Panasonic

Scroll Compressors

Application Manual

Panasonic Appliances Compressor (Dalian) Co., Ltd.

Ver. 201909

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Safety Instructions

Panasonic scroll compressor meets strict safety and operating standards. As the installer or service person, it is an important part of your job to read this instruction carefully before beginning.

	**ELECTRICAL SHOCK HAZARD**	**●Make sure the unit utilize grounded connection.** **●Disconnect all input power before servicing.** **●Install the cover of terminal box before energized.**
	**EXPLOSION OR FIRE HAZARD**	**●Remove the refrigerant before brazing operation.** **●Do not compress air or energize the compressor under vacuumed condition.** **●Use only approved refrigerants and refrigeration oil.**
	**PERSONAL INJURY**	**● Personal safety equipment must be used.**
	**BURN HAZARD**	**●Do not touch the compressor when it is running or stopping until it has cooled down.**

1.0 Structure and Operating Characteristics

1.1 Key Components

C-SB and C-SC series scroll compressors are manufactured in Panasonic Appliances Compressor (Dalian) Co., Ltd.

1.1.1 C-SB Series Scroll Compressors

C-SB series are vertical hermetic scroll compressors. The discharge baffle divides the compressor into two rooms: high-pressure room and low-pressure room. The motor is rigidly attached to the shell; Crankshaft is supported by main frame and bearing plate which are welded to the shell. Pump assembly consists of fixed scroll and orbiting scroll and Oldham ring. Orbiting scroll rotates on the surface of the main frame.

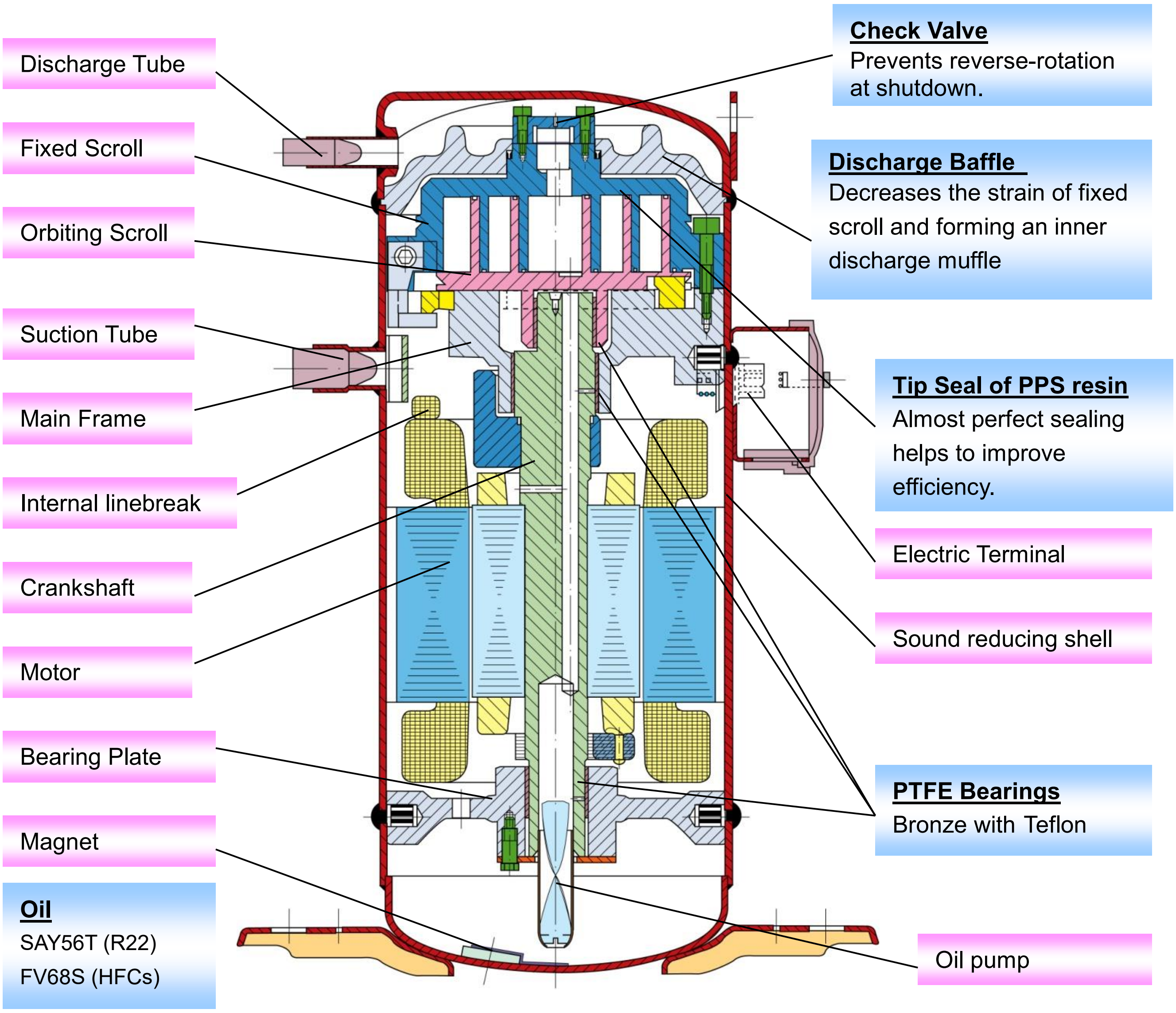


Figure 1-1 C-SB Scroll Compressor Components

See a cutaway view of C-SB series compressor in Figure1-1.

1.1.2 C-SC Series Scroll Compressor

The C-SC series are vertical scroll hermetic compressor, which are configured with the motor below the pump assembly. The fixed scroll divides the compressor into two rooms: high-pressure room and low-pressure room.

The motor is fixed between main frame and bearing plate by screws .The fixed scroll is fixed to the main frame by screws and the orbiting scroll rotates on the main frame.

