Service Literature

UNIT INFORMATION

Corp. 0903−L1
Revised: March 2011

TSA

6, 7.5, 10, 12.5, 15 & 20 ton

TSA SERIES UNITS

The TSA units are designed for light commercial applications, with a remotely located blower−coil unit or a furnace with an add−on evaporator coil. Capacities for the series are 6, 7−1/2, 10, 12.5, 15 and 20 tons (21, 26, 35, 44, 53, and 70 kW). All TS units use single speed scroll compressors. The 10 (120S4D), 12.5, 15 and 20 ton units each have two single−speed scroll compressors. TS units match with the TA blower−coil units. All TS units are three−phase and use HFC−410A refrigerant.

This manual covers TSA072S4S, TSA090S4S, TSA120S4S, TSA120S4D, TSA150S4D, TSA180S4D and TSA240S4D units. It is divided into sections which discuss the major components, refrigerant system, charging procedure, maintenance and operation sequence.

Information in this manual is intended for qualified service technicians only. All specifications are subject to change. Procedures in this manual are presented as a recommendation only and do not supersede or replace local or state codes.

WARNING

Electric shock hazard. Can cause injury or death. Before attempting to perform any service or maintenance, turn the electrical power to unit OFF at disconnect sw itch(es). Unit may have multiple power supplies.

WARNING

Refrigerant can be harmful if it is inhaled. Refrigerant must be used and recovered responsibly.

Failure to follow this warning may result in personal injury or death.

IMPORTANT

ALL major components (indoor blower/coil) must be matched to Lennox recommendations for compressor to be covered under warranty. Refer to Engineering Handbook for approved system matchups.

WARNING

Improper installation, adjustment, alteration, service or maintenance can cause property damage, personal injury or loss of life. Installation and service must be performed by a licensed professional installer or service agency.

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SPECIFICATIONS			6 - 7.5 TON
General Data	**Model No.**	**TSA072S4S**	**TSA090S4S**
	Nominal Size - Tons	6	7.5
Connections (sweat)	Liquid line - in. (o.d)	(1) 5/8	(1) 5/8
	Suction line - in. (o.d)	(1) 1-1/8	(1) 1-1/8
Refrigerant	R-410A	holding charge	
Condenser Coil	Net face area - sq. ft. Outer coil	29.3	29.3
	Inner coil	- - -	28.4
	Tube diameter - in. & no. of rows	3/8 - 1	3/8 - 2
	Fins per inch	20	20
Condenser Fan(s)	Diameter - in. & no. of blades	(1) 24 - 3	(1) 24 - 4
	Motor hp	(1) 1/3	(1) 1/2
	Total air volume - cfm	5100	5600
	Rpm	1075	1075
	Watts	430	580
Shipping Data	lbs. - 1 package	313	367

ELECTRICAL DATA							
	Line voltage data - 60 hz - 3 phase	**208/230V**	**460V**	**575V**	**208/230V**	**460V**	**575V**
	[1] Maximum Overcurrent Protection (amps)	45	20	15	50	25	20
	[2] Minimum circuit ampacity	27	14	11	35	17	13
Compressor	No. of Compressors	1	1	1	1	1	1
	Rated load amps	19	9.7	7.4	25	12.2	9
	Locked rotor amps	123	62	50	164	100	78
Condenser Fan Motor (1 phase)	No. of motors	1	1	1	1	1	1
	Full load amps	2.4	1.3	1	3	1.5	1.2
	Locked rotor amps	4.7	2.4	1.9	6	3	2.9

NOTE - Extremes of operating range are plus and minus 10% of line voltage.
[1] HACR type circuit breaker or fuse.
[2] Refer to National or Canadian Electrical Code manual to determine wire, fuse and disconnect size requirements.

SPECIFICATIONS			10 TON
General Data	Model No.	TSA120S4S	TSA120S4D
	Nominal Size - Tons	10	10
Connections (sweat)	Liquid line - in. (o.d)	(1) 5/8	(2) 5/8
	Suction line - in. (o.d)	(1) 1-3/8	(2) 1-1/8
Refrigerant	R-410A	holding charge	
Condenser Coil	Net face area - sq. ft. Outer coil	29.3	29.3
	Inner coil	28.4	28.4
	Tube diameter - in. & no. of rows	3/8 - 2	3/8 - 2
	Fins per inch	20	20
Condenser Fan(s)	Diameter - in. & no. of blades	(2) 24 - 3	(2) 24 - 3
	Motor hp	(2) 1/3	(2) 1/3
	Total air volume - cfm	8300	8300
	Rpm	1075	1075
	Watts	830	830
Shipping Data	lbs. - 1 package	427	505

ELECTRICAL DATA							
	Line voltage data - 60 hz - 3 phase	**208/230V**	**460V**	**575V**	**208/230V**	**460V**	**575V**
	[1] Maximum Overcurrent Protection (amps)	70	40	25	50	25	20
	[2] Minimum circuit ampacity	43	24	18	41	21	15
Compressor	No. of Compressors	1	1	1	2	2	2
	Rated load amps (total)	30.1	16.7	12.2	18 (32)	7.8 (15.6)	5.7 (11.4)
	Locked rotor amps (total)	225	114	80	110 (220)	52 (104)	38.9 (77.8)
Condenser Fan Motor (1 phase)	No. of motors	2	2	2	2	2	2
	Full load amps (total)	2.4 (4.8)	1.3 (2.6)	1 (2)	2.4 (4.8)	1.3 (2.6)	1 (2)
	Locked rotor amps (total)	4.7 (9.4)	2.4 (4.8)	1.9 (3.8)	4.7 (9.4)	2.4 (4.8)	1.9 (3.8)

NOTE - Extremes of operating range are plus and minus 10% of line voltage.
[1] HACR type circuit breaker or fuse.
[2] Refer to National or Canadian Electrical Code manual to determine wire, fuse and disconnect size requirements.

SPECIFICATIONS — 12.5 - 20 TON

	Model No.	TSA150S4D	TSA180S4D	TSA240S4D
General Data	Nominal Size - Tons	12.5	15	20
Connections (sweat)	Liquid line - in. (o.d)	(2) 5/8	(2) 5/8	(2) 5/8
	Suction line - in. (o.d)	(2) 1-1/8	(2) 1-1/8	(2) 1-3/8
Refrigerant	R-410A	holding charge		
Condenser Coil	Net face area - sq. ft. Outer coil	34.2	58.7	58.7
	Inner coil	33.3	57.7	57.7
	Tube diameter - in. & no. of rows	3/8 - 2	3/8 - 2	3/8 - 2
	Fins per inch	20	20	20
Condenser Fan(s)	Diameter - in. & no. of blades	(2) 24 - 4	(4) 24 - 3	(4) 24 - 3
	Motor hp	(2) 1/2	(4) 1/3	(4) 1/3
	Total air volume - cfm	10,300	16,600	16,600
	Rpm	1075	1075	1075
	Watts	1130	1660	1660
Shipping Data	lbs. - 1 package	538	860	950

ELECTRICAL DATA

	Line voltage data - 60 hz - 3 phase	208/230V	460V	575V	208/230V	460V	575V	208/230V	460V	575V
	[1] Maximum Overcurrent Protection (amps)	60	30	25	90	40	30	100	50	40
	[2] Minimum circuit ampacity	49	25	20	66	33	25	78	43	32
Compressor	No. of Compressors	2	2	2	2	2	2	2	2	2
	Rated load amps (total)	19 (38)	9.7 (19.4)	7.4 (14.8)	25 (50)	12.2 (24.4)	9 (18)	30.1 60.2)	16.7 (33.4)	12.2 (24.8)
	Locked rotor amps (total)	123 (246)	62 (124)	50 (100)	164 (328)	100 (200)	78 (156)	225 (450)	114 (228)	80 (160)
Condenser Fan Motor (1 phase)	No. of motors	2	2	2	4	4	4	4	4	4
	Full load amps (total)	3 (6)	1.5 (3)	1.2 (2.4)	2.4 (9.6)	1.3 (5.2)	1 (4)	2.4 (9.6)	1.3 (5.2)	1 (4)
	Locked rotor amps (total)	6 (12)	3 (6)	2.9 (5.8)	4.7 (18.8)	2.4 (9.6)	1.9 (7.6)	4.7 (18.8)	2.4 (9.6)	1.9 (7.6)

NOTE - Extremes of operating range are plus and minus 10% of line voltage.
[1] HACR type circuit breaker or fuse.
[2] Refer to National or Canadian Electrical Code manual to determine wire, fuse and disconnect size requirements.

OPTIONS / ACCESSORIES									
Item		Catalog No.	072S4S	090S4S	120S4S	120S4D	150S4D	180S4D	240S4D
CABINET									
Coil Guards	T2GARDD20L−1−	47W12	x	x					
	T2GARDD20M−1−	47W13			x	x			
	T2GARDD21M−1−	47W14					x		
	T2GARDD20N−1−	47W15						x	x
Hail Guards	T2GARDD10L−1−	47W16	x	x					
	T2GARDD10M−1−	47W17			x	x			
	T2GARDD11M−1−	47W18					x		
	T2GARDD10N−1−	47W19						x	x
Corrosion Protection		Factory	○	○	○	○	○	○	○
CONTROLS									
Low Ambient Control (0ºF)	T2CWKT01LM1−	44W17	x	x	x				
	T2CWKT02M−1−	44W18				x	x		
	T2CWKT03N−1−	44W19						x	x

NOTE −The catalog numbers that appear here are for ordering field installed accessories only.
○ − Factory Installed with extended lead time
X − Field Installed

