Liebert® PEX4™ Series

Precision Air Conditioning

User Manual

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Purpose of the Document

This document applies to the series of precision air conditioners and cooling solutions which maintain optimal environmental control of technological ecosystems at minimal operating costs. This document gives an overview of the specifications, installation, commissioning, and maintenance procedures with troubleshooting from the user perspective. The figures used in this document are for reference only.

Please read this manual carefully before installing, maintaining, and troubleshooting.

Liebert PEX4 Air-cooled precision CRAC is a professional device, only professionals are permitted to access the unit and is kept in a place where access is restricted to common people.

Styling used in this Guide

The styles used in the manual will be defined as mentioned in the following table:

Situation	Description
Warning/Danger/Caution 	• *The Warning/Danger/Caution note indicates a hazardous or potentially harmful situation that can result in death or injury. It also indicates instructions that need to be adhered to, failing which may result in danger and safety issues thereby having an adverse effect on the reliability of the device and security. Even for practices not related to physical injury, to avoid equipment damage, performance degradation, or interruption in service, follow the warning instruction, carefully.*
Note 	• *The Note section indicates additional and useful information. It also calls attention to best practices and industry-best protocols that are standardized and help make maximum utilization of the resources at hand. Helpful information related to the product also comes under the Note heading, helping the users with the definitions, concepts, and terminologies used in the manual.*

Version History

Version	Revision Date	Issue	Changes
1.0	08.04.2019		---

Safety Precautions and Measures

The important safety precautions and measures that should be followed during the installation and maintenance are described in the following sections.

Read the manual prior to installation and operation of the unit. Only qualified personnel should move, install, or service this equipment.

Before working on the equipment, the user reads and considers all precautions, compliance and safety measures. The unit control must be used exclusively for the purpose which it is intended for; the manufacturer takes no liability for incorrect use or a modification to the unit control.

Adhere to all the Warnings and Cautionary measures included in the manual.

Please read this manual carefully before installing, maintaining and troubleshooting; especially the Warning/Danger/Caution information in the User Guide. Apart from the User Guide, also pay attention to the warning labels on the unit and its components.

This manual is retained for the entire service life of the unit. The user must read all the precautions, danger, warnings, and cautionary measures mentioned in the manual prior to carrying out any operations on the unit. Each unit is equipped with an electric insulation which allows the users to work in safe conditions. The main switch is positioned on the electrical panel cover; to access it, open the right door. Before any maintenance operation, switch off the unit with this electrical insulation device to eliminate risks such as electrical shocks, burns, automatic restarting, moving parts, and remote control. The panel key, supplied along with the unit, must be kept by the personnel responsible for the maintenance. The protective covers can be removed after the electric power has been cut off by opening the main switch.

In the following sections, notice the various cautionary measures and warnings that need to be read carefully prior to installing or operating the system.

Disconnect the local and remote power supplies prior to working with the unit.

Prior to the installation process, read all the instructions, verify if all the parts are in place, and check the nameplate to ensure the voltage matches the available utility power for the unit.

The controller doesn't isolate power from the unit even in the Off mode, and some internal components still require and receive power during the Off mode.

If the unit door is open while the fans are operating, the airflow may result in abrupt slamming of the door resulting in injury. Another aspect is the presence of small objects in the fans bay that can result in object ejection during the fan start-up and there is a probable risk of being hit by these objects resulting in grievous injury and causing equipment damage.

The unit contains fluids and gases under high pressure. Therefore, the pressure should be relieved before working with the piping.

Various components such as compressors, refrigerant discharge lines, and humidifiers are extremely hot during the unit operation. Therefore, allow sufficient time for the unit to cool down before working with the unit cabinet. Handle the unit with extreme caution and wear safety equipment such as protective gloves, safety shoes, and arm protection while working with the hot compressors, discharge lines, and reheats.

There is a risk of water leaking that can damage both the equipment and the building. Effective water drain connection and facilities should be available. Installation should be precise. Implementation of the application and service practices should be appropriate and fault-free. Failure to comply with these norms will result in water leakage from the unit. Water leakage can lead to massive damage and loss of critical equipment in the hosting ecosystem. Therefore, care should be taken to ensure that the unit is not located directly above any equipment that could sustain damage due to water and excessive moisture. Use of a leak detection system for the unit and system supply lines are recommended by Vertiv Co.

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Chapter 1: Product Overview

1.1. Product Introduction

Liebert PEX4 series air conditioning is a medium and large-scale precision environmental control system, with high reliability, high sensible heat ratio and with high energy efficiency ratio, suitable for equipment room or computer room environment. It is designed to ensure a reasonable operating environment for critical system such as sensitive equipment, industrial process equipment, communications equipment and servers.

Liebert PEX4 series air conditioning includes 10 models of cooling unit (35 kW, 45 kW, 50 kW, 60 kW, 70 kW, 80 kW, 90 kW, 100 kW 110 kW, 120 kW). These models are available in both upflow and downflow configurations which are further differentiated as small cooling capacity (35 kW, 45 kW, 50 kW, 60 kW) with variable frequency drive single compressor and large cooling capacity units (70 kW, 80 kW, 90 kW, 100 kW, 110 kW, 120 kW) with two variable frequency compressors. To improve further efficiency of the configuration, EC fan and Electronic Expansion Valve (EEV) are the standard options. PEX4 also uses micro-channel evaporator, standard distribution air supply temperature sensor, but heating and humidification are optional. The optional humidifier (infrared or electrode) is available according to different requirements.

The PEX4 unit is compatible to both flat and 'V' type outdoor unit. Outdoor unit has pressure regulating fan speed to meet the system cooling demand. It improves the operational reliability of the system and also results in minimal noise pollution. In case of high-temperature applications, PEX4 can also be available with an optional LVC condenser spray device to meet the cooling requirements of the data center or equipment room or similar ecosystem.

1.2. Model Description

This chapter introduces models, appearance, components, optional configuration and refrigerant requirements of PEX4. The Liebert PEX4 series precision air conditioner (“PEX4” for short hereafter) is professional equipment, which is a medium-large size precision environment control system, suitable for the equipment room or computer room, featuring high reliability, high sensible heat ratio and large air flow. Liebert PEX4 model appearance is shown in Figure 1-1.

Upflow Model

Downflow Model

Figure 1-1 Liebert PEX4 Models

1.3. Model Nomenclature

Table 1-1 Liebert PEX4 Model Nomenclature

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
P	1	0	6	0	D	A	1	3	8	0	9	0	2	E	1	D	0	0	N	C	E	0	4	0

Digit 1,2 Product Model		**Digit 18 Installation Option**	
P	***PEX4***	***L***	***Air-Cooled, Long pipe> 30 m***
Digit 3 Net Cooling Capacity kW		C	Low Temp Kit
0-9	***Nominal Net Cooling Capacity - kW***	B	Low Temp Kit+Long Piping
Digit 4 Net Cooling Capacity kW		**Digit 19 Monitoring**	
0-9	***Nominal Net Cooling Capacity - kW***	***0***	***RS485***
Digit 5 Net Cooling Capacity kW		S	SIC Card
0-9	***Nominal Net Cooling Capacity - kW***	**Digit 20 Sensor**	
Digit 6 Air Discharge		***N***	***Supply Air Temp Sensor***
U	***Upflow***	A	Supply Air Pressure Sensor
D	***Downflow***	F	Smoke & High Temp Sensor
Digit 7 System Type		H	High Temp Sensor
A	***Air Cooled***	S	Smoke Sensor
Digit 8 Airflow		1	Supply Air Pressure & Smoke
1	***EC Plug Fan – Standard Static***	2	Supply Air Pressure & High Temp
Digit 9 Power Supply		3	Supply Air Pressure & Smoke & High Temp
3	***380 V to 415 V, 3 Ph+N~50 Hz/ 60 Hz***	4	Supply Air Temp & Smoke Sensor
Digit 10 Cooling System		5	High Temp & Supply Air Temp Sensor
8	***R-410a EC Scroll Compressor, Single Circuit***	6	Supply Air Sensor & Supply Air Temp Sensor
9	***R-410a EC Scroll Compressor, Dual Circuit***	7	High Temp & Supply Air Temp Sensor & Smoke Sensor
Digit 11 Humidification		8	Supply Air Sensor & Supply Air Temp & Smoke Sensor
0	***None***	9	Supply Air Pressure & High Temp & Supply Air Temp Sensor
H	Infrared Humidification	B	Supply Air Pressure & Smoke & High Temp & Supply Air Temp Sensor
S	Electrode Humidification		
Digit 12 Display		**Digit 21 Packaging**	
9	***9-Inch HMI***	P	Packaging – Standard Cardboard And Wooden Pallet
Digit 13 Re-Heating		***C***	***Packaging – Wooden Crate Export***
0	***None***	**Digit 22 Special Requirements**	
1	Electrical Heating Std. 1 Stage	A	SFA – None
2	Electrical Heating Opt. 2 Stage	***E***	***For Export***
Digit 14 Filtration		**Digit 23 Order Identifier**	
2	***G4 (EU4)***	***0***	***Standard ESP***
3	F5 (EU5)	1	High ESP 50 Pa
Digit 15 Coil and Valves		2	High ESP 100 Pa
E	***Standard DX Air Cooled Coil, EEV***	3	High ESP 150 Pa
Digit 16 Enclosure Options		4	High ESP 200 Pa
1	***Standard color black orange peel grain coating, ZP7021***	**Digit 24 Order Identifier**	
Digit 17 Main Switch High Voltage Option		***1-9***	***Factory Code***
D	***Main Non-Locking Disconnect***	**Digit 25 Order Identifier**	
A	Dual power automatic Switching (interlock contactor)	***0-9***	***Factory Code***

The standard components are represented in ***'Bold Italic'*** font in Table 1-1.

1.4. Components of PEX4 Model

1.4.1. Cabinet

The cabinet frame is constructed of 2.5 mm, 2.0 mm, and 1.2 mm folded galvanized steel. The exterior panels are constructed of 1.2 mm zinc coated sheet steel and insulated with foam insulation. The cabinet is powder coated in Charcoal Grey color and have a textured finish. The hinged front doors can be removed and include the captive 1/4 turn fasteners. PEX4 cabinet is divided into two sections- power module and cooling module. Power module is comprising of compressor (s) and control section.

1.4.2. Air Filter

The filter panels can be removed from the front of the unit. Filtration is provided by V/ A form and the dry disposable media housed in a metal frame. The rated efficiency is in accordance with EU4/ MERV8 standards. The unit is fitted with a Filter Differential Pressure Switch, which is connected to the microprocessor controller to provide 'Filter Clogged' warning indication.

1.4.3. EC Fans

The unit is fitted with one/ two direct-driven, high efficiency, single inlet, backward curved, centrifugal 'plug' type fan (s), with aluminum nozzle (s) and PP Plastic impeller (s). The fan motors are Electronically Commutated (EC), IP54, with internal protection and speed regulation via controller signal. The fans is statically and dynamically balanced. For down-flow applications, the EC fan is mounted within the raised floor for higher energy efficiency. A minimum raised floor height of 450 mm is required.

1.4.4. Inverter Scroll Compressor

PEX4 indoor unit is equipped with one/two (depending on capacity - >60 kW– two) scroll compressor driven by inverter. It has a wide speed range of 1000 RPM to 7200 RPM to help part load efficiency. The compressor is charged with lubricating oil, designed for operating with green refrigerant i.e. R410a. Each compressor has an internal motor protection and is mounted on vibration isolators. Wide range of 30% to 120% of rated capacity is attained by the system.

PEX4 uses scroll compressor with inverter drive arrangement can adjust the speed according to the change of refrigeration demand automatically, which greatly improves the overall energy efficiency of the system. Inverter system has a drive arrangement, which is compact in size with built-in DC reactor, that supports large torque under low speed with small torque ripple and speed control accuracy of ± 0.5%. It has high thermal reliability, long service life and CE certification.

Figure 1-2 Scroll Compressor

1.4.5. Oil Return Arrangement

The unit's intelligent oil return logic allows the proper return of oil to the compressor during the part load period. When the oil return adjustment is required, to maintain the running time of return oil, the compressor sets the return oil running speed.

1.4.6. EMI Filter

The PEX4 unit comes with a built-in Electromagnetic Interference (EMI) filter to suppress the interference which is generated by inverter drive system. EMI-filter conforms with class B standard and IEC No: EN55014-1.

1.4.7. Refrigeration Circuit

The refrigeration system is of the direct expansion type and includes one or two hermetic scroll compressors (with inverter drive arrangement), equipped with crankcase heaters and rota-lock connections. The system includes an auto reset high pressure control and low pressure control; also has EEV, high sensitivity refrigerant sight glass, large capacity filter dryer with rota-lock connections and charging/access ports in each circuit. Each circuit only connects to one compressor.

- *Do not use inferior quality refrigerant.*
- *For any consequences resulting from inferior quality refrigerant, Vertiv does not assume warranty responsibility.*

1.4.8. Electronic Expansion Valve (EEV)

Each circuit has two EEVs for better refrigerant distribution with a common drive to control both valves. The EEV is designed to collect temperature and pressure signals simultaneously to accurately modulate the refrigerant mass flow and to precisely regulate the flow of refrigerant. EEV has a wide operating envelope, also reduces the condensing pressure, thereby resulting in substantial energy savings. EEV also helps in maintaining constant superheat.

Figure 1-3 Electronic Expansion Valve

1.4.9. Evaporator Coil

In PEX4 series parallel flow tube evaporator is adopted, as shown in Figure 1-4. It uses aluminum material that reduces the weight of the evaporator and also reduces the copper consumption. At the same time, the design of the micro-channel greatly reduces the refrigerant charge amount and enhances heat transfer, optimizes the air bypass. Each cooling module consists of two separate evaporators, 'V' pattern for upflow unit and 'A' pattern for downflow unit.

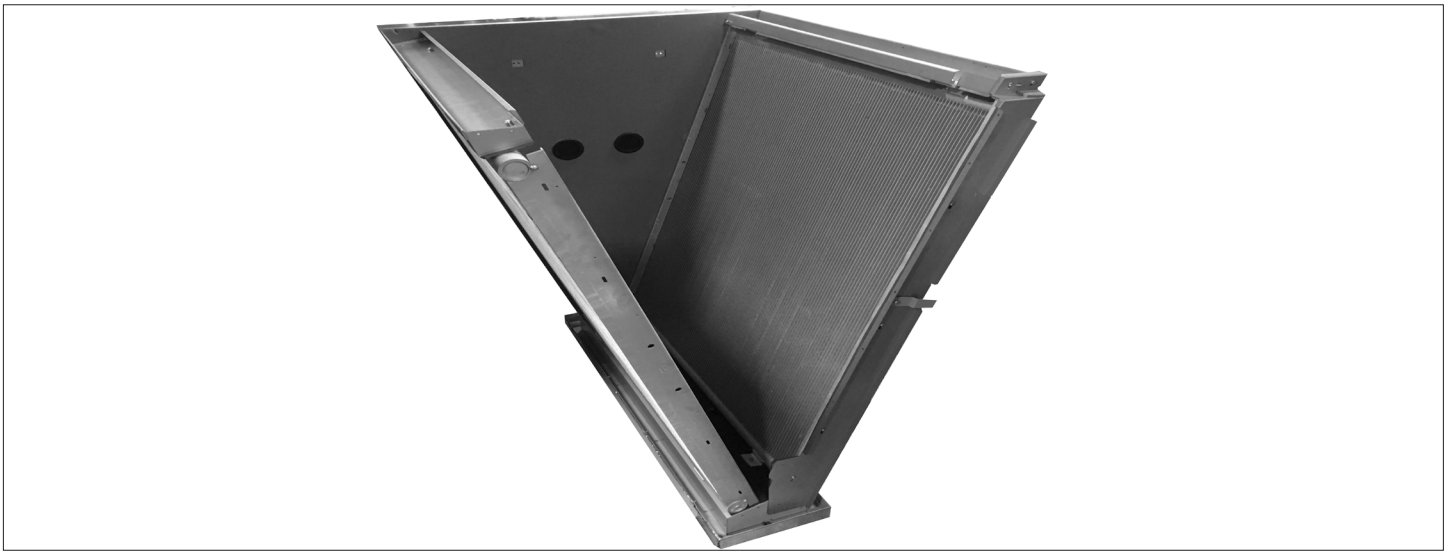


Figure 1-4 Evaporator Coil

1.4.10. Dehumidification- EC Fan

For dehumidification, the Compressor operates a specific cycle which uses an Electronic Expansion Valve (EEV) control logic called T_e . This EEV control logic adjusts EEV opening (normally closed) to reduce the surface temperature of the coil below the return dew point condition.

1.4.11. Remote Air-Cooled Condenser

Refer to “LSF/LDF condenser User Manual” and “LVC Series Condenser User Manual.”

1.4.12. Water-Under-Floor Sensor

Each unit is supplied with single water under floor point detector as standard. The alarm is triggered when the ‘water-under-floor sensor alerts the controller upon detection of water.

1.4.13. Controller

The Controller provides a simple operational user-interface and it is developed by using the latest and highly advanced PID regulation technology. The controller features self-recovery power failure and protection against high/low voltage. An accurate running status of the major components can be viewed through the menu operation. It uses RS485 to configure Modbus protocol or SIC card (optional) to configure SNMP protocol.

1.4.14. Color Display and HMI Features

PEX4 is equipped with 9-inch color display, which enables monitoring of operating status of the precision AC through menu-driven operations. It features auto restart function with high and low voltage protection, phase loss protection, and phase reversal protection. It can display up to 500 historical alarms.

It also has HMI features such as Temperature control– Proportional, PI, PID, Position Increment; different scenario for Room cooling or Optimizing aisle cooling. The cooling capacity is controlled via sensors such as return air temperature/ supply air temperature/ remote rack temperature sensors, etc. The Inverter compressor capacity helps in modulation for variable speed. The HMI also facilitates Supply and Return Air control, Heating control, EEV control, EC fan control, Humidification control, and Static Air Pressure control.

1.4.15. Monitoring

Liebert PEX4 inverter air conditioner series is capable of connecting to the Building Management System/ Building Automation System using the following protocols:

- Modbus RTU – Modbus Remote Terminal Unit (RTU) communication protocol over a RS-485 serial network (also known as Modbus RTU RS-485)
- SNMP (need to choose SIC card which is an optional component)

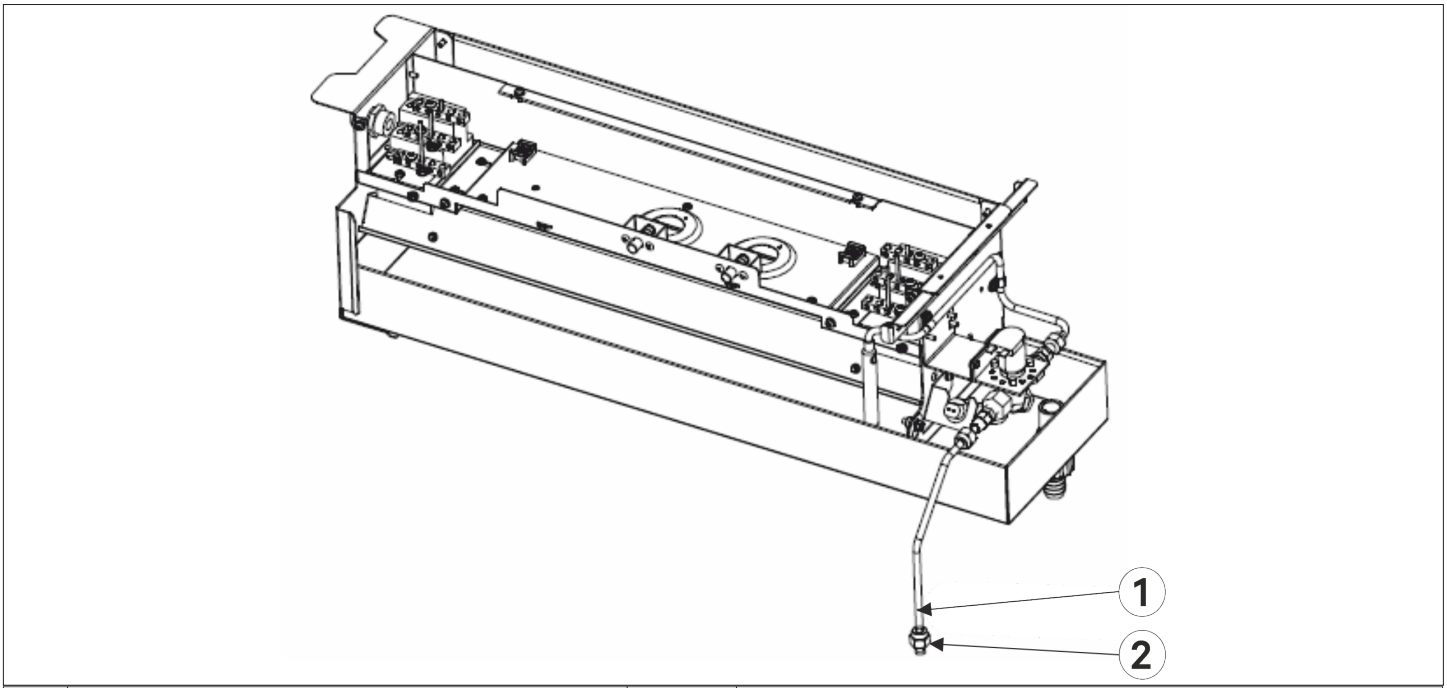
1.5. Additional Features

1.5.1. Humidifier

There are two options- Infrared humidifier and Electrode humidifier

- **Infrared Humidifier**

The infrared humidifier (shown in Figure 1-5) consists of infrared humidifier lamp, water injection valve, humidifying water dish, temperature alarm protection devices and water level alarm device. The infrared humidifier in the Liebert PEX4 series provides quicker and more responsive operation which is quite important for mission-critical applications. These humidifiers reduce the dependency of water quality.



No.	Description	No.	Description
1	Inlet pipe	2	Outlet joint

Figure 1-5 Infrared Humidifier

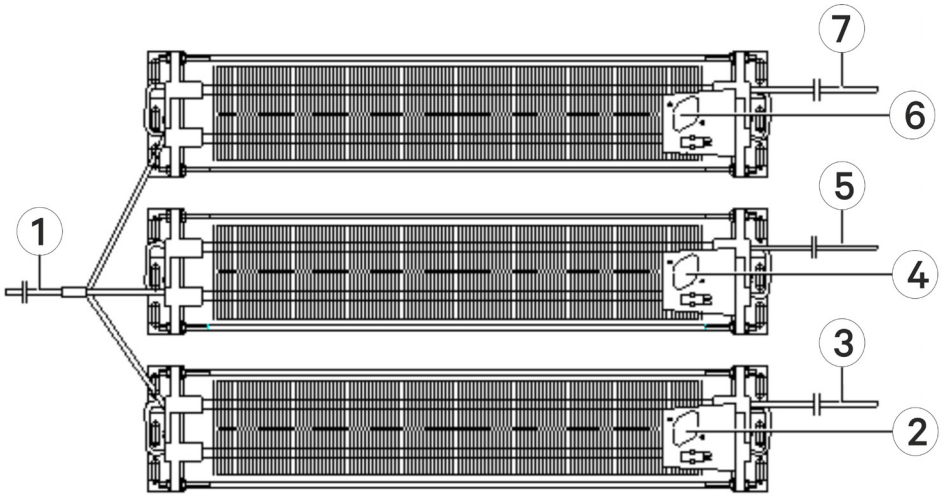
- **Electrode Humidifier**

The electrode humidifier uses the electrodes to boil the water in humidifier bottle to produce steam for humidifying purpose. It has different requirement for water quality and sizes of inlet/ outlet pipes with respect to standard. Steam from the cylinder is mixed with the discharge air from the evaporating coil by a copper steam distributor. The humidification rate for 1-bay unit is 5 kg and for 2-bay unit the humidification rate is 8 kg.

Figure 1-6 Electrode Humidifier

1.5.2. Electrical Heating

In the PEX4 models, the PTC (PTC= Positive Temperature Co-efficient) heaters are used and it features with fast temperature rising speed, automatic regulation of air temperature and power consumption. Its calorific value not only maintains Dry Bulb Temperature but also compensates temperature drops due to dehumidification. The lower surface temperature of the heater prevents the air from being ionized, thereby extending the service life. The 1-stage heater capacity is 9 kW for models P1035 to P1060 and 12 kW for rest of the models; for 2-stage, it is 18 kW & 24 kW. The material used for heating is metal. The safety devices, used in the reheater are two automatic reset Overheat Switches and one manual reset Overheat Switch.



No.	Description	No.	Description
1	Zero line (blue)	5	Live line (red)
2	Temperature controller soleplate	6	Temperature controller soleplate
3	Live line (red)	7	Live line (red)
4	Temperature controller soleplate		

Figure 1-7 Electrical Heater

1.5.3. Upflow Plenum

For upflow system, the plenum of the same size can be selected with the unit. All plenums have grills to regulate the airflow and can manually control the grills for different air directions. The material used for Plenum is hot galvanized plate with spraying material.

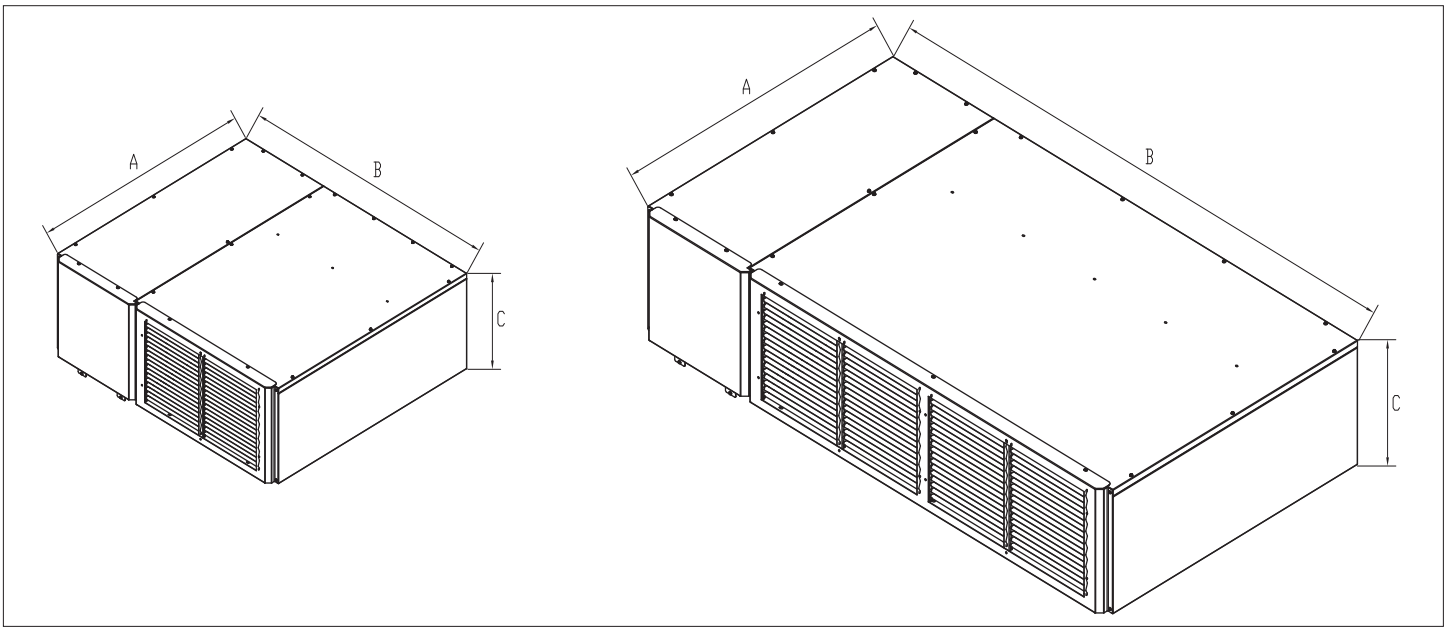


Figure 1-8 Plenum

1.5.4. Long Piping Kit (Air Cooled System)

The long piping kit is mandatory if the field piping equivalent length is more than 30 m. It is used with both check valve and solenoid valve. The long piping kit prevents the refrigerant from returning and concentrating after the compressor is turned off, ensuring the normal start of the compressor and make the system safer.

1.5.5. Smoke Detectors

The smoke detectors immediately shut-down the system and activate the alarm system when activated. The smoke detectors are mounted in the electrical panel with the sensing element in the return-air compartment. The smoke detector is not intended to function as or replace any room smoke-detection system that may be required by local or national codes. The smoke detectors shall include a supervision contact closure.

1.5.6. Fire Detectors

The fire detector can check the field return air temperature. It triggers fire alarm when the smoke level continues to rise along with elevated room temperature, or the temperature is too high and reaches the fire alarm threshold. The primary purpose of the sensor is to examine the air temperature and to initialize the anti-fire measures installed in the facility. Fire detector trips at 125 F±6 F, and when fire alarm occurs the unit will shutdown. Refer Figure 1-9.

