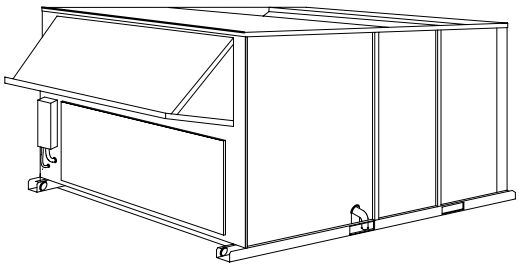
Installation Instructions

PHH Series – 3 Phase
12–1/2 & 15 Ton



PACKAGED HEAT PUMP UNITS

PRINTED IN MEXICO

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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.

⚠ 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.

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.

PROVIDE UNIT SUPPORT

Roofcurb

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

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

Curb should be level. This is necessary to permit unit drain to function properly. Unit leveling tolerances is ± $^1/_{16}$ in. per linear ft in any direction. Refer to Accessory Roof Curb Installation Instructions for additional information as required.

Alternate Unit Support

When the curb cannot be used, support unit with sleepers using unit curb support area. If sleepers 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 ± $^1/_{16}$ in. per linear ft in any direction. 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 and 4).

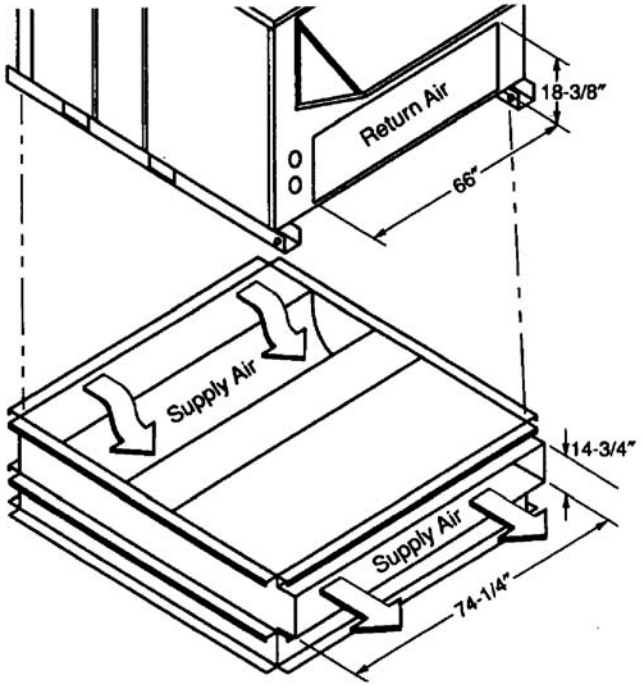
Do not install unit in an indoor location. Do not locate air inlets near exhaust vents or other sources of contaminated air.

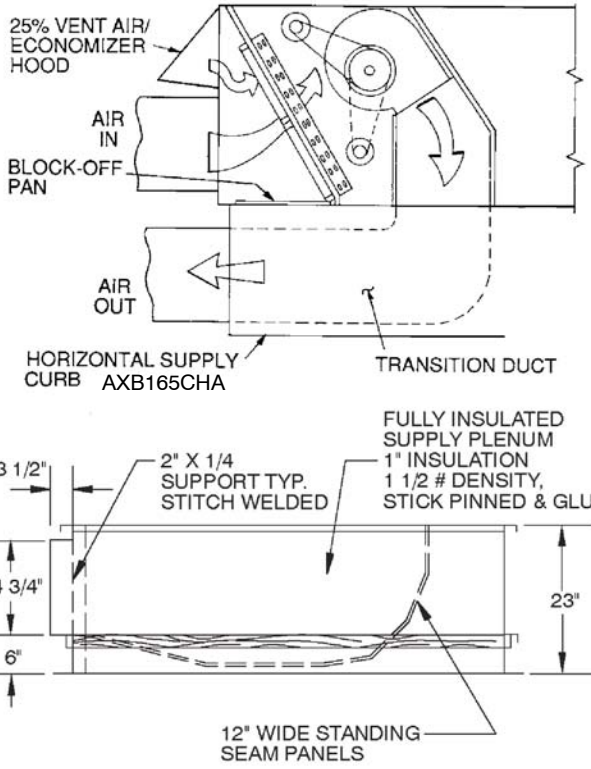
Although unit is weatherproof, guard against water from higher level runoff and overhangs.

Roof Mount

Check building codes for weight distribution requirements.

FIGURE 1 | **Horizontal Supply/ Return Adapter Installation**

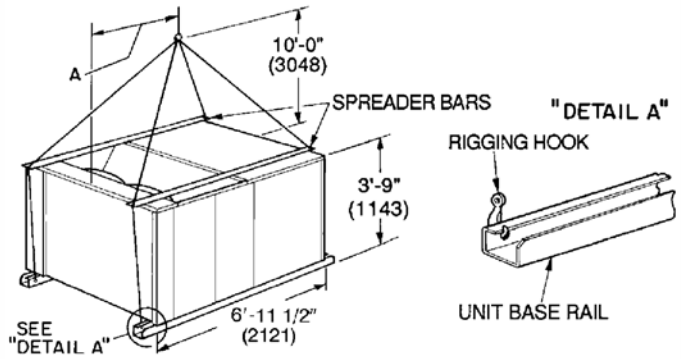




NOTE: AXB165CHA is a fully factory preassembled horizontal adapter and includes an insulated transition duct. The pressure drop through the adapter curb is negligible.
For horizontal return applications: The power exhaust and barometric relief dampers must be installed in the return air duct.

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

FIGURE 2 | **Rigging Details**



UNIT PHH	MAXIMUM SHIPPING WEIGHT		DIMENSION A	
	lb	kg	ft-in.	mm
150	1895	860	3-1	948
180	2205	1000	3-6	1059

NOTES:
1. Dimensions in ( ) are in millimeters.
2. Refer to Table 1 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. See Table 1 for economizer weight.
6. Weights given are for aluminum indoor coil plate fins and copper outdoor coil plate fins. Weights of other metal combinations are listed in Table 1.

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 PHH 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. 5. Field-fabricated concentric ductwork may be connected as shown in Fig. 6 and 7.

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 or 4 and 8 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 indoor air 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. 9). A trap at least 4-in. deep must be used.

Table 1 – Physical Data – PHH150–180

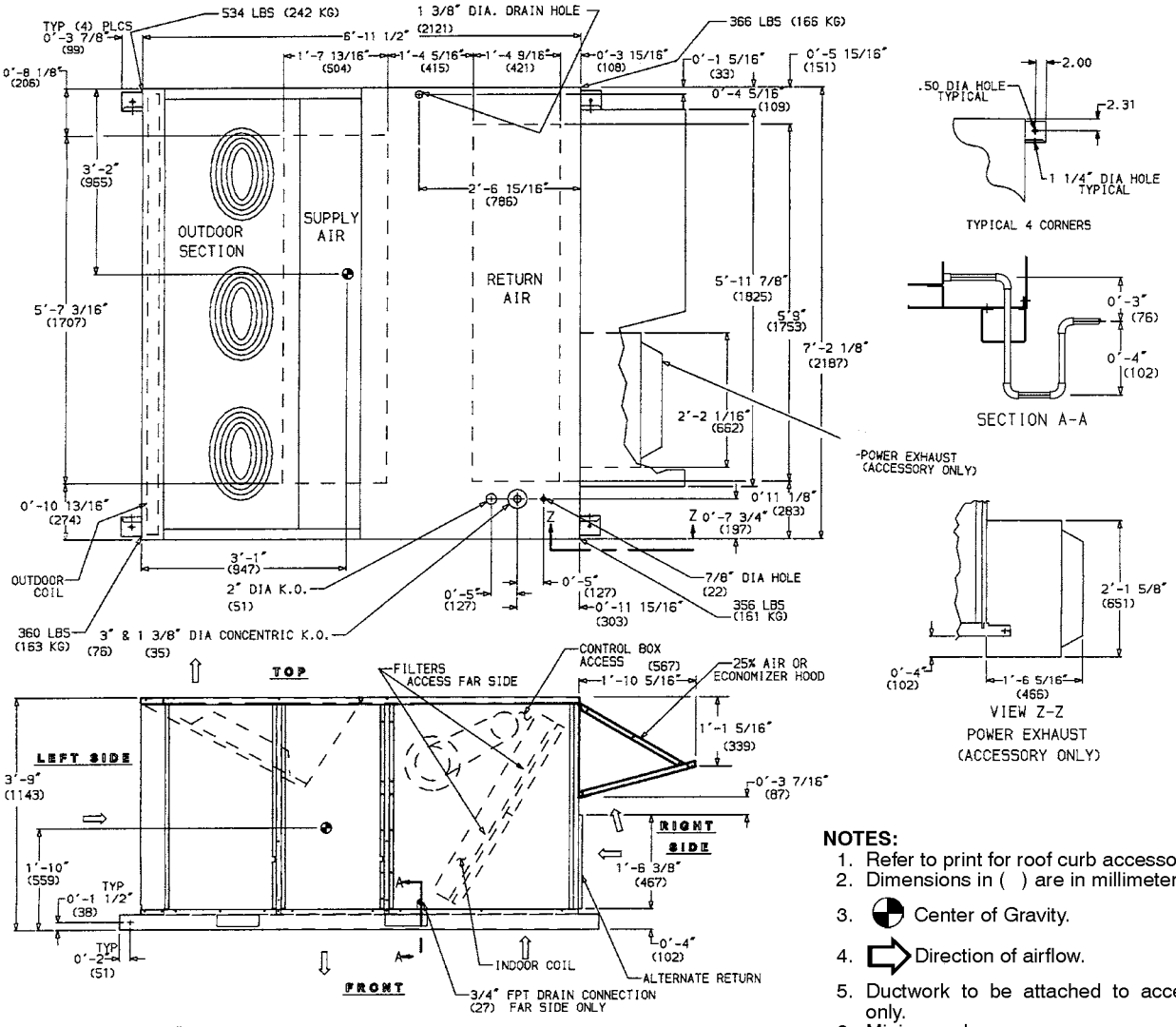
UNIT SIZE PHH	150	180
NOMINAL CAPACITY (tons)	$12^{1}/_{2}$	15
OPERATING WT (lb)		
Al*	1615	1925
Cu*	1815	2165
Electric Heat	65	65
Economizer	90	90
Roof Curb†	200	200
COMPRESSOR	Semi-Hermetic	
Type (Number)	06D-328 (1)	06D-818 (2)
Cylinders	6	4
Oil Change (oz.) (each circuit)	115	88
REFRIGERANT TYPE	R-22	
Charge (lb)		
System 1	26.0	16.5
System 2	—	16.5
OUTDOOR COIL	$^{3}/_{8}$ in., Internally Grooved Copper Tubes, Aluminum or Copper Lanced Fins	
Rows	3	3
Fins/in.	15	15
Total Face Area (sq ft)	21.7	21.7
OUTDOOR FAN	Propeller Type, Direct Drive	
Nominal Cfm	9,000	9,000
Number...Diameter (in.)	3...22	3...22
Motor Hp (1075 rpm)	$^{1}/_{2}$	$^{1}/_{2}$
Watts Input (Total)	1090	1090
INDOOR COIL	$^{3}/_{8}$ in., Internally Grooved Copper Tubes, Aluminum or Copper Lanced Fins, Face Split	
Expansion Device	Fixed Orifice	
Rows	3	3
Fins/in.	15	15
Total Face Area (sq ft)	17.5	17.5
INDOOR FAN	Centrifugal, Adjustable Pitch Belt Drive	
Quantity...Size (in.)	2...10 x 10	2...12 x 12
Nominal Cfm	5000	6000
Maximum Continuous Bhp	4.25	5.90
Fan Rpm Range	862-1132	799-1010
Maximum Allowable Rpm	1550	1550
Motor Pulley Pitch Diameter (in.)	3.1/4.1	3.7/4.7
Fan Pulley Pitch Diameter (in.)	6.0	11.4
Belt, Quantity...Type...Length (in.)	1...BX...42	1...BX...46
Pulley Center Line Distance (in.)	13.5-15.5	13.3-14.8
Speed Change Per Turn (rpm)	54	42
Pulley Maximum Full Turns	6**	6**
Factory Pulley Turns Setting	3	3
Factory Speed Setting (rpm)	1024	926
Fan Shaft Diameter (in.)	$1^{3}/_{16}$	$1^{7}/_{16}$
Motor Hp (Service Factor)	3.7 (1.15)	5.0 (1.15)
Motor Frame Size	56H	184T
Motor Efficiency	0.84	0.84

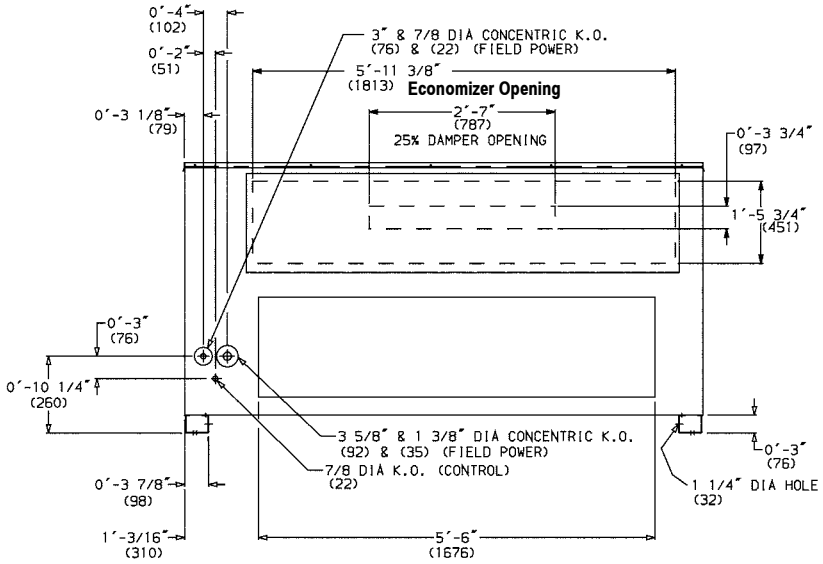
Table 1 – Physical Data – PHH150–180

HIGH-PRESSURE SWITCH	
Cutout (psig)	426
Reset (psig)	320
LOW-PRESSURE/LOSS-OF-CHARGE SWITCH	
Cutout (psig)	7
Reset (psig)	22
AIR INLET SCREENS	Cleanable
Economizer, Quantity...Size (in.)	2...20 x 25 x 1
	1...20 x 20 x 1
RETURN-AIR FILTERS (TYPE)	10% Efficient — 2-in. Throwaway Fiberglass
Quantity...Size (in.)	4...20 x 20 x 2
	4...16 x 20 x 2
DEFROST THERMOSTAT	
Defrost Time	30 min (Adjustable to 50 or 90 min)
Closes (F)	28
Opens (F)	65

LEGEND
Al – Aluminum
Cu – Copper
*Outdoor coil fin material.
†Weight of 14 in. roof curb.
**Pulley cannot be run at 0 or $^1/_2$ turns open.

