HANBELL

HANBELL PRECISE MACHINERY CO.,LTD.

Magnetic Centrifugal Compressor
RTM-090

Contents

Chapter 1. Introduction

This manual is intended as a guide for application engineers, consultants, sales engineers, and HVAC designers to use Hanbell RTM series centrifugal compressors. The copyright of this technical manual belongs to Hanbell Precise Machinery Co., Ltd.. Neither this publication nor any part of it may be reproduced or transmitted in any form or by any means without the prior permission of Hanbell Precise Machinery Co., Ltd..

Features

- Refrigerant – R134a
- Compressor – semi-hermetic design
- Shaft –made of high-strength alloy
- Impellers – closed type made of high-strength aluminum
- Bearings – magnetic bearings
- Motor –permanent magnet synchronous motor, independent cooling by liquid refrigerant
- Enclosure - IP54 protection

Ambience

RTM series compressors should be stored and operated within the following ambient temperature.

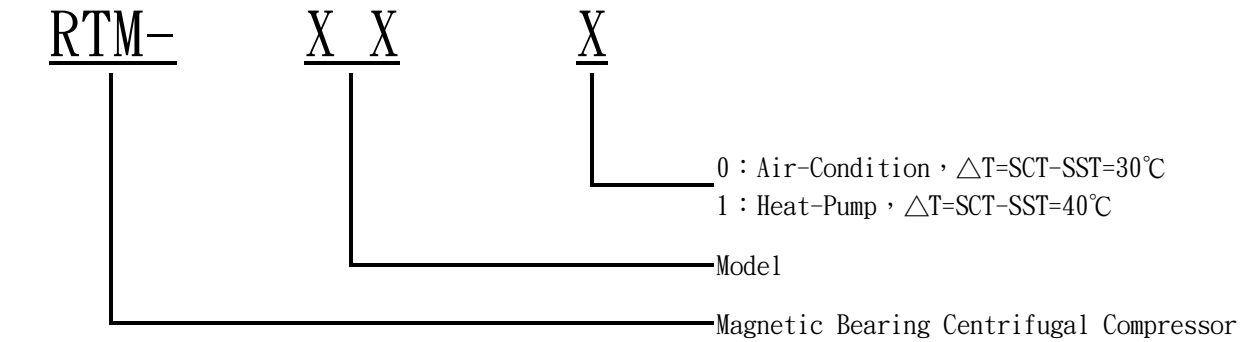
Storage：-25℃~55℃
Operation(Water-cooled)：ET：2℃~14℃ ；CT：15℃~55℃

Note：

1. Please refer to “Application limits” in chapter 2 for allowable operating conditions and Hanbell selection software for detailed performance data.
2. For special application limits, please contact Hanbell.
3. Chapter 7 contains instructions for the use of other AC electrical components.
4. In a humid environment, the compressor housing and piping should be insulated to prevent condensation.

Chapter 2. Basic design

2.1 Compressor nomenclature



2.2 Application limits

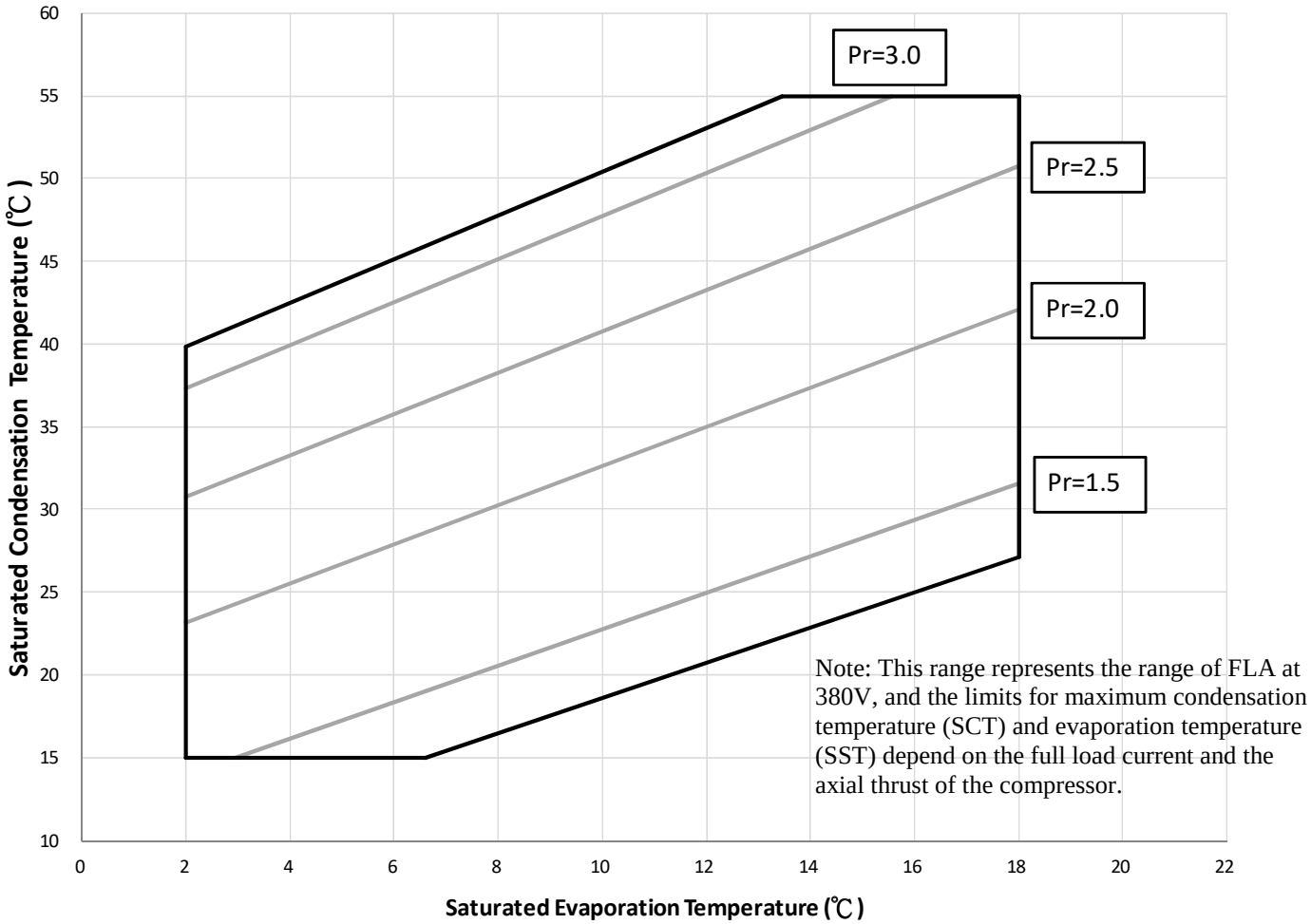


Figure 2.1 RTM-090 application limits

Note: Please refer to the latest compressor selection software for specific compressor capacity.

2.3 Compressor specifications

Model			RTM-090
Refrigerant			R134a
Nominal cooling capacity		USRT	400~450
Compressor	Type		Two-stage compression
	Axial guide vane control	IGV	20~100% continuous
	Frequency	Hz	225
Motor	Type		3 Phase, 2 Pole, Permanent magnet
	Starting		VFD
	Voltage	V	380~460±5%
	Insulation		Class H
	Protection		PT100*6
Transmission	Type		Direct-driven
	Lubrication		Oil free
Dimension (LxWxH)		m	1.3 X 0.8 x 0.7
Weight		kg	1050
Hydrostatic pressure test		kg/cm²g	22
Refrigerant heater		kW	1x 0.3

Table 2.1 Compressor specifications

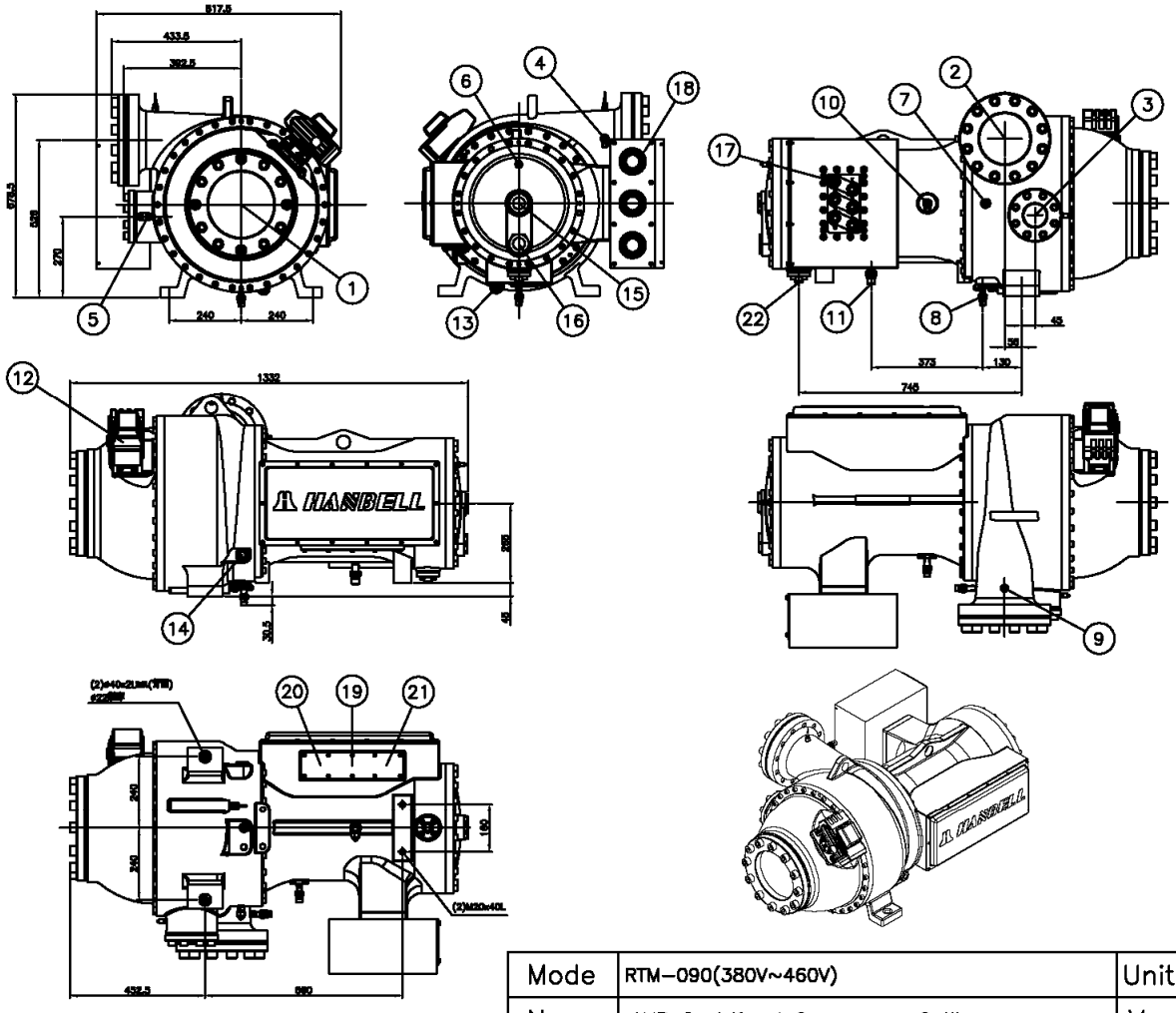
RTM-090 Performance			
USRT	RPM	COP	IPLV
400	13,000	6.53	11.0
450	13,500	6.33	10.5

Table 2.2 Compressor performance

Note: The performance is based on AHRI condition assuming a discharge check valve is installed.

2.4 Compressor outline

No.	Name	Specification	No.	Name	Specification
1	Suction flange	8" 20k (JIS)	12	Actuator	
2	Discharge flange	6" 20k (JIS)	13	Refrigerant heater	
3	Economizer connection	2 1/2" 20k(JIS)	14	Sight glass (refrigerant)	
4	Pressure connection (discharge)	1/4"FL	15	Sight glass	
5	Pressure connection (ECO)	1/4"FL	16	Sight glass (refrigerant)	
6	Pressure connection (motor)	1/4"FL	17	Cable connecter	M16,380V
7	Bearing cooling inlet (liquid+gas)	1/2"FL	18	Cable box flange	430*150
8	Bearing cooling outlet	1/4"FL	19	Temperature sensor port	6*PT100
9	Discharge temperature thermistor	PTC (optional)	20	Bearing cable connector(Z1)	
10	Motor Cooling (inlet/liquid)	1/4"FL	21	Bearing cable connector(Z2)	
11	Motor Cooling (outlet/liquid)	1/2"FL	22	Bearing cooling outlet	1 1/4"FL



Mode	RTM-090(380V~460V)	Unit	mm
Name	AMB Centrifugal Compressor Outline	Ver.	1.0
	HANBELL PRECISE TECHNOLOGY CO., LTD.		

