LENNOX Industries Inc.

Corp. 8705-L9

Litho U.S.A.

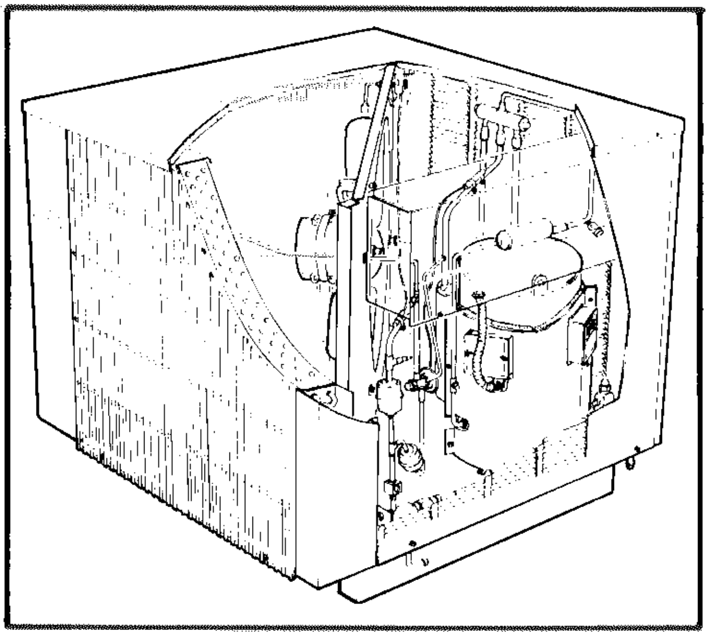
HP14 SERIES UNITS WITH TSC SOLID STATE TWO SPEED CONTROL

The HP14 is a residential heat pump which features a two speed compressor. Two speed operation was initially controlled by electromechanical timers and switches. Beginning with HP14 -9,-11 and -10,-12 series units, two speed operation will be controlled by the new Lennox TSC solid state two speed control.

HP14 -9,-11 series units utilize a Lennox two speed compressor and a TSC-1 two speed control. HP14 -10,12 series units utilize a Bristol two speed compressor and a TSC-2 two speed control.

The first part of this manual describes the components used in HP14's equipped with the TSC. The latter part of this manual describes the sequence of operation for units using the TSC.

Units not equipped with a TSC will have a slightly different sequence of operation from units which are equipped with a TSC.



SPECIFICATIONS

Model Number		HP14-261/411V	HP14-311/511V HP14-313/513V	HP14-411/651V HP14-413/653V
Outdoor Coil	Net face area (sq. ft.)	10.11	12.9	12.9
	Tube diameter (in.)	3/8	3/8	3/8
	No. of rows	3	3	4
	Fins per inch	15	15	15
Outdoor Fan	Diameter (in.)	20	24	24
	No. of blades	4	4	4
	Motor hp	1/5	1/4	1/4
	Cfm (factory setting)	2600	3300	3500
	RPM (factory setting)	1100	840	850
	Watts (factory setting)	240	325	320
Refrigerant-22 (charge furnished)	-9,-11 series units	11 lbs. 5 oz.	14 lbs. 0 oz.	18 lbs. 12 oz.
	-10,-12 series units	11 lbs. 4 oz.	13 lbs. 8 oz.	17 lbs. 5 oz.
Liquid line connection (sweat)		3/8	3/8	1/2
Vapor line connection (sweat)		3/4	7/8	1-1/8

ELECTRICAL DATA

Model Number		HP14-261/411V	HP14-311/511V	HP14-313/513V	HP14-411/651V	HP14-413/653V
Line voltage data - 60 Hz		208/230v/1ph	208/230v/1ph	208/230v/3ph	208/230v/1ph	208/230v/3ph
Compressor (Lennox) -9,-11 series units	Rated load amps	17.0	22.0	16.1	32.0	20.0
	Power factor	.97	.97	.90	.97	.90
	Locked rotor amps	90.0	133.0	125.0	163.0	144.0
Compressor (Bristol) -10,-12 series units	Rated load amps	17.3	24.4	14.1	30.8	19.2
	Power factor	.97	.97	.90	.97	.90
	Locked rotor amps	90.0	135.0	90.0	162.0	122.0
Outdoor Coil Fan Motor	Full load amps	2.0	2.0	2.0	2.0	2.0
	Locked rotor amps	3.5	4.0	4.0	4.0	4.0
Recommended maximum fuse or circuit breaker size (amps)	-9,-11 series units	40	50	35	60	45
	-10,-12 series nits	40	50	30	60	45
*Minimum circuit ampacity	-9,-11 series units	23.3	29.5	22.6	42.5	27.5
	-10,-12 series units	23.6	32.5	19.6	40.5	26.0

*Refer to National Electrical Code Manual to determine wire, fuse and disconnect size requirements.
NOTE - Extremes of operating range are plus 10% and minus 5% of line voltage.

I. INTRODUCTION

The HP14 incorporates a two speed compressor which shifts speeds to match load requirements. The HP14 can be applied to installations with cooling load matched to low speed operation and heating load matched to high speed operation. During the cooling season the heat transfer surfaces are oversized increasing the capacity and efficiency. During the heating season the unit automatically switches to high speed (when outdoor temperature drops below 55°F) for maximum capacity.

TABLE 1

UNIT	Tonnage at Low Speed	Tonnage at High Speed
HP14-261/411	2	3
HP14-310/510	2-1/2	4
HP14-410/650	3	5

A - Approved Matchups

All major components (indoor blower/coils) must be matched according to Lennox recommendations for the compressor to be covered under warranty. Refer to the Engineering Handbook for approved system matchups. A misapplied system will cause erratic operation and can result in early compressor failure.

Refrigerant line sets are available for the HP14-261/411 and 310/510 units. Line sets for the HP14-410/650 are field fabricated. Lines are furnished with a flare fitting for connection to the matching indoor coil and stubbed on the opposite end for sweat connection to the outdoor unit. Table 2 shows the line set model numbers and line sizes.

TABLE 2

Outdoor Unit Model No.	Line Set Model No.	Length of Lines (ft.)	Liquid Line (o.d. in.)	Vapor Line (o.d. in.)
HP14-261/411	L10-41-20	20	3/8	3/4
	L10-41-30	30		
	L10-41-40	40		
	L10-41-50	50		
HP14-310/510	L10-65-30	30	3/8	7/8
	L10-65-40	40		
	L10-65-50	50		
HP14-410/650	field fabricate	----	1/2	1-1/8

II. UNIT COMPONENTS

A - Control Box Components

1 - Transformer (T1)

All HP14's use a single 24VAC transformer T1 for the outdoor unit. The transformer supplies power to two speed control and contactors in the outdoor unit. This power is supplied through the safety switches (S4 and S5) in the outdoor unit.

A separate indoor transformer provides power to the indoor thermostat, the control circuits of the indoor unit, and all other controls in the outdoor unit. During use of the emergency heat function, the outdoor unit is isolated from control circuit power while the indoor unit and auxiliary heat continue to operate.

2 - TSC Two Speed Control (TSC-1 or TSC-2)

To control compressor speed, the TSC first determines if all safety circuits are o.k. The control then responds to 1st stage or 2nd stage demand accordingly. The control also initiates time delays to prevent short cycling between thermostat demands and between speed changes. The timed off delay between thermostat demands is approximately 5 minutes. The speed change delay is approximately 60 seconds.

3 - Contactor (K2)

Contactor K2 energizes low speed compressor operation in single phase units. In three phase units, K2 energizes high speed compressor operation. See table 3.

In single phase units, K2 also de-energizes the crankcase heater during compressor operation. In three phase units, K2 prevents both high speed and low speed from being energized at the same time by disconnecting contactor K1.

TABLE 3

Speed	Single Phase	Three Phase
Low	K2	K1
High	K1 & K2	K2

4 - Contactor (K1)

In single phase units, K1 and K2 are both energized to bring on high speed operation. Three phase units bring on only K1 for low speed operation.

In single phase units, K1 is energized with K2 to redirect voltage to the compressor terminals for high speed operation. K1 also de-energizes the low speed start windings while energizing the high speed start windings. K1 auxiliary contacts switch whenever K1 is energized to ensure that K2 is energized **with** K1 during high speed operation.

In three phase units, high speed demand de-energizes K1 and energizes K2. However, K1 is wired so that when de-energized, the contactor forms a parallel common connection to the motor windings for high speed. This forms a parallel Y connection for Lennox compressors and a parallel Delta connection for Bristol compressors. Low speed demand de-energizes K2 and energizes K1. When K1 is energized, the contactor forms a series Y or series Delta connection to the compressor windings depending on the type of compressor.

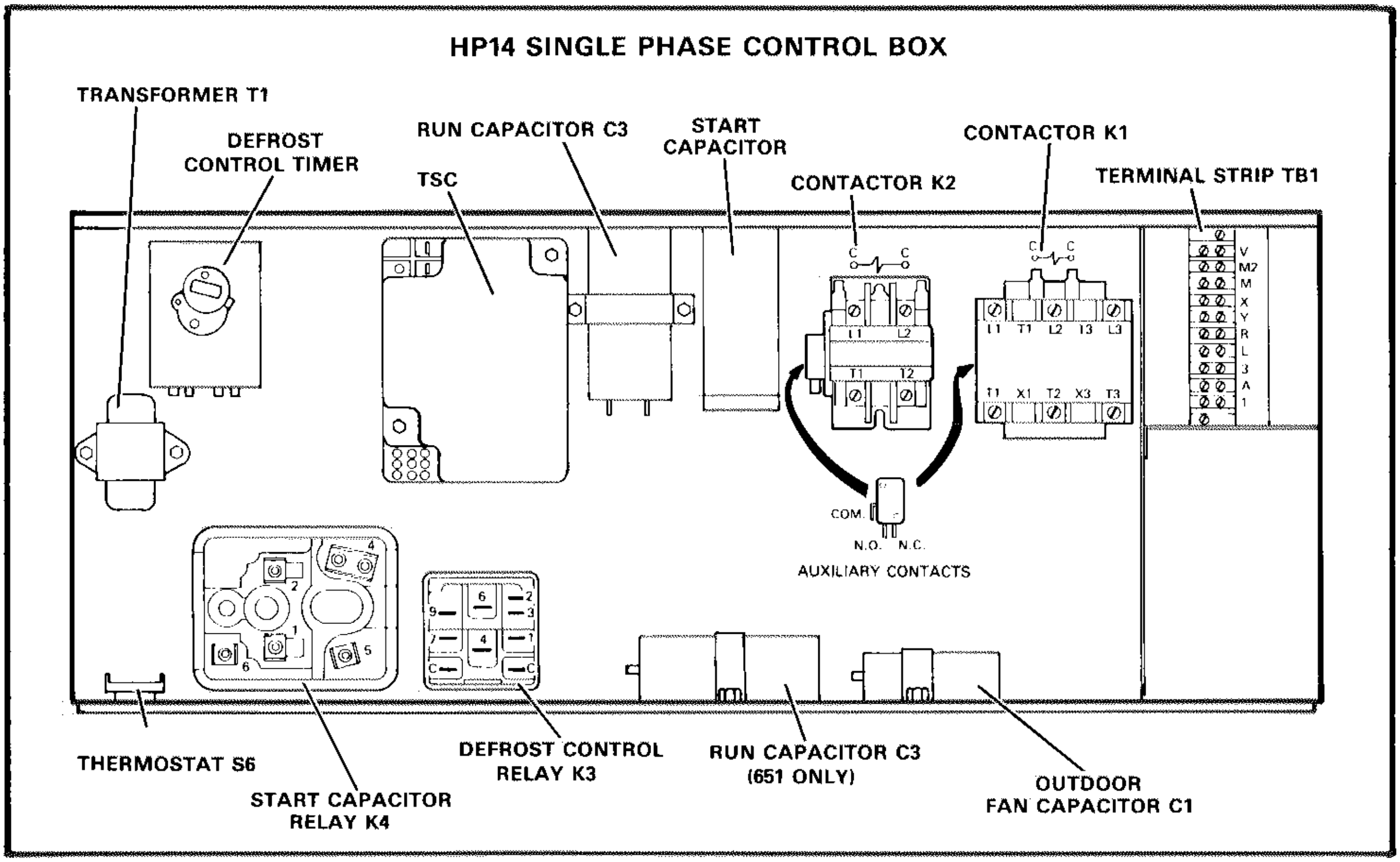


FIGURE 1

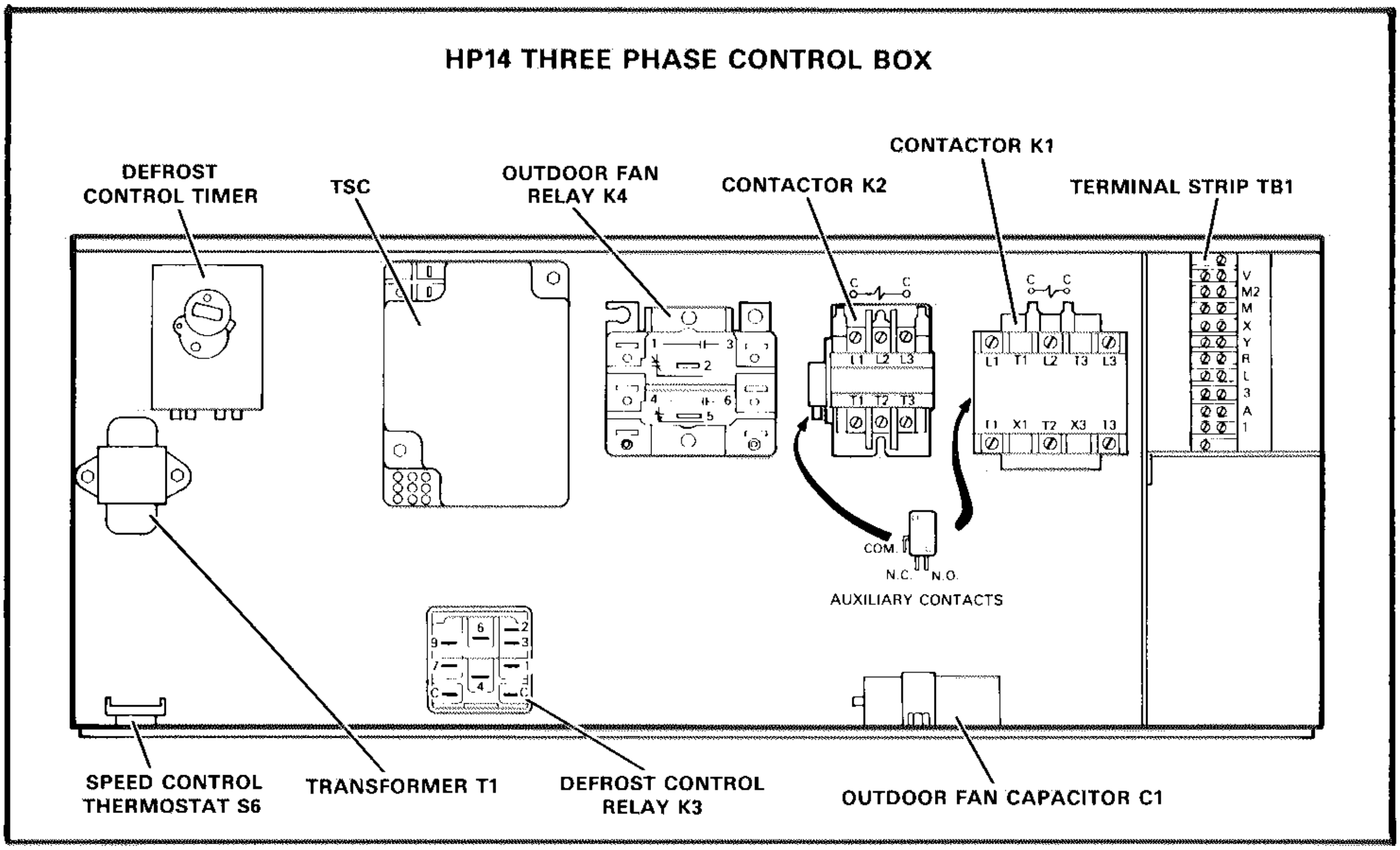


FIGURE 2

5 - **Relay (K4)**

In single phase units, K4 is a potential relay which controls the operation of the start capacitor. The relay is normally closed when K2 is de-energized. When K2 energizes, the compressor immediately begins start-up. K4 remains closed during the voltage drop due to compressor start-up and the start capacitor remains in the circuit. As the compressor gains speed and voltage is restored, K4 is energized and the start capacitor drops out.

In three phase units, K4 controls the operation of the outdoor fan and crankcase heater. The relay energizes the outdoor fan and de-energizes the crankcase heater during any cooling or heating demand.

6 - **Defrost Control Relay (K3)**

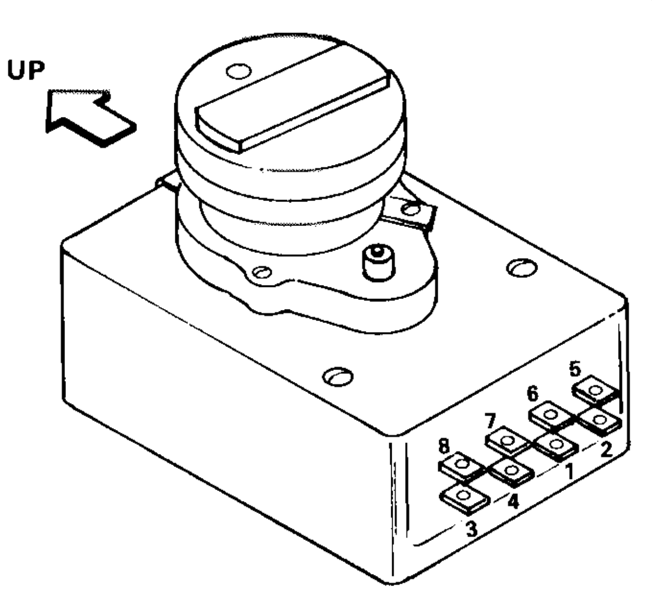
In all HP14's, K3 is energized by a defrost demand. Once K3 is energized, it remains energized until defrost is terminated. Defrost can only be terminated by the 10 minute defrost timer or the opening of the defrost thermostat (S8). When K3 is energized, it de-energizes the outdoor fan until defrost is terminated, energizes the reversing valve (L1) and brings on indoor auxiliary heat.

