

HP23 SERIES UNITS

The HP23 is a high-efficiency residential split-system heat pump. Extra large outdoor coil, coil circuiting and high outdoor coil air volume result in a high SEER rating (minimum of 10.0). HP23-141 through HP23-510 units are designed for use with an expansion valve or RFCIII system in the indoor unit. HP23-651/653 units are designed for use with an expansion valve only in the indoor unit.

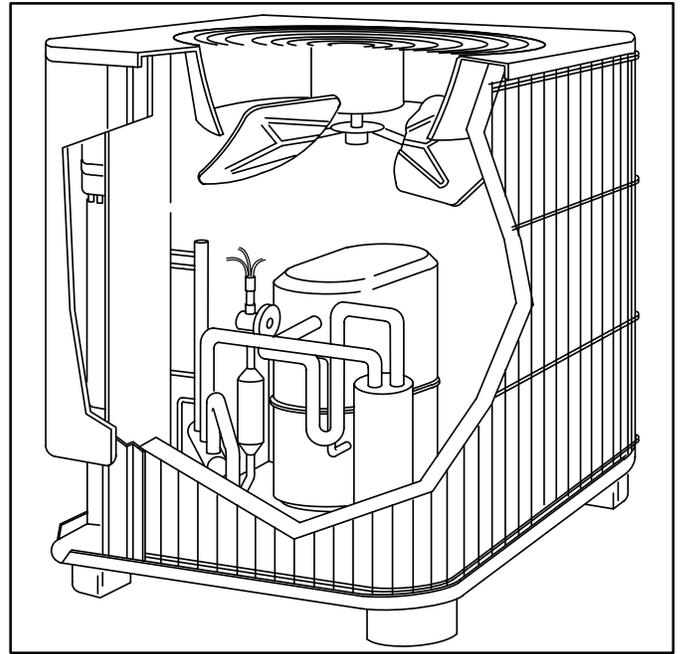
All compressors are hermetically sealed for trouble-free operation and long service life. Compressor components are spring mounted within the sealed housing. The compressor is installed in the unit on resilient rubber mounts to assure quiet, vibration-free operation. A built-in limit protects the compressor from excessive current and temperatures. A high pressure safety limit is furnished as standard. HP23-211 through HP23-650 models are furnished with crankcase heaters as standard equipment. The heater prevents liquid from accumulating in the compressor. The heater is temperature-actuated and operates only when required. A crankcase heater for HP23-141 units is optional, but suction accumulator is factory installed.

Several models are available in sizes ranging from 1 through 5 tons.

This manual is divided into sections which discuss major components refrigerant system, charging procedures, maintenance, and operation sequence.

Canadian specifications are marked (CAN).

All specifications in this manual are subject to change.



SPECIFICATIONS

Model No.			HP23-141	HP23-211	HP23-261	HP23-311
Condenser Coil	Net face area (sq. ft.)	Outer coil	12.60	12.60	12.60	14.70
		Inner coil	----	----	----	----
	Tube diameter (in.) & no. of rows		3/8 - 1	3/8 - 1	3/8 - 1	3/8 - 1
	Fins per inch		20	20	20	20
Condenser Fan	Diameter (in.) & no. of blades		20 - 3	20 - 3	20 - 3	20 - 3
	Motor hp		1/6	1/6	1/6	1/6
	Cfm		2630	2630	2630	2665
	Rpm		840	840	840	850
	Watts		210	210	210	210
*Refrigerant - 22 charge furnished			5 lbs. 3 oz.	5 lbs. 6 oz.	6 lbs. 2 oz.	7 lbs. 3 oz.
Liquid line (o.d. in.) connection (sweat)			**3/8	***3/8	***3/8	3/8
Suction line (o.d. in.) connection (sweat)			1/2	5/8	5/8	3/4

*Refrigerant charge sufficient for 20 ft. length of refrigerant lines.

**3/8" x 1/4" reducer furnished to adapt to 1/4 field fabricated line set.

***3/8" x 5/16" reducer furnished to adapt unit to 5/16" line set.

SPECIFICATIONS (contd.)

Model No.			HP23-411/HP23-413	HP23-461/HP23-463	HP23-511/HP23-513	HP23-651/HP23-653
Condenser Coil	Net face area (sq. ft.)	Outer coil	14.70	20	20.00	20.00
		Inner coil	3.9	---	6.3	19
	Tube diameter (in.) & no. of rows		3/8 — 1.3	3/8 — 1.0	3/8 — 1.3	3/8 — 2.0
	Fins per inch		20	20	20	20
Condenser Fan	Diameter (in.) & no. of blades		20 — 3	20 — 4	24 — 4	24 — 4
	Motor hp		1/6	1/4	1/4	1/4
	Cfm		2600	3980	3980	3950
	Rpm		845	840	830	825
	Watts		200	350	340	370
*Refrigerant — 22 charge furnished			7lbs. 14oz. / 7lbs. 5oz.	8 lbs. 3 oz.	9 lbs. 6 oz.	12 lbs. 13 oz.
Liquid line (o.d. in.) connection (sweat)			3/8	3/8	3/8	3/8
Suction line (o.d. in.) connection (sweat)			3/4	7/8	7/8	1-1/8

*Refrigerant charge sufficient for 20 ft. length of refrigerant lines.

ELECTRICAL DATA

Model No.		HP23-141	HP23-211	HP23-261	HP23-311-1	HP23-311-2	HP23-411	HP23-411-2
Line voltage data		208/230v 60hz-1ph						
Compressor	Rated load amps	5.0	8.1	10.9	12.2	13.7	16.3	16.2
	Power factor	.97	.99	.95	.97	0.99	.99	.91
	Locked rotor amps	26.3	49.0	61.0	71.0	75.0	86.7	96.0
Condenser Coil Fan Motor	Full load amps	1.1	1.1	1.1	1.1	1.1	1.1	1.1
	Locked rotor amps	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Rec. max. fuse or circuit breaker size (amps)		15	15	25	25	30	35	35
*Minimum circuit ampacity		7.4	11.3	14.8	16.4	18.2	21.5	21.3

*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.

ELECTRICAL DATA

Model No.		HP23-413		HP23-461-1	HP23-463-1	
Line voltage data — 60hz.		208/230 3ph	460v 3ph	208/230v 1ph	208/230v 3ph	460v 3ph
Compressor	Rated load amps	11.6	5.1	18.6	12.7	5.8
	Power factor	.88	.88	.94	.82	.82
	Locked rotor amps	65.1	32.8	102.0	91.0	42.0
Condenser Coil Fan Motor	Full load amps	1.1	0.6	1.7	1.7	1.1
	Locked rotor amps	1.7	0.9	3.1	3.1	2.2
Rec. max. fuse or circuit breaker size (amps)		25	15	40	30	15
*Minimum circuit ampacity		15.6	7.0	25.0	17.6	8.4

*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.

ELECTRICAL DATA

Model No.		HP23-511	HP23-513		HP23-651	HP23-653	
Line voltage data — 60 Hz		208/230v 1ph	208/230v 3ph	460v 3ph	208/230v 1ph	208/230v 3ph	460v 3ph
Compressor	Rated load amps	24.4	16.1	8.4	30.8	17.4	9.7
	Power factor	.98	.78	.78	.98	.78	.78
	Locked rotor amps	135.0	137.0	68.0	147.0	150.0	73.0
Condenser Coil Fan Motor	Full load amps	1.7	1.7	1.1	1.7	1.7	1.1
	Locked rotor amps	3.1	3.1	2.2	3.1	3.1	2.2
Rec. max. fuse or circuit breaker size (amps)		50	35	15	60	40	20
*Minimum circuit ampacity		32.2	21.9	10	40.2	23.5	13.3

*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 – UNIT INFORMATION

HP23 units are available in 1, 1-1/2, 2, 2-1/2, 3, 3-1/2, 4 and 5 ton capacities.

All major components (indoor blower/coil) 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.

II – UNIT COMPONENTS

Unit components are illustrated in figures 1 and 2.

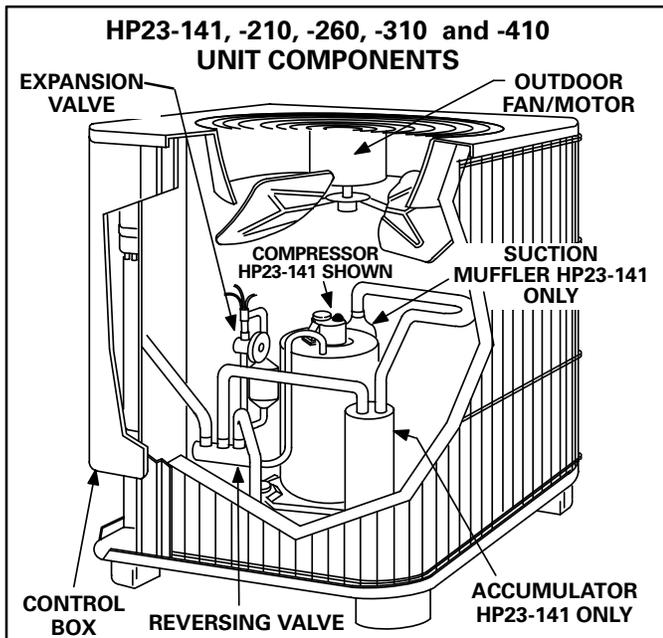


FIGURE 1

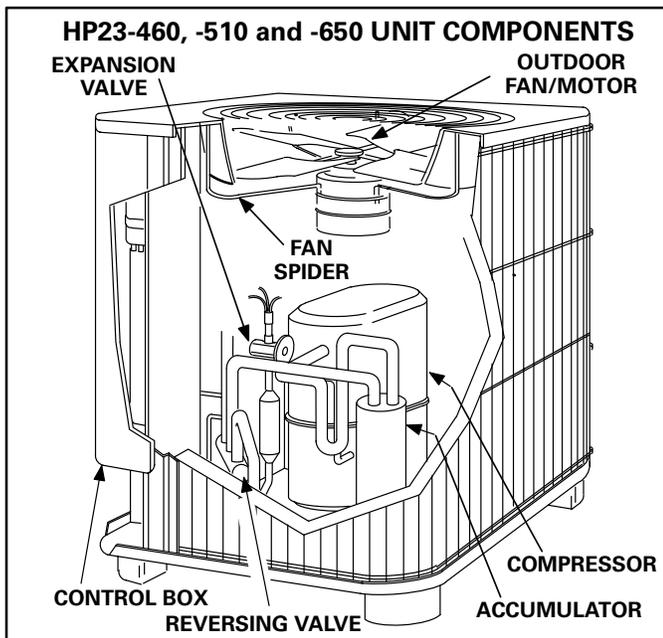


FIGURE 2

A – Control Box (Figures 3 and 4)

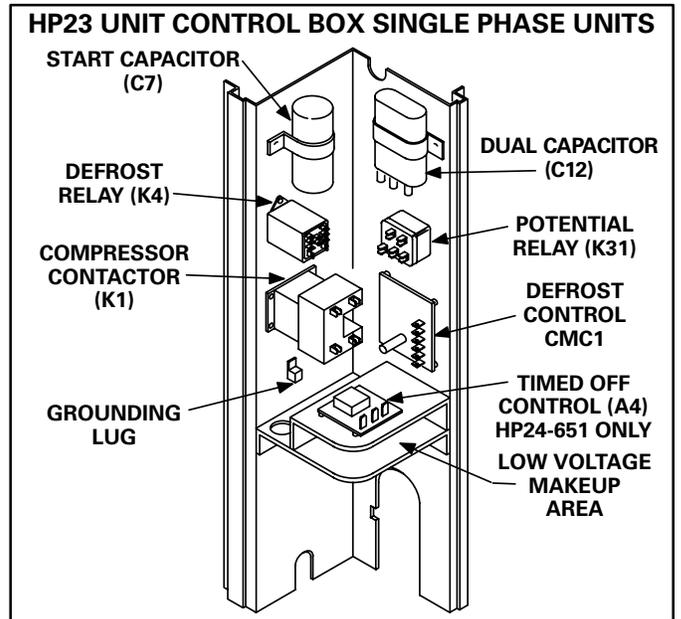


FIGURE 3

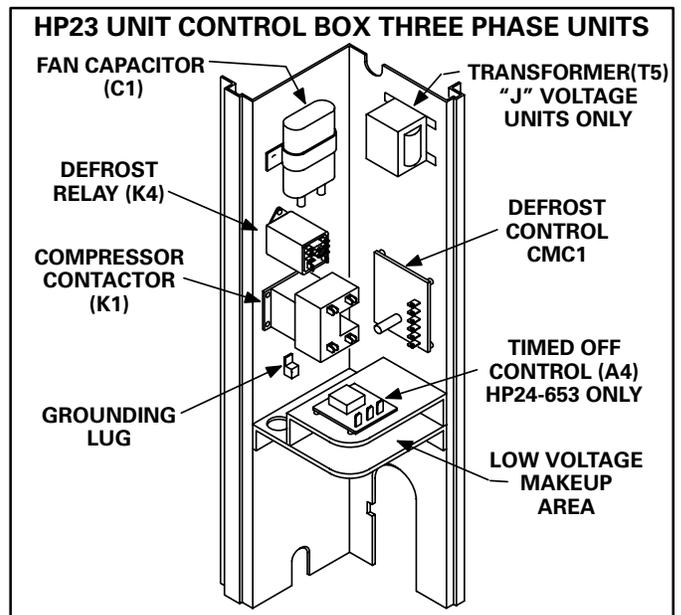


FIGURE 4

A low voltage make up area is provided for thermostat field wiring. Field thermostat wiring is made to color coded pigtail connections as illustrated in figure 5.

