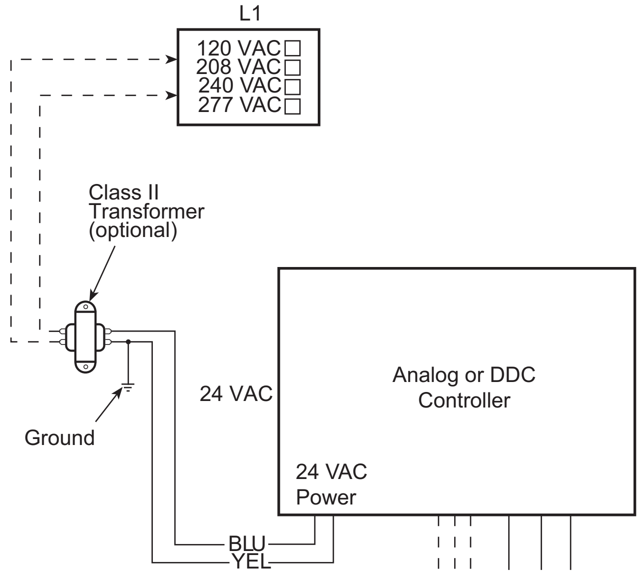
A field-supplied transformer is required if the unit was not equipped with a factory-installed transformer. See Fig. 5.

Single duct terminal units with electric heat are supplied with a single point wiring connection in the heater control box. All unit power is supplied through this connection. Models with electric heat are factory equipped with a control transformer. See Fig. 6.

Wiring and unit ampacities are referenced in Tables 3 and 4.

NOTE: Refer to wiring diagram attached to each unit for specific information on that particular unit. Units with 480-3-60 electric heater **REQUIRE** 4-wire, WYE connected power. Units with 208/230-v, 3-phase heater can be connected with 3-wire power.

Unit airflow should not be set outside of the range noted in Fig. 7 on page 8 The minimum recommended airflow for units with electric heat must be at least 75 cfm per kW and must not drop below the minimum values listed in the performance data table. The maximum unit discharge temperature should not exceed 120°F. Prevent air stratification by setting the discharge temperature no more than 15 degrees above the room temperature. Example: 90°F discharge in a 75°F room.



LEGEND

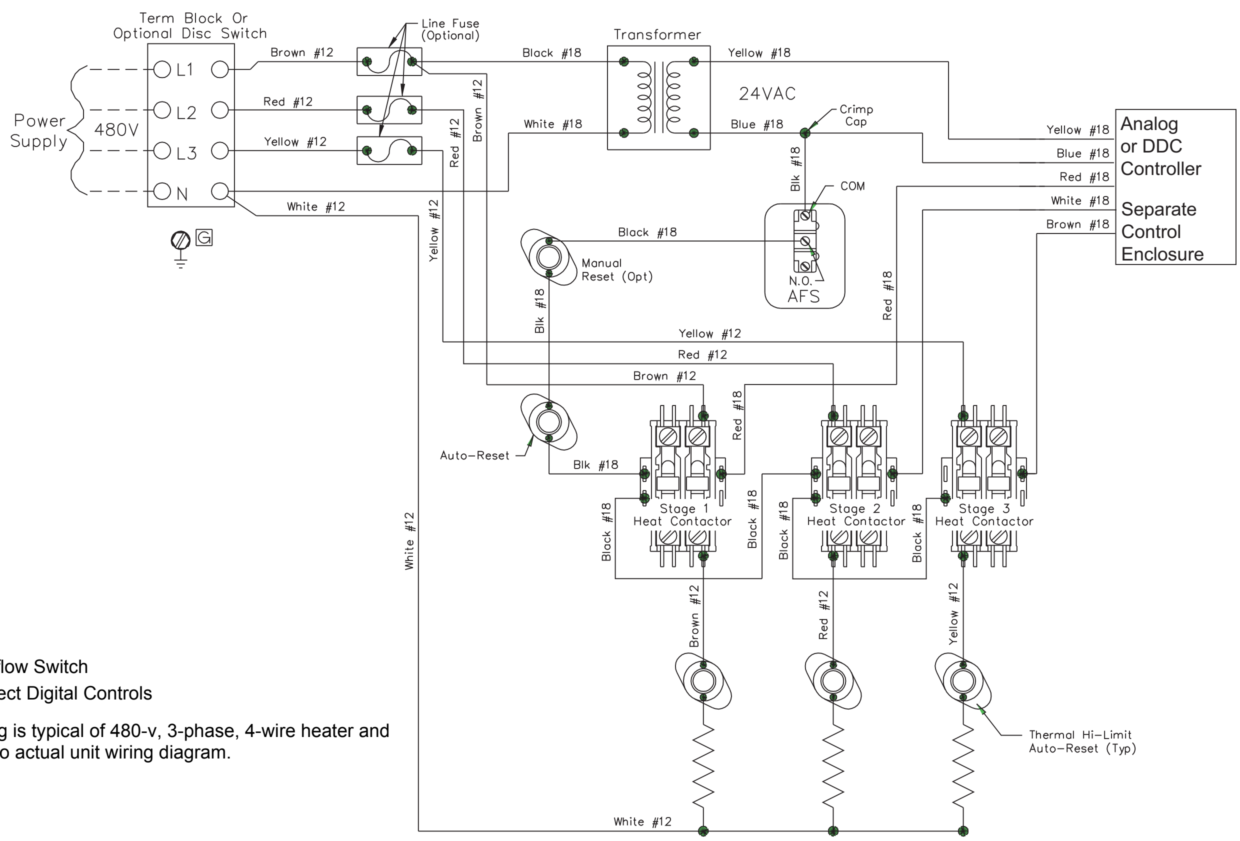
DDC — Direct Digital Controls

– – – – Field Wiring

——— Factory Wiring

NOTE: Drawing is typical — refer to actual unit wiring diagram for details.

Fig. 5 — Wiring of Optional Factory-Mounted Transformer



LEGEND

AFS — Airflow Switch

DDC — Direct Digital Controls

NOTE: Drawing is typical of 480-v, 3-phase, 4-wire heater and control. Refer to actual unit wiring diagram.

Fig. 6 — Typical Power Connections for 35E Units with 3-Stage Electric Heat

Table 3 — 35E Heater Power Wiring and Fuse Sizing (Single Phase, 60 Hz)

HEATER SIZE (kW)	BTUH	120-v		208-v		240-v		277-v	
		Heater FLA	AWG[a]	Heater FLA	AWG[a]	Heater FLA	AWG[a]	Heater FLA	AWG[a]
0.5	1,707	4.2	14	2.4	14	2.1	14	1.8	14
1.0	3,413	8.3	14	4.8	14	4.2	14	3.6	14
2.0	6,826	16.7	10	9.6	14	8.3	14	7.2	14
3.0	10,239	25.0	8	14.4	12	12.5	12	10.8	14
4.0	13,652	33.3	8	19.2	10	16.7	10	14.4	12
5.0	17,085	41.7	5	24.0	10	20.8	10	18.1	10
6.0	20,478	—	—	28.8	8	25.0	8	21.7	10
7.0	23,891	—	—	33.7	8	29.2	8	25.3	8
8.0	27,304	—	—	38.5	6	33.3	8	28.9	8
9.0	30,717	—	—	43.3	6	37.5	6	32.6	8
10.0	34,130	—	—	—	—	—	—	36.1	6
11.0	37,543	—	—	—	—	—	—	39.7	6
12.0	40,956	—	—	—	—	—	—	43.3	6

NOTE(S):

a. Values based on 75°C copper wire.

LEGEND

AWG — American Wire Gauge
FLA — Full Load Amps

Table 4 — 35E Heater Power Wiring and Fuse Sizing (3 Phase, 60 Hz)

