



Air-Cooled Condenser Installation & Operation

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Air-Cooled Condensers

Installation and Operation Guide

Applicable for Bohn, Larkin, Climate Control, and Chandler brands



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Inspection

Responsibility should be assigned to a dependable individual at the job site to receive material. Each shipment should be carefully checked against the bill of lading. The shipping receipt should not be signed until all items listed on the bill of lading have been accounted for.

Remove shrink wrap, if applicable, and check carefully for concealed damage. Any shortage or damages should be reported to the delivering carrier.

Damaged material becomes the delivering carrier's responsibility, and should not be returned to the manufacturer unless prior approval is given to do so. When uncrating, care should be taken to prevent damage. Heavy equipment should be left on units shipping base until it has been moved to the final location.

Notice: Please remove shrink wrap covering immediately upon delivery. The shrink wrap covering is intended for transportation purposes only, not for storage or prolonged use on the product.

System Warranty

This equipment is designed to operate properly and produce rated capacity when installed in accordance with accepted industry standards. Failure to meet the following conditions may result in voiding of the system warranty:

1. Protective shipping shrink wrap must be removed upon delivery
2. System piping must be installed following industry standards for good piping practices.
3. Inert gas must be charged into piping during welding.
4. System must be thoroughly leak checked and evacuated before initial charging. High vacuum gauge capable of reading microns is mandatory. Dial indicating pressure gauges are not acceptable.
5. Power supply to system must meet the following conditions:
 - a. Voltage for 208/230 motors not less than 195 volts or more than 253 volts.
 - b. All other voltages must not exceed +/- 10% of nameplate ratings.
 - c. Phase imbalance not to exceed 2%.
6. All controls and safety switch circuits properly connected per wiring diagram.
7. Factory installed wiring must not be changed without written factory approval.

Installation

Note: Installation and maintenance to be performed only by qualified personnel who are familiar with local codes and regulations, and experienced with this type of equipment.

Caution: Sharp edges and coil surfaces are a potential injury hazard. Avoid contact with them.

Unit Location

Units are designed for outdoor application and may be mounted on a roof or concrete slab (ground level installation). Roof mounted units should be installed level on steel channels or an I-beam frame to support the unit above the roof. Use of vibration pads or isolators is recommended. The roof must be strong enough to support the weight of the unit. Concrete slabs used for unit mounting should be installed level and be properly supported to prevent settling. A one-piece concrete slab with footings extending below the frost line is recommended.

The condenser should be located far enough away from any wall or other obstruction to provide sufficient clearance for air entrance. Do not attach ductwork to the coil inlet or fan outlet. Care should be taken to avoid air recirculation conditions that can be caused by sight screening, walls, etc. Also keep unit fan discharge away from any building air intakes. See page 4 for space and location requirements.

Sound Vibration

Units should be installed away from occupied spaces and above or outside of utility areas, corridors and auxiliary spaces to reduce the transmission of sound and vibration to occupied spaces. The refrigerant piping should be flexible enough to prevent the transmission of noise and vibration from the unit into the building. If the refrigerant lines are to be suspended from the structure of the building, isolation hangers should be used to prevent the transmission of vibration. Where piping passes through a wall, it is advisable to pack fiberglass and sealing compound around the lines to minimize vibration and retain flexibility in the lines.

The unit needs to be secured in its final location. Holes are provided in the base runner for this purpose.

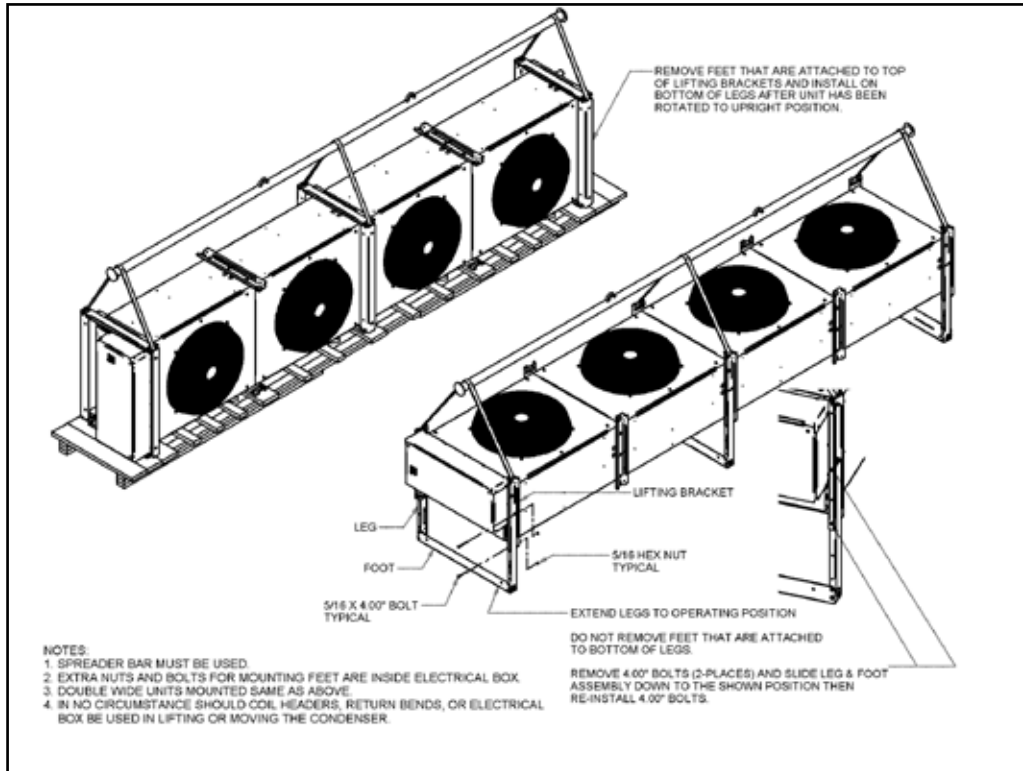
Warning: This equipment may contain a substance which harms the public health and environment by destroying ozone in the upper atmosphere. Venting of certain refrigerants to the atmosphere is illegal. Refrigerant recovery devices must be used when installing or servicing this product. Consult your local codes for requirements in your location.

Warning: There may be more than one source of electrical current in this unit. Do not service before disconnecting all power supplies.

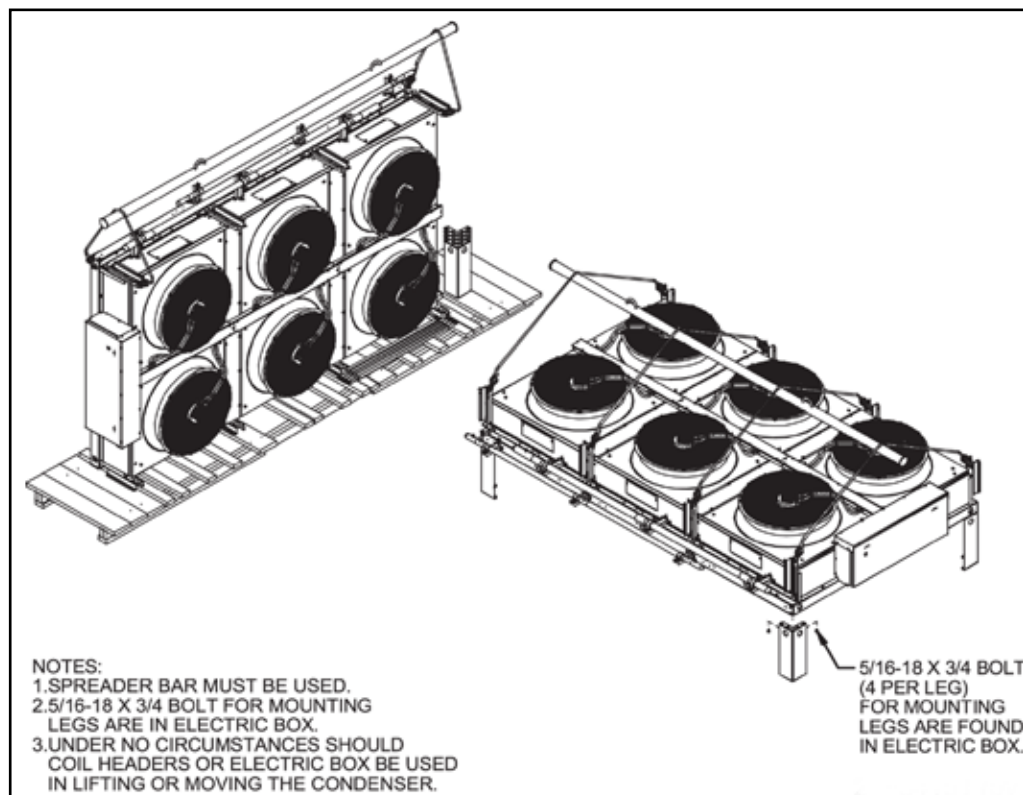
Rigging Instructions

- 1). Spreader bar must be used for all rigging.
- 2). Under no circumstance should coil connections, coil headers, return bends, or electrical box be used in lifting or moving the condenser.
- 3). Under no circumstance should any person be under the condenser.
- 4). If there are more than four lifting points on the condenser, more than four lifting points should be used.
- 5). Under no circumstance should the condenser lifting points be used to lift a condenser that has been attached to other equipment, like a steel frame. If condenser has been attached to other equipment, use lifting points provided on other equipment to lift complete assembly.

