

## TSC6 Two-Speed Control

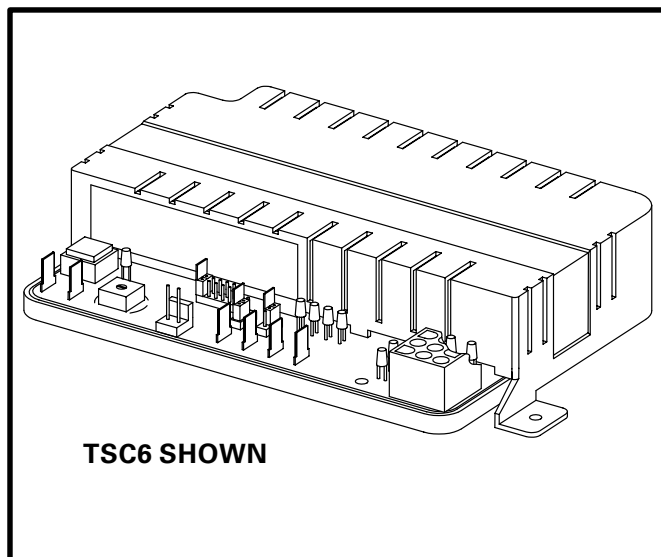
All HP21 -4 and -5 units (single and three phase) are equipped with a TSC6 two-speed control. The TSC6 (A14) two-speed control contains relays which energize compressor operation in response to thermostat demand. High speed operation can be energized and de-energized without passing through low speed. The control also contains safety timed-off delays and compressor over-temperature sensing which protect the compressor. The control has an external temperature probe to lock out low speed during low temperatures, plus a potentiometer used for setting the low speed lock out temperature. The adjustment range is 38° F (3.3° C) to 55° F (12.7° C) ±2° F (1.1° C). This lock out will occur in both heating and cooling modes.

A timed-off delay in the control prevents short cycling by locking out compressor operation for five minutes after the end of a thermostat demand or after a power failure. The control also counts "unit fault conditions." When 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 one fault. If three unit faults are counted 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. Unit faults are erased when power is interrupted. When thermostat demand changes stages, compressor operation stops for approximately one minute to allow refrigerant pressure to equalize in the system.

A manual override button aids servicing and troubleshooting, on the control. The manual override button, when pressed and released, bypasses the five-minute delay so low speed or high speed operation can be immediately energized. However, the control provides a one-minute delay between speed changes, which cannot be bypassed.

