LG
Life's Good

ENGLISH

OPERATION MANUAL

Water-cooled Modular Centrifugal Chiller

Before using the chiller, please read the safety instructions for correct use.
The instructions aim to save the safety of a user and to prevent any damage to property.
Keep the operation manual in a place that it is accessible to other users.
Only authorized person should use the product.

Model: RCWFM Series (250~2000RT)

P/NO : MFL68929304 (Rev 0)

www.lge.com

For your records

Staple your receipt to this page in case you need it to prove the date of purchase or for warranty purposes. Write the model number and the serial number here:

Model number :

Serial number :

You can find them on a label on the side of each unit.

Dealer's name :

Date of purchase :

1. CAUTIONS FOR SAFETY

The installation, transportation and bring-in of heavy objects, and environment of the product can be dangerous due to such factors as the pressure, electric equipment, location (roof and lifting method), etc. of the system.

While operating the product, please check and observe the warning/caution on the sticker or label attached to the product.

You must comply with the following instructions to prevent an injury or a property damage of the user or others.

- Incorrect operation of the product stemming from ignoring the instructions on the instruction manual may cause an injury or damage. The seriousness is classified into the following signs.
- LG Electronics does not take any responsibility for failures caused by careless management, natural disasters and damages of the power cord regardless of the warranty period.
- The content in the instruction manual may change for the improvement of the product without a notice.

⚠ WARNING

It can result in serious injury or death when the directions are ignored.

⚠ CAUTION

It can result in minor injury or product damage when the directions are ignored.

The meanings of the symbols used in this manual are as follows.

This is the symbol to call attention for the issues and operations that may cause danger.
To prevent the occurrence of the danger, read carefully and follow the instructions.

This is the symbol showing the how-to-use instruction in order to prevent danger.

Follow the direction.

1-1. WARNING

- Certified engineers should do electrical works following "Technology standard or wiring standard of an electrical installation", "Interior wiring standard" and the instruction manual and should use specific wires.
  - An improper power capacity or defect of electrical works may cause fire or electric shock.
- Ask the dealer or an authorized technician to install the chiller unit.
  - Improper installation by the user may result in water leakage, electric shock, or fire.
- For re-installation of the installed product, always contact a dealer or an Authorized Service Center.
  - There is risk of fire, electric shock, explosion, or injury.
- Make sure to equip the circuit breaker and fuse.
  - Improper wiring or installation may cause fire or electric shock.
- Do not disassemble, repair or reconfigure the unit.
  - LG Electronics is not responsible for the any damage or loss from the arbitrary disassembly, repair or reconfiguration of the unit.
- Make sure to ground the unit properly.
  - There is risk of fire or electric shock.
- Do not store or use flammable gas or combustibles near the chiller unit
  - There is risk of fire or failure of product.
- Do not reconstruct to change the settings of the protection devices.
  - If the pressure switch, thermal switch, or other protection device is shorted and operated forcibly, or parts other than those specified by LGE are used, fire or explosion may result.
- Install the unit on a foundation where the heavy weight can be supported.

- Insufficient strength of the foundation to support the chiller operation may cause the unit failure or injury.

• Installing the product in small space requires separate measures to keep the leakage of the refrigerant within the safety limits in case of any leakage.
  - Consult the authorized dealer for appropriate measures to prevent the refrigerant leakage from exceeding the safety limits. The leakage of refrigerant exceeding the safety limit may result in dangerous situations due to the lack of oxygen level in the room.
• Securely install the cover of control box and the panel.
  - If the cover and panel are not installed securely, dust or water may enter the unit and fire or electric shock may result.
• Do not operate the unit arbitrarily.
  - Incorrect operation of the unit may cause dangerous situations such as unit defects, leakage or electric shock. Always consult the authorized dealer.
• Do not use damaged circuit breaker or fuse works correctly all the time.
  - It may cause fire, electric shock or injury.
• Keep the control panel from any water getting in.
  - Do not wash the control panel with water. It can cause electric shock or defects.
• When the product is soaked (flooded or submerged), contact an Authorized Service Center.
  - There is risk of fire or electric shock.
• Make sure to use an exclusive cable of the product.
  - There is risk of fire or electric shock.
• Make sure to charge only the exclusive refrigerant R134a when installing or moving to other place.
  - If a different refrigerant or air is mixed with the original refrigerant, the refrigerant cycle may malfunction and the unit may be damaged.
• Do not touch the power switch with wet hands.
  - There is risk of fire, electric shock, explosion, or injury.
• Ventilate before operating the chiller unit when gas leaked out.
  - Do not use a phone or operate the power switch at this time. It may cause fire or explosion.
• Do not put any heavy object on the top of the unit or climb on the unit.
  - It may cause defects or injury.
• Be careful with the rotating part.
  - Do not put your fingers or a stick to the rotating part. It can cause injury.
• Use the fuse and circuit breaker with rated capacity.
  - It may cause fire and defects.
• Redesigning the control box is prohibited.
  - Lock the control box with possible locking device and if you need to open the control box inevitably, turn off the main power first.
• Do not touch the wiring or a parts inside the panel.
  - It may cause electric shock, fire or defects.
• Follow the permitted pressure level
  - Follow the regulated pressure for cold water, cooling water, refrigerant etc.
• Do not change the set values.
  - Do not change the set values of the controller and safety devices. Operating with inappropriate setting can cause damages. When changing the setting values, please consult with the specialist.
• Be careful of fire, earthquake and lightening.
  - In case of any natural disaster such as fire, earthquake or lightening, immediately stop operating the unit. If you continue to operate the unit, it can cause a fire or electronic shock.
• Follow all safety code.
  - When operate the chiller, follow the precautions on the manual, tag, sticker and label.
• Use of undesignated refrigerant and oil is prohibited.
  - Do not use undesignated refrigerant, freezer oil and brine. It may cause serious effect to the compressor and parts defect.
• During the installation and service, shut down the power supply.

- Electric shock can cause injury and death. Mark and check all switches so that the power is not recovered until the work is completed.

• Wear safety equipment

- Wear safety glasses and work gloves. Be careful when installing or operating the chiller and operating the electrical components.

• Always run fluid through heat exchangers when adding or removing refrigerant charge.

- Potential damage of the tube within the heat exchanger can be prevented. Use Appropriate brine solution in cooler fluid loops to prevent the freezing of heat exchangers when equipment is exposed to temperature below 0°C.

• Do not vent refrigerant relief valves within a building.

- Outlet from relief valves must be vented outdoors in accordance with the latest edition of ANSI/ASHRAE(American National Standards Institute/American Society of Heating, Refrigeration and Air Conditioning Engineers) 15 (Safety Code for Mechanical Refrigeration). The accumulation of refrigerant in an enclosed space can displace oxygen and cause asphyxiation. Provide adequate ventilation in enclosed or low overhead areas. Inhalation of high concentrations of refrigerant gas is harmful and may cause heart irregularities, unconsciousness or death. Misuse can be critical. Refrigerant gas is heavier than air and reduces the level of oxygen. It can cause irritation to eyes and skin.

• Be careful of water leakage.

- In case of any water leakage in the pump or pipe, immediately stop operating the unit. It may cause electric shock, electricity leakage or defects. Be careful of electric shock.

• Always ground the chiller during installation.

- It may cause electric shock.

• Do not leave refrigerant system open to air any longer than necessary.

- If the repair cannot be completed, seal the circuits to prevent any contamination or rust within the product, and charge dry nitrogen.

• Do not reuse compressor oil.

- It can damage the product.

• During installation, make the specified grounding before supplying the power, and during the dismantling, remove the grounding line at the end of the task.

• Use appropriate meters for measurement. Otherwise, it may cause injury or electric shock.

• Check all power connected to the control panel or starter panel to be shut off while applying the power.

- It may cause electric shock.

• Make sure to discharge the electric current before inspection or repair work.

- It may cause injury or electric shock.

• Do not open the 2nd phase side of the current transformer when power is on.

- High voltage could be discharged causing an electric shock.

• Remove foreign objects(working tools, wires, bolts, washers) after installation, inspection, and repair work.

- They may cause injury, fire, or damage.

• When using a condenser, make sure to verify the complete discharge before applying the power again. (Re-powering within 5 min. is prohibited.)

- It may cause electric shock, fire, damage, or malfunction.

• Change the condenser in case that the expansion exceeds the recommended limit.

- It may cause electric shock, fire, damage, or malfunction.

1-2. CAUTION

Operation & Maintenance

- Always check for gas(refrigerant) leakage after installation or repair of product.
  - Low refrigerant levels may cause failure of product.
- Do not install the unit where combustible gas may leak.
  - There is risk of fire or failure of product
- Keep level even when installing the product.
  - Unleveled refrigerant can cause problems to the product.
- Do not use the product for special usage or location such as preserving animal/plant, precision machine, artifact, etc.
  - It may cause property damage.
- Use the exclusive power cable of the enough allowable current capacity exclusively for the Chiller.
  - It may cause fire and electric shock.
- When installing the unit in a hospital, communication station, or similar place, provide sufficient protection against noise.
  - The inverter equipment, private power generator, high-frequency medical equipment, or radio communication equipment may cause the chiller to operate erroneously, or fail to operate. On the other hand, the chiller may affect such equipment by creating noise that disturbs medical treatment or image broadcasting.
- To protect the product from corrosion, do not install the product where it is exposed to sea wind(salt spray) directly. If necessary, please install shield.
  - It may cause product deformation and defects.
- Make the connections securely so that the outside force of the cable may not be applied to the terminals.
  - Inadequate connection and fastening may generate heat and cause fire. If the power cable got damaged, do not directly replace it, but call the service center for replacement first.
- Do not use the product in special environments.
  - Oil, steam and sulfuric steam can deteriorate the product performance or cause damage to the parts.
- Be careful when transporting the product.
  - When carrying the chiller, always consult with the specialized expert.
- When transporting the chiller, always follow the methods described in the manual.
  - If not, it can cause overturn, fall etc.
- Do not touch any of the refrigerant piping during and after operation.
  - Pipe during and after the operation can be hot or cold depending on the condition of the refrigerant flowing through the refrigerant pipe, compressor and refrigerant cycle parts.
    Touching the pipes at this time can cause burns or frostbites.
- Turn on the main power 12 hours before starting to operate the product.
  - If you operate the product immediately after turning on the main power, it can severely damage the internal parts.
    Keep the main power on while operating.
- Do not immediately turn off the main power after the product stops operating.
  - Wait at least 5 minutes before turning off the main power. Failure to do so can cause water leak or other issues.
- Do not operate the product with the panel or safety devices removed.
  - Rotating parts or high temperature/pressure parts can cause safety accidents.
- Be careful when disposing the product.
  - When disposing the chiller, request to the specialized expert.
- Use a firm stool or ladder when cleaning or maintaining the chiller.
  - It may cause an injury.
- Be careful of high temperature.
  - Be careful not to make body contact to the parts of the chiller in high temperature.
    It may cause a burn.
- Be careful of high voltage.
  - Install separate wiring for the power and always install and use dedicated power supply and circuit breaker.
    It can cause electric shock and fire.

- Be careful of chiller installation.
  - Keep enough clearance around the product for service and especially for air cooling type, install the product at well ventilated location where there is no obstacle.
- Harsh chemical, household bleach or acid cleaner should not used to clean outdoor or indoor coils of any kind.
  - These cleaners can be very difficult to rinse out of the coil and can accelerate corrosion at the fin/tube interface where dissimilar materials are in contact. Use environment friendly cleaner.
- Be careful when restarting the product.
  - When a safety device is triggered, remove the cause and then restart the product. Repeating the operation arbitrarily can cause fire and defect.
- Use appropriate tools.
  - Use tools appropriate for the repair work and calibrate the measuring devices accurately before using. Using inappropriate tools can cause an accident.
- Be careful of sound and odor.
  - If you hear a weird sound or smell an odor, immediately stop operating the system and contact the service center. It may cause fire, explosion or injury.
- Be careful of injury.
  - Check the safety label of the safety device. Follow the above precautions and the contents in the label. It may cause fire and injury. To prevent the formation of the condensed water, the pipe connected to the evaporator as well as the evaporator itself should be well insulated.
- Check.
  - Perform periodic checks. If any problem occurs, stop the operation and contact the service center. Insufficient check may cause fire, explosion or error.
- Do not attempt to bypass or alter any of the factory wiring.
  - Any compressor operation in the reverse direction will result in a compressor failure that will require compressor replacement.
- Do not use jumpers or other tools to short out components, or bypass the parts differently from recommended procedures.
  - Short-circuiting the control board ground line with other wires can damage the electric module or electric components.
- Water must be within design flow limits, and should be treated cleanly.
  - This make it possible to ensure proper machine performance and reduce the potential of tubing damage due to corrosion, scaling, erosion and algae. LG Electronics is not responsible for any damage caused by cooling water not treated or improperly treated.
- Consult a water treatment specialist for proper treatment procedures.
  - Hard scale may require chemical treatment for its prevention or remove.
- Do not overcharge refrigerant to the system.
  - Refrigerant overcharging results in higher discharge pressure with higher cooling fluid consumption. Also it can damage the compressor and increase the power consumption. Also it can damage the compressor and increase the power consumption.
- Do not add different type of oil.
  - It may cause abnormal operation of chiller.
- Turn controller power off before service work.
  - It secures safety and prevents damage to the controller.
- Maintain the compressor oil pressure to normal level.
  - Use proper safety precautions whem relieving pressure.
- Welding the evaporator head or nozzle part is not recommended.
  - If the part requires welding, remove the chilled water flow switch and entering/leaving fluid thermistors before welding.
  - After the welding is completed, reinstall the flow switch and thermistors.
  - Failure to remove these devices may cause component damage.
- Do not open the circuit breaker arbitrarily during the operation.
  - It may cause damage or malfunction.

- Do not operate with wet hand.
  - It may cause electric shock.
- During maintenance work, check whether all of the power lines connected to the control panel or starter panel are interrupted.
  - It may cause electric shock.
- When power is on, do not open the door of control panel or starter panel, and protective cover.
  - It may cause electric shock.
- Do not open the circuit breaker without permission while running.
  - It may cause damage or malfunction.
- Tighten bolts and screws with the specified torque.
  - Otherwise, it may cause fire, damage, or malfunction.
- Do not change electric or control devices arbitrarily.
  - It may cause fire, damage, or malfunction.
- Only the persons who have sufficiently studied the user's manual should operate the control panel or starter panel.
  - Otherwise, it may cause injury, fire, malfunction, or damage.
- Do not perform welding work near cables connected to the main unit.
  - Otherwise, it may cause fire or damage.
- Connect only the input/output signal cables specified in the drawing to the control panel or starter panel.
  - Otherwise, it may cause malfunction or damage.
- Use the rated electrical cables.
  - If not, it may cause fire or damage.
- Use specified parts for repair.
  - If not, it may cause fire or damage.
- Install the machine, control panel, and starter panel at a place where there is no combustible material.
  - Otherwise, it may cause fire.
- Do not exceed the voltage supply limit described in the relevant manual.
  - Otherwise, it may cause damage or malfunction.
- Connect the signal cables connected to the control devices following the circuit diagram.
  - It may cause damage or malfunction.
- Do not store the product in a place where is a flooding risk or a lot of moisture.
  - Otherwise, it may cause damage or malfunction.
- Do not use the indoor control panel or starter panel outside of the building.
  - Otherwise, it may cause damage or malfunction.

Thank you for using LG water-cooled centrifugal chiller.
Correct installation complying with this operation manual will guarantee much more convenient, safe and long-term use.

- Please read this manual before use in order to install the centrifugal chiller safely and correctly.
- After completing the installation, please carry out a test run and examine the chiller in accordance with the manual.

❊ This manual describes the introduction, control, start-up test, maintenance, and trouble shooting of the chiller.

CONTENTS

2. INTRODUCTION

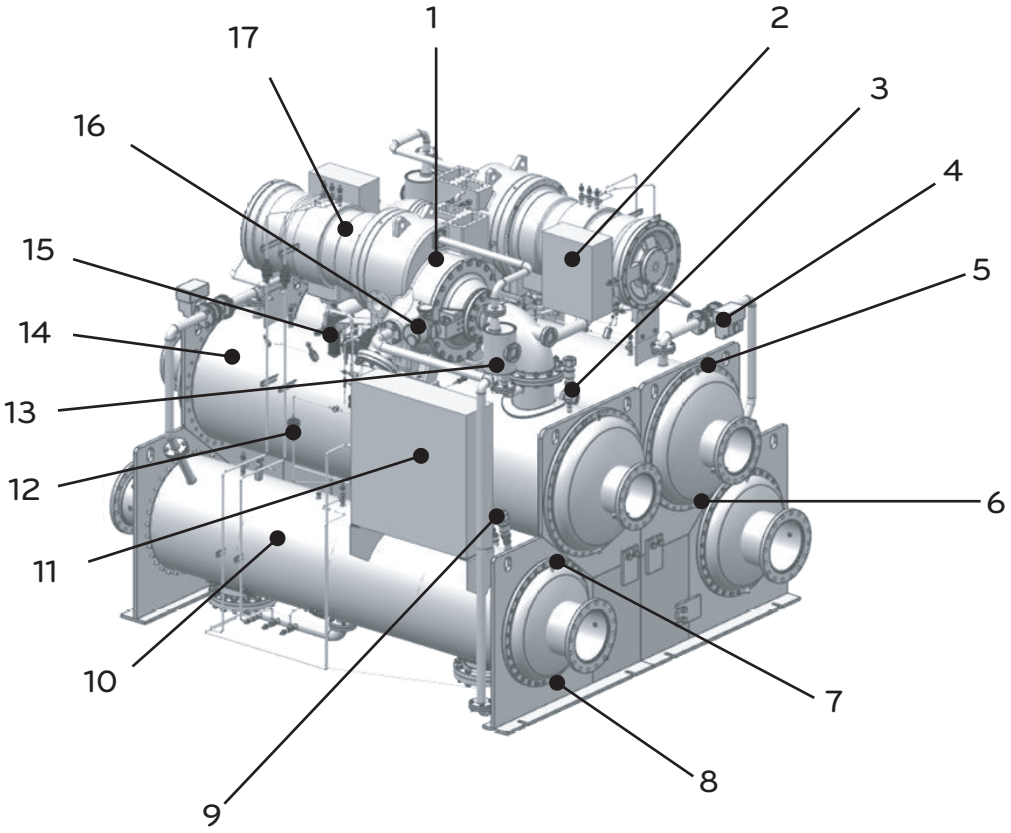
2-1. General Instruction

This manual explains the operation of two-stage Centrifugal Chiller of the RCWFM Series that uses R-134a and to which X30 controller is applied.

2-2. Product Structure

Figure 1 represents the general structure and part composition of the two-stage module Centrifugal Chiller.

As the location of the control board, the water box, direction of inlet/outlet of the chilled water/cooling water and some piping differ based on models and customer specifications, check the approved drawing matching with the site for the details.



1. Compressor
2. Terminal box for the compressor motor
3. Evaporator safety valve
4. Hot gas bypass (option)
5. Port for the air vent (chilled water)
6. Drain port & plug (chilled water)
7. Port for the air vent (cooling water)
8. Drain port & plug (cooling water)
9. Condenser safety valve
10. Condenser
11. Control panel
12. Drier filter
13. Oil Separator
14. Evaporator
15. Oil filter
16. Actuator (Vane motor)
17. Compressor motor

Figure 1. Components of 2-stage modular centrifugal chiller

2-3. Nomenclature

The nomenclature for the Fig. 2 centrifugal chiller is as follows.

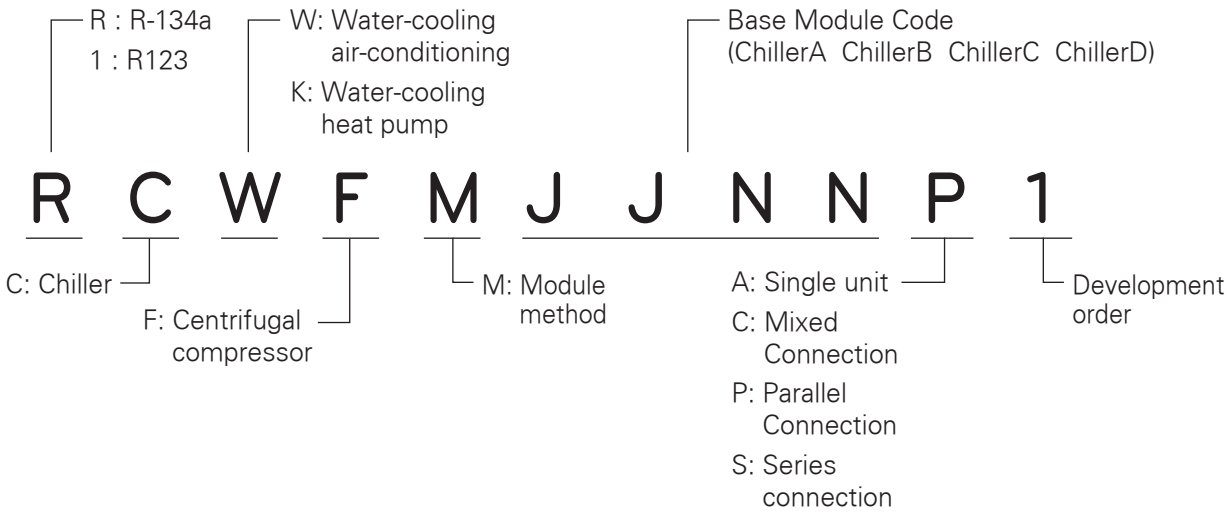


Figure 2. Naming Convention of a Model

Base Module

Module Code	compressor	Evaporator	Condenser	Product Weight [kg]	Operating Weight [kg]	Oil Weight [kg]	Refrigerant Weight [kg]
A	A1	AA	AA	5,900	7,100	40	300
B	A1	AC	AC	6,100	7,350	40	350
D	A3	AC	AC	6,100	7,350	40	350
E	A3	AC	AM	6,250	7,500	40	400
F	A3	AT	AM	6,400	7,650	40	400
G	B1	BA	BA	7,300	8,800	40	450
H	B2	BB	BB	7,600	9,150	40	500
J	B3	BC	BC	8,000	9,600	40	550
K	B3	BD	BD	8,400	10,000	40	650
N	None						

Combination of 2

Capacity		Chiller A	Chiller B	Chiller C	Chiller D
RT	kW				
600	2110	D	D	N	N
700	2461	F	F	N	N
800	2813	G	G	N	N
900	3164	H	H	N	N
1000	3516	J	J	N	N
1200	4219	K	K	N	N

Combination of 4

Capacity		Chiller A	Chiller B	Chiller C	Chiller D
RT	kW				
1400	4922	F	F	F	F
1600	5626	G	G	G	G
1800	6329	H	H	H	H
2000	7032	J	J	J	J
2400	8438	K	K	K	K

2-4. Information on nameplate

The nameplate is attached on the right side of the control panel. Basic information of the product can be identified on the plate and the history of the product can be quickly identified and appropriate measures can also be quickly taken in virtue of this information during service work.

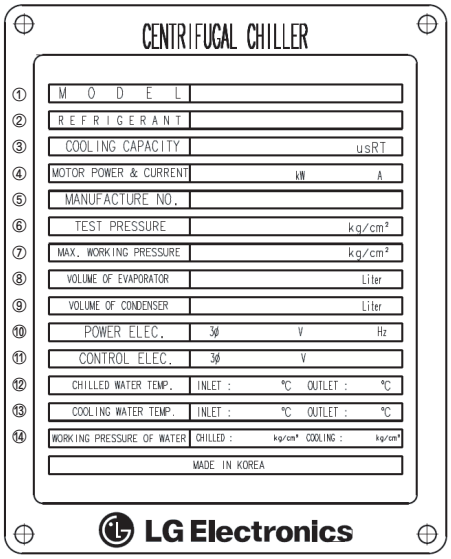


Figure 3. Nameplate

① Model name
② Refrigerant
③ Cooling capacity
④ Power and current required for motor
⑤ Manufacture's serial number
⑥ Internal pressure test pressure
⑦ Maximum working pressure (Design pressure)
⑧ Volume of Evaporator
⑨ Volume of Condenser
⑩ Power electricity
⑪ Control electricity
⑫ Temperatures of Chilled water inlet/outlet
⑬ Temperatures of Cooling water inlet/outlet
⑭ Maximum pressure of chilled water and cooling water

2-5. Conversion of Major Units

Temperature conversion table (°F ↔ °C)

- °F = (9/5 x °C) + 32
- °C = 5/9 x (°F - 32)

°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
1	-17.2	31	-0.6	61	16.1	91	32.8	121	49.4
2	-16.7	32	0	62	16.7	92	33.3	122	50.0
3	-16.1	33	0.6	63	17.2	93	33.9	123	50.6
4	-15.6	34	1.1	64	17.8	94	34.4	124	51.1
5	-15.0	35	1.7	65	18.3	95	35.0	125	51.7
6	-14.4	36	2.2	66	18.9	96	35.6	126	52.2
7	-13.9	37	2.8	67	19.4	97	36.1	127	52.8
8	-13.3	38	3.3	68	20.0	98	36.7	128	53.3
9	-12.8	39	3.9	69	20.6	99	37.2	129	53.9
10	-12.2	40	4.4	70	21.1	100	37.9	130	54.4
11	-11.7	41	5.0	71	21.7	101	38.3	131	55.0
12	-11.1	42	5.6	72	22.2	102	38.9	132	55.6
13	-10.6	43	6.1	73	22.8	103	39.4	133	56.1
14	-10.0	44	6.7	74	23.3	104	40.0	134	56.7
15	-9.4	45	7.2	75	23.9	105	40.6	135	57.2
16	-8.9	46	7.8	76	24.4	106	41.1	136	57.8
17	-8.3	47	8.3	77	25.0	107	41.7	137	58.3
18	-7.8	48	8.9	78	25.6	108	42.2	138	58.9
19	-7.2	49	9.4	79	26.1	109	42.8	139	59.4
20	-6.7	50	10.0	80	26.7	110	43.3	140	60.0
21	-6.1	51	10.6	81	27.2	111	43.9	141	60.6
22	-5.6	52	11.1	82	27.8	112	44.4	142	61.1
23	-5.0	53	11.7	83	28.3	113	45.0	143	61.7
24	-4.4	54	12.2	84	28.9	114	45.6	144	62.2
25	-3.9	55	12.8	85	29.4	115	46.1	145	62.8
26	-3.3	56	13.3	86	30.0	116	46.7	146	63.3
27	-2.8	57	13.9	87	30.6	117	47.2	147	63.9
28	-2.2	58	14.4	88	31.1	118	47.8	148	64.4
29	-1.7	59	15.0	89	31.7	119	48.3	149	65.0
30	-1.1	60	15.6	90	32.2	120	48.9	150	65.6

Table 1. Temperature conversion table

Pressure conversion table (lb/in^2 ↔ kg/cm^2)

- lb/in^2 = psi
  ex) 1 lb/in^2 = 0.07030696 kg/cm^2

lb/in^2	kg/cm^2	lb/in^2	kg/cm^2	lb/in^2	kg/cm^2	lb/in^2	kg/cm^2	lb/in^2	kg/cm^2
1	0.070	41	2.883	81	5.695	121	8.507	161	11.32
2	0.141	42	2.953	82	5.765	122	8.577	162	11.39
3	0.211	43	3.023	83	5.836	123	8.648	163	11.46
4	0.281	44	3.094	84	5.906	124	8.718	164	11.53
5	0.352	45	3.164	85	5.976	125	8.788	165	11.60
6	0.422	46	3.234	86	6.046	126	8.859	166	11.67
7	0.492	47	3.304	87	6.117	127	8.929	167	11.74
8	0.563	48	3.375	88	6.187	128	8.999	168	11.81
9	0.633	49	3.445	89	6.257	129	9.070	169	11.88
10	0.703	50	3.515	90	6.328	130	9.140	170	11.95
11	0.773	51	3.586	91	6.398	131	9.210	171	12.02
12	0.844	52	3.646	92	6.468	132	9.281	172	12.09
13	0.914	53	3.726	93	6.539	133	9.351	173	12.16
14	0.984	54	3.797	94	6.609	134	9.421	174	12.23
15	1.055	55	3.867	95	6.679	135	9.491	175	12.30
16	1.125	56	3.987	96	6.750	136	9.562	176	12.37
17	1.195	57	4.008	97	6.820	137	9.632	177	12.44
18	1.266	58	4.078	98	6.890	138	9.702	178	12.51
19	1.336	59	4.148	99	6.968	139	9.773	179	12.58
20	1.406	60	4.218	100	7.031	140	9.843	180	12.66
21	1.477	61	4.289	101	7.101	141	9.913	181	12.73
22	1.547	62	4.359	102	7.171	142	9.984	182	12.80
23	1.617	63	4.429	103	7.242	143	10.05	183	12.87
24	1.687	64	4.500	104	7.312	144	10.12	184	12.94
25	1.758	65	4.570	105	7.382	145	10.19	185	13.01
26	1.828	66	4.640	106	7.453	146	10.26	186	13.08
27	1.898	67	4.711	107	7.523	147	10.34	187	13.15
28	1.969	68	4.781	108	7.593	148	10.41	188	13.22
29	2.039	69	4.851	109	7.663	149	10.48	189	13.29
30	2.109	70	4.921	110	7.734	150	10.55	190	13.36
31	2.180	71	4.992	111	7.804	151	10.62	191	13.43
32	2.250	72	5.062	112	7.874	152	10.69	192	13.50
33	2.320	73	5.132	113	7.945	153	10.76	193	13.57
34	2.390	74	5.203	114	8.015	154	10.83	194	13.64
35	2.461	75	5.273	115	8.085	155	10.90	195	13.71
36	2.531	76	5.343	116	8.156	156	10.97	196	13.78
37	2.601	77	5.414	117	8.226	157	11.04	197	13.85
38	2.672	78	5.484	118	8.296	158	11.11	198	13.92
39	2.742	79	5.554	119	8.367	159	11.18	199	13.99
40	2.812	80	5.625	120	8.437	160	11.25	200	14.06

Table 2. Pressure conversion table

3. STRUCTURE OF 2-STAGE CENTRIFUGAL CHILLER

3-1. Cycle of Chiller

The cycle of 2-Stage centrifugal chiller uses eco-friendly high pressure refrigerant R-134a.

- In this cycle, as shown in the following figure, the low temperature and low pressure refrigerant gas vaporized in the evaporator passes the guide vane and is sucked into the first stage impeller of the compressor. The chiller capacity is controlled by the amount of sucked gas as it is controlled by the opening degree of the guide vane.
- The refrigerant gas sucked into the first impeller is compressed into mid-temperature and mid-pressure refrigerant gas and passes the return channel and is cooled by the low temperature refrigerant gas of economizer and then is sucked into the second stage impeller.
- The refrigerant gas sucked into the second stage impeller is discharged to the condenser after being compressed into high temperature and high pressure refrigerant gas and then is condensed after being cooled by the cooling water in the heat transfer tubes of condenser.
- The condensed liquid refrigerant passes the first stage expansion device and enters the lower part of the economizer which divides the liquid into gas and liquid refrigerant. The gas is mixed with the mid temperature and mid pressure gas which was compressed in the first stage impeller and then enters the second stage impeller. The liquid refrigerant enters the lower part of evaporator via the second stage expansion device.
- The liquid refrigerant which has entered the lower part of the evaporator is then spread through the whole length of the evaporator by distributor and finally evaporates by taking the heat from the chilled water flowing inside the evaporator tubes and repeats the same cycle.
- Some part of the over-cooled liquid refrigerant in the condenser, flows through the valve, filter, and moisture indicator; and flows being divided into the motor cooling system and the oil cooling system.
- The liquid refrigerant which flows into the motor is being sprayed to cool the motor's coil and then returns to the evaporator.
- The refrigerant which flows into the oil cooling system flows through the disc-shaped oil cooler and then returns to evaporator.

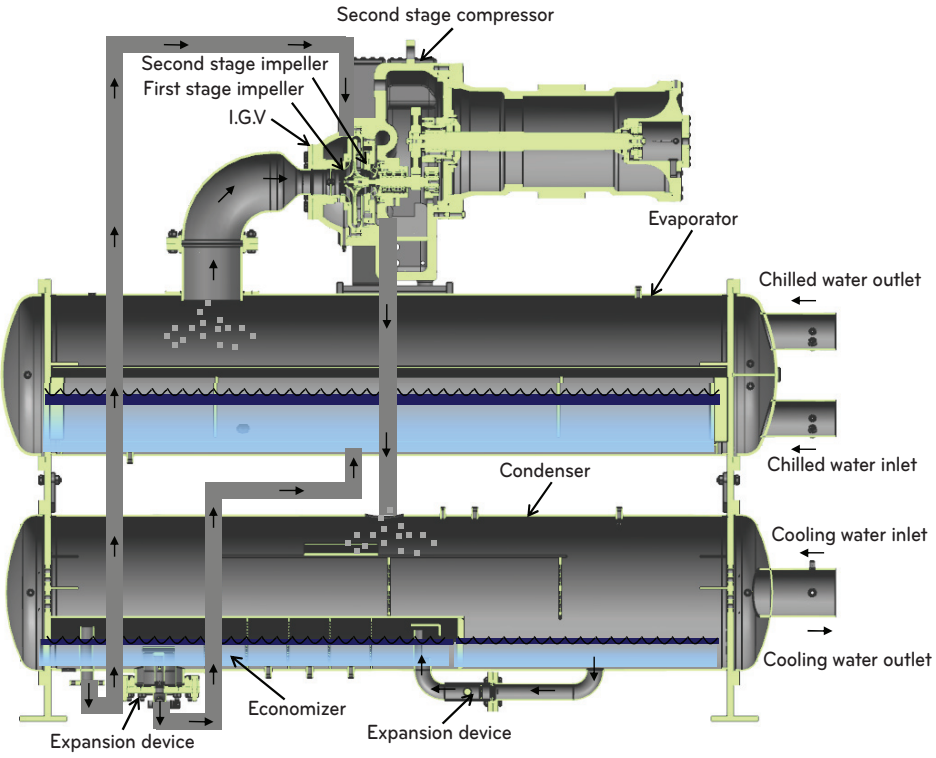


Figure 4. 2-Stage Centrifugal Chiller

3-2. Main Components of 2 Stage Centrifugal Chiller

Compressor

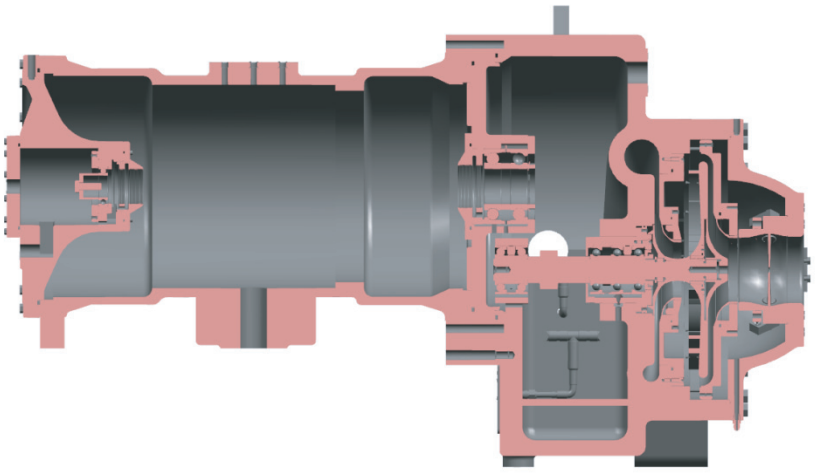


Figure 5. Hermetic two-stage high-speed compressor

*Two-stage Centrifugal chiller compressor is composed of impeller, bearing, diffuser, capacity control device and multiplying gear. It discharges the high temperature and high pressure gas to condenser, of which the compression was made as the low temperature and low pressure gas taken from the evaporator passed through impeller and diffuser.

The characteristics of major components are as follows.

1. Impeller
   - The vane of impeller designed aerodynamically on the basis of 3D fluid analysis guarantees the reliability in any operational condition.
   - The dynamic balancing of impeller minimizes vibration, and the thorough examination such as strength test, hardness test, non-destructive test, etc. for every impellers produced secures reliability.
2. Bearing
   - Bearing is composed of insulted bearing on motor axis and angular contact bearing on impeller axis.
   - The structure of bearing sustains radial load and axial load at the same time. The number of its components is less than the existing bearing system, which makes maintenance work easier.
   - In ball bearing system, the rotation system has a compact design since the amount of oil supply is small.
3. Capacity control device
   - It controls the capacity of the chiller by adjusting the refrigerant flow sucked through the compressor inlet and also controls the opening of the vane using the external actuator. The refrigerant flow sucked at this time is adjusted in accordance with set temperature of chilled water outlet.

Heat exchanger

Heat exchanger of two-stage centrifugal chiller is composed of an evaporator and a condenser and has two shells for easy separation. The heat transfer tubes are optimally arranged to maximize the heat exchanging ability. A refrigerant distributor is installed to spread the refrigerant evenly over the whole tubes for the purpose of preventing the surge or decrease of COP in partial load. A safety valve is installed at the upper part of the heat exchanger for an emergency situation.

