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Lindab **Pascal Water**

Design manual for water systems

Lindab®

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Pascal Water introduction

Picture 1. Open office, Professor active chilled beam installed with integrated lighting.

Pascal Introduction

The request for Demand controlled ventilation (DCV) systems in modern construction is increasing and with good reason. DCV systems in general save a lot of the energy used for transportation and cooling of air.

Active chilled beam (ACB) systems combine the advantages of a water based system with the means to supply fresh air into a room.

ACB´s use water to effectively regulate room temperatures with a high level of precision, and create a perfect indoor climate with fresh air, low sound levels and optimum comfort.

Water is a much better energy carrier than air.

Pascal water lets you take control

Pascal water is a demand controlled indoor climate system for the room. The core of the Pascal water system is a Lindab active chilled beam, an already energy efficient device for comfortable indoor climate and low energy use.

An ACB that already combines ventilation, cooling and heating will be equipped with a presence sensor and Regula Pascal Connect to fit into a Pascal system.
External lighting controlled by the Pascal system is an optional feature.

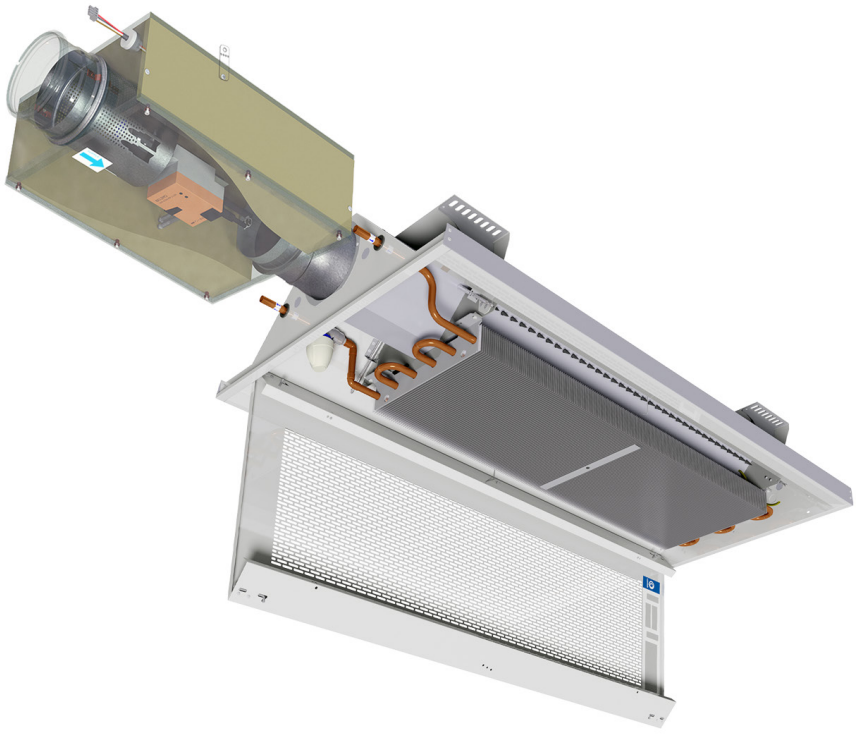
Pascal Water functionality

Pascal Water functionality

Lindab Pascal is a known solution that makes it more simple to fulfill the needs for a well functioning DCV system.
The solution is basically based on airflow regulation, which makes it a variable pressure system. Unlike constant pressure systems, the ventilation duct design is of less importance and the need for regulation equipment is less.
With a variable pressure system it is possible to obtain correct airflows in all parts of the system and in all operating conditions.

The DBV unit is in the heart of Pascal Water which regulates each chilled beam or diffuser in the system to the correct airflow. The unique linear cone damper technology of DBV unit, which makes it possible to handle up to 200 Pa with a low sound level, combined with an integrated actuator with precise airflow measurement, eliminates the need for any other regulation equipment between the fan and the chilled beam. One DBV unit makes a Lindab standard active chilled beam become a part of a DCV system.

The system is controlled by Regula units, where all settings and parameters can easily be adjusted. All components used in the system are delivered with standard settings from factory and can easily be adjusted and commissioned after installation. With a few standard components, no special requirements for duct design and a flexible system set up, Pascal makes designing, installation and commissioning much easier.
In order to maximize the use of free cooling, the system first regulates the air to the designed air volumes and afterwards regulates the water flow rate up to full power. This will also maintain a good indoor air quality by minimizing downdraughts.
In order to avoid unnecessary cooling of supply air, when outside temperature is higher than the supply air temperature, unoccupied rooms are first chilled by the water system.
In heating mode water and air are regulated in parallel, which means that a minimum of air have to be transported.
In order to use the lowest possible fan energy, there is always an open duct between air handling unit and the room where the highest pressure drop occurs.



Picture 2. Premum chilled beam with DBV box. Here shown with the box and beam open.

Pascal Water flexibility

Picture 3. Meeting room, active chilled beams Plexus with seperate regulated lighting.

Architectural flexibility

As with our other chilled beams a Pascal Water solution offers a lot of architectural freedom and easy adaption to future room usage. Pascal Water can of course be used together with a traditional wall-mounted radiator system, but it can also replace the radiator system and be the main heating unit in the room. Pascal Water makes the use of partitioning glass walls, glass facades and unrestrained door and window placement possible, without having to consider the limits that the piping of a conventional radiator system puts on the interior architecture.

Flexibility in changing conditions

Pascal Water is a simple but at the same time intelligent ventilation system.

The system automatically adapt to any new situation such as rebuilding, additional building or new (costumer-)demands.

Pascal Water energy

Low energy use and added sustainability

The use of different environmental and energy classification rankings as LEED, BREEAM, Green Building and Green Star are steadily on the rise. The reason for that is simple, both societies, owners, tenants and users want buildings that combine a good indoor climate with low energy use and a sustainable performance.

Letting Pascal Water manage the room's ventilation, cooling, heating and lighting means an improved energy and environmental ranking and of course happy and satisfied tenants. Pascal combined with an active chilled beam is also the ideal indoor climate system when sustainable energy sources are used – heat pumps, free cooling from sea- or groundwater and surplus heating. Utilizing the Pascal potential to its maximum, and combining it with the use of renewable energy sources, will make a substantial and a positive difference in these types of rankings.

Individual supply systems

Daily office work requires that we are flexible and mobile. Did you know that on average an office workspace is vacant 30-50 % of the working time? Supply systems for ventilation, cooling, heating and lighting, have to be adapted whether an individual employee is present or not. This means that the system consumes equally as much energy regardless if people are present or not. In other words, we have a large savings potential if we can adapt the supply systems to the individual.

Picture 4. Canteen, Professor with integrated lighting.

With Lindab's Pascal Water we have gathered the best energy saving technologies, Chilled beams and VAV. We do not only secure the best possible indoor climate when working, but also make sure to optimize energy consumption when you are off work. In a normal case, this saves 12 % on energy consumption compared to conventional chilled beam application. If lighting control is optional included the energy savings are higher.

Lindab will contribute to a better world by optimizing energy use in conditioned commercial buildings by demand control. Lindab's Pascal solution adapts to the change in energy demand and uses less energy than common systems without affecting the high comfort quality when you are present.

For todays and tomorrows needs

Demand controlled activity means lower energy use. With its intelligent sensor and control devices the Pascal water system is an excellent choice for low energy use and environmental awareness. When entering the room the presence sensor detects human presence and brings the supplying systems to the preset normal level. This means fresh ventilated air and cooling or heating to meet your requirement for a good indoor climate. The presence sensor can also activate the lighting. After leaving the room the system adjusts ventilation and cooling/heating to the preset low energy values and turns off the light. Pascal water has acted as the intelligent energy saver it is.

Energy simulations for Pascal system

In an earlier study carried out by SBi/Aalborg university comparing Pascal Water and a conventional chilled beam system with constant air volume (CAV).
The study showed 12% energy savings using Pascal Water when 50% of the building were occupied.
For further infomation about the study please contact the local Lindab office.

	Conventional (kWh/m²)	Pascal (kWh/m²)
Heating Water	20.08	17.23
Cooling Water	27	25.1
Heating Air	0.35	0.26
Cooling Air	0.49	0.49
Pump	0.23	0.03
Fan	0.98	0.35
Total	**49.13**	**43.46**

Table 1. Energy use in a building with conventional CAV-ACB system and Pascal Water solution.

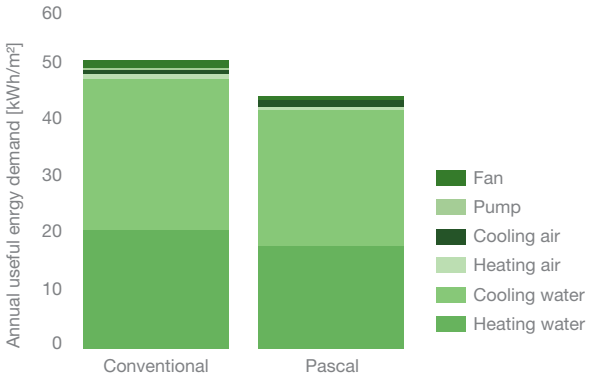


Diagram 1. Total energy use in a building with conventional CAV-ACB system and Pascal Water solution.

Pascal Water system description

System description

Dynamic active chilled beams
- Integrated or exposed active chilled beams.
- Used in combination with motorized VAV unit DBV or FTCU/VRU.
- Dynamic work area 0-100 % airflow.
- Low airflows with high under temperature without drafts.
- Integrated presence sensor for demand control.

Demand control
- Integrated presence sensor in active chilled beams.
- Standby airflow at non-occupancy in room.
- Light control at non-occupancy is possible via relay function.

Airflow regulation
- Variable pressure system secures correct airflows at all time.
- Flow measurement and regulation in DBV unit and FTCU/VRU.
- Supply unit DBV unit handles up to 200 Pa with low sound level.
- No need for balancing dampers between fan and active chilled beams.
- Easy wiring with Regula Connect on DBV unit.

Room regulation
- Temperature controller with flexible parameters.
- CO_2 regulation possible.
- Presence control possible.

Extract control
- Regula Master controls extract FTCU/VRU to obtain balance.
- No need for flow measurement in ducts for master /slave function.
- Possible to add constant flow factor.
- Possible to programme flow difference for under / overpressure.
- ERC(VRU) converts Exoline signal to 0-10 V flow signal to extract damper.
- EUC (FTCU) controls directly on Exoline signal from LRM/SRM.

Communication
- Exoline BUS communication between Regula Combi and Regula Master units.
- Exoline BUS communication to overall BMS system.
- Possible to communicate with other systems to overall BMS system via modbus or exoline.

Fan optimizer
- Regula Master register all damper positions in system.
- Optimizes fan speed to minimize energy consumption.
- Secures minimum one damper is 85% open.

Operating control
- Regula Master register damper movements in system.
- Regula Master alert is given if no damper movement.

