CONTENT

1. Overview

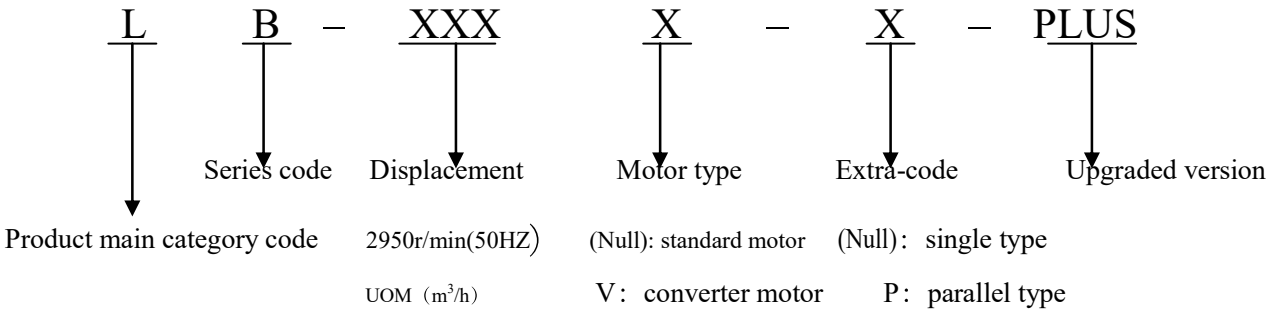
1.1 Product Introduction

HANBELL specially developed LB-PLUS series screw refrigeration compressor is for low temperature use, which integrates the low-temperature market application experience and customer demands in the recent years. With the features of excellent performance, simple structure, and easy to use, this series of products is especially in line with the application requirements of the field of low temperature, so it is widely used in agriculture, fisheries, meat, food industry, process cooling, ship refrigeration, freeze drying and other industries.

The application of LB series products is different from that of RC2 series products, so users must read this manual before installation, commissioning and operation. Any problems, please contact HANBELL.

The data of this manual are subject to change without notice.

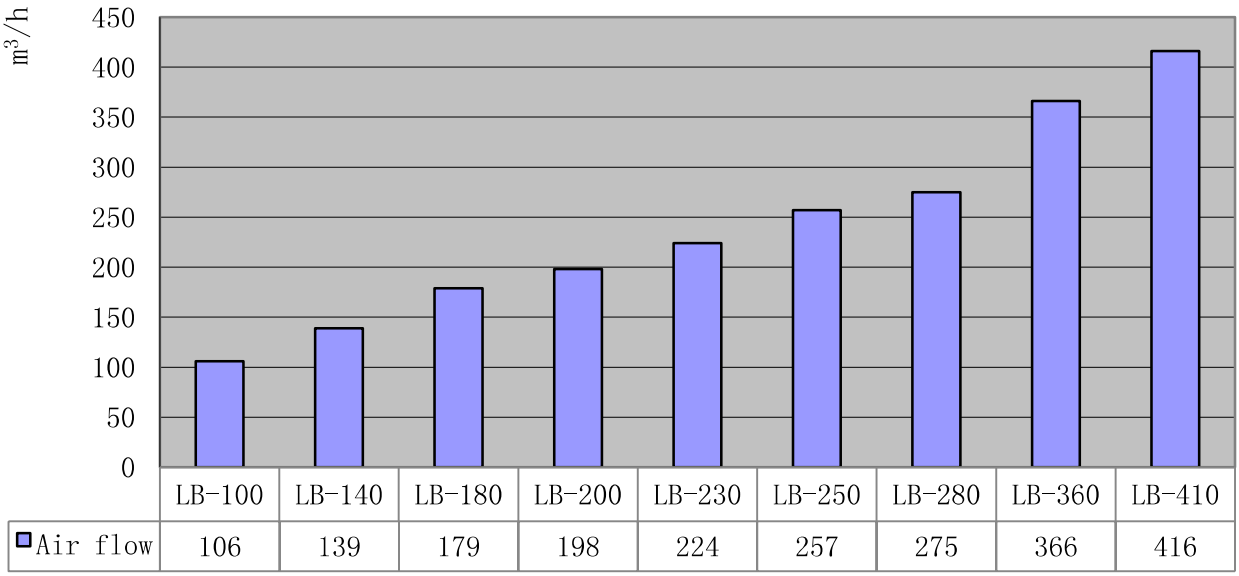
1.2 Nomenclature



- Compressor rated power: 380V/50Hz, if customers need other special voltage and frequency, please contact HANBELL.
- The standard motor of LB-PLUS product is PWS partial winding starting motor.
- Single type——compressor with built-in oil separator, hereinafter referred to as "single type".
- Parallel type——compressor without built-in oil separator, hereinafter referred to as "parallel type".
- If the compressor belongs to single type, the extra-code is omitted.
- If the compressor uses R22 refrigerant, refrigerant code is omitted.

1.3 Product Series

LB-PLUS invariable frequency compressor



LB-PLUS inverter compressor(Air flow Below 70HZ)

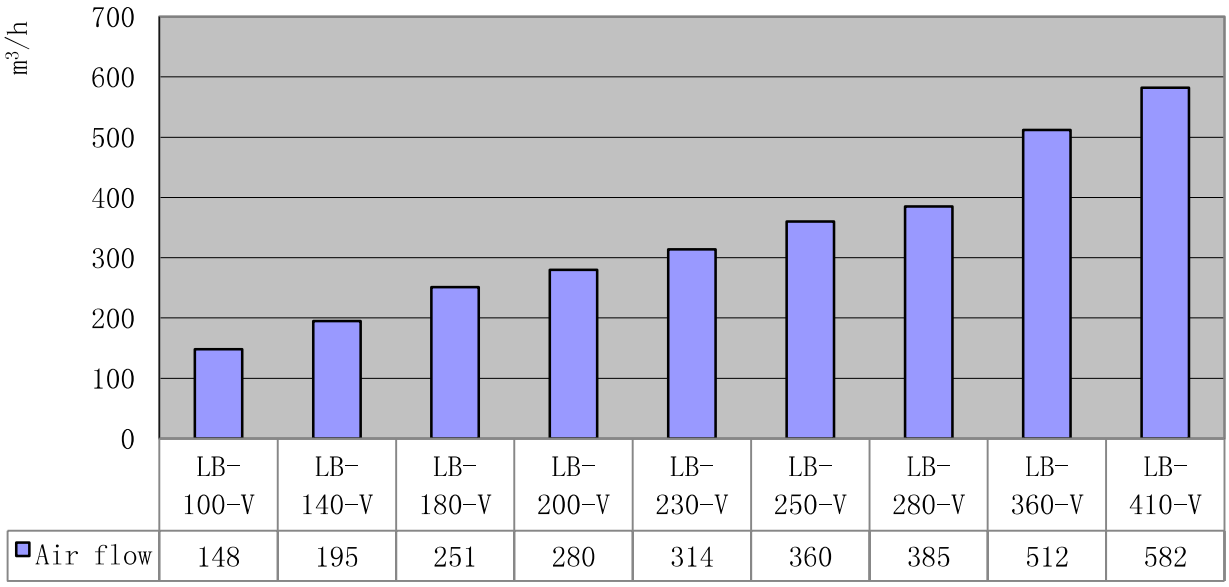


Figure 1 LB-PLUS Compressor Air Flow Specification Table

1.4 Design Specification

Table 1 Compressor Design Specification

Model(-PLUS)	Compressor			Motor					Oil filling volume	Oil heater	Strength test	Quality
	Air flow 50Hz m^3/h	Rotation speed 50Hz r/min	Lubrication method	Type	Starting type	Voltage (V) 50Hz	Insulation grade	Protection	L	W	bar	Kg
LB-100/ LB-100-P	106	2950	Oil difference pressure supply	3 phase 2 pole squirrel-cage inductor motor (frequency conversion optional))	Partial winding starting	380	LEVEL F	PTC +NTC	4.5	300	35	248/233
LB-140/ LB-140-P	139								7			290/275
LB-180/ LB-180-P	179								7.5			310/295
LB-200/ LB-200-P	198								10			440/420
LB-230/ LB-230-P	224								10			460/440
LB-250/ LB-250-P	257								10.5			464/446
LB-280/ LB-280-P	275								11			474/454
LB-360-P	366								-	-		370
LB-410-P	416								-	-		416

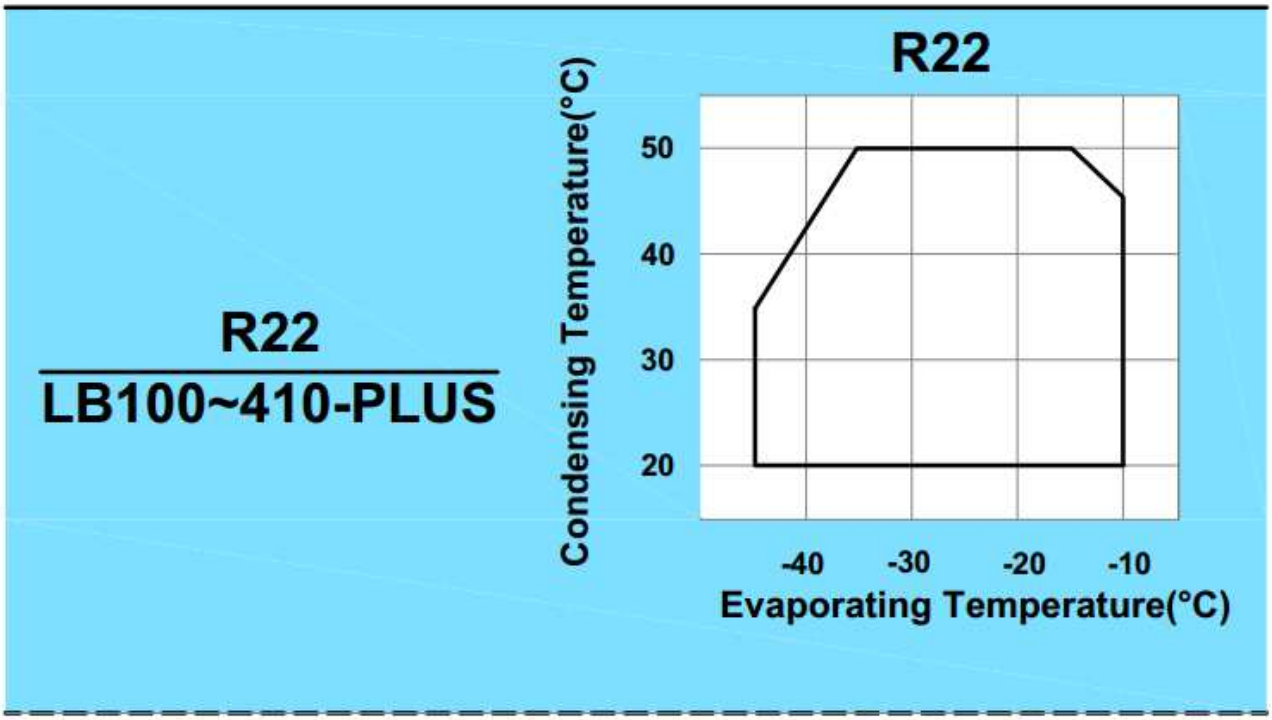
Note: Oil filling volume doesn't include -P products.

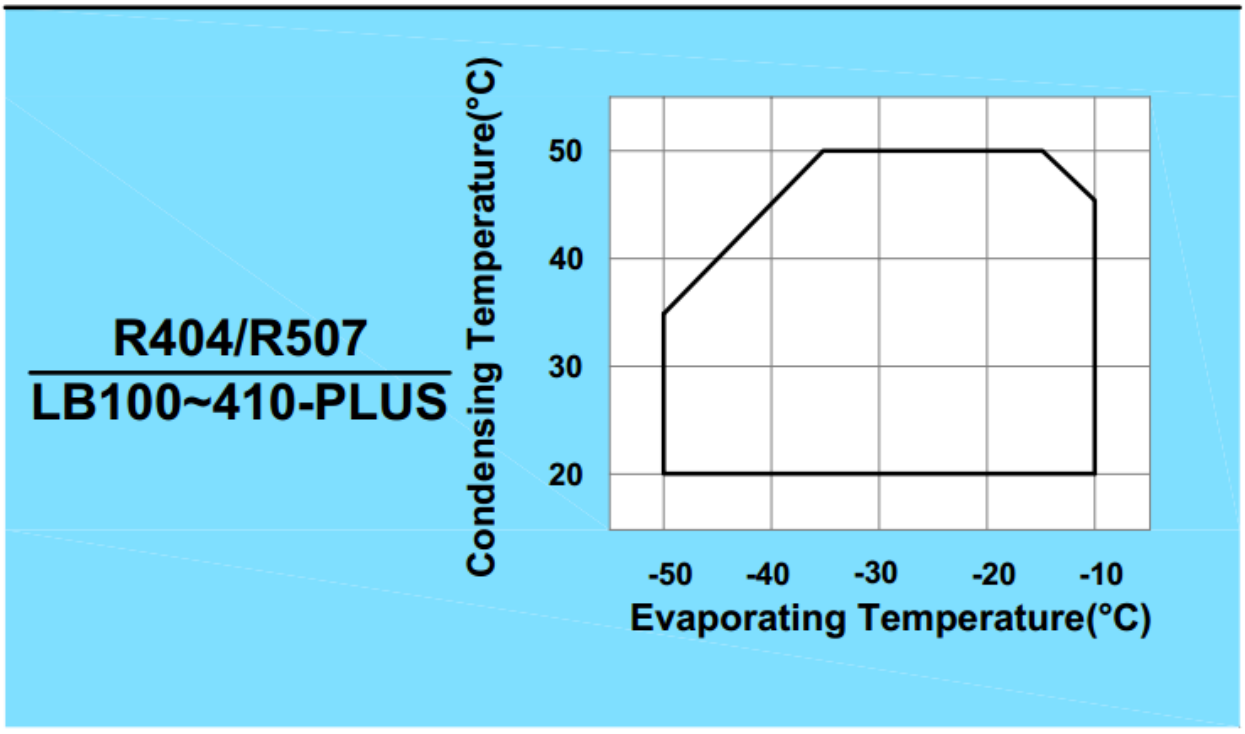
Model(-PLUS)	Frequency conversion parameter	
	Air flow m3/h(70Hz)	Range
LB-100-V/LB-100-V-P	148	30 ~ 70 HZ
LB-140-V/LB-140-V-P	195	
LB-180-V/LB-180-V-P	251	
LB-200-V/LB-200-V-P	280	
LB-230-V/LB-230-V-P	314	
LB-250-V/LB-250-V-P	360	
LB-280-V/LB-280-V-P	385	
LB-360-V-P	521	
LB-410-V-P	582	

Note:

Please confirm the rated current of the compressor under designed conditions according to the HANBELL model selection program, and select the contactor, power cord and fuse protection element according to the maximum operating current value determined by the initial temperature / limit operation.

1.5 Application Limits





1.6 Design Features

- Electronic expansion valve
  The LB-PLUS model adopts electronic expansion valve. Its precise control, stability in operation and simplification control of the package makes LB-PLUS simpler, safer and more reliable.
- Motor independent cooling
  It ensures that the motor runs at the ideal temperature, which effectively prolongs the service life of the motor. The harmful superheating of the suction refrigerant will no longer been increased. The refrigerant after cooling the motor enters the compression chamber to make up the gas, so it will not cause the cooling loss due to the cooling of motor, which achieves a higher energy efficiency ratio , especially in the low temperature application.
- Two types: single & parallel types
  LB100~280-PLUS is divided into two structural forms: with oil separator and without oil separator. LB360~410-PLUS has only one structure without oil separator. It can be applied to various application fields, and different suction and exhaust outlet directions can be selected.
- The wiring part is far away from the suction port to avoid the influence of electrical insulation
  Compared with the traditional low temperature screw compressor, the frosting phenomenon of the electrical part is reduced, which improves the safety.
- High efficiency multistage oil separation
  Patented design, the segmented high efficiency oil separator design ensures the lowest oil throwing rate during the compressor operation
- Frequency conversion motor optional
  The use of variable frequency motor achieves higher energy control range and more stable temperature control. Under the standard working condition of -35/40℃, the performance of part load is 20% higher than that of traditional slide valve energy regulation models.

2. Application

2.1 Compressor Application

2.1.1 Motor cooling

The traditional screw refrigeration compressor uses suction to cool the motor. When it works at low temperature conditions, the mass flow rate of refrigerant is very small. Refrigerant absorbs heat through the motor, resulting in a lot of harmful superheat, which improves the specific volume of the refrigerant and leads to the reduction of refrigerating capacity.

The LB-PLUS series compressor's motor uses independent cooling. The motor chamber and the compressor chamber are isolated, and a small amount of liquid refrigerant is used to cool the motor, which enables the motor to work in the ideal temperature range. Meanwhile, it can extend the service life of the motor. The gaseous refrigerant after cooling the motor enters the compression chamber to make up gas to avoid the refrigerating loss caused by the motor cooling. The effect is particularly obvious at low temperature.

In order to effectively control the refrigerant gose into the motor cavity, HANBELL designed the scheme to control the liquid jet of the motor:

- Electronic expansion valve specially designed for LB-PLUS

Use electronic expansion valve to control the temperature of the motor. As shown in Figure 4, the solenoid valve and the compressor start or stop at the same time. The electronic expansion valve is controlled by controller of LB-PLUS itself. Through a special algorithm, the temperature of the motor is controlled at around 60℃.

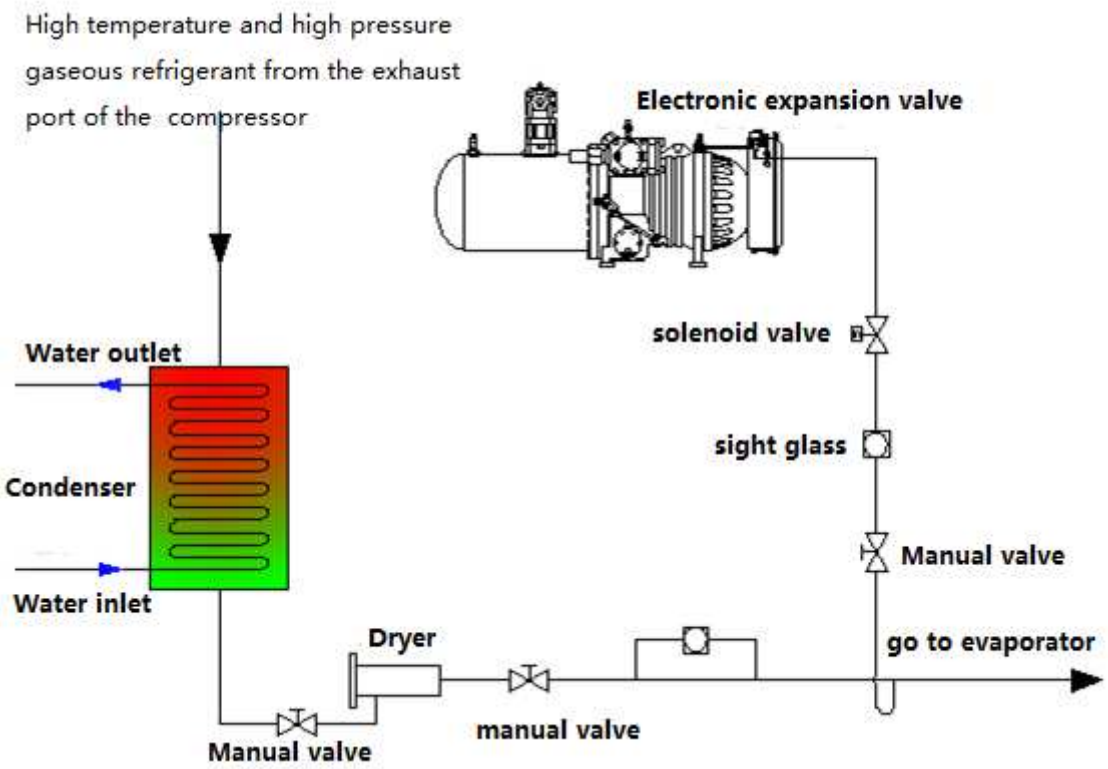


Figure 4 Motor cooling electronic expansion valve piping

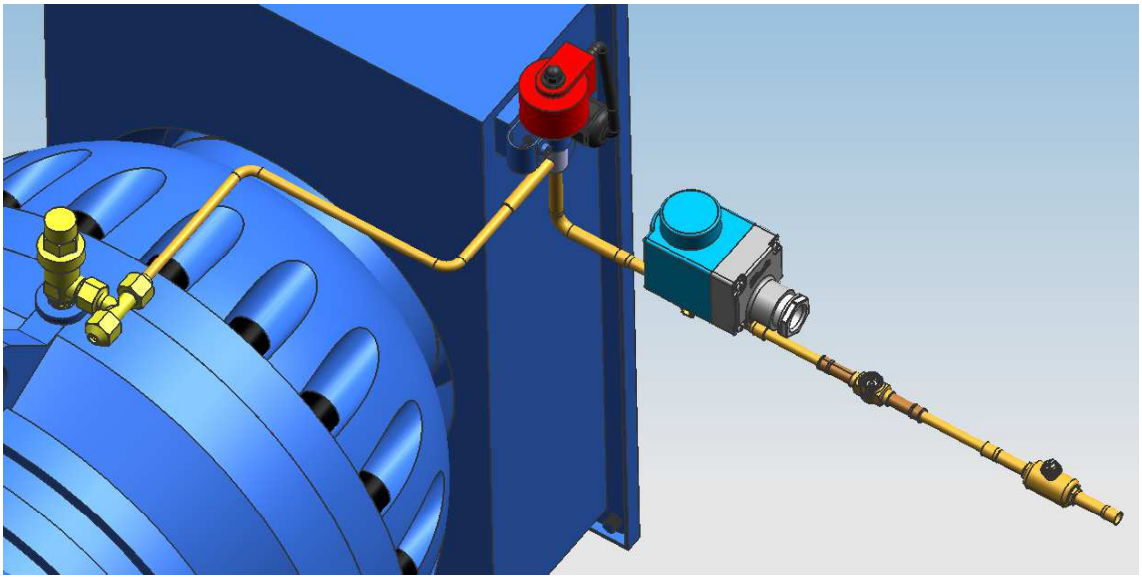


Figure 5 Electronic expansion valve installation diagram

- It is strictly forbidden to cut off the liquid injection of the motor when the compressor is running;
- It is strictly forbidden to connect the liquid injection of the motor when the compressor stops;

- The refrigerant extraction is introduced directly from the dry filter of the system liquid tube, and the extraction point must be before the economizer;
- The liquid injection of the motor should be taken from the bottom of the liquid pipe and a U type bending design shall be made(Figure 6);
- A normally closed solenoid valve shall be taken as the solenoid valve of the motor liquid injection.
- The sight glass is used to confirm whether the refrigerant is full or not, and it is strictly prohibited to run the compressor when the tube is not full or a large number of bubbles are produced.
- If the refrigerant is found not sufficient before starting or commissioning, it is recommended to fill the refrigerant from the side of the three way of the spray angle valve. If the machine is at the running state, the closing time of the angle valve cannot be more than 20s when the refrigerant tube is removed after the refrigerant is filled.
- The liquid level switch is suggested to be added to the high pressure liquid reservoir to prevent the leakage of fluorine after the long term operation of the system, resulting in the insufficient liquid supply of the motor cooling and the insufficient liquid supply of the evaporator, which will cause motor overheating and overheating of the exhaust, finally leading to the compressor failure.

