HANBELL

LA Series
Screw Compressor

Technical Manual

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INTRODUCTION

The Hanbell LA series semi-hermetic twin-screw compressor inherits all the quality and experience of our R series (RA, RB, RC) compressor. The LA series compressor is specially suitable for low temperature applications：frosty system, freezing system, condensing unit system, parallel system, full liquid type cooling water system, etc. LA series compressor has 25 models LA-90~LA-1520, with displacement (50／60Hz) from 90 / 109 m3/hr to 1523 / 1832 m3/hr.

1. Compressor’s characteristics

1-1 Multi country (Taiwan, China, USA, England) patented high efficiency 5 to 6 asymmetrical rotor profile.

1-2 Precise volume control system

Steps or continuous capacity control system are available.

1-3 Adjustable volume ratio (Vi) – available for LA-90 ~ LA-280 only.

Vi = 2.2～4.8 can be adjusted continuously according to the working condition, effectively avoiding the loss of efficiency due to under or over compression

1-4 Economizer applications

Economizer port is a standard accessory for LA series screw compressor.

Floating type medium pressure (Economizer returned pressure) design, no matter if compressor work at full load or partial load condition, always can track the best medium pressure value, it means economizer could develop the maximum efficiency during the operation. Avoiding the return of economizer pressure to low pressure side.

1-5 Applicable with：R22, R404A, R507A, R407C.

1-6 Resistant to high load condition with long life bearing design

1-7 PTC temperature thermistor for the protection of

(1) High motor coil temperature
(2) High discharge temperature
(3) High oil temperature (optional)

1-8 Low vibration and low noise.

1-9 High efficiency oil separator, low-pressure drop, external connection

2. Compressor specification

2-1 Design specification

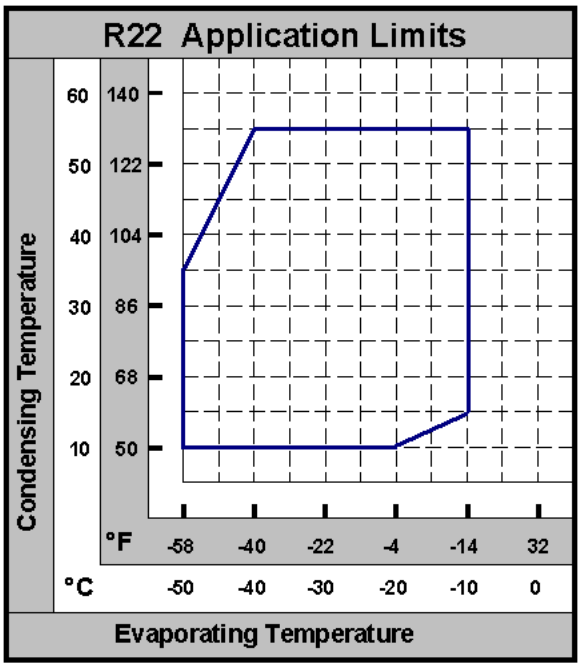
MODEL	COMPRESSOR					MOTOR							Hydrostatic Pressure Test	WEIGHT
	Displacement 60 / 50Hz	Rated Speed 60 / 50Hz	VI	Cap. Control (%)		Type	Nominal Hp		Starting -Up	Voltage (V)		Insulation	Protection		
				STEP	STEPLESS		60Hz	50Hz		60Hz	50Hz				
														Kg/cm2G	kg
LA-90	109/90			33, 66, 100	33~100		33	27							190
LA-110	129/107			33, 66, 100	33~100		39	32							195
LA-120	146/122			33, 66, 100	33~100		45	37							220
LA-140	172/144		2.2	33, 66, 100	33~100		53	44							250
LA-170	202/168		I	33, 66, 100	33~100		62	52		208 220 230 380 440 460 480 575					260
LA-200	235/196		4.8	25, 50, 75, 100	25~100		74	62	Y-△						300
LA-230	270/225			25, 50, 75, 100	25~100		85	71	PWS						325
LA-250	304/253			25, 50, 75, 100	25~100		93	77	DOL						380
LA-280	336/280			25, 50, 75, 100	25~100		101	84							415
LA-310	371/308			35, 50, 75, 100	35~100		110	91							550
LA-340	407/339			35, 50, 75, 100	35~100		121	101		220 230 380 440 460 480 575					570
LA-370	440/366			35, 50, 75, 100	35~100		130	108							590
LA-410	490/407	3550/2950		25, 50, 75, 100	25~100		146	121			380 400 415	Class F	PTC Protection	42	710
LA-470	567/471			25, 50, 75, 100	25~100		170-	141							780
LA-510	611/508			35, 50, 75, 100	35~100		183	152							750
LA-550	660/549		2.2	25, 50, 75, 100	25~100		195	162							830
LA-580	702/583		2.6	35, 50, 75, 100	35~100		210	175							810
LA-620	745/619		3.0	35, 50, 75, 100	35~100		220	183							860
LA-710	858/713		3.5	35, 50, 75, 100	35~100		250	208	Y-△						1050
LA-790	952/791			25, 50, 75, 100	25~100		276	230	DOL	380 440 460 480 575					1150
LA-830	993/825			30, 50, 75, 100	30~100		290	234							1185
LA-930	1117/929			35, 50, 75, 100	35~100		334	278							1210
LA-1090	1310/1089			35, 50, 75, 100	35~100		402	335							1430
LA-1280	1535/1276			30, 50, 75, 100	30~100		471	392							1580
LA-1520	1832/1523			25, 50, 75, 100	25~100		534	443							1630

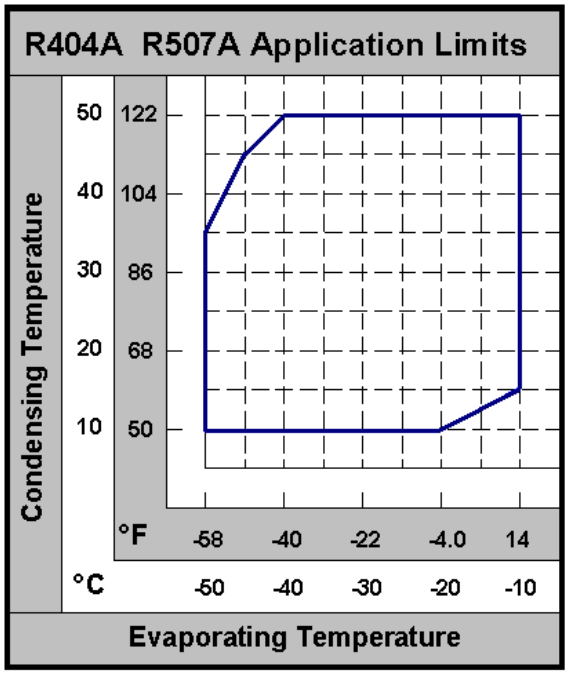
3 Phase, 2 Pole, Squirrel Cage, Induction Motor

Nominal Horse Power:

All above Nominal Hp are not equal to the maximum compressors Hp; Please refer to Hanbell selection software's output for the rated current, Maximum Continuous Current-M.C.C according to various working condition while selecting the contactor, cable, fuse and wire, etc…

2-2 Compressor application limits





Note :

1. When Hanbell screw compressor operates in partial or full load within limits, temperature of motor coil and discharge will rise concurrently. In order to keep compressor safely running continuously , Hanbell recommend usage of the following additional cooling devices :
   (1) Oil cooler. (2) Liquid injection for chamber. (3) Liquid injection for motor.

   Please refer to Hanbell selection software for application of additional cooling system.
   Hanbell recommends monitoring oil pressure differential and keep it 4 kg/cm2G over the suction pressure for adequate seal, lubrication and capacity control by pressure differential switch passively or by additional oil pump actively. Especially under operation conditions with low condensing temperature and high evaporating temperature like application in flooder water-cooled chillers, high-low pressure differential tends to be less than 4kg/cm2G, installation of oil pump is recommended to ensure regular oil pressure.

   Contact with Hanbell to verify potential operating conditions outside the limits shown.

2. Except LA-1090, LA-1280 & LA-1550 cool motor coils by liquid refrigerant directly, other models cool motor coils by refrigerant returned from evaporator. If compressors run continuously at partial load below 50%, failure of motor coils might happen due to insufficient cooling. Therefore, Hanbell emphasizes installation of liquid injection system to motor to make sure adequate cooling of motor coils for safe running of compressors. According to EN12900, suction superheat is 10°k and liquid sub-cooling is 0°k.
3. The minimum discharge superheat is recommended to be kept10°k higher than the condensing temperature to avoid liquid filling back to compressor and lubrication failure.

2-3 Compressor design feature

2.3.1 Compressor volume ratio

The Volume ratio (Vi) of the compressor can be defined as the ratio of suction volume of gas divided by discharge volume of gas of the compressor. The volume ratio directly affects the internal compression ratio or Pi of the compressor. A low Vi compressor corresponds to a low compression ratio compressor and high Vi compressors are used on higher compression ratio systems. In the equation below, in order to avoid over or under compression, the system compression ratio **(CR)** should be equal to the compressor internal compression ratio **(Pi)**. If CR is not equal to Pi, it would cause extra compensation of work / power of compressor and also decrease C.O.P. Refer also to the P-V (pressure – volume) diagram below to show the relation.

CR = Pd/Ps

Pi = Vi ^{k}

Vi = Vs/Vd

Where:

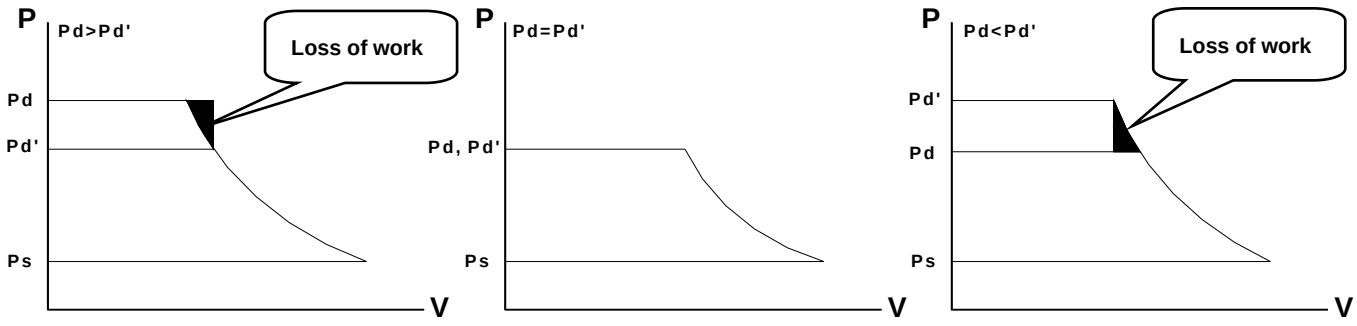
CR: system compression ratio **Pi:** internal compression ratio

Vi: internal volume ratio **Pd:** system pressure (absolute pressure)

Pd': discharge pressure (absolute pressure) **Ps:** suction pressure (absolute pressure)

Vs: suction volume **Vd:** discharge volume

K: refrigerant specific heat ratio



Under compression (CR > Pi) **CR = Pi** **Over compression (CR < Pi)**

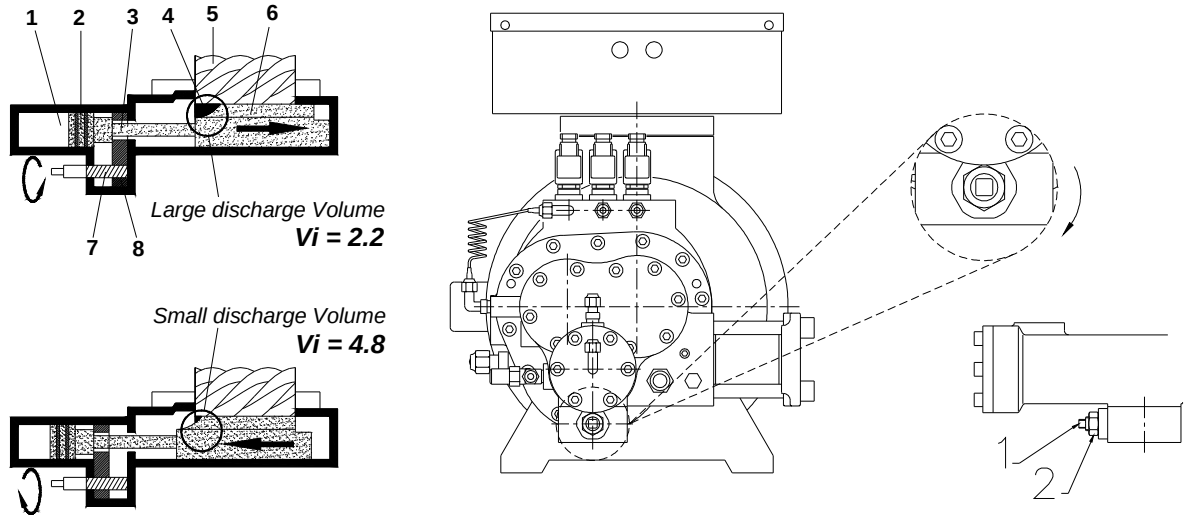
To ensure compressor performs in a high efficiency condition and prevent from additional power loss, Hanbell develops 2 kinds of volume ration control for LA series compressor :

a. Adjustable Vi – only for LA-90 ~ LA-280

b. Comprehensive built-in Vi – for LA-210 ~ LA-1520

a. Adjustable Vi

LA-90 ~ LA-280 had incorporated the idea of adjustable Vi, the customer can adjust and select the best value, between Vi=2.2~4.8 according to their working condition.



Adjustable type Vi illustration drawing

1. Chamber of volume ratio control	5. Compressor rotor
2. Volume ratio control piston	6. Volume ratio control slide valve
3. Volume ratio control piston rod	7. Volume ratio control adjustable bar
4. Discharge volume	8. Volume ratio control adjustable interconnection bar

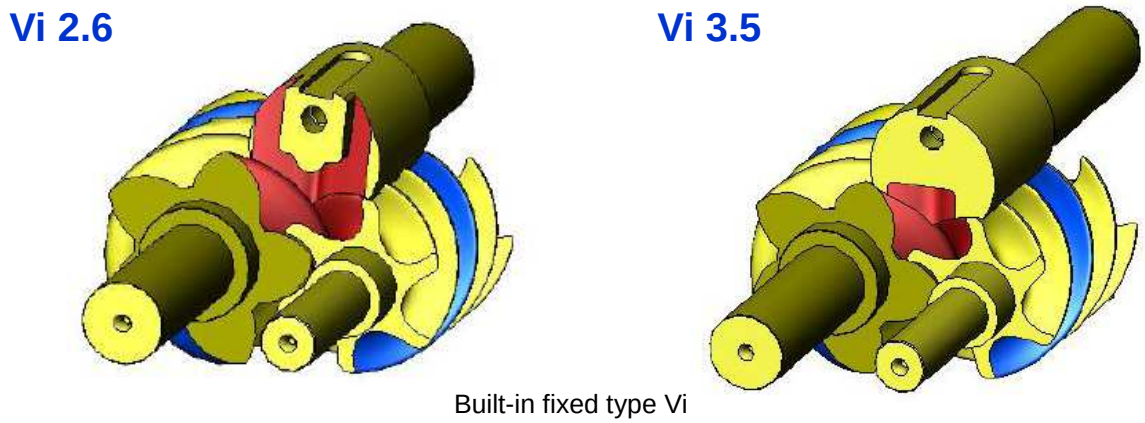
Adjustment e adjustment description:

1. As shown on the above drawing, the point 1 is a bar for volume ratio adjustment, and point 2 is a fix nut. Before starting the volume ratio adjustment, should unlock the fix nut, then turn the bar to start tht for volume ratio. Once finished, should lock again the fix nut.
2. When bar of point 1 is turned in clockwise direction, Vi increases and when it turned in counterclockwise direction, Vi decreases. Before adjusting the Vi, rotate first the bar in counterclockwise direction until it is fully tighten to assure that Vi is 2.2.
3. Each model's Vi relation with number of turn is shown in the table below, when the number of turn is 0 it means Vi=2.2.

Turns	0	2	4	6	8	10	12	14	16	18	20	22	24
VI(LA-90)	2.2	2.37	2.58	2.84	3.15	3.61	4.17	4.77	-				-
VI(LA-110)	2.2	2.33	2.49	2.68	3.09	3.53	4.11	4.74	-				-
VI(LA-120)	2.2	2.34	2.5	2.68	3.07	3.53	4.07	4.75	-				-
VI(LA-140)	2.2	2.31	2.44	2.59	2.84	3.14	3.46	3.83	4.30	4.75			
VI(LA-170)	2.2	2.30	2.41	2.53	2.80	3.12	3.45	3.80	4.23	4.71			
VI(LA-200)	2.2	2.33	2.49	2.67	2.9	3.2	3.62	4.17	4.77				
VI(LA-230)	2.2	2.32	2.46	2.62	2.84	3.14	3.55	4.1	4.75				
VI(LA-250)	2.2	2.2	2.2	2.31	2.43	2.62	2.84	3.09	3.38	3.71	4.03	4.39	4.76
VI(LA-280)	2.2	2.3	2.41	2.52	2.66	2.81	3.0	3.22	3.48	3.76	4.06	4.41	4.77

b. Built-in Vi

LA-310 ~ LA-1520 were designed with a comprehensive series of built-in fixed type volume ratio (Vi = 2.2, 2.6, 3.0, 3.5, 4.8), so the customer could select the suitable Vi according to different working condition. Please refer to Hanbell selection software to get the recommended Vi for different working condition.



Built-in fixed type Vi

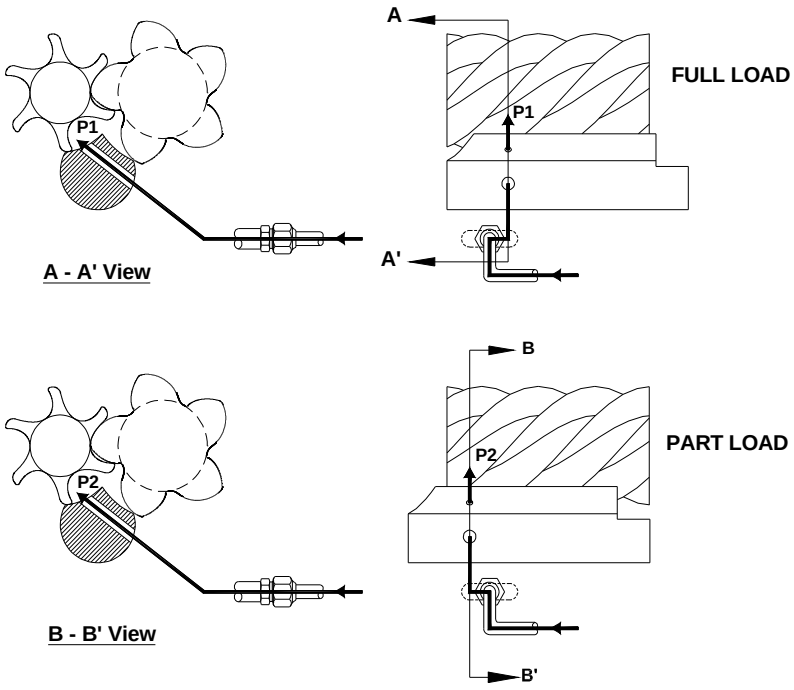
2.3.2 Floating type medium pressure (for application of economizer)

Normally, a fix type medium pressure compressor when combine with economizer, the economizer can only develop their effect in full load condition or closed to full load condition.

LA series uses floating medium pressure design, the floating mechanical is shown in the next drawing. Economizer not only in full load condition can reach the best medium pressure design in all load conditions, the economizer can reach the best medium pressure value and develop the maximum efficiency.

When compressor working in part load condition, the medium pressure floating system can avoid the return of economizer pressure to load pressure side.

Floating type medium pressure explanation



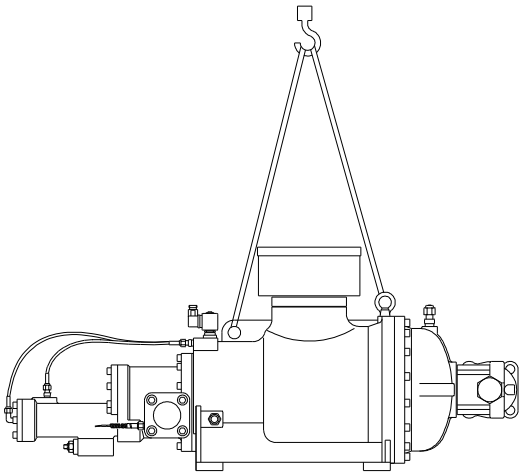
Medium pressure's position will vary as shown in the above drawing, Full load condition, medium pressure=P1, Partial load condition medium pressure=P2.

3. Compressor handling and Installation

3.1Compressor handling

After the compressor arrived at the warehouse, check the crates if it is kept in good condition and check all the compressor accessories and the shipping documents if there is any discrepancy or correct.

Each HANBELL screw compressor is carefully tested at the factory where every precaution and care is taken out to make sure that the compressor will reach the customer in perfect condition. When lifting the compressor, it is recommended to use a steel chain or steel cable as shown in the figure below, and also a safety rope can also be use provided it has loading capacity of 2000kgf.

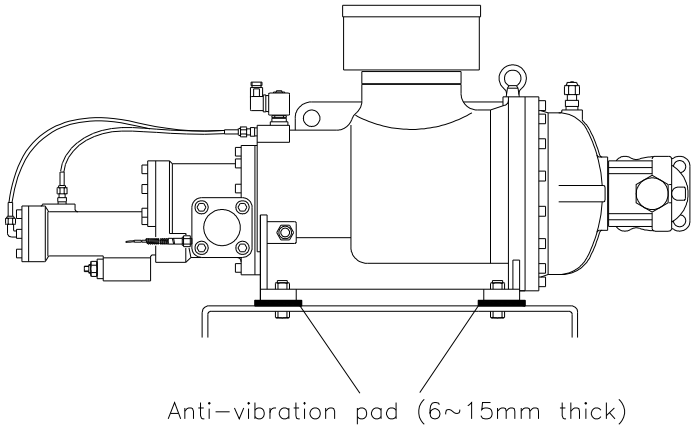


Make sure that the chains, cables, ropes or other lifting equipment are properly position so as to avoid damage to compressor or its accessories. Keep the compressor in horizontal position when lifting, and avoid the compressor to crash or fall on the ground; hit the wall or any other event that may damage it or its accessories.

3.2 Mounting the compressor

The installation of the compressor in the refrigeration system should be made accessible and make sure that the chiller base or site are far enough from the heat source to prevent heat radiation. The compressor should also be installed as close as possible to the electrical power supply for easier connection and must keep good ventilation and low humidity condition in the site. Make sure that the frame or supporter is strong enough to prevent excessive vibration and noise while the compressor are running and must reserve enough space for compressors' future overhauling work.

The compressor must be installed horizontally and in order to prevent excessive vibration transferred by the structure and piping of the chiller while in operation, the cushion or anti-vibration pad should be installed. The installation of the anti-vibration pad is shown in the figure below. The screws should only be tightened until slight deformation of the rubber pad is visible.



Attention on the compressor piping works

The unsuitable piping works done to the compressor could cause abnormal vibration and noise that might damage the compressor. Take notice of the following pointers to prevent this situation to happen:

1. Cleanliness of the system should be kept after welding the piping to avoid any swarf or debris contained inside the system as it may cause serious damage to the compressor during operation.

2. In order to reduce the vibration on the piping tubes, it is recommended to use copper tube to be the suction and discharge piping tubes. Copper tubes are better to minimize the vibration in the piping while the compressor is in operation. In case steel tubes are to be use in piping system, then the suitable welding works are very important to avoid any stress in the piping. This inner stress can cause harmonic vibration and noise that can reduce the life of the compressor. If a large-caliber copper tube is not easily accessible and a steel tube is used instead in suction port, Hanbell also recommends use of a copper tube in discharge port to best minimize abnormal vibration and noise.

3. Remove the oxidized impurities, swarf or debris caused by welding in the piping tubes, if these are sunk into the compressor the oil filter might be clogged resulting in the malfunctioning of lubrication system, bearings and capacity control system.

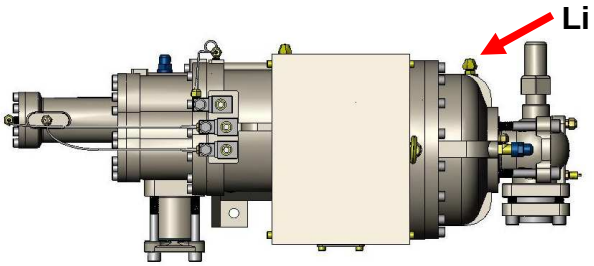
4. The material of suction and discharge flanges is forged steel and it can be welded directly with piping connectors. After welding the flanges and pipes, it must be cooled down by ambient air. Do not use water to cool it down water quenching is prohibited.

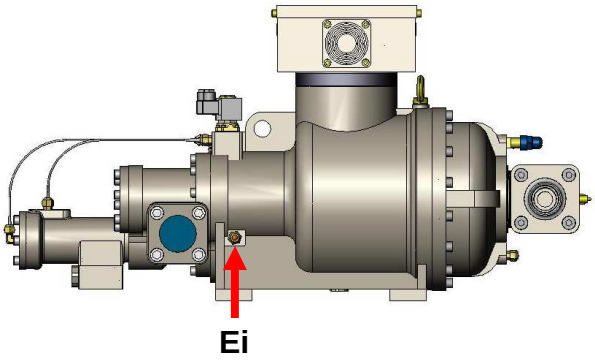
3-3 Connection of lubricant circuits、liquid injection system & economizer

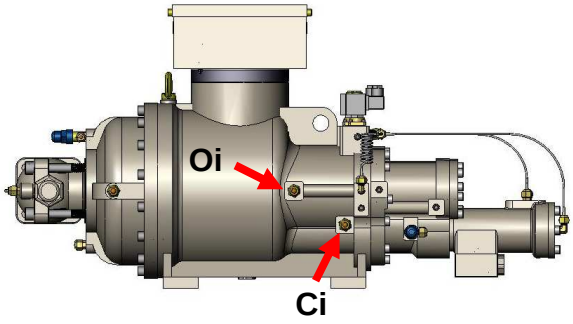
Model : LA-90 ~ LA-280

(1) Lubricant circuit, Liquid injection system and economizer connection diagram

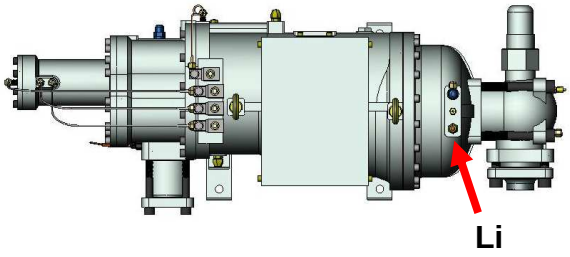
LA-90 ~ LA-170

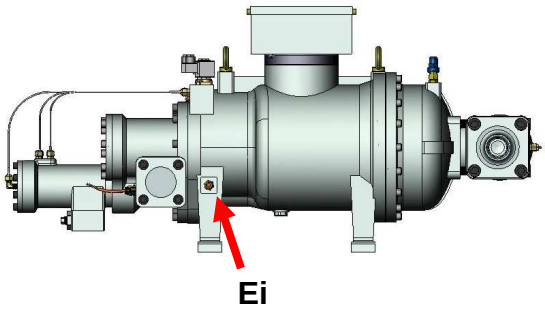


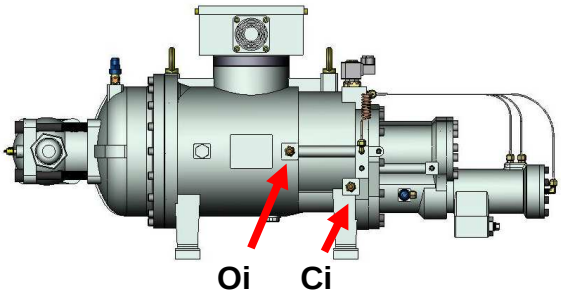




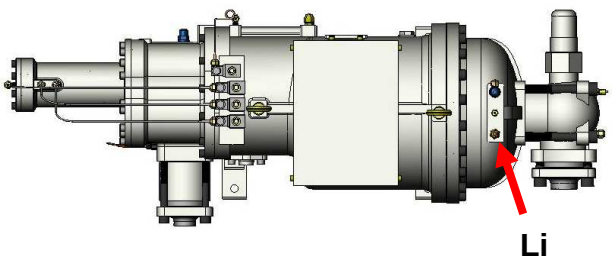
LA-200 ~ LA-230

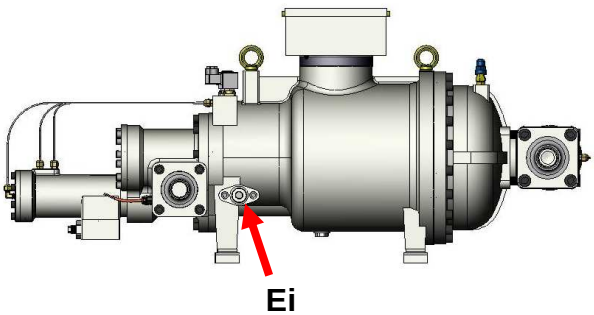


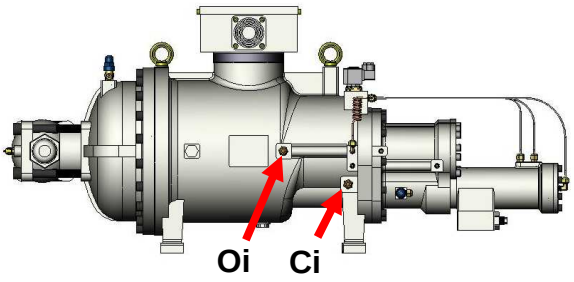




LA-250 ~ LA-280







■ Oi：Oil return port

Function：a. Support suction bearing lubrication

b. Support discharge bearing lubrication

c. Support differential oil pressure to capacity control system chamber

■ Ci：Oil injection or liquid injection port for compression chamber

Function：Cooling down compression chamber

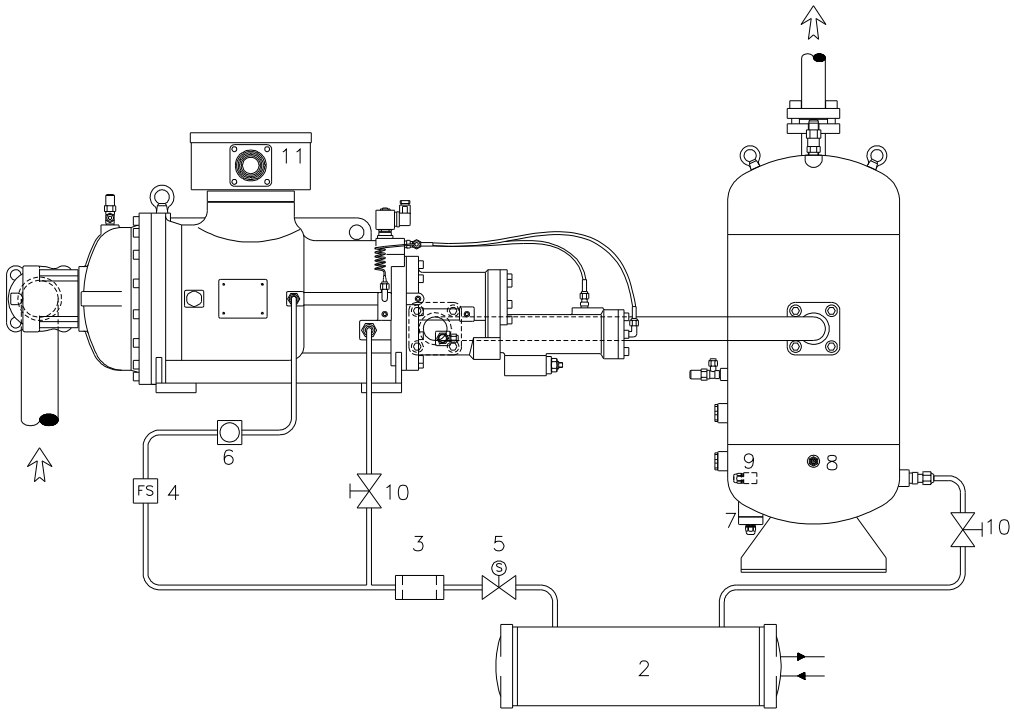
■ Li：Liquid injection port for motor winding

Function：Cooling down motor winding

■ Ei：Economizer return port

(2) Installation of lubricant circuit

To obtain high oil filtering efficiency, low pressure drop loss and non-interruption with lubricant supply system, the oil separator is built outside the compressor. The installation of lubricant circuit is a very important issue during the installation of the compressor. So before starting, make sure to read carefully all the instructions contain inside this manual, and make sure that each step is done in accordance with the specification.