Designing step by step

Designing a Pascal system is simple and can be done in few steps, as listed below here.

Details of each step follow on this page and a number of design principles can be found on the following pages.

1. Define room solution
   - Select numbers of Supply Regula Combi.
   - Select if demand control shall be used.
   - Select supply regulation type.
   - Select active chilled beam and/or diffuser type for supply air, dimension and placement.

2. Define extract strategy
   - Select extract principle.
   - Select extract diffuser type, dimension and placement (check integration of extract in chilled beam).
   - Define extract control and place VRU dampers.
   - Secure extract balance on floor level.

3. Define system layout
   - Identify system size.
   - Select numbers and placement of Single or Local Regula Master (SRM/LRM).
   - Select numbers of Global Regula Master (GRM).

Premises for the system

To achieve a well-functioning DCV system with Pascal a few premises should be met:

- One volume flow regulator must be between the fan and the active chilled beams in the system.
- Working pressure in the system must be below 200 Pa (calculated after AHU silencers).
- For systems with a working pressure exceeding 200 Pa, pressure limitation must be established on a zone level.
- Active chilled beams require a minimum of 30 Pa static pressure (check design criteria for ACB).
- ACB with JetCone setting should be according to the actual airflow rate setting of the DBV.

Designing a Pascal Water system

Room solution

Supply Regula Combi

The Pascal Water system regulates the room temperature by using a standard Supply Regula Combi (SRC) room controller in each room. More Supply Regula Combis are feasible for multiple temperature zones, for example in landscape offices.

Demand control

Presence control and/or CO_2 are optional. Both are available for external control by connecting demand control sensors to the Supply Regula Combi (SRC), typically via the Regula Connect Pascal card placed on the ACB, the DBV, or the FTCU/VRU.

Supply regulation

For hotel rooms, single offices, small open offices and similar room types a solution with regulation directly in front of the ACB will mean a DBV unit is needed. For large offices or other rooms with a large number of supply diffusers a solution with FTCU/VRU regulation in the supply duct can be chosen.

Note that using a FTCU/VRU solution may require installation of a SLU after the FTCU/VRU.

Active chilled beams

Choose the desired Pascal active chilled beam type, e.g. with integrated presence sensor and select the right size, according to technical data or Waterborne calculator on www.lindQST.com. Active chilled beams should be placed properly in the room to meet the given comfort demands in the room. Room calculations could be made in Lindab´s Indoor climate designer on www.lindQST.com.

Extract strategy

Extract principle

Extract in the rooms can be done by a central extract regulation, integrated extract in active chilled beam (depending on type/model), using overpressure valves or an extract diffuser placed in the room. For a room balanced solution extract dampers can be placed in the ducts into the rooms, controlled either by a parallel signal from Supply Regula Combi (SRC) or controlled by Regula Master. A Regula Master Pascal unit can handle up to 16 extract units.

Extract diffuser

Choose the desired extract diffuser type according to the chosen extract principle and select the right dimension, according to technical data.

Extract integrated in active chilled beam

Depending on active chilled beam type, model and size it might be the best solution to integrate the extract device invisible into the chilled beam.

Extract control

Define which supply units that affects which extract units and place the necessary FTCU/VRU dampers. Regula Master Pascal will register actual supply airflows in all selected rooms and control the corresponding extract units.

Extract balance

For a total balance of supply and extract on a floor level, areas with constant extract flow have to be considered. Typically the replacement air is taken from nearby rooms, therefore this can be corrected in the extract regulation of the given rooms, to secure a total balance.

System layout

System size

For small systems (up to 26 rooms) a Single Regula Master (SRM) can handle all the regulation of the system. For larger systems main unit must be a Global Regula Master (GRM) controlling up to 8 Local Regula Master (LRM) up to 8 x 26 rooms. For even bigger systems a number of GRM can be connected in cascade to control an unlimited number of rooms.

Local Regula Master (LRM)

In systems with LRM the placement of the units should be close to the units it shall control. But also an appropriate wiring should be taken into account when choosing numbers and placement of LRM.

LRM shall therefore be physically placed on the floor level, typically placed in a secondary room.

Global Regula Master (GRM)

GRM shall be placed close to the fan, since it has to control the fan speed.

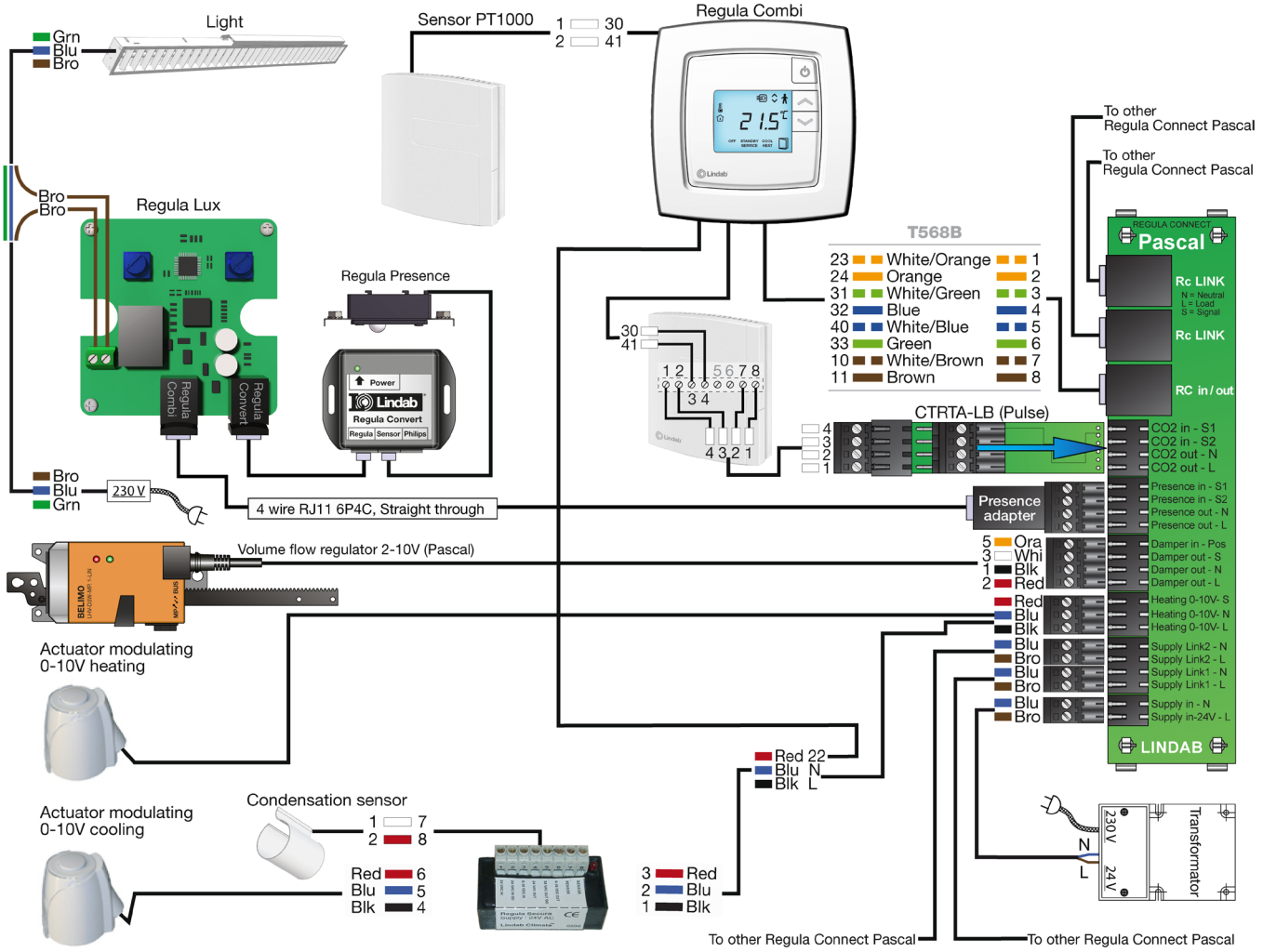
Pascal Water components

Which Lindab water products can be combined with Pascal Water

Principally, all Lindab ACB´s can be combined with Pascal water solution easily. For passive chilled beams (PCB´s) or radiant panels a combination with a ventilation system gives biggest benefit. It could be also integrated in existing systems. Specific features need to be taken into account; E.g. possibilities to integrate valves/actuators, extract valve or lighting.

ACB:	Architect, Celo, Munio, Plafond, Plexus, Premax, Premum and Professor XP.
PCB:	Carat
Radiant Panels:	Atrium Plana, Atrium and Loggia.

The best general overview you have with our "Product Overview Waterborne". More details you find in our specific product data sheets.
See all wiring configurations on www.lindQST.com.



Picture 5. Pascal Water, Schematic. Visit www.lindQST.com and use the "wiring scheme configurator" to design your own system and explore the many connection possibilities, such as CO_2 sensors, presence sensors etc.

Pascal Water system components

Component overview

	Product	Description	Function
Active chilled beams (ACB)	Premum, Premax, Plexus, Munio, Architect, Professor XP, Celo, Plafond (-P)	Active chilled beam with integrated presence sensor (-P)	• Dynamic active chilled beam to handle 0-100% airflow rate without drafts. • Presence sensor (-P) Indicates absence in room for lower airflow.
	Premum, Premax, Plexus, Munio, Architect, Professor XP, Celo, Plafond	Active chilled beam	• Dynamic active chilled beam to handle 0-100% airflow rate without drafts.
Active and passive plenum boxes	MBBV/MBV	Active plenum box with airflow rate regulation	• Airflow rate controlled by SRC. • Regulates airflow regardless of pressure. • Handles up to 200 Pa with low sound level. • Max. 10 pcs. per Regula Combi.
	MB	Passive plenum box with several damper options	• Manually balancing of airflow rate. • Handles up to 200 Pa with low sound level. • Several damper options.
	DBV	Active plenum box	• Airflow regulator which is placed before an active chilled beam. • Handles up to 200 Pa with low sound level.
Airflow measure eqiupment	VRU/VRA	Airflow regulator	• Airflow controlled by SRC / ERC. • Max. 10 pcs. per Regula Combi.
	FTCU	Ultra link	• Airflow controlled by SRC. • Max. 10 pcs pr SRC. • Used as EUC in extract, 1 FTCU = 1 EUC.
	FTMU	Airflow & Temperature Measuring (Ultralink)	• Measure airflow rate very accurat with ultra sound.
Regula and communication equipment	GRM/SRM	Global Regula Master / Single Regula Master	• Collects damper positions from all LRM. • Controls fan speed to minimize energy consumption.
	LRM	Local Regula Master	• Collects airflows and damper positions from SRC. • Controls ERC airflow based on SRC values. • Communicates all damper positions to GRM. • Performs operating control.
	SRC	Supply Regula Combi	• Room control with temperature regulation. • Control of supply airflows in MBV/DBV or FTCU/VRU. • Communicates airflows and damper position to SRM/LRM. • Max. 26 pcs. per SRM/LRM.
	ERC	Extract Regula Combi	• Control of extract airflow in VRU. • Communicates damper positions to LRM/SRM. • Max. ERC/EUC 16 pcs. per SRM/LRM.
	EUC	Extract Ultralink Controller	• A FTCU connected directly to SRM/LRM.
	Exoline RS485/Exoline TCP	BUS communication	• Communicates parameters between SRC / ERC and LRM / GRM
	2-10 V flow	Flow signal	• Controls airflows from SRC / ERC to MBB / DBV / VRU / FTCU.
	2-10 V position	Damper position signal	• Indicates damper position from MBV/DBV/FTCU/ VRU to SRC/ERC.
	TCP, Modbus, BACnet, EXOline	Bus commuication	• Communication to BMS.
Sound attenuators	SLU	Silencer	• Attenuates sound generated in VRU.
Sensors and accessories	CO_2	CO_2 sensor	• Indicates CO_2 level in the room.
	RH	Humidity sensor	• Indicates RH level in the room.
	PIR	Presence sensor	• Indicates occupancy in the room.
	TEMP	Temperature sensor	• Indicates temperature in the room.
	APR	Actuator for water valves	• 0-10 V or 24 V on/off.