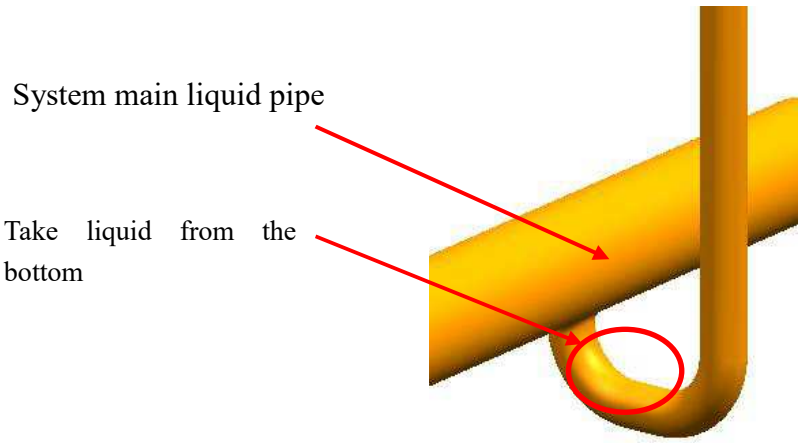


Figure 6 Liquid taken from the bottom

2.1.2 Oil line blocking pin

If an external oil cooler is required to be installed on single type compressor, oil blocking pin needs to be installed in the compressor (this would need to be written in the order). The function of the blocking pin is to block the oil internal cycle of the compressor, so as to realize the establishment of external oil circulation. (Figure 7)

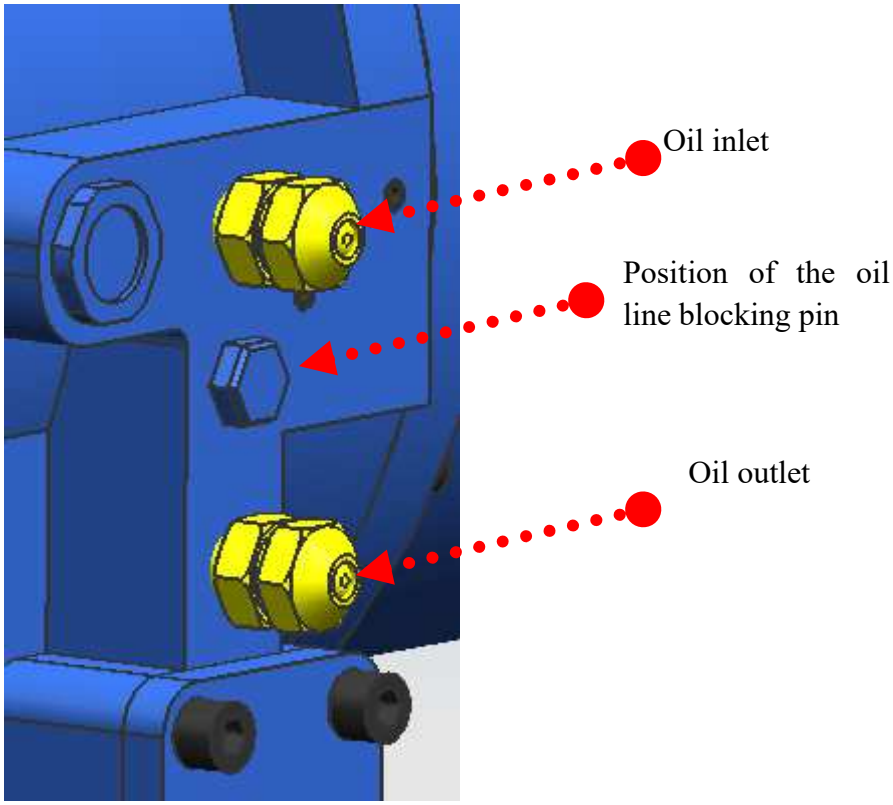


Figure 7 Oil line blocking pin diagram

2.2 Lubricant System

2.2.1 The function of lubricant

- The sealing oil film is formed between the rotors and the compression chamber and between the male rotor and female rotor to reduce the leakage of the refrigerant gas from the high pressure side to the low pressure side during the compression process.
- The lubricant will absorb and take away the heat generated by the gas refrigerant during the compression process and the heat generated by the mechanical movements among the bearings, so as to ensure the long-term normal operation of the compressor and reduce the discharge temperature.
- To form the oil film among the bearings so as to ensure the operation of the bearing under normal conditions.

2.2.2 Lubricant for LB-PLUS products

Table 2 Lubricant technical data

Refrigerant	R22	R404A/R507
Type	HBR-B03	HBR-B05
Proportion	1.01	0.957
Specific heat40℃（Kcal/kg K）	0.43	0.43

Note

- HANBELL only acknowledge the designated lubricant as written in above table.
- Minimum starting temperature of the lubricant: 20℃
- When the compressor stops, please open the oil heater (exclude long term stop).

2.2.3 The use and replacement of the lubricant

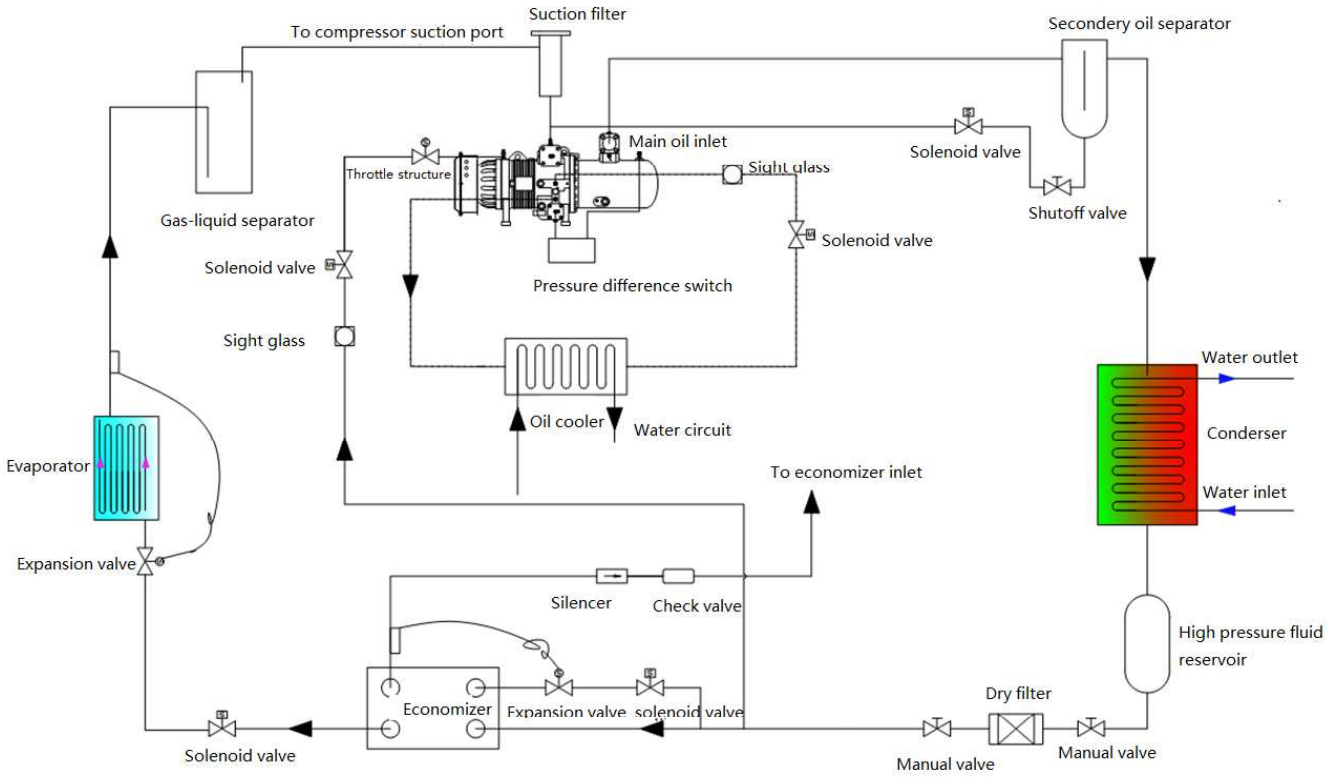
When the compressor is filled with lubricating oil, the system should be kept clean. After the initial operation of 2000 hours, it is recommended to refill the lubricant once more to ensure the long-term normal operation of the compressor.

- The lubricating oil is very easy to absorb the moisture in the air, so the lubricating oil should be avoided to be exposed to the air.
- In order to ensure the minimum water contained in the system, it is suggested that the system needs to be heated and evacuated as long as possible when the lubricant is replaced.
- The contamination in lubricating oil will cause the blockage of the oil circuit. Therefore, the oil filter must be installed in the external oil circuit system, and the pressure difference switch must be installed before and after the filter. When the pressure difference valve reaches the set point (1.5bar), the oil filter must be replaced or cleaned.
- If the compressor runs at a high temperature for a long time (95~110℃), it accelerates the deterioration of the lubricating oil. Please check the chemical performance of the lubricating oil regularly and shorten the interval of oil exchange.
- The acidification of lubricating oil will directly affect the service life of the motor. when the lubricating oil PH≤6, it should be replaced. (Please replace the system dry filter at the same time to ensure that the system is dry)
- If the compressor motor is burned, it will produce acid harmful substances and debris, and they will be brought into the system together. The inspection should be carried out according to the procedures mentioned above. Oil filters and lubricants must be changed many times until the cleanliness and acidity of the oil way reach the standard. The lubricating oil status needs to be traced regularly. Please replace it if the cleanliness and acidity beyond the standard range. Please pay attention to the cleanliness and dryness of the system as well.

⚠ Warning: If the customer was found not using HANBELL designated lubricants, HANBELL will not be responsible for the coming problems.

2.3 System application

LB-PLUS system flow chart: single type


Suction filter
To compressor suction port
Secondery oil separator
Main oil inlet
Throttle structure
Sight glass
Solenoid valve
Shutoff valve
Gas-liquid separator
Solenoid valve
Solenoid valve
Pressure difference switch
Sight glass
Water outlet
Oil cooler
Water circuit
Conderser
Evaporator
To economizer inlet
Water inlet
Expansion valve
Silencer
Check valve
High pressure fluid reservoir
Economizer
Expansion valve
solenoid valve
Dry filter
Solenoid valve
Manual valve
Manual valve

LB-PLUS system flow chart: parallel type

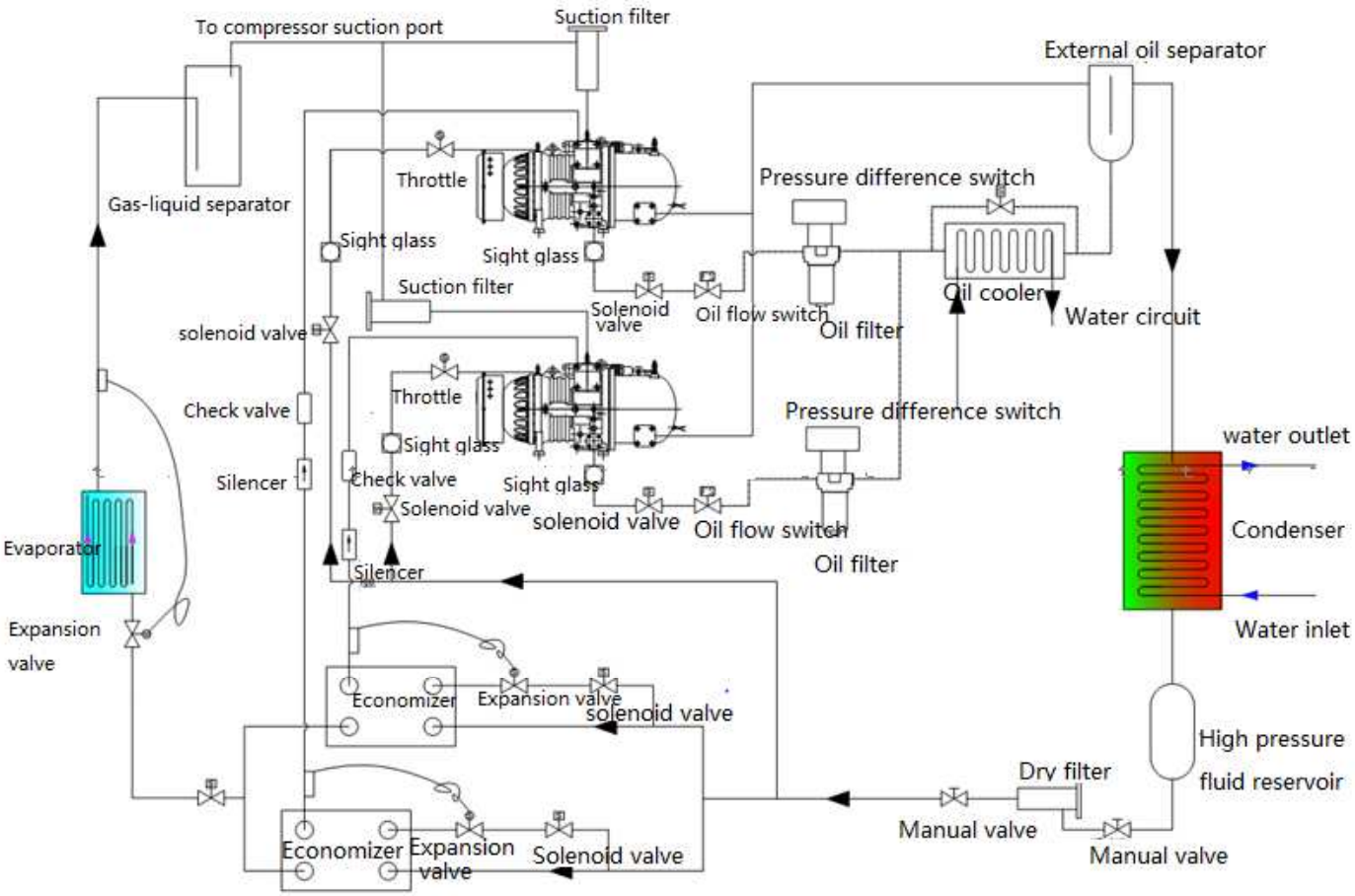
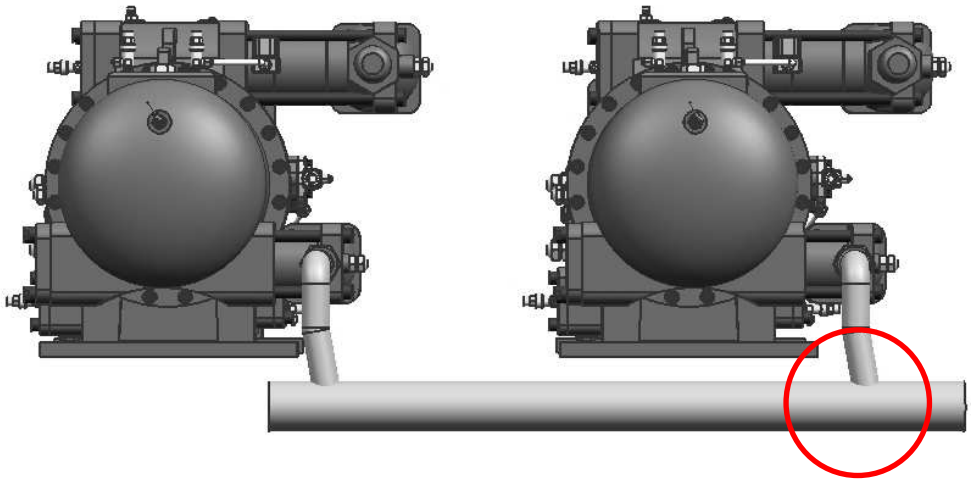


Figure 8 Basic system configuration

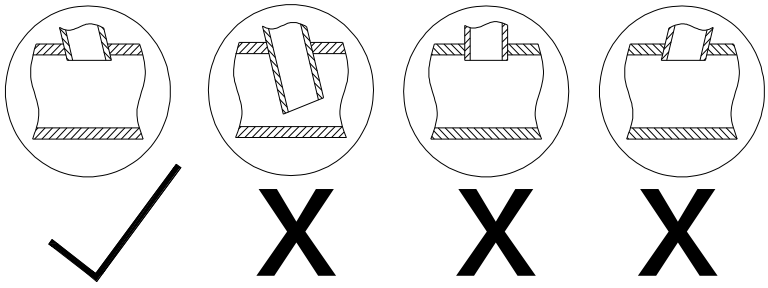
2.3.1 Suction and discharge pipe configuration

During normal operation, the vibration of the compressor is small, so there is no need for flexible connection among suction and discharge pipelines, but the pipeline must have enough flexible length, and it needs to be ensured that the suction and discharge pipeline will not generate stress on the compressor. It is suggested to use copper pipes as suction and discharge pipes, because copper pipes can be used to reduce the vibration damping of the pipeline when the compressor is running (Figure 9、10).



