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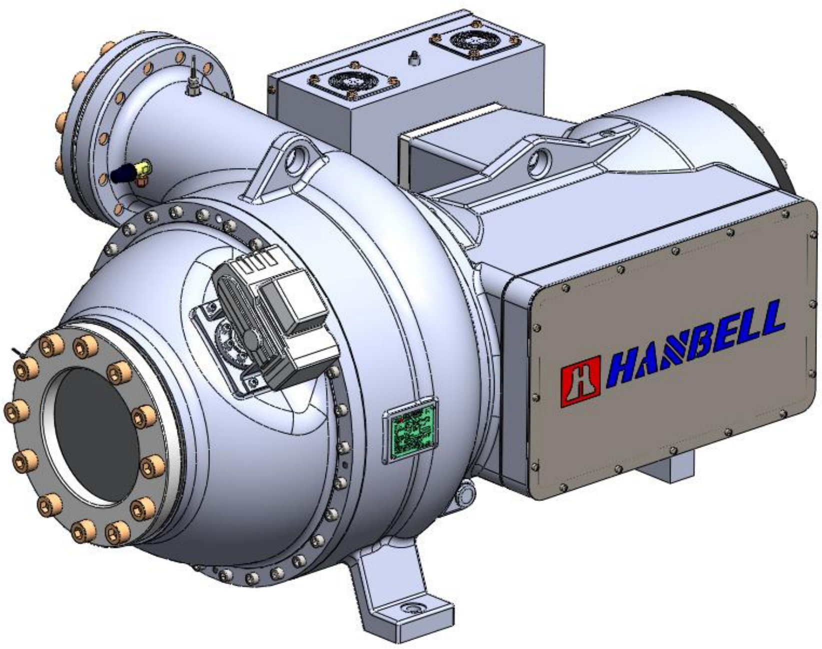
HANBELL PRECISE MACHINERY CO.,LTD.

Magnetic Bearing Centrifugal Compressor
(Featuring Delta Electronics technology)



Technical Manual

Contents

1. RTM SERIES COMPRESSOR 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.

1.1 Features :

- Refrigerant：R-134a
- 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

1.2 Ambience:

Temperature range for compressor storage and operation:
Storage: -5°C to 45°C
Operation (chiller): ET: 2°C to 14°C / CT: 15°C to 55°C
Operation (data center): ET: 15°C to 21°C / CT: 15°C to 40°C

1.2.1 **Compressor Storage Conditions**

- Relative Humidity: Ambient relative humidity should be below 90%, with no condensation.
- Atmospheric Corrosive Gas Content:
  Nitrogen oxides (NO_x) $\leq$ 5 mg/m^3,Hydrogen cyanide (HCN) $\leq$ 5 mg/m^3.
  Hydrogen sulfide (H_2S) $\leq$ 5 mg/m^3,Hydrogen chloride (ˋ ㄓ ˙) $\leq$ 5 mg/m^3.
  Chlorine (Cl_2) $\leq$ 1 mg/m^3Sulfur dioxide (SO_2) $\leq$ 10 mg/m^3
  Storage:
  ① The compressor must be stored indoors with ventilation. It must not be placed outdoors where it may be exposed to rain, dripping water, or direct sunlight.
  ② Do not store the compressor in corrosive, flammable, explosive, or oil mist-laden environments.

1.2.2 **Compressor Operating Environment**

- Voltage fluctuation range: Instantaneous ±10%, long-term ±5%.
- Voltage imbalance between phases: Within ±3%.
- Machine room operating temperature: 2–45°C.
- Relative humidity: Must be below 90%, with no condensation.
- Altitude: Below 1,000 meters. Higher altitudes may affect electrical insulation and conductivity.
- Atmospheric corrosive gas content : Nitrogen oxides (NO_x) ≤ 5 mg/m³,
  Hydrogen cyanide (HCN) ≤ 5 mg/m³,Hydrogen sulfide (H_2S) ≤ 5 mg/m³,
  Hydrogen chloride (HCl) ≤ 5 mg/m³,Chlorine (Cl_2) ≤ 1 mg/m³,
  Sulfur dioxide (SO_2) ≤ 10 mg/m³
- Installation：
  ① The compressor must be installed indoors with proper ventilation. Excessive ambient temperature is a major cause of electrical failure and accelerates corrosion.
  ② Do not install the compressor in environments that are corrosive, explosive, or contain oil mist, nor outdoors where it may be exposed to rain, water drips, or direct sunlight.
  ③ Install the compressor in a dust-free location. Excessive dust is one of the primary causes of electrical failure.
  ④ Ensure sufficient space around the compressor for inspection, maintenance, and hoisting (including vertical clearance).
- The suction end cap and motor casing of the compressor are in low-temperature, low-pressure areas that are prone to condensation. Proper insulation must be applied to prevent dripping water or moisture from corroding electrical components.

Notes 1. Refer to Chapter 2 for operating temperature ranges or use the performance table in the selection software.

Notes 2. For unconventional operating conditions, please consult Hanbell R&D personnel.

Notes 3. Consult the instructions provided when using motor units with rechargeable components.

Notes 4. In humid environments, besides insulating the compressor casing, pipeline insulation is also required to prevent condensation.

Notes 5. Insulation must be applied to the solenoid control wire terminals, solenoid power wire terminals, and RJ-45 terminals used for Modbus and keypad to prevent terminal corrosion due to low-temperature condensation.

Note: Voltage Imbalance Formula (Defined in NEMA):

$$\text{Voltage Imbalance (\%)} = \frac{100 \times |\text{Maximum (or Minimum) Phase Voltage - Average Voltage}|}{\text{Average Voltage}}$$

According to NEMA standards, three-phase motors should operate with a voltage imbalance of no more than 1%. If the imbalance exceeds 5%, the motor must not be started due to the risk of local coil overheating. Voltage imbalance also leads to current imbalance, typically 6–10 times the voltage imbalance, resulting in torque fluctuation, vibration, reduced motor life, and possible burnout.

1.3 Vibration：

Magnetic bearing compressors have shaft suspension characteristics that allow the rotor and machine body to operate without physical contact. Therefore, when using traditional vibration sensors, only specific frequency points related to drive harmonics can be detected. Compared to vibration behavior in machines with contact bearings, issues like rotor imbalance—normally causing vibration—are suppressed by the magnetic bearing's vibration control function (hereafter referred to as UFRC). As such, traditional vibration measurement methods are not applicable.
The magnetic bearing controller (hereafter referred to as MBC) is responsible for posture monitoring during operation. MBC includes a UFRC function that controls and suppresses system vibration during operation, preventing structural vibration. When rotor imbalance occurs, the MBC initiates suppression and simultaneously issues alarms and provides relevant diagnostic data as vibration judgment conditions. Therefore, as long as the conditions remain within the MBC's control range, no additional vibration protection is required.

Factory Vibration Standard: Overall < 1.0 mm/s

Notes 1. When rotor imbalance occurs but remains within the MBC's control range, large compressor vibration typically does not appear, since the MBC's suppression function is not yet activated and the rotor's kinetic energy is low.
Notes 2. The vibration standard is emphasized to ensure that the unit operates without abnormal vibration during factory testing.

1.4 Abbreviation description：

Abbreviation	English Definition	Chinese Definition
AC	Alternating Current	交流電
AHRI	Air-Conditioning, Heating, and Refrigeration Institute	美國空調制冷協會
ANSI	American National Standard Institute	美國國家標準協會
CT	Condensing Temperature	飽和冷凝溫度
EMC	Electromagnetic Compatibility	電磁兼容性
EMI	Electromagnetic Interference	電磁干擾
ET	Evaporating Temperature	飽和蒸發溫度
GB	Guo Biao (National Standard of The PRC)	中國國家標準
HGBP	Hot Gas Bypass	熱器旁通
IGV	Inlet Guide Vane	入口導葉

IP	International Protection Marking	國際防護等級認證
JIS	Japanese Industrial Standards	日本工業標準
MBC	Magnetic Bearing Controller	磁浮控制器
Pr	Pressure Ratio	壓縮比
RTM	Magnetic Centrifugal Refrigeration Compressor	磁浮離心式冷媒壓縮機
THD	Total Harmonic Distortion	總諧波失真
UFRC	Unbalance Force Rejection Control	轉軸不平衡抑制
UL	Underwrites Laboratories Inc.	美國保險商試驗所
VDC	Voltage Direct Current	直流電
VFD	Variable-Frequency Drive	變頻器

2. Basic design

2.1 Compressor nomenclature :

RT M – XX X

- 0 : Refrigeration , △T=CT-ET=30℃
- Model name: value*50 =Cooling/Heating Capacity
- Bearing type: Oil-free
- Compressor type: Centrifugal Refrigeration Compressor

2.2 Application limits :

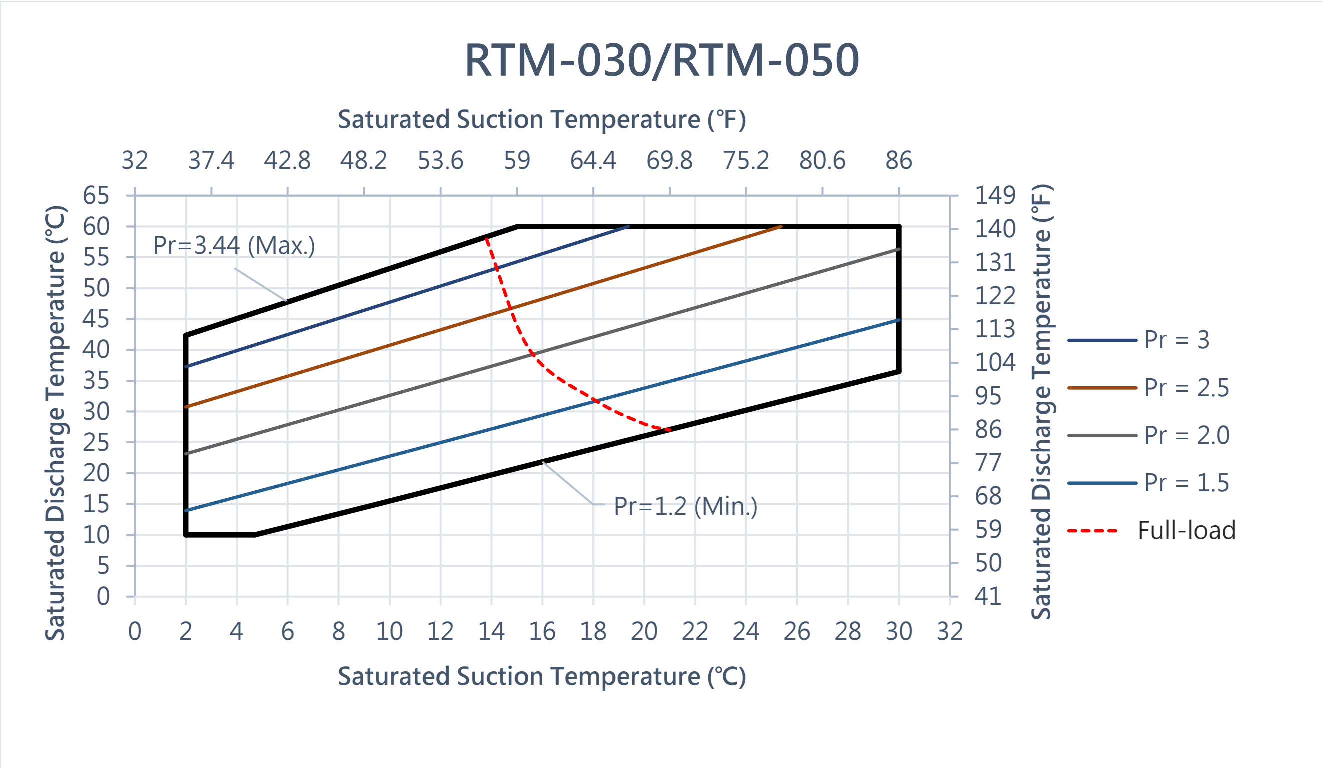


Figure 2-1 RTM-030/RTM-050 application limits @IGV=100%

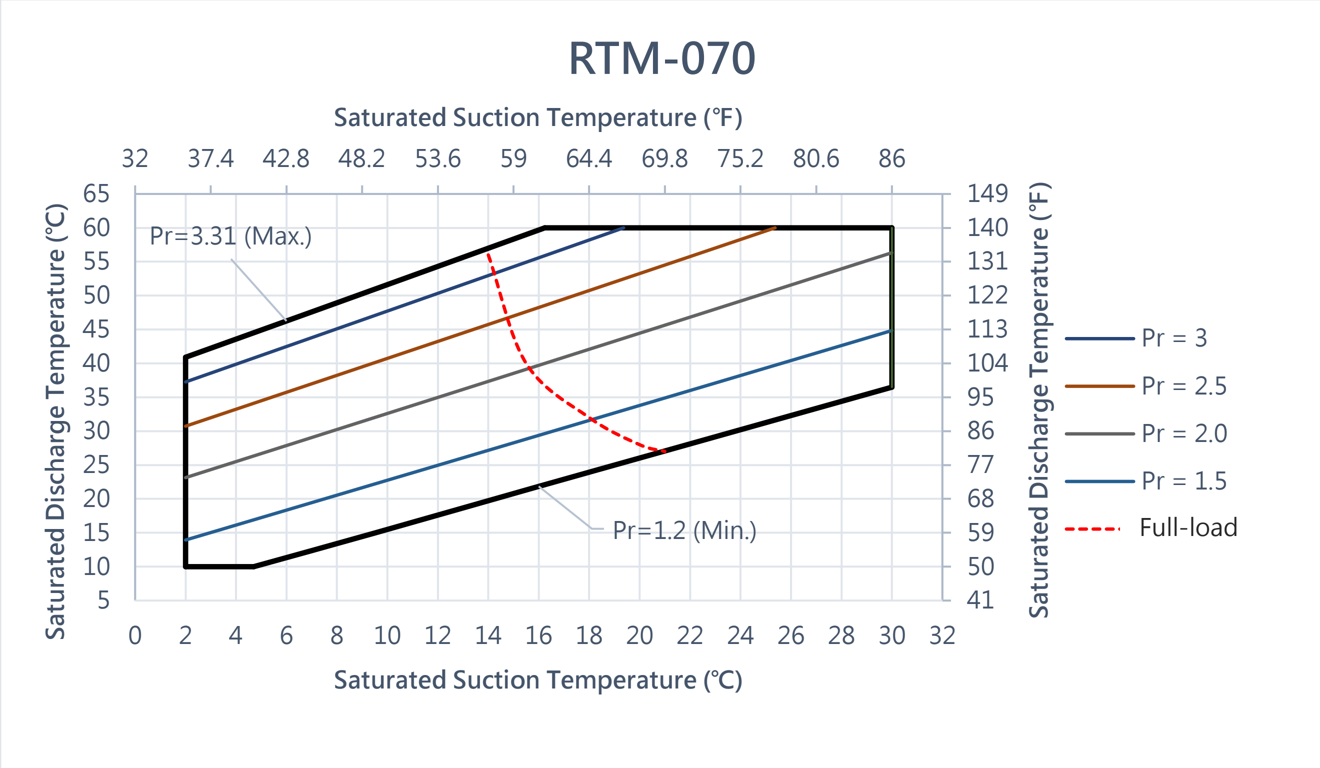


Figure 2-2 RTM-070 application limits @IGV=100%

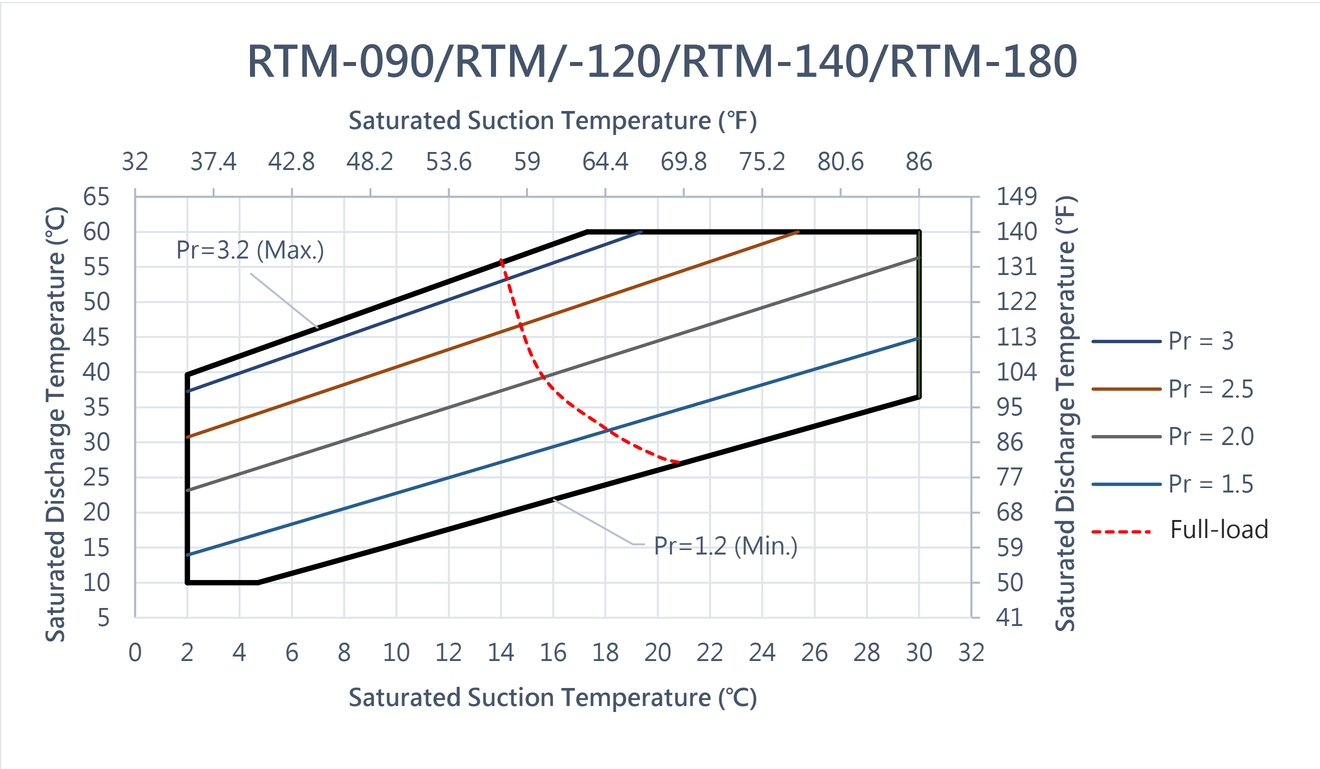


Figure 2-1 RTM-090/RTM-120/RTM-140/RTM-180
application limits @IGV=100%

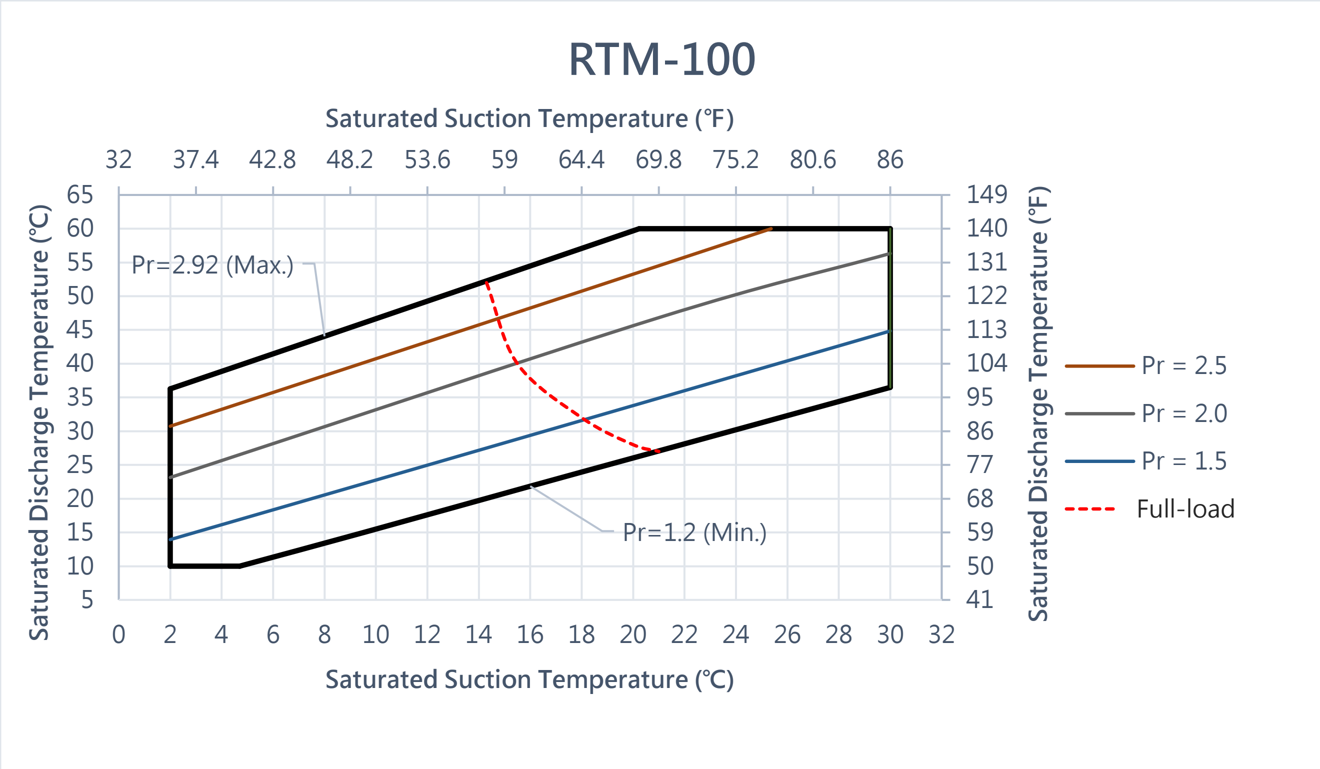


Figure 2-2 RTM-100 application limits @IGV=100%

Note 1. This range represents the range of FLA at 380V, and the limits for maximum condensing temperature (SCT) and evaporating temperature (SST) are depending on the full load current and the axial thrust of the compressor.

Note 2. Please refer to the latest compressor selection software for compressor capacity under specific working condition(s).

2.3 Compressor specifications :

Model			RTM-030		RTM-050	
Refrigerant			R134a			
Compressor	Type		Two-stage			
	Max. pressure ratio		3.44			
	Nominal cooling capacity	USRT	125	150	200	250
	Rated Frequency	Hz	350.0	366.6	293.3	318.3
	Max. Frequency	Hz	383.3		321.7	
	Min. Frequency	Hz	210.0		176.0	
	Axial guide vane control		20%~100% continuous			
	Movable Diffuser Control		NA			
Transmission	Type		Direct-driven			
	Lubrication		Oil free			
Motor	Type		3 Phase, 2 Pole, Permanent magnet motor			
	Starting		VFD			
	Power Voltage	V	380			
	Insulation		Class F			
Dimension (LxWxH)		m	1.02x0.62x0.53		1.13x0.74x0.59	
Weight		kg	395		573	
Hydrostatic pressure test		kg/cm^2g	22			

Table 2-1 RTM-030、RTM-050 Compressor specifications

Model			RTM-070		RTM-090	
Refrigerant			R134a			
Compressor	Type		Two-stage			
	Max. pressure ratio		3.31		3.2	
	Nominal cooling capacity	USRT	300	350	400	450
	Rated Frequency	Hz	230.0	240.0	216.6	225.0
	Max. Frequency	Hz	250.0		225.0	
	Min. Frequency	Hz	138.0		130.0	
	Axial guide vane control		20%~100% continuous			
	Movable Diffuser Control		NA			
Transmission	Type		Direct-driven			
	Lubrication		Oil free			
Motor	Type		3 Phase, 2 Pole, Permanent magnet motor			
	Starting		VFD			
	Power Voltage	V	380			
	Insulation		Class F			
Dimension (LxWxH)		m	1.3x0.8x0.7			
Weight		kg	1,050		1,150	
Hydrostatic pressure test		kg/cm^2g	22			

Table 2-2 RTM-070、RTM-090 Compressor specifications

Model			RTM-100	RTM-120
Refrigerant			R134a	
Compressor	Type		Two-stage	
	Max. pressure ratio		2.92	3.2
	Nominal cooling capacity	USRT	500	600
	Rated Frequency	Hz	218.3	231.3
	Max. Frequency	Hz	218.3	233.3
	Min. Frequency	Hz	131.0	139
	Axial guide vane control		20%~100% continuous	
	Movable Diffuser Control		NA	
Transmission	Type		Direct-driven	
	Lubrication		Oil free	
Motor	Type		3 Phase, 2 Pole, PM Motor	3 Phase, 4 Pole, PM Motor
	Starting		VFD	
	Power Voltage	V	380	
	Insulation		Class F	
Dimension (LxWxH)		m	1.34x0.85x0.76	1.39*0.85*0.76
Weight		kg	1,250	1300
Hydrostatic pressure test		kg/cm²g	22	

Table 2-3 RTM-100、RTM-120 Compressor specifications

Model			RTM-140		RTM-180	
Refrigerant			R134a			
Compressor	Type		Two-stage			
	Max. pressure ratio		3.2		3.2	
	Max. pressure ratio	USRT	600	700	800	900
	Rated Frequency	Hz	175.0	183.3	291.5	299.8
	Max. Frequency	Hz	191.7		333.3	
	Min. Frequency	Hz	105.0		175	
	Axial guide vane control		20%~100% continuous			
	Movable Diffuser Control		NA			
Transmission	Type		Direct-driven			
	Lubrication		Oil free			
Motor	Type		3 Phase, 2 Pole, PM Motor		3 Phase, 4 Pole, PM Motor	
	Starting		VFD			
	Power Voltage	V	380			
	Insulation		Class F			
Dimension (LxWxH)		m	1.56x0.85x0.83		1.82x1.02x0.95	
Weight		kg	1,450		1,800	
Hydrostatic pressure test		kg/cm²g	22			

Table 2-4 RTM-140、RTM-180 Compressor specifications

2.4 Compressor Performance:

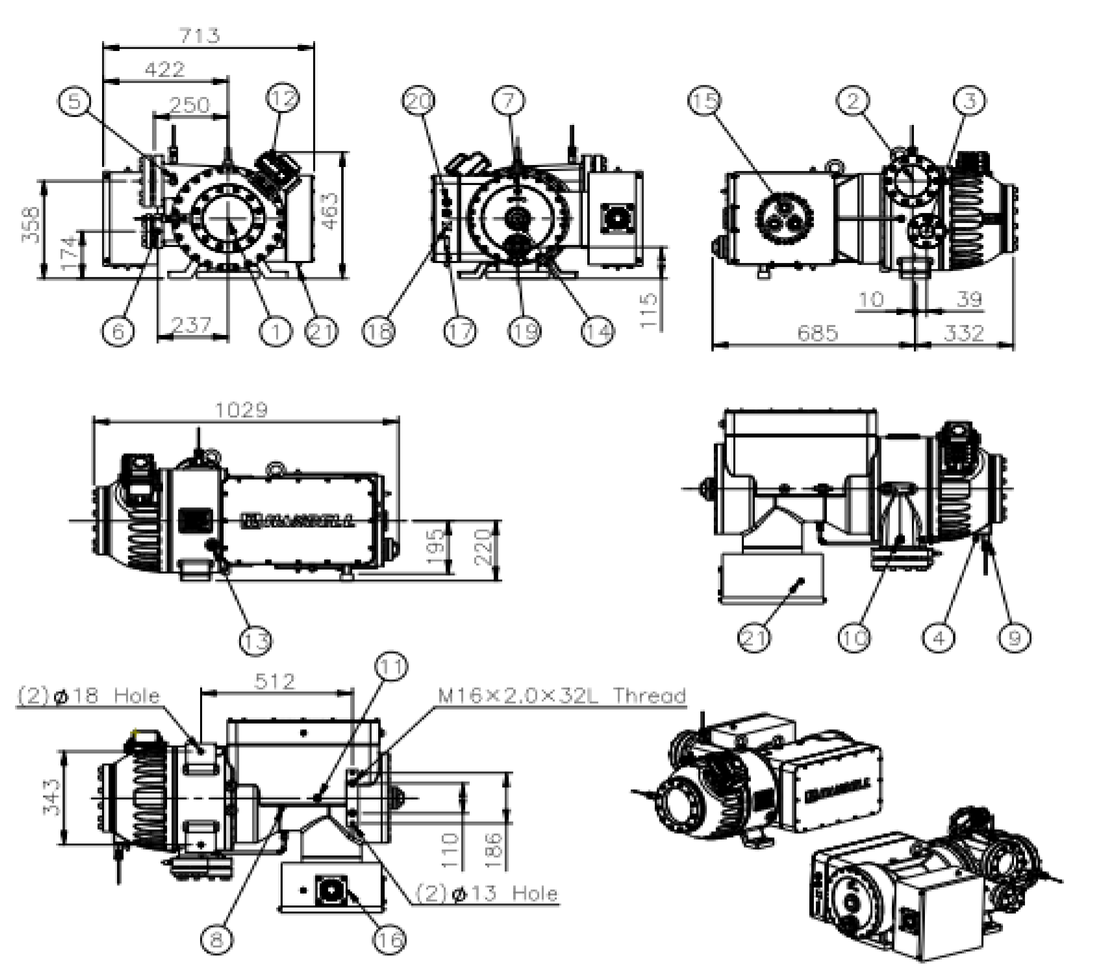
Model	USRT	COP	IPLV
RTM-030	125	6.37	10.23
	150	6.32	10.37
RTM-050	200	6.60	10.86
	250	6.52	11.00
RTM-070	300	6.54	10.37
	350	6.50	10.72
RTM-090	400	6.83	10.86
	450	6.67	10.96
RTM-100	500	6.92	11.61
RTM-120	600	6.42	11.35
RTM-140	600	6.61	10.39
	700	6.50	10.64
RTM-180	800	6.62	N/A
	900	6.6	N/A

Table 2-5 complete Performance Data for RTM Compressor Series

Note: The above performance data is based on testing in accordance with AHRI-55X standards.

