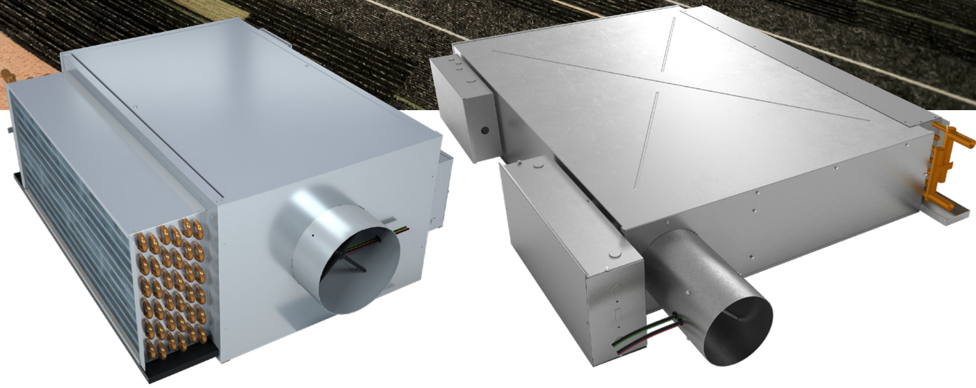
APPLICATION GUIDE

SERIES FAN POWERED CHILLED WATER TERMINALS

FDC-DOAS AND FDCLP2-DOAS

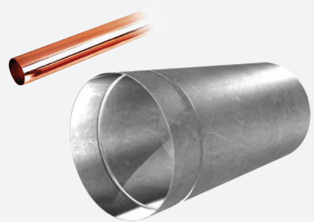


APPLICATION GUIDE
Series Fan Powered Chilled Water Terminals - FDC-DOAS and FDCLP2-DOAS

There is an increasing need for energy efficient air conditioning systems as energy codes becomes more stringent. Additionally, there is a desire from design engineers, contractors, and building owners to continue to utilize more "traditional" mixed overhead air distribution layouts, such as those associated with fan powered variable volume systems.

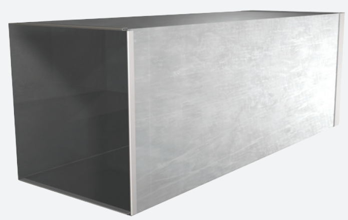
Series Fan Powered Chilled Water Terminals enter as the perfect hybrid between Chilled Beams or Radiant Panel technologies and a traditional "all-air" conditioning system.

Fan powered chilled water terminals within Dedicated Outdoor Air Systems strike the perfect balance between familiarity and efficiency. The fan powered chilled water terminal is comprised of a familiar series fan powered box, coupled with a highly efficient hydronic cooling system. The goal is to provide the minimum amount of fresh air to meet the ventilation and latent (wet) load requirements, while also utilizing water to move energy throughout a building to satisfy the sensible (dry) cooling loads. Utilizing water rather than air leads to energy savings, improved comfort, and the ability to easily integrate an upstream dedicated outdoor air system (DOAS).



1/2 in. Diameter Water Pipe & 7 in. Diameter Air Duct

VS.



18 in. x 18 in. Air Duct

18"x18" duct carries the same capacity as a 6" round duct and 1" water pipe. Water has a volumetric heat capacity ~3500 times that of air at sea level.

All Air Systems	Hybrid Systems
Use air for both sensible and latent load	Use water for sensible load and air for latent load and ventilation
Generally re-circulate air	Generally supply up to 100% outside air

THE BENEFIT OF DOAS OVER TRADITIONAL VAV

Traditional VAV is frequently cited by HVAC academics as having poor humidity control, as well as poor and unpredictable ventilation performance. This reality is largely due to the fact that air is used for all of the zone responsibilities including ventilation, latent cooling and sensible cooling within a space. The office application below has a number of different zones, each having their own requirements for both ventilation (as per ASHRAE 62.1) and cooling loads (both latent and sensible). The required cooling loads within the space would vary depending on a number of conditions including, but not limited to, solar load, occupancy, and zone envelope.

In an all air system, the supply air (typically provided at a fully saturated 55 degrees F) would provide the required cooling. The cool air requirement is typically much larger than the ventilation requirement, and varies with respect to the ventilation requirement for each zone (Zreq).

