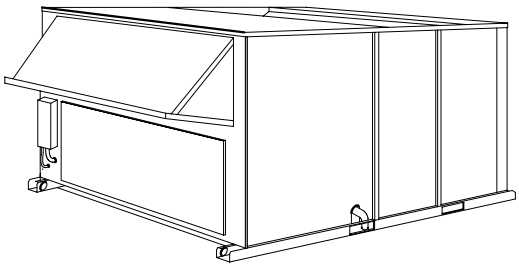
Installation Instructions

PAH Series – 3 Phase
12–1/2 to 15 Ton



PACKAGED ROOFTOP ELECTRIC COOLING/ELECTRIC HEATING UNITS

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CONTENTS

SAFETY CONSIDERATIONS

Installation and servicing of this equipment can be hazardous due to mechanical and electrical components. Only trained and qualified personnel should install, repair, or service this equipment.

Untrained personnel can perform basic maintenance functions such as cleaning and replacing air filters. All other operations must be performed by trained service personnel. When working on this equipment, observe precautions in the literature, on tags, and on labels attached to or shipped with the unit and other safety precautions that may apply.

Follow all safety codes. Installation must be in compliance with local and national building codes. Wear safety glasses, protective clothing, and work gloves. Have fire extinguisher available. Read these instructions thoroughly and follow all warnings or cautions included in literature and attached to the unit.

Recognize safety information. This is the safety-alert symbol ⚠. When you see this symbol 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 serious injury or death. **WARNING** signifies a hazard which **could** result in serious 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.

These instructions cover minimum requirements and conform to existing national standards and safety codes. In some instances, these instructions exceed certain local codes and ordinances, especially those that may not have kept up with changing residential construction practices. We require these instructions as a minimum for a safe installation.

INSTALLATION

IMPORTANT: Units have high ambient operating limits. If limits are exceeded, the unit will automatically lock the compressor out of operation. Manual reset will be required to restart the compressor.

⚠ WARNING

ELECTRICAL SHOCK HAZARD

Failure to follow this warning could result in personal injury or death.

Before installing or servicing system, always turn off power supply to unit and install lockout tag. There may be more than one disconnect switch. Turn off accessory heater power switch if applicable.

PROVIDE UNIT SUPPORT

Roofcurb

Assemble and install accessory roof curb or horizontal supply roof curb in accordance with instructions shipped with the accessory. Install insulation, cant strips, roofing, and counter flashing as shown. Ductwork can be secured to roof curb before unit is set in place.

IMPORTANT: The gasketing of the unit to the roof curb or horizontal supply roof curb is critical for a leakproof seal. Install gasket supplied with the roof curb or horizontal supply roof curb. Improperly applied gasket can result in air leaks and poor unit performance.

Roof curb must be level. This is necessary to permit unit drain to function properly. Unit leveling tolerance is $\pm\ ^1/_{16}$ in. per linear ft in any direction. Refer to Accessory Roof Curb or Horizontal Supply Roof Curb Installation Instructions for additional information as required.

Alternate Unit Support

When the curb or adapter cannot be used, support unit with sleeper rails using unit curb or adapter support area. If sleeper rails cannot be used, support long sides of unit with a minimum of 3 equally spaced 4-in. x 4-in. pads on each side.

RIG AND PLACE UNIT

Inspect unit for transportation damage. File any claim with transportation agency. Keep unit upright, and do not drop. Use spreader bars over unit to prevent sling or cable damage. Rollers may be used to move unit across a roof. Level by using unit frame as a reference; leveling tolerance is $\pm\ ^1/_{16}$ in. per linear ft in any direction. See Fig. 2 for additional information. Unit weight is shown in Table 1.

Four lifting holes are provided in ends of unit base rails as shown in Fig. 2. Refer to rigging instructions on unit.

Positioning

Provide clearance around and above unit for airflow, safety, and service access (Fig. 3).

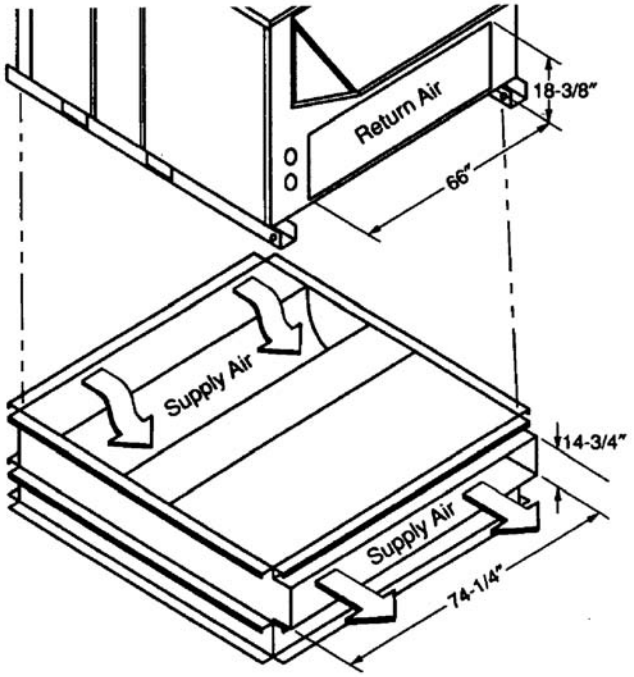
Do not install unit in an indoor location. Do not locate air inlets near exhaust vents or other sources of contaminated air.

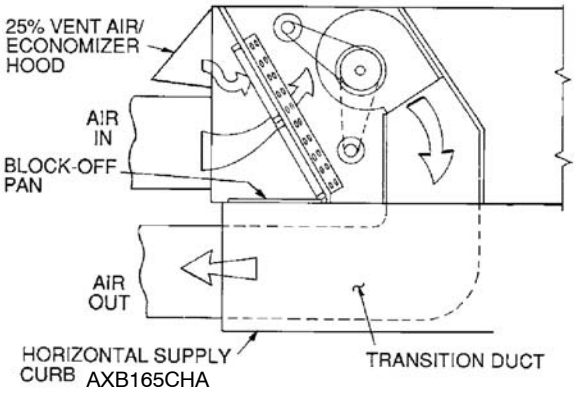
Although unit is weatherproof, guard against water from higher level runoff and overhangs.

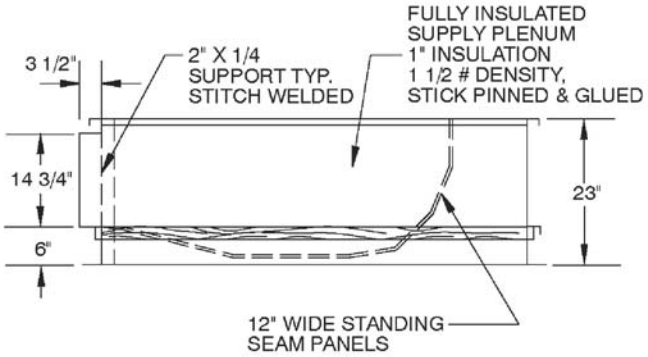
Roof Mount

Check building codes for weight distribution requirements.

FIGURE 1 | **Horizontal Supply/ Return Adapter Installation -- PAH155-180**



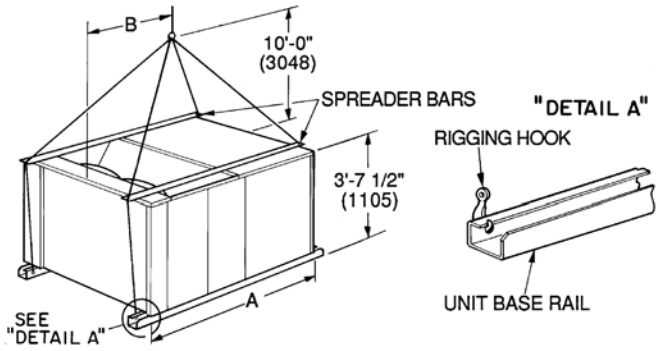




NOTE: AXB165CHA is a fully factory preassembled horizontal adapter and includes an insulated transition duct. The pressure drop through the adapter curb is negligible.
For horizontal return applications: The power exhaust and barometric relief dampers must be installed in the return air duct.

ACCESSORY PACKAGE NO.	CURB HEIGHT	DESCRIPTION
AXB165CHA	1′-11″ (584)	Pre-Assembled, Horizontal Adapter Roof Curb

FIGURE 2 | **Rigging Details**



NOTES:
1. Dimensions in ( ) are in millimeters.
2. Refer to Fig. 4 for unit operating weights.
3. Remove boards at ends of unit and runners prior to rigging.
4. Rig by inserting hooks into unit base rails as shown. Use corner post from packaging to protect coil from damage. Use bumper boards for spreader bars.
5. Weights do not include optional economizer. Add 90 lb for economizer weight.
6. Add 75 lb (34 kg) for crating on PAH155 and 180 units.
7. Add 150 lb (68 kg) for copper condenser coil. Add 280 lb (127 kg) for copper condenser and evaporator coils.

UNIT PAH	MAXIMUM SHIPPING WEIGHT		DIMENSIONS			
			A		B	
	lb	kg	ft-in.	mm	ft-in.	mm
155	1625	737	6-11 1/2	2121	4- 0	1219
180	1700	771	6-11 1/2	2121	3-10	1168

FIGURE 3 | **Base Unit Dimensions PAH155 - 180**

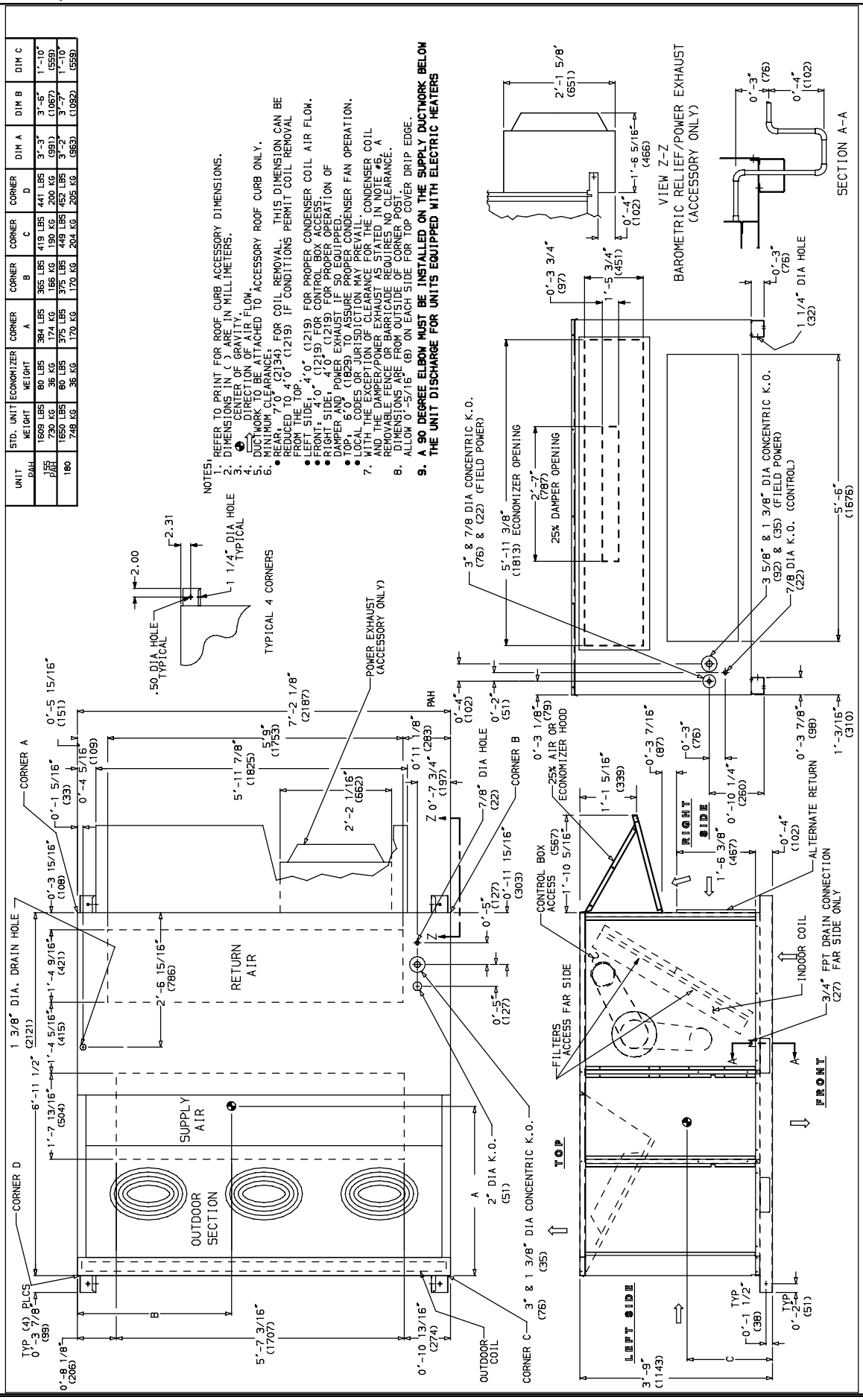


Table 1 - Physical Data - PAH155-180

UNIT PAH		155	180
NOMINAL CAPACITY (tons)		12	15
OPERATING WEIGHT (lb)Al*		1575	1650
Cu*		1855	1930
Economizer		90	90
Roof Curb†		200	200
COMPRESSOR Quantity...Model (Ckt 1, Ckt 2)		2...ZR72KC, 1...ZR57KC	1...ZR94KC, 1...ZR72KC
Number of Refrigerant Circuits		2	2
Crankcase Heater Watts		70	70
Loading (% of Full Capacity)		0, 53, 100	0, 60, 100
Oil (oz) (Ckt 1, Ckt 2)		60, 60	85, 60
REFRIGERANT TYPE		R-22	
Expansion Device		TXV	
Operating Charge (lb)**			
Circuit 1		20.7	19.5
Circuit 2		13.4	13.45
CONDENSER COIL		Cross-Hatched $^{3}/_{8}$-in. Copper Tubes, Aluminum Lanced or Copper Plate Fins	
Rows...Fins/in.		4...15	4...15
Total Face Area (sq ft)		21.7	21.7
CONDENSER FAN		Propeller Type	
Nominal Cfm		10,500	10,500
Quantity...Diameter (in.)		3...22	3...22
Motor Hp...Rpm		$^{1}/_{2}$...1050	$^{1}/_{2}$...1050
Watts Input (Total)		1100	1100
EVAPORATOR COIL		Cross-Hatched $^{3}/_{8}$-in. Copper Tubes, Aluminum Lanced Face Split	
Rows...Fins/in.		4...15	4...15
Total Face Area (sq ft)		17.5	17.5
EVAPORATOR FAN		Centrifugal Type	
Quantity...Size (in.)		2...12 x 12	2...12 x 12
Type Drive		Belt	Belt
Nominal Cfm		5200	6000
Std Motor Hp		2.9	5
Opt Motor Hp		3.7	—
Motor Nominal Rpm		1725	1745
Std Maximum Continuous Bhp		3.13	6.13
Opt Maximum Continuous Bhp		4.26	N/A
Motor Frame Size		56H	184T
Fan Rpm Range	Low-Medium Static	895-1147	873-1021
	High Static	1040-1315	1025-1200
Motor Bearing Type		Ball	Ball
Maximum Allowable Rpm		1,550	1,550
Motor Pulley Pitch Dia.	Low-Medium Static	3.1/4.1	4.9/5.9
	High Static	3.7/4.7	4.9/5.9
Nominal Motor Shaft Diameter (in.)		$^{7}/_{8}$	$1^{1}/_{8}$
Fan Pulley Pitch Diameter (in.)	Low-Medium Static	6.0	9.4
	High Static	6.0	8.0
Nominal Fan Shaft Diameter (in.)		$1^{3}/_{16}$	$1^{7}/_{16}$
Belt, Quantity...Type...Length (in.)	Low-Medium Static	1...BX...45	1...BX...50
	High Static	1...BX...45	1...BX...48
Pulley Center Line Distance (in.)		14.5-16.0	13.3-14.8
Speed Change per Full Turn of Movable	Low-Medium Static	45	37
Pulley Flange (Rpm)	High Static	45	44
Movable Pulley Maximum Full Turns			
From Closed Position		6††	4††
Factory Speed		3.5	3.5
Factory Speed Setting (Rpm)	Low-Medium Static	987	965
	High Static	1155	1134

Table 1 - Physical Data - PAH155-180

HIGH-PRESSURE SWITCH (psig)		
Cutout		426
Reset (Auto.)		320
LOW-PRESSURE SWITCH (psig)		
Cutout		27
Reset (Auto.)		44
FREEZE PROTECTION THERMOSTAT (F)		
Opens		30 ± 5
Closes		45 ± 5
OUTDOOR-AIR INLET SCREENS		Cleanable
Quantity...Size (in.)		2...20 x 25 x 1 1...20 x 20 x 1
RETURN-AIR FILTERS		Throwaway
Quantity...Size (in.)		4...20 x 20 x 2 4...16 x 20 x 2

LEGEND

Al — Aluminum
Bhp — Brake Horsepower
Cu — Copper
TXV — Thermostatic Expansion Valve

*Condenser coil material.
†Weight of 14-in. roof curb.
**Circuit 1 uses the lower portion of condenser coil and lower portion of evaporator coils, and Circuit 2 uses the upper portion of both coils.
††Due to belt and pulley, moveable pulley cannot be set to 0 to $1^{1}/_{2}$ turns open.