Detail drawing 1

Figure 9 Discharge piping diagram-parallel system



Detail drawing 1

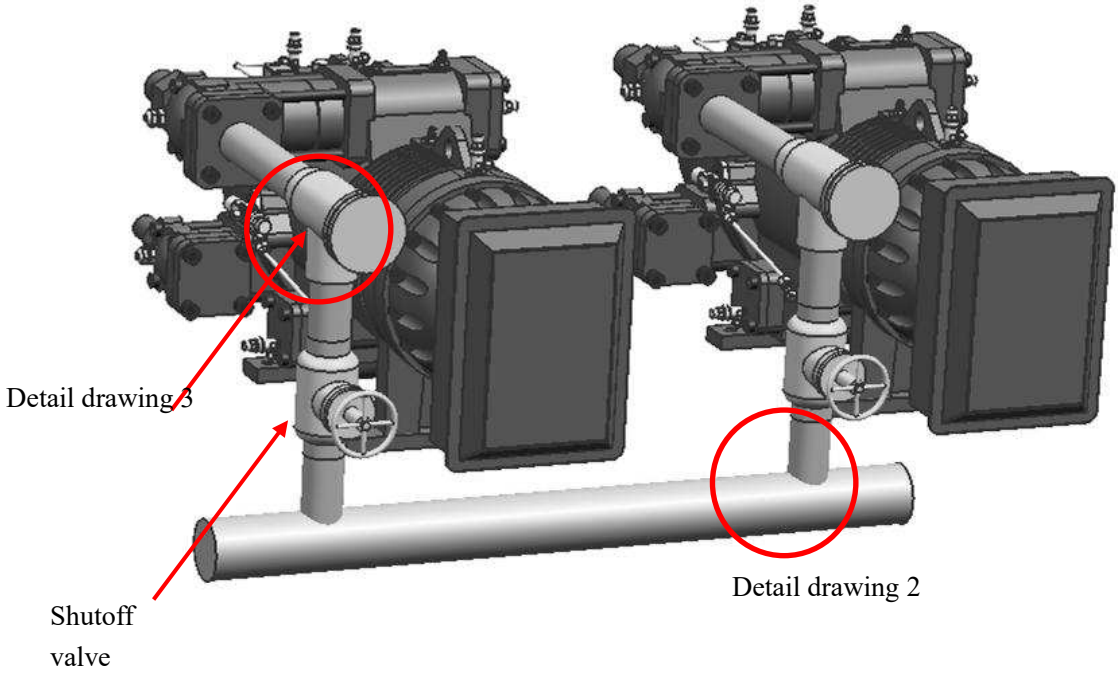
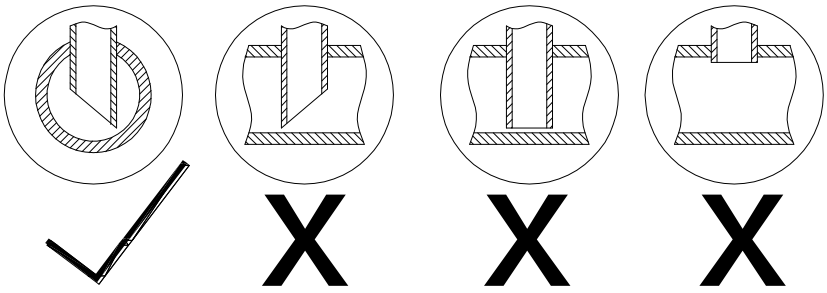
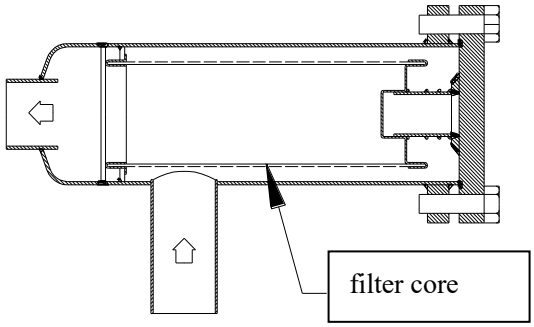


Figure 10 Suction piping diagram-parallel system



Detail drawing 2

The compressor itself is equipped with an air intake filter, but we still suggest to install a suction filter on the suction end (detail drawing 3) and clean it regularly, so that it is convenient for cleaning and replacement, with double protection at the same time. When the system starts to use, if the pressure drop is found greater than 0.5bar, please clean up in time until the system is clean. If the filter is found damaged, we need to replace it in time, and clean up the impurities in the pipeline. During installation, please ensure the correct direction of the filter. The shutoff valve is suggested to be added in the inlet and outlet in order to facilitate the maintenance.



Detail drawing 3

2.3.2 External oil circuit system

Generally speaking, if the compressor operates under low temperature conditions and the lubricating oil does not have auxiliary cooling, it will be unable to meet the operation requirements because of the high oil temperature. At this time, the customer is suggested to configure the external oil cooler which can achieve to reduce the discharge temperature, and can also prolong the service life of the system.

Note: It is required that the temperature of the oil inlet should not be higher than 60℃.

The oil cooling system is mainly divided into three types: 1. air cooling; 2. water cooling; 3. Refrigerant cooling.

The heat exchange of the oil cooler can be obtained by the HANBELL model selection program. The limit operating conditions should be taken into account, such as the maximum pressure difference (high condensation temperature and low evaporation temperature).

HANBELL requires that the pressure drop of the pipeline design of the external oil circuit system should not be greater than 1bar, so as not to affect the normal lubrication of the compressor. (Figure 11)

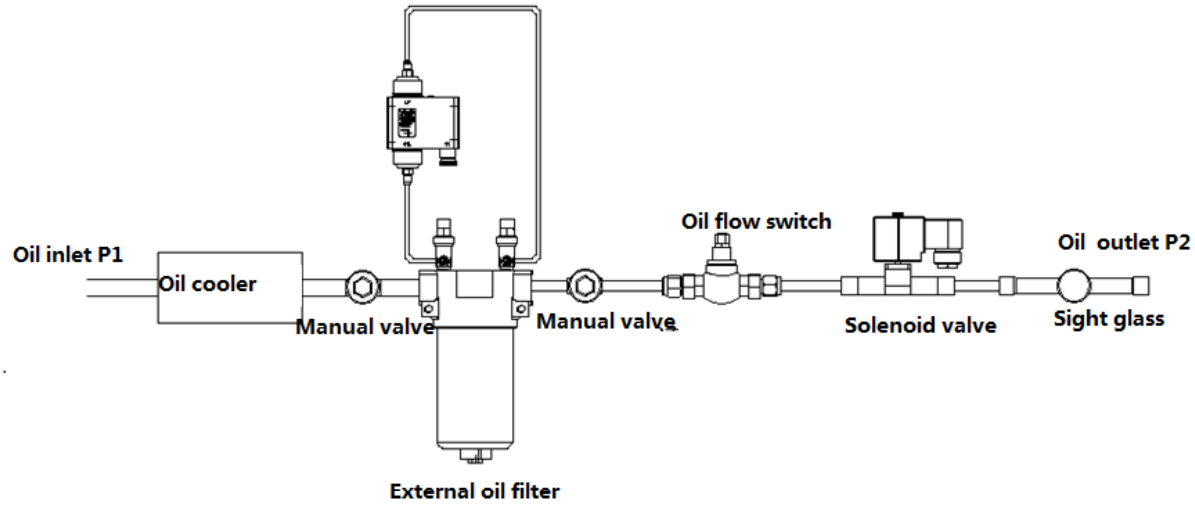


Figure 11 External oil circuit system

■ Air cooling type oil cooling

The fan accelerates the air flow which passes the fin of the oil cooler to cool the lubricating oil in the pipeline. The suggested is shown in Figure 12 and 13. For pressure difference switch, please refer to 3.2.5.

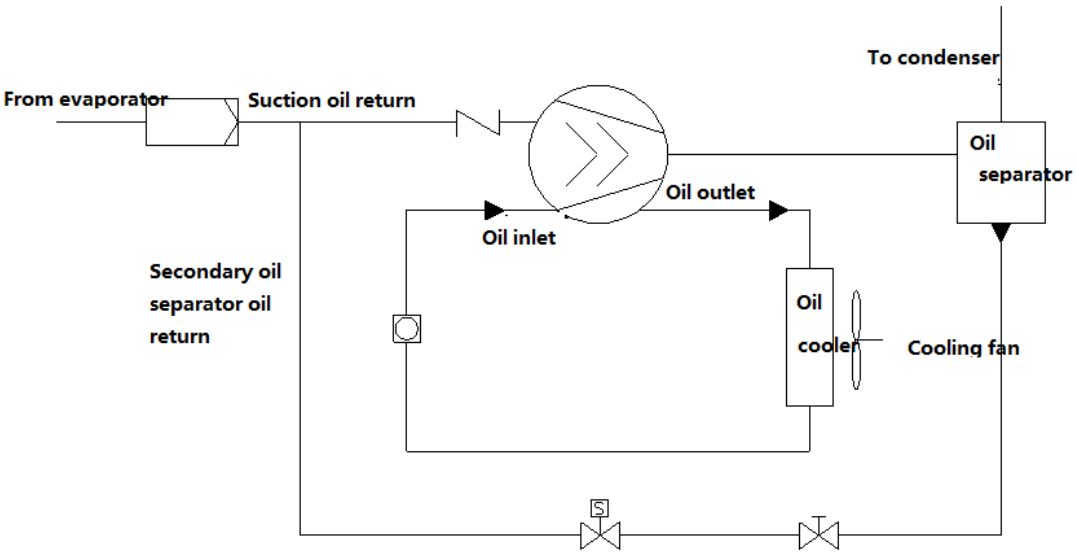


Figure 12 Air cooling type oil cooler single system

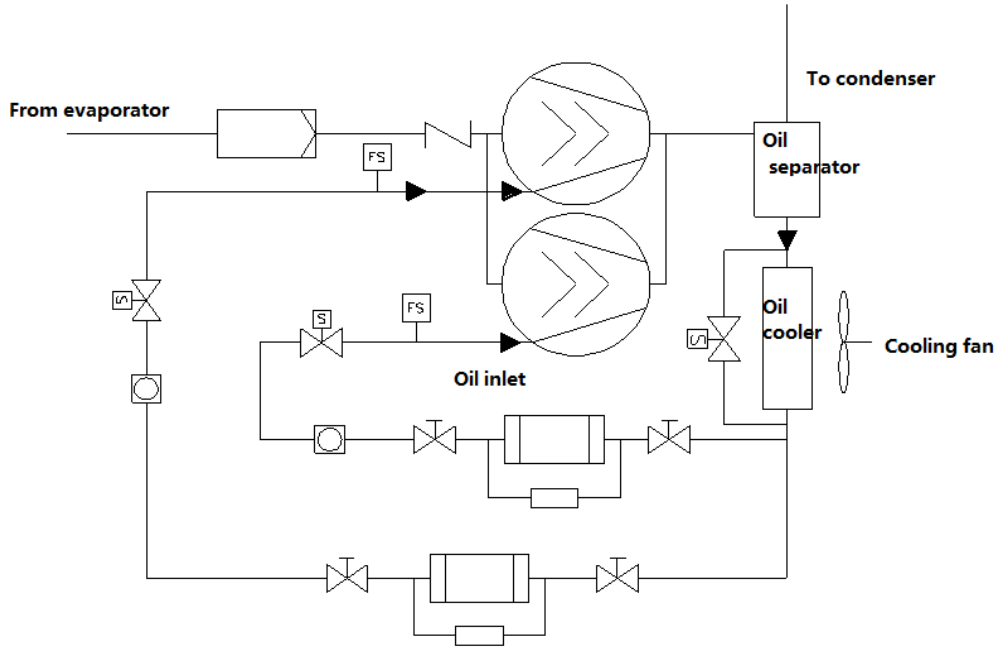


Figure 13 Air cooling type oil cooling parallel connection system

Icon	Description	Icon	Description
	Intake filter		Oil cooler
	Compressor		Oil separator
	Check valve		Sight glass
	Oil filter	FS	Oil flow switch
	Pressure difference switch	S	Solenoid valve
	Manual valve		

Table 3 Illustrations

■ Water cooling

The cooling water circulates through the pump and takes the heat of the lubricating oil through exchanging the heat with the pipeline. The suggested system flow is shown in Figure 14 and 15. For the pressure difference switch of single system, please refer to 3.2.5

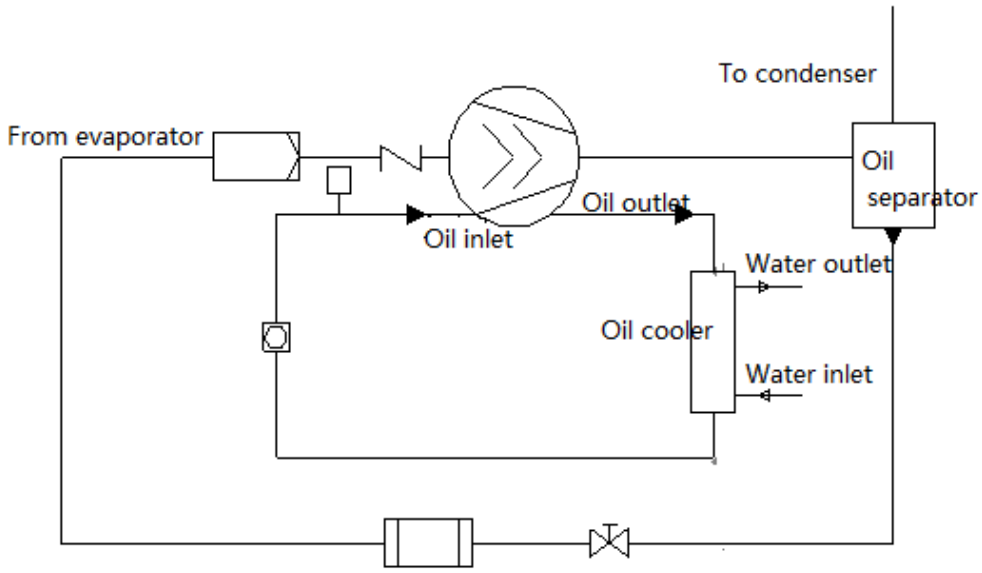


Figure 14 Water cooling type oil cooling single system

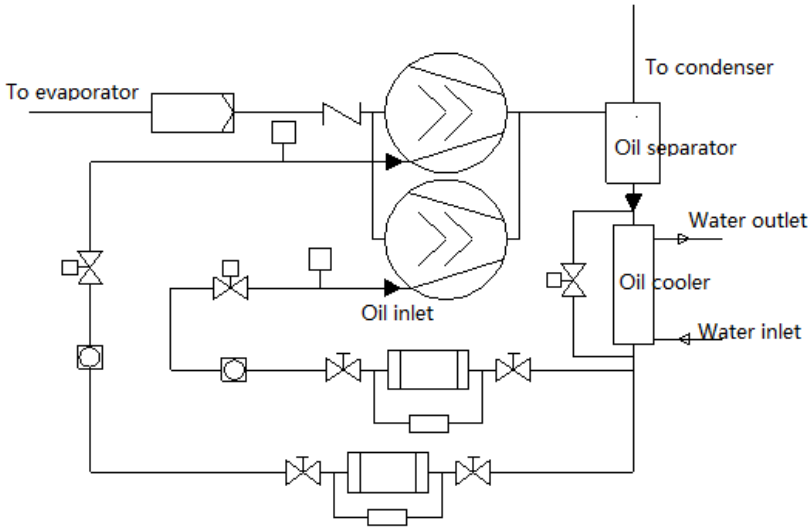


Figure 15 Water cooling type oil cooling parallel connection system

2.3.3 The configuration and use of external oil circuit

1. The oil cooler is suggested to be installed near the compressor. Moreover, the position of the oil cooler shall be lower than the oil level of the compressor and the oil separator, so as to prevent the lubricating oil from flowing back to the compressor or the oil separator when the compressor stops,

resulting in high oil level in the oil separator and liquid compression at starting point that lead to the overflow of the compressor. (Figure 16)

2. The oil cooler must have an oil return temperature control device to ensure that the oil return temperature is controlled at 40℃～60℃
3. The oil cooler must be used for the following working conditions.

   Evaporation temperature low（-20℃～-50℃）

   High suction superheat（＞15K）

⚠ Attention: Regarding the load of the oil cooler, please refer to the data of HANBELL model selector. When selecting, we must consider the limit oil cooling load in the working condition and consider the size of the oil cooler.

■ Configuration suggestions:

1) When the system is in normal operation, the pressure between high and low pressure shall not be less than 4bar (if the oil pressure difference cannot be established for a long time due to the system working environment, it is suggested to use Hanbell pressure maintenance valve);
2) In order to ensure the oil return temperature within the specified scope, an oil circuit with solenoid valve shall be connected between the inlet and outlet of the cooler. If the oil temperature is too low when the compressor is running, open the bypass solenoid valve so that the oil will be heated and the oil temperature will be rapidly increased. Meanwhile, it can effectively regulate the oil cooler load under different conditions. (Figure 17, 18)
3) The oil solenoid valve is recommended to be installed near the oil inlet of the compressor to avoid the oil flowing to the compression chamber when the compressor stops.

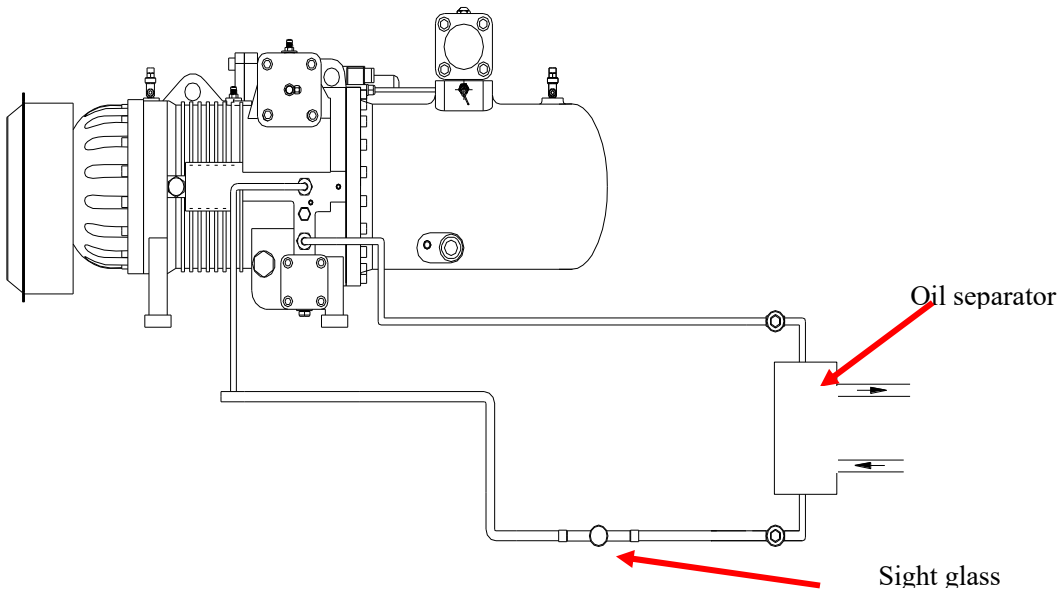


Figure 16 LB-100~280-PLUS Piping drawing of external oil cooling type oil circuit-single type

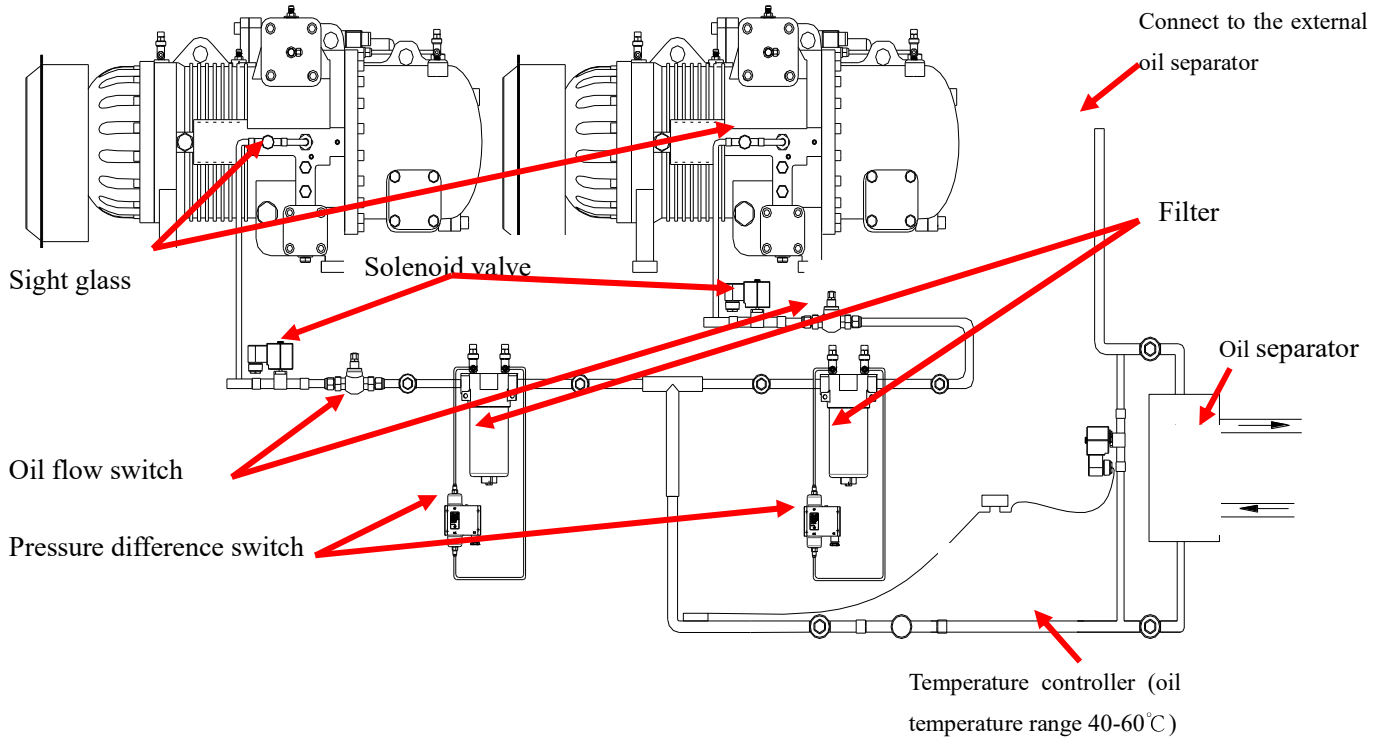


Figure 17 LB-100~280-PLUS Piping drawing of external oil cooling type oil circuit

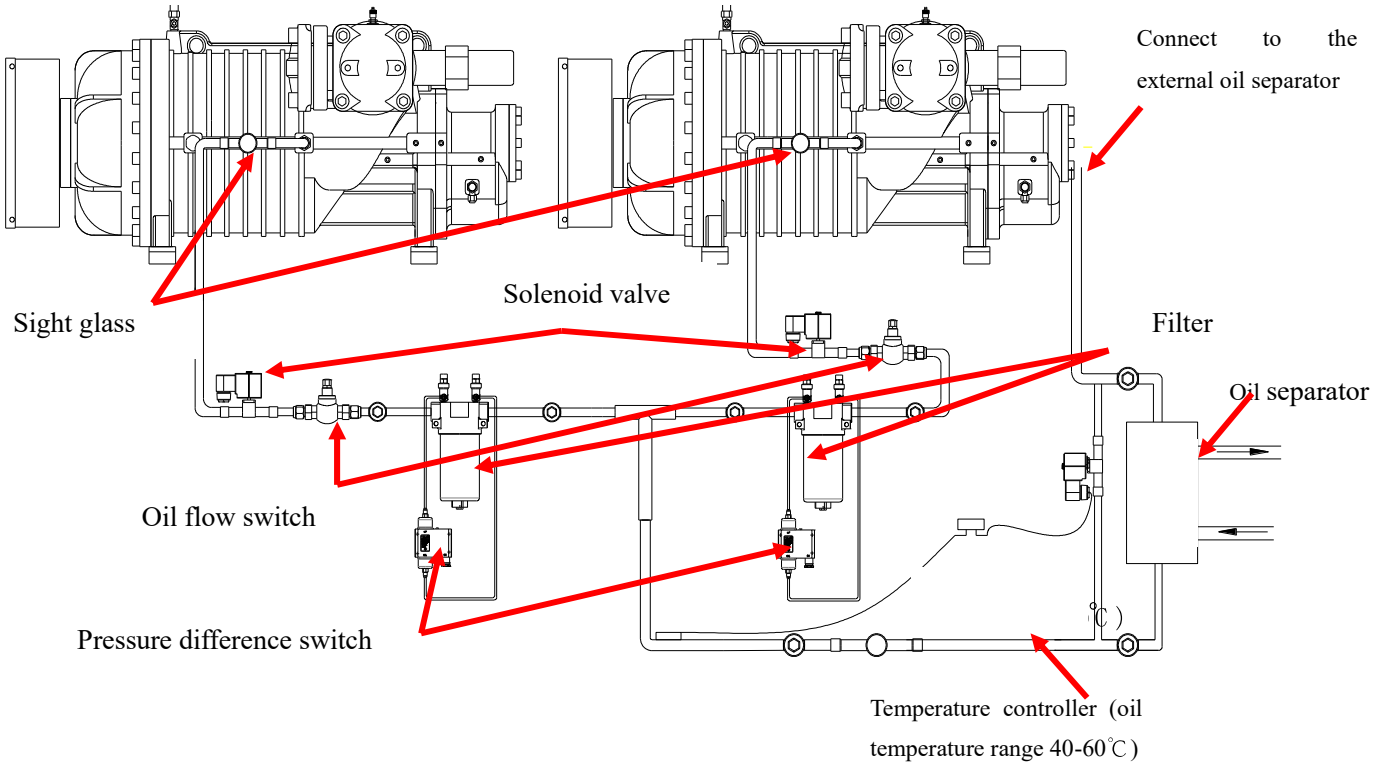


Figure 18 LB360/410-PLUS Piping drawing external oil circuit parallel connection

	Single type	Parallel type
LB100~180-PLUS	3/8"	Main oil pipe：5/8”，oil manifold：3/8"
LB200~280-PLUS	5/8"	Main oil pipe：1-1/8”， oil manifold：5/8"
LB360/410-PLUS	/	Main oil pipe：1-1/8”， oil manifold：5/8"

Oil circuit pipe diameter table

2.3.4 Economic configuration requirements

The economizer will further cool the refrigerant before the expansion valve of the system, which improves the refrigerating capacity and efficiency of the system, especially in the case of high condensation and low evaporation temperature.