FIGURE 3 | **Base Unit Dimensions, PHH150**



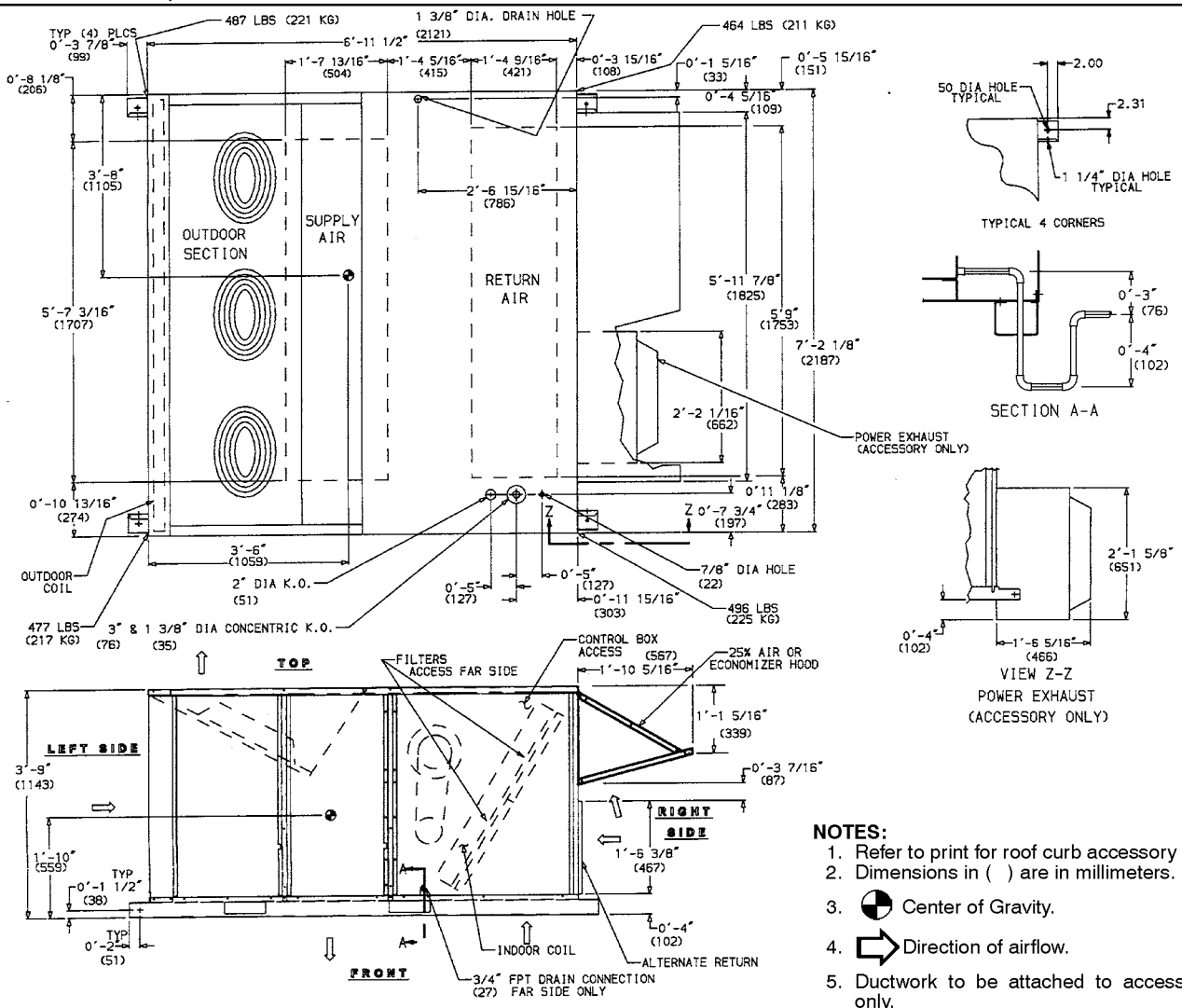


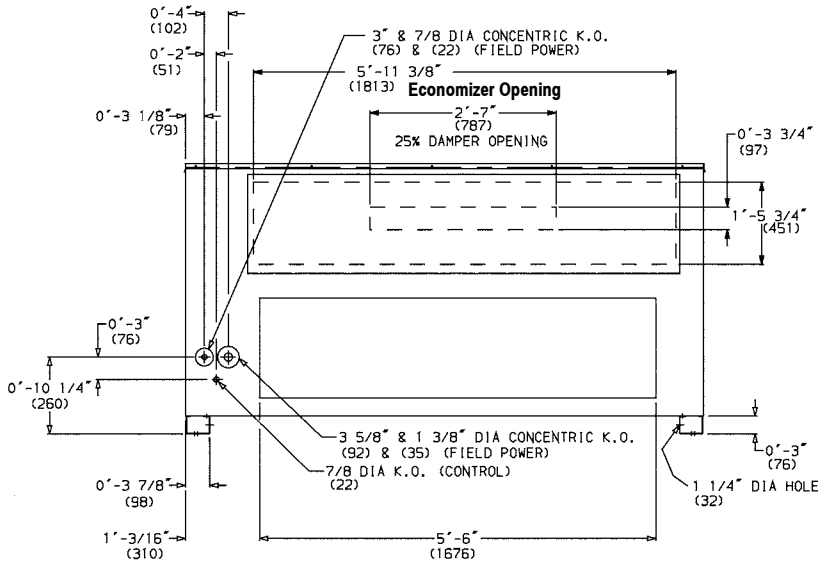
NOTES:

1. Refer to print for roof curb accessory dimensions.
2. Dimensions in ( ) are in millimeters.
3. ⊕ Center of Gravity.
4. ⇨ Direction of airflow.
5. Ductwork to be attached to accessory roof curb only.
6. Minimum clearance:
   - Rear: 7′-0″ (2134) for coil removal. This dimension can be reduced to 4′-0″ (1219) if conditions permit coil removal from the top.
   - Left side: 4′-0″ (1219) for proper outdoor coil airflow.
   - Front: 4′-0″ (1219) for control box access.
   - Right side: 4′-0″ (1219) for proper operation of damper and power exhaust (if so equipped).
   - Top: 6′-0″ (1829) to assure proper outdoor fan operation.
   - Local codes or jurisdiction may prevail.
7. With the exception of clearance for the outdoor coil and the damper/power exhaust as stated in note no. 6, a removable fence or barricade requires no clearance.
8. Dimensions are from outside of corner post. Allow $0'\text{-}^{5}/_{16}''$ (8) on each side for top cover drip edge.
9. A 90 degree elbow must be installed on the supply ductwork below the unit discharge for units equipped with electric heat.

STANDARD UNIT WEIGHT	ECONOMIZER WEIGHT
1615 lb (733 kg)	90 lb (41 kg)

FIGURE 4 | **Base Unit Dimensions, PHH180**



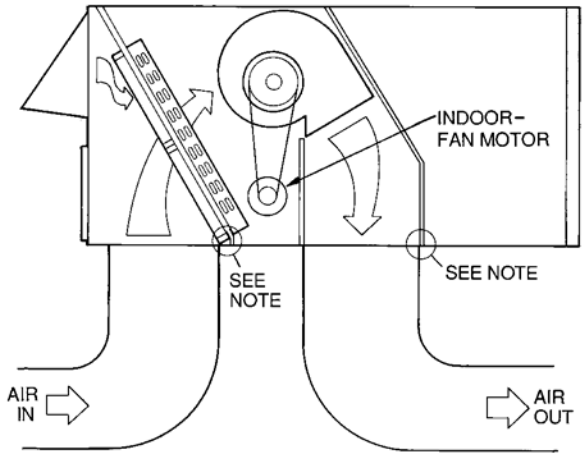


NOTES:

1. Refer to print for roof curb accessory dimensions.
2. Dimensions in ( ) are in millimeters.
3. Center of Gravity.
4. Direction of airflow.
5. Ductwork to be attached to accessory roof curb only.
6. Minimum clearance:
   - Rear: 7′-0″ (2134) for coil removal. This dimension can be reduced to 4′-0″ (1219) if conditions permit coil removal from the top.
   - Left side: 4′-0″ (1219) for proper outdoor coil airflow.
   - Front: 4′-0″ (1219) for control box access.
   - Right side: 4′-0″ (1219) for proper operation of damper and power exhaust (if so equipped).
   - Top: 6′-0″ (1829) to assure proper outdoor fan operation.
   - Local codes or jurisdiction may prevail.
7. With the exception of clearance for the outdoor coil and the damper/power exhaust as stated in note no. 6, a removable fence or barricade requires no clearance.
8. Dimensions are from outside of corner post. Allow $0'\text{-}^{5}/_{16}''$ (8) on each side for top cover drip edge.
9. A 90 degree elbow must be installed on the supply ductwork below the unit discharge for units equipped with electric heat.

STANDARD UNIT WEIGHT	ECONOMIZER WEIGHT
1925 lb (874 kg)	90 lb (41 kg)

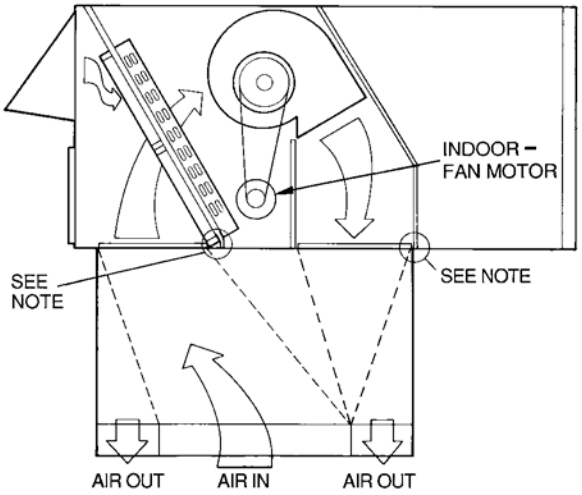
FIGURE 5 Air Distribution , Thru-the-Bottom



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

(PHH180 SHOWN)

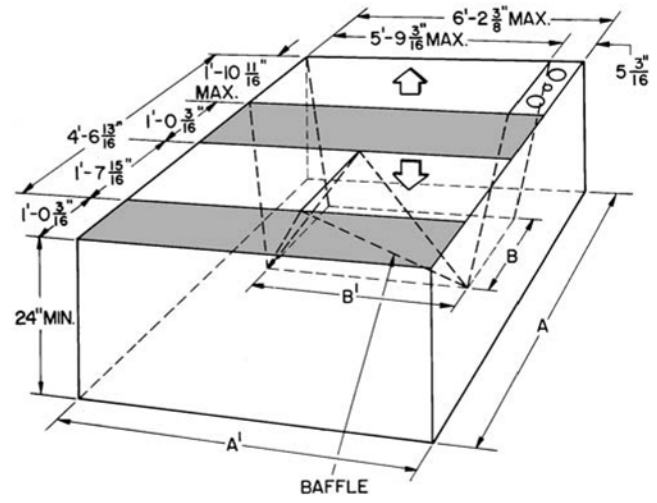
FIGURE 6 Concentric Duct Air Distribution



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

(PHH180 SHOWN)

FIGURE 7 Concentric Duct Details



Shaded area indicates block-off panels.

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

Make Electrical Connections

Field Power Supply

Unit is factory wired for voltage shown on nameplate.

When installing units, provide a disconnect of adequate size per NEC (National Electrical Code) requirements (Table 2).

All field wiring must comply with NEC and local requirements.

Route power lines through control box access panel or unit basepan (Fig. 3 and 4) to connections as shown on unit wiring diagram and Fig. 10.

Transformers no. 1 and 2 are wired for 230-v unit. If 208/203-v unit is to be run with 208-v power supply, the transformers must be rewired as follows:

1. Remove cap from red (208 v) wire.
2. Remove cap from orange (230 v) spliced wire.
3. Replace orange wire with red wire.
4. Recap both wires.

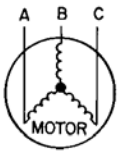
IMPORTANT: BE CERTAIN UNUSED WIRES ARE CAPPED. Failure to do so may damage the transformers.

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%.

Use the following formula to determine the percentage of voltage imbalance.

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

EXAMPLE: Supply voltage is 460-3-60.



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

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

$$= \frac{1371}{3}$$

$$= 457$$

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.

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.

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

FIGURE 8 **Condensate Drain Details**

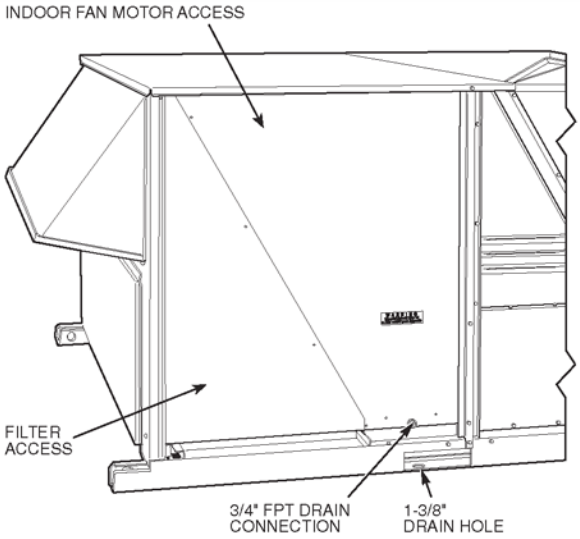


FIGURE 9 **Condensate Drain Piping Details**

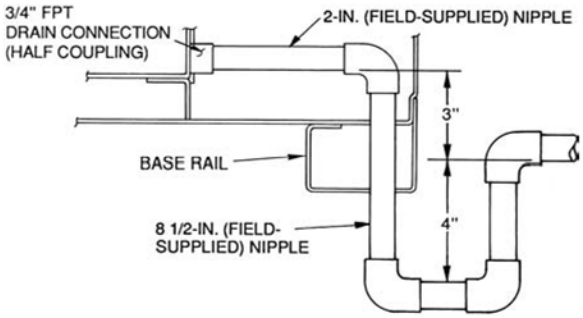
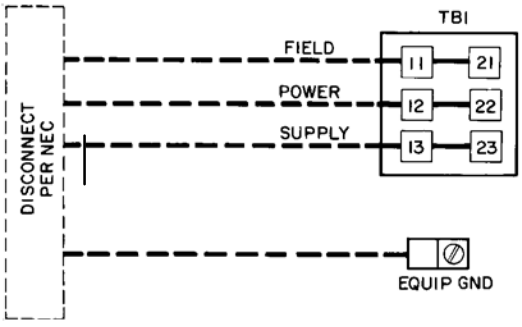


FIGURE 10 **Field Power Wiring Connections**



LEGEND

EQUIP GND	— Equipment Ground
kcmil	— Thousand Circular Mils
NEC	— National Electrical
TB	— Terminal Block

NOTE: The maximum wire size for TB1 is 350 kcmil for all unit voltages.

Field Control Wiring

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

Route thermostat cable or equivalent single leads of no. 18 AWG (American Wire Gage) colored wire from subbase terminals through conduit in unit to low-voltage connections as shown on unit label wiring diagram and in Fig. 11.

NOTE: For wire runs up to 50 ft, use no. 18 AWG 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 to the thermostat and will require a junction box and splice at the thermostat.

Set heat anticipator settings as indicated in Table 3. Settings may be changed slightly to provide a greater degree of comfort for a particular installation.

Optional Non-Fused Disconnect

On units with the optional non-fused disconnect, incoming power will be wired into the disconnect switch. Refer to Fig. 12 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.

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.