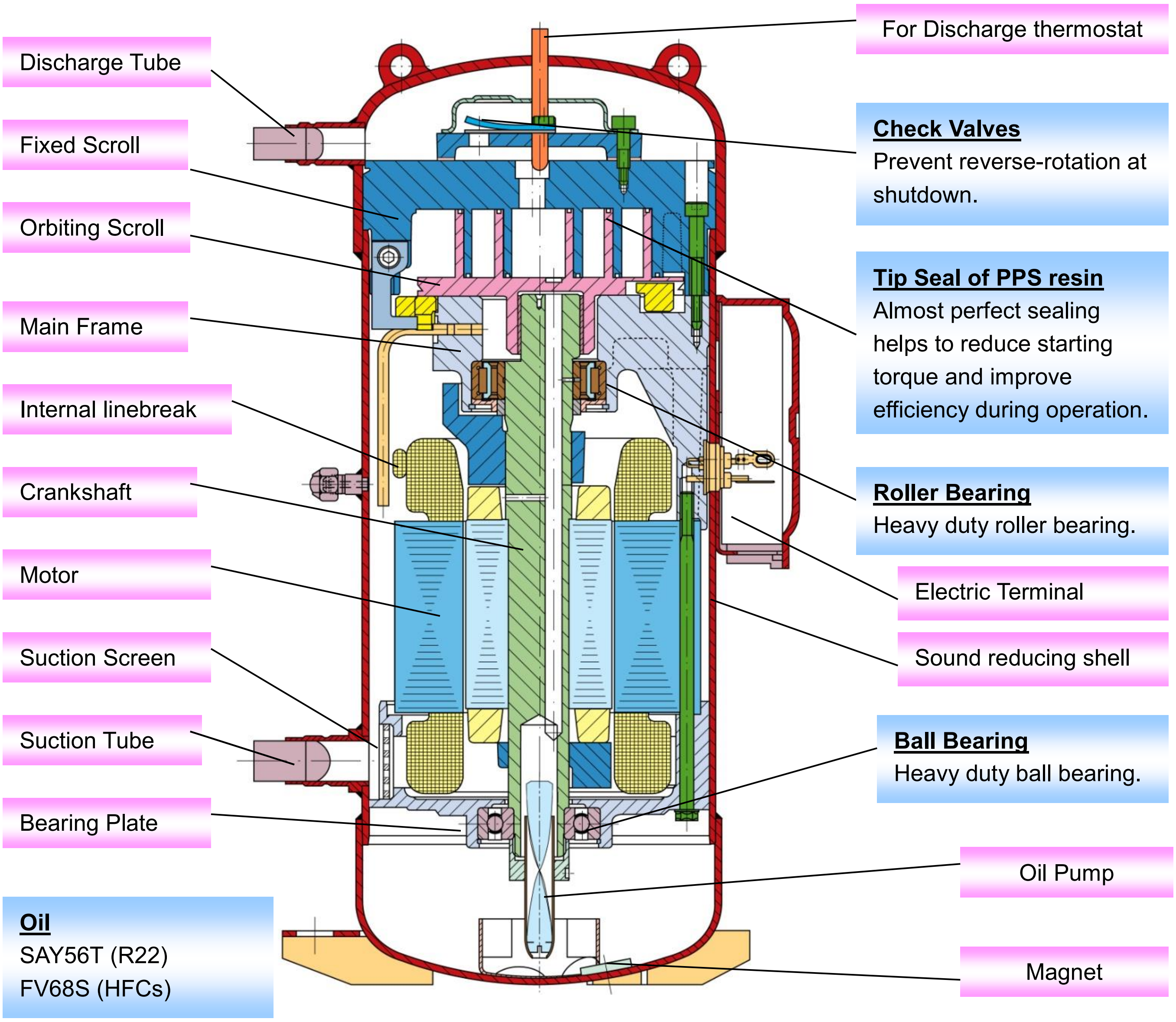


Figure 1-2 C-SC Scroll Compressor Components

See a cutaway view of C-SC series compressor in Figure1-2.

1.2 Scroll Compressor Operating Characteristics

Panasonic scroll compressor is designed with fixed eccentric and tip seals for axial sealing, resulting in low sound level and minimal gas leakage and therefore excellent efficiency. Separation of suction gas from the discharge side reduces heat transfer, further improving efficiency.

The Figure 1-3 below describes the scroll compression process:

First orbit; SUCTION gas enters at the perimeter of the scroll elements and is sealed as the scrolls rotate approximately one revolution.

Second orbit; During the COMPRESSION process, the gas is further compressed towards the center of the scroll elements to an intermediate pressure.

Third orbit; In the DISCHARGE orbit, the gas is further compressed to discharge pressure and then exits at the center through the discharge port.

With a three step simultaneous process of suction, compression and discharge and two gas pockets in each step that are 180 degrees apart, the compression process is balanced and very smooth, resulting in high efficiency, low sound/vibration and excellent reliability.

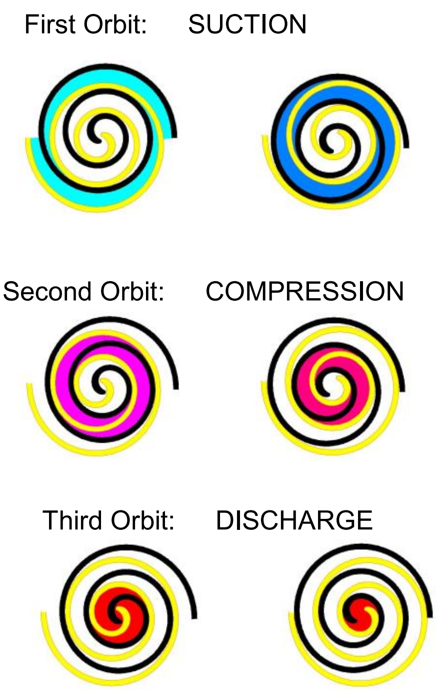


Figure 1-3

1.3 Compressor Design Pressure

The compressor's design pressure is shown in Table 1-1. The operating pressure in the system shall be lower than compressor design pressure.

Table 1-1 Compressor Design Pressure

Refrigerant	Low Pressure Side MPa(G)/psig	High Pressure Side MPa(G)/psig
R22	1.6/232	3.0/435
R407C	1.6/232	3.3/479
R410A	2.21/320	4.15/602

1.4 Refrigerant Oil

To improve the reliability, the specified designed premium quality refrigerant oil is used in the compressor. The refrigerant oil containing foam suppressor has the excellent thermal stability and high durability for overload conditions.

1.4.1 Oil Type

Each type of refrigerant oil is specially designed for certain types of refrigerant and operating conditions, if additional oil charge is added in the field, Only specified oil should be used.

Table 1-2 Type of Oil

Refrigerant	R22	R407C	R410A	R134a
Oil Model	SAY56T	FV68S	FV68S	FV68S
Oil Type	Mineral	Polyvinyl Ether （PVE）	Polyvinyl Ether （PVE）	Polyvinyl Ether （PVE）

1.4.2 Functions of Refrigerant Oil

1) Lubricate the moving parts to reduce mechanical friction.
2) Absorb the heat generated by mechanical friction .
3) Prevent refrigerant leakage at sealing surface.
4) Rust proof.

1.5 Motor Type

Panasonic scroll compressors can be applied under variable types of power sources, the motor type is shown in Table 1-3.

Table 1-3 Type of Motor

Frequency	Motor voltage code				
	B3	B5	B6	B8	B9
50Hz	200V	220~240V	-	380~415V	-
60Hz	200~220V	-	208~230V	440~460V	380V

2.0 System Design Considerations

2.1 Air-Conditioning System Design Criteria

2.1 .1 Condensing Pressure and Evaporating Pressure

The recommended condensing pressure and evaporating pressure for R22 systems at standard conditions are shown in the table 2-1 according to JIS standard.

Table 2-1 Recommended condensing and evaporating pressure

Pressure	Cooling	Heating
High side MPa(G)	1.8	2.0
Low side MPa(G)	0.45	0.40

It is necessary to adjust the system if the high side pressure or low side pressure has more than 0.1MPa deviation from the recommended pressure. Some reasons are listed in Table 2-2 for pressure deviation.

Table 2-2 Reasons of pressure deviation

Item		Low Side Pressure		
		Lower	Middle	Higher
High Side Pressure	Higher	<a>	--	<c>
	Same	--	OK	--
	Lower	<d>	--	<b>

Note: Higher: The tested pressure is higher than recommended pressure.
Lower: The tested pressure is lower than recommended pressure.
Same:The tested pressure is approximately same as recommended pressure.

<a> Too big of compressor size

<b> Too small of compressor size

<c> Too high of dry bulb temperature in the condenser side
Excessive refrigerant has charged in the system
Uneven refrigerant distribution in the circuits of condenser
Too low rotation speed of condenser fan

<d> Too low wet bulb temperature in the evaporator side
Uneven refrigerant distribution in the circuits of evaporator
Too low rotation speed of evaporator fan
Lack of refrigerant charge in the system
Too big superheating degree caused by improper size expansive valve or capillary

2.1.2 Sub Cooling Degree

The sufficient sub cooling degree can not only increase the cooling and heating capacity but also can keep the inlet of expansion valve or capillary full of liquid state refrigerant.

On the contrary, the insufficient sub cooling will cause flash gas occurring at the inlet of expansion valve, which will result in capacity reduction and increasing vibration, noise.

2.1.3 Superheating Degree

In order to prevent compressor from flooded back operation, a minimum suction superheating degree of 5K [10F], and a minimum sump superheating degree of 12K [21F] must be maintained.

It is necessary to keep the proper superheating degree since too big superheating will cause the high discharge temperature and the decrease of refrigerant mass flow rate.

2.1.4 Discharge Gas Temperature

The recommended discharge temperature is not higher than 95℃[200F] under the standard conditions.