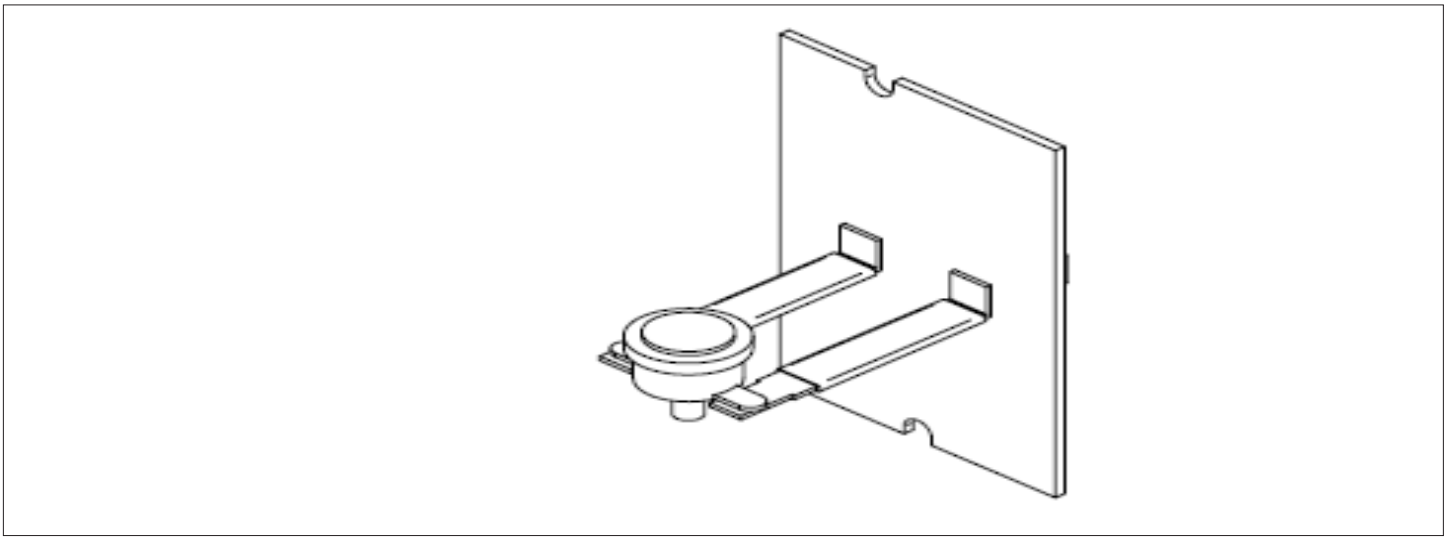


Figure 1-9 Fire Detector

1.5.7. High-Efficiency Filter

The unit is equipped with F5 grade filter for high efficiency output. This type of filter is applicable only to the environments requiring a higher level of air cleanliness.

1.5.8. Low Temperature Kit

In order to ensure that the air conditioner should normally start in the cold regions, a low temperature kit is configured to effectively establish the low pressure, required at the start of the unit to avoid any failure. Low temperature kit is also used when the outdoor unit is being placed more than 5m below from the indoor unit, consult Vertiv representative for more details.

1.6. Operating & Storage Environmental Requirements

1.6.1. Operating Requirements

The PEX4 operating environment meets the requirements of IEC 61000-3-12. The PEX4 storage environment meets the requirements of IEC60721-3-3:2002. Refer Table 1-2 and Table 1-3 for the operating environment and storage environment.

Table 1-2 Operating Environment Requirements

Project	Requirements	
Ambient temperature	Indoor	18 °C to 40 °C
	Outdoor	-15 °C to +45 °C, such as low temperature components, outdoor minimum operating temperature is -34 °C
Protection level (cooling unit)	IP20	
Altitude	< 1000 m, derating is required when location altitude is above 1000 m	
Operating voltage range	380V to 415V, 3 Ph+N~50 Hz/ 60 Hz	

1.6.2. Storage Requirements

Table 1-3 Storage Environment Requirements

Project	Requirements
General requirement	Clean room (no dust, etc.)
Environment humidity	Less than 80% Rh (30 °C)
Ambient temperature	-25 °C to +55 °C
Storage time	Total transportation and storage time should not exceed six months, otherwise the performance of the system needs to be re-calibrated.

Consult Vertiv local representative when operating in the following conditions:

1. *The voltage of the air conditioning unit is beyond the range of the operating voltage.*
2. *The altitude is higher than 1000 m.*
3. *If the operating condition is not as per the Table 1-2.*

Chapter 2: Installation

The Installation process consists of the following procedures, namely-

- Pre-installation
- Installation Preparation
- Mechanical Installation
- Electrical Installation

2.1. Pre-installation

2.1.1. Transportation & Movement

Railway and shipping are the preferred transport options for the CRAC. If transport by rail or by ship is unavailable, transport by road is recommended. When selecting road transport, roads without too many bumps are strongly recommended.

- Liebert PEX4 unit is heavy, it is recommended to use the mechanical equipment like electrical forklift to move the unit.
- Move the equipment to the location near the installation site/ room.
- If an electric forklift is used, insert the tines (forks) of the forklift below the pallet as displayed in Figure 2-1.
- Figure 2-1 shows how the forklift tines (forks) are inserted underneath the pallet and shows in the same picture below the illustration to the right that the lines should be aligned with the center of gravity to prevent the equipment from falling over.

Figure 2-1 Moving an Equipment Using a Forklift Truck

While moving the indoor unit, keep the obliquity within the range of 75° to 105°, as shown in Figure 2-2.

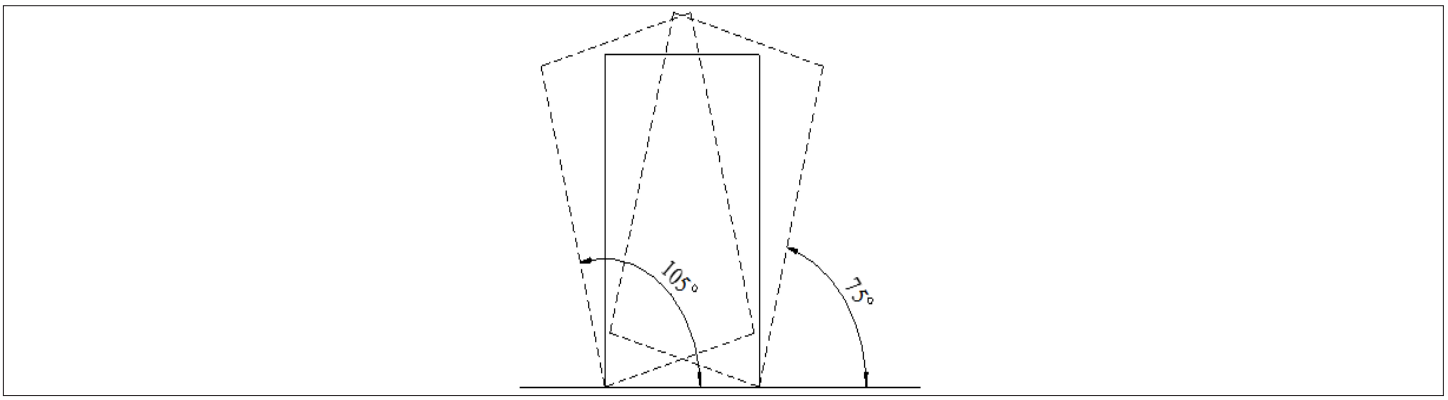


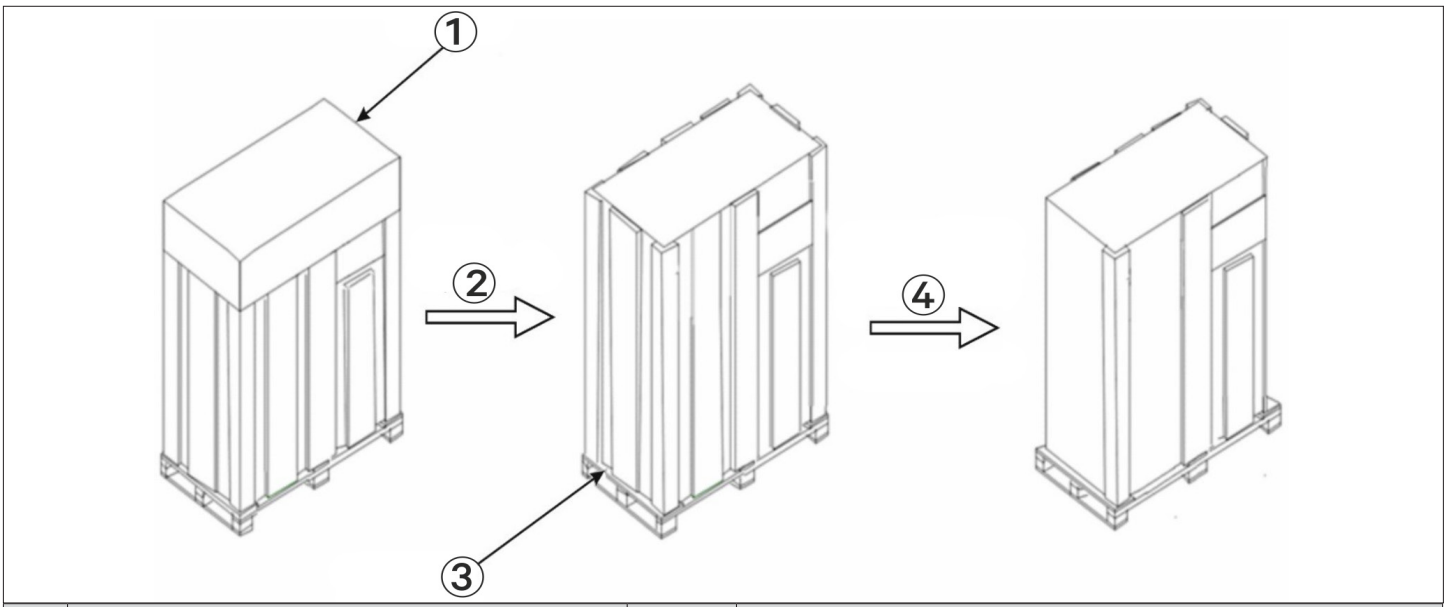
Figure 2-2 Obliquity of the System

2.1.2. Unpacking

Move the equipment to the location near the final installation site and unpack it. Follow the procedures below for unpacking

- **Removal of Paper Packaging**

Remove the packaging tape and carton at first, then remove the top cover followed by dismantling the unit on the sealing plastic, finally, remove the Honey Comb Paper Board. For better understanding see Figure 2-3.



No.	Description	No.	Description
1	Top Cover	3	Honey Comb Paper Board
2	Remove Top Cover	4	Remove sealing plastic film and Honey Comb Paper Board

Figure 2-3 Removal of Honey Comb Paper Board

- **Removal of Wood Packaging**

Use a claw hammer or straight screwdriver to straighten the connection hook that holds the side panels to the top cover, as shown in Figure 2-4.

Figure 2-4 Straightening the Hook

Firstly, straighten all the hooks holding side panel-I and remove side panel-I. Then straighten all the hooks holding side panel-II and remove side panel-II. Finally remove top cover-III, as shown in Figure 2-5.

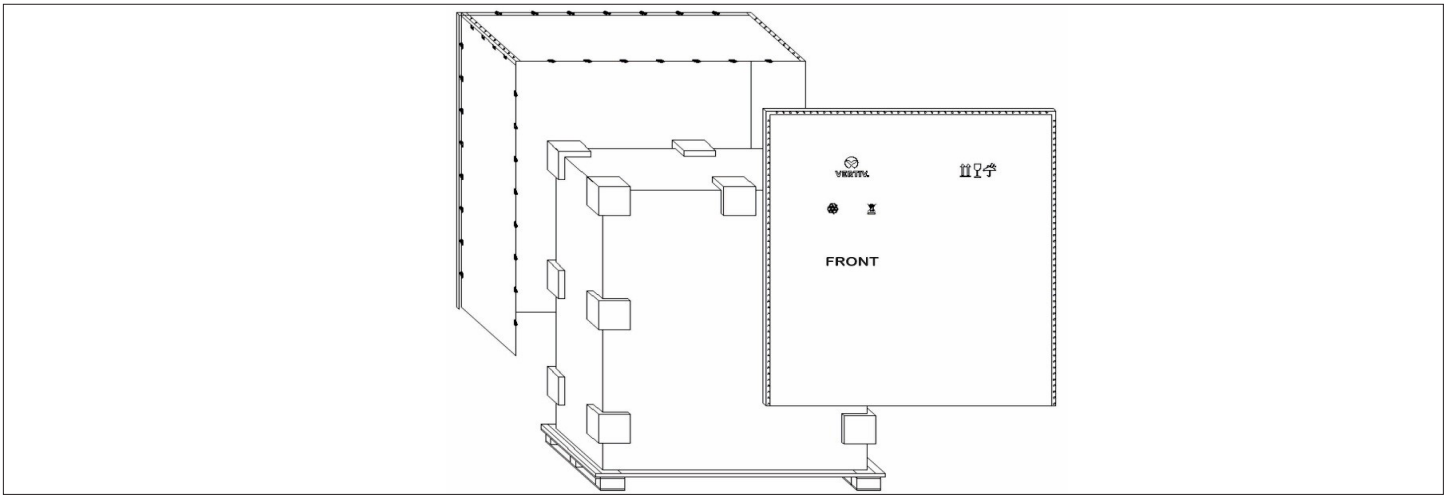
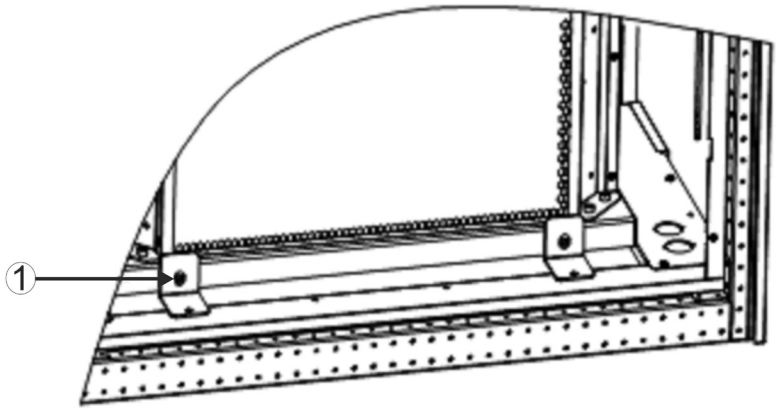


Figure 2-5 Removing Side Panel and Top Cover

- **Remove the Base Pallet**

The unit is fixed onto the base pallet with M8×65 bolts or M8×90 screw, as shown in Figure 2-6. Use a 17 mm open-end spanner, ratchet spanner or sleeve to remove the fixing bolts.



No.	Description
1	Screw (M8x20)

Figure 2-6 Floor Wood Screws Fixed Position

2.1.3. Inspection

Check that the fittings are complete and the components are intact against the packing list. If any parts are missing or damage is found, report immediately to the local office of the carrier and Vertiv local representative.

2.2. Installation Preparation (Site Preparation)

The PEX4 series is streamlined to keep the data centers, computer rooms and similar ecosystems in a favorable environment. Strict adherence with the installation procedures is required to ensure that the air conditioner is properly installed.

2.2.1. Equipment Room Requirements

The equipment room must be prepared before installation to ensure a smooth operating flow and to achieve the expected results. The data center must meets the standards to be properly ventilated and heated. The design specifications for the air conditioners must be ideal and should correspond to energy-efficient design standards.

Following are the requirements to maintain a favorable room environment prior to the installation.

The equipment room should have suitable and effective heat insulation.

- The equipment room should have a sealed and damp-proof layer. Polyethylene film should be used for the damp proof layer of the ceiling and walls. Alternatively, a moisture-proof paint can be used to simulate the same effect akin to Polyethylene. It is important to ensure that the coating on the concrete wall and floor are damp-proof.

- Outdoor air significantly increases the load of heating, cooling, humidification, and dehumidification. Therefore, all the doors and windows must be closed. Gaps and seams must be very narrow to prevent the outdoor air from entering the equipment room. It is an industry best practice to keep the infiltration of the outdoor air below 5% of the total indoor airflow. Apply appropriate thermal insulation and antifreeze measures for outdoor water pipes to avoid poor drainage and insufficient water supply caused by freezing.

- *Vertiv recommends that the site preparation is defined as per the requirements. However, if these requirements are not met, Vertiv recommends that rectifications to be made on the site in order to comply with the specified requirements and conditions.*
- *However, if the rectifications or modifications are not implemented, then Vertiv does not guarantee the accuracy and precision of the temperature and humidity provided by the unit.*

2.2.2. Installation Space Requirements

Adequate installation space for the indoor unit must be provided. The indoor unit of the air-cooled product must be installed on the floor of equipment room or computer Room and the outdoor unit must be installed at outside of data center, open to external ambient.

- *Do not use the indoor unit in the open and severe outdoor environment.*
- *Avoid locating the indoor unit in concave or narrow areas, which can obstruct the airflow, shorten the cooling cycle and result in air return short cycle and air noise.*
- *Avoid locating multiple indoor units close to each other that can result in short cycle of air and creating load imbalance.*
- *Do not install the unit within the vicinity of any other precision cooling equipment to avoid the leakage of condensed water produced due to imbalance load condition.*
- *Do not install other devices (such as smoke detector) over the indoor cabinet.*

2.2.3. Maintenance Space Requirement

When installing the unit, a minimum maintenance space of 900 mm must be reserved in-front of the air conditioner unit. The requirement for maintenance space is given in Figure 2-7.

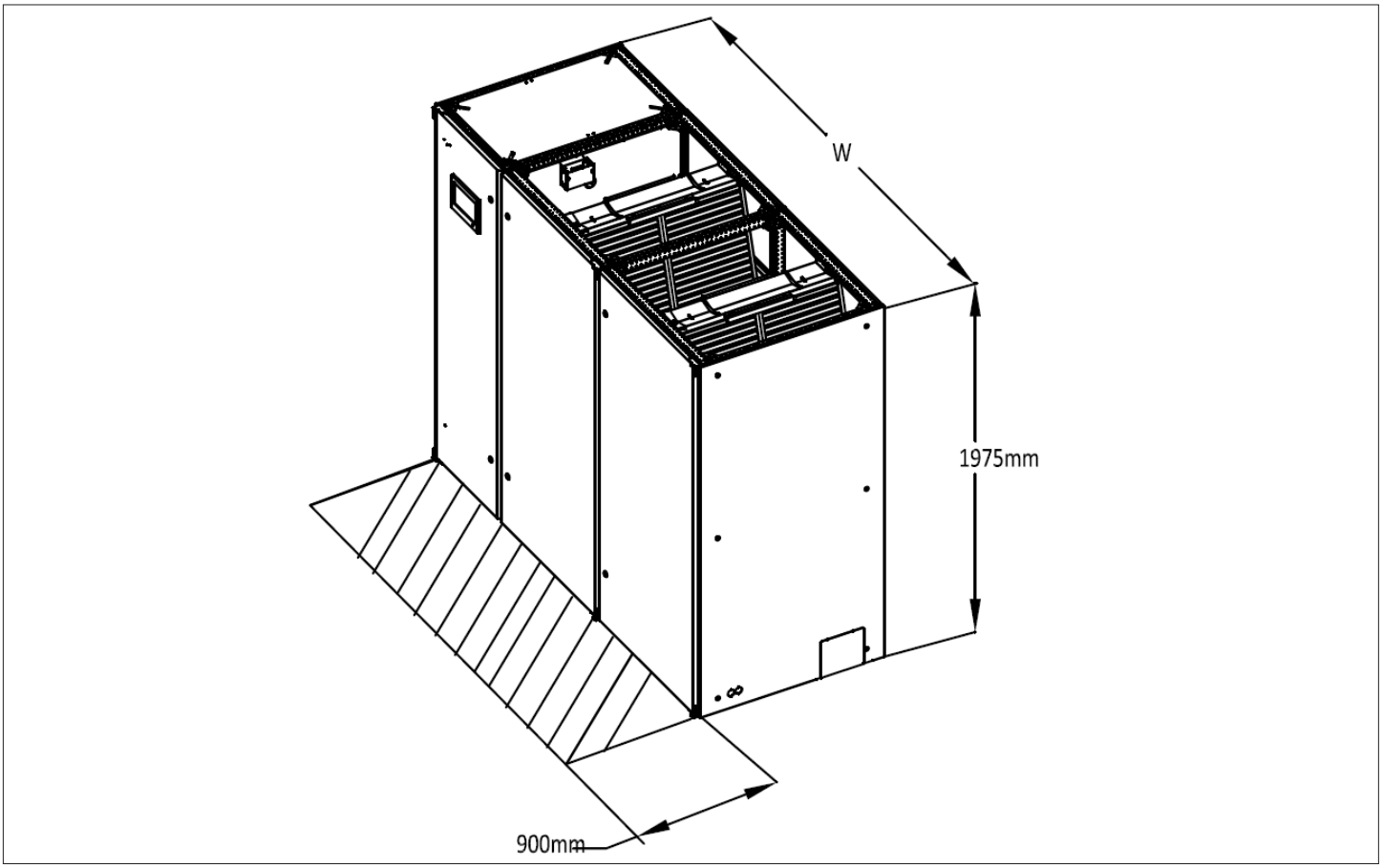


Figure 2-7 Maintenance Space of Unit

Normal maintenance space requirements are given in Table 2-1.

Table 2-1 Normal Maintenance Space (unit: mm/inch)

Space Location	Air Cooled Series	
Front	mm	inch
	900	35.4”

The given space parameters are used to provide regular maintenance, such as changing the air filter, adjusting the supply of the unit, cleaning the humidifier and so on.

2.2.4. Installation Tools

The following Table 2-2 shows the generic tool sets and utilities used in the installation and maintenance process:

Table 2-2 List of Generic Tools

Name	Drawing	Name	Drawing
Electric hand drill		Adjustable wrench	
Slotted screwdriver		Cross head screwdriver	
Stepladder		Forklift	
Drill		Wire cutting pliers	
Claw hammer		Diagonal cutting pliers	
Insulating shoes		Anti-static gloves	
Electrician knife		Cable ties	
Insulating tape		Insulating gloves	
Crimping pliers		Heat shrinkable tube	
Insulated torque wrench		Torque screwdriver	
Multi-meter		Clip-on ammeter	

The tools mentioned in Table 2-2 are generic and commonplace; however, depending on various factors such as site environment, local rules and regulations, cables, installation equipments, and on-site electrical connections these tools may vary in a real- time scenario.

Ensure that the tools used in the installation, operation, and maintenance processes are well insulated.

2.2.5. System Arrangement during Installation

The refrigerant piping is required to connect the indoor and outdoor units of the air-cooled system. The system arrangement diagram of the refrigeration system is shown in Figure 2-8

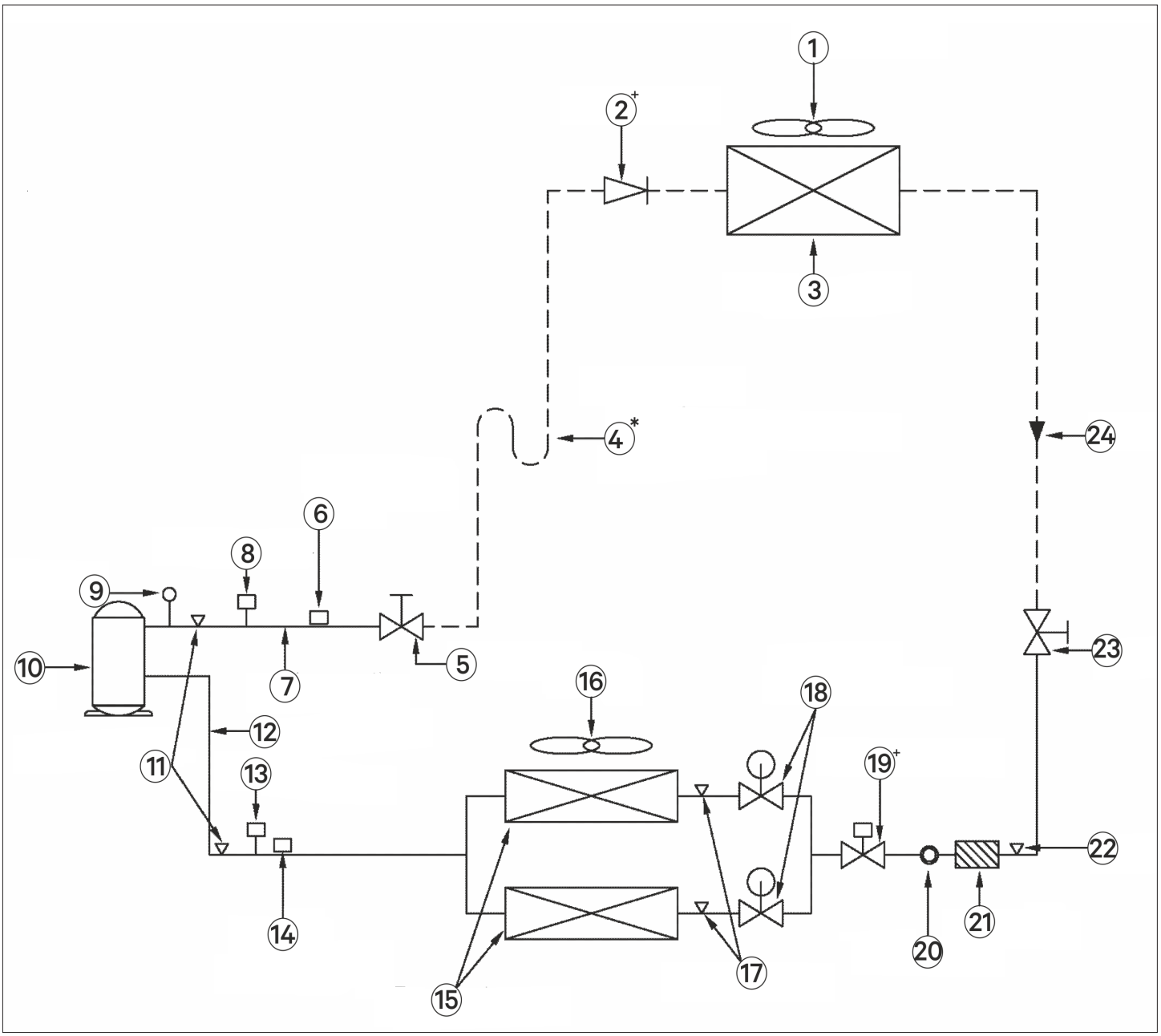


Figure 2-8 System Arrangement

List of the components of system arrangement diagram (Figure 2-8) is given in the below table.

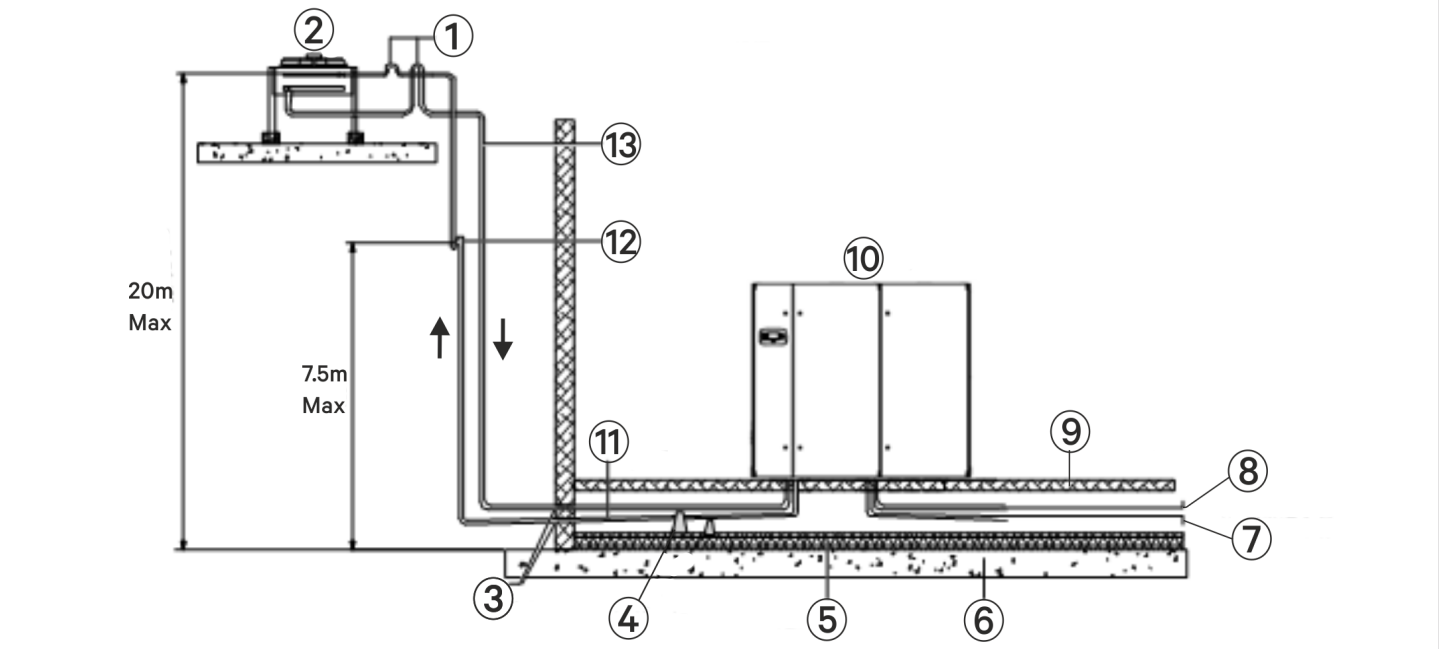
No.	Description	No.	Description
1	EC/ AC fan	13	LP transducer
2+	Check valve	14	Suction temperature sensor
3	Condenser Coil	15	Evaporator coil
4*	Oil trap (mounted one at every rise of 7.5 m)	16	EC fan
5	Shutoff valve	17	Schradar valve
6	Discharge temperature sensor	18	Electronic Expansion Valve
7	Discharge line	19+	Solenoid Valve
8	HP transducer	20	Sight glass
9	HP switch	21	Filter dryer
10	Scroll Compressor	22	Schradar valve
11	Schradar Valve	23	Shutoff valve
12	Suction line	24	Refrigerant flow

The following points should be considered before checking out the overall layout diagram:

- *The single system is used as an example.*
- *Components (marked with *) are not supplied by Vertiv but are recommended for the proper circuit operation and maintenance.*
- *+: When the pipeline equivalent length exceeds 30 m, these components are optional.*
- ═══════: *Factory piping*
- ==========: *Field piping (by technical personnel)*

2.2.6. System Installation Mode

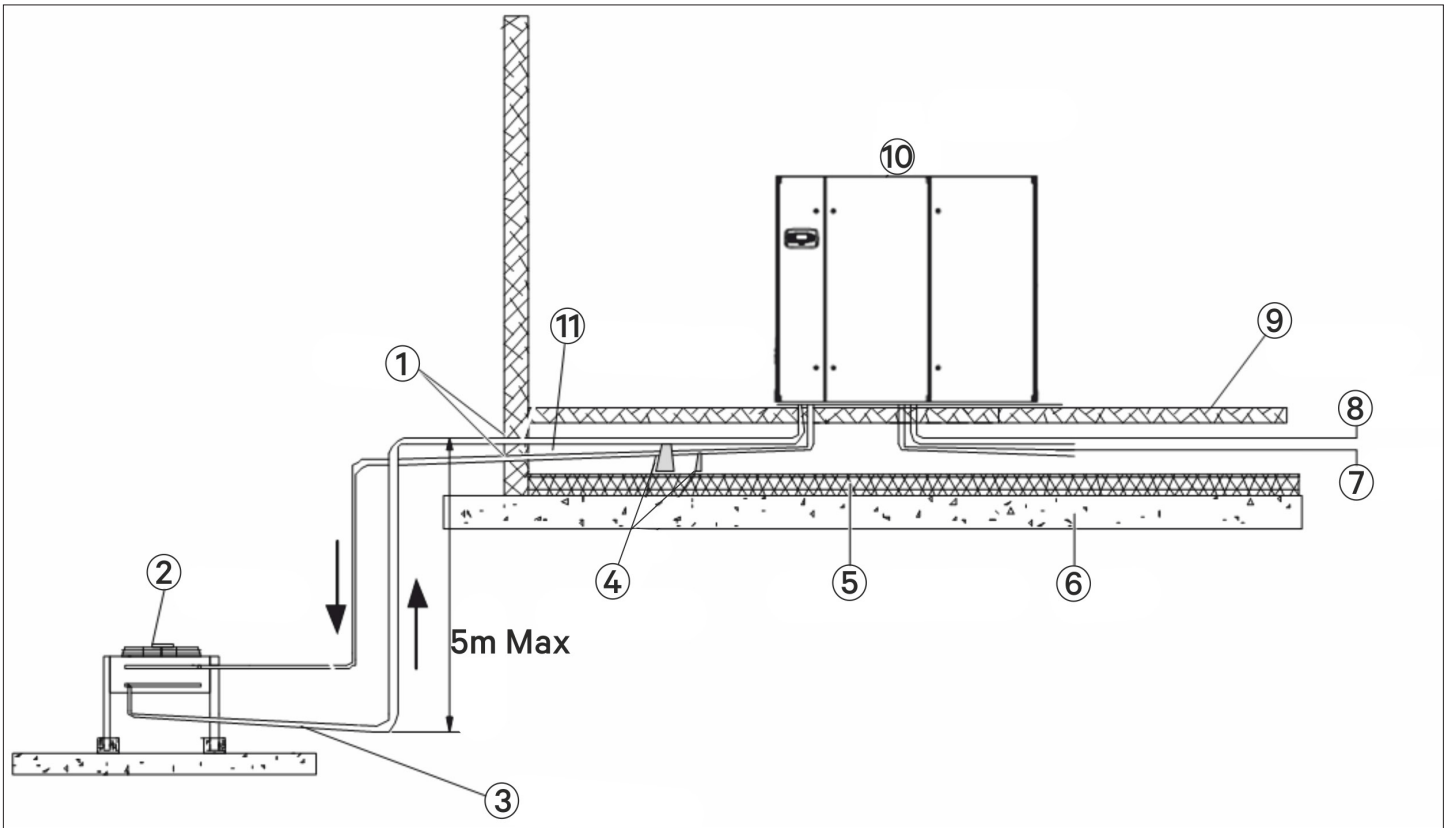
The system installation schematic diagram explains the process of installation for the condenser.