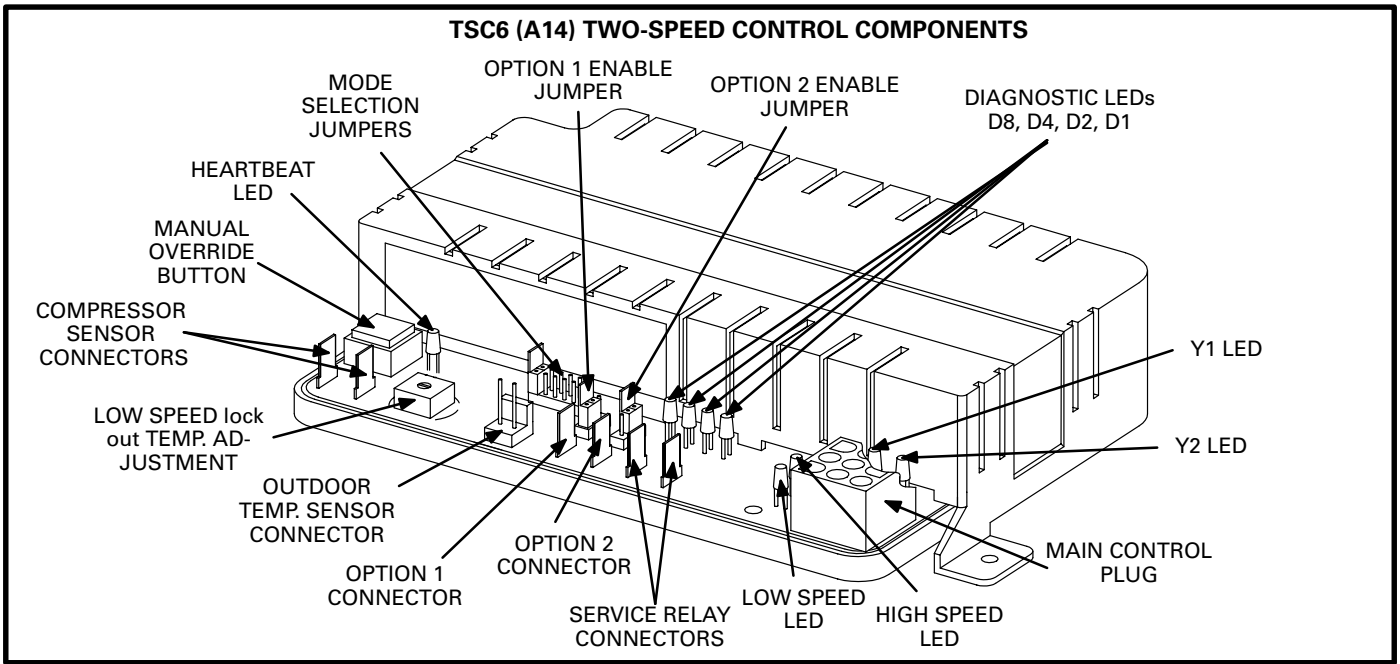
Do not use the override button immediately after power-up. If the button is pushed during the ten-second power-up delay, it has no effect. The control completes the five-minute delay.

The control continually self-tests its internal circuits and uses the diagnostic lights to indicate control failure.