2.5 Connections

2.5.1 Suction/discharge/economizer flange size

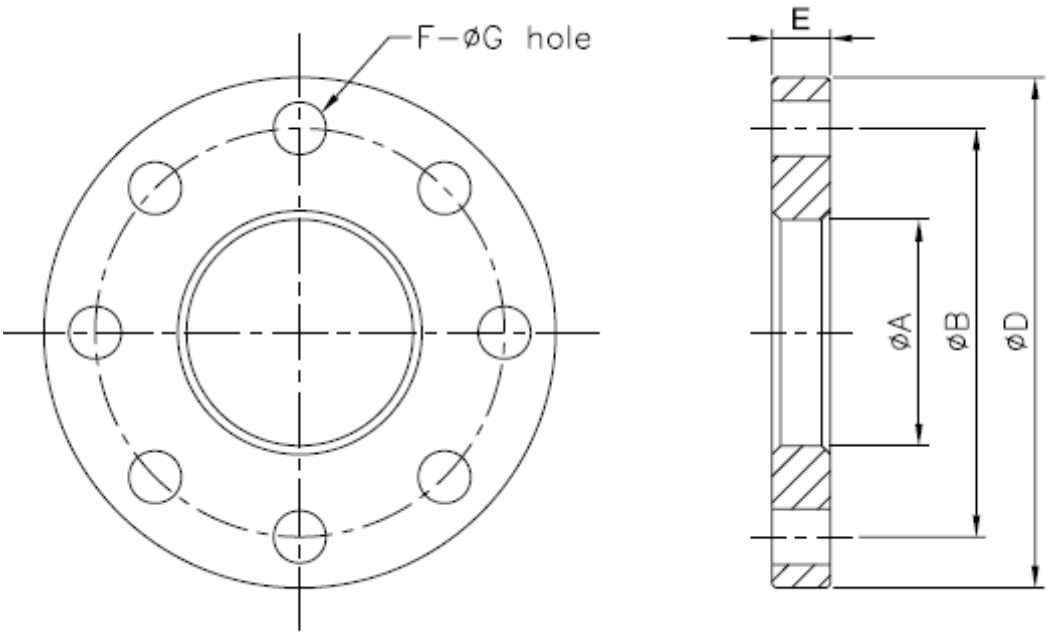


Figure 2.3 Flange

Position		Size	A		B	D	E	F	G	Piping thick.
			(JIS)	(GB)						
RTM-090	Suction	8"	218	221.5	305	350	30	12	25	11
	Discharge	6"	167	170.5	260	305	28	12	25	10.5
	Mid.-press. (Eco.)	2 1/2"	77.5	77.5	140	175	20	8	19	7
Remarks		※Material- standard JIS 20kg/cm²g steel unit: mm								
		※Thickness must be equal to the standard or larger								

Table 2.2 Flange dimensions

Note：

1. Please weld steel pipes onto flanges by butt-welding and make sure debris has been cleaned, otherwise the compressor might be damaged during running. Flow velocity in the discharge side of the compressor could be as high as 15~20 m/sec. High-speed discharge gas will make noise in discharge connection. In order to decrease the noise level, it's recommended to round sharp edges of joints of piping as shown in Figure 2.4
2. The discharge and suction piping is recommended to be one size larger to reduce pressure drop and noise level. If the noise level is high in discharge side, it is suggested to increase the piping thickness or enclose with acoustic foam shown in Figure 2.5.

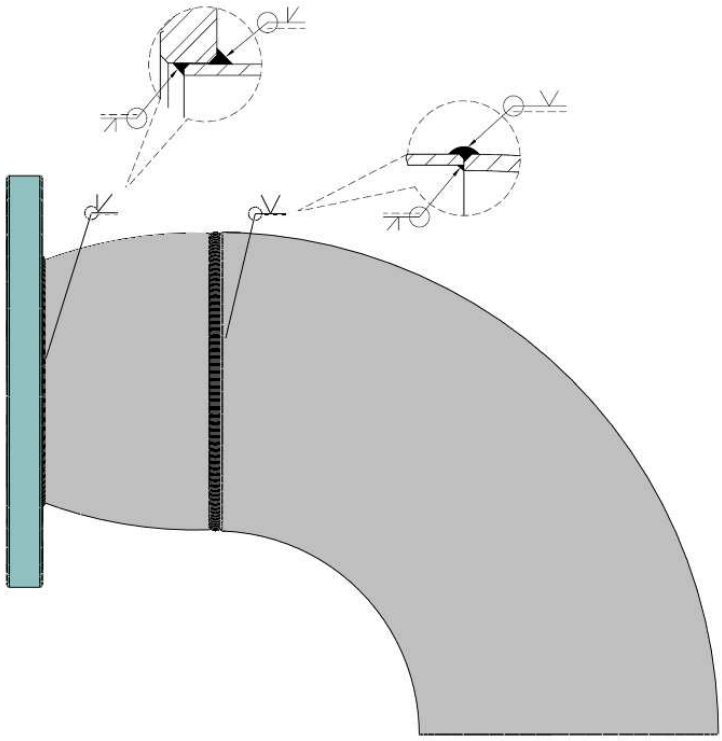


Figure 2.4 Discharge and suction piping

Note: Residue from welding might damage the compressor seriously.

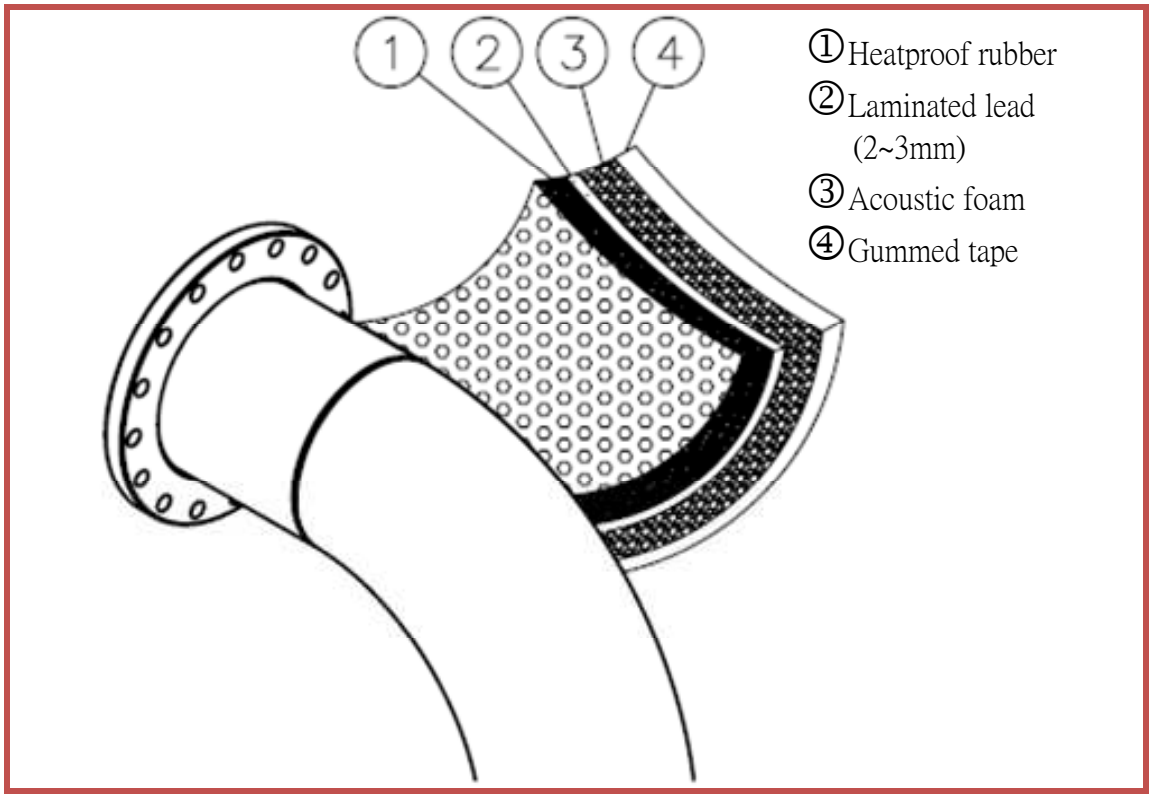


Figure 2.5 Enclosure of piping connection

2.5.2 Butterfly valve

For easy maintenance, the butterfly valve can be installed in condenser inlet and liquid line before expansion valve. When installing butterfly valve, the pipe must also be enlarged one size to effectively reduce the pressure drop.

Butterfly valve size		A	B	C	D	E	F	G	H	J	K	L
2 1/2″	65mm	121	48	58	97	162	111	16	11	32	64	20
3″	80mm	133	48	73	104	168	111	16	11	32	64	20
4″	100mm	171	52	94	120	191	111	16	11	32	64	19
5″	125mm	191	57	122	129	191	130	19	13	32	114	24
6″	150mm	219	57	149	141	203	130	19	13	32	114	24
8″	200mm	273	61	198	176	241	130	22	16	32	114	24
10″	250mm	332	70	248	217	273	155	30	22	51	114	27
Remark		※Dimension C is minima size when the valve opened totally unit：mm										
		※Operation Temp.：-29℃~260℃；Operation Pressure：1480psi										
		※Material- ASTAM351 GR CF8M stainless steel. Pressure level: ASME 150										
		※The butterfly valve is of wafer plate valves. Use ANSI 150 standard flange										

Table 2.3 Flange size

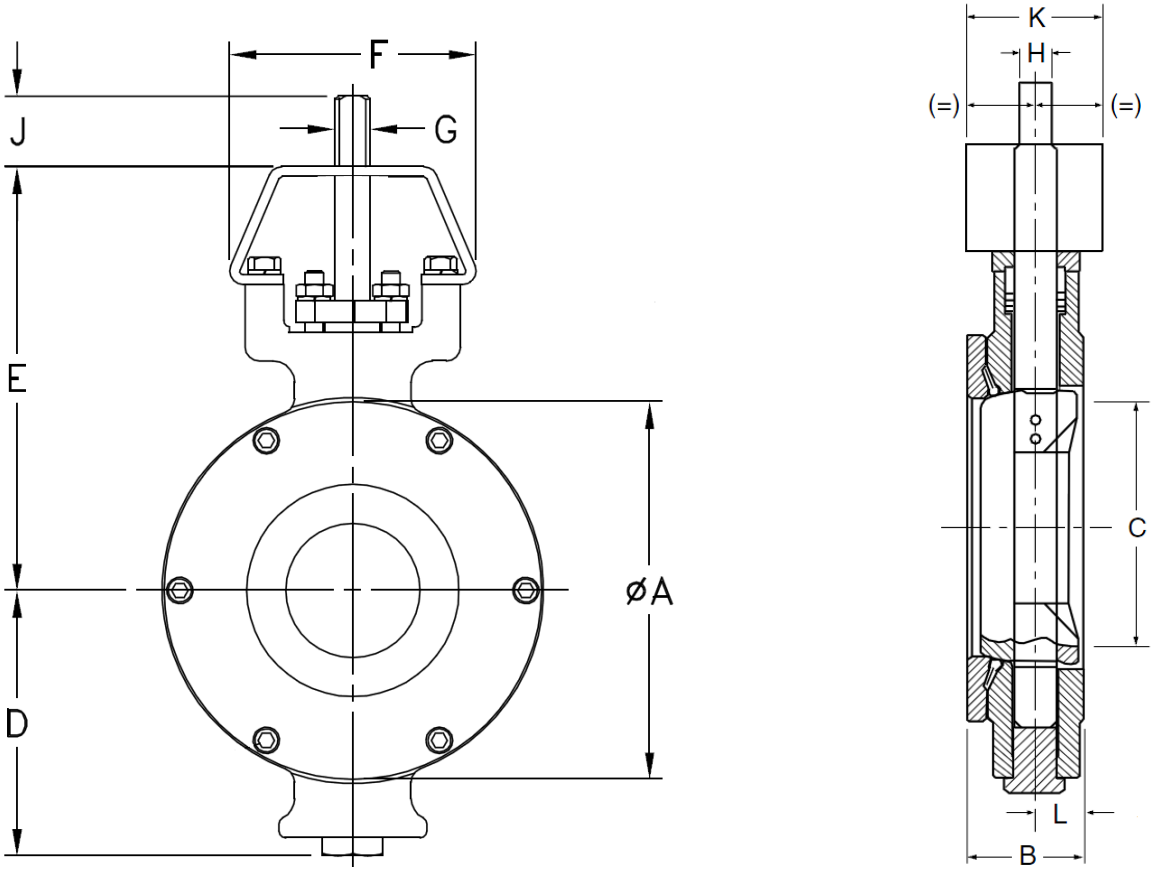


Figure 2.6 Outline of butterfly size

2.5.3 Check valve

To avoid the reverse rotation caused by emergency shutdown and protect active magnetic bearing (AMB), under high-speed compressing, installation of a check valve installed in the discharge side is necessary.

Size		A(mm)	B(mm)	C(mm)	E(mm)
6″	150mm	222.2	120.7	95.3	70
8″	200mm	279.4	163.5	116.7	74.6
Remark		※Operating temp.：-260℃~810℃ Hydraulic pressure testing: 31.6kg/cm^2(API-598)			
		※Material - ASTAM351 GR CF8M stainless steel. Pressure level : ASME 150			
		※The check valve is of wafer plate valve. Use ANSI 150 standard flange			

Table 2.4 Check valve size

No.	Name	Material
1	Valve	CF8M
2	Disc shield	A351- CF8M
3	Spring	SUS316
4	Alignment pin	SUS316
5	Bearing	PTFE
6	Bolt	SUS316
7	O ring	PTFE
8	Eye ring	A105

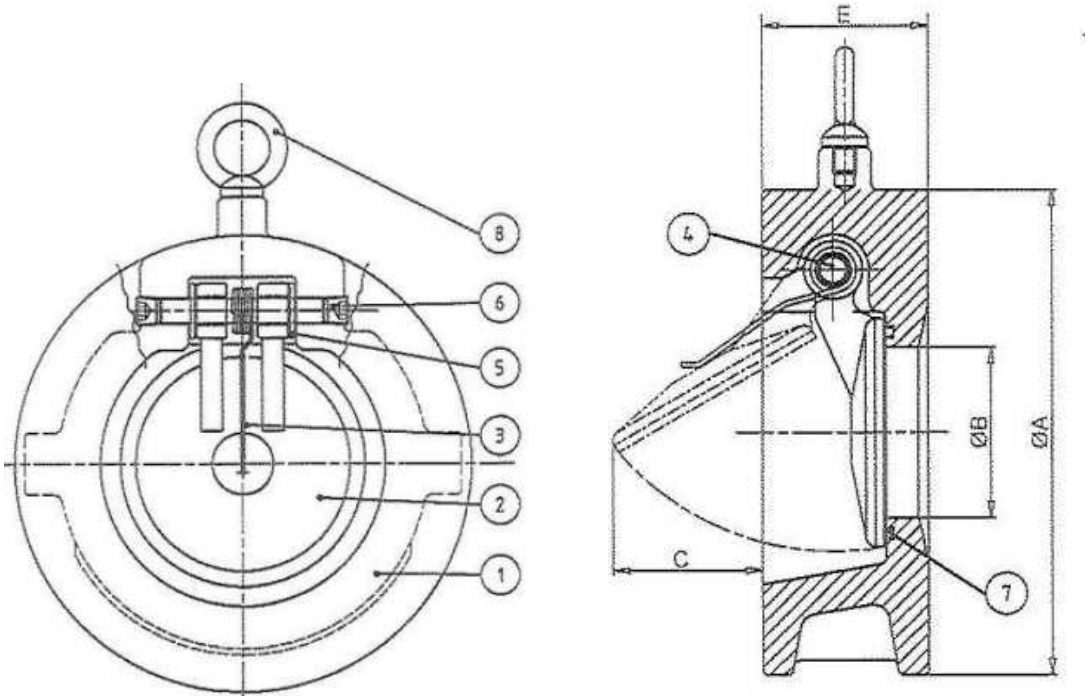


Figure 2.7 Pendulum check valve outline

3. Suction Structure

3.1 Inlet Guide Vanes

The cooling capacity of RTM Series centrifugal compressors is modulated with change in angles of inlet guide vanes. As illustrated in Figure 3.1, Refrigerant gas from the evaporator outlet flows through the suction nozzle to the compressor suction inlet. After the inlet nozzle, gas flow velocity increases due to the narrow passage. By changing angles of IGV, velocity and volume are changed as well as cooling capacity.

