



Installation, Operation and Maintenance Manual

D-EIMHP00508-16_01EN



Inverter air to water heat pumps

EWYD_BZ

50Hz – Refrigerant: R-134A

Original Instructions

▲ IMPORTANT

This Manual is a technical aid and does not represent a binding offer for Daikin.

Daikin has drawn up this Manual to the best of its knowledge. The content cannot be held as explicitly or implicitly guaranteed as complete, precise or reliable.

All data and specifications contained herein may be modified without notice. The data communicated at the moment of the order shall hold firm.

Daikin shall assume no liability whatsoever for any direct or indirect damage, in the widest sense of the term, ensuing from or connected with the use and/or interpretation of this Manual.

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▲ WARNING

Before starting the installation of the unit, please read this manual carefully. Starting up the unit is absolutely forbidden if all instructions contained in this manual are not clear.

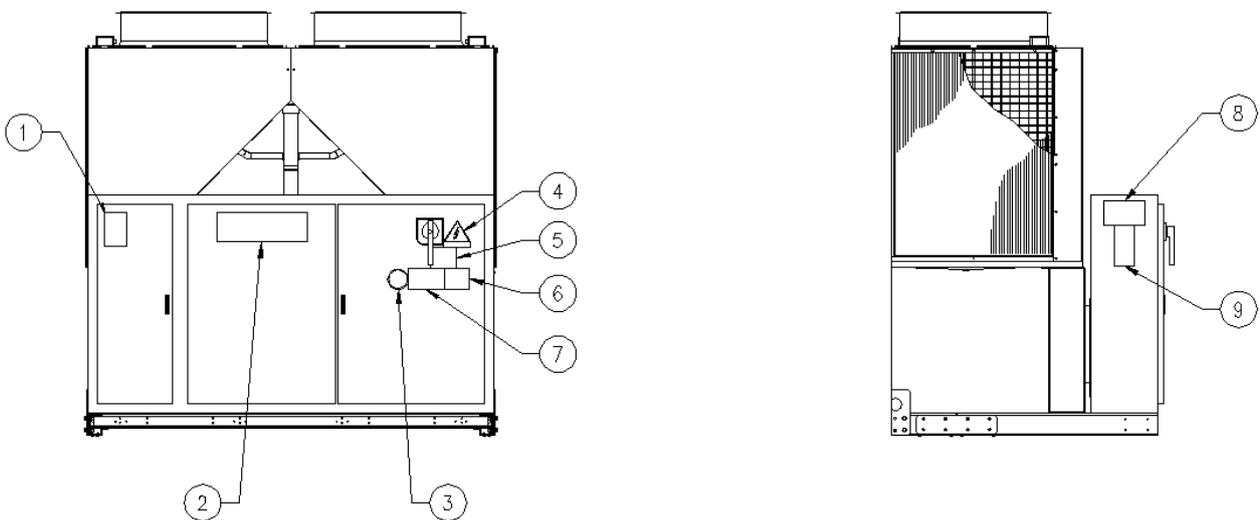
Key to symbols

△ Important note: failure to respect the instruction can damage the unit or compromise operation

⚠ Note regarding safety in general or respect of laws and regulations

⚡ Note regarding electrical safety

Description of the labels applied to the electrical panel



Label Identification

1 – Non flammable gas symbol	6 – Cable tightening warning
2 – Manufacturer's logo	7 – Water circuit filling warning
3 – Gas type	8 – Lifting instructions
4 – Electrical hazard symbol	9 – Unit nameplate data
5 – Hazardous Voltage warning	

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1. GENERAL INFORMATION

▲ ATTENTION

The units described in the present manual represent a high value investment, maximum care should be taken to ensure correct installation and appropriate working conditions.
Installation and maintenance must be performed by qualified and specifically trained personnel only.
Correct maintenance of the unit is indispensable for its safety and reliability. Manufacturer's service centres are the only having adequate technical skill for maintenance.

▲ ATTENTION

This manual provides information about the features and standard procedures for the complete series.

All the units are delivered from factory as complete sets which include wiring diagrams, inverter manuals, dimensional drawings with dimensions and weight, nameplate with technical characteristics attached to the unit.

WIRING DIAGRAMS, INVERTER MANUALS, DIMENSIONAL DRAWINGS AND NAMEPLATE MUST BE CONSIDERED ESSENTIAL DOCUMENTS AND AS A PART OF THIS MANUAL

In case of any discrepancy between this manual and the equipment's document refer to on board documents.
For any doubt ask Daikin or authorized centers

Purpose of this manual

The purpose of this manual is to allow the installer and the qualified operator to carry out required operations in order to ensure proper installation and maintenance of the machine, without any risk to people, animals and/or objects.

This manual is an important supporting document for qualified and trained personnel but it is not intended to replace such personnel.

All activities must be carried out in compliance with local laws and regulations.

Receiving the machine

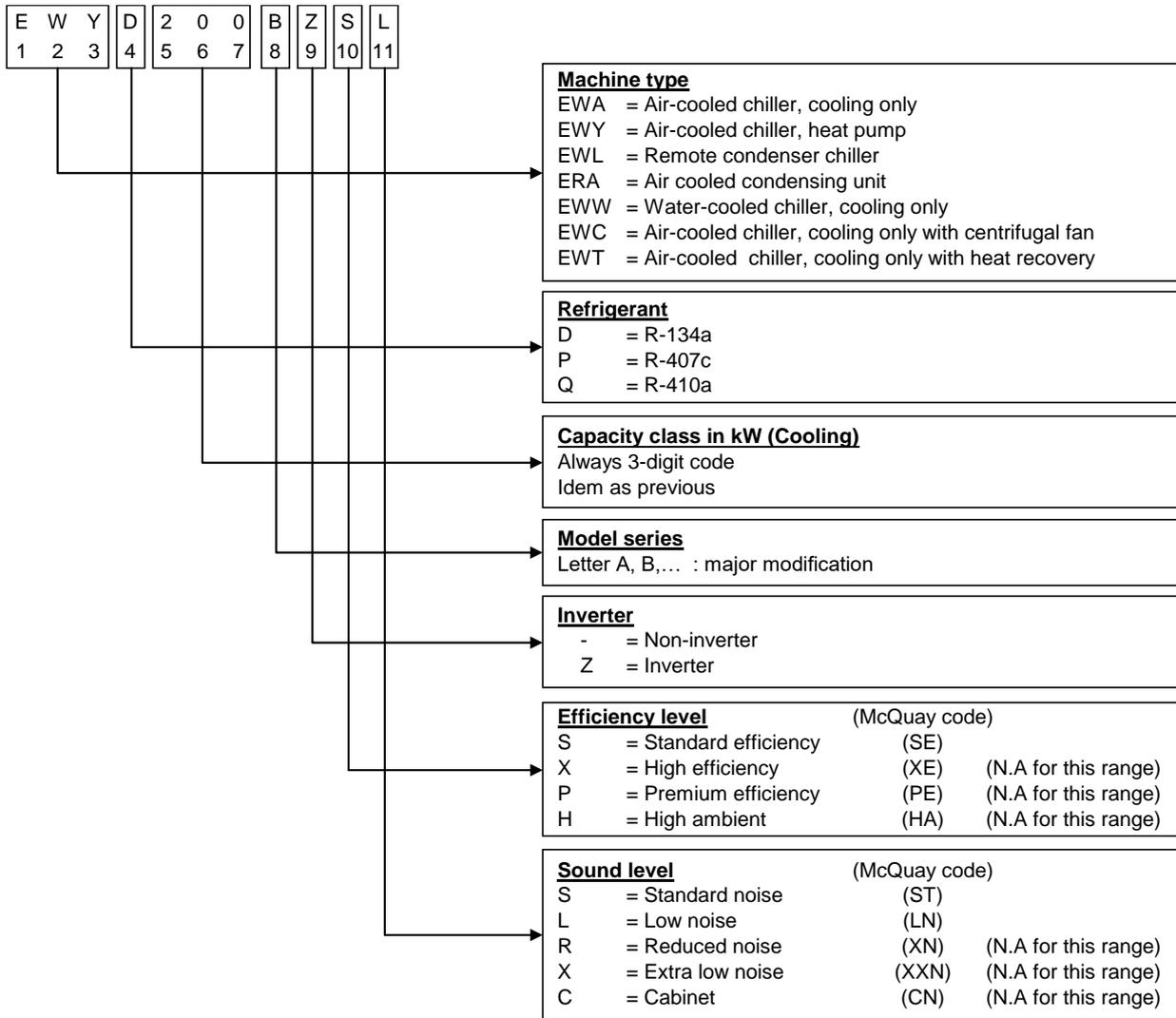
The machine must be inspected for any possible damage immediately upon reaching its final place of installation. All components described in the delivery note must be carefully inspected and checked; any damage must be reported to the carrier. Before connecting the machine to earth, check that the model and power supply voltage shown on the nameplate are correct. Responsibility for any damage after acceptance of the machine cannot be attributed to the manufacturer.

Checks

To prevent the possibility of incomplete delivery (missing parts) or transportation damage, please perform the following checks upon receipt of the machine:

- a) Before accepting the machine, please verify shipment documents and check the number of shipped items
- b) Check every single component in the consignment for missing parts or for any damage.
- c) In the event that the machine has been damaged, do not remove the damaged material. A set of photographs are helpful in ascertaining responsibility.
- d) Immediately report the extent of the damage to the transportation company and request that they inspect the machine.
- e) Immediately report the extent of the damage to the manufacturer representative, so that arrangements can be made for the required repairs. In no case must the damage be repaired before the machine has been inspected by the representative of the transportation company.

Nomenclature



2. OPERATING LIMITS

Storage

The environmental conditions must be within the following limits:

Minimum ambient temperature	:	-20°C
Maximum ambient temperature	:	57°C
Maximum R.H.	:	95% not condensing

▲ ATTENTION

Storing below the minimum temperature mentioned above may cause damage to components such as the electronic controller and its LCD display.

▲ WARNING

Storing above the maximum temperature may cause opening of the safety valves on the compressors' suction line.

▲ ATTENTION

Storing in condensing atmosphere may damage the electronic components.

Operation

Operation is allowed within the limits mentioned in the following diagrams

▲ ATTENTION

Operation out of the mentioned limits may damage the unit.
For any doubts contact the factory.

▲ ATTENTION

The maximum operating altitude is 2,000 m above sea level.
Please contact the factory if the equipment is to be operated at altitudes of between 1,000 and 2,000 m above sea level.

Figure 1 - Operating limits in cooling mode - EWYD~BZSS / EWYD~BZSL

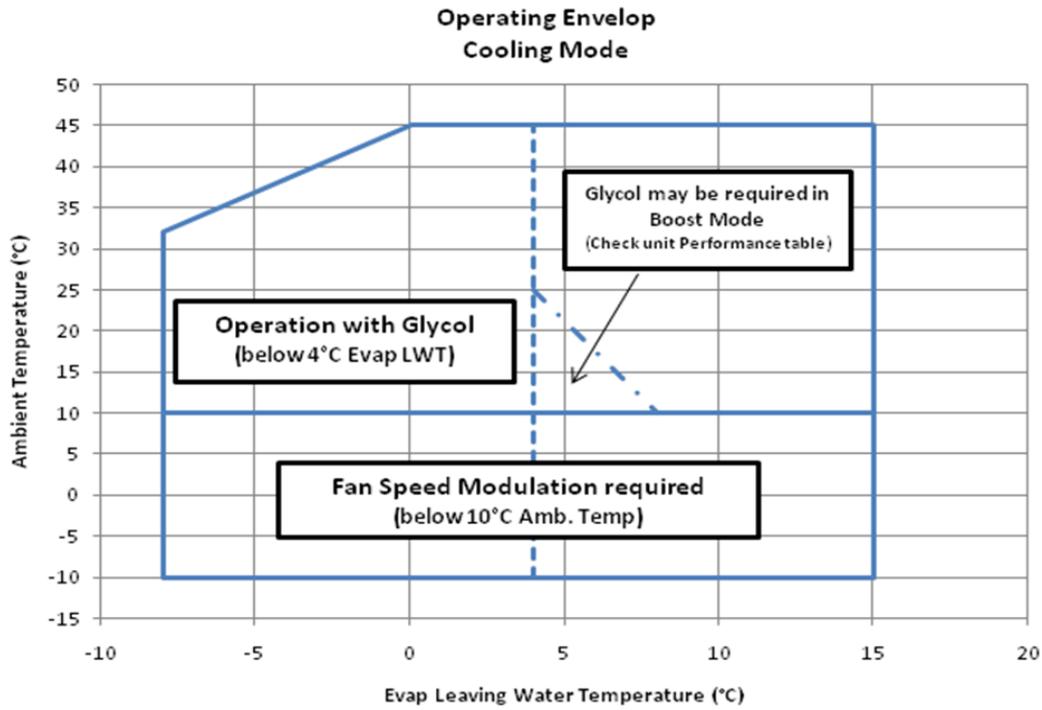
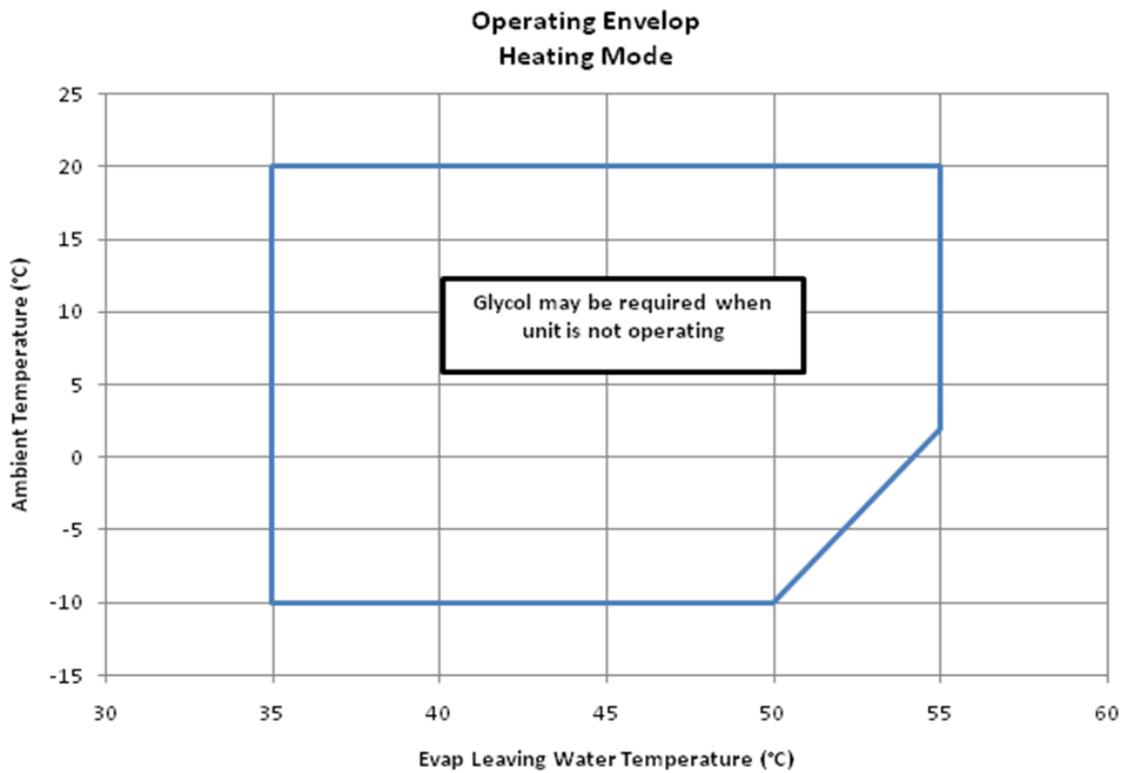


Figure 2 - Operating limits in heating mode - EWYD~BZSS / EWYD~BZSL



3. MECHANICAL INSTALLATION

Shipping

The stability and the absence of any kind of deformation of the unit during shipping must be ensured. If the machine is shipped with a wooden cross-plank on its base, this cross-plank must only be removed after the final destination has been reached.

Responsibility

The manufacturer declines all present and future responsibility for any damage to persons, animals or things caused by negligence of operators failing to follow the installation and maintenance instructions in this manual and/or the rules of good technical practice.

All safety equipment must be regularly and periodically checked in accordance with this manual and with local laws and regulations regarding safety and environment protection.

Safety

The machine must be secured to the ground.

It is essential to observe the following instructions:

- The machine can only be lifted using the lifting points marked in yellow that are fixed to its base. These are the only points that can support the entire weight of the unit.
- Do not allow unauthorised and/or unqualified personnel to access the unit.
- It is forbidden to access the electrical components without having opened the unit's main switch and switched off the power supply.
- It is forbidden to access the electrical components without using an insulating platform. Do not access the electrical components if water and/or moisture are present.
- All operations on the refrigerant circuit and on components under pressure must be carried out by qualified personnel only.
- Replacement of a compressor or addition of lubricating oil must be carried out by qualified personnel only.
- Sharp edges and the surface of the condenser section could cause injury. Avoid direct contact.
- Switch off the unit's power supply, by opening the main switch, before servicing the cooling fans and/or compressors. Failure to observe this rule could result in serious personal injury.
- Avoid introducing solid objects into the water pipes while the machine is connected to the system.
- A mechanical filter must be installed on the water pipe connected to the heat exchanger inlet.
- The machine is supplied with safety valves, that are installed both on the high-pressure and on the low-pressure sides of the refrigerant circuit.

