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User Manual

VLC Modular Chiller

Rev. 03 | September 2023

Review History			
First Edition	**Date**	**Elaborated by**	**Approval**
New Version	2/10/2023	CPJ	GOG
Revision Description	**Date**	**Change**	**Approval**
Options review	17/04/2023	GAAC	WRR
Data table update	26/04/2023	CPJ	GOG
Change control to 220V	06/09/2023	FAF	WRR

ABOUT THE MANUAL

The purpose of this manual is to provide the necessary information for the installation, operation and maintenance, which are enough to ensure the operation of the equipment under the conditions for which it was designed.

Considering that technological advancements will occur, Mecalor reserves the right to change this manual and the design of the equipment without prior warning.

Words like DANGER, ATTENTION and INFORMATION are used in the course of the manual to show warning situations as shown below:

	**DANGER**	Warns about immediate danger that may cause serious injuries or death.
	**ATTENTION**	Warns about unsafe practices, which if not avoided, may cause personal damages or death.
	**INFORMATION**	Relevant information about the equipment or recommendation about good working practices.

MANUFACTURER

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	**INFORMATION**	**Keep this manual in a place that is accessible to the user to consult in case of doubt.** This manual cannot be reproduced whole or in part without the prior authorization from Mecalor.

	**INFORMATION**	**Do not perform any procedure on the equipment in case of doubt after reading this manual.** This manual should guide the operator of the equipment, providing relevant information. Contact the technical support of Mecalor in case of doubt.

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General Description of the Product

1.1. Equipment Description

This equipment incorporates, in a single cabinet, all the refrigeration components required for liquid refrigeration, controlling the temperature with precision and adjusting its capacity according to the variations in the thermal load of the process, according to a predefined (*setpoint*) temperature.

Assembled in a compact carbon steel structure, powder painted with 70-micron thickness in olive green (RAL 6003), the VLC was designed to meet different demands of thermal load in applications of environment acclimatization or cooling of various processes, allowing the combination of up to 14 units in parallel, with individual control, therefore without the dependence on a single equipment, thus expanding the refrigeration capacity and modulation, with a system composed of compact equipment and reduced floor area.

The design was created to optimize energy efficiency, ensuring stable and adjustable temperature control to the variation of thermal load in the climatization of the environment or system served. Reference components in quality and technology were considered, ensuring not only the conventional functionalities but also a stable and robust operation. The equipment is divided into three main systems, according to the application: refrigeration circuit (refrigeration), hydraulic circuit, and control.

	INFORMATION	Design developed and built according to standards NR-10 (electrical safety) and NR-12 (operator protection).

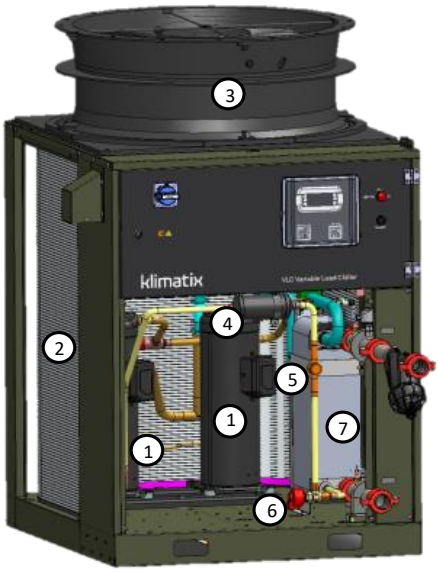
	ATTENTION	The adulteration of original components installed in the VLC is prohibited. This practice may put at risk the safety of the operator, the good functioning of the equipment and the loss of warranty.

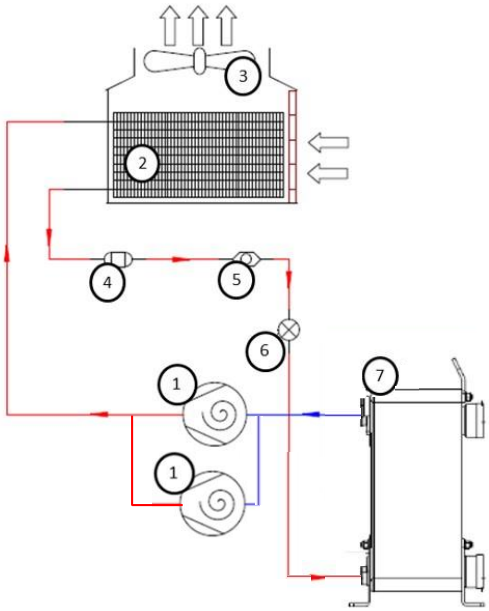
1.1.1. Refrigeration circuit

The refrigeration system of the VLC consists of a hermetic scroll compressor (1), available in versions with fixed tandem compressor or with inverter compressor, which is responsible for continuously sending the refrigerant in the form of hot gas to the condenser (2). In this condenser the refrigerant changes from overheated steam to sub-cooled liquid, and through this change of state, the condensing air receives the enthalpy (raising its temperature) of the refrigerant, passing through the condenser with the aid of a fan (3).

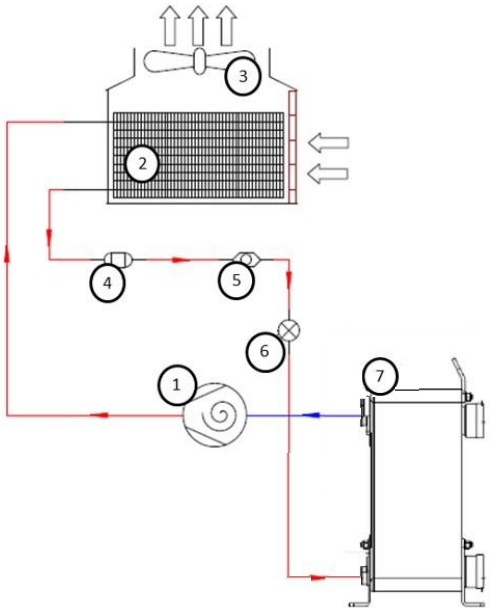
The refrigerant in the sub-cooled liquid condition passes through a filter drier (4), which is responsible for eliminating impurities and moisture present in the system. In addition to a liquid display (5), which is responsible for visually indicating the fluid situation inside the piping. When passing through the expansion valve (6) the refrigerant suffers a pressure drop, entering in the form of saturated liquid in the evaporator (7). Inside the evaporator the refrigerant fluid receives heat from the process fluid, going from the saturated liquid state to overheated steam, condition in which it can enter the compressor and restart the cooling cycle. As shown in the diagram below, the VLC uses a plate evaporator.

- Version with tandem compressors (VLC-A-15/18-F):





- Version with inverter compressor (VLC-15/18-I):



Item	Description
1	Hermetic Scroll Compressor
2	Microchannel Condenser (Air condensation)
3	Fan
4	Filter Drier
5	Liquid Display
6	Electronic Expansion Valve
7	Evaporator

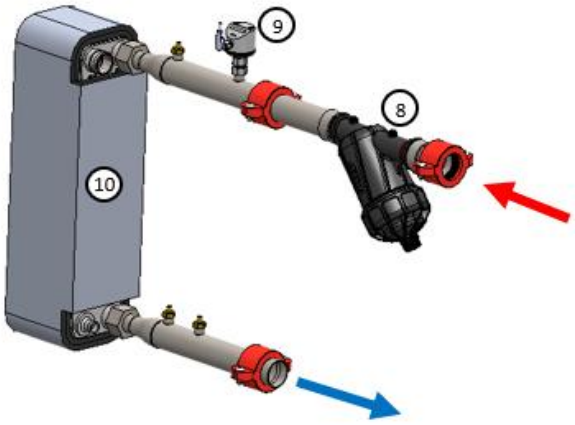
⚠	**DANGER**	**The compressors are equipments that operate with differential pressure between suction and discharge.** In suction, according to the condition of use, the pressure and temperature are low, which may cause burns. In discharge, according to the condition of use, the pressure and temperature are high, which may cause burns. The interior of the equipment should only be accessed by qualified personnel and Personal Protective Equipment (PPE).

	INFORMATION	A high pressure switch monitors the discharge pressure of the compressor, in case the pressure reaches the maximum safety value, it switches off the equipment.

1.1.2. Hydraulic circuit

The equipment is supplied ready for connection to the hydraulic circuit of the system, through Victaulic coupling type connections.

The return water from the process enters the equipment by initially passing through the Y filter for retaining solid particles (8), followed by the flow sensor (9), a component responsible for monitoring the water flow, ensuring that the water flow remains constant and within the operating limits so that there is no risk of freezing inside the evaporator. Subsequently, the water circulates through the evaporator (10) where it loses heat to the refrigerant inside the evaporator, proceeding to the outlet pipe, where it is directed to cool the process. This configuration is identical in all available versions of the VLC.



Item	Description
8	Water filter
9	Flow sensor
10	Evaporator

1.1.3. Control

All the electrical control and command components are installed inside the electrical panel (11), IP 54 protection, in the front part of the equipment.

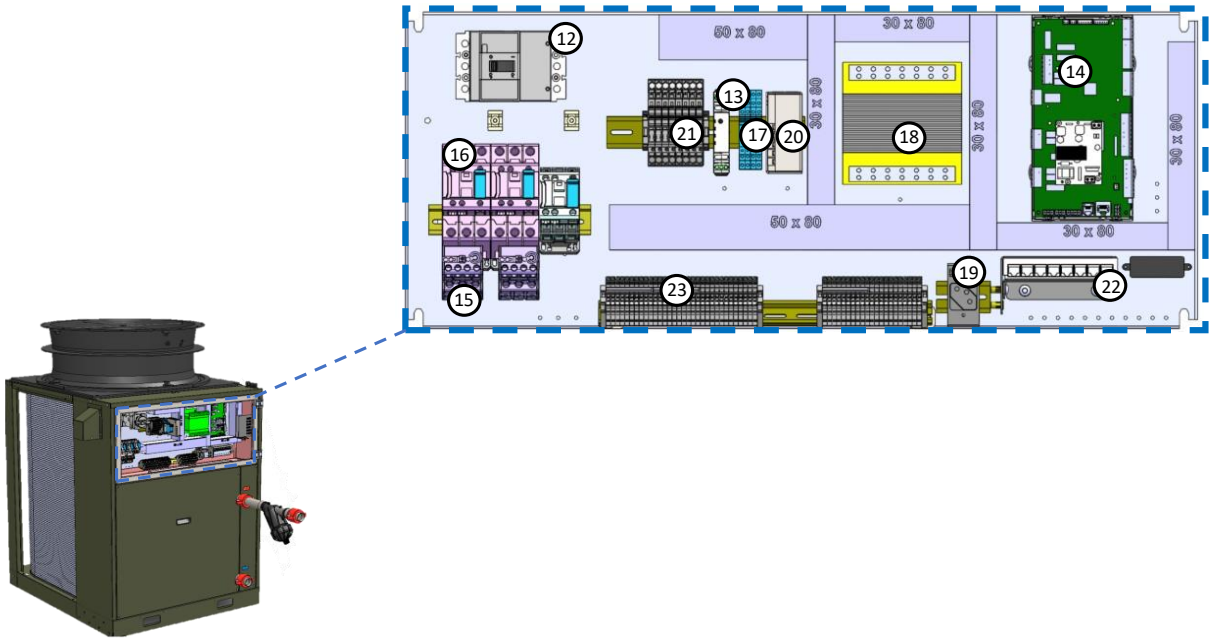
The control is performed by means of a semi-graphic interface (11) installed in the front part of the equipment, and a rotating handle (12) for activating the general switch, with the purpose of powering the equipment. The components for sectioning, control, and interconnection of units are located inside the electrical panel.

Item	Description
11	Semi-graphic interface
12	Key Switch

1.1.3.1. Electrical panel components - Version with fixed tandem compressors (VLC-A-15/18-F)

The power supply can be cut off by means of the main switch (12), thus enabling safe intervention during the equipment maintenance process. The equipment has protection against inversion of the power supply phases, and this monitoring is performed by the phase sequence relay (13). The system is controlled by a PLC (14) that, through signals received from the instruments installed in the equipment, performs the operation control command and system control through the turning on/off of the electric engines and electronic valves of the VLC unit. The adjustment of the working conditions as well as the monitoring of the parameters is done through an semi-graphic HMI (11).

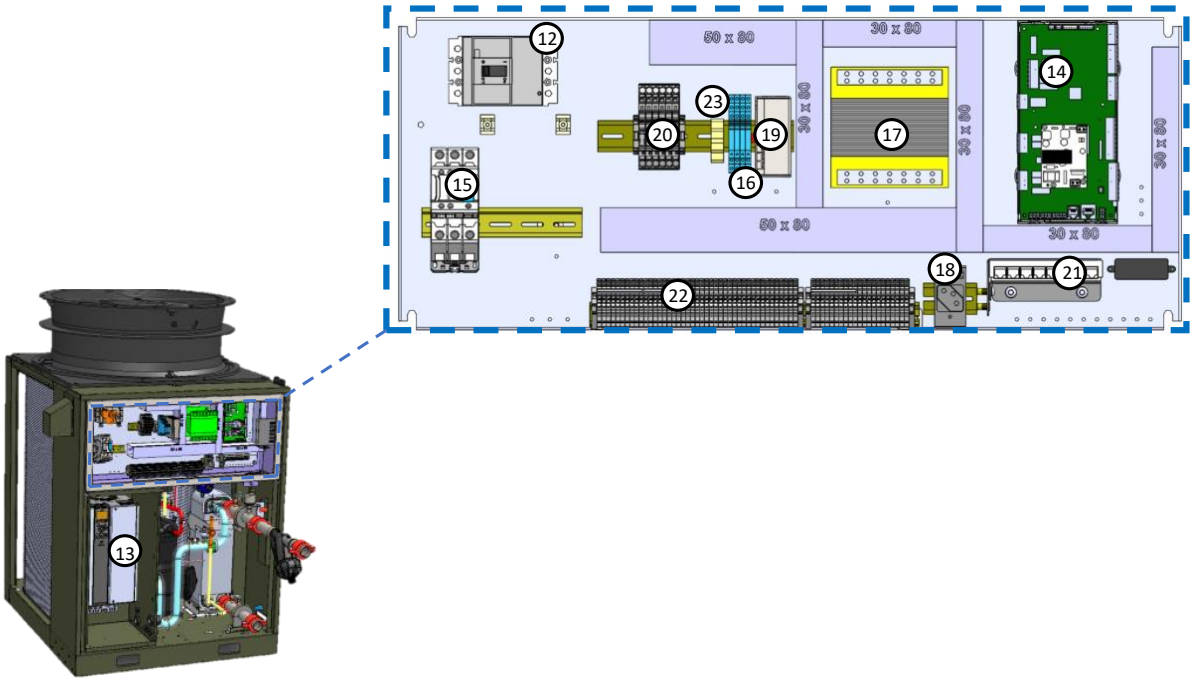
The system has thermal relays (15) for protection, contactors (16), and modular relays (17) to drive the components via PLC. To power the instruments and the control system, the transformer (18) converts the supply voltage of the equipment to 220V, supplying the outlet (19) and the switched power supply (20), which in turn converts the voltage from the transformer to the control voltage (24 Vdc). The devices are protected by glass fuses (21). Interconnection between units is made through the switch (22). The available external connections are made through the terminal strip (23).



