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ENGLISH

OPERATION & MAINTENANCE MANUAL

Water-Cooled Centrifugal Chiller

Please read this installation manual completely for safety before installing the product. The purpose of this manual is to keep the user safe and to prevent any property damage. After reading this installation manual, please retain it for future reference thoroughly Installation work must be performed in accordance with this installation manual by authorized personnel only.

Model : RCWF*P(200~3000RT)**

P/NO : MFL68929303 (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 _ WARNING/CAUTION

It can be dangerous when moving, installing and placing the system for its high pressure, electric devices and heavy weight especially when lifting the unit in a limited space(rooftop, lifted structure, etc.).

Please read carefully the warnings and cautions on this manual and the labels attached on the unit, and follow the instructions.

Please follow the following instructions to prevent any injury or property damage

- It may result in an injury or damages when neglecting the instructions on in this manual. The seriousness of the result can be classified as the following signs.
- Please note that any failure of system resulted by user's careless maintenance, natural disaster or the failure of the power cable shall not be warranted regardless of the warranty period.
- Please note that any part of this manual can be revised without notice for the product improvement.

⚠ 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

- Have all electric work done by a licensed electrician according to "Electric Facility Engineering Standard" and "Interior Wire Regulations" and the instructions given in this manual and always use a special circuit.
  - If the power source capacity is inadequate or electric work is performed improperly, electric shock or fire may result.
- 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.
- Use a dedicated outlet for this unit.
  - 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 exclusive wire for the product. Use power cables of sufficient current carring capacity and rating.
  - 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.

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Thank you for purchasing the water cooled centrifugal chiller of LG Electronics.
Installation as instructed after reading this manual will ensure the safety, convenience and long lifetime of the unit.
Please read this manual carefully for the correct installation and proper operation of the centrifugal chiller.
Once the installation completed, please run the start-up test and inspect according to the operating & maintenance manual.
❊ This manual describes the introduction, control, start-up test, maintenance, and trouble shooting of the chiller.

CONTENTS

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2. INTRODUCTION

2-1. General Information

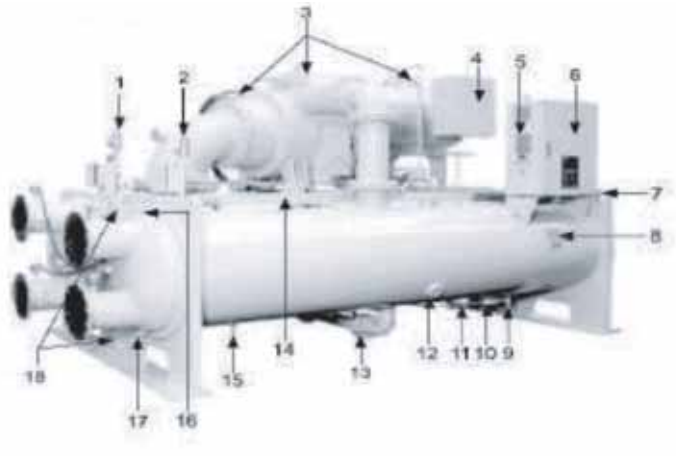
This manual describes the installation of water-cooled Single stage Centrifugal chiller using R-134a refrigerant and X30 controller applied.

2-2. System structure

Figure 1 shows the general parts location and components of the Single stage Centrifugal Chiller.

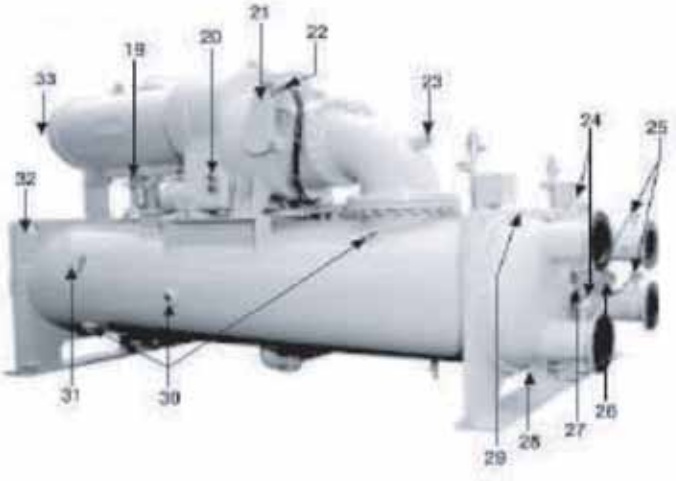
The location of control panel, type of water box, direction of inlet/outlet of the chilled/cooling water and some of the pipes may vary by model or the customer specifications. Please confirm with the approved drawings for the site.

Front view



1. Evaporator relief valve
2. Condenser relief valve
3. Lifting hole (Compressor)
4. Terminal box for compressor motor
5. Main name plate
6. Control panel
7. Lifting hole (Condenser)
8. Condenser name plate
9. Service valve
10. Filter dryer
11. Sight glass
12. Condenser sight glass
13. Refrigerant return line
    (Orifice + Butterfly valve)
14. Wire tray (optional)
15. Service valve
16. Air vent (for Cooling water)
17. Drain (for Cooling water)
18. Bracket for combining Heat exchanger

Rear view



19. Oil filter
20. Oil tank sight glass
21. Chain cover
22. Actuator (Guide vane)
23. Sight glass (Compressor inlet)
24. Chilled water temperature sensor
25. Cooling water temperature sensor
26. Cooling water differential pressure switch
27. Chilled water differential pressure switch
28. Drain (for Chilled water)
29. Air vent (for Chilled water)
30. Evaporator sight glass
31. Evaporator name plate
32. Lifting hole (Evaporator)
33. Sight glass (Motor)

Figure 1. Components of Single stage Centrifugal Chiller

2-3. Nomenclature

The nomenclature of the Centrifugal Chiller is as shown in the figure 2.

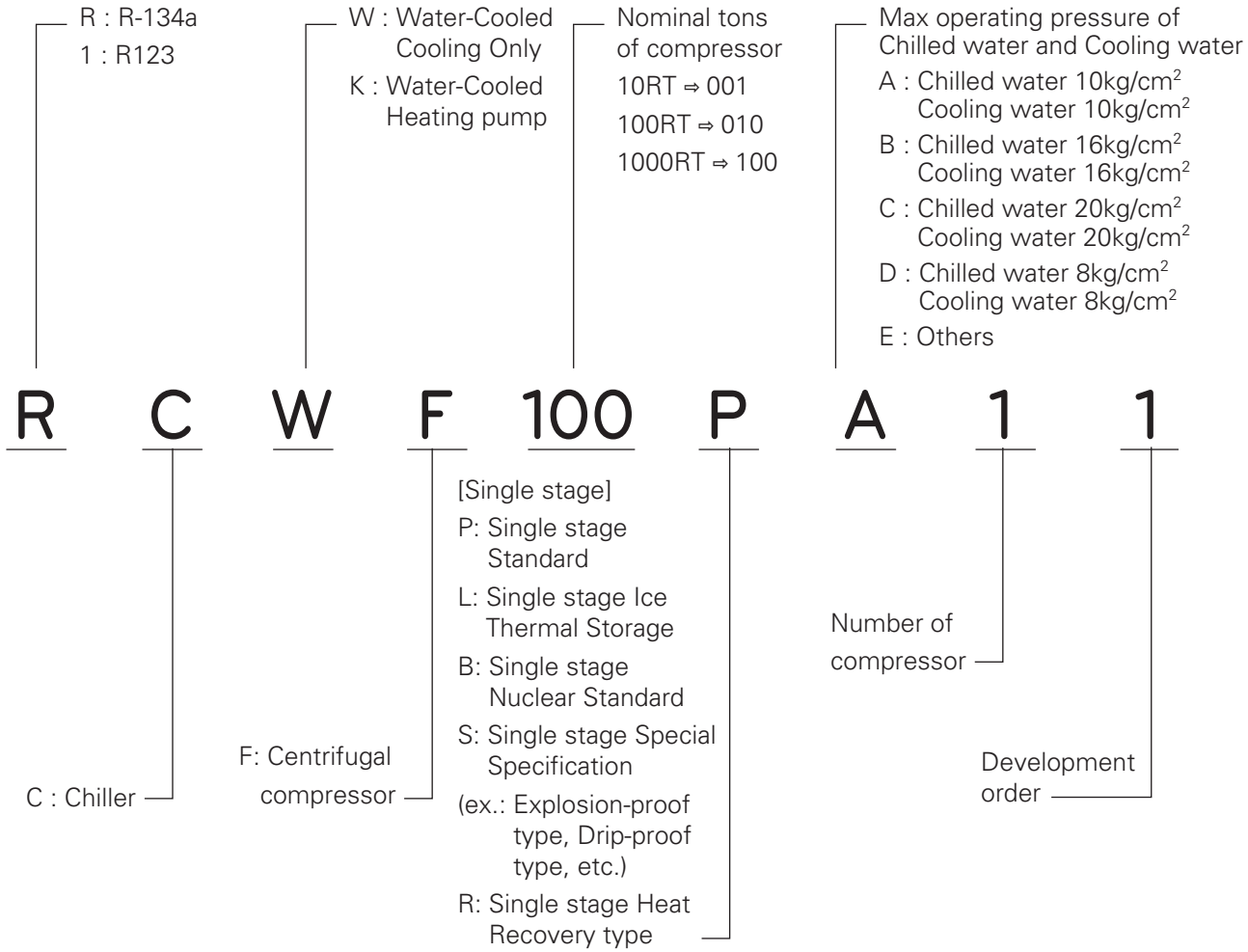


Figure 2. Nomenclature

2-4. Name plate

Name plate for the unit is attached on the right side of the control panel. General information of the product can be achieved from the plate, and the information can be used for quicker service later.

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

Fig. 3. Name plate

2-5. Main unit conversions

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

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3. STRUCTURE OF SINGLE STAGE CENTRIFUGAL CHILLER

3-1. Cycle of the chiller

Single stage Standard Centrifugal Chiller

Cycle of the Centrifugal chiller is generally used for reciprocating same form as a screw refrigeration cycle, uses a high-pressure refrigerant R-134a. In this cycle, as shown in the Figure 1-1, the low temperature and low pressure refrigerant gas vaporized from the evaporator goes through guide vane and taken into the impeller of the compressor. The amount of gas taken in at this time is adjusted by the opening of the guide vane to control the chiller capacity. The refrigerant gas taken into the impeller is compressed to high temperature and high pressure refrigerant gas, discharged to condenser, and condensed after losing heat by cooling water in the condenser heat transfer tubes. The condensed refrigerant liquid goes through the orifice and goes into the lower part of the evaporator, is distributed evenly through all length of the evaporator by the distribution plate, and is evaporated after taking heat from the chilled water flowing inside the evaporator heat transfer tubes, and the same cycle is repeated. Part of the refrigerant liquid over-cooled in the condenser flows through valve, filter, sight glass, and is separated and flows to motor cooling and oil cooling system. The refrigerant liquid that entered the motor is sprayed to cool down the motor coil and returns to the evaporator. The refrigerant flowing to the oil cooling system flows to the plate type heat exchanger (oil cooler), and the refrigerant leaving the heat exchanger returns to the evaporator.

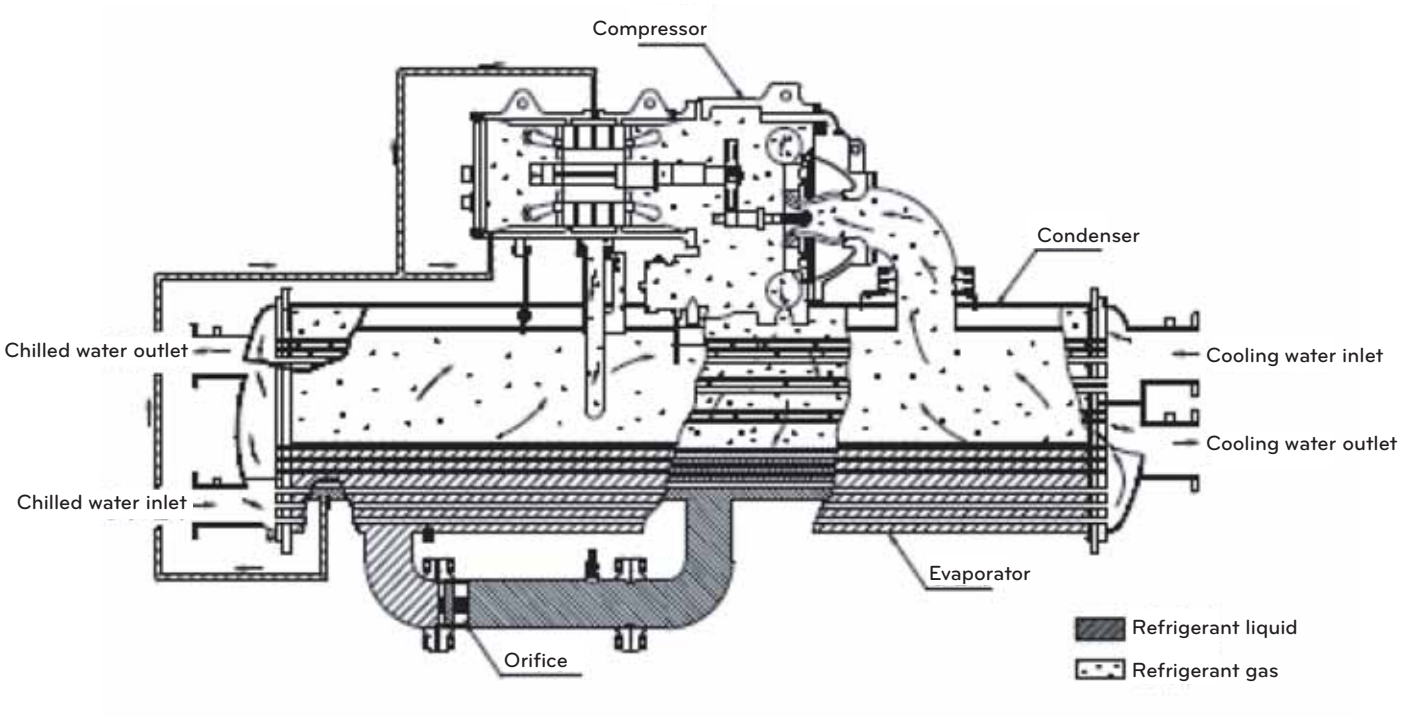


Fig 4. Single stage centrifugal chiller

3-2. Main components of the two stage centrifugal chiller

Compressor

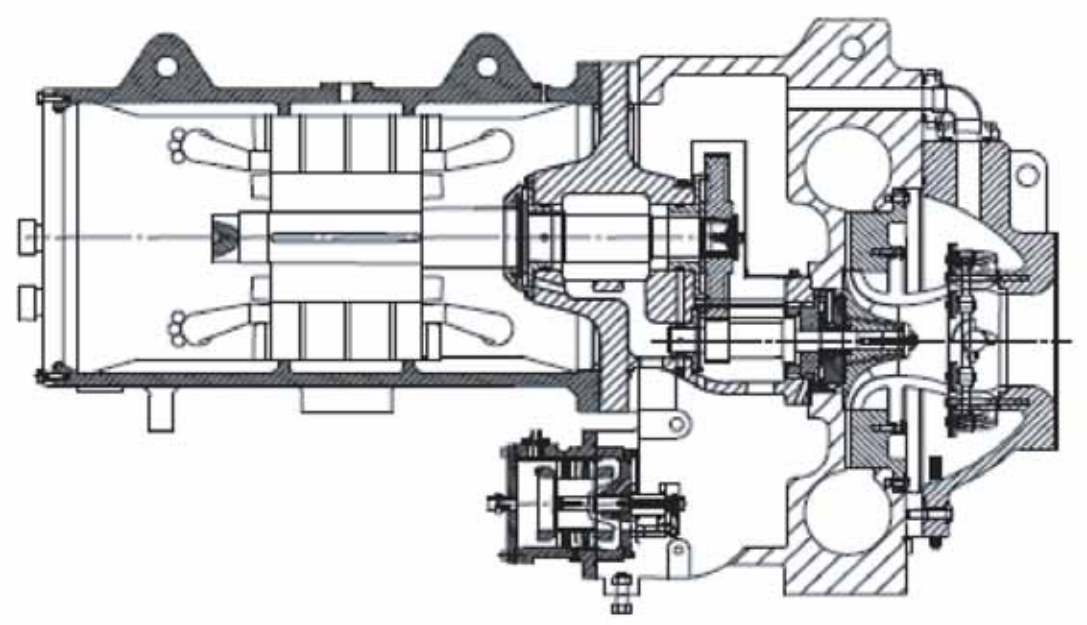


Fig 5. Hermetic single stage high-speed compressor

*The single stage turbo chiller compressor is composed of an impeller, bearing, diffuser, capacity control device and high-speed gear. The low temperature and low pressured gas taken from the evaporator, goes through impeller, diffuser and is finally discharged to the condenser as high temperature high pressure gas.

The characteristics of the main components are as follows.

1. Impeller
   - The vane of impeller designed aerodynamically based on the 3D fluid analysis, guarantees the reliability in any operational condition.
   - To minimize vibration, the impeller takes on the dynamic balancing work. It also guarantees the overall reliability of the impellers by taking the strength test, hardness test, and non-destructive test.
2. Bearings
   - Bearings are composed of a bearing in the motor axis, radial bearings and thrust bearings on the impeller axis.
   - Bearings are made of white metal to achieve persistence and corrosion resistance. It is designed to be used safely avoiding metal to metal contact during operation as the lubricating structure of Figure 8.
   - To increase the reliability of the journal bearings, Offset type and 3-Lobe type bearings are applied.
3. Capacity control device
   - It adjusts the refrigerant amount taken through the compressor inlet to adjust the capacity of the chiller, and it adjusts the opening of the vanes using the external actuator.
   - The amount of refrigerant taken in is adjusted according to the set of chilled water outlet temperature.

Heat exchanger

Heat exchanger of single stage centrifugal chiller is composed of two shell type for easy separation into evaporator and condenser. The tubes are arranged so as to maximize the heat exchanging ability. It is also designed so that the refrigerant can be spread evenly on all tubes for the sake of surge prevention and the COP decrease in part load operation. Efficiency increasing purpose sub cooler is adopted for the subcool of the condensed refrigerant.
A relief valve for an abnormal situation is at the upper part of the heat exchanger.

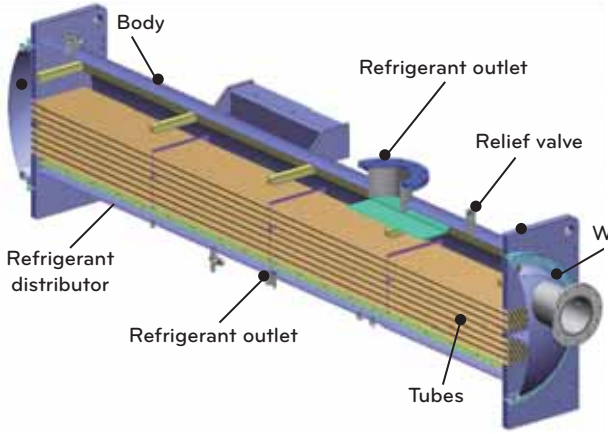


Figure 6. Evaporator

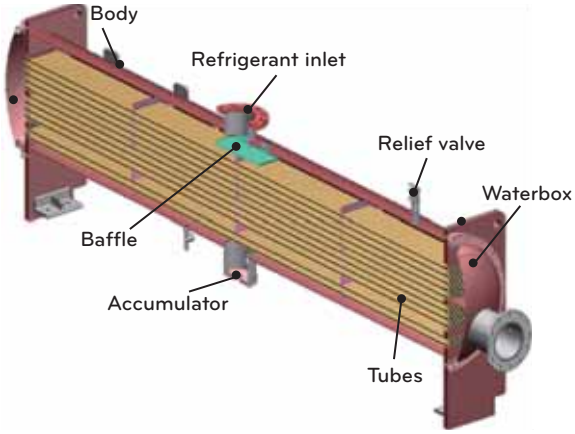


Figure 7. Condenser

Lubrication system

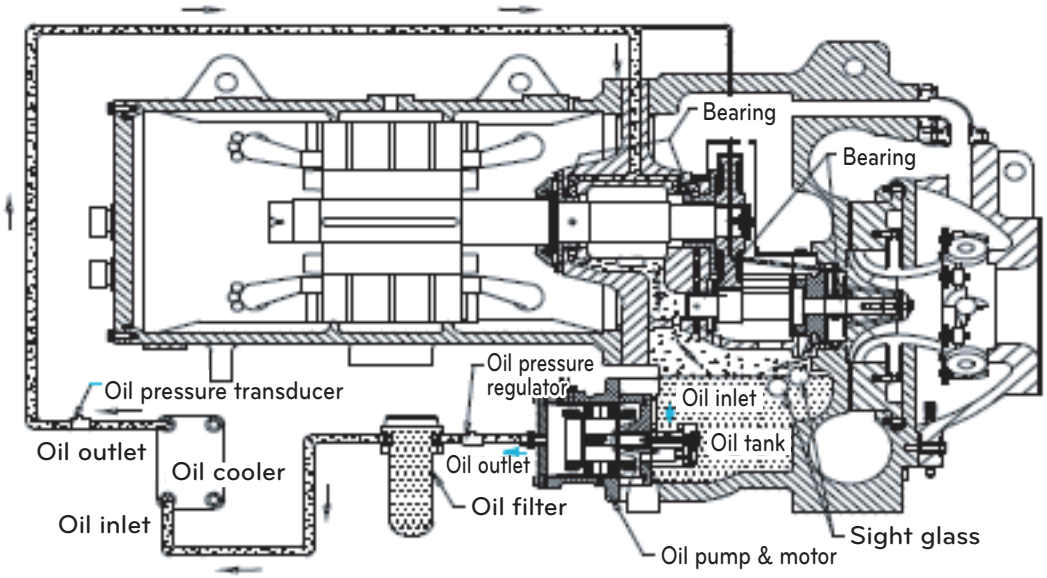


Figure 9. Lubrication cycle

Introduction

The discharged lubricating oil by the oil pump enters the oil filter to get rid of any unnecessary foreign substance. This oil becomes cooled to the temperature appropriate for operation condition after through the oil cooler, part of it directly enters gear and high speed side bearings, and the remainder directly enters motor shaft bearings. After the process, it will be drained into the oil tank. The above figure shows the lubrication system of single stage compression type.

Lubrication cycle

Lubricating oil is forwarded through the manual oil charge valve to the Lubrication System.
Oil level can be detected through a sight glass on the oil tank. During the operation, the level should be able to be detected at least from one of them.
The temperature of the oil tank is indicated on the control panel and its temperature range is 30~65 °C while operating. What the oil pump does is to transfer the oil from the oil tank to the system and the adequate pressure different would be 1.0 kg/cm^2 that is maintained by the oil pressure controller. The differential pressure can be seen on the control panel pressure gauge display by the differential pressure between oil tank and oil pump.

The oil pump also helps to send the oil to the oil filter. A valve is installed at the oil filter so that no need to drain the whole oil when replacing the filter only.
After the oil is sent to the oil cooler it is cooled by the refrigerant flowing from the condenser. The refrigerant cools the oil at the temperature between 40~60 °C.
A part of the oil flows through the thrust bearing and gear spray, whereas the rest lubricates the motor shaft bearings and the radial bearings. The oil temperature in the oil tank is measured by temperature sensor and displayed.
The timer automatically activates the oil pump for 120~180 seconds to maintain a constant pressure first before starting compressor. After the system has been shut down, 300~600 seconds lubricating is taken place after the compressor is stopped.

Oil reclaim system

Oil reclaim system provides the system to reclaim the oil from the heat exchanger and let it come back to the oil tank. Normally, it is reclaimed at the evaporator, and the vane housing. Refrigerant which came back into the oil tank will then be evaporated to the gas and flow through the DEMISTER line which is located at the upper part of the casing, and then it will be sent to the inlet of the compressor. Oil that is contained in the refrigerant is separated by the demister filter.

MAINTENANCE

Most of the lubrication related deficiencies in rotating parts of the chiller are because of the oil itself. If adequate viscosity, pressure and flow are not obtained, lubricating performance will decrease. Impure substances that are present in the oil also are a cause for the deficiencies.
Freon type refrigerant have chemical attraction with the oil. The viscosity changes according to the temperature and pressure of oil. We have designed the chiller with these problems into consideration.
An oil pump run by hermetic electro motor and a heater controlled by the controlling device are installed in the oil tank to prevent the trouble caused by the refrigerant inflow into the oil, decrease of the viscosity, damage of the pump caused by the cavitation (vaporizing of water and formation of bubbles as becoming partially low pressurized when water or flow at high speed) and the oil inflow into the refrigerant by forming. For these reasons the oil tank is maintained at a high temperature.
The reason to start the oil pump for certain while before the startup of the chiller, is to prevent the compressor's initial unsteady operation because the left over oil in bearings or in the oil line may contain significant amount of refrigerant flow in during the stoppage.
After the chiller has been shut down, oil pump will be operated until the compressor is totally stopped since the compressor rotates due to the internal force.
The only action that can be taken to prevent lubrication inferiority caused by blazing of the oil is replacing the oil itself. Thus when it is time for cooling operation, make sure that you do the oil replacing adequately.

Safety devices

For the sake of safe operation and the protection of the chiller, safety devices are ready as the next table.