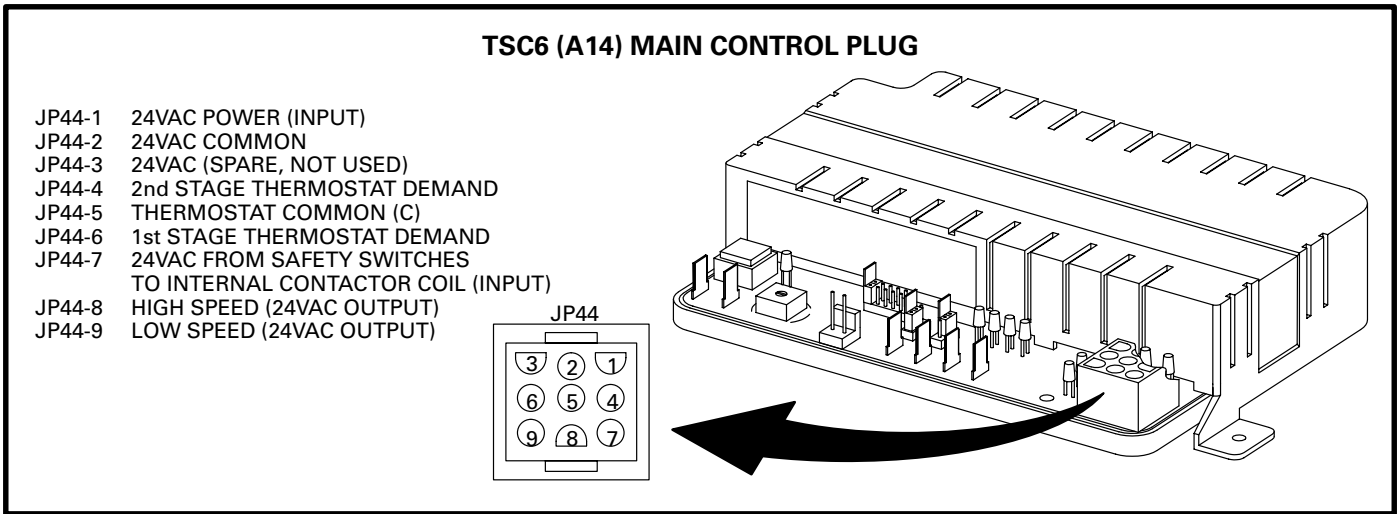


### Normal Operation Sequence

- 1- After self-test, the control begins a five-minute delay during which the unit is not operational (control and outdoor unit do not respond to thermostat demand). Once the five-minute delay is complete, the control waits in "OFF" mode for thermostat demand.
- 2- After receiving a thermostat demand, the TSC delays three seconds before responding.
- 3- Low speed demand (JP44-9) energizes low speed operation OR high speed demand (JP44-8) energizes high speed operation.
- 4- During unit operation, if low speed demand changes to high speed demand or if high speed demand changes to low speed, the control delays three seconds before responding. Then, all unit operation stops for 60±5 seconds (control de-energizes JP44-8 and JP44-9). 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 returns to step 2 above.
- 5- When thermostat demand is satisfied, all unit operation stops after a three-second delay (control de-energizes JP44-8 and JP44-9), the control resets (see unit fault conditions section) and returns to step two.
- 6- General Operation  
On power-up, the control begins a ten-second initial delay.



**FIGURE 1**



**FIGURE 2**

#### Two-Speed Control Fault Conditions

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

### ⚠ IMPORTANT

**If the cycle counter counts 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 unit may remain inoperable. The high pressure or low pressure conditions may still exist and must be located and corrected before the unit can be placed back in service. See diagnostic codes to determine problem.**

## ⚠ IMPORTANT

**If the control locks out, it can be reset by breaking thermostat demand for about five seconds then re-making thermostat demand. Also, anytime thermostat demand is removed or power is interrupted, the control resets to zero faults.**

### A fault occurs when:

1- Compressor operation is monitored by high and low pressure switches. These controls are wired in series. If either one trips, compressor operation is interrupted and one fault is counted. The control locks out compressor operation for a minimum of five minutes when a safety device terminates operation. High pressure switch must be reset manually but low pressure switch resets automatically.

It is likely that the control could count three unit faults from the low pressure switch during a single thermostat demand since this switch resets automatically. However, the cycle counter can only count unit faults from the high pressure switch if the reset button is pushed without interrupting thermostat demand.

2- On all units using the TSC two-speed control, terminals S1 and S2 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 through the sensors. The sensors increase their resistance as temperature increases (for example, too much superheat). When the resistance through the sensors increases above a preset limit, the control stops compressor operation for a minimum of five minutes. As the compressor windings cool, the resistance through the sensors drops below the reset limit, the control resets automatically and one fault is counted.

Check sensors by measuring resistance (ohms) through the sensors with the wires disconnected from the control (unit not running). The sensor wires are not polarity sensitive. Table 1 shows winding temperature sensor resistance values which will cause the TSC to lock out. When unit is operating normally, resistance through the sensors should be below the trip value shown in table 1.

**TABLE 1**

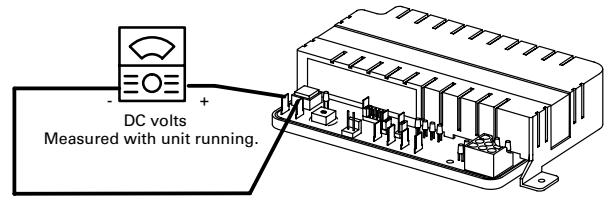
Compressor Winding Temperature Sensor	Trip Ohms Temp. Rise	Reset Ohms Temp. Fall
TSC6 Copeland Compressor	25K to 35K	8.4K to 10K

The control can be checked by comparing the resistance measured through the sensors to the voltage measured across the sensor terminals with the unit running. Table 2 shows voltage measured across two-speed control terminals S1 and S2 with the compressor running.