Drawing 1. Rigging Instructions for standard Air-Cooled Condenser



Drawing 2. Rigging Instructions for Air-Cooled Condenser with Microchannel Coil Technology



Space and Location Requirements

The most important consideration which must be taken into account when deciding upon the location of air-cooled equipment is the provision for a supply of ambient air to the condenser, and removal of heated air from the condenser area. Where this essential requirement is not adhered to, it will result in higher head pressures, which cause poor operation and possible eventual failure of equipment. Units must not be located in the vicinity of steam, hot air or fume exhausts.

Another consideration which must be taken is that the unit should be mounted away from noise sensitive spaces and must have adequate support to avoid vibration and noise transmission into the building. Units should be mounted over corridors, utility areas, rest rooms and other auxiliary areas where high levels of sound are not an important factor. Sound and structural consultants should be retained for recommendations.

Consideration should also be made to make sure there is sufficient space for removal/replacement of microchannel coils (when supplied). A minimum of one unit width should be allowed on the header end of the unit to provide sufficient clearance.

Walls or Obstructions

The unit should be located so that air may circulate freely and not be recirculated. For proper air flow and access all sides of the unit should be a minimum of "W" away from any wall or obstruction. It is preferred that this distance be increased whenever possible. Care should be taken to see that ample room is left for maintenance work through access doors and panels. Overhead obstructions are not permitted. When the unit is in an area where it is enclosed by three walls the unit must be installed as indicated for units in a pit.

Multiple Units

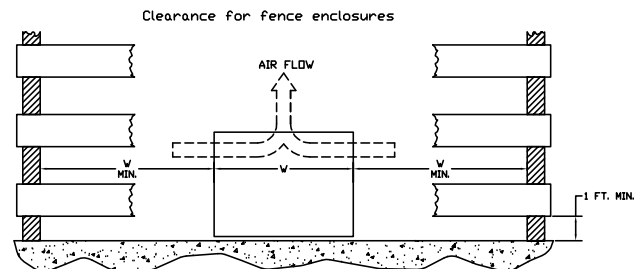
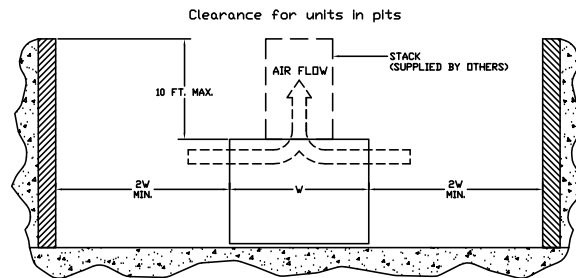
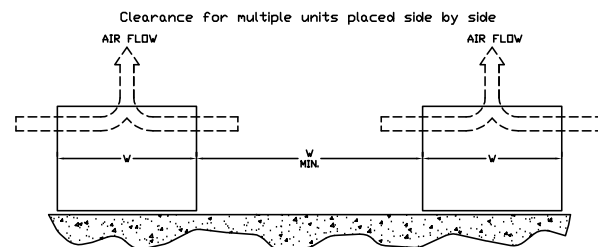
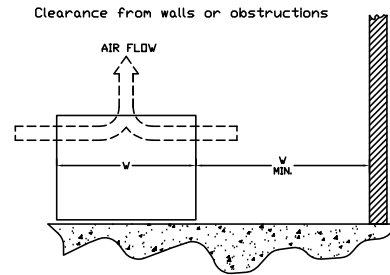
For units placed side by side, the minimum distance between units is the width of the largest unit. If units are placed end to end, the minimum distance between units is 4 feet.

Units in Pits

The top of the unit should be level with the top of the pit, and side distance increased to "2W". If the top of the unit is not level with the top of pit, discharge cones or stacks must be used to raise discharge air to the top of the pit. This is a minimum requirement.

Decorative Fences

Fences must have 50% free area, with 1 foot undercut, a "W" minimum clearance, and must not exceed the top of unit. If these requirements are not met, unit must be installed as indicated for "Units in pits".



* "W" = Total width of the condenser.

Typical Arrangements

Figure 1 illustrates a typical piping arrangement involving a remote condenser located at a higher elevation, as commonly encountered when the condenser is on a roof and the compressor and receiver are on grade level or in a basement equipment room.

In this case, the design of the discharge line is very critical. If properly sized for full load condition, the gas velocity might be too low at reduced loads to carry oil up through the discharge line and condenser coil. Reducing the discharge line size would increase the gas velocity sufficiently at reduced load conditions; however, when operating at full load, the line would be greatly undersized, and thereby create an excessive refrigerant pressure drop. This condition can be overcome in one of two following ways:

1. The discharge line may be properly sized for the desired pressure drop at full load conditions and an oil separator installed at the bottom of the trap in the discharge line from the compressor.
2. A double riser discharge line may be used as shown in Figure 2. Line "A" should be sized to carry the oil at minimum load conditions and the line "B" should be sized so that at the full load conditions both lines would have sufficient flow velocity to carry the oil to the condenser.

For more complete information, refer to the ASHRAE Handbook on Systems.

Figure 1

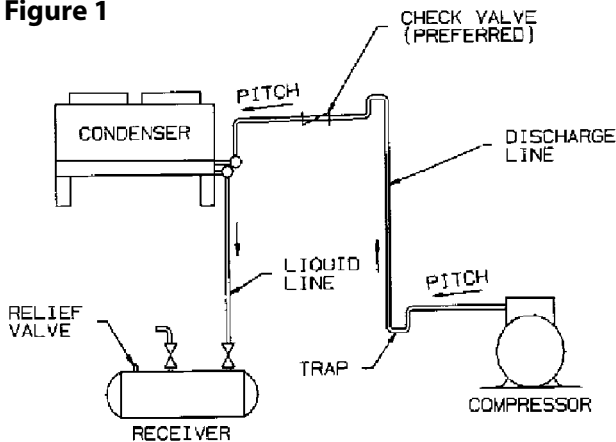
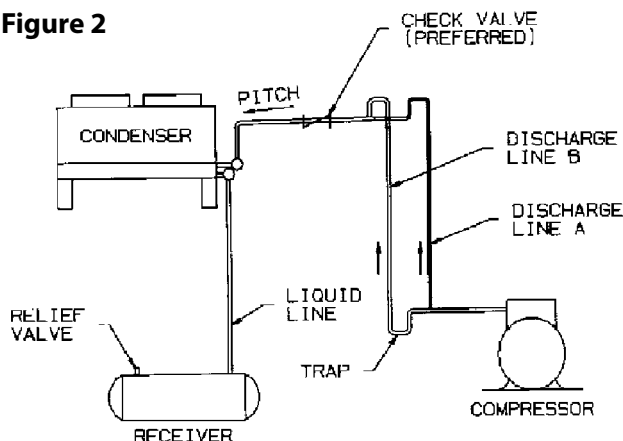


Figure 2



Notes:

1. All oil traps are to be as short in radius as possible. Common practice is to fabricate the trap using three 90 degrees ells.
2. Pressure relief valves are recommended at the condenser for protection of the coil.
3. A drain line check valve is recommended for applications where the condenser may be at a lower temperature than the receiver.

Installation, Refrigerant Piping

Install piping according to standard accepted refrigeration practice. The following recommendations should be adhered to:

1. See Tables 1 and 2 for discharge and liquid drain line sizes for remote condenser connections.
2. Use only refrigeration grade copper tubing.
3. Soft solder joints are not acceptable.
4. Put dry nitrogen through lines while brazing.
5. Do not leave dehydrated piping or components open to the atmosphere any longer than is absolutely necessary.
6. Inverted traps should be located near coil inlets as shown in Figures 1 & 2.