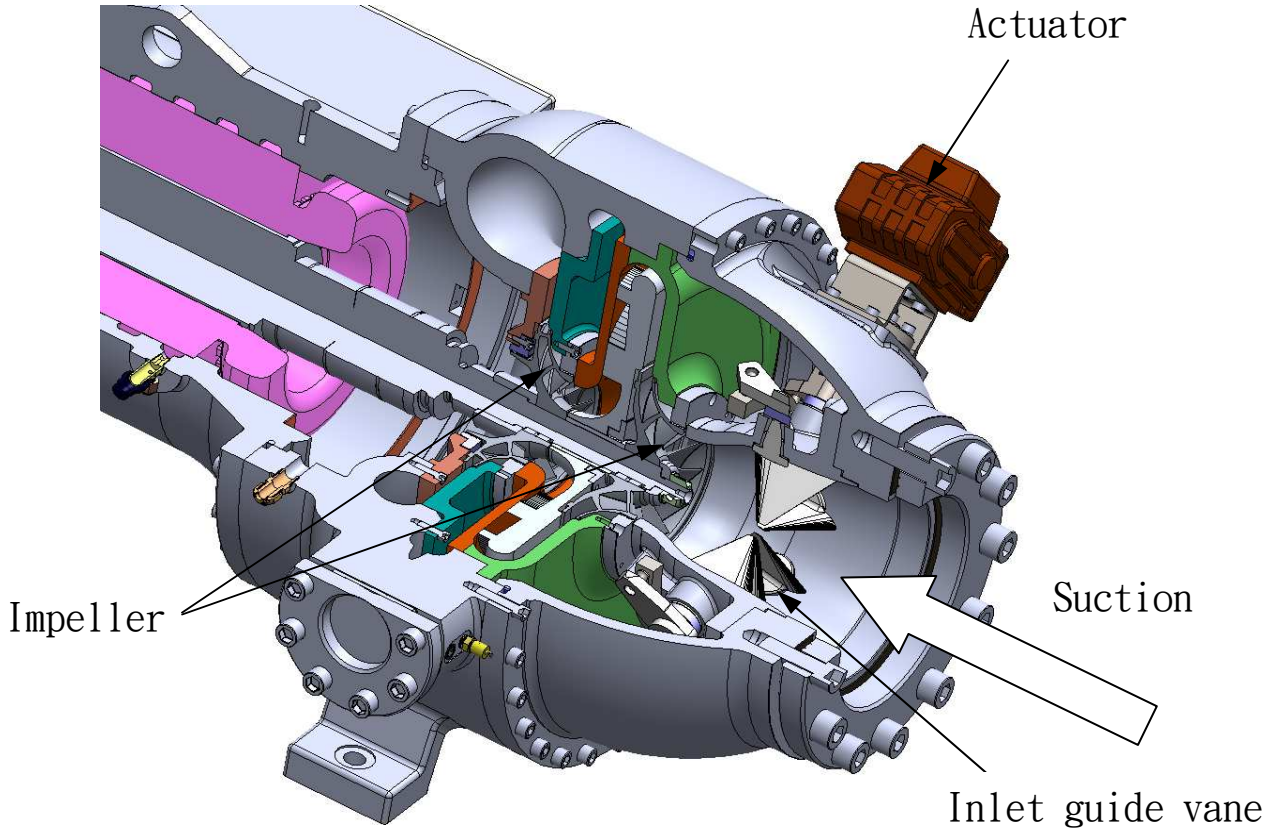


Figure 3.1 Compressor inlet

3.1.1 Control of inlet guide vanes

Angles of inlet guide vanes are automatically controlled through a vane actuator with a lever arm, and IGV opening ranges from 20% (minimum load) to totally open.

Opening of the vane actuator in percentage (%) has a linear relation to the control signal voltage. However, cooling capacity does not relate the angle changes of guide vanes. Therefore, vane actuator's opening in percentage (%) is not the same as the cooling capacity in percentage (%)

Note 1：When inlet guide vanes are completely closed, a small hole will be formed in the middle to keep a basic amount of gas flow into the compressor. When inlet guide vanes are fully closed, only Min. mass flow passes so the smallest cooling capacity will be established.

Note 2：The lower pressure ratio stands for the lower minimum unloading capacity.

Remark：1. IGV should be fully opened before start up. When HGBP opened before stop，please keep IGV fully opened.
2. IGV operating range is 20%~100%.
3. Actuator signal feedback window:

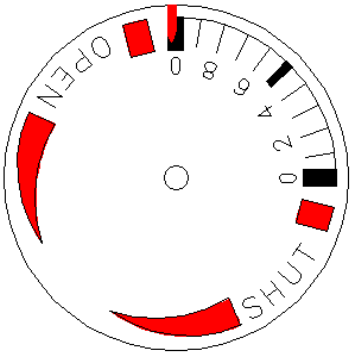


Figure 3.2 OPEN

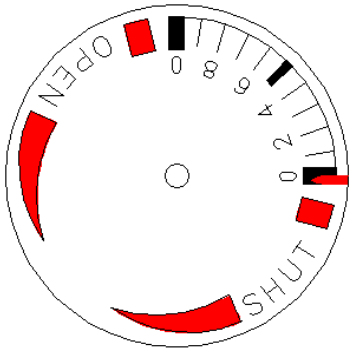


Figure 3.3 SHUT

3.2 Vane actuator control

3.2.1 Actuator data

RATED POWER	1Phase, AC 220V±10%(50/60Hz) 1Phase, AC 110V±10%(50/60Hz)
INPUT SIGNAL	4~20mA・DC；1~5V・DC
OUTPUT SIGNAL	4~20mA・DC
OUTPUT TORQUE	49N・m(5kgf・m)
OPERATION SPEED	15sec(50Hz)；12.5 sec(60Hz)
TRAVEL ANGLE	0~90°
RATED OPERATION TIME	Continuous (100%)
RESOLUTION	Over 1/250
DEAD ZONE	Max. 0.5%
PROTECTION	Motor thermal protector (120ºC)
AMBIENT TEMPERATURE	Ambient temperature within: -25~55ºC
RATED CURRENT	0.4A(220V)；0.7A(110V)
MOTOR	20W
INSULATION GRADE	Class E
INSULATION RESISTANCE	Between power terminal – case : 500V·DC / 100MΩ
WITHSTAND VOLTAGE	Between power terminal – case : 1500V·AC / 1 minute
WIRE INLET	G1/2×2
ENCLOSURE PROTECTION	NEMA-4X (IP-66)
WEIGHT	4.5kg

Table 3.1 Actuator data

Note：When operating at ambient temperature under 0℃, optional space heater is required to keep the actuator inside dry. Otherwise, moisture may condense under low temperature and high humidity or parts may shrink at low temperature.

3.2.2 Electrical connections

When using standard wire wiring, cable diameter should be Φ9 ~ Φ11; if other wire is used, please select the appropriate cable diameter, otherwise the water may penetrate.

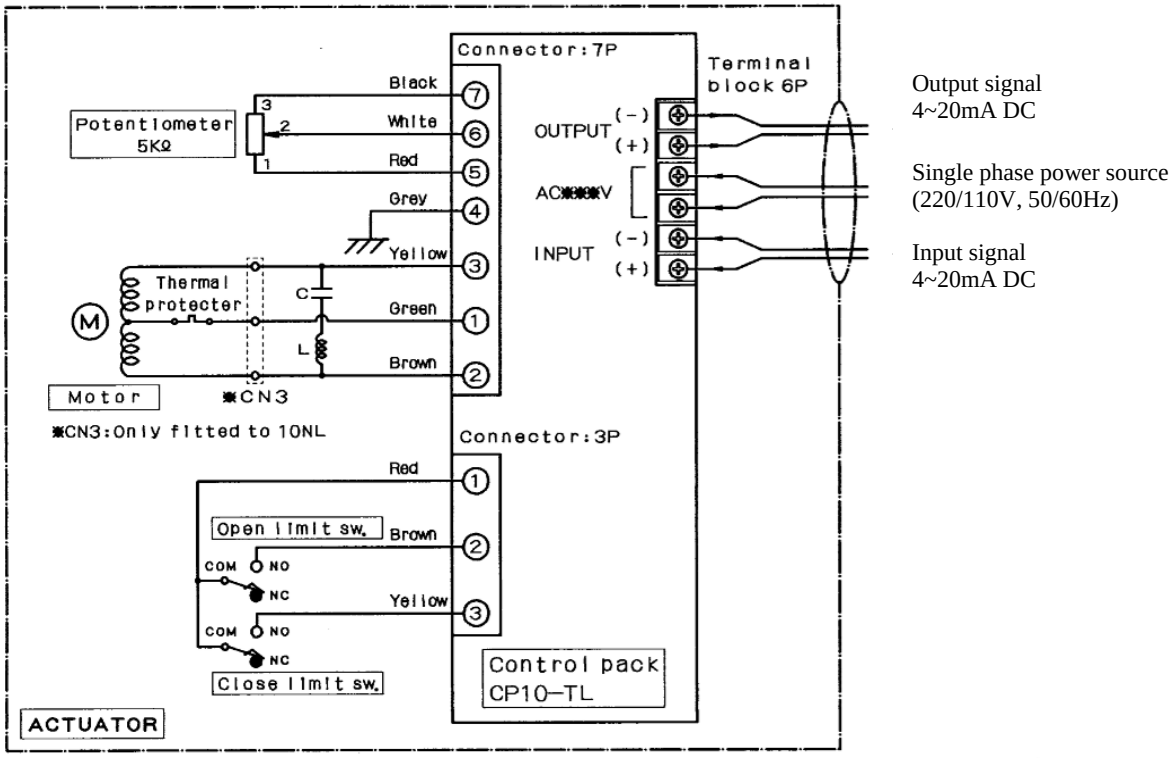


Figure 3.2 Wiring diagram (220/110V)

Remark：1. 5A fuse or breaker should be installed in main power supply. Voltage stabilizer is required to avoid the damage caused by the imbalance of voltage. (within 10%)
2. Signal wires for control should be shielded to prevent them from interference.
3. The actuator wiring shall not be parallel to the power cables.