2.1.5 Suction Accumulator

For air-conditioning system in which capillary is used or heat pump system, suction accumulator is necessary to prevent the uncontrolled liquid flooding back.

The proper size suction accumulator can:
1) Prevent liquid refrigerant migrating to compressor
2) Prevent liquid refrigerant being sucked into compressor.

The suction accumulator used in the system should at least meet the requirements as follow:
1) The size of the accumulator must be greater than 60% total refrigerant volume.
2) To ensure well oil return, a Φ1.5 mm orifice is necessary in the suction accumulator.
3) Filter mesh must be used to prevent orifice being blocked when orifice is smaller than Φ2.0 mm

2.1.6 System Charge Limit

The proper system charge can keep the system parameters in the normal level, such as cooling and heating capacity, sub cooling degree, suction and discharge temperature, compressor’s sump temperature, etc.

The refrigerant charge and refrigerant oil in the system should keep the ratio as follow:

Oil (kg)/ Refrigerant (kg)≥0.35

Note: Specific gravity of the Oil using in R22 series compressors is 0.92
Specific gravity of the Oil using in R407C/R410A/R134a series compressors is 0.94

If oil/refrigerant ratio is lower than 0.35, it will cause dilution of oil and lack of lubrication inside of compressor.

So please inform us before the system being tested under 0.35>oil(kg)/refrigerant (kg) ≥0.3 condition, some detailed advices will be given about oil level in compressor .

As a general requirement, oil (kg)/refrigerant (kg) >0.3 shall be kept.

2.2 Selection of Electrical Wiring

Voltage drop may occur due to the large current draw during compressor starting. The starting failure will occur if the starting voltage is under the range of compressor specifications, .So it is necessary to select the proper size of electrical wire.

2.2.1 Voltage Drop

See Figure 2-1 for the explanation of voltage drop.

a) Set Voltage:
   The voltage applied to compressor terminals before compressor is started.

b) Starting Voltage:
   The voltage applied to compressor terminals when compressor is being started. When compressor is starting, the big starting current will cause the drop of voltage. It will be very hard to start compressor if the starting voltage is too low.

c) Running Voltage:
   The line voltage applied to compressor terminals when compressor is running stably. This running voltage is a little lower than set voltage.

   The big voltage drop happens in compressor starting process, it will cause the failure of starting if the starting voltage is lower than 85% of rated voltage.

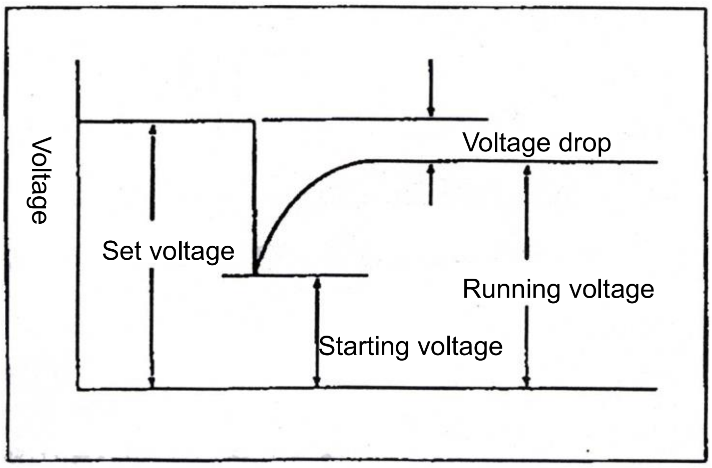


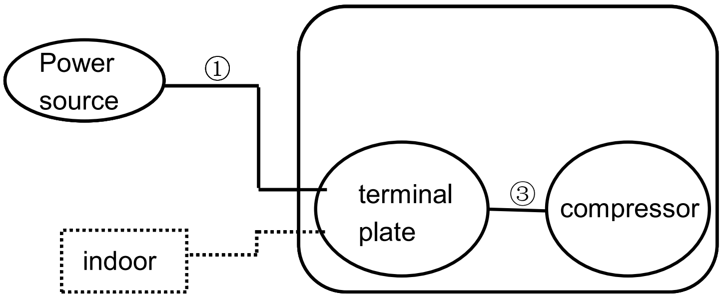
Figure 2-1

2.2.2 Selection of Electrical Wiring

The recommended wiring size is shown in the table 2-3.

Type of Unit

Window & Commercial Type Unit



Split Type (Separate Type)

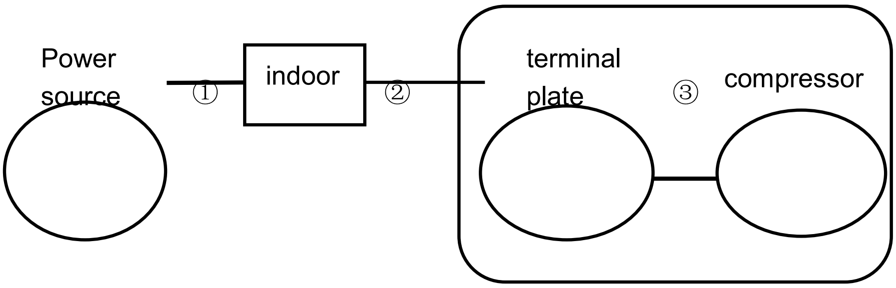


Table 2-3 SELECTION OF ELECTRICAL WIRING

Starting current (A)	Size of electrical wire (mm²)						
	Remark ① or Remark ①+② (heat-resistance Temperature: 60°C[140°F]: min.)						Remark③ (heat-resistance Temperature: 120°C[248°F] min.)
	5m max.	10m max.	15m max.	20m max.	30m max.	50m max.	1m max.
20max.	2.0	2.0	2.0	3.5	5.5	8.0	2.0
30max.	↑	↑	3.5	5.5	↑	14.0	↑
40max.	↑	3.5	5.5	↑	8.0	↑	↑
50max.	↑	↑	↑	8.0	14.0	22.0	↑
60max.	↑	5.5	↑	↑	↑	↑	↑
70max.	3.5	↑	8.0	14.0	↑	↑	3.5
80max.	↑	↑	↑	↑	22.0	30.0	↑
90max.	↑	↑	14.0	↑	↑	↑	↑
100max.	↑	8.0	↑	↑	↑	38.0	↑
110max.	↑	↑	↑	↑	↑	↑	↑
120max.	5.5	↑	↑	22.0	30.0	↑	↑
140max.	↑	14.0	↑	↑	↑	50.0	5.5
160max.	↑	↑	22.0	↑	↑	↑	↑
180max.	↑	↑	↑	↑	38.0	60.0	8.0
200max.	8.0	↑	↑	30.0	↑	↑	↑
220max.	↑	↑	↑	↑	50.0	80.0	↑
240max.	↑	↑	↑	↑	↑	↑	14.0

CAUTION OF GROUNDING:

The internal motor protector cannot protect the compressor against all possible failures.
Please be sure that the system utilizes the grounding connection when is installed in the field.

2.3 Voltage Balance

The voltages between compressor terminals should be balanced. When the line voltages applied to a three-phase compressor are not equal, unbalanced current in the stator windings will result. A small percentage voltage unbalance will result in a much larger percentage current unbalance. Consequently, the temperature rise of the motor windings is unbalanced and the overheated motor will cause the compressor failure.

The temperature rise can be estimated using the formulation as follows:

Percent Voltage Unbalance=100 X Max. Volt. Deviation from Avg.Volt./ Average Volt.

Temperature Rise= [Percent Voltage Unbalance]^2 X 2

To well protect the motor, The voltage unbalance(%) should be lower than 2%.

2.4 Deep vacuum Operation

Scroll compressors should never be used to evacuate an air-conditioning or refrigeration system. As a high volumetric efficiency machine, compressor will achieve extremely low vacuums when the suction side is restricted, this may cause internal arcing at the electric terminal and the damage of compressor.