Item	Description
13	Phase sequence relay
14	PLC
15	Thermal relay
16	Contactor
17	Modular relay
18	Control transformer
19	Power outlet
20	Switched power supply
21	Fuse strip
22	Switch
23	Terminal strips

1.1.3.2. Electrical panel components - Version with inverter compressor (VLC-A-15/18-I)

In the case of the version with inverter compressor, there is also a general switch for disconnecting the equipment (12); however, due to the existence of the frequency inverter of the compressor (13), this VLC version does not require the use of the phase sequence relay and thermal relay, since the frequency inverter already has these protections. The other components follow the same pattern as the version with fixed compressor.



Item	Description
13	Frequency inverter
14	PLC
15	Contactor
16	Modular relay
17	Control transformer
18	Power outlet
19	Switched power supply
20	Fuse strip
21	Switch
22	Terminal strips

1.2. Application scope

The VLC modular chiller can be applied in climatization systems of environments together with air handlers or in different sectors of the industry that require process cooling (extruders, injectors, blowers, welding equipment, laser cutting, and grinding machines, among others).

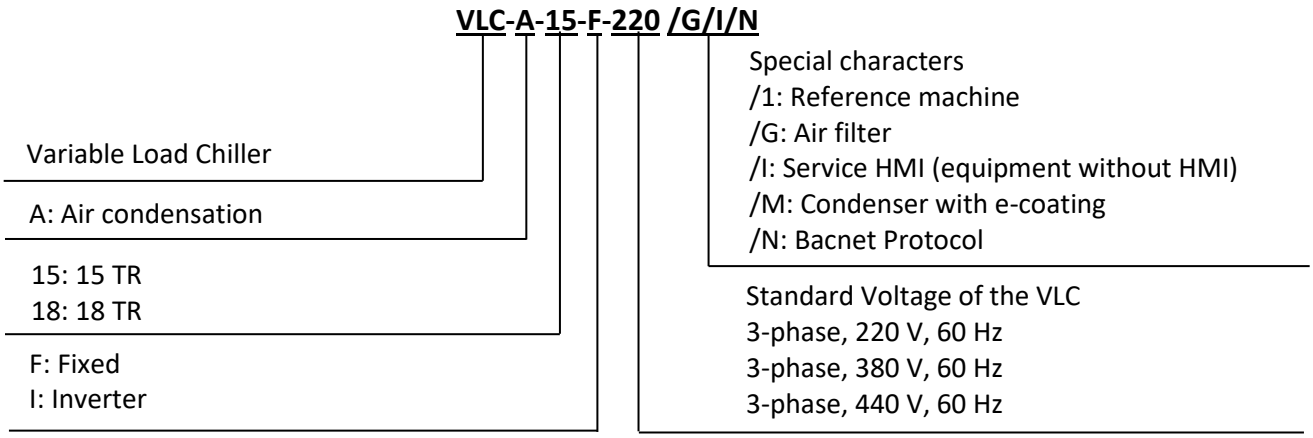
⚠	**ATTENTION**	Applications different from those intended for the product may put at risk the safety of the operator, the performance and even the breakage of a component of the VLC and the loss of warranty.

1.3. Optional items installed at the factory or on the field

Item	Installed in Factory	Installed on Field
Bacnet Communication	✓	✓
Parallel interconnect kit	⊘	✓
Air filter	✓	✓
Service HMI	✓	✓
Condenser with e-coating	✓	⊘

2. Technical Features

2.1. Nomenclature



	INFORMATION	Check special documentation described in the annex of this manual for VLC that has special character (/C/T) Some data in this manual such as electrical data may not apply to the VLC that has special characters.

2.2. Technical Information

Basic Information	Nominal Capacity		-	15TR		18TR	
	Model		-	VLC-A-15-I-220/380/440	VLC-A-15-F-220/380/440	VLC-A-18-I-220/380/440	VLC-A-18-F-220/380/440
	Compressor		-	Inverter	Fixed	Inverter	Fixed
	Nominal Capacity		kW	52,7	52,7	61,5	61,5
			TR	15		17,5	
Project Details	Effective Capacity (1)		kW	45,3	50	58,5	65,4
			TR	12,9	14,2	16,6	18,6
	Minimum capacity (3)		kW	13,5	26,4	18,2	35,6
			TR	3,8	7,5	5,2	10,1
	COP Compressor (AHRI) (1)		kW/kW	3,353	3,597	3,193	3,27
	COP (AHRI) (1)		kW/kW	2,993	3,221	2,933	3,024
	IPLV (1)		kW/kW	5,626	5,069	5,52	4,802
	Outlet water temperature		°C	7			
	Return water temperature		°C	12			
	ΔT Water		°C	5			
	Water flow (1)		m³/h	7,7	8,5	9,9	11,1
	Load loss	Perda de carga	kPa	51	57	52	61
	Evaporation temperature		°C	3,5	3,3	3,7	3,5
	Environment temperature		°C	35	35	35	35
	Condensation temperature		°C	45,7	46,6	48,6	50,3
	Overheating		K	6	6	6	6
	Subcooling		K	6	6	6	6
	Refrigerant fluid charge		kg	4,6	4,5	5,8	5,5
Electrical Details	Electrical voltages		V	220/380/440			
	Total Maximum Power		kW	20,9	22,6	26,7	29,7
	Compressor Maximum Power		kW	19	20,7	24,8	27,8
	Maximum Fan Power		kW	19	1,9	1,9	1,9
	Total Maximum Current	220V	A	59,1	63,1	75,83	77,9
		380V		33,2	39,4	41,84	48
		440V		32,6	32,6	41,24	43
	Starting current	220V	A	88	191	155	240
		380V		44	123	44	152
		440V		44	100	44	140
	Operating Power		kW	15,134	15,524	19,944	21,624

	Compressor Power		kW	13,5	13,9	18,3	20
	Fan Power		kW	1,624	1,624	1,624	1,624
	Operating Current	220V	A	43,32	47,5	58,54	61,5
		380V		23,17	28,6	30,91	36,8
		440V		21,51	23,7	28,19	33,1
Dimensional	Dimensions	Length	mm	1000			
		Width		1175			
		Height		1615			
		Weight	kg	345	312	386	338
	Hydraulic Pipeline	Inlet	pol	1.1/2	1.1/2	1.1/2	1.1/2
		Outlet	pol	1.1/2	1.1/2	1.1/2	1.1/2
	Refrigeration Pipeline	Discharge	pol	3/4	3/4	7/8	7/8
		Suction		1.1/8	1.1/8	1.3/8	1.3/8
		Liquid		5/8	5/8	3/4	3/4
Components	Compressor	Type	-	Inverter	Tandem (2x fixed compressors)	Inverter	Tandem (2x fixed compressors)
	Evaporator	Type	-	BHPE (Brazed Plate Heat Exchanger)			
	Condenser	Type	-	MCHE (Microchannel) Curved			
	Fan	Type	-	Axial EC/BLDC			
	Expansion valve	Type	-	Electronic expansion valve			
	Refrigeration Pipeline	Suction	pol	1.1/8	1.1/8	1.3/8	1.3/8
		Discharge	pol	3/4	3/4	7/8	7/8
		Liquid	pol	5/8	5/8	3/4	3/4
Noise	Compressor sound power	Partial	dBA	74	80	77	81
		Total	dBA	89	83	93	84
	Fan sound power	Partial	dBA	82			
		Total	dBA	82			
	Equipment sound power	Partial	dBA	83	84	83	85
		Total	dBA	90	86	93	86
	Equipment sound power (2 meters) (2)	Partial	dBA	66	67	66	68
		Total	dBA	73	69	76	69
	Equipment sound power (5 meters) (2)	Partial	dBA	58	59	58	60
		Total	dBA	65	61	68	61
	Equipment sound power (10 meters) (2)	Partial	dBA	52	53	52	54
		Total	dBA	59	55	62	55

(1) Operating conditions according to AHRI 551/591: Ambient temperature 35°C; Water inlet temperature 12°C; Water outlet temperature 7°C; Atmospheric pressure 101kPa.

(2) (2) Noise level measured at a set distance from the equipment.

(3) (3) Minimum operating capacity of the equipment in the following conditions: Ambient temperature 35°C; Water outlet temperature 7°C; Atmospheric pressure 101kPa.

	**ATTENTION**	The power in regime SHOULD NOT be used to size the electric protections and the power cable. To size the protections and power cable, use the maximum power described in the electrical data section.

	**INFORMATION**	Refrigerant Used: R-410A.

	**INFORMATION**	The power in regime is calculated based on the nominal operating condition of the equipment and it SHOULD NEVER be used to size the protections of the VLC, considering that the equipment may operate in conditions close to the maximum power of the equipment.

	**DANGER**	The refrigerant R-410A has relative higher pressures than the R-22 normally used in the application of Chillers. No other refrigerant should be used in the cooling system of the VLC. The meters applied should be suitable to operate with pressures of the R-410A fluid.

2.3. Identification plate attached to the VLC

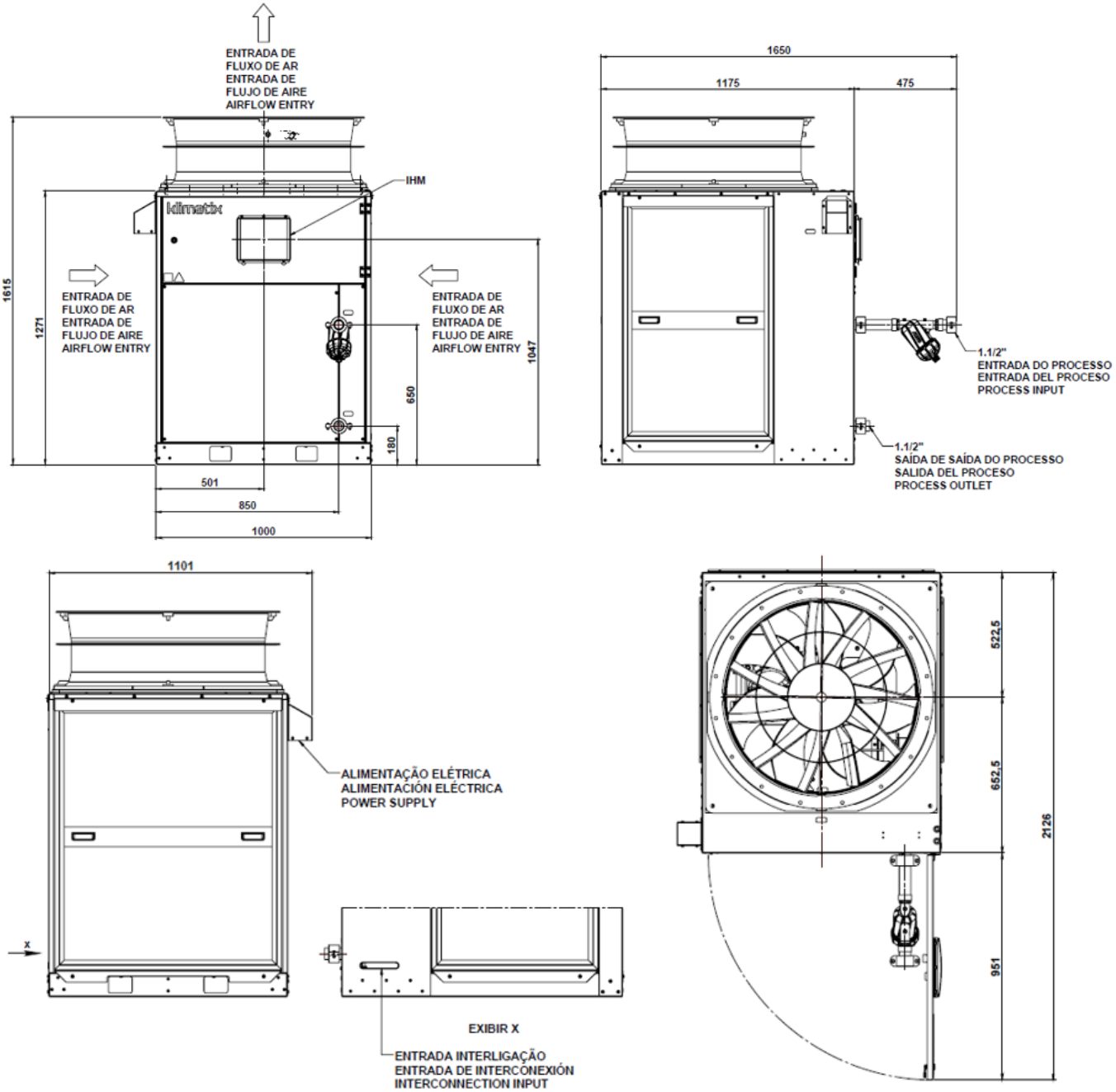
2.4. Operating limits

Some operating limits are described below and must be observed for good performance and operation of the equipment:

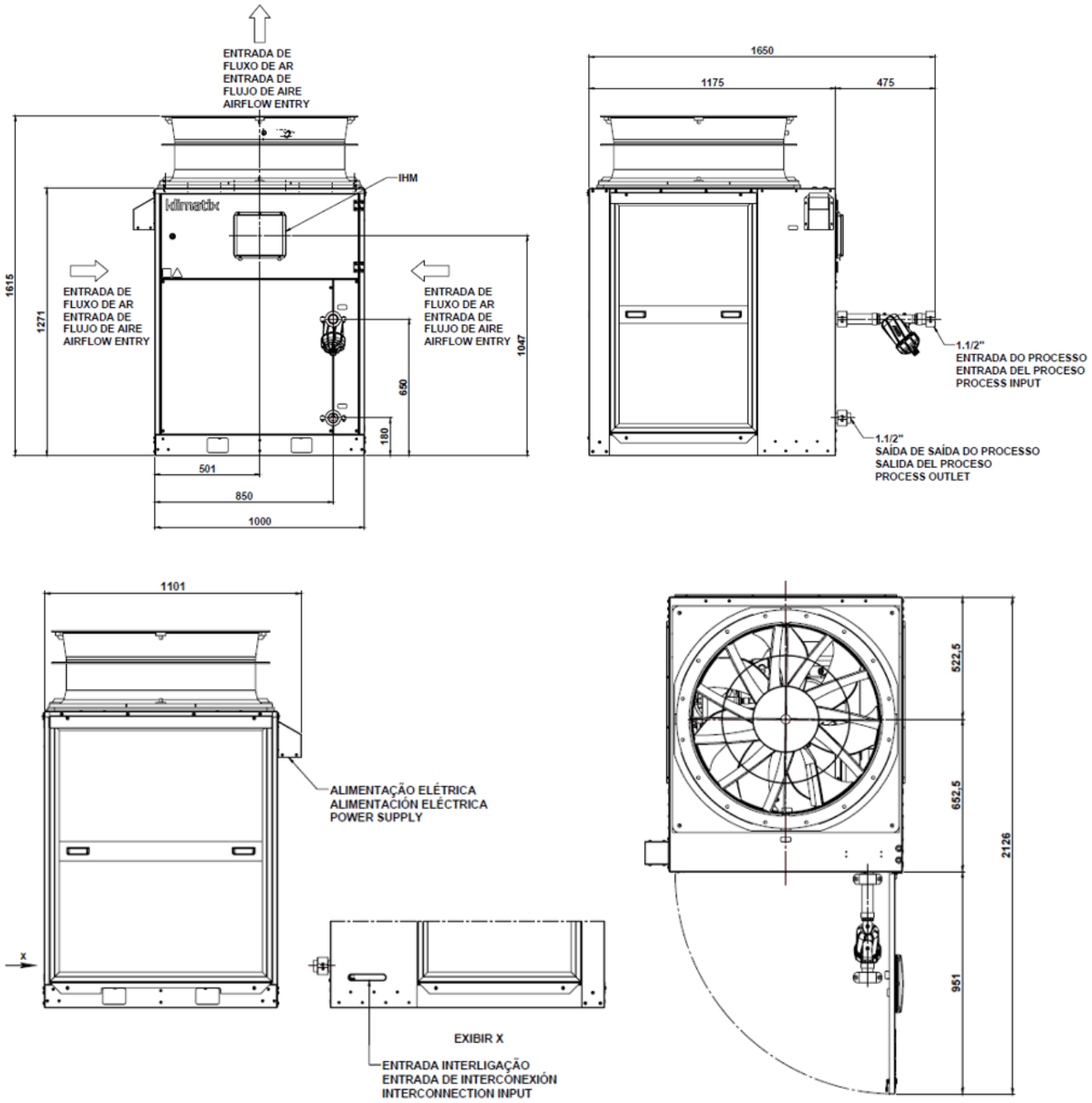
- Maximum outdoor temperature of up to 45°C;
- External ambient temperature of at least 5°C;
- Operation with water outlet temperature between 5 and 15°C.

2.5. Dimensions

2.5.1. VLC-15



2.5.2. VLC-18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1101
ALIMENTAÇÃO ELÉTRICA
ALIMENTACIÓN ELÉCTRICA
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x
EXIBIR X
ENTRADA INTERLIGAÇÃO
ENTRADA DE INTERCONEXIÓN
INTERCONNECTION INPUT
522,5
652,5
951
2126

2.6. Electrical Data

The customer is responsible for laying the electric cable up to the equipment and it must be performed by a qualified person.

Check the electrical features of the VLC on the identification plate attached to the equipment. The network voltage must comply with the VLC voltage and must be within the acceptable limits of ± 10 % (Voltage variations with a tolerance of ± 10 %: 220 V (198 ~242V); 380V (342 ~412V); 440 V (396 ~484V). The electrical data of the equipment will be presented below.

	**INFORMATION**	A power supply point is not necessary for the command/control circuit, because it is powered by the internal transformer of the equipment.

	**ATTENTION**	Consult the standards applicable to the electrical installation at the site so as to ensure that the installation of the VLC is according to the specified standards and prerequisites. For installations in Brazil, see standard NBR 5410 “Low Voltage Electrical Installations”.

	**ATTENTION**	DO NOT USE the electrical data of the following table to size the power supply point in VLC models that have special characters (/B/C/E/T). Check the special documentation described in the annex of this manual for VLC with special character.

	**ATTENTION**	The maximum power informed on the electrical data table should be used to size the protections and cables. DO NOT USE the power in regime that was calculated based on the nominal operating condition of the equipment.

Equip. (1)	Voltage (2) (V)	Maximum Current (A)	Cable (3) (mm²)
VLC-A-15-I	220	59.1	25
	380	32	10
	440	32	10
VLC-A-15-F	220	63.1	25
	380	38.2	10
	440	32	10
VLC-A-18-I	220	75.8	35
	380	40.7	16
	440	40.7	16
VLC-A-18-F	220	77.9	35
	380	46.8	16
	440	42.4	16

(1) Equipment in its configuration with fixed compressors or inverter compressor.

(2) Three-phase electrical voltage, at 60 Hz frequency, with an allowable variation of ± 10%.

(3) Diameter indication for cable per phase, for power supply of the main switch of the equipment. For distances greater than 50 meters, the cable should be resized.

3. Receiving

The receiving and moving of the equipment should be performed by the customer. In this stage, the following points should be checked:

- The data informed on the identification tag of the equipment should correspond to the information of the purchase order;
- The presence of all items, according to the order and invoice, and immediately inform the manufacturer in case of divergence or lack of items;

3.1. Packaging

For transports carried out in the country, the shipping of the VLC is performed in a crate of wood wrapped in high resistance plastic. For export, the shipping is carried out in a closed fumigated wooden package. Both packages were designed to be transported exactly the way they are shipped.

	**ATTENTION**	Do not pile boxes or deposit other volumes over package.

	**INFORMATION**	The VLC package was designed to ensure the integrity of the equipment during transport.

		Changes in the design of the package may result in damages on the equipment and loss of warranty

3.2. Unloading, Moving and Storage

As soon as the unit is received and before unloading, check to see if the package of the VLC does not have any damages caused during transport.

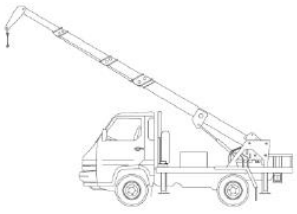
	INFORMATION	It is recommended to move the VLC to the installation site or near the installation site with the original package

	INFORMATION	It is recommended to store the VLC packaged in a dry place sheltered against dirt and bad weather in case the equipment remains unused for a long period of time before its installation and operation.

	INFORMATION	Check the general condition of the equipment IMMEDIATELY after opening the package. In case any damage is observed, take a picture and send it to the shipping company.

Use a forklift or a pallet jack to unload. Check the weight of the equipment to define the capacity of the forklift that will be used to unload the equipment. Perform the transport with the equipment only in the vertical position. Transport the volume to the installation site or near it and unpack it.

In some cases, it is impossible to use the forklift, because the installation site is inaccessible, requiring the use of a munck truck or hoisting with a crane.



	**ATTENTION**	Use canvas belts appropriate for the weight of the equipment to lift it. Unsafe practices may cause accidents, therefore, this process should be carried out by qualified people and with the suitable safety equipments.

4. Installation

The VLC was designed thinking of efficiency, durability and safety of the operator; however, the safety should be ensured by the correct installation, preventive maintenance performed periodically and the operation within the design conditions.

	**ATTENTION**	It is recommended for the installation of the equipment to be performed by Mecalor or by a qualified person. It is imperative for the installer to have a knowledge of local installation codes and regulations in order to ensure that the best mounting and safety practices are used.

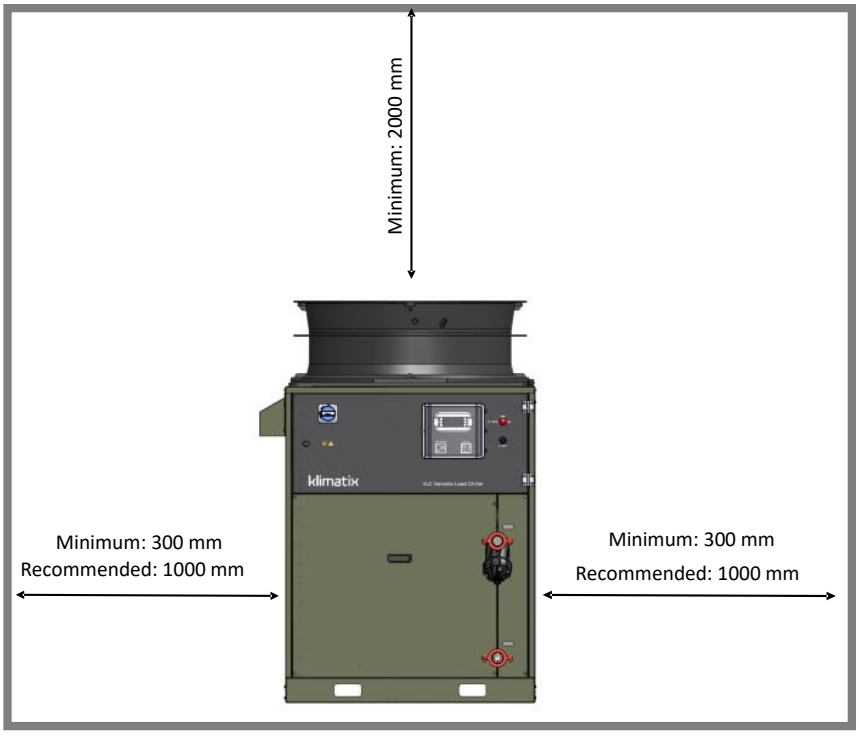
	**DANGER**	The VLC was not designed to work in an area classified as risk of explosion. If the use in these conditions is detected, the equipment will lose its warranty.

4.1. Installation site

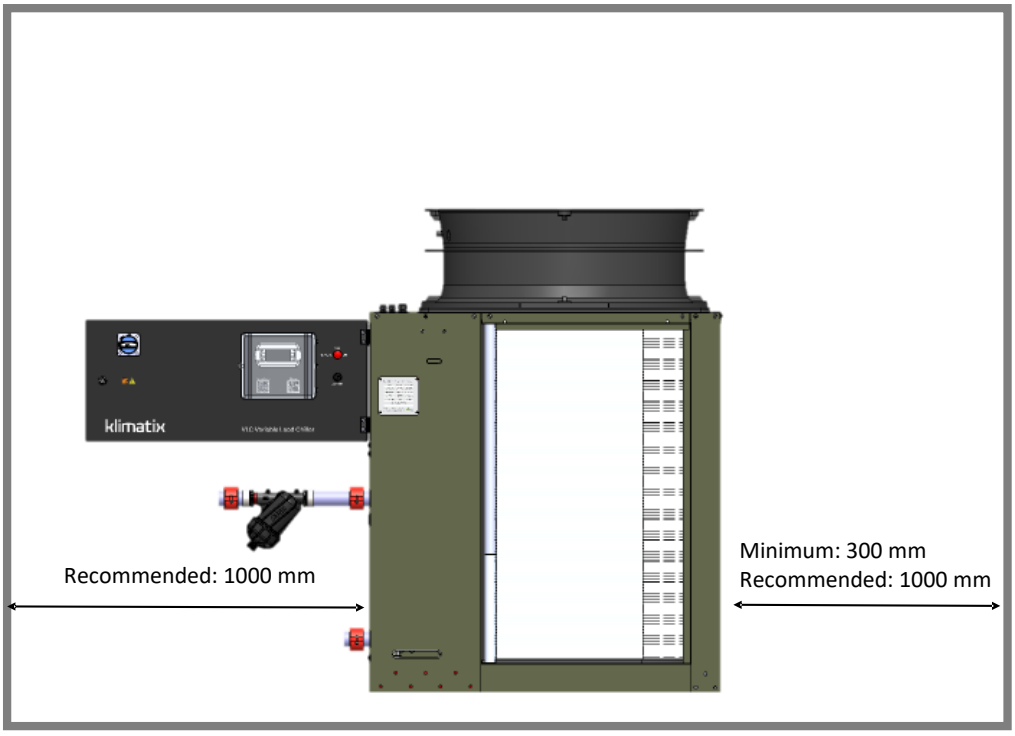
The good operation of the VLC depends mainly on the air flow that passes through the condenser; therefore, the equipment should be installed with good air circulation around it.

The floor where the VLC will be installed must be well leveled to avoid problems with water accumulation inside the equipment, as well as to maintain the correct return of the compressor oil and water from the hydraulic circuit. In case of the installation of various equipments in parallel, the bases must be leveled in the same plane.

Leave space around the unit to allow easy access for maintenance and provide good air circulation through the condenser. The VLC is designed for outdoor installation, so it is not necessary to install a cover over the equipment. If it is not possible to install it outdoors, it must be ensured that there is at least 2 meters of space between the fan and the environment cover, to avoid hot air recirculation in the place, impacting the refrigeration capacity of the equipment and possibly resulting in faults due to high-pressure refrigeration.



To facilitate access to the electrical panel and facilitate access for maintenance on the equipment, we recommend that there be 1 meter of space around the equipment.



	INFORMATION	Avoid installing the VLC in machining centers or in places with possible chips that may be deposited on the paint of the equipment. The chip deposited on the paint of the equipment may generate future problems of corrosion. In case it is not possible to install it in another location, clean the cabinet regularly to avoid the deposit of material on the structure.

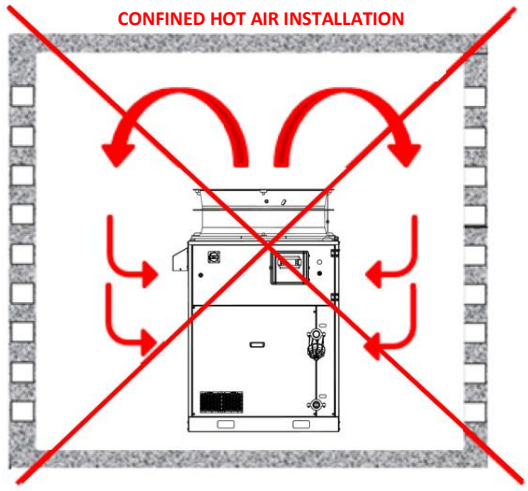
	INFORMATION	The space required around the VLC also refers to low walls or any other obstacles that may compromise the circulation of air from the fan for the condenser.