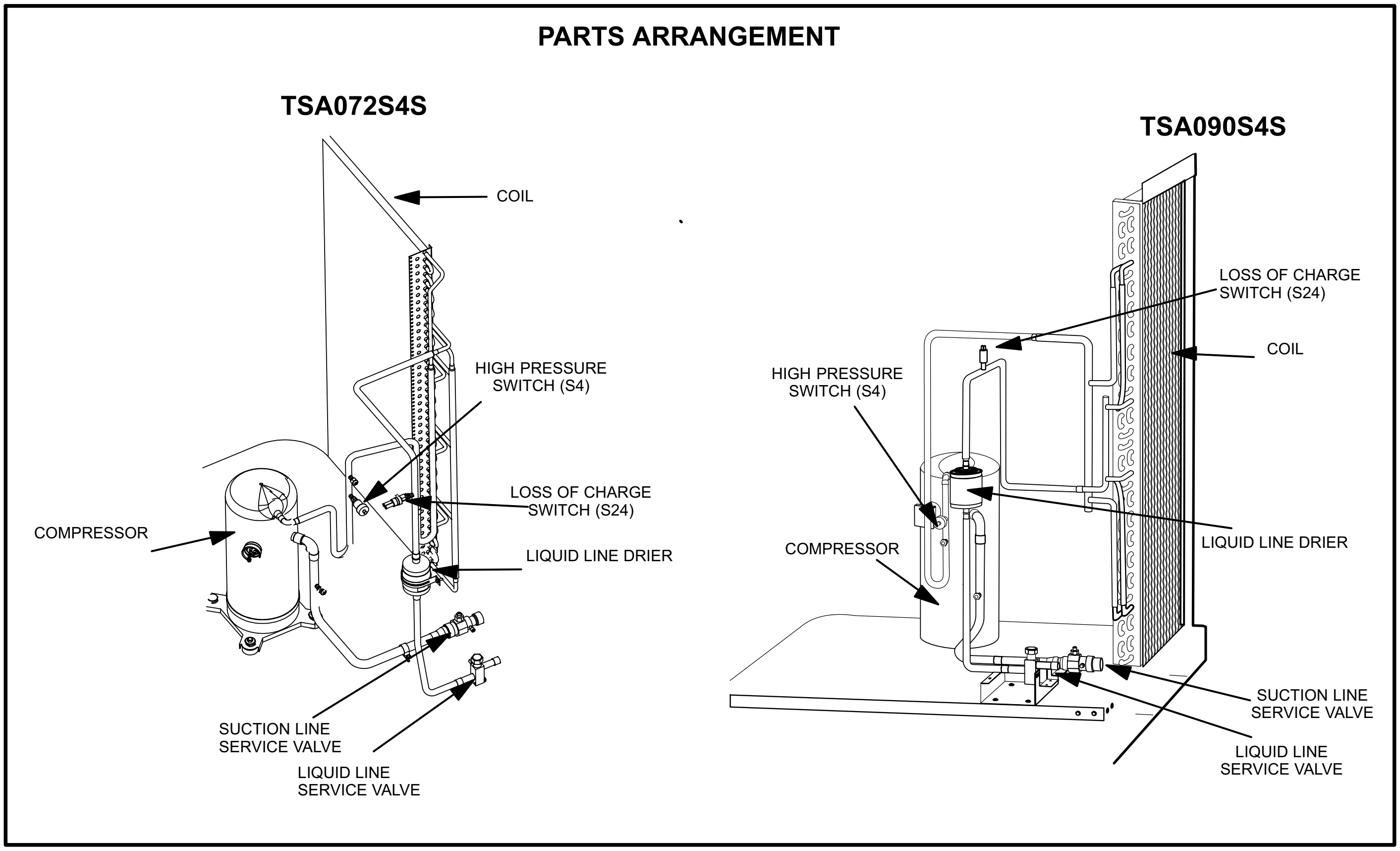


FIGURE 1

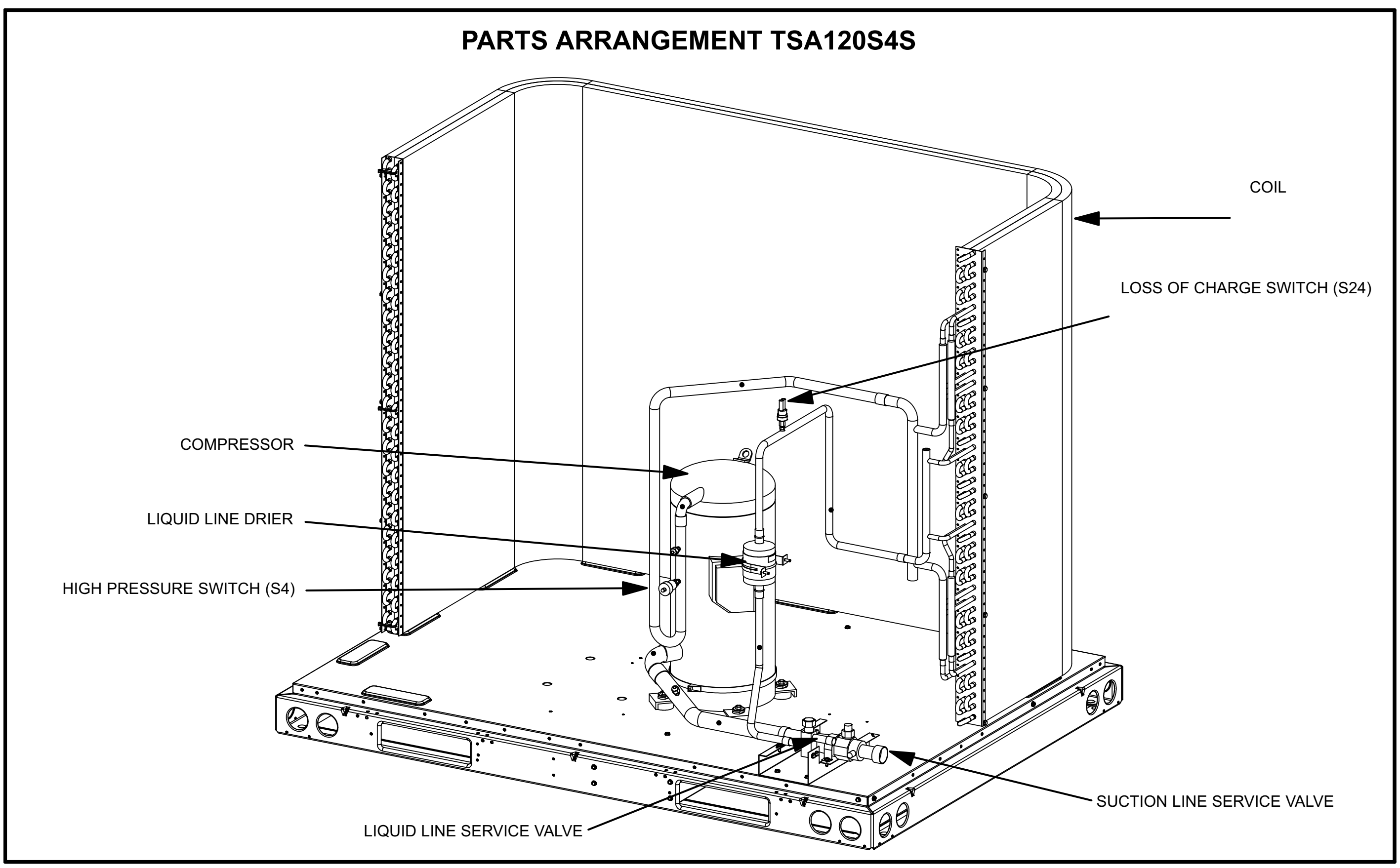


FIGURE 2

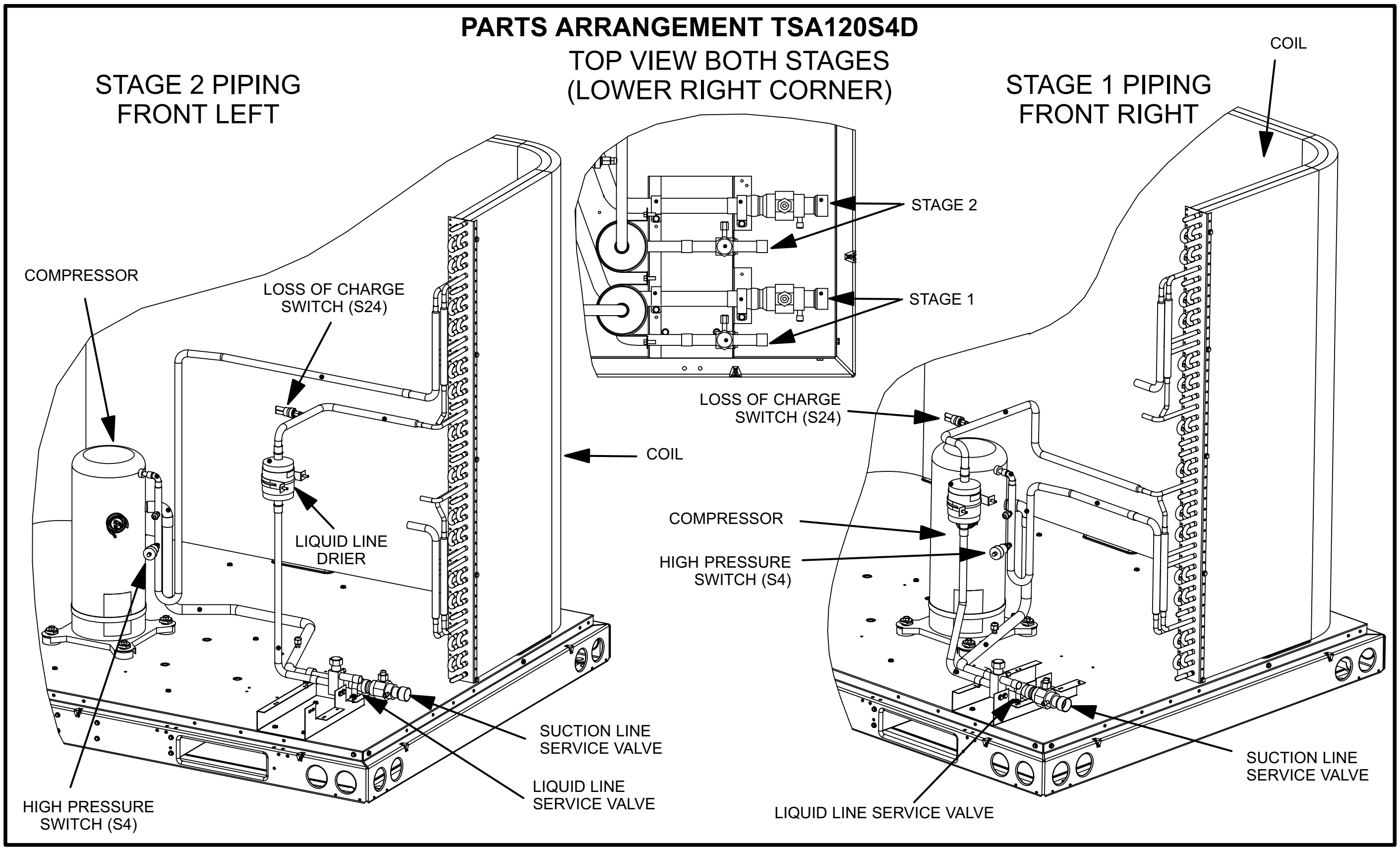


FIGURE 3

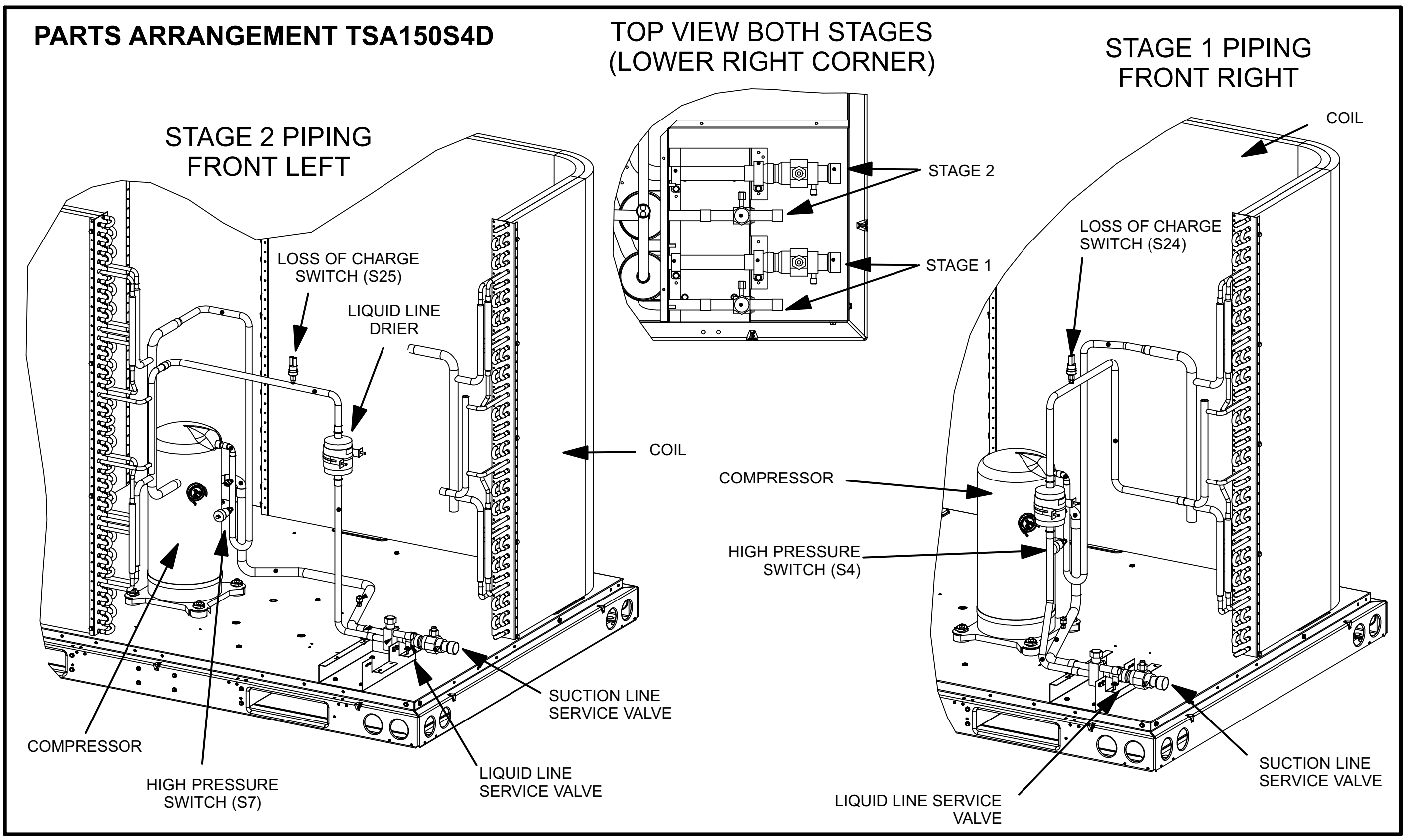


FIGURE 4

TSA180S4D PARTS ARRANGEMENT

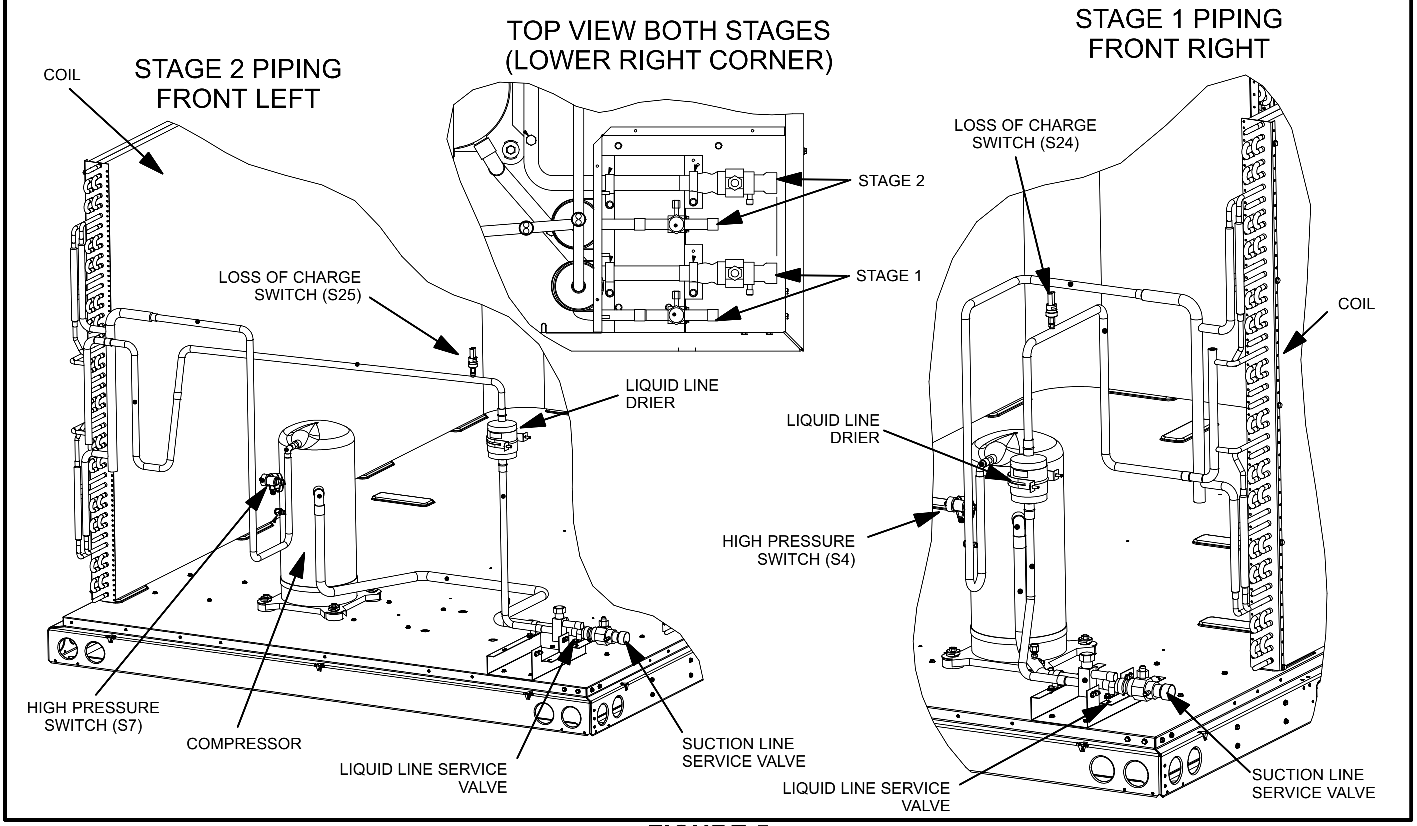


FIGURE 5

TSA240S4D PARTS ARRANGEMENT

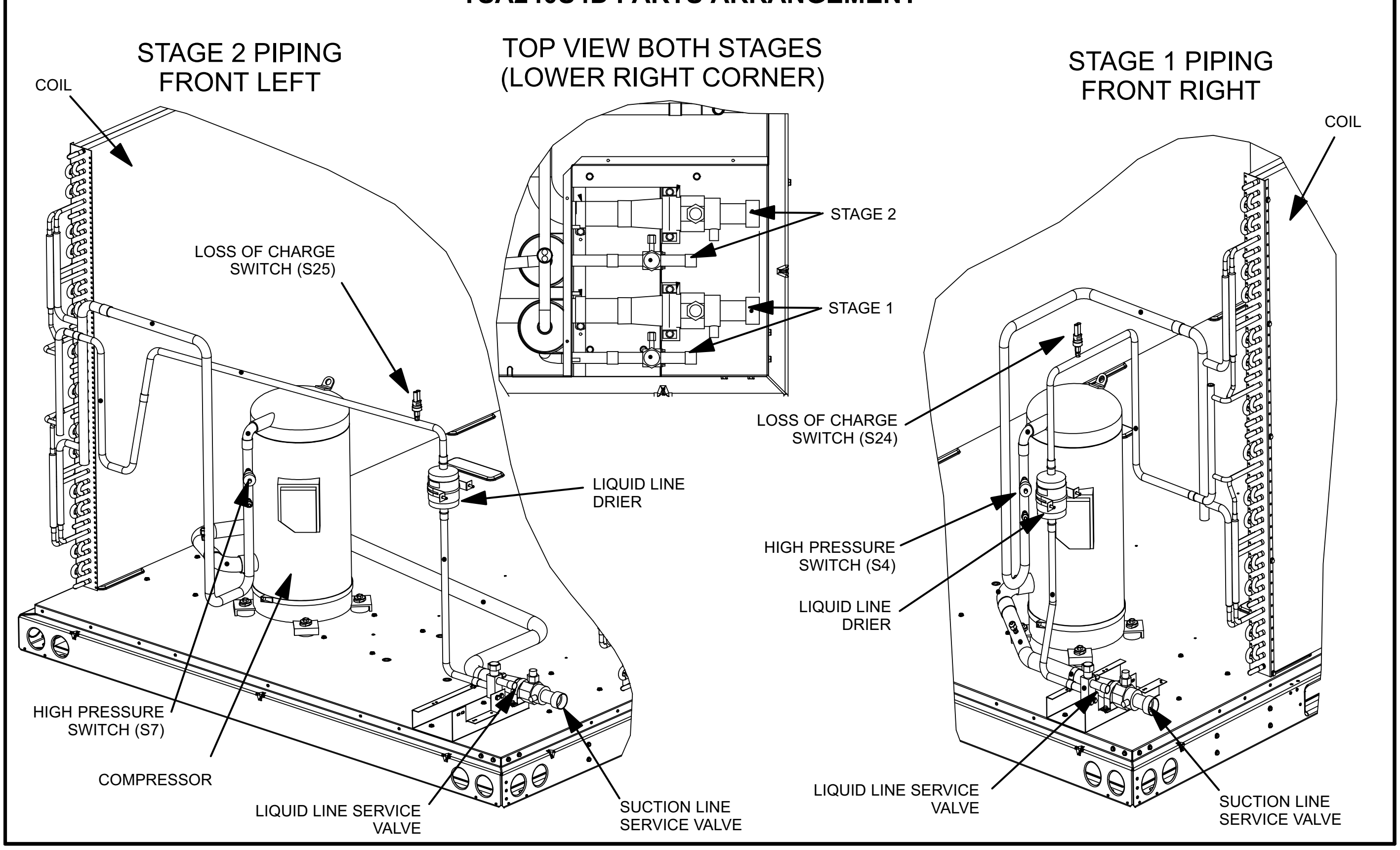