In case of sudden stop of the unit, follow the instructions on the **Control Panel Operating Manual** which is part of the on-board documentation delivered to the end user with this manual.

It is recommended to perform installation and maintenance with other people. In case of accidental injury or unease, it is necessary to:

- keep calm
- press the alarm button if present in the installation site
- move the injured person in a warm place far from the unit and in rest position
- contact immediately emergency rescue personnel of the building or if the Health Emergency Service
- wait without leaving the injured person alone until the rescue operators come
- give all necessary information to the the rescue operators

WARNING

Before carrying out any operation on the machine, please read carefully the instruction and operating manual. Installation and maintenance must be carried out by qualified personnel that is familiar with provisions of the law and local regulations and has been trained properly or has experience with this type of equipment.

WARNING

Avoid installing the chiller in areas that could be dangerous during maintenance operations, such as platforms without parapets or railings or areas not complying with the clearance requirements around the chiller.

Moving and lifting

Avoid bumping and/or jolting during unloading from the lorry and moving the unit. Do not push or pull the machine from any part other than the base frame. Secure the machine inside the lorry to prevent it from moving and causing damage to the panels and to the base frame. Do not allow any part of the unit to fall during transportation or unloading, as this could cause serious damage.

All units of the series are supplied with lifting points marked in yellow. Only these points may be used for lifting the unit, as shown in the following figure.

Procedure for extracting the machine from the container.
Container Kit Optional

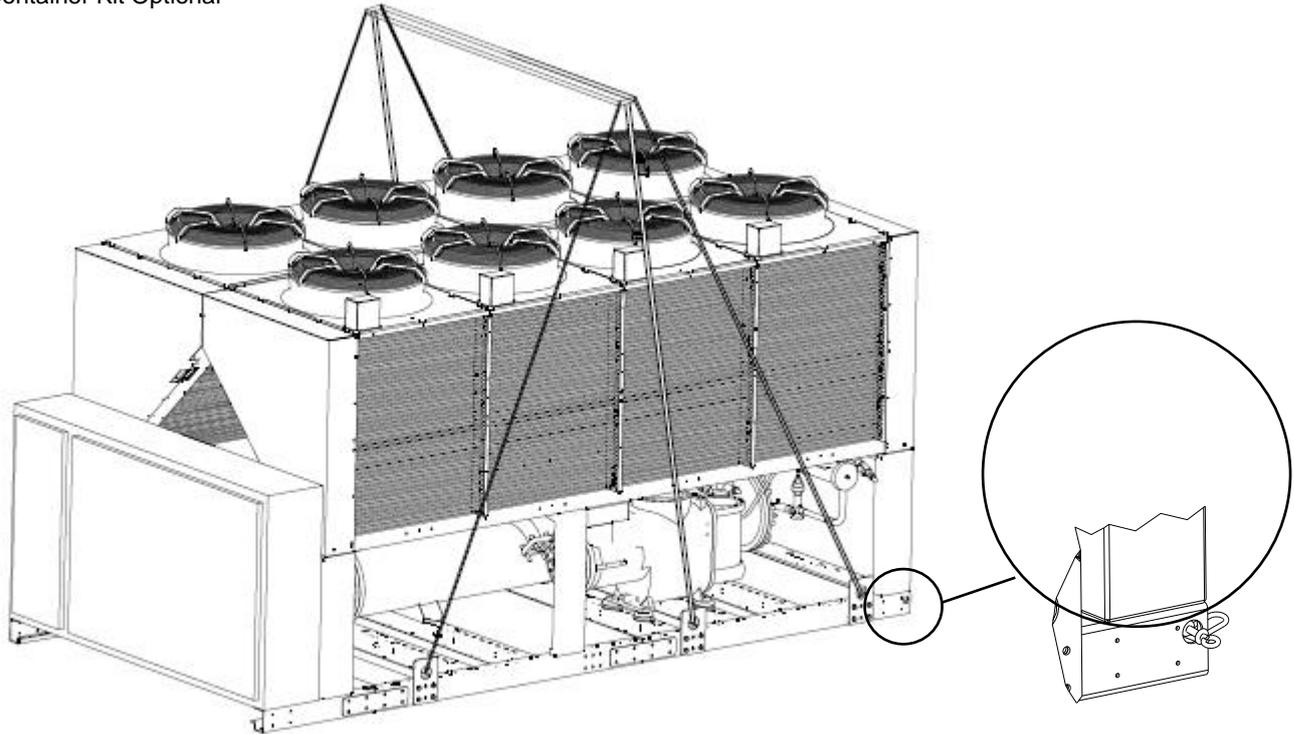


Figure 3 - Lifting the unit

The number and the location of lifting points changes from model to model. This picture is for reference only. Lifting tools (bars, ropes, etc) are not supplied.

⚠ WARNING

Both the lifting ropes and the spacing bar and/or scales must be strong enough to support the machine safely. Please check the unit's weight on the machine's nameplate. The weights shown in the "Technical specifications" tables in the "Specifications" chapter refer to standard units. Specific units might have accessories that increase overall weight (pumps, heat recovery, copper condenser coils, etc.).

⚠ WARNING

The unit must be lifted with the utmost attention and care. Avoid jolting when lifting and lift unit very slowly, keeping it perfectly orizzontal.

Positioning and assembly

All units are designed for installation outdoors, either on roofs or on the ground, provided that the installation area is free of obstacles that could reduce air flow to the condensers bank.

The unit must be installed on a robust and perfectly plan foundation; should the machine be installed on balconies or roofs, it might be necessary to use weight distribution beams.

For installation on the ground, a strong cement base that is at least 250 mm wider and longer than the machine must be provided. Also, this base must be able to support the weight of the machine as stated in the technical specifications.

If the machine is installed in places that are easily accessible to people and animals, it is advisable to install protection grids for the condenser and compressor sections.

To ensure the best possible performance on the installation site, the following precautions and instructions must be followed:

- Avoid air flow recirculation.
- Make sure that there are no obstacles to hamper air flow.
- Air must circulate freely to ensure proper flow in and flow out.
- Make sure to provide a strong and solid foundation to reduce noise and vibrations as much as possible.
- Avoid installation in particularly dusty environments, in order to reduce soiling of condensers.
- The water in the system must be particularly clean and all traces of oil and rust must be removed. A mechanical water filter must be installed on the machine's inlet piping.

Minimum space requirements

It is fundamental to respect minimum distances on all units in order to ensure optimum ventilation to the condenser. Limited installation space could reduce the normal air flow, thus significantly reducing the machine's performance and considerably increasing consumption of electrical energy.

When deciding where to position the machine and to ensure a proper air flow, the following factors must be taken into consideration: avoid any warm air recirculation and insufficient air supply to the air-cooled condenser.

Both these conditions can cause an increase of condensing pressure, which leads to a reduction in energy efficiency and refrigerating capacity. Thanks to the geometry of their air-cooled condensers, the units are less affected by poor air circulation conditions.

Also, the software has particularly the ability to compute the machine's operating conditions to optimise the load under abnormal operating circumstances.

Every side of the machine must be accessible for post-installation maintenance operations. Figure 4 shows the minimum space required.

Vertical air discharge must not be obstructed as this would significantly reduce capacity and efficiency.

If the machine is surrounded by walls or obstacles of the same height as the machine, it must be installed at a distance of at least 2500 mm. If these obstacles are higher, the machine must be installed at a distance of at least 3000 mm.

Should the machine be installed without observing the recommended minimum distances from walls and/or vertical obstacles, there could be a combination of warm air recirculation and/or insufficient supply to the air-cooled condenser which could cause a reduction of capacity and efficiency.

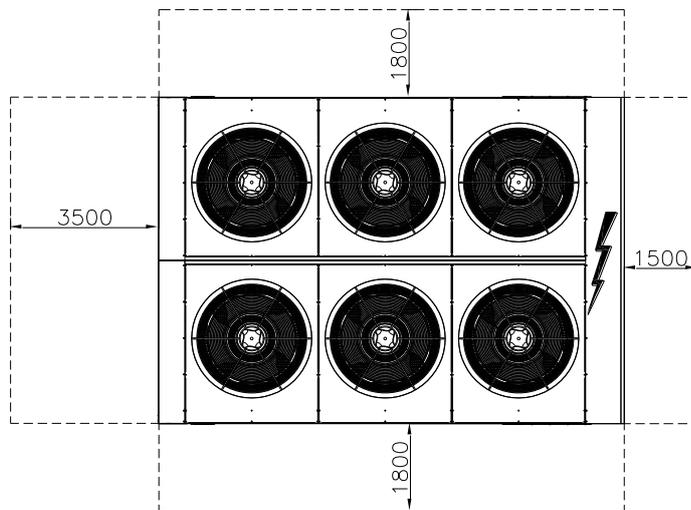


Figure 4 - Minimum clearance requirements for machine maintenance

In any case, the microprocessor will allow the machine to adapt itself to new operating conditions and deliver the maximum capacity available under any given circumstances, even if the lateral distance is lower than recommended.

When two or more machines are positioned side by side, a distance of at least 3600 mm between the respective condenser banks is recommended.

For further solutions, please consult Daikin technicians.

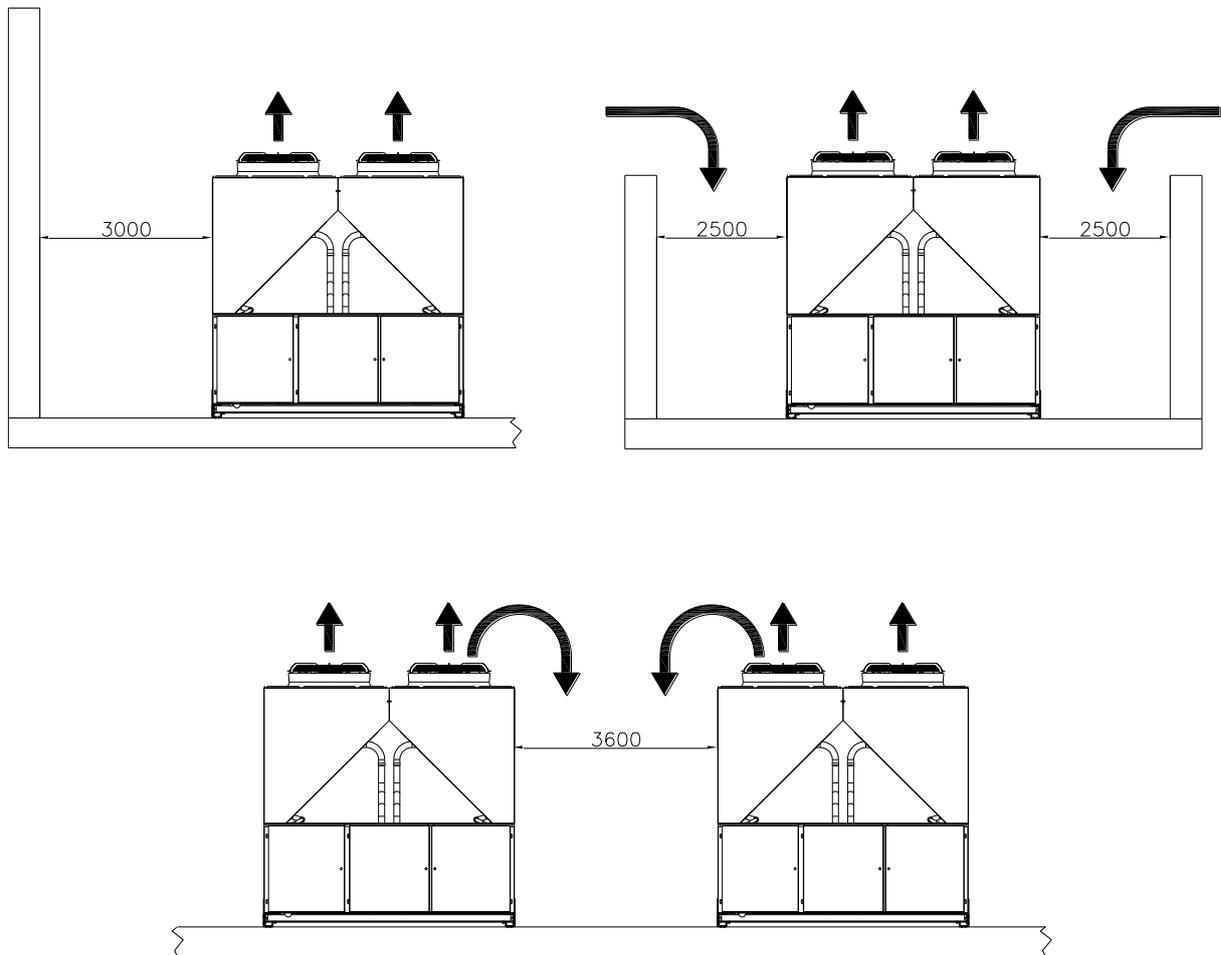


Figure 5 - Minimum recommended installation clearances

Distances shown in previous figures have not be considered a warranty for good installation; particular conditions (like venturi effects due to wind, very tall buildings, etc.) may cause air recirculation so affecting unit performances. It is a responsibility of the installer to assure that the unit condenser is fed with fresh air in any conditions

Sound protection

When sound levels require special control, great care must be exercised to isolate the machine from its base by appropriately applying anti-vibration elements (supplied as an option). Flexible joints must be installed on the water connections, as well.

Water piping

Piping must be designed with the lowest number of elbows and the lowest number of vertical changes of direction. In this way, installation costs are reduced considerably and system performance is improved.

The water system should have:

- 1 Anti-vibration mountings in order to reduce transmission of vibrations to the underlying structure.
- 2 Isolating valves to isolate the machine from the water system during service.
- 3 Manual or automatic air venting device at the system's highest point; drain device at the system's lowest point. Neither the evaporator nor the heat recovery device must be positioned at the system's highest point.
- 4 A suitable device that can maintain the water system under pressure (expansion tank, etc.).
- 5 Water temperature and pressure indicators on the machine to assist the operator during service and maintenance.
- 6 A filter or device that can remove foreign particles from the water before it enters the pump (in order to prevent cavitation, please consult the pump manufacturer for the recommended type of filter). The use of a filter prolongs the life of the pump and helps keep the water system in a better condition.
- 7 Another filter must be installed on the machine inlet water pipe, near the evaporator and heat recovery (if installed). The filter prevents solid particles from entering the heat exchanger, as they could damage it or reduce its heat exchanging capacity.
- 8 The shell and tube heat exchanger has an electrical resistance with a thermostat that ensures protection against water freezing at ambient temperatures as low as -25°C . All the other water piping outside the machine must therefore be protected against freezing.
- 9 The heat recovery device must be emptied of water during the winter season, unless an ethylene glycol mixture in appropriate percentage is added to the water circuit.

- 10 If the machine is intended to replace another, the entire water system must be emptied and cleaned before the new unit is installed. Regular tests and proper chemical treatment of water are recommended before starting up the new machine.
- 11 In the event that glycol is added to the water system as anti-freeze protection, pay attention to the fact that suction pressure will be lower, the machine's performance will be lower and water pressure drops will be greater. All machine-protection systems, such as anti-freeze, and low-pressure protection will need to be readjusted.

Before insulating water piping, check that there are no leaks.

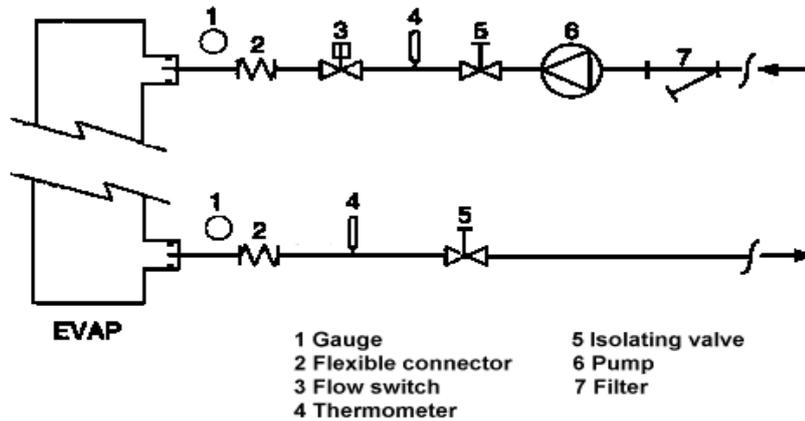


Figure 6 - Water piping connection for evaporator

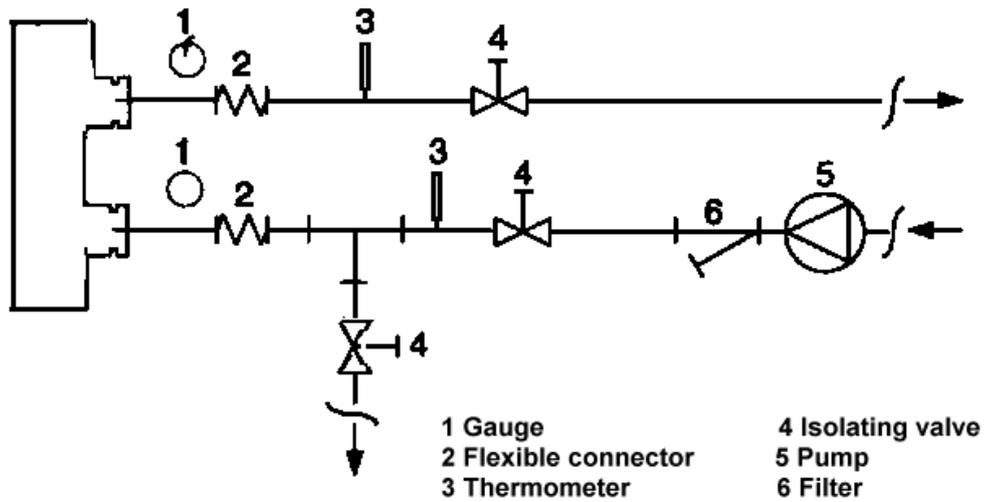


Figure 7 - Water piping connection for heat recovery exchangers

Legend translation

- | | |
|--------------------|--------------------|
| Gauge | Gauge |
| Flexible connector | Flexible connector |
| Flow switch | Flow switch |
| Thermometer | Thermometer |
| Isolating valve | Isolating valve |
| Pump | Pump |
| Filter | Filter |

▲ ATTENTION

Install a mechanical filter on the inlet to each heat exchanger. Failure to install a mechanical filter allows solid particles and/or welding slag to enter the exchanger. Installation of a filter having a mesh size not exceeding 0,5 – 1 mm is advised. The manufacturer cannot be held responsible for any damage to exchangers ensuing from the lack of a mechanical filter.

