



# Liebert<sup>®</sup> PDX

## Perimeter DX System

### PAM A-W-F Versions

#### Product Documentation

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This document, written in English, is the original version





# Contents

<b>1. Digit Nomenclature</b> .....	<b>1</b>
<b>2. Highlights and value proposition</b> .....	<b>3</b>
2.1 Liebert® PDX PAM highlights.....	3
2.2 Value proposition.....	5
2.2.1 Sustainable efficiency.....	5
2.2.2 Cooling continuity.....	6
2.2.3 Unique flexibility.....	6
2.2.4 Complete control.....	7
<b>3. Design compliance</b> .....	<b>9</b>
<b>4. Technical Highlights</b> .....	<b>11</b>
4.1 Intended use.....	11
4.1.1 Purpose of the unit.....	11
4.1.2 Operating conditions.....	11
4.1.3 Storage conditions.....	12
4.2 Cooling version.....	13
4.2.1 Air cooled versions.....	13
4.2.2 Water cooled and Freecooling versions.....	14
4.3 Airflow configurations.....	15
4.4 Frame sizes and structure.....	17
4.4.1 Frame sizes, general view.....	17
4.4.2 Frame structure in detail.....	18
4.5 Refrigerating circuit types.....	20
4.6 Refrigerating circuit main components.....	21
4.6.1 Compressors.....	21
4.6.2 Condenser.....	22
4.6.3 Electronic expansion valves.....	23
4.6.4 Evaporator coils.....	23
4.6.5 Safety devices, sensors and others.....	24
4.7 Air flow management.....	25
4.7.1 Fans.....	25
4.7.2 Air filtration.....	26
4.8 Power supply.....	28
4.8.1 Power supply options.....	28
4.8.2 ATS types and performance tables.....	29
4.8.3 Main components.....	30
4.8.4 Disconnecting switches.....	31
4.9 Control system.....	32
4.9.1 Control platform, I/O and modbus connect.....	32
4.9.2 User interfaces.....	34
4.9.3 Control modes and sensor management.....	35
4.9.4 Main safety functions.....	36
4.9.5 Teamwork logics.....	36
4.10 Optional electrical heaters for de-humidification.....	37
4.11 Optional Humidifier.....	38
4.12 Harmonic distortion and optional Active Harmonic Filter.....	40
4.12.1 Introduction to Harmonic Current Distortion phenomenon.....	40
4.12.2 Harmonic Current Distortion without Active Harmonic Filter option.....	40
4.12.3 Harmonic Current Distortion with embedded Active Harmonic Filter option (digit 18 = T).....	40
4.13 Packaging options.....	42
<b>5. Technical tables</b> .....	<b>43</b>
5.1 Model frame cooling airflow configurations.....	43
5.2 Refrigerating circuit technical tables.....	43
5.3 Water circuit technical tables.....	46
5.4 Electrical tables.....	47
5.5 Performance tables.....	50
5.5.1 PAM Air cooled Performance tables.....	50
5.6 Sound pressure level.....	54
5.6.1 Introduction.....	54
5.6.2 Test conditions.....	54
5.6.3 Sound Emission spectra.....	55
<b>6. Heat rejection for air cooled system: Liebert HPA-OAC</b> .....	<b>59</b>
6.1 Digit nomenclature.....	59
6.2 Digit compliance.....	60
6.3 Technical highlights.....	61
6.3.1 Intent use.....	61
6.3.2 Design features.....	62
6.3.3 Frame versions.....	63
6.3.4 Ambient kits.....	64
6.3.5 Accessories.....	67
6.3.6 Condenser coil treatments.....	68
6.4 Technical tables.....	68
6.4.1 Technical Data and Performances.....	68
6.4.2 Piping sizes.....	68
6.4.3 Installation dimensions for vertical airflow.....	69
6.4.4 Installation dimensions for horizontal airflow.....	70
6.4.5 Weights.....	70
6.4.6 Safety device settings.....	70
6.4.7 Internal volumes for Vertical airflow configuration.....	71
6.4.8 Internal volumes for Horizontal airflow configuration.....	71
<b>7. Heat rejection for water cooled system: Liebert HPD</b> .....	<b>73</b>
7.1 Digit nomenclature.....	73
7.2 Design compliance.....	74
7.3 Technical Highlights.....	74
7.3.1 Intent Use.....	74
7.3.2 Design features.....	74
7.4 Liebert® HPD-DY - Technical tables.....	75
7.4.1 Technical data and performances.....	75
7.4.2 Fan electrical data.....	76
7.5 Indoor unit – Outdoor dry cooler matching table.....	77

# Annexes

<b>Annex A - Refrigerating and hydraulic circuits.....</b>	<b>79</b>
<b>Annex B - Mechanical and Hydraulic connections.....</b>	<b>87</b>
<b>Annex C - Configurable options.....</b>	<b>89</b>
<b>Annex D - Configurable accessories.....</b>	<b>91</b>
<b>Annex E - Dimensions and weights.....</b>	<b>95</b>

## Abbreviations - Acronyms

Item	Definition
<b>ATS</b>	Automatic Transfer Switch
<b>BMS</b>	Building Management System
<b>EC</b>	Electronically Commutated [fans]
<b>EEV</b>	Electronic Expansion Valve
<b>OPEX</b>	OPerating EXpense
<b>MCB</b>	Miniature Circuit Breaker
<b>STO</b>	Safe Torque Off
<b>Ultracap</b>	Ultra capacitor
<b>U2U</b>	Unit to Unit
<b>UPS</b>	Uninterruptible Power Supply
<b>VFD</b>	Variable Frequency Drive



# 1. Digit Nomenclature

The unit is fully defined by the following digits.

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	A	M	0	6	6	D	A
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Dig.	Feature	Value	Description
1 2 3	Family name	PAM	P = Perimeter Unit, A = R513A, M = Motorized
4 5 6	Model*	000*	Unit Model, Nominal Cooling Capacity
7	Air delivery	U	Upflow
		H	Downflow Frontal
		D	Downflow Up
8	System type	A	Air cooled
		W	Water Cooled
		F	Water cooled with Indirect Freecooling
9	Fan type	E	High Efficiency fans
		P	High Power fans
10	Power supply	3	400 V / 3 ph / 50 Hz + N CE
11	Cooling system	A	Single Circuit, 1 Variable Speed Scroll, EEV
		B	Dual Circuit, 1 ON/OFF + 1 Variable speed, EEVs
		C	Dual Circuit, Tandem ON/OFF + 1 Variable speed, EEVs
		D	Dual Circuit, 1 Tandem ON/OFF + 1 tandem ON/OFF, EEVs
12	Humidification	0	None
		S	Electrode humidifier
13	Display control	0	None
		7	7" touch screen
14	Heaters	0	None
		1	Electric heaters standard capacity
15	Air filter	1	ePM10 50%
		2	ePM10 50% + DP transducer
		3	ePM10 50% + clogged filter switch
16	Condensing control	A	Heat rejection system controlled by indoor unit
17	Color	1	Black RAL 7021

Dig.	Feature	Value	Description
18	High Voltage option	D	Standard Power Supply
		G	Dual Power Supply Alternate (ATS)
		T	Standard Power Supply with Harmonic Filter ***
19	Predisposition	0	None
		S	Predisposition for Smart Aisle™****
		H	Predisposition for motorized damper installation
		L	Predisposition for extension hood installation
20	Monitoring	0	None
		1	Monitoring card (Modbus IP, BACnet IP, SNMP and HTTP)
21	Additional Devices	0	None
		1	MCB 10 A 1 ph for outdoor unit
		3	Condensate pump**
		4	Condensate pump** and MCB 10 A 1 ph for outdoor unit
22	Packaging	P	Standard: cardboard and foil with pallet
		C	Standard package with wooden crate
		S	Standard package with seaworthy crate
23	EMC Emissions	I	Industrial Grade
		R	Residential Grade
24	Revision	E	Free digit
25	Special requirements	A	Standard Vertiv™
		X	Special Vertiv™

\* The three digit tends to identify the unit Net Total Cooling Capacity in kW at standard conditions:

- Compressors and fans @ 100% speed;
- Room air temperature 30°C;
- Relative Humidity 35% RH;
- External static pressure [ESP] 20 Pa;
- Condensing temperature 45°C.

The correspondence model-Net Total Cooling Capacity is only indicative, for actual performances refer to the selection tools.

\*\* Condensate pump available only if digit 7 = U or H

\*\*\* Harmonic filter not available, as a standard, with ATS

\*\*\*\* Only available in downflow-up configurations



## 2. Highlights and value proposition

### 2.1 Liebert® PDX-PAM UHD highlights

#### Liebert® PDX-PAM UHD introduction

**Liebert® PDX-PAM UHD**, is the Vertiv™ product family of floor mount direct expansion precision air conditioning units for optimum regulation of temperature and humidity.

**Liebert® PDX-PAM UHD** is a factory assembled unit, designed for indoor installation, in rooms protected from weather agents.

The solution is specifically designed for air conditioning in rooms containing electronic equipment. Main target applications are:

- Small to medium datacenter, from 10 kW to 500+700kW;
- Edge applications;
- UPS and battery rooms.

**Liebert® PDX-PAM UHD** is the high-performance unit range designed to operate with eco-friendly lower-GWP nonflammable refrigerant **R513A** and deliver outstanding efficiency, reliability of operation and maximum flexibility of installation.

**Liebert® PDX-PAM UHD** allow you to comply recent regulation and respect your sustainability goals.

**R513A** enables a Global Warming Potential (**GWP**) reduction of -70% compared to traditional R410A, without any compromise in terms of safety and toxicity.

This refrigerant choice, together with the distinctive characteristics of the **Liebert® PDX-PAM UHD** units, allows for a reduction in installation costs (CAPEX): the additional machine and system safety features typical of systems that use flammable refrigerants are not required. no additional safety devices are required, as it happens with indoor units using flammable refrigerants.

**Liebert® PDX-PAM UHD** enable a true Total Equivalent Warming Impact (**TEWI**) optimization:

- direct emissions reduction thanks to eco-friendly low **GWP** refrigerant;
- indirect emissions reduction, thanks to innovative design that aims at maximizing system efficiency overall.

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#### Cooling capacity

The **Liebert® PDX-PAM UHD** model series offers units with net rated cooling capacity from 7 to 90 kW, with **R513A** refrigerant. The scalable cooling system can expand with evolving business needs.

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#### System configuration

Different system configurations indoor/outdoor units are possible for controlling condensation and managing the heat rejection of the heat subtracted to the room air:

- **Air cooled system:**

**Liebert® PDX-PAM UHD** indoor unit is coupled with **Liebert® HPA OAC** remote condenser.

- **Water cooled system:**

heat rejection is realized through a waterloop circuit and **Liebert® PDX-PAM UHD** indoor unit is coupled with **Liebert® HPD** drycooler.

- **Water cooled system with indirect free-cooling:**

heat rejection is realized through a waterloop circuit and **Liebert® PDX-PAM UHD** indoor unit is coupled with **Liebert® HPD** drycooler.

Indirect free-cooling can be realized, 100% or mixed mode, cooling down room air directly with chilled water re-circulated through the dry cooler.

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#### Technology

**Liebert® PDX-PAM UHD** are equipped with the most advanced industry technology.

The synchronized actions of below mentioned modulating components, optimized heat exchangers selections and an inhouse-developed control software, enable full continuous modulation, delivering higher efficiency throughout the whole year and precise supply air temperature control compliant to ASHRAE recommendation.

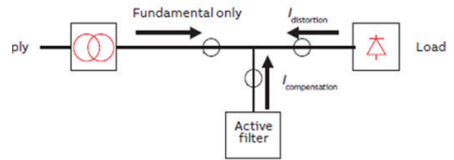
### Inverter-driven brushless motor compressors



### Electronically commutated (EC) fans



### Electronic expansion valve.



### Ready to use and flexible design

Liebert® PDX-PAM UHD are available for different air delivery versions:

- above or below the floor, suitable for raised or slab floor;
- **Upflow** or **Downflow** air supply;
- With or without extension hoods for cold or hot room containment.

The product layout has been engineered to maximize the cooling density for footprint, to allows to get more space for the IT equipment.

Extended options, accessories and features are available as standard. Furthermore, all the main components are factory installed, minimizing the installation costs on site.

The product is a ready to use solution, which allow a quick responsiveness in each project, improving the timing to finalize the data center design and accelerating speed-to-market.

### Strengths of the solution

Liebert® PDX-PAM UHD are an ideal solution for precision IT equipment cooling especially in those cases:

- No space or weight limitations to install chillers outside or on the roof;
- No water allowed in the white space;
- Fastest datacenter deployment;
- Modularity and redundancy at a sustainable cost;
- Simplicity of retrofit.



## 2.2 Value proposition

### 2.2.1 Sustainable efficiency

A mindful approach to environmentally friendly and sustainable cooling represents the latest challenge in the realm of IT cooling and precision air conditioning.

**Liebert® PDX-PAM UHD** enable allow you to comply recent regulation and respect your sustainability goals, enabling a true Total Equivalent Warming Impact (**TEWI**) optimization:

- direct emissions reduction thanks to the use of eco-friendly with lower global warming potential (lower-GWP);
- indirect emissions reduction, thanks to innovative design that aims at maximizing system efficiency overall.

#### Direct emission reduction

Absence of flammability risk allows to have a safe solution and reduce CAPEX costs, thanks to:

- ease and flexibility of installation;
- no need of additional safeties that are necessary with a flammable refrigerant option (leak detectors, mechanical ventilation, over pressurized electrical panel, etc).

Refrigerant	Type	Density	ASHRAE 34 class	GWP AR4	GWP F-GAS
R1234yf	HFO	Very Low	A2L Mildly flammable	4	0.5
R1234ze	HFO	Very Low	A2L Mildly flammable	7	1.4
R32	HFC	High	A2L Mildly flammable	675	675
R454B	HFC/HFO	High	A2L Mildly flammable	466	465
R454C	HFO	Medium	A2L Mildly flammable	148	146
R290	Pure fluid	Medium	A3 Highly flammable	3	3
R134a	HFC	Low	A1 NON flammable	1430	1430
R513A	HFC/HFO	Low	A1 NON flammable	631	629

#### Indirect emission reduction

**Liebert® PDX-PAM UHD** are equipped with the most advanced industry technology:

- Inverter-driven brushless motor compressors;
- Electronic Expansion Valve (**EEV**);
- Electronically Commutated (**EC**) fans.

For most of the time, the unit operates under partial load conditions. Thanks to the synchronized actions of above mentioned modulating components,

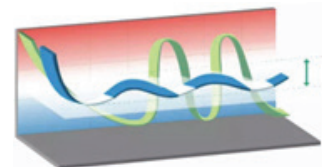
**Liebert® PDX-PAM UHD** can realize a continuous modulation of performance:

- avoiding ON-OFF cycles and related high startup currents;
- with a more stable regulation, avoiding the inefficient overshootings typical of ON-OFF behaviour;
- leveraging the superior efficiency of the compressors used at partial loads (optimum between 60-80%).

The interior of the unit has been designed for maximum aerodynamic efficiency.

**Liebert® PDX-PAM UHD** are equipped with optimized heat exchanger selection and an innovative patented filter solution, that allows larger surfaces for greater air flow, less air pressure drops and thus reduced fan consumption.

Thanks to all of this, **Liebert® PDX-PAM UHD** can deliver very high efficiency without any compromise coming due to the use of a lower density refrigerant, thus enabling to couple safety and true OPEX costs reduction.



## 2.2.2 Cooling Continuity

Cooling continuity and reliability are key factors for mission critical infrastructures.

**Liebert® PDX-PAM UHD** design aims to couple performance and reliability.

This is made possible thanks to the main components technology.

What?	Component	Constructive feature that makes it possible
Reduced mechanical wear	Compressor	Brushless motor VFD compressor
	Fans	Lighter fan impeller, made of fiberplastic material
		Self-lubricating bearings
	iCOM™ Control	Automatic envelope control (f.i. discharge temperature monitoring)
Reduced electrical stress	EEV	Liquid return prevention (best superheat control) SH controPrecise control of compressor suction superheat
	Compressor	Inverter driven compressors
	Fans	Electronically Commutated fan

Additionally, **Liebert® PDX-PAM UHD** have distinctive design features enables the possibility to develop a better:

- Distinctive design features and control logics that enhance unit and system reliability of operations;
  - Dual power feed option with Automatic Transfer Switch (**ATS**) option;
  - Embedded **UPS (Ultracap)** feeds the control board at least for **60** seconds in case of power outage, permitting system supervision and the fastest unit restart;
  - **Fast start logic:** the unit can recover from a power outage within **20-30s**;
  - **Each fan is controlled and powered independently, both in indoor and outdoor unit:** airflow continuity is guaranteed until the last fan is available to run;
  - Tandem compressors where applicable;
  - Multiple sensor logic: unit automatically adapts in order to grant the cooling and airflow to the servers when a sensor fail;
  - **Teamwork operations:** up to 32 **Liebert® PDX-PAM UHD** units can be connected together in a common network, sharing information on status with each other and managing critical operating situations with combined action.

## 2.2.3 Unique Flexibility

**Liebert® PDX-PAM UHD** range of units offer a unique flexibility of installations:

- Unit range (indoor & outdoor) and performance modulation capability makes the solution scalable, particularly in case of variable datacenter occupancy or IT load;
- Different cooling versions are available, air cooled, water cooled with or without indirect free cooling, for best adaptation to different thermal management requirements (*paragraph 4.2* for more details);
- Wide range of airflow delivery configurations, suitable for both raised and slab floor applications (*paragraph 4.3* for more details);
- Compact and modular design facilitate the transportation, installation, and maintenance operations (*paragraph 4.4* for more details).

System design (indoor & outdoor units) and extended range of operations make the solution suitable even for installations with the most stringent requirements:

- Extended range of operations, both indoor & outdoor units (*paragraph 4.1* for more details);
- Different coil treatments are available for remote condensers making their installation possible also in critical environments (*chapter 6* for more details);
- Equivalent pipe length between indoor unit and remote condenser up to 100m.

Extended configurable add-ons, wide range of options and accessories, make the solution easy to adapt to different datacenter lay-out and design requirements:

Main configurable Add-ons	Main options & accessories
Refrigerant post-heating	Motorized damper
Electrode humidifier	Smoke and Fire alarms
Clogged filter detection, sensors and alarm	Leak detectors
Condensate pump	Base frame
Dual power feed with automatic switchover	Antivibration dampers with adjustable height
Harmonic filters	Extension hood, different heights

## 2.2.4 Complete Control

### iCOM™

**Liebert® iCOM™** control is the heart of the direct expansion cooling system, managing not only **Liebert® PDX-PAM UHD** units but also outdoor heat rejection components.

The **Liebert® iCOM™** software embeds a comprehensive algorithm library developed and perfected over fifty years of experience for adapting perfectly to the different requirements: more than 10 different strategies to control temperature/humidity & airflow.

Cutting edge regulation logics like auto-adaptive regulation PID algorithms are combined with advanced safety algorithms like envelope control for indoor unit and anti-freeze routine for outdoor units.



#### User interface

The control set up can be done through a HD touch screen display. Its functions are replicated also in a web browser (virtual display).

#### Remote monitoring

A whole range of smart networking solutions is available: the unit can communicate with user BMS systems with extended parameter availability, as well as configured for VERTIV™ service platforms.

#### System configurations

All main components are connected on Modbus chain for perfect knowledge and control of how system is operating. Outdoor units are controlled directly from the unit's **Liebert® iCOM™** control. Unit to unit connection is possible via Ethernet.



### 3. Design compliance

The Liebert® PDX PAM UHD units are designed, manufactured and tested according to the following directives and standards:

- EU Directives**
- Machinery Directive 2006/42/CE;
  - PED Directive 2014/68/EU;
  - Low Voltage Directive 2014/35/UE;
  - EMC Directive 2014/30/UE;
  - RoHS II Directive 2011/65/EU;
  - RoHS III Directive EU/2015/863.

**CE Marking and Conformity Declaration**

The units are marked “**CE**”.

Each unit is supplied complete with individual test certificate and a certificate of conformity to the European Union Directives.

See also the last page.



**UKCA Marking and Conformity Declaration**

The units are marked “**UKCA**”.

Each unit is supplied complete with individual test certificate and a certificate of conformity to the UK Safety Regulations.



**Performance test norms**

- Cooling Capacity according to EN 14511;
- Sound Power Level according to ISO 3744.

Stationary air conditioners placed into the European Community market and operating with fluorinated greenhouse gases (F-gas, such as **R-513A**), have to comply with the F-gas Regulation (EU) No. 517/2014.

Refer to the F-gas regulation or the instruction manual for indications related to the minimum obligations for the operators that are responsible for the equipment during all its operative life until its disposal, especially in relation to leakage tests.

The unit performance is certified by an independent certifier, Eurovent and calculated as follows:

- Cooling Capacity according to EN 14511;
- Sound Power Level according to ISO 3744.

Each unit is factory-tested before shipment, including quality control checks and functionality tests of the main components.

The manufacturing plants are ISO 9001, ISO45001, ISO14001 certified.



## 4. Technical Highlights

### 4.1 Intent use

#### 4.1.1 Purpose of the Unit

Liebert® PDX PAM UHD have been designed and manufactured for the following purpose: precision air conditioning for indoor use in rooms protected from weather agents.

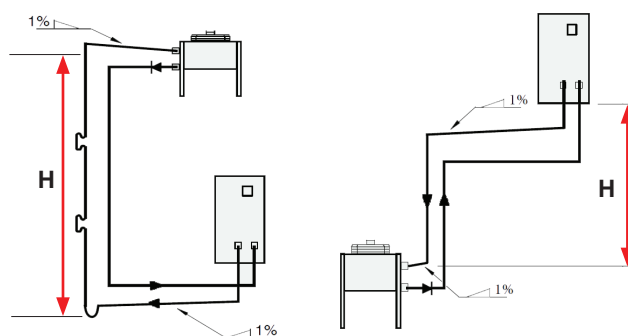
Liebert® PDX PAM UHD units are perimeter Direct Expansion units designed for use with **R513A** refrigerant.

#### 4.1.2 Operating conditions

Table 4.1 – Ambient conditions for operation

<b>Operating environment</b>	The unit is designed for indoor installation, protected from weather agents, with the following ambient conditions.	
<b>Air returning to the unit inlet (indoors conditions)</b>	Temperature	+20°C — +40°C
	Absolute humidity	5,5 — 12 g steam / kg air
	Relative humidity	15 — 60 %
	The allowed thermal load must be higher than 20% of the unit nominal cooling capacity. A lower thermal load will cause inaccurate temperature and humidity control and frequent compressor(s) switch <b>ON/OFF</b> .	
<b>Altitude (above sea level)</b>	Below 1 000 m	OK
	From 1 000 to 2 000 m	Allowed with inverter derating.
	Higher than 2 000 m	Not allowed, contact Vertiv™ Technical Support
<b>Outdoor temperature</b>	Temperature	-20°C — +48°C
	Recommended application conditions:	
	Safety valve pipe kit option “S”	0°C < T < +48°C
	Safety valve pipe kit option “R”	-5°C < T < +48°C
	Safety valve pipe kit option “L”	-20°C < T < +48°C
	For installation with ambient temperature below -20°C it is necessary to contact Vertiv™ technical support.	

#### Remote condensers position



**H** = level difference between the unit delivery and the condenser inlet.

**L** = total linear length of the piping + equivalent length of curves and valves.

Installation condition		Condenser	Check valve on return line	Liquid line thermal insulation
L < 60 m	-3 m < H < 20 m	Standard	Mandatory	Mandatory
L < 100 m	-8 m < H < 30 m	20% oversized	Mandatory	Mandatory
L < 60 m	-15 m < H < -8 m	30% oversized	Mandatory	Mandatory

Refer to instruction manual for refrigerant piping requirements (gradients, oil traps, etc) and for calculation of equivalent length of the piping.

## Water cooled and freecooling systems (Digit 8 = W or F)

Table 4.2 – Ambient conditions for operation

<b>Operating environment</b>	The unit is designed for indoor installation, protected from weather agents, with the following ambient conditions.	
<b>Air returning to the unit inlet (indoors conditions)</b>	Temperature	+20°C — +40°C
	Absolute humidity	5,5 — 12 g steam / kg air
	Relative humidity	15 — 60 %
	The allowed thermal load must be higher than 20% of the unit nominal cooling capacity. A lower thermal load will cause inaccurate temperature and humidity control and frequent compressor(s) switch <b>ON/OFF</b> .	
<b>Altitude (above sea level)</b>	Below 1 000 m	OK
	From 1 000 to 2 000 m	Allowed with inverter derating.
	Higher than 2 000 m	Not allowed, contact Vertiv™ Technical Support
<b>Water system</b>	Minimum water inlet temperature to condenser	6°C
	Maximum water pressure	16 bar
	Water - Glycol mixture limit	Up to 50% vol.
<b>Outdoor temperature</b>	Verify minimum working temperature of external Drycooler. Fluid mixture must be suitable for application. Contact Vertiv™ Technical Support for any question.	

### 4.1.3 Storage conditions

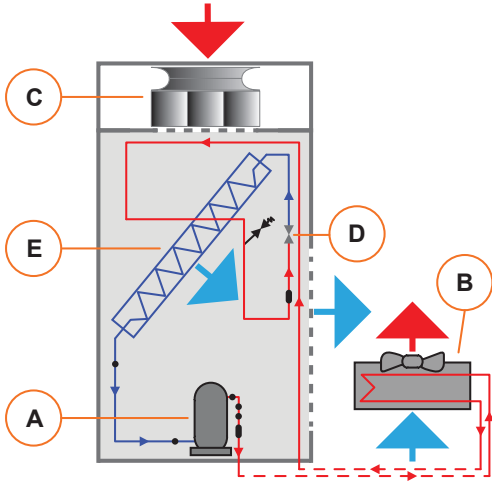
Table 4.3 – Ambient conditions for storage

<b>Storage environment</b>	Indoor environment, protected against weather agents Clean (no dust), well-ventilated, non-condensing
<b>Ambient temperature</b>	-20°C – +50°C
<b>Ambient humidity</b>	<90% and preventing condensation
<b>Storage time</b>	The total storage time should not exceed <b>six</b> months. If the storage time is longer than <b>six</b> months, then you must check the functionality of sensors and other electronic devices before putting in operation the unit.
<b>Position</b>	Keep the unit vertically upright.

## 4.2 Cooling versions

### 4.2.1 Air cooled versions, Digit 8 = A

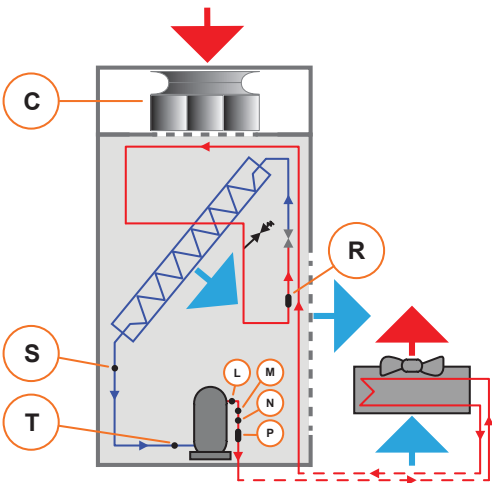
#### 4.2.1.1 Main components



Just as an example, the figure illustrates a simplified scheme for a **Downflow** unit with a single circuit with one compressor.

The main components of the circuit the following:

<b>A</b>	Compressor
<b>B</b>	Condenser (supplied separately)
<b>C</b>	Fan
<b>D</b>	Expansion valve
<b>E</b>	Evaporator

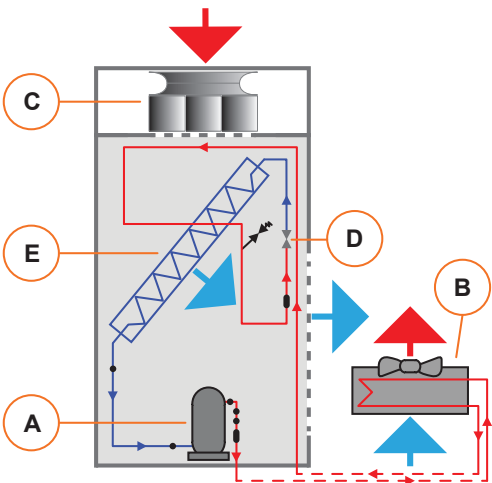


The circuit also include the following components:

<b>L</b>	High temperature sensor
<b>M</b>	High pressure switch
<b>N</b>	High pressure transducer
<b>P</b>	Oil separator
<b>R</b>	Filter dryer
<b>S</b>	Temperature sensor for the expansion valve control
<b>T</b>	Low pressure transducer for EEV control

Refer to *Annex A* for details about the refrigerating circuits.

#### 4.2.1.2 Operating principle



Just as an example, the figure illustrates a simplified scheme for a **Downflow** unit with a single circuit with one compressor.

The compressor **[A]** compress the refrigerant and pumps the hot gas into the outdoor air-cooled condenser **[B]**.

Here the refrigerant condenses into subcooled liquid state and feeds the evaporator **[E]** thanks to the modulating action of the Electronic Expansion Valve (**EEV**) **[D]**, that open or close according to the measured superheat value (temperature difference between compressor suction temperature and evaporating temperature).

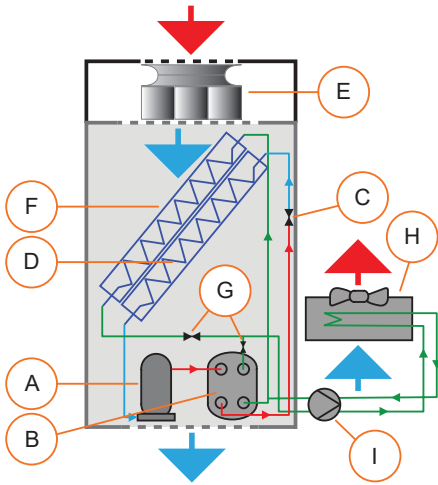
The fan **[C]** makes the **warm air** coming from the room to flow through the evaporator. The refrigerant evaporates and **cools down the air**, which flows again into the room.

Finally the refrigerant flows back to the compressor for a new compression cycle.

The operating principle is the same for all the airflow delivery configurations and circuit configurations. Dual circuit configuration have independent refrigerating circuits: each one must be connected to its own remote condenser.

## 4.2.2 Water cooled and free-cooling versions, Digit 8 = W or F

### 4.2.2.1 Main components

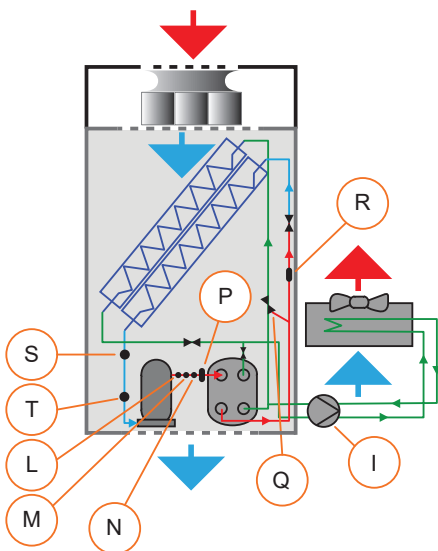


Just as an example, the figures illustrate a simplified scheme for a **Downflow** unit with a single circuit with one compressor.

The main components of the circuit are the following:

A	Compressor
B	Plate Condenser
C	Expansion valve
D	Evaporator
E	Fan
F	Water Coil
G	Water Valve
H	Drycooler (supplied separately)
I	Water Pump

Make reference to *Annex A - Refrigerating Circuit Diagrams* for details.



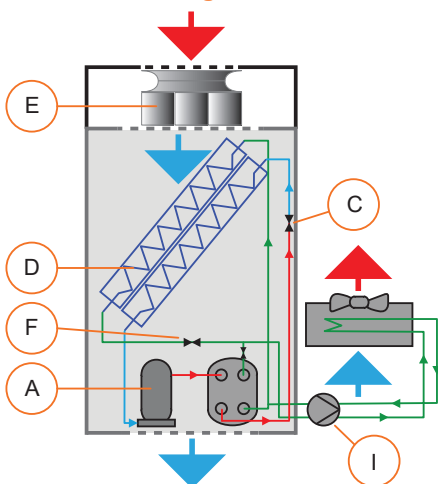
The circuit also includes the following components:

L	High temperature sensor
M	High pressure switch
N	High pressure transducer
P	Oil separator
Q	Safety Valve
R	Filter dryer
S	Temperature sensor for EEV control
T	Low pressure transducer for EEV control

Make reference to *Annex A* for the details about the refrigerating circuits.

### 4.2.2.2 Operating principle

#### Water cooled, Digit 8 = W



Just as an example, the figures illustrate a simplified scheme for a **Downflow** unit with a single circuit with one compressor.

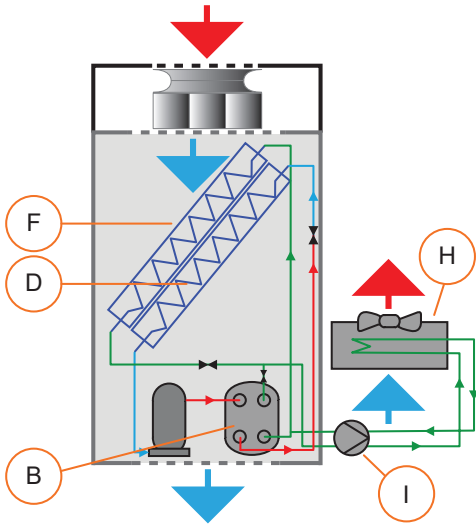
The compressor [A] compresses the refrigerant and pumps the hot gas into the water-cooled Braze Plate Heat Exchanger (BPHE) condenser [B].

Here the refrigerant condenses into subcooled liquid state and feeds the Evaporator [D] thanks to the modulating action of the Electronic Expansion Valve (EEV) [C], that opens or closes according to the measured superheat value (temperature difference between compressor suction temperature and evaporating temperature).

The fan [E] makes the warm air coming from the room to flow through the evaporator. The refrigerant evaporates and cools down the air, which flows again into the room. Finally the refrigerant flows back to the compressor for a new compression cycle. The heat rejection takes place through the closed waterloop circuit in the outdoor drycooler. The operating principle is the same for all the airflow delivery configurations and circuit configurations.

Dual circuit configuration has independent refrigerating circuits, each one with its own BPHE.

### Water cooled with Free-cooling, Digit 8 = F



The water cooled units with freecooling are equipped with a double coil evaporator: Direct expansion **DX** coil (refrigerant to air heat exchanger) and chilled water **CW** coil (water to air heat exchanger).