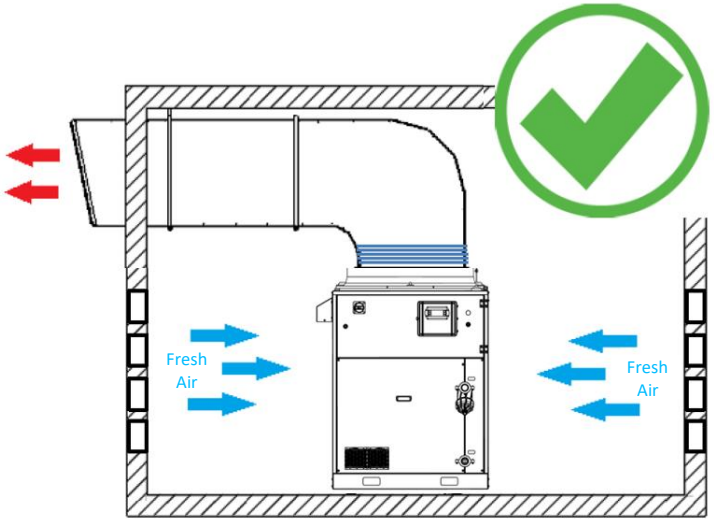
	INFORMATION	During installation, it is recommended to protect the VLC to prevent dirt from surrounding works from settling in the equipment cabinet. It is recommended to carry out general cleaning after installing the equipment.

	ATTENTION	Never block the air inlet and outlet flow.

4.1.1. Air exhaust duct

When there is no suitable ventilation or when there is the possibility of air recirculation, a hot air exhaust duct should be installed.





	**INFORMATION**	The VLC is equipped with an axial fan, which is not designed to be ducted. The exhaust duct to be installed is a grille and must have the smallest length possible in order to not cause excess load loss and consequently deactivate the equipment due to high pressure.

The following recommendations should be considered in order to correctly size the air exhaust duct:

- Maximum load loss in the duct: 20 Pa
- The length of the duct should not exceed 2.5 m
- The duct should be placed between the roof/wall in order not to overload the structure of the VLC
- There should be a flexible canvas placed between the duct and the upper part of the fan in order to avoid the transmission of vibration to the roof/wall and enable maintenance of the fan
- The highest load loss of a duct is mostly on the very short radius curve (<<D/2). Curves of bigger radiuses or close to D/2 avoid turbulent flow and excess load loss.

	**INFORMATION**	In case of doubts, consult Mecalor or the ASHRAE criteria for the correct size of the hot air exhaust duct.

	**INFORMATION**	Never restrict the air duct in the hot air outlet, this practice may cause the increase of load loss in the duct and deactivate the VLC due to high pressure.

4.2. Electrical installation

The electrical installation from the main power point to the terminals of the main switch of the VLC is under the responsibility of the customer or the installer hired by him.

	**DANGER**	Keep the main switch of the equipment always switched off at the time of installation or maintenance of the VLC. The noncompliance of this practice may cause personal damage or even death.

	**ATTENTION**	Use blockades and warnings like *"Equipment Under Maintenance"* when the installation or intervention is occurring on the VLC. Consult standard NR12 and local references for the correct signal of the equipment in case of installation or maintenance.

	**ATTENTION**	DO NOT USE the power in regime to size the circuit breaker and power cable. The electric safety devices should always be sized according to the installed/maximum power of the VLC.

	**ATTENTION**	The customer is responsible for the sizing and selection of the exclusive disconnection device of the VLC. Unsuitable sizing or out of the local regulations may put at risk the safety of the installation, causes damages to the equipment and loss of warranty.

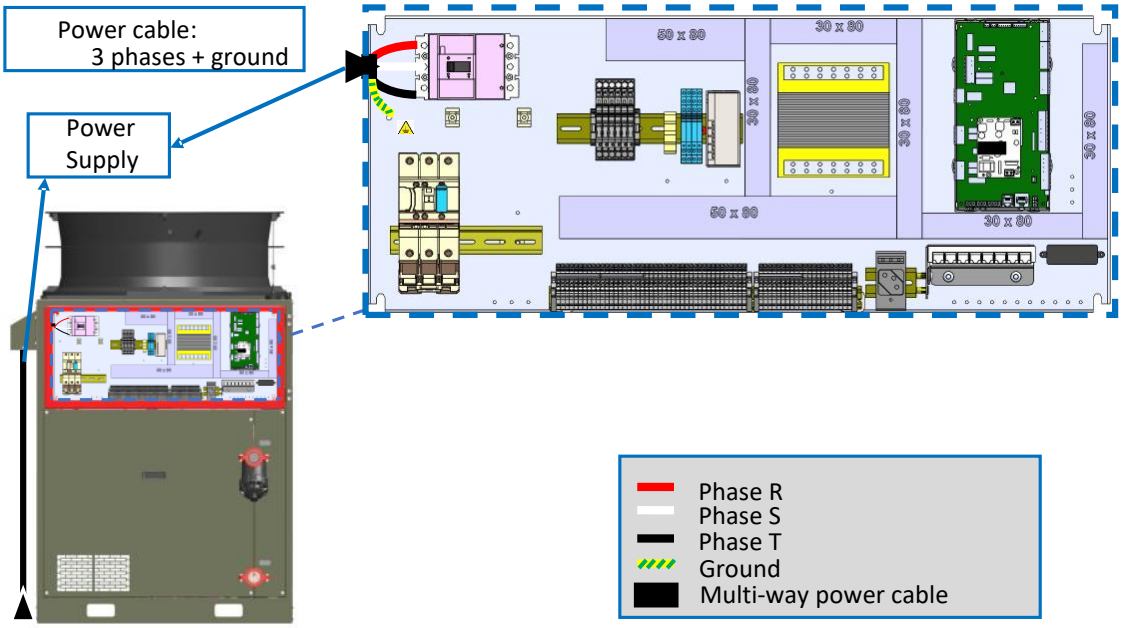
	**ATTENTION**	Consult the standards applicable to the electrical installation at the site so as to ensure that the installation of the VLC is according to the specified standards and prerequisites. For installations in Brazil, see standard NBR 5410 “Low Voltage Electrical Installations”.

	**DANGER**	High voltage in the connection boxes of the electrical panel, compressor, fan, reheating electric resistor and steam generator. Risk of injury or death. Only qualified personal with suitable safety equipment can handle these components and with the prior authorization from Mecalor.

Use an exclusive disconnection device (breaker) for the equipment and disconnect the three phases. The breaker and the power cable must comply with the electrical power requirements of the equipment, voltage and power described in the electrical data table in section 2.6 of this manual and support the current informed in it.

The electric power cables should enter through the back of the equipment and be laid up to the electrical panel through the indicated cable glands.

The R, S and T phases should be connected in the main switch and the ground cable in the green and yellow terminal.



4.2.1. Interconnection between units

The VLC makes it possible to combine up to 14 units in the same system operating in parallel, thus increasing the refrigeration capacity of the system. In this application, one of the units (reference machine) is supplied with a switch for interconnection and communication between all units of the system. Besides the switch, the reference machine is equipped with a semi-graphic HMI, which allows the monitoring and configuration of all units. The other units (conventional machines) are supplied without an HMI on the door of the electrical panel, only with a button for activation and a lamp to signal alarms, as shown in the illustration below:

Machine Reference **Conventional Machines**

The switch for interconnection can be supplied in a version with the capacity to integrate up to 7 units or up to 14 units. CAT5e cable or higher should be used for the interconnection. We recommend that the cable does not exceed 100 meters of distance to the switch.

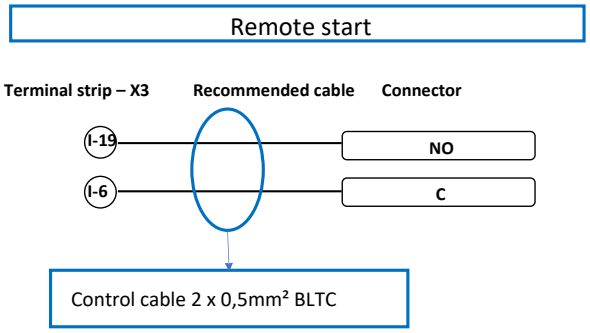
The VLC was developed so that the operation of the system does not depend on the reference machine; therefore, in case of a fault in the reference machine, the conventional machines will maintain the operation of the system, provided that the interconnection switch installed in the panel of the reference machine is kept energized.

4.2.2. External connections

The VLC also has some contacts for interaction with external interfaces, such as the integration of a button for remote activation of the equipment, a fault signal contact (fault summary), as well as points for reading and controlling water pressure and flow. The connection should be made as follows:

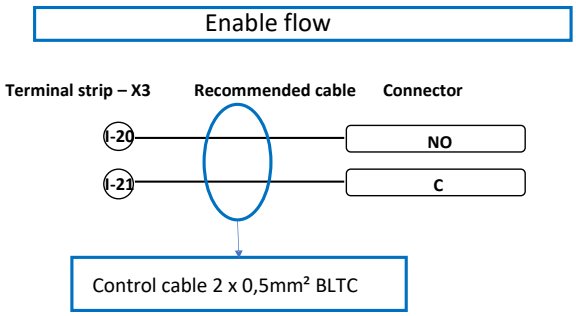
4.2.2.1. Remote start

Dry contact available for remote activation of the equipment.

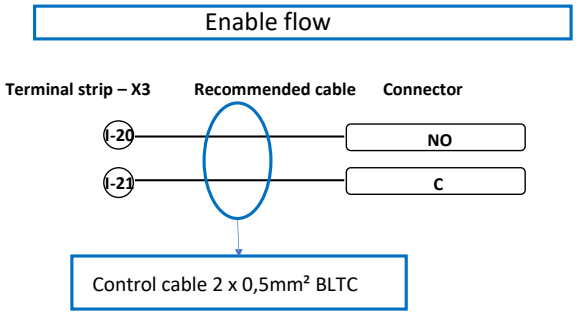


4.2.2.2. Enable flow

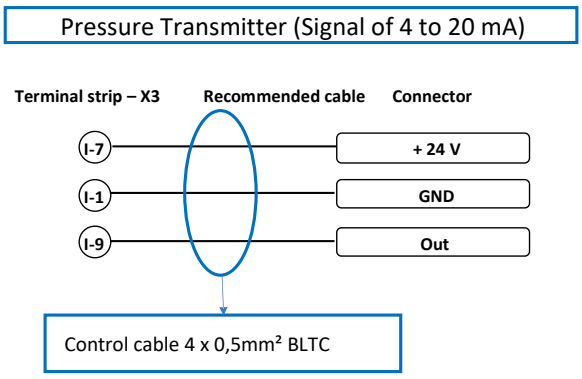
Contact intended for the activation control of an ON/OFF valve. This requires voltage to be available for activating the valve in question.



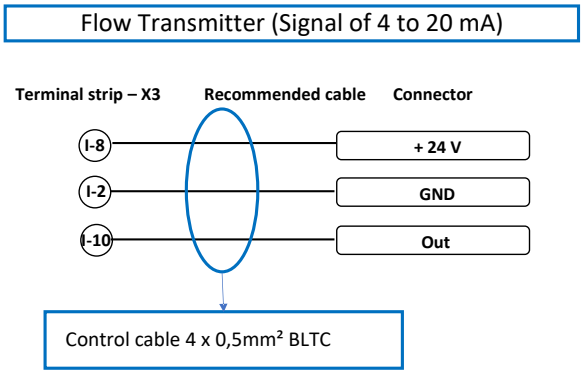
4.2.2.3. Fault summary



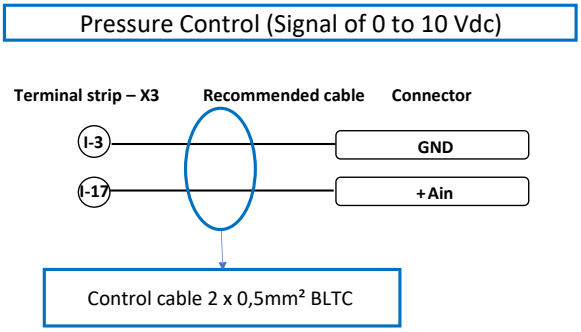
4.2.2.4. Pressure transmitter



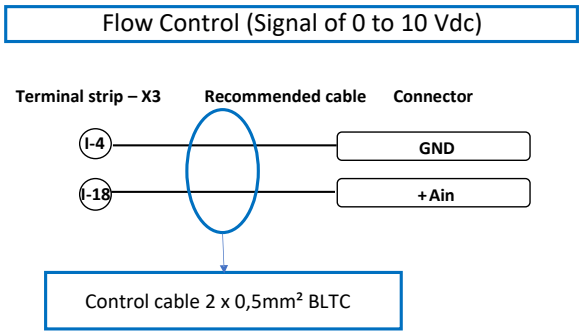
4.2.2.5. Flow transmitter



4.2.2.6. Pressure control

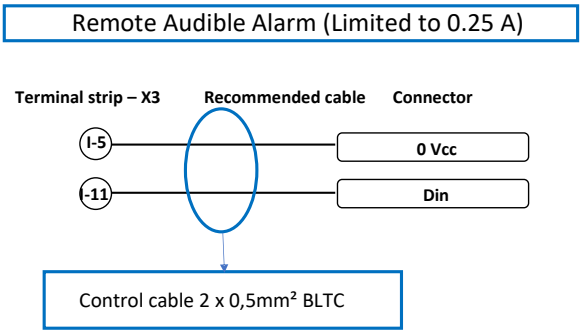


4.2.2.7. Flow control

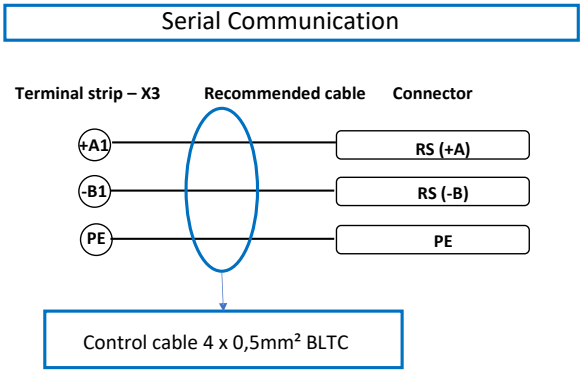


4.2.2.8. Remote audible alarm

24Vdc voltage contact for connection of an external audible alarm.