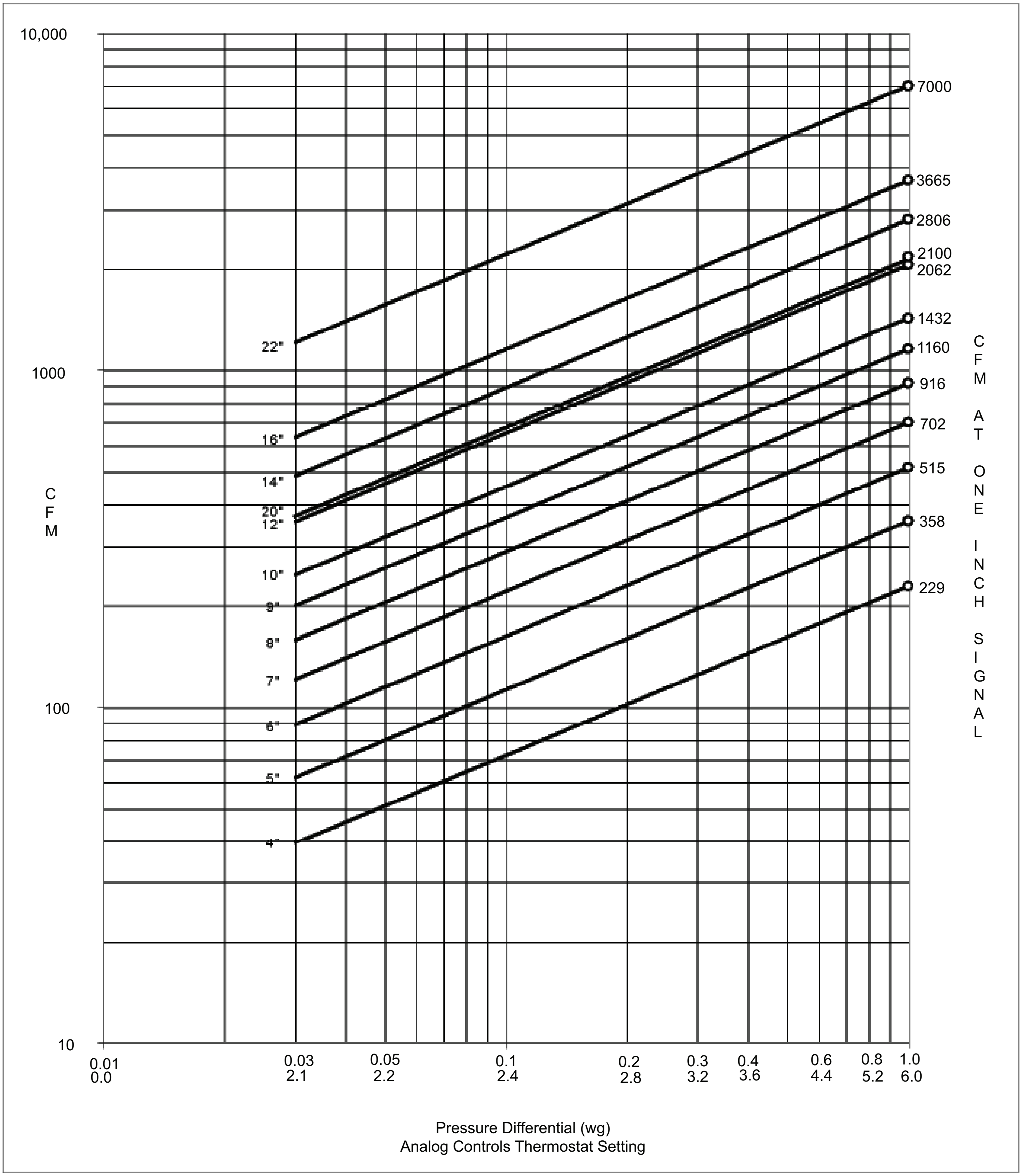
HEATER SIZE (kW)	BTUH	208-v		480-v	
		Heater FLA	AWG[a]	Heater FLA	AWG[a]
0.5	1,707	1.4	14	0.6	10
1.0	3,413	2.8	14	1.2	10
2.0	6,826	5.6	14	2.4	10
3.0	10,239	8.3	14	3.6	10
4.0	13,652	11.1	14	4.8	10
5.0	17,085	13.9	12	6.0	10
6.0	20,478	16.7	10	7.2	10
7.0	23,891	19.4	10	8.4	10
8.0	27,304	22.2	10	9.6	10
9.0	30,717	25.0	8	10.8	10
10.0	34,130	27.8	8	12.0	10
11.0	37,543	30.5	8	13.2	12
12.0	40,956	33.3	8	14.4	12
14.0	47,782	38.8	6	16.8	12
16.0	54,608	44.4	6	19.2	10
18.0	61,434	—	—	21.7	10
20.0	68,260	—	—	24.1	10
22.0	75,086	—	—	26.5	8
24.0	81,912	—	—	28.9	8
26.0	88,738	—	—	31.3	8
28.0	95,564	—	—	33.7	8
30.0	102,390	—	—	36.1	6
32.0	109,216	—	—	38.5	6
34.0	116,042	—	—	40.9	6
36.0	122,868	—	—	43.3	6

NOTE(S):

a. Recommended minimum wire size.

LEGEND

AWG — American Wire Gauge
FLA — Full Load Amps



LEGEND
CFM — $K\sqrt{\Delta P}$
CFM — ft^3/minute
K — Sensor Constant
ΔP — Pressure Differential (wg)

Fig. 7 — Inlet Flow Sensor, CFM vs Pressure Signal (Linear Averaging Probe Chart)

CONTROL SETUP

General

The 35E single-duct VAV (variable air volume) terminal is designed to supply a varying quantity of cold primary air to a space in response to a thermostat demand. Some units have reheat options to provide heating demand requirements as well. Most VAV terminals are equipped with pressure compensating controls to regulate the response to the thermostat independent of the pressure in the supply ductwork.

To balance the unit, it is necessary to set both the maximum and minimum set points of the controller. The many types of control options available each have specific procedures required for balancing the unit.

Set Points

Maximum and minimum airflow set points are normally specified for the job and specific for each unit on the job. Where maximum and minimum airflow levels are not specified on the order, default values are noted on unit ID label.

Field Adjustment of Minimum and Maximum Airflow Set Points

Each 35E unit is equipped with a flow probe that measures a differential pressure proportional to the airflow. The relationship between flow probe pressures and cfm is shown in the Linear Averaging Probe Chart (see Fig. 7). This chart is attached to each unit. There are several conventions (and no universally accepted method) in use for representing this flow factor:

MAGNIFICATION FACTOR

The magnification factor may be expressed as the ratio of either velocity or pressure of the output of the sensor to that of a pilot tube.

For example, a velocity magnification may be used. All probes develop an average signal of 1 in. wg at 2625 fpm. This gives a velocity magnification of 4005 / 2625 or 1.52.

It may be a pressure magnification factor. In this case, the ratio of pressures at a given air velocity is presented. For a velocity constant of 2626, at 1000 fpm, this is 0.1451 / 0.0623 = 2.33.

K-FACTOR

The K-factor may be represented in two ways:

- It may be a velocity K-factor, which is the velocity factor times the inlet area, (which for all probes is 2625 fpm/in. wg).
- Alternatively, it may be the airflow K-Factor, which is the velocity factor times the inlet area. For an 8-inch unit, therefore, this would be 2625 * 0.349, or 916. A separate airflow factor is required for each size. All Carrier VAV terminals have round inlets. Table 5 is a K-Factor table for all Carrier VAV terminal inlets.

System Calibration of the Linear Averaging Flow Probe

To achieve accurate pressure independent operation, the velocity sensor and flow probe must be calibrated to the controller. This will ensure that airflow measurements will be accurate for all terminals at system start-up.

System calibration is accomplished by calculating a flow coefficient that adjusts the pressure fpm characteristics. The flow coefficient is determined by dividing the flow for a given unit (design air volume in cfm), at a pressure of 1.0 in. wg differential pressure, by the standard pitot tube coefficient of 4005. This ratio is the same for all sizes regardless of which probe is used.

Determine the design air velocity by dividing the design air volume (the flow at 1.0 in. wg) by the nominal inlet area (sq ft). This factor is the K factor.

Carrier inlet areas are shown in the table below. The design air volume is also shown in this table. It can be determined from this table that the average design air velocity for 35E units is equal to 2656 fpm at 1.0 in. wg.

Record the information on a performance sheet (see Fig. 8). This will provide a permanent record of the balancing information.

- installation location information
- box size
- cooling minimum airflow (cfm) limit
- cooling maximum airflow (cfm) limit
- reheat (cfm) limit (if applicable)
- heating minimum airflow (cfm) limit (if applicable)
- heating maximum airflow (cfm) limit (if applicable)
- calibration gain (after balancing)
- set points

Table 5 — Inlet Probe Area and K Factor

UNIT SIZE 35E	04	05	06	07	08	09	10	12	14	16	22
Inlet Diameter (in.)	4.0	5.0	6.0	7.0	8.0	9.0	10.0	12.0	14.0	16.0	22.0
Velocity Magnification	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
Velocity Constant	2625	2625	2625	2625	2625	2625	2625	2625	2625	2625	2625
CFM K Factor	229	358	515	702	916	1160	1432	2062	2806	3665	7000
Inlet Area (sq ft)	0.087	0.136	0.196	0.267	0.349	0.442	0.545	0.785	1.069	1.396	2.667
Recommended Min cfm	40	62	89	122	159	201	248	357	486	635	1212

AIR TERMINAL PERFORMANCE SHEET

JOB NAME ______________________________

JOB LOCATION ______________________________

CUSTOMER ______________________________

ENGINEER ______________________________

BUILDING LOCATION/FLOOR ______________________________

BUS NUMBER ______________________________

CONTROL										SET POINTS				
Tag Number	Zone Address Number	Box Size (in./cfm)	Cooling (cfm)		Reheat cfm	Heating (cfm)		Heat	kW	Occupied		Unoccupied		Calibration Gain
			Min	Max		Min	Max	Type	Btu	Min	Max	Min	Max	Mult.