These units can operate in two modes:

- Direct expansion DX mode**  
 Same operating principle of water cooled unit.  
 The refrigerant is pumped by the compressor into the water-cooled Brazed Plate Heat Exchanger **BPHE** condenser **[B]**. Here the refrigerant condenses into subcooled liquid state and feeds the evaporator **[D]** thanks to the modulating action of the electronic expansion valve **EEV [C]**, The air flow is cooled down by means of the evaporator **DX** coil rows **[D]** and then supplied to the room thanks to fans **[E]** action, while the refrigerant flows back to the compressor for a new compression cycle. The heat rejection takes place through the closed waterloop circuit in the outdoor drycooler.
- Freecooling mode**  
 If the ambient temperature is low enough, the compressor is **OFF**. The fan **[E]** makes the warm air coming from the room to flow through the evaporator and is cooled by the water coil rows **[F]** before being returned to the room. The heat rejection takes place through the closed waterloop circuit in the outdoor drycooler **[H]**.

The operating principle is the same for all the airflow delivery configurations and circuit configurations.

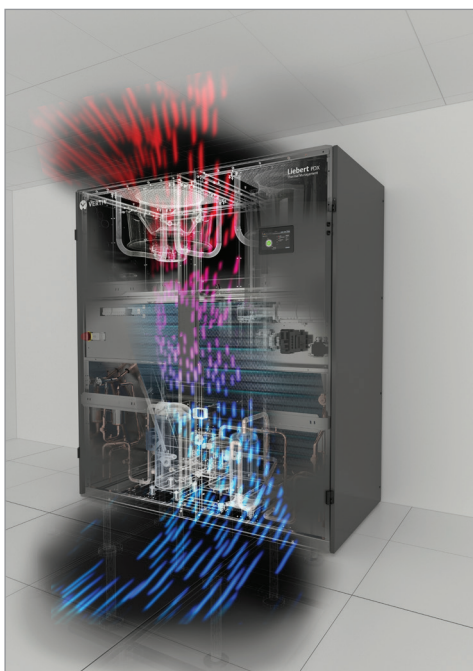
Dual circuit configuration have independent refrigerating circuits, each one with its own **BPHE**.

The unit switches between **DX** and **CW** mode according to external air temperature and unit inlet water temperature values.

If enabled, all units (no matter the airflow delivery or circuit configuration) can work with contemporary **DX** and **FC** operation **[Mixed mode]**.

## 4.3 Airflow configurations

### Downflow UP air delivery (Digit 7 = D)



Unit is placed above the floor, raised type.

The **warm air** returning from the room is drawn in by the fans located at the top of the unit (**red arrows**).

The **cold air**, having passed through the evaporator, is supplied (**blue arrows**) below the raised floor from the bottom section of the unit, that is completely open.

Finally the **cold air** will be delivered to the room through the grids placed in the raised floor.

### Upflow air delivery (Digit 7 = U)

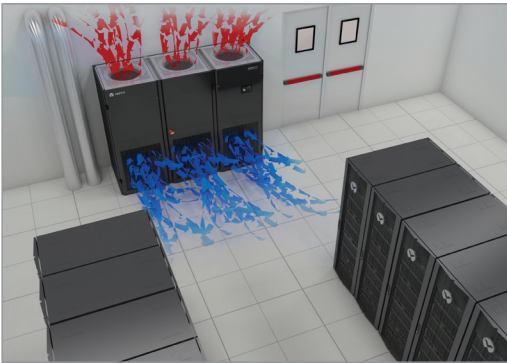


Unit is placed above the floor, raised or slab type.

The **warm air** returning from the room is drawn in through the grids located in the lower part of the frontal panel (**red arrows**).

The **cold air**, having passed through the evaporator, is supplied to the room from the upper side of the unit (**blue arrows**).

### Downflow Frontal air delivery (Digit 7 = H)



Unit is placed above the floor, raised or slab type.

The **warm air** returning from the room is drawn in by the fans located at the top of the unit (**red arrows**).

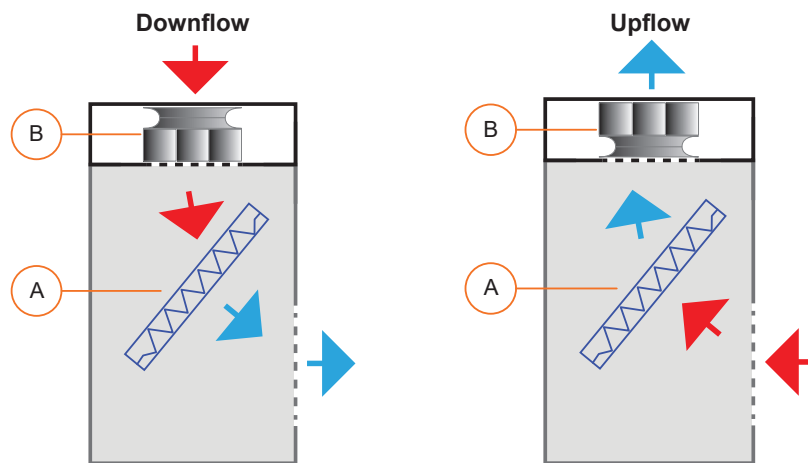
The **cold air**, having passed through the evaporator, is supplied to the room through the front grilles located at the bottom of the unit (**blue arrows**).

## 4.4 Frame sizes and structure

### 4.4.1 Frame sizes, general view

Each Liebert® PDX PAM UHD model is characterized by a specific frame and design height, which determine the overall dimensions of the unit:

Frame dimensions	Frame type	0	1	3	5
	Number of bays	1	1	2	3
Width x Depth (top view)					
Height	Standard				
		H = 1970 mm. The coil and the fan sections are factory assembled in the same cabinet.			



The unit frame is made by the coil section [A] and the fan section [B]. The coil section contains the refrigerating system of the unit (compressor, evaporator, expansion valve, etc), the electric panel and the control system.

The fan are place in the top and takes the **warm air** from the room into the unit. Two opposite fan orientation are possible, depending on airflow delivery configuration (**Digit 7 = U - Upflow** or **Digit 7 = D / H - Downflow**).

The air flows through the evaporator, **cools down** and blows out again in the room.

The heat rejection of the refrigerating circuit takes place in the outside unit depending on the cooling system (**Digit 8**).

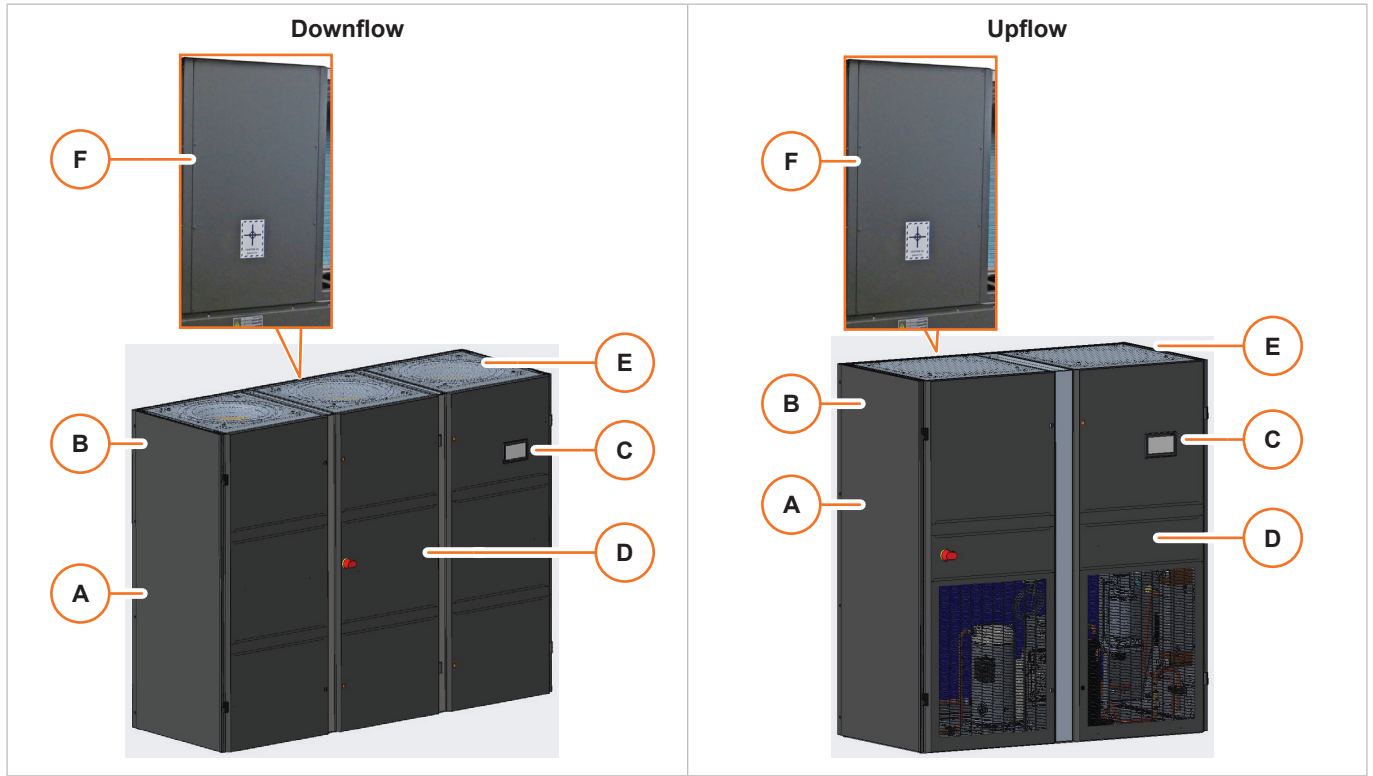
Mechanical accessories can be connected to the standard frame as explained later in this document: base frame with adjustable dampers, base module, extension hoods.

The cabinet is designed so that all the components are easily accessible for service and maintenance from the front of the unit and there is no need for top or lateral service area. Fans, valves and filters can be replaced without removing any other internal component.

Electrical panel is equipped with quick connectors (powers and signals) to reduce maintenance time in case of failure.

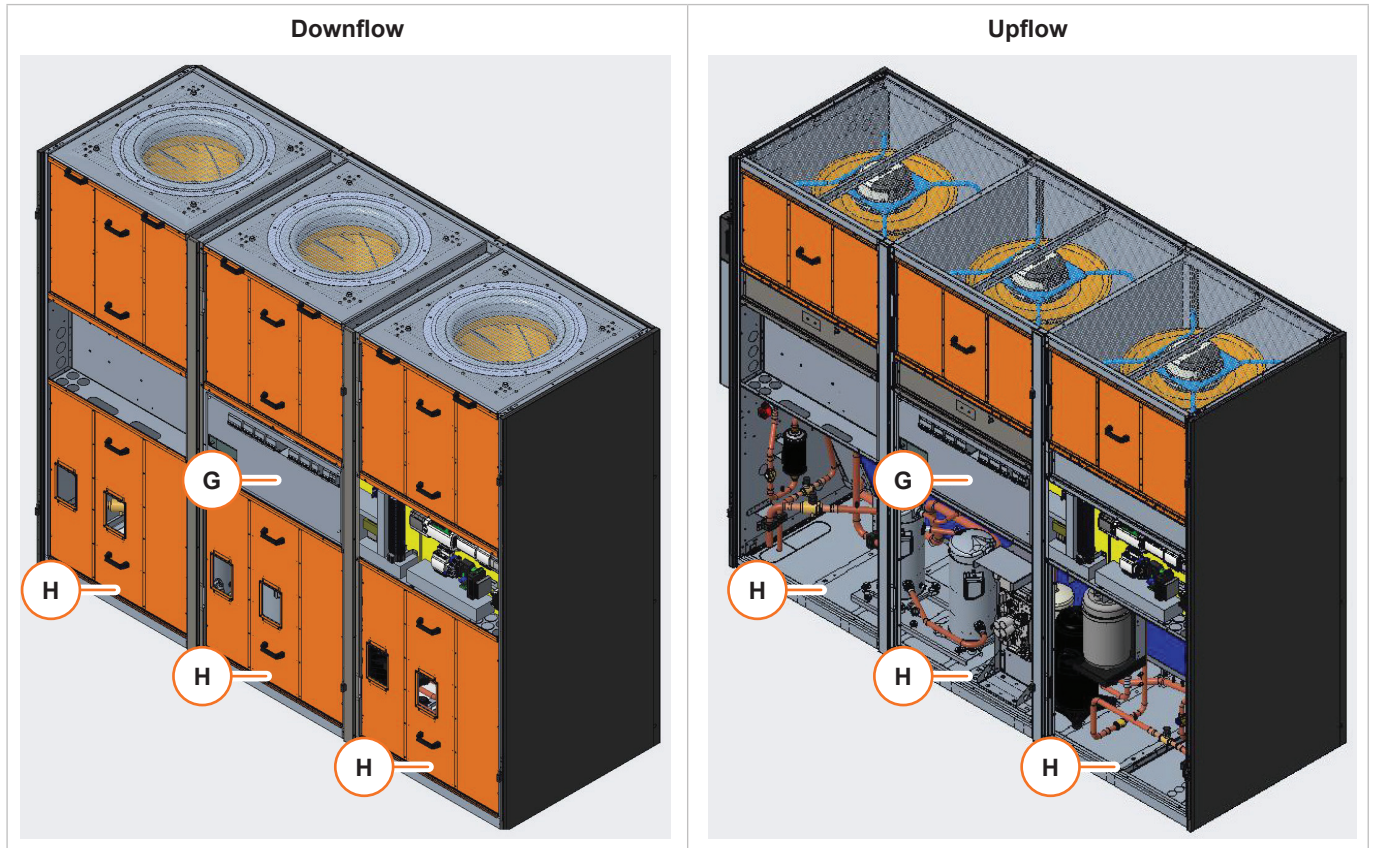
## 4.4.2 Frame structure in detail

### Doors closed



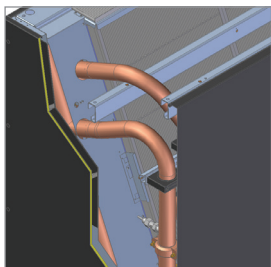
Ref.	Description	Remarks
A	<b>Coil section</b>	The coil section is completely closed by panels and by the door for protection against any contact with electric parts and hot or cold surfaces.
B	<b>Fan section</b>	The fan section is completely closed by panels and grids for protection against any contact with moving parts.
C	<b>Display panel</b>	The unit is usually controlled remotely by a network connection. The control panel is optional and may be placed on the front door or inside the front door.
D	<b>Doors</b>	The doors can be opened only by the proper tool.
E	<b>Fan safeguards</b>	The fixed panels (safeguards) can be removed only by loosening the fixing screws.
F	<b>Rear safeguards</b>	

## Doors opened



Ref.	Description	Remarks
G	Electric and control panel safeguards	The fixed safeguards can be removed only by loosening the fixing screws.
H	Compressor compartment	<p><b>For the Downflow versions:</b></p> <ul style="list-style-type: none"> <li>- the fixed safeguards can be removed only by loosening the fixing screws;</li> <li>- the holes for inspection and access to the connectors are protected by transparent plates, fixed by screws.</li> </ul> <p><b>For the Upflow versions:</b></p> <ul style="list-style-type: none"> <li>- in order to allow free airflow through the door, there are no safeguards to close the compressor compartment.</li> </ul>

## Frame materials and colour



The cabinet is manufactured from hot-dipped galvanized steel sheet, externally painted with **Black RAL 7021** color epoxy polyester powder paint and assembled using stainless steel screws and high tensile rivets. All the zincked metals parts are hot dip galvanized or powder coated in order to avoid zinc whiskers growing, minimizing any harmful zinc whiskers.

The rear and the fans section panels are double-skinned, with 20 mm Class A1 EU fireproof insulation sandwiched between the skins to reduce noise emission and heat loss. Frontal fan section panel has 40 mm of insulation thickness.

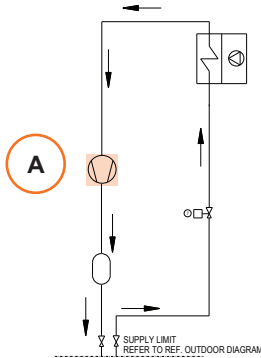
The side panels are isolated from the inside of the unit to form a complete double-skinned cabinet, and lined with 10 mm Class A1 EU fireproof insulation.

The frontal panels are assembled on hinges to make the access easier: in fact they can be opened by the fast closing lock. The rear and side panels are screwed to the supports.

## 4.5 Refrigerating circuit types

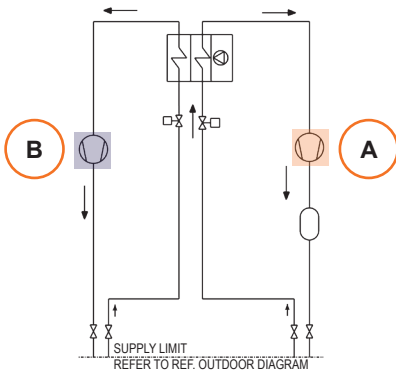
The following refrigerating circuits types are possible

### Single circuit (Digit 11=A)



Single circuit configuration equipped with a single compressor, variable speed type [A], and EEV.

### Dual circuit, single compressors (Digit 11=B)

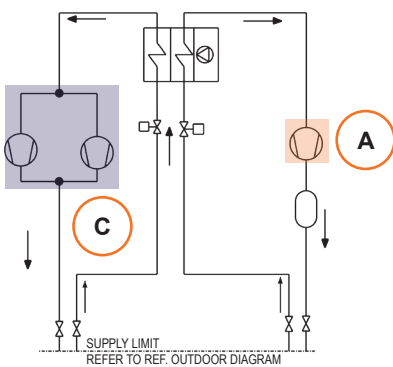


Dual circuit configuration:

- **Circuit 1** is equipped with a single compressor, fixed speed type [B], and EEV.
- **Circuit 2** is equipped with a single compressor, variable speed type [A], and EEV.

The evaporators and the condensers of the two circuits are independent.  
The evaporators are placed one after the other in the same coil section.

### Dual circuit, single tandem (Digit 11=C)

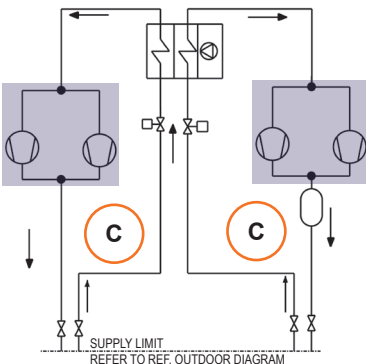


Dual circuit configuration:

- **Circuit 1** is equipped with a compressor tandem, fixed speed type [C], and EEV.
- **Circuit 2** is equipped with a single compressor, variable speed type [A], and EEV.

The evaporators and the condensers of the two circuits are independent.  
The evaporators are placed one after the other in the same coil section.

### Dual circuit, dual tandem (Digit 11=D)



Dual circuit configuration:

- **Circuit 1** is equipped with a compressor tandem, fixed speed type [C], and EEV.
- **Circuit 2** is equipped with a second compressor tandem, fixed speed type [C], and EEV.

The evaporators and the condensers of the two circuits are independent.  
The evaporators are placed one after the other in the same coil section.

## 4.6 Refrigerating circuit main components

### 4.6.1 Compressors

Liebert® PDX PAM UHD units are equipped with hermetic scroll compressors.

For single circuit models (**Digit 11 = A**) there is only refrigerant circuit 1 with a variable frequency driven compressor **VFD [B]** controlled by the **inverter [C]**.

For double circuit models:

- **Refrigerant circuit 1:** compressor/s on the left side are fixed speed type **[A]**.  
Single fixed speed compressor if **Digit 11 = B** or tandem fixed speed compressor if **Digit 11 = C**.
- **Refrigerant circuit 2:** compressor on the right side is **variable speed compressor [B]**.

Only exception is when **Digit 11 = D**, where both circuit 1 and circuit 2 are equipped with a tandem of fixed speed compressors.

Variable speed compressors are always equipped with an **oil separator [D]**, that collects the oil at the compressor delivery. The oil returns to the piping at the compressor suction through a **capillary [E]**.

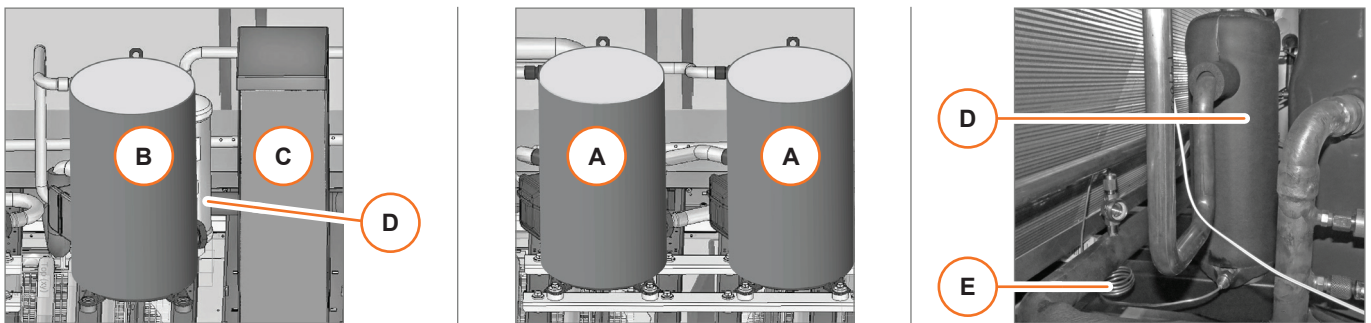
The high pressure drop of the capillary keeps under control the amount of oil and the temperature of the oil that returns to the compressor, even at maximum speed.

Oil separator is not present on circuits equipped with fixed speed compressors.

Fixed speed compressors are equipped with an external crankcase heater, mounted externally, on the lower part of the shell. The crankcase heater may be of belt type or surface type and has the function to pre-heat the oil/refrigerant mixture, to avoid presence of liquid at the compressor suction during the start-up phase.

Crankcase heater is not installed in **VFD** compressors, cause this functionality is realized through a specific inverter functionality.

An external check valve is always mounted on the compressor discharge line (both fixed speed or **VFD** type), to avoid return of liquid refrigerant from the condenser.



#### Variable speed compressors, technology details

The variable frequency drive communicates the cooling demand to the compressor motor. The motor dynamically adjusts its speed to generate the precise amount of cooling capacity required.

Compressor and driver undergo a “qualification process”, done by the OEMs, that ensure the best synergy and make possible a continuous and reliable modulation of cooling.

The use of variable-speed technology contributes to precise temperature control and high efficiency, mainly thanks to:

- better COP at part load conditions;
- reduced start-up currents thanks to soft start control (near zero inrush current).

Modulation range is comprise within the range 17-100%.

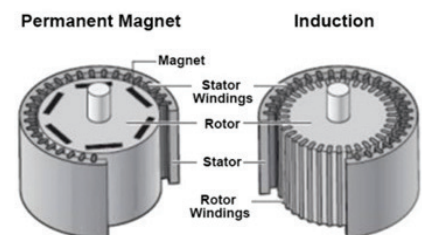
Liebert® PDX PAM UHD make use of variable speed compressor with interior permanent magnet motor (IPM), the latest generation of variable speed scroll compressors.

Permanent magnet motor design allows the highest electrical efficiency compared to traditional induction motors: there is no need to waste energy to create the “driving” electromagnetic field.

“Interior” design of the magnet means that they are embedded in the rotor: this, coupled with brushless design of the motor, enables very high rotational speed without any compromise in terms of reliability.

Finally the IPM design improves the overall power factor of the installation and boosts grid supply quality.

An additional advantage of **VFD** compressors is the lower noise emissions compared with conventional ON-OFF systems during partial load operations, that usually occur for more than 95% of the running time of the unit.

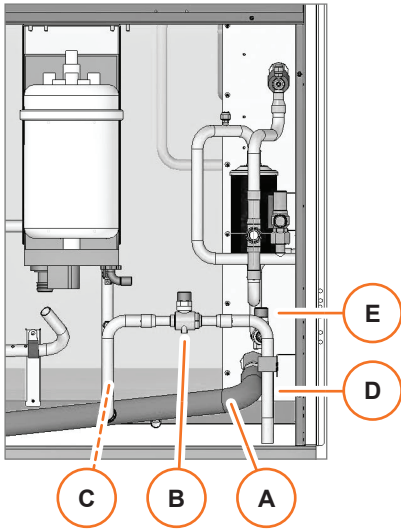


## 4.6.2 Condenser

### 4.6.2.1 Air cooled units (Digit 8 = A)

Each refrigerating system of the unit is connected on site to an external remote condenser which must be purchased separately. The remote condenser is controlled by the indoor unit control system, therefore only a **Liebert® OAC** condenser must be used. The safety valve is installed in the remote condenser.

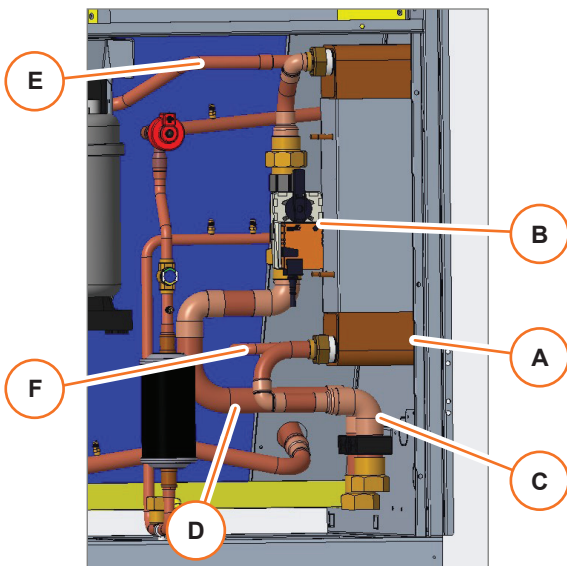
The following image show the relevant components installed on the compressor discharge line of air cooled unit.



<b>A</b>	Piping - outlet to the external condenser
<b>B</b>	Shut-off valve at delivery to the external condenser
<b>C</b>	Check valve at unit outlet to the condenser <i>Function:</i> The check valves prevent unwanted refrigerant migration between the unit and the condenser in anomalous conditions.
<b>D</b>	Piping - inlet from the external condenser
<b>E</b>	Shut-off valve at inlet from the external condenser

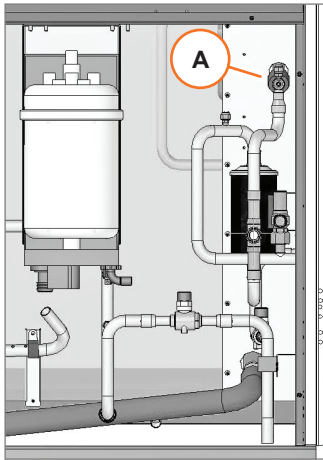
### 4.6.2.2 Water cooled units (Digit 8 = W or F)

Each refrigerant circuit is equipped with a brazed plates heat exchanger **BPHE**. Each refrigerant circuit is also equipped with a modulating **2-way water control valve**, ball type, that is piloted via a 0-10V signal by iCOM™ controller to manage the condensing control.



<b>A</b>	BPHE condenser
<b>B</b>	Condensing regulation valve
<b>C</b>	Inlet water piping
<b>D</b>	Outlet water piping
<b>E</b>	Refrigerant inlet water piping
<b>F</b>	Refrigerant outlet water piping

### 4.6.3 Electronic expansion valve



Each refrigerating circuit, no matter if a fixed speed or **VFD** compressor is installed, is equipped with electronic stepper valves **EEV** as expansion device.

The **EEV [A]** is driven by the iCOM™ control system and control the compressor suction superheat.

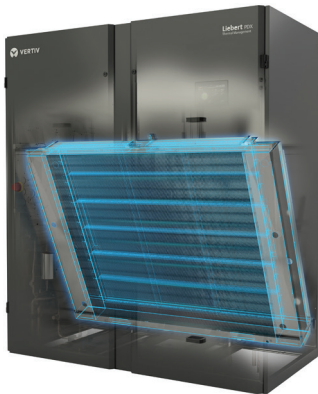
If the superheat is lower than the defined setpoint it means that there is too much liquid coming out from the evaporator: the iCOM™ control makes the **EEV** to close causing the evaporating pressure to drop, along with its corresponding evaporating temperature that is used to measure the superheat.

On the opposite, if the superheat is higher than the setpoint, it means there is superheated gas coming out from the evaporator: the iCOM™ control makes the **EEV** to open causing the evaporating pressure to rise, along with its corresponding evaporating temperature that is used to measure the superheat.

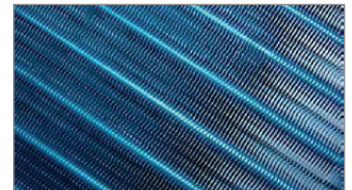
The use of an electronic expansion valve rather than a thermostatic valve guarantees a precise liquid feeding of evaporator and therefore a much better control of the superheat.

The **EEV** doesn't need of periodical re-tuning (self-calibrating).

### 4.6.4 Evaporator Coil

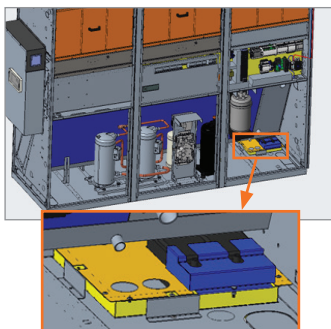
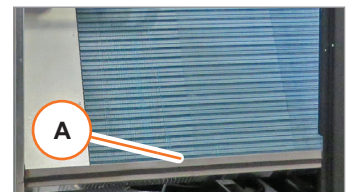


The large face area evaporator coil is manufactured from copper tubes, mechanically bonded to hydrophilic painted aluminum fins.



On double circuit units, the evaporator coil is staged type.

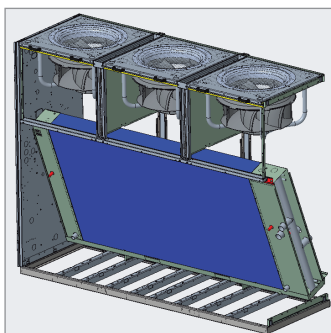
Evaporator coil is equipped with a stainless-steel condensate **drain pan [A]**. Condensate pump is a configurable option.



As an option it is possible to have **Upflow** unit with a condensate pump that allows draining of the water up to 3 m above the floor. The pump discharges both condensate water from exchange coil and drain water from humidifier (if installed).

Maximum discharge total head allowed 3 m (head + hydraulic connection loss).

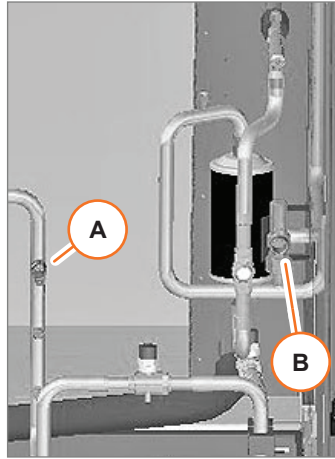
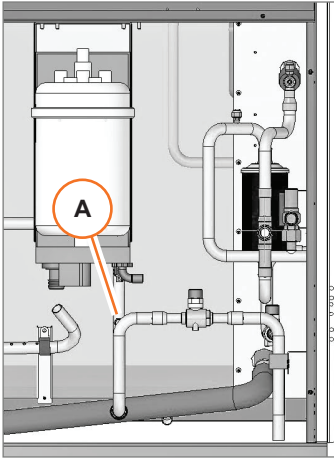
The final drain must be able to receive 10 l/min water at high temperature (max water temperature 80°C)



Free-cooling units (**Digit 8 = F**) have an additional water coil and a modulating 2-way water control valve to manage the chilled water coil in free-cooling mode.

## 4.6.5 Safety devices, sensors and others

Each refrigerating circuit is equipped with the following components.

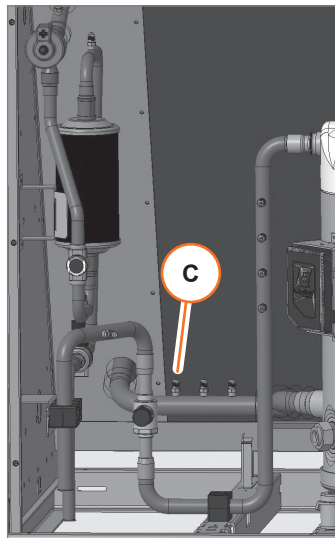
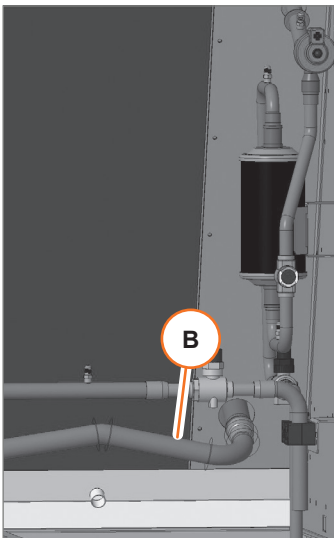


**High pressure switch [A]** for protection against excessive high discharge pressure.

In water water cooled and freecooling units (**Digit 8 = W or F**), a **safety valve [B]** is installed on the piping.

This valve is equipped with threaded connections so that the refrigerant may be discharged to the outside

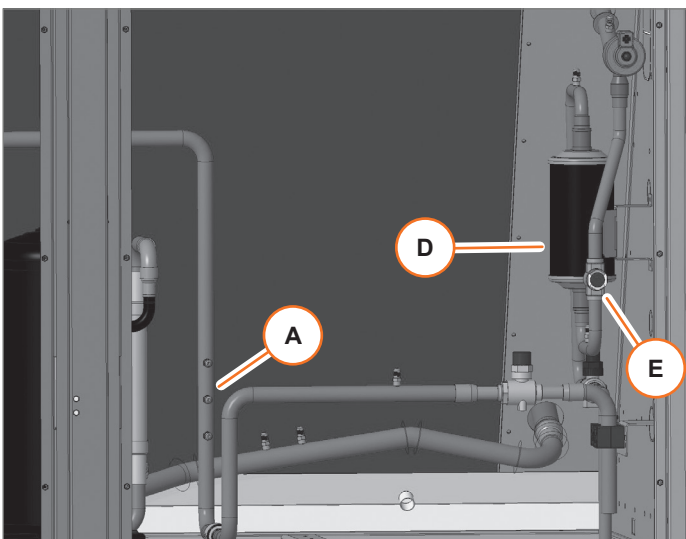
In air cooled unit (**Digit 8 = A**) this device is installed in the outdoor remote condenser.



**High pressure transducer [A]** and discharge temperature sensor, to control pressure at temperature at compressor outlet.

A **low pressure transducer [C]** is installed at the compressor suction to measure evaporating pressure and detection of too low evaporating pressure.

This sensor, together with the **suction temperature probe [B]** that measures refrigerant temperature at evaporator outlet, allows the superheat management through the **EEV**.



**Filter dryer [D]** is always present in the liquid line.

Filter aims to prevent any particle such as dirt, metal or chips to enter into the **EEV**.

Dryer primary function is to remove moisture from the refrigerant, thereby preventing freezing within the piping and the formation of acids and sludge upon contact with oil in the system.

**Sight glass [E]** can support to Check the refrigerant level and conditions (presence of bubbles, etc).

## 4.7 Air flow management

### 4.7.1 Fans

Each refrigerating circuit is equipped with the following components.