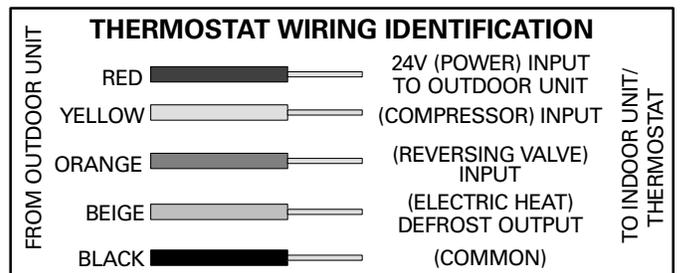


FIGURE 5

1 – Compressor Contactor K1

The compressor is energized by a contactor located in the control box. See figures 3 and 4. Contactors are SPST in single phase units and 3PST in three phase units. K1 is energized by the indoor thermostat terminal Y (24V). HP23 units are not equipped with a line voltage to 24V transformer. All 24 VAC controls are powered by the indoor unit. Refer to unit wiring diagram.

⚠ DANGER



Shock Hazard

All single phase HP23 units use single-pole contactors. One leg of compressor, capacitor and outdoor fan are connected to line voltage at all times. Potential exists for electrical shock resulting in injury or death. Remove all power at disconnect before servicing.

Can cause personal injury or death.

2 – Dual Capacitor C12

The compressor and fan in single phase units use permanent split capacitor motors. The capacitor is located inside the unit control box (see figure 3). A single “dual” capacitor (C12) is used for both the fan motor and the compressor (see unit wiring diagram). The fan side and the compressor side of the capacitor have different MFD ratings. See table 1 for dual capacitor ratings.

TABLE 1

HP23 (C12) DUAL CAPACITOR RATING				
Unit	Terminal	MFD	VAC	
HP23-141	FAN	5	370	
	HERM	25		
HP23-211/261	FAN	5		
	HERM	35		
HP23-311-1/411	FAN	5		
	HERM	45		
HP23-311-2	FAN	5		
	HERM	35		
HP23-411-2	FAN	5		
	HERM	40		
HP23-461	FAN	10		440
	HERM	40		
HP23-511/651	FAN	10		
	HERM	60		

3 – Potential Relay K31 (Start)

All single phase units use a potential relay which controls the operation of the starting circuit. The potential relay is located inside the unit control box (see figure 3). The relay is normally closed when contactor K2 is de-energized. When K1 energizes, the compressor immediately begins start-up. K31 remains closed during compressor start-up and start capacitor C7 remains in the circuit. As the compressor gains speed, K31 is energized. When K31 energizes, the contacts open and start capacitor C7 is taken out of the circuit.

4 – Start Capacitor C7

All single phase units use a start capacitor (C7). C7 is located inside the unit control box (see figure 3). C7 is wired in parallel with the compressor side of the dual capacitor. See table 2 for start capacitor ratings.

TABLE 2

HP23 START CAPACITOR RATING (C7)		
Unit	MFD	VAC
HP23-141/211/261	88-108	250
HP23-311-1/411	88-108	330
HP23-311-2	145-175	330
HP23-411 (CAN)	88-108	250
HP23-411-2/461/511	189-227	330
HP23-651	270-324	330

5 – Timed Off Control A4 (-651 / -653 only)

A time delay (A4) located in the control box is used on the HP23-650-2 series. See figures 3 and 4. The time delay is electrically connected between thermostat terminal Y and the compressor contactor. After cooling demand has stopped, A4 begins counting for five minutes. During the timing period, A4 disables the compressor contactor. Thermostat demand will have no effect on the unit. The unit cannot operate. After the delay, the compressor contactor can be energized.

⚠ DANGER

Do not attempt to repair this control. Unsafe operation will result. If the control has failed, replace the control.

6 – Fan Capacitor C1

The fan in three-phase units uses a single phase permanent split capacitor motor. A single capacitor C1 is used for the fan motor. C1 is located inside the unit control box (see figure 4). Table 3 shows the ratings of C1.

TABLE 3

HP23 FAN CAPACITOR RATING (C1)		
Unit	MFD	VAC
HP23-413Y,G	5	370
HP23-463/513/653G HP23-513,653J	7.5	370
HP23-463/513/653Y	10	370

7 – Transformer T5

Transformer T5 is used on all “J” voltage units. T5 is used as a step-down transformer for fan B4. T5 is rated at 3.4 VA with a 575 volt primary and a 460 volt secondary.

8 – Defrost Relay K4

The defrost relay controls defrost. The relay is a 3PDT relay powered 24 VAC from the thermostat. K4 is enabled during both cooling and heating modes (except emergency heat). It is only powered when the defrost control is calling for defrost. When energized, the reversing valve and indoor auxiliary heat are energized. Simultaneously, the outdoor fan is de-energized. K4 latches in for the duration of the defrost period. Refer to unit wiring diagram and operation sequence in the back of this manual.

9 – Defrost Control CMC1

The CMC1 defrost control (figure 6) is a solid state control manufactured by Hamilton Standard. The control provides automatic switching from normal heating operation to defrost mode and back. The control provides 14 minute defrost periods at 30, 60 or 90 minute field changeable intervals. The control monitors thermostat demand and “holds” the timer in place between thermostat demand. A set of diagnostic pins are also provided for troubleshooting the unit.

The control contains a solid state timer which switches an external defrost relay through 1/4” male spades mounted on the control’s circuit board. When the defrost thermostat closes (call for defrost), the defrost timer initiates a 30, 60 or 90 minute (depending on how the control is preset) timing sequence. If the defrost thermostat remains closed when the timing sequence ends, the defrost relay is energized and defrost begins.

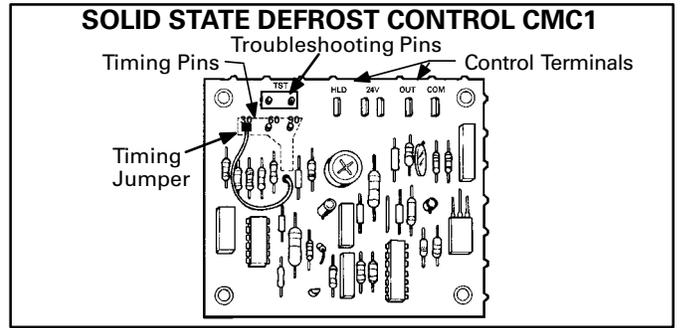


FIGURE 6

A defrost period can last up to 14 minutes and can be terminated two ways. If the defrost thermostat does not open within 14 minutes after defrost begins, the timer will de-energize the defrost relay and the unit will resume normal operation. If the defrost thermostat opens during the 14 minute defrost period, the defrost relay is de-energized and the unit resumes normal operation. Refer to figure 7.

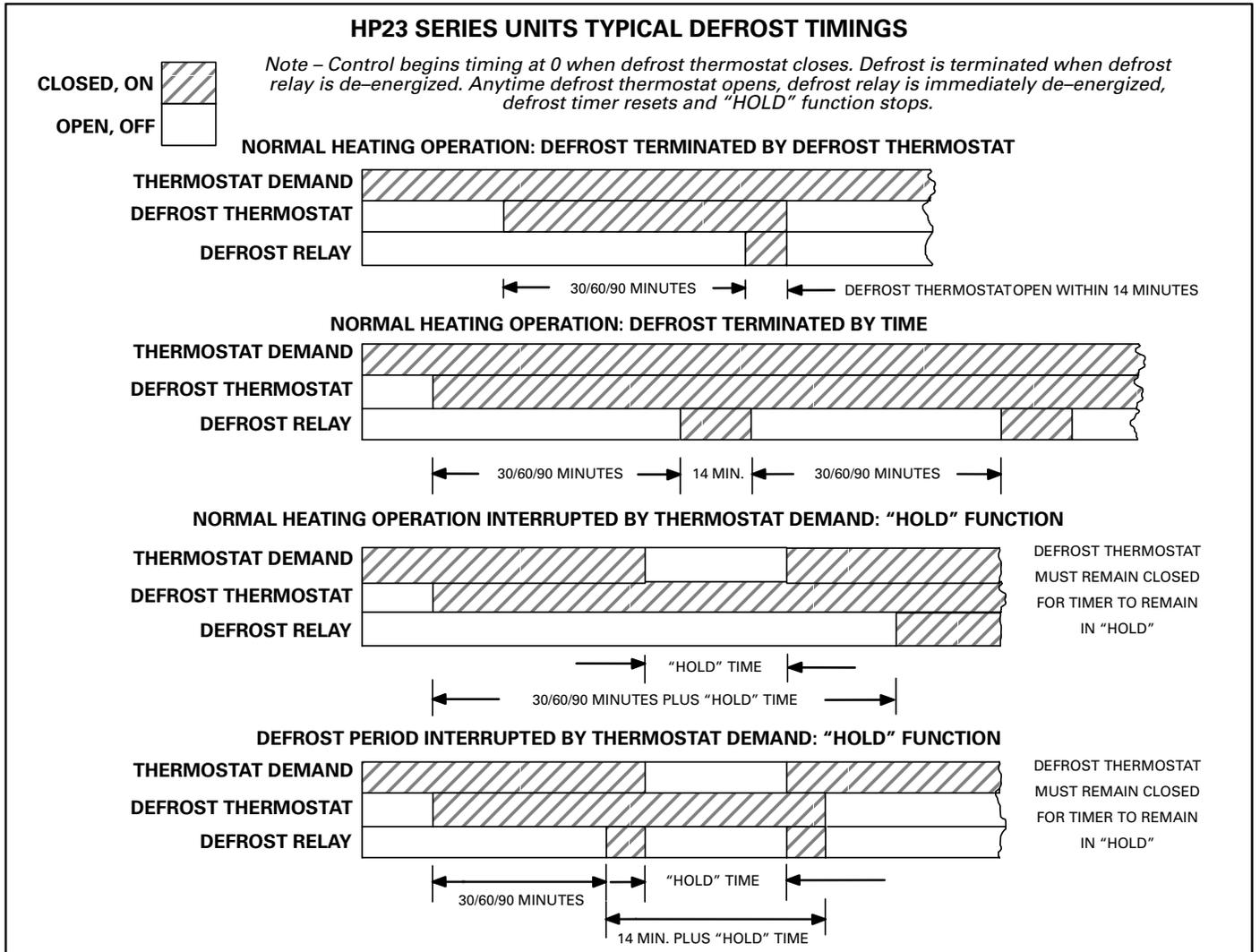


FIGURE 7

Defrost Control Components

1– Timing Pins 30, 60, 90

Each of these pins provides a different timed interval between defrosts. A jumper connects the pins to circuit board pin W1. Table 4 shows the timings of each pin. The defrost interval can be field changed to 30, 60 or 90 minutes. The defrost period (14 minutes) cannot be changed. To change the interval between defrosts, simply remove the jumper from the pin it is connected to and reconnect the jumper to one of the other available pins (see figure 8).