Fig. 8 — Air Terminal Performance Sheet

PNEUMATIC CONTROLS

Preparation for Balancing (Control Sequences 1102 and 1103)

1. Inspect all pneumatic connections to assure tight fit and proper location.
2. Verify that the thermostat being used is compatible with the control sequence provided (direct acting or reverse acting).
3. Check main air pressure at the controller(s). The main air pressure must be between 15 psi and 25 psi. (If dual or switched-main air pressure is used, check the pressure at both high and low settings.) The difference between "high" pressure main and "low" pressure main should be at least 4 psi, unless otherwise noted, and the "low" setting difference should exceed 15 psi.
4. Check that the unit damper will fail to the proper position when main air pressure is lost. Disconnect the pneumatic actuator line from the velocity controller and observe the VAV damper position. The damper should fail to either a normally open position (indicator mark on shaft end is horizontal) or a normally closed position (indicator mark on shaft end is vertical).
5. Check that there is primary airflow in the inlet duct.
6. Connect a magnehelic gauge, inclined manometer or other differential pressure measuring device to the balancing taps provided in the velocity probe sensor lines. The manometer should have a full scale reading of 0.0 to 1.0-in. wg. The high pressure signal is delivered from the front sensor tap (away from the valve), and the low pressure signal is delivered from the back line (near the valve). The pressure differential between high and low represents the amplified velocity pressure in the inlet duct.
7. Read the differential pressure and enter the Linear Averaging Probe Chart to determine the airflow in the terminal unit. This chart is shown in Fig. 7 and is also attached to the side of each unit. For example, a differential pressure of 0.10-in. wg for a size 8 unit yields an airflow of 275 cfm.

Volume controllers for 35EP units are shown in Fig. 9-11. Identification for each controller is shown in Table 6.

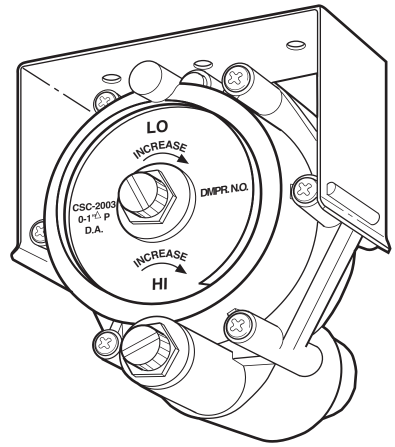


Fig. 9 — Pneumatic Volume Controller (Normally Open) for 35EP Unit (Beige Color)

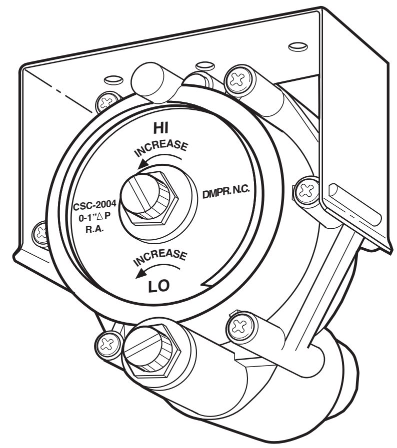


Fig. 10 — Pneumatic Volume Controller (Normally Closed) for 35EP Unit (Grey Color)

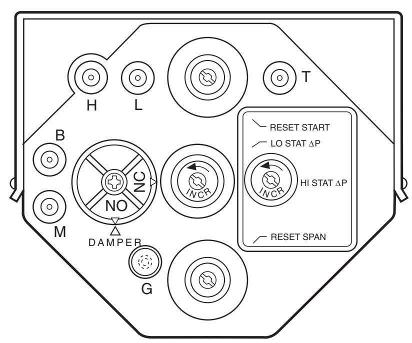


Fig. 11 — CSC 3000 Series Reset Volume Controller

Table 6 — Pneumatic Volume Controller Identification

CONTROL SEQUENCE	FUNCTION ARRANGEMENT IDENTIFICATION	FIG. NO.	KREUTER PART NO.
1102	DA-NO	9	CSC-2003
1103	RA-NC	10	CSC-2004
1104	DA-NO	11	CSC-3011
1105	DA-NC	11	CSC-3011
1106	RA-NO	11	CSC-3011
1107	RA-NC	11	CSC-3011
1108	DUAL MAX	11	CSC-3011
1109	HTG/CLG MAX	11	(2) CSC-3011
1110	DUAL MIN	11	CSC-3011

LEGEND

DA — Direct Acting
NC — Normally Closed
NO — Normally Open
RA — Reverse Acting

Balancing Procedure (Control Sequences 1102 and 1103)

DIRECT ACTING THERMOSTAT, NORMALLY OPEN DAMPER (CONTROL SEQUENCE 1102)

1. Minimum volume setting:
   a. Disconnect the thermostat line from the volume controller.
   b. Adjust the minimum volume control knob (marked “LO” and located in the center of the controller) shown in Fig. 9 to achieve the required minimum flow. To determine the required pressure differential, refer to Tables 2 and 5 and the Linear Averaging Probe Chart provided on the side of the VAV unit and in Fig. 7.
   c. Reconnect the thermostat line.
2. Maximum volume setting:
   a. Disconnect the thermostat line from the volume controller.
   b. Apply 15 + psi to the thermostat port on the volume controller (marked “T”) by tapping into the main air pressure line.
   c. Adjust the maximum volume control knob (marked “HI” and located at the side of the controller) until the desired pressure differential is registered on the manometer. To determine the required pressure differential, refer to Table 5 and the Linear Probe CFM vs Pressure Signal Graph provided on the side of the VAV unit and in Fig. 7.
   d. Reconnect the thermostat line.

REVERSE ACTING THERMOSTAT, NORMALLY CLOSED DAMPER (CONTROL SEQUENCE 1103)

1. Maximum volume setting:
   a. Disconnect the thermostat line from the volume controller.
   b. Adjust the maximum volume control knob (marked “HI” and located in the center of the controller) shown in Fig. 10 to achieve the required minimum flow.
   c. To determine the required pressure differential, refer to Tables 2 and 5 and the Linear Averaging Probe Chart provided on the side of the VAV unit and in Fig. 7.
   d. Reconnect the thermostat line.
2. Minimum volume setting:
   a. Disconnect the thermostat line from the volume controller.
   b. Apply 15 + psi to the thermostat port on the volume controller (marked “T”) by tapping into the main air pressure line.
   c. Adjust the minimum volume control knob (marked “LO” and located at the side of the controller) until the desired pressure differential is registered on the manometer. To determine the required pressure differential, refer to Table 5 and the Linear Averaging Probe Chart provided on the side of the VAV unit and in Fig. 7.
   d. Reconnect the thermostat line.

Balancing Procedure (Control Sequences 1104-1110)

1. Damper action is factory set at N.O. (normally open), or N.C. (normally closed). To change, perform the following steps:
   a. Loosen the damper selection screw.
   b. Turn the selection dial clockwise until the “NC” or “NO” arrow aligns with the “DAMPER” arrow.

NOTE: Accuracy in the alignment of the arrows is very important. Make this adjustment as exact as possible. See Fig. 12.

2. Pipe the controller: Connect port “B” to the damper actuator. Connect port “M” to the clean, dry main air. Connect port “T” to the thermostat output. Connect port “H” to the total pressure tap on the airflow sensor. Connect port “L” to the static pressure tap on the airflow sensor.

The controller can be set up for cooling or heating applications using either a Direct Acting (DA) or Reverse Acting (RA) thermostat signal. The two flow adjustments are labeled “LO STAT ΔP” and “HI STAT ΔP.”

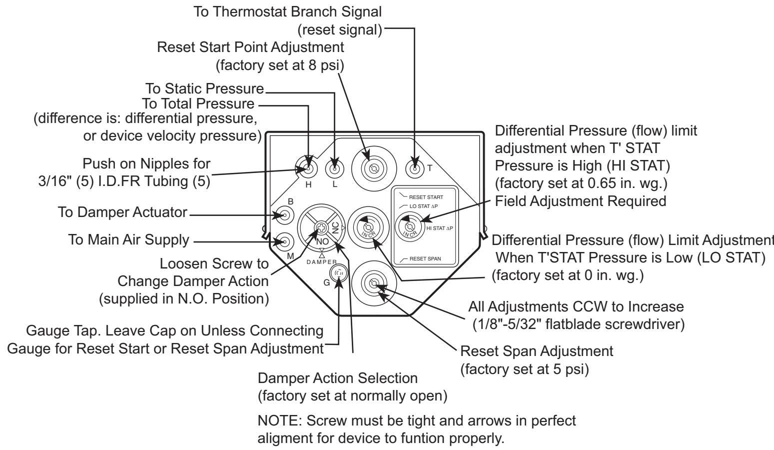


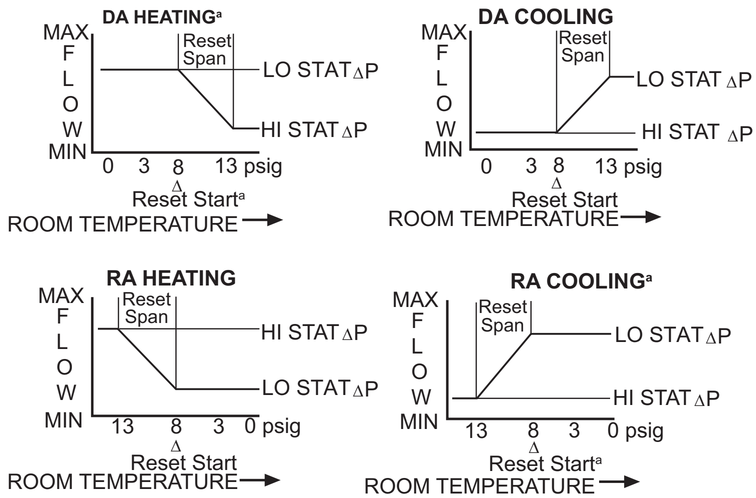
Fig. 12 — 3011 CSC Controller

LO STAT ΔP setting is the desired airflow limit when the thermostat pressure is less than, or equal to, the reset start point.