**Liebert® PDX PAM UHD** is equipped with the latest generation of centrifugal ‘plug’ type Electronically Commutated (**EC**) fan(s).

Modulation range is between 30% and 100% of the maximum speed is possible.

The design makes use of the most recent technological solutions with the goal to maximize efficiency and improve reliability:

- Impeller with curved blades corrosion resistant made of fiberglass plastic, a solution that allows keeping the current high strength of aluminum alloy adding the benefits of light weight and full flexibility on blade design of the new material;
- Fan wheel is statically and dynamically balanced and the bearings are self-lubricating;
- “S” shape separator are installed between the fans shall to eliminate turbulence effects of one fan to the others.

The good dampening behavior of the plastic and the supporting structure on which the fans are mounted helps to reduce noise emissions.

The fan motors is three-phase, with IP54, protected by thermal magnetic circuit breakers and controlled via Modbus signal via the controller.

When unit is equipped with more than one fan, in case one fails the unit doesn’t stop and provides cooling continuity. In case of communication failure between unit and control, watchdog function is available to force fans speed at fixed value.

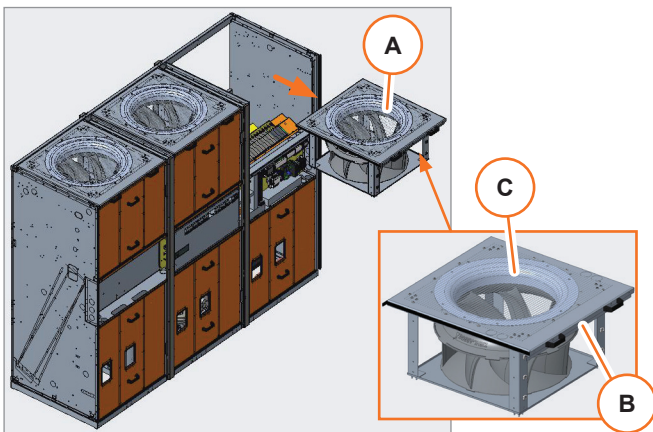
**Fans [A]** are installed on a **supporting frame [B]** that helps to reduce vibrations and simplify the maintenance operations. A **metallic grid [C]** provides mechanical protection to fans.

The following fan configuration are possible:

- **Digit 9 = E**, high efficiency fans, default configuration;
- **Digit 9 = P**, high power fans.

High power fans are equipped with more powerful EC fan(s), with the same technological design features, able to move more air for a certain available static pressure of the airflow.

Depending on unit models, these fans usually have a higher power consumption compared to high efficiency default fans.



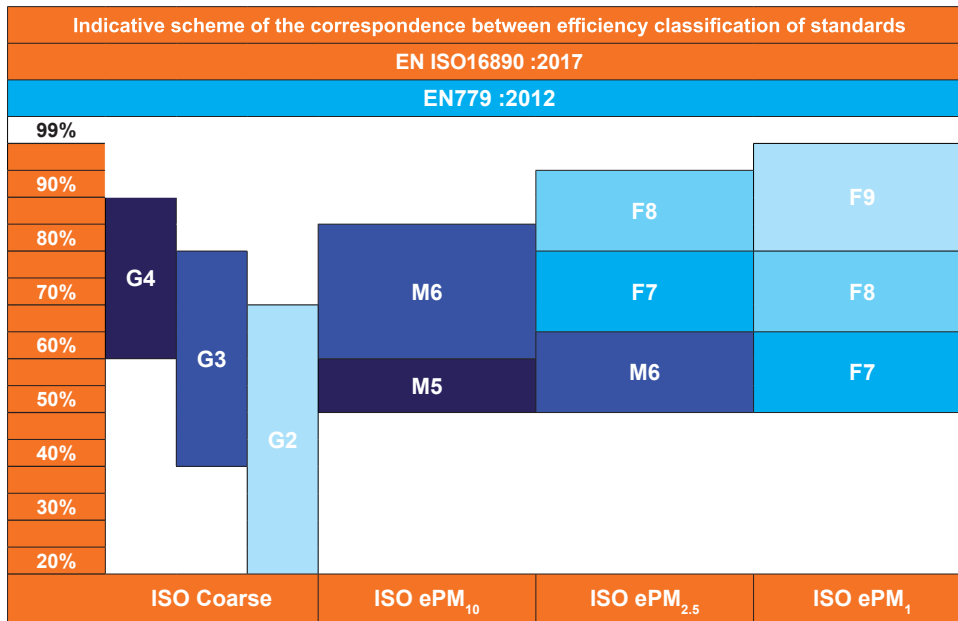
## 4.7.2 Air filtration

### 4.7.2.1 Air filter reference standards

The new standard ISO EN 16890:2017 has replaced the previous EN779:2012, used to characterize the filtration efficiency. As main difference, when in EN779 the efficiency was based on filtering particles with a diameter of 0.4  $\mu\text{m}$ , in ISO EN 16890 the efficiency is based on particulate with different dimensions, from 0.3  $\mu\text{m}$  to 10  $\mu\text{m}$  in accordance with the test group.

So, the nine classes of EN779 (G1, G2, G3, G4, M5, M6, F7, F8, F9) will be translated in the four filter groups (ISO Coarse, ISO ePM<sub>10</sub>, ePM<sub>2.5</sub>, ePM<sub>1</sub>, where **ePM** stands for “efficiency Particulate Matter”) and the relevant efficiency percentage, e.g. ISO ePM<sub>10</sub> 60%.

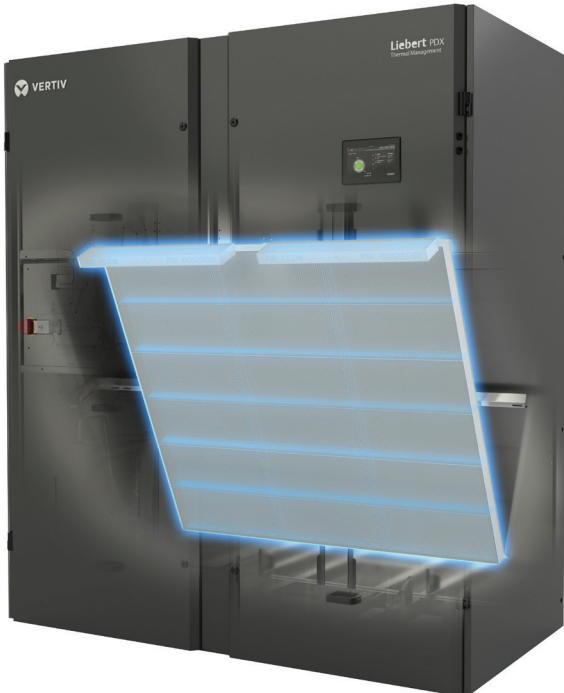
To have a reference about different standards, see tables below. It must be underlined that there is no precise link between them, due to the different test procedures and different measured values: the tables can be used as first general guidance, but not to exactly convert G1-F9 Filter Classes or ASHRAE MERV into ISO Filter Groups.



**Indicative scheme of the correspondence between efficiency classification of standards**

EN 779:2012	EN 779:2012	ASHRAE Standard 52.2
Coarse Filters Average Arrestance (Am)	Medium and Fine Filters Average Efficiency (Em)	Minimum Efficiency Reporting Value (MERV)
50% ≤ Am < 65% <b>G1</b>		<b>MERV 1-4</b>
65% ≤ Am < 80% <b>G2</b>		<b>MERV 1-4</b>
80% ≤ Am < 90% <b>G3</b>		<b>MERV 5</b>
90% ≤ Am <b>G4</b>		<b>MERV 6-8</b>
	40% ≤ Em < 60% <b>M5</b>	<b>MERV 8-10</b>
	60% ≤ Em < 80% <b>M6</b>	<b>MERV 9-13</b>
	80% ≤ Em < 90% <b>F7</b>	<b>MERV 13-14</b>
	90% ≤ Em < 95% <b>F8</b>	<b>MERV 14-15</b>
	95% ≤ Em <b>F9</b>	<b>MERV 16</b>

#### 4.7.2.2 Air filtering in Liebert® PDX PAM UHD



Liebert® PDX PAM UHD units are equipped with an air filter section with ePM10 50% filtration grade according to ISO/EN16890.

Standard filters are made by paper material and are completely recyclable. The filter pleated structure gives high filtration efficiency, low pressure drops and allows the use of the filter without metallic or cardboard frame.

The filter media is composed by fiber and latex.

They are easily accessed/replaced by opening the front (for **Upflow** units) or back (for **Downflow** units) panels.

On the top of the coil an “L” shape filter is placed to add more surface and to optimize coil exchange rate.

In downflow units filters are laying on the coil surface to maximize the filtering surface so reducing air pressure drop.

Liebert® PDX PAM UHD units with downflow air delivery configurations are equipped with an innovative coil filter section.

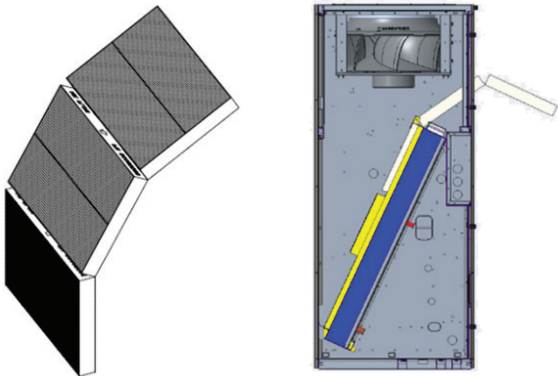
The new filter has a patented multi-section that provides an higher filter surface without any compromise in terms of easiness of maintenance.

This design allows to easily pull the entire filter from the back no matter how much wide the filtering surface is.

The increased filter surface makes possible to reduce air pressure drops with two advantages:

- greater air flow;
- reduced fan power consumption.

The benefit is enhanced efficiency compared to traditional design, with an energy saving that can be up to -5% for the entire unit.



Configurable digit options:

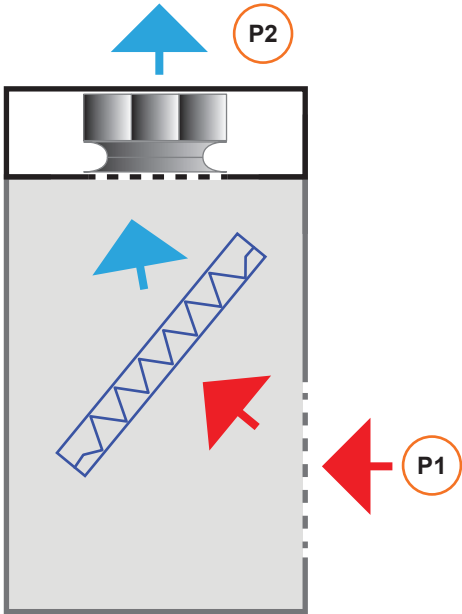
The unit can be configured with a filter differential static pressure switch, connected to the iCOM™ controller to provide “**filter clogged**” warning indications: **Digit 15 = 3**.



As an alternative, the unit can be fitted with a filter differential pressure transducer connected to the iCOM™ controller to provide a dynamic “**filter status**”: **Digit 15 = 2**.

### 4.7.2.3 External Static Pressure [ESP] management

With reference to the maximum fan speed, the following external static pressure limits must be respected at the nominal air flow rate:

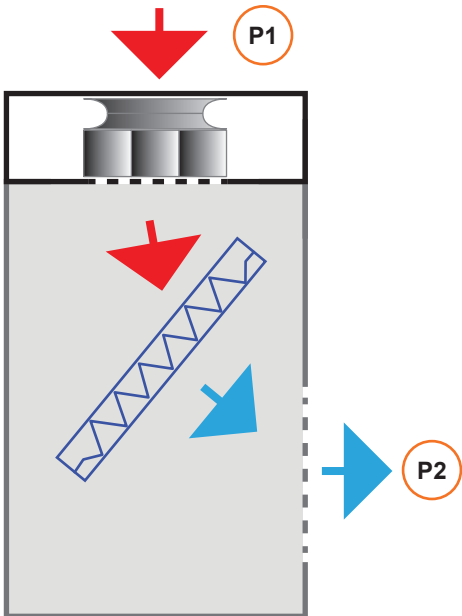


#### Upflow configurations

In unit with **Upflow** airflow delivery the ESP limit, the following External static pressure condition must be respected:

$$P2 - P1 \leq 300 \text{ Pa.}$$

It is implied that the ductwork for air channeling must be mechanically resistant to withstand the ESP.



#### Downflow configurations (all versions)

It operates under conditions of overpressure relative to the outside due to the ESP provided by the fans. In order to limit both the air leakage risk from gaskets (with consequent loss of efficiency) and vibration problems, the following External static pressure condition must be respected:

$$P2 - P1 \leq 150 \text{ Pa.}$$

If  $P1 = 0$  (atmospheric pressure) the max ESP possible is 150Pa.

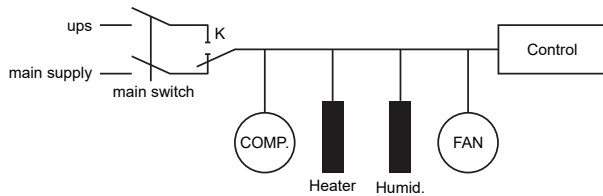
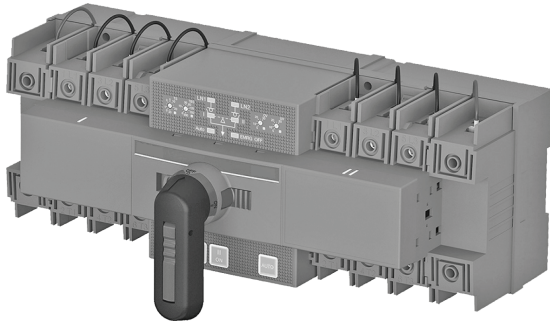
## 4.8 Power supply

### 4.8.1 Power supply options

Liebert® PDX PAM UHD are designed for a power supply of 400 V / 3ph + N / 50 Hz + Earth.

Electrical tolerance is  $V \pm 10\%$ ,  $Hz \pm 2$ .

As a standard the unit is delivered with standard single power supply (**Digit 18 = D**).



As a configurable option, the unit can be equipped with an automatic transfer switch **ATS (Digit 18 = G)** and be capable to manage dual alternate power supply.

The Automatic Transfer Switch (**ATS**) monitors the following conditions: no-voltage, phase-loss, overvoltage and under-voltage detection, transfer delays, generator start and stop, and remote test function.

In case of a power loss or major malfunction of line **I**, it can be used for operating the motorized change-over switch to the line **II**, provided that line **II** is operational.

Source transfer can be performed manually, locally using push buttons or fully automatically.

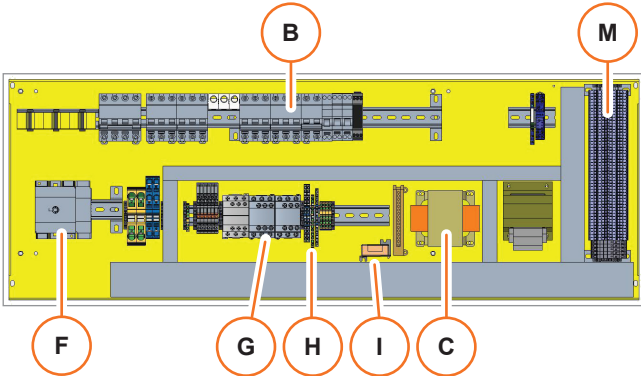
The automatic mode includes several operating methods: Line **I** priority, no line priority and manual back switching mode.

The following table explains what happens in case of power failure and after the power is restored.

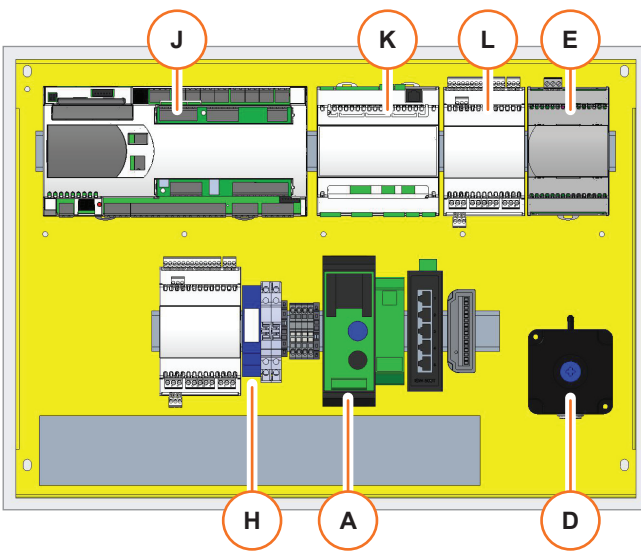
Option	Power supply type	What happens in case of power failure	What happens when the power is restored
<b>Standard power supply</b>	Single supply line	An <b>Ultracap</b> device supplies power to the control for about <b>60</b> seconds. The control immediately closes the <b>EEV</b> , so to avoid leakage between high and low pressure pipelines.	The unit restarts automatically. The control system reboots if the down time is more than <b>60</b> seconds
<b>Dual power supply alternate</b>	Double power supply to the <b>ATS</b> electric panel, which is connected to the main electric panel. Each power supply can supply completely the unit.	In case of failure of the main supply, the <b>ATS</b> (Automatic Transfer Switch) automatically switches to the second power supply. If the <b>Ultracap</b> avoids power interruption to the control for the time needed for the switching, then the unit restarts with a " <b>fast startup</b> ", which means it restarts from the status before the power failure. Otherwise the unit restarts automatically from scratch and the control system reboots.	The <b>ATS</b> remains on the second power supply until the main power supply is restored.

### 4.8.3 Main components

Power side (high voltage)

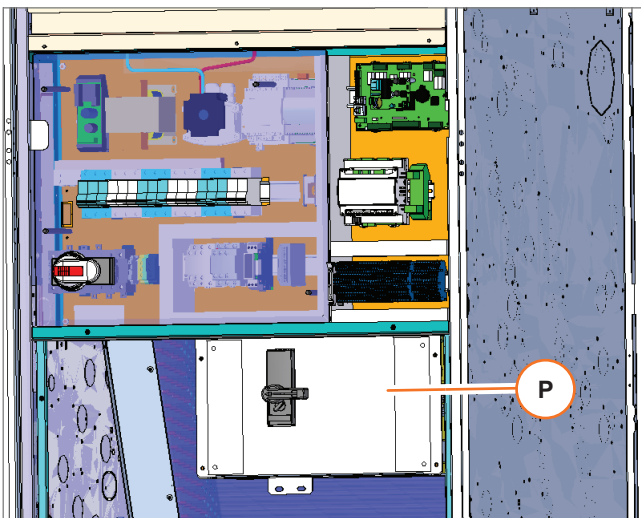


Control side (low voltage)



A	Power supply for touch screen
B	Thermal magnetic circuit breakers
C	Transformer
D	Clogged filter sensor
E	Ultracap
F	Disconnecting switch
G	Contactors
H	Relays
I	Amperometric transformer for humidifier
J	Control board
K	Humidifier control board
L	Expansion module
M	Terminal board

**NOTE** The electric panel is designed and manufactured according to EN 60204-1.



P	ATS (Automatic Transfer Switch) electric panel (optional)
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## 4.8.4 Disconnecting switches



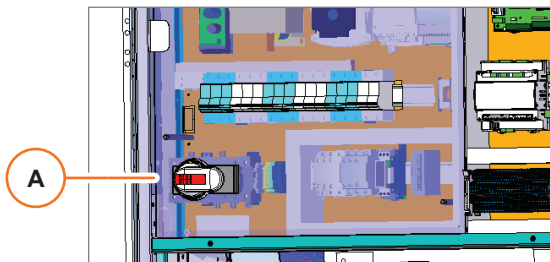
### WARNING

Due to the presence of **Ultracaps** for the control, inverter and other devices, the electric and control panels can retain a stored **high-voltage electrical charge** for a certain time.

Before removing the panels and working inside the electric and control panels proceed as follows:

- Open all the local and remote disconnecting switches of the unit;
- Wait at least **5 minutes**;
- Verify with a voltmeter that the power is **OFF**.

### Single power supply



#### A Disconnecting switch

This is a disconnecting switch and it cuts **OFF** the electric power supply to the whole unit.

### Dual alternate power supply



#### B ATS disconnecting switch



### WARNING

The power supply is connected to the **ATS** disconnecting switch [B].

After you turn **OFF** the main disconnector switch and you open the door, pay attention to the cable and components that are **still energized**.

## 4.8.2 ATS types and performance tables

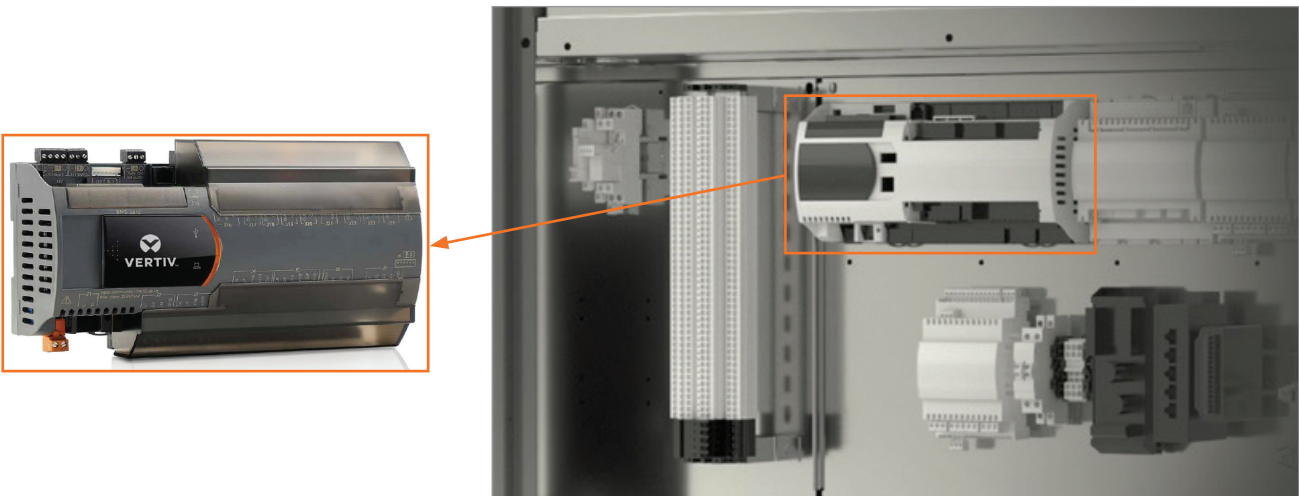
Unit models	ATS Type	Rating
PAM010	Type 01 - 63 A	63 A
PAM020	Type 01 - 63 A	63 A
PAM030	Type 01 - 63 A	63 A
PAM060	Type 01 - 125 A	125 A
PAM080	Type 03 - 160 A	160 A
PAM088	Type 03 - 160 A	160 A

Ratings		63 A	125 A	160 A
Type		Type 01	Type 01	Type 03
Frequencies		50 Hz	50 Hz	50 Hz
Thermal current $I_{th}$ at 40°C [A]		63	125	160
Short-circuit capacity	Rated short-time withstand current: $I_{CW}$ 1s [ $KA_{eff}$ ]	2,5 @ 1sec	2,5 @ 1sec	4
	Rated short-time withstand current: $I_{CW}$ 30ms [ $KA_{eff}$ ]	Not available	Not available	10
Switching time at $I_n$ excluding loss of supply sensing time and excluding any delay timers applicable	I – II or II – [ms]	2500	2500	180
	Duration of “Electrical Blackout” at $U_n$ [ms]	Not available	Not available	90
	I – O, O – I, II – O, O – II [ms]	1800–1900	1800–1900	45
Connection cross-section	Minimum size [Cu mm <sup>2</sup> ] flexible and rigid	10	10	10
	Maximum size [Cu mm <sup>2</sup> ] flexible and rigid	70	70	70

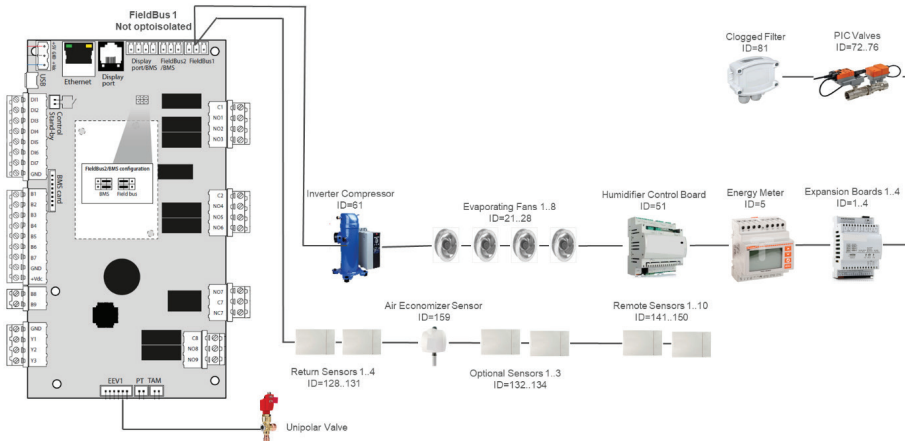
## 4.9 Control system

### 4.9.1 Control platform, I/O and modbus connections

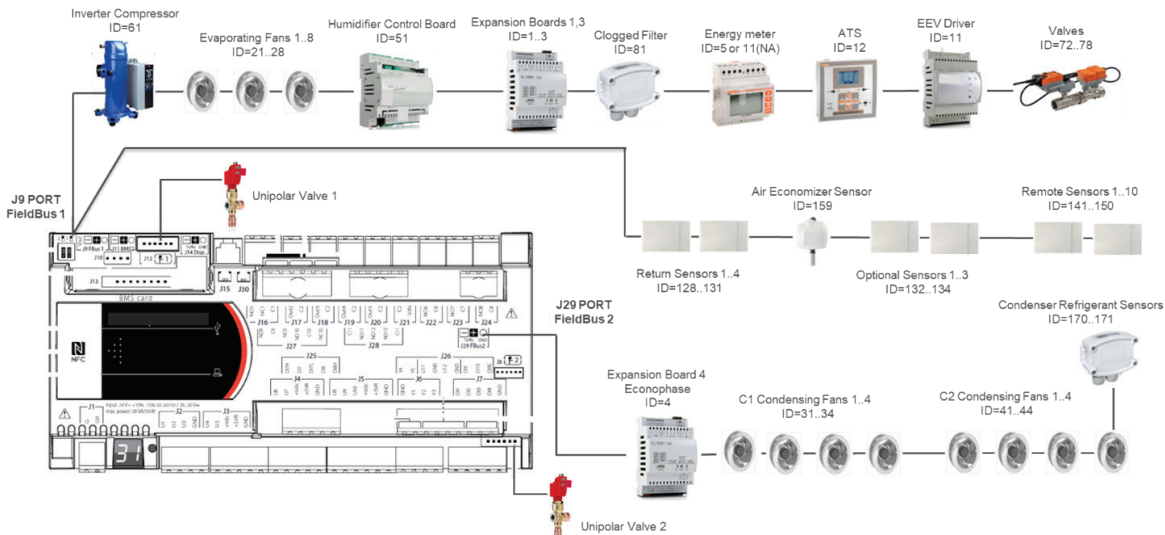
The unit control system is based on the iCOM3™ platform.



Units with single circuit configuration use the iCOM3™ small size.



Units with double circuit configuration the medium size hardware.



It's possible to navigate the software via a menu-driven structure that makes possible:

- Monitoring of the following information: alarms, event logs, unit view/status overview, operational status in percentage of each function, [I/O] addresses for sensors and field devices, room conditions, etc;
- Parameter set of the main functionalities (protected by password): setpoints, PID values, standby settings, timers/sleep mode, alarm setup, [I/O] configurations, sensors calibration, options setup, system/network setup, auxiliary boards, etc.

Each unit is equipped, on internal electrical panel, with an ON/OFF switch which allows to turn ON-OFF the unit in case unit's display is not available. Close to the switch a LED provides visual indication of the unit ON/OFF status.

Terminals are provided for remote start/stop control plus Volt-free 'Common Alarm', 'Common Warning'.

Main list of input/outputs [I/O] includes:

- Up to 6 configurable inputs for single circuit units;
- Up to 8 configurable inputs for double circuits units;
- 1 digital input for remote ON/OFF;
- 2 digital outputs to report general warning and general alarm;
- 2 RS485 Fieldbus line (Master or Master/Slave configurations);
- 1 Ethernet port.

## 4.9.2 User interfaces

In house developed software is already installed ready to be programmed.

The controller can be programmed, in alternative, through one of the following user interfaces:



A 7" inch semi-graphic LCD display installed on the unit, resolution 800 x 480 pixel (**Digit 13 = 7**).



A small 4.3" inch semi-graphic LCD display installed on the unit, resolution 132 x 64 pixel (option) that requires a power supply 24Vdc).



A 7" inch semi-graphic LCD display for remote use, resolution 800 x 480 pixel (accessory that requires a power supply 24Vdc).



A 10" inch, high-definition widescreen display for remote use, capacitive touchscreen, resolution 1280 x 800 pixel (accessory that requires a power supply 24Vdc).



External PC/Laptop: all the display functions are also replicated in a web browser.

User interface can be connected through the port accessible in the frontal panel:



**A** → **RJ11 - CANbus** port for connection of an external display.

**B** → **RJ45 - Ethernet** port for connection of an external laptop (not available when the unit is equipped with display panel. If required, it must be selected the ethernet switch in price list option).

### 4.9.3 Control modes and sensor management

The control as standard allows to manage:

- A return temperature and humidity sensor;
- A supply temperature sensor;
- Up to 10 active remote temperature and humidity sensors;
- Up to 3 read-only/passive room temperature and humidity reference sensors.

When multiple remote sensors are installed, the user can choose the minimum, maximum or average value.

This value will be used by the control for managing the unit. The user can also choose the redundancy option: in this case the control will consider the second sensor only if the first one is broken or missing. The same rule will be applied for succeeding redundant sensors.

The control has auto adaptive algorithms known as PIDs. Specific PIDs settings can be changed by the Service Personnel during commissioning, only if necessary. The user may only act on the set points of the main values, like air temperature and humidity control, and eventually decide the control loop logics.

Different refrigerating circuit priorities can be set:

- in cooling mode can be decided by the user, that can select the leading circuit (the first to start) or automatic mode (activation based on working hours);
- In dehumidification mode.

There are three main control loops that affects unit performances as described in the following.

#### Temperature control (server room).

Cooling request, which is used to drive the compressor capacity, is calculated based on deviation from the setpoint.

Four temperature control modes are possible:

1. **Return:** set point applied to the air entering the indoor unit;
2. **Supply:** set point applied to the air existing from the indoor unit;
3. **Return + Supply:** the controller uses the minimum deviation calculated on return and supply setpoints;
4. **Remote:** set point applied to the temperature measured by a remote sensor.

### Fan speed control

#### Evaporator

Minimum fan speed cannot be lower than 30% when compressor is **ON**.

Fan speed control is related to the supplied airflow and five control options are available:

1. **Return control mode:** fan speed modulated following the return air temperature deviation;
2. **Supply control mode:** fan speed modulated following the return air temperature deviation;
3. **Delta return/supply control mode:** the control tries to achieve a constant DT return/supply;
4. **Static Pressure control mode:** fan speed modulated to keep constant the static pressure;
5. **Fixed Speed:** no modulation, fans running at constant set point value (override in case of safety reasons);

Cooling capacity and fan speed PIDs are usually common but can be decoupled by the Service Personnel if needed. To control humidity in the room is possible to define a humidity control mode and a humidity control type

The fan speed can be limited or control be override in the following cases:

- **No power or high temperature alarm:** the fan will run at defined speed;
- **Manual mode;**
- **Single fan failure:** the remaining fans will be forced to maximum speed;
- **Heating, Humidification or Dehumidification ON:** the fan will run at defined speed till not higher call for fan speed occurs.

#### Condenser

The outdoor remote unit fans can be directly controlled via modbus by the indoor unit, with speed adjustment between 0 and 100% of the maximum speed. The input parameters for the speed adjustment are the following:

- compressor delivery pressure (measured by the pressure transducer);
- outdoor temperature (measured by an optional remote sensor in the condenser).

It is possible to set a limit to the maximum speed to reduce the noise emission.

## Humidity Control mode

Defines which sensors read will drive the humidification/dehumidification process.

- Return air;
- Remote sensor.

Once defined which sensor must be used for humidity control, four Humidity Control types are possible:

1. **Relative control type:** Humidity control driven by relative [%] humidity setpoint deviation;
2. **Relative compensated control type:** the setpoint will be recalculated by a fixed value based on the actual deviation from the temperature setpoint;
3. **Absolute:** Humidity control driven by absolute [g/Kg] humidity setpoint deviation;
4. **Dew Point:** Humidity control driven by dew point setpoint deviation.

In case of sensor failure, the unit automatically adapts and switch to a different preset emergency control mode.

### 4.9.4 Main safety functions

The control system manages all the safety and operating devices needed for reliable automatic operation.

Main protective functions are summarized in the following:

- Out of envelope: the control system automatically tries to keep the compressor operating point within the compressor operating map, eventually with synchronized actions with the **EEV**;
- Main controlled parameters are condensation pressure and evaporating pressure;
- High pressure control and high-pressure switch;
- The high-pressure switch may be handled in two different ways depending on the compressor type;
  1. **Relay:** the high-pressure switch sends a signal to a relay that cuts-off the power supply to the compressor;
  2. **STO (Safe Torque Off):** the high-pressure switch sends a signal to the inverter that cuts-OFF the power supply to the compressor (after the inverter) through a **STO** port.
- Low pressure control;
- **Fan protective functions:** electronic overheating protection, motor overheating protection, locked rotor protection, short circuit at the motor output;
- Compressor timing management (minimum **ON**, minimum **OFF**, activation delay);
- Watchdog function for fans (indoor / outdoor): in case a fan failure occurs, the other are forced to maximum speed.

More than 200 types of warnings / alarms / messages are displayed including:

- high temperature, low temperature, high relative humidity, low relative humidity, compressor failure, fan electrical failure, heater high temperature, sensor failure, etc.;
- iCOM™ control gives also the possibility of a fast start after a power **OFF**.

The following scenarios are possible:

- If the power **OFF** lasts less than **1** minute, that is if the main control board is kept alive by the **Ultracapacitor**, then the main **DX** circuit will restart within **20** seconds;
- If the power **OFF** lasts more than **1** minute, the main circuit will restart within **80** seconds;
- The second circuit is always allowed to start **8** seconds later than the first one.

### 4.9.5 Teamwork logics

Four 'teamwork' modes can be adopted.