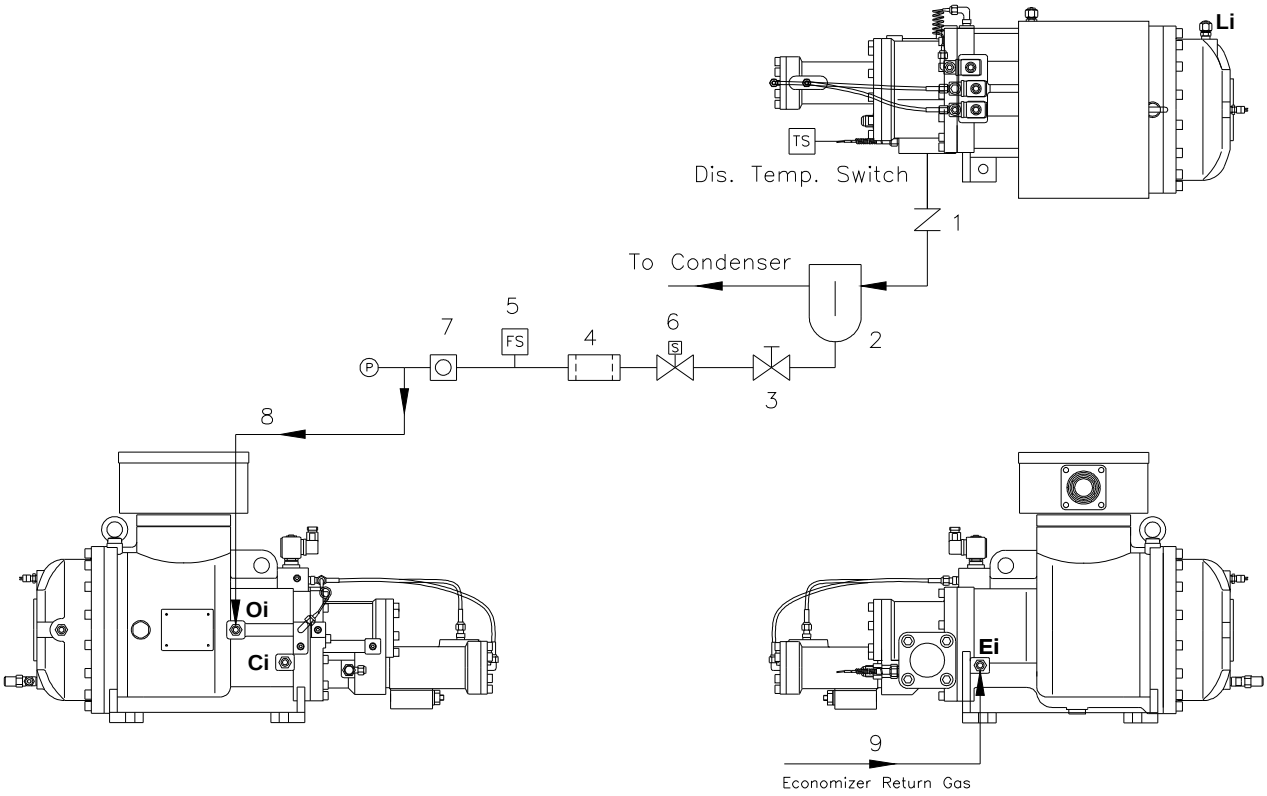
1. External oil separator
2. Oil cooler
3. Oil filter
4. Lubricant flow switch
5. Solenoid valve
6. Sight glass
7. Oil level switch
8. Oil temperature sensor
9. Oil heater
10. Stop valve
11. Compressor

Note：During the installation of lubricant circuit must take care of the following:

Select the reliable oil solenoid valve: If after the compressor is shut down and the solenoid valve can’t close completely, this will cause the lubricant to flow from high pressure to low pressure, which could lead to too low oil level inside the oil separator and can’t restart the compressor, or due to a lot of lubricant injected inside the compression chamber causing difficulty to restart.

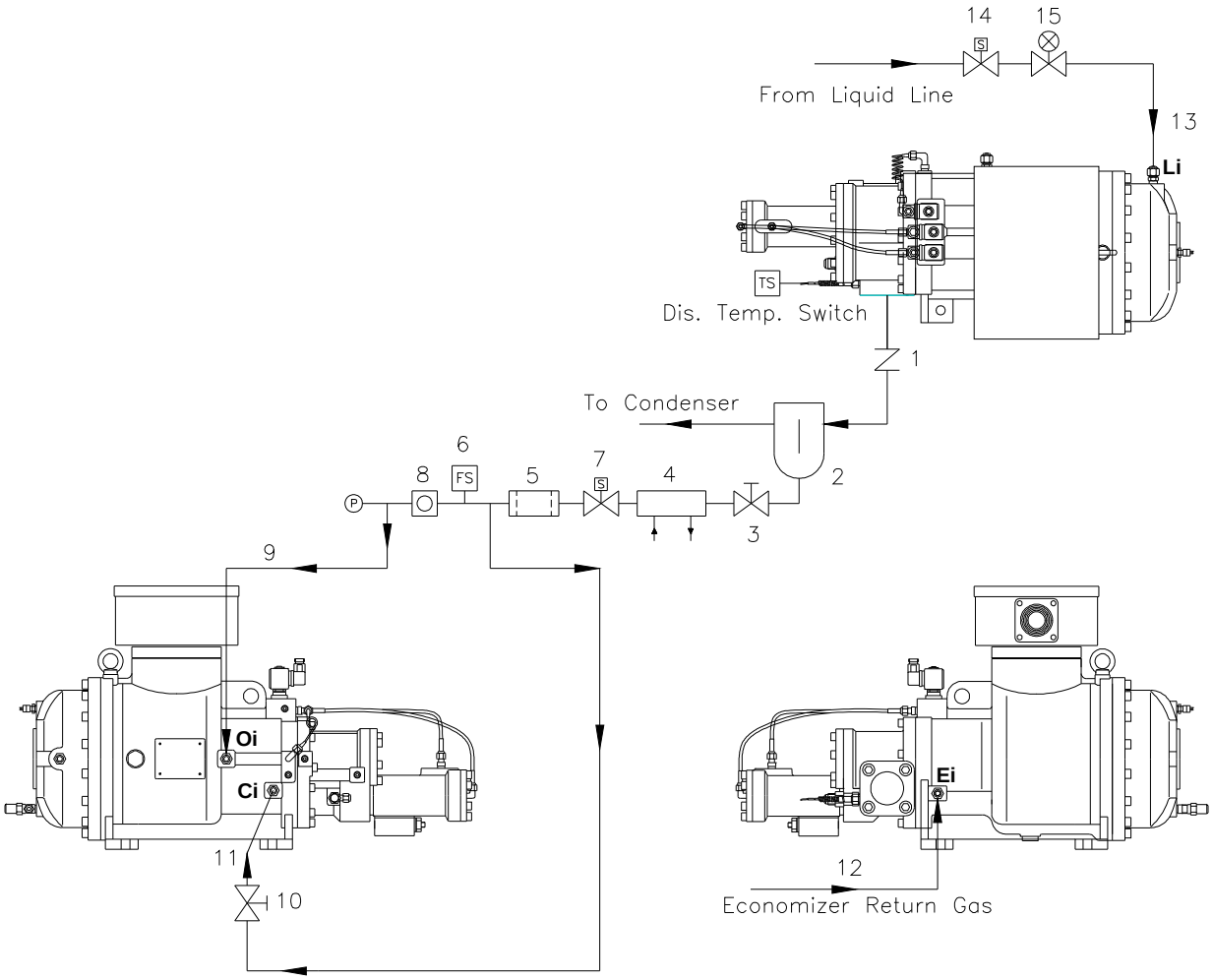
Please refer to the selection software for the capacity of liquid injection or oil cooler and following recommendation to install oil cooler, oil injection system and economizer.

Item	Oil cooler	Oil injection into compression chamber	Liquid injection into compression chamber	Liquid injection for cooling motor winding	Economizer
A	—	—	—	—	O



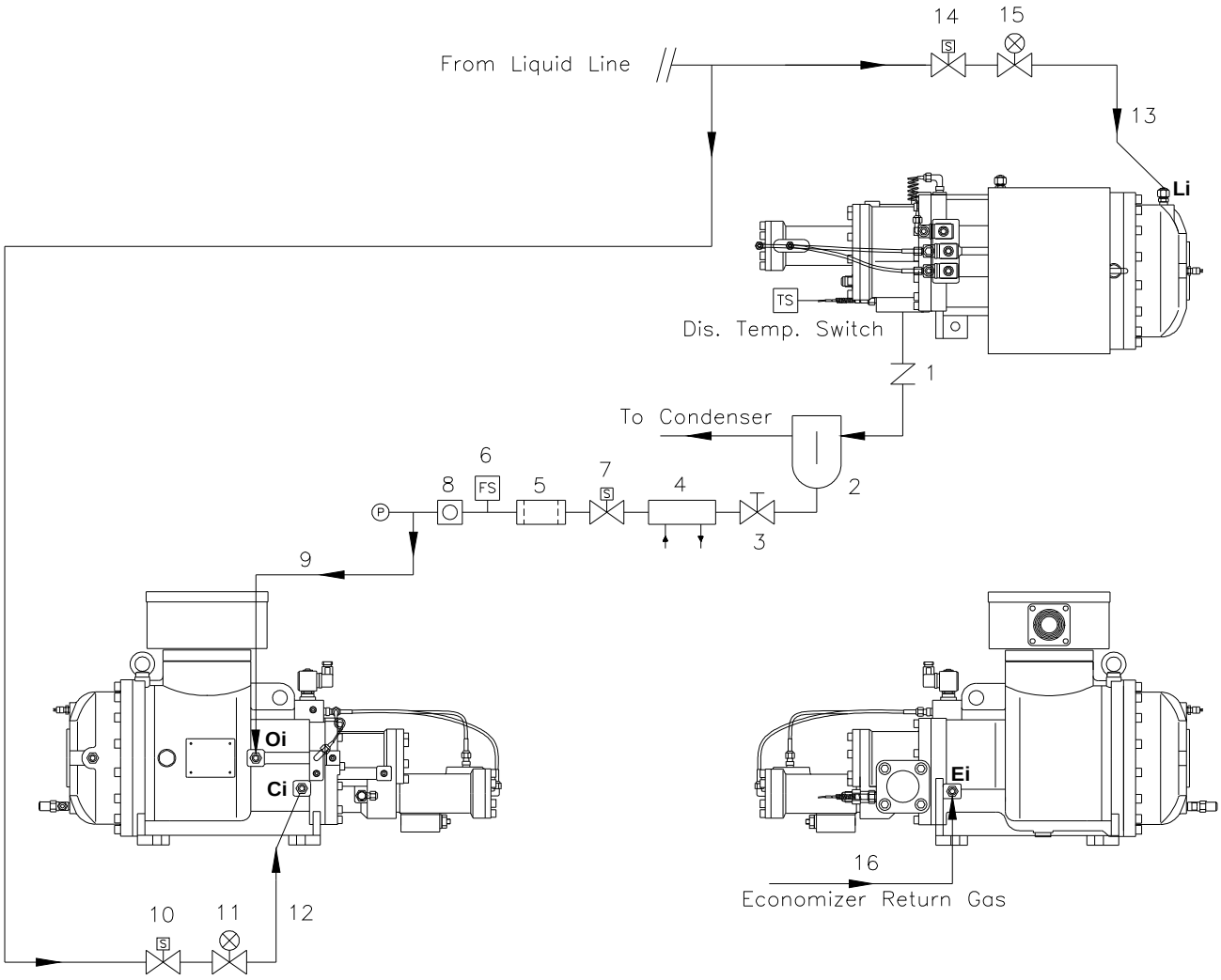
1. Check valve
2. External oil separator
3. Stop valve
4. Oil filter
5. Lubricant flow switch
6. Oil solenoid valve
7. Sight glass
8. To principal return oil port Qi
9. To medium pressure (Economizer return port) Ei

Item	Oil cooler	Oil injection into compression chamber	Liquid injection into compression chamber	Liquid injection for cooling motor winding	Economizer
B	O	O	—	O	O



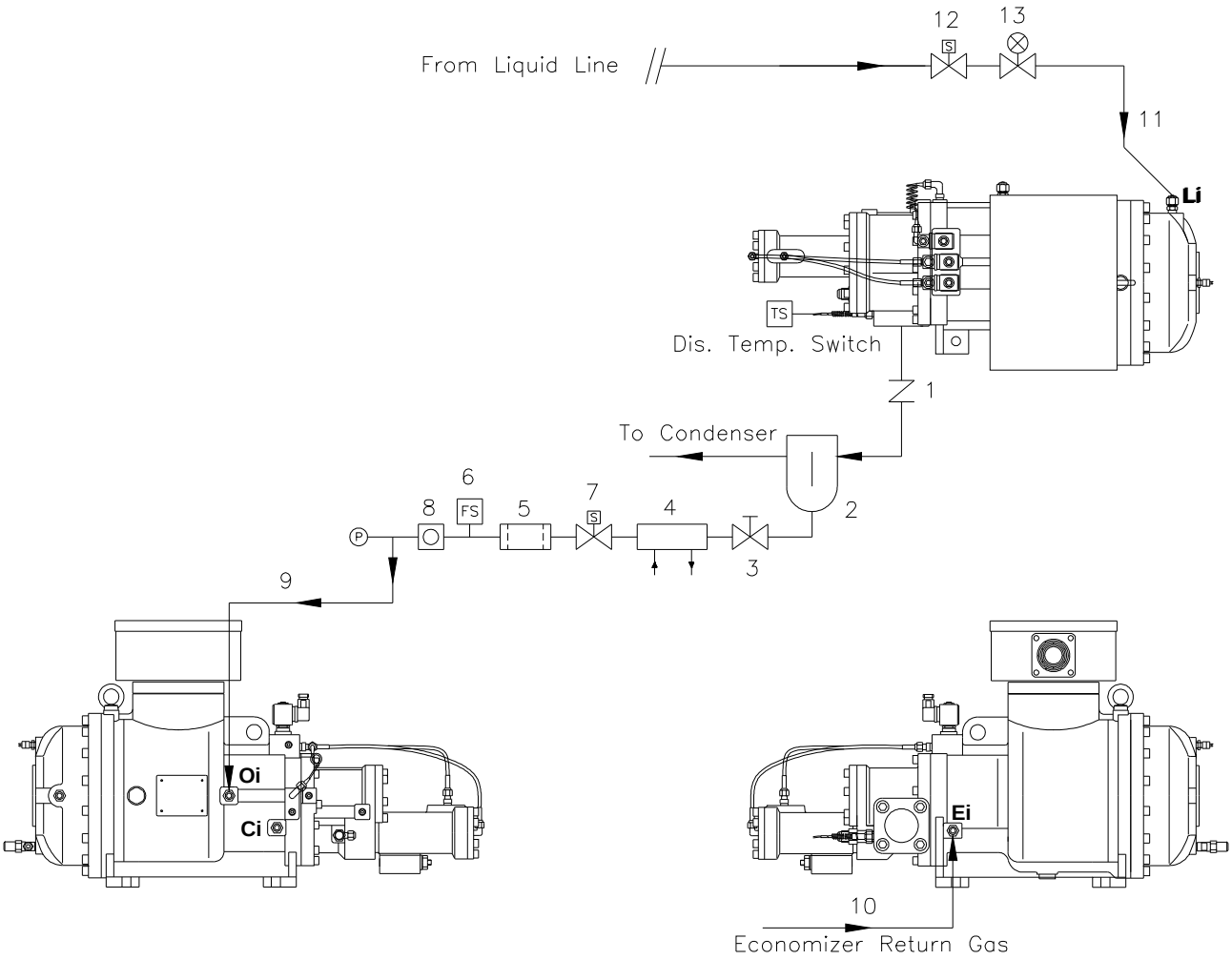
1. Check valve
2. External oil separator
3. Stop valve
4. Oil cooler
5. Oil filter
6. Lubricant flow switch
7. Oil solenoid valve
8. Sight glass
9. To principal oil return port Qi
10. Adjustable flow valve
11. Cooling compressor's chamber port Ci
12. To medium pressure (economizer return port) Ei
13. Liquid injection to motor winding port Li
14. Liquid injection solenoid valve
15. Liquid injection expansion valve

Item	Oil cooler	Oil injection into compression chamber	Liquid injection into compression chamber	Liquid injection for cooling motor winding	Economizer
C	O	—	O	O	O



1.	Check valve	9.	To principal return oil port
2.	External oil separator	10.	Liquid injection solenoid valve
3.	Stop valve	11.	Liquid injection expansion valve
4.	Oil cooler	12.	To cooling down compression chamber port Ci
5.	Oil filter	13.	Liquid injection to motor winding port Li
6.	Lubricant flow switch	14.	Liquid injection solenoid valve
7.	Oil solenoid valve	15.	Liquid injection expansion valve
8.	Sight glass	16.	To medium pressure (economizer return port) Ei

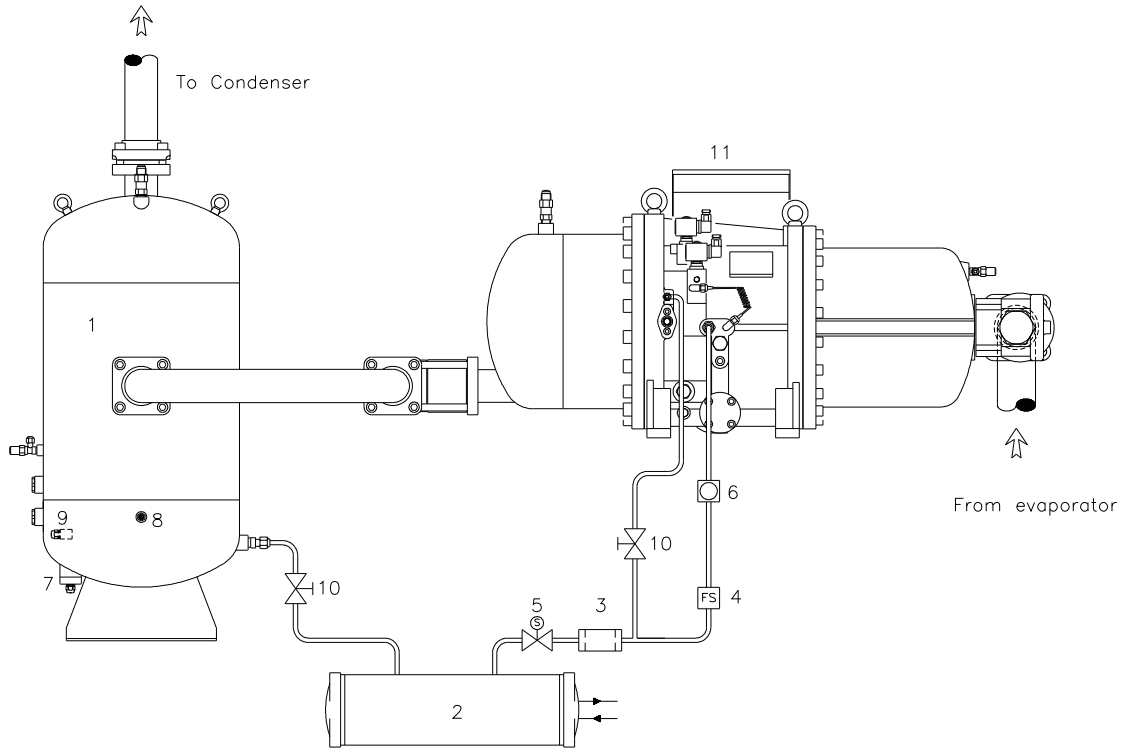
Item	Oil cooler	Oil injection into compression chamber	Liquid injection into compression chamber	Liquid injection for cooling motor winding	Economizer
D	O	—	—	O	O



1.	Check valve	8.	Sight glass
2.	External oil separator	9.	To principal return oil port Qi
3.	Stop valve	10.	To medium pressure (economizer return port) Ei
4.	Oil cooler	11.	Liquid injection to motor winding port Li
5.	Oil filter	12.	Liquid injection to solenoid valve
6.	Lubricant flow switch	13.	Liquid injection to expansion valve
7.	Oil solenoid valve		

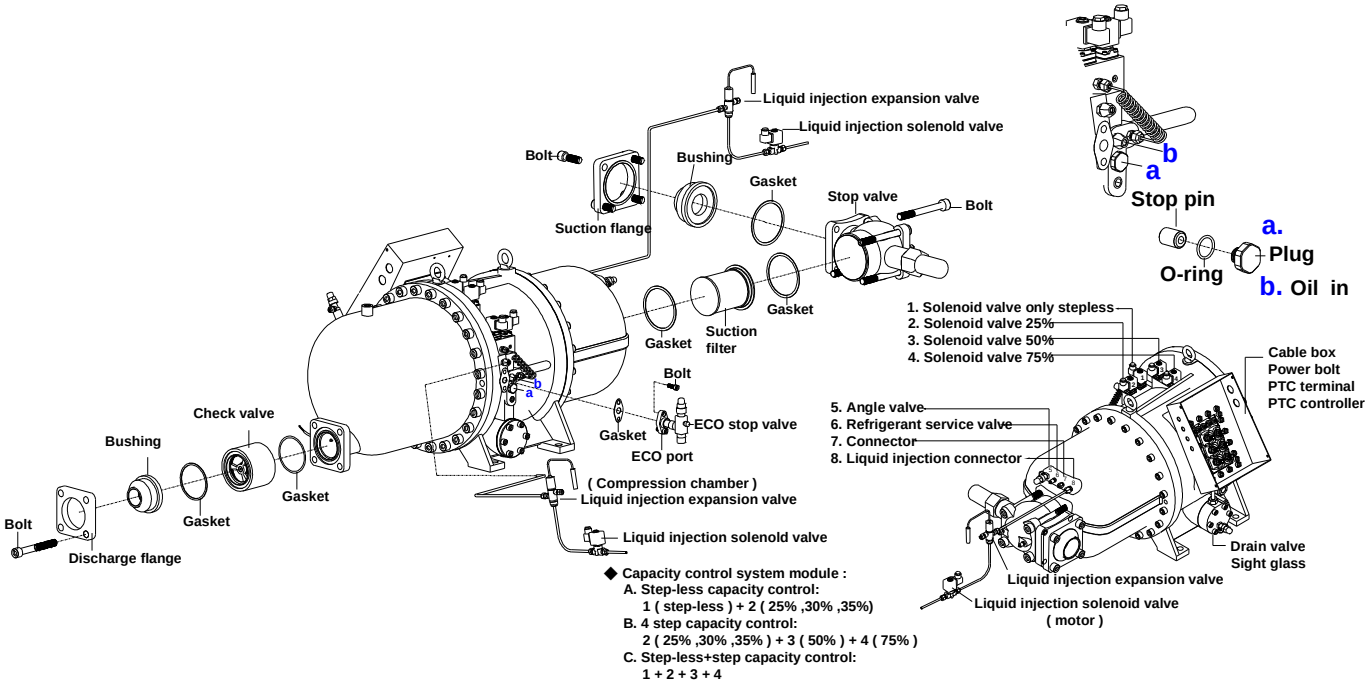
Model : LA-310 ~ LA-620

(1) Installation of lubricant circuit



1. External oil separator
2. Oil cooler
3. Oil filter and cartridge
4. Lubricant flow switch
5. Oil solenoid valve
6. Sight glass
7. Oil level switch
8. Oil temperature sensor
9. Oil heater
10. Manually adjustable flow valve
11. Compressor

(2) Lubricant circuit, Liquid injection system and economizer connection diagram



Model : LA-710 ~ LA-930

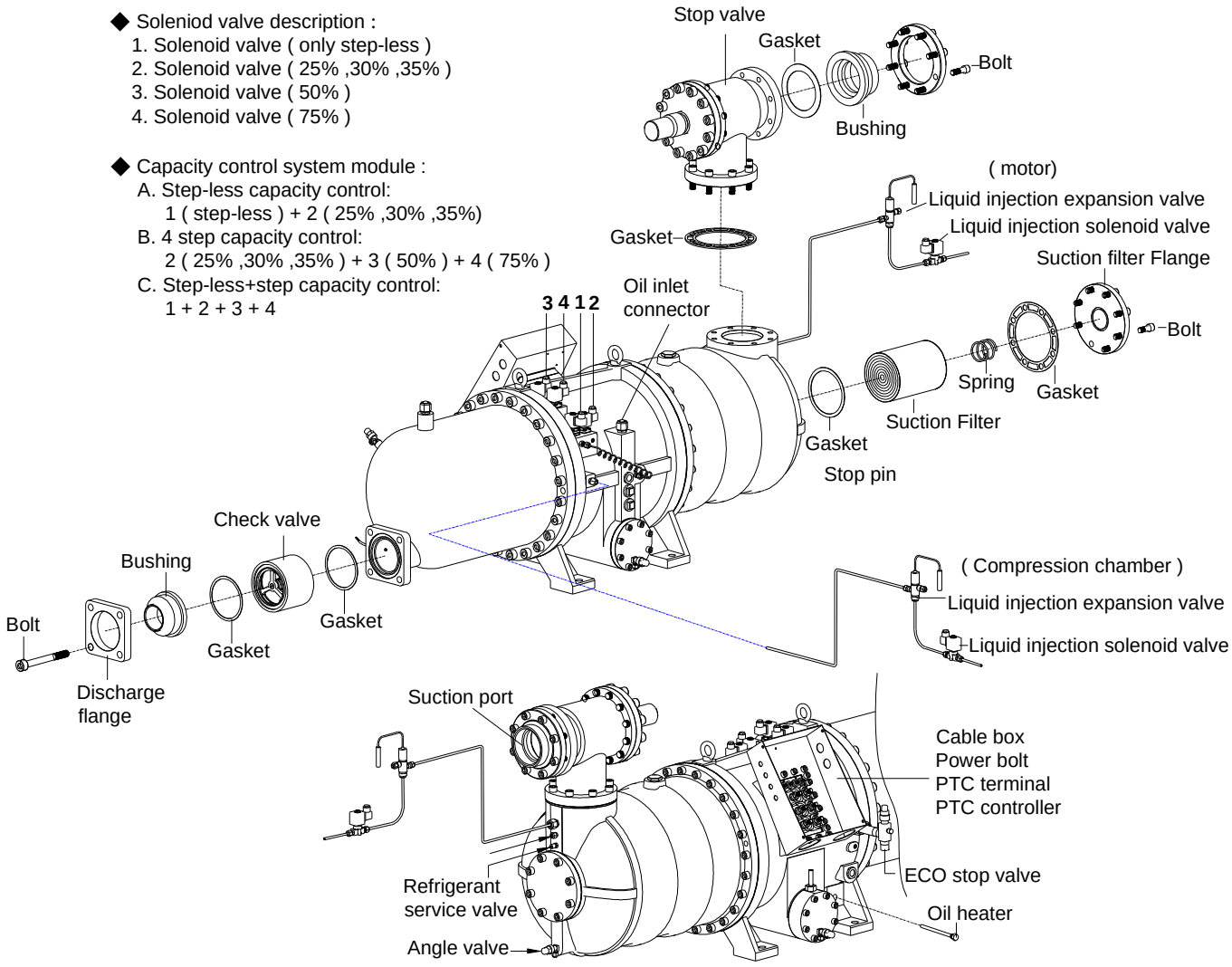
(1) Installation of lubricant circuit

Same as model LA-310 ~ LA-620

(2) Lubricant circuit, Liquid injection system and economizer connection diagram

◆ Soleniod valve description :
1. Solenoid valve (only step-less)
2. Solenoid valve (25% ,30% ,35%)
3. Solenoid valve (50%)
4. Solenoid valve (75%)

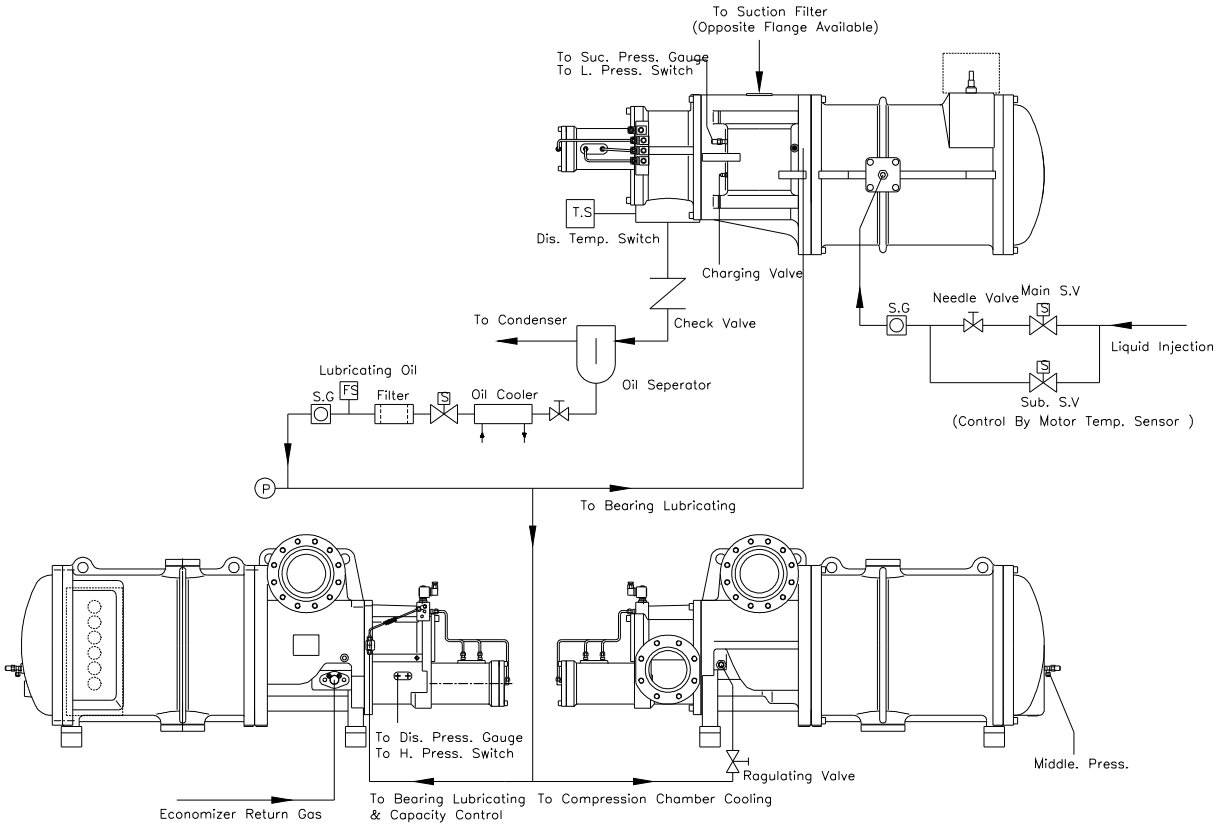
◆ Capacity control system module :
A. Step-less capacity control:
1 (step-less) + 2 (25% ,30% ,35%)
B. 4 step capacity control:
2 (25% ,30% ,35%) + 3 (50%) + 4 (75%)
C. Step-less+step capacity control:
1 + 2 + 3 + 4