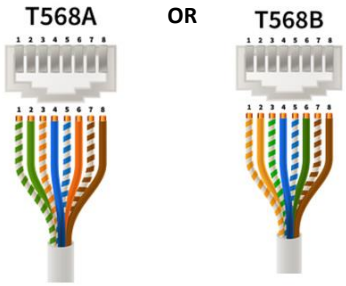
4.2.2.9. Serial communication



4.2.2.10. Ethernet

For interconnection between equipment and network, and between equipment, CAT5e cable or higher must be used. The connection should be made through a switch for which the customer is responsible.

Parallel configuration must be used for terminal connection (the terminals must be crimped in an identical way in both terminals) and connection standard T568A or T568B can be followed, as shown in the figure below:



	INFORMATION	The wiring and piping described in the figure are only an example of a general electrical installation and it does not consider the installation variables of the customer. The electrical piping should comply with the applicable codes.

	**INFORMATION**	The pipe for laying the power cable shown in the figure is only an indication of the connection points and it is not planned for a specific installation.

4.3. Hydraulic Installation

The hydraulic installation of the VLC must be according to the engineering practices and in agreement with the local regulations applicable to the standards of the industry.

Mecalor does not impose strict criteria for the selection of the materials that should be used in the design of the hydraulic pipe, but it recommends the minimum necessary for the correct installation of the VLC.

4.3.1. Material

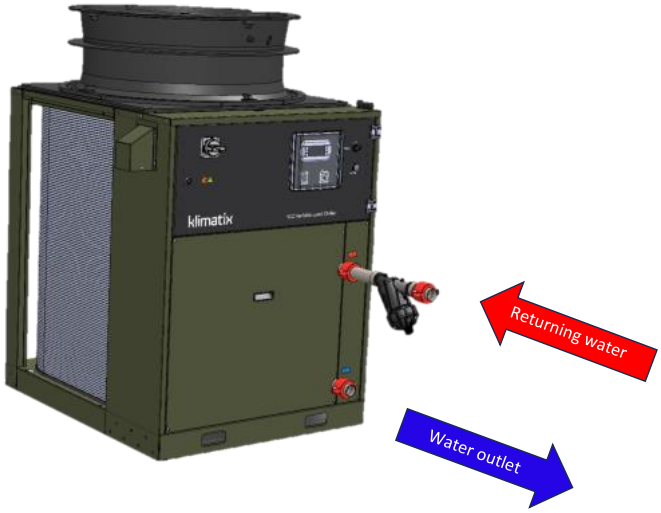
The material used in the hydraulic pipe may be in increasing order of cost, PVC, carbon steel, galvanized steel, copper and stainless steel. The installation with copper pipes and welded Yorkshire fittings presents the best cost-effective. Galvanized steel pipes have reasonable protection against corrosion and must be mounted with thread. An installation with PVC pipes connected with glue is the most economic solution, but it has the disadvantage of having low mechanical strength, and the tendency to break and crack with time. In counterpart, it is resistant to corrosion and the installation (as well as repair) is very simple.

	**INFORMATION**	The internal pipe of the hydraulic circuit of the VLC and it is fully manufactured in stainless steel. Mecalor recommends the use of stainless steel for the design of the hydraulic pipe of the CP.

	**INFORMATION**	Installing heat insulation on the entire length of the pipe prevents power consumption due to heat exchange of the pipe with the environment.

4.3.2. Interconnection Points

The VLC has two interconnection points, one for the cooling water return point and the other for the cooling water outlet from the system. The VLC is supplied with 1.1/2” diameter Victaulic coupling type connections. After the coupling, a stainless steel AISI 304 pipe tip is also supplied, allowing the welding of this tip on the process piping or the direct connection on the Victaulic coupling.



We recommend that block valves be installed at the entrance and exit of the equipment, with the objective of facilitating eventual maintenance on the equipment, as well as preventing the circulation of water inside the heat exchanger at times when the equipment is inoperative and another unit installed in the same circuit is in operation (parallel installation). For applications with more than one unit the VLC can be supplied with a valve and pipe kit for parallel connection of the equipment. The components that make up the optional hydraulic interconnection kit are discussed in more detail in section 4.4.2 of this manual.

In addition to the block valves, we recommend the installation of a by-pass in the line to ensure a constant flow of water circulating through the VLC heat exchanger. Low water flow rates can result in water freezing inside the heat exchanger, causing severe damage to the plates of this component, resulting in water entering the refrigeration circuit, causing irreversible damage to the compressor, and loss of warranty.

	INFORMATION	We recommend the installation of the shut-off valves in the cold water return and outlet of the VLC for future maintenance.

	ATTENTION	Do not use the cold water pipe of the VLC to support tool boxes or parts. The pipe was not designed to support objects, this practice may result in the rupture of the pipe and the stresses may be transmitted to the VLC, which may cause damages to its components.

	**INFORMATION**	Do not use valves that “strangle” the pipe. This practice may deactivate the equipment due to lack of water.

	**ATTENTION**	It is expressly forbidden to restrict the VLC pipe in the cold water return and outlet. This practice may cause undue load loss in the system and even the lack of water at the consumption point. The return and outlet pipe of the VLC was designed thinking on minimum load loss of the system, speed and flow suitable for the smallest tube diameter possible.

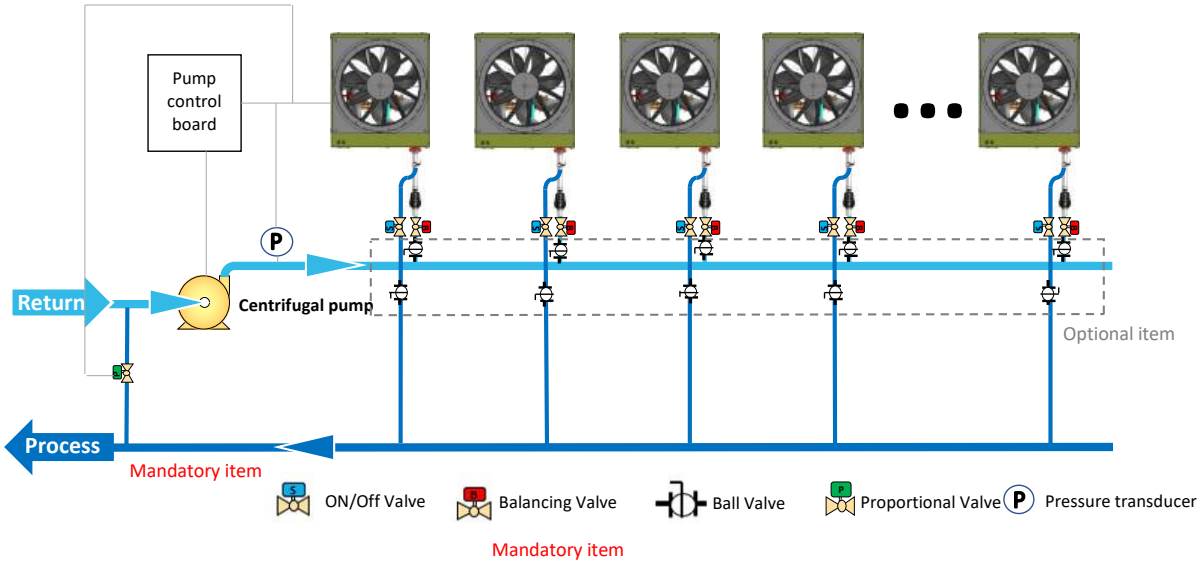
	**DANGER**	Never climb on the VLC pipe to carry out works at heights. The pipe was not designed to suffer specific overloads. This practice may result in the rupture of the pipe and consequent personal damages or even death.

4.3.3. Interconnection in parallel

In applications with more than one VLC installed in parallel, there is the possibility of installing a single pump for the overall supply of the hydraulic circuit or installing individual pumps for each VLC installed.

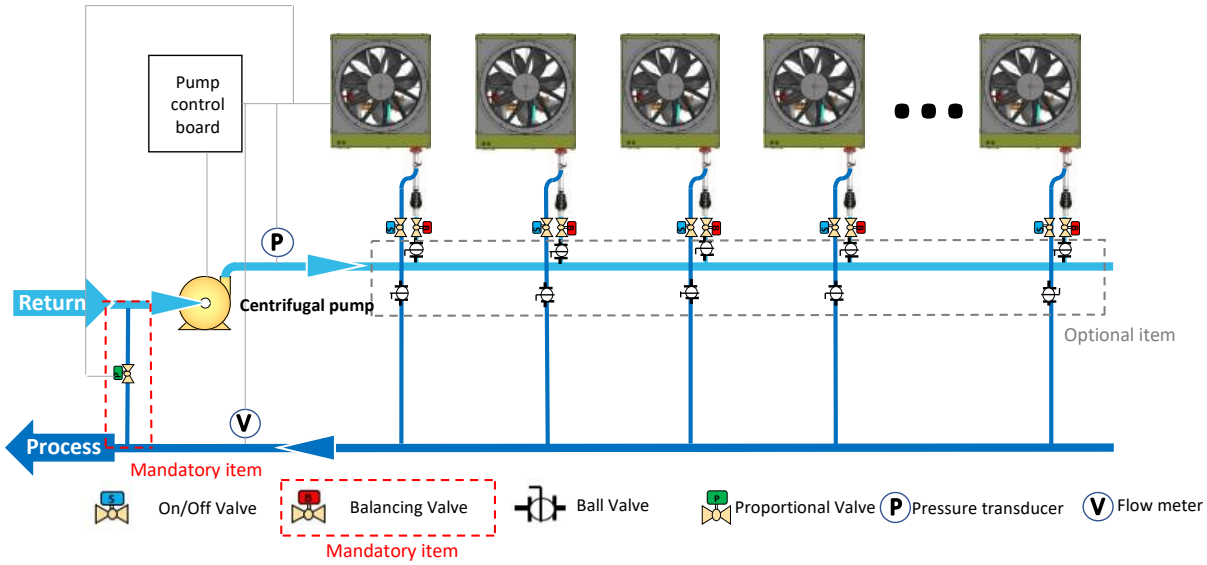
4.3.3.1. Interconnection with a single pump

In the installation with a single pump feeding the system, it is necessary to install an ON/OFF valve for each VLC. With this, only the valve of the operating VLC will remain open, immediately closing as soon as there is a rotation among the VLCs, or in case of the occurrence of any fault that interrupts the functioning of the operating VLC. Optionally, block valves can be installed at the entrance and exit of each equipment, with the purpose of facilitating eventual maintenance. The system must have flow balancing valves in each equipment, in addition to a by-pass in the line, thus ensuring constant pressure and flow of water in the system.



4.3.3.1.1. Interconnection with single pump - Variable speed pump

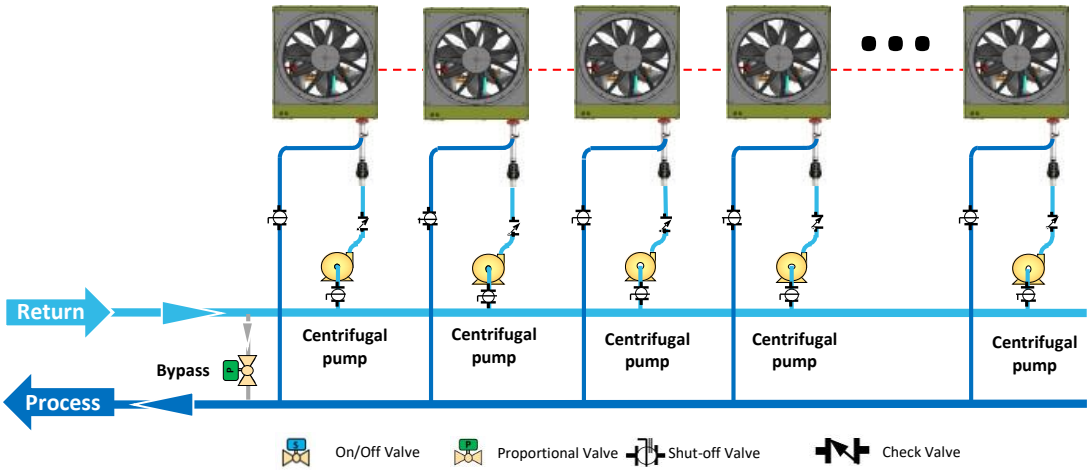
In the single pump configuration, there is still the possibility of controlling the rotation speed of the pump, thus enabling more precise control of the water flow and pressure of the system. The system configuration should follow the same recommendations of the system with fixed rotation single pump, with the only requirement being to implement the flow meter that will be interconnected to the pump controller.



4.3.3.2. Interconnection with individual pumps

In this installation format, each VLC is interlocked with its respective pump, where the pump is automatically shut off when the VLC ceases operation. This installation facilitates the balancing of the water flow between the modules, eliminating the need for balancing valves. We recommend the installation of a check valve in the return line of each VLC, to avoid the return of water through this line in inoperative equipment.

Individual Pumps (On/Off)



4.3.4. Need to add anti-freezing agent

In installations where the ambient temperature can reach values below 2°C it is recommended to add antifreeze in the process water, in order to avoid freezing the water, thus damaging the plates of the VLC plate heat exchanger (evaporator). We recommend the use of a solution of water and antifreeze according to the table below:

Room temperature (°C)	**Monoethylene-glycol** Volume (%)
-5	20
-8	30

	INFORMATION	In case another anti-freeze is used, care must be taken so that the freezing temperature of this solution is at least 5°C lower than the minimum working temperature.

	INFORMATION	To specify the quantity of the antifreeze, remember to consider the volume of the hydraulic pipes and the process.

4.3.5. Pipe Cleaning

After completing the hydraulic interconnection services between the VLC and the process, make sure the cleaning of the pipe is performed before start-up of the equipment. This service should be performed to prevent fouling of small particles in the main components of the VLC.

Both fouling with the existence of suspended solids reduces the flow capacity of the water and increases load loss in the pipe, able to cause an increase in power consumption. Also, fouling may cause corrosion in the major components depending on the crusted material.