Discharge Lines

The proper design of discharge lines involves two objectives:

1. To minimize refrigerant pressure drop, since high pressure losses cause increased compressor horsepower per ton of refrigerant.
2. Maintain sufficiently high gas velocity to carry oil through to the condenser coil and receiver at all loading conditions.

Table 1. Tons of Refrigeration

Line Size Type L Copper OD	Discharge Line						Drain Line Velocity 100 FPM Refrigerant	
	R-22 Sat. Suction Temp (°F)			R-404A/R-507 Sat. Suction Temp (°F)			R-22	R-404A/R-507
	-40	0	40	-40	0	40		
1/2	0.75	0.8	0.85	0.56	0.63	0.7	2.3	1.5
5/8	1.4	1.5	1.6	1.0	1.2	1.3	3.7	2.3
7/8	3.7	4.0	4.2	2.7	3.1	3.4	7.8	4.9
1-1/8	7.5	8.0	8.5	5.5	6.3	7.0	13.2	8.3
1-3/8	13.1	14.0	14.8	9.6	10.9	12.1	20.2	12.6
1-5/8	20.7	22.0	23.4	15.2	17.2	19.1	28.5	17.9
2-1/8	42.8	45.7	48.5	31.4	35.6	39.5	49.6	31.1
2-5/8	75.4	80.4	85.4	55.3	62.8	69.5	76.5	48.0
3-1/8	120.2	128.2	136.2	87.9	99.8	110.5	109.2	68.4
3-5/8	178.4	190.3	202.1	130.5	148.1	164.0	147.8	92.6
4-1/8	251.1	267.8	284.4	183.7	208.4	230.9	192.1	120.3

Source: ASHRAE Refrigeration Handbook:

1. Line sizes based on pressure drop equivalent to 1°F per 100 equivalent feet.
2. Values in Table are based on 105°F condensing temperature. Multiply Table capacities by the factors in Table 2 for other condensing temperatures.
3. If subcooling is substantial or the line is short, a smaller line size may be used. Applications with very little subcooling or very long lines may require larger sizes

Table 2. Condensing Temperature Correction Factor

Condensing Temperature	Discharge Line					
	R-22	R-404A	R-507	R-407C	R-410A	R-134a
90	0.88	0.922	0.924	0.872	0.889	0.882
100	0.95	0.974	0.975	0.957	0.963	0.961
110	1.04	1.009	1.005	1.036	1.032	1.026
120	1.10	1.026	1.014	1.009	1.096	1.078
130	1.18	1.043	1.024	1.182	1.160	1.156

Electrical Wiring

The electrical installation should be in accordance with National Electrical Code, local codes and regulations. Proper overcurrent protection should be provided for the fan motors.

All standard motors have internal inherent overload protectors. Therefore, contactors can be used instead of starters requiring thermal protectors, eliminating the problem of furnishing the proper heating elements.

All air-cooled condensers are furnished with either single-phase or three-phase fan motors which are identified by the unit dataplate.

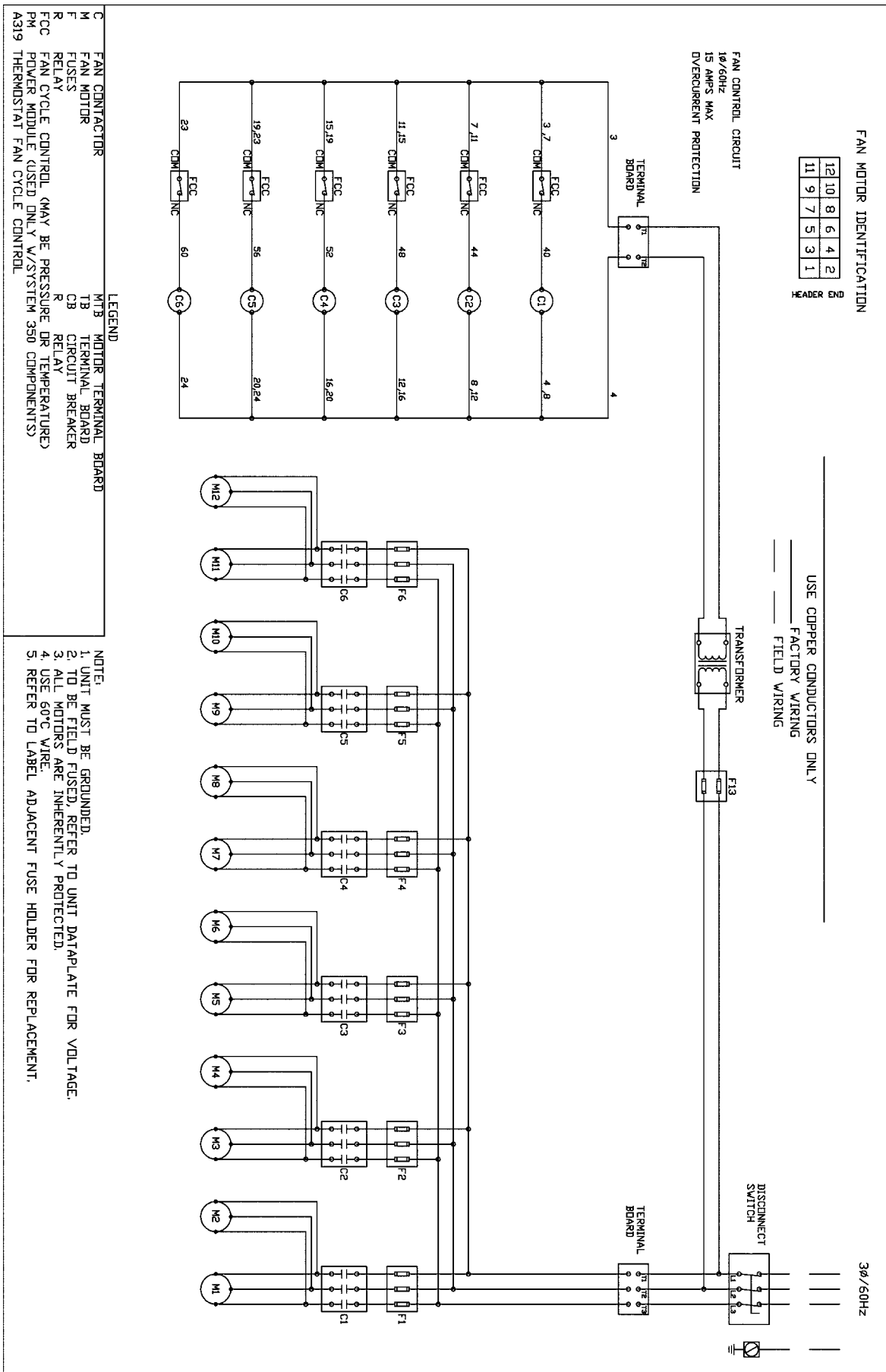
Electrical leads from each motor terminate at the unit junction box. Field connections must be made from these leads in accordance with local, state and national codes.

Three-phase motors must be connected to three-phase power of voltage to agree with motor and unit dataplate.

The motors are wired into a common junction box. Where fan cycling is furnished and factory installed, the motors are completely wired through the control and to the contactors. The motors must be checked for proper rotation. Be sure to check that motor voltage and control connection agree with electric services furnished.

WARNING: There may be more than one source of electrical current in this unit. Do not service before disconnecting all power supplies.

Diagram 1. Typical Condenser Wiring Diagram with Fan Cycle Controls



Start-Up

Check for proper fan rotation. Air is drawn through the coil on all units. Be sure the fans turn freely.

Rotation of the motors and blades should be in a "CW" direction looking at the unit from the blade side. On three phase units, it may be necessary to reverse two of the three power leads to the unit.

NOTE: The manifold assembly is not designed to support field piping. Any damages to the condenser due to excessive weight, pressure or vibration will not be covered by our standard warranty.

Discharge Gas Pulsation

Gas pulsations in a refrigeration system are most commonly associated with the compressor and connecting discharge piping. Variations in the system piping configuration, line sizing, operating pressures and compressor and component mounting all contribute to the presence and magnitude of these pulsations.

The vibration and movement of components caused by the pulsations may result in line breakage or damage to the condenser. In order to eliminate discharge pulsations and the potential for related condenser damage, it is recommended that a discharge muffler be installed in the refrigeration piping. In all cases, the recommendations of the compressor or muffler manufacturer must be followed when selecting these components.

Operation

Winter Operation Head Pressure Control

The capacity of an air-cooled condenser varies with the difference between the entering air dry bulb temperature and the condensing temperature of the refrigerant. Since air temperature in some regions varies as much as 100° from summer to winter, some means must be employed to keep the condensing temperature sufficiently high to insure proper operation of the refrigerant expansion valve during low ambient operation, and also allow sufficient capacity so that excessively high condensing temperatures do not result during high ambient conditions.