**TABLE 2**

### COMPRESSOR WINDING SENSOR OPERATING RANGE

Resistance Through Compressor Winding Temperature Sensor K-ohms (ohms x 1000)	Voltage Across TSC6 compressor sensor terminals with Unit Running DC Volts	
0	0	
1.0	1.70 – 1.82	
5.5	6.07 – 6.48	
6.9	6.86 – 7.33	
8.4	7.55 – 8.07	} Reset Range
10.0	8.16 – 8.72	
16.0	9.69 – 10.36	
20.0	10.34 – 11.05	
24.0	10.82 – 11.57	
25.0	10.93 – 11.68	} Trip Range
30.0	11.35 – 12.14	
35.0	11.68 – 12.48	



### MODE SELECTION JUMPERS

The control has six mode selection jumpers for selection of operating modes and problem code recall or test. Choose one of the first four modes for operation.

- Normal: Normal operation (default mode). Unit runs on high or low speed as the indoor thermostat load demands.
- Latch 1: After high speed demand is met, the unit remains in high speed until the low speed demand is satisfied.
- Latch 2: After the unit operates in low speed for 15 minutes consecutively, it switches to high speed until low speed demand is satisfied.
- Latch 3: After the unit operates in low speed for 30 minutes consecutively, it switches to high speed until low speed demand is satisfied.
- Recall: Used in conjunction with the bypass button to recall the stored problem codes.
- Test: Used in conjunction with the control button to start test mode.

Latch 2 or 3 modes are recommended in high humidity areas. If the jumper falls off or is removed, the control will continue to operate in the previously set mode until the control is reset due to loss of power, then the control will default to the Normal mode.

### TEST MODE

The control has a test mode. To initiate this mode, move the jumper to the test position and push the control button. The unit will operate in low speed for 10 seconds, turn off for ten seconds, then operate in high speed for 10 seconds. The control will only go into the test mode if there is no thermostat demand and 5 minutes has elapsed since the unit ran. The indoor blower does not run during this mode. The test mode cannot run more than once every 5 minutes.

### LED LIGHTS

Y1 and Y2 lights are connected directly to the inputs from the thermostat. They indicate low and high speed demand, respectively.

The HI and LO lights are connected directly across the contactor coils. They indicate if the high and low speed contactors are energized.

The HEARTBEAT light is connected to the microcontroller unit (MCU). It indicates when the control's MCU is operating correctly, and also when the control is in delay mode. It blinks at a rate of four times a second when the MCU is operating properly and at a rate of once every two seconds when in the delay mode (such as the 1 or 5 minute delay). If the LED is continuously on or off (assuming the power is on), the MCU is not operating properly and the control needs to be replaced.

The D1, D2, D4, and D8 (see figure 1) diagnostic lights display diagnostic codes to aid in unit troubleshooting. Refer to Diagnostic Code Table (table 3).

### Diagnostic Code Display

A problem code is normally displayed only for the duration of the error. There is one exception. During a lock out, the code for the problem causing the lock out flashes once a second even if the problem condition no longer exists. If other problems occur during a lock out condition, the codes for those problems will be saved in memory, but not displayed. The stored problem codes are displayed by recalling them from memory. The diagnostic codes can be re-displayed by setting the jumper to the recall position. The stored codes are displayed by pushing the push button. As previously mentioned, the push button is used to bypass the five-minute delay and to initiate the test mode. In addition, the button is used to step back through the stored diagnostic codes and erase the diagnostic code memory. Diagnostic codes are re-

called in the reverse order of actual occurrence. Each subsequent button push will display additional codes until the last one, which will stay on with additional button pushes. Hold the button down until the lights go off (approximately five seconds) to erase the memory. The control has a nonvolatile memory that stores the 63 most recent diagnostic codes. These codes are stored in memory, even in the event of a power loss.

Not all codes cause lock outs or indicate problems. The purpose of the diagnostic lights is to let the installer or service technician know what is going on with the entire system, not just the two-speed control. Some codes do indicate malfunctions or problems with either the control or the HP21, while others inform the technician of the unit's status. All codes, except for three, are stored in memory and may be recalled.