1. **No Teamwork.** The units work independently. Sensor values and setpoints are not shared. The control drives cooling, heating, ventilation, humidification, and dehumidification based on the local requests. Standby function and unit rotation are possible.
2. **Teamwork Mode 1 (Parallel).** In this mode all the units act in parallel as a unique system, delivering cooling, heating, ventilation, humidification, and dehumidification. All relevant control parameters are shared; if a value is changed in any of the units, all other units will follow with the same changed setting.
3. **Teamwork Mode 2 (Independent).** The control drives cooling, heating, ventilation, humidification, and dehumidification based on local requests, while avoiding operational conflict with the other units in the network. For example: If one unit is on cooling, no other unit may start heating. If one unit is on dehumidification, no other unit may start humidification. In this Teamwork mode, all relevant control parameters are shared; if a value is changed in any of the units, all other units will follow with the same changed setting.
4. **Teamwork Mode 3 (Smart Aisle™).** Local request is used for driving cooling and heating. This teamwork mode can be set only if the **Smart Aisle™** option has been enabled and remote sensors are ordered. A Master Unit controls duty, standby and rotation, calculates system values and sends it to the other units in the system. The Master holds the selected number of units and starts/stops the units to have the requested number of units working.

## 4.10 Optional electrical heaters for de-humidification

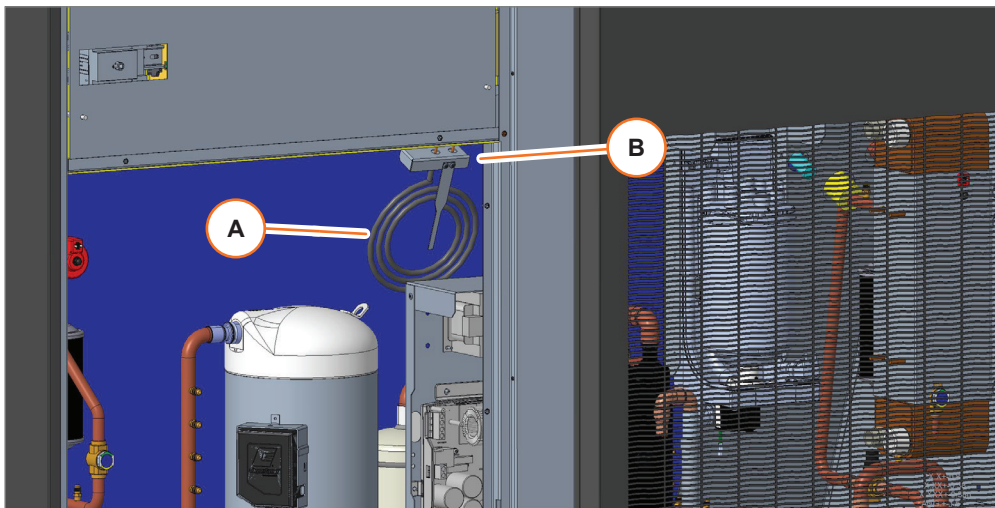
The heating resistors are utilized to maintain room dry-bulb conditions during a system call for dehumidification. Two standard capacities are managed (**Digit 14 = 1**):

Unit models	Nominal heating capacity
PAM010	1,5 kW
PAM020	
PAM030	
PAM060	
PAM080	3 kW
PAM088	

The heating resistors **[A]** are of a rigid design for extended operational life and each stage of heaters is made of finned armored stainless steel AISI 304 to maintain a low surfaces power density and therefore avoid ionization effects. Heating control is of the ON-OFF type.

The heaters are protected from short circuit through Miniature Circuit Breaker(s) and are phase balanced. Excessive air temperature is avoided through the intervention of a temperature thermostat **[B]** that can switch **OFF** the heaters. Manual reset is then necessary.

Image for reference, **Downflow (Up or Frontal)** air delivery configuration.



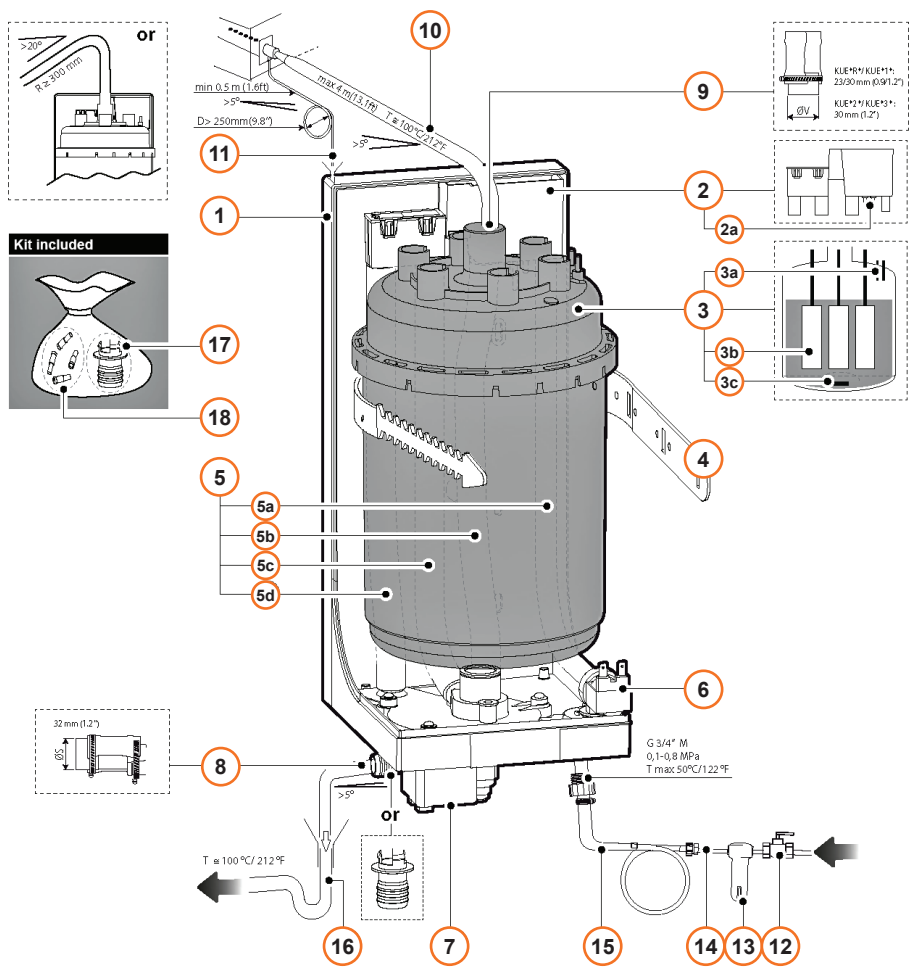
### 4.11 Optional humidifier

The unit can keep the humidity of the environment at the requested set point through humidification and dehumidification functions; the humidification function is embedded when humidifier is installed.

The unit can be fitted with an electrode boiler humidifier (**Digit 12 = S**).

The metal electrodes are immersed in the tank filled with common drinking water. When a voltage is applied on the electrodes, an electric current is created in the water, which is slightly conductive since it contains a certain quantity of dissolved mineral salts. The electric current heats the water until producing steam (Joule effect). The quantity of steam produced is proportional to the electric current, which is in turn proportional to the level of water.

The humidifier is complete with a water inlet valve, water outlet pump and a maximum water level sensor. Steam from the cylinder is mixed with the discharge air from the evaporating coil by means of a copper steam distributor.



1	Chassis
2	Fill tank
2a	Conductivity electrodes
3	Cylinder
3a	High level electrodes
3b	Immersed electrodes
3c	Filter inside the cylinder
4	Cylinder fastening strap
5	Hose kit
5a	Supply hose
5b	Fill hose
5c	Drain pump and overflow outlet hose
5d	Drain hose
6	Fill solenoid valve
7	Drain pump
8	Drain connection (Ø 32 mm)

**Steam distribution**

9	Steam outlet
10	Steam distribution hose
11	Steam condensate hose

**Water fill**

12	Manual valve (not supplied)
13	Mechanical filter (not supplied)
14	Supply hose (not supplied)
15	Connection hose

**Water drain**

16	Drain hose with siphon (not supplied)
----	---------------------------------------

**Kit included**

17	Straight and 90° connection hose (Ø 32 mm)
18	Connectors for electrodes 2a e 3a

#### Electrode humidifier technical data

Model	Main power supply	Setting <sup>(1)</sup>	Absorbed current	Power	MAX water cylinder volume	MAX water supply	MAX drained water
	[V ± 10%]	[kg/h]	[A]	[kW]	[l]	[l/min]	[l/min]
<b>KUECLH</b>	400 V / 3 ph / 50 Hz	1,3 - 3	3,2	2,25	3,3	0,6	7,0
<b>KUECLL</b>	400 V / 3 ph / 50 Hz	3,9 - 8	8,7	6	5,5	0,6	7,0

(1) The humidifier can be set between the 30% - 100% of the capacity, in steps of 10%. The humidifier mounted in the unit is factory-set to produce about 50% of the maximum value (see the iCOM™ manual).

Unit models	Humidifier type	Max Capacity
<b>PAM010</b>	KUECLH	3kg/h
<b>PAM020</b>	KUECLH	3kg/h
<b>PAM030</b>	KUECLH	3kg/h
<b>PAM060</b>	KUECLH	3kg/h
<b>PAM080</b>	KUECLL	8kg/h
<b>PAM088</b>	Not allowed as a standard	8kg/h

## Supply water

Only use drinking water with the following specifications:

- pressure between 0,1 and 0,8 MPa (1 and 8 bar);
- temperature between 1 and 40°C;
- instant flow rate no higher than the “MAX water supply”;
- hardness no greater than 400 ppm of CaCO<sub>3</sub> (40°fH);
- conductivity range: 75-1250 µS/cm.

#### Supply water chemical specifications

Inorganic compounds	Unit of measure	Normal water		Water with low salt content	
		MIN	MAX	MIN	MAX
Hydrogen ions	(pH)	7	8,5	7	8,5
Specific conductivity at 20°C (σ <sub>R</sub> , 20°C)	(σ <sub>R</sub> , 20°C) S/cm	350	1250	75	350
Total dissolved solids (TDS)	mg/l	(1)	(1)	(1)	(1)
Dry residue at 180°C (TH)	mg/l	(1)	(1)	(1)	(1)
Total hardness	mg/l CaCO <sub>3</sub>	100 <sup>(2)</sup>	400	50 <sup>(2)</sup>	160
Temporary hardness	mg/l CaCO <sub>3</sub>	60 <sup>(3)</sup>	300	30 <sup>(3)</sup>	100
Iron + Manganese	mg/l Fe+Mn	=	0.2	=	0.2
Chlorides	ppm Cl <sup>-</sup>	=	30	=	20
Silica	mg/l SiO <sub>2</sub>	=	20	=	20
Residual chlorine	mg/l Cl <sub>2</sub>	=	0.2	=	0.2
Calcium sulphate	mg/l CaSO <sub>4</sub>	=	100	=	60
Metallic Impurities	mg/l	0	0	0	0
Solvents, thinners, detergents, lubricants	mg/l	0	0	0	0

(1) = values depend on the specific conductivity; in general: TDS≈0,93\*σ<sub>R</sub>, 20°C; R180≈0,65\*σ<sub>R</sub>, 20°C;

(2) = not less than 200% of the chloride content in mg/l Cl<sup>-</sup>;

(3) = not less than 300% of the chloride content in mg/l Cl<sup>-</sup>.

## 4.12 Harmonic distortion and optional Active Harmonic Filter

### 4.12.1 Introduction to Harmonic Current Distortion phenomenon

Harmonic current distortion refers to the phenomenon where non-linear electrical loads introduce additional frequencies, known as harmonics, into the electrical current waveform. In an ideal electrical system, the current flowing through the circuit would be a pure sine wave at the fundamental frequency, such as 50 Hz or 60 Hz, depending on the region.

However, when non-linear loads are connected to the electrical grid, they draw current in a non-sinusoidal manner. This is because non-linear loads, such as power electronics devices (inverters, converters), variable speed drives, and other equipment, do not have a linear relationship between the voltage and current they draw from the grid. Instead, they draw current in short pulses or bursts, resulting in waveforms that deviate from the ideal sine wave.

These deviations from the ideal sine originates additional currents, called harmonics. The additional harmonic currents present in the electrical system occur at frequencies that are integer multiples of the system's fundamental frequency. These harmonics can interfere with the normal operation of electrical appliances and could lead to several issues within the electrical system if not properly controlled or mitigated.

- **Increased Power Losses**

Harmonic currents can cause additional resistive losses in cables, transformers, and other electrical components due to increased current flow and skin effect.

- **Overheating**

The presence of harmonic currents can cause additional heating in electrical components, such as transformers, capacitors, and conductors. This can lead to premature aging, reduced lifespan, and potential failures.

- **Voltage Distortion**

Harmonic currents can cause voltage distortion, leading to fluctuations in the supply voltage waveform. This can affect the performance of sensitive electronic equipment and may result in malfunctions or erratic behavior.

- **Resonance**

In systems with capacitive or inductive elements, harmonic currents can interact with the system's impedance to create resonance conditions. Resonance can amplify harmonic currents and voltages, leading to equipment damage and power quality issues.

Careful system design is essential to ensure the reliable and efficient operation of electrical networks, coupled with proper mitigation strategies like the adoption of harmonic filters (passive or active type).

The mitigation of harmonic currents through harmonic filters can be carried out with a centralized approach or with a decentralized approach, the latter involving limiting the phenomenon at each of the possible sources of disturbance.

A centralized approach for mitigation of Harmonic distortion is generally more cheap and effective.

Liebert® PDX PAM UHD units can be equipped with an Active Harmonic Filter in case a decentralized approach is preferred.

### 4.12.2 Harmonic Current Distortion without Active Harmonic Filter option

The following harmonic distortion values can be considered without installing any active harmonic filter option.

What	Refrigerating circuit configuration			At which condition
	Single Circuit	Dual Circuit without tandem	Dual Circuit with tandem	
Value	Value	Value	Value	
Power Factor	PF ≥ 0.9	PF ≥ 0.9	PF ≥ 0.9	At full load: compressor and fans at 100%
Total Demand Distorsion	TDD ≤ 50%	TDD ≤ 37%	TDD ≤ 34%	At the max operating current of the machine

In case of air cooled systems, values comprise also the distortion caused by the remote outdoor condenser, assuming to receive powered supply through the indoor unit.

#### ATTENTION

It's important to notice that what is important to mitigate is the absolute value of the Harmonic distortion current introduced into the system. The highest value occurs at full load rather than at partial load.

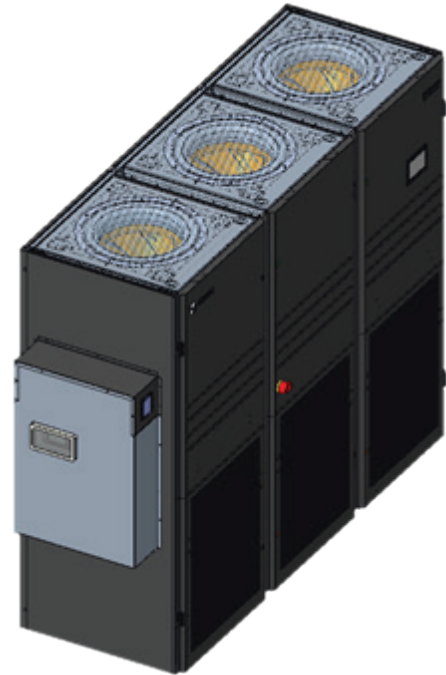
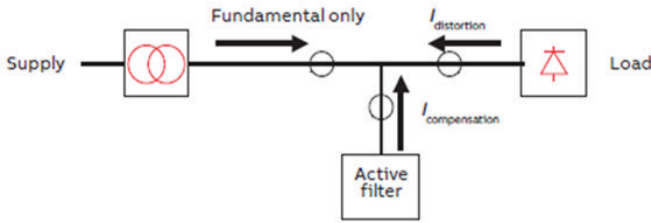
That's why we focus on the Total Demand Distortion, that is equivalent to Total harmonic Current Distortion THDi at full load (compressor and fans at 100%).

### 4.12.3 Harmonic Current Distortion with embedded Active Harmonic Filter option (digit 18 = T)

The IEEE 519 establishes criteria and limits for harmonic distortions introduced by electrical equipment and defines methods for their evaluation and measurement. The Vertiv™ qualified Active Harmonic Filter [AHF] coupled with PDX units are compliant with this standard.

The AHF is installed in parallel to the “polluting loads”, analyzes the line current and its associated harmonics and generates compensation currents which neutralize the harmonic pollution.

AHF is shipped together with the unit and directly installed in lateral position as shown in the following image



The Active Harmonic Filter enables a overall improve of system efficiency and reliability of operation:

AHF action	Advantage
Reduction of the harmonic current content	Decrease in absorbed
Compensation of reactive power	Increase of the power factor
Load balacing	Reduction of the current on the neutral conductor

The overall benefits are reduced power consumption (improved efficiency) and enhanced reliability of the electrical equipment. When AHF is present, the following performance were obtained in Vertiv™ laboratories:

What	Value	At which condition
Power factor	<b>PF ≥ 0.91</b>	At full load: compressor and fans at 100%
Total Demand Distortion	<b>TDD ≤ 8,5%</b>	At the maximum operating current of the machine
Total Harmonic current Distrotion	<b>THDi ≤ 15%</b>	At partial load: compressor & fan in the range 70-100%

#### ATTENTION

It's important to notice that what is important to mitigate is the absolute value of the Harmonic distortion current introduced into the system. The highest value occurs at full load rather than at partial load.

That's why suggest to consider Total Demand Distortion (at full load), rather than the Total harmonic Current Distortion THDi at partial load.

It's important to notice that previous values were obtained in a qualified laboratory with the following conditions:

- With a certain  $[I_{sc}] / [I_L]$  value, being  $I_{sc}$  the maximum short-circuits current at PCC and  $I_L$  the maximum demand load current;
- With a Total Harmonic Voltage Distortion  $THDv \leq 2\%$ ;
- Considering only one **Liebert® PDX PAM UHD** system (indoor / outdoor) installed on the same power grid.

Possible deviations from the declared values may be attributable to one or more of the following causes:

- A different value of the ration  $[I_{sc}] / [I_L]$  , that is a different impedance of the power supply line;
- Higher  $THDv$  values than 2%;
- Amount of non-linear loads in the same power grid (for instance number of **Liebert® PDX PAM UHD** system installed on the same power grid).

Pat attention to the following remarks:

- Setting of the filter is according primary/main line, on the secondary/emergency line the performance due to a different power source are not guaranteed;
- If exceeding the maximum working temperature, the AHF device will be automatically turn **OFF**.

### 4.13 Packaging options

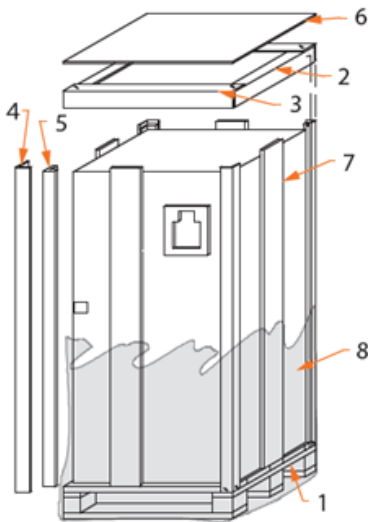
#### Standard: cardboard and foil with pallet, digit 22 = P

The Liebert® PDX PAM UHD units are packed on a wooden pallet [1], with shockproof angle pieces from pressed cardboard [2-3-4-5], panels in cardboard [6-7] and flexible polythene film [8].

#### Package with wooden crate, digit 22 = C

In addition to the standard package Liebert® PDX PAM UHD units are packed with a protective open wooden structure [9].

Standard Package

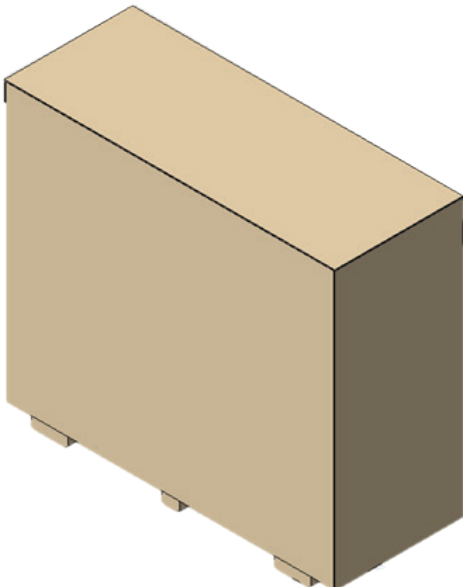


Package with wooden crate



#### Package with seaworthy crate , digit 22 = S

In addition to the standard package a protective and completely closed wooden crate is prepared. Inside it the Liebert® PDX PAM UHD unit is wrapped with a seaworthy bag/barrier.



## 5. Technical tables

### 5.1 Model-Frame-cooling-airflow configurations

Table 5.1 – PAM model – dimension – configuration

PAM	Frame	Bays	Height		Dimensions	Airflow			Cooling		
Model	Type	N°	Standard	Extended	W x D x H	D	H	U	A	W	F
Digit 1 to 6	--	--	--	--	--	Digit 7			Digit 8		
PAM010	Frame 0	1	YES	NO	750 x 750 x 1970 mm	YES	YES	YES	YES	NO	NO
PAM020	Frame 1	1	YES	NO	844 x 890 x 1970 mm	YES	YES	YES	YES	NO	NO
PAM030	Frame 1	1	YES	NO	844 x 890 x 1970 mm	YES	YES	YES	YES	NO	NO
PAM060	Frame 3	2	YES	NO	1750 x 890 x 1970 mm	YES	YES	YES	YES	YES	YES
PAM080	Frame 5	3	YES	NO	2550 x 890 x 1970 mm	YES	YES	YES	YES	YES	YES
PAM088	Frame 5	3	YES	NO	2550 x 890 x 1970 mm	YES	YES	NO	NO	NO	YES

PAM	Frame	Height		Dimensions	Airflow configuration			Cooling version			Refrigerating system			
Model	Type	Standard	Extended	W x D x H	D	H	U	A	W	F	A	B	C	D
Digit 1 to 6	--	--	--	--	Digit 7			Digit 8			Digit 11			
PAM010	Frame 0	YES	NO	750 x 750 x 1970 mm	YES	YES	YES	YES	NO	NO	YES	NO	NO	NO
PAM020	Frame 1	YES	NO	844 x 890 x 1970 mm	YES	YES	YES	YES	NO	NO	YES	NO	NO	NO
PAM030	Frame 1	YES	NO	844 x 890 x 1970 mm	YES	YES	YES	YES	NO	NO	YES	NO	NO	NO
PAM060	Frame 3	YES	NO	1750 x 890 x 1970 mm	YES	YES	YES	YES	YES	YES	NO	YES	NO	NO
PAM080	Frame 5	YES	NO	2550 x 890 x 1970 mm	YES	YES	YES	YES	YES	YES	NO	NO	YES	NO
PAM088	Frame 5	YES	NO	2550 X 890 X 1970 mm	YES	YES	NO	NO	NO	YES	NO	NO	NO	YES

### 5.2 Refrigerating circuit technical tables

Table 5.2 – PAM model - refrigerating circuit design

Unit model	Number of circuits	Refrigerant Circuit 1	Refrigerant Circuit 2
PAM010	1	1 x Variable speed compressor	--
PAM020	1	1 x Variable speed compressor	--
PAM030	1	1 x Variable speed compressor	--
PAM060	2	1 x Fixed speed compressor	1 x Variable speed compressor
PAM080	2	2 x Fixed speed compressor	1 x Variable speed compressor
PAM088	2	2 x Fixed speed compressor	2 x Fixed speed compressor

Table 5.3 – PAM model - Inverter derating factors

Unit model	
PAM010 PAM020 PAM030 PAM060 PAM080 PAM088	<p>For altitudes below 1000 m no derating is required.</p> <p>For altitudes between 1000 m and 2000 m, apply the following derating factors:</p> <ul style="list-style-type: none"> <li>- decrease the output current by 1% per 100 m of altitude above 1000 m;</li> <li>- or otherwise reduce the maximum ambient temperature by 1°C per 200 m of altitude above 1000 m.</li> </ul> <p>For altitudes above 2000 m please contact Vertiv™ Technical Support.</p>

Table 5.4 – PAM model – Refrigerant piping diameters and thickness – air cooled versions

Unit model	Refrigerant circuit	Gas		Liquid	
		External diameter	Thickness	External diameter	Thickness
		[mm]	[mm]	[mm]	[mm]
PAM010	C1	18	1,0	16	1,0
PAM020	C1	22	1,5	16	1,0
PAM030	C1	22	1,5	18	1,0
PAM060	C1	22	1,5	18	1,0
	C2	22	1,5	18	1,0
PAM080	C1	28	1,5	22	1,5
	C2	22	1,5	18	1,0

Table 5.5 – Charge [kg] of refrigerant for the reference system\*, Air cooled units

Unit model	System with Liebert® OAC condenser(s)	
	Refrigerant circuit 1 [kg]	Refrigerant circuit 2 [kg]
PAM010	16,8	--
PAM020	18,7	--
PAM030	24,9	--
PAM060	25,1	25,1
PAM080	37,3	31,6

\* table gives an estimation of the refrigerant amount needed to charge a system made of the following components:

- the unit;
- remote condenser(s) selected for an ambient temperature of 35°C, Liebert® OAC (finned and tube type);
- piping with an equivalent length of 30 m.

The precise amount of refrigerant charge must be determined by the installer as explained in the manual.

Table 5.6 – Charge [kg] of refrigerant for the reference system

Unit model	F version - Freecooling		W version - Water cooled	
	Refrigerant circuit 1	Refrigerant circuit 2	Refrigerant circuit 1	Refrigerant circuit 2
PAM060	9,5	8,5	9,5	8,5
PAM080	11,7	9,3	11,7	9,3
PAM088	12,3	10,8	--	--

\*Units are charged by factory

Table 5.7 – Oil type and initial amount for units with 50Hz power supply\*

Unit model	Refrigerant circuit 1		Refrigerant circuit 2	
	Oil type	Initial oil charge [dm <sup>3</sup> ]	Oil type	Initial oil charge [dm <sup>3</sup> ]
PAM010	FVC56EA	1,20	---	---
PAM020	FVC56EA	1,20	---	---
PAM030	FVC56EA	0,90	---	---
PAM060	POE RL32-3MAF	3,38	FVC56EA	0,9
PAM080	POE RL32-3MAF	2 x 1,89	FVC56EA	0,9
PAM088	POE RL32-3MAF	2 x 3,38	POE RL32-3MAF	2 x 1,89

\*The units are delivered with the compressor already containing the initial amount of oil given in the table.

Table 5.8 – Air system - Fans number and weight

Unit model	High Power EC Fan Module		EC Fan Module	
	Fan Number	Weight [kg]*	Fan Number	Weight [kg]
PAM010	1	47,5	1	37,5
PAM020	1	47,5	1	37,5
PAM030	1	47,5	1	37,5
PAM060	2	52,9	2	47,2
PAM080	3	52,9	3	47,2
PAM088	3	52,9	3	47,2

\*Values given for each single fan.

Table 5.9 – Safety devices settings

Unit model	High pressure alarm management		Safety devices settings	
	Refrigerant circuit 1	Refrigerant circuit 2	Refrigerant circuit 1	Refrigerant circuit 2
PAM010	STO	--	Open 20,8 +/-1,4 bar(g) Manual reset 14,8 ±2 bar(g) Normally closed Durability 10000 times	--
PAM020	STO	--	Open 20,8 +/-1,4 bar(g) Manual reset 14,8 ±2 bar(g) Normally closed Durability 10000 times	--
PAM030	STO	--	Open 20,8 +/-1,4 bar(g) Manual reset 14,8 ±2 bar(g) Normally closed Durability 10000 times	--
PAM060	Relay	STO	Open 20,8 +/-1,4 bar(g) Manual reset 14,8 ±2 bar(g) Normally closed Durability 10000 times	Open 20,8 +/-1,4 bar(g) Manual reset 14,8 ±2 bar(g) Normally closed Durability 10000 times
PAM080	Relay	STO	Open 20,8 +/-1,4 bar(g) Manual reset 14,8 ±2 bar(g) Normally closed Durability 10000 times	Open 20,8 +/-1,4 bar(g) Manual reset 14,8 ±2 bar(g) Normally closed Durability 10000 times
PAM088	Relay	Relay	Open 20,8 +/-1,4 bar(g) Manual reset 14,8 ±2 bar(g) Normally closed Durability 10000 times	Open 20,8 +/-1,4 bar(g) Manual reset 14,8 ±2 bar(g) Normally closed Durability 10000 times

**Relay** The high pressure switch sends a signal to a relay that cuts-off the power supply to the compressor.

**STO (Safe Torque Off)** The high pressure switch sends a signal to the inverter that cuts-off the power supply to the compressor (after the inverter) through a **STO** port.

## 5.3 Water circuit technical tables

Table 5.10 – water valves differential pressure

	2-WAY VALVE	
	Max differential pressure [kPa]	Close-OFF pressure [kPa]
For all models	350	1400

Table 5.11 – Water piping diameters and thickness, water cooled and freecooling systems

Unit model	F version - Freecooling		W version - Water cooled			
	External diameter	Thickness	Circuit 1		Circuit 2	
			External diameter	Thickness	External diameter	Thickness
	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
PAM060	35	1,5	35	1,5	35	1,5
PAM080	54	1,5	42	1,5	42	1,5
PAM088	54	1,5	--	--	--	--

Table 5.12 – Water piping connections, water cooled and freecooling systems

Models Unit Connections		PAM060		PAM080		PAM088
		Water cooled	Freecooling	Water cooled	Freecooling	Freecooling
IWC1	Water to condenser 1 inlet	Rp 1" ¼ ISO 7/1	Rp 1" ¼ ISO 7/1	Rp 1" ½ ISO 7/1	Rp 1" ½ ISO 7/1	Rp 1" ½ ISO 7/1
IWC2	Water to condenser 2 inlet	Rp 1" ¼ ISO 7/1	Rp 1" ¼ ISO 7/1	Rp 1" ½ ISO 7/1	Rp 1" ½ ISO 7/1	Rp 1" ½ ISO 7/1
OWC1	Water to condenser 1 outlet	Rp 1" ¼ ISO 7/1	Rp 1" ¼ ISO 7/1	Rp 1" ½ ISO 7/1	Rp 1" ½ ISO 7/1	Rp 1" ½ ISO 7/1
OWC2	Water to condenser 2 outlet	Rp 1" ¼ ISO 7/1	Rp 1" ¼ ISO 7/1	Rp 1" ½ ISO 7/1	Rp 1" ½ ISO 7/1	Rp 1" ½ ISO 7/1
IFC	Water inlet (Freecooling and dual fluid)	--	Rp 1" ½ ISO 7/1	--	O.D. 54mm* R 2** ISO 7/1	O.D. 54mm* R 2** ISO 7/1
OFC	Water outlet (Freecooling and dual fluid)	--	Rp 1" ½ ISO 7/1	--	O.D. 54mm* R 2** ISO 7/1	O.D. 54mm* R 2** ISO 7/1

\* Grooved connection

\*\* Optional. Threaded union on request

### Glycol mixture correction factors

The water glycol mixtures are used as medium for heat transfer where chiller is placed outside the building and outdoor temperature is below the freezing point of water.

Table 5.13 – Glycol suggested quantity

Ethylene glycol [% in weight]	0	10	20	30	40	50
Freezing temperature, °C (*)	0	-4,4	-9,9	-16,6	-25,2	-37,2
Mixture density at 20°C (*) [kg/l]	--	1017	1033	1049	1064	1080

(\*) Values are for Clariant Antifrogen N. For different brands, check manufacturer's data

The use of low freezing point mixtures causes a modification in the main thermodynamic properties of the units. The main parameters affected by the use of glycol mixtures are the following:

Table 5.14 – Cooling system - Glycol mixture correction factors

Parameter	Correcting factor	Ethylene glycol [% in weight]					
		0	10	20	30	40	50
Freezing temperature [°C]	--	0	-4,4	-9,9	-16,6	-25,2	-37,2
Cooling capacity	<b>F3</b>	1	0,987	0,977	0,969	0,958	0,950
Mixture volume flow rat	<b>F4</b>	1	1,046	1,080	1,098	1,150	1,210
Mixture side pressure drop	<b>F5</b>	1	1,053	1,109	1,168	1,234	1,311

We indicate as **RO**, **VO**, **DP0** respectively the unit cooling capacity, the water volumetric flow rate and the pressure drop with 0% ethylene glycol.

When we use glycol mixtures at different percentage with the same inlet and outlet temperatures at the heat exchanger, the performance will vary as follows:

- Cooling capacity = **RO** x **F3**;
- Volumetric flow rate = **VO** x **F3** x **F4**;
- Mixture pressure drop = **DP1** x **F5**.

where **DP1** is the unit water pressure drop for the new volumetric mixture flow rate.

## 5.4 Electrical tables

The data in the tables do not consider the absorbed current from the condensate pump and for other options not explicitly described.