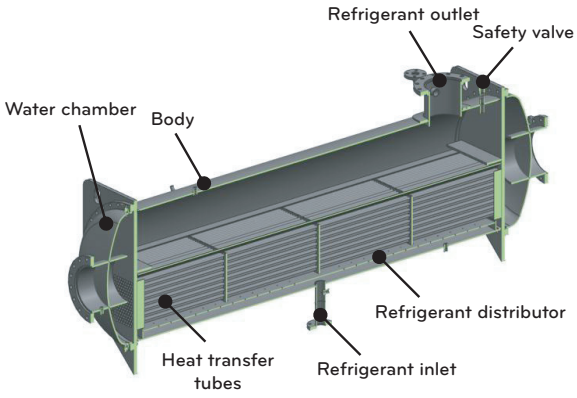


Figure 6. Evaporator

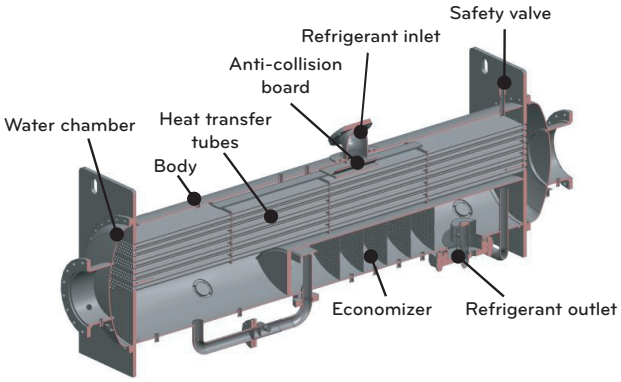


Figure 7. Condenser

Expansion device and economizer

Expansion device is composed of either butterfly valve and fixed orifice or refrigerant level sensor and motor butterfly valve, depending on its optional specification. In case of fixed orifice, the volume of circulating refrigerant varies with load so that the refrigerant level of the condenser changes. On the other hand, when a refrigerant level sensor and motor butterfly valves are used, the refrigerant level can be constant because motor butterfly valves control the opening degree in accordance with different volumes of circulating refrigerant.

Since the volume of refrigerant is constant, if the refrigerant level of the condenser does not change, the refrigerant level of the evaporator becomes constant. The partial load efficiency is good because the refrigerant level does not vary with the change of load, which makes it possible to always use all the heat transfer tubes.

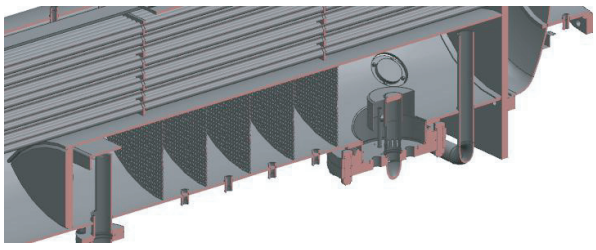


Figure 8. Economizer

The refrigerant which passes the first stage expansion device in the condenser is divided into liquid refrigerant and gas refrigerant in the economizer. The gas refrigerant is mixed with the mid-temperature and mid-pressure gas which was compressed in the first stage impeller and is sucked into the second stage impeller. The liquid refrigerant is sucked into the evaporator after passing the second stage expansion device. Between the first stage impeller and the second stage impeller, the first stage discharge refrigerant(superheated gas) is mixed with saturated gas supplied by the economizer and then is cooled before being sucked into the second impeller.

Thus, when the second stage impeller discharge gas temperature is decreased by the reduced temperature of the first stage impeller discharge gas, the required power for compressor can decrease so that the efficiency of cycle increases.

Therefore, the increased efficiency of cycle by the economizer raises the efficiency of 2-stage compression in comparison with that of 1-stage compression.

Lubrication system

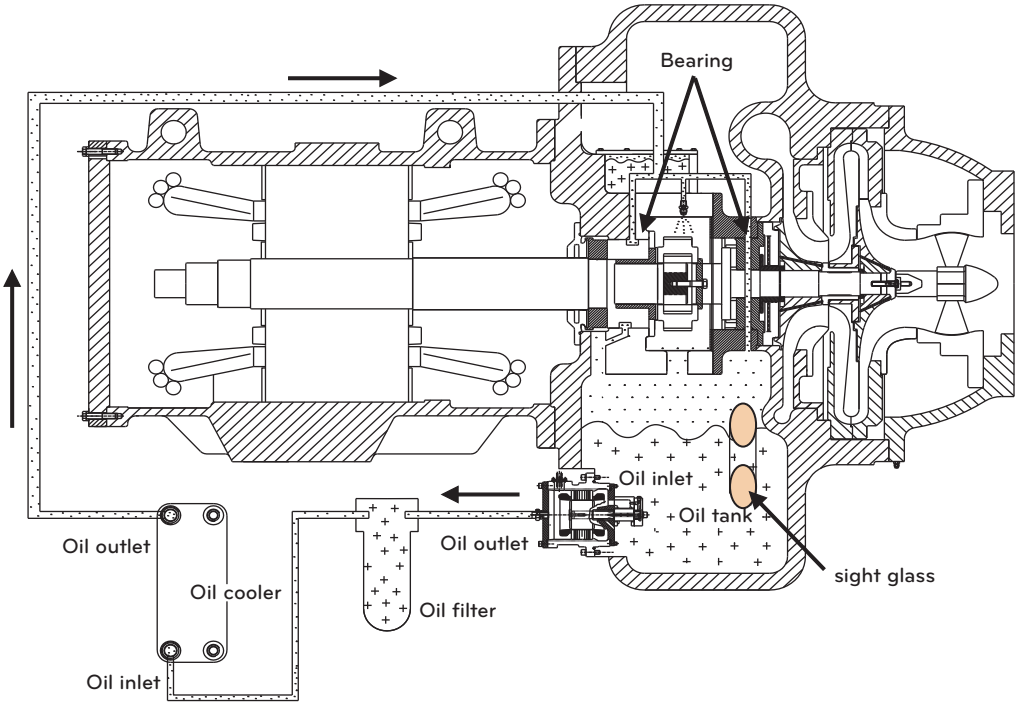


Figure 9. Lubrication cycle

Overview

The lubricating oil is discharged from the oil pump, passes through the oil filter to get relieved of foreign substances, and then is sent to the oil cooler. This oil is cooled to an appropriate temperature for operating condition by the oil cooler, and part of it is directly injected into the bearing on the gear and high speed side, and the remainder is directly injected into the bearing on the motor side.

After that, the oil is drained into the oil tank. The above figure shows the lubrication system of 2-stage compression.

Lubrication cycle

Oil is filled in the lubrication system by manual filling valve.
The oil level can be observed through the sight glass within the oil tank and the level shall should be observed through the sight glass during operation.
The temperature of the oil tank is indicated on the oil thermometer of the control panel and its temperature range should be 30~65 °C while operating.
The oil pump transfers the oil from the oil tank, and the oil pressure is maintained by the differential pressure of at least 1.0 kg/cm^2 when the pump discharges the oil.
This differential pressure can be confirmed by the difference between the oil tank pressure of the control panel pressure gauge and the oil pump pressure.
The oil pump sends the oil to the oil filter, and a valve is installed so that the oil filter can be exchanged without draining the oil. The oil is sent to the oil cooler and is cooled by the refrigerant from the condenser. The refrigerant cools the oil to the temperature of 40~60 °C.
The oil which departs the oil cooler lubricates the components of the rotating body(thrust bearing, multiplying gear, bear on the motor axis, radial bearing). The oil temperature is measured by the sensor within the oil tank and is displayed in the indicating window. When the chiller starts, the oil pump starts operating to lubricate the bearing by a constant pressure for 120~180 seconds before the timer starts the compressor, and the pump also operates for 300~600 seconds to lubricate the rotator of the compressor after the chiller stops.

Oil recovery system

Oil recovery system retrieves the oil from the heat exchanger of the chiller and makes it return to the oil tank. The system retrieves the oil mainly from the condenser together with refrigerant and also from guide vane housing. The refrigerant which comes into the oil tank evaporates into gas and is sent to the compressor inlet through the oil seperator line of the upper part of casing. The oil contained in the refrigerant is filtered by the demister filter.

Maintenance

Most of the defects of the rotating part in the chiller are caused by lubricating oil. Improper viscosity, oil pressure and flow contaminate the oil and deteriorate its lubricating performance, which can cause a defect.

Freon type refrigerants have a very close affinity with the oil, and its viscosity varies greatly with the change of temperature and pressure. Therefore, LG chiller has been designed with these characteristics in consideration.

In the oil tank, the oil pump driven by a hermetic motor and the heater controlled by a control device are installed. The tank is always maintained with high temperature in order to prevent such phenomenon as trouble by the mixture of oil and refrigerant, decrease of viscosity, damage of oil pump by cavitation (when water or fluid flows fast, the pressure of some part becomes relatively low so that water vaporizes and bubbles occur.) and inflow of refrigerant into oil by foaming.

The oil pump is operated for a while before the chiller starts being operated. This is to prevent the compressor from working in an unstable condition of the early stage where the refrigerant has flown into the oil of bearing or piping while the chiller stops. Since the compressor has inertial rotation after the chiller stops working, the oil pump also works until the compressor stops completely.

The only measure for defective lubrication caused by the deterioration of the oil is oil change. Therefore, changing work of the oil should be done thoroughly when the operation of cooling system is needed.

Safety devices

For safe operation and equipment protection the following devices are installed.

No.	Safety Devices	Installation Location	Measurement Item	Description	Quantity
1	Low temperature of chilled water	Chilled water inlet nozzle	Chilled water inlet temperature	This function is to stop the chiller when the chilled water outlet temperature is below 3°C since the chilled water can be frozen. This set value should never be changed.	1
2	Evaporator low pressure(low temperature)	Evaporator shell	Evaporating pressure(temperature)	The chiller stops in case the pressure in the evaporator drops below is not more than the following value. Standard set value: 1.95kg/cm^2	1
3	Condenser high pressure(high temperature)	Condenser shell	Condensing pressure(temperature)	The chiller stops in case the pressure in the condenser rises above is not more than the following value. Standard set value: 10.00kg/cm^2	1
4	Motor high temperature	Motor coil	Motor coil temperature	Temperature sensors are attached on each phase of coil in order to protect compressor motor, and the chiller stops when the coil temperature is not less than 90°C.	3
5	Compressor high temperature	Compressor outlet	Compressor discharge temperature	The chiller stops when the temperature of compressor discharge gas is not less than 70°C.	1
6	Bearing high temperature	Thrust bearing	Bearing temperature	Temperature sensor is installed at the thrust bearing which balances the thrust of impeller. The chiller stops when the temperature is not less than 85°C.	1
7	Low differential pressure of oil	Oil tank, oil pump outlet	Difference between oil supply pressure and suction pressure	When the differential pressure between oil supply pressure to bearing and the pressure in the oil tank is not more than 0.8kg/cm^2, the chiller stops.	1
8	Oil high temperature	Oil tank	Oil temperature in oil tank	When the oil temperature in the oil tank is not less than 74°C, the chiller stops.	1
9	Oil low temperature	Oil tank	Oil temperature in oil tank	Only when the temperature is not less than 30°C as the initial condition for starting the chiller, the chiller operation is possible.	1
10	Chilled water pump abnormality	Chilled water header	Chilled water loss head	When chilled water flow passing the heat transfer tube of evaporator is decreased, and the loss of head becomes below a set value, the chiller stops.	1
11	Cooling water pump abnormality	Cooling water header	Cooling water loss head	When cooling water flow passing the heat transfer tube of condenser is decreased and the loss of head becomes below a set value, the chiller stops.	1
12	Current limiting function	Control panel	Current	This function is to control the load of compressor motor. User may set arbitrarily within the scope of 40~100%.	1
13	Moisture indicator	Refrigerant supply piping	Water in refrigerant	This component has a function of changing color according to the quantity of moisture contained in refrigerant, and if there is no moisture it is green, and if there is moisture, it is yellow. In case yellow color appears, change the filter dryer.	1

No.	Item	Installation Location	Measurement Item	Description	Quantity
14	Relief valve	Evaporator shell, Condenser shell	Relief valve	When the pressure in the chiller exceeds a set value, the relief valve releases refrigerant in the air in order to prevent in advance a dangerous situation such as the increase of pressure which can be caused by fire. If the chiller is used in an enclosed place, piping from the relief valve to outside atmosphere should be installed.	1
15	Vane totally enclosed interlock	Vane motor	Working of temperature sensor	This function is to make compressor motor start with totally closed guide vane which is installed at the entrance of impeller to minimize starting current.	1
16	Abnormal temperature sensor	6 points including chilled water nozzle	each temperature sensor	It appears when temperature sensor is not connected or has its own defect.	1
17	Abnormal pressure sensor	4 points including evaporator shell	each pressure sensor	It appears when pressure sensor is not connected or has its own defect.	1
18	Overload relay	Control panel	Current	If compressor motor and oil pump motor are overloaded, each motor should be stopped.	1
19	Hot gas bypass valve	Evaporator shell, Condenser shell	Guide vane/ Hot gas valve opening	When vane is not more than 30%, hot gas bypass valve opens proportionally in order to prevent frequent shutdown at low load. At this time, hot gas of refrigerant in the condenser goes over to the evaporator and creates the load of the chiller arbitrarily so that both surge and frequent shutdown are prevented.	1

Table 3. Safety devices

ENGLISH

4. Control System

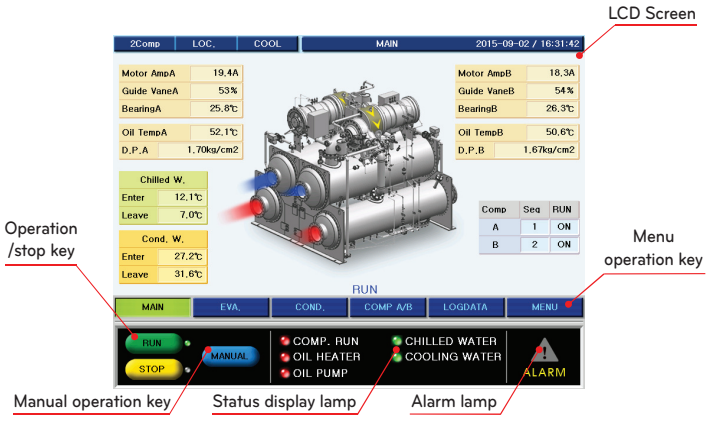
4-1. Constituents and main components of control panel

Controller

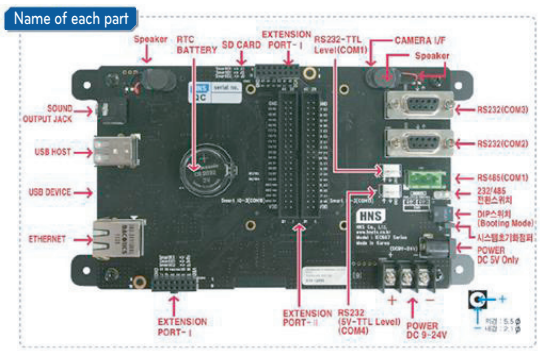
HMI which 7-inch color LCD has been applied to has a graphic configuration.

There are lamp keys for Operation/stop, vane and oil pump, compressor, oil pump, oil heater operation and chilled water/cooling water flow.

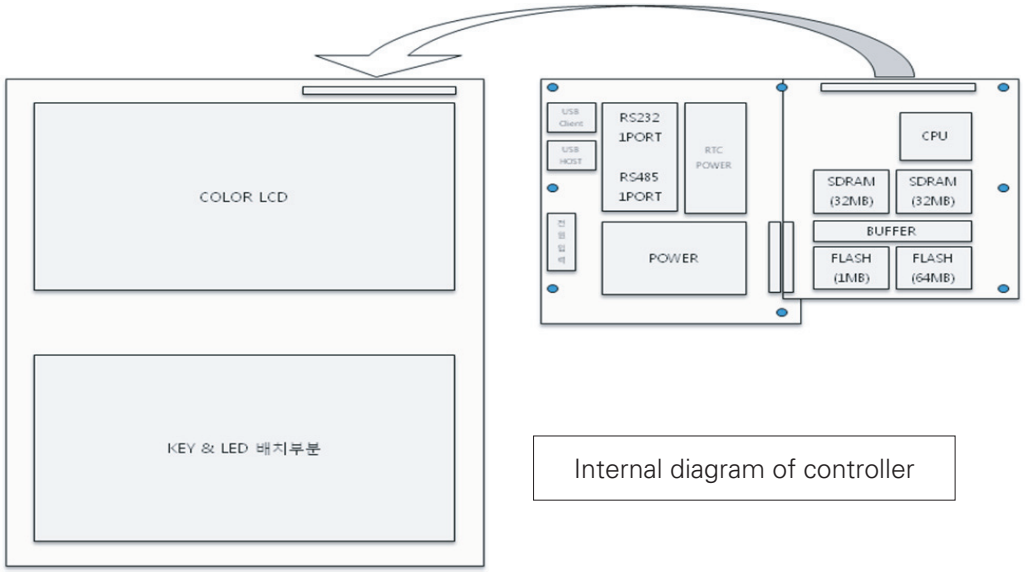
There are “Function Keys” at the bottom of the screen that change function according to the present screen to be able to access to the selected sub menu.



Front view of controller



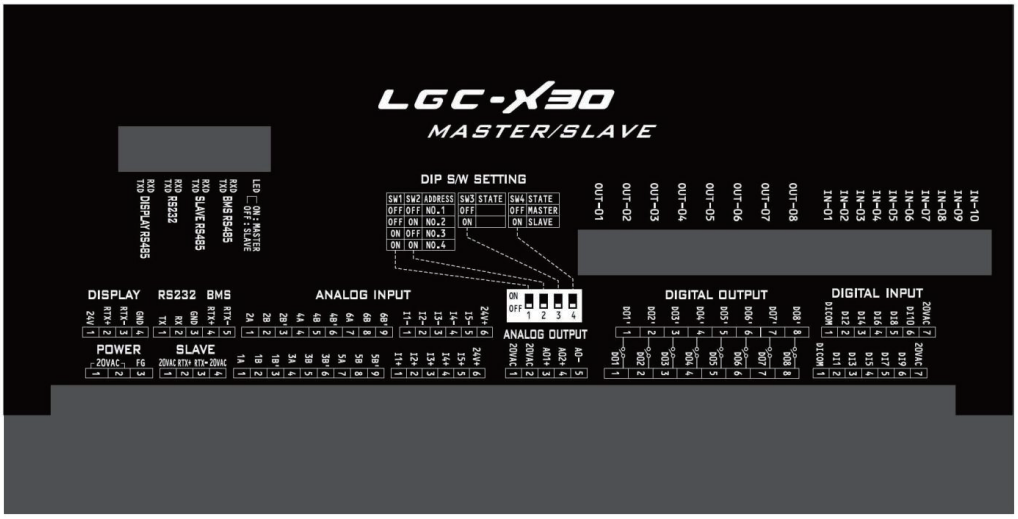
Rear view of controller



Internal diagram of controller

Figure 10. Controller

Master board and slave board are identical in hardware. It can be either master or slave by the set of DIP switch. (SW4 OFF: Master, ON: Slave). For the user's convenience, analogue input/output and digital input/output are composed of RS232, RS485 communication terminals.



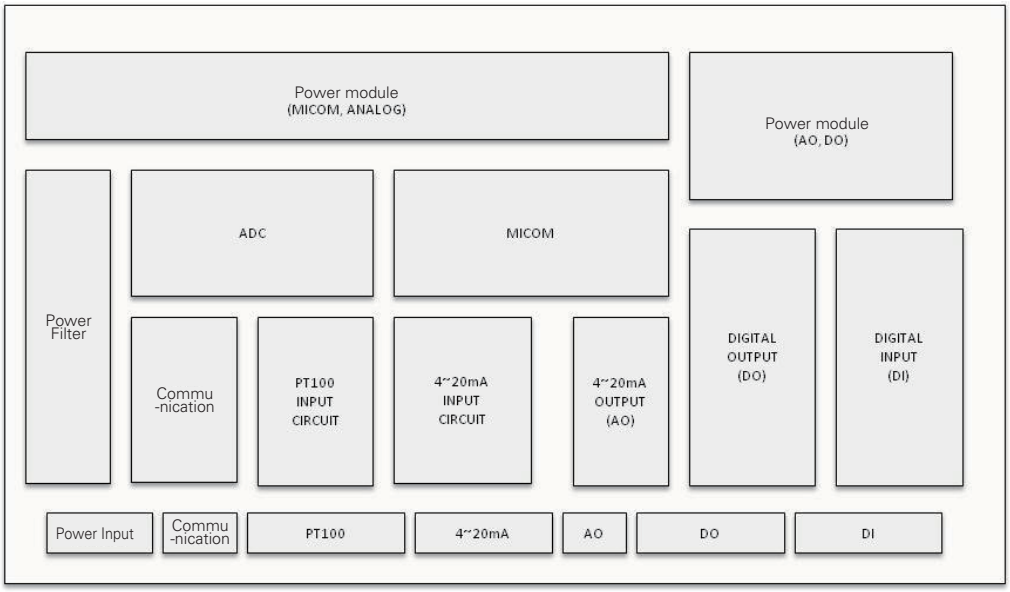


Figure 11. Internal construction of Master/Slave board

ENGLISH

Controller system diagram

Master, Slave, HMI, and Relay board communicate via RS485. One master/slave board is composed of analog input(temperature 12 channel, current 10 channel), analog output (current 4 channel), digital input (20 channel), and digital output (16 channel).
Relay board controls guide vane and diffuser vane.

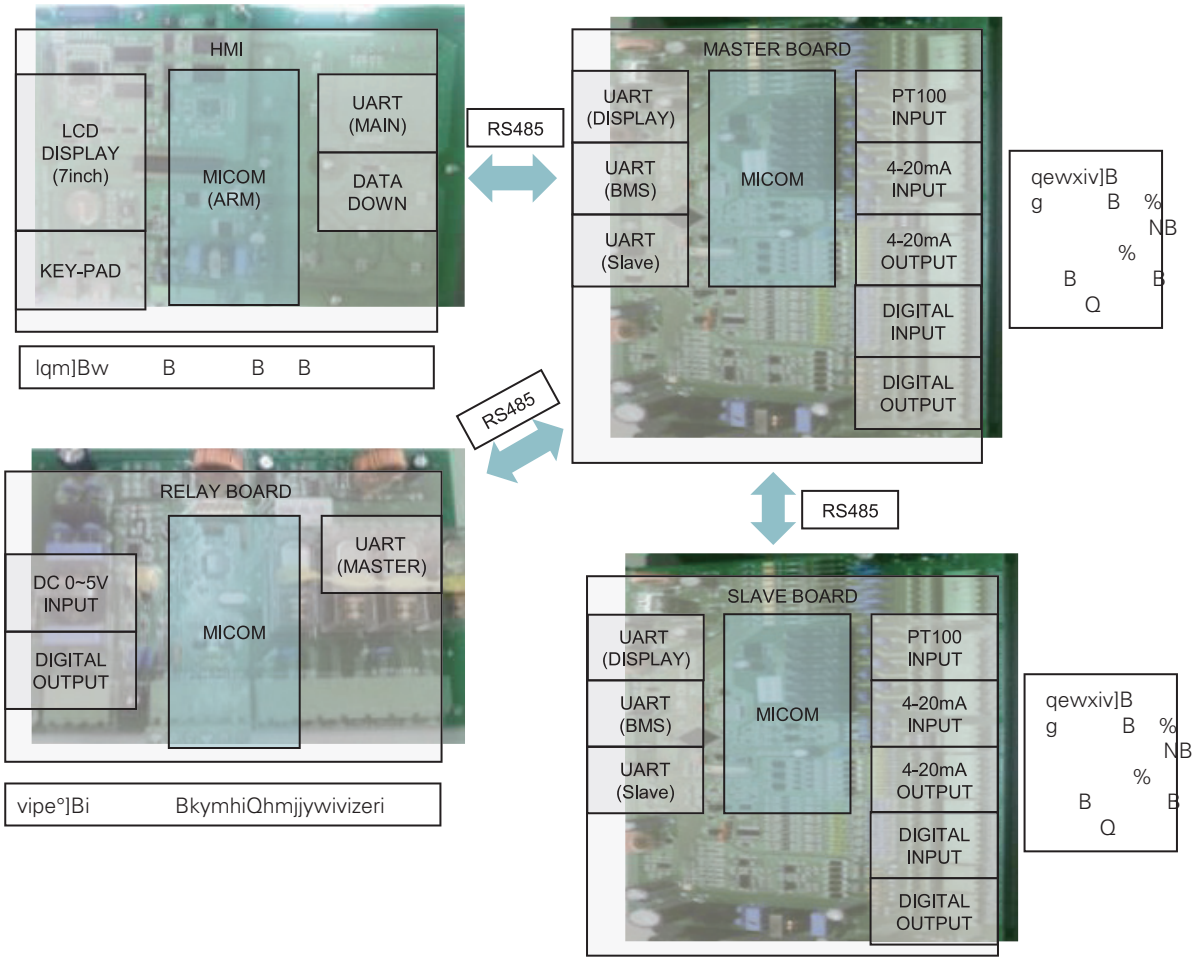


Figure 12. Controller block diagram

Other control parts

① Circuit breaker
② Relay
③ Magnetic
④ Contactor
⑤ Thermal relay
⑥ Buzzer
⑦ Terminal block
⑧ Transformer
⑨ Noise filter
⑩ Fuse
⑪ Relay board
⑫ Master board

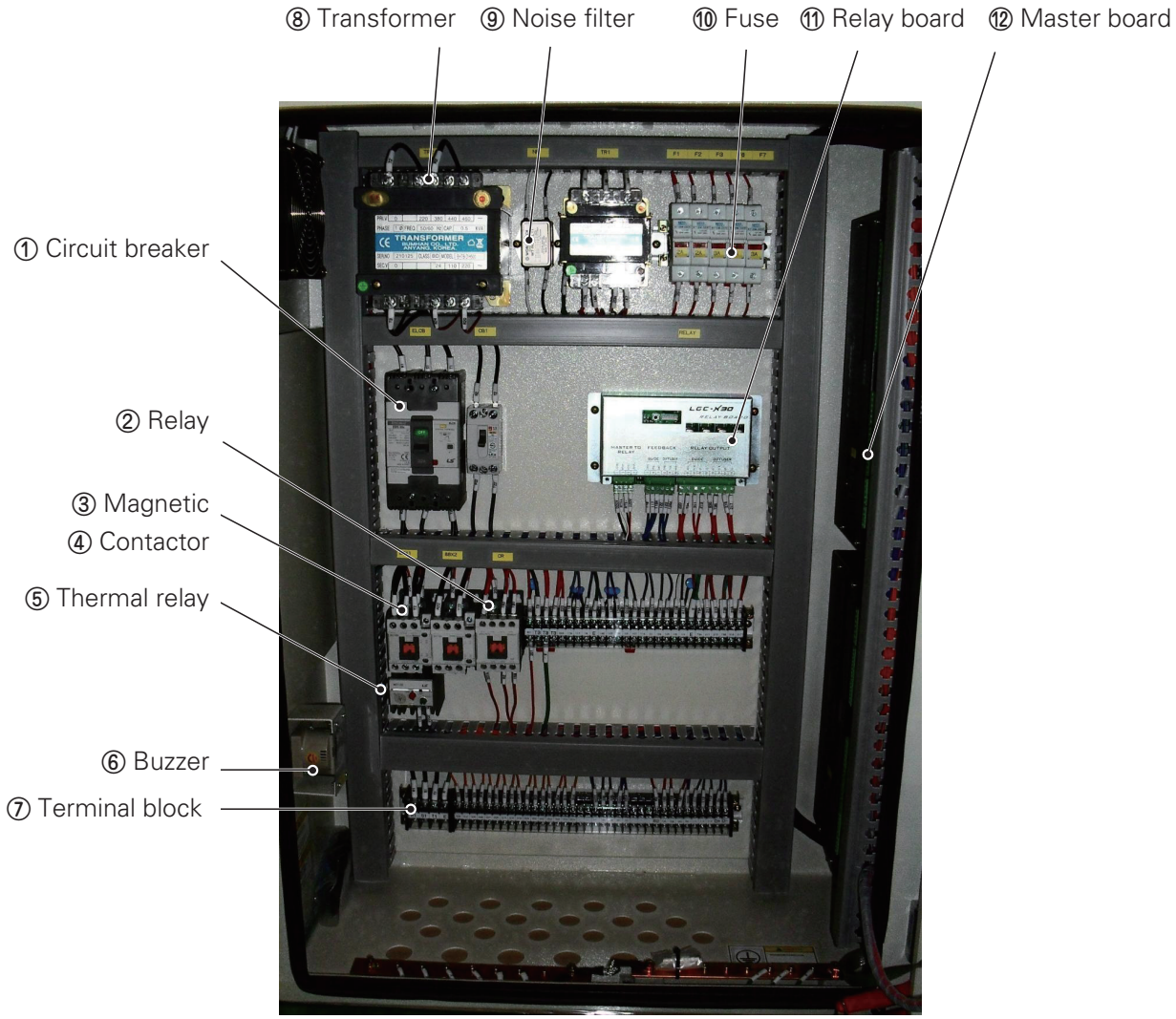


Figure 13. Control system

❊ The above arrangement is subject to change for improvement of design and model change or user's convenience. Thus, please refer to the approved drawings for details.

Optional Components Related with Control

BACnet converter

The controllers from LG basically support Modbus communication protocol.
If the higher level communication protocol is BACnet, you need to apply a separate BACnet converter for protocol conversion.
Communication converter is installed inside the control panel.
Please refer to the following table for the meaning and description of each lamp.

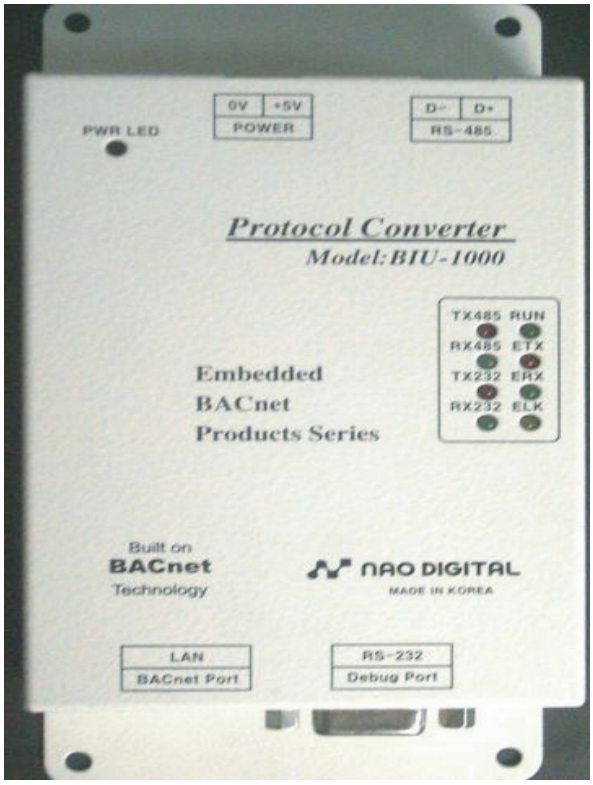


Fig 14. Converter

LED name	Condition	Description
TX485 RX485	Flashing	Normal data communication with MICOM
	Off	Error, Check communication line
TX232 RX232	Flashing	Normal data communication with BACnet
	Off	Error, Check communication line
RUN	Flashing every second	Board operates normally after finishing power-on test
	Maintaining On/Off	Error, Press the reset button or turn off power & reboot.
ETX ERX ELK		ELK is always on when LAN cable is connected. ERX flashes on data reception. ETX flashes on data transmission. line state LED

Table 4. Names of Converter Lamps

4-2. Constituents and main components of Starter

Starter

It is the electric panel for the start-up and protection of compressor motor of centrifugal chiller. It has the protective functions for the short-circuit current and over current.
During the motor start-up, it decreases the starting current, thereby reducing the electric capacity of passive equipment.

Starter panel has various configurations according to start-up type, high/low voltage source, options, etc. Thus, refer to the drawing provided with the product for the configuration of the starter panel.

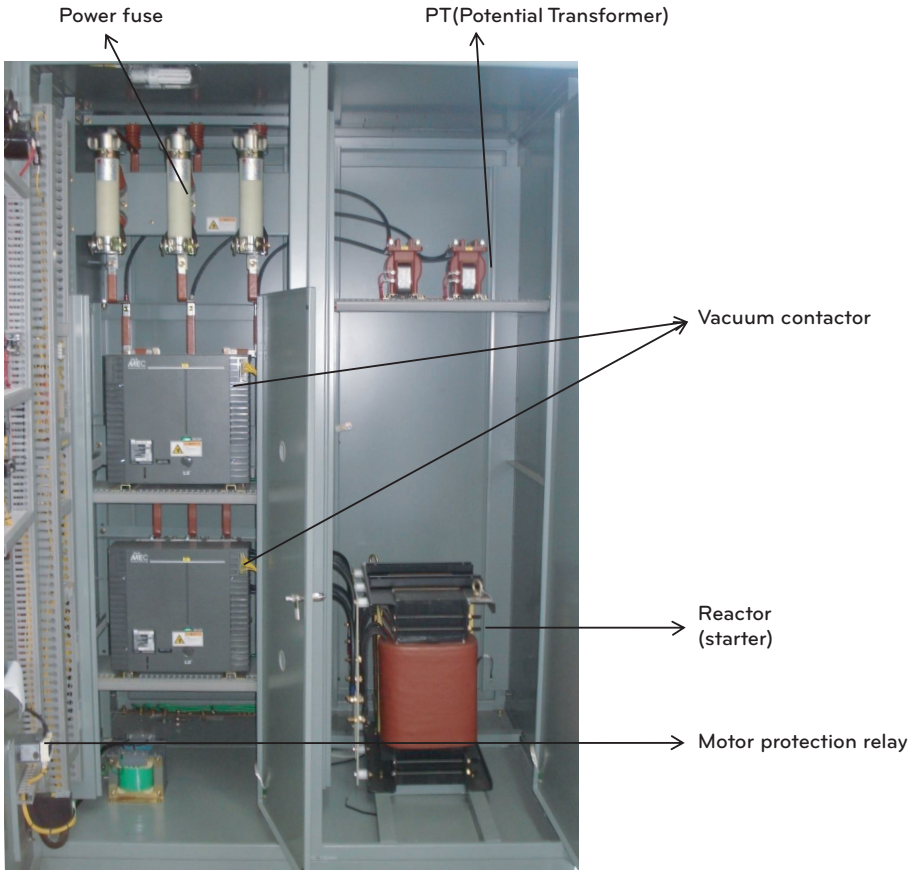
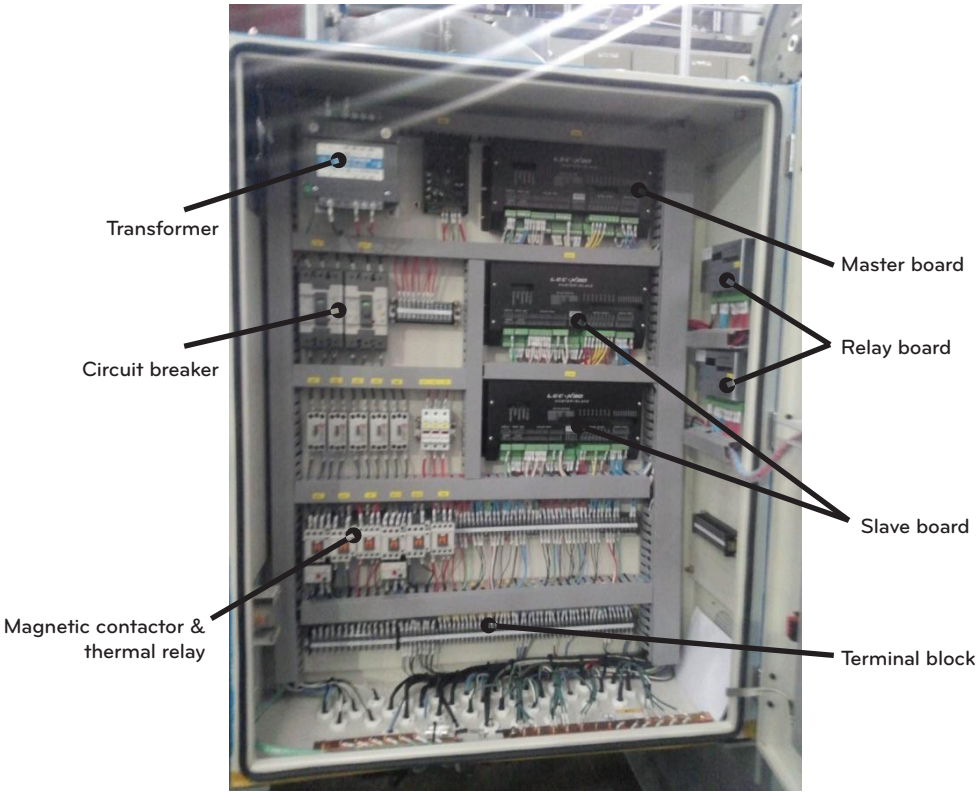


Figure 15. 6600V Reactor start-up type

❊ The above arrangement is subject to change for improvement of design and model change or user's convenience. Thus, please refer to the approved drawings for details.