No.	Description	No.	Description
1	Inverted traps (higher than the highest copper pipe of condenser)	8	Humidifier supply pipe
2	Outdoor unit	9	Raised floor
3	Sealed	10	Indoor unit
4	Supporting bars	11	Discharge pipe slope
5	Thermal isolated layer under floor	12	Oil trap (Oil storage bend)
6	Floor	13	Liquid pipe (avoid direct sunlight)
7	Condensate drain pipe		

Figure 2-9 Condenser is Placed Higher than the Compressors during Installation

If the condenser is installed higher than the compressor (see Figure 2-9), a back-bend should be fitted to the discharge line and liquid line of the condenser, so as to prevent the liquid refrigerant from flowing back when the condenser stops. The top end of the inverted back-bend should be installed higher than the ultimate level of the copper pipe of the condenser. However, if the condenser is installed lower than the compressor, then there is no need of modification.



No.	Description	No.	Description
1	Sealed	7	Condensate drain pipe
2	Outdoor unit	8	Humidifier supply pipe
3	Slope liquid	9	Raised floor
4	Supporting bars	10	Indoor unit
5	Thermal isolated layer under floor	11	Discharge pipe slope
6	Floor		

Figure 2-10 The Condenser is Placed Lower than the Compressor during Installation

The illustration in Figure 2-9 depicts the schematic diagram of system installation when the condenser is installed at a higher level than the compressor and Figure 2-10, when the condenser is installed at a lower level than the compressor.

2.3. Mechanical Installation

2.3.1. Indoor Unit Size and Weight (Product Dimension)

The dimensions and operational weight of the indoor units are depicted in Figure 2-11 & Figure 2-12 and Table 2-3 respectively. In PEX4 series unit installation, while lowering the fan, the floor height should not be less than 450 mm.

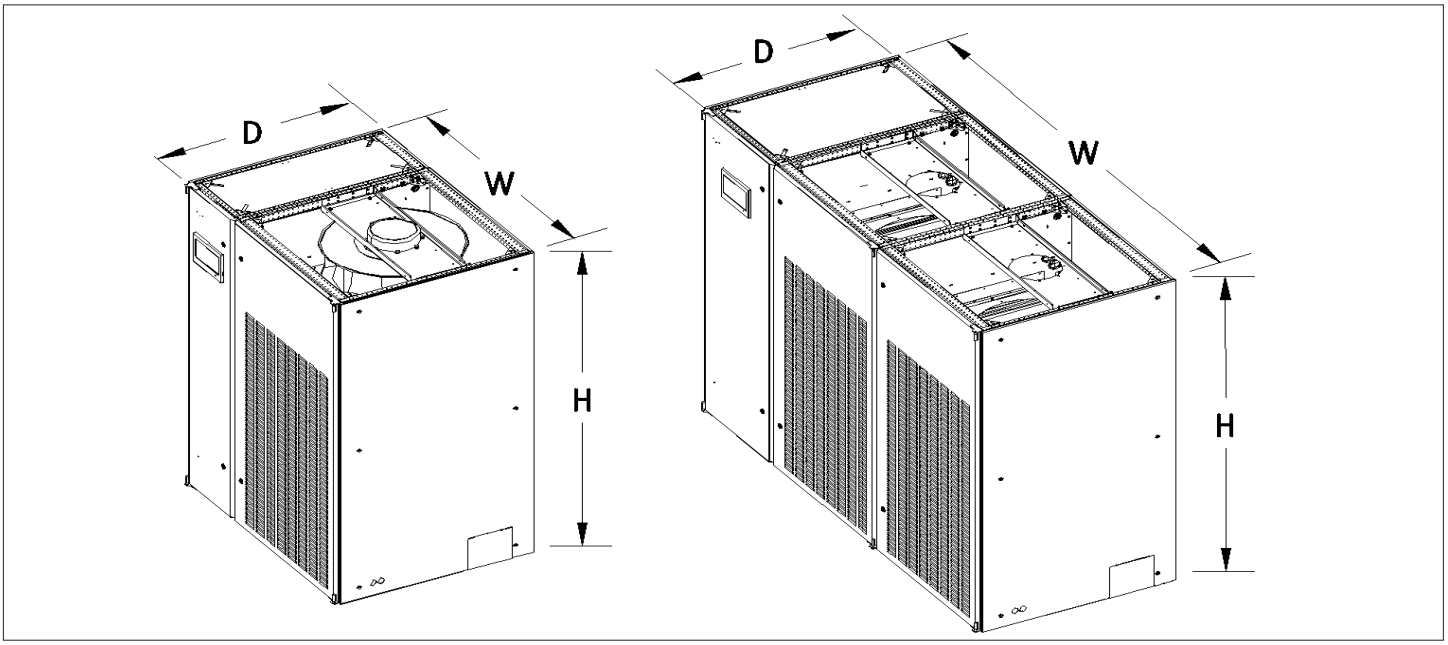


Figure 2-11 Upflow Indoor Unit

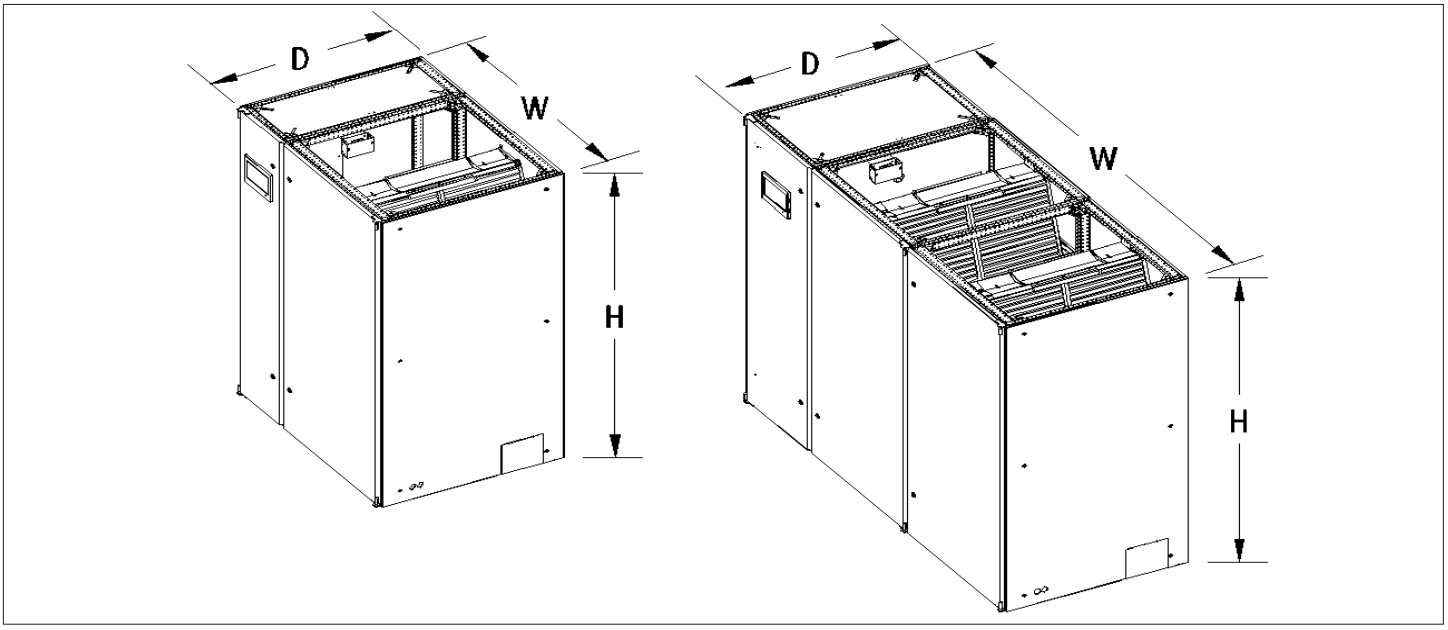


Figure 2-12 Downflow Indoor Unit

Table 2-3 Mechanical Parameters of Unit

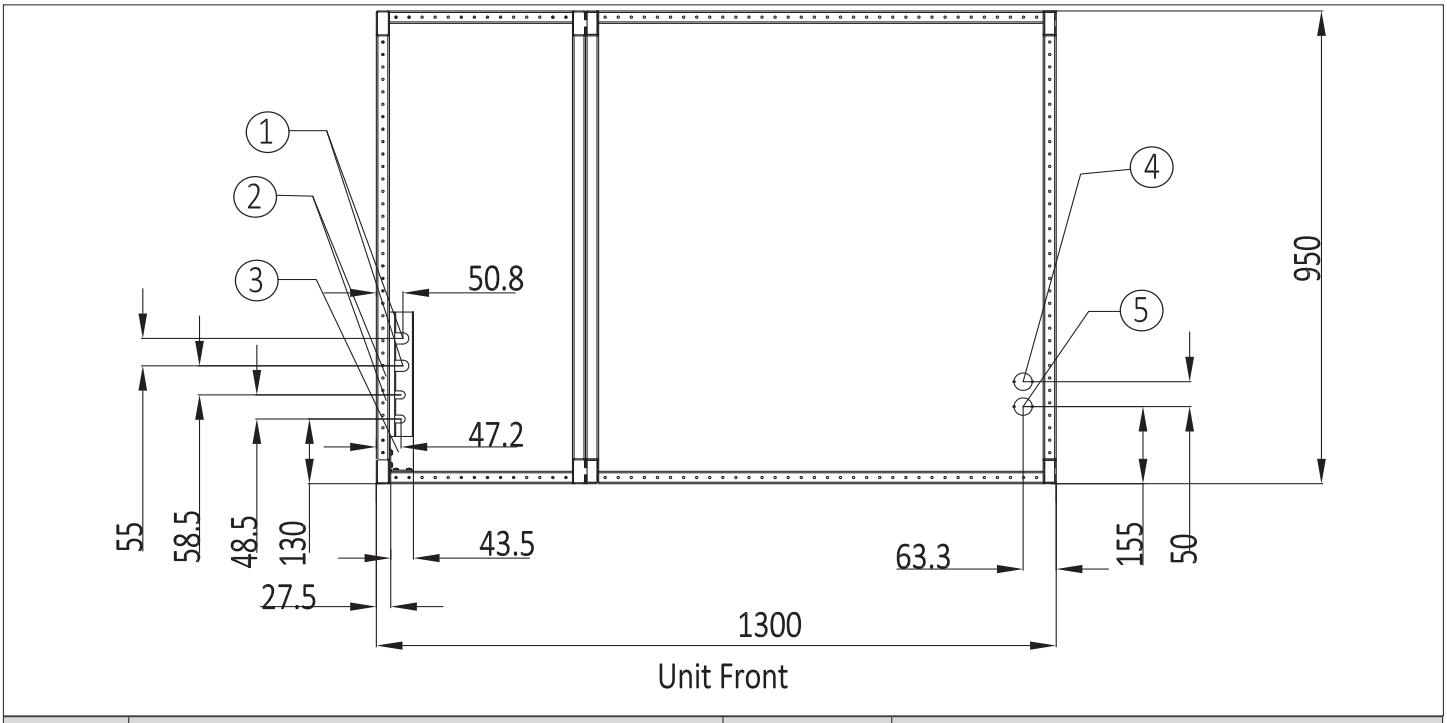
Product Model	Mechanical Parameter (WxDxH)		Operational Weight (Kg)
	mm	inch	
P1035	1330x995x1975	52.4”x39.2”x77.8”	425
P1045	1330x995x1975	52.4”x39.2”x77.8”	430
P1050	1330x995x1975	52.4”x39.2”x77.8”	460
P1060	1330x995x1975	52.4”x39.2”x77.8”	465
P2070	2430x995x1975	95.7”x39.2”x77.8”	750
P2080	2430x995x1975	95.7”x39.2”x77.8”	755
P2090	2430x995x1975	95.7”x39.2”x77.8”	760
P2100	2430x995x1975	95.7”x39.2”x77.8”	780
P2110	2430x995x1975	95.7”x39.2”x77.8”	785
P2120	2430x995x1975	95.7”x39.2”x77.8”	790

2.3.2. Dimension and Weight of Condenser

Refer to the “LSF/LDF Condenser User Manual” and “LVC Series Condenser User Manual.”

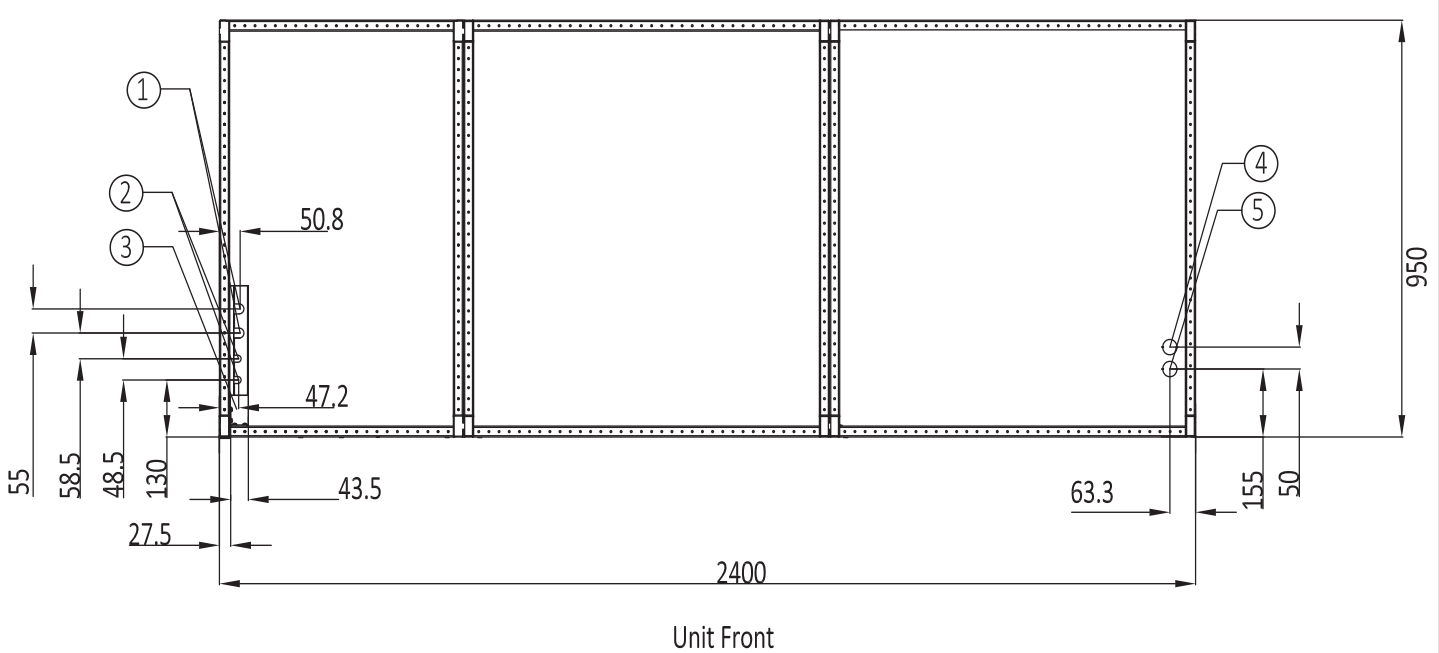
2.3.3. Base Plate Cut-out Position and Dimension

- **Base plate cut-out location dimensions:** The cut-out position and dimensions are shown in Figure 2-13, Figure 2-14 and Figure 2-15.



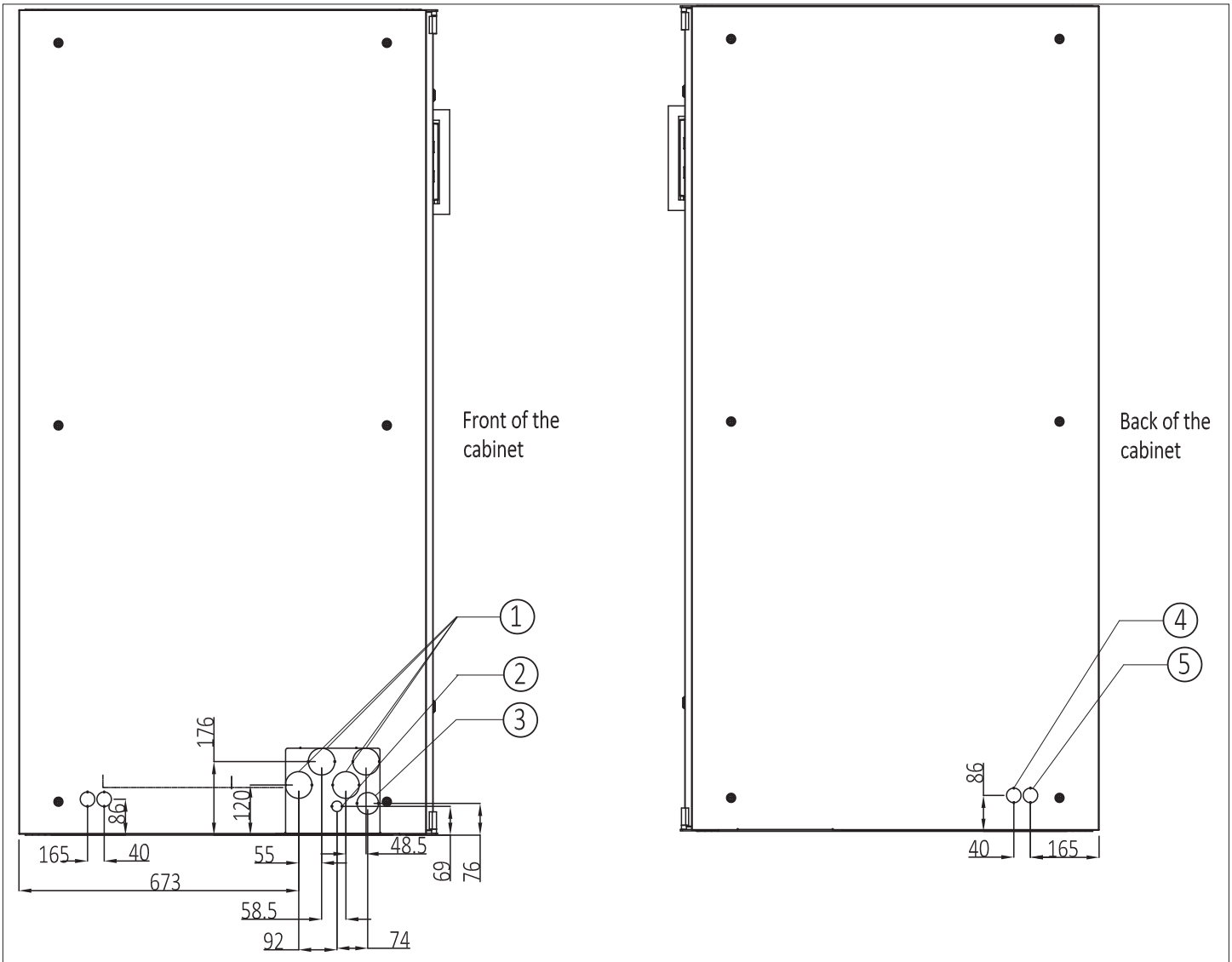
No.	Description	No.	Description
1	Discharge pipe Ø22	4	Condensate drain outlet
2	Liquid pipe inlet Ø16	5	Humidification pipe inlet
3	Cable entry 65x25		

Figure 2-13 The Position of Pipe Bottom Outlet of Single Cabinet Unit (unit: mm)



No.	Description	No.	Description
1	Discharge pipe Ø22	4	Condensate drain outlet
2	Liquid pipe inlet Ø16	5	Humidification pipe inlet
3	Cable entry 65x25		

Figure 2-14 The Position of Pipe Bottom Outlet of Dual Cabinet Unit (unit: mm)



No.	Description	No.	Description
1	Discharge pipe Ø22	4	Condensate drain outlet
2	Liquid pipe inlet Ø16	5	Humidification pipe inlet
3	Cable entry 65x25		

Figure 2-15 Left and Right Panel with Nozzle Position of Cut-out Location Dimensions (unit: mm)

If it is difficult to connect the pipes from the base plate as per the cable layout, the knocking holes on the side plate can also be used for the connection as shown in Figure 2-15. Select the inlet and outlet holes according to the actual needs. Ensure only one service is used per opening.

The equipment has knock-outs, ensure to mount sleeve to the cable holes to avoid cutting the cables.

2.3.4. Position and Dimension of Air Outlet on Top Cover

The position and dimensions of air outlet on the top cover of upflow unit are shown in Figure 2-16 and in Table 2-4 respectively.

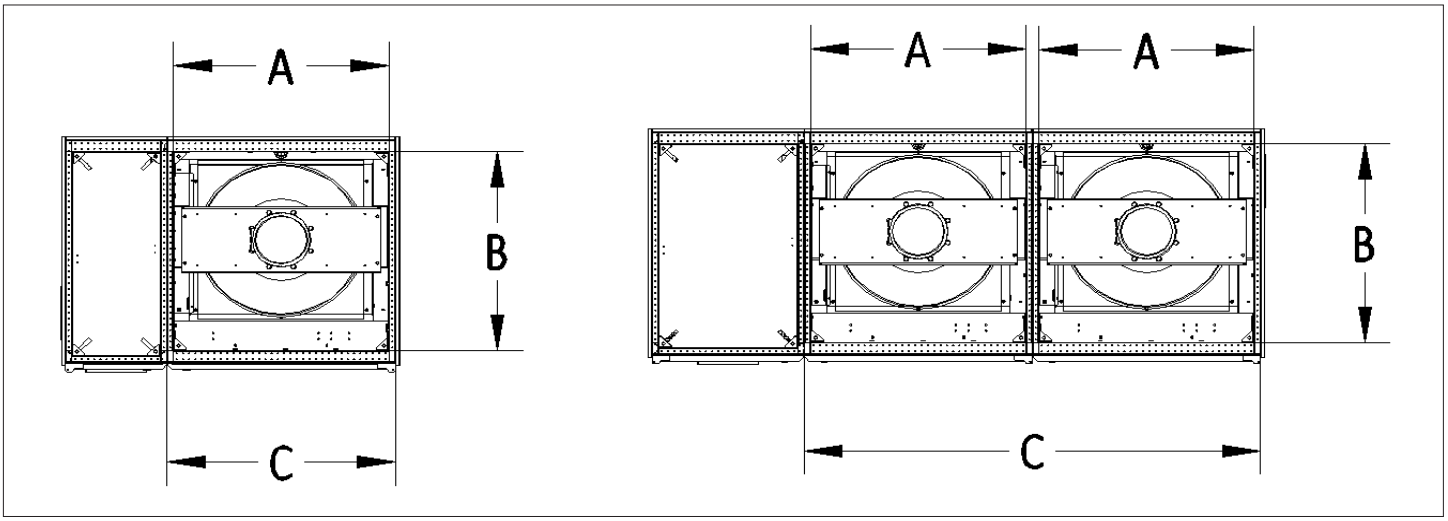


Figure 2-16 The Position of Air Outlet on Top Cover Upflow Unit

Table 2-4 Dimensions of Air Outlet on Top Cover of Upflow Unit

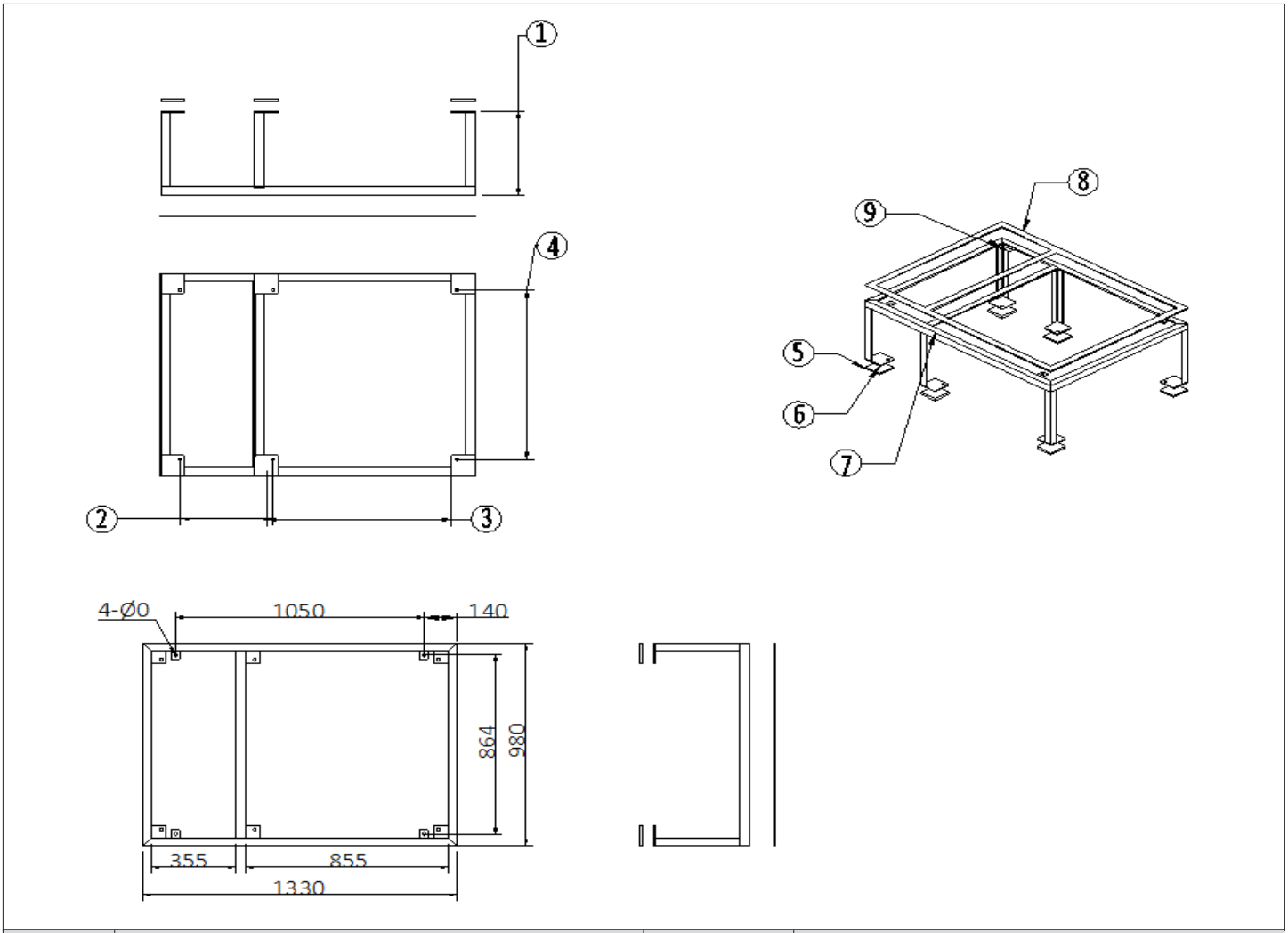
Type	A		B		C	
	mm	inch	mm	inch	mm	inch
Module series1	850	33.5”	900	35.4”	900	35.4”
Module series2	850	33.5”	900	35.4”	1800	70.9”

- *Module series 1 contains P1035, P1045, P1050, P1060 series units.*
- *Module series 2 contains P2070, P2080, P2090, P2100, P2110, P2120 series unit.*

2.3.5. Indoor Installation

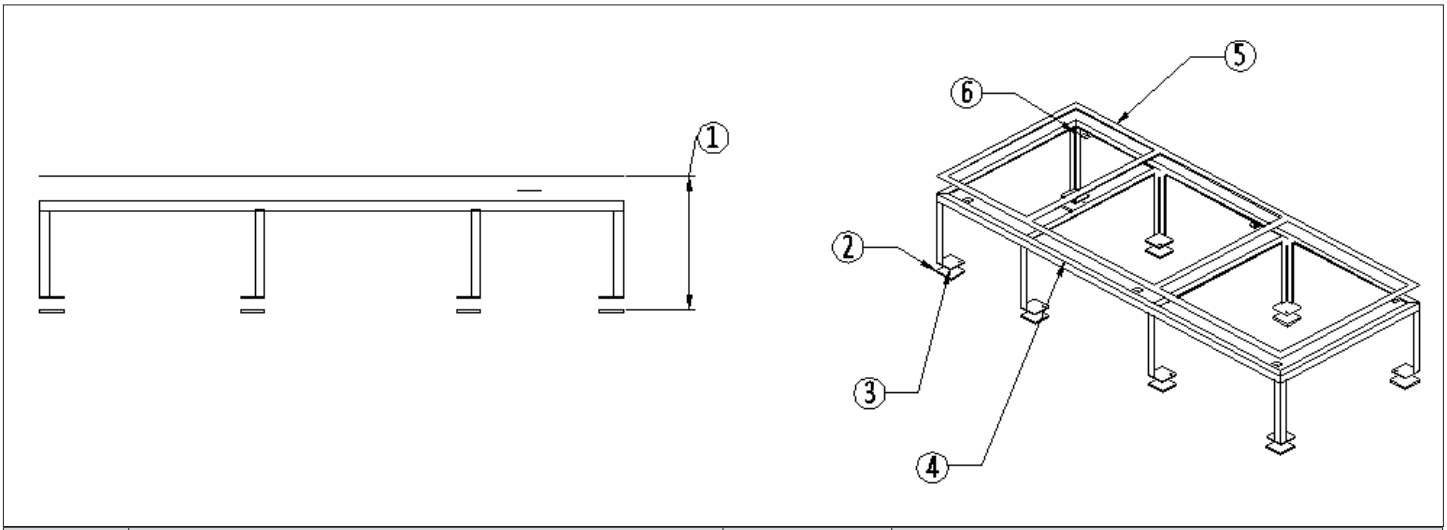
- **Floor Stand**

The floor stand has to be prepared by the installation team according to the dimensions, weight, and height of the unit. To ensure the rigidness of the structure, size the floor stand according to Figure 2-17 & Figure 2-18.