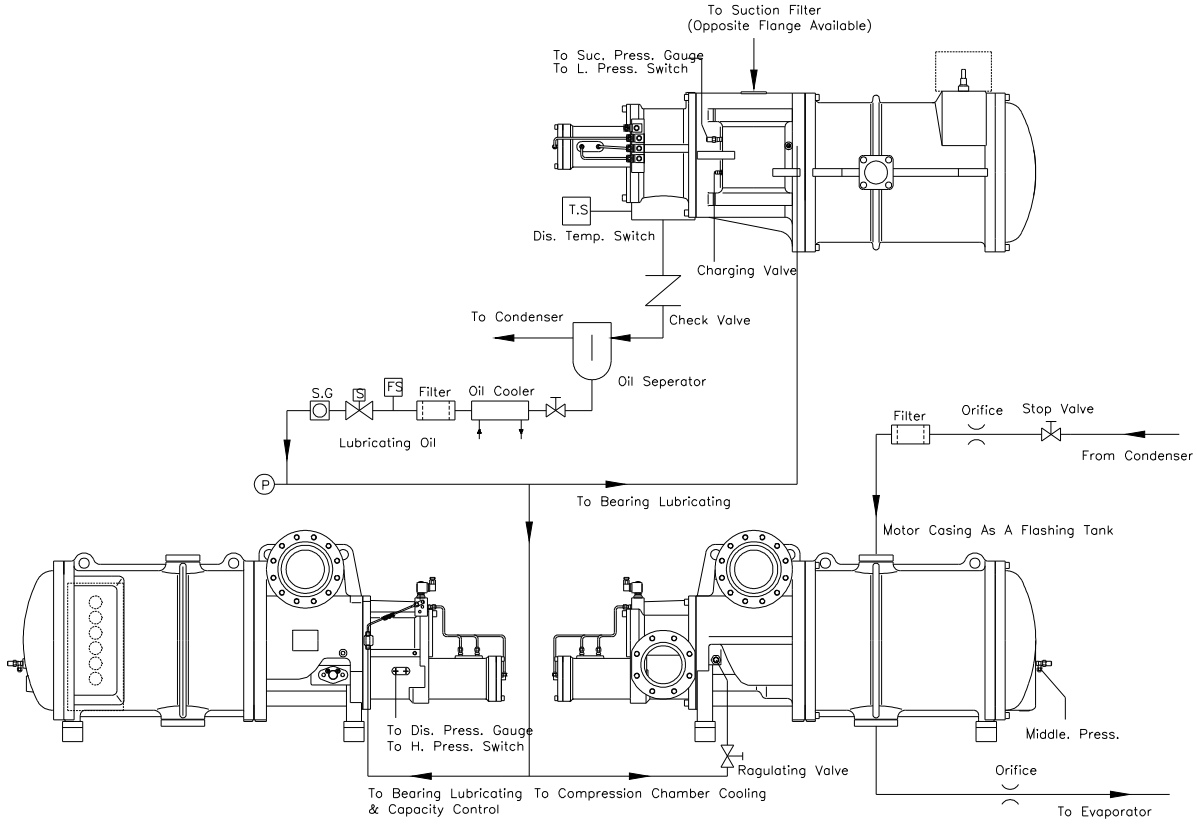
Model : LA-1090, LA-1280, LA-1520

Lubricant circuit, Liquid injection system and economizer connection diagram

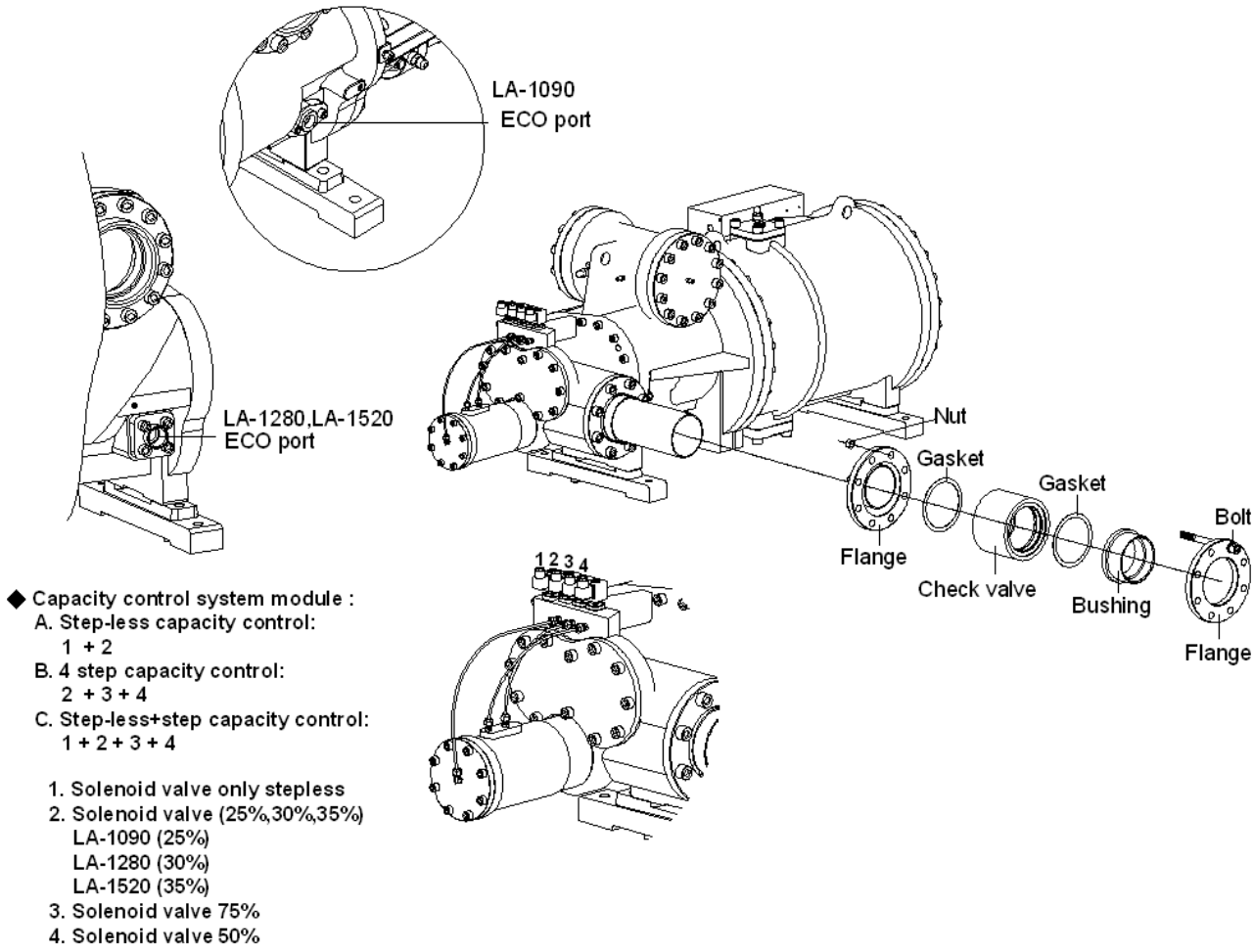
A :



B:



(3) Installation & connection of compressor



4. Capacity control system

The LA series screw compressors are equipped with either 3-steps/4-steps capacity control system or continuous (step-less) capacity control system. Both of the capacity control systems are consist of a modulation slide valve, piston rod, cylinder, piston and piston rings. The slide valve and the piston are connected by a piston rod. The principle of operation is using the oil pressure to drive the piston in the cylinder. See Fig 6, the lubrication oil flows from the oil sump through the oil filter cartridge and capillary then fills into the cylinder due to the positive oil pressure bigger than the right side of spring force plus the high pressure gas. The positive pressure differential causes the piston to moved toward the right side in the cylinder. When the slide valve moves toward the right side, the effective compression volume in the compression chamber increases. This means the displacement of refrigerant gas also increases, as a result the refrigeration capacity also increases. However, when any of the step solenoid valve (for 3-step/4-step capacity control system) is energized, the high pressure oil in the piston cylinder bypasses to the suction port causing the piston and the slide valve to moved toward the left side, then some of the refrigerant gas by pass from the compression chamber back to the suction end. As a result, the refrigeration capacity decreases because of the reduction of displacement of refrigerant gas flowing in the system.

The piston spring is used to push the piston back to its original position, i.e. minimum loading position in order to reduce the starting current for the next starting-up. If the compressor started at full load capacity it may result in over current start. The capillary is used to maintain and restrain a suitable amount of oil flow into the cylinder. The

modulation (step-less) solenoid valves are controlled by a micro controller or temperature switch to modulate the piston position smoothly with stable output of capacity.

If the oil filter cartridge, capillary, or modulation solenoid valves are not working well in the capacity control system, this may result in the abnormality and ineffectiveness of the capacity control system.

The modulation range of each model are shown on the following table :

Model	LA-90				LA-110				LA-120				LA-140				LA-170			
STEP (%)	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F
	33	66	N/A	100	33	66	N/A	100	33	66	N/A	100	33	66	N/A	100	33	66	N/A	100
STEP-LESS (%)	33~100				33~100				33~100				33~100				33~100			

Model	LA-200				LA-230				LA-250				LA-280				LA-310			
STEP (%)	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F
	25	50	75	100	25	50	75	100	25	50	75	100	25	50	75	100	35	50	75	100
STEP-LESS (%)	25~100				25~100				25~100				25~100				40~100			

Model	LA-340				LA-370				LA-410				LA-470				LA-510			
STEP (%)	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F
	35	50	75	100	35	50	75	100	25	50	75	100	25	50	75	100	35	50	75	100
STEP-LESS (%)	35~100				35~100				25~100				25~100				35~100			

Model	LA-550				LA-580				LA-620				LA-710				LA-790			
STEP (%)	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F
	25	50	75	100	35	50	75	100	35	50	75	100	35	50	75	100	25	50	75	100
STEP-LESS (%)	25~100				35~100				35~100				35~100				25~100			

Model	LA-830				LA-930				LA-1090				LA-1280				LA-1520			
STEP (%)	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F	S	M1	M2	F
	30	50	75	100	35	50	75	100	35	50	75	100	30	50	75	100	25	50	75	100
STEP-LESS (%)	30~100				35~100				35~100				30~100				25~100			

S : start % or minimum % of compressor capacity.

M1 : 50% or 66% compressor capacity depending on different model.

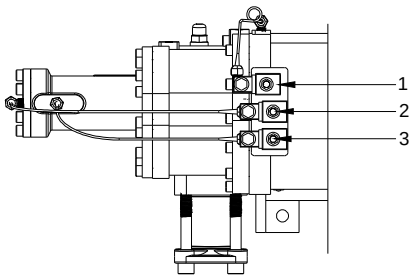
M2 : 75% compressor capacity. (LA-90 ~ LA-280 are not available)

F : Full load (100%) compressor capacity

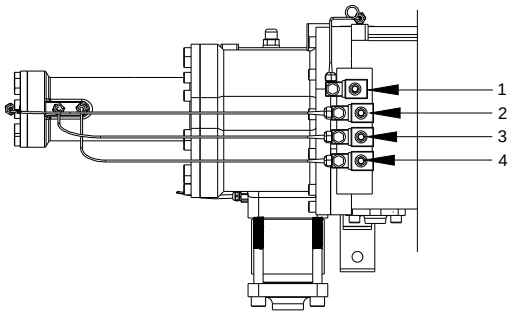
Before stop of the compressor, HANBELL strongly recommends that the unloading solenoid valve of step-less control system or minimum loading solenoid valve of steps control system should be kept energized for 20~30 seconds so that the pressure in the cylinder is then released. When starting the compressor again, it is in min. loading position for light duty start.

4.1 Capacity control logic

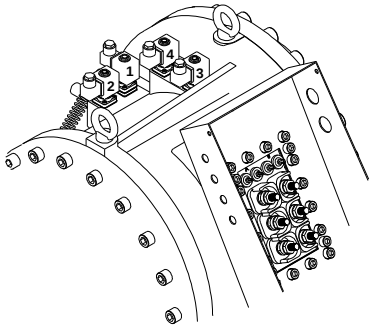
The capacity control solenoid valves of different models are equipped as the pictures shown below. Please refer to the pictures and description in 4.1.1 and 4.1.2 for the detail of capacity control logic.



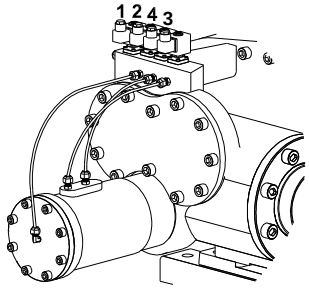
LA-90 ~ LA-170



LA-200 ~ LA-280



LA-310 ~ LA-930



LA-1090 ~ LA-1520

4.1.1 3 or 4 steps capacity control

Solenoid Valve		1	2	3	4
Normal Open / Normal Close		NO	NC	NC	NC
Standard / Optional		OPTIONAL	STANDARD	STANDARD	STANDARD
Control Logic	S % (Start)	ON	ON	OFF	OFF
	M1 % (66% or 50%)	OFF	OFF	ON	OFF
	M2 % (75%)	OFF	OFF	OFF	ON
	F % (Full Load / 100%)	OFF	OFF	OFF	OFF

Note:

ON : Solenoid valve energized

OFF: Solenoid valve not energized

Warning： If the S % (start) capacity is essential to be kept running for a long time, the problem of oil return, motor cooling and high discharge temperature and other problem should be considered seriously to prevent inappropriate operation of the compressor which may damage it seriously.

4.1.2 Stepless capacity control

Solenoid Valve		1	2	3	4
Normal Open / Normal Close		NO	NC	NC	NC
Standard / Optional		STANDARD	STANDARD	OPTIONAL	OPTIONAL
Control Logic	Start	ON	ON	OFF	OFF
	Loading	OFF	OFF	OFF	OFF
	Unloading	ON	ON	OFF	OFF
	Hold / Stable	ON	OFF	OFF	OFF

Note:

ON : Solenoid valve energized

OFF: Solenoid valve not energized

Step-less and Steps capacity control has the same working principle but different in solenoid valves application. Step-less capacity control uses a normally close (Unloading) and another normally open (Loading) solenoid valve; these solenoid valves control the input and output of oil into capacity control chamber. The control system apply magnetic field to solenoid valves to control the input and output of oil to capacity control chamber to move the slide valve in step-less capacity.

In continuous capacity control system, a normally open solenoid valve (Loading) and normally closed solenoid valve (Unloading) are equipped on the inlet and outlet of the piston cylinder respectively. These two solenoid valves are controlled by the chiller temperature controller, hence refrigeration capacity can be modulated between S (start) %~100% continuously. The exactness of temperature control depends on the precision of temperature sensor.

The timer resolution of control system, affects the capacity control's speed. Hanbell recommend to set the timer resolution between 0.1~1second, to have a precise capacity control. If the resolution is set more than 1 second, then it is recommended to add a flow control device to obtain a smooth capacity control.
Step-less capacity control system, uses normally open and another normally closed capacity solenoid valves, and this design is to allow compressor to restart without getting any problem after emergency stop.

5. Lubricant

The main function of lubricant is to lubricate the bearing and increase the compressor's bearing life. High oil viscosity will reduce the oil viscosity and caused poor lubrication and heat absorption in the compressor. If the compressor operated under critical condition, then extra oil cooler is required to decrease oil temperature. The

oil viscosity is recommended to keep over $15\ mm^2/s$, at any temperature. Some high viscosity oil is recommended to apply to the high working condition. It happens more often that the return oil from the evaporator is insufficient due to the high viscosity of oil, which is difficult to be carried back, that causes the loss of oil in the compressor. If the system encounters the oil return problem then a 2nd oil separator is recommended to installed to overcome this problem.

5-1 Lubrication warning

(1) Use only qualified oil and do not mix different brand of oil together. Different kinds of refrigerant should match different kinds of oil, note that some synthetic oil are incompatible with mineral oil. The new oil filled into the compressor could be totally cleaned up the system, fill the compressor with oil during the initial operation then re-fill the oil again to ensure it is completely clean.

(2) For the chiller system using synthetic oil, make sure not to expose the oil to atmosphere for a long time. It is necessary to vacuum the system completely when installing the compressor.

(3) If the customer wants to use special type of oil, it must contact first the manufacturer. In order to vaporize the water in the system, it is suggested to heat the system and vacuum the system as long as possible after changing of new oil in the system

(4) If the system encounters a compressor motor burned, the acidity debris is still remain inside the system so follow the procedures mentioned above to overhaul the system. It is necessary to check the oil acidity after 72 hours operation and change it again until the oil acidity is in the standard value.

5-2 Changing oil

Lubrication oil is one of the most important factor in the system in order to maintain the good operating, lubricating, cooling, sealing and driving the capacity piston of the compressor.

Following is the probable problems existing in the system that should be faced:

1. Contaminationd of oil caused by debris or swarf causing oil filter clogged.
2. Acidified of system due to the moisture, which caused corroded motor.
3. System spoiled of oil due to compressor running at long duration of high discharge temperature causes bearings life to shorten.

Below are the lists of time period in changing the lubrication oil of the system:

1. Change oil periodically：Check the lubrication oil for every 10, 000 hours of continuous running. For the first operation of the compressor, it is recommended to change oil and clean oil filter after running 20,000 hours. Because of the piping debris or swarf that may be accumulated inside the system after continuous operation, it is necessary to check the oil after 2,500 hours or after one year of running. Check the system whether clean or not and then change the oil every 20,000 hours or after 4 years of running while the system is operating under good condition.

2. Clogged oil filter may cause compressor bearings failure. In order to prevent the clogging of oil filter, an optional pressure differential switch are recommended to be installed. The switch will trip when the oil pressure differential reaches the critical point between the primary and secondary sides. The compressor will shut down automatically to prevent the bearings from getting damage due to the lack of lubrication oil.

3. If the compressor discharge temperature often keeps higher and approaching the critical point then the oil will spoil gradually in a short time, so check the oil characteristic every 2 months if possible. It is necessary to change the oil if the characteristics of the oil are out of the specification. In case it cannot be checked the oil characteristics periodically, then change the oil after 4 years of operation or after 20,000 hours of continuous running.

4. Acidified of lubricant oil causes the reduction of bearing’s life and motor’s life. Check the oil acidity periodically and change the oil if the oil acidity value measured lower than PH6. Change the deteriorated dryer periodically if possible to keep the system dryness.

5. Refer to the oil changing procedure especially after overhauling the system due to motor burned out. Check the oil quality monthly or periodically and change the oil if the oil is out of standard specs, it is necessary to take care of the oil quality and system cleanliness and dryness periodically.

5-3 Lubricant recommendations

R-22

	UNITS	TOTAL LUNARIA		SUN SUNISO		SHELL CLAVUS		BP ENERSYN	
		32	56	3GS	4GS	32	68	LPS32	LPS68
Color, ASTM		1.0	1.5	L0.5	L1.0	–	–	Yellow	Yellow
Specific Gravity		0.882	0.883	0.910	0.914	–	–	0.86	0.87
Viscosity 40℃	mm^2/s	32	56	29.5	54.5	31.5	61.8	32	68
100℃	cSt	5.0	7.0	4.36	6.07	4.79	6.70	–	–
Flash Point	℃	200	220	176	188	350	385	143	161
Pour Point	℃	-48	-40	-40	-35	-35	-30	-39	-27
T.A.N	MgKOH/g	0.01	0.01	0.00	0.00	<0.02	<0.02	–	–
Copper Strip 100℃/3hr		1a	1a	1a	1a	1b (1hr)	1b (1hr)	–	–
Moisture	ppm	15	15	20	20	–	–	–	–
Floc Point	℃	-75	-75	-53	-45	-56.6	-51.1	–	–
Dielectric Strength 2.5mm	kV	75	75	50	50	35	35	–	–

R-134a, R-404A, R-507A

	UNITS	CPI SOLEST		MOBIL EAL Arctic		ICI EMKARATE RL		CASTROL SW	
		LT-32	68	32	68	32S	68S	32	68
Color, ASTM		–	–	L0.5	L0.5	–	–	–	–
Specific Gravity		0.965	0.957	0.993	0.971	0.972	0.973	–	–
Viscosity 40℃	mm^2/s	29	64	32	63	31.3	72.2	32	68
100℃	cSt	5.9	8.9	5.5	8.3	5.7	10.1	5.7	8.8
Flash Point	℃	243	266	245	254	250	270	245	250
Pour Point	℃	-52	-43	-54	-43	-48	-42	-54	-39
T.A.N	mg KOH/g	–	–	<0.1	<0.1	<0.02	<0.02	0.15	0.15
Copper Strip 100℃/3hr		–	–	1a	1a	–	–	–	–
Moisture	ppm	–	–	<50	<50	<40	<40	50	50
Floc Point	℃	–	–	–	–	–	–	–	–
Dielectric Strength 2.5mm	kV	48.2	33.8	–	–	–	–	–	–

6. Electrical data and design

6.1 Motor design

HANBELL LA series screw compressors are fitted with Y-Δ motor as standard. But Δ/ΔΔ motor (Part Winding Starting – PWS) is also available for model LA-00 ~ LA-410.

i.e.

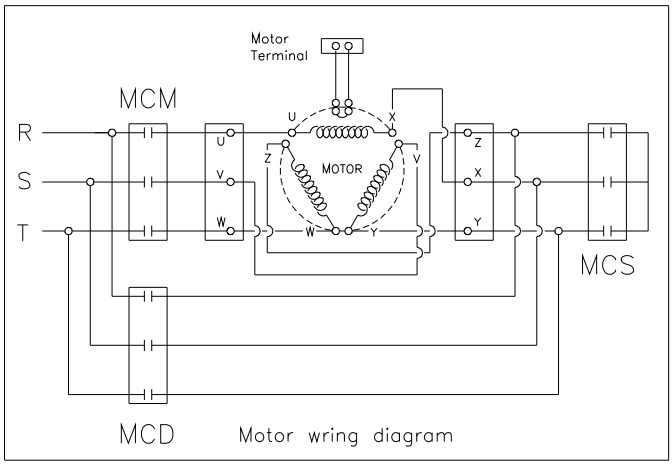
- LA-90 ~ LA-410 both Y-Δ motor and Δ/ΔΔ motor are available.
- LA-470 ~LA-1520 only Y-Δ motor are available.

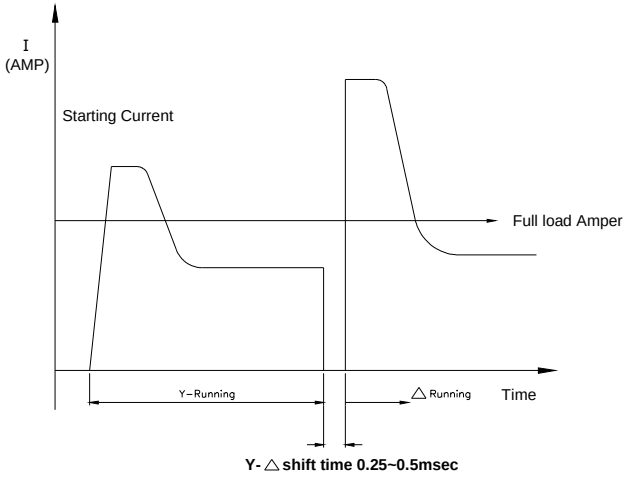
Y-Δ Starting

Y-Δ motor connects motor coil by Y connection during starting therefore reducing voltage on coils to 1/√3 of input voltage and reconnects motor coil by △ connection after starting. By doing so, we can decrease starting current thorough voltage drop, i.e., so-called voltage-drop starting.

Y-Δ motor connection method is shown in the following motor wiring diagram:

In Y connection, MCM、MCS are inductive while motor leads Z,X,Y are tied together as a neutral connecting as Y fashion. A few seconds later (3 ~ 5 sec is recommended), MCM, MCS become deductive. Around 0.25 sec later, MCM,MCD are inductive，it turns out △ run connection.





Please pay attention : After Y start，MCM & MCS are deductive for 0.25msec and then MCM & MCD are inductive for Δ run. Within as transient as 0.25msec, pseudo short circuit might occur due to inappropriate action of contactors, causing trip of compressors. When it occurs, we recommend usage of adjustable Y-Δ dedicated Timer or slightly lengthen span of time for MCM, MCS deduction - MCM,MCD re-induction from 0.25 msec to 0.5 msec max directly in micro controller or PLC program. Please refer to Y-Δ shift time diagram for details. Because motor is not powered during Y-Δ shift, shorter Y-Δ shift span is suggested to prevent second start due to decreased rotation speed. However, if Y-Δ shift span is too short, aforementioned pseudo short circuit might occur.

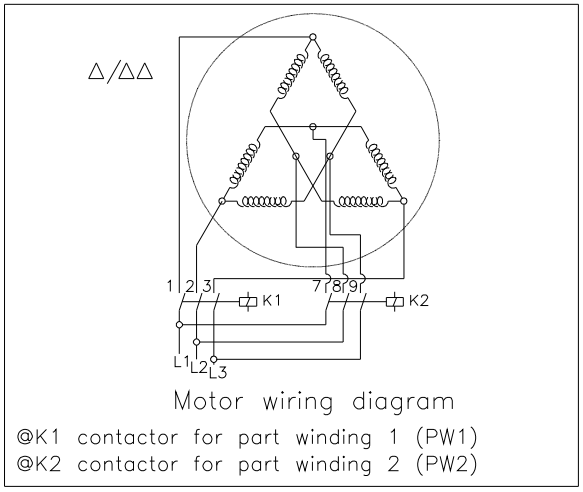
Characteristics of Y-Δ Starting

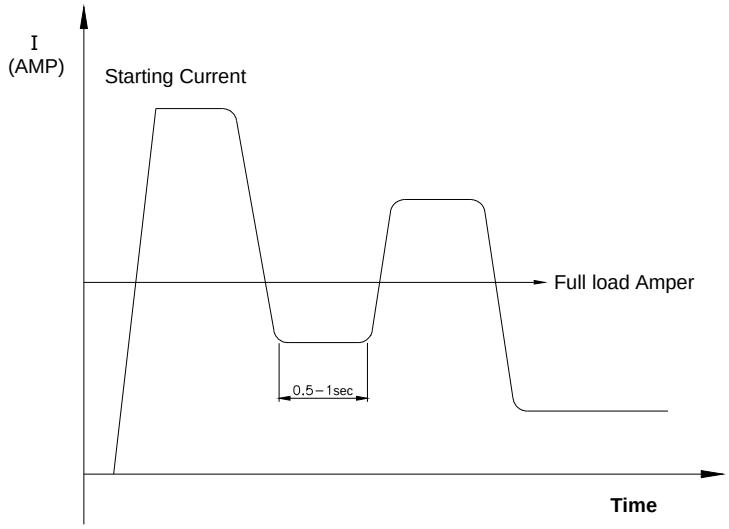
1. Starting current in Y connection is 1/3 of lock rotor ampere.
2. Starting torque in Y connection is 1/3 of lock rotor torque.
3. Acceleration of motor rotor becomes smaller at full-load starting,，therefore compressors require starting at partial load.

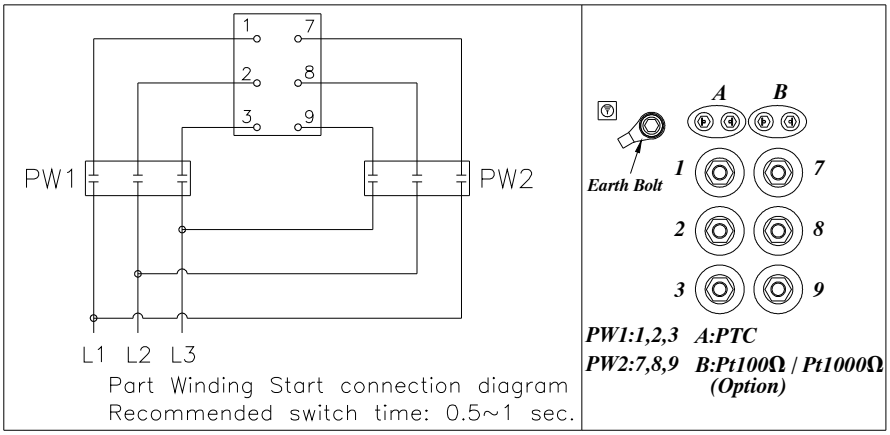
Δ/ΔΔ (PW) starting

LA-90 ~ LA-410 are available to be fitted with PWS motor for customer's application as an optional accessory。

Please refer to the follow diagram for the wiring of PWS motor.





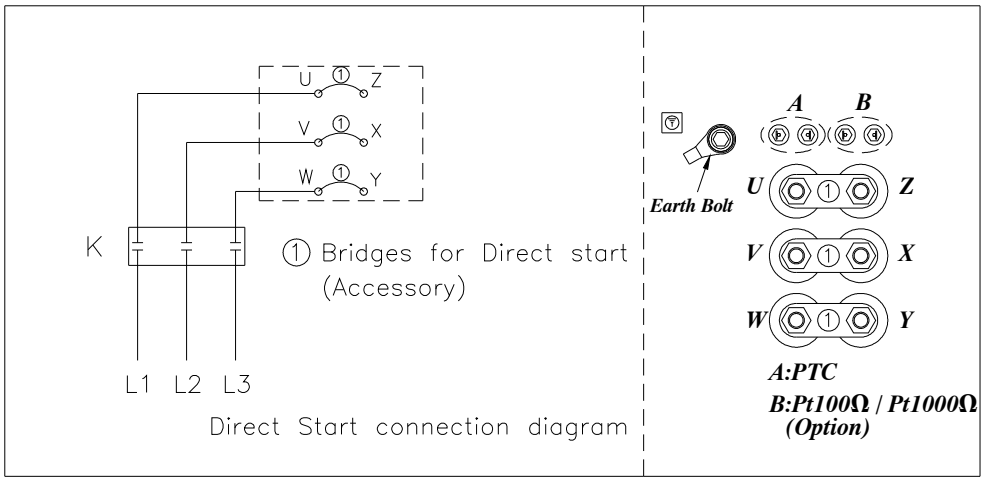


The selection of both of the motor contactors (k1 / k2) is each for approx. 60% of the max. running current. The recommended time delay of the switching relay k1 is to be set at 0.5 second and not more than 1 second.

PWS Starting features

1. The starting current is around 40% ~ 70% of full-winding Locked Rotor Current. It depends on the design and motor size.
2. Low starting torque.

Direct On Line start



Besides Y-Δ and PWS start, if there were any inquiry of Direct on line start、Soft start、Inverter start or Series reactance reduced voltage start, please contact Hanbell for further.

6.2 Compressor protection devices

The table below shows the list of protection devices which are essential to protect the compressor and operate safely. Follow the protection devices listed in the below table to ensure the compressor running under normal condition.

Protection device	Set point	Remark
Motor wiring temperature protector (PTC sensor)	Cutout 120℃, Cut in 75℃	Standard
Discharge temperature protector (PTC sensor)	Cutout 110℃, Cut in 60℃	Standard
Phase reversal protector (INT69Y)		Optional
Phase failure protector (INT69Y)		Optional
Oil level switch		Optional
Oil filter pressure differential switch	Cutout 2.5Kg/cm^{2}G	Optional
Oil flow switch		Optional
PT100Ω or PT1000Ω for liquid injection to motor chamber.	Solenoid valve open 85℃, Solenoid valve close 75℃	Optional

The motor thermister and discharge thermister are the temperature sensors with quick response while the temperature approach to their set point; the thermisters must be connected in series to a controller (INT69 or INT69Y) in terminal box as a guardian to protect the compressor. Alarm lamp for this protector is required to be embedded on the control panel as indicator. Any intention to short the controller for startup the compressor is prohibited especially in Hanbell. It is beyond Hanbell's responsibility to keep the warrantee of compressor if there is any above action found.