3.2.3 Wiring

Make effective water proof if vinyl tubes or conduits are used：

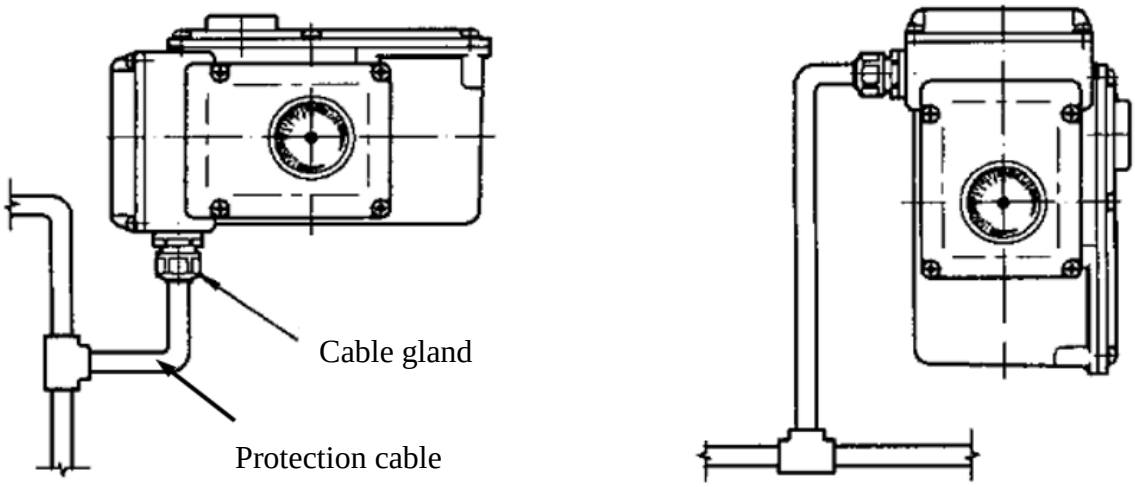


Figure 3.3 Wiring

3.2.4 Control info.

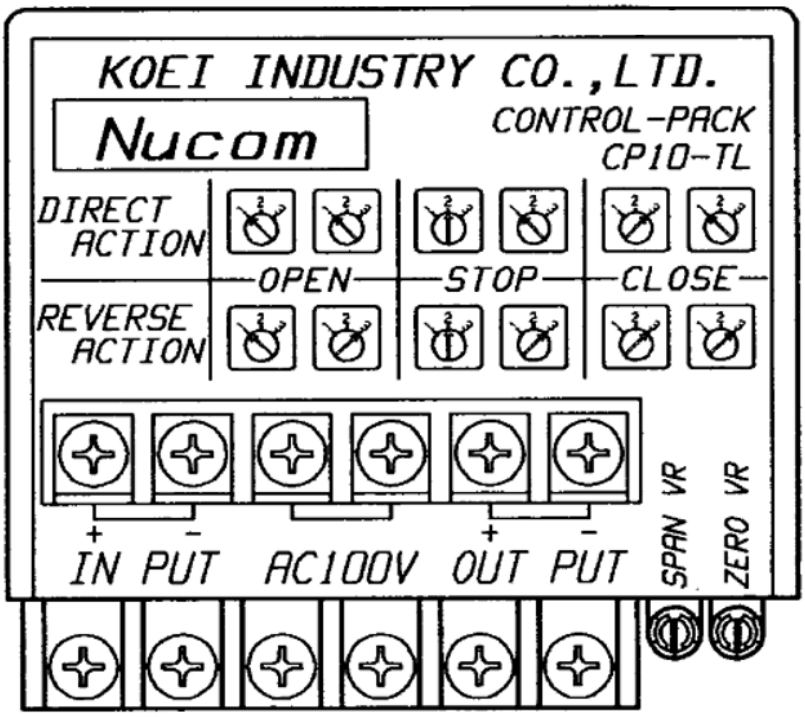


Figure 3.4 Control pack

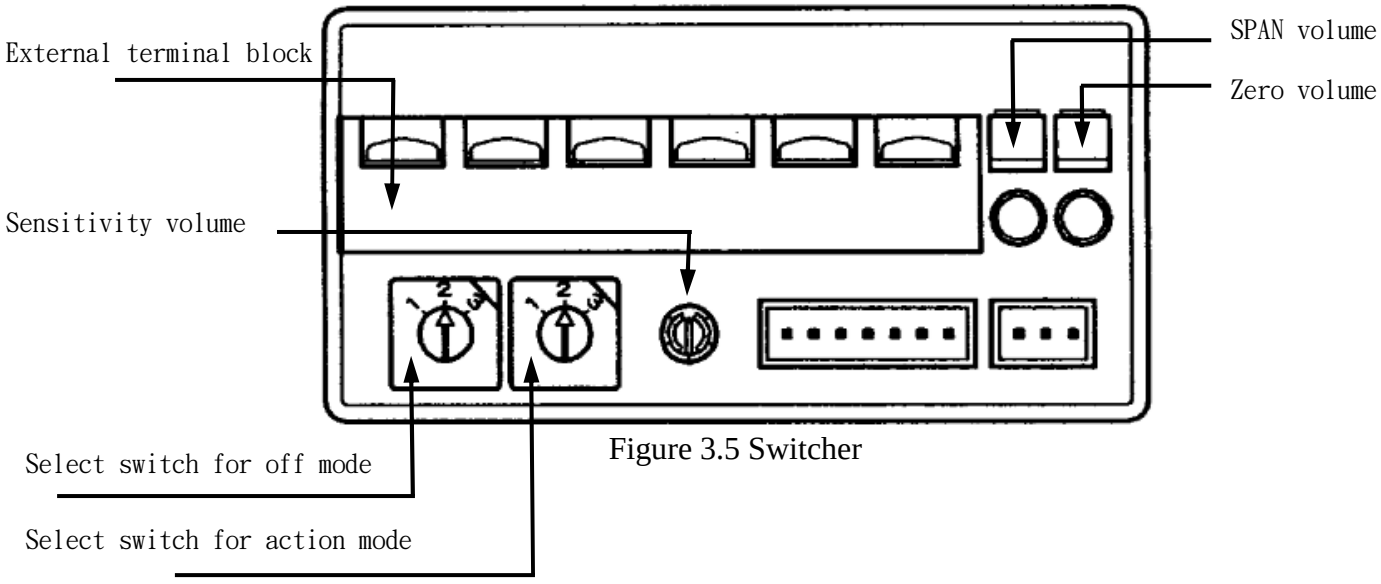
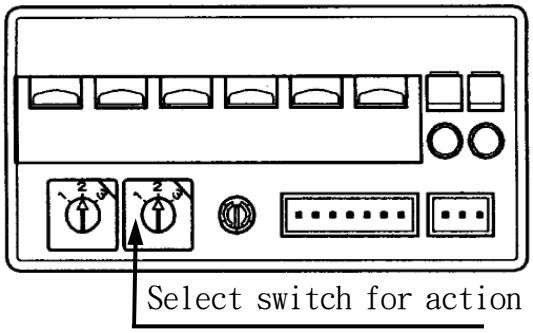
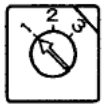


Figure 3.5 Switcher

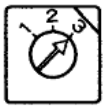
※Direction mode

Either direct or reverse action is selectable at this switch.





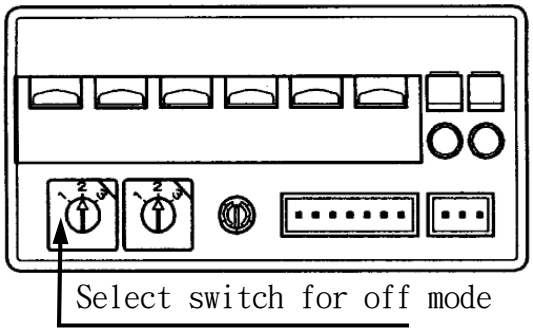
1 = Direct action
Input signal 20mA → Close
Input signal 4mA → Open

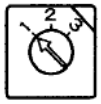


3 = Reverse action
Input signal 4mA → Open
Input signal 20mA → Close

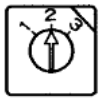
※Selection of a mode during signal interruption：

A mode among open/stop/close is selectable at this switch in case of signal interruption





Select switch 1 = Close action

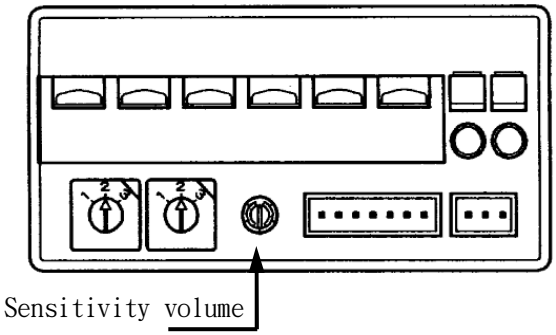


Select switch 2 = Stop action

Select switch 3 = Open action

Note：When the input signal is less than 2mA, the actuator is judged to be interrupted and transferred to the specified state, so the control device and signal 4~20mA must be adjusted correctly.

※ Sensitivity volume：

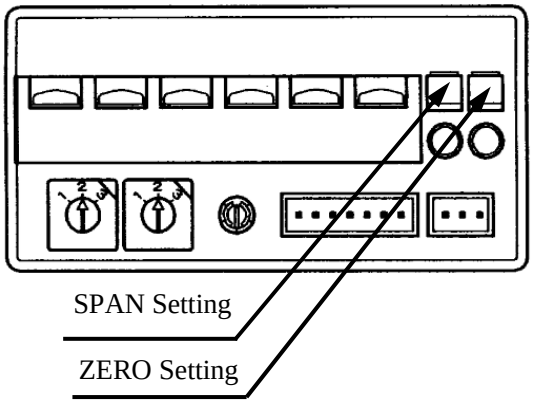


* Sensitivity volume
  Clockwise for higher
  Counter clockwise for lower

* Max. sensitivity:
  Resolution = 1/400

* Min. sensitivity:
  Resolution = 1/100

※ ZERO/SPAN Setting：



* ZERO volume
  CW = To increase (to OPEN direction)
Adjustable range - 25 ~ +25 %

* SPAN volume
  CW = To increase (to OPEN direction)
Adjustable range - 50 ~ +200 %

Remark：

1. Before the compressor is shipped out from the factory, the zero and span knobs have been adjusted to the best position. Do not adjust if not necessary. If adjustment is required, please use a small screwdriver to turn gently (excessive force will cause damage in the knob).
2. When adjusting IGV, turn to the fully-close position and then do fully-open position adjustment.

※Note：Because the forward turn of the actuator is opposite to the IGV connecting rod's, the zero knob is fully opened while the span knob is fully closed. To avoid risk, this adjustment should be done by qualified personnel.

3.2.5 Troubleshooting

TROUBLE	PROBABLE CAUSE	SOLUTION
Motor does not start up	1. Power failed or dropped 2. Signal failed or dropped 3. Wire broken or disconnected 4. Thermal protector functioned 5. Limit switches functioned at an intermediate position 6. Motor advancer defective 7. Control pack defective	1. Check and supply power 2. Check and input signals 3. Change the wire or re-connect the terminal 4. Lower the ambient temperature 5. Decrease duty rate 6. Eliminate overload at valve 7. Re-adjust the limit cam 8. Change advancer (condenser) 9. Change control pack

Aperture unfixable (Hunting)	1. Noise on signal line 2. Noise on potentiometer 3. Potentiometer and opening gear loose	1. Check input signal 2. Change potentiometer 3. Check the fixing screws
Aperture does not match input signal	1. A wrong signal input 2. Improper adjustment of ZERO/SPAN 3. Potentiometer slipped	1. Check the input signals 2. Re-adjust ZERO/SPAN 3. Re-adjust the aperture on the potentiometer
Aperture signal does not output	The opening signal is broken or poorly connected	Check the wiring connection

3.3 Capacity adjustment

According to AHRI standard, the capacity control range is 100%~25%. To achieve the best performance, please follow the equation of safety margin line (refer chapter 3.4). The compressor loading/unloading will work with the control of IGV：

1. Speed control：In general, cooling capacity will change about 2% by adjusting 1 Hz, or 2% of leaving chilled water temp. change (approx. 0.1℃). Please refer to the following table：

	Target leaving chilled water temp.: 7℃				
Range	＜6.3℃	6.3℃~6.8℃	6.8℃~7.2℃	7.2℃~7.8℃	＞7.8℃
Control mode	Fast unloading	unloading	Neutral	Loading	Fast loading
Inverter output	-1Hz	-0.5Hz	0	+0.5Hz	+1Hz

2. IGV control：When the frequency reaches to surge line, the unloading will be controlled by IGV.

3. The control for target water temp. is based on input signal, and output signal is used for setting the frequency and opening of IGV. It is suggested to install anti-interference devices on chiller unit.

3.4 Equation of safety margin line

Description of Surge：

When the centrifugal compressor is at part load, the angle of guide vane becomes smaller and refrigerant volume entering compressor also reduces; when the volume flow decreases to a certain extent, surge and stall may occur. As shown in Figure 3.6 Typical fixed-frequency compressor performance map, when compressors operate above the Surge Line, stall or surge may occur. When the compressor surges, discharge pressure drops suddenly lower than the pressure in condenser so high-pressured gas flows reversely to the compressor; therefore, gas flows inside the compressor turbulently and it causes higher vibration and noise. Meanwhile, heat cannot be dissipated and refrigerant gas cannot be cooled down; high temperature inside the compressor may cause severe damage to high-speed shaft. In addition, alternatively varied pressure due to reverse flow may influence compressor’s moving parts so bearings may bear heavier load and be damaged. Therefore, compressor’s operating map must be confined below the Surge Line. Please refer to Hanbell selection software for more details of allowable compressor operating map to prevent surge.

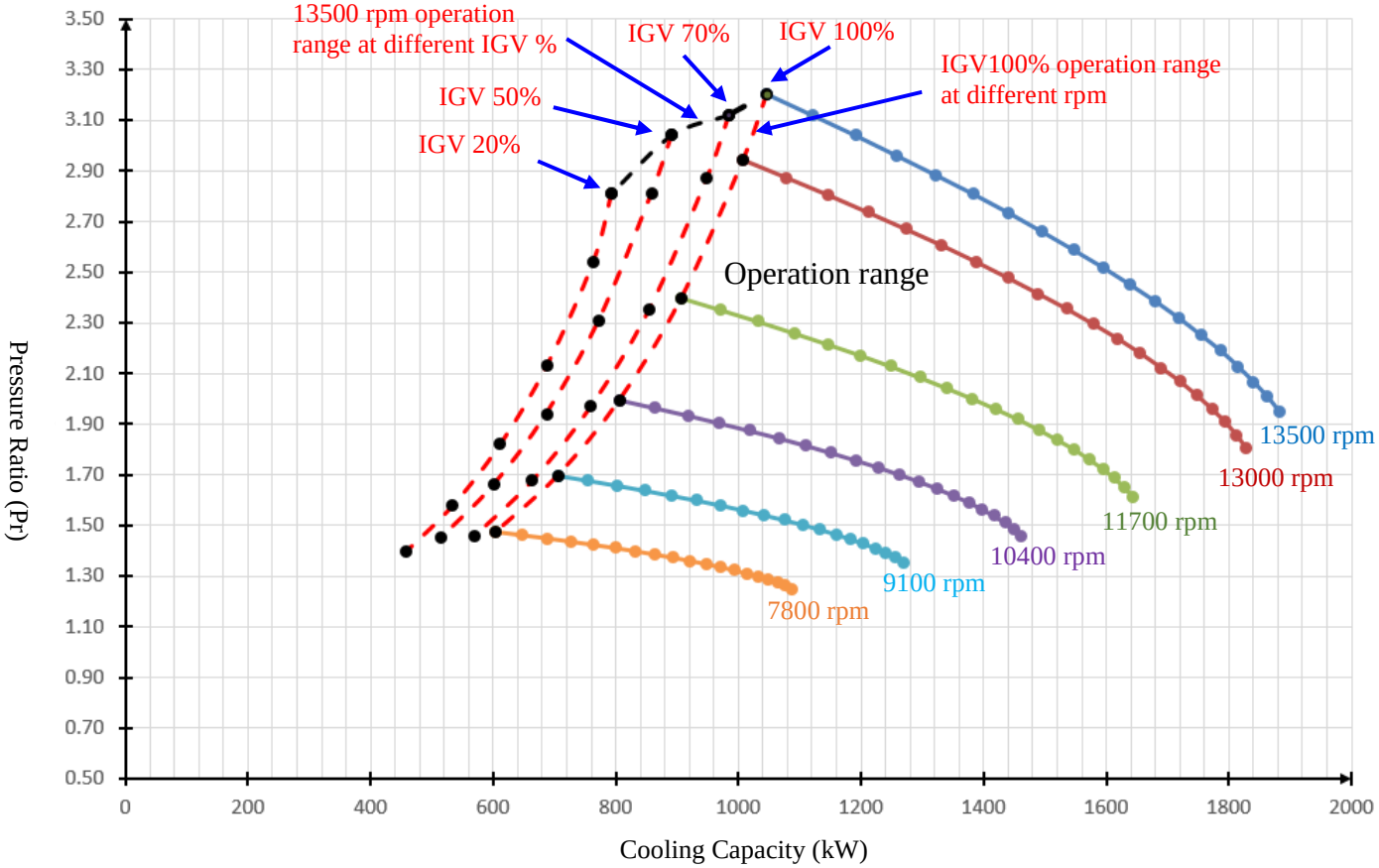


Figure 3.6 Operating range

Equation of safety margin line is a polynomial of IGV actuator's opening in percentage.
While operating, beware the pressure difference exceed the safety margin.

$$z = a+b/x+cy+d/x^2+ey^2+fy/x+g/x^3+hy^3+iy^2/x+jy/x^2$$

1. a、b、c、d、e、f、g、h、i、j are constant
2. z=Hz(minima operating frequency)；x= opening of IGV (%)/10；y= pressure ratio

Note：
1. When doing the minimum operation frequency calculation, 2~3Hz buffer will be considered.
2. Safety margin on each model is not the same, please contact HANBELL representatives.