No.	Description	No.	Description
1	400 mm< According to the site installer height ≤550 mm	6	Bottom plate
2	Expansion bolt mounting hole on-site customization	7	Fixed steel plate
3	Expansion bolt mounting hole on-site customization	8	Upper rubber damping pad
4	Expansion bolt mounting hole (on-site self-determined) height	9	Incline tie joint
5	Bottom plate cushion		

Figure 2-17 Floor Stand of the Single Unit



No.	Description	No.	Description
1	400 mm< According to the site installer height ≤550 mm	4	Fixed steel plate
2	Bottom plate cushion	5	Upper rubber damping pad
3	Bottom plate	6	Incline tie joint

Figure 2-18 Floor Stand of the Double Unit

- **Installing Floor Stand**

Determine the installation position according to the requirements of Section 2.2.2, and fix the floor stand onto the selected mounting position. The floor stand shall be fixed to the ground through expansion bolts or spot welding, and the floor stand shall be calibrated by horizontal ruler before it is fixed. Ensure the floor stand should be lifted enough to make the top surface of the unit absolutely horizontal. While designing and installing the downflow unit which requires lowering of EC fan, we must consider the proper gap distance and the base strength of the floor stand.

- **Damping Treatment**

Place a layer of rubber cushion on the top, side of the floor stand, and on the bottom of the steel plate respectively to avoid transmission of vibration during operation of the unit. Refer Table 2-5 for more details.

Table 2-5 Dimensions of Rubber Cushion for Vibration Absorbing

Project		Specifications Units in mm
Rubber Damping Pad	Above	Thickness: 3 mm to 5 mm
	Side	Thickness: 2 mm to 3 mm
	Bottom	Thickness: 10 mm to 12 mm

- *For the downflow unit, the base must be greater than the height of 400mm and for the upflow unit, the base height must be about 200mm.*
- *The side panels are suspended to the frame of the unit, ensure that floor stand should bear the weight of the panels.*
- *The distance between the obstacles that may obstruct the air supply around the upper edge of the base and the outer edge of the EC fan shall be greater than 160mm*

2.4. Installation Considerations

Installation precautions for outdoor unit are as follows:

- To ensure the cooling performance of the unit, install the condenser in the outdoor with sufficient airflow. Do not install where dust or snow can obstruct the condenser coil. Ensure no steam around the unit, waste heat and so on.
- The installation conditions are recommended to allow the user to adopt a horizontal installation that reduces noise.
- To reduce the impact of noise around the environment, the condenser should be installed away from the residential area (≥15 m).
- Be careful not to damage the building's waterproof layer when installing the condenser on the building's roof. Please comply with the relevant local premises rules.
- Position the condenser higher than the indoor unit to ensure normal oil return.

2.5. Pipe Installation Unit (Air-cooled Units)

There are four kinds of pipe to be joint as follows:

- Condensed drain piping connection of the indoor unit
- Humidifier inlet pipe connection
- Connection of the copper pipe (discharge and liquid pipe) between the indoor and outdoor unit.
- Long piping kit.

The following points need to be taken into consideration during the piping process:

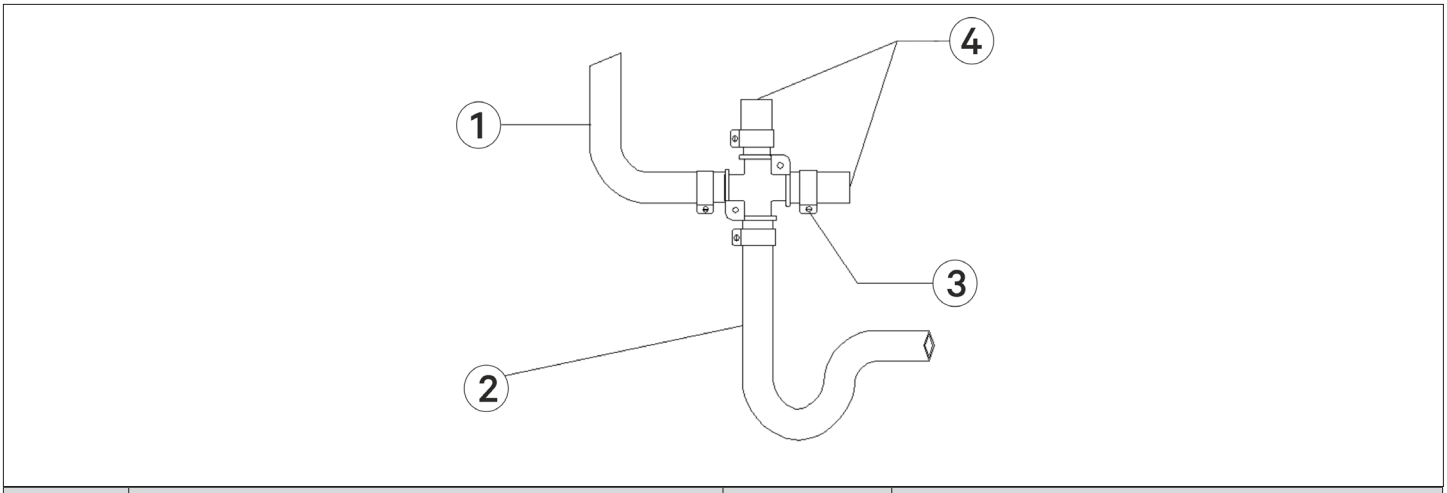
- *All the joints of the refrigerating pipes must be silver-brazed.*
- *The selection, layout, and fixing of the pipes should comply to the industry standards and norms.*
- *Vacuum pumping and refrigerant charging operations, and procedures must conform to the industry standards.*
- *Pressure drop, compressor oil return, noise, and vibration must be considered during the designing and installation process.*

2.5.1. Condensate Drain Piping Connection of the Indoor Unit

The condensate of Infrared humidifier and evaporator is connected by a cross connector and drained through the drain pipe, as shown in Figure 2-19. The pipe outer diameter is 25 mm. If the drain pipe is used by three or more units, the minimal pipe outer diameter should be 40 mm.

When connecting the drain pipe, ensure that the 'U' bend is installed vertically and the 'U' shape is not distorted, to ensure that the condensate can be drained immediately and effectively.

Because the Infrared humidifier contains flowing hot water, the water pipe must be resistant to heat higher than 90 °C.



No.	Description	No.	Description
1	From evaporated condensate water pan	3	Hose clamp
2	Condensate drain pipe connection	4	Plug

Figure 2-19 Connection of the Drain Pipe of Condensate Water

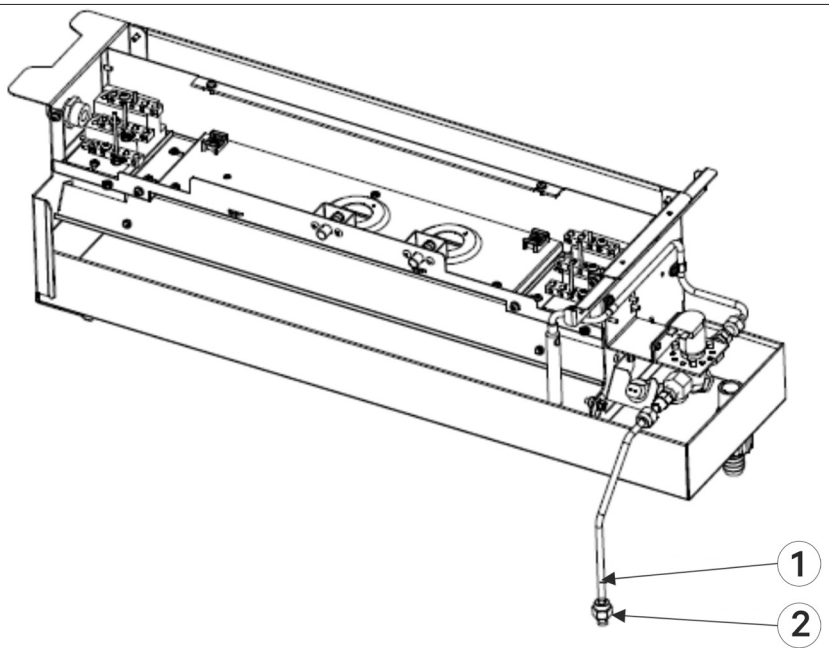
2.5.2. Humidification Inlet Pipe Connection

For the connection of water inlet pipe to the humidifier select the nearest point to the unit. The material used for the inlet pipe is galvanized pipe, aluminum plastic pipe, Ppr Hot-Melt pipe. And GI pipe is recommended.

- **Infrared Humidifier**

Requirements for connecting the water inlet pipe of infrared humidifier: To facilitate maintenance, an isolation valve should be fitted to the water inlet pipe. Ensure that the water inlet pipe is sealed properly to prevent leakage. The infrared humidifier reserves a copper pipe (OD: 6.35 mm), as shown in Figure 2-20. There is a 1/4" copper nut at the end of the copper pipe followed with the 1/4" × 1/2" conversion copper thread connector, which has been connected to the copper nut to avoid any loose contact.

- *Where the main channel pipe pressure may exceed 700 kPa (the main line pressure should be between 100 kPa to 700 kPa), a pressure reducer should be fitted.*
- *Where the main pipe pressure falls below 100 kPa, a water tank and pump system should be used.*



No.	Description	No.	Description
1	Inlet pipe	2	Outlet joint

Figure 2-20 Infrared Humidifier

- **Electrode Humidifier**

Requirements for connecting water inlet pipe of electrode humidifier: Water inlet pipe uses 3/4" G screw-threaded connection pipe.

Water filter and water quality detection are recommended to prevent the water quality from affecting the normal operation of the humidifier.

2.6. Refrigerant Piping Connection

Select the appropriate dimensions (Pipe diameter & Wall thickness) of pipes connecting the indoor and outdoor units. Considering the effect of the diameter and wall thickness of copper piping on the pressure drop of the system, the pipe dimensions of the indoor and outdoor units should be determined according to the specifications in Table 2-9 or consult Vertiv local representative. The recommended dimensions of piping is given in Table 2-6 & Table 2-7.

Table 2-6 Recommended Dimensions for Piping

Model	P1035		P1045		P1050		P1060		P2070		P2080	
Pipe length	D	L	D	L	D	L	D	L	D	L	D	L
10m	19/19	16/16	19/19	16/16	19/19	16/16	22/19	16/16	19/19	16/16	19/19	16/16
20m	19/19	16/16	22/19	16/16	22/22	16/16	22/22	19/16	19/19	16/16	22/19	16/16
30m	22/19	16/16	22/22	16/16	22/22	19/16	25/22	19/16	22/19	16/16	22/19	16/16
40m*	22/19	16/16	25/22	19/16	25/22	19/16	25/25	19/19	22/19	16/16	22/22	19/16
50m*	22/22	19/16	25/22	19/16	25/22	19/16	28/25	22/19	22/22	19/16	25/19	19/16
60m*	25/22	19/16	25/22	19/16	28/22	19/19	28/25	22/19	25/22	19/16	25/22	19/16

Table 2-7 Recommended Dimensions for Piping

Model	P2090		P2100		P2110		P2120	
Pipe length	D	L	D	L	D	L	D	L
10m	19/19	16/16	19/19	16/16	19/19	16/16	22/19	16/16
20m	22/19	16/16	22/22	16/16	22/22	16/16	22/22	19/16
30m	22/22	16/16	22/22	19/16	25/22	19/16	25/22	19/16
40m*	25/22	19/16	25/22	19/16	25/22	19/16	25/25	19/19
50m*	25/22	19/16	25/22	19/16	25/25	19/19	28/25	22/19
60m*	25/22	19/16	28/22	19/19	28/25	22/19	28/25	22/19

Table 2-8 Metric and Imperial Equivalent Values of Piping

Metric/Imperial Equivalents								
mm	13	16	19	22	25	28	32	35
inch	1/2	5/8	3/4	7/8	1	1-1/8	>1-1/4	1-3/8

- *Long piping kit should be added to the equivalent length marked with *.*
- *The equivalent values for metric and imperial conventions are shown in Table 2-8.*
- *D: Discharge line, L: Liquid pipe.*
- *25/22: horizontal pipe diameter is 25 mm, vertical pipe diameter is 22 mm*
- *If the pipe length exceeds 60 m or less than 20 m, please consult Vertiv local representative for details.*
- *If the outdoor temperature is below -15 °C, use the low temperature kit and consult Vertiv local representative for details.*

Table 2-9 Recommended Dimensions for Piping

Piping Size (outside diameter)		Wall thickness	
mm	inch	mm	inch
16	5/8	≥1	0.04”
19	>3/4	≥1	0.04”
22	7/8	≥1	0.04”
25	1	≥1.1	0.04”
28	1-1/8	≥1.2	0.05”
32	>1-1/4	≥1.5	0.06”
35	1-3/8	≥1.5	0.06”

Table 2-9 shows the copper piping specification as per IEC 61000-3-12. If the project site uses semi-hard or soft copper pipes, consult Vertiv technical staff for the selection wall thickness, otherwise it leads to system leakage or explosion.

2.6.1. Refrigerant Piping Connection General Principle

The recommended “Equivalent length” for each connector is shown in Table 2-11 including the calculation of the pressure loss caused by the elbow joint. The installer should confirm the suitability of the site according to the following situation.

1. If the equivalent length exceeds 30 m, or the vertical height difference between the indoor and outdoor units exceeds the values given in Table 2-10, consult Vertiv local representative for technical support before installation and if any modification is required.

Table 2-10 Vertical Height Difference Between Indoor and Outdoor Units

Relative position	Distance
Outdoor unit higher than indoor unit	Max: +20 m
Outdoor unit less than indoor unit	Maximum: - 5 m

2. The equivalent length can be calculated by selecting appropriate dimension in accordance with the respective diameter. For details refer Table 2-11.

Table 2-11 Equivalent Length of Each Local Component

Diameter of Liquid Pipe (inch)	Equivalent Length (m)		
	90° Elbow	45° Elbow	T Type Tee
3/8	0.21	0.10	0.76
1/2	0.24	0.12	0.76
5/8	0.27	0.15	0.76
3/4	0.3	0.18	0.76
7/8	0.44	0.24	1.1
1-1/8	0.56	0.3	1.4

- *If the vertical distance between indoor and outdoor units exceeds the values in Table 2-10, consult Vertiv local representative.*
- *'U' trap should be provided at every 7.5 m of vertical distance. Please consult Vertiv local representative for details.*
- *Notes and instruction labels are pasted onto the base and the side panel close to the ball valve. Ensure that the ball valve must be wrapped with a wet cloth before brazing to protect the label from burning.*
- *Connect the discharge pipe and liquid pipe of the indoor unit according to the instructions on the labels.*
- *Horizontal sections of the discharge pipe should be sloped down from the compressor with a slope of at least 1:200 (5 mm down for each 1 m run).*
- *The discharge pipes should be insulated where they are routed in the conditioned space (including under the raised floor).*

The exposure time of system pipes must not exceed 15min. Longer exposure will result in moisture affecting the compressor lubrication oil, which affect the life of the key components and the system operation stability.

2.6.2. Refrigerant Requirement

The unit has a specifically designed air conditioning system that requires a desired per-specified quality of refrigerant (R410a) to perform continuously at the most optimum efficiency. For the details on the quantity of refrigerant to be charged inside the system refer Table 2-12 and Table 2-13.

- *Do not use refrigerant of inferior quality. For any consequences resulting from inferior quality refrigerant, Vertiv does not assume warranty responsibility.*

Table 2-12 Indoor Refrigerant Charge (Unit: kg)

Indoor Model	P1035	P1045	P1050	P1060	P2070	P2080	P2090	P2100	P2110	P2120
	Single Circuit	Single Circuit	Single Circuit	Single Circuit	Double Circuit	Double Circuit	Double Circuit	Double Circuit	Double Circuit	Double Circuit
Standard Charge	3.3	3.3	3.4	3.4	2x3.32	2x3.32	2x3.32	2x3.44	2x3.44	2x3.44

Table 2-13 Outdoor Refrigerant Charge (Unit: kg)

Outdoor Model	LSF52	LSF62	LSF70	LSF76	LSF85	LVC106	LVC140	LVC152	LVC170
	Single Circuit	Single Circuit	Single Circuit	Single Circuit	Single Circuit	Single Circuit	Single Circuit	Single Circuit	Single Circuit
Standard Charge	6.23	5.67	5.67	7.34	9.79	6.39	6.10	7.19	9.58

Refrigerant Charge = Charge of Indoor Unit + Charge of Outdoor Unit + (Refrigerant Charge per Unit Length of Liquid Pipe x Length of Extended Pipe)

The system has a sufficient amount of oil for piping up to 50 m, if piping length exceeds 50 m then additional oil is required in the system (equal to extra 6% of refrigerant amount). Unit for extra oil quantity is expressed in litre (L).

Table 2-14 Amount of Refrigerant per Unit Length of Liquid Pipe (Unit: kg/m)

Liquid Pipe OD (mm)	Refrigerant Charge per Unit Length of Liquid Pipe (kg/m)
16	0.17
19	0.24
22	0.32
25	0.42

Please contact Vertiv local representative when operating under the following condition

- *For non-standard vertical/ horizontal piping length based refrigerant amount.*
- *In case of different condenser.*

2.6.3. Copper Pipe Brazing Requirements

- In order to ensure safety in the connecting pipes and solder joints before brazing, it is necessary to clean the air conditioning system with nitrogen to release the pressure from the system.
- The copper pipes should be thermally insulated. When the copper pipes pass through the wall or other obstacles, it is recommended to use the shock absorber and other isolation measures to avoid direct contact with the wall, as well as to prevent the entry of dust, water vapor, solid particles into the copper pipes.
- In order to ensure the quality of brazing, use high-quality silver-based solder welded pipe joints. The brazing pipeline should be filled with nitrogen to protect the brazing process.
- The selection, placement and fixation of piping; system vacuum and filling of refrigerant are required to operate according to industry standards. The parameters such as pipeline pressure drop, compressor return oil, noise reduction and vibration should be considered while designing and construction process.
- The copper pipe interface should be polished after brazing, the burr should be cleared and the inside of the copper pipe should also be cleaned. Refer following cleaning methods.

1. The slender wire is wrapped in a cotton cloth dipped in the alcohol (or acetone), pulled back and froth into the copper pipe. For specific operation, refer to the Figure 2-21.

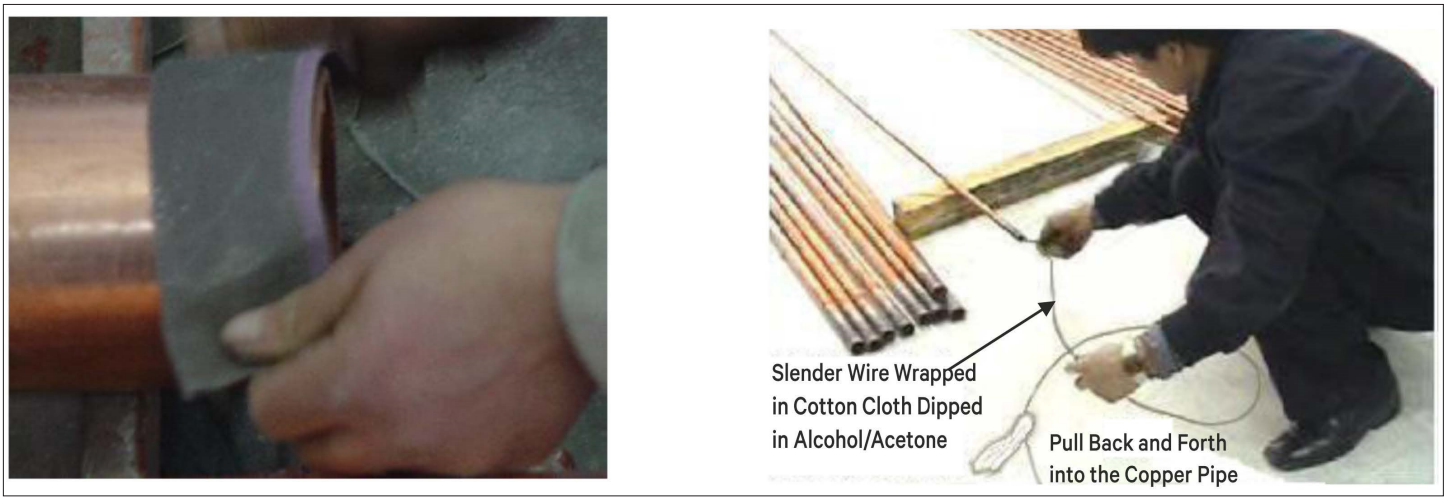


Figure 2-21 Copper Pipe Cleaning Method

2. Nitrogen protection should be used in the brazing process and the edges of the copper pipes should be sealed to prevent impurities and wet air from entering the copper pipe. For specific operation of the seal, refer to Figure 2-22.

Figure 2-22 Copper Pipe Seal Protection Schematic

3. If other devices, such as globe valve, schrader valve, expansion valve, etc., are located within one meter of the brazing point on the copper pipe, apply the wet cloth to wrap the devices as a protective treatment, see Figure 2-23.

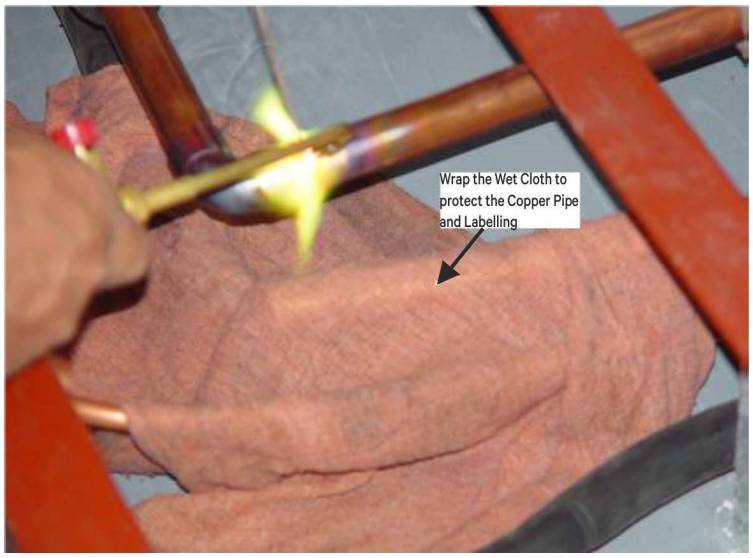
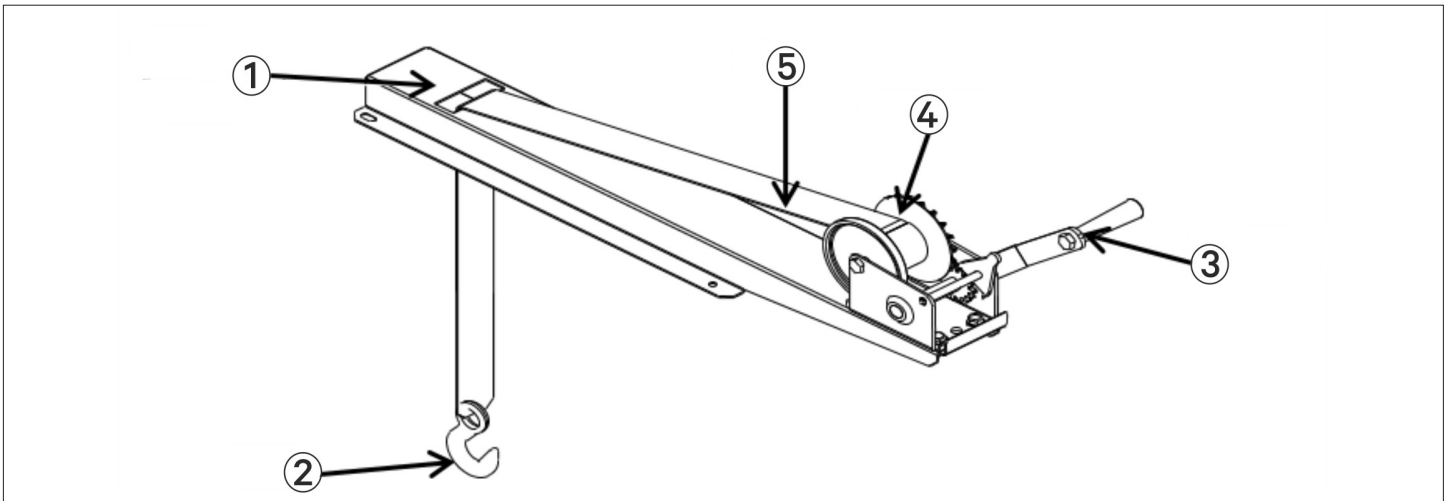


Figure 2-23 Copper Pipe Brazing Protection Diagram

4. After brazing, use high-pressure nitrogen blowing pipe to remove the internal pipeline residual dust and beryllium oxide and other impurities. If the pipeline passes through the wall, soft material should be used to seal the gaps on the wall around the hole. The soft material also plays a role in the insulation of heat and absorbs vibration between the wall and the surface of the pipe.

2.7. Lowering the Fan

Before commissioning, the EC fans of the downflow unit must be lowered. The downflow unit is equipped with a lowering tool when it is shipped. The lowering tool that uses winch is shown in Figure 2-24. It includes hand winch, hook, sling, handle, winch bracket and a L shaped lifting component.