The low limit of the head pressure is dependent upon the required pressure drop across the thermostatic expansion valve. For normal air conditioning applications, head pressure should be maintained above a condensing temperature corresponding to 90° F. This, in effect, corresponds to a normal lower limit of about 60° F ambient air. Since air conditioning is not normally required at these lower ambient temperatures, condenser head pressure control may not always be necessary. However for those applications which are of such a nature that operation is required below 60° F ambient air temperature, additional head pressure control will be required.

Fan Cycling

A decrease in ambient air temperature results in a capacity increase in the air-cooled condenser. This capacity increase is directly proportional to the temperature difference between the condensing temperature and the temperature of the ambient air entering the condenser. Since air-cooled condensers are often required to operate over a wide range of ambient air temperatures and variable loading conditions, provisions must be made to maintain the overall system balance. Any air-cooled condenser tends to run at a low head pressure when operating in a low ambient air temperature. Low head pressures could result in poor expansion valve operation and poor system operation.

The cycling of condenser fans provides an automatic means of maintaining head pressure control, within reasonable limits, at lower ambient air temperatures. A fan cycling control system allows fans to cycle in sequence by sensing either ambient temperature or condensing pressures. However, care must be used by the engineer or installing contractor in making adjustments to prevent short cycling of the fan motors. A fan cycle is a time measure beginning when a motor starts normal running operation through an off cycle until the next time the motor starts. Short cycling is normally caused by too close a differential in the control settings or set points. If flooding valves are used with fan cycling, they must be set to follow the fan cycling.

Recommended differential settings for ambient sensing thermostats are 5° F and a minimum of 35 PSIG differential for pressure switches. However, system or climate conditions vary and the controls may require further field adjustment to provide optimum system performance and prevent short cycling.

Any fan cycles that are less than three minutes in duration are considered short cycling and must always be avoided. Continuous fan motor short cycling over extended periods of time will be detrimental to the systems long-term reliability. In order to sustain proper product integrity fan cycle controls must be configured so individual fan motors do not cycle more than 120 times per day or less than 3 minutes per any single cycle. Adjust controls accordingly. It is also recommended that the fan closest to the header end of the condenser be wired to run continuously, whenever the compressor(s) is (are) operational. Cycling all of the fans off usually results in rapid, short cycling of the fans and erratic head pressure control.

If additional head pressure control is necessary beyond letting the lead fan run, we recommend adding variable speed or flooding controls. If cycling the header fan is necessary for adequate head pressure control, we recommend cycling on pressure. Ambient sensing thermostats should never be used to cycle the lead fan.

Fans must not cycle in multiples except on double wide single circuit condensers where they may cycle in pairs (one motor on each side). Do not cycle more than two fans at a time on double wide condensers and only one fan at a time on single wide condensers.

Fan Cycling with "J" Series Motors

If operated with fan cycling, "J" Series microchannel condensers should only be operated with two stages of fan cycling per refrigeration circuit. This is required to maintain consistent air/refrigerant flow across the condenser. This is important both to ensure correct operation and prevent damage to the condenser/refrigeration system.

Fan Cycling Head Pressure Controls

Condenser fans are cycled to maintain adequate head pressure. Ambient and pressure fan cycling are available as optional equipment.

Ambient fan cycling cycles fans in response to the ambient air temperature. This control is ideal for multi-circuited condensers or for systems operating in mild ambient conditions. See table 3 for minimum ambient temperatures for fan cycling. Set points for thermostats will vary depending on the number of fans and condenser design T.D. See table 4 for recommended set points.

Pressure fan cycling cycles fans in response to condenser pressure. This style of control is more appropriate where the load on the condenser will vary due to multiple compressor operation or stages of unloading or systems incorporating heat reclaim or hot gas defrost.

Variable Speed

Condenser head pressure control is provided by varying the air flow through the condenser by changing the RPM of the condenser fan. This control package is offered in combination with ambient fan cycling. The fan motor next to the header end of the condenser is the variable speed fan.

The remainder of the fans are constant speed and are cycled separately using ambient sensing thermostats. On condensers with two rows of fans, two variable speed fans are provided (one per row) and the remainder of the fans are constant speed and are cycled in pairs.

Splitting Controls

Additional head pressure can be provided by valving off a portion of the condenser circuit and removing that portion from the refrigeration circuit. This is often referred to as splitting a condenser. In addition to providing a means of head pressure control, this control will reduce the amount of refrigerant required to operate the condenser with a flooded head pressure control.

Condenser splitting is recommended as a seasonal adjustment controlled by ambient temperature. An initial setting of 50° to 55° F with a 20° F differential is recommended. A pressure switch is also provided as a backup control to prevent high head pressures from occurring during heavy load conditions.

On condensers with a single row of fans the control package consists of an ambient sensing thermostat, a pressure switch sensing condensing pressure and a splitting relay. The splitting relay provides a set of dry contacts to control the valves required to split the condenser (valves supplied by others).

On condensers with double rows of fans, additional controls and contactors are provided to cycle all of the fans on the side of the condenser which has been split off.

Except as noted above, the splitting packages do not control fan cycling. It is recommended that fan cycling be controlled by combining the splitting package with pressure fan cycling.

Flooding Head Pressure Controls

Another means of head pressure control is to change the condenser capacity by filling the inside of the condenser with liquid refrigerant. Flooding controls are ideal for condensers operating in low ambient conditions (beyond the limits of fan cycling controls) or under partial load conditions. These controls require additional refrigerant charge to flood the condenser. This additional refrigerant charge can often be reduced by incorporating the flooded control with one of the fan cycle controls previously described.

Several styles of flooding valves or combinations of valves are available. Contact the valve manufacturer for specific recommendations.

Refrigerant Charge

The refrigerant charge for summer operation can be found in table 9. This table also contains the additional charge required by flooding style controls.

Table 8 contains the recommended flooding charge required when combining fan cycling with flooding valves.

Table 3 contains the recommended flooding charge for Microchannel Condensers. Due to minimal variation in refrigerant charge requirements for various applications on microchannel condensers, one refrigerant charge level has been selected which will meet the needs of common applications. The point selected is 15°F DTD and -20°F minimum ambient temperature.

Table 3. Refrigerant Charge for Microchannel Condensers

Model	R404A Flooded Refrigerant Charge* (lbs.)
NRGD02A014	10
NRGD04A027	20
NRGD06A041	30
NRGD08A054	40

* Does not include Manifolding

Table 4. Minimum Ambient for Fan Cycling for Standard Air-Cooled Condensers

Number of Fans		Design T.D.*				
Single Row	Double Row	30	25	20	15	10
2	4	35	45	55	60	70
3	6	15	30	40	55	65
4	8	0	15	30	45	60
5	10	0	10	20	35	55
6 / 7	12 / 14	0	0	10	30	50

* Based on maintaining 90°F minimum condensing temperature.

Table 5. Mechanical Fan Cycling Thermostat Settings for Standard Air-Cooled Condensers

Number of Fans

Number of Fans		Design T.D.	Thermostat Setting				
Single Row	Double Rows		1	2	3	4	5
2	4	30	60				
		25	65				
		20	70				
		15	75				
		10	80				
3	6	30	60	40			
		25	65	55			
		20	70	60			
		15	75	65			
		10	80	65			
4	8	30	60	50	30		
		25	65	55	40		
		20	70	65	50		
		15	75	70	60		
		10	80	75	70		
5	10	30	60	55	45	30	
		25	65	60	50	35	
		20	70	65	60	40	
		15	75	70	65	55	
		10	80	75	70	65	
6 / 7	12 / 14	30	55	50	40	30	25
		25	65	60	55	45	35
		20	70	65	60	50	40
		15	75	70	65	60	50
		10	80	75	70	65	60

Table 6. Electronic Fan Cycling Thermostat Settings * for Standard Air-Cooled Condensers

Number of Fans		A350 Design T.D.	Set Point	S350 Temperature Stage Modules Offset Settings			
Single Row	Double Rows			Offset Settings			
				2	3	4	5
2	4	30	60				
		25	65				
		20	70				
		15	75				
		10	80				
3	6	30	60	20			
		25	65	10			
		20	70	10			
		15	75	10			
		10	80	15			
4	8	30	60	10	30		
		25	65	10	25		
		20	70	5	20		
		15	75	5	15		
		10	80	5	10		
5	10	30	60	5	15	30	
		25	65	5	15	30	
		20	70	5	10	30	
		15	75	5	10	20	
		10	80	5	10	15	
6 / 7	12 / 14	30	55	5	15	25	30
		25	65	5	10	20	30
		20	70	5	10	20	30
		15	75	5	10	15	25
		10	80	5	10	15	20

* Johnson Controls Style S350 operation.
 5° differential set on all modules. All modules set in the “heating” mode.