FIELD FABRICATE DUCTWORK

Secure all ducts to building structure. Use flexible duct connectors between unit and ducts as required. Insulate and weatherproof all external ductwork, joints, and roof openings with counter flashing and mastic in accordance with applicable codes.

Ducts passing through an unconditioned space must be insulated and covered with a vapor barrier.

The PAH units with electric heat require a 1-in. clearance for the first 24 in. of ductwork.

Outlet grilles must not lie directly below unit discharge.

NOTE: A 90-degree elbow must be provided in the ductwork to comply with UL (Underwriters Laboratories) codes for use with electric heat.

⚠ WARNING

PERSONAL INJURY OR DEATH HAZARD

Failure to follow this warning could result in personal injury or death.

For vertical supply and return units, tools or parts could drop into ductwork and cause an injury. Install a 90-degree turn in the return ductwork between the unit and the conditioned space. If a 90-degree elbow cannot be installed, then a grille of sufficient strength and density should be installed to prevent objects from falling into the conditioned space. Due to electric heater, supply duct will require 90-degree elbow.

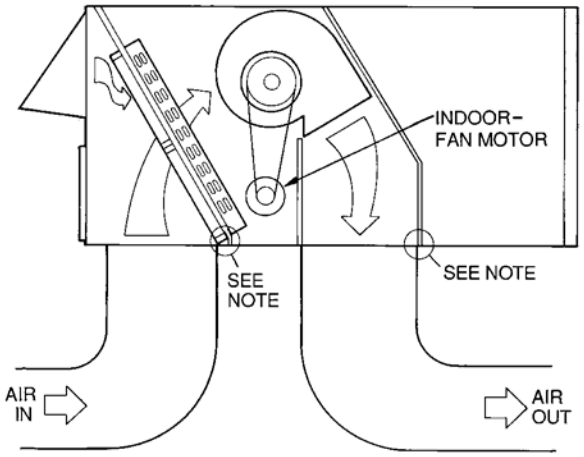
MAKE UNIT DUCT CONNECTIONS

Unit is shipped for thru-the-bottom duct connections. Ductwork openings are shown in Fig. 4. Field-fabricated concentric ductwork may be connected as shown in Fig. 5 and 6. Attach all ductwork to roof curb and roof curb basepans. Refer to installation instructions shipped with accessory roof curb for more information.

TRAP CONDENSATE DRAIN

See Fig. 3 and 7 for drain location. Plug is provided in drain hole and must be removed when unit is operating. One $^3/_4$-in. half-coupling is provided inside unit evaporator section for condensate drain connection. An $8^1/_2$ in. x $^3/_4$-in. diameter nipple and a 2-in. x $^3/_4$-in. diameter pipe nipple are coupled to standard $^3/_4$-in. diameter elbows to provide a straight path down through holes in unit base rails (see Fig. 8). A trap at least 4-in. deep must be used.

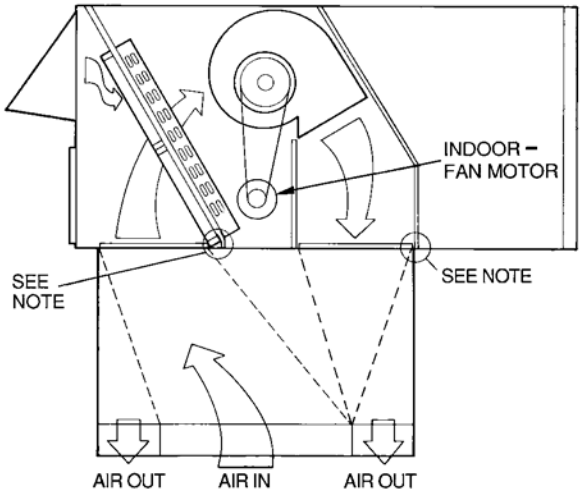
FIGURE 4 Air Distribution , Thru-the-Bottom



NOTE: Do not drill in this area, as damage to basepan may result in water leak.

(PAH180 SHOWN)

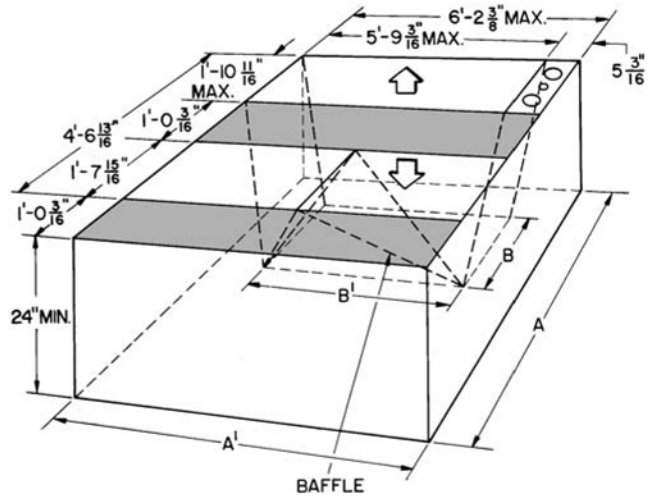
FIGURE 5 Concentric Duct Air Distribution



NOTE: Do not drill in this area, as damage to basepan may result in water leak.

(PAH180 SHOWN)

FIGURE 6 Concentric Duct Details



Shaded area indicates block-off panels.

NOTE: Dimensions A, A′ and B, B′ are obtained from field-supplied ceiling diffuser.

FIGURE 7 Condensate Drain Details (PAH155 Shown)

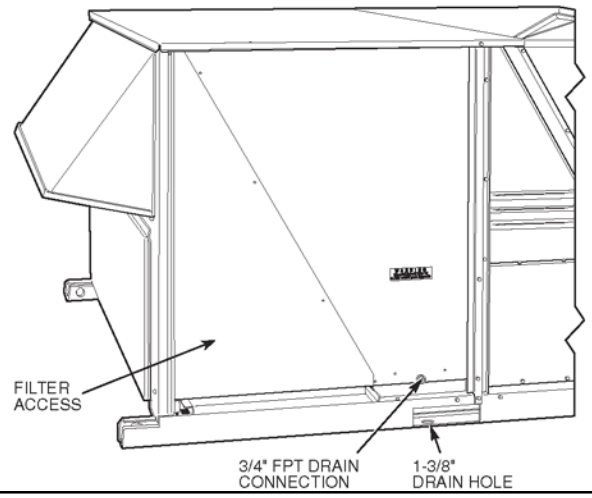
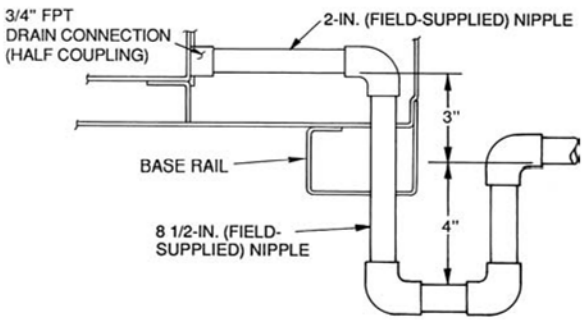


FIGURE 8 Condensate Drain Piping Details



Make Electrical Connections

Field Power Supply

Unit is factory wired for voltage shown on nameplate.

When installing units, provide a disconnect, per NEC (National Electrical Code) requirements, of adequate size (Table 2). Electrical heater data is shown in Table 3.

All field wiring must comply with NEC and local requirements.

Route power lines through control box access panel or unit basepan (Fig. 3) to connections as shown on unit wiring diagram and Fig. 9.

Operating voltage to compressor must be within voltage range indicated on unit nameplate. On 3-phase units, voltages between phases must be balanced within 2% and the current must be balanced within 10%. See Table 2, Note 2.

IMPORTANT: If the supply voltage phase imbalance is more than 2%, contact your local electric utility company immediately.

Unit failure as a result of operation on improper line voltage or excessive phase imbalance constitutes abuse and may cause damage to electrical components.

Field Control Wiring

Install an approved accessory thermostat assembly according to the installation instructions included with accessory. Locate thermostat assembly on a solid interior wall in the conditioned space to sense average temperature.

Route thermostat cable or equivalent single leads of colored wire from subbase terminals through conduit in unit to low-voltage connections as shown on unit label wiring diagram and in Fig. 10.

NOTE: For wire runs up to 50 ft, use no. 18 AWG (American Wire Gage) insulated wire (35 C minimum). For 50 to 75 ft, use no. 16 AWG insulated wire (35 C minimum). For over 75 ft, use no. 14 AWG insulated wire (35 C minimum). All wire larger than no. 18 AWG cannot be directly connected at the thermostat and will require a junction box and splice at the thermostat.

Set heat anticipator settings as indicated in Table 4. Settings may be changed slightly to provide a greater degree of comfort for a particular installation.

FIGURE 9 Field Power Wiring Connections

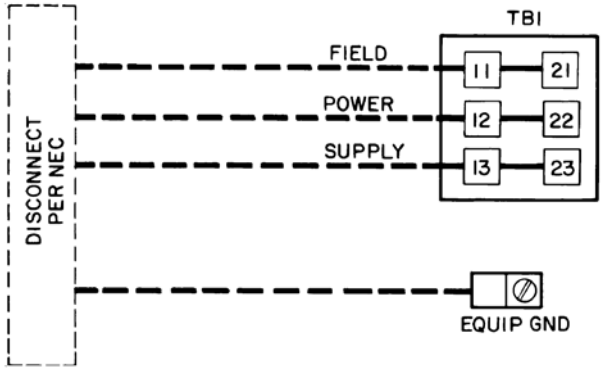


FIGURE 10 Field Control Thermostat Wiring

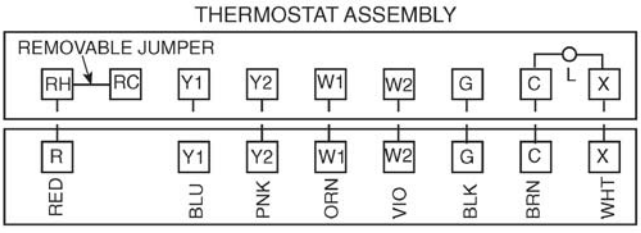


Table 2 — Electrical Data

UNIT PAH	Nominal Voltage (3 Ph 60 Hz)	Voltage Range		Compressor No. 1		Compressor No. 2		OFM			IFM		Power Exhaust		Electric Heat		Power Supply	
		Min	Max	RLA	LRA	RLA	LRA	Qty	Hp	FLA (ea)	Hp	FLA	FLA	LRA	kW	FLA	MCA	MOCP†
155 (Standard IFM)	208/230	187	253	20.7	156	20.7	156	3	0.5	1.7	2.9	8.8/8.4	—	—	—	—	60/60	80/80
													4.6	18.8	—	—	64/63	80/80
													—	—	14/19	39/45	60/67	80/80
													4.6	18.8	14/19	39/45	66/73	80/80
													—	—	26/34	71/82	100/113	100/125
													4.6	18.8	26/34	71/82	106/119	110/125
													—	—	42/56**	117/135	157/146	175/175
													4.6	18.8	42/56**	117/135	163/151	175/175
	460	414	508	10	75	10	75	3	0.5	0.8	2.9	4.2	—	—	—	—	29	35
													2.3	6.0	—	—	31	40
													—	—	15	18	29	35
													2.3	6.0	15	18	31	40
													—	—	32	39	54	60
													2.3	6.0	32	39	57	60
													—	—	55**	66	71	80
													2.3	6.0	55**	66	74	80
155 (Optional IFM)	208/230	187	253	20.7	156	20.7	156	3	0.5	1.7	3.7	10.5/11.0	—	—	—	—	62/63	80/80
													4.6	18.8	—	—	67/67	80/80
													—	—	14/19	39/45	62/70	80/80
													4.6	18.8	14/19	39/45	68/76	80/80
													—	—	26/34	71/82	102/116	110/125
													4.6	18.8	26/34	71/82	108/122	110/125
													—	—	42/56**	117/135	159/149	175/175
													4.6	18.8	42/56**	117/135	165/155	175/175
	460	414	506	10	75	10	75	3	0.5	0.8	3.7	4.8	—	—	—	—	30	35
													2.3	6.0	—	—	32	40
													—	—	15	18	30	35
													2.3	6.0	15	18	32	40
													—	—	32	39	55	60
													2.3	6.0	32	39	58	60
													—	—	55**	66	72	80
													2.3	6.0	55**	66	75	80
180	208/230	187	253	32.1	195	20.7	156	3	0.5	1.7	5.0	15.8/15.8	—	—	—	—	82/82	110/110
													4.6	18.8	—	—	86/86	110/110
													—	—	26/34	71/82	109/122	110/125
													4.6	18.8	26/34	71/82	114/128	125/150
													—	—	42/56	117/135	166/155	175/175
													4.6	18.8	42/56	117/135	172/161	175/175
													—	—	56/75**	156/180	176/200	200/225
													4.6	18.8	56/75**	156/180	182/206	200/225
	460	414	508	16.4	95	10	70	3	0.5	0.8	5.0	7.9	—	—	—	—	41	50
													2.3	6.0	—	—	43	50
													—	—	32	39	59	60
													2.3	6.0	32	39	62	70
													—	—	55	66	76	90
													2.3	6.0	55	66	79	90
													—	—	80**	96	106	125
													2.3	6.0	80**	96	109	125

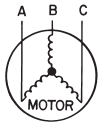
See LEGEND on next page.

LEGEND
FLA – Full Load Amps
HACR – Heating, Air Conditioning and Refrigeration
IFM – Indoor–Fan Motor
LRA – Locked Rotor Amps
MCA – Minimum Circuit Amps
MOCP – Maximum Overcurrent Protection
NEC – National Electrical Code
OFM – Outdoor–Fan Motor
RLA – Rated Load Amps

1. In compliance with NEC requirements for multimotor and combination load equipment (refer to NEC Articles 430 and 440), the overcurrent protective device for the unit shall be fuse or HACR breaker. Canadian units may be fuse or circuit breaker.
2. **Unbalanced 3-Phase Supply Voltage**
   Never operate a motor where a phase imbalance in supply voltage is greater than 2%. Use the following formula to determine the percent voltage imbalance.

$$\% \text{ Voltage Imbalance} = 100 \times \frac{\text{max voltage deviation from average voltage}}{\text{average voltage}}$$

Example: Supply voltage is 460-3-60



AB = 452 v
BC = 464 v
AC = 455 v

$$\text{Average Voltage} = \frac{452 + 464 + 455}{3} = \frac{1371}{3} = 457$$

Determine maximum deviation from average voltage.
(AB) 457 – 452 = 5 v
(BC) 464 – 457 = 7 v
(AC) 457 – 455 = 2 v

Maximum deviation is 7 v.

Determine percent of voltage imbalance.

$$\% \text{ Voltage Imbalance} = 100 \times \frac{7}{457} = 1.53\%$$

This amount of phase imbalance is satisfactory as it is below the maximum allowable 2%.

IMPORTANT: If the supply voltage phase imbalance is more than 2%, contact your local electric utility company immediately.

Table 3 — Electric Resistance Heater Data

UNIT PAH	HEATER kW Unit Voltages 208	230	240	460	480	HEATER STAGES	% HEAT PER STAGE	MAXIMUM STAGES*	MINIMUM Heating Cfm Cfm	L/s	HEATER AMPS 208	230	240	460	480
155	14	17	19	14	15	1	100	1	3750	1770	39.3	43.4	45.3	17.2	17.9
	26	31	34	30	32	2	50/50	2			71.3	78.9	82.3	37.3	39.0
	42	52	56	50	55	2	33/67	3			117.0	129.4	135.0	63.3	66.1
180	26	31	34	30	32	2	50/50	2	3750	1770	71.3	78.8	82.3	37.3	39.0
	42	52	56	50	55	2	33/67	3			117.0	129.4	135.0	63.3	66.1
	56	69	75	73	80	2	50/50	4			155.9	172.4	179.9	92.0	96.0

*Maximum number of stages using accessory low-ambient kit or head pressure control device and low-ambient kit.
NOTE: Heaters are rated at 240 and 480 v.

Table 4 — Heat Anticipator Settings

UNIT PAH	UNIT VOLTAGES	kW*	STAGE 1	STAGE 2
155, 180	208/230-3-60	14/19	.40	—
		26/34	.40	.66
		42/56	.66	.40
		56/75	.66	.66
	460-3-60	15	.40	—
		32	.40	.40
		55	.40	.66
		80	.66	.66

*Heater kW is based on heater voltage of 208 v, 240 v, or 480 v.

Optional Non-Fused Disconnect

On units with the optional non-fused disconnect, incoming power will be wired into the disconnect switch. Refer to Fig. 11 for wiring for 100 and 200 amp disconnect switches. Units with an MOCP (maximum overcurrent protection) under 100 will use the 100 amp disconnect switch. Units with an MOCP over 100 will use the 200 amp disconnect switch. Refer to the applicable disconnect wiring diagram.