2.5 Brief Power Interruptions

The brief power interruptions can cause powered reverse rotation on single phase compressors. When power is reapplied, the compressor may continue to run in the reverse direction for several minutes, until the internal linebreak cycles the compressor off. After tripping the linebreak, the compressor will operate in the correct direction when power is restored. During powered reverse rotation, the compressor will sound much louder than during normal operation.

To prevent this situation, an anti-short cycle timer of 3 minutes off / 7 minutes on duration is recommended. This will allow the compressor to be de-energized for at least 3 minutes after each power interruption.

2.6 Protection Devices

2.6.1 Internal Motor Protector

Panasonic scroll compressors are protected by internal linebreaks on the motor windings for single phase and three phase models. Internal linebreaks respond to over-current, high temperature and a combination of both.

The protector is the automatic reset device containing a snap action bimetal switch. In three phase compressors they protect against secondary single phasing. The motor protector is designed to protect against variety fault conditions such as failure to start, running overload and fan failure, locked rotor, abnormal operation of contactor. The test is necessary to be sure that the motor protector will not trip under the overload conditions.

For B3 models (for Japan market, 3PH-50Hz-200V/3PH-60Hz-200~220V), the motor is protected by internal thermostats with external breakers. The internal thermostats respond only to high temperature, so an outside overload relay is required to protect compressor against over-current conditions.

2.6.2 Protection Devices Required

For air-conditioning or heat pump unit, the following protective devices should be installed:

1) Reverse Phase Protector

Scroll compressor will only compress in one rotational direction. This is very important for three phase compressors since three-phase induction motor will run in either rotational direction equally depending on phasing of the power. Reverse rotation will result in excessive noise, and no suction / discharge pressure differential appears as well as no cooling effect in the suction line.

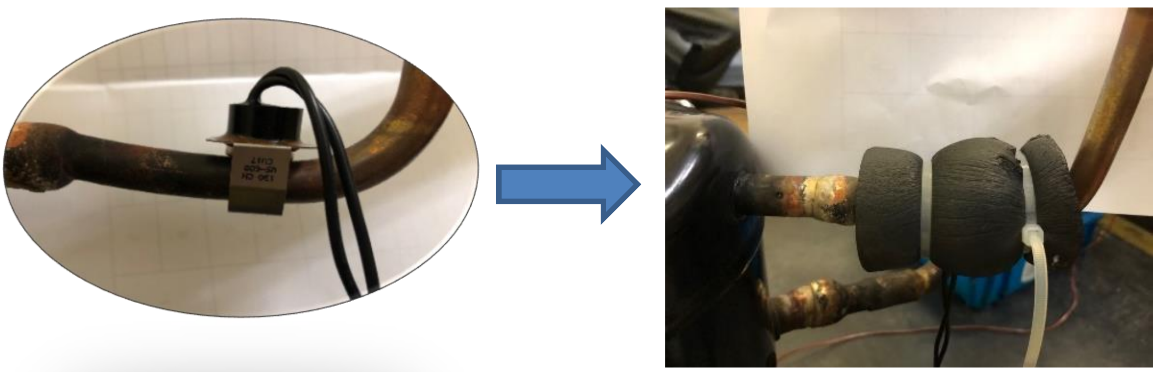
For three phase systems, mechanic device or reverse rotation module in the system control unit is necessary in preventing three phases compressor from running in the reverse rotational direction.

2) Discharge Gas Thermostat

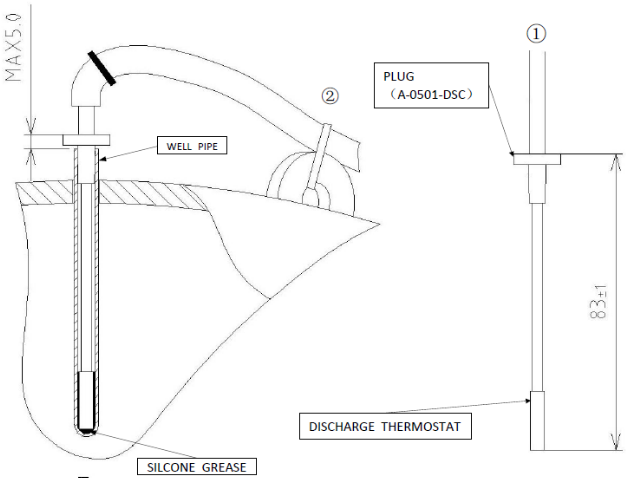
The discharge temperature will rise rapidly if the compressor is running under the overload conditions or lack of refrigerant conditions.

The maximum discharge temperature should be maintained by a discharge thermostat .

For the C-SB series, it is located on the discharge line within 100mm(4”) of the compressor shell and must not exceed 130℃(266F). The discharge thermostat should be installed on top side of the discharge tube, it should not be attached underneath the tube. It is important that the discharge thermostat should also be well insulated as below picture.



The C-SC series has a sensor well on the top shell and that temperature must not exceed 135℃(275F).



To maintain these limit, trip settings of 130±5℃(265±10F) and reset of 95±11℃(205±20F) for C-SB, trip setting of 135±5℃(275±10F) and reset of 86±15℃(187±27F)for C-SC should be required.

3) Low Pressure Switch

Panasonic scroll compressors require a low-pressure switch to protect against loss of refrigerant conditions. The recommended settings are listed in Table 2-4.

Table 2-4 Low Pressure Switch Setting

Refrigerant	Cut-Off setting
R22	4.3 psig (0.03MPa G)
R407C	7.3 psig (0.05MPa G)
R410A	22 psig (0.15MPa G)
R134a	4.3 psig (0.03MPa G)

The temperature in the scroll set and motor will rise rapidly due to loss of refrigerant charge. The low-pressure switch will react upon low pressure occurs in the system. Sometimes, the low-pressure switch will react in priority to the action of discharge thermostat or motor protector when the large amount of refrigerant leaks in the short time.

Do not operate the compressor in exceeding 30 seconds when running under 0.03MPa (G).

4) Crankcase Heater

The refrigerant is usually gathering in coldest point within the system during OFF cycle and the compressor might become the right one where most of liquid refrigerant centralized.

The liquid refrigerant may be taken into scroll plates with refrigerant oil in foam status when compressor restarts. It may cause the damage of the scroll plates.

Panasonic recommends crankcase heaters should be used on all applications to ensure long lasting reliability. A 35-Watts crankcase heater is recommended for C-SB series and an 88-Watts crankcase heater for C-SC series. The crankcase heater must be energized for a minimum of 5 hours prior to starting compressor.

The crankcase heater should be well attached to the compressor shell, shown as Fig 2-2 and Fig 2-3.