Economizer operation in supercooling cycle:

In general, a heat exchanger is used as a liquid supercooling device to achieve the purpose of supercooling of liquid refrigerant. A portion of the refrigerant will be drawn from the condenser pipe, which will enter the subcooler through the expansion valve, absorbing the heat and evaporating, and exchange heat with the backflow liquid refrigerant. After heat absorption, the superheated saturated vapor enters the medium pressure compression section through the compressor's economic interface for compression. This model can effectively improve the quality of the liquid refrigerant refrigeration unit, and at the same time, the discharge temperature can be effectively reduced. (Figure 19)

- The selection of economizer:

The tube and shell type heat exchanger can be used as an economizer. Please select the load of the economizer according to the relevant technical parameters in the HANBELL software.

- The selection of economizer expansion valve:

If you want to get more valve selection guidance for economizer expansion valves, please contact HANBELL.

- The control model of economizer:

It is suggested that when the system starts to run stable, the high and low pressure ratio is greater than 3 or the low pressure side pressure reaches the set value, then the economic cycle can be opened in order to avoid the lubricating oil in the compressor back to the economizer, producing extra vibration and noise, even the crack of the pipe.

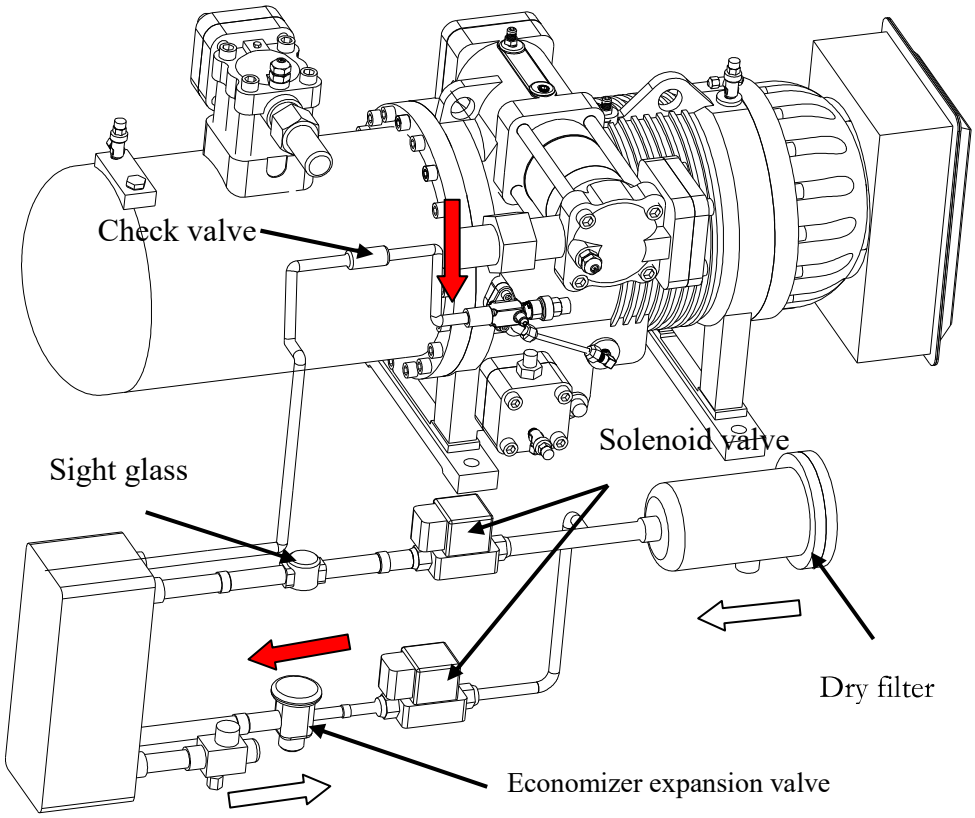


Figure 19 Economizer piping drawing - Single type

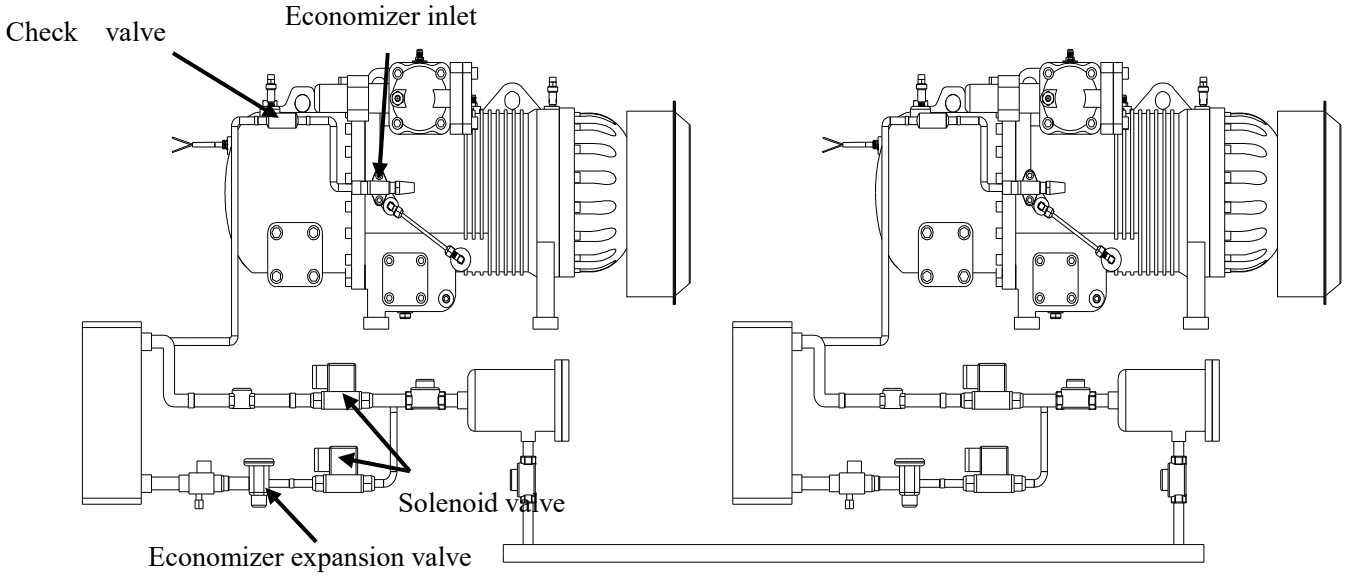


Figure 20 Economizer piping drawing - parallel connection

- Suggestions for economizer pipe line:
  1. The economizer (supercooler) should be installed below the compressor to prevent the liquid refrigerant in the economizer flow back to the compressor during the shutdown. (Figure 19, 20)
  2. In the unstable operating conditions or when closing the economizer circuit, a part of the oil and refrigerant will flow back to the pipeline of the economizer, so it is suggested to make a U-shape near the pipe line of the mouth of the economizer to have an upstream pipeline, leaving a 150mm upstream line distance.
  3. In low pressure ratio conditions, the pulsating airflow inside the compressor will flow back, which causes abnormal vibration and noise, so it is suggested to install buffer (silencer) and check valve near the entrance pipeline of the economizer.
  4. Please use corresponding pipes according to the size of the LB-PLUS series compressor's economizer interface.
  5. Besides the heat preservation requirements, we should pay attention to vibration of the pipelines.

2.3.5 Condensing pressure regulation

The compressor's suction and exhaust pressure difference valve shall achieve 4bar within 30 seconds after starting. If the pressure difference is too small, it will cause insufficient fuel supply, leading to the compressor shutdown in a period of time after starting (oil flow and pressure differential protection). At this time, it needs to do condensing pressure control, ensuring enough high and low pressure difference can be established within a short period of time to ensure compressor oil supply. The customer is suggested to use HANBELL optional pressure maintenance valve, and the pressure maintenance valve related information, please contact HANBELL.

The following conditions will cause the pressure difference to be too low:

- Ambient temperature too low, the condenser is installed outside and it is shut down for a long time.
- Parallel system single compressor start
- Heat gas defrosting and reverse circulation
- Double stage system low pressure compressor

2.3.6 Parallel system operation requirements

- When the parallel system starts, the compressors will start one after another (no two compressor is allowed to start at the same time), and the time interval is above 30s.
- When the compressors finish start process and come to work stably, please observe whether the

lubricating oil of the external oil separator is clear or not, and make ensure the position of the oil level in the high level. The oil recovery temperature is controlled at 40~60℃.

- After the compressor is running for a period of time, if the pressure drop of the external oil filter is more than 1.5bar before and after the external oil filter, the external oil filter core should be cleaned or replaced.
- In the parallel system the compressors can share one external oil separator. It is suggested that the oil filter and the oil flow switch can be configured separately for each compressor.


Attention:

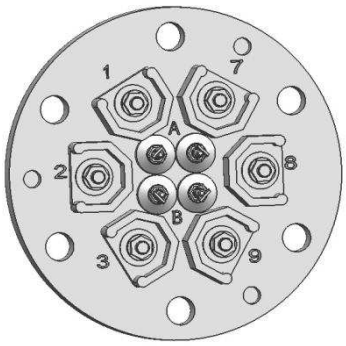
- For parallel system, the liquid level switch is installed on the external oil separator to avoid affecting the compressor oil return due to the low oil level.
- For parallel system, the external oil heater is installed on the external oil separator. The oil heater on-off is controlled by the oil temperature sensor inside the oil separator.
- For parallel system, an oil filler and oil relief valve should be installed on the external oil separator to ease the replacement and supplement of lubricant.
- The machine cannot be start if temperature of the system lubricating oil is lower than 20℃ or higher than 60℃.

For more information about the oil line, please contact HANBELL.

2.4 Motor control

2.4.1 Part winding start

Hanbell screw compressor is equipped with part winding start (PWS) motor.



——A connect to PTC

——B connect to NTC

Figure 21 Compressor wiring

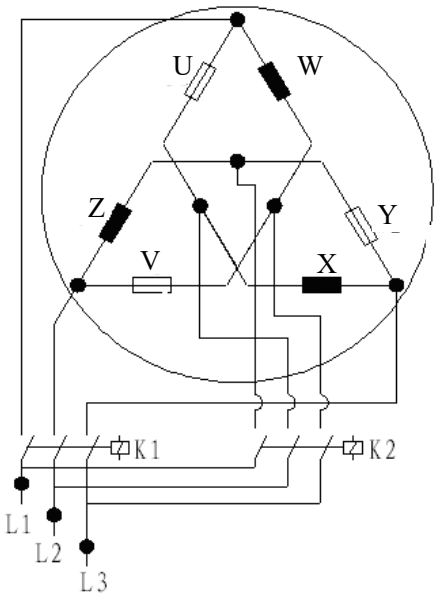
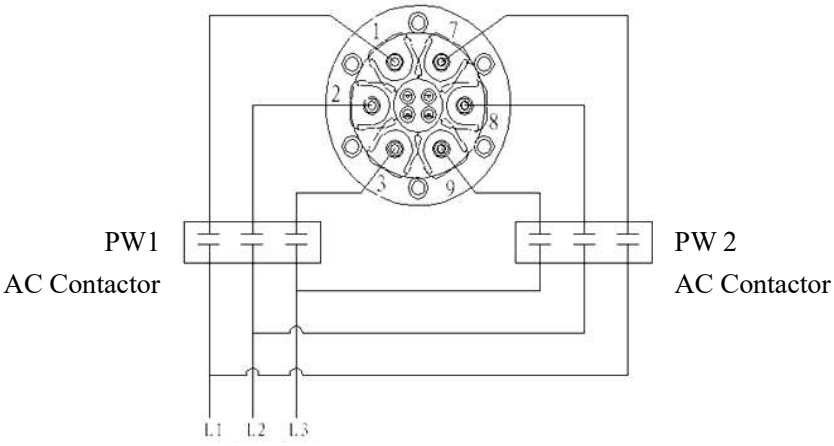


Figure 22 Part winding start



Three phase power supply
380V/50HZ

Figure 23 Compressor motor wiring

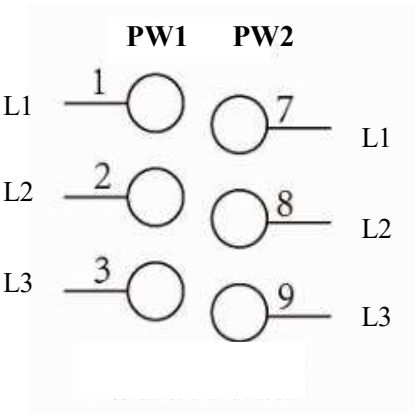


Figure 24 Winding wiring diagram

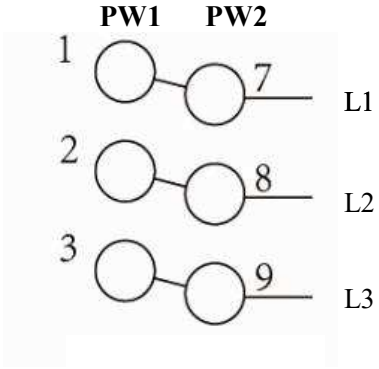
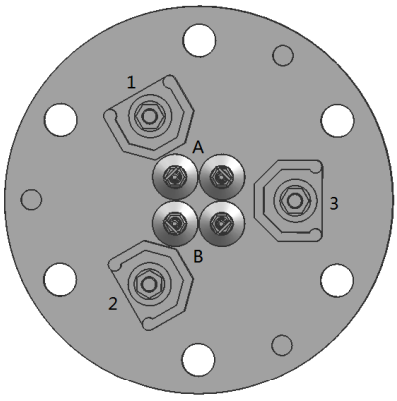


Figure 25 Direct start wiring diagram

■ Suggestions:

1. Switching time for winding start: 0.5s
2. It is suggested that the selection of the motor contactor (k1/k2) requires the respective rated current to be equal to about 60% of the maximum operating current.
3. The starting characteristics of the partial winding: the starting current is 40% ~ 70% of the total locked rotor current of the winding, and the starting torque is high.
4. Frequency conversion motor
   The wiring diagram of the LB-V-PLUS series frequency conversion compressor is as follows.



——A connect to PTC

——B connect to NTC

..

2.4.2 Power requirements

■Power restriction

Voltage restriction Long time operation: Rated pressure ±5%

Instantaneous operation: Rated pressure ±10%

Frequency: Rated frequency ±2%

■Three-phase voltage unbalance

The unbalanced three-phase voltage is mainly caused by unequal distribution of three-phase load.

NEMA (The Association of Electrical Equipment and Medical Imaging Manufacturers) defines voltage unbalance & current unbalance as below:

■

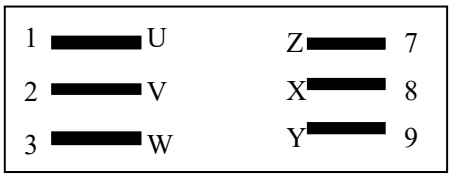
$$\text{Voltage unbalance rate} = \frac{\text{Difference between average and maximum voltage of three phase voltage}}{\text{average valve of voltage}} * 100\ \%$$

$$\text{Current unbalance rate} = \frac{\text{Difference between average and maximum current of three phase current}}{\text{average valve of current}} * 100\ \%$$

The imbalance of current will change within the range of 6~10 times of the percentage of voltage unbalance. Over current will cause overheating of the winding, which will shorten the life of the compressor, and even destroy the motor. If the unbalanced voltage is large, the torque will be reduced and the operating requirements cannot be met, so the motor will not be able to get the required rotation speed.

NEMA declares that when the voltage imbalance of the motor terminal is not more than 1%, the multiphase motor can be successfully opened to operating state at rated startup. But it is not allowed to start the motor when the voltage unbalance is more than 5%, which will damage the motor. It is suggested to install an extra high and low voltage protector at the place where the voltage is unstable. Set the rated voltage range within ±5%, to ensure the safe and long-term operation of the compressor.

It is suggested that if the difference of the maximum and minimum phase current is bigger than 3% of the average current during compressor operation, the three-phase power lines can be exchanged as shown in figures 25 and 26. If the unbalanced phase does not change with phase modulation, it is possible to confirm that it's not the motor problem. Please turn off the machine in time and wait the problem to be solved. If it is motor problem, please contact HANBELL company.



Figu 26 Standard connection of main power supply line

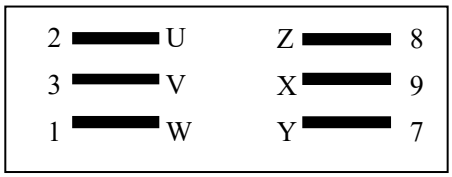


Figure 27 Main power supply line connection during test

2.4.3 Electromagnetic contactor selection

Please refer to the section of contactor in the electrician manual. It is recommended to refer to the AC3 specifications, and to choose the suitable contactor according to the data and the system design.

- Suggestions

1. The set value of the conventional electronic leakage protector should be higher than 50mA (moist area recommended 25mA).
2. The grounding resistance should not exceed 500 Omega.
3. If the electronic leakage protector alarm, please check whether the insulation device is normal and its line setting is correct or not.
4. Please select the appropriate AC contactor, air switch, and power line according to the maximum operating current in below table.

2.4.4 Compressor electrical specification table

Table 4 Compressor motor technical data (Power： 380V/50Hz)

Model(-PLUS)	LB-100	LB-140	LB180	LB-200	LB-230	LB-250	LB280	LB360	LB410
Locked rotor current LRA（A）	218	310	370	508	565	565	710	780	1020
Start current（A）	145	155	196	315	350	350	462	507	663
Maximum working current MCC（A）	57	78	94	114	127	138	151	203	232
KM1，KM2 contactor（A）	40	50	65	90	95	95	115	150	150
Wire selection（mm2）	6	10	16	25	25	35	35	50	50

- Locked rotor current: the motor rotor fails to rotate because of heavy load or other reasons, and at this time the current of the motor is locked rotor current.
- Starting current: the maximum current reached before the motor input current reaches the stable state.
- The highest start and stop frequency: 6 times per hour;
- Shortest operation time: 5 minutes

Frequency conversion motor technical data (Power: 380V/70Hz)

Model(-PLUS)	LB100-V	LB140-V	LB180-V	LB200-V	LB230-V	LB250-V	LB280-V	LB360-V	LB410-V
Locked rotor current LRA（A）	240	323	437	713	825	825	932	1132	1286
Maximum working current MCC（A）	94	119	143	151	180	199	210	234	274
KM contactor (A)	65	90	95	115	150	150	150	150	185
Wire selection（mm2）	16	25	35	50	50	70	70	95	95

2.5 Installation and fixation

- when it is applied to normal system, the compressor must be installed horizontally
- It is suggested that the compressor should not be installed directly on the heat exchanger. If, the compressor must be installed in that way due to condition restriction, please ensure the strength of the load-bearing structure.
- It is suggested to use a fixed steel structure support frame to install the compressor and use the damping pad to reduce the effect of compressor vibration on the system.
- For marine system, the compressor should be installed along the axial direction of the ship, and the external oil tank and pressure maintenance valve need to be configured. Please contact Hanbell company for more installation suggestions.