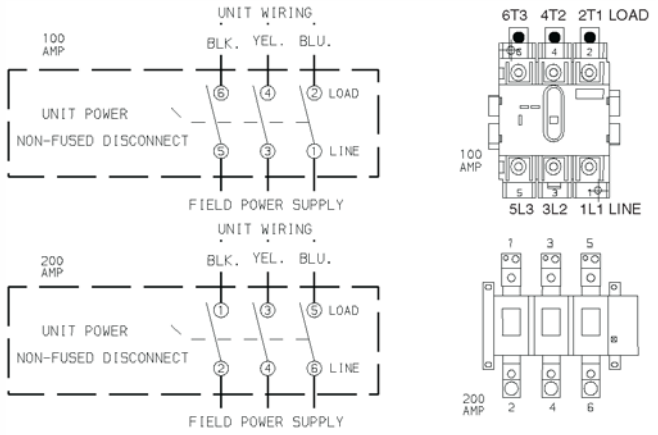
To prevent breakage during shipping, the disconnect handle and shaft are shipped and packaged inside the unit control box. Install the disconnect handle before unit operation. To install the handle and shaft, perform the following procedure:

1. Open the control box door and remove the handle and shaft from shipping location.
2. Loosen the Allen bolt located on the disconnect switch. The bolt is located on the square hole and is used to hold the shaft in place. The shaft cannot be inserted until the Allen bolt is moved.
3. Insert the disconnect shaft into the square hole on the disconnect switch. The end of the shaft is specially cut and the shaft can only be inserted in the correct orientation.
4. Tighten the Allen bolt to lock the shaft into position.
5. Close the control box door.
6. Attach the handle to the external access door with the two screws provided. When the handle is in the ON position, the handle will be vertical. When the handle is in the OFF position, the handle will be horizontal.
7. Turn the handle to the OFF position and close the

door. The handle should fit over the end of the shaft when the door is closed.

8. The handle must be in the OFF position to open the control box door.

FIGURE 11 **Optional Non-Fused Disconnect Wiring**



NOTE: The disconnect takes the place of TB-1 as shown on the unit wiring diagram label and the component arrangement label.

Optional Convenience Outlet

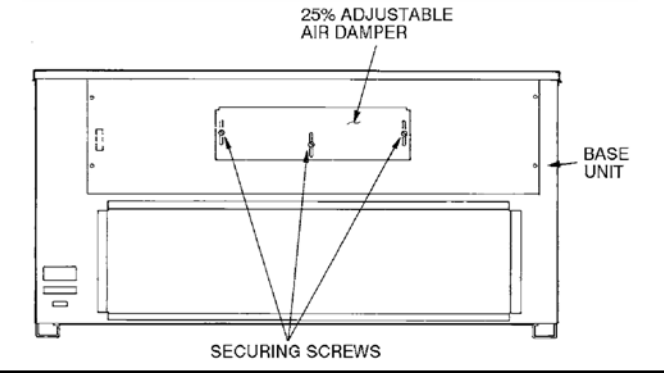
On units with optional convenience outlet, a 115-v GFI (ground fault interrupt) convenience outlet receptacle is provided for field wiring. Field wiring should be run through the $^{7}/_{8}$-in. knockout provided in the basepan near the return air opening.

MAKE OUTDOOR-AIR INLET ADJUSTMENTS

Manual Outdoor-Air Damper

All units (except those equipped with a factory-installed economizer) have a manual outdoor-air damper to provide ventilation air. Damper can be preset to admit up to 25% outdoor air into return-air compartment. To adjust, loosen securing screws and move damper to desired setting. Then retighten screws to secure damper (Fig. 12).

FIGURE 12 **25% Outdoor Air Section Details**



INSTALL OUTDOOR-AIR HOOD

The outdoor-air hood is common to 25% air ventilation and economizer. If economizer is factory installed, all electrical connections have been made and adjusted at the factory. Assemble and install hood in the field.

IMPORTANT:If the unit is equipped with the optional economizer component, move the outdoor-air temperature sensor prior to installing the outdoor-air hood. See the Optional economizer section for more information.

NOTE: The hood top panel, upper and lower filter retainers, hood drain pan, baffle (size 180) and filter support bracket are secured opposite the outdoor coil end of the unit. The screens, hood side panels, remaining section of filter support bracket, seal strip, and all other hardware are in a package located inside the return-air filter access panel (Fig. 13).

1. Attach seal strip to upper filter retainer. See Fig. 14.
2. Assemble hood top panel, side panels, upper filter retainer, and drain pan (see Fig. 15).
3. Secure lower filter retainer and support bracket to unit. Leave screws loose on size 180 units.
4. Slide baffle (size 180) behind lower filter retainer and tighten screws.
5. Loosen sheet metal screws for top panel of base unit located above outdoor-air inlet opening, and remove screws for hood side panels located on the sides of the outdoor-air inlet opening.
6. Match notches in hood top panel to unit top panel screws. Insert hood flange between top panel flange and unit. Tighten screws.
7. Hold hood side panel flanges flat against unit, and install screws removed in Step 5.
8. Insert outdoor-air inlet screens and spacer in channel created by lower filter retainer and support bracket.
9. Attach remaining section of filter support bracket.

FIGURE 13 **Outdoor Air Hood Component Location**

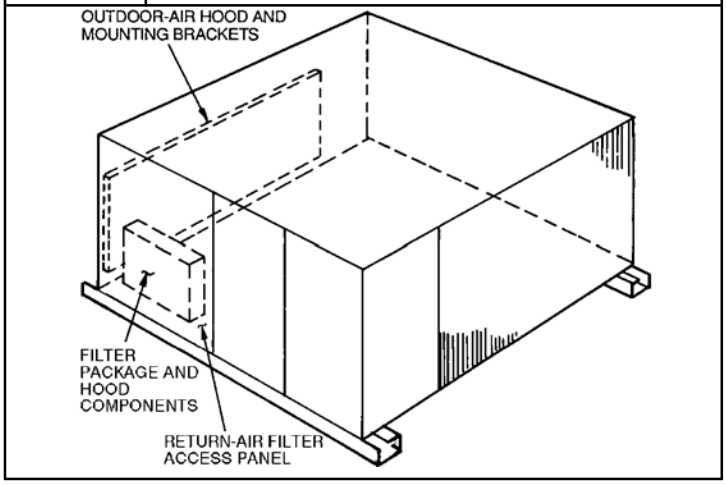
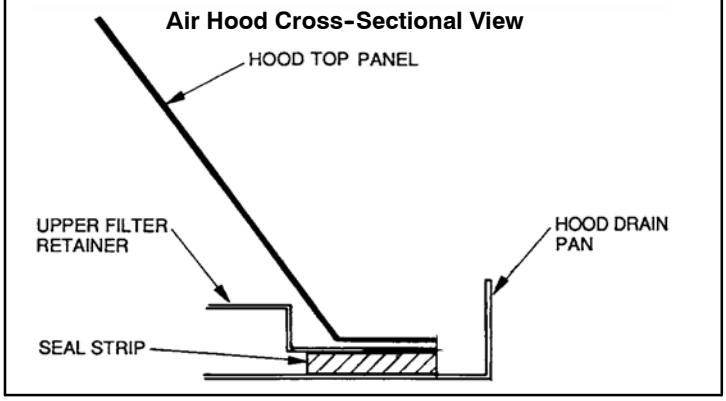


FIGURE 14 **Seal Strip Location**



INSTALL ALL ACCESSORIES

Refer to the accessory installation instructions included with each accessory.

Adjust Factory-Installed Options

Optional Economizer

See Figs. 16 and 17 for economizer component locations.

NOTE:These instructions are for installing the optional economizer only. Refer to the accessory economizer installation instructions when field installing an economizer accessory.

To complete installation of the optional economizer, perform the following procedure.

1. Remove the economizer hood. Refer to Step 8 — Install Outdoor-Air Hood on page 10 for information on removing and installing the outdoor-air hood.
2. Relocate outdoor air temperature sensor from shipping position to operation position on economizer. See Fig. 17.

IMPORTANT:Failure to relocate the sensor will result in the economizer not operating properly.

3. Re-install economizer hood.
4. Install all economizer accessories. economizer wiring is shown in Fig. 18.

Outdoor air leakage is shown in Table 5. Return air pressure drop is shown in Table 6.

FIGURE 15 Outdoor Air Hood Details

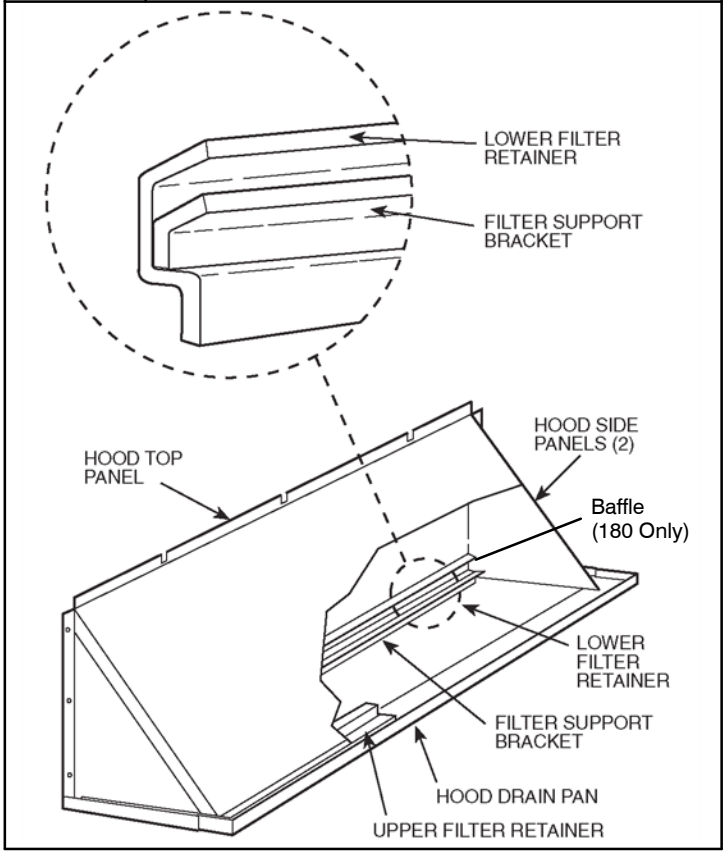


Table 5 – Outdoor Air Damper Leakage

	DAMPER STATIC PRESSURE (in. wg)					
	0.2	0.4	0.6	0.8	1.0	1.2
LEAKAGE (cfm)	35	53	65	75	90	102

Table 6 – Return Air Pressure Drop

CFM					
4500	5000	5400	6000	7200	7500
0.040	0.050	0.060	0.070	0.090	0.100

FIGURE 16 Economizer Component Locations (End View)

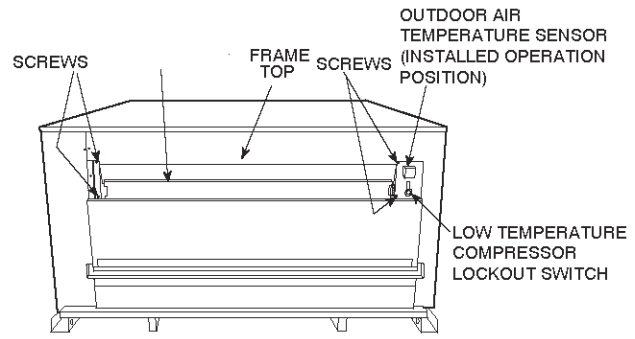
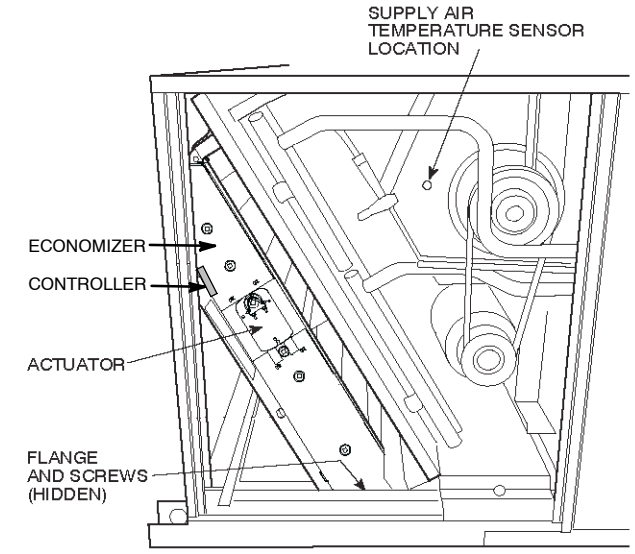


FIGURE 17 Economizer Component Locations (Side View)



Economizer Standard Sensors

Outdoor Air Temperature (OAT) Sensor

The outdoor air temperature sensor (HH57AC074) is a 10 to 20 mA device used to measure the outdoor-air temperature. The outdoor-air temperature is used to determine when the economizer can be used for free cooling. The sensor must be field-relocated. See Fig. 16. The operating range of temperature measurement is 40 to 100 F.

Supply Air Temperature (SAT) Sensor

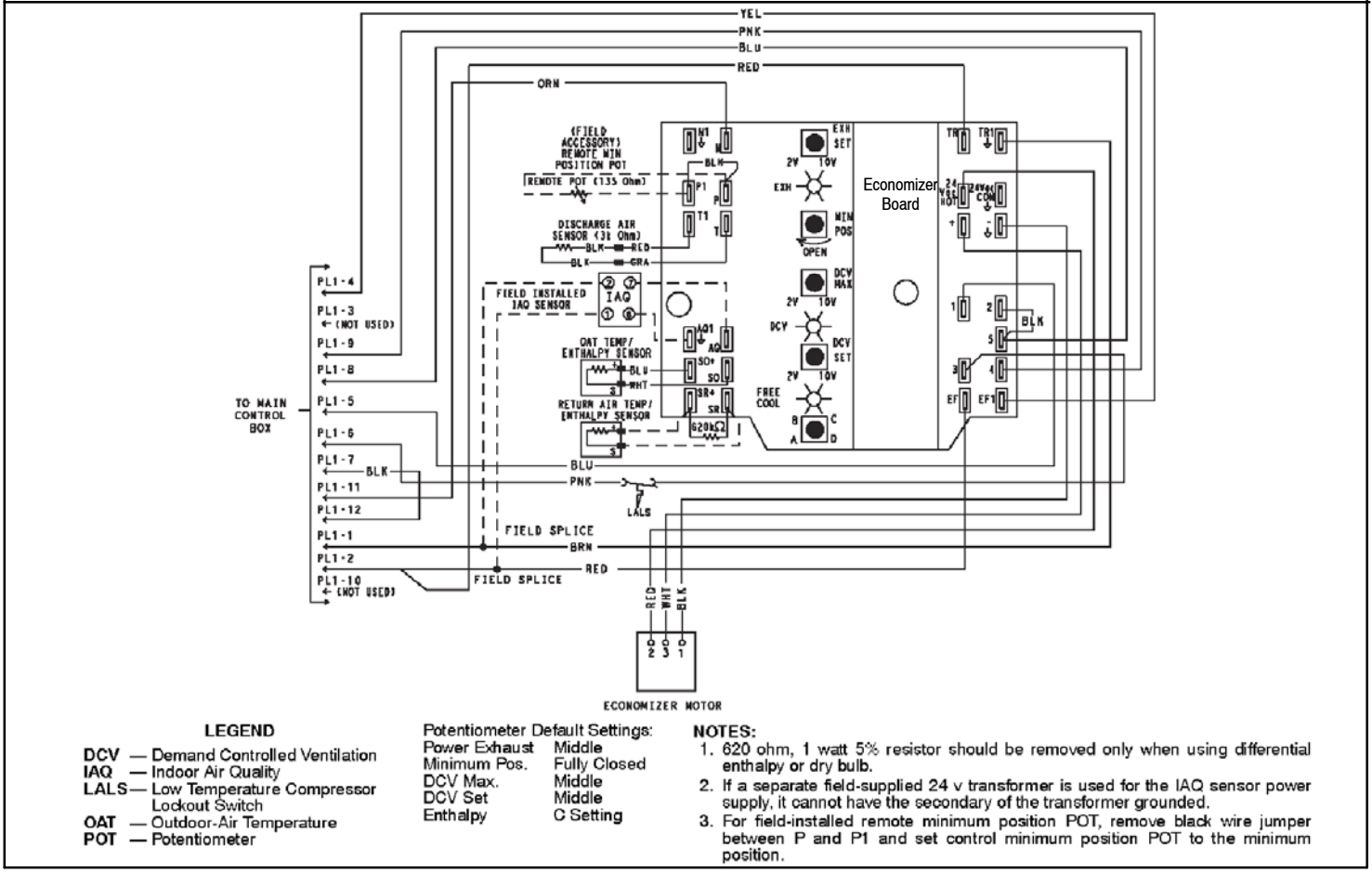
The supply air temperature sensor is a 3 K thermistor located at the inlet of the indoor fan. See Fig. 20. This sensor is factory installed. The operating range of temperature measurement is 0° to 158 F. See Table 7 for sensor temperature/resistance values.

The temperature sensor looks like an eyelet terminal with wires running to it. The sensor is located in the “crimp end” and is sealed from moisture.

Low Temperature Compressor Lockout Sensor

The economizer is equipped with an ambient temperature lockout switch located in the outdoor air stream which is used to lockout the compressors below a 42 F ambient temperature.