TABLE 4

CMC1 DEFROST CONTROL TIMINGS	INTERVAL BETWEEN DEFROSTS WITH JUMPER CONNECTED TO:			DEFROST TIME
	30	60	90	
NORMAL OPERATION	30 ± 3 MIN.	60 ± 6 MIN.	90 ± 9 MIN.	14 ± 1.4 MIN.
"TST" PINS JUMPER TOGETHER	7 ± 0.7 SEC.	14 ± 1.4 SEC.	21 ± 2.1 SEC.	3.3 ± 0.3 SEC.

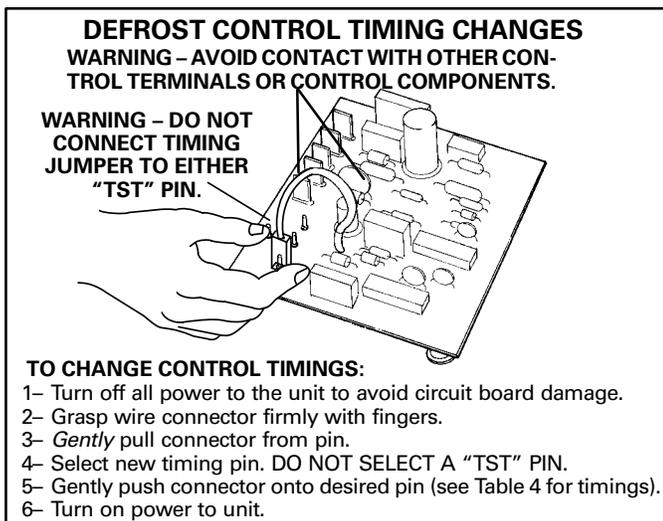


FIGURE 8

2– Timing Jumper

The timing jumper is a factory installed jumper on the circuit board used to connect pin W1 to one of the three timing pins. The jumper may be connected to any one of the timing pins but must never be connected to either of the "TST" pins. See Caution below.

CAUTION

Do not connect timing jumper to either "TST" pin. "TST" pins are used only during a test and must not connect with any of the timing pins. Control damage will result.

3– "COM" Terminal

Terminal "COM" provides 24VAC Common.

4– "HLD" Terminal

Terminal "HLD" holds the internal timer in place between thermostat demands and allows the unit to continue timing upon resumption of thermostat demand. Terminal "HLD" is connected directly to thermostat demand.

NOTE – Hold function operates between thermostat demands only when defrost thermostat is closed. This is the only time that the timer is operating.

5– "TST" Pins

Each board is equipped with a set of test pins for use in troubleshooting the unit. When jumpered together, these pins reduce the control timing to about 1/256 original time (see table 4 and figure 9).

IMPORTANT

Control will begin test mode only if normal load is applied to control terminals. Do not attempt to operate or test control out of unit.

DEFROST CONTROL TEST MODE

WARNING – AVOID CONTACT WITH OTHER CONTROL TERMINALS OR CONTROL COMPONENTS.

TO PLACE CONTROL IN TEST MODE:

- 1– Turn off all power to avoid damaging the circuit board.
- 2– Make sure all control terminals are connected as shown on unit wiring diagram before attempting to place control in test mode. See NOTE below.
- NOTE – Control will not go into test mode when disconnected from unit. Unit load must be applied to control terminals before the control will go into test mode.*
- 3– Connect jumper to "TST" pins as shown.
- 4– Turn indoor thermostat to heat mode and adjust to highest temperature setting.
- 5– Turn on power to unit.
- 6– See Table 4 for control timings in "TST" mode.
- 7– Be sure to turn off power and remove jumper when test is complete. Turn on power and re-adjust thermostat.

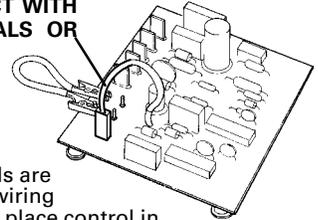


FIGURE 9

6– "24V" Terminal

Terminal "24V" receives 24VAC from the control transformer through the defrost thermostat. This terminal powers the control's internal timer and relays. Terminal "24V" is powered only when there is a call for defrost (defrost thermostat closed). The timer begins timing at 0 only after terminal "24V" receives power.

7– "OUT" Terminal

Terminal "OUT" controls defrost when connected to one side of the defrost relay coil. An internal relay connected to terminal "OUT" closes to allow external defrost relay to energize and initiate defrost. At the end of the defrost period, the internal relay connected to terminal "OUT" opens to de-energize the external defrost relay.

B – Compressor

All units except for the -141 units utilize a conventional reciprocating compressor. Table 5 shows the specifications of compressors used in HP23 series units.

TABLE 5

HP23 COMPRESSOR SPECIFICATIONS					
Unit	Voltage	Phase	LRA	RLA	Oil fl.oz.
HP23-141	208/230	1	26.3	4.8	15**
HP23-211	208/230	1	49	6.8	32*
HP23-261	208/230	1	61	9.2	32*
HP23-311-1	208/230	1	71.0	11.7	32*
HP23-311-2	208/230	1	75.0	13.7	45*
HP23-411	208/230	1	86.7	14.2	54*
HP23-411-2	208/230	1	96	16.2	55*
HP23-413	208/230	3	65.1	9.2	54*
HP23-413	460	3	32.8	4.6	54*
HP23-411 (CAN)	208/230	1	94	14.5	40*
HP23-413 (CAN)	208/230	3	78	9.4	40*
HP23-413 (CAN)	460	3	40	4.8	40*
HP23-461	208/230	1	102	20.4	55*
HP23-463	208/230	3	91	14.0	55*
HP23-463	460	3	42	6.4	55*
HP23-511	208/230	1	135	19.0	65*
HP23-513	208/230	3	137.0	13.0	65*
HP23-513	460	3	69.0	6.5	65*
HP23-513	575	3	58.0	5.2	65*
HP23-651	208/230	1	147	24.0	65*
HP23-653	208/230	3	150	16.0	65*
HP23-653	460	3	73	8.0	65*
HP23-653	575	3	62.0	6.4	65*

*Shipped with conventional white oil (Sontex 200LT) or 3GS. 3GS oil may be used if additional oil is required.

**Shipped with 60% Zerol 300 – 40% Sontex 200LT. Zerol 300 may be used if additional oil is required.

1 – Rotary Compressor (-141 Units Only)

HP23-141 units utilize a hermetically sealed rotary-type compressor manufactured by Tecumseh Products. It is illustrated in figure 10.

The compressor has four moving parts: a rotor shaft, eccentric, roller and a blade. See figure 11.

The compressor rotor shaft is attached directly to the compressor motor. The rotor shaft is permanently attached to an eccentric. The eccentric is inside the roller and as the eccentric rotates, the roller rotates. The spring loaded blade is in continuous contact with the roller. The contact and a thin layer of oil form a seal separating the suction port from the discharge port at all times.

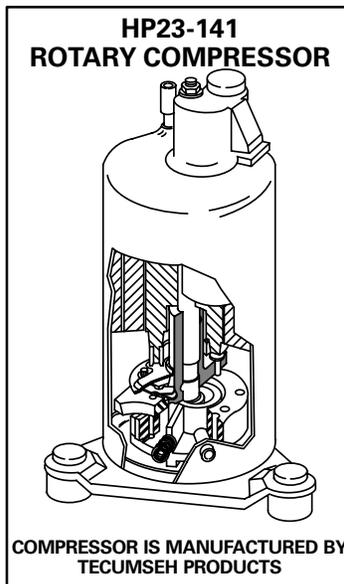


FIGURE 10

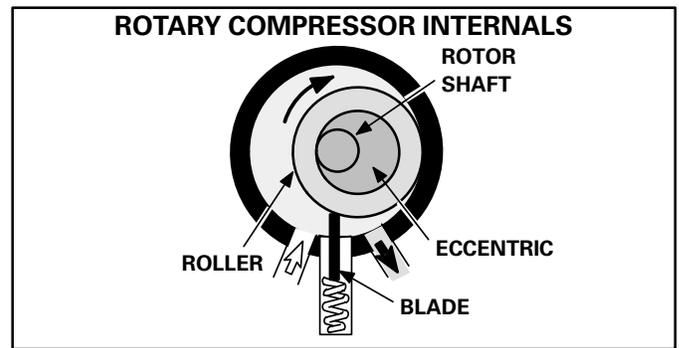


FIGURE 11

Figure 12 illustrates the four steps in a rotary compressor's continuous intake cycle. The spring-loaded blade is compressed fully at the beginning of an exhaust cycle. At this instant the compression is beginning (1). The roller rotates and compression continues (2). The suction port is always separated from the discharge port (3). Intake continues and the compressed vapor is discharged (4).

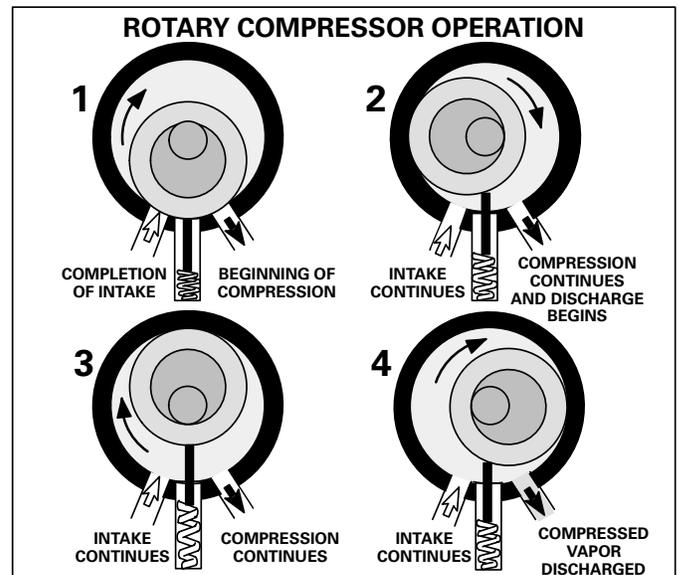


FIGURE 12

a – Suction Muffler (-141 Units Only)

All HP23-141 units are equipped with a suction muffler that is externally mounted on the compressor shell and attached to the suction line. The muffler contains two wire mesh filters for added compressor protection. Refer to figures 1 and 22.

2 – Accumulator

All HP23-141, -460, -510 and -650 units are equipped with an accumulator that is mounted in the suction line. The accumulator protects the compressor from liquid slugging. Refer to figures 1 and 23.

3 – Compressor Cover (Figure 13)

A compressor cover constructed of vinyl-faced fiberglass is used on all HP23-261 through -650 units. The cover provides an acoustic barrier. The cover slides over the compressor and is held secure with velcro™ straps. Slits are provided for installation around the discharge and suction lines.

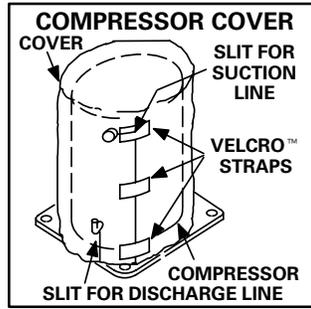


FIGURE 13

4 – Crankcase Heater

A crankcase heater is used on all HP23-211 through HP23-650 models. The well-mounted insertion-type heater is self-regulating. See table 6 for crankcase heater specifications. Crankcase heater is optional on -141 units.

