WHITE PAPER

Variable speed in HVAC

Selecting variable speed technology

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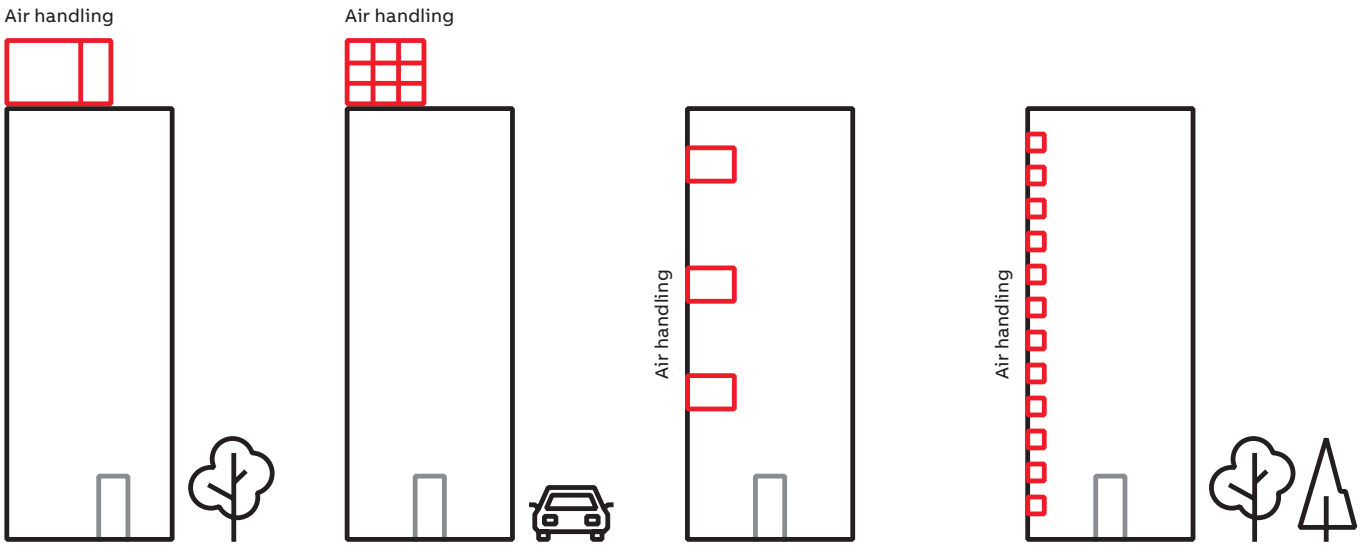
Ecodesign

Today the combination of customer expectations and a push for higher eco-friendly regulations is driving demand for higher efficiencies. Within EU the developing Ecodesign regulations, in particular EU327/2011 (for fans 125 W-500 kW) and EU547/2012 (for water pumps), guide designs toward more efficient movement of air and water. Manufacturers of pumps or fans need to comply with these tightening regulations and provide more energy efficient solutions that meet minimum defined efficiency levels.

At the same time there are different mechanical design solutions used that can be applied to new buildings and installations. A large air handling unit, which uses a single, large fan for the supply and the return sides, can be replaced by a split point-of-use system that is distributed throughout the building which, however, complicates maintenance of the building. Alternatively, as in the case of a centralized air handling system, the fans inside can be split into multiple smaller fans. These types of split systems require less duct work and provide more local control for occupants. Using multiple small fans on a centralized air handling has the potential to offer better system efficiency due to better heat exchanger efficiency, also known as coil efficiency, but causes issues with maintaining required static pressure. System design is further complicated by the wide range of different motor and control technologies available to consumers.

Four different ways to manage air handling in a building



Centralized large fan air handling unit

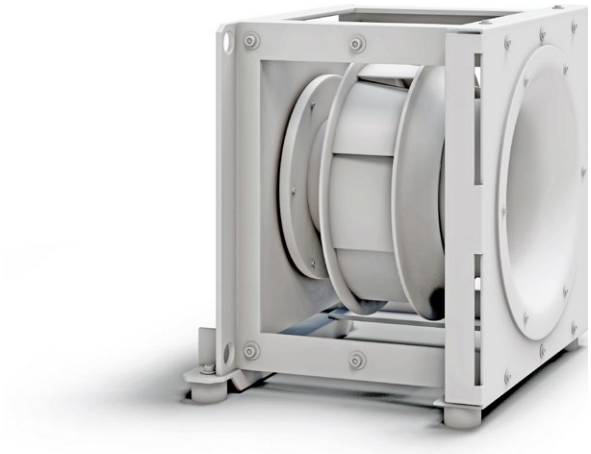
Centralized fan array air handling unit

Distributed air handling (fan array or singe fan)

Decentralized air handling (singe fan)

What are EC fans and pumps?