- For DA Cooling or RA Heating:
  Adjust LO STAT ΔP to the desired minimum airflow with 0 psig (or a pressure less than the reset start point) at port "T." The LO STAT ΔP must be set first. The LO STAT ΔP will affect the HI STAT ΔP setting.
- For RA Cooling or DA Heating:
  Adjust LO STAT ΔP to the desired maximum airflow with 0 psig (or a pressure less than the reset start point) at port "T." The LO STAT ΔP must be set first. The LO STAT ΔP will affect the HI STAT ΔP setting.

HI STAT ΔP setting is the desired airflow limit when the thermostat pressure is greater than, or equal to, the reset stop-point. The reset stop-point is the reset span pressure added to the reset start-point pressure.

- For DA Cooling or RA Heating (see Fig. 13):
  Adjust HI STAT ΔP to the desired maximum airflow with 20 psig (or a pressure greater than the reset stop point) at port "T." The HI STAT ΔP must be set last. The HI STAT ΔP setting will be affected by the LO STAT ΔP setting.
- For RA Cooling or DA Heating (see Fig. 13):
  Adjust HI STAT ΔP to the desired minimum airflow with 20 psig (or a pressure greater than the reset stop point) at port "T." The HI STAT ΔP must be set last. The HI STAT ΔP setting will be affected by the LO STAT ΔP setting.



NOTE:

a.) May require changing the RESET START from 8.0 to 3.0 psig if sequencing is involved.

Fig. 13 — Reset Cycle for CSC-3011 Control

NOTE: IF the LO STAT ΔP Limit must be set at "0" (zero minimum), do not turn the LO STAT ΔP knob fully clockwise. The knob will adjust one and one-half turns after a zero minimum is reached. Turning the LO STAT ΔP knob fully clockwise will result in a negative reset condition. This means that when the controller begins to reset at the reset start point, it must first overcome the negative adjustment and will not begin to reset from "0" until a higher thermostat reset pressure is reached. This negative reset will also reduce the effective range of the controller by reducing the low end reset, narrowing the reset span. If a zero minimum is required, adjust the LO STAT ΔP knob until the controller just begins to crack the damper open, and then back-off one-quarter turn and verify zero airflow. (This is typically 2-1/2 knob rotations counter clockwise from the fully clockwise position.)

NOTE: After the "LO STAT ΔP" and "HI STAT ΔP" initial adjustments are made, cycle the thermostat pressure a few times to settle the internal reset mechanisms and verify settings. Fine tune the settings if necessary. The thermostat pressure may be left at a high pressure and the "G" port cap may be removed and replaced to cycle the reset mechanism.

RESET START setting is factory set at 8.0 psig. This is the lowest thermostat pressure that the LO STAT ΔP airflow will begin to reset towards the HI STAT ΔP airflow. To change the RESET START setting: regulate thermostat pressure to the "T" port to the desired reset start point pressure, adjust RESET START adjustment until pressure at the "G" port is slightly higher than 0 psig, i.e., 0.1 psig.

NOTE: The "G" port taps into the controller's internal reset chamber, which always starts at 0 psig. The RESET START adjustment is a positive bias adjustment that sets the desired thermostat start point to the controller's internal reset start point of 0 psig.

RESET SPAN setting is factory set at 5.0 psig. This is the required change in thermostat pressure that the controller will reset between the LO STAT ΔP setting and the HI STAT ΔP setting. To change the RESET SPAN setting: adjust RESET SPAN adjustment until pressure at the "G" port equals the desired reset span pressure. (Do not adjust.)

NOTE: The "G" port taps into the controller's internal reset chamber, which will always be at a pressure between 0 psig and the RESET SPAN pressure.

Preventative Maintenance

1. Inspect pneumatic tubing for loose connections or leaks.
2. Clean out pneumatic line filters regularly according to manufacturers recommendations.

Pneumatic Control Troubleshooting

See Table 7 on page 15 for the problem and problem cause troubleshooting information.

Table 7 — Troubleshooting[a,b,c,d,e,f,g]

PROBLEM	PROBABLE CAUSE
Controller does not reset to maximum or minimum set point during balance procedure.	Balancer is using the thermostat for control signal. An artificial signal must be provided in place of the thermostat.
Controller does not reset to maximum or minimum set point during operation.	Thermostat is not demanding maximum or minimum air volume. Main air pressure at the controller is less than 15 psi.
Pneumatic actuator does not stroke fully.	Leak in pneumatic line between the controller and the actuator. Main air pressure at the controller is less than 15 psi. Leak in the diaphragm.
Air valve stays in wide open position.	Velocity probe is blocked by an obstruction (sandwich bag, etc.). Insufficient supply air in the inlet duct.

NOTE(S):

a. Always check for the following the main air pressure (15 psi to 25 psi) at the controller.
b. Always check for disconnected or kinked pneumatic lines to the controller.
c. Always check the quality of compressed air (oil or water in lines).
d. Always check for blocked velocity probe or insufficient primary supply air.
e. Always check for leaks in the actuator diaphragm.
f. Always check for mechanical linkage of the actuator/air valve.
g. Always check for proper thermostat signal and logic (direct/reverse acting).

ANALOG CONTROLS

Balancing Procedures (Control Sequences 2100-2105)

The analog electronic control system is a pressure independent volume reset control that uses a KMC CSP-4702 controller-actuator (see Fig. 14).

Adjustments for the minimum and maximum airflows are made at the thermostat.

The thermostat (CTE-5202) operates on a 16 VDC power supply from the CSP 4702 controller and outputs a 0 to 10 VDC signal on the AO1 and AO2 terminals. AO1 is used as the cooling output and AO2 is used as the heating output.

Thermostat Installation

For proper operation, mount the thermostat on an interior wall. Do not mount the thermostat in a location that will cause it to be affected by direct sunlight or other heat or cold sources. The thermostat should be clear of all obstructions so it can properly sense the room temperature.

Complete rough-in wiring at each location prior to thermostat installation. Cable insulation must meet local building codes.

1. Remove thermostat cover. If the thermostat is locked on the back plate, turn the two hex screws in on the bottom of the cover (in the two outermost holes) in the back plate CLOCKWISE until they clear the cover. Do not remove these screws completely. Swing the thermostat up and away from the back plate to remove it.
2. Route the wires through the opening in the back plate.
3. Install the back plate directly to the junction box using the screws supplied with the thermostat. Verify the hex screws used for securing the cover are located at the bottom before installing.
4. Connect the wires to the terminal block. Refer to the wiring diagram located on the inside cover of the control enclosure of each unit showing the wiring terminations.
5. Replace the thermostat cover. Turn the two hex screws COUNTER CLOCKWISE until they are flush with the bottom cover and secure it to the back plate.

Programming Thermostat

1. The thermostat has three sequences that are selectable from the display screen. To access the configuration menu on the thermostat, press and hold the Up and Down arrows for 10 seconds until the display starts flashing "LIMITS". Use the Up and Down arrows to scroll between the different menu options or set a specific value. Use the Setpoint button to select a menu or set a value.
2. To set the minimum and maximum airflow limits, Use AO1 Min and AO1 Max or AO2 Min and AO2 Max. Use the Table 8 on page 18 to determine thermostat setting for the CFM per inlet size.
3. For details on how to program the thermostat for each control sequence see the specific control sequence submittal.

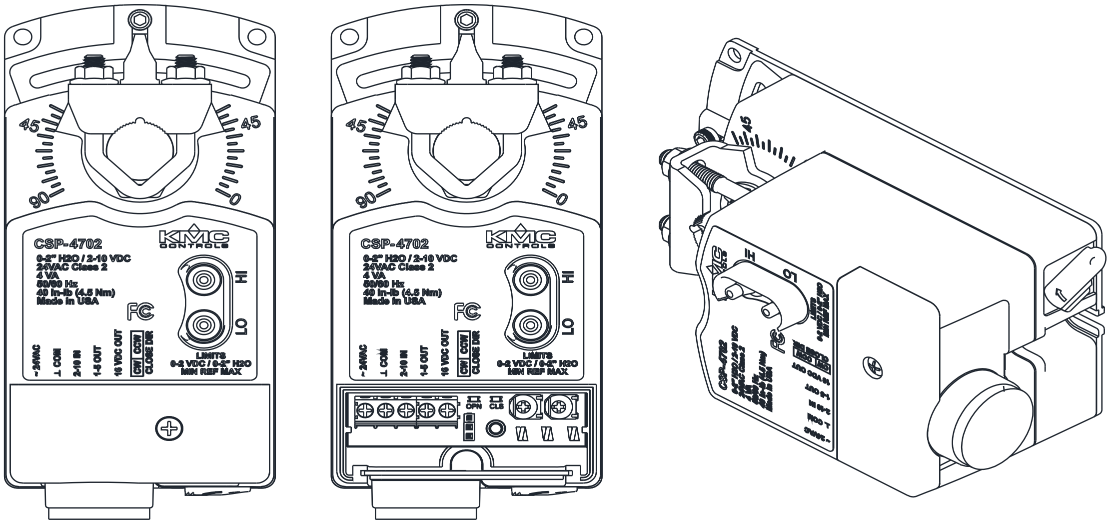


Fig. 14 — KMC CSP-4702

Analog Control Troubleshooting

The following troubleshooting procedure is directed towards single duct cooling applications. The same concepts can be applied to other configurations.

