BUS Enabled Fans

Value-Added for Refrigeration Display Cases & Bottle Coolers

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Abstract
BUS communication is a new option available for the latest refrigerated display cases and bottle coolers. This paper reviews the advantages BUS enabled fans can provide over current fan solutions for these applications. BUS communication has been successfully used in larger rooftop condenser fans in supermarket applications for many years; now, this new option can be used to enhance smaller refrigeration systems.

Current challenges
Refrigerated display case manufacturers are tasked with producing a commercial product that maintains specific food and beverage temperatures required for food safety and freshness. Organizations such as the U.S. Department of Energy, the Environmental Protection Agency and Energy Star are mandating OEMs to redesign products to comply with multiple energy efficiency requirements.

Overview of fans types and configurations used by commercial equipment OEMs

- **Separate motor, impeller and basket assembly**
  This air moving assembly is very common and has been in use for many years. An AC or EC (electronically commutated) internal rotor motor with a set speed is mated to a stamped metal or molded plastic impeller of a chosen diameter and pitch – providing required air flow at a certain backpressure. Usually these components are from three independent sources and not optimized to work in unison. Due to the limited possible combinations of impeller diameter and pitch with a fixed motor speed, this method leaves little room for fine tuning the air flow. Refrigeration designers often need to over-design their systems, accepting the noise and excessive energy consumption that accompanies it. The motor and impeller assembly can either be mounted by the motor end shield or by using a preformed venturi (wall ring). Alternatively, the motor and impeller are mounted in a simple hole cut in sheet metal that does not provide any acoustic or air performance advantages. Refrigeration designers have to plan for their equipment to deliver a consistent temperature while in operation during "worst case" scenarios. Many refrigeration systems are only subjected to these worst case conditions for a short period throughout their operating life; the net result is wasted energy and excessive noise. Usually, these assemblies operate at one speed with no adjustments for changing conditions. Typically, motors that have been used in these applications were not equipped with BUS communication.

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- **Pre-assembled fan assembly**
  The complete fan assembly, using energy efficient, external electronically commutated (EC) rotor motors is the next generation of fans offered to OEMs. These assemblies include an aerodynamically optimized and factory balanced plastic impeller - permanently mounted to the EC motor. The assemblies work in tandem with a matched venturi designed for the best airflow and providing low noise characteristics. Delivered as a pre-assembled fan unit, it allows OEMs to install fan assemblies directly into refrigeration systems during construction, eliminating the need for sub- assembly operations. A shallow mounting depth enables these units to fit into tight spots providing low profile refrigeration designs often resulting in more internal room in the refrigerated area. These pre-assembled fans come in several diameters and speeds; fan speeds are programmable by the refrigeration OEM. The most suitable fan diameter is chosen by the refrigeration designer; the required airflow is then fine-tuned by programming the motor to the specific RPM setting to deliver just the right amount of air movement. Programming the EC motor RPM at the OEM level, based on the needs of the installation, allows the RPM resolution setting as small as 10 RPM increments. Refrigeration designers can fine tune the operation of the fan to deliver the optimum air flow without wasted energy or excessive noise. These EC fans are commonly available with standard two speed operation. The designer can easily "toggle" between programmed speed 1 and programmed speed 2 for operation under varying conditions. Once the EC fans are programmed for the specific application, the fans operate at the two design RPM settings without any further variations to the RPM. As with the older style motor, impeller and basket assemblies, designers have to consider the "worst case" operating conditions; but, in this instance, the programmed two speeds could be used in average and worst case conditions, or, other varying operating conditions: door openings and after defrost cycles. The two speed system provides design flexibility, reduced parts inventory for OEMs and reduced fan energy consumption during “typical" operating conditions. Currently, these EC fan assemblies are available with two speed option, programmable RPM motor - without BUS communication.

- **Latest offering - pre assembled fan assembly with BUS option**
  The latest fan assembly is equipped with BUS communication. Replacing the two programmed speeds, BUS communication from a master controller is used to vary motor RPM and provide additional motor feedback. This paper will review each of these features and point out how they can be utilized in a refrigeration application. These new refrigeration fans with the BUS options are complete fan assemblies (see image below).