Table 2. Component overview

Pascal system description

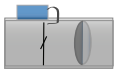
System description

All solutions described in the design manual chapters are based on Pascal program 8 (Pascal Water). This is a standard supply program in Regula Combi. For extract with ERC program 7 is used. For EUC no program setting is needed.
All general setting for the Pascal system can be done via the web configuration tool Pascal Operate, which is a integrated part of Regula Master HTML.

Symbol and cable overview

FTMU
Airflow & temperature measuring (Ultralink)

FTCU / EUC (FTCU)
Airflow regulator & temperature measuring (Ultralink)

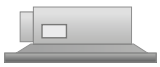


VRU
Airflow regulator

Sound attenuator

MBV with ceiling diffuser
Plenembox, Airflow regulator

DBV
Straight through plenumbox, Airflow regulator

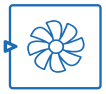


ACB
Active Chilled Beam

OLR
Pressure control valve

Water actuator

Room controller



Supply fan
Extract fan

Extract airflow

Supply airflow

Presence sensor

Humidity sensor

CO_2 sensor

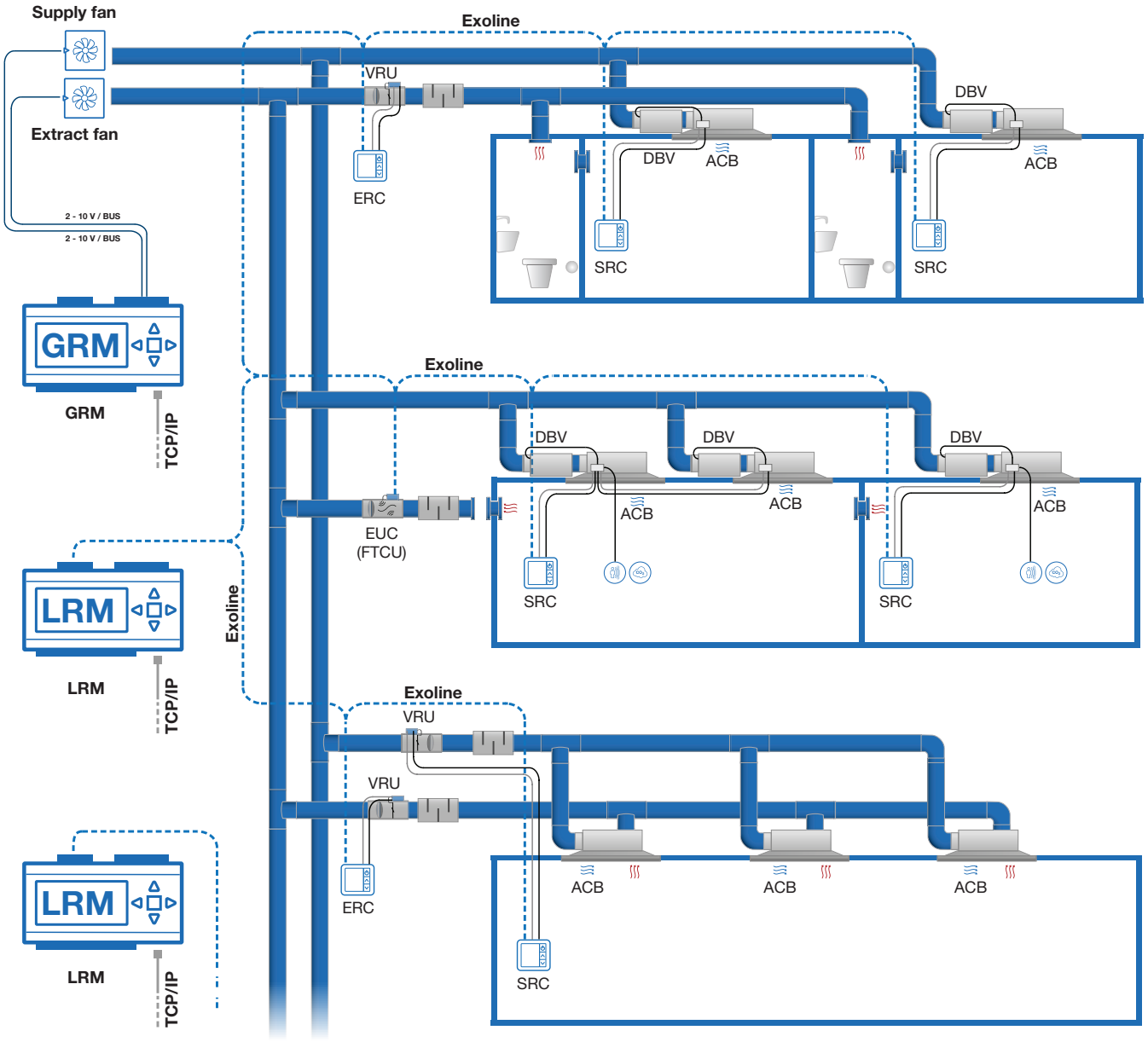
Temperature sensor

2-10 V flow signal

RJ45 data cable

Exoline RS485/Exoline TCP,
Bus communication

System description



Picture 8. Pascal Water system drawing

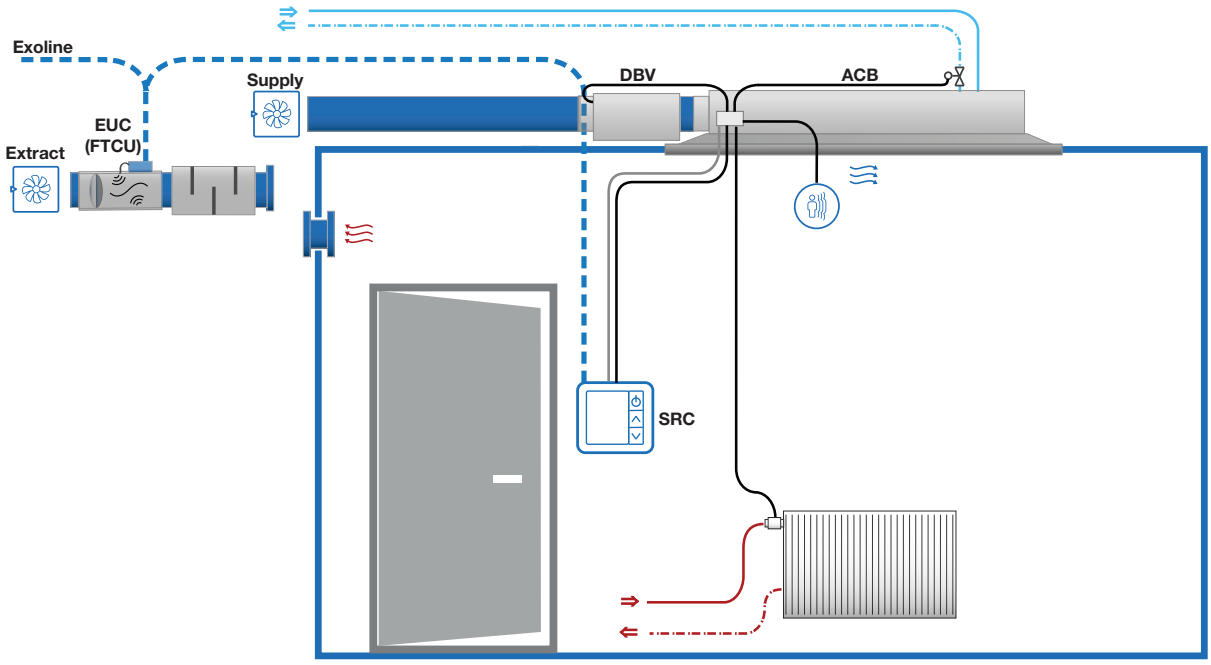
Pascal Water design manual

1. Single office solution

In this office an active chilled beam compined with a DBV unit is installed in the supply air system. For the extract different strategies are available. In general extract could be balanced in each room by FTCU or VRU combined with a diffusers or centrally combined with overflow valves. In case of absence, all the supply systems regulated by Pascal will be set to a minimum level (stand-by). This means, that lighting is off and fresh air is set to the desired minimum level. When there is absence, the Regula Combi controller enters stand-by mode which also means that the temperature has been allowed to slide relative to the setpoint value to reduce the need for cooling/heating. When a person enters the room Pascal turns into occupied-mode, light turns on, ventilation damper opens (DBV) and the Regula Combi will reduce the dead zone and regulate cooling/heating to reach the desired temperature. When the room is empty again, Regula Combi will return to the stand-by mode after 30 minutes adjustable. If the temperature in the room during absence would slide outside the expanded dead zone, the airflow from DBV will be increased. When DVB reaches the maximal allowed airflow, then the cooling valve will start open. For heating it is opposite.

1.1 Active chilled beam and heating via seperate radiator

Supply: **Demand controlled regulation with DBV unit and presence sensor**
Extract: **Central regulation with overpressure valve**



Picture 9. Single office: ACB and heating via seperate radiator.

