

MICROELECTRONICS

HOWARD ABRAMOWITZ

CLEANROOM FFU CONTROLLERS TARGET SMALL SYSTEM REQUIREMENTS

Cost-effective, sophisticated FFU solutions are now available for small cleanrooms

Fan filter unit (FFU) implementation continues to be the preferred solution for new cleanroom installations both large and small. Communication and control of these FFU systems have been confined solely to the large system installations, leaving the small rooms to continue using manual set-and-forget FFUs. With

a greater emphasis today on cost reduction and energy conservation (running cost), more options are being demanded by the cleanroom customer. Since both mini-environments within large cleanrooms and in small installations (100 FFUs or less) continue to dominate the market need (over 90% of all installations), this is an area receiving the greater attention. Large system customers can afford high-end, sophisticated FFU controllers; they use expensive programmable logic controllers (PLC) and hire system integrators to put a cleanroom management system together. These solutions become prohibitively expensive as the system size shrinks. Less sophistication is needed and there are fewer FFUs over which the system integrator overhead can be spread. Most small cleanrooms' FFUs remain as passive, dumb systems. New solutions are now available, making the control of these units in small cleanrooms viable and cost-effective.

Defining the Need

In most cleanroom systems, the challenges are similar for both small and large installations. There

is the initial cost of the system: installation costs; balancing costs; and servicing costs. For large installations, there is often a significant investment in plant and equipment at stake. Table 1 compares critical needs of large and small cleanroom environments. It identifies opportunities for improved small system implementation. Major differences are

in the resources that can be thrown at the task and the technical depth of the installation team putting in the cleanroom. For example, to be able to address the set-up, balancing, and energy savings potential of clock-calendar features, additional barriers will come into play. For the small cleanroom, the system must be simple to set up and run. The small cleanroom installer is often unwilling to bear the expense of customizing installations with unique software.

Simplicity, ease-of-set-up, and ease-of-use dictate a standardized approach to the solution. Table 2 presents the short list of features and expectations that revolve around making a smart cleanroom solution viable for small and minienvironments. Figure 1 outlines a functional block diagram.

To avoid complications, most small cleanrooms will not invest in high-end FFU systems that contain high-efficiency DC brushless motors. DC system controls are available but are relatively expensive. Lower cost AC fan

LARGE SYSTEM	SMALL SYSTEM	SMALL SYSTEM REQUIREMENTS
Expensive high-end facility equipment and building management systems	Specific function space with limited equipment expenditure	Low cost
Building management system (BMS) available and installed	BMS either not available or not desired to be hooked in	Self-contained functionality
System integration needed for building, cleanroom, and equipment coordination	No system integrators often involved	Keep it simple
Long term cost evaluation: life cycle costs viewed	Entry level cost priority: short term payback	Low cost is key to acceptance
Constant monitoring and adjustments are the norm	"Set it/Forget it" is the norm	Features easy to manage
Uses high end DC system for noise and energy cost	Uses AC-driven FFU with no controls & lowest cost	System compatible with AC and DC
Customized space with planning and optimization	Standard solutions from multiple vendors available	Standard solution for broad utilization

Table 1: Large system vs. small systems comparison chart

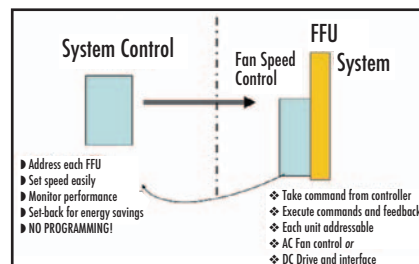


Figure 1. Block diagram of a simple fan filter system for small cleanroom installations

Easy to mount and attach
Simple user interface
Supports small networks
No installer configuration required
Checks status
Adjusts speed
One-Step/Set-Back capability

Table 2. Small system short list of critical system parameters

systems are the norm in small systems but the availability of smart, low-cost AC fan controls are very limited. The lack of product options, high cost, and added complexity have forced small cleanrooms to use a manual control option— set-it-and-forget-it position.