TABLE 6

HP23 CRANKCASE HEATER RATINGS	
Unit	Rating (Watts)
HP23-211/-261/-311	19 watts
HP23-411/-413	27 watts
HP23-411/-413 (CDN)	30 watts
HP23-411-2,-461,-510 and -650	40 watts

C – Outdoor Fan Motor

All units use single-phase PSC fan motors which require a run capacitor. In all units, the outdoor fan is controlled by the compressor contactor and defrost relay.

ELECTRICAL DATA tables in this manual show specifications for outdoor fans used in HP23s.

Two different mounting arrangements are used (fan up and fan motor up) see figures 14 and 15.

Access to the outdoor fan motor on all units is gained by removing the six screws securing the fan guard. See figures 14 and 15. The outdoor fan motor is attached to the fan guard on "motor up" units and is removed with the fan guard. See figure 14.

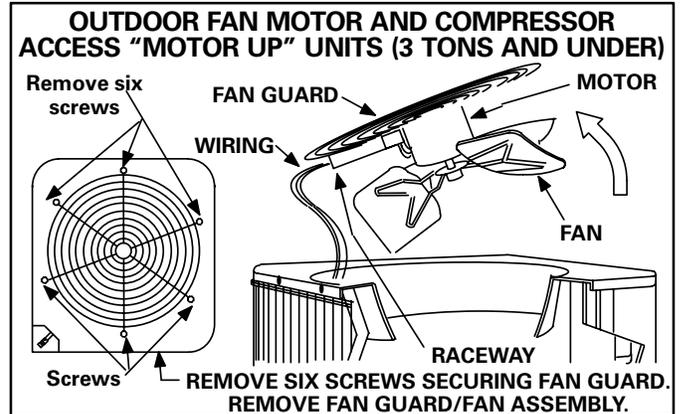


FIGURE 14

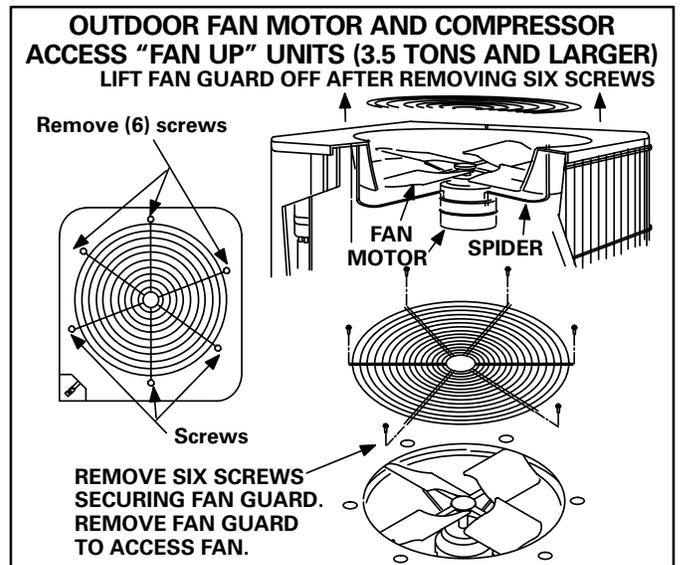


FIGURE 15

D – Reversing Valve L1 and Solenoid

A refrigerant reversing valve with electromechanical solenoid is used to reverse refrigerant flow during unit operation. The reversing valve requires no maintenance. It is not rebuildable. If the reversing valve has failed, it must be replaced.

If replacement is necessary, access reversing valve by removing the control box. HP23-460 through -650 series units have a filler panel that can also be removed for reversing valve access. Refer to figure 16.

HP23 SERIES REVERSING VALVE ACCESS (CONTROL BOX REMOVAL)

NOTE-UNIT ELECTRICAL COMPONENTS AND PLUMBING HAVE BEEN DELETED FOR CLARITY

- 1 - Turn off all power to unit and remove control box cover. If rigid conduit is used to route wiring to outdoor unit, disconnect power leads at contactor, remove hardware attaching conduit to control box and move conduit out of the way. **DISCHARGE CAPACITORS.** Thermostat wiring can be left intact.
- 2 - Label and disconnect the three fan motor leads from control box. Remove unit top. Note-fan guard/fan/fan motor is left intact.
- 3 - On HP23-460 thru -650 models remove panel. Do not disconnect plumbing.
- 4 - Remove four screws securing plate to control box.
- 5 - Disconnect and label compressor and crankcase leads. Pull leads into compressor compartment. Disconnect reversing valve wiring harness from reversing valve coil. Disconnect High-pressure limit switch/rexet button.
- 6 - Remove four screws securing control box to outdoor coil. Remove control box by lifting straight up and out of unit.
- 7 - Reverse procedures for reassembly.

FIGURE 16

III - REFRIGERANT SYSTEM

Refer to figures 17, 18 and 19 for refrigerant flow in the heating and cooling modes. The reversing valve is energized during cooling demand and during defrost.

HP23 LIQUID LINE COMPONENTS

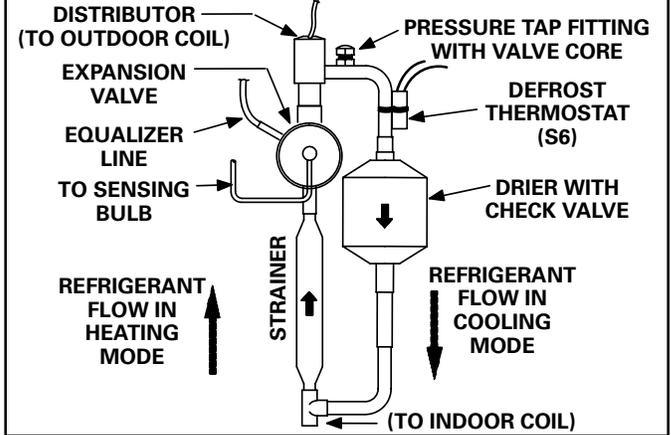


FIGURE 17

HP23 COOLING CYCLE (SHOWING GAUGE MANIFOLD CONNECTIONS)

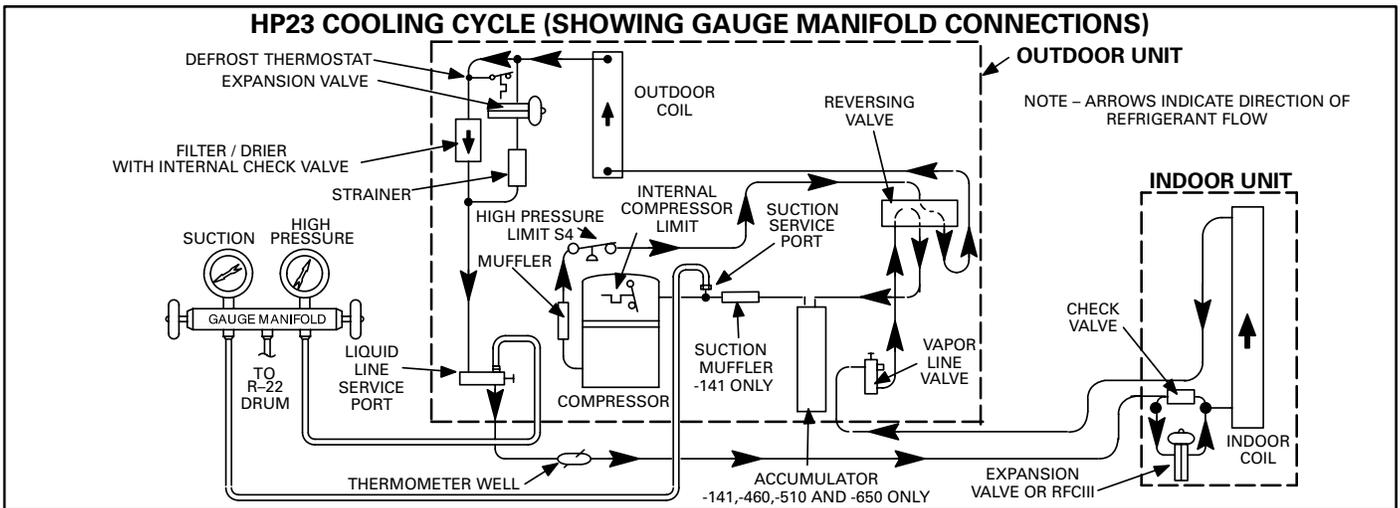


FIGURE 18

HP23 HEATING CYCLE (SHOWING GAUGE MANIFOLD CONNECTIONS)

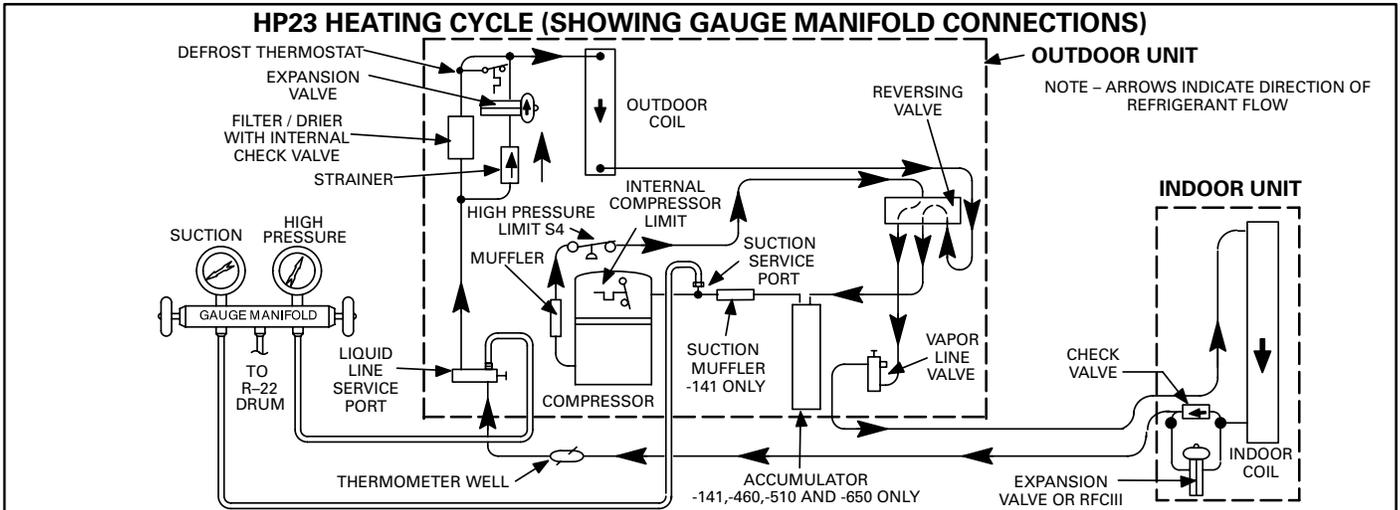


FIGURE 19

A – Service Valves

The liquid line and vapor line service valves and gauge ports are accessible from outside of the unit. Full service liquid and vapor line valves are used. See figures 20 and 21. The service ports are used for leak testing, evacuating, charging and checking charge.

1 – Liquid Line Service Valve

A full-service liquid line valve made by one of several manufacturers may be used. All liquid line service valves function the same way, differences are in construction. Valves manufactured by Parker are forged assemblies. Valves manufactured by Primore are brazed together. Valves are not rebuildable. If a valve has failed it must be replaced. The liquid line service valve is illustrated in figure 20.