Traditionally, EC stands for Electronically Commuted and typically refers just to motors. However, within the HVAC industry the term may be used to describe any motor technology and drive package that is integrated together as a single assembly, possibly with a pump or fan as well. These EC fans often have external rotors where fan blades are integrated with the external rotor housing. In most cases, EC pumps integrate the motor directly with the pump. Therefore, the EC motors are not sized in traditional IEC dimensions. They are application-specific and customized. This also mostly requires an entire fan or pump to be replaced if the bearing or the motor fails – where traditional motors are easily repaired or replaced, and bearings are normally stocked locally. For the owner, this can lead to much higher life cycle costs. Further, the replacement EC fan and pump assemblies may not be as available as traditional motors, drives and fan wheels and especially fans have to be sourced from the original supplier. Presently the power range of this type of EC packages range from few watts to around 6 kW.



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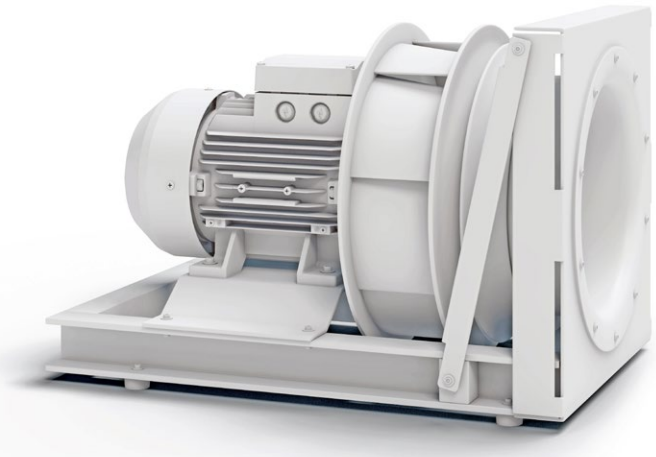
Integrated EC fan package



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Traditional motor & fan package

What matters to users and designers?

Every technical solution to system configurations has its own benefits and drawbacks. In order to reach best system efficiency, the efficiencies of the individual components have to be optimized in a manner that does not cause more losses on other components within the system. Only looking at individual component efficiency can actually lead to lower system efficiency. What matters is the total system or wire to air/water efficiency that includes all components from drive to motor to mechanical load to coil efficiency.

$$\eta_{system} = \eta_{drive} \cdot \eta_{motor} \cdot \eta_{coupling} \cdot \eta_{fan} \cdot \eta_{coil}$$

However, the way the components are integrated can especially on the fan side cause additional losses, which negatively affect the wire to air efficiency. If the motor is partly blocking the air flow through the fan wheel, the pressure drop over the fan increases and total efficiency is lower, as is the available static pressure.

Efficiency alone does not cover the requirements of the applications. Customers need to consider the integration of their components into other existing, or new, equipment and systems. Pipes and ducts can create limitations that are not planned in initial design. IEC motor and drive combinations have the ability to show system efficiency and offer the user and designer some flexibility to correct for unforeseen challenges of “system effect” in duct or pipe. With existing ductwork the ability to generate enough static pressure is essential, and with the EC fans they often have to be over dimensioned in terms of power to reach the nominal static pressure, and thus running far from their best efficiency point. In short, traditional motor/drive packages have the ability to meet the required design criteria and pressure requirements without overdimensioning.

Offering enough I/O connectivity and direct native BTL-certified BACnet communication to the building management systems is essential in many fan and pump applications in buildings. HVAC specific macros, alongside PID/Loop controllers, make integration into difficult applications much easier. They allow drives to speak in industry terminology and offer HVAC expected capabilities such as Override.

The standard options on ABB variable frequency drives provide the user, contractor or system integrator with more options for control and more flexibility in application. Utilizing direct connection, from feedback devices such as air flow measurement meters, pressure, temperature and CO_2 sensors to built-in standalone controllers, offer robust functionality for the HVAC systems – even when the connection to the control system is lost the drive needs to continue operation seamlessly.

Power electronics can have an effect on the other equipment on the site if they are not chosen and installed properly. The ability to connect to public low voltage networks is challenging and consists of multiple technical requirements. Complying with harmonics and EMC requirements of the installation site is mandatory to avoid problems and protect equipment. It is important to ensure that the electrical specification covers all variable speed controllers, not just stand alone VFDs. Additionally, size, system efficiency, and integration of solutions are also a concern when adding more components to a system setup.