7 - **Defrost Control Timer**

A defrost control timer is used to control the initiation and termination of the defrost period. By closing contacts 1-2 for 20 ± 10 seconds every 90 minutes (or 30 minutes - as preset), the control asks for a defrost. If the defrost timer, defrost thermostat and defrost pressure switch all agree that defrost is needed (all switches closed), relay K3 is allowed to energize to initiate defrost.

When the timer asks for a defrost by closing contacts 1-2, contacts 6-7 are already closed. Contacts 6-7 latch-in relay K3 for as long as the defrost thermostat remains closed. If the defrost thermostat does not open after 10 ± 1 minutes, timer contacts 6-7 open to terminate defrost. The defrost timer does not allow defrost to last more than 10 ± 1 minutes. 90 minutes (or 30 minutes - as preset) after contacts 6-7 open, contacts 1-2 close to ask for another defrost.

The defrost timer can be field adjusted from a 90 minute to a 30 minute defrost interval if warranted by climatic conditions. See Figure 4 for defrost timer sequence of operation.



HP14 DEFROST TIMER

FIGURE 3

Figure 3 shows the defrost timer. It is a motor driven cam switch timer. The motor uses 24 VAC at 3 watts powered from the indoor transformer. The motor drives 3 cams in a clockwise rotation (as viewed from the cam end) to operate 2 snap action S.P.D.T. switches.

With the timer mounted in the control box the 30 minute cam is the far cam and the 90 minute cam is the middle cam. These two cams work together and are used to initiate the defrost sequence. They are connected to terminals 6 & 7 on the defrost timer. The near (fixed) cam is used to terminate defrost after 10 minutes and is connected to terminals 1 & 2 on the defrost timer.

Figure 4 is the switch timing sequence chart for the defrost timer. Control functions of the timer are explained in the sequence of operation section of this manual.

Both the 30 minute cam and the 90 minute cam contact a single S.P.D.T switch which activates terminals 6 & 7. To change the defrost interval from 90 minutes to 30 minutes the 90 minute cam is removed.

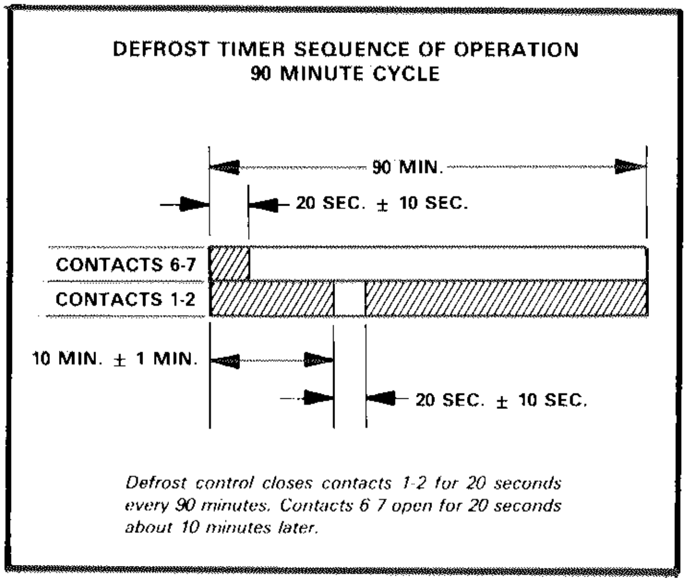


FIGURE 4

TO CONVERT FROM 90 MINUTE TO 30 MINUTE DEFROST INTERVAL:

1 - Turn off power to unit.
2 - Disconnect wires to timer and remove timer from unit.
3 - Remove mounting screws and timer cover as shown in figure 5.

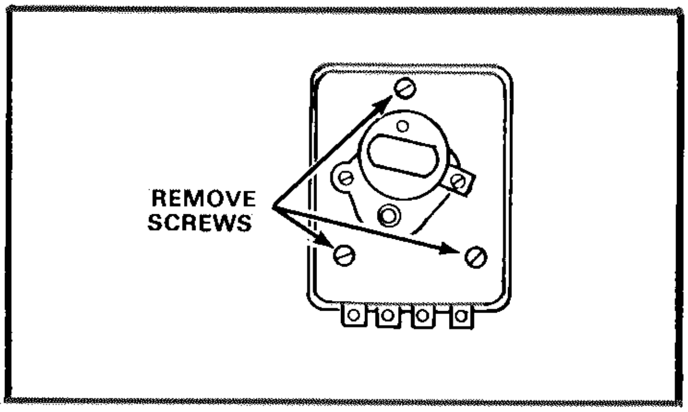


FIGURE 5

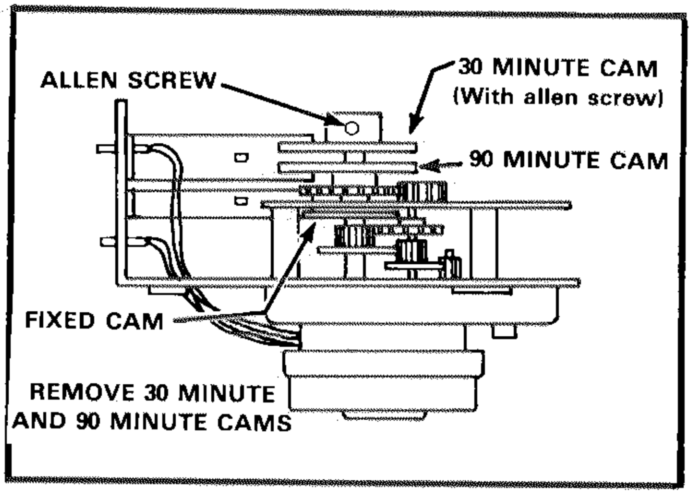


FIGURE 6

4 - Loosen allen screw and remove BOTH cams as shown in figure 6.
5 - Install 30 minute cam only (cam with allen screw).
6 - Align the allen screw on the 30 minute cam with the 45° edge of the fixed cam as shown in figure 7. Tighten the allen screw.
7 - Install timer cover and secure with mounting screws.
8 - Install timer in unit and connect wires to timer terminals. Refer to unit wiring diagram for proper wiring connections.
9 - Turn on power to unit.
10 - Unit will follow the same sequence of operation shown in figure 4 except defrost interval will be every 30 minutes.

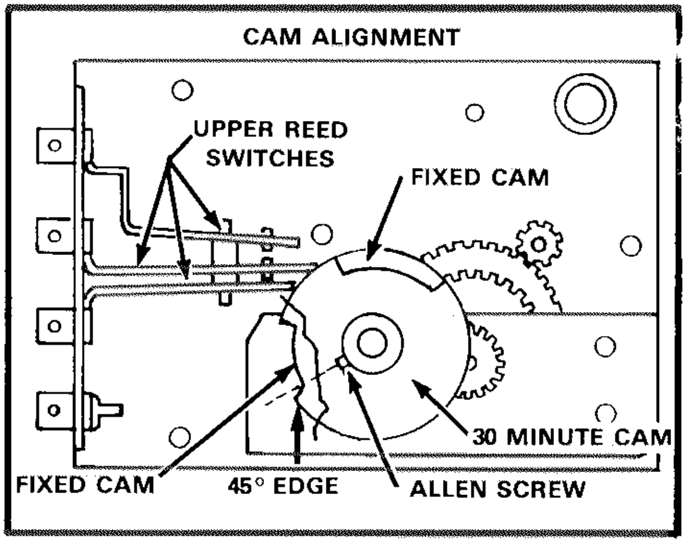


FIGURE 7

8 - Speed Control Thermostat (S6)

The speed control thermostat regulates compressor speed during the heating mode only. When the thermostat closes during low outdoor temperature, the thermostat contacts jumper 'M' to 'M2' to bring on high speed. A 10°F differential prevents frequent compressor speed changes. When outdoor temperature increases to 65°F during heating cycle, S6 opens and the compressor switches to low speed. When outdoor temperature drops to 55°F during heating cycle, the switch closes and the compressor switches to high speed.

9 - Start Capacitor (C2)

All single phase units use a start capacitor connected in parallel with the run capacitor. This capacitor is switched off by relay K4 when the compressor nears full speed. Table 4 shows start capacitor ratings for single phase HP14's.

Three phase units do not use start capacitors.

TABLE 4

Unit	MFD	VAC
261/411-9,-11P	145 - 175	330
311/511-9,-11P	145 - 175	330
411/651-9,-11P	176 - 216	320 or 330
261/411-10,-12P	145 - 175	330
311/511-10,-12P	145 - 175	330
411/651-10,-12P	176 - 216	320 or 330

10 - Run Capacitor (C3/C4)

All single phase units use run capacitors to maximize compressor efficiency. Model 411/651-P voltage units use multiple run capacitors. Multiple capacitors are connected in parallel with the start capacitor. Run capacitors are also connected in parallel with the start capacitor. Table 5 shows run capacitor ratings for single phase HP14's.

TABLE 5

Unit	Number of Capacitors	MFD	VAC
261/411-9,-11P	1	35	440
311/511-9,-11P	1	45	
411/651-9,-11P	2	30	
		25	
261/411-10,-12P	1	35	
311/511-10,-12P	1	45	
411/651-10,-12P	2	30	
		25	

11 - Fan Capacitor (C1)

All HP14's use single phase outdoor fans which require run capacitors to maximize efficiency. Table 6 shows fan run capacitor ratings for HP14's.

TABLE 6

Unit	MFD	VAC
261/411V	5	370
311/511V	7	
313/513V	7	
411/651V	7	
413/653V	7	

B - Unit Parts

1 - Compressor (B1)

Table 7 shows the specifications of two speed compressors used in HP14's. All compressors are rated at 208/230 VAC. Crankcase heaters are controlled by HP14 circuitry.

2 - Outdoor Fan (B2)

The specifications table on page 1 of this manual shows the specifications of outdoor fans used in HP14's. In single phase units outdoor fan B2 is controlled by relay K3. In three phase units, outdoor fan B2 is controlled by relays K3 and K4.

3 - Crankcase Heater (HR)

All HP14's use insertion type PTC crankcase heaters. Lennox compressors (-9, -11 series units) use 40 watt heaters and Bristol compressors (-10, -12 series units) use 30 watt heaters. See compressor section.

4 - High Pressure Switch (S5)

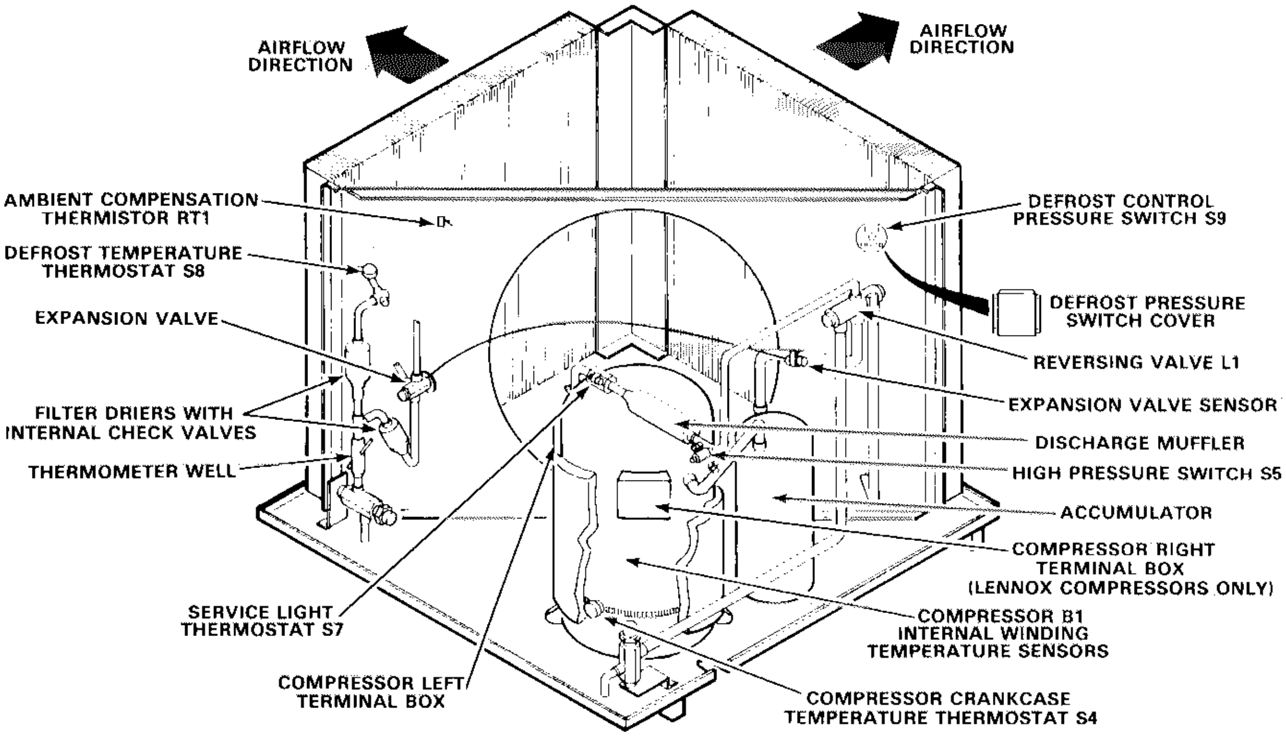
All units are equipped with a high pressure switch (manual reset type) mounted on the compressor discharge line. The manually reset high pressure switch has a 'cut-out' point of 410 psig. The switch is connected to JP1-7 of the two speed control and is connected in series with the crankcase temperature thermostat.

5 - Crankcase Temperature Thermostat (S4)

All HP14's are equipped with a crankcase temperature limit switch. The switch is mounted to the outside bottom of the compressor shell inside the compressor insulating jacket. It is fastened by means of a strap and fasteners. It prevents the compressor from operating at an exceedingly high oil temperature by opening the control circuit at 190°F. It automatically resets at 110°F on a temperature fall. Note that the crankcase temperature thermostat is connected in series with the high pressure switch (S5) to JP1-7 of the two speed control.

TABLE 7

Unit	Phase	Capacity Btuh		LRA	LRA	RLA	Oil
		Low	High	Low	High		
261/411V-9,-11P	1	15,500	34,400	38	90	17	65 fl. oz. ZEROL 150 SUS
311/511V-9,-11P	1	23,100	48,500	49	133	22	
313/513V-9,-11Y	3	23,100	48,200	50	125	16.1	
411/651V-9,-11P	1	29,300	61,500	54	163	32	
413/653V-9,-11Y	3	29,300	61,600	65	144	20	
261/411V-10,12P	1	16,600	34,900	39	90	17.3	50 Fl. Oz. BRISTOL SP581007 150 SUS
311/511V-10,-12P	1	22,600	46,400	53	135	24.4	
313/513V-10,-12Y	3	22,600	46,400	50	90	14.1	
411/651V-10,-12P	1	29,700	61,400	56	162	30.8	
413/653V-10,-12Y	3	29,700	61,400	72	122	19.2	



HP14 INTERNAL
PARTS ARRANGEMENT

FIGURE 8

6 - Service Light Thermostat (S7)

All units are equipped with a service light thermostat which is mounted on the compressor discharge line. The switch is connected to the service light in the indoor thermostat. The switch is closed on compressor start-up. When the compressor discharge line temperature reaches 130±5°F, S7 opens. If discharge line temperature drops below 110±5°F during unit operation (indicating a problem in the system), the switch closes. If thermostat demand is present when S7 closes, the service light is powered to indicated service is needed.

7 - Ambient Compensation Thermistor (RT-1)

All HP14's have a small device mounted on the fan orifice panel called an ambient compensation thermistor (RT-1). This device is connected in series with a heat anticipation resistor inside the indoor thermostat. This feature helps to prevent abnormal droop caused by the anticipation resistors. RT-1 is a NTC thermistor (negative temperature coefficient - increase in temperature equals decrease in resistance). As outdoor temperature increases, the resistance across RT-1 drops. As the resistance across RT-1 drops, the current through the heat anticipation resistor increases. Therefore, heat anticipation increases as outdoor temperature decreases. Resistance at 77°F = 260 ohms ±5%; at 100°F = 150 ohms; at 32°F = 861 ohms.

8 - Defrost Thermostat (S8)

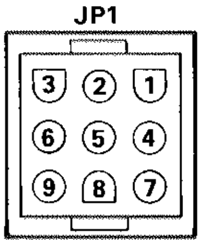
A defrost thermostat is mounted on the liquid line between the drier and the distributor. The thermostat opens at 60±5°F and closes at 35±4°F. For defrost to begin, S8 must be closed (along with S9) when defrost timer contacts 1-2 close. If S8 or S9 are open when defrost timer contacts 1-2 close, defrost will not initiate and the unit will continue with normal operation. After 30 or 90 minutes (as preset at the defrost timer), the defrost timer checks again to see if defrost is needed. Defrost cycle will be terminated by S8 if, during a defrost period, the liquid line reaches 60°F and opens.

9 - Defrost Pressure Switch (S9)

A pressure sensor mounted on the fan orifice panel between the outdoor coil and the orifice panel senses the buildup of ice on the outdoor coil. The switch senses ice buildup by monitoring the air pressure between the orifice panel and the outdoor coil. As ice builds on the outdoor coil, negative pressure builds between the coil and the orifice panel. When the pressure reaches 0.27±0.03 in. W.C., S9 closes. Defrost can only be initiated if S8 **and** S9 are both closed when defrost timer contacts 1-2 close. If S8 or S9 are open when defrost timer contacts 1-2 close, defrost will not initiate and the unit will continue with normal operation. Defrost cycles are allowed by S9 but cannot be terminated by S9.