Cleaning should be performed after filling and purging the system, putting the equipment into operation and circulating water for a certain period of time. After this procedure, stop the circulation of water and clean the water filter. Reassemble the filter and carry out the circulation of water in the system again (repeat this procedure until the water filter is clean).

After observing that the filter is clean, drain all the water from the system and fill it again, after which the system is ready for operation.

We recommend the daily cleaning of the water filter during the beginning of operations, gradually spacing the cleaning time to that recommended in the preventive maintenance.

	**INFORMATION**	The equipment should not be switched on without prior authorization from Mecalor, under the penalty of suspension of the warranty.

4.4. Optional Installation

4.4.1. Bacnet Communication

The standard equipment has a Carel PLC and standard communication via MODBUS TCP/IP or MODBUS RTU RS-485, allowing the monitoring of parameters, remote on/off and setpoint adjustment. Optionally the system can be supplied with a plugin for Bacnet communication, if necessary for compatibility with management or monitoring software of the plant where the equipment is installed.

4.4.2. Parallel interconnect kit

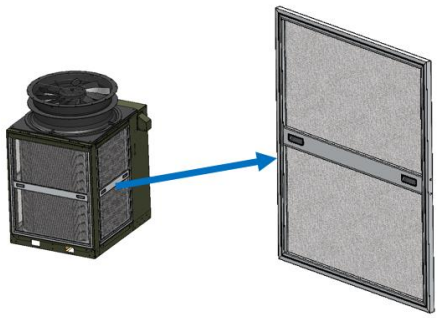
The VLC allows the interconnection of up to 7 units installed in parallel. To facilitate this interconnection, the system can be supplied with an interconnection kit for the units, containing the inlet/outlet interconnection pipes, collector pipes for the outlet and water return to the process, Victaulic connections, manual block valves, solenoid block valve, flow balancing valve, and a by-pass for the hydraulic circuit controlled by proportional valve. The manual block valves are installed in the inlet and outlet

connections of the VLC, with the purpose of allowing the isolation or removal of the equipment from the hydraulic line without impacting the operation of the rest of the system. The solenoid valve is installed in the outlet line of the VLC, and is controlled by the equipment's PLC, so that it is activated only when the equipment starts operating and immediately closing after the shutdown of the equipment, either by rotation routine between units or by the occurrence of a fault. The flow balancing valve is installed in the water inlet line of the equipment and its purpose is to keep the water flow constant in the system, thus ensuring a more stable temperature control in the process to be cooled. The electrical interconnection of the electronic valves contained in the kit is supplied ready to use.

4.4.3. Air filter

For the correct functioning of the VLC it is necessary to ensure that the condensation system of the equipment works without interferences, whether by low air flow, hot air recirculation, or dirt accumulation in the microchannel condenser.

Optionally, the VLC can be supplied with filters on the sides and rear of the equipment, protecting the microchannel condenser from dirt coming from the place where the equipment is installed. The filters are of the shaded screen type, being attached to the equipment by means of screws, thus enabling the removal of the filters for washing with a high-pressure washer, as will be addressed in section 6.2 of this manual.



4.4.4. Condenser with e-coating

For installations in environments subject to sea air or aggressive atmospheres, the conventional condenser may suffer corrosion due to its total aluminum composition, thus reducing its durability. To avoid this type of occurrence, it is possible to supply the VLC with a condenser with e-coating paint, which is a surface treatment in aluminum that provides protection against corrosion.

4.4.5. Service HMI

In an application with two or more VLCs installed in parallel, only the reference machine is supplied with HMI, being possible to monitor and control all the units through this HMI, according to information in section 4.2.1 of this manual. However, there is the option of providing an additional HMI for remote use in conventional units, in specific situations where it is necessary to view information from the HMI without the possibility of traveling to the reference machine, such as corrective maintenance, for instance.

The service HMI is already supplied with cable for connection to the PLC of the VLC.

4.4.6. Remote Monitoring

As an option, the VLC can be supplied with the NEO remote monitoring system, which is independent of the local network for operation and allows remote assessments / interventions on equipment operating in national or international territory.

The NEO system allows monitoring via browser of the VLC's operating data, process variables and faults recorded 24 hours a day, bringing better reliability and safety to the process.

4.5. Start-up check-list

Final Inspection Checklist of the Installation Before Start-Up

Installation site	Hydraulic Installation
☐ Is the general state of the VLC in perfect conditions to start operation?	☐ Was the interconnection between the VLC and the process carried out?
☐ Is the installation base of the VLC leveled?	☐ Is the pipe diameter according to the water inlet and outlet diameter of the VLC?
☐ Does the base of the VLC have channels or drain to drain out accumulated water?	☐ Was the water filter installed?
☐ Is the space required around the VLC as specified in the manual?	☐ Were shut-off valves were installed in the inlet and outlet of the VLC?
☐ Was the air exhaust duct sized correctly, without restrictions in the outlet? (if applicable)	☐ Was the interconnection carried out without diameter restriction along its entire length?
Electrical installation	☐ Was an air trap installed at the highest point of the piping?
☐ Is the voltage and frequency the same as indicated on the plate of the VLC?	☐ Were the water quality criteria met?

☐	Was the exclusive circuit breaker sized correctly according to the maximum power and voltage of the VLC?	☐	Are there suitable supports attached to the entire length of the hydraulic pipe?
☐	Was the power cable correctly sized according to the maximum power and voltage of the VLC?	☐	Was the pipe duly insulated?
☐	Was the power cable laid up to the terminals of the electrical panel?	☐	Was the pipe cleaned?
☐	Are the R, S and T phases connected correctly?	☐	Was the water filter cleaned?
☐	Was the VLC grounded?		

	**INFORMATION**	After completion of the electric and hydraulic installation, fill the inspection checklist of the installation and request from the Technical Support department for execution of the start-up of the equipment with a minimum of 48 hours in advance.

	**INFORMATION**	The equipment should not be switched on without prior authorization from Mecalor, under the penalty of suspension of the warranty.

5. Operation

Below is a set of instructions for the correct operation of the VLC, as well as the change of the control temperature of the equipment and access to the alarm screens.

The operating actions do not require the use of PPEs unless the installation environment of the VLC demands it. The customer is responsible for establishing which PPEs the operator must use.

The customer must provide suitable lighting for the environment where the VLC is installed and where maintenance services will be performed, if necessary.

Before starting operation with equipment, we must:

- Check the electrical connections between the components, cables and terminals, tightening when necessary;

- Check the gauges and fittings of the electrical conductors;
- Check the gauges and fittings of the pipes;
- Check to see if the safety devices of the equipment and installation are not activated;
- Check the control fuses;
- Check the voltage and difference between the electric power supply phases;
- Check to see if the air flow of the unit is not blocked and if there is suitable ventilation in the equipment installation site.

The control of the equipment is done through the PLC installed in the electrical panel of the VLC, including all the functions related to temperature control.

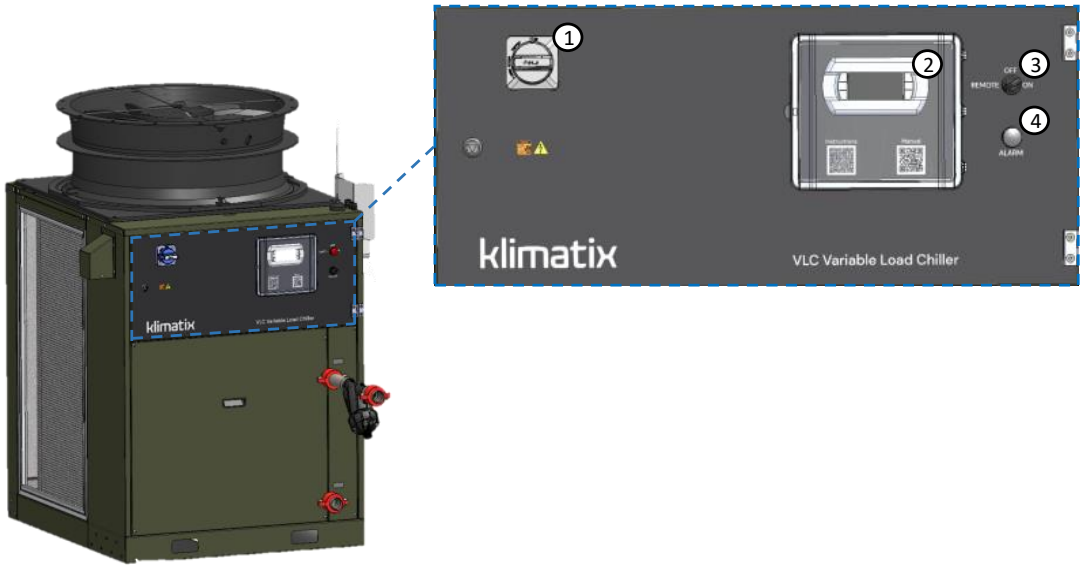
	**ATTENTION**	It is recommended for the operator to go through training before operating the equipment. The VLC is easy to operate, but the operator must be qualified and have the minimum knowledge to operate the equipment safely.

5.1. Start-up

	**INFORMATION**	The equipment should not be switched on without prior authorization from Mecalor, under the penalty of suspension of the warranty.

All the equipment operation is done through the HMI installed on the front part of the equipment. The HMI (2), activation switch (3), and alarm indication led (4) are protected by an acrylic frame.

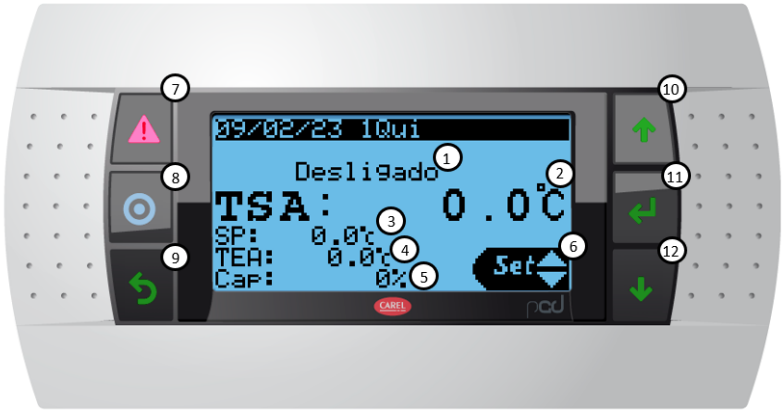
To start the operation of the equipment, after checking all items indicated in the previous section and activating the main switch (1), turn the activation switch (3) to the "ON" position. If the HMI (3) does not start operating, check if there is voltage at the inlet of the general switch of the equipment.



Item	Description
1	Key Switch
2	HMI
3	Drive switch
4	Fault indication LED

5.2. HMI – Human Machine Interface

Through the HMI of the main equipment, it is possible to perform all the configuration and control of the VLC, besides visualizing in real time the information referring to the operation status and process variables. Below is an illustration of the HMI interface in its initial screen:



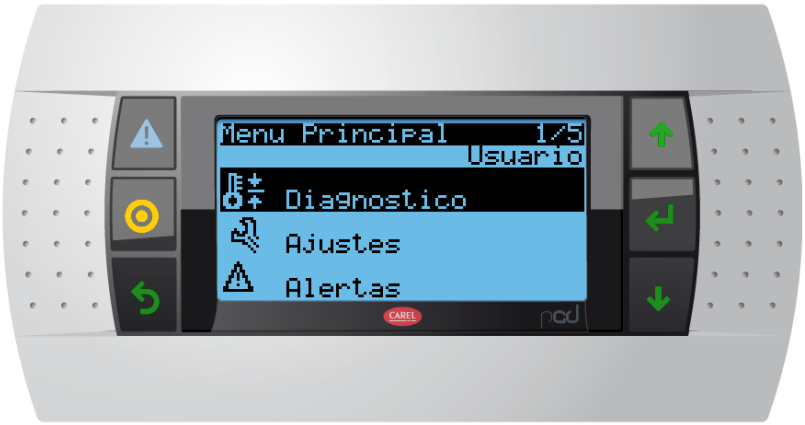
Item	Description
1	Equipment status

2	Water Outlet Temperature
3	Water temperature set-point
4	Water inlet temperature
5	Cooling capacity
6	Set-point adjustment
7	Active alarms
8	Programming
9	Return to previous screen
10	Up directional button
11	Enter
12	Down directional button

In the initial screen, we have the indication of the equipment status (1), and the equipment only starts operating when the switch button is pressed to the ON position. Next, we have the indication of the outlet water temperature for the process (2), water temperature set-point (3), process water return temperature (4), VLC refrigeration capacity (5), and a menu to adjust the set-point (6), which is activated by the enter button (11) while the HMI is in the initial screen. A password will be required to change the setpoint. The setpoint can be changed using the user password. By default, the passwords initially supplied are:

- Username: 10

In case of fault, the active faults can be viewed by pressing the active alarms button (7). The programming button (8) is used to access the main menu of the equipment. The main menu provides access to view all of the operating statuses and settings of the controller. After accessing the menu, use the return button (9) to go back to the initial HMI screen.



Inside the main menu will be the diagnosis menu, where it is possible to see all the VLC operation statuses. It is also possible to access the settings menu on it, where all the controller parameterization is done.

The VLC is supplied fully configured, with no need to change these settings for the initial operation of the equipment. The controller's factory password must be used to access the settings menu.

6. Maintenance

Carrying out the maintenance procedures at the recommended intervals will ensure the proper functioning of the equipment within the conditions for which it was designed and manufactured.

The maintenance activity must only be carried out by technical specialists who must observe and respect the rules and control the maintenance performed.

	**DANGER**	Never perform any type of maintenance while the equipment is energized. This practice can put at risk the operator and the operation of the equipment, able to cause loss of control of the process, breakage of the equipment and physical damages to the operator, in addition to loss of warranty.

6.1. Corrective Maintenance

All VLC faults are indicated on the HMI alarm screen. The failures of the VLC are divided into two types: Warnings and Alarms. In case a failure occurs on the VLC, before applying the procedures described below, check the failure log as described in the previous session.

When the fault is of the Alert type, it will only be registered in the fault history, however, in alarm condition, the icon indicating alarm is signaled on the HMI and the red led on the VLC panel is activated.

	**ATTENTION**	The procedures described below can only be performed by qualified people who have the knowledge on the operation of the equipment. Procedures performed by the layman may result in injuries or breakage of a component.