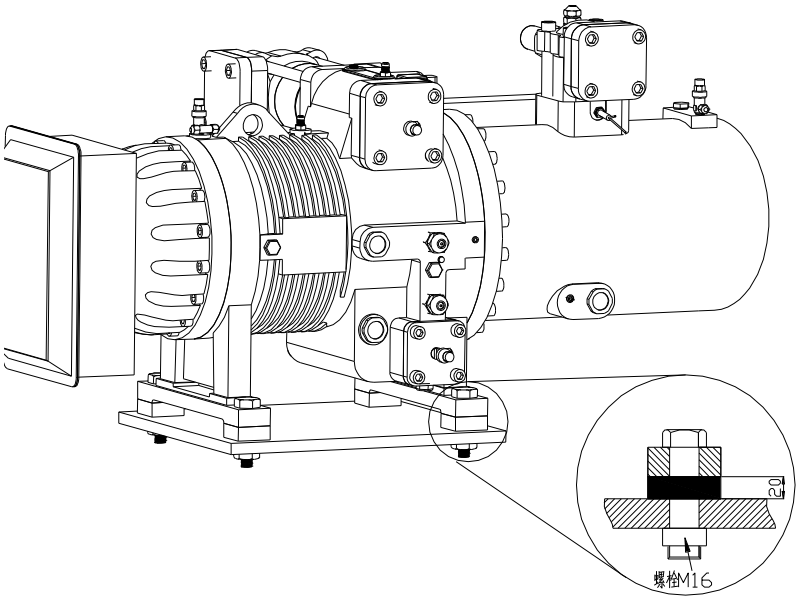
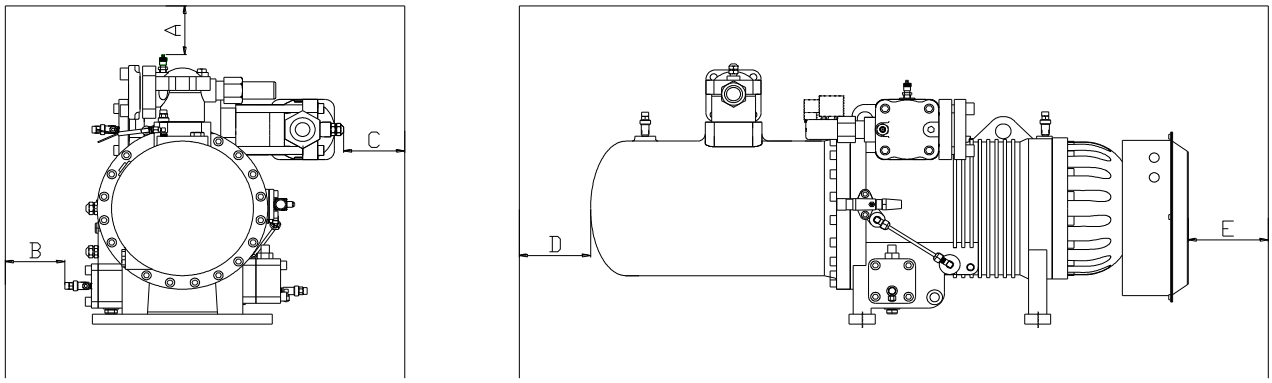


Figure 29 Installation diagram of compressor damping pad

- When the damping pad is being installed, the four bottom bolts should be uniformly stressed and the nuts should be tightened appropriately, and make sure to use spring gasket in order to ensure they won't be loose during long-term operation of the compressor.
- Suggestions for installation place

1. Keep away from other heat sources to prevent thermal radiation;
2. Be close to the electric control cabinet for easy wiring;
3. The compressor installation place and direction shall be easy for oil level check and daily maintenance.
4. The installation position shall be strong enough so as not to cause resonance and noise.
5. Avoid to install the compressor in places with high humidity and bad ventilation.

6. Reserve sufficient place for after-sales service.



Service room	A	B	C	D	E
LB-100-PLUS	300	300	300	300	300
LB-140-PLUS	310	320	326	335	316
LB-180-PLUS	310	320	326	344	316
LB-200-PLUS	410	335	426	476	368
LB-230-PLUS	410	335	426	476	368
LB-250-PLUS	410	335	426	476	368
LB-280-PLUS	410	335	426	476	368
LB-360-PLUS	400	300	426	300	316
LB-410-PLUS	400	300	426	300	316

Figure 30 Compressor installation diagram

3. Spare parts

3.1 Spare parts table

Item	Description	Model	
		Single	Parallel
1	Suction shutoff valve	●	●
2	Intake control solenoid valve	●	●
3	Discharge shutoff valve	●	●
4	PTC discharge temperature sensor	●	●
5	NTC motor coil temperature sensor	●	●
6	PTC motor coil temperature sensor	●	●
7	INT-69HBY protection module	●	●
8	Damping pad	●	●
9	Electronic expansion valve and its controller	●	●
10	Oil pressure difference protector	●	●
11	Suction check valve	●	●
12	Oil circuit solenoid valve	/	●
13	External oil filter	/	●
14	Oil flow switch	/	●
15	Sight glass	/	●
16	Oil circuit block pin	/	●
17	Oil flow switch	●	/
18	Pressure maintenance valve	/	/
19	Frequency conversion controller	/	/
20	Discharge check valve	/	/

Table 5 Compressor configuration table

Note: 1. The final interpretation of the above table belongs to HANBELL.

2.●: standard parts ／: optional parts

3. The above parts are subject to the contract.

3.2 Oil circuit parts

3.2.1 Oil flow switch

In order to prevent the compressor from losing oil, an oil flow switch should be installed in the compressor system which has an external oil separator.

The specifications of the oil flow switch are shown in the following chart.

Specification table:

Model	Size	Interface	Applicable model
138	3/8"	Thread/weld	LB-100~180-PLUS
125	5/8"	Thread/weld	LB-200~410-PLUS

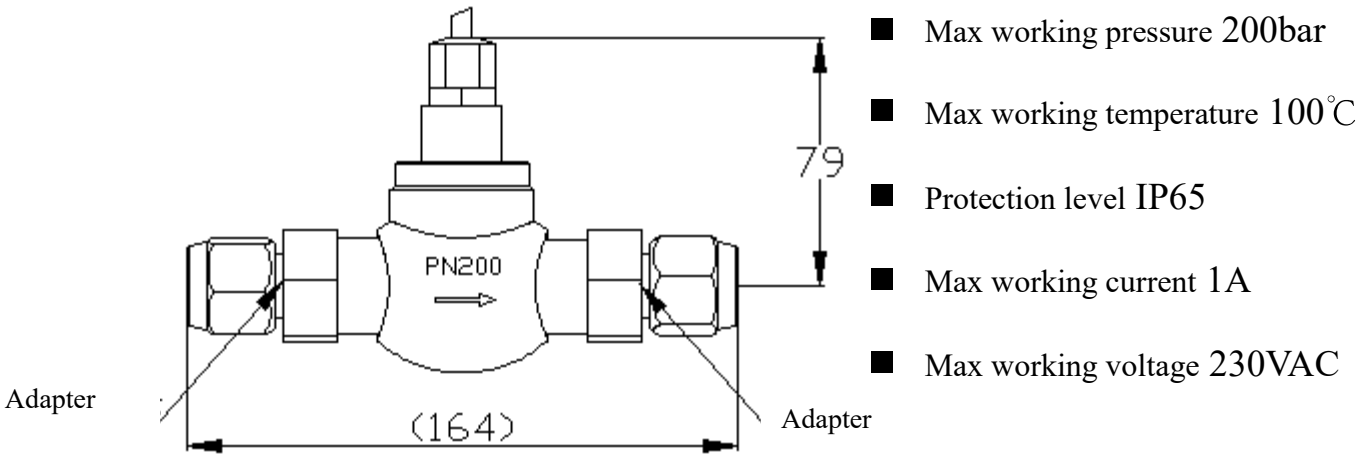
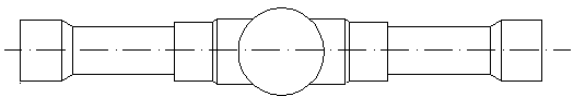


Figure 31 Oil flow switch diagram

3.2.2 Oil circuit sight glass

■ Sight glass

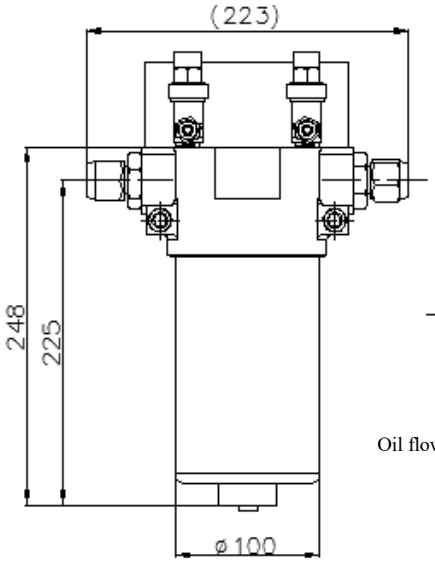


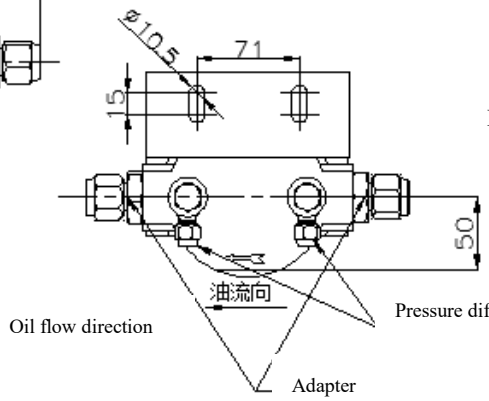
■ Max working pressure 35bar

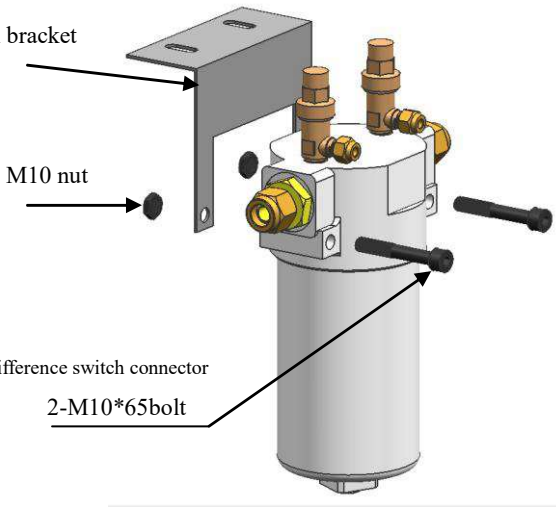
■ Max working temperature 100℃

Figure 34 Oil circuit sight glass

3.2.3 External oil filter







External oil filter bracket installation diagram

- Max working pressure 28bar
- Working temperature-55~120℃

Specification table:

Size	Interface	Applicable model
3/8"	Thread/Weld	LB-100~180-PLUS
5/8"	Thread/Weld	LB-200~410-PLUS

Figure 32 External oil filter diagram

3.2.4 Oil circuit solenoid valve

■ Oil circuit solenoid valve

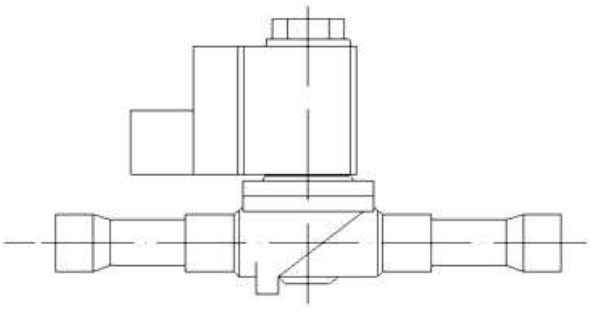


Figure 33 Oil circuit solenoid valve diagram

- Max working pressure 35bar
- Max working temperature 105℃
- Power 220V/ 50Hz

Direction arrow at the bottom “⟶”

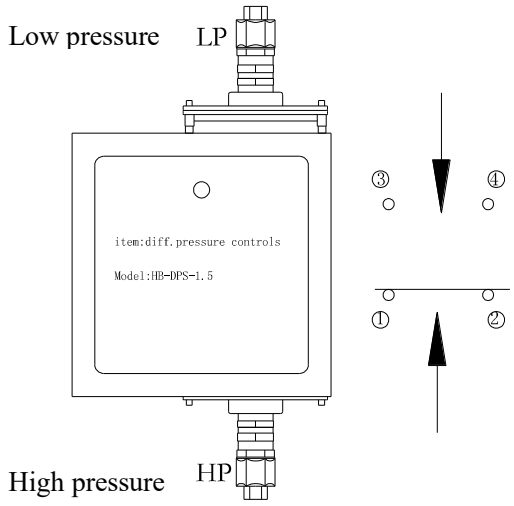
3.2.5 Oil pressure differential switch

Function: check the pressure drop before and after the oil filter screen. If the pressure drop exceeds the set value, the oil pressure differential switch will jump off , so as to prevent too much the impurity of foreign matter adsorbed on the surface of the oil filter screen, which will do harm to the oil supply system.

Specification: For oil pressure differential switch provided by HANBELL, the standard jump off value setting is 1.5bar. It can be reset by hand.

Instructions for use: non external oil system of single system, the high pressure connector (HP) pressure differential switch is connected to the compressor high pressure interface (high pressure side angle valve or angle valve at the discharge oil separator side). The low pressure connector (LP) is connected to the compressor oil filter flange angle valve. When the oil resistance is greater than the set value (1.5bar), the pressure differential switch is activated(OFF) to cut off the compressor control circuit to remind the user to clean up the compressor built-in oil filter

Parallel system (or single system with external oil circuit), please install the pressure differential switch at the inlet and outlet of the external oil filter. When the alarm is broken, please clean and replace the oil filter element in time.



when the pressure differential switch controller is in normal state, 1 and 2 is connected; when the pressure difference increases and exceeds the set value, 3 and 4 is connected; when the pressure difference decreases and lower than the set valve, please push the reset button, thus 1 and 2 is connected

Figure 35 Pressure differential switch diagram

3.3 System parts

3.3.1 Suction and discharge shutoff valve

In order to facilitate the maintenance and repair of the machine, it is recommended to install the suction and exhaust shutoff valves for the compressor. Please refer to the following table to know about HANBELL shutoff valve.

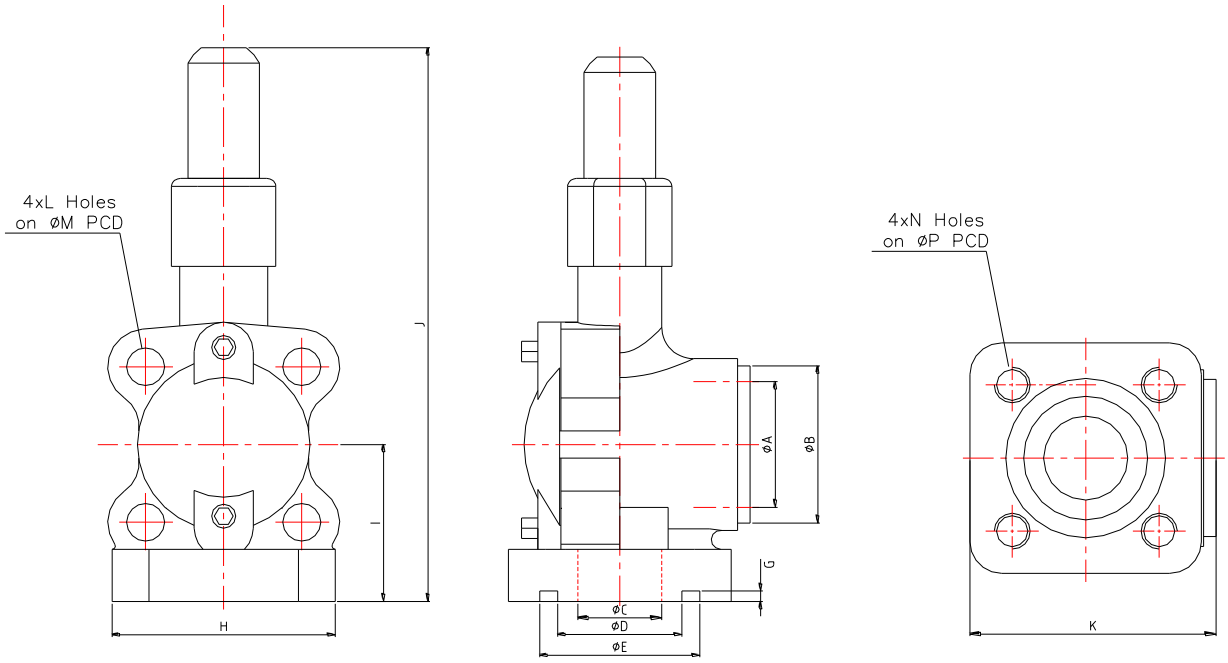


Figure 35 Shutoff valve dimension

SPEC	Standard dimension														UOM: mm
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P
11/2"	60	75	40	59	76	6	5	108	75	256	115	18	105	M16x2	105
2"	70	90	60	69	91	6	5	122	86	280	128	18	120	M16x2	120
21/2"	90	110	67	89	111	6	5	137	95	307	153	18	140	M16x2	140
3"	100	120	80	99	121	6	5	154	117	398	177	22	160	M20x2.5	160
4"	125	145	105	124	146	6	5	171	130	445	201	22	185	M20x2.5	185

* Shutoff valve specification

Max working pressure	Strength test（gas pressure）	Temperature range
28 bar	35 bar	-50～150℃

3.3.2 Damping pad

Function: to reduce the additional vibration and noise during compressor operation.

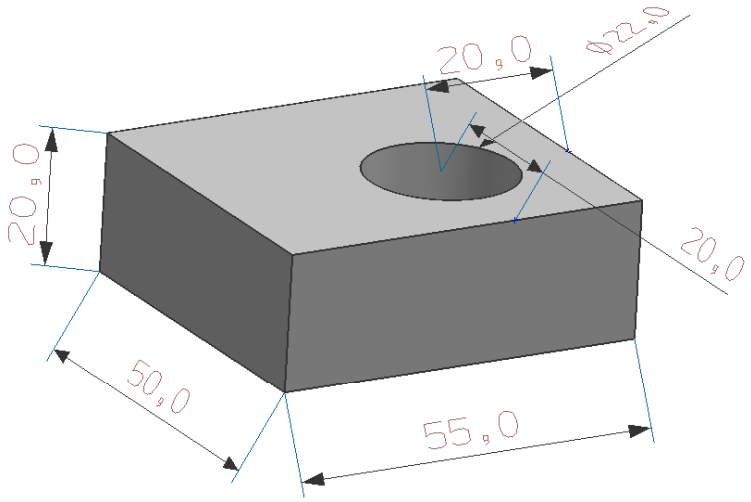


Figure 36 Compressor damping pad specification (mm)

3.4 Electrical parts

3.4.1 INT69 HBY Diagnose protection module

a) Application description:

The protection module INT69 HBY Diagnose is the advanced product of the protection module series, which is used for the compressor protection microcontrollers. The flexible response function is added in the phase sequence monitoring, which improves the practicability and prolongs the life of the refrigeration system. INT69 HBY Diagnose automatically stores work and error data in a memory. Only through a specific transmission line, the data can be read on a personal computer and be used for diagnostic analysis.

b) Function description:

- The series PTC thermistor enters the signal input end of the protection module.
- If any resistance value of the thermistors rise above the jump off value, the protection module will jump off. The blocking value of PTC will reduce to the reset value. After 5 minutes of reset time, the module will automatically reset. In the first disconnected 24 hours, if the PTC values raise to the reset value again, the reset time will be 60 minutes. If the PTC third time rise to the reset value in 24 hours, the module will be locked and cannot be reset automatically.

- One second after the motor starts, the motor phase monitoring function is activated and will remain to be activated for 5 seconds. Motor phase being abnormal or motor being underphase will cause the protection module to be disconnected and locked.
- In order to avoid the compressor shutdown caused by reversal after the compressor shutdown, the phase monitoring function will only maintain for 20 seconds after the motor is stopped.
- LED (light-emitting diode) (red / Green / orange) shows its working information.
- The motor protection module cannot be used in the variable frequency drive device.
- The PTC short circuit will cause deadlock, and the short cycle will lead to the reset delay.
- If the reset delays when the temperature reduces or the error is removed, please reset the module. The compressor needs to be restarted after the reset.

⚠ This module must be assembled and maintained by a professional electrician. It should have European or national standards, when the module is connected to electrical equipment and cooling devices. The connection line between the junction box and the temperature sensor must be the insulation line.