TSC-1 & TSC-2 TWO SPEED CONTROL SEQUENCE OF OPERATION

JP1-1 24VAC POWER (INPUT)
JP1-2 24VAC NEUTRAL (GROUND)
JP1-3 NOT USED
JP1-4 THERMOSTAT STAGE 2
JP1-5 THERMOSTAT COMMON (C)
JP1-6 THERMOSTAT STAGE 1
JP1-7 24VAC FROM PRESSURE SWITCHES
TO INTERNAL CONTACTOR COIL (INPUT)
JP1-8 HIGH SPEED (24VAC OUTPUT)
JP1-9 LOW SPEED (24VAC OUTPUT)



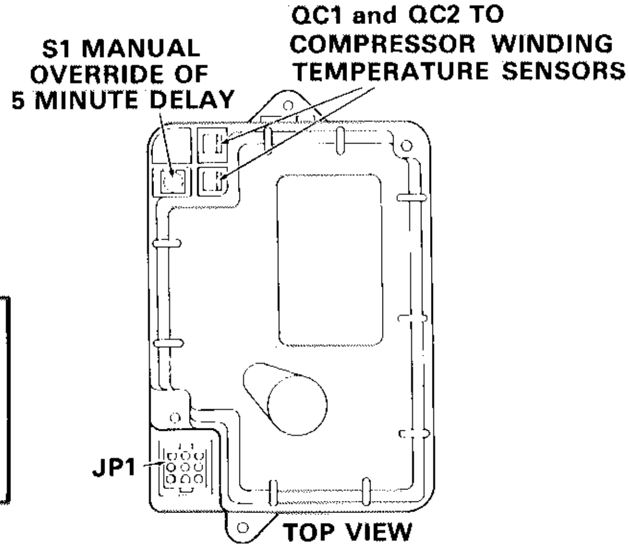


FIGURE 9

10 - TSC-1 & TSC-2 TWO SPEED CONTROLS

The TSC two speed control (figure 9) is a Lennox built control designed for use with two speed condensing units and heat pumps. The control provides automatic switching from low speed to high speed operation and back. The TSC-1 is a two speed control designed for use with Lennox two speed compressors. The TSC-1 will initially be used on all HP14 -9,-11 series units. The TSC-2 is a two speed control designed for use with Bristol two speed compressors. The TSC-2 will initially be used on all HP14 -10,-12 series units. The control replaces electromechanical timers, relays and switches used in earlier units.

The TSC two speed control contains relays which energize low speed or high speed compressor operation in response to thermostat demand. High speed operation can be energized and de-energized without passing through low speed. The control also contains safety timed off delays and compressor over-temperature sensing which help protect the compressor.

A timed-off delay in the control delays compressor operation for 5 minutes after the end of each thermostat demand or after a power failure to prevent short cycling (see Miscellaneous section). The control also counts unit fault conditions. Whenever the compressor stops due to a safety limit trip or if the compressor winding temperature becomes too hot, the control's internal cycle counter accumulates 1 fault. If three unit faults are accumulated during the same thermostat demand, the control 'locks-out' and stops all unit operation. The control can be reset by 'breaking and remaking' thermostat demand. Also, unit faults are erased when power is interrupted. Whenever thermostat demand changes stages, compressor operation stops for approximately 1 minute to allow refrigerant pressure to equalize in the system.

In order to aid servicing and troubleshooting, a manual override button has been placed on the control. The manual override button, when pressed and then released, bypasses the 5 minute delay so low speed or high speed operation can be directly energized.

Normal Operation Sequence

1 - General Operation
On power up, the control begins a 10 second initial power-up delay.

2 - The control then begins a 5 minute time delay during which the unit is not operational (control and outdoor unit do not respond to thermostat demand). Once the 5 minute delay is complete, the control waits in 'OFF' mode for thermostat demand.

3 - After receiving a new thermostat demand, the two speed control delays 3 seconds before responding.

4 - Low speed demand (JP1-6) energizes low speed operation (JP1-9) OR high speed demand (JP1-4) energizes high speed operation (JP1-8).

5 - If thermostat demand stops during low speed or high speed operation, all unit operation stops after a 3 second delay (control de-energizes JP1-8 and JP1-9), the control resets (see Unit Fault Conditions section) and the control returns to step 2 above.

6 - During unit operation, if low speed demand changes to high speed demand or if high speed demand changes to low speed demand, the control delays 3 seconds before responding. Then, all unit operation stops for 60 ± 5 seconds (control de-energizes JP1-8 and JP1-9). This allows refrigerant pressure to equalize in the system. At the end of the 60 ± 5 second delay, the control responds to whatever thermostat demand is present. If no thermostat demand is present, the control resets (see Unit Fault Conditions section) and the control returns to step 2 above.

Two Speed Control Unit Fault Conditions

If the control is in low speed operation, high speed operation, 'OFF' mode, or speed change delay, the control will 'count' or accumulate unit faults on an internal cycle counter. Only faults which occur during compressor operation and cause the compressor to shut off are counted. After each fault is counted, the control stops all unit operation, resets and begins the 5 minute time delay (step 2, sequence of operation). If the control senses a fault at the end of the 5 minute delay, the unit will not restart. If the control 'counts' 3 unit faults during the same thermostat demand, the control 'locks-out' all unit operation.

NOTE - If the control 'locks-out', it can be reset by breaking thermostat demand for about 5 seconds then remaking thermostat demand. Also, anytime thermostat demand is removed or power is interrupted, the control resets to zero faults.

A unit fault occurs under the following conditions:

A - On heat pumps, compressor operation is controlled by the high pressure switch and crankcase temperature thermostat. These controls are wired in series. If either one trips, compressor operation is interrupted and 1 fault is accumulated. The high pressure switch must be reset manually while the crankcase temperature switch resets automatically. It is likely that the control could accumulate 3 unit faults from the crankcase temperature switch during a single thermostat demand since this switch resets automatically. However, The cycle counter only accumulates unit faults from the high pressure switch if the reset button is pushed without interrupting thermostat demand.

B - On all units using the TSC two speed control, terminals QC1 and QC2 on the control are connected to temperature sensors (thermistors) which monitor the temperature of the compressor motor windings. The two speed control measures the resistance across the sensors. The sensor wires are not polarity sensitive. The sensors increase their resistance as temperature increases. When the resistance across the sensors increases above a preset limit, the control stops compressor operation. As the compressor windings cool, the resistance across the sensors drops. When the resistance across the sensors drops below the reset limit, the control resets automatically and 1 fault is accumulated. Table 8 shows the resistance values for winding temperature sensors in different compressors.

IMPORTANT - If the cycle counter accumulates three faults during the same thermostat demand, the control 'locks-out'. The outdoor unit remains inoperable until thermostat demand is broken. This indicates further troubleshooting is needed. Though the control can be reset by breaking thermostat demand, the outdoor unit may remain inoperable. The high pressure or high temperature conditions may still exist and must be located and corrected before the unit can be placed back in service.

TABLE 8

Compressor Winding Temperature Sensors	Trip Ohms Temperature Rise	Reset Ohms Temperature Fall
TSC-1 Lennox Compressor	16K to 24K	5.5K to 6.9K
TSC-2 Bristol Compressor	25K to 35K	8.4K to 10K

Two Speed Control Manual Override

The manual override button is designed to be an aid in servicing and troubleshooting the control or the unit. When the button is pushed and then released, the control bypasses the 5 minute override delay.

If the button is pushed DURING THE INITIAL 10 SECOND POWER-UP DELAY, the button has no effect. The control completes the 5 minute delay as in normal operation. DO NOT USE THE OVERRIDE BUTTON FOR AT LEAST 11 SECONDS AFTER POWER-UP.

If the override button is pushed and released DURING THE 5 MINUTE TIME DELAY, the control bypasses the time delay and goes directly to the 'OFF' mode where it waits for 1st stage or 2nd stage demand.

FOR OVERRIDE, THE OVERRIDE BUTTON MUST BE PUSHED **AFTER** THE 5 MINUTE DELAY HAS BEGUN.

The manual override button has no effect during the 60±5 second speed change delay.

Miscellaneous

A - The control delays approximately 3 seconds before responding to any new command. The control responds 3 seconds after a new thermostat demand and releases 3 seconds after the end of a thermostat demand. See IMPORTANT below.

IMPORTANT - THE CONTROL RESPONDS TO THE MANUAL OVERRIDE BUTTON 3 SECONDS AFTER THE BUTTON IS RELEASED TO PROVIDE TIME TO MOVE HANDS AND FINGERS AWAY FROM THE CONTROL BOX AREA.

B - To prevent compressor short cycling, the control immediately returns to step 2 of the sequence of operation if any of the following occur:

1 - A safety circuit shutdown (pressure or temperature sensors).

2 - Breaking and remaking of thermostat demand.

3 - Power failure followed immediately by power-up.

NOTE - If the control will not reset after 'locking-out'. Check the manually reset controls. A fault condition may still exist.

DANGER - DO NOT ATTEMPT TO REPAIR THE CONTROL. UNSAFE OPERATION MAY RESULT. USE THE SEQUENCE OF OPERATION ONLY AS A GUIDE FOR DIAGNOSING PROBLEMS. IF THE CONTROL IS FOUND TO BE FAULTY, SIMPLY REPLACE THE ENTIRE CONTROL.

CAUTION - THE INTERNAL CIRCUITRY IS SUSCEPTIBLE TO DAMAGE BY ELECTROSTATIC DISCHARGE. TO PREVENT THIS TYPE OF DAMAGE, DO NOT REMOVE THE CONTROL'S COVER.

C - Refrigerant System

All units in the HP14 series have stubbed liquid and vapor lines for sweat connections to the line set feeding the indoor coil. Each unit also has liquid and vapor line service valves inside the cabinet. Standard heat pump refrigeration circuitry is used with inverse outdoor coil circuiting. The inverse circuiting allows for refrigerant flow from bottom to top of outdoor coils in the defrost mode providing positive defrost and better condensate run-off.

Separate discharge and suction service ports are provided at the compressor for connection of gauge manifold during charging procedures. Figures 11 and 12 show the gauge manifold connections to the service ports and refrigerant flow in the cooling and heating cycles.

A check valve between the outdoor coils is used to redirect refrigerant flow depending on whether the unit is in cooling mode or heating mode. In cooling mode (figure 11) the check valve is closed and the outdoor coils are in a series circuit. In heating mode (figure 12) the check valve is open and the outdoor coils are in a parallel circuit.

It is very critical not to overcharge a heat pump system. It is recommended that the system be charged while in the cooling mode if weather conditions permit. If the unit must be charged while in the heating mode, the charge should be rechecked in the cooling mode as soon as outdoor conditions permit. The HP14 MUST be run on high speed when checking charge with the thermometer wells.

D - Charging Procedure

This charging procedure is intended as a general guide. It is intended for use on expansion valve systems only. For best results, indoor temperature should be 70°F to 80°F. Be sure to monitor system pressures while charging. Avoid charging unit in heating mode. This charging procedure is for cooling mode only.

A standard R-22 temperature/pressure conversion chart is required if outdoor temperature is below 60°F.

1 - Turn indoor thermostat to 'OFF' position.
2 - Indoor temperature should be between 70°F (21°C) and 80°F (27°C).
3 - Fill thermometer well with oil (to assure accurate reading). DO NOT insert thermometer in well now.
4 - Install high pressure gauge to the thermometer well service port (DO NOT USE THE COMPRESSOR DISCHARGE PORT). Connect the low pressure gauge to the compressor suction line service port (between the compressor and accumulator).
5 - Turn indoor thermostat to 'COOL' mode and adjust to lowest temperature setting (call for both stages of cooling so compressor is energized on high speed).
6 - If power to outdoor unit has been off, allow 10 seconds for two speed control to power up. Press and release manual override button on two speed control. Compressor should energize on high speed within 3 seconds.
7 - If outdoor temperature is less than 60°F, liquid pressure must be in the 200-250psig range. The higher pressure is necessary for checking charge. In order to boost liquid pressure when outdoor temperature is low, the side air intake louvers and service access opening can be blocked. Block equal sections of side air intake until liquid pressure is in 200-250psig range.

   If outdoor temperature is above 60°F, do not block side air intake louvers.

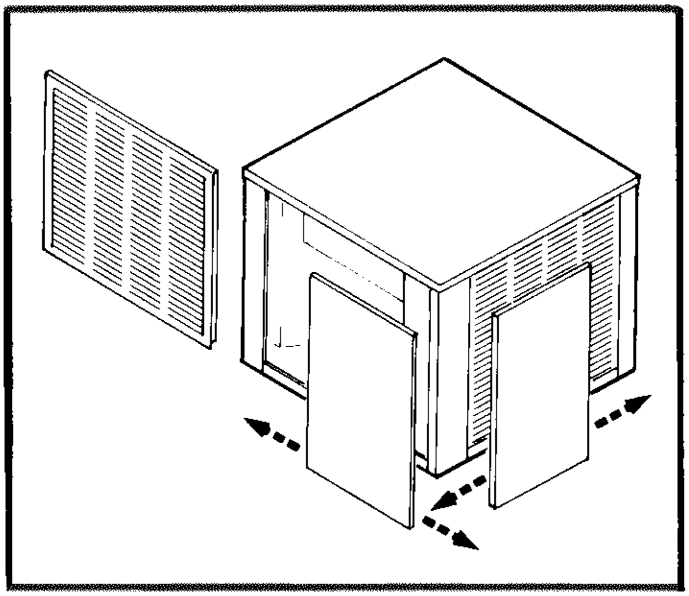


FIGURE 10

8 - Use approach method if outdoor temperature is above 60°F (steps 9-12).

   Use subcooling method if outdoor temperature is below 60°F (steps 13-16).

Approach Method (Outdoor Temperature Above 60°F):

9 - Check outdoor temperature.
10 - Insert thermometer in well and check liquid line temperature.
11 - Approach temperature = liquid temperature minus ambient temperature. Approach temperature should approximate the values given in table 9.

TABLE 9

Model	Approach Temperature (°F)
HP14-261/411-9,-11	6.0 to 8.0
HP14-310/510-9,-11	5.0 to 7.0
HP14-410/650-9,-11	10.0 to 12.0
HP14-261/411-10,-12	7.0 to 9.0
HP14-310/510-10,-12	6.0 to 8.0
HP14-410/650-10,-12	8.0 to 10.0

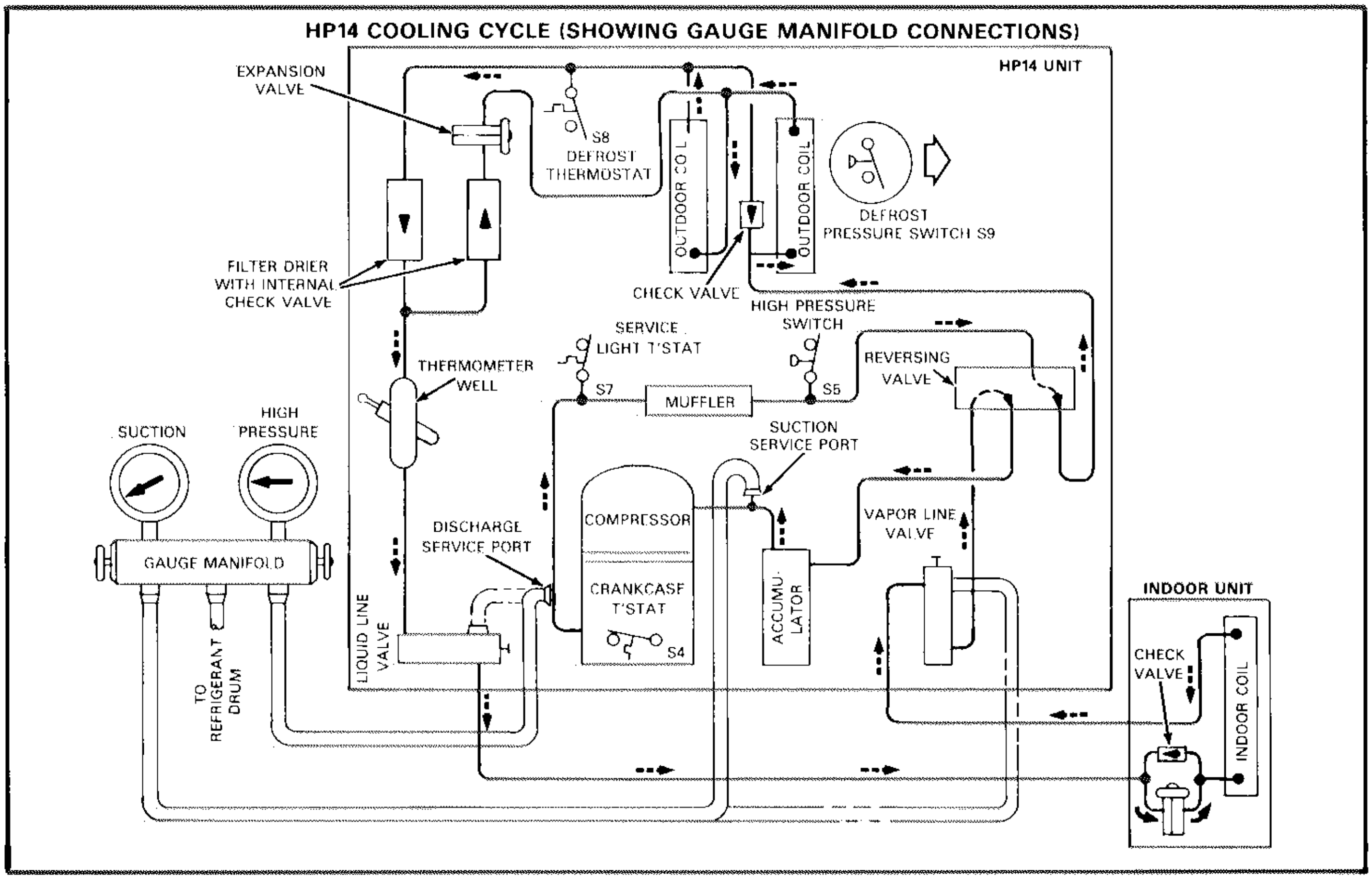


FIGURE 11

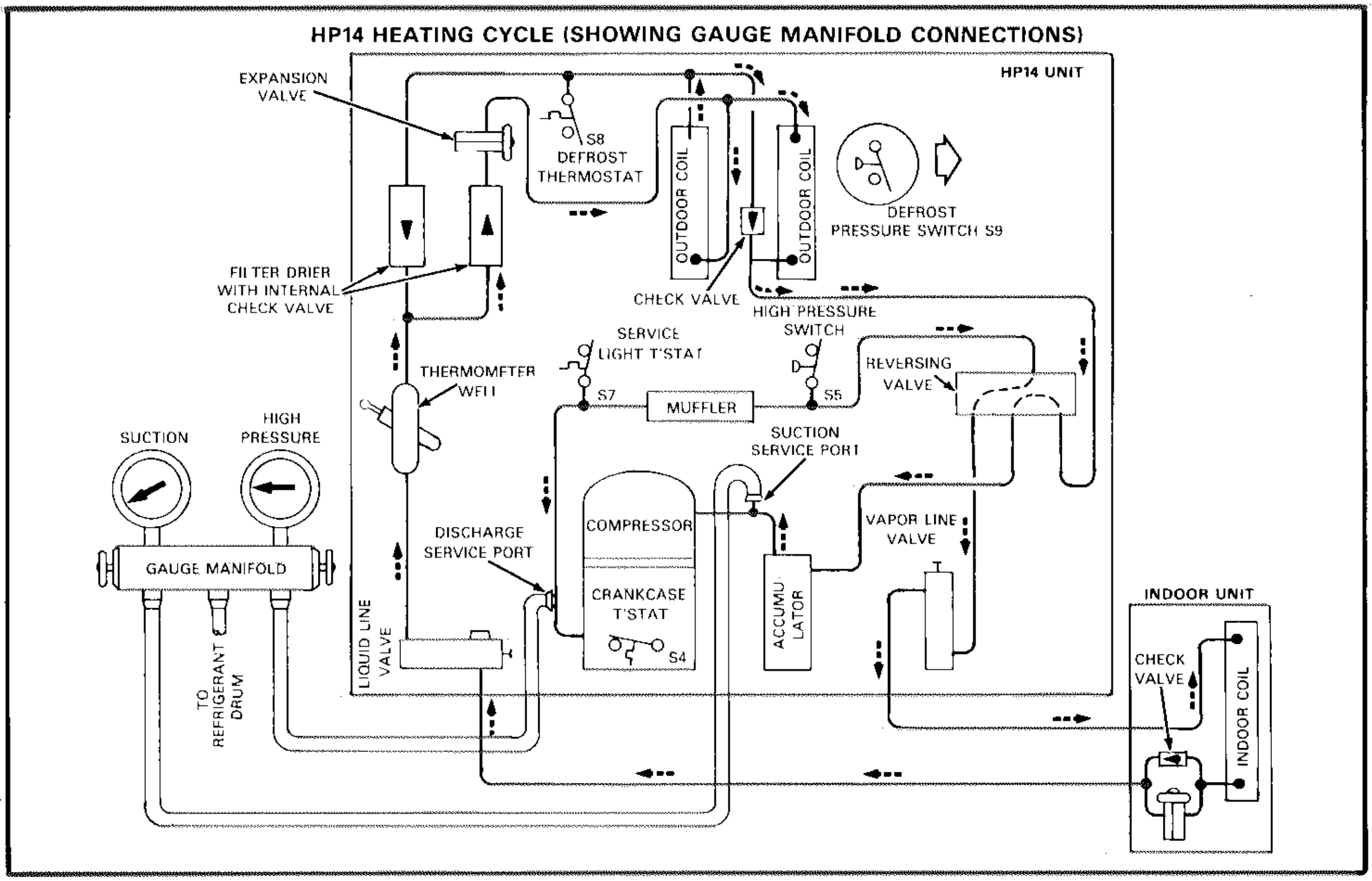


FIGURE 12

12 - An approach temperature greater than the value shown in table 8 indicates an undercharge. Add refrigerant slowly and continue to watch liquid line temperature (thermometer well) until approach temperature approximates the value given in table 9.