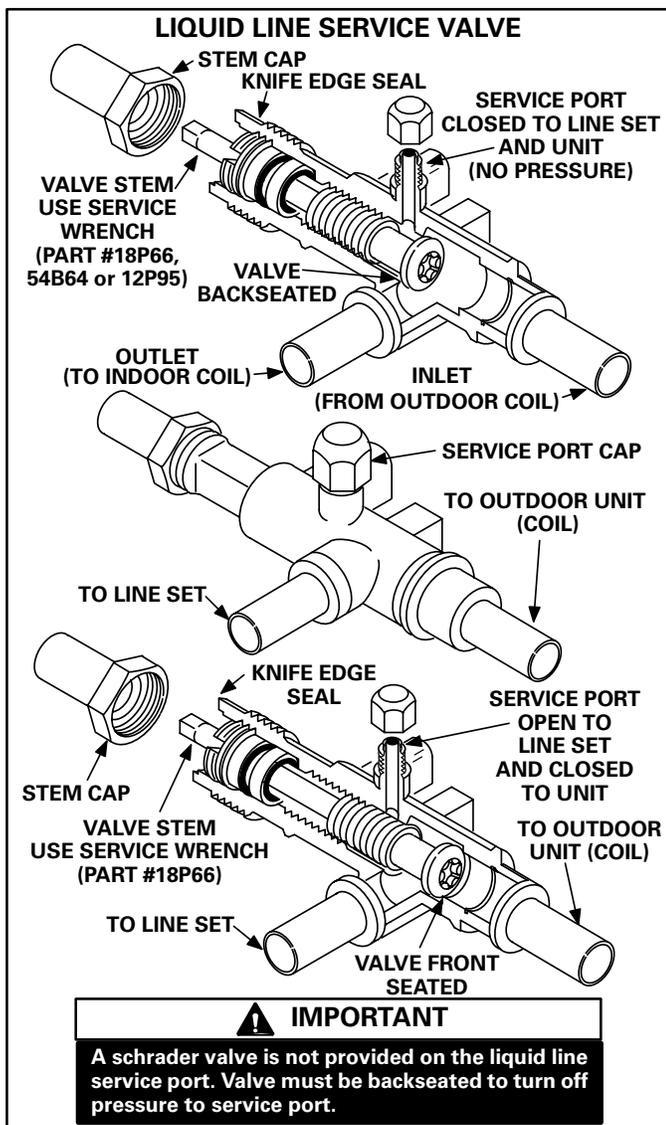


FIGURE 20

The valve is equipped with a service port. There is no schrader valve installed in the liquid line service port. A service port cap is supplied to seal off the port.

The liquid line service valve is a front and back seating valve. When the valve is backseated the service port is not pressurized. The service port cap can be removed and gauge connections can be made.

⚠ CAUTION

The service port cap is used to seal the liquid line service valve. Access to service port requires backseating the service valve to isolate the service port from the system. Failure to do so will cause refrigerant leakage.

⚠ IMPORTANT

A schrader valve is not provided on the liquid line service port. Valve must be backseated to turn off pressure to service port.

To Access Service Port:

- 1 – Remove the stem cap. Use a service wrench (part #18P66, 54B64 or 12P95) to make sure the service valve is backseated.
- 2 – Remove service port cap and connect high pressure gauge to service port.
- 3 – Using service wrench, open valve stem (one turn clockwise) from backseated position.
- 4 – When finished using port, backseat stem with service wrench. Tighten firmly.
- 5 – Replace service port and stem cap. Tighten finger tight, then tighten an additional 1/6 turn.

To Close Off Service Port:

- 1 – Using service wrench, backseat valve.
 - a – Turn stem counterclockwise.
 - b – Tighten firmly.

To Open Liquid Line Service Valve:

- 1 – Remove the stem cap with an adjustable wrench.
- 2 – Using service wrench, backseat valve.
 - a – Turn stem counterclockwise until backseated.
 - b – Tighten firmly.
- 3 – Replace stem cap, finger tighten then tighten an additional 1/6 turn.

To Close Liquid Line Service Valve:

- 1 – Remove the stem cap with an adjustable wrench.
- 2 – Turn the stem in clockwise with a service wrench to front seat the valve. Tighten firmly.
- 3 – Replace stem cap, finger tighten then tighten an additional 1/6 turn.

2 – Vapor Line Service Valve

A full service non-backseating vapor line service valve is used on all HP23 series units. Different manufacturers of valves may be used. All vapor line service valves function the same way, differences are in construction.

Valves manufactured by Parker are forged assemblies. Primore and Aeroquip valves are brazed together. Valves are not rebuildable. If a valve has failed it must be replaced. The vapor line service valve is illustrated in figure 21.

The valve is equipped with a service port. A schrader valve is factory installed. A service port cap is supplied to protect the schrader valve from contamination and assure a leak free seal.

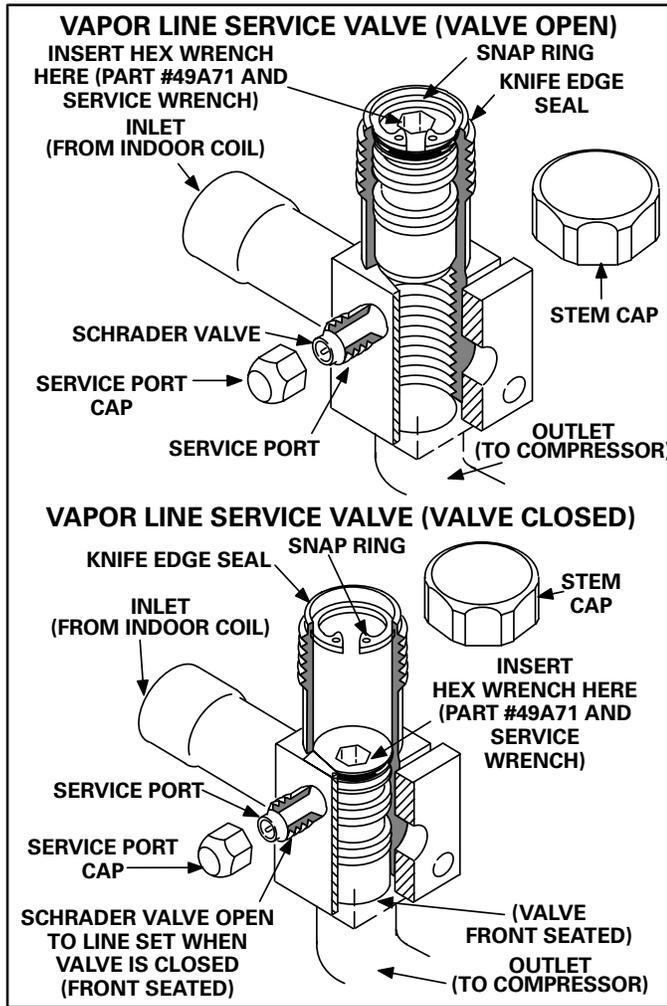


FIGURE 21

To Access Schrader Port:

- 1 – Remove service port cap with an adjustable wrench.
- 2 – Connect gauge to the service port.
- 3 – When testing is completed, replace service port cap. Tighten finger tight, then tighten an additional 1/6 turn.

To Open Vapor Line Service Valve:

- 1 – Remove stem cap with an adjustable wrench.
- 2 – Using service wrench and 5/16" hex head extension (part #49A71) back the stem out counterclockwise until the valve stem just touches the retaining ring.

⚠ DANGER

Do not attempt to backseat this valve. Attempts to backseat this valve will cause snap ring to explode from valve body under pressure of refrigerant. Personal injury and unit damage will result.

- 3 – Replace stem cap tighten firmly. Tighten finger tight, then tighten an additional 1/6 turn.

To Close Vapor Line Service Valve:

- 1 – Remove stem cap with an adjustable wrench.
- 2 – Using service wrench and 5/16" hex head extension (part #49A71) turn stem in clockwise to seat the valve. Tighten firmly.
- 3 – Replace stem cap. Tighten finger tight, then tighten an additional 1/6 turn.

B – Plumbing

See figures 22 and 23 for unit refrigerant components. Field refrigerant piping consists of liquid and vapor lines from the outdoor unit (sweat connections). Use Lennox L10 series line sets as shown in table 7 or field fabricated refrigerant lines.

TABLE 7

LINE SET SPECIFICATIONS				
Condensing Unit Model No.	Line Set Model No.	Length of Vapor & Liq. Lines (ft.)	Liquid Line (o.d. ft.)	Vapor Line (o.d. ft.)
HP23-141	*Not Available	— — —	**1/4	1/2
HP23-211	L10-21-20	20	***5/16	5/8
	L10-21-25	25	***5/16	5/8
HP23-261	L10-21-35	35	***5/16	5/8
	L10-21-50	50	***5/16	5/8
HP23-311	L10-41-20	20	3/8	3/4
	L10-41-30	30	3/8	3/4
HP23-410	L10-41-40	40	3/8	3/4
	L10-41-50	50	3/8	3/4
HP23-460	L10-65-30	30	3/8	7/8
	L10-65-40	40	3/8	7/8
HP23-510	L10-65-50	50	3/8	7/8
HP23-651	*Not Available	— — —	3/8	1-1/8

*Field Fabricate
 **3/8" x 1/4" reducer furnished to adapt unit to 1/4 field fabricated line set.
 *** 3/8" x 5/16" reducer furnished to adapt unit to 5/16" line set.

IV – CHARGING

Unit charge is based on a matching indoor coil and outdoor coil with a 20 foot (6096mm) line set depending on date of manufacture. For varying lengths of line set, refer to table 8.

TABLE 8

Liquid Line Set Diameter	Ounce per 5 foot (ml per mm) adjust from 20 ft. (6096mm)*
1/4 in. (6 mm)	1 ounce per 5 feet (30 ml per 1524 mm)
5/16 in. (8mm)	2 ounce per 5 feet (60 ml per 1524 mm)
3/8 in. (10 mm)	3 ounce per 5 feet (90 ml per 1524 mm)

*If line set is greater than 20 ft. (6.10m) add this amount. If line set is less than 20 ft. (6.10m) subtract this amount