6.3 The supply power

1. Limitation of supply power

a. Voltage limitation
Long term running : rated voltage ±5%
Instant running : rated voltage ±10%

b. Frequency : Rated frequency ±2%

Note that in the region where the electricity power is unstable, install an additional Hi-Low voltage protector with ± 5% under and over tolerance outside the normal voltage to ensure the safe running of the compressor.

2. Unbalanced voltages :

Unbalanced voltages usually occur because of variations in the load. When the load on one or more of the phases is different than the other(s), unbalanced voltages will appear. This can be due to different impedances, or type and value of loading on each phase. Unbalanced voltages can cause serious problems, particularly to motor.

NEMA defines voltage unbalance as follows :

$$\text{Percent voltage unbalance} = 100 \times \frac{\text{(maximum voltage deviation from average voltage)}}{\text{(average voltage)}}$$

NEMA states that polyphase motors shall operate successfully under running conditions at rated load when voltage unbalance at the motor terminals does not exceed 1%. Further, operation of a motor with above a 5% unbalance condition is not recommended, and will probably result in damage to the motor.
Unbalanced voltages at motor terminals cause phase current unbalance ranging from 6 to 10 times the percent voltage unbalance for a fully loaded motor. This causes motor over current resulting in excessive heat that shortens motor life, and hence, eventual motor burnout. If the voltage unbalance is great enough, the reduced torque capability might not be adequate for the application and the motor will not attain reated speed.
Some of the more common causes of unbalance voltages are :

- Unbalanced incoming utility supply
- Unequal transformer tap settings
- Large single phase distribution transformer on the system.
- Open phase on the primary of a 3 phase transformer on the distribution system
- Faults or grounds in the power transformer

- Open delta connected transformer banks
- A blow fuse on 3 phase bank of power factor improvement capacitors
- Unequal impedance in conductors of power supply wiring
- Unbalanced distribution of single phase loads such as lighting
- Heavy reactive single phase loads such as welders

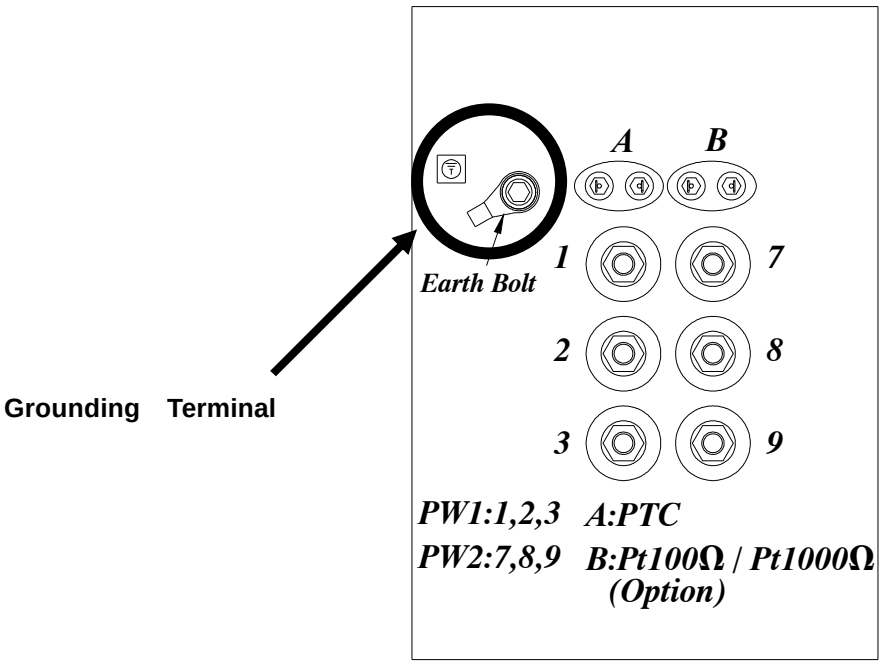
An 3 phase unbalanced voltages protector is upon request as optional accessory. Please contact with Hanbell for more detail.

6.4 Selection of magnetic contactor

Please refer to AC3 specification, compressor selection program and design conditions of system to choose suitable contactor.

6.5 Grounding

There's a grounding terminal inside cable box. Please accurately connect it to grounding of control panel for the system.



Suggestion:

a. The regular setting of electric leak protection should be greater than 50mA; for a humid location, 25mA is better.

b. Grounding voltage of casing should be no greater than 50V; for a humid location, the limit is 25V.

c. Grounding resistance should be no greater than 500 Ohm.

d. Air cut board (ACB) is regularly equipped with electric leak protection. Please refer to related settings for its normal action.

e. If electric leak protection is active, please check if insulation of equipments is normal and if its wiring and setting are correct. Please make sure nothing is wrong before turning on the power. If there are any questions, please contact the supplier of equipments.

7.Compressors accessories

To supply “Total Solution” for customers, Hanbell designs complete standard and optional accessories according to various application requirements for safe and steady running and best performance of compressors.

7.1. Compressors standard and optional accessories

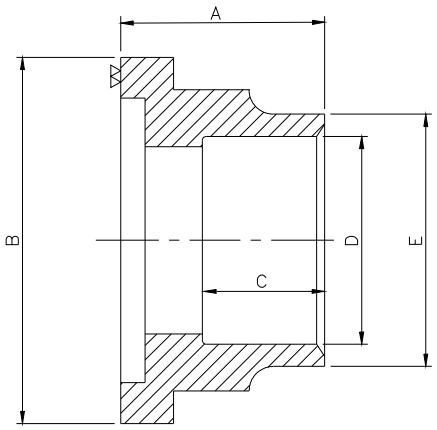
● **: Standard,** △ **: Optional,** **X : No need**

Model & Accessory	LA-																								
	90	110	120	140	170	200	230	250	280	310	340	370	410	470	510	550	580	620	710	790	830	930	1090	1280	1520
Steps or Step-less capacity control system	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Compatible Steps& step-less capacity control system	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Discharge check valve (Horizontal)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Suction & discharge connection bushings	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Suction & discharge stop valves	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
INT 69 controller	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
PTC temp. sensor	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
INT69Y controller	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
IP54 cable box	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Oil drain valve	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Liquid injection system (solenoid valve + expansion valve)	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Liquid injection system (solenoid valve + stop valve)	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
External oil separator	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
External oil filter	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Oil flow switch	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Economizer	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Economizer connection stop valve	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Oil cooler	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Oil pump	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Safety valve	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Explosion proof accessories	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Mounting pad	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Lubricant oil	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Micro controller	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Sound jacket	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Temperature sensors Pt100Ω or 1000Ω	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	●	●	●

Note : The accessory chart is just for customers’ reference only. Actual specification and accessories enclosed might vary with different quotation & agreement. If any optional accessory is required and out of the above mentioned standard accessory, please contact with Hanbell for detail specification and price of accessory.

7.2. Description of accessories

a. Suction and discharge connection bushings



Model	Standard Discharge Flange Bushing		Standard Suction Flange Bushing	
	Steel pipe	Copper pipe	Steel pipe	Copper pipe
LA-90	1 1/2″	1 5/8”	2″	2 1/8”
LA-110	1 1/2″	1 5/8”	2″	2 1/8”
LA-120	1 1/2″	1 5/8”	2 1/2″	2 5/8”
LA-140	1 1/2″	1 5/8”	2 1/2″	2 5/8”
LA-170	1 1/2″	1 5/8”	2 1/2″	2 5/8”
LA-200	2″	2 1/8”	3″	3 1/8”
LA-230	2″	2 1/8”	3″	3 1/8”
LA-250	2 1/2″	2 5/8”	3″	3 1/8”
LA-280	2 1/2″	2 5/8”	3″	3 1/8”
LA-310	2 1/2″	2 5/8”	3″	3 1/8”
LA-340	2 1/2″	2 5/8”	4″	4 1/8”
LA-370	2 1/2″	2 5/8”	4″	4 1/8”
LA-410	3″	3 1/8”	4″	4 1/8”
LA-470	3″	3 1/8”	4″	4 1/8”
LA-510	3″	3 1/8”	4″	4 1/8”
LA-550	3″	3 1/8”	4″	4 1/8”
LA-580	3″	3 1/8”	4″	4 1/8”
LA-620	4″	4 1/8”	5″	5 1/8”
LA-710	4″	4 1/8”	5″	5 1/8”
LA-790	4″	4 1/8”	5″	5 1/8”
LA-830	4″	4 1/8”	5″	5 1/8”
LA-930	4″	4 1/8”	5″	5 1/8”
LA-1090	5″	N/A	6″	N/A
LA-1280	6″	N/A	8″	N/A
LA-1520	6″	N/A	8″	N/A

Specification and dimension of optional flange bushing

Model	Discharge / Suction port	Materials and Sizes of pipes		Dimension of flanges bushing				
				A	B	C	D	
LA-90 LA-110	Discharge	Copper	1 1/2"	52	75	35	38.3	49
			1 5/8"				41.6	52
			1 3/4"				44.8	55
			2"				51.1	62
			2 1/8"				54.3	65
		Steel	1 1/4"				3.3	58
			1 1/2"				49.3	64
	Suction	Copper	1 5/8"	50	90	30	41.6	55
			1 3/4"				44.8	55
			2"				51.1	62
			2 1/8"				54.3	65
			2 1/2"				63.8	74
			2 5/8"				67	74
		Steel	1 1/2"				49.3	60
			2"				61.3	74
LA-120 LA-140 LA-170	Discharge	Copper	1 1/2"	52	75	35	38.3	49
			1 5/8"				41.6	52
			1 3/4"				44.8	55
			2"				51.1	62
			2 1/8"				54.3	65
		Steel	1 1/4"				43.3	58
			1 1/2"				49.3	64
	Suction	Copper	1 5/8"	60	110	35	41.6	52
			1 3/4"				44.8	55
			2"				51.1	62
			2 1/8"				54.3	65
			2 1/2"				63.8	74
			2 5/8"				67	77
			3 1/8"				79.8	90
		Steel	1 1/2"				49.3	64
			2"				61.3	76
			2 1/2"				77.2	90
LA-200 LA-230	Discharge	Copper	1 5/8"	50	90	30	41.6	55
			1 3/4"				44.8	55
			2"				51.1	62
			2 1/8"				54.3	65
			2 1/2"				63.8	74
			2 5/8"				67	74
		Steel	1 1/2"				49.3	60
			2"				61.3	74
	Suction	Copper	2'	66	120	45	51.1	62
			2 1/8"				54.3	65
			2 3/8"				60.7	71
			2 1/2"				63.8	74
			2 5/8"				67	77
			3"				76.6	87
			3 1/8"				79.8	90
		Steel	2"				61.3	76
			2 1/2"				77.2	92
			3"				90.2	103

Model	Discharge / Suction port	Materials and Sizes of pipes		Dimension of flanges bushing				
				A	B	C	D	
LA-250 LA-280 LA-310	Discharge	Copper	1 5/8"	60	110	35	41.6	52
			1 3/4"				44.8	55
			2"				51.1	62
			2 1/8"				54.3	65
			2 1/2"				63.8	74
			2 5/8"				67	77
			3 1/8"				79.8	90
		Steel	1 1/2"				49.3	64
			2"				61.3	76
			2 1/2"				77.2	90
	Suction	Copper	2'	66	120	45	51.1	62
			2 1/8"				54.3	65
			2 3/8"				60.7	71
			2 1/2"				63.8	74
			2 5/8"				67	77
			3"				76.6	87
			3 1/8"				79.8	90
		Steel	2"				61.3	76
			2 1/2"				77.2	92
			3"				90.2	103
LA-340 LA-370	Discharge	Copper	1 5/8"	60	110	35	41.6	52
			1 3/4"				44.8	55
			2"				51.1	62
			2 1/8"				54.3	65
			2 1/2"				63.8	74
			2 5/8"				67	77
			3 1/8"				79.8	90
		Steel	1 1/2"				49.3	64
			2"				61.3	76
			2 1/2"				77.2	90
	Suction	Copper	2 5/8"	76	145	50	67	87
			3"				76.6	87
			3 1/8"				79.8	90
			3 5/8"				92.4	103
			4"				102	112
			4 1/8"				105.1	116
		Steel	3"				90.2	105
			3 1/2"				102.8	117
			4"				115.6	128

Model	Discharge / Suction port	Materials and Sizes of pipes		Dimension of flanges bushing				
				A	B	C	D	
LA-410 LA-470 LA-510 LA-580	Discharge	Copper	2'	66	120	45	51.1	62
			2 1/8"				54.3	65
			2 3/8"				60.7	71
			2 1/2"				63.8	74
			2 5/8"				67	77
			3"				76.6	87
			3 1/8"				79.8	90
		Steel	2"				61.3	76
			2 1/2"				77.2	92
			3"				90.2	103
	Suction	Copper	2 5/8"	76	145	50	67	87
			3"				76.6	87
			3 1/8"				79.8	90
			3 5/8"				92.4	103
			4"				102	112
			4 1/8"				105.1	116
		Steel	3"				90.2	105
			3 1/2"				102.8	117
			4"				115.6	128
LA-620 LA-710 LA-790 LA-790 LA-830 LA-930	Discharge	Copper	2 5/8"	76	145	50	67	87
			3"				76.6	87
			3 1/8"				79.8	90
			3 5/8"				92.4	103
			4"				102	112
			4 1/8"				105.1	116
		Steel	3"				90.2	105
			3 1/2"				102.8	117
			4"				115.6	128
	Suction	Copper	4 1/8"	80	174	35	105.1	121.2
			5 1/8"	75			130.5	146.5
			5"	75			127.5	146.5
		Steel	4"	80			153.6	134
			5"	75			141.3	134
LA-1090	Discharge	Steel	5"	75	174	35	141.3	154
	Suction	Steel	6"	75	215	40	166.7	196
LA-1280 LA-1529	Discharge	Steel	6"	75	215	40	166.7	196
	Suction	Steel	8"	75	260	40	218	241

b. INT69 control module and PTC temperature sensor

In order to protect the compressor , each compressor has been installed three PTC temperature sensors inside motor coil and another one at the discharge side of compressor. These sensors are connected to an INT69 control module to monitor the motor coil temperature and discharge temperature as well. If the temperature in one of the areas monitored exceeds the nominal response temperature of the respective PTC thermistor, the sensor resistance increases and the INT69 control module switches the motor contactor off. The module resets when the temperature drops below the response temperature by approx. 3 K. The output replay provides a potential-free change-over contact and is energized as long as the nominal response temperature is not exceeded.

The “ Shut down lock-out” function is recommended to the control logic for INT69 to prevent from frequently start / stop of compressor.

Technical data of INT69

- Supply voltage

  220V ~ 240V ±10%, 3VA , 40 ~60 Hz

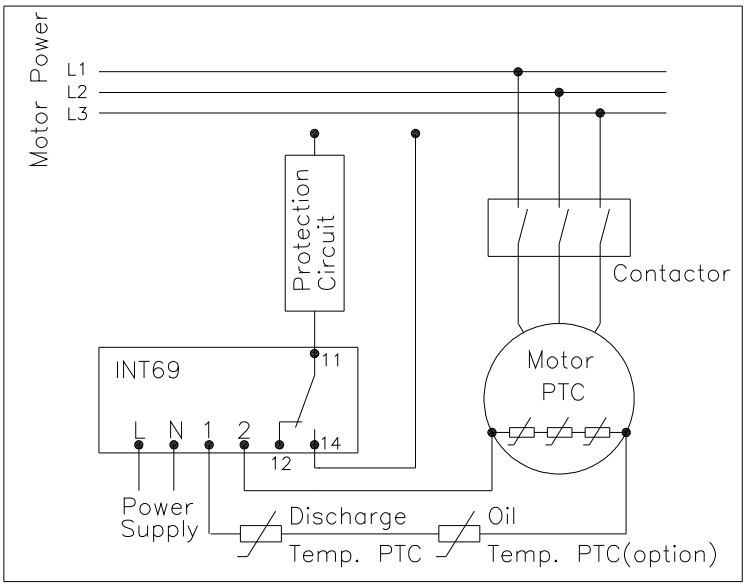
  115V -15% ~ +10%, 3VA , 50/60 Hz
- Ambient temperature

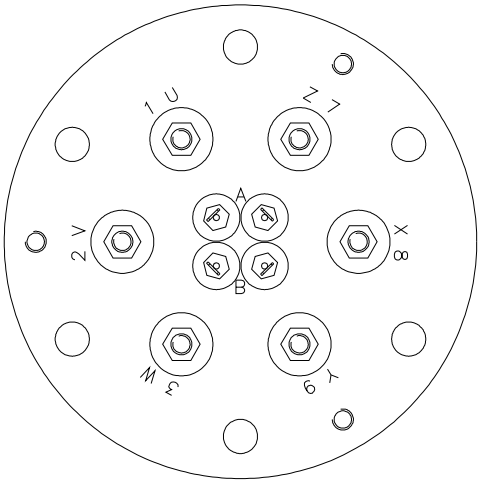
  -30 ~ +70 ℃
- Relay output

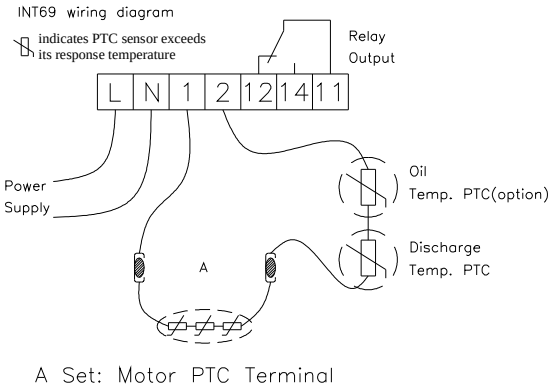
  Switch voltage AC 250V

  Continuous current max. 6A

INT69 & PTC temperature sensors connection diagram



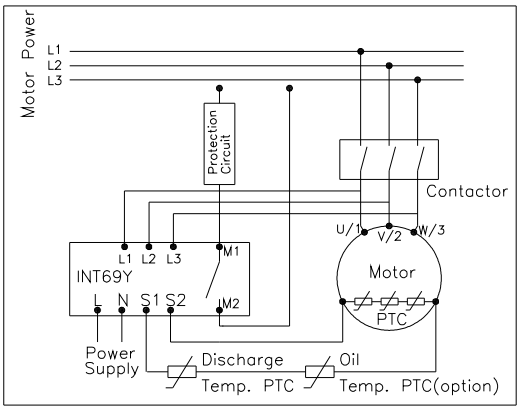


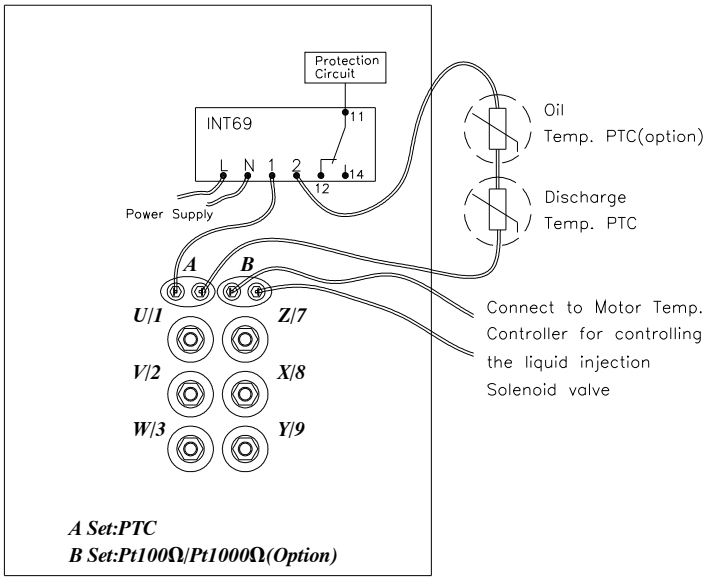


A Set: Motor PTC Terminal

In addition to the temperature monitoring function of INT69, Hanbell also supplies INT69Y motor protector with the monitoring functions of phase loss , phase sequence , motor temperature, discharge temperature as an optional accessory.

INT69Y & PTC temperature sensors connection diagram





Phase loss, phase sequence :

Phase sequence and phase loss monitoring functions are active during a 5s window 1s after compressor start (power on L1-L2-L3)

If one of these parameter is incorrect, the relay locks out (contacts M1-M2 are open).

The lockout can be cancelled by mains reset of approx. 5s (disconnect L-N)

Motor temperature:

Motor temperature is constantly measured by a thermistor (PTC) loop connected on S1-S2.

If any thermister exceeds its response temperature, its resistance increases above trip level and the output relay trips (contacts M1-M2 are open). After cooling down below the response temperature , a 5min time delay is activated. After the delay has elapsed, the relay pulls in again (contacts M1-M2 are closed).

The time delay can be cancelled by mains reset of approx. 5s (disconnect L-N)

Technical data of INT69Y

- Supply voltage

  115V ~ 240V -15% ~ +10% 3VA , 50/60 Hz
- Ambient temperature

  -30 ~ +60 ℃
- Relay output

  Switch voltage AC 240V, max. 2.5A, C300
- Phase sensor

  3 AC, 50/60Hz, 200 ~ 575 V ± 10%

c. External oil separator

Hanbell specially designs a complete series of external oil separators – OS series with characteristics of high filtration efficiency and low pressure drop. The following table shows details of OS series:

Note：It is recommended to install a buffer before the external oil separator to avoid noise and vibration which caused by resonance.

1. Technical data：

Model	Type	Oil Volume (Liter)		Range of application based on Displacement (m^3/hr) (Recommended)	Shell Diameter
		High level	Low level		
OS40	Vertical	17	9	205	14”
OS50	Vertical	22	12	206~270	16”
OS65	Vertical	31	18	271~440	18”
OS80	Horizontal	33	20	441~705	20”
OS100	Horizontal	40	27	706~1120	20”
OS125	Horizontal	50	30	1121~1310	24”
OS150	Horizontal	60	36	1311~1835	24”

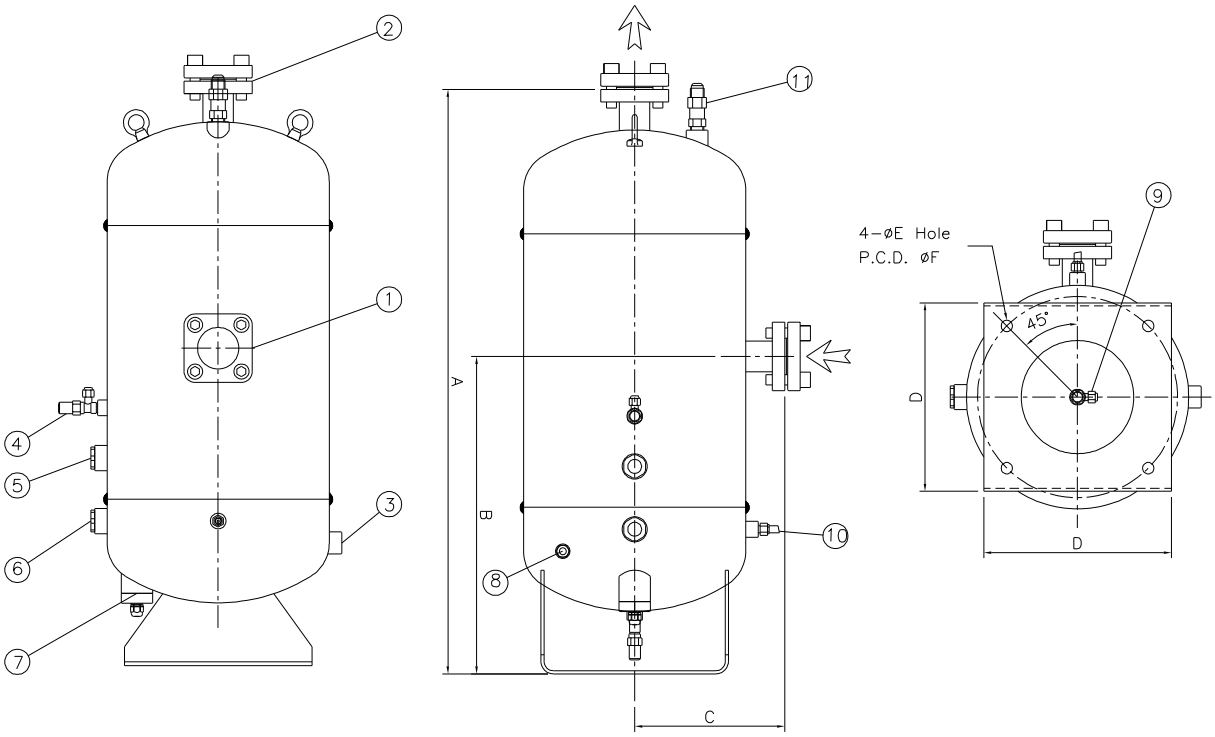
2. Accessories：

No.	Description	OS40	OS50	OS65	OS80	OS100	OS125	OS150
1	Refrigerant inlet	1 1/2”	2”	2 1/2”	3”	4”	5”	6”
2	Refrigerant outlet	1 1/2”	2”	2 1/2”	3”	4”	5”	6”
3	Oil outlet	5/8” Flare	5/8” Flare	5/8” Flare	1” PF	1” PF	1 1/4” PF	1 1/4” PF
4	Oil charge valve	1/4” Flare						
5	High oil S.G.	1 PCS						
6	Low oil S.G.	1 PCS						
7	Oil level switch	1 PCS						
8	Oil heater	150W	150W	150W	150W	150W	300W	300W
9	Oil drain valve	1/4” Flare						
10	Oil temp. protection (option)	1/8” NPTF						
11	Safety valve (option)	1/2”	1/2”	1/2”	1”	1”	1 1/2”	1 1/2”

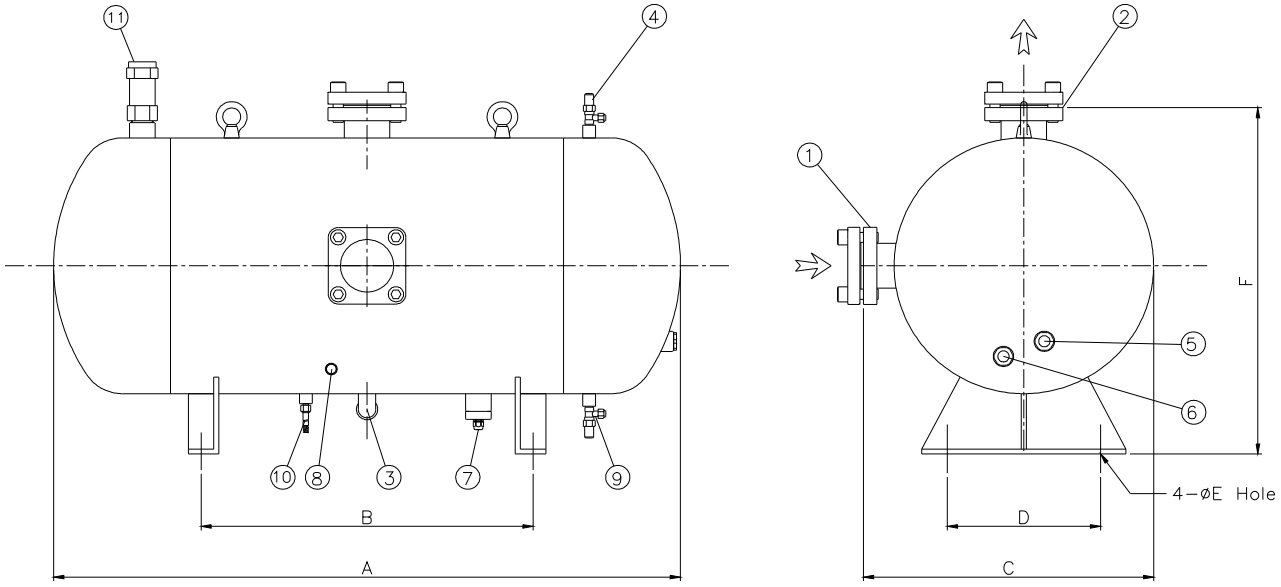
3. Dimensions：

No.	OS40	OS50	OS65	OS80	OS100	OS125	OS150
A	930	1050	1110	1227	1637	1829	2229
B	505	585	595	650	1000	1080	1480
C	240	275	300	568	354	409	409
D	300	350	350	300	300	400	400
E	18	22	22	23	23	23	23
F	320	360	360	688	698	830	830

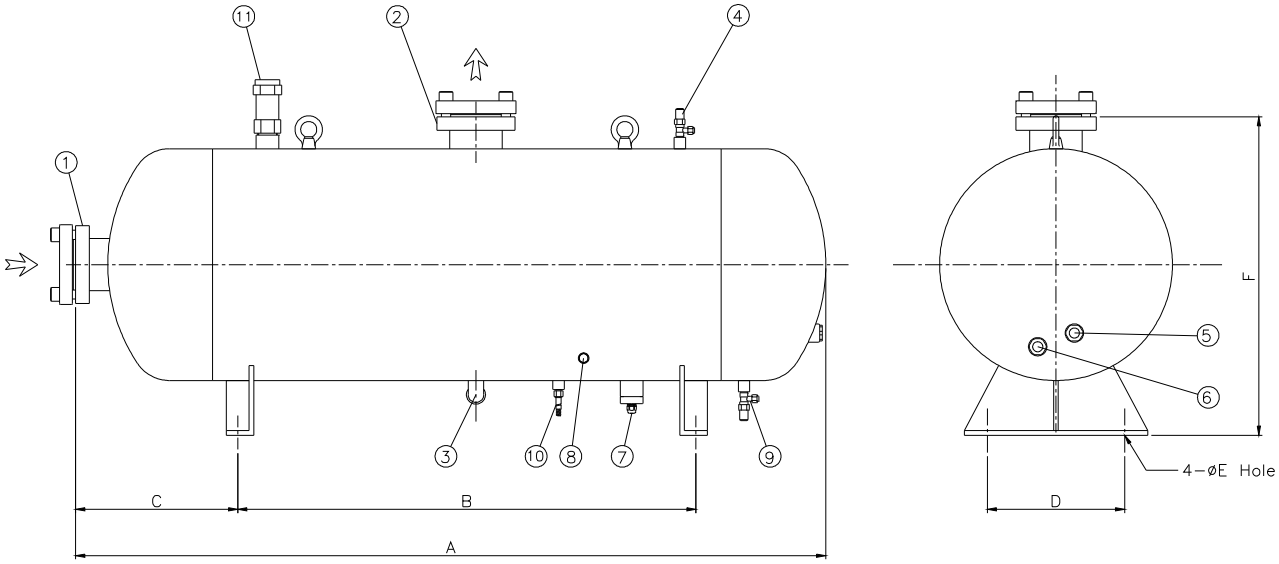
Vertical External Oil Separator-OS40, OS50, OS65



Horizontal External Oil Separator-OS80



Horizontal External Oil Separator-OS100, OS125, OS150

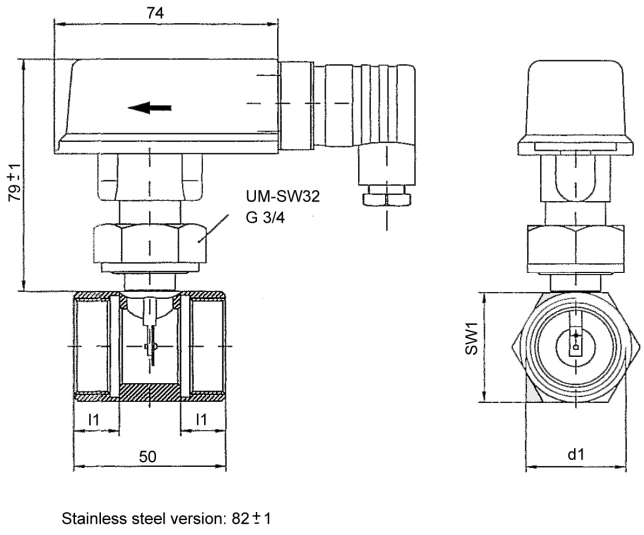


d. Oil flow switch

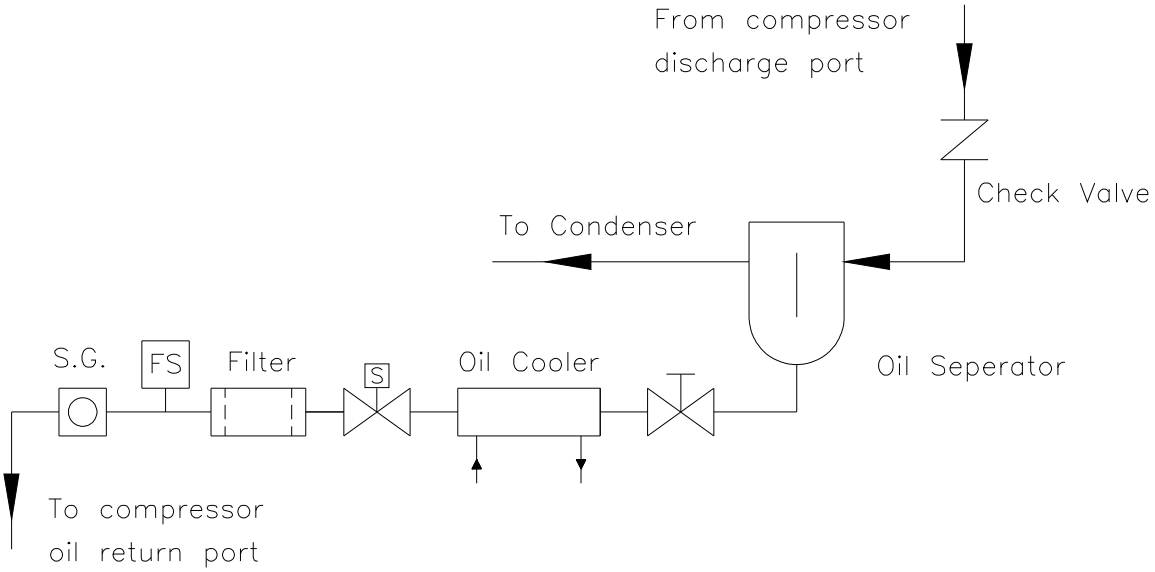
Oil flow switch operates with external oil separator to prevent oil deficient compressor. Specification and installation of Oil flow switch are shown as below:

Specification:

Model	Type	Size	Process connection d1	Setpoint range(H_20, 20℃)		Max. flow rate [l/min]	Dimensions		
				Increasing flow [l/min]	Decreasing flow [l/min]		l_1	Nut size sw[mm]	
								Brass	Stainless steel
LA-90 LA-110 LA-120 LA-140 LA-170	VHS 10M	DN 10	3/8” BSP	2, 5…3,2	2,2…2,9	60	11	19	27
LA-200 LA-230 LA-250 LA-280 LA-310 LA-340 LA-340 LA-370 LA-410 LA-470 LA-510 LA-550 LA-580 LA-620	VHS 15M	DN 15	1/2” BSP	3, 4…4,2	3,0…3,8	67	11	19	27
LA-710 LA-790 LA-830 LA-930	VHS 20M	DN 20	3/4” BSP	7, 0…9,1	6,4…8,2	180	15	27	32
LA-1090 LA-1280 LA-1520	VHS 25M	DN 25	1” BSP	13,5…17,0	12,0…15,5	195	15	32	41



Oil flow switch

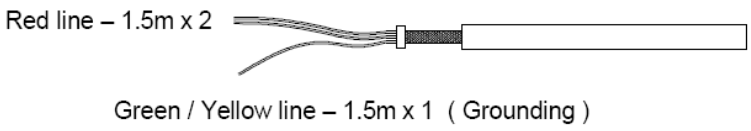


Installation of oil flow switch

e. Oil heater

Before restart of compressor after shutdown for a long time, please turn on oil heater at least 8 hours to make the temperature inside compressor higher than system temperature and ambient temperature and then it can prevent condensation of refrigerant inside oil sump of compressor which may result in liquid compression in next start and poor lubrication due to too low viscosity. In addition, Hanbell also offers 300W oil heater to keep adequate lubricant temperature for large external oil separator and applications in areas with low ambient temperature.