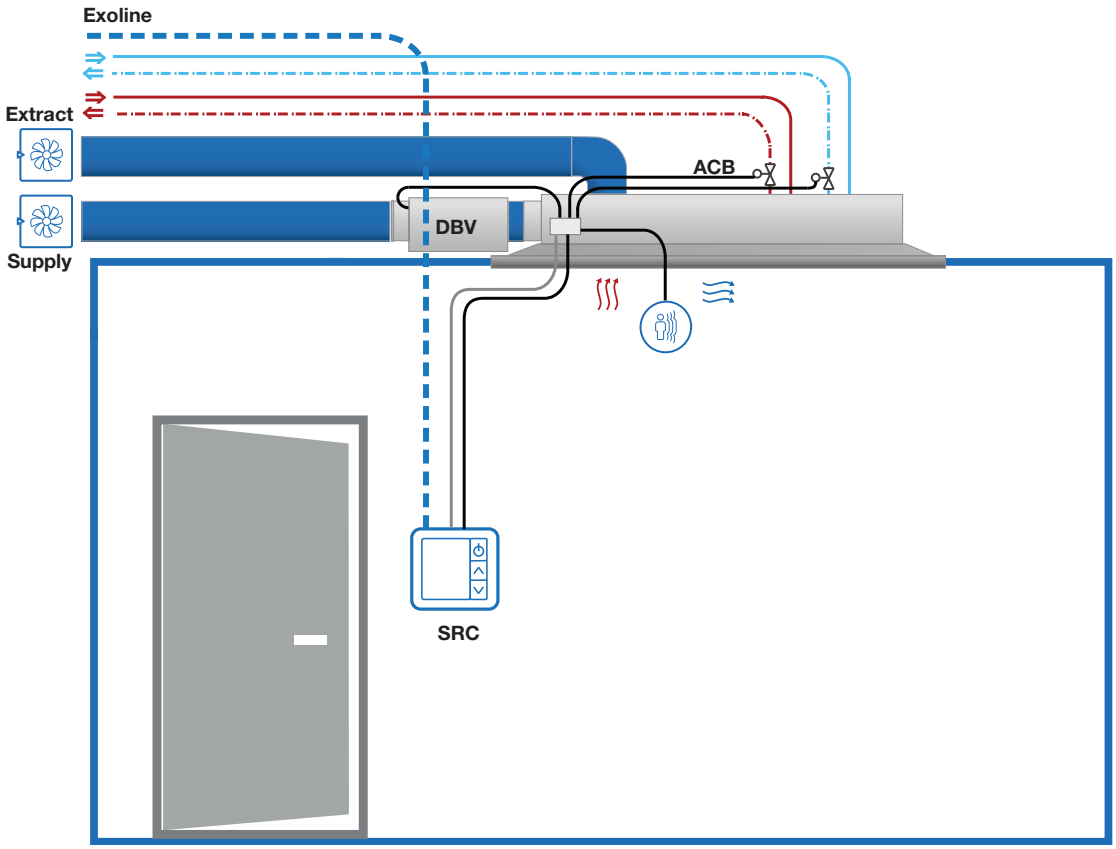
- SRC measures actual room temperature.
- Integrated presence sensor detects occupancy in room (optional).
- SRC gives 2-10 V flow signal to DBV unit according to room temperature.
- At unoccupancy in room SRC regulates DBV unit to “standby mode”.
- DBV unit regulates the correct required airflow rate regardless of pressure.
- Multiple DBV unit controlled by same SRC can be wired with parallel signal.
- DBV unit indicate actual damper position to SRC by a 2-10 V position signal.
- SRC communicates airflow rate and actual damper position to LRM/SRM.
- If additional cooling/heating is required SRC gives 2-10 V signal to either heating valve or cooling valve.
- Extract controlled centrally in corridor.
- Extract from room via overpressure valve.

NOTE:
Extract from room can also be realized via a seperate extract diffuser or extract integrated in the beam.
Without a presence sensor, the standby mode can by activated on SRC manually.
Without the presence sensor, the room can also be regulated according to temperature by the internal temperature sensor in the SRC.
By adding a CO_2-Sensor the CO_2 level can control the DBV unit.

Pascal Water design manual

1.2 Active chilled beam with integrated heating

Supply: **Demand controlled regulation with DBV unit**
Extract: **Central regulation with extract integrated in the ACB**



Picture 10. Single office: ACB with integrated heating

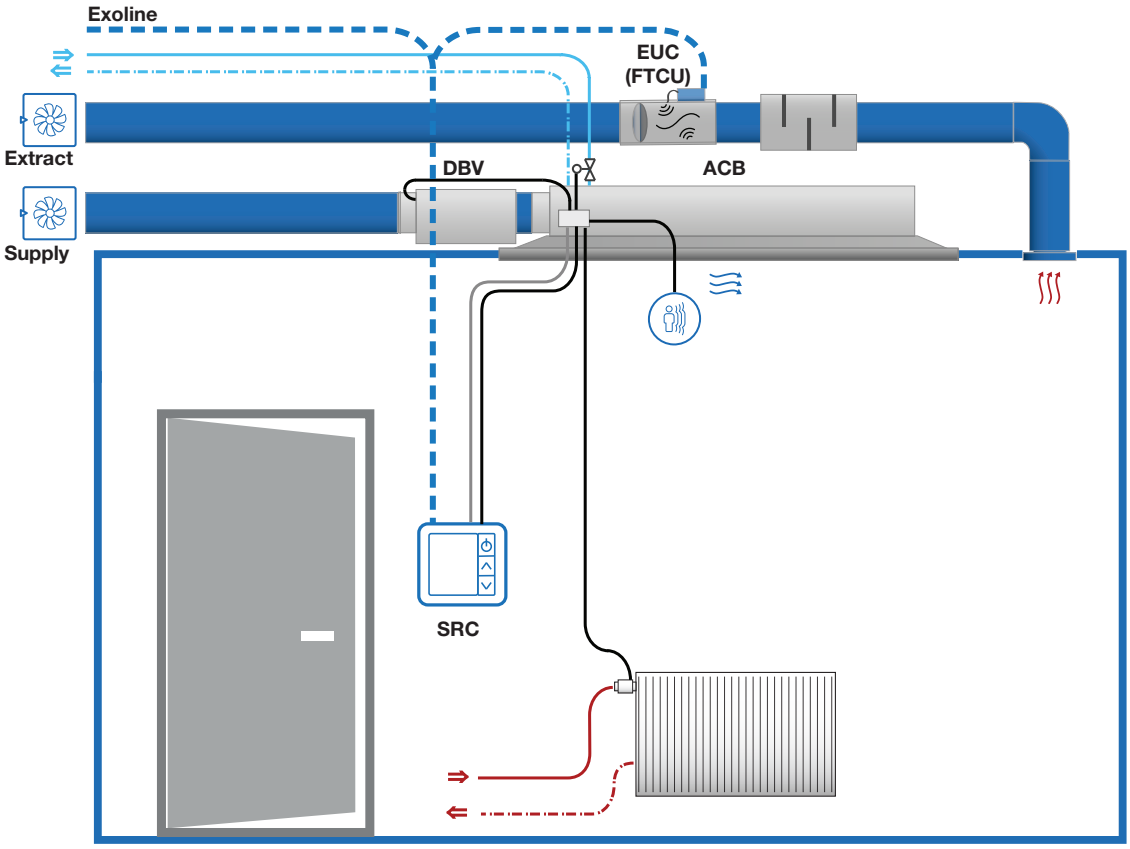
- SRC measures actual room temperature.
- Integrated presence sensor detects occupancy in room.
- SRC gives 2-10 V flow signal to DBV unit according to room temperature.
- At unoccupancy in room SRC regulates DBV unit to “standby mode”.
- DBV unit regulates the correct required airflow rate regardless of pressure.
- Multiple DBV unit controlled by same SRC can be wired with parallel signal.
- DBV unit indicate actual damper position to SRC by a 2-10 V position signal.
- SRC communicates airflow rate and actual damper position to LRM/SRM.
- If additional cooling/heating is required SRC gives 2-10 V signal to either heating valve or cooling valve.
- Extract controlled centrally in corridor.
- Extract from room via overpressure valve.
- Max. 16 EUC/ERC per LRM/SRM, communication via Exoline.

NOTE:
Extract from room can also be realized via a seperate extract diffuser or extract integrated in the beam.
Without a presence sensor, the standby mode can by activated on SRC manually.
Without the presence sensor, the room can also be regulated according to temperature by the internal temperature sensor in the SRC.
By adding a CO_2-Sensor the CO_2 level can control the DBV.

Pascal Water design manual

1.3 Active chilled beam and heating via seperate radiator

Supply: **Demand controlled regulation with DBV unit**
Extract: **Balanced extract with EUC (FTCU)**



Picture 11. Single office: ACB and heating via seperate radiator solution.

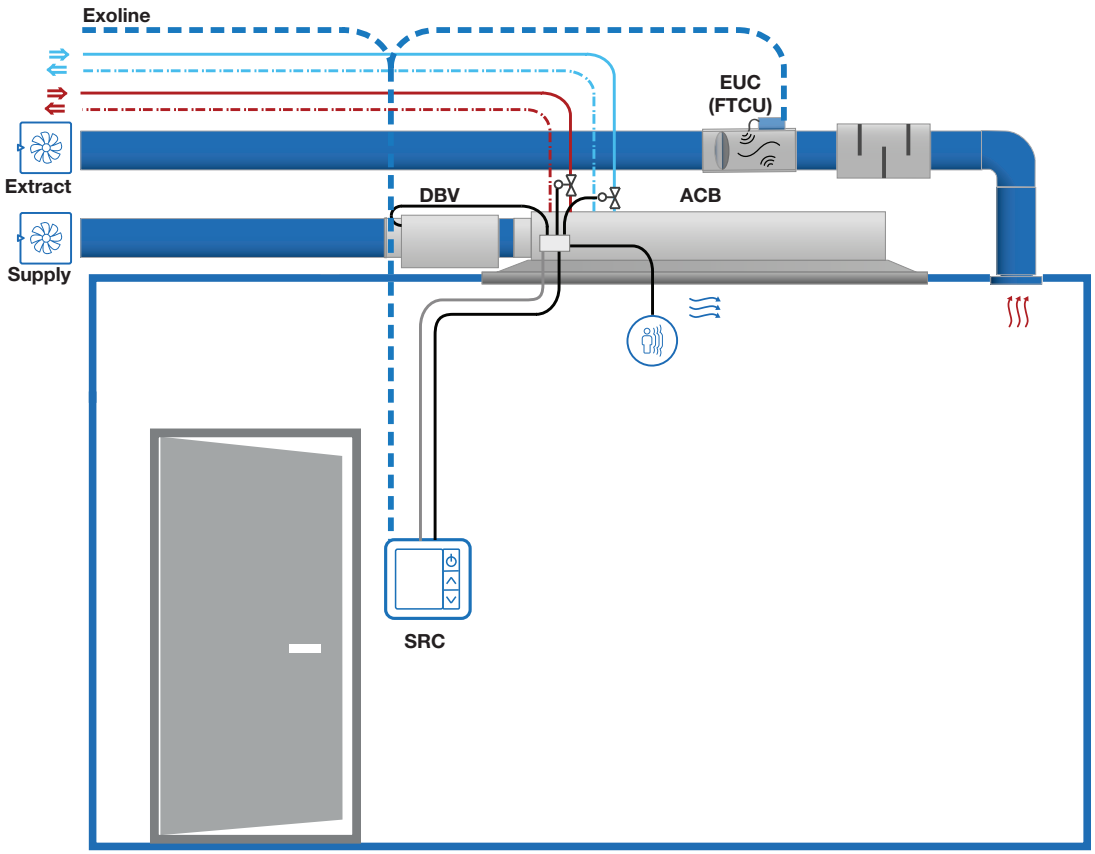
- SRC measures actual room temperature.
- Integrated presence sensor detects occupancy in room.
- SRC gives 2-10 V flow signal to DBV unit according to room temperature.
- At unoccupancy in room SRC regulates DBV unit to “standby mode”.
- DBV unit regulates the correct required airflow rate regardless of pressure.
- Multiple DBV unit controlled by same SRC can be wired with parallel signal.
- DBV unit indicate actual damper position to SRC by a 2-10 V position signal.
- SRC communicates airflow rate and actual damper position to LRM/SRM.
- If additional cooling/heating is required SRC gives 2-10 V signal to either heating valve or cooling valve.
- Extract controlled centrally in corridor.
- Extract from room via overpressure valve.
- Max. 16 EUC/ERC per LRM/SRM, communication via Exoline.