Table 5.15 – Electrical data for cooling only - 400 V / 3ph + N / 50 Hz + Earth

Unit model	High Efficiency EC Fan Module				High Power EC Fan Module				Recommended wires size [mm <sup>2</sup> ] <sup>(2)</sup>	MIN/MAX Cu cable size [mm <sup>2</sup> ]
	FLA TOT [A]	LRA [A]	Reccomended circuit breaker <sup>(1)</sup>	Power factor cosφ	FLA TOT [A]	LRA [A]	Reccomended circuit breaker <sup>(1)</sup>	Power factor cosφ		
<b>PAM010</b>	28	28	32	0,90	29	29	40	0,90	"5G 10mm <sup>2</sup> or 3x10 + 1x10 + 1x10mm <sup>2</sup> "	1.5...35mm <sup>2</sup>
<b>PAM020</b>	28	28	32	0,90	29	29	40	0,90	"5G 10mm <sup>2</sup> or 3x10 + 1x10 + 1x10mm <sup>2</sup> "	1.5...35mm <sup>2</sup>
<b>PAM030</b>	36	36	50	0,90	37	37	50	0,90	"5G 10mm <sup>2</sup> or 3x10 + 1x10 + 1x10mm <sup>2</sup> "	1.5...35mm <sup>2</sup>
<b>PAM060</b>	68	163	80	0,86	67	162	80	0,86	"5G 25mm <sup>2</sup> or 3x25 + 1x16 + 1x16mm <sup>2</sup> "	10...70mm <sup>2</sup>
<b>PAM080</b>	84	170	100	0,87	82	168	100	0,87	"5G 35mm <sup>2</sup> or 3x35 + 1x16 + 1x16mm <sup>2</sup> "	10...70mm <sup>2</sup>
<b>PAM088</b>	106	201	125	0,78	104	199	125	0,78	"3x50 + 1x25 + 1x25mm <sup>2</sup> "	10...70mm <sup>2</sup>

(1) Recommended circuit breaker size breaker C curve, RCD I<sub>dn</sub>=0,3A type B or B++

(2) PVC insulated Cu cables 40°C see tab.6 EN60204-1 B1

Table 5.16 – Electrical data for cooling + heating - 400 V / 3ph + N / 50 Hz + Earth

Unit model	High Efficiency EC Fan Module				High Power EC Fan Module				Recommended wires size [mm <sup>2</sup> ] <sup>(2)</sup>	MIN/MAX Cu cable size [mm <sup>2</sup> ]
	FLA TOT [A]	LRA [A]	Reccomended circuit breaker <sup>(1)</sup>	Power factor cosφ	FLA TOT [A]	LRA [A]	Reccomended circuit breaker <sup>(1)</sup>	Power factor cosφ		
PAM010	34	34	40	0,94	35	35	40	0,94	"5G 10mm <sup>2</sup> or 3x10 + 1x10 + 1x10mm <sup>2</sup> "	1.5...35mm <sup>2</sup>
PAM020	34	34	40	0,94	35	35	40	0,94	"5G 10mm <sup>2</sup> or 3x10 + 1x10 + 1x10mm <sup>2</sup> "	1.5...35mm <sup>2</sup>
PAM030	42	42	50	0,93	43	43	50	0,93	"5G 10mm <sup>2</sup> or 3x10 + 1x10 + 1x10mm <sup>2</sup> "	1.5...35mm <sup>2</sup>
PAM060	75	170	100	0,89	74	169	100	0,89	"5G 25mm <sup>2</sup> or 3x25 + 1x16 + 1x16mm <sup>2</sup> "	10...70mm <sup>2</sup>
PAM080	90	176	125	0,90	89	175	125	0,90	"5G 35mm <sup>2</sup> or 3x35 + 1x16 + 1x16mm <sup>2</sup> "	10...70mm <sup>2</sup>
PAM088	112	207	125	0,82	111	206	125	0,82	" 3x50 + 1x25 + 1x25mm <sup>2</sup> "	10...70mm <sup>2</sup>

(1) Recommended circuit breaker size breaker C curve, RCD I<sub>dn</sub>=0,3A type B or B++

(2) PVC insulated Cu cables 40°C see tab.6 EN60204-1 B1

Table 5.17 – Electrical data for cooling + humidification - 400 V / 3ph + N / 50 Hz + Earth

Unit model	High Efficiency EC Fan Module				High Power EC Fan Module				Recommended wires size [mm <sup>2</sup> ] <sup>(2)</sup>	MIN/MAX Cu cable size [mm <sup>2</sup> ]
	FLA TOT [A]	LRA [A]	Reccomended circuit breaker <sup>(1)</sup>	Power factor cosφ	FLA TOT [A]	LRA [A]	Reccomended circuit breaker <sup>(1)</sup>	Power factor cosφ		
PAM010	31	31	40	0,92	32	32	40	0,92	"5G 10mm <sup>2</sup> or 3x10 + 1x10 + 1x10mm <sup>2</sup> "	1.5...35mm <sup>2</sup>
PAM020	31	31	40	0,92	32	32	40	0,92	"5G 10mm <sup>2</sup> or 3x10 + 1x10 + 1x10mm <sup>2</sup> "	1.5...35mm <sup>2</sup>
PAM030	39	39	50	0,92	40	40	50	0,92	"5G 10mm <sup>2</sup> or 3x10 + 1x10 + 1x10mm <sup>2</sup> "	1.5...35mm <sup>2</sup>
PAM060	72	167	100	0,87	70	165	100	0,87	"5G 25mm <sup>2</sup> or 3x25 + 1x16 + 1x16mm <sup>2</sup> "	10...70mm <sup>2</sup>
PAM080	93	179	125	0,90	91	177	125	0,90	"5G 35mm <sup>2</sup> or 3x35 + 1x16 + 1x16mm <sup>2</sup> "	10...70mm <sup>2</sup>

(1) Recommended circuit breaker size breaker C curve, RCD I<sub>dn</sub>=0,3A type B or B++

(2) PVC insulated Cu cables 40°C see tab.6 EN60204-1 B1

Table 5.18 – Fans electrical data

Unit model	High Efficiency EC Fan Module		High Power EC Fan Module	
	Motor Size [kW]	FLA @ 400V 50Hz	Motor Size [kW]	FLA @ 400V 50Hz
PAM010	1,90	3,1	2,60	4,2
PAM020	1,90	3,1	2,60	4,2
PAM030	1,90	3,1	2,60	4,2
PAM060	3,35	6,2	3,50	5,6
PAM080	3,35	6,2	3,50	5,6
PAM088	3,35	6,2	--	5,6

**NOTE** Values given for each single fan. The model is for 50 Hz.

Table 5.19 – Compressors electrical data for 400 V / 3ph / 50 Hz

Unit model	Operating Ampere [A]		FLA [A]		LRA [A]		Nominal Power [kW]		Winding Resistance [Ω]	
	Fixed Speed	Variable Speed	Fixed Speed	Variable Speed	Fixed Speed	Variable Speed	Fixed Speed	Variable Speed	Fixed Speed	Variable Speed
PAM010	--	--	--	18,0	--	18,0	--	10,5	--	1,23
PAM020	--	--	--	18,0	--	18,0	--	10,5	--	1,23
PAM030	--	--	--	24,0	--	24,0	--	14,0	--	0,37
PAM060	--	--	23,0	24,0	118	24,0	--	14,0	1,23	0,37
PAM080	--	--	15,9+15,9	24,0	102+102	24,0	--	14,0	1,72+1,72	0,37
PAM088	--	--	23+23 15,9+15,9	--	118+118 102+102	--	--	--	1,23+1,23 1,72+1,72	--

Table 5.20 – Electrical accessories, 400 V / 3ph / 50 H

Unit model	Electrical heaters		Humidifier		Condensate pump*	
	FLA [A]	Nominal Power [kW]	FLA [A]	Nominal Power [kW]	FLA [A]	Nominal Power [kW]
PAM010	6,5	1,50	3,2	2,25	1,6	0,15
PAM020	6,5	1,50	3,2	2,25		
PAM030	6,5	1,50	3,2	2,25		
PAM060	6,5	1,50	3,2	2,25		
PAM080	13,0	3,00	8,7	6,00		
PAM088	6,5	1,50	-	-		

## 5.5 Performances

### 5.5.1 PAM Air cooled Performance tables

Table 5.21 – Performance with compressor @80% and DT=12°C, PAM Air cooled

Air cooled - A version		→	PAM010	PAM020	PAM030	PAM060	PAM080
Refrigerating circuits	n°		1	1	1	2	2
Compressors	n°		1	1	1	1/1	1/2
Fans	n°		1	1	2	2	3
Power supply	-		400V / 3ph / 50Hz				
Refrigerant	-		R513A				
Filter	-		ePM10 50%				
Fans	Type		High Power				
Unit inlet air temperature	°C		30				
Unit inlet air relative humidity	%		35				
Sea level	m		0				
Compressor modulation	%		80				
Supply air temperature	°C		18				
Condensing temperature	°C		45				
Input conditions	Nominal air flow	m³/h	2955	3904	6005	11703	14999
	Net Total cooling capacity	kW	11,8	15,3	23,6	45,8	59,2
	Net sensible cooling capacity	kW	11,8	15,3	23,6	45,8	59,2
	Unit power input	kW	3,34	4,17	7,09	11,87	15,53
	Fan power input	kW	0,27	0,39	1,12	2,04	2,43
	Net sensible EER	-	3,53	3,67	3,33	3,86	3,81
	Fan modulation	%	45	52	76	69	65
	External static pressure ESP	Pa	30				
Upflow - UA	Nominal air flow	m³/h	3004	3931	6107	11791	15413
	Net Total cooling capacity	kW	11,9	15,5	24,2	46,9	61
	Net sensible cooling capacity	kW	11,9	15,5	24,2	46,9	61
	Unit power input	kW	3,3	4,09	6,87	11,58	14,78
	Fan power input	kW	0,23	0,32	0,91	1,74	1,65
	Net sensible EER	-	3,61	3,79	3,52	4,05	4,13
	Fan modulation	%	42	48	71	65	55
	External static pressure ESP	Pa	30				
Downflow Up - DA	Nominal air flow	m³/h	3043	3935	6138	11944	15686
	Net Total cooling capacity	kW	12	15,6	24,3	47,3	61,6
	Net sensible cooling capacity	kW	12	15,6	24,3	47,3	61,6
	Unit power input	kW	3,26	4,04	6,8	11,44	14,61
	Fan power input	kW	0,19	0,27	0,84	1,6	1,47
	Net sensible EER	-	3,68	3,86	3,57	4,13	4,22
	Fan modulation	%	39	45,2	70	62	52
	External static pressure ESP	Pa	0				
Downflow Frontal - HA	Nominal air flow	m³/h	3043	3935	6138	11944	15686
	Net Total cooling capacity	kW	12	15,6	24,3	47,3	61,6
	Net sensible cooling capacity	kW	12	15,6	24,3	47,3	61,6
	Unit power input	kW	3,26	4,04	6,8	11,44	14,61
	Fan power input	kW	0,19	0,27	0,84	1,6	1,47
	Net sensible EER	-	3,68	3,86	3,57	4,13	4,22
	Fan modulation	%	39	45,2	70	62	52
	External static pressure ESP	Pa	0				

Table 5.22 – Max cooling capacity, compressor and fans @100% PAM Air cooled

Air cooled - A version		→	PAM010	PAM020	PAM030	PAM060	PAM080
Refrigerating circuits	n°		1	1	1	2	2
Compressors	n°		1	1	1	1/1	1/2
Fans	n°		1	1	2	2	3
Power supply	-		400V / 3ph / 50Hz				
Refrigerant	-		R513A				
Filter	-		ePM10 50%				
Fans	Type		High Power				
Unit inlet air temperature	°C		30				
Unit inlet air relative humidity	%		35				
Sea level	m		0				
Compressor modulation	%		100				
Fan modulation	%		100				
Condensing temperature	°C		45				
Input conditions	Nominal air flow	m³/h	7641	8357	8137	18611	25937
	Net Total cooling capacity	kW	14,8	19,2	28,9	56,9	70,5
	Net sensible cooling capacity	kW	14,8	19,2	28,9	56,9	70,5
	Unit power input	kW	6,47	7,4	10,63	20,21	26,39
	Fan power input	kW	2,54	2,51	2,45	6,36	9,24
	Net sensible EER	-	2,29	2,59	2,72	2,82	2,67
	Supply air temperature	°C	24,1	23,0	19,2	20,7	21,8
	External static pressure ESP	Pa	30				
Upflow - UA	Nominal air flow	m³/h	8387	9156	9007	20367	32870
	Net Total cooling capacity	kW	15,6	20,2	30,5	59,7	75,6
	Net sensible cooling capacity	kW	15,6	20,2	30,5	59,7	75,6
	Unit power input	kW	6,4	7,25	10,59	20,48	27,41
	Fan power input	kW	2,51	2,42	2,44	6,62	10,2
	Net sensible EER	-	2,44	2,79	2,88	2,92	2,76
	Supply air temperature	°C	24,5	23,4	19,9	21,3	23,2
	External static pressure ESP	Pa	30				
Downflow Up - DA	Nominal air flow	m³/h	8508	9279	9130	20825	33572
	Net Total cooling capacity	kW	15,7	20,2	30,6	60,1	76
	Net sensible cooling capacity	kW	15,7	20,2	30,6	60,1	76
	Unit power input	kW	6,39	7,23	10,57	20,54	27,49
	Fan power input	kW	2,5	2,4	2,43	6,68	10,26
	Net sensible EER	-	2,46	2,79	2,89	2,93	2,76
	Supply air temperature	°C	24,6	23,5	20,0	21,4	23,3
	External static pressure ESP	Pa	0				
Downflow Frontal - HA	Nominal air flow	m³/h	8508	9279	9130	20825	33572
	Net Total cooling capacity	kW	15,7	20,2	30,6	60,1	76
	Net sensible cooling capacity	kW	15,7	20,2	30,6	60,1	76
	Unit power input	kW	6,39	7,23	10,57	20,54	27,49
	Fan power input	kW	2,5	2,4	2,43	6,68	10,26
	Net sensible EER	-	2,46	2,79	2,89	2,93	2,76
	Supply air temperature	°C	24,6	23,5	20,0	21,4	23,3
	External static pressure ESP	Pa	0				

Table 5.23 – Performance with compressor @80% and DT=12°C, PAM Water cooled

Water cooled - W version		→	PAM060	PAM080
Refrigerating circuits	n°		2	2
Compressors	n°		1 + 1	1 + 2
Fans	n°		2	3
Power supply	-		400V / 3ph / 50Hz	
Refrigerant	-		R513A	
Cooling fluid @ condenser	-		Water	
Filter	-		ePM10 50%	
Fans	Type		High Power	
Input conditions	Unit inlet air temperature	°C	30	
	Unit inlet air relative humidity	%	35	
	Sea level	m	0	
	Compressor modulation	%	80	
	Supply air temperature	°C	18	
	Water inlet temperature	°C	30	
	Condensing temperature	°C	45	
	Upflow - UW	Nominal air flow	m³/h	11599
Net Total cooling capacity		kW	45,7	59,2
Net sensible cooling capacity		kW	45,7	59,2
Unit power input		kW	11,98	14,96
Fan power input		kW	2,14	2,04
Net sensible EER		-	3,81	3,96
Fan modulation		%	71	60
External static pressure ESP		Pa	50	
Water flow		l/s	1,13	2
Water side pressure drop		kPa	9	13
Downflow Up - DW	Nominal air flow	m³/h	12416	15154
	Net Total cooling capacity	kW	49,1	60
	Net sensible cooling capacity	kW	49,1	60
	Unit power input	kW	11,36	14,87
	Fan power input	kW	1,74	1,77
	Net sensible EER	-	4,32	4,03
	Fan modulation	%	60	56
	External static pressure ESP	Pa	30	
	Water flow	l/s	1,21	1,50
	Water side pressure drop	kPa	10	13
Downflow Frontal - HW	Nominal air flow	m³/h	12381	15188
	Net Total cooling capacity	kW	49	59,8
	Net sensible cooling capacity	kW	49	59,8
	Unit power input	kW	11,36	14,18
	Fan power input	kW	1,48	1,35
	Net sensible EER	-	4,31	4,22
	Fan modulation	%	60	50
	External static pressure ESP	Pa	0	
	Water flow	l/s	1,21	1,51
		kPa	10	13

Table 5.24 – Max cooling capacity, compressor & fans @100%, PAM Water cooled

Water cooled - W version		→	PAM060	PAM080
Refrigerating circuits	n°		2	2
Compressors	n°		1 + 1	1 + 2
Fans	n°		2	3
Power supply	-		400V / 3ph / 50Hz	
Refrigerant	-		R513A	
Cooling fluid @ condenser	-		Water	
Filter	-		ePM10 50%	
Fans	Type		High Power	
Input conditions	Unit inlet air temperature	°C	30	
	Unit inlet air relative humidity	%	35	
	Sea level	m	0	
	Compressor modulation	%	100	
	Fan modulation	%	100	
	Water inlet temperature	°C	30	
	Condensing temperature	°C	45	
	Upflow - UW	Nominal air flow	m³/h	20512
Net Total cooling capacity		kW	59	72
Net sensible cooling capacity		kW	59	72
Unit power input		kW	20,55	26,95
Fan power input		kW	6,64	9,78
Net sensible EER		-	2,87	2,67
Supply air temperature		°C	21	23
External static pressure ESP		Pa	50	
Water flow		l/s	1,73	2,12
Water side pressure drop		kPa	13	17
Downflow Up - DW	Nominal air flow	m³/h	23087	32870
	Net Total cooling capacity	kW	62,2	73,2
	Net sensible cooling capacity	kW	62,2	73,2
	Unit power input	kW	20,82	27,38
	Fan power input	kW	6,62	10,2
	Net sensible EER	-	6,90	2,67
	Supply air temperature	°C	22	23
	External static pressure ESP	Pa	30	
	Water flow	l/s	1,82	2,17
	Water side pressure drop	kPa	14	18
Downflow Frontal - HW	Nominal air flow	m³/h	23560	33572
	Net Total cooling capacity	kW	62,4	73,5
	Net sensible cooling capacity	kW	62,4	73,5
	Unit power input	kW	20,84	27,44
	Fan power input	kW	6,92	10,26
	Net sensible EER	-	2,99	2,68
	Supply air temperature	°C	22	23
	External static pressure ESP	Pa	0	
	Water flow	l/s	1,83	2
	Water side pressure drop	kPa	14	18

## 5.6 Sound pressure level

### 5.6.1 Introduction

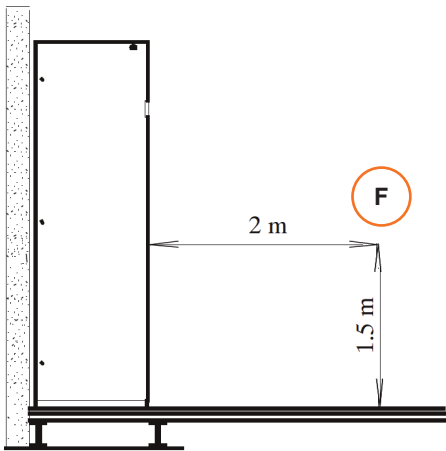
Liebert® PDX PAM UHD units have been designed with particular care for sound and vibration problems.

Highest ventilation efficiency combined with the lowest sound emission have been obtained by the following design criteria:

- optimization of the aerualic circuit by accurate researches made in our thermodynamic laboratories, with special focus on coils and filters;
- complete mechanical insulation of the compressor department and ventilating section.

### 5.6.2 Test conditions

#### Test conditions



All tests are performed in our laboratories under the conditions described below, in accordance with standard UNI EN ISO 3744 / 3746 .

Test conditions: fans at 80% of EC fan modulation with 50 Pa available external static pressure, with clean filters. The noise levels refer to free field conditions.

The following tables show sound levels for every octave band frequency.

The data refers to the main configurations used; for different configurations consult GRS software.

### Key for tables reading

The tables in this chapter show sound levels for every octave band frequency.

The sound levels (both global and for each octave band) are expressed in dB with a tolerance of (- 0/+2) dB.

The data are referred to the main used configurations; for different configurations consult GRS software.

The following keys are used:

<b>PWL</b>	Sound Power Level calculated according to UNI EN ISO 3744 procedure method.
<b>SPL</b>	UNI EN ISO 3744 specifies methods for determining the sound power level or sound energy level of a noise source from sound pressure levels measured on a surface enveloping the noise source (Vertiv™ unit). The sound power level produced by the noise source, in frequency bands or with frequency A-weighting applied, is calculated using those measurements.
<b>Mode <sup>(1)</sup></b>	Only ventilation, measured as explained in <i>Test conditions</i> above.

## 5.6.3 Sound Emission spectra

### 5.6.3.1 Air cooled versions, Digit 8 = A

Measurement conditions: Inverter scroll cooling system@100% cooling capacity, High Power EC fan module, max airflow.

Table 5.25 – Sound Power Level [dB] - Upflow configuration

Unit model	Mode	Level	Octave band frequency (Hz)									Sound level [dB(A)]
			31,5	63	125	250	500	1000	2000	4000	8000	
PAM010	(1)	SPL	62,2	62,2	65,3	71,7	64,8	56,2	53,4	52,9	49,2	66,6
	(2)	SPL	62,2	62,2	65,3	71,7	64,8	56,4	55,3	53,7	50	66,8
	(3)	PWL	64,4	64,4	70,9	80,2	75,5	73,4	69,5	66,4	64,7	78,6
PAM020	(1)	SPL	63,2	63,2	66,3	72,7	65,8	57,2	54,4	53,9	50,2	67,6
	(2)	SPL	63,2	63,2	66,8	72,7	65,9	57,9	57,4	56,1	51,8	68,1
	(3)	PWL	65,4	72,1	79	87,8	83,2	81,5	78,3	75,5	73,1	86,8
PAM030	(1)	SPL	62,9	62,9	66	72,4	65,5	56,9	54,1	53,6	49,9	67,3
	(2)	SPL	62,9	62,9	66,1	72,4	65,6	57,4	56,4	54,5	53,4	67,7
	(3)	PWL	65,1	71,8	78,3	87,5	82,9	81	77,3	73,9	74,7	86,3
PAM060	(1)	SPL	51,8	54,9	65,9	62,9	64,9	63,9	62,9	60,9	52,9	69,3
	(2)	SPL	54	56,6	67,6	64,6	65	65,3	63,5	63,6	54,3	70,6
	(3)	PWL	91,8	89,6	81,2	79,7	80,3	82,1	77,9	76,2	71,4	85,8
PAM080	(1)	SPL	56,8	59,8	70,8	67,8	69,8	68,8	67,8	65,8	57,8	74,2
	(2)	SPL	56,8	59,8	70,8	67,8	69,9	70,2	68,5	68,5	59,2	75,5
	(3)	PWL	92,8	92,8	84,4	82,9	85,2	87	82,9	81,1	76,3	90,6

Table 5.26 – Sound Power Level [dB] - Downflow Up configuration

Unit model	Mode	Level	Octave band frequency (Hz)									Sound level [dB(A)]
			31,5	63	125	250	500	1000	2000	4000	8000	
PAM010	(1)	SPL	63,2	63,2	66,3	72,7	65,8	57,2	54,4	53,9	50,2	67,6
	(2)	SPL	63,2	63,2	66,3	72,7	65,8	57,4	56,3	54,7	51	67,8
	(3)	PWL	65,4	65,4	71,9	81,2	76,5	74,4	70,5	67,4	65,7	79,6
PAM020	(1)	SPL	64,2	64,2	67,3	73,7	66,8	58,2	55,4	54,9	51,2	68,6
	(2)	SPL	64,2	64,2	67,8	73,7	66,9	58,9	58,4	57,1	52,8	69,1
	(3)	PWL	66,4	73,1	80	88,8	84,2	82,5	79,3	76,5	74,1	87,8
PAM030	(1)	SPL	64	64	67,1	73,5	66,6	58	55,2	54,7	51	68,4
	(2)	SPL	64	64	67,2	73,5	66,7	58,5	57,5	55,6	54,5	68,8
	(3)	PWL	66,2	72,9	79,4	88,6	84	82,1	78,4	75	75,8	87,4
PAM060	(1)	SPL	50,9	54	65	62	64	63	62	60	52	68,4
	(2)	SPL	53,1	55,7	66,7	63,7	64,1	64,4	62,6	62,7	53,4	69,7
	(3)	PWL	90,9	88,7	80,3	78,8	79,4	81,2	77	75,3	70,5	84,9
PAM080	(1)	SPL	54,7	57,7	68,7	65,7	67,7	66,7	65,7	63,7	55,7	72,1
	(2)	SPL	54,7	57,7	68,7	65,7	67,8	68,1	66,4	66,4	57,1	73,4
	(3)	PWL	90,7	90,7	82,3	80,8	83,1	84,9	80,8	79	74,2	88,5

Table 5.27 – Sound Power Level [dB] - Downflow frontal configuration

Unit model	Mode	Level	Octave band frequency (Hz)									Sound level [dB(A)]
			31,5	63	125	250	500	1000	2000	4000	8000	
PAM010	(1)	SPL	70,4	70,4	73,5	79,9	73	64,4	61,6	61,1	57,4	74,8
	(2)	SPL	70,4	70,4	73,5	79,9	73	64,6	63,5	61,9	58,2	75
	(3)	PWL	72,6	72,6	79,1	88,4	83,7	81,6	77,7	74,6	72,9	86,8
PAM020	(1)	SPL	71,3	71,3	74,4	80,8	73,9	65,3	62,5	62	58,3	75,7
	(2)	SPL	71,3	71,3	74,9	80,8	74	66	65,5	64,2	59,9	76,2
	(3)	PWL	73,5	80,2	87,1	95,9	91,3	89,6	86,4	83,6	81,2	94,9
PAM030	(1)	SPL	71,2	71,2	74,3	80,7	73,8	65,2	62,4	61,9	58,2	75,6
	(2)	SPL	71,2	71,2	74,4	80,7	73,9	65,7	64,7	62,8	61,7	76
	(3)	PWL	73,4	80,1	86,6	95,8	91,2	89,3	85,6	82,2	83	94,6
PAM060	(1)	SPL	55,8	58,9	69,9	66,9	68,9	67,9	66,9	64,9	56,9	73,3
	(2)	SPL	58	60,6	71,6	68,6	69	69,3	67,5	67,6	58,3	74,6
	(3)	PWL	95,8	93,6	85,2	83,7	84,3	86,1	81,9	80,2	75,4	89,8
PAM080	(1)	SPL	59,6	62,6	73,6	70,6	72,6	71,6	70,6	68,6	60,6	77
	(2)	SPL	59,6	62,6	73,6	70,6	72,7	73	71,3	71,3	62	78,3
	(3)	PWL	95,6	95,6	87,2	85,7	88	89,8	85,7	83,9	79,1	93,4

**LEGEND**

The sound levels global and for each octave band are expressed in dB with a tolerance of ( 0/+2) dB.

- (1) Unit SPL Fan (2m, f.f.,dB).
- (2) Unit SPL Fan+comp (2m, f.f.,dB).
- (3) Unit PWL Fan+comp discharge (dB).

**5.6.3.2 Water cooled and freecooling versions, Digit 8 = W-F**

Measurement conditions: Inverter scroll cooling system@100% cooling capacity, High Power EC fan module, max airflow.

Table 5.28 – Sound Power Level [dB] - Upflow configuration

Unit model	Mode	Level	Octave band frequency (Hz)									Sound level [dB(A)]
			31,5	63	125	250	500	1000	2000	4000	8000	
PAM060	(1)	SPL	53,7	56,8	67,8	64,8	66,8	65,8	64,8	62,8	54,8	71,2
	(2)	SPL	55,9	58,5	69,5	66,5	66,9	67,2	65,4	65,5	56,2	72,5
	(3)	PWL	93,7	91,5	83,1	81,6	82,2	84	79,8	78,1	73,3	87,7
PAM080	(1)	SPL	58,5	61,5	72,5	69,5	71,5	70,5	69,5	67,5	59,5	75,9
	(2)	SPL	58,5	61,5	72,5	69,5	71,6	71,9	70,2	70,2	60,9	77,2
	(3)	PWL	94,5	94,5	86,1	84,6	86,9	88,7	84,6	82,8	78	92,3
PAM088	(1)	SPL	58,6	61,6	72,6	69,6	71,6	70,6	69,6	67,6	59,6	76
	(2)	SPL	58,6	61,6	72,6	69,6	71,7	72	70,3	70,3	61	77,3
	(3)	PWL	94,6	94,6	86,2	84,7	87	88,8	84,7	82,9	78,1	92,4

Table 5.29 – Sound Power Level [dB] - Downflow Up configuration

Unit model	Mode	Level	Octave band frequency (Hz)									Sound level [dB(A)]
			31,5	63	125	250	500	1000	2000	4000	8000	
PAM060	(1)	SPL	53,1	56,2	67,2	64,2	66,2	65,2	64,2	62,2	54,2	70,6
	(2)	SPL	55,3	57,9	68,9	65,9	66,3	66,6	64,8	64,9	55,6	71,9
	(3)	PWL	93,1	90,9	82,5	81	81,6	83,4	79,2	77,5	72,7	87,1
PAM080	(1)	SPL	55	58	69	66	68	67	66	64	56	72,4
	(2)	SPL	55	58	69	66	68,1	68,4	66,7	66,7	57,4	73,7
	(3)	PWL	91	91	82,6	81,1	83,4	85,2	81,1	79,3	74,5	88,8
PAM088	(1)	SPL	56,3	59,3	70,3	67,3	69,3	68,3	67,3	65,3	57,3	73,7
	(2)	SPL	56,3	59,3	70,3	67,3	69,4	69,7	68	68	58,7	75
	(3)	PWL	92,3	92,3	83,9	82,4	84,7	86,5	82,4	80,6	75,8	90,1

Table 5.30 – Sound Power Level [dB] - Downflow frontal configuration

Unit model	Mode	Level	Octave band frequency (Hz)									Sound level [dB(A)]
			31,5	63	125	250	500	1000	2000	4000	8000	
PAM060	(1)	SPL	57,8	60,9	71,9	68,9	70,9	69,9	68,9	66,9	58,9	75,3
	(2)	SPL	60	62,6	73,6	70,6	71	71,3	69,5	69,6	60,3	76,6
	(3)	PWL	97,8	95,6	87,2	85,7	86,3	88,1	83,9	82,2	77,4	91,8
PAM080	(1)	SPL	61,1	64,1	75,1	72,1	74,1	73,1	72,1	70,1	62,1	78,5
	(2)	SPL	61,1	64,1	75,1	72,1	74,2	74,5	72,8	72,8	63,5	79,8
	(3)	PWL	97,1	97,1	88,7	87,2	89,5	91,3	87,2	85,4	80,6	94,9
PAM088	(1)	SPL	61,1	64,1	75,1	72,1	74,1	73,1	72,1	70,1	62,1	78,5
	(2)	SPL	61,1	64,1	75,1	72,1	74,2	74,5	72,8	72,8	63,5	79,8
	(3)	PWL	97,1	97,1	88,7	87,2	89,5	91,3	87,2	85,4	80,6	94,9

#### LEGEND

The sound levels global and for each octave band are expressed in dB with a tolerance of ( 0/+2) dB.

(1) Unit SPL Fan (2m, f.f.,dB).

(2) Unit SPL Fan+comp (2m, f.f.,dB).

(3) Unit PWL Fan+comp discharge (dB).



## 6. Heat rejection for air cooled system: Liebert® HPA-OAC

Liebert® PDX-PAM UHD air cooled units with or without free cooling (Digit 8 = A) must be coupled with Liebert® HPA-OAC remote condenser.

### 6.1. Digit nomenclature

The unit is fully defined by the following digits.

1 2 3 4 5 6 7 8 9 10 11



O A C 0 5 8 M V



Digit	Feature	Value	Description
1 2 3	Family name	OAC	O = Outdoor Unit, A = R513A, C = Condenser Unit
4 5 6	Model*	017	17kW
		033	33kW
		042	42kW
		058	58kW
		087	87kW
		095	95kW
7	Control	M	Controlled by indoor unit
8	Air flow delivery	V	Vertical air flow
		H	Horizontal air flow
9	Ambient kit	S	Safety Valve, Shut-Off Valve
		R	Liquid receiver, Safety Valve, Shut-Off Valve
		L	Head pressure Valve, Liquid receiver, Safety Valve, Shut-Off Valve
10	Packaging**	G	Standard package with wooden crate
		M	Standard package with seaworthy crate
11	Power supply and coil treatment	S	230 V / 1 ph / 50-60 Hz without coating
		T	230 V / 1 ph / 50-60 Hz with Epoxy coating
		U	230 V / 1 ph / 50-60 Hz with Electrofin coating

\* The three digit tends to identify the nominal Heat rejection Capacity in kW at standard conditions: Delta (T<sub>saturated condensing</sub> - T<sub>air inlet</sub>) = 15K; T<sub>coil air inlet</sub> = 35°C; Liquid subcooling = 3K; Installation height = 0m above the sea level; clean exchange surfaces.

\*\* Standard package means cardboard and polythene, with pallet.

## 6.2 Design compliance

The **Liebert® OAC** units are designed and manufactured in accordance with the following European Directives:

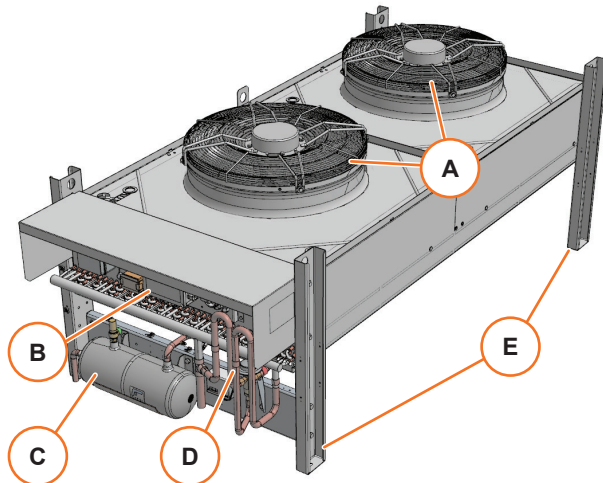
<b>EU Directives</b>	<ul style="list-style-type: none"> <li>- Machine Directive 2006/42/CE</li> <li>- PED Directive 2014/68/EU</li> <li>- Low Voltage Directive 2014/35/UE</li> <li>- EMC Directive 2014/30/UE</li> <li>- RoHS II Directive 2011/65/EU</li> <li>- RoHS III Directive EU/2015/863</li> </ul>
<b>Electrical board</b>	<ul style="list-style-type: none"> <li>- EN 60204-1</li> <li>- CEI 20-22 II</li> <li>- IEC 332-3 cat. A.</li> </ul>
<b>Electro-Magnetic Compability (EMC)</b>	<ul style="list-style-type: none"> <li>- EN 61000-6-2:2005 Electromagnetic compatibility (EMC) - Part 6-2: Generic standards – Immunity for industrial environments</li> <li>- EN 61000-6-3:2011 Electromagnetic compatibility (EMC) - Part 6-3: Generic standards – Emission standard for residential, commercial, and light-industrial environments</li> </ul>
<b>Performances</b>	<ul style="list-style-type: none"> <li>- Heat rejection capacities tests (with R410A): UNI EN 327</li> <li>- Sound pressure levels (referred to 5m far from the unit): EN13487</li> </ul>
The <b>Liebert® OAC</b> units are designed, manufactured, and tested in full or partial accordance with the following Standards:	
<b>Performance test norms</b>	<ul style="list-style-type: none"> <li>- Cooling Capacity according to EN 14511</li> <li>- Sound Power Level according to ISO 3744</li> </ul>
<b>CE Marking and Declaration of Conformity</b>	<p>The units are marked “<b>CE</b>”</p> <p>Each unit is supplied complete with individual test certificate in accordance with internal procedures and a Declaration of Conformity to the relevant European Union Directives.</p> 
<b>UKCA Marking and Declaration of Conformity</b>	<p>The units are marked “<b>UKCA</b>”</p> <p>Each unit is supplied complete with individual test certificate in accordance with internal procedures and a Declaration of Conformity to the relevant UK Safety Regulations.</p> 

## 6.3 Technical Highlights

### 6.3.1 Intent Use

<b>Operating environment</b>	The unit is designed for outdoor installation. Do not use in explosive, acid, or anyway aggressive atmosphere. In case of installation near the sea or other particularly atmosphere conditions consider selecting the Epoxy coating or Electrofin.	
<b>Altitude (above sea level)</b>	Below 1 000 m	OK
	Higher than 1 000 m	De rating required
<b>Outdoor temperature</b>	Air temperature at the dry cooler inlet	-20°C — +48°C
	Recommended application conditions:	
	Ambient kit option “S”	0°C < T < +48°C
	Ambient kit option “R”	-5°C < T < +48°C
Ambient kit option “L”	-20°C < T < +48°C	
For installation with ambient temperature below -20°C it is necessary to contact Vertiv™ technical support.		
<b>Outdoor ambient</b>	Temperature	-40°C — +70°C
	Temperature	5% RH ... 85% RH
The total storage time should not exceed <b>six</b> months. Otherwise, the performance needs to be re-calibrated.		