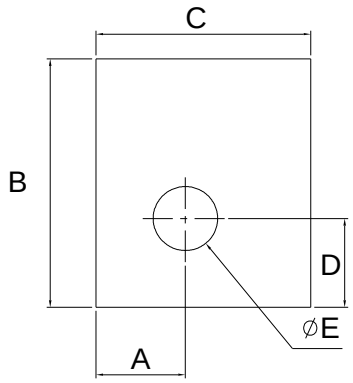
Specification : 150W, 300W, 110V or 220V, IP 54, UL approval



150W , 300W oil heater

f. Mounting pad

To avoid extra vibration and noise resulted from direct contact between compressor footings and the base on which compressor is mounted, it is recommended to add mounting pads in between as the drawing below shown.

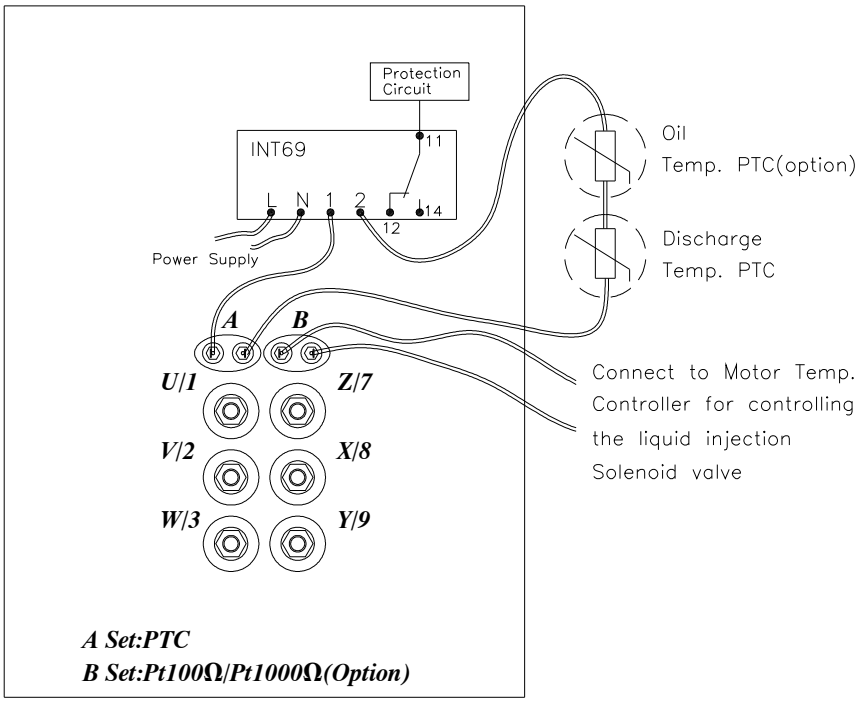


Model	A	B	C	D	E	Thickness
LA-90 LA-110 LA-120 LA-140 LA-170 LA-200 LA-230 LA-250 LA-280 LA-310	25	70	60	25	18	15 mm
LA-340 LA-370 LA-410 LA-470 LA-510 LA-550 LA-580 LA-620 LA-710 LA-790 LA-830 LA-930	35	110	85	30	22	15 mm
LA-1090 LA-1280 LA-1520	42.5	105	85	41	22	15 mm

g. Temperature sensors Pt100Ω or Pt1000Ω

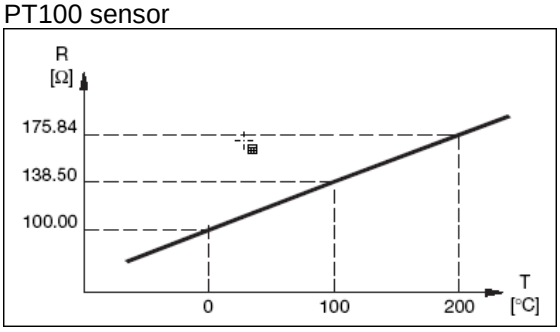
PT100 or PT1000 is a kind of “built-in” type temperature sensor installed in the motor coil. Please connect it to microcontroller of system and use for motor temperature display, setpoint of alarm & trip (lockout), and precisely controlling liquid injection solenoid valve in order to properly protect Hanbell compressor.

Motor of LA-1090,1280 & 1520 compressor adopts independent liquid injection cooling system，other models utilize suction return gas to cool motor coil. To effectively detect temperature of motor coil and adequately adjust volume of liquid injection by measured temperature, Hanbell specially mounts PT100 or PT1000 sensor on motor coil as an standard accessory for LA-1090,1280 & 1520 and optional accessory for others.



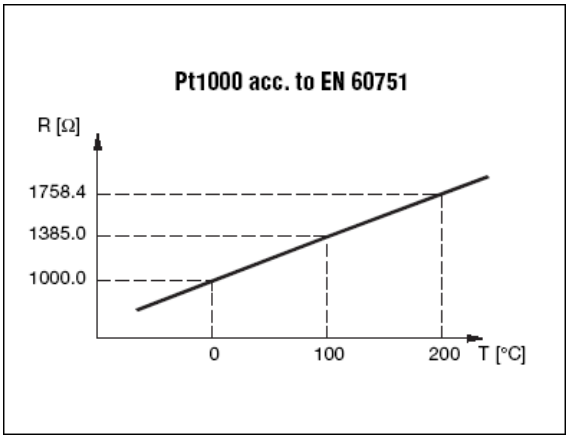
Specification :

PT100 sensor



- Recommended max. meas. Current for heat coefficient <0.1K - DC 1 ~ 3 mA
- Heating coefficient - 10mΩ/K
- Sensor resistance at 0℃ - 100Ω±0.12Ω
- Change of resistance 0 ~ 100℃ - 0.385Ω/K
- Insulation test voltage U is – AC 1.5kV

PT1000 sensor



- Recommended max. meas. Current for heat coefficient < 0.1K – DC0.2 ~ 2mA
- Sensor resistance at 0℃ - 1000Ω±1.20Ω
- Change of resistance 0 ~ 100℃ - 3.85Ω/K
- Insulation test voltage U is – AC 1.5kV

Please specify PT100 or PT1000 sensor when placing orders to Hanbell. In addition, except LA-1090,1280 & 1520 compressors, other models can also be equipped with PT100 or PT1000 sensor as a optional to adjust liquid injection to precisely control motor coil while running.

8. Operation and maintenance

8.1 Compressor start-up

PRE-START CHECKING Table below shows the required procedures and checkpoints before starting-up the compressor during commissioning or initial operation of the unit.

Items	Things to be checked	States or standard values
1. Accessories	1. Oil level 2. Oil heater 3. System valves status 4. Solenoid valves 5. Capillary	1. Higher than the middle line of oil level sight glass 2. Should be kept energizing after compressor shut down. 3. Opened 4. Fixed 5. No serious distortion or damaged
2. Electrical system	1. Voltage of main power 2. Voltage of control circuit 3. Insulation resistance value of the motor between phase to phase and phase to ground. 4. Power terminals and wire cables' terminal connection. 5. Grounded 6. Capacity of electrical accessories 7. Settings of switches, sensors and controllers.	1. Electricity voltage should be kept within 5% to the rated voltage, instant maximum voltage drop while starting should be less than 10% to the rated voltage. 2. Standard voltage is 220V.Maximum voltage is 230V. If there is other demand, contact HANBELL. 3. Insulation resistance value should be above 5MΩ. 4. Power terminals are firmly fixed on terminal block and well insulated. Keep wire cables away from heat source and sharpened metal. Power terminals are fixed firmly and well insulated. Terminal screw and block are both required. 5. (Ruled by the local Electricity Regulations.) 6. Properly selected (or inquired by the system designer.) 7. Properly set (or inquired by the system designer.)
3. Piping system	1. Outer piping system 2. Leakage test 3. Bolts to fix the compressor.	1. Fixed firmly. 2. No leakage. 3. Fix the compressor tightly.
4. Safety devices	1. Motor coil sensor (thermister) 2. Discharge sensor (thermister) 3. Controller	1. Connected in series with discharge sensor to controller. 2. Connected in series with motor sensor to controller. 3. Closed circuit with N.C. & N.O.

In addition to the pre-start checking given in the above table, also consider the following:

a. It is necessary to pay more attention to the auxiliary facilities while the chiller is commissioning at the job-site and the periodic maintenance after the initial start-up.

b. In order to keep the capacity control smoothly under the low ambient temperature with the normal viscosity of oil, oil heater should be kept energizing after compressor has been shut down for preparation for the next start-up.

c. Check that all the settings on each pressure switch are correct.

d. Check if all the stop valves in the system are already open.

e. Check the rotating direction of the compressor by starting the compressor for a split second (approx. 0.5…1 sec.) and check the suction and discharge pressure gauges. The correct rotating direction is: suction pressure drops immediately and the discharge pressure will going up.

f. The compressor lubrication oil should be check immediately after starting. Oil level should be within sight glass range or higher than the middle line of oil level sight glass.

g. Oil foaming can be generated during starting phase, but it should reduce when the compressor is under stable operating conditions. Otherwise this can indicate excessive liquid in the suction gas.

h. The running condition of compressor after commissioning at the job-site should be adjusted as; the discharge temperature will be at least 20K above the saturated condensing temperature and the suction vapor superheat should be within 10K to the saturated evaporating temperature.

i. The whole plant, especially the pipelines and capillary tubes must be checked for abnormal vibrations. Contact HANBELL or local distributor if any abnormal vibrations or noise found while the compressor is running.

j. Regularly check-up the plant according to national regulations and the following items should also be checked:

- Operating data of the machine
- Check the lubrication/level of oil
- All compressor monitoring parts
- Check electrical cable connections and tightness

8.2 Troubleshooting

The table below shows some problem that might encounter in the jobsite during commissioning or upon operation of compressor. This table will only serve as a guide for the Engineer to understand the situation once the problem occurred in the site.

PROBLEMS	PROBABILITY CAUSES	REMEDY / CORRECTIVE ACTION
Sudden trip of motor thermister / sensor	Low suction pressure cause low refrigerant flow rate	Install liquid injection to motor coil
	Refrigerant shortage	Charge refrigerant
	Suction filter clogged	Clean filter
	High suction temperature	Install liquid injection to motor coil
	High suction superheat	Adjust the superheat less than 10℃
	Unstable electricity system or failure	Check electricity power supply
	Motor overload	
	Bad motor coil causing temperature rising rapidly	
Compressor unable to load	Low ambient temperature or high oil viscosity.	Turn on the oil heater before compressor start.
	Capillary clogged.	Clean or replace capillary
	Modulation solenoid valve clogged or solenoid valve coil burnt.	Clean / purge solenoid valve core or replace the solenoid valve coil
	Internal built-in oil line clogged.	Check and clean the compressor oil circuit
	Piston stuck-up.	Change piston or piston ring
	Oil filter cartridge clogged.	Clean oil filter (replace if needed)
	Too small the high-low pressure differential.	Minimum pressure differential is 4 bar. Consider to install an oil pump.
	Modulation solenoid valve clogged or burnt.	Clean or replace the solenoid valve
	Piston rings worn off or broken, or cylinder damaged resulting leakage.	Change piston (if cylinder damaged severely, change the cylinder)

PROBLEMS	PROBABILITY CAUSES	REMEDY / CORRECTIVE ACTION
Compressor unable to unload.	Lubrication oil insufficient.	Check the oil level of the compressor if enough, add some oil if necessary
	Leakages at internal discharge cover plate end side.	Check or replace the gasket and tighten the bolts.
	Solenoid valve voltage misused.	Check the control voltage
	Piston stuck-up.	Change the piston set, and check the cylinder and slide valve.
	Capacity control logic unsuitable.	Check
Poor insulation of motor	1. Bad compressor motor coil.	Check the coil or change the motor stator
	2. Motor power terminal or bolt wet or frosty.	
	3. Motor power terminal or bolt bad or dusty.	
	4. Bad insulation of magnetic contactors.	
	5. Acidified internal refrigeration system.	
	6. Motor coil running long time continuously under high temperature.	
	7. Compressor restart counts too many times.	
Compressor starting failure or Y-Δ starter shifting failure	Slide valve piston unable to go back to its lowest % original position.	Check if the unloading SV is energized once the compressor shut down. Unload the compressor before shot down.
	Voltage incorrect.	Check the power supply
	Voltage drop too big when starting the compressor or magnetic contactor failure or phase failure.	Check the power supply and the contactor.
	Motor broken down	Change the motor
	Motor thermister sensor trip.	See “sudden trip of motor sensor” above
	Incorrect supply power connection.	Check and re-connect
	Y-Δ timer failure.	Check or replace.
	Discharge or suction stop valve closed.	Open the stop valve
	Improper connection between node terminals of Y-Δ wiring.	Check and re-connect the wiring
	Rotor locked	Check and repair
	Earth fault	Check and repair
	Protection device trip	Check
Abnormal vibration and noise of compressor	Damaged bearings.	Change bearing.
	Phenomenon of liquid compression.	Adjust proper suction superheat
	Friction between rotors or between rotor and compression chamber.	Change screw rotors or/and compression chamber.
	Insufficient lubrication oil.	Check the oil level of the compressor if enough, add some oil if necessary.
	Loosen internal parts.	Dismantle the compressor and change the damaged parts.
	Electromagnetic sound of the solenoid valve.	Check

PROBLEMS	PROBABILITY CAUSES	REMEDY / CORRECTIVE ACTION
	System harmonic vibration caused by improper piping system.	Check the system piping and if possible improve it using copper pipe.
	External debris fallen into the compressor.	Dismantle the compressor and check the extent of the damage.
	Friction between slide valve and rotors.	Dismantle the compressor and change the damaged parts.
	Motor rotor rotates imbalance.	Check and repair.
Compressor does not run	Motor line open	Check
	Tripped overload	Check the electrical connection
	Screw rotors seized	Replace screw rotors, bearings etc….
	Motor broken	Change motor.
High discharge temperature	Insufficient refrigerant.	Check for leaks. Charge additional refrigerant and adjust suction superheat less than 10℃
	Condenser problem of bad heat exchange.	Check and clean condenser
	Refrigerant overcharge.	Reduce the refrigerant charge
	Air / moisture in the refrigerant system	Recover and purify refrigerant and vacuum system
	Improper expansion valve.	Check and adjust proper suction super heat
	Insufficient lubrication oil.	Check the oil level and add oil.
	Damaged bearings.	Stop the compressor and change the bearings and other damaged parts.
	Improper Vi value.	Change the slide valve.
	No system additional cooling (Liquid injection or oil cooler)	Install additional system cooling (liquid injection or oil cooling or both base on working condition limitation)
Compressor losses oil	Lack of refrigerant	Check for leaks. Charge additional refrigerant.
	Improper system piping	Check and correct the piping or install an external oil separator
	Refrigerant fills back	Maintain suitable suction superheat at compressor
Low suction pressure	Lack of refrigerant	Check for leaks. Charge additional refrigerant.
	Evaporator dirty or iced	Defrost or clean coil
	Clogged liquid line filter drier	Replace the cartridge
	Clogged suction line or compressor suction strainer	Clean or change suction strainer
	Expansion valve malfunctioning	Check and reset for proper superheat
	Condensing temperature too low	Check means for regulating condensing temperature

Note: The replacement of compressor internal parts should be perform only by a qualified / certified service technician with full knowledge of HANBELL screw compressor or it should be a Service Engineer from HANBELL.

8.3 Compressor checking list

Please fill out the compressor checking list and send it to Hanbell, if any failure of compressor happened. Hanbell will reply and suggest the solution to resolve the failure.

CHECKING LIST OF HANBELL SCREW COMPRESSOR TROUBLESHOOTING

Compressor model: Compressor S/N:

System design condition SCT/SST: Evaporator type:

Refrigerant type: Liquid injection:☐ Motor side ☐ Chamber

Voltage: R-S: S-T: R-T: Over load setting : A

Start-Delta setting: Sec Delta-Delta setting: Sec

Starting current: A Delta current: A (Finish starting)

Operating current (Full load): R: S: T:

The problem of complain:

- ☐ A: abnormal noise: dbm; at which capacity
- ☐ B: abnormal vibration
- ☐ C:Over current
- ☐ D:Motor burn out
- ☐ E:Unable to load
- ☐ F:Unable to unload
- ☐ G:Leakage(PLS with photos)
- ☐ H:Accessary parts damaged(PLS with photos)
- ☐ I: Other (PLS interpreation)

Suction Pressure	Discharge Pressure	Suction Temperature	Discharge Temperature	Liquid Line Temperature	Condenser water temperature		Chiller Water Temperature		Oil Cooler Temperature		Economize temperature	
					Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet

E-mail : sales@hanbell.com Fax : +886-3-4836223 Tel : +886-3-4836215

9. Applications

9.1 Additional cooling

When compressors operate in the following application conditions, installation of an additional auxiliary cooling apparatus is recommended to lower discharge temperature, maintain proper temperature of lubricant and replenish cooling for motor coil… to ensure safe running of compressors with efficiency.

- Air cooled system
- High compression ratio system such as heat pump, low temperature refrigeration system
- High discharge temperature system such as heat recovery system
- If compressors have to run at partial load below 50% continuously in a long term.
- Any other heavy duty application

There are two type of additional cooling of compressor (liquid injection and oil cooler) that described separately as below. Please also refer to **chapter 3.3** for the connection and installation of additional cooling system. The cooling capacity of additional cooling can be calculated by the HANBELL selection software or manually. For manual calculation, consider the most extreme conditions to be expected during actual operations i.e. minimum evaporating temperature, maximum suction gas super heat and condensing temperature.

a. Liquid injection applications

In areas with high condensing temperature and/or low evaporating temperature as in the limitation diagram, additional cooling is required in order for the compressor to work properly. A relatively simple method of additional cooling is direct refrigerant injection in the compressor either in the motor side or compression chamber side.

The purpose of installing a liquid injection system is to prevent the compressor from overheat. The system installed an expansion valve with tube, piped between the liquid line and compressor for cooling down the compression chamber and motor to ensure the continuous and safe running of the compressor. The suction superheat should be controlled between 5K~10K for the application of air-cooled and heat pump chillers by means of expansion valve devices. These devices can be adjusted by the stem of the expansion valve to control the suction superheat by means of refrigerant flow rate. When the initial startup, the loading of the chiller is heavy due to the high temperature of chilled returned water, so the liquid injection devices capacity should be selected or calculated enough to reduce the overheat of the compressor.

Liquid injection applied with low temperature expansion valve

When the compressor applied in the low temperature system (E.T. ≦ -10℃) the compression ratio is high at this condition, also the discharge temperature will be very high. There are two connectors for the liquid injection in the compressor, one is in the motor side to cool down the motor temperature and reduce the discharge temperature. The other is in the compression chamber side and its function is to reduce the discharge temperature and increase the compression efficiency.

Liquid injection applied with high temperature expansion valve

Select the high temperature expansion valve, which can sense the discharge temperature with its remote bulb. This can control the opening of expansion valve proportionally, and can reach the best cooling effect; it will control the compressor discharge temperature at an optimal situation of around 80°C.

It can also install an additional solenoid valve or service valve in front of the high temperature expansion valve for the maintenance purposes. The solenoid valve will be opened while starting the compressor, and it also can be added a stop valve in piping for the system maintenance. The equilibrium tube of high temperature expansion valve should be connected to the high-pressure side to counter the internal pressure.

b. Oil cooler application

Compared to liquid injection applications, oil cooler application reduces the discharge temperature and at the same time gives better efficiency. Oil cooler application can be classified into 3 types: cooling by refrigerant, cooling by ambient air, cooling by cooling water.

9.2 Economizer applications

HANBELL screw compressor can be fitted with an additional middle pressure connection for economizer operation. With this form of operation, refrigeration capacity and also system efficiency can be improved by means of a sub-cooling circuit or two-stage refrigerant expansion.

Based on HANBELL extensive research a special design of the Economizer connection has been developed so that the connection causes no additional back flow losses during compression. As a result of this, compressor capacity is fully retained in all operating conditions.

Please refer to Hanbell selection software for the calculation of Economizer at different working conditions.

Principle of operation

As opposed to the reciprocating operation of a piston compressor, the compression in a screw compressor takes place only with one flow direction. When the rotors turn, refrigerant vapor is pressed into the rotor grooves by the opposing rotor teeth and transported to end wall of the corresponding working space. In this phase, the volume is steadily reduced and the vapor is compressed from suction pressure to condensing pressure.

The pressure at the additional middle connection is at a similar level to the intermediate pressure with a two-stage system. As a result of these features, a screw compressor of this design can be combined with an additional sub-cooling circuit or an intermediate pressure vessel (flash type sub-cooler) for two-stage expansion. These measures result in a clearly increased refrigeration capacity due to additional liquid sub-cooling, especially with high-pressure ratios. The power consumption of the compressor increases slightly compare to the additional work that takes place at a better level of efficiency.

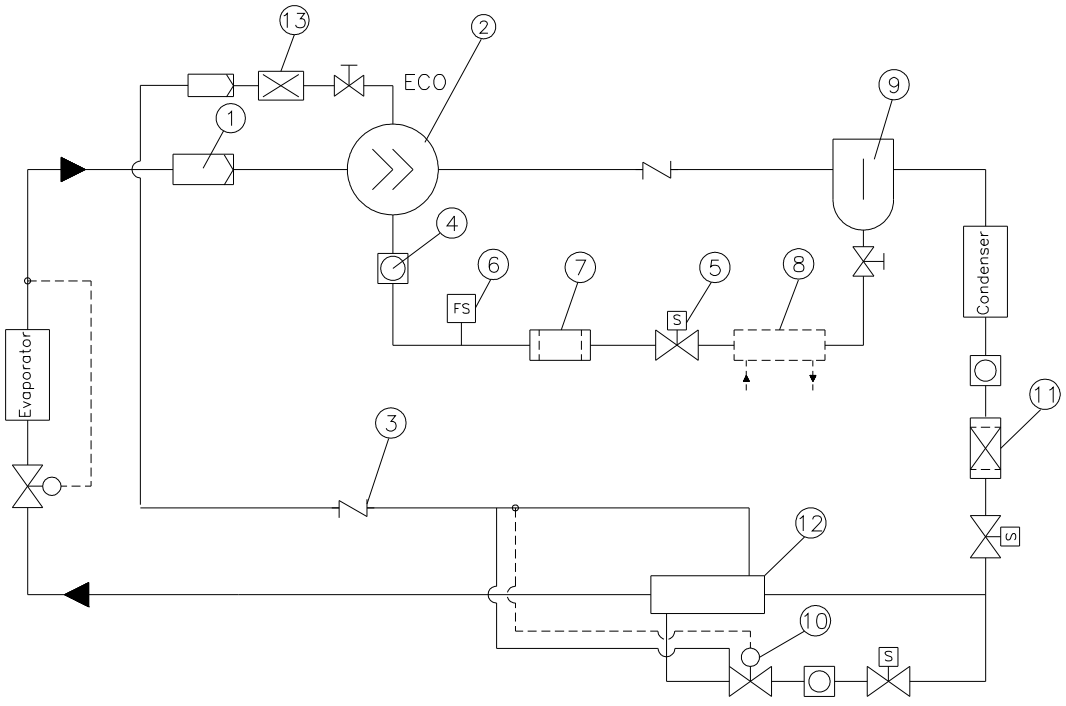
System with Economizer (sub-cooler)

With this form of operation, a heat exchanger (refrigerant sub-cooler) is used to sub-cooled liquid refrigerant. The sub-cooling is achieved by injecting a part of the refrigerant from the condenser through an expansion device in counter flow into the sub-cooler, which then evaporates due to the absorption of heat. The superheated vapor is pulled into the compressor at the Economizer connection and mixed with the vapor, which is already slightly compressed from the evaporator.

The sub-cooled liquid is at condensing pressure with this form of operation, the pipeline to the evaporator does not therefore require any special features, aside from insulation. The system can be generally applied.

Economizer application system chart - Shell & tube subcooler :

NO	Description	NO	Description
1	Suction filter	8	Oil cooler
2	Compressor	9	External oil separator
3	Check valve	10	Expansive valve
4	Sight glass	11	Dry filter
5	Flow switch solenoid valve	12	Oil subcooler
6	Flow switch	13	muffler
7	Oil filter cartridge		



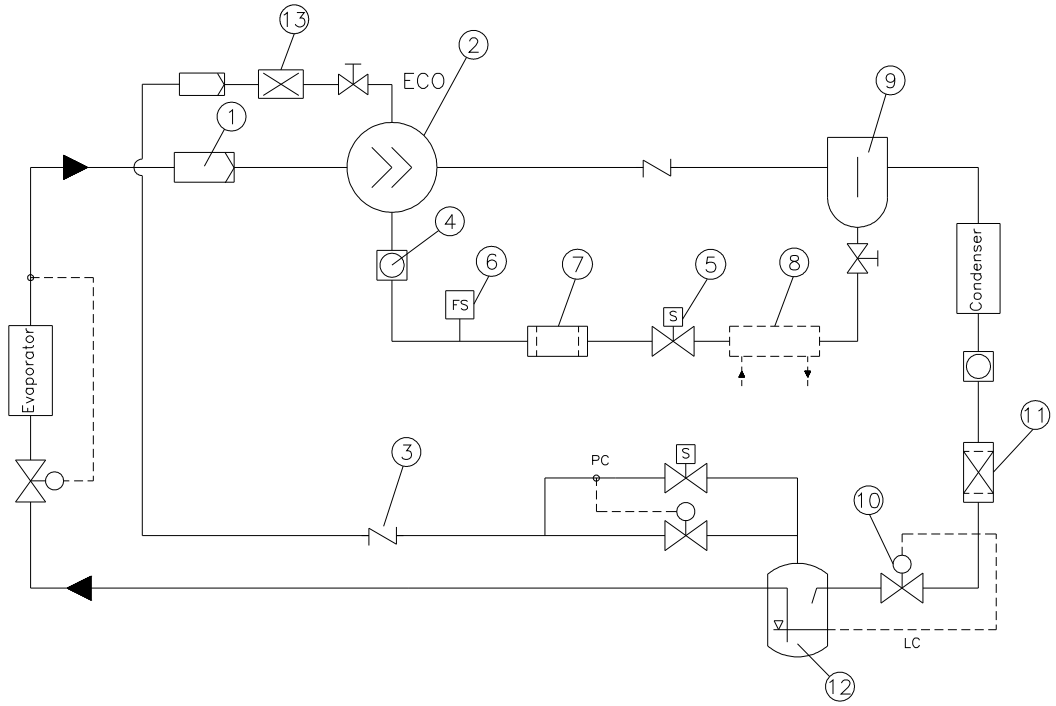
System with Economizer (flash type)

The liquid sub-cooling is achieved with this form of operation by reducing the boiling point pressure in an intermediate pressure vessel **(flash type sub-cooler)** arrange between condenser and evaporator. This physical effect leads to the cooling of the liquid down to the boiling point, due to evaporation of part of the liquid. To stabilize the pressure of the vessel, a regulator is used which at the same time controls the quantity of vapor flowing to the Economizer connection of the compressor.

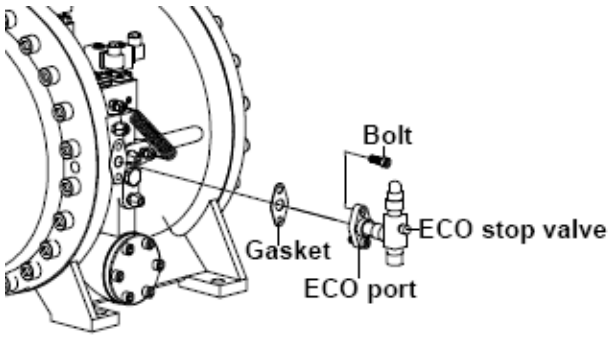
This form of operation gives the most economical thermodynamic performance due to direct heat exchanging. As the intermediate pressure is reduced to the boiling point temperature this system should only be used with flooded evaporators.