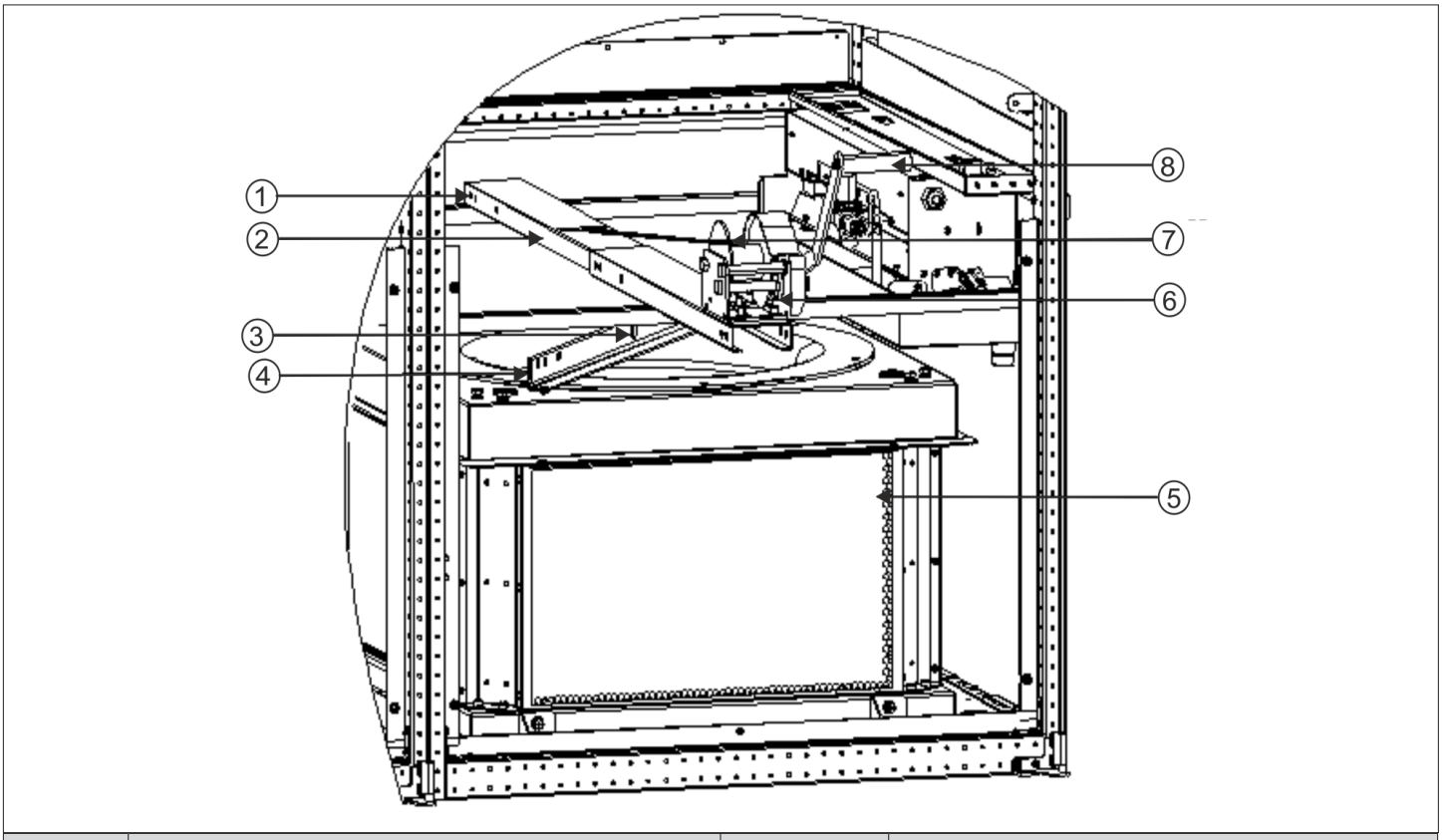


No.	Description	No.	Description
1	Winch bracket	4	Winch
2	Hook	5	Sling
3	Handle		

Figure 2-24 Fan Elevator Assembly (Winch mode)

- **Lowering Procedure:**

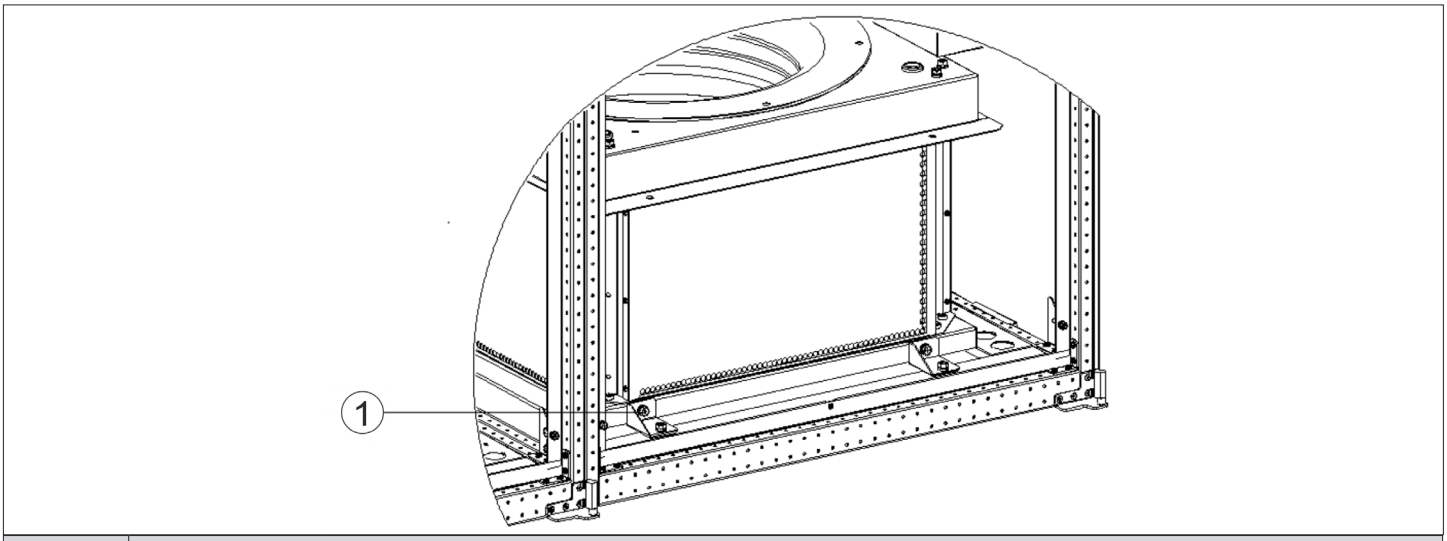
1. Installing lift and lowering kit for EC fan: Open the unit maintenance cover, check the fixing bolts (refer, total 2 PCS) of the L shaped lifting component to ensure that it is fixed properly, and then install the fixing bolts (total 4 PCS) of the winch bracket, as shown in Figure 2-25.



No.	Description	No.	Description
1	Bolt	5	Fan
2	Winch bracket	6	Winch
3	Lifting hole	7	Sling
4	L-shaped lifting	8	Handle

Figure 2-25 Installed Winch Bracket

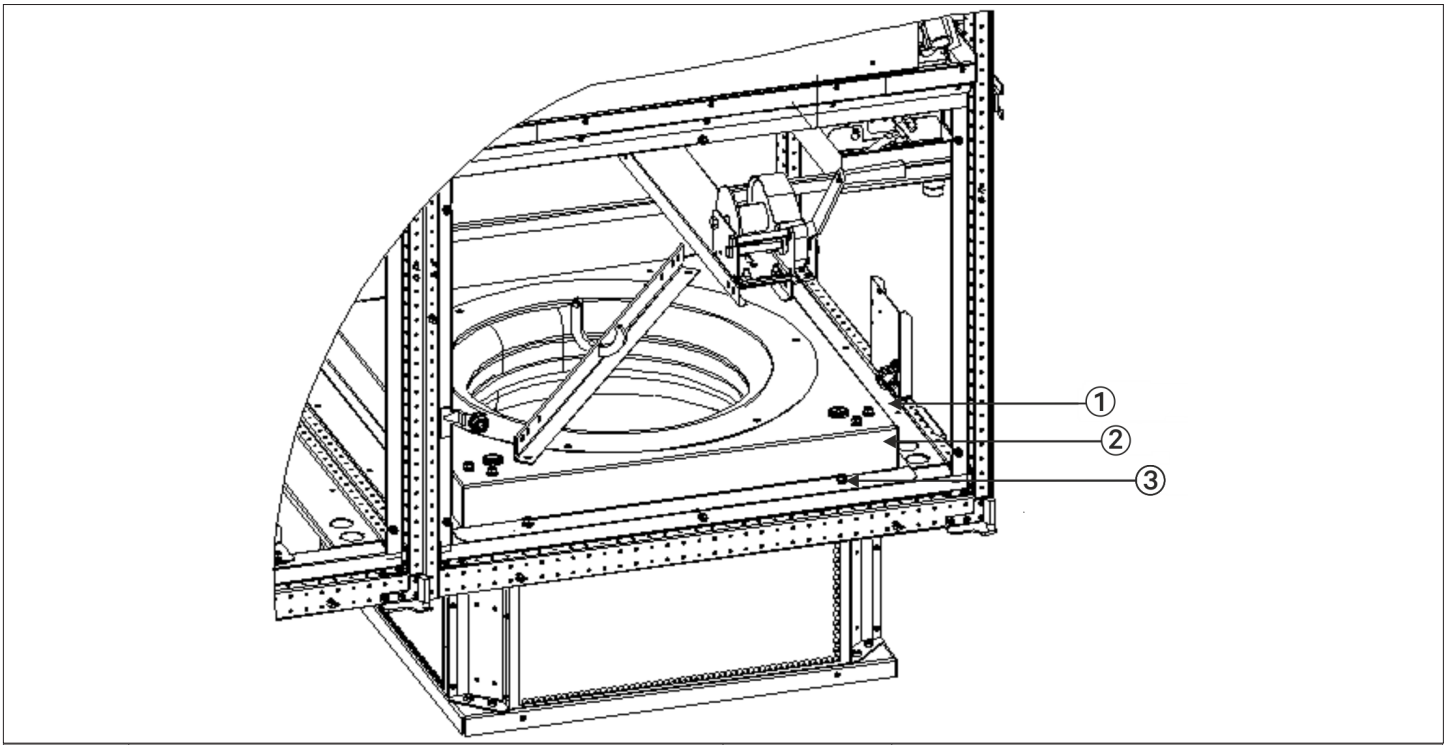
2. Turn the handle and use the hook of the winch to hook the L-shaped lifting component to the middle round hole (refer Figure 2-26). Adjust the handle until the sling is completely tight.
3. Cut off the cable tie that binds the fan cables to ensure that the cable length meets the fan lowering requirements, and then remove the fixing bolts (refer Figure 2-26, total 4 PCS) for fan lowering.
4. Hold the winch handle firmly, and then turn the handle counterclockwise to lower the fan. After the fan has been lowered, the status is shown in Figure 2-27.



No.	Description
1	Bolt

Figure 2-26 Position of Fixing Bolt

5. Install the fixing bolts, as shown in Figure 2-26 with total 4 PCS of bolts holding the arrangement tight during operation.



No.	Description	No.	Description
1	Base pallet of unit	3	Bolt
2	Top cover of fan		

Figure 2-27 Lowered Fan

6. Remove the hook from the L shaped lifting component, turn the handle clockwise, tidy the sling and remove the fixing bolts (refer Figure 2-27: Position of Fixing Bolt, totally 2 PCS) of the winch bracket, and removed the winch and the bracket assembly.

7. Remove the fixing bolts of the L shaped lifting component and removed the L-shaped lifting component. At this point, the operation of lowering the fan of the 1-bay unit is completed. For the unit with two fans, lower the other fan too, using the fan elevator assembly. The requirements are as follows;

8. Repeat steps 1-7 of the 1-bay unit to lower the other fan.

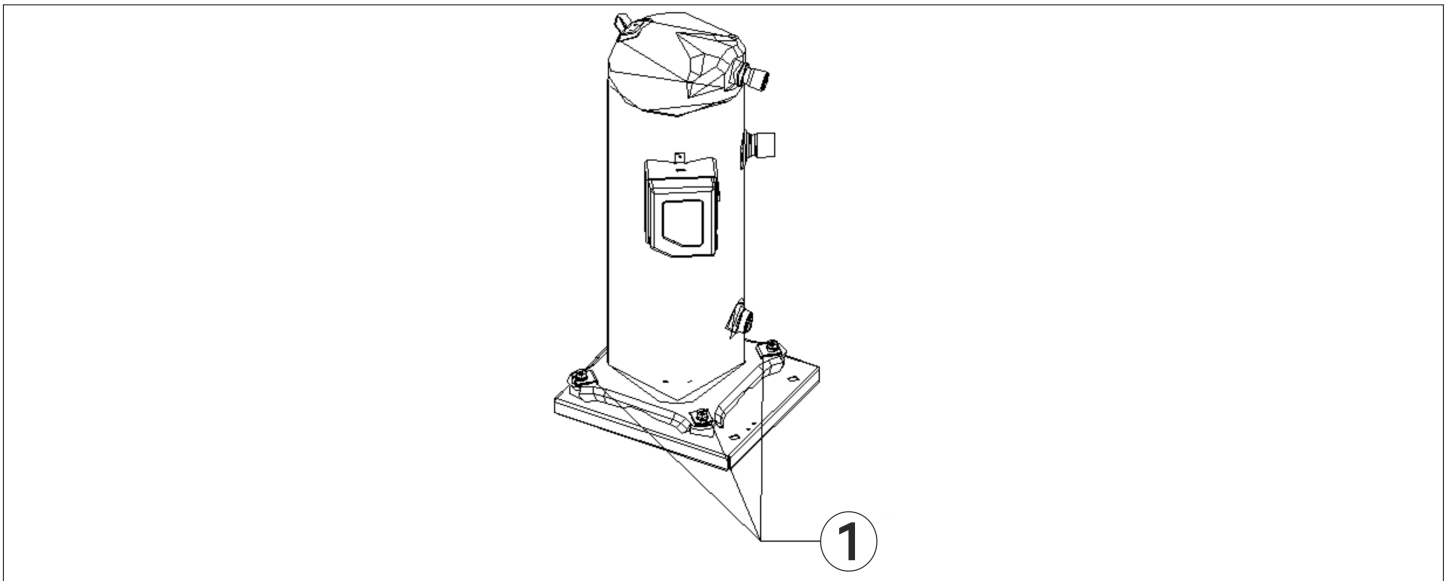
9. After lowering all fans, arranged the fan cables in right order and fix them using a cable tie.

10. Confirm whether the EC fan has been lowered and installed and ensure that the blade does not touch the fan housing when the fan rotates.

2.7.1. Removing Transportation Fixing Plate of Compressor

Damping cushions are added to the base of compressor to reduce the vibration and noise during operation. However, such method cannot best resist the vibration while transporting the unit and may result in loosening connections and wearing of certain parts. Hence to ensure the rigidity of the compressor during transportation, three L-shaped fixing plates are added to the compressor bases.

- *Remove the three L-shaped fixing plates after installation, and then restore the bolts and washers in reverse sequence of the disassembly process.*
- *The fastening torque of the bolts is (12±1) Nm.*



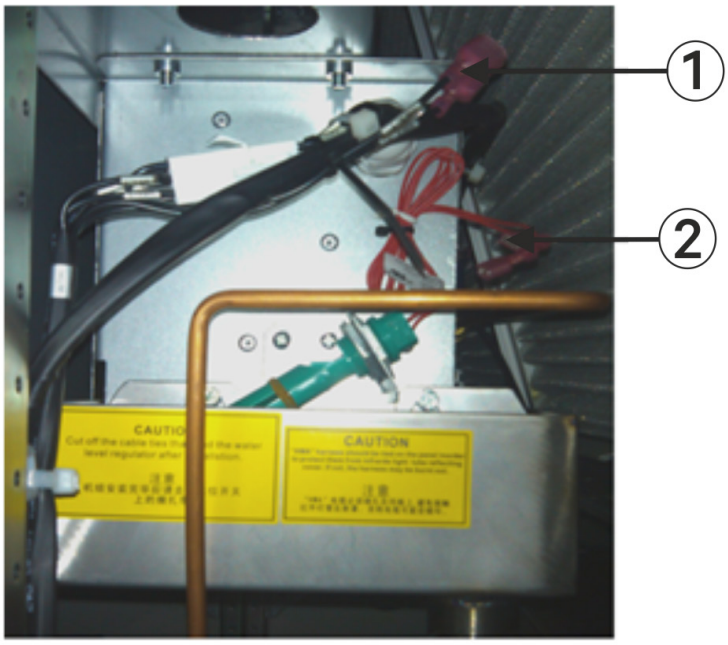
No.	Description
1	L-shaped fixed sheet metal (total 3 PCS)

Figure 2-28 Position of "L" Shape Fixing Plate

2.7.2. Removing of Fasteners of Infrared Humidifier

The floating pole of the humidifier high water-level switch is tightly bound together with a rubber string before delivery, as shown in Figure 2-29. Remove the rubber string before the unit operation. Otherwise, the unit cannot detect the high water-level alarm.

- *Do not touch the lamps with bare hands.*

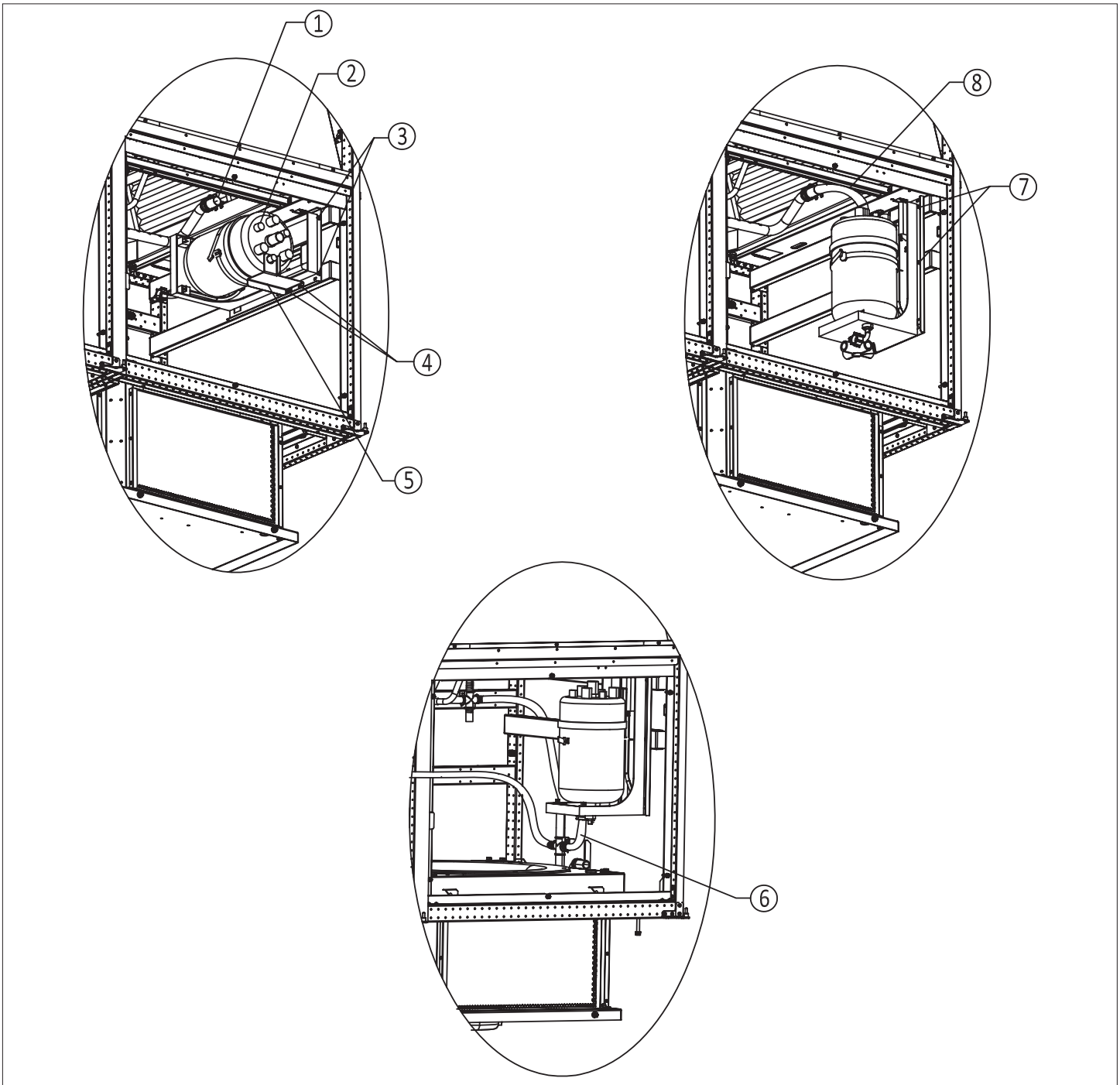


No.	Description	No.	Description
1	Connect the HWA cable to plug terminal	2	Plug terminal

Figure 2-29 High Water Level Detection Float Switch Lever and Terminal HWA

2.7.3. Removing of Fasteners from Electrode Humidifier

The electrode humidification bottle has been placed horizontally for transport convenience. At site, the transportation board and fasteners need to be removed and the humidification bottle can be turned into a vertical position, the specific operation steps are as shown in Figure 2-30.



No.	Description	No.	Description
1	Pipeline	5	Remove transportation fixing plate
2	Electronic humidification	6	Connect the electrode humidifier with drain pipe
3	Removable fixing screw	7	Flip the electrode humidifier as shown
4	Remove transportation fixing screw	8	Connect the inlet of electrode humidifier to the hose pipe line.

Figure 2-30 Mounting of Electrode Humidifier

2.7.4. Removing Pipe Fasteners

To prevent the long copper pipes from scratching the metal plate and being damaged, the pipes are cushioned with foam or bound before delivery. Remove those materials before power-on commissioning.

2.7.5. Installation Inspection

Table 2-15 Installation Inspection Checklist

Items	Results
Leave enough space around the unit for maintenance.	
The equipment is installed vertically, and the installation fasteners have been fixed.	
The pipes between the indoor unit and outdoor unit have been connected, and the ball valves of the indoor unit and outdoor unit have been opened completely.	
Condensate pump is installed (if required).	
The drain pipe has been connected.	
The water supply pipe for the Infrared humidifier has been connected.	
All pipe joints tightened.	
Fasteners for transportation have been removed.	
Irrelevant things (such as transportation material, structure material, and tools) inside or around the equipment have been cleared after the equipment is installed.	
The airflow distribution system has been installed in each room (e.g. raised floor/ grill, duct, etc.).	
The upflow unit must have plenum or have air duct connection, and the fan and heater shall not be accessible after installation.	

Everything is checked and verified, follow the electrical installation.

2.8. Electrical Installation

In this section, the electrical installation of the PEX4 unit is explained in-depth, which include the installation considerations, indoor wiring, power lines connection to the outdoor unit, and the checklist.

2.8.1. Installation Notes

- The connection of all power cables, control cables, and ground cables should comply with the local and national electrical regulations. Parts of the equipment suitable for outdoor use should not be lighter than the normal PVC sheathed cord GB5023.1 (IDT IEC60277). In outdoor use, the power cord should not be lighter than neoprene armored cords (line 57 in IEC 60245).
- The electrical installation and maintenance must be performed by authorized professional/installation personnel.
- See the unit name-plate for the full load current. The cable sizes should meet the local wiring rules.
- Mains supply requirement: 380V to 415 V, 3 Ph+N~50 Hz/ 60 Hz.
- If the soft power cable uses Y-connection, and if the cable is damaged, it must be replaced by professional service personnel.
- Before the wiring, use a volt-meter to measure the power supply voltage and ensure that the power supply has been switched off.
- The applicable grid for this air conditioner: TN, TT star connection power system; consult Vertiv local representative for other connections.
- A breaking device must be provided to be disconnected from power supply.
- Install suitable RCD according to actual installation.

2.8.2. Wiring of Indoor Unit

- **Locating electrical ports of indoor unit**

Locations of the low voltage devices are visible after the front door of the electrical control box of the indoor unit is opened, as shown in Figure 2-31. The distribution information of the detailed low voltage components are differentiated according to the labels.

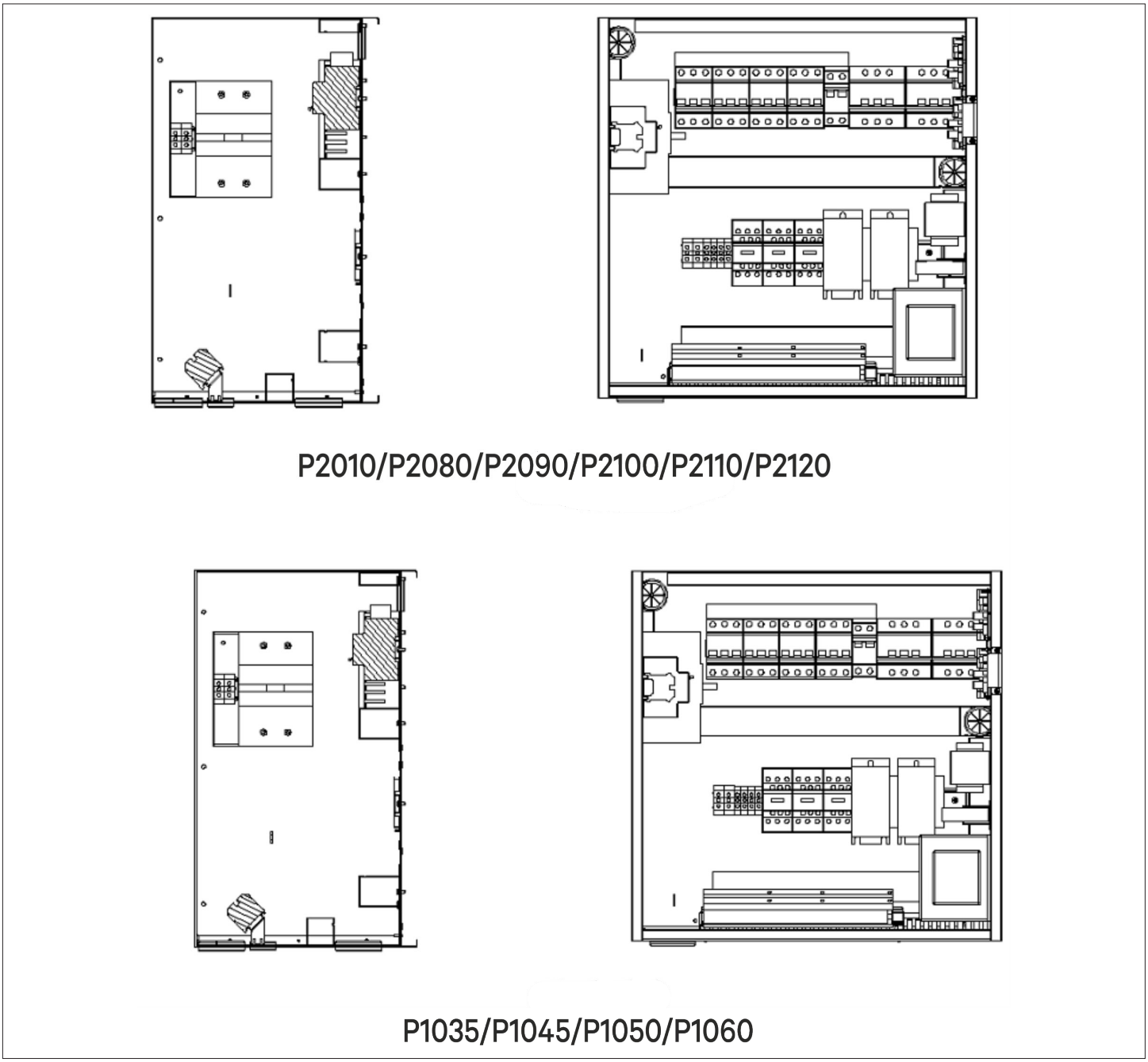


Figure 2-31 Electrical Control Box

- **Connecting power cable of indoor unit**

Figure 2-31 shows the details of the location of power connectors in the electrical control box, connect terminals L1 ~ L3, N, and PE respectively to their counterparts of external power supply. Reserve some redundancy of the incoming cable and fix the cable to the cable clamp located on the inner side panel of the unit, refer Figure 2-29. The types of wiring cables are of copper conductor, and the cross-section-area requirements of the copper wires can vary with the different models. For the cable specification, refer the rated Full Load Ampere (FLA) in Table 2-16.

