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## 1. Overview

For conventional single-stage screw compressors, Its evaporation temperature can only reach  $-40\sim-50\text{ }^{\circ}\text{C}$  during freezing application. If you want to break this application limitation, it is required to use two-stage compressor or cascade system. Meanwhile, the working condition of high pressure ratio brings problems to the traditional single-stage compressors during compression process, such as excessive gas leakage and high exhaust temperature etc., which leads to low efficiency and poor reliability when it is working in such harsh conditions.

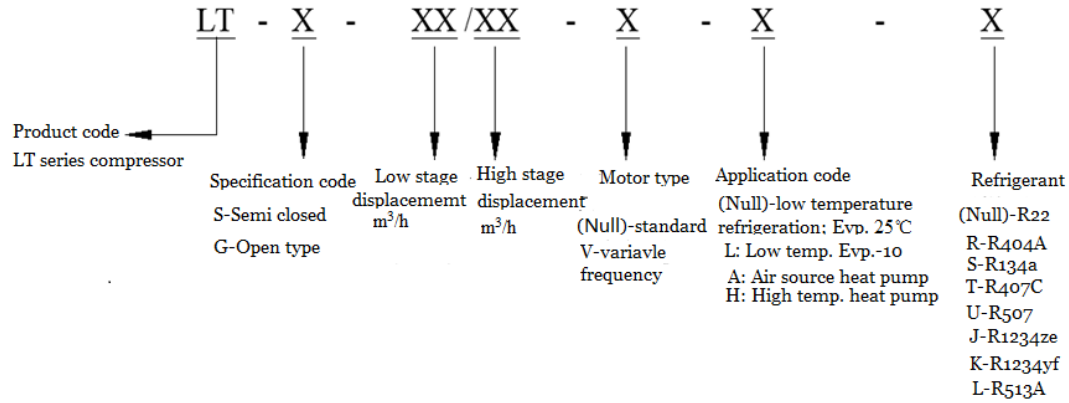
The compound two-stage compressor well solves above problems. Compared with the two-stage compressors or cascade system, the compound two-stage compressors occupy less space and the system is easy to control, so it's more efficiency and reliable.

LT Series compound two-stage compressor's evaporation temperature can be as low as  $-60\sim-65\text{ }^{\circ}\text{C}$  , Its full load evaporating temperature can be  $-25\text{ }^{\circ}\text{C}$ , LT-S-L Series compound two-stage low temperature compressor is based on the LT-S series which modified the internal structure and optimized the motor matching to increase the compressor full-load evaporation temperature to  $-10\text{ }^{\circ}\text{C}$ , So that LT-S-L series can meet the requirements of industrial refrigeration、 quick freezing tunnel and freezing library without pre-cooling

For above reasons, Therefore The Shanghai Hanbell Precise Machinery Co., Ltd. developed the LT series high temperature compressors. High efficiency and reliability under big pressure differential and compression ratio working condition is the main demand in designing. It is a elitist product which accumulates Shanghai Hanbell's rich technology and extensive application experience. It can be widely used in many industries such as high temperature hot water, central heating and so on.

## 2. Product Specification

### 2.1 Nomenclature



Low temperature products codification	Application field
LT-S-XX/XX	R22 Application of refrigeration
LT-S-XX/XX-R&U	R404A&R507 Application of refrigeration
LT-S-XX/XX-L	R22 Application of refrigeration
LT-S-XX/XX-L-R&U	R404A&R507 Application of refrigeration

Table 2-1.LT series low temperature compressor nomenclature

### 2.2 Product Line

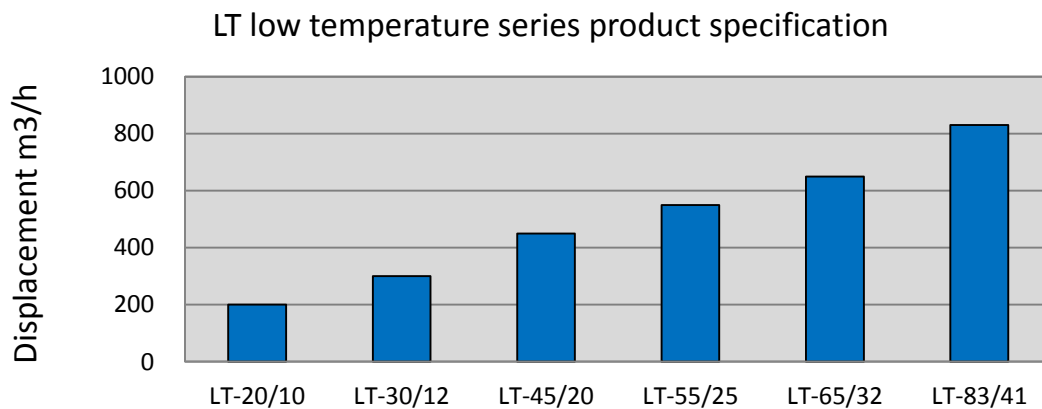


Table 2-2.LT low temperature series product specification

★

Low temp. products codification		Model range
LT-S-XX/XX	LT-S-XX/XX- R&U	LT-20/10~LT-83/41
LT-S-XX/XX-L	LT-S-XX/XX-L- R&U	LT-20/10、LT-45/20~LT-83/41

### 2.3 Compressor specification table

Model	Compressor								
	Low pressure stage	High pressure stage	Rotation speed 50Hz r/min	Capacity control		Lubrication type	Noise		
	Displacement	Displacement		Step type	Stepless type		Freezing/ Refrigeration LT-S	Freezing/ Refrigeration LT-S-L	
	50Hz	50Hz					dB		
m3/h	m3/h	Step type	Stepless type						
LT-20/10	224	99	2950	10%/50% 100%	10% ~ 100%	Pressure differential oil supply	81	81	
LT-30/12	316	137					81	/	
LT-45/20	450	207					83	84	
LT-55/25	551	257		84	85				
LT-65/32	651	313		10%/50% 75%/100%	86		88		
LT-83/41	840	396		87	89				
Model	Quality		Motor					Strength test	
	Kg		Type	Starting	Voltage (V) 50Hz	Insulation level	Protection	bar	
	Freezing/ Refrigeration LT-S	Freezing/ Refrigeration LT-S-L						Freezing/ Refrigeration LT-S	Freezing/ Refrigeration LT-S-L
LT-20/10	598	620	3 phase 2 pole squirrel cage induction motor	Star delta	380	Level F	PTC+ PT100 (NTC optional)	35	
LT-30/12	620	/							
LT-45/20	1158	1200							
LT-55/25	1195	1230							
LT-65/32	1395	1450							
LT-83/41	1430	1490							

Table 2-3.LT series compressor specification

### 2.4 Operating range graph

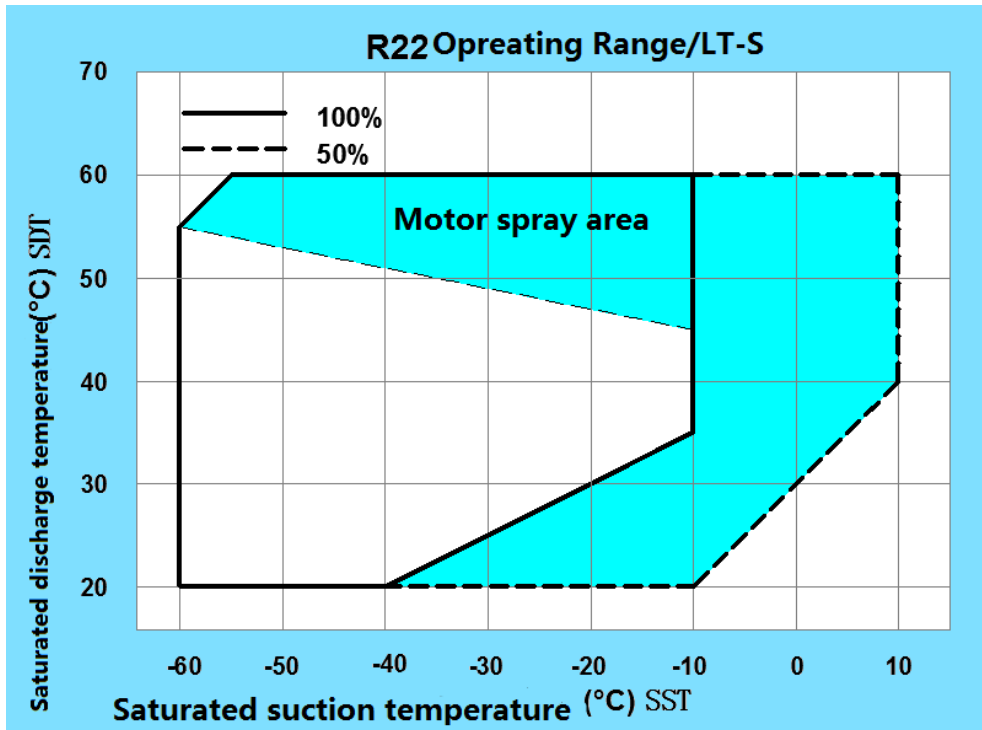
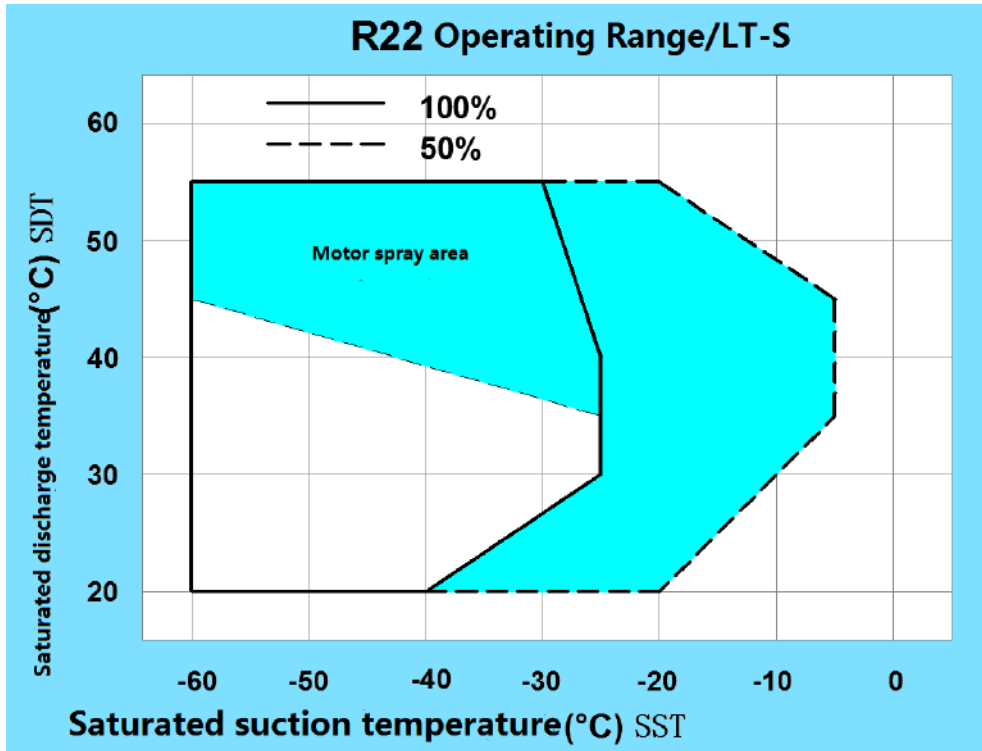


图 2-1. R22 运行范围图

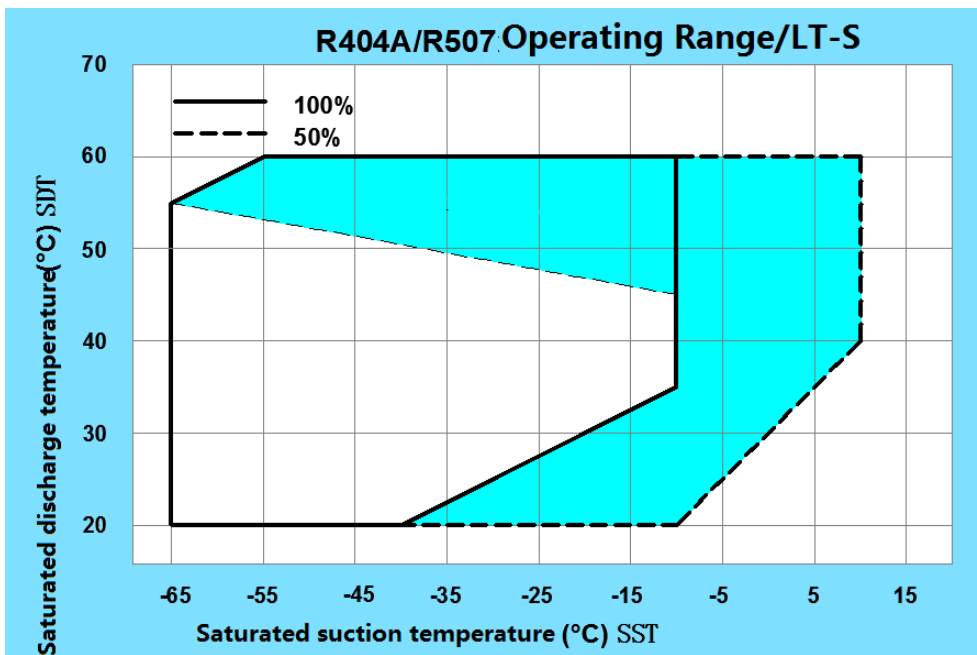
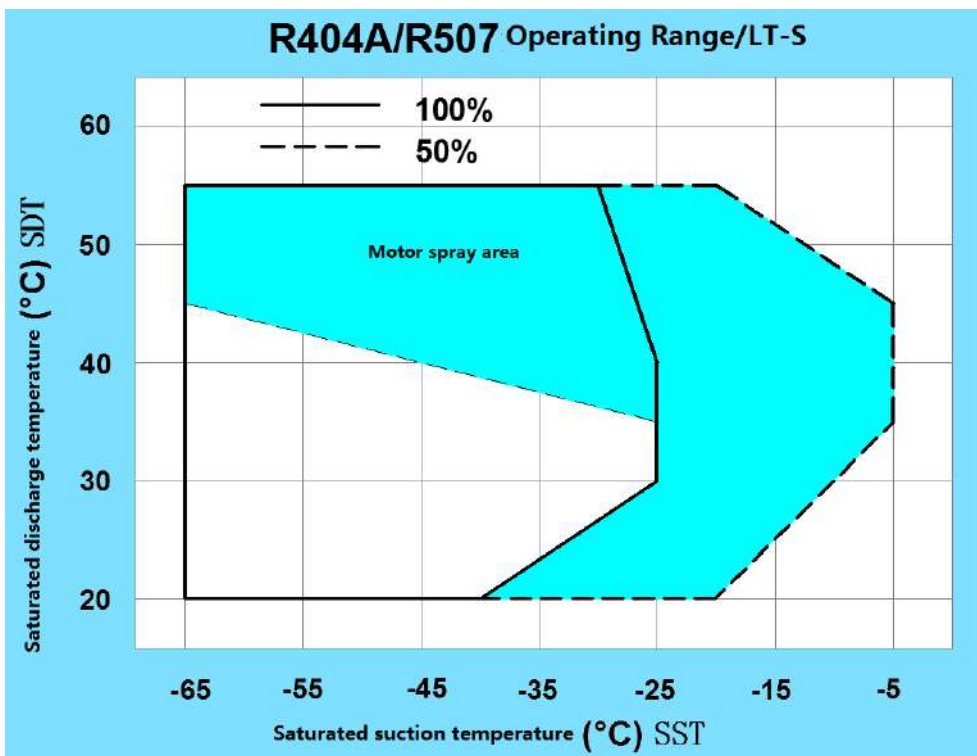


图 2-2.R404A 运行范围图

## **3. Construction & Functions**

### **3.1 Design Features**

#### **1) Starting load**

Starting with light load; its starting load is similar to ordinary single stage compressor, so as to avoid greater impact on power grid.

#### **2) Motor cooling channel**

Excellent motor cooling channel design which ensures the high efficiency of the compressor, while realizing the reliable cooling of the motor, so that the compressor can operate in a very wide range, and a more extensive scope of application.

#### **3) integrated design of system parts**

Pre-installed medium pressure check valves, shut off valves and economizer filters that ensure reliable protection of compressors and simplify customer system configuration.

#### **4) Motor temperature visualization**

The embedded temperature sensor of motor, PT100, PT1000 and NTC, are optional, which can directly read the motor temperature to control the motor temperature.

### **3.2 Capacity modulation system**

LT series screw compressor is equipped with 3/4 step capacity modulation system or continuous (stepless) capacity modulation system.

Both of the two capacity modulation systems are composed of slide valve, piston rod, piston cylinder and piston. As shown in Figure 3-1 below.

When the spool is fully in contact with the suction side, the screw rotor is in full-load suction state, at which time the working volume of the compressor is maximized. As the spool is separated from the suction side, it moves toward the exhaust side. A bypass cavity is formed between the slider and the suction side. Its presence causes the compressed gas in this range to be bypassed directly to the low pressure, and the actual suction volume of the screw rotor is reduced. The more the slide valve moves toward the exhaust side, the smaller the actual suction volume of the compressor will be. And the system cooling capacity will also reduce

The slide valve is driven by the pressure differential among the internal capacity modulation system.

The lubricant comes from the external oil separator and passes through the oil filter then enters into the oil inlet port of the compressor, and at last divided to both



sides of the piston. As a result, the piston can be controlled by discharging the high pressure lubricant at one side to low pressure, letting it flow to the low pressure side so that the slide valve will move with the piston to realize the loading and unloading of the compressor.

The purpose of the piston spring is to push the piston to its initial position (min. load position), so as to realize the automatic unloading start. It not only reduces the mechanical impact on the compressor's moving parts, but also reduces the electrical current during compressor start up.

Stepless capacity control, solenoid valve(SV1:unloading, SV3:50%, SV5:100%) is controlled by a micro controller or a thermal switch to adjust the piston smoothly to stably control cold output. If the oil filter capillary or solenoid valve of the capacity modulation system don't work properly, it will cause the capacity modulation system to be abnormal and fail.

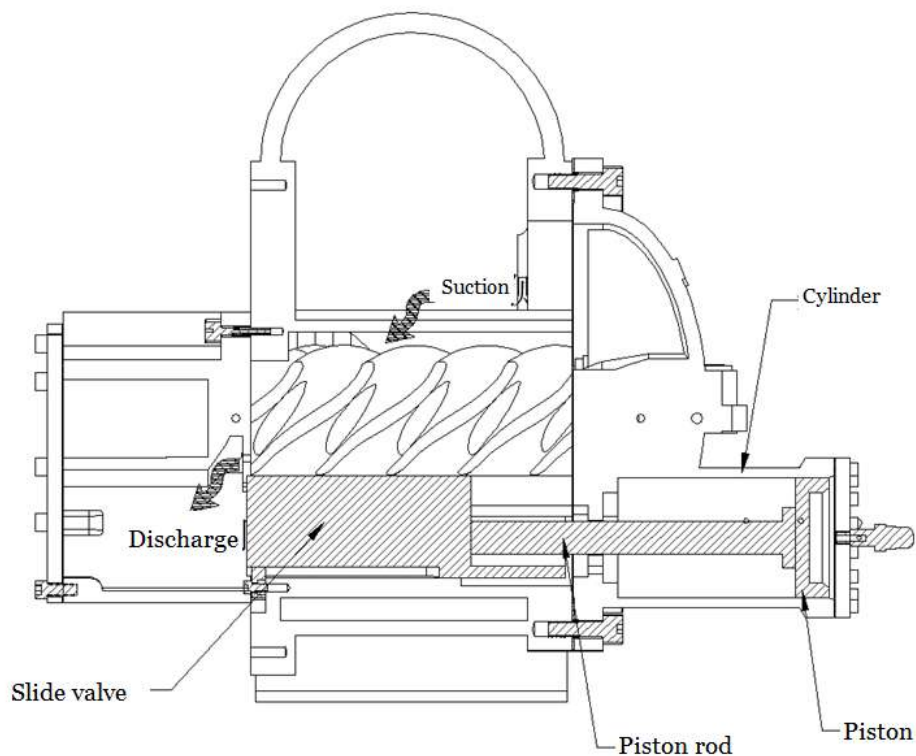


Figure 3-1.Capacity Modulation System

### 3.2.1 Step type capacity modulation system

#### 1) Step type control logic

**Y: Energize the solenoid valve**      **N: Do not energize the solenoid valve**

LT-83/41& 65/32 Capacity modulation system	SV1:Unload (NC)	SV2:10% (NC)	SV3:50% (NC)	SV4:75% (NC)	SV5:100% (NC)
100% load	N	N	N	N	Y
75% load	Y	N	N	Y	N
50% load	Y	N	Y	N	N
10% load (startup/stop)	Y	Y	N	N	N
LT-20/10&30/12 LT-45/20&55/25 Capacity modulation system	SV1:unload (NC)	SV2:10% (NC)	SV3:50% (NC)	/	SV5:100% (NC)
100% load	N	N	N	/	Y
50% load	Y	N	Y	/	N
10% load (startup/stop)	Y	Y	N	/	N

Table 3-1. Step Type Capacity Modulation Control Logic

#### 2) Step type capacity modulation graph

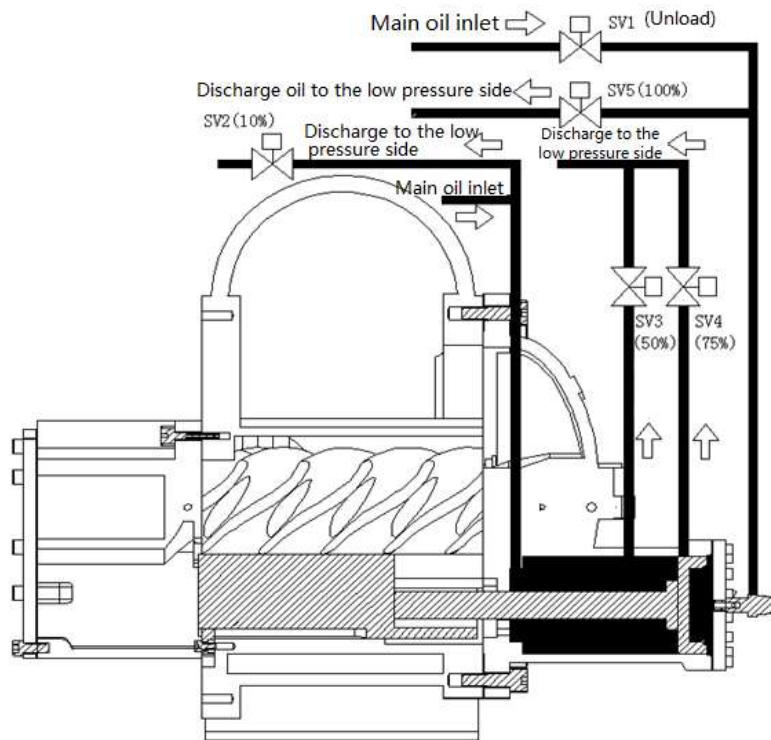


Figure 3-2. Step Type Capacity Modulation

### 3) Step type control logic description

#### ⊙ 10% load

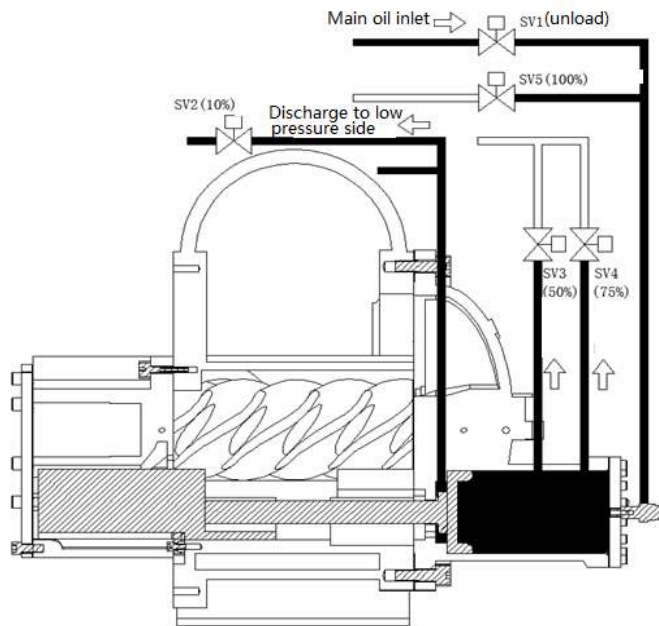


Figure 3-3. 10% Load

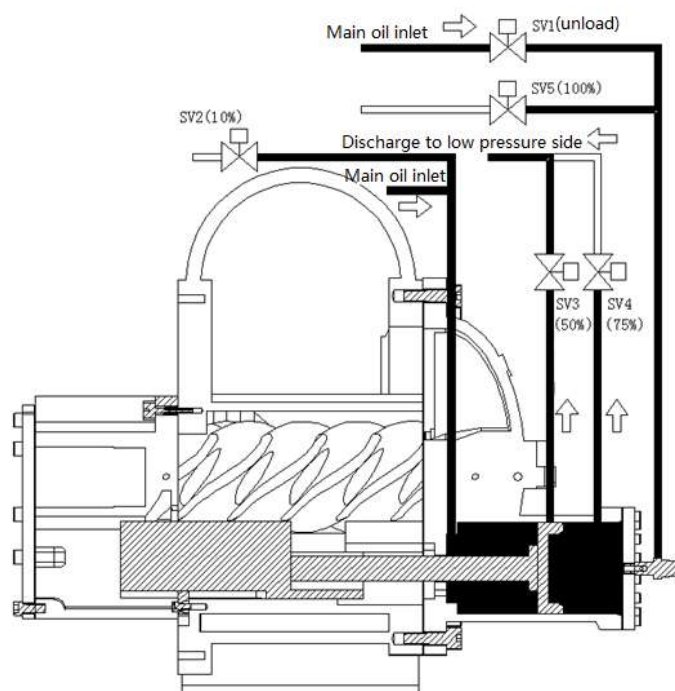
When starting up the compressor, SV1(unload) & SV2 (10%) need to be energized to make the piston keep at the 10% position(left side)

In this state, the high pressure oil passes through SV1(unload) then goes to the right side of the piston. At the same time, the oil from left

side of the piston passes through SV2 (10%) then discharge to the low pressure side. By doing so, the piston can be held at the 10% load position.