FIGURE 18 **Economizer Wiring**



LEGEND

DCV — Demand Controlled Ventilation
IAQ — Indoor Air Quality
LALS — Low Temperature Compressor Lockout Switch
OAT — Outdoor-Air Temperature
POT — Potentiometer

Potentiometer Default Settings:

Power Exhaust	Middle
Minimum Pos.	Fully Closed
DCV Max.	Middle
DCV Set	Middle
Enthalpy	C Setting

NOTES:

1. 620 ohm, 1 watt 5% resistor should be removed only when using differential enthalpy or dry bulb.
2. If a separate field-supplied 24 v transformer is used for the IAQ sensor power supply, it cannot have the secondary of the transformer grounded.
3. For field-installed remote minimum position POT, remove black wire jumper between P and P1 and set control minimum position POT to the minimum position.

Table 7 – SUPPLY AIR SENSOR TEMPERATURE/ RESISTANCE VALUES

TEMPERATURE (F)	RESISTANCE (ohms)
–58	200,250
–40	100,680
–22	53,010
–4	29,091
14	16,590
32	9,795
50	5,970
68	3,747
77	3,000
86	2,416
104	1,597
122	1,080
140	746
158	525
176	376
185	321
194	274
212	203
230	153
248	116
257	102
266	89
284	70
302	55

Economizer Control Modes

Determine the economizer control mode before set up of the control. Some modes of operation may require different sensors. Refer to Table 9. The economizer is supplied from the factory with a supply–air temperature sensor and an outdoor– air temperature sensor. This allows for operation of the economizer with outdoor air dry bulb changeover control. Additional accessories can be added to allow for different types of changeover control and operation of the economizer and unit.

Outdoor Dry Bulb Changeover

The standard controller is shipped from the factory configured for outdoor dry bulb changeover control. The outdoor air and supply air temperature sensors are included as standard. For this control mode, the outdoor temperature is compared to an adjustable set point selected on the control. If the outdoor-air temperature is above the set point, the economizer will adjust the outdoor-air dampers to minimum position. If the outdoor-air temperature is below the set point, the position of the outdoor-air dampers will be controlled to provide free cooling using outdoor air. When in this mode, the LED next to the free cooling set point potentiometer will be on. The

changeover temperature set point is controlled by the free cooling set point potentiometer located on the control. See Fig. 19. The scale on the potentiometer is A, B, C, and D. See Fig. 20 for the corresponding temperature changeover values.

Table 8 – ECONOMIZER SENSOR USAGE

APPLICATION	ECONOMIZER WITH OUTDOOR AIR DRY BULB SENSOR	ECONOMIZER WITH SINGLE ENTHALPY SENSOR
	Accessories Required	Accessories Required
Outdoor Air Dry Bulb	None. The outdoor air dry bulb sensor is factory installed.	DNTEMPSN002A00*
Differential Dry Bulb	DNTEMPSN002A00*	(2) DNTEMPSN002A00*
Single Enthalpy	HH57AC078	None. The single enthalpy sensor is factory installed.
Differential Enthalpy	HH57AC078 and DNENTDIF004A00*	DNENTDIF004A00*

*DNENTDIF004A00 and DNTEMPSN002A00 accessories are used on many different base units. As such, these kits may contain parts that will not be needed for installation.

†33ZCSENCO2 is an accessory CO_2 sensor.

**33ZCASPCO2 is an accessory aspirator box required for duct-mounted applications.

FIGURE 19 Economizer Controller Potentiometer and LED Locations

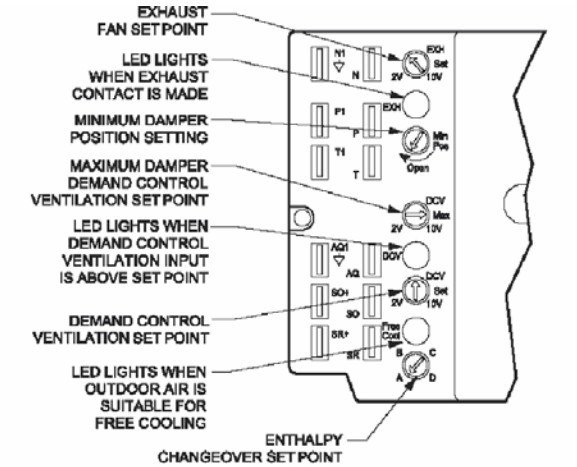
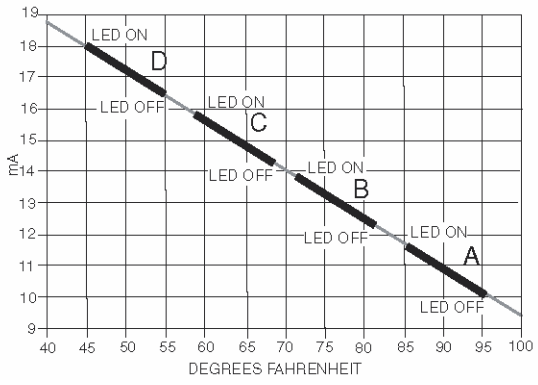


FIGURE 20 Outdoor Air Temperature Changeover Set Points



Differential Dry Bulb Control

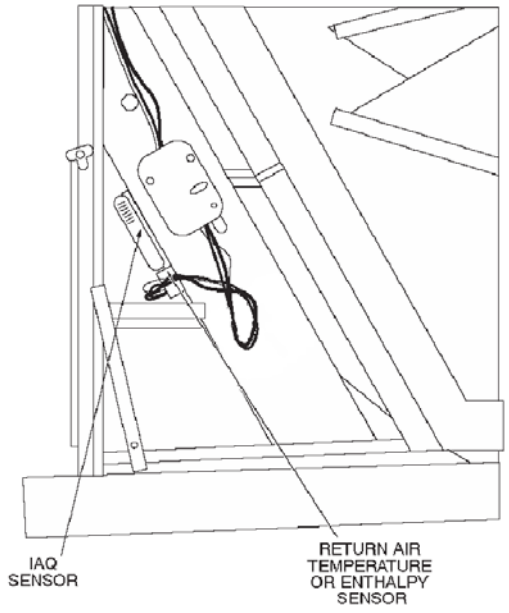
For differential dry bulb control the standard outdoor dry bulb sensor is used in conjunction with an additional accessory return air sensor (part number DNTEMPSN002A00). The accessory sensor must be mounted in the return airstream. See Fig. 21.

In this mode of operation, the outdoor-air temperature is compared to the return-air temperature and the lower temperature airstream is used for cooling. When using this mode of changeover control, turn the free cooling/enthalpy set point potentiometer fully clockwise to the D setting. See Fig. 20.

Outdoor Enthalpy Changeover

For enthalpy control, accessory enthalpy sensor (part number HH57AC078) is required. Replace the standard outdoor dry bulb temperature sensor with the accessory enthalpy sensor in the same mounting location. See Fig. 16. When the outdoor air enthalpy rises above the outdoor enthalpy changeover set point, the outdoor-air damper moves to its minimum position. The outdoor enthalpy changeover set point is set with the outdoor enthalpy set point potentiometer on the economizer controller. The set points are A, B, C, and D. See Fig. 20. The factory-installed 620-ohm jumper must be in place across terminals SR and SR+ on the economizer controller. See Fig. 19 and 23.

FIGURE 21 Return Air Temperature or Enthalpy Sensor Mounting Location



Differential Enthalpy Control

For differential enthalpy control, the economizer controller uses two enthalpy sensors (HH57AC078 and CRENTDIF004A00), one in the outside air and one in the return airstream on the economizer frame. The economizer controller compares the outdoor air enthalpy to the return air enthalpy to determine economizer use. The controller selects the lower enthalpy air (return or outdoor) for cooling. For

example, when the outdoor air has a lower enthalpy than the return air and is below the set point, the economizer opens to bring in outdoor air for free cooling.

Replace the standard outside air dry bulb temperature sensor with the accessory enthalpy sensor in the same mounting location. See Fig. 16. Mount the return air enthalpy sensor in the return airstream. See Fig. 21. The outdoor enthalpy changeover set point is set with the outdoor enthalpy set point potentiometer on the economizer controller. When using this mode of changeover control, turn the enthalpy set point potentiometer fully clockwise to the D setting.

NOTE: Remove 620-ohm resistor if differential enthalpy sensor is installed.

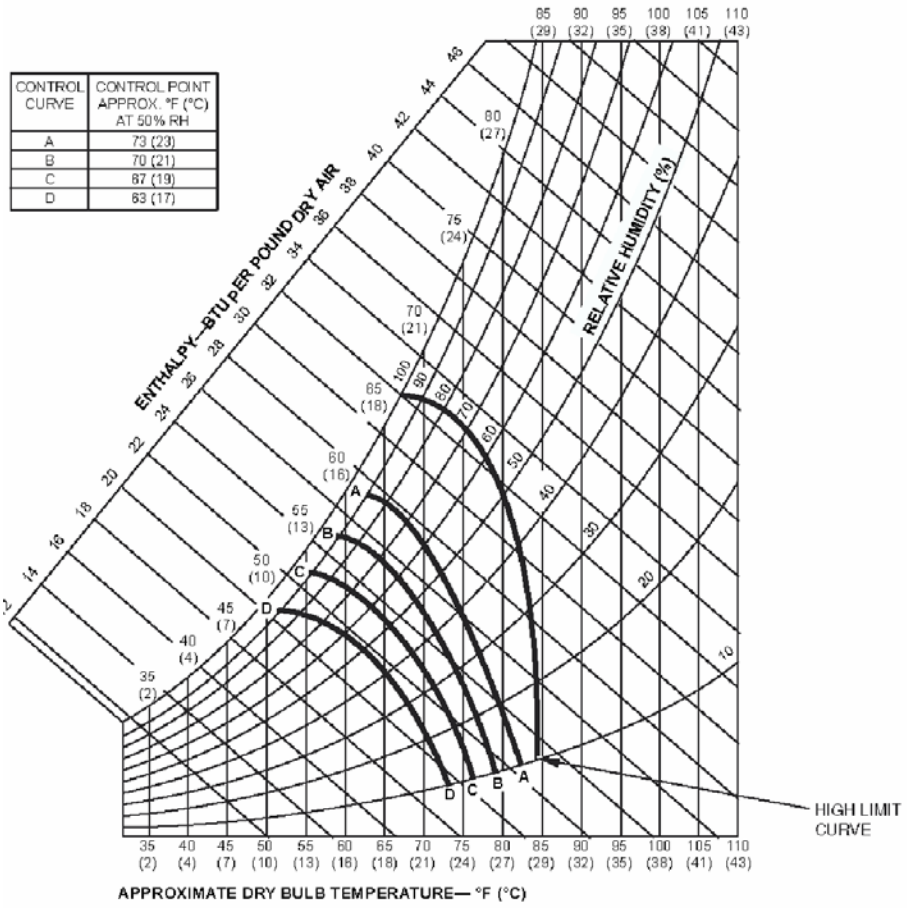
Indoor Air Quality (IAQ) Sensor Input

The IAQ input can be used for demand control ventilation control based on the level of CO_2 measured in the space or return air duct.

Mount the accessory IAQ sensor according to manufacturer specifications. The IAQ sensor should be wired to the AQ and AQ1 terminals of the controller. Adjust the DCV potentiometers to correspond to the DCV voltage output of the indoor air quality sensor at the user-determined set point. See Fig. 24.

If a separate field-supplied transformer is used to power the IAQ sensor, the sensor must not be grounded or the economizer control board will be damaged.

FIGURE 22 **Enthalpy Changeover Settings**



Exhaust Set Point Adjustment

The exhaust set point will determine when the exhaust fan runs based on damper position (if accessory power exhaust is installed). The set point is modified with the Exhaust Fan Set Point (EXH SET) potentiometer. See Fig. 19. The set point represents the damper position above which the exhaust fan will be turned on. When there is a call for exhaust, the economizer controller provides a 45 ± 15 second delay before exhaust fan activation to allow the dampers to open. This delay allows the damper to reach the appropriate position to avoid unnecessary fan overload.

Minimum Position Control

There is a minimum damper position potentiometer on the economizer controller. See Fig. 19. The minimum damper position maintains the minimum airflow into the building during the occupied period.

When using demand ventilation, the minimum damper position represents the minimum ventilation position for VOC (volatile organic compound) ventilation requirements. The maximum demand ventilation position is used for fully occupied ventilation.

When demand ventilation control is not being used, the minimum position potentiometer should be used to set the

occupied ventilation position. The maximum demand ventilation position should be turned fully clockwise.

Adjust the minimum position potentiometer to allow the minimum amount of outdoor air, as required by local codes, to enter the building. Make minimum position adjustments with at least 10° F temperature difference between the outdoor and return-air temperatures.

FIGURE 23 **Economizer Control**

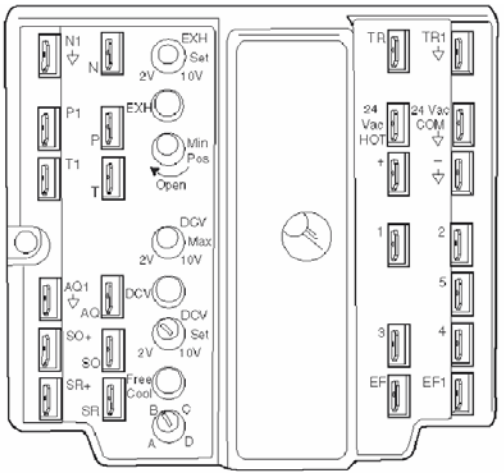
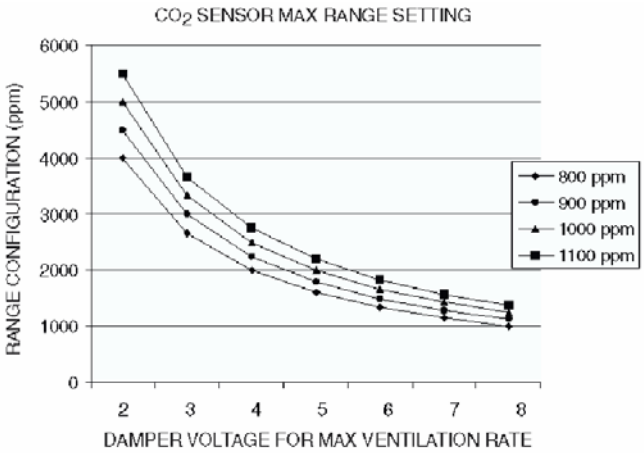


FIGURE 24 **CO_2 Sensor Maximum Range Setting**



To determine the minimum position setting, perform the following procedure:

1. Calculate the appropriate mixed-air temperature using the following formula:

$$(T_O \times \frac{OA}{100}) + (TR \times \frac{RA}{100}) = T_M$$

T_O = Outdoor-Air Temperature
OA = Percent of Outdoor Air
T_R = Return-Air Temperature
RA = Percent of Return Air
T_M = Mixed-Air Temperature

As an example, if local codes require 10% outdoor air during occupied conditions, outdoor-air temperature is 60 F, and return-air temperature is 75 F.

(60 x .10) + (75 x .90) = 73.5 F

2. Disconnect the supply-air sensor from terminals T and T1.
3. Ensure that the factory-installed jumper is in place across terminals P and P1. If remote damper positioning is being used, make sure that the terminals are wired according to Fig. 19 and that the minimum position potentiometer is turned fully clockwise.
4. Connect 24 vac across terminals TR and TR1.
5. Carefully adjust the minimum position potentiometer until the measured mixed-air temperature matches the calculated value.
6. Reconnect the supply-air sensor to terminals T and T1.

Remote control of the economizer damper is desirable when requiring additional temporary ventilation. If a field-supplied remote potentiometer (Honeywell part number S963B1128) is wired to the economizer controller, the minimum position of the damper can be controlled from a remote location.

To control the minimum damper position remotely, remove the factory-installed jumper on the P and P1 terminals on the economizer controller. Wire the field-supplied potentiometer to the P and P1 terminals on the economizer controller. See Fig. 23.

Damper Movement

Damper movement from full open to full closed (or vice versa) takes $2^1/_2$ minutes.

Thermostats

The economizer control works with conventional thermostats that have a Y1 (cool stage 1), Y2 (cool stage 2), W1 (heat stage 1), W2 (heat stage 2), and G (fan). The economizer control does not support space temperature sensors. Connections are made at the thermostat terminal connection board located in the main control box.

Occupancy Control

The factory default configuration for economizer control is occupied mode. This is implemented by the RED jumper at TB2-9 to TB2-10. When unoccupied mode is desired, remove the RED jumper and install a field-supplied timeclock function between TB2-9 and TB2-10. When the timeclock contacts are closed, the economizer control will be in occupied mode. When the timeclock contacts are open (removing the 24-v signal from terminal N), the economizer will be in unoccupied mode.

Demand Controlled Ventilation (DCV)

When using the economizer for demand controlled ventilation, there are some equipment selection criteria which should be considered. When selecting the heat capacity and cool capacity of the equipment, the maximum ventilation rate must be evaluated for design conditions. The maximum damper position must be calculated to provide the desired fresh air.

Typically the maximum ventilation rate will be about 5 to 10% more than the typical cfm required per person, using normal outside air design criteria.