NOTE: For about 15 seconds after power is applied, no rotation occurs and one or both of the LEDs will flash.

CONTROLLER

1. Check that the shaft moves freely. (Press and hold the actuator release clutch and manually rotate the shaft.)
2. Check wiring. (See Wiring Issues section.)
3. Check for a tripped circuit breaker to the transformer, for proper supply voltage from the transformer (or power supply), and for enough capacity (VA) for all connected devices.
4. Check that the direction jumper is in the proper position.
5. Check the polarity and level of the input signal from the thermostat.

WRONG ROTATION DIRECTION OR STROKE RANGE

1. Check the position of the direction jumper.
2. Check the Min and Max flow limits on the thermostat.
3. Check the adjustable stop position.

NO PRESSURE OUTPUT SIGNAL FROM INLET SENSOR

1. Check the wiring.
2. Check air flow and sensor. Tubing should be free of kinks and restrictions. Sensor must be oriented in the correct airflow direction.

WIRING ISSUES

1. Check for correct wiring at unit and thermostat.
2. At the Controller, verify 24 vac at terminals "~" (phase) and "-" (ground). Tolerance can be –15% to +20% (20.4 to 28.8 vac).
3. Verify 16 vdc at terminals "16 VDC" and "COM"
   a. Tolerance is 15.0 to 17.0 vdc power supply to thermostat.
   b. If not correct, disconnect thermostat and recheck.
   c. If still incorrect, replace CSP controller.
4. Check "Requested Flow" voltage on terminal "2-10 IN" and "COM".
   a. Use Table 8 to correlate into cubic feet per minute (CFM)
   b. If reading is not what is desired, see "calibration to adjust thermostat.

NOTE: Never jumper terminal 16 vdc to "-" as this would cause a short, and possibly damage the power supply

NOTE: When using the same transformer for more than one control, the phase and ground must be consistent with each device.

Table 8 — Thermostat Settings for the CFM per Inlet Size

AO1 and AO2 SETTING	SENSOR SIGNAL (in. wg)	CFM PER INLET SIZE											
		4	5	6	7	8	9	10	12	14	16	20	22
0-2	**0.00**	0	0	0	0	0	0	0	0	0	0	0	0
2.1	**0.03**	36	57	81	111	145	183	226	326	444	580	315	1107
2.2	**0.05**	51	80	115	157	205	259	320	461	627	820	445	1565
2.3	**0.08**	63	98	141	192	251	318	392	565	768	1004	545	1917
2.4	**0.10**	72	113	163	222	290	367	453	652	887	1159	630	2214
2.5	**0.13**	81	127	182	248	324	410	506	729	992	1296	704	2475
2.6	**0.15**	89	139	200	272	355	449	555	798	1087	1420	771	2711
2.7	**0.18**	96	150	216	293	383	485	599	862	1174	1533	833	2928
2.8	**0.20**	102	160	231	314	410	519	640	922	1255	1639	891	3130
2.9	**0.23**	109	170	244	333	435	550	679	978	1331	1739	945	3320
3.0	**0.25**	115	179	258	351	458	580	716	1031	1403	1833	996	3500
3.1	**0.28**	120	188	270	368	481	608	751	1081	1472	1922	1045	3671
3.2	**0.30**	125	196	282	384	502	635	784	1129	1537	2008	1091	3834
3.3	**0.33**	131	204	294	400	522	661	816	1175	1600	2089	1136	3991
3.4	**0.35**	136	212	305	415	542	686	847	1220	1660	2168	1178	4141
3.5	**0.38**	140	219	316	430	561	710	877	1263	1718	2244	1220	4287
3.6	**0.40**	145	226	326	444	580	733	905	1304	1775	2318	1260	4427
3.7	**0.43**	149	233	336	457	597	756	933	1344	1829	2389	1299	4563
3.8	**0.45**	154	240	346	471	615	778	960	1383	1882	2459	1336	4696
3.9	**0.48**	158	247	355	484	632	799	987	1421	1934	2526	1373	4824
4.0	**0.50**	162	253	364	496	648	820	1012	1458	1984	2592	1408	4950
4.1	**0.53**	166	259	373	508	664	840	1037	1494	2033	2656	1443	5072
4.2	**0.55**	170	265	382	520	680	860	1062	1529	2081	2718	1477	5191
4.3	**0.58**	174	271	391	532	695	879	1086	1563	2128	2779	1510	5308
4.4	**0.60**	177	277	399	543	710	898	1109	1597	2174	2839	1543	5422
4.5	**0.63**	181	283	407	555	724	917	1132	1630	2218	2898	1575	5534
4.6	**0.65**	185	289	416	566	739	935	1154	1662	2262	2955	1606	5644
4.7	**0.68**	188	294	423	576	753	953	1176	1694	2305	3011	1636	5751
4.8	**0.70**	192	299	431	587	767	970	1198	1725	2348	3067	1666	5857
4.9	**0.73**	195	305	439	597	780	987	1219	1755	2389	3121	1696	5960
5.0	**0.75**	198	310	446	608	794	1004	1240	1785	2430	3174	1725	6062
5.1	**0.78**	202	315	454	618	807	1021	1260	1815	2470	3227	1753	6162
5.2	**0.80**	205	320	461	627	820	1037	1281	1844	2510	3278	1782	6261
5.3	**0.83**	208	325	468	637	832	1053	1300	1873	2549	3329	1809	6358
5.4	**0.85**	211	330	475	647	845	1069	1320	1901	2587	3379	1836	6454
5.5	**0.88**	214	335	482	656	857	1085	1339	1929	2625	3428	1863	6548
5.6	**0.90**	217	340	489	666	869	1100	1358	1956	2662	3477	1890	6641
5.7	**0.93**	220	344	496	675	881	1115	1377	1983	2699	3525	1916	6732
5.8	**0.95**	223	349	502	684	893	1130	1395	2009	2735	3572	1941	6823
5.9	**0.98**	226	353	509	693	905	1145	1414	2036	2771	3619	1967	6912
6.0	**1.00**	229	358	515	702	916	1160	1432	2062	2806	3665	1992	7000

PROPORTIONAL (SSR) ELECTRIC HEAT START-UP, OPERATION AND SERVICE

Proportional SSR Heat is an electronic, time-proportional electric heat system. The heat output of the heater is modulated utilizing quiet, rapid performing solid state relays. The relays are switched off and on to allow the heating of electrical resistance elements. The proportion of time the relay is on dictates the proportion of maximum heat the electric heater can produce. The solid state relays are switched off and on by a supplied Electric Heat Module (EHM). The EHM accepts an input signal from the terminal unit controller or thermostat for the amount of heat desired. The EHM can accept a variety of different input signals when interfacing with controls. The type of input the EHM will accept is modified by changing the position of one or two jumpers easily accessible on the board.

Proportional SSR Heat is available with an optional discharge temperature sensor. When used with the discharge sensor option, the Proportional SSR Heat system will modulate outgoing temperature from the unit between the maximum temperature setting and initial temperature of incoming air before heating began. The discharge temperature setpoint is easily adjusted in the field by rotating the temperature dial on the EHM. The EHM will not allow temperatures over the setpoint so as to prevent overheating, stratification, and energy waste from heated air lost through overhead returns.

⚠ WARNING

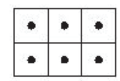
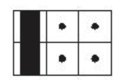
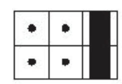
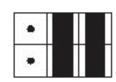
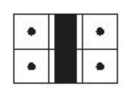
Units with Proportional SSR Heat use solid state relays, which generate heat when used. The temperature of the control box and/or heat sinks may be hot to the touch, causing personal injury.

Start-Up

INPUT SETTING

The Proportional SSR Heat board can be controlled and operated in 7 different ways. The units are ordered with an LXY code, where X is coded for unit power and Y is coded for the application (1-7). This Y application can be changed in the field. The application desired is chosen by placement of jumpers in the corner of board (see Fig. 15). The jumper settings shown in Table 9 represent the pins at the bottom corner of the control board as shown in Fig. 15. See Fig. 16-22 for application wiring diagrams.