NOTE:
Extract from room can also be realized via a seperate extract diffuser or extract integrated in the beam.
Without a presence sensor, the standby mode can by activated on SRC manually.
Without the presence sensor, the room can also be regulated according to temperature by the internal temperature sensor in the SRC.
By adding a CO_2-Sensor the CO_2 level can control the DBV.
Extract from room can also be realized with FTCU instead of VRU and ERC. SLU is still needed.

Pascal Water design manual

1.4 Active chilled beam with integrated heating

Supply: **Demand controlled regulation with DBV unit**
Extract: **Central regulation with extract integrated in the ACB**



Picture 12. Single office: ACB with integrated heating

- SRC measures actual room temperature.
- Integrated presence sensor detects occupancy in room.
- SRC gives 2-10 V flow signal to DBV unit according to room temperature.
- At unoccupancy in room SRC regulates DBV unit to “standby mode”.
- DBV unit regulates the correct required airflow rate regardless of pressure.
- Multiple DBV unit controlled by same SRC can be wired with parallel signal.
- DBV unit indicate actual damper position to SRC by a 2-10 V position signal.
- SRC communicates airflow rate and actual damper position to LRM/SRM.
- If additional cooling/heating is required SRC gives 2-10 V signal to either heating valve or cooling valve.
- Extract controlled centrally in corridor.
- Extract from room via overpressure valve.
- Max. 16 EUC/ERC per LRM/SRM, communication via Exoline.

NOTE:
Extract from room can also be realized via a seperate extract diffuser or extract integrated in the beam.
Without a presence sensor, the standby mode can by activated on SRC manually.
Without the presence sensor, the room can also be regulated according to temperature by the internal temperature sensor in the SRC.
By adding a CO_2-Sensor the CO_2 level can control the DBV.

Pascal Water design manual

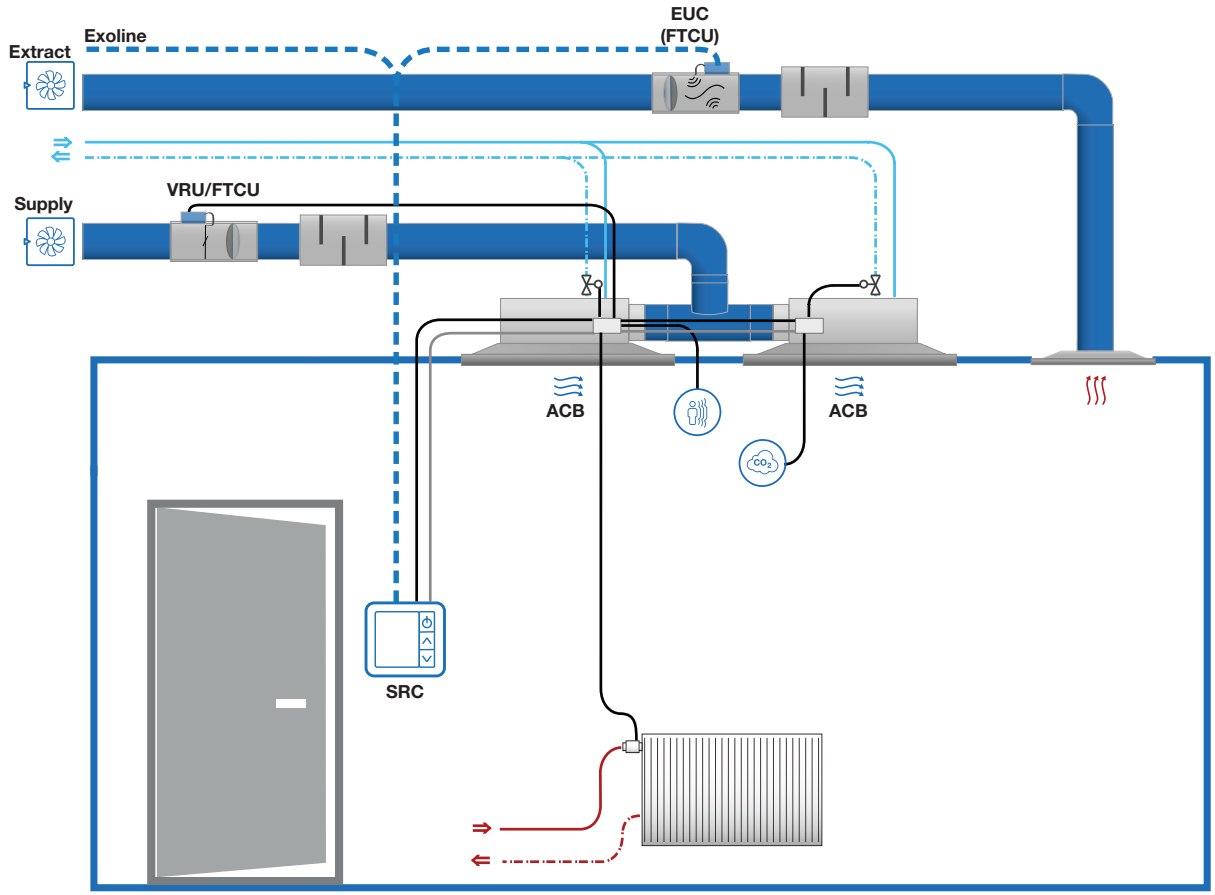
2. Conference room solution

Conference or meeting rooms are just like single offices defined as one climate zone and are controlled the same way regarding fresh air, temperature and lighting.

The big difference is that when a conference rooms gets occupied, it is typically with several persons and for shorter periods. The system therefore needs to be able to deliver more air and cooling and faster. Typically, more or larger ACB's are needed. This can be solved with one larger VRU/FTCU infront for airflow regulation.
In conference rooms CO_2-sensors are recommended in addition to temperature and presence regulation.
Note! The maximal number of actuators that can be connected to the digital output is 10 for cooling and heating, respectively.

2.1 Active chilled beams and heating via seperate radiators

Supply: **Demand control regulation with zone ultralink FTCU**
Extract: **Extract diffuser balanced with EUC (FTCU)**



Picture 13. Conference room : ACB´s and heating via seperate radiator.

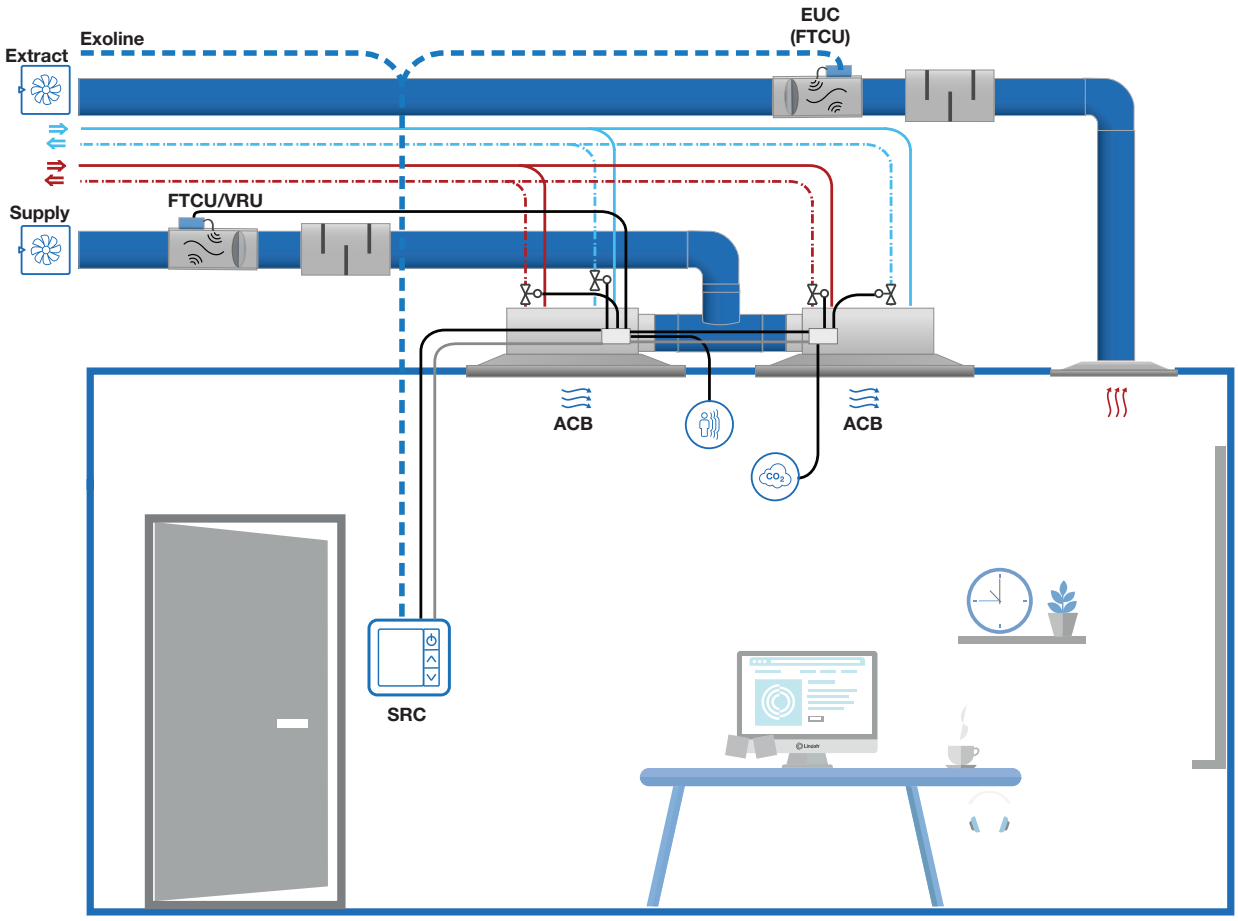
- SRC measures actual room temperature.
- External CO_2 sensor measures CO_2 level in room.
- Integrated presence sensor detects occupancy in room.
- SRC gives 2-10 V flow signal to supply air FTCU according to room temperature and CO_2 level.
- At unoccupancy in room SRC regulates FTCU to "standby mode".
- FTCU signals actual damper position to SRC by a 2-10 V position signal.
- SRC communicates airflow rate and actual damper position to LRM/SRM.
- EUC (FTCU) gets flow signal via Exoline from LRM/SRM, to obtain room balance.
- Damper position from EUC (FTCU) is communicated to LRM/SRM.
- Fan optimizer function on both supply and extract.
- Max. 16 EUC/ERC per LRM/SRM, communication via Exoline.