★ Note: 10% load is for start up only. Running the compressor at 10% load for a long time is not recommended.

#### ⊙ 50% load



At this time, the capacity adjustment solenoid valves SV1 (unload) and SV3 (50%) are active.

Under 50% load, SV1(unload) &SV3 (50%) are energized.

In this state, the high pressure oil passes to the left side of the piston continuously. At the same time, the oil passes through SV1 (unload) then goes to the right side of the piston.

If the piston is at the left side of the 50% hole (the loading is less than 50%), the oil at the right side of the piston will pass through SV3 (50%) and discharge to the low pressure side then the piston will move to right side until the position blocks the 50% hole. Thus the compressor is loaded to 50% smoothly.

Vice versa, if the piston is at the right side of the 50% hole (the loading is more than 50%), the oil in the left side of the piston will pass through SV3 (50%) and go out to the low pressure side then the piston will move to left until the position blocks the 50% hole. Thus the compressor is loaded to 50% smoothly.

### ☉ 75% Load

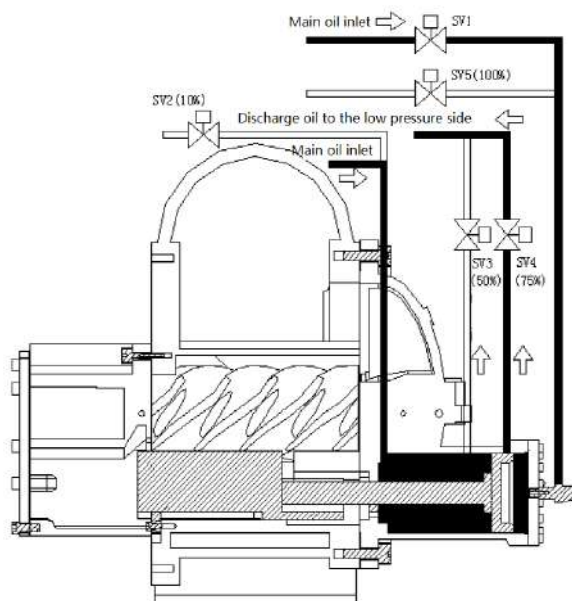


Figure 3-5.75% Load

**Under 75% load, SV1 (unload) & SV4 (75%) are energized.**

**The logic of 75% load is similar to that of 50%. The piston can be held around 75% position by 75% hole to make the compressor run under 75% load.**

### ☉ 100% Load

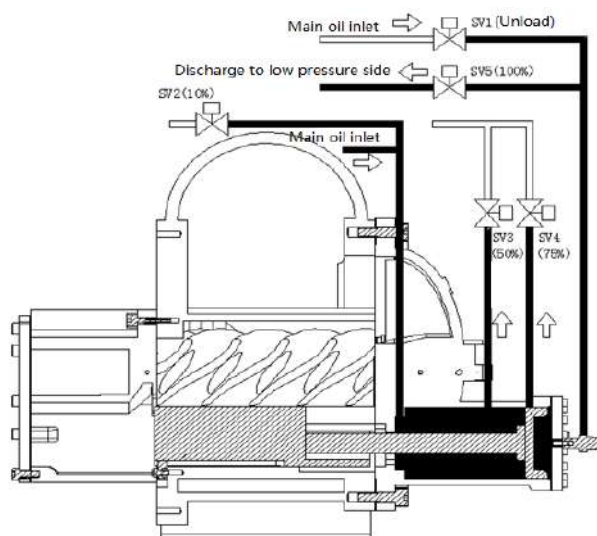


fig3-6.100% Load

Under 100% load, SV5 (100%) is energized. In this state, the high pressure oil passes to the left side of the piston continuously. At the same time, the oil in the right side of the piston passes through SV5 (100%) then goes to the low pressure side to make the piston be held at 100% position.

#### 4) Step type capacity modulation and water temperature control

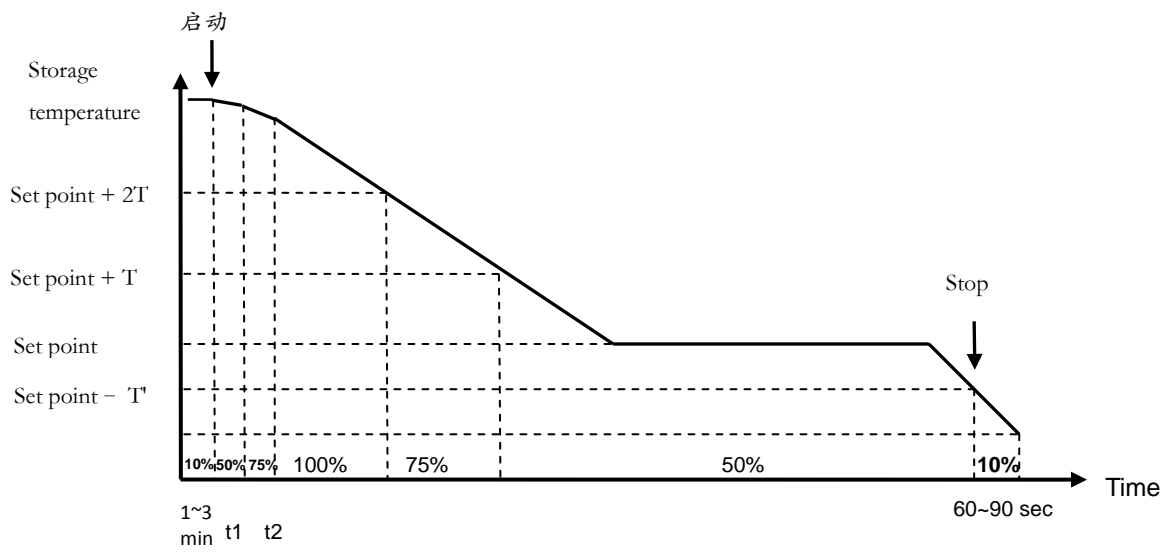


Figure 3-7. Step type capacity modulation and water temperature control

★Note: T & T' should be adjusted by system designer's experience and practical application.

### 3.2.2 Stepless type capacity modulation system

Stepless type is suitable when the refrigeration system needs to achieve precise control of cooling capacity.

#### 1) Stepless type control logic

**N: Do not energize the solenoid valve**

LT series Capacity modulation system	SV1: unload (NC)	SV2:10% (NC)	SV3:50% (NC)	SV5:100% (NC)
Load	N	N	N	Pulse activating
Unload	Pulse activating	N	Stay energized	N
Keep load state	N	N	N	N
10% load (start/shutdown)	Stay energized	Stay energized	N	N

Table 3-2. Stepless Type Capacity Modulation Control Logic 50%~100%

## 2) Stepless type capacity modulation graph

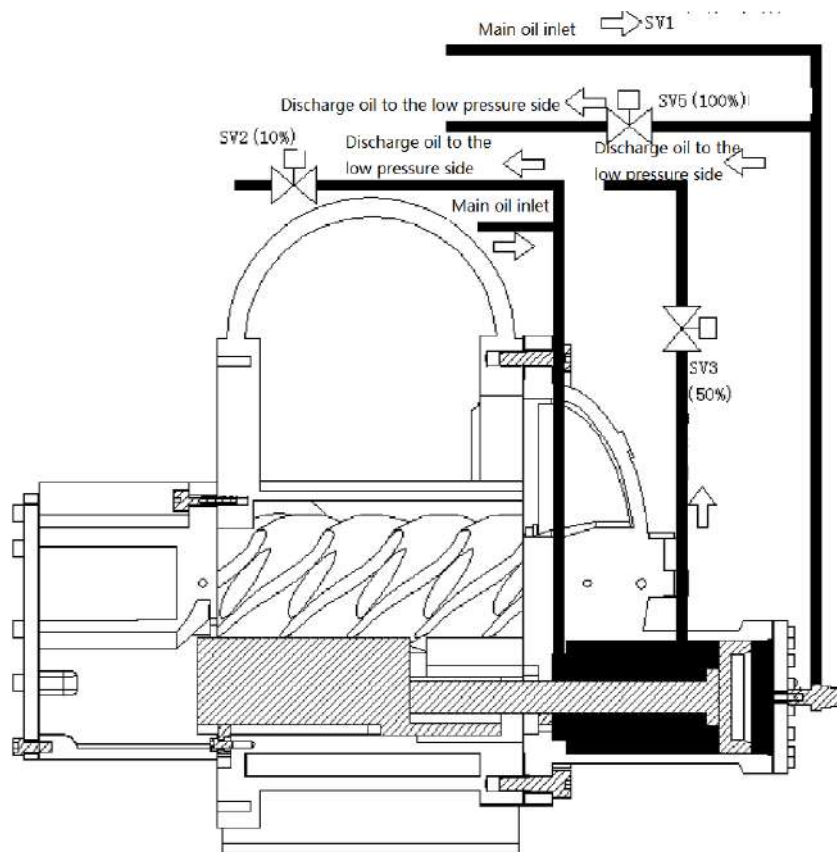


Figure 3-8. Stepless Type Capacity Modulation

## 3) Stepless type control logic description

In stepless type capacity modulation system, the oil keeps going to the left side of the piston. The oil bypass in the left side of the piston is controlled by SV3 (50%). The oil inlet in the right side of the piston is controlled by SV1 (unload) and oil bypass in the right side of the piston is controlled by SV5 (100%). These three solenoid valves are controlled by temperature controller or PLC.

Through the three solenoid valves, the cooling capacity can be controlled at any position from 50%~100%, so through periodical adjustment of SV1、SV3、SV5, the energy output can controlled stably.

★Note: SV2(10%) can only be used for machine start and stop. Don't run the machine at 10% load for long time once the machine is started. It shall be switched to load model directly.

The stepless type capacity modulation system shall be connected to the micro controller(optional), eg. PLC etc. in order to control the system at the target working condition.



⊙ **Load**

During load process, the SV5 (100%) adopts pulse activating, and the rest solenoid valve are not energized.

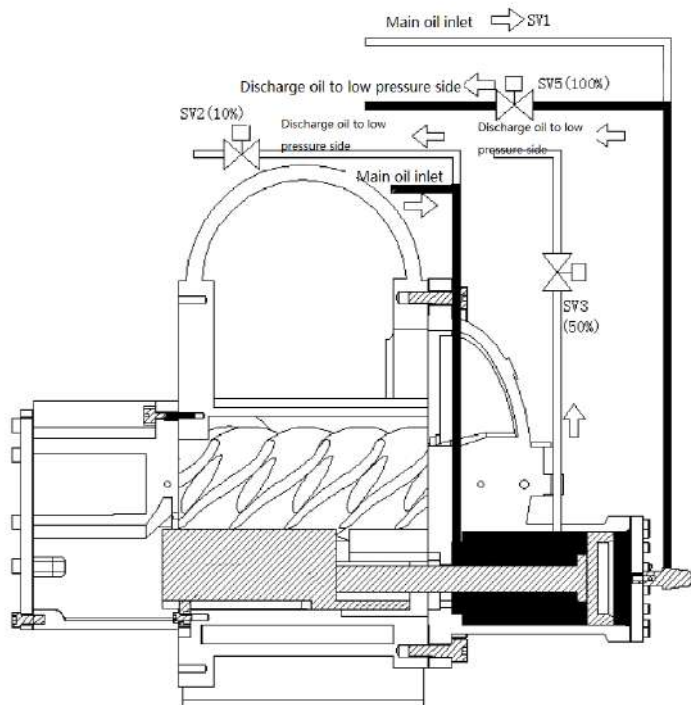


Figure 3-9. Load

In this kind of situation, the high pressure oil goes into the left side of the piston continuously and the oil in the right side of the piston bypasses through SV5 (100%) to the low pressure side.

The piston will continue to move to the right side and the compressor complete load process.

⊙ **Unload**

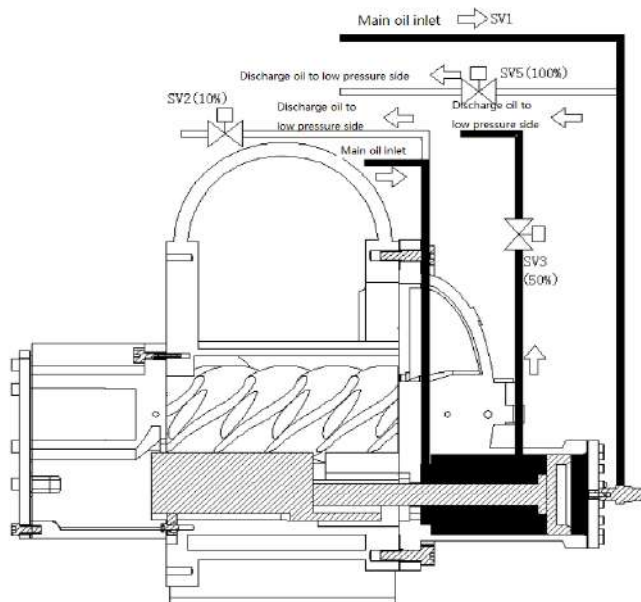


Figure 3-10. Unload bypasses to the low pressure side, so that the piston continues to move to the left side, and the compressor will load to 50% piston.

During unload process, the SV2(50%) stays active, and SV1 (unload) adopts pulse activating, and the rest solenoid valve are not energized.

The high pressure oil continues to go to the left side of the piston and goes into the right side of the piston passing through SV1(unload).

Through SV3(50%), it



⊙ **Keep load state**

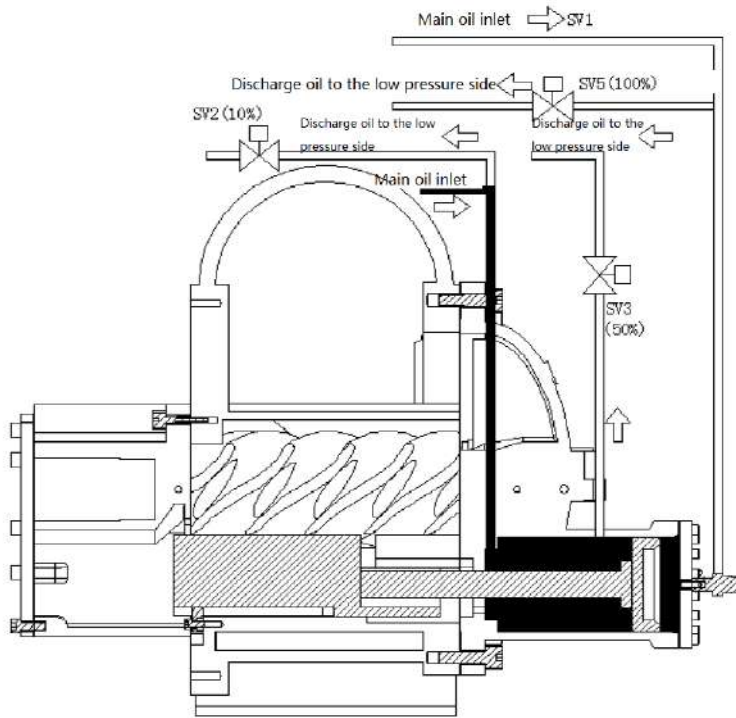


Figure 3-11. Keep Load State

During this process, all S/V are not energized. The high pressure oil coming continues to go to the left side of the piston. The left side oil inlet of the piston SV1(unload) and SV5(100%) are closed to keep the oil amount in the right side of the piston. The piston will not be able to move and stay at its original position, so that the compressor capacity will not change as well.

### ◎ Stepless type capacity modulation and water temperature control

Below picture shows the load control of single compressor in the application of stepless type capacity modulation.

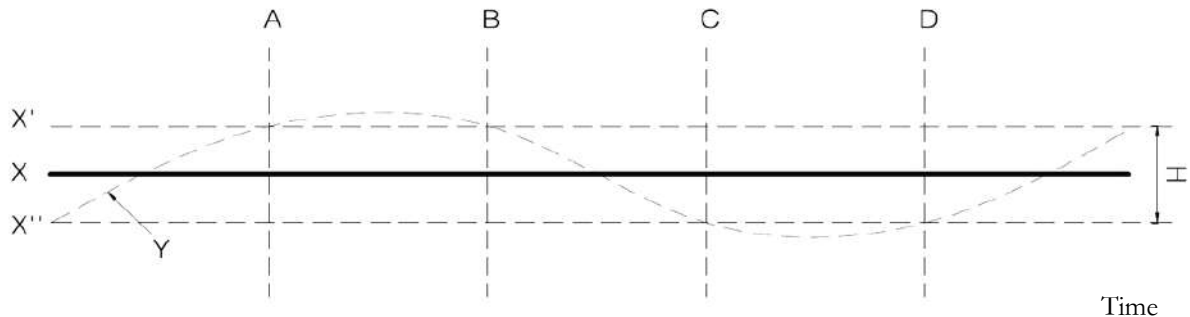


Figure 3-12. Stepless Type Capacity Modulation

★Note: X' Upper Limit; X'' Lower Limit; X Set Point; H Control Range; Y Actual valve

#### \* Description:

- The actual water temperature exceeds the upper limit between A & B. It means the compressor ought to unload until the actual value is within the control range.
- The real value is smaller than the bottom line between C & D. It means the required cooling capacity is decreasing and the compressor needs to be unloaded until the real value returns to the control range.

Figure 3-13. Solenoid Valve Action Intervals-Stepless Type

★Note: For detail stepless type capacity modulation control logic, please refer to

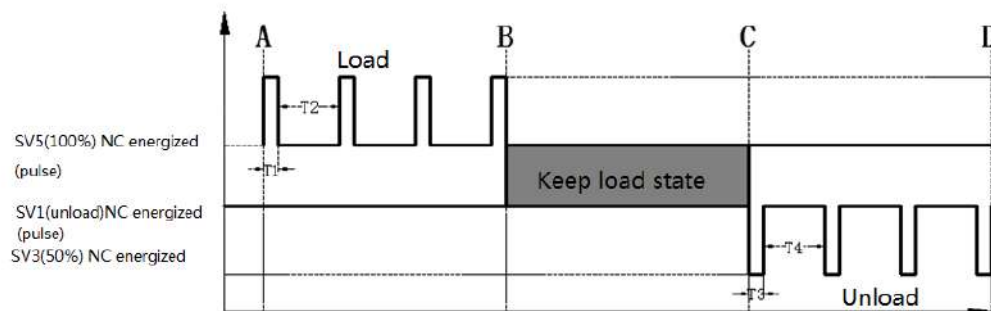


Table 3-2

Load/Unload functions between A and B, C and D.

- ❖ Energized: Solenoid valve is powered and energized
- ❖ Close: Solenoid valve is not energized
- ❖ T1, T3: Pulse time 0.5~1.5 seconds
- ❖ T2, T4: Pause time 10~20 seconds

### 3.2.3 The Location of the Solenoid Valves

#### 1) LT-83/41&LT-65/32

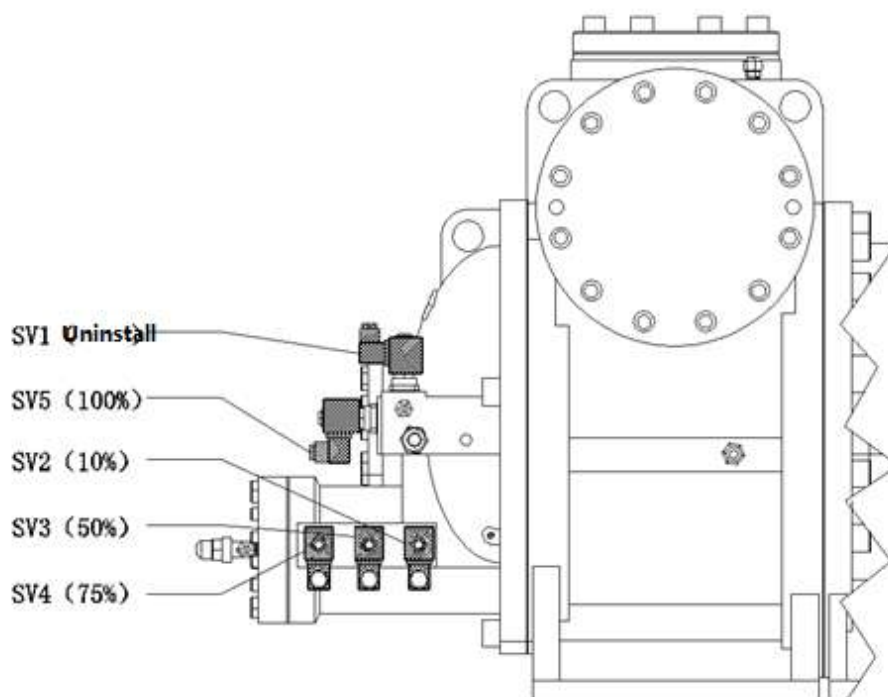


Figure 3-14.LT-83/41&LT-65/32 solenoid valve location

#### 2) LT-20/10&LT-30/12&LT-45/20&LT-55/25

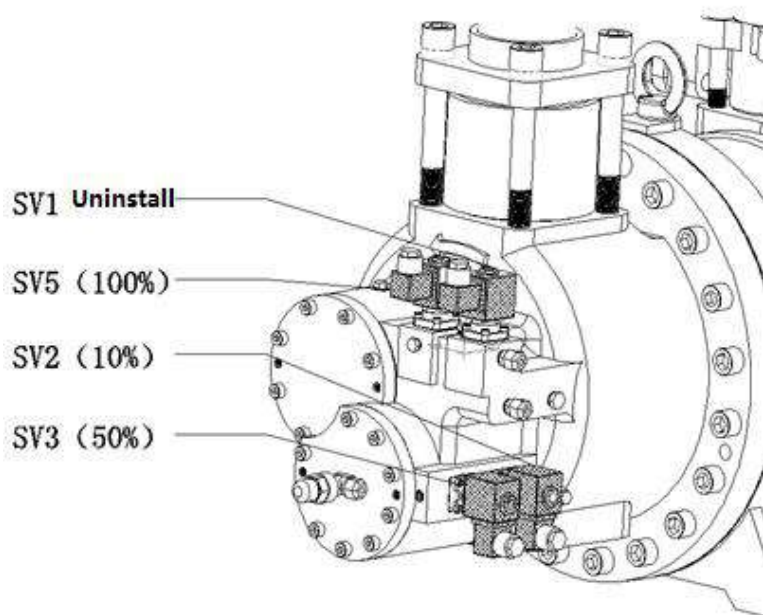


Figure 3-15.LT-20/10&LT-30/12&LT-45/20&LT-55/25 Solenoid Valve Location

### 3) Compressor unloading for startup, and stop

To decrease the mechanical loading to compressor's parts and decrease the starting current during start up. Hanbell designs for LT compressor the function of unloading startup. To ensure compressor loads steadily, please follow Figure 3-16 to load step by step during the whole loading process.