A proportional anticipatory strategy should be taken with the following conditions: a zone with a large area, varied occupancy, and equipment that cannot exceed the required ventilation rate at design conditions. Exceeding the required ventilation rate means the equipment can condition air at a maximum ventilation rate that is greater than the required

ventilation rate for maximum occupancy. A proportional-anticipatory strategy will cause the fresh air supplied to increase as the room CO_2 level increases even though the CO_2 set point has not been reached. By the time the CO_2 level reaches the set point, the damper will be at maximum ventilation and should maintain the set point.

In order to have the CO_2 sensor control the economizer damper in this manner, first determine the damper voltage output for minimum or base ventilation. Base ventilation is the ventilation required to remove contaminants during unoccupied periods. The following equation may be used to determine the percent of outside-air entering the building for a given damper position. For best results there should be at least a 10 degree difference in outside and return-air temperatures.

$$(T_O \times \frac{OA}{100}) + (TR \times \frac{RA}{100}) = T_M$$

T_O = Outdoor-Air Temperature
OA = Percent of Outdoor Air
T_R = Return-Air Temperature
RA = Percent of Return Air
T_M = Mixed-Air Temperature

Once base ventilation has been determined, set the minimum damper position potentiometer to the correct position.

The same equation can be used to determine the occupied or maximum ventilation rate to the building. For example, an output of 3.6 volts to the actuator provides a base ventilation rate of 5% and an output of 6.7 volts provides the maximum ventilation rate of 20% (or base plus 15 cfm per person). Use Fig. 28 to determine the maximum setting of the CO_2 sensor. For example, a 1100 ppm set point relates to a 15 cfm per person design. Use the 1100 ppm curve on Fig. 28 to find the point when the CO_2 sensor output will be 6.7 volts. Line up the point on the graph with the left side of the chart to determine that the range configuration for the CO_2 sensor should be 1800 ppm. The economizer controller will output the 6.7 volts from the CO_2 sensor to the actuator when the CO_2 concentration in the space is at 1100 ppm. The DCV set point may be left at 2 volts since the CO_2 sensor voltage will be ignored by the economizer controller until it rises above the 3.6 volt setting of the minimum position potentiometer.

Once the fully occupied damper position has been determined, set the maximum damper demand control ventilation potentiometer to this position. Do not set to the maximum position as this can result in over-ventilation to the space and potential high-humidity levels.

CO_2 Sensor Configuration

The CO_2 sensor has preset standard voltage settings that can be selected anytime after the sensor is powered up. See Table 9.

Use setting 1 or 2 for equipment. See Table 9.

1. Press Clear and Mode buttons. Hold at least 5 seconds until the sensor enters the Edit mode.
2. Press Mode twice. The STDSET Menu will appear.
3. Use the Up/Down button to select the preset number. See Table 9.
4. Press Enter to lock in the selection.
5. Press Mode to exit and resume normal operation.

The custom settings of the CO_2 sensor can be changed anytime after the sensor is energized. Follow the steps below to change the non-standard settings:

1. Press Clear and Mode buttons. Hold at least 5 seconds until the sensor enters the Edit mode.
2. Press Mode twice. The STDSET Menu will appear.
3. Use the Up/Down button to toggle to the NONSTD menu and press Enter.
4. Use the Up/Down button to toggle through each of the nine variables, starting with Altitude, until the desired setting is reached.
5. Press Mode to move through the variables.
6. Press Enter to lock in the selection, then press Mode to continue to the next variable.

Dehumidification of Fresh Air with DCV Control

Information from ASHRAE indicates that the largest humidity load on any zone is the fresh air introduced. For some applications, a field-supplied energy recovery unit can be added to reduce the moisture content of the fresh air being brought into the building when the enthalpy is high. In most cases, the normal heating and cooling processes are more than adequate to remove the humidity loads for most commercial applications.

If normal rooftop heating and cooling operation is not adequate for the outdoor humidity level, an energy recovery unit and/or a dehumidification option should be considered.

Table 9 – CO_2 Sensor Standard Settings

Setting	Equipment	Output	Ventilation Rate (cfm/Person)	Analog Output	CO_2 Control Range (ppm)	Optional Relay Setpoint (ppm)	Relay Hysteresis (ppm)
1	Interface w/Standard Building Control System	Proportional	Any	0–10V 4–20 mA	0–2000	1000	50
2		Proportional	Any	2–10V 7–20 mA	0–2000	1000	50
3		Exponential	Any	0–10V 4–20 mA	0–2000	1100	50
4	Economizer	Proportional	15	0–10V 4–20 mA	0–1100	1100	50
5		Proportional	20	0–10V 4–20 mA	0–900	900	50
6		Exponential	15	0–10V 4–20 mA	0–1100	1100	50
7		Exponential	20	0–10V 4–20 mA	0–900	900	50
8	Health & Safety	Proportional	—	0–10V 4–20 mA	0–9999	5000	500
9	Parking/Air Intakes/ Loading Docks	Proportional	—	0–10V 4–20 mA	0–2000	700	50

START-UP

Use the following information and Start-Up Checklist on last page to check out unit PRIOR to start-up.

UNIT PREPARATION

Check that unit has been installed in accordance with these installation instructions and all applicable codes.

COMPRESSOR MOUNTING

Compressors are internally spring mounted. Do not loosen or remove compressor holddown bolts.

REFRIGERANT SERVICE PORTS

Each refrigerant system has a total of 3 Schrader-type service gage ports. One port is located on the suction line, one on the compressor discharge line, and one on the liquid line. In addition, Schrader-type valves are located underneath the low-pressure switches. Be sure that caps on the ports are tight.

COMPRESSOR ROTATION

It is important to be certain the compressors are rotating in the proper direction. To determine whether or not compressors are rotating in the proper direction:

1. Connect service gages to suction and discharge pressure fittings.
2. Energize the compressor.
3. The suction pressure should drop and the discharge pressure should rise, as is normal on any start-up.

If the suction pressure does not drop and the discharge pressure does not rise to normal levels:

1. Note that the evaporator fan is probably also rotating in the wrong direction.
2. Turn off power to the unit.
3. Reverse any two of the incoming power leads.
4. Turn on power to the compressor.

The suction and discharge pressure levels should now move to their normal start-up levels.

NOTE: When compressors are rotating in the wrong direction, the unit will have increased noise levels and will not provide heating and cooling.

After a few minutes of reverse operation, the scroll compressor internal overload protection will open, which will activate the unit's lockout and requires a manual reset. Reset is accomplished by turning the thermostat on and off.

INTERNAL WIRING

Check all electrical connections in unit control boxes; tighten as required.

CRANKCASE HEATER

Crankcase heater(s) is energized as long as there is power to the unit and the compressor is not operating.

IMPORTANT: Unit power must be on for 24 hours prior to start-up. Otherwise, damage to compressor may result.

EVAPORATOR FAN

Fan belt and variable pulleys are factory-installed. See Tables 11-13 for fan performance data. Be sure that fans rotate in the proper direction. See Table 10 for air quantity limits. See Table 14 for static pressure information for accessories and options. See Table 15 for fan rpm at various motor pulley settings. See Table 16 for evaporator fan motor data. To alter fan performance, see Evaporator Fan Performance Adjustment section.

NOTE: A $3^1/_2$-in. bolt and threaded plate are included in the installer's packet. They can be added to the motor support channel below the motor mounting plate to aid in raising the fan motor.

Table 10 — Air Quantity Limits

UNIT PAH	MINIMUM CFM	MAXIMUM CFM
155	3600	6,000
180	4500	7,500

CONDENSER-FANS AND MOTORS

Condenser fans and motors are factory set. Refer to Condenser-Fan Adjustment section as required. Be sure that fans rotate in the proper direction.

RETURN-AIR FILTERS

Check that correct filters are installed in filter tracks (see Table 1). Do not operate unit without return-air filters.

OUTDOOR-AIR INLET SCREENS

Outdoor-air inlet screens must be in place before operating unit.

Table 11 — Fan Performance — PAH155 (With Standard Indoor Fan Motor)*

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	0.2			0.4			0.6			0.8			1.0		
	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp
3750	522	687	0.70	608	841	0.88	704	1045	1.12	781	1229	1.35	853	1419	1.58
4000	549	792	0.82	635	956	1.02	729	1170	1.27	805	1364	1.51	876	1565	1.77
4250	577	903	0.95	661	1078	1.16	753	1302	1.44	828	1506	1.69	898	1716	1.96
4500	604	1021	1.09	687	1207	1.32	776	1440	1.61	850	1653	1.88	919	1873	2.16
4750	631	1147	1.25	713	1343	1.49	800	1584	1.79	872	1807	2.07	940	2037	2.36
5000	658	1281	1.41	738	1486	1.67	822	1735	1.98	893	1968	2.27	959	2207	2.58
5250	684	1423	1.59	763	1637	1.86	844	1894	2.18	913	2135	2.49	979	2385	2.80
5500	710	1572	1.77	787	1796	2.06	865	2060	2.39	933	2311	2.71	997	2571	3.03
5750	736	1732	1.98	811	1965	2.27	887	2235	2.61	953	2496	2.93	1015	2765	3.26
6000	762	1900	2.19	835	2143	2.50	907	2419	2.84	972	2689	3.17	—	—	—
6250	787	2080	2.42	858	2332	2.73	927	2612	3.08	—	—	—	—	—	—

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	1.2			1.4			1.6			1.8			2.0		
	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp
3750	921	1617	1.83	987	1823	2.09	1051	2051	2.38	1114	2301	2.69	1174	2563	3.02
4000	943	1773	2.03	1007	1989	2.30	1070	2227	2.60	1132	2486	2.92	1190	2756	3.25
4250	964	1934	2.23	1027	2161	2.52	1089	2408	2.83	1148	2676	3.16	—	—	—
4500	984	2102	2.44	1046	2339	2.74	1106	2596	3.06	—	—	—	—	—	—
4750	1003	2276	2.66	1064	2524	2.97	1123	2790	3.29	—	—	—	—	—	—
5000	1022	2457	2.89	1082	2717	3.21	—	—	—	—	—	—	—	—	—
5250	1040	2646	3.12	—	—	—	—	—	—	—	—	—	—	—	—
5500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5750	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6250	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

LEGEND

Bhp — Brake Horsepower

FIOP — Factory-Installed Option

Watts — Input Watts to Motor

*Standard low-medium static drive range is 895 to 1147 rpm. Alternate high-static drive range is 1040 to 1315. Other rpms require a field-supplied drive.

NOTES:

1. Maximum continuous bhp for the standard motor is 3.13. The maximum continuous watts is 2700. Do not adjust motor rpm such that motor maximum bhp and/or watts is exceeded at the maximum operating cfm.
2. Static pressure losses (i.e., economizer) must be added to external static pressure before entering Fan Performance table.
3. Interpolation is permissible. Do not extrapolate.
4. Fan performance is based on wet coils, clean filters, and casing losses. See Table 14 for accessory/FIOP static pressure information.
5. Extensive motor and drive testing on these units ensures that the full bhp and watts range of the motor can be utilized with confidence. Using fan motors up to the watts or bhp rating shown will not result in nuisance tripping or premature motor failure. Unit warranty will not be affected.
6. Use of a field-supplied motor may affect wiring size.

Table 12 — Fan Performance — PAH155 (With Optional Indoor Fan Motor)*

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	0.2			0.4			0.6			0.8			1.0		
	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp
3750	522	687	0.70	608	841	0.88	704	1045	1.12	781	1229	1.35	853	1419	1.58
4000	549	792	0.82	635	956	1.02	729	1170	1.27	805	1364	1.51	876	1565	1.77
4250	577	903	0.95	661	1078	1.16	753	1302	1.44	828	1506	1.69	898	1716	1.96
4500	604	1021	1.09	687	1207	1.32	776	1440	1.61	850	1653	1.88	919	1873	2.16
4750	631	1147	1.25	713	1343	1.49	800	1584	1.79	872	1807	2.07	940	2037	2.36
5000	658	1281	1.41	738	1486	1.67	822	1735	1.98	893	1968	2.27	959	2207	2.58
5250	684	1423	1.59	763	1637	1.86	844	1894	2.18	913	2135	2.49	979	2385	2.80
5500	710	1572	1.77	787	1796	2.06	865	2060	2.39	933	2311	2.71	997	2571	3.03
5750	736	1732	1.98	811	1965	2.27	887	2235	2.61	953	2496	2.93	1015	2765	3.26
6000	762	1900	2.19	835	2143	2.50	907	2419	2.84	972	2689	3.17	1033	2968	3.51
6250	787	2080	2.42	858	2332	2.73	927	2612	3.08	991	2892	3.42	1050	3181	3.76

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	1.2			1.4			1.6			1.8			2.0		
	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp
3750	921	1617	1.83	987	1823	2.09	1051	2051	2.38	1114	2301	2.69	1174	2563	3.02
4000	943	1773	2.03	1007	1989	2.30	1070	2227	2.60	1132	2486	2.92	1190	2756	3.25
4250	964	1934	2.23	1027	2161	2.52	1089	2408	2.83	1148	2676	3.16	1205	2954	3.49
4500	984	2102	2.44	1046	2339	2.74	1106	2596	3.06	1164	2872	3.39	1219	3158	3.73
4750	1003	2276	2.66	1064	2524	2.97	1123	2790	3.29	1179	3073	3.63	1233	3366	3.98
5000	1022	2457	2.89	1082	2717	3.21	1139	2990	3.53	1194	3280	3.88	1247	3579	4.22
5250	1040	2646	3.12	1099	2916	3.45	1154	3198	3.78	1208	3493	4.12	1259	3797	4.47
5500	1057	2843	3.36	1115	3124	3.69	1169	3412	4.03	1222	3712	4.37	1272	4019	4.72
5750	1074	3048	3.60	1131	3339	3.94	1184	3634	4.28	1235	3936	4.63	1283	4244	4.97
6000	1091	3261	3.85	1147	3562	4.20	1198	3861	4.54	1247	4165	4.88	1295	4472	5.22
6250	1107	3483	4.11	1162	3793	4.46	1212	4095	4.80	1260	4398	5.14	1306	4701	5.48

LEGEND

Bhp — Brake Horsepower
FIOP — Factory-Installed Option
Watts — Input Watts to Motor

*Standard low-medium static drive range is 895 to 1147 rpm. Alternate high-static drive range is 1040 to 1315. Other rpms require a field-supplied drive.

NOTES:

1. Field-supplied motor.
2. Maximum continuous bhp for the optional motor is 4.26. The maximum continuous watts is 3610. Do not adjust motor rpm such that motor maximum bhp and/or watts is exceeded at the maximum operating cfm.
3. Static pressure losses (i.e., economizer) must be added to external static pressure before entering Fan Performance table.
4. Interpolation is permissible. Do not extrapolate.
5. Fan performance is based on wet coils, clean filters, and casing losses. See Table 14 for accessory/FIOP static pressure information.
6. Extensive motor and drive testing on these units ensures that the full bhp and watts range of the motor can be utilized with confidence. Using fan motors up to the watts or bhp rating shown will not result in nuisance tripping or premature motor failure. Unit warranty will not be affected.
7. Use of a field-supplied motor may affect wiring size.

Table 13 — Fan Performance — PAH180*

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	0.2			0.4			0.6			0.8			1.0		
	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp
4500	753	1307	1.53	753	1307	1.53	784	1397	1.64	859	1635	1.92	928	1880	2.20
4800	747	1384	1.62	747	1384	1.62	806	1563	1.83	878	1808	2.12	946	2060	2.42
5100	741	1465	1.72	752	1500	1.76	828	1745	2.05	898	1996	2.34	964	2255	2.65
5700	735	1659	1.95	805	1895	2.22	876	2156	2.53	942	2423	2.84	1004	2696	3.16
6000	759	1854	2.18	832	2118	2.48	901	2388	2.80	965	2663	3.12	1026	2943	3.45
6300	790	2088	2.45	860	2360	2.77	926	2638	3.09	988	2920	3.43	1048	3208	3.76
6600	821	2340	2.74	888	2621	3.07	952	2906	3.41	1013	3196	3.75	1070	3491	4.10
6900	852	2611	3.06	917	2900	3.40	979	3194	3.75	1038	3492	4.10	1094	3794	4.45
7200	883	2903	3.40	946	3200	3.75	1006	3501	4.11	1063	3807	4.47	1118	4117	4.83
7500	914	3215	3.77	975	3521	4.13	1033	3830	4.49	1089	4143	4.86	1142	4461	5.23

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	1.2			1.4			1.6			1.8			2.0		
	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp
4500	993	2133	2.50	1055	2394	2.81	1114	2662	3.12	1170	2938	3.45	1224	3220	3.78
4800	1009	2319	2.72	1070	2585	3.03	1127	2859	3.35	1183	3139	3.68	1236	3427	4.02
5100	1026	2521	2.96	1086	2794	3.28	1142	3073	3.60	1196	3359	3.94	1248	3650	4.28
5700	1064	2975	3.49	1120	3260	3.82	1174	3551	4.17	1226	3848	4.51	1277	4151	4.87
6000	1083	3228	3.79	1139	3520	4.13	1192	3817	4.48	1243	4119	4.83	1292	4427	5.19
6300	1104	3501	4.11	1158	3799	4.46	1210	4102	4.81	1260	4410	5.17	1309	4724	5.54
6600	1125	3791	4.45	1178	4095	4.80	1229	4405	5.17	1278	4720	5.54	1326	5039	5.91
6900	1147	4101	4.81	1199	4412	5.18	1249	4728	5.55	1297	5050	5.92	—	—	—
7200	1170	4431	5.20	1221	4749	5.57	1270	5072	5.95	—	—	—	—	—	—
7500	1193	4781	5.61	1243	5107	5.99	—	—	—	—	—	—	—	—	—

AIRFLOW (cfm)	AVAILABLE EXTERNAL STATIC PRESSURE (in. wg)														
	2.2			2.4			2.6			2.8			3.0		
	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp	Rpm	Watts	Bhp
4500	1276	3509	4.12	1326	3805	4.46	1375	4107	4.82	1421	4414	5.18	1467	4728	5.55
4800	1287	3721	4.36	1336	4020	4.72	1384	4326	5.07	1430	4638	5.44	1475	4955	5.81
5100	1299	3949	4.63	1347	4253	4.99	1395	4563	5.35	1440	4879	5.72	—	—	—
5700	1325	4458	5.23	1373	4772	5.60	1418	5091	5.97	—	—	—	—	—	—
6000	1340	4741	5.56	1387	5060	5.93	—	—	—	—	—	—	—	—	—
6300	1356	5043	5.91	—	—	—	—	—	—	—	—	—	—	—	—
6600	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6900	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7200	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

LEGEND

Bhp — Brake Horsepower
FIOP — Factory-Installed Option
Watts — Input Watts to Motor

*Standard low-medium static drive range is 873 to 1021 rpm. Alternate high-static drive range is 1025 to 1200. Other rpms require a field-supplied drive.