3.5 Hot Gas By Pass (HGBP)

Hot gas bypass is to bypass gas refrigerant or liquid refrigerant from condenser into evaporator through a proportional valve.

Function: When the load reaches certain value the surge would happen. To continue the low load operation, the hot gas by pass valve can be opened to increase suction pressure and lower discharge pressure as well as compression ratio.

Because hot gas bypass is to transfer compressed gas from the condenser (high-pressure side) to the evaporator (low-pressure side), enormous noise may occur. It is recommended to enlarge the inner diameter of piping after the HGBP valve to keep flow speed under 10 m/sec.

In piping, the proportional valve should be installed as close as possible to the evaporator, and also at another side of suction entry (motor side) to lower the noises.
Besides, a muffler or shield should be installed at the evaporator to prevent splashed liquid refrigerant, which may damage the compressor.

Note1: The system with hot gas bypass is inefficient. It should be avoided whenever possible. Many system applications still require hot gas bypass in order to avoid surge or maintain constant chilled water temperatures from zero load to full load.
Note2: Required flow for HGBP depends on the difference between required minimum cooling capacity and the minimum load compressor can reach. If the IGV is at minimum opening and cooling capacity is 50%, and end user needs 20%. The pipe diameter and flow need to be considered based on the 30% difference.

3.6 Middle pressure stop valve

Between the ECO port of the compressor and the economizer, it is recommended to install a stop valve near the middle pressure port, it will avoid liquid goes back to compressor ECO port when compressor running at partial loading. Under partial loading, liquid refrigerant entering the economizer might be poured into the ECO port instead of the suction port.

4. MOTOR

4.1 Motor cooling

There are two ways to cool the magnetic centrifugal compressor. They are by cooling the motor stator, and by cooling the motor rotor and magnetic bearing. For the motor stator cooling, it is by high-pressured liquid refrigerant coming from the condenser. The inlet and outlet positions are shown as the "Motor cooling inlet (liquid)" and the "Motor cooling outlet" below. For the cooling on the motor rotor and the magnetic bearing, it is mainly by the medium-pressured gas coming from the economizer. The inlet and outlet positions are shown as the "Bearing cooling inlet (liquid + gas)" and "Bearing cooling outlet" as below. It should be noted that when the shaft length's elongation and bearing's temperature is in alarm value (see Chapter 4.3 for alarm values), we can turn on the auxiliary liquid refrigerant (from the condenser) to mix with the medium-pressured gas to cool the magnetic bearing or motor rotor (as the 4.4 pipeline diagram). At the same time, opening the "Auxiliary outlet of the bearing cooling" can prevent refrigerant be fluid.

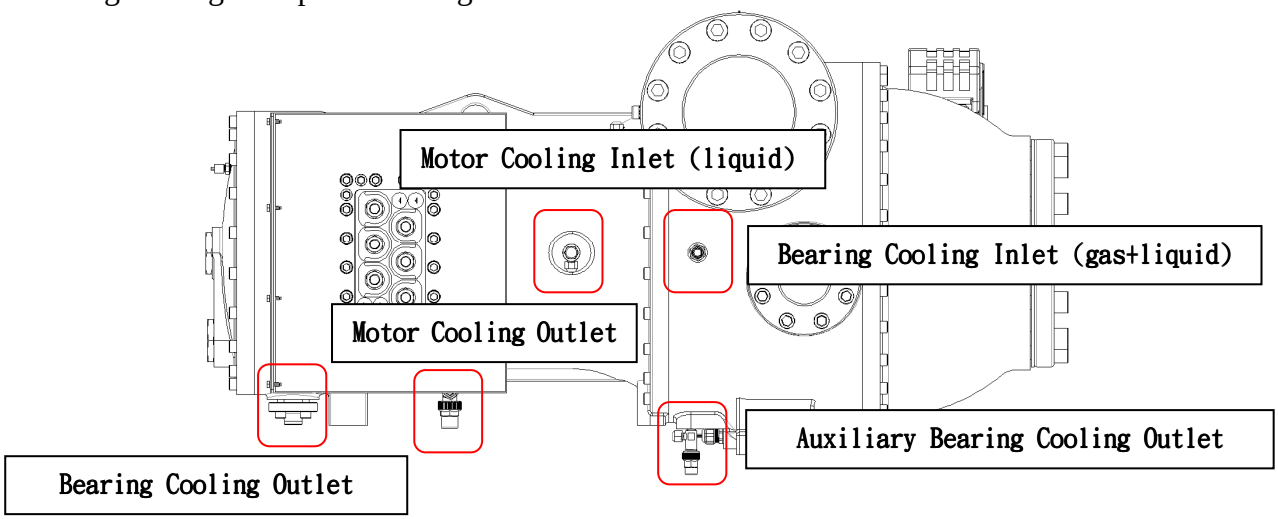


Figure 4.1 Motor & Bearing Cooling

4.1.1 Heater

One 300W UL approved heater has been installed in every compressor as a standard accessory. The function of the heater is to prevent condensation of refrigerant inside compressor. Before restart of compressor after shutdown for a long time, please turn on heater at least 24 hours.

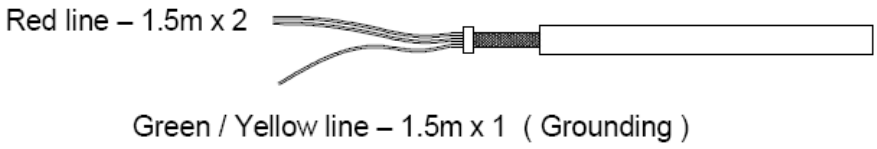


Figure 4.2 Heater

Spec.：300W; 110V or 220V; IP 54; UL certified

Note: If compressor is installed in low ambient temperature, please turn on the heater once compressor stop running.

4.1.2 Pt100 RTD (Resistance Temperature Detector)

- Recommended max. measurement current DC 1 ~ 3mA for heat coefficient <0.1℃
- Heating coefficient: 10mΩ/K
- Sensor resistance at 0℃: 100Ω±0.12Ω
- Change of resistance 0 ~ 100℃: 0.385Ω/K
- Insulation test voltage (V): AC 1.5kV

Note: To avoid interference, signal control cable must installed shielded wire.

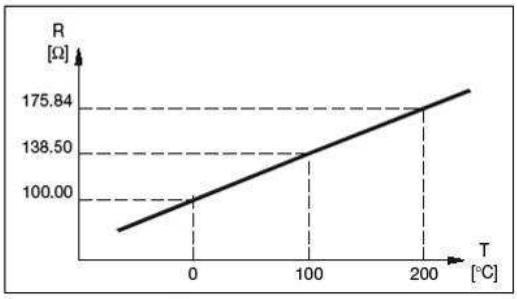


Figure 4.3 Pt100 thermostat

4.2 Liquid returned from motor and bearings

The piping connection is showing in Figure 4.4：

※Motor Cooling Outlet is connected to Economizer

※Bearing Cooling Outlet is connected to Evaporator

Note：Bearing Cooling Outlet is connected to Evaporator, to reduce the pressure inside motor chamber.

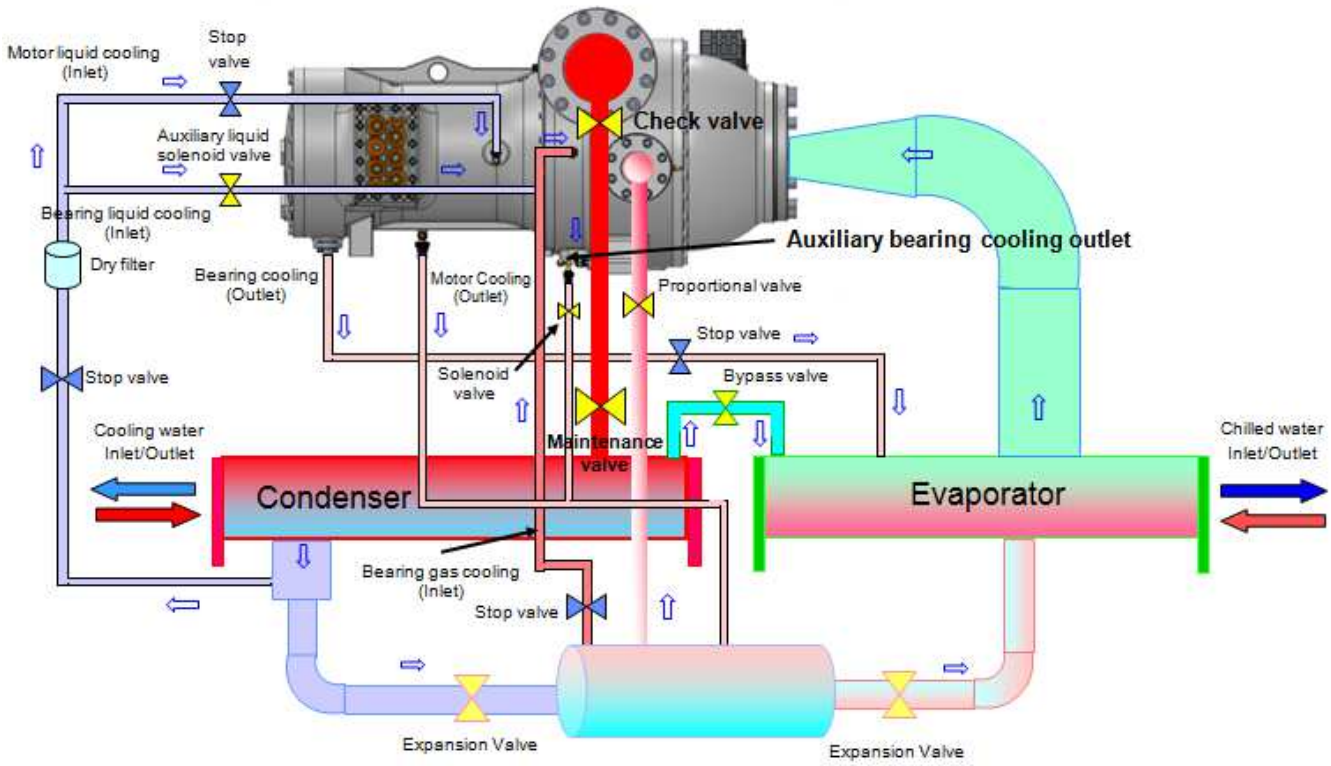


Figure 4.4 Cooling system

4.3 Motor Temperature Control

There are six set of Pt100 installed in motor winding to monitor motor temperature and suggest control logic is listed below:

1.

※Motor Temp.：T＞90℃(alarm)；T > 100℃(tripping)

※Bearing Temp.：T＞75℃(alarm)；T > 85℃(tripping)

※Liquid injection should be turned on if the alarm from motor temp. or bearing temp. alarm is on (refer figure4.4)

※The auxiliary liquid solenoid valve can be closed when the motor temperature ≦80℃ or magnetic bearing temperature ≦65℃.

※Bearing cooling (gas type) stop valve should be open when compressor running.

2.

※Shaft stretch：>300μm(alarm)；>400μm(tripping)

※The auxiliary liquid solenoid should be opened when the Shaft stretch is greater than the warning value.

※When the shaft stretch ≦250 μm can be turn off auxiliary liquid solenoid.

Please consult Hanbell representatives for details on Shaft stretch calculation.

Note: The controller must warning when one of Pt100 sensor detecting the temperature higher than upon definition temperature, and compressor must stop until the reason has been found out.

Remark：Six sets of Pt100 are showing in different color with red, white, black, yellow, blue, and gray. Common line is in green.

4.4 Motor connection

4.4.1 Voltage & Frequency

The RTM compressor is working on following power supply range:

380V±5%(342V~418V)
400V±5%(360V~440V)
460V±5%(414V~506V)

Table 4.1 Rated Voltage Supply Range

50 Hz±3%(47Hz~53Hz)
60 Hz±3%(57Hz~63Hz)

Table 4.2 Rated Frequency Supply Range

Note：1. Frequency is applied for power generator, not compressor motor frequency.

2. The chart above is suggested for the compressor and its accessory such as inverter. For other electronic components, please double check their designed power supply.

4.4.2 Components of inverter

The connection of inverter is showing in figure 4.5：

1. No-Fuse Breaker(NFB)：To protect an electrical circuit from damage caused by excess current, the selection of the NFB shall be based on the current under full load condition. 600DCV/16A is suggested

Note：Full load current is calculated when reactor is applied.

2.EMC/EMI Line Filter：To reduce the interference of the power supply, it shall be complied with EMC/EMI

3. Sine Wave filter：It can effectively reduce stretch length of the shaft by high frequency wave from inverter during operation.