No.	Safety Devices	Installation Location	Measurement Item	Description	Quantity
1	Chilled Water Temperature Low	Chilled water inlet nozzle	Chilled water inlet temperature	Chiller stops operation if the chilled water outlet temperature below 3°C to prevent freezing of the chilled water. Do not change this set value.	1
2	Evaporator Pressure Low (Temperature Low)	Evaporator shell	Vaporizing pressure (temp.)	If the pressure inside of evaporator reaches below of the following table, then the chiller stops operation. (Based on the design temperature 43 °C) Standard setting value: 1.95kg/cm^2	1
3	Condenser Pressure High (Temperature High)	Condenser shell	Condensing pressure (temperature)	If the pressure inside of condenser reaches above of the following table, then the chiller stops operation.(Based on the design temperature 43 °C) Standard setting value: 10.00kg/cm^2	1
4	Motor Temperature High	Motor coil	Motor coil temperature	To prevent the motor of the compressor, temperature sensors were installed on each phase of coil and when the temperature exceeds 90°C, the chiller stops operation.	3
5	Compressor Temperature High	Compressor outlet	Compressor discharge temperature	If the discharging gas temperature of the compressor exceeds over 70°C, the chiller stops operation.	1
6	Bearing Temperature High	Thrust bearing	Bearing temperature	Temperature sensor is installed on the thrust bearing that holds the impeller's thrust. Chiller will stop operation if the temperature exceeds 85°C.	1
7	Oil Differential Pressure Low	Oil tank, oil pump outlet	Differential pressure of supplied and intake oil pressure	If the differential pressure between the oil pressure supplied to the bearing and the oil pressure in the oil tank is below 1.0 kg/cm^2, the chiller will stop the operation.	1
8	Oil Temperature High	Oil tank	Oil temperature inside of oil tank	The chiller will stop if the oil temperature in the oil tank is above 74°C.	1
9	Oil Temperature Low	Oil tank	Oil temperature inside of oil tank	The temperature should be over 30°C as an initial operating condition to enable the chiller to operate.	1
10	Chilled Water Pump Abnormal	Chilled water header	Chilled water head loss	The chiller will stop if the head loss of the chilled water flow passing through the evaporator tubes decreases so much that the loss head becomes lower than the standard.	1
11	Cooling Water Pump Abnormal	Cooling water header	Cooling water head loss	The chiller will stop if the head loss of the cooling water flow passing through the condenser tubes decreases so much that the loss head becomes lower than the standard.	1
12	Current Limiting Function	Control panel	Current	It is a controlling function of Motor Amps that can be set freely in the range of 40 ~ 100% to adjust the current load to the motor of compressor.	1
13	Moisture Indicator	Refrigerant supply pipe	Moisture in the refrigerant	The moisture indicator changes the color depending on the amount of moisture in the refrigerant. When there is no moisture it will be green, but if not it will be yellow. It is the time to change into a new filter if you can see the yellow color.	1

No.	Item	Installation Location	Measurement Item	Description	Quantity
14	Relief Valve	Evaporator & condenser shell	Relief valves	To prevent the accident by unexpected fire, and so on which can cause pressure increase in the chiller, the relief valve will be operated and exhaust the refrigerant into the air if the pressure exceeds more than the standard. If the chiller is used in a closed environment, please install a pipe that starts from the relief valve to the outer air.	1
15	Vane Full Close Interlock	Vane motor	Operability of temperature sensors	To minimize the starting current, it is a function to enable the compressor to operate only after full close of the guide vane installed at the inlet of the impeller.	1
16	Temperature Sensor Abnormal	6 locations including chilled water nozzle	Each temperature sensor	It alarms when temperature sensor is not connected or due to the sensor's own flaw.	1
17	Pressure Sensor Abnormal	4 locations including Evaporator shell	Each pressure sensor	It alarms when pressure sensor is not connected or due to the sensor's own flaw.	1
18	Overload relay	Control panel	Current	If overload is imposed on compressor motor or oil pump motor, it stops the motor.	1
19	Hot Gas Bypass Valve	Evaporator shell, Condenser shell	Guide vane / hot gas valve opening	It prevents frequent start ups at low load, and hot gas bypass valve opens proportionally when vane becomes 30% or lower. At this time, hot refrigerant gas of condenser goes to evaporator and makes certain chiller load to prevent surge and to prevent frequent startup stop of the chiller.	1

Table 3. Safety devices

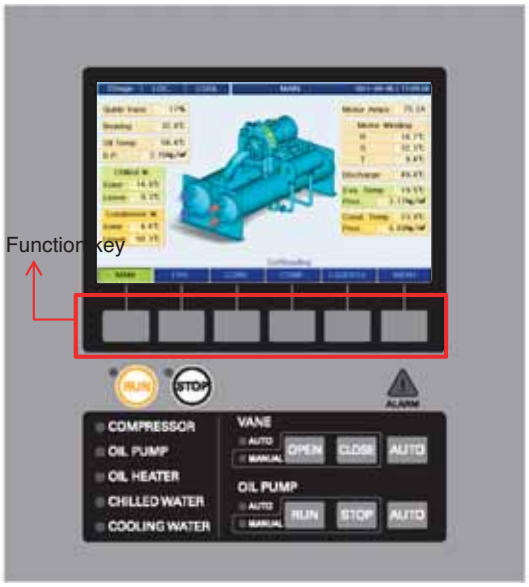
ENGLISH

4. CONTROL SYSTEM

4-1. Components of control panel and main parts

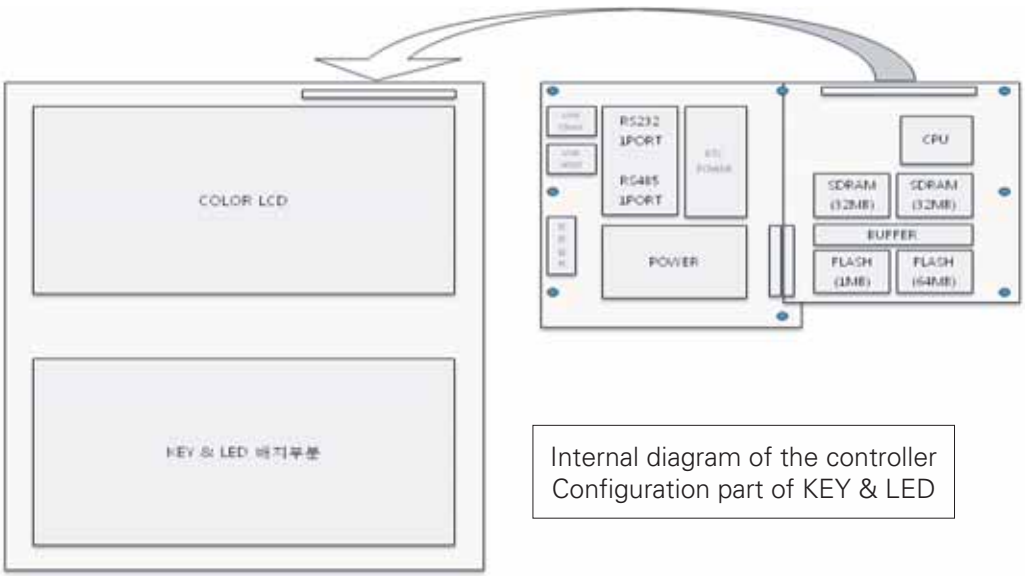
Controller

HMI with 7 inch Color LCD display is composed of graphical interface.
There are lamp keys for run/stop, vane and oil pump, compressor, oil pump, oil heater operation and cooling/chilled water flow.
There is "Function Key" at the bottom of the screen that changes the features according to the current screen to be able to access to the selected sub menu.



Front view of the controller

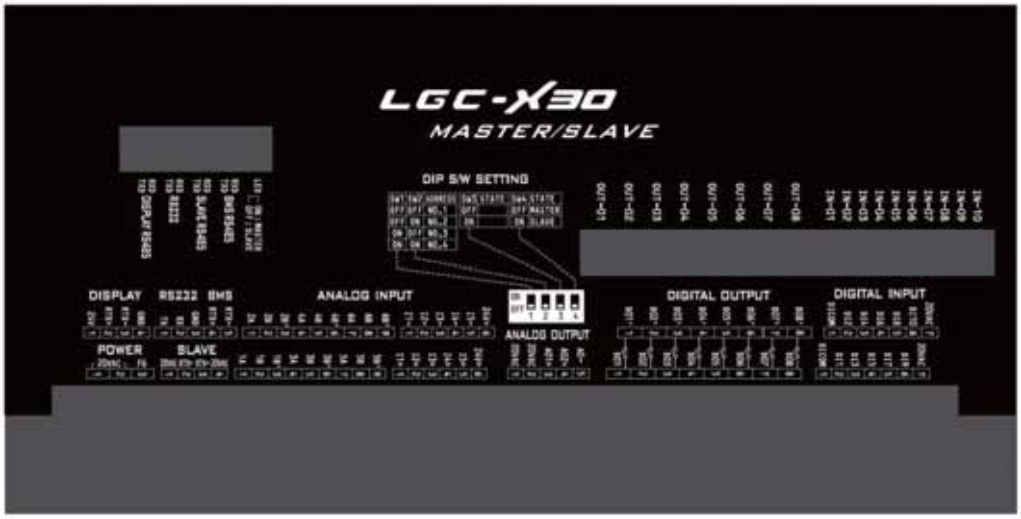
Rear view of the controller



Internal diagram of the controller
Configuration part of KEY & LED

Fig 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, digital input/output connected via RS232, RS485 communication connections is available along with the analogue input/output.



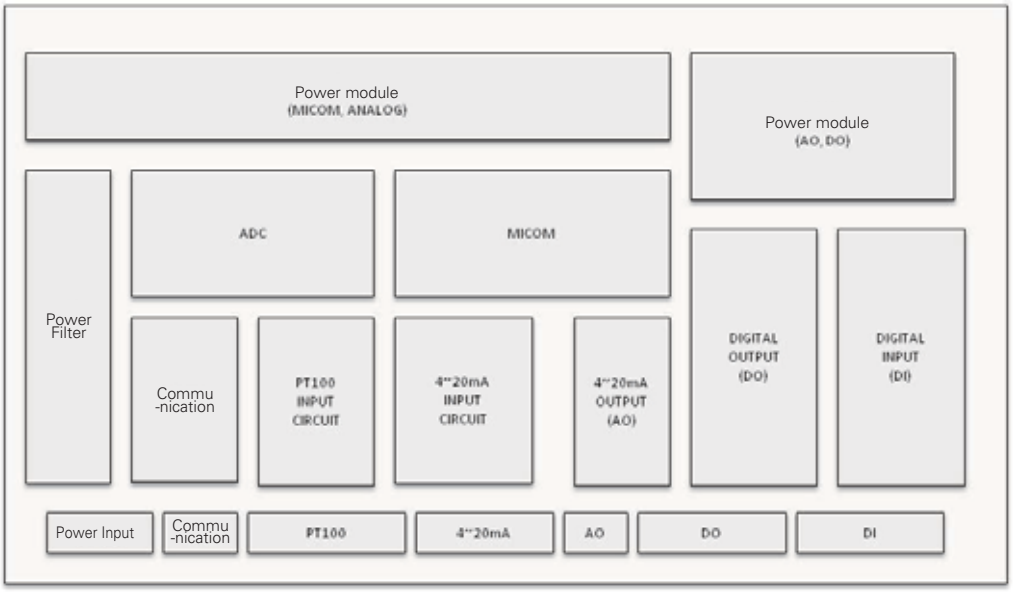


Figure 11. Internal diagram of master/slave board

Controller system diagram

Master, slave, HMI, Relay board communicates via RS485. On either one of master or slave board have 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.

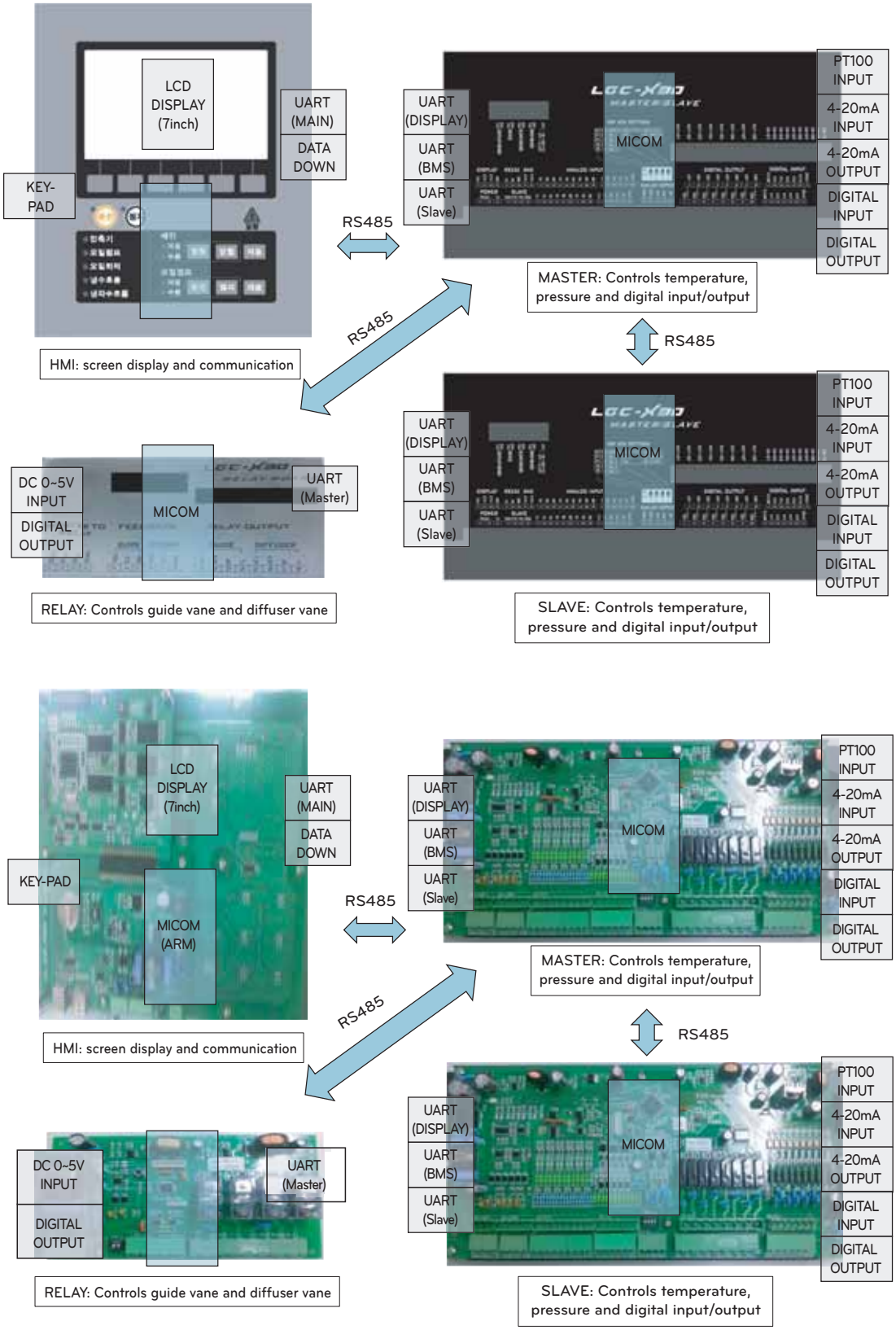


Fig 12. Controller block diagram

Other control parts

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

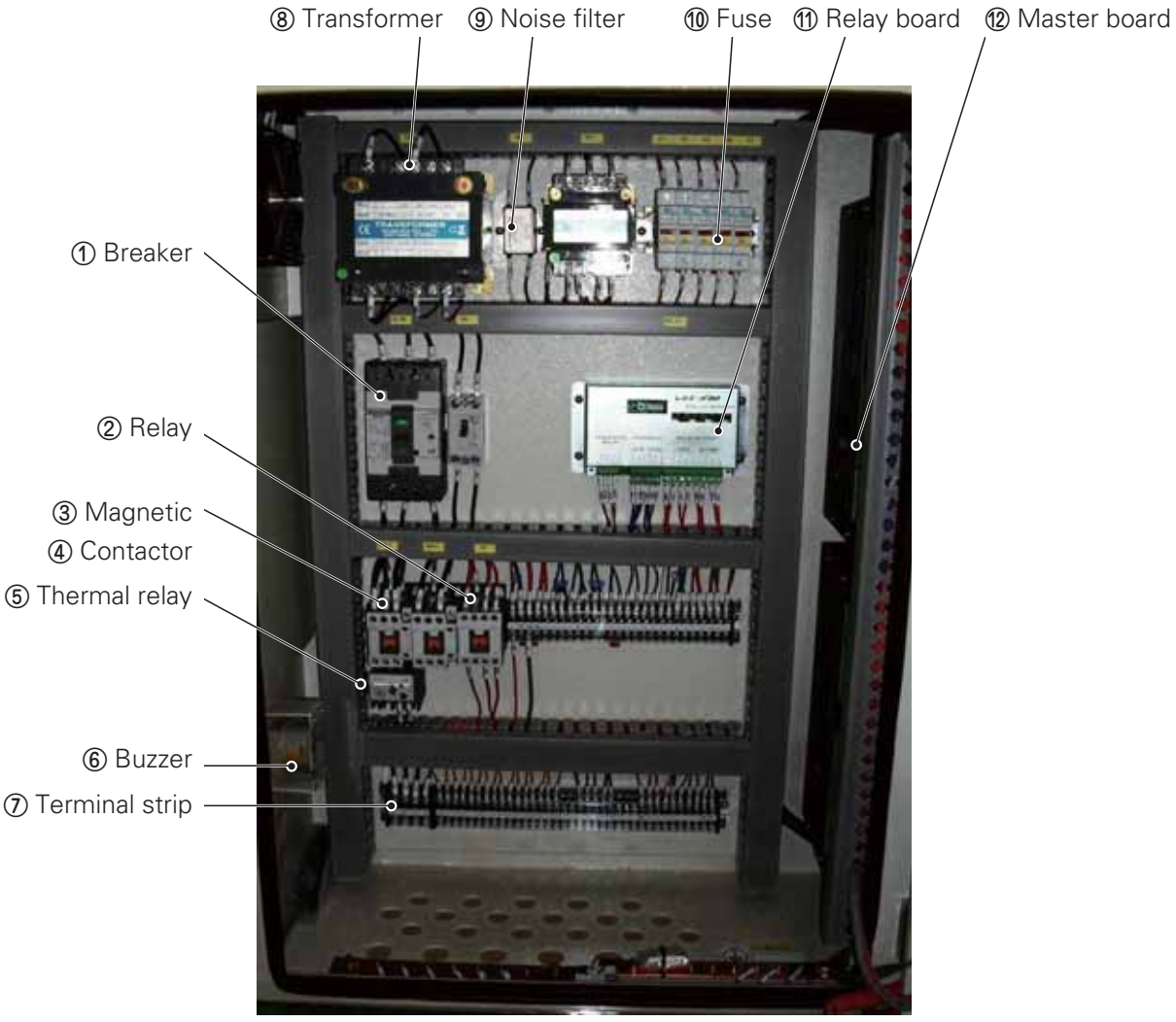


Fig 13 Control system.

※ The above configuration may be changed for the sake of the improvement of design, product or user convenience. Thus, please refer to the approved drawings for details.

Optional parts related controller

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 finished Power-on test, and in normal operating
	Maintaining On/Off	Error, Press the reset button or turn off power & reboot.
ETX ERX ELK	LED on at Ethernet Line	ELK is always on when LAN cable is connected. ERX flashes on data reception. ETX flashes on data transmission.

Table 4. Lamps on the converter

4-2. Components of starter panel and main parts

Starter panel

It is the electric panel for start-up of compressor motor of centrifugal chiller and the motor protection. It has the protective functions for the current short-circuit and over load.
During the motor start-up, it decreases the current for motor start-up by decreasing electricity consumption of the electric facility. Starter panel has various configurations according to start-up type, high/low voltage power, options, etc. Thus, refer to the drawing supplied together with the product for the configuration of the starter panel.

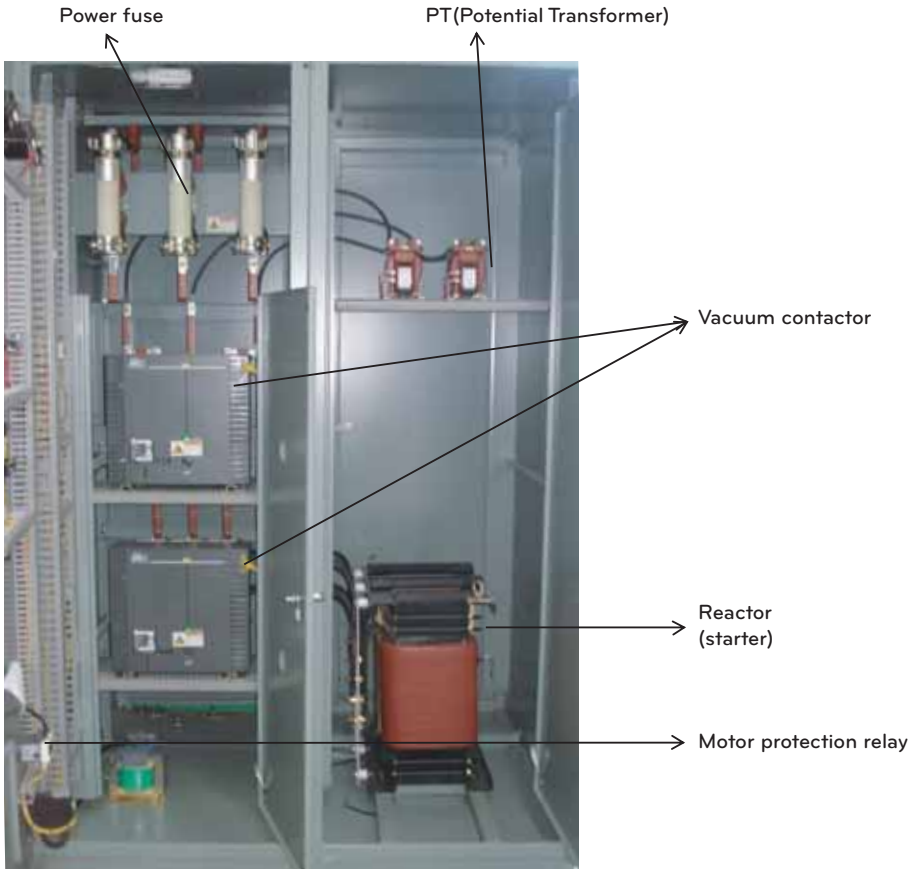


Fig 15. 6600V reactor start-up type

❊ The above configuration may change for the sake of design enhancement, model type, or user convenience. Thus, please refer to the approved drawing for details.

4-3. Basic control algorithm

Unique P(proportional), I(integral), and D(differential) algorithms applied to chilled water temperature control, and compared to the existing method, it enabled optimal control by minimizing time to approach the target value, remaining deviation, Under-shoot and Over-shoot during initial start-up and automatic/manual conversion of vane operation.

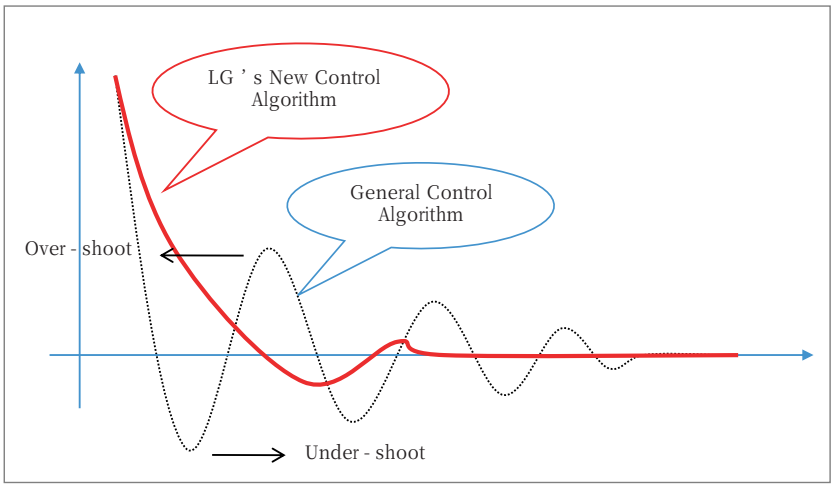


Fig 16. Control algorithm

- Soft loading
  - Approach to the control target value with Soft start-up
  - Solved unnecessary stops due to rapid guide vane opening during start-up

- Advanced control
  - Advanced high class control algorithm development for high precision compared to the existing PID control method
  - Prevention of Temperature Cycling due to Overshoot/Undershoot during the conversion from manual to automatic mode
  - Intensive safety control by executing preventive control before chiller reaching abnormal stop point, minimize unnecessary stops of the chiller.

4-4. 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(option)
- Protocol
  - Basic: MODBUS
  - Option: BACnet, TCP/IP

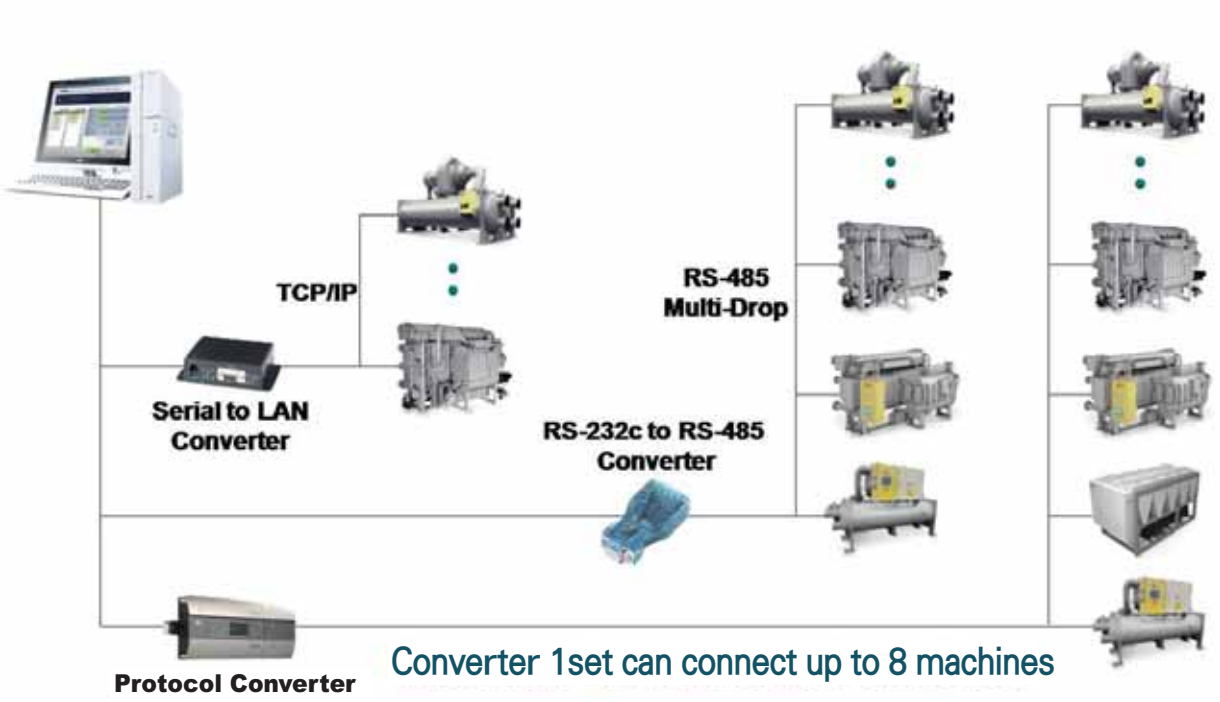


Fig 17. Detail diagram of BMS

4-5. Control Screen (Product function)

Controller Menu Configuration

• User setting

User setting	Refrigerant level setting	System Information (Output)	Account management
Running Mode setting	ECO Refrigerant level setting	Ice Making mode selection	Management No. 1
Control Mode setting	ECO Refrigerant level P	Remote Selection display	Management No. 2
Chilled water outlet temperature	ECO Refrigerant level I	Chilled water Pump operation	Management No. 3
Ice Making outlet temperature	ECO Refrigerant level dead band	Cooling water Pump operation	System Setting Password
Chilled water temperature P	ECO Refrigerant level valve initial value	Cooling Tower Fan 1 operation	Operation Remaining time
Chilled water temperature I	CON Refrigerant level setting	Cooling Tower Fan 2 operation	Chilled water inlet temperature.
Chilled water temperature D	CON Refrigerant level P	Cooling Tower Fan 3 operation	Chilled water outlet temperature
Automatic Operation temperature (set value +)	CON Refrigerant level I	Cooling Tower Fan 4 operation	Cooling water inlet temperature
Automatic Stopping temperature (set value -)	CON Refrigerant level dead band	Hot Gas Valve	Cooling water outlet temperature
Antifreeze Operation function	CON Refrigerant level valve initial value	Inverter	Evaporator temperature
Antifreeze Operation temperature		Oil Heater Run	Condenser temperature
Motor Current limit	Manual operation	Oil Pump Run	Evaporator pressure
Guide Vane Upper Limit	Vane opening	Buzzer	Condenser pressure
Hot gas setting (Guide vane %)	Diffuser opening	Operation Status display	Chilled water flow normal contact
Hot gas upper limit setting	Hot gas opening	Warning Status display	Cooling water flow
Hot gas lower limit setting	ECO valve manual	Display of Abnormal Status	Remote temperature setting *
Cooling water inlet temperature	CON valve manual	Compressor Operation Status	Hot Gas Valve AO *
Cooling water temperature P		Vane Opening	VFD AO *
Cooling water temperature I	System Information (Input)	Diffuser Opening	Motor Bearing temperature *
Cooling water temperature D	Ice Making mode selection		Heat Recovery temperature
	Remote Run/Stop signal	System Information (Timer)	Compressor Discharge temperature
Dual Mode setting	Refrigerant temperature low contact	Chilled water Pump Stop Delay Timer	Oil temperature
Lead/Lag Conversion Method selection	Condenser Pressure high contact	Cooling water Pump Start-up Delay Timer	Bearing temperature *
Lead/Lag Conversion Time selection	Chilled water Flow normal contact	Cooling water Pump Stop Delay Timer	Motor Winding temperature (R) *
LAG Start-up Load (current %)	Cooling water Flow normal contact	Flow Chattering Ignore Timer	Motor Winding temperature (S) *
LAG Start-up Delay time	Chilled water Pump interlock	VGD control Delay Timer	Motor Winding temperature (T) *
LAG Stop Load (current %)	Cooling water Pump interlock	Oil Circulation timer before Run	Oil Tank Pressure *
LAG Stop Delay time	Key Lock	Oil Circulation timer after Stop	Oil Pump Pressure
	Input 10	Oil Pressure Check Timer	Current
Scheduled operation setting	Bearing temperature high contact	Vane Close Timer at Start-up	Voltage *
Scheduled Operation Pattern setting (Run)	Motor Winding temperature high contact	Vane Close Timer at Stop	Power *
Scheduled Operation Pattern setting (Stop)	Oil Pump Overload contact	Vane Open Delay timer	Guide Vane AO *
Scheduled Operation Pattern setting (Temperature)	Vane Closing contact	Compressor Start-up Check Timer	Diffuser Vane AO *
Scheduled Operation Pattern setting (Current)	Compressor Motor Power Normal	Anti-Recycle Timer	Vibration sensor *
	Compressor Start-up check		Compressor discharge temperature 2
System Information	Starter Abnormal		Oil temperature 2
Input Status check	Diffuser Manual		Bearing temperature 2
Output Status check	Diffuser Manual close		Motor Winding temperature (R) 2 *
Timer Check	Diffuser Manual open		Motor Winding temperature (S) 2 *
Operation data saving period			Motor Winding temperature (T) 2*
Communication ID (machine number)			Oil Tank Pressure 2 *
Baud rate			Oil Pump Pressure 2
Language			Current 2
Temperature unit selection			Voltage 2 *
Pressure Unit selection			Power 2 *
Flow Unit selection			Guide Vane AO 2 *
LCD brightness control			Diffuser Vane AO 2 *
			Relay 1
			Relay 2