2.5 Compressor Outline:

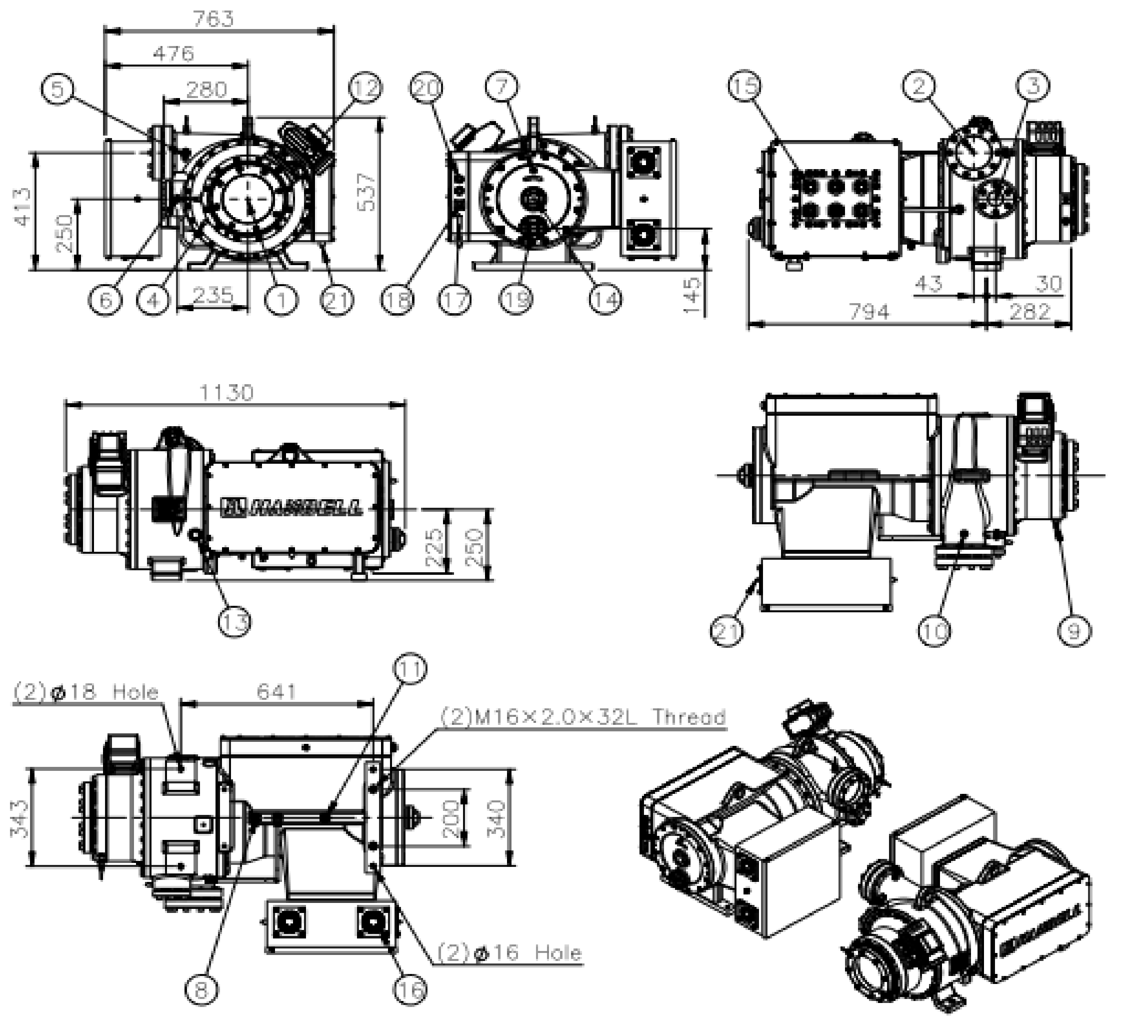
No.	Name	Specification	No.	Name	Specification
1	Suction flange	6" 20K	12	Actuator(IGV1)	220V,50/60Hz
2	Discharge flange	4" 20K	13	Sight glass(Refrigerant)	
3	ECO flange	1-1/2" 20K	14	Sight glass(motor direction)	
4	Suction pressure,Ps	1/4"FL	15	Motor power connector	5/8"-11 UNC
5	Discharge pressure,Pd	1/4"FL	16	Cable box outlet	ϕ88
6	ECO pressure,Pe	1/4"FL	17	Control & sensor port	D-SUB 25Pin
7	Motor pressure,Pmo	1/4"CV	18	AMBD power connector	4P 150VDC
8	Bearing cooling outlet	1/4"FL	19	Cooling outlet	1-1/4" steel/copper
9	Suction temperature,Ts	PT-100	20	Modbus port	RJ45
10	Discharge temperature,Td	PT-100	21	Drain port	1/4"PS
11	Cooling inlet	3/8"FL			



Mode	RTM-030 DT	Unit	mm
Name	AMB Centrifugal Compressor Outline	Ver.	2.0
	HANBELL PRECISE TECHNOLOGY CO., LTD.		

Figure 2-3 RTM-030 Outline Drawing

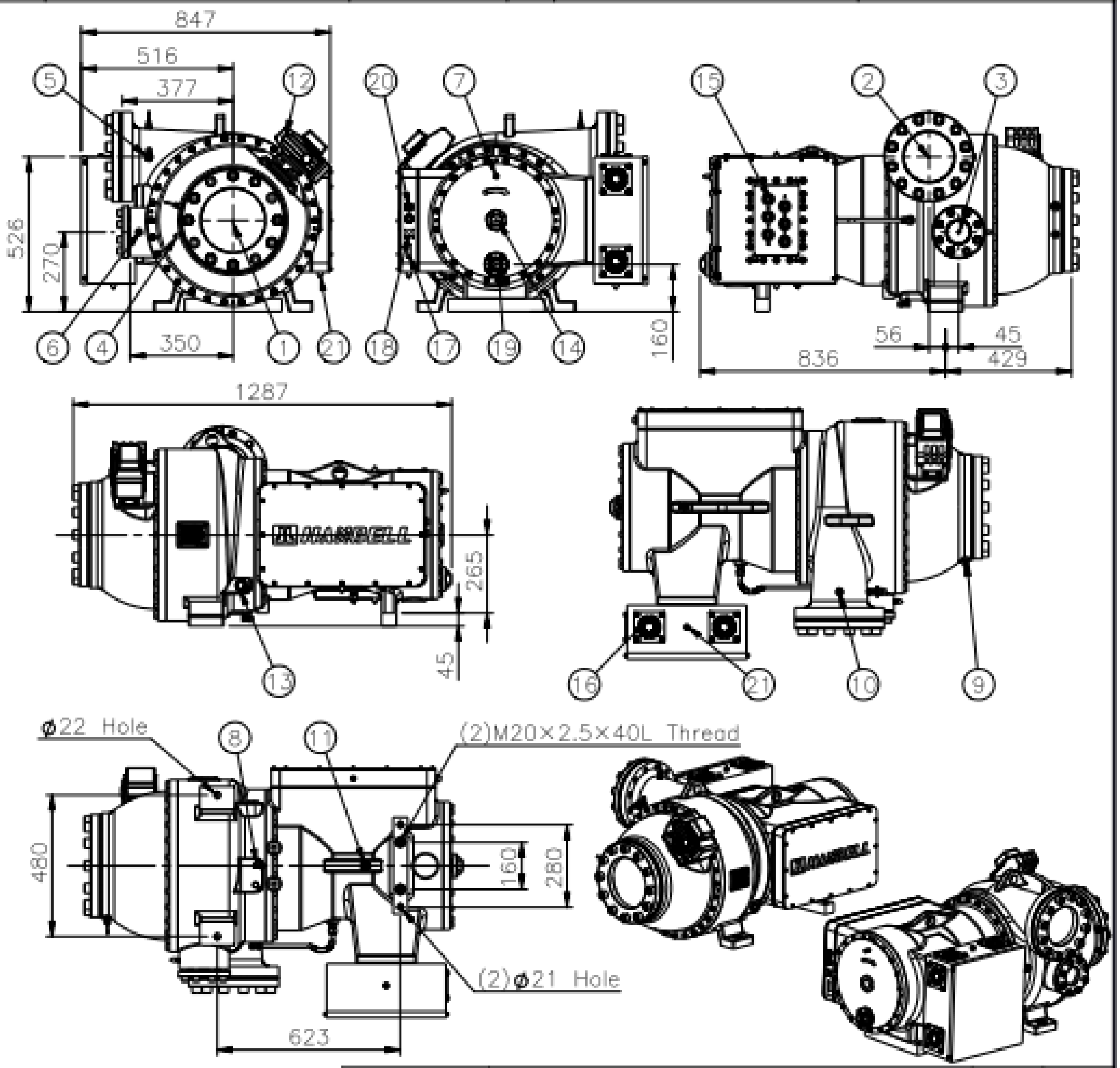
No.	Name	Specification	No.	Name	Specification
1	Suction flange	6" 20K	12	Actuator(IGV1)	220V,50/60Hz
2	Discharge flange	4" 20K	13	Sight glass(Refrigerant)	
3	ECO flange	1-1/2" 20K	14	Sight glass(motor direction)	
4	Suction pressure,Ps	1/4"FL	15	Motor power connector	5/8"-11 UNC
5	Discharge pressure,Pd	1/4"FL	16	Cable box outlet	ϕ88
6	ECO pressure,Pe	1/4"FL	17	Control & sensor port	D-SUB 25Pin
7	Motor pressure,Pmo	1/4"CV	18	AMBD power connector	4P 150VDC
8	Bearing cooling outlet	1/4"FL	19	Cooling outlet	1-1/4" steel/copper
9	Suction temperature,Ts	PT-100	20	Modbus port	RJ45
10	Discharge temperature,Td	PT-100	21	Drain port	1/4"PS
11	Cooling inlet	1/2"FL			



Mode	RTM-050 DT	Unit	mm
Name	AMB Centrifugal Compressor Outline	Ver.	2.0
	HANBELL PRECISE TECHNOLOGY CO., LTD.		

Figure 2-4 RTM-050 Outline Drawing

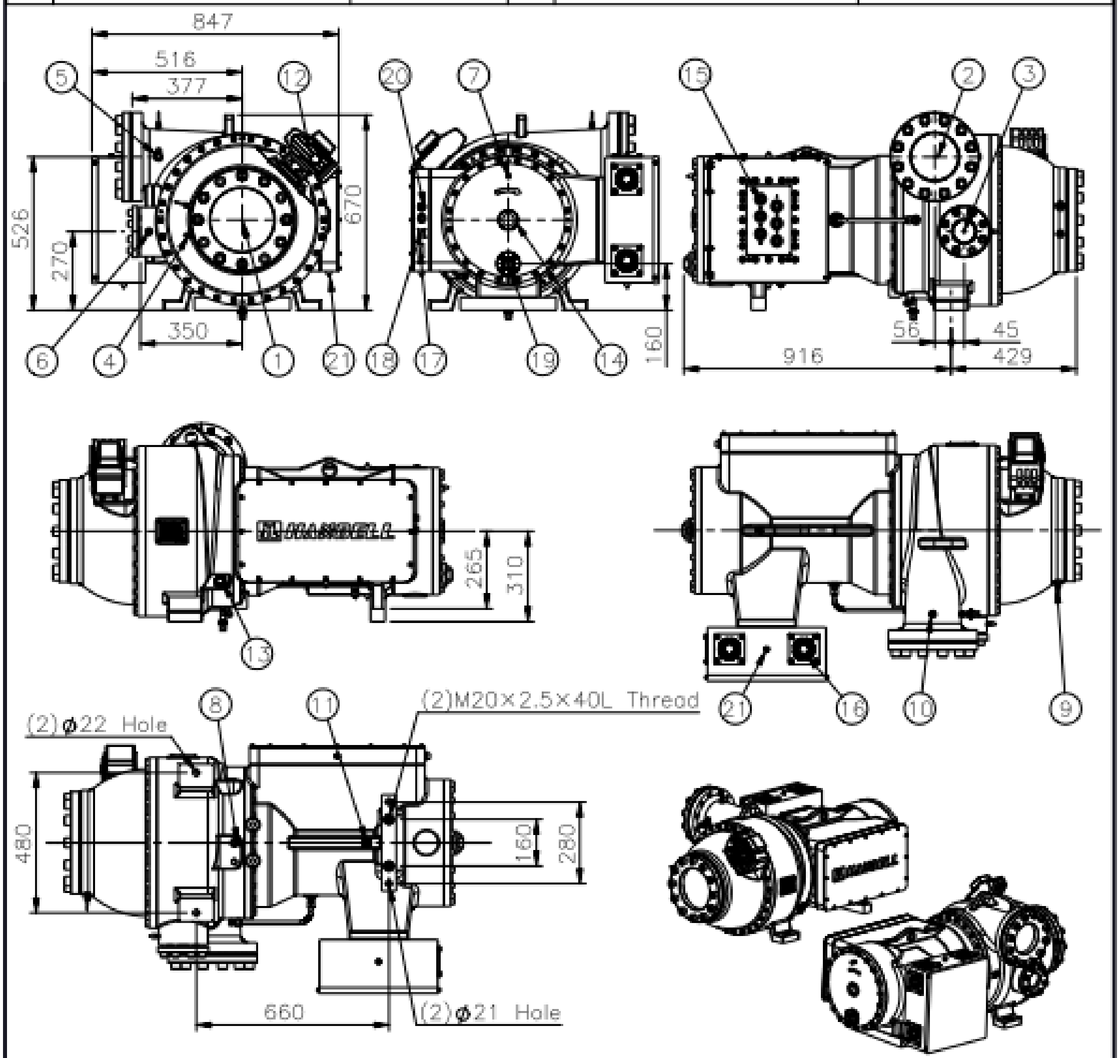
No.	Name	Specification	No.	Name	Specification
1	Suction flange	8" 20K	12	Actuator(IGV1)	220V,50/60Hz
2	Discharge flange	6" 20K	13	Sight glass(Refrigerant)	
3	ECO flange	2 1/2" 20K	14	Sight glass(motor direction)	
4	Suction pressure,Ps	1/4"FL	15	Motor power connector	5/8"-11 UNC
5	Discharge pressure,Pd	1/4"FL	16	Cable box outlet	ϕ88
6	ECO pressure,Pe	1/4"FL	17	Control & sensor port	D-SUB 25Pin
7	Motor pressure,Pmo	1/4"CV	18	AMBD power connector	4P 150VDC
8	Bearing cooling outlet	1/4"FL	19	Cooling outlet	1-1/4" steel/copper
9	Suction temperature,Ts	PT-100	20	Modbus port	RJ45
10	Discharge temperature,Td	PT-100	21	Drain port	1/4"PS
11	Cooling inlet	1/2"FL			



Mode	RTM-070 DT	Unit	mm
Name	AMB Centrifugal Compressor Outline	Ver.	3.0
	HANBELL PRECISE TECHNOLOGY CO., LTD.		

Figure 2-5 RTM-070 Outline Drawing

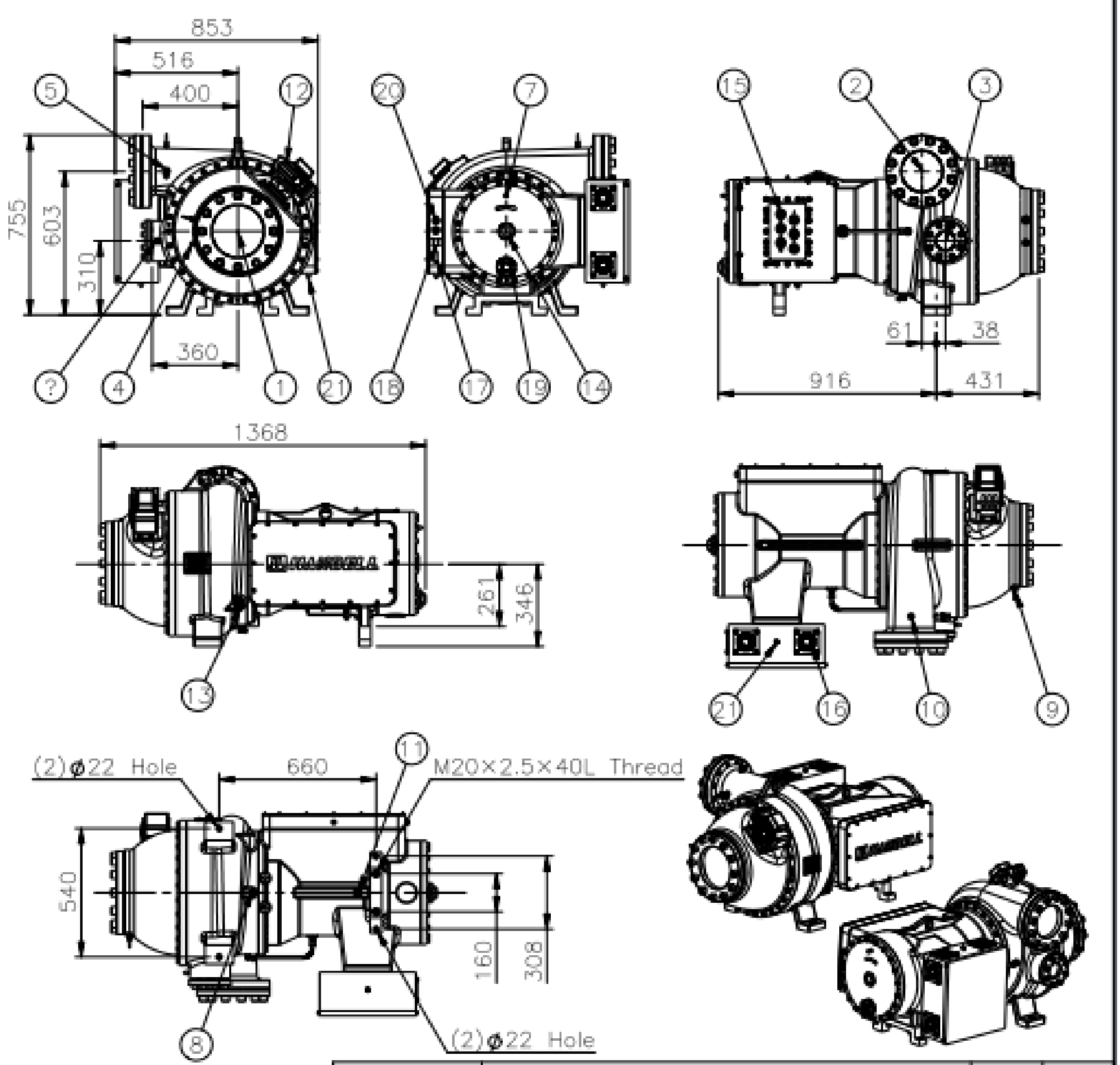
No.	Name	Specification	No.	Name	Specification
1	Suction flange	8" 20K	12	Actuator(IGV1)	220V,50/60Hz
2	Discharge flange	6" 20K	13	Sight glass(Refrigerant)	
3	ECO flange	2 1/2" 20K	14	Sight glass(motor direction)	
4	Suction pressure,Ps	1/4"FL	15	Motor power connector	5/8"-11 UNC
5	Discharge pressure,Pd	1/4"FL	16	Cable box outlet	φ88
6	ECO pressure,Pe	1/4"FL	17	Control & sensor port	D-SUB 25Pin
7	Motor pressure,Pmo	1/4"CV	18	AMBD power connector	4P 150VDC
8	Bearing cooling outlet	1/4"FL	19	Cooling outlet	1-1/4" steel/copper
9	Suction temperature,Ts	PT-100	20	Modbus port	RJ45
10	Discharge temperature,Td	PT-100	21	Drain port	1/4"PS
11	Cooling inlet	1/2"FL			



Mode	RTM-090 DT	Unit	mm
Name	AMB Centrifugal Compressor Outline	Ver.	3.0
	HANBELL PRECISE TECHNOLOGY CO., LTD.		

Figure 2-6 RTM-090 Outline Drawing

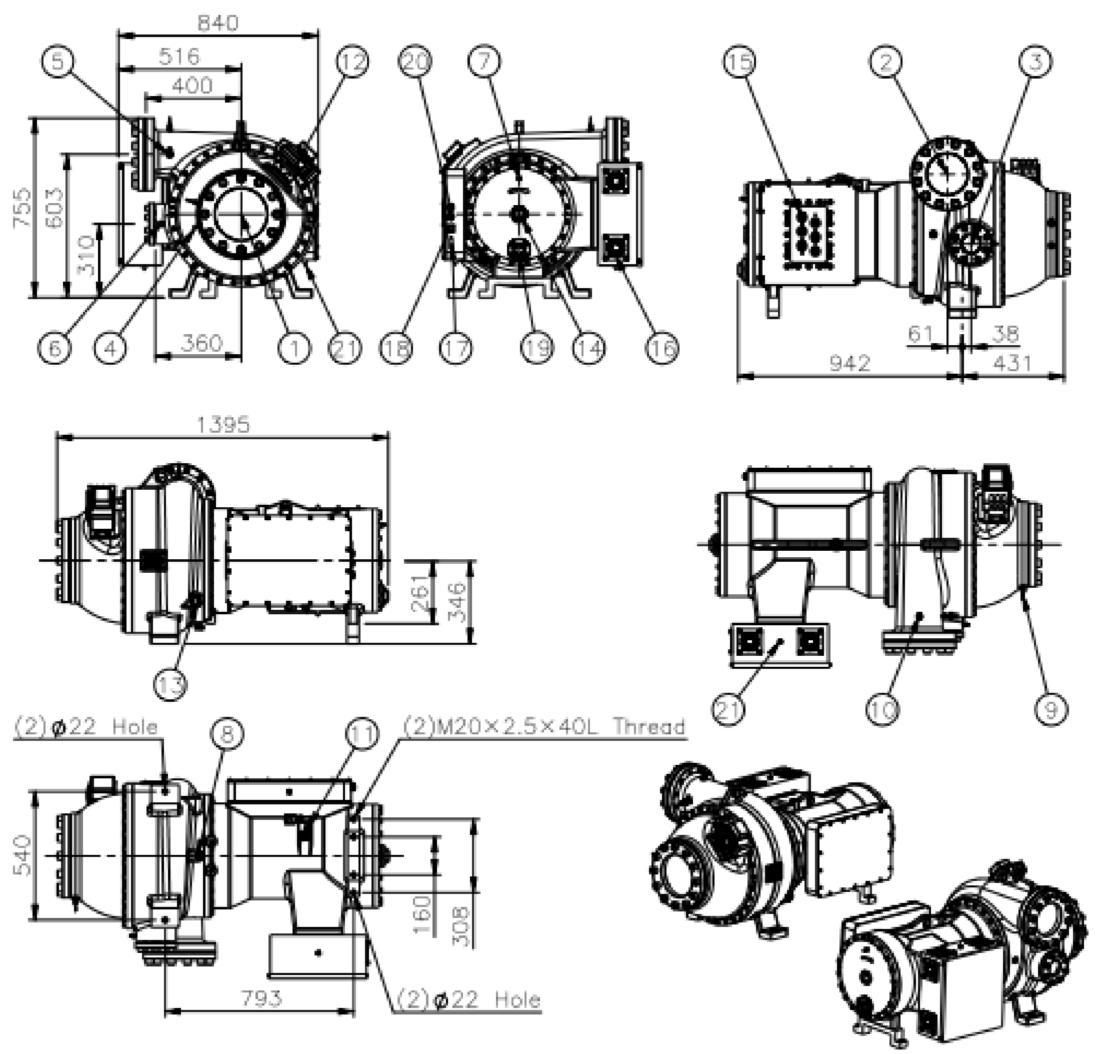
No.	Name	Specification	No.	Name	Specification
1	Suction flange	8" 20K	12	Actuator(IGV1)	220V,50/60Hz
2	Discharge flange	6" 20K	13	Sight glass(Refrigerant)	
3	ECO flange	2 1/2" 20K	14	Sight glass(motor direction)	
4	Suction pressure,Ps	1/4"FL	15	Motor power connector	5/8"-11 UNC
5	Discharge pressure,Pd	1/4"FL	16	Cable box outlet	ϕ88
6	ECO pressure,Pe	1/4"FL	17	Control & sensor port	D-SUB 25Pin
7	Motor pressure,Pmo	1/4"CV	18	AMBD power connector	4P 150VDC
8	Bearing cooling outlet	1/4"FL	19	Cooling outlet	1-1/4 steel/copper
9	Suction temperature,Ts	PT-100	20	Modbus port	RJ45
10	Discharge temperature,Td	PT-100	21	Drain port	1/4"PS
11	Cooling inlet	1/2"FL			



Mode	RTM-100 DT	Unit	mm
Name	AMB Centrifugal Compressor Outline	Ver.	2.0
	HANBELL PRECISE TECHNOLOGY CO., LTD.		

Figure 2-7 RTM-100 Outline Drawing

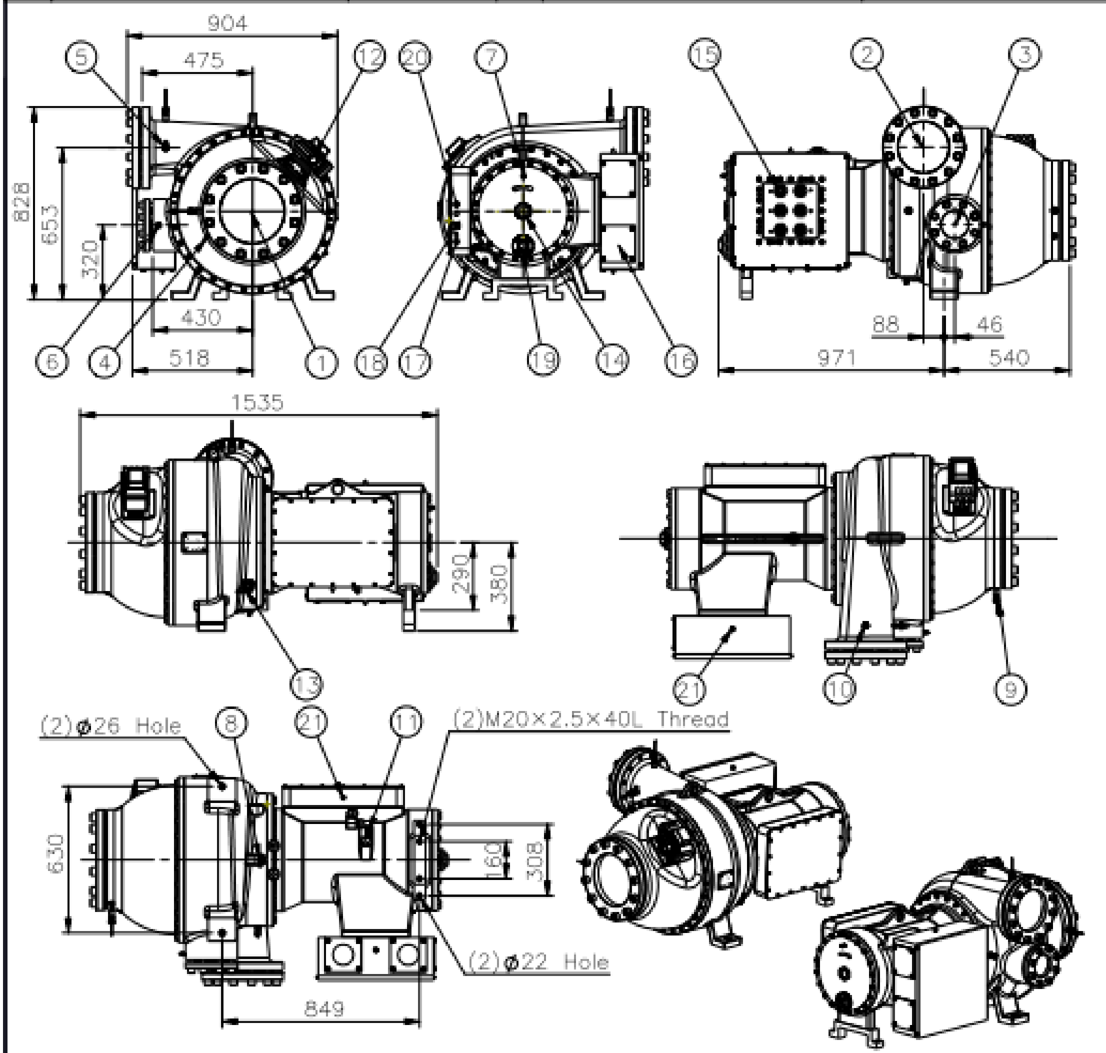
No.	Name	Specification	No.	Name	Specification
1	Suction flange	8" 20K	12	Actuator(IGV1)	220V,50/60Hz
2	Discharge flange	6" 20K	13	Sight glass(Refrigerant)	
3	ECO flange	2-1/2" 20K	14	Sight glass(motor direction)	
4	Suction pressure,Ps	1/4"FL	15	Motor power connector	5/8"-11 UNC
5	Discharge pressure,Pd	1/4"FL	16	Cable box outlet	ϕ88
6	ECO pressure,Pe	1/4"FL	17	Control & sensor port	D-SUB 25Pin
7	Motor pressure,Pmo	1/4"CV	18	AMBD power connector	4P 150VDC
8	Bearing cooling outlet	1/4"FL	19	Cooling outlet	1-1/2" steel/copper
9	Suction temperature,Ts	PT-100	20	Modbus port	RJ45
10	Discharge temperature,Td	PT-100	21	Drain port	1/4"PS
11	Cooling inlet	1/2"FL			



Mode	RTM-120 DT	Unit	mm
Name	AMB Centrifugal Compressor Outline	Ver.	1.0
	HANBELL PRECISE TECHNOLOGY CO., LTD.		

Figure 2-10 RTM-120 Outline Drawing

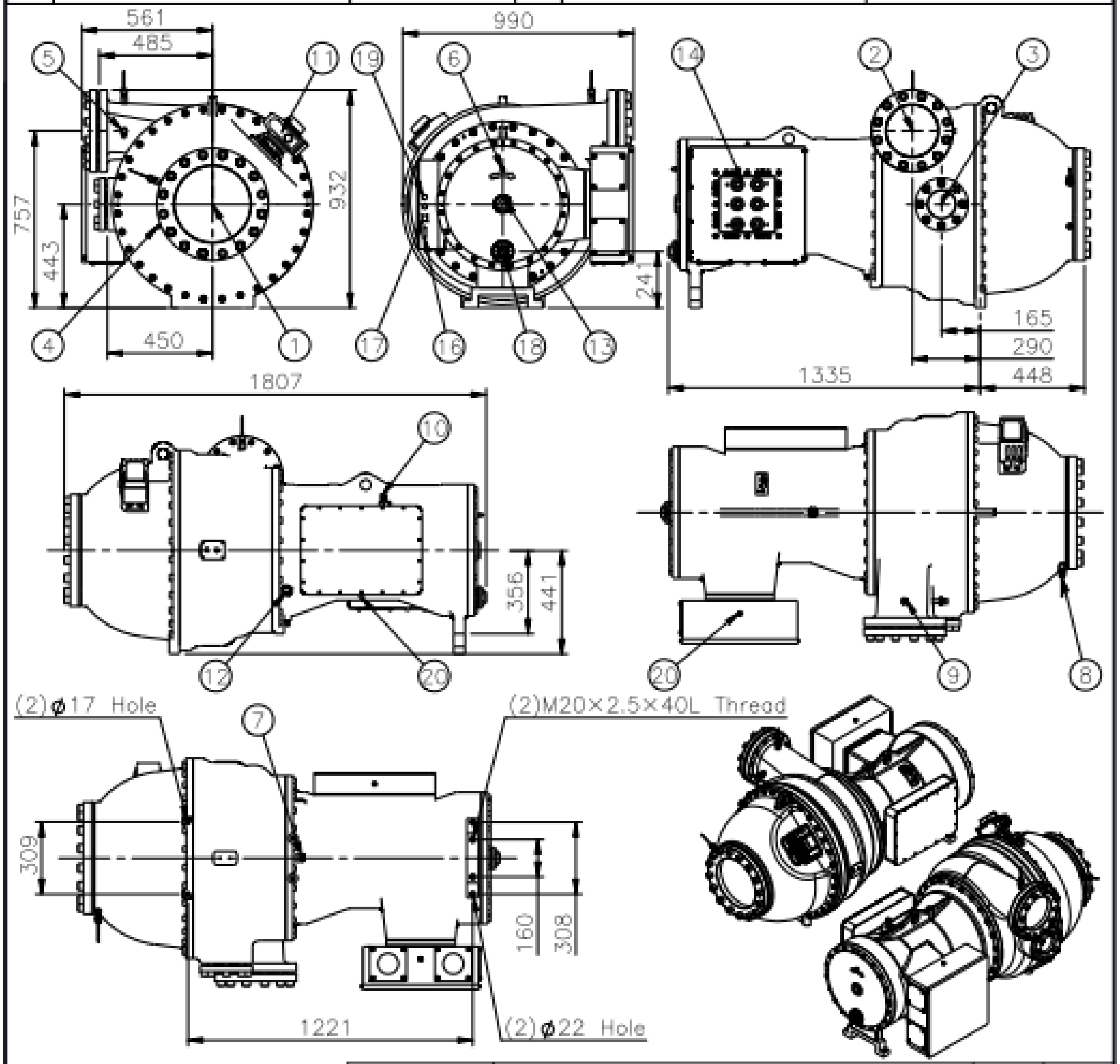
No.	Name	Specification	No.	Name	Specification
1	Suction flange	10" 20K	12	Actuator(IGV1)	220V,50/60Hz
2	Discharge flange	8" 20K	13	Sight glass(Refrigerant)	
3	ECO flange	4" 20K	14	Sight glass(motor direction)	
4	Suction pressure,Ps	1/4"FL	15	Motor power connector	7/8"-14 UNC
5	Discharge pressure,Pd	1/4"FL	16	Cable box outlet	ϕ114
6	ECO pressure,Pe	1/4"FL	17	Control & sensor port	D-SUB 25Pin
7	Motor pressure,Pmo	1/4"CV	18	AMBD power connector	4P 150VDC
8	Bearing cooling outlet	1/4"FL	19	Cooling outlet	1-1/2" steel/copper
9	Suction temperature,Ts	PT-100	20	Modbus port	RJ45
10	Discharge temperature,Td	PT-100	21	Drain port	1/4"PS
11	Cooling inlet	1/2"FL			



Mode	RTM-140 DT	Unit	mm
Name	AMB Centrifugal Compressor Outline	Ver.	2.0
	HANBELL PRECISE TECHNOLOGY CO., LTD.		