Current trends

Master controllers are successfully being used in European case designs. A controller is needed for use with the latest BUS controlled evaporator and condenser fans. They are also being used to control and communicate with a supervisory system as well as components such as expansion valves, lighting, compressors and other mechanical features in the refrigerated display case or bottle cooler.

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Feature Overview for BUS controlled fans

- **Features that enhance the design of a current refrigeration system.**
  Independently regulating the speed of each fan in a display case provides a more uniform temperature throughout a loaded display case. Thermal sensors placed in specific areas within the case maintain a closed loop temperature control. This can best be mapped out by the OEM at the design level to set the optimum RPM for even cooling. By using independent fan speeds, the case can be divided up into sections with each fan and sensor operating independently, while being regulated by a master controller. A command from the master controller can be used to set the RPM of a specific fan, any combination of fans, or all of the fans in the system. RPM is determined by the master controller based on analysis input data collected and interpreted.

- Faster recovery time to temperature set point after defrost cycle achieved by increasing the fan RPM for a short period until the set point is reached again. Fan RPM can be easily be changed as needed to suit changing conditions. Events that can trigger changes include: day/night operation, occupancy feedback, door opening/closing, and the use of night curtains or any other monitored variable.

- These new EC fans are currently available with a 24 VDC input through a DC power supply that may be powering the LED case lighting. Single phase 115 or 230 VAC, 50/60 Hz input units are also planned.

- Low voltage DC input fans eliminate high voltage safety issues, providing world-wide manufacturers with a "single fan" part number for inventory and repair.

- Fan airflow direction can be reversed as needed. For example, running the fan at short intervals in the reverse direction helps "blow out" debris and keeps a condenser clear.

Added-Value for the End User

Fan status is continually monitored by the master controller; a notification can be sent if a specific fan is not operating as expected. The master controller can pass this information along to the end user by initiating an alarm light. In a more sophisticated configuration, the alarm can be tied into a building automation system. External monitoring using web based or cellular networks can be used and provide e mail or text notifications. Fan status alarms for locked rotor, low input voltage, confirmation of commanded RPM, over current and loss of communication are all possible and simplify troubleshooting the refrigeration unit. A technician not familiar with specific refrigeration system can easily use error codes to assist with the troubleshooting process. Additionally, a technician can access the error code(s) remotely if the master controller is equipped for this capability. The technician arrives at the customer site prepared with the correct replacement part(s).

Each fan has a specific address in a system; alerts are specific to a unique fan in a specific location. Quick and efficient trouble shooting eliminates the need to empty a loaded display case to identify the problem. With an exact fan address, only the specific area of the display case requires unloading. Access to the specific fan is easy and no time is wasted during a repair.

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One of the key features of the BUS enabled fan is the ability of the unit to monitor the total run hours that the fan has logged. This is extremely valuable when incorporating a preventative maintenance schedule in a large store system. Preventing equipment downtime is a significant benefit to the end users.

Conclusion

The addition of BUS communication to fans used in display cases and bottle coolers solves many existing design challenges. It offers numerous benefits to the OEM, the end-user and their customers, and the maintenance personnel responsible for keeping these refrigeration units running daily and reliably. By choosing to use a BUS fan, significant value adding features immediately becomes available in the overall design. These advantages are both cost prohibitive and technologically challenging using conventional alternate methods, such as a variety of complex mechanical controls. Fans with BUS communication for display case and bottle coolers are currently available to OEMs. These help meet the demands for reliable, energy efficient systems without changing the existing design footprint of display cases and without adding complexity to the overall design.

Author information

With more than 12 years of experience at ebm-papst Inc., **Lou Moffa** listens to the challenges our customers face and recommends air-moving solutions that help refrigerant system engineers, warehouse owners and supermarket managers keep food fresh across a variety of storage and display environments. As the company's **Market Manager – Commercial Refrigeration**, Lou holds an automated manufacturing engineering degree from Waterbury State Technical and a Bachelor of Science in manufacturing engineering from Central Connecticut State University.

Energy saving complete fan assembly for evaporator or condenser applications.

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