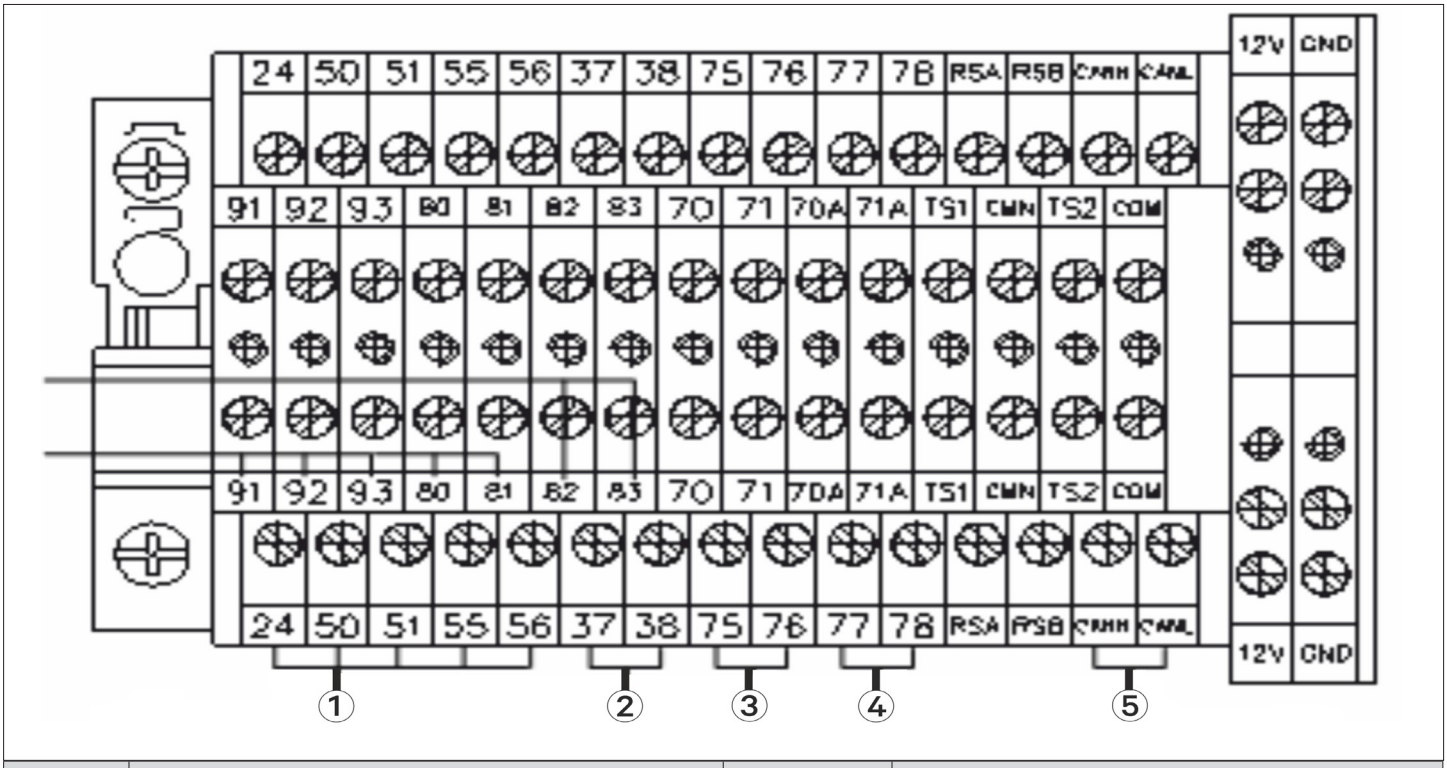
Table 2-16 Rated Full Load Ampere (FLA) (unit: A)

Models	Full Load amps (Comp+ Fan)	Col. A + 1 Stage Heating	Col. A + 2 Stage Heating	Col. A + Electrode Humidification (No Heating)	Col. A + Infrared Humidification (No Heating)
	(A)	(B)	(C)	(D)	(E)
P1035 (U/D)	27.4	41.0	54.6	32.6	33.6
P1045 (U/D)	29.5	43.1	56.7	34.6	35.6
P1050 (U/D)	37.8	51.4	65.0	43.0	43.9
P1060 (U/D)	38.7	52.3	65.9	43.8	44.8
P2070U	54.9	73.0	91.2	63.2	64.1
P2080U	58.9	77.1	95.2	67.2	68.1
P2090U	58.9	77.1	95.2	67.2	68.1
P2100U	75.7	93.8	111.9	83.9	84.8
P2110U	75.7	93.8	111.9	83.9	84.8
P2120U	77.4	95.5	113.6	85.6	86.5
P2070D	54.9	73.0	91.2	63.2	66.3
P2080D	58.9	77.1	95.2	67.2	70.4
P2090D	58.9	77.1	95.2	67.2	70.4
P2100D	75.7	93.8	111.9	83.9	87.1
P2110D	75.7	93.8	111.9	83.9	87.1
P2120D	77.4	95.5	113.6	85.6	88.8

- *FLA values of first four single compressor-based models are same for Upflow (U) and Downflow (D) units.*
- *The FLA values of Air-cooled unit do not account the outdoor unit current.*
- *MCB & Cable sizes are selected as per local electrical norms.*

2.8.3. Connecting Control Cables

The position of field connection terminals is shown in Figure 2-31 and the enlarged view of the terminal optimizing aisle is shown in Figure 2-32. The upper part of the terminal optimizing aisle is connected with the unit, and the lower part is the interface of the user control signal line.



No.	Description	No.	Description
1	Customized alarm terminal/ water under floor sensor	4	RS-485 interface
2	37/38 are short connection remove this short wire at remote shutdown	5	CANH/CANL terminal
3	External general alarm		

Figure 2-32 Enlarged View of Terminal Block

Before connecting the control line, it is mandatory to perform the corresponding anti-static measures.

2.8.4. Connecting Water-Under-Floor Sensor

Each unit is equipped with a water-under-floor sensor. Connect one end of the sensor to terminal 51# and the other end to the common terminal 24#. The number of the sensors in parallel connection are not limited, but each unit has only one water-under-floor alarm.

2.8.5. Remote Shutdown

As shown in Figure 2-32, 37# and 38# terminals can connect to remote shutdown switch, and they have been shorted in the factory and the shorting cable must be removed if the terminals are to be connected to the remote shutdown switch.

When 37# and 38# are opened, the unit will be shut down.

2.8.6. Customized Alarm Terminal

Terminals 50#, 51# and 55# can be connected to three kinds of sensors, and terminal 24# is their common terminal and can be defined as smoke sensor and water-under-floor sensor. After the customer terminals are connected to external alarm signals, the corresponding customized alarm should be set through the controller. When the contact is open, and no external alarm is generated, the input state of the customer terminal is open. But when the contact is closed, and the external alarm is generated, the input state of the customer terminal will be shorted. At this point, the air conditioner system will generate an audible alarm, and the controller HMI will display the alarm information.

- Terminals 50# and 24#: Smoke detector alarm switch
- Terminals 37# and 38#: Remote alarm
- Terminals 51# and 24#: Water-under-floor sensor by factory setting

2.8.7. External General Alarm

Terminals 75# and 76# can be connected to the external general alarms. The output signals to external alarm devices, such as alarm indicator. When critical alarm occurs, the contact is closed to trigger remote alarms, send signals to the building management system or dial the system automatically. The power supply of the external general alarm system is user-prepared.

2.8.8. Connecting Solenoid Valve of Pipe Extension Kit (Optional)

The solenoid valve of the pipe extension kit has two control cables used to connect with the corresponding terminals of the control board. The solenoid valve cables of 1# system and 2# system in dual system unit should be marked separately to avoid wrong connection. For specific wiring terminals in the interface board, refer to the circuit diagram printed on the unit label.

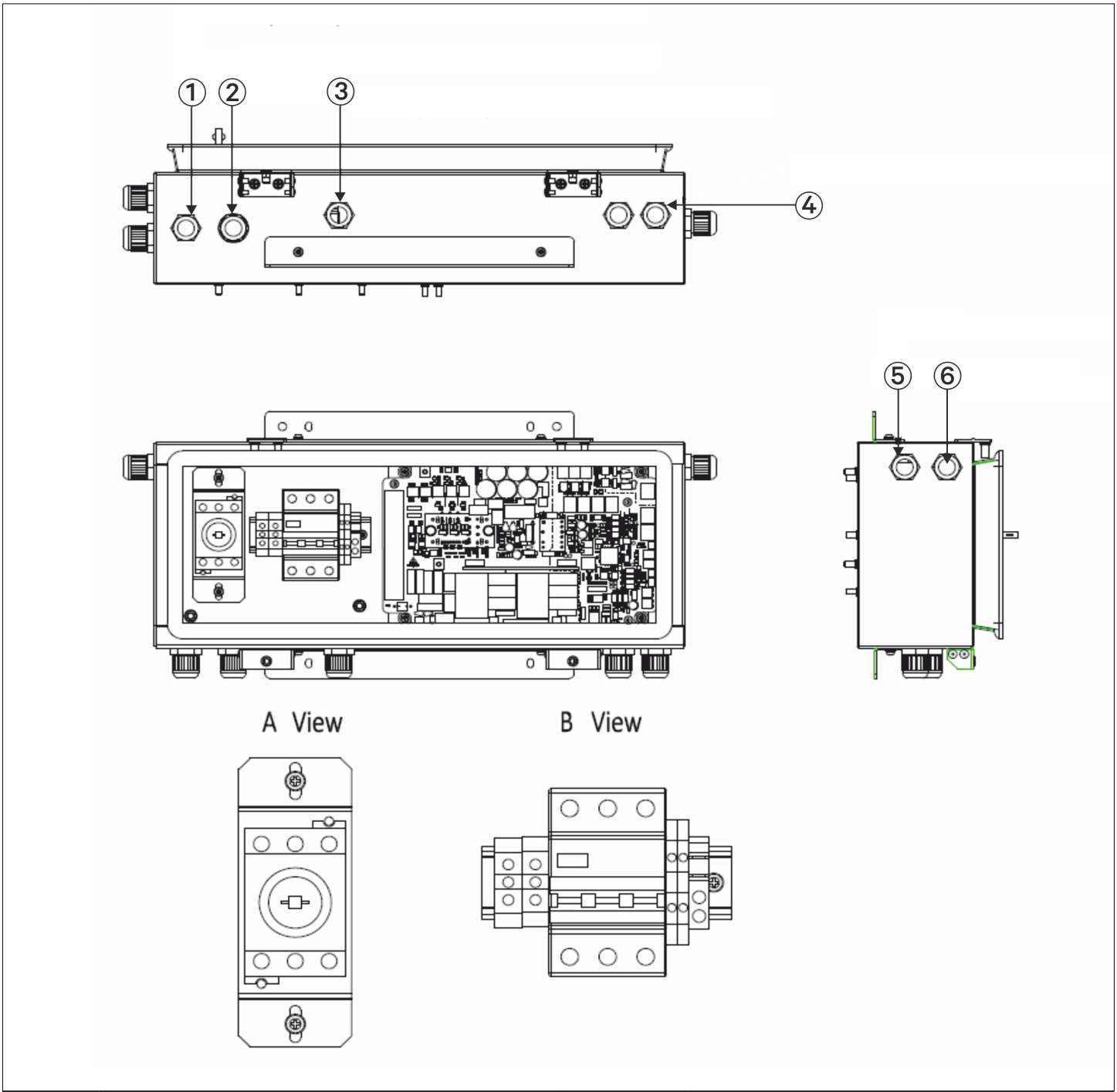
The controller uses the 24V AC solenoid valve port, if other types of solenoid valves are used, consult Vertiv local representative.

2.8.9. Wiring of Condenser

- **Connecting Control Signal Terminals:** 70#/71# and 70A#/71A# are control signal input terminals for two circuits of condensers and their switching status are identical with those of the compressor.
- **Connecting Control Signal Cables:** In accordance with the cable connection instructions in the Liebert Condenser User Manual, open the sealed panel of the condenser's electrical control box to reveal the fan speed controller board. The signal cable connection of condenser is as follows.
- **Wiring of a condenser with single system used to match an indoor unit with single system:** The digital signal of dry contact J6 on the board (refer cable terminals section in Liebert PEX Condenser User Manual for the locations) is connected with the control terminals 70#/71# of the indoor unit.
- **Wiring of two condensers with single system used to match an indoor unit with dual system:** The digital signals of dry contact J6 on the condenser board corresponding to compressor 1# are connected with the control terminals 70#/71# of the indoor unit, and the digital signals of dry contacts J6 on the condenser board corresponding to compressor 2# are connected with the control terminals 70A#/71A# of the indoor unit.
- **Wiring of a condenser with dual system used to match an indoor unit with dual system:** Short the terminals 70# & 70A# and 71# & 71A#. The digital signal of dry contact J6 on the board can be connected with the control terminals 70#/71# or 70A#/71A#.

2.8.10. Connecting Power Cables of Condenser

The power cables of the outdoor unit are connected to the MCBs reserved in the condenser (refer Figure 2-33). Liebert PEX4 is configured with the indoor unit matching the two systems- the external power supply cables and compressor signal cables respectively.



No.	Description	No.	Description
1	Waterproof joint of external power cable	4	Waterproof joint of pressure sensor cable
2	Waterproof joint of compressor signal	5	Waterproof joint of fan power wire
3	Waterproof joint of spray module cable	6	Waterproof joint of fan over temperature switch

Figure 2-33 External Power Supply Wiring Diagram Liebert LVC System

2.8.11. Electrical Installation Inspection

After the electrical installation is completed, confirm the following points as given in the following Table 2-17.

Table 2-17 Installation Inspection Checklist

Items	Results
The power supply voltage meets the rated voltage on the unit nameplate.	
The system electric loop has no open circuit or short circuit.	
Power cables and ground cables to the MCBs, indoor unit and outdoor unit are well connected.	
The ratings of the MCBs and fuses are correct.	
The control cables are well connected.	
All the cables connections are fastened, with no loose screws.	

Chapter 3: Controller Operating Instruction

3.1. HMI Display

PEX4 unit uses 'Global HMI 9-inch Color Display Board', as shown in Figure 3-1 with following characteristics:

1. Menu-based operation, monitors and displays the operation status of precision cooling air-conditioning equipment, it also keeps the control environment within the set range.
2. It has power-down self-recovery function such as high and low voltage protection, phase loss protection, reverse phase protection and other functions.
3. The menu operation provides an accurate understanding of the system's main parameters and operational status.
4. Expert fault diagnosis system, can automatically display the current fault content, helps maintenance personnel for equipment maintenance.
5. It can display 500 historical alarms.
6. Configured CAN interface, using CAN communication protocols.

Figure 3-1 HMI Screen Display Panel Main Interface

3.2. Light Indicator

Display board have four LED indicators, the corresponding colors and functions are described in Table 3-1

Table 3-1 Indicator Function

Light	Function Description
Blue	The display is starting.
Yellow	The display fails to communicate with the Control Panel or the system shuts down.
Green	System operating normally.
Red	The system has alarms and buzzer rings.

3.3. Start-Up Interface

After the unit is powered ON, color display startup screen shown in Figure 3-2.

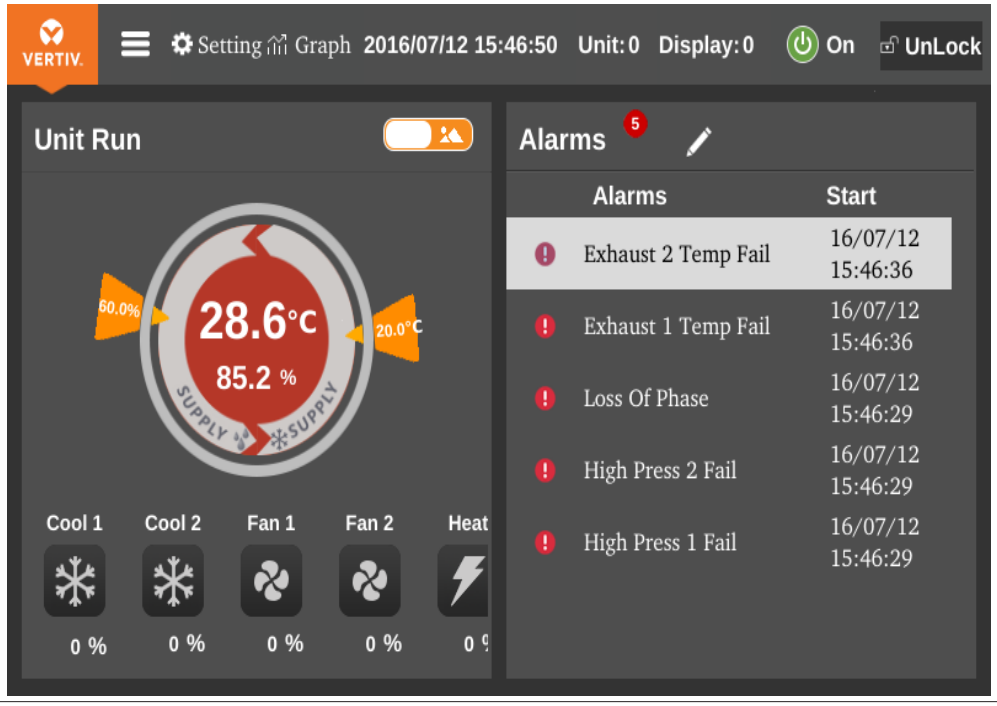


Figure 3-2 Start Interface

3.4. User Menu

Table 3-2 provides the list of menu keys and its functional description.

Table 3-2 Interface Key and Function

Keys	Functional Description
Menu button	Press this button to display the main menu page by page and enter the various sub-menus
User button	Press this button to enter the main page to see the systems primary data readings
Settings button	Press this button to enter the temperature and humidity settings page, the system can set temperature and humidity in the control mode
Off button	The unit is turned off, click this button for at least 2s, the unit will be powered on, if the unit is running, click this button for at least 2s, the unit gets shut down
Unlock button	Press this button, enter the user login password to log in, login will not appear after the Settings menu icon opens
Toggle button (left)	Press the toggle button to switch between the graphical display mode and the list display mode
Toggle button (right)	Press this button to switch between the current sensor readings and current alarm pages
Time display icon	Displays the current time
Temperature set point icon	Displays the current temperature set point control mode according to the current control mode, and points to the corresponding arc position according to the temperature value ration.
Humidity set point icon	Displays the current humidity set point, and points to the corresponding arc position according to the proportion of humidity value.
Actual temperature	Displays the current actual temperature value, the current display mode is switched according to the control sequence.
Status display	Displays the current state of the unit and respective components.
Sensor reading list	Displays the current operating status of each sensor and its respective components.
Alarm List	Displays all the current alarms.

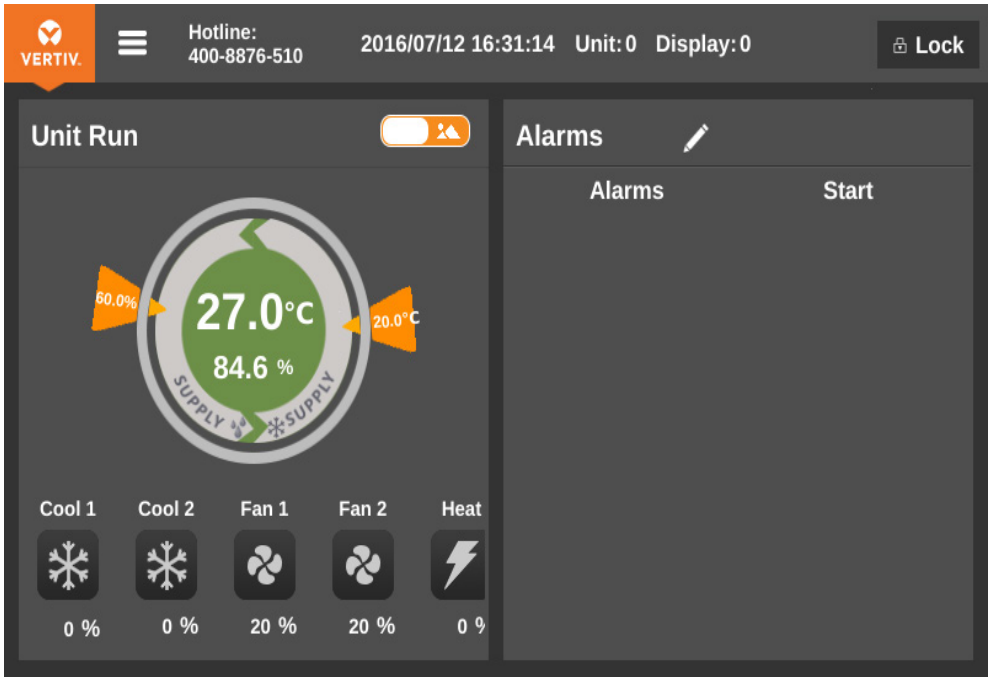


Figure 3-3 Color Display Screen – Locked

Figure 3-4 Color Display Screen – Unlocked

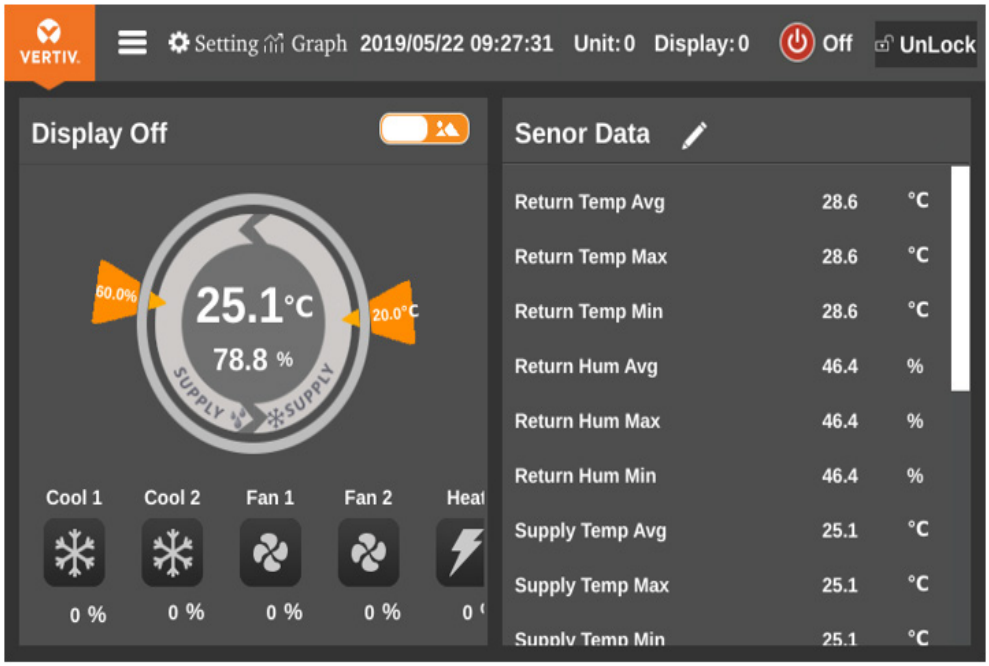


Figure 3-5 Real-time Sensor Data Parameter List - Unlocked

3.4.1. Password Interface

Press on the Lock icon in the upper right corner of the display, the password interface is displayed, as shown in Figure 3-6.

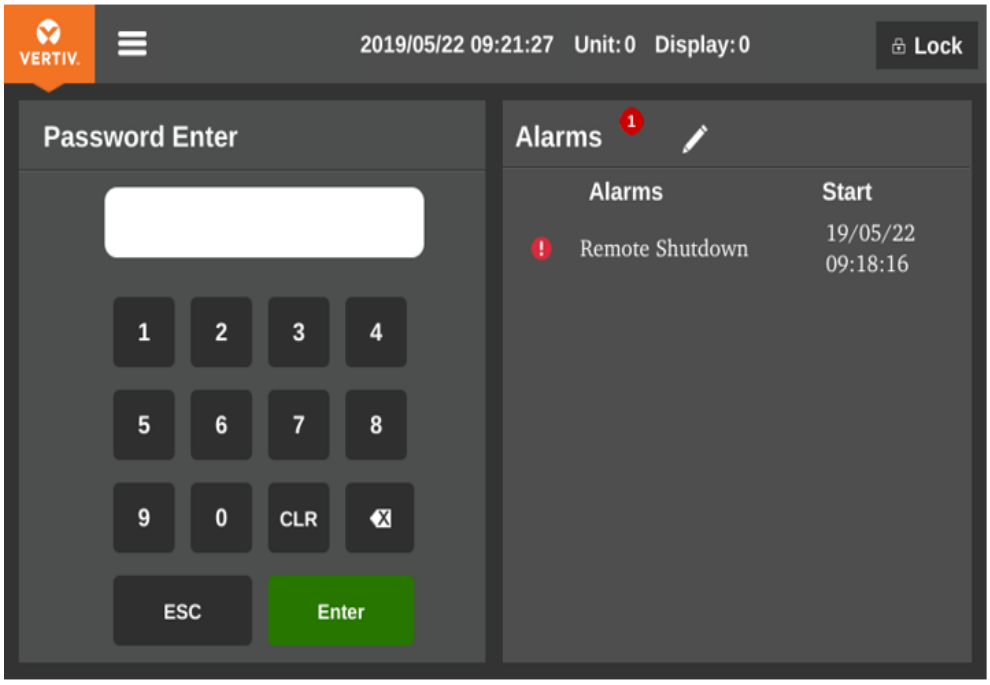


Figure 3-6 Password Interface

Table 3-3 shows the different levels of password for accessing the menu. The detailed explanation is provided in the same table.

Table 3-3 User Access Level

Password level	User	Password	Remark
Level 1	General Operator	0001	Allow user can browse all menu information; and able to set all parameters.
Level 2	Maintenance Personnel	0002	Allows user to modify primary, level two password protection parameters and modify the first level/ second-level password
Level 3	Manufacturer Technician	--	Allows user to modify primary, level two, level three password protection parameters, and modify the first level/ second level II password, three level password is not allowed to be modified

For the specific password input procedure, refer to Example 1. If incorrect password is entered, press CLR (Clear key) to make the changes.

If the users do not enter the password and press the Enter button, the users can view the menu settings, but can not change any parameters, similar to the incorrect example of the password.

Example 1: Enter the password to enter the main menu after the system is powered ON, perform the following operations to enter the main menu.

1. Press the Unlock button to enter the password interface.
2. Enter the user correct login password in the password interface.
3. After entering the correct password, in the main interface, the corresponding parameters of the unit can be modified.

3.4.2. Menu

Press the MENU button to enter the respective sub-menu options to be viewed and set the system state as shown in Figure 3-7.

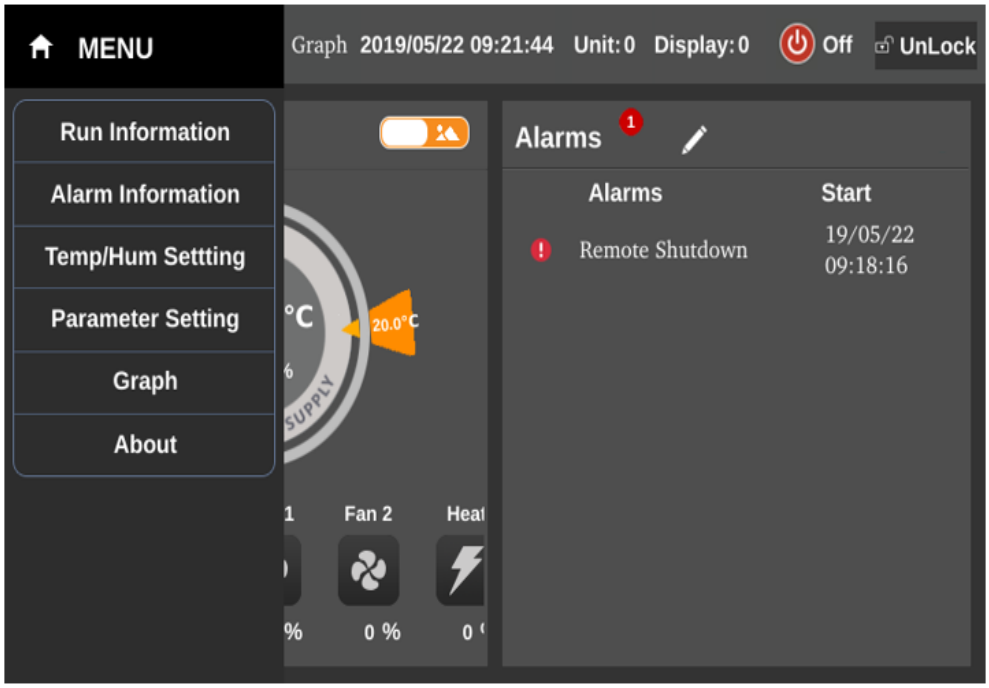


Figure 3-7 Menu

3.4.3. Alarm Menu

Current Alarms: Press the Alarm menu icon in the main menu to enter the page as shown in Figure 3-8. It contains two pages: Alarm Status and Alarm History. The current alarm page is used to monitor the current alarm status record of the AC unit, indicating no alarm or specific alarm status information. Specific alarm status information includes serial number, alarm content, alarm time, as shown in Figure 3-8.

The latest Alarm SN is the largest number. Press the Up or Down button to scroll through the status records if more than one alarm is activated. Up to 500 historical alarm records can be stored. They will not be cleared upon system Power-OFF.

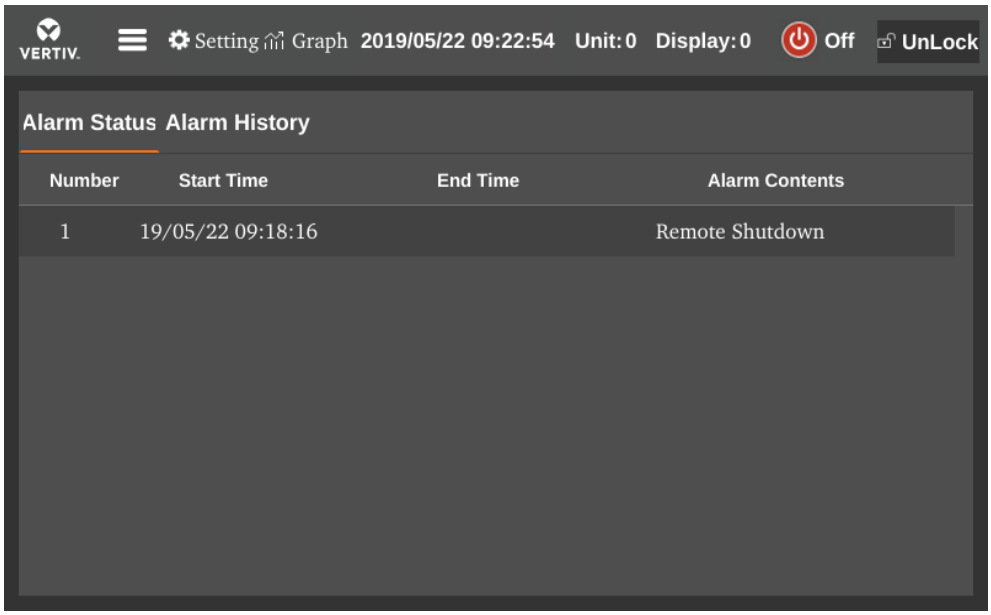


Figure 3-8 Alarm Menu

Alarm History: The Alarm History is used to view the historical alarm records, including the Alarm Status Number (quantifiable number of history alarms), Alarm Serial Number and Alarm Type, Alarm Time (Start and End Time) as shown in Figure 3-9.