Table 1: Zone Requirements

Zone	Ventilation Requirement, Voz (CFM)	Sensible Cooling Load Requirement, Qc,sensible (MBH)	Airflow Requirement for Sensible Cooling Load (CFM)	Ratio of Outdoor Air to Supply Air, Zreq
A	35	7.05	325	0.107
B	75	9.11	420	0.179
C	35	7.05	275	0.107
D	90	13.02	600	0.150
E	175	32.55	1500	0.117
F	220	35.10	3000	0.072

Because one air handler is servicing all of these zones, the zone with the largest ratio of ventilation air to supply air (Zone B) will set the ratio for the whole system. This means all other zones will have an excess of ventilation air which will not be utilized. In some cases, excess air will return to the air handler, but in most cases much of this air will be wasted, and exhausted into the environment.

Table 2: Excess Conditioned Ventilation Air

Zone	A	B	C	D	E	F	Total
Excess Outdoor Air (CFM)	23	0	23	17	93	321	477

When utilizing a dedicated outdoor air system, only the minimum airflow required for ventilation is provided to each zone. This ensures the ventilation of each zone is always satisfied regardless of the cooling requirement of the zone. Additionally, there is no energy waste due to excess conditioned outdoor air, the size of the DOAS air handler can be reduced, and the risk of overcooling due to ventilation requirements is eliminated.

THE PURPOSE OF OUTDOOR AIR IN A DEDICATED OUTDOOR AIR SYSTEM

The outdoor air in a dedicated outdoor air system is only required to ventilate the zone, and satisfy its latent cooling load. Through determination of the latent load and ventilation requirements within the zone, the outdoor air can be provided at the desired temperature and volume to fulfil the requirements with maximum efficiency.

Continuing on with the previous example and utilizing the same office layout, the zone requirements for latent load and outdoor airflow are listed in Table 3.

Table 3: Ventilation and Latent Load Requirements

Zone	A	B	C	D	E	F
Ventilation Requirement, Voz (CFM)	35	75	35	90	175	220
Latent Load, QL (Btu/hr)	400	800	400	1000	2000	2400

Using each zone's ventilation requirement, the humidity ratio of the supply OA [W_{ca}] can be established to ensure the required latent load (QL) is met. The following equation is utilized:

$$QL = 0.69 \times V_{oz} \times (W_{space} - W_{CA})$$

It is assumed for this example that the desired design day humidity ratio of the zone [W_{space}] is 64.4 grains/pound, which corresponds to a dew point temperature of 55 degrees Fahrenheit.

Table 4: Humidity Ratio and Dew Point Temperature

Zone	A	B	C	D	E	F
Humidity Ratio OA, W_{CA} (gr/lb)	47.84	48.94	47.84	48.30	47.84	48.22
Dew Point Temperature (F)	47	48	47	48	47	48

As displayed in Table 4, the corresponding required humidity ratio can then be transformed to an equivalent supply dew point temperature. The supply air is often fully saturated, so the dew point temperature would be the dry-bulb temperature of the supply air that is provided to the zone at 100% RH. The minimum dew point calculation would set the requirement for the whole system. In the example, the supply air temperature would be 47° F.

Thus, both the latent load and the ventilation requirement are effectively treated with the same minimized air volume.

DOAS DESIGN ADVANTAGES WITH A SERIES FAN POWERED CHILLED WATER TERMINAL

Series fan powered terminals are a powerful and effective way to capitalize on the benefits of a dedicated outdoor air system. Series fan powered terminals are designed around a motor and blower assembly which is responsible for air delivery to the zone. The airflow that is discharged is a combination of conditioned air from an air handler or rooftop unit and induced, preconditioned air that is present in the plenum.

The schematic on the left, and Table 5 below, help provide context to these airflow relationships.