Figure 2-11 RTM-140 Outline Drawing

No.	Name	Specification	No.	Name	Specification
1	Suction flange	12" 20K	12	Sight glass(Refrigerant)	
2	Discharge flange	8" 20K	13	Sight glass(motor direction)	
3	ECO flange	4" 20K	14	Motor power connector	7/8"-14 UNC
4	Suction pressure,Ps	1/4"FL	15	Cable box outlet	ϕ114
5	Discharge pressure,Pd	1/4"FL	16	Control & sensor port	D-SUB 25Pin
6	Motor pressure,Pmo	1/4"CV	17	AMBD power connector	4P 150VDC
7	Bearing cooling outlet	1/4"FL	18	Cooling outlet	1-1/2" steel/copper
8	Suction temperature,Ts	PT-100	19	Modbus port	RJ45
9	Discharge temperature,Td	PT-100	20	Drain port	1/4"PS
10	Cooling inlet	1/2"FL			
11	Actuator(IGV1)	220V,50/60Hz			



Mode	RTM-180 DT	Unit	mm
Name	AMB Centrifugal Compressor Outline	Ver.	2.0
	HANBELL PRECISE TECHNOLOGY CO., LTD.		

Figure 2-12 RTM-180 Outline Drawing

Note1. All models of protector junction boxes are equipped with a 1/4" PS drain hole. A drain pipe must be connected to prevent condensation water from accumulating at the bottom of the junction box.

2.6 Connections：

2.6.1 Suction/discharge/economizer flange size：

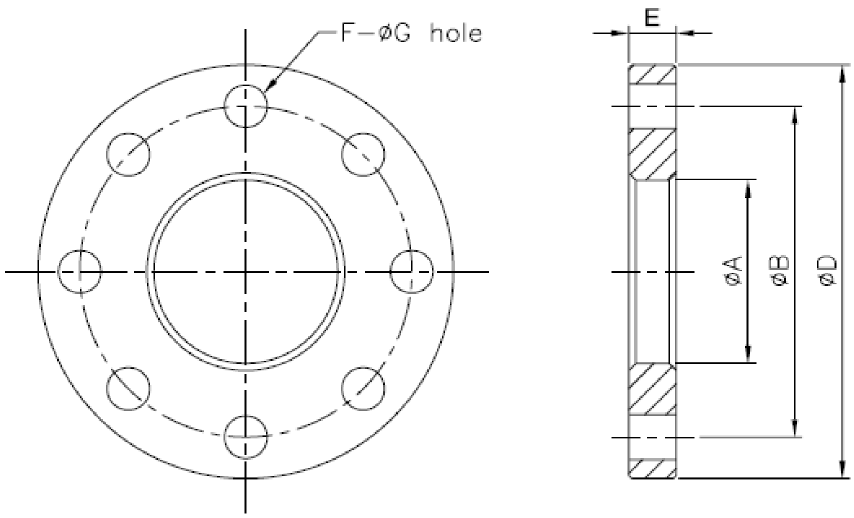


Figure 2-13 Flange

Position		Size	A			B	D	E	F	G	Pipe Wall
			GB	JIS	AMSE						
RTM-070 RTM-090 RTM-100 RTM-120	Suction	8"	221.5	218	223.1	305	350	30	12	25	> 8.2
	Discharge	6"	170.5	167	172.3	260	305	28	12	25	> 7.1
	ECO. port	2 1/2"	77.5	77.5	77	140	175	20	8	19	> 5.2
RTM-030 RTM-050	Suction	6"	170.5	167	172.3	216	247	27	12	14	> 7.1
	Discharge	4"	116	116	118.3	160	190	30	10	14	> 6
	ECO. port	1 1/2"	50	50	52.3	95	125	20	6	14	> 3.7
RTM-140	Suction	10"	276.5	270	277	380	430	34	12	27	> 9.3
	Discharge	8"	221.5	218	223.1	305	350	30	12	25	> 8.2
	ECO. port	4"	116	116	118.3	185	225	24	8	23	> 6
RTM-180	Suction	12″	327.5	320	332.8	430	480	36	16	27	>10.3
	Discharge	8"	221.5	218	223.1	305	350	30	12	25	> 8.2
	ECO. port	4"	116	116	118.3	185	225	24	8	23	> 6
Remarks		※Material - standard JIS 20kg/cm^2g /GB PN16 steel. Unit: mm									
		※Wall thickness must meet or exceed standard; thicker walls can reduce noise.									
		※RTM-030 and RTM-050 use custom, non-standard flanges.									
		※GB flanges may use sleeves matching inner diameter.									
		※Sleeve outer diameters must follow relevant standards.									

Table 2-4 Flange dimensions

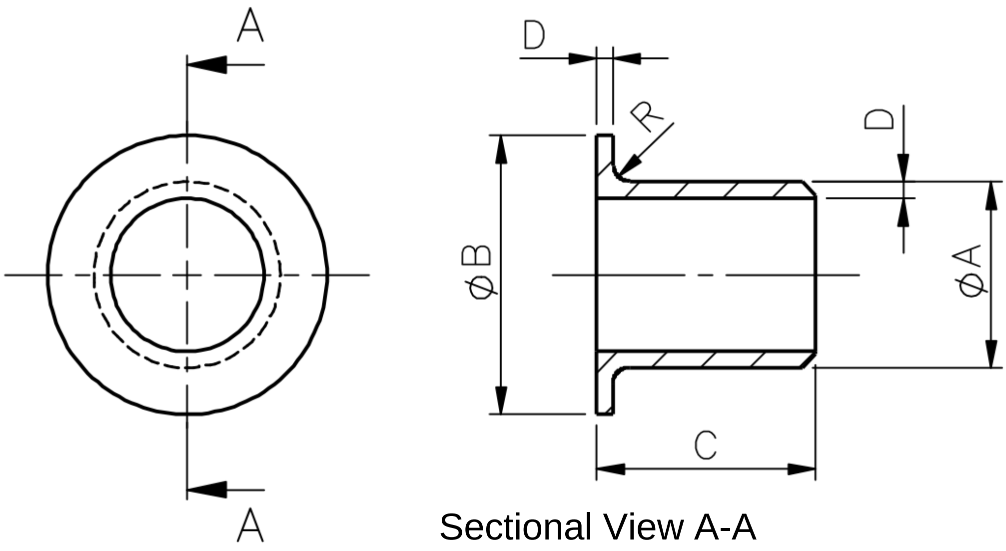


Figure 2-8 Flange bushing

Flange Size	A	B	C	D	R
1 1/2″	48.6	73	50	3	3
2 1/2″	76.3	105	65	3.5	4
4″	114.3	157	75	4	5
6″	165.2	216	90	5	5
8″	216.3	270	100	6.5	5
10″	267.4	324	125	6.5	5
12″	318.5	381	150	6.5	5
Note	※Material - SUS304 Unit: mm				

Table 2-5 Bushing dimension

Note1. Please weld steel pipes onto flanges by butt-welding and make sure debris has been cleaned, otherwise the compressor might be damaged during operation. Flow velocity on 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 is recommended to remove sharp edges of joints during flange welding as shown in Figure 2.15.

Note2. 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 2.16.

Note3. The flange bushing is made by stainless steel, and the steel pipe is made by carbon steel. When welding with different materials, please select appropriate solder to avoid fracture due to insufficient welding strength.

Note4. Outline drawings in chapter 2.5 is without flange bushing. Please refer to the table 2-5 for the bushing size.

Note5. The flange gaskets need to be paired with flanges specified in the GB standard listed in Table 2-4.。

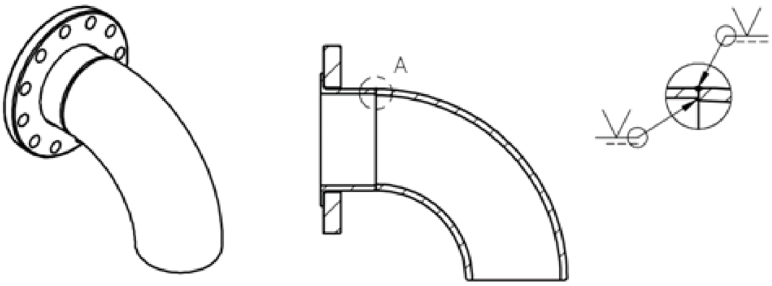


Figure 2-15 Suction and Discharge Piping Layout Diagram

Note: Failure to properly clean welding residues may cause severe damage to the compressor!

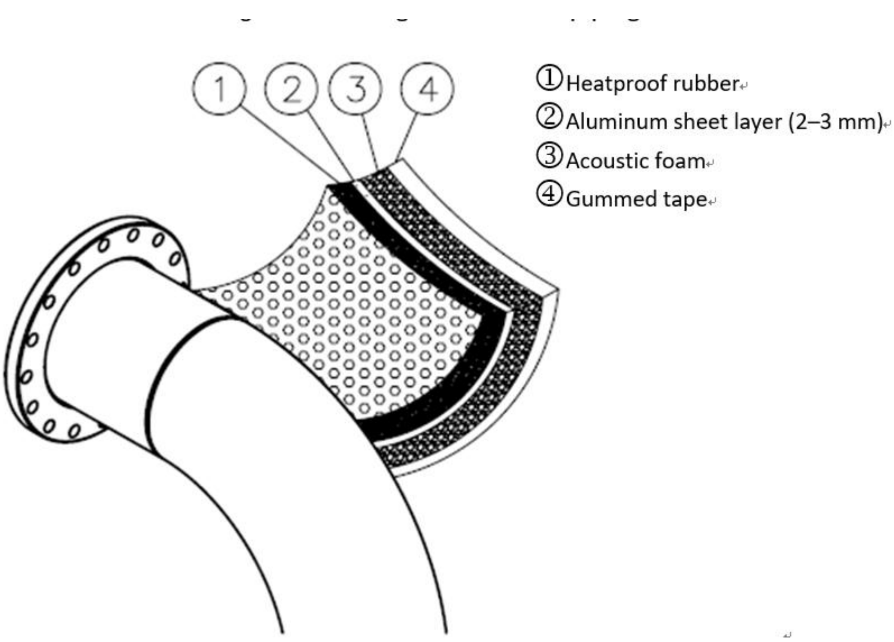


Diagram 2-16 Discharge acoustics enclosure

2.6.2 Discharge stop valve/butterfly type (optional) :

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

The pressure drop of the butterfly valve is listed as table below：

Model	Size (inch)	Hydraulic Resistance (K)	Density (kg/m^3)	Velocity (m/s)	Pressure Drop (kPa)
RTM-030	6"	0.64	42.6	6.7	0.61
RTM-050	6"	0.64	42.6	11.1	1.69
RTM-070	8"	0.5	42.6	9.1	0.88
RTM-090	8"	0.5	42.6	11.7	1.46
RTM-100/120	8"	0.5	42.6	13.0	1.80
RTM-140/180	10"	0.51	42.6	11.6	1.47

Table 2-6 Pressure drop

Note : The density and velocity and based on following working condition CT/ET=36/6℃；The pressure drop of the selected butterfly valve is recommended to be <0.1bar.

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 minimum size when the valve is 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 2-7 Flange size

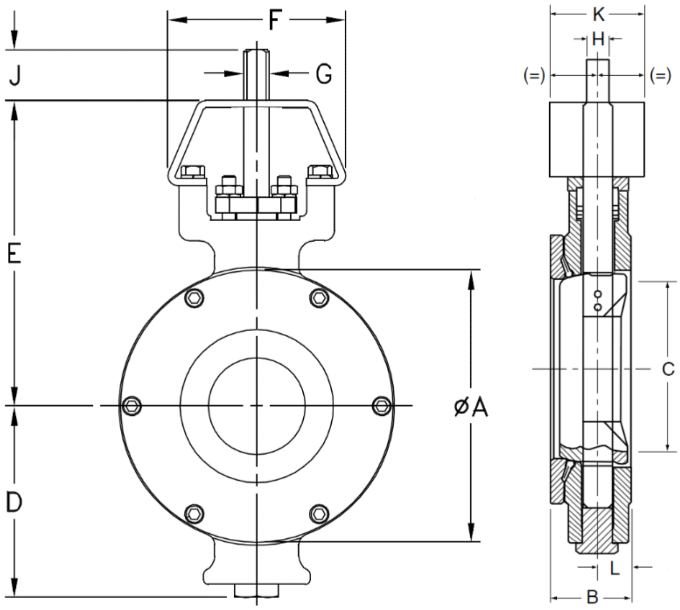


Figure 2-9 Outline of butterfly size

2.6.3 Discharge check valve：

To protect compressor from serious damage due to reverse rotation after emergency stop or shutdown, it is necessary to install the discharge check valve.

Warning：Discharge check valve is mandatory.

Check valve size		A(mm)	B(mm)	C(mm)	D(mm)
4″	100mm	64	156	112	53
6″	150mm	76	213	160	77
8″	200mm	89	267	210	102
10″	250mm	114	328	260	107
Remark		※The check valve is of the wafer type and must be clamped using ANSI 150 standard flanges.			

Table 2-8 Check valve size

Warning：The selected check valve may be either a dual-plate type or a single-disc swing type. The recommended pressure drop should be less than 0.1 bar.

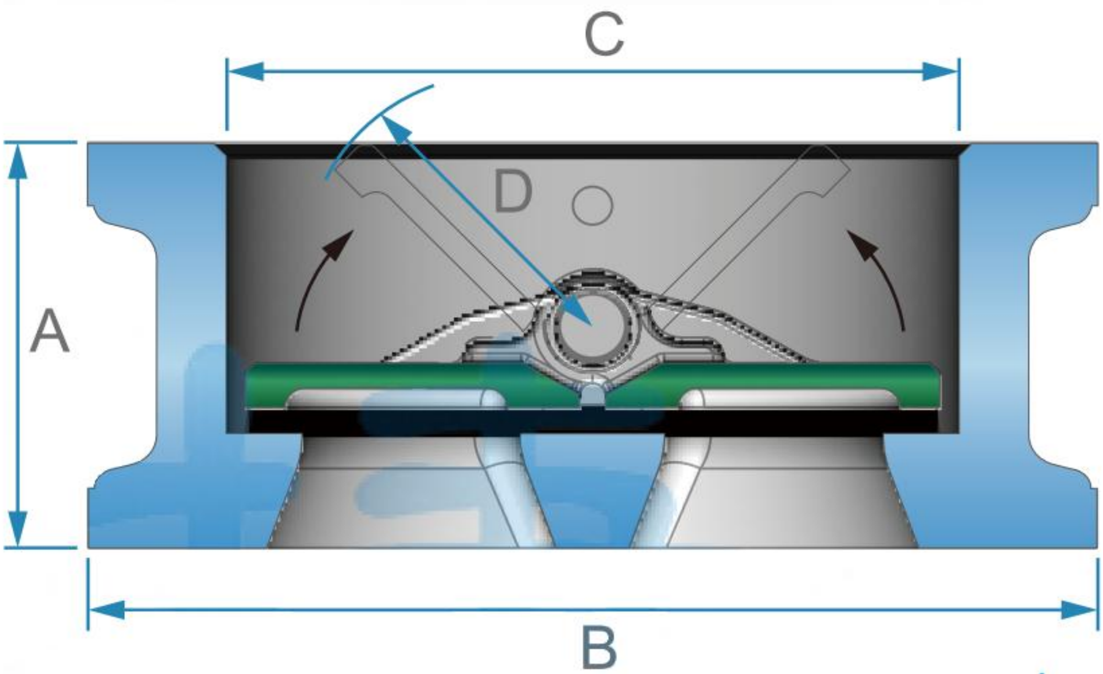
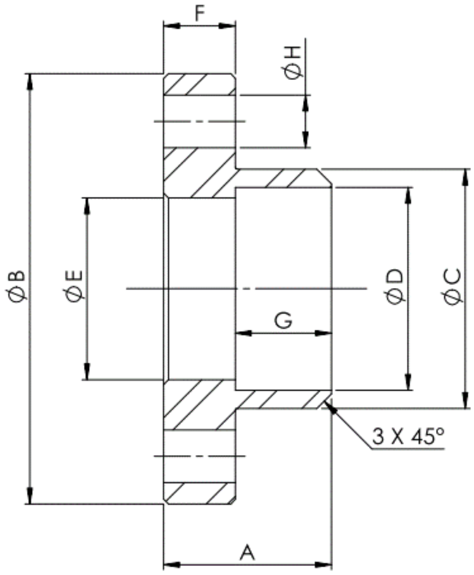


Figure 2-10 Dual plate discharge check valve

2.6.4 Motor Drain Flange：



Model	Position	Size / Material		A	B	C	D	E	F	G	H
		Copper tube	Steel pipe								
RTM-030 RTM-050	Liquid Injection Outlet	1-3/8"	1-1/4"	70	80	42	35.5	33.5	20	50	11
RTM-070 RTM-090 RTM-100	Liquid Injection Outlet	1-3/8"	1-1/4"	70	90	42	35.5	33.5	20	50	11
RTM-120 RTM-140 RTM-180	Liquid Injection Outlet	1-1/2"	1-1/2"	70	90	48	38.5	38	20	50	11

3. Suction Structure：

3.1 Inlet Guide Vanes：

The cooling capacity of the RTM compressor is mainly adjusted by changing the RPM (using a VFD), but this is limited in its range. Therefore, the RTM compressor is also equipped with an inlet guide vane (IGV) angle adjustment mechanism to increase the cooling capacity, as shown in Figure 3.1. The gas refrigerant enters the compressor through the evaporator and then passes through the IGV before entering the impeller. By adjusting the angle of the IGV, the gas flow angle entering the impeller is changed, causing the gas flow to generate pre-swirl. When the gas flow angle decreases, the cooling capacity also decreases. This allows for further adjustment of the capacity. For the difference between frequency adjustment and IGV control, please refer to Figure 3-8 in chapter 3.4.1."

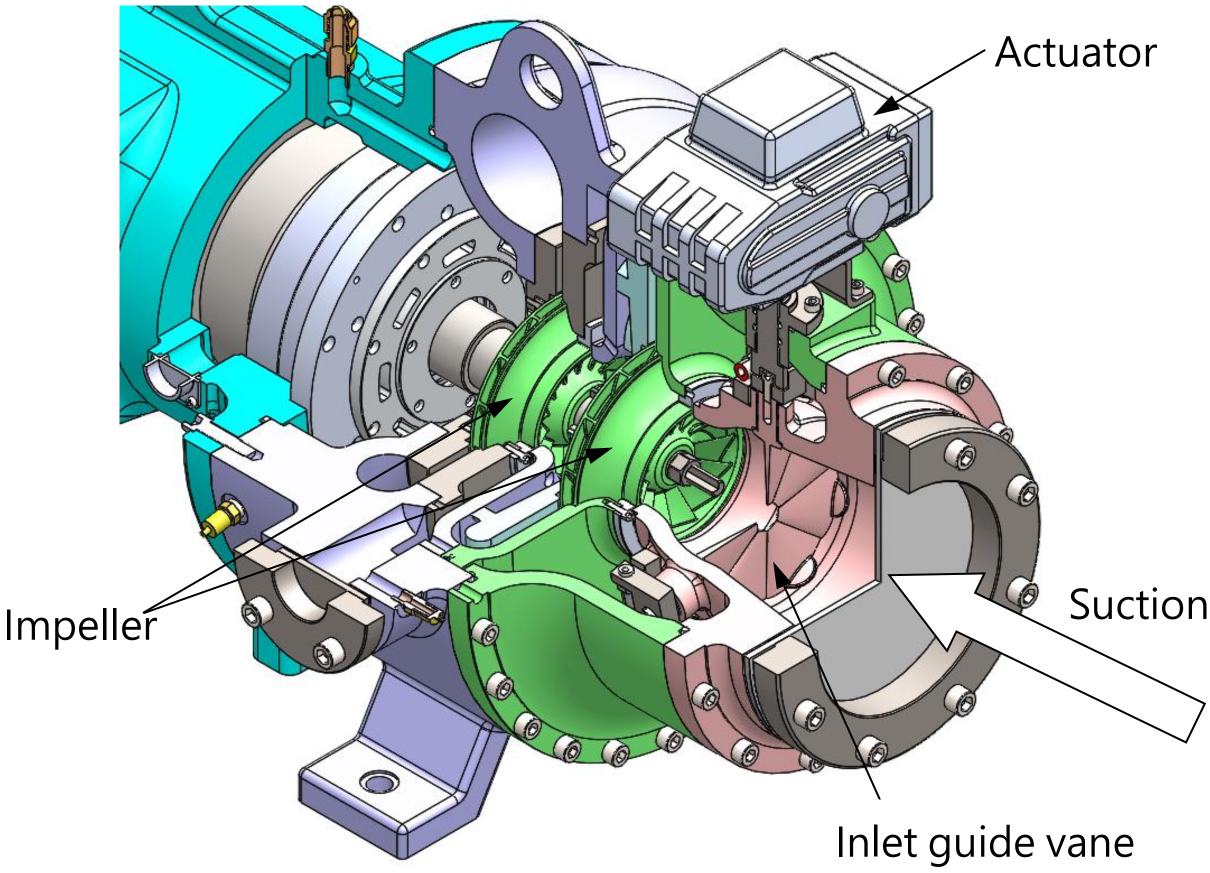


Figure 3-1 Compressor inlet guide vanes

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 100% (full load).
Opening of the vane actuator in percentage (%) has a linear relation to the control signal. 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. When the operating pressure ratio is lower, the lower minimum cooling capacity can be reached.

Note :

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

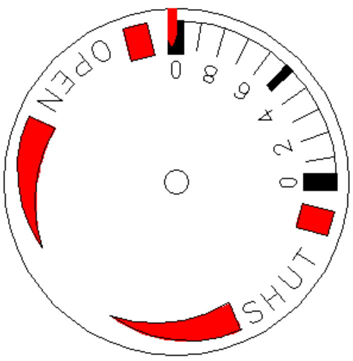


Figure 3-2 IGV OPEN

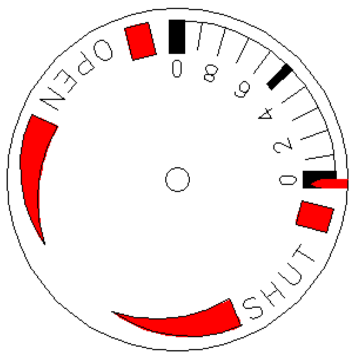


Figure 3-3 IGV SHUT

3.2 Actuator :

3.2.1 Actuator information :

POWER	1Phase，AC 220V±10%(50/60Hz)
INPUT SIGNAL	4~20mA·DC、1~5V·DC、2~10V·DC
OUTPUT SIGNAL	4~20mA·DC
OUTPUT TORQUE	100N-m、50N-m(RTM-030 only)
OPERATION SPEED	30 sec(50Hz)；25 sec(60Hz)
TRAVEL ANGLE	0~90°
RATED OPERATION TIME	Continuous (100%)
RESOLUTION	1%，minimum 0.16mA
DEAD ZONE	0.5%以內
PROTECTION	Motor thermal protector (120℃)
AMBIENT TEMPERATURE	-30~+60℃
RATED CURRENT	0.35A(220V)
MOTOR	25W
INSULATION GRADE	Class E
INSULATION RESISTANCE	500V·DC/100MΩ
WITHSTAND VOLTAGE	1500VAC/1 分鐘
WIRE INLET PORT	G1/2×2
ENCLOSURE PROTECTION	IP-67
WEIGHT	3kg

Table 3-1 Actuator data

Note:

1. When operating at ambient temperature under 0°C, optional space heater (optional) 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.
2. The standard input control signal is 4-20mA DC. If customers plan to apply to “1-5V DC or 2-10V DC”, please inform Hanbell beforehand. The controller version does not support to switch different input signals. The available specification of output feedback signal is 4-20mA DC only.

3.2.2 Electrical connections :

The outer diameter of cable should be Φ9 ~ Φ11. If other size of wire is used, please select the correct cable gland otherwise the water may penetrate.

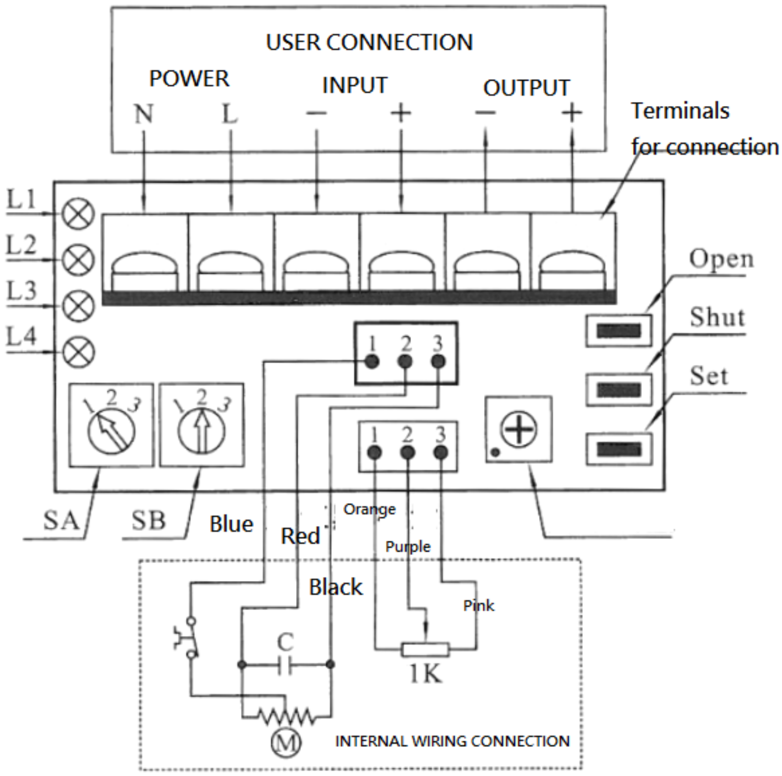


Figure 3-4 Wiring diagram (single phase, 220V)

Note :

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

3.2.3 Electrical Wiring :

Make effective protection when using cable gland and vinyl tube. Please refer to figure 3.5 :

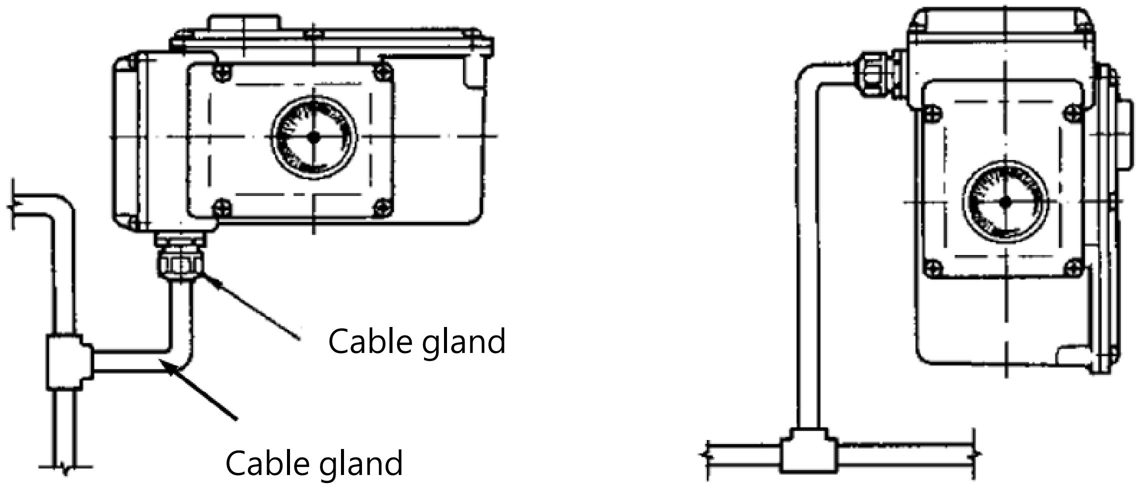


Figure 3-5 Illustration of electrical wiring

3.2.4 Setting of Control :

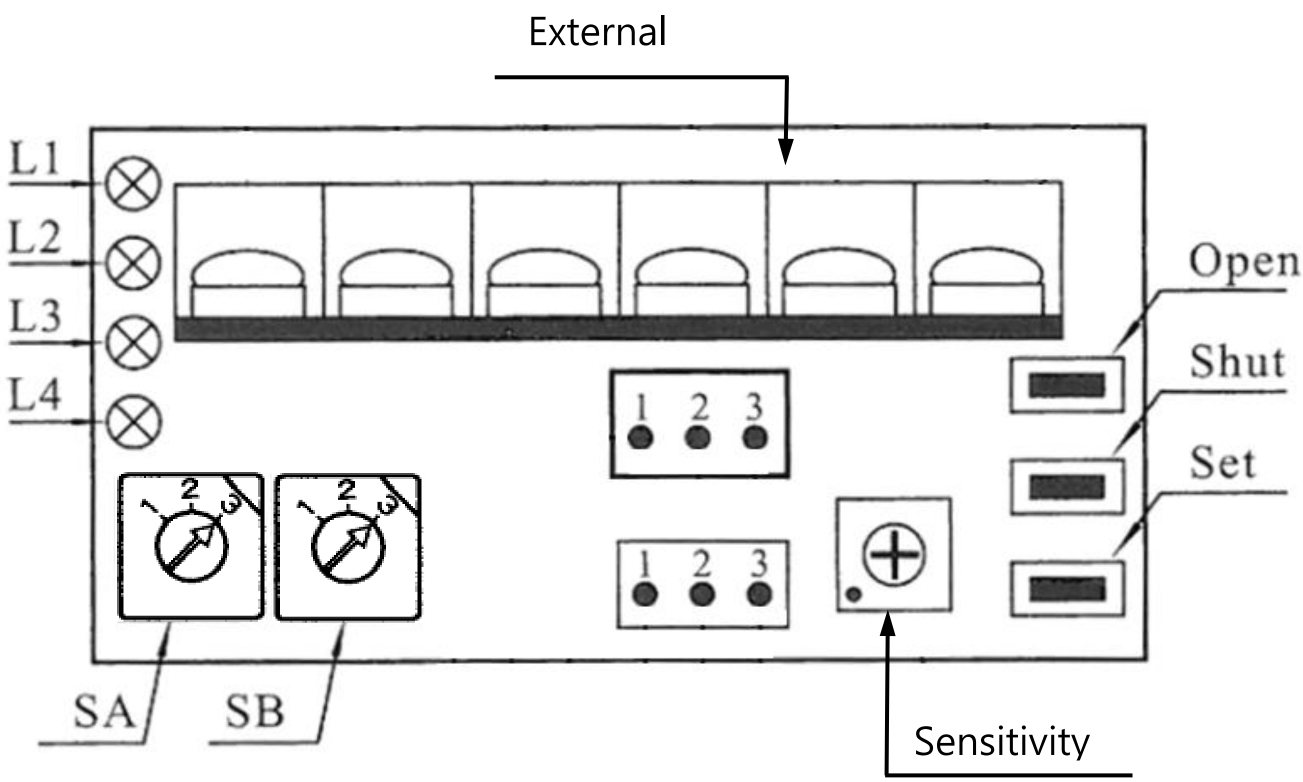
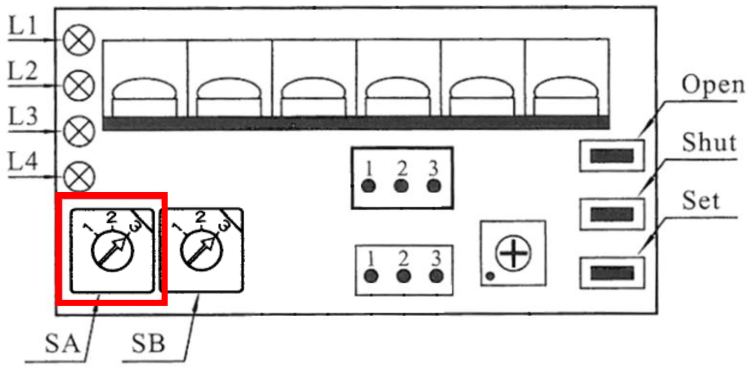
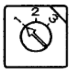


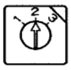
Figure 3-6 DIP Rotary Switch

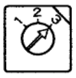
3.2.4.1 Input and Output Signal Settings：



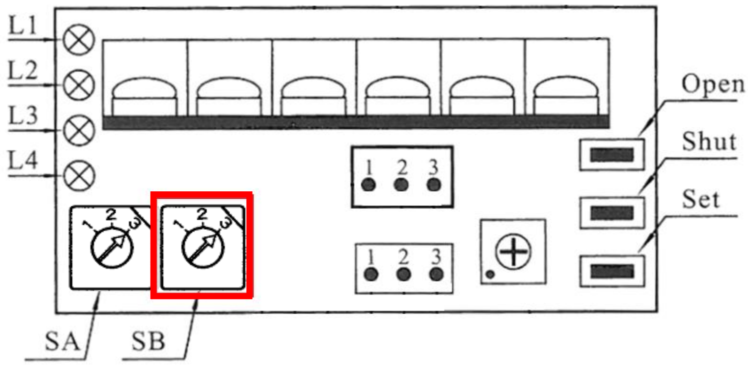
SA Rotary Switch Settings：


When the selector is set to 1 → Normal Operation (Input signal: 20 mA, Feedback output: 20 mA)

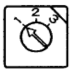

When the selector is set to 2 → Setting Mode (Used for stroke setting or manual operation)

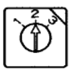

When the selector is set to 3 → Reverse Operation (Input signal: 20 mA, Feedback output: 4 mA)

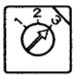
3.2.4.2 Action Settings When Input Signal is Abnormal：



SB Rotary Switch Settings：


Set the selector to 1 → Fully Closed.