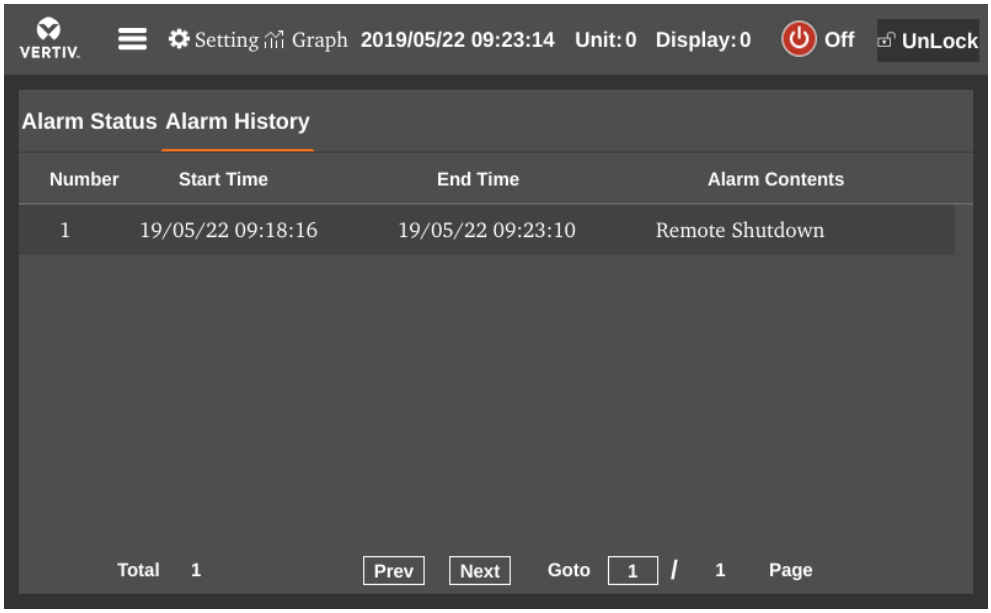


Figure 3-9 Alarm History

Press the Up or Down button to scroll through the status records if more than one alarm is activated. Up to 500 historical alarm records can be stored. They will not be cleared upon system Power-Off.

Parameters/ System Settings: Enter the user password and login to access the System Setting icon. Press the icon to enter the System Setting page. The System Setting also includes the system parameters, valve parameters and pump parameters settings, as shown in Figure 3-10.

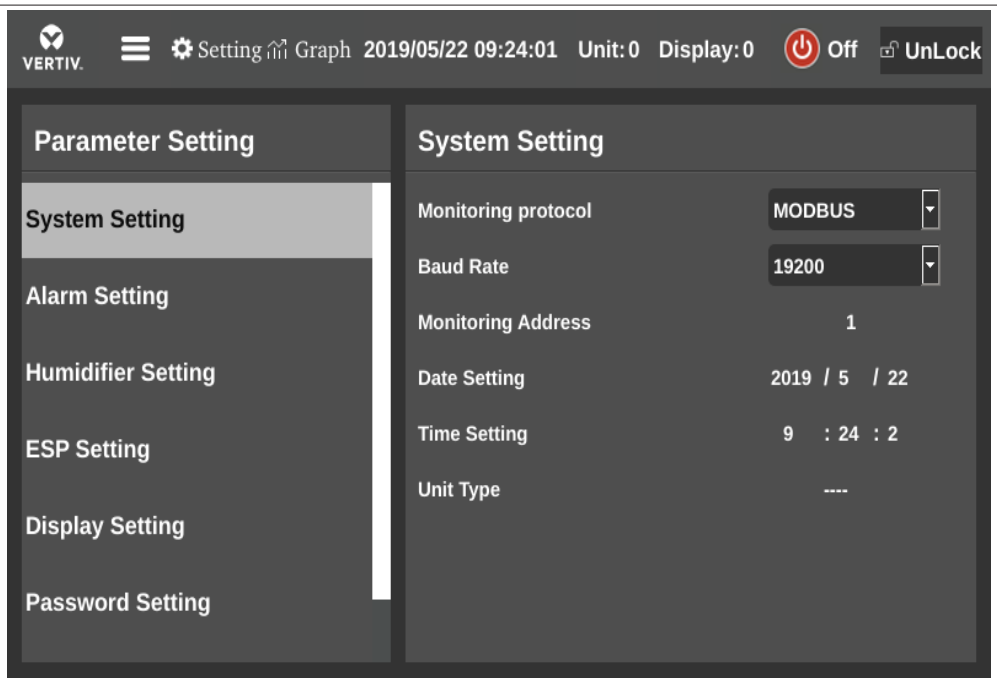


Figure 3-10 Parameters/ System Setting

In the System Setting screen, the system parameters can be set to Monitoring protocol, Baud Rate, Monitoring Address, the Display Address, Date and Time Setting. The specific setting methods are as follows:

Example 1: Setting the control temperature

1. Temperature Setting item, press the position number, the interface appears as shown in Figure 3-11.
2. In the interface, enter the corresponding temperature values.
3. Press on Enter, to complete the setup.

Example 2: To modify the parameters; for example, to set the Humidity Setting menu item in the Temperature and Humidity Setting menu.

1. Press on the main menu interface Temperature and Humidity Settings.
2. Enter the Temperature and Humidity Setting interface and Press the Humidity Setting page.
3. In the Humidity Setting interface, press to set the corresponding setting value.
4. After the parameters are selected, press Enter to confirm the parameters take effect.
5. Press the Home icon to return to the home page.

After changing the parameters, press Enter to confirm, else the Humidity Setting will keep the original parameters.

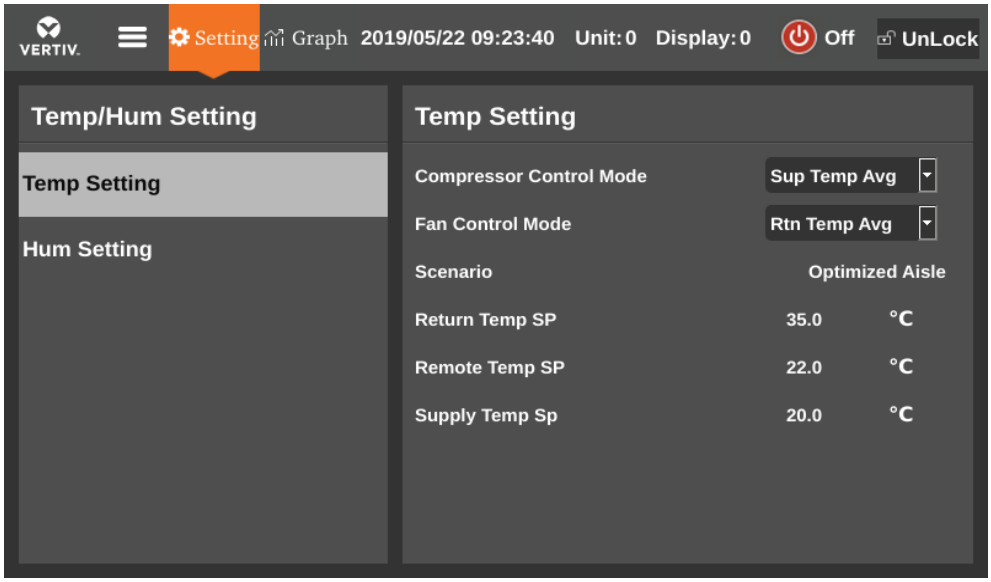


Figure 3-11 Temperature Setting

Example 3: Control Mode Settings

1. Control Mode item, Press the drop-down button next to the box.
2. Select the appropriate control mode in the drop-down menu as shown in Figure 3-12 to complete the set.

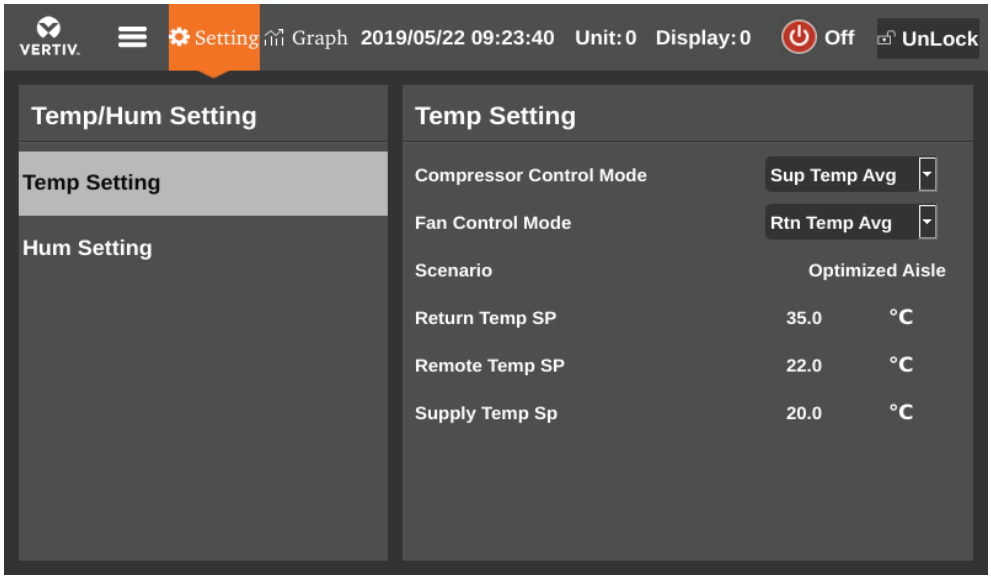


Figure 3-12 Control Mode Settings

Example 4: Application Setting

1. Press the application drop-down box.
2. Select columns between the Compressor Control Mode and Fan Control Mode will switch automatically to the air supply average, select the room, Compressor Control and Fan Control Mode switches to the return air average automatically.

Do not change the default values of the initial settings. It is recommended to change the settings only under the guidance of qualified service professional.

Alarm Setting Parameters: Press the Alarm Setting icon, enter the alarm settings page as shown in Figure 3-13. A keyboard appears in the interface. Enter the upper and lower limits, the alarm value will be saved.

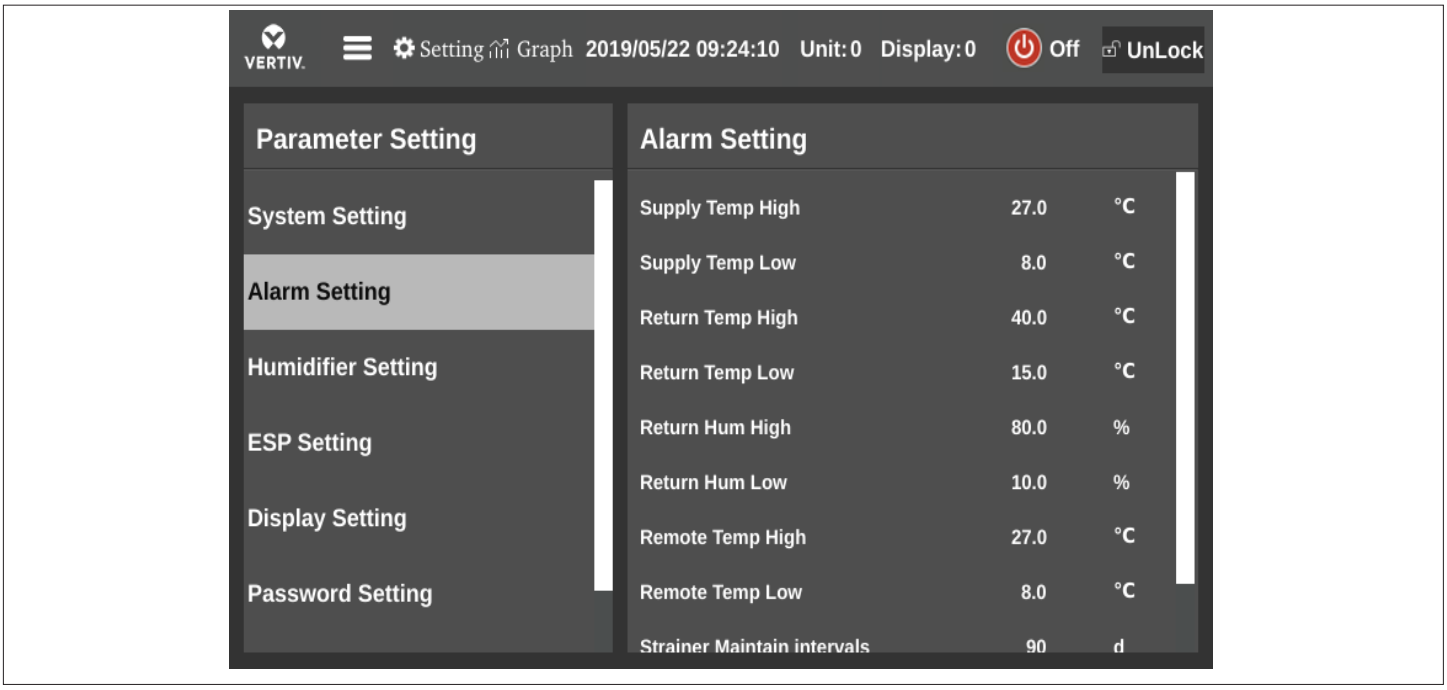


Figure 3-13 Alarm Setting Parameters

Humidifier Setting Parameters: Press the Humidifier Setting icon to enter the humidifier settings page as shown in Figure 3-14.

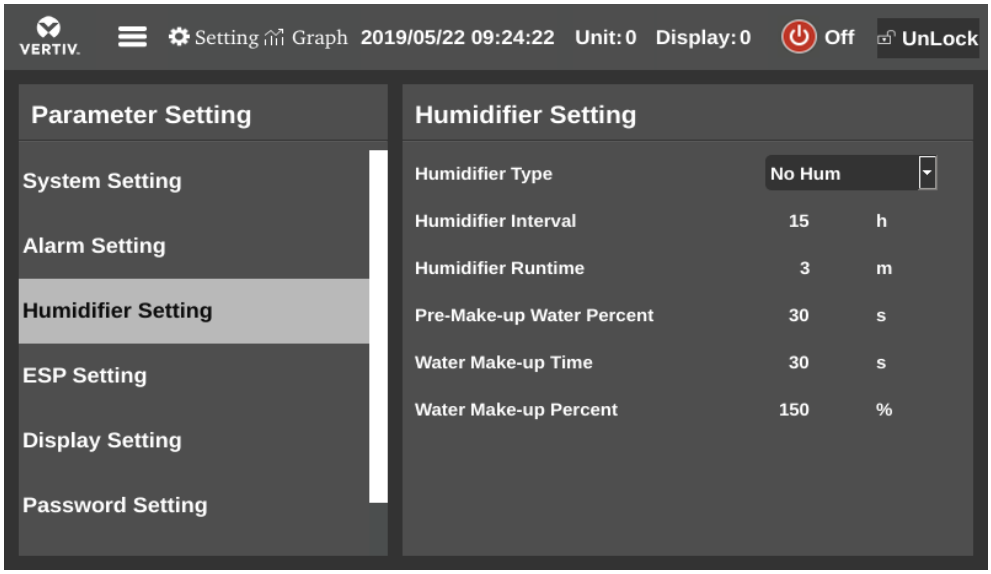


Figure 3-14 Humidifier Setting Parameters

When modifying the alarm value on the keyboard, the alarm value needs to be modified within the upper and lower limits.

Teamwork Settings: Press the Parameter Setting in the menu to enter the parameter settings page. Press the Teamwork Setting to modify the teamwork function, set the parameters such as the Rotation Cycle, Rotation Quantity and Rotate At (the rotation time), as shown in Figure 3-15.

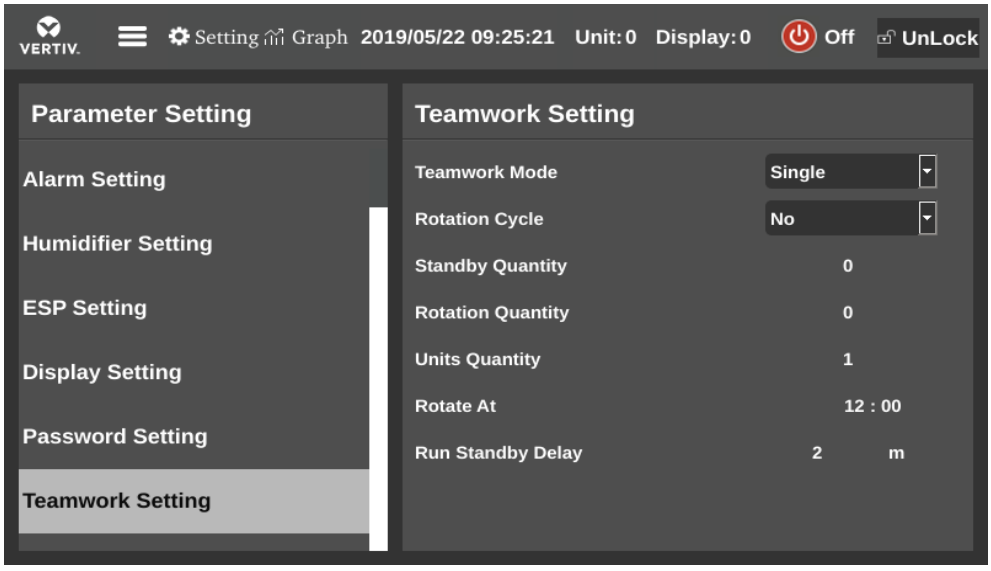


Figure 3-15 Teamwork Settings

External Static Pressure Settings: Press the External Stattic Pressure (ESP) Setting button, to enter the interface as shown in Figure 3-16. Press the intermediate data display frame, a keyboard will pop-up then parameters can be set according to maximum and minimum values of airflow pressure on the keyboard.

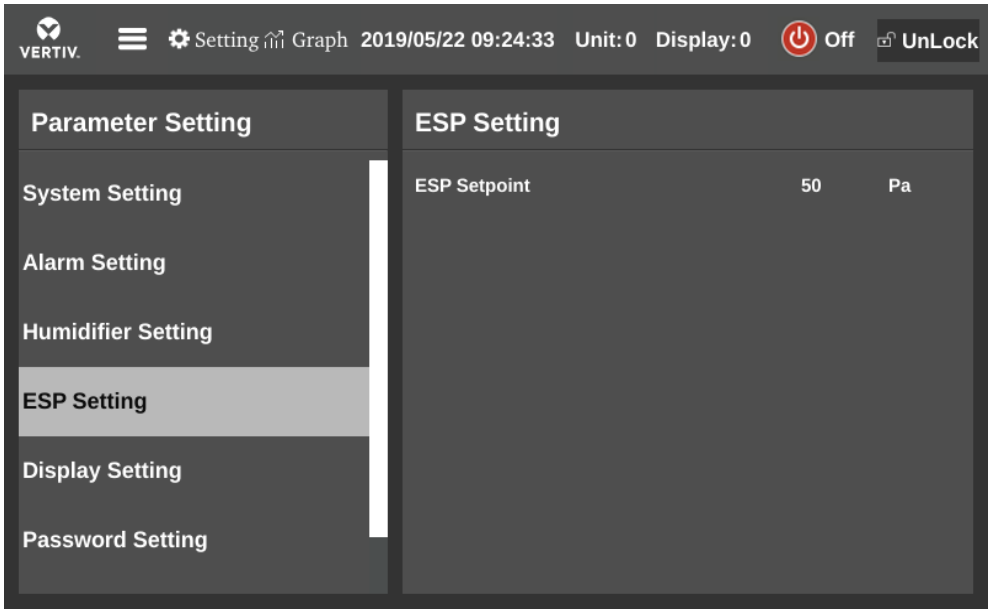


Figure 3-16 External Static Pressure Settings

Display Settings: Press the Display Setting icon interface shown in Figure 3-17, press the Parameter Setting menu, then press the Display Language setting to press the language settings in the drop- down box, display English support. The drop- down box of the unit type can be set on the unit type.

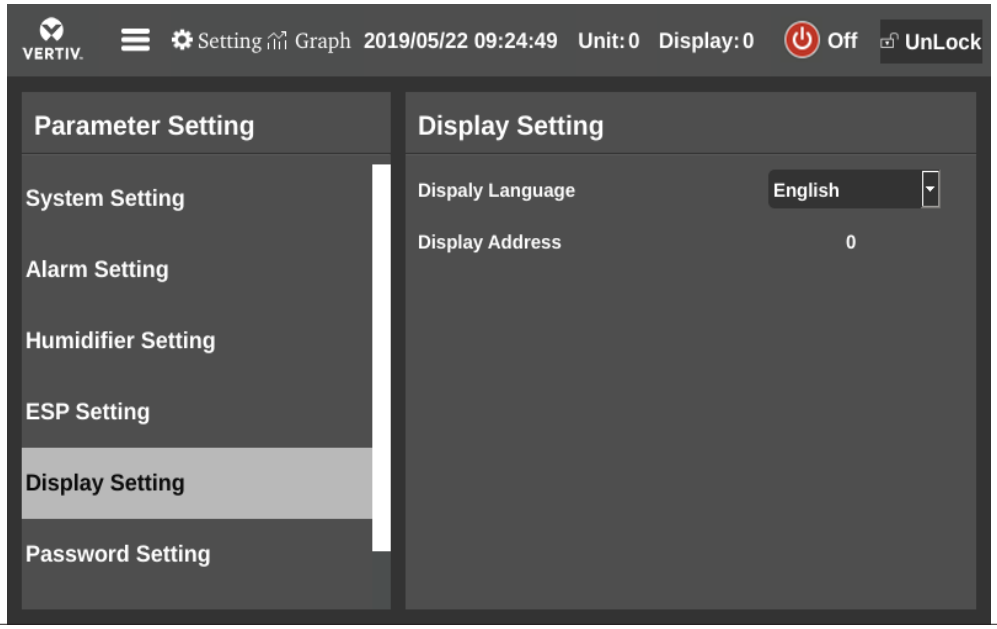


Figure 3-17 Display Settings

Start Password Settings: Press the Settings icon, start to enter the settings page, shown in Figure 3-18. Press to start the password box, keyboard will pop-up, then enter the start password, if the password is correct, then set the start pop-up box can be used and if the password is wrong, set the pop-up start boxes cannot be used.

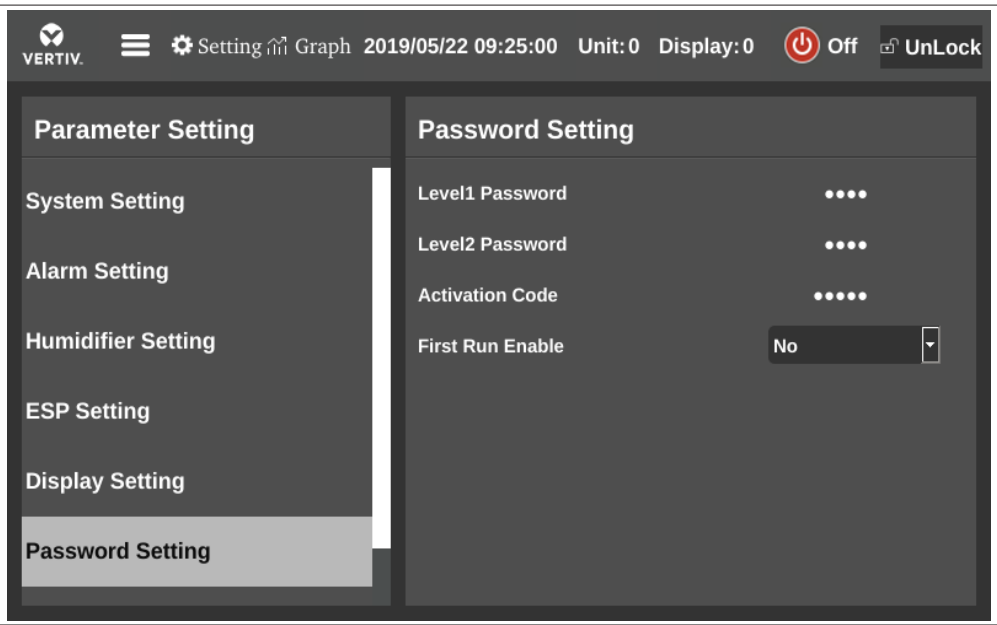


Figure 3-18 Start Password Settings

3.5. Unit Status

3.5.1. Temperature and Humidity Status

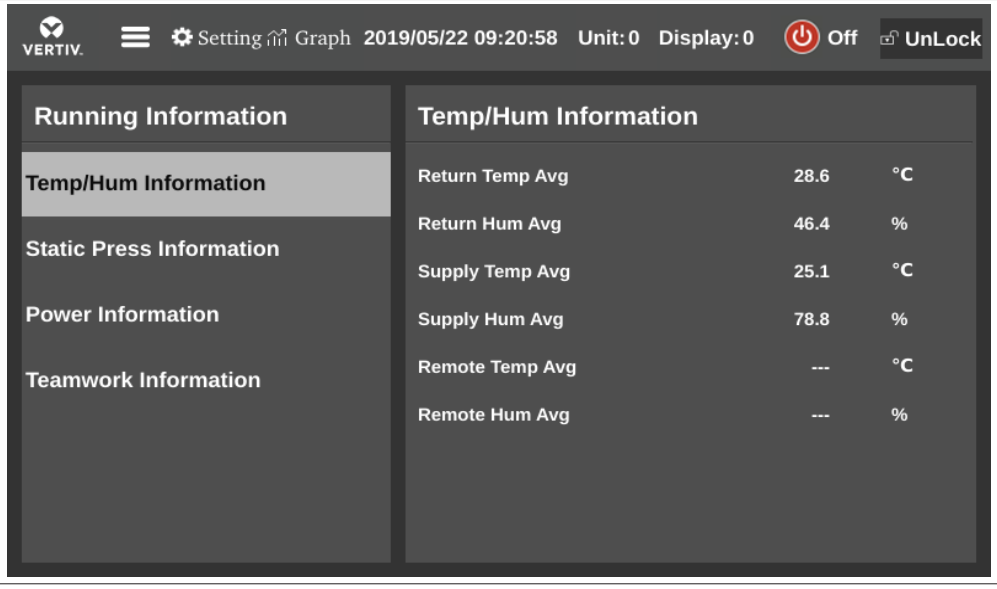


Figure 3-19 Temperature and Humidity Status

Press on the main menu screen, or the top of the “Settings” button, to enter the Temperature and Humidity Setting page. The Compressor and fan control mode can be modified by the digital keyboard press according to the low temperature and humidity limit temperature set on the keyboard.

Temperature and Humidity Curves: Press the menu button, then press the temperature and humidity to view the temperature and humidity curve graph interface. Press on any one of the corresponding curves of FIG button that appears in the menu. “-” can reduce the display range of the graph, press reduced to two hours.“+” can enlarge the graph display range, press to enlarge two hours.

Figure 3-20 Temperature Curves

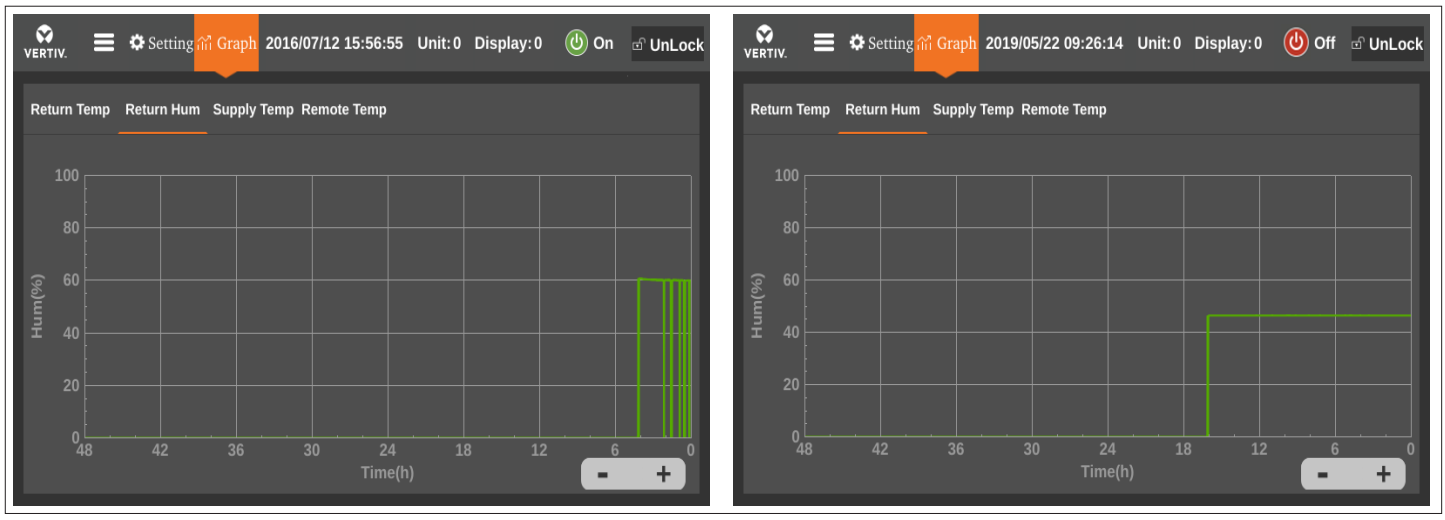


Figure 3-21 Humidity Curves

3.5.2. Power Information Display

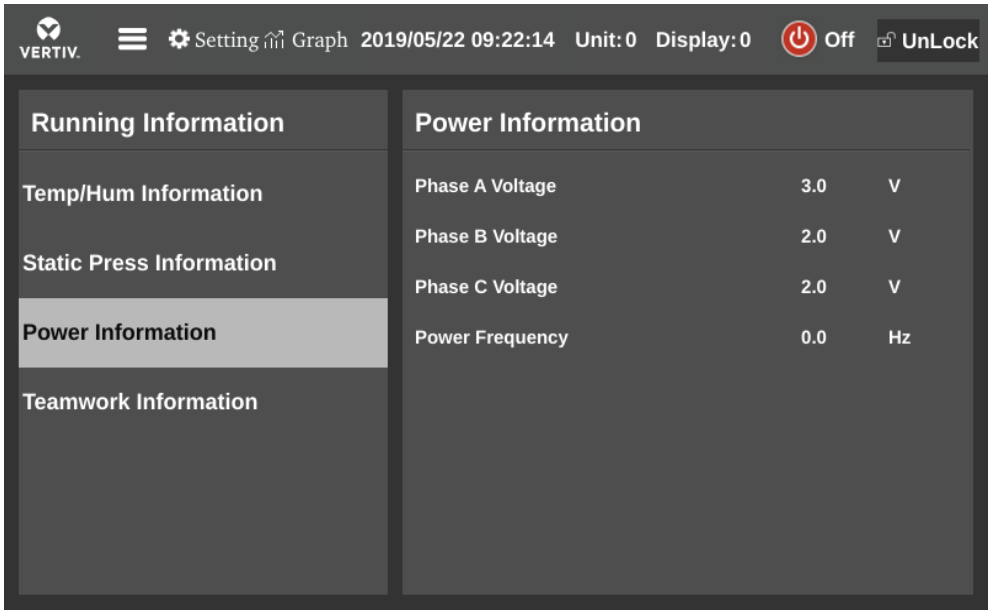


Figure 3-22 Power Information Display

3.6. Hardware and Software Information

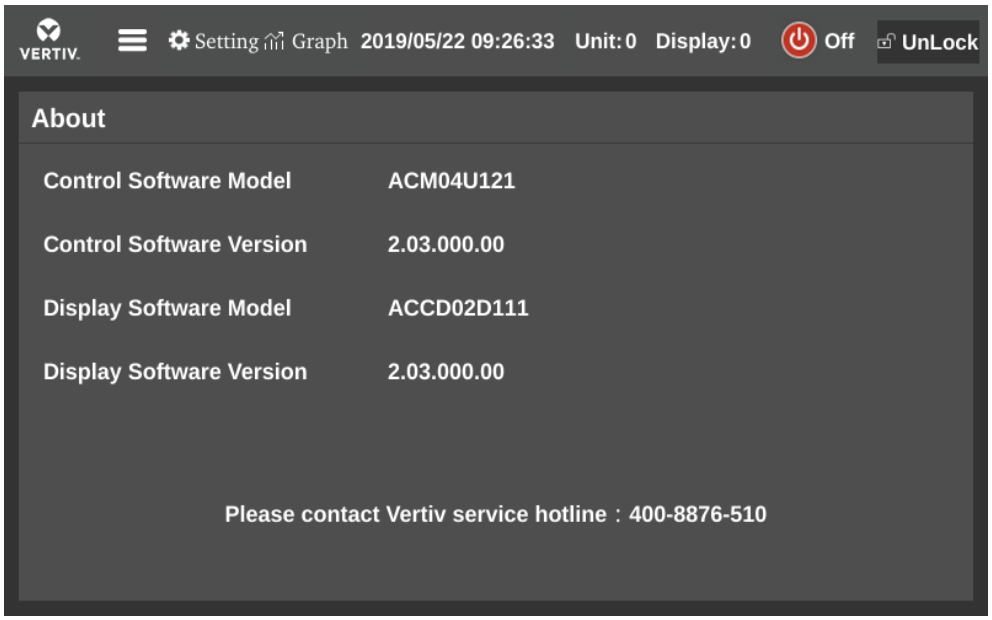


Figure 3-23 Hardware & Software Information

3.7. Remote Monitoring Mode

Liebert PEX4 inverter air conditioner series supports a variety of monitoring methods:

- Modbus RTU – Modbus Remote Terminal Unit (RTU) communication protocol over a RS-485 serial network (also known as Modbus RTU RS-485)
- Optional SIC cards, access through SNMP network management software agreement.