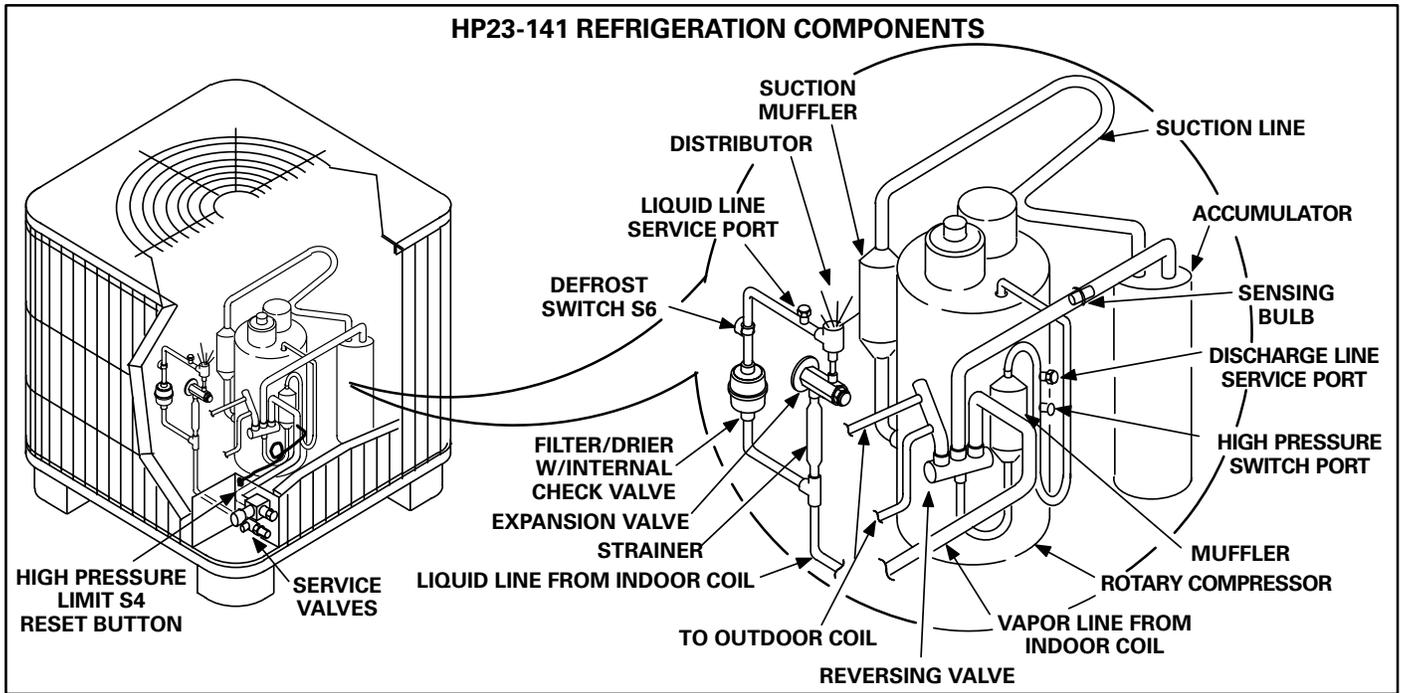


FIGURE 22

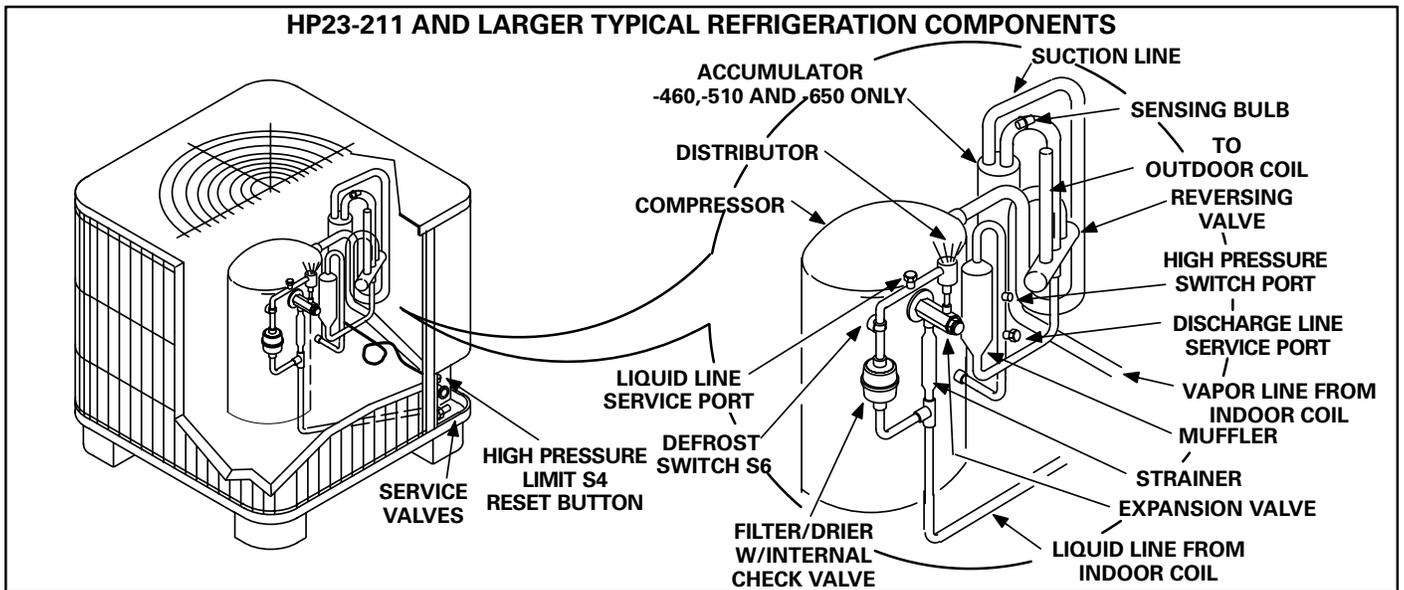


FIGURE 23

A – Pumping Down System

⚠ CAUTION
 Deep vacuum operation (operating compressor below 0 psig) can cause internal fusite arcing resulting in a damaged or failed compressor. This type of damage will result in denial of warranty claim.

The system may be pumped down when leak checking the line set and indoor coil or making repairs to the line set or indoor coil.

- 1- Attach gauge manifold.
- 2- Front seat (close) liquid line valve.
- 3- Start outdoor unit in cooling mode.
- 4- Monitor suction gauge. Stop unit when 0 psig. is reached.
- 5- Front seat (close) suction line valve.

B – Evacuating the System

⚠ IMPORTANT

The compressor should never be used to evacuate a refrigeration or air conditioning system.

- 1– Attach gauge manifold. Connect vacuum pump (with vacuum gauge) to center port of gauge manifold. With both manifold service valves open, start pump and evacuate indoor coil and refrigerant lines.

⚠ IMPORTANT

A temperature vacuum gauge, mercury vacuum (U-tube), or thermocouple gauge should be used. The usual Bourdon tube gauges are not accurate enough in the vacuum range.

- 2– Evacuate the system to 29 inches (737mm) vacuum. During the early stages of evacuation, it is desirable to stop the vacuum pump at least once to determine if there is a rapid loss of vacuum. A rapid loss of vacuum would indicate a leak in the system and a repeat of the leak testing section would be necessary.
- 3– After evacuating system to 29 inches (737mm), close gauge manifold valves to center port, stop vacuum pump and disconnect from gauge manifold. Attach an upright nitrogen drum to center port of gauge manifold and open drum valve slightly to purge line at manifold. Break vacuum in system with nitrogen pressure by opening manifold high pressure valve. Close manifold high pressure valve to center port.
- 4– Close nitrogen drum valve and disconnect from gauge manifold center port. Release nitrogen pressure from system.
- 5– Connect vacuum pump to gauge manifold center port. Evacuate system through manifold service valves until vacuum in system does not rise above 29.7 inches (754mm) mercury (5mm absolute pressure) within a 20-minute period after stopping vacuum pump.
- 6– After evacuation is complete, close manifold center port, and connect refrigerant drum. Pressurize system slightly with refrigerant to break vacuum.

C – Leak Testing (To Be Done Only After Pump Down)

- 1– Attach gauge manifold and connect a drum of dry nitrogen to center port of gauge manifold.
- 2– Open high pressure valve on gauge manifold and pressurize line set /indoor coil to 150 psig (1034 kPa).
- 3– Check lines and connections for leaks.
- 4– Release nitrogen pressure from the system, correct any leaks and recheck.

⚠ CAUTION

When using dry nitrogen, a pressure reducing regulator must be used to prevent excessive pressure in gauge manifold, connecting hoses, and within the system. Regulator setting must not exceed 150 psig (1034 kpa). Failure to use a regulator can cause equipment failure resulting in injury.

NOTE-If electronic leak detector is used, add a trace of refrigerant to the nitrogen for detection by the leak detector.

D – Charging

Charging must be done in the cooling mode. If system is completely void of refrigerant, the recommended and most accurate method of charging is to weigh the refrigerant into the unit according to the total amount shown on the unit nameplate.

If weighing facilities are not available or if unit is just low on charge, the following procedure applies. RFC and TXV systems use different charging methods. Separate discharge and vapor line service ports are provided outside the unit for connection of gauge manifold during charging procedure as well as a suction line service port.

1 – Expansion Valve Systems

The following procedures are intended as a general guide for use with expansion valve systems only. For best results, indoor temperature should be between 70 °F and 80 °F. If outdoor temperature is 60 °F (16 °C) or above the approach method of charging is used. If outdoor temperature is less than 60 °F (16 °C) the subcooling method of charging is used. Slight variations in charging temperature and pressure should be expected. Large variations may indicate a need for further servicing.

⚠ IMPORTANT

The following procedures require accurate readings of ambient (outdoor) temperature, liquid temperature and liquid pressure for proper charging. Use a thermometer with accuracy of ± 2 °F and a pressure gauge with accuracy of ± 5 PSIG.

APPROACH METHOD (TXV SYSTEMS)

(Ambient Temperature of 60°F [16°C] or Above)

- 1 – Connect gauge manifold. Connect an upright R-22 drum to center port of gauge manifold.
- 2 – Record outdoor air (ambient) temperature.
- 3 – Operate indoor and outdoor units in cooling mode. Allow outdoor unit to run until system pressures stabilize.
- 4 – Make sure thermometer well is filled with mineral oil before checking liquid line temperature.

5 – Place thermometer in well and read liquid line temperature. Liquid line temperature should be a few degrees warmer than the outdoor air temperature. Table 9 shows how many degrees warmer the liquid line temperature should be. Add refrigerant to make the liquid line temperature cooler.

Recover refrigerant to make the liquid line temperature warmer.

TABLE 9

APPROACH METHOD – EXPANSION VALVE SYSTEMS AMBIENT TEMPERATURE OF 60 °F (16 °C) OR ABOVE	
Model	Liquid Line °F Warmer Than Outside (Ambient) Temperature
HP23-141	6
HP23-211	5
HP23-261	7
HP23-311	14
HP23-411/413	14
HP23-411/413 (CAN)	11
HP23-461/463	11
HP23-511/513	11
HP23-651/653	7

**SUBCOOLING METHOD (TXV SYSTEMS)
(Ambient Temperature Below 60°F [16°C])**

NOTE- It may be necessary to restrict air flow in order to reach liquid pressures in the 200-250 psig range which are required for checking charge. Block equal sections of air intake panels as shown in figure 24, moving obstructions sideways until liquid pressures in the 200-250 psig range are reached.

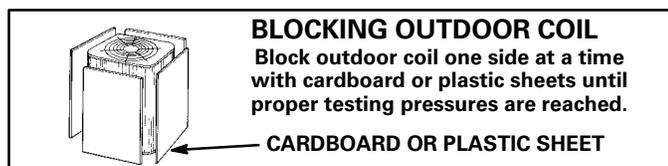


FIGURE 24

- 1 – Connect gauge manifold. Connect an upright R-22 drum to center port of gauge manifold.
- 2 – Operate indoor and outdoor units in cooling mode. Allow outdoor unit to run until system pressures stabilize.

3 – Make sure thermometer well is filled with mineral oil before checking liquid line temperature.

4 – Read liquid line pressure and convert to condensing temperature using temperature/pressure conversion chart.

Condensing temperature (read from gauges) should be a few degrees warmer than the liquid line temperature.

5 – Place thermometer in well and read liquid line temperature. Table 10 shows how much warmer the condensing temperature should be.

TABLE 10

SUBCOOLING METHOD – EXPANSION VALVE SYSTEMS AMBIENT TEMPERATURE BELOW 60 °F (16 °C)	
Model	Condensing Temp °F Warmer Than Liquid Line
HP23-141	4 ± 2
HP23-211	9 ± 2
HP23-261	13 ± 2
HP23-311	9 ± 2
HP23-411/413	9 ± 2
HP23-411/413 (CAN)	13 ± 2
HP23-461/463	8 ± 2
HP23-511/513	6 ± 2
HP23-651/653	7 ± 2

Add refrigerant to make the liquid line temperature cooler.

Recover refrigerant to make the liquid line temperature warmer.

6 – When unit is properly charged liquid line pressures should approximate those given in table 11.

⚠ IMPORTANT

Use table 11 as a general guide for performing maintenance checks. Table 11 is not a procedure for charging the system. Minor variations in pressures may be expected due to differences in installations. Significant deviations may mean the system is not properly charged or that a problem exists with some component in the system. Used prudently, table 11 could serve as a useful service guide.