Note：Following electronic devices are suggested by Hanbell (RTM-090)：

Devices	Model
(KEB)Inverter*1-8kHz	30F5E0W-Y03H
(KEB)EMC/EMI Line Filter*2	28E4T60-1001
(KEB)Reactor*2	26Z1B04-1000
(KEB)Sine-Wave-Filter *1	30Z1G04-1005
(KEB)DC Fuse*2	12U420E-3W00
(KEB)COMM Board (Modbus)	00F5060-A000
(KEB)COMM Board (Profinet)	00F5060-L100

Note：(1) For the inverter with carrier frequency up to 8kHz design, Sine Wave Filter is not a necessary device.

(2) When the carrier frequency of the inverter is between 4kHz to 8kHz, Sine-Wave-Filter is necessary to be installed.

(3) The reactor shall be installed as illustrate in chart 4.5. There shall be good ventilation system and the panel shall install the cooling fan.

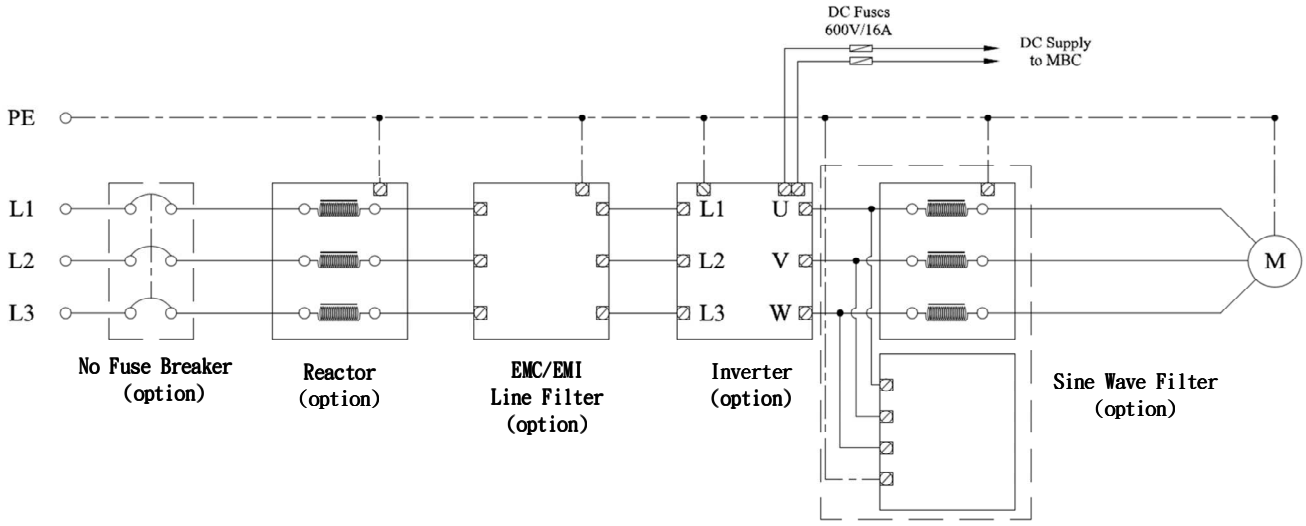


Figure 4.5 Inverter connection

4.4.3 Grounding

Grounding point in electric system normally is a neutral point. Exposed compressor conductor should not be electrified in normal use. But there is possibility that the compressor is electrified under malfunction condition. For security purpose, HANBELL strongly ask grounding of below devices during installation：

1. M12 grounding screw in terminal box should be reliably connected with grounding wire.
2. All of the electronic components.
3. Electronic component, metal sheath of power cable, palpable threading pipe, cable metal trunking, cable trays should be grounded.
4. Power cable grounding wire should use copper wire or tinned copper braided wire, and the cross-sectional area should follow below table

Power Cable (mm^2)	Grounding Wire(mm^2)
120 and lower	16
150 and higher	25

Table 4.3 Power cable cross-sectional area

Note：Resistance of grounding should not be higher than 8Ω

4.4.4 Cable of main power input

Power cable should meet the IECA S-19-81 standard, 600V insulated wire, Hypalon. Please choose wiring size of power supply under 1.25 safety margin of maximum load. Wire diameter, cross-sectional area, and current can refer to table 5.2. All on-site supply of cables and wires, equipment and field wiring, cable wire terminals and equipment are necessary to comply with various regulations and engineering requirement. Power cables shall be with braid sleeve and able to avoid the interference with others. The power cable connection is showing on figure 4.6. Please double check the phase sequence when wiring.

Note：1. The power cable gland should be insulated properly with heat shrinking tube

2. The power cable shall sustain the maximum permissible current under 90℃ (40℃ ambient temperature)

600V Hypalon Cable (*1C)			
Section Area (mm^2)	Maximum Permissible current(A)	Section Area (mm^2)	Maximum Permissible current(A)
50	200	150	410
60	230	200	500
80	280	250	570
100	330	325	670
125	370	400	760

Table 4.4 600V Hypalon Maximum Permissible current

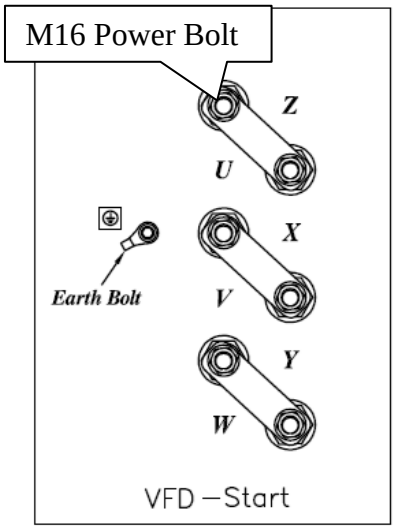


Figure 4.6 Power Terminal Connector

4.4.5 Connection notice

1. Check the power supply characteristics in line with the nameplate. The power cable must be made of copper.
2. It is not allowed to change the shape and dimension of cable box.
3. The power bolts are made of brass, which cannot sustain the weight of high voltage cables. External cable shelves or tension-ease devices to support the high voltage cables must be applied. HANBELL does not provide wiring terminals.
4. When tightening the terminals of power bolts, use torque wrench with the torque lower than 700kgf-cm (5/8” & 9/16” copper nut).
5. Cable wiring and construction inspection rules must follow local electrical regulations.
6. The insulation material of the main power and control cables should be screen effective to avoid signal interferes, and maintain proper distance in between cables during installation.

4.5 MCC (Maximum Continuous Current) of motor

Model	Voltage(V)	(kW)	MCC (A)
RTM-090	380	310	597

5. Control line connection

MBC、THD typical I/O connections

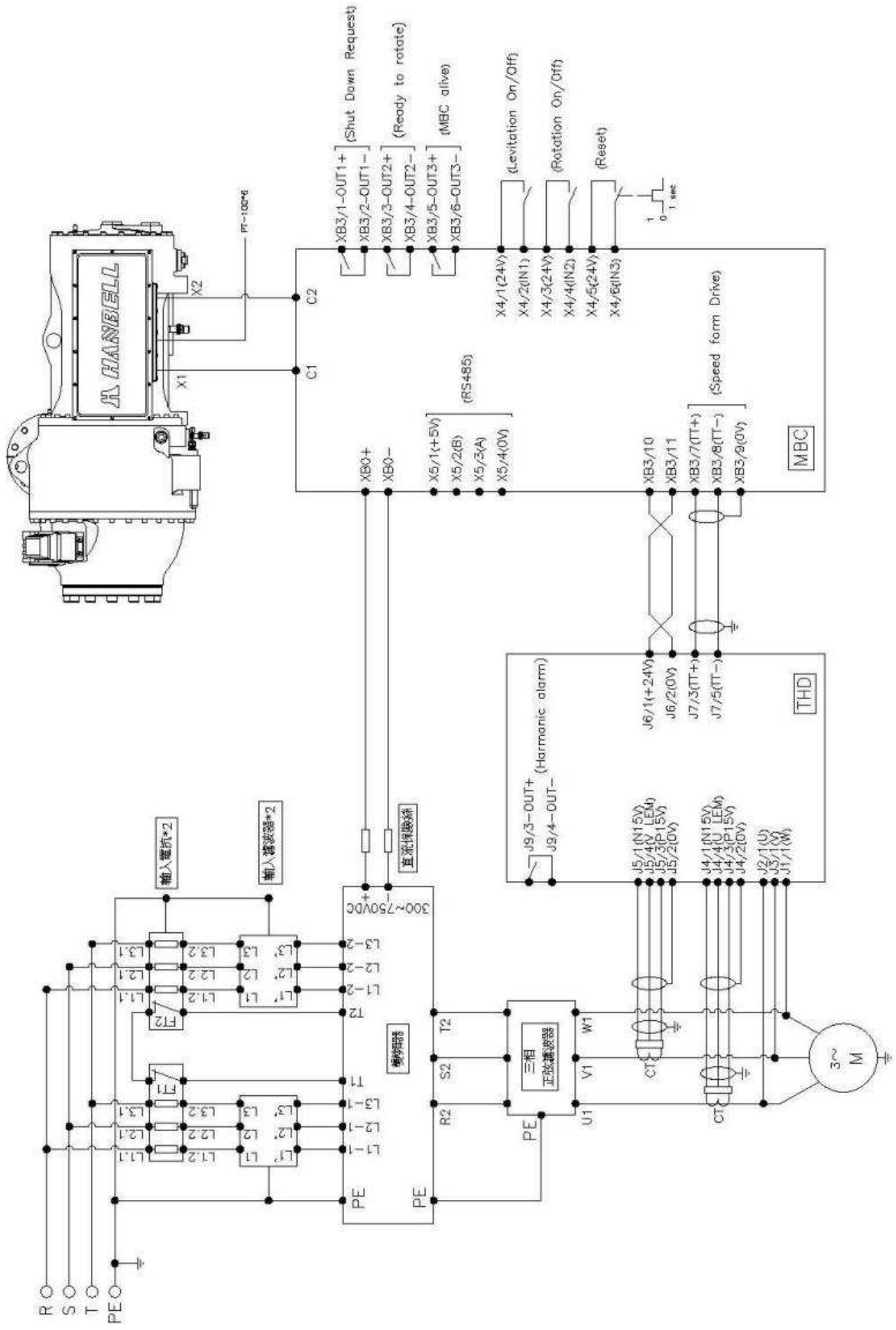


Figure 5.1 Compressor control connection

5.1 Magnetic Bearing Controller (MBC) info

Length (mm)	305
Width (mm)	360
Height (mm)	445
Weight (kg)	27
IP protection degree (*For storage, IP 2X or higher level is required)	IP 1X (Body)
Operation Temp. (℃)	+5~+40℃
Relative humidity (%)	30%~70%
Storage Temp. (℃)	-25℃~+55℃
Power	350~750 VDC
Max. power output	1500W
Relay dry contact output	250 VAC/0.25A max or 30 VDC/2A max
Protocol	ModBus RS485， Cable length<100m

5.2 MBC installation notice

※Please keep the installation space for MBC as figure 5.3 below for good cooling effect.

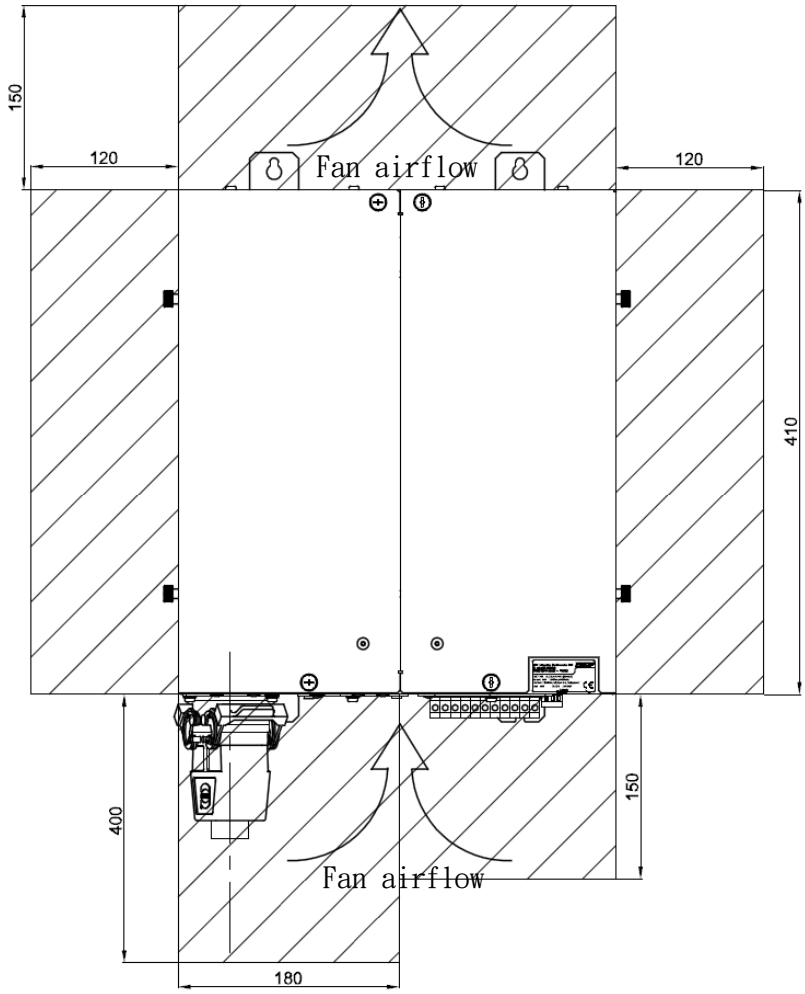
※Please keep MBC located at least 400mm from the ground.