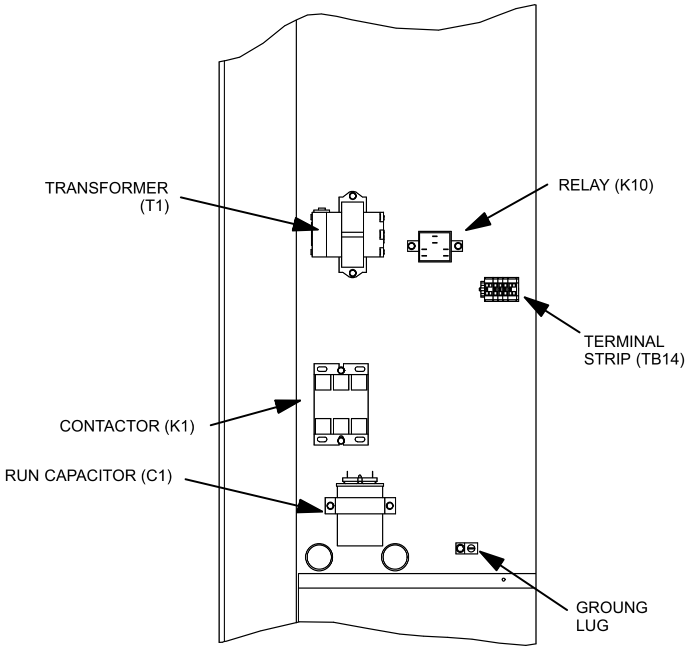
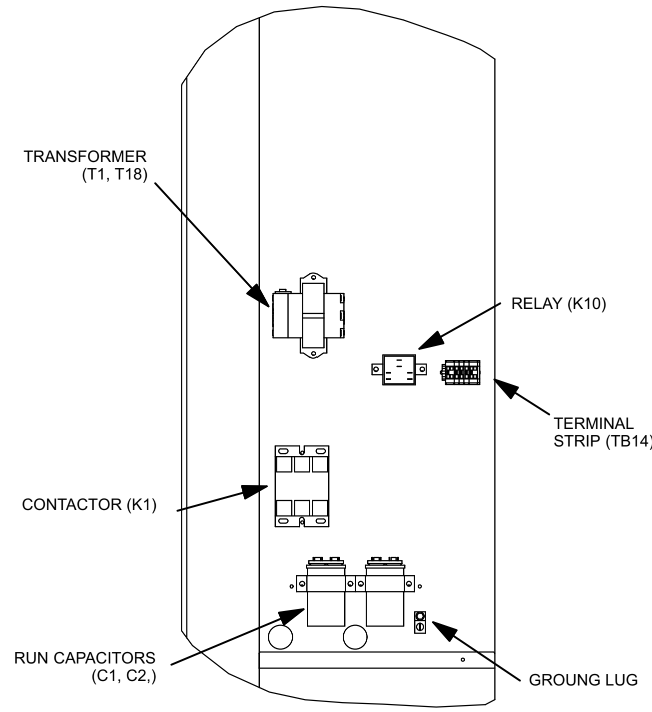


FIGURE 6

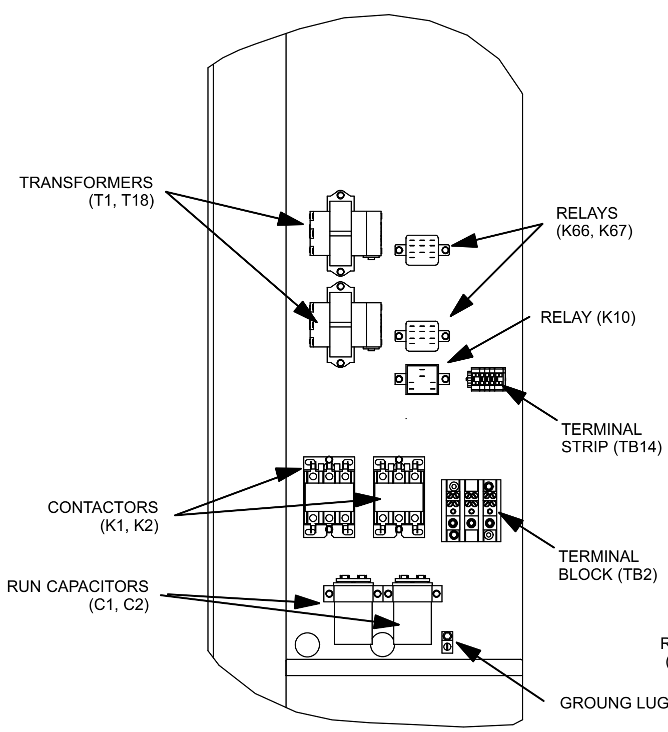
CONTROL BOX



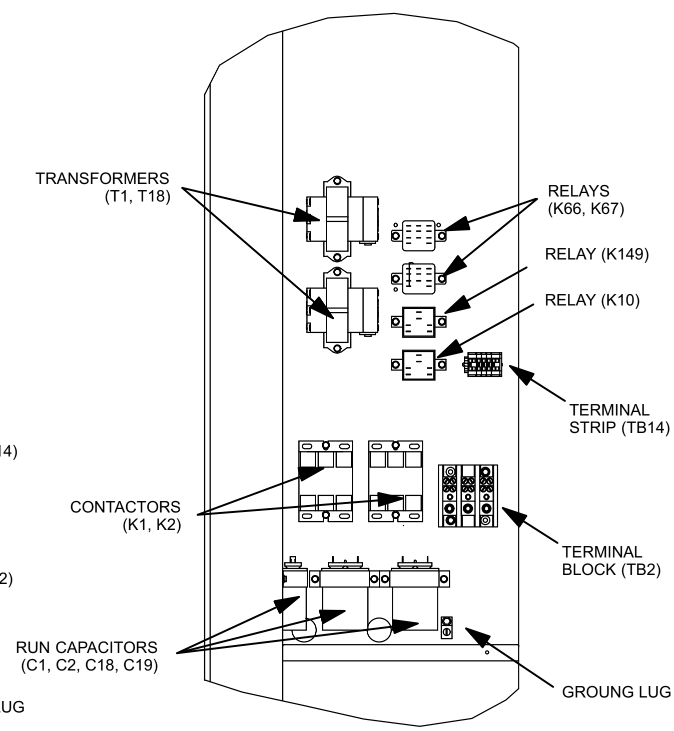
TSA072S AND TSA090S



TSA120S4S



TSA120S4D AND TSA150S4D



TSA180S4D AND TSA240S4D

FIGURE 7

I-UNIT COMPONENTS

The TSA parts arrangements are shown in figures 1 through 5 and control boxes in figure 7.