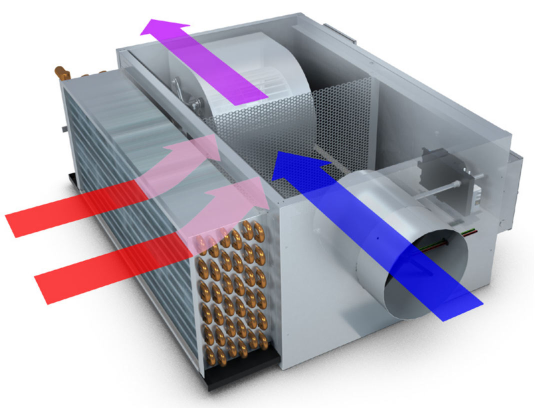
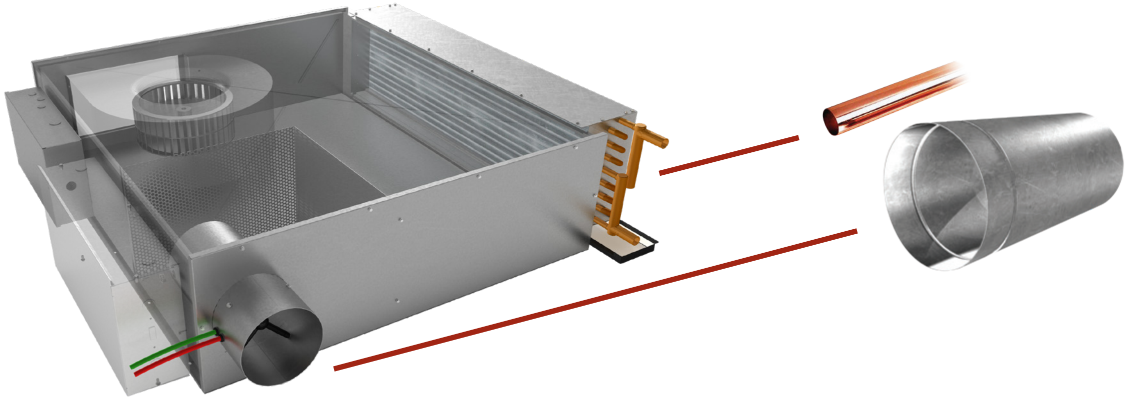


Table 5: Series FPT Airflow Relationships

Fan (Total Discharge) Airflow CFM	Primary (Outdoor) Airflow CFM	Coil (Induced) Airflow CFM
1200	400	800
1200	200	1000
800	200	600
800	400	400

As seen above, the volume of airflow induced through the side of the unit (and the sensible cooling coil) is completely independent of the airflow that is provided through the primary air valve. By varying the control signal to the motor and the primary air damper, all three airflow variables are capable of being modulated and controlled.



Thus, the series fan powered terminal unit can be leveraged to capitalize on the DOAS design. The primary air valve and cross-flow sensor address the requirement for outdoor airflow measurement and control, which allows for ventilation and latent load requirements to be met. Additionally, this primary air valve can easily implement demand control ventilation technologies. The large return air opening, and the natural induction of plenum air allows for a large sensible cooling coil to be utilized to address the sensible loads of the zone. Two, four, six or eight rows of cooling can be utilized to fine tune airside and waterside requirements. The large blower, equipped with an electronically commutating motor (ECM) allows for large air volumes, long duct runs, and multiple air outlets, coupled with the full catalog of Price Industries diffusers.

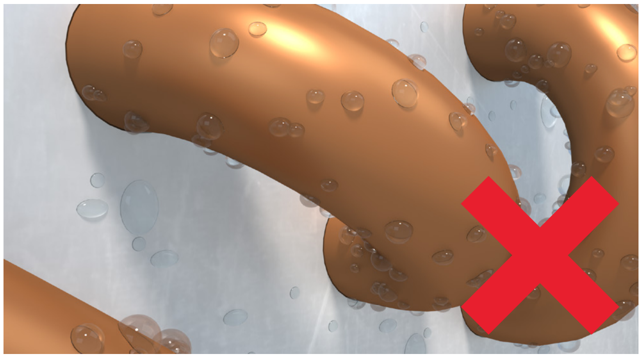
Benefits of utilizing series fan powered chilled water terminals:

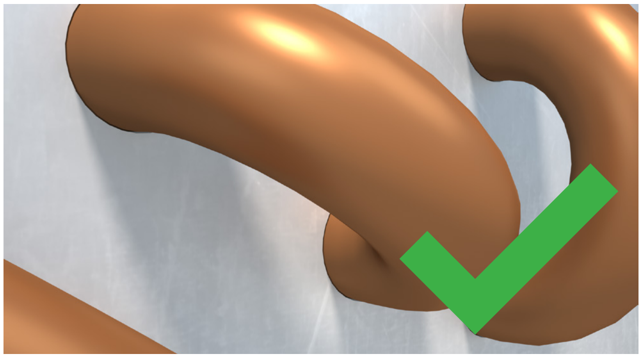
+ Humidity Control is independent of thermal control due to variability of coil and primary CFM
+ Cross-flow sensor and butterfly damper allow for monitoring and control of fresh air, as well as the option for Demand Control Ventilation Strategies
+ ECM accounts for higher external static pressures allowing for diverse outlet options and variable duct length
+ Less equipment in comparison to other DOAS technologies, leading to less equipment and easier installations
+ Terminal fan allows for the Air Handler to turn off during unoccupied mode, or morning warm-up