NOTE:
Central supply FTCU can also be replaced by single DBV in front of every ACB.
Extract from room can also be realized integrated in the ACB.

Pascal Water design manual

2.2 Active chilled beam with integrated heating

Supply: **Demand control regulation with zone ultralink FTCU**
Extract: **Extract diffuser balanced with EUC (FTCU)**



Picture 14. Conference room: ACB's with integrated heating

- SRC measures actual room temperature.
- External CO_2 sensor measures CO_2 level in room.
- Integrated presence sensor detects occupancy in room.
- SRC gives 0-10 V flow signal to supply air FTCU according to room temperature and CO_2 level.
- At unoccupancy in room SRC regulates FTCU to "standby mode".
- FTCU signal actual damper position to SRC by a 2-10 V position signal.
- SRC communicates airflow rate and actual damper position to LRM/SRM.
- EUC (FTCU) gets flow signal via Exoline from LRM/SRM, to obtain room balance.
- Damper position from EUC (FTCU) is communicated to LRM/SRM via Exoline.
- Fan optimizer function on both supply and extract .
- Max. 16 EUC/ERC per LRM/SRM, communication via Exoline.

NOTE:
Central supply FTCU/VRU can also be replaced by single DBV unit in front of every ACB.
Extract from room can also be realized integrated in the ACB.

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3. Open office solution

In an open office environment, many people share the same indoor environment. This means, that the supply systems such as ventilation, cooling, heating and lighting cannot fully be adapted to the individual. Normally, such offices are handled as one regulation zone.
Pascal Water makes it possible to divide the open office space in smaller local control zones. In these zones, presence sensors will control both the overall and local supplies to optimize both the indoor climate and energy use. Here, in a combination of Pascal Water with ACB or Pascal Air with MBV/DBV and diffusers can offer the best solution. Also an combination is possible.

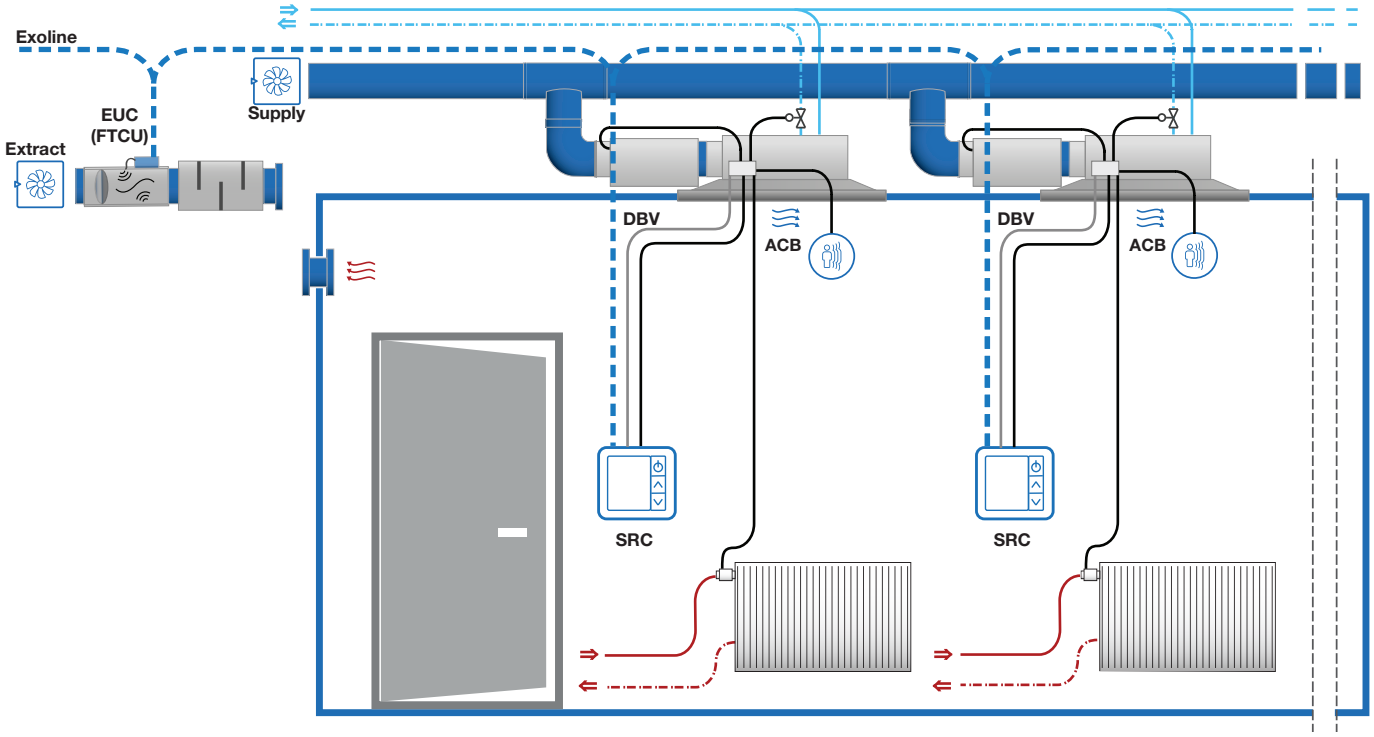
Example of operation

Fresh air supply is controlled by each local presence sensor that is activated. This also means that fresh air is always supplied locally at the individual workspace. If the room temperature cannot be maintained at the desired level due to the number of active chilled beams that are active, the DBV units in stand-by mode will be activated and gradually open until room temperature again is within the defined dead zone.

Optional lighting can be activated by a relay sensor (Regula Lux), when presence in the room is detected by a presence sensor.

3.1 Active chilled beams and heating via seperate radiators

Supply: **Demand control regulation with several temperature zones in office**
Extract: **Central regulation with overpressure valve**



Picture 15. Open office: ACB´s and heating via seperate radiator.

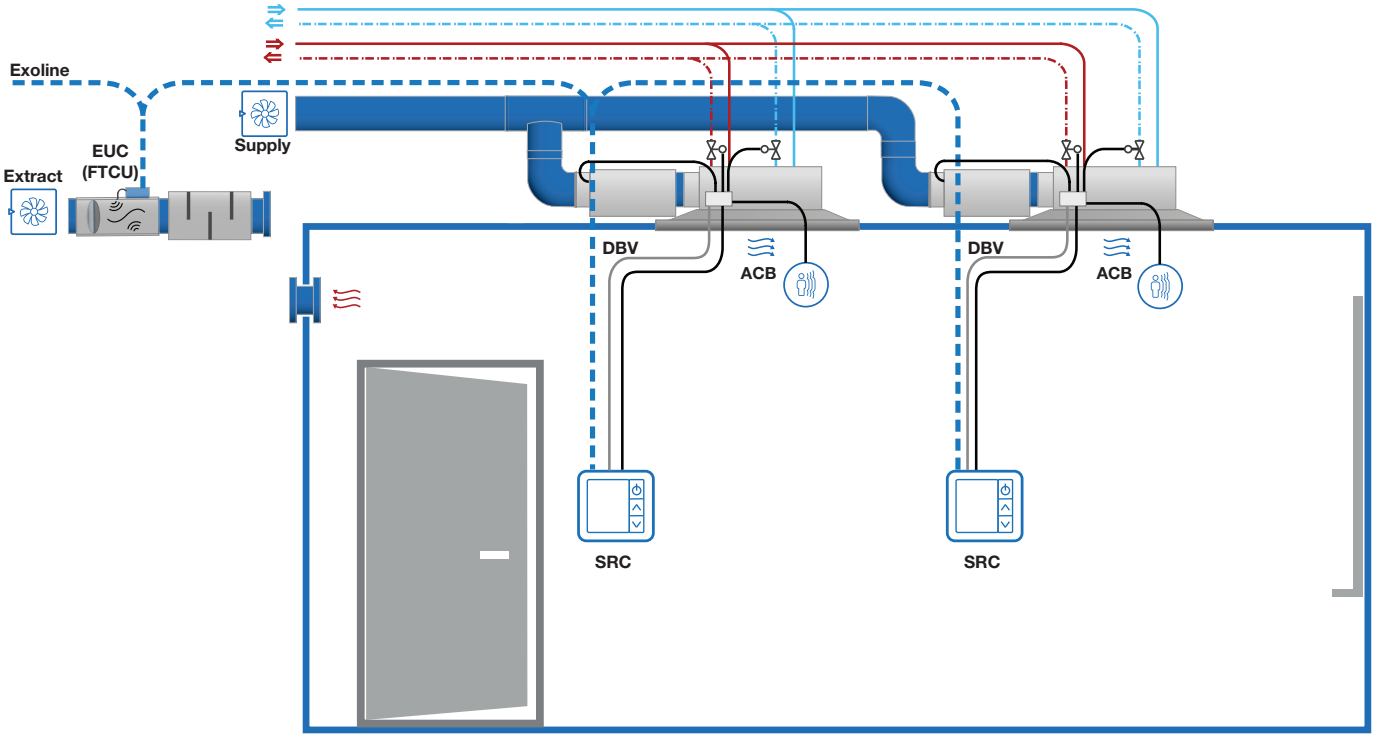
- SRC measures actual room temperature.
- Integrated presence sensor detects occupancy in room.
- DBV unit regulates to correct airflow rate regardless of pressure.
- Multiple DBV units controlled by same SRC can be wired with parallel signal.
- DBV unit signal actual damper position to SRC by a 2-10 V position signal.
- SRC gives 2-10 V flow signal to supply air FTCU/VRU according to room temperature and CO_2 level.
- SRC communicates airflow rate and actual damper position to LRM/SRM.
- At unoccupancy in room SRC regulates DBV to “standby mode”.
- EUC (FTCU) gets flow signal via Exoline from LRM/SRM, to obtain room balance.
- Damper position from EUC (FTCU) is communicated to LRM/SRM via Exoline.
- Fan optimizer function on both supply and extract.
- Max. 16 EUC/ERC per LRM/SRM, communication via Exoline.

NOTE:
DBV's can also be replaced by a central FTCU/VRU.
Extract from room can also be realized integrated into the ACB or above suspend ceilling.

Pascal Water design manual

3.2 Active chilled beam with integrated heating

Supply: **Demand control regulation with several temperature zones in office**
Extract: **Central regulation with overpressure valve**



Picture 16. Open office: ACB's with integrated heating.