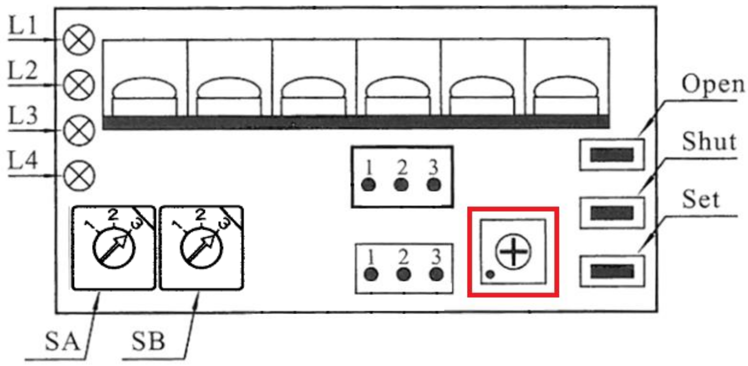

Set the selector to 2 → Hold Position.


Set the selector to 3 → Fully Open (Preset Value).

Note : When the input signal is less than 2.5mA or higher than 22mA, the actuator is judged to be interrupted and transferred to the specified state, so the control device and signal 4 to 20mA must be adjusted correctly.

※If the aperture of IGV decreased rapidly, the compressor might operate into surge area which might lead to the loss control of magnetic bearings and cause the damage of the mechanism. Therefore, when the control signal is malfunctioned, the IGV should be set as fully open to prevent surging during the compressor restart.

3.2.4.3 Control Signal Sensitivity Setting :



Volume	1	2	3	4	5	6	7	8	9	10
Sensitivity	0.5%	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%

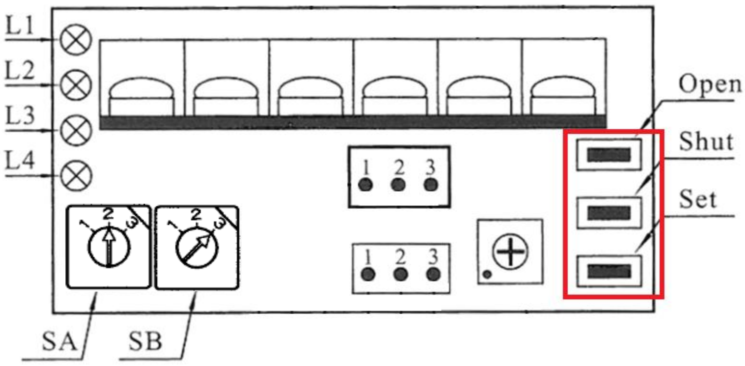
Table 3-2 Comparison of sensitivity volume

Note :

1. 1.The default volume is set as 2 (1.0%).
2. 2.Do not adjust arbitrarily to avoid actuator malfunction.

3.2.4.4 Stroke Setting :

Set the control signal for full open and full close positions.



- Setting the Full Close Position：
  1. Turn the SA switch to position 2 to enter setting mode.
  2. Press open or Shut to drive the actuator to the fully closed position.
  3. Press and hold both the Shut and Set buttons for 4 seconds, and release them when the L2 indicator light turns on — the setting is now complete.

- Setting the Full Open Position：
  1. Turn the SA switch to position 2 to enter setting mode.
  2. Input a 20mA current signal.
  3. Press open or Shut to rotate the actuator to the fully open position.
  4. Press and hold both the Shut and Set buttons for 4 seconds, and release them when the L2 indicator lights up — setting is complete.

- Completed Setting：

  Turn the SA switch back to position 3 to enable signal control.

Note：

1. When reversing the actuator, there is no need to press any buttons. Simply follow the procedure above.
2. This actuator does not have micro-limit switches; stroke limits are controlled by the potentiometer.
3. When adjusting the IGV, please complete the full close position setting before performing full open position adjustments.

3.2.4.5 Feedback Signal Calibration：

When the feedback current terminal is powered on, verify whether the fully open and fully closed position feedback signals are accurate. If the deviation exceeds 1%, calibration must be performed according to the following steps.

1. Turn the SA switch to position 2 to enter the setting mode.
2. Press and hold the Set button, then simultaneously press the Open and Shut buttons. Hold all three buttons until the L2 indicator light turns on this enters the full-close 4 mA feedback signal calibration mode. 。
3. Observe the multimeter reading and use the Open button (to increase) or Shut button (to decrease) to adjust the current until the feedback current reads 4 ± 0.02 mA.
4. After calibration, press the Set button until the L2 indicator light goes off, then press and hold the Set button again until the L2 light turns on again — this enters the full-open 20 mA feedback signal calibration mode.
5. Observe the multimeter reading and use the Open button (to increase) or Shut button (to decrease) to adjust the current until the feedback current reads 20 ± 0.02 mA.
6. After calibration, press the Set button until the L2 light goes off again — calibration is complete.

Note：Factory-default units are pre-calibrated. Normally, no additional calibration is required.

3.2.5 LED Indicator Description：

When a fault occurs, indicators L1–L4 will light up respectively to indicate the cause of the failure, as shown below.

Signal	Color	Condition	Reason
L1	Green	Power indicator	The indicator lights up when L and N terminals are powered, indicating normal operation.
L2	Red	Input signal failure	1. Input signal is less than 2.5 mA or greater than 22 mA (out of range); possible input signal disconnection, short circuit, or wiring issue. 2. If wiring is confirmed to be normal and the light remains on, the controller may be faulty.
L3	Red	Position detection circuit error	1. Possible issue with potentiometer wiring; a short or disconnection may have occurred. Normally, the voltage between two ends should be approx. 4V. 2. If wiring is confirmed normal and the light is still on, the controller may be faulty.
L4	Red	Jamming fault	1. Mechanical jamming is possible. Check if the actuator linkage is stuck or blocked, and whether manual lever can move freely. 2. If confirmed normal and the light remains on, the controller may be faulty
NA	NA	Output signal response mismatch / cannot complete full stroke	1. Full open signal setting does not input 20 mA correctly. 2. Actual feedback signal is abnormal. → These can usually be resolved by redoing full open position setting. If not, controller may be faulty
NA	NA	Feedback signal does not match actuator position	1. Possible potentiometer wiring error; a short or disconnection may have occurred, causing this light to turn on. 2. If the position cannot be read correctly, the controller may be faulty

Table 3-3 Description of blink code

3.2.6 Troubleshooting :

TROUBLE	PROBABLE CAUSE	SOLUTION
Motor does not start up	The power is not connected	Connect the power correctly
	Signal failed or terminals dropped	Reconnect the terminal correctly
	The wire is broken	Change or repair the wire
	Wrong input voltage or the voltage is too low	Check the input voltage
Power ON/OFF	Indicator light is damaged.	Replace the indicator light.

indicator light is not illuminated		
Water damage of actuator	Cable does not meet the water-proof standard	Contact Hanbell for the repair service
	Actuator feedback window is damaged	
	The casing is damaged or o ring is not sealed properly	

Table 3-4 Description of trouble shooting

3.3 Capacity Modulation of Chiller：

3.3.1 Capacity Modulation：

According to the part-load temperature conditions specified by AHRI regulations in the United States, the compressor capacity modulation range can vary from 25% to 100%, or even lower (this depends on the compression ratio).To ensure the compressor operates at optimal efficiency, capacity adjustment must follow the variable frequency surge control equation provided by Hanbell. For details regarding this equation, please refer to Section 3.4.2. Compressor loading and unloading are carried out by coordinating the motor speed with the Inlet Guide Vanes (IGV) to achieve capacity modulation, as introduced below：

- Speed Control：
  The cooling capacity of a compressor is directly proportional to its motor speed and the power consumption is directly proportional to the cube of motor speed, therefore cooling capacity can be adjusted by motor speed and lower motor speed generates higher operating efficiency. By PID control, the cooling capacity of the compressor can be changed to achieve the requested water temperature setting.

- IGV Control：
  When the motor speed decreases to the lowest operable frequency, further reduction is not possible, therefore IGV (Inlet Guide Vanes) control is a secondary method. The minimum operable frequency needs to be calculated by inputting the compressor operating pressure ratio & IGV opening % into the Hanbell variable frequency resonance equation. For more details, please refer to section 3.4.2.

- Hot Gas Bypass (HGBP)：
  When operating conditions become extremely, the compressor cannot be operated in good condition by motor speed and IGV opening %, the hot gas bypass needs to be activated. This action reduces the compression ratio to make the compressor continue operating steadily. It is strongly recommended to install the external line of hot gas bypass with compressor to ensure that it can operate under partial load reliably.

- Compressor Control Logic：

Hanbell RTM series has dedicated control logic, which includes cooling capacity modulation and protection control logic. If customer has any concern of development of chiller control program, please contact Hanbell.

3.3.2 Power Consumption Efficiency of RTM with VFD：

RTM series is designed as direct-driven mechanism with variable frequency. This consumption efficiency design is widely applied to different turbine product and can be explained by similarity principle.

According to the affinity laws (similarity principles), the relationships between rotational speed, flow rate, pressure ratio, and power consumption are as follows: :

$Q \propto N$

$Pr \propto N^2$

$P \propto N^3$

in which：

Q：Cooling capacity

Pr：Pressure ratio

P：Rotation speed

N：Rotation speed

The relationship between cooling capacity, power consumption, and rotational speed is shown in Figure 3-7.

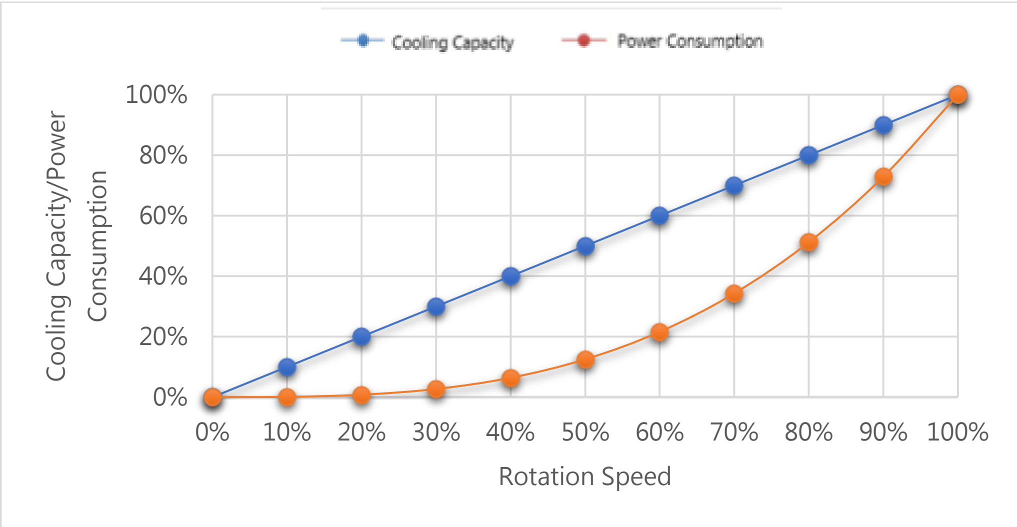


Figure 3-7 Affinity Laws Illustration

According to the diagram above, when the rotation speed decelerates to 50%, cooling capacity will decrease to 50% simultaneously.

Under this scenario, power consumption will be approximately 13% due to it is proportional to the cube of rotation speed. This means the power consumption of variable frequency design is roughly 37% lower than fixed frequency design.

3.4 Operation Range：

3.4.1 IGV Capacity Control with VFD：

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. 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. In addition, the magnetic bearing may cause high axis current which will lead to compressor emergency stop. Therefore, compressor’ s operating map must be confined below the Surge Line.

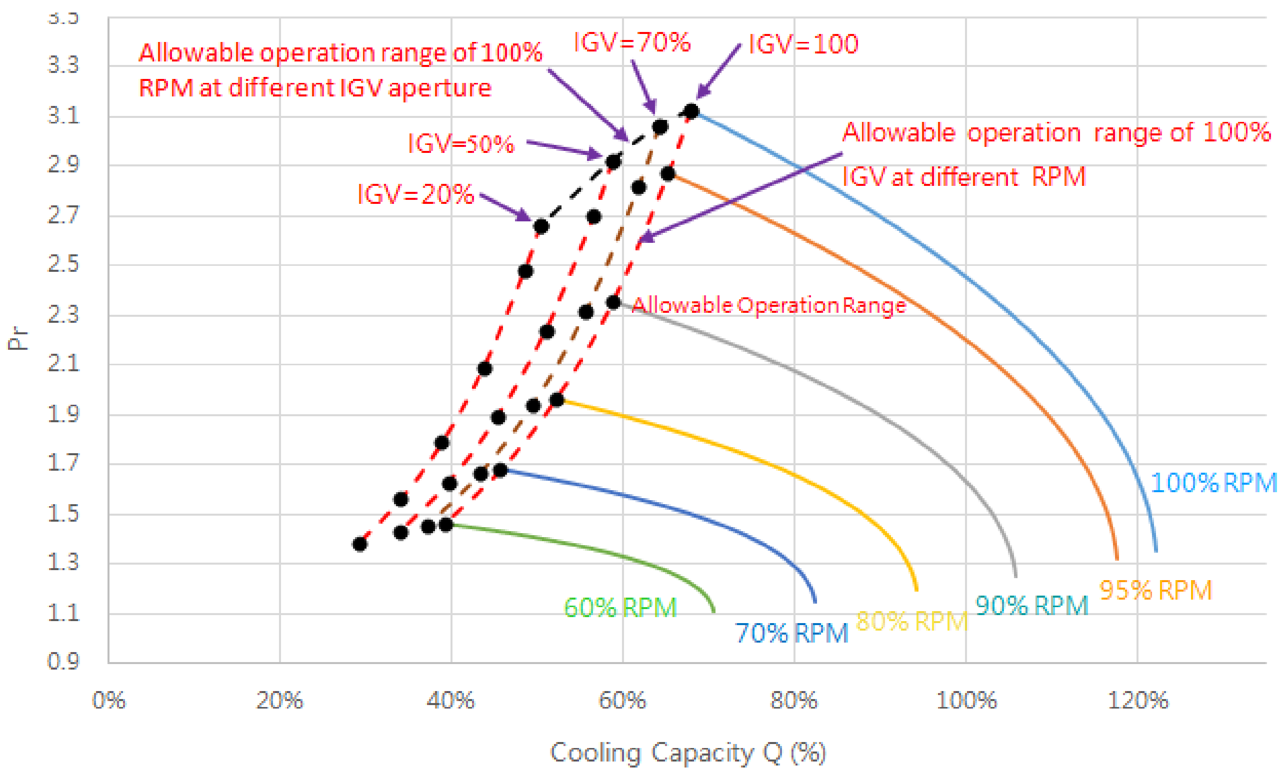


Figure 3-8 IGV Operating range

3.4.2 Equation of Surge Line :

Equation of Surge Line is consisted of IGV aperture, pressure ratio and frequency. The equation should be monitored strictly during the capacity modulation of compressor to prevent the frequency is operated out of the limit of the equation.

Parameter	Description				
x	IGV aperture, the input value is from 20 to 100.				
y	Pressure ratio				
z	Frequency Hz (RPM/60)				
Model	Equation				
	$z=a+b/x+c/y+d/x^2+e/y^2+f/(xy)+g/x^3+h/y^3+i/(xy^2)+j/(x^2y)$				
	Coefficient				
RTM-030	a	b	c	d	e
	5.71863E+02	1.55999E+03	-8.60058E+02	-1.48060E+04	7.69278E+02
	f	g	h	i	j
	-9.62103E+02	7.06646E+04	-4.26526E+02	3.45306E+00	3.34200E+03
RTM-050	a	b	c	d	e
	4.79626E+02	1.89150E+03	-7.83493E+02	-2.34156E+04	7.81626E+02
	f	g	h	i	j
	-1.17095E+03	9.64749E+04	-4.42905E+02	7.15374E+01	7.26142E+03
RTM-070	a	b	c	d	e
	3.77182E+02	1.89012E+02	-5.75815E+02	4.47873E+03	5.33694E+02
	f	g	h	i	j
	-2.82460E+02	-1.97711E+04	-2.97779E+02	3.10561E+01	-1.22848E+03
RTM-090	a	b	c	d	e
	2.31754E+02	1.47245E+03	2.08859E+02	1.37774E+04	-9.89387E+02
	f	g	h	i	j
	-6.27408E+03	7.13687E+04	6.39512E+02	7.21424E+03	-3.45464E+04
RTM-120	a	b	c	d	e
	-2.65726E+03	-8.47648E+04	2.61732E+04	-5.07726E+05	-7.71573E+04
	f	g	h	i	j
	4.73538E+05	-6.91000E+05	7.37389E+04	-6.44673E+05	1.31917E+06
RTM-180	a	b	c	d	e
	5.09590E+02	-1.36733E+03	-8.15878E+02	4.40851E+04	7.80913E+02
	f	g	h	i	j
	2.48509E+03	2.41861E+04	-4.26079E+02	-1.38266E+03	-3.98565E+04
Model	Equation				
	$z=a+b/x+cy+d/x^2+ey^2+fy/x+g/x^3+hy^3+iy^2/x+jy/x^2$				
	Coefficient				
RTM-100	a	b	c	d	e
	-1.92092E+02	-2.30346E+02	3.60106E+02	-3.58764E+03	-1.18274E+02
	f	g	h	i	j
	5.20922E+02	2.89490E+04	1.45950E+01	-9.47418E+01	-2.12740E+02
RTM-140	a	b	c	d	e
	1.42185E+01	-1.58706E+03	7.92077E+01	-1.00932E+04	-1.02928E+01

	f	g	h	i	j
	1.50315E+03	9.81232E+04	6.27651E-01	-2.55726E+02	1.53194E+03

Table 3-5 Safety margin line of each model

Note1.The calculation result of minimum frequency operation reaches surging line, therefore, the frequency of the control logic should be considered to add 2 to 3 Hz based on the calculation value for safety factor.

Note2. For control logic requirements, please contact Hanbell personnel.

Note3. The equations for RTM-090 and RTM-140 have been updated to optimize the operating range under partial load conditions.

3.5 Hot Gas Bypass (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.

Warning : Do not apply solenoid valve for HGBP to prevent system efficiency because of the high resistance.

Note1. HGBP will lead to the inefficiency of system, it should be avoid during the capacity modulation. However, in many applications, HGBP is still required for avoiding surging or maintaining the water temp. During minimum 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 aperture and cooling capacity is 50%, and end user needs 20%. The pipe diameter and flow need to be considered based on the 30% difference.

Note3. Recommended hot gas bypass piping diameters:

For RTM-030 to RTM-050 models, use pipe size 2.5” or above. For RTM-070 to RTM-140 models, use pipe size 3” or above.

Note4. For multi-compressor operation, please consult Hanbell technical personnel.

3.6 Intermediate-Pressure Shut-Off Valve :

When a single unit is equipped with more than one compressor, it is recommended to add an intermediate-pressure shut-off valve on the ECO pipeline near each compressor. When a standby compressor stops running, due to the existence of pressure, residual refrigerant, or flash gas (from the plate or shell-and-tube heat exchanger), the refrigerant may flow back through the ECO port into the standby compressor, causing it to rotate in reverse.

Normally, when the standby unit is shut down, the magnetic bearing rotor is in a non-levitating state. Long-term reverse rotation may damage the auxiliary bearing.

In single-compressor systems, the intermediate-pressure shut-off valve may be omitted.

Note1.The intermediate-pressure shut-off valve should be an ON-OFF type electric valve.

Note2. Do not use solenoid valve as an alternative, as this may result in serious pressure drops and affect compressor performance.

4. Motor :

4.1 Motor and Magnetic Bearing Cooling Path :

The motor is cooled using high-pressure liquid refrigerant from the condenser.

When the motor temperature and bearing temperature exceed the alarm threshold (see alarm values in Section 4.3), the auxiliary liquid refrigerant (from the condenser) is activated for additional cooling (refer to Figure 4-2 – Piping Diagram).

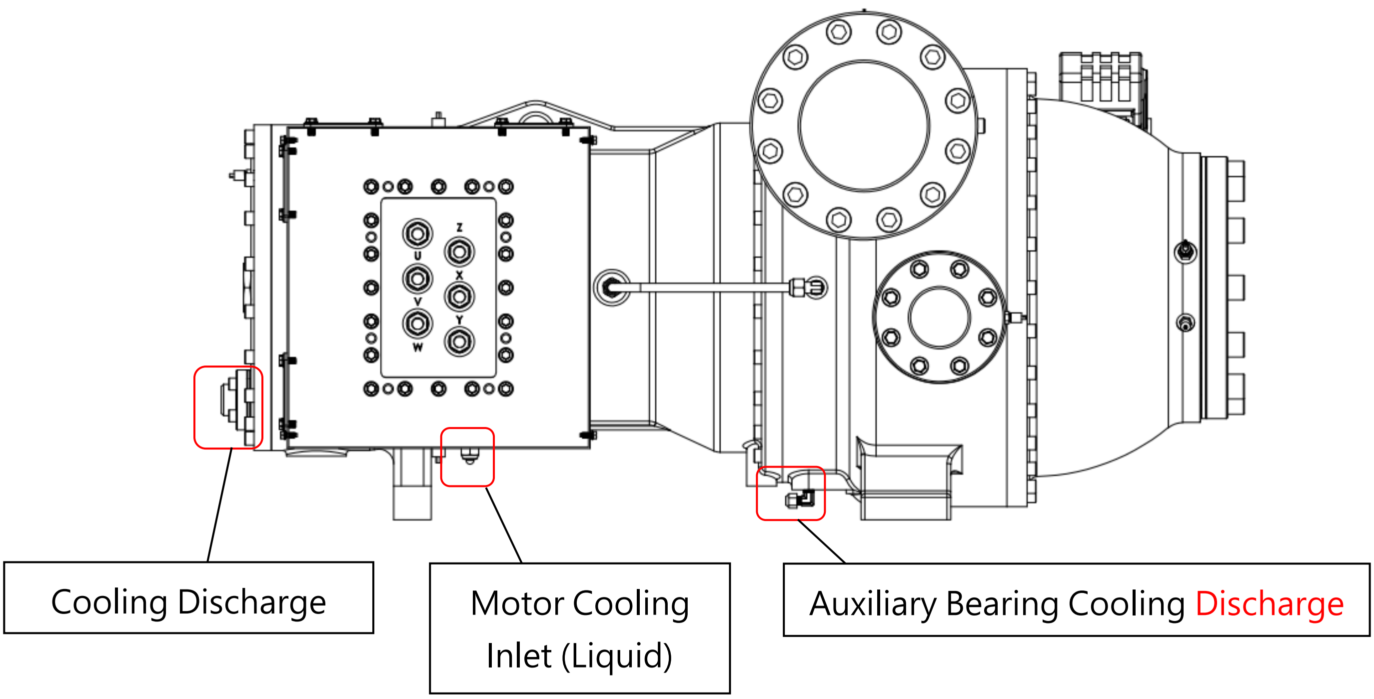


Figure 4-1 Motor and Magnetic Bearing Cooling Diagram

4.2 Motor And Bearing Cooling Connections :

4.2.1 RTM-030 ~ 180_Connection of Cooling Pipes ：

- Motor cooling inlet: Connected from the high pressure liquid line after condenser.
  - Angle valve No. 10 (or needle valve) is the primary cooling line, and this line is normally open. The ball valve must be adjusted to reduce the flow rate in order to meet the motor temperature, bearing temperature, and Ke value requirements under rated conditions, and to avoid excessive refrigerant injection, which may affect chiller performance.
  - Angle valve No. 11 (or needle valve) is the auxiliary cooling line.
    The ball valve opening must be adjusted to reduce the flow to meet the motor temperature, bearing temperature, and Ke value requirements under maximum load conditions, and to avoid excessive refrigerant injection that could affect chiller performance. This line is controlled by solenoid valve No. 9, which is normally closed. The solenoid valve will open only when the motor temperature, bearing temperature, and Ke value meet the required conditions.
- Bearing Cooling Outlet and Auxiliary Bearing Cooling Outlet should be connected to the bottom of the evaporator.
- For some models, the cooling channels are built-in, and no external cooling bypass line is provided.

Note :

1. The bearing liquid/gas outlet must be connected to the evaporator. Failure to do so may cause increased pressure in the motor chamber, resulting in excessive axial thrust. In severe cases, the magnetic bearing system may trigger an alarm.
2. Do not install a solenoid valve on the return liquid line.