4-3. Components of control panel



4-4. Basic control algorithm

By applying unique P(proportional), I(integral), and D(differential) algorithms to the control of chilled water temperature, optimal control has been achieved compared with the existing methods in virtue of minimized Under-shoot and Over-shoot during initial start-up and automatic/manual conversion of vane operation, remaining deviation, and the time required to approach the target value.

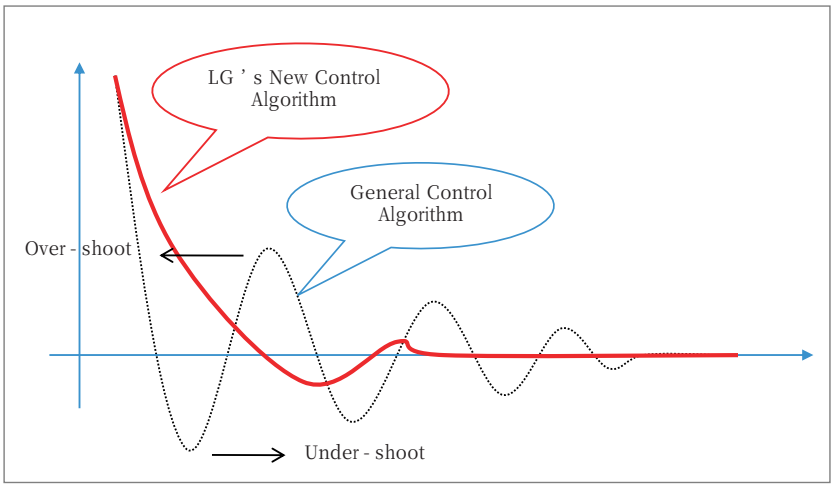


Figure 16. Control algorithm

- Soft loading
  - Approach the control target value with soft start-up
  - Solve unnecessary abnormal stop due to rapid guide vane opening during start-up

- Advanced control
  - Achieve control of high precision by implementing more advanced high class control algorithm than the existing PID control method
  - Prevent temperature cycling due to Overshoot/Undershoot during the conversion from manual to automatic mode
  - Intensive safety control: Carry out preventive control before the chiller reaches abnormal stop point, and thereby minimize unnecessary abnormal stops of the chiller.

4-5. BMS support function

Centrifugal chiller's basic communication protocol is Modbus protocol, and it can be compatible with high level communication methods.

Communication protocol support

- Communication method
  - Basic: RS-485, Ethernet (optional)
- Protocol
  - Basic: MODBUS
  - Optional: BACnet, TCP/IP

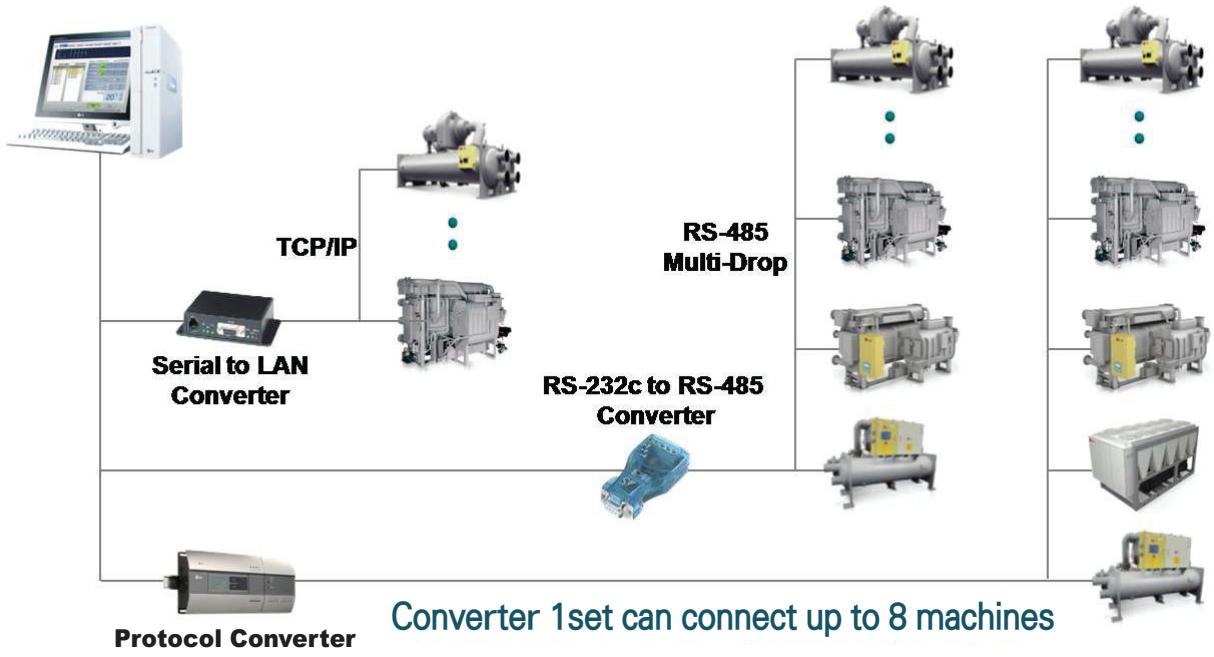


Figure 17. Detail drawing of BMS

4-6. Control Screen(Function of Product)

Controller menu configuration

• User setting

User setting
Operation mode setting
Control mode setting
Chilled water outlet temperature
Ice making outlet temperature
Chilled water temperature P
Chilled water temperature I
Chilled water temperature D
Automatic operation temperature (set value +)
Automatic stop temperature(set value-)
Antifreeze operation function
Antifreeze operation temperature
Motor current limit
Guide vane upper limit
Hot gas setting (Guide vane %)
Hot gas upper limit setting
Hot gas lower limit setting
Cooling water inlet temperature
Cooling water temperature P
Cooling water temperature I
Cooling water temperature D

Interlocking operation setting
Compressor balanced operation
Balanced operation time
LAG start-up load
LAG start-up delay time
LAG stop load
LAG stop delay time
Modular interlocking operation
Module connection setting
Start-up mode setting
LEAD compressor setting

Manual operation
Compressor operation A
Oil pump operation A
Vane opening A
Diffuser opening A
Hot gas opening A
ECO valve manual A
CON valve manual A
Compressor operation B
Oil pump operation B
Vane opening B
Diffuser opening B
Hot gas opening B
ECO valve manual B
CON valve manual B

System information(Input)
Ice making mode selection display
Remote operation/stop signal
Low temperature contact of refrigerant
High pressure contact of condenser
Chilled water flow normal contact point
Normal contact of cooling water flow
Chilled water pump interlock
Cooling water pump interlock
Key Lock
Input 10
Bearing high temperature contact point
High temperature contact of motor winding
Oil pump overload contact point
Vane closing contact point
Compressor motor power normal
Compressor start up check
Starter panel abnormality
Diffuser manual
Diffuser manual close
Diffuser manual open

System information(output)
Ice making mode selection display
Remote selection display
Chilled water pump operation
Cooling water pump operation
Cooling tower fan 1 operation
Cooling tower fan 2 operation
Cooling tower fan 3 operation
Cooling tower fan 4 operation
Hot gas valve A
Hot gas valve B
Oil heater operation A
Oil pump operation A
Buzzer
Operation status display
Compressor emergency stop A
Abnormal status display
Compressor operation status A
Compressor motor operation A
ECO valve A
CON valve A
Oil heater operation B
Oil pump operation B
Compressor emergency stop B
Compressor operation status B
Compressor motor operation B
ECO valve B
CON valve B

Scheduled operation setting
Scheduled operation pattern setting(operation)
Scheduled operation pattern setting(stop)
Scheduled operation pattern setting(temperature)
Scheduled operation pattern setting(current)

System information(Timer)
Chilled water pump stop delay timer
Cooling water pump start-up delay timer
Cooling water pump stop delay timer
Flow chattering ignore timer
VGD control delay timer
Oil circulation timer before start-up B
Oil circulation timer after stop B
Oil pressure check timer B
Oil circulation timer before start-up A
Oil circulation timer after stop A
Oil pressure check timer A
Vane close timer at start-up A
Vane close timer at stop
Vane open delay timer A
Compressor start-up check timer A
Restart prevention timer A
Vane close timer at start-up B
Vane open delay timer B
Compressor start-up check timer B
Restart prevention timer B

System information
Operation data saving cycle
Communication ID (machine number)
Baud rate
Language
Temperature unit selection
Pressure unit selection
Flow unit selection
LCD brightness control

• System setting

Refrigerant level setting
ECO refrigerant level setting
ECO refrigerant level P
ECO refrigerant level I
ECO refrigerant level setting B
ECO refrigerant level valve initial value
ECO refrigerant level setting A
CON refrigerant level P
CON refrigerant level I
COND refrigerant level setting B
CON refrigerant valve initial value

Control information setting
Control calculation cycle
Control temperature dead band
Oil-Evaporator Differential Temperature
On temperature of oil heater
Off temperature of oil heater
Automatic restart after power failure
Motor rated current A
Motor rated current B
Model selection
Operation time limit
Guide vane control dead band
Diffuser vane control dead band
VFD calculation period
Cooling tower PID calculation cycle
Refrigerant level control
Refrigerant level calculation period
Refrigerant level control dead band
Refrigerant valve control dead band
Oil heater mode

Timer setting
Chilled water pump stop delay timer
Cooling water pump start-up delay timer
Cooling water pump stop delay timer
Flow chattering ignore timer
VGD control delay timer
Oil circulation timer before start-up B
Oil circulation timer after stop B
Oil pressure check timer B
Oil circulation timer before start-up A
Oil circulation timer after stop A
Oil pressure check timer A
Vane close timer at start-up A
Vane close timer at stop
Vane open delay timer A
Compressor start-up check timer A
Restart prevention timer A
Vane close timer at start-up B
Vane open delay timer B
Compressor start-up check timer B
Restart prevention timer B

Account management
Management No. 1
Management No. 2
Management No. 3
System setting password
Operation remaining time
Chilled water inlet temperature
Chilled water outlet temperature
Cooling water inlet temperature
Cooling water outlet temperature*
Evaporator temperature
Condenser temperature
Evaporator pressure A
Condenser pressure A
Evaporator pressure B
Condenser pressure B
Remote temperature setting *
Hot gas valve A *
Hot gas valve B *
Motor bearing temperature *
Compressor discharge temperature A
Oil temperature A
Bearing temperature A *
Motor winding R temperature A*
Motor winding S temperature A *
Motor winding T temperature A *
Oil tank pressure A *
Oil pump pressure A
Current A
Voltage *
ECO level A
CON level A
ECO valve A
CON valve A
Compressor discharge temperature B
Oil temperature B
Bearing temperature B *
Motor winding R temperature B *
Motor winding S temperature B *
Motor winding T temperature B *
Oil tank pressure B *
Oil pump pressure B
Current B
ECO level B
CON level B
ECO valve B
CON valve B
Guide vane A
Diffuser vane A
Guide vane B
Diffuser vane B

• System setting

Abnormal condition setting
Lower limit of chilled water temperature
Lower limit of oil differential pressure
High temperature of oil
High temperature of compressor discharge
High temperature of bearing
High temperature of motor winding
Low temperature of evaporator refrigerant
Low pressure of evaporator
High pressure of condenser
Lower limit of motor voltage
Upper limit of vibration
Lower flow of chilled water
Lower flow of cooling water
High temperature of cooling water
Condensation prevention time
Oil Pump Preiod
High Oil differential Pressure

Safety control setting
Soft start output period
Soft start valve output
Soft stop vane opening
Prevention of high temperature of bearing
Prevention of high temperature of motor winding
Prevention of low voltage of motor
Prevention of high temperature of compressor discharge
Prevention of low temperature of evaporator refrigerant
Prevention of low pressure of evaporator
Prevention of high pressure of condenser
Setting upper limit of surge pressure
Setting lower limit of surge pressure
Surge temperature high level setting
Surge temperature low level setting
Changing amount of surge detection current
Surge occurrence detection time
Surge occurrence detection number
Prevention of vibration upper limit
Excessiveness of liquid intake prevention
Automatic limit of set value

Sensor correction
Chilled water inlet temperature
Chilled water outlet temperature
Cooling water inlet temperature
Cooling water outlet temperature
Evaporator temperature
Condenser temperature
Evaporator pressure A
Condenser pressure A
Evaporator pressure B
Condenser pressure B
Remote temperature setting
Compressor discharge temperature A
Oil temperature A
Bearing temperature A
Motor winding R temperature A
Motor winding S temperature A
Motor winding T temperature A
Oil tank pressure A
Oil pump pressure A
Current A
ECO level A
CON level A
Compressor discharge temperature B
Oil temperature B
Bearing temperature B
Motor winding R temperature B
Motor winding S temperature B
Motor winding T temperature B
Oil tank pressure B
Oil pump pressure B
Current B
ECO level B
CON level B

Sensor setting
Evaporator pressure A
Condenser pressure A
Evaporator pressure B
Condenser pressure B
Remote temperature setting signal
Hot gas valve A
Hot gas valve B
Oil tank pressure A
Oil pump pressure A
Current sensor A
ECO level A
CON level A
ECO valve A
CON valve A
Option setting mode A
Guide vane min. A
Guide vane max. A
Guide vane AD value A
Minimum value setting / Maximum value setting A
Diffuser vane min. A
Diffuser vane max. A
Diffuser vane AD value A
Minimum value setting / Maximum value setting A
Oil tank pressure B
Oil pump pressure B
Current sensor B
ECO level B
CON level B
ECO valve B
CON valve B
Option setting mode B
Guide vane min. B
Guide vane max. B
Guide vane AD value B
Minimum value setting / Maximum value setting B
Diffuser vane min. B
Diffuser vane max. B
Diffuser vane AD value B
Minimum value setting / Maximum value setting B

Controller menu configuration

Method of controlling menu and the names of control part

Display of control device of two-stage centrifugal chiller has the basic screen that can check the current operation status, main menu which has the components for convenient use of two-stage centrifugal chiller, such as user setting and problem/caution information, etc., and system menu for sensor setting or system related setting.

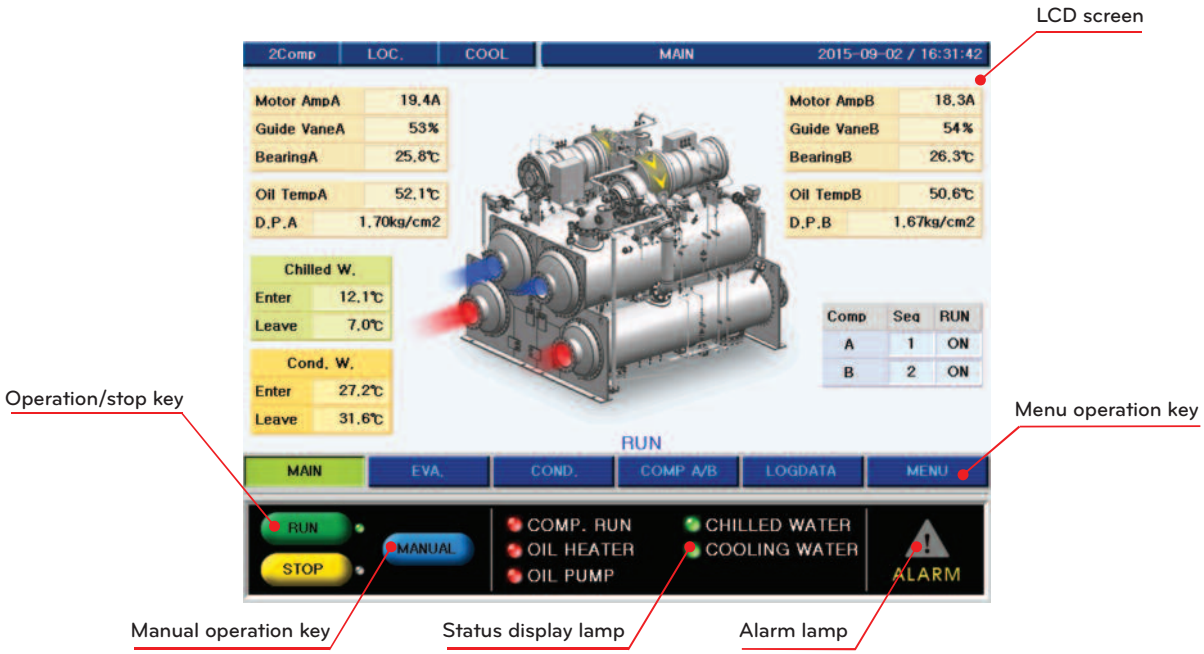


Figure 18. Front of controller

CAUTION

Do not operate the controller with a sharp object.
It may cause damage to the controller.

Names of control part

Name	Description
LCD screen	It is the color LCD screen displaying the operation information and the status of the chiller in text (Korean, English and Chinese) or graphical animation.
Menu operation key	These are keys for operating the menu on the screen such as selection of submenu and operation conditions. The function keys shown at the bottom of the LCD screen change depending on the selected screen.
Manual operation key	This key is for manual control(operation/stop or open/close) of compressor, oil pump, guide vane, diffuser vane, hot gas valve, ECO valve, and CON valve. It automatically operates when "automatic" is displayed. When "manual" is displayed, manual operation is possible. Open/close keys operate only while they are pressed.
Alarm lamp	It is activated on the occurrence of emergency or cautious status. If this is activated, an alarm message explaining the status is displayed on the message line. When alarm is activated, the cancel key is also displayed with buzzer sound. If the cancel key is pressed, the buzzer sound will stop as the cancel key disappears. And if the emergency warning stops, the message will also disappear.
Operation/stop button	This key operates and stops the chiller. When the button on the pop-up screen is pressed, it is activated. During the chiller operates “Operation” lamp is on, and when stopped “Stop” lamp is on.
Status display lamp	It indicates the operation and stop of the chiller or devices(oil pump, oil heater, etc.) attached to it, and the status of chilled water or cooling water flow. When oil heater or pump operates, the lamp is on.

Table 5. Names of control part

Names of Color LCD screen display part

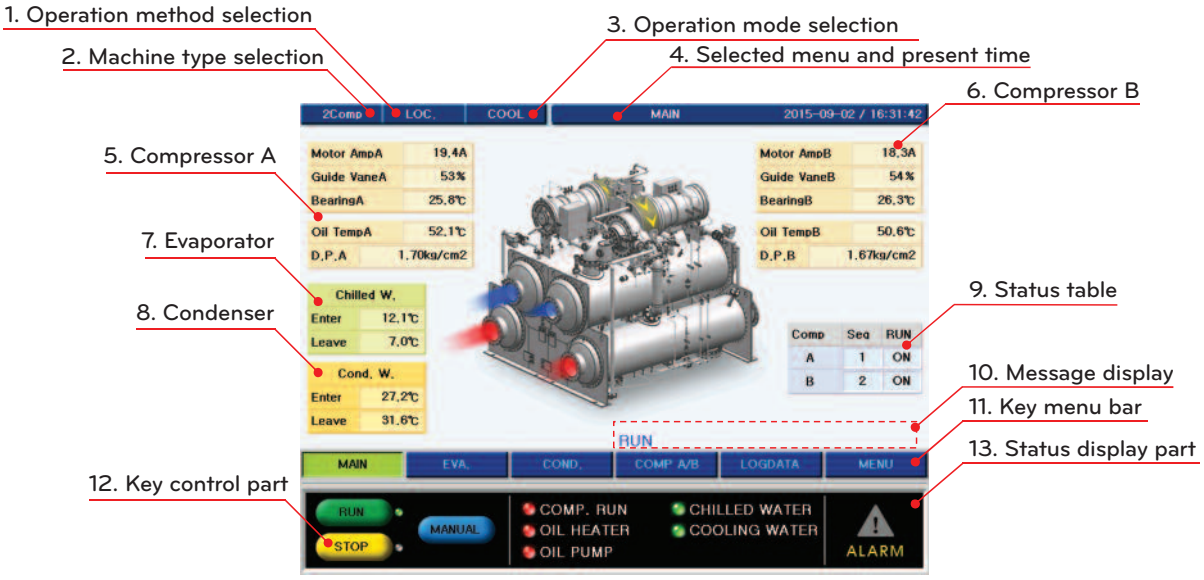


Figure 19. LED screen

① Operation method selection
For operation method, there are on-site operation where the chiller is operated directly on site, scheduled operation where automatic operation at scheduled time is possible, and remote operation where the chiller is to operated remotely. The display part of the screen shows the selected method.

② Machine type selection
Three types of machines R134a 2 Stage, R134a, and R123 are available.
(When any type is selected, the main board is automatically reset to change into the selected model.)

③ Operation mode selection
Since only cooling operation is available for air-conditioning chiller, cooling is always indicated. In case the chiller is for low temperature, cooling and icing mode is indicated depending on mode. (refer to the control mode setting in user setting of main menu)

④ Present time
The present year, month, date, day, hour and minute are displayed.

⑤ Displayed item
The temperature, pressure, etc. of each part of the chiller are displayed.

⑥ Key menu bar
The functions for the menu control key are displayed.

⑦ Message display
Operation/stop, status of chiller, emergency/caution, warning etc. is displayed.

Basic screen

It shows input and calculated output of each sensor attached to the body of the chiller. When the controller is on, the initial screen is displayed.

1) Main screen

- The animation screen of the whole chiller and relevant DATA are displayed.
  - Path : MAIN

Figure 20. Main screen

2) Evaporator

- It shows the animation screen of evaporator and related DATA.
  - Path : EVA.

Figure 21. Screen of evaporator

3) Condenser

• It shows the animation screen of condenser and related DATA.
- Path : COND.

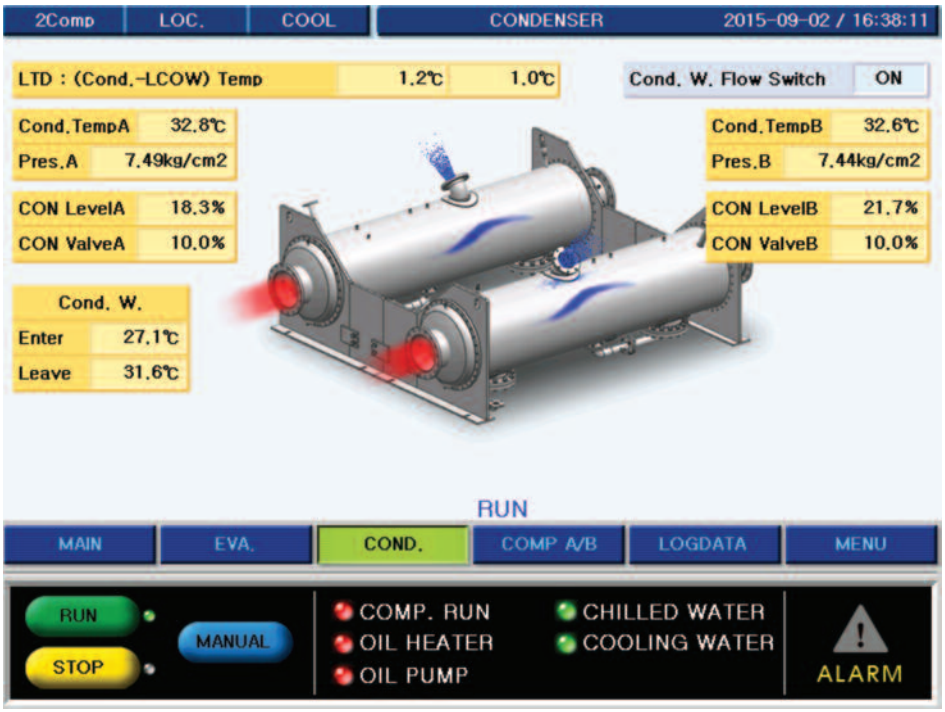


Figure 22. Screen of condenser

4) Compressor

• It shows the animation screen of condenser and related DATA.
- Path : COMP.

Figure 23. Screen of compressor

5) Log Data

• It shows information and history of operation, abnormal log data.
- Path : LOGDATA

Figure 24. Screen of Operation history

6) Menu

• It shows the menu screen.
- Path : MENU

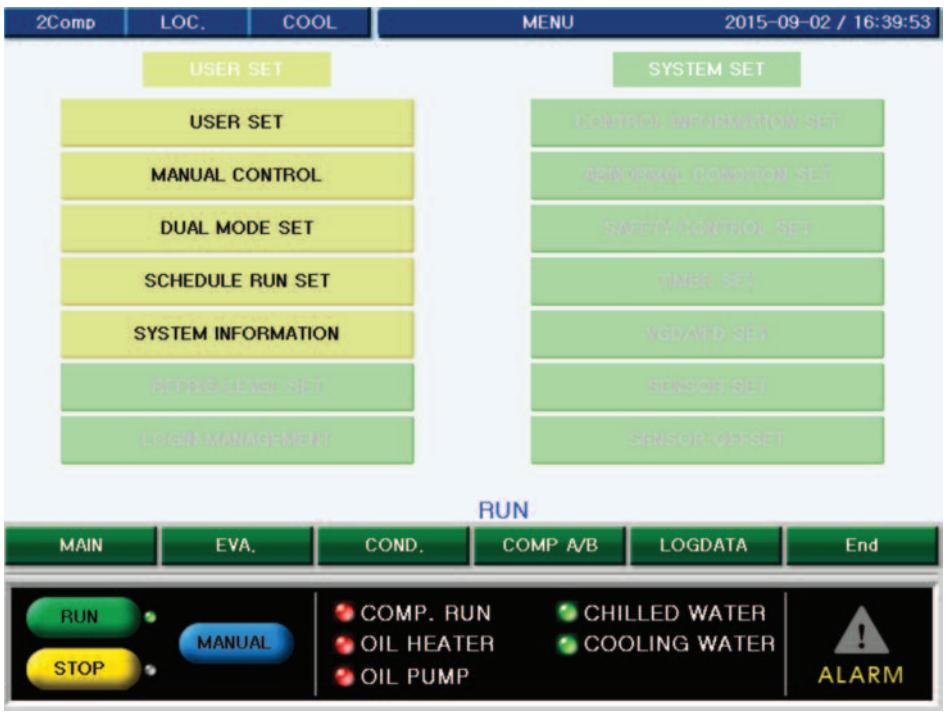


Figure 25. Menu Screen

List of items displayed on screen

✔: Item which can be displayed

No.	No.	Display range	R134a	R123	Remark
1	Chilled water inlet temperature	-40.0~140.0 °C	✔	✔	
2	Chilled water outlet temperature	-40.0~140.0 °C	✔	✔	
3	Cooling water inlet temperature	-40.0~140.0 °C	✔	✔	
4	Cooling water outlet temperature	-40.0~140.0 °C	✔	✔	
5	Compressor discharge temperature	-40.0~140.0 °C	✔	✔	Note 1.
6	Oil tank temperature	-40.0~140.0 °C	✔	✔	
7	Compressor bearing temperature	-40.0~140.0 °C	✔	✔	Note 2.
8	Motor winding R phase temperature	-40.0~140.0 °C	✔	✔	Optional
9	Motor winding S phase temperature	-40.0~140.0 °C	✔	✔	Optional
10	Motor winding T phase temperature	-40.0~140.0 °C	✔	✔	Optional
11	Evaporator pressure	760~0 mmHgA		✔	
		0.00~20.00kg/cm^2		✔	
12	Condenser pressure	-1.00~5.00kg/cm^2		✔	
		0.00~20.00kg/cm^2		✔	
13	Oil tank pressure	0.00~20.00kg/cm^2		✔	
14	Oil pump pressure	-1.00~5.00kg/cm^2		✔	
		0.00~20.00kg/cm^2		✔	
15	Current	0~1999A	✔	✔	Note 3.
16	ECO level	0~9999V	✔	✔	Optional
17	COND level	0~9999KW	✔	✔	Optional
18	ECO valve	0~3000 m^3/h	✔	✔	Optional
19	COND valve	0~3000 m^3/h	✔	✔	Optional
20	Vane opening pressure	0~100 %	✔	✔	
21	Chilled water outlet setting	3~30.0 °C	✔	✔	
22	Evaporator refrigerant temperature	-18.9~27.6 °C		✔	low pressure
		-26.1~57.2 °C		✔	high pressure
23	Condenser refrigerant temperature	-17.8~61.8 °C		✔	low pressure
		-26.1~57.2 °C		✔	high pressure
24	Oil differential pressure	-5.00~5.00kg/cm^2	✔	✔	
25	Hot gas valve output	0~100 %	✔	✔	Optional
26	Frequency of chilling tower fan inverter	0~60 Hz	✔	✔	Optional
27	PID calculation output	0~100 %	✔	✔	
28	Automatic operation setting	Calculated value	✔	✔	
29	Automatic stop setting	Calculated value	✔	✔	
30	Actual setting of temperature	3.0~50.0 °C	✔	✔	Note 4.

❋ Note

1. R134a: Standard, R123: Optional
2. In low pressure, displayed as "Motor bearing temperature"
3. If the setting value of current sensor range is below 200A, it should be shown until one decimal.
4. For ice making(low temperature), -10.0~50.0°C

Table 6. List of items displayed on screen

7) Main menu

- Main menu has user setting and system setting on the whole, as is shown in the following figure.
  - User setting, linked operation setting, scheduled operation setting and system information can be set by all users.
  - Account management, sensor correction, control information setting, and abnormal condition setting, safety control setting, timer setting, VGD/VFD setting, and sensor setting cannot be carried out without the password, so that only the system manager can set them.

- Menu screen
  - Path : MENU

Figure 26. Input status check screen

- Detailed items of main menu

Displayed item	Use
User setting	Menu where user determines set values, such as control temperature, PID, etc., necessary to operate the chiller.
Interlocking operation setting	Menu where items used in Dual Comp. are set.
Scheduled operation setting	Menu where the times and temperatures by time are set to operate/stop the chiller at the designated times.
System information	Menu where I/O input and output, timer operation, version, present time, operation information saving period, IP address, communication speed, set language, chiller type and other such overall information can be checked.
Account management	Menu where password and management number can be revised.
Sensor correction	Menu which corrects displayed values of each sensor.
Control information setting	Menu that sets the most basic facts about the operation of chiller.
Safety control setting	Menu where items related to safety control are set in order to prevent emergency stop during the operation of chiller.
Abnormal condition setting	Menu that sets the emergency stop conditions of the chiller.
Timer setting	Menu that sets the emergency stop conditions of the chiller.
VGD/VFD setting	Menu where the relationship between vane opening and diffuser opening is set.
Sensor setting	Menu that sets 4~20mA sensor, vane and diffuser.

Table 7. Items of main menu

User setting

- Operation method setting consists of operation method selection menu, where on-site operation, scheduled operation or remote operation are selected, and operation mode menu, where the choice between ice making and cooling operation is made. Only if, however, ice making mode is used in system function setting, "operation mode selection" is displayed.

  - Path : MENU ➡ USER SET ➡ Select

Figure 27. User setting menu

1. You can choose the desired item by touching it on the above user setting menu screen.
2. When you make a choice, you change a set value by using 'Dial' button(which is the same as the method of "password setting").

1) Operation mode determination
   - On-site: The chiller is operated/stopped by means of the operation/stop key of the control panel on the site where the chiller is installed.
   - Remote: The chiller is operated/stopped by means of the remote operation/stop signal(no voltage contact signal: switch, relay contact signal) in a remote place(a site office or automatic control panel).
   - Scheduled: The chiller is automatically operated/stopped following the program set by a user who inputs operation/stop time and temperature in the controller through 'scheduled operation menu'(refer to 'scheduled operation setting' on P45).

2) Control mode selection

   This is available when it is installed in a ice storage chiller which has ice making operation function.
   When ice making mode is used in system function setting, the menu is displayed. Otherwise, the menu does not appear.
   - Cooling: control mode setting which operates at room temperature(7~12°C)
   - Ice making: low temperature operation mode which operates at low temperature(-5~0°C)

3) Other user settings

   This menu inputs initial set values and functions necessary to operate the chiller.

   By pressing an item which is to be set by means of the menu selection bar, the key menu changes into previous, next, decrease, increase. A flickering cursor appears at set value.

   The value is determined by first designating the number of digits by means of 'previous' and 'next' keys, second changing the value by means of 'decrease' and 'increase' keys, then finally pressing the setting key.

4) Setting display screen

Item	Setting range	Default value	Setting unit	Time to set
Operation mode setting	On-site/Scheduled/Remote	on-site		Always
Control mode setting	Cooling/Ice making	cooling		Always(*)
Chilled water outlet temperature	3.0°C~ 30.0°C	7.0°C	0.1	Always
Ice making outlet temperature	-20°C~30°C	-5°C	0.1	Always
Chilled water temperature P	1°C~10°C	6.8°C	0.1	Always
Chilled water temperature I	0 sec~ 3600 sec	111 sec	1	Always
Chilled water temperature D	0 sec~ 360 sec	2 sec	1	Always
Automatic operation temperature (set value+)	0.0°C~10.0°C	2.0°C	0.1	Always
Automatic stop temperature(set value-)	0.0°C~10.0°C	2.0°C	0.1	Always
Anti-freeze operation function	Used/Not used	Unused		Always
Antifreeze operation temperature	0.0°C~10.0°C	3.0°C	0.1	Always
Motor current limit	1~100%	100%	1	Always(**)
Guide vane upper limit	1~100%	100%	1	Always(**)
Hot gas setting (Guide vane %)	0~100%	30%	1	Always(**)
Hot gas upper limit setting	0~100%	100%	0.1	Always
Hot gas lower limit setting	0~100%	0%	0.1	Always
Cooling water inlet temperature	10.0~50.0°C	28.0°C	0.1	Always
Cooling water temperature P	1.0°C~10.0°C	4.0°C	0.1	Always
Cooling water temperature I	0 sec~ 3600 sec	0 sec	1	Always
Cooling water temperature D	0 sec~ 360 sec	0 sec	1	Always

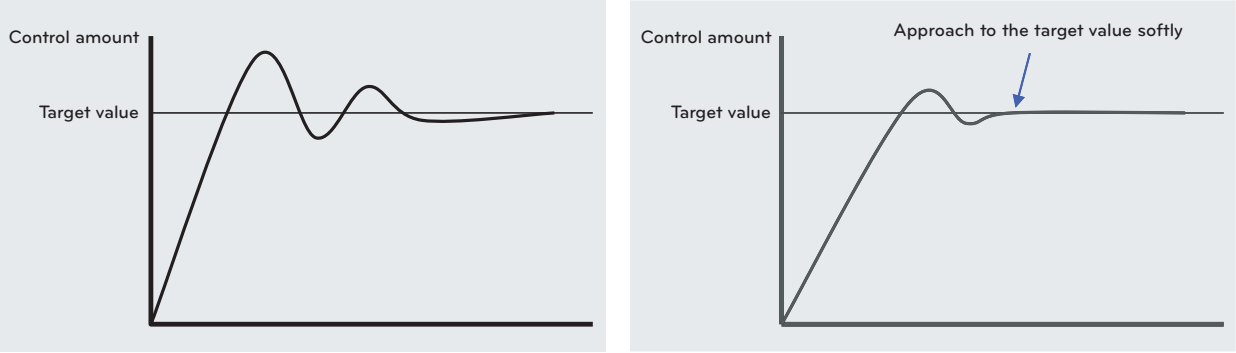
(*) can be displayed and applied only when ice making(low temperature) chiller is designed.

(**) can be displayed and operated only when hot gas valve is installed.

Table 8. Items on user setting screen

5) P.I.D temperature control

By applying unique P(proportional), I(integral), and D(differential) algorithms to the control of chilled water temperature, optimal control has been achieved compared with the existing methods in virtue of minimized Under-shoot and Over-shoot during initial start-up and automatic/manual conversion of vane operation, remaining deviation, and the time required to approach the target value.



<Existing control method> <LG's new PID control>

Figure 28. Comparison of control methods

(1) Chilled water outlet temperature
It is the menu to set the chilled water outlet P.I.D control temperature during cooling operation.
It is the set temperature which is the target value of control in PID control calculation.
In case the scheduled operation is set, this item is not displayed.

(2) Chilled water temperature P (proportional)
It sets the proportional control range P value used for PID control of chilled water during cooling operation.

(3) Chilled water temperature I (integral)
It sets the integral control range I value used for PID control of chilled water during cooling operation.

(4) Chilled water temperature D (differential)
It sets the differential control range D value used for PID control of chilled water during cooling operation.

(5) Chilled water outlet temperature – ice making
It is the menu to set the outlet control temperature in ice making mode.

6) Cooling tower fan step control

This operation mode is provided for cooling tower fan control in order to control cooling water inlet temperature stably. In standard method, one cooling tower fan is connected to the control panel of the chiller to operate/stop it. As many as four cooling tower fans can be connected. (Connection of two or more fans is optional.)

⚠ CAUTION

Confirm the specifications of the cooling tower fan motor maker before setting.

When a cooling tower is connected to controller, confirm the maximum number of daily operation and restart time after stop of the cooling tower fan motor before setting.