Table 2 - Electrical Data

Unit PHH	Voltage (3 Ph, 60 Hz)	Voltage Range		Compressor No. 1		Compressor No. 2		OFM		I FM		Power Exhaust		Electric Heat*		Power Supply		Disconnect Sizing	
		Min	Max	RLA	LRA	RLA	LRA	Qty	FLA (ea)	Hp	FLA	FLA	LRA	FLA	kW	MCA	MOCP†	RLA	LRA
150	208/230	187	253	39.7	228	—	—	3	1.7	3.7	10.5/10.5	—	—	—/—	—/—	65/ 65	100/100	64/64	387/387
														39/45	14/19	114/122	125/150	64/64	
														72/82	26/34	155/168	175/175	94/107	
														117/135	42/56	211/200	225/225	147/167	
												4.6	18.8	—/—	—/—	70/ 70	100/100	69/69	406/406
														39/45	14/19	119/126	125/150	69/69	
														72/82	26/34	159/173	175/175	100/112	
														117/135	42/56	216/205	225/225	152/173	
	460	414	508	19.9	114	—	—	3	0.8	3.7	4.8	—	—	—	—	32	50	31	189
														18	15	54	60	31	
														39	32	81	90	50	
														66	55	98	110	82	
												2.3	6.0	—	—	34	50	34	195
														18	15	57	70	34	
														39	32	83	90	53	
														66	55	100	110	84	
180	208/230	187	253	28.2	160	28.2	160	3	1.7	5	15.8/15.8	—	—	—/—	—/—	84/84	110/110	89/89	499/485
														72/82	26/34	174/187	175/200	101/112	
														117/135	42/56	231/219	250/225	153/173	
												4.6	18.8	—/—	—/—	89/89	110/110	94/94	518/504
														72/82	26/34	179/191	200/200	106/118	
														117/135	42/56	235/224	250/225	158/179	
	460	414	508	14.1	80	14.1	80	3	0.8	5	7.9	—	—	—	—	42	50	44	238
														39	32	91	100	54	
														66	55	108	110	85	
												2.3	6.0	—	—	44	50	47	244
														39	32	93	100	57	
														66	55	110	125	88	

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

*Heater capacity (kW) is based on heater voltage of 208 v, 240 v, or 480 v. If power distribution voltage to unit varies from rated heater voltage, heater kW will vary accordingly.

†Fuse or HACR circuit breaker. This is the maximum size permissible; smaller fuse size may be used where conditions permit.

NOTES:
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. The Canadian units may be fuse or circuit breaker.
2. MCA calculation for units with electric heaters over 50 kW = (1.25 x IFM amps) + (1.00 x heater FLA).

FIGURE 11 | **Field Control Thermostat Wiring**

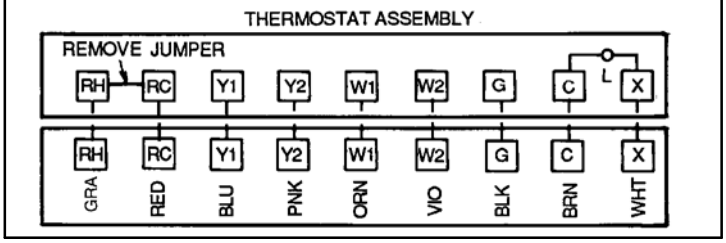
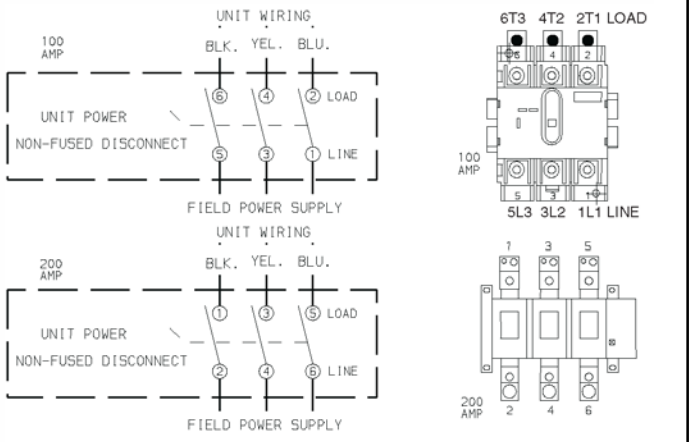


Table 3 - Heat Anticipator Settings

UNIT PHH	UNIT VOLTAGE	HEATER kW	STAGE 1	STAGE 2
150	208/230-3-60	14/19	.40	—
		26/34	.40	.40
		42/56	.66	.40
	460	15	.40	—
		32	.40	.40
		55	.40	.66
180	208/230	26/34	.40	.66
		42/56	.66	.40
	460	32	.40	.40
		55	.40	.66

FIGURE 12 **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.

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. 13).

INSTALL OUTDOOR-AIR HOOD

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.

The same type of factory-installed hood is used on units with 25% air ventilation and units with an economizer.

NOTE: The hood top panel, upper and lower filter retainers, hood drain pan, 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. 14).

1. Attach seal strip to upper filter retainer. See Fig. 15.
2. Assemble hood top panel and side panels, upper filter retainer, and hood drain pan (Fig. 16).
3. Secure lower filter retainer and long section of filter support bracket to unit. See Fig. 16.
4. Loosen sheet metal screws for base unit top panel located above outdoor-air inlet opening, and remove screws for hood side panels located on the sides of the outdoor-air inlet opening.
5. Match notches in hood top panel to unit top panel screws. Insert hood flange between unit top panel flange and unit. Tighten screws.
6. Hold hood side panel flanges flat against unit, and install screws removed in Step 4.
7. Insert outdoor-air inlet screens and spacer in channel created by lower filter retainer and filter support bracket.
8. Attach remaining short section of filter support bracket.

INSTALL ALL ACCESSORIES

After all the factory-installed options have been adjusted, install all field-installed accessories. Refer to the accessory installation instructions included with each accessory.

FIGURE 13 **25% Outdoor Air Section Details**

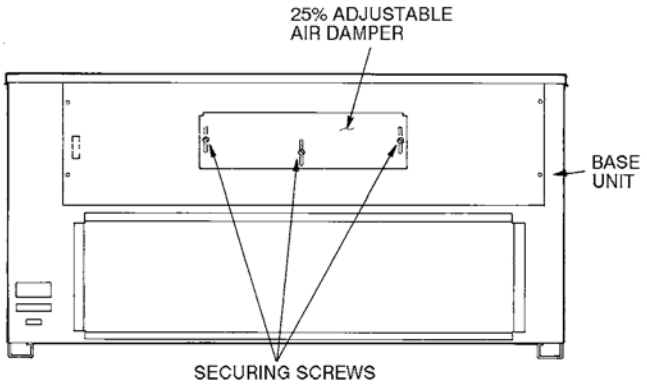


FIGURE 14 **Outdoor Air Hood Component Location**

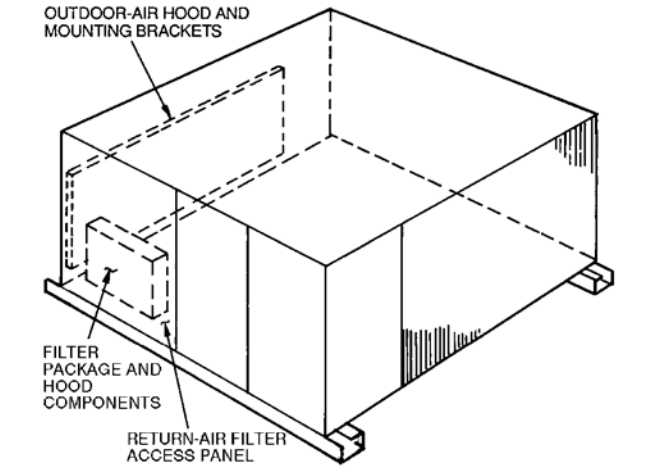


FIGURE 15 **Seal Strip Location**

Air Hood Cross-Sectional View

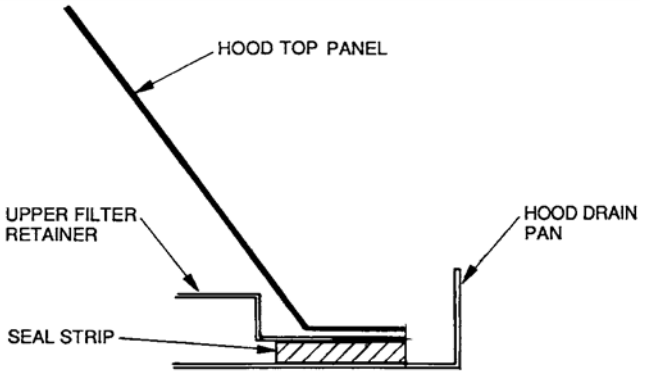
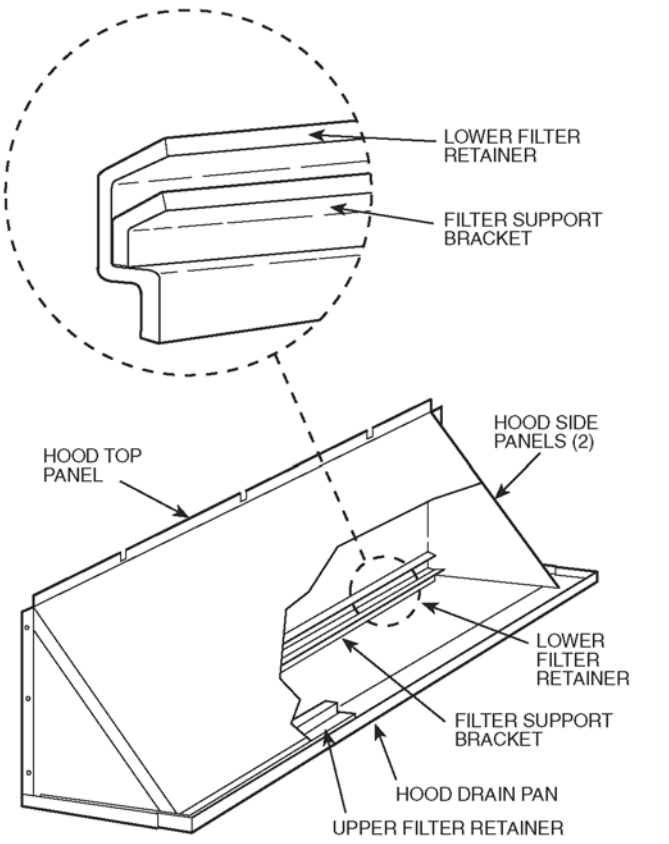
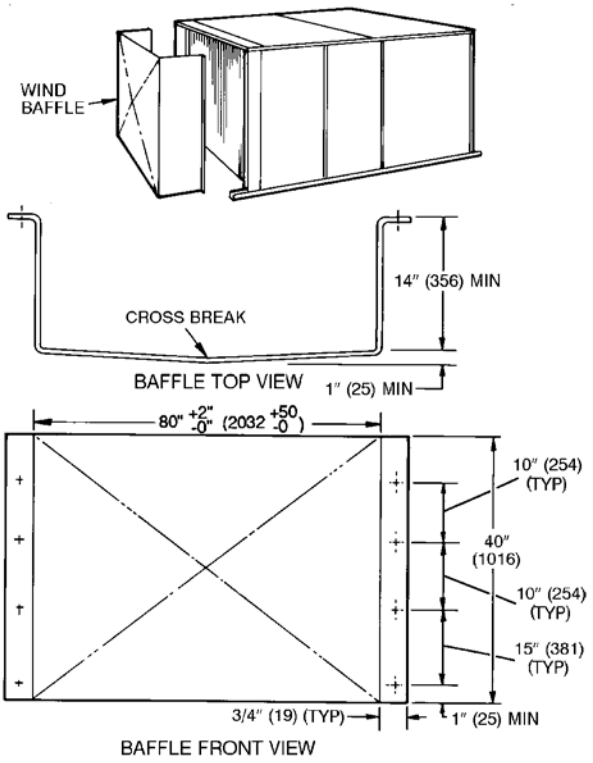


FIGURE 16 | **Outdoor Air Hood Details**



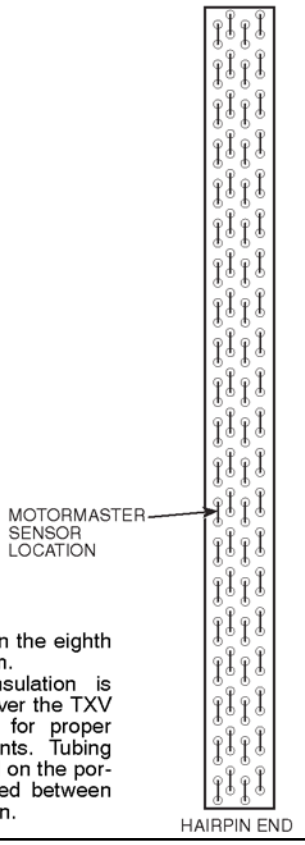
NOTE: The outdoor-air hood comes with a baffle which is not used on these units. Discard the baffle.

FIGURE 17 | **Wind Baffle Details**



NOTE: Dimensions in ( ) are in mm.

FIGURE 18 | **Head Pressure Controller Sensor Location**



NOTES:
1. All sensors are located on the eighth hairpin up from the bottom.
2. Field-installed tubing insulation is required to be installed over the TXV bulb and capillary tube for proper operation at low ambients. Tubing insulation is only required on the portion of suction line located between indoor and outdoor section.

Head Pressure Controller Installation

Install Field-Fabricated Wind Baffles

Wind baffles must be field-fabricated for all units to ensure proper cooling cycle operation at low ambient temperatures. See Fig. 17 for baffle details. Use 20-gage, galvanized sheet metal, or similar corrosion-resistant metal for baffles. Use field-supplied screws to attach baffles to unit. Screws should be $^1/_4$-in. diameter and $^5/_8$-in. long. Drill required screw holes for mounting baffles.

Install Head Pressure Controls

Only one Head Pressure control is required per unit. The control must be used in conjunction with the accessory 0° F low ambient kit (purchased separately). The head pressure controller device controls outdoor fan no. 1 while outdoor fans no. 2 and 3 are sequenced off by the accessory 0° F low ambient kit.

Accessory 0° F Low Ambient Kit — Install the accessory 0° F low ambient kit per instruction supplied with accessory.

Sensor Assembly — Install the sensor assembly in the location shown in Fig. 18.

Motor Mount — To ensure proper fan height, replace the existing motor mount with the new motor mount provided with accessory.

Transformer (460-V Units Only) — On 460-volt units a transformer is required. The transformer is provided with the accessory and must be field-installed.

Adjust Factory-Installed Options

Optional Economizer

See Figs. 19 and 20 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 11 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. 19.

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. 21.

Outdoor air leakage is shown in Table 4. Return air pressure drop is shown in Table 5.