ELECTROSTATIC DISCHARGE (ESD)
Precautions and Procedures

CAUTION

Electrostatic discharge can affect electronic components. Take precautions during unit installation and service to protect the unit's electronic controls. Precautions will help to avoid control exposure to electrostatic discharge by putting the unit, the control and the technician at the same electrostatic potential. Neutralize electrostatic charge by touching hand and all tools on an unpainted unit surface before performing any service procedure.

A-CONTROL BOX COMPONENTS

1 - Transformer T1 & T18

All TSA models use a single line voltage to 24VAC transformer mounted in the control box. Transformer T1 supplies power to control circuits in the TSA unit. The transformer is rated at 70VA and is protected by a 3.5 amp circuit breaker (CB8). CB8 is internal to the transformer. The 208/230 (Y) voltage transformers use two primary voltage taps as shown in figure 8, while 460 (G) and 575 (J) voltage transformers use a single primary voltage tap. T18 is identical to T1 used in TS120, 150, 180 and 240 and is protected by internal circuit breaker CB18.

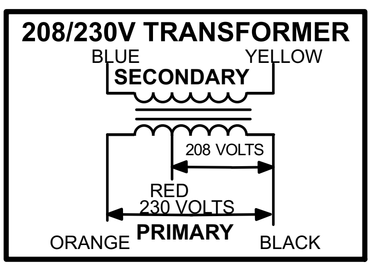


FIGURE 8

NOTE-208 volt units are field wired with the red wire connected to control transformer. 230 volt units are factory wired with the orange wire connected to control transfomer primary.

2 - Terminal Strip TB14 & TB2

Terminal strip TB14 used in all units distributes 24V power and common from the transformer T18 to the control box components. Terminal strip TB2 used in the 120, 150, 180 and 240 units, distributes line voltage to line voltage components.

3 - Condenser Fan Capacitors C1, C2, C18, C19

All TSA units use single-phase condenser fan motors. Motors are equipped with a fan run capacitor to maximize motor efficiency. Condenser fan capacitors C1, C2, C18 and C19 assist in the start up of condenser fan motors B4, B5, B21 and B22. Capacitor ratings will be on condenser fan motor nameplate.

4 - Compressor Contactor K1 (all units) K2 (120S4D, 150, 180, 240)

All compressor contactors are three-pole double- break contactors with a 24V coil. In TSA072, 090 and 120S4S, K1 energizes compressor B1. In TSA120S4D, 150, 180 and 240 units, K1 and K2 energize compressors B1 and B2.

5 - Condenser Fan Relay K10 (all units) K149 (180, 240)

Condenser fan relays K10 and K149 are DPDT with a 24V coil. In all units K10 energizes condenser fan B4 (fan 1) in response to thermostat demand. In the TS-120S4D, 150, 180 and 240, K10 also energizes condenser fan B5 (fan 2) In the TSA180 and 240 K149 energizes condenser fans B21 (fan 3) and B22 (FAN 4) in response to thermostat demand.

6 - Cooling Relays K66 & K67 (120S4D, 150, 180, 240)

Cooling relays K66 and K67 are N.O. 3PDT relays. K66 is energized from "Y1" (1st stage cool), which in turn energizes contactor K1. K67 is energized by "Y2" (2nd stage cool), which in turn energizes contactor K2. This sequence is the start up of compressors B1 and B2.

B-COOLING COMPONENTS

⚠ WARNING

Refrigerant can be harmful if it is inhaled. Refrigerant must be used and recovered responsibly.

Failure to follow this warning may result in personal injury or death.

1 - Compressor

ALL TSA model units use scroll compressors. Compressor B1 operates during all cooling demand and is energized by contactor K1 upon receiving first stage demand. Compressor B2 operates only during second stage cooling demand, and is energized by contactor K2. See ELECTRICAL section or compressor nameplate for compressor specifications.

SCROLL COMPRESSOR

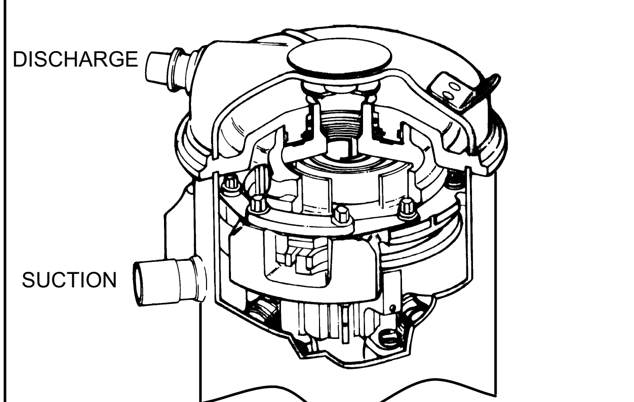


FIGURE 9

The scroll compressor design is simple, efficient and requires few moving parts. A cutaway diagram of the scroll compressor is shown in figure 9. The scrolls are located in the top of the compressor can and the motor is located just below. The oil level is immediately below the motor.

The scroll is a simple compression concept centered around the unique spiral shape of the scroll and its inherent properties. Figure 10 shows the basic scroll form. Two identical scrolls are mated together forming concentric spiral shapes (figure 11). One scroll remains stationary, while the other is allowed to "orbit" (figure 12). Note that the orbiting scroll does not rotate or turn but merely orbits the stationary scroll.

NOTE - During operation, the head of a scroll compressor may be hot since it is in constant contact with discharge gas.

⚠ IMPORTANT

Three-phase scroll compressor noise will be significantly higher if phasing is incorrect. Compressor will operate backwards so unit will not provide cooling. If phasing is incorrect, disconnect power to unit and reverse any two power leads (L1 and L3) preferred) to unit.

SCROLL FORM

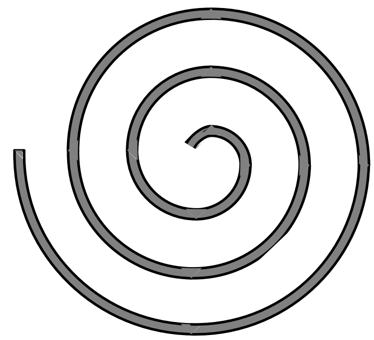


FIGURE 10

CROSS-SECTION OF SCROLLS

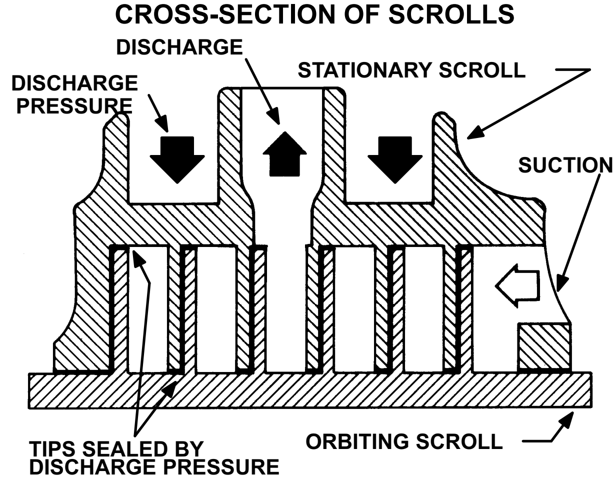


FIGURE 11

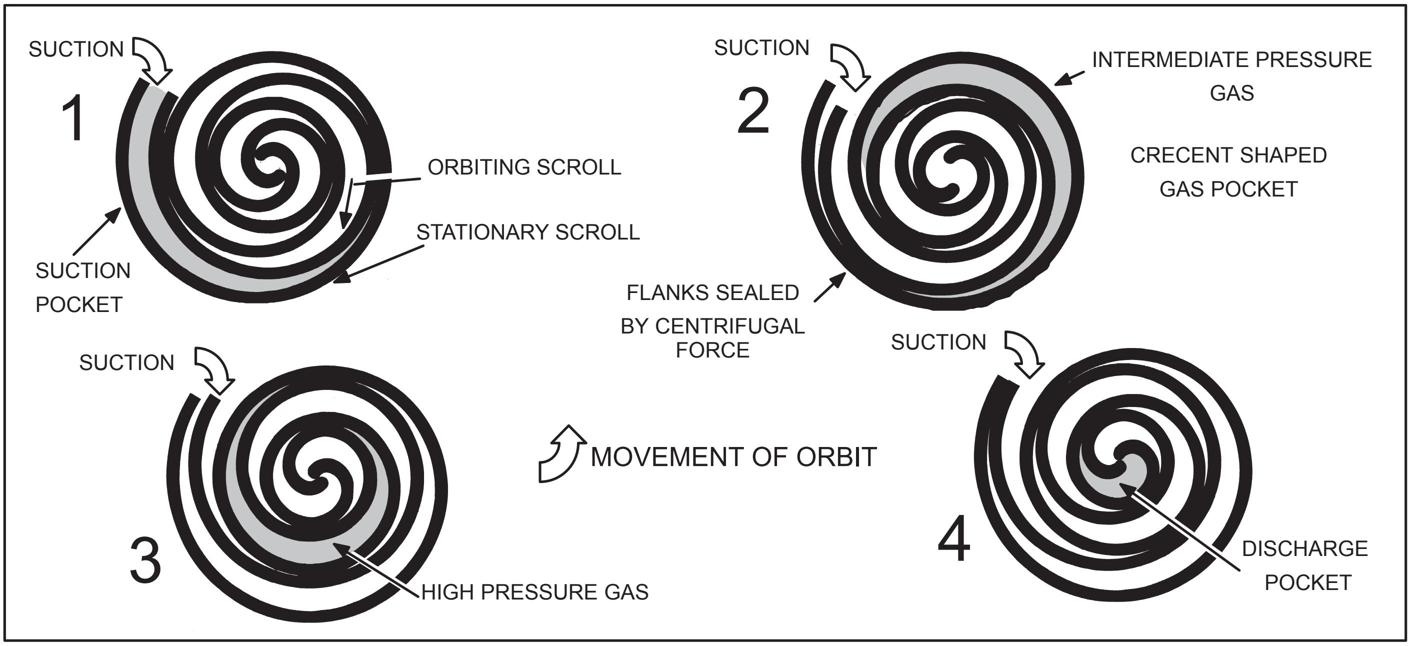


FIGURE 12

The counterclockwise orbiting scroll draws gas into the outer crescent shaped gas pocket created by the two scrolls (figure 12− 1). The centrifugal action of the orbiting scroll seals off the flanks of the scrolls (figure12−2). As the orbiting motion continues, the gas is forced toward the center of the scroll and the gas pocket becomes compressed (figure 12− 3). When the compressed gas reaches the center, it is discharged vertically into a chamber and discharge port in the top of the compressor (figure 11). The discharge pressure forcing down on the top scroll helps seal off the upper and lower edges (tips) of the scrolls (figure 11). During a single orbit, several pockets of gas are compressed simultaneously providing smooth continuous compression.

The scroll compressor is tolerant to the effects of liquid return. If liquid enters the scrolls, the orbiting scroll is allowed to separate from the stationary scroll. The liquid is worked toward the center of the scroll and is discharged. If the compressor is replaced, conventional cleanup practices must be used.

Due to its efficiency, the scroll compressor is capable of drawing a much deeper vacuum than reciprocating compressors. Deep vacuum operation can cause internal fusite arcing resulting in damaged internal parts and will result in compressor failure. Never use a scroll compressor for evacuating or "pumping-down" the system. This type of damage can be detected and will result in denial of warranty claims.

The scroll compressor is quieter than a reciprocating compressor, however, the two compressors have much different sound characteristics. The sounds made by a scroll compressor do not affect system reliability, performance, or indicate damage.

2 − Crankcase Heaters HR1 (all units) & HR2 (120S4D, 150, 180, 240)

All TSA series units use a belly−band type crankcase heater. Heater HR1 is wrapped around compressor B1 and heater HR2 is wrapped around compressor B2. HR1 and HR2 assure proper compressor lubrication at all times.

3 − High Pressure Switch S4 (all units) & S7 (120S4D, 150, 180, 240)

The high pressure switch is a manual−reset SPST N.C. switch which opens on a pressure rise. The switch is located in the compressor discharge line and is wired in series with the compressor contactor coil. When discharge pressure rises to 640 ± 10 psig (4413 ± 69 kP) the switch opens and the compressor is de−energized.

4 − Low Ambient Switch S11 (all units) & S84 (120S4D, 150, 180, 240)

The low ambient switch is a field accessory, auto−reset SPST N.O. pressure switch, which allows for mechanical cooling operation at low outdoor temperatures. All TS units are equipped with S11. TSA120S4D, 150, 180 and 240 units are equipped with both S11 and S84. A switch is located in each liquid line. In all TSA units, S11 is wired in series with fan relay K10. In the TSA120S4D and 150, S84 is wired in series with S11 and contactor K10. In the TS−180 and 240, S84 is wired in series with fan relay K149. When liquid pressure rises to 450 ± 10 psig (3103 ± 69 kPa), the switch closes and the condenser fan is energized. When the liquid pressure drops to 240 ± 10 psig (1655 ± 69 kPa) the switch opens and the condenser fan in that refrigerant circuit is de−energized. This intermittent fan operation results in higher evaporating temperature, allowing the system to operate without icing the evaporator coil and losing capacity.