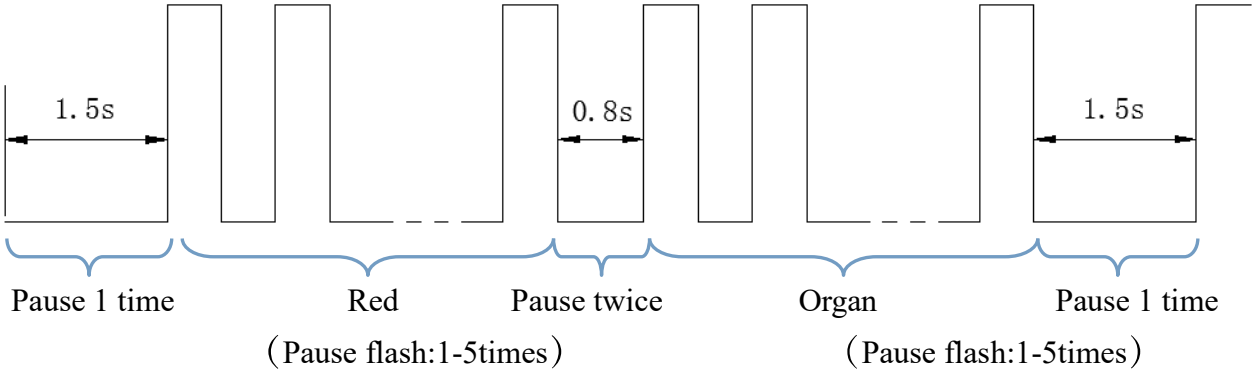
c) Technical data

Item	Technical data	Item	Technical data
Supply voltage	AC 50/60HZ 115/240V±10% 3VA	System PTC short circuit monitoring	Normally<30Ω
Motor voltage	3 AC 50/60Hz 200/690V ±10%	Over frequency operation	Not support
— Sensor type — R25, All — Maximum connection length	Connect 1-2 AMS sensors and 1-9 PTC in serious as optional; serious connection shall meet the DIN 44081 and DIN 44082 standards <1.8KΩ 30M	—Motor static jump off 1 times/24h 2 times/24h 3times/24h —Switching frequency —Phase stagger —Phase loss Cancel deadlock or reset delay	5min±1min 60min±12min Deadlock 5min±1min Deadlock Deadlock Power off and reset
Ambient temperature	-30…70℃	Maximum switching frequency	Three times on and off switching within 30 seconds
Phase monitor — Phase sequence — Phase loss — Inactivation	Activated 1 second after the motor starts and will remain monitoring for 5 seconds Activated 1 second after the motor starts and will remain monitoring till the machine stops About 20 seconds after the motor stops	Delay reset relay —Power —Mechanical life	AC 240V 2.5A C300 at least AC/DC 24V 20mA one million times on and off switching

d) Signal light flashing

The signal lamp is for convenient, fast and easy repair; the lighting signal is composed of red and orange. The current state of light flashing depends on the number of pulse flashes.

Signal is as below:



Signal light description	Green light	Compressor operation
	Green light flash	Compressor operation
	Red/organ flash	Faults occur; relay jump off; compressor stop; please refer to below table

First flash sequence (red light)	Second flash sequence(organ)	Description
1	1	Motor temperature: static jump off; winding temperature over high
	3	Motor temperature: reset delays after static jump off
	4	Motor temperature: temperature sensor detects open circuit or short circuit
2	1	Motor voltage: phase sequence wrong
	2	Motor voltage: phase stagger/three phase asymmetry
3	1	Power supply voltage: module access power supply too low
If the green light is always on but the compressor cannot start: use the multimeter to test the resistance between M1 and M2. If it is found to be blocked, the protector needs to be replaced.		

e) Appearance and wiring

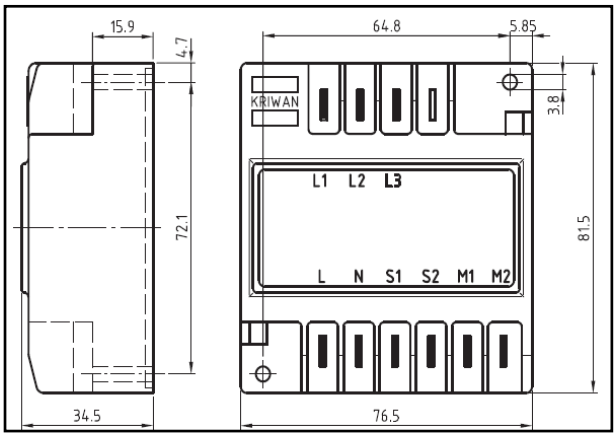


Figure37 INT69 HBY Diagnose diagram

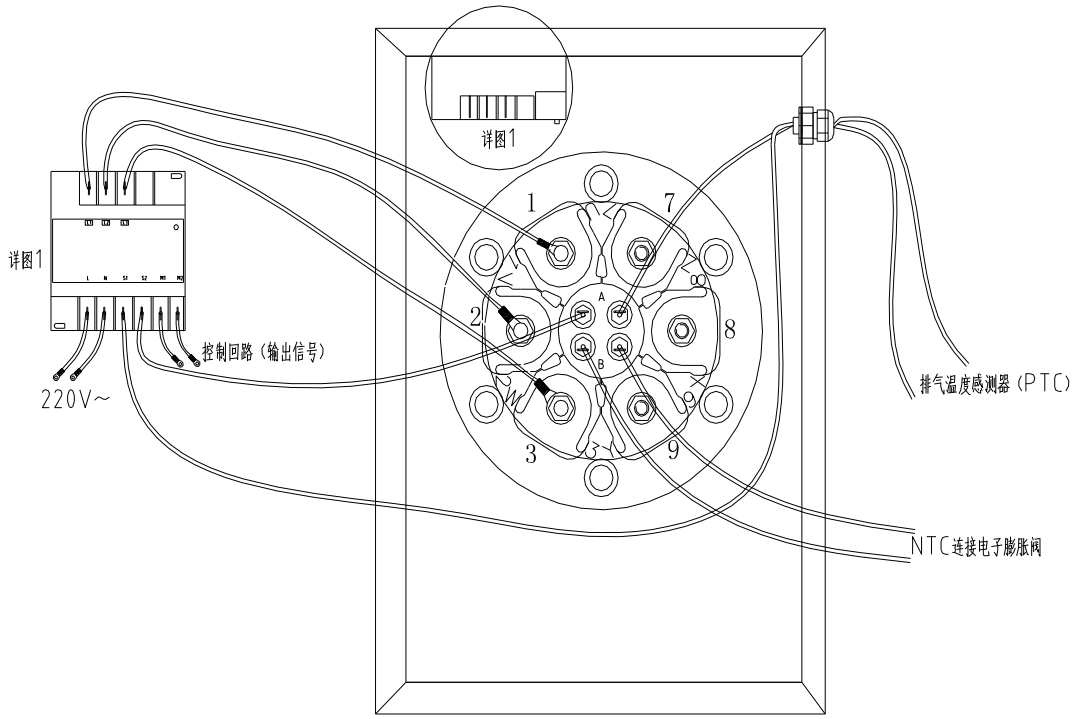


Figure 38 INT69 HBY&PTC connection diagram

Note: the above picture only indicates the connection method of protection module; it is not the compressor startup mode.

3.4.2 Electronic expansion valve and controller

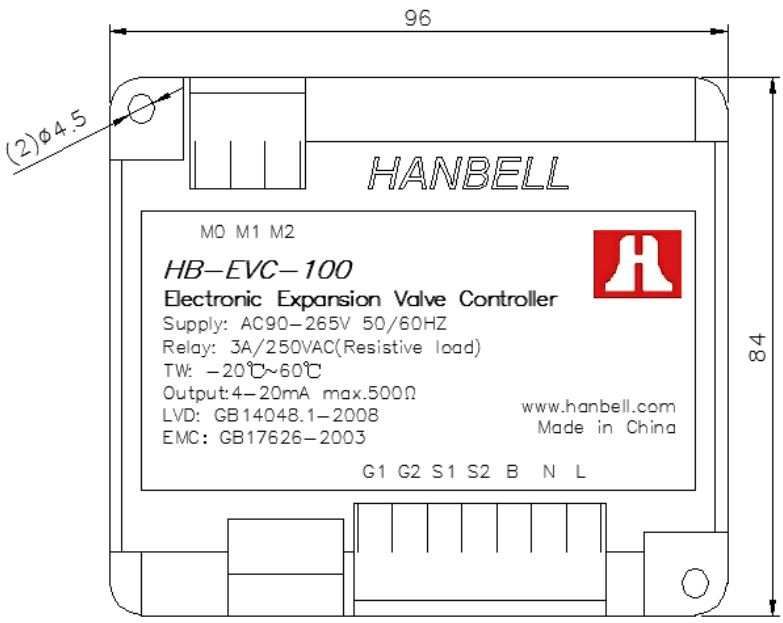
a) Application and function:

The newly added electronic expansion valve module is used to control the motor temperature of LB-PLUS serious low temperature refrigeration compressor. The electronic expansion valve module is composed of an electronic expansion valve and a controller. The controller reads the temperature of the motor through the resistance signal from the motor embedded NTC sensor to automatically control the opening of the electronic expansion valve to achieve automatic control of the liquid spray of the motor.

b) Technical data

Supply voltage	AC 50/60HZ 100-265V ,12Wmax
Output current	4-20ma corresponding motor temperature 0-110℃
Sensor type	NTC 10K@25℃， β=3435
Ambient temperature	-20-60℃ operation period 20-80%Rh. no condensation
Start frequency	Max once/min
Rely	3A/250Vac Resistive load
Protection level	IP20

c) Appearance and wiring



Size schematic diagram

Function	Description	Note
NTC fault feedback	Normal condition:M0 and M1 are normally closed; M0 and M2 are disconnected; open circuit or short circuit: M0 and M1 are normally open; M0 and M2 are closed	1) L must be connected to the firing line, N must be connected to the zero line, otherwise the terminal B will burn and the controller cannot operate normally. 2) Wiring correctly, 1min after the controller gets power, the compressor can be switched on. When the compressor is stopped and started again, it needs more than 1min interval, otherwise the motor will be burned
Motor temperature feedback	G1 & G2 side current output 4-20m, corresponding motor temperature 0-110℃	
Motor temperature control	S1 & S2 connect motor NTC	

3.4.3 Embedded NTC

NTC is one kind of embedded temperature sensor which is installed inside the motor coil. It is connected with the electronic expansion valve to display the temperature of the motor, and precisely control the liquid jet to protect the compressor (refer to figure 38).

3.4.4 NTC temperature sensor and resistance valve

Empirical value formula：$R = 10 * e^{3435*(\frac{1}{273+T}-\frac{1}{273+25})}$, 10 is the resistance valve when temperature comes to 25℃; R is the resistance valve when temperature is T.

Temp	Resistance valve			Temp	Resistance valve			Temp	Resistance valve		
	Max	Typical	Min		Max	Typical	Min		Max	Typical	Min
℃	KΩ	KΩ	KΩ	℃	KΩ	KΩ	KΩ	℃	KΩ	KΩ	KΩ
-10	43,52	42,47	41,43	31	8,11	8,01	7,92	72	2,15	2,10	2,05
-9	41,55	40,57	39,60	32	7,83	7,73	7,63	73	2,09	2,04	1,99
-8	39,69	38,77	37,86	33	7,55	7,45	7,36	74	2,03	1,98	1,93
-7	37,92	37,06	36,21	34	7,29	7,19	7,10	75	1,98	1,92	1,87
-6	36,25	35,44	34,64	35	7,04	6,94	6,85	76	1,92	1,87	1,82
-5	34,66	33,90	33,15	36	6,79	6,70	6,61	77	1,87	1,82	1,77
-4	33,15	32,44	31,73	37	6,56	6,47	6,37	78	1,81	1,77	1,72
-3	31,72	31,05	30,39	38	6,34	6,25	6,15	79	1,76	1,72	1,67
-2	30,36	29,73	29,11	39	6,12	6,03	5,94	80	1,72	1,67	1,62
-1	29,06	28,48	27,89	40	5,92	5,83	5,74	81	1,67	1,62	1,58
0	27,83	27,28	26,74	41	5,72	5,63	5,54	82	1,62	1,58	1,53
1	26,65	26,13	25,62	42	5,53	5,44	5,35	83	1,58	1,53	1,49
2	25,52	25,03	24,55	43	5,34	5,26	5,17	84	1,54	1,49	1,45
3	24,44	23,99	23,54	44	5,17	5,08	4,99	85	1,49	1,45	1,41
4	23,42	23,00	22,57	45	5,00	4,91	4,83	86	1,45	1,41	1,37
5	22,45	22,05	21,66	46	4,83	4,75	4,67	87	1,42	1,37	1,33
6	21,53	21,15	20,78	47	4,68	4,59	4,51	88	1,38	1,34	1,30
7	20,64	20,30	19,95	48	4,52	4,44	4,36	89	1,34	1,30	1,26
8	19,81	19,48	19,15	49	4,38	4,30	4,22	90	1,31	1,27	1,23
9	19,01	18,70	18,39	50	4,24	4,16	4,08	91	1,27	1,23	1,19
10	18,25	17,96	17,67	51	4,10	4,03	3,95	92	1,24	1,20	1,16
11	17,51	17,24	16,97	52	3,97	3,90	3,82	93	1,21	1,17	1,13
12	16,81	16,56	16,30	53	3,85	3,77	3,70	94	1,17	1,14	1,10
13	16,14	15,90	15,67	54	3,73	3,65	3,58	95	1,14	1,11	1,07
14	15,50	15,28	15,06	55	3,61	3,54	3,46	96	1,12	1,08	1,04
15	14,89	14,69	14,48	56	3,50	3,43	3,35	97	1,09	1,05	1,02
16	14,31	14,12	13,92	57	3,39	3,32	3,25	98	1,06	1,02	0,99
17	13,75	13,58	13,39	58	3,28	3,22	3,15	99	1,03	1,00	0,97
18	13,22	13,06	12,89	59	3,18	3,12	3,05	100	1,01	0,97	0,94
19	12,72	12,56	12,40	60	3,09	3,02	2,95	101	0,98	0,95	0,92
20	12,24	12,09	11,94	61	2,99	2,93	2,86	102	0,96	0,92	0,89
21	11,77	11,63	11,50	62	2,90	2,84	2,77	103	0,93	0,90	0,87
22	11,32	11,20	11,07	63	2,82	2,75	2,69	104	0,91	0,88	0,85
23	10,90	10,78	10,66	64	2,73	2,67	2,61	105	0,89	0,86	0,83
24	10,49	10,38	10,27	65	2,65	2,59	2,53	106	0,87	0,84	0,81
25	10,10	10,00	9,90	66	2,57	2,51	2,45	107	0,84	0,82	0,79
26	9,73	9,63	9,53	67	2,50	2,44	2,38	108	0,82	0,80	0,77
27	9,38	9,28	9,18	68	2,42	2,36	2,31	109	0,80	0,78	0,75
28	9,04	8,94	8,84	69	2,35	2,30	2,24	110	0,79	0,76	0,73
29	8,72	8,62	8,52	70	2,28	2,23	2,17				
30	8,41	8,31	8,21	71	2,22	2,16	2,11				

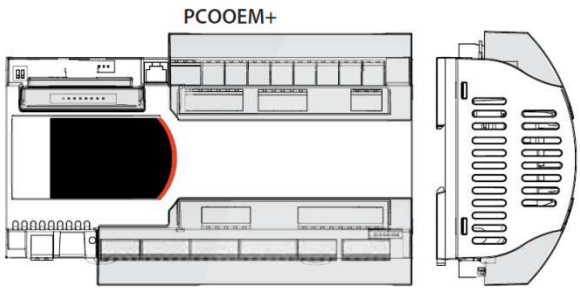
Table 6 NTC sensor temperature and resistance valve 10K@25℃

3.4.5 Frequency conversion controller

3.4.5.1 Controller introduction

The frequency conversion controller is specially developed for LB-PLUS series inverter compressor, which greatly simplifies the development difficulty and development cost of the frequency conversion unit. Its operation is simple and has a good man-machine interface. It can achieve effective and timely control of the variable frequency compressor, and accurately control the temperature of and saves energy, which is very suitable for food, medicine and other industries that have harsh requirements for low temperature.

The frequency conversion controller consists of a host PCOOM+ and a PLDPRO manipulator. PCOOEM+ has a built-in control program, and the running parameters of program and system devices are stored in FLASH-MEMORY and EEPROM, so that data can be reliably stored. The PLDPRO manipulator is the terminal of the whole system control, which can be used to set the parameters and display the feedback parameters of the compressor and the frequency converter. PLDPRO graphic display is a control terminal. It can manage graphics through graphic display, and can process international characters. When it alarms, the buzzer will send out sound signals. The temperature range (-20~60) and the protection level of the front panel of the manipulator is IP65.



Controller host

PLDPRO manipulator

3.4.5.2 Design features

1. Control model of frequency converter

The controller is through two methods, evaporation water outlet temperature and suction pressure, to control the temperature to ensure the temperature within the preset range. At the same time, the ability to handle some abnormal conditions is also available. (see the following table for specific functions)

Function	Description
Temperature adjustment	Through the feedback of evaporation water outlet temperature and suction pressure to realize the loading and unloading, so as to adjust the temperature
Motor high temperature management	The temperature of the motor is higher than the unloading point, compressor unloads and will resume until the temperature is lower than the safety point
Motor high temperature alarm	If the temperature of the motor is higher than the alarm point, the compressor stops.
High current management	If the current is higher than the unloading point, the compressor unloads and it will resume when the temperature is lower than the safety point.
High current alarm	If the current is higher than the alarm point, the compressor stops.
High discharge pressure management	If the discharge pressure higher than the unloading point, the compressor unloads and it will resume when it reaches the safety point.
High discharge pressure alarm	If the discharge pressure higher than the alarm point, the compressor stops.
Low pressure alarm	If the suction pressure is lower than the alarm point, the compressor stops.

2. Simple control logic

On the basis of ensuring the safety and reliability of the compressor operation, the principle of control is simplified, and it is easy to use.

3. Accurate and fast temperature control

The controller can response quickly to the feedback of temperature or pressure, and control the compressor's loading and unloading by a frequency converter, so as to ensure that the temperature reaches quickly and is in a reasonable interval.

4. Ensure reliable & safe operation of the compressor

The controller has a complete abnormal handling program and alarm program. It can make timely and effective response when the unit is in trouble, so as to ensure the safety and reliability of the unit.

☆If you want more information and instructions for frequency control, please contact HANBELL company.

4. Maintenance

4.1 Items to be checked before machine starting

Items	Key points to be checked	Corresponding confirmation method
1. Compressor and spare part appearance check	1.Refrigerant oil level; 2.Lubricant oil temperature; 3. Inlet & outlet shutoff valve completely open; 4.Motor liquid injection angle valve completely open	1. High oil level is full; 2. Before trial operation, the oil need to be heated to around 40℃, the time required for heating is about 8 hours; 3. Open the shutoff valve dustproof nut to check; 4. Open the motor injection angle valve dustproof nut to check;
2. Electrical system	1. Main power supply voltage value 2.Control circuit voltage value 3.Interphase and ground insulation resistance of motor 4. Connection between power and wire 5. Grounding wire installation 6.Switch, sensor, and controller setting	1. The voltage fluctuation range of the main power supply is controlled within the rated voltage 380V±5%, and the instantaneous voltage drop is less than 10% when it starts; 2. The standard voltage of the control circuit is 220V±10%; if there are other requirements, please contact Hanbell company; 3. Insulation valve shall be higher than 5MΩ; 4. The power supply is connected to the junction box with good insulation. The power line should be far away from the heat source and the metal with angular angle, so as to avoid the damage of the insulation skin. It should be equipped with a junction box and a junction box bolt; 5.Make sure it is installed;
3. Pipeline system	1. Whether the pipe is secured or not; 2. Make sure no leakage on the pipe	1. visual check of manual check 2. Check with a leak detector or soapy water, especially at the welding area and interface.
4. Protection device	1. Coil temperature protection 2. Discharge temperature protection 3. Oil level switch	1. Not activated(closed circuit) 2. Not activated(closed circuit) 3. Full oil level(closed circuit)

Table 7 Items to be checked before machine starting

4.2 Items to be checked during operation

- Power on the compressor for about 0.5-1 seconds to determine whether the compressor rotation is normal or not by monitoring the suction and exhaust pressure (the normal rotation of the compressor: the suction pressure drops immediately and the exhaust pressure rises).
- After starting, check the lubricating oil in the sight glass on the external oil line to find out whether it is full or not. If you found any problems, please check the pressure difference between the high and low pressure, check if the filter is blocked or not (pressure difference alarm), whether the oil return solenoid valve of the external oil separator is open or not, if the oil outlet is blocked or not, check whether the motor temperature ascend too fast, if spray liquid pipe supplies liquid or not (Concerning control logic, please refer to the 2.1.1).
- When the compressor is started, the lubricating oil in the oil separator will produce foam in short time, but the lubricating oil foam will disappear when the compressor works under the rated condition. In general, the normal oil level in the oil separator shall be above the middle level of the low oil level sight glass, and the minimum level shall not be lower than the middle level of the low oil level sight glass (Figure 38), otherwise it means insufficient oil filling or compressor oil spitting. (please refer to 4.3)
- The operating conditions of the compressor should be adjusted according to the following way: the discharge temperature should be over 30K than that of condensing temperature, and the overheat of the suction is within 15K.
- The whole equipment, especially the pipe, must pass the abnormal vibration test. If there is abnormal vibration or noise during the operation of the compressor, please contact HANBELL.
- If the compressor is in operation for a long time, the following items should be checked daily: machine operation data (such as: three-phase voltage, line current of the compressor etc.), the oil temperature and oil level of the lubricant, all sensing parts, the connecting and fastening of the wire, and the sight line of the oil circuit.
- When the condensing unit is in operation, special attention should be paid to its auxiliary equipment, as well as the maintenance schedule of the unit after the first start operation.
- To ensure normal viscosity of the lubricating oil at low ambient temperature and ensure smooth lubrication of the bearing, it is recommended that the oil heater on the external oil separator should be kept open when the compressor is shut down, so as to prepare for the next start.