Economizer application system chart – Flash Tank :

NO	Description	NO	Description
1	Suction filter	8	Oil cooler
2	Compressor	9	External oil separator
3	Check valve	10	Expansive valve
4	Sight glass	11	Dry filter
5	Flow switch solenoid valve	12	Flash tank
6	Flow switch	13	muffler
7	Oil filter cartridge		



Note : When apply the economizer to compressor, it is strongly recommended to install a economizer stop valve before the economizer gas return port to operate as a buffer or muffler (or install a muffer after stop valve as the charts shown above) could efficiently prevent the vibration of piping caused by compression pulse.

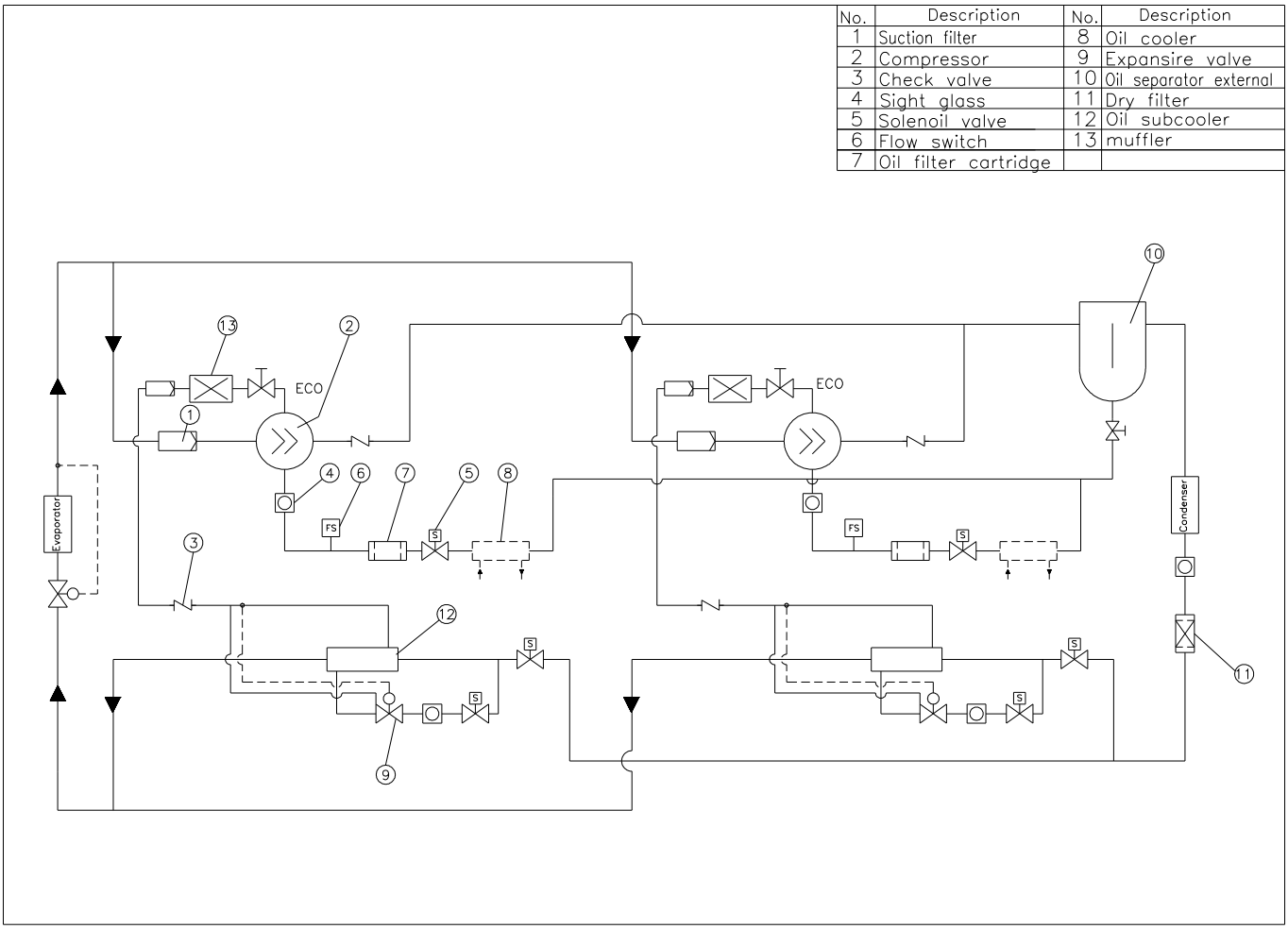


9.3 Parallel system applications

In the rack or parallel system, it is possible to happen the unequal-distribution of returned oil from the evaporator that could cause low oil level in one or more of the compressors. Be sure to install the oil level switch inside each compressors and oil flow switch installed in each oil return line to ensure the returned oil in each compressor with normal oil level.

The basic design of the system is shown below, twin compressor parallel system connections. The accessories installed are the basic and if there are more applications or protection required, contact HANBELL or local distributor/agent for more information or further confirmation.

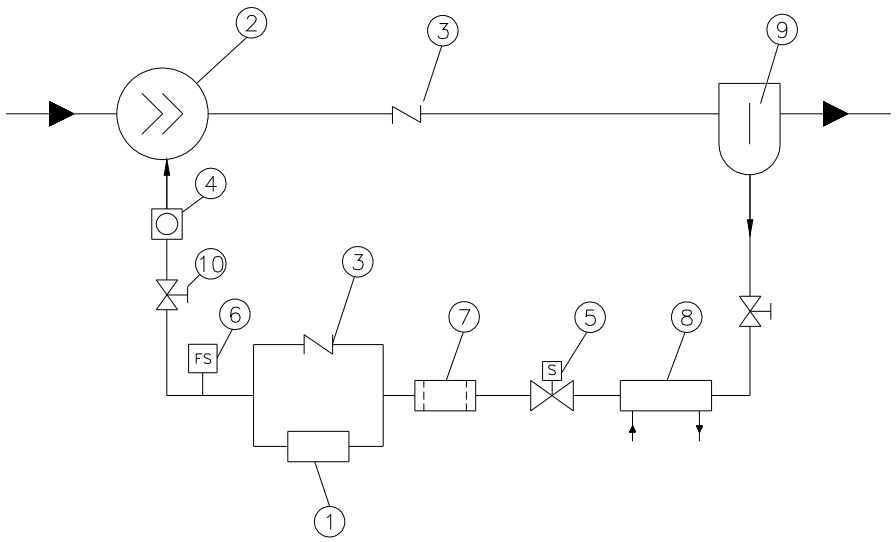
Twin compressor parallel connection



9.4 Oil pump application

An addition oil pump is recommended to install to the system when the differential pressure of oil pressure and suction pressure is less than 4bar (for example: water cooled flooder chiller). If compressor is operating at the mentioned condition, the failure of modulation and lubrication will be happened and will seriously damage the compressor. Besides the installation of additional oil pump, a high – low pressure differential switch is also recommended to install to this kind of system. Please contact with Hanbell for more detail information of oil pump.

No.	Description	No.	Description
1	Oil pump	6	Flow switch
2	Compressor	7	Oil filter cartridge
3	Check valve	8	Oil cooler
4	Sight glass	9	External oil separator
5	Solenoid valve	10	Service valve



9.5 Important note of applications of compressor

9.5.1 Pump down

Do not pump down the compressor on the chiller as a routine operation except only for temporary maintenance or a long term shut down. Because pump down will cause extremely high temperature in the compression chamber and overheat of the motor as well due to less amount of refrigerant in the suction side. When doing the pump down, be sure to take notice of the items listed below :

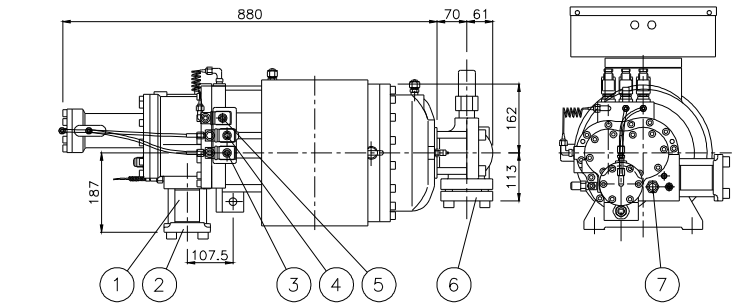
a. Hanbell recommends that whenever doing the pumping down of the compressor, the compressor is also recommended to run at 100% capacity.
b. Pump down should be done once each time, as it may be dangerous to the compressor, compression chamber for pumping down repeatedly.
c. The minimum suction pressure when doing the pump down should be over 0.5kg/cm2G
d. The allowable length of time for pumping down a compressor should not be over 15 seconds.
e. When doing the pump down of compressor, must take notice of the high discharge temperature should not exceed 110℃.
f. Take notice of high/low pressure reading the oil level of the compressor and the noise of running as well. If there is any abnormal value or situation, then emergently stop the pump down.

Long term partial load operation

If compressors have to run at partial load below 50% continuously, though maybe within operation limits under such operation condition and with temperature of motor below trip setting for overheating, insufficient dissipation of heat in motor will occur due to lower flow rate of suction gas at partial load. If compressors operate under high temperature for a long time, insulation of motor will deteriorate gradually at risk of serious motor damage finally. In such severe operation conditions, Hanbell strongly recommends installation of liquid injection system to cool motor coil and use of PT100 or PT1000 sensor as described in chapter 7.2 , to effectively control temperature of motor while running. It is suggested to switch on liquid injection when temperature of motor coil is higher than 80℃ and turn off liquid injection when it’s lower than 65℃.

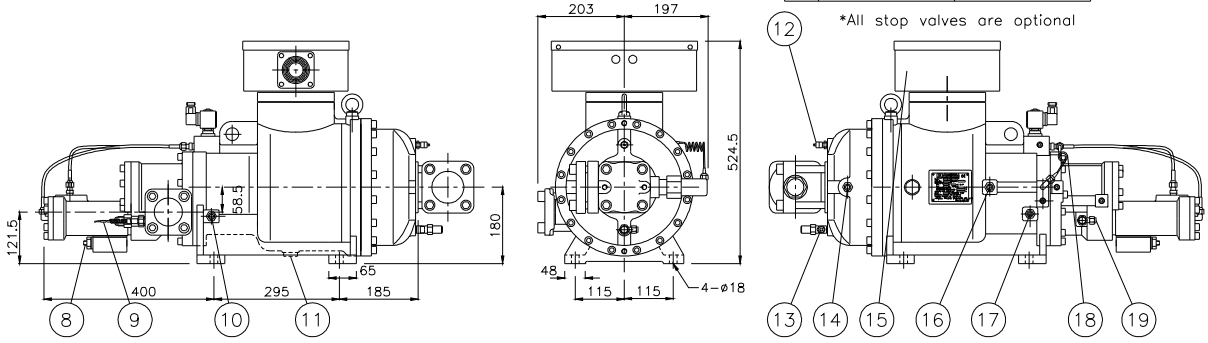
10. Compressor outline dimensions

LA-90 Outline Dimension Drawing

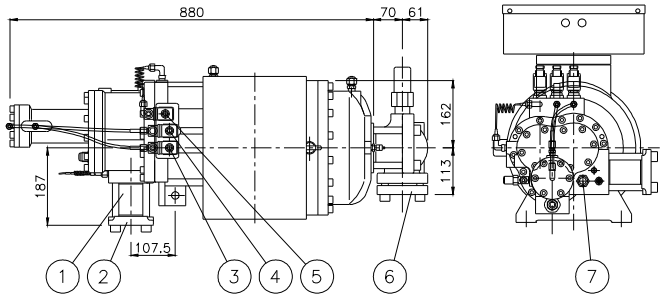


No.	Description	Remarks
1	Check valve	1 1/2"
2	Discharge flange	1 1/2"
3	Solenoid valve	66%(NC)
4	Solenoid valve	33%(NC)
5	Solenoid valve	Stepless(NO),option
6	Suction flange	2"
7	Safety Valve	option
8	Vol. ratio adj. rod	
9	Discharge temp. sensor	110°C
10	Economizer port	3/8"Flare
11	Oil drain valve	
12	Charge valve	1/4"Flare
13	Suction angle valve	1/4"Flare
14	Motor Liquid injection port	3/8"Flare
15	Cable box	
16	Oil inlet	3/8"Flare
17	Compression chamber Liquid(oil or refrigerant) injection port	3/8"Flare
18	Capillary	
19	Angle valve	1/4"Flare

*All stop valves are optional

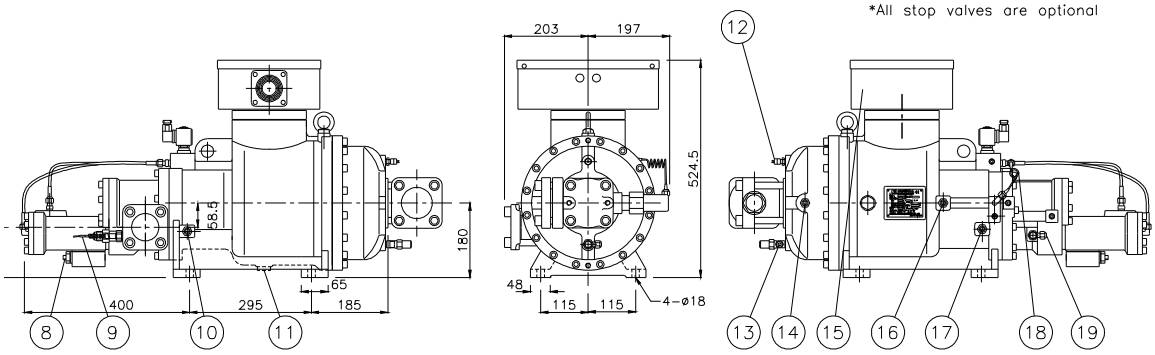


LA-110 Outline Dimension Drawing

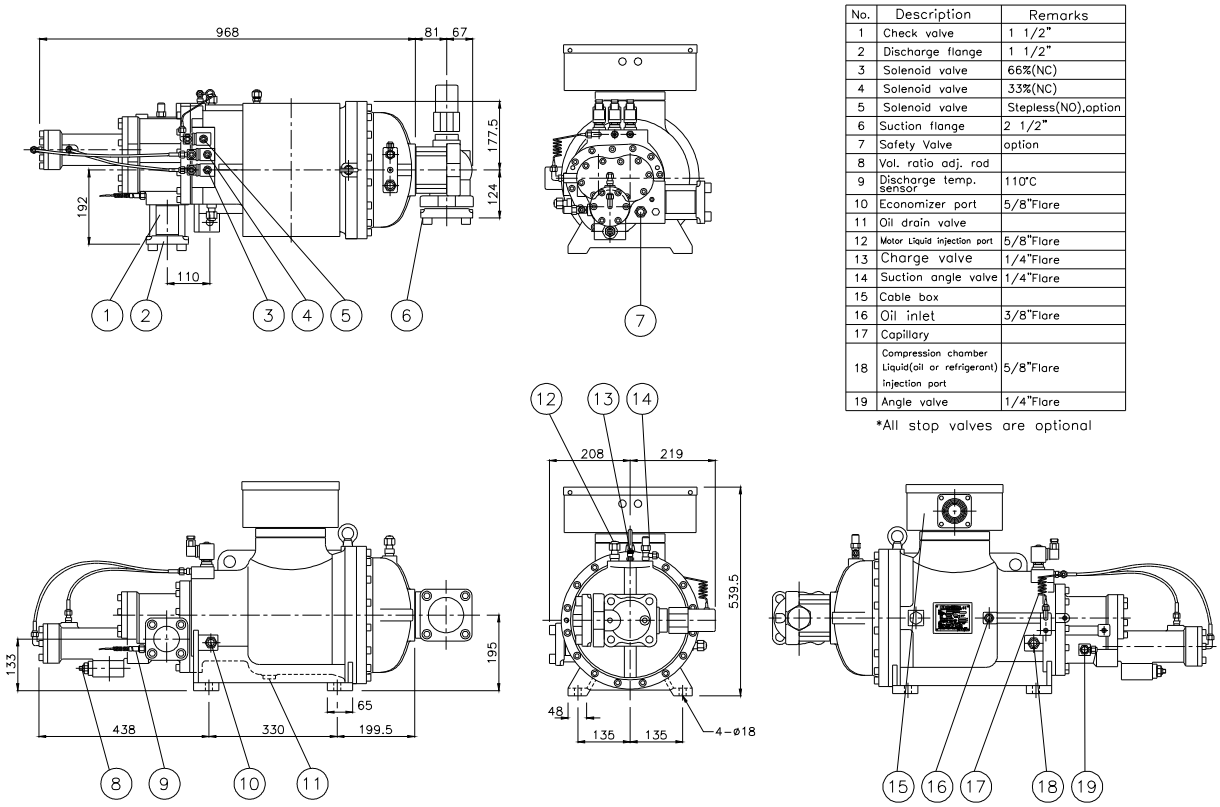


No.	Description	Remarks
1	Check valve	1 1/2"
2	Discharge flange	1 1/2"
3	Solenoid valve	66%(NC)
4	Solenoid valve	33%(NC)
5	Solenoid valve	Stepless(NO),option
6	Suction flange	2"
7	Safety Valve	option
8	Vol. ratio adj. rod	
9	Discharge temp. sensor	110°C
10	Economizer port	3/8"Flare
11	Oil drain valve	
12	Charge valve	1/4"Flare
13	Suction angle valve	1/4"Flare
14	Motor Liquid injection port	3/8"Flare
15	Cable box	
16	Oil inlet	3/8"Flare
17	Compression chamber Liquid(oil or refrigerant) injection port	3/8"Flare
18	Capillary	
19	Angle valve	1/4"Flare

*All stop valves are optional



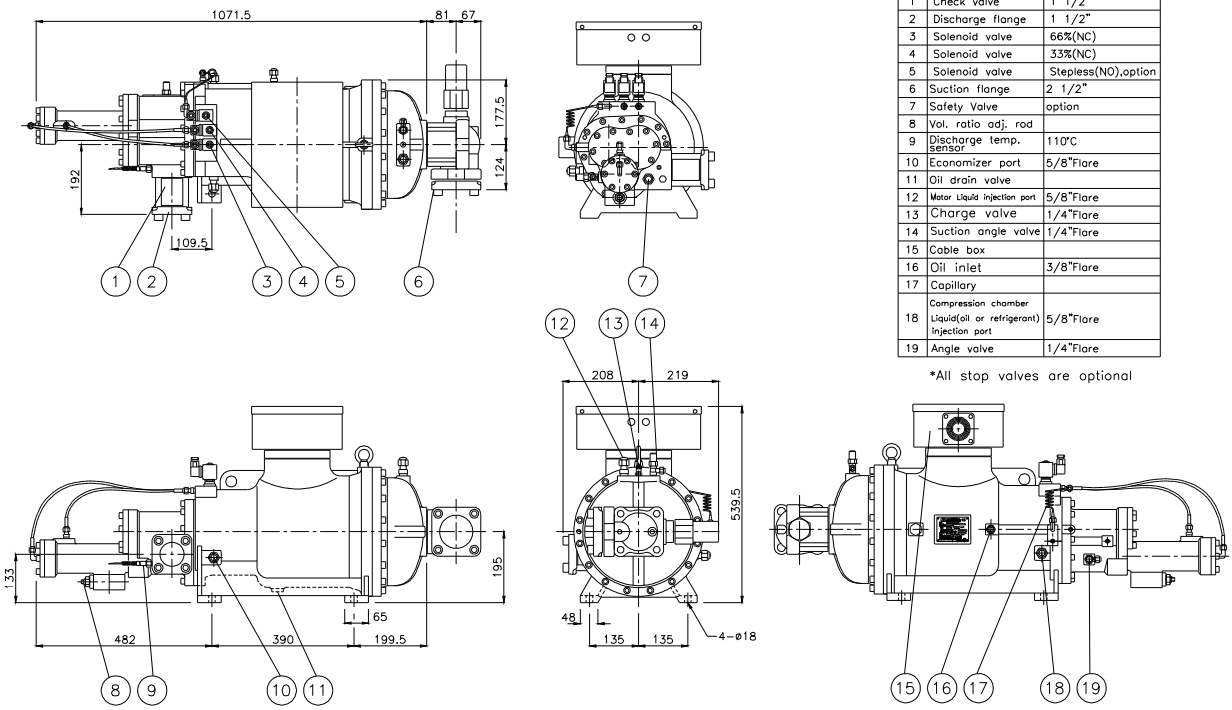
LA-120 Outline Dimension Drawing



No.	Description	Remarks
1	Check valve	1 1/2"
2	Discharge flange	1 1/2"
3	Solenoid valve	66%(NC)
4	Solenoid valve	33%(NC)
5	Solenoid valve	Stepless(NO),option
6	Suction flange	2 1/2"
7	Safety Valve	option
8	Vol. ratio adj. rod	
9	Discharge temp. sensor	110°C
10	Economizer port	5/8"Flare
11	Oil drain valve	
12	Motor Liquid injection port	5/8"Flare
13	Charge valve	1/4"Flare
14	Suction angle valve	1/4"Flare
15	Cable box	
16	Oil inlet	3/8"Flare
17	Capillary	
18	Compression chamber Liquid(oil or refrigerant) injection port	5/8"Flare
19	Angle valve	1/4"Flare

*All stop valves are optional

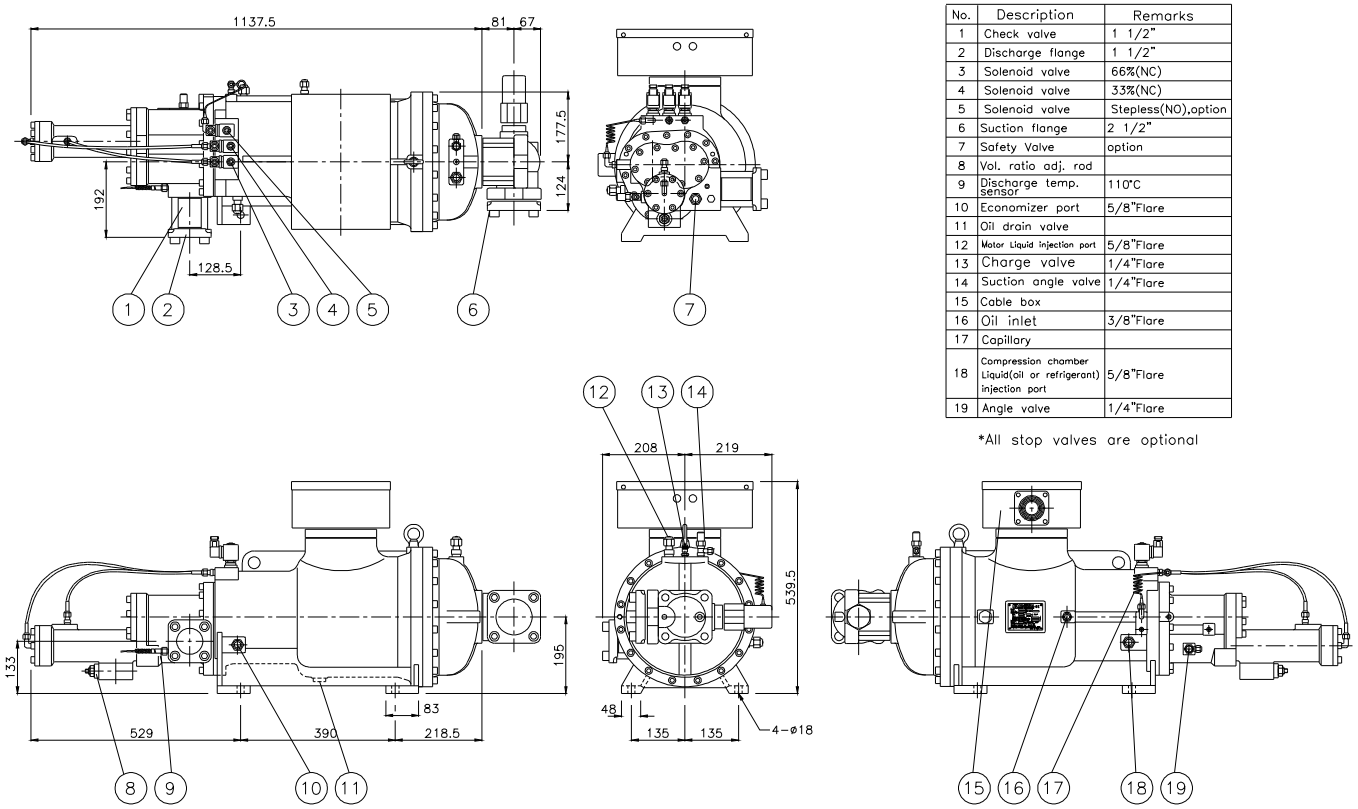
LA-140 Outline Dimension Drawing



No.	Description	Remarks
1	Check valve	1 1/2"
2	Discharge flange	1 1/2"
3	Solenoid valve	66%(NC)
4	Solenoid valve	33%(NC)
5	Solenoid valve	Stepless(NO),option
6	Suction flange	2 1/2"
7	Safety Valve	option
8	Vol. ratio adj. rod	
9	Discharge temp. sensor	110°C
10	Economizer port	5/8"Flare
11	Oil drain valve	
12	Motor Liquid injection port	5/8"Flare
13	Charge valve	1/4"Flare
14	Suction angle valve	1/4"Flare
15	Cable box	
16	Oil inlet	3/8"Flare
17	Capillary	
18	Compression chamber Liquid(oil or refrigerant) injection port	5/8"Flare
19	Angle valve	1/4"Flare

*All stop valves are optional

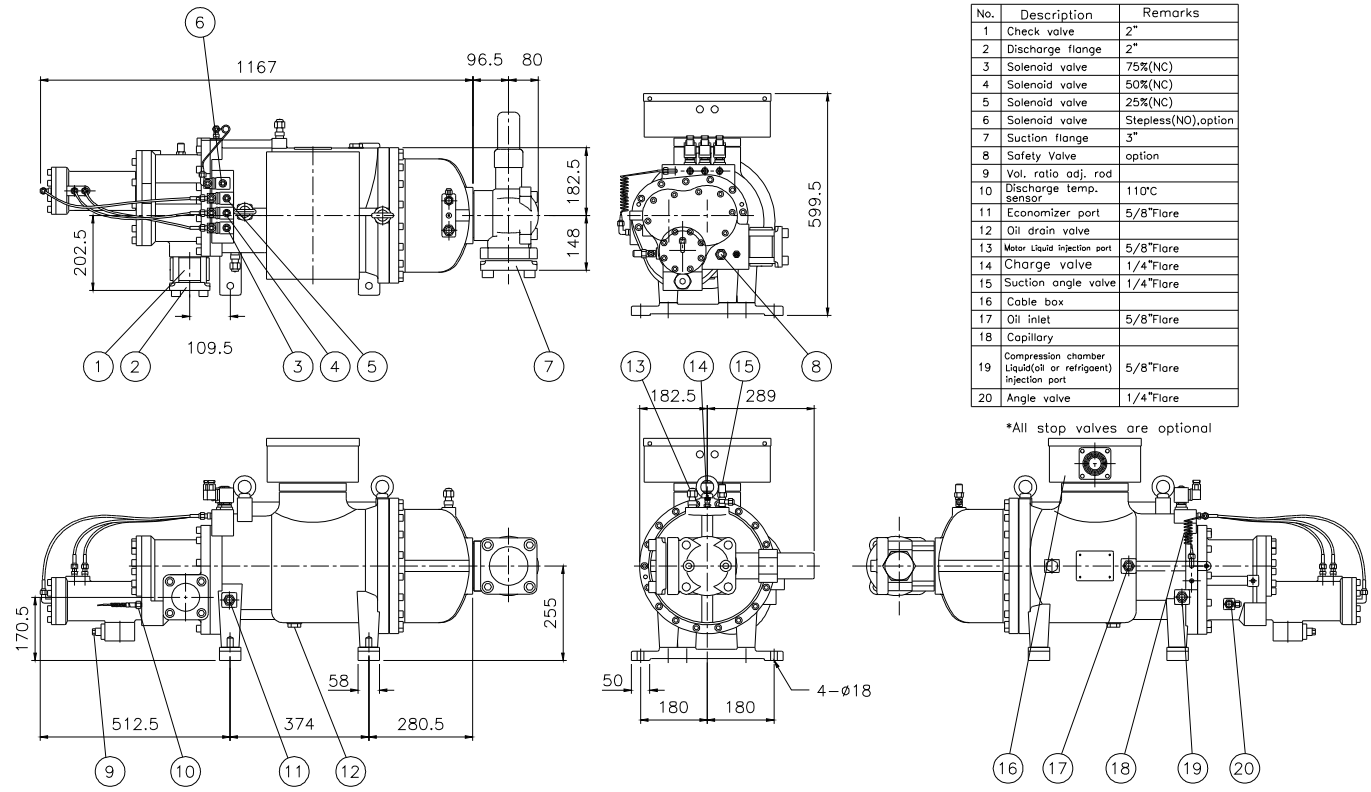
LA-170 Outline Dimension Drawing



No.	Description	Remarks
1	Check valve	1 1/2"
2	Discharge flange	1 1/2"
3	Solenoid valve	66%(NC)
4	Solenoid valve	33%(NC)
5	Solenoid valve	Stepless(NO),option
6	Suction flange	2 1/2"
7	Safety Valve	option
8	Vol. ratio adj. rod	
9	Discharge temp. sensor	110°C
10	Economizer port	5/8"Flare
11	Oil drain valve	
12	Motor Liquid injection port	5/8"Flare
13	Charge valve	1/4"Flare
14	Suction angle valve	1/4"Flare
15	Cable box	
16	Oil inlet	3/8"Flare
17	Capillary	
18	Compression chamber Liquid(oil or refrigerant) injection port	5/8"Flare
19	Angle valve	1/4"Flare