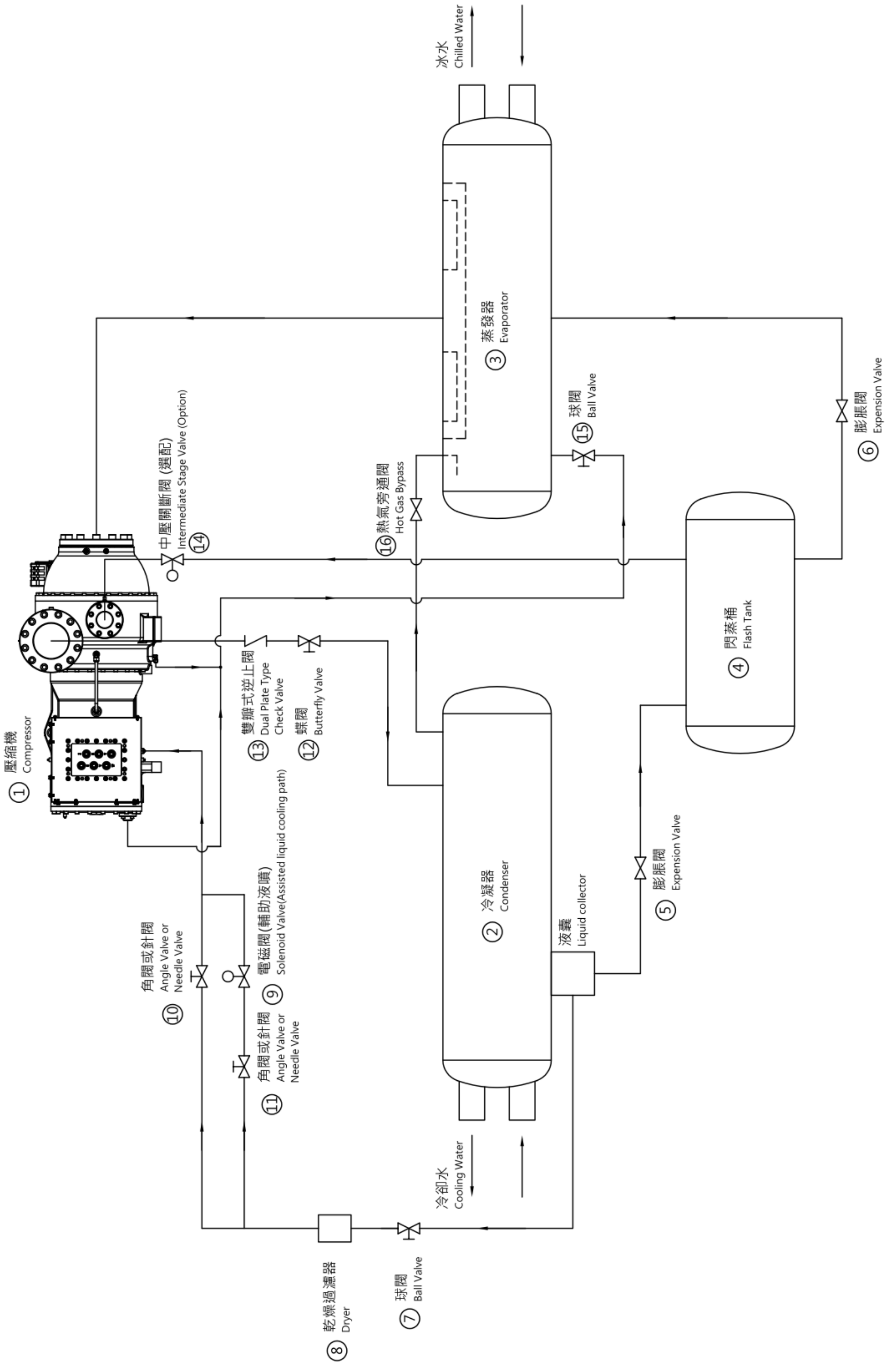


Figure 4-1 Cooling system of RTM series (flash tank)

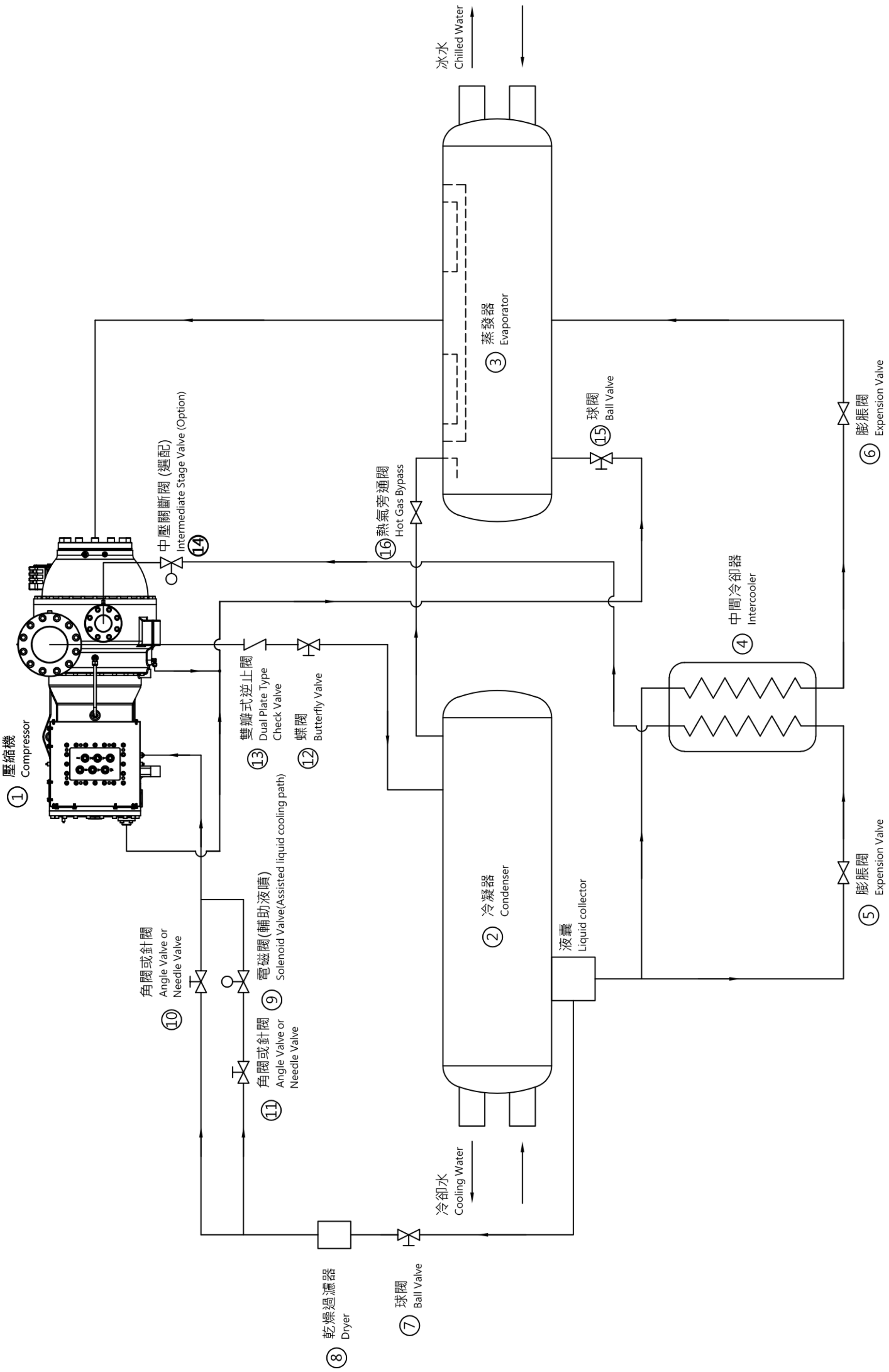


Figure 4-2 Cooling system of RTM series (subcooler)

Note1. It is recommended to apply butterfly valve as discharge service valve (No.12) to prevent pressure drop which may influence chiller performance.

Note2. Item 14, the intermediate pressure shut-off valve, is optional. It is required only for systems with two or more compressors to prevent reverse rotation during standby caused by pressure differences. Single-compressor systems typically do not require this valve.

4.3 Temperature Control of Motor and Magnetic Bearings :

Built-in Pt100 temperature sensors are installed on the motor (6 sensors) and the magnetic bearings (4 sensors). These sensors perform synchronized measurements during operation and serve as the basis for protecting the motor and bearings.

Protection settings are as follows: (based on the highest temperature reading)

- Motor Temperature：

Item	Temperature
Auxiliary liquid solenoid valve closes	65℃
Auxiliary liquid solenoid valve opens	80℃
Alarm and shutdown	90℃

Table 4-1 Motor Temperature Protection Values

- Bearing Temperature：

Item	Temperature
Auxiliary liquid solenoid valve closes	60℃
Auxiliary liquid solenoid valve opens	70℃
Alarm and shutdown	85℃

Table 4-2 Bearing Temperature Protection Values

- Ke (Back Electromotive Force, Back EMF)：

Set point \ Model	RTM-030		RTM-050			RTM-070	RTM-090 RTM-100	RTM-120	RTM-140	RTM-180
Electric Motor (Rotating Part) Version	A	B	A/B	C	D	A	A	A	A	A
Ke setting value of inverter	7	7	9	9	9	13.5	14.5	15	17.6	18.5
Solenoid valve of auxiliary liquid pipe off	6.56	7.30	9.10	8.70	8.79	12.59	13.67	13.2	16.30	17.77
Solenoid valve of auxiliary liquid pipe open	6.44	7.17	8.90	8.60	8.63	12.36	13.43	13	16.20	17.45
Tripping point	6.32	7.04	7.90	7.80	8.48	12.14	13.19	12.7	16.03	17.14

Table 4-3 Ke Back EMF Protection and Setting Values

Note1. If either the motor stator temperature, magnetic bearing temperature, or the back EMF (Ke value) feedback from the inverter exceeds the warning threshold, the auxiliary liquid solenoid valve must be activated (see Figure 4-2: System with Flash Tank Piping Diagram).

Note2. The back EMF (Ke value) can only be retrieved via Modbus communication with the inverter. Refer to Section 5.3 for communication setup.

Note3. Under normal conditions, the gas-phase cooling inlet valve for the bearing should remain open.

Note4. During startup acceleration, the Ke value may fluctuate significantly, potentially triggering alarms and startup failure. It is recommended to temporarily disable Ke protection during acceleration and re-enable it once startup is complete.

4.4 Motor Connection :

4.4.1 Voltage & Frequency :

Below table is the allowable operation range of input voltage and frequency of inverter which is tested by Hanbell. It might lead to the damage of inverter if operated out of limit：

Model	Brand of Inverter	Range of rated voltage
RTM-030 ~ RTM-140	Delta	360V~480V

Table 4-4 Input Voltage Range on the Primary Side of the Inverter

Range of frequency
50 Hz±3Hz
60 Hz±3Hz

Table 4-5 Range of rated frequency

Note：

1. The frequency range mentioned applies only to the power supply frequency, not the compressor motor's operating frequency.
2. The rated voltage range shown here refers to the input voltage range permitted by the compressor motor, not the inverter's full operating voltage range.
3. The voltage and frequency specifications above are based on Hanbell-recommended inverter brands and their corresponding components. If other electrical components are selected by the customer, please ensure full compatibility.
4. After disconnecting the AC power, do not touch the inverter's internal circuits or components until the POWER indicator (located behind the digital keypad) turns off, as high voltage may still be present. To avoid potential faults, wait until the indicator light turns off before restoring power.
5. Please connect to a 3-phase 3-wire Y power system or a 3-phase 4-wire Y system to comply with UL standards.
6. If the inverter generates leakage current exceeding 3.5 mA AC or 10 mA DC on the protective grounding conductor, the conductor must meet national regulations or follow IEC 61800-5-1 grounding standards.
7. Grounding requirements：
    a. Ensure both the inverter and motor are properly grounded to protect personnel, ensure correct operation, and reduce electromagnetic emissions.
    b. Ground wire diameter must meet local safety code requirements.

c. Grounding terminals must be securely connected to reduce the risk of lightning damage, electric shock, and electromagnetic noise interference.

4.4.2 Inverter Components :

Figure 4-4 illustrates a typical motor connection configuration. The definition and requirements for the associated components must comply with the following specifications：

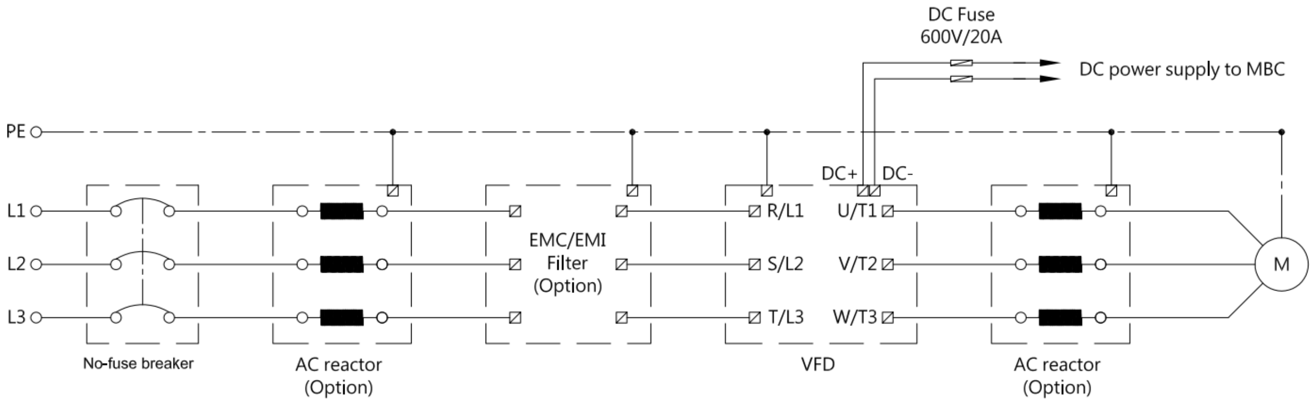


Figure 4-3 Connection of Inverter

4.4.2.1 Variable Frequency Drive (VFD)：

The variable frequency drive (VFD) is primarily used to drive the compressor motor and supply power to the magnetic controller.

Below is a list of the VFD models and specifications currently developed by Hanbell：

Model	Inverter specification								
	Brand	Model of Inverter	INPUT		OUTPUT				Firmware
			V	A	HP	V	KVA	kW	
RTM-030	Delta	VFD1100C43A-HS	360-480	207	150	0-480	175	110	1.07
RTM-050		VFD2200C43A-HS	360-480	400	300	0-480	367	220	
RTM-070		VFD3550C43A-HS	360-480	625	475	0-480	544	355	
RTM-090		VFD3550C43A-HS	360-480	625	475	0-480	544	355	
RTM-100		VFD3550C43A-HS	360-480	625	475	0-480	544	355	
RTM-120		VFD5000CP43C-21	360-480	866	600	0-480	690	450	
RTM-140		VFD866VP43SHTHA	360-480	866	600	0-480	690	450	
RTM-180		VFD3550C43A-HS*2	360-480	625*2	475*2	0-480	544*2	355*2	

Table 4-6 VFD Specification Table

Note: For selection, please refer to Chapter 8.1 – Compressor Spare Parts.

4.4.2.2 Fuse-less Circuit Breaker：

To prevent overcurrent from damaging the compressor and related electrical components or affecting safety, a circuit breaker should be installed at the input upstream to provide protection. The specification of the circuit breaker must be selected based on the full-load current requirements under actual operating conditions to ensure sufficient protection.

4.4.2.3 AC Reactor :

Installing an AC reactor on the inverter input side increases line impedance, improves power factor, reduces input current, expands system capacity, and suppresses harmonic interference generated by the inverter. Another key function is to protect the inverter from voltage or current surges originating from the power source. For example, when the main power supply capacity exceeds 500 kVA or when power factor correction capacitors are switched in, the resulting surge may damage the inverter's internal circuits. Installing an AC reactor on the input side can effectively suppress such transients.

Warning：As shown in Figure 4-4, the AC reactor installed in the main circuit operates at high temperature. Adequate ventilation around the unit is required, and the use of a forced cooling fan is recommended to prevent overheating.

Note: For optional components, refer to Section 8.1 – Compressor Accessories.

4.4.2.4 Zero-Phase Reactor：

1. Used to reduce radiated electromagnetic interference, especially in environments with audio equipment. It also helps suppress both input- and output-side noise. The effective suppression range is from the AM band up to 10 MHz.

2. Wiring Methods

(1) Install the zero-phase RF filter on the input side of the inverter. Pass all three-phase power wires through the core in the same direction and with equal turns. Do not pass the ground wire through the zero-phase reactor, as this will reduce the noise suppression effect.

(2) Install the zero-phase RF filter on the output side of the inverter. Pass all three-phase motor wires through the core in the same direction and with equal turns before connecting to the motor terminals. Do not pass the ground wire through the zero-phase reactor, or noise filtering effectiveness will be compromised.

Note: The zero-phase reactor on the power input side is optional, while the zero-phase reactor on the output side is standard.

4.4.2.5 EMC/EMI Filter：

Filters have a significant impact on compressor performance. To minimize electromagnetic interference, users must select EMC/EMI filters that are certified in accordance with the regulations of the respective country. If compliance is not feasible due to specific considerations, users must implement alternative solutions and adhere to relevant EMC standards.

Note: For optional components, refer to Section 8.1 – Compressor Accessories.

4.4.2.6 AC Output Reactor :

When the cable length between the motor and inverter exceeds 75 meters, the increased stray capacitance between wires may result in leakage current. This can trigger overcurrent protection, increase leakage current, or cause inaccurate current display. In severe cases, the inverter may be damaged. Under such conditions, an output reactor must be installed.

4.4.3 Grounding :

Grounding in electric system is a must. 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：

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

Power Cable (mm2)	Grounding Wire(mm2)
120 and lower	16
150 and higher	25

Table 4-7 Power cable cross-sectional area

Note: It is suggested that resistance of grounding should not be higher than 10Ω. However, please follow local electrical regulation before the value is determined.

4.4.4 Cable of main power input :

Main power cable should meet local electrical safety regulation. 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 4.8.

- 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. Please refer to diagram 4.4 for the connection.
- Please double check the phase sequence when wiring.

Note1. The power cable gland should be insulated properly with heat shrinking tube.

Note2. The power cable shall sustain the maximum permissible current under 90℃ (40℃ ambient temperature)。

Note3. The maximum operating ampere (table 4-8) for first and secondary side of inverter should be considered when selecting power cable.。

600V Hypalon Cable (*1C)			
Section Area (mm2)	Maximum Permissible current(A)	Section Area (mm2)	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 4-8 600V Hypalon maximum permissible current

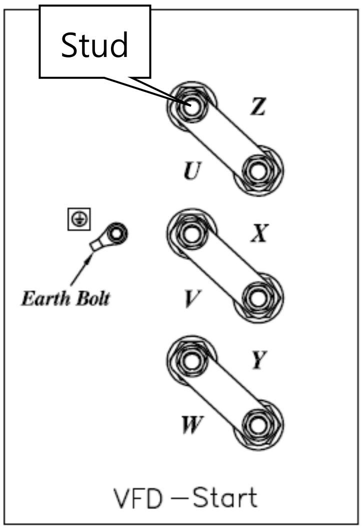


Figure 4-4 Connection of terminal plate

4.4.5 Connection notice :

- When wiring the compressor, ensure that the main power cable connected to the compressor complies with the voltage specifications indicated on the nameplate, and the cable must be made of copper.
- The user and installation contractor are strictly prohibited from altering the shape or size of the terminal box.
- The motor terminal posts are made of brass. Therefore, they must not bear the weight of high-voltage cables. Installers must use cable supports or strain relief devices outside the terminal box to ensure that the motor terminals are not subjected to the cable's weight.

  ※Hanbell does not supply cable terminals.
- When tightening the cable connections on the motor terminals (using A & B nuts), a torque wrench must be used. The torque should not exceed 300 kgf-cm, and the

connections must be securely fastened.

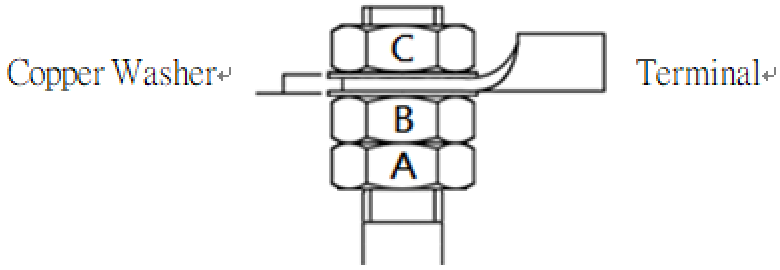


Figure 4-5 Power bolt connection

- Cable routing and acceptance must comply with the requirements of GB50168-92 "Code for Construction and Acceptance of Cable Installation Works.
- It is recommended to use shielded cables for both the main circuit and control circuit. Maintain an appropriate distance between them during installation to prevent electromagnetic interference.
- The three-phase motor cables must be grouped as U/V/W and X/Y/Z respectively. Only one group of power cables is allowed to enter each terminal hole at the same time. This is to prevent magnetic induction from generating high temperatures around the terminal area, as shown in the illustration below.

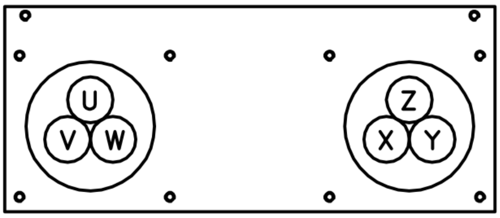


Figure 4-6 Cable box wiring entry and cables

4.5 Motor MCC :

The table below shows the maximum operating current on the primary and secondary sides of the VFDs rated for 380V compressors :

Model	Voltage(V)	Power(kW)	Primary MCC(A)	Secondary MCC(A)
RTM-030	380	100	189	210
RTM-050	380	180	306	340
RTM-070	380	220	387	430
RTM-090	380	285	486	540
RTM-100	380	300	522	580
RTM-120	380	405	639	710
RTM-140	380	440	711	790
RTM-180	380	630	1035	1150

Table 4-9 Maximum Current Values at VFD Primary and Secondary Sides

Note1. The above parameters must be matched with the VFD models listed in Table 4-6.
Note2. The listed primary current values are based on 380V input voltage. Actual current may vary with different input voltages.
Note3. The secondary side maximum current output is a fixed value and is not affected by the input voltage.

4.6 RTM-030_Terminal connection notice：

The shape of terminal cover plate for RTM-030 is circle, power bolts position is shown below. The adapter is provided for different direction of cable entry. The connection instruction is recommended as below.

4.6.1 Side connection：

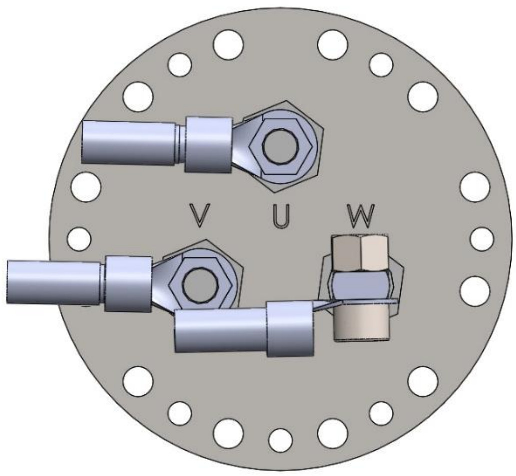


Figure 4-7 Side connection front view

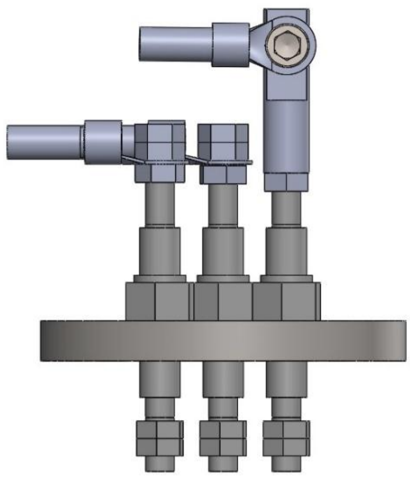


Figure 4-8 Side connection side view

4.6.2 Bottom connection：

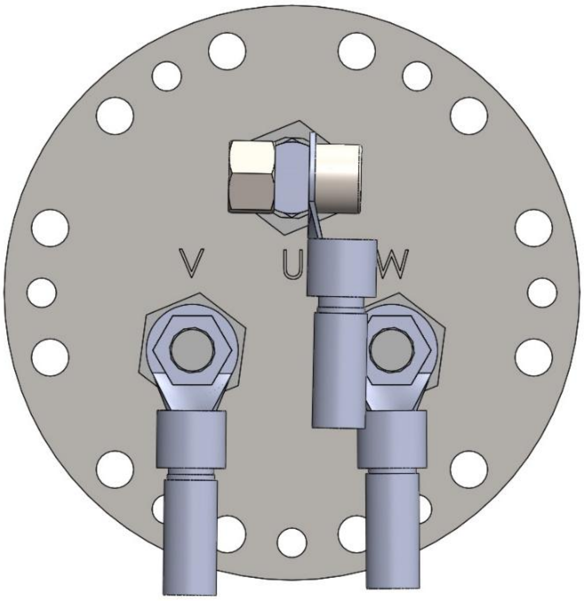


Figure 4-9 Bottom connection front view

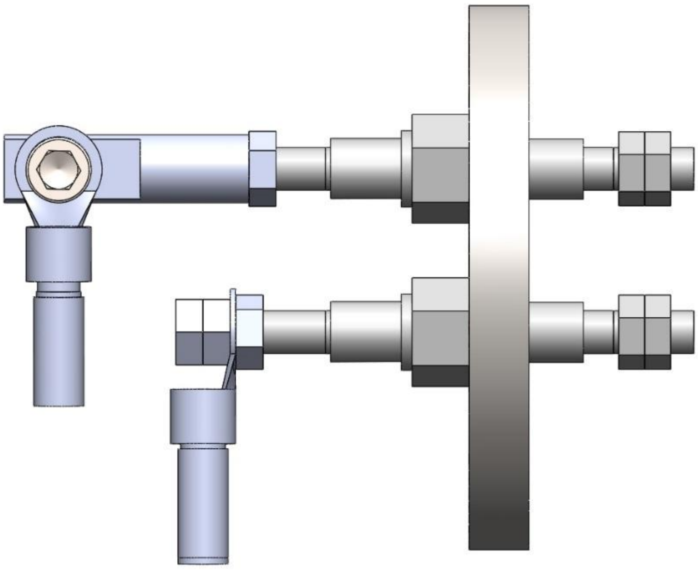


Figure 4-10 Bottom connection side view

5. Control Wiring Interface Connection :

5.1 Connection Method Between Compressor and Components :

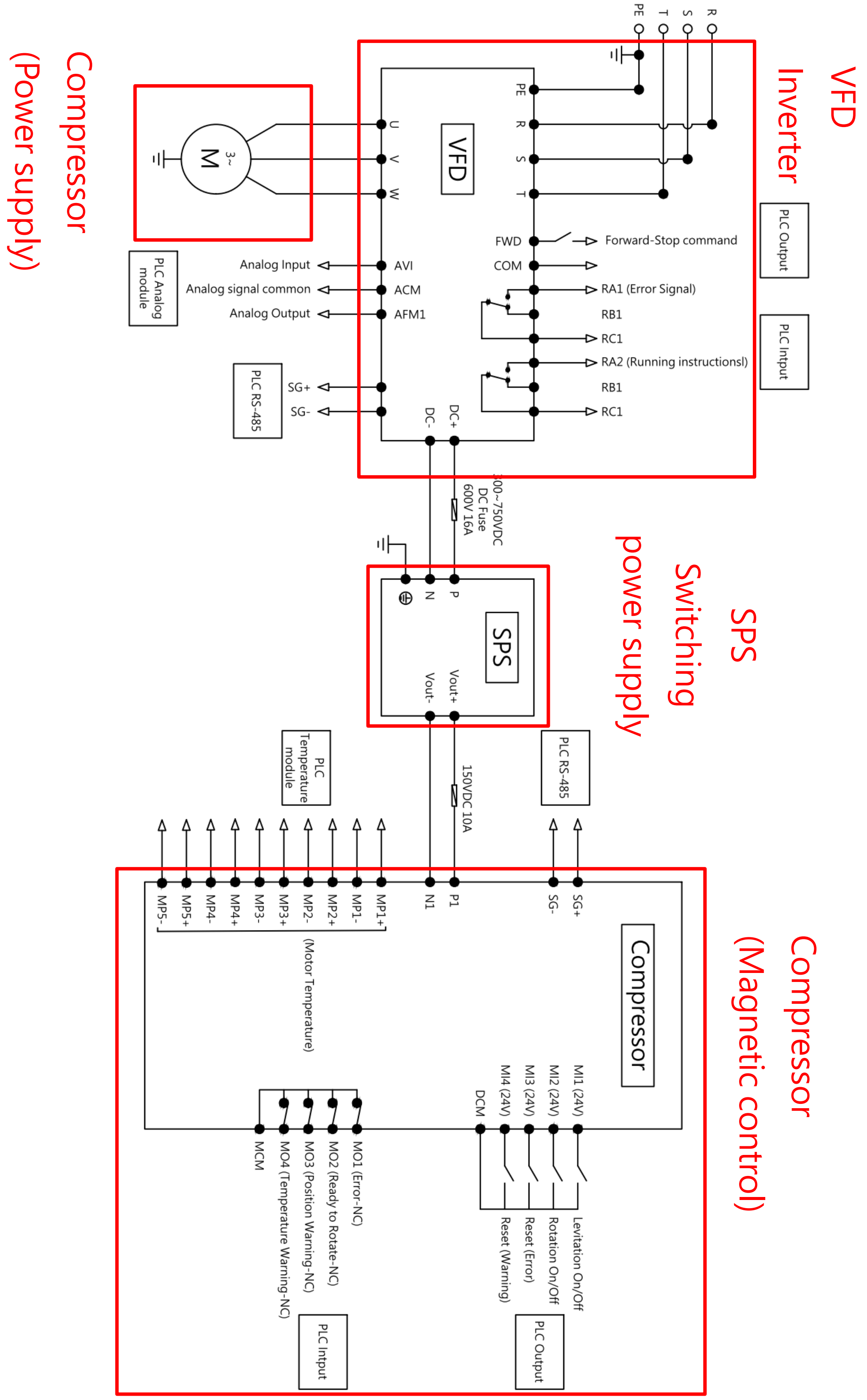


Figure 5-1 Compressor control connection

5.2 Magnetic Bearing Controller (MBC) Overview :

The magnetic bearing controller consists of two components: the controller module (MBC) and the power supply module (SPS). As shown in Figure 5-1, DC power is supplied from the inverter DC bus to the SPS module, which then distributes power to the MBC module.

Model	VFDC1012P00123K00A	VFDDD1012C205D-0A
Items	Delta Controller module (MBC)	Delta Power module (SPS)
Firmware	1.02	1.03
Length (mm)	266	268
Width (mm)	260	503
Height (mm)	57	101
Weight (kg)	2.4	7
IP protection code	IP 00	IP 20
Operation Temp. (°C)	-10°C~+50°C (Natural convection)	-10°C~+50°C (Natural convection)
Relative humidity (%)	Max. 90%	Max. 90%
Storage Temp. (°C)	-40℃~+70℃	-40℃~+70℃
Power	145~155VDC	250~600VDC
Maximum loss power	3000	3000
Relay dry contact output	250 VAC / 0.25A max 30 VDC / 2A max	N/A
Protocol	Modbus RS485 Cable length<10m	N/A

Table 5-1 Magnetic bearing controller specification

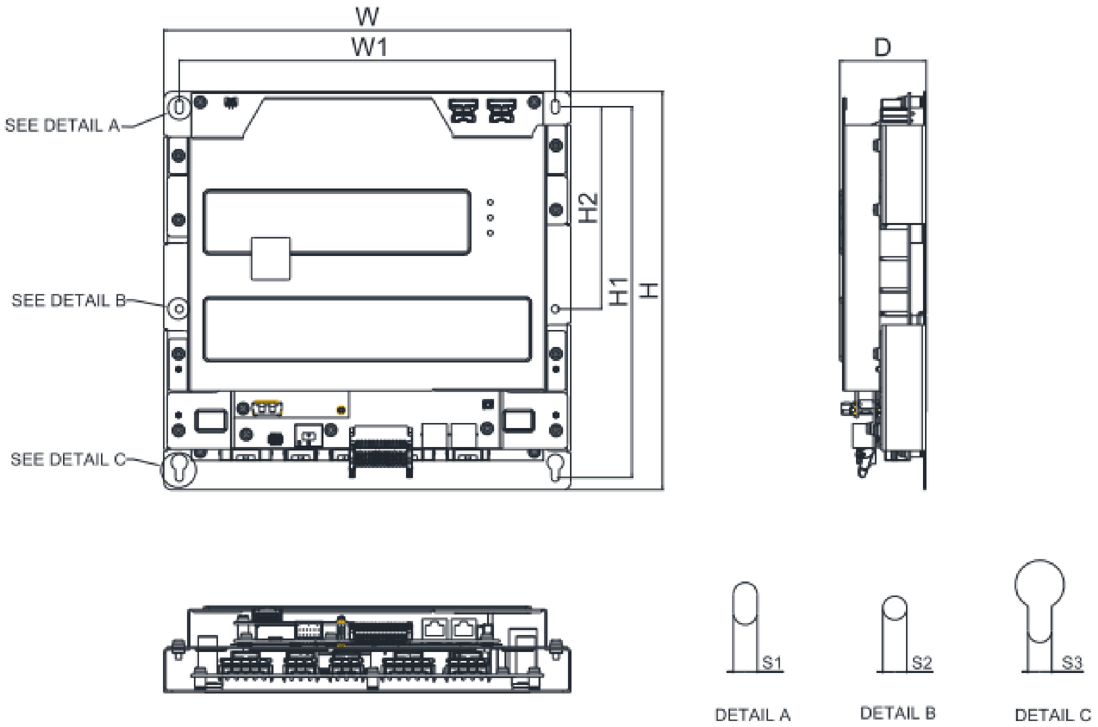
Note :

1. The signal lines should be shielded to avoid interference.
2. Signal lines must not be placed in the same conduit as power lines to prevent signal interference.
3. If the product is to be installed in harsh environments such as condensation, dust, etc., please install the product in an IP54-rated environment, such as a cabinet.
4. Please download the original technical manual from the official Delta Electronics website：

item	Content
File Name	DELTA_IA-MDS_C2000-HS_UM_TC_20210415.pdf
Language	English
File URL	https://filecenter.deltaww.com/Products/download/06/060101/Manual/DELTA_IA-MDS_C2000-HS_UM_TC_20210415.pdf

5.2.1 Controller module :

5.2.1.1 Controller module (MBC) outline：



DIMENSION: UNIT: mm [inch]

W	H	D	W1	H1	H2	S1	S2	S3
266 [10.48]	260 [10.24]	57 [2.25]	245.4 [9.67]	242.0 [9.53]	132.0 [5.20]	5.2 [0.21]	5.2 [0.21]	5.2 [0.21]

單位：mm [inch]

框號 B	W	H	D	W1	H1	H2	S1	S2	S3
控制模組	266 [10.48]	260 [10.24]	57 [2.25]	245.4 [9.67]	242.0 [9.53]	132.0 [5.20]	5.2 [0.21]	5.2 [0.21]	5.2 [0.21]

Figure 5-2 controller module outline and dimension

Note：The MBC (Magnetic Bearing Controller) is built inside the unit, and therefore has no external enclosure.