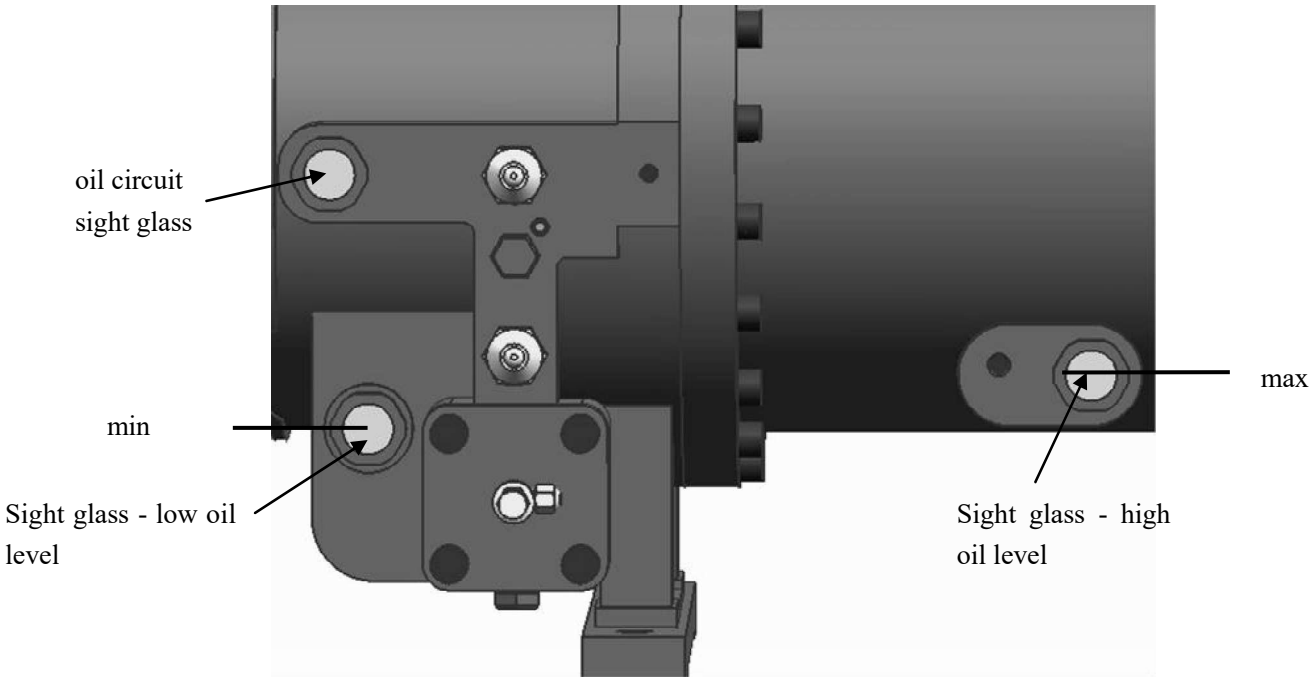


Figure 39 Compressor oil level mark

⚠ Note:

When the compressor is running, the oil level needs to be between the middle line of the high oil sight glass and the middle line of the low oil sight glass. Through the sight glass, the flow of lubricating oil can be seen and the oil is clear and transparent. If the oil level is lower than the low oil level sight glass, it is necessary to shut down and refuel. Please check whether the suction is with liquid or not (oil return shows white or a large number of bubbles occurs), because it will lead to the sharply increase of oil spitting of oil separator, which finally causes the compressor to lose oil.

If the discharge temperature is too low and the boot lubricating oil temperature of the oil separator is too low, it will also cause the refrigerant dissolves in the lubricating oil, which will not only cause the compressor bearing damage, and also make it easier for compressor oil loss. If it is a full liquid system, please check whether the oil return solenoid valve is open the oil return according to the set control logic.

⚠ Emergency stop

- Cut off the power supply and stop the compressor. For major accidents, please cut off the main switch of the compressor power supply, the whole compressor will be stopped.
- Close all the fluid supply valves on the system as soon as possible, and close the suction and discharge valves of the compressor.

- Find out the causes of the failure or accident and eliminate it.
- In case of sudden power outage, in addition to closing the compressor suction, discharge valve and evaporator supply valve in time, the power switch should be cut off and the cause of power outage should be ascertained.

4.3 Faults analysis

Faults	Possible causes
Compressor motor coil temperature protection jump off	1. The motor load is too large, the cooling is insufficient or the motor liquid spray solenoid valve is invalid. 2. Coil protection switch failure 3. Poor electrical system or failure 4. Poor motor coil, temperature increase too high 5. Controller of electronic expansion valve failure, no current output
Poor motor insulation	1. The wire joint of the compressor motor is humid. 2. Poor compressor motor 3. Poor compressor wiring terminal 4. The electromagnetic contactor is poorly insulated. 5. Internal acidification of the system, corrosion and insulation 6. The coil is running at high temperature for long time, causing deterioration of the insulation. 7. Frequent start, coil deterioration. 8. Too much water contained in the refrigerant
The motor cannot be started or switched	1.Voltage too low or voltage error. 2. The voltage drop of the starting voltage is too large and the electromagnetic contactor cannot be absorbed. 3. Motor failure. 4. Underphase, reverse phase and lack of phase 5. Motor protection switch activated. 6. Incorrect wiring of motor coil. 7. Bad △−△ start timer 8. The current setting is too small or the improper selection of circuit breaker. 9. Poor electromagnetic contactor

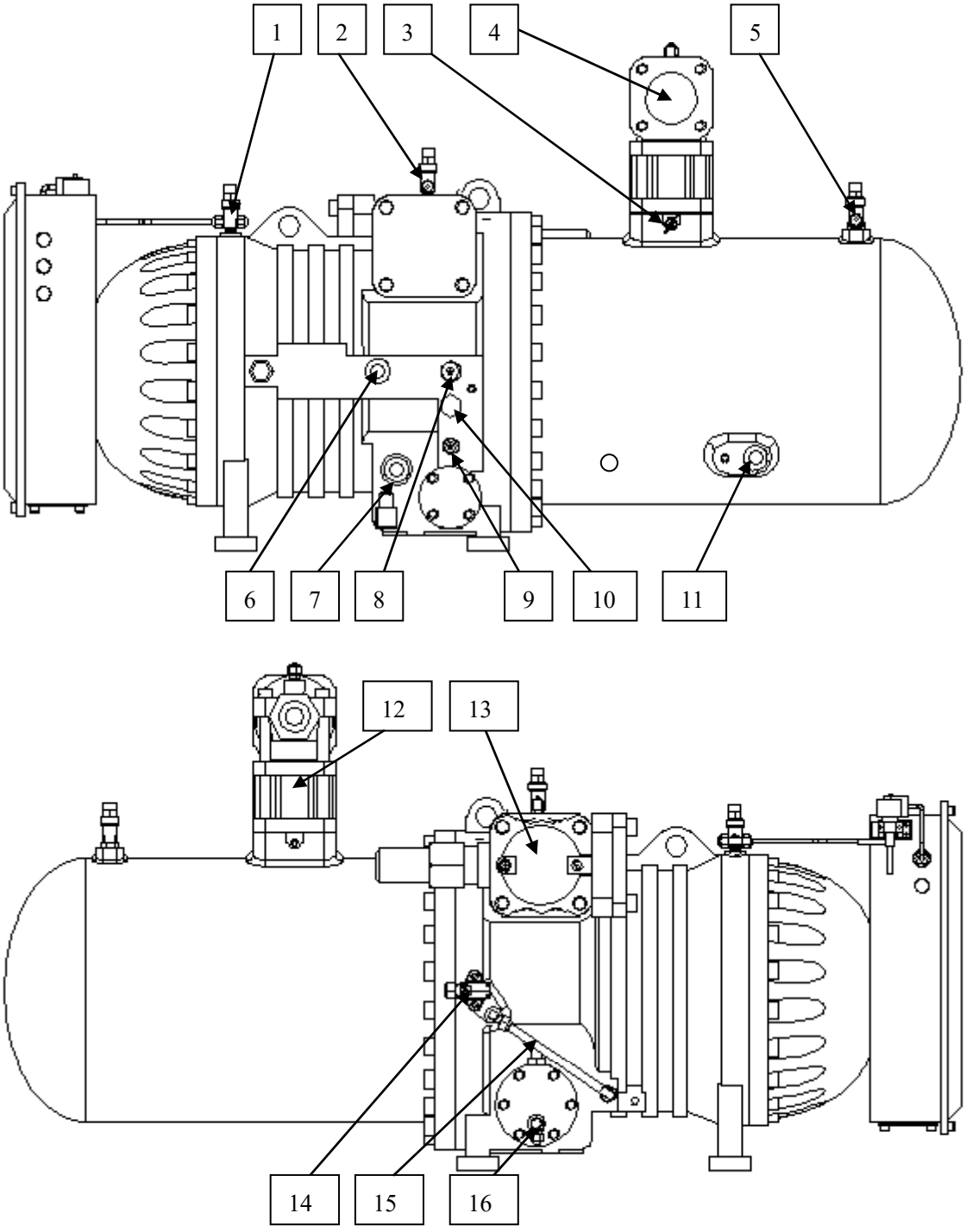
Abnormal vibration or noise	1.Bearing damage. 2.Compressor liquid compression. 3. The rotor is overheated & friction with the rotor or the shell. 4. Oil loss causes poor lubrication. 5. The internal parts loose 6. Poor piping, without flexible stretch causing resonance 7. The foreign body enters the compression chamber.
Discharge temperature too high	1. Excessive heat of inhalation refrigerant (insufficient refrigerant, abnormal expansion valve). 2. High pressure too high (bad cooling, air comes into the system, high temperature of cooling water, insufficient cooling water flow, poor heat transfer effect of condenser). 3. The compression ratio is too large and there is no auxiliary cooling. 4. Bearing damage, rotor friction. 5. The loss of oil or oil level is too low.
System low voltage alarm	1. Insufficient refrigerant 2. The evaporator has severe frosting, which affects heat transfer. 3. The opening of the expansion valve is too small, the temperature package is loose, and the thermal insulation is not made. 4. The intake filter is frozen or dirty. 5. The evaporator is too small. 6. Low voltage protection setting.
System high pressure alarm	1. Too much refrigerant 2. The effect of heat exchange is not good because the condenser is dirty or air comes into it. 3. The discharge temperature is too high. 4. The expansion valve is dirty and blocked. 5. The condenser is too small. 6. High pressure protection setting problem.
Oil flow alarm	1. Oil flow switch failure 2. The condensing pressure cannot be set up at starting, and the oil supply pressure difference is not enough. 3. Oil circuit blocked 4. Oil circuit solenoid valve failure

Discharge temperature too low	1. Compressor suction has fluid 2. Oil return temperature too low 3. The opening of the expansion valve of the system liquid tube is too large 4. The opening of the economic expansion valve is too big
Insufficient oil supply in compressor	1. Exhaust temperature too low 2. Oil separator filter net failure 3. Oil temperature of the oil separator is too low (not open oil heater before starting) 4. Suction or gas supplement has liquid 5. Economic expansion valve opening is too big 6. Insufficient oil returning during suction 7. Excessive pressure drop in external oil circuit causing poor oil supply

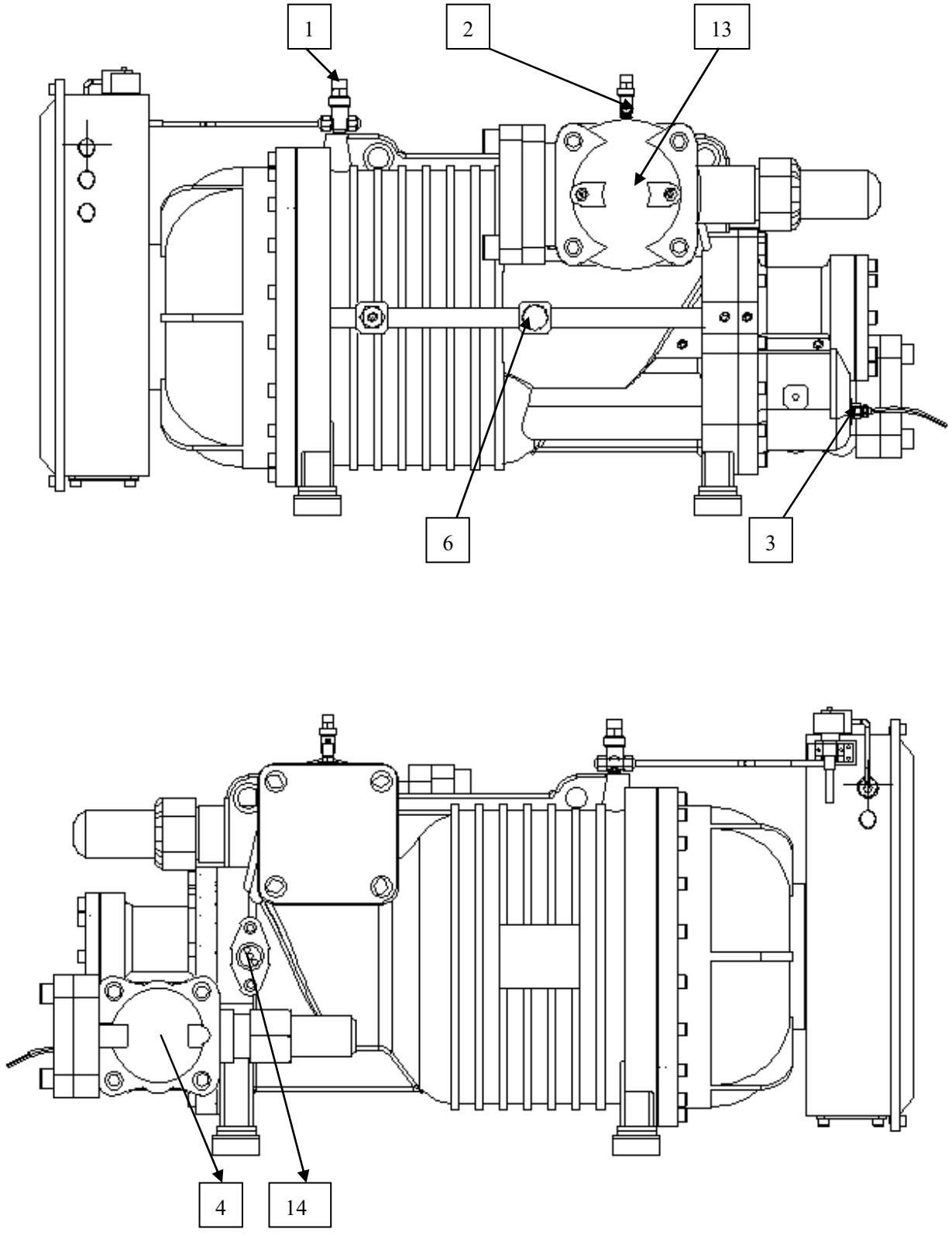
5. Appearance and functions

5.1 Appearance structure

■External structure-single machine



LB100~280-PLUS Low temperature screw compressor external structure



LB360/410-PLUS Low temperature screw compressor external structure

No.	Description (-PLUS)	LB-100~180	LB-100~180-P	LB-200~280	LB-200~280-P	LB-360/410
1	Motor liquid injection angle valve	1/4″	1/4″	1/4″	1/4″	1/4″
2	Low voltage detective valve	1/4″	1/4″	1/4″	1/4″	1/4″
3	Discharge temperature sensor	PTC	PTC	PTC	PTC	PTC
4	Discharge shutoff valve	1-1/2″	1-1/2″	2″	2″	2-1/2″ &3″
5	High temperature detective valve	1/4″	1/4″	1/4″	1/4″	1/4″
6	Oil circuit sight glass	✓	✓	✓	✓	×
7	Low oil level sight glass	✓	✓	✓	✓	×
8	Oil inlet connector	3/8″	3/8″	5/8″	5/8″	5/8″
9	Oil outlet connector	3/8″	×	5/8″	×	×
10	Oil circuit block pin	×	✓	×	✓	×
11	High oil level sight glass	✓	×	✓	×	×
12	Discharge check valve	1-1/2″	1-1/2″	2″	2″	2-1/2″ &3″
13	Suction shutoff valve	2″	2″	3″	3″	4″
14	Economizer interface	Ø16.1 (copper)	Ø16.1 (copper)	Ø16.1 (copper)	Ø16.1 (copper)	Ø28.8 (copper)
15	Motor gas return pipe	✓	✓	✓	✓	✓（internal flow channel）
16	Pressure difference switch connector	1/4″	×	1/4″	×	×

“✓” :standard
“×”:optional

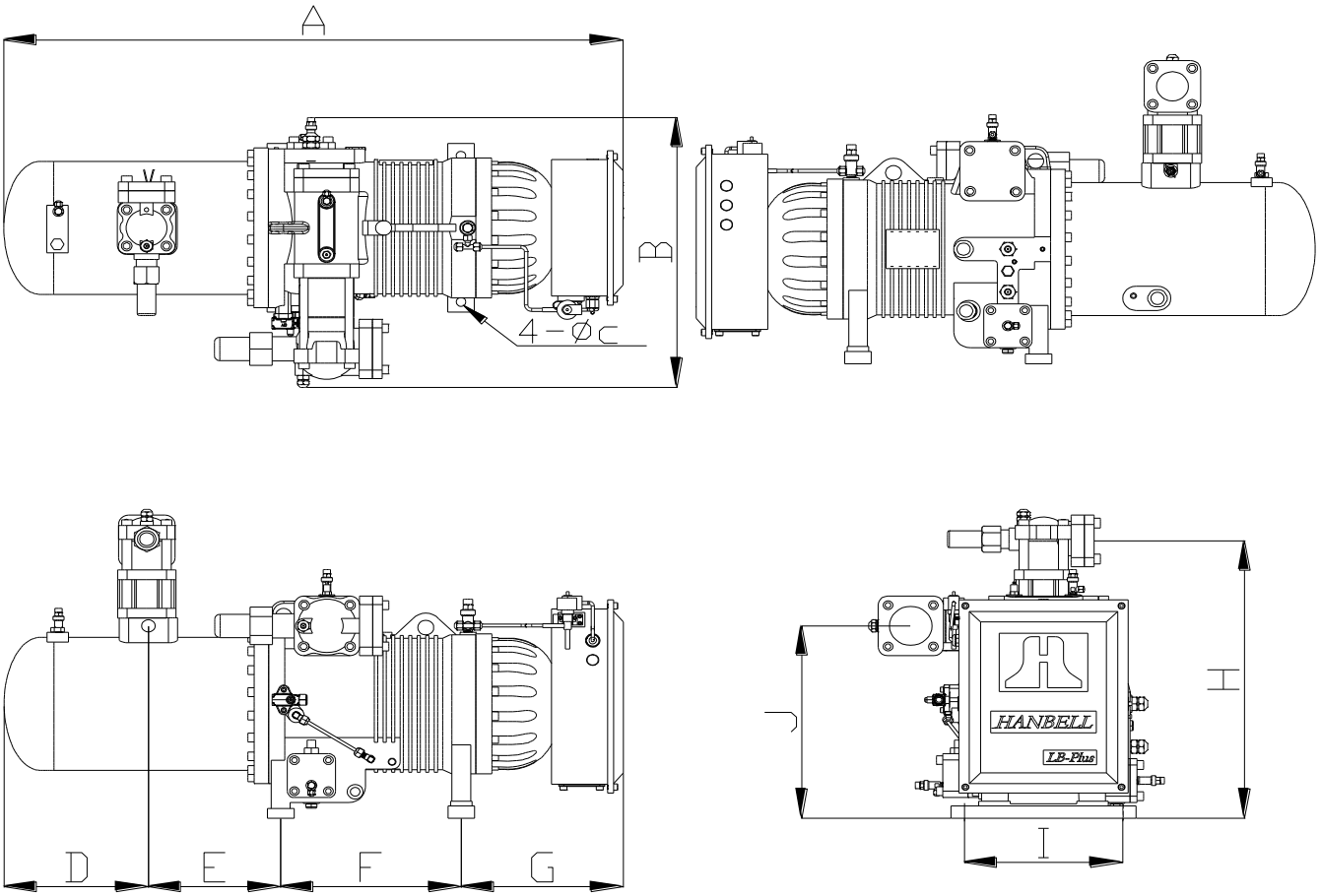
5.2 LB100~410-PLUS interface

Model -PLUS	Discharge port	Copper pipe	Steel pipe	Suction port	Copper pipe	Steel pipe	ECO interface	Main oil inlet	Main oil return port	Motor liquid injection port
LB100	1-1/2"	Φ42	Φ49.3	2"	Φ55	Φ61.3	Φ16（焊接）	3/8"（Φ9.7）	3/8"（Φ9.7）	1/4"（Φ6.5）
LB140	1-1/2"			2"			Φ16（焊接）	3/8"（Φ9.7）	3/8"（Φ9.7）	1/4"（Φ6.5）
LB180	1-1/2"			2"			Φ16（焊接）	3/8"（Φ9.7）	3/8"（Φ9.7）	1/4"（Φ6.5）
LB200	2"	Φ55	Φ61.3	3"	Φ80.5	Φ90.2	Φ16（焊接）	5/8"（Φ16）	5/8"（Φ16）	1/4"（Φ6.5）
LB230	2"			3"			Φ16（焊接）	5/8"（Φ16）	5/8"（Φ16）	1/4"（Φ6.5）
LB250	2"			3"			Φ16（焊接）	5/8"（Φ16）	5/8"（Φ16）	1/4"（Φ6.5）
LB280	2"			3"			Φ16（焊接）	5/8"（Φ16）	5/8"（Φ16）	1/4"（Φ6.5）
LB360	2-1/2"	Φ68	Φ77.2	4"	Φ93	Φ110	Φ28.8（焊接）	5/8"（Φ16）	5/8"（Φ16）	1/4"（Φ6.5）
LB410	3"	Φ80.5	Φ90.2	4"			Φ28.8（焊接）	5/8"（Φ16）	5/8"（Φ16）	1/4"（Φ6.5）

⚠ Note: 1. The pipe size in above tables is the casing pipe size.