When compressor is about to shut down, it is also required to unload to ensure that the slide valve is at lowest loading position during next startup and compressor could have an unloading startup. Thus Hanbell requires no matter what load condition of the compressor is, it should be unloaded step by step till minimum load before stop according to below Figure 3-16.

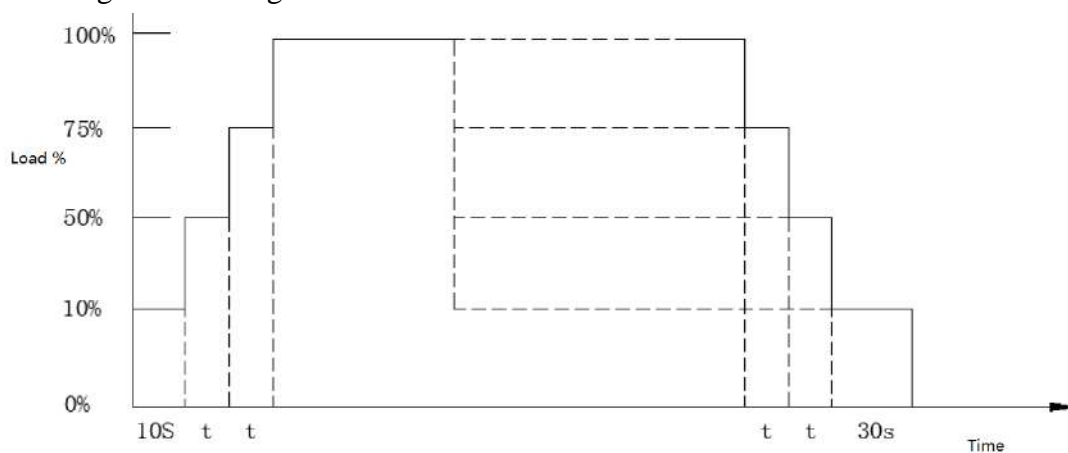


Figure 3-16. Compressor Startup and Stop Process

**⚠ Caution:**

- 1) After startup, keep the minimum load for 10 seconds. Before shut down, keep the minimum load for 30 seconds(Time can be set to 10~60seconds).
- 2) After startup, when the pressure difference between high pressure and middle pressure is less than 3.5bar, the compressor shall be run at 10% load at low pressure stage. Don't load and open ECO.
- 3)  $t=30$  seconds(Time can be set to 30~60seconds).
- 4) After the compressor shut down, the SV1 (unload) & SV2(10%) need to be still energized for 3 minutes, so as to ensure the compressor can still at min load position at next startup.
- 5) Hanbell strongly recommends that the compressor start-up and shutdown control logic shall refer to above graph. For detail information please refer to the regulations written in LT-S Control Requirements.

## 4. Lubricant

### 4.1 Lubricant Specification

Model	LT-S-(L)	
Refrigerant	R22	R404A&R507
Condensing Temp./°C	+20 ~ +60	+20 ~ +60
Evaporating Temp./°C	-60 ~ -10	-65 ~ -10
Temperature Restriction	110	110
Type	HBR-B03	HBR-B05
Proportion	0.87	0.957
Specific heat 40°C (Kcal/kg K)	0.43	0.43
Oil temperature during operation	40~60	40~60

Table 4-1. Lubricant Specification

**⚠ Caution:**

- 1) Please refer to the table above to select the suitable lubricant and refrigerant and its operation range need to be taken into consideration as well.
  - 2) Hanbell strongly recommends do not use the lubricant which isn't certified by Hanbell since it may damage the compressor seriously.
  - 3) This specification table is for LT series compressors only.
  - 4) The oil temperature at the point when the compressor starts is suggested to be 5K higher than the corresponding saturation temperature of the oil separator in order to avoid too much oil containing in the refrigerant which may affect the lubricant.
  - 5) After compressor stops, please turn on the oil heater of the external oil separator. If the compressor shuts down for a long time, please turn off the oil heater. Please heat the lubricant for more than 2 hours before next start up.
- 1) Be sure to make the system clean and no welding spatter and other impurities before lubricant filling
  - 2) In order to ensure that the system is dry enough, it should be dehumidified before filling. It is advisable to fill the system with dry nitrogen first and then vacuum the system. The vacuum time should be as long as possible. It is strongly recommended to repeat the above steps several times to minimize the water contained in the system.

**⚠ Caution**

- 1) Do not use the lubricant which is not approved by Hanbell, otherwise it may cause

serious damage to the compressor

- 2) Do not mix different brands of lubricants, otherwise they may cause serious damage to the compressor. Pay attention to it when replacing lubricating oil for the system.

## **4.2 The Replacement of Lubricant**

### **4.3.1 Oil Change Schedule**

- 1) Check lubricant every 10,000 hours after continuous running. For the first operation of the compressor, it is recommended to change the oil and clean the external oil filter after running 2,000 hours. Check the system whether clean or not and then change oil every 20,000 hours or after 4 years continuous running if the system operates in good condition.
- 2) The oil will deteriorate if the compressor runs at high discharging temperature (above 95°C) in the long term. Please avoid this situation, but if it's necessary to run in this condition, please shorten the intervals of oil changing.

### **4.3.2 Pre-cautions for changing oil**

- 1) It is recommended to check the quality of oil periodically in order to maintain the lubrication performance.
- 2) The lubricant absorbs moisture in the air. Avoid to expose it to the air for a long time  
If the compressor motor is burned, the acid and harmful substances and burned debris will be brought into the system. Therefore, the oil filters and lubricants must be replaced repeatedly. It is suggested to replace the lubricating oil again after 72 hours of operation until the quality of the lubricating oil in the system returns to standard valve.
- 3) The foreign body in the oil will block the oil line, so it is necessary to install an oil filter in the external oil line. Also, the pressure differential sensor need to be installed before and after the oil filter. If the pressure differential valve between these two sensors reaches 1.5 bar, the oil filter need to be changed.
- 4) The acidity of oil will directly affect the life of the motor, and it is recommended to change the oil when  $\text{PH} \leq 6$ . (Please also change the filter drier at the same time to make sure the system is dry.)
- 5) It is important to replace the oil, especially when the motor is burnt because the acidity remains in the system. By replacing the oil can help check the status of the

system. Check the acidity of the lubricant, and re-change the oil after the system runs for 72 hours until the acidity of the lubricant reaches the standard value.

- 6) In case of motor burned out, please not only change the compressor, but also change the oil and check the condition of the oil periodically. If the acidity exceeds the standard, please change it immediately and always be aware of the cleanliness and moisture contained in the system.

## 5. System Application

★**Note:** Please consult Hanbell for parallel application and heat pump application.

### 5.1 Piping Design

#### 5.1.1 Suction and Discharge Piping Layout

##### 1) Material and structure of suction and discharge pipe

The vibration of the compressor is small in normal operation, so it is not necessary to use flexible joints for suction and discharge tubes, but the pipes need to have enough flexible length to ensure the suction and discharge pipes won't cause any stress to the compressor. It is recommended to use copper tube for the suction and discharge piping in order to decrease the piping vibration when the compressor is in operation.

##### 2) The dimensions of suction and discharge piping:

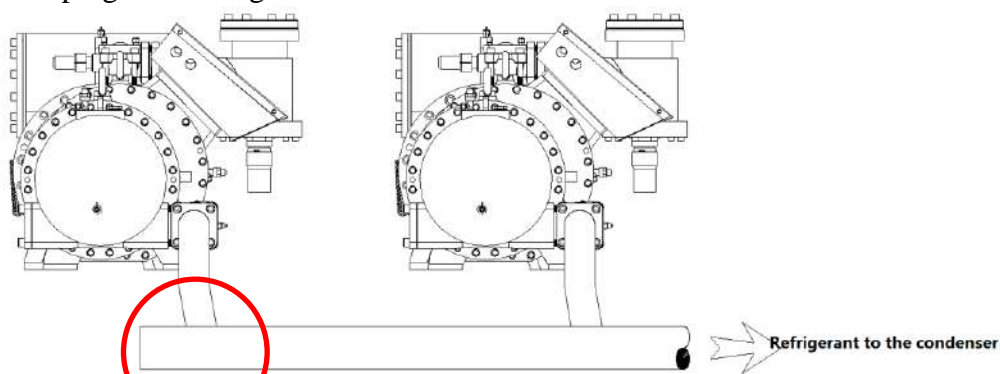
It is suggested to design the dimension of suction and discharge piping according to Hanbell recommendation (refer to 10.2.2).

##### 3) Piping for parallel system

To improve the system operation efficiency, it's necessary to reduce the gas-flow resistance and consider the oil return of suction piping. The recommended piping of suction and discharge side for parallel system is shown below:

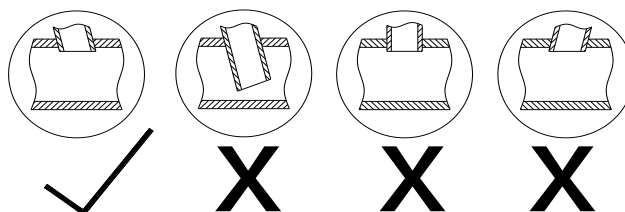
Be aware of the area of the main pipe should not be less than the area of the other pipes to make sure the pressure drops could be controlled in reasonable range.

##### \* Piping at discharge side



Detail drawing 1

Figure 5-1. Discharge Piping for Parallel System



##### \* Piping at suction side



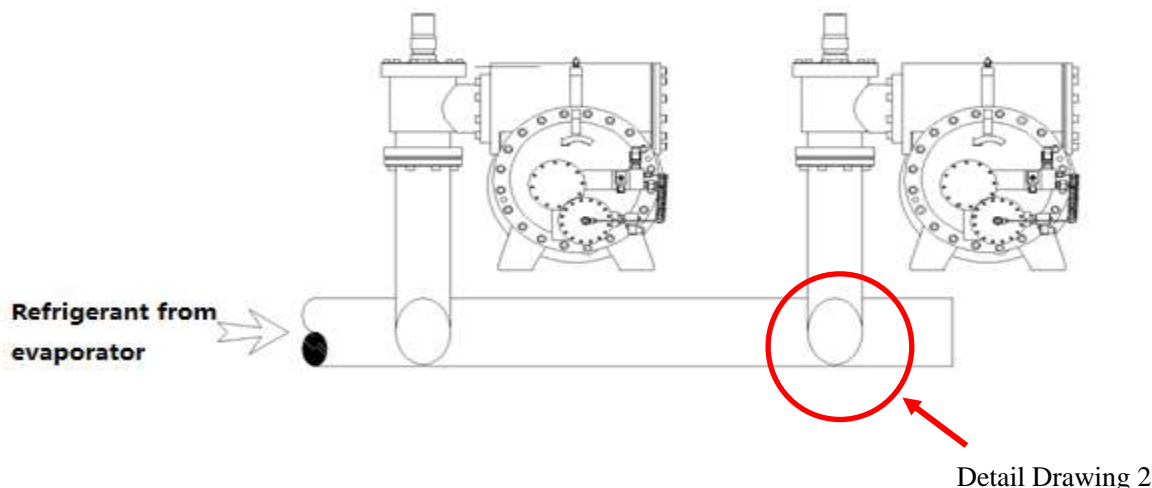
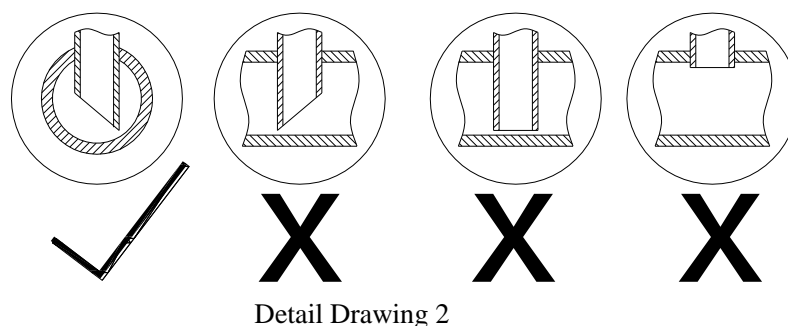


Figure 5-2 Suction Piping for Parallel System



**4) Suction filter**

This model of compressor has a built-in suction filter, but it is only used as a final protection. It should not be used as a suction filter that needs to be cleaned regularly.

So It is necessary to install a suction filter (25μm) which is easy to remove and clean it regularly.

When the system is first used, it may need to be cleaned up frequently. If the pressure drop is bigger than 0.5 bar, the filter element should be replaced or cleaned until the system is clean. When the filter is disassembled, if the filter is found to be damaged, it needs to be replaced in time, and the impurities in the pipeline should be cleaned up. Ensure that the filter is oriented correctly during installation and it is recommended to add a shut-off valve at the inlet and outlet for easy maintenance. Hanbell The recommended suction filter design is shown in Figure 5-3 below.

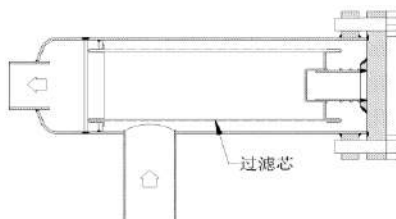


Figure 5-3.suction filter

★Note: External suction filter should be used for cryogenic refrigeration systems.

### 5.1.2 Economizer Piping Layout

#### 1) Economizer pipe dimension

A shut-off valve of the economizer is the standard accessory. It's recommended to design the dimension of the pipes according to Hanbell suggested valve (Refer to 10.2.2 ).

#### 2) Economizer check valve

When the operating conditions are unstable or when the economizer loop is closed, a part of oil and refrigerant will flow back to the economizer pipe. In order to prevent this phenomenon, this type of compressor is equipped with economic check valve as standard.

#### 3) Economizer intake filter

There is a built-in intake filter in the compressor, which is mainly used for catching the impurities from the economizer and its pipes during the initial operation to avoid serious damage to the compressor. This filter is not suitable for regular cleaning and replacement of filter elements. If the system does have such requirements, an external filter should be equipped on the economizer pipeline.

### 5.1.3 Minimum pressure valve

The oil pressure differential of the compressor between high pressure and medium pressure shall be able to reach 2.5 bar in 30 seconds after start up to ensure the lubricant can go into the compressor on time.

If the compressor fails to establish the pressure differential, it will cause insufficient oil supply, leading to compressor shut down even damaging the compressor.

Therefore, we provide a minimum pressure valve for LT series compressor so as to achieve the pressure differential between high pressure and middle pressure quickly. The minimum pressure valve should be mounted after the external oil filter, and connected to the compressor medium pressure test point.

The location and installation of the minimum pressure valve is shown as below picture.

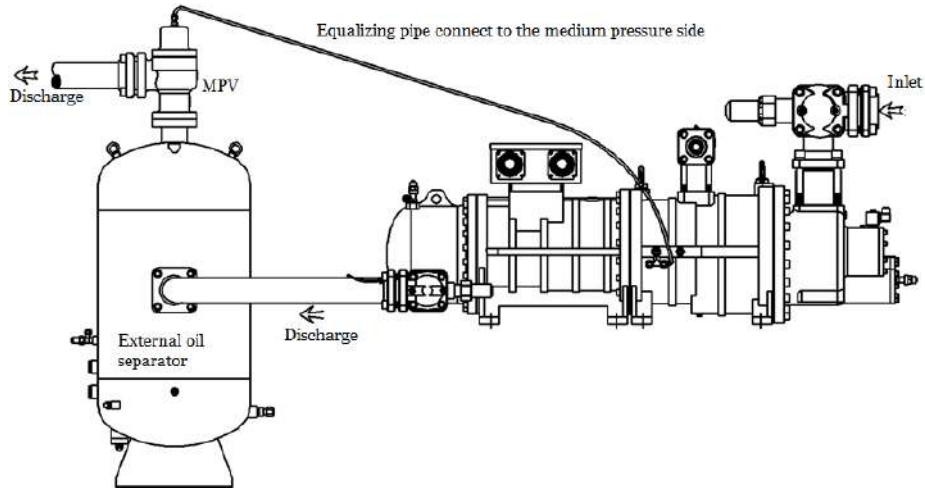


Figure 5-4. Minimum Pressure Valve Installation Graph  
Minimum Pressure Valve Configuration Compound & Parallel Connection

Model	Compound	Parallel connection		
		Two in parallel	Three in parallel	Four in parallel
LT-20/10	2"	3"	4"	5"
LT-45/20	2.5"	4"	5"	6"
LT-55/25	2.5"	4"	5"	6"
LT-65/32	2.5"	4"	5"	6"
LT-83/41	2.5"	4"	5"	6"

Fig 5-1. Table 5-1. Minimum Pressure Valve Configuration Compound & Parallel Connection

★Note: For LT series compressors, the standard minimum pressure valve size we provide to you is the same as that of the discharge valve.

★Note: Besides the standard size, other sizes are optional (refer to 10.2.4)

★Note: LT series compressor must be equipped with minimum pressure valve.

### 5.1.4 Liquid Line Filter Dryer

It will cause damage to the compressor and system even a low moisture content left in the system, so it's a must to install a filter drier on liquid line to keep the system dry.

### 5.1.5 Sight Glass with Moisture Indicator

It is strongly recommended to install the sight glass with moisture indicator in order to observe the moisture content in the system. When the moisture content is high, it is necessary to change the filter dryer

★Note: Hanbell can provide the sight glass with moisture indicator as an option.

## 5.2 Oil Line

### 5.2.1 Oil Supply

The oil is supplied by pressure differential. Through the pressure difference between the oil separator and the injection point, the lubricating oil continuously flows from the oil separator to the compressor. These lubricants are sprayed into the bearing and compression chamber, and then carried out with the discharging gas. The oil will enter the oil separator again and complete the circulation of the oil circuit.

### 5.2.2 Lubrication and Capacity Control Modulation

The oil will be injected from two oil injection connectors which supply the oil to high and low stage bearings respectively as shown below. Besides, the connector for the lubrication of low stage bearings is also used for oil supply to capacity control system.

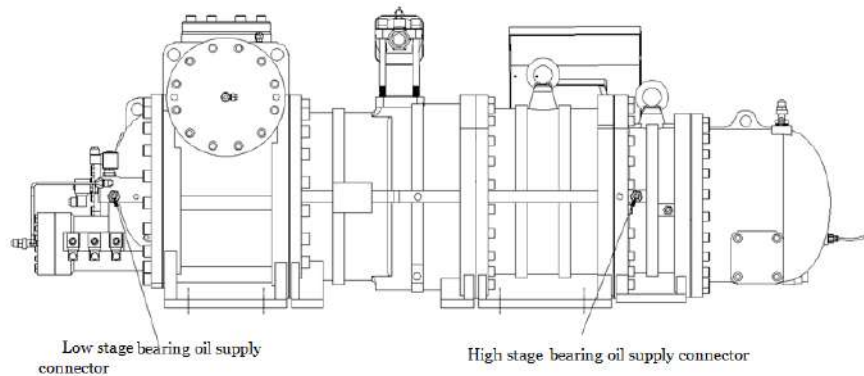


Figure 5-5.Oil Supply Connector for High Stage & low Stage Bearing

### 5.2.3 Compressor chamber injection system

In some certain working conditions, the compressor might need liquid injected to the chamber to lower the discharge temperature and make sure the compressor will be operated properly. There is one port for liquid injection to chamber. (As shown in the Figure 5-6 below)

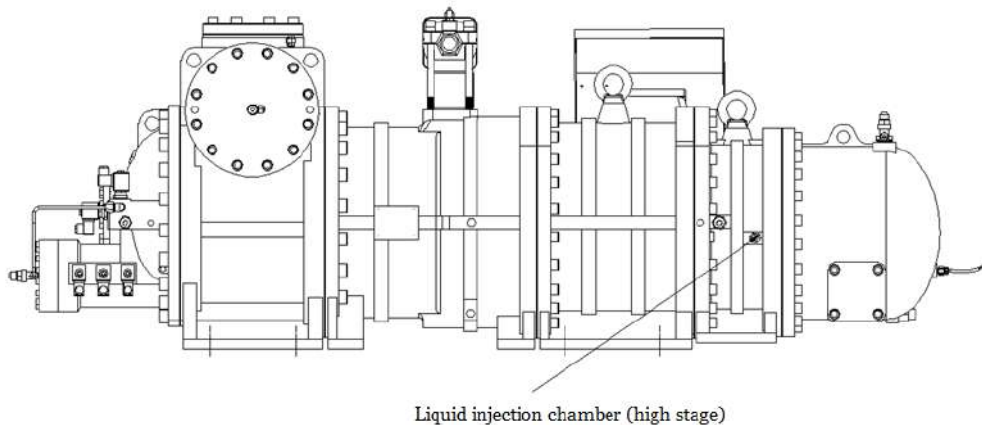


Figure 5-6.Connector for Liquid Injection to Chamber

### 1) High Stage Compression Chamber Cooling

After low stage compression, the gas temperature is high. Although the economizer provides medium pressure air to mix with the low stage discharged gas, which realizes intermediate cooling to some extent, the refrigerant remains with high temperature because it is also responsible for the cooling of the motor. Thus, when the refrigerant with over high temperature is compressed in high stage, the liquid injection cooling function become a must. That's why Hanbell requires that the high stage chamber liquid injection cooling must be applied.

★Note: Hanbell recommends to use oil for liquid injection to chamber.

### Basic Oil Circuit System(right)

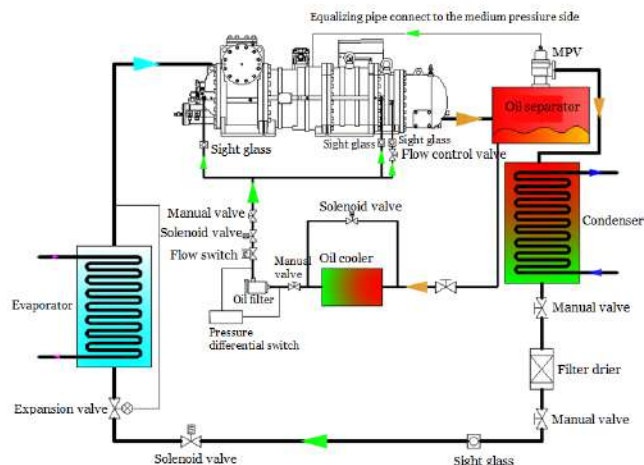


Figure 5-7. Basic Oil Circuit System

### 5.2.4 Protection in Oil Circuit

The normal operation of the oil circuit system is critical to the reliability of compressor. To ensure the normal operation of the capacity modulation, the bearing lubrication and the cooling effect, please pay attention to the below points:

#### 1) Oil temperature

Hanbell has strict requirements on the oil inlet temperature of the compressor

when it is running.

When the oil temperature is too low:

- ❖ It may lead to the viscosity of the lubricant over high and insufficient oil supply and abnormal capacity modulation and so on.
- ❖ It may cause excessive liquid refrigerant dissolving in the lubricant, which leads to severe oil being carried over, resulting in oil lacking in the system. The lubrication effect will be influenced as well, and it will lead to the bearing to be damaged.

When the oil temperature is too high:

- ❖ The lubricant viscosity will be reduced, so the lubrication effect will be poor, which leads to premature of bearing.
- ❖ It will lead to poor cooling effect, which results in machine stop protection due to high discharge temperature. Even more, it may cause compressor stuck.
- ❖ High temperature will accelerate the deterioration of the lubricant and shorten the service life of the bearing. If the lubricant isn't replaced on time, it may cause serve damage to the compressor.