Abnormal setting may cause damage and overheat of cooling tower fan motor, with the result that the motor can stop.

When the setting of main menu/system menu/safety control setting/cooling tower control is determined to be 'step', the cooling tower fan control carries out step control operation.

(1) Cooling tower fan operation
It sets the operating temperature of cooling tower fan during cooling operation. When the cooling water inlet temperature exceeds a set value, all the cooling tower fans start operating.

(2) Cooling tower fan stop
It sets the stop temperature of cooling tower fan during cooling operation. When the cooling water inlet temperature becomes below a set value, all the cooling tower fans stop operation.

7) Cooling tower fan inverter control

It is the control method to supply stable cooling water inlet temperature, and it is applied when inverter is used for cooling tower fan motor control. The main menu/system menu/safety control setting/cooling tower control setting of the controller should be inverter.

- It can be used only when inverter is attached to the user MCC (MOTER CONTROL CENTER) panel. It is an option and it can be applied after consulting with LG.
- The control output of the cooling tower fan can be either 4-20mA, 0-5 Vdc or 0-10Vdc.

(1) Cooling water temperature P value
If inverter is used to control cooling water inlet temperature, it sets the proportional section P of the PID control.

(2) Cooling water temperature I value
If inverter is used to control cooling water inlet temperature, it sets the integral section I of the PID control.

(3) Cooling water temperature D value
If inverter is used to control cooling water inlet temperature, it sets the differential section D of the PID control.

(4) Cooling water inlet temperature
It sets the cooling water inlet temperature that is the standard for cooling tower fan inverter control.

8) It is to set motor current control operation to protect motor from overload.

The current limit operation is carried out as follows, and temperature control is not carried out during current limit operation.
However, if PID calculation value during current limit is smaller than the vane opening of current limit, it performs closing operation according to the PID calculation value.

- Current limit operation

For example, if rated current is 518A, and current limit is set to 80%, then as in the following Fig, at position ①, where current is 80% of the rated current, vane opening stops, and when the current reaches point ②, where current is 105% of the current limit set value, it closes vane until the current drops to point ①.
If the current becomes lower than point ①, it starts the normal temperature control again.

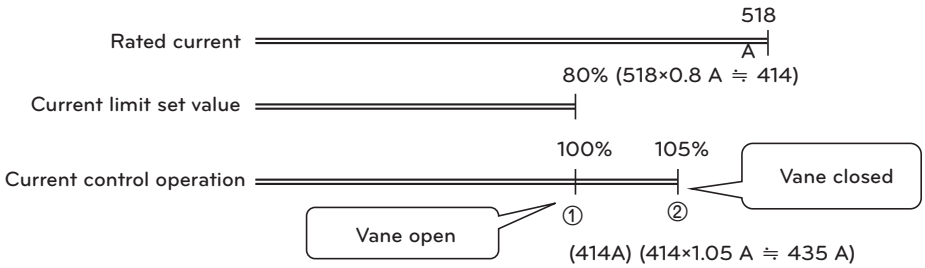


Figure 29. Detailed diagram of current limit

9) Guide vane upper limit

It is the function to protect motor from overload or to artificially limit load of chiller.
It limits the opening of guide vane so that it does not open over a set value.

10) Hot gas setting (vane %)

This item is set when hot gas bypass valve is applied.
It reads the opening guide feedback signal of the guide vane, and hot gas bypass valve performs opening operation at the time when the opening became the set value during the guide vane closing operation. If this value is set to 30%, hot gas bypass valve performs opening operation when main guide vane opening becomes 30%, and hot gas bypass valve is open 100%(hot gas upper limit setting) when guide vane opening is 0%.

11) Hot gas upper limit setting

This item is set when hot gas bypass valve is applied.
It sets the upper limit value of hot gas bypass valve opening, and it limits the opening so that the opening should not pass the set value.
If this value is set to 50%, hot gas bypass valve will not open above that value.

12) Hot gas lower limit setting

This item is set when hot gas bypass valve is applied.
It sets the lower limit value of hot gas bypass valve opening, and it limits the closing down to the set value.
If this value is set to 5%, hot gas bypass valve will not close below that value.

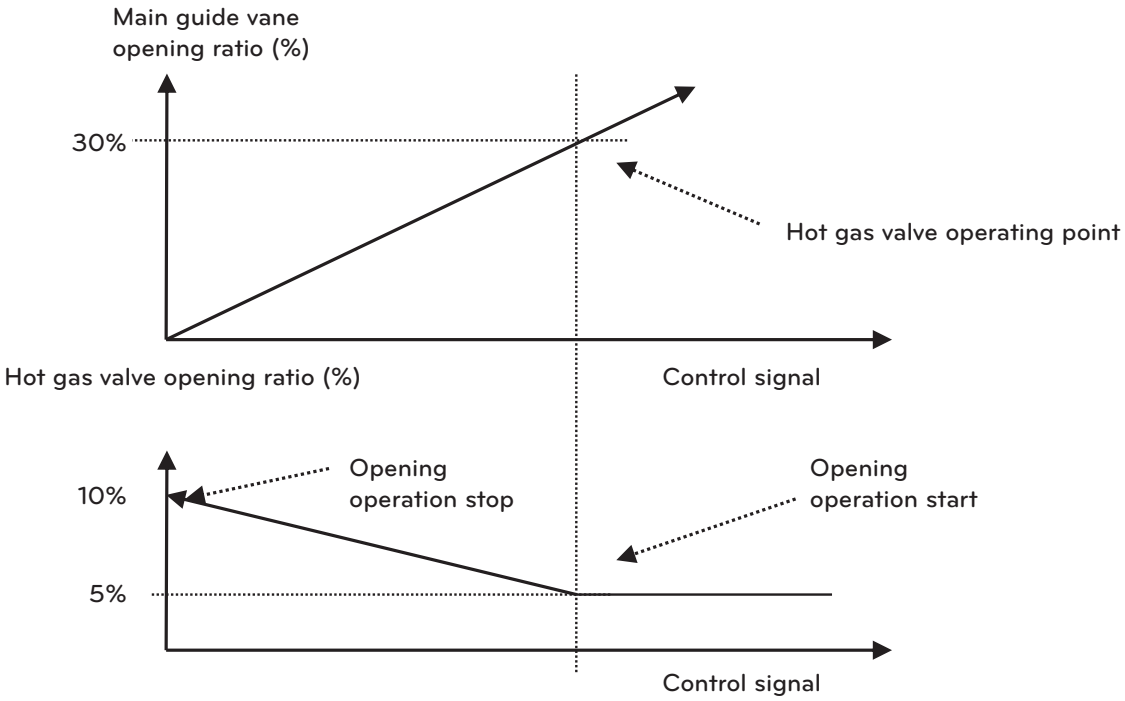


Figure 30. Hot gas valve application diagram

Interlocking operation setting

- It is the setting menu to link when dual compressors are used.
  Usage is the same as 'P40 User setting'.
  - Path : MENU ➡ LOGIN MANAGEMENT ➡ Select

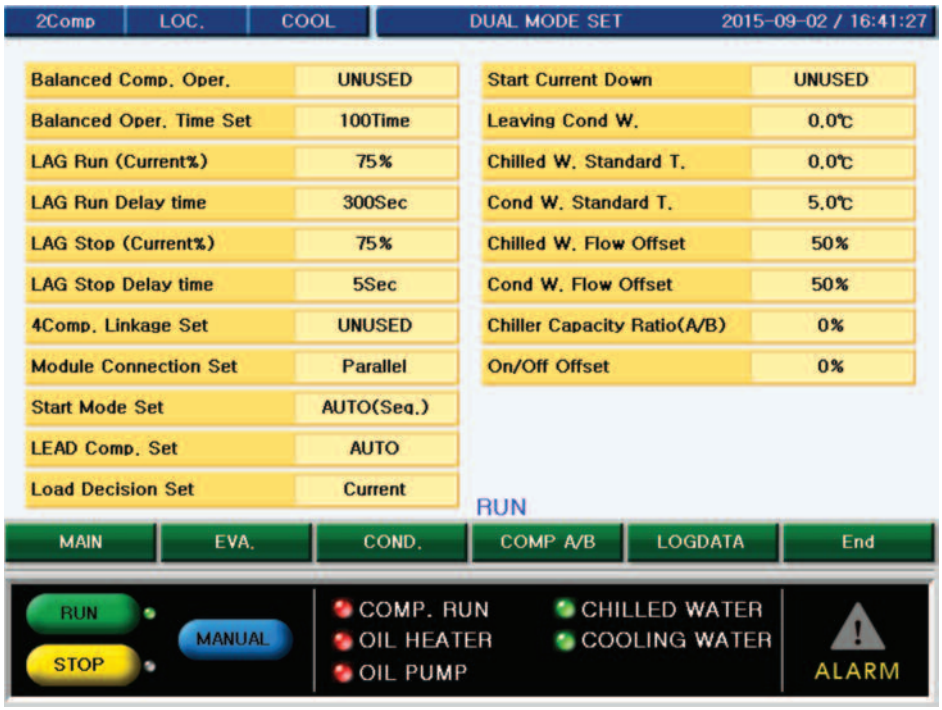


Figure 31. Linked operation setting screen

Compressor balanced operation	Uniform operation mode in consideration of the lifecycle of compressor
Balanced operation time	Uniform operation time setting of compressor
LAG start up load	LAG compressor start up condition
LAG start up delay time	LAG compressor start up condition
LAG stop load	LAG compressor stop condition
LAG stop delay time	LAG compressor stop condition
Modular interlocking operation	Since it is 4Comp chiller setting option, 2Comp chiller is 'unused'.
Module connection setting	Series/parallel setting
Start-up mode setting	Chiller start up method setting
LEAD compressor setting	LEAD compressor user setting
Load decision setting	Load decision condition setting
Start Current Down	Compressor current down on start setting

- Comp. having the least operating time starts first.
- Each Comp can have linked operation or independent manual operation.
- Load increase operation
  1) Chilled water outlet temperature > set value of chilled water outlet temperature + 0.5°C
  2) Current ≥ Lag start up load set value
  3) Satisfaction of operation condition according to load factor judged
  4) The above three condition should be kept as long as Lag start up delay time.
- Load decrease operation
  1) Satisfaction of stop condition according to load factor judged
  2) The above condition should be kept as long as Lag stop delay time.

※ The above conditions are subject to change, depending on chilled water outlet temperature setting and chiller condition.

Scheduled operation setting

- Usage is the same as 'P40 User setting'.
  - Path : MENU ➡ SCHEDULE RUN SET ➡ Select

Figure 32. Scheduled operation setting screen

Please refer to the following example for the setting.

Figure 33. Example screen of scheduled operation

Example)

① You can set 8 patterns for scheduled operating. (Setting value of start/stop time, temperature and current)

② Pattern applications are classified into 5 types in total.

③ Select the day for scheduled operation in the calendar screen, and select one from the “5 types”.

▶ Explanation for setting scheduled operation

① 2014. 6. 8 : 06:00 RUN / 09:00 STOP, 09:00 RUN / 12:00 STOP

② 2014. 6. 15 : 06:00 RUN / 09:00 STOP, 09:00 RUN / 12:00 STOP
12:00 RUN / 15:00 STOP, 15:00 RUN / 18:00 STOP

You can set Operation/stop time, day, and control temperature with each step.

Confirm whether the current day and time are correct at the user setting.

System information

- Path : MENU ➡ SYSTEM INFORMATION ➡ Select

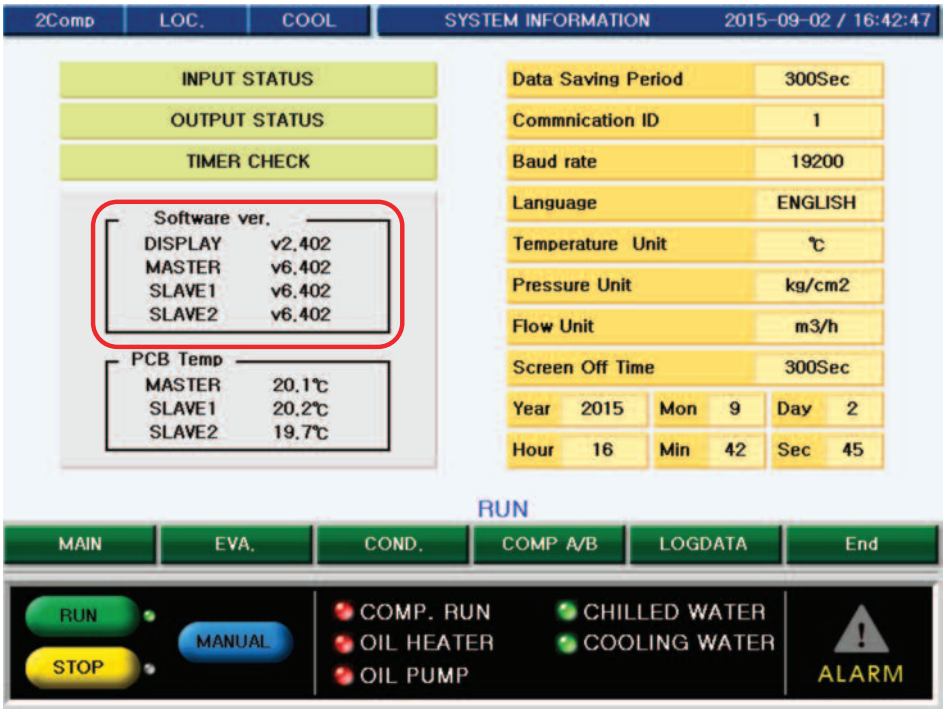


Figure 34. System information

It is the screen displaying the version of the program (Master, Slave and Display) applied to the controller.
The "software version number" displayed in the figure is to be displayed for management, and it is useful when an error occurred in the controller.

1) Year, month, day, day of week, hour, minute, second

It is the place to set date and time. It becomes the standard for saving time of information, problem/caution occurrence time and scheduled operation time. It is the time that becomes the standard for controller operation. Thus, please check if there is any deviation with the current time.

2) Operation data saving cycle

It sets the cycle for saving the operation data.

Operation data are the values of sensor measurements displayed on the basic screen, and operation data are saved periodically at the time set during the chiller operation.

Provided that, an error related information is saved immediately in the controller memory as soon as it occurs regardless of the saving period.

3) LCD brightness control

It is the menu to adjust LCD brightness.

You can control brightness of LCD by pressing up and down buttons. 'Up' to brighten screen and 'down' to darken.

Pressing 'End' key will end the LCD brightness control.

4) Baud rate setting

It sets the baud rate at one of 9600bps, 19200bps, and 38400bps.

5) Input status display

- It indicates the status of digital input ports as ON (closed circuit) and OFF (open circuit).
  This menu is to check the status of the input signal contact connected to the control panel of the chiller.
  During the digital input check inspection, make sure to check the control circuit diagram to prevent other signal from being input to the controller input terminal.
  If the connections are mixed with other signal lines, the controller PCB may get damaged.
  - Path : MENU ➡ SYSTEM INFORMATION ➡ INPUT STATUS ➡ Select

Figure 35. Input status check screen

① Move to the screen of main/evaporator/condenser/compressor

② Input status -> output status -> timer status screen movement button

Displayed item	Status	Contact operation status	Remark
Ice making mode selection display	ON/OFF	Ice making operation: close	
Remote operation/stop signal	ON/OFF	Operation signal input: close	
Low temperature contact of refrigerant	ON/OFF	Low temperature refrigerant: close	Optional
High pressure contact of condenser	ON/OFF	High pressure occurs: close	
Normal contact of chilled water flow	ON/OFF	Normal water flow: close	
Normal contact of cooling water flow	ON/OFF	Normal water flow: close	
Chilled water pump interlock	ON/OFF	Pump operation: close	
Cooling water pump interlock	ON/OFF	Pump operation: close	
High temperature contact of bearing	ON/OFF	High temperature occurs: close	
High temperature contact of motor winding	ON/OFF	High temperature occurs: close	
Overload of oil pump	ON/OFF	Overload: close	
Vane close contact	ON/OFF	Vane closes: close	
Abnormal power source of compressor motor	ON/OFF	Power source is applied: close	
Compressor start up check	ON/OFF	Compressor operates: close	
Abnormal contact of starter	ON/OFF	Abnormality occurs: close	
Low contact of oil differential pressure	ON/OFF	Normal differential pressure: close	

Table 9. Digital input display items

6) Output status check

- It displays the ON (=close) and OFF (=open) status of digital output port along with the analog output status. This menu displays the output status by internal calculation in the controller, and it is composed to be able to check the output result of the controller calculation. If the actual output status is different from the menu, you have to check the status of controller I/O board and its wiring.

  - Path : MENU ➡ SYSTEM INFORMATION ➡ OUPUT STATUS ➡ Select

Figure 36. Output status check screen

Displayed item	Status	Contact operation status	Remarks
Ice making mode selection display	ON/OFF	Ice making mode: close	For customer
Remote selection display	ON/OFF	Remote operation: close	For customer
Chilled water pump operation	ON/OFF	Pump operation: close	For customer
Cooling water pump operation	ON/OFF	Pump operation: close	For customer
Cooling tower fan 1 operation	ON/OFF	Fan operation: close	
Cooling tower fan 2 operation	ON/OFF	Fan operation: close	
Cooling tower fan 3 operation	ON/OFF	Fan operation: close	
Cooling tower fan 4 operation	ON/OFF	Fan operation: close	
Hot gas valve	0~100%		
Oil heater operation	ON/OFF	Heater operation: close	
Oil pump operation	ON/OFF	Pump operation: close	
Buzzer	ON/OFF	Malfunction: close	
Operation status display	ON/OFF	Operation: close	
Compressor emergency stop	ON/OFF	Emergency stop: close	For customer
Abnormal status display	ON/OFF	Malfunction: close	For customer
Compressor operation status	ON/OFF	Compressor operation: close	For customer
ECO valve opening	0~100%		
COND valve opening	0~100%		

☞ ON : Relay Close, OFF : RelayOpen

Table 10. Output display items

7) Timer status check

- It displays the operation status of various timers calculating in the controller.
  This menu is designed for easier view of the operation status.
  In this menu, you cannot set the timer.
  - Path : MENU ➡ SYSTEM INFORMATION ➡ TIMER CHECK ➡ Select

Figure 37. Timer status screen

Displayed item	Display range	Initial value(standard setting)
Chilled water pump stop delay	0~1800	300 sec.
Cooling water pump start delay	0~60	5 sec.
Cooling water pump stop delay	0~1800	30 sec.
Flow chattering ignorance	0~60	2 sec.
VGD control delay timer	1~3600	1800 sec.
Oil circulation before start-up	0~600	180 sec.
Oil circulation after stop	0~600	300 sec.
Oil pressure check	0~60	10 sec.
Vane close at start up	0~600	120 sec.
Vane close at stop	0~600	120 sec.
Vane open delay	0~60	30 sec.
Compressor start up check	0~60	20 sec.
Restart prevention	5~3600	1800 sec.

Table 11. Timer display items

냉매 레벨 설정

• 냉매 레벨 제어 설정이 가능합니다. 냉매 레벨의 목표 값과 레벨 밸브를 제어하기 위한 P 값과 I 값, 그리고 냉동기 기동 시 초기 냉매 레벨 목표 값을 설정합니다.

- Path : MENU ➡ SENSOR OFFSET ➡ Select

Figure 38. 냉매 레벨 화면

Control information setting

• This is the place to set values related to safety control of the chiller. Select an item which you want to set by touching it, then a dial is popped up. Input a value into the popped-up dial and press ENT, then the value is set.

Usage is the same as 'P40 User setting'.

- Path : MENU ➡ CONTROL INFORMATION SET ➡ Select

Figure 39. Control information setting

Abnormal condition setting

- This is the place to set values related to abnormal stop of the chiller.
  Select an item which you want to set by touching it, then a dial is popped up. Input a value into the popped-up dial and press ENT, then the value is set.

- Path : MENU ➡ ABNORMAL CONDITON SET ➡ Select

Figure 40. Abnormal condition screen

1) Chilled Water Temperature Lower Limit

It sets the lower limit value to prevent freezing of the chilled water.

If the chilled water outlet temperature is lower than the set value of 'chilled water outlet temperature lower limit', the chiller will abnormally stop.

2) Oil Differential Pressure Lower Limit

It sets the lower limit of the oil differential pressure. If the oil differential pressure during the chiller operation becomes lower than the set value, the chiller will abnormally stop.

3) Oil Temperature Upper Limit

It sets the upper limit of the oil temperature. If the oil temperature of the chiller is higher than the set value, the chiller will abnormally stop.

4) Compressor Discharge Temperature Upper Limit

It sets the upper limit of the compressor discharge temperature.
If the compressor discharge temperature during the chiller operation becomes higher than the set value, the chiller will abnormally stop.

5) Bearing Temperature Upper Limit

It sets the upper limit of the bearing temperature
If the bearing temperature goes above the set value, the chiller will abnormally stop.

6) Motor Winding Temperature Upper Limit

It is the menu to set upper limit temperature of motor winding.
If any one of the motor winding R, S, or T phase temperature exceeds the set value, it will stop the chiller abnormally.

7) Evaporator Refrigerant Temperature Lower Limit

It is the place to set the lower limit of the evaporator temperature.
If the evaporator temperature during the chiller operation becomes lower than the set value, the chiller will abnormally stop.

8) Evaporator Pressure Lower Limit

It sets the lower limit of the evaporator pressure.
If the evaporator pressure during the chiller operation becomes lower than the set value, the chiller will abnormally stop.

9) High pressure of condenser

It sets the upper limit of the condenser pressure.

If the condenser pressure during the chiller operation becomes higher than the set value, the chiller will abnormally stop.

10) Motor Voltage Lower Limit

It is the menu to set the rated voltage of the compressor motor.

Based on this value, motor voltage lower limit control will be performed.

11) Max Vibration Limit (option)

It sets the upper limit of value of vibration of the chiller. If the vibration is higher than the set value, the chiller will abnormally stop.

12) Chilled Water Flow Low Limit (option)

It sets the lower limit of value of flow of the chilled water. If the flow is lower than the set value, the chiller will abnormally stop.

13) Condenser Water Flow Low Limit (option)

It sets the lower limit of value of flow of the Condenser water. If the flow is lower than the set value, the chiller will abnormally stop.

14) Condenser Water Temperature High Limit (option)

It sets the upper limit of temperature of the Condenser water. If the temperature is higher than the set value, the chiller will abnormally stop.

15) Condenser Prevent Time Limit

It sets the lower limit of temperature of the oil and the evaporator.

16) Oil Pump Period Onstop

It sets the period of oil pump the chiller on stop. If the chiller matain the “stop” status more than the set value, the Oil Pump will run for 1 minute.

17) High Oil Differential Pressure

It sets the upper limit of oil differential pressure. If the differential pressure is higher than the set value, the chiller will abnormally stop.

Safety control setting

- It is the place to set the values related to the safety control of the chiller. Select an item which you want to set by touching it, then a dial is popped up. Input a value into the popped-up dial and press ENT, then the value is set.
  - Path : MENU ➡ SAFETY CONTROL SET ➡ Select

Usage is the same as 'P40 User setting'.

Figure 41. Safety control setting screen

No.	Setting Item	Setting Range	Initial Value / Unit	Remarks
1	Soft start output cycle	5.0~60.0	10.0 sec.	
2	Soft start output	0.0~5.0	1.0 sec.	
3	Soft stop vane opening	0~100	10%	
4	Prevention of high temperature of bearing	50~100	95%	Note 1.
5	Prevention of high temperature of motor winding	50~100	95%	Option
6	Prevention of low voltage of motor	50~100	95%	
7	Prevention of high temperature of compressor discharge	50~100	95%	Note 1.
8	Prevention of low temperature of evaporator refrigerant	50~100	95%	Option
9	Prevention of low pressure of evaporator	50~100	95%	
10	Prevention of high pressure of condenser	50~100	95%	
11	Setting upper limit of surge pressure	0.70~12.00	12.00kg/cm^2	Note 1.
12	Setting lower limit of surge pressure	0.00~10.00	7.00kg/cm^2	Note 1.
13	Surge temperature high level setting	0.5~12.0	5.6 °C	Note 1.
14	Surge temperature low level setting	0.0~10.0	5.0 °C	Note 1.
15	Amount of change of surge current	1~100	25%	Note 1.
16	Surge occurrence detection time	0~1800	120 sec.	Note 1.
17	Number of application of surge	1~100	12 times	Note 1.

Table 12. Safety control setting items

Note1. R134a : Standard application
R22 : Optional

Timer setting

- It is the place to set the values related to timer required for chiller operation.
  Select an item which you want to set by touching it, then a dial is popped up.
  Input a value into the popped-up dial and press ENT, then the value is set.

- Path : MENU ➡ TIMER SET ➡ Select

Usage is the same as 'P40 User setting'.

Figure 42. Timer setting screen

No.	Setting item	Setting Range	Initial Value/Unit
1	Chilled water pump stop delay	1~1800	300 sec.
2	Cooling water pump start-up	1~60	5 sec.
3	Cooling water pump stop check	1~1800	30 sec.
4	Flow chattering ignorance	1~60	2 sec.
5	Oil circulation before start-up	30~600	180 sec.
6	Oil circulation after stop	30~600	300 sec.
7	Oil pressure check timer	1~60	10 sec.
8	Vane close at start up	30~600	120 sec.
9	Vane close at stop	30~600	120 sec.
10	Vane open delay	0~600	30 sec.
11	Compressor start-up check	10~60	20 sec.
12	Restart prevention timer	10~3600	1800 sec.

Table 13. Timer setting items

VGD/VFD setting

- It is the screen to set the relationship between guide vane and diffuser vane, and to set the control point when VFD is used. For diffuser vane, since it is only applied to R134a two stage centrifugal chiller, so you don't have to set it for other models.

  - Path : MENU ➡ VGD/VFD SET ➡ Select

  Usage is the same as 'P40 User setting'.

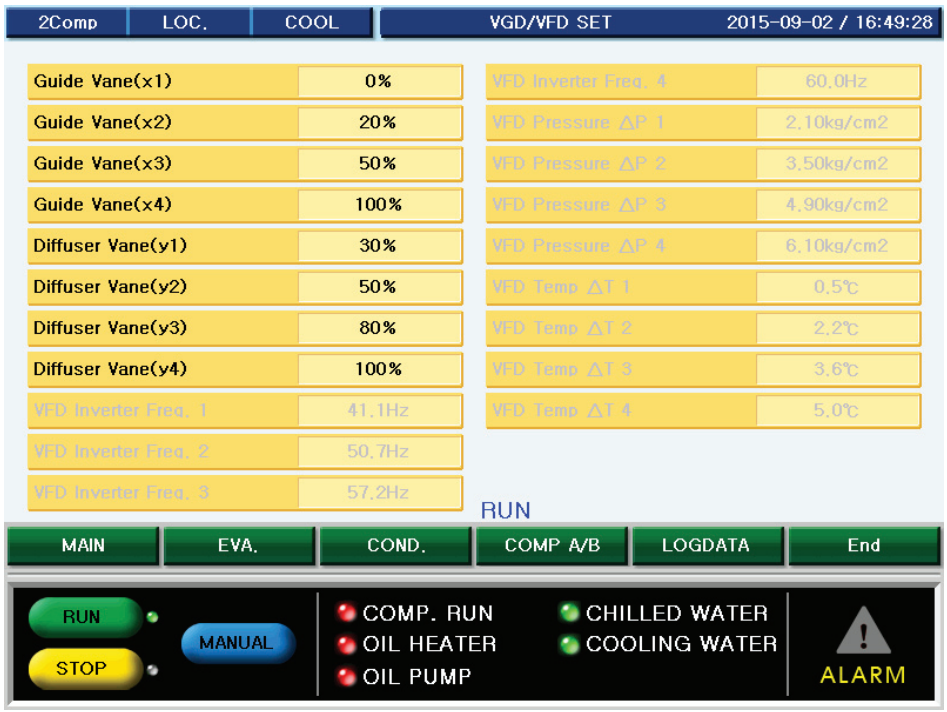


Figure 43. VGD/VFD setting screen

Category	Setting Range	Initial value	Set value	Remarks
Inverter frequency 1	40Hz~60Hz	41.1Hz	40.0Hz	Inverter Frequency 4-20mA output
Inverter frequency 2	40Hz~60Hz	50.7Hz	45.0Hz	
Inverter frequency 3	40Hz~60Hz	57.2Hz	51.0Hz	
Inverter frequency 4	40Hz~60Hz	60.0Hz	60.0Hz	
Pressure ΔP 1	2.0~10.0Kg/cm^2	2.1Kg/cm^2	2.1Kg/cm^2	Condensing-evaporating pressure
Pressure ΔP 2	2.0~10.0Kg/cm^2	3.5Kg/cm^2	2.5Kg/cm^2	
Pressure ΔP 3	2.0~10.0Kg/cm^2	4.9Kg/cm^2	4.1Kg/cm^2	
Pressure ΔP 4	2.0~10.0Kg/cm^2	6.1Kg/cm^2	6.8Kg/cm^2	
Temperature ΔT 1	0.0~20.0 °C	0.5 °C	1.3 °C	Chilled water inlet-set temperature
Temperature ΔT 2	0.0~20.0 °C	2.2 °C	2.8 °C	
Temperature ΔT 3	0.0~20.0 °C	3.6 °C	3.7 °C	
Temperature ΔT 4	0.0~20.0 °C	5.0 °C	5.0 °C	
Inverter calculation cycle	1-100 sec.	60	60	

Table 14. VGD/VFD setting items

- VFD control operation

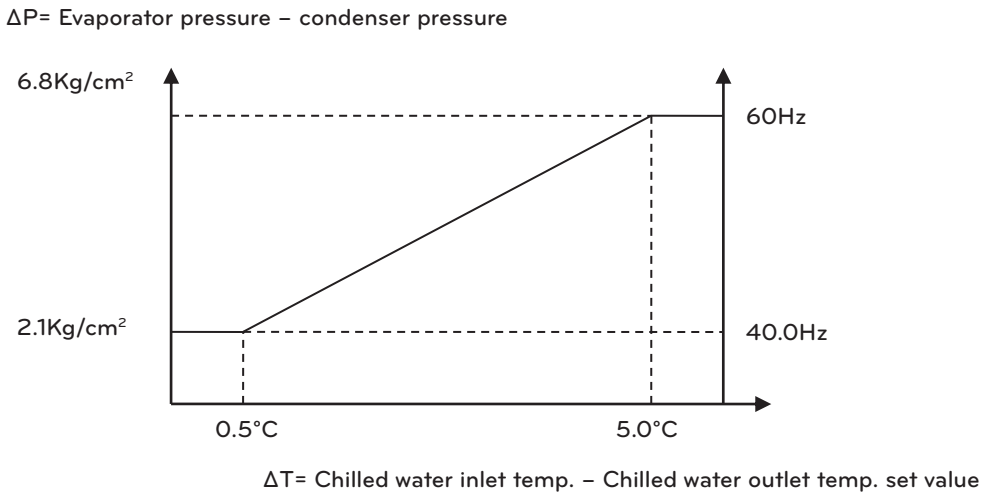


Figure 44. Detailed diagram of VFD control

센서설정

- 가각 압력 센서 및 전류 센서 등의 설정을 하는 메뉴로 정확한 설정을 해야 하며, 사용으로 설정된 센서에만 유효합니다. 수동 조작으로 가이드 베인 및 디퓨저 베인의 AD값을 최소/최대로 변경 후 Reserved를 ON으로 변경 후 해당 설정(최소값 설정, 최대값 설정)을 선택하여 설정을 마칩니다.

  - Path : MENU ➡ SENSOR SET ➡ Select

Usage is the same as 'P40. User setting'.

Figure 45. Sensor setting screen

Sensor correction

- It is the menu to check operation data, temperature control graph, start/stop information, etc. stored in the controller of the chiller. You can also check the information of the total accumulated number of operations (number of start/stop) and total accumulated operation time of the chiller and main subsidiary devices.

  - Path : MENU ➡ SENSOR SET ➡ Select

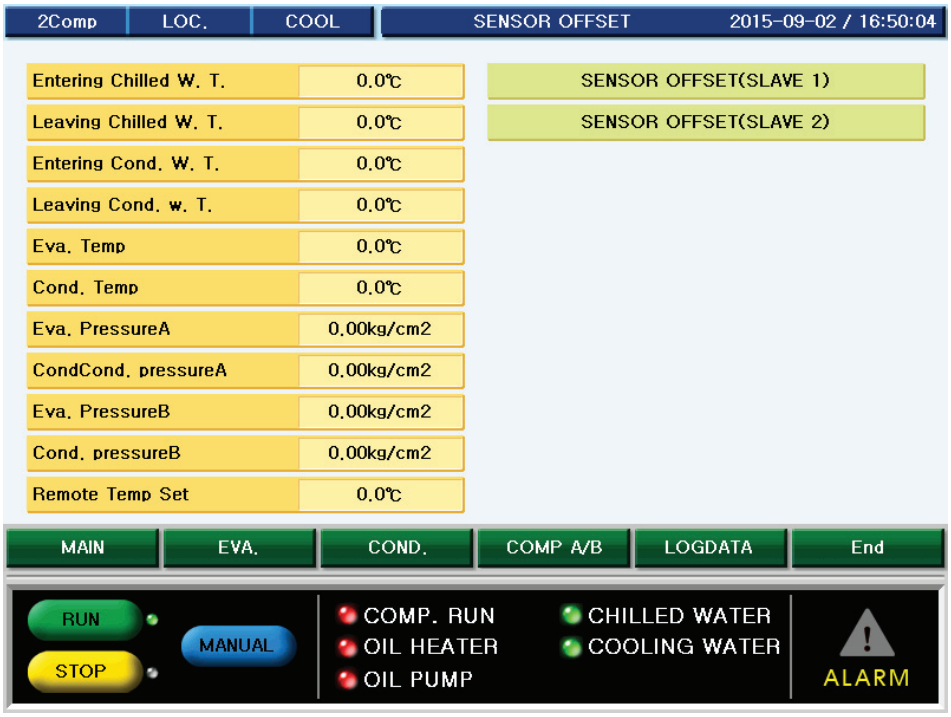


Figure 46. Chiller history screen

LOGDATA

- It is the menu to check operation data, temperature control graph, start/stop information, etc. stored in the controller of the chiller. You can also check the information of the total accumulated number of operations (number of start/stop) and total accumulated operation time of the chiller and main subsidiary devices.

  - Path : LOGDATA

Figure 47. Log data screen of chiller

1) Operation information

- Path : LOGDATA ➡ Run Info.

Figure 48. Operation information screen of chiller

2) Operation data

- Path : LOGDATA ➡ Run Info.

Figure 49. Operation data screen of chiller

3) Error data

- Path : LOGDATA ➡ Run Info.

Figure 50. Error data information screen

① You can check up 1~300 data by means of a button.

② You can select error history help by means of a button.

4) Help

• It displays the help message about the errors and precautions. If Help key is pressed on the error and precaution screen, the help message for the corresponding message is displayed on the help screen. Previous key will show the help message of the previous numbered and Next key for the next numbered help message.

- Path : LOGDATA ➡ Run Info.

Touch the corresponding message

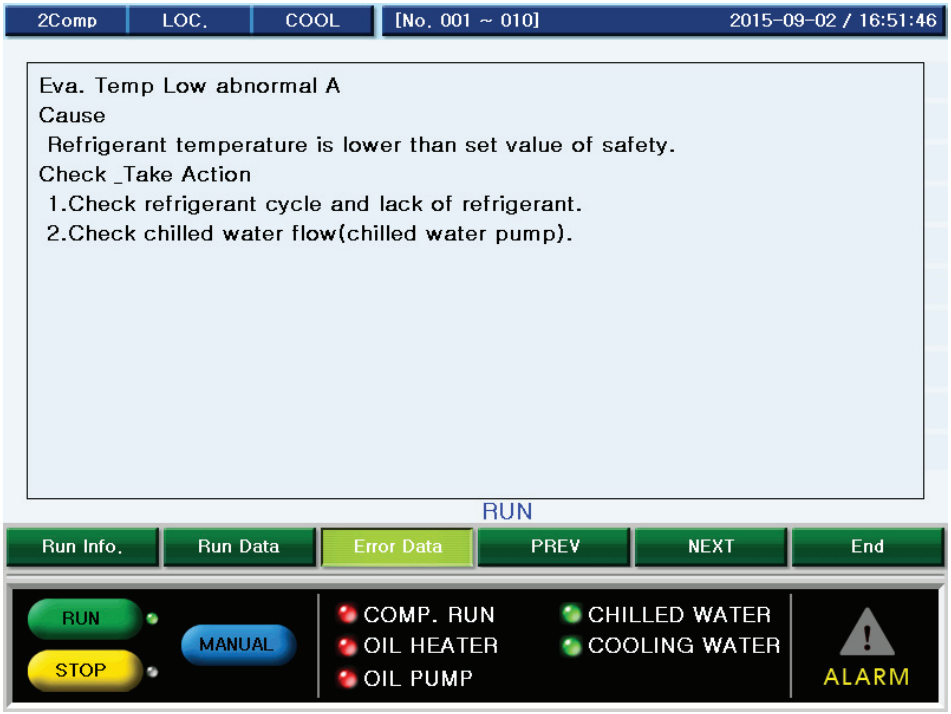


Figure 51. Help function screen

5) Print

- Path : LOGDATA ➡ Run Info.