- SRC measures actual room temperature.
- Integrated presence sensor detects occupancy in room.
- DBV unit regulates to correct airflow rate regardless of pressure.
- Multiple DBV units controlled by same SRC can be wired with parallel signal.
- DBV unit signal actual damper position to SRC by a 2-10 V position signal.
- SRC gives 2-10 V flow signal to supply air FTCU/VRU according to room temperature and CO_2 level.
- SRC communicates airflow rate and actual damper position to LRM/SRM.
- At non-occupancy in room SRC regulates DBV to "standby mode".
- EUC (FTCU) gets flow signal via Exoline from LRM/SRM, to obtain room balance.
- Damper position from EUC (FTCU) is communicated to LRM/SRM via Exoline.
- Fan optimizer function on both supply and extract .
- Max. 16 EUC/ERC per LRM/SRM, communication via Exoline.

NOTE:
DBV's can also be replaced by a central FTCU/VRU.
Extract from room can also be realized integrated into the ACB or above suspend ceilling.

Pascal Water design manual

4. Hotel room solution

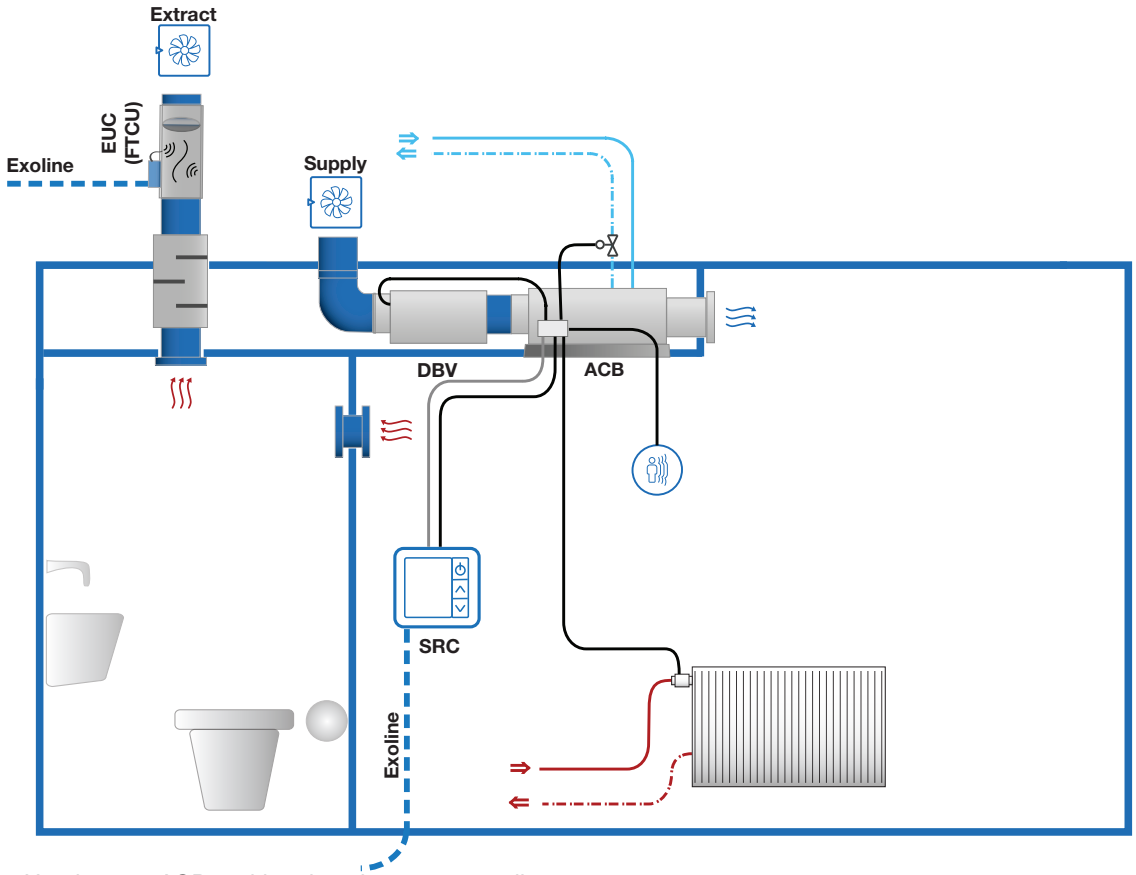
For hotel rooms, our recommendation are Munio or Plafond (ACB) combined with DBV. The extract air device is placed in the toilet/bathroom and ensures an under pressure keeping the wet bathroom air out of the hotel room. The extract air device, EUC, can be ballanced with the supply. Optionally a humidity sensor can be combined with the presence sensor, to ensure the the wet air to be removed.
When the humidity excess the set limit, it overrules the temperature and presence regulation and increases the air change rate in the room. When the humidity comes below the set limit, then the air flow control goes back to normale operating mode.

Operation example

In case the room is booked and a guest is entering (“occupied”, detected by a key card reader or a presence sensor) the supply air to the beam will be regulated according to program 8 and if cooling/heating is needed the valve will open to the beam accordingly.
When the guest is leaving the room for a while, Regula Combi will return to the “stand-by” mode after 30 minutes. The supply system regulated by Pascal will be set to desired minimum level, until the temperature in the room slide outside the expanded dead zone, the DBV in the supply air will open more and more until the temperature again is reached. Max airflow most be reached, before the control valve for cooling or heating will open until the temperature re-enters the expanded dead zone.
When there is absence, the temperature has been allowed to slide relative to the set point value to reduce the need for cooling/heating. This means that lighting is off and fresh air is set to the desired minimum level. When there is absence, the Regula Combi controller enters stand-by mode.
When a guest enters the room again, the Pascal system turns into presence mode again.

4.1 Active chilled beam and heating via seperate radiator

Supply: **Demand control regulation**
Extract: **Balance regulation with overpressure valve**



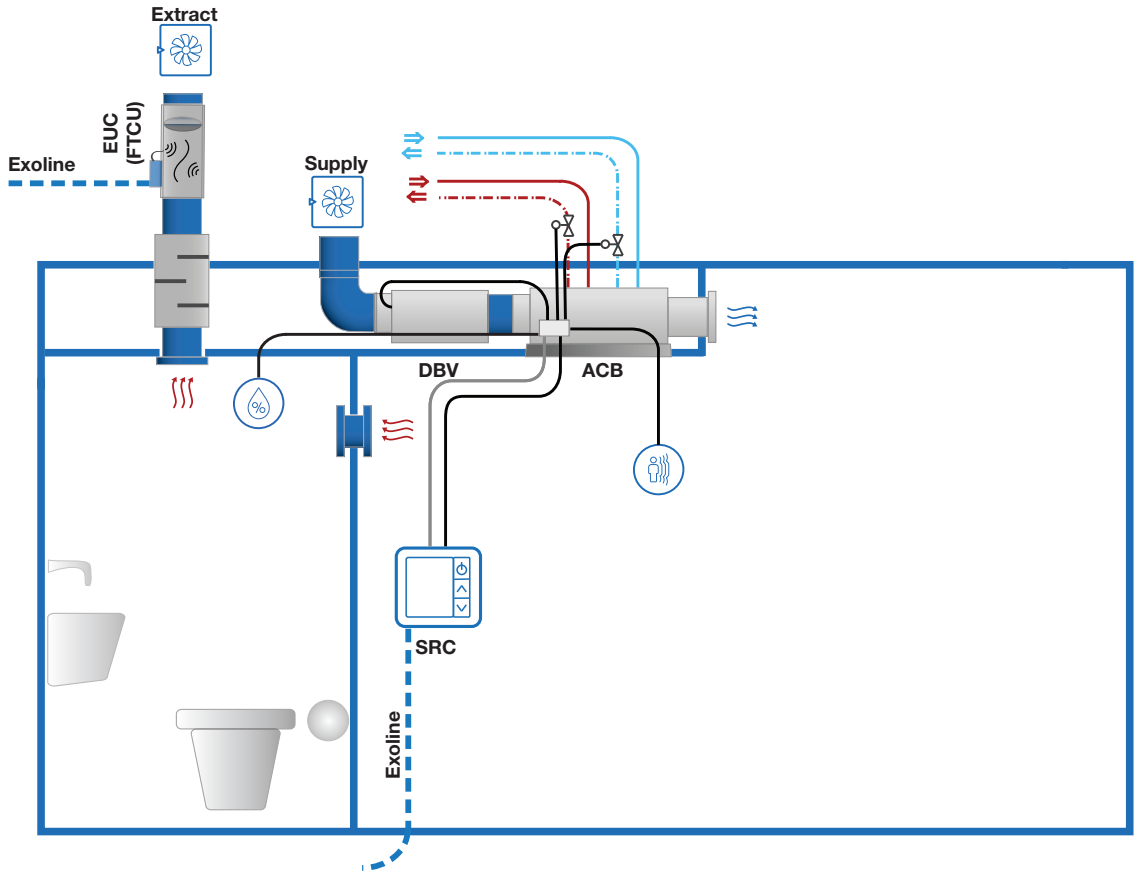
Picture 17. Hotel room: ACB and heating via seperate radiator.

- SRC measures actual room temperature and gives 2-10 V flow signal to DBV unit.
- DBV unit regulates to correct airflow rate regardless of pressure.
- DBV unit signal actual damper position to SRC by a 2-10 V position signal.
- SRC communicates airflow rate and actual damper position to LRM/SRM.
- EUC (FTCU) gets flow signal via Exoline from LRM/SRM, to obtain room balance.
- Damper position from EUC (FTCU) is communicated to LRM/SRM via Exoline.
- Fan optimizer function on both supply and extract.
- Max. 16 EUC/ERC per LRM/SRM, communication via Exoline.

Pascal Water design manual

4.2 Active chilled beam with integrated heating

Supply: **Demand control regulation**
Extract: **Balance regulation with overpressure valve**



Picture 18. Hotel room: ACB with integrated heating

- SRC measures actual room temperature and gives 2-10 V flow signal to DBV unit.
- DBV unit regulates to correct airflow rate regardless of pressure.
- The airflow is temperature regulated, with occupancy input from presence sensor or keycard.
- Optional a humidity sensor can be placed in the bath room, to secure that wet air i removed.
- DBV unit signal actual damper position to SRC by a 2-10 V position signal.
- SRC communicates actual flow and damper position to LRM/SRM.
- EUC (FTCU) gets flow signal via Exoline from LRM/SRM, to obtain room balance.
- Damper position from EUC (FTCU) is communicated to LRM/SRM via Exoline.
- Fan optimizer function on both supply and extract.
- Max. 16 EUC/ERC per LRM/SRM, communication via Exoline.