Table 4 – 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 5 – Return Air Pressure Drop

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

FIGURE 19 Economizer Component Locations (End View)

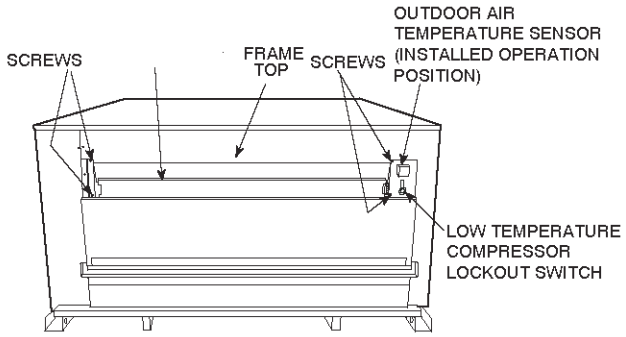


FIGURE 20 Economizer Component Locations (Side View)

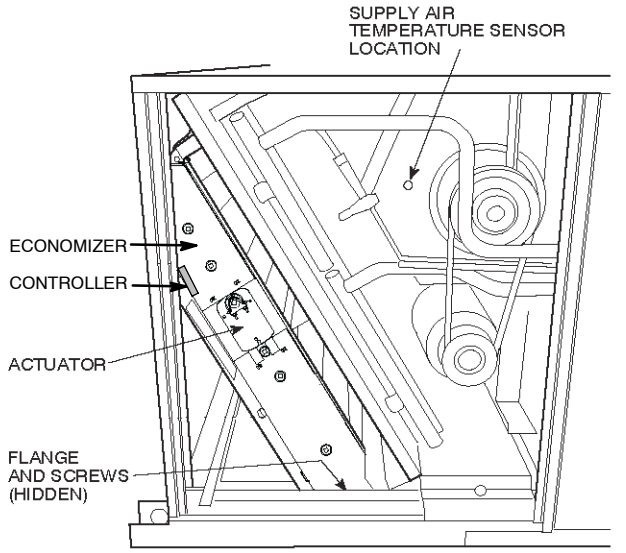
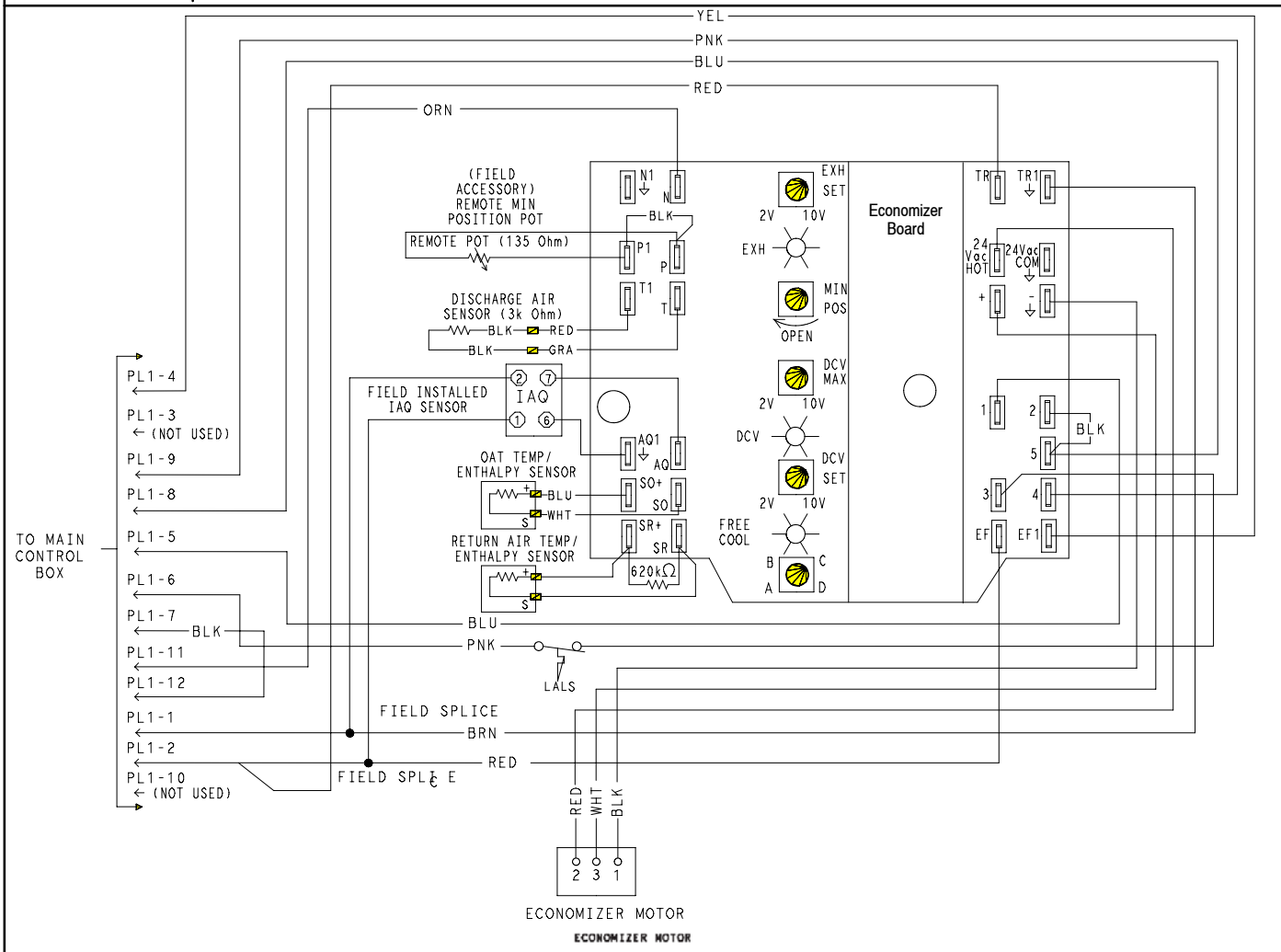


FIGURE 21 | **Economizer Wiring**



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.

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 is factory-installed on the economizer in the outdoor airstream. (See Fig. 19.) 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 6 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. (See Fig. 19.)

Table 6 – 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 7. 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. 22. The scale on the potentiometer is A, B, C, and D. See Fig. 23 for the corresponding temperature changeover values.

FIGURE 22 **Economizer Controller Potentiometer and LED Locations**

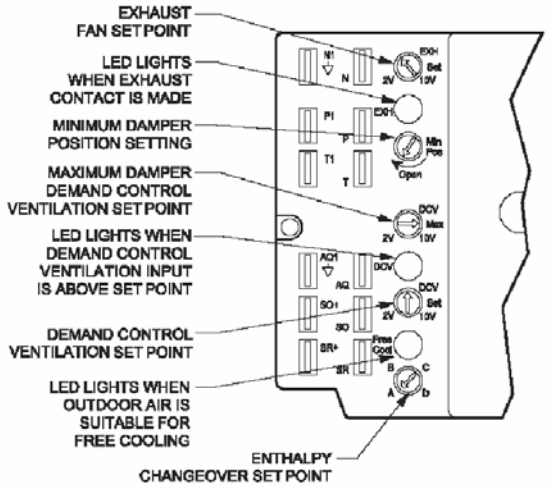


Table 7 – ECONOMIZER SENSOR USAGE

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.

Differential Dry Bulb Control

For differential dry bulb control the standard outdoor dry bulb sensor is used in conjunction with an additional accessory dry bulb sensor (part number DNTEMPSN002A00). The accessory sensor must be mounted in the return airstream. See Fig. 24.

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. 22.

FIGURE 23 **Outdoor Air Temperature Changeover Set Points**

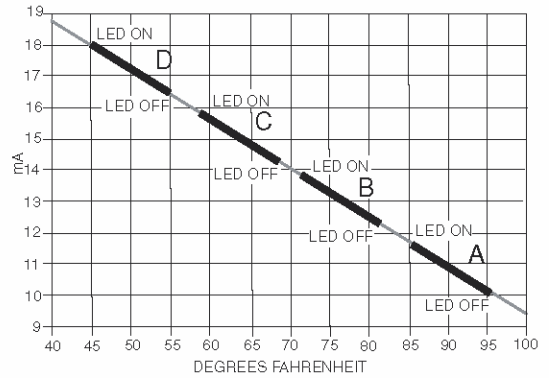
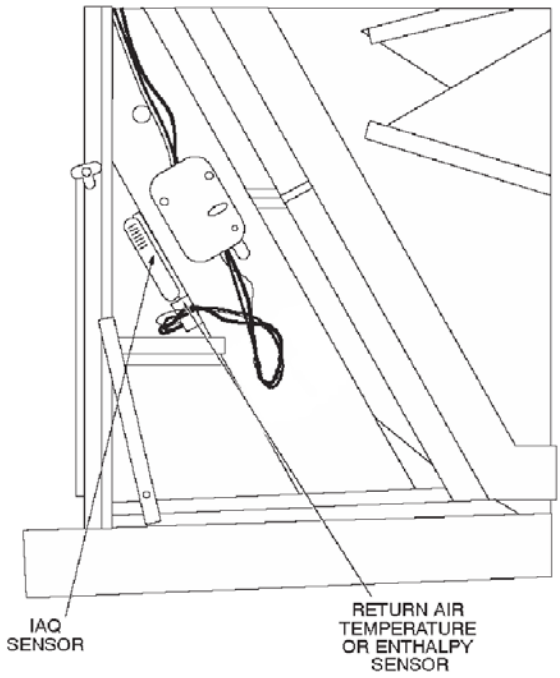


FIGURE 24 **Return Air Temperature or Enthalpy Sensor Mounting Location**



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. 19. 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. 25. The factory–installed 620–ohm jumper must be in place across terminals SR and SR+ on the economizer controller. See Fig. 22 and 26.

Differential Enthalpy Control

For differential enthalpy control, the economizer controller uses two enthalpy sensors (HH57AC078 and DNENTDIF004A00), 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. 19. Mount the return air enthalpy sensor in the return airstream. See Fig. 24. 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. 27.

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.

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. 22. 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.

FIGURE 25 **Enthalpy Changeover Settings**

CONTROL CURVE	CONTROL POINT APPROX. °F (°C) AT 50% RH
A	73 (23)
B	70 (21)
C	67 (19)
D	63 (17)

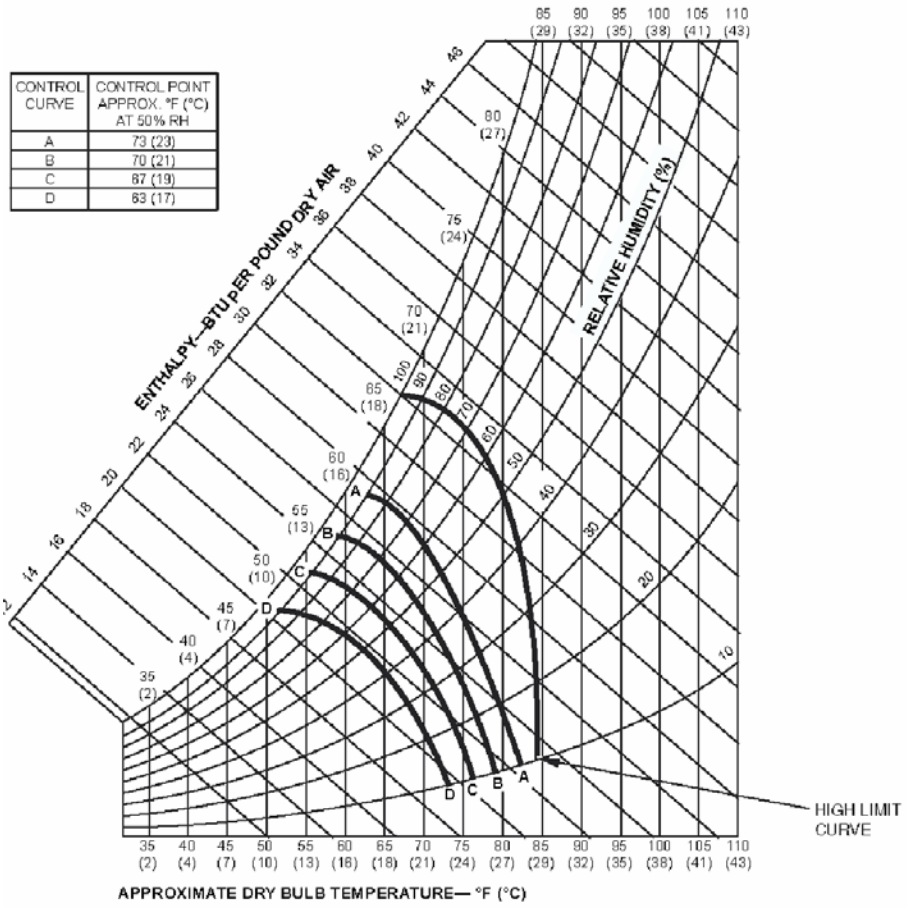


FIGURE 26 **Economizer Control**

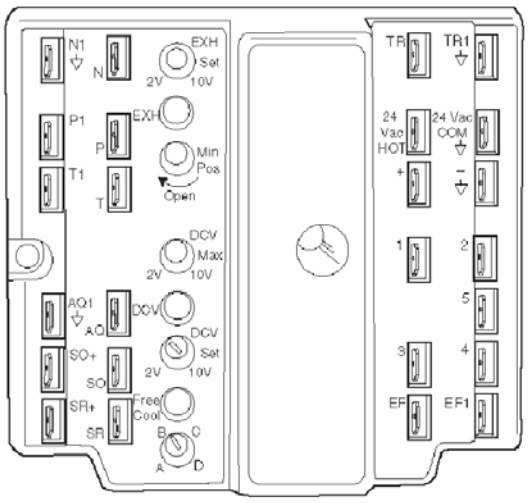
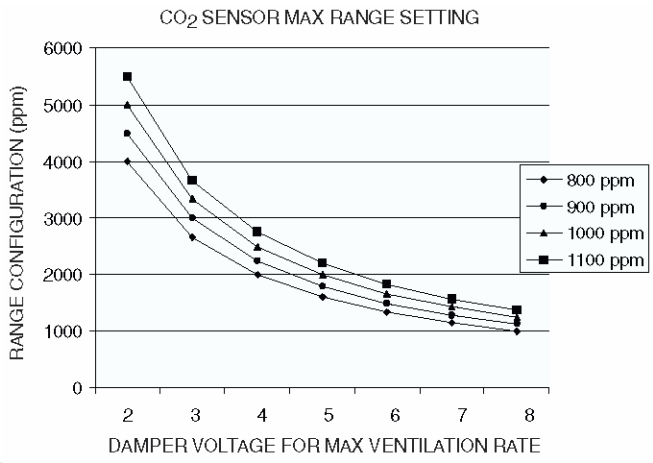


FIGURE 27 **CO_2 Sensor Maximum Range Setting**



Minimum Position Control

There is a minimum damper position potentiometer on the economizer controller. See Fig. 22. 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.

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. 21 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. 26.

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 open, the unit control will be in unoccupied mode; when the contacts are closed, the unit control will be in occupied 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. 27 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. 27 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 8.

Use setting 1 or 2 for equipment. See Table 8.

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 8.
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.

DEFROST CYCLE

The defrost timer is factory set at 30 minutes. The timer may be field-adjusted to 50 or 90 minutes by moving the wire from the 30 minute contact to the 50 to 90 minute contact. At the end of the time period, the defrost cycle will begin. See Fig. 28.

Table 8 – 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 complete Start-Up Checklist on last page to check out unit PRIOR to start-up.

I. UNIT PREPARATION

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

II. COMPRESSOR MOUNTING

Loosen compressor holddown bolts until sideways movement of the washer under each holddown bolt head can be obtained. Do not loosen completely, as bolts are self-locking and will maintain adjustment.

III. INTERNAL WIRING

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

IV. REFRIGERANT SERVICE PORTS AND VALVES

Each PHH unit has 2 Schrader-type service ports per circuit; one on the suction line and one on the liquid line. Be sure that caps on the ports are tight. The units also have 2 service valves per circuit; one on the suction line and one on the discharge line. Be sure all valves are open.

V. CRANKCASE HEATERS

Heaters are energized as long as there is power to unit.

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

VI. INDOOR FAN

Fan belt and pulleys are factory installed. Remove tape from the fan pulley and adjust pulleys on PHH150 units as required. See Service section on page 24 for instructions on adjusting indoor fan performance. See Table 9 for air quantity limits. See Tables 10 and 11 for fan performance data. Be sure that fans rotate in the proper direction. See Table 12 for static pressure drops for accessories and options. See Fig. 29 and 30 for fan performance using horizontal adapter and power exhaust. See Table 13 for fan rpm pulley settings. See Table 14 for indoor-fan motor performance. To alter fan performance, see Indoor-Fan, PHH150 Units and Indoor-Fan, PHH180 Units sections, pages 25 and 26.