Water treatment

Before putting the machine into operation, clean the water circuit. Dirt, scale, corrosion residue and other foreign material can accumulate inside the heat exchanger and reduce its heat exchanging capacity. Pressure drop can increase as well, thus reducing water flow. Proper water treatment therefore reduces the risk of corrosion, erosion, scaling, etc. The most appropriate water treatment must be determined locally, according to the type of system and local characteristics of the process water.

The manufacturer is not responsible for damage to or malfunctioning of equipment caused by failure to treat water or by improperly treated water.

Table 1 - Acceptable water quality limits

DAE Water quality requirements	Shell&tube	BPHE
Ph (25 °C)	6.8 ÷ 8.4	7.5 – 9.0
Electrical conductivity [μ S/cm] (25°C)	< 800	< 500
Chloride ion [mg Cl- / l]	< 150	< 70 (HP1); < 300 (CO2)
Sulphate ion [mg SO42- / l]	< 100	< 100
Alkalinity [mg CaCO3 / l]	< 100	< 200
Total Hardness [mg CaCO3 / l]	< 200	75 ÷ 150
Iron [mg Fe / l]	< 1	< 0.2
Ammonium ion [mg NH4+ / l]	< 1	< 0.5
Silica [mg SiO2 / l]	< 50	NO
Chlorine molecular (mg Cl2/l)	< 5	< 0.5

Evaporator and recovery exchangers anti-freeze protection

All evaporators are supplied with a thermostatically controlled anti-freeze electrical resistance, which provides adequate anti-freeze protection at temperatures as low as -25°C . However, unless the heat exchangers are completely emptied and cleaned with anti-freeze solution, additional methods should also be used against freezing.

Two or more of below protection methods should be considered when designing the system as a whole:

- 12 Continuous water flow circulation inside piping and exchangers
- 13 Addition of an appropriate amount of glycol inside the water circuit
- 14 Additional heat insulation and heating of exposed piping
- 15 Emptying and cleaning of the heat exchanger during the winter season

Partial heat recovery heat exchangers (desuperheaters) are not protected against freezing (no heater is installed).

▲ WARNING

It is the responsibility of the installer and/or of local maintenance personnel to ensure that two or more of the described anti-freeze methods are used. Make sure that appropriate anti-freeze protection is maintained at all times. Failure to follow the instructions above could result in damage to some of the machine's components. Damage caused by freezing is not covered by the warranty.

Installing the flow switch

To ensure sufficient water flow through the evaporator, it is essential that a flow switch be installed on the water circuit. The flow switch can be installed either on the inlet or outlet water piping. The purpose of the flow switch is to stop the machine in the event of interrupted water flow, thus protecting the evaporator from freezing.

The flow switch on the heat recovery circuit prevents the machine from shutting down due to high pressure.
The flow switch must be a paddle-type flow switch that is suitable for heavy-duty outdoor applications (IP67) and pipe diameters in the range of 1" to 6".
The flow switch is provided with a clean contact which must be electrically connected to terminals 8 and 23 of terminal board M3 (check the machine's wiring diagram for further information).
The flow switch must be adjusted to intervene (switch off the unit) when the flow rate is lower than no less than 50% of nominal flow rate.
For further information regarding device installation and settings, please read the instruction leaflet in the device box.

Adjusting the flow switch's trigger sensitivity

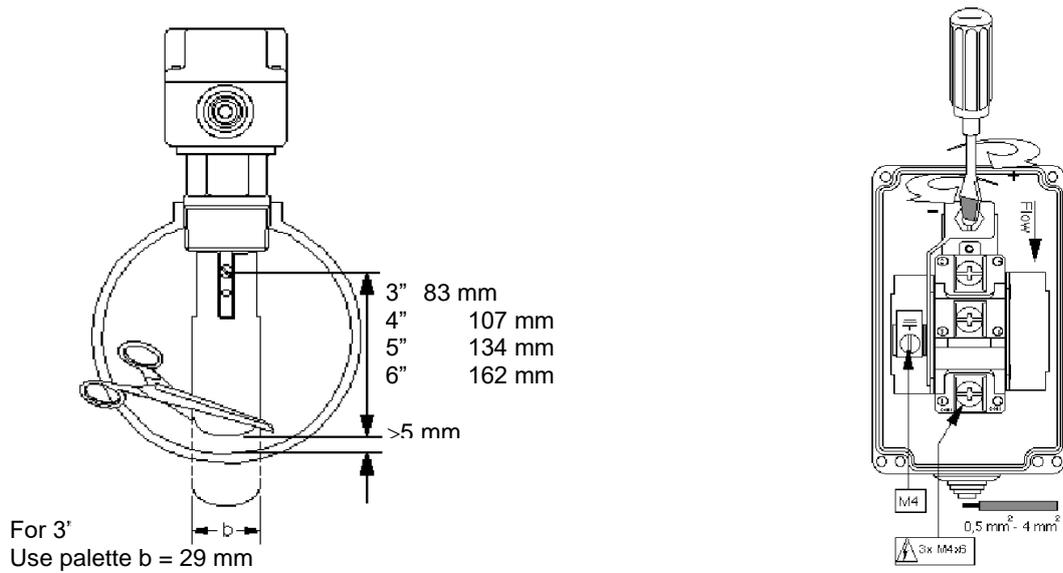
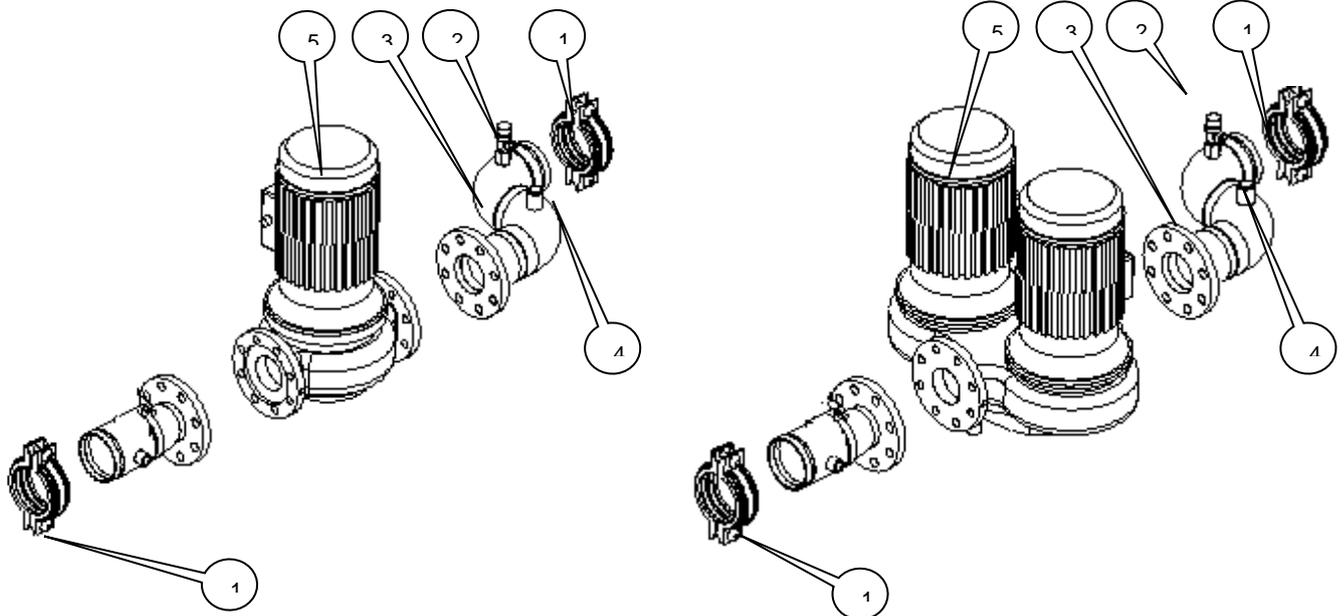


Figure 8 - Adjusting the safety flow switch

Hydronic kit (optional)

The optional hydronic kit intended for use with this series of machines (except 072.2÷079.2 LN units) includes either a single in-line pump or a twin in-line pump. According to the choice made when ordering the machine, the kit could be configured as in the following figure.

Single-pump hydronic kit Twin-pump hydronic kit



- 1 Victaulic joint
- 2 Water safety valve
- 3 Connecting manifold
- 4 Anti-freeze electrical resistance connection (not supplied)
- 5 Water pump (single or twin)

N.B.: Components on some machines could be arranged differently.

Figure 9 - Single- and twin-pump hydronic kit

Expansion tank and automatic water refilling group, mandatory in any water loop, are not supplied with the hydronic kit. It is a responsibility of the installer to size and install correctly these components

Refrigerating circuit safety valves

Each system comes with safety valves that are installed on each circuit, both on the evaporator and on the condenser. The purpose of the valves is to release the refrigerant inside the refrigerating circuit in the event of certain malfunctions.

⚠ WARNING

This unit is designed for installation outdoors. However, check that there is sufficient air circulation through the machine. If the machine is installed in closed or partly covered areas, possible damage from inhalation of refrigerant gases must be avoided. Avoid releasing the refrigerant into the atmosphere.

The safety valves must be so connected to discharge outdoors. The installer is responsible for connecting the safety valves to the discharge piping and for establishing their size.

4. ELECTRICAL INSTALLATION

General specifications

CAUTION

All electrical connections to the machine must be carried out in compliance with laws and regulations in force. All installation, management and maintenance activities must be carried out by qualified personnel. Refer to the specific wiring diagram for the machine that you have purchased and which was sent with the unit. Should the wiring diagram not appear on the machine or should it have been lost, please contact your nearest manufacturer office, who will send you a copy.

CAUTION

Only use copper conductors. Failure to use copper conductors could result in overheating or corrosion at connection points and could damage the unit. To avoid interference, all control wires must be installed separately from the power cables. Use separate electrical conduits for this purpose.

CAUTION

Before any installation and connection work, the system must be switched off and secured. After switching off the unit, the intermediate circuit capacitors of the inverter are still charged with high voltage for a short period of time. The unit can be worked on again after it has been switched off for 5 minutes.

CAUTION

The units of the series are provided with non-linear high power electrical components (compressor and fan VFD, which introduce higher harmonics) can cause considerable dispersion to earth, of about 2 A.

The electricity supply system protection must take the above values into account.

Electrical components

All power and interface electrical connections are specified in the wiring diagram that is shipped with the machine.

The installer must supply the following components:

- Power supply cables (dedicated conduit)
- Interconnection and interface cables (dedicated conduit)
- Thermal-magnetic circuit breaker of suitable size (please see electrical data)

Electrical wiring

Power circuit:

Connect electrical power supply cables to the terminals of the general circuit breaker located on the machine's terminal board. The access panel must have a hole of appropriate diameter for the cable used and its cable gland. A flexible conduit can also be used, containing the three power phases plus ground.

In any case, absolute protection against any water penetrating through the connection point must be ensured.

Control circuit:

Every machine of the series is supplied with an auxiliary 400/ 230V control circuit transformer. No additional cable for the control system power supply is thus required.

Only if the optional separate accumulation tank is requested, the electrical anti-freeze resistance must have a separate power supply.

Electrical heaters

The machine has an electrical anti-freeze heater that is installed directly in the evaporator. Each circuit also has an electrical heater installed in the compressor, whose purpose is to keep the oil warm thus preventing the presence of liquid refrigerant mixed with the oil in the compressor. Obviously, the operation of the electrical heaters is guaranteed only if there is a constant power supply. If it is not possible to keep the machine powered when inactive during winter, apply at least two of the procedures described in the "Mechanical installation" section under the paragraph "Antifreeze protection of evaporator and heat recovery exchangers".

Water pump control

Connect the control contactor coil power supply to terminals 27 and 28 (pump #1) and 401 and 402 (pump 2) located on terminal board M3, and install the contactor on a power supply having the same voltage as the pump contactor coil. The terminals are connected to a clean microprocessor contact.

The microprocessor contact has the following commutation capacity:

Maximum voltage: 250 Vac
Maximum current: 2A Resistive - 2A Inductive
Reference standard: EN 60730-1

The wiring described above allows the microprocessor to manage the water pump automatically. It is good practice to install a clean status contact on the pump's thermal-magnetic circuit breaker and to connect it in series with the flow switch.

Alarm relays – Electrical wiring

The unit has a clean-contact digital output that changes state whenever an alarm occurs in one of the refrigerant circuits. Connect this signal to an external visual, sound alarm or to the BMS in order to monitor its operation. See the machine's wiring diagram for wiring.

Unit On/ Off remote control – Electrical wiring

The machine has a digital input that allows remote control. A startup timer, a circuit breaker or a BMS can be connected to this input. Once the contact has been closed, the microprocessor launches the startup sequence by first turning on the first water pump and then the compressors. When the contact is opened the microprocessor launches the machine shutdown sequence. The contact must be clean.

Double Setpoint – Electrical wiring

The Double Setpoint function allows to change over the unit setpoint between two predefined values in the unit controller by interposing a circuit breaker. An example of an application is ice production during the night and standard operation during the day. Connect a circuit breaker or timer between terminals 5 and 21 of terminal board M3. The contact must be clean.

External water Setpoint reset – Electrical wiring (Optional)

The machine's local setpoint can be modified by means of an external analogue 4-20mA signal. Once this function has been enabled, the microprocessor allows to modify the setpoint from the set local value up to a differential of 3°C. 4 mA correspond to 0°C differential, 20mA correspond to the setpoint plus the maximum differential.

The signal cable must be directly connected to terminals 35 and 36 of the M3 terminal board.

The signal cable must be of the shielded type and must not be laid in the vicinity of power cables, so as not to induce interference with the electronic controller.

Unit limitation – Electrical wiring (Optional)

The machine's microprocessor allows to limit the capacity according to two different criteria:

- Load limitation: The load can be varied by means of a 4-20mA external signal from a BMS.

The signal cable must be directly connected to terminals 36 and 37 of the M3 terminal board.

The signal cable must be of the shielded type and must not be laid in the vicinity of the power cables, so as not to induce interference with the electronic controller.

- Current limitation: The machine's load can be varied by means of a 4-20mA signal from an external device. In this case, current control limits must be set on the microprocessor so that the microprocessor transmits the value of the measured current and limits it.

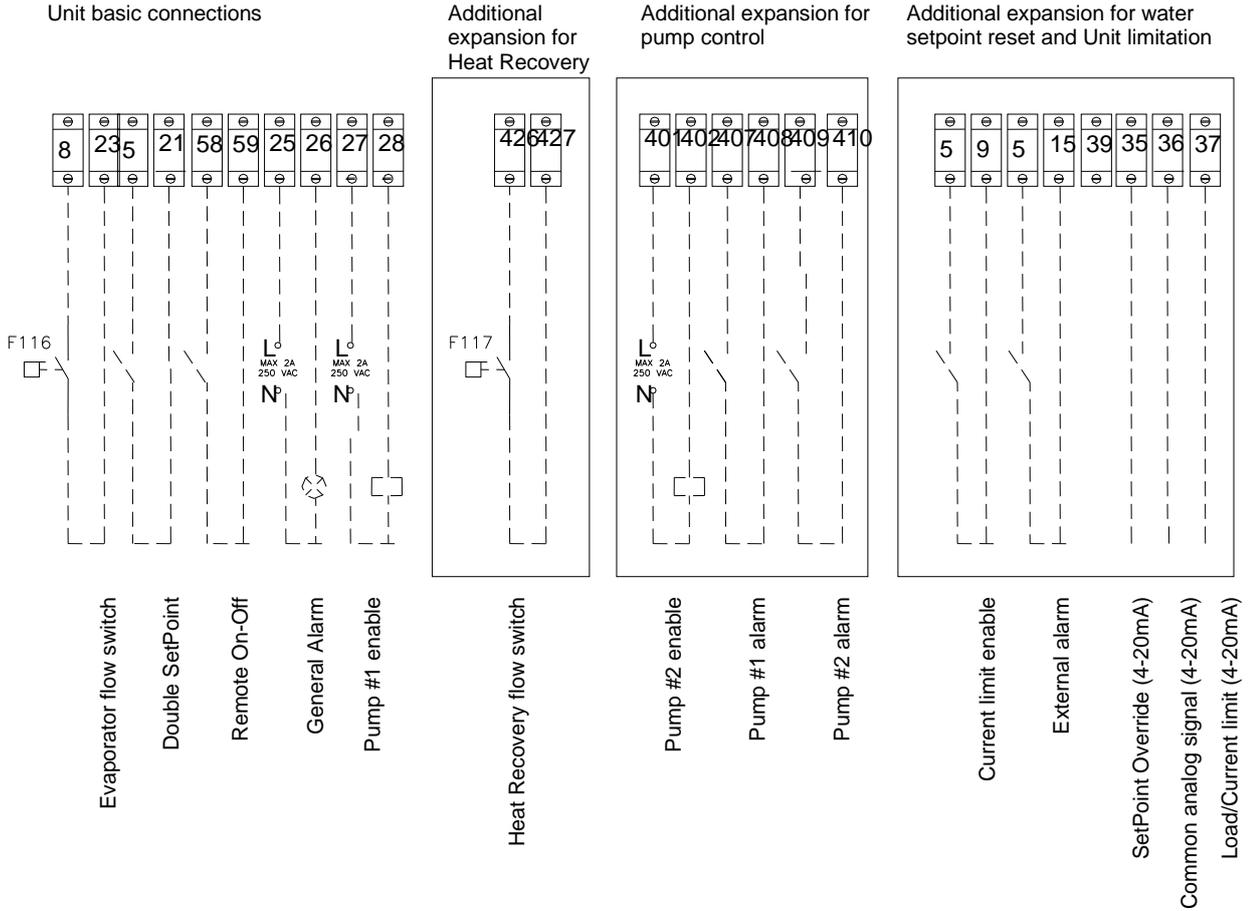
The signal cable must be directly connected to terminals 36 and 37 of the M3 terminal board.