Table 9 — Proportional SSR Heat Applications

APPLICATION	DESCRIPTION	JUMPER SETTINGS
LX1 — On/Off	This application accepts one 24 vac input at “Inc” to step the heater output from OFF to 100% heater kW rating. The signal may be pulsed off and on over a small time period to provide proportional heat. For example, a signal that is on for 4.5 seconds every 10 seconds would produce 45% of the heater’s kW rating.	
LX2 — 2 Stage (2Stg)	This two stage application accepts two 24 vac inputs to step the heater output from off to 50% or 100% heater kW rating. A signal to “Inc” is 50% and a signal to “Dec” is 100%	
LX3 — 0-10-v	This application accepts a 0-10 vdc (0-20mA) signal to modulate the heater output. The output is proportional to input signal (for example, 4.5 volts sets the heater to 45% of kW rating).	
LX4 — 2-10-v	This application accepts a 2-10 vdc (4-20 mA) signal to modulate the heater output. The output is proportional to input voltage above 2 volts (for example, 4.5 volts sets the heater to 25% of kW rating).	
LX5 — Incremental (Incr)	This application accepts one 24 vac input to modulate heater output. An increase signal will increase the heater output from 0% to 100% over a 4-minute 15-second interval, staying at 100% afterward. When the signal is removed, the heater output will decrease to 0% over the same time period. This application mirrors a Normally Closed hot water valve.	
LX6 — Binary (Bin)	This application accepts two 24 vac inputs to step the heater from off to 33%, 67%, or 100% of the heater’s kW rating. A signal to “Inc” is 33%, a signal to “Dec” is 67%, and a signal to both is 100%.	
LX7 — 3 Point Floating (Float)	This floating input application accepts two 24 vac inputs to increase or decrease the heater output. As the increase signal is sent, the heater output will increase from 0% to 100% over a 4-minute 15-second interval. If the increase signal is removed, or a decrease signal is also added, the heater output will stay constant at present point. When only the decrease signal is received, the heater output will decline from the present level to 0% over the same time period. This application mirrors a three-point floating hot water valve.	

WIRING

See Fig. 15. The EHM control board is powered by 24 vac (Fig. 15, item 1) from the transformer in the electric heater. The EHM has auxiliary 24vac outputs (Fig. 15, item 2) that can be used to power the unit's electrical controls. Next to the "Xfmr" inputs are the "+" and "–" relay connections (Fig. 15, item 3) that control the solid state relays by sending pulses of ~25 vdc.

There are two terminations to use for dc volt control (Fig. 15, item 4) of the electric heat (applications LX3 and LX4). These are polar sensitive. The "+" signal from the controller must be connected to "Signal" on the EHM Control Board. The "–" from the controller must be connected to "Com" next to "Signal" (**not** "iCom"). A termination to "–" is possible, but not necessary, to measure mA signals to the board.

There are three terminations for 24 vac control (Fig. 15, item 5) of the electric heat (applications LX1, LX2, LX5, LX6, and LX7). "Inc" is for the increase signal in applications LX5 and LX7, as well as the first stage heat signal in applications LX1, LX2, and LX6. "Dec" is for the decrease signal in application LX7, as well as the second stage heat signal in applications LX2 and LX6. A connection to "iCom" is necessary for all of these 24 vac applications. If the unit's controller does not have a common output, a jumper to the correct "Aux" terminal can be used. If the unit controller outputs the "24vac" side from its input power, a jumper should be made from "Neutral" to "iCom" (see sample schematic, Fig. 23). If the unit controller outputs the "Neutral" side of its input power, a jumper should be made from "24vac" to "iCom".