Chapter 4: General Maintenance

The system operation and maintenance of the Liebert PEX4 air conditioner are explained in brief from an end-user perspective. It includes information related to routine maintenance and inspection of electrical connections, wiring, system diagnosis, visual appearance checks, and drainage maintenance among others.

Prior to operation and maintenance, the lethal voltage may be present in the equipment which can be fatal. All notes, warnings, and cautions marked on the equipment as well as the ones mentioned in the manual must be considered, otherwise, it may leads to injury and fatality.

Only qualified service and maintenance personnel can perform system operation and maintenance.

4.1. Manual Operation Function

The controller features a diagnostic function that enables the user to manually turn On/ Off the components on site to check, if the components are working normally.

4.2. Electrical Connection Inspection

The inspection items include:

1. Conduct overall electrical insulation test, find out the unqualified contacts and handle them. Note to disconnect the fuses or MCBs of the control part during the test that the high voltage should damage the control components.
2. Check the contactors before power-on and ensure the contactors can act freely without obstruction.
3. Clean the electric and control elements of dust with a brush or dry compressed air.
4. Check the closing of contactors for arcs or signs of burned. Replace the contactor if necessary.
5. Fasten all the electrical connection terminals.
6. Check that the sockets and plugs are in good condition. Replace those loosen ones.
7. If the power cables are damaged, to avoid any further damage, the cables must be replaced by professional personnel.

4.3. Control Component Appearance Inspection

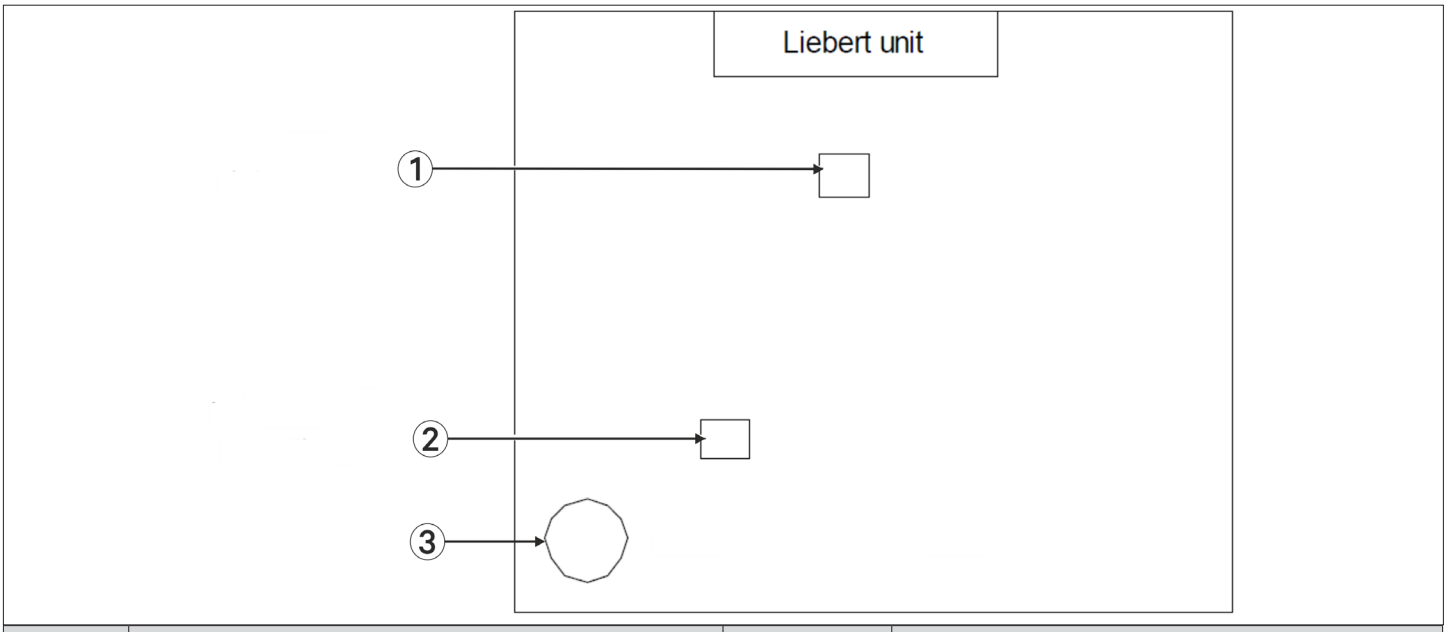
Carry out visual inspection and simple function test by referring to the following items:

1. Visually inspect the power transformers and isolation transformers, and test the output voltage of the indoor unit and the outdoor unit.
2. Check that there are no signs of aging on the control interface board, control board, temperature and humidity sensor board and fuse board.
3. Clean the electrical control elements and control board of dust and dirt with a brush and electronic dust removing agent.
4. Check and fasten the I/O ports at the control interface board, including the connection between control board and control interface board, as well as between the temperature/humidity sensor board and the interface board.
5. Check the connection between the user terminals (70#, 71#, 70A#, 71A#, 37#, 38#) and the control interface board.
6. Check the output connection between the control interface board and various contactors and solenoid valves for liquid pipes. Also check the input connection between control interface board and fan overload protector, high pressure switch, heating over-temperature protection switch, humidifier protection switches, discharge air temperature sensor, and a low pressure sensor. Check the connection parts such as high pressure switches and solenoid valves, and replace the component if are in poor connection or faulty.
7. Check and replace electrical components that are faulty, such as control fuses (or MCBs) and control boards.
8. Check the specification and aging condition of the control cable and power cable between the indoor unit and the condenser, and replace the cables when necessary.
9. Use temperature and humidity measuring meters with higher precision to measure and calibrate the temperature and humidity sensors.

- *Set the humidity control mode to 'relative humidity control' during the calibration process.*
- *Adjust the setpoints. Check the action of the functional parts and the auto-flush control logic of water pan of the infrared humidifier according to the control logic.*
- *Simulate and check the operation of the protection devices including high and low pressure alarm, high and low temperature alarm, high water level alarm and over-temperature protection.*
- *Check the water detection sensor.*

4.4. Water Leak Detector

Connect water leak detectors and through the controller confirm the alarm information. The detector should be located away from any drainage discharge on the floor, 2 m to 2.5 m away from the unit. Do not place it directly under the unit. Figure 4-1 shows the recommended location for the water leak detection sensor.



No.	Description	No.	Description
1	Location of water detection sensor	3	Drain pipes on the ground
2	Location of the water detection sensor		

Figure 4-1 Recommended Location for the Water Detection Sensor

- *Before fastening the connection of any mechanical parts or cables, ensure that the power supply of the control unit has been disconnected.*
- *Do not use the water detection sensor adjacent to flammable liquid or use it to detect flammable liquid.*

4.5. Air Filter

The efficiency of the air filter in the unit is 30%, which complies with US ASHRAE52-76 and Eurovent 4/5 standards, and the dust resistance value is 90% (EU4 standard). To ensure the normal operation of the filter, the filter service alarm logic is provided by the controller. The default fan running time is 2000 hours when the time is exceeded, the filter service alarm is triggered. The user needs to replace the filter based on the clogging condition of the filter. The filter must be checked once a month, and be replaced as required during operation.

- *Cut the power supply before replacing the filter.*
- *Clear the fan running time to '0' after replacing the filter.*

4.6. Fan Kit Maintenance

Regular checking of the EC fan includes inspection of the motor operating status, fan impeller state, and the clearance between the fan and airflow-leading ring. Check whether the fan or the airflow-leading ring has been installed properly and firmly. Ensure that the fan blades do not hit the adjacent metal plates under any circumstances. Clear the clogging element which leads to reduce air volume and affect refrigeration system. In addition, the fan fault alarm of the control board and alarm point of the EC Fan is connected in series. If the rotating speed is abnormal, the unit will ideally generate an EC fan fault alarm.

- *Turn off the fan/unit prior to replacement of the filter.*
- *The speed regulating control board of the outdoor EC fan has a possibility of an electrical shock leading to injury. Therefore, do not touch the board when the unit is powered on.*
- *While the unit is powered on, do not strictly touch the fan mesh enclosure as it may end up damaging caused by the fan operation.*

4.7. Infrared Humidifier

During the normal operation of the infrared humidifier, sediment such as mineral particles will accumulate on its water pan. To ensure efficient operation of the infrared humidifier, the sediment needs to be cleaned regularly. However, the cleansing cycle varies because the water quality is different in different regions. It is recommended to check and cleanse (when necessary) the water pan once a month. The auto flush function of the infrared humidifier can prolong the cleaning cycle. However, regular checks and maintenance are necessary.

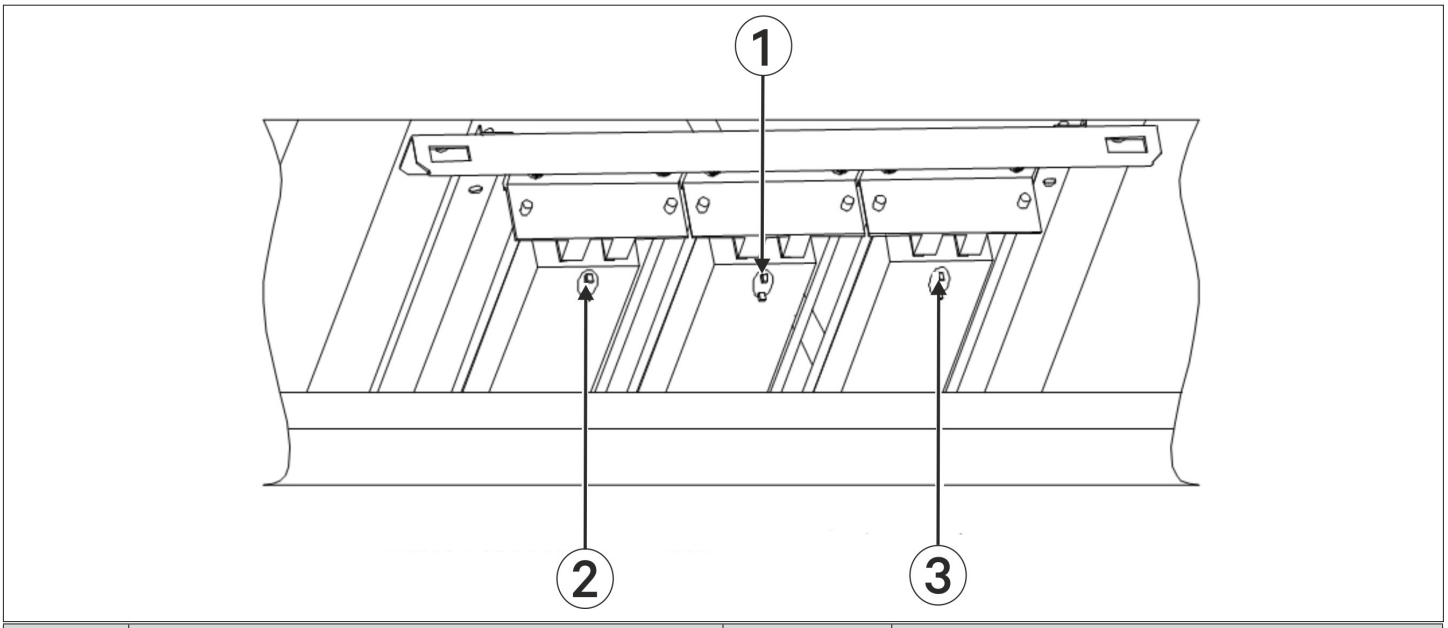
Cleaning steps:

1. Remove the water level standpipe to drain the water pan.
2. Disconnect the drainage pipe.
3. Remove the safety switch of the water pan.
4. Remove the fixing screws at the two ends of the pan and pull out the water pan. Cleanse the water pan with water and hard brush.
5. Restore the water pan by reversing the preceding procedures.

Before exercising the corresponding operation, ensure that the power supply has been switched off; also, ensure that the water in the water pan is close to the room temperature before draining the water from the infrared humidifier water pan to avoid the personal injury.

4.8. Electrical Heater

The electrical heater includes three temperature switches that are connected serially to the control loop, whereas two of the switches are reset automatically, the remaining one is a manual reset switch. Figure 4-2 shows a schematic representation of the three switches inside an electrical heater.



No.	Description	No.	Description
1	Manual reset temp switch	3	Auto reset temp switch
2	Auto reset temp switch		

Figure 4-2 PTC Electrical Reheater

The following steps need to be followed during inspection and maintenance of the electric heater:

1. Check the electrical heater for rust. Use an iron brush to remove the rust, if possible, or replace it if the rustiness is immense or if there is some damage.
2. When heating is required, but heating is not effective, or no heating effect is observed, a multimeter should be used to check whether the cable connected to the temperature switch is functioning correctly to ensure that the three temperature switches are normal.
3. If the cable is not functioning properly, remove the electrical heater and check if the manual reset switch is disconnected. Next, check the automatic reset switches or the electric heater pipe for damage or faulty condition.

Before exercising the corresponding operation, ensure that the power supply has been switched off.

4.9. Cooling System

1. To find any abnormalities and abrasions, the components of the cooling system should be inspected monthly.
2. Because component failure is usually accompanied by their corresponding faults, regular checking is an imperative function to implement in order to avoid most system failures.
3. Inlet and outlet water pipes must be properly fixed and must not vibrate against the wall, floor or frame of the unit.
4. Inspect all water pipes and fixing brackets every six months for signs of wear and tear.

Chapter 5: Troubleshooting

Troubleshooting is to be performed by the trained and qualified service personnel. However, the checklists have been provided just for reference purpose.

- *Certain circuits carry lethal voltages. Only professional technicians are allowed to maintain the unit. Extreme care and caution is required while troubleshooting online.*
- *If jumpers are used for troubleshooting, remember to remove the jumpers after the troubleshooting, if not removed the connected jumpers may bypass certain control functions and increase the risk to the equipment.*

5.1. Componentwise Alarm and Solutions

5.1.1. Fan Troubleshooting

Refer Table 5-1 for fan fault diagnosis and treatment.

Table 5-1 Fault Diagnosis and Treatment of Fans

Symptom	Potential Causes	Items to be Examined or Handled Process
EC fan cannot be started	Fan power supply failure	Check if the fan MCB is closed. When the MCB is closed, check if the phase voltage is normal.
	Control board failure	• Check if the output percentage of fans are 0. • If not, check terminal J64 (1-Bay unit) or terminal J64 & J86 (2-Bay unit) is/ are analog output of 0 Vdc to 10 Vdc. If so, the control board probably fails and needs to be changed.
	Fan power module failure	Check the alarm indicator of the fan power module to judge if the control board fails.
	Loss of airflow alarm	Check whether there is Loss of Airflow Alarm. If the alarm default temperature difference value is too low (10 °C plus is suggested)
	EC fan fault	• Check if the fans L1, L2 and L3 are power-off, or have phase failure or under voltage. • Check if the analog output of J64 or J86 is in the range of 0 Vdc to 10 Vdc. • Check if the motor is blocked (over current). • Check if the motor is over heated. • If the issue is #1, #2 or #3, the motor can recover its operation after clearing the fault. • If the motor is over heated, power-off the fan, and power-on after the motor cools down. • If there is other failure mode, then it should be sent to manufacture for maintenance.

5.1.2. Heating System Troubleshooting

Refer Table 5-2 for troubleshooting the heating system.

Table 5-2 Diagnosis and Treatment of Heating System

Symptom	Potential Causes	Items to be Checked or Handling Process
Heating system does not operate and the contactor does not close	No heating demand	Check the PACC controller's status and confirm whether there is heating demand.
	Heating auxiliary relay fault	Check if the light next to the heating auxiliary relay is on and whether the line is correct.
	Heating system safety device failure	• Use a multimeter to check J21-1 (for single electrical heating), J21-2 (for two electrical heating), and if the voltage across the terminals G is about 24 V, then move further to safety means across the resistor and if the resistance is large, it indicates that the security device must be disconnected. • Check if the manual reset switch is turned off. in case of the reset switch is automatic, check for damage of electrical heater. Use an ohmmeter to check if the electrical heater is damaged by checking the resistance of its resistor.
Contactor closed, no heating effect	Main power failure of heater	• Check if the air switch heating system is closed or not. • If the contactor is closed, check heating engaged state of contactors L1, L2 and L3 supply voltages is normal.
	Heater burnout	Cut off the power supply and use an ohmmeter to check if the electrical heater is damaged by checking the resistance.

5.1.3. Compressor and AC System Troubleshooting

Table 5-3 Diagnosis and Treatment of Compressor and AC system

Symptom	Potential Causes	Items to be Checked or Handling Process
Compressor can not start	Power not connected (off)	Check the main power switch, fuse or circuit breaker and connecting wires.
	Power overload and MCB tripped	Manual reset, check the average current value.
	Loose circuit connections	Check if circuit connectors are firmly connected.
	Short circuit due to motor winding burnout	Check the static resistance imbalance of motor windings, if found defective, replace immediately.
Contactor did not close and compressor is not running	No CFC (call for cooling) output	Check the PACC controller status.
	High pressure switch actuates	• Check if the wiring of switch is connected to controller. • Check if there is high pressure alarm on high pressure switch status.

Symptom	Potential Causes	Items to be Checked or Handling Process
Contactor did not close and compressor is not running	Compressor Contactor fault	• Check if contactor is functioning. • Check if there is 24 Vdc between J18-3 (compressor 1) and terminal G. And also of J20-1 (compressor 2) and terminal G.
	Suction temperature sensor fault	• Check if the wiring of sensor is connected to controller. • Check if there is suction temperature sensor failure or the readings are in normal range.
	Low pressure sensor fault	• Check if the wiring of sensor is connected to controller. • Check if there is low pressure sensor failure or the readings are in normal range.
	Drive fault	• Check if the wiring of compressor drive is normal. • Check if the current is too large. • Check if the proper ventilation is available to the drive.
	EEV fault	• Check if the wiring of EEV board is normal. • Check the EEV fault code and replace the EEV board.
	Drive communication fault	Check the inverter 458 communication line wiring is intact, and then re-power, reset or eliminate this alarm on HMI panel.
	Circuit breaker tripped	Check the line voltage after checking the circuit breaker and contactor.
	Built-in protection of the compressor is disconnected	Check if the compressor windings are open. If open, wait for its automatic reset after cools down.
	Detecting the discharge gas temperature sensor	Check if there is high discharge temperature alarm or low discharge temperature superheat alarm in alarm history list.
	Detecting a low-pressure sensor	Check if there is low-pressure alarm in the alarm view history.
	Suction temperature sensor fault	• Check if the wiring of sensor is connected to controller. • Check if there is suction temperature sensor failure or the readings are in normal range.
	Low pressure sensor fault	• Check if the wiring of sensor is connected to controller. • Check if there is low pressure sensor failure or the readings are in normal range.
	Drive fault	• Check if the wiring of compressor drive is normal. • Check if the current is too large. • Check if the drive gets proper ventilation.
	Drive communication fault	Check the inverter 458 communication line wiring is intact, and then re-power on reset or eliminate this alarm on HMI panel.
	EEV fault	• Check if the wiring of EEV board is normal. • Check the EEV fault code and replace the EEV board.
Compressor operation stopped for 5 minutes	Refrigerant leakage, too low voltage detection/ abnormality	• Check the suction pressure. • Check the wiring of low-pressure sensor. • Check if the differentiation between low pressure sensor reading and the actual pressure are within ± 0.3 bar (high and low pressure sensor values can be read in service tool, referred in gauge pressure).

Symptom	Potential Causes	Items to be Checked or Handling Process
High- pressure protection Low exhaust pressure	Ball valves do not open	Check, if all ball valves in the refrigeration system are opening properly.
	Condenser coils gets dirty or clogged (air cooled)	Clean the condenser or plate heat exchanger.
	Inlet water temperature is too high or water flow is too small (water cooled)	Check the water quality (Water-cooled system).
	Condensing system does not operate	• Check the condenser fan (air-cooled system). • Check the water quality (water-cooled system).
	Excessive amount of refrigerant charge	Check whether supercooling is too high.
	High pressure switch fault	• Check if the two terminals of high pressure switch is shorted. • Check the resistance between J18-3 and terminal G for HP switch #1 and J20-1 and G for HP switch #2.
	Compressor contactor fault or compressor delay fault	• Manually open compressor through service tool, if there is 24 Vdc between contactor A1 & A2, while the contactor does not actuate, then replace the contactor. • If there is no 24 Vdc between A1 and A2, then check whether there is 24 Vdc between J18-3 (system #1) or J20-1 (system #2) and terminal G. If there is, then replace the compressor delay.
	Electric valve improperly adjusted (water-cooled)	• Check if the differentiation between high pressure sensor readings and actual values are within ± 0.6 bar (high and low pressure sensors values can be read in service tool, shown as gauge pressure). • Check whether the electric ball valve of the plate heat exchanger functions well.
Low discharge pressure	Excessive flow or low water temperature (water cooled)	Check water supply system.
	Refrigerant leakage	Check if there is any leakage, if identified repair immediately the leakage area and add refrigerant.
	Outdoor fan speed controller failure, leading to running at full speed and do not change along with high pressure	• Check if the high pressure sensor of condenser fails. • If condenser controller fault is confirmed, replace the speed controller immediately.
After starting, suction and discharge pressure unchanged	The compressor running reversely or Suction and discharge connected	• If it runs reversely, replace any two compressor L line (inverter output). • If another reason, then replace the compressor.

Symptom	Potential Causes	Items to be Checked or Handling Process
Low suction pressure or back fluid	Lack of refrigerant in the system	Check for leakages while maintenance and adding the refrigerant.
	Dirty air filter	Replace the air filter.
	Filter dryer clogging	Replacing the filter dryer.
	Improper setting of Electronic Expansion Valve superheat	Adjust the Electronic Expansion Valve control parameter as factory default settings or add the right amount of refrigerant.
	Electronic Expansion Valve device failure	Replacement of Electronic Expansion Valve.
	Poor air flow distribution	Check the supply air, return air flow system.
	Condensing pressure is too low	Check the condenser system.
	External static pressure is large, leading to air flow attenuation	Check the air flow duct or re-evaluate external static pressure.
Compressor excessive noise	Back flow of liquid refrigerant	Check for “if the suction pressure is low” or back flow of liquid.
	Poor lubrication	Add refrigerant oil
	Compressor transport fixture not removed	Remove transportation fasteners/fixtures
	The compressor running reversely	Refer to “After starting, suction and discharge pressure unchanged”.
Operation of the compressor overheating	Compression ratio is high	Check the evaporator and condenser fans are operating correctly.
	Suction superheat is high	Adjust the Electronic Expansion Valve settings or add the appropriate amount of refrigerant.
Remarks: The basis of above symptoms are based on the existing CFC.		

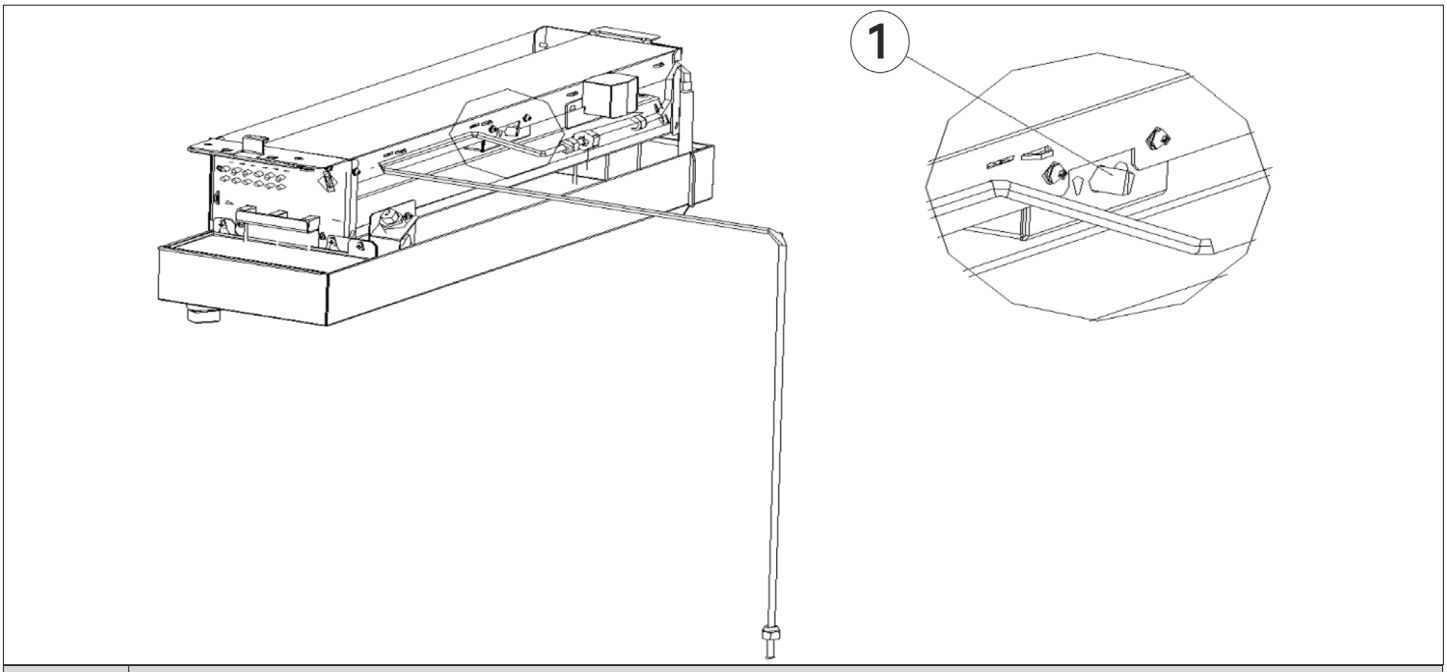
5.1.4. Infrared Humidifier Troubleshooting

Table 5-4 Diagnosis and Treatment of Infrared Humidifier

Symptom	Potential Causes	Items to be Checked or Handling Process
Humidification ineffective	No water in water pan	• Check the water supply. • Check if the water supply solenoid valve is working. • Check the state of the high water-level switch and water level regulator. • Check whether the water supply pipe is clogged or not.
	The humidification contactor does not close	• Check the opened safety devices of the infrared humidifier: Water pan over-temperature protection switch and lamp over-temperature protection switch. • Check the voltage between terminal J18-2 and G on terminal row. If it is 24 V, then check the resistance of protection switch. If the resistance is very high, then the switch needs to be replaced.
	Humidifier main power failure	• Check if the humidifier MCB is closed. If humidifier contactor closed state, check whether L1, L2 and L3 voltages are normal.
	Infrared humidifier lamp burned	Replace the lamp.

- High-Temp Switch

The manual-reset high-temp switch is fitted above the lamps. When overheat occurs due to abnormal situation, the switch cut-offs the power supply to the lamps.



No.	Description
1	Reset button

Figure 5-1 Infrared Humidifier Reset Button