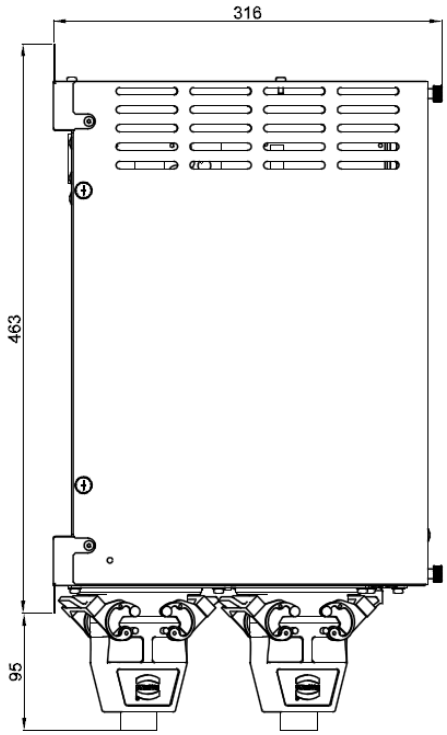
※Keep dust, oil, water away from MBC.

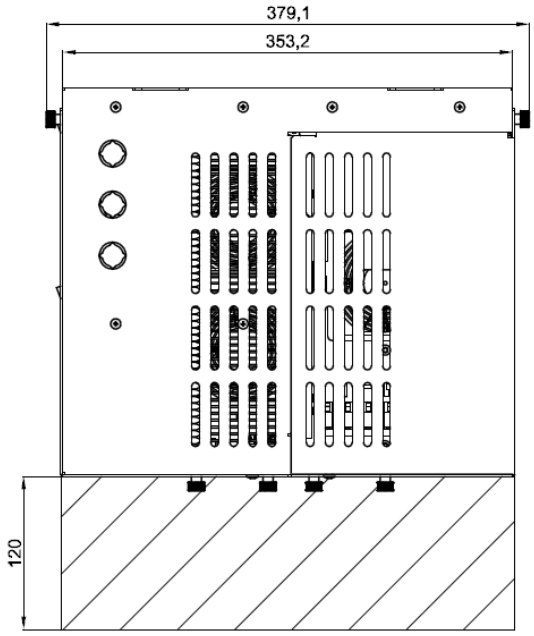
※MBC should installed in a stable place without vibration.

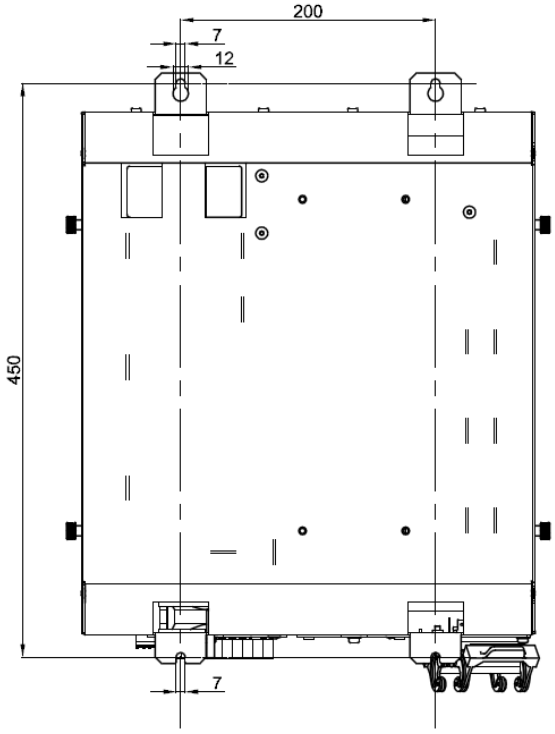
※Make sure the MBC is operated within proper relative humidity to avoid the electronic components damage.

5.3 MBC outline









5.4 MBC connection port

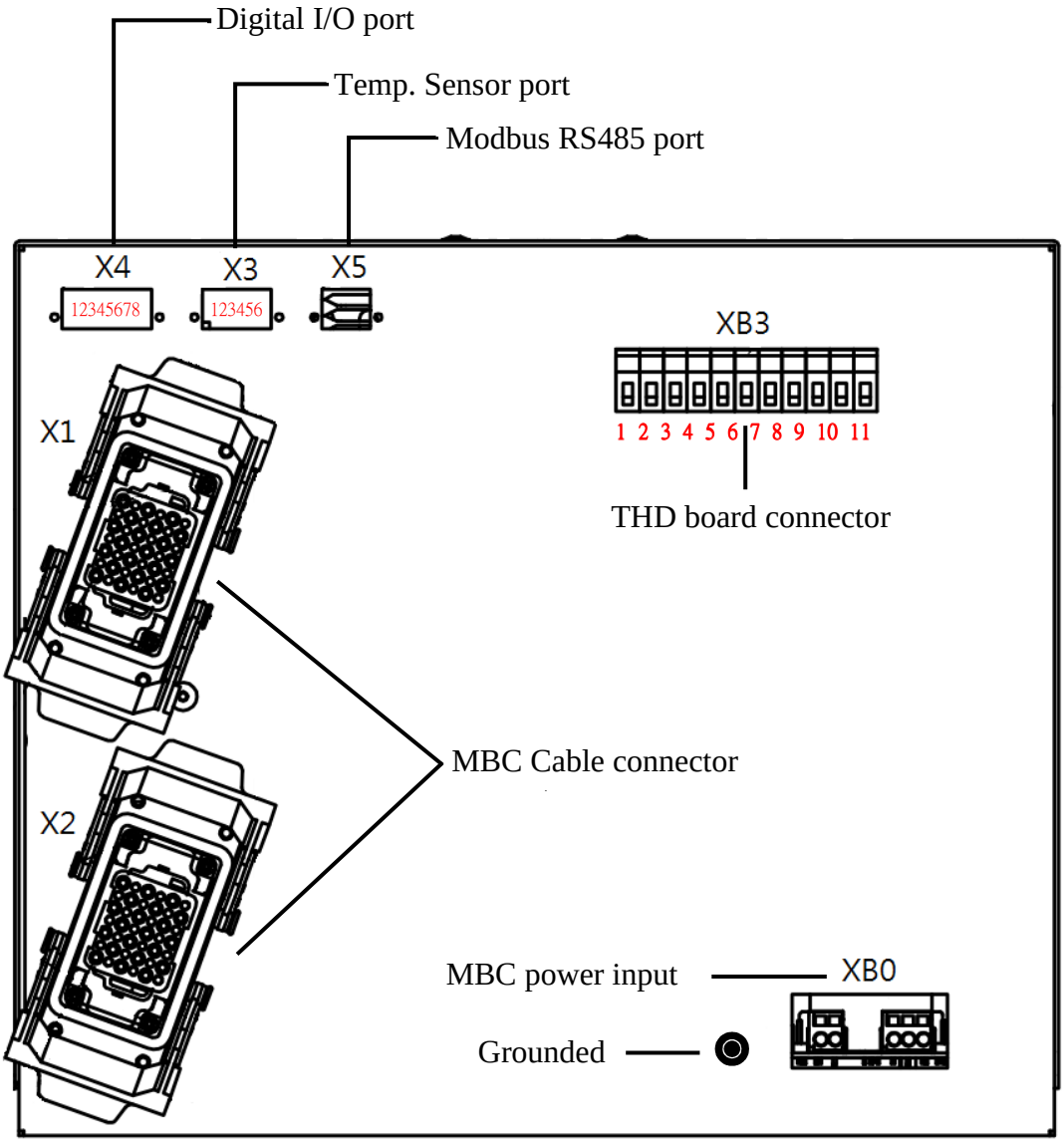


Figure 5.1 MBC connection

5.5 MBC connection data

I/O	Description
XB0	1.350~750 VDC 2. 2Pin(+)；3Pin(-)。
X1	Front bearing cable connector to motor, 2m (refer to figure 5.1)
X2	Rear bearing cable connector to motor, 2m (refer to figure 5.1)
X3	Spare contact
X4	24V DC signal to MBC
X5	RS-485 protocol port (refer to figure 5.1)
XB3	Max. 250VAC/0.25A or 30VDC/2A power supply. (refer to figure 5.1)

5.5.1 Additional info. about connection port

1. X4：Use I/O to monitor magnetic bearings by 24 VDC power supply (refer to figure 5.1)：
Digital-In1： Levitation (X4 terminal number：1 and 2)
Reply open (0V) → Levitation OFF。
Reply closed (24V) → Levitation ON。

Digital-In 2：Rotation (X4 terminal number：3 and 4)
Reply open (0V) →Rotation OFF。
Reply closed (24V) →Rotation ON。

Digital-In 3：Reset (X4 terminal number：5 and 6)
Reply open (0V) → Reset OFF。
Reply closed (24V) → Reset ON。

2. XB3：The signal from relay inside of MBC
Digital-Out1： Shut Down Request, SDR (XB3 terminal number：1 and 2)
Reply open → SDR ON。
Reply closed → SDR OFF。
Note：When SDR ON, the shaft is still in suspension status, must reset before restarting.

Digital-Out 2：Ready to rotate (XB3 terminal number：3 and 4)
Reply open → Not ready。
Reply closed → Ready。

Digital-Out 3：MBC status (XB3 terminal number：5 and 6)
Reply open → MBC power is off
Reply closed → MBC in operation

5.5.2 Communication of MBC and PLC

Please refer MBC Communication address-1.1

5.6 Total Harmonic Distortion (THD) info.

Length (mm)	105
Width (mm)	155
Height (mm)	50
Weight (kg)	0.25
IP protection degree (*For storage, IP 2X or higher level is required)	IP 00(Body)
Operation Temp. (℃)	+5~+40℃
Relative humidity (%)	30%~70%
Storage Temp. (℃)	-25℃~+55℃
Power	24 VDC

5.7 THD installation & fix

※The THD board is provided mounted on a RS100 support. The THD board must be mounted in the upright position on DIN rail as figure 5.2.

※The THD board must be installed with proper space away from cable tray.

※High voltages are presented on the THD board. It is suggested to install plexiglass cover.

※The link between the THD board (power supply 24Vdc) and MBC must be carried out with a twisted wires.

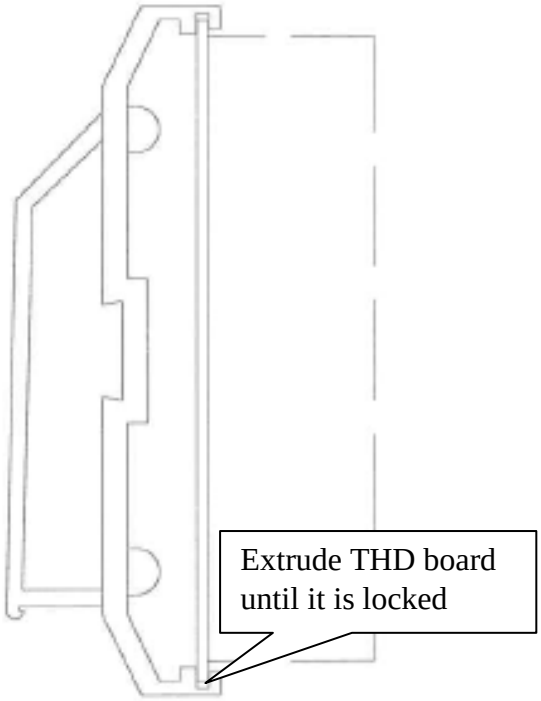


Figure 5.2 THD installation

5.8 THD connector

THD connection terminal numbers are shown as figure 5.3, please refer to figure 5.1：