An approach temperature less than the value shown indicates an overcharge. Do not vent refrigerant into atmosphere. Use only approved refrigerant reclaiming methods.

When the unit is properly charged, the system pressure should approximate the pressures given in the Normal Operating Pressure Table (table 10).

Subcooling Method (Outdoor Temperature Below 60°F):

13 - Insert thermometer in well and check liquid line temperature.

14 - Read liquid line pressure and convert to temperature (use standard R-22 temperature/pressure conversion chart). This is the condensing temperature.

15 - Subcooling = condensing temperature minus liquid temperature. Subcooling should approximate the values given in Table 11.

TABLE 11

Model	Subcooling (°F)
HP14-261/411-9,-11	17.0 to 23.0
HP14-310/510-9,-11	17.0 to 23.0
HP14-410/650-9,-11	22.0 to 28.0
HP14-261/411-10,-12	17.0 to 23.0
HP14-310/510-10,-12	8.0 to 14.0
HP14-410/650-10,-12	11.0 to 17.0

16 - A subcooling temperature less than the value shown in table 9 indicates an undercharge. Add refrigerant slowly and continue to watch liquid line temperature (thermometer well) until subcooling temperature approximates the value given in table 11.

A subcooling temperature greater than the value shown indicates an overcharge. Do not vent refrigerant into atmosphere. Use only approved refrigerant reclaiming methods.

TABLE 10

NORMAL OPERATING* PRESSURE TABLE		HP14-261/411V -9,-11		HP14-311/511V HP14-313/513V -9,-11		HP14-411/651V HP14-413/653V -9,-11		HP14-261/411V -10,-12		HP14-311/511V HP14-313/513V -10,-12		HP14-411/651V HP14-413/653V -10,-12	
MODE	OUTDOOR COIL ENTERING AIR TEMP.	LIQUID ±10 PSIG	SUCTION ±5 PSIG	LIQUID ±10 PSIG	SUCTION ±5 PSIG	LIQUID ±10 PSIG	SUCTION ±5 PSIG	LIQUID ±10 PSIG	SUCTION ±5 PSIG	LIQUID ±10 PSIG	SUCTION ±5 PSIG	LIQUID ±10 PSIG	SUCTION ±5 PSIG
COOLING	65°F	150	66	155	65	165	64	153	66	142	65	150	65
	85°F	200	70	210	69	215	69	212	70	202	69	215	70
	95°F	230	72	240	71	250	72	243	72	235	71	245	72
	105°F	265	75	275	74	280	75	277	75	265	74	280	75
HEATING	30°F	190	35	190	35	190	35	155	35	170	35	160	35
	40°F	210	45	210	45	210	44	220	45	195	45	210	45
	50°F	230	55	230	55	235	52	280	55	208	55	270	55
	60°F	250	65	250	65	250	62	285	65	210	65	260	65

*Unit operating on high speed, indoor return air at 80°F for cooling.

III. UNIT DIAGRAMS & SEQUENCE OF OPERATION

A - COMPRESSOR STARTUP

SINGLE PHASE TWO SPEED COMPRESSOR - FIGURE 13

The single phase compressor has a two speed, capacitor start-capacitor run motor. For starting, the start and run capacitors are in parallel to provide the proper starting torque. The start capacitor is disconnected by the potential relay when the motor comes up to speed. The run capacitor remains connected to the start winding and the motor runs as a two phase induction motor with improved power factor and torque characteristics provided by the capacitor.

Low speed compressor motor operation is provided by powering the run windings (internally connected in series) from terminals 1 (common) and 7. The windings form a four pole motor operating at 1800 RPM. The four low speed start windings are in series and are connected to terminals 1 (common) and 8. They are used with the start and run capacitors and potential relay to start and bring the motor up to speed.

High speed compressor motor operation is provided when the run windings are connected in parallel; terminals 1 (common) and 7 to L1 and terminal 2 to L2. The windings form a 2 pole motor operating at 3600 RPM. The two high speed start windings are in series and connected to terminals 1 (common) and 3.

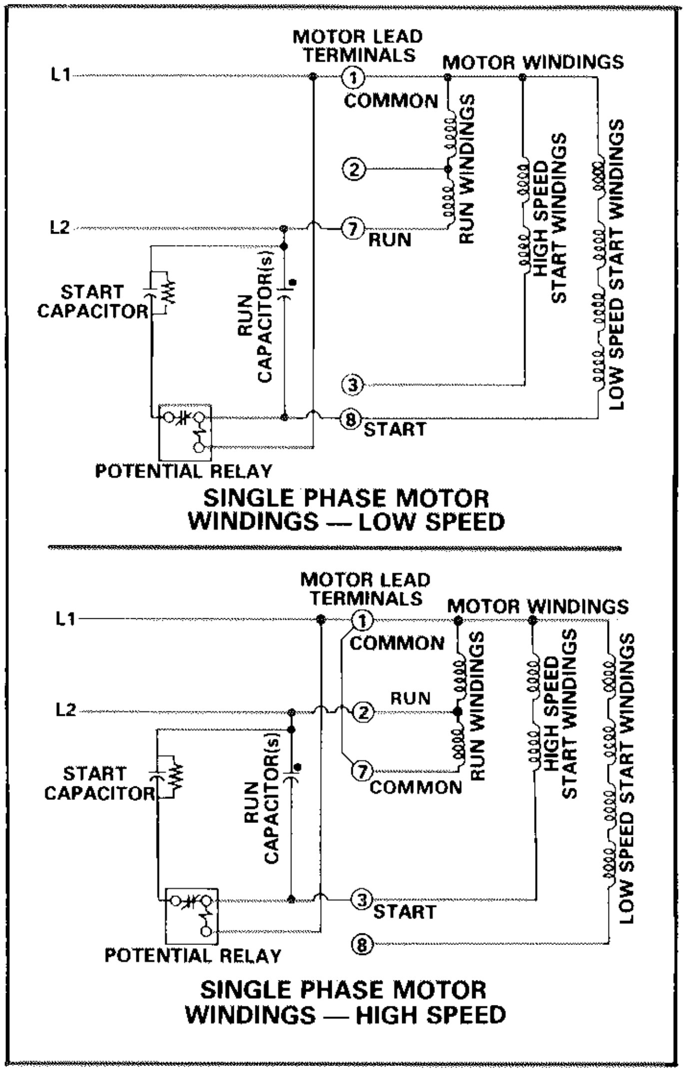


FIGURE 13

THREE PHASE TWO SPEED COMPRESSOR -FIGURE 14

This compressor has a two speed, three phase induction motor. Capacitors are not needed to provide the proper phase and torque characteristics.

Low speed operation is provided when the motor windings are connected in a series circuit. The motor operates at 1800 RPM. Lennox compressors are connected in a series 'Y' circuit. Bristol compressors are connected in a series 'Delta' circuit.

High speed operation is provided when the motor windings are connected in a parallel circuit. Auxiliary contacts on the low speed contactor provide this connection. Lennox compressors are connected in a parallel 'Y' circuit. Bristol compressors are connected in a parallel 'Delta' circuit.

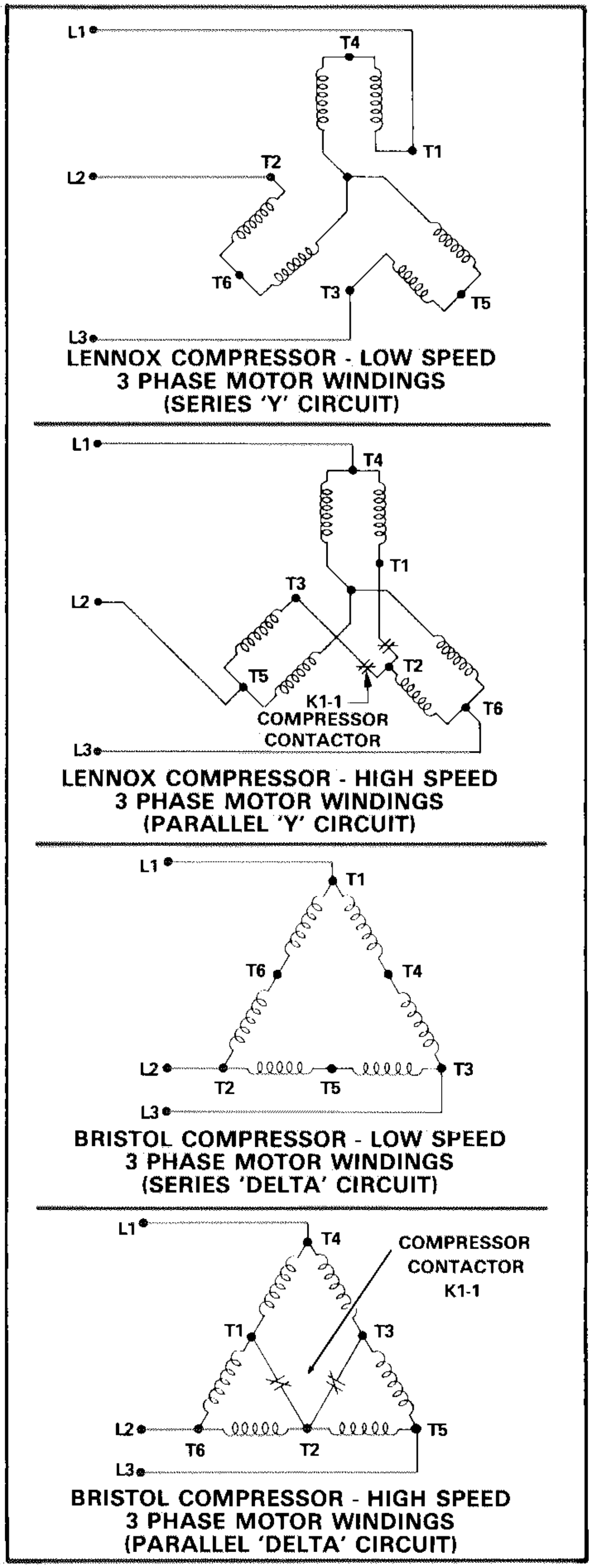
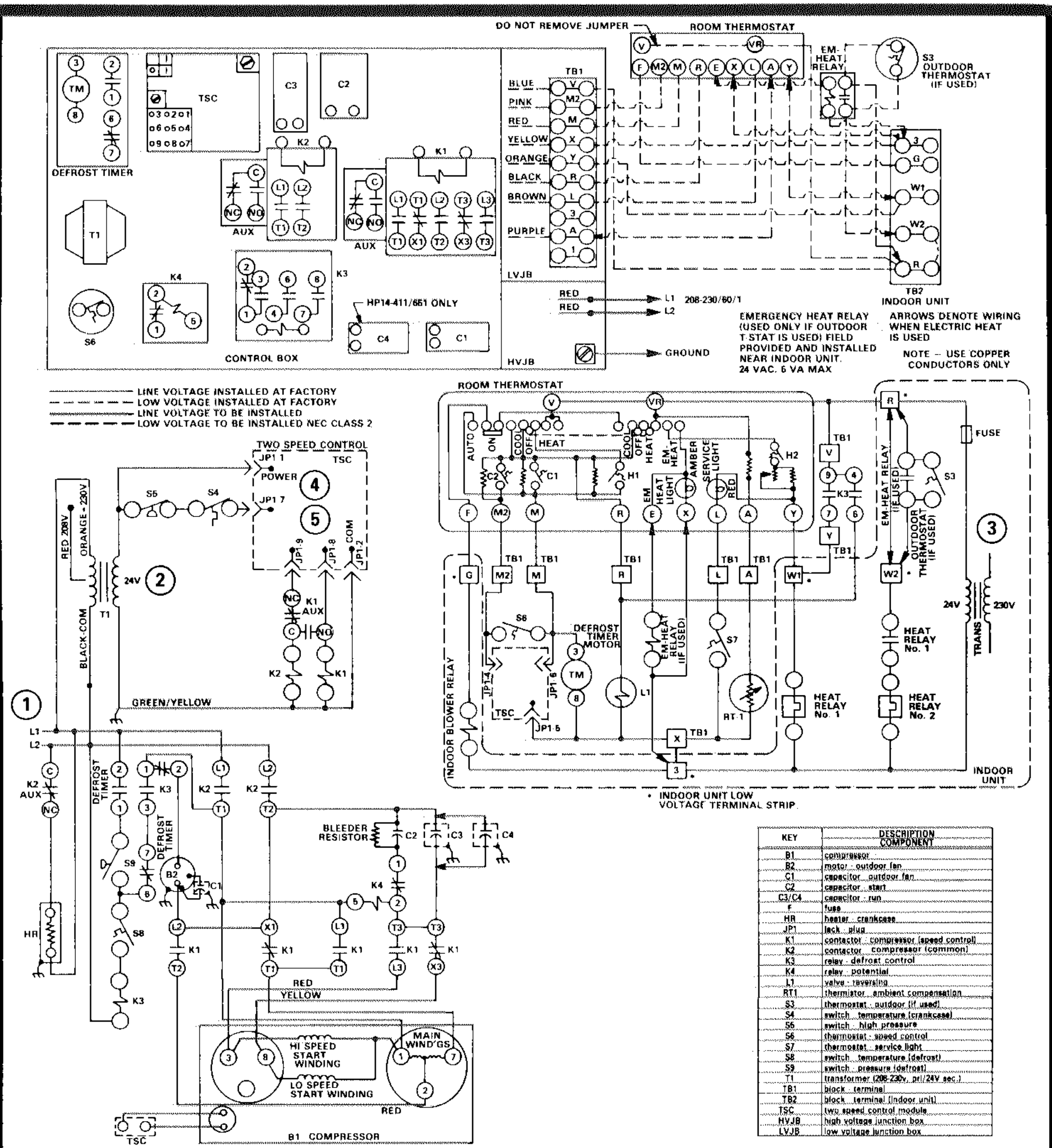


FIGURE 14



KEY	DESCRIPTION COMPONENT
B1	compressor
B2	motor - outdoor fan
C1	capacitor - outdoor fan
C2	capacitor - start
C3/C4	capacitor - run
F	fuse
HR	heater - crankcase
JP1	jack - plug
K1	contactor - compressor (speed control)
K2	contactor - compressor (common)
K3	relay - defrost control
K4	relay - potential
L1	valve - reversing
RT1	thermistor - ambient compensation
S3	thermostat - outdoor (if used)
S4	switch - temperature (crankcase)
S5	switch - high pressure
S6	thermostat - speed control
S7	thermostat - service light
S8	switch - temperature (defrost)
S9	switch - pressure (defrost)
T1	transformer (208-230v, pri/24V sec.)
TB1	block - terminal
TB2	block - terminal (indoor unit)
TSC	two speed control module
HVJB	high voltage junction box
LVJB	low voltage junction box

B - SINGLE PHASE STARTING SEQUENCE

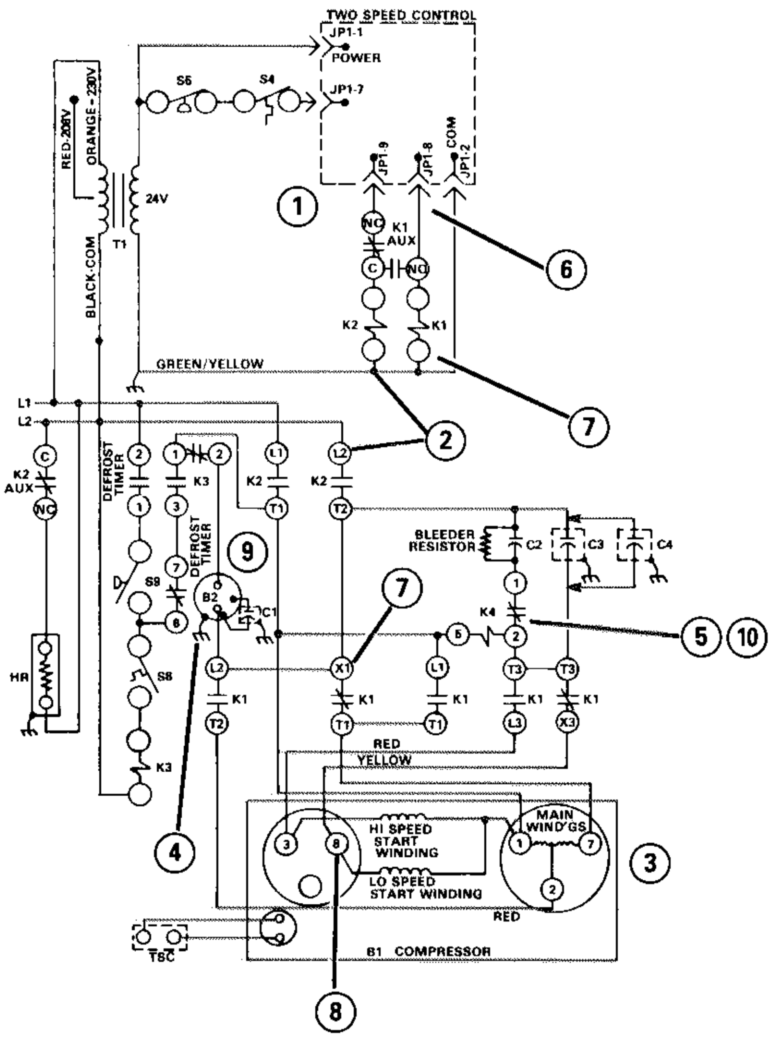
1 - Line voltage feeds through L1 and L2 to energize outdoor transformer T1 and outdoor unit. Crankcase heater is energized through relay K2 auxiliary contacts.