Figure 52. Print function screen

- User set print: It prints the user set page.
- System set print: It prints the current system set value.
- Operation information print: It prints from start to end page for operation information (1~300).
  - Auto print: Print with regular time interval.
  - Print mode: "1"– All data, "2"– only unit (used by start-up)
- Operation data print: It prints from start to end page for operation data. (1~300)
- Error data Print: It prints from start to end page for error data. (1~300)

6) Graph

- Path : LOGDATA ➡ Run Info.

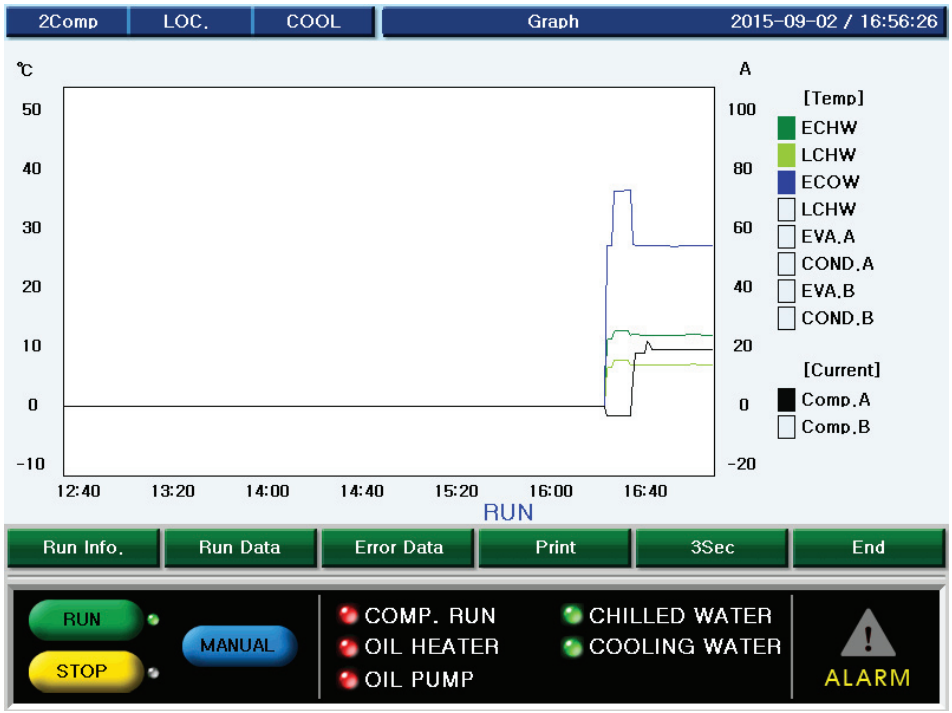


Figure 53. Data graph screen

Connection of remote control signal and status signal

Method of connecting remote operation/stop signals

- No voltage contact continuous signal 2 wires

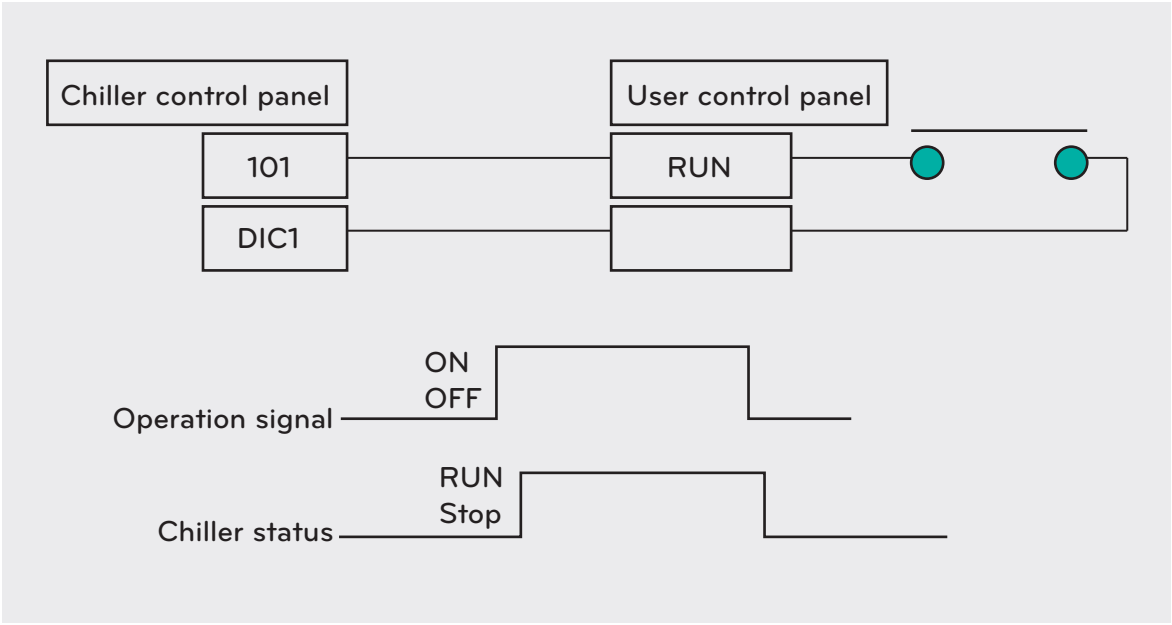


Figure 54. Detailed diagram of remote control signal

※ Minimum Operation/Stop pulse maintaining time: 2 sec.

Power panel and connection signals

Signal name	Signal type	Signal type	Caution
Chilled water pump interlock Cooling water pump interlock	Input (No voltage contact)	It is the interlock to confirm whether the electromagnetic contactor for starting pump is 'ON'. If the input signal does not exist at start-up, the chiller will not operate. If the input does not exist during operation, an error happens.	It outputs DC24V to detect the status of the contact. Make sure to have no contact resistance over 100 Ω. (Do not handle the electric wire pipe together with other power lines.)
Chilled water pump Operation/Stop Cooling water pump Operation/Stop Cooling tower fan Operation/Stop	Output (No voltage contact)	It is the Operation/Stop signal of the pump or fan. Connect it when it is operated by interfacing operation/stop signal from chiller.	Use it within AC250V 0.1A (resistance load).

Table 15. Detailed diagram of power panel and connection signals

Central monitor panel and connecting signals

Signal name	Signal type	Meaning of the signal	Caution
Contact for motor start-up checking signal	Output (No voltage contact)	ON when start signal is input OFF when stop signal is input	Use it within AC250V 0.1A(resistance load).
Contact for indicating Operation/Stop	Output (No voltage contact)	ON when chiller operates OFF when chiller stops	
Contact for indicating a fault	Output (No voltage contact)	ON when there is a problem in the chiller.	
Contact for indicating remote operation	Output (No voltage contact)	ON when remote operation mode is selected	
Contact for indicating warning	Output (No voltage contact)	ON when alarm breaks	

Table 16. Detailed diagram of central monitor panel and connecting signals

Check list prior to inspection

1) Thorough preparation
   Check the first-aid method and the safety of the machine and equipment. Arrange the work site.

2) Review with the circuit diagram
   If the power system receives power from another source, check every power supply, power applications to the first side of the circuit and the state of the ground wire.

3) Contact
   Check if you could closely and certainly contact with the relevant departments.

4) Check for zero-voltage and safety measures.
   While inspecting the main circuit, please review the following items for safety.
   - Open the related breaker and disconnecting switch and make the main circuit zero voltage.
   - Check for zero-voltage with an electroscope and make groundings where it is necessary.
   - Withdraw the breaker to be disconnected and attach a warning sign board "Checking".
   - Operate the disconnecting switch after shutting the power off.
   - Especially if the power is supplied via another source such as consumer side power distributing panel, automatic control, MCC, etc., do the above c., d. process on the other side switches.

5) Cautions for voltage and current
   While checking the connection part of the condenser or cable, conduct grounding after discharging the remaining electric charge.

6) Prevent mal-operation
   Attach a 'Caution' and 'power off' mark.

7) Prepare insulated protection equipment
   Put on the protection gear (insulation glove, safety helmet, insulated boots, safety apparel, etc.) proper to the rated voltage.

8) Measures against infestation of rat, insects, etc.
   Take countermeasures to prevent rat, insects, etc. from entering the panel.

Check list after inspection.

1) Final Check
   - Check whether any worker is inside the panel
   - Check whether removal of the temporary building for the inspection has not been delayed.
   - Check whether every bolt has been all tighten.
   - Check whether any tool has been left.
   - Check whether there was any rat/insect infestation.
2) Recording inspection results

   Be sure to record check & repair point and date and status of product failure during the inspection, which can be used as a reference data for the next inspection.

⚠ CAUTION

Establish the general plan that can identify machine's operation load, operating time and surrounding environment through daily inspection.

As the inspection cycle described in this manual is for general period inspection, specify your inspection plan according to the load status and usage frequency.

Do not test the insulation resistance on the second side of the power control transformer or the controller.

Do not test insulation resistance on the components (e.g. sensor, switch, etc.) which are connected to the controller.

General Inspection items

Inspection	Inspection categories	Inspection items	Daily	1 year	2 years	Judgment Standard
All	Ambient Environment	Is there any dust? Is the ambient temperature and humidity within the standard? Is there any abnormal vibration?	o			Refer to Ch.1. Environment Condition.
	Equipment	Is there any abnormal vibration or noise?	o			Should be Normal
Main circuit / Control circuit	Input Voltage	Is the main circuit voltage normal? Is the main circuit voltage normal?	o			Refer to Ch.1. Environment Condition.
	Insulation Resistance Test	Prior to the insulation resistance test, cut off every power supply. While measuring the insulation resistance between the primary side of the breaker and the bus bar, disconnect every wire connected to the bus bar.		o		* Low voltage (600Vac or less) DC 500V class mega, it should be 5MΩ or more. * High voltage (exceeding 600Vac, 7000Vac) DC 1000V class mega, it should be 30MΩ or more.
	Overheating	Is there any trace of overheating in each component?		o		Should be Normal
	Fixed parts	Is there any unfasten fixed parts?		o		Should be Normal
	Conductor/Wire	Is the conductor not polluted? Is the wire not damaged?		o		Should be Normal
	Terminal Block	Is there any damaged parts?		o		Should be Normal
	Relay/Contactor	Is there any shaking during operation? Is the contactor not damaged?		o		Should be Normal
	Space Heater	Is there any discoloration of the heater component in the starter panel?		o		Should be Normal
	Sensor & Switch	Is there any disconnection or short circuit? Is the contacting section not damaged?		o		Should be Normal
	Grounding	Is there any rust on the connection part? Is there any damage in the grounding conductor? Is there any noise in the grounding system? Note: Grounding resistance shall meet the requirements of the related codes and standards.		o		Should be Normal
	Phase advance capacitor	Is there any damaged parts? Is the expansion under the limit?	o			Should be Normal
	Cooling Fan	Is there any abnormal noise? (Control panel)	o			Should be Normal
Control function	Safety Function	Is the safety function properly operating? Is the start-up sequence properly operating? Is the stop sequence properly operating? Is the temperature regulation within the specification?		o		Normal control
Display	Analog Value	Is the displayed value correct?		o		Should be in the allowed range
		Display lampDoes the indication lamp display with the normal brightness?	o			Lamp is On during operation

Table 17. General inspection items

4-7. Startup and Control sequence

Signal Flowchart

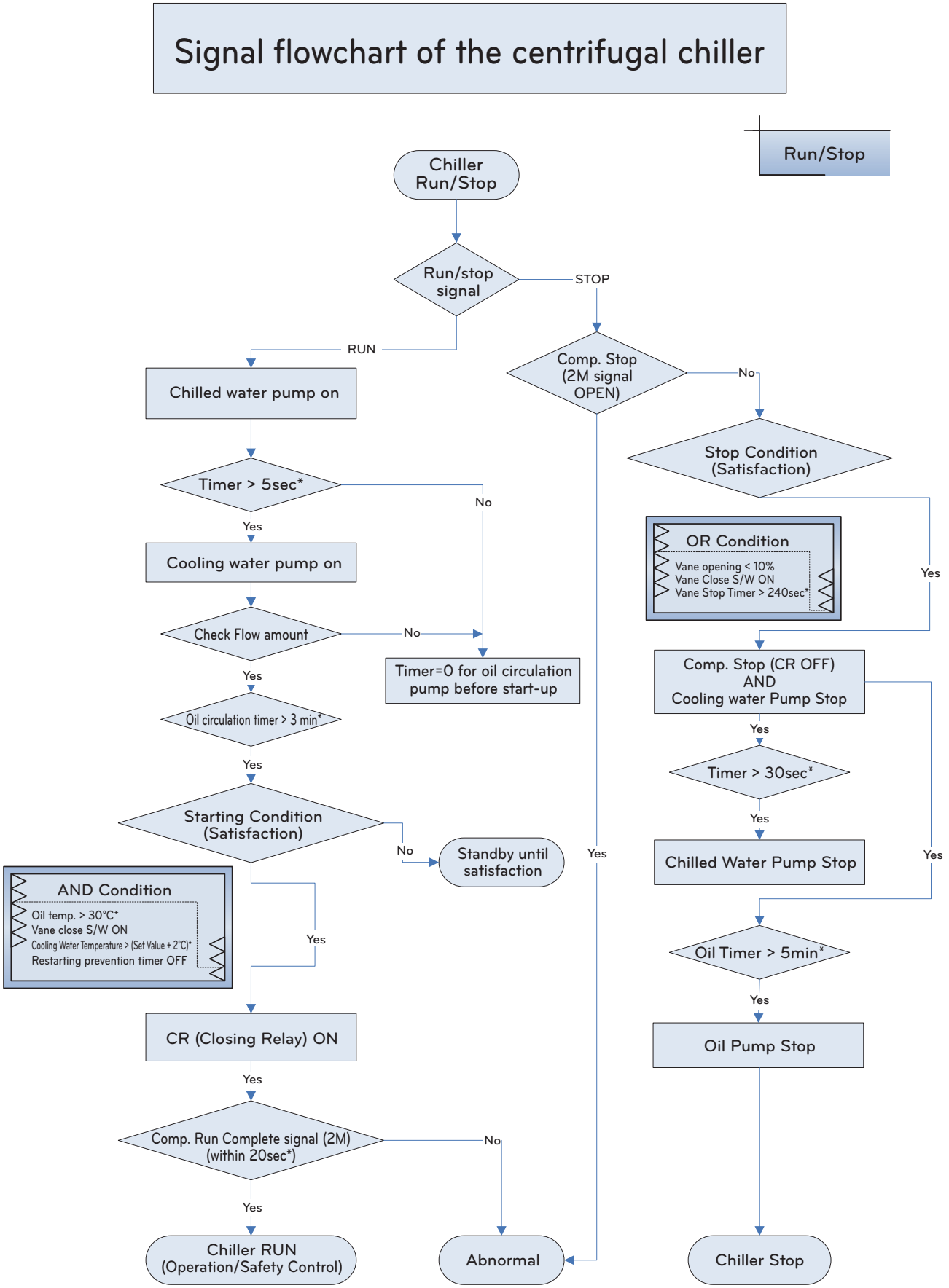
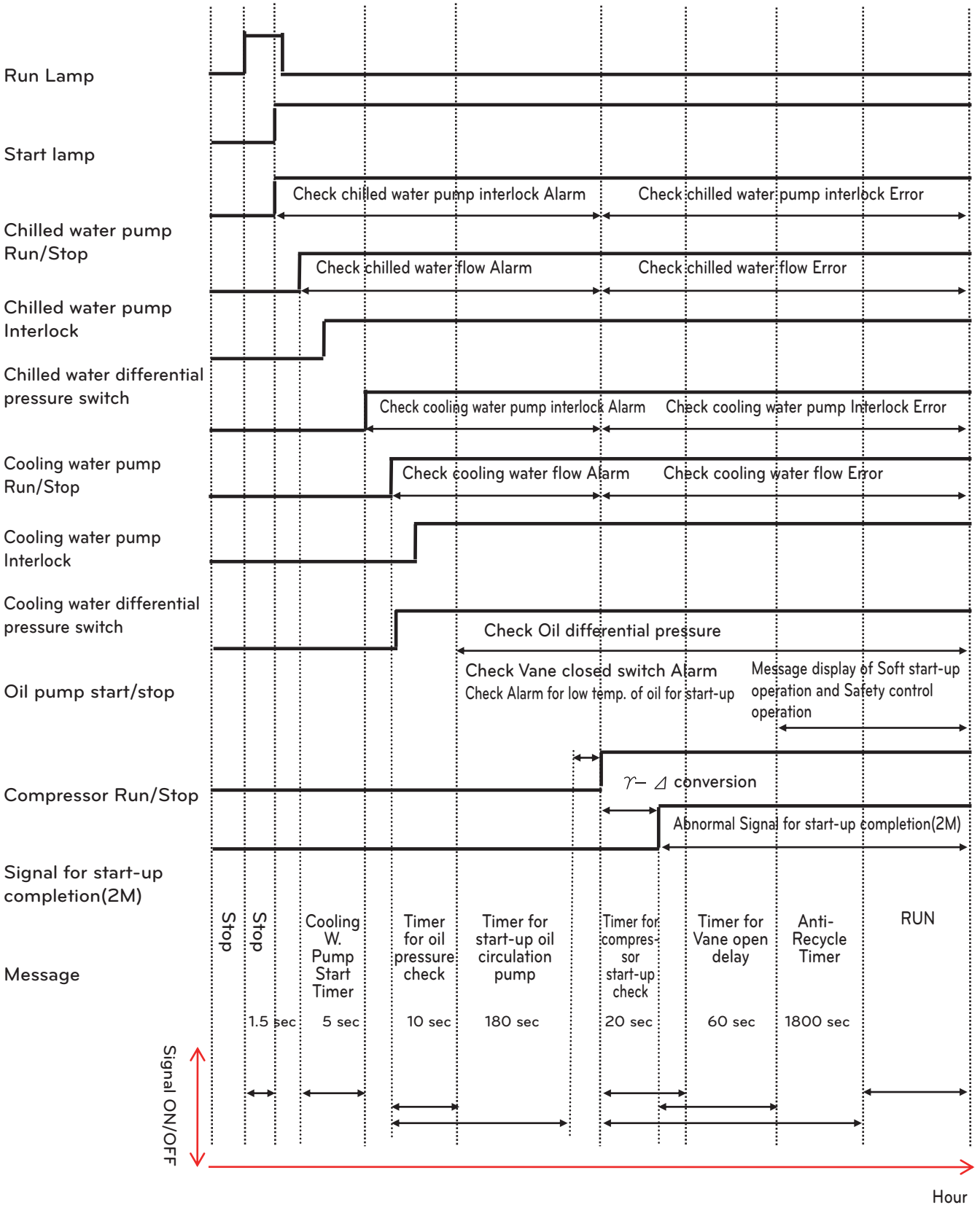


Figure 55. Signal Flowchart

Turbo Timing Sequence - Run



Turbo Timing Sequence - Stop

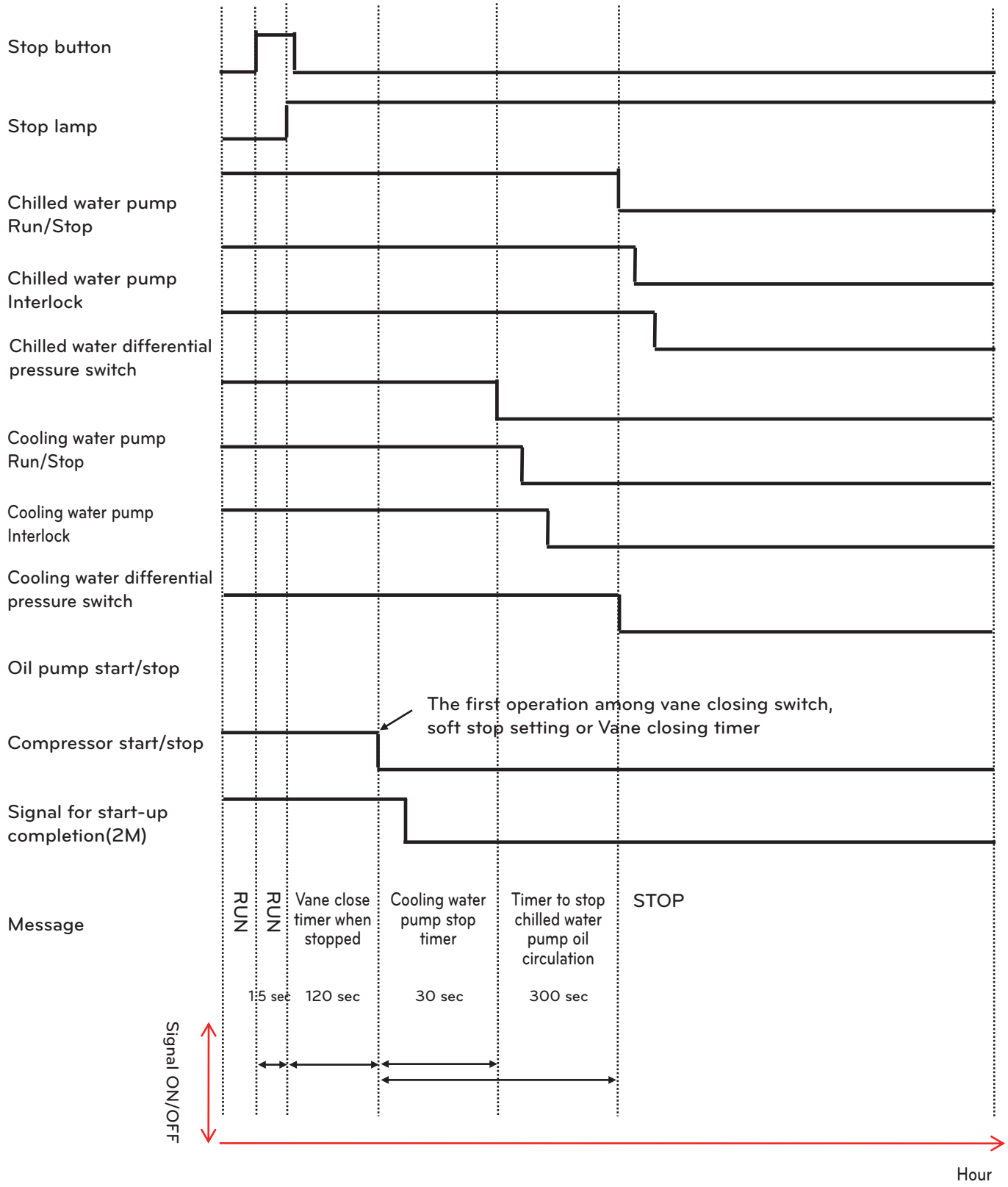


Figure 56. Time sequence

4-8. Product protection function

Protection Logic

Classification	Content	Cause	Operation	Condition
Sensor	Sensor abnormality on Temperature, Pressure and Current Etc.	Sensor abnormality on Temperature, Pressure and Current Etc.	Chiller Stops	Abnormal
Interlock	Chilled water pump interlock error	Pump interlock problem detected during operation	Chiller Stops	Abnormal
	Cooling water pump interlock error	Pump interlock problem detected during operation	Chiller Stops	Abnormal
	Abnormal low flow of chilled water	Flow-interlock problem detected during operation	Chiller Stops	Abnormal
	Abnormal low flow of cooling water	Flow-interlock problem detected during operation	Chiller Stops	Abnormal
Temperature and Pressure	Controlling abnormal high oil temperature	Overheated oil detected	Chiller Stops	Abnormal
	Abnormal high condenser pressure	Abnormal high condenser pressure detected	Chiller Stops	Abnormal
	Abnormal low evaporator pressure	Abnormal low evaporator pressure detected	Chiller Stops	Abnormal
	Preventing refrigerant leak of the evaporator	Abnormal low temperature refrigerant detected	Chiller Stops	Abnormal
	Abnormal high temperature compressor discharge	Abnormal high temperature compressor discharge detected	Chiller Stops	Abnormal
	Abnormal high temperature motor winding	Abnormal high temperature motor winding detected	Chiller Stops	Abnormal
	Abnormal high temperature of the bearing	Abnormal high temperature bearing detected	Chiller Stops	Abnormal
	Abnormal low temperature chilled water	Abnormal low temperature chilled water detected	Chiller Stops	Abnormal
Surge occurrence	Compressor surge current error	Compressor surge current error detected	Chiller Stops	Abnormal
Voltage	Abnormal low voltage	Abnormal low voltage of compressor motor detected	Chiller Stops	Abnormal

Classification	Content	Cause	Operation	Condition
Prevention control	Preventing low oil temperature starting	Oil Temp ≤ Low set value of starting oil	Low oil temperature prevention control precaution displayed	Caution
	Low voltage prevention	If the voltage of the compressor motor is below the low voltage prevention set value – (100-set value)/2, the guide vanes are closed.	Display of prevention, control or precaution message for low voltage	Caution
	High condenser pressure prevention	If the condenser pressure is above the high pressure prevention set value +(100-set value)/2, the guide vanes are closed.	Display of prevention, control or precaution message for high pressure of condenser	Caution
	Low evaporator pressure prevention	If the Pressure of the evaporator is below the low pressure prevention set value-(100-set value)/2, the guide vanes are closed.	Low evaporator pressure prevention precaution displayed	Caution
	Low evaporator refrigerant temperature prevention	If the evaporator temperature is below the low temperature prevention set value-(100-set value)/2, the guide vanes are closed	Low evaporator refrigerant temperature prevention control precaution displayed	Caution
	High compressor discharge temperature prevention	If the discharging temperature of the compressor is below the low temperature prevention set value + (100-set value)/2, the guide vanes are closed	Display of prevention, control or precaution message for high temperature of compressor discharge	Caution
	High bearing temperature prevention	If bearing temperature is above the high temperature prevention set value + (100- set value)/2, the guide vanes are closed	Display of prevention, control or precaution message for high temperature of bearing	Caution
	Control to prevent low chilled water temperature	If chilled water temperature is below the low temperature prevention set value - (100- set value)/2, the guide vanes are closed	Display of prevention, control or precaution message for low temperature of chilled water outlet	Caution
	Compressor surge current prevention	If a current change above the set value occurs (set times/3) times within the set time, the guide vanes are closed	If a current change above the set value occurs (set times/3) times within the set time, the guide vanes are closed	Caution
	Control to prevent the motor from over-current	If the compressor motor current reaches the set value*105%, the guide vanes are closed to lower the current under the set value	Display of prevention, control or precaution message for over-current on compressor motor.	Caution
	High motor winding temperature prevention	If the temperature of the motor winding is over the high temp prevention set value+(100-set value)/2, the guide vanes are closed	Display of prevention, control or precaution message for high temperature of motor winding	Caution
	Control to prevent condensation	T_eva ≤ Oil T-10 or T_eva ≤ -0.0227*OilT^2 + 2.4361*OilT - 24.604	A precaution message is displayed during the anti-condensation control operation. If stopped, unable to be operated.	Caution

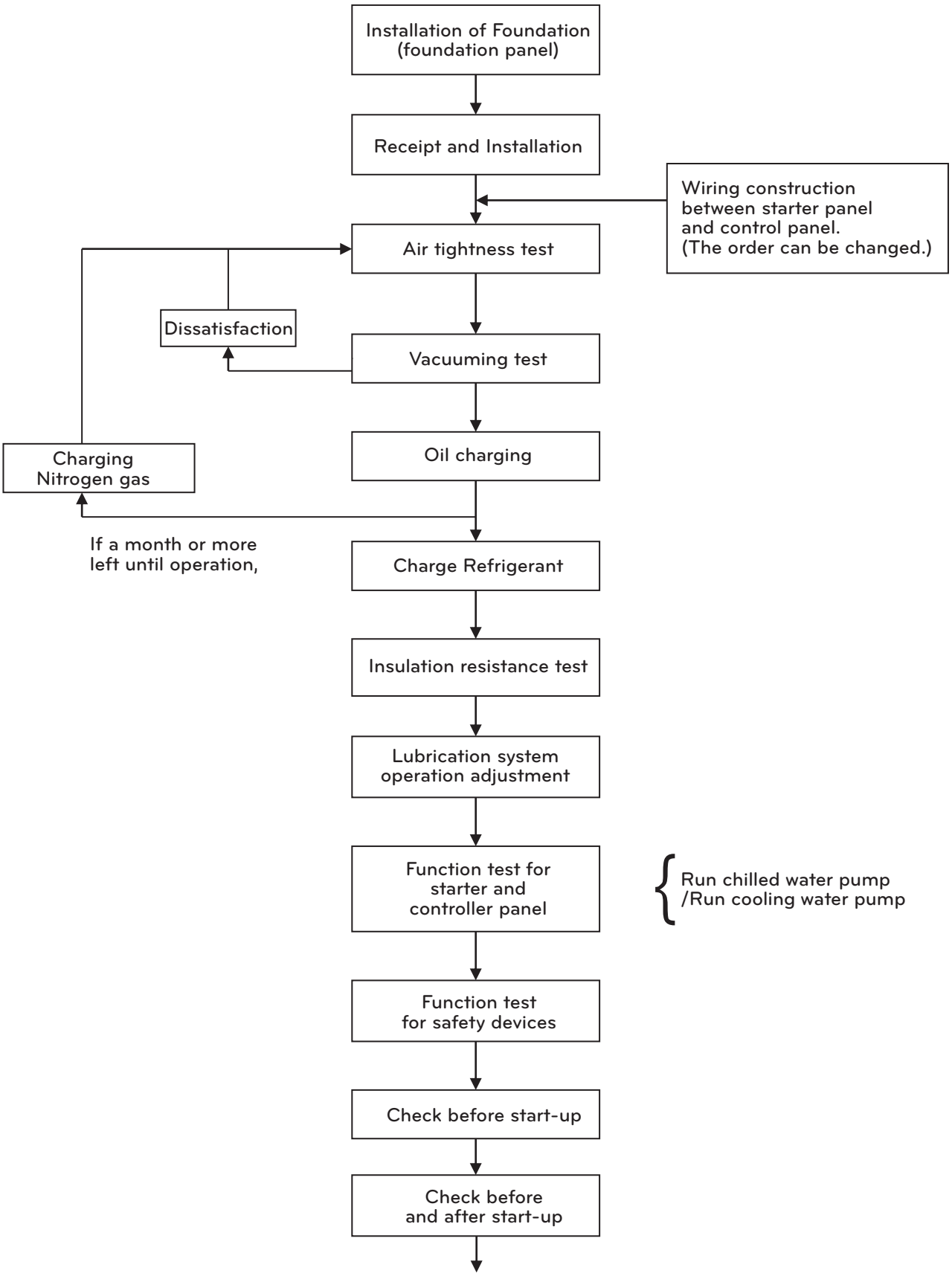
Classification	Content	Cause	Operation	Condition
Switch contact	High temperature contact of motor winding opens	Winding temperature input contact open	Chiller stops	Abnormal
	Low temperature contact of evaporator refrigerant close	Low temperature contact of evaporator refrigerant close	Chiller stops	Abnormal
	Over-current contact of oil pump close	Thermal over-current relay contact attached to the oil pump power line close	Chiller stops	Abnormal
	High temperature contact of bearing close	High temperature contact of bearing close	Chiller stops	Abnormal
	High temperature contact of bearing close	High pressure contact of condenser close	Chiller stops	Abnormal
	Condenser high pressure input contact close	Start-up failure	Chiller stops	Abnormal
	No input signal of the compressor start-up completion	Delta contactor open during operation	Chiller stops	Abnormal
	Starting panel contactor open during operation	Starting panel abnormal contact closed	Chiller stops	Abnormal
	Compressor motor power contact open	Compressor motor power contact open	Chiller stops	Abnormal

Table 18. Protection logic

5. TEST RUN

5-1. Bring-in and Installation Check

Bring-in, installation and test run



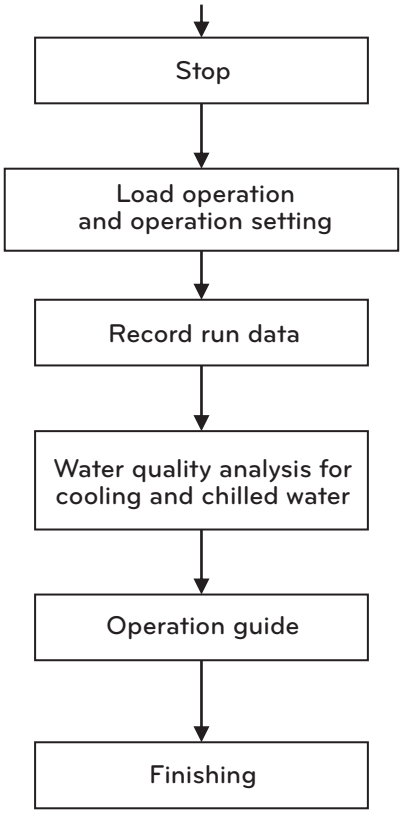


Figure 57. Process from bring-in to test run

Site selection

- If the chiller have to be installed near heat generating devices: keep distance more than 5 meters from boilers and hot-air blower, and more than 2 meters from other heat generating devices.
- Choose a well-ventilated place and avoid a place with high temperature
- Choose a place with low humidity
- Secure enough space for service (for control and tube and pipe repair & maintenance)

Foundation

- Build the foundation to bear the concentrated weight of the chiller.
- The foundation should be higher than the surface of the water and a drainage system should be installed.
- Install a drain pipe on the drainage system.

Bring-in and installation

- Bring in the chiller horizontally to the ground as much as possible
- Before installation, put an anti -vibration pad on the base mat of the foundation and the horizontal degree should within ±1mm
- Check whether the horizontality of the anti-vibration pad is within ±1mm using a leveling instrument. If not, readjust it to be in ±1mm using a spacer.

5-2. Preparation for test run

Preparation work for test run

- Preparation for test run means the work done before the first operation of the chiller after bring-in and installation or before reoperation after long-term stoppage(about one month or more).
  Preparation for test run is a maintenance process that should be done at least once a year after installation, which is very elementary and important.

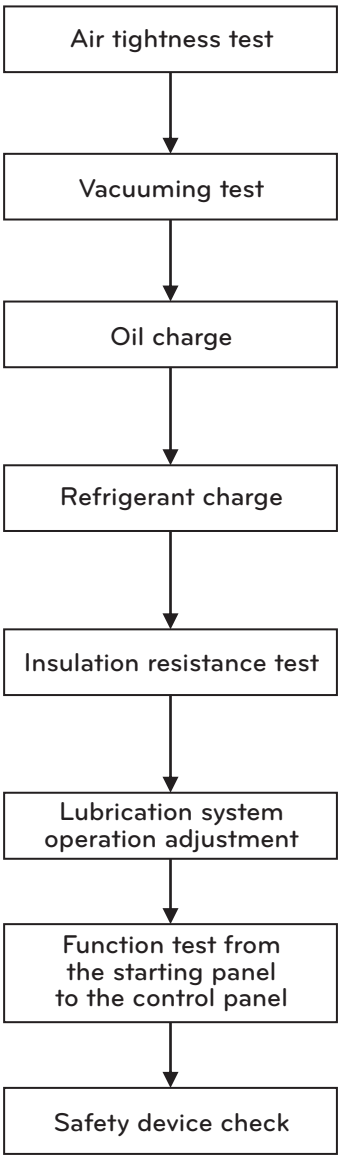


Figure 58. Preparation process for test run

Checking leaking parts

It is recommended to perform the leakage test following the order of Figure. 58
Refer to temperature and pressure value of the refrigerant in Table 18.

Leakage test

• Situations demanding leakage test
  - After the chiller is disassembled and repaired
  - In case the nitrogen's pressure charged in the factory during transportation and before initial start-up becomes lower.

• Potential points for leaking
  - Parts where the gasket is used
  - Screw tightened parts, bolts and nuts
  - Connecting parts of the copper tube
  - Welded parts of the sight-glass
  - Compressor motor terminal

• Inspection method
  1) Charge nitrogen until the internal pressure becomes 2 kg/cm^2, 5 kg/cm^2, 9~9.5 kg/cm^2, and in each pressure point carry out a leakage test in order.
  2) Perform a soapy water test on every connecting part.
  3) If the inspection pressure maintains for 30 minutes, prepare for an inspection on smaller parts.
  4) Mark the leaking parts.
  5) Eject inner pressure.
  6) Repair every leaking part.
  7) Do a leakage test again on the repaired parts.
  8) After performing a large leaking test, increase the pressure up to the value of 9~9.5 kg/cm^2.
  9) Do a small leakage test and fix leaking parts.
  10) After the leakage test is finished, release nitrogen carefully.

* Close the evaporator valve, as the safety valve of the evaporator can open when the inner pressure of the chiller increase.