Solution Tools

If we are looking at small system solutions, there is a need for different elements to make it a successful installation. A smart AC controller is needed and a low cost controller/master will allow for smart, local set-up and balancing to be deployed. The system has to be smart enough to offer the features identified in Table 2.

AC Speed Control: There are numerous solutions available for the AC smart control. The most sophisticated systems are single-phase variable frequency controls. These controls are frowned upon by many fan suppliers as they do not rate their fans for “inverter grade” and limit warranties if they are used. Phase-Control solutions are preferred. The AirCare VariPhase™ solution (Figure 2) attempts to provide speed control, network communications, and improved efficiency into a cost-effective package. Its 3-wire configuration aids in improving efficiency and extending motor life. Also, motor hum is reduced at lower speeds, eliminating a nagging element of AC control systems. Figure 3 provides some data related to comparative speed control efforts

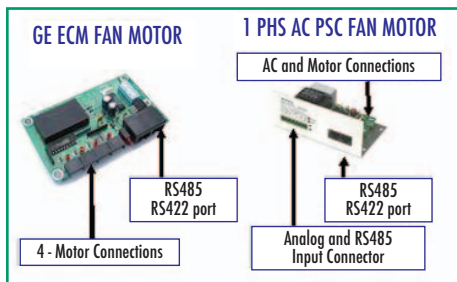


Figure 2. AirCare VariPhase™ and GE-ECM Interface for Small System Networks

and the benefits of smart control systems (i.e. linear speed control, lower noise, and higher efficiency).

DC Speed Control: For DC speed control there are even more options. Companies offering DC fans often provide full hardware systems, leaving it to the customer to provide their own system integration. Major DC motor/fan suppliers (i.e. EBM, GE Motors) and FFU manufacturers (i.e. ENVIRCO, Gebhart) offer proprietary solutions in this arena. An example of a “network” interface for the GE-ECM motor is also shown in Figure 2. Customers can integrate small system solutions while taking advantage of the inherent efficiencies of the DC brushless performance.

Master-Control/System Console: Most large systems assume system integrator expertise is available and take full advantage of a large-scale building management system. Clock/calendar features are common and all systems contain floor-plan layout and computer screen local control templates. Small systems can neither remain affordable or take advantage of such sophistication. Table 2 is a short list of key parameters that provide the lion’s share of small system needs.

Small system solution innovation is being made on two fronts: PLC system suppliers (i.e. SAIA-Burgess) offer lower cost PLCs with building block software designed to work in a small environment. The combined cost of PC plus

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PLC hardware is a factor of two lower than those available three years ago. System suppliers targeting the smaller system can offer semi-custom solutions (Figure 4) at reduced cost. However, these systems still need software and programming efforts—often a roadblock to small system implementation.

A “non-programmable” solution is available providing a custom designed dedicated controller that is targeted at specific applications. The Air-Care Console™ (Figure 5) is an out-of-the-box controller designed for the small cleanroom market. These controllers can work with the AC or DC addressable motor controls identified above (Figure 2). Dedicated controllers offer a lower cost for applications that have traditionally used general purpose tools.

Small System Features

Ease of Installation/Balancing: For small AC systems, a customer can save 50% of the installation and balancing time to hook up. At rates of \$75 to \$100 per hour for installation and balancing cost, the savings can be significant. **Set-Back Results (Example):** Consider a cost analysis of an AC system using 2 x 4 ft. FFUs typically running 250 watts at full speed. A small cleanroom was operated typically 10 hours per day, 5 days per week. A set-back to 110 watts (500 RPM from 1100 RPM) was requested. Calculating the savings at a cost of \$0.22 per kwh, system savings exceed \$150/year. Without any other savings, the payback for system installation was approximately 9 months. A good rule of thumb is for every 50 watts