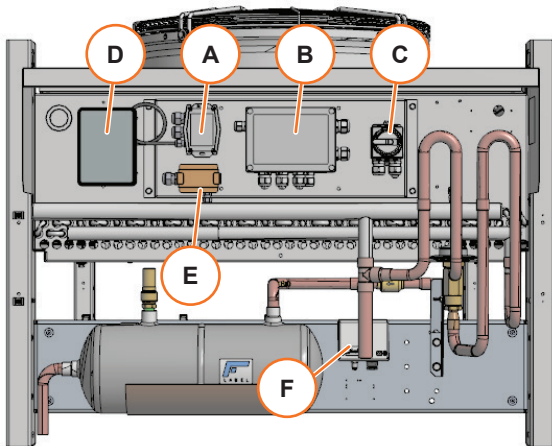
### 6.3.2 Design features



A	Fans
B	Electric box
C	Liquid receiver (optional)
D	Pipe kit
E	Supporting structure

- The Liebert® OAC condensers are equipped either with EC axial fans.
- The EC fan is an integral assembly of an electronically commutated motor, quiet fan blade assembly and finger/hail guard.
- The cabinet legs are made of aluminum.
- The finned-tube heat exchanger provides high heat-dissipating efficiency and is convenient for maintenance.
- The optional receiver stores refrigerant to help fulfill the needs for low temperature load in winter and high temperature load in summer. There are three connection ports in the receiver to connect refrigerant inlet pipe, refrigerant outlet pipe, and safety valve. The safety valve is shipped separately with connecting piping kit and must be installed on field.

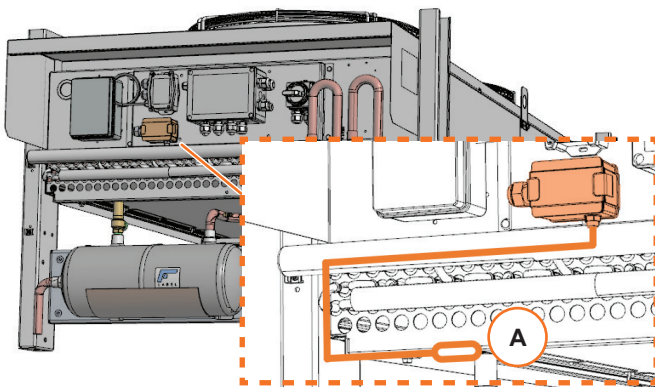
#### Electric system



A	Temperature probe box (optional)
B	Main electric box
C	Main switch
D	Electrical Junction box (for Electrical heater, Pressure switch, Thermostat)
E	Temperature probe box (optional)
F	Pressure control switch

- The main switch [C] is a disconnecting switch and cuts off electric power supply to the condenser unit.
- The controller, connected to the main unit, starts/stops the condenser unit operation.

- The condenser is quickly and easily installed, all internal wiring is completed at the factory with only electrical connections and pipe kit with safety valve needs to be connected at the job site.
- The Liebert® OAC condensers are controlled by the control of the indoor unit via Modbus protocol.



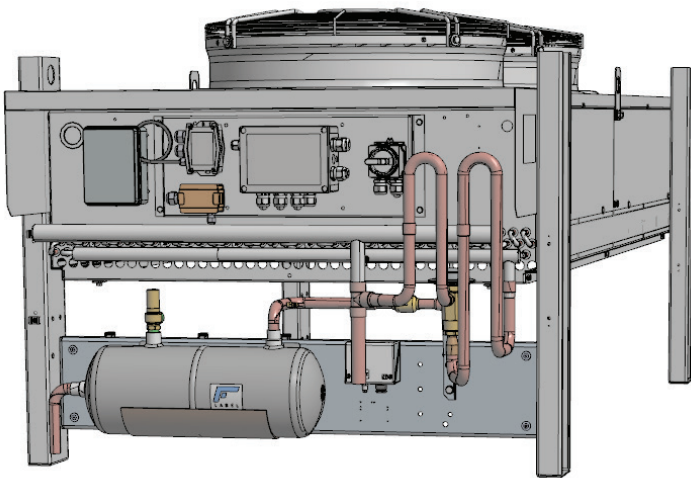
- It's possible to install a temperature probe [A] on the end plate under the control box to monitor that ambient temperature

### 6.3.3 Frame versions

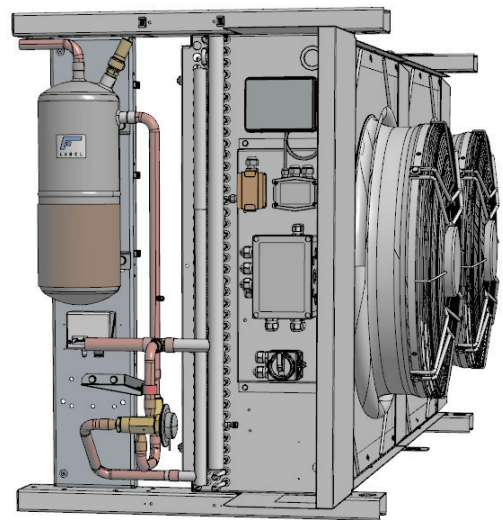
The Liebert® OAC condensers are available with 3 frame sizes: **1 fan**, **2 fans** and **3 fans**.



For each frame size two versions are possible: **Vertical (Digit 7 = V)** or **Horizontal (Digit 7 = H)** air flow configurations.



**VERTICAL = Vertical airflow**



**HORIZONTAL = Horizontal airflow**

### 6.3.4 Ambient kits

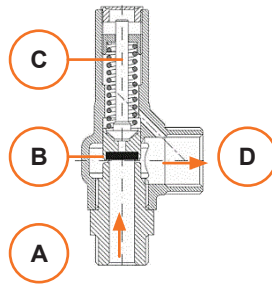
Ambient kit are supplied loose (like accessories) and shall be installed on field.

#### Ambient kit type S (Digit 8 = S)

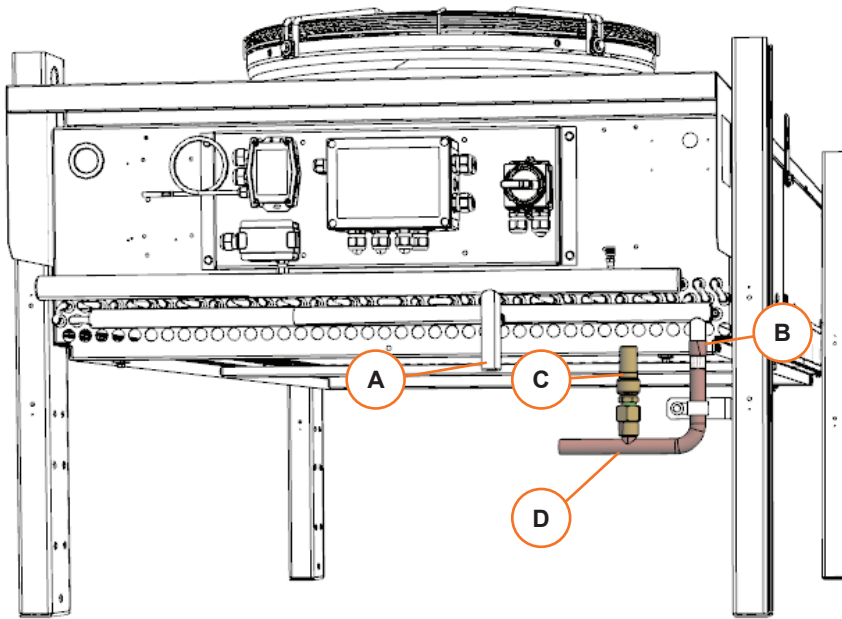
Suitable for ambient temperature above 0°C, comprise of pressure safety valve, shut-off valve and piping connections.

The safety valve provides protection against possible overpressures of the refrigerating system.

If the pressure in the system exceeds the set pressure of the safety valve, the valve opens and relieves excess pressure from vessels or equipment.

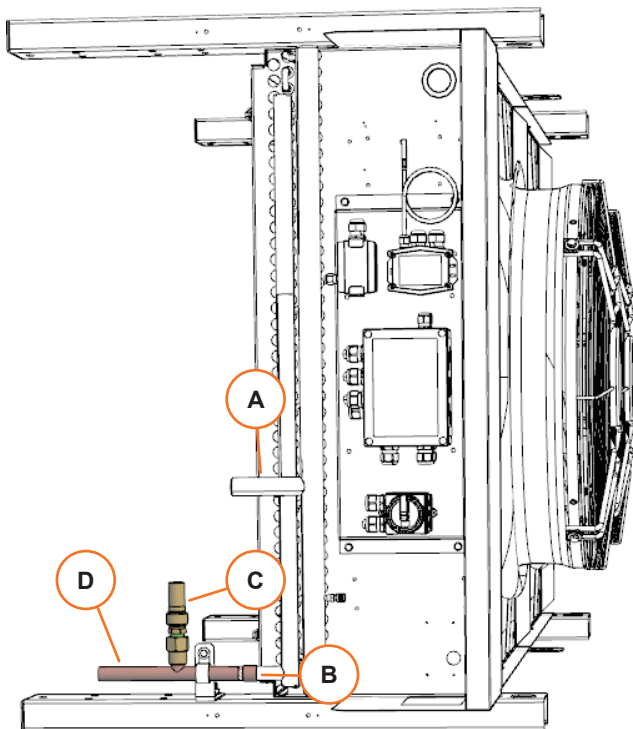


A	Inlet from the circuit or pressure vessel
B	Closing disc
C	Spring
D	Discharge Outlet



A	Condenser inlet from the system
B	Condenser outlet
C	Pressure Safety valve
D	Outlet connection to the system

Shut-off valves are included in the kit and should be attached on site.



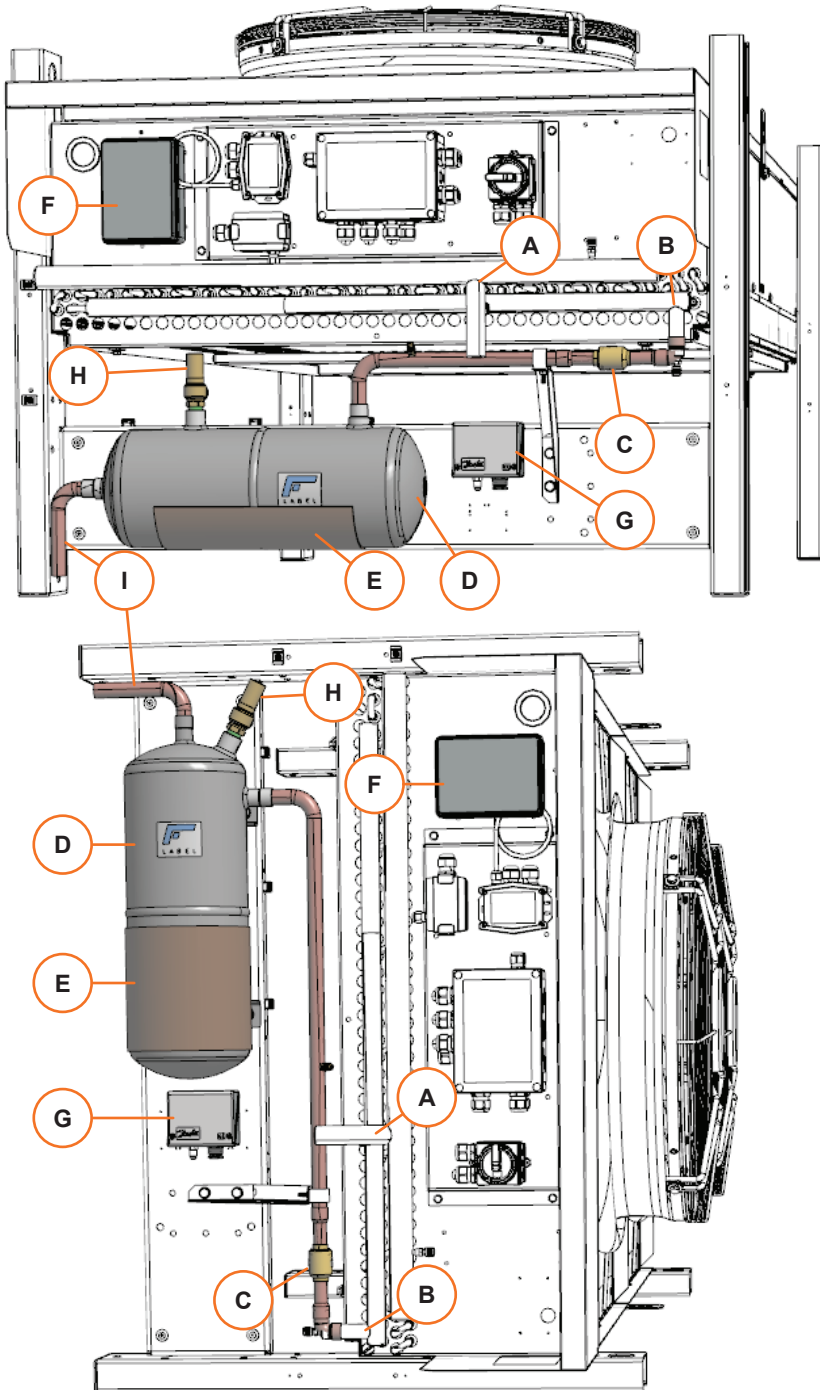
### Ambient kit type R (Digit 8 = R)

Suitable for ambient temperature down to  $-5^{\circ}\text{C}$ , comprise of liquid receiver, pressure safety valve, shut-off valve and piping connections.

In addition to what supplied with ambient kit **S**, also a liquid receiver is comprised in the bundle.

The receiver is equipped with a heater pad, which is controlled by the pressure switch, that is activated depending on refrigerant pressure in the receiver:

- When the refrigerant pressure in the receiver is lower than 1.4 MPa, the pressure switch will be closed and the heater pad will start heating;
- When the refrigerant pressure in the receiver is higher than 1.9 MPa, the pressure switch will be opened and the heaterpad will stop heating.



A	Condenser inlet from the system
B	Condenser outlet
C	Check valve (Non-return valve)
D	Liquid receiver covered by thermal sleeve
E	Surface heater for liquid receiver
F	Thermostat for surface heater
G	Pressure switch
H	Pressure Safety valve
I	Outlet connection to the system

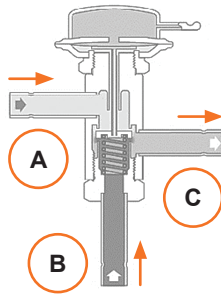
Shut-off valves are included in the kit and should be attached on site.

**Ambient kit type L (Digit 8 = L)**

Suitable for ambient temperature down to -20°C.

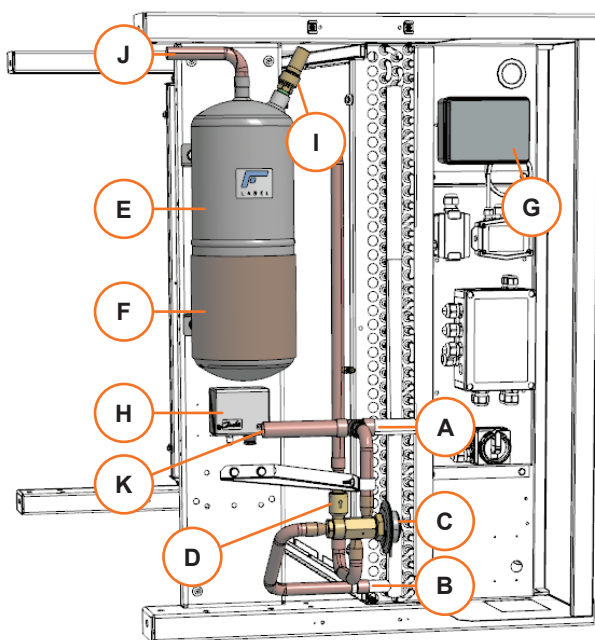
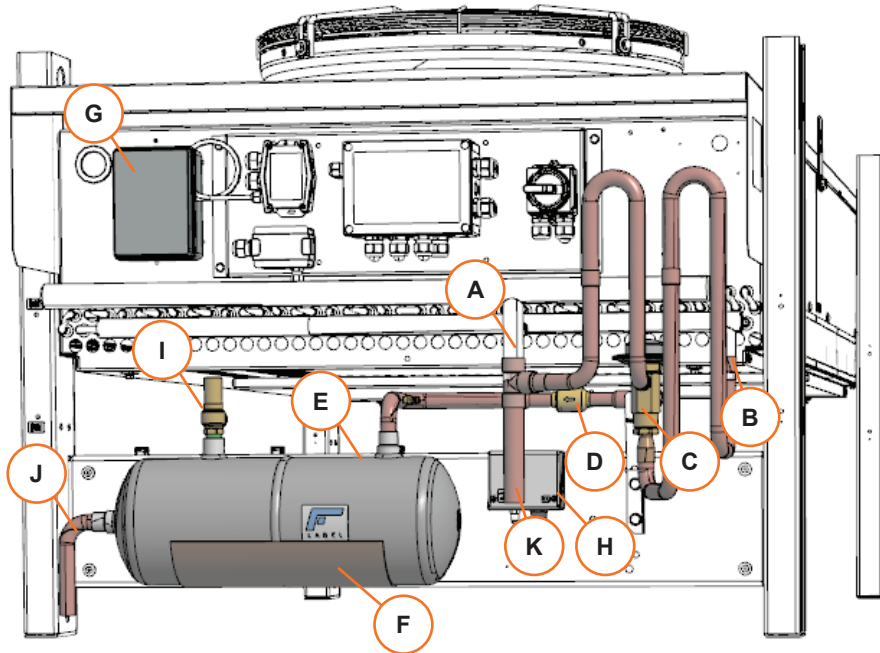
In addition to what supplied with option R, also head pressure control valve and check valves are comprised in the kit.

The head pressure valve is a three-way modulating valve that responds to discharge pressure. When the discharge pressure falls below a certain value, the discharge port is opened and the discharge gas bypasses the condenser. When the discharge pressure is high, the discharge port is closed and there is full liquid flow to the condenser.



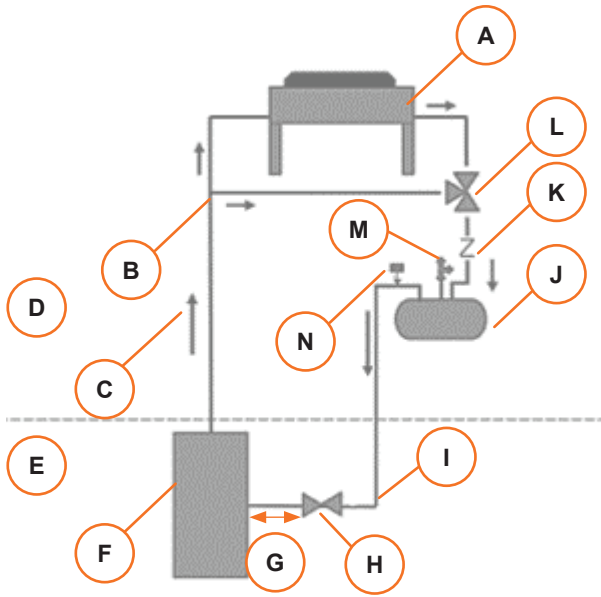
<b>A</b>	Connected with discharge pipe
<b>B</b>	Connected with condenser
<b>C</b>	Connected with receiver

Check valve is installed between the head pressure valve and the receiver on the liquid line, to prevent the refrigerant from flowing back to the condenser.



<b>A</b>	Condenser inlet
<b>B</b>	Condenser outlet
<b>C</b>	LAC Head pressure control valve
<b>D</b>	Check valve (non-return valve)
<b>E</b>	Liquid receiver covered by thermal sleeve
<b>F</b>	Surface heater for liquid receiver
<b>G</b>	Thermostat for surface heater
<b>H</b>	Pressure switch
<b>I</b>	Pressure Safety valve
<b>J</b>	Outlet connection to the system
<b>K</b>	Intlet connection from the system

Shut-off valves are included in the kit and should be attached on site.



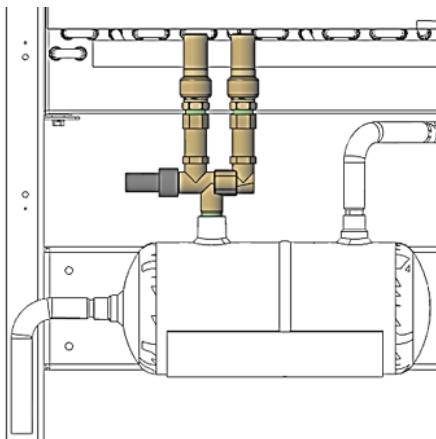
A	Condenser
B	Discharge pipe
C	Refrigerant flow direction
D	Outdoor environment
E	Indoor environment
F	Evaporator
G	max. 2 m distance
H	Shut-off valve / Solenoid valve
I	Liquid pipe
J	Liquid receiver
K	Check valve
L	Head pressure valve
M	Safety valve
N	Pressure switch

### 6.3.5 Accessories

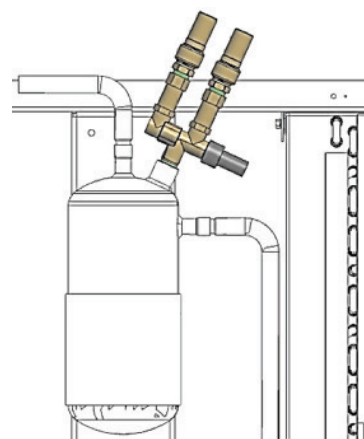
#### Changeover valve for pressure safety valve

The changeover valve is a service device for dual pressure relief valve assembly. It allows the user to perform maintenance or replacement on the isolated valve while the system remain operational and protected by the other valve in the assembly.

Vertical air flow configuration



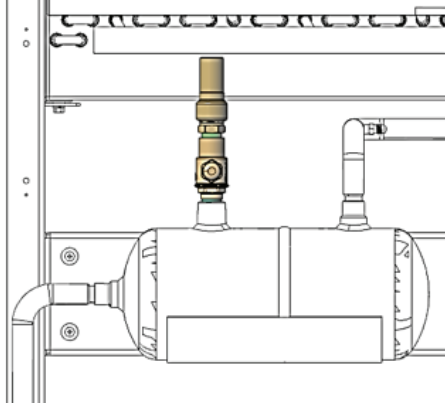
Horizontal air flow configuration



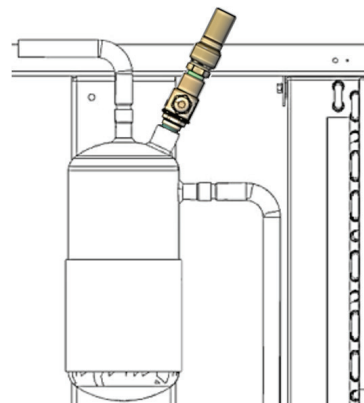
#### Shut-off valve for pressure safety valve

The shut-off valve is installed between the liquid receiver vessel and the pressure safety valve. Closing the shut-off valve allows removing of the valve for periodic checking or replacement without draining the refrigerant system.

Vertical air flow configuration



Horizontal air flow configuration



### 6.3.6 Condenser coil treatments

Digit 11 = S, No treatment

Digit 11 = T, Epoxy Coating

Digit 11 = U, Electrofin coating

Finned coil coating selection for different atmospheric corrosivity category:

Atmospheric corrosivity category (ISO 922)	C1, C2	C3		C4	C5	C6
		Inland	Coastal			
Corrosivity	Very low, low	Medium	Medium	High	Very high	Extreme
Typical environment - examples	Indoor, Rural areas	Urban areas	Urban areas	Polluted urban, industrial, coastal areas	Very high pollution & salt deposition areas	Extreme industrial, coastal areas
OAC config. Digit 11 = S	OK	OK	NR	NR	NR	NR
OAC config. Digit 11 = T	OK	OK	AP	NR	NR	NR
OAC config. Digit 11 = U	OK	OK	OK	OK	AP	NR

NOTE:

OK = Suitable application;

AP = Acceptable when protection is applied. Lifespan may be shortened! Protection could be additional separating wall or filter screen;

NR = Not recommended application.

## 6.4 Liebert® HPA-OAC, technical tables

### 6.4.1 Technical Data and Performances

Model	Voltage	Total heat Rejection *	Air volume	Noise level **	Power input	Current absorption	FLA
		[kW]	[m³/h]	[dB(A)] @5m	[kW]	[A]	[A]
OAC017	230 V 1ph 50-60 Hz	20,59	6140	55	0,76	3,53	4,0
OAC033		29,49	7180	48	0,47	2,02	3,0
OAC042		46,65	16140	50	0,88	3,81	2 x 3,0
OAC058		54,42	15380	50	0,91	3,92	2 x 3,0
OAC087		81,82	23100	52	1,36	5,87	3 x 3,0
OAC095		87,76	21570	52	1,41	6,05	3 x 3,0

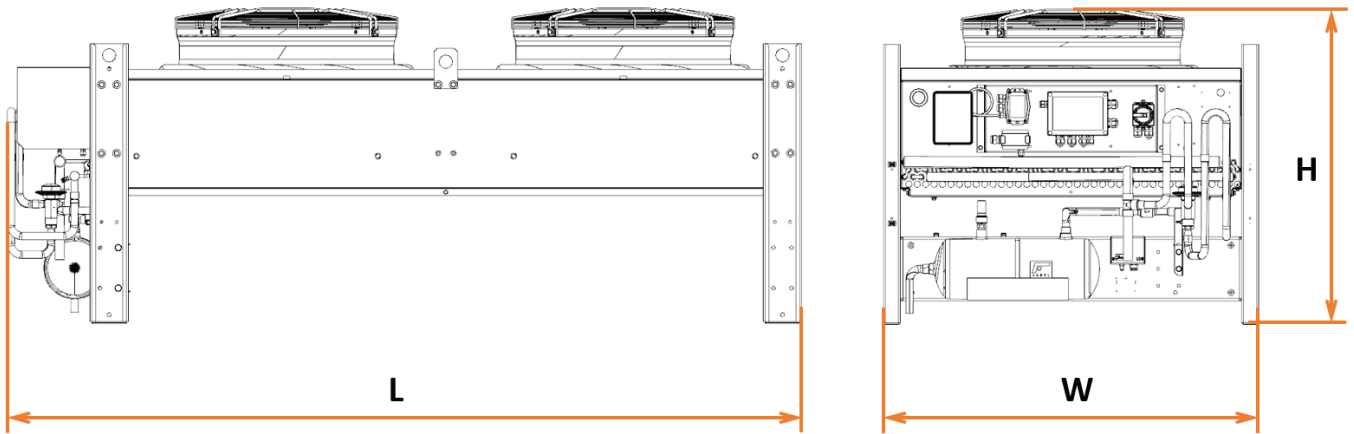
**Total Heat Rejection\*** @ R410A; Delta (T<sub>saturated</sub> condensing - T<sub>air inlet</sub>)=15K; T<sub>coil air inlet</sub> = 35°C; Liquid subcooling = 3K; Installation height = 0m above the sea level; clean exchange surfaces.

**Noise Level\*\*** Sound Pressure Level measured with horizontal installation in the same operative conditions, referred to 5 m far from the unit, in a free field over a reflecting plane (according to EN13487).

### 6.4.2 Piping sizes

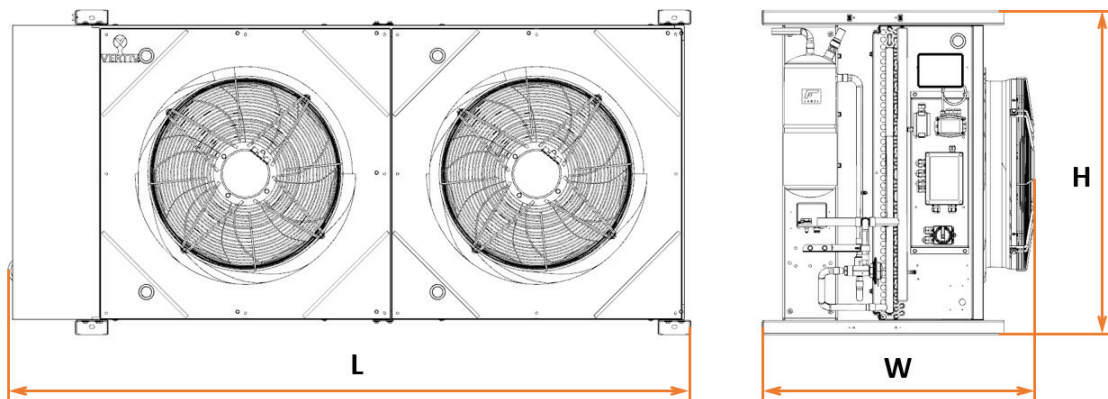
Model	Pipe IN	Pipe OUT
OAC017	22	28
OAC033	22	28
OAC042	22	28
OAC058	22	28
OAC087	22	28
OAC095	22	28

### 6.4.3 Installation dimensions for vertical airflow



Model	Dimension		
	L [mm]	W [mm]	H [mm]
OAC017*VS	1054	892	950
OAC017*VR	1054	892	950
OAC017*VL	1119	892	950
OAC033*VS	1330	1113	936
OAC033*VR	1330	1113	936
OAC033*VL	1359	1113	936
OAC042*VS	2330	1113	936
OAC042*VR	2330	1113	936
OAC042*VL	2359	1113	936
OAC058*VS	2330	1113	936
OAC058*VR	2330	1113	936
OAC058*VL	2359	1113	936
OAC087*VS	3330	1113	936
OAC087*VR	3330	1113	936
OAC087*VL	3359	1113	936
OAC095*VS	3330	1113	936
OAC095*VR	3330	1113	936
OAC095*VL	3359	1113	936

### 6.4.4 Installation dimensions for horizontal airflow



Model	Dimension		
	L [mm]	W [mm]	H [mm]
OAC017*HS	1054	950	892
OAC017*HR	1054	950	898
OAC017*HL	1117	950	898
OAC033*HS	1330	936	1113
OAC033*HR	1330	936	1113
OAC033*HL	1345	936	1113
OAC042*HS	2330	936	1113
OAC042*HR	2330	936	1113
OAC042*HL	2345	936	1113
OAC058*HS	2330	936	1113
OAC058*HR	2330	936	1113
OAC058*HL	2345	936	1113
OAC087*HS	3330	936	1113
OAC087*HR	3330	936	1113
OAC087*HL	3345	936	1113
OAC095*HS	3330	936	1113
OAC095*HR	3330	936	1113
OAC095*HL	3345	936	1113

### 6.4.5 Weights

Model	Total unit weight	Gross weight	Packaging weight
	[kg]	[kg]	[kg]
OAC017	34,9	56,3	21,4
OAC033	85,9	125,9	40
OAC042	118,6	178,6	60
OAC058	126,6	186,6	60
OAC087	182,40	265,4	83
OAC095	202,1	285,1	83

### 6.4.6 Safety device settings

Model	HP switch	Safety valve
OAC017	Open: 20,8 +0/-1,4 bar(g) Manual reset: 14,8 ±2 bar(g) Normally closed. Durability 10 000 times	Setting 22,9 bar(g) Over pressure 10% Closing variation 15%
OAC033		
OAC042		
OAC058		
OAC087		
OAC095		

### 6.4.7 Internal volumes for Vertical airflow configuration

Model	Coil volume	Liquid receiver	Pipe kit	Total
	[L]	[L]	[L]	[L]
OAC017*VS	6,40	4,6	0,11	11,11
OAC017*VR	6,40	4,6	0,22	11,22
OAC017*VL	6,40	4,6	0,89	11,89
OAC033*VS	12,40	10,7	0,11	23,21
OAC033*VR	12,40	10,7	0,21	23,31
OAC033*VL	12,40	10,7	0,88	23,98
OAC042*VS	18,30	10,7	0,11	29,11
OAC042*VR	18,30	10,7	0,21	29,21
OAC042*VL	18,30	10,7	0,88	29,88
OAC058*VS	18,30	10,7	0,11	29,11
OAC058*VR	18,30	10,7	0,21	29,21
OAC058*VL	18,30	10,7	0,88	29,88
OAC087*VS	26,70	10,7	0,11	37,51
OAC087*VR	26,70	10,7	0,21	37,61
OAC087*VL	26,70	10,7	0,88	38,28
OAC095*VS	35,80	10,7	0,11	46,61
OAC095*VR	35,80	10,7	0,21	46,71
OAC095*VL	35,80	10,7	0,88	47,38

### 6.4.8 Internal volumes for Horizontal airflow configuration



Model	Coil volume	Liquid receiver	Pipe kit	Total
	[L]	[L]	[L]	[L]
OAC017*HS	6,40	4,6	0,08	11,08
OAC017*HR	6,40	4,6	0,27	11,27
OAC017*HL	6,40	4,6	0,53	11,53
OAC033*HS	12,40	10,7	0,08	23,18
OAC033*HR	12,40	10,7	0,30	23,40
OAC033*HL	12,40	10,7	0,59	23,69
OAC042*HS	18,30	10,7	0,08	29,08
OAC042*HR	18,30	10,7	0,30	29,30
OAC042*HL	18,30	10,7	0,59	29,59
OAC058*HS	18,30	10,7	0,08	29,08
OAC058*HR	18,30	10,7	0,30	29,30
OAC058*HL	18,30	10,7	0,59	29,59
OAC087*HS	26,70	10,7	0,08	37,48
OAC087*HR	26,70	10,7	0,30	37,70
OAC087*HL	26,70	10,7	0,59	37,99
OAC095*HS	35,80	10,7	0,08	46,58
OAC095*HR	35,80	10,7	0,30	46,80
OAC095*HL	35,80	10,7	0,59	47,09





## 7.2 Design compliance

The Liebert® HPD units are designed, manufactured and tested according to the following directives and standards:

<b>EU Directives</b>	<ul style="list-style-type: none"> <li>- PED97/23/CEE</li> <li>- 73/23/CEE</li> <li>- EMC 89/336/CEE (EN61000-6-2; EN 61000-6-3)</li> <li>- 98/37/CE</li> </ul>	
<b>CE Marking and Conformity Declaration</b>	<p>The units are marked “CE”.</p> <p>Each unit is supplied complete with individual test certificate and a certificate of conformity to the European Union Directives.</p> <p>See also the last page.</p>	
<b>UKCA Marking and Conformity Declaration</b>	<p>The units are marked “UKCA”.</p> <p>Each unit is supplied complete with individual test certificate and a certificate of conformity to the UK Safety Regulations.</p>	

## 7.3 Technical Highlights

### 7.3.1 Intent Use

<b>Operating environment</b>	<p>The unit is designed for outdoor installation.</p> <p>Do not use in explosive, acid, or anyway aggressive atmosphere.</p> <p>In case of installation near the sea or other particularly atmosphere conditions consider selecting the Epoxy coating.</p>	
<b>Altitude (above sea level)</b>	Below 1 000 m	OK
	Higher than 1 000 m	De rating required
<b>Outdoor temperature</b>	Air temperature at the dry cooler inlet	-20°C — +46°C
<b>Water temperature</b>	Max dry cooler inlet water temperature	+60°C
<b>Storage environment</b>	Clean (no dust), well-ventilated indoor environment.	
<b>Outdoor ambient</b>	Temperature	-40°C — +70°C
	Temperature	5% RH ... 85% RH
	The total storage time should not exceed six months. Otherwise, the performance needs to be re-calibrated.	