FIGURE 28 | **Defrost Board Timer Warning**

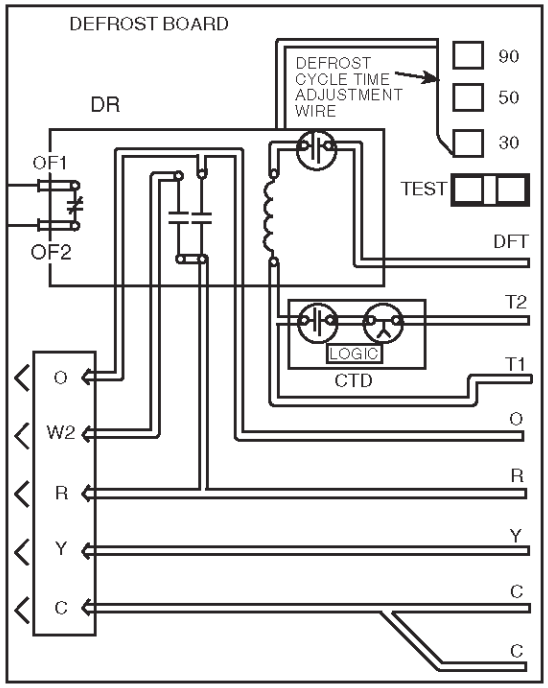


Table 9 — Air Quantity Limits

UNIT PHH	MINIMUM AIRFLOW (Cfm)	MAXIMUM AIRFLOW (Cfm)
150	3750	6250
180	4500*	7500

*Minimum cfm is 5600 when electric heater is used.

Table 10 — Fan Performance Data, PHH150 Units

AIRFLOW (Cfm)	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	**724**	**481**	**0.55**	**838**	**685**	**0.78**	937	889	1.01	1028	1097	1.25	1111	1309	1.49
4000	**754**	**613**	**0.70**	865	824	0.94	962	1034	1.18	1050	1247	1.42	1131	1463	1.67
4250	**786**	**757**	**0.86**	893	975	1.11	987	1191	1.36	1073	1408	1.60	**1152**	**1629**	**1.86**
4500	**818**	**914**	**1.04**	922	1138	1.30	1013	1360	1.55	1097	1583	1.80	**1174**	**1808**	**2.06**
4750	**850**	**1084**	**1.23**	951	1313	1.50	1040	1541	1.76	1122	1770	2.02	**1197**	**2000**	**2.28**
5000	883	1267	1.44	980	1501	1.71	1068	1736	1.98	**1147**	**1969**	**2.24**	**1221**	**2204**	**2.51**
5250	917	1464	1.67	1011	1703	1.94	1096	1943	2.21	**1174**	**2183**	**2.49**	**1246**	**2423**	**2.76**
5500	950	1675	1.91	1041	1918	2.19	1124	2165	2.47	**1201**	**2409**	**2.75**	**1272**	**2655**	**3.02**
5750	985	1901	2.17	1072	2147	2.45	**1153**	**2400**	**2.73**	**1228**	**2650**	**3.02**	**1298**	**2901**	**3.31**
6000	1020	2142	2.44	1103	2391	2.72	**1183**	**2649**	**3.02**	**1256**	**2905**	**3.31**	**1324**	**3160**	**3.60**
6250	1055	2398	2.73	**1135**	**2650**	**3.02**	**1213**	**2912**	**3.32**	**1284**	**3175**	**3.62**	**1352**	**3435**	**3.91**

AIRFLOW (Cfm)	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	**1190**	**1526**	**1.74**	**1265**	**1746**	**1.99**	**1337**	**1972**	**2.25**	**1405**	**2199**	**2.51**	**1471**	**2431**	**2.77**
4000	**1208**	**1684**	**1.92**	**1281**	**1908**	**2.17**	**1351**	**2136**	**2.43**	**1418**	**2368**	**2.70**	**1483**	**2603**	**2.97**
4250	**1227**	**1853**	**2.11**	**1299**	**2082**	**2.37**	**1367**	**2313**	**2.64**	**1433**	**2548**	**2.90**	**1496**	**2787**	**3.18**
4500	**1247**	**2036**	**2.32**	**1317**	**2268**	**2.58**	**1384**	**2503**	**2.85**	**1448**	**2742**	**3.12**	**1510**	**2983**	**3.40**
4750	**1269**	**2232**	**2.54**	**1337**	**2468**	**2.81**	**1403**	**2707**	**3.08**	**1465**	**2948**	**3.36**	**1526**	**3194**	**3.64**
5000	**1291**	**2441**	**2.78**	**1358**	**2680**	**3.05**	**1422**	**2923**	**3.33**	**1484**	**3168**	**3.61**	**1544**	**3418**	**3.89**
5250	**1315**	**2664**	**3.03**	**1380**	**2907**	**3.31**	**1443**	**3154**	**3.59**	**1503**	**3403**	**3.88**	**1562**	**3655**	**4.16**
5500	**1339**	**2900**	**3.30**	**1403**	**3148**	**3.59**	**1464**	**3398**	**3.87**	**1524**	**3651**	**4.16**	—	—	—
5750	**1364**	**3151**	**3.59**	**1426**	**3403**	**3.88**	**1486**	**3657**	**4.17**	1545	3914	4.46	—	—	—
6000	**1389**	**3416**	**3.89**	**1450**	**3672**	**4.18**	1510	3930	4.48	—	—	—	—	—	—
6250	**1415**	**3695**	**4.21**	1476	3957	4.51	1534	4219	4.81	—	—	—	—	—	—

LEGEND

Bhp — Brake Horsepower Input to Fan

FIOP — Factory-Installed Option

Watts — Input Watts to Motor

NOTES:

1. **Boldface** indicates field-supplied drive required.
2. ▭ indicates field-supplied motor and drive required.
3. Factory-shipped motor drive range is 862 to 1132 rpm. Other rpms may require a field-supplied drive.
4. Maximum continuous bhp is 4.25 maximum continuous watts are 3775. Do not adjust motor rpm such that motor maximum bhp and/or watts is exceeded at the maximum operating cfm.
5. Static pressure losses (i.e., economizer) must be added to external static pressure before entering Fan Performance table.
6. Interpolation is permissible. Do not extrapolate.
7. Fan performance is based on wet coils, clean filters, and casing losses. See Table 12 for accessory/FIOP static pressure information.
8. Extensive motor and drive testing on these units ensures that the full horsepower 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.

Table 11 — Fan Performance Data, PHH180 Units

AIRFLOW (Cfm)	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	**584**	**717**	**0.8**	**695**	**952**	**1.1**	**798**	**1205**	**1.3**	893	1483	1.7	984	1786	2.0
4800	**609**	**839**	**0.9**	**717**	**1085**	**1.2**	815	1346	1.5	907	1630	1.8	994	1938	2.2
5100	**634**	**971**	**1.1**	**738**	**1229**	**1.4**	833	1500	1.7	921	1791	2.0	1006	2104	2.4
5400	**660**	**1118**	**1.3**	**760**	**1389**	**1.6**	852	1669	1.9	937	1968	2.2	**1019**	**2286**	**2.6**
5700	**687**	**1284**	**1.4**	**783**	**1566**	**1.8**	873	1858	2.1	956	2165	2.4	**1034**	**2490**	**2.8**
6000	**712**	**1458**	**1.6**	805	1752	2.0	892	2055	2.3	973	2371	2.7	**1049**	**2703**	**3.0**
6300	**736**	**1644**	**1.8**	826	1952	2.2	911	2265	2.5	990	2591	2.9	**1064**	**2930**	**3.3**
6600	**763**	**1856**	**2.1**	851	2176	2.4	933	2502	2.8	1010	2837	3.2	**1082**	**3186**	**3.6**
6900	**788**	**2078**	**2.3**	873	2410	2.7	954	2747	3.1	**1029**	**3093**	**3.5**	**1099**	**3451**	**3.9**
7200	813	2316	2.6	896	2662	3.0	975	3011	3.4	**1048**	**3367**	**3.8**	**1117**	**3734**	**4.2**
7500	841	2584	2.9	921	2943	3.3	998	3304	3.7	**1070**	**3672**	**4.1**	**1137**	**4049**	**4.5**

AIRFLOW (Cfm)	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	**1070**	**2113**	**2.4**	**1151**	**2458**	**2.8**	**1229**	**2819**	**3.2**	**1302**	**3194**	**3.6**	**1371**	**3578**	**4.0**
4800	**1078**	**2269**	**2.5**	**1157**	**2620**	**2.9**	**1233**	**2990**	**3.3**	**1306**	**3374**	**3.8**	**1375**	**3769**	**4.2**
5100	**1086**	**2439**	**2.7**	**1164**	**2795**	**3.1**	**1238**	**3170**	**3.5**	**1310**	**3560**	**4.0**	**1378**	**3965**	**4.4**
5400	**1097**	**2626**	**2.9**	**1172**	**2986**	**3.3**	**1245**	**3366**	**3.8**	**1315**	**3763**	**4.2**	**1382**	**4174**	**4.7**
5700	**1110**	**2835**	**3.2**	**1183**	**3200**	**3.6**	**1253**	**3584**	**4.0**	**1322**	**3986**	**4.5**	**1388**	**4404**	**4.9**
6000	**1122**	**3053**	**3.4**	**1193**	**3422**	**3.8**	**1262**	**3810**	**4.3**	**1329**	**4216**	**4.7**	**1393**	**4638**	**5.2**
6300	**1135**	**3286**	**3.7**	**1204**	**3660**	**4.1**	**1271**	**4052**	**4.5**	**1336**	**4461**	**5.0**	**1399**	**4887**	**5.5**
6600	**1151**	**3549**	**4.0**	**1218**	**3928**	**4.4**	**1283**	**4325**	**4.8**	**1347**	**4739**	**5.3**	**1409**	**5169**	**5.8**
6900	**1167**	**3821**	**4.3**	**1232**	**4207**	**4.7**	**1295**	**4608**	**5.2**	**1357**	**5026**	**5.6**	1417	5460	6.1
7200	**1183**	**4113**	**4.6**	**1246**	**4505**	**5.0**	**1308**	**4912**	**5.5**	1368	5335	6.0	1437	5773	6.5
7500	**1202**	**4437**	**5.0**	**1264**	**4837**	**5.4**	1324	5251	5.9	1383	5679	6.4	1440	6122	6.9

LEGEND

Bhp — Brake Horsepower Input to Fan

FIOP — Factory-Installed Option

Watts — Input Watts to Motor

NOTES:

1. **Boldface** indicates field-supplied drive required.
2. ▭ indicates field-supplied motor and drive required.
3. Factory-shipped motor drive range is 799 to 1010 rpm. Other rpms may require a field-supplied drive.
4. Maximum continuous bhp is 5.90 maximum continuous watts are 5180. Do not adjust motor rpm such that motor maximum bhp and/or watts is exceeded at the maximum operating cfm.
5. Static pressure losses (i.e., economizer) must be added to external static pressure before entering Fan Performance table.
6. Interpolation is permissible. Do not extrapolate.
7. Fan performance is based on wet coils, clean filters, and casing losses. See Table 12 for accessory/FIOP static pressure information.
8. Extensive motor and drive testing on these units ensures that the full horsepower 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.

Table 12 — Accessory / FIOP Static Pressure (in. wg)

ACCESSORY/FIOP	UNIT SIZE PHH	UNIT VOLTAGE	kW	AIRFLOW (Cfm)								
				3750	4000	4500	5000	5600	6000	6250	7200	7500
Electric Heaters	150	208/230-3-60	14,34 42,56	0.05 0.06	0.05 0.06	0.06 0.07	0.07 0.08	0.08 0.10	0.09 0.12	0.09 0.13	†	†
		460-3-60	15,32 55	0.05 0.06	0.05 0.06	0.06 0.07	0.07 0.08	0.08 0.10	0.09 0.12	0.09 0.13	†	†
	180	208/230-3-60	26,34 42,56	*	*	*	*	0.08 0.10	0.09 0.12	0.09 0.13	0.11 0.16	0.12 0.17
		460-3-60	32 55	*	*	*	*	0.08 0.10	0.09 0.12	0.09 0.13	0.11 0.15	0.12 0.17
economizer	All	All	—	0.03	0.03	0.04	0.05	0.06	0.07	0.07	0.09	0.10

LEGEND

FIOP — Factory-Installed Option

*Do not operate unit with electric heat at this cfm. Operation at this cfm is below electric heat required minimum cfm.

†Do not operate unit at this cfm. Operation at this cfm is above unit maximum cfm limit.

Table 13 — Fan Rpm at Motor Pulley Settings* (Factory-Supplied Drives)

UNIT PHH	MOTOR PULLEY TURNS OPEN												
	0	1/2	1	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6
150	†	†	1132	1105	1078	1051	1024	997	970	943	916	889	862
180	†	†	1010	989	968	947	926	905	883	862	841	820	799

*Approximate fan rpm shown.
†Due to belt and pulley size, pulley cannot be set to this number of turns open.

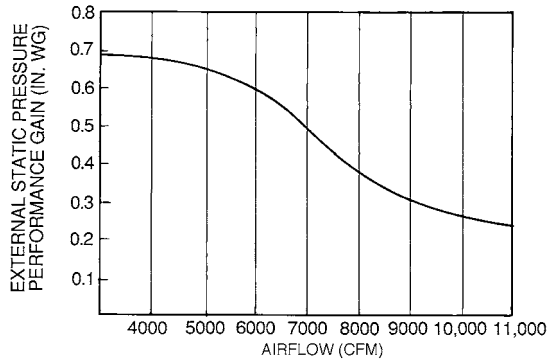
NOTE: To run units at speeds not listed, field-supplied drives are required.

Table 14 — Indoor Motor Performance

UNIT PHH	UNIT VOLTAGE	MAXIMUM ACCEPTABLE CONTINUOUS BHP*	MAXIMUM ACCEPTABLE OPERATING WATTS	MAXIMUM AMP DRAW	MOTOR EFFICIENCY
150	208/230	4.25	3775	10.5	85.8
	460			4.9	85.8
180	208/230	5.90	5180	15.8	87.5
	460			7.9	87.5

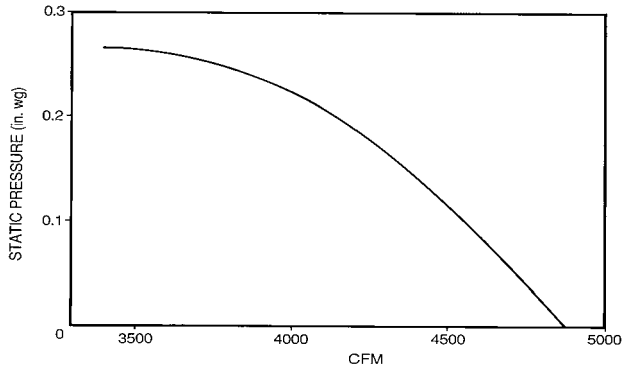
LEGEND
Bhp – Brake Horsepower

FIGURE 29 Horizontal Supply/Return Fan Performance with AXB165CHA Horizontal Supply Adapter



NOTE: The AXB165CHA horizontal supply and return adapter accessory improves PHH fan performance by increasing external static pressure by amount shown above.

FIGURE 30 Fan Performance Using Accessory Power Exhaust



OUTDOOR FANS AND MOTORS

Fans and motors are factory set. Refer to Outdoor-Fan Adjustment section on page 26 as required.

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.

OPERATING SEQUENCE

Cooling, Units Without Economizer

When thermostat calls for cooling, terminals G and Y1 are energized. The indoor-fan contactor (IFC), reversing valve solenoids (RVS1 and RVS2 [RVS2 on size 180 only]) and compressor contactor are energized and indoor-fan motor, compressor, and outdoor fan starts. The outdoor-fan motor runs continuously while unit is cooling.