  Note: The open pressure of the condenser's safety valve is 1.05.Mpa(10.71 kg/cm^2)
  The open pressure of the evaporator's safety valve is 0.99 Mpa (10.1 kg/cm^2)

Temperature °C	Pressure 1kg/cm^2	Temperature °C	Pressure 1kg/cm^2	Temperature °C	Pressure 1kg/cm^2
-26.18	0	15	3.9517	51	12.740
-20	0.3255	16	4.1136	52	13.087
-19	0.3850	17	4.2793	53	13.400
-18	0.4465	18	4.4491	54	13.800
-17	0.5101	19	4.6230	55	14.167
-16	0.5758	20	4.6230	56	14.540
-15	0.6437	21	4.9932	57	14.921
-14	0.7138	22	5.1697	58	15.308
-13	0.7862	23	5.3605	59	15.703
-12	0.8610	24	5.5558	60	16.104
-11	0.9381	25	5.7555	61	16.513
-10	1.0176	26	5.9597	62	16.929
-9	1.0996	27	6.1685	63	17.353
-8	1.1841	28	6.3819	64	17.784
-7	1.2713	29	6.6001	65	18.223
-6	1.3610	30	6.8231	66	18.670
-5	1.4535	31	7.0510	67	19.124
-4	1.5486	32	7.2838	68	19.587
-3	1.6466	33	7.5216	69	20.057
-2	1.7474	34	7.7644	70	20.536
-1	1.8512	35	8.0124	71	21.023
0	1.9579	36	8.2657	72	21.518
1	2.0675	37	8.5242	73	22.023
2	2.1803	38	8.788	74	22.535
3	2.2962	39	9.0578	75	23.057
4	2.4153	40	9.3318	76	23.587
5	2.5376	41	9.6128	77	24.127
6	2.6632	42	9.8988	78	24.676
7	2.7922	43	10.190	79	25.234
8	2.9246	44	10.488	80	25.802
9	3.0604	45	10.791	81	26.379
10	3.1998	46	11.101	82	26.966
11	3.3428	47	11.416	83	27.563
12	3.4894	48	11.738	84	28.171
13	3.6397	49	12.066	85	28.788
14	3.7938	50	12.400	86	29.417

Table 19. HFC-134a Temperature / Pressure

Vacuum Dehydrating, Vacuum Test

- Vacuum dehydrating should be carried out to remove the moisture in the machine, if the machine has been exposed in the air for a long time, or moisture has been detected in the machine, or the refrigerant pressure has been entirely lost due to leaking.

⚠ WARNING

Do not do an insulation resistance test or operate the oil pump/compressor motor during the vacuum test.
Even an instant rotation to check rotation can destroy the electrical insulation and cause serious damage.

- Generally vacuum dehydrating is performed at room temperature.
  The higher the temperature is, the faster the dehydrating work is done.
  Stronger vacuum is required to dehydrate in low room temperature.
  The process of vacuum dehydrating work is as follows.
  1) Connect the high capacity vacuum pump (Approximately above 120 LPM) to the refrigerant charge valve.
     The length of the pipe from the pump to the machine should be as short as possible, but the diameter of the pipe should be as big as possible, in order to minimize gas flow resistance.
  2) If the pressure gauge is installed or pressure value from MICOM is available, the pressure gauge or the value may be used to measure the vacuum.
  3) During vacuum operation, open all the valves except the valves that are connected to outside air.
  4) If the ambient temperature of the machine is above 15.6 °C while the vacuum pump is operating and if the pressure gauge is indicating 756mmHg, operate the vacuum pump for approximately 2 more hours.
     If the internal pressure is below 756 mmHg, the accumulated moist in the machine will be frozen and this ice will be evaporated slowly, which will delay the dehydrating. If there is hot water in such a situation, let the evaporator and the condenser be flowed by the hot water and then operate the vacuum pump.
  5) Close the vacuum pump valve and stop the pump, and then record the value of the vacuum gauge.
     If the ambient temperature changes while reading the degree of the vacuum, convert and modify the temperature change into pressure using the following equation.

$$\triangle P + (760 + H)x \left[\frac{t2}{273 + t2} - \frac{t1}{273 + t1} \right] mmHg$$

H: Internal pressure prior to inspection (mmHg)
t1: Ambient temperature prior to inspection (°C)
t2: Ambient temperature after inspection (°C)

Table 19. HFC-134a Temperature / Pressure

  6) The vacuum dehydrating work is completed if there is no change in the vacuum gauge value after waiting for 4 hours. The machine is well air-tight if the leak rate is below 0.1 mmHg/h(=0.1 Torr/h). If the vacuum gauge value rose up, repeat step 4) and 5).
  7) If the value still changes after several times of vacuum dehydrating, set the inner pressure of the machine above 9~9.5kg/cm^2. G and perform a leakage test. After fixing the leaking part, try dehydrating again.

Oil Charge

1) Generally the chiller's compressor is oil-charged when it is delivered. If not, charge oil by following the steps below.
2) Charge oil through the charging valve located at the bottom of the oil tank. At this time, make inside the machine vacuum using a vacuum pump. (If refrigerant is charged prior to oil charging, the refrigerant charged will evaporate and eventually the pressure will rise. Thus, charge oil first.)
   If the inner machine pressure is high, use a pump for charging from the oil tank. In this case, the discharge pressure of the pump should be more than 14 kg/cm^2.G, when the suction pressure is 0kg/cm^2.
   G.Oil charging or removal, however, must be done when the chiller is completely stopped.
3) The oil should be charged to make the oil level more than 2/3 of the sight glass. If both the oil pressure and the temperature are within the threshold value, oil foaming may be allowed.
4) Be cautious not to let any air enter during oil charging.

Refrigerant charge

⚠ CAUTION

When refrigerant charging or discharging is performed on a machine that is vibration-proofed by springs, fix the springs not to move up and down. If not, it may give severe stress on the connection pipe.

1) The chiller is charged with nitrogen gas when it is delivered. Remove nitrogen gas on the site before charging refrigerant.
2) Start the chilled water and cooling water pump to prevent freezing when the refrigerant is charged.
3) It is most preferable to adjust the charge amount of the refrigerant when the chiller is operated up to the design loading. Adjust the amount of refrigerant using the difference between chilled water outlet temperature and evaporation temperature and through the sight glass.

Insulation resistance test

1) Mega test is to obtain the insulation resistance through measuring the leaking current which is flowing through an insulation material when direct voltage is applied to this insulation material.

$$\text{Insulation resistance} = \frac{\text{Leak Current}}{\text{Applied Voltage}}$$

For 3000V, 6000V class: Use Mega for 1000V
For 380V, 440V class: Use Mega for 500V.

2) Prohibit access of any unrelated person, during the test for the usage of high voltage.
3) Shut down all the external power supplies that are connected to the chiller, before performing the test. As the 3-phase motor of 500hp or more can cause danger due to the charge charged during inspection, discharge it after inspection before handling the ground terminal.
5) Do not perform the high voltage mega test in vacuum condition.
6) Electrical insulation resistance drops as the temperature increases and is sensitive to the temperature. As the temperature change can be expressed by temperature coefficient, the temperature coefficient on the motor and the applied equation is as follows.

Temperature of the insulator during inspection (°C)	Temperature coefficient	Temperature of the insulator during inspection (°C)	Temperature coefficient
0	0.4	40	2.50
5	0.5	45	3.15
10	0.63	50	3.98
15.6	0.81	55	5.00
20	1.00	60	6.30
25	1.25	65	7.90
30	1.58	70	10.00
35	2.00	75	12.60

Table 20. The Temperature coefficient according to the temperature of the insulator

7) Other factors that affect insulation resistance
<Pollution of insulator surface> Remove such foreign substances before inspection.
If absorptive and deliquescent materials like acid, chloride and etc. are attached to the surface of the insulator, they affect insulation resistance.
<Condensed water> If the temperature of the insulator is under the dew point of the ambient temperature, moisture condenses on the insulator's surface (especially, on the crack and flaw) so this greatly affects the insulation resistance. The inspection should be performed when the insulator's temperature is above the dew point of the ambient temperature. The dry bulb and the wet bulb temperature of the ambient air should be recorded.
<Absolute humidity> Although the insulator's temperature is above the dew point temperature, the amount of the atmospheric vapor influences the insulation resistance. Avoid inspection where the absolute humidity is high.

8) Apply electric current continuously for a minute to the spot to be measured. Measure and record the insulation resistance. The applied inspection standard assumes that the insulator's temperature is 20°C. (When the measurement was performed at a different temperature, use the temperature coefficient and convert the value indicated after a minute.)

9) Take a step as below according to the insulation condition

Temperature of the insulator during inspection(°C)	Indicated value after a minute	Action
Danger	Below 2 MΩ	Repair or Exchange
Bad	Below 50 MΩ	Troubleshooting
Re-inspection	50~ 100 MΩ	Troubleshooting
Good	100~500 MΩ	
Better	500~1000 MΩ	
Excellent	Above 1000 MΩ	

❉ A motor in the range of "Bad" and "Re-Inspection" at the mega insulation test should undergo a POLARIZATION INDEX Test.

Table 21. Insulation condition

10) Polarization Index Test
Record the indicated value after a minute and after 10 minute during the mega test.

$$\text{Insulation Inhaling rate} = \frac{\text{indicated value after 10 minutes}}{\text{indicated value after 1 minute}}$$

Condition	Insulation absorption rate
Danger	Equal to or less than 1
Bad	Less than 1.5
Re-Inspection	Equal to or greater than 1.5 and less than 2
Good	Equal to or greater than 2 and less than 3
Better	Equal to or greater than 3 and less than 4
Excellent	Equal to or greater than 4

If the insulation absorption rate of a motor is in the "Danger" range, the motor must be returned or replaced.

If the insulation absorption rate of a motor is above the "Bad" range, the motor must be additionally checked after 4 hours of careful operation.

Table 22. Insulation absorption rate state.

11) The follow items should be recorded in the case of the mega test
- Type and voltage of the mega tester
- Connection part of the mega tester
- Ambient temperature and humidity of the test place. Tank's internal pressure in case of an enclosed type.
- Stay time of the equipment before the inspection

Function test from the starting panel to the control panel

• Test before start-up

1. Control panel and electric wiring
   Shut down the power and check the controlling parts and switches for any foreign substances. Check the operational condition and connection of each terminal by directly operating the switches.
2. Voltage
   Check whether the value indicated at the voltmeter of the starter panel is identical with the operational voltage rated on the chiller's nameplate.
3. Chilled and cooling water circulation system.
   Operate the chilled and cooling water pump and check whether the operational state is properly displayed on the panel.

• Operation test of control device

1. Check the wiring condition
   Check whether the wiring of power, sensor, etc. are properly connected.
   Especially, the power line should be thoroughly examined.
2. Check the display of the panel after power on
   Be extra-careful on any symptoms of short for the first 5 sec. after power on.
   If any of following symptoms occurs, shut down the power immediately and check for any abnormality.
3. Check the value displayed on the panel.
   Check whether each sensor value of the panel is normal. If the sensor indicates abnormality, or any error message is displayed, check the connection condition of the sensor.
4. No power operation
   Shut down the power of the main motor, and operate to examine whether it properly operates until the operational signal of the starting panel. If any error message occurs, check the related part.

• Safety device check

Operation test on chilled and cooling water flow.

- Close valves of chilled and cooling water pumps and check whether the switch for finding out abnormal flow operates.

5-3. Test run and start-up

• After the preparation for test run is completed, proceed with checking as the process represented below.

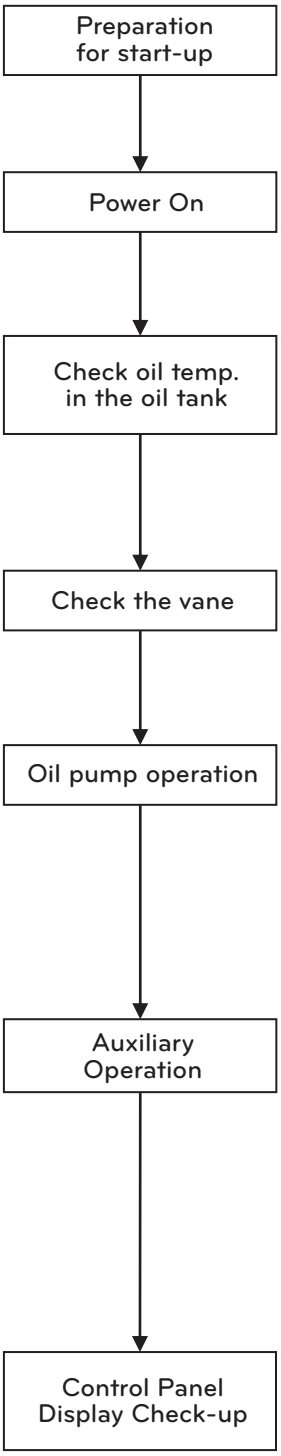


Figure 59. Test run process.

1) Input power to the control and starting panels, and check them.
2) Input power to the oil heater 1~2 hours before start-up and check whether the oil temperature in the tank is 30~65°C.
3) Check whether the vane opening is 0% and then set the vane's operation condition on "Auto".
   When the chiller stops, the vane is supposed to maintain 0% automatically on any condition of "Auto", "Open", "Stop" and "Closed".
4) Set the oil pump operational condition on "Auto".
5) Activate the chilled water pump. When starting the pump, close the outlet valve, open the air discharge valve, and then open the valve carefully to avoid water hammering so that the necessary amount of flow passes through.
   If water leak out continuously after the air is discharged through the air outlet, close the air valve.
6) Start the cooling water pump. Be careful as step 5)
7) Check whether the control panel displays works properly. Check whether the display shows that it is possible to operate on site and whether the chiller is ready to operate.

• If the chiller is to be started at the site, operate it safely follow the steps below.
If any abnormality is detected, shut down the chiller immediately and follow the “troubleshooting” procedure.
For more detailed information refer to the “check list”.

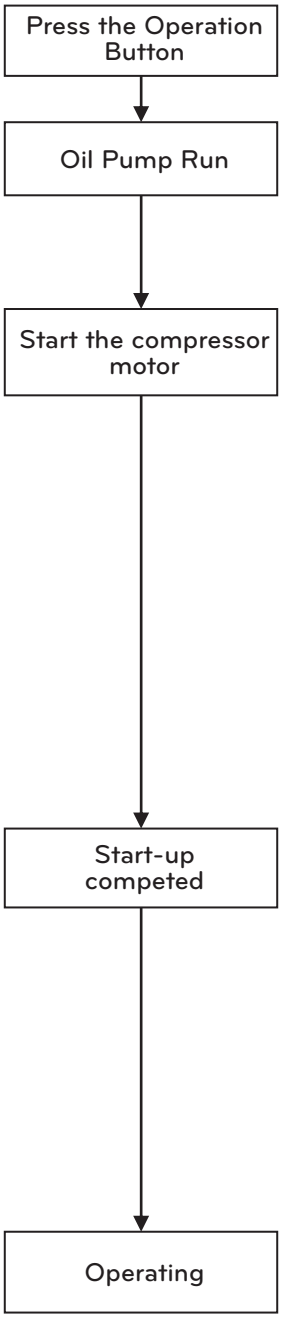


Figure 60. Test run procedure (2)

1) Check the oil pressure
When the operation button on the control panel is pressed, oil pump will be activated that leads to the increase of the oil pressure, and if the differential pressure between the oil supplied to the bearing and the inner tank oil is over above 1.0 kg/cm^2 for 120~180 sec., the compressor motor will be stared.
2) Check the direction of the rotation of the compressor motor.
3) Characteristics of starting-up
In this case, the two items below need to be checked up simultaneously, so the process should be conducted by two persons.
   * The direction of the motor rotation
   Record the rotation direction on the half load section of the motor. If it is rotating in the opposite direction, stop the chiller and change 2 phases among 3 phases.
   * Characteristics of starting-up
   Check the start-up current and the acceleration completion time as in the characteristic table of “check list”.
4) Check the operating current
5) Motor cooling situation
   * Operating current
   When the start-up is completed, the vane gradually opens and the operating current increases as well. The operating current should not exceed the rated current of the motor. If it exceeds the rated current, adjust it by using the current setting method of the “capacity control module”
   * Cooling situation of the motor
   Periodically check the surface temperature of the motor during operation.
   * Check the temperature of the oil tank and the bearing
   Check if the oil tank and the bearing temperature is maintained at 40~65°C. If not, refer to "Trouble Shooting" and "Check List".
6) Check various pressure status
7) Check operating sound and vibration
8) Temperature of chilled water inlet/outlet
9) Temperature of cooling water inlet/outlet

• Load operation and operation adjustment

After start-up and stoppage operation, perform load operation as below.

In any cases, do not exceed the rated current of the motor.

Although the current limit value has been set to prevent overlord by the motor current restricting function (as described in "Product Protection Function"), please reconfirm.

Modify the temperature control function according to the lord.

Modify the "user setting" function by following what is described in "Product Protection Function"

In case of automatic operation

Set the vane operation mode on auto

1) In case of load increase
   Open the guide vane until the rated current of the motor to maintain the outlet temperature of chilled water.
2) When the load is parallel with present performance of the chiller
   The guide vane operates by being stopped at a certain opening angle.
3) In case of load decrease
   - In opposition to 1), close the guide vane to maintain the outlet temperature of chilled water
   - As the load continuously decreases, the outlet temperature of chilled water will decrease, so the chiller will stop by "Chiller operation/stoppage" function. If the outlet temperature of chilled water increases to the setup temperature, it will operate automatically.
   - Even if the chiller stops, the oil pump continues residual operation.
     The purpose of this function is to preserve oil pressure during stoppage (due to inertia operation that lasts for at least one minute after stoppage) and to protect the motor from frequent 'operation' and 'stoppage'.

5-4. Starting-up after long-term stoppage

If you have to stop the operation for a long period, transfer the refrigerant to a separate container to reduce the probability of machine pressure and leakage.

Charge approximately 5kg of refrigerant to prevent inflow of air into the machine.

If the temperature of the area where the chiller is installed frequently goes below zero, drain chilled water, cooling water and condensate to prevent freezing. Open the water room drains as well.

Leave alone the oil in the machine and supply power to the oil heater to maintain minimum temperature.

Before operating the centrifugal chiller after a long-term of stoppage (not less than 1 month) or instant stoppage (less than a month), check the followings.

1. Unstable part or any error should be repaired to make the machine operate smoothly.

2. To prevent refrigerant loss due to leakage during the stoppage, the following inspections should be obligatory.
   1) Compressor (Brief check on the rotating parts)
   * Check briefly the outward state of the impeller, bearing and other rotating parts.
      ◇ Connection of the impeller and the shaft
      ◇ Assembly of the gear
      ◇ Foreign substance in the gear box
      ◇ End play of the impeller shaft
      ◇ Assembly of the guide vane
      ◇ Check the vane and the drive shaft
      ◇ Check the gap between the impeller and the cover with a thickness gauge
   2) Lubrication system
      ◇ Loosening and crack of the oil pipe
      ◇ Replace or clean the oil filter
      ◇ Clean the oil tank
      ◇ Oil Change
   3) Refrigeration System
      ◇ Check refrigerant pollution◇ Clean the ejector
      ◇ Ejector cleaning
      ◇ Clean the heat pipe
      ◇ Analyze water quality
      ◇ Exchange or clean any types of filters
   4) Preservation of water side of evaporator and condenser (Countermeasures against corrosion during stoppage)
      During long-term stoppage, consider the following steps to prevent heat pipe corrosion on the condenser/evaporator.
      - Brush every pipe and remove any scales completely, and then fill the pipes with clean water. If finished, preserve it with a rustic proof material in it.
      - Preserve it after draining out water completely in principle.
      - Execute carefully every regular preliminary check-up and system check during operation and carry out a control test before start-up. If the oil level of the compressor is abnormally high, the refrigerant might have been absorbed by the oil.

3. Check 1 and 2 above and then start-up in accordance with the standards presented in “Test run and start-up”

5-5. Shutdown

• If you want to shut down the chiller, obey the following procedure.

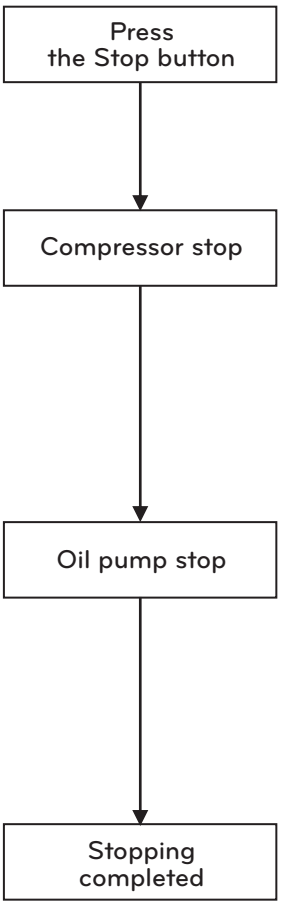


Figure 61. Shutdown procedure

1) If the stop button on the control panel is pressed, the vane is closed automatically.
2) Check the time when compressor motor stopped..
   - Even after the chiller stops, the compressor motor is still in an inertial motion, so measure the time until the compressor completely stops.
3) Check whether the oil pump operates residually.
   - Check whether the oil pump operates residually for a definite time, even after the chiller stops.
4) Checklist after the stoppage
   - Stop the cooling water pump.
     In this case, stop the pump after gradually closing the outlet valve.
   - Stop the chilled water pump.
     In this case, stop the pump after gradually closing the outlet valve.
   - Record the actual oil and refrigerant level after stop.

LG Electronics

Person in Charge	Manager

Confirmation of Test run Preparation Completion

High-pressure Centrifugal Chiller(Single Stage/Two Stage)

Receipt Number : RNA

Client's Name		Client's Address, Contact Number	
Model		Confirmation of the Client	(Seal)
Serial Number		Inspector	(Seal)
Power Specification	Primary Power : V3Ø Secondary : V	Inspection Date	Year Month Day ~ Year Month Day

* Caution : The results of the test run preparation should be confirmed both by a working personal of LG and the person in charge from the constructor. Any accident due to machine disorder or damaged parts after the confirmation is not included in the guarantee of LG, so always check the condition of the machine.
* Actually measured and confirmed facts should be recorded on each item.

1. Check the surrounding space for chiller installation ☐
   • Write down the distance if it is smaller than the rules.

Back side
More than 2.0 m (m)

Left Side
more than ____ m
(m)

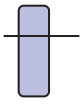
Right Side
more than ____ m
(m)

Front side More than 2.0 m (m)
Height More than 2.0 m (m)

• Foundation establishment yes ☐ no ☐

◎ The demand to secure enough space as much as the length of the chiller for future heat pipe replacement.

2. Exterior test ☐
   1) Nitrogen filling pressure kg/cm²
   2) Installation state of the parts
   - CONTROL PANEL : Inner parts check ☐
   - START PANEL : Inner parts check ☐
   - Copper pipe damage : yes ☐ no ☐
   - Direction of the water pipe's inlet and outlet : check ☐
   - Preventive support against water pipe deflection : yes ☐ no ☐
   - Oil charge level state



   - Any damaged parts? _____ yes ☐ no ☐

3. Control and power wiring connection ☐
   (Mark ○ on the relevant item)

   Check how the starting panel works :
   Y-△, Reactor, Korndörfer, Line start
   In case of reactor or Korndörfer, check the tap

   50% 65% 80%

4. Leak test ☐
   Is the refrigerant released being charged? yes ☐ no ☐
   ※ If the chiller is issued with refrigerant charged, carry out only soap water leak test with the refrigerant pressure itself.
   Nitrogen Gas injection ( )BT, ( )kg/cm²
   Soap water leak test for the main body (by naked eyes) yes ☐ no ☐
   Leaking parts

5. Leaving alone in a vacuum condition ☐
   Ambient temperature : _____ °C
   Attained degree of vacuum _____ mmHg (in case of gauge)
   Attained degree of vacuum (in case of gauge) :
   start ( ), finish ( ) TOTAL _____ Hr

   Leak yes ☐ no ☐
   Leaking parts _____

6. Refrigerant and oil charging ☐
   1) Chilled and cooling water circulation yes ☐ no ☐
   2) Amount of the charged refrigerant _____ kg

7. Compressor insulation resistance measurement ☐
   R : _____ MΩ
   S : _____ MΩ
   T : _____ MΩ

8. Interlock construction of chilled water and cooling water ☐
   Interlock wiring installation yes ☐ no ☐

9. Significant things to report _____

☑ Unnecessary ○ Good ☒ Bad ⊠ Good after mend

LG Electronics

Confirmation of the commissioning completion of the turbo chiller

[R-134a (1-Stage /2-Stage)]

[X-30 : Rev - 03]

Customer name		Customer Address	
Contact information		Customer identification	
Commissioning date		Commissioning operator	
Model No.		Motor capacity	
Refrigeration capacity		Power specification	Power: V, Control:: V
Rated RT		Chilled water temperature	Inlet: °C, Outlet: °C
Manufacturing No.	Evaporator: kg/cm^2, Condenser: kg/cm^2	Cooling water temperature	Inlet: °C, Outlet: °C
Safety valve set value		Maximum operating pressure	Chilled water: kg/cm^2 ,Cooling water: kg/cm^2

* Caution: The results of commissioning should be confirmed both by the SVC agent authorized by LG and the local facility manager. Any heat transfer tube burst due to abnormality on the water circulation system is not covered by the warranty of LG, so always check the circulation state of chilled water(normal air-conditioning) and cooling water(when ice making is finished).

1. Visual inspection ☐
   1) Damage of main body and parts
      Damaged parts: .....
   2) Leakage of fastening parts
      Leaking parts: .....
   3) Panel cleaning status
      Start-up panel .....
      Chiller control panel .....

2. Inspection related to operation ☐
   1) Check the pressure of the evaporator and the condenser
   2) Direction of rotation of the compressor: Clockwise
   3) Vibration or unusual noise during operation
      .....
   5) Compressor motor insulation resistance test
      Type of MΩ TESTER: DC V
      Result of measurement: MΩ
      Remarks: .....

3. Parts assembly status ☐
   1) Instrumentation (Pressure gauges, Switches)
   2) Each valves
   3) SIGHT GLASS
   4) Safety valve seals
   5) Refrigerant piping
   6) Check if the Angle V/V on the motor is opened
   7) Others
      .....
      .....

4. Circuit test ☐
   1) Connection of the wiring of each component
   2) Grounding status of main body and panel
   3) Connection of control power wiring

5. Start-up panel function test ☐
   Start-up method:
   Y-Δ/Reactor/ Korndörfer/
   Line-start electro magnetic contactor/
   High-voltage vacuum electromagnetic contactor(VCS)
   Start-up time(T1) SEC
   Start-up failure (T2) SEC

☑ Unnecessary ○ Good ☒ Bad ⊠ Good after mend

LG Electronics

Operation record table

R-134a (1-level/2-level), R-123

MODEL : _____

Manufacture NO. : _____

6. Safety device function test

Low chilled water temperature abnormal operation

Evaporator low pressure abnormal operation

High motor temperature abnormal operation(MTD)

High condenser pressure abnormality(HP)

Start-up panel start-up TIMER

Start-up failure TIMER

Motor relay operation(MPR)

Each sensors (PT 100 Ω)

Check S/W settings of the pressure and the differential pressure during operation

Chilled water input and output pressure: /

Set value:

Cooling water input and output pressure: /

Set value:

7. Check subsidiary equipment ☐

1) Piping connection direction of chilled water and cooling water

2) Drain piping of chilled water and cooling water

3) Whether the instrument is attached

Classification	Air vent	Pressure gauge	Thermometer
Chilled water	Yes/No	Yes/No	Yes/No
Cooling water	Yes/No	Yes/No	Yes/No

4) Check PUMP

Classification	Capacity (Kw*number of equipment)	Flow rate (m^3/Hr)	Lifting height (m)
Chilled water	Yes/No	Yes/No	Yes/No
Cooling water	Yes/No	Yes/No	Yes/No

5) Composition of the interlocking circuit (type of pump operation and stop)

Chilled water pump Auto/Manual

Cooling water pump Auto/Manual

6) INTER-LOCK composition

Chilled water pump Yes/No

Cooling water pump Yes/No

7) Cooling tower temperature control method

Micom computer linking/Central Monitoring panel/Thermostat

Others:

8. Remarks ☐

1) Preparation for Commissioning and Measures taken against abnormalities before or after commissioning

2) Replace the parts and attach the photos of refrigerant & leaking parts, and record it.

Oil amount initially charged(Liter)			
Supplemented amount/ extracted amount(Liter)	Supplied	Extracted	
	Supplied	Extracted	
	Supplied	Extracted	
	Supplied	Extracted	
	Supplied	Extracted	
Total charged amount			

3) Check installation status

* Chiller installation location(indoor /outdoor)

Ground/underground/rooftop/other places

☑ Unnecessary ○ Good ☒ Bad ⊠ Good after mend

LG Electronics

Operation record table

R-134a (1-level/2-level), R-123

MODEL : _____

Manufacture NO. : _____

Measuring items		Unit	1	2	3	4	5	6	7	8
		Hour: Minute	:	:	:	:	:	:	:	:
Chilled water	Inlet pressure	kg/cm^2								
	Outlet pressure	kg/cm^2								
	Inlet temperature	°C								
	Outlet temperature	°C								
Evaporator	Pressure	kg/cm^2								
	Refrigerant temperature	°C								
	LTD	°C								
Cooling water	Inlet pressure	kg/cm^2								
	Outlet pressure	kg/cm^2								
	Inlet temperature	°C								
	Outlet temperature	°C								
Condenser	Pressure	kg/cm^2								
	Refrigerant temperature	°C								
	LTD	°C								
Compressor	Current limit	%								
	Operation current	A								
	Winding temperature	°C								
	Bearing temperature	°C								
	Discharge gas temperature	°C								
	Vane opening	%								
	Diffuser opening	%								
Others										

LG Electronics

Operation record table

R-134a (1-level/2-level), R-123

MODEL : _____

Manufacture NO. : _____

※ Substitute with a printout depending on the site situation.
- Write down manually, if printing is not available.

[MICOM setting check]

1. User set data

Operation mode setting	on-site/scheduled/remote
Control mode setting	cooling/ice making
Chilled water outlet temperature	°C
Ice making outlet temperature	°C
Chilled water temperature P	°C
Chilled water temperature I	Sec
Chilled water temperature D	Sec
Automatic operation temperature (set value +)	°C
Automatic stop temperature(set value-)	°C
Antifreeze operation function	Used/Not used
Antifreeze operation temperature	°C
Motor current limit	%
Guide vane upper limit	%
Hot gas setting (Guide vane %)	%
Hot gas upper limit setting	%
Hot gas lower limit setting	%
Cooling water inlet temperature	°C
Cooling water temperature P value	°C
Cooling water temperature I value	Sec
Cooling water temperature D value	Sec

2. Interlock mode setting(2-comp type)

Interlock mode selection	A : LEAD, LAG B : LEAD, LAG
Interlock mode conversion	Automatic/manual
Interlock conversion time	Hr
LAG start-up point	%
LAG stop point	%
LAG start-up delay	Sec
LAG stop delay	Sec

3. System information

Input state check	
Software version(X-30)	
DISPLAY (DISPLAY)	V :
MASTER (MAIN)	V :
SLAVE-1 (IN/OUT)	V :
SLAVE-2	V :
Operation data saving cycle	Sec
Communication ID (machine number)	
Baud rate	4800 / 9600 / 19200 / 38400
Language	Korea/English/Chinese/Others
Temperature unit selection	°C / °F
Pressure unit selection	kg/cm2
Flow unit selection	m3/h
LCD brightness control	Sec
Time setting : Year	
Month	Day

4. Account management

< Option setting - MASTER >

Chilled water inlet temperature	Used/Not used
Chilled water outlet temperature	Used/Not used
Cooling water inlet temperature	Used/Not used
Cooling water outlet temperature	Used/Not used
Evaporator temperature	Used/Not used
Condenser temperature	Used/Not used
Evaporator pressure	Used/Not used
Condenser pressure	Used/Not used
Chilled water flow amount	Used/Not used
Cooling water flow amount	Used/Not used
Remote temperature setting	Used/Not used
Hot gas valve A/O	Used/Not used
VDF A/O	Used/Not used
Motor bearing temperature	Used/Not used

LG Electronics

Operation record table

R-134a (1-level/2-level), R-123

MODEL : _____

Manufacture NO. : _____

< Option setting- SLAVE >

Compressor discharge temperature	Used/Not used
Compressor bearing temperature	Used/Not used
Motor winding R phase temperature	Used/Not used
Motor winding S phase temperature	Used/Not used
Motor winding T phase temperature	Used/Not used
Oil Tank Pressure	Used/Not used
Oil pump pressure	Used/Not used
Current	Used/Not used
Voltage	Used/Not used
Power	Used/Not used
Guide vane A/O	Used/Not used
Diffuser vane A/O	Used/Not used
Vibration sensor	Used/Not used

5. Control information

Ice making mode	Used/Not used
Control operation cycle	Sec
Control temperature dead zone	°C
Oil temperature low limit at start-up	°C
On temperature of oil heater	°C
Off temperature of oil heater	°C
Automatic restart upon restoration of electric power	Stop/Start
Motor rated current	A
MODEL selection	R- 123 / R- 134a
Operation time limit	Used/Not used
Guide vane control dead zone	%
Cooling tower PID operation cycle	Sec
Refrigerant valve use setting	Used/Not used

6. Abnormal condition setting

Chilled water temperature lower limit	°C
Oil Differential Pressure Lower Limit	kg/cm^2
Oil Temperature Upper Limit	°C
Compressor Discharge Temperature Upper Limit	°C
High temperature of compressor bearing	°C
Low temperature of evaporator refrigerant	°C
Low pressure of evaporator	kg/cm^2
High pressure of condenser	kg/cm^2

7. Safety control setting

Soft start output cycle	Sec
Soft start valve output	Sec
Soft stop vane opening	%
Prevention of high temperature of bearing	%
Prevention of high temperature of motor winding	%
Prevention of high temperature of compressor discharge	%
Prevention of low temperature of evaporator refrigerant	%
Prevention of low pressure of evaporator	%
Prevention of high pressure of condenser	%
Setting upper limit of surge pressure	kg/cm^2
Setting lower limit of surge pressure	kg/cm^2
Surge temperature high level setting	°C
Surge temperature low level setting	°C
Changing amount of surge detection current	%
Surge occurrence detection time	Sec
Surge occurrence number	Numbers
Prevention of vibration upper limit	°C

8. Timer setting

Chilled water pump stop delay timer	Sec
Cooling water pump start-up-stop timer	Sec
Cooling water pump stop delay timer	Sec
Flow chattering ignore timer	Sec
Oil circulation timer before start-up	Sec
Oil circulation timer after stop	Sec
Oil pressure check timer	Sec
Vane close timer at start-up	Sec
Vane close timer at stop	Sec
Vane open delay timer	Sec
Compressor start-up check timer	Sec
Restart prevention timer	Sec

LG Electronics

Operation record table

R-134a (1-level/2-level), R-123

MODEL : _____

Manufacture NO. : _____

9. VGD/VFD setting

Vane opening (X1)	%
Vane opening (X2)	%
Vane opening (X3)	%
Vane opening (X4)	%
Diffuser opening (Y1)	%
Diffuser opening (Y2)	%
Diffuser opening (Y3)	%
Diffuser opening (Y4)	%

10. Sensor setting

Evaporator pressure sensor	kg/cm^2
Condenser pressure sensor	kg/cm^2
Chilled water flow rate	m^3/h
Cooling water flow rate	m^3/h
Hot gas valve	%
Oil tank pressure sensor	kg/cm^2
Oil pump pressure sensor	kg/cm^2
Current sensor	A
Diffuser opening	Auto/Manual
Offset setting mode	ON/OFF
Guide vane min.	
Guide vane max.	
Guide Vane AD value	
Diffuser vane min.	
Diffuser vane max.	
Diffuser Vane AD value	

6. MAINTENANCE

6-1. Criterion of Repair Inspection

Repair Check and Overhaul

• Deterioration of the machine

Although there may not be any malfunction or structural deformation of the machine, it generally can be worn or aged due to being used for a long time. If a centrifugal chiller has been operated for a long time, though still operating without failure, the insulation of the motor could be declined or abrasion of the rotating section could occur due to the secondary product of oil burning and carbonization. In many cases, such problems could be detected externally by any symptoms like vibration or abnormal sounds, so it is very important to take a preventive action prior to the occurrence of an accident and maintain a proper working condition for the sake of long life cycle of the machine.

• Time to do overhaul (repair)

Normally, the failure rate of the machine is distributed as below.

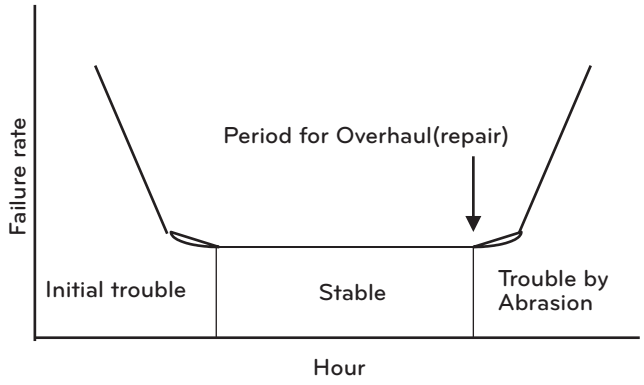


Figure 62. Machine Failure Rate

<Initial Trouble> resulting from manufacturing occurs at the beginning stage of machine's operation, and this is prevented by the pre-operation check at the factory before delivery.