### 7.3.2 Design features

Liebert® HPD Dry Coolers are the range of liquid coolers, able to cover rated heat exchange capacities from 8 to 400 kW.

#### Main features:

- Possibility to select two design: standard and low noise, mostly indicated for residential installations;
- The frame is made up of a sturdy structure in galvanized steel, totally painted (**RAL 9002**);
- Possibility of installation with horizontal or vertical air flow with simple operations on site, with the same model of Dry Cooler, without needing any wiring or re-wiring inside the unit;
- Power supply can be either 230V 1 ph 50Hz or 400V 3ph 50Hz, depending on selected model;
- Electrical boxes and accessories are water proof;
- Modulating fan speed regulator (optional), for a continuous modulation of the fan speed, installed on the machine, wired and factory-set, thus making the connection steps on site and the unit start-up extremely easy; the fan speed regulator with phase cut-off can be selected to control up to two setpoint values for the water delivery temperature of the Dry Cooler;
- The axial fans are EC type, equipped with protection grid and are statically and dynamically;
- They are equipped with motors able to operate within a wide range of outdoor working temperatures. Protection degree IP 54. Single-phase fans feature an electric condenser incorporated in the terminal board;
- Tubes are in copper and fins in aluminum, with wide heat exchange surface. Upon request (optional), the unit can be ordered with fins in epoxy-coated aluminum, with a better protection. The coil manifolds are in copper, with flanged connections in AISI 304 stainless steel, dimensions according to UNI EN 1092-1 type 13 PN16, for the models with three-phase power supply and male gas threaded connections for the single-phase models.

## 7.4 Liebert® HPD-DY - Technical tables

### 7.4.1 Technical data and performances

Tab. 7.1 - Technical characteristics / Caratteristiche tecniche

STD Noise Level Drycooler Model	STD Capacity (kW)	Air Flow (m³/h)	Water Flow (m³/h)	Water Pressure drop (kPa)	Internal volume (dm³)	SPL 10m f.f. dB(A)	Hydraulic connection (inch)	Vertical air flow			Horizontal air flow			Net Weight (kg)
								Lenght (mm)	Height (mm)	Width (mm)	Lenght (mm)	Height (mm)	Width (mm)	
DYS011	11,2	6500	0,54	23	5.6	46	2 X 1"	767	954	1240	580	814	1240	68
DYS013	12,3	5950	0,59	20	7.4	46	2 X 1"	767	954	1240	580	814	1240	73
DYS017	18,0	13800	0,87	56,7	7.4	49	2 X 1"	767	954	2120	580	814	2120	103
DYS022	22,6	12600	1,09	76,8	11	49	2 X 1"	767	954	2120	580	814	2120	111
DYS028	30,9	17315	1,49	44,4	17.5	44	2 X 1" 1/4"	1067	1080	2360	630	1114	2360	152
DYS035	38,6	16115	1,86	88,2	23.2	46	2 X 1" 1/4"	1067	1080	2360	630	1114	2360	166
DYS044	40,0	18620	1,93	42,2	30	48	2 X 1" 1/2"	1067	1150	2960	680	1114	2960	216
DYS050	52,3	40525	2,52	39,8	44	51	2 X 1" 1/4"	1067	1150	4260	680	1114	4260	304
DYS065	67,1	39220	3,24	30,3	36	51	2 X 2"	1245	1386	3340	965	1328	3340	358
DYS084	85,8	36180	4,14	62,8	58	51	2 X 2"	1245	1386	3340	965	1328	3340	394
DYS122	117,2	56920	5,66	33,5	68	53	2 X 2" 1/2"	1245	1386	4815	965	1328	4815	547
DYS175	169,9	72370	8,2	55,8	115	54	2 X 3"	1245	1386	6290	965	1328	6290	731
DYS220	229,0	110385	11,06	76,6	129	56	2 X 4"	2295	1386	4815	965	2393	4815	960
DYS267	244,5	107050	11,8	26,1	161	56	2 X 4"	2295	1386	4815	965	2393	4815	1010
DYS330	295,8	147180	14,29	23,1	172	57	2 X 4"	2295	1386	6290	965	2393	6290	1324
DYS400	375,0	183975	18,11	43,6	218	58	2 X 4"	2295	1386	7765	965	2393	7765	1688

Capacities calculated with Tair IN = 35°C; Twater IN = 45°C; Twater OUT = 40°C

Fluid is pure water; Slm zero meter / 0 m

Sound pressure level @ 10 m free field, in accordance with EN13487

Tab. 7.2 - Technical characteristics / Caratteristiche tecniche

STD Noise Level Drycooler Model	STD Capacity (kW)	Air Flow (m³/h)	Water Flow (m³/h)	Water Pressure drop (kPa)	Internal volume (dm³)	SPL 10m f.f. dB(A)	Hydraulic connection (inch)	Vertical air flow			Horizontal air flow			Net Weight (kg)
								Lenght (mm)	Height (mm)	Width (mm)	Lenght (mm)	Height (mm)	Width (mm)	
DYL008	7,30	5110	0,35	27,10	3.7	34	2 X 3/4"	767	954	1240	580	814	1240	61
DYL011	9,82	4430	0,47	13,50	7.3	34	2 X 1"	767	954	1240	580	814	1240	71
DYL015	14,80	10220	0,71	40,20	7.4	37	2 X 1"	767	954	2120	580	814	2120	98
DYL017	18,58	9595	0,90	54,60	11	37	2 X 1"	767	954	2120	580	814	2120	107
DYL027	27,55	14395	1,33	33,10	16.5	39	2 X 1" 1/4"	767	954	3000	580	814	3000	149
DYL040	36,62	15	1,77	45,80	30	41	2 X 1" 1/2"	1067	1150	2960	680	1114	2960	216
DYL047	51,06	24680	2,47	67,40	33	43	2 X 2"	1067	1150	4260	680	1114	4260	276
DYL055	54,92	22810	2,64	44,20	44	43	2 X 2"	1067	1150	4260	680	1114	4260	304
DYL065	66,11	32905	3,19	19,50	44	44	2 X 2" 1/2"	1067	1150	5560	680	1114	5560	358
DYL085	89,49	48475	4,32	33,10	54	44	2 X 2" 1/2"	1245	1386	4815	965	1328	4815	520
DYL100	105,04	47490	5,07	58,80	68	44	2 X 2" 1/2"	1245	1386	4815	965	1328	4815	547
DYL130	140,16	63315	6,77	60,50	91	45	2 X 2" 1/2"	1245	1386	6290	965	1328	6290	696
DYL160	172,59	79145	8,33	33,60	116	46	2 X 4"	1245	1386	7765	965	1328	7765	774
DYL210	214,48	87700	10,35	46,10	161	47	2 X 4"	2295	1386	4815	965	2393	4815	1010
DYL270	285,91	116935	13,80	45,30	215	48	2 X 4"	2295	1386	6290	965	2393	6290	1394
DYL350	352,74	146170	17,03	26,40	273	49	2 X 4"	2295	1386	7765	965	2393	7765	1778

Capacities calculated with Tair IN = 35°C; Twater IN = 45°C; Twater OUT = 40°C

Fluid is pure water; Slm zero meter / 0 m

Sound pressure level @ 10 m free field, in accordance with EN13487

## 7.4.2 Fan electrical data

Tab. 7.3 - Fan Electrical Data

STANDARD NOISE LEVEL DRYCOOLER MODEL	FAN SPEED	Power supply	EC fan motors		
			Motor Model	Absorbed power (kW)	FLA (A)
DYS011	1420	230/1/50	EBM A3G 500-AM-56-23	0,75	3,4
DYS013	1420	230/1/50		0,75	3,4
DYS017	1420	230/1/50		1,5	6,8
DYS022	1420	230/1/50		1,5	6,8
DYS028	1140	230/1/50	EBM A3G 630-AR-85-90	1,94	3,2
DYS035	1140	400/3/50		1,94	3,2
DYS044	900	400/3/50	EBM A3G 710-AO81-90	1,86	3
DYS050	1020	400/3/50	EBM A3G800-AU21-09	6,05	9,2
DYS065	1020	400/3/50		6,05	9,2
DYS084	1020	400/3/50		6,05	9,2
DYS122	1020	400/3/50		9,075	13,8
DYS175	1100	400/3/50		12,1	18,4
DYS220	1100	400/3/50		18,15	27,6
DYS267	1100	400/3/50		18,15	27,6
DYS330	1100	400/3/50		24,2	36,8
DYS400	1100	400/3/50		30,25	46

Tab. 7.4 - Fan Electrical Data

LOW NOISE LEVEL DRYCOOLER MODEL	FAN SPEED	Power supply	EC fan motors		
			Motor Model	Absorbed power (kW)	FLA (A)
DYL008	1100	230/1/50	A3G 500-AD-01-58	0,36	2,2
DYL011	1100	230/1/50		0,36	2,2
DYL015	1100	230/1/50		0,72	4,4
DYL017	1100	230/1/50		0,72	4,4
DYL027	1100	400/3/50	A3G 710-AO81-90	1,08	6,6
DYL040	900	400/3/50		1,86	3
DYL047	900	400/3/50		2,79	4,5
DYL055	900	400/3/51		2,79	4,5
DYL065	900	400/3/50	A3G800-AS26-09	3,72	6
DYL085	925	400/3/50		6,6	10,2
DYL100	925	400/3/50		6,6	10,2
DYL130	925	400/3/50		8,8	13,6
DYL160	1000	400/3/50		11	17
DYL210	1000	400/3/50		13,2	20,4
DYL270	1000	400/3/50		17,6	27,2
DYL350	1000	400/3/50		22	34

## 7.5. Indoor unit – Outdoor dry cooler matching tables

The following indications must be intended as suggestions and must not be considered in substitution of calculation that shall be always performed using Vertiv™ qualified rating tools.

Models	External temperature up to 30°C		External temperature up to 35°C		External temperature up to 40°C		External temperature up to 45°C	
	Standard	Low noise	Standard	Low noise	Standard	Low noise	Standard	Low noise
<b>PAM060</b>	1 x DYS050	1 x DYL050	1 x DYS065	1 x DYL065	1 x DYS084	1 x DYL084	1 x DYS175	1 x DYL160
<b>PAM080</b>	1 x DYS084	1 x DYL085	1 x DYS084	1 x DYL085	1 x DYS122	1 x DYL100	1 x DYS220	1 x DYL210
<b>PAM088</b>	1 x DYS122	1 x DYL130	1 x DYS175	1 x DYL130	1 x DYS175	1 x DYL160	1 x DYS220	1 x DYL210

The table shows the recommended combinations of the Dry Coolers **Liebert® HPD** with the air conditioners **Liebert® PDX PAM UHD**, according to the external air temperature.

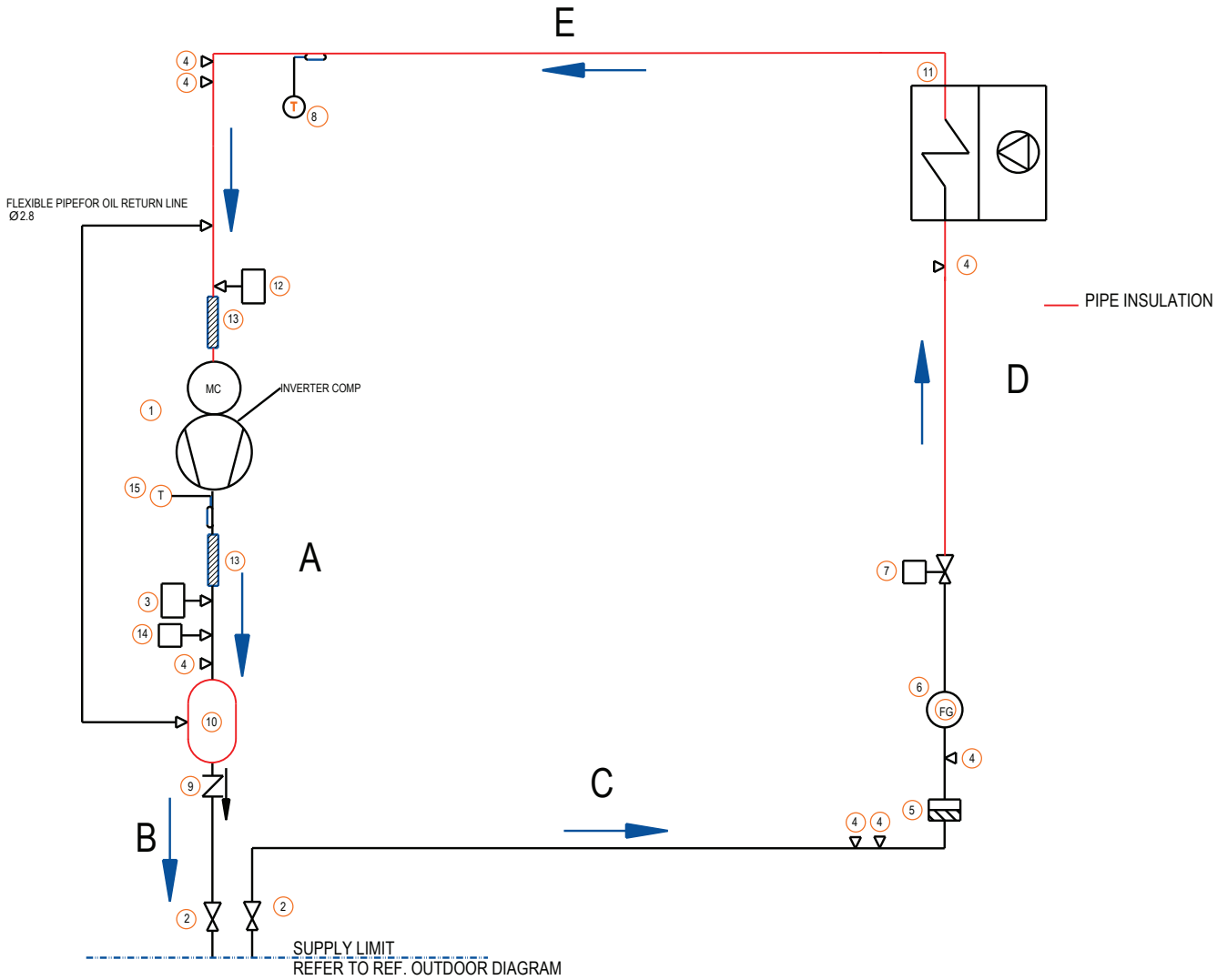
The combinations have been evaluated considering a mixture of water and ethylene glycol up to 30% as thermal exchange fluid. The above indications are approximate and must be checked on the basis of other specific operating conditions.

For operating conditions other than those indicated in the table, refer to qualified rating software and to the Dry Coolers User Manual.



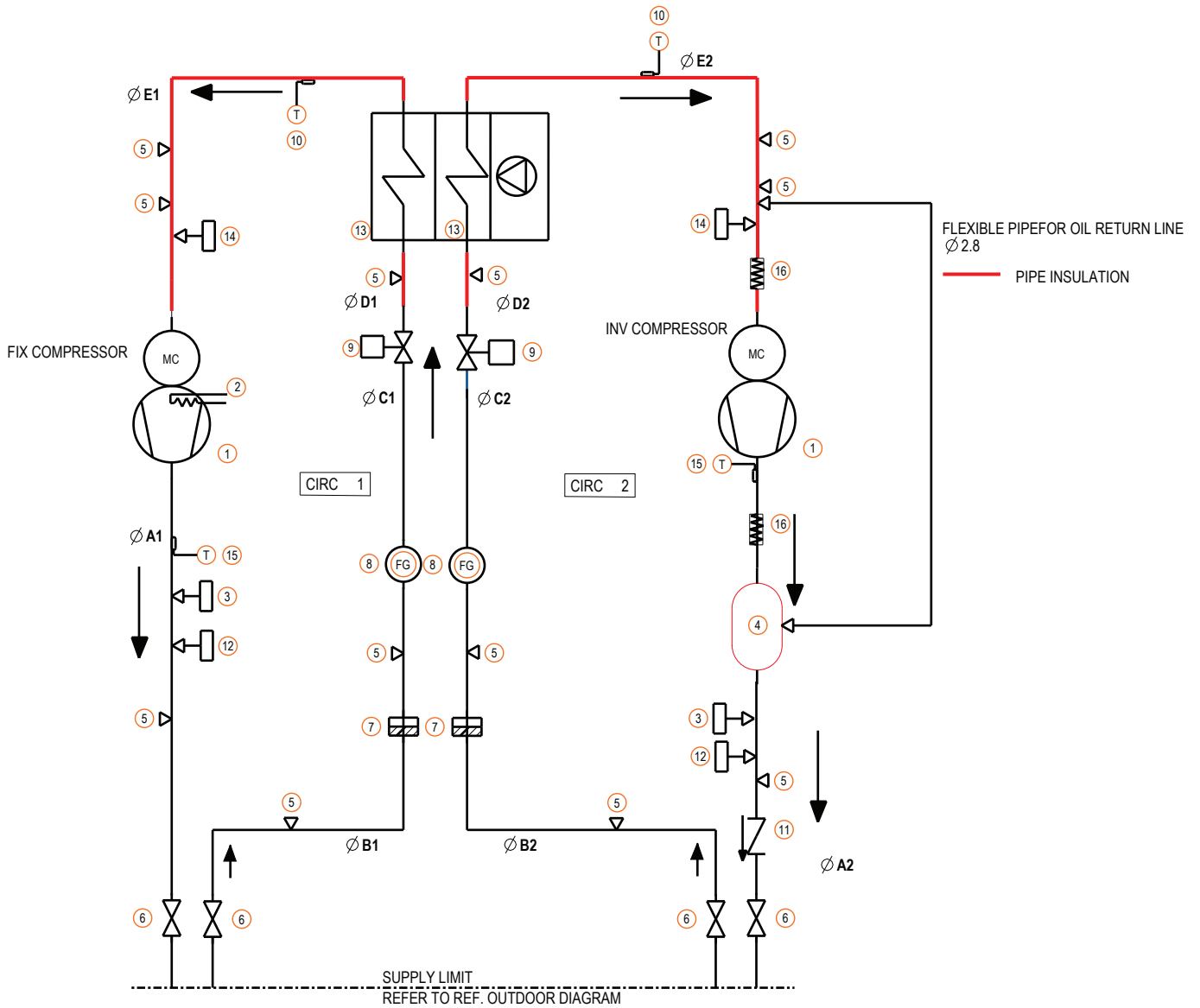
# Annex A - Refrigerant and Hydraulic Circuits

PAM010A / 020A / 030A - Air cooled versions (Digit 8 = A), refrigerating circuit type A (Digit 11 = A)



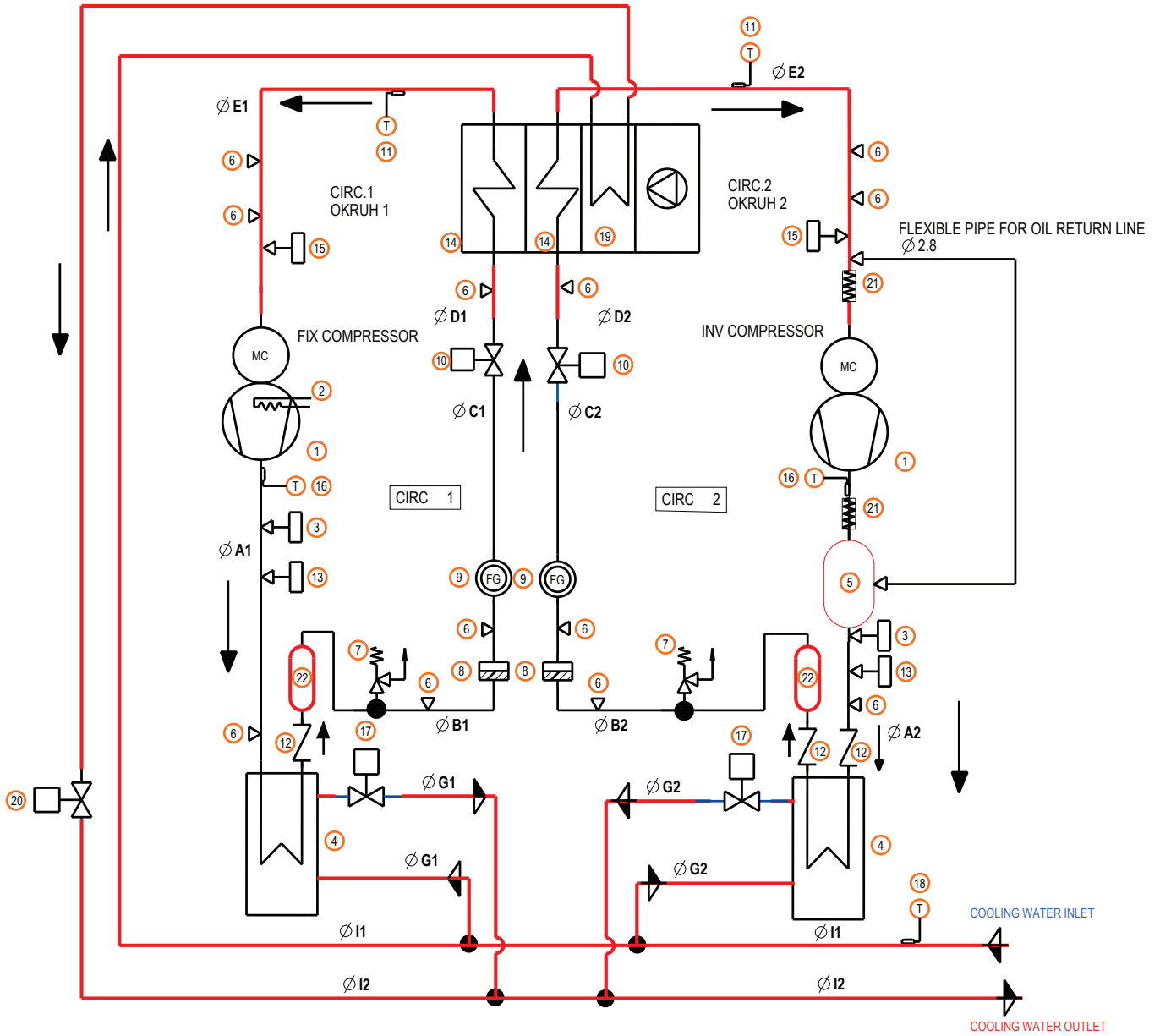
POS.	DESCRIPTION	POS.	DESCRIPTION
1	Compressor	9	Check Valve
2	Shut-OFF Valve	10	Oil Separator
3	High Pressure Switch	11	Evaporator
4	Access Valve 1/4"	12	Low Pressure Trasdncer
5	Filter Dryer	13	Vibration Adsorber
6	Sight Glass	14	High Pressure Trasdncer
7	Electronic Expasion Valve (EEV)	15	Temperature Discharge Sensor
8	Temperature Sensor for EEV		

**PAM060A - Air cooled versions (Digit 8 = A), refrigerating circuit type B (Digit 11 = B)**



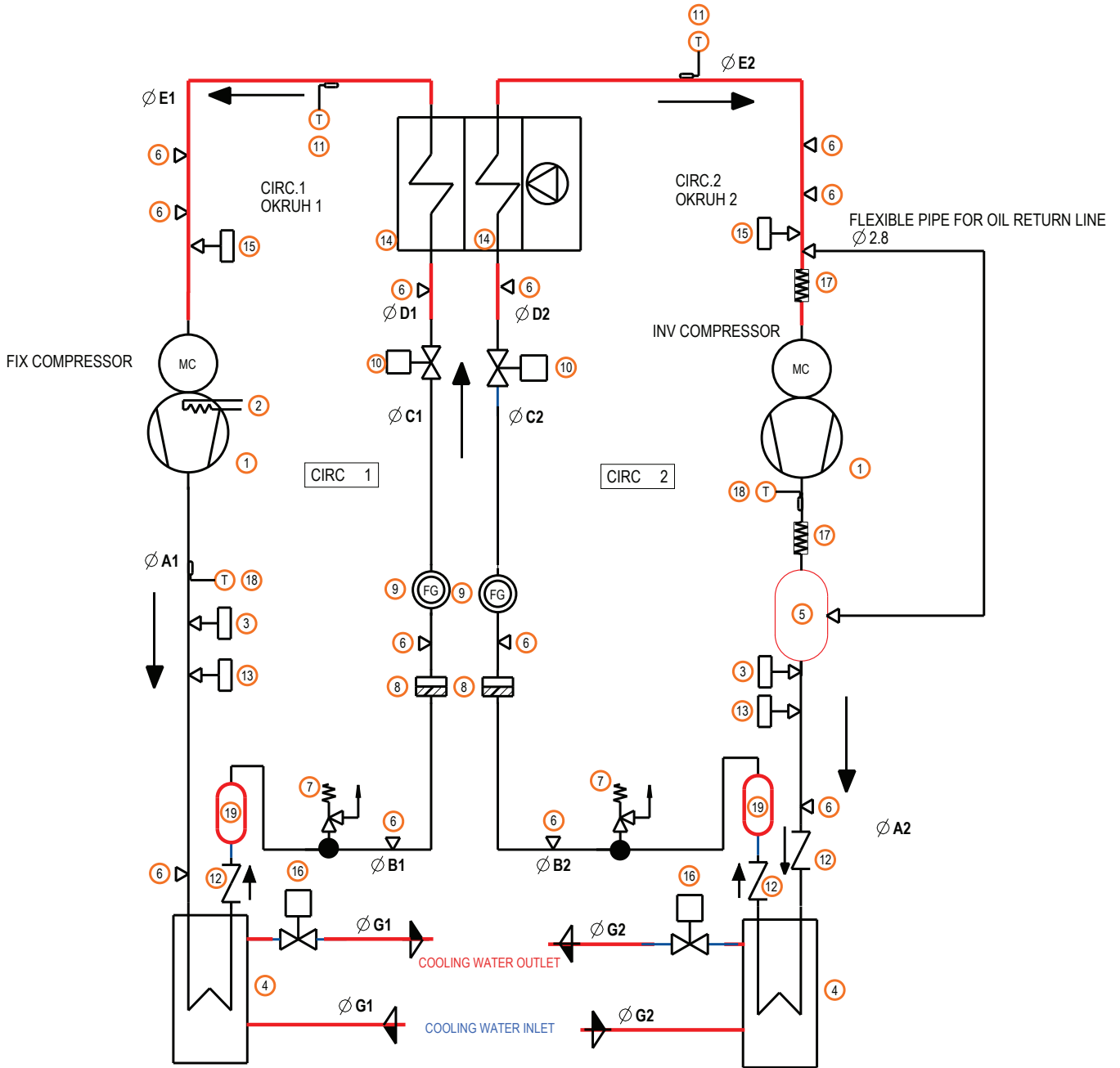
POS.	DESCRIPTION	POS.	DESCRIPTION
1	Compressor	9	Electronic Expansion Valve (EEV)
2	Crankcase Heater	10	Temperature Sensor for EEV
3	High Pressure Switch	11	Check Valve
4	Oil Separator	12	High Pressure Trasdncer
5	Access Valve 1/4"	13	Evaporator
6	Shut-OFF Valve	14	Low Pressure Trasdncer
7	Filter Dryer	15	Temperature Discharge Sensor
8	Sight Glass	16	Vibration Adsorber

**PAM060F - Air cooled versions (Digit 8 = A), refrigerating circuit type C (Digit 11 = C)**



POS.	DESCRIPTION	POS.	DESCRIPTION
1	Compressor	12	Check Valve
2	Crankcase heater	13	High Pressure Trasducer
3	High Pressure Switch	14	Evaporator
4	Water Cooled Condenser	15	Low Pressure Trasducer
5	Oil Separator	16	Temperature Discharge Sensor
6	Access Valve 1/4"	17	Condensing Regulation Water Valve
7	Safety Valve	18	Inlet Water Sensor
8	Filter Dryer	19	Chilled Water Coil
9	Sight Glass	20	Chiller Water 2 way Valve
10	Electronic Expasion Valve (EEV)	21	Vibration Adsorber
11	Temperature Sensor for EEV	22	Liquid Receiver

**PAM060W - Water cooled versions (Digit 8 = W), refrigerating circuit type B (Digit 11 = B)**



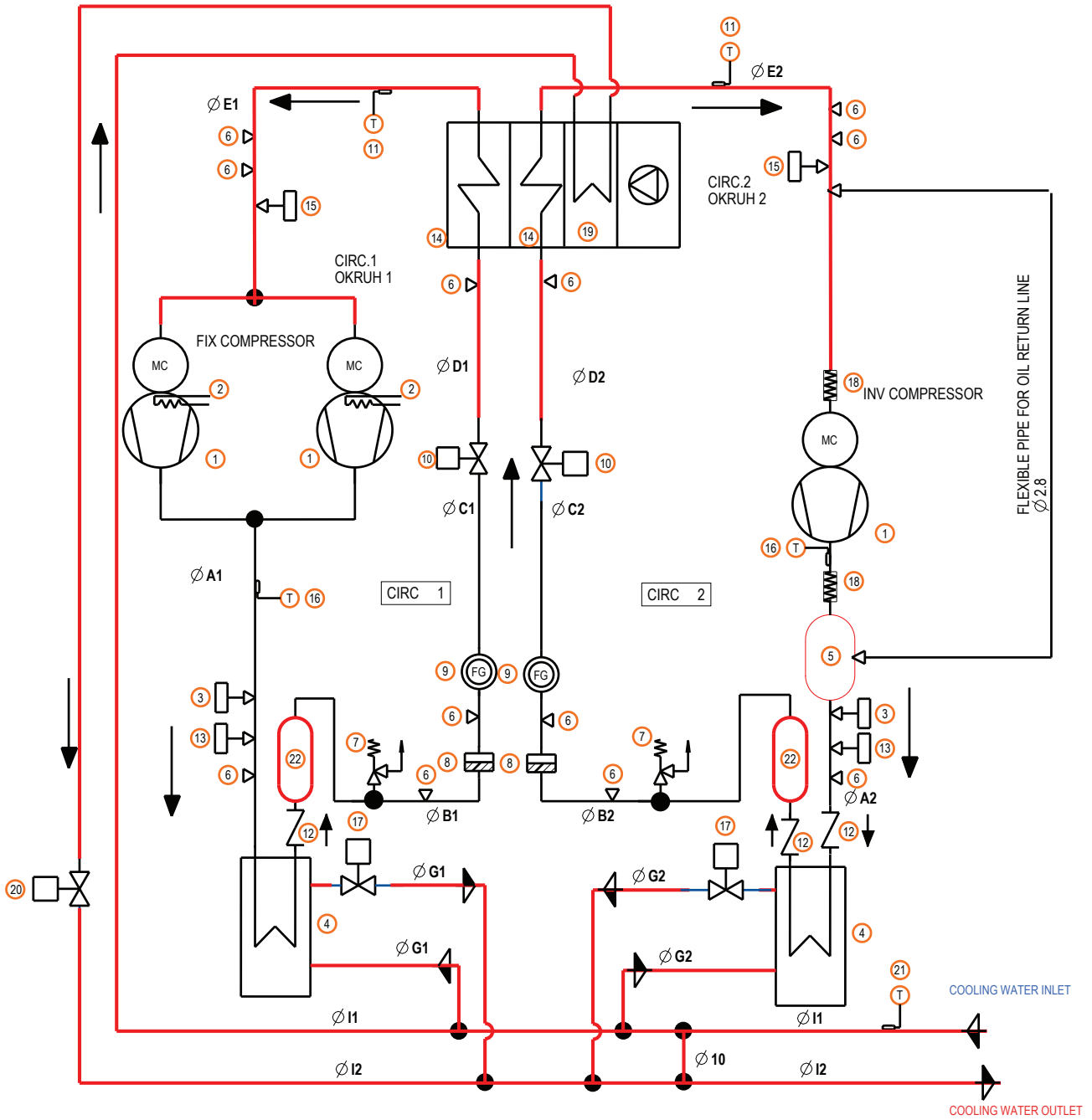
POS.	DESCRIPTION	POS.	DESCRIPTION
1	Compressor	10	Electronic expansion valve (EEV)
2	Crankcase heater	11	Temperature Sensor for EEV
3	High Pressure Switch	12	Check Valve
4	Water Cooled Condenser	13	High Pressure Trasdncer
5	Oil Separator	14	Evaporator
6	Access Valve 1/4"	15	Low Pressure Trasdncer
7	Safety Valve	16	Condensing Regulation Water Valve
8	Filter Dryer	17	Vibration Adsorber
9	Sight Glass	18	Temperature Discharge Sensor
		19	Liquid Receiver