 Note

- 1) When the compressor is running, the oil inlet temperature of should be kept between 20°C ~60°C
- 2) When compressor stops, the oil heater needs to be switched on to make the oil temperature above 20°C
- 3) When compressor has stopped for a long time, the oil heater can be switched off. However, a great number of refrigerant may be dissolved in lubricant due to long term stop, so the lubricant may be diluted in the lubricant and its viscosity is too low. That's why the oil requires to be heated to 20°C before machine start.

★Hanbell can provide the oil heater as an option (Refer to 10.4.4) .

## 2) Oil filter

The cleanliness of the lubricant is very important to the compressor. If the welding debris or other debris enters the compressor along with the lubricant, it will lead to the wearing of bearings or the stuck of screw rotors. Thus, Hanbell requires to install an oil filter and it must be after the oil cooler to ensure no new debris will enter into the lubricant once it is filtered.

Meanwhile, we suggest to install a pressure differential switch to detect pressure drop before & after the oil filter. If the pressure drop bigger than 1.5 bar, the compressor must be stopped for cleaning or replacing the oil filter to ensure enough pressure to deliver the lubricant and cleanliness.

★Note: Refer to Figure 5-7 for the layout of oil filter and pressure difference switch.

### 3) Oil pressure differential

This type of compressor relies on the pressure difference of the lubricating oil to provide oil circulation power. To ensure that the lubricating oil can be continuously supplied into the compressor when the compressor is running, the oil pressure of the compressor lubricating oil and the medium pressure of the compressor must be ensured. There is a pressure difference of more than 2.5 bar in the cavity. Therefore, Hanbell requires this protection should be added when designing the system protection.

### 4) Oil level protection

The oil supply to compressor cannot be guaranteed only by the oil pressure differential, so it is suggested to install an oil level switch to ensure the oil circulation.

### 5) Oil flow protection

To ensure the oil supply and increase the reliability, an oil flow switch is also suggested to be installed.

★Note: Refer to Figure 5-7 for oil flow switch installation

2) Hanbell provides oil flow switch as an optional (refer to 10.3.1)

## 5.2.5 Oil cooling system

It is normally used in high pressure ratio working conditions. Under such working condition, a lot of heat will be generated, and part of the heat will be taken away by the lubricant, so if additional measures are not taken to cool down the lubricant, the temperature will be over high, which cannot be able to meet the conditions of compressor's normal operation

Installing an external cooler is a normal way to solve the problem, which can make the temperature of the lubricant remain at a certain reasonable range. So that the compressor can work properly even in strict working conditions.

⚠ Note:

- 1) It is suggested to install the oil cooler near the cooler.
- 2) When the piping of the cooler is designed, please make sure to avoid the gas

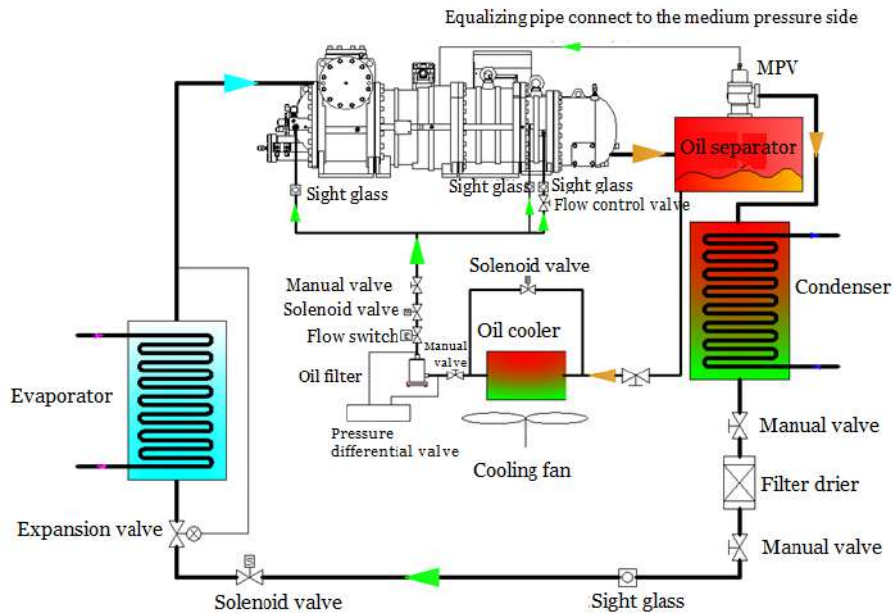
chamber form inside the oil cooler or the lubricant inside the cooler go into the oil separator or the compressor after compressor is stopped. That's why the position of the oil cooler is normally lower than that of the compressor and the oil separator.

- 3) Be sure to equip a temperature control device for the oil cooler to ensure that the oil temperature is between 40°C~60°C.
- 4) A bypass way is suggested to be designed for ease the control of oil temperature. Refer to Figure 5-8 &5-9 &5-10.



Below is the three oil cooler layout suggested by Hanbell.

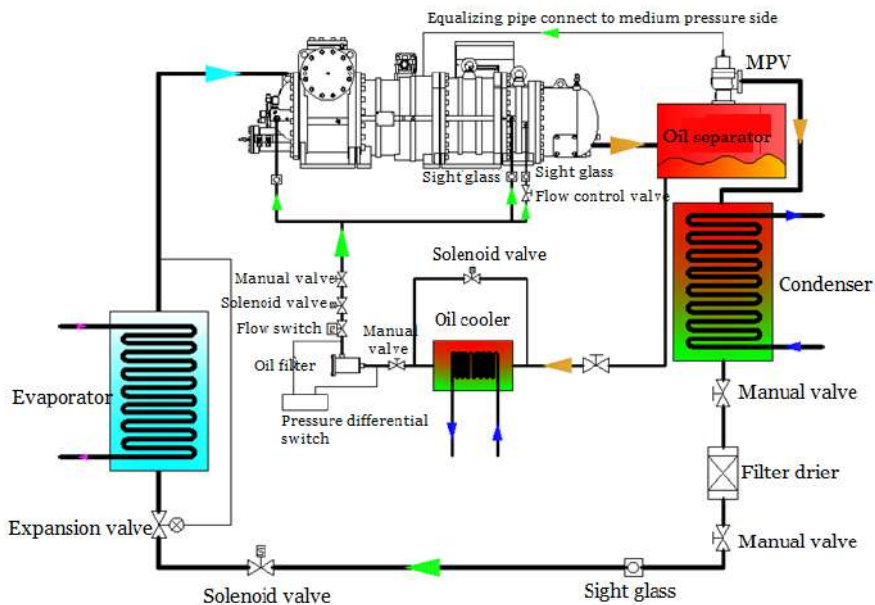
1) Air cooling type



★Note: During heating operation, it is recommended not to use the air cooling type oil cooler to avoid heat loss.

Figure 5-8. Air Cooling Oil Cooler

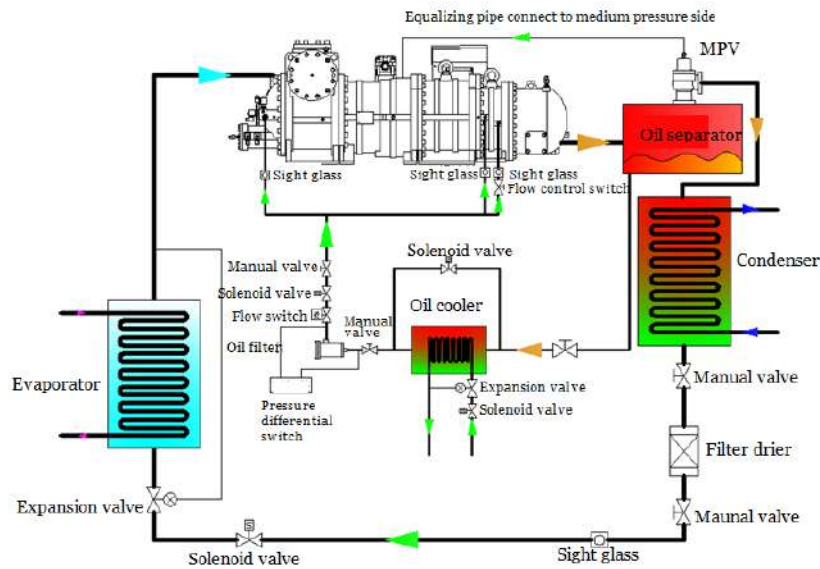
2) Water cooling type



★Note: If the water temperature appropriate, the water is suggested to be taken from the water inlet of the condenser to recover the oil cooler load to the hot water side.

Figure 5-9. Water Cooling Oil Cooler

### 3) Refrigerant oil cooling



★Note: Oil cooler takes liquid from the liquid pipe and returns back to compressor medium pressure gas inlet

Figure 5-10. Refrigerant oil cooling

### 5.3 Motor Liquid Injection Cooling

The motor cooling of the compressor is mainly based on the cooling of gaseous refrigerant. The refrigerant gas discharged from the low-pressure stage flows through the motor together with the economizer gas to achieve cooling of the motor.

However, in strict working condition, the cooling effect of gas refrigerant is not sufficient. So Hanbell designed a connector to assist the cooling of the motor, from which the liquid refrigerant can be injected to the medium pressure chamber. Once the liquid refrigerant enters the medium pressure chamber, it will diffuse with the air flow to realize the cooling of the motor. Meanwhile, it guarantees the minimum energy loss and expand the working condition of the compressor.

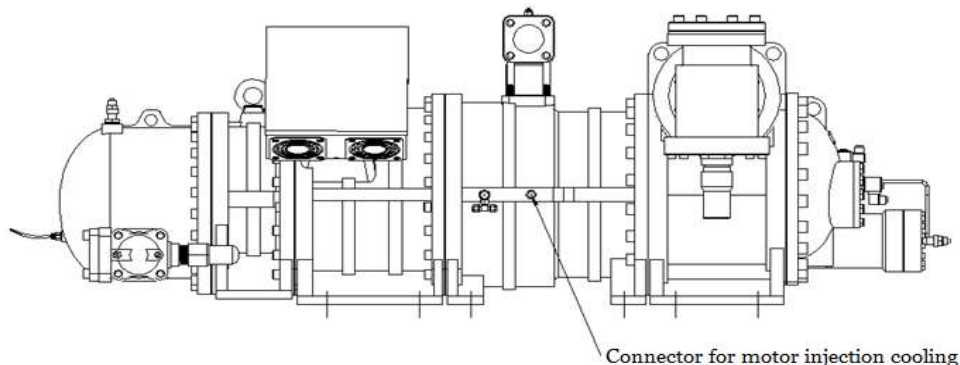


Figure 5-11. Motor liquid spray cooling joint

- ★1) Note: Refer to 2.4 for the working condition of motor liquid spray cooling joint
- 2) PT 100 motor temperature sensor is a standard accessory for controlling the liquid injection solenoid valve.

## **5.4 Economizer System**

Cooling capacity and efficiency will be increased by applying an economizer in front of the expansion valve to get sub cool effect. Economizer has significant effect especially in high pressure ratio working condition.

For a compound two stage compressor, the economizer is even more required. Due to its two stage compression design, the economizer effect is magnified. The increase of both cooling capacity and COP are more significant than those of single stage compressor. The gas supplied by the economizer could reduce the discharge temperature from low stage, which reduces the discharge temperature at high stage. This increases the compressor performance, reliability and widens the application limit.

Here are two typical application systems for the economizer:

### **5.4.1 Economizer System with Sub Cooler**

With this form of operation, a heat exchanger (subcooler) is used to sub-cool 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 compressed in low stage.

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.

Typical LT economizer system with subcooler

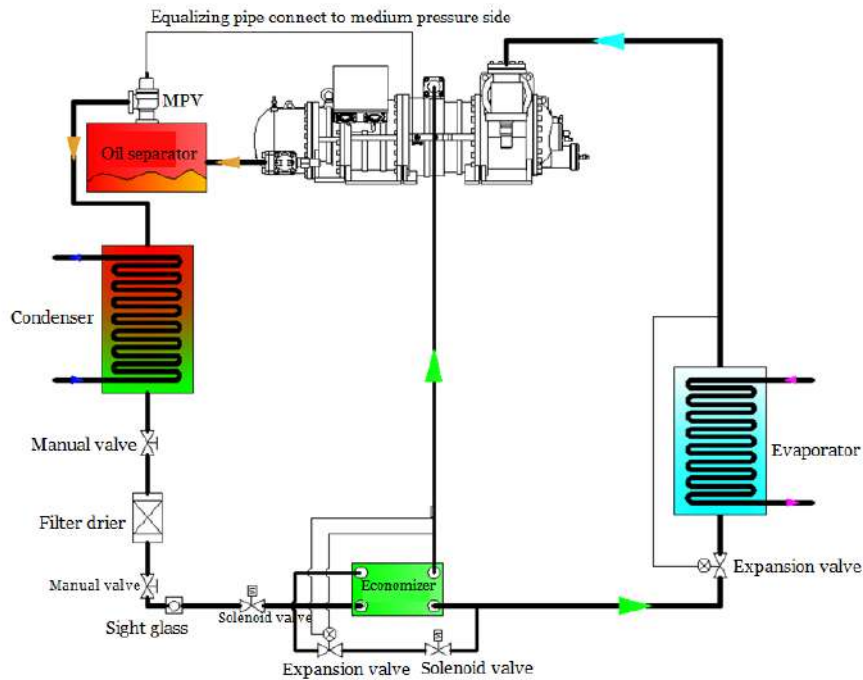


Figure 5-12. Economizer System with Subcooler

#### 5.4.2 Economizer System with Flash Type Subcooler

The Liquid sub-cooling is achieved by reducing the boiling point pressure in a medium pressure vessel (flash type subcooler) whose pressure is between condensing and evaporating pressure. 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 economizer connection of the compressor. This form of operation gives the most economical thermodynamic performance due to direct heat exchanging.

Typical LT economizer system with flash type subcooler

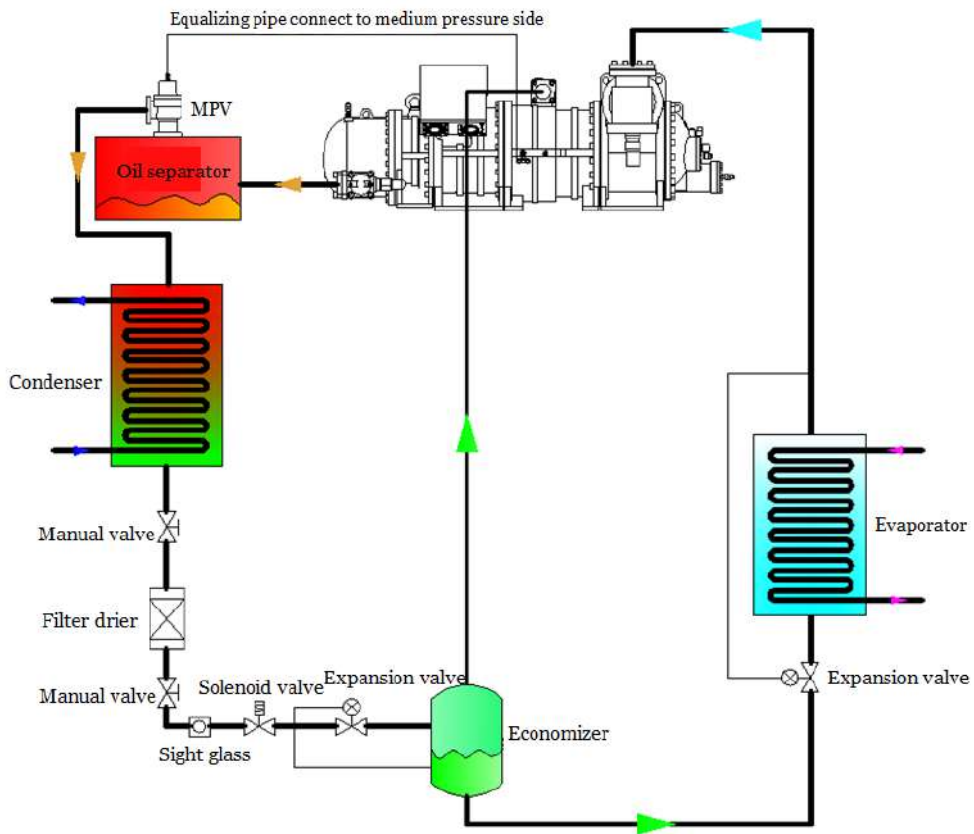


Figure 5-13. Economizer System with Flash Type Subcooler



## 6. Electrical Design

### 6.1 Electrical parameters and design

#### \* Motor Design

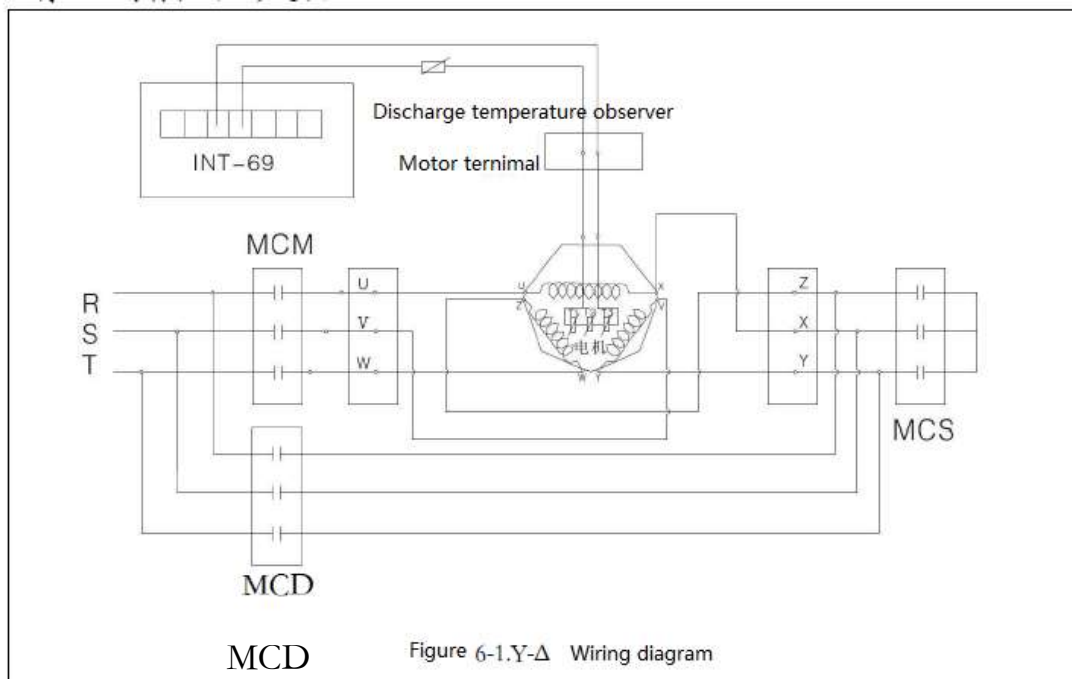
The standard starting method of Hanbell LT series screw compressor is Y- $\Delta$  start.

#### 6.1.1 Y- $\Delta$ Start

The starting mode of Y- $\Delta$  connection is a Y connection during starting, and the voltage on the winding is reduced to 1/3 of the input voltage. When it completes the starting process, it will resume to  $\Delta$  connection. By doing so, we can decrease starting current through voltage drop, i.e., so-called voltage-drop starting.

The wiring of Y- $\Delta$  starting is shown as follow:

In Y connection, MCM, MCS are energized to make Z, X, Y three points together and become the center point of Y connection. A few seconds (3~5 seconds is recommended), MCM, MCS converts. About 0.25 seconds later, MCM, MCD are energized to convert to  $\Delta$  connection.



#### ⚠ Caution:

After Y mode starting, 0.25 seconds after MCM & MCS complete conversion process, MCM & MCD are energized for  $\Delta$  running. Pseudo short circuit might occur within 0.25 seconds due to improper action of the contactor, causing trip of the



compressor. When this occurs, we recommend to use an adjustable Y- $\Delta$  timer or time delayer to lengthen the time for MCM, MCS conversion — it takes 0.25 to 0.5 seconds to re-energize. Please refer to Y- $\Delta$  shift time graph for details. Because motor is not powered during Y- $\Delta$  shift, shorter Y- $\Delta$  shift span is suggested to prevent second start due to decreased rotation speed. However, if Y- $\Delta$  shift span is too short, above mentioned pseudo short circuit might occur.

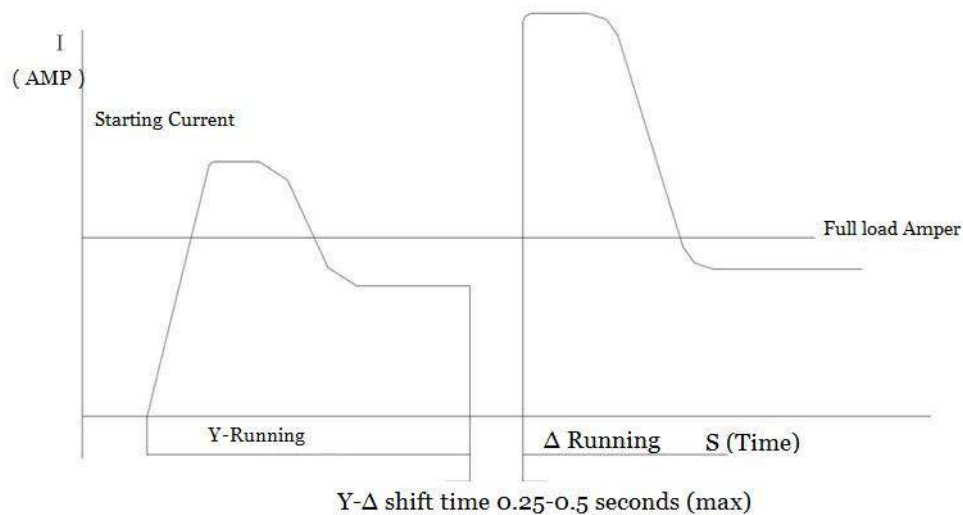


Figure 6-2. Y- $\Delta$  Shift Time

#### \* Y- $\Delta$ start features

- 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.
- ◇ Except for Y- $\Delta$  start, concerning soft start or reactance start, please kindly contact Hanbell for further information.

#### 6.1.2 Power requirements

##### \* Power limitation

- ❖ Voltage limitation
- ❖ Long term operation: within  $\pm 5\%$  of rated voltage
- ❖ Instant operation: within  $\pm 10\%$  of rated voltage
- ❖ Frequency: within  $\pm 2\%$  of rated frequency

##### ⚠ Caution

In the region where the electricity power is unstable, install an additional



hi-low voltage protector with  $\pm 5\%$  tolerance of normal voltage to ensure safe operating of the compressor.

※ Unbalanced Voltage

Unbalanced voltage usually occurs because of variations in the load. During loading process, when one or more of the phases are different from the other(s), unbalanced voltage will appear. This can be due to different impedances, or type and value of the loading in each phase. Unbalanced voltage can cause serious problems, particularly to the motor.

❖ NEMA defines voltage unbalances as follows:

$$\text{Percent voltage unbalance} = \frac{\text{Maximum voltage deviation from average voltage}}{\text{Average voltage}} \times 100\%$$

❖ NEMA states that poly-phase motors shall operate successfully under running conditions at rated load when voltage unbalance at the motor terminals does not exceed 1%. Furthermore, operation of a motor with over 5% unbalance is not recommended for it probably results in motor damage.

Unbalanced voltages at motor terminals cause phase current unbalance ranging from 6 to 10 times the percent of 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 rated speed.

### 6.1.3 MCC&LRA

Model	Start current LRA ( $\Delta$ start/Y start)	Max. operation current MCC (A)
LT-S-20/10	420/140	105
LT-S-30/12	620/206	160
LT-S-45/20	810/270	200
LT-S-55/25	875/292	240
LT-S-65/32	1430/477	285
LT-S-83/41	1430/477	360

Model	Start current LRA (△start/Y start)	Max. operation current MCC (A)
LT-S-20/10-L	880/294	140
LT-S-45/20-L	1675/558	260
LT-S-55/25-L	1675/558	310
LT-S-65/32-L	2625/875	365
LT-S-83/41-L	2625/875	465

Table 6-1. MCC&amp;LRA

- 1) Above data is based on 380V, 50Hz power supply.
- 2) The LRA&MCC data above has nothing to do with the refrigerant or working condition.