5.2.1.2 Description of Magnetic Controller Module Terminals：

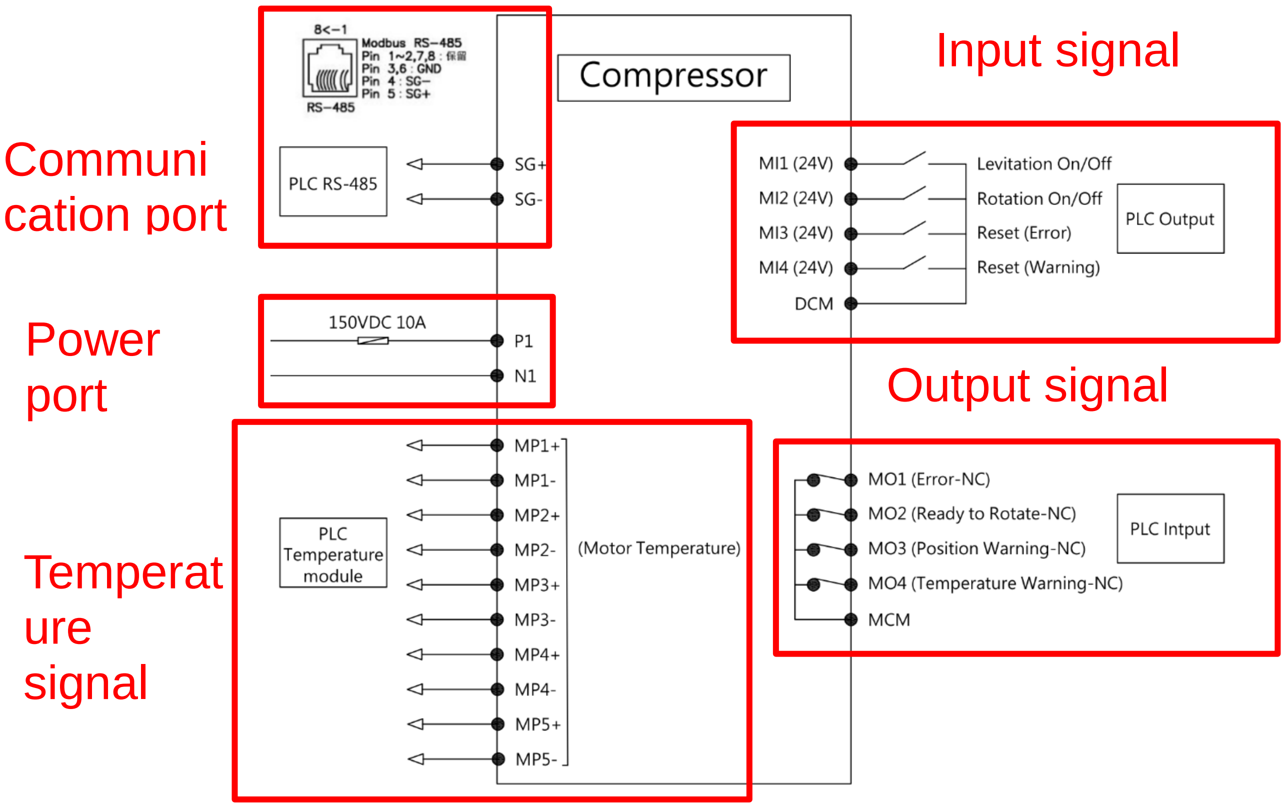


Figure 5-3 Controller module (MBC) connection port

5.2.1.3 Input Signal Terminals：

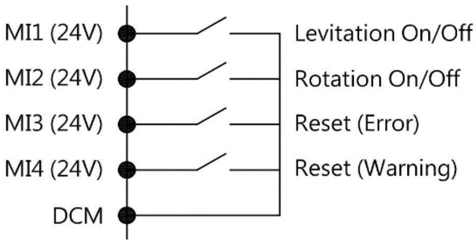


Figure 5-4 Magnetic Controller MI Terminal Diagram

Note: These I/O input signals are driven by 24VDC, and are used to control bearing levitation and reset warning/error signals.

Item	Port	Port condition	Bearing condition
Levitation	MI1 DCM	Open	Drop
		Closed	Levitate
Rotation / Operation	MI2 DCM	Open	Idle State
		Closed	Operating (Protection Active)
Reset	MI3(MI4) DCM	Open	No Action
		Closed (1s)	Reset / Restore

Table 5-2 Description of Magnetic Controller MI Terminals

5.2.1.4 Output Signal Terminals：

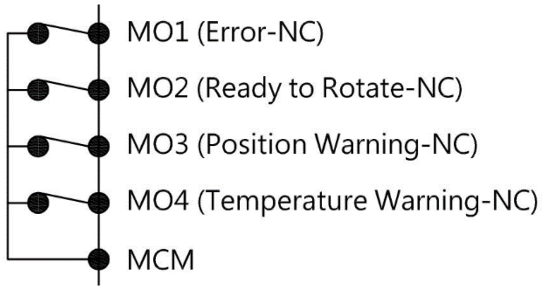


Figure 5-5 Magnetic Controller MO Terminal Diagram

Note: These I/O signals are dry contacts, used to indicate magnetic bearing status and warning conditions.

Item	**Port**	**Port condition**	**Bearing condition**
Error	MO1 MCM	Open	Alarm / Abnormal
		Closed	Normal
Ready to Rotate	MO2 MCM	Open	VFD not ready
		Closed	VFD ready
Position Warning	MO3 MCM	Open	Position warning
		Closed	Normal
Temperature Warning	MO4 MCM	Open	Bearing temperature warning
		Closed	Normal

Table 5-3 Description of Magnetic Controller MO Terminals

Note1. MO3 is for bearing position warning only and this port can be ignored. Compressor tripping is following MO1.

Note2. MO4 is for reference of high bearing temperature. The function of high bearing temperature protection is covered by MO1, hence, MO4 can be ignored.

5.2.1.5 Modbus Communication Parameters for Controller：

Item	MBC Parameter	Default	Setting Range
Communication address	09-00	1	1～254
Baud Rate	09-01	9.6	4.8~115.2Kbps
Communication Timeout	09-03	0.0	0.0~100.0 Sec
Communication Format	09-04	13	1：7、N、2 (ASCII) 2：7、E、1 (ASCII) 3：7、O、1 (ASCII) 4：7、E、2 (ASCII) 5：7、O、2 (ASCII) 6：8、N、1 (ASCII) 7：8、N、2 (ASCII) 8：8、E、1 (ASCII) 9：8、O、1 (ASCII) 10：8、E、2 (ASCII) 11：8、O、2 (ASCII) 12：8、N、1 (RTU) 13：8、N、2 (RTU) 14：8、E、1 (RTU) 15：8、O、1 (RTU) 16：8、E、2 (RTU) 17：8、O、2 (RTU)
Communication response delay time	09-09	2.0	0.0~200.0ms

Table 5-4 Modbus Communication Parameters of Magnetic Controller

Note: Above settings can be adjusted as per application requirement by keypad.

5.2.1.6 Magnetic Controller – Modbus Communication Address Description:

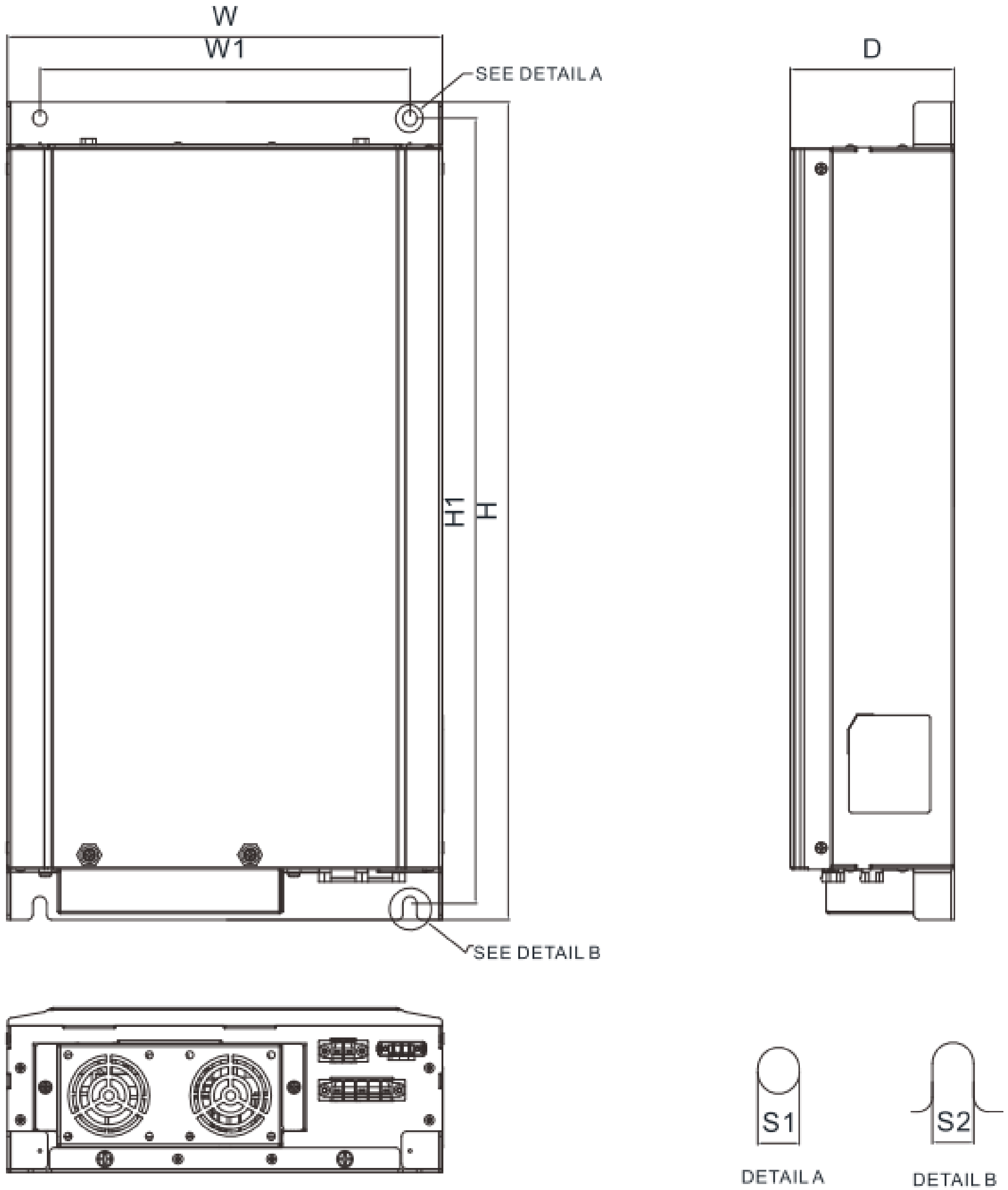
Type	Port Code	Description	
Control order	2000H	Bit1~0	00B : Non-function
			01B : Non-Levitation
			10B : Levitation
			11B : Non-function
		Bit5~4	00B : Non-function
			01B : Alarm clear
			10B : Alarm clear
			11B : Non-function
	2002H	Bit1	1 : Reset (Other bits should remain set to 0.)
Status information	2100H	High byte :Warn Code Low byte :Error Code	
	2101H	Bit1~0	00B : MBC stops
			11B : MBC in operation
	2108H	0 : Non-Levitation	
		1 : Levitation	
	2200H	Front bearing V: Position change of shaft (um)	
	2201H	Front bearing W: Position change of shaft (um)	
	2202H	Back bearing V: Position change of shaft (um)	
	2203H	Back bearing W: Position change of shaft (um)	
	2204H	Axial Position change of shaft (um)	
	2205H	Front bearing V1: Current (A)	
	2206H	Front bearing V3: Current (A)	
	2207H	Front bearing W1: Current (A)	
	2208H	Front bearing W3: Current (A)	
	2209H	Back bearing V2: Current (A)	
	220AH	Back bearing V4: Current(A)	
	220BH	Back bearing W2: Current (A)	
	220CH	Back bearing W4: Current (A)	
	220DH	Axial bearing Z1: Current (A)	
	220EH	Axial bearing Z2: Current (A)	
	220FH	Motor frequency (Hz)	
	2210H	DC bus voltage(V)	
	2212H	Switching element temperature (℃)	
	2215H	Front radial bearing temperature (℃)	
	2216H	Front axial bearing temperature (℃)	
	2217H	Back axial bearing temperature (℃)	
	2218H	Back radial bearing temperature (℃)	

Table 5-5 MBC Modbus Communication Address Table

Note1: Modbus communication is half-duplex and cannot perform read and write operations simultaneously.

Note2: Different bits at communication address 2002H have their respective functions. Therefore, when executing a reset, only Bit 1 can be commanded.

5.2.2 Power module (SPS) outline：

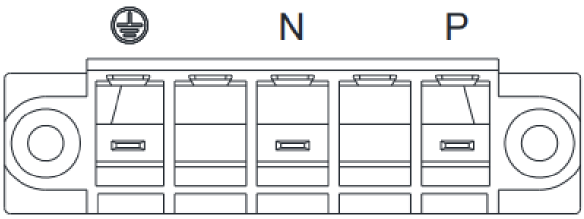


Frame	W	H	D	W1	H1	S1	S2
B	267.8 [10.54]	503.0 [19.81]	101.0 [3.82]	227.8 [8.97]	483.0 [19.02]	8.5 [0.35]	8.5 [0.35]

Figure 5-6 SPS Power module dimension

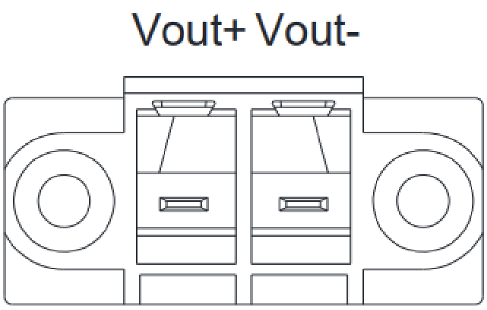
5.2.2.1 Power module connection :

Input Port:



Port Name	PIN	Description
Input Port	1	P
	3	N
	5	PE

Output Port:



Port Name	PIN	Description
Output Port	1	Vout-
	2	Vout+

- Input port :
  P terminal connect with VFD inverter DC+
  N terminal connect with VFD inverter DC-
- Output port :
  Vout+ is connected to control module terminal P
  Vout– is connected to control module terminal N

Note1. Refer to Figure 5-1 for wiring instructions.

Note2. It is recommended to add a 16A fuse to the input side to prevent power module damage caused by abnormal voltage input.

Note3. After shutting off power to the inverter, wait until the inverter's POWER indicator (located behind the digital keypad) turns off before reapplying AC power. This prevents power cycling within a short period, which may damage the equipment.

Note4. Before modifying wiring, the magnetic bearing controller power must be turned off. The internal DC filter capacitors require time to discharge. To ensure safety, use a DC voltmeter to confirm that the voltage has dropped below 25 VDC. Only then should wiring work begin. If sufficient discharge time is not allowed, residual voltage may remain inside the drive. Making connections at this point could result in a short circuit and visible sparking. To ensure personal safety, always perform wiring operations under a no-voltage condition.

5.3 VFD Terminals and Common Communication Parameters：

This section explains the wiring and parameter settings for the VFD and magnetic bearing controller (MBC) when connecting to a PLC

5.3.1 Inverter (VFD) connection instruction and parameter setting：

5.3.1.1 VFD Parameter Settings

The following terminal configuration uses external control signals. The inverter supports parameter settings for both AVI and ACI analog input types.

VFD Control Terminals	
Terminal	Terminal
FWD	Forward run
MI1	Fault reset
RA1	Fault output
RA2	Running output
AVI	Frequency command input
AFM1/AFM2	Output frequency

Table 5-6 VFD Control Terminals

VFD Parameter Settings		
Parameter	Parameter	Parameter
00-20	Frequency command source	2
00-21	Operation command source	1
02-01	Multi-function input 1 (MI1)	5
02-02	Multi-function input 2 (MI2)	0
02-13	Multi-function output 1 (RLY1)	11
02-14	Multi-function output 2 (RLY2)	1
02-12	Input mode selection	0
03-00	AVI analog input function	1
03-01	ACI analog input	0

	function	
03-20	AFM1 multi-function output	0
03-28	AVI input selection	0
09-00	Communication address	11
09-01	COM1 Baud rate	9.6
09-04	COM1 Format	13

Table 5-7 VFD AVI Parameter Settings

VFD Parameter Settings		
Parameter	Parameter	Parameter
00-20	Frequency command source	2
00-21	Operation command source	1
02-01	Multi-function input 1 (MI1)	5
02-02	Multi-function input 2 (MI2)	0
02-13	Multi-function output 1 (RLY1)	11
02-14	Multi-function output 2 (RLY2)	1
02-12	Input mode selection	0
03-00	AVI analog input function	0
03-01	ACI analog input function	1
03-23	AFM1 multi-function output	0
03-29	AVI input selection	0
03-31	Communication address	1
09-00	COM1 Baud rate	11
09-01	COM1 Format	9.6

09-04	Frequency command source	13

Table 5-8 VFD ACI Parameter Settings

Note1： To use 4–20 mA feedback, change the wiring to AFM2, set DIP switch to 0–20 mA (see Figure 5-7), and change parameter 03-31 to 1.

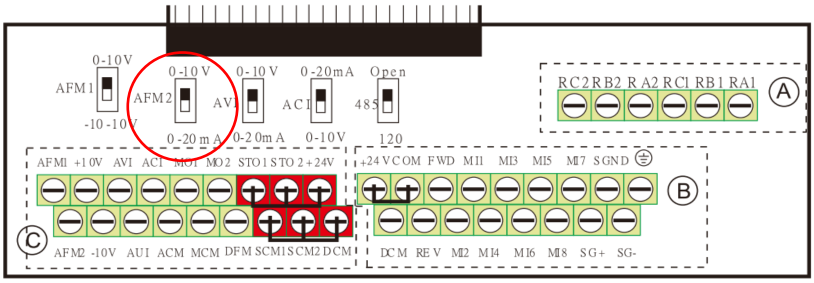


Figure 5-7 Control Terminal Wiring

Note2： To enable MODBUS control, change parameters 00-20 to 1 and 00-21 to 2.

5.3.1.2 MBC Parameter Settings

MBC Parameter Settings.

MBC Control Terminals	
Terminal	Description
MI1	Levitation
MI3	Fault reset
MI4	Special alarm reset
MO1	Fault indicator
MO2	Stable levitation indicator

Table 5-9 MBC Control Terminals

MBC Parameter Settings:		
Parameter	Parameter	Parameter
00-21	Operation command source	1
09-00	Communication address	12

09-01	COM1 Baud rate	9.6
09-04	COM1 Format	13

Table 5-10 MBC (Magnetic Bearing Controller) Parameter Settings

Note1: For MODBUS control, change 00-21 to 2.

5.3.2 VFD and MBC PLC Wiring Diagram

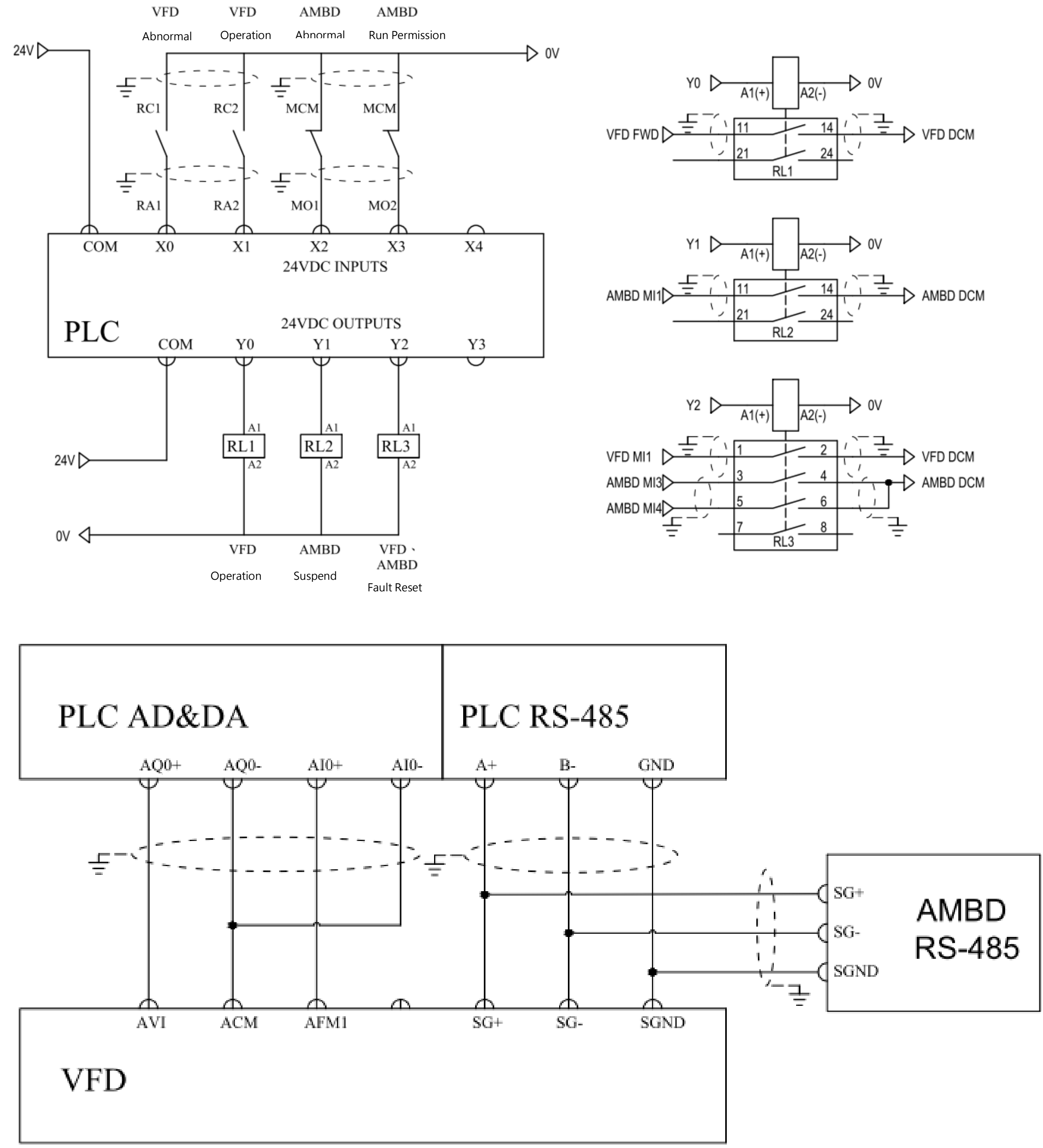


Figure 5-8 Wiring Diagram of VFD and Magnetic Contactor Connected to PLC (AVI Signal Wiring)

Note1: Both VFD and MBC signals are connected to the PLC. The VFD must only operate when the MBC indicates stable levitation (MO2 is active), to avoid compressor damage.

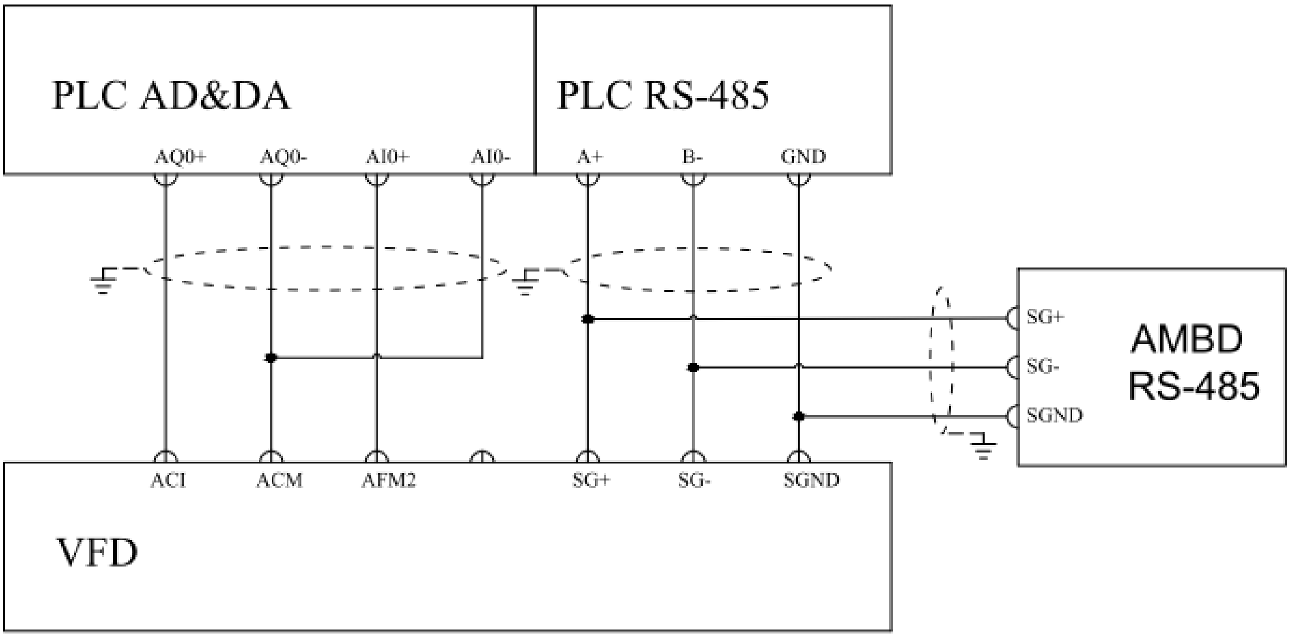


Figure 5-9 VFD ACI Wiring Diagram

5.3.3 VFD Modbus Communication Parameters：

Parameter Name	Parameter	Default	Setting range
Communication Address	09-00	1	1 ~ 254
Communication Baud Rate	09-01	9.6	4.8~115.2Kbps
Communication Error Handling	09-02	3	0: Warn and continue operation 1: Fault and ramp to stop 2: Fault and coast to stop 3: No warning, no fault and continue operation
Communication Timeout Detection	09-03	0.0	0.0~100.0 秒
Communication Format	09-04	13	1 : 7 · N · 2 (ASCII) 2 : 7 · E · 1 (ASCII) 3 : 7 · O · 1 (ASCII) 4 : 7 · E · 2 (ASCII) 5 : 7 · O · 2 (ASCII) 6 : 8 · N · 1 (ASCII) 7 : 8 · N · 2 (ASCII) 8 : 8 · E · 1 (ASCII) 9 : 8 · O · 1 (ASCII) 10 : 8 · E · 2 (ASCII)

			11 : 8 · O · 2 (ASCII) 12 : 8 · N · 1 (RTU) 13 : 8 · N · 2 (RTU) 14 : 8 · E · 1 (RTU) 15 : 8 · O · 1 (RTU) 16 : 8 · E · 2 (RTU) 17 : 8 · O · 2 (RTU)
Communication Response Delay Time	09-09	2.0	0.0~200.0ms

Table 5-11 VFD Modbus Communication Parameter Table

Note: Communication format settings can be configured via the keypad or with assistance from Hanbell technical personnel.

5.3.4 Frequently Used Modbus Communication Addresses for Inverter (VFD) :

Type	Communication Address	Function Description	
Control Requirement	2000H	Bit1~0	00B : No function
			01B : Stop
			10B : Run
			11B : JOG RUN
		Bit5~4	00B : No function
			01B : FWD
			10B : REV
			11B : Alternating Rotation Command
	2001H	Frequency command (Hz)	
	2002H	Bit1	1 : Reset (Other bits should remain set to 0.)
Status information	2100H	High byte :Warn Code Low byte :Error Code	
	2101H	Bit1~0	00B : VFD stops
			11B : VFD operating
	2102H	Frequency command (Hz)	
	2103H	Output Frequency (Hz)	
	2104H	Output current (A).	
	2105H	DC bus voltage (V)	
	2106H	Output voltage (V)	
	210FH	Power output (kW)	
	2200H	Output Current (A) (same as register 2104H)	
	2202H	Output Frequency (Hz) (same as 2103H)	
	2203H	DC Bus Voltage (V) (same as 2105H)	
	2204H	Output Voltage (V) (same as 2106H)	
	2206H	Display actual motor speed kW of U, V, W (kW)	
	2224H	Display Maximum Output Frequency of VFD (kHz)	
	223FH	Display Ke Value	

Table 5-11 VFD Modbus communication port list

Note1: Modbus communication is half-duplex and cannot perform read and write operations simultaneously.

Note2: Each Bit in communication register 2002H has its own function; therefore, only Bit 1 can be set when executing Reset.

Note3: For inverter firmware versions prior to v9.107, Ke value reading must be done via 2236H. However, some older firmware versions may not support reading Ke through channel 2236H. In such cases, set inverter parameter 00-04 to 54, then use channel 2116H to read the value, or contact inverter supplier personnel for firmware upgrade. For firmware version v1.07 and above, the Ke value can be read via 223FH. If using version v9.107 or above.

5.4 Inspection Method of Inverter：

The capacitance might be fully discharged if the inverter is shut down for a long while. Hence, the component might be damaged if the inverter is inputted power without any inspection. Therefore, the inspection procedure is mandatory.

- Inspection Target: VFD
- Inspection Tool：A multimeter with a diode test mode (symbol：⊣▷⊢)
- Inspection Procedure：
  1. Completely power off the VFD.
  2. Disconnect the power cable on point R, S, T on primary and U, V, Won secondary and DC bus.
  3. Switch to diode measurement mode.
  4. Use a multimeter to measure the continuity of the primary side R, S, T points and the secondary side U, V, W points with the direct current bus P, N points. The diagram below is a simplified circuit diagram of the inverter for reference.