*All stop valves are optional

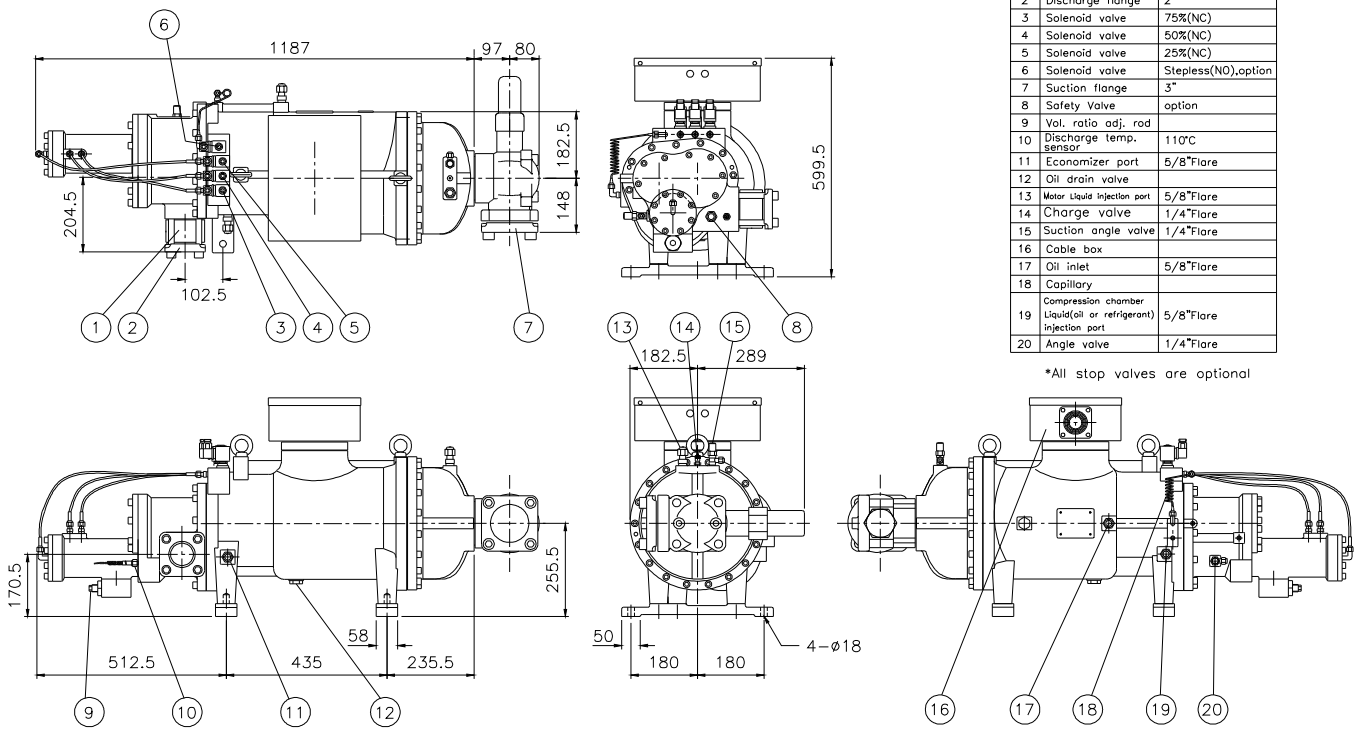
LA-200 Outline Dimension Drawing



No.	Description	Remarks
1	Check valve	2"
2	Discharge flange	2"
3	Solenoid valve	75%(NC)
4	Solenoid valve	50%(NC)
5	Solenoid valve	25%(NC)
6	Solenoid valve	Stepless(NO),option
7	Suction flange	3"
8	Safety Valve	option
9	Vol. ratio adj. rod	
10	Discharge temp. sensor	110°C
11	Economizer port	5/8"Flare
12	Oil drain valve	
13	Motor Liquid injection port	5/8"Flare
14	Charge valve	1/4"Flare
15	Suction angle valve	1/4"Flare
16	Cable box	
17	Oil inlet	5/8"Flare
18	Capillary	
19	Compression chamber Liquid(oil or refrigaent) injection port	5/8"Flare
20	Angle valve	1/4"Flare

*All stop valves are optional

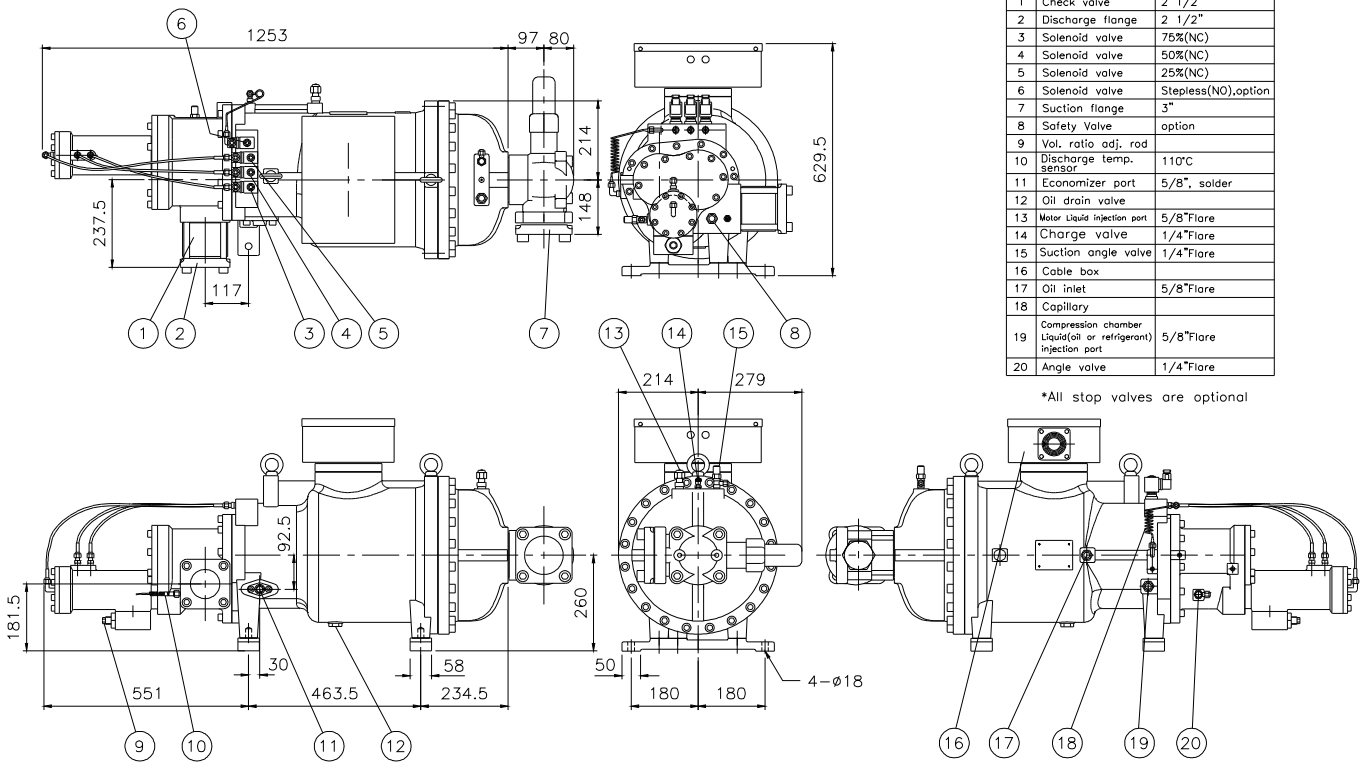
LA-230 Outline Dimension Drawing



No.	Description	Remarks
1	Check valve	2"
2	Discharge flange	2"
3	Solenoid valve	75%(NC)
4	Solenoid valve	50%(NC)
5	Solenoid valve	25%(NC)
6	Solenoid valve	Stepless(NO),option
7	Suction flange	3"
8	Safety Valve	option
9	Vol. ratio adj. rod	
10	Discharge temp. sensor	110°C
11	Economizer port	5/8"Flare
12	Oil drain valve	
13	Motor Liquid injection port	5/8"Flare
14	Charge valve	1/4"Flare
15	Suction angle valve	1/4"Flare
16	Cable box	
17	Oil inlet	5/8"Flare
18	Capillary	
19	Compression chamber Liquid(oil or refrigerant) injection port	5/8"Flare
20	Angle valve	1/4"Flare

*All stop valves are optional

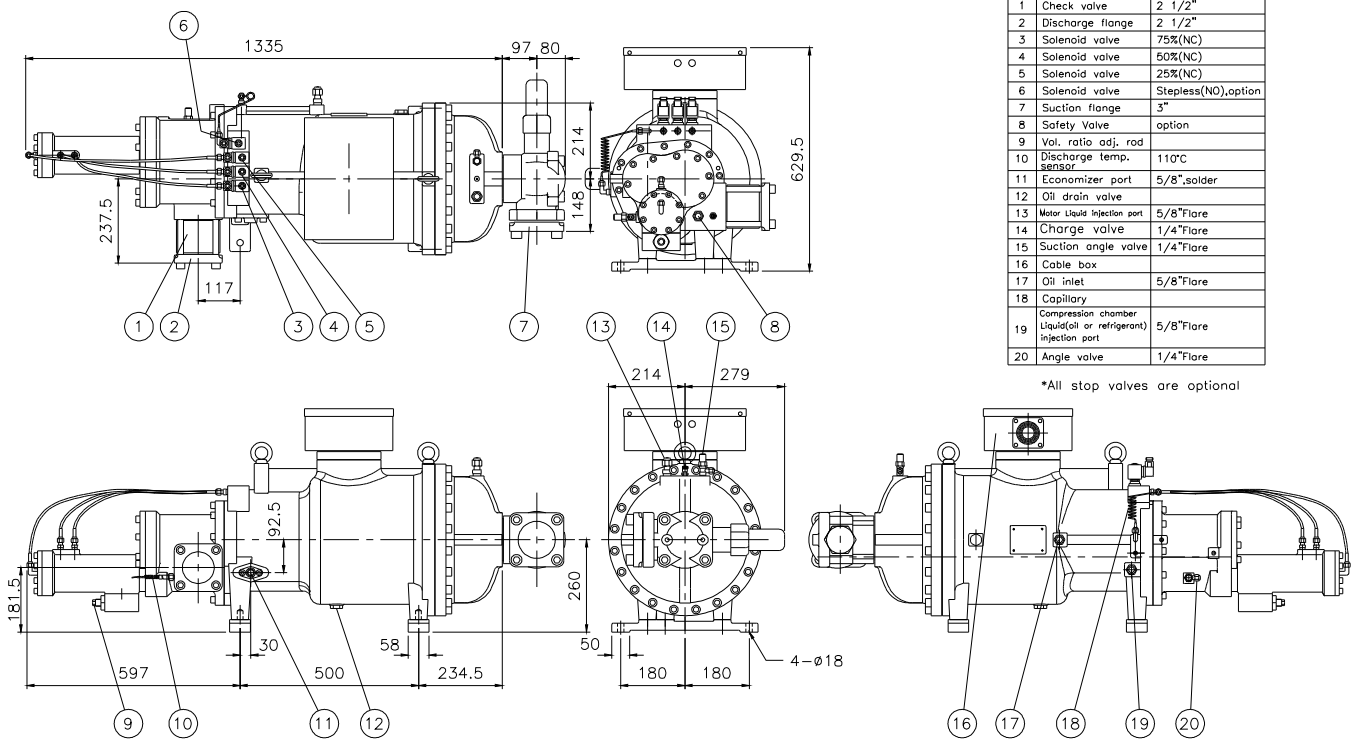
LA-250 Outline Dimension Drawing



No.	Description	Remarks
1	Check valve	2 1/2"
2	Discharge flange	2 1/2"
3	Solenoid valve	75%(NC)
4	Solenoid valve	50%(NC)
5	Solenoid valve	25%(NC)
6	Solenoid valve	Stepless(NO),option
7	Suction flange	3"
8	Safety Valve	option
9	Vol. ratio adj. rod	
10	Discharge temp. sensor	110°C
11	Economizer port	5/8", solder
12	Oil drain valve	
13	Motor Liquid injection port	5/8"Flare
14	Charge valve	1/4"Flare
15	Suction angle valve	1/4"Flare
16	Cable box	
17	Oil inlet	5/8"Flare
18	Capillary	
19	Compression chamber Liquid(oil or refrigerant) injection port	5/8"Flare
20	Angle valve	1/4"Flare

*All stop valves are optional

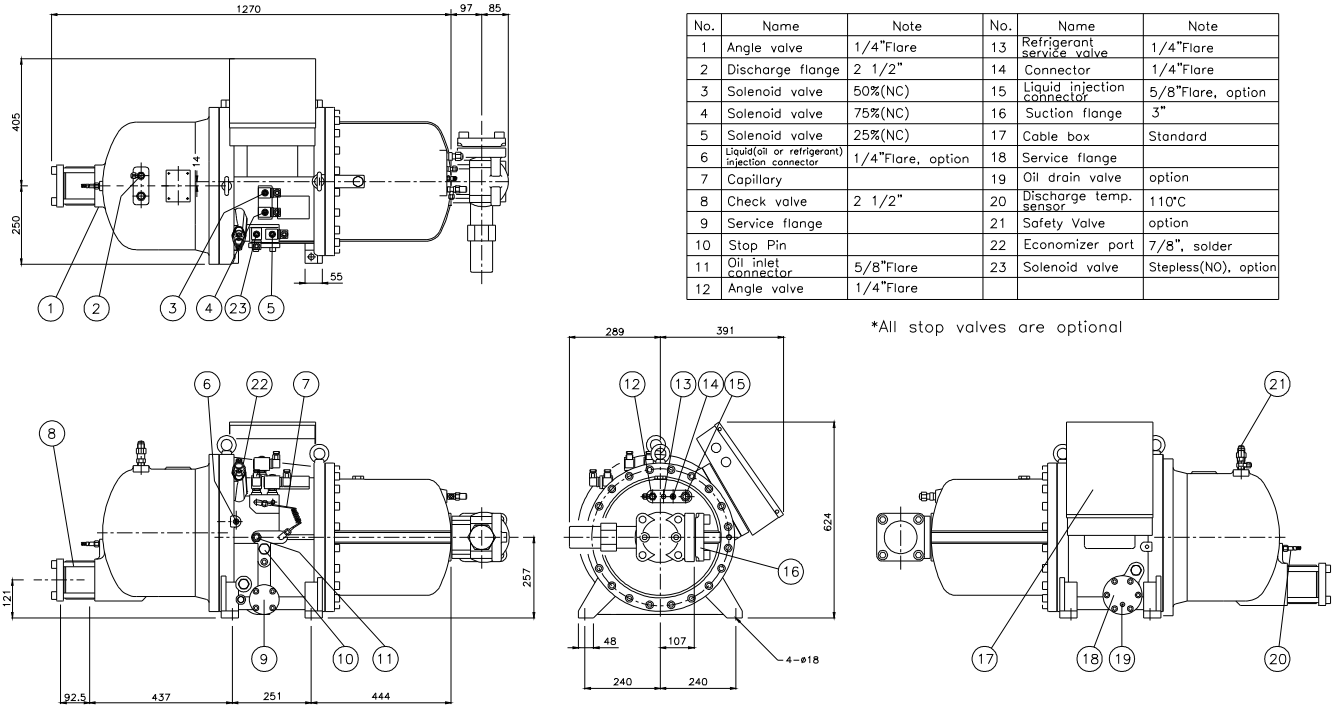
LA-280 Outline Dimension Drawing



No.	Description	Remarks
1	Check valve	2 1/2"
2	Discharge flange	2 1/2"
3	Solenoid valve	75%(NC)
4	Solenoid valve	50%(NC)
5	Solenoid valve	25%(NC)
6	Solenoid valve	Stepless(NO),option
7	Suction flange	3"
8	Safety Valve	option
9	Vol. ratio adj. rod	
10	Discharge temp. sensor	110°C
11	Economizer port	5/8",solder
12	Oil drain valve	
13	Motor Liquid injection port	5/8"Flare
14	Charge valve	1/4"Flare
15	Suction angle valve	1/4"Flare
16	Cable box	
17	Oil inlet	5/8"Flare
18	Capillary	
19	Compression chamber Liquid(oil or refrigerant) injection port	5/8"Flare
20	Angle valve	1/4"Flare

*All stop valves are optional

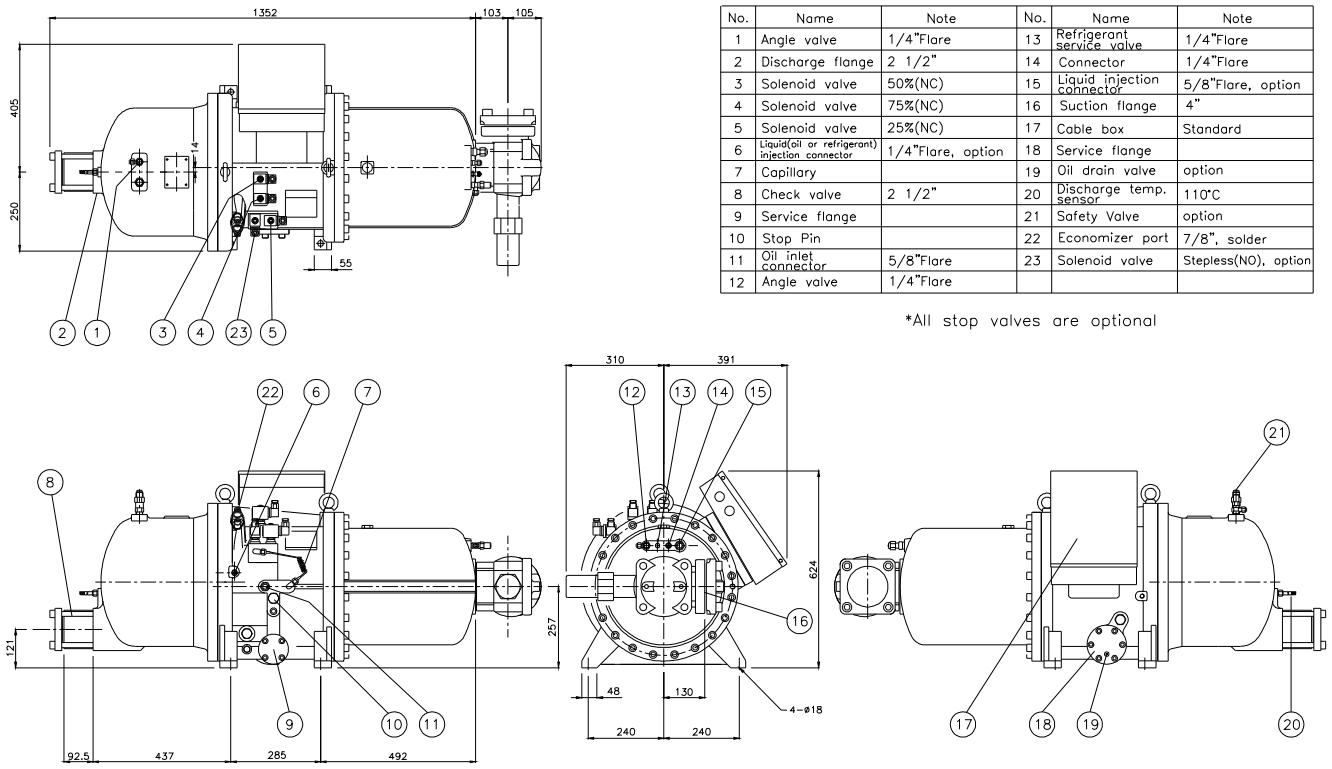
LA-310 Outline Dimension Drawing



No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Refrigerant service valve	1/4"Flare
2	Discharge flange	2 1/2"	14	Connector	1/4"Flare
3	Solenoid valve	50%(NC)	15	Liquid injection connector	5/8"Flare, option
4	Solenoid valve	75%(NC)	16	Suction flange	3"
5	Solenoid valve	25%(NC)	17	Cable box	Standard
6	Liquid(oil or refrigerant) injection connector	1/4"Flare, option	18	Service flange	
7	Capillary		19	Oil drain valve	option
8	Check valve	2 1/2"	20	Discharge temp. sensor	110°C
9	Service flange		21	Safety Valve	option
10	Stop Pin		22	Economizer port	7/8", solder
11	Oil inlet connector	5/8"Flare	23	Solenoid valve	Stepless(NO), option
12	Angle valve	1/4"Flare			

*All stop valves are optional

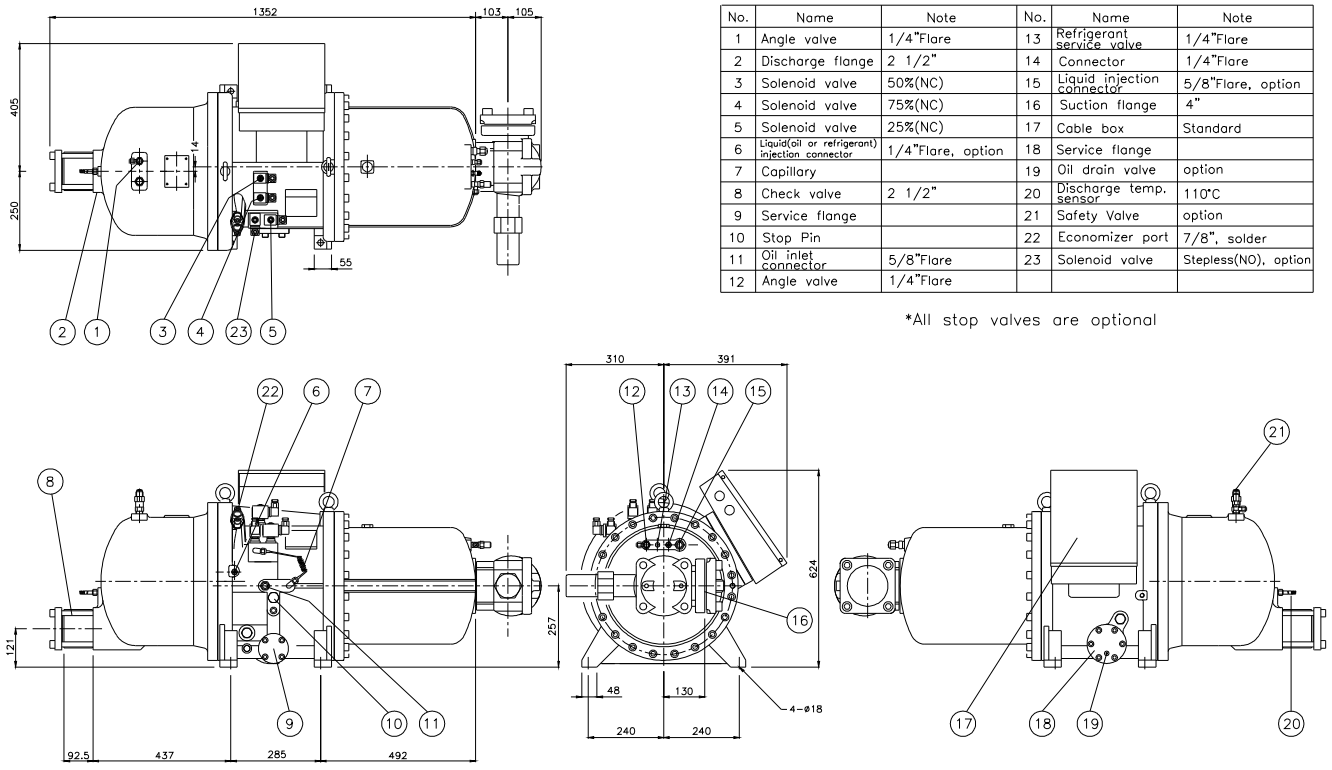
LA-340 Outline Dimension Drawing



No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Refrigerant service valve	1/4"Flare
2	Discharge flange	2 1/2"	14	Connector	1/4"Flare
3	Solenoid valve	50%(NC)	15	Liquid injection connector	5/8"Flare, option
4	Solenoid valve	75%(NC)	16	Suction flange	4"
5	Solenoid valve	25%(NC)	17	Cable box	Standard
6	Liquid(oil or refrigerant) injection connector	1/4"Flare, option	18	Service flange	
7	Capillary		19	Oil drain valve	option
8	Check valve	2 1/2"	20	Discharge temp. sensor	110°C
9	Service flange		21	Safety Valve	option
10	Stop Pin		22	Economizer port	7/8", solder
11	Oil inlet connector	5/8"Flare	23	Solenoid valve	Stepless(NO), option
12	Angle valve	1/4"Flare			

*All stop valves are optional

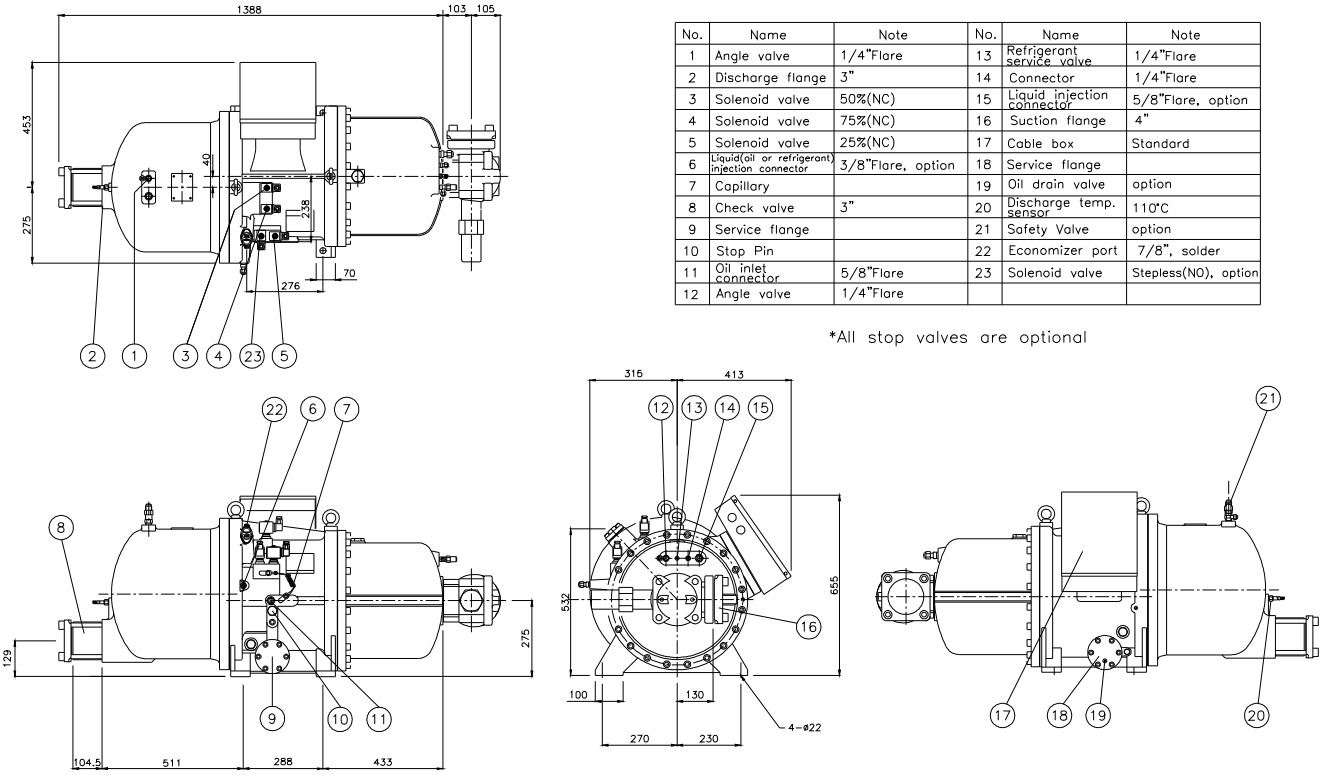
LA-370 Outline Dimension Drawing



No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Refrigerant service valve	1/4"Flare
2	Discharge flange	2 1/2"	14	Connector	1/4"Flare
3	Solenoid valve	50%(NC)	15	Liquid injection connector	5/8"Flare, option
4	Solenoid valve	75%(NC)	16	Suction flange	4"
5	Solenoid valve	25%(NC)	17	Cable box	Standard
6	Liquid(oil or refrigerant) injection connector	1/4"Flare, option	18	Service flange	
7	Capillary		19	Oil drain valve	option
8	Check valve	2 1/2"	20	Discharge temp. sensor	110°C
9	Service flange		21	Safety Valve	option
10	Stop Pin		22	Economizer port	7/8", solder
11	Oil inlet connector	5/8"Flare	23	Solenoid valve	Stepless(NO), option
12	Angle valve	1/4"Flare			

*All stop valves are optional

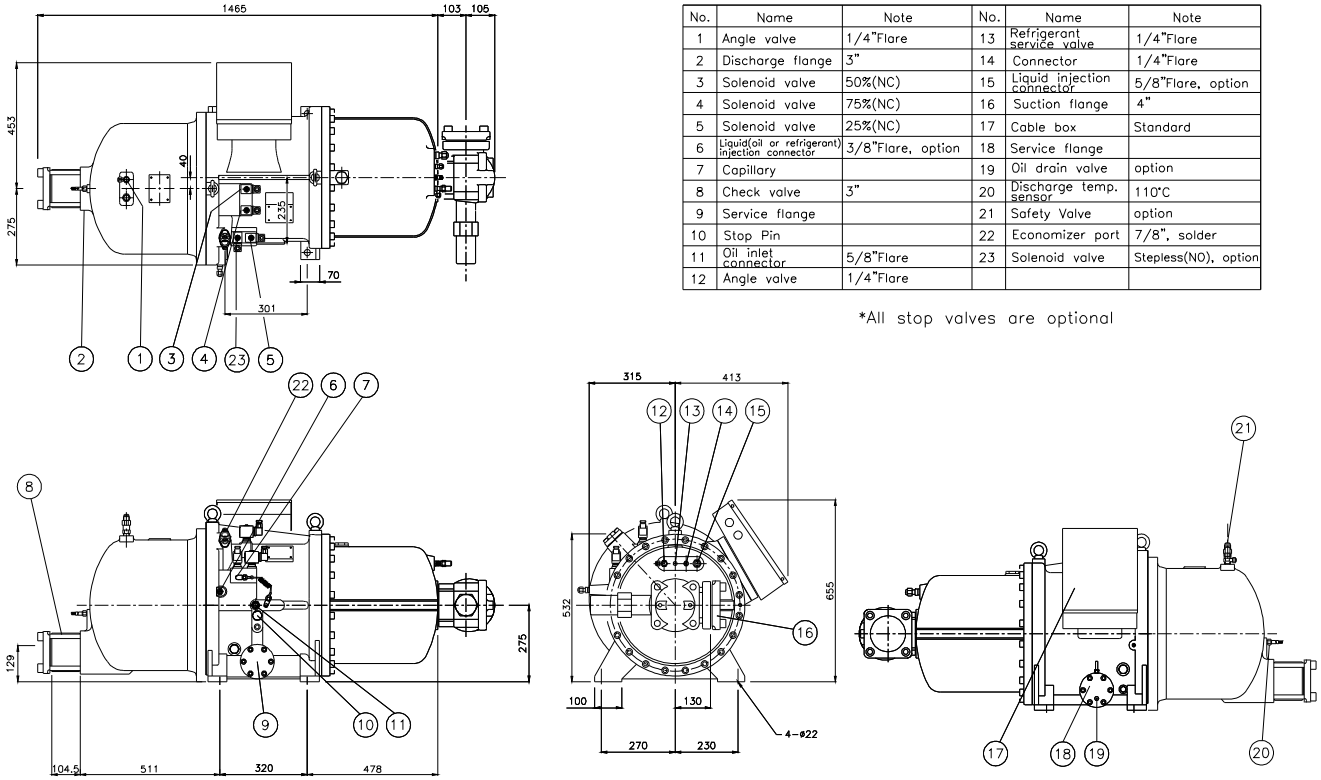
LA-410 Outline Dimension Drawing



No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Refrigerant service valve	1/4"Flare
2	Discharge flange	3"	14	Connector	1/4"Flare
3	Solenoid valve	50%(NC)	15	Liquid injection connector	5/8"Flare, option
4	Solenoid valve	75%(NC)	16	Suction flange	4"
5	Solenoid valve	25%(NC)	17	Cable box	Standard
6	Liquid(oil or refrigerant) injection connector	3/8"Flare, option	18	Service flange	
7	Capillary		19	Oil drain valve	option
8	Check valve	3"	20	Discharge temp. sensor	110°C
9	Service flange		21	Safety Valve	option
10	Stop Pin		22	Economizer port	7/8", solder
11	Oil inlet connector	5/8"Flare	23	Solenoid valve	Stepless(NO), option
12	Angle valve	1/4"Flare			

*All stop valves are optional

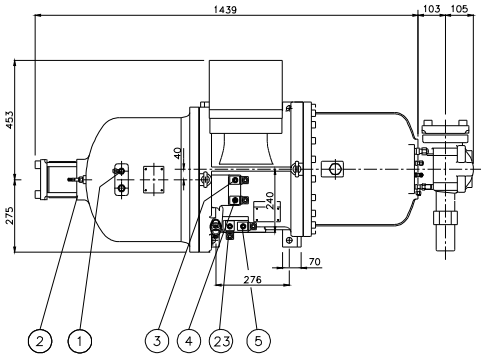
LA-470 Outline Dimension Drawing



No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Refrigerant service valve	1/4"Flare
2	Discharge flange	3"	14	Connector	1/4"Flare
3	Solenoid valve	50%(NC)	15	Liquid injection connector	5/8"Flare, option
4	Solenoid valve	75%(NC)	16	Suction flange	4"
5	Solenoid valve	25%(NC)	17	Cable box	Standard
6	Liquid(oil or refrigerant) injection connector	3/8"Flare, option	18	Service flange	
7	Capillary		19	Oil drain valve	option
8	Check valve	3"	20	Discharge temp. sensor	110°C
9	Service flange		21	Safety Valve	option
10	Stop Pin		22	Economizer port	7/8", solder
11	Oil inlet connector	5/8"Flare	23	Solenoid valve	Stepless(NO), option
12	Angle valve	1/4"Flare			