Table 7. Pressure Chart for Standard Air-Cooled Condensers

Number of Fans		Design T.D.	Refrigerant	Control Settings Pressure Switch Cut-In Settings				
Single Row	Double Rows			PC1	PC2	PC3	PC4	PC5
2	4			20	R134a	147		
		R22	215					
		R404A	220					
3	6	20	R134a	147	155			
			R22	215	245			
			R404A	220	247			
4	8	20	R134a	147	155	160		
			R22	215	231	247		
			R404A	220	238	255		
5	10	20	R134a	147	153	156	160	
			R22	215	225	236	247	
			R404A	220	238	250	260	
6 / 7	12 / 14	20	R134a	147	150	153	157	160
			R22	215	223	230	239	247
			R404A	220	238	245	255	265

Based on 20° T.D.;;
 For (R404A/R507) set cutout 35 PSIG below cut-in; for (R134A) set cutout 25 PSIG below cut-in.
 Fan on header end to remain on whenever compressor is operating.

Table 8. Refrigerant Charge for Fan Cycling plus Flooded Condenser (lbs. R-22) on Standard Air-Cooled Condensers

Model*	Summer Charge	25° TD				20° TD				15° TD				10° TD			
		40°F	20°F	0°F	-20°F	40°F	20°F	0°F	-20°F	40°F	20°F	0°F	-20°F	40°F	20°F	0°F	-20°F
1	8	7	8	9	9	8	9	10	10	9	10	11	11	13	12	12	12
2	10	9	12	13	14	11	13	14	15	13	14	15	16	17	18	17	18
3	10	1	6	8	10	4	8	10	11	7	10	12	13	10	13	14	14
4	15	2	9	12	15	7	12	15	17	12	16	18	19	17	19	21	22
5	20	3	11	16	19	9	16	20	22	15	21	24	25	21	25	27	28
6	22	0	3	10	15	0	10	16	20	0	17	22	25	0	24	27	29
7	30	0	4	13	20	0	12	20	26	0	21	27	32	0	29	34	38
8	51	0	0	8	22	0	6	23	35	0	22	38	48	0	37	52	61
9	70	0	0	11	29	0	8	31	46	0	29	51	63	0	49	71	80
10	64	0	0	0	15	0	0	17	33	0	0	39	52	0	0	60	70
11	86	0	0	0	19	0	0	22	44	0	0	50	69	0	0	78	93
12	102	0	0	0	6	0	0	8	37	0	0	37	69	0	0	66	100
13	118	0	0	0	0	0	0	0	29	0	0	0	69	0	0	0	108
14	19	3	12	17	20	9	17	21	23	15	22	25	26	21	27	29	29
15	29	4	17	24	29	13	24	30	34	22	31	36	39	31	38	41	43
16	40	5	22	32	38	17	31	39	44	29	40	46	50	41	49	53	56
17	44	0	5	20	31	0	18	31	40	0	31	42	49	0	44	53	59
18	58	0	7	27	42	0	25	42	54	0	43	57	66	0	61	71	79
19	104	0	0	17	44	0	12	47	69	0	43	77	95	0	74	107	119
20	140	0	0	22	57	0	16	62	91	0	57	102	125	0	99	141	157
21	125	0	0	0	30	0	0	34	67	0	0	77	105	0	0	120	141
22	172	0	0	0	39	0	0	44	88	0	0	100	137	0	0	156	186
23	201	0	0	0	11	0	0	16	74	0	0	74	137	0	0	132	200
24	236	0	0	0	0	0	0	0	57	0	0	0	135	0	0	0	213

* See Model Cross Reference Table #10.

Table 9. Refrigerant Charge. Lbs. R-22 for Flooded Condensers on Standard Air-Cooled Condensers

Model*	Refrigerant R-22 Charge for summer Operation, Lbs.	Additional Refrigerant R-22 Charge Required for Flooded Condenser Operation Lbs. For 20°F TD Minimum Ambient at Condenser				
		+60	+40	+20	+0	-20
1	8	7	10	11	11	11
2	10	10	13	15	15	16
3	10	10	13	14	15	15
4	15	15	19	21	22	23
5	20	19	26	29	30	31
6	22	22	29	32	34	35
7	30	29	38	42	44	46
8	51	50	66	74	77	80
9	70	66	87	96	100	105
10	64	62	83	92	95	99
11	86	83	110	122	127	132
12	102	100	132	147	153	159
13	118	117	155	172	179	186
14	19	20	27	29	31	32
15	29	30	39	44	46	47
16	40	39	51	57	59	62
17	44	44	58	64	67	70
18	58	59	78	86	90	94
19	104	99	131	146	152	158
20	140	131	174	193	201	209
21	125	126	168	186	194	201
22	172	165	219	243	253	263
23	201	201	267	296	308	320
24	236	233	310	343	357	372

* See Model Cross Reference Table #10.

Table 10. Flooded Charge Temperature Difference Factor for Standard Air-Cooled Condensers

Ambient, °F	Design T.D.				
	30	25	20	15	10
+60	–	0.38	1.0	1.74	2.46
+40	0.59	0.80	1.0	1.19	1.40
+20	0.76	0.88	1.0	1.13	1.25
0	0.84	0.91	1.0	1.07	1.16
-20	0.88	0.93	1.0	1.05	1.13

Table 11. Model Cross Reference for Standard Air-Cooled Condensers

Model Reference	*NH	*NL	*NX	*NQ	*NE
1	*NH-S01-A007	*NL-S01-A007	*NX-S01-A006	*NQ-S01-A005	*NE-S01-A008
2	*NH-S01-A009	*NL-S01-A008	*NX-S01-A008	*NQ-S01-A006	*NE-S01-A009
3	*NH-S02-A011	*NL-S02-A010	*NX-S02-A010	*NQ-S02-A008	*NE-S02-A011
4	*NH-S02-A015	*NL-S02-A014	*NX-S02-A013	*NQ-S02-A010	*NE-S02-A015
5	*NH-S02-A017	*NL-S02-A016	*NX-S02-A015	*NQ-S02-A012	*NE-S02-A018
6	*NH-S03-A022	*NL-S03-A021	*NX-S03-A020	*NQ-S03-A016	*NE-S03-A023
7	*NH-S03-A026	*NL-S03-A024	*NX-S03-A023	*NQ-S03-A017	*NE-S03-A027
8	*NH-S04-A029	*NL-S04-A028	*NX-S04-A026	*NQ-S04-A021	*NE-S04-A031
9	*NH-S04-A034	*NL-S04-A032	*NX-S04-A030	*NQ-S04-A023	*NE-S04-A036
10	*NH-S05-A037	*NL-S05-A036	*NX-S05-A033	*NQ-S05-A026	*NE-S05-A039
11	*NH-S05-A044	*NL-S05-A042	*NX-S05-A038	*NQ-S05-A029	*NE-S05-A047
12	*NH-S06-A053	*NL-S06-A050	*NX-S06-A045	*NQ-S06-A034	*NE-S06-A056
13	*NH-S07-A061	*NL-S07-A055	*NX-S07-A052	*NQ-S07-A042	*NE-S07-A065
14	*NH-D04-A021	*NL-D04-A020	*NX-D04-A020	*NQ-D04-A016	*NE-D04-A023
15	*NH-D04-A029	*NL-D04-A028	*NX-D04-A026	*NQ-D04-A021	*NE-D04-A031
16	*NH-D04-A034	*NL-D04-A032	*NX-D04-A030	*NQ-D04-A023	*NE-D04-A036
17	*NH-D06-A044	*NL-D06-A042	*NX-D06-A040	*NQ-D06-A031	*NE-D06-A046
18	*NH-D06-A051	*NL-D06-A048	*NX-D06-A045	*NQ-D06-A034	*NE-D06-A054
19	*NH-D08-A058	*NL-D08-A056	*NX-D08-A053	*NQ-D08-A041	*NE-D08-A062
20	*NH-D08-A068	*NL-D08-A065	*NX-D08-A061	*NQ-D08-A046	*NE-D08-A073
21	*NH-D10-A074	*NL-D10-A071	*NX-D10-A066	*NQ-D10-A052	*NE-D10-A079
22	*NH-D10-A088	*NL-D10-A083	*NX-D10-A076	*NQ-D10-A057	*NE-D10-A093
23	*NH-D12-A106	*NL-D12-A100	*NX-D12-A091	*NQ-D12-A069	*NE-D12-A112
24	*NH-D14-A123	*NL-D14-A110	*NX-D14-A104	*NQ-D14-A083	*NE-D14-A129

* First letter of model corresponds to a particular brand. B is Bohn. L is Larkin. C is Climate Control. H is Chandler.