#### Code 1 – Power Loss for Two Electrical Cycles

This code indicates that the unit's power skipped two electrical cycles (33–40 milliseconds). It may suggest that power to the unit is "dirty" or is of low quality. Code 1 is stored.

#### Code 2 – Input Indication

This code indicates that a change has been made and that the control acknowledges the change. It does not indicate a problem condition. It indicates activity such as jumper setting changes, delay overrides, or addition of an optional safety device to Option 1 or 2. Code 2 is not stored.

#### Code 3 – Unsteady Thermostat Input

Code 3 indicates intermittent inputs from the room thermostat. Most likely, there is a loose connection at the thermostat when this condition appears. Code 3 is stored.

#### Code 4 – Pressure Switch Opens < Two Minutes

If the low or high pressure switch opens after the compressor has run for **less than** two minutes, Code 4 will be displayed. This may indicate blockage or fan failure. Code 4 is stored. If the unit still operates after code is displayed, the low pressure switch stops operation (low pressure is auto-reset). Check for low system charge.

#### Code 5 – Pressure Switch Opens > Two Minutes

If the low or high pressure switch opens after the compressor has run for **more than** two minutes, Code 5 is displayed. This may indicate an improper charge or coil obstruction. Code 5 is stored. If the unit still operates after code is displayed, the low pressure switch stops operation (low pressure is auto-reset). Check for low system charge.

#### Code 6 – Hot Compressor < Five Minutes

Code 6 indicates the compressor temperature exceeded its limit after running **less than** five minutes. Code 6 is stored.

**TABLE 3  
TSC6 DIAGNOSTICS CODES**

CODE NUMBER	CONDITION	DISPLAY LIGHTS			
		8	4	2	1
1	Power loss for two cycles	OFF	OFF	OFF	ON
2	Input Indication	OFF	OFF	ON	OFF
3	Unsteady Input	OFF	OFF	ON	ON
4	Pressure Switch Open <2 minutes	OFF	ON	OFF	OFF
5	Pressure Switch Open > 2 minutes	OFF	ON	OFF	ON
6	Hot Compressor < 5 min. (or open sensor)	OFF	ON	ON	OFF
7	Hot Compressor > 5 min. (or open sensor)	OFF	ON	ON	ON
8	Option 1 < 5 minutes	ON	OFF	OFF	OFF
9	Option 1 > 5 minutes	ON	OFF	OFF	ON
10	Option 2 Open	ON	OFF	ON	OFF
11	Compressor Temp. Sensor Problem	ON	OFF	ON	ON
12	Outdoor temperature Sensor	ON	ON	OFF	OFF
13	Not Used	ON	ON	OFF	ON
14	Test Mode	ON	ON	ON	OFF
15	No Jumper in place Indication	ON	ON	ON	ON

**Code 7 – Hot Compressor > Five Minutes**

Code 7 indicates the compressor temperature exceeded its limit after running **more than** five minutes. Code 7 is stored.

**Code 8 – Option 1 < Five Minutes**

Code 8 occurs if the Option 1 safety device switch opens after the compressor runs **less than** five minutes. Code 8 is stored.

**Code 9 – Option 1 > Five Minutes**

Code 9 occurs if the Option 1 safety device switch opens after the compressor runs **more than** five minutes. Code 9 is stored.

**Code 10 – Option 2**

Code 10 is displayed if the Option 2 safety device switch opens. Code 10 is stored.

**Code 11 – Compressor Temperature Sensor Shorted**

This code indicates that the compressor temperature sensor wires have shorted together. Code 11 is stored.

**Code 12 – Outdoor Temperature Sensor**

This code indicates a problem with the operation of the outdoor temperature sensor. Code 12 is stored.

**Code 13 – Not Used**

This code may be used in future models of the two-speed control, but at this time has no function and, therefore, is not stored.

**Code 14 – Test Mode**

Code 14 does not indicate a problem. The control is in TEST mode when this code is displayed. See Mode Jumper Selections section.

**Code 15 – No Jumper in Place**

Code 15 is displayed when the mode jumper is not in place. Make sure jumper is placed securely across the selected set of pins for the appropriate mode of operation.