**Terminal coverplate**

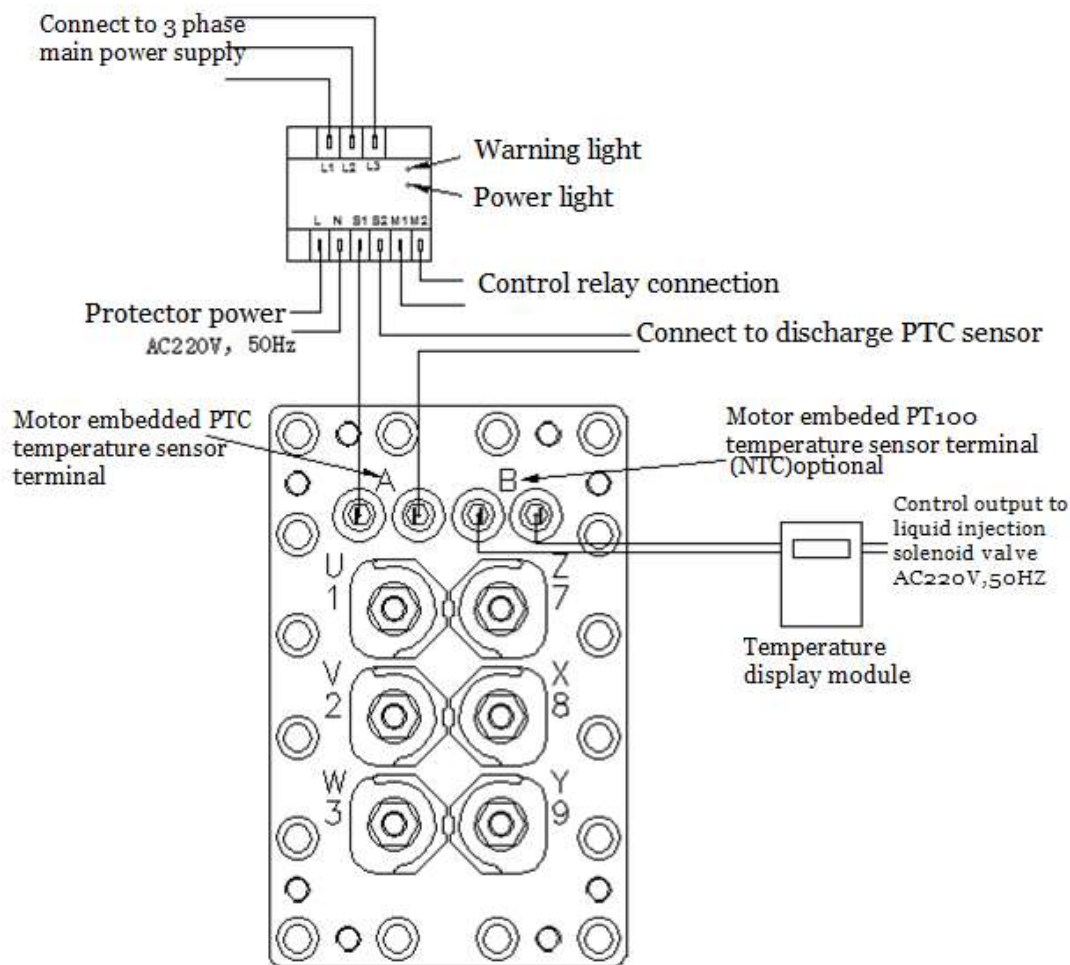


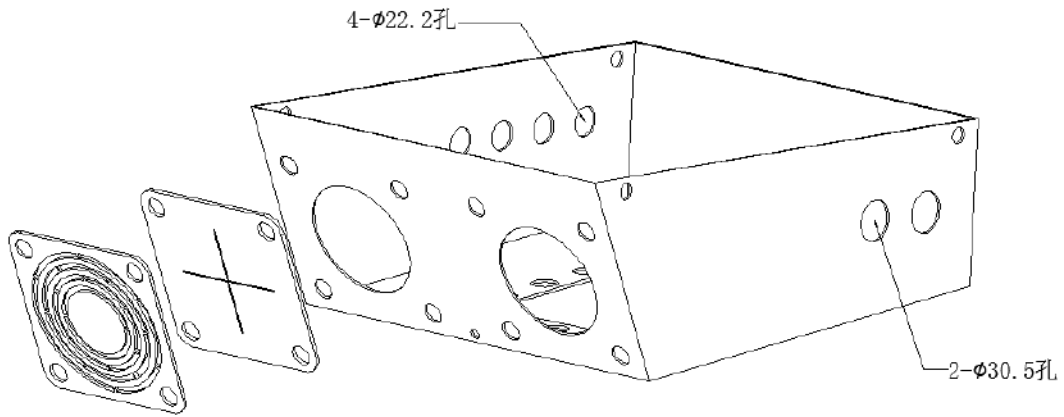
Figure 6-3. Terminal cover plate graph

Fig 6-2.Nuts specification for bolts on terminal cover plate

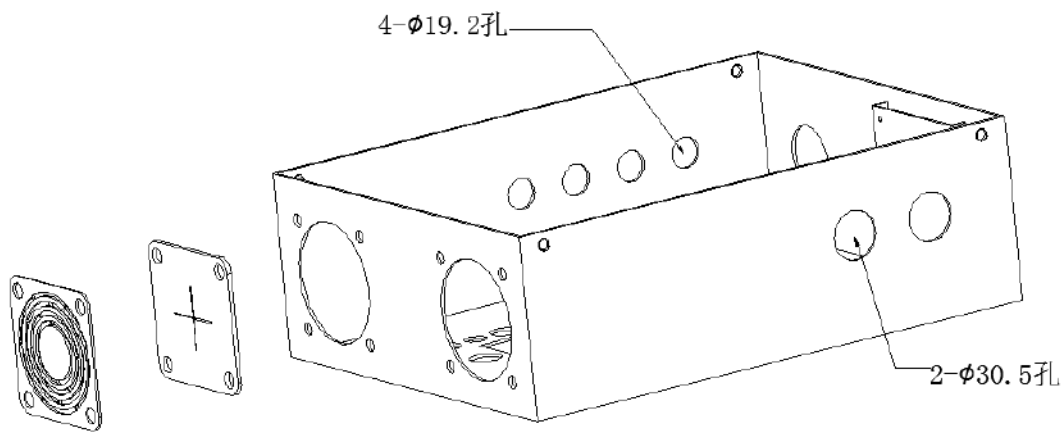
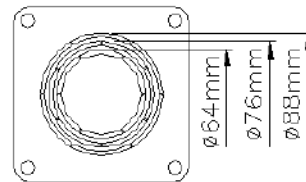
Model	Specification	Torque (N.m)
LT-S-20/10	M12 NUT	35
LT-S-30/12	M12 NUT	35
LT-S-45/20	M12 NUT	35
LT-S-55/25	M12 NUT	35
LT-S-65/32	M12 NUT	35
LT-S-83/41	M12 NUT	35
LT-S-20/10-L	M12 NUT	35
LT-S-45/20-L	M16 NUT	50
LT-S-55/25-L	M16 NUT	50
LT-S-65/32-L	M16 NUT	50
LT-S-83/41-L	M16 NUT	50

**Terminal box**

An IP54 terminal box is provided as standard accessory. Please refer to below graphs for dimensions.



- LT-45/20
- LT-55/25
- LT-65/32
- LT-83/41



- LT-20/10
- LT-30/12

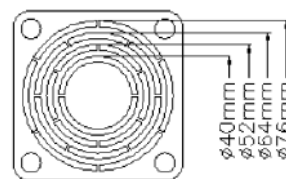


Figure 6-4. Terminal Box Dimension

## 7. Compressor Installation

### 7.1 Open compressor wooden crate

Upon receiving the compressor, please check if the crate is intact, and compressor is in good condition. Please also check accessories and documents to be consistent with order.

⚠ Caution: compressor is charged with 0.5~1bar of nitrogen before delivery. Please release the interior pressure before dismantling any parts on compressor.

### 7.2 Compressor Lifting

When lifting the compressor, it is recommended to use a steel chain or steel cable. Make sure that chains, cables or other lifting equipments are properly positioned as shown in Figure 7-1 to protect the compressor and its accessories from damaging. Keep the compressor in horizontal position when lifting, and prevent it from crashing, falling on the ground, hitting the wall or any other accident that may damage it or its accessories.

⚠ Caution:

- 1) Please ensure the steel cable weight load is sufficient.
- 2) Check the steel cable and hook before lifting, making sure there is no deform or crack to avoid accident.
- 3) Ensure sufficient space for lifting.

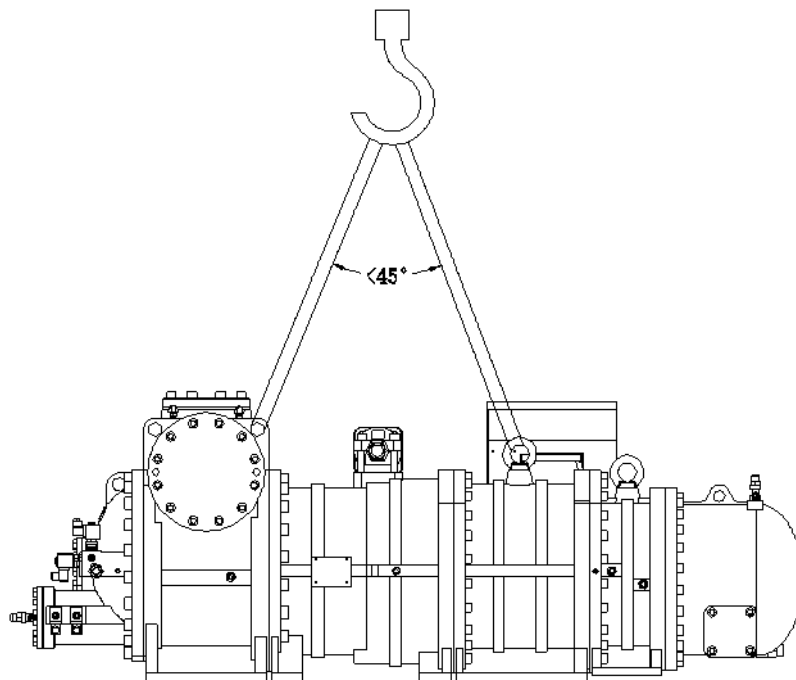


Figure 7-1.Compressor Lifting

### 7.3 Compressor installation

The installation of the compressor in the refrigeration system should be accessible and make sure that the compressor is away 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. It is necessary to keep good ventilation and low humidity condition in the site. Make sure that the frame or support is strong enough to prevent excessive vibration and noise while the compressor is running and must reserve enough space for compressors' future maintenance work.

Compressor should be installed horizontally. Meanwhile, it is recommended to install mounting pad to avoid the compressor from delivering vibrations to the piping.

The compressor anchor holes (NO.1~4) are chosen as in figure 7-2&7-3.

#### 1) LT-65/32&LT-83/41

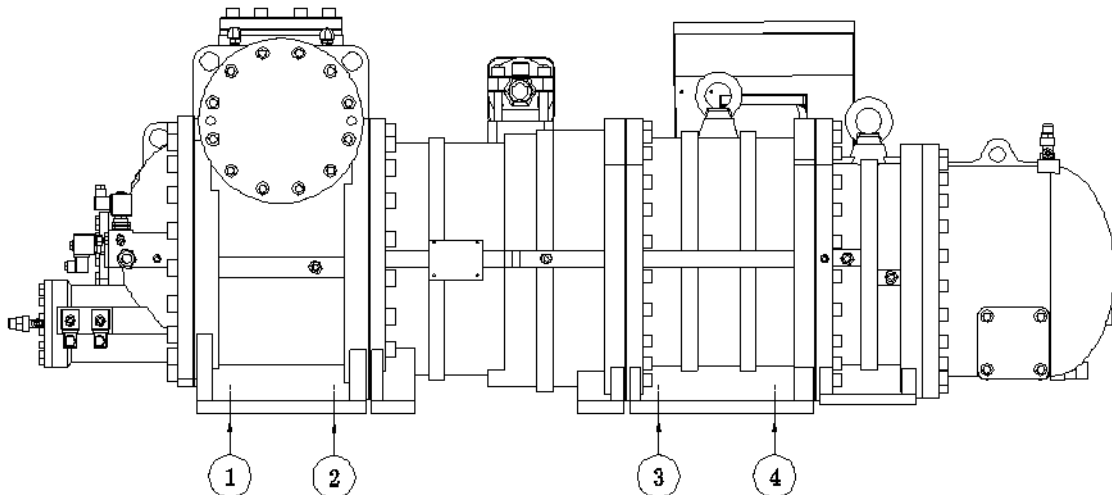


Figure 7-2.LT-83/41&LT-65/32anchor hole

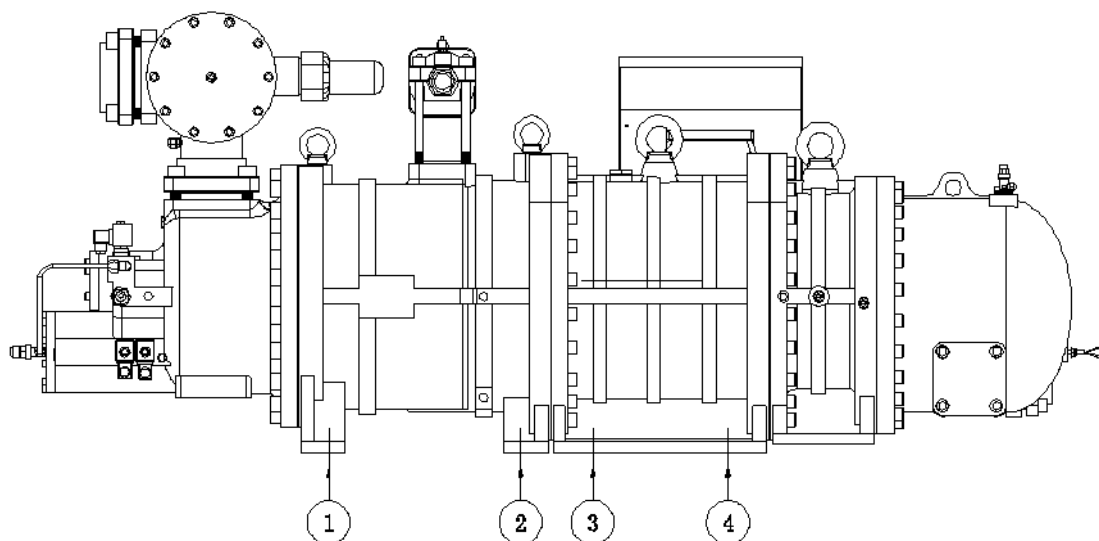
**2) LT-45/20&LT-55/25**

Figure 7-3.LT-45/20&amp;LT-55/25 anchor holes

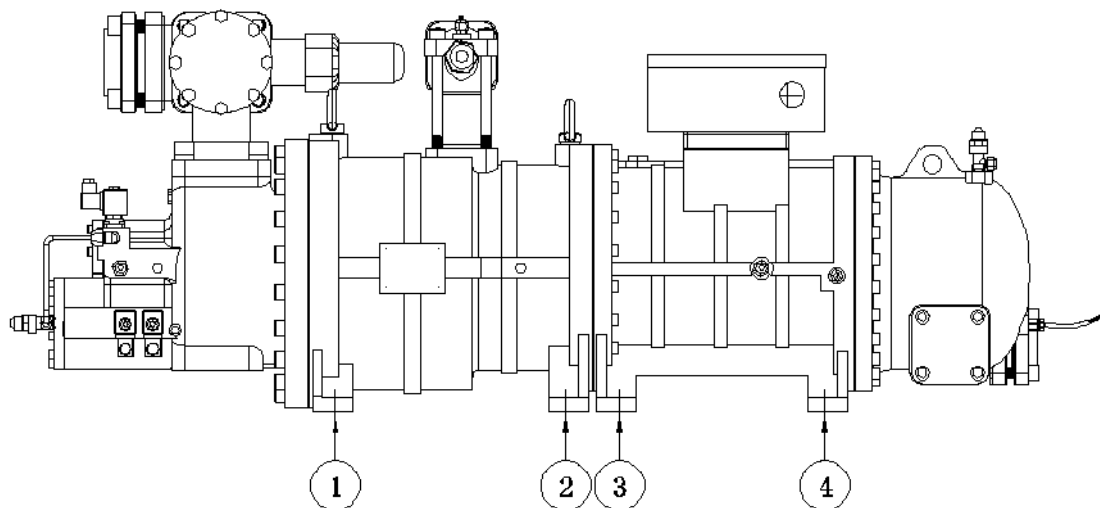
**3) LT-20/10&LT-30/12**

Figure 7-4. LT-20/10&amp;30/12 anchor holes

## 8. Operation and Maintenance

### 8.1 Compressor commissioning check

#### 1.1.1 Check list before Start

Items	Main points to check	Standard States
1.Compressor and accessories	1. Oil level of external oil separator; 2.Oil temperature; 3.Open stop valves; 4.Open motor liquid injection port (angle valve); 5.Open oil hydraulic cylinder angle valves; 6.Open external oil circuit valves;	1.High oil level is full; 2. Before start up, heat up the oil to around 40°C/Heating time is around 8Hrs ; 3. Open caps of stop valves to check; 4. Open caps of motor injection angle valves to check; 5. Open caps of oil hydraulic cylinder angle to check; 6. Open caps of external oil circuit valves to check
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' terminals connection 5. Grounded 6. Setting of switches, sensors and controllers	1. 10% Main power voltage fluctuation range within $\pm 5\%$ . Instant voltage drop during start up is less than 10% ; 2. Voltage of auxiliary power is 220V $\pm 10\%$ , other requirements please contact Hanbell; 3. Resistance value should exceed 50M $\Omega$ ; 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. Installation confirmation 6. Refer to Electrical Control
3. Piping system	1. Check the pipes are well fixed 2. Check if there is any leakage	1. Visual check or manual check 2. Use leak detector or soap water to check , especially on connections and welding junctions.
4. Protection devices	1. Coil temperature protection 2. Discharge temperature protection 3. Oil level switch 4. PT100motor temperature sensor	1. No action (close circuit) 2. No action (close circuit) 3. Oil is full (close circuit) 4. Same or close to environment temperature



### 8.1.2 Check list during operation

- 1) Start up compressor for 0.5~1 second. Confirm the rotation direction through monitoring suction and discharge pressure.(correct rotation direction: suction pressure goes down and discharge pressure goes up at the same time)
- 2) Check if the lubricant of the oil sight glass on external oil line is full after start up. In case of abnormal, please check pressure differential between high and medium pressure (oil pressure differential supply), oil filter and oil line solenoid valve.
- 3) There will be some oil foams in the oil separator during start up but only in a short time. When working under rated working condition, the foam will disappear. Otherwise it means the system is without sufficient oil or there is oil carryover problem.
- 4) The operating conditions of the compressor should be adjusted in the following ways: R404A exhaust temperature should be higher than 15K condensation temperature, R22 exhaust temperature should be higher than 25K condensation temperature;
- 5) The whole system should pass vibration test, especially the piping. If there is abnormal vibration and noise from compressor, please contact HANBELL.
- 6) Below items need to be checked every day, when compressor is operating in a long time: Compressor running data such as 3 phase voltage, current, etc. Oil temperature, oil level, all the sensors, wiring junctions, and oil line sight glass.
- 7) When condensing unit operates in job site, we should be aware of its complementary devices and the maintenance schedule after first commissioning.
- 8) To keep the lubricant viscosity normal at low ambient temperature and to ensure the function of bearing lubrication, it is suggested to keep the oil heater in the external oil separator “on” after compressor is turned off. This is to prepare for the next start up.
- 9) In the running state of the compressor, the liquid supply valve shall not be closed for evacuation.

## 8.2 rouble shooting table

Faults	Possible cause
Motor temperature sensor trip	<ol style="list-style-type: none"> <li>1. Motor over load, liquid injection solenoid valve fault</li> <li>2. Coil protection switch fault</li> <li>3. Electrical system fault</li> <li>4. Poor motor coil, temperature too high</li> <li>5. Motor cooling expansion valve failure</li> </ol>
Poor motor insulation	<ol style="list-style-type: none"> <li>1. Motor connector wet dew</li> <li>2. Bad motor</li> <li>3. Poor motor terminal</li> <li>4. Poor insulation of electromagnetic contactor</li> <li>5. Acid in the system deteriorates the insulation</li> <li>6. Long term running at high temperature cause motor insulation deterioration</li> <li>7. Frequent start up, coil deterioration</li> <li>8. Too much water content in the refrigerant.</li> </ol>
Motor fail to start up or switch	<ol style="list-style-type: none"> <li>1. Inlet solenoid valve failure, which leads to compressor start up at full load</li> <li>2. Voltage too low or wrong</li> <li>3. excessive voltage drop during start up, electromagnet contactors fail to be adsorbed</li> <li>4. Motor failure</li> <li>5. Phase loss or phase reverse</li> <li>6. Motor protection switch is energized</li> <li>7. Wrong connection of motor terminals</li> <li>8. Timer of Y-<math>\Delta</math> starting malfunctions</li> <li>9. Overcurrent setting too small or air switch selection selection inappropriate</li> <li>10. Poor contact of electromagnet contactors</li> </ol>
Abnormal vibration or noise	<ol style="list-style-type: none"> <li>1. Bearing damage</li> <li>2. Liquid compression</li> <li>3. Friction between the rotors and the shells of the air end.</li> <li>4. Poor lubrication effect due to oil loss.</li> <li>5. Inner parts loose</li> </ol>