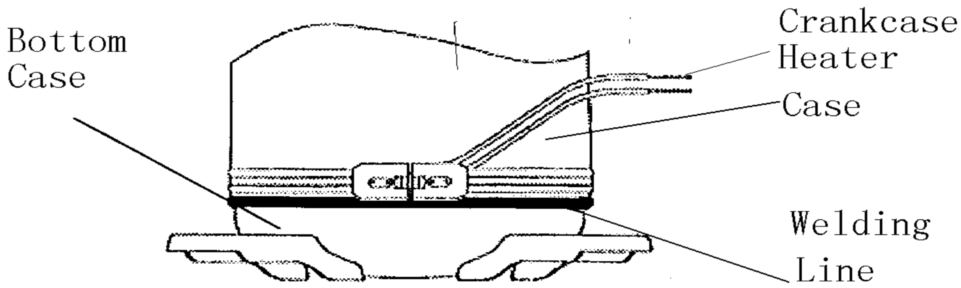


Figure 2-2 Position of crankcase heater for C-SB models

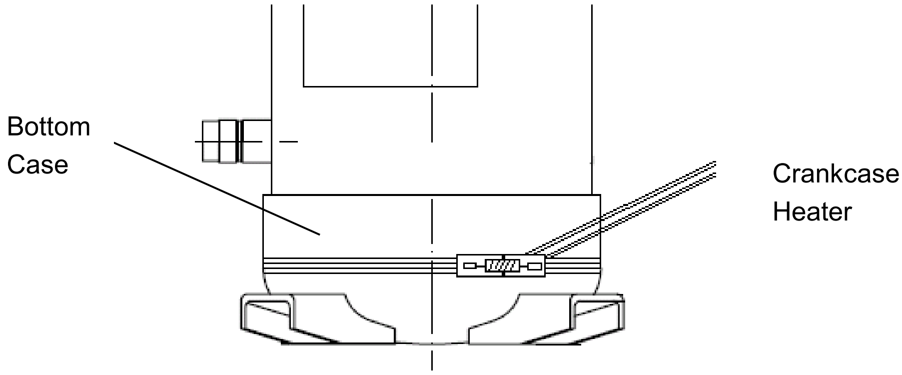


Figure 2-3 Position of crankcase heater fo C-SC models

5) High-Pressure Switch

Panasonic scroll compressors require a high-pressure switch in order to protect the compressor during blocked fan or fan failure conditions. The recommended settings are shown in Table 2-5

Table 2-5 High Pressure Switch Setting

Refrigerant	Cut-Off setting
R22	435 psig (3.0MPa G)
R407C	464 psig (3.2MPa G)
R410A	602 psig (4.15MPa G)
R134a	348 psig (2.4MPa G)

2.7 Application Standard & Limit (For R22, R407C and R410A)

The following requirements apply to vertical type hermetic scroll compressors:

Standard: Applicable to ordinary conditions in Japan JIS B8616 or standards relative to JIS B8616, such as standard rating conditions, maximum operating conditions, low temperature conditions, etc.

Limit: Applicable to transitional brief period, such as starting and beginning of defrost mode.

Table 2-6

<table>
<tr><th>No.</th><th>Item</th><th>Standard</th><th>Limit</th><th>Note</th></tr>
<tr><td>1</td><td>Evaporating Temp. Range</td><td>-15~12℃(5～54 °F)</td><td>-25~15℃(-13～59 °F)</td><td></td></tr>
<tr><td>2</td><td>Condensing Temp. Range</td><td>30~65℃(86～149 °F)</td><td>68℃(155 °F)
65℃(149 °F) max. for R407C/R410A</td><td></td></tr>
<tr><td>3</td><td>Compression Ratio</td><td>2 ~ 6</td><td>10
(8 max. for R407C/R410A)</td><td></td></tr>
<tr><td>4</td><td>Winding Temp.</td><td>115℃(240 °F) Max.</td><td>125℃(257 °F)</td><td></td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">Shell Bottom Temp.</td><td colspan="2">90℃(194 °F) Max.</td><td></td></tr>
<tr><td colspan="2">Evaporating Temp. + 12K(21 °F) Min.</td><td>Operating</td></tr>
<tr><td colspan="2">Ambient Temp. + 11K(20 °F) Min.</td><td>Not Operating</td></tr>
<tr><td rowspan="2">6</td><td rowspan="2">Discharge Gas Temp.</td><td rowspan="2">115℃(240 °F) Max.</td><td>130℃(266°F) Max. for C-SB</td><td>Within 10cm(4in.) of the discharge fitting</td></tr>
<tr><td>135℃(275°F) Max. for C-SC</td><td>Inside of the well pile on the top of comp.</td></tr>
<tr><td>7</td><td>Suction Gas Temp.</td><td>Superheat: 5K(10 °F) Min.</td><td>No excessive noise</td><td>Items 4,5,6 and 14 shall be kept.</td></tr>
<tr><td>8</td><td>Running Voltage</td><td colspan="2">Within ±10% of the rated voltage</td><td>Voltage at comp. terminals</td></tr>
<tr><td rowspan="2">9</td><td rowspan="2">Starting Voltage</td><td colspan="2">Three Phase Models: 85% of the rated voltage min.</td><td rowspan="2">Voltage at comp. terminals</td></tr>
<tr><td colspan="2">Single Phase Models: 90% of the rated voltage min.</td></tr>
<tr><td rowspan="2">10</td><td rowspan="2">On/Off Period</td><td colspan="2">On Period: Until the oil level returns to the center of the lower bearing</td><td rowspan="2">For at least 7 minutes -on/3 minutes-off is recommendable</td></tr>
<tr><td colspan="2">Off Period: Until balance of high and low pressure is obtained</td></tr>
<tr><td>11</td><td>Refrigerant Charge</td><td colspan="2">Oil/Refrigerant(wt.)⩾0.35
(Specific gravity of the Oil: SAY56T: 0.92; FV68S: 0.94)</td><td></td></tr>
<tr><td>12</td><td>Life Time</td><td colspan="2">200,000 cycle</td><td></td></tr>
<tr><td rowspan="2">13</td><td rowspan="2">Minimum Oil Level</td><td>C-SB: Center of the lower bearing</td><td>C-SB:Bottom of the lower bearing</td><td></td></tr>
<tr><td colspan="2">C-SC: No less then 70% of the initial oil charge</td><td></td></tr>
<tr><td rowspan="2">14</td><td rowspan="2">Abnormal Pressure Rise/Drop</td><td colspan="2">Pressure Rise: see the Table 2-5</td><td>By high pressure switch</td></tr>
<tr><td colspan="2">Pressure Drop: see the Table 2-4</td><td>By low pressure switch</td></tr>
<tr><td>15</td><td>Copper Piping Stress</td><td colspan="2">Start/Shutdown: 34.32N/mm^2 Max. Run: 12.26N/mm^2 Max.</td><td></td></tr>
<tr><td>15</td><td>System Moisture Level</td><td colspan="2">200ppm Max.</td><td></td></tr>
<tr><td>16</td><td>System Uncondensable Gas Level</td><td colspan="2">1 Vol.% Max.
Residual Oxygen 0.1 Vol.% Max.</td><td>24 hrs. after vacuuming: 1.01kPa (0.15 psig) Max.</td></tr>
<tr><td>17</td><td>Tilt</td><td colspan="2">5° Deg.Max.</td><td></td></tr>
</table>

* Operation beyond the above limits must be approved by PAPCDL.

2.8 Compressor Selection Table

The successful application of scroll compressor is dependent on a good match between system design and compressor. Please fill in the following table and inform us.

Table 2-7

[Required Information for Selection]

Company Name:		Data:
SYSTEM INFORMATION	Type of unit	*[ ] Split system [ ] else *[ ] Air conditioning [ ] Heat pump
	Rated capacity	Cooling: kW Heating: kW
	Target market (country)	
	Power source	Phase: Frequency: Voltage:
	Amount of refrigerant charge	Total: g (piping length m) Additional charge g/m
	Piping design	Pipe length max m
	Estimated Production Quantity	units/year
	Estimated Production Date	
	Production Place	
COMPRESSOR	Application	
	Nominal output	
	Rated capacity	kW (ARI)
	Power source	Phase: Frequency: Voltage:
Remark:		

2.9 System Test Data Table

In order to make better application of the compressor, the system test result is very important for both sides. Please fill the table below and inform us.