TABLE 11

OUTDOOR COIL ENTERING AIR TEMPERATURE	HP23 NORMAL OPERATING PRESSURES (COOLING MODE)																	
	HP23-141		HP23-211		HP23-261		HP23-311		HP23-410		HP23-410 (CAN)		HP23-461/463		HP23-511/513		HP23-651/653	
	LIQ. ± 10 PSIG	SUC. ± 10 PSIG	LIQ. ± 10 PSIG	SUC. ± 10 PSIG	LIQ. ± 10 PSIG	SUC. ± 10 PSIG	LIQ. ± 10 PSIG	SUC. ± 10 PSIG	LIQ. ± 10 PSIG	SUC. ± 10 PSIG	LIQ. ± 10 PSIG	SUC. ± 10 PSIG	LIQ. ± 10 PSIG	SUC. ± 10 PSIG	LIQ. ± 10 PSIG	SUC. ± 10 PSIG	LIQ. ± 10 PSIG	SUC. ± 10 PSIG
65° F (TXV)	137	78	145	72	160	74	170	75	175	75	175	76	160	72	165	72	150	73
75° F (TXV)	155	79	165	73	185	76	195	77	200	76	200	77	185	74	185	73	175	75
85° F (TXV)	182	80	195	74	215	78	225	78	227	77	230	78	215	76	210	76	200	76
95° F (TXV)	210	82	225	77	245	80	255	80	260	79	260	79	245	78	240	78	235	78
105° F (TXV)	240	83	255	79	275	84	290	82	295	81	295	81	280	80	275	80	265	80
65° F (RFC III)	130	59	150	61	150	60	165	62	170	61	160	62	155	61	155	63	*	*
75° F (RFC III)	155	67	170	68	175	67	190	69	205	68	190	68	180	63	185	64	*	*
85° F (RFC III)	175	75	195	75	205	73	220	74	230	73	225	70	210	68	210	69	*	*
95° F (RFC III)	210	82	230	81	240	78	255	80	265	79	255	77	240	73	245	74	*	*
105° F (RFC III)	240	87	260	85	280	81	285	84	305	82	385	81	275	76	275	78	*	*

*For an approved match-up the HP23-651/653 must be used with a TXV.

2 – RFCIII Systems

The system should not be charged at ambients below 60 °F (15°C). If charging below 60 °F (15°C) is required, the recommended method of charging is to weigh the refrigerant into the unit according to the total amount shown on the unit nameplate. For line sets varying from 20 feet , refer to table 8 for refrigerant charge adjustment. If ambient temperature is above 60 °F (15°C) use the subcooling method outlined below.

SUBCOOLING METHOD (RFCIII SYSTEMS) (Ambient Temperature Above 60°F [16°C])

- 1 – Connect gauge manifold. Connect an upright R-22 drum to center port of gauge manifold.
- 2 – Operate indoor and outdoor units in cooling mode. Allow outdoor unit to run until system pressures stabilize.
- 3 – Make sure thermometer well is filled with mineral oil before checking liquid line temperature.
- 4 – Read liquid line pressure and convert to condensing temperature using temperature/pressure conversion chart.
Condensing temperature (read from gauges) should be a few degrees warmer than the liquid line temperature.

TABLE 12

SUBCOOLING METHOD—RFCIII Systems*		Condensing Temp°F Warmer Than Liquid Line At Various Ambients					
Outdoor Unit	Indoor Unit	65°F	75°F	85°F	95°F	105°F	115°F
		HP23-141	CB/CBH19-21	5	5	4	1
HP23-211	CB/CBH19-21	13	13	13	12	6	4
HP23-261	CB/CBH19-26	12	12	11	9	7	5
HP23-311	CB/CBH19-31	12	12	10	8	6	4
HP23-410	CB/CBH19-41	17	15	14	11	8	5
HP23-410 (CAN)	CB/CBH19-41	18	16	15	12	9	6
HP23-460	CB/CBH19-41	11	10	7	6	4	2
HP23-510	CB19-51	11	10	8	7	5	2

*Approved matchups only

- 5 – Place thermometer in well and read liquid line temperature. Table 12 shows how much warmer the condensing temperature should be.

Add refrigerant to make the liquid line temperature cooler.

Recover refrigerant to make the liquid line temperature warmer.

- 6 – When unit is properly charged liquid line pressures should approximate table 11.

E – Oil Charge

Refer to table 5 on page 6.

V – MAINTENANCE

At the beginning of each heating or cooling season, the system should be cleaned as follows:

A – Outdoor Unit

- 1 – Clean and inspect outdoor coil. (Coil may be flushed with a water hose).
- 2 – Visually inspect all connecting lines, joints and coils for evidence of oil leaks.

⚠ IMPORTANT

If insufficient heating or cooling occurs, the unit should be gauged and refrigerant charge checked.

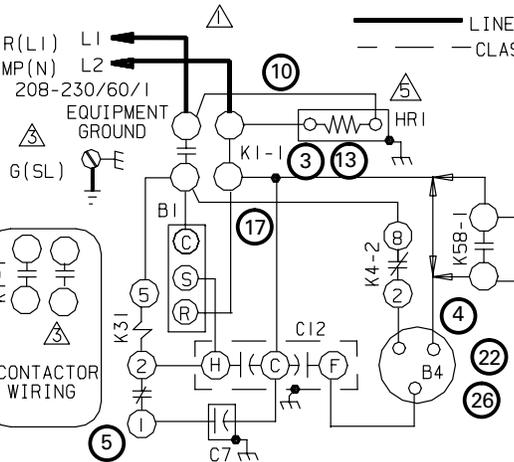
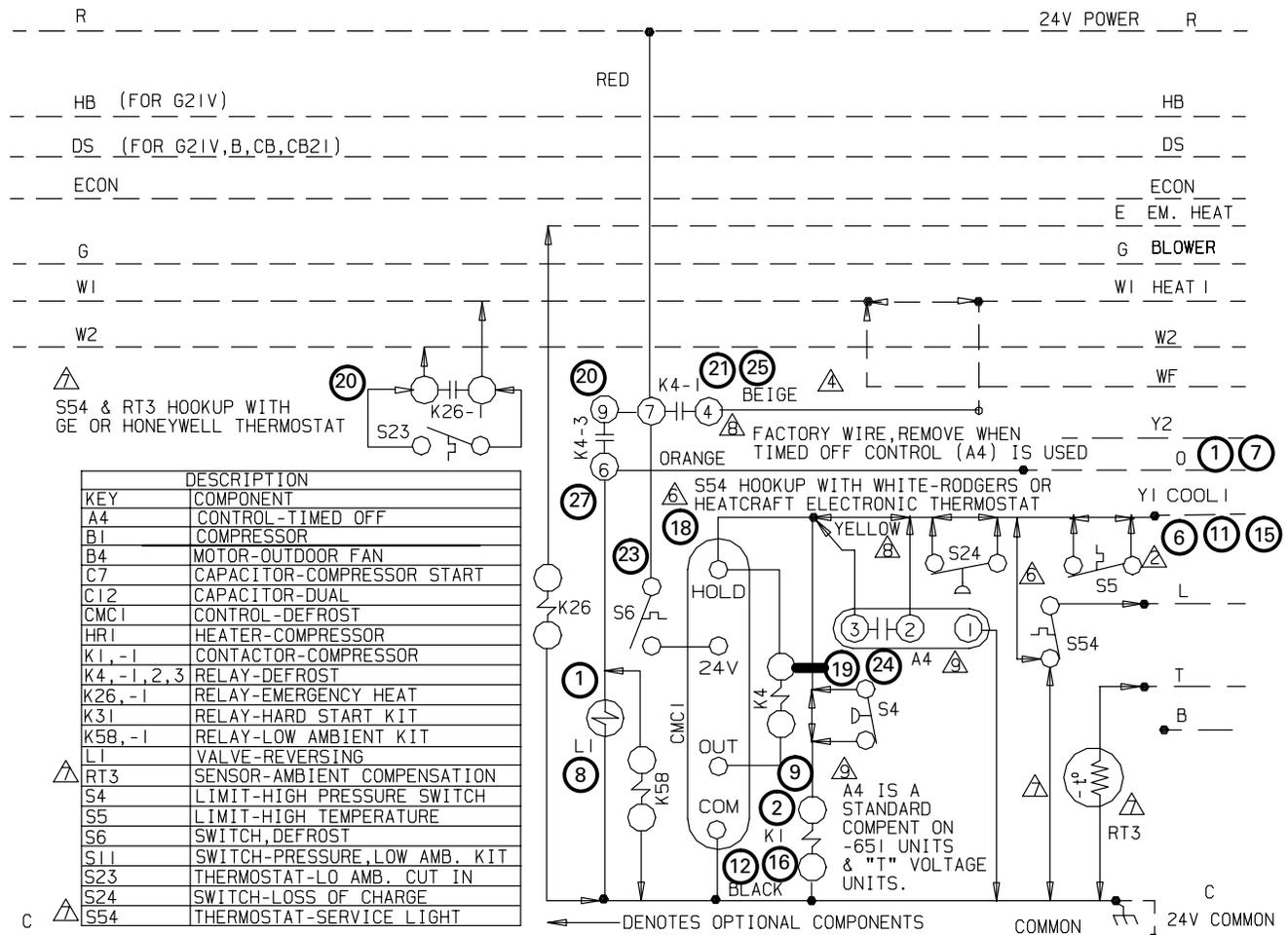
B – Indoor Coil

- 1 – Clean coil if necessary.
- 2 – Check connecting lines and coil for evidence of oil leaks.
- 3 – Check condensate line and clean if necessary.

C – Indoor Unit

- 1 – Clean or change filters.
- 2 – Adjust blower cooling speed. Static pressure drop over coil should be checked to determine correct blower CFM. Refer to Lennox Engineering Handbook.
- 3 – Belt Drive Blowers - Check condition and tension.
- 4 – Check all wiring for loose connections.
- 5 – Check for correct voltage at unit.
- 6 – Check amp-draw on blower motor.
Unit nameplate _____ Actual _____.

HP23 SINGLE PHASE OPERATING SEQUENCE



— LINE VOLTAGE FIELD INSTALLED
 - - - CLASS II VOLTAGE FIELD INSTALLED
 ⚠ FOR USE WITH COPPER CONDUCTORS ONLY. REFER TO UNIT RATING PLATE FOR MINIMUM CIRCUIT AMPACITY AND MAXIMUM FUSE SIZE

⚠ USED ONLY IF COMPRESSOR THERMOSTAT IS NOT INTERNAL
 ⚠ "T" VOLTAGE UNITS ONLY
 ⚠ FUELMASTER HOOKUP
 ⚠ HRI IS A FIELD INSTALLED OPTION ON HP23-141 UNITS

LETTER DESIGNATION	VOLTAGE
P	208-230/60/1
T	220-240/50/1

LENNOX Industries Inc. WIRING DIAGRAM 3/94

HEAT PUMP-OUTDOOR UNITS

HP23-141, 211, 261, 461, 511, 651-2-P
 HP23-311-3-P
 HP23-411-2, -3-P
 HP23-261-1T

HEAT PUMP SECTION-B

Supersedes Form No. New Form No. 531,016W

WARNING- ELECTRIC SHOCK HAZARD, CAN CAUSE INJURY OR DEATH. UNIT MUST BE GROUND IN ACCORDANCE WITH NATIONAL AND LOCAL CODES.

HP23 SINGLE PHASE OPERATING SEQUENCE

A-HP23 P Voltage Operation Sequence

This is the sequence of operation for HP23 "P" voltage units. The sequence is outlined by numbered steps which correspond to circled numbers on the adjacent diagram.

NOTE- The thermostat used may be electromechanical or electronic.

NOTE- Transformer in indoor unit supplies power (24 VAC) to the thermostat and outdoor unit controls.

COOLING:

- 1 – Cooling demand initiates at Y1 in the thermostat. Internal thermostat wiring energizes terminal O energizing the reversing valve L1.
- 2 – 24VAC energizes compressor contactor K1.
- 3 – K1-1 N.O. closes energizing compressor (B1) and outdoor fan motor (B4).
- 4 – Outdoor fan motor (B4) begins immediate operation.
- 5 – Compressor (B1) begins start-up. Hard start contactor K31 remains closed during start-up and start capacitor C7 remains in the circuit. As the compressor gains speed, K31 is energized. When K31 is energized the contacts open and start capacitor C7 is taken out of the circuit.

END OF COOLING DEMAND:

- 6 – Cooling demand is satisfied. Terminal Y1 is de-energized.
- 7 – Thermostat terminal O is de-energized.
- 8 – Reversing valve L1 is de-energized
- 9 – Compressor contactor K1 is de-energized.
- 10 – K1-1 opens and compressor (B1) and outdoor fan motor (B4) are de-energized and stop immediately.