• User setting

Control Information Setting	Abnormal Condition Setting	Sensor correction	Sensor set
Ice Making mode	Chilled water temperature Lower Limit	Chilled water Inlet temperature	Evaporator Pressure Sensor
Control Calculation Period	Oil Differential Pressure Lower Limit	Chilled water Outlet temperature	Condenser Pressure Sensor
Control temperature Dead band	Oil temperature High	Cooling water Inlet temperature	Chilled water Flow
Oil temperature Low Limit at Start-up	Compressor Discharge temperature High	Cooling water Outlet temperature	Cooling water Flow
Oil Heater on temperature	Bearing temperature High	Evaporator temperature	Remote temperature Setting Signal
Oil Heater off temperature	Motor winding temperature High	Condenser temperature	Hot gas Valve
Restart after Power failure	Evaporator Refrigerant temperature Low	Evaporator pressure	VFD
Motor rated Current	Evaporator Pressure Low	Condenser Pressure	Oil Tank Pressure Sensor
Motor rated voltage	Condenser Pressure High	Chilled water Flow	Oil Pump Pressure Sensor
Model Selection	Motor Voltage Lower Limit	Cooling water Flow	Current Sensor
Operation Time Limit	Vibration Upper Limit	Remote temperature Setting	Voltage Sensor
Guide Vane Control Dead band		Compressor Discharge temperature	Power Sensor
Diffuser Vane Control Dead band	Safety control setting	Oil temperature	Guide Vane AO
VFD Calculation Period	Soft Loading Output Period	Bearing temperature	Diffuser Vane AO
Cooling Tower PID Calculation Period	Soft Loading Valve Output	Motor Winding temperature (R)	Diffuser Opening
Refrigerant Valve Usage Setting	Soft Stop Vane Opening	Motor Winding temperature (S)	Option Setting Mode
ECO Refrigerant Valve Calculation Period	Bearing temperature High Prevention	Motor Winding temperature (T)	Guide Vane Min.
CON Refrigerant Valve Calculation Period	Motor Winding temperature High Prevention	Oil Tank Pressure	Guide Vane Max.
Refrigerant Valve Control Dead band	Motor Voltage Low Prevention	Oil Pump Pressure	Guide Vane AD value
	Compressor Discharge temperature High Prevention	Current	Minimum Value Setting / Maximum Value Setting
Timer Setting	Evaporator Refrigerant temperature Low Prevention	Voltage	Diffuser Vane Minimum
Chilled water Pump Stop Delay Timer	Evaporator Pressure Low Prevention	Power	Diffuser Vane Maximum
Cooling water Pump Start-up Delay Timer	Condenser Pressure High Prevention	Compressor Discharge temperature 2	Diffuser Vane AD Value
Cooling water Pump Stop Delay Timer	Surge Pressure High Level Setting	Oil temperature 2	Minimum Value Setting / Maximum Value Setting
Flow Chattering Ignore Timer	Surge Pressure Low Level Setting	Bearing temperature 2	Oil Tank Pressure Sensor 2
VGD Control Delay Timer	Surge temperature High Level Setting	Motor Winding temperature (R) 2	Oil Pump Pressure Sensor 2
Oil Circulation timer before Run	Surge temperature low level Setting	Motor Winding temperature (S) 2	Current Sensor 2
Oil Circulation Timer after stop	Surge Detection Current Change Amount	Motor Winding temperature (T) 2	Voltage Sensor 2
Oil Pressure Check Timer	Surge Occurrence Detection Time	Oil Tank pressure 2	Power Sensor 2
Vane Close Timer at Start-up	Surge Occurrence Detection Count	Oil Pump pressure 2	Guide Vane AO 2
Vane Close Timer at Stop	Vibration Upper Limit Prevention	Current 2	Diffuser Vane AO 2
Vane Open Delay Timer	Liquid Intake Prevention Excessiveness	Voltage 2	ECO Valve Manual
Compressor Start-up Check Timer		Power 2	CON Valve Manual
Anti-Recycle Timer			Offset Setting Mode
			Guide Vane Minimum
			Guide Vane Maximum
			Guide Vane AD Value
			Minimum Value Setting / Maximum Value Setting
			Diffuser Vane minimum
			Diffuser Vane maximum
			Diffuser Vane AD value
			Minimum Value Setting / Maximum Value Setting

Controller Menu Configuration

Controlling menu and the names of control panel part

Two Stage centrifugal chiller control device display has the basic screen that can check the current operation status, main menu for user to conveniently use two Stage centrifugal chiller such as user setting, problem/caution information, etc., and system menu for sensor setting, system related setting.

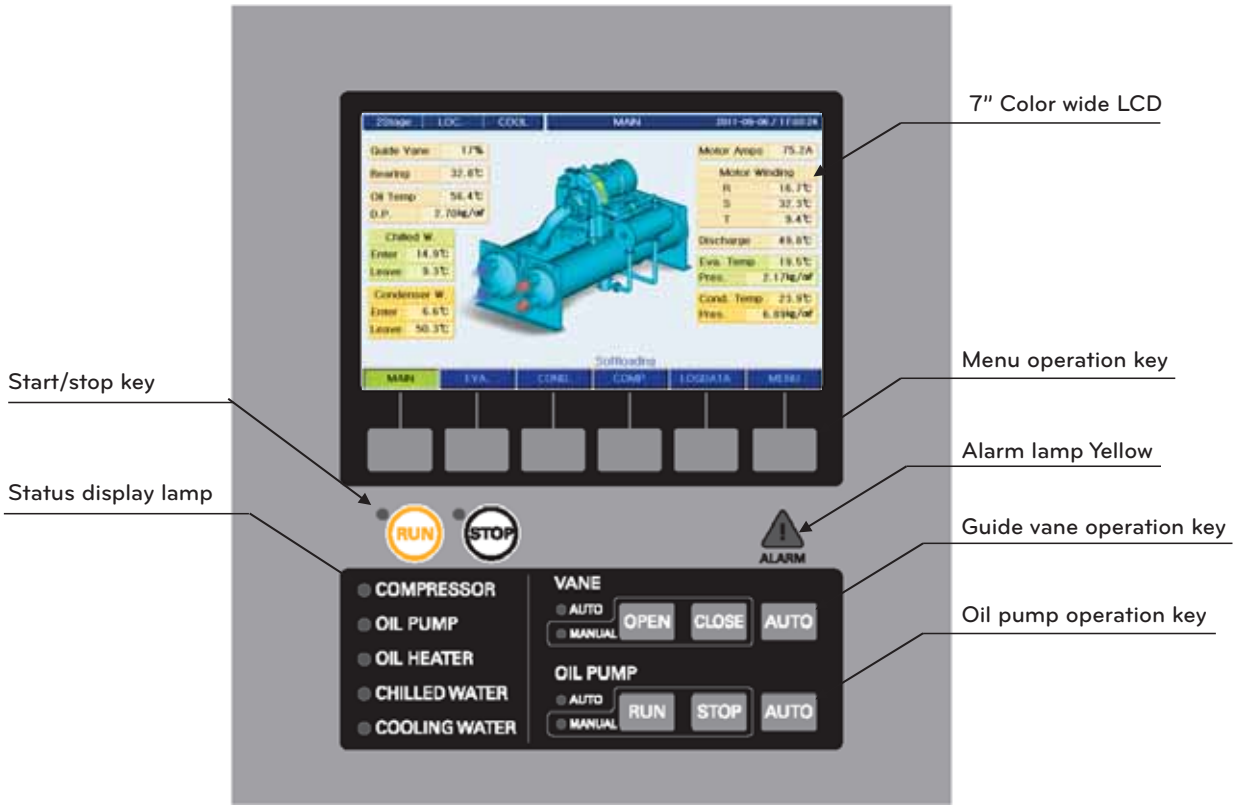


Fig 18. Front side of controller

CAUTION

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

Names of control part

Name	Description
LCD screen	It is the LCD screen displaying the operation information and the status of the chiller in text (Korean, English and Chinese) or graphical animation.
Menu Control Key	These are keys are for selecting the menu on the screen such as selection of sub-menu and operation conditions. The functions keys shown at the bottom of the LCD screen changes depending on the selected screen.
Guide vane manual control key	It opens and closes the guide vane manually.
	Manual control of the guide vane is possible only when the Vane Manual indication light is on.
	Open/Close key- operates only while pressed.
Oil Pump Manual Control Key	It is to run and stop the oil pump manually.
	Manual control is possible only when the Oil Pump Manual lamp is on. To enable the manual control, it has to be pushed for approximately 1.5seconds.
Alarm Lamp	It is activated on the condition of abnormality or cautious status.
	If this is activated, an alarm message explaining the status is displayed on the message line. When alarm is activated, 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 cause of the abnormality is taken care of, the message will also be disappeared.
Run/Stop key	It is the key to run and stop the chiller.
	To activate this button, it must be pressed for more than 1.5 seconds. During the chiller operation “Run” lamp is on, and when stopped “Stop” lamp on.
Status Indicating Lamp	These display the status of operation of the chiller and the devices attached on the chiller such as oil pump, oil heater and the flow condition of chilled & cooling water.

Table 5. Names of operation part

Names of Color LCD screen display part

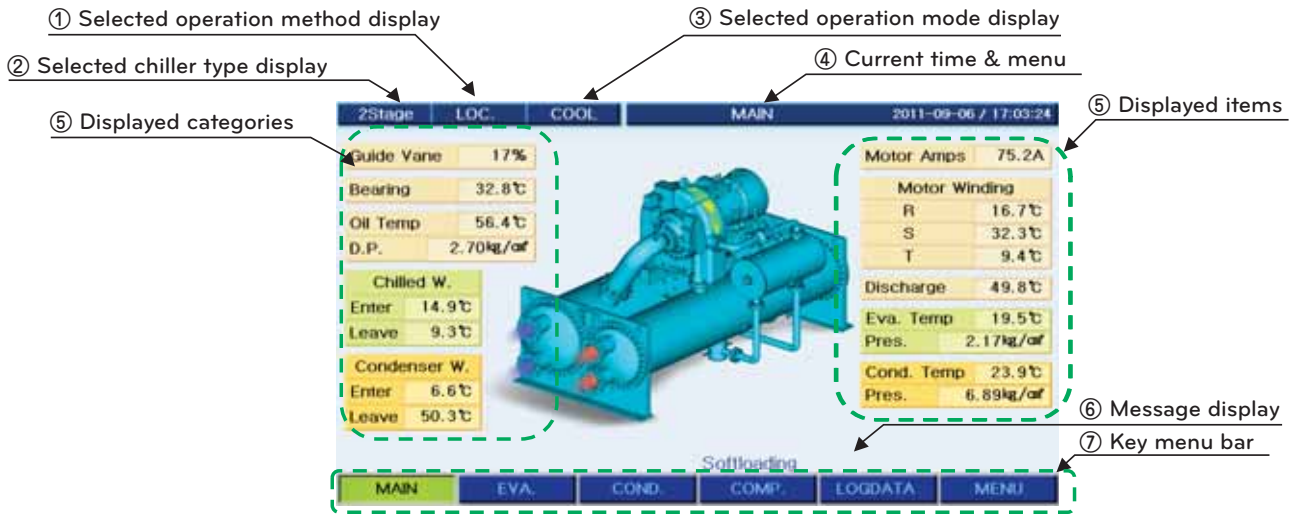


Fig 19. LED screen diagram

① Selected operation method display
There are Local, Schedule and Remote modes selecting how to operate the chiller. That is, Local is to operate the chiller at the local place where the chiller is, Schedule to operate on the scheduled time and Remote to operate in a remote place. It indicates the current operation mode on the screen.

② Selected chiller type display
Chiller type can be selected among R134a 2 stage, R134 and R123.
(When one is selected, it automatically resets the main board, and changes to the selected chiller type mode.)

③ Selected operation mode display
There is only a cooling mode for the air-conditioning chillers. Thus only Cooling mode will be displayed. If it is the chiller for low temperature, it will display Cooling and Icing according to the setting. (Refer to the user setting of main menu and control mode)

④ Current time display
It displays the current year, month, day, day of week, hour, and minute information.

⑤ Displayed items
It displays current operation temperatures, pressures and other current status information of the parts with sensors.

⑥ Key menu bar
It displays the functions of menu control keys.

⑦ Message Display
It displays Run/Stop, operation condition, problem/caution, etc.

ENGLISH

Basic Screen

It is the screen displaying input values and calculated output status value of each sensor attached to the main body of the chiller. When power on the controller, it is displayed as default screen initially.

1) Main

- It shows animation screen and related DATA of the entire chiller.
  - Route : MAIN

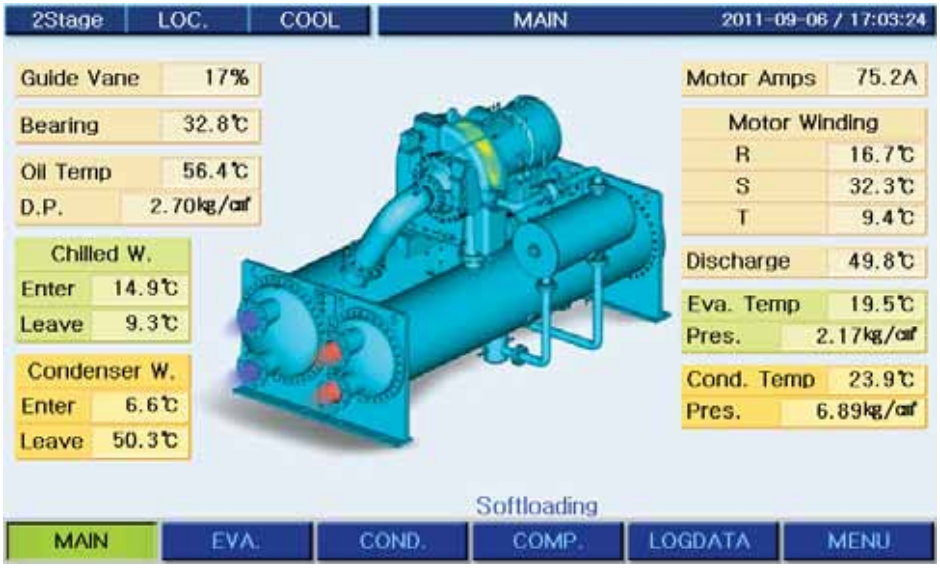


Fig 20. Main screen

2) Evaporator

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

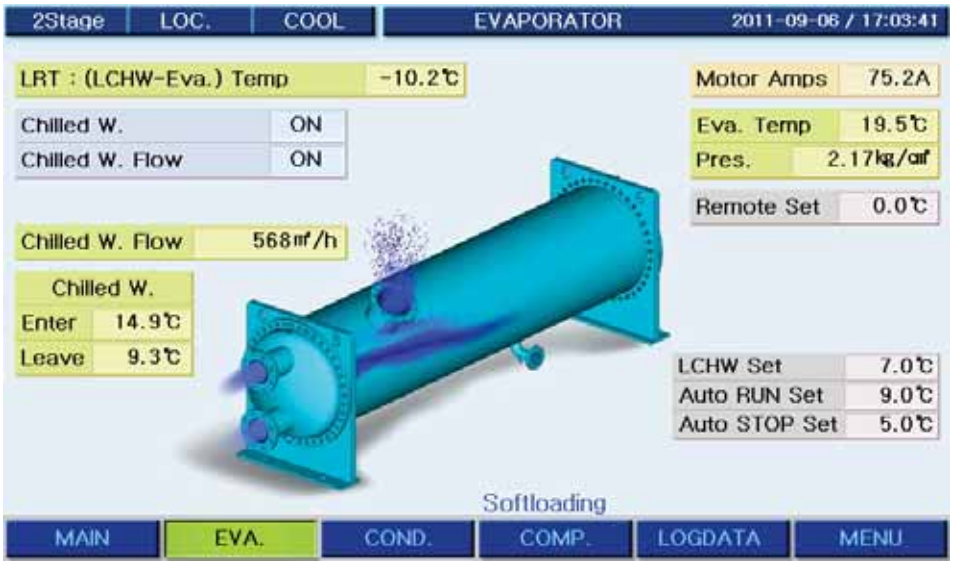


Fig 21. Screen of Evaporator

3) Condenser

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

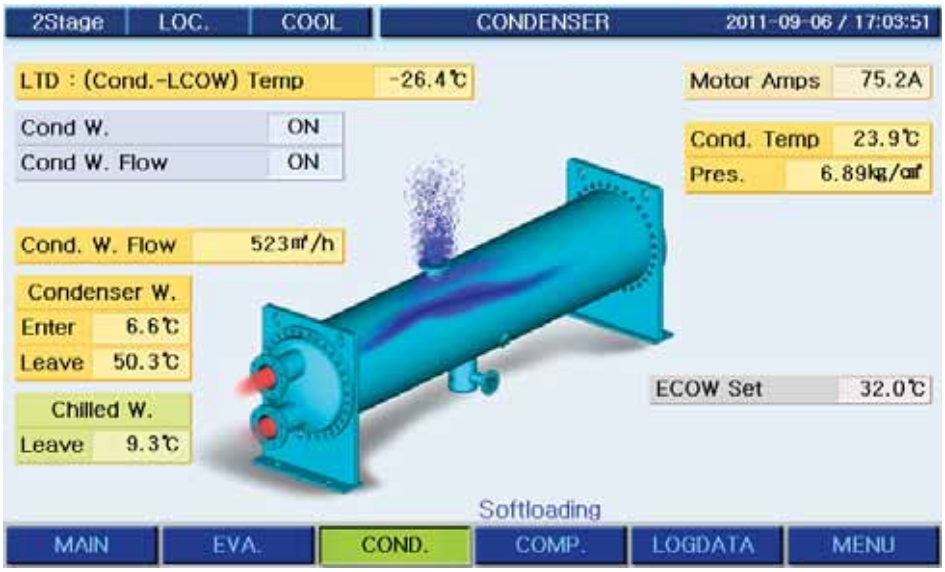


Figure 22. Screen of Condenser

4) Compressor

• It shows animation screen and related DATA of the compressor.
- Route : COMP.

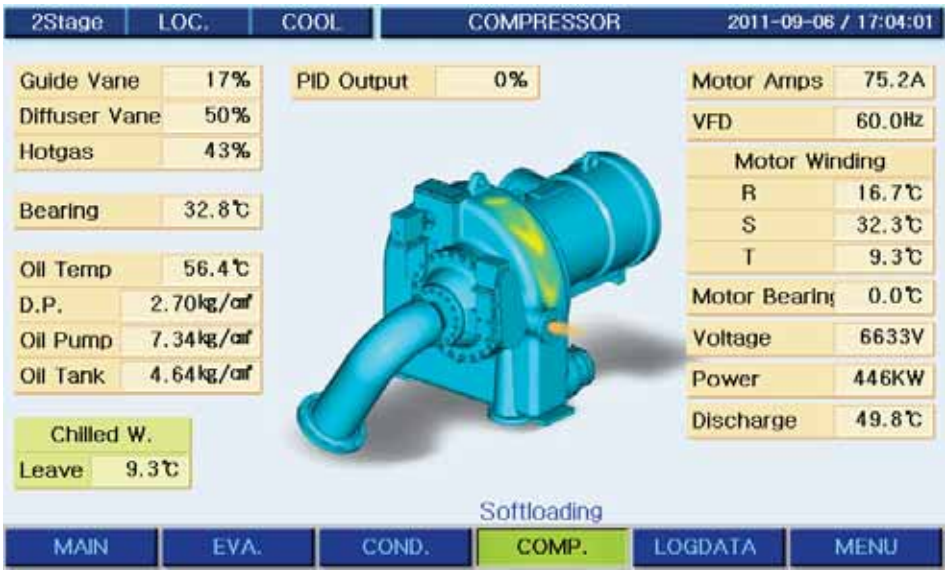


Figure 23. Screen of Compressor

5) History

• It shows operation information, operation history and error history DATA.
- Route : LOGDATA

Figure 24. Screen of Operation History

6) Menu

• It shows the menu screen.
- Route : MENU

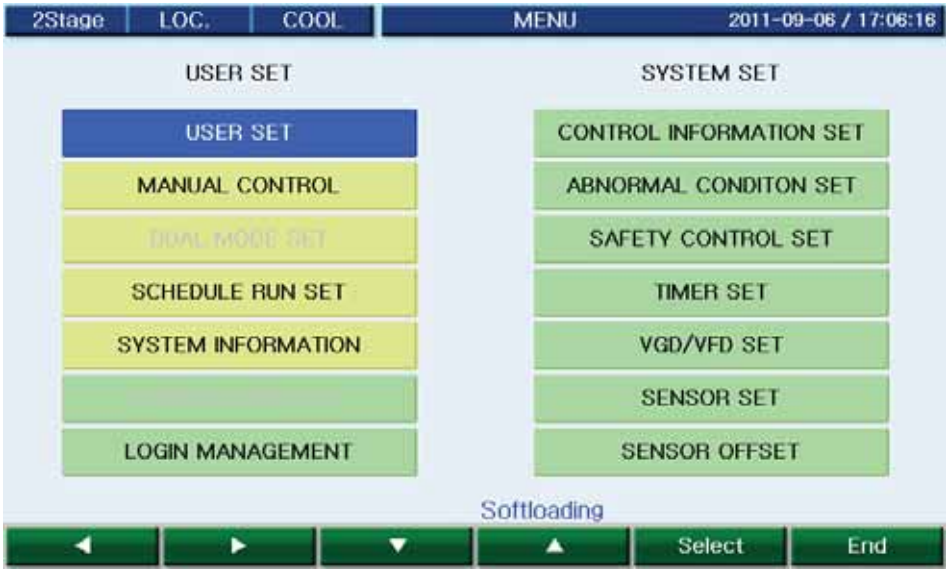


Figure 25. Menu screen

Screen Display Item List

✔: Items

No.	No.	Display Range	R134a high pressure	R123 low pressure	Remarks
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	✔	✔	
6	Oil Tank Temperature	-40.0~140.0 °C	✔	✔	Note 1.
7	Compressor Bearing Temperature	-40.0~140.0 °C	✔	✔	
8	Motor Winding R phase Temperature	-40.0~140.0 °C	✔	✔	Note 2.
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		✔	When low pressure is used
		0.00~20.00kg/cm^2		✔	When high pressure is used
12	Condenser Pressure	-1.00~5.00kg/cm^2		✔	When low pressure is used
		0.00~20.00kg/cm^2		✔	When high pressure is used
13	Oil Tank Pressure	0.00~20.00kg/cm^2		✔	When high pressure is used
14	Oil Pump Pressure	-1.00~5.00kg/cm^2		✔	When low pressure is used
		0.00~20.00kg/cm^2		✔	When high pressure is used
15	Current	0~1999A	✔	✔	
16	Voltage	0~9999V	✔	✔	Note 3.
17	Power	0~9999KW	✔	✔	Optional
18	Cooling water flow amount	0~3000 m^3/h	✔	✔	Optional
19	Chilled water flow amount	0~3000 m^3/h	✔	✔	Optional
20	Vane opening pressure	0~100 %	✔	✔	
21	Cooling 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 pressure difference	-5.00~5.00kg/cm^2	✔	✔	
25	Hot gas valve output	0~100 %	✔	✔	Optional
26	Cooling tower fan inverter frequency	0~60 Hz	✔	✔	Optional
27	PID calculation output	0~100 %	✔	✔	
28	Automatic operation setting	Calculated value	✔	✔	
29	Automatic stop setting	Calculated value	✔	✔	
30	Actual temp. set value	3.0~50.0 °C	✔	✔	Note 4.

❉ Note

1. R134a is high pressure/ standard and R123 is low pressure/ option.
2. Displayed as "TEMPERATURE-MOTOR BEARING" For Low Pressure Use)
3. Can display a decimal point if the current sensor range is lower than 200A.
4. For Ice Making -10.0~50.0°C (for low temperature)

Table 6. Screen Display Items List

7) Main menu

• Main menu mainly has user setting and system setting as in the following figure.
  - Users can set user set, dual set, schedule set and system information.
  - Login management, sensor correction, control information setting, abnormal condition setting, safety control setting, timer setting, VGD/VFD setting and sensor setting, can only be set by system manager with password input.

• Menu screen
  - Route : MENU

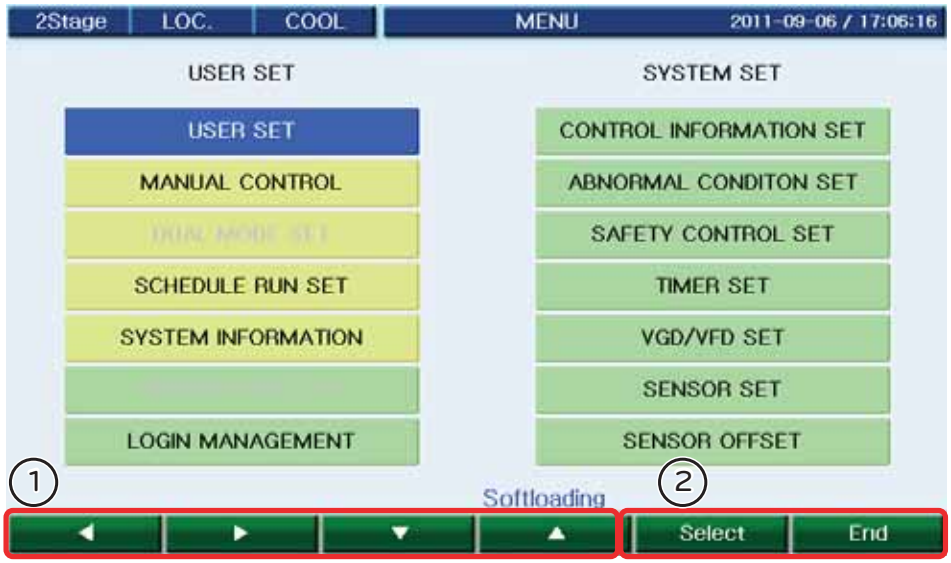


Figure 26. Input status check screen

When a menu selected using ① button, it moves to the sub menu.

When 'Select' at ② button pressed, it moves to the MENU page. When 'End' button pressed, it returns to the default BASIC screen.

- Descriptions of Main menu

Displayed items	Usage
USER SET	It is the menu for users to set values required for chiller operation such as control target temperature, PID value, etc.
DUAL MODE SET	It is the menu to set categories used in Dual Compressor
SCHEDULE RUN SET	It is the menu to set time for chiller to automatically start/stop at the designated time and the temperature for each time period.
System information	Menu to check overall system information such as I/O, timer operation, version, current time, operation information saving period, communication address, communication speed, language setting, model selection, etc.
SYSTEM INFORMATION	It is the menu to check overall system information such as I/O status, timer operation, version, current time, operation information saving period, communication address, baud rate, language, machine type, etc.
LOGIN MANAGEMENT	It is the menu to change password and management number.
SENSOR CORRECTION	It is the Menu to set the most basic information in the chiller operation
SAFETY CONTROL SET	It is the menu to set categories related to safety control to prevent abnormal stops during operation.
ABNORMAL CONDITON SET	It is the menu to set abnormal stop conditions of the chiller.
TIMER SET	It is the menu to set abnormal stop conditions of the chiller.
VGD/VFD SET	It is the menu to set the relationship between vane opening and diffuser opening rate.
SENSOR SET	It is the menu to set 4~20mA sensor setting, vane and diffuser.

Table 7. Main menu categories

User setting

- Operation mode setting screen has the menu of Local, Timer and Remote mode selecting running type, and has modes of Icing or Cooling selecting operation purpose. Provided that, "operation mode selection" menu is displayed only when Icing mode is set.
  - Route : MENU ➡ USER SET ➡ Select

Figure 27. User setting menu

1. In the above user setting menu screen, select arrow keys to move and select desired category.
2. During the selection, you can use "increase" and "decrease" button to change the set value. (Same as the Password setting" method)

1) RUN MODE SET
   - Local: To run and stop the chiller at the local site where the chiller is using Run/Stop key on the control panel.
   - Remote : To run and stop the chiller at a remote place like site office or automatic control panel using remote Run/Stop signal(no voltage contact signal or position relay contact signal)
   - Scheduled: To run automatically run and stop the chiller on the basis of the scheduled time by the setting of the scheduled operation. Refer to 44p. Timer operation setting.

2) Control Mode selection

   This menu can be used when it is installed in a chiller manufactured for ice thermal storage that can perform ice making operation. This menu is displayed when ice making mode is selected in the system function setting. If ice making mode is not selected, this menu will be disabled.
   - COOL: It is the standard chiller running mode cooling at the 7~12°C.
   - ICING: It is the low temperature type chiller running mode icing at -5~0°C.