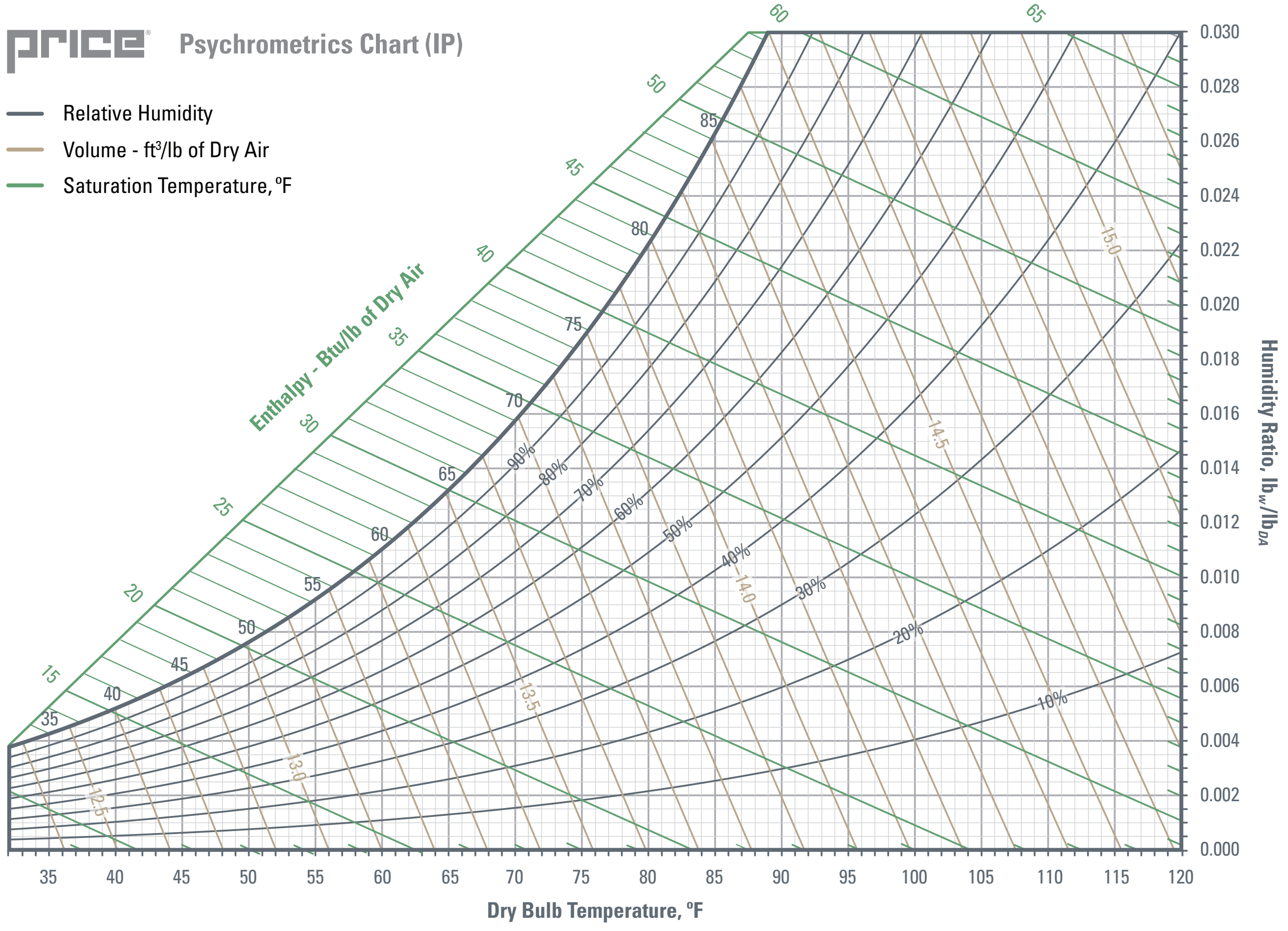
DETERMINING THE ENTERING WATER TEMPERATURE FOR THE CHILLED WATER SENSIBLE COIL

The entering water temperature for the sensible chilled water coil must be higher than the dew point temperature of the plenum. This is required to ensure the coil operates in a sensible fashion.