The signal cable must be of the shielded type and must not be laid in the vicinity of the power cables, so as not to induce interference with the electronic controller.

A digital input allows to enable the current limitation at the desired time. Connect the enabling switch or the timer (clean contact) to terminals 5 and 9.

Attention: the two options cannot be enabled simultaneously. Setting one function excludes the other.

Figure 10 - User connection to the interface M3 terminal boards



The VFD and related problems

The units described in this manual use a VFD (Variable Frequency Driver) to vary the compressor rotation speed and consequently the refrigerant charge generated, maintaining the efficiency of the compressor itself at extremely high levels compared to other methods of capacity unloading.

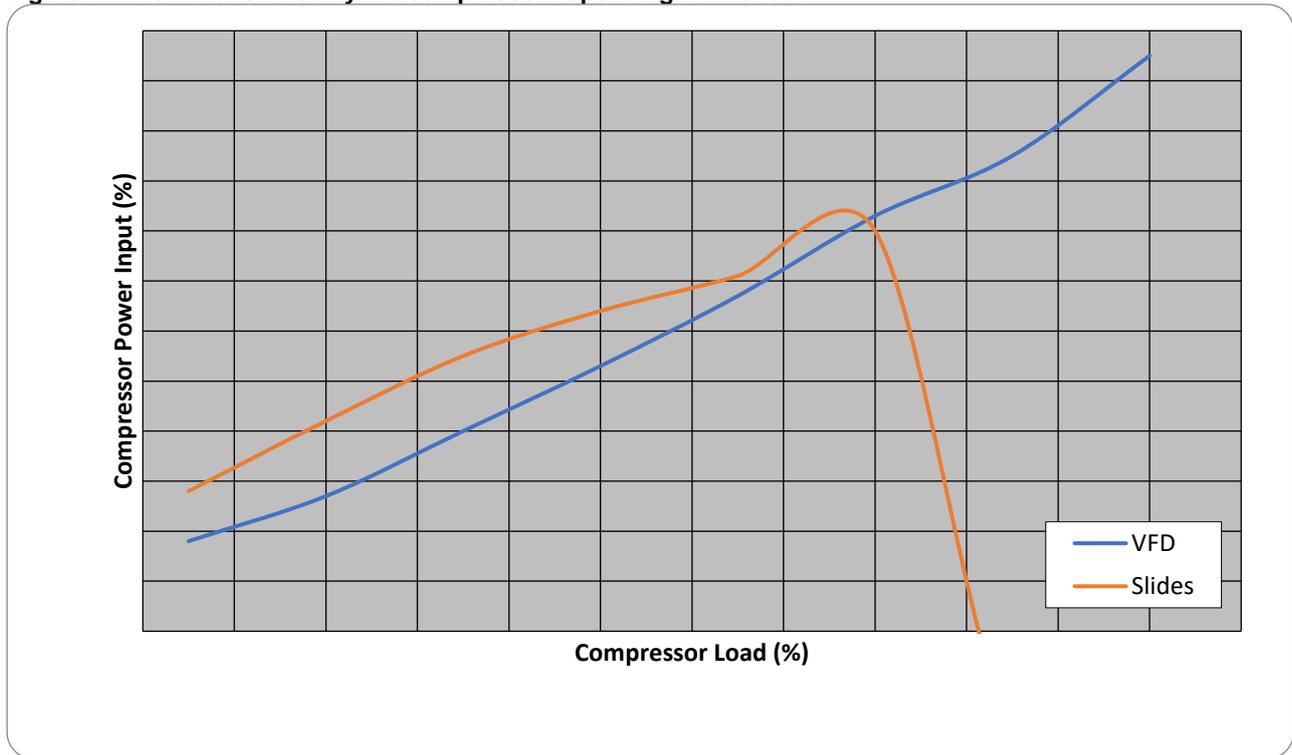
Also the rotation speed of the fan is controlled by VFD in order to improve efficiency at partial load.

Fig. 12 illustrates the power absorbed by a typical single-screw compressor, depending on the load developed by the compressor, in the classic solution of unloading using slides and with speed variation

Notice how the input power is always lower (by up to 30%) in the case of speed variation compared to the use of unloading slides.

Furthermore, in the case of speed variation, the compressor can rotate faster than its nominal speed and thus develop a load greater than 100%, which is obviously impossible with a fixed speed rotation, thus recovering loss in capacity due to unfavourable environmental conditions, such as low ambient temperature.

Figure 11 - Power absorbed by the compressor depending on the load



The operating principle of the VFD

The VFD (also known as an “inverter”) is an electronic power device designed to vary the speed of rotation of induction motors.

The motors revolve at a practically fixed rpm speed which depends only on the frequency of the power supply (*f*) and on the number of poles (*p*), as per the following formula:

$$rpm = \frac{f \cdot 60}{p}$$

(In fact, for the motor to produce torque, the rotation speed, known as the speed of synchronism, must be slightly less than that calculated above.)

To vary the speed of rotation of an induction motor, the supply frequency of the same therefore needs to vary.

The VFD does this, starting with a fixed grid frequency (50 Hz for European power grid, 60 Hz for the US) operating in three steps:

- step one involves a rectifier to transform the alternating current into direct current, which is typically achieved using a diode rectifier bridge (leading solutions use bridges with SCR)
- step two involves charging the capacitors (direct current bus, also known as a DC-Link)
- step three involves the reconstruction of the alternating current (a genuine inverter) by means of a transistor bridge (normally IGBT) with variable voltage and frequency values, set by the control system. The voltage is in fact the result of a high-frequency PWM modulation (in the range of a few kHz) from which the fundamental variable frequency component is taken (typically 0-100 Hz).

The problem with harmonics

The rectifier bridge of a VFD requires current from the grid that is not purely sinusoidal. Indeed, due to the presence of diodes, which are non-linear components, the current absorbed by a rectifier bridge has a higher frequency than the frequency of the power grid. Such components are known as harmonics: in the case of a power supply at 50 Hz, the component at 50 Hz is defined as the fundamental harmonic, while the second harmonic is the component at 100 Hz, the third harmonic is the component at 150 Hz, and so on. (In the case of a power supply at 60 Hz, the fundamental component is that at 60 Hz, the second that at 120 Hz, the third is that at 180 Hz, and so on.)

Figure 12 - Typical diagram of a VFD

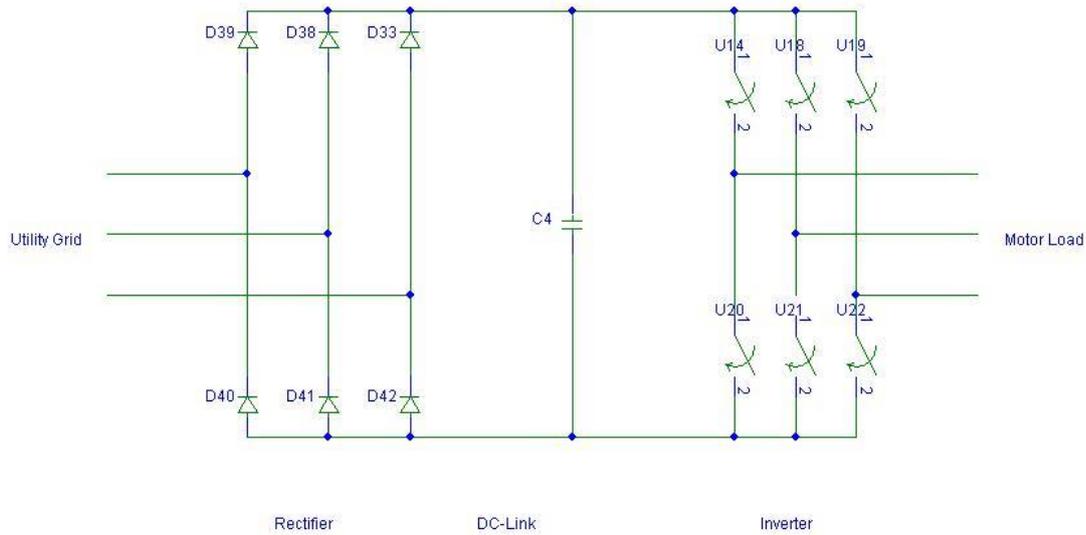
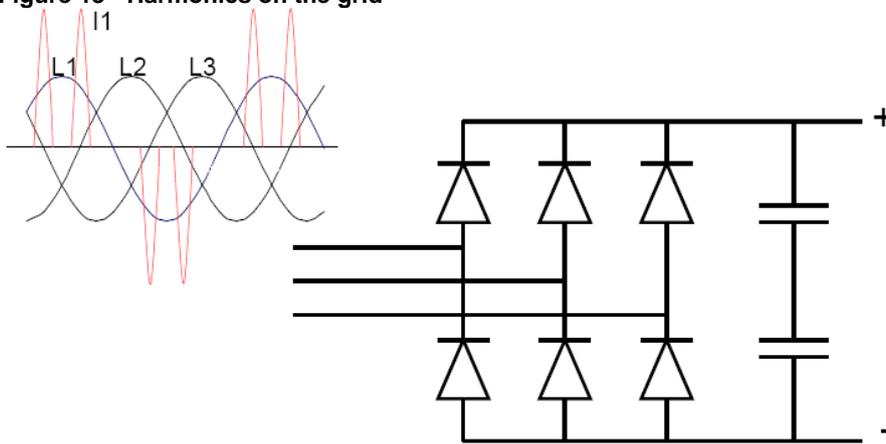


Figure 13 - Harmonics on the grid



Since the rectifier bridge sees before it a direct current stage, the current taken is practically in phase with the voltage. However, the formula below no longer applies

$$P_{act} = \sqrt{3} \cdot V \cdot I \cdot \cos\varphi \quad \text{NO}$$

because the harmonic components in excess of the fundamental harmonic do not contribute to the active power. Several values therefore need to be defined:

Displacement Power Factor

$$DPF = \cos\varphi$$

Power Factor (total power)

$$PF = \frac{I_1}{I} \cdot DPF$$

The Power Factor takes into account both phase displacement as well as harmonic content, expressed as a ratio of the fundamental component I_1 to the current and the overall effective value. It actually expresses which part of the input current is converted into active power. It is worth mentioning that in the absence of an inverter or electronic devices in general, the DPF and PF are the same.

Moreover, many electricity boards only take into account the DPF, since the harmonic content is not measured, but only the absorption of active and reactive power.

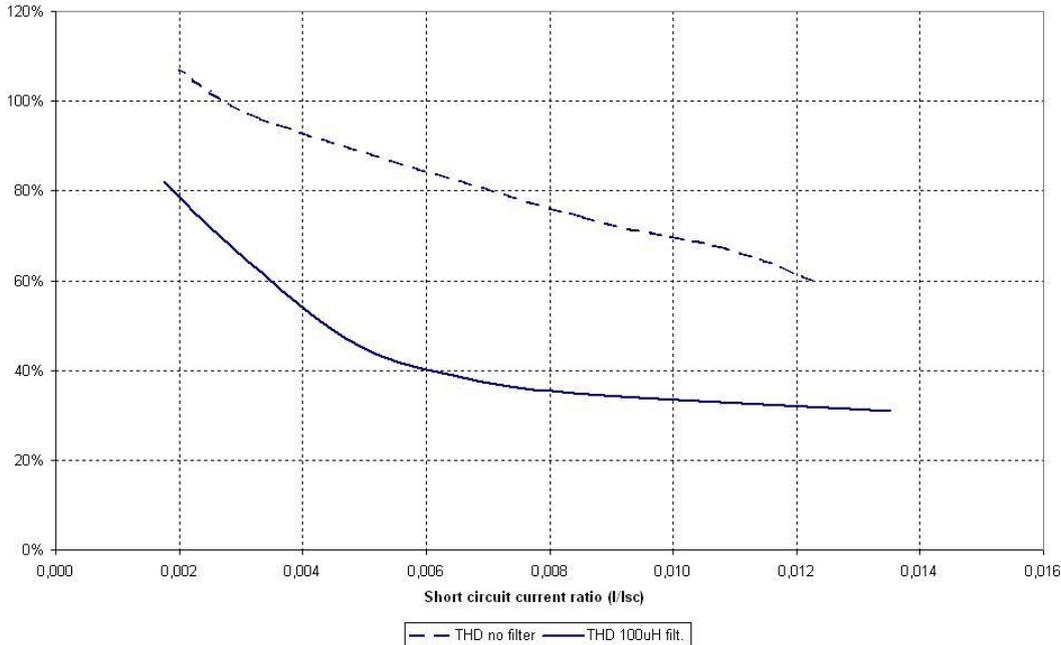
Another measuring index for the harmonics in the grid is provided by the harmonic distortion coefficient THD_i (Total Harmonic Distortion):

$$THD_i = \sqrt{\frac{I^2 - I_1^2}{I_1^2}}$$

In a VFD without remedial devices, harmonic distortion can reach values of more than 100% (i.e. the harmonic components can, all together, reach more than the fundamental component).

To reduce the harmonic content of the current (and so the THD), the units illustrated in this manual are equipped with line inductance. Since the harmonic content depends on the ratio of the current required by the VFD to the short-circuit current in the wiring point, for a given plant, the THD varies according to the machine absorption. For example, fig. 14 illustrates the value of the THD with or without a filter inductance, for different values of the ratio of VFD current to the short-circuit current in the wiring point.

Figure 14 - Harmonic content with and without line inductance

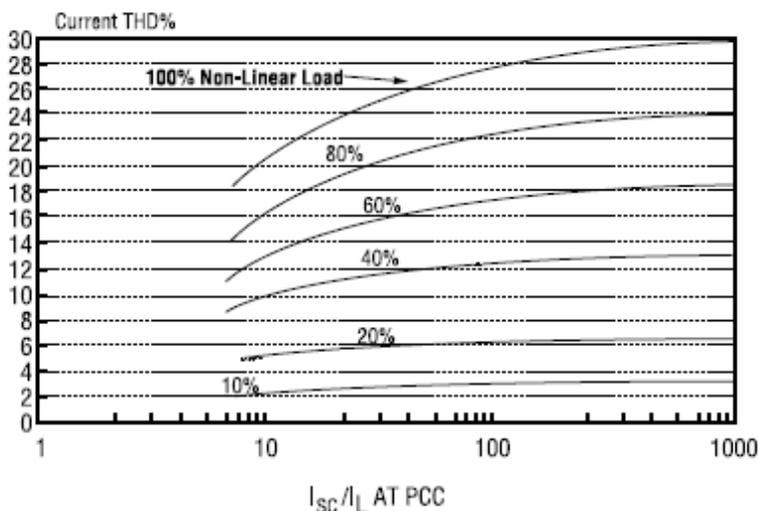


It must however be mentioned that the harmonic distortion drops in value if other utilities are connected at the connection point (PCC): the greater the weight of these utilities, the smaller the current distortion will be. Fig. 16 illustrates the total harmonic distortion in the point where the unit is wired to the grid, according to the ratio between the short circuit current in the connection point (I_{sc}) and the current drawn by the unit (I_L) and the percentage power absorbed by the unit compared to the total power supplied by the grid at the connection point.

Notice how the harmonic distortion at the connection point can feature very low values (below 5%) when the short circuit current is less than 20 times the unit current and this makes up a percentage of no more than 20% of the total load of the grid.

In any case, the harmonic distortion introduced by the unit must be evaluated in relation to the specific application, subject to a detailed analysis of the entire grid and of the loads powered.