3) Other settings

   It is a menu to set functions and default values needed for the chiller operation.
   Move to the category where to set by pressing MENU selection bar and SELECT key for selection. Then the MENU are changed to arrows (previous, next, down and up) by which you can move to the item to set on flashing cursor.
   Move to the digit by Previous and Next key, change the value by Up and Down key, and press SELECT key will set the value.

4) Setting display screen

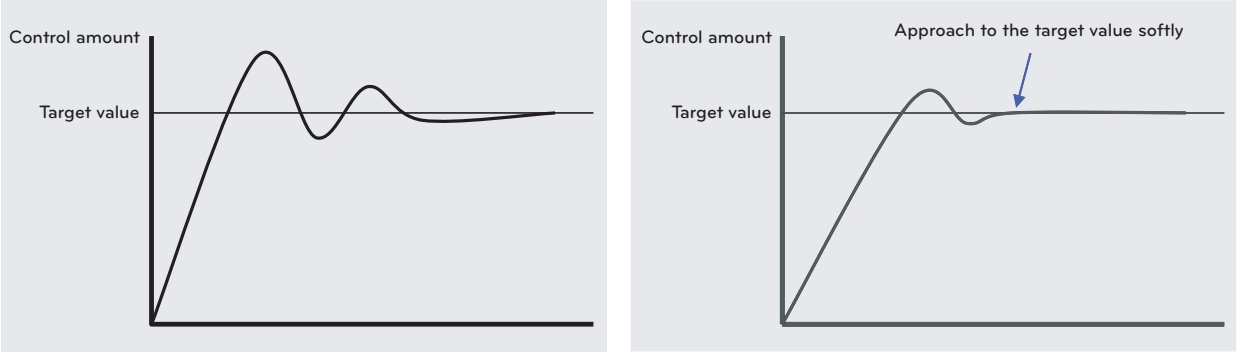
Item	Boundary of setting	Default Value	Setting Unit	Time to set
RUN MODE SET	LOC/SCH/REM	LOC.		Always
CONTROL MODE SET	COOL/ICE	COOL		Always(*)
Chilled W. Outlet Temp	3.0 °C~30.0 °C	7.0°C	0.1	Always
Iced W. Outlet Temp	-20 °C~30 °C	-5°C	0.1	Always
Chilled W. Temp P	1 °C~10 °C	2.0°C	0.1	Always
Chilled W. Temp I	0~3600 sec.	200 sec.	1	Always
Chilled W. Temp D	0~360 sec.	2 sec.	1	Always
Auto Run Temp (Set Temp+)	0.0 °C~10.0 °C	2.0°C	0.1	Always
Auto STOP Temp (Set Temp-)	0.0 °C~10.0 °C	2.0°C	0.1	Always
Anti-freeze Use	Used / Unused	Unused		Always
Anti-freeze Temp	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(**)
HOTGAS VALVE (GUIDE VANE %)	0~100%	30%	1	Always(**)
HOTGAS UPPER LIMIT SET	0~100%	100%	0.1	Always
HOTGAS LOWER LIMIT SET	0~100%	0%	0.1	Always
Cooling W. Inlet Temp.	10.0~50.0 °C	32.0°C	0.1	Always
Cooling W. Temp P	1.0 °C~10.0 °C	4.0°C	0.1	Always
Cooling W. Temp I	0~3600 sec.	0 sec.,	1	Always
Cooling W. Temp D	0~360 sec.	0 sec.	1	Always

(*): This mark means the item is displayed and applied only for icing (low temperature use) chiller.

(**): This mark means the item is displayed and operated only when hot gas valve is installed.

Table 8. Table of User Setting Items

5) PID Temperature Control
Unique P(proportional), I(integral), and D(differential) algorithms applied in controlling chilled water temperature. Comparing to the existing method, it has optimized in control by minimizing time to approach the target value, remaining deviation and Under-shoot and Over-shoot during the initial start-up and automatic/manual conversion of vane operation.



<Existing control method> <LS new P.I.D control>

Figure 28. Comparison of the control methods

(1) Chilled water outlet temperature
It is the Menu to set chilled water outlet P.I.D control temperature during cooling operation.
It is the set temperature that becomes the control target value in the PID control calculation.
If timer operation is set, this category is not displayed.

(2) Chilled water temperature proportional band value (CHILLED MODE-P)
It sets the proportional control range of P value which is used to control PID of the chilled water temperature during cooling operation.

(3) Chilled water temperature integral value (CHILLED MODE-I)
It sets the integral control range of I value which is used to control PID of the chilled water temperature during cooling operation.

(4) Chilled water temperature derivative value (CHILLED MODE-D)
It sets the derivative control range of D value which is used to control PID of the chilled water temperature during cooling operation.

(5)Chilled water outlet temp. – Icing
It is the Menu to set outlet control temperature in icing mode.

(6) Cooling tower fan step control
It is the operation method provided for cooling tower fan control for stable cooling water inlet temperature control. Standard type provides 1 cooling tower fan connected to the chiller control panel for start/stop, and up to 4 cooling tower fans can be connected and used. (2 or more connections is option)

⚠ CAUTION

Set after checking the specification of the cooling tower fan motor maker.

If cooling tower is connected to the controller, check and set the possible number of operations per day and time possible for reactivation of the cooling tower fan motor.

If it is not set correctly, operation may stop due to damage and overheating of the cooling tower fan motor.

If the setting of main menu/system menu/safety control setting/cooling tower control selection becomes ‘step’, the cooling tower fan control operates in step control.

(1) Cooling tower fan operation
It sets the operation temperature of the cooling tower fan during cooling operation.
If the cooling water inlet temperature goes above the set value, all cooling tower fans will start operation.

(2) Cooling tower fan stop
It sets the temperature that stops the cooling tower fans during cooling operation.
If the cooling water inlet temperature goes below the set value, all cooling tower fans will stop.

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 shall be inverter.

- It can be used when inverter is attached to 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 one of 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 becomes 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. Provided that, 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

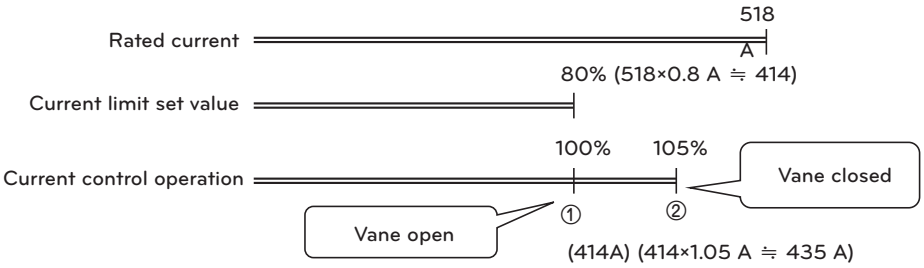


Fig 29. Current limit detail diagram

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 not to be over set value.

10) Hot gas setting (vane %)

It is the item to 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 from 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

It is the item to 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 up to 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

It is the item to 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.

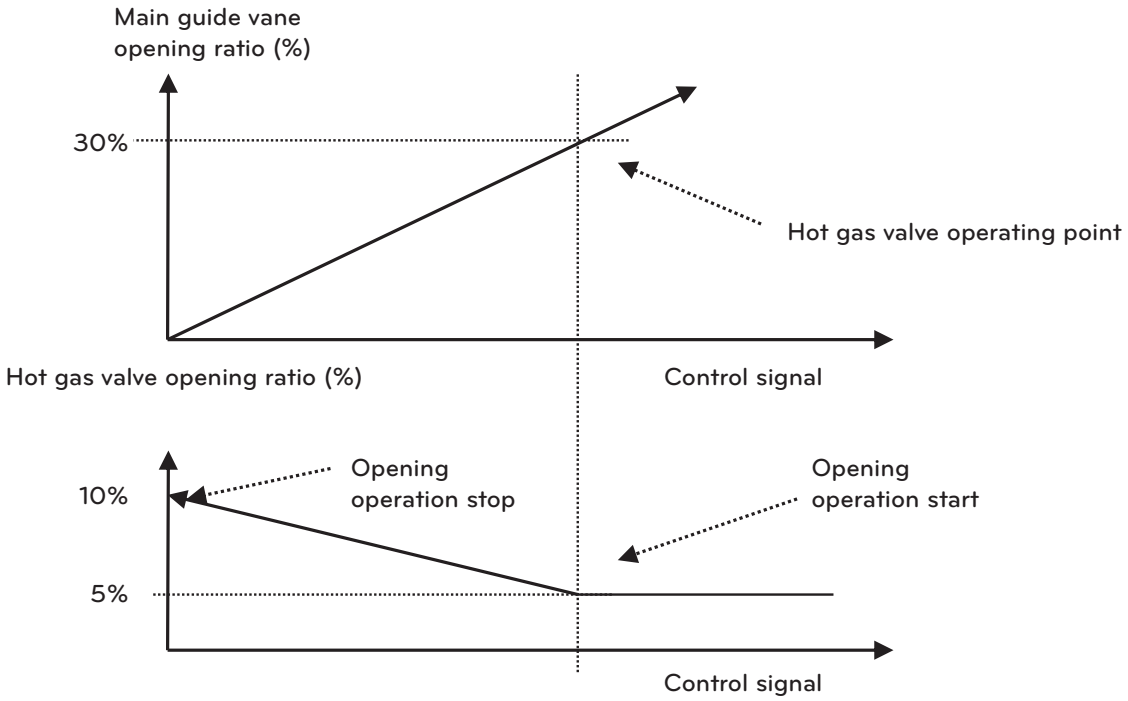


Fig 30. Hot gas valve application diagram

DUAL MODE SET

- It is the setting menu to interface when dual compressors are used.
  The usage is same as 'P40. User setting'.
  - Route : MENU ➡ LOGIN MANAGEMENT ➡ Select

Fig 31. Dual operation setting screen

Schedule operation setting

- The usage is the same as 'P40. User setting'.
  - Route : MENU ➡ SCHEDULE RUN SET ➡ Select

Fig 32. Schedule operation setting screen

Please refer to the example for the setting.

Fig 33. Schedule operation setting example screen

Example)
① You can set 8 patterns for scheduled operating. (Setting value of start/stop time, temperature and current)
② Pattern applications are classified to total of 5 types.
③ Select the day for scheduled operation in the calendar screen, and select one from the "5 types".

▶ Explanation for setting scheduled operation
① 2009. 8. 1: 06:00 RUN / 09:00 STOP, 09:00 RUN/ 12:00 STOP
② 2009. 8. 9: 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 run/stop time, day, and control temperature with each step.
Confirm whether the current day and time are correct at the System Information page.

SYSTEM INFORMATION

- Route : MENU ➡ SYSTEM INFORMATION ➡ Select

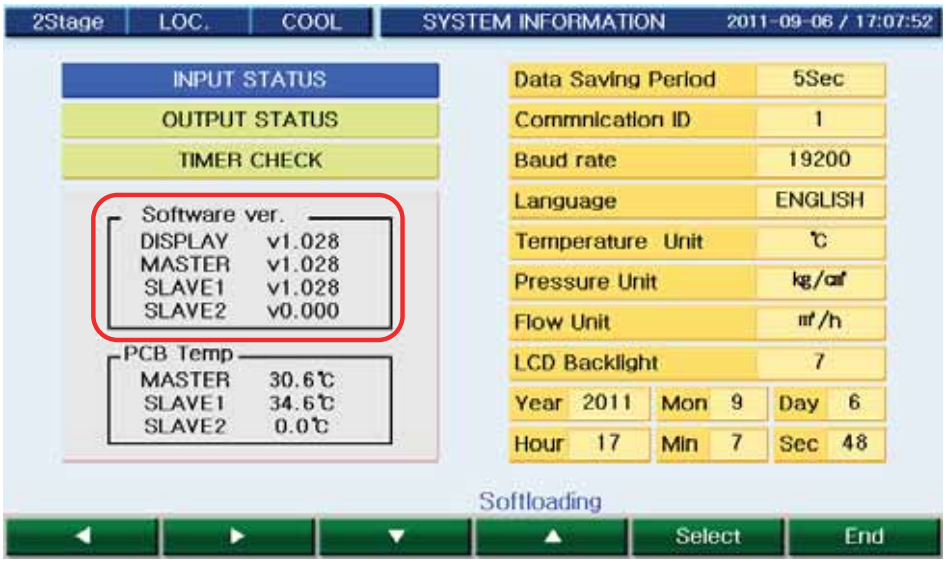


Fig 34. System information

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 saved time 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 and correct if so.

2) Operation data saving cycle

It sets the cycle for saving the operation data.

Operation data are all of 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.

ENGLISH

5) Input status display

- Digital input ports indicate the status as ON (closed circuit) and OFF (open circuit).
  It is the 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 input to the controller input connector. If the connections are mixed with other signal lines, the controller PCB may get damaged.
  - Route : MENU ➡ SYSTEM INFORMATION ➡ INPUT STATUS ➡ Select

Fig 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 Items	Status	Contact operation status	Remarks
Ice Mode Indicating	ON/OFF	If ice making mode selected: Close	
Remote Run	ON/OFF	If running signal input: Close	
Refrig. Temp Low	ON/OFF	Refrigerant Temperature low: Close	Optional
Cond. High Pressure	ON/OFF	If high pressure is detected: Close	
Chilled W. Flow	ON/OFF	If flow rate normal: Close	
Cond. W. Flow	ON/OFF	If flow rate normal: Close	
Chilled W. Pump Interlock	ON/OFF	If pump running: Close	
Cond. W. Pump Interlock	ON/OFF	If pump running: Close	
Bearing Temp High	ON/OFF	If high temperature is contacted: Close	
Motor Winding Temp High	ON/OFF	If high temperature is contacted: Close	
Oil Pump Overload	ON/OFF	If overloaded: Close	
Vane Closed	ON/OFF	If vane closed: Close	
Main Power Normal	ON/OFF	If power is supplied : Close	
Comp. Moto Run Complete	ON/OFF	If compressor is on operation: Close	
Starter Abnormal	ON/OFF	If abnormality detected: Close	
Diffuser Manual	ON/OFF	If manual stop : Close	2Stage
Diffuser Manual Close	ON/OFF	If manual close : Close	2Stage
Diffuser Manual Open	ON/OFF	If manual open: Close	2Stage
Purge Press Switch	ON/OFF	If pressure increased: Close	R123

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.

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

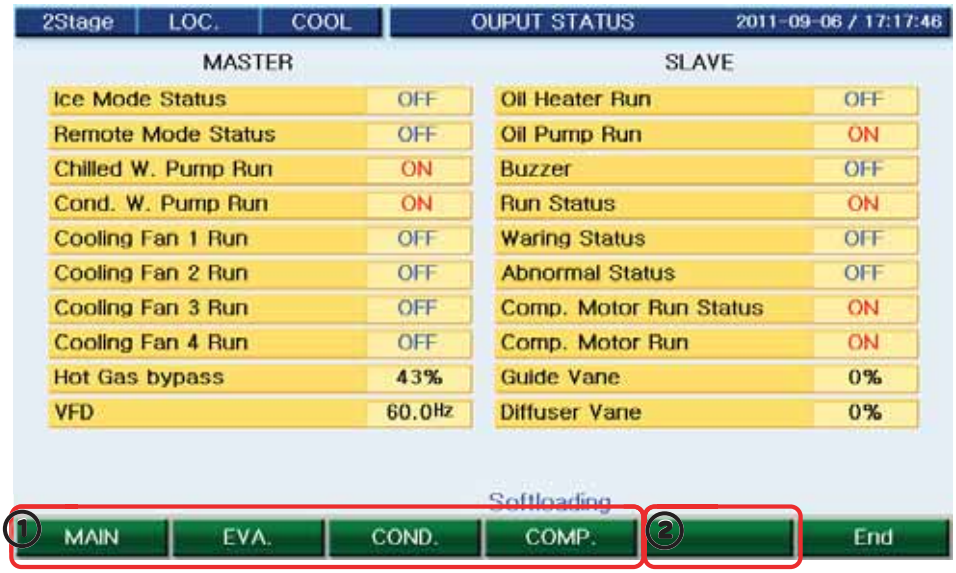


Fig 36. Output status check screen

① Move to main/ evaporator /condenser/compressor screen.

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

Displayed items	Status	Contact operation status	Remarks
Ice Mode Status	ON/OFF	If ice mode selected: Close	For customer
Remote Mode Status	ON/OFF	If remote run selected: Close	For customer
Chilled W. Pump Run	ON/OFF	If chilled water pump on: Closed	For customer
Cond. W. Pump Run	ON/OFF	If cooling water pump on: Closed	For customer
Cooling Fan 1 Run	ON/OFF	If cooling tower Fan 1 on: Closed	
Cooling Fan 2 Run	ON/OFF	If cooling tower Fan 2 on: Closed	
Cooling Fan 3 Run	ON/OFF	If cooling tower Fan 3 on: Close	
Cooling Fan 4 Run	ON/OFF	If cooling tower Fan 4 on: Close	
Hot Gas bypass	0~100%		
VFD	0~60Hz		
Oil Heater Run	ON/OFF	If oil heater on: Close	
Oil Pump Run	ON/OFF	If oil pump on: Close	
Buzzer	ON/OFF	If abnormality detected: Close	
Run Status	ON/OFF	If operation switch pressed: Close	
Warning Status	ON/OFF	If caution is alarmed: Close	For customer
Abnormal Status	ON/OFF	If abnormality is detected: Close	For customer
Comp. Motor Run Status	ON/OFF	If compressor on operation: Closed	For customer
Guide Vane	0~100%		
Diffuser Vane	0~100%		

Table 10. Output display categories

7) Timer status check

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

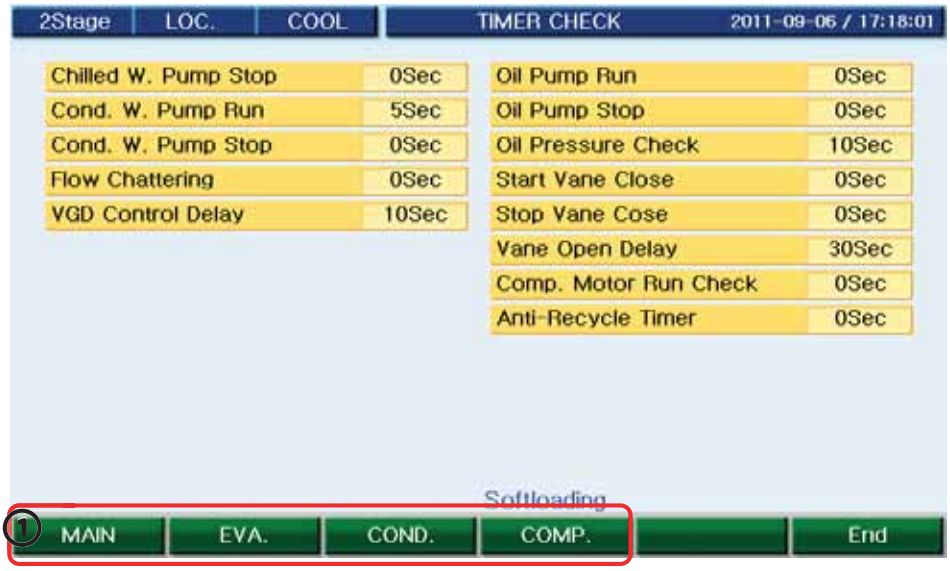


Fig 37. Timer status screen

① Move to main/evaporator/condenser/compressor screen

Displayed Item	Display range	Initial value(standard setting)
Chilled W. Pump Stop	0~1800	300 sec.
Cond. W. Pump Run	0~60	5 sec.
Cond. W. Pump Stop	0~1800	30 sec.
Flow Chattering	0~60	2 sec.
VGD Control Delay	1~3600	1800 sec.
Oil Pump Run	0~600	180 sec.
Oil Pump Stop	0~600	300 sec.
Oil Pressure Check	0~60	10 sec.
Start Vane Close	0~600	120 sec.
Stop Vane Close	0~600	120 sec.
Vane Open Delay	0~60	30 sec.
Comp. Motor Run Check	0~60	20 sec.
Anti-Recycle Timer	5~3600	1800 sec.

Table 11. Timer display categories

Sensor Correction

- Each sensor value can be calibrated. The correction set boundary is -5~5°C for temperature, -2kg/cm^2~2kg/cm^2 for pressure, -50m^3/h~50m^3/h for flow amount, -200~200A/V/KW for current, voltage, and power.

  - Route : MENU ➡ SENSOR OFFSET ➡ Select

Figure 38. Sensor screen

Control information setting

- This is the place to set values related to safety control of the chiller. Move to the category where to set by pressing MENU selection bar and SELECT key for selection. Then key MENU are changed to arrows (Previous, Next, Down and Up) by which you can move to the item to set on flashing cursor. Then move to the digit by Previous and Next key, change the value by Up and Down key, and press SELECT key will set the value.
  Usage is the same as 'P40 User setting'.

- Route : MENU ➡ CONTROL INFORMATION SET ➡ Select

Fig 39. Control information screen

Abnormal Condition Setting

- This is the place to set the values related to abnormal stop of the chiller. Move to the category where to set by pressing MENU selection bar and SELECT key for selection. Then the key MENU are changed to arrows (previous, next, down and up) by which you can move to the item to set on flashing cursor. Move to the digit by Previous and Next key, change the value by Up and Down key, and press SELECT key will set the value.

- Route : MENU ➡ ABNORMAL CONDITON SET ➡ Select

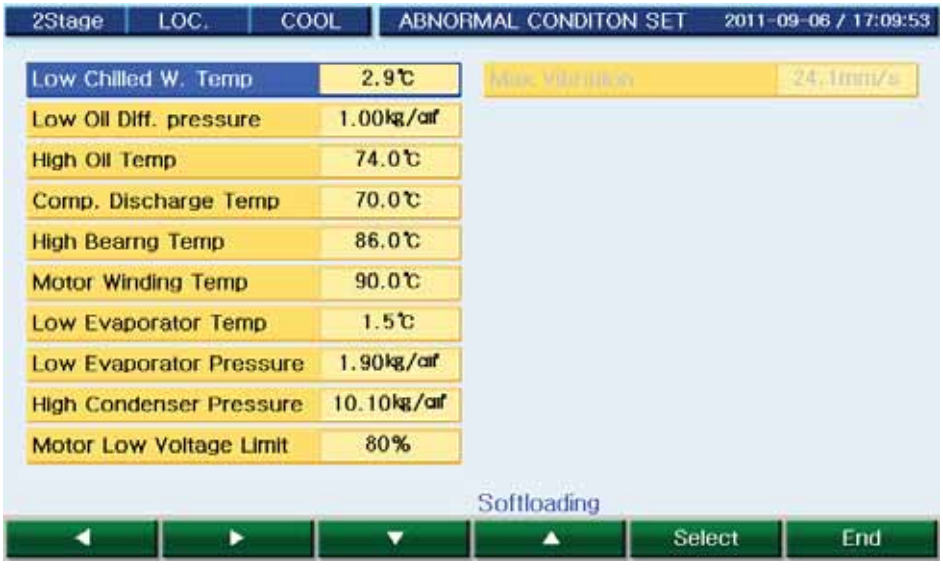


Fig 40. Abnormal Condition screen

1) Chilled Water Temperature Low 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', chiller will abnormally stop.

2) Oil Differential Pressure Low 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, chiller will abnormally stop.

3) Oil Temperature High Limit

It sets the upper limit of the oil temperature

If the chiller oil temperature is higher than the set value, chiller will abnormally stop.

4) Compressor Discharge Temperature High Limit

It sets the upper limit of the compressor discharge temperature

If the compressor discharge temperature during the chiller operation becomes bigger than the set value, chiller will abnormally stop.

5) Bearing Temperature High Limit

It sets the upper limit of the bearing temperature

If the bearing temperature goes above the set value, chiller will abnormally stop.

6) Motor Winding Temperature High 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 alarming Abnormal.

7) Evaporator Refrigerant Temperature Low 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, chiller will abnormally stop.

8) Evaporator Pressure Low Limit

It sets the lower limit of the evaporator pressure.

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

9) Condenser Pressure High

It sets the upper limit of the condenser pressure.

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

10) Motor Low Voltage 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.

Safety control setting

- It is the place to set the values related to the safety control of the chiller. Move to the category where to set by pressing key MENU selection bar and SELECT key for selection. Then the MENU are changed to arrows (previous, next, down and up) by which you can move to the item to set on flashing cursor. Move to the digit by Previous and Next key, change the value by Up and Down key, and press SELECT key will set the value.

- Route : MENU ➡ SAFETY CONTROL SET ➡ Select

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

Fig 41. Safety control setting screen

No.	Setting Item	Setting Range	Initial Value / Unit	Remarks
1	Softloading Output Period	5.0~60.0	10.0 sec.	
2	Softloading Output	0.0~5.0	1.0 sec.	
3	Softstop Vane Openrate	0~100	10%	
4	Bearing Temp High	50~100	95%	Note 1.
5	Motor temp High	50~100	95%	Option
6	Voltage Low	50~100	95%	
7	Comp. High	50~100	95%	Note 1.
8	Eva. Temp Low	50~100	95%	Option
9	Eva. Pressure Low	50~100	95%	
10	Cond. Pressure High	50~100	95%	
11	Surge High Pressure Set	0.70~12.00	12.00kg/cm^2	Note 1.
12	Surge Low Pressure Set	0.00~10.00	7.00kg/cm^2	Note 1.
13	Surge High Temp Set	0.5~12.0	5.6 °C	Note 1.
14	Surge Low Temp Set	0.0~10.0	5.0 °C	Note 1.
15	Surge Current %	1~100	25%	Note 1.
16	Surge Monitoring Time	0~1800	120 sec.	Note 1.
17	Surge Occuring Count	1~100	12 times	Note 1.

Table 12. Safety control setting categories

Note1. For the chiller with R134a (High Voltage) the above devices are standard applied.
For the chiller with R22(Low Voltage) optional

Timer setting

- It is the place to set the values related to timer required for chiller operation. Move to the category where to set by pressing MENU selection bar and SELECT key for selection. Then the MENU are changed to arrows (previous, next, down and up) by which you can move to the item to set on flashing cursor. Move to the digit by Previous and Next key, change the value by Up and Down key, and press SELECT key will set the value.

- Route : 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 W. Pump Stop	1~1800	300 sec.
2	Cond. W. Pump Run	1~60	5 sec.
3	Cond. W. Pump Stop	1~1800	30 sec.
4	Flow Chattering ignore	1~60	2 sec.
5	Oil Pump Run	30~600	180 sec.
6	Oil Pump Stop	30~600	300 sec.
7	Oil Pressure Check	1~60	10 sec.
8	Start Vane Close	30~600	120 sec.
9	Stop Vane Close	30~600	120 sec.
10	Vane Open Delay	0~600	30 sec.
11	Comp. Motor Run Check	10~60	20 sec.
12	Anti-Recycle	10~3600	1800 sec.

Table 13. Timer setting

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.

- Route : 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
VFD Inverter Frequency 1	40Hz~60Hz	41.1Hz	40.0Hz	Inverter Frequency 4-20mA output
VFD Inverter Frequency 2	40Hz~60Hz	50.7Hz	45.0Hz	
VFD Inverter Frequency 3	40Hz~60Hz	57.2Hz	51.0Hz	
VFD Inverter Frequency 4	40Hz~60Hz	60.0Hz	60.0Hz	
VFD Pressure ΔP 1	2.0~10.0Kg/cm^2	2.1Kg/cm^2	2.1Kg/cm^2	Condenser-Evaporator Pressure
VFD Pressure ΔP 2	2.0~10.0Kg/cm^2	3.5Kg/cm^2	2.5Kg/cm^2	
VFD Pressure ΔP 3	2.0~10.0Kg/cm^2	4.9Kg/cm^2	4.1Kg/cm^2	
VFD Pressure ΔP 4	2.0~10.0Kg/cm^2	6.1Kg/cm^2	6.8Kg/cm^2	
VFD Temp ΔT 1	0.0~20.0 °C	0.5 °C	1.3 °C	Chilled water inlet - Set temperature
VFD Temp ΔT 2	0.0~20.0 °C	2.2 °C	2.8 °C	
VFD Temp ΔT 3	0.0~20.0 °C	3.6 °C	3.7 °C	
VFD Temp ΔT 4	0.0~20.0 °C	5.0 °C	5.0 °C	
Inverter calculation period	1-100 sec.	60	60	

Table 14. VGD/VFD setting categories

- VFD control operation

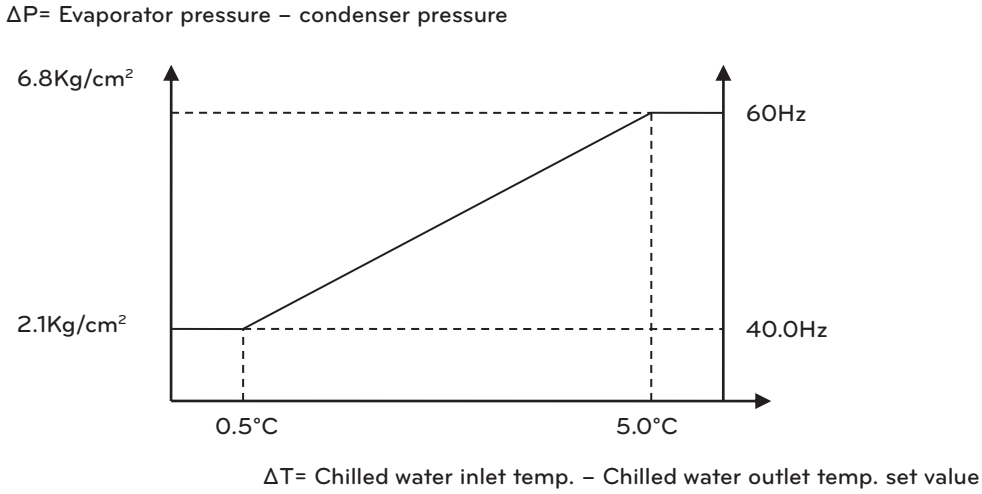


Figure 44. VFD control detail diagram

Sensor set

- It is the menu to set each pressure sensor and current sensor, etc., and you have to set precisely, and it is only effective for the sensors set for use. After changing AD value of the guide vane and diffuser vane to min./max. by manual operation, change Reserved to ON, and finish the setting by selecting the corresponding setting(min. value setting, max. value setting).