[System Test Result]

Data:

System Model : ____________ Compressor Model: ____________

Refrigerant charge: ________ kg Power source: ____________

2.9.1 Maximum operating condition

1) Table 2-8: Temperature Conditions

Mode	Indoor	Outdoor
Cooling	DB/WB: / ℃	DB/WB / ℃ or Water Inlet/ Outlet / ℃
Heating	DB/WB: / ℃	DB/WB: / ℃ or Water Inlet/Outlet / ℃

2) Table 2-9: Performance data

Item	Cooling			Heating		
	Minimum Voltage	Rated Voltage	Maximum Voltage	Minimum Voltage	Rated Voltage	Maximum Voltage
Voltage (V)						
Compressor input (W)						
Compressor Current(A)						
Motor Winding Temperature (℃)						
Compressor discharge gas temp. (℃)						
Compressor suction gas temp. (℃)						
Compressor shell bottom temp. (℃)						
Condensing Temperature(℃)						
Evaporating Temperature(℃)						
Temp. before expansive valve(℃)						
High Side Pressure MPa(G)						
Low Side Pressure MPa(G)						

Remark: G: gauge pressure

2.9.2 Low-Temperature Operation Test

1) **Table 2-10: Temperature Conditions**

Mode	Indoor	Outdoor
Cooling	DB/WB: / ℃	DB/WB / ℃ or Water Inlet/ Outlet / ℃
Heating	DB/WB: / ℃	DB/WB: / ℃ or Water Inlet/Outlet / ℃

2) **Table 2-11: Performance data**

Item	Cooling			Heating		
	Minimum Voltage	Rated Voltage	Maximum Voltage	Minimum Voltage	Rated Voltage	Maximum Voltage
Voltage (V)						
Compressor input (W)						
Compressor Current (A)						
Motor Winding Temperature (℃)						
Compressor discharge gas temp. (℃)						
Compressor suction gas temp. (℃)						
Compressor shell bottom temp. (℃)						
Condensing Temperature(℃)						
Evaporating Temperature(℃)						
Temp. before expansive valve(℃)						
High Side Pressure MPa(G)						
Low Side Pressure MPa(G)						

Remark: G: gauge pressure

2.9.3 Start performance and Voltage drop performance

Table 2-12:

Tested item	Customer's test standard	Test result	Customer's Judgment	Test Condition	Remark
Voltage drop under overload conditions					
Restart after overload operation					
Restart with liquid refrigerant depositing in compressor					

2.9.4 The Sample Compressors Information

1) Total sample quantity: ______________________________

2) Series numbers of the tested samples: ______________________________

3) The date of receiving the samples: ______________________________

3. 0 Assembly and Manufacturing Process Considerations

For safe installation and trouble-free operation of compressor and air-conditioning system, below instructions should be carefully read and strictly followed before beginning.

3.1 Removing Rubber Plug

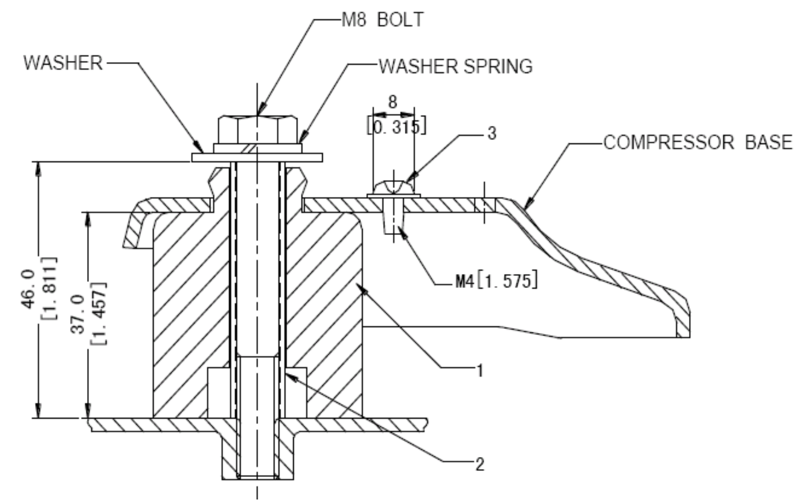
Each compressor is shipped with a dry Nitrogen holding charge between 0.12~0.18MPa (G) (18~26 psig) and sealed with rubber plugs. The discharge plug should be removed first before pulling the suction plug to avoid loss of oil. Compressor should be installed into system within 15 minutes after removing the plugs.

The compressor should be kept vertical and not be declined while removing rubber plugs.

Do not use the compressor from which the discharge sound cannot be heard when removing rubber plugs.

3.2 Compressor Mounting

Please use the mounting accessories (grommets and sleeves) that are supplied or specified by Dalian Panasonic, as shown in Figure 3-1.



1-Mounting Grommet 2-Mounting Sleeve

Figure 3-1 Mounting Parts for C-SB

3.3 Residual Moisture

System residual moisture level should be kept less than 200ppm for C-SB models and 500ppm for C-SC models. Normally if the vacuum degree of system can be achieved, the residual moisture level will also meet this requirement.

3.4 Tube Brazing

During brazing the system piping to the compressor, it is important to maintain the cleanliness inside the piping to prevent water, solid contamination and so on entering into the system. Do not bend the discharge or suction lines or force the piping into the compressor connections since this may increase piping stress and potential failure. See figure below for recommended materials and procedure.

3.4.1 Brazing material:

A silver-phosphorus and other silver brazing materials are recommended for all kinds metal brazing. A copper-phosphorus brazing material is also acceptable for copper brazing.

See Table 3-1 for recommended brazing materials.

Table 3-1: Recommended Brazing Material

Metal	Silver (%)	JIS Code	Brazing Temp.℃	JIS standard
Copper to Copper	4.8~5.2	BcuP-3	720~815	Z 3264
Copper to Steel with copper coated	35	BAg-2	700~845	Z 3261
*Copper to Steel *Steel with copper coated to steel *Steel to Steel	45	BAg-1	620~760	Z 3261

3.4.2 Nitrogen purge

During brazing the system piping to the compressor a Nitrogen purge with high purity (99.8% min.) must be used to prevent oxidation contamination. The nitrogen purge cannot be stopped until the piping temperature below 200℃. See Figure 3-2 below for recommended flow method of nitrogen purge.

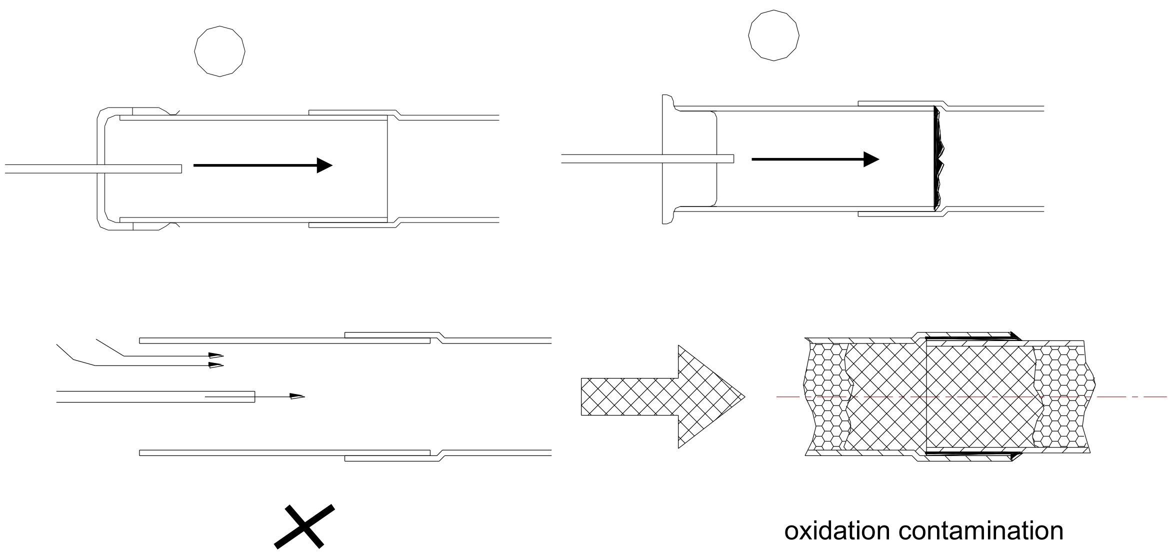


Figure 3-2 The flow method to prevent the oxidation contamination

3.4.3 The clearance and Insertion length of brazing parts (reference)

The recommended clearance and minimum insertion length of copper pipes are shown in the Table 3-2.