Figure 15 - Harmonic content varying according to the percentage of non-linear loads



5. OPERATION

Operator's responsibilities

It is important that the operator is appropriately trained and becomes familiar with the system before operating the machine. In addition to reading this manual, the operator must study the microprocessor operating manual and the wiring diagram in order to understand start-up sequence, operation, shutdown sequence and operation of all the safety devices. Read the VFD manual carefully.

During the machine's initial start-up phase, a technician authorized by the manufacturer is available to answer any questions and to give instructions as to the correct operating procedures.

The operator is advised to keep a record of operating data for every installed machine. Another record should also be kept of all the periodical maintenance and servicing activities.

If the operator notes abnormal or unusual operating conditions, he is advised to consult the technical service authorized by the manufacturer.

Description of the machine

This machine, of the air-cooled condenser type, is made up of the following main components:

- **Compressor:** The state-of-the-art single-screw compressor of the Fr3100 series is of the semi-hermetic type and utilises gas from the evaporator to cool the motor and allow optimal operation under any expected load conditions. The oil-injection lubrication system does not require an oil pump as oil flow is ensured by the pressure difference between delivery and suction. In addition to ensuring lubrication of ball bearings, oil injection dynamically seals the screw, thus enabling the compression process.

- **Water heat exchanger:** Direct-expansion shell and tube heat exchanger for all models, it works as an evaporator when the machine is in chiller mode and as a condenser when it is in heat pump mode.

- **Air heat exchanger:** Finned-pack type with internally micro-finned tubes, that expand directly on the high-efficiency open fin; it works as an evaporator when the machine is in chiller mode and as a condenser when it is in heat pump mode.

- **Fan:** High-efficiency axial type. Allows quiet operation of the system, even during adjustment.

- **Expansion valve:** The standard machine has an electronic expansion valve, which is controlled by an electronic device called a Driver that optimises its operation.

- **4-way valve:** Allows the compressor delivery to be shunted towards the air heat exchanger for water chiller mode or towards the water heat exchanger for water heater mode.

- **VFD:** This is an electronic power device that allows the continuous variation of the compressor/fan rotation speed, ensuring the modulation of the load provided with the utmost efficiency.

Description of the refrigeration cycle

The low-temperature refrigerant gas from the evaporator is drawn by the compressor through the electric motor, which gets cooled by the refrigerant. It is subsequently compressed and during this process the refrigerant mixes with the oil from the oil separator. The oil introduced is used to lubricate both the seal between the screw and the shell as well as between the screw and the star.

The high-pressure oil-refrigerant mixture is introduced into the centrifuge-type high-efficiency oil separator, where the oil is separated from the refrigerant. The oil accumulated on the bottom of the separator is forced by the pressure difference back into the compressor while the oil-free refrigerant is sent to the condenser where the superheated refrigerant vapour cools down and starts to condense and then the refrigerant subcools.

The heat taken from the fluid during the de-superheating, condensation and subcooling phase is transferred to the outside air in chiller mode or to the water – which is thus heated - in heat pump mode.

The subcooled fluid flows through the high-efficiency filter dryer and then it reaches the expansion element (expansion valve) through which a pressure drop takes place resulting in the vaporisation of part of the refrigerant liquid.

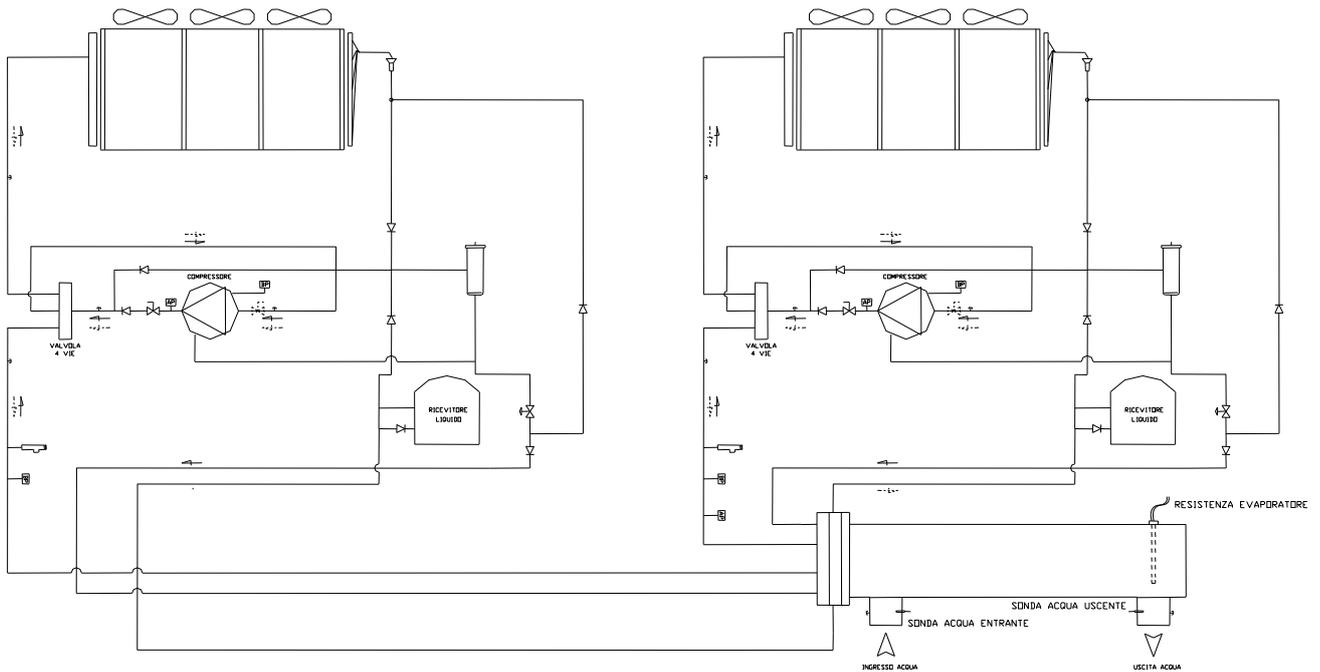
The result at this point is a low-pressure and low-temperature liquid-gas mixture entering the evaporator, where it takes the heat required for vaporisation.

After the liquid-vapour refrigerant has been evenly distributed into the evaporator tubes, it exchanges heat with the water to be cooled (in chiller mode), thus reducing the water temperature, or with the outside air (in heat pump mode) while it gradually gets completely vaporised and then superheated.

Once it has reached the superheated-vapour state, the refrigerant leaves the evaporator and is once again taken into the compressor to repeat the cycle.

In the heat pump unit, the water heat exchanger can be used to cool (chiller mode) or heat (heat pump mode) the water that flows through it. To perform both functions (which obviously cannot be carried out simultaneously, and so the desired operating mode needs to be selected), the water heat exchanger needs to be able to work as an evaporator (chiller mode) or as a condenser (heat pump mode). This is accomplished thanks to a special valve (4-way valve) designed to shunt the fluid on the oil separator outlet towards the water heat exchanger (in chiller mode) or towards the water heat exchanger (in heat pump mode), making it work as a condenser and connecting the other heat exchanger (water heat exchanger in chiller mode and air heat exchanger in heat pump mode) onto the compressor suction, making it work as an evaporator. The difference in internal volume between an air heat exchanger and a water heat exchanger makes it necessary for the circuit to feature an element (liquid receiver) designed to house the difference in liquid in both operating modes.

Figure 16 - Refrigeration cycle



LEGENDA

- |> VALVOLA RITEGNO
- E ATTACCO 1/4" SAE
- |> VALVOLA DI SICUREZZA
- |> VALVOLA DI ESPANSIONE
- [AP] PRESSOSTATO ALTA PRESSIONE
- |> SPIA PASSAGGIO LIQUIDO
- [BP] PRESSOSTATO BASSA PRESSIONE
- |> TRASDUTTORE ALTA PRESSIONE
- |> RUBINETTO LINEA LIQUIDO
- |> RUBINETTO DI ASPIRAZIONE (OPTIONAL)
- |> RUBINETTO DI MANDATA
- |> RUBINETTO DI CARICA 1/4" SAE
- |> DIREZIONE FLUIDO IN REFRIGERAZIONE
- |> DIREZIONE FLUIDO IN RISCALDAMENTO

Valvola ritegno	Check valve
Attacco 1/4" SAE	1/4" SAE connection
Valvola di sicurezza	Safety valve
Valvola di espansione	Expansion valve
Pressostato alta pressione	High-pressure switch
Spia passaggio liquido	Liquid flow sight glass
Pressostato bassa pressione	Low-pressure switch
Trasduttore alta pressione	High pressure transducer
Rubinetto linea liquido	Liquid line valve
Rubinetto di aspirazione (optional)	Suction valve (optional)
Rubinetto di mandata	Delivery valve
Rubinetto di carica 1/4" SAE	1/4" SAE charge valve
Direzione fluido in refrigerazione	Direction of fluid for cooling
Direzione fluido in riscaldamento	Direction of fluid for heating

Figure shows two circuits unit. For three circuit units the third circuit is identical to the first two and the evaporator has one gas line and one liquid line more.

Description of the refrigeration cycle with heat recovery

The low-temperature refrigerant gas from the evaporator is drawn by the compressor through the electric motor, which gets cooled by the refrigerant. It is subsequently compressed and during this process the refrigerant mixes with the oil from the oil separator.

The high-pressure oil-refrigerant mixture is introduced into the centrifuge-type high-efficiency oil separator, where the oil is separated from the refrigerant. The oil accumulated on the bottom of the separator is forced by the pressure difference back into the compressor while the oil-free refrigerant is sent to the partial recovery heat exchanger where it cools down by reducing its superheat temperature while warming the water which travels through the heat exchanger. From the outlet of the heat exchanger, the refrigerant fluid first passes through the 4-way valve, then it enters the air heat exchanger (in chiller mode) or the water heat exchanger (in heat pump mode), where it is condensed and subcooled while heating the outside air (forced ventilation) or the water respectively.

The subcooled fluid flows through the high-efficiency filter dryer and then it reaches the expansion element through which a pressure drop takes place resulting in the vaporisation of part of the refrigerant liquid.

The result at this point is a low-pressure and low-temperature liquid-gas mixture that is introduced into the water heat exchanger (chiller mode) or air heat exchanger (heat pump mode), where it takes the heat required for vaporisation.

After the liquid-vapour refrigerant has been evenly distributed into the tubes of the heat exchanger, it exchanges heat with the water to be cooled (in chiller mode), thus reducing the water temperature, or with the outside air (in heat pump mode) while it gradually gets completely vaporised and then superheated.

Once it has reached the superheated-vapour state, the refrigerant leaves the heat exchanger and is once again taken into the compressor to repeat the cycle.

Controlling the heat recovery circuit and installation recommendations

The partial heat recovery system is available in both chiller and heat pump mode and is not managed and/or controlled by the machine. The installer should follow the suggestions below for best system performance and reliability:

1. Install a mechanical filter on the heat exchanger inlet pipe.
2. Install shut-off valves to isolate the heat exchanger from the water system during periods of inactivity or system maintenance.
3. Install a drain valve that allow the heat exchanger to be emptied in the event that air temperature is expected to fall below 0°C during periods of inactivity of the machine.
4. Install flexible anti-vibration joints on the heat recovery water inlet and outlet piping, so that transmission of vibrations, and therefore of noise, to the water system is kept as low as possible.
5. Do not load exchanger joints with the weight of the heat recovery piping. The water joints of the exchangers are not designed to support the weight of the piping.
6. Should heat recovery water temperature be lower than ambient temperature, it is advised to switch off the heat recovery water pump 3 minutes after having switched off the last compressor.

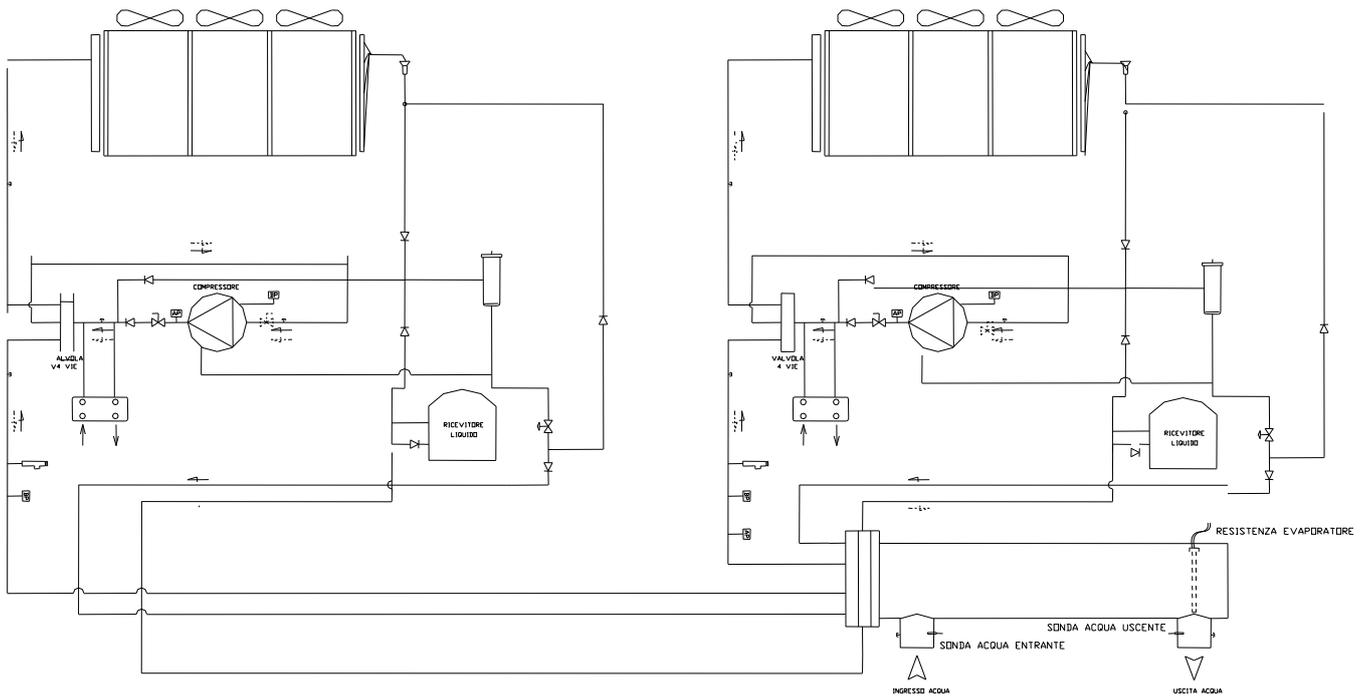
▲ ATTENTION

Heat recovery has been designed as an additional source of external heat; in fact, the availability of recovered heat is guaranteed only with a cooling circuit which functions when cooled water is requested.

In particular, it cannot function correctly if the water entering the exchanger is cooler than 35°C for periods exceeding the normal time needed for the system to reach normal running conditions (about 15 minutes): functioning for prolonged periods under such conditions can cause malfunctions in the cooling circuit and will trigger off the protective devices. The installer must also ensure that the temperature of the water in the recovery circuit reaches the minimum value allowed as soon as possible.

For the same reasons, there must be no water flowing through the exchanger when the cooling circuit is switched off.

Figure 17 - Refrigeration cycle with partial heat recovery



LEGENDA

- |— VALVOLA RITEGNO
- E ATTACCO 1/4" SAE
- |— VALVOLA DI SICUREZZA
- |— VALVOLA DI ESPANSIONE
- [AP] PRESSOSTATO ALTA PRESSIONE
- SPIA PASSAGGIO LIQUIDO
- [BP] PRESSOSTATO BASSA PRESSIONE
- |— TRASDUTTORE ALTA PRESSIONE
- |— RUBINETTO LINEA LIQUIDO
- |— RUBINETTO DI ASPIRAZIONE (OPTIONAL)
- |— RUBINETTO DI MANDATA
- |— RUBINETTO DI CARICA 1/4" SAE
- |— DIREZIONE FLUIDO IN REFRIGERAZIONE
- |— DIREZIONE FLUIDO IN RISCALDAMENTO

Valvola ritegno	Check valve
Attacco 1/4" SAE	1/4" SAE connection
Valvola di sicurezza	Safety valve
Valvola di espansione	Expansion valve
Pressostato alta pressione	High-pressure switch
Spia passaggio liquido	Liquid flow sight glass
Pressostato bassa pressione	Low-pressure switch
Trasduttore alta pressione	High pressure transducer
Rubinetto linea liquido	Liquid line valve
Rubinetto di aspirazione (optional)	Suction valve (optional)
Rubinetto di mandata	Delivery valve
Rubinetto di carica 1/4" SAE	1/4" SAE charge valve
Direzione fluido in refrigerazione	Direction of fluid for cooling
Direzione fluido in riscaldamento	Direction of fluid for heating

(*) Water inlet and outlet data are given for indication only. Refer to the dimensional diagram of the machine for the exact water connection of the partial recovery exchangers.

Figure shows two circuits unit. For thre circuit units the third circuit is identical to the first two and the evaporator has one gas line and one liquid line more.

Compressor

The single-screw compressor is of the semi-hermetic type with an asynchronous three-phase, two-pole motor which is directly splined on the main shaft. The suction gas from the evaporator cools the electric motor before entering the suction ports. There are temperature sensors inside the electric motor which are completely covered by the coil winding and constantly monitor motor temperature. Should the coil winding temperature become very high (120°C), a special external device connected to the sensors and to the electronic controller will de-activate the corresponding compressor.