- Route : MENU ➡ SENSOR SET ➡ Select

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

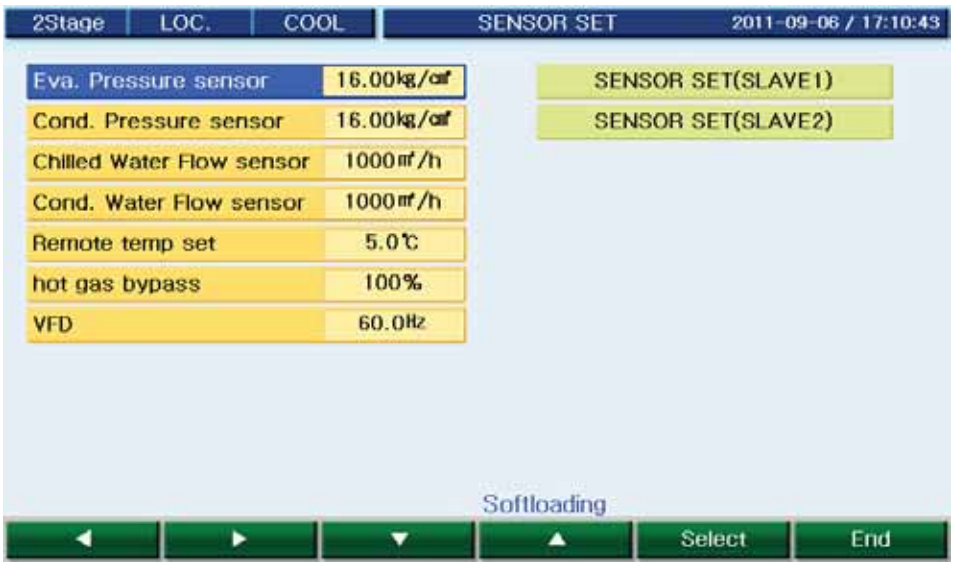


Figure 45. Sensor setting screen

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.

- Route : LOGDATA

Figure 46. Chiller history screen

1) Run Information

- Route : LOGDATA ➡ Run Info.

Fig 47. Chiller operation information screen

You can check up to 1~300 data using ① button.

2) Run Data

- Route : LOGDATA ➡ Run Data

Fig 48. Operation history information screen

3) Error Data

- Route : LOGDATA ➡ Error Data

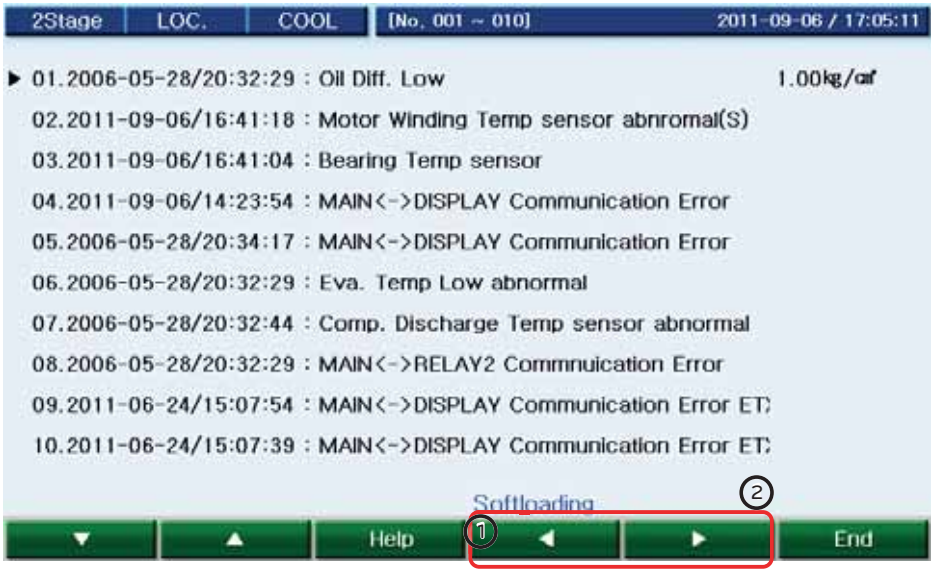


Fig 49. Error history information screen

You can check up to 1~300 data using ① button.
You can select error history help using ② button.

4) Help Feature

- It displays the help message about the errors and cautions. If Help key is pressed on the error and caution 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.
  - Route : LOGDATA ➡ Error Data ➡ Help

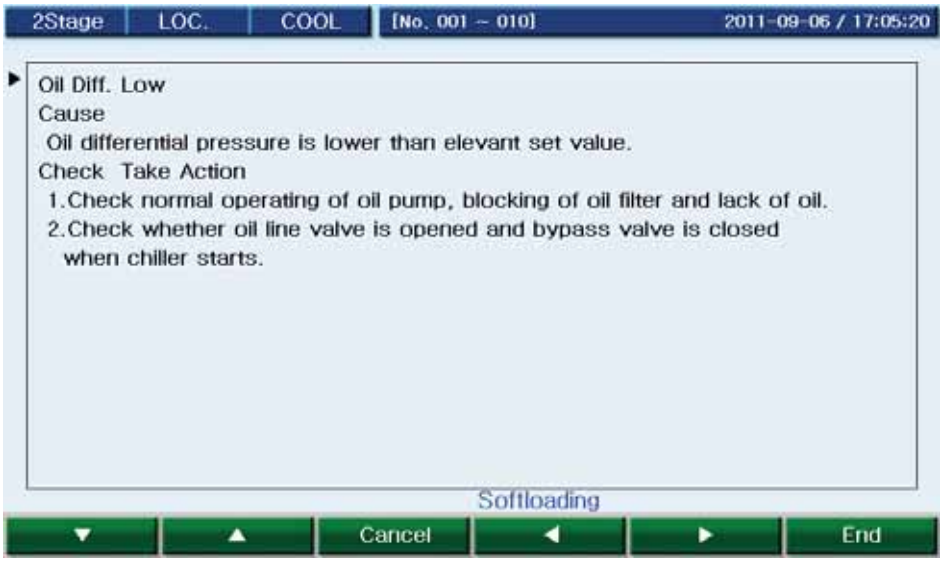


Fig 50. Help function screen

5) Print

- Route : LOGDATA ➡ Print ➡ Select

Fig 51. Print function screen

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

6) Graph

- Route : LOGDATA ➡ Graph

Fig 52. Data graph screen

Use ①buttons to move and select the corresponding data graph display category.
Activated data will be displayed as reversed at ②.

Manual operation screen

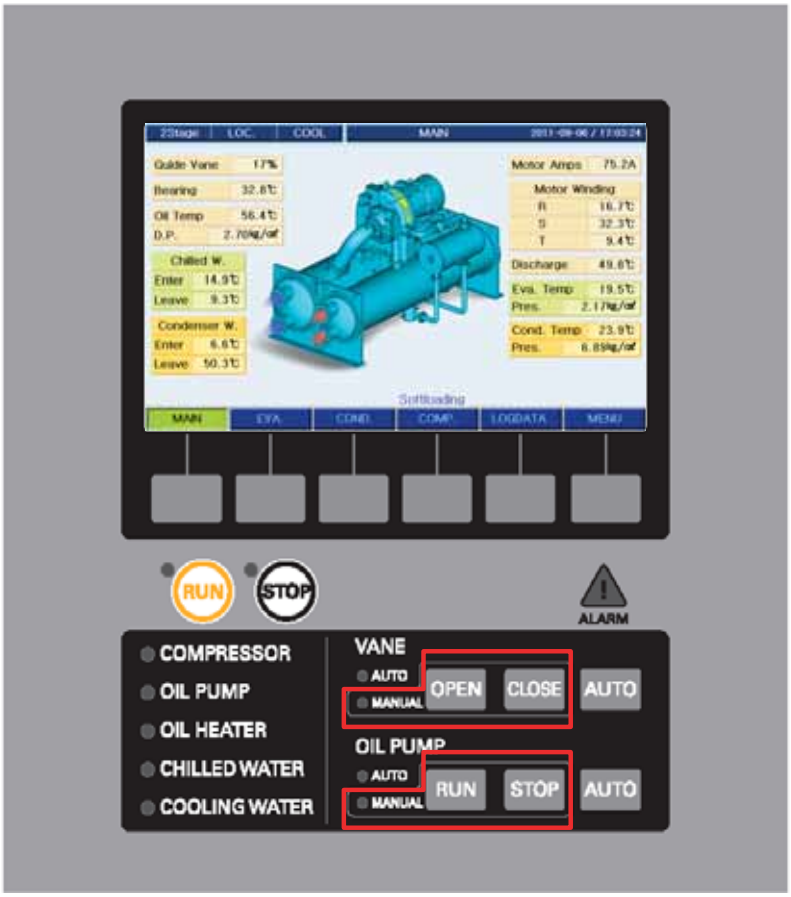


Fig 53. Manual operation screen

Vane

It is to open and close thee vane (guide vane) manually from the menu. It is composed to be operated as the same as the control valve automatic/manual conversion key and open/close key on the front of the display device. When it is stopped, forced closing is operated by control logic, so manual open does not work.

Oil pump

It is to operate the oil pump manually from the menu. It is composed to be operated as the same as the oil pump automatic/manual conversion key and start/stop key on the front of the display device. Manual stop does not work to protect chiller during the operation.

Remote control signal and the connection

Remote Run/Stop signal connection

• No voltage and continuous contact (2 wire connection)

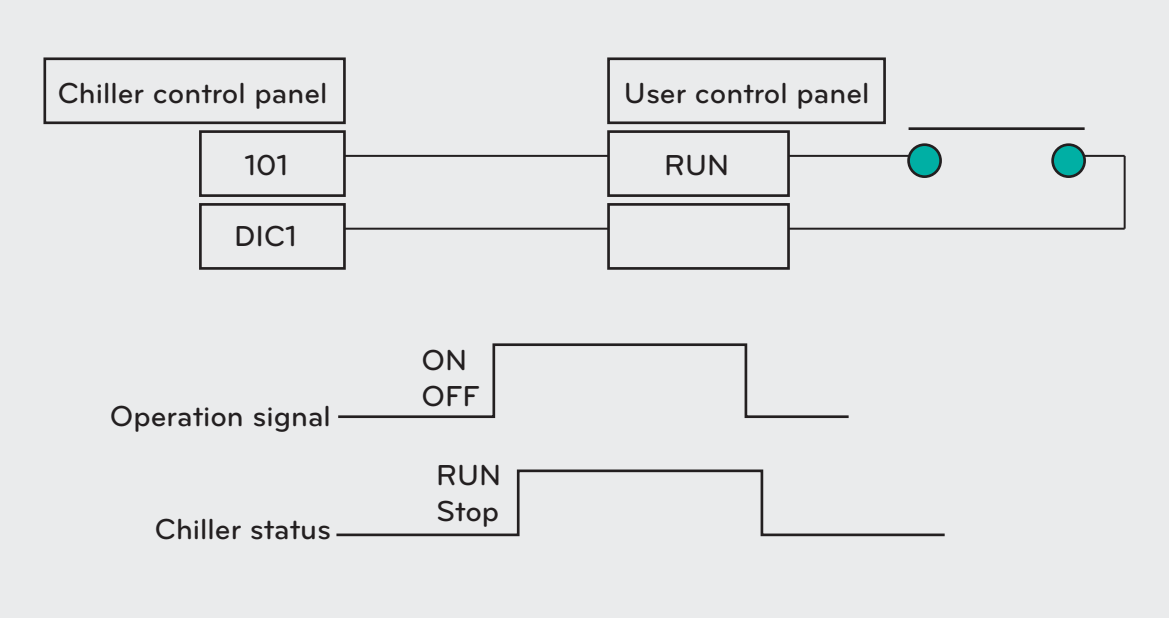


Fig 54. Remote control signal detail diagram

※ Min. Run/Stop pulse maintaining time: maintains for at least 2 sec.

Manual operation screen

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 pump motor starter is 'ON'. If the input signal does not exist during starting, the chiller will not start. If the input signal does not exist during running, it will sense as abnormal state and warn.	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 Run/Stop Cooling water pump Run/Stop Cooling tower Fan Run/Stop	Output (No voltage contact)	It is the Run/Stop signal of the pump or fan. Connect it when it is operated by interfacing start/stop signal from chiller.	Use it within AC250V 0.1A (resistance load). Refer to final manual 69P.

Table 15. Manual operation screen detail diagram

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	Use it within AC250V 0.1A (resistance load).
		OFF when stop signal is input	
Contact for Run/Stop indicator	Output (No voltage contact)	ON when chiller operation	
		OFF when chiller is stopped	
Contact indicating Chiller FAULT	Output (No voltage contact)	ON when there is a problem in the chiller	
Indicate chiller at REMOTE run mode	Output (No voltage contact)	ON when remote operation mode is selected	
Chiller WARNING	Output (No voltage contact)	ON when alarm breaks	

Table 16. Central monitoring panel and connection signal detail diagram

Check list before inspection

1) Thorough preparation

Check first aid method, arrangements around the work site, and safety of the facility and machine.

2) Review with circuit diagram

If power system receives power from another source, check the powers to the panels, power application to the 1st side of the circuit breaker and proper grounding.

3) Contact

Check if you can closely contact with the relevant departments.

4) Check for no voltage state and safety measures

During the inspection of the main circuit, please review the following issues for safety.

- Open the related breaker and disconnecting switch and make no voltage on the main circuit.
- Check no voltage status with electroscope, and make groundings where necessary.
- Open circuit breakers and disconnect switches and attach a warning sign board "Checking".
- Use the disconnection switch operation after power is disconnected.
- Especially when the power is supplied via another source such as consumer side power distribution panel, automatic control, MCC panel, etc., take the above c) and d) actions to the other side switches.

5) Cautions for current and voltage

Discharge the remaining charges and conduct grounding before you inspect the condenser and cable connection part.

6) Prevention from wrong operation

Disconnect the power and attach a caution mark.

7) Prepare insulated protection equipment

Wear safety protection equipment such as insulated gloves, safety helmet, insulated boots, and safety apparel fit for the rated voltage.

8) Measures against rat, insects, etc.

Take countermeasures to prevent rat, insects, snakes, etc from entering into the panel.

List to check after maintenance

1) Final check
   - Check whether any staff is inside the panel.
   - Check whether the removal of the temporary building for inspection is being delayed.
   - Make sure not to forget bolt tightening work.
   - Check if any tools are left.
   - Check whether rat or insects have been in.
2) Recording of the inspections

   When inspection, make sure to record the summary of the inspections and repairs, status of the failure and date, etc. to utilize them as the reference for the next inspection.

⚠ CAUTION

Establish the daily inspections to be able to check the load of the machine in operation, operation time, operation environment, etc.

The inspection period stated in this manual is a general inspection period. Therefore establish the inspection plan according to the load status of the machine and usage frequency.

Do not test the insulation resistance on the 2nd side of the transformer for controller or control power.

Do not test the insulation resistance on the parts like sensor, switch, etc. which are connected to the controller.

General Inspection items

Inspection	Inspection categories	Inspection items	Daily	1 year	2 years	Criteria
All	Ambient environment	Is there any dust? Is the ambient temperature and humidity adequate? Is there any abnormal vibration?				Refer to Chapter 1. Environmental conditions
	Equipment	Is there any vibration or noise?				No abnormality
Main circuit / Control circuit	Input voltage	Is the main circuit voltage normal? Is the main circuit voltage normal?				Refer to Chapter 1. Environment
	Insulation resistance test	Disconnect all power before testing insulation resistance. Insulation between the transformer 1st side and grounding bus-bar. When measuring the resistance, disassemble all grounding wires connected to grounding bus–bar.				*Low voltage (600Vac or less) DC 500V class mega, it shall be 5MΩ or more. *High voltage (exceeding 600Vac, 7000Vac) DC 1000V class mega, it shall be 30MΩ or more.
	Overheating	Is there any trace of overheating in each component?				No abnormality
	Fixed parts	Is there any missing fixed parts?				No abnormality
	Conductor/wire	Is there any contamination of conductor? Is there any damage in the wires?				No abnormality
	Terminal	Is there any damaged part?				No abnormality
	Relay /contactor	Is there any oscillation during operation? Is there any damage on the connector?				No abnormality
	Space heater	Is there any color change of the heater component in starter panel?				No abnormality
	Sensor & switch	Is there any disconnection or short circuit? Is there any damage in the contact part?				No abnormality
	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.				No abnormality
	Phase advance capacitor	Is the expansion under the limit?				No abnormality
	Cooling fan	Is there any abnormal noise? (Control Panel)				No abnormality
Control function	Safety function	Is the safety function in normal operation? Is the start-up sequence normally carried out? Is the stop sequence normally carried out? Is the temp. regulation within the specification?				Normal control
Display	Analog value	Is the displayed value correct?				No abnormality
	Indication Lamp	Is the indication lamp displayed with the normal brightness?				No abnormality

Table 16. General Inspection Items

ENGLISH

4-6. Startup and Control sequence

Signal Flowchart

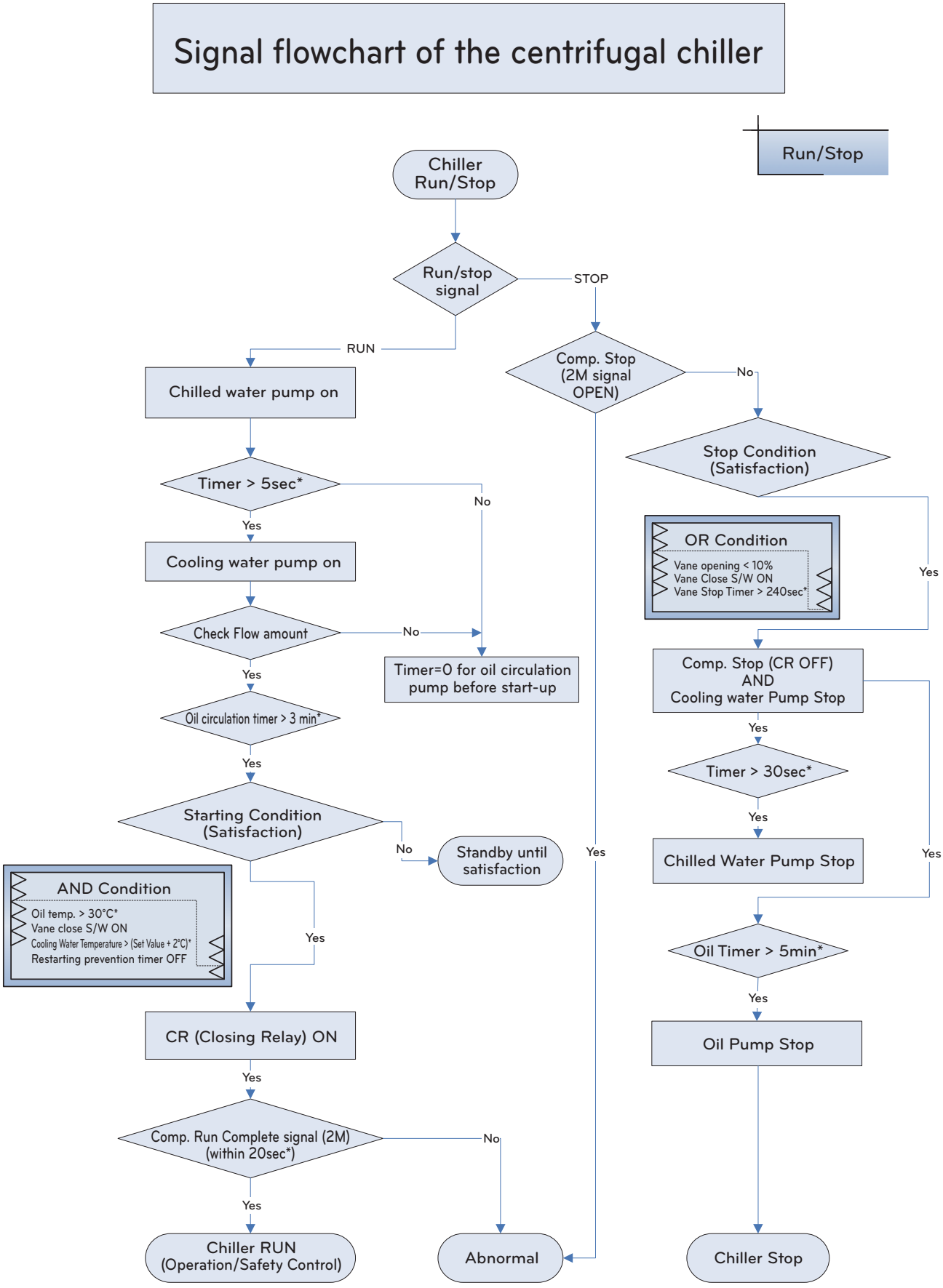


Figure 55. Signal flowchart

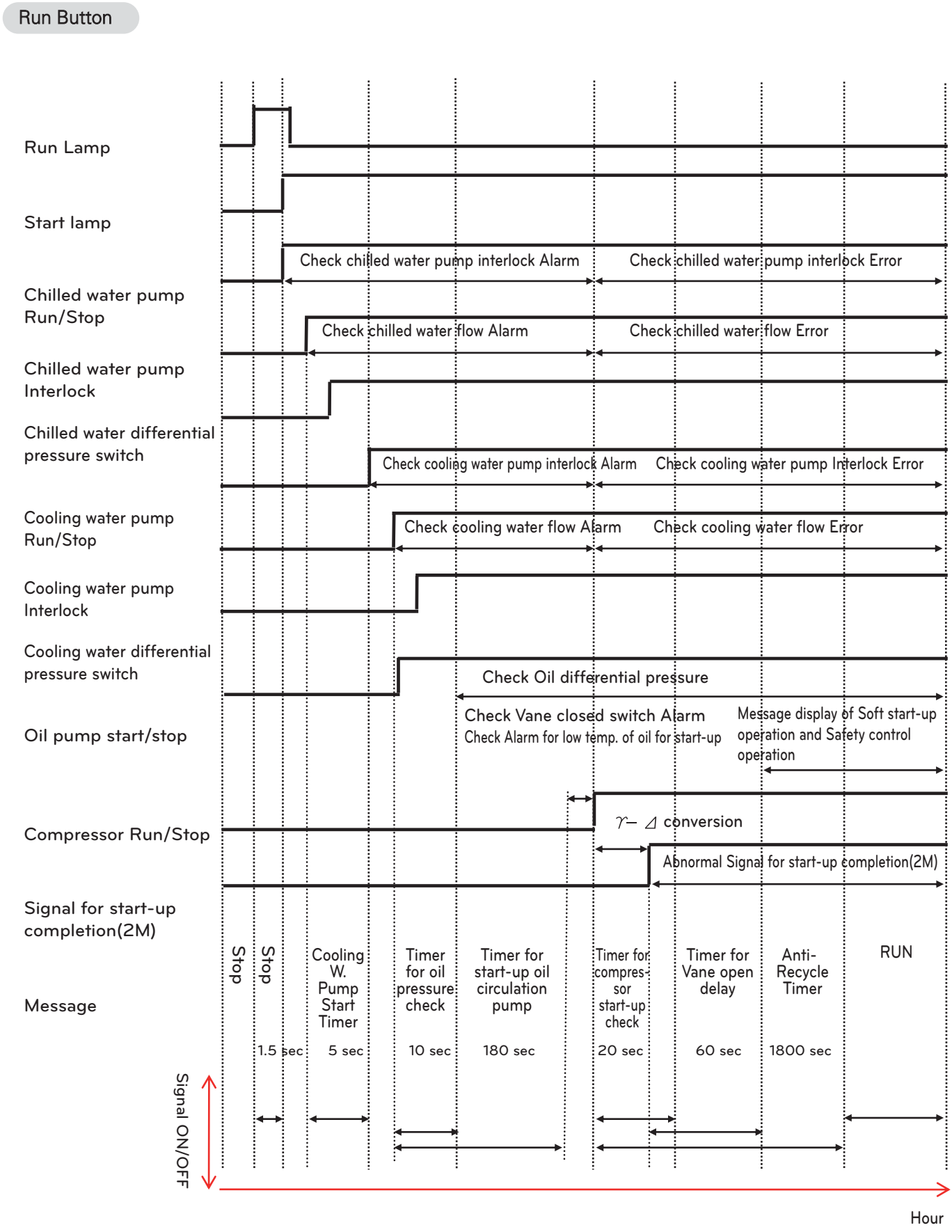


Figure 56. Timing Sequence

Stop button

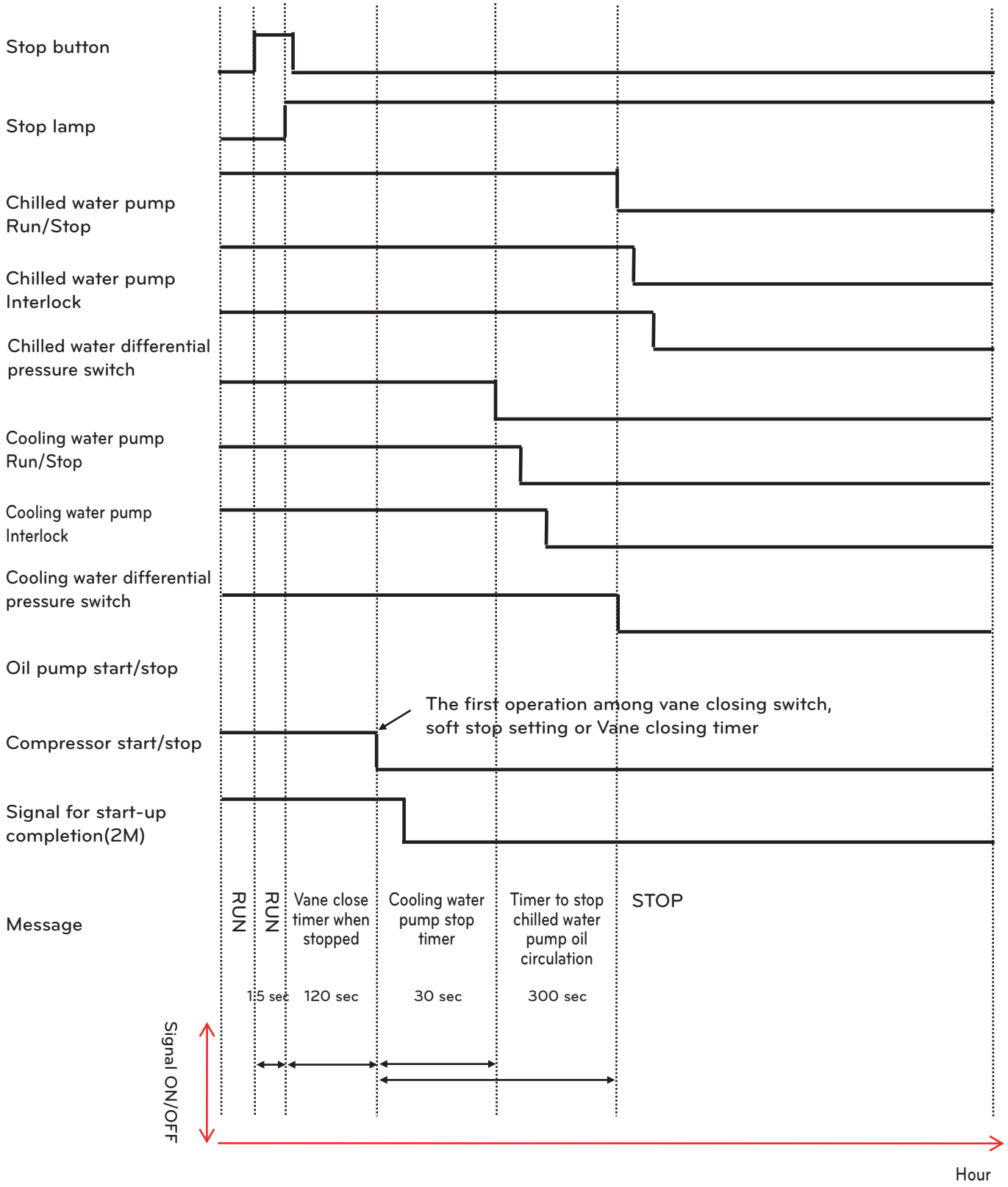


Figure 57. Timing Sequence

4-7. Product protection function

Protection Logic

Classification	Content	Cause	Operation	Condition
Sensor	Temperature, pressure and current sensors abnormality	Detected abnormality from temperature, pressure or current sensors	Chiller stops	Abnormal
Interlock	Chilled water pump interlock Error	Detected Error with pump interlock during operation	Chiller stops	Abnormal
	Cooling water Pump Interlock Error	Detected Pump interlock problem was detected during operation	Chiller stops	Abnormal
	Chilled water low-flow abnormal	Detected Flow interlock problem was detected during operation	Chiller stops	Abnormal
	Cooling water Flow Low Error	Detected Flow interlock problem was detected during operation	Chiller stops	Abnormal
Temperature and pressure	Control of High temperature of Oil Error	Detected High temperature of Oil	Chiller stops	Abnormal
	Error of Condenser Pressure High Error	Detected Condenser Pressure High	Chiller stops	Abnormal
	Evaporator Low Pressure Error	Detected Evaporator Pressure Low	Chiller stops	Abnormal
	Evaporator Refrigerant Prevention Error	Detected Evaporator Refrigerant Temperature Low Error	Chiller stops	Abnormal
	Compressor discharge Temperature High error	Detected Compressor discharge temperature High Error	Chiller stops	Abnormal
	Motor winding temperature High Error	Detected Motor winding temperature High Error	Chiller stops	Abnormal
	Bearing high temperature problem	Detected Bearing high Temperature Error	Chiller stops	Abnormal
	Chilled water temperature Low error	Detected chilled water outlet temperature Low error	Chiller stops	Abnormal
Surge occurred	Compressor Surge current Error	Detected Compressor Surge current Error	Chiller stops	Abnormal
Voltage	Detected Low Voltage Error	Detected Compressor motor Voltage Low Error	Chiller stops	Abnormal