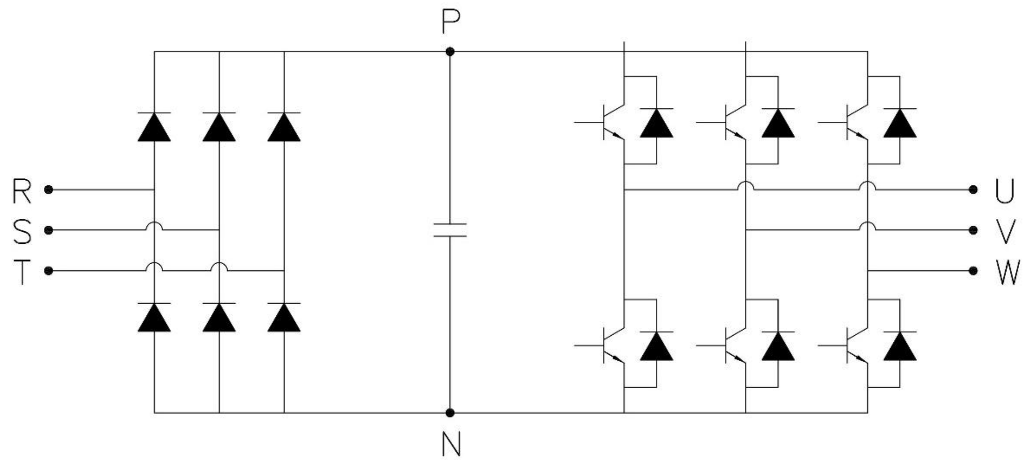


Figure 5-11 Inverter electrical circuit

5. Measure the port as the following table.

Primary			Secondary		
Polarity		Status	Polarity		Status
Positive(+)	Negative(-)		Positive(+)	Negative(-)	
R	P	Conducting	U	P	Conducting
S	P	Conducting	V	P	Conducting
T	P	Conducting	W	P	Conducting
R	N	Not Conducting	U	N	Not Conducting
S	N	Not Conducting	V	N	Not Conducting
T	N	Not Conducting	W	N	Not Conducting
P	R	Not Conducting	P	U	Not Conducting
P	S	Not Conducting	P	V	Not Conducting
P	T	Not Conducting	P	W	Not Conducting
N	R	Conducting	N	U	Conducting
N	S	Conducting	N	V	Conducting
N	T	Conducting	N	W	Conducting

Table 5-12 VFD inspection table

6. When conducting measurements, different brands of multimeters may produce varying readings, but the measurements of each phase should be similar. If the measured values are significantly different, it indicates the inverter is faulty. In general, the primary side is a rectifier module, and the secondary side is an VFD module, so the readings measured on the primary and secondary sides will also differ.
7. If the measurement results are abnormal, you may try charging the DC bus before re-measuring. The charging method varies depending on the VFD brand.
   If unsure, please refer to the technical manual or user guide of the specific VFD.
   If abnormalities persist after charging, please contact the original manufacturer for inspection.

5.5 Lifetime of Magnetic Bearing and MBC：

The lifetime of magnetic bearing and MBC is designed for more than 10 years

In order to make sure magnetic bearing and MBC are working properly, it is required to carry out dust cleaning every 3 year：

- Clean the dust on the PCB board of MBC to prevent short circuits and MBC failure.
- Clean the dust on MBC cooling fan and heat sink, to prevent MBC overheating due to fan blockage or poor heat dissipation.
- The magnetic bearings are installed inside the compressor and does not require additional maintenance.

Must follow the operation requirement of environment：

- Operation temperature： +5℃ ~ +40℃ (free convection)
- Relative humidity：30% ~ 70%
- Altitude：Lower than 1,000 meters

5.6 Troubleshooting：

Please contact Hanbell representative for MBC troubleshooting.

5.7 Unconventional Site-Specific Requirements：

5.7.1 High Power Factor and Low Harmonic Distortion Requirements：

Due to the application of VFD may decrease the power factor and generate harmonic distortion then affecting the quality of power supply, it is recommended to install active harmonic filters to improve power quality if there are power quality requirements at jobsites.

The RTM Series is recommended to be operated with Delta Electronics APF3000 Series active harmonic filters. The specifications are as shown below：

Model	APF Selection	CT Selection
RTM-030	APF130B43N-20	CT-C1000*3
RTM-050	APF200B43N-20	
RTM-070	APF130B43N-20 x 2	
RTM-090 RTM-100	APF170B43N-20 x 2	
RTM-120	APF200B43N-20 x 2	
RTM-140	APF170B43N-20 x 3	
RTM-180	APF170B43N-20 x 4	

Table 5-13 APF Selection Table

If there is a need for active harmonic filters, please contact Hanbell.

5.7.2 Unstable Power Quality Application：

The power supply of magnetic bearing controller is provided by the inverter, which is not only supplying power but also providing dEb protection function (deceleration energy backup). It prevents from sudden power failure then magnetic bearings falling suddenly at high speed.

However, when the power quality at sites is unstable or multiple large fixed-frequency units share the same power supply, the dEb protection function may be triggered by momentary voltage drops, then leading to VFD trips.

To avoid frequent triggering of dEb protection function, customers can install an external UPS (Uninterruptible Power System) instead of the dEb to provide power to the magnetic bearing controller to solve the problem.

UPS configuration can be referenced in the following diagram :

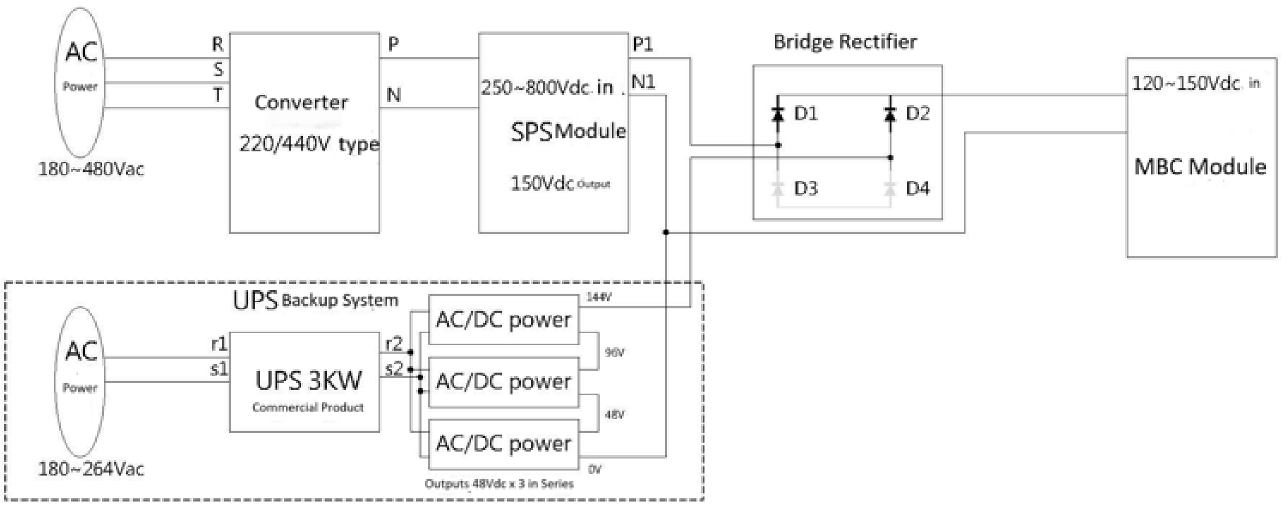


Figure 5-12 External UPS Circuit Configuration Diagram

After setting up the UPS system, the dEb function of the inverter needs to be disabled by setting the inverter parameter Pr 07-13=0 to turn off the dEb function.

In most cases where power quality is unstable, power quality issues may cause the compressor to fail to operate properly. These issues can usually be resolved by adjusting the inverter parameters to eliminate abnormal shutdowns. Please be sure to consult Hanbell's service personnel to assist with evaluating and providing solutions. If compressor malfunctions or damages occur due to improper parameter settings or unapproved procedures, such situations will not be covered under warranty.

5.8 Interference Prevention Suggestions：

5.8.1 Inverter and Magnetic Controller Wiring (Shielding Suggestions)

- All power cables must be effectively separated by wire type, and routed in separate areas, or isolated using metal layers/metal conduits inside the control cabinet.
  In particular, sensitive control cables must maintain uninterrupted spacing from wires in other areas. It is recommended to divide into four classes (Class 1~4) as follows: :
  a. Class 1 - Highly sensitive to EMI, such as low-voltage high-speed signal lines, control lines, communication cables, and data cables.
  b. Class 2 - Susceptible to EMI, such as low-speed communication lines and low-voltage (24V) power cables.
  c. Class 3 - EMI-emitting cables, such as VFD input power cables.
  d. Class 4 - Strong EMI sources, such as VFD motor output cables.
- According to the above classification, the recommended separation distances between different types of cables are shown in the diagram below：

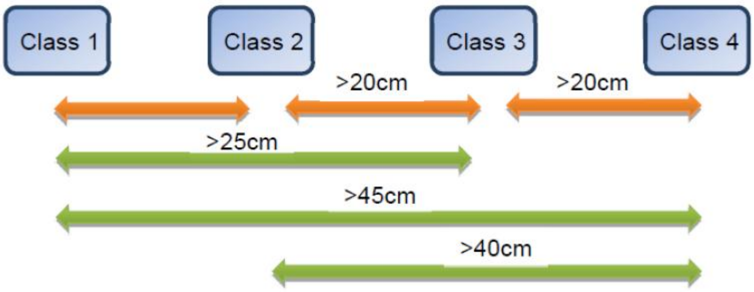


Figure 5-13

- When the distance requirement cannot be met, please install zero phase reactor on Class 4. Use shielded cable or ferrite core filter on Class 1 lines that are easily affected by interference
- When the separation distance between different cable types cannot be maintained, cables must be laid out in orthogonal (90°) directions. For example, signal lines, data lines, and filtered power cables must be routed at right angles to unfiltered power lines to reduce cross-talk and interference.

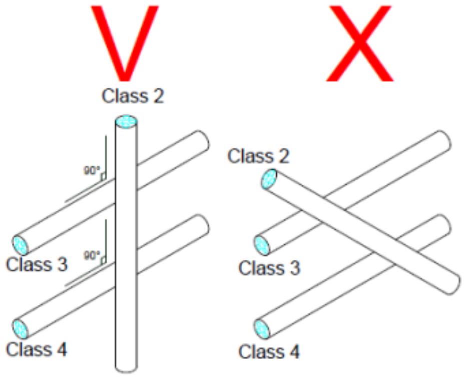


Figure 5-14

- All wiring must be kept as short as possible.
- Remove any excess conductors or ground both ends to avoid floating grounds.

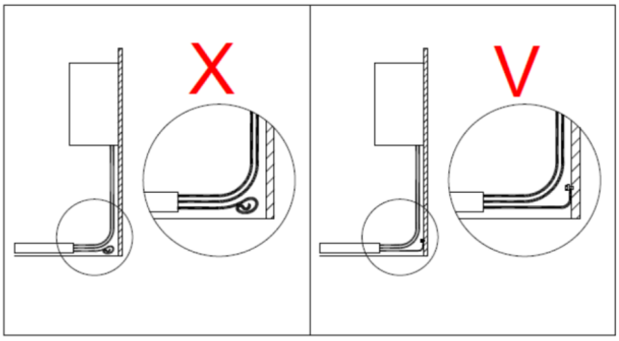


Figure 5-15

- Motor cables must be kept away from other data lines connected to the motor (e.g., encoder line or motor temperature sensor line, etc.).
- Power cables should not be suspended in the air and should be laid flat on a metal surface.
- For equipment that is easily affected by interference, it is recommended to isolate the inverter separately and keep it away from strongly interfering equipment.

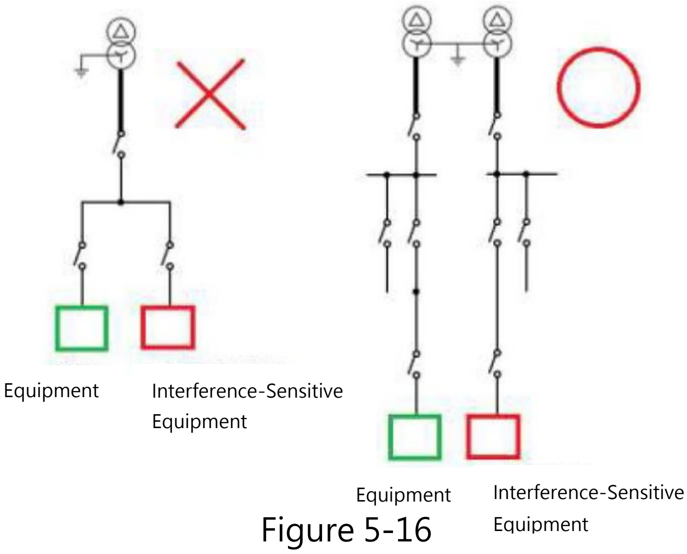
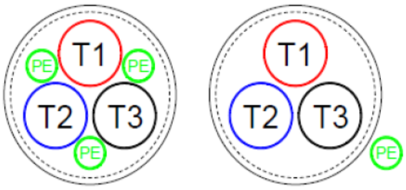


Figure 5-16

- For contactor circuits, relays, and solenoids, RC snubber circuits must be installed to suppress high-frequency interference generated when switching components are turned off (such as RC elements or varistors with AC coils and free-wheeling diodes or varistors for DC coils). These protective circuits must be installed close to the coil.

5.8.2 Compressor (Interference Suppression Recommendations)

- It is recommended to use isolated motor cables.



Recommended Shielded Cable Configurations. The left diagram shows a symmetrical three-phase power line with a symmetrical PE line. The center diagram shows a three-phase power line with a separated PE line. The right diagram shows an asymmetrical three-phase power line with a PE line.

Figure 5-17

- Shielded cable grounding methods
  a. It is recommended to ground the shielding layer at both ends, with a large contact area to ensure reliable grounding. The grounding point should be located as close as possible to where the cable enters the electrical panel. It is recommended to use Ohm clamps for ring-type grounding.

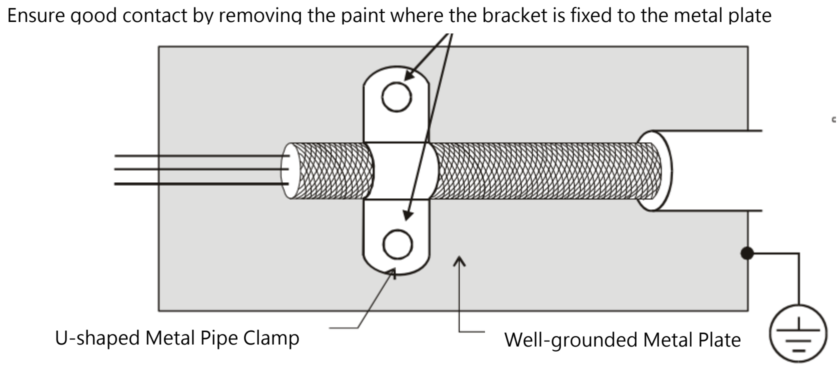


Figure 5-18

  b. The shorter the distance between the shielding layer and the PE grounding point, the better. Low-inductance connections should be used to reduce impedance.
  c. Use shielded cable glands to ensure effective shielding performance.

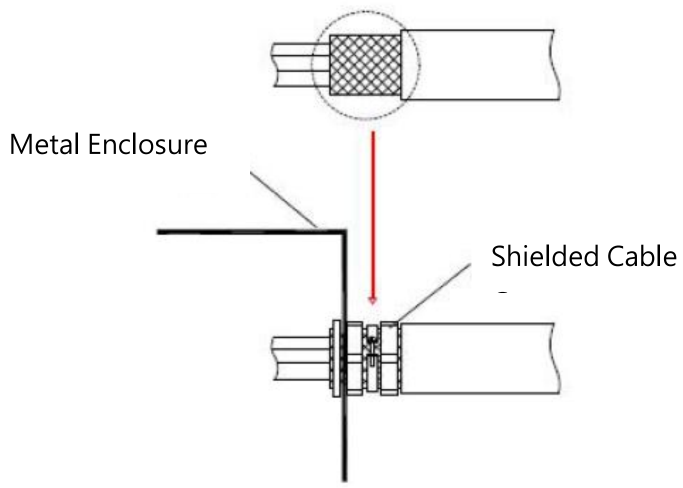


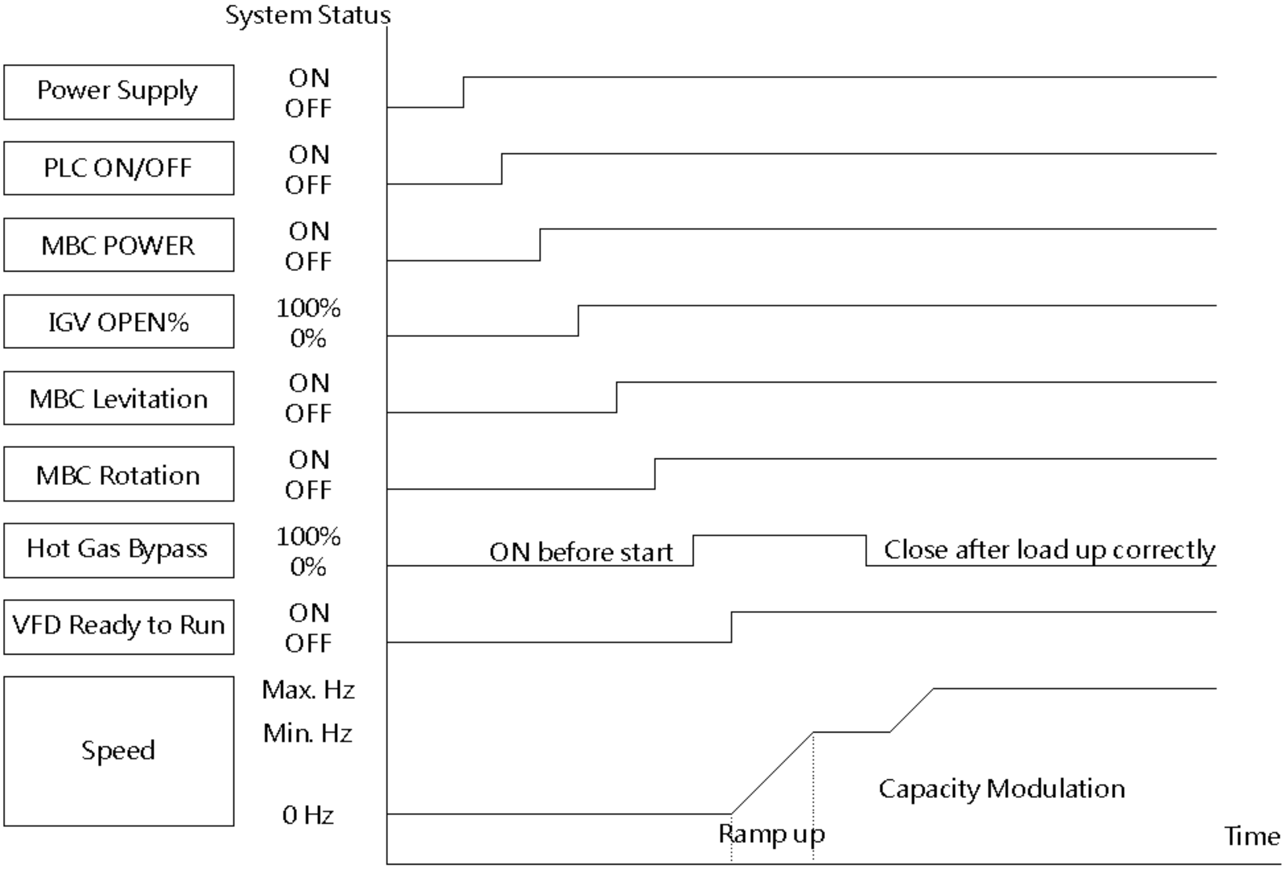
Figure 5-19

d. When using shielded cables with a zero-phase reactor, do not route the shielding layer through the reactor. Ground the shielding layer at the shortest possible distance.

- Supplemental Notes on Zero-Phase Reactors
  a. Since high currents pass through the power input/output cables, care must be taken to avoid magnetic core saturation.
  b. Composite magnetic powder cores are currently the most ideal material. They support higher frequency applications and can provide high impedance by increasing the number of turns.
  c. When installing, place the zero-phase reactor as close to the VFD output side as possible. If the cable diameter allows, wrap multiple turns through the core. The more turns, the better the noise suppression effect.
  d. The normal operating temperature of a zero-phase reactor must be below 85°C (176°F). If the reactor becomes saturated, its temperature will rise. If it exceeds 85°C (176°F), increase the number of zero-phase reactors used.

6. Compressor Control Sequence：

6.1 Start Sequence：



Note：Ramp-up rate : 0.02 x Max. Hz/s

Figure 6-1 Start sequence

Note：

1. If there are control requirements related to turning on/off the thermal air circulation, please contact Hanbell personnel.
2. Max. Hz refers to the rated speed of the compressor. Please refer to the specification table of the compressor series in Chapter 2.3.
3. Min. Hz refers to the minimum operating speed calculated through the noise vibration formula. The speed must not be lower than the minimum speed specified for each compressor model.

6.2 Shutdown Sequence：

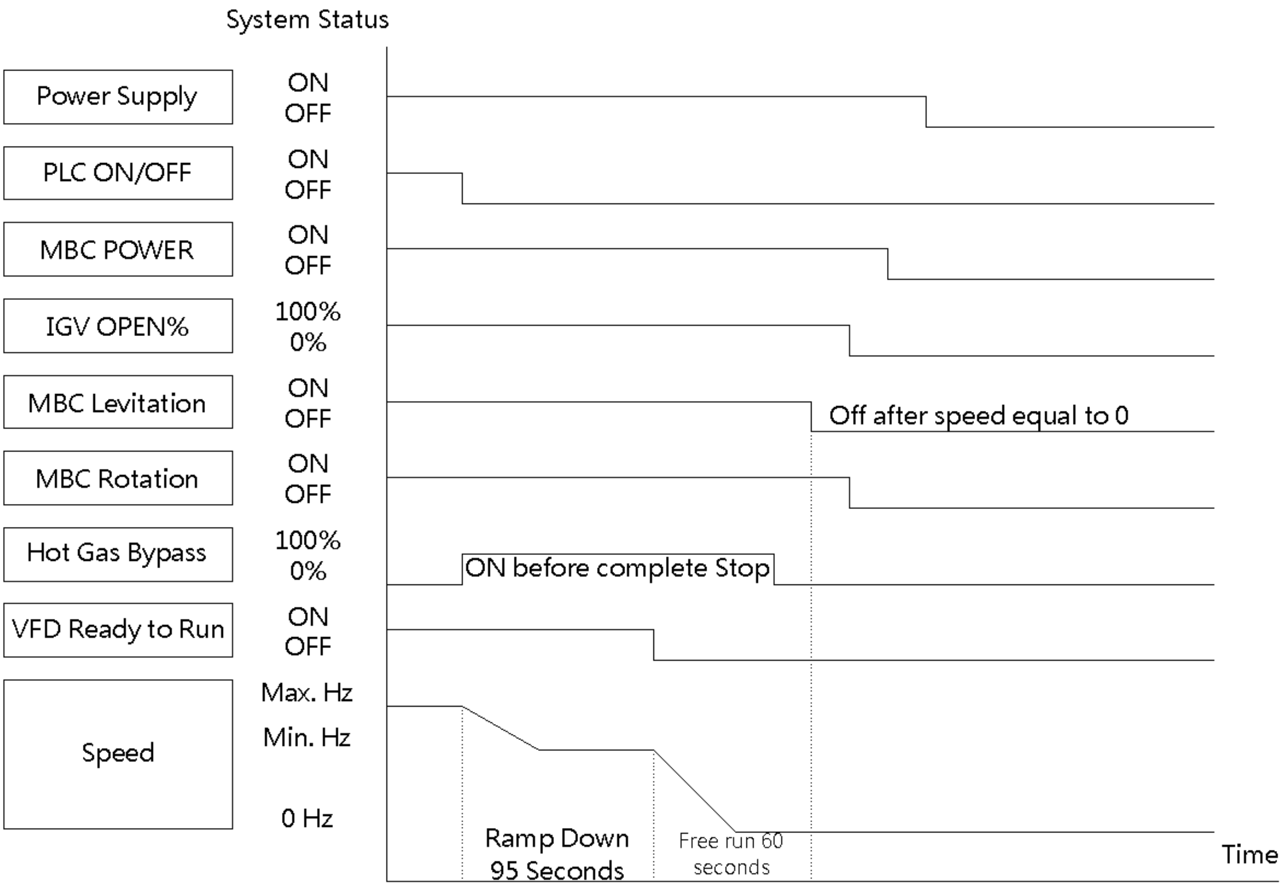


Figure 6-2 Shutdown sequence

Note：

1. The compressor must be ensured to have fully decelerated to zero speed before the MBC levitation command is released (OFF).
2. The recommended deceleration time is 95 seconds, which may be increased depending on site conditions. During compressor deceleration, the rotation speed, should be reduced as much as possible to shorten the free-stop time. When the deceleration time ends, the inverter will immediately stop outputting the speed command, allowing the compressor to enter free stop.
3. Compressor shutdown must be done by directly cutting off the rotation command, allowing the compressor to freely stop. It is not allowed to send a speed-zero command to stop the compressor. If a speed-zero command is sent, the deceleration rate will be limited by the inverter setting. This may result in a prolonged low-speed operation which may result in compressor surge and damage.
4. After free stop, at least 60 seconds wait is required before turning off the MBC levitation command (levitating OFF).
5. When stopping, the IGV must be adjusted to the fully open position so that the minimum compressor speed can be minimized.

6.3 VFD/AMBD- Pre-Startup Testing：

1. Confirm that all VFD/AMBD parameters and wiring have been properly configured.
   - Verify the phase sequence on both the input and output sides of the VFD; ensure there are no phase-to-phase short circuits and that all wiring is secure and correct.
   - Confirm that the VFD's DI/DO/AI/AO and the AMBD's DI/DO, communication ports, sensor connectors, electromagnetic connectors, and power connectors are all correctly and securely connected.
   - Check VFD/AMBD operation control parameters.
   - Check VFD/AMBD communication parameters (Group 09: 09-00, 09-01, 09-04).
   - Ensure the relevant DI/DO/AI/AO parameters on the VFD are properly set.
   - Confirm that the VFD's 00-20 (frequency command source) and 00-21 (operation command source) are set according to application requirements.
   - Confirm that the AMBD's 00-21 (operation command source) is also correctly set.
2. It is necessary to confirm whether the compressor rotation direction matches the design direction. The confirmation methods are as follows：
   a. Method 1: Via upper-level controller (PLC)
      - Activate magnetic bearing levitation.
      - Manually open the IGV, hot gas bypass, and high/low-pressure expansion valves.
      - Issue a speed command to the VFD (set to 2 Hz) and initiate a start/stop cycle. Observe the rotor direction through the motor end cap viewing window—it should rotate clockwise.
      - After confirmation, reset all system settings to default values.
   b. Method 2: If PLC operation is not available, perform the test using the VFD keypad.
      - Disconnect the keypad from the VFD and connect it to the RJ45 port on the AMBD that provides internal power using a network cable.
      - Configure AMBD parameters via the keypad; set 00-21 to 0 (digital operator mode), then press Run to activate levitation.
      - Reconnect the keypad to the VFD, set 00-20 to 0 (frequency input from keypad), and 00-21 to 0 (operation from keypad).
      - Then, use the keypad to set VFD speed to 2 Hz and perform start/stop. Observe rotor direction through the motor end cap viewing window—it should rotate clockwise.
      - After confirmation, revert AMBD parameter 00-21 and VFD parameters 00-20 and 00-21 to their required settings.

c. If the compressor rotates in the wrong direction, it is recommended to check the following：

- Whether the phase sequence of the VFD primary side/secondary side is correct.
- Whether the VFD wiring is set for forward rotation startup.

7. Compressor lifting and installation :

7.1 Compressor Hoisting :

- When hoisting the compressor, it is recommended to use the lifting lugs or slings as shown in Figure 7-1, or slings capable of bearing a load of 2,500 kg.
- Ensure that the lifting lugs or slings are securely fixed at the appropriate positions on the compressor. During hoisting, the compressor must be kept level to prevent any damage to the compressor or its components.

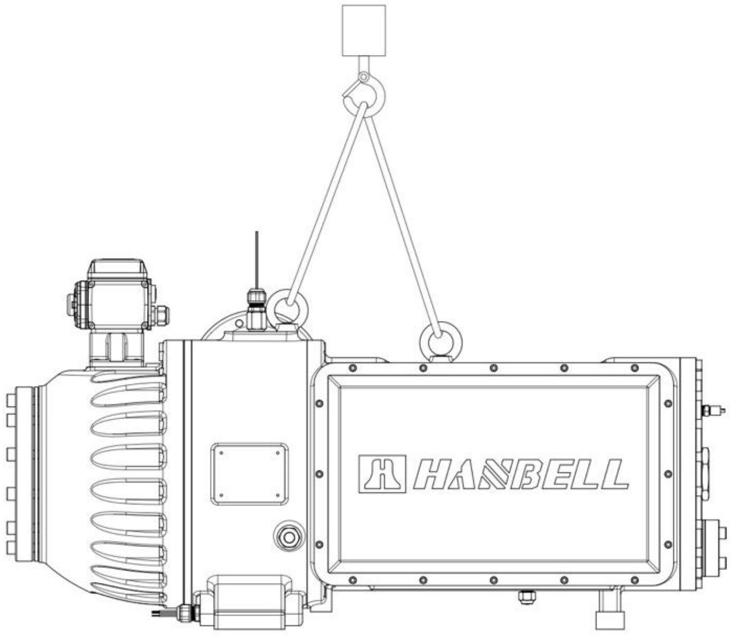


Figure 7-1 Lifting compressor

7.2 Compressor Installation-:

- The compressor should be installed in a well-ventilated, non-humid environment near the power supply.
- The compressor must be installed on a solid and level surface to prevent vibration and noise during operation. Sufficient maintenance clearance must be reserved, with at least 600 mm of space around the unit.
- The compressor mounting base must be installed level and equipped with anti-vibration pads. As shown in Figures 7-2 and 7-3, the anti-vibration pads should be compressed to a slight degree during installation to ensure firm and stable support.

Note : The installation height of the compressor must be higher than the evaporator, and the base of the compressor must also be higher than the liquid level of the economizer. This is to prevent backflow of refrigerant into the compressor and additional pressure differences in the piping due to liquid column height.