There are only two moving rotating parts and there are no other parts in the compressor with an eccentric and/or alternative movement.

The basic components are therefore only the main rotor and the satellite that carry out the compression process, meshing perfectly together.

The compressors of all models of the series are Fr3100. The Fr3100 compressor has one single satellite on the upper section of the screw.

Compression sealing is done thanks to a suitably shaped special composite material that is interposed between the main screw and the satellite. The main shaft on which the main rotor is splined is supported by 2 ball bearings. The system made up in this way is both statically and dynamically balanced before assembly.

Figure 18 - Picture of Fr3100 compressor



A large access cover on the upper part of Fr3100 compressor allows for quick and easy maintenance.

Compression process

With the single-screw compressor the suction, compression and discharge process takes place in a continuous manner thanks to the upper satellite. In this process the suction gas penetrates into the profile between the rotor, the teeth of the upper satellite and the compressor body. The volume is gradually reduced by compression of the refrigerant. The compressed gas under high pressure is thus discharged into the built-in oil separator. In the oil separator the gas/ oil mixture and the oil are collected in a cavity in the lower part of the compressor, where they are injected into the compression mechanisms in order to ensure the compression's sealing and lubrication of the ball bearings.

Figure 19 - Compression process

1. and 2. Suction

Main rotor flutes 'a', 'b' and 'c' are in communication at one end with the suction chamber via the bevelled rotor end face, and are sealed at the other end by the star rotor teeth. As the main rotor turns, the effective length of the flutes increases with a corresponding increase in the volume open to the suction chamber: Diagram 1 clearly shows this process. As flute 'a' assumes the position of flutes 'b' and 'c' its volume increases, inducing suction vapour to enter the flute.

Upon further rotation of the main rotor, the flutes which have been open to the suction chamber engage with the star teeth. This coincides with each flute being progressively sealed by the main rotor. Once the flute volume is closed off from the suction chamber, the suction stage of the compression cycle is complete.

A Suction gas

3. Compression

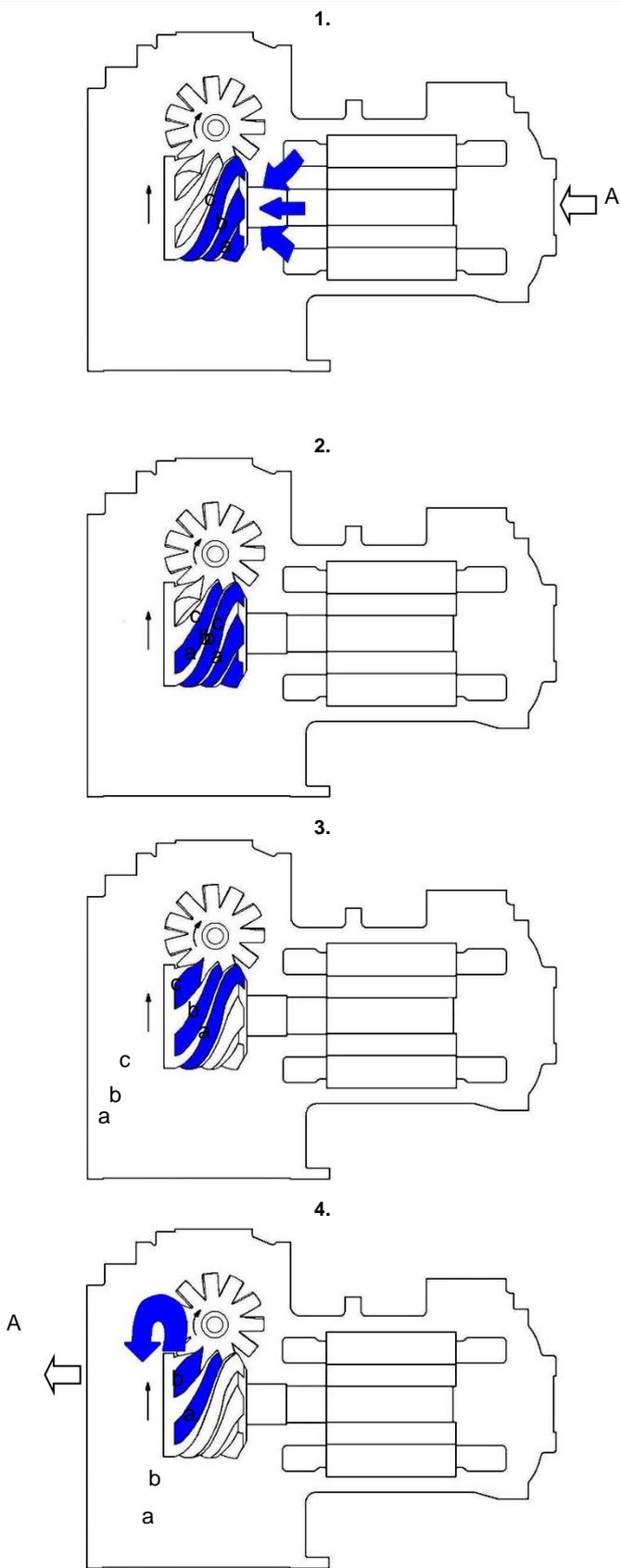
As the main rotor turns, the volume of gas trapped within the flute is reduced as the length of the flute shortens and compression occurs.

4. Discharge

As the star rotor tooth approaches the end of a flute, the pressure of the trapped vapour reaches a maximum value occurring when the leading edge of the flute begins to overlap the triangular shaped discharge port.

Compression immediately ceases as the gas is delivered into the discharge manifold. The star rotor tooth continues to scavenge the flute until the flute volume is reduced to zero. This compression process is repeated for each flute/star tooth in turn.

A Discharge gas



Oil separator not shown

Cooling capacity control

The compressors are factory-equipped with a stepless cooling capacity control system.

An unloading slide reduces the intake groove volume and its actual length. This slide is used to operate the compressor at minimum and maximum load, and as in all other conditions the cooling capacity is adjusted by the inverter, which modulates the speed of the screw (for further details on how the inverter works, please refer to the enclosed Combivert manual).

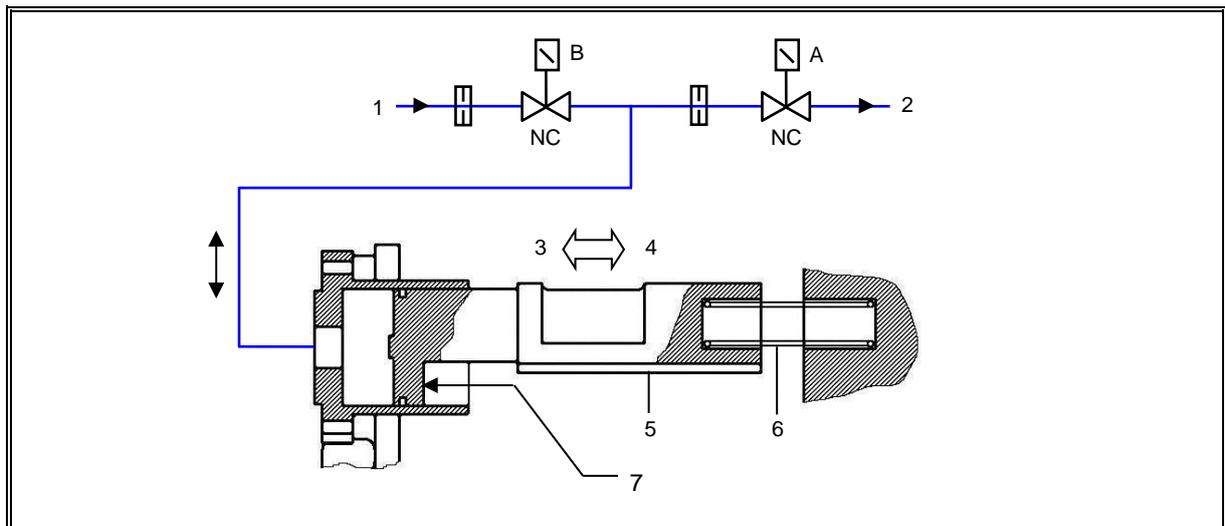
The unloading slide is controlled by the pressure of the oil coming from the separator or by the effect of oil released to the compressor suction; a spring provides the balancing force needed to move the slide.

The oil flow is controlled by two different solenoid valves 'A' and 'B', according to inputs from the unit controller. The solenoids are normally-closed (NC) and they open when powered.

During the compressor operation, the valve position is controlled by the pressure inside the cylinder.

In the EWYD-BZ- heat pump, the unloading slide is only used to keep the compressor at minimum load upon start-up. This, together with a start-up at reduced speed, prevents the compressor from taking in liquid, which could damage it, even under extremely severe conditions such as when the operating mode is changed from chiller to heat pump or vice versa.

Figure 20 - Capacity control mechanism for Fr3100 compressor



- 1 Oil supply
- 2 Oil vent to suction
- 3 Unload
- 4 Load
- 5 Slide
- 6 Spring
- 7 Discharge pressure acts on this side of piston

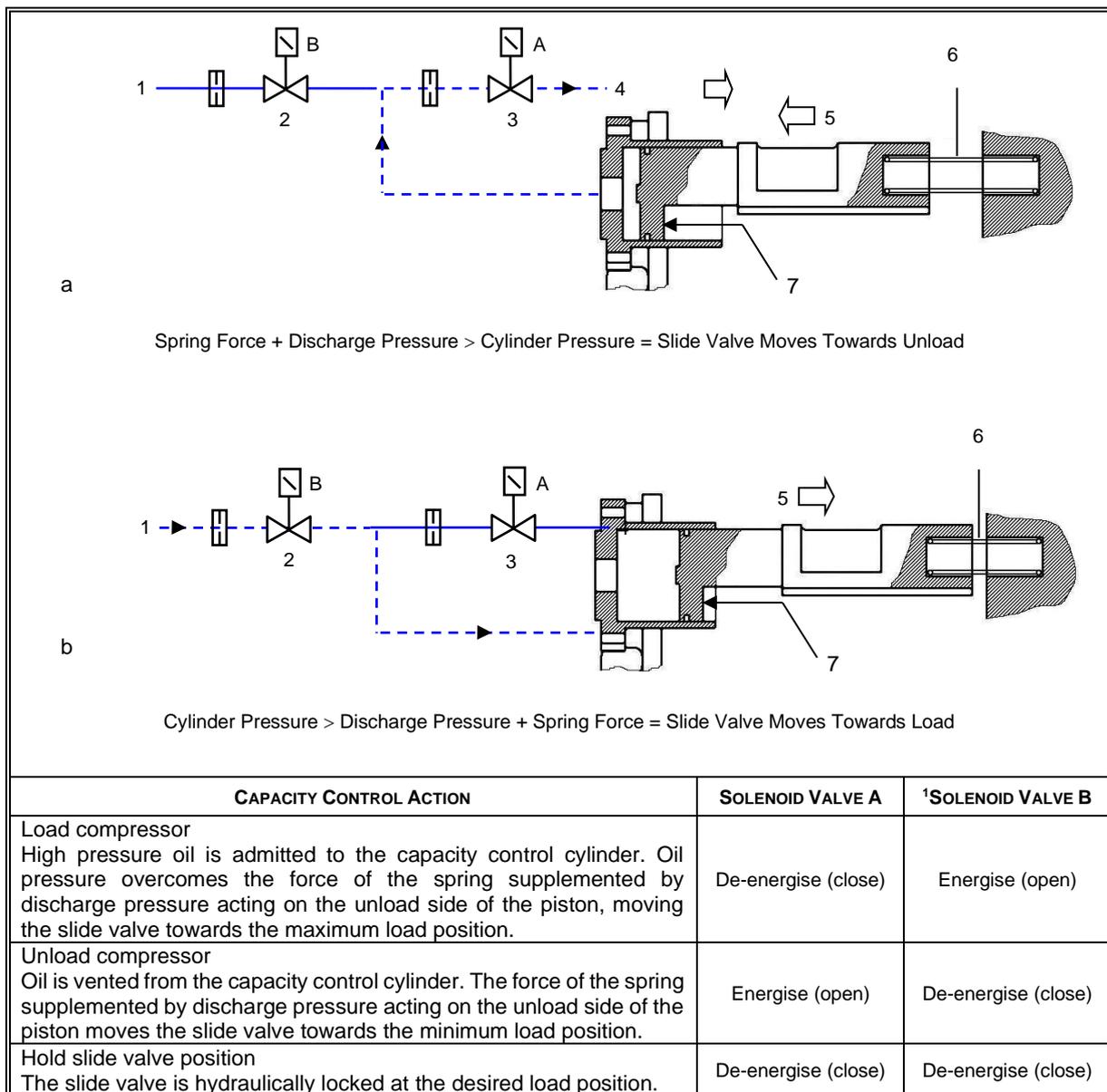


Figure 21 - Continuously variable capacity control for Fr3100 compressor

- a Compressor unloading
- 1 Oil supply
 - 2 De-energised (closed)
 - 3 Energised (open)
 - 4 Oil vent
 - 5 Unload
 - 6 Spring expands
 - 7 Discharge pressure acts on this side of piston
- b Compressor loading
- 1 Oil supply
 - 2 Energised (open)
 - 3 De-energised (closed)
 - 4 Oil vent
 - 5 Load
 - 6 Spring compressed
 - 7 Discharge pressure acts on this side of piston

6. PRE-STARTUP CHECKS

General

Once the machine has been installed, use the following procedure to check that it has been done properly:

CAUTION

Before servicing the machine in any way, open the general disconnect switch on the machine main power supply. When the machine is off but the disconnect switch is in the closed position, unused circuits are live, as well. Never open the terminal board box of the compressors before having opened the unit's general disconnecting switch.

CAUTION

After switching off the unit, the intermediate circuit capacitors are still charged with high voltage for a short period of time. Capacitor full discharge takes approximately 5 minutes. Wait for the LEDs on the inverter to turn off before attempting to access parts which could potentially be live. Please consult the inverter manual for further details.

Inspect all the electrical connections to the power circuits and to the compressors including the contactors, fuse carriers and electrical terminals and check that they are clean and well secured. Even though these checks are carried out at the factory on every machine that is shipped, vibrations during transportation may loosen some electrical connections.

CAUTION

Check that the electrical terminals of cables are well tightened. A loose cable can overheat and give rise to problems with the compressors.

Open discharge, liquid, liquid injection and suction (if installed) valves.

ATTENTION

Do not start up the compressors if the delivery, liquid, liquid injection or suction valves are closed. Failure to open these valves may cause serious damage to the compressor.

Put all the fan circuit breakers (from F16 through F20 and from F26 through F30) on the On position.

IMPORTANT

If the fan circuit breakers are forgotten open, both compressors will trip due to high pressure (chiller mode) or low pressure (heat pump mode) when the machine is started up for the first time. Resetting the high-pressure alarm requires opening the compressor compartment and resetting the mechanical high-pressure switch.

Check the power supply voltage at the general door-handle switch terminals. The power supply voltage must be the same as that on the nameplate. Maximum allowed tolerance $\pm 10\%$.

Voltage unbalance between the three phases must not exceed $\pm 3\%$.

The unit comes with a factory-supplied phase monitor that prevents compressors and fans from starting in the event of wrong phase sequence. Properly connect the electrical terminals to the disconnect switch so as to ensure alarm-free operation. If the phase monitor triggers an alarm once the machine has been powered, just invert two phases at the general disconnect switch supply (unit power supply). Never reverse the electrical wiring on the motor.

Fill the water circuit and remove air from the system's highest point and open the air valve above the evaporator shell. Remember to close it again after filling. The design pressure on the water side of the evaporator is 10.0 bar. Never exceed this pressure at any time during the life of the machine.

▲ IMPORTANT

Before putting the machine into operation, clean the water circuit. Dirt, scaling, corrosion residue and other foreign material can accumulate in the heat exchanger and reduce heat transfer capacity. Pressure drops can also increase, consequently reducing water flow. Thus, correct water treatment reduces the risk of corrosion, erosion, scaling, etc. The most appropriate water treatment must be established locally according to the type of installation and local characteristics of the process water.

The manufacturer is not responsible for damage or bad operation of the apparatus resulting from failure to treat water or from incorrectly treated water.

Units with an external water pump

Start the water pump and check the water system for any leaks; repair these if necessary. While the water pump is in operation, adjust the water flow until the design pressure drop for the evaporator is reached. Adjust the flow switch trigger point (not factory-supplied), to ensure operation of the machine within a $\pm 20\%$ flow range.

Units with a built-in water pump

This procedure foresees factory installation of the optional single -or twin- water pump kit.

Check that switches Q0, Q1 and Q2 are in the open position (Off or 0). Also check that the thermal-magnetic switch Q12 in the electrical panel control area, is in the Off position.

Close the general Q10 door-block switch on the main board and move the Q12 switch to the On position.

▲ CAUTION

From this moment onwards, the machine will be under electrical power. Use extreme caution during subsequent operation.

A lack of attention during subsequent operation may cause serious personal injury.

Single pump To start the water pump, turn the Q0 switch to the On (or 1) position and wait for the unit On message to appear on the display. Adjust the water flow until the evaporator design pressure drop is reached. Adjust the flow switch (not included) at this point, to ensure that the machine operates within a $\pm 20\%$ flow range.