Classification	Content	Cause	Operation	Condition
Prevention Control	Starting prevention when Oil temperature Low	Oil temperature ≤ starting oil low setting value	Oil low temperature prevention control caution message displayed caution message displayed	Caution
	Prevention of Low voltage	If compressor motor voltage is below the low voltage prevention set value - (100- set value)/2, close the guide vanes	Display warning message to prevent control of Low Voltage	Caution
	Prevention of Condenser Pressure High	If the condenser pressure is above the Prevention of High pressure set value + (100- set value)/2, the guide vane is closed.	Display warning message to prevent control of Condenser Pressure High	Caution
	Prevent evaporator low-pressure	If the Evaporator pressure is below the low pressure prevention set value- (100- set value)/2, close the guide vanes.	Display warning message to prevent control of Evaporator low pressure	Caution
	Evaporator Refrigerant Low temperature Prevention	If the Evaporator temperature is below the low temperature prevention set value- (100-set value)/2, close the guide vanes.	Display warning message of Evaporator Refrigerant temperature Low Prevention control	Caution
	Prevention of Compressor discharge temperature high	If compressor discharge temperature is above the high temperature prevention set value + (100-setting value)/2, the guide vanes is closed.	Display warning message to prevent control of compressor discharge temperature high	Caution
	Prevention Bearing temperature High	If bearing temperature goes above the temperature prevention high set value + (100- set value)/2, the guide vanes is closed.	Display message warning to prevent control of Bearing temperature High	Caution
	Preventive control of chilled water low temperature	If chilled water temperature is below the low temperature prevention set value - (100- set value)/2, close the guide vanes.	Chilled water outlet temperature, low-temperature prevention control caution message is displayed	Caution
	Compressor surge current prevention	If current changes more than set value during operation and if it occurs (set times /3) times within the set time, the guide vanes is closed.	Display of warning message to prevent surge current to compressor	Caution
	Preventive control of Motor over-current	When the compressor Motor Amps reaches the set value*105%, the vane is closed to lower current below set value.	Display warning message to prevent control for compressor motor over current	Caution
	Prevention of Motor winding high temperature	If motor winding temperature is above the high prevention set value + (100- set value)/2, close the guide vanes.	Display warning message to prevent control of high temperature of Motor winding	Caution

Classification	Content	Cause	Operation	Condition
Switch contacts	Motor winding temperature High Open	Motor winding temperature input contact is Open.	Chiller stops	Abnormal
	Evaporator Refrigerant Low temperature Contact Closed	Evaporator Refrigerant Low temperature Contact Closed	Chiller stops	Abnormal
	Oil pump over-current contact is closed	Thermal over-current contact attached to oil pump power supply is closed	Chiller stops	Abnormal
	Bearing temperature High contact closed	Bearing temperature, high temperature contact is closed	Chiller stops	Abnormal
	Condenser high pressure contact is closed	Condenser high pressure input contact is closed	Chiller stops	Abnormal
	Start-up failed	Compressor starting completed. No input signal	Chiller stops	Abnormal
	Delta contactor is open in operation	Starter panel contactor is open during operation	Chiller stops	Abnormal
	Starter panel abnormal, contact closed	Starter panel abnormal, input contact is closed	Chiller stops	Abnormal
	Power to Compressor Motor contact open	Compressor power supply contact is open during operation	Chiller stops	Abnormal

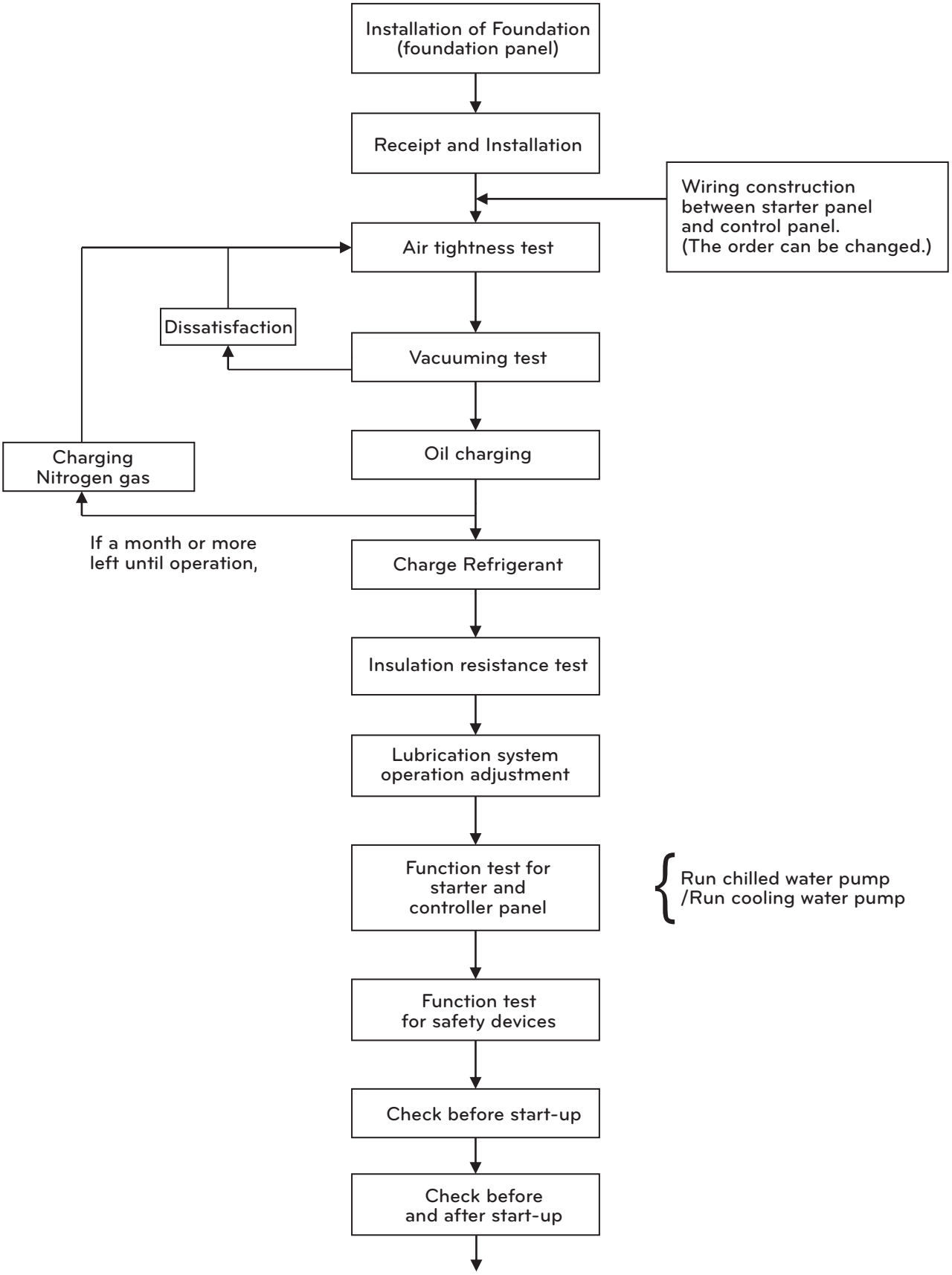
Table 17. Protection Logic

ENGLISH

5. START-UP

5-1. Delivery and Installation Check

From Receipt, Installation to Startup



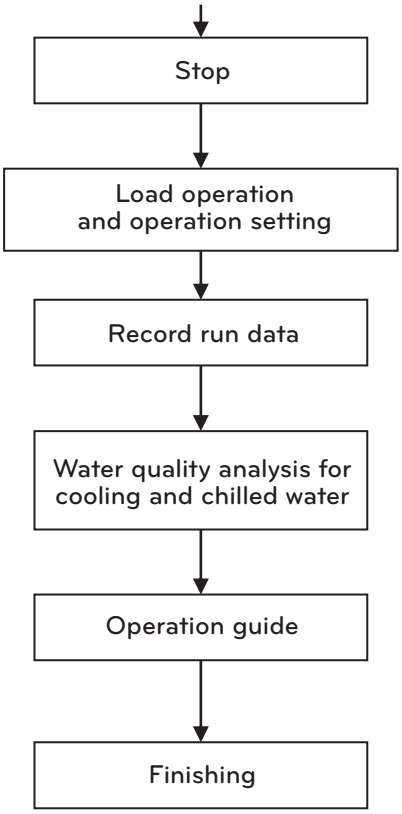


Fig 58. From receipt to Startup

Selecting a location

- If the chiller has to be installed near heat generating devices, keep distances more than 5 meters from boilers and hot-air blowers, and more than 2 meters from other heat generating devices.
- Choose a well-ventilated place and avoid place with high temperature.
- Choose a place with less humid.
- Provide ample space for service (for control and maintenance of pipes and tubes)

Foundation

- Build the foundation to withstand the concentrated heavy weight of the chiller.
- The foundation should be higher than the surface of the water, and install the drainage around.
- Be sure to install the drain pipe to the drainage hole.

Receipt and Installation

- The chiller should be installed evenly leveled to the ground.
- Install the chiller on a foundation with flat support surfaces, level within ±1mm with the manufacturer-supplied isolation pad assemblies under the unit.
- Make sure the foundation surface is flat and leveled within ±1mm using a level, and if not, readjust it within: ±1mm, using spacers.

ENGLISH

5-2. Preparation for start-up

Preparation for start-up

- It is called start-up run that the first run after receipt and installation or the run after long-term stoppage (over 1 month) before the regular operation of the chiller.
- Preparation for start-up is the maintenance and repairing work at least once a year after installation\, which is a very basic and important task.

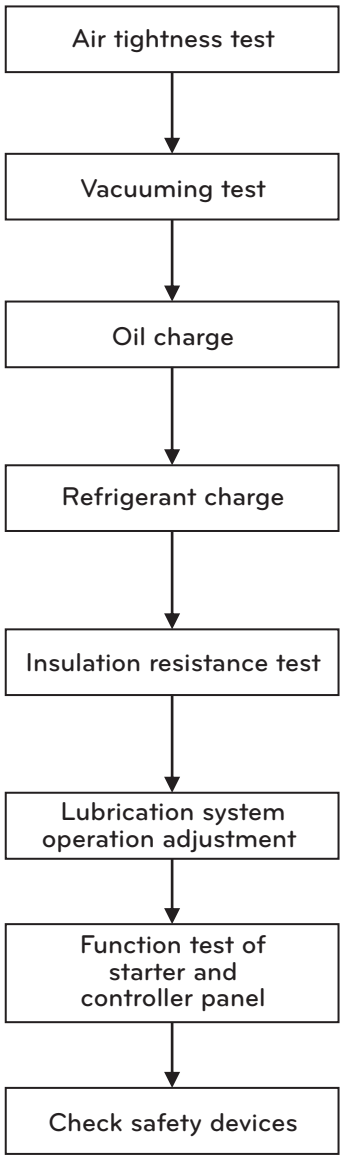


Fig. 59. Preparation procedure for start-up

Checking the leak parts

It is recommended to perform leakage test following the steps in Fig 58.
Refer to the temperature and pressure values of the refrigerant in Table 18.

Leakage Inspection

• The condition that requires the leak test
  - After the chiller is disassembled and repaired,
  - If the nitrogen's pressure charged in factory was lower during the transportation before the initial start-up:

• Weak Points for leak:
  - Parts where the gasket is used
  - Nut tighten part, bolt and nut
  - Copper tube connecting part
  - Sight-glass welded part
  - Compressor motor terminal

Inspection method

1) Charge the nitrogen in order until the internal pressure of the machine reaches 2 kg/cm^2, 5 kg/cm^2, 9~9.5 kg/cm^2.
2) Perform the soapy water test on every connecting part.
3) If the inspected pressure lasts for more than 30 min., prepare to do the soapy water test for smaller parts.
4) Mark the leaking point.
5) Eject the inner pressure of the machine.
6) Fix all the leaking points.
7) Do leak test again on the repaired points
8) After performing the large leaking test, increase the inner pressure up to the value of 9~9.5 kg/cm^2.
9) Do the small leak test and fix them all.
10) After the leak test Is finished, exhaust the nitrogen gas very carefully.

* Please close the valve of evaporator, as when you increase the pressure inside of the chiller, the relief valve on the evaporator may get open.

Note: Open the relief valve on the condenser by1.05 Mpa (10.71 kg/cm^2).
The relief valve on the evaporator open at 0.99 Mpa (10.1 kg/cm^2)

Temperature °C	Pressure 1kg/cm²	Temperature °C	Pressure 1kg/cm²	Temperature °C	Pressure 1kg/cm²
-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 18. HFC-134a Temperature / Pressure

Vacuum Dry & Vacuum Test

- The vacuum dry work has to be taken to eliminate the humidity when the machine is exposed to the atmospheric air for a long time or it is indicated that the moisture got into the machine or complete pressure loss of refrigerant happened due to refrigerant leak.

WARNING

Do not operated the compressor motor or the oil pump motor, and do not take any insulation resistance test when performing the vacuum dry work.

Even instant rotation for rotation check-up can damage the electrical insulation and cause huge damage.

- Generally the vacuum dry work is performed at a room temperature. The higher the room temperature is, the faster the vacuum dry performance will be done. Stronger vacuum quality is required to evaporate the moist in the environment of lower room temperature. The vacuum dry working procedure 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 and the diameter of the pipe as big as possible for minimum gas flow resistance.
  2) To measure the vacuum, if the pressure gauge is installed or pressure value from MICOM is available, the pressure gauge may be used.
  3) When vacuuming work, open all the valves except the valves connected to external.
  4) Allow approximately 2 hours of additional vacuum pump operation, if the surrounding temperature of the machine is above 15.6 °C, and while the vacuum pump is operated if the manometer is indicating 756mmHg. If the internal pressure of the chiller is kept below 756 mmHg, the accumulated moist in the machine would be frozen and then this ice is evaporated more slowly than in normal condition, which leads to a delay of the vacuum dry work. If there is hot water at this situation, let the evaporator and the condenser be flowed by the hot water and then operate the vacuum pump.
  5) Fasten the vacuum pump valve and stop the pump, and then record the vacuum gauge value. When reading the degree of the vacuum while the surrounding temperature varies, it has to be compensated by converting the temperature change into pressure using below equation.

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

H: Internal pressure before the inspection (mmHg)

t1: Surrounding temp. before the inspection (°C)

t2: Surrounding temp. after the inspection (°C)

Table 19. HFC-134a Temperature / Pressure

  6) The vacuum dry work is terminated 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 time of vacuum dry work, set the inner machine pressure above 9~9.5kg/cm^2.G and perform the leak inspection. After fixing the part where it is leaking, redo the vacuum dry work.

Oil charge

1) Generally the chiller is charged with the oil in the compressor when shipping from the manufacturer, but if not, follow the steps as described below.
2) Charge the oil through the charging valve located at the bottom of the oil tank. At this time, make the inner part of the machine vacuum using a vacuum pump. (If the refrigerant charging is proceeded, the charged refrigerant will evaporate and eventually the pressure will rise. Thus, do the oil charging first.) If the inner machine pressure is high, use the pump from the tank for the charging. In this case, the Discharging pressure of the pump shall be more than 14 kg/cm^2.G when the suction pressure is 0kg/cm^2.G. The oil charging or removal, however, must be done at the condition that the chiller is totally stopped.
3) The oil level must be charged more than 2/3 of the sight glass. Also if only the oil pressure and the temperature are within the designated range, oil foaming may be happening.
4) Be cautious not to let any air enter into during oil charging.

Refrigerant charge

⚠ CAUTION

When the refrigerant charging or discharging is performed on a machine that uses springs for isolation at the bottom, fix the springs not to move up and down. The spring moving may stress the connected pipe line.

1) The chiller is charged with nitrogen gas when leaving from the factory. Remove the nitrogen gas at the job-site before doing the refrigerant charging.
2) Operate the chilled and cooling water pump to prevent freezing when performing the refrigerant charging.
3) It is the most preferable to adjust the refrigerant charge amount when the Chiller is operated under the design load. Adjust the amount of refrigerant by the difference between chilled water outlet temperature and evaporation temperature and through the sight glass.

Insulation resistance test

1) Mega test is to apply the direct voltage to the insulation material to obtain insulation resistance by measuring the leaking current through the material.

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

For 3000 and 6000V class: use mega for 1000V.
For 380 and 440V class: use mega for 500V.

2) Keep away any unnecessary personnel during the test for it is using high voltage.
3) Cut all the exterior power that is supplied to the chiller before performing the test. The 3-phase motor that is for above 500hp, can cause danger due to the electric charge when the inspection was performed. Thus, completely discharge it after the inspection and then handle the ground terminal.
5) Do not perform the high voltage mega test in vacuum condition.
6) Electrical insulation resistance drops in accordance with the temperature increases, and is sensitive to the temperature change which means that it varies. The changed temperature can be written in temperature coefficient and the temperature coefficient and applied equation is as follows.

Insulation Resistance in inspecting (°C)	Temperature coefficient	Insulation Resistance in inspecting (°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. Temperature coefficient under insulation temperature

7) Other factors that influence the insulation resistance
<Pollution of the outer surface of the insulation body> If absorptive and deliquescent materials like acid, chloride and etc are adhered on the surface of the insulation body, they influence the insulation resistance. Remove the foreign substances before the inspection. <Condensing Point> If the insulation body temperature is below the surrounding temperature's dew point, moisture condensation can be preset on the insulation body surface (especially at the crack and the groove) and influence the insulation resistance. The inspection should be taken into action when the insulation body temperature is above the surrounding temperature's dew point. Record the dry bulb and the wet bulb temperature surrounding air. <Absolute Humidity> Even through the insulation body temperature is above the dew point, the atmospheric vapor influences insulation resistance. Avoid conduction test at the place where the absolute humidity is high present.

8) Apply an electric current for a minute to the spot to be measured up insulation resistance. Read and record the value. Apply the inspection standard when the insulation body temperature is 20 °C. (When measured at a different temperature, use the temperature coefficient and convert the value indicated after a minute.)

9) Taking measures according to insulated condition.

Temp. of insulation body at inspection (°C)	Value indicated 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	

❈ Motor that is within the range of "Bad" and "Re-Inspection" at the mega insulation test, must take the POLARIZATION INDEX test.

Table 21. Insulation condition

10) Polarization Index Test
Record the indicated value appeared when performing the mega test after a minute and the one after 10 minutes.

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

Condition	Insulation Absorption Rate
Danger	Below 1
Bad	Below 1,5
Re-Inspection	1.5~2
Good	2~3
Better	3~4
Excellent	Above 4

If the motor's insulation absorption rate is within the range of "Danger", must be returned or replaced.

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

Table 22. Insulation absorption rate status

11) The following should be recorded when performing the mega test
- Type and voltage of the mega tester
- Connection part of the mega tester
- Surrounding temperature and humidity of the test taking place and the tank's internal pressure in case of hermetic type
- Stoppage period before the inspection

Function test for starter and controller panel

- Test before the Start-up

1. Control Panel and Electric lines
   Cut the power and check the controlling parts and switches for any foreign substances. Also check for normal operation and terminal connection conditions by handling the switches.
2. Voltage
   Check if the voltage indicated at the voltage meter of the starter panel is identical to the rated voltage on the chiller name plate.
3. Chilled and cooling water circulation system
   Check if the chilled and cooling water operation is depicted properly on the display by activating individual pump.

- Control Device Operation Test

1. Check the wiring condition
   Check whether the wiring of power, sensor, etc. are properly connected.
   Special checking should be taken to power line.
2. Check the display condition after control power in
   Be more cautious if there is any symptom of getting short for 5 seconds after the power is in.
   If problem occurs, immediately cut the power and check for abnormality.
3. Check values displayed on the panel
   Check if the display indicating sensor values are normal.
   If the sensor indicates abnormal or error message is displayed, check the connection of the sensors.
4. No power operation
   While the power of the main motor is cut, operate and check whether the operation is normal up to the Starter panel operation signal. If a message displayed for abnormality, check the part.

- Check of Safety Device

Flow operation test for chilled water and cooling water

- Close the valves located at the pipe of the chilled and cooling water, and check whether the differential pressure switches for flowing are working properly or not.

5-3. Start-up

• After the preparation is done for start-up, proceed as follows.

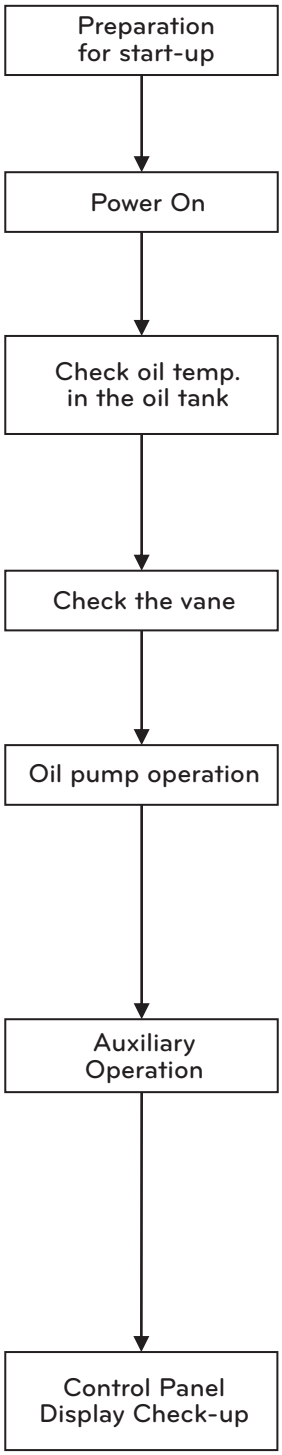
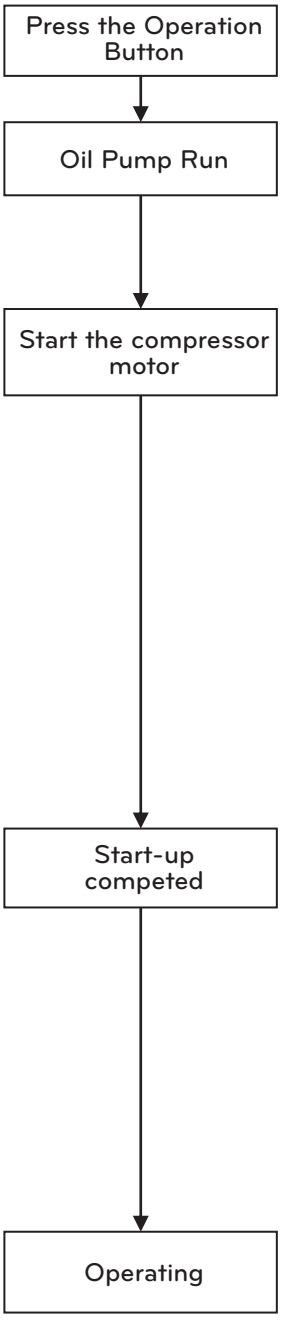


Figure 60. Start-up procedure

1) Input power to the control panel and the starter panel, and check the status.
2) Input power to the oil heater 1~2 hours prior to the main operation and make sure that the temperature of the oil inside the tank is 30~65°C.
3) After checking the vane opening as 0%, set the vane's operation to "Auto". The vane is to maintain 0% on any condition of "Auto", "Open", "Stop", "Closed" when the chiller stops.
4) Set the oil pump condition of the control panel to "Auto".
5) Activate the chilled water pump. When operating, close the outlet valve, open the air ventilation valve and then open the outlet valve to a small carefully to avoid water hammering so that necessary amount of flow passes through. If water keeps coming out after the air discharged through the air outlet, close the air valve.
6) Activate the cooling water pump. Caution required just as step 5).
7) Check the control panel display if it is working properly. Check if the display is showing local operation mode and chiller's possible operation condition.

- If the chiller is working under Local Operation Mode, follow the steps as follows. If strange situation is detected, shut down the chiller immediately and follow the "troubleshooting" procedure. For more detailed information, refer to the "Check list".



1) Checking the oil pressure
   When the operation button on the control panel is pressed, oil pump will be activated that leads to an increase in the oil pressure and if the differential pressure between supplying oil to the bearing and the inner tank oil lasts for 120~180 sec. over 0.8 kg/cm^2, the compressor motor will be operated.
2) Direction of the compressor motor's rotation.
3) Starting characteristic
   At this time, 2 items check-up is needed simultaneously. Make sure 2 people are working together.
   - Direction of the motor's rotation
     Record the rotating direction at the counter load part of the motor. If the direction is opposite, stop the chiller and change the two among three phases.
   - Starting Characteristic
     Check the starting current, acceleration completion time as on the "Check List".
4) Check the Operating Current
5) Motor Cooling Status
   - Operating Current
     After the start-up is done, the vane will be opened gradually and the current increases simultaneously. Operation current should not exceed the rated current.
     If exceeds, set it referring to the “capacity control module.”
   - Motor Cooling Status
     Periodic physical check-up of the motor surface temperature is required while operation.
   - Checking the oil tank and the bearing temperature
     Check if the oil tank and the bearing temperature is preserved at 40~65°C. If not refer to "Trouble Shooting" and "Check List".
6) Checking all sorts of pressure status
7) Checking the operating sound and vibration
8) Chilled-water inlet and outlet temperature
9) Cooling-water inlet and outlet temperature

Fig 61. Start-up procedure (2)

• Load Operation and the Operational Setup

After the Start and the Stoppage operation, perform the Load Operation as follows.

In any cases, let do not exceed the electromotor rated current.

As mentioned already at the "Product Protection Function", it would not be able to be overloaded due to the set of the motor current limiting function, but please double check.

Set the temperature control function according to the load.

Set the user's setting function as mentioned already in the "Product Protection Function".

When performing automatic operation

Set the vane operation mode to auto

1) In case of load increasing
   To preserve the chilled water outlet temperature, the guide vane is opened up to the electromotor rated current.
2) When the load is parallel with present performance of the chiller
   The guide vane is stopped at a certain degree of opening.
3) In case of load decreasing
   - In opposition to 1), to preserve the chilled water temperature the guide vane is close.
   - When the load is continuously decreased, the chilled water outlet temperature will be decreased and the chiller will be stopped by the function of "Chiller operation/stoppage". If the chilled water outlet temperature increases to the level of setup temperature, it will be operated automatically.
   - The oil pump will perform additional operation even after the chiller's shut down.
     The purpose of this action is to preserve the oil pressure (for inertia operation of about 1 min. after the chiller shut down) and to protect the electromotor from frequent start and stoppage.