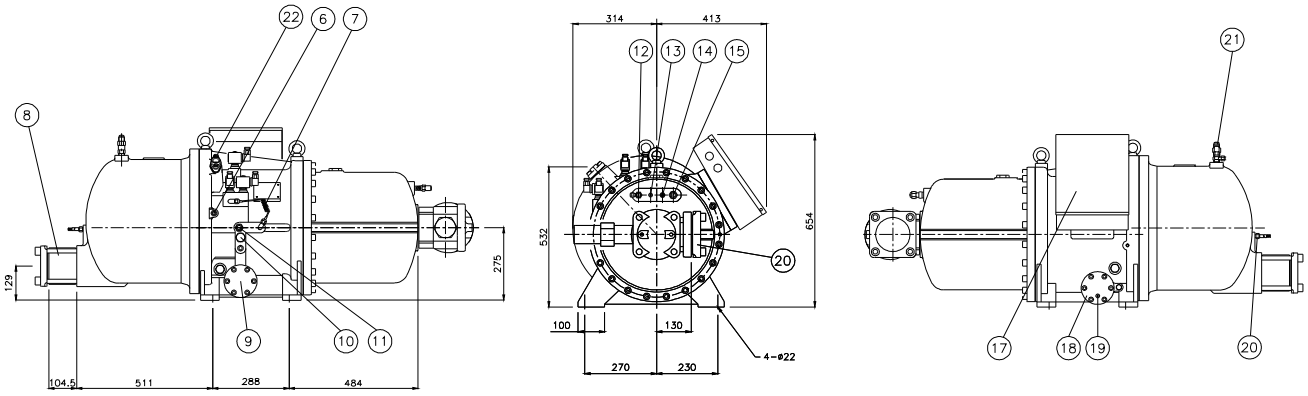
*All stop valves are optional

LA-510 Outline Dimension Drawing

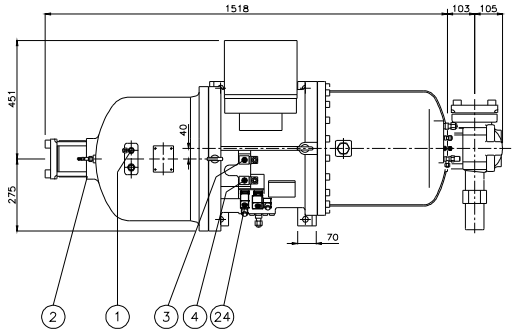


No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Refrigerant service valve	1/4"Flare
2	Discharge flange	3"	14	Connector	1/4"Flare
3	Solenoid valve	50%(NC)	15	Liquid injection connector	5/8"Flare, option
4	Solenoid valve	75%(NC)	16	Suction flange	4"
5	Solenoid valve	25%(NC)	17	Cable box	Standard
6	Liquid(oil or refrigerant) injection connector	3/8"Flare, option	18	Service flange	
7	Capillary		19	Oil drain valve	option
8	Check valve	3"	20	Discharge temp. sensor	110°C
9	Service flange		21	Safety Valve	option
10	Stop Pin		22	Economizer port	7/8", solder
11	Oil inlet connector	5/8"Flare	23	Solenoid valve	Stepless(NO), option
12	Angle valve	1/4"Flare			

*All stop valves are optional

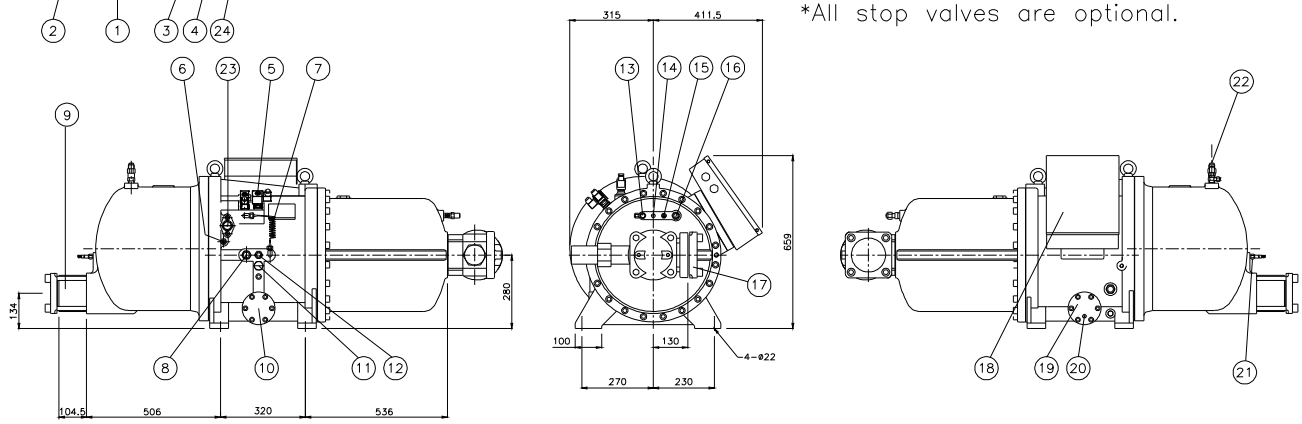


LA-550 Outline Dimension Drawing

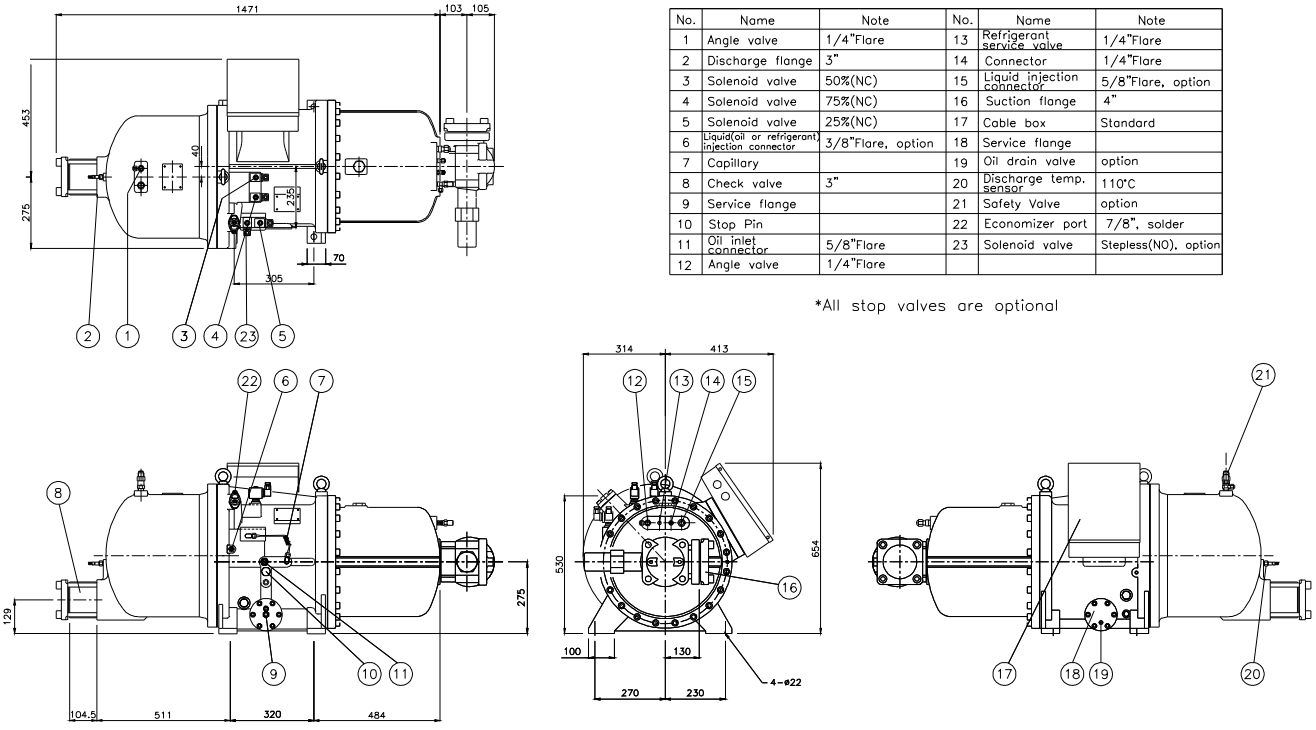


No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Angle valve	1/4"Flare
2	Discharge flange	3"	14	Refrigerant service valve	1/4"Flare
3	Solenoid valve	50%(NC)	15	Connector	1/4"Flare
4	Solenoid valve	75%(NC)	16	Liquid injection connector	5/8"Flare, option
5	Solenoid valve	25%(NC)	17	Suction flange	4"
6	Liquid(oil or refrigerant) injection connector	3/8"Flare, option	18	Cable box	Standard
7	Capillary		19	Service flange	
8	Oil flow sight glass		20	Oil drain valve	option
9	Check valve	3"	21	Discharge temp. sensor	110°C
10	Service flange		22	Safety Valve	option
11	Stop Pin		23	Economizer port	1 1/8", solder
12	Oil inlet connector	5/8"Flare	24	Solenoid valve	Stepless(NO), option

*All stop valves are optional.



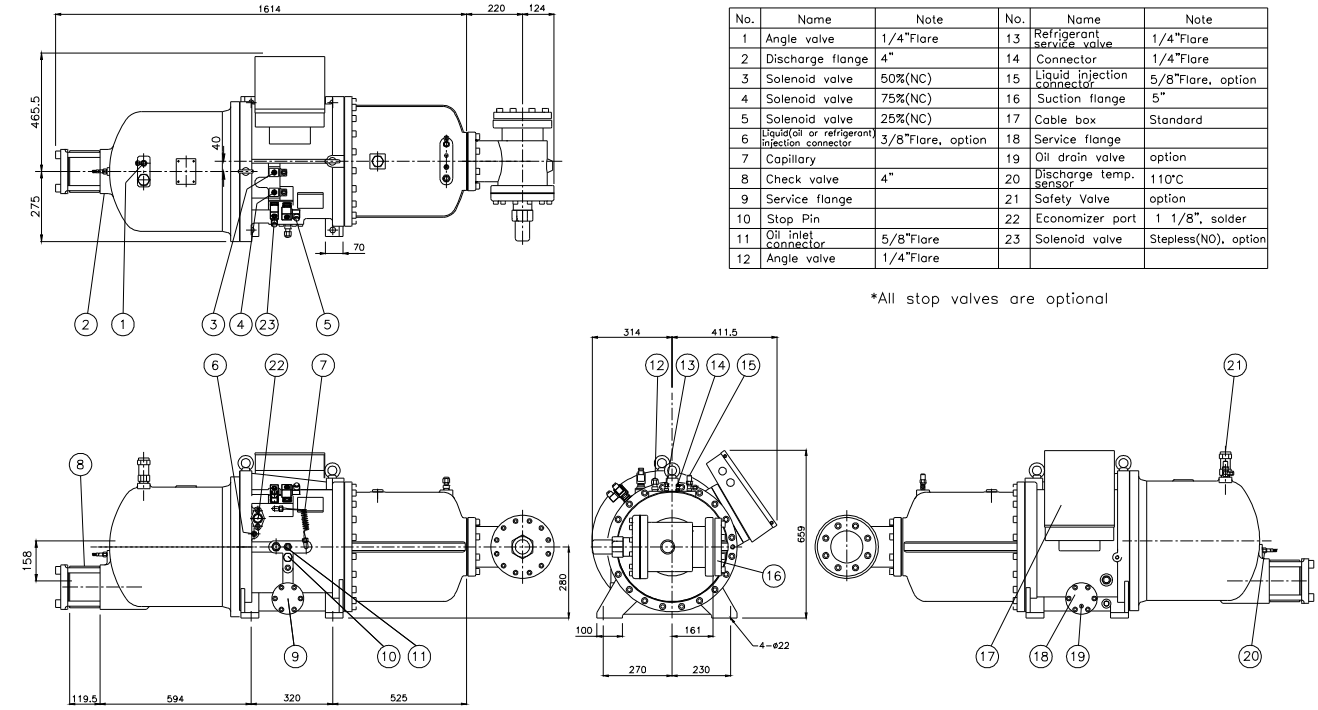
LA-580 Outline Dimension Drawing



No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Refrigerant service valve	1/4"Flare
2	Discharge flange	3"	14	Connector	1/4"Flare
3	Solenoid valve	50%(NC)	15	Liquid injection connector	5/8"Flare, option
4	Solenoid valve	75%(NC)	16	Suction flange	4"
5	Solenoid valve	25%(NC)	17	Cable box	Standard
6	Liquid(oil or refrigerant) injection connector	3/8"Flare, option	18	Service flange	
7	Capillary		19	Oil drain valve	option
8	Check valve	3"	20	Discharge temp. sensor	110°C
9	Service flange		21	Safety Valve	option
10	Stop Pin		22	Economizer port	7/8", solder
11	Oil inlet connector	5/8"Flare	23	Solenoid valve	Stepless(NO), option
12	Angle valve	1/4"Flare			

*All stop valves are optional

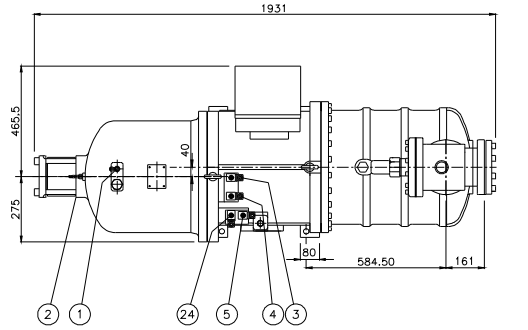
LA-620 Outline Dimension Drawing



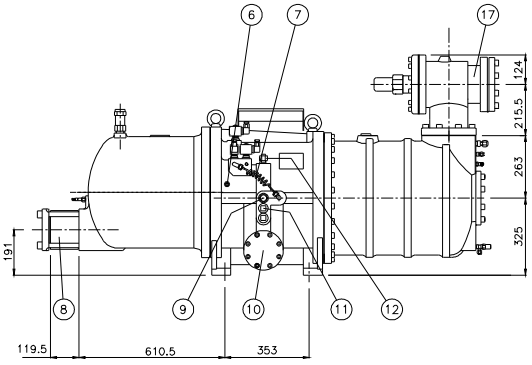
No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Refrigerant service valve	1/4"Flare
2	Discharge flange	4"	14	Connector	1/4"Flare
3	Solenoid valve	50%(NC)	15	Liquid injection connector	5/8"Flare, option
4	Solenoid valve	75%(NC)	16	Suction flange	5"
5	Solenoid valve	25%(NC)	17	Cable box	Standard
6	Liquid(oil or refrigerant) injection connector	3/8"Flare, option	18	Service flange	
7	Capillary		19	Oil drain valve	option
8	Check valve	4"	20	Discharge temp. sensor	110°C
9	Service flange		21	Safety Valve	option
10	Stop Pin		22	Economizer port	1 1/8", solder
11	Oil inlet connector	5/8"Flare	23	Solenoid valve	Stepless(NO), option
12	Angle valve	1/4"Flare			

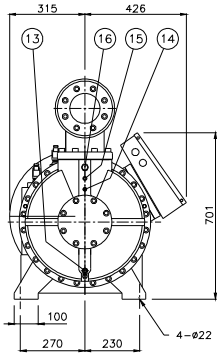
*All stop valves are optional

LA-710 Outline Dimension Drawing

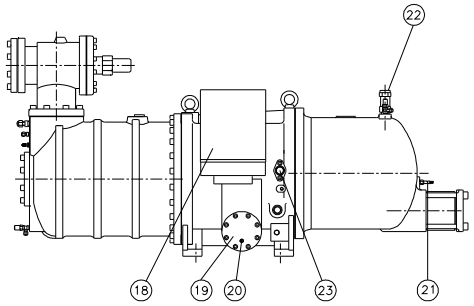


No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Angle valve	1/4"Flare
2	Discharge flange	4"	14	Refrigerant service valve	1/4"Flare
3	Solenoid valve	50%(NC)	15	Connector	1/4"Flare
4	Solenoid valve	75%(NC)	16	Liquid injection connector	5/8"Flare
5	Solenoid valve	25%(NC)	17	Suction flange	5"
6	Liquid(oil or refrigerant) injection connector	3/8"Flare	18	Cable box	Standard
7	Capillary		19	Service flange	
8	Check valve	4"	20	Oil drain valve	option
9	Oil flow sight glass		21	Discharge temp. sensor	110°C
10	Service flange		22	Safety Valve	option
11	Stop pin		23	Economizer port	1 1/8", solder
12	Oil inlet connector	3/4"Flare	24	Solenoid valve	Stepless(NO), option

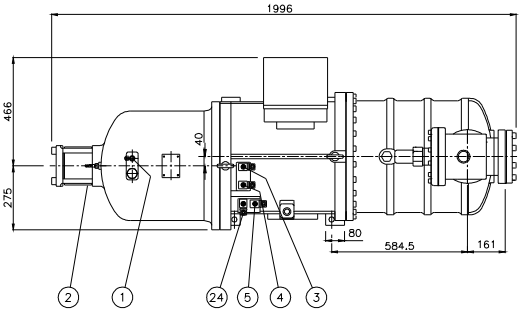




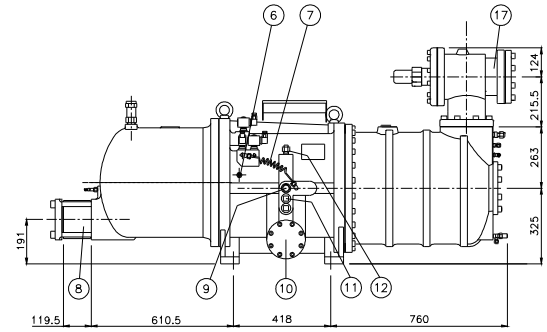
*All stop valves are optional.

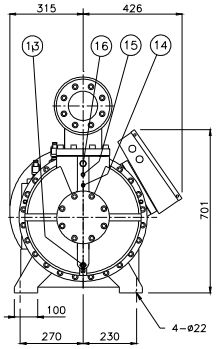


LA-790 Outline Dimension Drawing

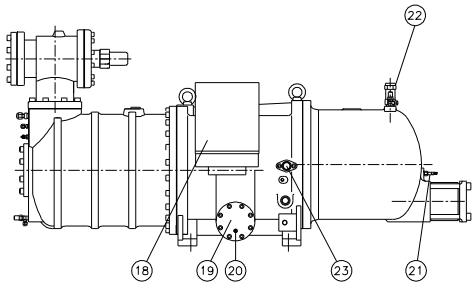


No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Angle valve	1/4"Flare
2	Discharge flange	4"	14	Refrigerant service valve	1/4"Flare
3	Solenoid valve	50%(NC)	15	Connector	1/4"Flare
4	Solenoid valve	75%(NC)	16	Liquid injection connector	5/8"Flare
5	Solenoid valve	25%(NC)	17	Suction flange	5"
6	Liquid(oil or refrigerant) injection connector	3/8"Flare	18	Cable box	Standard
7	Capillary		19	Service flange	
8	Check valve	4"	20	Oil drain valve	option
9	Oil flow sight glass		21	Discharge temp. sensor	110°C
10	Service flange		22	Safety Valve	option
11	Stop pin		23	Economizer port	1 1/8", solder
12	Oil inlet connector	3/4"Flare	24	Solenoid valve	Stepless(NO), option

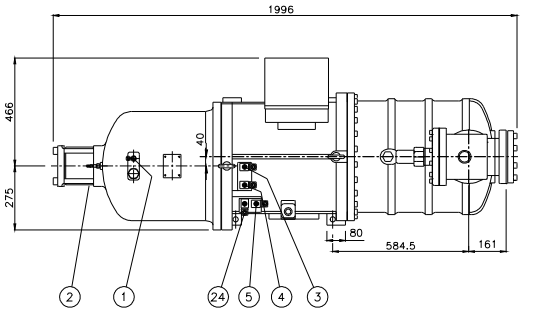




*All stop valves are optional.

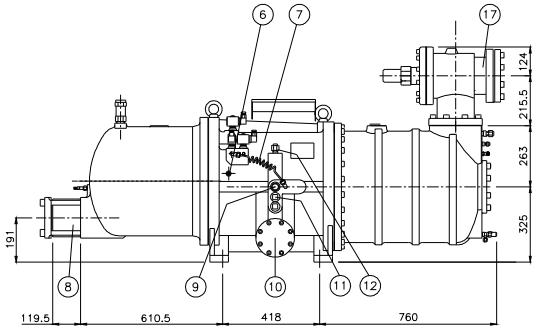


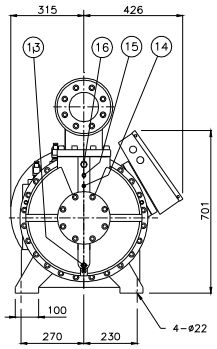
LA-830 Outline Dimension Drawing

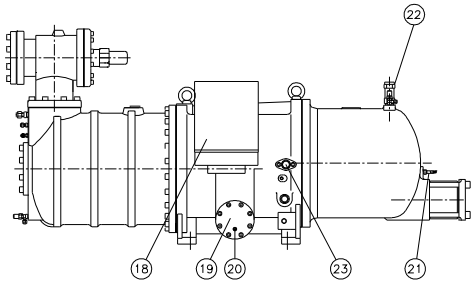


No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Angle valve	1/4"Flare
2	Discharge flange	4"	14	Refrigerant service valve	1/4"Flare
3	Solenoid valve	50%(NC)	15	Connector	1/4"Flare
4	Solenoid valve	75%(NC)	16	Liquid injection connector	5/8"Flare
5	Solenoid valve	25%(NC)	17	Suction flange	5"
6	Liquid(oil or refrigerant) injection connector	3/8"Flare	18	Cable box	Standard
7	Capillary		19	Service flange	
8	Check valve	4"	20	Oil drain valve	option
9	Oil flow sight glass		21	Discharge temp. sensor	110°C
10	Service flange		22	Safety Valve	option
11	Stop pin		23	Economizer port	1 1/8", solder
12	Oil inlet connector	3/4"Flare	24	Solenoid valve	Stepless(NO), option

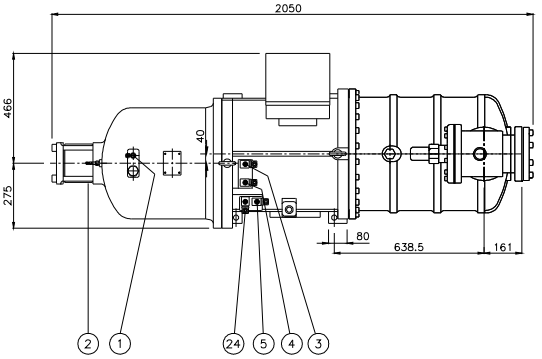
*All stop valves are optional.





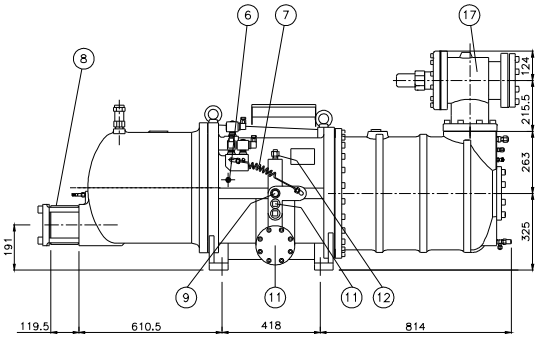


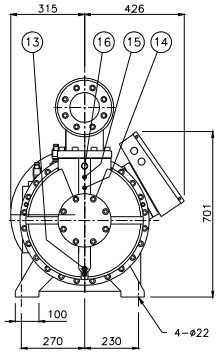
LA-930 Outline Dimension Drawing

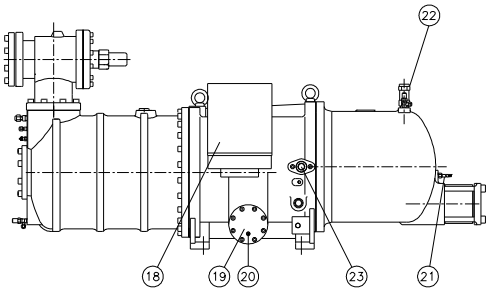


No.	Name	Note	No.	Name	Note
1	Angle valve	1/4"Flare	13	Angle valve	1/4"Flare
2	Discharge flange	4"	14	Refrigerant service valve	1/4"Flare
3	Solenoid valve	50%(NC)	15	Connector	1/4"Flare
4	Solenoid valve	75%(NC)	16	Liquid injection connector	5/8"Flare
5	Solenoid valve	25%(NC)	17	Suction flange	5"
6	Liquid(oil or refrigerant) injection connector	3/8"Flare	18	Cable box	Standard
7	Capillary		19	Service flange	
8	Check valve	4"	20	Oil drain valve	option
9	Oil flow sight glass		21	Discharge temp. sensor	110°C
10	Service flange		22	Safety Valve	option
11	Stop pin		23	Economizer port	1 1/8", solder
12	Oil inlet connector	3/4"Flare	24	Solenoid valve	Stepless(NO), option

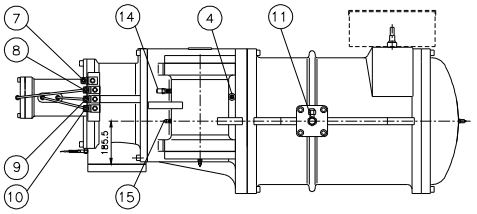
*All stop valves are optional.



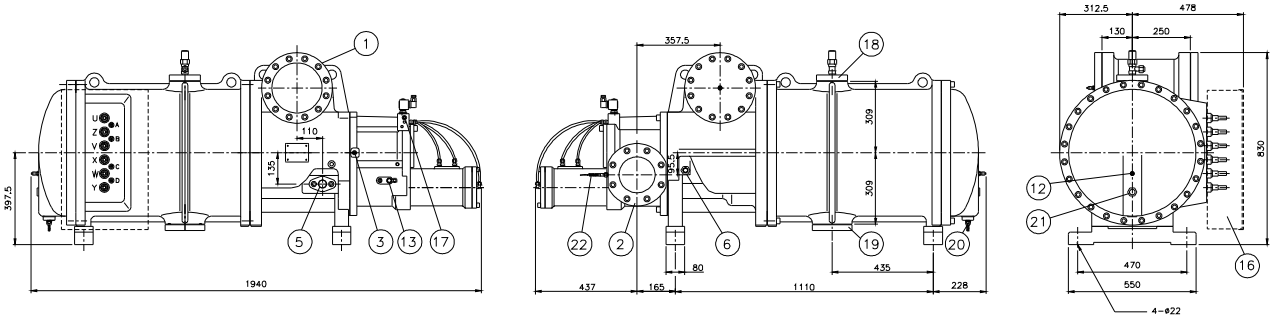




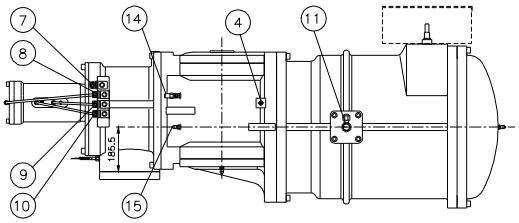
LA-1090 Outline Dimension Drawing



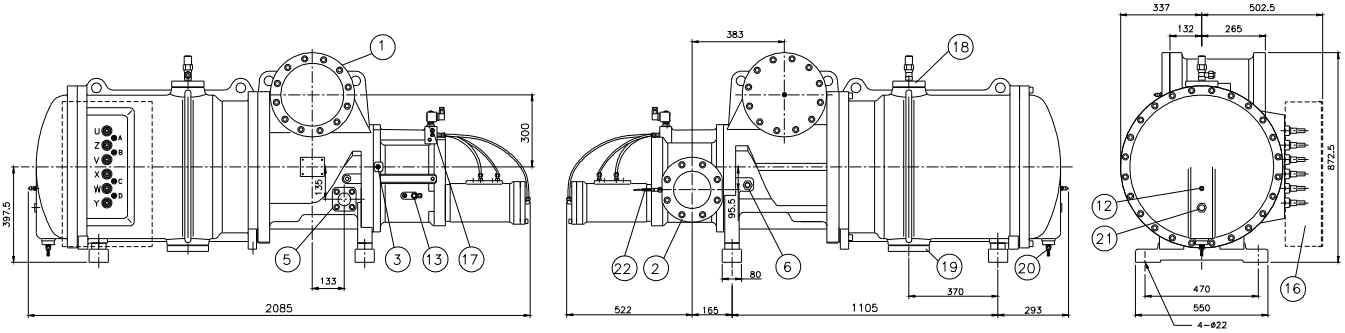
No.	Name	Note	No.	Name	Note
1	Suction flange	6"	12	Refrigerant service valve	1/4"Flare
2	Discharge flange	5"	13	Angle valve	1/4"Flare
3	Oil connector	1/4"Flare	14	Angel valve	1/4"Flare
4	Oil connector	3/8"Flare	15	Refrigerant service valve	1/4"Flare
5	Economizer port	1 1/8", solder	16	Cable box	
6	Oil injection connector	5/8"Flare	17	Modulation control oil connector	1/4"Flare
7	Solenoid valve	Stepless(NO), option	18	Economizer flangle(in)	2 1/2"
8	Solenoid valve	35%(NC)	19	Economizer flangle(out)	4"
9	Solenoid valve	75%(NC)	20	Level switch	option
10	Solenoid valve	50%(NC)	21	Sight glass	
11	Liquid injection connector	1/2"Flare	22	Discharge temp. sensor	110°C



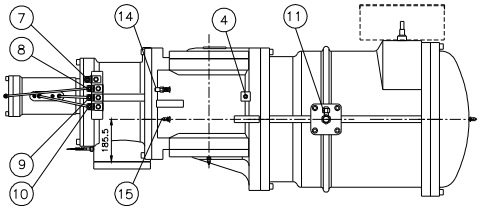
LA-1280 Outline Dimension Drawing



No.	Name	Note	No.	Name	Note
1	Suction flange	8"	12	Refrigerant service valve	1/4"Flare
2	Discharge flange	5"	13	Angle valve	1/4"Flare
3	Oil connector	1/4"Flare	14	Angel valve	1/4"Flare
4	Oil connector	3/8"Flare	15	Refrigerant service valve	1/4"Flare
5	Economizer port	1 5/8", solder	16	Cable box	
6	Oil injection connector	5/8"Flare	17	Modulation control oil connector	1/4"Flare
7	Solenoid valve	Stepless(NO), option	18	Economizer flangle(in)	2 1/2"
8	Solenoid valve	30%(NC)	19	Economizer flangle(out)	4"
9	Solenoid valve	75%(NC)	20	Level switch	option
10	Solenoid valve	50%(NC)	21	Sight glass	
11	Liquid injection connector	1/2"Flare	22	Discharge temp. sensor	110°C



LA-1520 Outline Dimension Drawing



No.	Name	Note	No.	Name	Note
1	Suction flange	8"	12	Refrigerant service valve	1/4"Flare
2	Discharge flange	5"	13	Angle valve	1/4"Flare
3	Oil connector	1/4"Flare	14	Angel valve	1/4"Flare
4	Oil connector	3/8"Flare	15	Refrigerant service valve	1/4"Flare
5	Economizer port	2 1/8", solder	16	Cable box	
6	Oil injection connector	5/8"Flare	17	Modulation control oil connector	1/4"Flare
7	Solenoid valve	Stepless(NO), option	18	Economizer flangle(in)	2 1/2"
8	Solenoid valve	25%(NC)	19	Economizer flangle(out)	4"
9	Solenoid valve	75%(NC)	20	Level switch	option
10	Solenoid valve	50%(NC)	21	Sight glass	
11	Liquid injection connector	1/2"Flare	22	Discharge temp. sensor	110°C