Twin pump The system foresees the use of a twin pump having two motors, each as a backup to the other. The microprocessor enables one of the two pumps with a view to minimising the number of hours and start-ups. To start one of the two water pumps, turn the Q0 switch to the On (or 1) position and wait for the unit On message to appear on the display. Adjust the water flow until the evaporator design pressure drop is reached. Adjust the flow switch (not included) at this point, to ensure that the machine operates within a $\pm 20\%$ flow range. To start the second pump, keep the first one on for at least 5 minutes, then open the Q0 switch, wait for the first pump to turn off. Close the Q0 switch again to start the second pump.

Using the microprocessor keypad it is possible, however, to set pump start-up priorities. Please see the microprocessor manual for the relevant procedure.

Electrical power supply

The machine's power supply voltage must be the same as that specified on the nameplate $\pm 10\%$ while the voltage unbalance between phases must not be in excess of $\pm 3\%$. Measure the voltage between phases and if the value does not fall within the established limits, correct it before starting the machine.

▲ ATTENTION

Provide suitable power supply voltage. Unsuitable power supply voltage could cause malfunction of the control components and undesired triggering of the thermal protection devices, along with a considerable reduction in the life of the contactors and electric motors.

Unbalance in power supply voltage

In a three-phase system, excessive unbalance between the phases causes overheating of the motor. The maximum allowed voltage unbalance is 3%, calculated as follows:

$$\text{Unbalance \%: } \frac{V_{MAX} - V_{AVG}}{V_{AVG}} \times 100 = \text{ ______ \%}$$

AVG = average

Example: the three phases measure respectively 383, 386 and 392 Volts, the average is:

$$\frac{383 + 386 + 392}{3} = 387 \text{ V}$$

thus the unbalance percentage is

$$\frac{392 - 387}{387} \times 100 = 1,29\% \quad \text{below the maximum allowed (3\%)}$$

Power supply of electrical heaters

Each compressor comes with an electrical heater located at the bottom of the compressor. Its purpose is to warm up the lubricating oil and thus avoid the mixing of refrigerant fluid within.

It is therefore necessary to ensure that the heaters are powered at least 24 hours before the planned start-up time. To ensure that they are activated, it is sufficient to keep the machine on by closing the general disconnecting switch Q10.

The microprocessor, however, has a series of sensors that prevent the compressor from being started up when the oil temperature is not at least 5°C above the saturation temperature corresponding to the current pressure.

Keep the Q0, Q1, Q2, Q3 and Q12 switches in the Off (or 0) position until the machine is to be started up.

7. STARTUP PROCEDURE

Turning on the machine

1. With the general switch Q10 closed, check that switches Q0, Q1, Q2 and Q12 are in the Off (or 0) position and the Q8 switch is in the requested position.
2. Close the thermal-magnetic switch Q12 and wait for the microprocessor and the control to start. Check that the oil temperature is warm enough. The oil temperature must be at least 5 °C above the saturation temperature of the refrigerant in the compressor.
3. If the oil is not warm enough, it will not be possible to start the compressors and the phrase "Oil Heating" will appear on the microprocessor display.
4. Start the water pump should the machine not be supplied with one.
5. Put the Q0 switch on the On position and wait for "Unit-On/ Compressor Stand-By" to appear on the display.
6. If the water pump is supplied with the machine, the microprocessor should start it at this point.
7. Check that the water heat exchanger pressure drop is the same as the design pressure drop and correct if necessary. The pressure drop must be measured at the factory-supplied charge connections placed on the evaporator nozzles. Do not measure the pressure drops at points where any valves and/or filters are interposed.
8. Only at the first start-up, put the Q0 switch in Off position to check that the water pump stays on for three minutes before it stops (this applies to the built-in pump and any external pump).
9. Put the Q0 switch in On position once again.
10. Check that the local temperature setpoint is set to the required value by pressing the Set button.
11. Turn the Q1 switch to On (or 1) to start compressor #1.
12. Once the compressor has started, wait for at least 1 minute for the system to stabilise. During this time the controller will perform a series of operations to empty the evaporator (Pre-Purge) to ensure a safe start-up.
13. At the end of the Pre-Purge, the microprocessor will start loading the compressor, now running, in order to reduce the outlet water temperature. The correct functioning can be verified by checking the supply frequency and the current supplied by the VFD.
14. Check refrigerant evaporation and condensation pressure.
15. Check that the cooling fans have started, as a response to an increase in condensation pressure (chiller mode).
16. Check the circuit operating parameters by verifying:
 - Superheating of refrigerant at compressor suction
 - Superheating of refrigerant at compressor discharge
 - Subcooling of liquid coming out of the condenser banks
 - Evaporation pressure
 - Condensation pressure

Except for liquid temperature, which requires the use of an external thermometer, all other measurements can be carried out by reading the relevant values directly on the on-board microprocessor display.
17. Turn the Q2 switch to On (or 1) to start compressor #2.
18. Repeat steps 10 through 15 for the second circuit.

Table 2 - Typical working conditions with compressors at 100%

Mode	Suction superheating	Discharge superheating	Liquid subcooling
Chiller	4 ± 6 °C	20 ± 25 °C	3 ± 6 °C
Heat pump	6 ± 9 °C	25 ± 30 °C	2 ± 5 °C

▲ IMPORTANT

The symptoms of a low refrigerant charge are:

- low evaporation pressure
- high suction and discharge superheating (outside the aforesaid limits)
- Low super-cooling value

In this case, add R134a refrigerant to the relevant circuit. The system has been provided with a charge connection between the expansion valve and the evaporator. Charge refrigerant until working conditions return to normal. Remember to reposition the valve cover when finished.

19. To turn off the machine temporarily (daily or weekend shutdown) turn the Q0 switch to Off (or 0) or open the remote contact between terminals 58 and 59 on terminal board M3 (Installation of remote switch to be carried out by the customer). The microprocessor will activate the shutdown procedure, which requires several seconds. Three minutes after the compressors have been shut down, the microprocessor will shut down the pump. Do not switch off the main power supply so as not to de-activate the electrical resistances of the compressors and the evaporator.

▲ IMPORTANT

If the machine is not supplied with a built-in pump, do not shut down the external pump before 3 minutes have elapsed after the last compressor has shut down. Early shutdown of the pump triggers a water-flow failure alarm.

Selecting an operating mode

The chiller operating mode (water cooling) is selected by setting the Q8 switch in 0 (or off) position, while the heat pump operating mode (water heating) is selected by setting the Q8 switch in 1 (or on) position.

The switch can be made either with the compressors in motion or turned off with the unit on or off (Q0 switch on 0 or off). In the first two instances, the unit will be turned off by the controller and kept turned off for an amount of time that can be set, to be checked (factory-setting 5 minutes) and then restarted in the desired operating mode.

Shutdown for a long time

1. Turn switches Q1 and Q2 to the Off (or 0) position to shut down the compressors, using the normal pump-down procedure.
2. After the compressors have been shut down, turn switch Q0 to Off (or 0) and wait for the built-in water pump to shut down. If the water pump is managed externally, wait for 3 minutes after the compressors have shut down before turning off the pump.
3. Open the Q12 (Off position) thermal magnetic switch inside the control section of the electrical board then open the general disconnect switch Q10 to cut off the machine's power supply entirely.
4. Close the compressor intake valves (if any) and delivery valves and also the valves located on the liquid and liquid injection line.
5. Place a warning sign on every switch that has been opened, advising to open all the valves before starting the compressors.
6. If no water and glycol mixture has been introduced into the system, discharge all the water from the evaporator and from the connected piping if the machine is to remain inactive during the winter season. One must remember that once the machine's power supply has been cut off, the antifreeze electrical resistance cannot function. Do not leave the evaporator and piping exposed to the atmosphere during the entire period of inactivity.

Starting up after seasonal shutdown

1. With the general disconnect switch open, make sure that all the electrical connections, cables, terminals and screws are well tightened to ensure good electrical contact.
2. Verify that the power supply voltage applied to the machine is within $\pm 10\%$ of the nominal nameplate voltage and that the voltage unbalance between phases is within $\pm 3\%$ range.
3. Verify that all control devices are in good condition and functioning and that there is a suitable thermal load for start-up.
4. Verify that all the connection valves are well tightened and that there are no refrigerant leaks. Always reposition the valve covers.
5. Verify that switches Q0, Q1, Q2 and Q12 are in the open position (Off). Turn the general disconnect switch Q10 to the On position. Doing this will allow to turn on the electrical resistances of the compressors. Wait at least 12 hours for them to warm up the oil.
6. Open all suction, delivery, liquid and liquid injection valves. Always reposition valve covers.
7. Open the water valves to fill the system and vent the air from the evaporator through the vent valve installed on its shell. Verify that there are no water leaks from the piping.

8. SYSTEM MAINTENANCE

▲ WARNING

All routine and extraordinary maintenance activities on the machine must be carried out solely by qualified personnel who are familiar with the machine characteristics, operation and maintenance procedures, and who are aware of the safety requirements and risks involved.

▲ WARNING

The causes of repeated shutdowns deriving from triggering of safety devices must be investigated and corrected. Re-starting the unit after simply resetting the alarm can seriously damage the equipment.

▲ WARNING

A correct refrigerant and oil charge is essential for optimal operation of the machine and for environmental protection. Any oil and refrigerant recovery must conform to legislation in force.

General

▲ IMPORTANT

Besides the checks suggested in the routine maintenance program, it is recommended to schedule periodical inspections, to be carried out by qualified personnel, as follows:

4 inspections per year (1 every 3 months) for units running about 365 days per year;

2 inspections per year (1 at seasonal start-up and the second one in the middle of the season) for units running about 180 days per year with seasonal operation.

1 inspection per year for units that run for a season of approximately 90 days/year (at seasonal start-up).

It is important that during initial start-up and periodically during operation, routine verifications and checks are performed. These must also include verification of suction and condensation pressure. Verify through the built-in microprocessor that the machine operates within the normal superheating and subcooling values. A recommended routine maintenance programme is shown at the end of this chapter while a form for collecting operational data can be found at the end of this manual. Weekly recording of all the machine's operating parameters is recommended. Collecting this data will be very useful to the technicians in the event that technical assistance is called for.

Compressor maintenance

▲ IMPORTANT

Since the compressor is of the semi-hermetic type, it requires no scheduled maintenance. However, for granting the highest levels of performance and efficiency and for preventing malfunctions, it is recommended that a visual check for wear in the satellite and clearances between main screw and the satellite is carried out every 10.000 running hours. Such inspection has to be carried out by qualified and trained personnel.

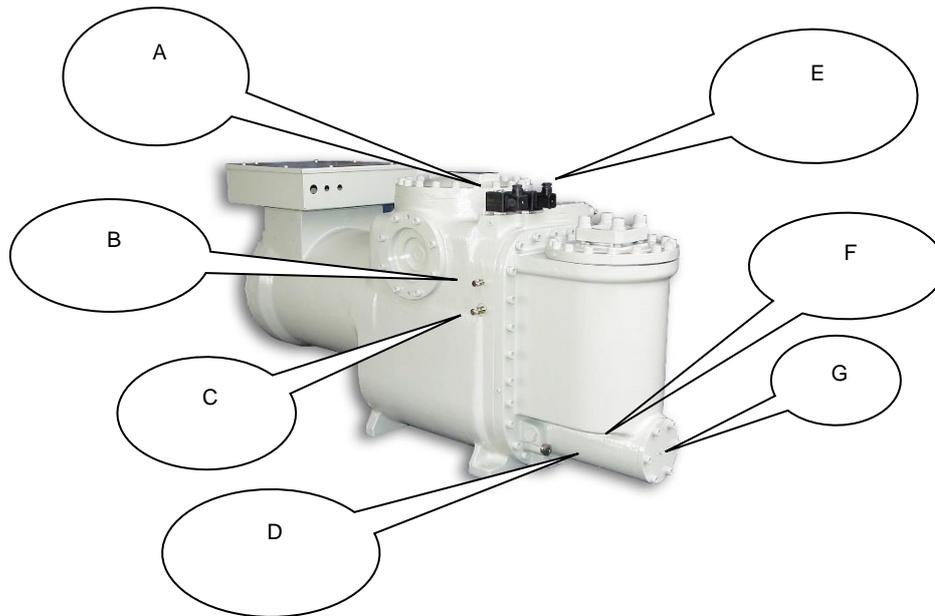
The analysis of vibrations is a good method for verifying the mechanical conditions of the compressor. Verification of vibration readings immediately after start-up and periodically on an annual basis is recommended. The compressor load must be similar to the previous measurement's load to ensure measurement reliability.

Lubrication

The units do not require a routine procedure for lubrication of components. The fan bearings have permanent lubrication and no additional lubrication is therefore required.

Compressor oil is of the synthetic type and is highly hygroscopic. It is therefore advised to limit its exposure to the atmosphere during storage and filling. It is recommended that the oil be exposed to the atmosphere for no more than 10 minutes.

The compressor oil filter is located under the oil separator (delivery side). Its replacement is advised when its pressure drop exceeds 2.0 bar. The pressure drop across the oil filter is the difference between the compressor discharge pressure and the oil pressure. Both these pressures can be monitored through the microprocessor for both compressors.



- A "A" unloading solenoid valve
- B High pressure switch
- C High pressure transducer
- D Oil/discharge temperature sensor
- E "B" loading solenoid valve
- F Oil transducer (hidden side)
- G Oil filter

Figure 22 - Installation of control devices for Fr3100 compressor

Routine maintenance

Table 3 - Routine maintenance programme

List of Activities	Weekly	Monthly (Note 1)	Yearly (Note 2)
General:			
Reading of operating data (Note 3)	X		
Visual inspection of machine for any damage and/or loosening		X	
Verification of thermal insulation integrity			X
Clean and paint where necessary			X
Analysis of water (6)			X
Electrical:			
Verification of control sequence			X
Verify contactor wear – Replace if necessary			X
Verify that all electrical terminals are tight – Tighten if necessary			X
Clean inside the electrical control board			X
Visual inspection of components for any signs of overheating		X	
Verify operation of compressor and electrical resistance		X	
Measure compressor motor insulation using the Megger			X
Refrigeration circuit:			
Check for any refrigerant leakage		X	
Verify filter dryer pressure drop		X	
Verify oil filter pressure drop (Note 5)		X	
Analyse compressor vibrations			X
Analyse compressor oil acidity (7)			X
Condenser section:			
Clean condenser banks (Note 4)			X
Verify that fans are well tightened			X
Verify condenser bank fins – Comb if necessary			X

Notes:

- 1 Monthly activities include all the weekly ones.
- 2 The annual (or early season) activities include all weekly and monthly activities.
- 3 Machine operating values should be read on a daily basis thus keeping high observation standards.
- 4 In environments with a high concentration of air-borne particles, it might be necessary to clean the condenser bank more often.
- 5 Replace the oil filter when the pressure drop across it reaches 2.0 bar.
- 6 Check for any dissolved metals.
- 7 TAN (Total Acid Number) :
 - ≤0,10 : No action
 - Between 0.10 and 0.19 : Replace anti-acid filters and re-check after 1000 running hours. Continue to replace filters until the TAN is lower than 0.10.
 - >0,19 : Replace oil, oil filter and filter dryer. Verify at regular intervals.

Replacement of filter dryer

It is strongly advised that the filter dryer cartridges be replaced in the event of a considerable pressure drop across the filter or if bubbles are observed through the liquid sight glass while the subcooling value is within the accepted limits.

Replacement of the cartridges is advised when the pressure drop across the filter reaches 50 kPa with the compressor under full load.

The cartridges must also be replaced when the humidity indicator in the liquid sight glass changes colour and shows excessive humidity, or when the periodic oil test reveals the presence of acidity (TAN is too high).

Procedure to replace the filter dryer cartridge

▲ ATTENTION

Ensure proper water flow through the evaporator during the entire servicing period. Interrupting the water flow during this procedure would cause the evaporator to freeze, with consequent breakage of internal piping.

1. Shut down the relevant compressor by turning the Q1 or Q2 switch to Off.
2. Wait until the compressor has stopped and close the valve located on the liquid line.
3. Start the relevant compressor by turning the Q1 or Q2 switch to On.
4. Check the relevant evaporation pressure on the microprocessor display.
5. When the evaporation pressure reaches 100 kPa turn the Q1 or Q2 switch again to turn off the compressor.
6. Once the compressor has stopped, place a label on the compressor start-up switch that is under maintenance, to prevent undesired start-ups.
7. Close the compressor suction valve (if any).
8. Using a recovery unit, remove surplus refrigerant from the liquid filter until atmospheric pressure is reached. The refrigerant must be stored in a suitable and clean container.

▲ ATTENTION

To protect the environment, do not release removed refrigerant into the atmosphere. Always use a recovery and storage device.

9. Balance internal pressure with external pressure by pressing the vacuum pump valve installed on the filter cover.
10. Remove the filter dryer cover.
11. Remove the filter elements.
12. Install the new filter elements in the filter.
13. Replace the cover gasket. Do not allow any mineral oil onto the filter gasket so as not to contaminate the circuit. Use only compatible oil for this purpose (POE).
14. Close the filter cover.
15. Connect the vacuum pump to the filter and pull vacuum to 230 Pa.
16. Close the vacuum pump valve.
17. Recharge the filter with the refrigerant recovered during emptying.
18. Open the liquid line valve.
19. Open the suction valve (if any).
20. Start the compressor by turning switch Q1 or Q2.