5-4. Startup procedure after long-period of stoppage

When letting the chiller to be still for a long period of stoppage, the refrigerant must be transferred to a separate refrigerant pot to prevent machine pressure decrease and leak.

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

If the installed area of the chiller is frequently a place of below zero, drain the chilled water, cooling water and the condensing water to prevent freezing. Also waterbox drain must be opened.

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

Before operating the centrifugal chiller after long-period of stoppage (longer than 1 month) or instant stoppage (less than a month), follow the next steps.

1. The machine should be checked for unstable part or for abnormality for smooth operation.

2. To prevent refrigerant loss due to leak during the stoppage, following steps must be taken.
   1) Compressor (simple inspection over the rotating part)
   * Simply check from the appearance of the impeller, bearing and rotating part.
      ◇ Combination status of the impeller and the shaft
      ◇ Assemble condition of the Gear
      ◇ Foreign substance in the gear box
      ◇ End play of the impeller shaft
      ◇ Assemble condition 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
      ◇ Loosen and crack of the oil pipe
      ◇ Replacing or clearing the oil filter
      ◇ Cleaning the oil tank
      ◇ Replacing the oil
   3) Refrigeration System
      ◇ Check the refrigerant pollution possibility
      ◇ Clean the ejector
      ◇ Clean the tube
      ◇ Water quality analysis
      ◇ Exchange or clean filter related parts
   4) Condenser, Evaporator Preservation (Corrosion countermeasures while stoppage)
      During a long term period stoppage, follow the next steps for the corrosion countermeasures due to condenser and evaporator tube corrosion.
      - Each tube should be brushed and the scales must be removed completely. Fill it in with clean water. Finally preserve it with rustic proof material in it.
      - In principle preserve the chiller without water after complete drain.
      - Execute all regular maintenance check-up and the inspection for the operation system with care. Controlling test should be taken before the main operation.
        If the compressor oil indicates an abnormal high-level display, there are possibilities that the oil absorbed the refrigerant.

3. Start the machine in accordance with “Start-up” after checking the 1~2 items.

5-5. System Shutdown

• When stopping the product, perform it in the following order.

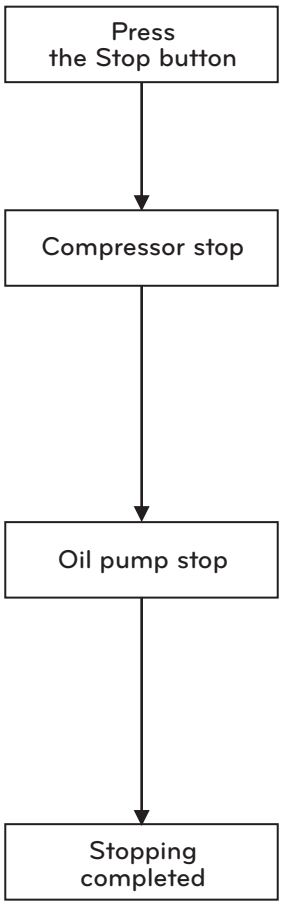


Figure 62. Stopping Procedure

1) The vane is automatically closed when the stop button on the control panel is pressed.
2) Check the compressor motor stoppage time
   - Measure the delay time to the compressor's mechanical stop after the chiller's shutdown; the delay time due to motor's inertia moment.
3) Check the oil pump remaining operation
   - Check if the oil pump is operating till a resolved time after the chiller's shut down.
4) Checklist after stoppage
   - Stop the cooling water pump.
     In this case, close the outlet valve of the pump gradually and then stop the cooling water pump.
   - Stop the chilled water pump.
     Close the outlet valve of the pump gradually and then stop the chilled water pump.
   - Record the oil and the refrigerant level after stop.

6. MAINTENANCE

6-1. Maintenance criteria

Maintenance and overhaul inspection (repairs)

• Usage Deterioration of Machine

Although there may not be any malfunction or structural deformation of the machine, it generally can be worn or aged after a long time usage. Though a centrifugal chiller which has been operated for a long time is operating, the motor can be declined and abrasion of the rotating section due to the secondary creation caused by oil burning, carbonization and etc. In many cases, such symptoms can normally be detected externally by the vibration and abnormal sounds that are present. In these cases, it is very important to take preventive action prior to the occurrence of accident and maintain a proper working condition for the sake of the machine's longer life.

• Examination and thorough overhaul (Repair)

The trouble ratio of a machine is normally distributed as the following Fig.

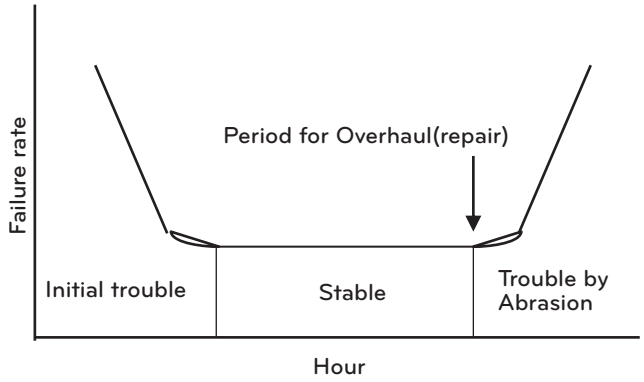


Figure 63. Machine failure rate

<Period of Initial Failure> occurs at the beginning stage of the machine’s operation due to the manufacturing matter from the factory itself.

Then it enters the <Period of Stabilization> that is followed by the <Period of Abrasion> after a certain period of time.

If it enters to the <Period of Abrasion> region, possibility of the machine's failure is going to rise up. Thus, it is very essential to take thorough overhaul (repairing) action will prevent accidents and allow an optimum maintenance.

We recommend on the basis of a long term experience and statistical data that you take the thorough overhaul (repairing) action at the following period.

1) Chiller for commercial cooling : Every 5 years

2) If is an industrial process machine that is working throughout the whole year and requires a high reliance: Annually

• Criteria for Overhaul

Accidents may take place if there are irresistible abrasion and deformation that leap over the assigned limit of the machine’s individual parts.

For instance, if the bearing wears out, the destroyed oil film will cause the metallic contact to happen, which will lead to a high possibility of the bearing burning out.

The impeller itself might be able to have a contact with other parts and be destroyed. If the central distance of the velocity increasing gear leaps over a certain number, teeth of gear could also be destroyed.

Thus LG Electronics sets up (1) Utilization Limit (2) Exchanging Standards and based on these criteria, "Thorough Overhaul Procedure" was made to maintain the chiller under proper operating condition till next overhaul period, and according to this standard, composing parts can be inspected and replaced.

• Merits of the Maintenance Contract System

(1) Economic Efficiency

- Deterioration of machine can be minimized by a regular maintenance action.
- As machine life id prolonged, the possibility of huge accident is reduced, which can save maintenance cost.
- As the contact is performed based on yearly predetermined cost, the effective management over the budget of the maintenance cost can be possible.
  In order to prevent an unexpected cost caused by a sudden breakdown a counseling service with the customer is provided in advance.
- Opportunity loss of customer's production process resulted from the unexpected stop of machine can be eliminated.

(2) Safeness

- Through checking a lot of safety devices, safe use of the machine without trouble can be possible.
- As a regular inspection is applied before trouble, breakdown is prevented beforehand.
- In case of maintenance contract, as training is provided, operator's management skill over the machine is developed.

(3) Quickness

- As machine status can be always checked through a regular inspection, precise instruction can be given to even a trouble notice by phone call.
- Maintenance Contract machines will get the premium service as the first creditor even during the rush season when there are plenty of service loads.

Maintenance Contract Work Details (Standard)

1. Inspection before the start cooling

(1) Air-tightness Test
(2) Refrigerant charging
(3) Electricity related insulation test
(4) Safety device setting
(5) Function test between Starter panel ~ Control panel
(6) Vacuuming
(7) Chiller operation setup

2. Maintenance during the cooling period (1 time)

(1) Electricity related insulation test
(2) Checking the operation Setup
(3) Chiller operation setup

3. After finishing cooling season

(1) Refrigerant full extraction
(2) Nitrogen gas charging & sealing
(3) Filter checking(Replacing)
(4) Cleaning oil tank
(5) Checking the operation record
(6) Checking sensors (Replacing)
(7) Picking Oil
(8) Air tightness test
(9) Electricity-relate insulation test
(10) Function test between Starter panel ~ Control panel
(11) Checking the oil pump
(12) Chiller operation setup

4. Water quality analysis (1 time)

• Chiller for Annual Operation

1. Check-up during the Operation period (5 time)
   (1) Electricity related insulation test
   (2) Inspection the operation record
   (3) Chiller operation setup

2. Overall Maintenance (once)
   (1) Refrigerant full extraction
   (2) Nitrogen gas charging & sealing
   (3) Filter inspection (Replacing)
   (4) Cleaning oil tank
   (5) Checking the operation record
   (6) Checking sensors (Replacing)
   (7) Oil extraction
   (8) Air tightness test
   (9) Electricity-relate insulation test
   (10) Function test between Starter panel ~ Control panel
   (11) Checking the oil pump
   (12) Chiller operation setup

3. Water quality analysis

• Standard Maintenance Frequency

(1) Chiller for Cooling only; Cooling Start x 1, During operation x 1, Cooling Completion x 1
(2) Chiller for Annual Operation : During Operation x 5, Overall Maintenance x 1

• Excluded Items

(1) Cleaning the Heat Exchanger
(2) Overhaul(repair)
(3) Items that are not listed in the contract

Overhaul(repair)

• Compressor

1. Compressor Overhaul(repair)
   (1) Preparation
   (2) Disassemble Compressor
   (3) Check capacity controlling device
   (4) Inspection over the Compressor parts and cleaning
   (5) High-speed gear inspection
   (6) Inspecting Impeller shaft
   (7) Assemble Compressor
   (8) Check Flow rate
   (9) Putting parts
   (10) Cleaning

2. Auxiliary Work
   (1) Air-tightness Test
   (2) Vacuum drying
   (3) Nitrogen gas charging & sealing
   (4) Full extraction of Refrigerant
   (5) Refrigerant charging
   (6) Extraction of the Oil
   (7) Cleaning the Oil tank
   (8) Inspect the Filter types
   (9) Electricity-relate insulation test
   (10) Checking the Oil pump
   (11) Inspect and control over the safety device
   (12) Starter panel ~ Control panel operating test
   (13) Chiller operation setup
   (14) Check over the operation record

• Motor

1. Motor overhaul (repair)
   (1) Check Stator coil and rotor
   (2) Check the Parts
   (3) Measure Shaft Vibration, Concentricity degree
   (4) Air gap, End Play measurement
   (5) Gear disassemble and assemble
   (6) Electricity wiring disassemble and assemble
   (7) Insulation Resistance Measurement
   (8) Winding Resistance measurement

2. Auxiliary works
   (1) Refrigerant , Oil pipe Disassemble and Assemble

• Standard Contract Disassemble Inspection(Repairing) Parts

1. Compressor
   (1) Bearing
   (2) Shaft labyrinth
   (3) Impeller shim (1st level, 2nd level)
   (4) O-ring, Gasket
   (5) Oil filter

2. Motor
   (1) Bearing
   (2) Rear cover
   (3) O-ring, Gasket
   (4) Filter Drier, Moisture Indicator

• Excluded Work from standard

1. Starter panel Disassemble Inspection(repairing)
2. Replacing Motor Coil
3. Cleaning the Heat exchanger

• The Others

1. Compressor
   (1) Impeller
   (2) Diffuser
   (3) Impeller cover
   (4) Impeller shaft
   (5) Return channel 1, 2, 3
   (6) Gear
   (7) Plate type Heat exchanger
   (8) Capacity adjustment device
   (9) Lock nut, bolt

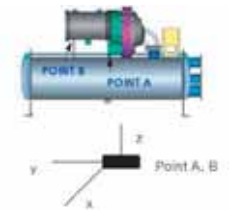
2. Motor

6-2. Periodic maintenance

Daily inspection

Checks the evaporator and condenser pressure, oil tank pressure, differential oil pressure and discharge oil pressure of the chiller. Compare the values with the ones of the general chillers maintenance table.

- Compressor and motor daily inspection standard

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 Ear	
		Measure using the vibration measuring instrument if necessary	
		Noise: Below 85dB	
		When there's no abnormal vibration	
		below x,y,z: 25 m	

* The motor adopts liquid refrigerant cooling system. It supplies the liquid refrigerant by the differential pressure between the condensing and evaporation pressure.
* Check and make sure that the refrigerant liquid supplying line's moisture indicator is showing green.
  If the green color is altered to yellow, it means that the moisture quantity has exceeded more than the standard quantity in the machine. Thus, replace the filter dryer.

Fig 64. Compressor and motor daily inspection standard

- Daily inspection of Condensers

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 below 21°C, condensing pressure would be decreased, which will lead to a lack of differential pressure at the motor cooling and the oil cooler and finally become the situation of insufficient of cooling water.

The main cause of worsening the heat exchange can be seen for the scale attached inside cooling pipe and insufficient cooling water amount.

Fig 65. Condenser daily inspection standard

- Evaporator daily inspection standards

Classification	Inspection items		Inspection method	Criteria
Evaporator	Chilled water	Inlet	Check at the Panel	Below 5~15°C
		Outlet	Check at the Panel	Above 3°C
	Above 3°C		Check at the Panel	5~10 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 evaporation pressure is decreased, the evaporator tube freezes and eventually damaged, or compressor surge would also be possible. Causes of the decreased evaporating pressure would be insufficient refrigerant quantity, low temperature water and abnormal heat exchanging efficiency. Like the condenser tubes, if foreign substances are in or the scales adhered, corrosion may occur which will lead to a in efficient heat exchanging. This happens to decrease the refrigeration ability or may be the cause for surge.

Fig 66. Evaporator daily inspection standard

- Daily inspection standard of Compressor and motor. Generally, the failure ratio of a machine is distributed as the shape drawn in the following Fig.

Classification	Inspection items	Inspection method	Criteria
Oil	Oil amount	Visual inspection	At least one of two sight glasses should have oil level appearance.
	Temp.	Check at the Panel	30~60°C
	Differential Pressure	Check at the Panel	0.8 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 67. Compressor and motor machine failure ratio

<Lubrication cycle>

The oil is taken through the manual valve into the tank. The level of the oil can be detected by the one sight glasses on the oil tank. When the compressor is stopped oil should be able to be found through the sight glass.

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

The oil pump transfers the oil from the tank and the pressure at that time would be above 0.8kg/cm^2.

The oil pump is sending the oil to the oil filter, where a valve is installed so that there is no need to drain the whole system when replacing the filter.

Afterwards the 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.

Oil that left the cooler passes through the oil pressure transducer and then to the refrigerant expanding valve's temperature sensor box, flows to the 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 that is located at the lower part of the compressor.

The control device operates the oil to the oil pump prior to the main operation for 120~180 seconds at a constant pressure. At stoppage when the main operation has stopped, it performs a 300 seconds of after lubrication.

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

If the guide vane opens too quickly, it will let the refrigerant in the oil to be boiled because of the intake pressure's rapid decrease, which will eventually cause foaming. This foaming will lead to dropping the pressure in oil pump, and the low pressure of oil lead finally bad lubrication.

Monthly inspection

- Compressor and motor monthly inspection standard

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.)

Fig 68. Compressor and motor monthly inspection standard

- Generally the starting current of the motor is about 600% that of the rated current in direct input. And in case of y-Δ , it is 200%, for kondorfer 250%, and for Reactor 400%.
- Measuring frequency and record should be at least once a month for daily/monthly inspections. This data can be the clue of solution if problems are occurred to the motor.

- Lubrication system monthly inspection standard

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

Fig 69. Lubrication system monthly inspection standard

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

Fig 70. Yearly inspection standard

<Water quality analysis>

The cooling water at the open circulation type cooling tower uses the evaporation latent heat to lower down the water temperature and also recycles it.

At this time the water evaporates and the chloride ions in the water and the acid ions will increase. This will lead to enrichment situation and eventually deteriorate the water quality.

Also, in the cooling tower, water and air are always in contact with each other and the contaminating material(automobile exhaust gas, sulfurous acid gas, dust, gas of chemical plants such as ammonia or petroleum gas, etc.) deteriorates the water quality even more.

These pollutant causes can corrode the pipe, scales adhered causes the tubes to have holes and lockouts which are leading to a decreasing effect of heat exchanger.

Therefore, it may end to replacing the tubes, increased power cost, or the chiller failure.

Thus, cooling water quality must be maintained at a certain level.

Water quality analysis should be taken place periodically and if the results are out of the standards boundary(Table 23.), it must be replaced. At the beginning of the season and at the initial starting of the machine, water quality analysis is inevitable.

To prevent the cooling water enrichment, certain amount of cooling water should be drained during the circulation and then supplying fresh cooling water. Another way of water quality analysis would be using chemical handling.

<Tubes State>

If water corroded dirt is adhered or foreign substances are mixed in the tubes, resistance is increased which makes it hard for the chiller to have a good efficiency. It also makes it easy to cause surge.

If sandy like solid materials are mixed in the cooling water, erosion or corrosion may occur at the entrance of the tubes, therefore when cleaning the tubes make sure that you check the inner surface of it.

Install a filter at the inlet of the cooling water pipe. Generally, a cooling tower is used for the cooling water system, but when using the subterranean water or the riparian water it is possible for the scales to be adhered easily due to low quality of water compared to the chilled water.

	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 below 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 refers to the factor related to the corrosion or scaling trend.

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

(4) If the temperature is high (40°C or above), generally the corrosion rate becomes high especially for steel that directly contacts water without any protective coating. It is recommended to have an effective plan for the water such as adding anti-corrosive additive or air removal process, etc.

Table 23. Water quality management standard for chilled water/cooling water

Refrigerant and oil charge amount
Single stage centrifugal chiller

Frame	Refrigeration capacity (RT)	Amount of refrigerant (kg)	Oil quantity (L)
3	250 ~ 400	450	40
4	500 ~ 600	550	40
5	650 ~ 850	750	60
6	900 ~ 1300	950	62
7	1400 ~ 2000	2100	120

Table 24. Refrigerant and oil charging amount for Single Stage centrifugal chiller

6-3. Maintenance during off-season

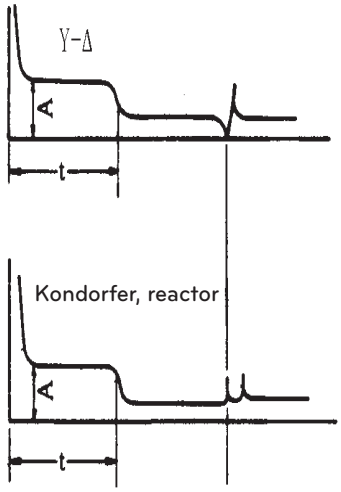
(1) If the operation needs to be stopped, to reduce the machine pressure and leak possibility, move the refrigerant to a separate refrigerant container.

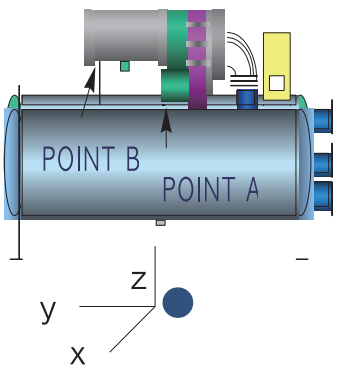
(2) To prevent intake of air into the machine, store the machine with about 5kg refrigerant charged or to apply 0.5kg nitrogen.

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

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

6-4. Annual maintenance(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="13">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>Pass Fail</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 rowspan="2">T1: start-up timer
T2: subsi -diary timer</td></tr>
<tr><td colspan="2"></td><td colspan="2">Start-up current: A</td><td>A=
A</td></tr>
<tr><td colspan="2"></td><td colspan="3">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></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>Pass Fail</td><td></td></tr>
<tr><td>Check opening status</td><td>Shall operate smoothly</td><td>Pass Fail</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>Pass Fail
Xa =μ
Ya =μ
Za =μ
Xb =μ
Yb =μ
Zb = μ</td><td></td></tr>
</table>

6-4. Table for Annual maintenance(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	Pass Fail	
Lubrication system	O	Oil amount		Visual inspection	Check with sight glass on the gear box during operation	Pass Fail	
	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 (0.8 kg/cm^2 or more)		
	O	Oil pressure vibration		Vibration of the pressure value		Yes No	
	O	Oil leakage		Oil system visual inspection		Pass Fail	
	O	Oil pump noise		Check with ears		Pass Fail	
	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%	Pass Fail	
		Chilled water differential pressure switch		Decrease chilled water amount to check the operation		Pass Fail	
		Cooling water differential pressure switch		Decrease cooling water amount to check the operation		Pass Fail	

Table 25. Table for Annual maintenance

6-4. Table for Annual maintenance

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 the problems happened due to the reasons as follows; poor water quality, customer's poor maintenance and natural disaster.
2. Overhaul for the compressor should be done in 5 years or in 10000 hours, whichever comes first.
3. Beware that some items can be changed without prior notice for the product improvement.

Table 26. Operation Inspection table

6-5. Oil maintenance

Compressor oil replacement

- Checking the Lubrication System

Record the level of the oil on the oil tank sight glass in operation, and check the level when the chiller is stopped. If the level has dropped below the lower part sight glass, it is necessary to check whether the oil recovery system is working properly. If oil is needed, add it through the oil charging valve. To charge the oil opposite from the refrigerant pressure, a pump is needed. The charging quantity of the oil should be referred to LG Electronics and the specification of the additional oil should match with that of LG Electronic's chiller oil. Added oil shall be recorded for its amount and date.

- Oil specification

Use oil recommended by LG.

Category	Unit	Characteristic 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		1	Anti-corrosion ability of the oil
(100 °C, 3h)			

Table 27. Oil specification

<Available oils>

- Oil from LG
- Japan sun oil : Icecold SW68
- Castrol : Castrol Icematic SW68

• Oil replacement

We recommend you to replace the oil on the first year of the chiller's operation and every 3-year period depending on the oil analysis.

1) Mark the current oil level.
2) Open the control circuit breaker and oil heater circuit breaker.
3) Gradually open the oil charging valve to drain the oil. Opposite from the chiller pressure, open the valve very slowly.
4) After locking the valves at both ends of the oil filter, use the valve to gradually reduce the pressure within the oil filter, and change the oil filter.
5) Charge oil to the machine using a pump.
   To be charged till the level of middle or higher at the sight glass, approximately 50~60ℓ of oil is needed. Heat until the oil temperature reaches 40°C by turning on the oil heater. For the sake of controlling test, operate the oil pump manually for 2 minutes. The level of the oil should be indicating at the sight glass.

Oil Filter Change

- Oil Filter Change

Replace the oil filter annually or in the time of overhaul.

Oil filter can be replaced in a condition that the refrigerant is in the chiller.

1) Check if the compressor is in the stop state and also if the compressor circuit breaker is opened.
2) Shut down the oil pump power.
3) Close the oil filter separator valves.
4) When opening the oil filter housing, do it slowly.

⚠ CAUTION

Decrease the pressure of the oil filter housing very slowly because it is in a high temperature state.

5) Make vacuum in the filter housing after the filter exchange or assembling. After the vacuum has been done, open the separation valve and if there is insufficient amount of oil, add oil through the charging valve.

6-6. General Maintenance

Non-periodical maintenance

- Maintenance of the compressor bearing and the gear
  The core of maintaining bearing and the gear can be said adequate lubrication. Preserve the recommended oil amount, temperature and pressure by using the right level of oil. Do a thorough maintenance check-up on the lubrication system periodically. To inspect the bearing, the compressor must be completely disassembled.
  To take out the bearing and to inspect it, a high technology specialist is needed. Excessive abrasion can occasionally be detected by excessive vibration or by the bearing's temperature.

- Refrigerant leak inspection
  HFC-134a has higher pressure than air in room temperature, so it requires the refrigerant leak test utilizing electronic detector, halogen leak detector or soapy water.
  If the refrigerant leak is overall the entire chiller with large volume, immediately stop using the system and fix it first. If the refrigerant was lost or the machine has been opened during the service period, the chiller itself or related tank must be taken leak test by adding pressure.
  Refer to 5-5-2 for leak inspection.

Charging refrigerant and leakage test

- Refrigerant characteristics
  Usage refrigerant is HFC-134a.
  HFC-134a evaporates at -26°C in normal air pressure, so it shall be stored in a pressured container or storage tank.
  Refrigerant has almost no smell when it is mixed with air, and it is non-combustible in air pressure.

⚠ CAUTION

The refrigerant HFC-134a dissolves oil and some non-metallic material, dries skin, and makes oxygen deficiency resulting in suffocation at high concentration. Thus be very careful not to inhale or touch by hand or eye contact 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 28. The property of HFC-134a

- The adjustment of refrigerant charging amount

  If it is necessary to control the refrigerant charging amount for a better performance of the machine itself, operate the machine in a design load and add or remove the refrigerant until it satisfies the difference temperature of the chilled water outlet and the evaporator refrigerant.
  Do not over charge. Refrigerant can be charged through the storage tank or directly charged into the chiller.

- Refrigerant leak inspection

  HFC-134a has higher pressure than air in room temperature, so it requires the refrigerant leak test utilizing electronic detector, halogen leak detector or soapy water. Check for a good room ventilation and check whether the leaked refrigerant is concentrated in one place of the room to prevent a wrong measurement result.
  Before performing any repair for leak, move all refrigerant from the leaked container.

- Refrigerant leakage

  If there is large refrigerant leak, chiller performance degraded or operation impossible, it is recommended to stop the chiller and repair first.

- Refrigerant filter

  Refrigerant filter /drier in the refrigerant cooling pipes of the motor needs to be replaced once a year. It may require more frequent replacement according to the status of the filter. To find the existence of moisture in the refrigerant, sight glass is installed next to the filter. If moisture through the sight glass is detected, perform a thorough leak inspection to find the source of the water.

Cleaning Heat exchanger tubes (Evaporator/Condenser)

Inspect Heat exchanger tubes

- Evaporator

  When the first operation season is over, clean the evaporator tubes.

  These tubes have foreign substances inside. Thus to clean the tubes thoroughly, a special caution should be exercised. The tubes condition, at this time, will become the data to determine how often tubes needs to be cleaned and whether the water treatment in the chilled water(brine) system is appropriate. Check for any corrosion or scale in the chilled water inlet/outlet temperature sensor. For corrosion, replace the sensor, and for scale, remove the scale.

- Condenser

  Cooling water circuit is generally an open type system, so it is easy to have the tubes contaminated and scale to be adhered. Therefore, the tubes in condenser need to be cleaned at least once a year. If the water quality is contaminated, clean more frequently. Check the corrosion or scale in the cooling water inlet/outlet temperature sensor. For corrosion, replace the sensor, and For scale, remove the scale.

  The reason that it is higher than the normal condenser pressure and not reaching previous chilling load is generally because tubes are contaminated or there is an air in the machine.

  If the temperature difference between cooling water outlet and condenser refrigerant is great, the condenser tubes may be contaminated or water flow is not good.

  HFC-134a is a high pressure refrigerant, so it is easier to have refrigerant leak than air enters inside.

  During the cleaning of the tube, use a specially designed brush to prevent scratch on the tubes wall.

  Never use wire brush.

⚠ CAUTION

For the prevention of severe scales and the removal of the scales, treat with chemical. For a proper treatment, consult with water treatment specialist.

Check items before operation after long term stop

- Check list before start-up

1. Control Panel and Electric lines
   Shut down the breaker, check for any foreign substance in the control parts, switches, etc.. Controls the switches to check whether it operates in normal and connection status for each connector are OK.
2. Voltage
   Read the voltage meter on the starter panel and check if it matches with the usage voltage on the name plate of the chiller.
3. Chilled and cooling water circulation system
   Operate cooling water and chilled water pumps to check if their operation status are properly displayed on the panel.

- Control device operation test

1. Check the connection condition
   Check if the power, sensor, etc. are properly connected.
   Special checking should be taken to power line.
2. After power on, check the display status of the panel.
   Pay special attention if there is any sign of short circuit for about 5 sec. after power on.
   If any of the following symptoms occur, immediately disconnect power and check for problem.
3. Check values displayed on the panel
   Check whether each sensor value displayed on the panel is correct.
   If any error message is displayed or sensor value is not normal, check sensor connection status.
4. No power operation
   Run while the main motor power is off, and check for normal operation to the operation signal of starter panel.
   If any error message appears, check the corresponding part.