2 - Transformer T1 provides 24 VAC to TSC and contactors K1 and K2.

3 - The indoor transformer supplies 24 VAC to the indoor unit and the indoor thermostat. Note that some of the outdoor unit's controls are controlled by the indoor thermostat.

4 - On power-up, 24 VAC is fed through JP1-1 and JP1-7 to TSC. TSC begins a 10 second power-up delay.

5 - TSC begins a 5 minute delay during which the outdoor unit is not operational. After the 5 minute delay, TSC waits in 'OFF' mode for 1st stage or 2nd stage demand.



KEY	DESCRIPTION COMPONENT
B1	compressor
B2	motor outdoor fan
C1	capacitor · outdoor fan
C2	capacitor start
C3/C4	capacitor · run
F	fuse
HR	heater crankcase
JP1	jack plug
K1	contactor · compressor (speed control)
K2	contactor · compressor (common)
K3	relay · defrost control
K4	relay potential
L1	valve · reversing
RT1	thermistor · ambient compensation
S3	thermostat · outdoor (if used)
S4	switch · temperature (crankcase)
S5	switch · high pressure
S6	thermostat · speed control
S7	thermostat · service light
S8	switch temperature (defrost)
S9	switch · pressure (defrost)
T1	transformer (208-230v. pri/24V sec.)
TB1	block terminal
TB2	block terminal (indoor unit)
TSC	two speed control module
HVJB	high voltage junction box
LVJB	low voltage junction box

C - SINGLE PHASE COMPRESSOR STARTUP

LOW SPEED:

1 - 1st stage demand: If all safety circuits check out, TSC energizes JP1-9.

2 - Contactor K2 is energized through contactor K1 N.C. auxiliary contacts. K2 auxiliary contacts open to de-energize the crankcase heater. All other K2 contacts close to start outdoor fan operation, energize the start circuit and begin compressor low speed startup.

3 - Compressor B1 terminal 1 and the outdoor fan circuit are energized by K2 contacts L1-T1. Compressor terminal 7 is energized by contactor K2 terminal L2-T2 through contactor K1 terminal T1-X1. Compressor terminal 8 (start winding) is energized by contactor K2 terminal L2-T2 through the start (C2) and run (C3) capacitors and contactor K1 terminal T3-X3.

4 - Outdoor fan (B2) is energized through relay K3 terminals 1-2 when contactor K2 contacts L1-T1 and L2-T2 close.

5 - As the compressor nears full speed, potential relay K4 energizes and K4 contacts open to de-energize the start capacitor.

HIGH SPEED:

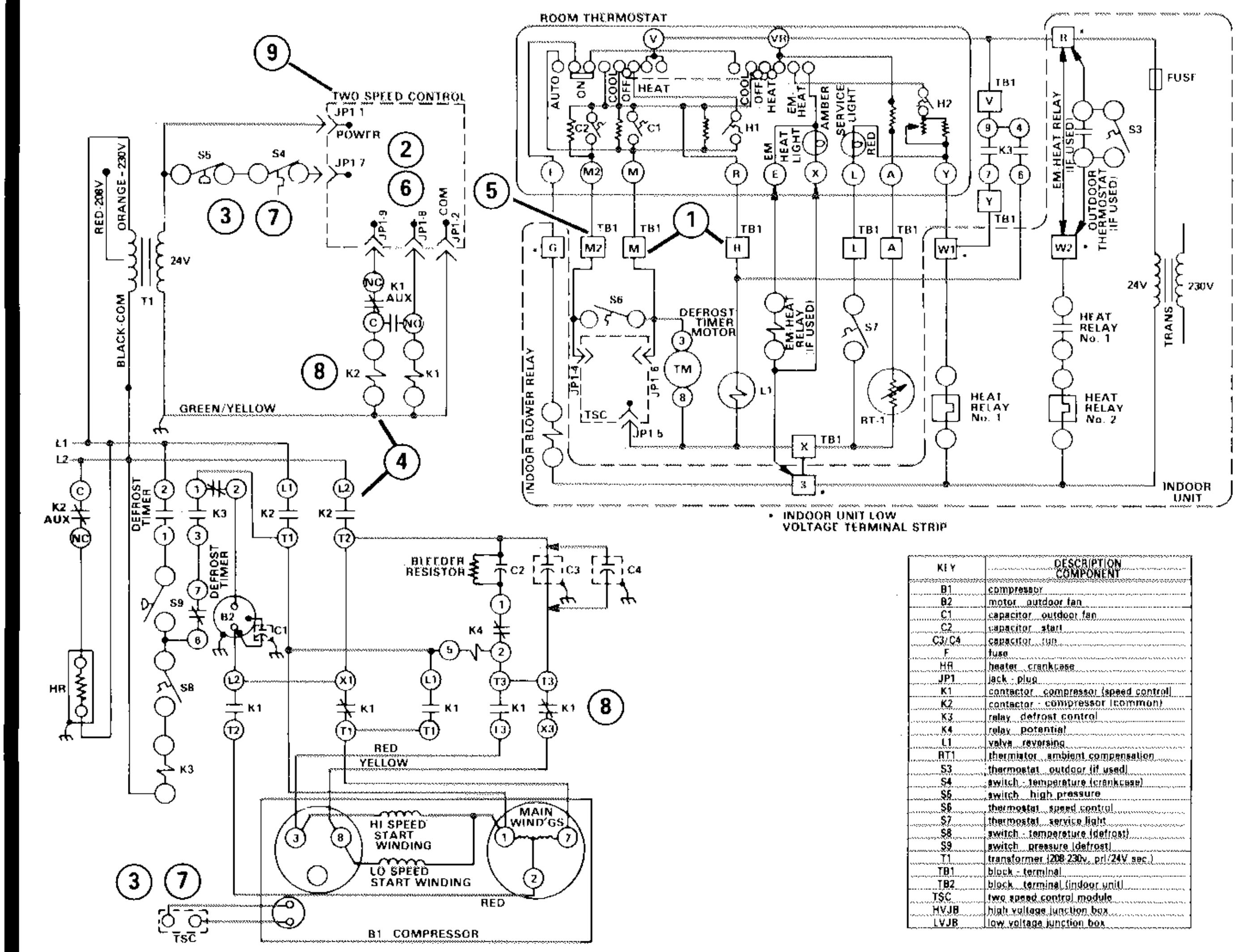
6 - 2nd stage demand: If all safety circuits check out, TSC energizes JP1-8.

7 - Contactor K1 energizes and K1 N.O. auxiliary contacts close to energize contactor K2. K2 auxiliary contacts open to de-energize the crankcase heater. All other K2 contacts close. K1 contacts L1-T1, L2-T2 and L3-T3 close while contacts T1-X1 and T3-X3 open.

8 - Compressor B1 terminal 3 (start winding) is energized by contactor K2 terminal L2-T2 through the start (C2) capacitor and run (C3) capacitors and through contactor K1 terminal L3-T3. Compressor terminal 2 is energized by contactor K2 terminal L2-T2 through contactor K1 and terminal L2-T2. Compressor terminal 1 is energized directly by contactor K2 terminal L1-T1. Compressor terminal 7 is energized by contactor K2 terminal L1-T1 through contactor K1 terminal L1-T1.

9 - Outdoor fan (B2) is energized through relay K3 terminals 1-2 when contactor K2 contacts L1-T1 and L2-T2 close.

10 - As the compressor nears full speed, potential relay K4 energizes and K4 contacts open to de-energize the start capacitor (C2).



KEY	DESCRIPTION COMPONENT
B1	compressor
B2	motor outdoor fan
C1	capacitor outdoor fan
C2	capacitor start
C3/C4	capacitor run
F	fuse
HR	heater crankcase
JP1	jack - plug
K1	contactor compressor (speed control)
K2	contactor - compressor (common)
K3	relay defrost control
K4	relay potential
L1	valve reversing
RT1	thermistor ambient compensation
S3	thermostat outdoor (if used)
S4	switch - temperature (crankcase)
S5	switch high pressure
S6	thermostat speed control
S7	thermostat service light
S8	switch - temperature (defrost)
S9	switch pressure (defrost)
T1	transformer (208-230v. pri/24V sec.)
TB1	block - terminal
TB2	block terminal (indoor unit)
TSC	two speed control module
HVJB	high voltage junction box
LVJB	low voltage junction box

D - SINGLE PHASE COOLING SEQUENCE

1 - 1st stage cooling demand energizes TB1-M and TB1-R. TB1-R energizes reversing valve L1. TB1-M energizes TSC terminal JP1-6 and the defrost timer motor (defrost timer contacts 1-2 close to ask for defrost every 90 minutes but defrost cannot initiate because S8 cannot close when unit is in cooling mode).
NOTE - 2nd stage cooling demand may be energized directly without passing through 1st stage (step 5).

2 - TSC delays 3 seconds before responding to the new command.

3 - If the unit is changing from 2nd stage to 1st stage demand, TSC initiates speed change delay and de-energizes JP1-8 and JP1-9 to stop all unit operation for 60 ± 5 seconds. After TSC completes the 60 ± 5 second speed change delay or if the unit is starting-up is 1st stage directly from 'OFF' mode (step 5), TSC checks safety circuits by looking for 24 VAC at JP1-7 and by checking resistance across wires connected to QC1 and QC2.

4 - If all safety circuits check-out, TSC energizes K2 and compressor begins low speed startup (previous page).

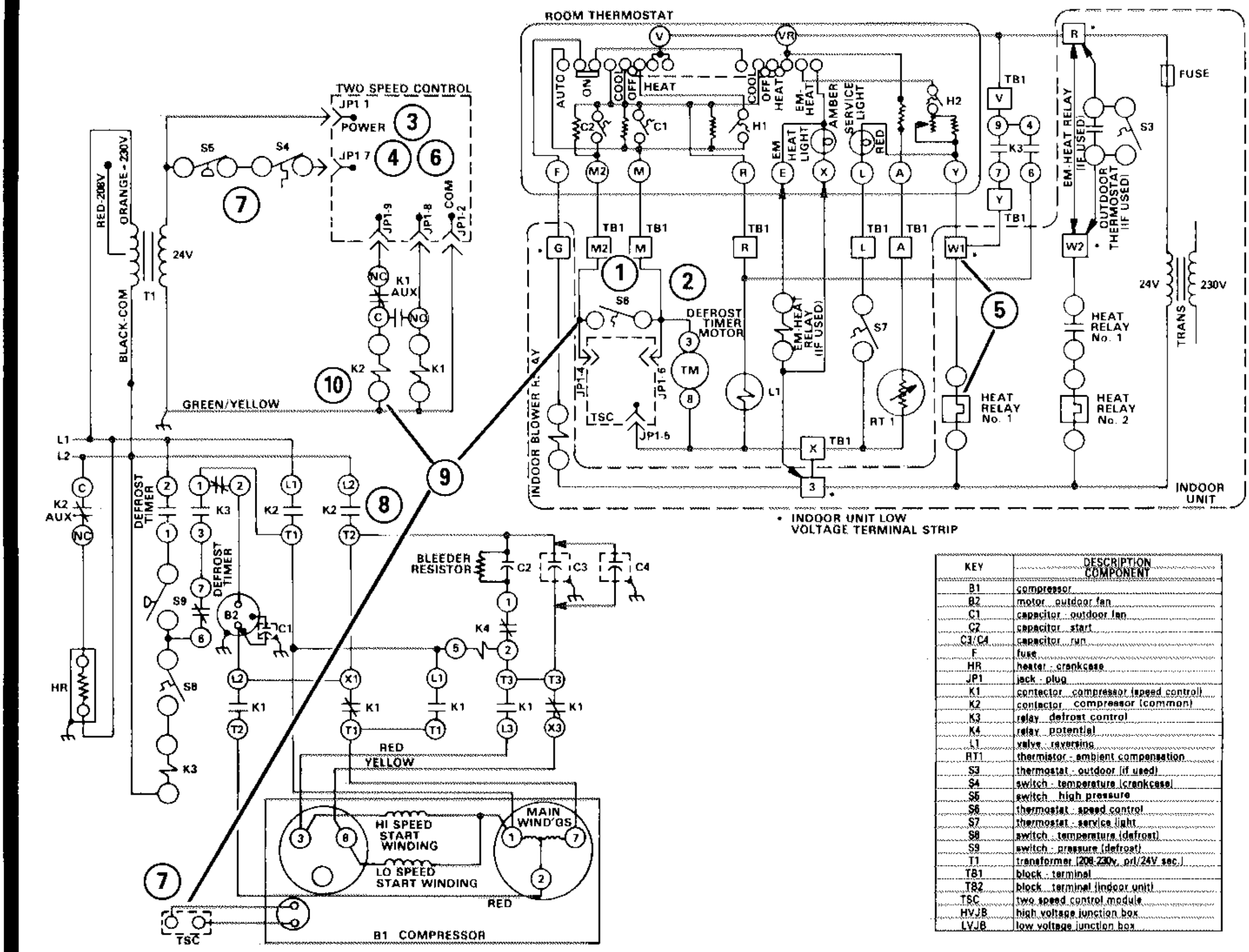
5 - 2nd stage cooling demand energizes TB1-M, TB1-M2 and TB1-R. TB1-R energizes reversing valve L1. TB1-M2 energizes TSC terminal JP1-4. TB1-M energizes TSC terminal JP1-6 and the defrost timer motor (see NOTE in step 1 about defrost timer operation).

6 - TSC delays 3 seconds before responding to the new command.

7 - If the unit is changing from 1st stage to 2nd stage demand the TSC initiates speed change delay and de-energizes JP1-8 and JP1-9 to stop all unit operation for 60 ± 5 seconds. After TSC completes the 60 ± 5 second speed change delay or of the unit is starting up in 2nd stage directly from 'OFF' mode (step 5), TSC checks safety circuits by checking resistance across wires connected to QC1 and QC2.

8 - If all safety circuits check-out, TSC energizes K1 and K2 and the compressor begins high speed startup (previous page).

9 - When thermostat demand satisfied or if thermostat is switched 'off' or switched to 'heating' mode, all outdoor unit operation stops after a delay of 3 seconds. TSC then completely resets (erase accumulated faults - see TSC operation sequence) before beginning a 5 minute timed off delay.



KEY	DESCRIPTION COMPONENT
B1	compressor
B2	motor outdoor fan
C1	capacitor · outdoor fan
C2	capacitor start
C3/C4	capacitor run
F	fuse
HR	heater - crankcase
JP1	jack - plug
K1	contactor compressor (speed control)
K2	contactor compressor (common)
K3	relay defrost control
K4	relay potential
L1	valve · reversing
RT1	thermistor - ambient compensation
S3	thermostat - outdoor (if used)
S4	switch - temperature (crankcase)
S5	switch high pressure
S6	thermostat · speed control
S7	thermostat - service light
S8	switch · temperature (defrost)
S9	switch - pressure (defrost)
T1	transformer (208-230v. pri/24V sec.)
TB1	block - terminal
TB2	block terminal (indoor unit)
TSC	two speed control module
HVJB	high voltage junction box
LVJB	low voltage junction box

E - SINGLE PHASE HEATING SEQUENCE

1 - Speed control thermostat determines whether the compressor is to operate on high or low speed based on outdoor temperature. If outdoor temperature drops below 55°F, S6 closes and a 2nd stage demand is sent to TSC causing the compressor to run on high speed. If outdoor temperature rises above 65°F, S6 opens and the compressor runs on low speed.

2 - 1st stage demand energizes TB1-M. TB1-M energizes TSC terminal JP1-6 and the defrost timer motor. Defrost timer motor contacts 1-2 close every 90 minutes to ask for defrost.

NOTE - Defrost timer is adjustable and may be adjusted to cycle more frequently than 90 minutes.

NOTE - 2nd stage heating demand may be energized directly without passing through 1st stage.

3 - TSC delays 3 seconds before responding to the new command.

4 - If the unit is changing from 2nd stage to 1st stage demand TSC initiates speed change delay and de-energizes JP1-8 and JP1-9 to stop all unit operation for 60±5 seconds.

5 - 2nd stage heating demand energizes TB1-M and terminal Y of the indoor thermostat. TB1-M energizes TSC terminal JP1-6 and the defrost timer motor. Terminal Y of the indoor thermostat energizes the indoor auxiliary heat relay for 2nd stage heat.

OUTDOOR TEMPERATURE ABOVE 65°F (S6 OPEN):

6 - If speed control thermostat S6 opens or closes during compressor operation, TSC initiates speed change delay and stops all unit operation for 60±5 seconds.

