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TECHNICAL BULLETIN

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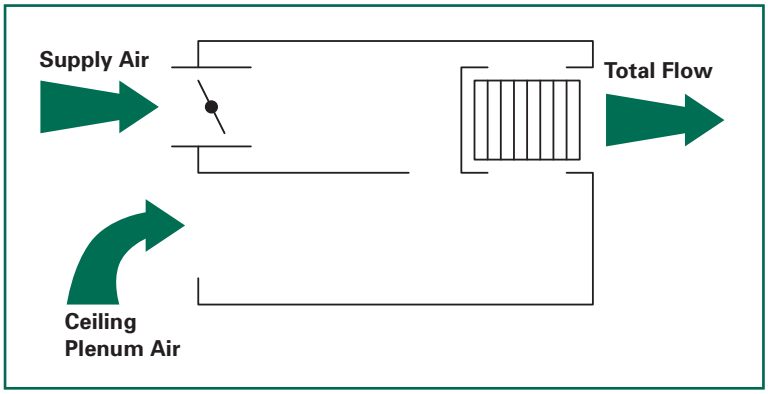
SERIES TYPE FAN POWERED AIR TERMINALS

PREVENTING BACKWARD FAN ROTATION

General

Series fan boxes can provide high occupant comfort levels by providing a constant flow of air to the space while maintaining constant air change rates and throw distances from air outlets. By blending ceiling plenum air induced thru the induction opening of the box with conditioned air metered through the primary inlet (and adding reheat coils for boxes serving perimeter zones), high levels of mixing and ADPI are obtained. Due to the arrangement of Series boxes, however, they are prone to backward fan operation when control strategies and sequencing are not considered.

This type of air terminal is sometimes referred to as a Constant Volume fan box and is arranged such that the primary air inlet and ceiling plenum induction opening are in series with the box fan, with the primary inlet and induction opening in parallel with each other:



With this arrangement, the box fan air flow rate is the same as the supply air flow rate into the space:

Fan CFM = Primary CFM + Induction CFM

Because of this, the box fan must be running to deliver the air into the space and the primary flow rate must be controlled such that it does not exceed the capacity of the fan. Otherwise, primary air will spill out of the induction opening into the ceiling plenum.

Occupied-Unoccupied Modes

Series fan boxes are often used to maintain perimeter zone setback temperatures during unoccupied modes when the central air handling system is shut-down. The ability of these types of boxes to add heat to perimeter zones without primary air is an important design concept promoting their use.

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Fan Reverse-Backward Rotation

Fan box motors are very often permanent, split capacitor starting (PSC) type motors. The motors are normally fractional HP, custom wound, and matched with capacitors to achieve an optimum balance of performance (operating efficiency, sound, and torque) when used with SCR speed control devices. The motor is typically direct coupled to a forward curved wheel-blower assembly. Reverse rotation of the motor-blower assembly is a common phenomenon that occurs when the fan motor power is off, and the box casing is positively pressurized by the primary air (air spilling out of the induction opening into the ceiling plenum), such that the motor-blower begins to rotate in a reverse mode. The speed or rpm will be proportionate to the level of pressurization. Reverse rotation can be high enough such that when the motor is energized, the assembly will continue to run backwards, at reduced air flow capacity. This often occurs when the building is coming out of the setback / unoccupied mode, and the central air handling system is initially started up. This can reduce the life of the motor, although statistical data is not available on this abnormal / unintended operating condition.

Electronically Commutated Motors (ECM's) do not experience this problem.

Control Strategies to Prevent Backward Spin

The only caveat to prevent this from occurring is to energize the box fan first, before pressurizing the primary supply duct and introducing primary air into the box casing.

For systems utilizing Direct Digital Controls (DDC) on the fan boxes and networked via a Building Automation System, the "no cost" solution is to incorporate a startup sequence that energizes the fan box motor several seconds or minutes prior to starting the central air handling systems.

For stand-alone systems including electronic analog or pneumatic controls, use a control package that incorporates an air flow switch to interlock fan startup with the pressure as sensed at the air flow sensor in the primary inlet of the fan box. Another option is to bring an external signal to each box (pneumatic or electrical) to initiate occupied mode sequences.

Conclusion

There are no magical anti-backward rotation devices to prevent backward spin. The inherent phenomenon of backward spin of PSC type motors is typical in the industry. By specifying the proper controls and control logic, this issue will not infiltrate your projects.