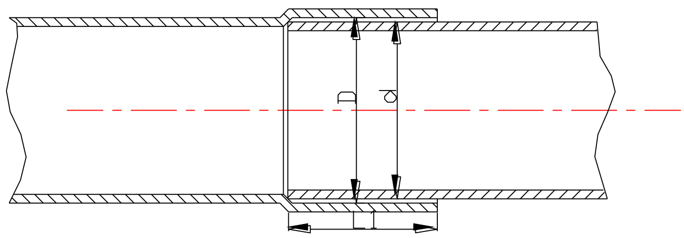


Table 3-2 The clearance and length

Piping O.D.(mm)	Minimum Insertion Length L1 (mm)	Clearance D-d (mm)
5~8	6	0.05~0.35
8~12	7	0.05~0.35
12~16	8	0.05~0.45
16~25	10	0.05~0.45
25~35	12	0.05~0.55
35~45	14	0.05~0.55

3.4.4 Brazing Procedures

See Figure 3-3 for brazing area.

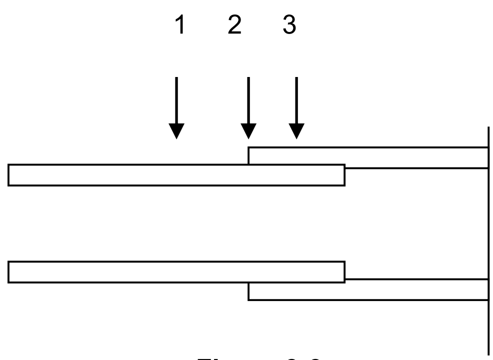


Figure 3-3

a) A double-tipped torch is recommended during brazing;

b) Clean the compressor tubing and system piping prior to assembly;

c) Apply heat to Area 1, moving the torch up, down and around the tube in order to heat it evenly. It will become dull orange in color.

d) Move the torch to area 2 until it reaches dull orange in color and heat that area evenly.

e) Add braze material to the joint while moving the torch around the joint to flow braze material evenly around the circumference.

f) After braze material flows around the joint, move to area 3, to draw the braze material into the joint. The time spent heating area 3 should be minimal, to keep excess braze material from entering the compressor.

3.5 Leakage Test

The enclosure strength test should be performed to check system leakage by means of charging pressurized nitrogen into the system. Pressurizing should be completed step by step instead of reaching the test pressure immediately.

1） Hold 0.5MPa pressure for 5 minutes to check whether the pressure is decreasing.
2） Hold 1.5MPa pressure for 5 minutes to check whether the pressure is decreasing.
3） Record the ambient temperature and pressure when the test pressure is attained (unit design pressure).
4） Ensure the system can hold the test pressure without decreasing for 24 hours. If pressure decreasing occurs in any step, leakage points should be checked and repaired immediately.

Note:
1) Never use refrigerant, oxygen, dry air, combustible and toxic gas as the test medium to avoid the risk of fire or explosion.
2）Charge the test gas both from the gas line and liquid line of the system simultaneously .
3）The design pressure should be in the scale of the pressure gauge .
4) Pressure may change ＋/－0.01MPa/℃ as the ambient temperature changes.

3.6 Evacuation

The system must be evacuated by a vacuum pump to remove the residual moisture and un-condensable gas. It is essential to connect the vacuum pump to both the high-pressure side and low-pressure side simultaneously to ensure that the system is completely evacuated.

It is necessary to confirm the vacuum degree of the system after removing the vacuum pump from the system. Sufficient vacuum degree means:

30 seconds after removing the vacuum pump	below 1.0Torr
24 hours after removing the vacuum pump	below 7.6Torr

Please select proper size of vacuum pump according to the above vacuum degree requirements.

Do not use compressor as a vacuum pump and NEVER energize the compressor under vacuumed conditions.

3.7 Refrigerant Charge

It is recommended that system charging be done using the weighted charge method, by adding liquid refrigerant to the condenser outlet side of system. Only gas refrigerant can be charged to compressor suction tube. Charging at the high and low pressure side of a system with gas simultaneously at a controlled rate is also acceptable. Do not exceed the manufacturer’s charge amount limit and NEVER charge liquid at suction side of compressor.

The excessive refrigerant charged in system will result in dilution of oil and lack of lubrication on sliding parts, in severe cases liquid refrigerant flooding back to compressor and compressor failure will occur.

3.8 Wiring Connections

PANASONIC scroll compressors will only compress gas in the counterclockwise direction when viewed from the top. Since single phase motors start and run in only one direction, reverse rotation is not a major consideration. Three phase motors will start and run in either direction, depending on the phase angles of the supplied power. This requires care during installations to ensure the compressor is operating in the proper direction.

Verification of proper rotation is done by observing suction and discharge pressures when the compressor is operating. A decrease in discharge pressure and an increase in suction pressure indicate reverse rotation. After several minutes of operation the compressor internal linebreak will de-energize the compressor. In order to correct this situation, disconnect the power and switch any two power leads at the unit contactor. NEVER switch leads directly at the compressor.

Internal wiring of the compressor is consistent with the direction of rotation. As a result, once the correct phasing is determined for a specific system or installation, connecting properly phased leads to the same terminals should maintain proper rotation direction.

A phase monitor can be applied to ensure correct rotation when power is initiated. Labeling for three phase models is U, V, W and for single phase C (common), S (start) and R (run). Each compressor is labeled with the appropriate sequence. As showed in wiring diagram, the line phases R (L1), S (L2) and T (L3) should be connected to terminals U, V and W, respectively.

Spade terminals type　　　　Screw terminals type

Figure 3-4 Compressor Terminal

3.9 Terminal cover and clip

The terminal cover and clip should be installed prior to operation of the compressor. To ensure the cover is properly installed, a double check should be done to make sure the lead wires are not pinched under it.

3.10 Preliminary Running

In order to lubricate the compressor movement parts, the compressor should be operated at least 3 seconds within 15min after refrigerant charged. Check the following items:

1) To check whether abnormal sound or abnormal tube vibration occurs.
2) To check whether refrigerant leaks from the connection part.
3) To check the cooling effect.

3.11 Start Compressor with Balanced Pressure

The OFF cycle setting of compressor should be at least 3 minutes which is the period to balance the high side and low side pressure of system. Especially for single phase models, starting the compressor with balanced pressure should be always followed.

3.12 Servicing Scroll Compressors

3.12.1 Compressor Functional Check

The following procedures should be followed to determine if the compressor is functioning properly:

1) Voltage of the unit should be measured and verified as correct.

2) An evaluation of the electrical system should be performed next. The motor should be checked by using continuity and short to ground testing. The internal motor protector should be given time to reset if a continuity break is found in the motor windings. External breakers and associated wiring should be checked.

3) Operation of indoor and outdoor fan/blower should be checked and verified as correct.

4) Check the refrigerant charge levels by connecting service gauges to the suction and liquid service valves and then turning on the compressor. Correlate the operating pressures to the system manufacturer specifications for the existing conditions under which the unit is operating.

5）On heat pump, check that the reversing valve is operating properly and verify that compressor current is within published compressor specifications at the proper operating conditions. If there is a significant deviation from current published specifications occurs (+/-15% or more) this may indicate a defective compressor.

3.12.2 System Evacuation

When evacuating a compressor in the field, it is extremely important to use a vacuum manifold set with at least 2 vacuum lines connected to the system. One line connected to the high side and the other connected to the low side of the system. This procedure is necessary to ensure the system is completely evacuated, since the scroll sets can seal under some non-energized conditions and thus isolate the high and low sides from each other. If there is refrigerant left in the system, this can create a hazard when unbrazing the piping. When compressor is replaced, the filter-dryer should also be replaced. .