6.2. Fault indication

All equipment faults are recorded in the HMI fault history, however, the alarm signal is only issued when there are active alerts/alarms. Some alarms stop the operation of the equipment partially or completely and depending on the situation require an immediate diagnosis and solution.

When an alarm is identified, it is recommended to check the fault history to identify previously registered alerts, complementing the information for an accurate diagnosis.

Description of the fault	Component		Consequence	Type		Rearm		Probable cause	Procedure
	TAG	Description		Alert	Alarm	Manual	Automatic		

Control turned off		Activation contact	Does not enable any engine		X		X	Open activation contact	Check to see if the electrical contact is closed. If so, check for the presence of a 24V signal at the ID1 input connection wires. If there is no signal continuity, check for poor contact in the connection.
Fan fault	VT1	Fan fault relay	Turns off the cooling system		X	X	X	Disarm the fan thermistor	Check to see if the voltage and current of the fan are within the specification of the electrical data table of the equipment In case of abnormalities in the operating current, check for the existence of poor contact in the electrical connection, imbalance or lock in the fan or excess ambient temperature at the installation site of the equipment.
Compressor thermal	RT1, RT2	Compressor thermal relay	Turns off the cooling system		X	X	X	Compressor thermal relay trip	Check to see if the voltage and current of the compressor are within the specification of the electrical data table of the equipment. .
High blood pressure	PHL1	High-pressure switch	Turns off the cooling system		X	X	X	High pressure in refrigeration circuit	Check the cleaning conditions of the condenser and the existence of hot air recirculation in the installation room of the equipment.
Pressure fault	PLL1	Low pressure switch	Turns off the cooling system		X	X	X	Low pressure in cooling circuit	Carry out an alarm reset attempt. If the refrigeration system starts operating again, check if there are bubbles in the liquid display. In case the liquid display is bubbling, call a refrigeration technician to perform an analysis on the equipment in order to identify leakage points of the refrigerant fluid. If it is impossible to reset the fault, do not make any further attempts and call a refrigeration technician.

Insufficient water	FLL1	Flow sensor	Turns off the cooling system		X	X	X	Low water flow	Check for restrictions in the hydraulic circuit or malfunction in the process pump. If the water flow is found to be suitable, check for dirt on the flow sensor rod.
Fault inverter	INV1	Frequency inverter	Turns off the cooling system		X	X	X	Alarm in the frequency inverter	Check the active fault in the frequency inverter.
Phase missing or sequence	RST	Phase sequence relay	Turns off the cooling system		X	X	X	Inversion or lack of power in one of the power supply phases of the equipment	Check if the RST phases are in the correct sequence and properly balanced.
Water inlet sensor	PTS1	Water inlet temperature sensor	Turns off the cooling system		X	X	X	Temperature not within sensor reading range	Check to see if the sensor is properly in the equipment.
								Bad contact in the sensor connection or open sensor	Check to see if the electrical connection of the sensor is according to the electrical diagram.
High/low temperature at the water inlet of the chiller			Alert	X		X	X	Temperature not within setpoint	Check for the existence of other alerts/alarms that are preventing the operation of the equipment.

Water outlet sensor	PTS3	Water outlet temperature sensor	Turns off the cooling system		X	X	X	Temperature not within sensor reading range	Check to see if the sensor is properly in the equipment.
								Bad contact in the sensor connection or open sensor	Check to see if the electrical connection of the sensor is according to the electrical diagram.
High temperature at the water outlet of the chiller			Alert	X		X	X	Temperature not within setpoint	Check for the existence of other alerts/alarms that are preventing the operation of the equipment.
Low temperature at the water outlet of the chiller			Turns off the cooling system		X	X	X	Low water temperature	Low thermal charge in the system or sensor reading error.
Low temperature protection sensor	PTS2	Evaporator outlet temperature sensor	Turns off the cooling system		X	X	X	Temperature not within sensor reading range	Check to see if the sensor is properly in the equipment.
								Bad contact in the sensor connection or open sensor	Check to see if the electrical connection of the sensor is according to the electrical diagram.
Low temperature at the evaporator outlet			Alert	X		X	X	Low water temperature	Low thermal charge in the system or sensor reading error.

Temperature below freezing temperature			Turns off the cooling system		X	X	X		
Water pressure sensor	TP1	Water pressure transmitter (external)	Forces the by-pass control output to the value set in parameter		X	X	X	Bad contact in transmitter connection or open transmitter	Check to see if the electrical connection of the transmitter is according to the electrical diagram.
High pressure in the hydraulic line			Turns off the cooling system					High pressure in hydraulic circuit	Check for obstructions in the hydraulic circuit.
Liquid line sensor	TS3	Liquid line temperature sensor	Alert	X		X	X	Temperature not within sensor reading range	Check to see if the sensor is properly in the equipment.
								Bad contact in the sensor connection or open sensor	Check to see if the electrical connection of the sensor is according to the electrical diagram.
High temperature in the liquid line			Alert	X		X	X	Temperature above the value set in parameter	Check if the parameter is adjusted according to the setup
								Sensor badly positioned	Check to see if the sensor is properly in the equipment.

Low temperature in the liquid line	TS3	Liquid line temperature sensor	Alert	X		X	X	Temperature below the value set in parameter	Check if the parameter is adjusted according to the setup
								Badly positioned sensor	Check to see if the sensor is properly in the equipment.
Suction temperature sensor	TS4	Suction temperature sensor of the compressor	Turns off the cooling system		X	X	X	Temperature not within sensor reading range	Check to see if the sensor is properly in the equipment.
								Bad contact in the sensor connection or open sensor	Check to see if the electrical connection of the sensor is according to the electrical diagram.
Low pressure transmitter	PS2	Low pressure transmitter	Turns off the cooling system		X	X	X	Pressure not within transmitter reading range	Check to see if the transmitter is properly positioned in the equipment.
								Bad contact in transmitter connection or open transmitter	Check to see if the electrical connection of the transmitter is according to the electrical diagram.
Low evaporating temperature			Alert	X		X	X	Temperature below the value set in parameter	Check if the parameter is adjusted according to the setup
								Badly positioned transmitter	Check to see if the transmitter is properly positioned in the equipment.
Evaporating temperature at critical limit			Turns off the cooling system		X	X	X	Temperature below the value set in parameter	Check if the parameter is adjusted according to the setup

								Badly positioned transmitter	Check to see if the transmitter is properly positioned in the equipment.
High pressure transmitter	PS1	High pressure transmitter	Turns off the cooling system		X	X	X	Pressure not within transmitter reading range	Check to see if the transmitter is properly positioned in the equipment.
								Bad contact in transmitter connection or open transmitter	Check to see if the electrical connection of the transmitter is according to the electrical diagram.
High condensation temperature			Alert	X		X	X	Temperature above the value set in parameter	Check if the parameter is adjusted according to the setup
								Badly positioned transmitter	Check to see if the transmitter is properly positioned in the equipment.
Low condensation temperature			Alert	X		X	X	Temperature below the value set in parameter	Check if the parameter is adjusted according to the setup
								Badly positioned transmitter	Check to see if the transmitter is properly positioned in the equipment.
Water flow transmitter	TV1	Flow transmitter (external)	Turns off the cooling system		X	X	X	Pressure not within transmitter reading range	Check to see if the transmitter is properly positioned in the equipment.
								Bad contact in transmitter connection or open transmitter	Check to see if the electrical connection of the transmitter is according to the electrical diagram.
Low water flow			Alert	X		X	X	Flow below the value set in parameter	Check if the parameter is adjusted according to the setup
								Badly positioned transmitter	Check to see if the transmitter is properly positioned in the equipment.
Water flow at critical limit			Turns off the cooling system		X	X	X	Flow below the value set in parameter	Check if the parameter is adjusted according to the setup
								Badly positioned transmitter	Check to see if the transmitter is properly positioned in the equipment.
Discharge temperature sensor	TS2	Discharge temperature sensor of the compressor	Alert	X		X	X	Temperature not within sensor reading range	Check to see if the sensor is properly in the equipment.
								Bad contact in the sensor connection or open sensor	Check to see if the electrical connection of the sensor is according to the electrical diagram.
High discharge temperature								Temperature above the value set in parameter	Check if the parameter is

									adjusted according to the setup
								Badly positioned sensor	Check to see if the sensor is properly in the equipment.
Discharge temperature at critical limit			Turns off the cooling system		X	X	X	Temperature above the value set in parameter	Check if the parameter is adjusted according to the setup
								Badly positioned sensor	Check to see if the sensor is properly in the equipment.
Ambient temperature sensor	TS1	Ambient temperature sensor	Alert	X		X	X	Temperature not within sensor reading range	Check to see if the sensor is properly in the equipment.
								Bad contact in the sensor connection or open sensor	Check to see if the electrical connection of the sensor is according to the electrical diagram.
Low ambient temperature								Temperature below the value set in parameter	Check if the parameter is adjusted according to the setup
								Badly positioned sensor	Check to see if the sensor is properly in the equipment.
High ambient temperature	TS1	Ambient temperature sensor	Alert	X		X	X	Temperature above the value set in parameter	Check if the parameter is adjusted according to the setup
								Badly positioned sensor	Check to see if the sensor is properly in the equipment.
Low SH	VEE1	Electronic expansion valve	Turns off the cooling system		X	X	X	Low superheating	Call a refrigeration technician to check the operation of the cooling system.
								Reading error in the pressure sensors/transmitters	Check to see if the temperature sensors and pressure transmitters are making the correct reading. In case of abnormalities, check to see if the connection of the component is according to the electrical diagram.
High SH	VEE1	Electronic expansion valve	Turns off the cooling system		X	X	X	High overheating	Call a refrigeration technician to check the operation of the cooling system.
								Reading error in the pressure sensors/transmitters	Check to see if the temperature sensors and pressure transmitters are making the correct reading. In case of abnormalities, check to see if the connection of the component is according to the electrical diagram.

LOP	VEE1	Electronic expansion valve	Turns off the cooling system		X	X	X	Low pressure	Call a refrigeration technician to check the operation of the cooling system.
								Reading error in the pressure sensors/transmitters	Check to see if the temperature sensors and pressure transmitters are making the correct reading. In case of abnormalities, check to see if the connection of the component is according to the electrical diagram.
MOP	VEE1	Electronic expansion valve	Turns off the cooling system		X	X	X	High pressure	Check the cleaning conditions of the condenser and the existence of hot air recirculation in the installation room of the equipment.
								Reading error in the pressure sensors/transmitters	Check to see if the temperature sensors and pressure transmitters are making the correct reading. In case of abnormalities, check to see if the connection of the component is according to the electrical diagram
Prot - Damaged water inlet sensor	PTS1	Water inlet temperature sensor	Alert	X		X	X	Bad contact in the sensor connection or open sensor	Check to see if the electrical connection of the sensor is according to the electrical diagram.
Prot - Damaged water outlet sensor	PTS3	Water outlet temperature sensor	Alert	X		X	X	Bad contact in the sensor connection or open sensor	Check to see if the electrical connection of the sensor is according to the electrical diagram.
Prot - Damaged evaporator water outlet sensor	PTS2	Evaporator outlet temperature sensor	Alert	X		X	X	Bad contact in the sensor connection or open sensor	Check to see if the electrical connection of the sensor is according to the electrical diagram.
High/low evaporating temperature outside the Zone 1...10 of the envelope	C1	Compressor (Only available in version with inverter compressor)	Alert	X		X	X	Compressor operating outside ideal envelope conditions	Call a refrigeration technician to check the operation of the cooling system.
High/low condensation temperature outside the Zone 1...10 of the envelope									
Envelope outside of Zone 1...4									

Envelope outside Critical Zone 5...10			Turns off the cooling system		X	X	X	Compressor operating outside the critical zone envelope	
High delta T	PTS1 and PTS3	Inlet and outlet water temperature sensor	Alert	X		X	X	Difference between inlet (PTS1) and outlet (PTS3) temperature is greater than specified in parameter	Check if the parameter is adjusted according to the setup Check whether sensors PTS1 and PTS2 are correctly positioned in the equipment and performing a correct temperature reading

Critical high delta T			Turns off the cooling system		X	X	X	Difference between inlet (PTS1) and outlet (PTS3) temperature is greater than specified in parameter	Check if the parameter is adjusted according to the setup Check whether sensors PTS1 and PTS2 are correctly positioned in the equipment and performing a correct temperature reading

6.3. Preventive Maintenance

The correct Preventive Maintenance of the equipment may avoid future breakdowns and shutdowns of the equipment. For this, we recommend the procedures described below.

Preventive Maintenance – General			
Item	**Frequency**	**Procedure**	**Notes**
Painting Structure	Monthly	Check the general condition of the cabinet painting and retouch if necessary	Cabinet color specifications: olive green color: RAL 6003
Insulation of the pipe	Every six months	Check the insulation conditions of the pipes and replace damaged insulations	Damaged insulations or insulations with excess moisture should be replaced.
Vibration	Every six months	Check for excess vibration in the equipment. Place your hand on the body of the compressor and visually check the pipe; this procedure is necessary to obtain a reference standard in relation to the normal vibration of the equipment	Check for possible cracks on welded points.
Fixation of components	Every six months	Check the engine fittings: fan and compressor	Retighten loose bolts.
Air filter (side closing screens)	Monthly	Clean the side closing screens	It is recommended to increase the cleaning frequency in environments with high rate of suspended particles.

		Check the condition of the closing screen	Replace if damaged.
Water filter	Monthly	Remove the filter element, wash and reinstall	It should not be mounted with missing discs.
Equipment door	Monthly	Open and close the door	The door should be aligned and closed without difficulty.
Equipment door locks	Monthly	Close the door, lock it and then unlock it	There should be no interference between the latch and the door. The door should be pressed against the rubber seal and not allow gaps.
Alignment and closing of the set of plates	Monthly	Check the alignment of the closing plates of the cabinet	They should be aligned and must not have any fixation bolts.
Insulation of the electrical panel	Monthly	Check the fastening of the seal and possible damages to the seal of the panel.	Carry out the replacement of the electrical panel seal.
Water leak	Monthly	Check the hydraulic piping/connections for water leakage (or signs of leakage)	Retighten the connections.
Process water condition	Monthly	Check the appearance of the process water	It must be translucent and without solid particles.
			If not, take a sample and send it for analysis (see annex on Water Quality).