NOTES:

1. Maximum continuous bhp for the standard motor is 6.13. The maximum continuous watts is 5180. Do not adjust motor rpm such that motor maximum bhp and/or watts is exceeded at the maximum operating cfm.
2. Static pressure losses (i.e., economizer) must be added to external static pressure before entering Fan Performance table.
3. Interpolation is permissible. Do not extrapolate.
4. Fan performance is based on wet coils, clean filters, and casing losses. See Table 14 for accessory/FIOP static pressure information.
5. Extensive motor and drive testing on these units ensures that the full bhp and watts range of the motor can be utilized with confidence. Using fan motors up to the watts or bhp rating shown will not result in nuisance tripping or premature motor failure. Unit warranty will not be affected.
6. Use of a field-supplied motor may affect wiring size.

Table 14 — Accessory/FIOP Static Pressure (in. wg)

UNIT PAH	HEATER RATED VOLTAGE	AIRFLOW (Cfm)	ELECTRIC HEATERS PRESSURE DROP (kW)	ECONOMISER PRESSURE DROP
155,180	208/240-3-60	3,750	0.05 (14/19, 26/34) 0.06 (42/56) 0.07 (56/75)	0.03
		4,000	0.05 (14/19, 26/34) 0.06 (42/56) 0.07 (56/75)	0.04
		5,000	0.07 (14/19, 26/34) 0.08 (42/56) 0.10 (56/75)	0.05
		6,000	0.09 (14/19, 26/34) 0.12 (42/56) 0.15 (56/75)	0.07
		7,200	0.11 (14/19, 26/34) 0.16 (42/56) 0.20 (56/75)	0.09
		7,500	0.12 (14/19, 26/34) 0.17 (42/56) 0.21 (56/75)	0.10
	480-3-60	3,750	0.05 (15, 32) 0.06 (55) 0.07 (80)	0.03
		4,000	0.05 (15, 32) 0.06 (55) 0.07 (80)	0.04
		5,000	0.07 (15, 32) 0.08 (55) 0.10 (80)	0.05
		6,000	0.09 (15, 32) 0.12 (55) 0.15 (80)	0.07
		7,200	0.11 (15, 32) 0.15 (55) 0.20 (80)	0.09
		7,500	0.12 (15, 32) 0.17 (55) 0.21 (80)	0.10

LEGEND

FIOP — Factory-Installed Option

NOTES:
1. Heaters are rated at 240 v and 480 v.
2. The factory-assembled horizontal adapter substantially improves fan performance.
3. The static pressure must be added to external static pressure. The sum and the evaporator entering-air cfm should then be used in conjunction with the Fan Performance table to determine blower rpm, bhp, and watts.

Table 15 — Fan Rpm and Motor Pulley Settings*

	NUMBER OF TURNS OPEN												
UNIT PAH	0	1/2	1	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6
155†	1147	1124	1101	1078	1055	1032	1010	987	964	941	918	895	††
155**	1315	1292	1269	1246	1223	1200	1178	1155	1132	1109	1086	1063	1040
180†	††	††	††	††	1021	1002	984	965	947	928	910	891	873
180**	††	††	††	††	1200	1178	1156	1134	1112	1091	1069	1047	1025

*Approximate fan rpm shown.
†Indicates standard drive package.
**Indicates alternate drive package.
††Due to belt and pulley style, pulley cannot be set to this number of turns open.

Table 16 — Evaporator Fan Motor Specifications

UNIT PAH	NOMINAL HP	VOLTAGE	MAX WATTS	EFF. %	MAX BHP	MAX BkW	MAX AMPS
155 (Standard Motor)	2.9	208	2700	85.8	3.13	2.34	9.46
	2.9	230	2700	85.8	3.13	2.34	8.6
	2.9	460	2700	85.8	3.13	2.34	4.3
155 (Optional Motor)	3.7	208	3610	85.8	4.26	3.27	10.5
	3.7	230	3610	85.8	4.26	3.27	10.5
	3.7	460	3610	85.8	4.26	3.27	4.8
180	5	208	5180	87.5	6.13	4.57	15.8
	5	230	5180	87.5	6.13	4.57	15.8
	5	460	5180	87.5	6.13	4.57	7.9

LEGEND

BHP — Brake Horsepower

OPERATING SEQUENCE

Cooling, Units Without Economizer

When thermostat calls for cooling, terminals G and Y1 are energized. The indoor (evaporator) fan contactor (IFC), outdoor fan contactor (OFC), and compressor contactor no. 1 (C1) are energized and evaporator-fan motor, condenser fans and compressor no. 1 start. The condenser-fan motors run continuously while unit is cooling. If the thermostat calls for a second stage of cooling by energizing Y2, compressor contactor no. 2 (C2) is energized and compressor no. 2 starts.

Heating, Units Without Economizer (If Optional or Accessory Heater is Installed)

Upon a call for heating through terminal W1, IFC and heater contactor no. 1 (HC1) are energized. On units equipped for 2 stages of heat, when additional heat is needed HC2 is energized through W2.

Cooling, Units With Economizer

When free cooling is not available, the compressors will be controlled by the zone thermostat. When free cooling is available, the outdoor-air damper is modulated by the economizer control to provide a 50 to 55 F supply-air temperature into the zone. As the supply-air temperature fluctuates above 55 or below 50 F, the dampers will be modulated (open or close) to bring the supply-air temperature back within set point limits.

For economizer operation, there must be a thermostat call for the fan (G). This will move the damper to its minimum position during the occupied mode.

Above 50 F supply-air temperature, the dampers will modulate from 100% open to the minimum open position. From 50 F to 45 F supply-air temperature, the dampers will maintain at the minimum open position. Below 45 F the dampers will be completely shut. As the supply-air temperature rises, the dampers will come back open to the minimum open position once the supply-air temperature rises to 48 F.

If optional power exhaust is installed, as the outdoor-air damper opens and closes, the power exhaust fans will be energized and deenergized.

If field-installed accessory CO_2 sensors are connected to the ecomomizer control, a demand controlled ventilation strategy will begin to operate. As the CO_2 level in the zone increases above the CO_2 set point, the minimum position of the damper will be increased proportionally. As the CO_2 level decreases because of the increase in fresh air, the outdoor-air damper will be proportionally closed. Damper position will follow the higher demand condition from DCV mode or free cooling mode.

Damper movement from full closed to full open (or vice versa) will take between $1^1/_2$ and $2^1/_2$ minutes.

If free cooling can be used as determined from the appropriate changeover command (switch, dry bulb, enthalpy curve, differential dry bulb, or differential enthalpy), a call for cooling (Y1 closes at the thermostat) will cause the control to modulate the dampers open to maintain the supply air temperature set point at 50 to 55 F.

As the supply-air temperature drops below the set point range of 50 to 55 F, the control will modulate the outdoor-air dampers closed to maintain the proper supply-air temperature.

Heating, Units With Economizer

When the room thermostat calls for heat, the heating controls are energized as described in the Heating, Units Without Economizer section. When the indoor fan is energized, the economizer damper moves to the minimum position. When the indoor fan is off, the economizer damper is fully closed.

SERVICE

⚠ WARNING

ELECTRICAL SHOCK HAZARD

Failure to follow this warning could result in personal injury or death.

Before installing or servicing system, always turn off power supply to unit and install lockout tag. There may be more than one disconnect switch. Turn off accessory heater power switch if applicable.

CLEANING

Inspect unit interior at beginning of each heating and cooling season and as operating conditions require. Remove unit top panel and/or side panels for access to unit interior.

Evaporator Coil

Clean as required with commercial coil cleaner.

Condenser Coil

Clean condenser coil annually and as required by location and outdoor-air conditions. Inspect coil monthly — clean as required.

Condensate Drain

Check and clean each year at start of cooling season. In winter, keep drains and traps dry.

Filters

Clean or replace at start of each heating and cooling season, or more often if operating conditions require. Refer to Table 1 for type and size.

Outdoor-Air Inlet Screens

Clean screens with steam or hot water and a mild detergent. Do not use throwaway filters in place of screens.

LUBRICATION

Compressors

Each compressor is charged with the correct amount of oil at the factory. Conventional white oil (Sontex 200LT) is used. White oil is compatible with 3GS oil, and 3GS oil may be used if the addition of oil is required. See compressor nameplate for original oil charge. A complete recharge should be four ounces less than the original oil charge. When a compressor is exchanged in the field it is possible that a major portion of the oil from the replaced compressor may still be in the system. While this will not affect the reliability of the

replacement compressor, the extra oil will add rotor drag and increase power usage. To remove this excess oil, an access valve may be added to the lower portion of the suction line at the inlet of the compressor. The compressor should then be run for 10 minutes, shut down and the access valve opened until no oil flows. This should be repeated twice to make sure the proper oil level has been achieved.

Fan Shaft Bearings

For size 155 units, bearings are permanently lubricated. No field lubrication is required. For size 180 units, lubricate bearings at least every 6 months with suitable bearing grease. Extended grease line is provided for far side fan bearing (opposite drive side). Typical lubricants are given below:

MANUFACTURER	LUBRICANT
Texaco	Regal AFB-2*
Mobil	Mobilplex EP No. 1
Sunoco	Prestige 42
Texaco	Multifak 2

*Preferred lubricant because it contains rust and oxidation inhibitors.

Condenser and Evaporator-Fan Motor Bearings

The condenser and evaporator-fan motors have permanently sealed bearings, so no field lubrication is necessary.

EVAPORATOR FAN PERFORMANCE ADJUSTMENT (Fig. 25 - 27)

Fan motor pulleys are factory set for speed shown in Table 1.

To change fan speeds:

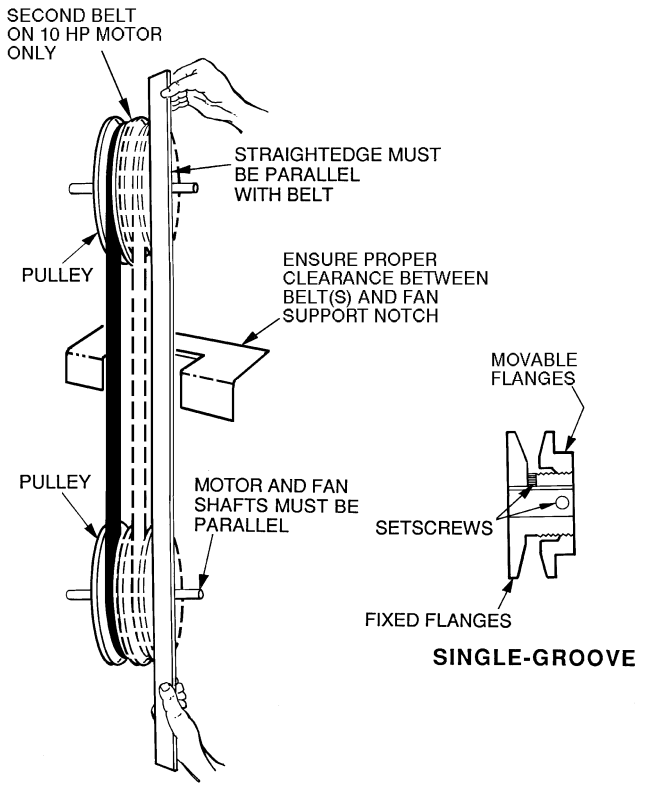
1. Shut off unit power supply.
   a. Size 155 only: Loosen belt by loosening fan motor mounting plate nuts.
   b. Size 180 only: Loosen nuts on the 2 carriage bolts in the mounting base. Install jacking bolt and plate under motor base (bolt and plate are shipped in installer's packet). Using bolt and plate, raise motor to top of slide and remove belt. Secure motor in this position by tightening the nuts on the carriage bolts.
2. Loosen movable-pulley flange setscrew.
3. Screw movable flange toward fixed flange to increase speed and away from fixed flange to decrease speed. Increasing fan speed increases load on motor. Do not exceed maximum speed specified in Table 1.

   See Table 10 for air quantity limits.
4. Set movable flange at nearest keyway of pulley hub and tighten setscrew. (See Table 1 for speed change for each full turn of pulley flange.)
5. Replace and tighten belts (see Belt Tension Adjustment section on page 25).

To align fan and motor pulleys:

1. Loosen fan pulley setscrews.
2. Slide fan pulley along fan shaft.
3. Make angular alignment by loosening motor from mounting plate.

FIGURE 25 | **Evaporator Fan Alignment and Adjustment**



EVAPORATOR FAN SERVICE AND REPLACEMENT

A. PAH155 Units (See Fig. 26)

NOTE: To remove belts only, follow Steps 1-6.

1. Remove filter and supply-air section panels.
2. Remove unit top panel.
3. Loosen carriage nuts A and B holding motor mount assembly to fan scroll side plates.
4. Loosen screw C.
5. Rotate motor mount assembly (with motor attached) as far as possible away from evaporator coil.
6. Remove belt.
7. Rotate motor mount assembly back past original position toward evaporator coil.
8. Remove motor mounting nuts D and E (both sides).
9. Lift motor up through top of unit.
10. Reverse above procedure to reinstall motor.
11. Check and adjust belt tension as necessary.

B. PAH180 Units (See Fig. 27)

The PAH180 units use a fan motor mounting system that features a slide-out motor mounting plate. To replace or service the motor, slide out the bracket.

1. Remove the evaporator-fan access panel and the heating control access panel.
2. Remove the center post (located between the evaporator fan and heating control access panels) and all screws securing it.
3. Loosen nuts on the 2 carriage bolts in the motor mounting base.

4. Using jacking bolt under motor base, raise motor to top of slide and remove belt. Secure motor in this position by tightening the nuts on the carriage bolts.
5. Remove the belt drive.
6. Remove jacking bolt and tapped jacking bolt plate.
7. Remove the 2 screws that secure the motor mounting plate to the motor support channel.
8. Remove the 3 screws from the end of the motor support channel that interfere with the motor slide path.
9. Slide out the motor and motor mounting plate.
10. Disconnect wiring connections and remove the 4 mounting bolts.
11. Remove the motor.
12. To install the new motor, reverse Steps 1-11.