3.12.3 Remove the Failed Compressor

The preferred method of remove a compressor is to cut the connecting lines using a tubing cutter. However, unbrazing is also acceptable using the following precautions. Check to be sure all refrigerant has been evacuated using the procedure above in 3.12.2. If there is still refrigerant in the system, this when combined with the compressor oil can ignite if it comes in contact with a flame.

(1) Use the suitable welding machine or tools to remove the connecting pipes, screws, flanges or service valves;

(2) Check the oil in failed compressor. If oil is in black color (the normal color of oil for R22 models is light yellow and colorless for HFC models), if necessary to clean the system piping before installing new compressor.

3.12.4 Brazing Procedure

See figure below for the procedure for field servicing.

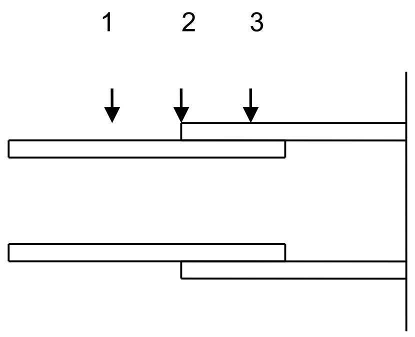


Figure 3-5

To disconnect:

1) Disconnect power and remove wires from terminal box.
2) Insure ALL pressure is out of the system (check high and low sides).
3) Heat areas 2 and 3 slowly and uniformly until braze material softens and the tube can be removed from the compressor fitting.

To Reconnect:

4) Recommended brazing material is specified in section 3.4.
5) Clean tube and fitting until shiny like a new penny.
6) Re-insert tube into fitting.
7) Heat tube uniformly in Area 1, moving slowly to area 2 until it reaches dull orange in color, apply the brazing material to the joint.
8) Heat the joint uniformly by moving the torch around the joint to flow braze material evenly around the circumference.
9) Slowly move the torch to area 3 to draw the braze material into the joint.
10) Do not overheat the joint. A cherry red color indicates overheating and can weaken the joint and fittings.

3.12.5 Compressor Replacement for Motor Burn Out

If a motor burn out is present, follow the procedure as below :

1) Evacuate the system per section 3.12.2.
2) Remove the compressor as outlined in sections 3.12.3 and then follow proper clean-out procedures as detailed in system instructions.
3) Replace the liquid line filter dryer and install a properly sized suction line filter dryer.
4) Run system and recheck pressure drop across suction filter dryer within 48 hours. If pressure drop is excessive, replace both the liquid line and suction line filter dryers.

3.12.6 Returning Failure Compressor

1) The failure compressor should be sealed on suction tube and discharge tube to prevent the refrigerant oil flowing out during transportation.
2) Please record the following items in a list: Compressor Model, Manufacturing Series Number, Air-conditioning Model and Air-conditioning Manufacturing Number, Failure Time, Failure Descriptions and Failure Reasons, etc.

The field information should be returned together with compressor. It is strongly recommended to record as detailed as possible for the accurate failure analysis.

3.13 Other Consideration

1) Installation should be completed within 15 minutes after removing the rubber plugs.

2) Do not use the compressor to compress air.

3) Do not energize the compressor under vacuumed condition.

4) Do not tilt over the compressor while carrying it.

5) Do not remove the paint.

4. 0 Troubleshooting

Problem	Probable Cause	
Compressor failure to start	Power source	Power source switch off
		Fuse broken
		Too low voltage at compressor terminals
	Wiring	Disconnection of wiring
	Control devices	Improper setting of temperature controller
		Protection devices trip (Discharge temp. High-Low pressure Switch etc)
		Loss of Phase
		Wrong phase sequence
	Compressor	Internal motor protector trips
		Excessive liquid in compressor
		Inside components broken
		Motor burns out (windings broken or short to ground)
Compressor shut down shortly after starting	Power source	Failure of breaker
	Refrigerant circuit	High pressure side blockage
		Low pressure side blockage
	Electrical components	Failure of contactor (rapid fluctuation or contacts welded)
	Temperature controller	Temperature controller trips
	Compressor	Abnormal line voltage
		Motor winding overheating due to lack of phase
		Motor winding overheating caused by unbalanced voltage
		Motor winding overheating caused by loss of refrigerant
		Too high discharge pressure
		Too high suction superheating degree
		Non-condensable gas mixed in system
		Insufficient cooling for compressor
		Inside failure of compressor

Problem	Probable Cause	
Abnormal running noise	Flooded-start	During off cycle, liquid refrigerant migrates to the compressor and mixed with lubricant oil
		Refrigerant overcharged
	Piping	Resonance vibration occurs
	Compressor	Electromagnetic noise of motor
		Lack of oil in the compressor
		Worn or broken components inside of compressor
	Compressor	Contaminations mix in compressor
		Reverse rotation of compressor
		Feet of the compressor touch the system base
Compressor runs but poor cooling effect	High discharge pressure	Non-condensable gas mixed in system
		Refrigerant overcharged
		Condenser fan failure
		Dirty condenser coil
		Short air cycle
	Low discharge pressure	Insufficient refrigerant in system
		Leakage of refrigerant
		Too low ambient temperature
		Large air flow through condenser
		Liquid refrigerant flooding back
		Worn compressor
	High suction pressure	Too high heat load
		Poor heat insulation
		Worn compressor
	Low suction pressure	Too low heat load
		Evaporator dirty or iced
		Blockage of expansion device
		Blockage of refrigeration circuit or leakage of refrigerant
Compressor Frosted/dew	------	Improper size of expansion valve
		Too low heat load
Smelly	------	Large amount of refrigerant leakage
		Overheating of electronic components
		Overheating of compressor shell

5. 0 Explanation for FAQ

5.1 Refrigerant oil mixture with liquid refrigerant will result in lower insulation resistance value and higher leakage current readings.

Solution: It is recommended to operating the system for a brief time to redistribute the refrigerant through the system.

5.2 During reclaiming refrigerant process, the suction pressure drop causes compressor to discharge discontinuously, the check valve inside of compressor will open and shut repeatedly and make clatter. But it will not affect reliability of the compressor.

1) Although above mentioned clatter makes no affect on the reliability of the compressor, if the compressor keeps operating under low suction pressure status, the motor winding and discharge temperature will raise up rapidly.

2) The running period with low suction pressure under 0MPa (G) should be less than 1 minute.

5.3 Reverse Phase Protector cannot protect the compressor from reverse rotation due to wrong wiring internal of the A/C system.

1) The function of Reverse Phase Protector is to protect the compressor from reverse rotation due to the external wrong wiring into A/C system.

2) See Table 5-1 for judgments on reverse rotation of compressor

Table 5-1 Judgments on reversal rotation of compressor

Item	Normal Rotation	Reverse Rotation
Discharge Tube Temp.	Increasing rapidly	No obvious changes
Suction Tube Temp.	Decline	Slightly increasing
Discharge Pressure	Increasing rapidly	No obvious changes
Suction Pressure	Decline	No obvious changes
Vibration & Noise	Instant great before coming to steadily	Always great
Current	Normal	Over excess of nominal value

5.4 Compressor temporary halting due to internal motor protector trips.

1) Internal motor protector working principle

The linebreak motor protector is the automatic reset device containing a snap action bimetal switch. In three phase compressor it protects against secondary single phasing. The motor protector is designed to protect against variety fault conditions such as failure to start, running overload and fan failure, locked rotor, abnormal operation of contactor.

2) Status after the internal protector trips

When internal protector tripping, the circuit will be open between each of 3-phase R-S-T. Under the case of overheat of motor, the high temperature of compressor shell will be found.

3) Reset time

When internal motor protector has tripped, it will take 30 to 40 minutes to reset and then the compressor will restart.

4) Notice in field application

On a field application, when the internal motor protector has tripped, the compressor will stop while each of 3 terminals is still energized, to which either the customer or serviceman may regard the compressor as fail down. Therefore, the above-mentioned situation should be taken into consideration.