Maintenance

Air-cooled condensing units require a minimum of maintenance. The unit coil will require a periodic cleaning and this can be accomplished by a brush, vacuum cleaner, pressurized air

stream or a commercially available coil cleaning foam. All of the condenser fan motors have sealed ball bearings. The only acceptable service to these bearings is replacement.

General Cleaning Instructions

Heatcraft recommends that the finned surface of this unit be cleaned approximately every six months; more frequent cleaning may be required if extreme conditions cause clogging or fouling of air passages through the finned surface.

Calgon Corporation's CalClean 41352 (or equal) should be acceptable for cleaning this unit. CalClean should be applied liberally to entering air and leaving air surfaces of the finned area in accordance with the label directions.

Cleaning Instructions for Microchannel Coils

- Use non acidic cleaners (pH < 10.5).
- Ekeivate temperature of mixed cleaner to 120°F.
- Use of a power washer with a **broad** spray pattern is acceptable.

CAUTION: Under no circumstances should this unit be cleaned with an acid-based cleaner.

In-Warranty Return Material Procedure

Material may not be returned except by permission of authorized factory service personnel of Heatcraft Refrigeration Products in Stone Mountain, Georgia. A "Return Goods" tag will be sent to be included with the returned material. Enter the required information on the tag in order to expedite handling at our factories and prompt issuance of credits. All parts shall be returned to the factory designated on the "Return Goods" tag, transportation charges prepaid.

The return of a part does not constitute an order for replacement. Therefore, a purchase order must be entered through your nearest Heatcraft Refrigeration Products representative. The order should include part number, model number and serial number of the unit involved.

Following our careful inspection of the returned part and if it is determined that the failure is due to faulty material or workmanship, credit will be issued on customer's purchase order.

Parts by InterLink™

When writing to the factory for service or replacement parts, refer to the model number and serial number of the unit as stamped on the serial plate attached to the unit. If replacement parts are required, mention the date of installation of the unit and date of failure, along with an explanation of the malfunctions and a description of the replacement parts required.




Table 12. InterLink™ Condenser Parts List

Fan RPM	Motor Size	Fan Motor Part No.	Fan Blade Part No.	Fan Guard Part No.
1140 (H Models)	1.5 HP	25316401	22900401	23105701
1140 (Var. Speed)	0.75 HP	25317101	2292625	23105701
830 (L Models)	1.5 HP	25316601	22929501	23105701
830 (X Models)	1 HP	25316301	22929501	23105701
540 (Q Models)	0.5 HP	25316201	22929301	23105701
1030 (E Models, 230V)	2.2 kW	25316905 (7 blade)		--
1030 (E Models, 460V)	2.2 kW	25317005 (7 blade)		--
850 (G Models, 230V)	815 W	25321201		--
850 (G Models, 460V)	815 W	25321301		--
1130 (E Models, 230V)	2.0 kW	25318801 (5 blade)		--
1130 (E Models, 460V)	2.0 kW	25318901 (5 blade)		--


Contact the InterLink™ Customer Service Department for parts to specific condenser models at 800-686-7278, interlinkparts@heatcraftcpd.com, or www.heatcraftcpd.com.

E & G Series Motors with Integrated Variable Speed


E & G Series units use an EC motor/fan blade combination to provide variable speed condenser control. All components required to run the motor at variable speeds are built into the motor.



Warning! When connecting the unit to the supply power, dangerous voltages occur. Do not open the motor within the first 5 minutes after disconnection of all phases.
Be sure that the unit is isolated.



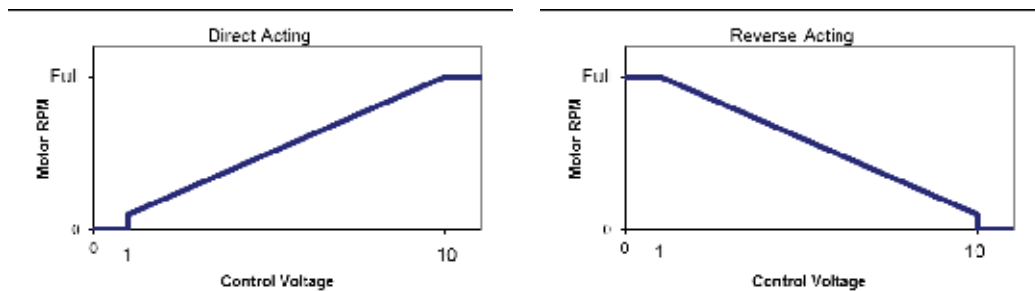
Warning! Dangerous external voltages can be present at terminal KL2 even with the unit turned off.



Warning! With a control voltage fed in or a set speed value being saved, the motor will restart automatically after a power failure.

Speed Adjustment Characteristics

The EC motor varies its speed linearly based on a 0-10 VDC input signal. The motor can be operated as either Direct Acting or Reverse Acting. For Direct Acting, at 10 VDC the motor runs at full speed; at 0 VDC, the motor turns off. Charts of the speed control curves are shown below.



The input control signal can be supplied from any controller that outputs a 0-10 VDC signal. For units with a control signal supplied from a rack control or other external controller, the unit is provided with a terminal board for control signal wiring. Units with factory installed proportional pressure controls require no installation wiring.

External Control Signal

Contact control manufacturer for setup of external controller to provide 0-10 VDC control signal. Wire the control signal to terminal board in unit control box. See Diagrams #2 and #3 for typical external signal control wiring.

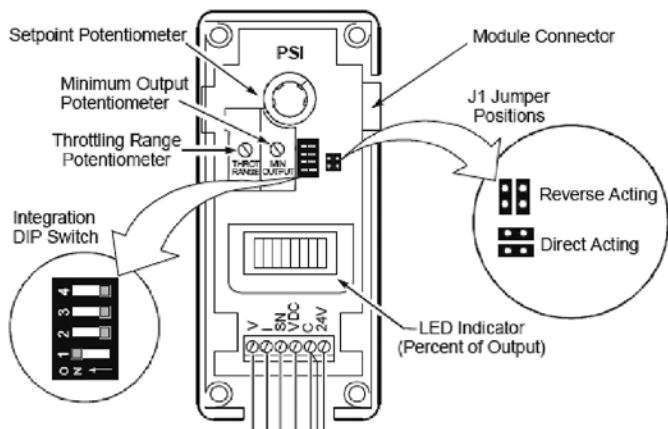
External Control for G Series Motors

When an external control is used with G Series motors, the external controller must be set to output a minimum speed of 10%. It should not allow a minimum speed of 0%. The external controller should also be set to have a minimum throttling range of 40 psig or 15°F.

Proportional Pressure Control

Units with factory installed proportional pressure controls use a PI controller to vary the motor speed in order to maintain a constant desired head pressure. The PI controller has five user adjustable features:

- Head Pressure Setpoint
- Minimum Output
- Throttling range
- Integration constant
- Reverse acting or direct acting mode of operation



Head Pressure Setpoint

The head pressure setpoint potentiometer is adjustable from 90-250 psig. Typical setpoints are from 150-200 psig. Note: Very low setpoints may cause the fan motors to run full speed continually if the condenser is not properly sized. The fans will turn off if the system pressure falls below the desired setpoint.

Minimum Output

The minimum output potentiometer controls the minimum signal sent to the motor. It is adjustable from 0-60%. If this is adjusted to 60%, the motors will not start running until 6V is applied to the motor. The motor will start running at 60% of full speed. For E Series motors, it is recommended this setting be left at 0%. For G Series motors, this setting must be set at 10%. To set the minimum output to 10%, adjust the knob until the first LED Indicator turns on.

Throttling range

The throttling range potentiometer controls how far the system pressure must deviate from the control setpoint to generate a 100% output signal from the control. It is adjustable from 10-100 psig. The throttling range determines how quickly the motor will reach full speed when detecting a change in head pressure. For example, if the setpoint is 200 psig and the throttling range is 50 psig, when the system pressure is below 200 psig, the fans will be off. When the system pressure reaches 250 psig, the fans will be at full speed (see Chart 1 below). To make the fans ramp more slowly the throttling range should be increased (see Chart 2 below). To maximize sound reduction and energy savings and to provide the most stable control, it is recommended this setting be left at 100 psig. For G Series motors, this setting must not be set below 40 psig.