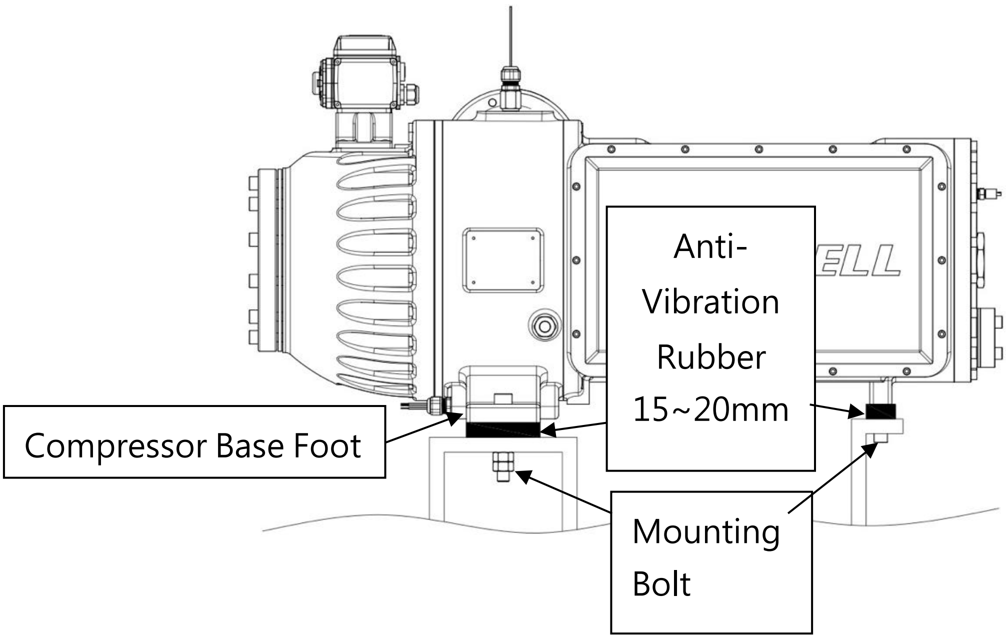


Figure 7-2 Compressor Base Installation (Without Foot Plate)

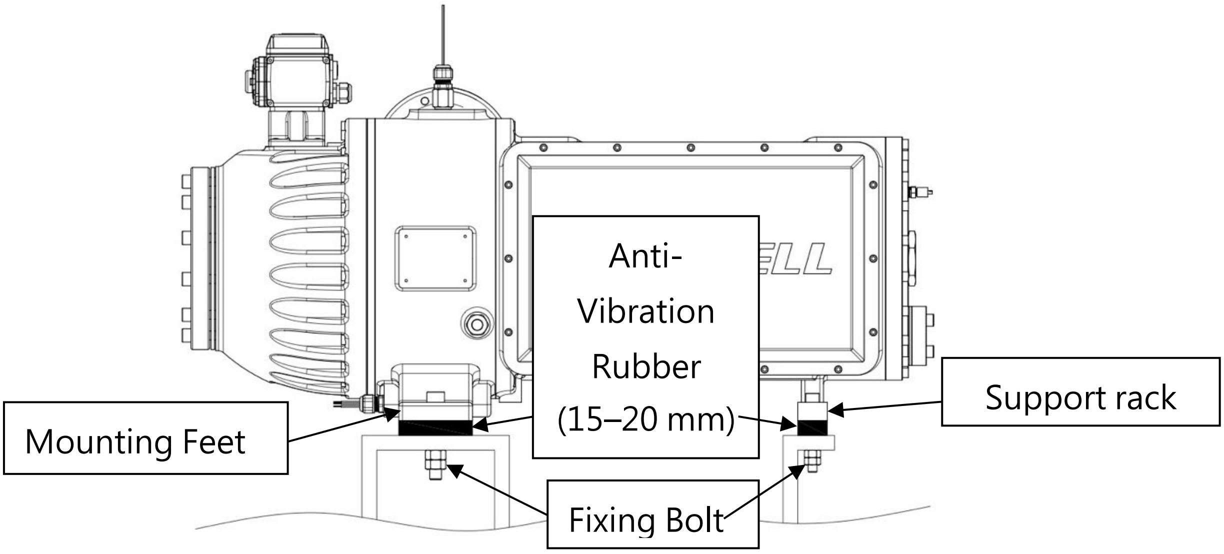


Figure 7-3 Compressor Base Installation (With Foot Plate)

8. Instruction Notes :

8.1 Compressor Accessories :

To meet different user requirements, our company has specially designed a complete set of standard and optional accessories for users to choose from, ensuring smooth and stable compressor operation and maximum performance. During the first unpacking, please check whether the accessories listed below are complete. If any items are missing or incomplete, please contact your Hanbell sales representative.

● : Standard 、△ : Optional

Models and Accessory	● : Standard △ : Optional	Remark
Suction & Discharge Connection Flanges	●	
Economizer Connection Flanges	●	
IP54 Terminal Box	●	On compressor
Discharge Temperature Sensor(Pt100)	●	
Anti-vibration Pads	△	
Shut-off Butterfly Valve (Discharge)	△	
Discharge Check Valve (Dual Flap Type)	△	
VFD	●	
EMI/EMC filter	△	
AC Input Reactor	△	
Input Zero-Phase Reactor	△	
Output Zero-Phase Reactor	●	
AC Output Reactor	△	
DC Fuse (600V/20A)	△	
APF Active Power Filter	△	
UPS Magnetic Controller Backup System	△	
Insulation Cover	●	Suction, intermediate,

		discharge,

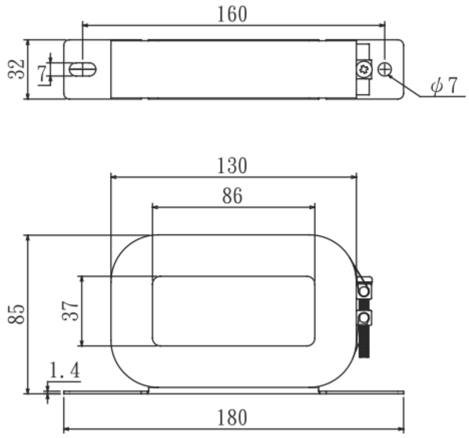
Table 8-1 Accessories List

Note： If there are any optional items required, please contact HANBELL to have further specification and prices information.

8.1.1_Model and Appearance of Zero-Phase Reactor

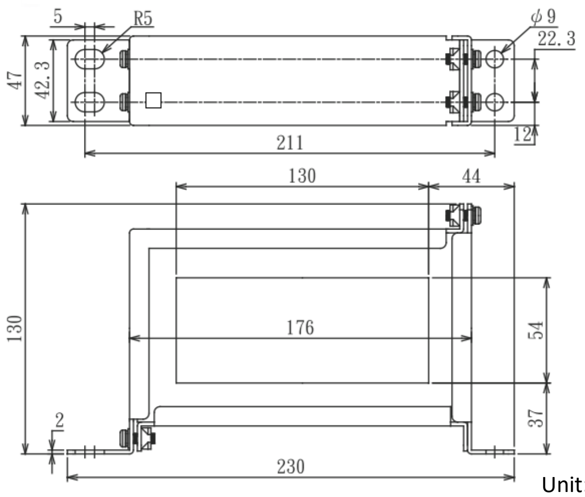
Model	Zero-Phase Reactor Specification	
	Brand	Model Number
RTM-030	Ningmao	RFI-02
RTM-050		RFI-03
RTM-070		RFI-04
RTM-090		RFI-04
RTM-100		RFI-04
RTM-120		RFI-04
RTM-140		RFI-04
RTM-180		RFI-04

RFI-02 Dimension Drawing



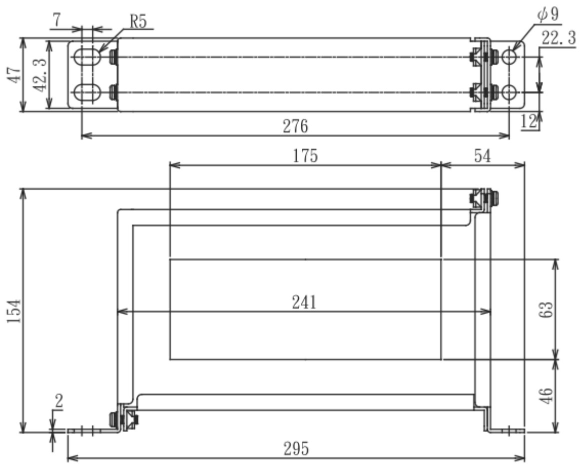
Unit: mm

RFI-03 Dimension Drawing



Unit: mm

RFI-04 Dimension Drawing



Unit: mm

8.1.2_Waterproof D-SUB Connector

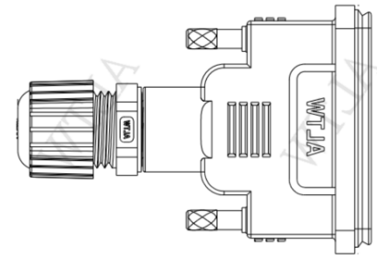


Figure 8-1 Waterproof Connector

- The signal cable connector for the magnetic bearing control board uses the waterproof connector shown in Figure 8-1. During installation, a flat-head screwdriver should be used to tighten the connector, followed by a torque wrench set to 3.5 kgf/cm to prevent abnormalities in motor temperature or control signals.

8.2 Related Components :

- When the compressor leaves the factory, all components on the main unit are turned off. Before startup, users must confirm that all components are properly activated.
- Carry out IGV actuator calibration and opening test:
  Confirm 0%~100% (input signal is 4~20mA or other signal specification) operation is normal, and IGV opening should be to 100% during compressor start-up.
- HGBP and Intermediate Pressure Shut-off Valve test: check 0 ~ 100% opening, and both valves should be to 100% during compressor start-up.

8.3 Pre-Power-On Inspection :

- Confirm that the voltage supplied to the compressor from the VFD is correct.
- Confirm that the power supply to the magnetic bearing controller (DC 300~750V) is correct and all alarms are reset. Carry out communication check by sending levitation command using the controller.

Note1. The compressor is prohibited from operating during self-check, including under vacuum conditions.

Note2. If the magnetic controller has been powered off for an extended period, it must be powered on and the rotor levitated for 4 hours before starting the compressor. During the charging period, the shaft must remain levitated but must not rotate. The components that require charging include the magnetic controller and the power module. Due to prolonged power disconnection, the capacitors in the circuit may be fully discharged. If the compressor is started directly, the bearings may fail to operate correctly. Therefore, pre-charging with rotor levitation is necessary to allow full capacitor charging in the circuit.

Note3. If the inverter has been powered off for a long time, the internal capacitors may have insufficient voltage, resulting in performance degradation. Therefore, it is recommended to energize once every 2 years for 3 to 4 hours to restore the capacitor's capacity and ensure the inverter operates normally. If it has not been charged for more than 2 years, the internal capacitors may be fully discharged. If powered on directly, there is a risk of damage. Therefore, it is necessary to use a transformer to reduce the voltage to 70%–80% of the rated voltage and charge for 1 hour, then restore to rated voltage and charge for another 3 hours to recover capacitor performance and ensure the inverter functions normally.
(Compressor operation is prohibited during the charging period.)

8.4 System requirement :

- The system piping should be kept clean, and there should be no welding slag or rust inside the piping, or it may cause compressor damage.
- A proper-size check valve must be installed in the discharge piping and the selected valve should ensure minimum pressure drop. Since the pressure and temperature in the discharge line can be high, the selected check valve should be relatively durable and made of materials with verified reliability.
- If the compressor is installed in a humid environment, appropriate protective and anti-moisture measures must be taken.
- If the compressor is not used for a long time, especially during winter, refrigerant may condensing into the compressor. Check the inspection window before starting to ensure no liquid refrigerant accumulating in the compressor. The liquid refrigerant can be drained back to evaporator by using the angle valve at the bottom of compressor.
- If maintenance requires disassembly of the compressor motor, after disassembly and before reassembly, the inside of the motor and windings should be thoroughly dried to prevent condensation or moisture that could lead to winding short circuits and internal rusting of the compressor.

8.5 Control requirement :

- Frequent start/stop of the compressor is not allowed. To prevent high temperature in the motor, it is recommended to set a minimum restart interval of 10 minutes.

- After the inverter is powered off, ensure full discharge of the inverter capacitor before restarting to prevent damage from inrush current.
- When installing pressure sensors for suction/discharge pressure, the installation location should be as close as possible to the suction/discharge port of the compressor. Do not install the sensor at a point where pressure drops due to elbows or valves, or the calculation of operating pressure ratio may deviate and affect compressor performance.

Appendix 1: Damper Actuator Settings Description：

Actuator Basic Specifications：

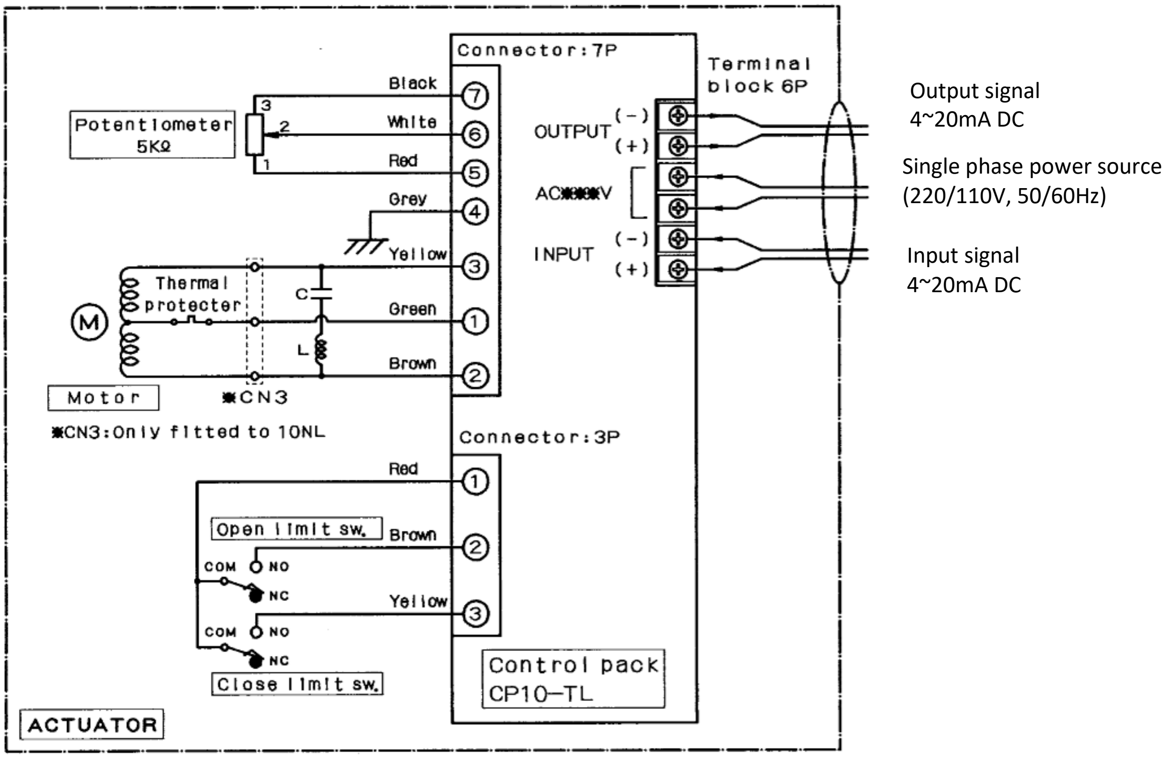
Input Signal	1Phase，AC 220V±10%(50/60Hz) 1Phase，AC 110V±10%(50/60Hz)
Output Signal	4~20mA·DC；1~5V·DC
Output Torque	4~20mA·DC
Operating Time	49N·m(5kgf·m)
Control Angle	15sec(50Hz)；12.5 sec(60Hz)
Operating Mode	0~90°
Resolution	Continuous operation (100%)
Dead Zone	1/250 (approx. 0.5%) Minimum input variation: 0.064mA
Protection	Within 0.5%
Operating Temperature	Thermostat (120°C)
Rated Current	-25~+55℃
Motor Output Power	0.4A(220V)；0.7A(110V)
Motor Insulation	20W
Motor Dielectric Strength	Class E
Withstand Voltage	500V·DC/100MΩ
Conduit Port	1500VAC/1 minute
Enclosure	G1/2×2
Weight	NEMA-4X (IP-66)
Input Signal	4.5kg

Actuator Basic Specifications Table

Note： When the operating environment is below 0°C, it is necessary to install a built-in space heater to prevent condensation and maintain internal temperature. This avoids issues caused by internal moisture condensation or freezing during startup in low-temperature and high-humidity environments, which can result in actuator malfunction or damage.

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.



Wiring diagram (220/110V)

Remark：

1. A 5A fuse or circuit breaker must be installed on the main power input, and a surge protector must also be installed to prevent voltage fluctuations (within ±10% of rated voltage) from damaging the actuator or control board.
2. Signal wiring should use shielded cable to prevent interference.
3. The actuator power supply must not be connected in parallel with other power equipment.

Wiring Installation：

When using cable glands and protective sleeves, ensure full protection is properly implemented.

Refer to Figure 3.3 as a guideline.：

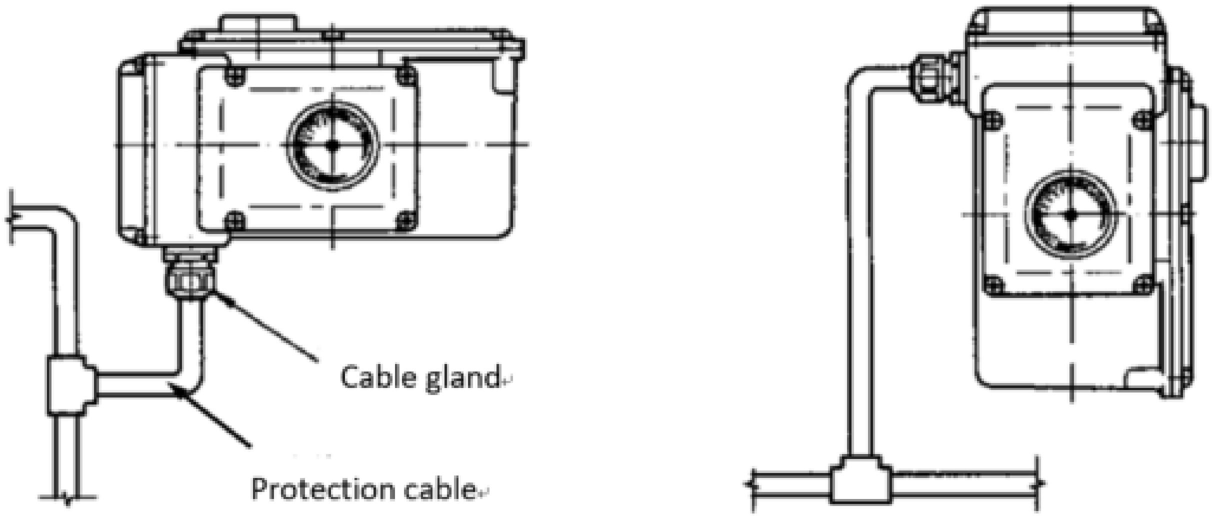


Figure 3.3 Cable Gland Illustration

Control Function Overview：

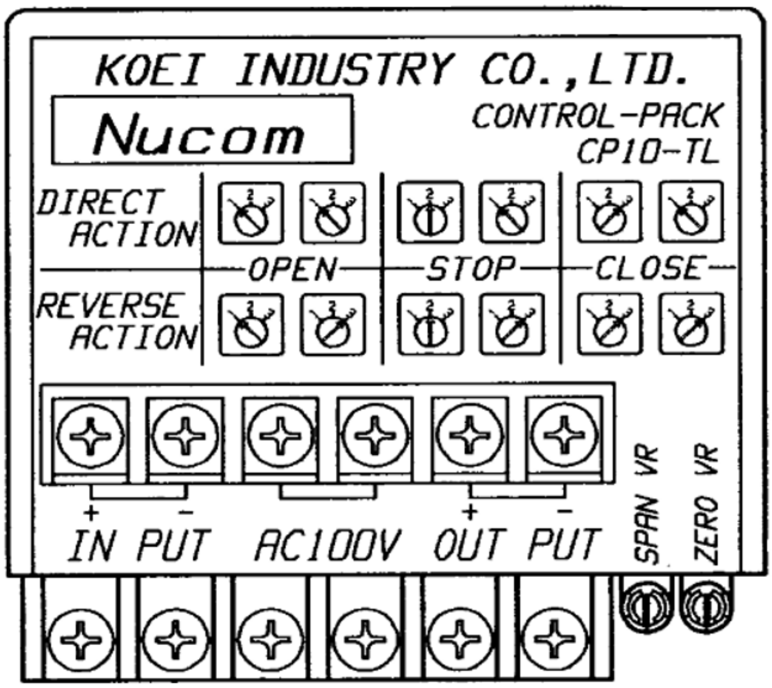


Figure 3.4 Control Box Interface

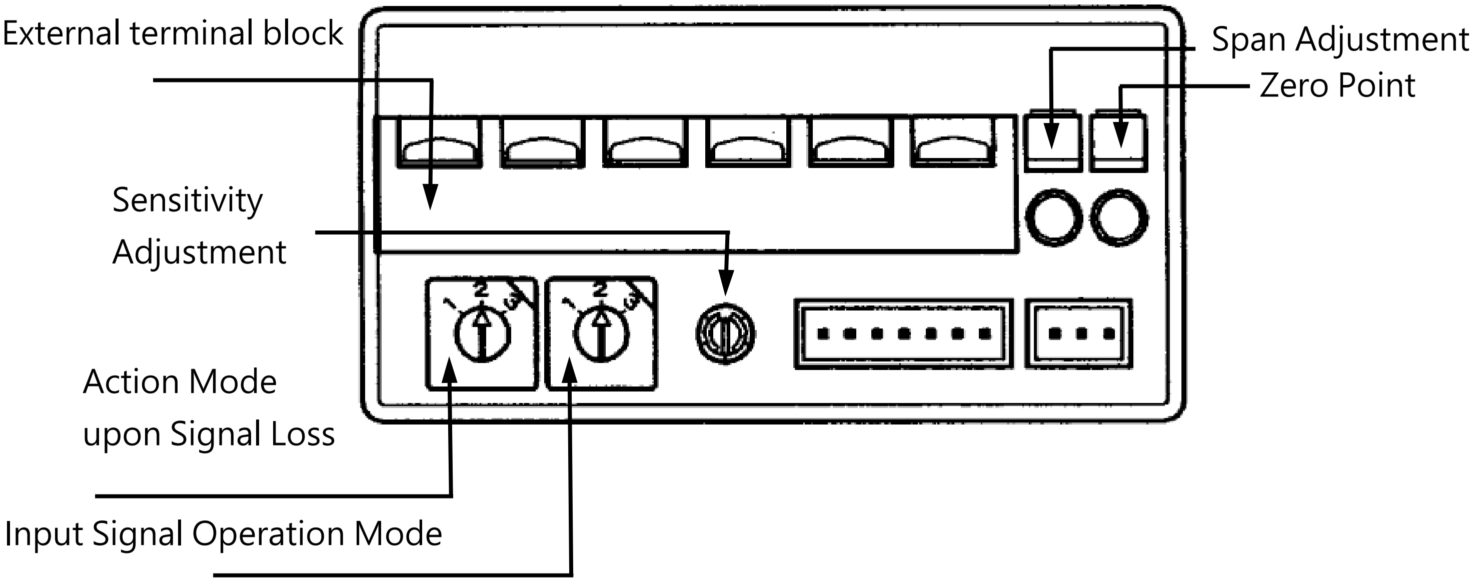
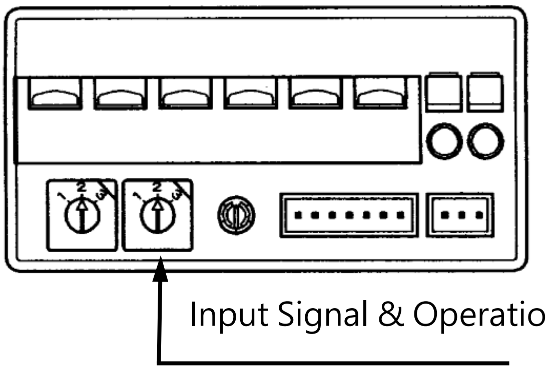
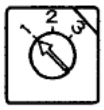


Figure 3.5 Switcher

Input Signal and Operation Mode Settings：

Settings for Direct or Reverse action can be made using the selector switch。





Switch Position 1: (Default)

Input signal 20 mA → IGV Fully Open

Feedback signal 4 mA

Input signal 4 mA → IGV Fully Closed

Feedback signal 20 mA

Selector Switch at Position 3

Input signal 4 mA → IGV Fully Open

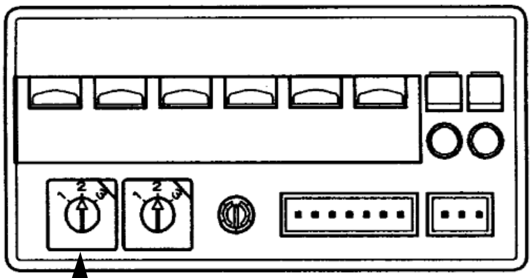
Feedback signal 4 mA

Input signal 20 mA → IGV Fully Closed

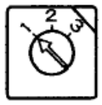
Feedback signal 20 mA

Action Setting When Input Signal Is Disconnected：

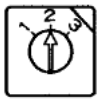
When the input signal is interrupted, you can choose one of three setting modes: Open, Stop, or Close.



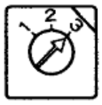
Select switch for action



When the selector switch is set to 1
→ IGV fully open (default)
IGV fully open (Operation Mode 3)



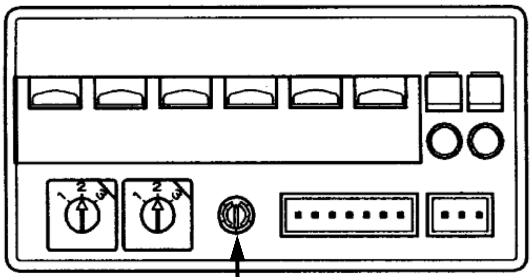
When the selector switch is set to 2
→ Stop



When the selector switch is set to 3
→ IGV fully closed
IGV fully closed (Operation Mode 3)

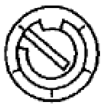
Note：When the input signal is lower than 2 mA, the actuator will interpret it as a disconnection and switch to the designated state. Therefore, the control device and the adjustment of the 4–20 mA signal must be accurate.

Sensitivity volume：

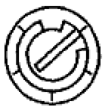


Sensitivity

Turn clockwise → Increase sensitivity
Turn counterclockwise → Decrease sensitivity

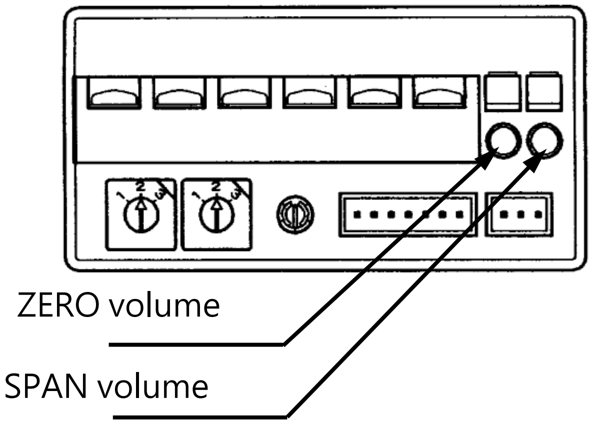


Maximum sensitivity resolution: 1/400



Minimum sensitivity resolution: 1/100

Stroke Setting：



Zero Point Adjustment Knob：
Clockwise rotation is the positive direction.
Adjustment range: 25% to +25%.。
Span Adjustment Knob：
Clockwise rotation is the positive direction.
Adjustment range: 50% to 200%.

Note：

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.

Special Attention：The forward rotation direction of the above actuator is opposite to the movement direction of the IGV linkage. In other words, adjusting the zero-point knob to fully open will result in the span knob adjusting to fully closed. Adjustment must be performed by experienced personnel, as improper handling may lead to malfunctions or other risks.

Troubleshooting :

TROUBLE	PROBABLE CAUSE	SOLUTION
Motor does not rotate	1. Insufficient or no power supply 2. Input signal lost or too weak 3. Wiring disconnected or not connected to terminal block 4. Thermal protector activated 5. Limit switch triggered at intermediate position 6. Motor phase advance capacitor damaged 7. Motor disconnected 8. Control box malfunction	1. Check power supply voltage 2. Check input signal 3. Reconnect wiring or replace terminal block 4. Lower ambient temperature 5. Reduce usage frequency 6. Load too heavy 7. Adjust limit stopper 8. Replace capacitor 9. Replace motor 10. Replace control box
Opening position keeps fluctuating	1. Signal source interference 2. Voltage divider interference 3. Divider gear or opening gear loosened	1. Improve signal source 2. Replace potentiometer 3. Tighten gear bolts
Input signal does not match opening position	1. Incorrect input signal 2Poor zero/span adjustment 3. Potentiometer gear misaligned	1. Check input signal 2. Re-adjust zero and span knobs 3. Reposition potentiometer gear
No opening signal	Opening signal disconnected or poor contact	Check the wiring

Appendix 2：Legacy Motor and Magnetic Bearing Cooling Piping :

The cooling system for the magnetic bearing centrifugal compressor consists of two main parts: cooling the motor stator and cooling the motor rotor along with the magnetic bearings. The motor stator is cooled using high-pressure liquid refrigerant supplied from the condenser. The inlet and outlet for this flow are labeled in the diagram below as "Motor Cooling Inlet (Liquid)" and "Motor Cooling Outlet."

The motor rotor and magnetic bearings are primarily cooled by medium-pressure gas from the economizer. Their respective inlet and outlet are shown in the diagram as "Bearing Cooling Inlet (Liquid + Gas)" and "Bearing Cooling Outlet." It is important to note that when the motor temperature or bearing temperature exceeds the warning threshold, auxiliary liquid refrigerant (also from the condenser) will be introduced to mix with the medium-pressure gas for enhanced cooling of the magnetic bearings or rotor. At the same time, the "Bearing Cooling Auxiliary Outlet" may be opened to prevent refrigerant accumulation.

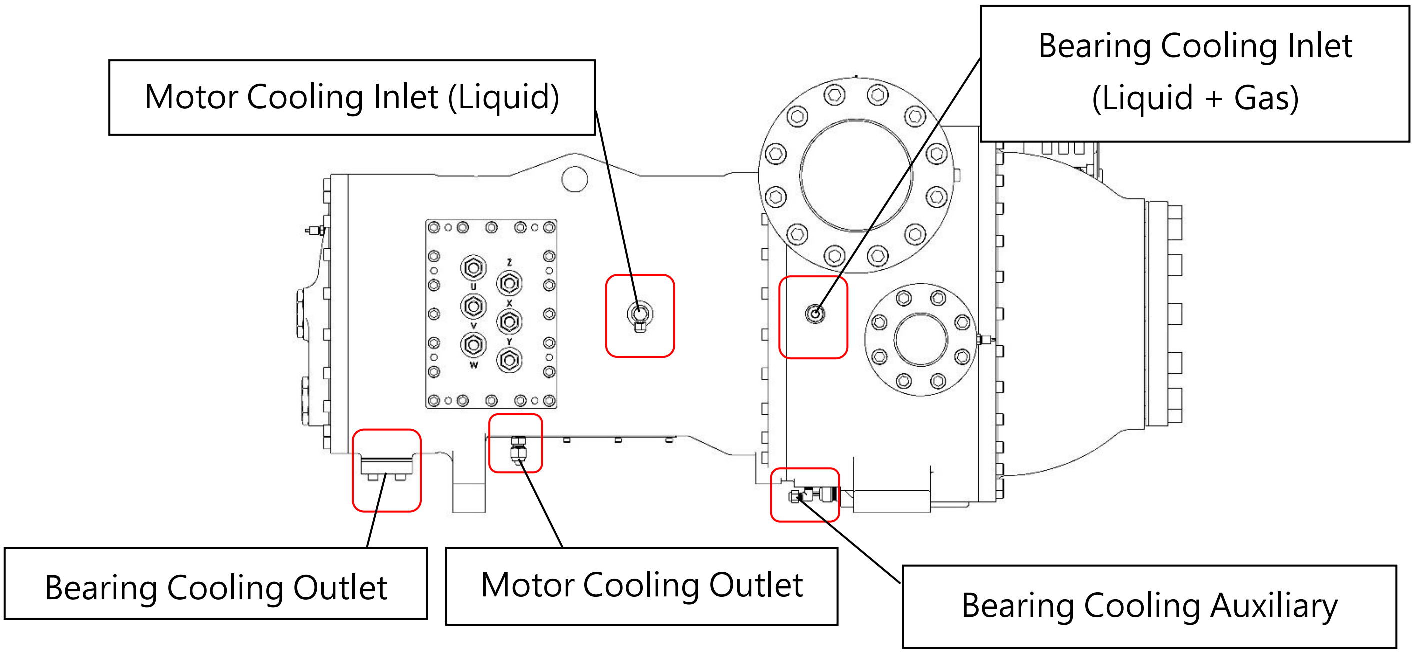


Figure 4-1 Motor and Magnetic Bearing Cooling Schematic