Then it enters <Stabilization> period and after a certain amount of time <Abrasion> period follows resulting from deterioration. When it enters the <Abrasion> period, possibility of machine failure rises up, so if an overhaul (repair) is taken before entering this period, accidents are prevented and optimum maintenance is possible

Based on long-term statistics of LG, we recommend an overhaul (repair) period as below.

(1) Dedicated cooling air conditioner: Every 5 Years

(2) If used for industrial process all over a year or for important purposes that requires a high reliance: Annually

• Criteria of Overhaul (repair)

Accidents may possibly occur, if irresistible abrasion and deformation over the limitations happen to the individual parts of the machine

For instance, if the bearing wears out, the oil film will be destroyed, which will also cause metallic contact so that the bearing will burn-out with good possibility. The impeller might make contact with other parts so thereby can be destroyed and if the center to center space between gears decrease below a certain value, the teeth of gear could also be destroyed.

Thus LG Electronics sets up (1) Utilization Limitations (2) Exchanging Standards. Based on these standards, the time left until the next "Overhaul(repair)" and "overhaul(repair) standard" should be made and recorded. Inspection and replacement on each part should be conducted following these standards to maintain normal operation.

• Merits of the maintenance contract system

(1) Economical

- Machine deterioration could be minimized by developing and carrying out a maintenance schedule plan.
- As the machine's life increases, the possibility of an accident is reduced, which leads to maintenance cost saving.
- By carrying out the contract based on a yearly fixed cost, effective budget management is possible. In order to prevent any unexpected cost caused by a sudden breakdown, a counseling service with the customer is provided in advance.
- Opportunity loss of the production process resulting from unexpected machine stoppage can be eliminated.

(2) Safety

- Many safety devices of the machine are checked and repaired, so the machine could operate safely without accident.
- To prevent any breakdowns in advance, a regular inspection will be conducted before any problem occurs.
- The contract provides technique guidance at the site that will enhance the management ability.

(3) Speed

- As the machine status will be always checked through regular inspection, correct instructions can be given even by a call on the breakdown status
- Maintenance contract has a priority even during the busy season when service loads is high.

Maintenance Contract Work Details (Standard)

• Air conditioner only for cooling

1. Inspection before the start of cooling

(1) Air-tightness test
(2) Refrigerant charge
(3) Electricity-related insulation test
(4) Checking and adjusting safety devices
(5) Function test between starter panel ~ control panel
(6) Vacuum operation
(7) Chiller operation setup

2. Inspection during the cooling period (once)

(1) Electricity-related insulation test
(2) Checking the daily operation record
(3) Chiller operation setup

3. Inspection after completing cooling

(1) Extraction of refrigerant
(2) Nitrogen gas charging & sealing
(3) Filter check (Replacing)
(4) Cleaning the oil tank
(5) Checking the daily operation record
(6) Sensor check (Replacing)
(7) Picking up the oil
(8) Air tightness test
(9) Electricity-related insulation test
(10) Operation test between starter panel ~ control panel
(11) Oil pump check
(12) Chiller operation setup

4. Water quality analysis (once)

• Air conditioner for Annual Operation

1. Inspection during operation period(5 times)
   (1) Electricity-related insulation test
   (2) Checking the daily operation record
   (3) Chiller operation setup

2. Overall Inspection (once)
   (1) Extraction of refrigerant
   (2) Nitrogen gas charging & sealing
   (3) Filter check (Replacing)
   (4) Cleaning the oil tank
   (5) Checking the daily operation record
   (6) Sensor check (Replacing)
   (7) Picking up the oil
   (8) Air tightness test
   (9) Electricity-related insulation test
   (10) Operation test between starter panel ~ control panel
   (11) Oil pump check
   (12) Chiller operation setup

3. Water quality analysis

• Standard inspection frequency

(1) Air conditioner only for cooling: Cooling Start x once, during the operation season x once, end of the operation season x once.

(2) Air conditioner for annual operation: During the season X 5 times, Overall inspection X once.

• Items not included in standard inspection

(1) Cleaning the heat exchanger

(2) Overhaul(repair)

(3) Other items that are not listed in the contract

Overhaul (Repair)

• Compressor

1. Compressor overhaul(repair)
   (1) Preparation
   (2) Disassembling the compressor
   (3) Check capacity controlling device
   (4) Inspection and cleaning over the parts of compressor
   (5) Multiplying gear inspection
   (6) Impeller shaft check
   (7) Assembling the compressor
   (8) Flow rate check
   (9) Attaching the auxiliary parts
   (10) Cleaning

2. Auxiliary Work
   (1) Air-tightness test
   (2) Vacuum drying
   (3) Nitrogen gas charging & sealing
   (4) Extraction of refrigerant
   (5) Refrigerant charge
   (6) Extraction of refrigerant
   (7) Cleaning the Oil tank
   (8) Inspecting the filters
   (9) Electricity-related insulation test
   (10) Oil pump check
   (11) Inspection and adjustment on safety devices
   (12) Starter panel ~ control panel operating test
   (13) Chiller operation setup
   (14) Checking the daily operation record

• Motor

1. Motor overhaul (repair)
   (1) Checking stator coil and rotor
   (2) Checking components
   (3) Measure shaft vibration, concentricity degree
   (4) Air gap, end play measurement
   (5) Disassembling and assembling the gear
   (6) Disassembling and assembling the electric wiring
   (7) Insulation resistance measurement
   (8) Winding Resistance measurement

2. Auxiliary works
   (1) Disassembling and assembling the refrigerant and the oil pipe

• Overhauled parts(repair) according to the standard contract

1. Compressor
   (1) Radial bearing (one)
   (2) Kingsbery bearing (one)
   (3) Shaft labyrinth (first level one, second level two)
   (4) Impeller shim (first level, second level)
   (5) O-ring, Gasket
   (6) Oil filter

2. Motor
   (1) Thrust bearing (one)
   (2) Radial bearing (one)
   (3) Rear cover(one)
   (4) O-ring, Gasket
   (5) Filter drier, Moisture indicator

• Work items not included in the standard

1. Overhauling (repairing) the starter panel
2. Replacing the motor coil
3. Cleaning the heat exchanger

• Parts not included in the standard

1. Compressor
   (1) Impeller (first level one, second level two)
   (2) Diffuser (one)
   (3) Impeller cover (first level one, second level two)
   (4) Impeller shaft (one)
   (5) Return channel 1, 2, 3 (second level one for each)
   (6) Gear (one)
   (7) Plate type heat exchanger (one)
   (8) Capacity adjustment device (one)
   (9) Lock nut, bolt

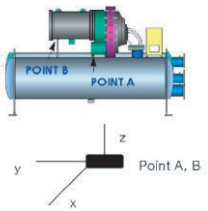
2. Motor

6-2. Inspection by period

Daily Inspection

Check the pressure of the evaporator and the condenser, oil tank pressure, differential oil pressure and discharge oil pressure of the chiller. Compare it with the value presented on the general chillers' operational feature table.

- Daily inspection standard for the compressor and the motor

Classification	Inspection items	Inspection method	Criteria
Compressor, Motor	Motor Cooling Condition	Check the refrigerant flow via. Moisture Indicator	Able to see the refrigerant flow
	Able to see the refrigerant flow	Measure the temperature of the outer surface of the motor using a surface thermometer	Able to see the refrigerant flow
	Motor Drain Temp.	Measure the draining pipe's outer surface with the thermometer	Able to see the refrigerant flow
	Motor Drain Oil Flow	Measure using Differential Pressure	Able to see the refrigerant flow
	Compressor discharge gas temp.	Check temp. at the control panel	Able to see the refrigerant flow
	Vibration/noise 	Check with the hand and ears When measuring the vibration by means of a measuring instrument out of necessity 89dBA and below If no abnormal vibration x,y,z: 25μm and below	

* The motor adopts liquid refrigerant cooling system. It supplies the liquid refrigerant by the differential pressure between the condensing and evaporating pressure.
* Check and make sure that moisture indicator of the liquid refrigerant supply line shows green.
  If the green changes to yellow, it means that the moisture amount in the machine has exceeded the limitation, so replace the filter dryer.

Figure 63. Daily inspection standard for the compressor and the motor

- Daily inspection standard for the condenser

Classification	Inspection items		Inspection method	Criteria
Condenser	Cooling water	Inlet	Check at the Panel	Below 34 °C
		Outlet	Check at the Panel	21°C or more
	Condensing pressure state		Check at the Panel	5~10 kg/cm^2
	Heat exchanging state		Temperature difference between condensing temp. and cooling water outlet temp.	Temperature difference between condensing temp. and cooling water outlet temp.

* If the outlet temperature of the cooling water is 21°C or below, condensing pressure decreases. This makes insufficient differential pressure which is needed for motor cooling and for the oil cooler, and finally leads to shortage of the refrigerant.
* Attaching a scale inside the cooling pipe and cooling water shortage could be regarded as the main cause that worsens heat exchange.

Figure 64. Daily inspection standard for the condenser

- Daily inspection standard for the Evaporator

Classification	Inspection items		Inspection method	Criteria
Evaporator	Chilled water	Inlet	Check at the Panel	5~15°C or below
		Outlet	Check at the Panel	3 °C or above
	Above 3°C		Check at the Panel	2~4 kg/cm^2
	Heat exchanger condition		Temperature Difference between the evaporation temp. and the chilled water outlet temp.	0.5~3°C
	Refrigerant charging amount		Check through the sight glass	
	Refrigerant condition		Check through the sight glass	

* When evaporating pressure decreases, evaporator tube freezes and is damaged, or compressor surge could happen. Insufficient refrigerant, low water temperature, trouble on heat exchange, etc. are the main causes of evaporating pressure decrease.
* Like the condenser tube, if any foreign substances flow in or scales adhere, corrosion may occur which leads to weakening heat exchange function. Eventually, weak heat exchange also weakens refrigerating ability or can cause surge effect.

Figure 65. Daily inspection standard for the Evaporator

- Daily inspection standard of compressor, motor
  In general, the failure rate of a machine is distributed as shown in the following figure.

Classification	Inspection items	Inspection method	Criteria
Oil	Oil amount	Visual inspection	Whether there is an oil level on the sight glass
	Temp.	Check at the Panel	30~60°C
	Differential Pressure	Check at the Panel	above 1.3 kg/cm^2
	Oil Pressure Vibration	Check at the Panel	No Vibration
	Leakage	Visual inspection of the oil system	There shall be no leak
	Oil pump Noise	Check by ear	No abnormality
	Oil pump remaining flow operation	Stop the chiller and check with watch	300 sec.

Figure 66. Mechanical failure of compressor and motor

<Lubrication cycle>

The oil is charged in the oil tank through a manual valve. The oil level can be observed by the sight glasses on the oil tank and it should be observable when the compressor stops.

The temperature of the oil tank is displayed on the panel and the temperature would be 30~65 °C during operation.

The oil pump transfers the oil from the tank and the oil pressure remains by the differential pressure being equal to or greater than 0.8 kg/cm^2 .

As the oil pump sends oil to the oil filter, a valve is installed so that there is no need to drain all oil that flow into to the oil system when replacing the filter.

Afterwards, oil is sent to the oil cooler and then cooled by the refrigerant from the condenser.

The refrigerant cools off the oil as low as 30~60 °C.

The oil leaving the cooler passes through the oil pressure transducer and the temperature sensing box of the refrigerant expanding valve. At last, it arrives at bearings and gears for lubrication.

The oil temperature is measured at the high-speed thrust bearing and the oil is drained to the oil tank located at the lower section of the compressor.

When the machine starts up, the control device operates the oil pump and preliminarily lubricates the bearing for 120~180 sec. in a constant pressure prior to the compressor start-up. When the machine stops, it carries out after-lubrication for 300 sec. after the compressor stops.

Soft start-up opens the guide vane slowly during start-up to prevent oil from foaming.

If the guide vane is opened too quickly, the suction pressure will rapidly decrease and the refrigerant in the oil will boil which leads to oil-forming. As a result, the efficiency of the oil pump and the oil pressure decrease, which leads to bad lubrication.

Monthly Inspection

- Monthly inspection standard of the compressor and the motor

Classification	Inspection category	Inspection method	Criteria
Compressor and Motor	Motor insulation	Measure at 1000V mega	Above 100 MΩ
	Vane operation	Visual inspection of the opening status	In Vane Full Close, 0% Check indication in Vane Full Open, 100%
		Check the status of opening indication	Soft movement of Indication Value
	Protector insulation	500V mega (Protector ~ Main Coil, Protector ~ ground) Measuring	Above 3 MΩ
	Characteristics of start-up	Mark ● for the corresponding start-up method 1. Direct standing start-up 2. Y-Δ start-up 3. Kondorfer start-up 4. Reactor start-up * In case of chilled water outlet temp _°C	Time of start-up current flow t: 5~25 sec.
			Start-up current: A
			Timer set value (sec.)

Figure 67. Monthly inspection standard of the compressor and the motor

- Generally the starting current of the motor is, about 600% of the rated current in case of line start-up, 200% in case of Y-Δ start-up, 250% in case of Korndörfer start-up, and 400% in case of Reactor start-up.
- Measure frequency of the daily/monthly inspections should be least once for a month. This data could be the clue of solution if any problem occurs to the motor.

- Monthly inspection standard of the lubrication system.

Classification	Inspection items	Inspection method	Criteria
Oil	Oil charging amount	Check through the sight glass	Refer to the standard charging amount
	Oil Pump Motor insulation	Check through the sight glass	3MΩ

Figure 68. Monthly Inspection Criteria for Lubricating System

Yearly Inspection

- Yearly Inspection

Classification	Inspection items	Inspection method	Criteria
Motor	Motor Terminal fasten bolt	Check the slackness	Check the loose Loose terminal finishing state
Condenser	Chemical analysis	Water quality analysis	Water quality standard
	Tubes condition	Check it at the operation record or by opening the waterbox.	No pollution
Evaporator	Chemical analysis	Water quality analysis	Water quality standard
	Tubes condition	Check it at the operation record or by opening the waterbox.	No pollution
Oil and lubricant	Oil cooler cleaning	Clean by refrigerant	No corrosion or pollution should be present
	Ejector cleaning	Disassemble cleaning	No abnormality
	Filter cleaning	Filter exchanging, Cleaning the housing	No abnormality
	Oil tank cleaning	Disassemble cleaning	No pollution
	Oil Replacing		2000 hours or 1 year

Figure 69. Yearly Inspection standard.

<Water quality analysis>

For the open circulation type, cooling water is reused after its temperature is lowered by means of water's latent heat of evaporation.

In this case, as water evaporates, chloride ions, acid ions and etc. increase in water. This means cooling water enrichment happens, which eventually deteriorate water quality.

In addition, water and air always are in contact in the cooling tower, polluted material (automobile exhaust gas, sulfurous acid gas, dust, gas of chemical plants such as ammonia or petroleum gas and etc.) deteriorates the water quality further.

Such cooling water pollution causes pipe corrosion and scale adherence, which, in turn, makes holes on tubes, copper pipe clogging, and low heat exchange ability.

Therefore, it may cause replacing tubes, power cost increase, or the chiller failure. Thus, the quality of cooling water must be maintained at a proper level.

Regular water quality analysis should be conducted and if the results are out of the standards (See "Table 23. Chilled and cooling water control standard"), water should be changed. Water quality analysis should be conducted necessarily at the beginning of the season or when the machine is initially starting.

To prevent cooling water enrichment, you can drain a certain amount of cooling water and supply fresh cooling water during cooling water circulation or you can use a chemical to maintain water quality.

<Condition of heat-transfer tube>

If scales adhere to the inside of the tube, or foreign substances flow into the tube, the tube gets clogged so the heat resistance increases, and chilling ability decreases, and surge might occur.

If sandy like solid materials flow into the cooling water, erosion or corrosion might occur at the inlet or outlet of the tubes, therefore, make sure to check inside the tubes during tube cleaning.

Install a filter at the inlet of the cooling water pipe. Though a cooling tower is generally used for the cooling water system, if you, however, use the subterranean water or stream water, more scales may adhere due to bad water quality.

	Item	Cooling water system			Chilled water system		Trend	
		Circulation type		Once through type				
		Circulating water	Supplied water	Once through water	Circulating water (Below 20°C)	Supplied water	Corrosion	Scaling
Standard Item	pH(25°C)	6.5~8.2	6.0~8.0	6.8~8.0	6.8~8.0	6.8~8.0	o	o
	Electric conductivity (Ma/m)(25°C) (μs/cm) (25°C)	below 80 obelow 800	below 30 below 300	below 40 below 400	below 40 below 400	below 30 below 300	o	o
	Chloride ion ($mgCl^{-}$/L)	below 200	below 50	below 50	below 50	below 50	o	
	Sulfuric ion ($mgSO_4^{2-}$/L)	below 200	below 50	below 50	below 50	below 50	o	
	Acid consumption (pH4.8) ($mgCaCO_3$/L)	below 100	below 50	below 50	below 50	below 50		o
	Total hardness ($mgCaCO_3$/L)	below 200	below 70	below 70	below 70	below 70		o
	Calcium hardness ($mgCaCO_3$/L)	below 150	below 50	below 50	below 50	below 50		o
	Ion silica ($mgSiO_2$/L)	below 50	below 30	below 30	below 30	below 30		o
Reference item	Iron (mgFe/L)	below 1.0	below 0.3	below 1.0	below 1.0	below 0.3	o	
	Copper (mgCu/L)	below 0.3	below 0.1	below 1.0	below 1.0	below 0.1	o	o
	Sulfide ion ($mgSO^{2-}$/L)	Not detected	Not detected	Not detected	Not detected	Not detected	o	
	Ammonium ion ($mgNH_4$+/L)	below 1.0	below 0.1	below 1.0	below 1.0	below 0.1	o	
	Residual chlorine (mgCl/L)	below 0.3	below 0.3	below 0.3	below 0.3	below 0.3	o	
	Free carbon dioxide ($mgCO_2$/L)	below 4.0	below 4.0	below 4.0	below 4.0	below 4.0	o	
	Stability index	5.0~7.0	—	—	—	—	o	o

Note)

(1) Name and unit of the items are based on KS MD100.

(2) O sign within the table indicates that the factor is related to the tendency of corrosion or scale occurring.

(3) Unit and value within the parenthesis show data based on previous unit given for reference.

(4) If the temperature is high (40°C or above) the corrosion rate generally becomes also high. Especially if steel-made products directly contacts water without any protective coating, it is preferable to make an effective plan such as adding anti-corrosive additive or air removal process, etc.

Table 23. Chilled and cooling water control standard

Base Module

Module Code	compressor	Evaporator	Condenser	Product Weight [kg]	Operating Weight [kg]	Oil Weight [kg]	Refrigerant Weight [kg]
A	A1	AA	AA	5,900	7,100	40	300
B	A1	AC	AC	6,100	7,350	40	350
D	A3	AC	AC	6,100	7,350	40	350
E	A3	AC	AM	6,250	7,500	40	400
F	A3	AT	AM	6,400	7,650	40	400
G	B1	BA	BA	7,300	8,800	40	450
H	B2	BB	BB	7,600	9,150	40	500
J	B3	BC	BC	8,000	9,600	40	550
K	B3	BD	BD	8,400	10,000	40	650
N	None						

Combination of 2

Capacity		Chiller A	Chiller B	Chiller C	Chiller D
RT	kW				
600	2110	D	D	N	N
700	2461	F	F	N	N
800	2813	G	G	N	N
900	3164	H	H	N	N
1000	3516	J	J	N	N
1200	4219	K	K	N	N

Combination of 4

Capacity		Chiller A	Chiller B	Chiller C	Chiller D
RT	kW				
1400	4922	F	F	F	F
1600	5626	G	G	G	G
1800	6329	H	H	H	H
2000	7032	J	J	J	J
2400	8438	K	K	K	K

6-3. Maintenance during the Off Season

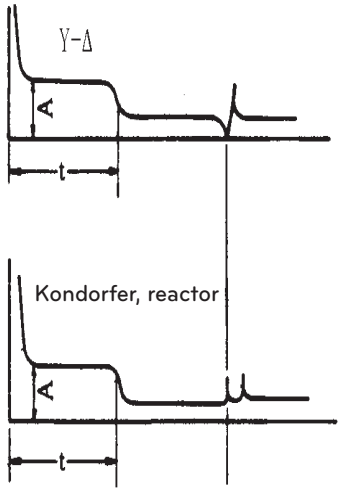
(1) If the operation needs to be stopped, to reduce machine pressure and leak possibility, move the refrigerant to a separate refrigerant container.

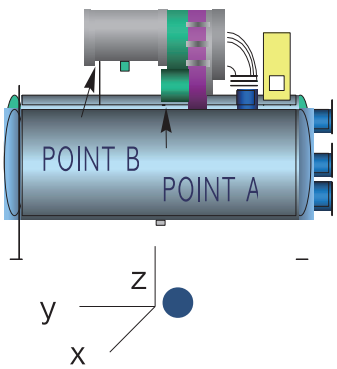
(2) To prevent air intake into the machine, store the machine with about 5kg of refrigerant charged or about 0.5kg of nitrogen pressurized.

(3) If the place where the machine is installed goes below 0°C frequently, drain cooling water, chilled water and condensed water and then open the water room drain to prevent freezing.

(4) Leave the oil charged in the machine as it is, and supply power to the oil heater to maintain minimum oil tank temperature.

6-4. Checklist of Regular Maintenance Inspection(1/2)

<table>
<tr><th colspan="3">Inspection items</th><th>Inspection method</th><th>Criteria</th><th>Actual measurement</th><th>Decision</th></tr>
<tr><td rowspan="11">Compressor</td><td rowspan="2">O</td><td rowspan="2">Motor cooling status</td><td>Check refrigerant flow status from moisture indicator</td><td>Check flow status</td><td>Yes No</td><td></td></tr>
<tr><td>Touch the surface of the motor with hand</td><td>10~30 °C</td><td>Yes No</td><td></td></tr>
<tr><td>O</td><td>Motor insulation</td><td>Measured at 1000V</td><td>100MΩ or more</td><td>MΩ</td><td></td></tr>
<tr><td>O</td><td>Start-up characteristics (mark O in the corresponding start-up method)</td><td> 

In case of chilled water outlet temp. ( ) °C</td><td>Start-up time
T=5~25 sec.</td><td>t =
sec.</td><td></td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td>Start-up current: A</td><td>A=
A</td><td></td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2">Timer set value (sec.)
<table>
<tr><th colspan="2">Timer</th><th>Y-△</th><th>Kondorfer</th><th>reactor</th><th>Actual measurement</th></tr>
<tr><td rowspan="2">High pressure</td><td>T1</td><td>10/0.5</td><td>10</td><td>10/0.5</td><td></td></tr>
<tr><td>T2</td><td>20</td><td>20</td><td>20</td><td></td></tr>
<tr><td rowspan="2">Low pressure</td><td>T1</td><td>15/0.5</td><td>15</td><td>15/0.5</td><td></td></tr>
<tr><td>T2</td><td>30</td><td>20</td><td>30</td><td></td></tr>
</table>
Check timer set value with independent timer operation test after disconnecting high voltage.</td><td>T1: start-up timer
T2: subsi -diary timer</td></tr>
<tr><td rowspan="2">O</td><td rowspan="2">Vane operation</td><td>Check opening 0~100%</td><td>Check 0, 100%</td><td>Yes No</td><td></td></tr>
<tr><td>Check opening status</td><td>Shall operate smoothly</td><td>Yes No</td><td></td></tr>
<tr><td>O</td><td>Vane opening</td><td>Check opening ratio</td><td>In normal operation</td><td>%</td><td></td></tr>
<tr><td>O</td><td>Operation current</td><td>Check current value</td><td>Less than 105% of the rated</td><td>A</td><td></td></tr>
<tr><td>O</td><td>Motor stopped time</td><td>After chiller is stopped, check from half-load side of the motor when the meter axes stopped time</td><td>10~60 sec.</td><td>sec.</td><td></td></tr>
<tr><td>O</td><td>Discharge gas temp.</td><td>Measure the surface of the bolts with thermometer</td><td>About 30~90°C</td><td>°C</td><td></td></tr>
<tr><td>O</td><td>Vibration noise</td><td>Touch with hand or check with ears
 
</td><td>When there is no problem</td><td>Yes No
Xa =μ
Ya =μ
Za =μ
Xb =μ
Yb =μ
Zb = μ</td><td></td></tr>
</table>

6-4. Checklist of Regular Maintenance Inspection(2/2)

Inspection items				Inspection method	Criteria	Actual measurement	Decision (OX)
Condenser	O	Cooling water	Inlet	Check with thermometer	34°C or less (standard condition)	°C	
			Outlet	Check with thermometer	24°C or more (standard condition)	°C	
	O	Condensing pressure (temp.)		Check with manometer (thermometer)	6~10 kg/cm^2 (26~42 °C)	kg/cm^2 (°C)	
	O	Heat exchanging status		Difference between condensing temp. and cooling water outlet temp.	1~3 °C	°C	
Evaporator	O	Chilled water	Inlet	Check with thermometer	6~15 °C		
			Outlet	Check with thermometer	4°C or more		
	O	Evaporating pressure (temp.)		Check with manometer (thermometer)	2~5 kg/cm^2 (0~21 °C)	kg/cm^2 (°C)	
	O	Heat exchanging status		Difference between chilled water outlet temp. and evaporating temp.	1~3 °C	°C	
	O	Refrigerant charging amount		Check through sight glass	Refer to 10.5 standard charging amount		
	O	Boiling status		Visual inspection		Yes No	
	O	Refrigerant contamination		Check through sight glass	Whether contaminating material, moisture, oil is included	Yes No	
Lubrication system	O	Oil amount		Visual inspection	Check with sight glass on the gear box during operation	Yes No	
	O	Oil charging amount		Accumulated charging amount after charging new refrigerant	Refer to 10.5 standard charging amount	Month Day l	
	O	Oil tank temp.		Check with thermometer	30~65 °C	°C	
	O	Temp. of Bearing		Check with thermometer	50~85 °C	°C	
	O	Oil differential pressure		Check with manometer	Oil supply pressure – Oil tank pressure (above 1.3 kg/cm^2)		
	O	Oil pressure vibration		Vibration of the pressure value		Yes No	
	O	Oil leakage		Oil system visual inspection		Yes No	
	O	Oil pump noise		Check with ears		Yes No	
	O	Oil pump remaining operation		Measure with watch	300 sec.	min.	
Safety Device		Vane operation		Manual opening of vane	• Stop at rated current • Closed at 105%	Yes No	
		Chilled water differential pressure switch		Decrease chilled water amount to check the operation		Yes No	
		Cooling water differential pressure switch		Decrease cooling water amount to check the operation		Yes No	

Table 24. Checklist of Regular Maintenance Inspection

6-4. Checklist of Regular Maintenance Inspection

Operation Inspection Table (A)

Inspection date: Year Month Day

Address	(Tel)		
Company	(Staff in charge)		
Model		Serial No.	
Main motor	Serial No. Rated voltage(V): Max. output(KW): Rated current(A):		
Changes			
Replaced parts			
Conclusion			

Person in charge of service:

Note:

1. The manufacturer is not responsible for problems resulting from poor water quality, poor maintenance by the client, and natural disaster
2. Overhaul of the compressor should be conducted in 10,000hr or 5 years, whichever comes fast.
3. Beware that some items could be changed without any notice for product improvement.

Table 25. Operation Inspection Table

6-5. Oil Maintenance

Compressor Oil Change

- Checking the Lubrication System.

  Record the oil level presented on the sight glass of the oil tank during operation, and observe the level when the chiller is stopped. If the level has dropped below the sight glass window, you should necessarily check whether the oil recovery system is working properly. If oil charging is necessary, add oil through the oil charging valve. To charge oil by resisting the pressure of the refrigerant, a pump is needed. For the proper amount of charging, refer to the oil charge amount of each model, and the oil that has been added should match the specification of LG's chiller. The date and amount of the oil added should be recorded.

- Oil specification

  Use the oil that LG recommends.

Category	Unit	Characteris-tic value	Meaning
Density	kg/m^3	960	Check for the specified product and for any foreign substance mixed
Color	°C °C	L0.5	Check initially specified product
Ignition point	mm^3/s	250	Fire and explosion risk, preservation stability
Flowing point	mgKOH/g	-40	Stability during the initial start-up, preservation stability
Kinematic viscosity @ 40 °C		67.3	Lubrication, friction loss, sealing effect, cooling capability
@ 100 °C		8.29	
Viscosity index		90	Relationship to the viscosity change due to temp. change
Total acid value		0.01	Measure oxidation of the oil itself compared to the initial total acid value
Corrosion of the copper plate (100 °C, 3h)		1	Anti-corrosion ability of the oil

Table 26. Oil specification

<Available oil>

Oil authenticated by LG

- Oil Change

  We recommend you to change the oil every 3 years according to the first year operation and the annual oil analysis.

  1) Record the current oil level.
  2) Open the control circuit breaker and oil heater circuit breaker.
  3) Gradually open the oil charging valve to drain oil. Resisting against the pressure of the chiller, open the valve slowly.
  4) After closing the valves at the both ends of the oil filter, gradually reduce the pressure within the filter by using the upper valve and then change the filter.
  5) Charge oil to the machine by using a pump. For the oil to be charged over the middle level of the sight glass, approximately 50~60ℓ of oil is needed.
     Power the oil heater until the oil temperature is at least 40°C.
     For the controlling test, operate the oil pump manually for 2 minutes.
     The oil level should be able to be observed at the sight glass when the chiller is stopped.

Oil Filter Change

- Oil Filter Change

Replace the oil filter annually or when the machine is opened for repair.

LG chiller's oil filter can be separated for replacement even if the refrigerant is still in the chiller.

1) Check whether the compressor stopped and the compressor circuit breaker is opened.
2) Shut down the oil pump power.
3) Close the valves for oil filter separation.
4) When you open the oil filter housing, do it gradually.

⚠ CAUTION

As the oil filter housing is in high pressure, reduce the pressure gradually.

5) Make the filter housing vacuum after filter change and assembly have been completed. After evacuation is completed, open the valve for separation and charge oil by the oil charge valve when the oil is insufficient.

6-6. General maintenance

Occasional maintenance

- The compressor bearing and the gear maintenance
  Proper lubrication is the key of bearing and gear maintenance. Use oil in a good grade and maintain the recommended amount, temperature and pressure. Check the lubrication system in detail regularly.
  To inspect the bearing, the compressor must be completely disassembled. To take out the bearing and inspect it, a high-level technician is demanded.
  Excessive bearing abrasion can be detected occasionally by excessive vibration or by the temperature of the bearing.

- Refrigerant leakage test
  The pressure of HFC-134a is higher than the air in room temperature, so a leakage test should be conducted by using an electronic detector, a halogen leak detector or soapy water.
  If refrigerant leak is noticeably large to the entire chiller, immediately stop the machine and fix it first.
  If the refrigerant was lost or the machine has been opened during maintenance, a leakage test must be conducted by pressurizing the chiller and the related tanks.
  Refer to 5-2-2 for the leakage test.

Refrigerant Charge and Leakage Test

- Characteristics of the refrigerant
  HFC-134a is the refrigerant in use HFC-134a evaporates at -26°C in normal air pressure, so it should be stored in a pressured container or a storage tank.
  When the refrigerant has been mixed with air, it is almost odorless, and it is nonflammable in air pressure.

⚠ DANGER

As HFC-134a dissolves oil and some non-metallic materials dehydrates the skin and makes hypoxia resulting in suffocation, be careful not to inhale and not to make any contact with your hands or eyes when you handle the refrigerant.

<Characteristics Table>

Molecule formula		$CH_2F\text{-}CF_3$
Molecule amount		102.031
Boiling point (air pressure)	°C	-26
Freezing point	°C	-101
Critical temp.	°C	101
Critical pressure	$kg/cm^2.A$	41.5
Density of saturated fluid (25°C)	kg/m^3	1206
Specific volume of saturated vapor (25°C)	m^3/kg	0.031
Specific heat ratio, vapor (25 °C, air pressure)		1.1186
Evaporative latent heat (25°C)	kcal/kg	42.54

Table 27. The property of HFC-134a

- Controlling the charge amount of the refrigerant

If it is necessary to control the refrigerant charge amount to improve the performance of the machine itself, operate the machine under its designed load and add or remove the refrigerant gradually until the temperature difference between the chilled water outlet and the evaporator's refrigerant becomes minimized or gets to the designed condition. Do not overcharge.

The refrigerant can be charged through the storage tank or directly into the chiller.

- Refrigerant leakage test

The pressure of HFC-134a is higher than air in room temperature, so a leakage test should be conducted by using an electronic detector, a halogen leak detector or soapy water. Indoor ventilation must be good, and check whether the refrigerant is concentrated in one place to prevent wrong measurement. Before performing any necessary maintenance work for leakage, move refrigerant completely from the leaked container.

- Refrigerant leakage

If there was a large refrigerant leak, chiller performance degrades or even machine operation can be impossible. In such cases, please stop the chiller and repair it first.

- Refrigerant filter

Usually the refrigerant filter or drier in the refrigerant cooling pipes of the motor needs to be replaced once a year, it should be, however, replaced more frequently if required according to the status of the filter.
To figure out whether any moisture is in the refrigerant, sight glass is installed next to the filter.
If moisture is detected through the sight glass, perform an exhaustive leak test to find the source of the water.

Cleaning the tubes of the Heat Exchanger(Evaporator/Condenser)

Inspecting the heat exchanger tubes

- Evaporator

When the first operation season is over, clean the evaporator tubes.
These tubes have foreign substances inside them, so you should pay special attention to cleaning these tubes thoroughly.
The condition of the tubes at that time will indicate how often the tubes need to be cleaned and whether the water treatment in the chilled water (brine) system is appropriate.
Check for any corrosion or scale on the temperature sensor of the chilled water inlet/outlet. For corrosion, replace the sensor, and for scale, remove it.

- Condenser

The cooling water circuit is generally an open type system, so tubes are easily contaminated, and scales easily adhere. Therefore, clean the tubes of condenser at least once a year, and if the water quality is contaminated clean more frequently.
Check for corrosion or scale on the temperature sensor of the cooling water inlet/outlet. For corrosion, replace the sensor, for scale, remove it.
If the condenser pressure is higher than normal and if the condenser does not reach the previous chilling load, in general cases, it is because the tubes are contaminated or air is in the machine.
If the temperature difference between cooling water outlet and condenser refrigerant is great, the condenser tubes may be contaminated or the water flow is not good.
HFC-134a is a high pressure refrigerant, so it is easier to have a refrigerant leak than air inflow.
During tube cleaning, use a specially designed brush to prevent scratch on the walls of the tubes. Never use a wire brush.

⚠ CAUTION

To prevent and remove severe scales, treat it with chemicals. For a proper treatment, consult with a water-treatment specialist.

Check items before operation after long term stop

- Check list before a start-up

1. Control panel and electric wiring
   Shut down the breaker, check for any foreign substance in the control parts, switches, etc. Control the switches to check whether it normally operates and check the connection of each terminal
2. Voltage
   Read the voltmeter of the starter panel and check if it matches the working voltage indicated at the nameplate of the chiller
3. Chilled water and cooling water circulation system
   Operate cooling water and chilled water pumps to check if their operation status are properly displayed on the panel.

- Operation test of control device

1. Check the wiring condition
   Check if the power, sensor, etc. are properly connected.
   Especially, the power line should be thoroughly checked.
2. Turn the power on and check the display status of the panel.
   Pay special attention if there is any sign of short circuit during the initial 5 sec. after power on.
   If any of the following symptoms occurs, immediately disconnect the power and check the problem.
3. Check the values displayed on the panel.
   Check whether values of each sensor are displayed on the panel correctly. If any error message appears or values of the sensor are not normal, check the connection of each sensor.
4. No power operation
   Shut the main power down and operate. Check whether it normally operates until the operation signal of starter panel. If any error message appears, check the relevant part.

- Safety device check

Operation test on chilled and cooling water flow.
Close the valves of the cooling water and chilled water pipes to check whether the switch which determines normal and abnormal flow is working properly.

7. TROUBLESHOOTING

7-1. Causes and actions for alarms

Actions for problems

- Actions for the abnormal signal displayed on the controller
- Please take actions according to the following instruction

  Check the signal and refer to the help message.
  Select the help message of the abnormal signal at the menu and check the contents of the problem and actions against it.
  Remove the cause of the problem by referring to drawing, parts of the circuit related to the problem or the manual.
  If the content for the problem is not in the manual or drawing, request help to LG experts. Check the temperature control condition, pressure status, etc.