**PAM080A - Water cooled versions (Digit 8 = W), refrigerating circuit type C (Digit 11 = C)**



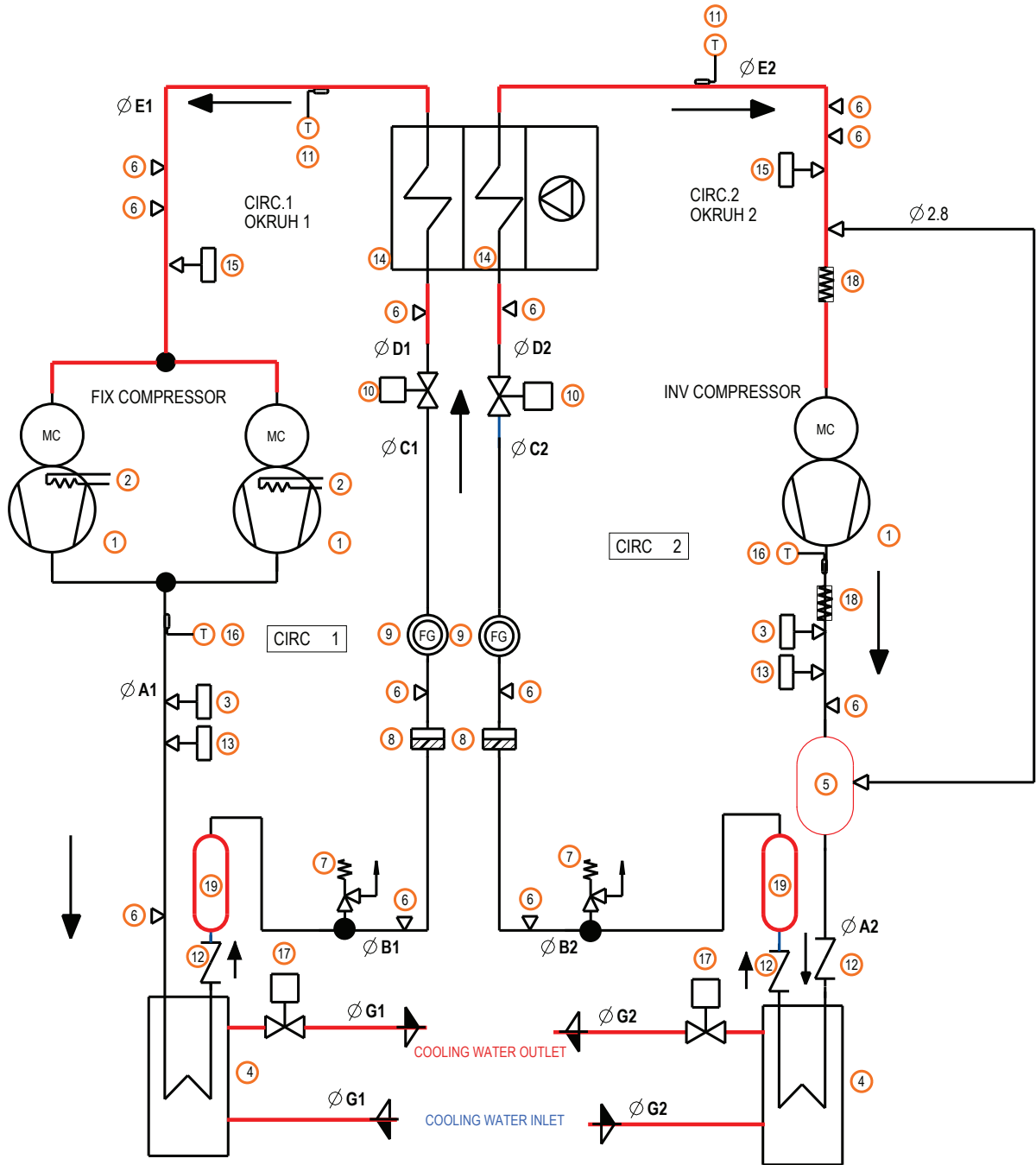
POS.	DESCRIPTION	POS.	DESCRIPTION
1	Compressor	9	Electronic expansion valve (EEV)
2	Crankcase Heater	10	Temperature Sensor for EEV
3	High Pressure Switch	11	Check Valve
4	Shut-OFF Valve	12	High Pressure Trasdncer
5	Oil Separator	13	Evaporator
6	Access Valve 1/4"	14	Low Pressure Trasdncer
7	Filter Dryer	15	Temperature Discharge Sensor
8	Sight Glass	16	Vibration Adsorber

**PAM080F - Free-Cooling versions (Digit 8 = F), refrigerating circuit type C (Digit 11 = C)**



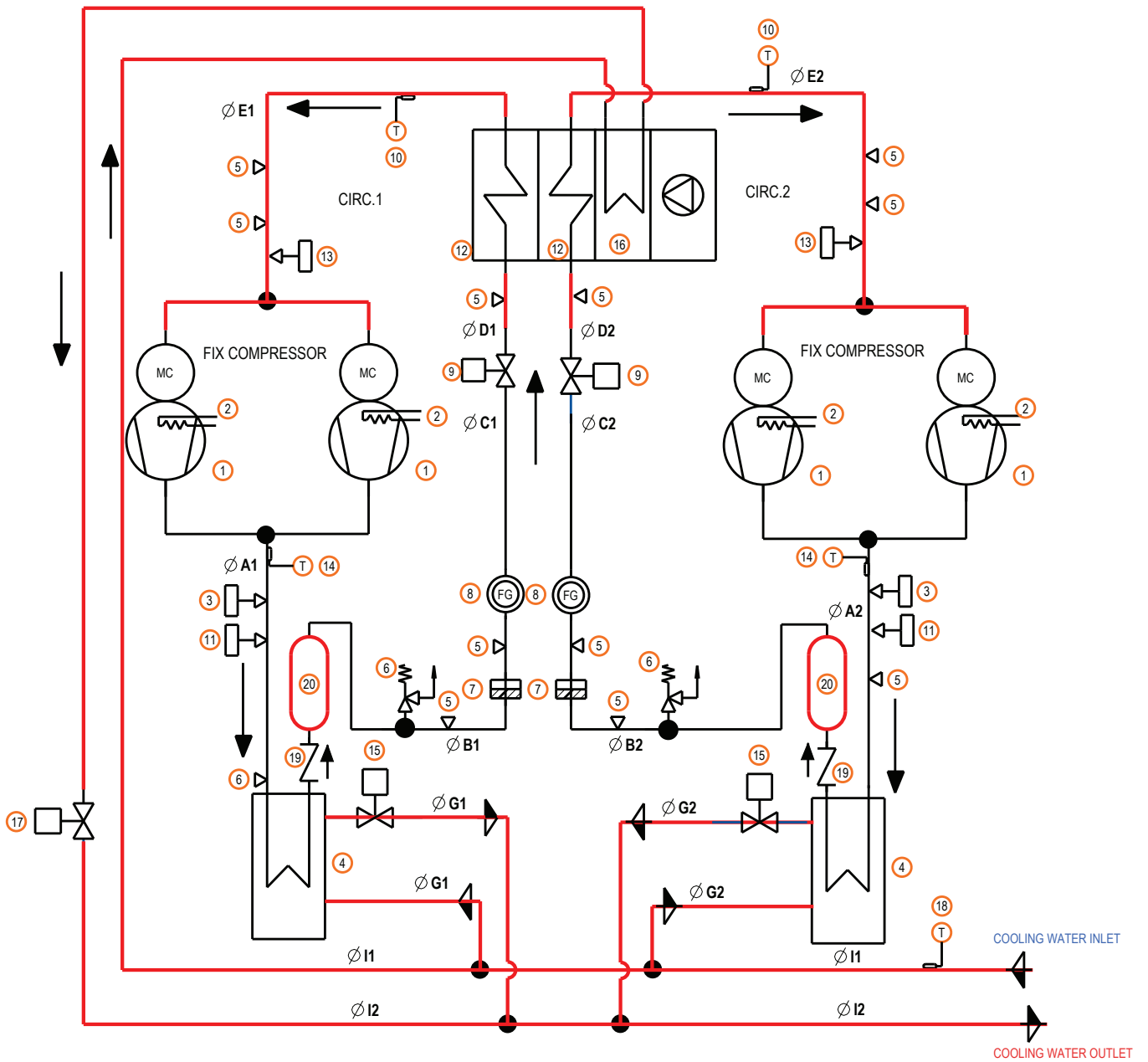
POS.	DESCRIPTION	POS.	DESCRIPTION
1	Compressor	12	Check Valve
2	Crankcase heater	13	High Pressure Trasdncer
3	High Pressure Switch	14	Evaporator
4	Water Cooled Condenser	15	Low Pressure Trasdncer
5	Oil Separator	16	Temperature Discharge Sensor
6	Access Valve 1/4"	17	Condensing Regulation Water Valve
7	Safety Valve	18	Vibration Adsorber
8	Filter Dryer	19	Chilled Water Coil
9	Sight Glass	20	Chiller Water 2 way Valve
10	Electronic Expasion Valve (EEV)	21	Inlet Water Sensor
11	Temperature Sensor for EEV	22	Liquid Receiver

**PAM080W - Free-Cooling versions (Digit 8 = F), refrigerating circuit type D (Digit 11 = D)**



POS.	DESCRIPTION	POS.	DESCRIPTION
1	Compressor	10	Electronic expansion valve (EEV)
2	Crankcase heater	11	Temperature Sensor for EEV
3	High Pressure Switch	12	Check Valve
4	Water Cooled Condenser	13	High Pressure Trasdncer
5	Oil Separator	14	Evaporator
6	Access Valve 1/4"	15	Low Pressure Trasdncer
7	Safety Valve	16	Temperature Discharge Sensor
8	Filter Dryer	17	Condensing Regulation Water Valve
9	Sight Glass	18	Vibration Adsorber
		19	Liquid Receiver

**PAM088F - Air cooled versions (Digit 8 = A), outdoor refrigerating circuit for head pressure control valve installation**



POS.	DESCRIPTION	POS.	DESCRIPTION
1	Compressor	11	High Pressure Trasdncer
2	Crankcase heater	12	Evaporator
3	High Pressure Switch	13	Low Pressure Trasdncer
4	Water Cooled Condenser	14	Temperature Discharge Sensor
5	Access Valve 1/4"	15	Condensing Regulation Water Valve
6	Safety Valve	16	Chilled Water Coil
7	Filter Dryer	17	Chiller Water 2 way Valve
8	Sight Glass	18	Inlet Water Sensor
9	Electronic expansion valve (EEV)	19	Check Valve
10	Temperature Sensor for EEV	20	Liquid Receiver

## Annex B - Mechanical and Hydraulic Connections

Tab. B.1 - PAM connection table

Symbol	Description	PAM010	PAM020	PAM030	PAM060			PAM080			PAM088
		Air cooled	Air cooled	Air cooled	Air cooled	Water cooled	Free cooling	Air cooled	Water cooled	Free cooling	Free cooling
IL1	Refrigerant liquid line inlet circuit 1	O.D. 16mm	O.D. 16mm	O.D. 18mm	O.D. 18mm	--	--	O.D. 22mm	--	--	--
IL2	Refrigerant liquid line inlet circuit 2	--	--	--	O.D. 18mm	--	--	O.D. 18mm	--	--	--
OG1	Refrigerant gas line outlet 1	O.D. 18mm	O.D. 22mm	O.D. 22mm	O.D. 22mm	--	--	O.D. 28mm	--	--	--
OG2	Refrigerant gas line outlet 2	--	--	--	O.D. 22mm	--	--	O.D. 22mm	--	--	--
IWC1	"Water to condenser 1 inlet"	--	--	--	--	Rp 1"1/4 ISO 7/1	Rp 1"1/4 ISO 7/1	--	Rp 1"1/2 ISO 7/1	Rp 1"1/2 ISO 7/1	Rp 1"1/2 ISO 7/1
IWC2	"Water to condenser 2 inlet"	--	--	--	--	Rp 1"1/4 ISO 7/1	Rp 1"1/4 ISO 7/1	--	Rp 1"1/2 ISO 7/1	Rp 1"1/2 ISO 7/1	Rp 1"1/2 ISO 7/1
OWC1	"Water to condenser 1 outlet"	--	--	--	--	Rp 1"1/4 ISO 7/1	Rp 1"1/4 ISO 7/1	--	Rp 1"1/2 ISO 7/1	Rp 1"1/2 ISO 7/1	Rp 1"1/2 ISO 7/1
OWC2	"Water to condenser 2 outlet"	--	--	--	--	Rp 1"1/4 ISO 7/1	Rp 1"1/4 ISO 7/1	--	Rp 1"1/2 ISO 7/1	Rp 1"1/2 ISO 7/1	Rp 1"1/2 ISO 7/1
IFC	Water inlet (Freecooling and dual fluid)	--	--	--	--	--	Rp 1"1/2 ISO 7/1	--	--	O.D. 54mm* R2** ISO 7/1	O.D. 54mm* R2** ISO 7/1
OFC	Water outlet (Freecooling and dual fluid)	--	--	--	--	--	Rp 1"1/2 ISO 7/1	--	--	O.D. 54mm* R2** ISO 7/1	O.D. 54mm* R2** ISO 7/1
HF	Humidifier feed	R ½ ISO 7/1									
HD	Humidifier drain	drain hose I.D. 32 mm									
EC	Electrical power supply	Ø 48 mm									
EC aux	Low voltage cables	Ø 40 - Ø 36 mm									
CD	Condensate Drain	O.D.20mm									

\* Grooved connection;

\*\* Optional. Threaded union on request.

Tab. B.2 - PAM model reference drawing for dimensions and connections

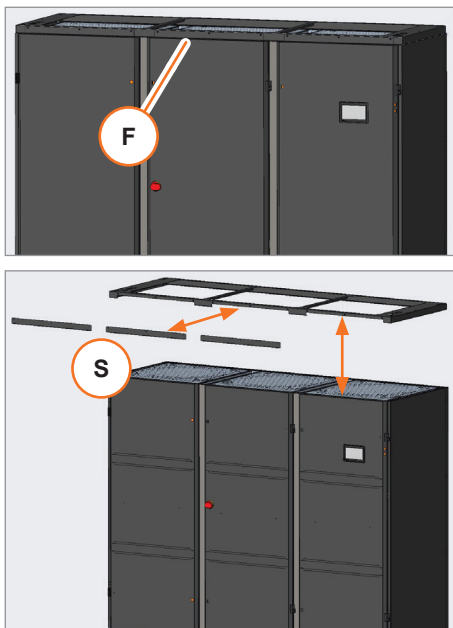
Description	Reference drawing n°
PAM010 A DOWNFLOW	60139934
PAM010 A FRONTAL	60139935
PAM010 A UPFLOW	60139936
PAM020-030 A DOWNFLOW	60140207
PAM020-030 A FRONTAL	60140208
PAM020-030 A UPFLOW	60140209
PAM060 A DOWNFLOW	60139846
PAM060 A UPFLOW	60139847
PAM060 A FRONTAL	60139848
PAM060 W DOWNFLOW	60155616
PAM060 W UPFLOW	60155617
PAM060 W FRONTAL	60155618
PAM060 F DOWNFLOW	60155619
PAM060 F UPFLOW	60155620
PAM060 F FRONTAL	60155621
PAM080 A DOWNFLOW	60139849
PAM080 A UPFLOW	60139851
PAM080 A FRONTAL	60139852
PAM080 W DOWNFLOW	60155622
PAM080 W UPFLOW	60155623
PAM080 W FRONTAL	60155624
PAM080-088 F DOWNFLOW	60155625
PAM080 F UPFLOW	60155626
PAM080 F FRONTAL	60155627

Tab. B.3 - PAM wiring diagrams reference

Description	Reference drawing n°
EP 380-400/3N/50-60 C PAM010 INV	10042960
EP 380-400/3N/50-60 C+H+Hu PAM010 INV	10042961
EP 380-400/3N/50-60 C PAM020 INV	10042962
EP 380-400/3N/50-60 C+H+Hu PAM020 INV	10042963
EP 380-400/3N/50-60 C PAM030 INV	10042964
EP 380-400/3N/50-60 C+H+Hu PAM030 INV	10042965
EP 400/3N/50 C PAM060 FIX+INV	10042966
EP 400/3N/50 C+H+Hu PAM060 FIX+INV	10042967
EP 400/3N/50 C PAM080 FIX+INV	10042968
EP 400/3N/50 C+H+Hu PAM080 FIX+INV	10042969
EP 400/3N/50 C PAM088 FIX+FIX	10052749
EP 400/3N/50 C+H+Hu PAM088 FIX+FIX	10052750

## Annex C - Configurable options

### 1 - Mechanical predisposition (Digit 19 = L)



#### Description

This is a connection flange kit that must be installed on the upper frame of the unit in case any mechanical option or accessory (standard or custom) shall be placed on the top (dampers, extension hood, etc).

When selected, the flange [F] is already mounted on the unit top.

To remove the flange the side panel [S] shall be dismantled to access the fixing screws.

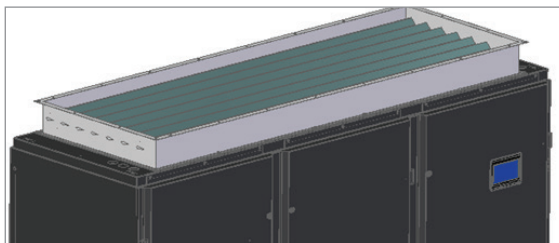
This kit is NOT required for **Upflow** units.

#### For airflow version

**H - Downflow Frontal**  
**D - Downflow Up**

### 2 - Damper options

#### Overpressure damper



#### Description

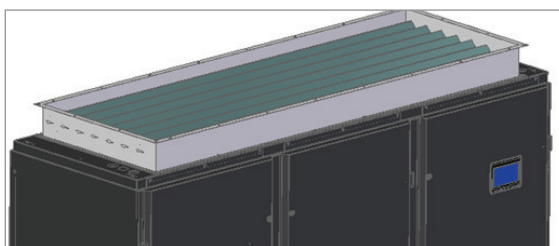
Overpressure damper fitted on the top of the unit, which closes in case of lack of airflow exploiting gravity effect.

This option avoid air flow inside the unit when fans are not running.

#### For airflow version

**U - Upflow**

#### Motorized damper - Motorized Damper with spring return



#### Description

This option require the mechanical predisposition (**Digit 19 = H**).

A motorized damper with servomotor is fitted on the top directly controlled by the unit.

In case of power failure, the spring return allows the damper to close, therefore avoiding air passing through a not working unit.

The unit controls the damper in the safest way managing fans depending on damper position.

Requires the mechanical predisposition (**Digit 19 = H**).

Previous option can be supplied with spring return design (standard is normally close position).

#### For airflow version

**U - Upflow**  
**H - Downflow Frontal**  
**D - Downflow Up**

### 3 - Control and Display Hardware options

#### Small LCD Display



It's a semi-graphic LCD monochromatic terminal with 132 x 64 pixel resolution, LED backlighted. It provides six buttons to navigate through the screen; a red LED indicator and an audible signal generated by a buzzer activate in case of alarm/warning.

Connection to the controller is available via dedicated **RJ11** serial port. It can be installed as an alternative to 7" touchscreen display (**Digit 13 = 7**).

#### Alarm card



An alarm board is fitted, allowing remote monitoring of the main alarms from the unit via Volt-free contacts (up to 6). The outputs (all together) can be set to N.O. (normally open) or N.C. (normally closed).

#### Ethernet switch



Ethernet Switch with five **RJ45** ports and LED indicators is installed in the electrical panel.

#### Static pressure control



Unit can be equipped (or predisposed) for a pressure transducer through which fan speed is modulated to keep static pressure constant. The following options are possible.

- Unit equipped with differential pressure sensor 0-200 Pa;
- Fan Module predisposition for a pressure sensor 0-200 Pa;
- Unit equipped with differential pressure sensor 0-50 Pa;
- Fan Module predisposition for a pressure sensor 0-50 Pa.

In case multiple units are connected in teamwork, they share pressure sensor data to provide greater flexibility, visibility, and control. User can decide to control the fans on the average reading collected in the sensor network. In case of failure, system can work until only one sensor is available. Refer to instruction manual 10098382MAN\_ENG.

### 4 - Control software options

#### FAST RESTART

The '**fast start**' software feature is enabled.

Compressor minimum **OFF** Time is reduced to **10** seconds for variable speed compressors and **0** seconds for fixed speed (standard value is in both cases **180s**). Activation delay between tandem compressors or different circuits is reduced to **8** seconds and no other delays are considered.

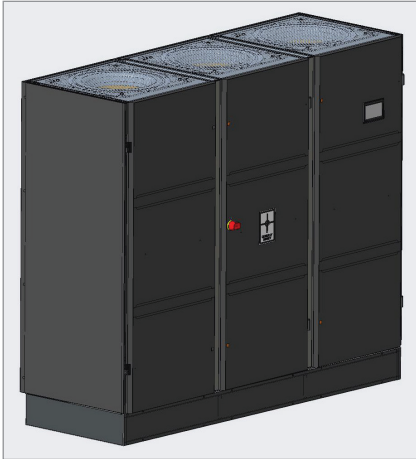
#### ATS STATUS

iCOM™ control can monitor which is the line that supply power to the unit, reading status position of the **ATS**.

# Annex D - Configurable accessories - Supplied loose when selected, ready to be installed on field

## 1. Mechanical accessories

### Base module

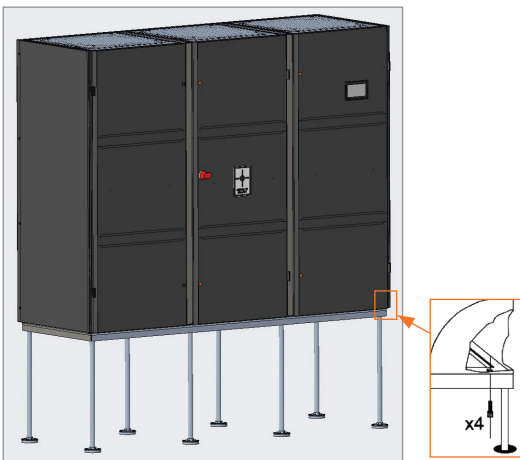


**Purpose** This accessory has been developed for unit with **Upflow** or **Downflow frontal** air delivery configuration (**Digit 7 = U or H**).

**For airflow version** **U - Upflow**  
**H - Downflow frontal**

**Available height** It's a 200 mm high base module that can be installed on the bottom of the cabinet to allow services (pipes, cabling, etc.) to enter the base of the unit when a raised floor is not installed.

### Base frame with antivibrations dampers

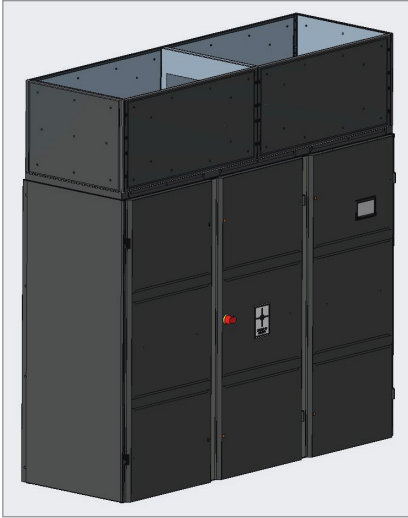


**Description** This accessory is for unit with **Downflow Up** air delivery configuration (**Digit 7 = D**) and can be used to support unit when installed with a raised floor.

**For airflow version** **U - Upflow**  
**H - Downflow Frontal**  
**D - Downflow Up**

**Available height** It consists of a leg kit with adjustable height from 120 to 800 mm, to be installed on the bottom part of the unit.

## Vertical flow extension hood (plenum)



### Description

Plenum is an additional duct on the unit top, fixed by screws (not supplied) that simplifies the connection to the ceiling or to other equipment making easier to realize cold/hot containment configurations. The plenum has the same design of the cabinet and comprises of sandwich panels lined with non-flammable insulation material of class 0 (ISO 1182.2).

When plenum is selected in units with **Downflow Frontal** or **Downflow-Up** air flow configurations (**Digit 7 = D or H**), top flange kit is required (mechanical predisposition **Digit 19 = L**).

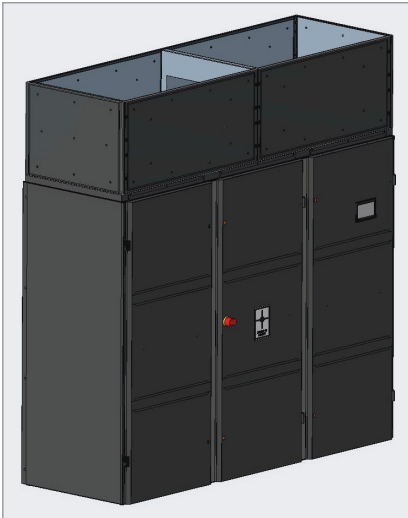
### For airflow version

**U - Upflow**  
**H - Downflow Frontal**  
**D - Downflow Up**

### Available heights

It can be supplied as an accessory with different heights: 500 - 600 - 700 - 800 - 900 mm

## Vertical flow extension hood with damper



### Description

Accessory similar to the vertical flow extension hood, but available with a standard height of 600 mm and equipped with a motorized damper.

### For airflow version

**U - Upflow**  
**H - Downflow Frontal**  
**D - Downflow Up**

## Horizontal hood with grill

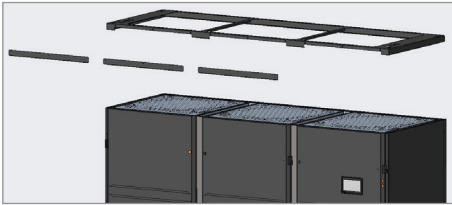


**Description** This plenum is for unit with **Upflow** air delivery configuration (**Digit 7 = U**).

This accessory can be installed on top of the unit., with 600 mm height horizontal air flow delivery through a double deflection grill.

**For airflow version** **U - Upflow**

## Predisposition kit for plenum



**Description** This accessory is identical to the mechanical predisposition option of the frame. (**Digit 19 = L**), that allows the fitting of an accessory on the top of the cabinet.

It's already included when a standard extension hood is configured, but may also be ordered apart for installation of custom hoods.

Additional mechanical accessories that can be ordered for the startup are the following ones:

- Check valve kit for outdoor remote condenser;
- Replacement kit for unit filters.

## 2. Monitoring and control accessories

### Smoke detector



The smoke detector senses the room air, shuts down the unit upon detection, and sends visual and audible alarm.

Dry contacts are available for a remote customer alarm. This smoke detector is not intended to function as or replace any room smoke detection system that may be required by local or national codes.

## Liquistat leak detector



The kit comprises of a single point sensor made up of a corrosion-proof metal covering, with access to the two terminals for connecting the line. The flooding alarm detects the presence of water or of any other conductive liquid and activates an alarm. Up to 5 sensors can be connected to the same flooding alarm device to control many points in the room.

## Liqui-Tect™ 410 leak detector



The **Liebert® Liqui-Tect™ 410 (LT410)** is a leak spot detector that provides double-point detection of leaks. The sensor has two gold-plated sensing probes to prevent corrosion and to provide accurate readings. Mounting brackets allow for sensor height adjustment and leveling. Two independent outputs grant flexibility with the capacity to provide two independent signals.

## Liqui-Tect™ 460 leak detector



The **Liebert® Liqui-Tect™ 460 (LT460)** is a leak zone detector, that provides zone detection of leaks, protecting equipment by constantly monitoring the area for leaking liquids.

The **LT460** is the ideal solution for perimeter sensing or serpentine coverage of areas requiring up to 100 feet of LT500Y leak detection cable. Two independent outputs grant flexibility with the capacity to provide two independent signals.

## Kit Remote Display



Kit including a touch-screen display, designed to control multiple units equipped with iCOM™ controllers and connected in the same Ethernet Network. The kit comprises of a wall-mount ready box. Power supply for all models is 230 Vac, through Schuko socket.

Two alternatives available: touchscreen display 7" and 10".

Additional control and monitoring accessories that can be ordered for the startup are the following ones:

- Modbus cables, from 25 m to 100 m long with wire cross section 0.75 mm<sup>2</sup>;
- Temperature and humidity sensors.

# Annex E - Dimensions and weights

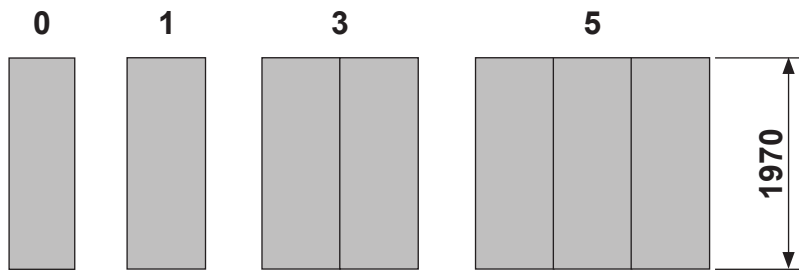
Table E.1 – PAM overall dimensions

PAM model	Frame Type	Unit without package			Digit 22 = C Unit with standard package			Digit 22 = C Unit with wooden crate			Digit 22 = S Unit with seaworthy crate		
		W	D	H	W	D	H	W	D	H	W	D	H
		PAM010	Frame 0	750	750	1970	830	820	2140	932	922	2218	927
PAM020	Frame 1	844	890	1970	924	960	2140	1026	1062	2218	1021	1056	2395
PAM030	Frame 1	844	890	1970	924	960	2140	1026	1062	2218	1021	1056	2395
PAM060	Frame 3	1750	890	1970	1830	960	2140	1932	1062	2218	1926	1056	2395
PAM080	Frame 5	2550	890	1970	2630	960	2140	2732	1062	2218	2726	1056	2395
PAM088	Frame 5	2550	890	1970	2630	960	2140	2732	1062	2218	2726	1056	2395

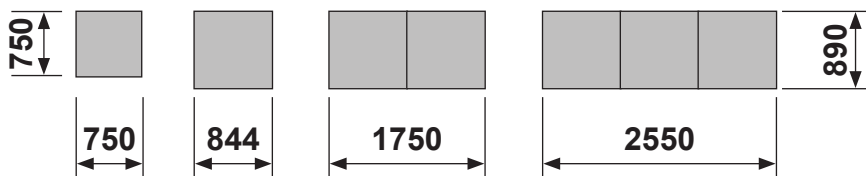
## Overall dimensions

### Standard units

Front view

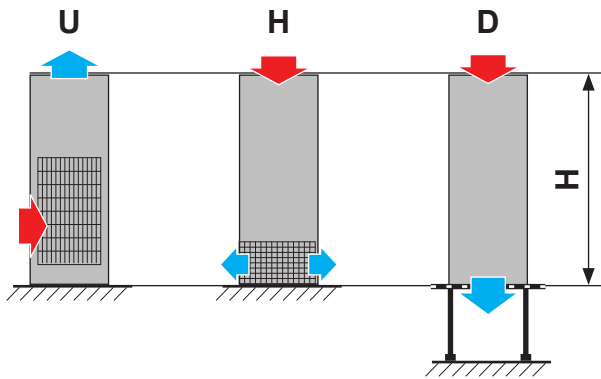


Top view



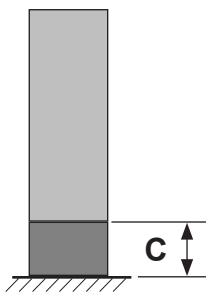
The figure above shows the dimensions of the standard units, by frame type, without any accessory.

## Height from the floor



Standard [H] = 1970 mm

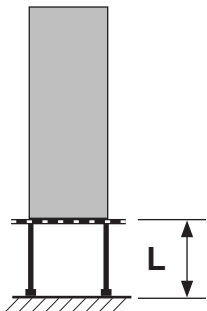
## Height of the accessories at bottom



**Base module**

Height [C]:  
- 200 mm

U - Upflow  
H - Downflow Frontal



**Legs kit**

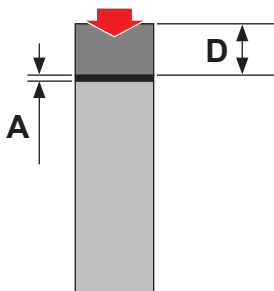
The height [L] is adjustable within the following ranges:  
- 30–370 mm  
- 370–570 mm  
- 570–800 mm

**Base frame**

The height [L] is adjustable within the following range:  
- 120–800 mm

D - Downflow Up

## Height of the accessories on top



**Connecting flange**

Height [A] 50 mm

(accessory needed to mount other accessories on top of the unit)

**Accessory on top of the unit**

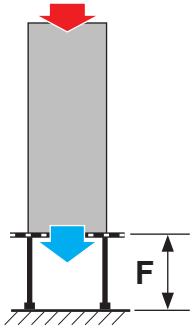
Height [D]: see the table below.

H - Downflow Frontal  
D - Downflow Up

Accessory	Height D [mm]	+ Height A of connecting flange [mm]*
Vertical flow extension hood	500 - 600 - 700 - 800 - 900	50
Motorized damper	150	50
Plenum with Damper	600	50
Horizontal hood with grid	600	50

\* For **Downflow Up** and **Frontal** air delivery.

### Free space from the floor

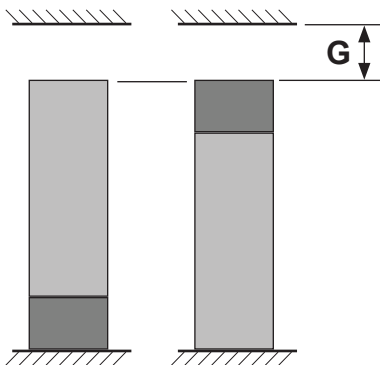


Free space [F] between the bottom of the unit and the floor

- Maximum: 800 mm, which is the maximum available height for the base frame or legs kit (see above).
- Minimum to obtain the declared performances: 600 mm
- Minimum allowable to obtain the minimum working conditions: 300 mm

D - Downflow Up

### Free space from the ceiling



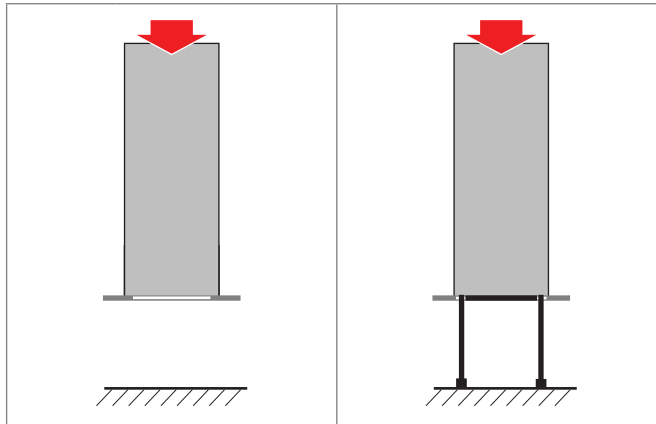
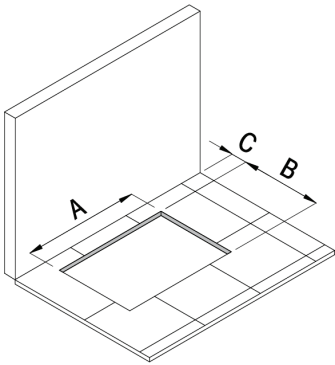
Free space [G] between the ceiling and the unit top, including any accessory mounted on top or bottom



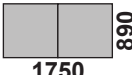
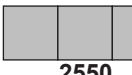
- Minimum to obtain the declared performances: 600 mm
- Minimum allowable to obtain the minimum working conditions: 300 mm

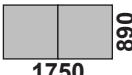
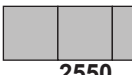
H - Downflow Frontal

D - Downflow Up

## Hole in the floor for Downflow versions



Frame type for UHD A	No accessories for support			With base frame		
	A [mm]	B [mm]	C [mm]	A [mm]	B [mm]	C [mm]
0  750 750	650	620	70	714	690	30
1  844 844	740	760	70	804	830	30
3  890 1750	1650	760	70	1726	840	30
5  890 2550	2450	760	70	2526	840	30

Frame type for UHD W-F	No accessories for support			With base frame		
	A [mm]	B [mm]	C [mm]	A [mm]	B [mm]	C [mm]
3  890 1750	1650	760	70	1726	840	30
5  890 2550	2450	760	70	2526	840	30

## Units Weight

Unit Model		Unit Weight [kg]	Packaging Weight* [kg]
PAM010	UHD A	285	17
PAM020		354	19
PAM030		363	19
PAM060		730	28
PAM080		937	42
PAM060	UHD W	749	28
PAM080		1027	42
PAM088		--	--
PAM060	UHD F	832	28
PAM080		937	42
PAM088		1113	42

\* Standard package with wooden crate, with or without seaworthy package





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