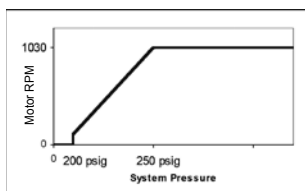


Chart 1. Ramp characteristics with 200 psig setpoint and 50 psig throttling range

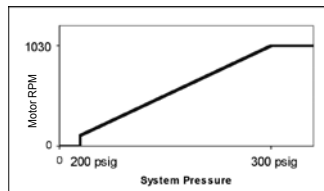
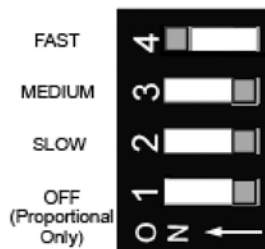


Chart 2. Ramp characteristics with 200 psig setpoint and 100 psig throttling range

Integration constant

The integration constant switch provides ability to change controller from a proportional only control to a proportional plus integral control. To provide the most responsive system to maintain a stable head pressure, it is recommended this setting be left on "fast."



Reverse acting or direct acting mode of operation

The reverse acting/direct acting jumper is used to ensure the controller responds correctly to maintain desired head pressure. In Direct Acting (DA) mode, the motor speed increases as the pressure rises above desired setpoint. For proper condenser operation, this jumper MUST be in Direct Acting (DA) mode. Failure to ensure J1 jumper is in direct acting mode will cause the system to trip on high head pressure.

See Diagram #4 for typical proportional pressure control wiring.

Standard Wiring Configuration

Standard VSEC units are wired in a Direct Acting Series Wired configuration. This configuration allows for the maximum sound and energy reduction as well as the most stable head pressure control. The control signal is delivered to the lead motor (located at the header end of the unit). The lead motor relays the control signal to the adjacent lag motor. This relay is done until the last motor is reached. As each lag relays the control signal, it adjusts the signal so the next lag will run slightly slower than the upstream motor. The end result of this is that when a motor receives a small enough signal, it will turn off. This provides built-in fan cycling.

Protective Features

The EC motors have many built-in protective features.

The EC motors have functions within the motor to protect against:

- over-temperature of electronics
- over-temperature of motor
- incorrect rotor position detection

With any of these failures, the motor stops electronically and the alarm relay is switched. With one of these failures, the motor WILL NOT automatically restart. To reset, the power supply has to be switched off for a minimum 20 seconds once the motor is at standstill.

Locked-rotor protection

As soon as the rotor is blocked, the motor gets switched off electronically and the alarm relay is switched. After de-blocking, the motor WILL restart automatically.

Under-voltage protection

If power supply voltage falls below $\sim 150\text{VAC}/3\phi$ (for 230V motors) or $\sim 290\text{VAC}/3\phi$ (for 460V motors) for 5 seconds minimum, the motor will be switched off electronically and the alarm relay is switched. If power supply voltage returns to correct values, the motor WILL restart automatically.

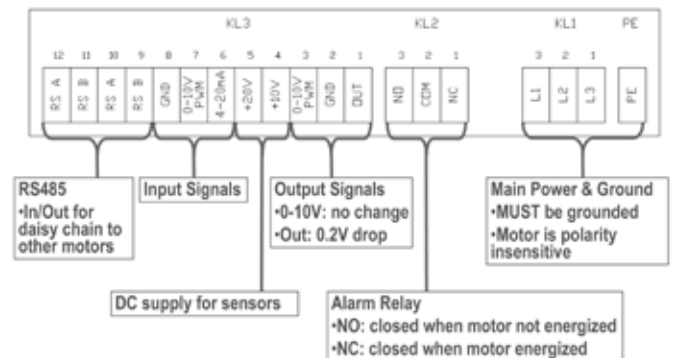
Phase failure

If 1 phase fails for 5 seconds minimum, the motor will be switched off electronically and the alarm relay is switched. If all 3 phases return to correct values, the motor WILL restart automatically within 10-40 seconds.

EC Motor Wiring

All EC motor wiring is done at the factory. If any motor wiring needs to be done in the field, the diagrams below indicate the terminal pin configurations inside the motor junction box.