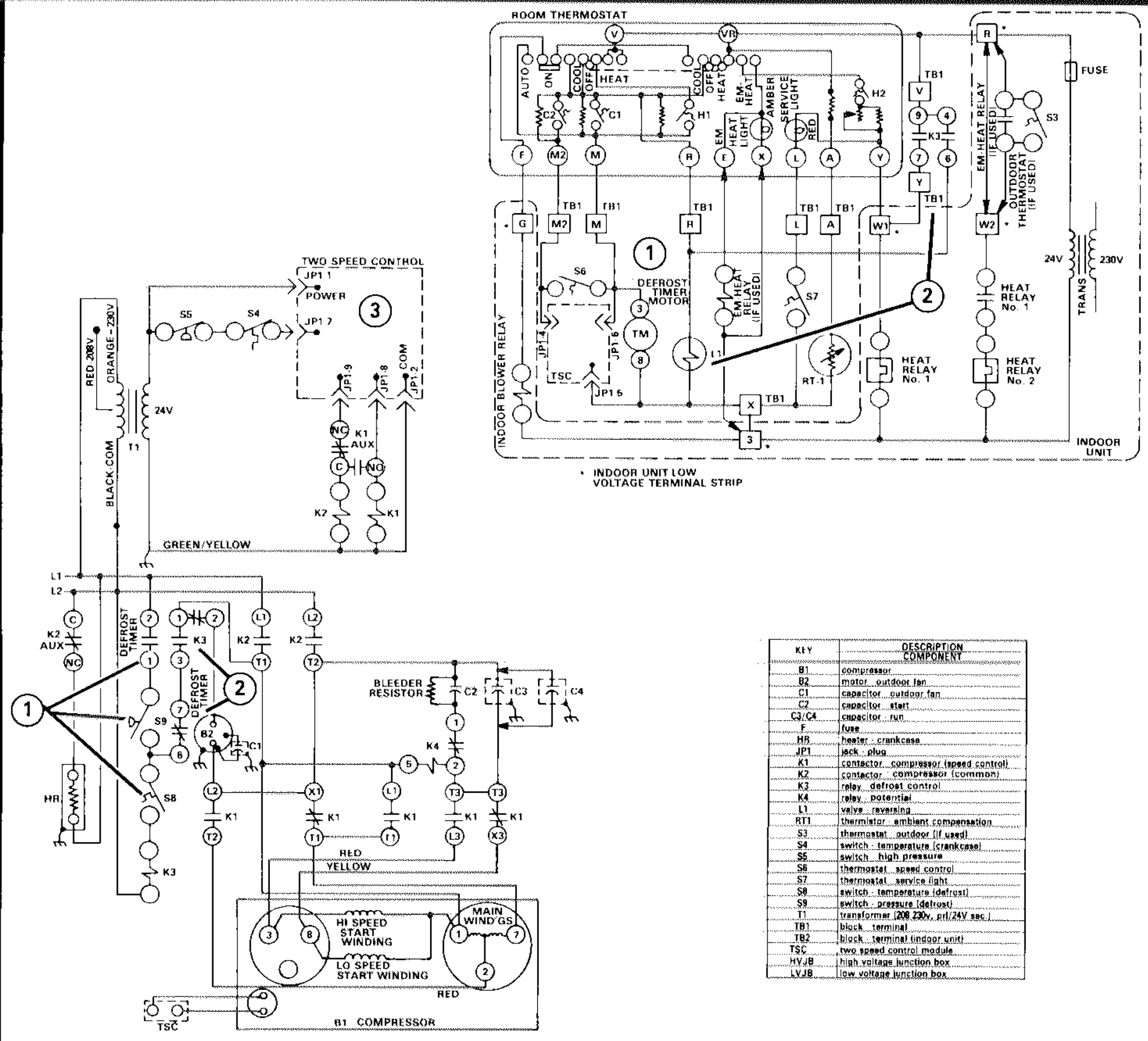
7 - TSC checks safety circuits by checking safety circuits and checking resistance across wires connected to QC1 and QC2.

8 - If all safety circuits check-out, TSC energizes K2 and compressor begins low speed startup.

OUTDOOR TEMPERATURE BELOW 55°F (S6 CLOSED):

9 - If speed control thermostat S6 opens or closes during compressor operation, TSC initiates speed change delay and stops all unit operation for 60±5 seconds. After TSC completes 60±5 second speed change delay or if the unit is starting-up is 2nd stage directly from 'off' mode, TSC checks safety circuits by looking for 24 VAC at JP1-7 and by checking resistance across wires connected to QC1 and QC2.

10 - If all safety circuits check out, TSC energizes K1 and K2 and compressor begins high speed startup.



KEY	DESCRIPTION COMPONENT
B1	compressor
B2	motor outdoor fan
C1	capacitor outdoor fan
C2	capacitor start
C3/C4	capacitor - run
F	fuse
HR	heater - crankcase
JP1	jack - plug
K1	contactor compressor (speed control)
K2	contactor compressor (common)
K3	relay defrost control
K4	relay - potential
L1	valve - reversing
RT1	thermistor - ambient compensation
S3	thermostat outdoor (if used)
S4	switch - temperature (crankcase)
S5	switch high pressure
S6	thermostat speed control
S7	thermostat service light
S8	switch - temperature (defrost)
S9	switch - pressure (defrost)
T1	transformer (208 230v, pri/24V sec.)
TB1	block terminal
TB2	block - terminal (indoor unit)
TSC	two speed control module
HVJB	high voltage junction box
LVJB	low voltage junction box

F - SINGLE PHASE DEFROST SEQUENCE

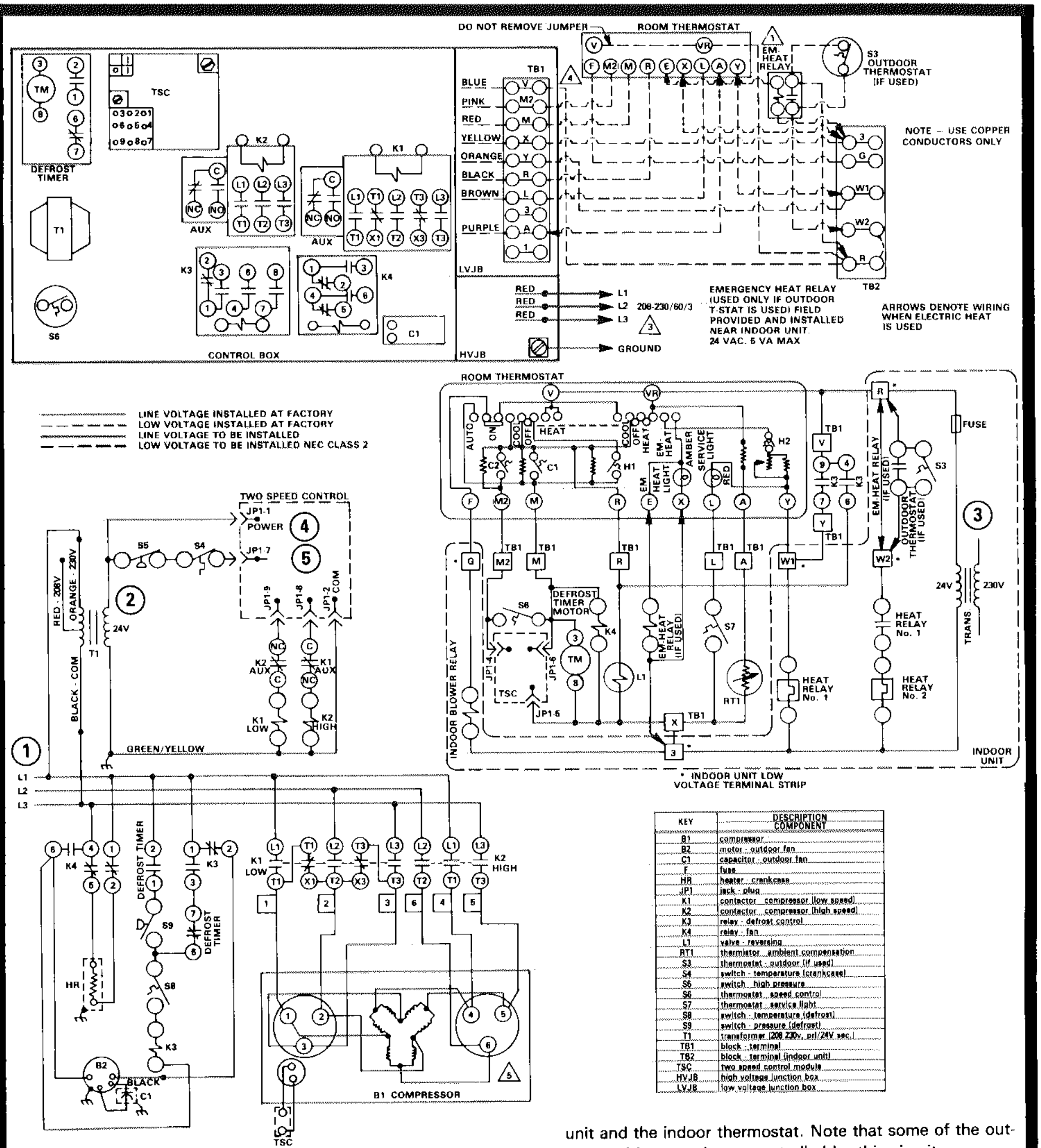
1 - Every 90 minutes of compressor operation, defrost timer contacts 1-2 close for 20 ± 10 seconds. During the time contacts 1-2 are closed, if the defrost pressure switch S9 and the defrost thermostat S8 are also closed, relay K3 energizes and defrost begins.

2 - Relay K3 controls defrost:
When relay K3 energizes, K3 contacts 1-3 close. This 'latches-in' relay K3 so defrost may only be terminated by defrost timer contacts 6-7 or the defrost thermostat. Defrost timer contacts 6-7 open 10 ± 1 minutes after relay K3 energizes to terminate defrost. Defrost can also be terminated by the defrost thermostat by opening when the outdoor liquid line reaches 60 ± 5°F.

When relay K3 energizes, K3 contacts 4-6 close to energize the reversing valve and K3 contacts 7-9 close to energize the indoor auxiliary heat relay. K3 contacts 1-2 open to de-energize the fan motor.

The unit resumes normal heating operation when relay K3 de-energizes.

3 - When thermostat demand is satisfied or if thermostat is switched 'off' or switched to 'heating' mode, all outdoor unit operation stops after a delay of 3 seconds. TSC then completely resets (erase accumulated faults - see TSC operation sequence) before cycling through the 5 minute timed off delay (single phase starting sequence).



KEY	DESCRIPTION COMPONENT
B1	compressor
B2	motor - outdoor fan
C1	capacitor - outdoor fan
F	fuse
HR	heater - crankcase
JP1	jack - plug
K1	contactor - compressor (low speed)
K2	contactor - compressor (high speed)
K3	relay - defrost control
K4	relay - fan
L1	valve - reversing
RT1	thermistor - ambient compensation
S3	thermostat - outdoor (if used)
S4	switch - temperature (crankcase)
S5	switch - high pressure
S6	thermostat - speed control
S7	thermostat - service light
S8	switch - temperature (defrost)
S9	switch - pressure (defrost)
T1	transformer (208 230v, pri/24V sec.)
TB1	block - terminal
TB2	block - terminal (indoor unit)
TSC	two speed control module
HVJB	high voltage junction box
LVJB	low voltage junction box

G - THREE PHASE STARTING SEQUENCE

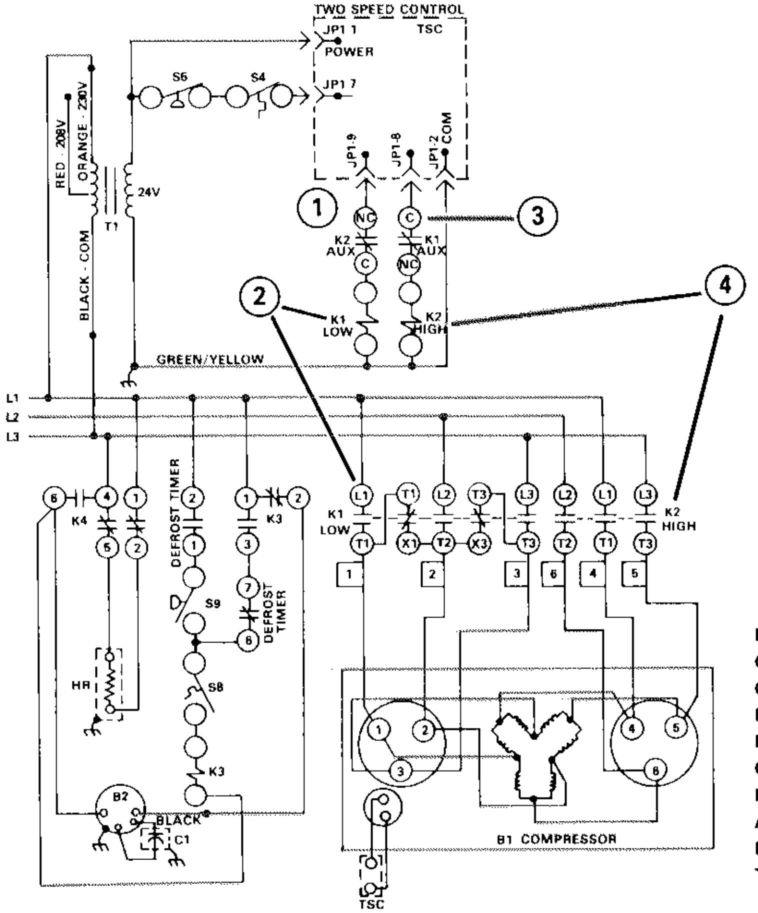
1 - Line voltage feeds through L1, L2 and L3 to energize the outdoor transformer (T1) and the unit. Crankcase heater is energized through relay K4 contacts 4-5 and 1-2.

2 - Transformer T1 provides 24 VAC power to TSC and contactors K1 and K2.

3 - The indoor transformer supplies 24 VAC power to the indoor unit and the indoor thermostat. Note that some of the outdoor unit's controls are controlled by this circuit.

4 - On power-up 24 VAC is fed through JP1-1 and JP1-7 to TSC. TSC begins a 10 second power-up delay.

5 - TSC then begins a 5 minute delay during which the outdoor unit is not operational. After the 5 minute delay, TSC waits in 'off' mode for 1st stage or 2nd stage demand. If thermostat demand is present during this delay, relay K4 energizes and the outdoor fan operates.



KEY	DESCRIPTION COMPONENT
B1	compressor
B2	motor - outdoor fan
C1	capacitor - outdoor fan
F	fuse
HR	heater - crankcase
JP1	jack - plug
K1	contactor - compressor (low speed)
K2	contactor - compressor (high speed)
K3	relay - defrost control
K4	relay - fan
L1	valve - reversing
RT1	thermistor - ambient compensation
S3	thermostat - outdoor (if used)
S4	switch - temperature (crankcase)
S5	switch - high pressure
S6	thermostat - speed control
S7	thermostat - service light
S8	switch - temperature (defrost)
S9	switch - pressure (defrost)
T1	transformer (208-230v. pri/24V sec.)
TB1	block - terminal
TB2	block - terminal (indoor unit)
TSC	two speed control module
HVJB	high voltage junction box
LVJB	low voltage junction box

IMPORTANT - THIS DIAGRAM DEPICTS BRISTOL COMPRESSOR INTERNAL WIRING. REFER TO PAGE 13 FOR LENNOX COMPRESSOR INTERNAL WIRING. LENNOX AND BRISTOL TERMINAL CONNECTIONS ARE THE SAME.

H - THREE PHASE COMPRESSOR STARTUP

LOW SPEED:

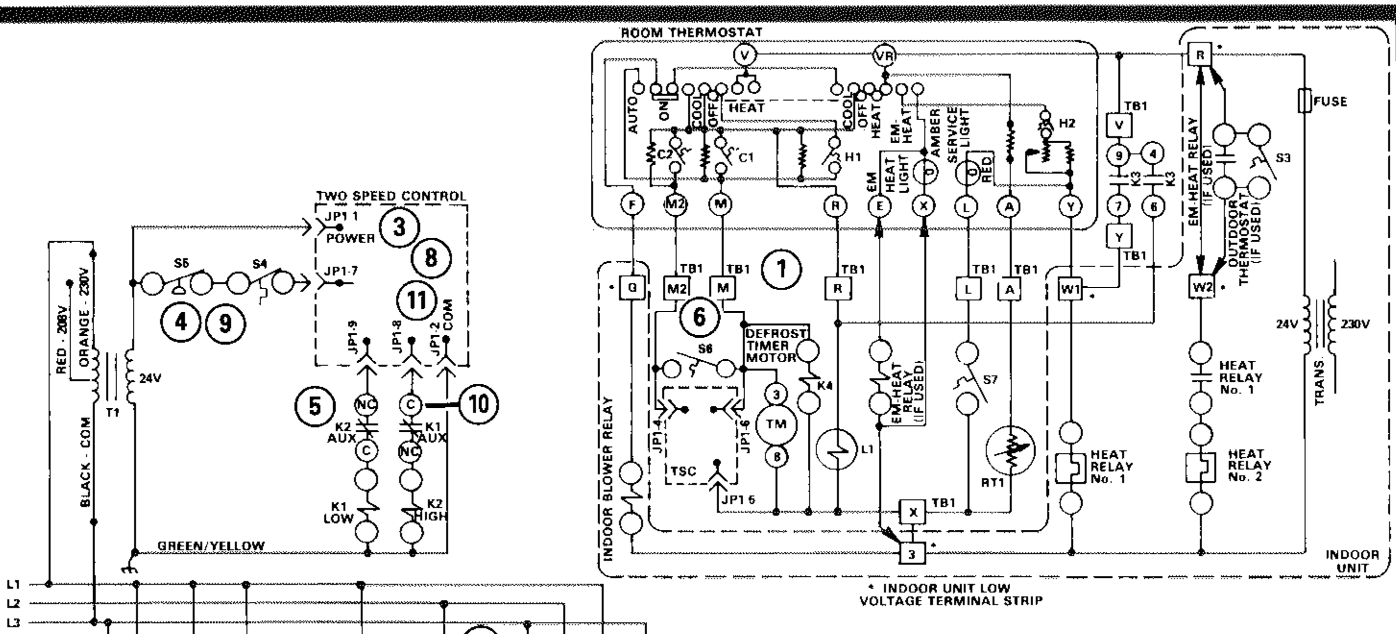
1 - If all safety circuits check-out, TSC energizes JP1-9.