5 - Filter Drier (all units)

All TS model units have a filter drier that is located in the liquid line of each refrigerant circuit at the exit of each condenser coil. The drier removes contaminants and moisture from the system.

6 - Condenser Fan B4 (all units)
B5 (120S4D, 150, 180, 240)
B21 & B22 (180, 240)

See page 2 for the specifications on the condenser fans used in the TS units. All condenser fans have single- phase motors. The TSA072 and 090 units are equipped with a single condenser fan. The TSA120 and 150 are equipped with two fans and the 180 and 240 have four fans. The fan assembly may be removed for servicing by removing the fan grill, unplugging the motor then loosening the motor bracket. The assembly will lift out.

7 - Loss of Charge Switch S24 & S25

The loss of charge switch is an auto-reset SPST N.C. switch which opens on a pressure drop (almost a complete loss of charge). All TSA units have S24 and the 120S4D through 240 have S25. The switch is located in the liquid line and wired in series with compressor contactor and high pressure switch. S24 is wired in series with first stage cool and S25 is wired in series with second stage cool. When pressure drops below 40± 5 psig (indicating loss of charge in the system) the switch opens and compressor is de-energized. The switch automatically resets when refrigerant is added and pressure in the discharge line rises above 90± 5 psig.

II- REFRIGERANT SYSTEM

A-Plumbing

Field refrigerant piping consists of liquid and suction lines connecting the condensing unit and the indoor unit. Liquid and suction service valves are located in a compartment at the corner of the unit below the control box. Piping can be routed directly from the service valves or field supplied elbows can be added to divert the piping as required

Refer to table 1 for field-fabricated refrigerant line sizes for runs up to 50 linear feet (15 m).

TABLE 1

TSA Unit	Liquid Line	Suction Line
072	5/8” (16 mm)	1-1/8” (29 mm)
090	5/8” (16 mm)	1-1/8” (29 mm)
120S4S	5/8” (16 mm)	1-3/8” (35 mm)
120S4D	5/8” (16 mm)	1-1/8” (29 mm)
150	5/8” (16 mm)	1-1/8” (29 mm)
180	5/8” (16 mm)	1-1/8” (29 mm)
240	5/8” (16 mm)	1-3/8” (35 mm)

Refrigerant Line Limitations

You may install the unit in applications that have line set lengths of up to 50 linear feet (15 m) with refrigerant line sizes as outlined in table 1 (excluding equivalent length of fittings). Size refrigerant lines greater than 50 linear feet (15m or greater) according to the Lennox Refrigerant Piping Design and Fabrication Guidelines (Corp. 9351-L9) or latest version.

B-Service Valves

OPERATING SERVICE VALVES

The liquid and suction line service valves are typically used for removing refrigerant, flushing, leak testing, evacuating, checking charge and charging.

IMPORTANT

Only use Allen wrenches of sufficient hardness (50Rc - Rockwell Harness Scale minimum). Fully insert the wrench into the valve stem recess.

Service valve stems are factory-torqued (from 9 ft-lbs for small valves, to 25 ft-lbs for large valves) to prevent refrigerant loss during shipping and handling. Using an Allen wrench rated at less than 50Rc risks rounding or breaking off the wrench, or stripping the valve stem recess.

Each valve is equipped with a service port which has a factory-installed valve stem.

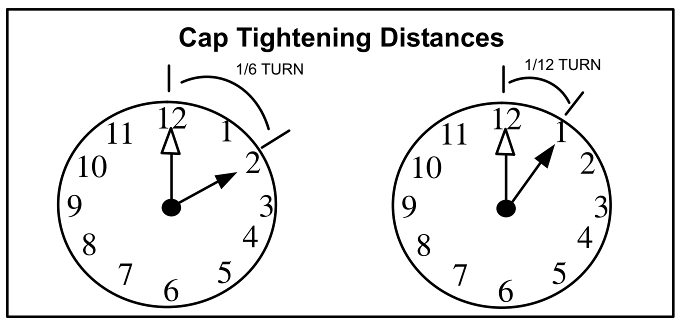


FIGURE 13

IMPORTANT

To prevent stripping of the various caps used, the appropriately sized wrench should be used and fitted snugly over the cap before tightening.

TABLE 2
Torque Requirements

Part	Recommended Torque	
Service valve cap	8 ft.- lb.	11 NM
Sheet metal screws	16 in.- lb.	2 NM
Machine screws #10	28 in.- lb.	3 NM
Compressor bolts	90 in.- lb.	10 NM
Gauge port seal cap	8 ft.- lb.	11 NM

To Access Angle-Type Service Port:

A service port cap protects the service port core from contamination and serves as the primary leak seal.

1.. Remove service port cap with an appropriately sized wrench.
2.. Connect gauge to the service port.
3.. When testing is completed, replace service port cap and tighten as follows:
- *With Torque Wrench*: Finger tighten and then tighten per table 2.
- *Without Torque Wrench*: Finger tighten and use an appropriately sized wrench to turn an additional 1/6 turn clockwise as illustrated in figure 13.

To Open Liquid Line Service Valve:

1 - Remove stem cap with an adjustable wrench.
2 - Using service wrench and 5/16” hex head extension if needed (part #49A71) back the stem out counterclockwise until the valve stem just touches the retaining ring.
3 - Replace stem cap. Tighten finger tight, then tighten an additional 1/6 turn. Do not over torque.

To Close Liquid Line Service Valve:

1 - Remove stem cap with an adjustable wrench.
2 - Using service wrench and 5/16” hex head extension if needed (part #49A71), turn stem clockwise to seat the valve. Tighten firmly.
3 - Replace stem cap. Tighten finger tight, then tighten an additional 1/6 turn. Do not over torque.
3 - Replace stem cap. Tighten finger tight, then tighten an additional 1/6 turn. Do not over torque.

Service (Ball) Valve

Some TSA units are equipped with a full service ball valve, as shown in figure 15. One service port that contains a valve core is present in this valve. A cap is also provided to seal off the service port. The valve is not rebuildable so it must always be replaced if failure has occurred.

Opening the Suction Line Service Valve

1 - Remove the stem cap with an adjustable wrench.
2 - Using a service wrench, turn the stem counterclockwise for 1/4 of a turn.
3 - Replace the stem cap and tighten it firmly.

Closing the Suction Line Service Valve

1 - Remove the stem cap with an adjustable wrench.
2 - Using a service wrench, turn the stem clockwise for 1/4 of a turn.
3 - Replace the stem cap and tighten firmly.

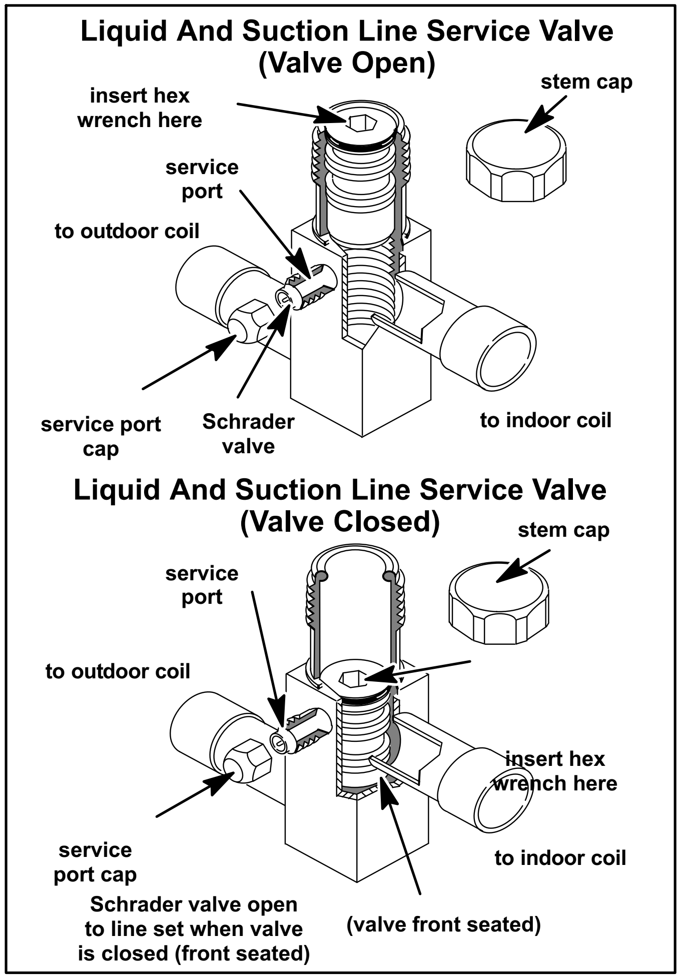


FIGURE 14

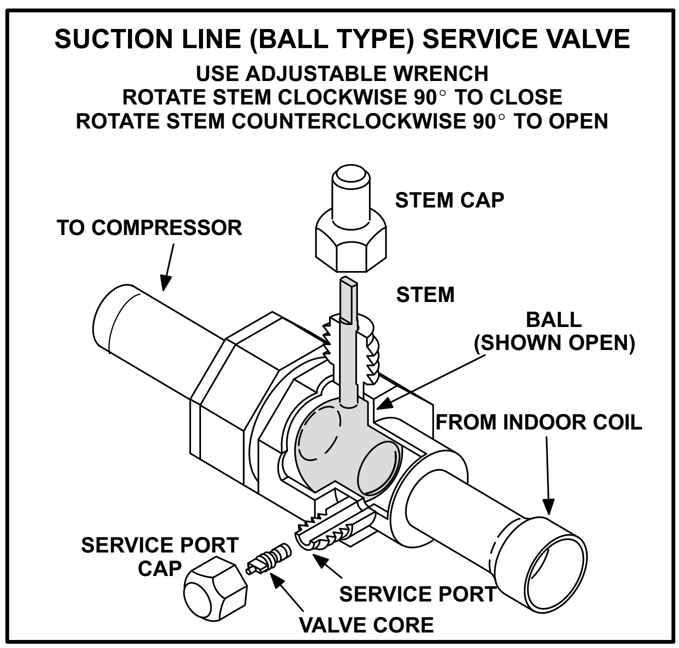


FIGURE 15

III-START UP

The following is a general procedure and does not apply to all thermostat control systems. Refer to sequence of operation in this manual for more information.

WARNING

Crankcase heaters must be energized for 24 hours before attempting to start compressors. Set thermostat so there is no compressor demand before closing disconnect switch. Attempting to start compressors during the 24-hour warm -up period could result in damage or failed compressors.

1 - Set fan switch to AUTO or ON and move the system selection switch to COOL. Adjust the thermostat to a setting far enough below room temperature to bring on compressors. Compressors will start and cycle on demand from the thermostat (allowing for unit and thermostat time delays).
2 - Each circuit is field charged with HCFC-410A refrigerant.
3 - Refer to Charging section for proper method of checking and charging the system.

IMPORTANT

Three-phase scroll compressors must be phased sequentially to ensure correct compressor rotation and operation. At compressor start-up, a rise in discharge and drop in suction pressures indicate proper compressor phasing and operation. If discharge and suctions pressures do not perform normally, follow the steps below to correctly phase in the unit.

1 - Disconnect power to the unit.
2 - Reverse any two field power leads (L1 and L3 preferred) to the unit.
3 - Reapply power to the unit.

Discharge and suction pressures should operate at their normal start-up ranges.

NOTE - Compressor noise level will be significantly higher when phasing is incorrect and the unit will not provide cooling when compressor is operating backwards. Continued backward operation will cause the compressor to cycle on internal protector.

IV- CHARGING

A-Leak Testing

IMPORTANT

Leak detector must be capable of sensing HFC refrigerant.

WARNING

Refrigerant can be harmful if it is inhaled. Refrigerant must be used and recovered responsibly.

Failure to follow this warning may result in personal injury or death.

WARNING

Fire, Explosion and Personal Safety Hazard.

Failure to follow this warning could result in damage, personal injury or death.

Never use oxygen to pressurize or purge refrigeration lines. Oxygen, when exposed to a spark or open flame, can cause damage by fire and/ or an explosion, that could result in personal injury or death.

1.. Connect an HFC-410A manifold gauge set as illustrated in figure 16.
2.. Open the valve on the HFC-410A cylinder (suction only).
3.. Open the high pressure side of the manifold to allow HFC-410A into the line set and indoor unit. Weigh in a trace amount of HFC-410A. *[A trace amount is a maximum of two ounces (57 g) refrigerant or three pounds (31 kPa) pressure].*
4.. Close the valve on the HFC-410A cylinder and the valve on the high pressure side of the manifold gauge set.
5.. Disconnect the HFC-410A cylinder.
6.. Connect a cylinder of dry nitrogen with a pressure regulating valve to the center port of the manifold gauge set.
7.. Adjust dry nitrogen pressure to 150 psig (1034 kPa). Open the valve on the high side of the manifold gauge set in order to pressurize the line set and the indoor unit.
8.. After a few minutes, open one of the service valve ports and verify that the refrigerant added to the system earlier is measurable with a leak detector.

NOTE - Amounts of refrigerant will vary with line lengths.

9.. Check all joints for leaks.
10.. Purge dry nitrogen and HFC-410A mixture.
11.. Correct any leaks and recheck.
12.. After leak testing disconnect gauges from service ports.