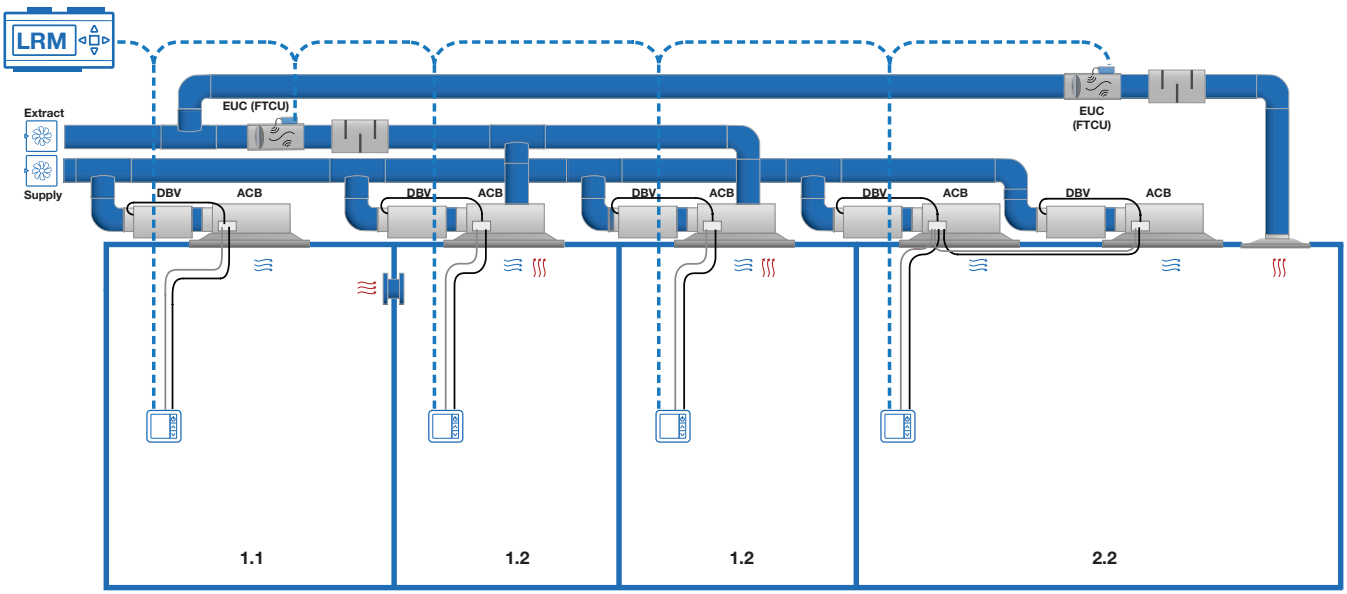
Pascal design manual

5. Complete Pascal building solution

The different Pascal Water room solutions can be combined in several ways to solve the buildings needs. Here are listed some variations. This means, that the Pascal can solve most building needs, with mixed use, in same Pascal system.

The Pascal Water room-solutions can also be combined with Pascal Air solutions. See the seperate design manual for Pascal Air.

5.1 Office building
Supply: Demand controlled with temperature regulator and DBV.
Extract: Balanced airflow with EUC (FTCU)



Picture 19. Office building: Four different room solutions.

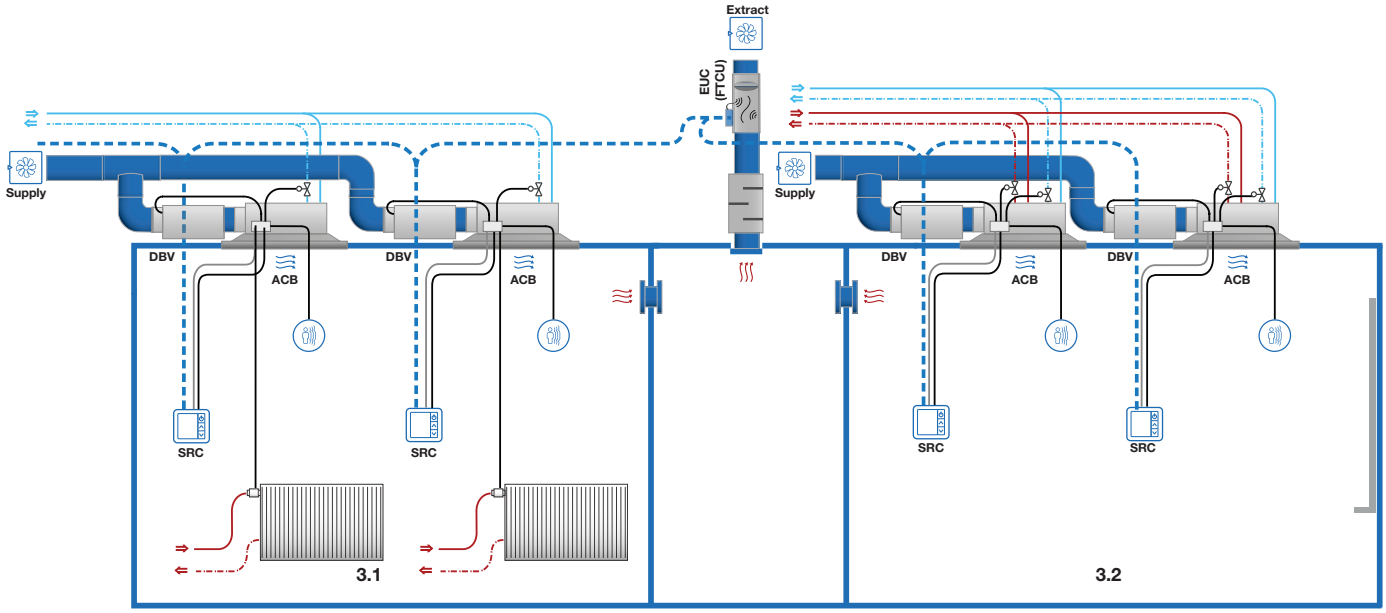
- SRC regulates supply airflow rate in DBV and communicates this airflow to LRM/SRM.
- LRM/SRM regulates extract on EUC (FTCU) to room (1.1) via overpressure is balanced with extract from room (2).
- LRM/SRM regulates extract on EUC to rooms (1.2) to secure room balance.
- LRM/SRM regulates extract on EUC to room (2.2) to secure room balance.
- SRC and EUC (FTCU) communicates damper positions to LRM/SRM.
- Damper positions for both supply and extract is used for fan optimizer function.
- Max. 26 SRC and 16 EUC/ERC pr LRM/SRM.

Note! The maximal number of actuators that can be connected to the digital output, of a SRC is 10 for cooling and heating, respectively.

Pascal design manual

5.2 Open offices

Supply: **Demand control regulation with several temperature zones in office**
Extract: **Central from hallway**



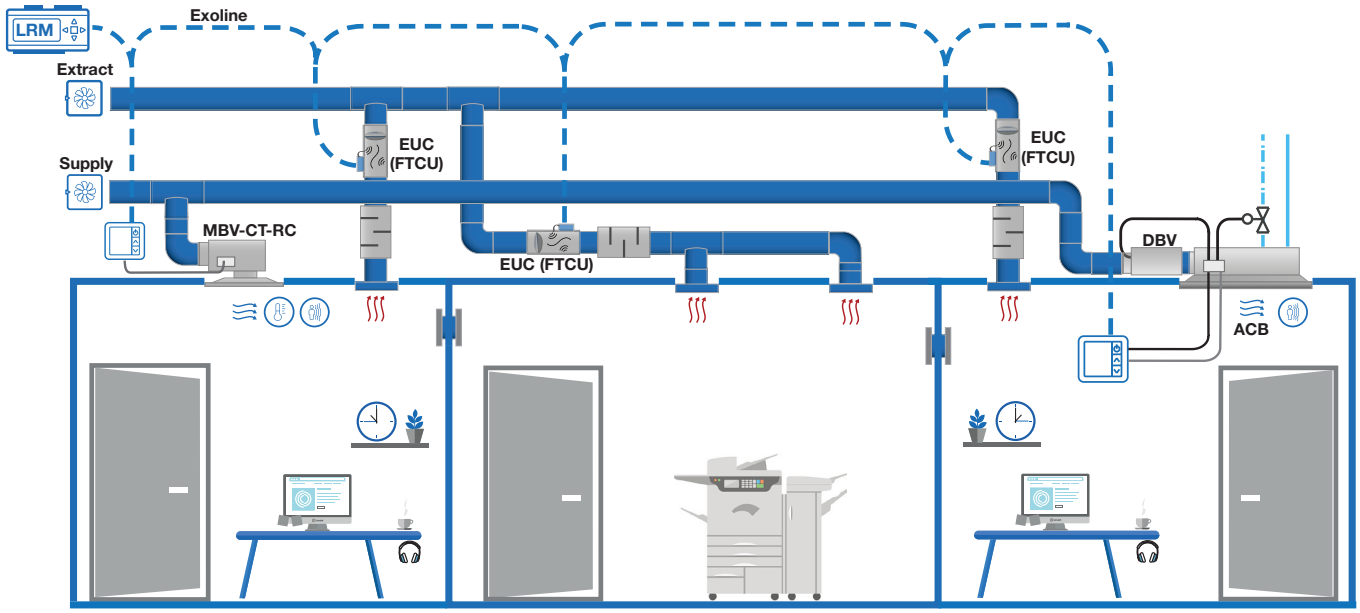
Picture 20. Open offices: ACB's with supply air in rooms but central extract air.

- SRC regulates supply airflow rate in DBV and communicates this airflow to LRM/SRM.
- LRM/SRM regulates extract on EUC (FTCU). Extract from rooms (3.1) via overpressure valves via overpressure is balanced with extract from room (3.2).
- LRM/SRM regulates extract on EUC (FTCU).
- EUC (FTCU) is balanced with all four SRC's.
- SRC and EUC (FTCU) communicates damper positions to LRM/SRM.
- Damper positions for both supply and extract is used for fan optimizer function.
- Max. 26 SRC and 16 EUC/ERC pr LRM/SRM.

Pascal design manual

5.3 Combined air and water solution

Supply: Single offices with different heat loads
Extract: Ballanced between offices and printer station



Picture 21. Combined office solutions with both Water and Air solutions.

With Pascal it is possible to combine all the different solutions in the same system even Water and Air solutions. Also on in the same section (LRM/SRM).

- In the left room an Air solution is showed, with MBV on supply and EUC on extract.
- In the middel is an only extract solution, with constant air flow. The ballancing supply air comes from the adjacent rooms.
- The constant air flow is divided up and subtracted from the airflow in EUCs in the adjacent rooms.
- In the right room is showed a Water solution. Supply with a DBV in front of an ACB. Ballanced extract with an EUC.
- All damper positions comunicated via Exoline to LMR/SRM.
- EUC also comunicates the measured airflow and temperature.

Most of us spend the majority of our time indoors. Indoor climate is crucial to how we feel, how productive we are and if we stay healthy.

We at Lindab have therefore made it our most important objective to contribute to an indoor climate that improves people's lives. We do this by developing energy-efficient ventilation solutions and durable building products. We also aim to contribute to a better climate for our planet by working in a way that is sustainable for both people and the environment.

Lindab | For a better climate