Heating, Units Without Economizer

Upon a request for heating from the space thermostat, terminal W1 will be energized with 24 v. The IFC, outdoor-fan contactor (OFC), C1, and C2 (size 180 only) will be energized. The indoor fan, outdoor fans, and compressor no. 1, and compressor no. 2 are energized and RVS1 and RVS2 (size 180 only) are deenergized and switch position.

If the space temperature continues to fall while W1 is energized, W2 will be energized with 24 v, and the heater contactor(s) (HC) will be energized, which will energize the electric heater(s).

When the space thermostat is satisfied, W2 will be deenergized first, and the electric heater(s) will be deenergized.

Upon a further rise in space temperature, W1 will be deenergized.

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 fan will be energized and deenergized.

If field-installed accessory CO_2 sensors are connected to the economizer 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.

Defrost

When the temperature of the outdoor coil drops below 28 F as sensed by the defrost thermostat (DFT2) and the defrost timer is at the end of a timed period (adjustable at 30, 50, or 90 minutes), reversing valve solenoids (RVS1 and RVS2) are energized and the OFC is deenergized. This switches the position of the reversing valves and shuts off the outdoor fan. The electric heaters (if installed) will be energized.

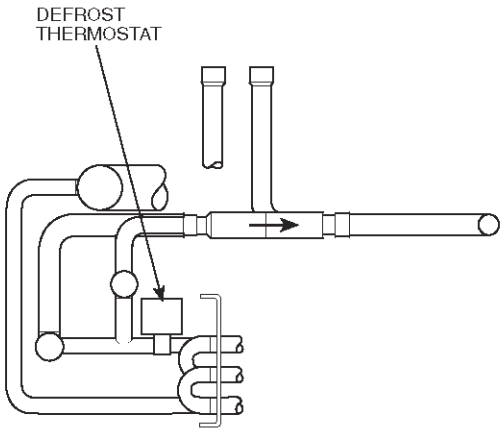
The unit continues to defrost until the coil temperature as measured by DFT2 (see Fig. 31) reaches 65 F, or the duration of defrost cycle completes a 10-minute period.

During the Defrost mode, if circuit 1 defrosts first, RVS1 will oscillate between Heating and Cooling modes until the Defrost mode is complete.

At the end of the defrost cycle, the electric heaters (if installed) will be deenergized; the reversing valves switch and the outdoor-fan motor will be energized. The unit will now operate in the Heating mode.

If the space thermostat is satisfied during a defrost cycle, the unit will continue in the Defrost mode until the time or temperature constraints are satisfied.

FIGURE 31 **Defrost Thermostat Location**



NOTE: Defrost thermostat is located at the bottom tee of circuit no. 1 and the top tee of circuit no. 2.

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.

Indoor Coil

Clean as required with a commercial coil cleaner.

Outdoor Coil

Clean outdoor 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.

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. Observe the level in the sight glass immediately after shutdown while the oil is still warm. If the oil level is observed when the oil is cold, the level observed may be a mixture of oil and refrigerant which is not a true indication of the oil level. If oil level observed is not between the low limit and high limit levels as indicated in Fig. 32, add oil until it is in the correct range.

Fan Shaft Bearings

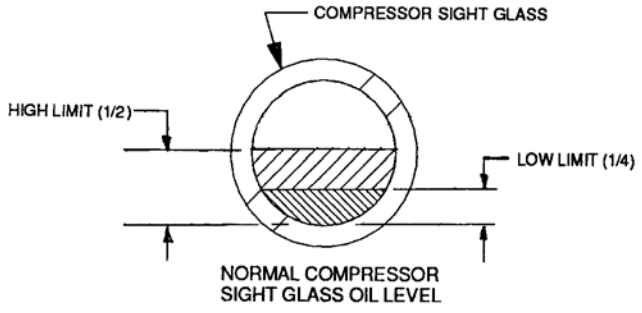
For size 150 units, bearings are permanently lubricated. No field lubrication is required. For size 180 units, the bearings are of the pillow block type and have grease fittings. The bearing opposite the motor end has an extended tube line so it can be lubricated from the motor side. Lubricate the bearings twice annually.

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.

FIGURE 32 **Compressor Sight Glass Oil Level**



Outdoor and Indoor-Fan Motor Bearings

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

INDOOR FAN, PHH150 UNITS

Performance Adjustment

Fan motor pulleys on the PHH150 units are factory set for speed shown in Table 1.

To change fan speeds:

1. Shut off unit power supply.
2. Loosen belt by loosening fan motor mounting plate nuts.
3. Loosen movable-pulley flange setscrew (see Fig. 33).
4. 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.
5. Set movable flange at nearest keyway of pulley hub and tighten setscrew.

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.

Service and Replacement (see Fig. 34)

NOTE: To remove belts only, follow Steps 1-7.

1. Remove filter and supply-air section panels.
2. Remove unit top panel.
3. Remove coil guard.
4. Loosen screws A and B on both sides of motor mount assembly.
5. Loosen screw C.
6. Rotate motor mount assembly (with motor attached) as far as possible away from indoor coil.
7. Remove belt.
8. Rotate motor mount assembly back past original position toward indoor coil.
9. Remove motor mounting nuts D and E (both sides).
10. Lift motor up through top of unit.
11. Reverse Steps 1-10 to install new motor.
12. Check and adjust belt tension as necessary.

FIGURE 33 **Indoor Fan Pulley Adjustment**

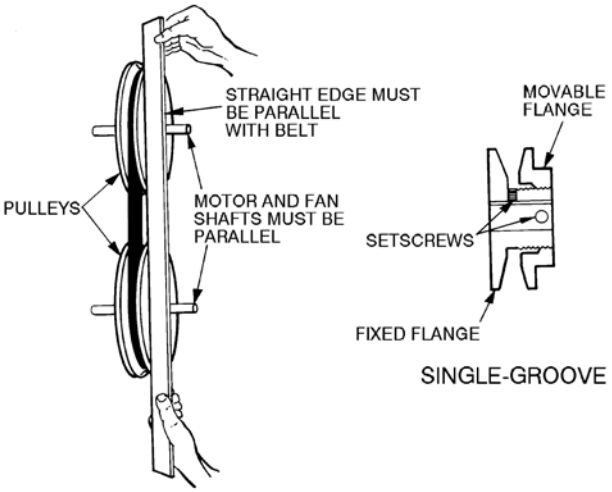
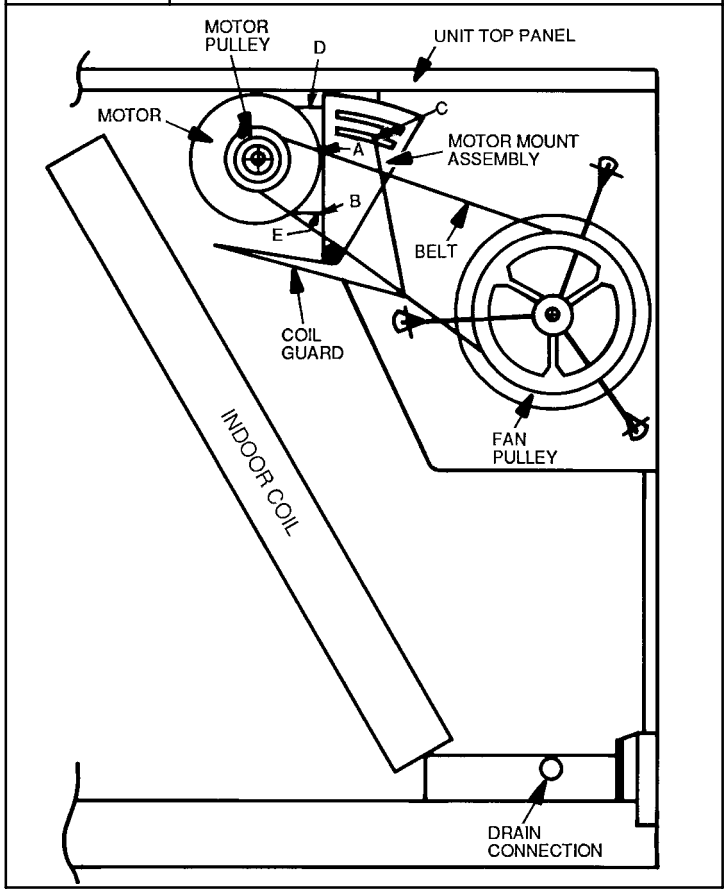


FIGURE 34 **PHH150 Indoor Fan Motor Section**



INDOOR FAN, PHH180 UNITS

Performance Adjustment

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

To change fan speeds:

1. Shut off unit power supply.
2. 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.
3. Loosen movable-pulley flange setscrew (See Fig. 33).
4. 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 9 for air quantity limits.
5. 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.)
6. Replace and tighten belts. See Belt Tension Adjustment section below.

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.

Service and Replacement (see Fig. 35)

The PHH180 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 indoor-fan access panel and the heating control access panel.
2. Remove the center post (located between the indoor fan and heating control access panels) and all screws securing it.
3. Loosen nuts on the two 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.
13. Check and adjust belt tension as necessary.

BELT TENSION ADJUSTMENT

To adjust belt tension:

1. Loosen fan motor bolts.
2. a. Size 150 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.

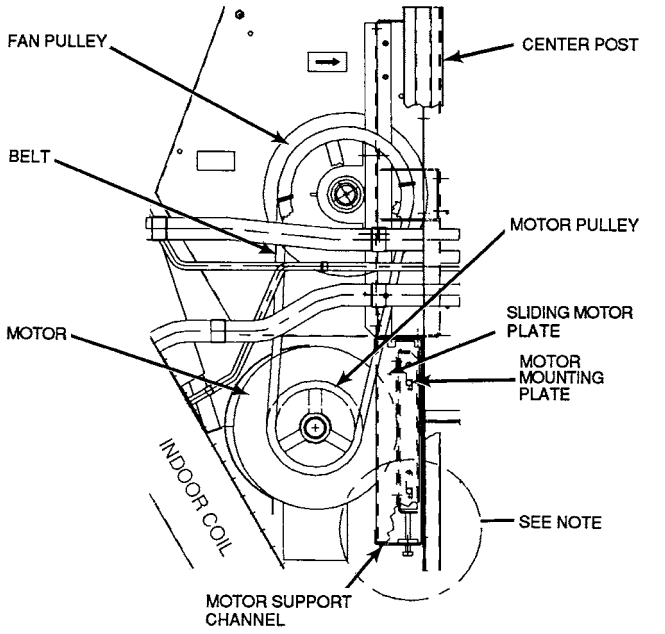
VI. OUTDOOR-FAN ADJUSTMENT (Fig. 37)

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

POWER FAILURE

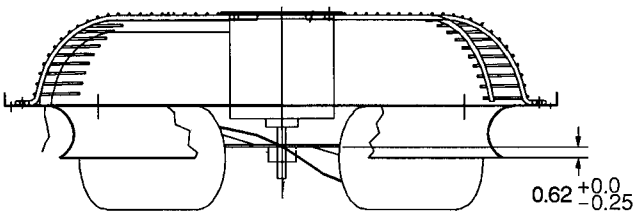
Dampers have a spring return. In event of power failure, dampers will return to fully closed position until power is restored. *Do not manually operate damper motor.*

FIGURE 35 | **PHH180 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.

FIGURE 36 | **Outdoor Fan Adjustment**



NOTE: Dimensions are in inches.

REFRIGERANT CHARGE

Amount of refrigerant charge is listed on unit nameplate and in Table 1.

Unit panels must be in place when unit is operating during charging procedure.

No Charge

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

Low Charge, Cooling

Using appropriate cooling charging chart (see Fig. 37 and 38), add refrigerant until conditions of the chart are met. Note that charging charts are different from those normally used. Charts are based on charging units to correct superheat for various operating conditions. An accurate pressure gage and temperature sensing device are required. Connect temperature sensing device to service port on suction line and insulate it so that outdoor ambient temperature does not affect reading. Indoor-air cfm must be within normal operating range of unit.

To Use Cooling Charging Chart

Take outdoor ambient temperature and read the suction pressure gage. Refer to appropriate chart to determine correct suction temperature. If suction temperature is high, add refrigerant. If suction temperature is low, carefully recover some of the charge. Recheck suction pressure as charge is adjusted.

Example (Fig. 38)

Outdoor Temperature . . . . . 85 F
Suction Pressure . . . . . 70 psig
Suction Temperature Should be . . . . . 60 F
(Suction Temperature may vary ± 5 F.)

Low Charge, Heating

If outdoor ambient temperature is above 40 F, operate unit on cooling and refer to Low Charge, Cooling section above. If outdoor ambient is below 40 F, evacuate system and weigh in specified amount of refrigerant. (Refer to Table 1.)

FILTER DRIER

Replace whenever refrigerant system is exposed to atmosphere.

PROTECTIVE DEVICES

Compressor Protection

Overcurrent

Each compressor has one manual reset, calibrated trip, magnetic circuit breaker. Do not bypass connections or increase the size of the circuit breaker to correct trouble. Determine the cause of the trouble and correct it before resetting the breaker.

Overtemperature

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

Crankcase Heater

Each compressor has 125-watt crankcase heaters to prevent absorption of liquid refrigerant by oil in the crankcase when the compressor is idle. Since power for the crankcase heaters is drawn from the unit incoming power, main unit power must be on for the heaters to be energized.

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

Compressor Lockout

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

Indoor-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.

Outdoor-Fan Motor Protection

Each outdoor-fan motor is internally protected against overtemperature.

FIGURE 37 **PHH150 Cooling Charging Chart**

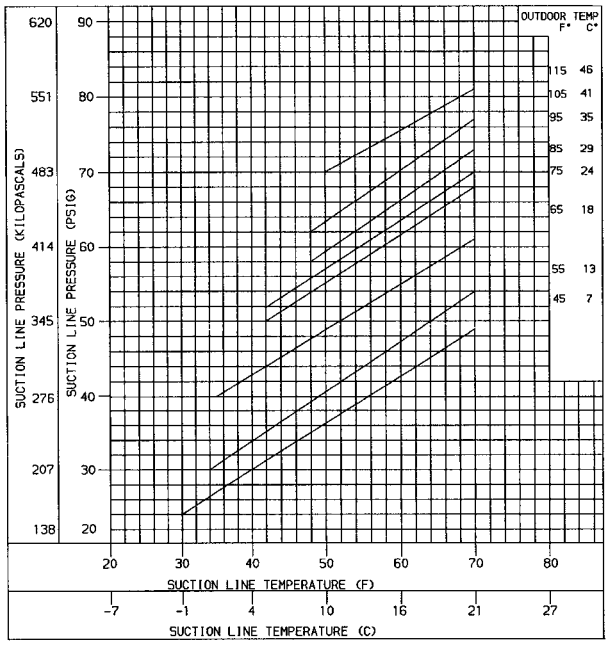
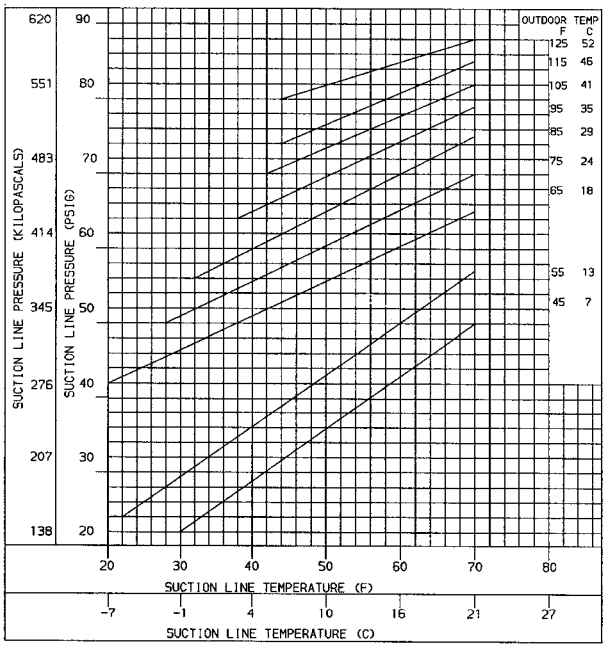


FIGURE 38 **PHH180 Cooling Charging Chart**



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 indoor coil. It detects frost build-up and turns off the compressor, allowing the coil to clear. Once the frost has melted, the compressor can be reenergized by resetting the CLO from the thermostat.