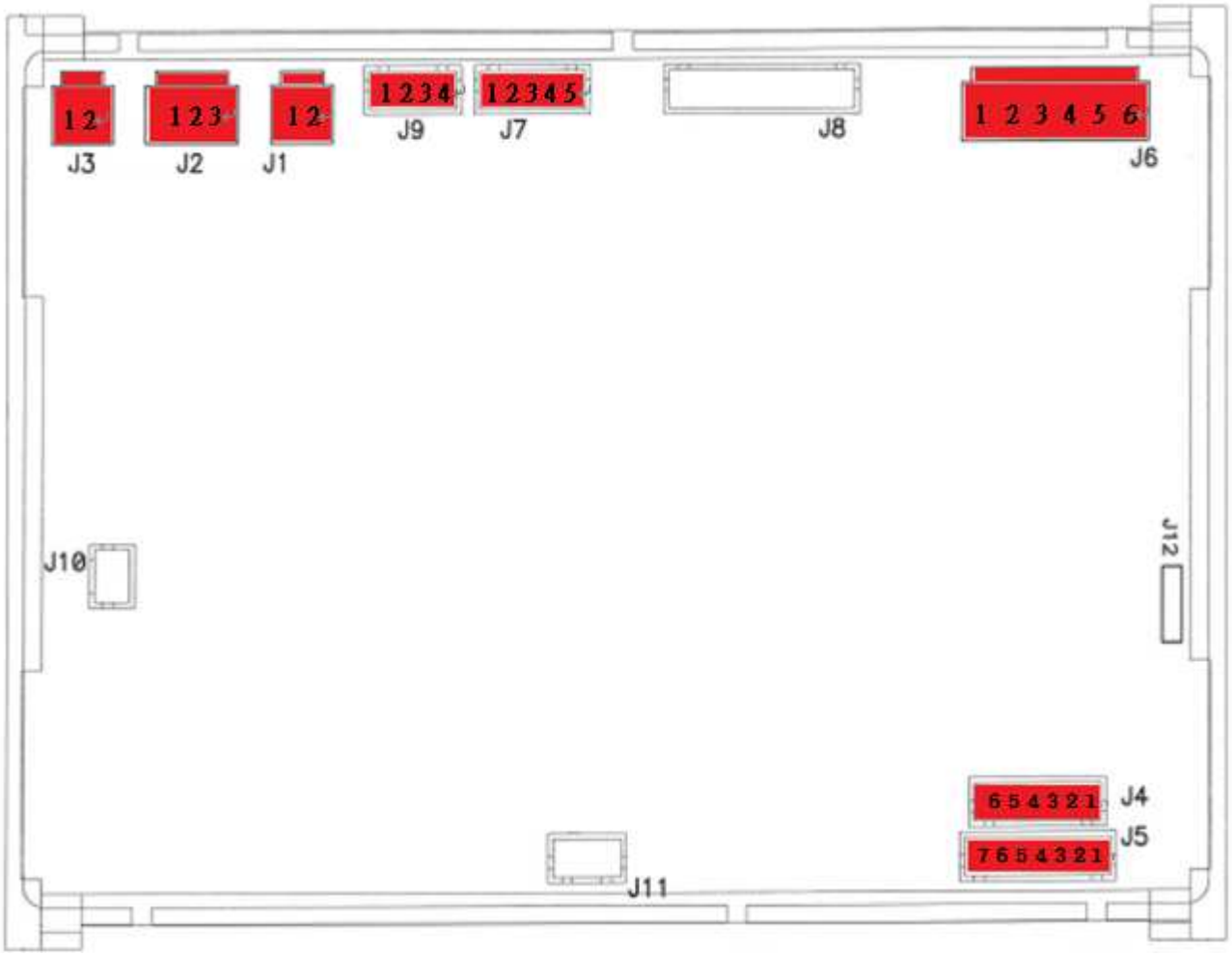


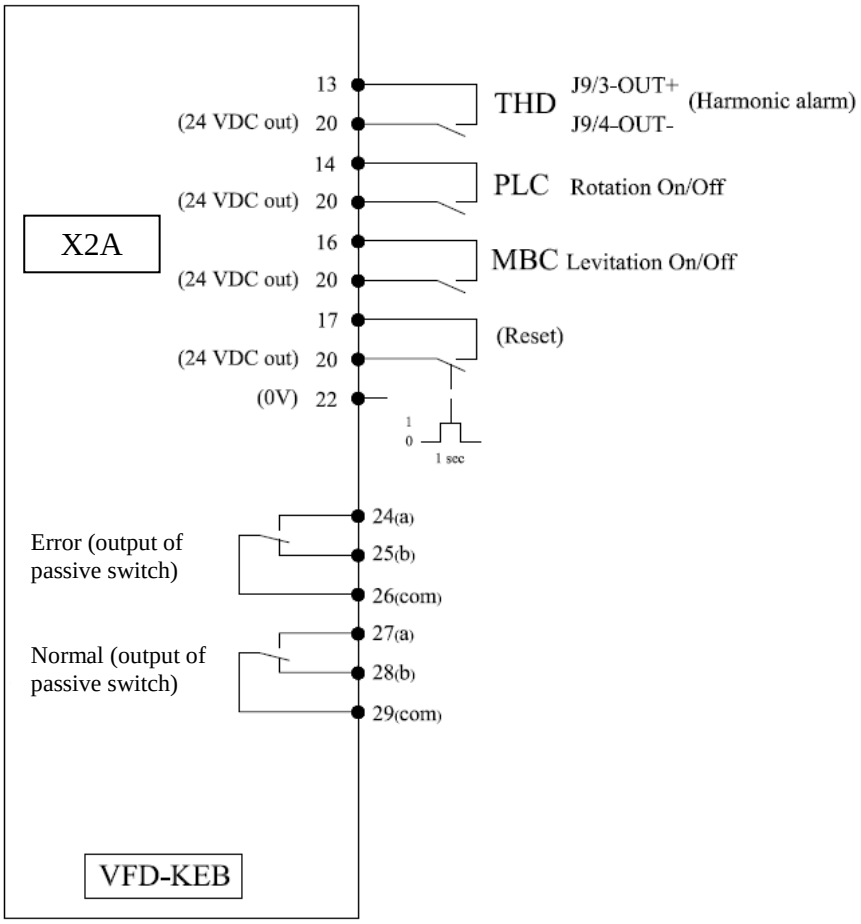
Figure 5.3 THD outline

Terminal	Pin Number	Pin Name	Pin Description
J1	1	W	W phase voltage of motor
J2	1	U	U phase voltage of motor
J3	1	V	V phase voltage of motor
J4	J4.1	N15V	LEM(CT) -15V power supply
	J4.2	0V	LEM(CT) 0V power supply
	J4.3	P15V	LEM(CT) +15V power supply
	J4.4	U_LEM	Phase U current
J5	J5.1	N15V	LEM(CT) -15V power supply
	J5.2	0V	LEM(CT) 0V power

			supply
	J5.3	P15V	LEM(CT) +15V power supply
	J5.4	V_LEM	Phase V current
J6	J6.1	P24VI	THD +24V power supply
	J6.2	0VI	THD 0V power supply
J7	J7.3	TPTOUR_AMB	Top Tour output(+)，isolated
	J7.5	0V_AMB	Top Tour output(-)，isolated
J9	J9.1	Harmonic_Alarm_1A	Dry contact, open in case of alarm
	J9.2	Harmonic_Alarm_1B	Dry contact, open in case of alarm

5.9 Variable Frequency Drive (VFD) Connector

Description of KEB inverter connection：



Remark：The figure is only for KEB, other brands may be different.

5.10 Parameter of inverter

Please refer KEB VFD parameter-1.1

6. Compressor lifting and installation

6.1 Compressor lifting

1. When lifting compressor, it is recommended to use steel chain or cable as figure 6.1, or other safety ropes with loading capacity 2500kg.
2. Make sure the steel chain or cable are properly positioned and keep the compressor in horizontal level to prevent damage in compressor and its accessories during installation.

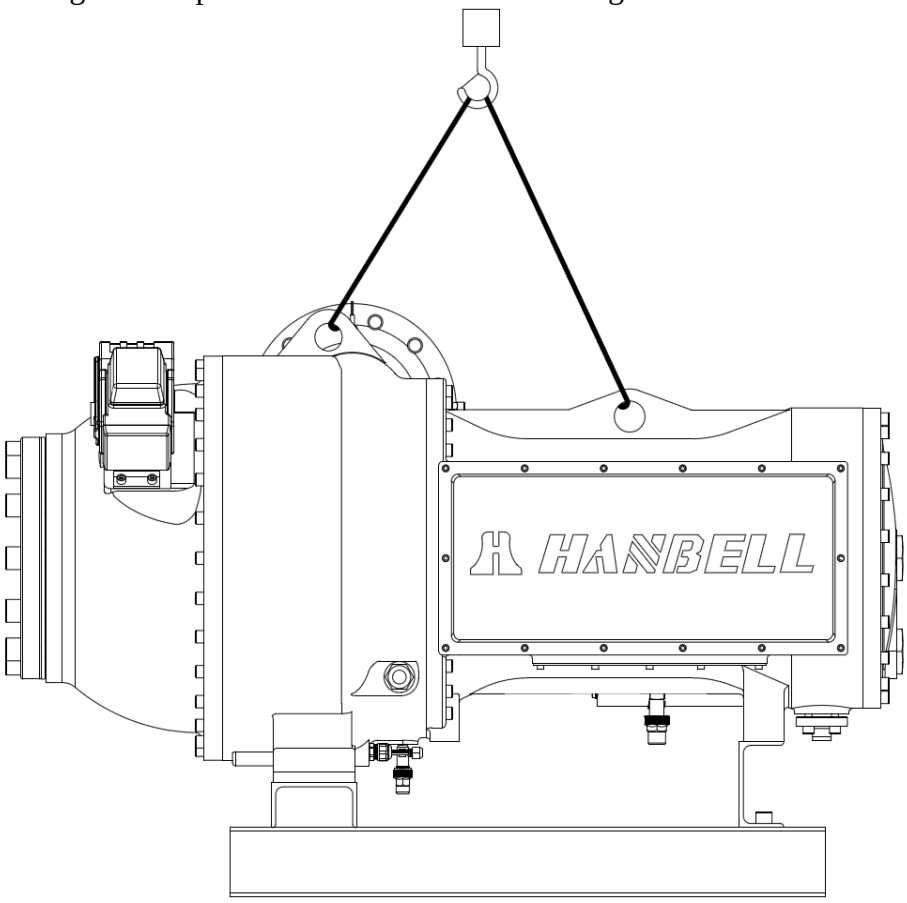


Figure 6.1 Lifting compressor

6.2 Compressor installation

1. Compressor should be mounted close to power supply and keep it under proper ventilation and low humidity condition.
2. Make sure the frame that supports compressor is strong enough to resist possible vibration and noise during operation and reserve at least 600mm service space around compressor.
3. Compressor has to be installed in horizontal position and installation cushion pad is also recommended, as figure 6.2.

Remark: Compressor should be installed at higher position than evaporator and compressor-foot position should be higher than ECO liquid level in order to prevent pressure loss on liquid return.

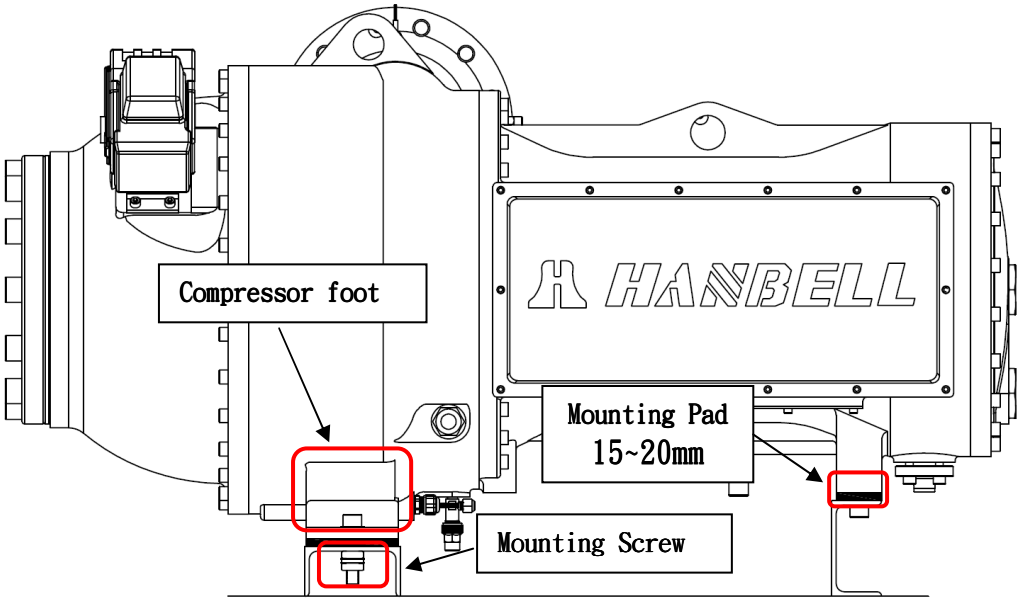


Figure 6.2 Installation of Mounting Pad

7. Instructions

7.1 Accessories

In order to fulfill customers' demand, Hanbell provides full set of standard and option accessories for variable applications to ensure the stability and efficiency of compressor in the field.

●：Standard　　△：Option

Accessories	RTM
Suction/ Discharge flange*1	●
Economizer flange*1	●
Actuator*1	●
IP54 Terminal Box*1	●
Refrigerant Heater (300W)*1	●
Motor Temperature Sensor(Pt100) *1	●
Discharge Temperature Sensor(Pt100 or Pt1000)*1	●
MBC*1	●
Magnetic Controller wire (with Adaptor)*2	●
Controller Current Transformer (CT)*2	●
Controller Terminal*1(Kit)	●
THD Plate*1	●
Copper Bridge*3	●
Mounting Pad	△
Actuator Heater (Special spec.)	△
Butterfly Valve	△
Discharge Check Valve	△
Inverter (KEB)	△
EMI/EMC filter (KEB)	△
Reactor (KEB)	△
Sine-Wave Filter (KEB)	△
DC/Fuse (KEB) (600V/16A)	△
COMM Board (Profinet / Modbus)	△

Table 8.1 Accessory list

7.2 Valves

1. All kinds of valves installed on compressor are closed before delivery. Please make sure to open the valves before testing run.
2. Actuator power supply and opening test: test from 0 ~ 100% (input signal is 4~20mA or other spec). When start up, the opening at start point should be 20%.
3. HGBP/Proportion Valve opening test: test 0 ~ 100%. When start up, the opening at start point of HGBP is 100%, and 0% for proportion valve.

7.3 Testing before power supply

1. Check the voltage supply to compressor from inverter is correct.
2. Check THD Board wiring connection, including Current Transformer, voltage feedback, power supply and its specification. (24V DC is supplied by MBC)

3. Check the voltage supplied to Magnetic Controller from inverter is correct (VDC 350~750V). If correct, input the power and make shaft levitated by controller. Before shaft is levitated, make sure to reset all alarm messages.
Remark:
1. It is forbidden to run the compressor during checking process, even under vacuum circumstance.
2. The shaft must levitated 8 hours before starting if the compressor shouting down for 6 months. SDR may shows error but not effecting the levitation. The time of levitation in proportion to the shout off time, the compressor can be started after levitation. SDR error will be removed automatically.

7.4 System requirement

1. System pipe has to be clean. It can't be contaminated by welding debris or steel scrap, which can cause damage to compressor.
2. Proper size of check valve should be installed in discharge pipe and the pressure drop should be as small as possible. The pressure and temperature is high in discharge side, so the material and quality of check valve has to be reliable.
3. If compressor is operated under humid circumstance, proper preservation and protection is necessary.
4. If compressor is shut-down for a long term, especially in the winter, refrigerant tends to flow back into compressor. Please check if refrigerant is accumulated in the compressor from sight glass before start up the compressor. If necessary, the liquid returning angle-valve can lead the refrigerant to evaporator.

7.5 Control requirement

1. In order to avoid motor over-heat, compressor is not allowed to start/stop frequently. The interval between start/stop should be at least 10 minutes.
2. Discharge/Suction pressure sensor for calculating Surge equation has to be installed close to Discharge/Suction port.

7.6 Others

A check valve is recommended to be installed close to condenser on discharge piping to prevent gas back flow when emergency stop.

Appendix:

AC	Alternating current
AHRI	Air Conditioning, Heating and Refrigeration Institute
ANSI	American National Standard Institute
CT	Condensing Temperature
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ET	Evaporator Temperature
GB	National Standards of People's Republic of China
HGBP	Hot Gas By Pass
IGV	Inlet Guide Vane
IP	Industry Pack
JIS	Japanese Industrial Standards
LEM	Current Transformer (CT)
MBC	Magnetic Bearing Control
RTM	Hanbell Oil-free centrifugal
UL	Underwriters Laboratories Inc.
VDC	Direct Current
VFD	Inverter