FIGURE 26 | **PAH155 Indoor Fan Motor Section**

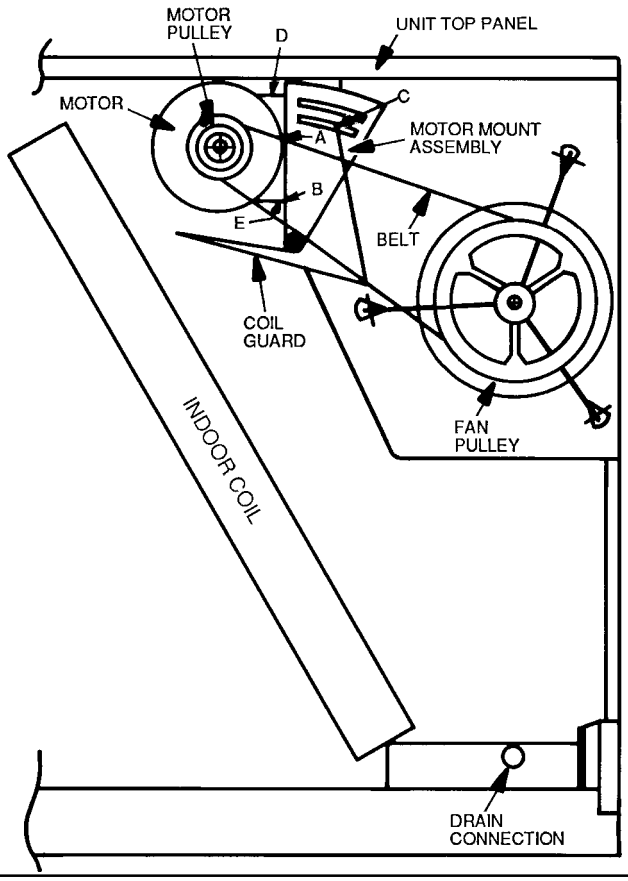
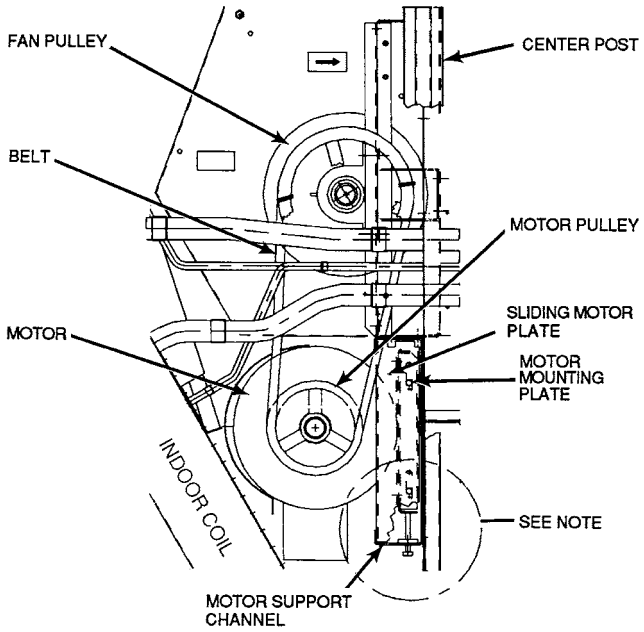


FIGURE 27 | **PAH180 Indoor Fan Motor Section**



NOTE: A $3^1/_2$-in. bolt and threaded plate are included in the installer's packet. They can be added to the motor support channel below the motor mounting plate to aid in raising the motor.

BELT TENSION ADJUSTMENT

To adjust belt tension:

1. Loosen fan motor bolts.
2. a. Size 155 units:

   Move motor mounting plate up or down for proper belt tension ($^1/_2$ in. deflection with one finger).

   b. Size 180 units:

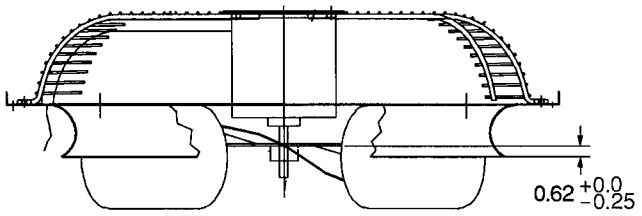
   Turn motor jacking bolt to move motor mounting plate up or down for proper belt tension ($^3/_8$ in. deflection at midspan with one finger [9 lb force]).
3. Tighten nuts.
4. Adjust bolts and nut on mounting plate to secure motor in fixed position.

CONDENSER-FAN ADJUSTMENT

PAH155/180 UNITS (Fig. 28)

1. Shut off unit power supply.
2. Remove access panel(s) closest to the fan to be adjusted.
3. Loosen fan hub setscrews.
4. Adjust fan height on shaft using a straightedge placed across the fan orifice.
5. Tighten setscrews and replace panel(s).
6. Turn on unit power.

FIGURE 28 | **Outdoor Fan Adjustment – PAH155/180**



NOTE: Dimensions are in inches.

POWER FAILURE

Dampers have a spring return. In event of power failure, dampers will return to fully closed position until power is restored. *Do not manually operate economizer motor.*

REFRIGERANT CHARGE

Amount of refrigerant charge is listed on unit nameplate and in Table 1. Refer to GTAC II; Module 5; Charging, Recovery, Recycling, and Reclamation section for charging methods and procedures. Unit panels must be in place when unit is operating during charging procedure.

NOTE: Do not use recycled refrigerant as it may contain contaminants.

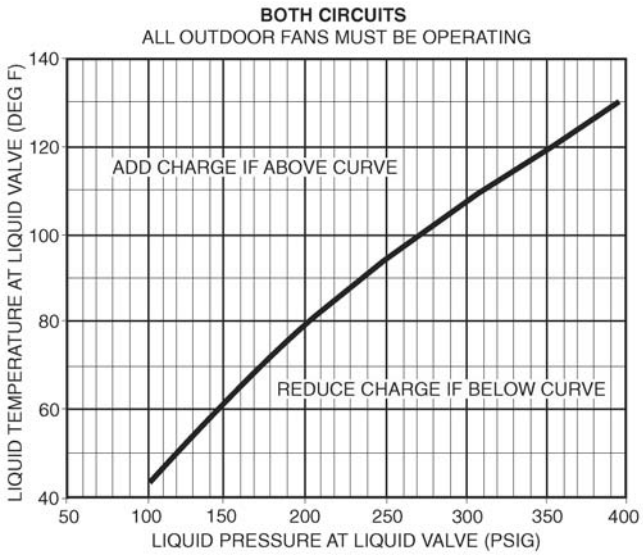
No Charge

Use standard evacuating techniques. After evacuating system, weigh in the specified amount of refrigerant (refer to Table 1).

Low Charge Cooling

Using cooling charging chart (see Fig. 29), add or remove refrigerant until conditions of the chart are met. Note that charging chart is different from those normally used. An accurate pressure gage and temperature-sensing device is required. Charging is accomplished by ensuring the proper amount of liquid subcooling. Measure liquid line pressure at the liquid line service valve using pressure gage. Connect temperature sensing device to the liquid line near the liquid line service valve and insulate it so that outdoor ambient temperature does not affect reading.

FIGURE 29 | **Cooling Charging Chart**



To Use the Cooling Charging Chart

Use the above temperature and pressure readings, and find the intersection point on the cooling charging chart. If intersection point on chart is above line, add refrigerant. If intersection point on chart is below line, carefully recover some of the charge. Recheck suction pressure as charge is adjusted.

NOTE: Indoor-air cfm must be within normal operating range of unit. All outdoor fans must be operating.

The TXV (thermostatic expansion valve) is set to maintain between 15 and 20 degrees of superheat at the compressors. The valves are factory set and should not require re-adjustment.

FILTER DRIER

Replace whenever refrigerant system is exposed to atmosphere.

PROTECTIVE DEVICES

Compressor Protection

Overtemperature

Each compressor has an internal protector to protect it against excessively high discharge gas temperatures.

Overcurrent

Each compressor has internal line break motor protection.

Crankcase Heater

All units are equipped with a 70-watt crankcase heater to prevent absorption of liquid refrigerant by oil in the crankcase when the compressor is idle. The crankcase heater is energized whenever there is main power to the unit and the compressor is not energized.

IMPORTANT: After prolonged shutdown or servicing, energize the crankcase heaters for 24 hours before starting the compressors.

Compressor Lockout

If any of the safeties (high-pressure, low-pressure, freeze protection thermostat, compressor internal thermostat) trip, or if there is loss of power to the compressors, the cooling lockout (CLO) will lock the compressors off. To reset, manually move the thermostat setting.

Evaporator Fan Motor Protection

A manual reset, calibrated trip, magnetic circuit breaker protects against overcurrent. Do not bypass connections or increase the size of the breaker to correct trouble. Determine the cause and correct it before resetting the breaker.

Condenser-Fan Motor Protection

Each condenser-fan motor is internally protected against overtemperature.

High and Low-Pressure Switches

If either switch trips, or if the compressor overtemperature switch activates, that refrigerant circuit will be automatically locked out by the CLO. To reset, manually move the thermostat setting.

Freeze Protection Thermostat (FPT)

An FPT is located on the top and bottom of the evaporator coil. They detect frost build-up and turn off the compressor, allowing the coil to clear. Once the frost has melted, the compressor can be reenergized by resetting the compressor lockout.

Relief Devices

All units have relief devices to protect against damage from excessive pressures (i.e., fire). These devices protect the high and low side.

Control Circuit, 24-V

This control circuit is protected against overcurrent by a 3.2 amp circuit breaker. Breaker can be reset. If it trips, determine cause of trouble before resetting. See Fig. 30 for typical wiring diagram.

Replacement Parts

A complete list of replacement parts may be obtained from your distributor upon request.

Optional Hinged Access Doors

When the optional service package is ordered or the if the hinged access doors option is ordered, the unit will be provided with external and internal hinged access doors to facilitate service.

Four external hinged access doors are provided. All external doors are provided with 2 large $^1/_4$ turn latches with folding bail-type handles. (Compressor access doors have one latch.) A single door is provided for filter and drive access. One door is provided for control box access. The control box access door is interlocked with the non-fused disconnect which must be in the OFF position to open the door. Two doors are provided for access to the compressor compartment.

Two internal access doors are provided inside the filter/drive access door. The filter access door (on the left) is secured by 2 small $^1/_4$ turn latches with folding bail-type handles. This door must be opened prior to opening the drive access door. The drive access door is shipped with 2 sheet metal screws holding the door closed. Upon initial opening of the door, these screws may be removed and discarded. The door is then held shut by the filter access door, which closes over it.

FIGURE 30 | **Typical Wiring Schematic**

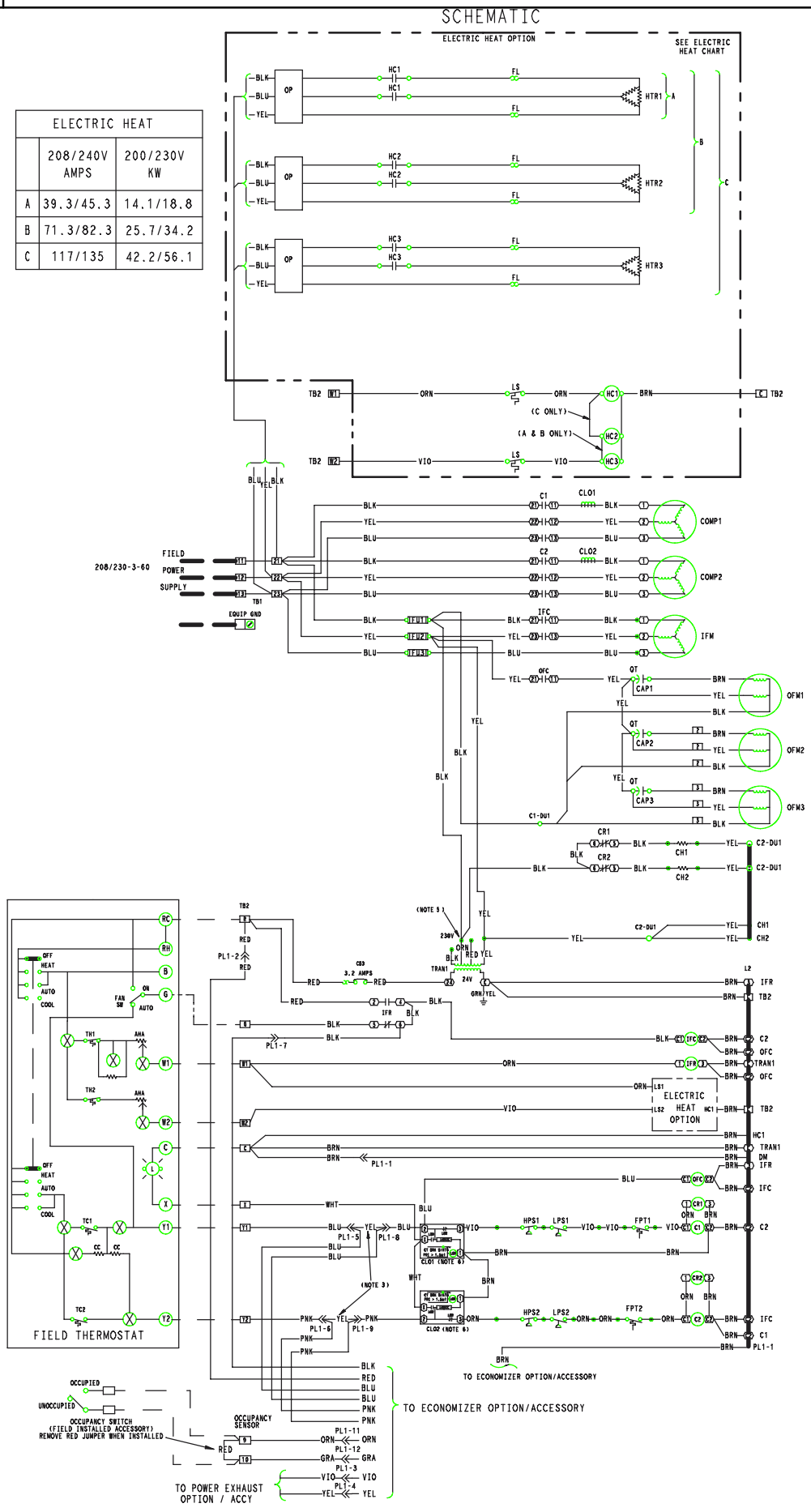
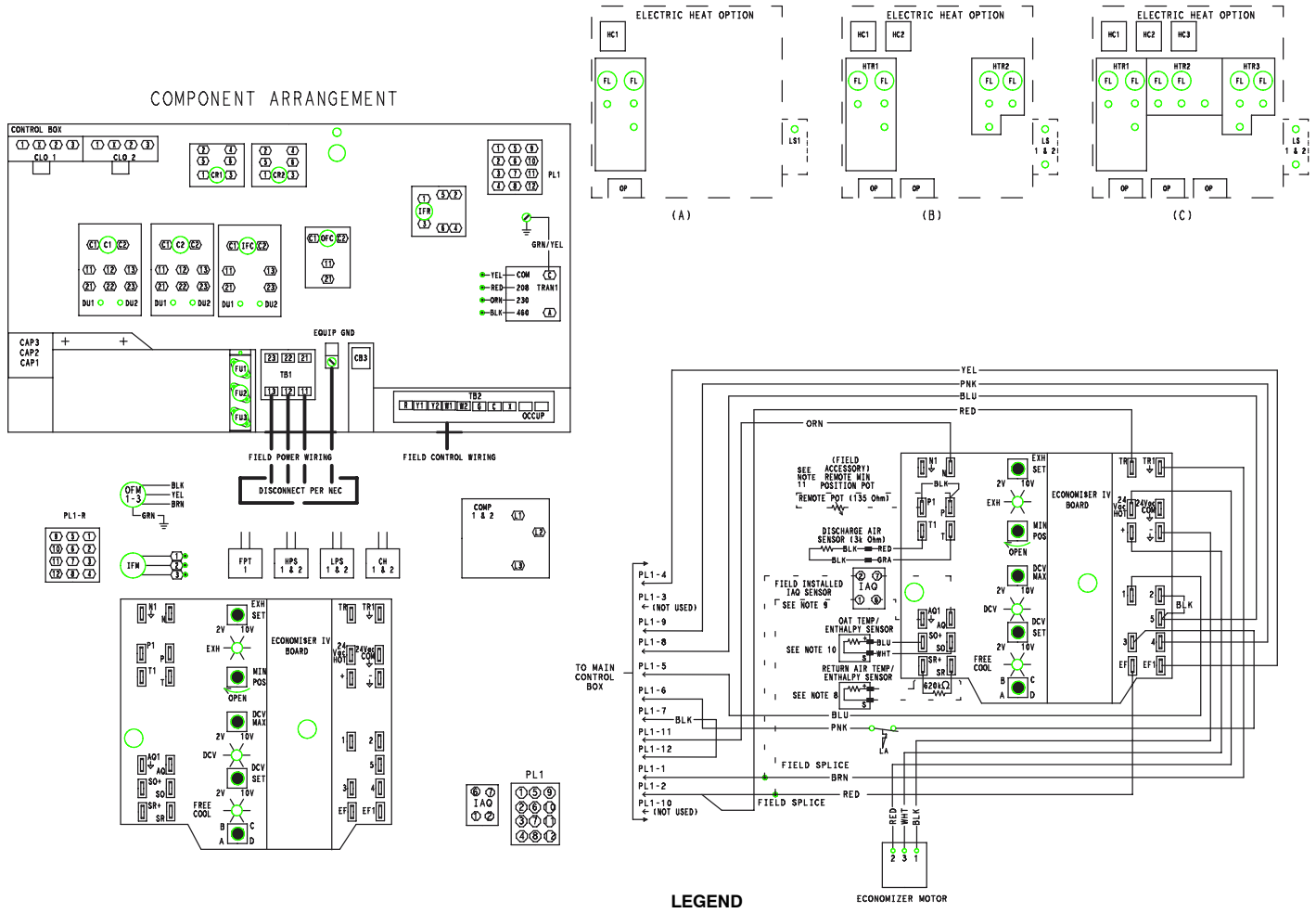


FIGURE 31 | **Typical Component Arrangement, PAH180 Shown**



AHA — Adjustable, Heat Anticipator
C — Contactor, Compressor
CAP — Capacitor
CB — Circuit Breaker
CC — Cooling Compensator
CH — Crankcase Heater
CLO — Compressor Lockout
COMP — Compressor Motor
CR — Control Relay
DM — Damper Motor
DU — Dummy T erminal
EQUIP — Equipment
FL — Fuse Link
FPT — Freeze Protection Thermostat
FU — Fuse
GND — Ground
HC — Heater Contactor
HPS — High-Pressure Switch
IAQ — Indoor Air Quality Sensor
IFC — Indoor Fan Contactor
IFM — Indoor Fan Motor
IFR — Indoor Fan Relay
L — Light
LALS — Low Temperature Compressor Lockout Switch
LLSV — Liquid Line Solenoid Valve

LOR — Lockout Relay
LPS — Low-Pressure Switch
LS — Limit Switch
NEC — National Electrical Code
OAT — Outdoor Air Temperature Sensor
OCCUP — Occupancy Sensor
OFC — Outdoor Fan Contactor
OFM — Outdoor Fan Motor
OP — Overload Protection
PL — Plug Assembly
PRI — Primary
QT — Quadruple Terminal
RAT — Return Air T emperature Sensor
SW — Switch
TB — Terminal Block
TC — Thermostat Cooling
TH — Thermostat Heating
TRAN — Transformer

Terminal (Marked)
Terminal (Unmarked)
Terminal Block
Splice

Factory Wiring
Field Control Wiring
Accessory or Optional Wiring
To indicate common potential only; not to represent wiring.
Economizer Motor
Remote POT Field Accessory
OAT Sensor
Disch Air Sensor
RAT Accessory Sensor
Low Ambient Lockout Switch

NOTES:
1. Compressor and/or fan motor(s) thermally protected. Three phase motors protected against primary single phasing conditions.
2. If any of the original wire furnished must be replaced, it must be replaced with Type 90° C or its equivalent.
3. Jumpers are omitted when unit is equipped with economizer.
4. IFCB must trip amps is equal to or less than 140% FLA.
5. On TRAN1 use BLK lead for 460-v power supply and ORN lead for 575-v power supply.
6. The CLO locks out the compressor to prevent short cycling on compressor overload and safety devices; before replacing CLO check these devices.
7. Number(s) indicates the line location of used contacts. A bracket over (2) numbers signifies a single pole, double throw contact. An underlined number signifies a normally closed contact. Plain (no line) number signifies a normally open contact.
8. 620 Ohm, 1 watt, 5% resistor should be removed only when using differential enthalpy or dry bulb.
9. If a separate field-supplied 24 v transformer is used for the IAQ sensor power supply, it cannot have the secondary of the transformer grounded.
10. OAT sensor is shipped inside unit and must be relocated in the field for proper operation.
11. For field installed remote minimum position POT. remove black wire jumper between P and P1 and set control minimum position POT to the minimum position.