A Connect an HFC-410A manifold gauge set high pressure hose to the suction valve service port.

B With both manifold valves closed, connect the cylinder of HFC-410A refrigerant to the center port of the manifold gauge set.

C After the line set has been connected to both the indoor and outdoor units, check the line set connections and indoor unit for leaks. Use the following procedure to test for leaks:

NOTE - LATER IN THE PROCEDURE, THE HFC-410A CONTAINER WILL BE REPLACE BY THE NITROGEN CONTAINER.

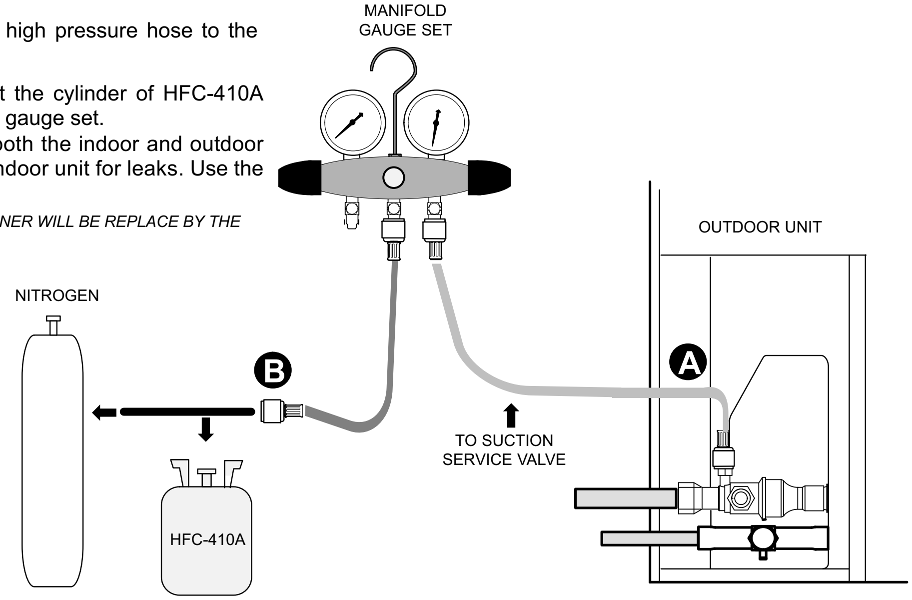
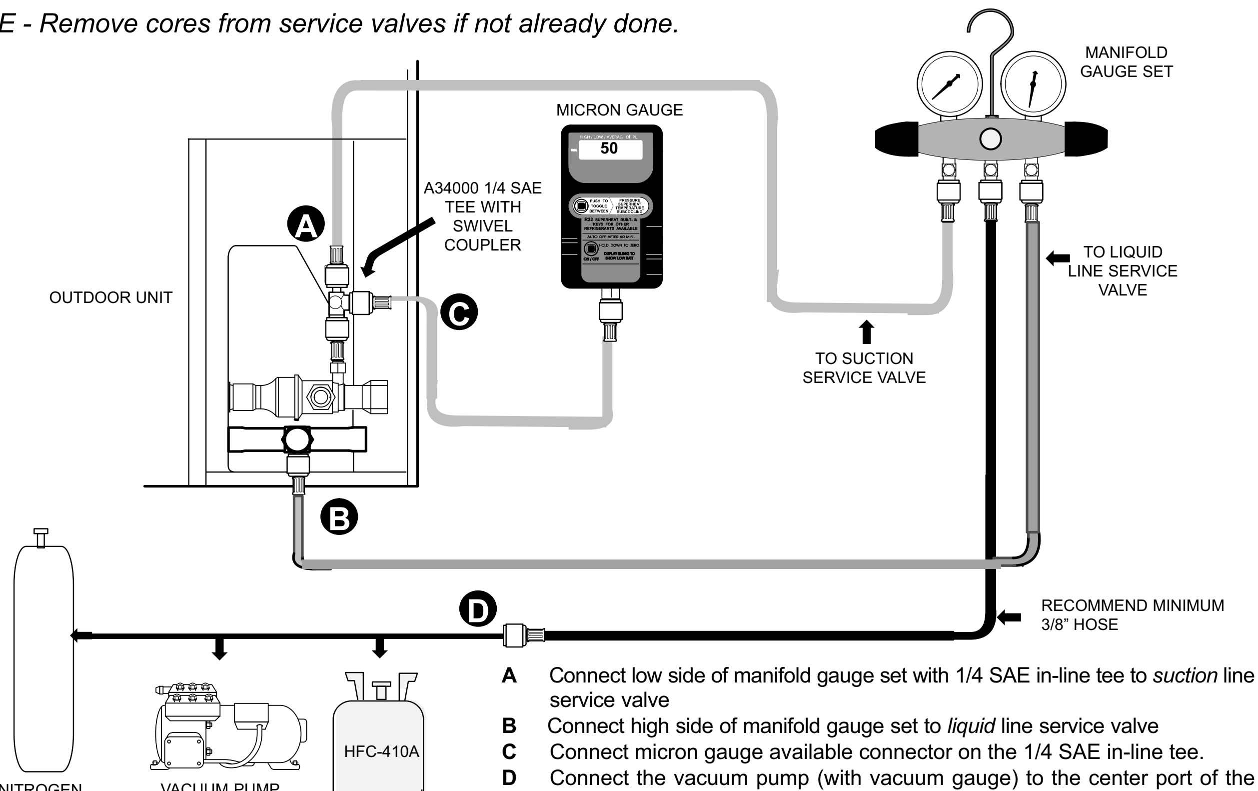


FIGURE 16

B-Evacuating the System

NOTE - Remove cores from service valves if not already done.



A Connect low side of manifold gauge set with 1/4 SAE in-line tee to *suction* line service valve

B Connect high side of manifold gauge set to *liquid* line service valve

C Connect micron gauge available connector on the 1/4 SAE in-line tee.

D Connect the vacuum pump (with vacuum gauge) to the center port of the manifold gauge set. The center port line will be used later for both the HFC-410A and nitrogen containers.

FIGURE 17

⚠ WARNING

Danger of Equipment Damage. Avoid deep vacuum operation. Do not use compressors to evacuate a system. Extremely low vacuums can cause internal arcing and compressor failure. Damage caused by deep vacuum operation will void warranty.

⚠ IMPORTANT

Use a thermocouple or thermistor electronic vacuum gauge that is calibrated in microns. Use an instrument capable of accurately measuring down to 50 microns.

Evacuating the system of non-condensables is critical for proper operation of the unit. Non-condensables are defined as any gas that will not condense under temperatures and pressures present during operation of an air conditioning system. Non-condensables and water suction combine with refrigerant to produce substances that corrode copper piping and compressor parts.

NOTE - Remove cores from service valves if not already done.

1.. Connect an HFC-410A manifold gauge set as illustrated in figure17.

2.. Open both manifold valves and start the vacuum pump.

3.. Evacuate the line set and indoor unit to an **absolute pressure** of 23,000 microns (29 inches of mercury).

*NOTE - During the early stages of evacuation, it is desirable to close the manifold gauge valve at least once to determine if there is a rapid rise in pressure this indicates a relatively large leak. If this occurs, **repeat the leak testing procedure**.*

*NOTE - The term **absolute pressure** means the total actual pressure within a given volume or system, above the absolute zero of pressure. Absolute pressure in a vacuum is equal to atmospheric pressure minus vacuum pressure.*

4.. When the absolute pressure reaches 23,000 microns (29 inches of mercury), close the manifold gauge valves, turn off the vacuum pump and disconnect the manifold gauge center port hose from vacuum pump. Attach the manifold center port hose to a dry nitrogen cylinder with pressure regulator set to 150 psig (1034 kPa) and purge the hose. Open the manifold gauge valves to break the vacuum in the line set and indoor unit. Close the manifold gauge valves.

5.. Shut off the dry nitrogen cylinder and remove the manifold gauge hose from the cylinder. Open the manifold gauge valves to release dry nitrogen from the line set and indoor unit.

6.. Reconnect the manifold gauge to vacuum pump, turn pump on, and continue to evacuate line set and indoor unit until the absolute pressure does not rise above 500 microns within a 20-minute period after shutting off vacuum pump and closing the manifold gauge valves.

7.. When the absolute pressure requirement above has been met, disconnect the manifold hose from the vacuum pump and connect it to an upright cylinder of HFC-410A refrigerant. Open the manifold gauge valve pressure line set to break vacuum with 2 to 5 psi.

8.. Perform the following:

A Close manifold gauge valves

B Shut off HFC-410A cylinder

C Reinstall service valve cores by removing manifold hose from service valve. Quickly install cores with core tool while maintaining a positive system pressure.

D Replace the stem caps and secure finger tight, then tighten an additional one-sixth (1/6) of a turn as illustrated in figure 13.

C-Charging

TSA units have a factory holding charge of 1 pound of HFC-410A in each circuit. Additional refrigerant will need to be added during installation (table 3).

TABLE 3
Adding Refrigerant

Models	25 Feet[1] (pounds)	Liquid Line Diameter (inches)	Suction Line Diameter (inches)	Adjustment per foot of Line[2] (Ounces)
TSA072S4S	11	5/8	1-1/8	1.7
TSA090S4S	16	5/8	1-1/8	1.7
TSA120S4S	17	5/8	1-3/8	1.8
TSA120S4D	20[3]	5/8	1-1/8	1.7
TSA150S4D	21[3]	5/8	1-1/8	1.7
TSA180S4D	29[3]	5/8	1-1/8	1.7
TSA240S4D	35[3]	5/8	1-3/8	1.8

[1] Total amount of charge necessary to accommodate 25 feet of line set.

[2] If line set length is greater than 25 feet, add this amount to each circuit. If line set is less than 25 feet, subtract this amount from each circuit. Refer to Lennox Refrigerant Piping Design and Fabrication Guidelines for more information.

[3] Amounts listed are total charge.

NOTE - Refrigerant line sets longer than 200 feet (60 meters) are not recommended. For assistance contact Lennox Application Department.

To check the charge, use the following procedure:

1.. Attach gauge manifolds and operate unit in **cooling mode** until system stabilizes (approximately five minutes). Make sure outdoor air dampers are closed.

2.. Use a thermometer to accurately measure the outdoor ambient temperature.

3.. Apply the outdoor temperature to tables 5 and 6 to determine normal operating pressures.

4.. Compare the normal operating pressures to the pressures obtained from the gauges. Minor variations in these pressures may be expected due to differences in installations. Significant differences could mean that the system is not properly charged or that a problem exists with some component in the system. **Correct any system problems before proceeding.**

5.. If discharge pressure is high, remove refrigerant from the system. If discharge pressure is low, add refrigerant to the system.

- Add or remove charge in increments.
- Allow the system to stabilize each time refrigerant is added or removed.

CHARGE VERIFICATION - APPROACH METHOD

Use the following approach method along with the normal operating pressures to confirm readings.

1.. Using the same thermometer, compare liquid temperature at service valve to outdoor ambient temperature.

Approach Temperature = Liquid temperature minus ambient temperature

2.. Approach temperature should as indicated in table 4 for each stage. An approach temperature greater than this value indicates an undercharge. An approach temperature less than this value indicates an overcharge.

TABLE 4
HFC-410A Approach Temperatures

Models	Stage	Approach Temperature (°F)	Approach Temperature (°C)
TSA072S4S	1	7.0	3.9
TSA090S4S	1	7.0	3.9
TSA120S4S	1	6.0	3.3
TSA120S4D	1	6.0	3.3
	2	6.0	3.3
TSA150S4D	1	6.0	3.3
	2	6.0	3.3
TSA180S4D	1	6.0	3.3
	2	6.0	3.3
TSA240S4D	1	6.0	3.3
	2	6.0	3.3

3.. Do not use the approach method if system pressures do not match pressures in table 1. The approach method is not valid for grossly over or undercharged systems.