Troubleshooting (1/3)

Abnormal category	Displayed contents	Cause	Action
Chilled water inlet temperature sensor	Chilled water inlet temperature sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or re-wire
Chilled water outlet temperature sensor	Chilled water outlet temperature sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Cooling water inlet temperature sensor	Cooling water outlet temperature sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Cooling water outlet temperature sensor error	Compressor discharge temperature sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Bearing temperature sensor	Bearing temperature sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Motor winding R phase temperature sensor	Motor winding R phase temperature sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Motor winding S phase sensor	Motor winding S phase temperature sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Motor winding T phase sensor	Motor winding T phase temperature sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Evaporator pressure sensor	Evaporator pressure sensor	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Condenser pressure sensor	Condenser pressure sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Oil tank pressure, temperature sensor	Oil tank pressure sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Oil pump pressure sensor	Oil pump pressure sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Current transducer	Current sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire
Voltage transducer	Voltage sensor error	Sensor disconnection/short-circuit Main board Malfunction	Check parts or wiring Replace parts or rewire

Troubleshooting (2/3)

Abnormal category	Displayed contents	Cause	Action
Power transducer	Power sensor error	Sensor disconnection/short-circuit Main Board Malfunction	Check parts or wiring Replace parts or re-wire
Compressor discharge temperature	Compressor discharge temperature high	Compressor discharge temperature is detected to be over the set value	Check compressor discharge temperature displayed on the controller screen. Check the set value and correct if it is wrong
Oil tank temperature	Oil tank temperature is high	Oil tank temperature is detected to be over the set value.	Check the oil tank temperature displayed on the controller screen. Check the set value and correct if it is wrong
Bearing temperature	Bearing temperature high	Bearing temperature is detected to be over set value	Check bearing temperature displayed on the controller screen Check the set value and correct if it is wrong.
Motor winding R(S,T) phase temperature	Motor winding R(S,T) phase temperature high	Motor winding R(S,T) phase temperature is detected to be over set value.	Check motor coil R(S,T) phase temperature displayed on the controller. Check the set value and correct if it is wrong.
Condenser pressure	Condenser pressure high	Condenser pressure is detected to be over set value	Check condenser pressure displayed on the controller Check the set value and correct if it is wrong
High temperature contact of motor winding	Motor winding high temperature contact activated	Motor winding contact is activated in a high temperature	Check the motor winding temperature Check winding high temperature contact activation status and wiring status
Chilled water outlet temperature	Low Chilled water temperature abnormality	Chilled water outlet temperature detected to be below the set value Non or small cooling load	Check chilled water outlet temperature displayed on the controller or on the thermometer Check the set value and correct if it is wrong
Evaporator pressure	Low evaporator pressure	Evaporator pressure is detected to be under the set value	Check evaporator pressure displayed on the controller Check the set value and correct if it is wrong
Oil differential pressure	Low oil differential pressure	Oil differential pressure is detected to be under the set value	Check the oil differential pressure displayed on the controller Check the set value and correct if it is wrong
Main power voltage	Main power voltage abnormality	Main power voltage is detected to be under the set value	Check the voltage of the main power and current setting value Check parts or wiring Replace parts or re-wire
Starter panel abnormality	Starter panel abnormality	Abnormal starter panel contact activation	Check the contact status of the starter panel and remove the cause of the contact activation Check related parts or wiring Replace malfunctioning parts or re-wire
Start-up failure	Start-up failure	During the start-up, 2M magnet switch is not working	Check the 2M magnet operating status Check parts or wiring Replace parts or re-wire
Chilled water pump interlock	Chilled water pump interlock error	The pump interlock signal is disconnected during normal operation. Pump stopped. Wrong wiring. IO board malfunction.	Check parts or wiring Replace parts or re-wire
Cooling water pump interlock	Cooling water pump interlock error	The pump interlock signal is disconnected during normal operation. Pump stopped. Wrong wiring. IO board malfunction.	Check parts or wiring Replace parts or re-wire

Troubleshooting (3/3)

Abnormal category	Displayed contents	Cause	Action
Vane close switch	Vane is not closed	Vane closed during start-up, switch opened	Check vane close switch's operation status and the wiring. Adjust the position of the vane close switch or re-wire
High condenser pressure	High condenser pressure contact activation	Condenser pressure is higher than the pressure switch set condition.	Check condenser's pressure. Check condenser high pressure contact status or wiring Replace parts or re-wire
Low evaporator refrigerant temperature	Evaporator refrigerant low temperature contact activation	Evaporator refrigerant temperature is lower than the switch set condition	Check evaporator refrigerant temperature. Check evaporator refrigerant's low temperature contact condition or the wiring. Replace parts or re-wire
Surge occurrence	Surge occurrence	Surge occurrence	Check changing amount of surge current. Reset the surge prevention range
Oil pump	Oil pump overload contact activation.	Oil pump current is more than the set current for overload	Check the oil pump overload setting condition and the wiring Replace parts or re-wire
Chilled water flow interlock	Abnormal low flow of chilled water	Flow signal has been disconnected during normal operation. Pump stopped. Flow (differential pressure) switch Abnormal setting Wrong wiring. IO board malfunction	Adjust set value and check. Check parts or wiring. Replace parts or re-wire
Cooling water flow interlock	Abnormal low flow of cooling water	Pump interlock signal has been disconnected during operation. Pump stopped. Wrong wiring. IO board malfunction	Check parts or wiring. Replace parts or re-wire
Start-up completion signal (2M)	Delta contactor opening during operation	Delta contactor signal has been disconnected during operation	Check parts or wiring Replace parts or re-wire
Evaporator refrigerant temperature	Evaporator refrigerant low temperature abnormality	Evaporator refrigerant temperature has been detected to be lower than set value	Check temperature of the evaporator refrigerant displayed on the controller screen. Check the set value and correct if it is wrong
Communication	MAIN <-> I/O communication error	Communication error between boards	Check parts or wiring. Replace parts or re-wire
Sensor correction	Set value is damaged, set value is damaged	Not adjusted sensor	Adjusting by using a precision resistor
Main board	Main board reset	Main board reset during operation	Check the applied voltage of the controller and the wiring Remove the cause of the noise
Display device	Display board reset	Display board reset during operation	Check the applied voltage of the controller Remove the cause of the noise Check the wiring

Table 28. Troubleshooting

How to do when problem occurs

Vane sensor abnormality

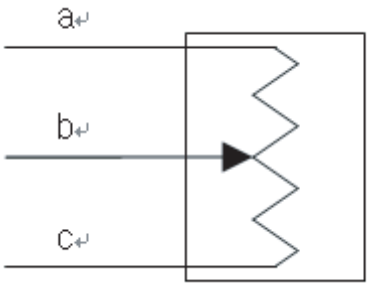


Figure 70. Vane Sensor

Vane sensor

After converting the tester to the resistance measurement mode, measure resistance between ‘a’ and ‘b’ and there should be a certain resistance.
Then convert the vane to manual operation mode. In this case, if the vane moves, in turn there should be a movement at vane sensor and the resistance value should also change.
If the resistance value doesn’t change while the vane sensor is moving, the wiring is wrong or the vane sensor is damaged.
While the vane comes to be completely open from an initially completely closed status, the vane sensor is normal, if the resistance between ‘a’ and ‘b’ regularly increases, and the resistance between ‘b’ and ‘c’ regularly decreases.
Also measure resistance between ‘a’, ‘b’, ‘c’, and main body, and each line should be isolated.
If the vane sensor is normal, re-connect the sensor, and check whether the vane value is 0% when completely closed, and 100% when completely opened.
If the value changes and vane opening % is wrong, the sensor needs to be reset.
If the value doesn’t change, check if in ‘sensor setting-guide vane setting” category 100% is set and also check if the A/D value of the sensor changes when vane moves.
If sensor value changes, reset the vane.
If the value of sensor doesn’t change, convert the tester to the measuring point of 30V DC and then measure the voltage with + at the point where vane sensor ‘a’ is connected and - at the point where vane sensor ‘c’ is connected in the control terminal. The result shall be 5V DC.
If the voltage is not measured as a normal condition, check the main input power to the relay board.
If the relay main power and vane sensor is normal, and the sensor value doesn’t change, then replace relay board.

Temperature sensor (PT-100) abnormality

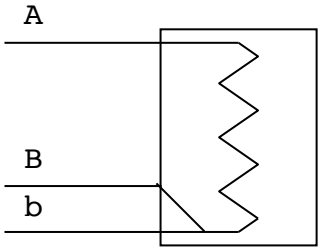


Figure 71. Temperature sensor

After disconnecting the connection of the temperature sensor from the controller and setting the tester to resistance measurement mode, measure the resistance between A and B; and among b's. The results should be between from 84.27Ω(-40°C) to 153.58Ω(140°C).
(If you check at the PT-100 temperature table, you can find the value corresponding to actual temperature)
If the resistance value is not in the range presented above, connection lines are wrong or the sensor is damaged.
Connect the resistance generator (decade resistance box) to the controller. Then by changing to 0°C at 100.00Ω, 10°C at 103.90Ω, and 28°C at 110.9Ω, check if the temperature displayed on the controller changes according to the resistance change.
If normal value is not displayed on the screen, check if the sensor is set correctly.
If the sensor value does not change when the resistance value changes, check the main power of the main board, and if the power is normal and there is no input value on the sensor, the master or slave board needs to be replaced.

Temp(°C)	Rt (Ω)	Temp(°C)	Rt (Ω)	Temp(°C)	Rt (Ω)	Temp(°C)	Rt (Ω)
-200	18.52	20	107.79	240	90.47	450	264.18
-190	22.83	30	111.67	250	194.1	460	267.56
-180	27.1	40	115.54	260	197.71	470	270.93
-170	31.34	50	119.4	270	201.31	480	274.29
-160	35.54	60	123.24	280	204.9	490	277.64
-150	39.72	70	127.08	290	208.48	500	280.98
-140	43.88	80	130.9	300	212.05	510	284.3
-130	48	90	134.71	310	215.61	520	287.62
-120	52.11	100	138.51	320	219.15	530	290.92
-110	56.19	110	142.29	330	222.68	540	294.21
-100	60.26	120	146.07	340	226.21	550	297.49
-90	64.3	130	149.83	350	229.72	560	300.75
-80	68.33	140	153.58	360	233.21	570	304.01
-70	72.33	150	157.33	370	236.7	580	307.25
-60	76.33	160	161.05	380	240.18	590	310.49
-50	80.31	170	164.77	390	243.64	600	313.71
-40	84.27	180	168.48	400	247.09	610	316.92
-30	88.22	190	172.17	410	250.53	620	320.12
-20	92.16	200	175.86	420	253.96	630	323.3
-10	96.09	210	179.53	430	257.38	640	326.48
0	100	220	183.19	440	260.78	650	329.64
10	103.9	230	186.84				

Table 29. PT-100 Temperature Table

Using 4mA~20mA, 2-line type sensor, controller power

Check if the wiring between the sensor and the controller is properly connected.

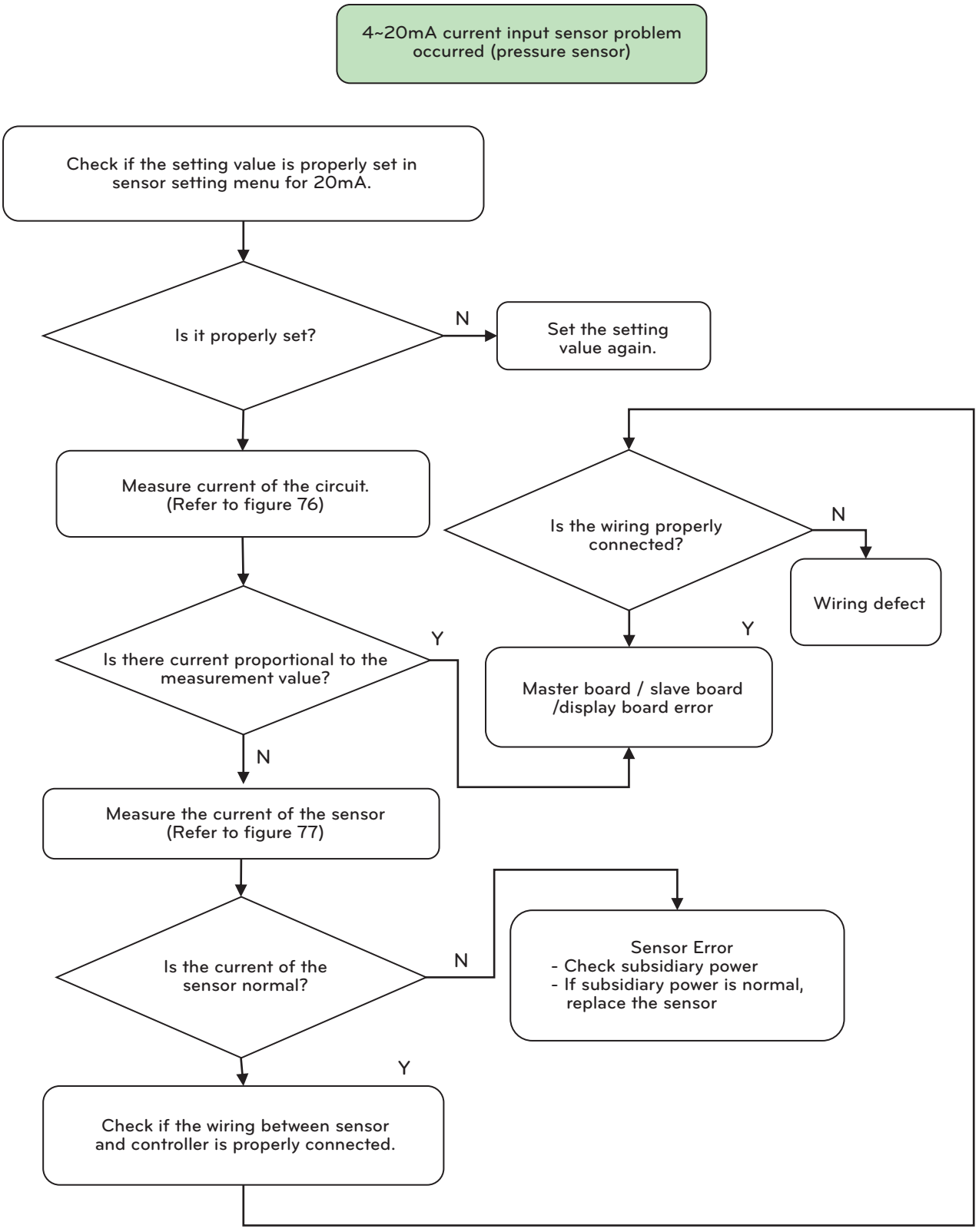


Figure 72. Pressure Sensor

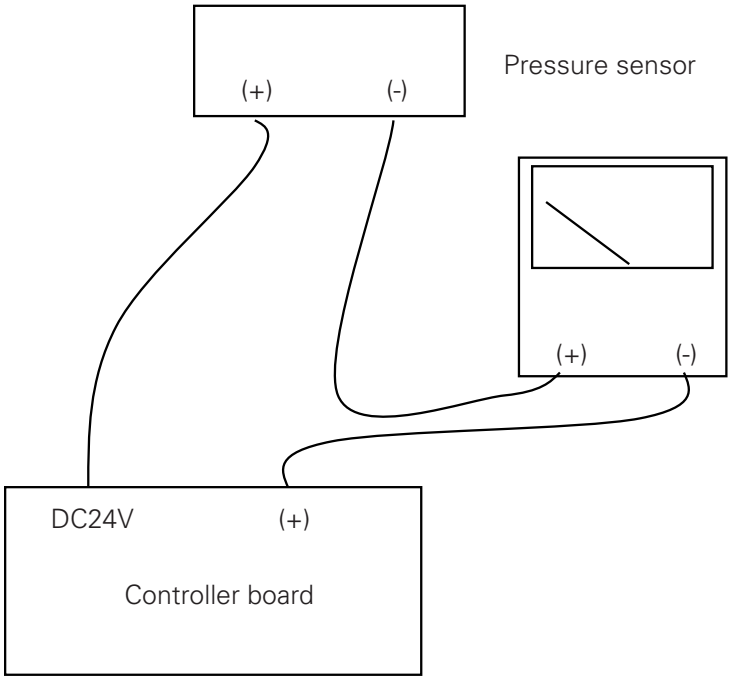


Figure 73. Current Loop Measurement Circuit

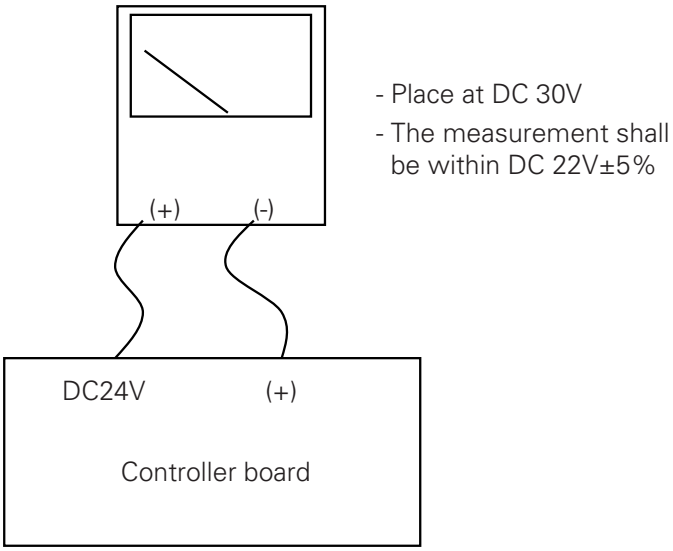


Figure 74. Controller Voltage Measurement Circuit

Though the inspection was carried out as above, but if the cause could not be found yet, connect current generator to the input connector(DC24V and (+)) of the controller, and check if the indicated value of the controller changes according to the value of the current generator.

In such case, if the indicated value of the controller doesn't change according to the current generator, the controller should be judged defected.

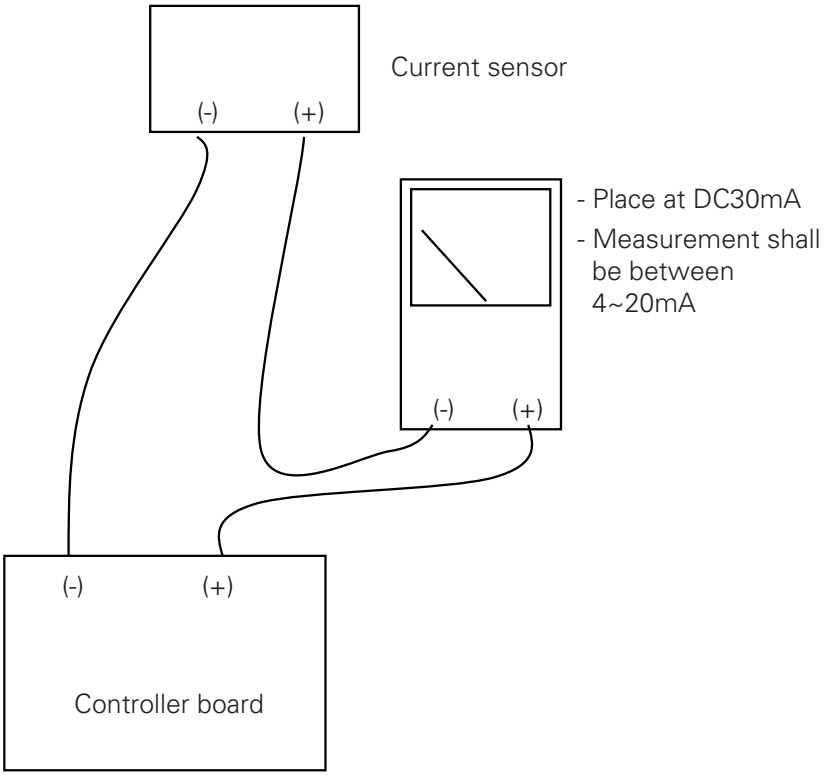


Figure 75. Pressure sensor

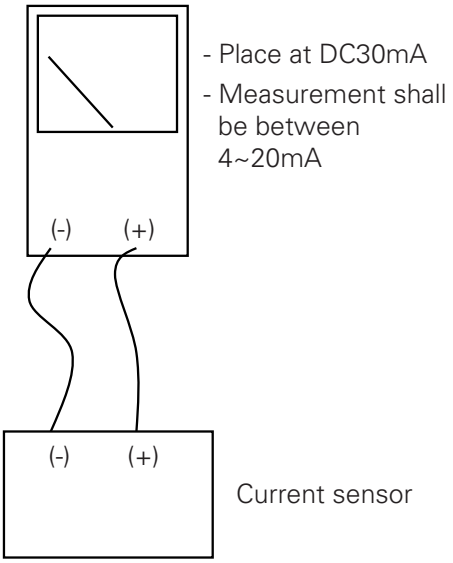


Figure 76. Current Sensor measurement circuit

The digital input signal can't be checked at the controller.

Though the no voltage contact signal is properly input to the digital input of the controller, but if still the controller finds it as abnormal, or if all the digital input signals doesn't change, this is due to I/O board power connector contact failure or communication failure between I/O board and main board.

Check the connection condition of the communication line between I/O board and main board, and if no problem, short-circuit the not-working wiring terminal of controller's digital inputs with the COM Terminal (23, 24) of the I/O board, and check whether the LED LAMP that matches the I/O board input terminal get lights.

Select "Menu key" – "System Information" – "I/O input" at the controller display, then Short-circuit/open the abnormal terminal(that has been short circuit) with COM terminal to see whether the input status changes as "ON"/ "OFF".

Check whether the DC voltage between COM terminal of the controller's digital input and the wire-disconnected digital input is measured as 18V.

If normal, re-connected and check the operation.

If main power and communication of the board is normal and the I/O input doesn't work, then the board has to be replaced.

Check by referring to the flow chart and the tester connection diagram represented as below

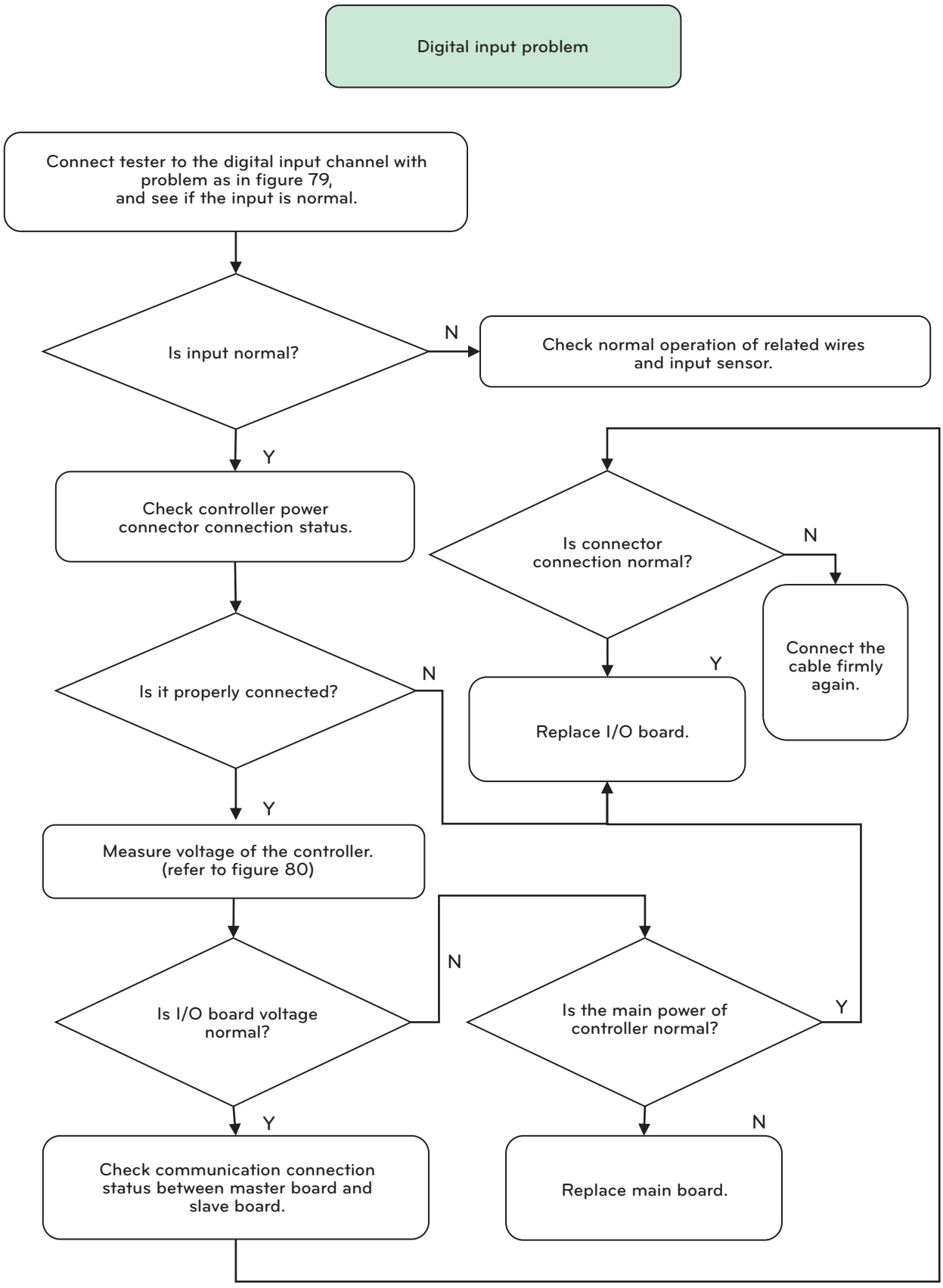


Figure 77. Digital input abnormality

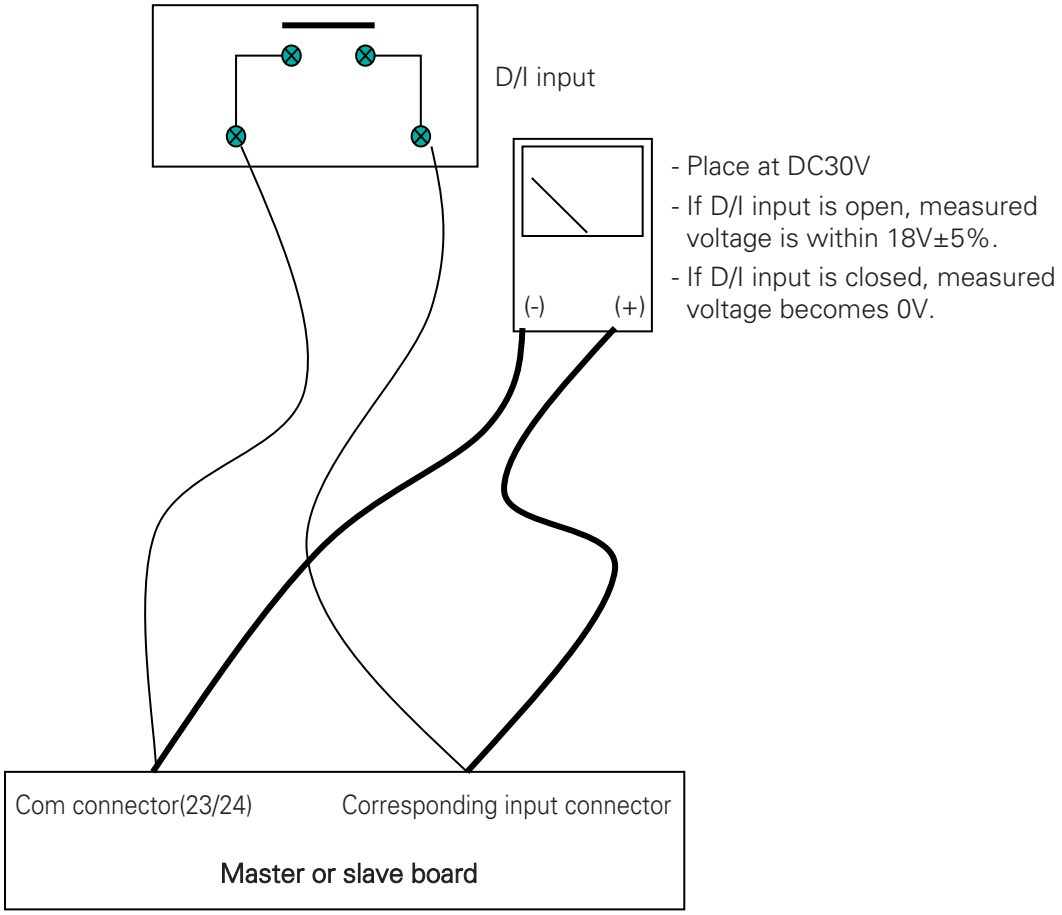


Figure 78. Master or Slave Board Current Measurement Circuit

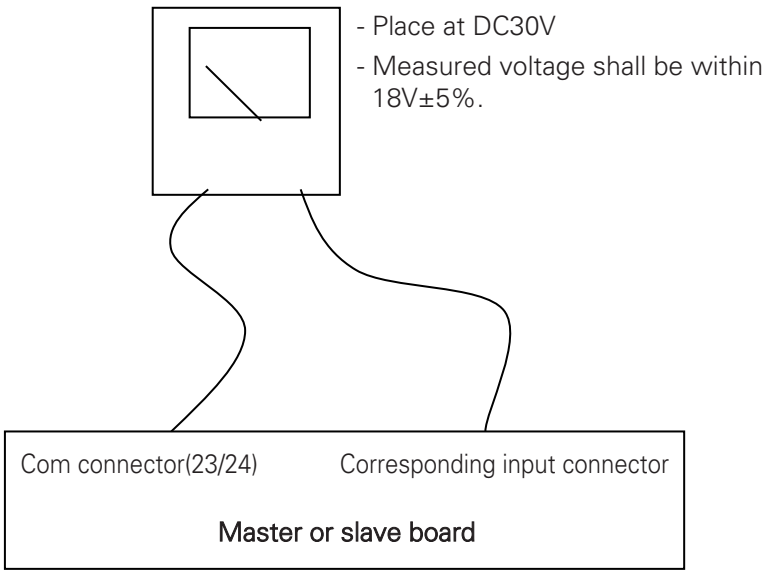


Figure 79. Master or Slave Board Current Measurement Circuit

Communication error

This error occurs because each board signal message couldn't communicate with each other. First, check the connection of the communication lines of each board. Now, 2 RDX+, RDX- lines of the master board should be connected to same polarity RDX+, RDX- of the slave board and the relay board, and likewise the 2 RDX+, RDX- lines of the master board should also be connected to the same polarity. If it is not properly connected to the proper connector, communication is impossible, so please connect to the proper connector.

7-2. Action for Each State of Chiller

Abnormal rise of condensing pressure (cause of surge)

Status	Decision criteria	Cause	Remedy
Temperature difference between cooling water outlet and condensing is large.	Above 3°C	1. Air is mixed into machine 2. Tube contaminated 3. Insufficient cooling water amount 4. Air taken in from cooling water pump intake	1. Clean tube 2. Check cooling water system and increase to specified amount 3. Enhance pump intake
Condensing pressure is high	9.5 kg/cm^2 or more	1. High Temp. Cooling water → Lower the performance of cooling tower 2. Chilled water high temp. 3. Cooling water bypass in waterbox 4. Tubes contaminated	1. Check cooling tower performance 2. Lower chilled water temp. 3. Replace gasket in waterbox 4. Clean tube
Chilled water temperature is normal. However the temperature difference between the inlet and outlet of cooling water is large.	Check chiller data sheet	1. Cooling water amount decreased 2. Air taken in from cooling water pump intake	1. Check the cooling water system and increase to specified amount 2. Enhance pump intake

Table 30. Causes and countermeasures for condense pressure decrease

Abnormal decrease of evaporating pressure (Cause of surge occurrence)

Status	Decision criteria	Cause	Remedy
Evaporating pressure is low and chilled water inlet/outlet temperature difference is small	-	1. Butterfly valve adjustment defect 2. Insufficient chilled water amount 3. Tube contaminated 4. Insufficient refrigerant amount	1. Butterfly valve opening adjustment 2. Check chilled water system (flow) 3. Clean tube 4. Recharge refrigerant
Difference between evaporating temperature and chilled water outlet temperature is increased	Above 3°C	1. Insufficient charging of refrigerant 2. Contamination of refrigerant 3. Decreased chilled water amount 4. Air mixed in chilled water 5. Chilled water bypass in waterbox 6. Tube contaminated	1. Add refrigerant 2. Clean refrigerant 3. Check chilled water system and increase to specified amount 4. Enhance chilled water pump intake 5. Replace gasket in waterbox 6. Clean tube

Table 31. Causes and countermeasures for decrease of evaporating pressure

Problem in lubrication system

Status	Decision criteria	Cause	Remedy
Oil pressure is low	(Oil discharge pressure - oil tank pressure) < 1.3 kg/cm^2	1. Oil filter clogged 2. Insufficient oil 3. Pressure transducer defect 4. Oil pump defect	1. Oil filter cleaning or replacement 2. Recharge oil 3. Change transducer 4. Check if oil supply valves are closed 5. Check if oil temp. is low
Oil temp. is high in oil tank	74°C or more during operation	1. Oil is not sufficiently supplied to bearing 2. Oil heater setting value defect 3. Refrigerant is not sufficiently supplied to oil cooler 4. Excessive oil amount 5. Bearing abrasion	1. Adjust oil pressure, and check oil filter, oil system. 2. Adjust set value 3. Check condensed refrigerant amount and filter drier. 4. Remove oil to make it adequate amount 5. Need disassembly and repair
Rapid change of oil pressure	-	1. Oil manometer defect 2. Oil pump cavitation 3. Insufficient oil	1. Change manometer 2. Apply power to oil heater 3. Recharge oil
Oil tank temp. is low	Below 30°C	1. Oil heater fuse disconnected 2. Oil heater disconnected 3. Black out for long time, power unit stopped	1. Replace fuse 2. Replace oil heater 3. Wait until oil tank temperature meets the specified temperature. And if it does not rise, contact LG service personnel.
Oil in oil tank increased when it is stopped	-	1. Oil temperature is too low and oil is dissolved by solvent.	1. Check whether oil heater is disconnected. 2. Make sure the oil heater is on when the chiller unit shut down for long-term.

Table 32. Causes and countermeasures for lubrication system abnormality.

Others

Status	Decision criteria	Cause	Remedy
Compressor discharge temp. is low	-	1. Intake of fluid refrigerant	1. Extract adequate amount of refrigerant
Motor overload	-	1. Chilled water inlet temp. is high 2. Intake of liquid refrigerant 3. Intake of oil 4. Condenser high pressure 5. Gauge defect	1. Adjust chilled water temp. set value 2. Extract refrigerant 3. Regenerate refrigerant 4. Refer to 6-2-1 5. Change gauge
Abnormal vibration, current vibration	-	1. Oil pressure is higher than specification 2. A lot of fluid refrigerant intake 3. Bearing gap is big	1. Adjust to specified pressure 2. Extract refrigerant 3. Disassembly and inspection
Abnormal sound in compressor main body	-	1. Contact of the rotating part 2. Bearing abrasion, damage	1. Need to disassemble and repair 2. Need to disassemble and repair
Abnormal sound	-	1. Noise transferred from cooling water and chilled water pipe 2. Guide vane assembly defect 3. Isolation device defect	1. Apply flexible join and spring isolator in the pipes 2. Reassemble or replacement 3. Replace isolator device
Moisture indicator turns yellow during operation	-	1. Moisture is 30ppm or more 2. Moisture indicator defect	1. Drain moisture in the machine 2. Replace moisture indicator
Insufficient chilling capability	-	1. Condensing pressure is high 2. Evaporating pressure is low 3. Gauge defect	1. Refer to 6-2-1 2. Refer to 6-2-2 3. Replace gauge
leak in shaft part capacity adjustment device	-	1. Shaft stop bolt is not tightened	1. Tighten stop bolt clockwise and check leakage

Table 33. Causes and countermeasures for other abnormality of the chiller

8. OPERATION INSPECTION RECORD

8-1. Check list for operation record

LG Electronics

Operation record table

R-134a (1-level/2-level), R-123

MODEL : _____

Manufacture NO. : _____

Measurement Category		Unit	1	2	3	4	5	6	7	8
		Hour:Min.	:	:	:	:	:	:	:	:
Chilled water	Inlet pressure	kg/cm^2								
	Outlet pressure	kg/cm^2								
	Inlet temp.	°C								
	Outlet temp.	°C								
	Chilled water flow	m^3/h								
Evapora-tor	Pressure	kg/cm^2								
	Refrigerant temp.	°C								
Cooling water	Inlet pressure	kg/cm^2								
	Outlet pressure	kg/cm^2								
	Inlet temp.	°C								
	Outlet temp.	°C								
	Cooling W. Flow	m^3/h								
Con-denser	Pressure	kg/cm^2								
	Refrigerant temp.	°C								
Oil	TANK pressure	kg/cm^2								
	PUMP pressure	kg/cm^2								
	Differential pressure	kg/cm^2								
	Temp.	°C								
Compres-sor	Current limit value	%								
	Operating current	A								
	Winding temp.	°C								
	Temp. of Bearing	°C								
	Discharge gas temp.	°C								
	Vane opening	%								
	Diffuser opening	%								
Others	1. Chiller start time 2. Chiller stop time 3. Maintenance issues		4. Operation time 5. Number of start-ups 6. Moisture indicator color							

Table 34. Operation record


LG
Life's Good