Replacement of the oil filter

▲ ATTENTION

The lubrication system has been designed to keep most of the oil charge inside the compressor. During operation, however, a small amount of oil circulates freely in the system, conveyed by the refrigerant. The amount of replacement oil going into the compressor should therefore be equal to the quantity removed rather than the amount stated on the nameplate; this will avoid excess of oil during the following start-up.

The quantity of oil removed from the compressor must be measured after having allowed the refrigerant present in the oil to evaporate for a suitable amount of time. To reduce the refrigerant content in the oil to a minimum, it is advised that the electrical resistances be kept on and that the oil be removed only when it has reached a temperature of 35÷45°C.

▲ ATTENTION

The replacement of the oil filter requires careful attention with regard to oil recovering; the oil must not be exposed to air for more than about 30 minutes (at temperatures higher than -40°C).

In case of doubts, verify oil acidity or, if it is not possible to carry out the measurement, replace the charge of lubricant with fresh oil stored in sealed tanks or in a way that meet supplier specifications.

The compressor oil filter is located under the oil separator (discharge side). It is strongly advised that it be replaced when its pressure drop exceeds 2.0 bar. The pressure drop across the oil filter is the difference between the compressor delivery pressure minus oil pressure. Both pressures can be controlled through the microprocessor for both compressors.

Required materials:

Oil filter Code 7384-188 for Fr3100 compressor – Quantity 1
Gaskets kit Code 128810988 – Quantity 1

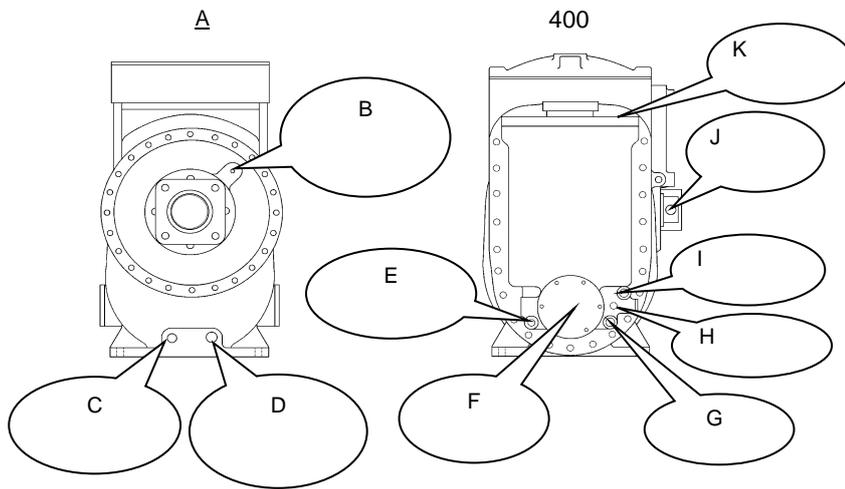
Compatible oils:

Mobile Eal Arctic 68
ICI Emkarate RL 68H

The standard oil charge for a compressor is 13 litres.

Procedure to replace oil filter

1. Shut down both compressors by turning the Q1 and Q2 switches to the Off position.
2. Turn the Q0 switch to Off, wait for the circulation pump to turn off and open the general disconnect switch Q10 to cut off the machine's electrical power supply.
3. Place a label on the handle of the general disconnect switch in order to prevent accidental start-up.
4. Close the suction, discharge and liquid injection valves.
5. Connect the recovery unit to the compressor and recover the refrigerant in a suitable and clean container.
6. Evacuate the refrigerant until the internal pressure has turned negative (compared to atmospheric pressure). The amount of refrigerant dissolved in the oil is reduced to a minimum in this way.
7. Drain the oil in the compressor by opening the drain valve located under the motor.
8. Remove the oil filter cover and remove the internal filter element.
9. Replace the cover and internal sleeve gasket. Do not lubricate the gaskets with mineral oil in order not to contaminate the system.
10. Insert the new filter element.
11. Reposition the filter cover and tighten the screws. The screws must be tightened alternately and progressively setting the torque wrench at 60Nm.
12. Charge the oil from the upper valve located on the oil separator. Considering the high hygroscopy of ester oil, it should be charged as quickly as possible. Do not expose ester oil to the atmosphere for more than 10 minutes.
13. Close the oil charging valve.
14. Connect the vacuum pump and evacuate the compressor up to a vacuum of 230 Pa.
15. On reaching the above vacuum level, close the vacuum pump valve.
16. Open the system's delivery, suction and liquid injection valves.
17. Disconnect the vacuum pump from the compressor.
18. Remove the warning label from the general disconnect switch.
19. Close the general disconnecting switch Q10 to supply power to the machine.
20. Start the machine by following the start-up procedure described above.



- A Suction side
- B Low pressure measurement point
- C Oil drainage tap position
- D Position of oil-heating electrical resistance
- E Oil temperature sensor
- F Oil filter cover
- G Minimum oil level
- H Oil transducer
- I Maximum oil level
- J Liquid injection
- K Oil loading plug

Figure 23 - Front and back views for Fr3100

Refrigerant charge

▲ ATTENTION

The units have been designed to operate with R134a refrigerant. So DO NOT USE refrigerants other than R134a.

▲ ATTENTION

The addition or removal of refrigerant gas must be carried out in compliance with the laws and regulations in force.

▲ ATTENTION

When refrigerant gas is added to or removed from the system, ensure proper water flow through the water heat exchanger for the entire charge/discharge time. Interrupting the water flow during this procedure would cause the evaporator to freeze with consequent breakage of its internal piping. Damage caused by freezing makes the warranty void.

▲ ATTENTION

Removal of the refrigerant and replenishing operations must be performed by technicians who are qualified to use the appropriate materials for this unit. Unsuitable maintenance can result in uncontrolled losses in pressure and fluid. Do not disperse the refrigerant and lubricating oil in the environment. Always be equipped with a suitable recovery system.

The units ship with a full refrigerant charge, but in some cases it might be necessary to replenish the machine in the field.

▲ ATTENTION

Always verify the causes of a loss of refrigerant. Repair the system if necessary then recharge it.

The machine can be replenished under any stable load condition (preferably between 70 and 100%) and under any ambient temperature condition (preferably above 20°C). The machine should be kept running for at least 5 minutes to allow the fan steps, and thus the condensation pressure, to stabilise.

Note: When the load and the number of active fans vary, so does the subcooling and it requires several minutes to stabilise again. However, the subcooling should not come below 3°C under any condition. Also, the subcooling value can change slightly as the water temperature and the suction superheating vary. As the suction superheating value decreases, there is a corresponding decrease in subcooling.

One of the following two scenarios can arise in a machine without refrigerant:

- 1 If the refrigerant level is slightly low, suction superheating is always higher than normal and the valve is wide open. Replenish the circuit as described in the replenishment procedure.
- 2 If the gas level in the machine is moderately low, the corresponding circuit could have some low-pressure stops. Replenish the corresponding circuit as described in the replenishment procedure.

Note: The liquid receiver must be completely full in heat pump mode when the machine contains the correct charge.

Procedure to replenish refrigerant

1. If the machine has lost refrigerant, it is necessary to first establish the causes before carrying out any replenishment operation. The leak must be found and repaired. Oil stains are a good indicator, as they can appear in the vicinity of a leak. However, this is not necessarily always a good search criterion. Searching with soap and water can be a good method for medium to large leaks, while an electronic leak detector is required to find small leaks.
2. Add refrigerant to the system through the service valve located on the suction pipe or through the Schrader valve located on the water heat exchanger inlet pipe.
3. The refrigerant can be added under any load condition between 25 and 100% of the system capacity. Suction superheating must be between 4 and 6°C.
4. Add enough refrigerant to fill the liquid receiver completely in heat pump mode.
5. Check the subcooling value by reading the liquid pressure and the liquid temperature near the expansion valve. The subcooling value must be between 4 and 8°C and between 10 and 15°C for the machines with an economiser. With reference to the above mentioned values, the subcooling will be lower at 75÷100% load and higher at 50% load.
6. When the ambient temperature is above 16°C, all fans should be on.

Overcharging the system will entail a rise in the compressor's discharge pressure, owing to excessive filling of the condenser section pipes.

Table 4 - Pressure/ Temperature

Pressure/Temperature table for R-134a							
°C	bar	°C	bar	°C	bar	°C	bar
-14	0,71	12	3,43	38	8,63	64	17,47
-12	0,85	14	3,73	40	9,17	66	18,34
-10	1,01	16	4,04	42	9,72	68	19,24
-8	1,17	18	4,37	44	10,30	70	20,17
-6	1,34	20	4,72	46	10,90	72	21,13
-4	1,53	22	5,08	48	11,53	74	22,13
-2	1,72	24	5,46	50	12,18	76	23,16
0	1,93	26	5,85	52	13,85	78	24,23
2	2,15	28	6,27	54	13,56	80	25,33
4	2,38	30	6,70	56	14,28	82	26,48
6	2,62	32	7,15	58	15,04	84	27,66
8	2,88	34	7,63	60	15,82	86	28,88
10	3,15	36	8,12	62	16,63	88	30,14

9. STANDARD CHECKS

Temperature and pressure sensors

The unit comes factory-equipped with all the sensors listed below. Periodically check that their measurements are correct by means of reference instruments (manometers, thermometers); correct the wrong readings as necessary using the microprocessor keypad. Well-calibrated sensors ensure better efficiency for the machine and a longer lifetime.

Note: refer to the microprocessor use and maintenance manual for a complete description of applications, settings and adjustments.

All sensors are preassembled and connected to the microprocessor. The descriptions of each sensor are listed below:

Outlet water temperature sensor – This sensor is located on the evaporator outlet water connection and is used by the microprocessor to control the machine load depending on the system's thermal load. It also helps control the evaporator's antifreeze protection.

Inlet water temperature sensor – This sensor is located on the evaporator inlet water connection and is used for monitoring the return water temperature.

External air temperature sensor – Optional. This sensor allows to monitor the external air temperature on the microprocessor display. It is also used in the "OAT setpoint override".

Compressor discharge pressure transducer – This is installed on every compressor and allows to monitor the discharge pressure and to control the fans. Should the condensation pressure increase, the microprocessor will control the compressor load in order to allow it to function even if the compressor gas flow must be reduced. It also contributes to the oil control logic.

Oil pressure transducer - This is installed on every compressor and allows to monitor the oil pressure. The microprocessor uses this sensor to inform the operator on the conditions of the oil filter and on how the lubrication system is functioning. By working together with the high- and low-pressure transducers, it protects the compressor from problems deriving from poor lubrication.

Low-pressure transducer – This is installed on every compressor and allows to monitor the compressor suction pressure along with low pressure alarms. It contributes to complementing the oil control logic.

Suction sensor – This is installed on each compressor and allows to monitor the suction temperature. The microprocessor uses the signal from this sensor to control the electronic expansion valve.

Compressor discharge temperature sensor – This is installed on each compressor and allows to monitor compressor discharge temperature and oil temperature. The microprocessor uses the signal from this sensor to control the liquid injection and to shut down the compressor in case that the discharge temperature reaches 110°C. It also protects the compressor from pumping liquid refrigerant at start-up.

10. TEST SHEET

It is recommended that the following operation data are recorded periodically in order to verify the correct function of the machine over the time. These data will also be extremely useful to the technicians who will be performing routine and/or extraordinary maintenance on the machine.

Water side measurements

Mode		Chiller	Heat pump
Chilled water setpoint	°C	_____	_____
Leaving water temperature	°C	_____	_____
Entering water temperature	°C	_____	_____
Pressure drop	kPa	_____	_____
Water flow rate	m ³ /h	_____	_____

Refrigerant side measurements

Circuit #1		Compressor Load	_____	%
		N° of active Fans	_____	
		N° of expansion valve cycles	_____	
Refrigerant/ Oils pressure		Evaporation pressure	_____	bar
		Condensation pressure	_____	bar
Refrigerant temperature		Oil pressure	_____	bar
		Evaporation saturated temperature	_____	°C
		Suction gas pressure	_____	°C
		Suction superheating	_____	°C
		Condensation saturated temperature	_____	°C
		Discharge superheating	_____	°C
		Liquid temperature	_____	°C
		Subcooling	_____	°C
Circuit #2		Compressor Load	_____	%
		N° of active Fans	_____	
		N° of expansion valve cycles	_____	
Refrigerant/ Oils pressure		Evaporation pressure	_____	bar
		Condensation pressure	_____	bar
Refrigerant temperature		Oil pressure	_____	bar
		Evaporation saturated temperature	_____	°C
		Suction gas pressure	_____	°C
		Suction superheating	_____	°C
		Condensation saturated temperature	_____	°C
		Discharge superheating	_____	°C
		Liquid temperature	_____	°C
		Subcooling	_____	°C
External air temperature			_____	°C

Electrical measurements

Analysis of the unit's voltage unbalance:

Phases:	RS	ST	RT
	_____ V	_____ V	_____ V

$$\text{Unbalance \%} = \frac{V_{MAX} - V_{AVG}}{V_{AVG}} \times 100 = \text{_____ \%}$$

AVG = average

Compressors current – Phases:

	R	S	T
Compressor #1	_____ A	_____ A	_____ A
Compressor #2	_____ A	_____ A	_____ A

Fans current:

#1	_____ A	#2	_____ A
#3	_____ A	#4	_____ A
#5	_____ A	#6	_____ A
#7	_____ A	#8	_____ A

11. SERVICE AND LIMITED WARRANTY

All machines are factory-tested and guaranteed for 12 months as of the first start-up or 18 months as of delivery. These machines have been developed and constructed according to high quality standards ensuring years of failure-free operation. It is important, however, to ensure proper and periodical maintenance in accordance with all the procedures listed in this manual.

We strongly advise stipulating a maintenance contract with a service authorized by the manufacturer in order to ensure efficient and problem-free service, thanks to the expertise and experience of our personnel.

It must also be taken into consideration that the unit requires maintenance also during the warranty period.

It must be borne in mind that operating the machine in an inappropriate manner, beyond its operating limits or not performing proper maintenance according to this manual can void the warranty.

Observe the following points in particular, in order to conform to warranty limits:

1. The machine cannot function beyond the specified limits
2. The electrical power supply must be within the voltage limits and without voltage harmonics or sudden changes.
3. The three-phase power supply must not have an unbalance between phases exceeding 3%. The machine must stay turned off until the electrical problem has been solved.
4. No safety device, either mechanical, electrical or electronic must be disabled or overridden.
5. The water used for filling the water circuit must be clean and suitably treated. A mechanical filter must be installed at the point closest to the evaporator inlet.
6. Unless there is a specific agreement at the time of ordering, the evaporator water flow rate must never be above 120% and below 80% of the nominal flow rate.

12. PERIODIC OBLIGATORY CHECKS AND STARTING UP OF APPLIANCES UNDER PRESSURE

The units are included in category III of the classification established by the European Directive PED 2014/68/EU.

For chillers belonging to this category, some local regulations require a periodic inspection by an authorized agency. Please check with your local requirements.

13. IMPORTANT INFORMATION REGARDING THE REFRIGERANT USED

This product contains fluorinated greenhouse gases. Do not vent gases into the atmosphere.

Refrigerant type: R134a
GWP(1) value: 1430

(1)GWP = Global Warming Potential

The refrigerant quantity is indicated on the unit name plate.

Periodical inspections for refrigerant leaks may be required depending on European or local legislation. Please contact your local dealer for more information.

14. FACTORY AND FIELD CHARGED UNITS INSTRUCTIONS

The refrigerant system is charged with fluorinated greenhouse gases and the refrigerant charge is impressed on the plate, shown below, which is applied inside the electrical panel.

Fill in with indelible ink the refrigerant charge label supplied with the product as following instructions:

- the refrigerant charge for each circuit (1; 2; 3) added during commissioning (on-site charging)
- the total refrigerant charge (1 + 2 + 3)
- calculate the greenhouse gas emission with the following formula:

$$GWP * total\ charge\ [kg]/1000$$

(use the GWP value mentioned on the greenhouse gases label. This GWP value is based on the 4th IPCC Assessment Report.)

	a	b	c	p	
	Contains fluorinated greenhouse gases			CH-XXXXXXXX-KKKKXX	
m	R134a	1 =	Factory charge	+ Field charge	d
n	GWP: 1430	2 =		kg	e
		3 =		kg	e
		1 + 2 + 3 =		kg	f
	Total refrigerant charge Factory + Field			kg	g
	GWP x kg/1000			tCO ₂ eq	h

- a Contains fluorinated greenhouse gases
- b Circuit number
- c Factory charge
- d Field charge
- e Refrigerant charge for each circuit (according to the number of circuits)
- f Total refrigerant charge
- g Total refrigerant charge (Factory + Field)
- h Greenhouse gas emission of the total refrigerant charge expressed
- m Refrigerant type
- n GWP = Global Warming Potential
- p Unit serial number



In Europe, the emission of greenhouse gases of the total refrigerant charge in the system (expressed in tonnes of equivalent CO₂) is used to determine the frequency of maintenance interventions. Follow the applicable legislation.

15. DISMISSION AND DISPOSAL

The unit is made of metal, plastic and electronic parts. All of these components must be disposed of in accordance with local disposal laws and if in scope with the national laws implementing the Directive 2012/19/EU (RAEE).

Lead batteries must be collected and sent to specific waste collection centers.

Avoid the escape of refrigerant gases into the environment by using suitable pressure vessels and tools for transferring the fluids under pressure. This operation must be carried out by competent personnel in refrigeration systems and in compliance with the laws in force in the country of installation.



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