TABLE 5
HFC-410A Normal Operating Pressures (Liquid +10 and Suction +5 psig) (Single-Stage Units)

Temp*	072S4S		090S4S		120S4S	
	Liquid	Suction	Liquid	Suction	Liquid	Suction
65° F (18° C)	272	131	256	129	259	132
75° F (24° C)	311	134	296	131	299	135
85° F (29° C)	355	137	337	131	341	137
95° F (35° C)	401	139	384	135	388	139
105° F (41° C)	455	143	431	137	437	142
115° F (46° C)	513	143	483	142	491	145
125° F (52° C)	574	148	537	146	548	147

Temperature of air entering outdoor Coil

TABLE 6
HFC-410A Normal Operating Pressures (Liquid +10 and Suction +5 psig) (Dual-Stage Units)

TEMP	120S4D STAGE 1		120S4D STAGE 2		150S4D STAGE 1		150S4D STAGE 2	
°F	Liquid	Suction	Liquid	Suction	Liquid	Suction	Liquid	Suction
65	236	133	245	131	264	129	261	126
75	275	138	285	134	303	131	302	128
85	316	142	326	136	344	133	345	131
95	366	146	368	147	391	136	391	134
105	409	147	419	142	440	138	442	136
115	458	150	469	145	493	141	496	139
125	516	153	528	148	554	143	557	142

TEMP	180S4D STAGE 1		180S4D STAGE 2		240S4D STAGE 1		240S4D STAGE 2	
°F (°C)*	Liquid	Suction	Liquid	Suction	Liquid	Suction	Liquid	Suction
65	228	126	234	124	254	133	257	128
75	266	127	272	125	289	134	296	128
85	307	130	313	126	333	136	337	132
95	355	132	359	129	379	140	383	136
105	414	136	409	132	431	143	437	138
115	469	139	464	137	492	144	486	142
125	522	138	513	142	556	146	550	142

Temperature of air entering outdoor Coil

TABLE 7
HFC-410A Temperature (°F) - Pressure (Psig)

°F	Psig	°F	Psig	°F	Psig	°F	Psig	°F	Psig	°F	Psig	°F	Psig	°F	Psig
32	100.8	48	137.1	63	178.5	79	231.6	94	290.8	110	365.0	125	445.9	141	545.6
33	102.9	49	139.6	64	181.6	80	235.3	95	295.1	111	370.0	126	451.8	142	552.3
34	105.0	50	142.2	65	184.3	81	239.0	96	299.4	112	375.1	127	457.6	143	559.1
35	107.1	51	144.8	66	187.7	82	242.7	97	303.8	113	380.2	128	463.5	144	565.9
36	109.2	52	147.4	67	190.9	83	246.5	98	308.2	114	385.4	129	469.5	145	572.8
37	111.4	53	150.1	68	194.1	84	250.3	99	312.7	115	390.7	130	475.6	146	579.8
38	113.6	54	152.8	69	197.3	85	254.1	100	317.2	116	396.0	131	481.6	147	586.8
39	115.8	55	155.5	70	200.6	86	258.0	101	321.8	117	401.3	132	487.8	148	593.8
40	118.0	56	158.2	71	203.9	87	262.0	102	326.4	118	406.7	133	494.0	149	601.0
41	120.3	57	161.0	72	207.2	88	266.0	103	331.0	119	412.2	134	500.2	150	608.1
42	122.6	58	163.9	73	210.6	89	270.0	104	335.7	120	417.7	135	506.5	151	615.4
43	125.0	59	166.7	74	214.0	90	274.1	105	340.5	121	423.2	136	512.9	152	622.7
44	127.3	60	169.6	75	217.4	91	278.2	106	345.3	122	428.8	137	519.3	153	630.1
45	129.7	61	172.6	76	220.9	92	282.3	107	350.1	123	434.5	138	525.8	154	637.5
46	132.2	62	175.4	77	224.4	93	286.5	108	355.0	124	440.2	139	532.4	155	645.0
47	134.6			78	228.0			109	360.0			140	539.0		

V-MAINTENANCE

Installation and service must be performed by a licensed professional installer (or equivalent) or a service agency. At the beginning of each cooling season, the system should be checked as follows:

⚠WARNING

Electric shock hazard. Can cause injury or death. Before attempting to perform any service or maintenance, turn the electrical power to unit OFF at disconnect switch(es). Unit may have multiple power supplies.

OUTDOOR UNIT

1.. Clean and inspect outdoor coil (may be flushed with a water hose). Ensure power is off before cleaning.

2.. Outdoor unit fan motor is pre-lubricated and sealed. No further lubrication is needed.

3.. Visually inspect all connecting lines, joints and coils for evidence of oil leaks.

4.. Check all wiring for loose connections.

5.. Check for correct voltage at unit (unit operating).

6.. Check amp draw on outdoor fan motor.

UNIT NAMEPLATE: _________ ACTUAL: __________

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

INDOOR COIL

1.. Clean coil if necessary.

2.. Check connecting lines, joints and coil for evidence of oil leaks.

3.. Check condensate line and clean if necessary.

INDOOR UNIT

1.. Clean or change filters.

2.. Blower motors are prelubricated and permanently sealed. No more lubrication is needed.

3.. Adjust blower speed for cooling. Measure the pressure drop over the coil to determine the correct blower CFM. Refer to the unit information service manual for pressure drop tables and procedure.

4.. *Belt Drive Blowers* - Check belt for wear and proper tension.

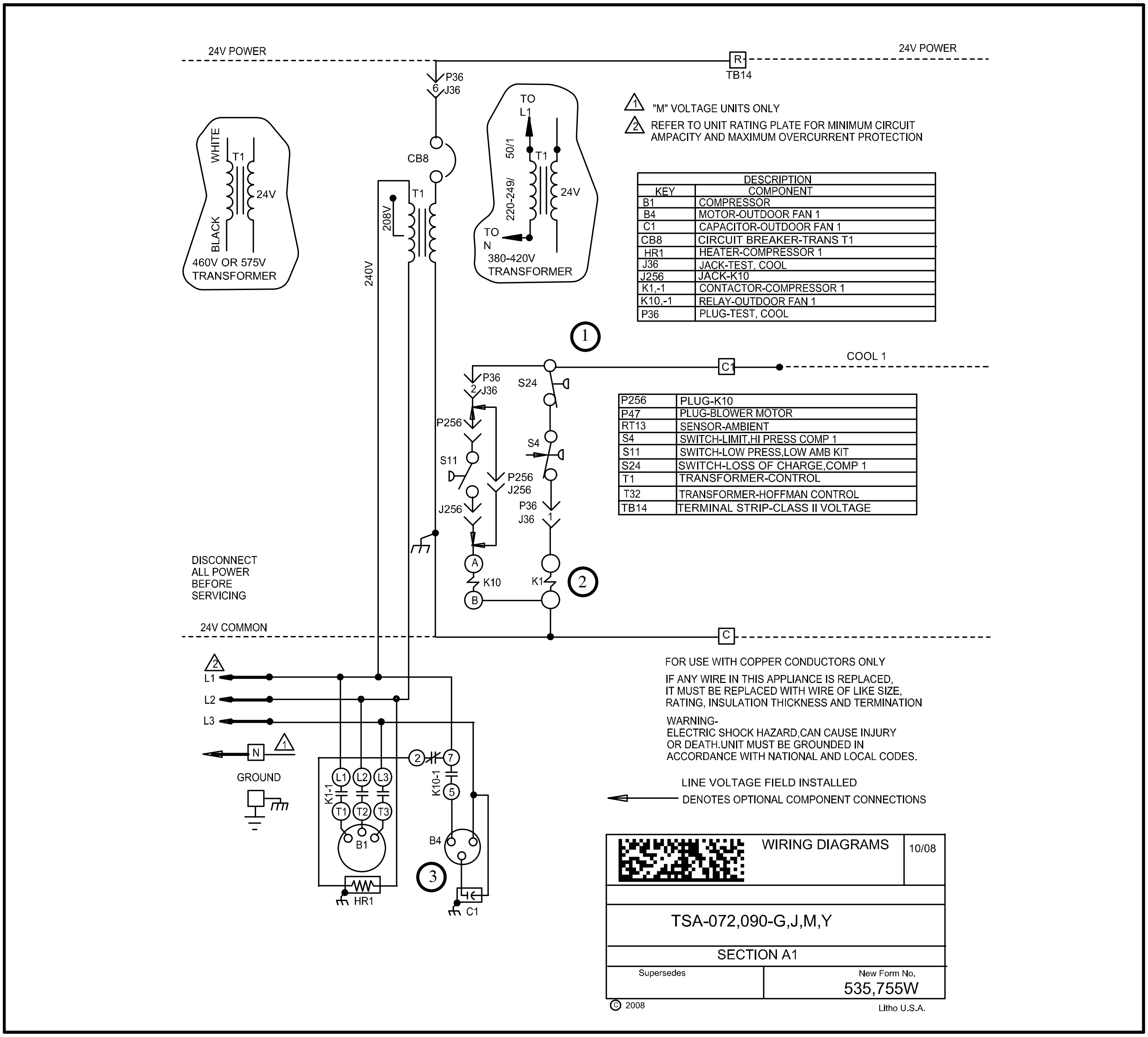
5.. Check all wiring for loose connections.

6.. Check for correct voltage at unit. (blower operating)

7.. Check amp draw on blower motor.

UNIT NAMEPLATE: _________ ACTUAL: __________

VI-Wiring Diagram and Sequence of Operation
A-TSA072-090

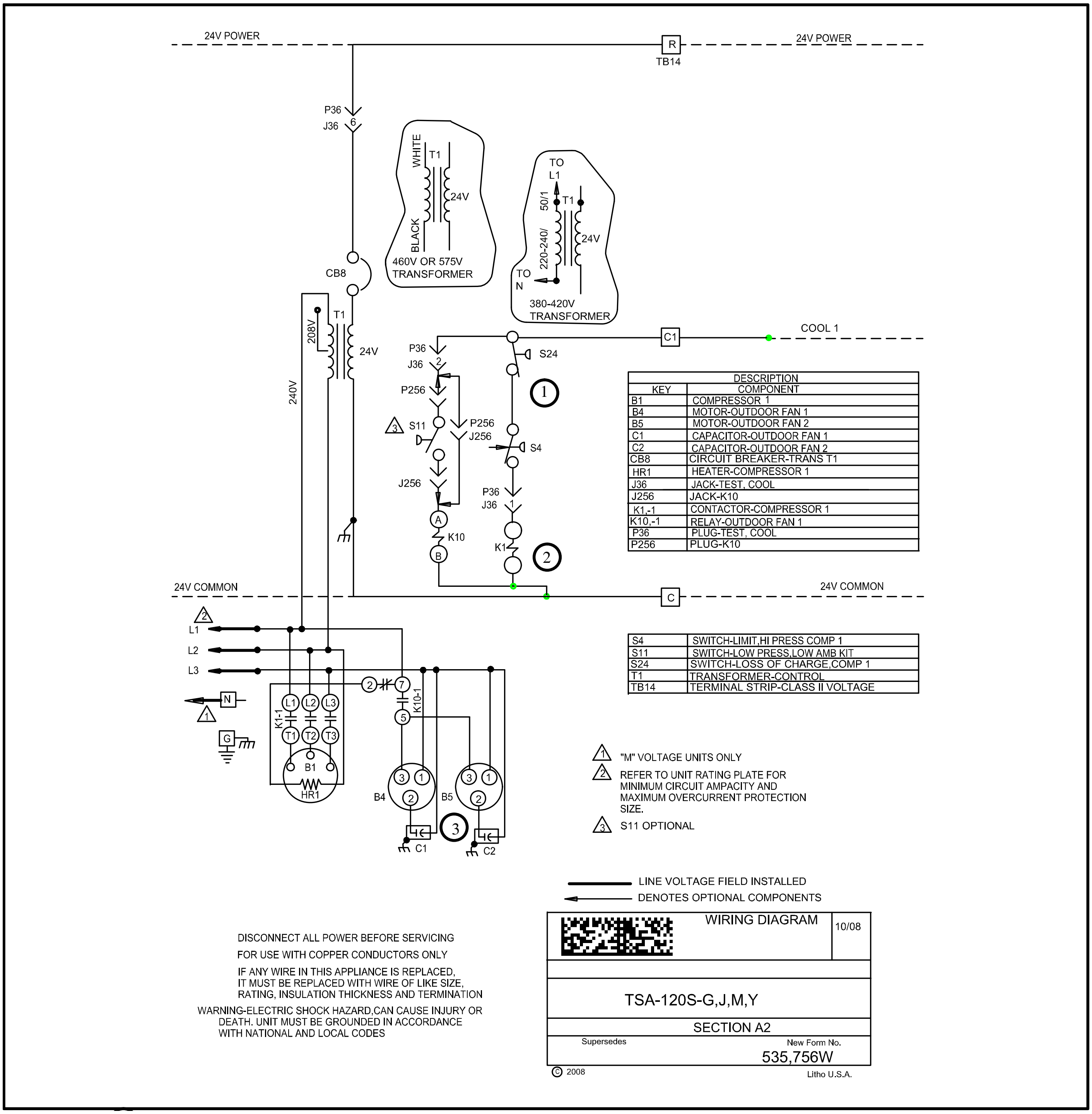


1 - Cooling demand energizes at thermostat terminal Y1. Voltage passes through N.C. loss of charge switch S24 and N.C. high pressure switch S4. At the same time voltage passes through optional low ambient switch S11 and or A6 Hoffman control.

2 - Compressor contactor K1 and outdoor fan relay K10 are energized.

3 - K1-1 closes energizing compressor B1 and K10-1 closes energizing outdoor fan B4. Crankcase heater HR1 is denergized.