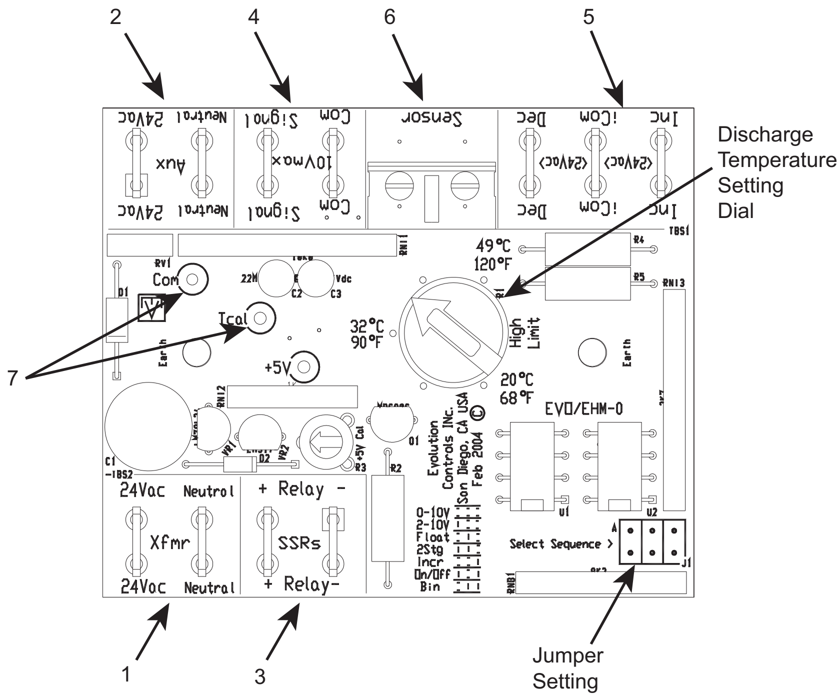


Fig. 15 — EHM Control Board

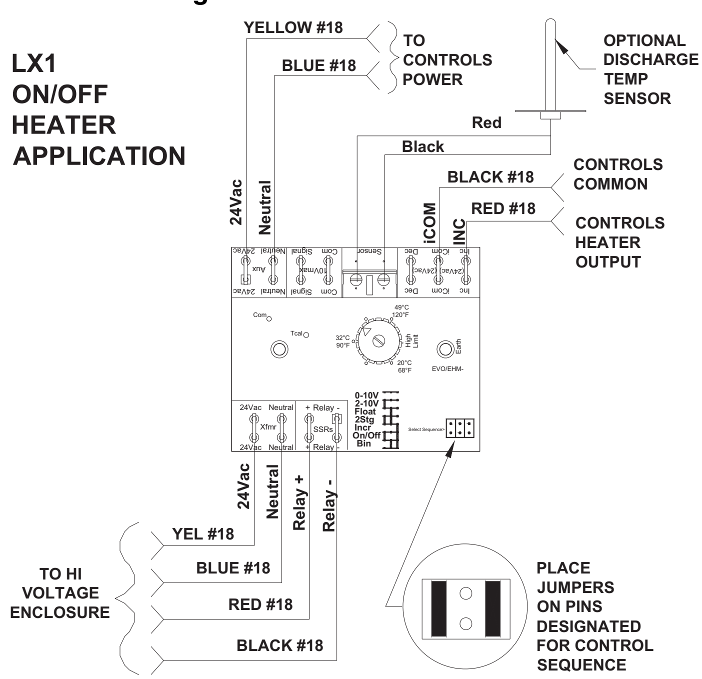


Fig. 16 — LX1 Application Wiring

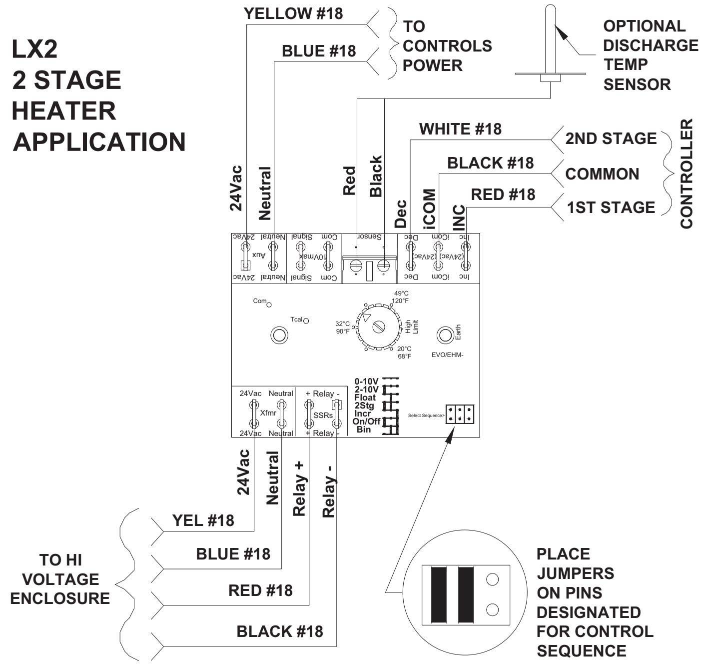


Fig. 17 — LX2 Application Wiring

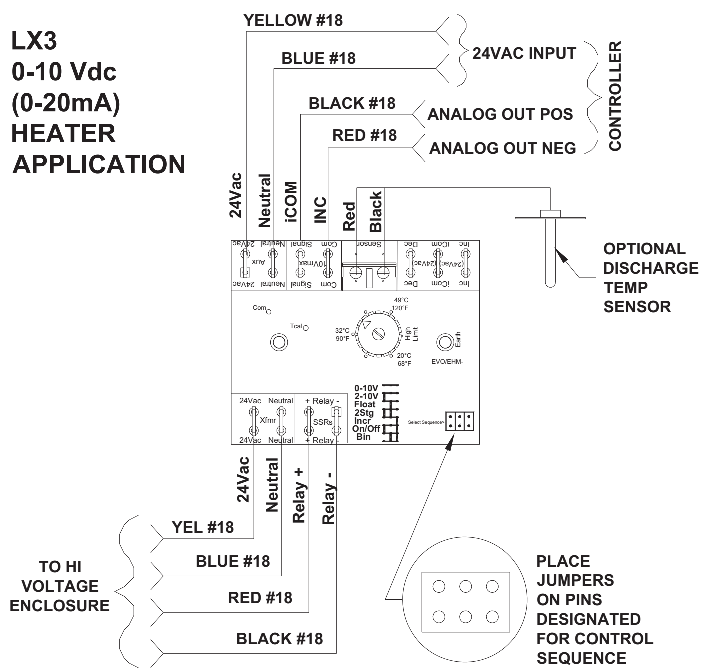


Fig. 18 — LX3 Application Wiring

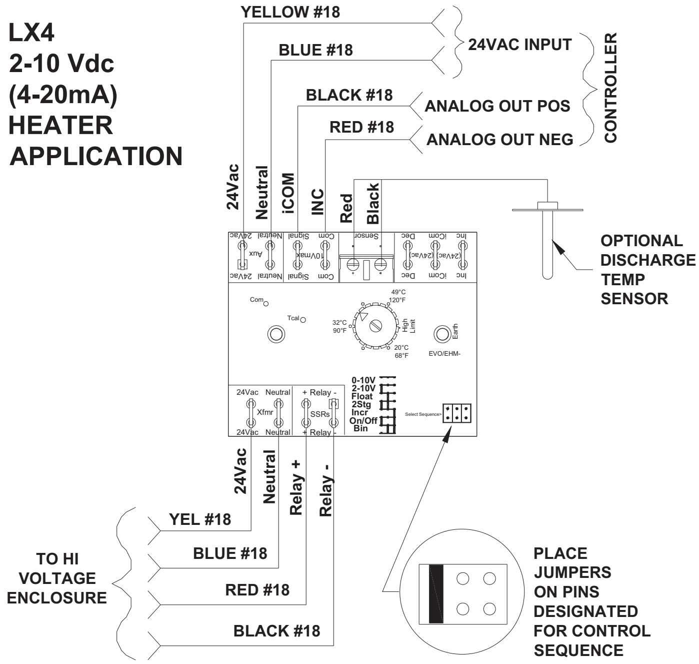


Fig. 19 — LX4 Application Wiring

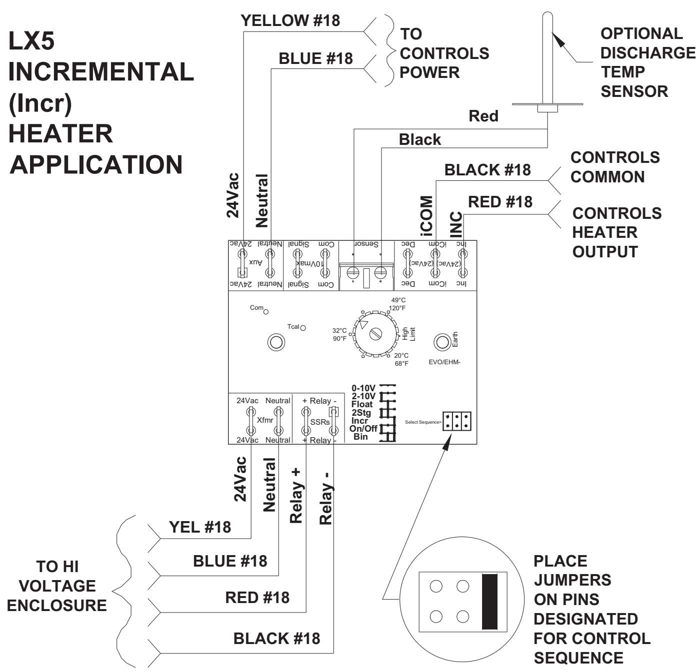


Fig. 20 — LX5 Application Wiring

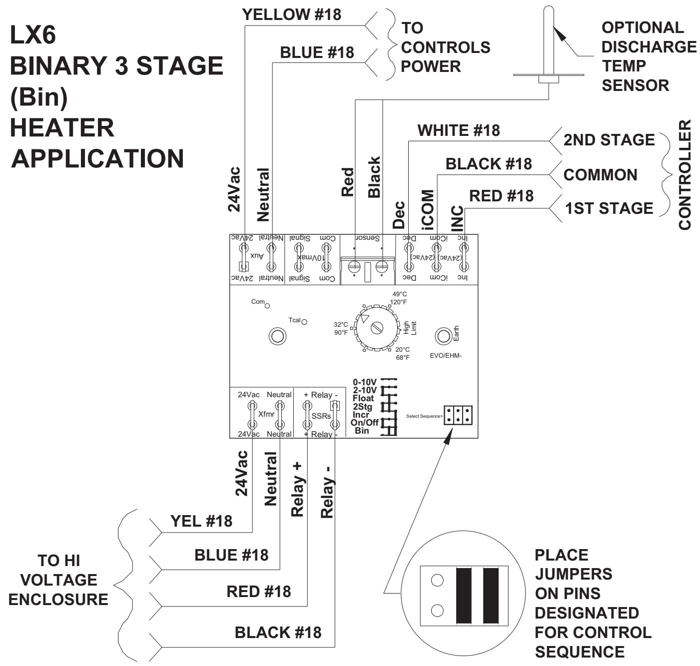


Fig. 21 — LX6 Application Wiring

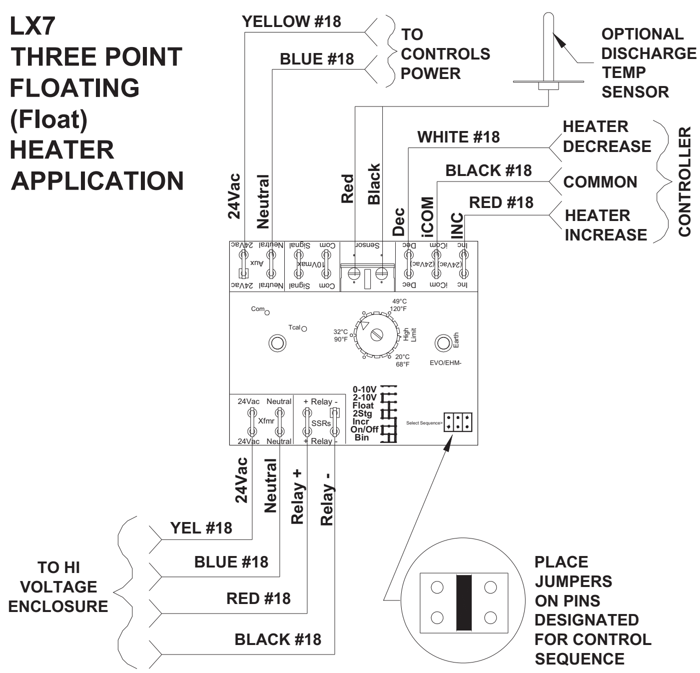
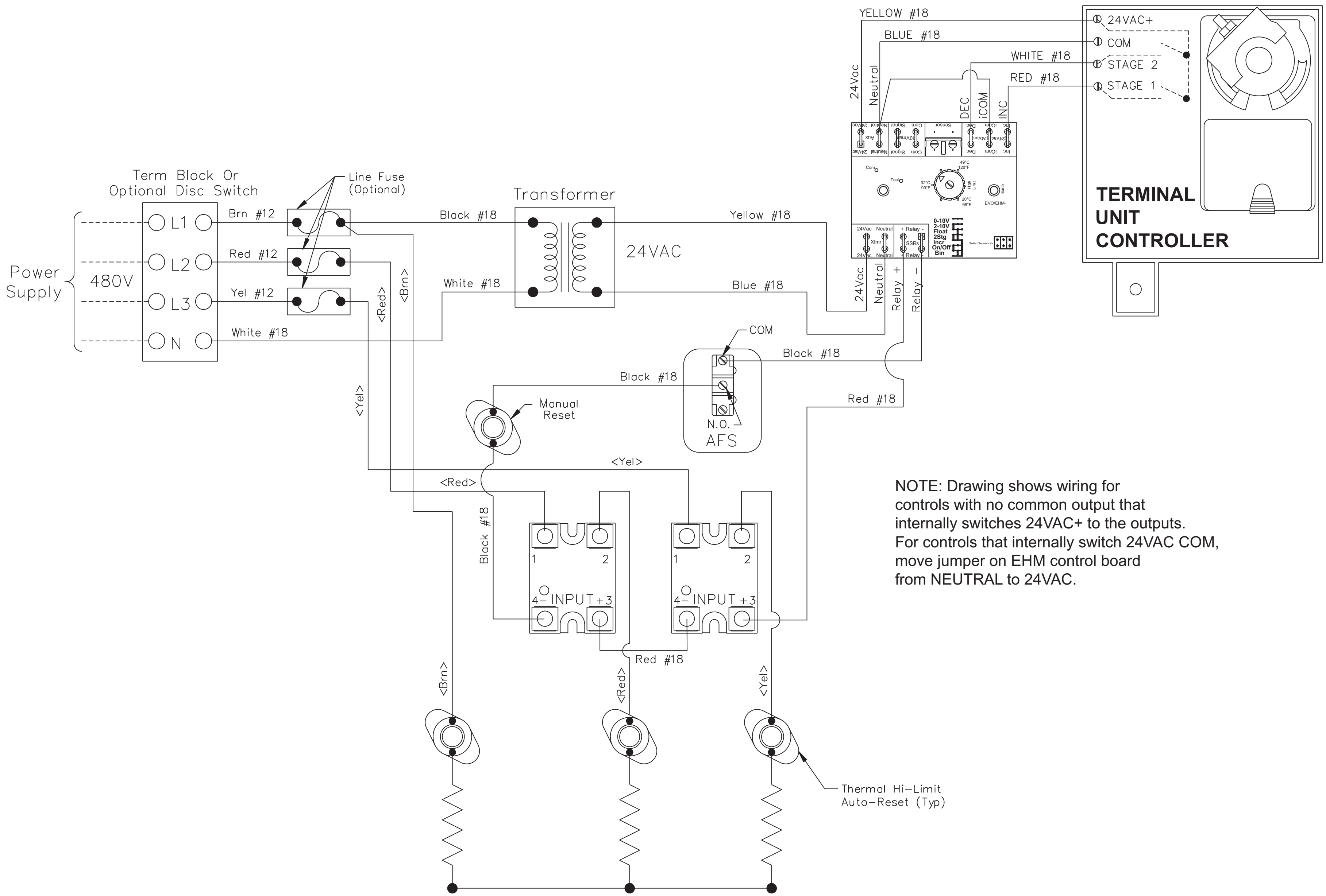