FIRST STAGE HEAT:

- 11 – Heating demand initiates at W1 in the thermostat.

- 12 – 24VAC energizes compressor contactor K1.

- 13 – K1-1 N.O. closes energizing compressor and outdoor fan motor.

- 14 – See steps 4 and 5.

END OF FIRST STAGE HEAT:

- 15 – Heating demand is satisfied. Terminal W1 is de-energized.

- 16 – Compressor contactor K1 is de-energized.

- 17 – K1-1 opens and compressor (B1) and outdoor fan motor (B4) are de-energized and stop immediately.

DEFROST MODE:

- 18 – During heating operation when outdoor coil temperature drops below $35^{\circ} \pm 4^{\circ} \text{F}$ Defrost Switch (thermostat) S6 closes.

- 19 – Defrost control CMC1 begins timing. If defrost thermostat (S6) remains closed at the end of the 30,60 or 90 minute period, defrost relay K4 energizes and defrost begins.

- 20 – N.O. K4-3 closes energizing the reversing valve.

- 21 – N.O. K4-1 closes energizing W1 on TB1 terminal strip of indoor unit. Indoor unit operates in the first stage heat mode.

- 22 – N.C. K4-2 opens and outdoor fan motor B4 stops.

- 23 – Defrost continues 14 ± 1 minutes or until thermostat switch (S6) opens. When defrost thermostat opens defrost control CMC1 loses power and resets.

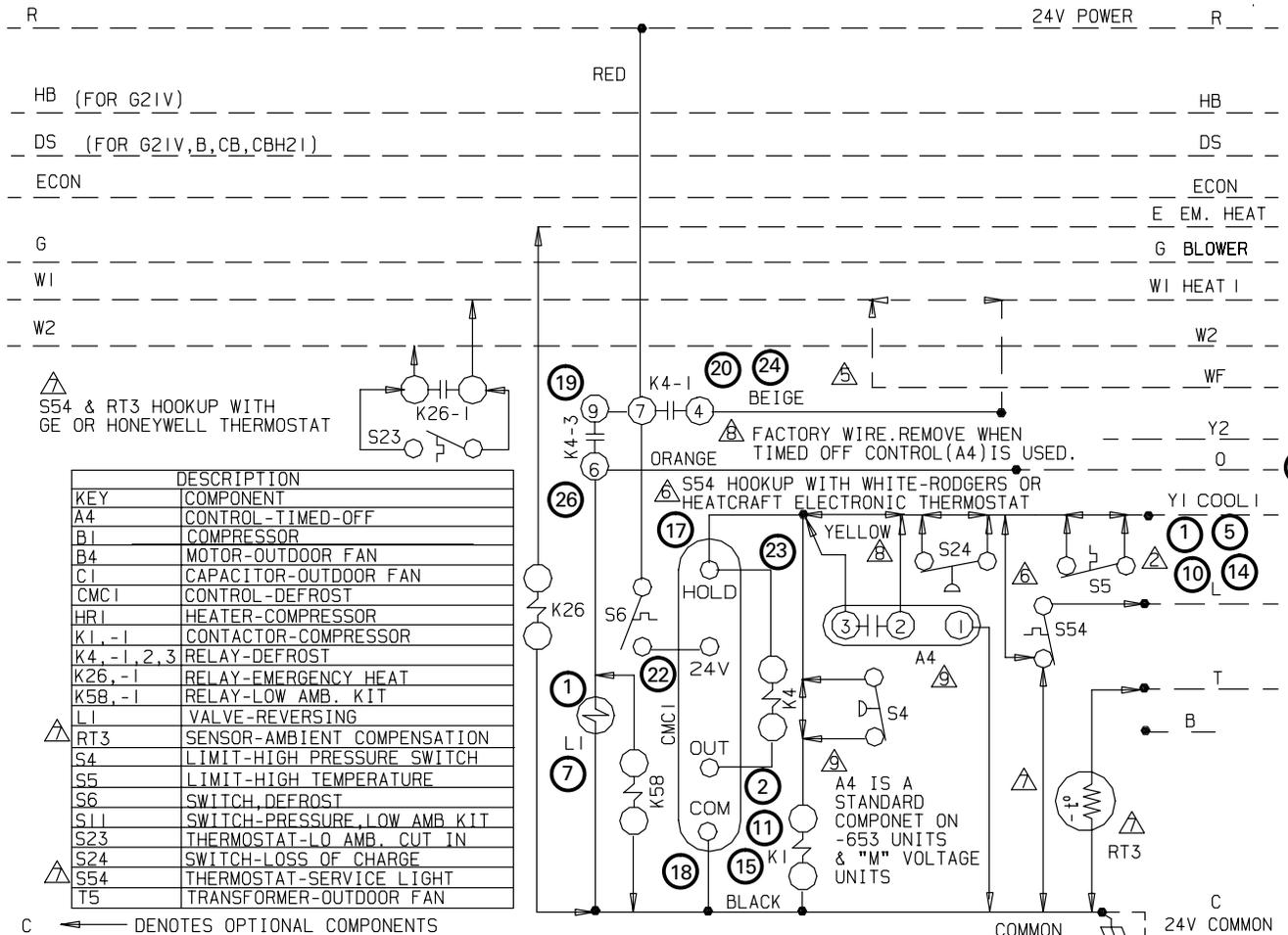
- 24 – Defrost relay K4 is de-energized.

- 25 – K4-1 opens and W1 on terminal strip TB1 of indoor unit is de-energized.

- 26 – K4-2 closes and the outdoor fan begins operation.

- 27 – K4-3 opens de-energizing the reversing valve.

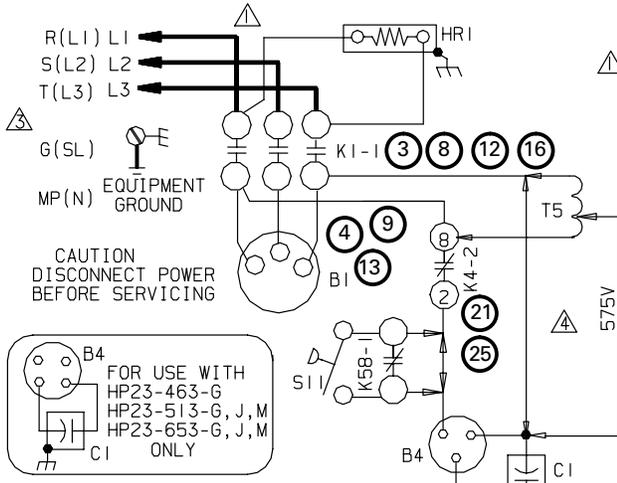
HP23 THREE PHASE OPERATING SEQUENCE



△ S54 & RT3 HOOKUP WITH GE OR HONEYWELL THERMOSTAT

KEY	DESCRIPTION
A4	CONTROL-TIMED-OFF
B1	COMPRESSOR
B4	MOTOR-OUTDOOR FAN
C1	CAPACITOR-OUTDOOR FAN
CMC1	CONTROL-DEFROST
HRI	HEATER-COMPRESSOR
K1, -1	CONTACTOR-COMPRESSOR
K4, -1, 2, 3	RELAY-DEFROST
K26, -1	RELAY-EMERGENCY HEAT
K58, -1	RELAY-LOW AMB. KIT
L1	VALVE-REVERSING
RT3	SENSOR-AMBIENT COMPENSATION
S4	LIMIT-HIGH PRESSURE SWITCH
S5	LIMIT-HIGH TEMPERATURE
S6	SWITCH, DEFROST
S11	SWITCH-PRESSURE, LOW AMB. KIT
S23	THERMOSTAT-LO AMB. CUT IN
S24	SWITCH-LOSS OF CHARGE
S54	THERMOSTAT-SERVICE LIGHT
T5	TRANSFORMER-OUTDOOR FAN

C ← DENOTES OPTIONAL COMPONENTS



WARNING-ELECTRIC SHOCK HAZARD, CAN CAUSE INJURY OR DEATH. UNIT MUST BE GROUNDED IN ACCORDANCE WITH NATIONAL AND LOCAL CODES

— LINE VOLTAGE FIELD INSTALLED
 - - - CLASS II VOLTAGE FIELD INSTALLED

△ FOR USE WITH COPPER CONDUCTORS ONLY. REFER TO UNIT RATING PLATE FOR MINIMUM CIRCUIT AMPACITY AND MAXIMUM FUSE SIZE

LETTER DESIGNATION	VOLTAGE
Y	208-230/60/3
G	460/60/3
J	575/60/3
M	380-420/50/3

△ FOR FUELMASTER HOOKUP
 △ USED ONLY IF COMPRESSOR THERMOSTAT IS NOT INTERNAL
 △ "M" VOLTAGE UNITS ONLY
 △ "J" VOLTAGE UNITS ONLY

LENNOX Industries Inc. WIRING DIAGRAM 3/94

HEAT PUMP-OUTDOOR UNITS

HP23-413, 463-2-Y, G
 HP23-513, 653-2-Y, G, J
 HP23-413, 513, 653-1M

HEAT PUMP SECTION-B

Supersedes Form No. 529,642W New Form No. 531,017W

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HP23 THREE PHASE OPERATING SEQUENCE

A-HP23 P Voltage Operation Sequence

This is the sequence of operation for HP23 "Y", "G", and "J" voltage units. The sequence is outlined by numbered steps which correspond to circled numbers on the adjacent diagram.

NOTE- The thermostat used may be electromechanical or electronic.

NOTE- Transformer in indoor unit supplies power (24 VAC) to the thermostat and outdoor unit controls.

COOLING:

- 1 – Cooling demand initiates at Y1 in the thermostat. Internal thermostat wiring energizes terminal O energizing the reversing valve L1.
- 2 – 24VAC energizes compressor contactor K1.
- 3 – K1-1 N.O. closes energizing compressor (B1) and outdoor fan motor (B4).
- 4 – Compressor (B1) and outdoor fan motor (B4) begin immediate operation.

END OF COOLING DEMAND:

- 5 – Cooling demand is satisfied. Terminal Y1 is de-energized.
- 6 – Thermostat terminal O is de-energized.
- 7 – Reversing valve L1 is de-energized
- 8 – Compressor contactor K1 is de-energized.
- 9 – K1-1 opens and compressor (B1) and outdoor fan motor (B4) are de-energized and stop immediately.

FIRST STAGE HEAT:

- 10 – Heating demand initiates at W1 in the thermostat.
- 11 – 24VAC energizes compressor contactor K1.
- 12 – K1-1 N.O. closes energizing compressor and outdoor fan motor.

- 13 – Compressor (B1) and outdoor fan motor (B4) begin immediate operation.

END OF FIRST STAGE HEAT:

- 14 – Heating demand is satisfied. Terminal W1 is de-energized.
- 15 – Compressor contactor K1 is de-energized.
- 16 – K1-1 opens and compressor (B1) and outdoor fan motor (B4) are de-energized and stop immediately.

DEFROST MODE:

- 17 – During heating operation when outdoor coil temperature drops below $35^{\circ} \pm 4^{\circ} \text{F}$ Defrost Switch (thermostat) S6 closes.
- 18 – Defrost control CMC1 begins timing. If defrost thermostat (S6) remains closed at the end of the 30,60 or 90 minute period, defrost relay K4 energizes and defrost begins.
- 19 – N.O. K4-3 closes energizing the reversing valve.
- 20 – N.O. K4-1 closes energizing W1 on TB1 terminal strip of indoor unit. Indoor unit operates in the first stage heat mode.
- 21 – N.C. K4-2 opens and outdoor fan motor B4 stops.
- 22 – Defrost continues 14 ± 1 minutes or until thermostat switch (S6) opens. When defrost thermostat opens defrost control CMC1 loses power and resets.
- 23 – Defrost relay K4 is de-energized.
- 24 – K4-1 opens and W1 on terminal strip TB1 of indoor unit is de-energized.
- 25 – K4-2 closes and the outdoor fan begins operation.
- 26 – K4-3 opens de-energizing the reversing valve.