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. Typical wiring is shown in Fig. 39 and 40.

OPTIONAL HINGED ACCESS DOORS

When the optional service package is ordered or 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.

REPLACEMENT PARTS

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

FIGURE 39 | **Typical Wiring Schematic, PHH150 – 208/230v Shown**

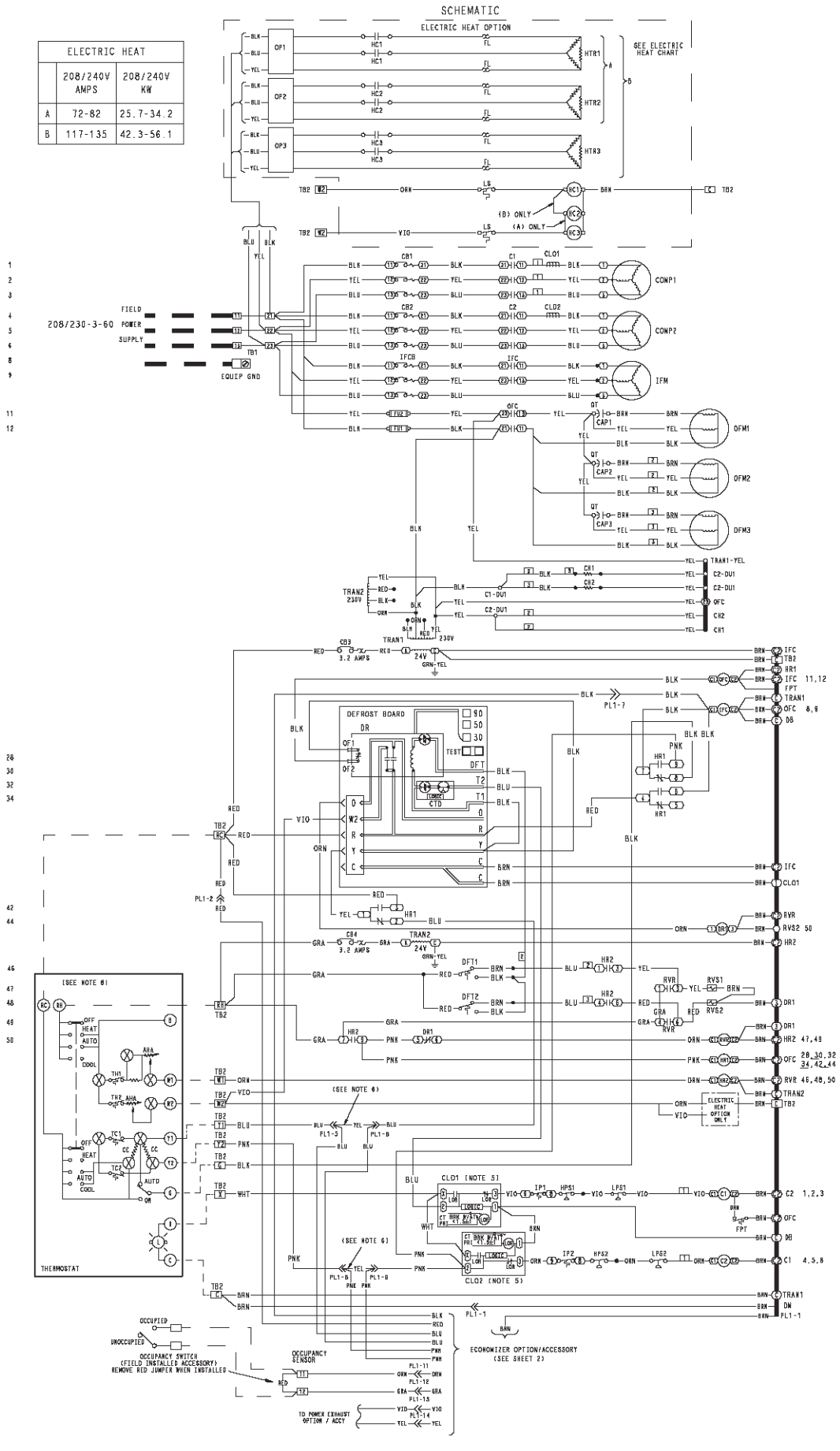
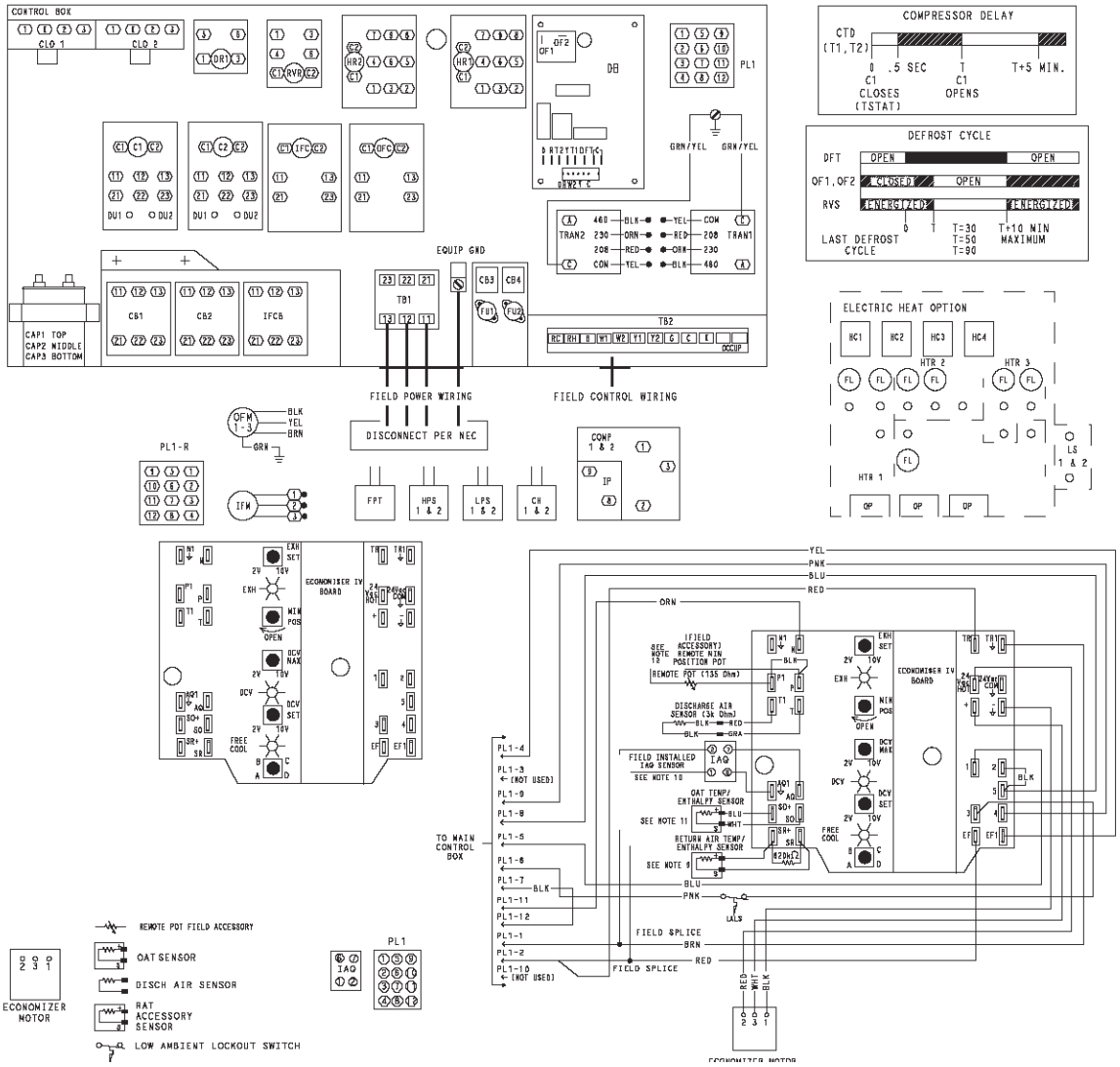


FIGURE 40 | **Typical Component Arrangement, PHH150 – 208/230v Shown**



LEGENDS AND NOTES FOR FIGURES 39 AND 40.

LEGEND

AHA	—	Adjustable, Heat Anticipator
BRK W/AT	—	Breaks with Amp Turns
C	—	Contactor, Compressor
CAP	—	Capacitor
CB	—	Circuit Breaker
CC	—	Cooling Compensator
CH	—	Crankcase Heater
CLO	—	Compressor Lockout
COMP	—	Compressor Motor
CTD	—	Compressor Time Delay
DB	—	Defrost Board
DFT	—	Defrost Thermostat
DM	—	Damper Motor
DR	—	Defrost Relay
DU	—	Dummy Terminal
EQUIP	—	Equipment
FL	—	Fuse Link
FPT	—	Freeze Protection Thermostat
FU	—	Fuse
GND	—	Ground
HC	—	Heater Contactor
HPS	—	High-Pressure Switch
HR	—	Heat Relay
HTR	—	Heater
IAQ	—	Indoor Air Quality Sensor
IFC	—	Indoor-Fan Contactor
IFCB	—	Indoor-Fan Circuit Breaker
IFM	—	Indoor-Fan Motor
IP	—	Internal Protector
L	—	Light
LALS	—	Low Temperature Compressor Lockout Switch
LPS	—	Low-Pressure Switch
LS	—	Limit Switch
NEC	—	National Electric Code
OAT	—	Outdoor Air Temperature Sensor
OCCUP	—	Occupancy Sensor
OFC	—	Outdoor Fan Contactor
OFM	—	Outdoor Fan Motor
OP	—	Overcurrent Protector
PL	—	Plug Assembly
QT	—	Quadruple Terminal
RVR	—	Reversing Valve Relay
RVS	—	Reversing Valve Solenoid
TB	—	Terminal Block
TC	—	Thermostat Cooling
TH	—	Thermostat Heating
TRAN	—	Transformer


Terminal (Marked)


Terminal (Unmarked)


Terminal Block


Splice

Factory Wiring

Field Wiring

Option/Accessory 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. TRAN1 is wired for 230-v operation. If unit is 208-v, disconnect the black wires from the ORN TRAN wire and reconnect to the RED TRAN wire, apply wirenuts to wires.
4. CB1,2 must trip amps are equal to or less than 156% FLA, IFCB 140%.
5. The CLO locks out the compressor to prevent short cycling on compressor overload and safety devices; before replacing CLO, check these devices.
6. Jumpers are omitted when unit is equipped with economizer.
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. Remove jumper between RC & RN.
9. 620 Ohm, 1 watt, 5% resistor should be removed only when using differential enthalpy or dry bulb.
10. 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.
11. OAT sensor is shipped inside unit and must be relocated in the field for proper operation.
12. 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 15 and figs. 41–44 for unit troubleshooting information.

A. Cooling Cycle

1. Hot gas from compressor flows through the 4-way valve and is directed to the outdoor-coil header. At the header it is condensed and subcooled through converging circuits (7-2-1). Refrigerant leaves the outdoor-coil by way of the check valve to the liquid line.
2. The refrigerant then flows through the filter drier and feeds the indoor coil by way of fixed orifice tubes on each circuit.
3. Each circuit evaporates the refrigerant, and the circuits are combined in the indoor-coil header with some of the circuits flowing through the check valve.
4. The refrigerant then flows through the 4-way valve, accumulator and back to the compressor.

B. Heating Cycle

1. Hot gas from the compressor flows through the 4-way valve and is directed to the indoor-coil header. At the header it is condensed and directed through subcooling circuits and out the indoor-coil check valve to the liquid line.
2. The refrigerant then flows through a strainer and feeds the outdoor-coil by way of fixed orifice tubes on each circuit.
3. Each circuit evaporates the refrigerant, and the circuits are combined in the outdoor-coil header with some of the circuits flowing through the check valve.
4. The refrigerant then flows through the 4-way valve, accumulator and back to the compressor.

Economizer Troubleshooting

See Table 16 for economizer logic.

A functional view of the economizer is shown in Fig. 45. 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

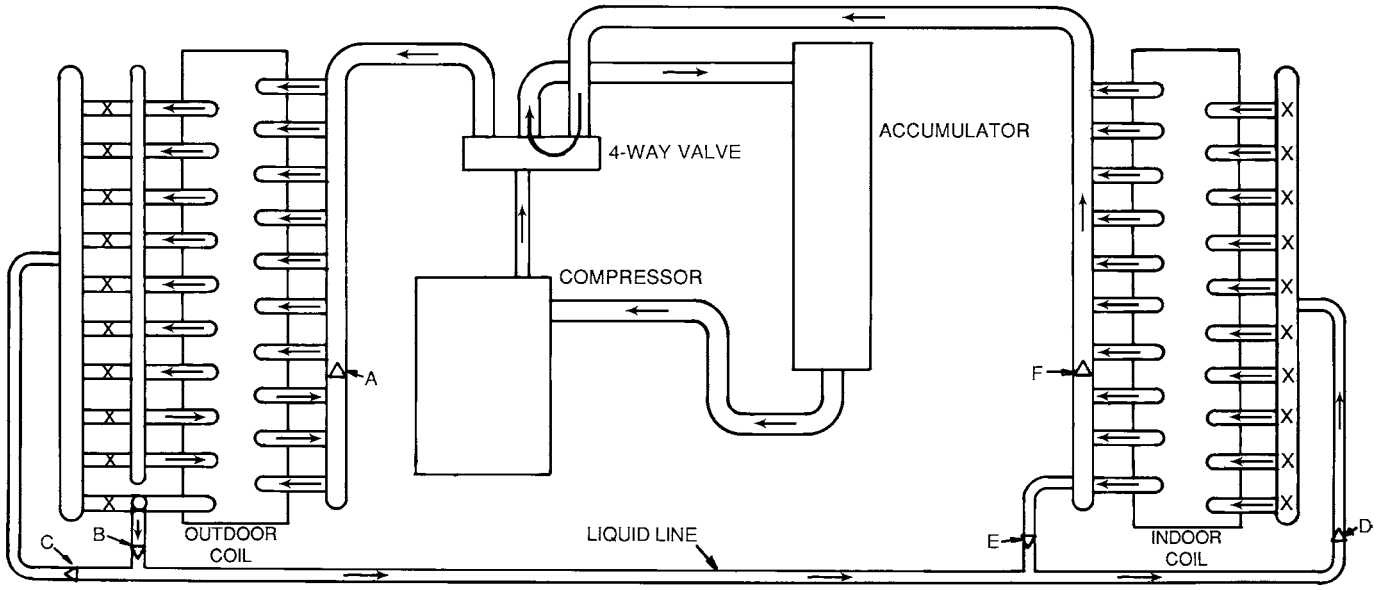
This procedure is used to return the economizer to operation. No troubleshooting or testing is done by performing the following procedure.