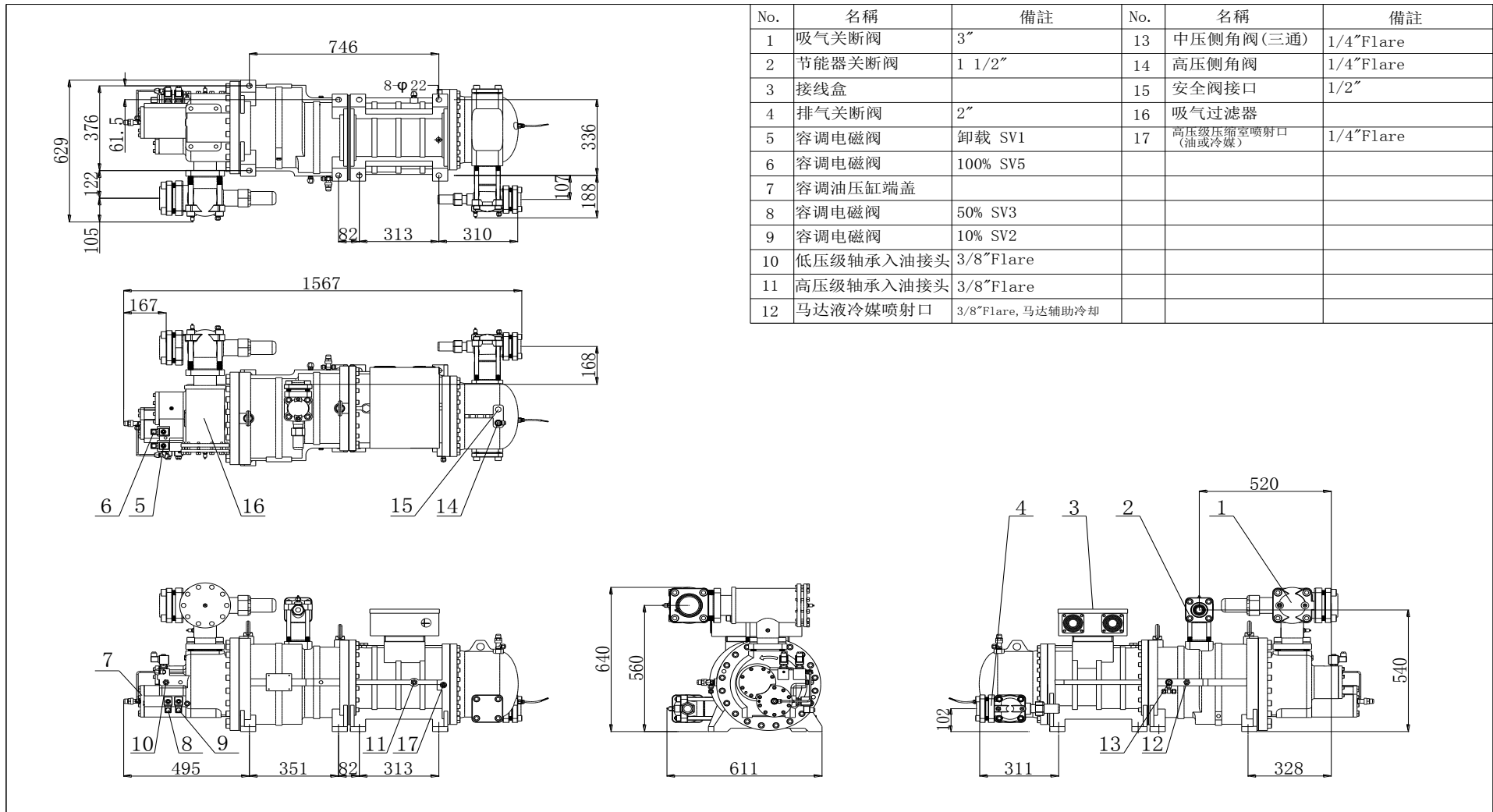
	<ol style="list-style-type: none"> <li>6. Poor piping causing resonance</li> <li>7. Foreign objects enter the compression chamber.</li> </ol>
Reverse time of the rotor is too long	<ol style="list-style-type: none"> <li>1. Stop action is not set in control logic</li> <li>2. Suction check valve stuck, fail to be closed</li> </ol>
Discharge temperature too high	<ol style="list-style-type: none"> <li>1. Suction superheat too high (insufficient refrigerant, expansion valve malfunction)</li> <li>2. High pressure too high (poor cooling effect, air goes into the system, cooling water temperature too high, insufficient cooling water flow, poor heat exchange of the condenser)</li> <li>3. Compression ratio over high &amp; no auxiliary cooling</li> <li>4. Bearing damage &amp; rotor friction</li> <li>5. Oil leakage or oil level too low</li> <li>6. Suction check valve piston suck and fail to open</li> </ol>
System low pressure alarm	<ol style="list-style-type: none"> <li>1. Insufficient refrigerant</li> <li>2. Evaporator frosts seriously and it affects heat exchange</li> <li>3. Opening of the expansion valve too small; temperature sensor failure</li> <li>4. Suction filter is blocked by ice or debris</li> <li>5. Capacity of evaporator is too small</li> <li>6. Wrong setting of the low pressure protection</li> </ol>
System high pressure alarm	<ol style="list-style-type: none"> <li>1. Excessive re frigerant</li> <li>2. Condenser blocked or air goes into it, causing poor heat exchange</li> <li>3. Discharge temperature too high</li> <li>4. Expansion valve blocked by ice or debris</li> <li>5. Capacity of evaporator is too small</li> <li>6. Wrong setting of the high pressure protection</li> </ol>
Oil flow alarm	<ol style="list-style-type: none"> <li>1. Oil flow switch failure</li> <li>2. Condensing pressure fails to be established, causing insufficient oil supply pressure differential</li> <li>3. Oil line blocked</li> <li>4. Oil line solenoid valve failure</li> </ol>
Discharge temperature too low	<ol style="list-style-type: none"> <li>1. Liquid compression</li> <li>2. Temperature of returned oil is too low</li> <li>3. The opening of expansion valve on liquid line is too large</li> </ol>

	4. The opening of ECO expansion valve is too large
Oil carry over	1. Discharge temperature too low 2. Oil filter failure 3. Oil temperature of the oil separator too low(Oil heater not switched on before operation) 4. Liquid compression 5. The opening of ECO expansion valve is too large

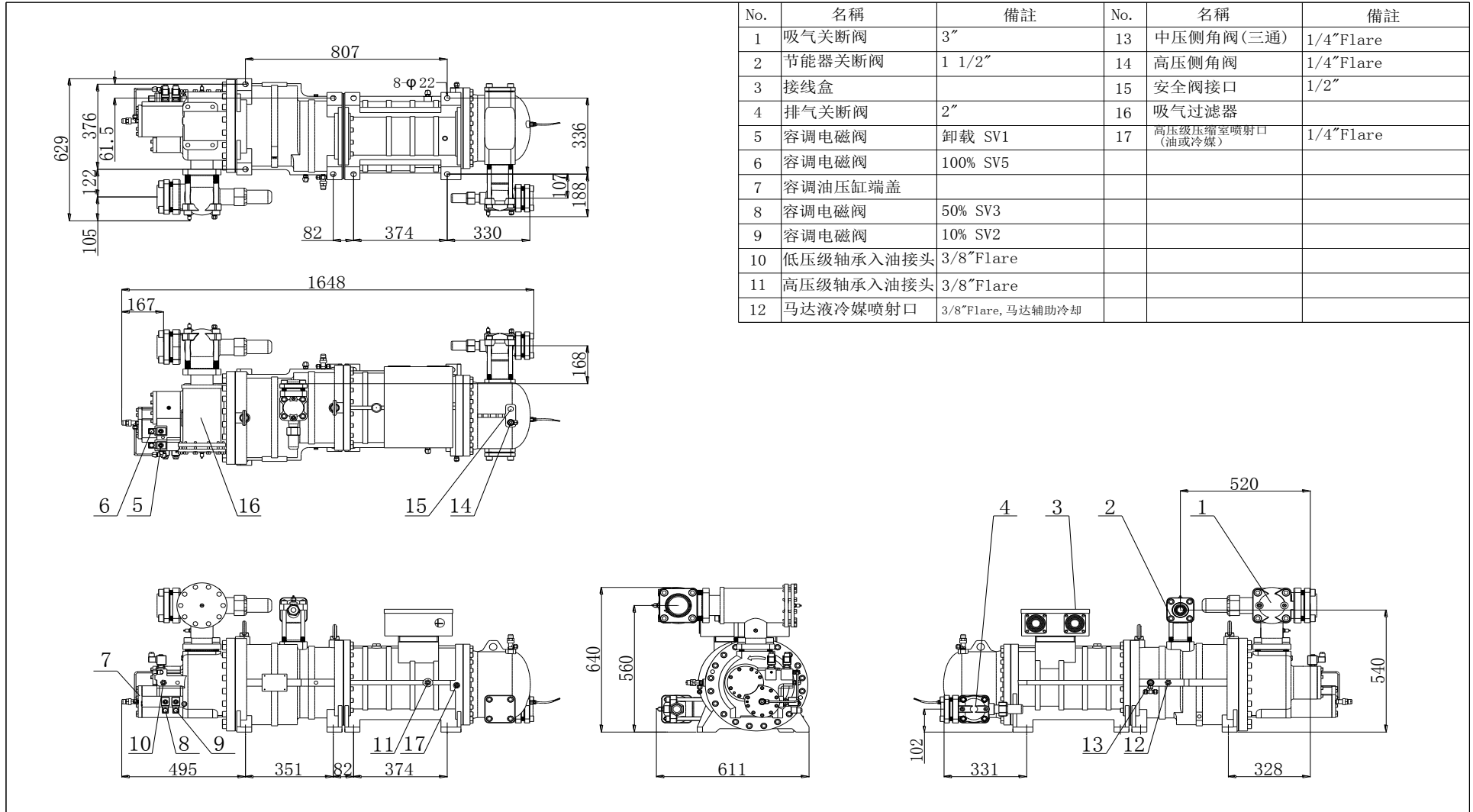
Table 8-2. Trouble shooting

## 9. Dimensions

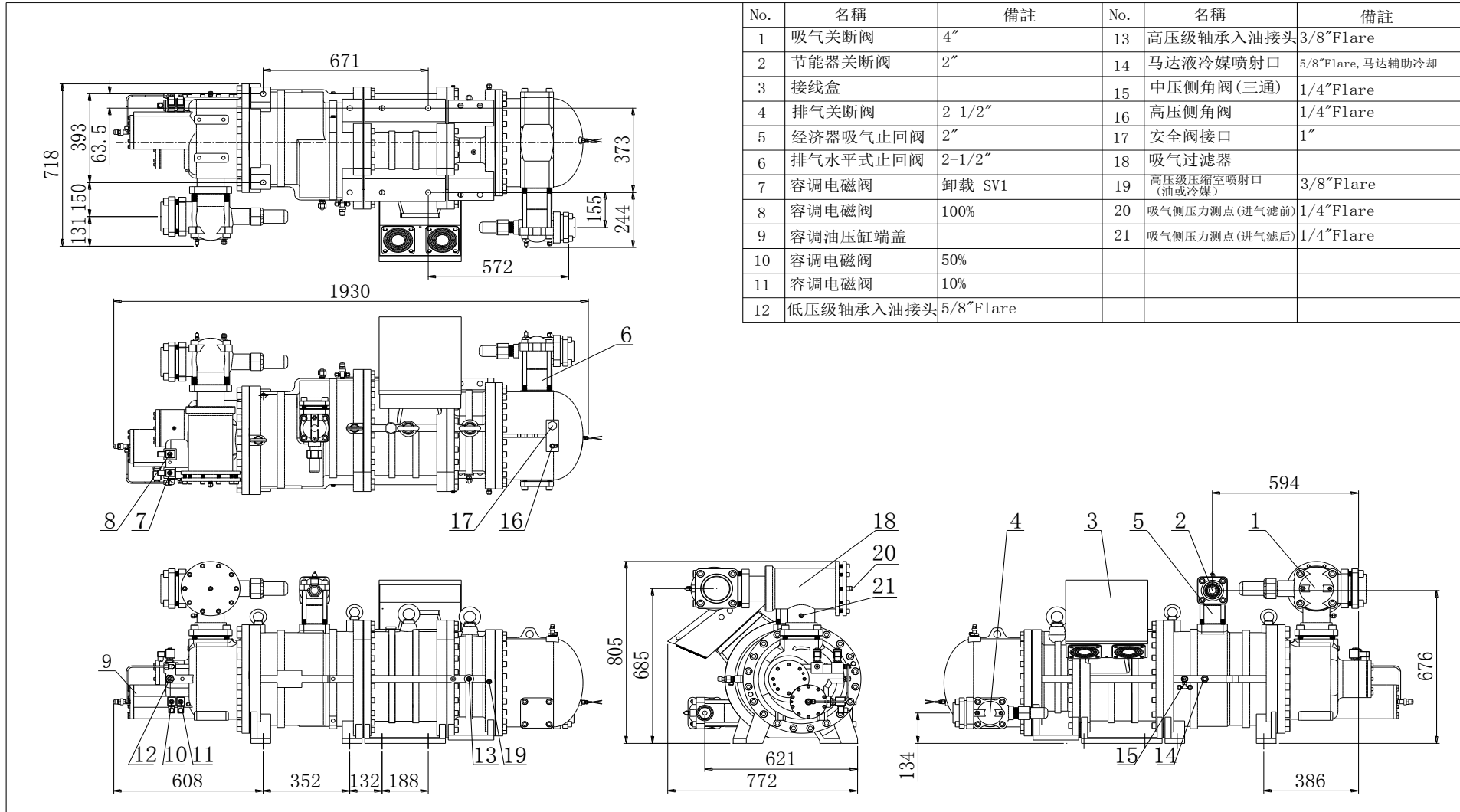
### 9.1 LT-S-20/10 Drawing



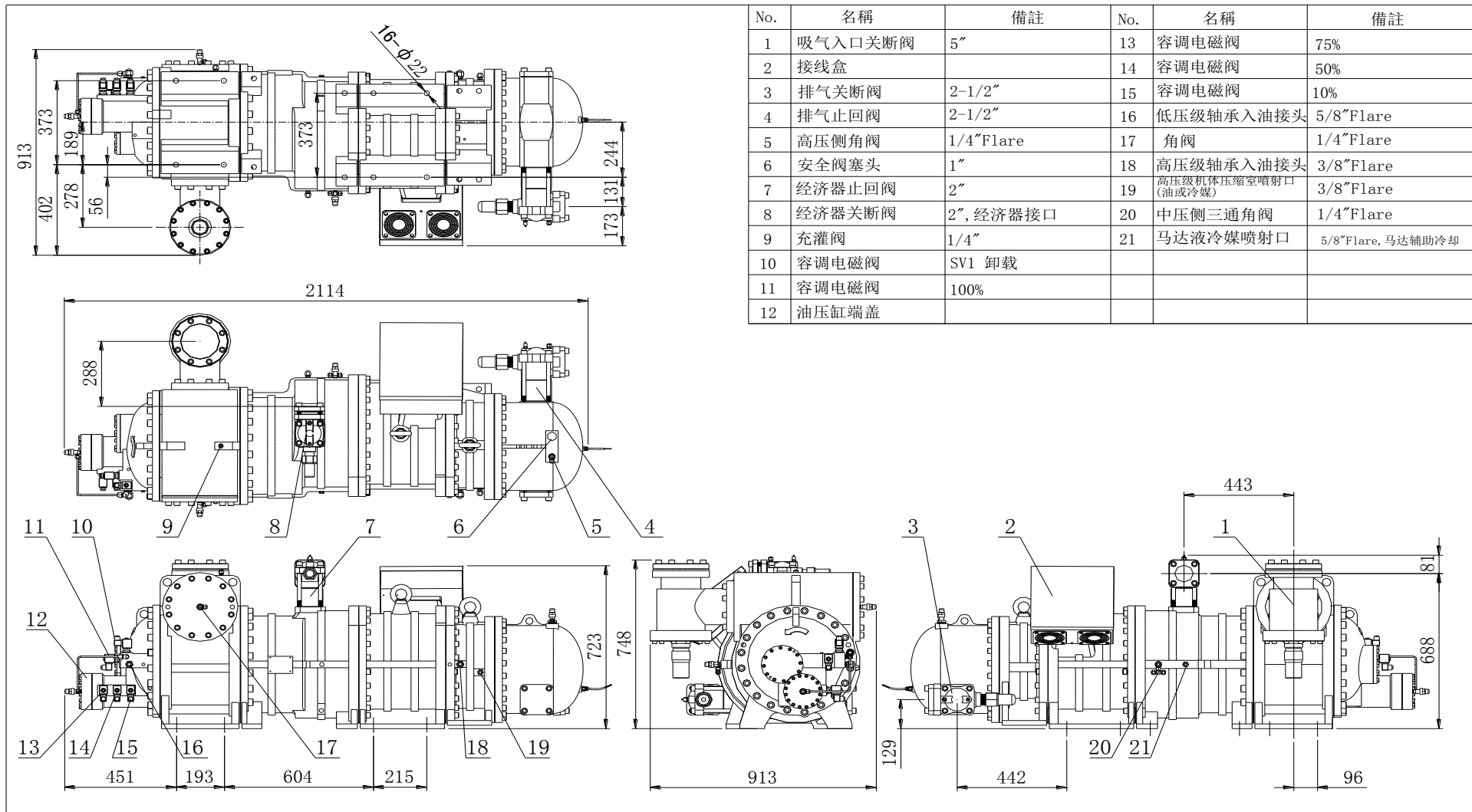
## 9.2 LT-S-30/12 Drawing



9.3 LT-S-45/20&LT-S-55/25 Drawing

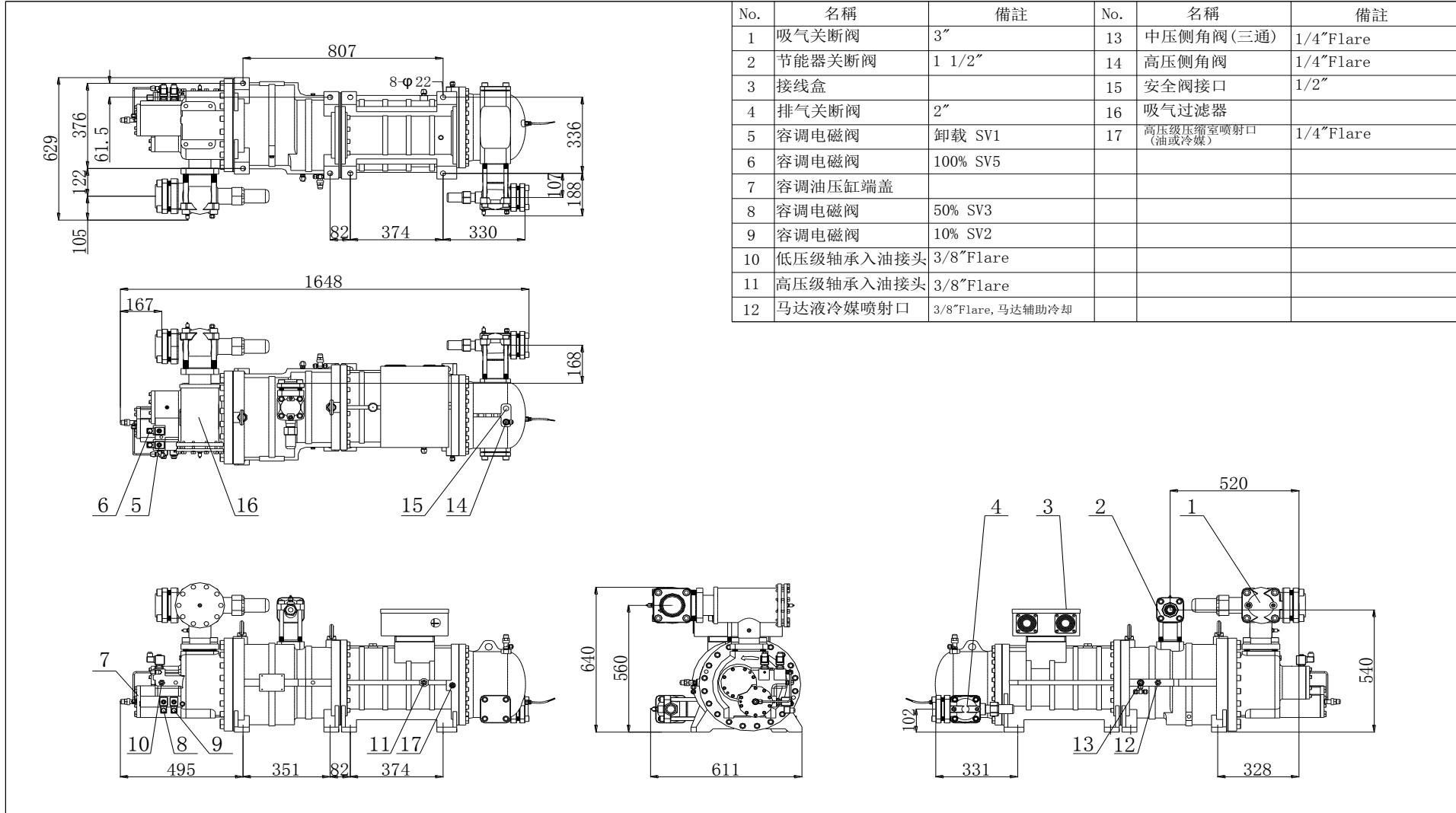


### 9.4 LT-S-65/32&LT-S-83/41 Drawing

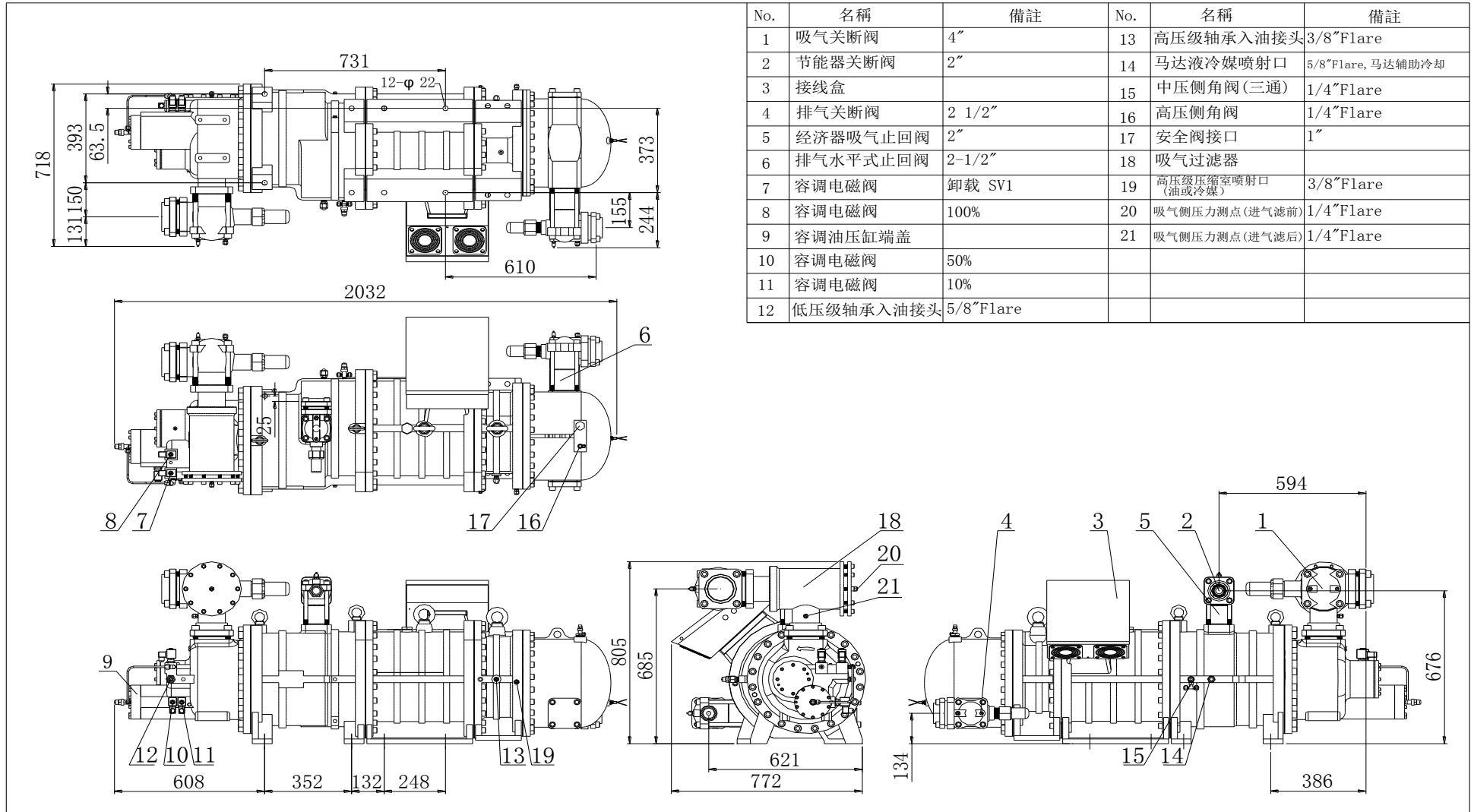




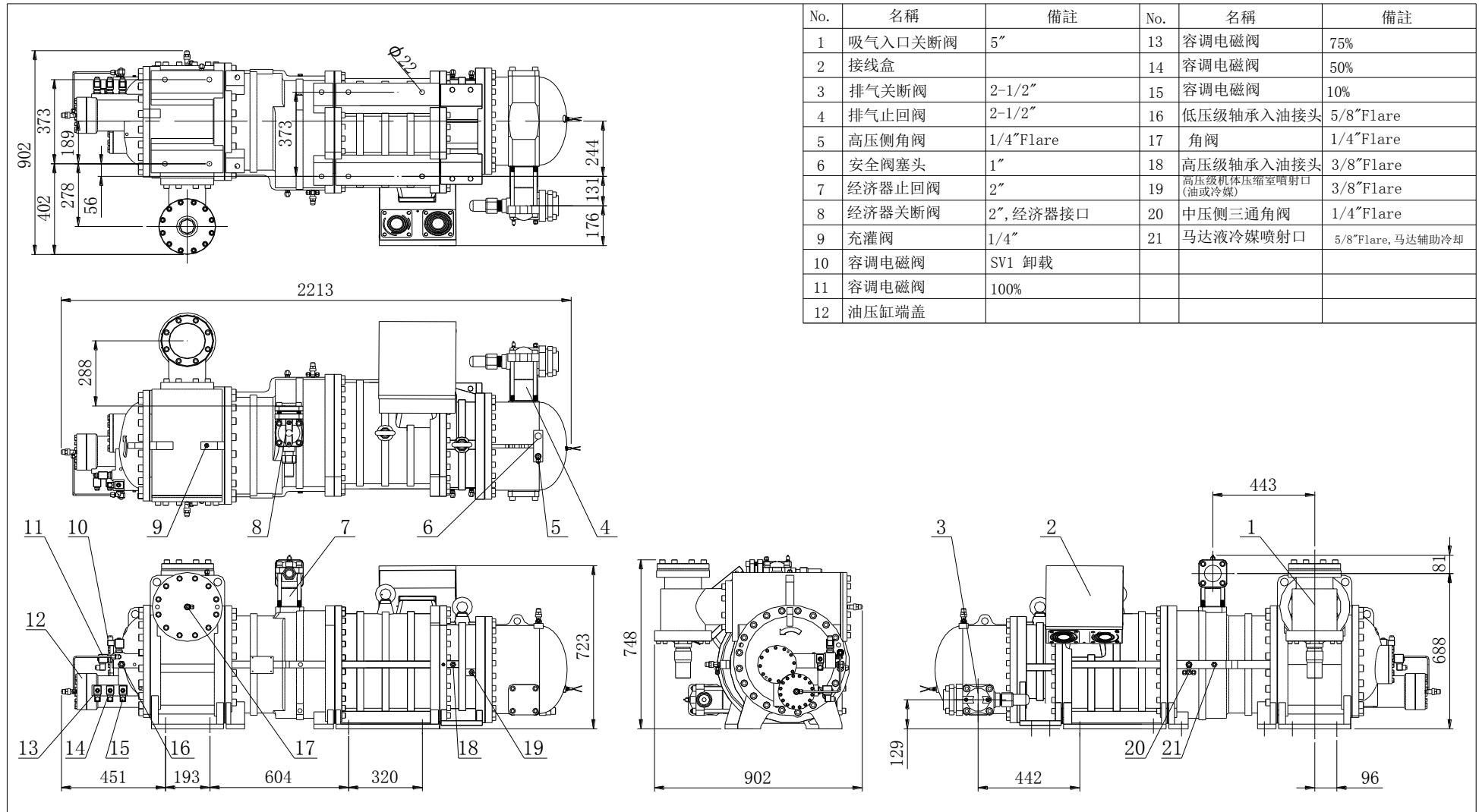
9.5 LT-S-20/10-L Drawing



### 9.6 LT-S-45/20 & LT-S-55/25-L Drawing



### 9.7 LT-S-65/32 & LT-S-83/41-L Drawing



## 10. Accessories

In order to provide customers with an overall solution, HANBELL design standard accessories and optional accessories according to different application requirements to ensure that the compressor can be safe, stable operation, and achieve the highest efficiency.