Motors with 7 fan blades



Motors with 5 fan blades

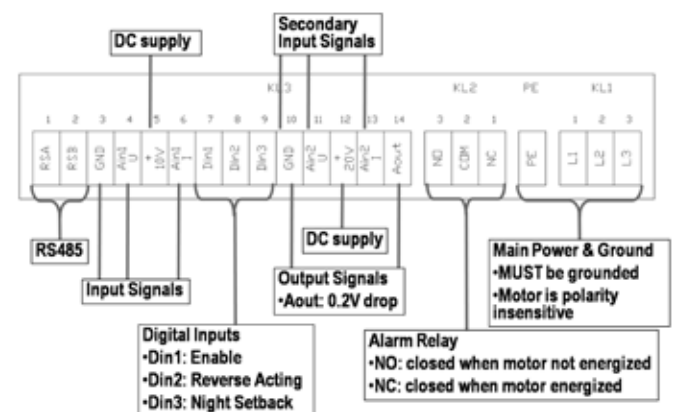


Diagram 2. Typical "G" Condenser Wiring Diagram with External Signal

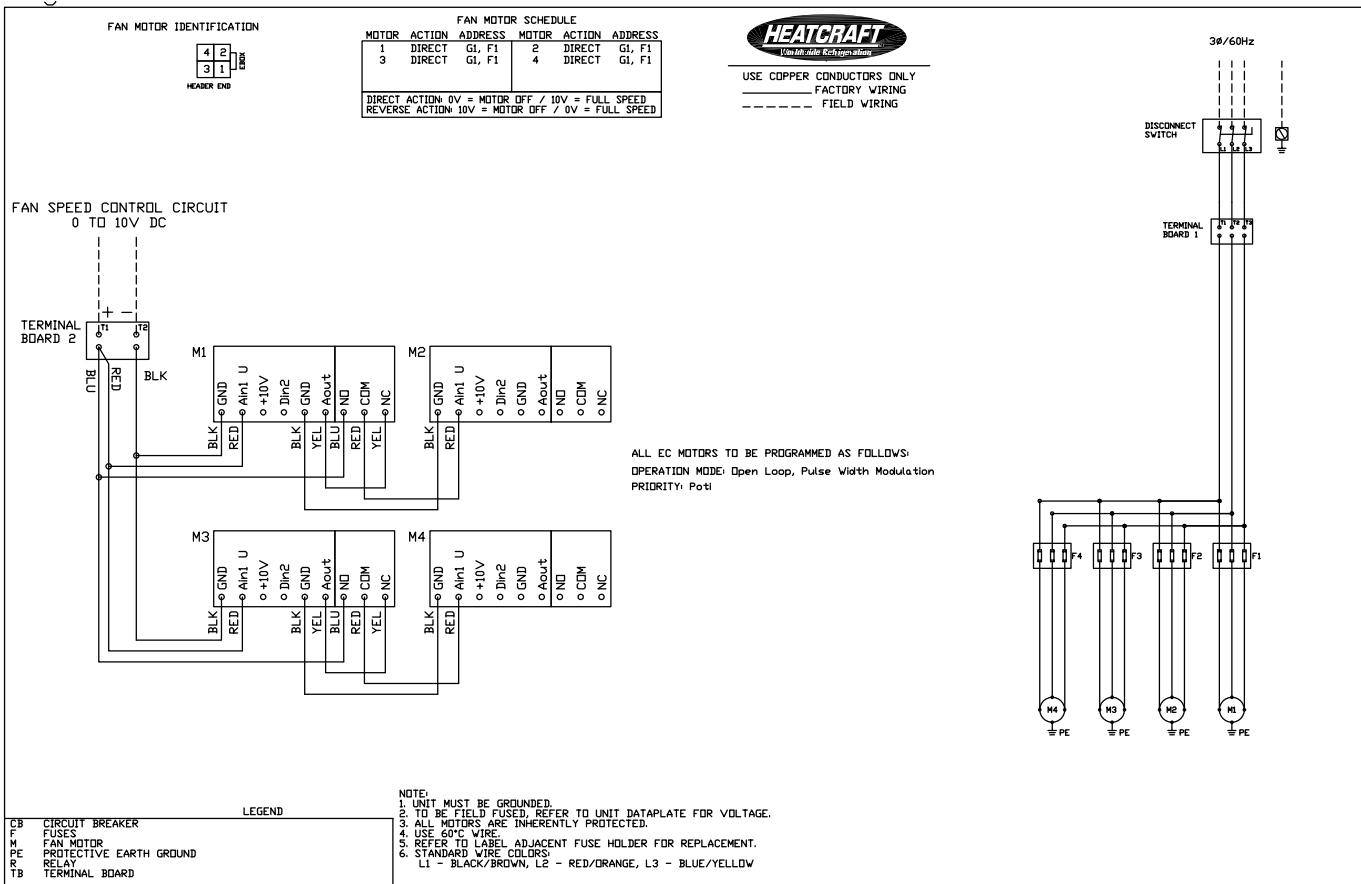


Diagram 3. Typical E Condenser Wiring Diagram with External Signal

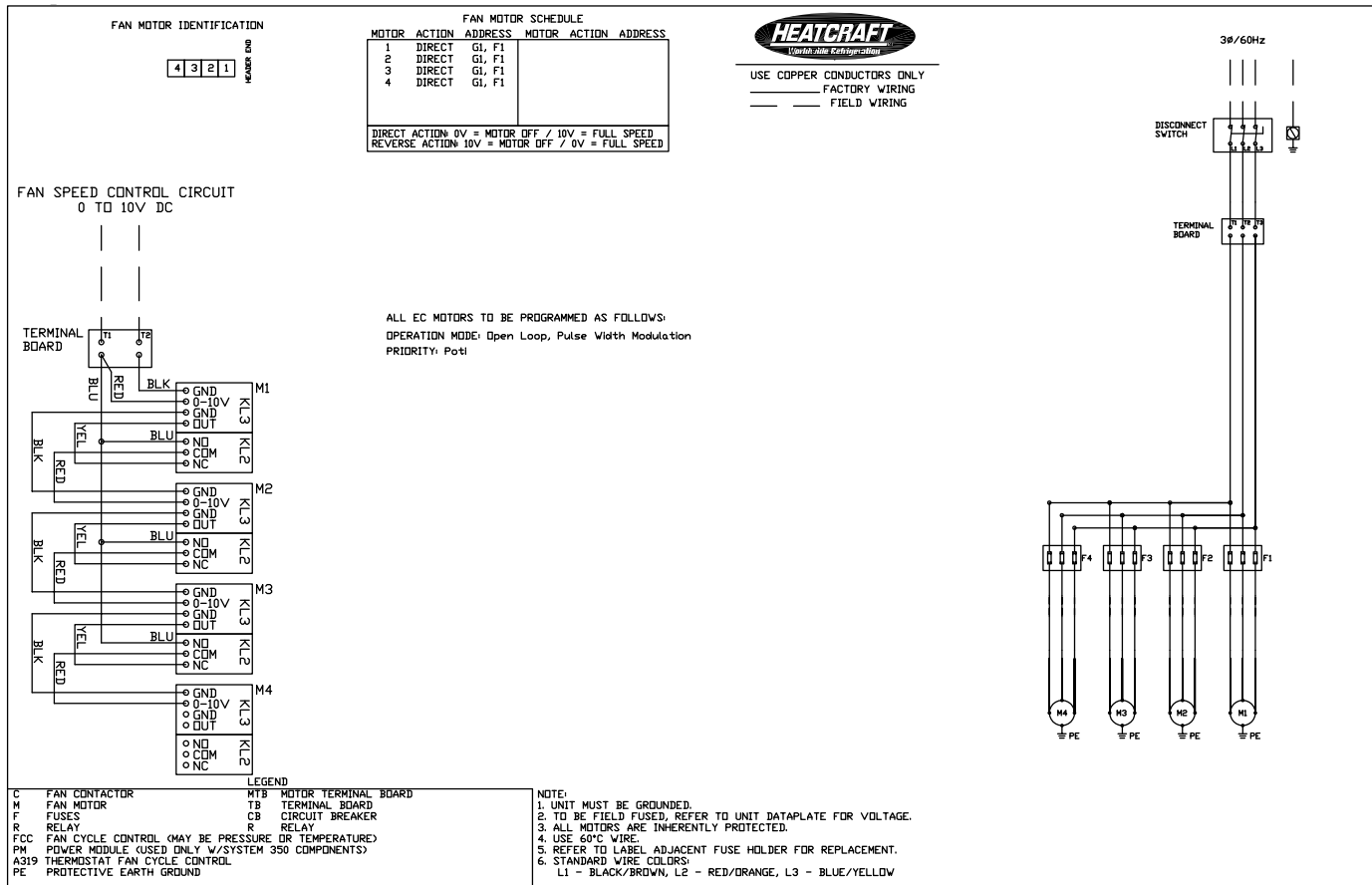
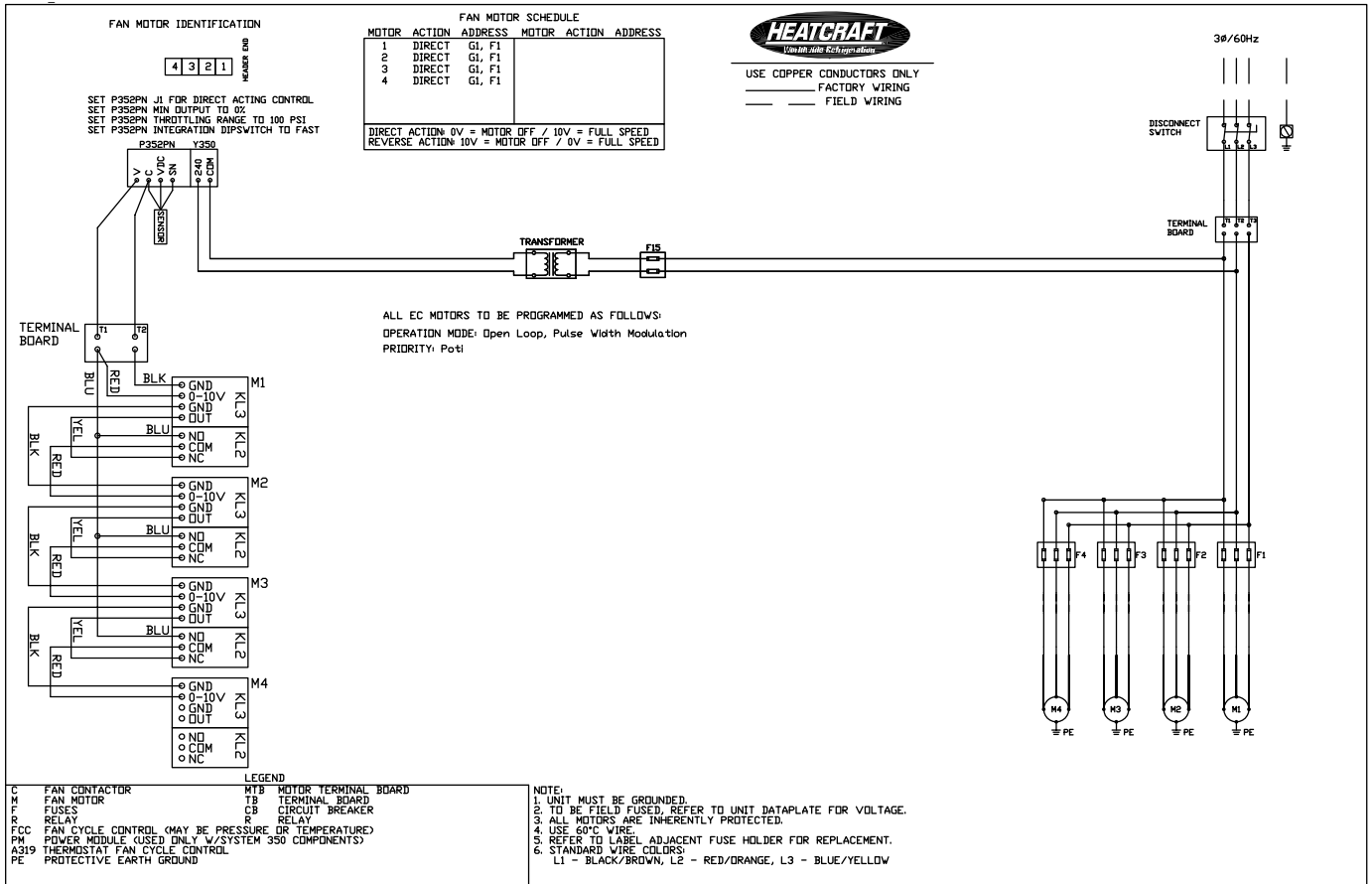


Diagram 4. Typical E Condenser Wiring Diagram with Proportional Pressure Control



Installation Check List

Condenser

Start Up Date

Model #

Serial #

Electrical

Voltage

Amperage

Installer:

Name & Address

Telephone:

Please retain this information with the condenser.

Since product improvement is a continuing effort, we reserve the right to make changes in specifications without notice.

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