**SERVICE RELAY**

The control has a built-in service relay. This relay controls the thermostat service light or communicates with an alarm device. The relay signals the alarm device in such a manner that the alarm device can distinguish between a lock out and a non-lock out condition. The relay contacts are normally open when no problems or lock out conditions occur. A non-lock out condition is reported by closing the contacts for the duration of the next no-demand period. If the control goes into a lock out state, the relay will close and remain closed until the next loss of demand. If the service light on the room thermostat is connected to the service relay, the light will turn on if the control is in a lock out. It will not turn on if the control is detecting non-lock out problems. In order for the service relay to indicate only a lock out condition, one side of the relay must be wired to the alarm and the other side to Y2. During a simultaneous Y1 and Y2 demand with a non-lock out condition, the alarm will energize for a very short duration (.2 seconds). If both an alarm device and thermostat service lights are used, an additional external relay may be required depending on the thermostat used.

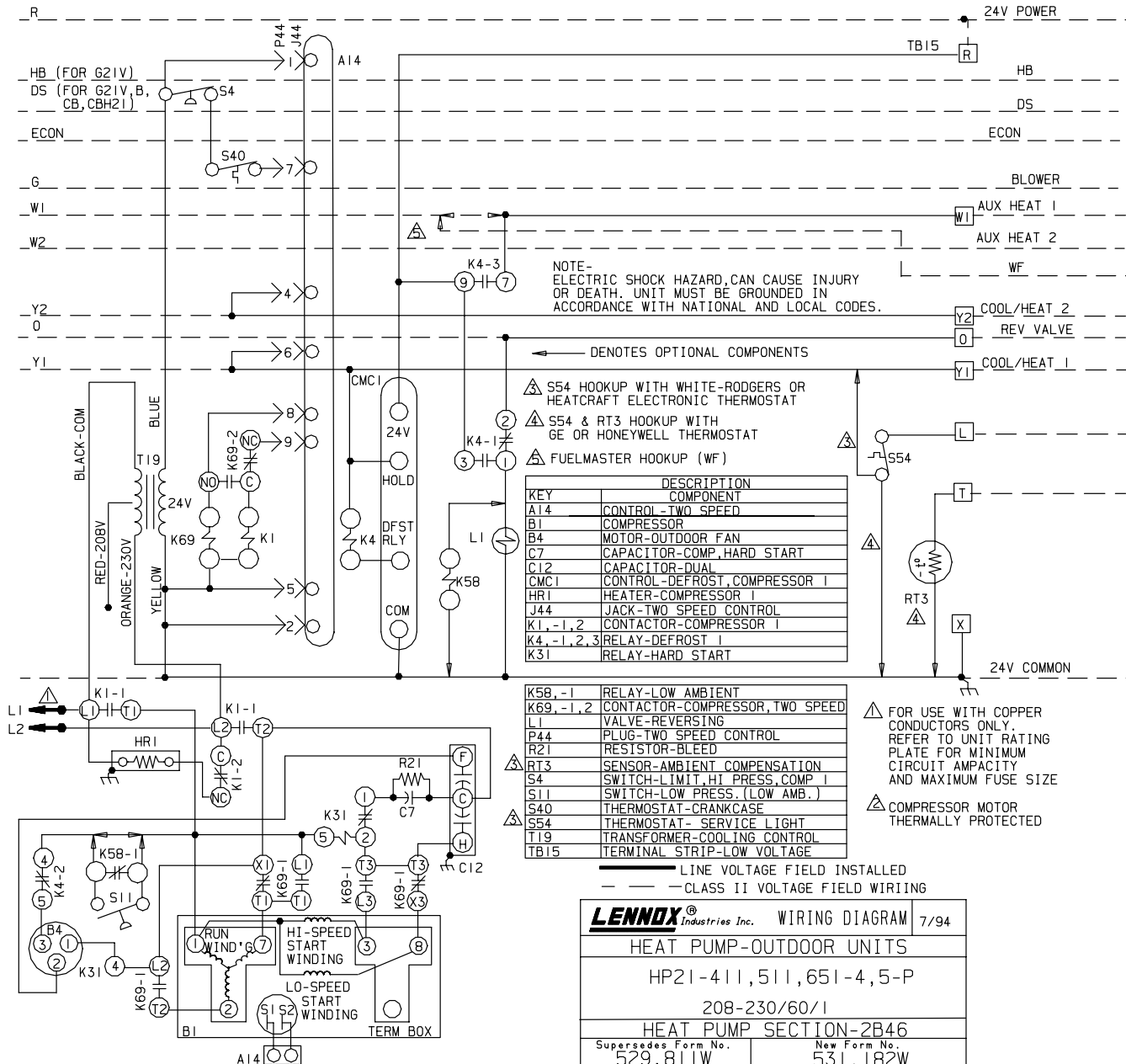
**OPTIONAL INPUTS**

The control has two optional inputs for additional protection devices. If options 1 or 2 are going to be used, move the three pin mini-jumper to the YES side. OPT 1 input will lock out the compressor on the third count. OPT 2 input will not lock out the compressor at any time, but will display and store the problem code (see Diagnostic code Table). These inputs are designed for normally closed switches connected to 24VAC.