B-TSA120S4S

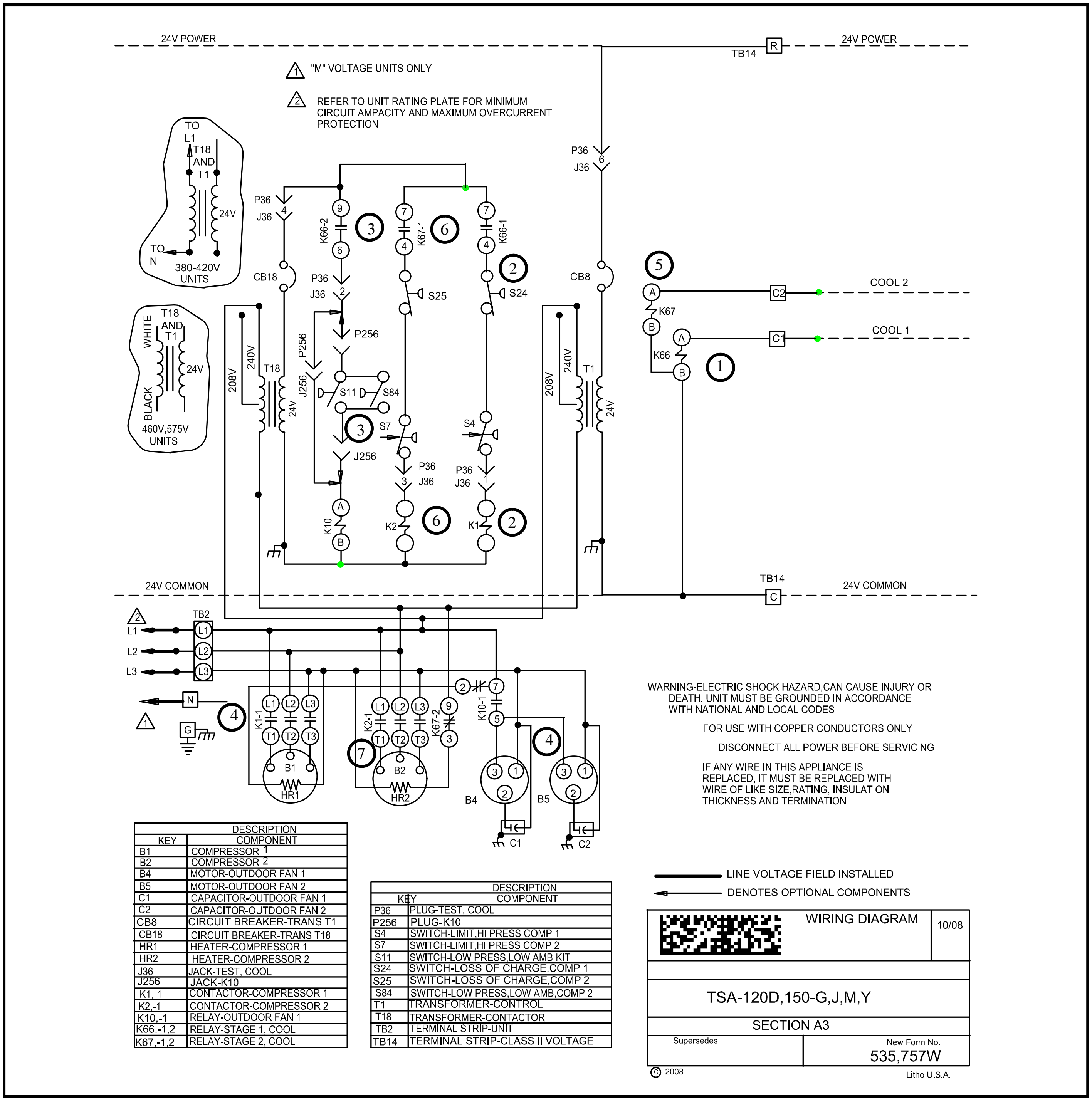


1 - Cooling demand energizes at thermostat terminal Y1. Voltage passes through N.C. loss of charge switch S24 and N.C. high pressure switch S4. At the same time voltage passes through optional low ambient switch S11.

2 - Compressor contactor K1 and outdoor fan relay K10 are energized.

3 - K1-1 closes energizing compressor B1 and K10-1 closes energizing outdoor fans B4 and B5. Crankcase heater HR1 is denergized.

C-TSA120S4D, 150



KEY	DESCRIPTION COMPONENT
B1	COMPRESSOR 1
B2	COMPRESSOR 2
B4	MOTOR-OUTDOOR FAN 1
B5	MOTOR-OUTDOOR FAN 2
C1	CAPACITOR-OUTDOOR FAN 1
C2	CAPACITOR-OUTDOOR FAN 2
CB8	CIRCUIT BREAKER-TRANS T1
CB18	CIRCUIT BREAKER-TRANS T18
HR1	HEATER-COMPRESSOR 1
HR2	HEATER-COMPRESSOR 2
J36	JACK-TEST, COOL
J256	JACK-K10
K1,-1	CONTACTOR-COMPRESSOR 1
K2,-1	CONTACTOR-COMPRESSOR 2
K10,-1	RELAY-OUTDOOR FAN 1
K66,-1,2	RELAY-STAGE 1, COOL
K67,-1,2	RELAY-STAGE 2, COOL

KEY	DESCRIPTION COMPONENT
P36	PLUG-TEST, COOL
P256	PLUG-K10
S4	SWITCH-LIMIT,HI PRESS COMP 1
S7	SWITCH-LIMIT,HI PRESS COMP 2
S11	SWITCH-LOW PRESS,LOW AMB KIT
S24	SWITCH-LOSS OF CHARGE,COMP 1
S25	SWITCH-LOSS OF CHARGE,COMP 2
S84	SWITCH-LOW PRESS,LOW AMB,COMP 2
T1	TRANSFORMER-CONTROL
T18	TRANSFORMER-CONTACTOR
TB2	TERMINAL STRIP-UNIT
TB14	TERMINAL STRIP-CLASS II VOLTAGE

First stage cool

1 - Cooling demand energizes K66 relay coil at thermostat terminal Y1.

2 - K66-1 contacts close, voltage passes through S24 loss of charge switch and high pressure switch S4, energizing compressor contactor K1.

3 - At the same time, K66-2 contacts close sending voltage through optional low ambient switch S11 and low pressure switch S84, energizing out door fan relay K10.

4 - K1-1 closes energizing compressor B1. K10-1 closes energizing outdoor fans B4 and B5. Crankcase heaters HR1 and HR2 are de-energized.

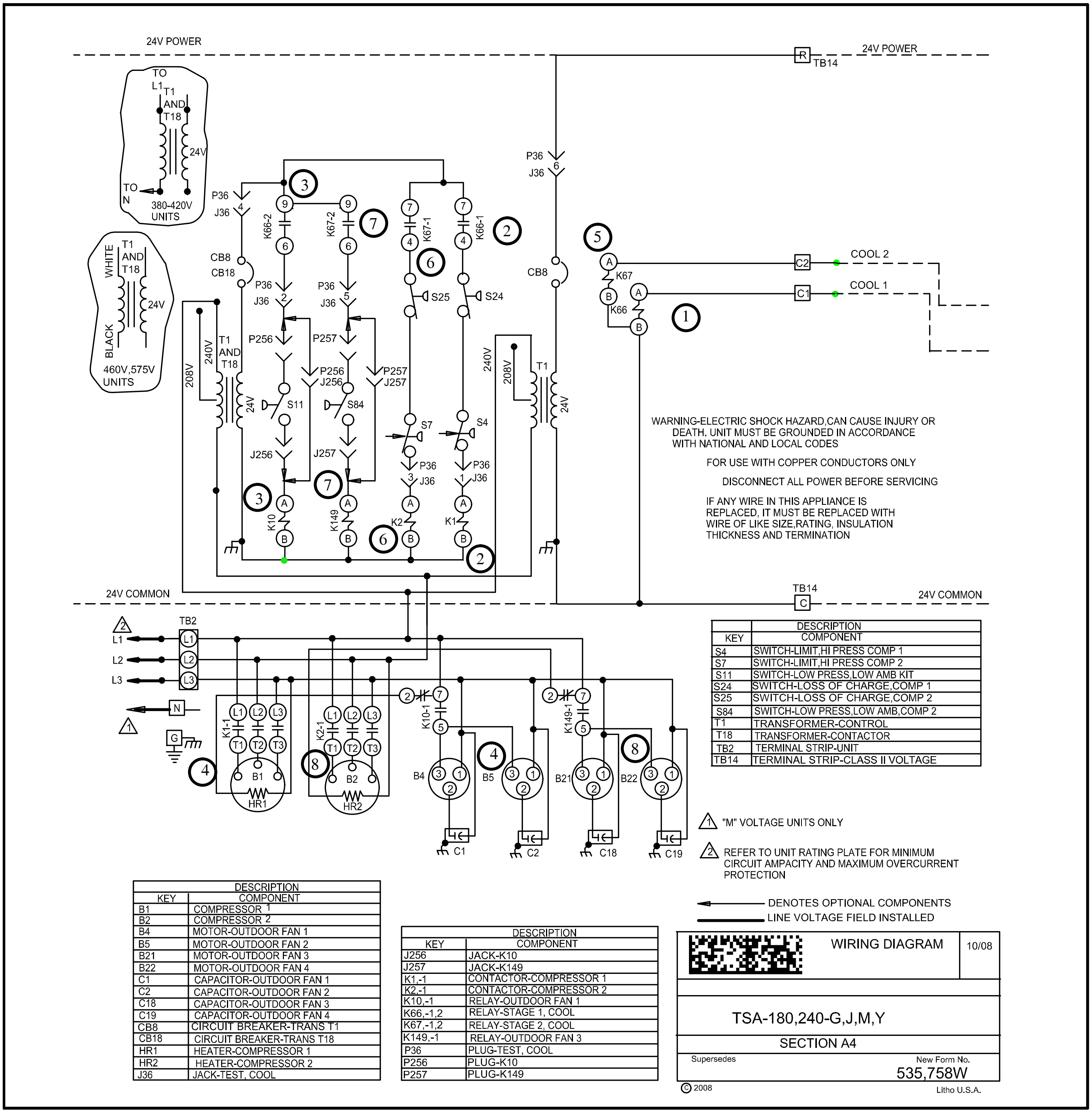
Second stage cool

5- Cooling demand energizes K67 relay coil at thermostat terminal Y2.

6- K67-1 contacts close, voltage passes through S25 loss of charge switch and S7 high pressure switch energizing compressor contactor K2.

7- K2-1 closes energizing compressor B2.

D-TSA180, 240



KEY	DESCRIPTION COMPONENT
S4	SWITCH-LIMIT,HI PRESS COMP 1
S7	SWITCH-LIMIT,HI PRESS COMP 2
S11	SWITCH-LOW PRESS,LOW AMB KIT
S24	SWITCH-LOSS OF CHARGE,COMP 1
S25	SWITCH-LOSS OF CHARGE,COMP 2
S84	SWITCH-LOW PRESS,LOW AMB,COMP 2
T1	TRANSFORMER-CONTROL
T18	TRANSFORMER-CONTACTOR
TB2	TERMINAL STRIP-UNIT
TB14	TERMINAL STRIP-CLASS II VOLTAGE

KEY	DESCRIPTION COMPONENT
B1	COMPRESSOR 1
B2	COMPRESSOR 2
B4	MOTOR-OUTDOOR FAN 1
B5	MOTOR-OUTDOOR FAN 2
B21	MOTOR-OUTDOOR FAN 3
B22	MOTOR-OUTDOOR FAN 4
C1	CAPACITOR-OUTDOOR FAN 1
C2	CAPACITOR-OUTDOOR FAN 2
C18	CAPACITOR-OUTDOOR FAN 3
C19	CAPACITOR-OUTDOOR FAN 4
CB8	CIRCUIT BREAKER-TRANS T1
CB18	CIRCUIT BREAKER-TRANS T18
HR1	HEATER-COMPRESSOR 1
HR2	HEATER-COMPRESSOR 2
J36	JACK-TEST, COOL

KEY	DESCRIPTION COMPONENT
J256	JACK-K10
J257	JACK-K149
K1,-1	CONTACTOR-COMPRESSOR 1
K2,-1	CONTACTOR-COMPRESSOR 2
K10,-1	RELAY-OUTDOOR FAN 1
K66,-1,2	RELAY-STAGE 1, COOL
K67,-1,2	RELAY-STAGE 2, COOL
K149,-1	RELAY-OUTDOOR FAN 3
P36	PLUG-TEST, COOL
P256	PLUG-K10
P257	PLUG-K149

First stage cool

1 - Cooling demand energizes K66 relay coil at thermostat terminal Y1.

2 - K66-1 contacts close, voltage passes through S24 loss of charge switch and high pressure switch S4 energizing contactor K1.

3 - At the same time K66-2 closes sending voltage through optional low pressure switch S11 energizing relay K10.

4 - K1-1 contacts close energizing compressor B1. K10-1 contacts close energizing outdoor fans B4 and B5. K10 terminals 2 and 7 open, de-energizing crankcaseheater HR1

Second stage cool

5- Cooling demand energizes K67 relay coil at thermostat terminal Y2.

6- K67-1 contacts close, voltage passes through S25 loss of charge switch and S7 high pressure switch energizing K2.

7- At the same time K67-2 closes sending voltage through S84 low pressure switch energizing relay K149.

8- K2-1 contacts close energizing compressor B2 and K149-1 contacts close energizing outdoor fans B21 and B22. K149 terminals 2 and 7 open de-energizing crankcase heater HR2.