Over years of use, mechanical equipment always needs maintenance. Standard motor offerings give a wide range of serviceable parts and opportunities, such as replacing bearings, to continue the lifespan of the motor. Available spare parts and how readily spare parts are offered is important. Long waiting times for spare parts and service is not acceptable and quick local support is essential.

Drive and motor technology benefits

How do you commission your system? You can commission your system with tailored HVAC terminology and your local language through a single unified user-interface for motor control of pumps and fans, offered by the extended power range within one product family.

How do you ensure availability in the years to come? By using accepted industry standard technology employing standard sized motors and components, users are not dependent on a particular supplier. These are readily available from partners and stock, and are therefore not subject to long lead times. They are available everywhere geographically and include global service, replacement and spare parts.

How do you optimize your system efficiency? Utilizing optimized packages of high efficiency motors, such as SynRM, with ABB drives allows reaching the designed operating point in terms of pressure and flow without overdimensioning any of the components.

How do you notice if your components are not running as they should? ABB drives can provide continuous feedback to the BAS/BMS so that AHU performance will be consistent at both low and high demand. Each individual fan motor can provide feedback and be adjusted to work at its most efficient operating point. When the nominal operating conditions are not met, the drive notifies this. Additionally, the diagnostics functions inside the drive can inform of coming maintenance needs such as fan replacement before failures occur.

How do you effortlessly integrate to your BAS/BMS system? There is no need to use any gateways for connecting to the building management system with our native, embedded BACNet communications. Each additional component is an additional risk of failure in the system.

How do you keep your system running when communication to the BAS / BMS is lost? The drive has a built-in controller that allows operation to continue seamlessly so that even without external controllers the static pressure or constant air volume can be maintained.

How do you keep your system operating when your supply voltage is 15% below nominal? Thanks to the internal undervoltage controller that adjusts the output to maintain operation in undervoltage situations, the drive can continue its operation. Even when there is a short total loss of supply, the drive can use the kinetic energy of the mechanical system that keeps it running for short periods. If you use a drive with active rectifier, such as the ultra-low harmonic drive ACH580-31, then you can even maintain full output voltage, when the input is 15% below nominal.

Can you keep your drive running in a +50 ° C or a -15 ° C ambient temperature? With the wide ambient range, the drive can operate. Additionally in cold and wet conditions the motor heating function of the drive allows to keep the motor dry without additional motor heaters.

How do you implement your machine safety? Thanks to the TÜV-certified safe torque off functionality the drive can deliver complete safety circuit for mechanical maintenance inside the AHU without complicated external components. This also makes the compliance with documentation requirements of the machinery directive 2006/42/EU instruction Ed. 2.1 a lot easier as critical stop functions are certified safe.

Can I mitigate harmonic problems with usage of passive filters or active filters? With the ultra-low harmonic drives there is no need for solutions using many components – the single ULH drive package has everything in a simple and compact package for 3% THDi performance – far below the IEEE519 5% TDDi limit. Additionally, reduce transformer dimensions and see fewer disturbances on your electrical network thanks to the active supply unit in ULH drive.

Can I connect the drive anywhere? Embedded swinging choke technology and ULH variant come with C2 EMC filters, which allow for our drives to be compliant to public low voltage network connections everywhere.

What benefits does the ACH580 with SynRM motor offer? Guaranteed efficiency with any HVAC drive and motor package, and reduced motor noise with our SynRM drive and motor packages. The SynRM motors are also easier for maintenance of both the AHU and motor itself. There is no need to lock the shaft to prevent dangerous voltages forming like with permanent magnet motors and the motor maintenance is simpler with SynRM than permanent magnet motors.

There are no more I/O points to connect my sensors and instruments, what can I do? All I/O points on the drive can be used via the fieldbus interface. This allows all extra I/O points to be used saving the cost of extra I/O units in the system.

Can I monitor my system? The drive offers wide range of signals and measurements, such as the output current, motor load, event log of past events, histogram of the load curve and many more values.

Is it possible to change configuration such as the ramp times remotely? The integrated native BACnet communication and Modbus offer access to all needed parameters inside the drive. BACnet IP is also available as an option and both native and IP versions are BTL certified for increased interoperability.

What additional components are needed? There is no need for any additional components. The drive will protect the motor without extra earth monitoring equipment or motor protection components.

For more information, please contact your local ABB representative or visit

abb.com/drives
abb.com/drivespartners
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