Assuming typical design plenum conditions of 75˚ F dry-bulb and 62˚ F wet-bulb, the relative humidity of the plenum will be 50%, with a dew point temperature of approximately 55˚ F. This means that the entering water temperature of the coil must be at least 56˚ F to prevent condensation. Traditional chilled water fan powered DOAS systems see entering water temperatures in the range of 56˚-58˚ F.







CALCULATING SENSIBLE CAPACITY FOR SERIES FAN POWERED CHILLED WATER TERMINAL UNITS

It is critical to understand and properly define the sensible capacity that is imparted on the zone via series fan powered chilled water terminals. A portion of this total sensible capacity is due to the cold ventilation air being provided through the primary valve and another portion of the total sensible capacity is due to the sensible cooling coil placed on the unit return. Both of these sources of sensible cooling sum together to equal the total sensible cooling which the series fan powered chilled water terminal imparts on the zone.

Primary Air Capacity

The primary air sensible capacity is imparted on the zone by replacing warm air mass within the space with cooler air mass from the supply diffusers. This capacity is represented by the following equation:

$$Q_{C,primary} = 1.085 \times CFM_{primary} \times \left(T_{exhaust} - T_{supply}\right)$$

Where:

$Q_{c,primary}$ is the sensible cooling capacity from primary air measured in MBH

$CFM_{primary}$ is the fresh air volume supplied through the inlet of the FPCWT measured in CFM

$T_{exhaust}$ is the temperature of air at the zone exhaust measured in degrees Fahrenheit

T_{supply} is the temperature of the primary air supplied through the inlet of the FPCWT measured in degrees Fahrenheit.

Coil Capacity

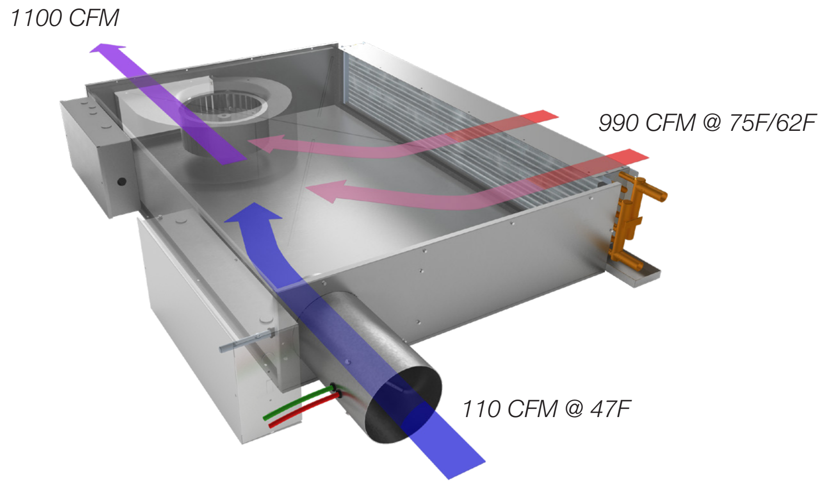
The coil sensible capacity $Q_{c,coil}$ is imparted on the zone by cooling preconditioned ceiling or plenum air via elevated chilled water temperatures (water temperatures above the dew point temperature of the zone). This should come from a manufacturers AHRI 410 certified performance data, such as Price All-In-One.

Total Capacity

The total capacity of the series FPTU-DOAS terminal unit can be most accurately calculated through the following equation:

$$Q_{c,total} = Q_{c,coil} + Q_{c,primary}$$

CALCULATING TOTAL CAPACITY EXAMPLE



'Coil' Sensible Capacity: **16.4 MBH**

From Selection Software:

- Rows: 8
- EAT: 75/62 F
- EWT: 57 F
- GPM: 4.68
- DeltaT: 7 F

'Primary' Sensible Capacity: **3.3 MBH**

MBH = 1.08 * CFM * deltaT
= 1.08 * 110 * (75 - 47)
= 3.3 MBH

'Total' Sensible Capacity: = Coil + Primary
= 16.4 + 3.3
= **19.7 MBH**

TERMINAL UNITS

Product Improvement is a continuing endeavour at Price. Therefore, specifications are subject to change without notice. Consult your Price Sales Representative for current specifications or more detailed information. Not all products may be available in all geographic areas. All goods described in this document are warranted as described in the Limited Warranty shown at **priceindustries**.com. The complete Price product catalog can be viewed online at **priceindustries**.com.

Price is a registered trademark of Price Industries Limited. © 2022. Printed in Canada. v001