TROUBLESHOOTING

Unit Troubleshooting

Refer to Table 17 and fig. 30 for unit troubleshooting information.

Economizer Troubleshooting

See Table 18 for economizer logic.

A functional view of the economizer is shown in Fig. 32. Typical settings, sensor ranges, and jumper positions are also shown.

Preparation

This procedure is used to prepare the economizer for troubleshooting. No troubleshooting or testing is done by performing the following procedure.

NOTE:This procedure requires a 9-v battery, 1.2 kilo-ohm resistor, and a 5.6 kilo-ohm resistor which are not supplied with the economizer.

IMPORTANT:Be sure to record the positions of all potentiometers before starting troubleshooting.

1. Disconnect power at TR and TR1. All LEDs should be off. Exhaust fan contacts should be open.
2. Disconnect device at P and P1.
3. Jumper P to P1.
4. Disconnect wires at T and T1. Place 5.6 kilo-ohm resistor across T and T1.
5. Jumper TR to 1.
6. Jumper TR to N.
7. If connected, remove sensor from terminals S_O and +. Connect 1.2 kilo-ohm 4074EJM checkout resistor across terminals S_O and +.
8. Put 620-ohm resistor across terminals S_R and +.
9. Set minimum position, DCV set point, and exhaust potentiometers fully CCW (counterclockwise).
10. Set DCV maximum position potentiometer fully CW (clockwise).
11. Set enthalpy potentiometer to D.
12. Apply power (24 vac) to terminals TR and TR1.

Differential Enthalpy

To check differential enthalpy:

1. Make sure economizer preparation procedure has been performed.
2. Set the enthalpy potentiometer to A (fully CCW). The Free Cool LED should be lit.
3. Set the enthalpy potentiometer to D (fully CW). The Free Cool LED should turn off.
4. Remove 620-ohm resistor across S_O and +. The Free Cool LED should turn off.
5. Return economizer settings and wiring to normal after completing troubleshooting.

Single Enthalpy

To check single enthalpy:

1. Make sure economizer preparation procedure has been performed.
2. Set the enthalpy potentiometer to A (fully CCW). The Free Cool LED should be lit.
3. Set the enthalpy potentiometer to D (fully CW). The Free Cool LED should turn off.
4. Return economizer settings and wiring to normal after completing troubleshooting.

DCV (Demand Controlled Ventilation) and Power Exhaust

To check DCV and Power Exhaust:

1. Make sure economizer preparation procedure has been performed.
2. Ensure terminals AQ and AQ1 are open. The LED for both DCV and Exhaust should be off. The actuator should be fully closed.
3. Connect a 9-v battery to AQ (positive node) and AQ1 (negative node). The LED for both DCV and Exhaust should turn on. The actuator should drive to between 90 and 95% open.
4. Turn the Exhaust potentiometer CW until the Exhaust LED turns off. The LED should turn off when the potentiometer is approximately 90%. The actuator should remain in position.
5. Turn the DCV set point potentiometer CW until the DCV LED turns off. The DCV LED should turn off when the potentiometer is approximately 9 v. The actuator should drive fully closed.
6. Turn the DCV and Exhaust potentiometers CCW until the Exhaust LED turns on. The exhaust contacts will close 30 to 120 seconds after the Exhaust LED turns on.
7. Return economizer settings and wiring to normal after completing troubleshooting.

DCV Minimum and Maximum Position

To check the DCV minimum and maximum position:

1. Make sure economizer preparation procedure has been performed.
2. Connect a 9-v battery to AQ (positive node) and AQ1 (negative node). The DCV LED should turn on. The actuator should drive to between 90 and 95% open.
3. Turn the DCV Maximum Position potentiometer to midpoint. The actuator should drive to between 20 and 80% open.
4. Turn the DCV Maximum Position potentiometer to fully CCW. The actuator should drive fully closed.
5. Turn the Minimum Position potentiometer to midpoint. The actuator should drive to between 20 and 80% open.
6. Turn the Minimum Position Potentiometer fully CW. The actuator should drive fully open.
7. Remove the jumper from TR and N. The actuator should drive fully closed.
8. Return economizer settings and wiring to normal after completing troubleshooting.

Supply-air Input

To check supply-air input:

1. Make sure economizer preparation procedure has been performed.
2. Set the Enthalpy potentiometer to A. The Free Cool LED turns on. The actuator should drive to between 20 and 80% open.
3. Remove the 5.6 kilo-ohm resistor and jumper T to T1. The actuator should drive fully open.
4. Remove the jumper across T and T1. The actuator should drive fully closed.

5. Return economizer settings and wiring to normal after completing troubleshooting.

Economizer Troubleshooting Completion

This procedure is used to return the economizer to operation. No troubleshooting or testing is done by performing the following procedure.

1. Disconnect power at TR and TR1.
2. Set enthalpy potentiometer to previous setting.
3. Set DCV maximum position potentiometer to previous setting.
4. Set minimum position, DCV set point, and exhaust potentiometers to previous settings.
5. Remove 620-ohm resistor from terminals S_R and +.
6. Remove 1.2 kilo-ohm checkout resistor from terminals S_O and +. If used, reconnect sensor from terminals S_O and +.
7. Remove jumper from TR to N.
8. Remove jumper from TR to 1.
9. Remove 5.6 kilo-ohm resistor from T and T1. Reconnect wires at T and T1.
10. Remove jumper from P to P1. Reconnect device at P and P1.
11. Apply power (24 vac) to terminals TR and TR1.

Table 17 — Cooling Service Analysis

PROBLEM	CAUSE	REMEDY
Compressor and Condenser Fan Will Not Start.	Power failure.	Call power company.
	Fuse blown or circuit breaker tripped.	Replace fuse or reset circuit breaker.
	Defective thermostat, contactor, transformer, or control relay.	Replace component.
	Insufficient line voltage.	Determine cause and correct.
	Incorrect or faulty wiring.	Check wiring diagram and rewire correctly.
	Thermostat setting too high.	Lower thermostat setting below room temperature.
Compressor Will Not Start but Condenser Fan Runs.	Faulty wiring or loose connections in compressor circuit.	Check wiring and repair or replace.
	Compressor motor burned out, seized, or internal overload open.	Determine cause. Replace compressor.
	Defective overload.	Determine cause and replace.
	Compressor locked out	Determine cause for safety trip and reset lockout.
	One leg of 3-phase power dead.	Replace fuse or reset circuit breaker. Determine cause.
Compressor Cycles (other than normally satisfying thermostat).	Refrigerant overcharge or undercharge.	Recover refrigerant, evacuate system, and recharge to nameplate.
	Defective compressor.	Replace and determine cause.
	Insufficient line voltage.	Determine cause and correct.
	Blocked condenser.	Determine cause and correct.
	Defective overload.	Determine cause and replace.
	Defective thermostat.	Replace thermostat.
	Faulty condenser-fan motor.	Replace.
	Restriction in refrigerant system.	Locate restriction and remove.
Compressor Operates continuously.	Dirty air filter.	Replace filter.
	Unit undersized for load.	Decrease load or increase unit size.
	Thermostat set too low.	Reset thermostat.
	Low refrigerant charge.	Locate leak, repair, and recharge.
	Air in system.	Recover refrigerant, evacuate system, and recharge.
	Condenser coil dirty or restricted.	Clean coil or remove restriction.
Excessive Head Pressure.	Dirty air filter.	Replace filter.
	Dirty condenser coil.	Clean coil.
	Refrigerant overcharged.	Recover excess refrigerant.
	Faulty TXV.	1. Check TXV bulb mounting and secure tightly to suction line. 2. Replace TXV if stuck open or closed.
	Air in system.	Recover refrigerant, evacuate system, and recharge.
	Condenser air restricted or air short-cycling.	Determine cause and correct.
Head Pressure Too Low.	Low refrigerant charge.	Check for leaks, repair, and recharge.
	Restriction in liquid tube.	Remove restriction.
Excessive Suction Pressure.	High heat load.	Check for source and eliminate.
	Faulty TXV.	1. Check TXV bulb mounting and secure tightly to suction line. 2. Replace TXV if stuck open or closed.
	Refrigerant overcharged.	Recover excess refrigerant.
Suction Pressure Too Low.	Dirty air filter.	Replace filter.
	Low refrigerant charge.	Check for leaks, repair, and recharge.
	Metering device or low side restricted.	Remove source of restriction.
	Faulty TXV.	1. Check TXV bulb mounting and secure tightly to suction line. 2. Replace TXV if stuck open or closed.
	Insufficient evaporator airflow.	Increase air quantity. Check filter and replace if necessary.
	Temperature too low in conditioned area.	Reset thermostat.
	Field-installed filter drier restricted.	Replace.

LEGEND

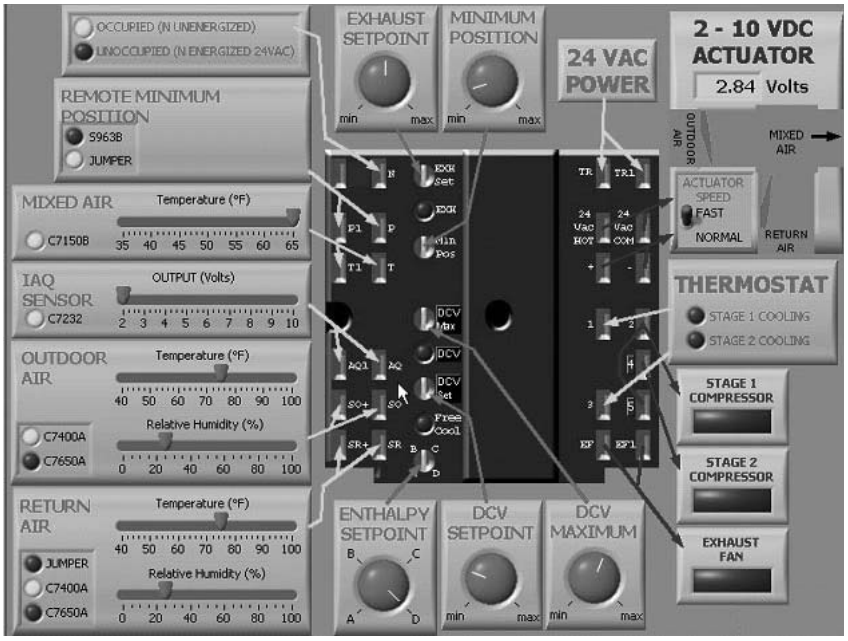
TXV — Thermostatic Expansion Valve

TABLE 18 — ECONOMIZER INPUT/OUTPUT LOGIC

INPUTS					OUTPUTS			
Demand Control Ventilation (DCV)	Enthalpy*		Y1	Y2	Compressor		N Terminal†	
	Outdoor	Return			Stage 1	Stage 2	Occupied	Unoccupied
							Damper	
Below set (DCV LED Off)	High (Free Cooling LED Off)	Low	On	On	On	On	Minimum position	Closed
			On	Off	On	Off		
			Off	Off	Off	Off		
	Low (Free Cooling LED On)	High	On	On	On	Off	Modulating** (between min. position and full-open)	Modulating** (between closed and full-open)
			On	Off	Off	Off		
			Off	Off	Off	Off	Minimum position	Closed
Above set (DCV LED On)	High (Free Cooling LED Off)	Low	On	On	On	On	Modulating†† (between min. position and DCV maximum)	Modulating†† (between closed and DCV maximum)
			On	Off	On	Off		
			Off	Off	Off	Off		
	Low (Free Cooling LED On)	High	On	On	On	Off	Modulating***	Modulating†††
			On	Off	Off	Off		
			Off	Off	Off	Off		

*For single enthalpy control, the module compares outdoor enthalpy to the ABCD set point.
† Power at N terminal determines Occupied/Unoccupied setting: 24 vac (Occupied), no power (Unoccupied).
** Modulation is based on the supply-air sensor signal.
†† Modulation is based on the DCV signal.
***Modulation is based on the greater of DCV and supply-air sensor signals, between minimum position and either maximum position (DCV) or fully open (supply-air signal).
††† Modulation is based on the greater of DCV and mixed air sensor signals, between closed and either maximum position (DCV) or fully open (supply-air signal).

FIGURE 32 **Economizer Functional View**



START-UP CHECKLIST
(Remove and Store in Job File)

MODEL NO.: _____ DATE: _____

SERIAL NO.: _____ TECHNICIAN: _____

I. PRE-START-UP

- ☐ VERIFY THAT ALL PACKING MATERIALS HAVE BEEN REMOVED FROM UNIT
- ☐ VERIFY PROPER ADJUSTMENT OF INDOOR FAN MOTOR ADJUSTMENT BOLT
- ☐ VERIFY INSTALLATION OF OUTDOOR-AIR HOOD
- ☐ VERIFY INSTALLATION OF FLUE HOOD AND WIND BAFFLE
- ☐ VERIFY THAT CONDENSATE CONNECTION IS INSTALLED PER INSTRUCTIONS
- ☐ VERIFY THAT ALL ELECTRICAL CONNECTIONS AND TERMINALS ARE TIGHT
- ☐ CHECK THAT AIR INLET FILTERS ARE CLEAN AND IN PLACE
- ☐ VERIFY THAT UNIT IS LEVEL
- ☐ CHECK FAN WHEEL AND PROPELLER FOR LOCATION IN HOUSING/ORIFICE, AND VERIFY SET SCREW IS TIGHT
- ☐ VERIFY THAT FAN SHEAVES ARE ALIGNED AND BELTS ARE PROPERLY TENSIONED
- ☐ VERIFY THAT SCROLL COMPRESSOR IS ROTATING IN THE CORRECT DIRECTION
- ☐ VERIFY THAT CRANKCASE HEATERS HAVE BEEN ENERGIZED FOR AL LEAST 24 HOURS

II. START-UP

ELECTRICAL

SUPPLY VOLTAGE L1-L2 _____ L2-L3 _____ L3-L1 _____

COMPRESSOR AMPS - COMPRESSOR NO. 1 L1 _____ L2 _____ L3 _____

INDOOR-FAN AMPS - COMPRESSOR NO. 2 L1 _____ L2 _____ L3 _____

SUPPLY FAN AMPS _____ EXHAUST FAN AMPS _____

TEMPERATURES

OUTDOOR-AIR TEMPERATURE _____ F DB (Dry-Bulb)

RETURN-AIR TEMPERATURE _____ F DB _____ F WB (Wet-Bulb)

COOLING SUPPLY AIR _____ F

ELECTRIC HEAT SUPPLY AIR _____ F

PRESSURES (COOLING MODE)

REFRIGERANT SUCTION CIRCUIT NO. 1 _____ PSIG CIRCUIT NO. 2 (180 ONLY) _____ PSIG

REFRIGERANT DISCHARGE CIRCUIT NO. 1 _____ PSIG CIRCUIT NO. 2 (180 ONLY) _____ PSIG

- ☐ VERIFY REFRIGERANT CHARGE USING CHARGING CHARTS

GENERAL

- ☐ ECONOMIZER MINIMUM VENT AND CHANGEOVER SETTINGS TO JOB REQUIREMENTS