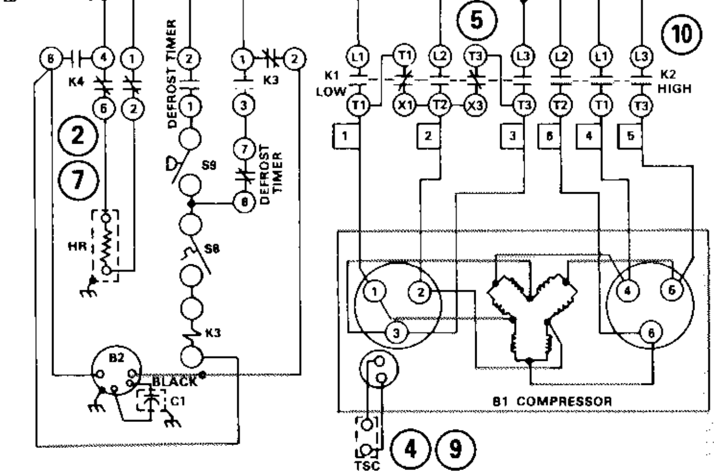
2 - Contactor K1 is energized through K2 N.C. auxiliary contacts. K1 auxiliary contacts open to disconnect relay K2. Contacts T1-X1 and T3-X3 open to disconnect the high speed wiring circuitry. Contacts L1-T1, L2-T2 and L3-T3 close to energize low speed operation. This arrangement forms a series Y connection to the motor windings for low speed.

HIGH SPEED:

3 - If all safety circuits check-out, TSC energizes JP1-8.

4 - Contactor K2 is energized through contactor K1 N.C. auxiliary contacts. K2 auxiliary contacts open to disconnect contactor K1. Contacts L1-T1, L2-T2 and L3-T3 close to energize high speed. K1 contacts T1-X1 and T3-X3 close to form a parallel Y connection to the motor windings for high speed operation.





IMPORTANT - THIS DIAGRAM DEPICTS BRISTOL COMPRESSOR INTERNAL WIRING. REFER TO PAGE 13 FOR LENNOX COMPRESSOR INTERNAL WIRING. LENNOX AND BRISTOL TERMINAL CONNECTIONS ARE THE SAME.

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TB1	block - terminal
TB2	block - terminal (indoor unit)
TSC	two speed control module
HVJB	high voltage junction box
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I - THREE PHASE COOLING SEQUENCE

1 - 1st stage cooling demand energizes TB1-M and TB1-R. TB1-R energizes reversing valve L1. TB1-M energizes TSC terminal JP1-6, relay K4 and the defrost timer motor (defrost timer contacts 1-2 close to ask for defrost every 90 minutes but defrost cannot initiate because S8 cannot close when unit is in cooling mode).

NOTE - 2nd stage cooling demand may be energized directly without passing through 1st stage (step 6).

2 - Relay K4 contacts 4-5 and 1-2 open to de-energize the crankcase heater and contacts 4-6 close to energize the outdoor fan (B2).

3 - TSC delays 3 seconds before responding to the new command.

4 - If the unit is changing from 2nd stage to 1st stage demand, TSC initiates speed change delay and de-energizes JP1-8 and JP1-9 to stop compressor operation for 60 ± 5 seconds. OUTDOOR FAN CONTINUES TO OPERATE. After TSC completes the 60 ± 5 second speed change delay or if the unit is starting-up in 1st stage directly from 'off' mode, TSC checks safety circuits by looking for 24 VAC at JP1-7 and by checking resistance across wires connected to QC1 and QC2.

5 - If all safety circuits check-out, TSC energizes JP1-9 and compressor begins low speed startup.

6 - 2nd stage cooling demand energizes TB1-M, TB1-M2 and TB1-R. TB1-R energizes reversing valve L1. TB1-M2 energizes TSC terminal JP1-4. TB1-M energizes TSC terminal JP1-6, relay K4 and the defrost timer motor (see note in step about defrost timer operation).

7 - Relay K4 contacts 4-5 and 1-2 open to de-energize the crankcase heater and contacts 4-6 close to energize the outdoor fan B2.

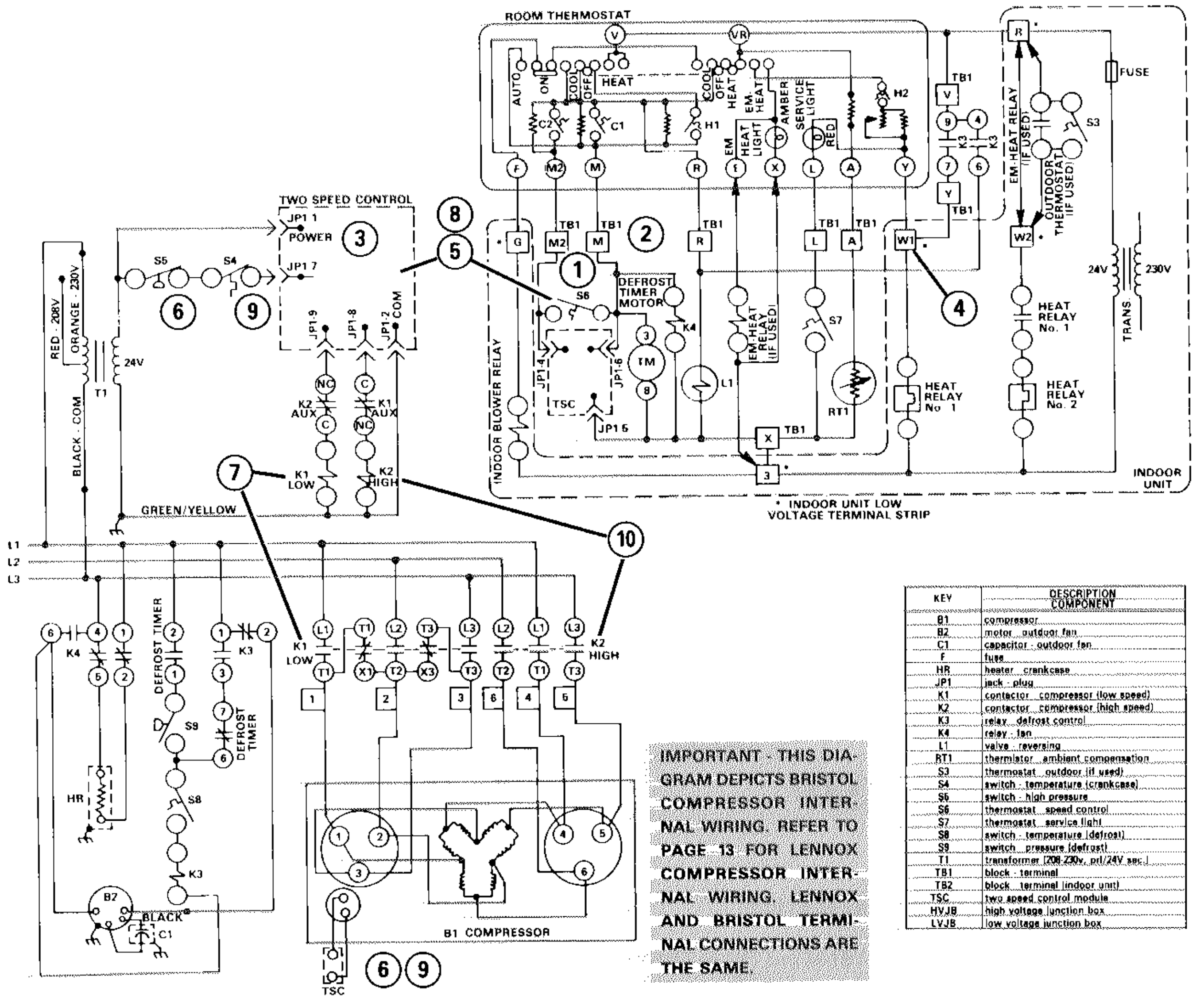
8 - TSC delays 3 seconds before responding to the new command.

9 - If the unit is changing from 1st stage to 2nd stage demand TSC initiates speed change delay and de-energizes JP1-9 to stop compressor operation for 60 ± 5 seconds. OUTDOOR FAN CONTINUES TO OPERATE.

After TSC completes the 60 ± 5 second speed change delay or if the unit is starting-up in 2nd stage directly from 'off' mode (step 6), TSC check safety circuits by looking for 24 VAC at JP1-7 and by checking resistance across wires connected to QC1 and QC2.

10 - If all safety circuits check-out, TSC energizes JP1-8 and compressor begins high speed startup.

11 - When thermostat demand is satisfied or if thermostat is switched 'off', the outdoor fan immediately stops. After a delay of 3 seconds compressor operation stops. TSC then completely resets (erase accumulated faults - see TSC operation sequence) and returns.



KEY	DESCRIPTION COMPONENT
B1	compressor
B2	motor outdoor fan
C1	capacitor - outdoor fan
F	fuse
HR	heater crankcase
JP1	jack - plug
K1	contactor compressor (low speed)
K2	contactor compressor (high speed)
K3	relay defrost control
K4	relay - fan
L1	valve - reversing
RT1	thermistor ambient compensation
S3	thermostat outdoor (if used)
S4	switch - temperature (crankcase)
S5	switch - high pressure
S6	thermostat speed control
S7	thermostat service light
S8	switch - temperature (defrost)
S9	switch pressure (defrost)
T1	transformer (208-230v. pri/24V sec.)
TB1	block - terminal
TB2	block terminal (indoor unit)
TSC	two speed control module
HVJB	high voltage junction box
LVJB	low voltage junction box

IMPORTANT - THIS DIAGRAM DEPICTS BRISTOL COMPRESSOR INTERNAL WIRING. REFER TO PAGE 13 FOR LENNOX COMPRESSOR INTERNAL WIRING. LENNOX AND BRISTOL TERMINAL CONNECTIONS ARE THE SAME.

J - THREE PHASE HEATING SEQUENCE

1 - Speed control thermostat determines whether the compressor is to operate on high or low speed based on outdoor temperature. If outdoor temperature drops below 55°F, S6 closes and the compressor runs on high speed. If outdoor temperature rises above 65°F, S6 opens the compressor runs on low speed.

2 - 1st stage demand energizes TB1-M. TB1-M energizes TSC terminal JP1-6, relay K4 and the defrost time motor. Defrost timer contacts 1-2 close every 90 (or as preset) to ask for defrost.

NOTE - 2nd stage heating demand may be energized directly without passing through 1st stage.

3 - TSC delays 3 seconds before responding to the new command.

4 - 2nd stage heating demand energizes TB1-M and terminal Y of the indoor thermostat. TB1-M energizes TSC terminal JP1-6, relay K4 and the defrost timer motor. Terminal Y of the indoor thermostat energizes the indoor auxiliary heat relay for 2nd stage heat.

OUTDOOR TEMPERATURE RISE ABOVE 65°F (S6 OPEN):

5 - If the speed control thermostat opens during compressor operation, TSC initiates a speed change delay and stops compressor operation for 60 ± 5 seconds. OUTDOOR FAN CONTINUES TO OPERATE.

6 - TSC checks safety circuits by looking for 24 VAC at JP1-7 and by checking resistance across wires connected to QC1 and QC2.

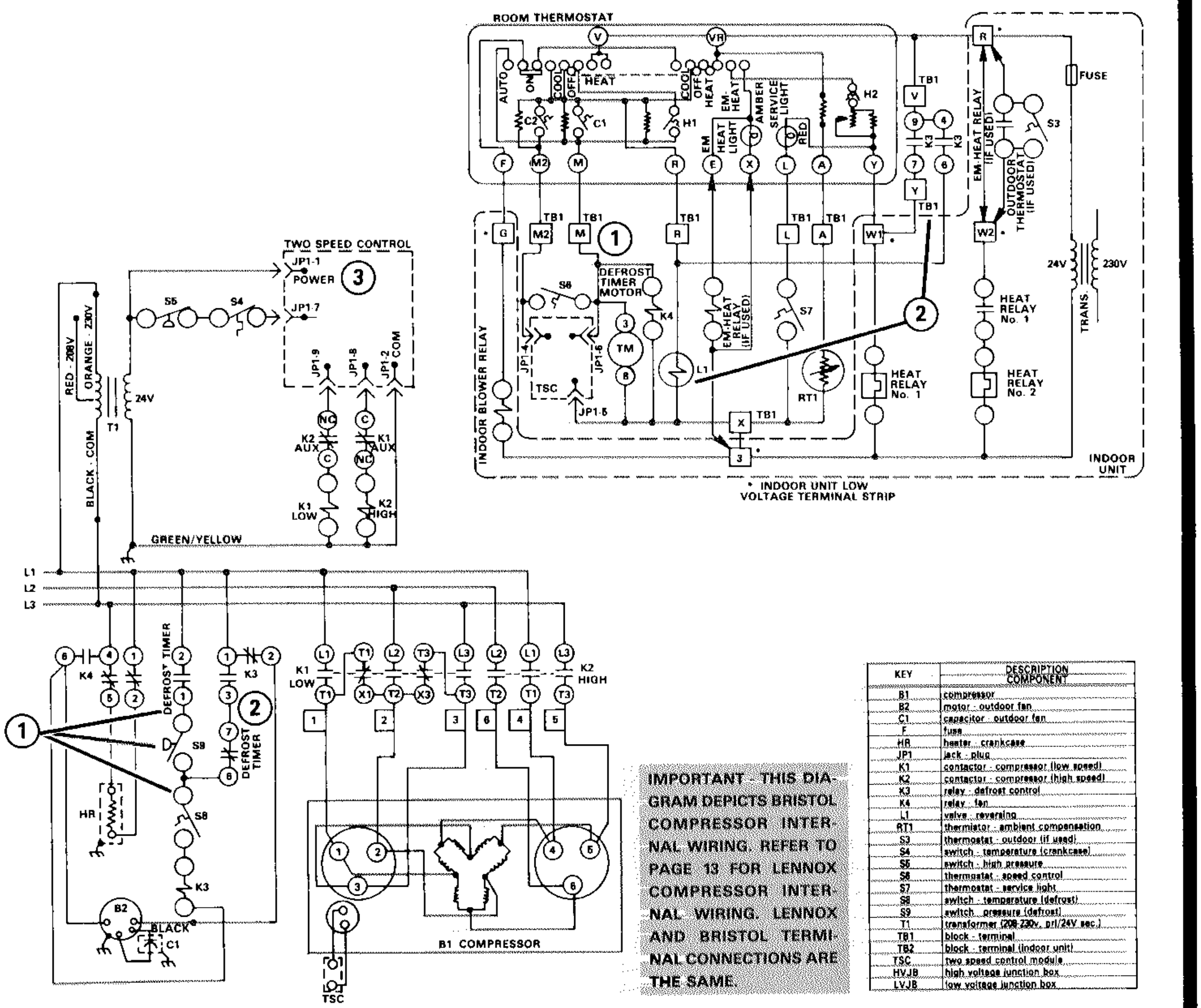
7 - If all safety circuits check-out, TSC energizes JP1-9 and compressor begins low speed startup.

OUTDOOR TEMPERATURE DROP BELOW 55°F (S6 CLOSED):

8 - If the speed control thermostat closes during compressor operation, TSC initiates a speed change delay and stops compressor operation for 60 ± 5 seconds. OUTDOOR FAN CONTINUES TO OPERATE.

9 - TSC checks all safety circuits by looking for 24 VAC at JP1-7 and by checking resistance across wires connected to QC1 and QC2.

10 - If all safety circuits check-out, TSC energizes JP1-8 and compressor begins high speed startup.



IMPORTANT - THIS DIAGRAM DEPICTS BRISTOL COMPRESSOR INTERNAL WIRING. REFER TO PAGE 13 FOR LENNOX COMPRESSOR INTERNAL WIRING. LENNOX AND BRISTOL TERMINAL CONNECTIONS ARE THE SAME.

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JP1	jack - plug
K1	contactor - compressor (low speed)
K2	contactor - compressor (high speed)
K3	relay - defrost control
K4	relay - fan
L1	valve - reversing
RT1	thermistor - ambient compensation
S3	thermostat - outdoor (if used)
S4	switch - temperature (crankcase)
S5	switch - high pressure
S6	thermostat - speed control
S7	thermostat - service light
S8	switch - temperature (defrost)
S9	switch - pressure (defrost)
T1	transformer (208-230v, pri/24V sec.)
TB1	block - terminal
TB2	block - terminal (indoor unit)
TSC	two speed control module
HVJB	high voltage junction box
LVJB	low voltage junction box

K - THREE PHASE DEFROST SEQUENCE

1 - Every 90 minutes of compressor operation (or as preset), defrost timer contacts 1-2 close for 20 ± 10 seconds. During the time contacts 1-2 are closed, if the defrost pressure switch S9 and the defrost thermostat S8 are also closed, relay K3 energizes and defrost begins.

2 - Relay K3 controls defrost:
When relay K3 energizes, K3 contacts 1-3 close. This 'latches-in' relay K3 so defrost may only be terminated by defrost timer contacts 6-7 or the defrost thermostat. Defrost timer contacts 6-7 open 10 ± 1 minutes after relay K3 energizes to terminate defrost. Defrost can also be terminated by the defrost thermostat by opening when the outdoor liquid line reaches 60 ± 5°F.

When relay K3 energizes, K3 contacts 4-6 close to energize reversing valve L1 and contacts 7-9 close to energize the indoor auxiliary heat relay. K3 contacts 1-2 open to de-energize the outdoor fan.

The unit resumes normal heating operation when relay K3 de-energizes.

3 - When thermostat demand is satisfied or if thermostat is switched 'off' the outdoor fan immediately stops. After a 3 second delay, compressor operation stops. TSC then completely resets (erase accumulated faults - see TSC operation sequence) before cycling through the 5 minute timed off delay (three phase starting sequence).

TWO SPEED CONTROL
TROUBLESHOOTING FLOWCHART

START HERE

CHECK SUPPLY VOLTAGE.
IS SUPPLY VOLTAGE WITHIN RANGE
SHOWN ON UNIT RATING PLATE?

NO — CORRECT POWER SUPPLY. / YES

MANUALLY RESET HIGH PRESSURE SWITCH 'S5'
IN OUTDOOR UNIT IF TRIPPED

CHOOSE COOLING OR HEATING MODE

HIGH SPEED COOLING

1 - TURN INDOOR THERMOSTAT TO 'OFF' POSITION.
2 - SET INDOOR THERMOSTAT TO LOWEST TEMPERATURE SETTING.
3 - TURN INDOOR THERMOSTAT TO 'COOL' MODE.
4 - IF POWER TO OUTDOOR UNIT HAS BEEN OFF, WAIT AT LEAST 10 SECONDS TO ALLOW TSC TO POWER-UP.
5 - PUSH AND RELEASE THE OVERRIDE BUTTON ON THE TSC TO BYPASS THE 5 MINUTE TIMED-OFF DELAY.
6 - ALLOW 1 MINUTE FOR THE UNIT TO START.

DOES UNIT START AND RUN ON HIGH SPEED?

YES / NO — **GO TO (A) ON NEXT PAGE**

IS UNIT IN COOLING MODE?
REVERSING VALVE SHOULD BE ENERGIZED.
REVERSING VALVE ENERGIZED?