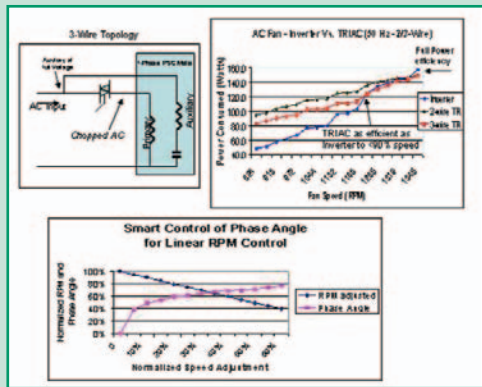


Figure 3. Improved performance and linear speed control results of smart AC phase-control

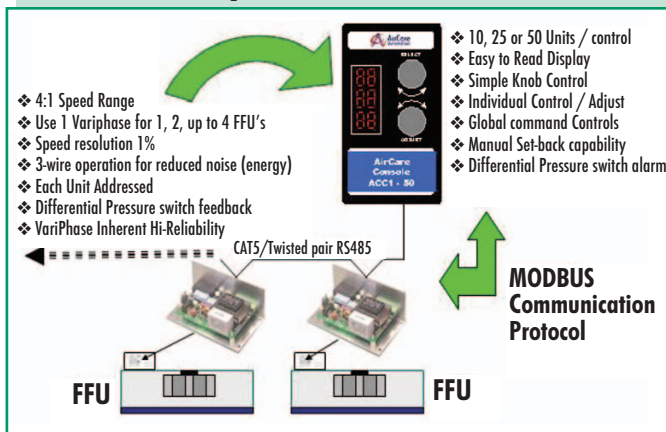


Figure 4. PC+PLC System Diagram

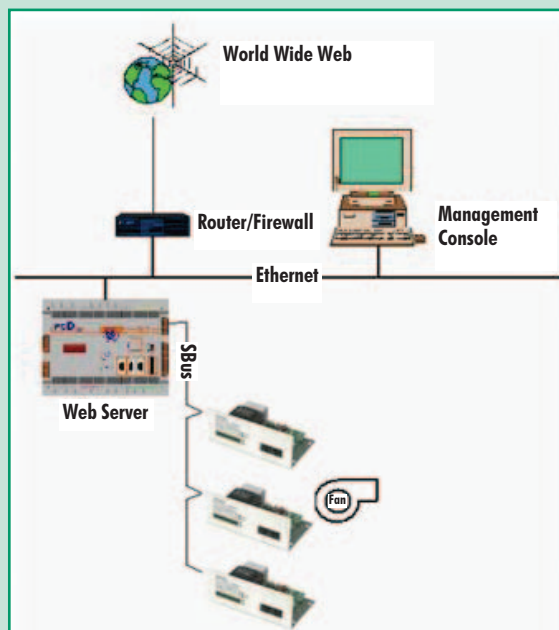


Figure 5. AirCare Console™ + AirCare VariPhase™ AC phase control system diagram

of power one can set-back and save, one can reduce electric consumption by more than \$50.00 per year (\$1/year/watt saved upon set-back). When one includes lower installation and balancing costs, ease of reducing full speed flow to optimize the cleanroom application, and the cost saving on the filter media by extending its useful life, it is estimated that a payback of less than 6 months is realistic. Along with the lower fan noise and the flexibility to adjust and reconfigure cleanroom space, the system is now very cost effective.

Conclusion

With the continuing growth of small cleanroom systems and the greater utilization of mini-environments in large cleanroom space, there is a growing demand for solutions that improve FFU operation and save both save energy and reduce cost. Low-cost dedicated controllers (consoles) coupled with both improved AC controls and out-of-the box DC solutions will give system users a breadth of options that were previously unavailable. Lower cost PC+PLC solutions are also moving into a cost-effective range, even where higher levels of sophistication are desired. New systems are available that require no programming and provide performance features that are targeted for cleanroom utilization. Power savings of more than 100 watts and cost saving of greater than \$100 per FFU (per year) are achievable.

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