### 10.1 Accessory List

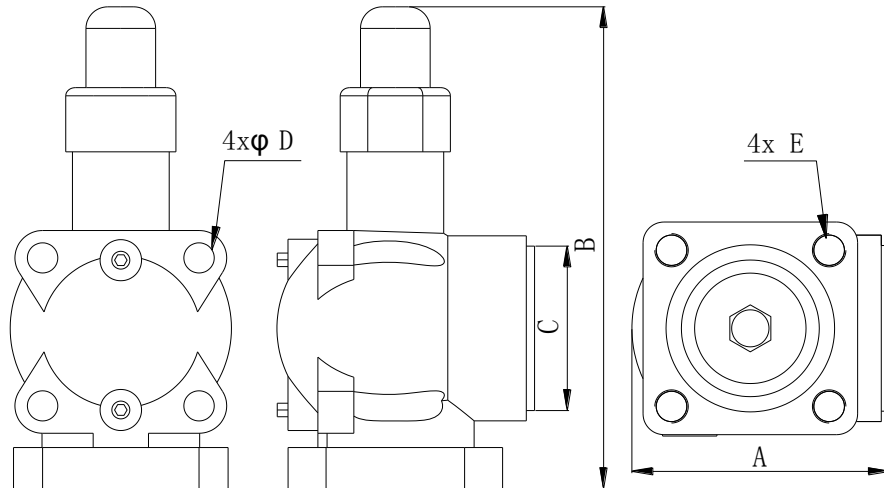
LT Accessory List-LT Series			●	Standard
			△	Optional
No	Description	Qty	Compound	In parallel
1.	Protection module	1	●	●
2.	Suction shut-off valve	1	●	●
3.	Discharge shut-off valve	1	●	●
4.	ECO shut-off valve	1	●	●
5.	Suction tube	1	●	●
6.	Discharge tube	1	●	●
7.	ECO tube	1	●	●
8.	Discharge check valve	1	●	●
9.	ECO check valve	1	●	●
10.	Intake filter (suction)	1	●	●
11.	Intake filter(medium pressure)	1	●	●
12.	External oil filter	1	●	●
13.	Pressure differential switch(manual reset)	1	●	●
14.	Mounting pad	8	●	●
15.	Minimum pressure valve	1	●	●
16.	Oil Flow switch	1	●	●
17.	Hanbell lubricant	1	△	△
18.	Solenoid valve oil circuit	1	△	△
19.	Oil heater 300W	1	△	△
20.	Oil level switch	1	△	△

★Note :The standard quantity of minimum pressure valve for compound and compressor in parallel is one. Please refer to Table 5-1 Minimum Pressure Valve Configuration Compound & Parallel Connection

## 10.2 Accessory for gas refrigerant line

### 10.2.1 Shut-off valve

For easy maintenance and repair, it is suggested to install suction, discharge and economizer shut-off valve. Dimension and specification are shown below.



10-1. Shut-off valve graph

Specification	Dimension				
	A	B	φC	φD	F
1-1/2"	115	263	75	18	M16X2
2"	131	284	90	18	M16X2
2-1/2"	147	289	110	18	M16X2
3"	177	351	120	22	M20X2.5
4"	209	407	145	22	M20X2.5

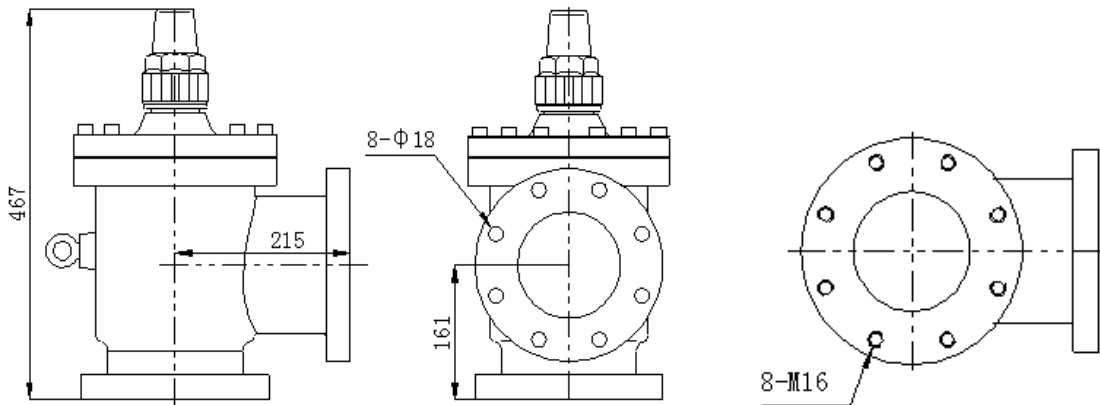


Figure 10-2. 5" Suction shut-off valve

**\* Specification of shut-off valve**

Model	Size		
	Suction	Discharge	Economizer
LT-20/10	3"	2"	1 1/2"
LT-30/12	3"	2"	1 1/2"
LT-45/20	4"	2 1/2"	2"
LT-55/25	4"	2 1/2"	2"
LT-65/32	5"	2 1/2"	2"
LT-83/41	5"	2 1/2"	2"

**10.2.2 Tube**

LT Standard specification for the tubes of LT series compressor

Model	Discharge flange tube standard		Suction flange tube standard		Economizer flange tube standard	
	Steel	Copper	Steel	Copper	Steel	Copper
	LT-20/10	2	2 1/8"	3	3 1/8"	1 1/2
LT-30/12	2	2 1/8"	3	3 1/8"	1 1/2	1 5/8"
LT-45/20	2 1/2	2 5/8"	4	3 5/8"	2	2 1/8"
LT-55/25	2 1/2	2 5/8"	4	3 5/8"	2	2 1/8"
LT-65/32	2 1/2	2 5/8"	5	4 1/8"	2	2 1/8"
LT-83/41	2 1/2	2 5/8"	5	4 1/8"	2	2 1/8"

★Note: Above table lists the standard flange tube size of Hanbell LT series compressors. Their size specifications are shown in the table below. If the specification of the flange tube is not specified in order, Hanbell will provide standard flange tube as written in above table.

If non-standard flange bushing is required, please contacts Hanbell sales representative when purchasing the compressor.

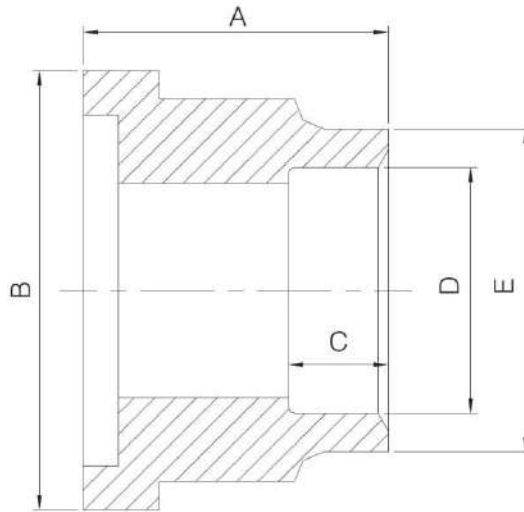
**LT Series tube size and specification**


Figure 10-3. Tube

Model	Location	Diameter and material		Dimension				
				A	B	C	D	E
LT-20/10 LT-30/12	Discharge	Copper	2 1/8"	50	90	30	55	65
		Steel	2"				61.3	74
	Suction	Copper	3 1/8"	66	120	45	80.5	90
		Steel	3"				90.2	103
	Economizer	Copper	1 5/8"	52	75	35	42	52
		Steel	1 1/2"				49.3	64
LT-45/20 LT-55/25	Discharge	Copper	2 5/8"	60	110	35	68	77
		Steel	2 1/2"				77	90
	Suction	Copper	3 5/8"	76	145	50	93	103
		Steel	4"				110	128
	Economizer	Copper	2 1/8"	50	90	30	55	65
		Steel	2"				61.3	74
LT-83/41 LT-65/32	Discharge	Copper	2 5/8"	60	110	35	68	77
		Steel	2 1/2"				77	90
	Suction	Copper	4 1/8"	80	174	35	106	121
		Steel	5"	75			135	154
	Economizer	Copper	2 1/8"	50	90	30	55	65
		Steel	2"				61.3	74

### 10.2.3 Check valve

Hanbell configured for the LT series models of the exhaust valve is horizontal. When the compressor is stopped, the teflon valve will automatically close the valve by the drive of the internal spring to block the reverse flow of the high-pressure airflow, thus greatly reducing the compressor reversal time and protecting the compressor.

#### 1) Economizer check valve (Horizontal type)

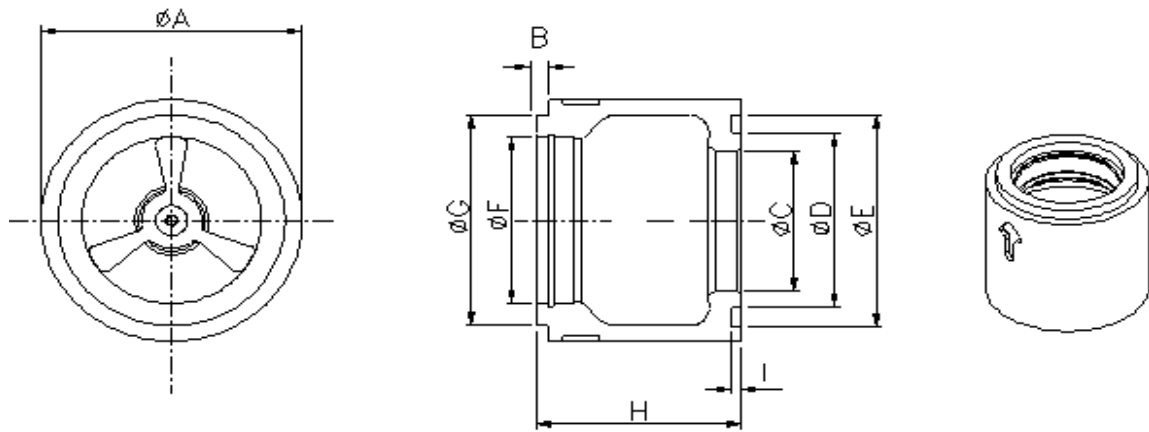


Figure 10-4.Economizer check valve

Size	UOM: mm								
	A	B	C	D	E	F	G	H	I
2"	102	6	53	69	91	65	90	85	5
2 1/2"	122	6	69	89	111	85	110	97	5
3"	138	6	80	99	121	95	120	108	5
4"	163	6	96	124	146	120	145	123	5



## 2) Discharge check valve (horizontal type)

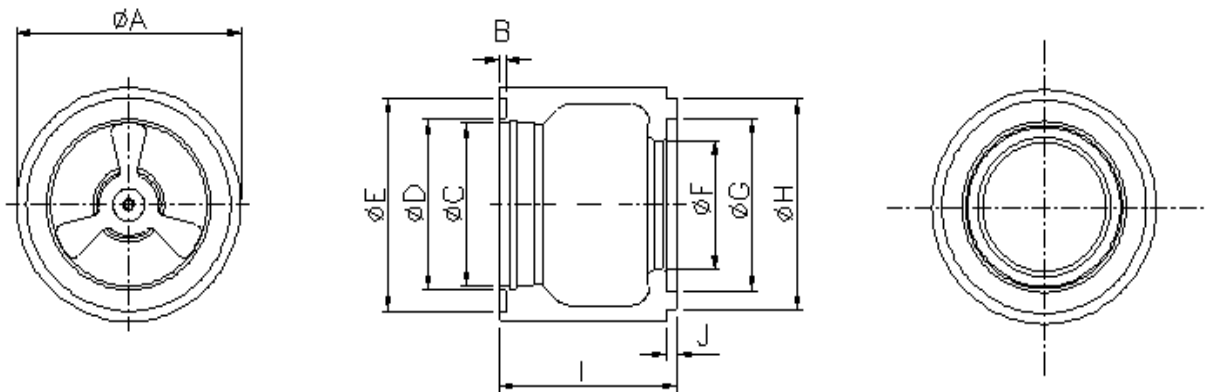


Figure 10-5. Discharge check valve

Size	UOM: mm									
	A	B	C	D	E	F	G	H	I	J
1 1/2"	86	4	55	59	76	42	60	75	80.5	6
2"	102	4	65	69	91	53	70	90	85	6
2 1/2"	122	4	85	89	111	67	90	110	97	6
3"	138	4	95	99	121	80	100	120	108	6
4"	163	4	120	124	146	96	125	145	123	6
6"	238	5	190	195	216	146	190	215	160	6

★Note: the size of the check valve is same to that of the shut-off valve. Refer to 10.2.1

### 10.2.4 Minimum pressure valve

The minimum pressure valve can make the compressor quickly establish enough high and low pressure difference in a short time once the compressor starts. When the compressor starts running, the minimum pressure valve ensures the internal oil supply pressure of the compressor. Thus, the compressor capacity adjustment and loading is smooth, so it's especially suitable for the air-cooled heat pump and the compressor which has insufficient supply pressure differential caused by the seasonal reasons. The minimum pressure valve also has a check valve's function, When the compressor stops, the minimum pressure valve will quickly cut off the compressor's connection to the exhaust pipe to prevent the high pressure gas flow back into the compressor, so as to avoid the long-term reversal of the compressor effectively.

★Note: Please refer to 5.1.3 and Figure 5-4 for the installation of the minimum pressure valve.

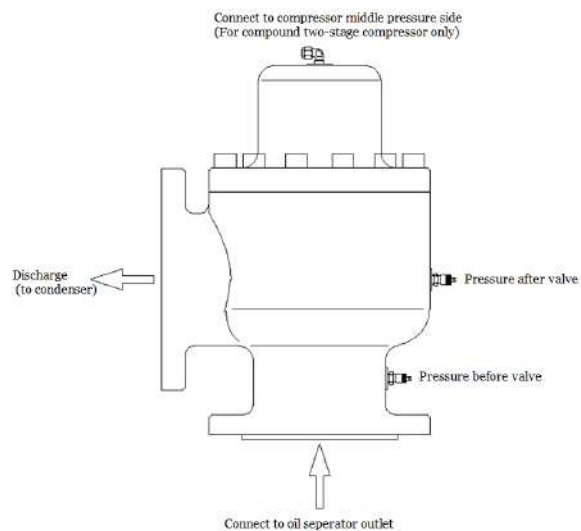
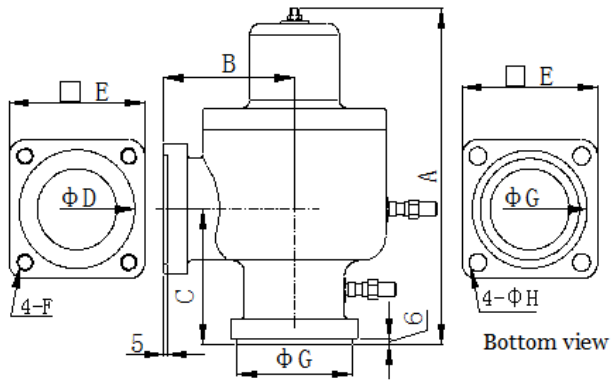


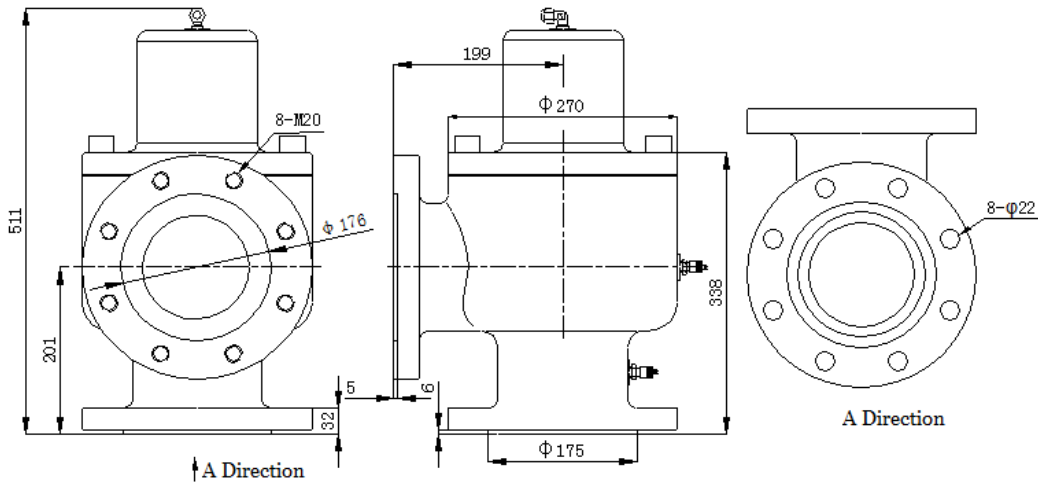
Figure 10-6. Minimum Pressure Valve

Tech data Specification	Pressure differential during start process	Temperature range	Pressure loss
1.5"	3.6±0.3Bar	<120℃	<0.1Bar
2"			
2.5"			
3"			
4"			
5"			
6"			

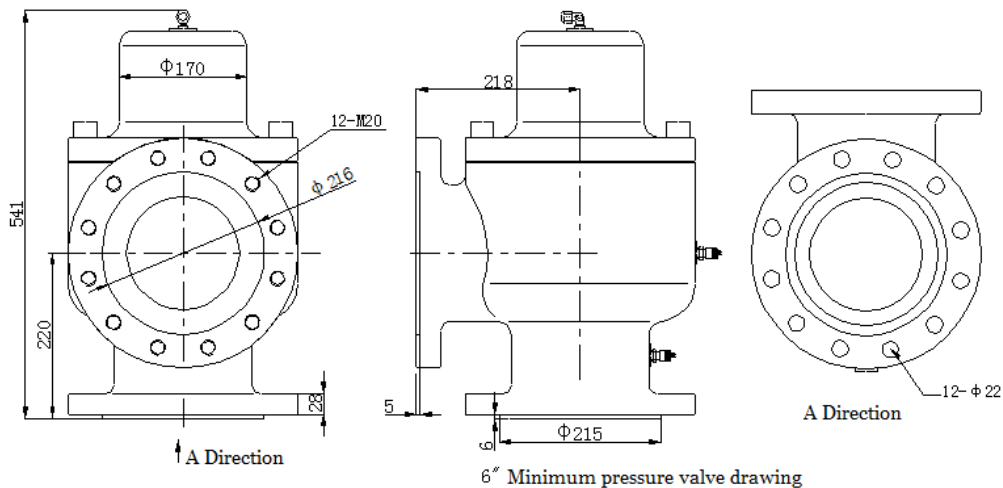


SIZE	A	B	C	D	E	F	G	H
1.5 inch	235	93	119	76	109	M16	75	18
2 inch	247	105	126	91	122	M16	90	18
2.5 inch	300	110	136	111	134	M16	110	18
3 inch	364	122	156	121	153	M20	120	22
4 inch	413	165	166	146	171	M20	145	22

1.5"~4" Minimum pressure valve drawing



5" Minimum pressure valve drawing



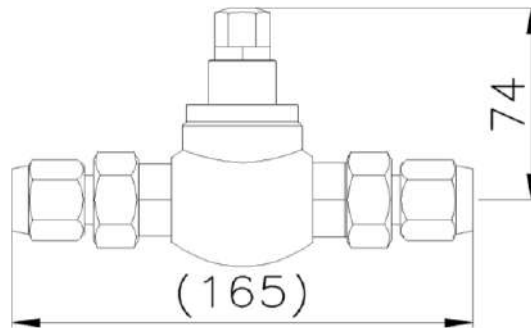
6" Minimum pressure valve drawing

### 10.3 Oil line accessory

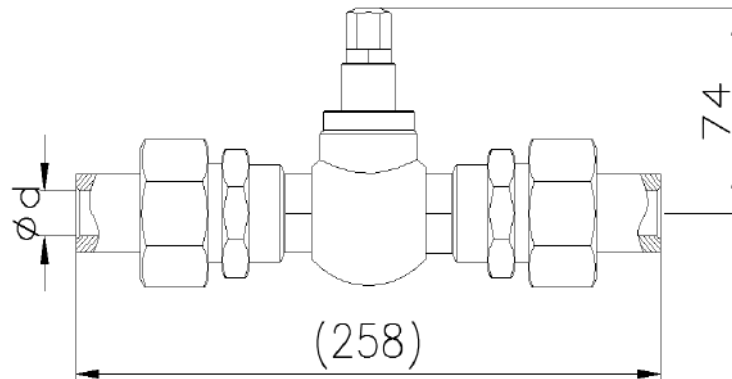
#### 10.3.1 Oil flow switch

An oil flow switch should be installed in the oil returned line if the external oil separator is installed to protect the compressor. The drawing and specification of the oil switch is shown below:

Type	Interface	Dimension		Model
		Thread	Welding (d)	
Type 125	Thread/welding	5/8"	16	LT-20/10
Type 125	Welding	/	22.5	LT-45/20~83/41



Thread Type



Welding Type

Figure 10-7. Oil Flow Switch Drawing

#### Functions

❖ Maximum working pressure 200bar
❖ Maximum working temperature 100°C
❖ Protection grade IP65
❖ Maximum working current 1A
❖ Maximum working voltage 230VAC

### External oil filter

The external oil filter provided by Hanbell is washable. The mesh accuracy is 300 mesh. It's structure and size are as follows:

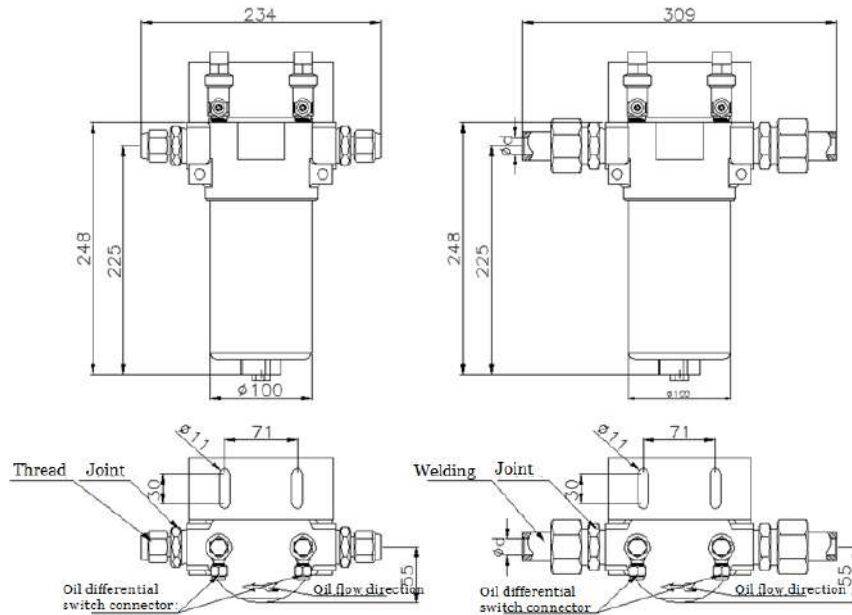


Figure 10-8. External Oil Filter Drawing

Interface	Dimension		Model
	Thread	Welding	
Thread/welding	5/8"	16	LT-20/10
Welding	/	22.5	LT-45/20~83/41

External Oil Filter Specification

### \* External Oil Filter Mounting Bracket Drawing

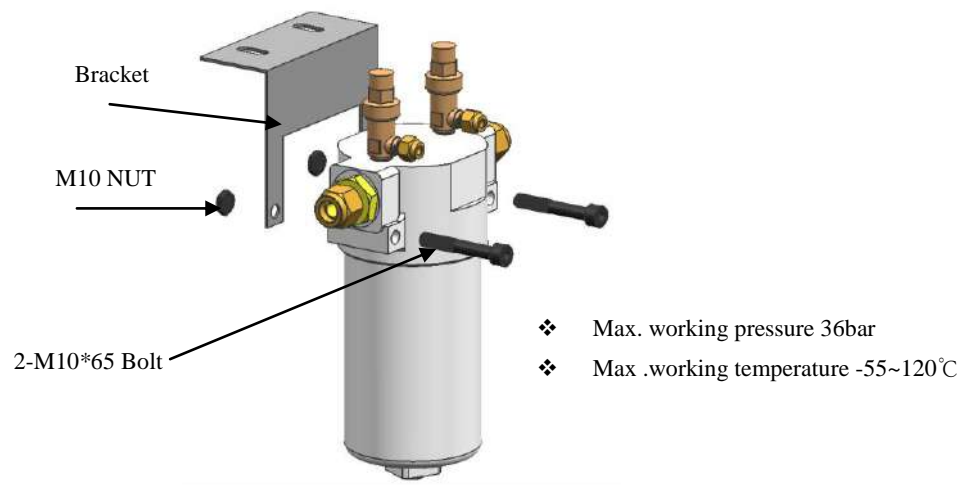
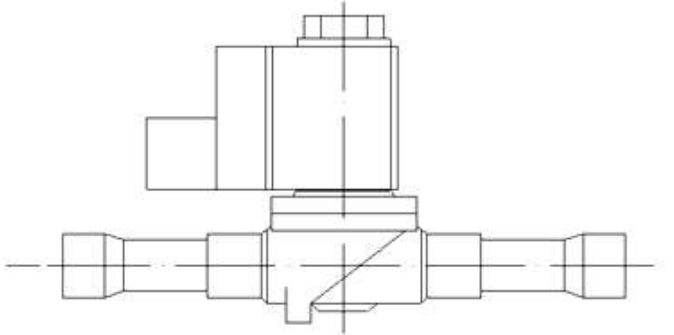


Figure 10-9. External Oil Filter Mounting Bracket

### 10.3.2 Oil Line Solenoid Valve

#### ◇ Oil Line Solenoid Valve



Oil circuit solenoid valve appearance

- ❖ Max. working temperature 105°C
- ❖ Power 220V/ 50HZ

Direction arrow at the bottom



### 10.3.3 Oil Pressure Differential Switch

- \* Function: Detect the pressure drop before and after the oil filter. If the pressure drop exceeds the trip point, the switch will be activated to prevent the excessive debris to be absorbed at the filter film, which will damage the oil supply system.
- \* Specification: Hanbell standard trip valve is 1.5 bar and the valve can be reset manually.
- \* Instructions: For compound compressor without external oil line system, the high pressure connector (HP) of the pressure differential switch is connected to the high pressure connector of the compressor (high pressure angle valve or discharge oil separator side angel valve) ; the low pressure connector (LP) is connected to the oil filter flange of the compressor. When the oil resistance exceeds the set valve (1.5 bar), the pressure differential switch (OFF) cuts off the compressor control circuit to remind the user to clean the filter.

For compressors connected in parallel or compound compressor with external oil line, the oil pressure differential switch shall be installed on the inlet and outlet of the external oil filter. When the circuit is cut off, please clean or change the oil filter.

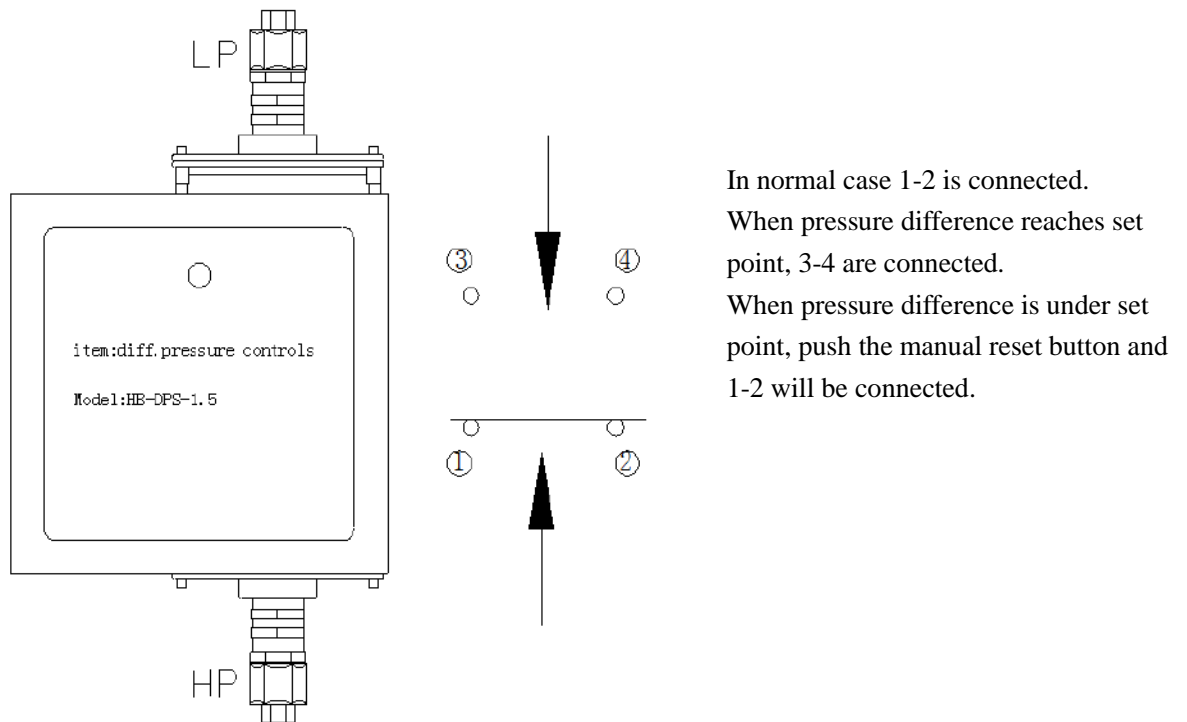


Figure 10-10. Pressure Differential Switch

## 10.4 Electrical Accessory

### 10.4.1 INT69 HBY Diagnose Protection module

The INT69 HBY Diagnose protection module is developed for micro controller, phase sequence and phase lack of the compressor.

Protection Module INT69 HBY Diagnose is an advanced product microcontrollers for compressor-protection. It can effectively extend the life of the refrigeration system. INT69 HBY Diagnose automatically saves work and error data in its memory. The data can be read on a personal computer and used for diagnostic analysis through a specific transmission line.

Functional description :

- ❖ The series PTC thermistor enters the signal input side of the protection module
- ❖ The protection module trips off if the resistance of any of the thermistors rises above its trip value. The resistance of the PTC drops below the reset resistance. After 5 minutes of reset time, the module is automatically reset. Within 24 hours of the first trip disconnection, the second PTC resistance rises above the reset resistance value and the reset time is 60 min. If the third PTC resistance rises above the reset resistance within 24h, the module will lock up and cannot be

automatically reset.

- ❖ The motor phase monitoring function will activated after 1 s of motor start and is continuously monitored for 5 s. Abnormal motor phase or motor phase loss will cause the protection module to open and lock.
- ❖ In order to avoid tripping due to reversal after the compressor is stopped, the phase monitoring function is only maintained for 20 seconds after the motor is stopped.
- ❖ LED (Light Emitting Diode) (Red/Green/Orange) displays its working information.
- ❖ The motor protection module cannot be used for variable frequency drives.
- ❖ A short circuit in the PTC can cause a lock, and a short-term cycle can cause a reset delay.
- ❖ The delay should be reset and the module reset after the temperature is reduced or the error is eliminated; then restart the compressor .

⚠ This module must be assembled and maintained by a professional electrician. Module connection electrical equipment and cooling devices should have European or national standards. The connection between the junction box and the temperature sensor must be insulated..

### Technical Parameters:

Project	Technical Parameters	Project	Technical Parameters
Supply voltage	AC 50/60HZ 115/240V ±10% 3VA	System PTC short circuit monitoring	Usually <30Ω
Motor voltage	3 AC 50/60Hz 200/690V ±10%	Exceeding frequency	Not support
— sensor type — R25, all — maximum connection length	Optional 1-2 AMS sensors in series, 1-9 PTC, series standard according to DIN 44081 and DIN 44082 <1.8KΩ 30M	— Motor static trip 1 time /24h 2 times /24h 3 times /24h — On-off level — Wrong phase — Lost phase Cancel lock or reset delay	5min ±1 min 60min ±12min Locked up 5min ±1 min Locked up Locked up
Ambient temperature	-30...70℃	Maximum switching frequency	Switch 3 times in 30 seconds
Phase monitoring - Phase sequence - Lost phase - Inactivation	Activated after 1s of motor start, continuous monitoring for 5s Activated 1 second after of motor start, monitoring until shutdown About 20 seconds after the motor stopped	Delay reset relay —power supply —Mechanical life	AC 240V 2.5A C300 at least AC/DC 24V 20mA 1 million switching cycles

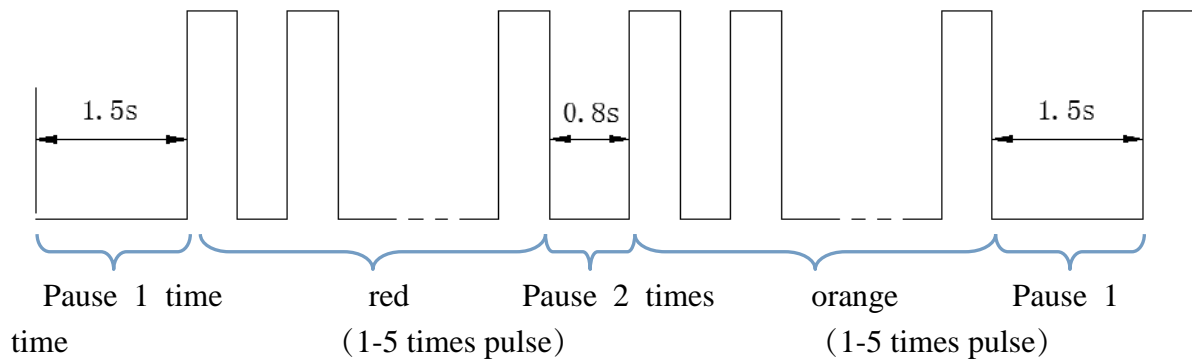
### Signal light flash :

The signal display is quick and easy to access; the light signal consists of periodic red and orange flashes; the current light flash status depends on the number



of pulsed flashes.

The signal is as follows



Signal light overview	Green	Compressor operation
	Flashing green	Compressor running
	Flashing red/orange	Fault, relay tripped, compressor down; See the table below for details.

First blinking sequence (red)	Second blinking sequence (orange)	description
1	1	Motor temperature: static trip, winding temperature is too high
	3	Motor temperature: reset delay after static trip
	4	Motor temperature: The temperature sensing element detects an open or short circuit
2	1	Motor voltage: phase sequence error
	2	Motor voltage: wrong phase / three phase asymmetry
3	1	Power supply voltage: module is too low for power supply

The green light is on but the unit cannot be started: use the multimeter resistance file to measure the conduction between M1 and M2. If the M1-M2 is not conducting, replace the protector.

### Appearance and wiring:

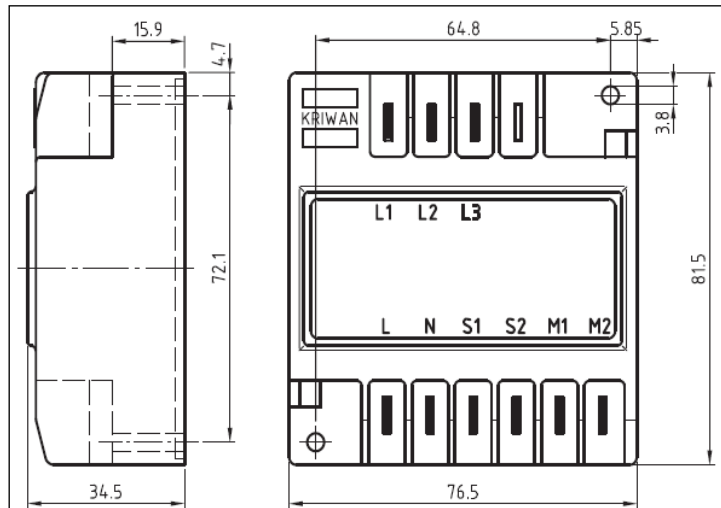


Figure 10-11. INT69 HBY Diagnose Appearance

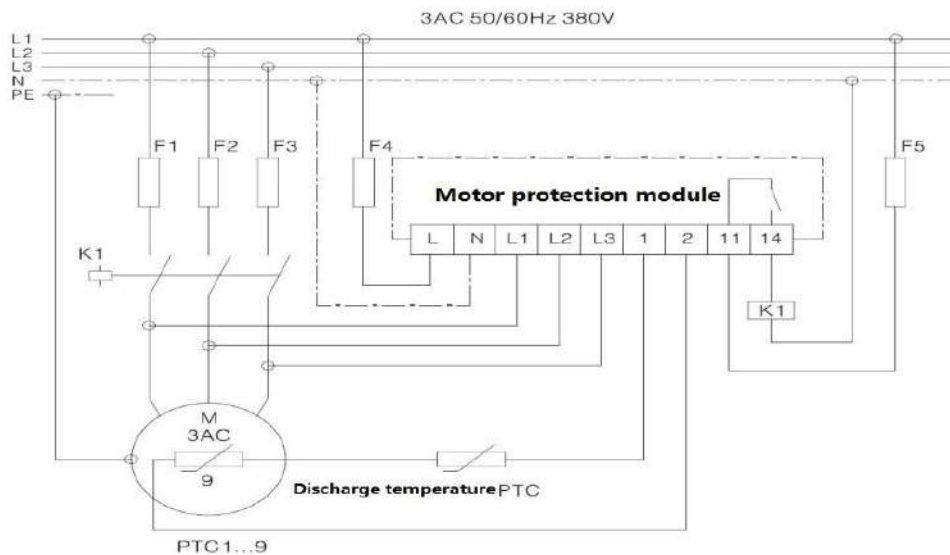
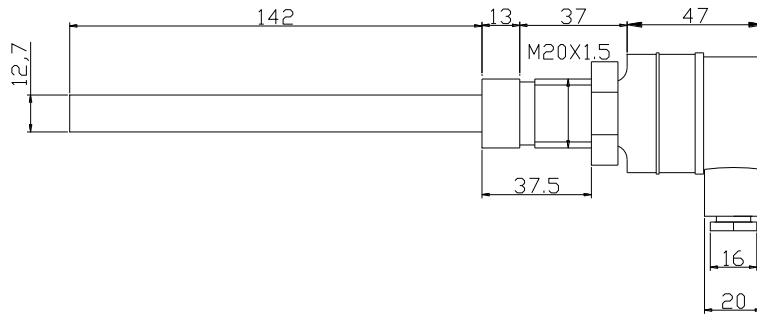


Figure 10-12. INT69 HBY&PTC Connection Graph

**⚠ Note:** The above figure only shows the connection mode of the protection module, not the compressor startup mode.

### 10.4.2 300W oil heater

Each Hanbell compressor is equipped with a UL approved 300W oil heater as standard accessories. Before starting the compressor again after a long shutdown. Please keep the oil heater on for more than 8 hours to ensure that the internal temperature of the compressor is higher than the system temperature and ambient temperature. So as to avoid liquid refrigerant in the compressor tank causing liquid compression or poor lubrication due to low viscosity of lubricating oil at the next startup



specification: 300W; 220V; IP54; UL certified





### 10.4.3 Oil level switch

Photoelectric level switch

- Application note:

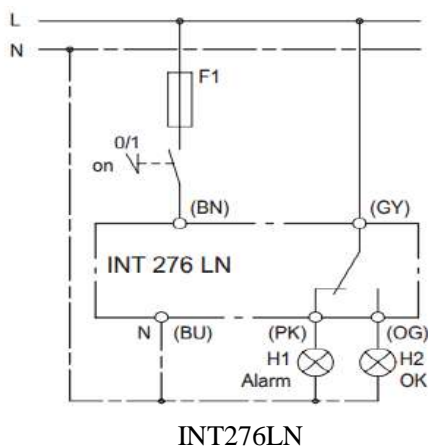
The photoelectric level switch is used to monitor the lubricating oil level of the compressor. Its inside contains an infrared light emitting diode and a light receiver. The light emitted by the LED is directed into the prism at the top of the sensor. When the liquid is not submerged in the prism, the light is reflected directly from the prism back to the receiver; when the liquid is submerged in the prism, the light is refracted into the liquid and the receiver is unable to receive the light. By sensing this change, the receiver can drive an internal electrical switch to activate an external alarm or control circuit.

- Function Description:

No.	Features	effect
1	Oil level protection	The compressor oil level can be detected in real time to prevent the compressor from being seriously damaged due to oil loss.
2	Action delay	In order to avoid compressor failure when oil level fluctuation occurs, this product is recommended to set the delay as 60-90 S before cut off the compressor power supply. When the oil level is continuously higher than the detection oil level 60-90 S, the compressor will automatically reset. .
3	Signal indication	INT276LN:  <ul style="list-style-type: none"> <li> The oil level is higher than the detection oil level</li> <li> The oil level is lower than the detection oil level</li> <li> When internal fault, input voltage is too low or abnormal</li> </ul> installation

- Wiring method and using instructions :

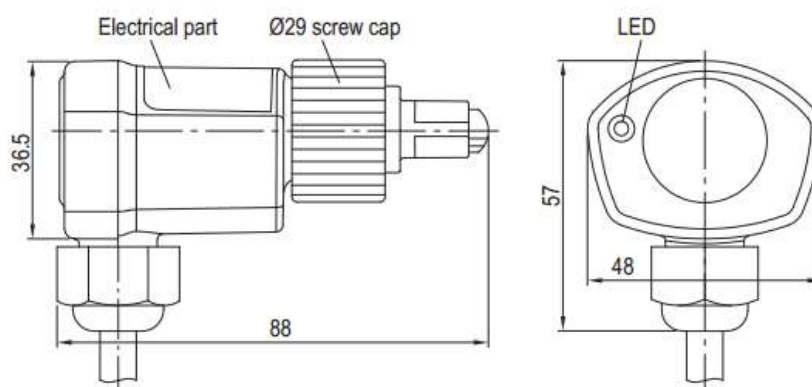
- 1) When L1, L2, L3 are connected to the power supply, ensure that the voltage value is within the allowable range specified by the product, otherwise the product will not work normally.
- 2), the blue line and the brown line are respectively connected to the L1 and N power lines (220V) as the power supply for the liquid-liquid switch;
- 3), the gray line is connected to L1;
- 4), the orange wire is connected to the unit protection circuit, and the start and stop of the compressor motor is indirectly controlled by the opening and closing of the control relay;
- 5), pink line connected to the unit alarm circuit.



● Technical Parameters :

No.	Project	Parameter	No.	Project	Parameter
1	Power supply voltage	AC50/60Hz 230V ±10%	4	Power supply delay	3s ±1s
2	Ambient temperature range	-30°C...+60°C	5	Action delay	5s ±2s
3	Mirror maximum temperature tolerance	+120°C	6	Relay level	AC 240V 2.5A

● Size and installation



INT276LN

- Note:**
1. Ensure Photoelectric connector thread and lens cleaning;
  2. Thread the module along the end of the mechanical part to ensure that the electrical terminals are vertically downward;
  3. Fasten external connection nut with bare hands

● Compressor delay control instructions

When setting the photoelectric liquid level switch time, in order to avoid the compressor frequency failure stop when the oil level fluctuation occurs, this product can set the delay of 60-90 S and then cut off the compressor power supply. Therefore, it is recommended to set the time delay for the photoelectric level switch control to be 60-90 seconds.

That is, when the compressor is running, if the oil level detected by the optical

liquid level switch is lower than the control oil level line for a period of time ( $5 \pm 2$  s), the liquid level switch sends a signal to supply oil to the compressor. ; When the oil level is higher than the control oil level line for a period of time ( $5 \pm 2$ s), the liquid level switch is automatically reset.

If the oil level detected by the optical level switch is lower than the control oil level line for a period of time, the liquid level switch sends a signal, and the compressor oil level does not reach the control oil level line during the period of 60-90 s. , the compressor will cut off the motor power line for a protective shutdown.

● Fault analysis and processing

symptom	problem analysis	Solution
Liquid level alarm in correct level	1. The mirror detection head is covered with dirt; 2. The surface of the mirror is scratched and opaque	1. Cleaning the dirt attached to the mirror; 2. Replace the new mirror.
The semaphore is displayed as "abnormal"	1. 220V Low voltage; 2. The temperature of the medium is too high, causing damage to the internal components of the module. ; 3 Module and connector are not tightened; 4. Coil damage	1. Connect the LN terminal power supply, the voltage value should be within the specified range; 2. The temperature at which the photo-liquid switch operates is within its allowable range ; 3. Lock the joint nut with your bare hands ; 4. Replace the coil
Action delay invalid or error	1. Wiring error; 2. Coil damage	1. Wiring according to the correct wiring ; 2. Replace the coil
Note ,that the optical level switch is not working properly and there are the following possibilities:: 1. Use environmental chemicals to damage the liquid liquid coil wire, etc. ; 2. The humid environment causes a short circuit in the photo-liquid coil.		

## 10.5 Other accessories

### 10.5.1 Cushion

⚠ To avoid additional vibration and noise due to direct contact between the compressor and its mounting feet and mounting base, it is recommended to install a cushion under the compressor foot. The torque required for the installation of the damping pad is 20~30N.m.

⚠ Note: The position of the compressor anchor is detailed in 7.3

\* size and specification sheet :

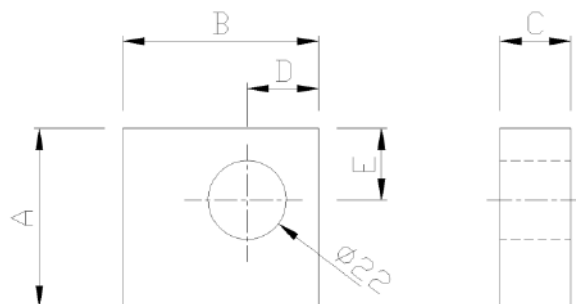


fig10-12. compressor cushion

\* specification sheet :

No.	A(mm)	B(mm)	C(mm)	D(mm)	E(mm)	Applicable models
1	50	55	20	20	20	LT-20/10
2	80	100	20	25	25	LT-45/20~LT-83/41