Fig. 22 — LX7 Application Wiring



NOTE: Drawing shows wiring for controls with no common output that internally switches 24VAC+ to the outputs. For controls that internally switch 24VAC COM, move jumper on EHM control board from NEUTRAL to 24VAC.

Fig. 23 — Sample Proportional SSR Heat Schematic

DISCHARGE TEMPERATURE SETPOINT

Proportional SSR Heat comes with a discharge temperature setpoint (DTS) option. This option allows a maximum temperature to be set at the board to prevent overheating of discharge air. When the unit receives a signal to start heating, the board will take an initial temperature reading and modulate heat from that point to the maximum temperature. For example, if a thermostat requires only a 10% heating output of air that was initially 60°F and has a maximum temperature setting of 90°F, the EHM will modulate the heater's output temperature to 63°F (the additional 3 degrees calculated from (90 – 60) x 10%). This allows heaters to be sized for morning warm-up in the winter and still comfortably operate on those days when the inlet temperatures are slightly warmer.

The discharge temperature sensor comes with a 9 ft cable for mounting in the downstream ductwork. The sensor should be mounted a minimum of 3-in. from the discharge of the unit and centered in the side of the ductwork. Avoid installing the sensor near an elbow, take off, or transition. The sensor can be mounted by drilling a 1/2-in. hole into the ductwork, inserting the sensor, and securing it with 2 sheet metal screws. The sensor is 6-in. long, and the tip should not touch any part of the ductwork.

Neither the jumper settings nor the controls wiring needs to be changed when this option is installed. The EHM control board will detect if a sensor has been connected, and it will adjust the control function accordingly. The sensor wires are connected to the screw terminals at the Sensor (Fig. 15, item 6) location on the EHM. The connection at this termination is not polar sensitive and the two wires may be switched with no effect.

The desired discharge temperature is set by rotating the discharge temperature set point dial arrow to the maximum outlet temperature desired. To fine-tune the discharge temperature set point, connect the positive and negative leads of a multimeter to Tcal and Com (Fig. 15, item 7), respectively, on the EHM. Then place a jumper between the two screw heads on the sensor termination. Rotate the discharge temperature set point dial until the desired voltage per temperature is obtained. See Table 10. After the voltage is obtained, the EHM board must be reset. To reset the board, remove the jumpers and then place back in correct position.

It should be noted that the *ASHRAE Fundamentals Handbook* (Chapter 31) states that discharging air at a temperature more than 15°F above the room (90°F in a 75°F room) will likely result in significant unwanted air temperature stratification.

It is recommended that heater output be ramped or staged when switching from cooling to heating modes. On initial call for maximum or near maximum heat, from cooling mode, the heater may overshoot the desired temperature by up to 20°F for 10 to 20 seconds (on oversized heaters). As the EHM begins modulating heater output, the discharge temperature will quickly drop to the desired set point. Temperatures within ±2°F of the desired setpoint are reached within 90 seconds with oversized heaters.

Table 10 — DTS Voltage per Temperature

TEMP (°F)	dc VOLT	TEMP (°F)	dc VOLT	TEMP (°F)	dc VOLT	TEMP (°F)	dc VOLT	TEMP (°F)	dc VOLT
68	0.00	**80**	0.58	**90**	0.95	**100**	1.23	**110**	1.44
69	0.05	**81**	0.62	**91**	0.98	**101**	1.25	**111**	1.46
70	0.10	**82**	0.66	**92**	1.01	**102**	1.27	**112**	1.48
71	0.15	**83**	0.70	**93**	1.04	**103**	1.30	**113**	1.50
72	0.20	**84**	0.74	**94**	1.07	**104**	1.32	**114**	1.51
73	0.26	**85**	0.77	**95**	1.10	**105**	1.34	**115**	1.53
74	0.30	**86**	0.81	**96**	1.12	**106**	1.36	**116**	1.55
75	0.35	**87**	0.85	**97**	1.15	**107**	1.38	**117**	1.56
76	0.40	**88**	0.88	**98**	1.18	**108**	1.40	**118**	1.58
77	0.44	**89**	0.91	**99**	1.20	**109**	1.42	**119**	1.60
78	0.49							**120**	1.61
79	0.53								

Troubleshooting Proportional SSR Heat

PROBLEM: NO HEAT WHEN CALLED FOR

1. Confirm the jumper setting is correct for the input given.
   a. If the controls are outputting vdc, the jumper should be set as shown in Table 9 on page 19 for applications LX3 and LX4.
   b. If the controls are outputting 24 vac, the jumper setting should be set as shown in Table 9 on page 19 for applications LX1, LX2, LX5, LX6, and LX7. See also Fig. 16-22.
2. Check that wiring to the EHM is correct.
   a. If using applications LX3 and LX4, confirm the positive vdc connection is wired to the "Signal" terminal, and the negative vdc connection is wired to the "Com" terminal. See Fig. 15.
   b. If using 24vac, confirm the wires are terminated correctly at (5) with a connection at "iCom". See Fig. 15. If an "Aux" terminal (Fig. 15, item 2) on the EHM has been jumpered to "iCom", make sure that the opposite 24vac input is output at the controls (see Fig. 23 for one example).
3. Check that airflow is above minimum. Terminal units with electric heat come with pressure switches to ensure that heater elements have airflow over them. See catalog for minimum airflow required for specific size terminal units. Fan boxes must have minimum downstream static of 0.1 inch.
4. Check that discharge temperature setpoint is not below the airflow temperature.
5. Check relay wiring. Solid state relays are polarity sensitive. The wire from "+" on the EHM control board should be terminated on "+3" VDC terminal of the relay. The wire from "–" on the EHM control board should be terminated on "4–" VDC terminal of the relay. If two relays are used in the heater, the relays are daisy-chained from "4–" to "+3" together. See Fig. 23 for one example.

PROBLEM: DISCHARGE TEMPERATURE NOT AT TEMPERATURE SETTING

1. Check that wires from sensor are stripped and terminated in EHM control terminals.
2. Check that wires from controls are terminated at the correct point on EHM board. Increase or stage 1 signal should be terminated at "Inc". Decrease or stage 2 signal should be terminated at "Dec".
3. Check volt setting. See "Sample Proportional SSR Heat Schematic" on page 24 and Table 10 on page 25.
4. Check sensor placement. Make sure that sensor is well placed in the side of the duct, vertically centered and at least 36-in. from discharge. Sensor tip should not touch inside of ductwork. If available, remove the discharge sensor and measure the temperature of the air using a temperature probe and compare it to an average reading of the discharge air of the diffusers in that zone. If the sensor is located near an elbow, duct take off, or transition, several locations may need to be tested to find a location that provides an accurate reading.
5. Try staging or ramping of output on oversized heaters. When controls call for full heat from cooling mode, if heaters are too large and heating times are small, the heater output may be over setpoint. Staging or ramping of output over a 60-second interval will provide smooth transition. If only one output of heat is available from controls, application LX5 will proportionally ramp heat output from 0 to 100% over a 4-minute 15-second span.