Preventive Maintenance - Mechanical			
Item	**Frequency**	**Procedure**	**Notes**
Fan	Monthly	Check for excess vibration in the fan	Retighten the bolts
		Check cleaning of the fan	Clean the fan
Evaporator	Every six months	Check to see if it is necessary to clean the evaporator fins.	Clean the blades of the condensers with compressed air at low pressure (be careful not to bend the exchanger fins)
		Check for signs of encrustation on the fins of the heat exchanger	In case of signs of encrustation, call for technical support to assess and eventually carry out technical cleaning of the exchanger.
Compressor	Monthly	Check the oil level in compressors with oil display	With the compressor switched off, the oil level should at least be 1/4 and at most 3/4 of the display
Condenser	Monthly	Clean the fins of the condenser with the use of a WAP (be careful not to dent the fins of the condenser)	It is recommended to increase the cleaning frequency in environments with high rate of suspended particles.
		Check the room air temperature	The ambient temperature must not exceed 45°C
Refrigeration piping	Monthly	After 2 minutes of operation, check to see if the liquid display indicates the dark color and no bubbles	If the display indicates a light color, there is moisture in the system. If it shows bubbles, there is refrigerant leak

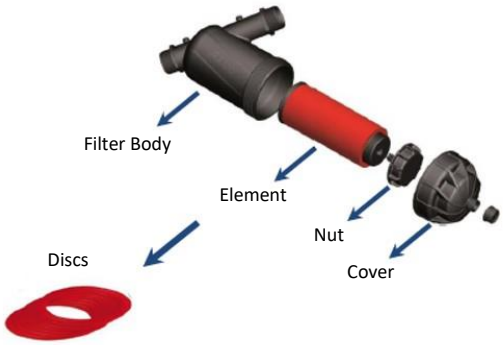
		Check for signs of oil leak in the pipe	The fluid leak should be corrected as soon as possible. Complete the refrigerant gas and oil load of the compressor, if necessary

Preventive Maintenance – Electrical			
Item	**Frequency**	**Procedure**	**Notes**
Electrical Panel	Every six months	Check for any loose components of the electrical panel	Retighten the terminals or bolts
		Measure the fan currents and compare them to the current specified in the equipment checklist	Motor operation should be checked when currents are above specified
Engine switch box	Every six months	Check to see if the junction box terminals of the engines are coming loose	Retighten the terminals or bolts
Temperature sensors	Monthly	Check the calibration of the temperature sensors	Compare the outlet and return air temperatures with a calibrated standard thermometer
Clean the electrical panel	Every six months	Clean inside the electrical panel	The electrical panel should be clean, without dust and fillings
Terminal strips	Every six months	Check to see if all the electric cables are connected to their respective terminals	There should be no loose wires or "jumpers" inside the electrical panel
Fan	Monthly	Measure the current of phases R, S and T	Compare the currents indicated in the electrical data of the equipment
		Check the voltage variation between phases	It should not exceed 10%.
Compressor	Monthly	Measure the current of phases R, S and T	Compare the currents indicated in the electrical data of the equipment
		Check the voltage variation between phases	It should not exceed 10%.

6.2.1. Cleaning procedure of the water filter, air filter and microchannel condenser

6.2.1.1. Water filter

The water filter of the VLC consists of four main components, as described in the image below:



Carry out the following steps in order to clean the filter:

i. Switch off the VLC and close the stop valves;

ii. Remove the cover of the filter in order to have access to the filter element;

iii. Slacken the bolt that keeps the discs attached to the body of the element;

iv. Wash the discs with running water preferably with a high pressure washer;

v. Retighten the bolt, mount and reposition again the filter element on the filter body ensuring that no disc is missing.

	INFORMATION	Leave a small gap between the discs when retightening the bolt of the filter element. Excess torque applied the torque will leave the filter element rigid and will compromise the filtration process.

	ATTENTION	Never put the VLC into operation without water filter. This practice will leave the evaporator vulnerable to clogging, which can cause the water inside the evaporator to freeze, resulting in the rupture of the plates, causing severe damage to the equipment and loss of warranty.

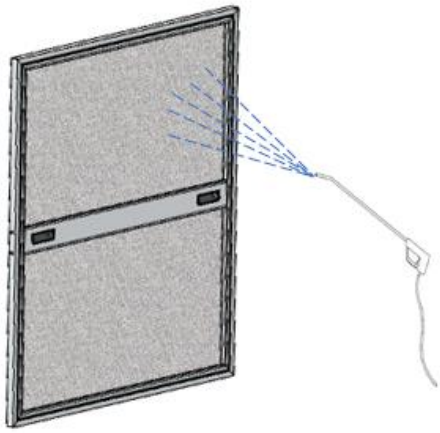
	ATTENTION	The use of the filter without the filter element or with a reduced number of discs compromises the efficiency of the equipment filtration and may result in the suspension of the warranty.

6.2.1.2. Air filter (Optional Item)

The optional air filters consist of a screen mounted on an aluminum frame and have the function of retaining solid particles coming from the installation environment (dust, insects, leaves, debris), preserving the microchannel condenser of the equipment. The periodic wash of the air filter is essential for the good performance of the equipment.

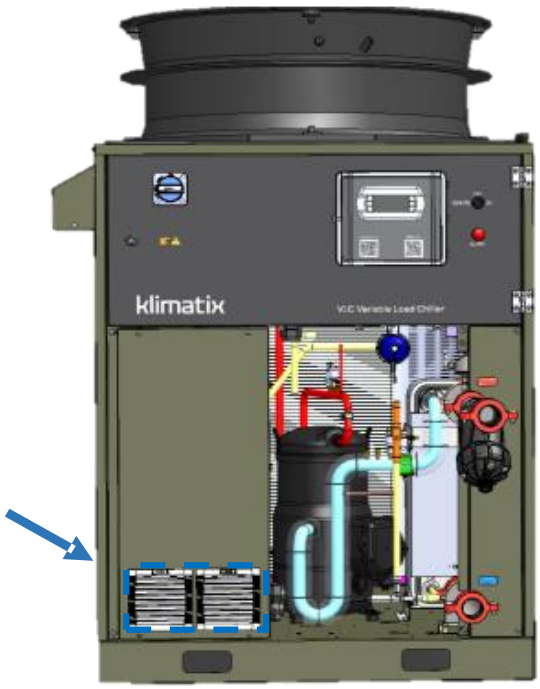
We recommend using a high-pressure washer for cleaning the filters.

The washing of the air filter should be carried out every 30 days, but in case the installation site is very dirty, it is recommended to increase the cleaning frequency.



6.2.1.3. Cleaning of the inverter filter

For VLC models equipped with the inverter compressor, there is a frame inside the cabinet for protection of the frequency inverter. To ensure proper operation and preserve the integrity of the inverter, it is necessary to ensure that there is good ventilation for the inverter. The inverter panel has air filters to prevent dirt from entering the panel and the inverter itself. We recommend that the filter elements of the air filters be cleaned monthly, or more often depending on where the VLC is installed.

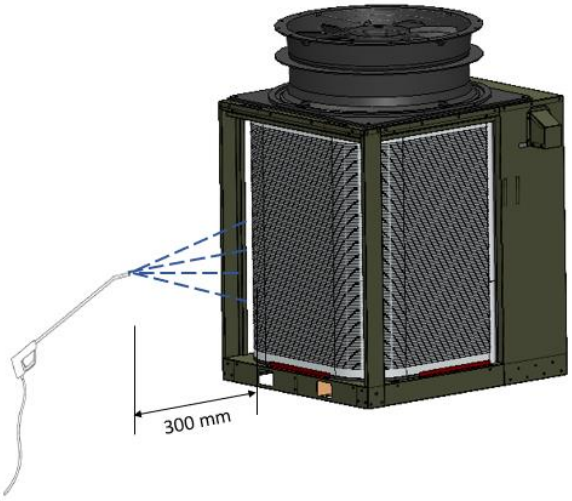


6.2.1.4. Microchannel condenser

It is extremely important for the cleaning of the microchannel condenser to be carried out periodically. This process, in addition to extending the life of the condenser, prevents equipment breakdowns from occurring due to obstructions caused by dirt, filings and dust.

The following precautions should be taken when cleaning the condenser:

i. Remove the air filters from the sides of the equipment structure (if the VLC has been supplied with this option);
ii. Use a high pressure washer with spray nozzle to wash the condensers with clean water;
iii. The jet of water from the spray nozzle should be in the form of a fan and directed perpendicular to the surface of the condenser to prevent the fins from being dented.
iv. The jet of water cannot be applied on a direct point of the surface of the condenser;
v. Keep a distance of 300mm between the spray nozzle and the surface of the condenser.



7. Technical Services

In addition to quality products, Mecalor offers its customers personalized services through a specialized team, aligned with the technological innovations of the market and prepared to offer solutions suitable to the need of the customer.

7.1. Start-up

Despite being a very simple procedure, it is important for the customer to contact Mecalor in order for the installation conditions to be checked and for the start-up to be authorized.

7.2. Preventive Maintenance Agreements

With aim to prevent failures, Mecalor offers customized preventive maintenance agreements. The agreements consist of the periodic visits of technicians who check, gauge and test the condition and performance of the equipments.

The Mecalor Preventive Maintenance Plan ensures the correct operation of your equipment and reduces the possibility of shutdowns due to failure.

7.3. Retrofitting (Reform of Equipments)

In many cases an equipment with outdated technology may be technologically updated through the application of modern techniques developed by Mecalor. Mecalor Retrofitting Service consists of:

- Study of the current conditions of the equipment, evaluating whether retrofitting is worthwhile;
- Study of the adaptability of the equipment to the new technology;
- Execution of the scope;
- Try-out;
- Project Documentation.

7.4. Training

Mecalor conducts specific training to meet the most diverse preparation needs of the maintenance and operation teams. The trainings are provided according to necessity.

8. Disposal and the environment

The VLC should be disposed at the end of its service life so as to reduce any negative impact on the environment. The following are recommended for such:

• Dismount the equipment according to all the safety recommendations applicable in the execution of the maintenance services;

• Reuse its components by applying it in other machines or in the production process, such as: reuse of the centrifugal pump, its electric motor, etc.;

• Separate materials that can be recycled and send them for recycling; for example: recycle carbon steel steel, bronze, plastics, etc.;

• Separate non-reusable materials and components and dispose of them, observing the effective legal recommendations. Special attention should be given to batteries, lubricant oil and refrigerant.

In case there is leakage of the compressor oil of the PS, on any surface, immediate containment should be provided, pouring sawdust over the oil and then, after absorption, collect the sawdust and carry out complete cleaning of the affected area. This waste should be stored in an exclusive container for proper disposal afterwards.

During the replacement of the lubricant oil in the VLC, the container and remaining excess oil should be stored in a suitable place to subsequently be sent to recycling.

In case refrigerant leakage is detected in the equipment, maintenance should be requested urgently.

Any mechanical or electric component that is replaced due to failure or upgrade should be disposed according to the recommendations and effective rules.

9. Warranty Term

1. OBJECT AND VALIDITY

1.1. The warranty includes repair and/or replacement of any faulty component, as long as it is due to fabrication defect..

1.2. The validity of the warranty of the equipments manufactured by Mecalor is 365 days counted from the date of issuance of the sales invoice of the product, of which there are 90 consecutive days of legal warranty and 275 consecutive days of complementary warranty, the latter provided by Mecalor as an additional benefit to the customer.

1.3. In case the equipment is purchased with extended warranty, this should be recorded in the official business proposal issued by Mecalor and it exclusively consists of the increase of the complementary warranty, being that the legal warranty will always be 90 consecutive days.

1.4. This warranty term is valid only for products sold and used in Brazil.

2. WARRANTY VALIDATION

2.1. The customer should inform Mecalor technical support in writing immediately after identification of the possible manufacturing defect.

2.2. Once the information of the possible defect is received, the technical support team of Mecalor should evaluate the possible causes and issue a technical opinion.

2.3. In case the manufacturing defect is confirmed, Mecalor must provide the replacement or repair of the defective component within the shortest period of time possible.

2.4. The Warranty period offered by Mecalor covers the costs for repair and replacement of parts with manufacturing defect, including expenses with the transport of technicians and tools, equipment freight or expenses with shipping of parts and components to the billing address of the equipment.

2.5. It is mandatory for the customer to return the defective components to Mecalor to confirm the failure at the supplier (if applicable), under the penalty of bearing the costs involved.

2.6. The warranty establishes the execution of services during business hours, with additional charge for extra hours of services provided outside this period and transport fee for services performed on the installations of third parties.

3. LOSS OF WARRANTY

3.1. The warranty will lose its validity in case it is confirmed through technical evaluation that the defect is as a result of failures during transport, installation, startup, maintenance or improper use by the customer or third parties.

3.2. Start-up of the equipment can only be performed by the customer with the written authorization form the technical support of Mecalor or with the presence of our authorized technicians, when this optional service is part of the Mecalor scope of supply, under the penalty of loss of warranty.

3.3. Incompatibility caused by products purchased from third parties and installed with Mecalor products or application in noncompliance with the information established in our technical and business proposal.

3.4. The warranty will lose its validity if the contracting party fails to comply with purchase and sales agreement, even if the agreement is tacit, including regarding the compliance of the equipment purchased.

4. GENERAL EXCLUSIONS AND LIMITATIONS

4.1. Once Mecalor provides technical support in warranty within the limits established by law and by the good service practices, we shall not be held responsible for direct or indirect costs or loss of revenue eventually supported by the customer as a result of eventual equipment defect.

4.2. The customer will be responsible for the expenses with eventual shipping of the equipment to the factory or to any authorized technical representative of Mecalor to carry out technical support.

4.3. The replacement of components due to use or natural wear of the equipment, such as seals, sensors, engines, contactors, circuit breakers, among others.

4.4. Normal operating adjustments, maintenance and application of the equipment, such as sending of technicians to check the safety alarms, parameterization and technical assistance to optimize the performance of the product.

Customer	Serial number	Warranty period

10. Attachments

The documents that complement this manual are described below and may be different from standardized documents. In case the nomenclature of the MCA has a special character, consult the specific documentation applied to the equipment.

	**INFORMATION**	Consult the special documents in case the nomenclature of the MCA has a special character as described in the *nomenclature* section in the *technical characteristics* chapter of this manual..

Complementary documents of this manual:

- Dimensional;
- Wiring diagram;
- Flowchart;
- List of Components;
- Water quality;
- Setup;
- Electrical Data Table.