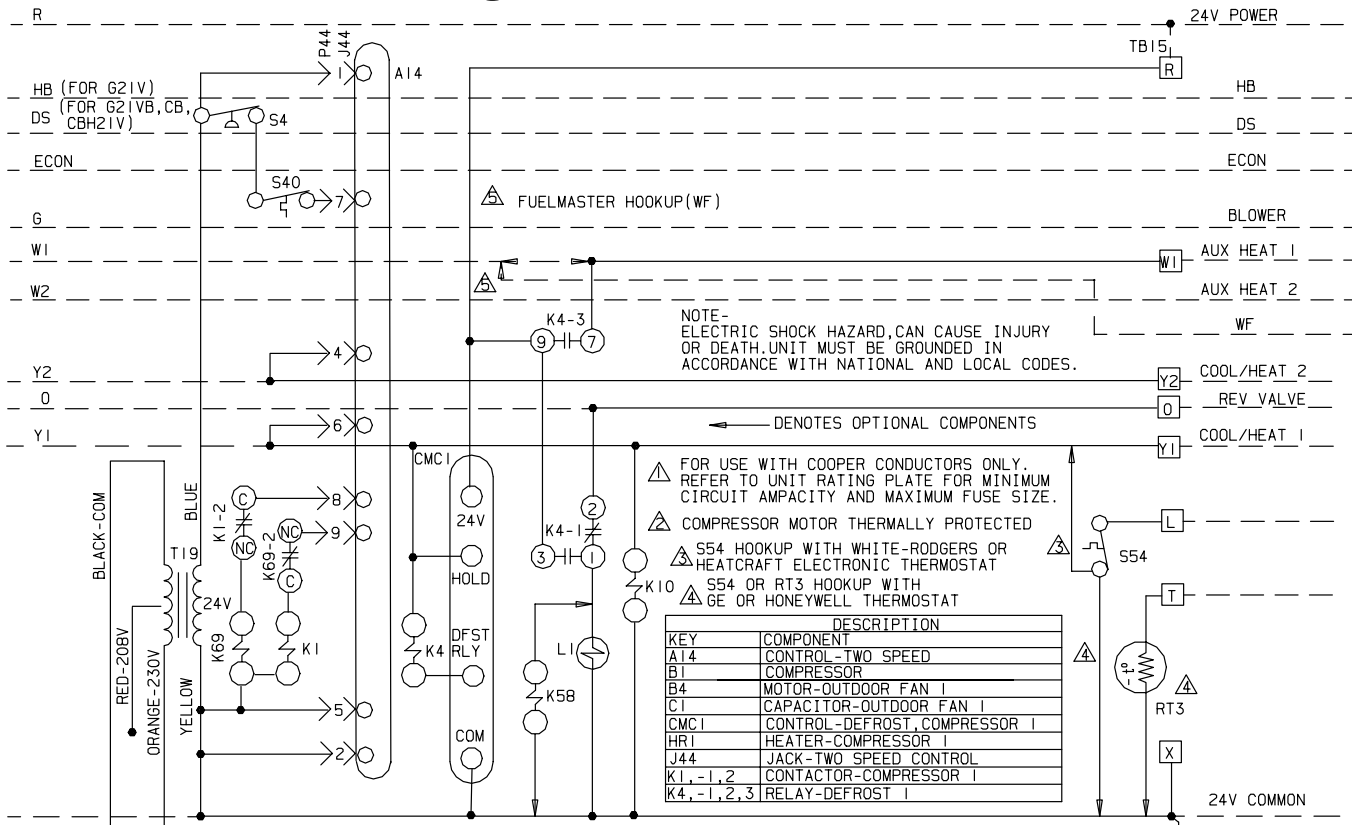
**⚠ CAUTION**

**Do not remove the jumpers unless additional protection controls are going to be installed. If OPT 1 jumper is not connected to the NO pin, the control will lock out the compressor. If OPT 2 is not connected to the NO pin, the display only shows the problem code.**

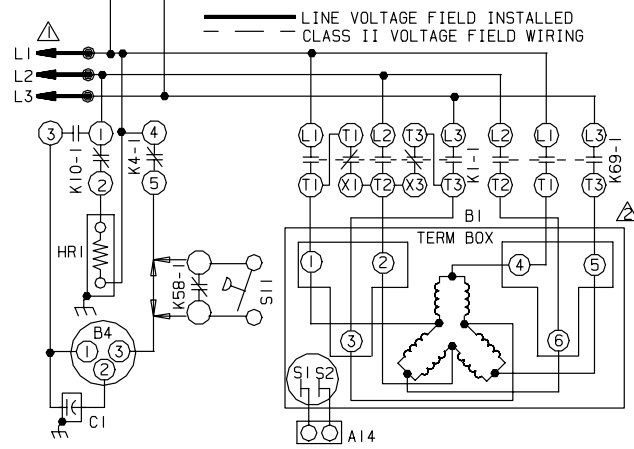
# HP21-4/-5 Wiring (Single Phase Units Shown)



# HP21-4/-5 Wiring (Three Phase Units Shown)



DESCRIPTION	
KEY	COMPONENT
A14	CONTROL-TWO SPEED
B1	COMPRESSOR
B4	MOTOR-OUTDOOR FAN I
C1	CAPACITOR-OUTDOOR FAN I
CMCI	CONTROL-DEFROST, COMPRESSOR I
HR1	HEATER-COMPRESSOR I
J44	JACK-TWO SPEED CONTROL
K1, -1, 2	CONTACTOR-COMPRESSOR I
K4, -1, 2, 3	RELAY-DEFROST I



K10, -1	CONTACTOR-OUTDOOR FAN
K58, -1	RELAY-LOW AMBIENT
K69, -1, 2	CONTACTOR-COMPRESSOR, TWO SPEED
L1	VALVE-REVERSING
P44	PLUG-TWO SPEED CONTROL
RT3	SENSOR AMBIENT COMPENSATION
S4	SWITCH-LIMIT, HI PRESS, COMP I
S1	SWITCH-LOW PRESS. (LOW AMB.)
S40	THERMOSTAT-CRANKCASE
S54	THERMOSTAT-SERVICE LIGHT
T19	TRANSFORMER-COOLING CONTROL
TB15	TERMINAL STRIP-LOW VOLTAGE

**LENNOX** Industries Inc. WIRING DIAGRAM 7/94

HEAT PUMP-OUTDOOR UNITS

HP21-413, 513, 653-4, 5-Y  
208-230/60/3

HEAT PUMP SECTION-2B47

Supersedes Form No.	New Form No.
	531, 183W

# NOTES