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 15 — CHECK VAVLE FUNCTIONS

Check Valve Indentification (See Fig. 42 and 43)	Location	Cooling Cycle	Heating Cycle	Cooling Cycle Check Vavle Stuck		Heating Cycle Check Vavle Stuck	
				Open	Closed	Open	Closed
A	Outdoor coil; Header	Closed	Open	Lose circuiting in outdoor coil. Acts like low charge.	Normal	Normal	Bottom 3 circuits restricted
B	Outdoor coil; Liquid line feeding fixed orifice	Open	Closed	Normal	Lose some capacity	Restricted outdoor fixed orifice	Normal
C	Outdoor coil; Liquid line leaving coil	Closed	Open	Restricted liquid line	Normal	Normal	Flooding outdoor coil and compressor
D	Indoor coil; Liquid line feeding fixed orifice	Open	Closed	Normal	Restricted indoor fixed orifice	Lose some capacity	Normal
E	Indoor coil; Liquid line leaving coil	Closed	Open	Bypasses coil and floods compressor	Normal	Normal	Restricted liquid line
F	Indoor coil; Header	Open	Closed	Normal	Bottom circuits of indoor coil inactive	Lose indoor coil circuiting — symptom of low charge	Normal

FIGURE 41 | **Heat Pump Cooling Cycle**



LEGEND

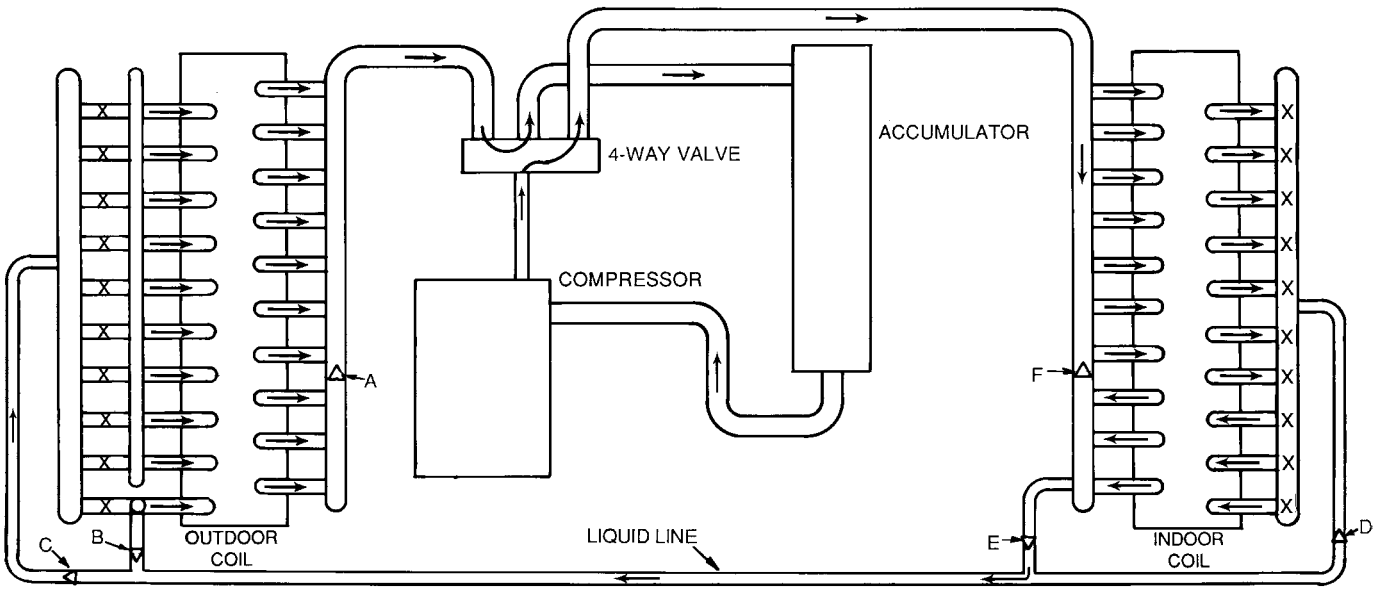
→ — Refrigerant Flow Direction
Δ — Check Valve Flow Direction
X — Fixed Orifice

NOTE: Circuitry shown is for single system; **PHH180** units have 2 individual and independent refrigeration systems that each operate in an identical manner.

CHECK VALVE*	COOLING
A	Closed
B	Open
C	Closed
D	Open
E	Closed
F	Open

*See Table 15 for check valve operation details.

FIGURE 42 | **Heat Pump Heating Cycle**



LEGEND

→ — Refrigerant Flow Direction
Δ — Check Valve Flow Direction
X — Fixed Orifice

NOTE: Circuitry shown is for single systems. PHH180 units have 2 individual and independent refrigeration systems that each operate in an identical manner.

CHECK VALVE*	COOLING
A	Open
B	Closed
C	Open
D	Closed
E	Open
F	Closed

*See Table 15 for check valve operation details.

FIGURE 43 **Trouble Shooting Chart, Heating Cycle**

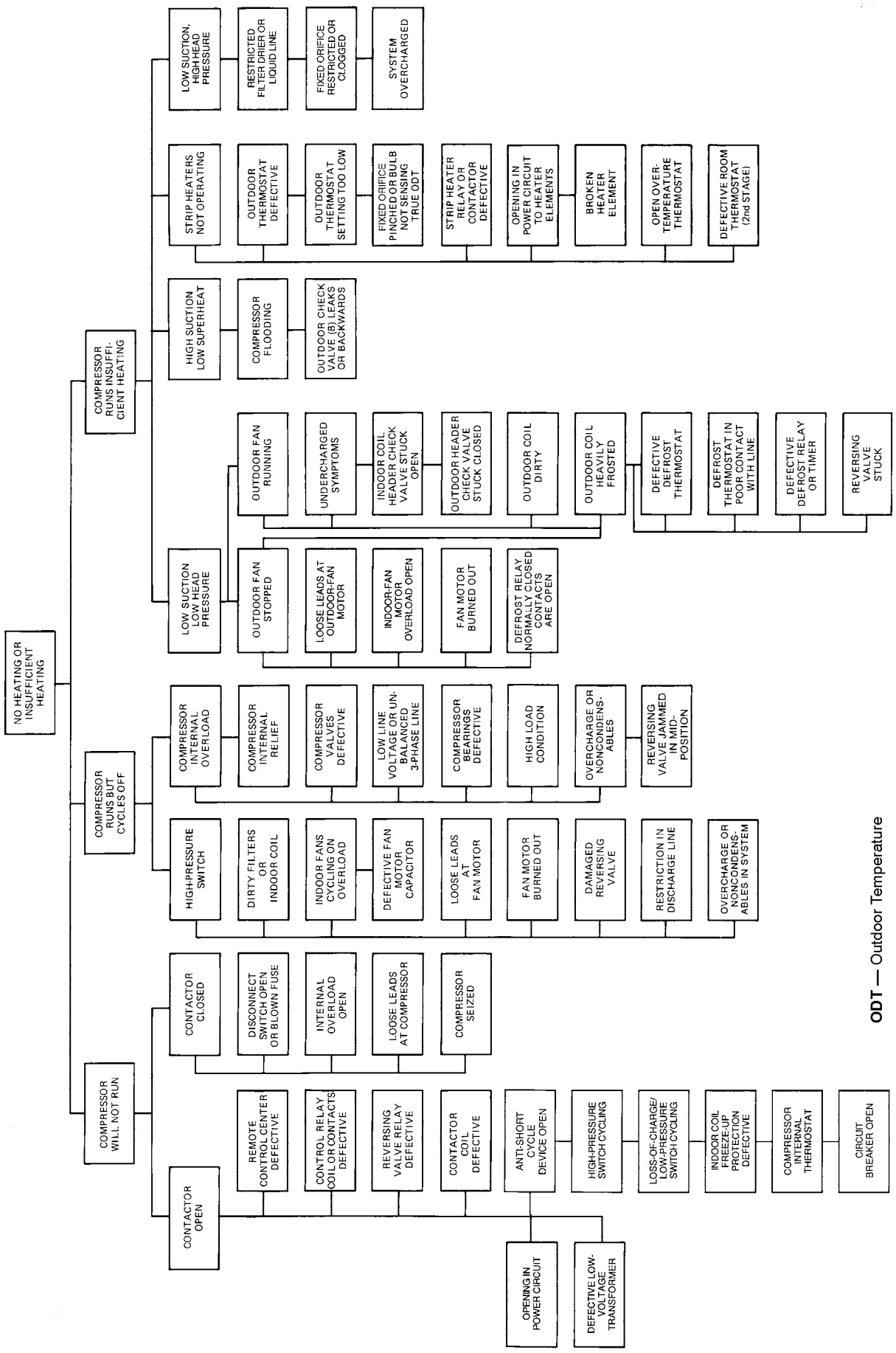


FIGURE 44 **Trouble Shooting Chart, Cooling Cycle**

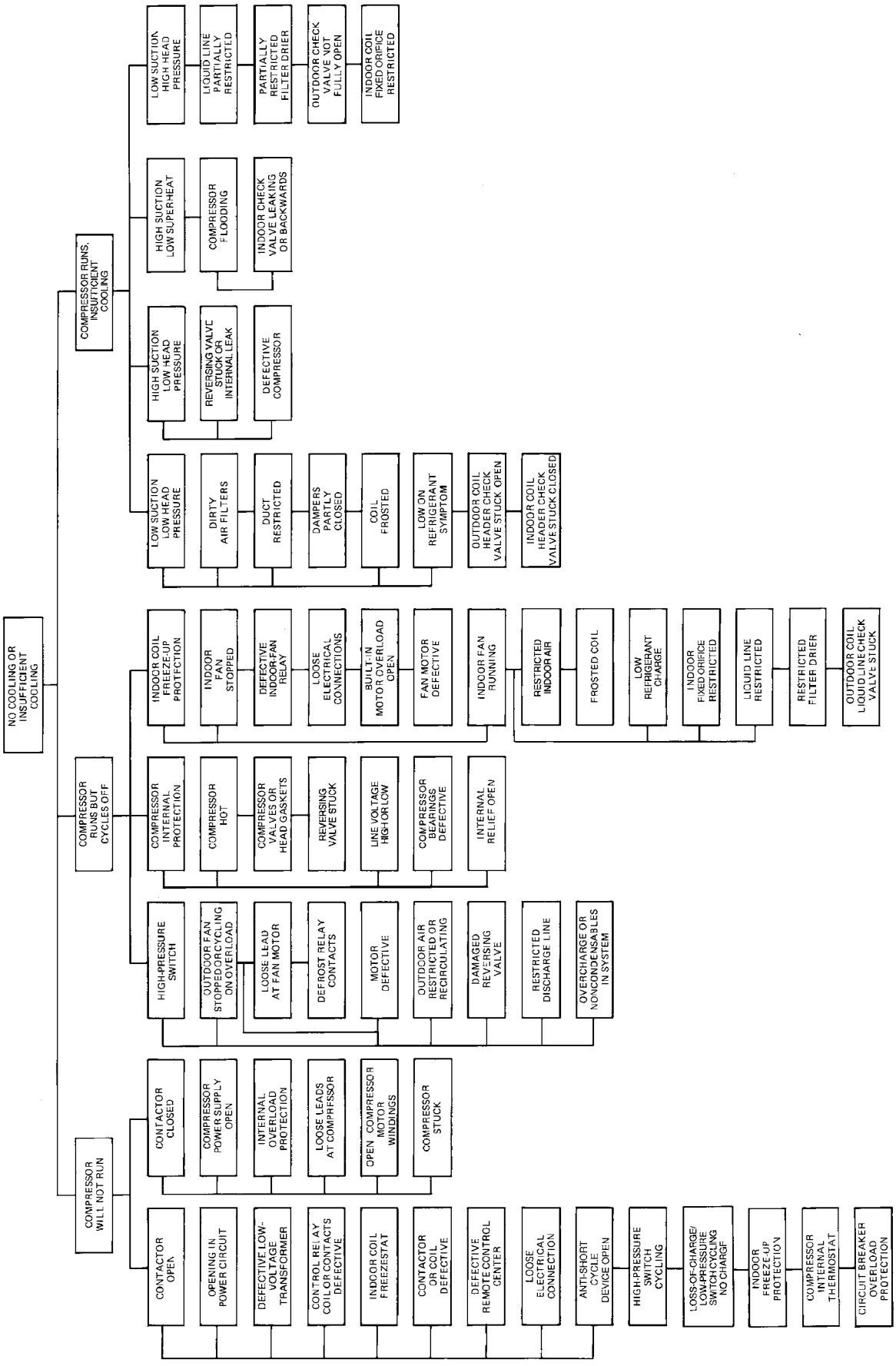
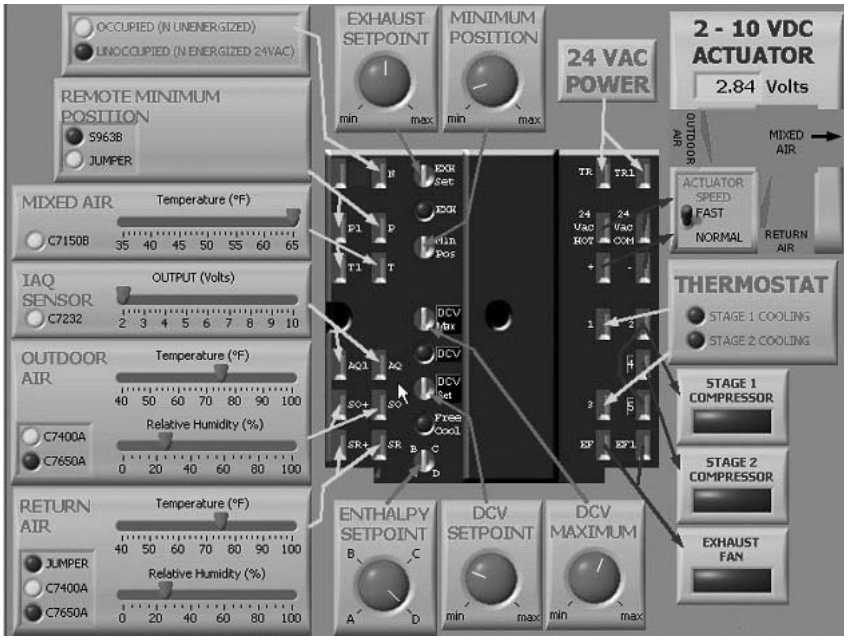


TABLE 16 — ECONOMIZER INPUT/OUTPUT LOGIC

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 45 **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 (150 UNITS) AND ADJUSTMENT BOLT AND PLATE (180 UNITS)
- ☐ LOOSEN ALL SHIPPING HOLDDOWN BOLTS PER INSTRUCTIONS
- ☐ OPEN ALL SERVICE VALVES (SUCTION, DISCHARGE, AND LIQUID)
- ☐ VERIFY INSTALLATION OF OUTDOOR AIR HOOD
- ☐ 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 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 (180 ONLY) L1 _____ L2 _____ L3 _____

SUPPLY FAN AMPS _____ EXHAUST FAN AMPS _____

ELECTRIC HEAT AMPS L1 _____ L2 _____ L3 _____

TEMPERATURES

OUTDOOR-AIR TEMPERATURE _____ F DB (Dry-Bulb)
RETURN-AIR TEMPERATURE _____ F DB _____ F WB (Wet-Bulb)
COOLING SUPPLY AIR _____ F
HEAT PUMP 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