- Check safety devices

Flow operation test for chilled water and cooling water
Close the valves installed on the cooling water and chilled water pipes to check whether the flow checking switch is working correctly.

7. TROUBLESHOOTING

7-1. Causes and actions for alarms

Actions for problems

- How to react to the problem display from controller
- Please take actions according to the following instructions

  Check the displayed contents and refer to the help message. Select help menu corresponding to the problem message and check the contents of the problem and how to react. Remove the cause of the problem according to the parts or drawing of the circuit related to the problem or manual. If the contents for the problem is no in the manual or drawing, consult our experts. Check the temperature control status, pressure status, etc.

Troubleshooting (1/3)

Abnormal category	Displayed contents	Cause	Action
Chilled Water Inlet temperature Sensor	Chilled Water Inlet temperature Sensor Error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Chilled water outlet temperature sensor	Chilled water outlet temperature sensor Error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Cooling water inlet temperature Sensor	Chilled water outlet temperature sensor Error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Cooling water outlet temperature Sensor	Chilled water outlet temperature sensor Error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Compressor discharge temperature sensor	Compressor discharge temperature sensor error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Bearing temperature sensor	Bearing temperature sensor problem	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Motor winding R phase temperature sensor	Motor winding R phase temperature sensor error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Motor winding S phase sensor	Motor winding S phase sensor error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Motor winding T phase sensor	Motor winding T phase sensor error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Evaporator pressure sensor	Evaporator pressure sensor error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Condenser pressure sensor	Condenser pressure sensor error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Oil tank pressure temperature sensor	Oil tank pressure temperature sensor error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Oil pump pressure sensor	Oil pump pressure sensor error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Current transducer	Current sensor error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`
Voltage transducer	Voltage sensor error	Sensor disconnected/short-circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire`

Troubleshooting (2/3)

Abnormal category	Displayed contents	Cause	Action
Power transducer	Power sensor error	Sensor disconnected / short circuit	Main board malfunction Check parts status or wiring Replace parts or re-wire
Compressor discharge temperature	Compressor discharge temperature high	Compressor discharge temperature is detected to be over 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 high	Oil tank temperature is detected to be over set value	Check 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 screen. 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 screen. Check the set value and correct if it is wrong
Motor Winding high temp. contact	Motor Winding high temp. active	Motor winding high temp. contact is active	Check motor winding temp. Check winding high temp. contact status and wiring status
Chilled water outlet temp	Chilled water temp low Error	Chilled water outlet temp. is detected to be below set value. There is no or small cooling load	Check chilled water outlet temp. or temp. on the thermometer. Check the set value and correct if it is wrong
Evaporator pressure	Evaporator pressure low	Evaporator pressure is detected to be below set value.	Check evaporator pressure displayed on the controller screen. Check the set value and correct if it is wrong
Oil differential pressure	Oil differential pressure low	Oil differential pressure is detected to be below set value.	Check oil differential pressure displayed on the controller screen. Check the set value and correct if it is wrong
Main power voltage	Main power voltage problem	Main power voltage is detected to be below set value.	Check the voltage of main power and the voltage set value. Check the status of the related parts and wiring Replace parts or repair
Starter panel abnormal	Starter panel abnormal	Starter panel abnormal, contact is active	Check the contact status of the starter panel and remove the cause of the contact. Check related parts status or wiring Replace parts of malfunction or re-wire
Start-up failed	Start-up failed	During the start-up 2M magnet switch is not working	Check 2M magnet operating status. Check the status of the parts or wiring Replace parts or re-wire
Chilled water pump Interlock	Chilled water pump Interlock Error	Pump interlock signal is disconnected during normal operation. Pump stopped Wrong wiring IO board malfunction	Check parts status or wiring Replace parts or re-wire
Cooling water pump Interlock	Cooling water pump Interlock Error	Pump interlock signal is disconnected during normal operation. Pump stopped. Wrong wiring IO board malfunction	Check parts status or wiring Replace parts or re-wire

Troubleshooting (3/3)

Abnormal category	Displayed contents	Cause	Action
Vane closed switch	Vane is not closed	Start Vane Close Switch is open	Check vane closed switch operation status and wiring. Adjust position of vane closed switch or re-wire
Condenser high pressure	Condenser high pressure contact active	Condenser pressure is higher than the pressure switch set status	Check condenser pressure. Check condenser high pressure contact status or wiring Replace parts or re-wire
Evaporator refrigerant low temp.	Evaporator Refrigerant Low Temp Contact Activate	Evaporator refrigerant temp. is lower than the switch set status	Check evaporator refrigerant temp. Check evaporator refrigerant low temp. contact status or wiring Replace parts or re-wire
Surge occurred	Surge occurred	Surge occurred	Check surge current change amount Reset the surge protection area
Oil pump	Oil pump overload contact active	Oil pump current is more than overload set current	Check oil pump overload setting status and wiring Replace parts or re-wire
Chilled water flow interlock	Chilled water flow low abnormal	Flow signal is disconnected during normal operation. Pump stopped Flow (differential pressure) switch setting problem. Wrong wiring. IO board malfunction	Correct set value and check Check parts status or wiring. Replace parts or re-wire
Cooling water flow interlock	Cooling water flow low abnormal	Pump interlock signal is disconnected during normal operation. Pump stopped Wrong wiring. IO board malfunction	Check parts status or wiring. Replace parts or re-wire
Start-up competed signal (2M)	Delta contactor open during operation	Delta contactor signal is disconnected during operation	Check parts status or wiring. Replace parts or re-wire
Evaporator refrigerant temp.	Evaporator refrigerant temp. low temp. problem	Evaporator refrigerant temp. is detected to be lower than set value	Check evaporator refrigerant temp. 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 status or wiring. Replace parts or re-wire
Sensor correction	Set value is damaged. Sensor needs to be set	Sensor is not corrected	Calibration using precision resistance device
Main board	Main board reset	Main board is reset during operation	Check voltage applied to the controller and wiring. Remove cause of noise.
Display device	Display board reset	Display board is reset during operation	Check voltage applied to the controller Remove cause of noise. Check wiring

Table 29. Troubleshooting

Remedy for abnormal status

Vane sensor error

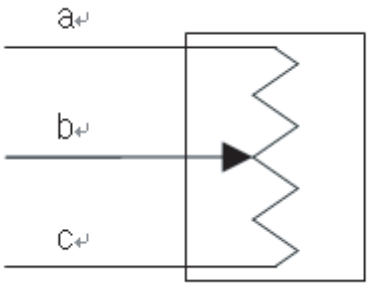


Fig 71. Vane sensor

Vane sensor

Release vane sensor connection from the relay board. After converting the tester to the resistance measurement mode, measure resistance between a and b, and there shall be a certain resistance. And after converting the vane to manual operation, when the vane is moved, there shall be vane sensor movement and change in resistance value. Even if the vane sensor is moving but there is no change of resistance value, wiring is wrong or vane sensor is damaged. While vane is completely closed, and opened completely, if the resistance between a and b increases uniformly and resistance between b and c of the vane sensor decreases uniformly, vane sensor is OK. Also measure resistance between a, b, c, and main body, and it shall not be angle line.

If the vane sensor is normal, re-connect the sensor, completely close the vane, and check if vane value is 0% and 100% after completely opening. If the value changes and vane opening % is wrong, sensor needs to be set again.

If there is no change of value, check if 100% is set in 'sensor setting-guide vane setting" category, and check if A/D value sensor value changes when vane moves. If sensor value changes, set vane again.

If sensor value does not change, convert tester to DC voltage 30V measuring position, and when voltage is measured with + at the point where vane sensor "a" is connected and – at the point where vane sensor c is connected, DC 5V must be measured.

If the voltage is not correct, check relay board main input power.
If relay main power is normal, vane sensor is normal, and sensor value does not change, then replace relay board.

Temp. sensor(PT-100) problem

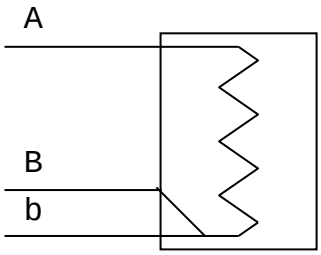


Fig 72. Temp. sensor

Release the temperature sensor connection from the controller and after converting the tester to resistance measurement mode, and when resistance between A and B, b is measured, the resistance shall be between 84.27Ω(-40°C) and 153.58Ω(140°C). (If you check from PT-100 temperature table, you can find the value corresponding to the actual temperature) If the resistance value is outside the measurement boundary, connection is wrong or sensor is damaged. Connect resistance generator(Decade resistance box) to the controller and as 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 change of the resistance. 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 is changed, check the main power of the main board again, and if power is normal and there is no sensor input value, 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 30. PT-100 Temp. Table

4mA~20mA, 2-line type sensor, controller power used.
Check if the wiring between sensor and controller is properly connected.

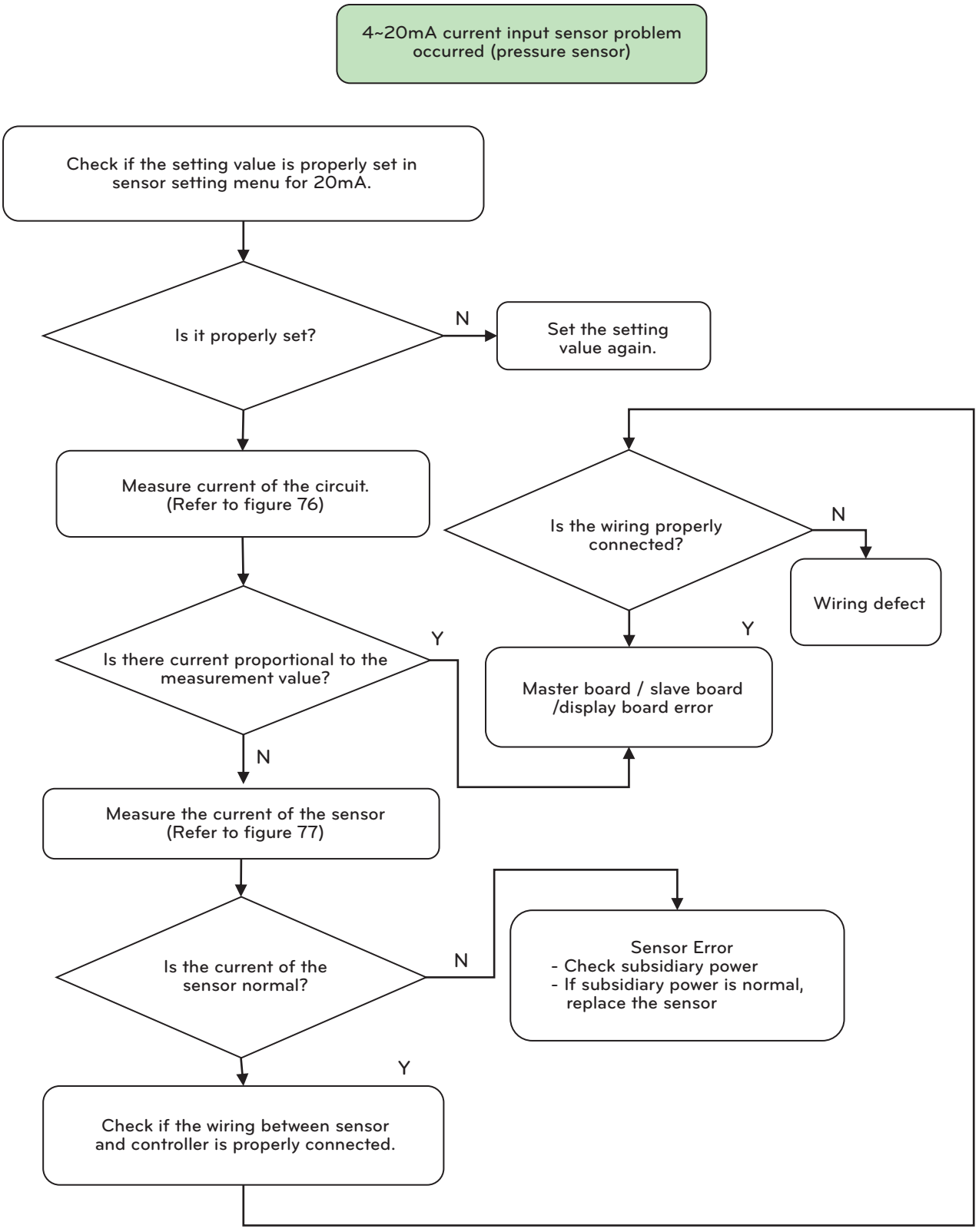


Figure 73. Pressure sensor

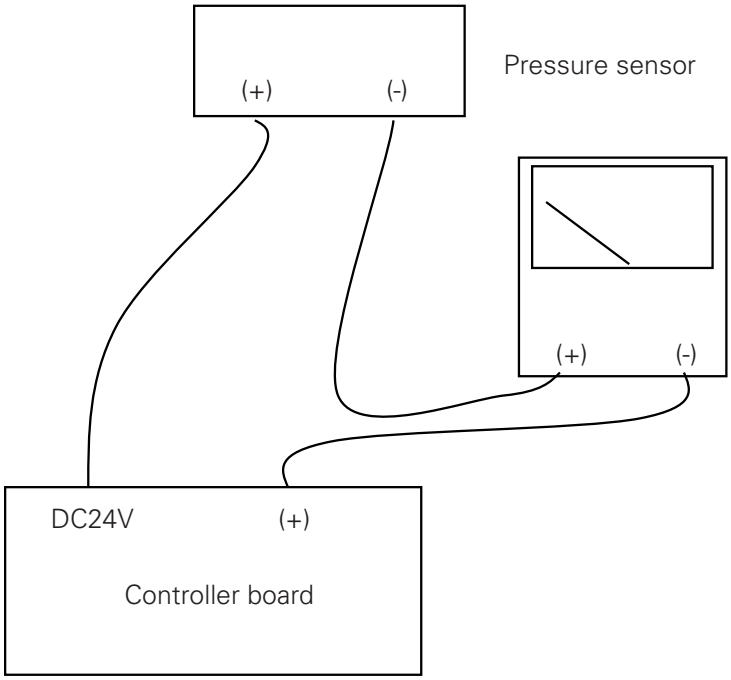


Figure 74. Current loop measurement circuit

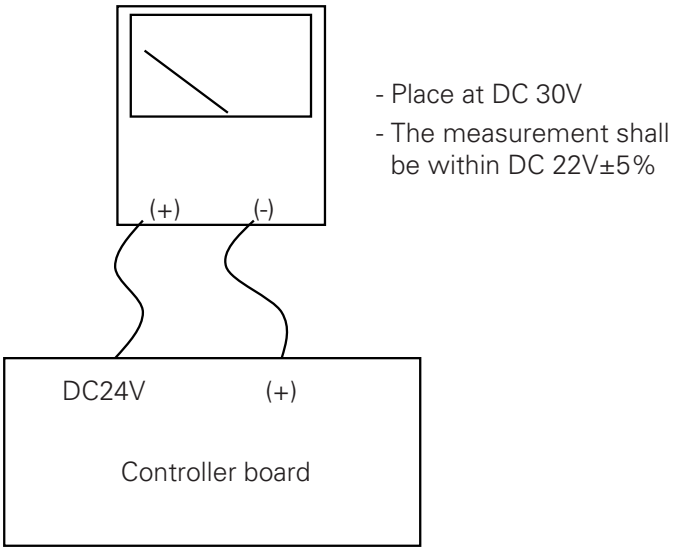


Figure 75. Controller voltage measurement circuit

Even if the inspection was carried out as above, if the cause couldn't be found, connect current generator to the input connector(DC24V and (+)) of the controller and check if the indicator value changes according to the change of the current.

In such case, if the controller indicator value does not change according to the change of the current, it shall be decided as controller defect.

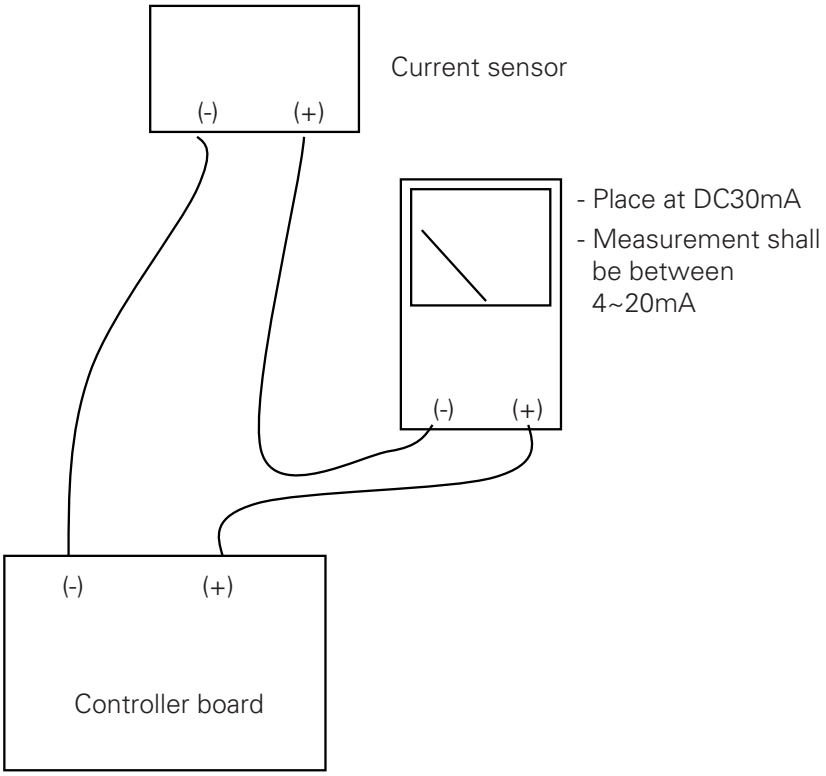


Figure 76. Pressure sensor

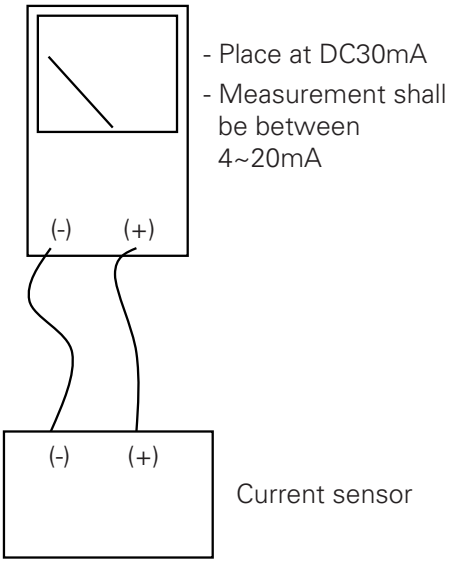


Figure 77. Current sensor measurement circuit

Digital input signal is not checked by the controller.

If the no voltage contact signal is properly input to the digital input of the controller but controller finds it as abnormal or if there is no change of all digital input signals, it is because of the defective connection of I/O board power connector or no communication between I/O board and main board.

Check communication line connection status between I/O board and main board, and it there is no problem, short-circuit the connector of the wiring among the controller digital inputs that does not work to COM connector (23, 24) of controller I/O board to check whether LED LAMP corresponding to the I/O board input connector is lighted.

Select "menu key" – "system information" – "I/O input" of the controller display, short-circuit/open abnormal connectors and COM connector to see if input status changes to "ON"/"OFF".

When DC voltage between COM connector of the controller digital input and the wire released digital input, check if 18V is measured.

If there is no problem, connect them again and check operation.

If the corresponding board main power and communication is normal and I/O input still does not work the board needs to be replaced.

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

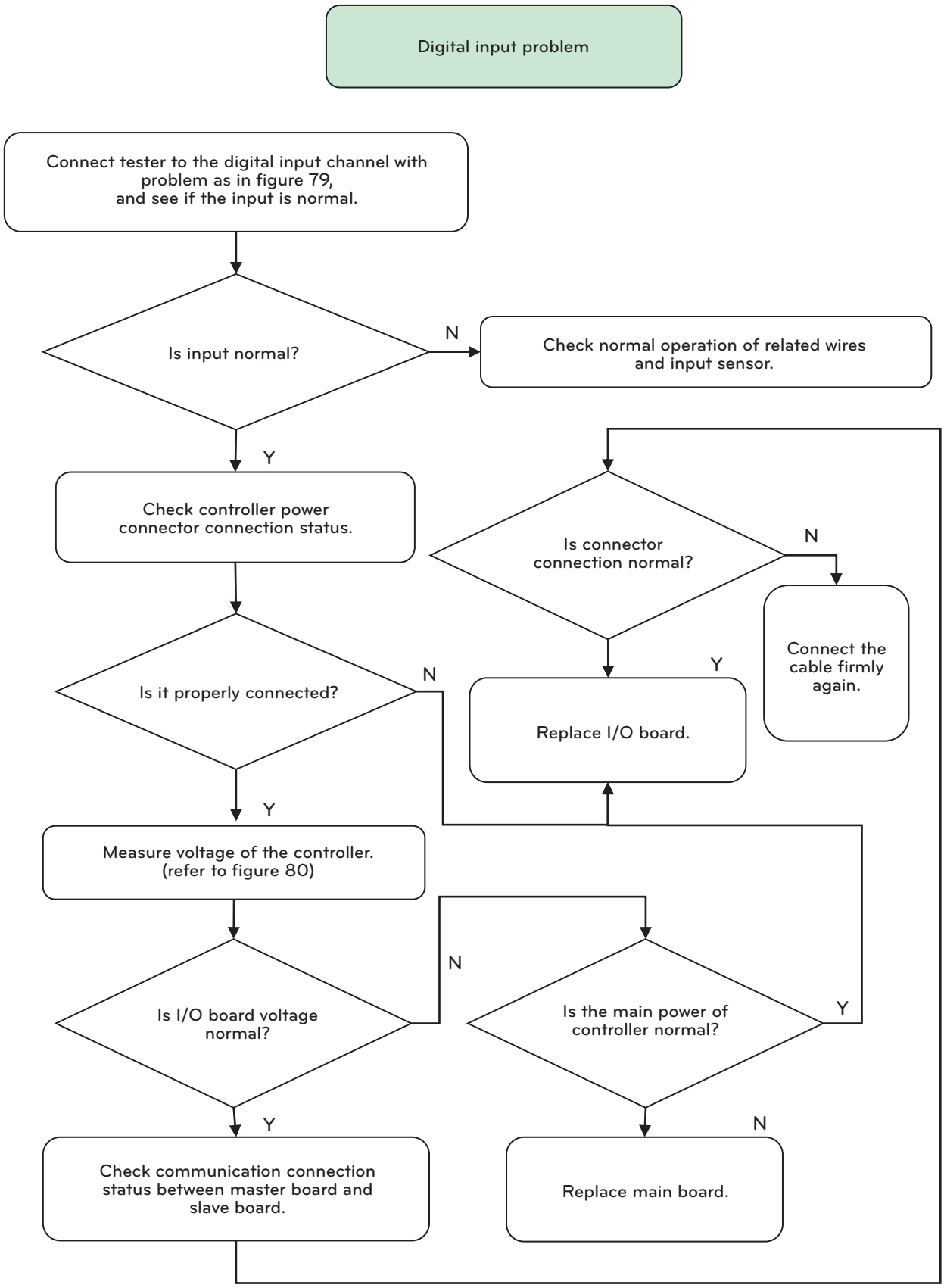


Figure 78. Digital input problem

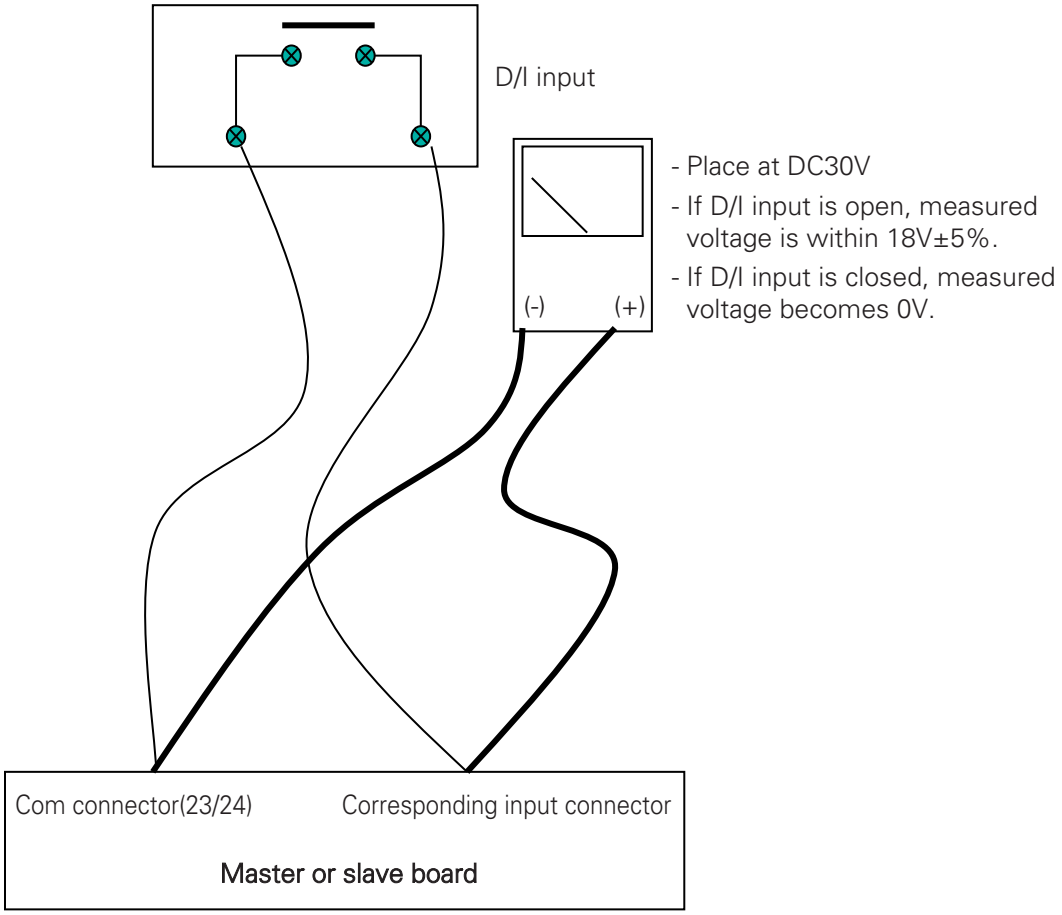


Figure 79. The current measurement circuit for master or slave board

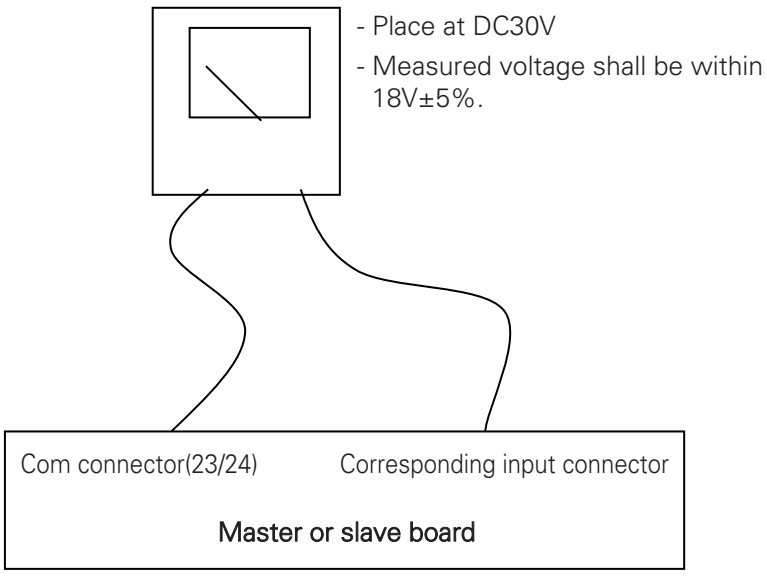


Figure 80. The current measurement circuit for master or slave board

Communication error

It is the error caused by no communication corresponding to the displayed message is made between each board. First, check communication line connection status between each board. At this time, 2 RDX+ and RDX- lines of master board shall be connected to the same polarity of RDX+ and RDX- of slave board and relay board, and 2 RDX+ and RDX- of master board shall be connected to the same polarity. If it is not properly connected to the corresponding communication connector, communication cannot be made, so it must be connected to the designated connector.

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 31. Master or Slave board current measurement circuit

Abnormal drop of evaporator pressure (cause of surge)

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 32. Cause and Action for drop of evaporating pressure

Problem in lubrication system

Status	Decision criteria	Cause	Remedy
Oil pressure is low	(Oil discharge pressure – oil tank pressure) < 0.8 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 33. Cause and action for problem in lubrication system

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 34. Cause and countermeasure for chiller problems

ENGLISH

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 35. Operation record table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