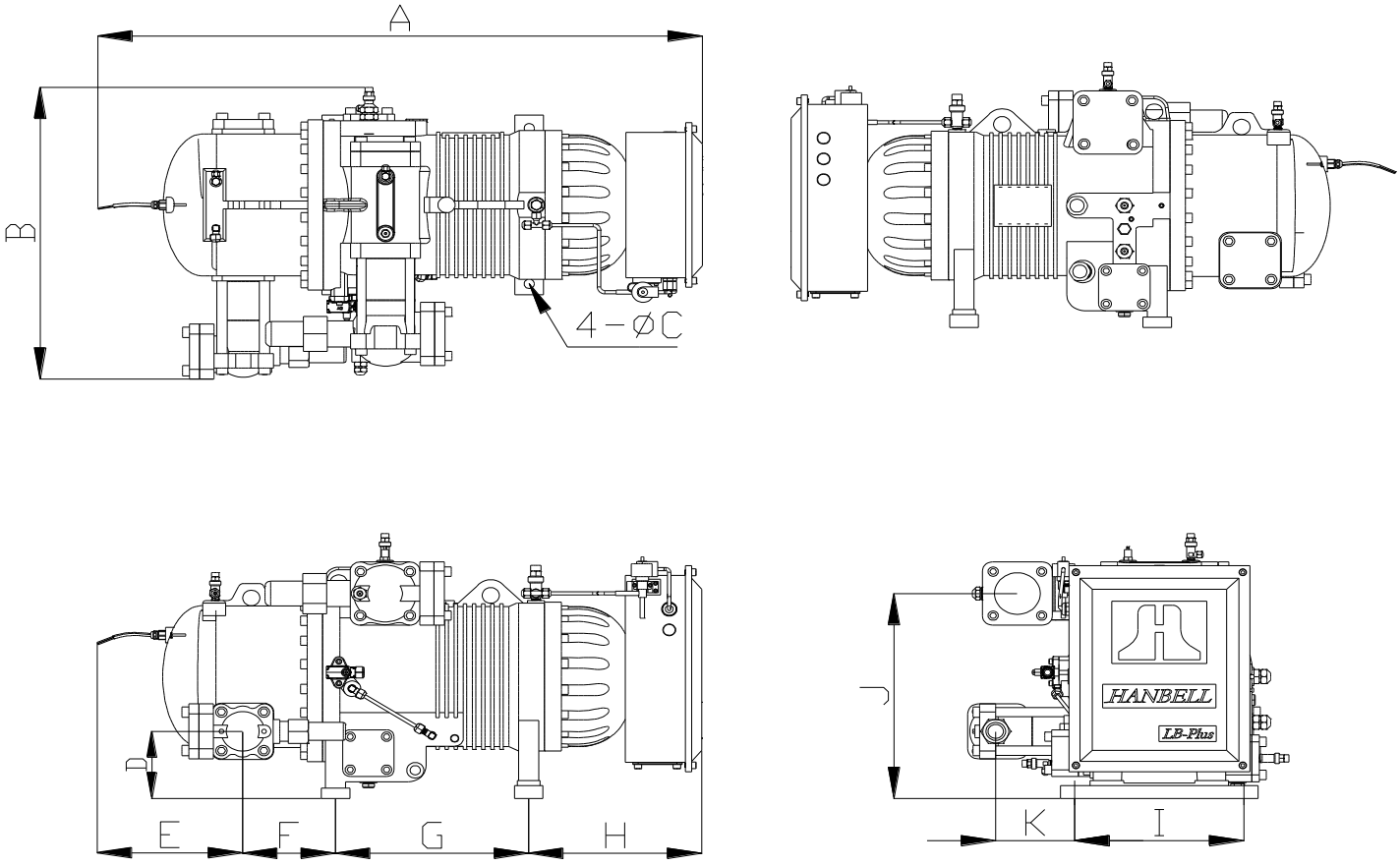
2. LB-V-PLUS/LB-V-P-PLUS/LB-P-PLUS/LB-PLUS series compressors, please refer to above table.

5.3 LB100~280-PLUS Dimension



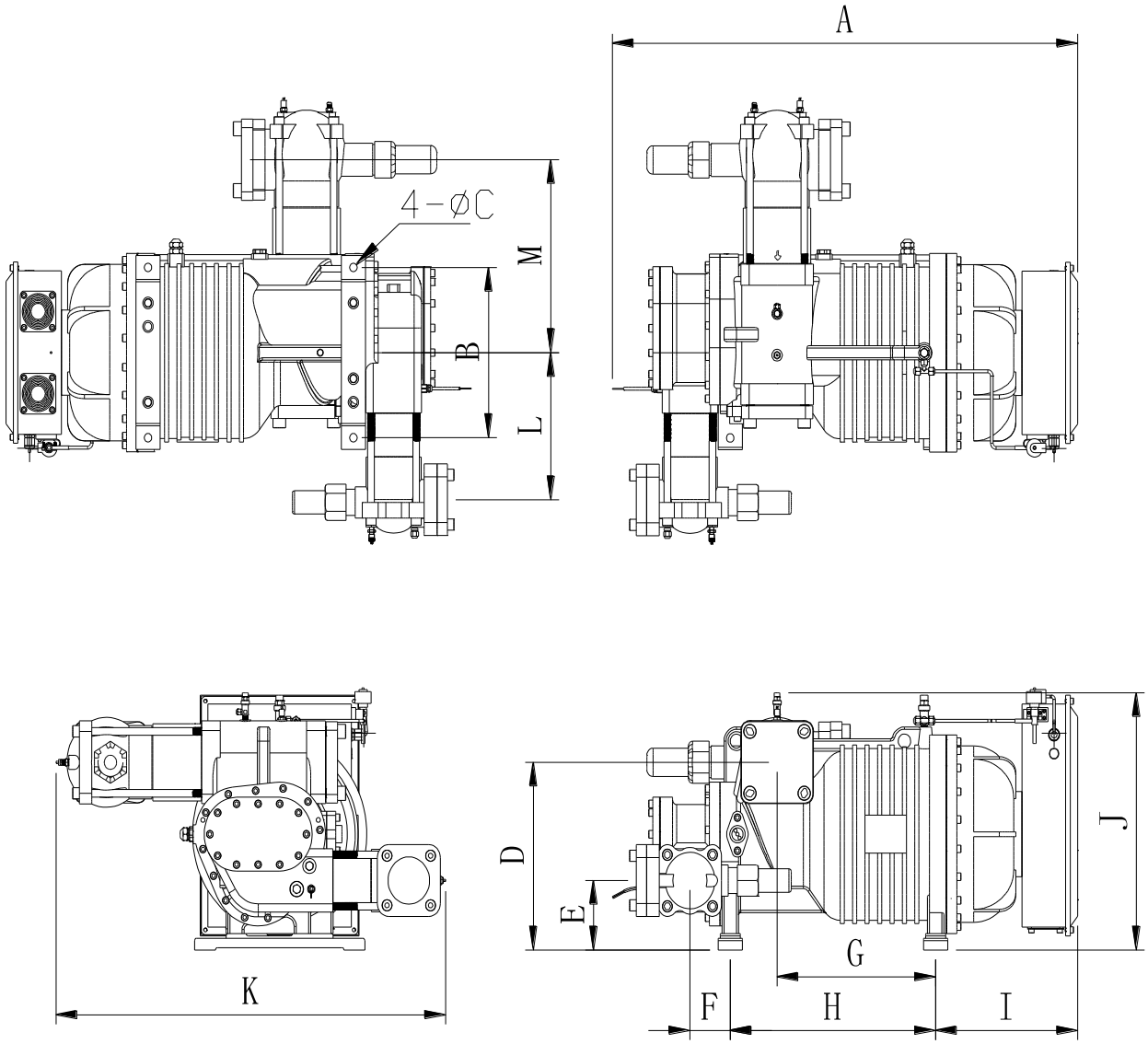
Model	A	B	C	D	E	F	G	H	I	J
LB100	1163.5	554	18	(275)	247.5	338	303	569	300	395
LB140	1199	584	18	(297)	255.5	339	308	578	350	402.5
LB180	1263	584	18	(297)	255.5	405	308	578	350	402.5
LB200	1410	645	18	(427)	270.3	390	332	683	350	449.5
LB230~28	1445	649	18	(427)	265.3	411	340	683	386	483

5.5 LB100~280P-PLUS Dimension



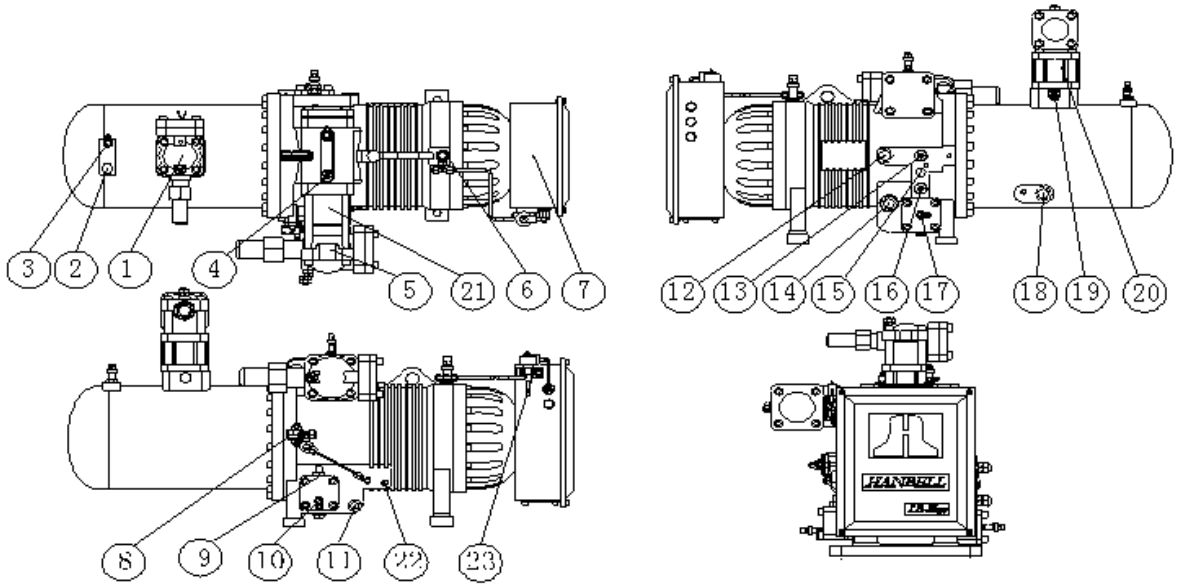
Model	A	B	C	D	E	F	G	H	I	J	K
LB100-P	1004	562	18	129.5	(254)	163.5	338	303	300	395	133
LB140-P	1017	597	18	117	(241)	177	339	308	350	402.5	104
LB180-P	1083	611	18	117.6	(241)	177	405	308	350	402.5	104
LB200-P	1186	630	18	112.5	(235)	230	390	332	350	449.5	158
LB230~280-P	1218	630	18	112.5	(235)	234	411	340	386	483	152

5.6 LB360/410-PLUS Dimension



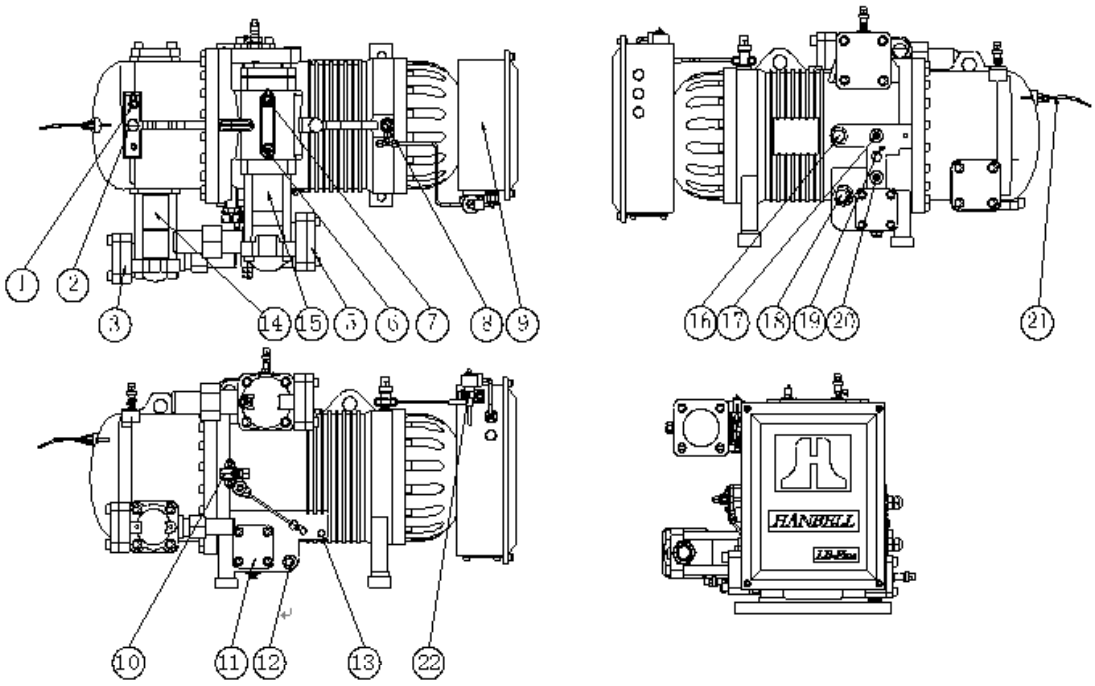
Model	A	B	C	D	E	F	G	H	I	J	K	L	M
LB360	1137	360	18	397	147	98	384.5	495	342.5	538	939	301	408
LB410	1237	360	18	397	156	106	465.8	576.3	342.5	538	949	327	408

5.7 LB100~280-PLUS Dimension



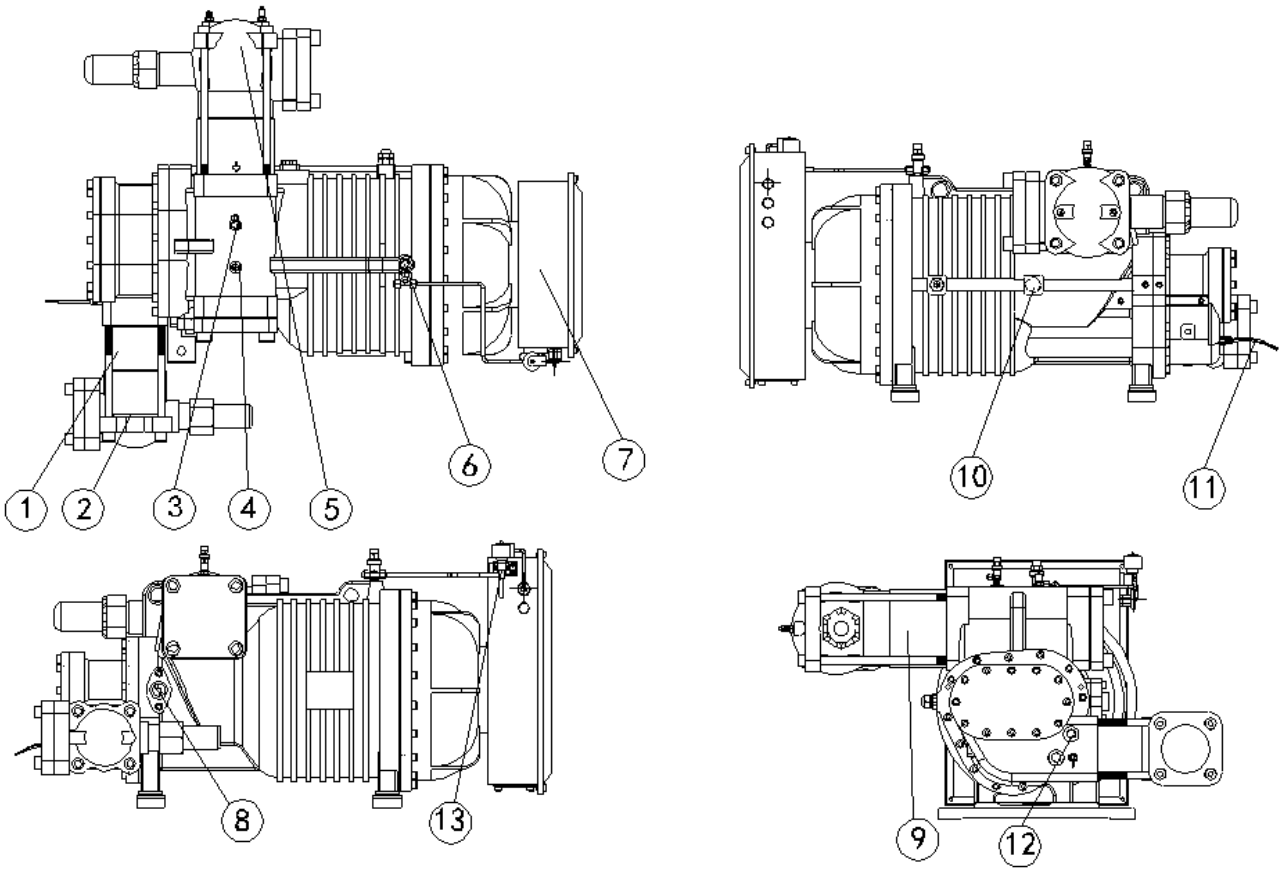
No.	Description	Note	No.	Description	Note	No.	Description	Note	No.	Description	Note
1	Discharge shutoff valve		7	Terminal box	IP54	13	Oil inlet connector		19	Discharge temperature switch	
2	Safety valve plug		8	ECO connector		14	Low oil pressure sight glass		20	Discharge check valve	
3	High pressure operation angle valve	1/4"	9	Liquid level switch		15	Oil circuit block pin		21	Suction check valve	
4	Low pressure filling	1/4"	10	Angle valve	1/4"	16	Oil outlet		22	Fixing hole	
5	Low pressure shutoff valve		11	Heater	220V/300	17	Angle valve	1/4"	23	Electronic expansion valve	
6	Motor chamber angle valve	1/4"	12	Oil circuit sight glass		18	High oil level sight glass				

5.8 LB100~280-P-PLUS Dimension



No.	Description	Note	No.	Description	Note	No.	Description	Note	No.	Description	Note
1	High pressure angle valve	1/4"	7	Low pressure angle valve	1/4"	13	Motor liquid injection temperature		19	Oil circuit block pin	
2	Safety valve plug	1/2"NPT	8	Motor liquid refrigerant injection	1/4"	14	Discharge check valve		20	Plug	
3	Discharge shutoff valve		9	Terminal box		15	Intake check valve		21	Discharge temperature PTC	110℃
4	Solenoid valve		10	ECO connector	3/8"	16	Oil circuit sight glass		22	Electronic expansion valve	
5	Suction shutoff valve		11	Clening hole cover		17	Oil inlet connector	1/4"			
6	Filling valve	1/4"	12	Plug		18	Plug				

5.9 LB360/410-PLUS Dimension



No.	Description	Note	No.	Description	Note
1	Discharge check valve	LB360 2-1/2" lb410 3"	8	ECO flange	1 1/8 "
2	Discharge shutoff valve	3"	9	Suction check valve	4"
3	Filling valve	1/4"	10	Oil inlet connector	5/8"
4	Low pressure angle valve	1/4"	11	Discharge temperature	PTC/110 ℃
5	Suction shutoff valve	4"	12	Safety valve plug	1/2"
6	Motor liquid refrigerant injection port		13	Electronic expansion valve	
7	Terminal box		14		

Note:

1. Suction check valve is standard part; discharge check valve is optional.
2. Any problems, please contact Hanbell.