YES / NO

CHECK VOLTAGE ACROSS TERMINALS 'R' AND 'X' AT THE UNIT'S LOW VOLTAGE TERMINAL STRIP 'TB1'.
IS VOLTAGE 24 ± 6VAC?

YES — CHECK REVERSING VALVE FOR MALFUNCTIONS. REPLACE IF NECESSARY.
NO — CHECK INDOOR THERMOSTAT FOR MALFUNCTIONS AND REPLACE IF NECESSARY.

REPEAT TROUBLESHOOTING PROCEDURE.

HIGH SPEED COOLING O.K.

LOW SPEED COOLING

1 - TURN INDOOR THERMOSTAT TO 'OFF' POSITION.
2 - DISCONNECT THERMOSTAT WIRE FROM TERMINAL 'M2' OF THE HEAT PUMP'S LOW VOLTAGE TERMINAL STRIP 'TB1'.
3 - SET INDOOR THERMOSTAT TO LOWEST TEMPERATURE SETTING.
4 - TURN INDOOR THERMOSTAT TO 'COOL' MODE.
5 - IF POWER TO OUTDOOR UNIT HAS BEEN OFF, WAIT AT LEAST 10 SECONDS TO ALLOW TSC TO POWER UP.
6 - PUSH AND RELEASE THE OVERRIDE BUTTON ON THE TSC TO BYPASS THE 5 MINUTE TIMED-OFF DELAY.
7 - ALLOW 1 MINUTE FOR THE UNIT TO START.

DOES THE UNIT START AND RUN ON LOW SPEED?

YES / NO — **GO TO (B) ON NEXT PAGE**

IS UNIT IN COOLING MODE?
REVERSING VALVE SHOULD BE ENERGIZED.
REVERSING VALVE ENERGIZED?

YES — LOW SPEED COOLING O.K.

TSC OPERATING PROPERLY.
RE-ASSEMBLE UNIT.

NO —

CHECK VOLTAGE ACROSS TERMINALS 'R' AND 'X' AT THE UNIT'S LOW VOLTAGE TERMINAL STRIP 'TB1'.
IS VOLTAGE 24 ± 6VAC?

YES — CHECK REVERSING VALVE FOR MALFUNCTIONS.
NO — CHECK INDOOR THERMOSTAT FOR MALFUNCTIONS. REPLACE IF NECESSARY.

REPEAT TROUBLESHOOTING PROCEDURE.

HIGH SPEED HEATING

1 - TURN INDOOR THERMOSTAT TO 'OFF' POSITION.
2 - PLACE A JUMPER WIRE ACROSS SPEED CONTROL THERMOSTAT 'S6' IN OUTDOOR UNIT.
3 - SET INDOOR THERMOSTAT TO HIGHEST TEMPERATURE SETTING.
4 - TURN INDOOR THERMOSTAT TO 'HEAT' MODE.
5 - IF POWER TO OUTDOOR UNIT HAS BEEN OFF, WAIT AT LEAST 10 SECONDS TO ALLOW TSC TO POWER UP.
6 - PUSH AND RELEASE THE OVERRIDE BUTTON ON THE CONTROL TO BYPASS THE 5 MINUTE TIMED-OFF DELAY.
7 - ALLOW 1 MINUTE FOR THE UNIT TO START.

DOES UNIT START AND RUN ON HIGH SPEED IN HEATING MODE?

NO — **GO TO (A) ON NEXT PAGE**
YES — HIGH SPEED HEATING O.K.

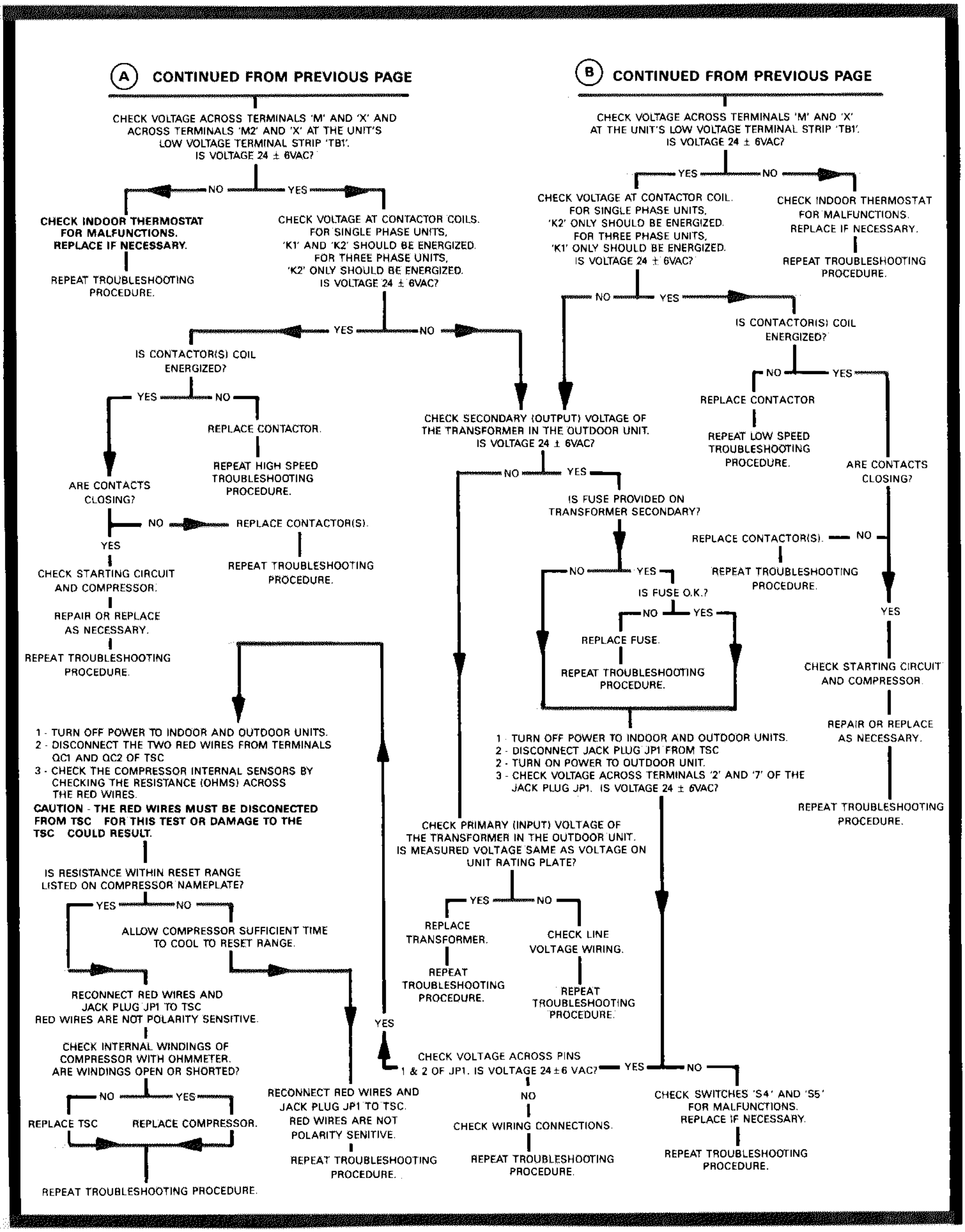
LOW SPEED HEATING

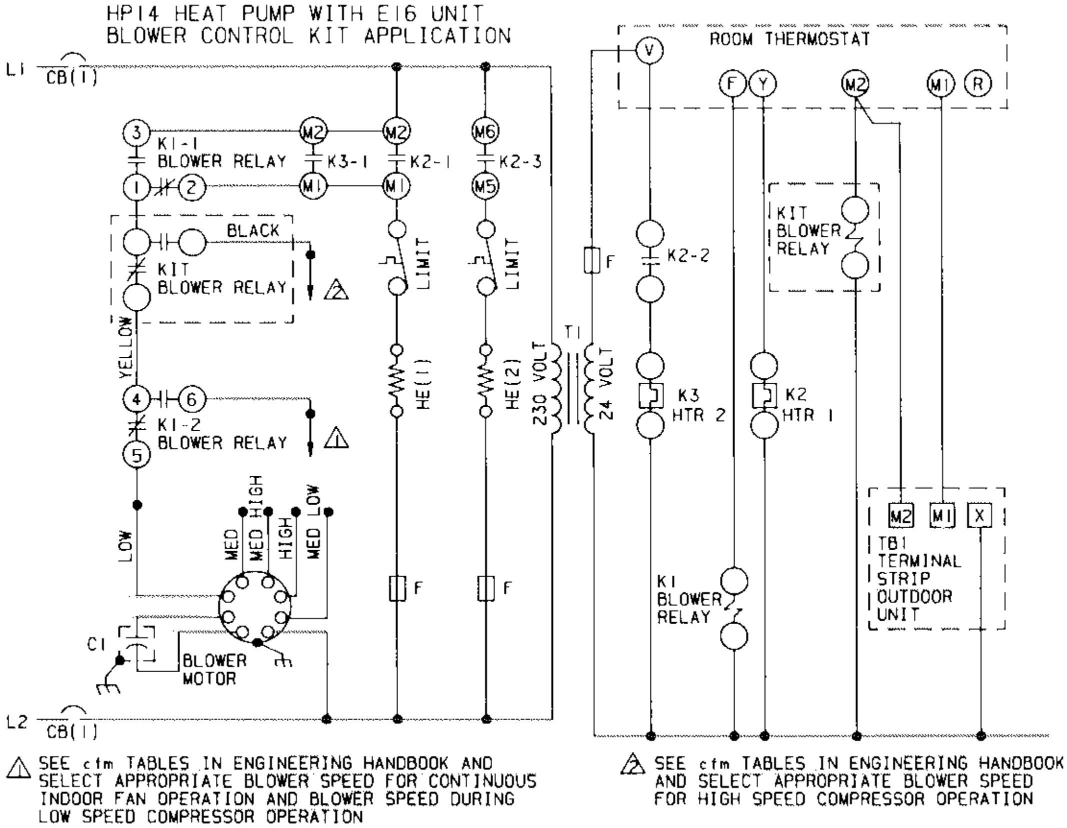
1 - TURN INDOOR THERMOSTAT TO 'OFF' POSITION.
2 - REMOVE THE JUMPER WIRE FROM ACROSS THE SPEED CONTROL THERMOSTAT 'S6'.
3 - DISCONNECT THE FACTORY WIRING FROM EITHER SIDE OF THE SPEED CONTROL THERMOSTAT 'S6'.
4 - SET INDOOR THERMOSTAT TO HIGHEST TEMPERATURE SETTING.
5 - TURN THERMOSTAT TO 'HEAT' MODE.
6 - IF POWER TO OUTDOOR UNIT HAS BEEN OFF, WAIT AT LEAST 10 SECONDS TO ALLOW TSC TO POWER-UP.
7 - PUSH AND RELEASE THE OVERRIDE BUTTON ON THE TSC TO BYPASS THE 5 MINUTE TIMED-OFF DELAY.
8 - ALLOW 1 MINUTE FOR THE UNIT TO START.

DOES UNIT START AND RUN ON LOW SPEED IN HEATING MODE?

NO — **GO TO (B) ON NEXT PAGE**
YES — LOW SPEED HEATING O.K.

TSC OPERATING PROPERLY.
RE-ASSEMBLE UNIT.


(A) CONTINUED FROM PREVIOUS PAGE
CHECK VOLTAGE ACROSS TERMINALS 'M' AND 'X' AND ACROSS TERMINALS 'M2' AND 'X' AT THE UNIT'S LOW VOLTAGE TERMINAL STRIP 'TB1'. IS VOLTAGE 24 ± 6VAC?
NO
YES
CHECK INDOOR THERMOSTAT FOR MALFUNCTIONS. REPLACE IF NECESSARY.
REPEAT TROUBLESHOOTING PROCEDURE.
CHECK VOLTAGE AT CONTACTOR COILS. FOR SINGLE PHASE UNITS, 'K1' AND 'K2' SHOULD BE ENERGIZED. FOR THREE PHASE UNITS, 'K2' ONLY SHOULD BE ENERGIZED. IS VOLTAGE 24 ± 6VAC?
YES
NO
IS CONTACTOR(S) COIL ENERGIZED?
YES
NO
REPLACE CONTACTOR.
REPEAT HIGH SPEED TROUBLESHOOTING PROCEDURE.
ARE CONTACTS CLOSING?
NO
REPLACE CONTACTOR(S).
REPEAT TROUBLESHOOTING PROCEDURE.
YES
CHECK STARTING CIRCUIT AND COMPRESSOR.
REPAIR OR REPLACE AS NECESSARY.
REPEAT TROUBLESHOOTING PROCEDURE.
1 - TURN OFF POWER TO INDOOR AND OUTDOOR UNITS.
2 - DISCONNECT THE TWO RED WIRES FROM TERMINALS QC1 AND QC2 OF TSC
3 - CHECK THE COMPRESSOR INTERNAL SENSORS BY CHECKING THE RESISTANCE (OHMS) ACROSS THE RED WIRES.
CAUTION - THE RED WIRES MUST BE DISCONECTED FROM TSC FOR THIS TEST OR DAMAGE TO THE TSC COULD RESULT.
IS RESISTANCE WITHIN RESET RANGE LISTED ON COMPRESSOR NAMEPLATE?
YES
NO
ALLOW COMPRESSOR SUFFICIENT TIME TO COOL TO RESET RANGE.
RECONNECT RED WIRES AND JACK PLUG JP1 TO TSC RED WIRES ARE NOT POLARITY SENSITIVE.
CHECK INTERNAL WINDINGS OF COMPRESSOR WITH OHMMETER. ARE WINDINGS OPEN OR SHORTED?
NO
YES
REPLACE TSC
REPLACE COMPRESSOR.
REPEAT TROUBLESHOOTING PROCEDURE.
RECONNECT RED WIRES AND JACK PLUG JP1 TO TSC. RED WIRES ARE NOT POLARITY SENITIVE.
REPEAT TROUBLESHOOTING PROCEDURE.
(B) CONTINUED FROM PREVIOUS PAGE
CHECK VOLTAGE ACROSS TERMINALS 'M' AND 'X' AT THE UNIT'S LOW VOLTAGE TERMINAL STRIP 'TB1'. IS VOLTAGE 24 ± 6VAC?
YES
NO
CHECK VOLTAGE AT CONTACTOR COIL. FOR SINGLE PHASE UNITS, 'K2' ONLY SHOULD BE ENERGIZED. FOR THREE PHASE UNITS, 'K1' ONLY SHOULD BE ENERGIZED. IS VOLTAGE 24 ± 6VAC?
CHECK INDOOR THERMOSTAT FOR MALFUNCTIONS. REPLACE IF NECESSARY.
REPEAT TROUBLESHOOTING PROCEDURE.
NO
YES
IS CONTACTOR(S) COIL ENERGIZED?
NO
YES
REPLACE CONTACTOR
REPEAT LOW SPEED TROUBLESHOOTING PROCEDURE.
ARE CONTACTS CLOSING?
REPLACE CONTACTOR(S).
NO
REPEAT TROUBLESHOOTING PROCEDURE.
YES
CHECK STARTING CIRCUIT AND COMPRESSOR.
REPAIR OR REPLACE AS NECESSARY.
REPEAT TROUBLESHOOTING PROCEDURE.
CHECK SECONDARY (OUTPUT) VOLTAGE OF THE TRANSFORMER IN THE OUTDOOR UNIT. IS VOLTAGE 24 ± 6VAC?
NO
YES
IS FUSE PROVIDED ON TRANSFORMER SECONDARY?
NO
YES
IS FUSE O.K.?
NO
YES
REPLACE FUSE.
REPEAT TROUBLESHOOTING PROCEDURE.
1 - TURN OFF POWER TO INDOOR AND OUTDOOR UNITS.
2 - DISCONNECT JACK PLUG JP1 FROM TSC
2 - TURN ON POWER TO OUTDOOR UNIT.
3 - CHECK VOLTAGE ACROSS TERMINALS '2' AND '7' OF THE JACK PLUG JP1. IS VOLTAGE 24 ± 6VAC?
CHECK PRIMARY (INPUT) VOLTAGE OF THE TRANSFORMER IN THE OUTDOOR UNIT. IS MEASURED VOLTAGE SAME AS VOLTAGE ON UNIT RATING PLATE?
YES
NO
REPLACE TRANSFORMER.
REPEAT TROUBLESHOOTING PROCEDURE.
CHECK LINE VOLTAGE WIRING.
REPEAT TROUBLESHOOTING PROCEDURE.
YES
CHECK VOLTAGE ACROSS PINS 1 & 2 OF JP1. IS VOLTAGE 24±6 VAC?
YES
NO
NO
CHECK WIRING CONNECTIONS.
REPEAT TROUBLESHOOTING PROCEDURE.
CHECK SWITCHES 'S4' AND 'S5' FOR MALFUNCTIONS. REPLACE IF NECESSARY.
REPEAT TROUBLESHOOTING PROCEDURE.



A - INDOOR BLOWER CONTROL KIT

Application:

Indoor blower control kit is used to provide the option of varying indoor blower speeds during compressor operation in two speed units. This option is especially important in locations with high humidity. Typically, the indoor blower speed control kit is wired to provide a lower indoor blower speed during low speed compressor operation. This reduces the amount of air passing across the indoor coil and increases the effectiveness of humidity removal. A higher indoor blower speed can then be selected for use during high speed compressor operation. The higher speed must meet the minimum cfm requirements for high speed operation.

Installation:

1 - Turn off electrical power at indoor unit disconnect switch.
2 - Use 7/8" knockout to make a mounting hole in the control box near the existing blower motor relay.
3 - Remove nut from back of relay, insert wires through knockout and tighten mounting nut so that relay stays securely in place.
4 - Continue with wiring section.

Wiring:

A - Low Voltage Wiring

Use wire nuts to splice blue relay coil leads into wire from terminal M_2 of room thermostat.

B - High Voltage Wiring

1 - Run red wire from common terminal of kit control relay to terminal 1 of existing indoor blower relay.
2 - Run yellow wire from normally closed terminal of kit relay to terminal 2 of existing indoor blower relay.
3 - Use cfm tables in Lennox engineering handbook to select a speed tap connection for wire from terminal 6 of existing indoor blower relay. This will be the indoor blower speed for continuous indoor fan operation and blower speed during low speed compressor operation.

NOTE - For most effective humidity control, lowest possible indoor blower speed should be selected for low speed compressor operation.

4 - Use cfm tables in Lennox engineering handbook to select a speed tap connection for black wire from normally open contact of kit relay. This will be the indoor blower speed during high speed compressor operation.
5 - Replace access panels and restore electrical power to unit.