Using Modbus Controls For EC Fans to Reduce HVAC Energy Consumption

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Controlling energy cost without sacrificing comfort in mid-size to large commercial buildings has always been a challenge. With energy costs soaring, the challenge has taken on a new urgency.

Fans are the primary consumers of electricity in HVAC equipment, and, as a category of products, are among the largest energy users in the world. In fact, a recent article in ASHRAE Journal stated that 23% of all energy usage worldwide is for the operation of fans. Given this fact, the need for greater efficiency in HVAC fan operations is obvious.

Greater efficiency is also within reach. In this article, we focus on how to use existing Modbus protocol system management technology with “smart” electronically commutated (EC) fans to optimize fan performance while reducing energy consumption.

Axial and backward curved radial EC fans.

Several advanced OEM fan manufacturers who are suppliers to the HVAC industry are now offering EC fans with built-in Modbus communications capabilities. This eliminates the need for separate fan control modules and greatly simplifies networking equipment across large zones.

Additionally, Modbus communication interface software developed specifically for fan operations is now readily available, simplifying the process even further. It is
not unusual for fan manufacturers to provide their own Modbus driver software at no cost for use with their Modbus capable fans.

**Why Modbus?**

Modbus is one of the de facto standard communications protocols. It was first introduced in the late 1970s to communicate with programmable logic controllers (PLCs). Originally used in factory automation and process controls, it was later adopted into building management systems. Today Modbus is used worldwide in office buildings, airports, schools, hotels, hospitals and other commercial, industrial and institutional facilities.

Modbus allows for communication between about 250 devices connected within the same network, depending on the Modbus variation being employed. While Modbus is a type of master/slave (or client/server) protocol it allows the master device and all the slave or server devices to be controlled individually.

A typical Modbus network has one master and one or more slaves or servers. Each slave has a unique 8-bit device address or unit ID number. Commands sent from the master device contain the address for the particular slave device for which the message is intended. Only the intended device will act on the command, even though other devices might receive it. This is the aspect of the protocol that provides for individual communication with all networked devices.

While each server fan has its own ID number, and reacts only to messages sent to that ID, the system operator can also “broadcast” commands to all operating fan units. This is often accomplished by assigning broadcast messages an ID of zero (0). Broadcast messages are acted upon by all server fans simultaneously, as long as they are properly received.
A facilities manager or system operator can remotely control the connected devices, including scheduling, start/stop commands, change of operation mode and change of settings. Building or plant operations can be continually optimized using data transferred from the connected devices, such as status messages, alarms and energy usage meters.

**Open Source/Open Networks**

There are several types of Modbus. The most common is Modbus RTU, which operates on a RS-485 network. RTU stands for Remote Terminal Unit. Modbus is open source technology. Protocol specifications are available from [www.modbus-ida.org](http://www.modbus-ida.org) at no cost.

It is a favorite of systems integrators and automation contractors as a way to integrate different types of devices from different sources into a single network.

Because of this easy accessibility and because it is a simple, reliable, adaptable technology, Modbus is now used for a wide range of applications, from HVAC, to water and waste water management, to oil and gas processing, to manufacturing automation.

Important elements of HVAC control are common functions for Modbus, such as I/O interface, AC/DC drive control and monitoring or sensor input capabilities.

Well-defined functions make HVAC implementation easier, and fan manufacturers now routinely provide their own proprietary Modbus interface software that simplifies the process even further. Used in combination with “smart” EC fans that feature built-in communication capability, no additional hardware such as a control unit or a frequency inverter is needed upstream. As a result, equipment cost is reduced, as well.

**Single User Interface**

Unlike conventional separate units that serve one relatively small zone, a networked HVAC system that is designed to maintain comfortable air conditioning in medium to large areas must use multiple units working together as a “team”.

In a conventional scenario, each individual air conditioning unit each has its own user interface and control device. The user interface, usually a wall mounted thermostat, includes a display device and buttons or switches, which comprise the operational interface. The control device might include a temperature sensor and control circuitry.
Individual user interfaces are eliminated with Modbus controls. In a Modbus system, a single master or client device using a low-level communication network (such as Modbus RTU) with a common interface, can control all units with the highest efficiency and reduced energy consumption.

**Simple Six-Step Process**

1) The first step in attaining optimal HVAC performance with lower energy usage is proper fan product selection. For the purpose of controlling and reducing energy consumption across a large networked HVAC system, standardizing on one fan manufacturer and one software solution will simplify the process and improve the results. Creating a system made up entirely of products from one manufacturer will eliminate interface problems.

Selection criteria should include product quality, performance, efficiency and product range (size and configuration). Fans must be electronically commutated to allow for 100% variable speed control. (EC fans have other benefits, as well. Controlled by maintenance-free electronic circuitry, they run cooler and quieter with longer service life.) Fans should have built-in Modbus communication capabilities to facilitate connections. No special connectors or tools should be needed for communication wiring. The availability of pre-configured Modbus driver interface software should be an important consideration.
2) The client and all server devices must be linked together in a communication network. Modbus RTU is a serial network and must be physically connected using the appropriate RS-485 interface. Since most PCs do not support RS-485, plug-in converters for RS-232 and USB to RS-485 are available from several sources, including fan manufacturers. The fan must be connected to the network and also to the power supply.

[Caption: Example 1]

3) The fan must be added to the software driver. (See example 1: choose the fan icon in the tool bar; click on each fan symbol to add the associated fan to the system)

[Caption: Example 2]
4) Configure each fan's parameters. (See example 2: double click on the appropriate fan symbol to open the configuration window. Add fan address and name. Select the appropriate bus system. Set fan parameters.)

5) Run a system check/initialization. (See example 3: system check provides visualization that each server fan is communicating with the control system. The lightning bolt shows actual communication with each fan serially. The system is operable after initialization.)
6) Set controls for each fan. (See example 4: Open the configuration window and click on the operating values tab. Here you will find all the necessary tools to set or adjust the fans’ operating controls.)

Once Step 6 is complete, the system operator or building manager is in control of each fan individually and the facility as a whole from his or her computer. Each fan unit will operate to its own settings in its particular area. Sensors connected to each operating fan unit will maintain control settings and can record relevant data. Fan operations can be precisely monitored and managed individually and as a system.

**Vendor Software or Your Own?**

In the example above, the final four steps in the control process were completed through a Modbus interface provided by a fan manufacturer. Given its availability, its cost (usually there is none) and the fact it is already configured to easily control fan operations, vendor software is often a good choice.

Interface software from fan OEMs sometimes includes “extras”, too, that in-house programmers might not have the time or the expertise to include. For example, Rosenberg’s ECPParam software allows operators to visualize the current state of any selected fan. It provides animated graphing of the curves of the speed, setpoint and sensor signal. This is visualization is useful for operators to see how a fan is reacting to external influence if pressure, airflow or temperature controls are used. The reported values can also be stored in a file for diagnostic purposes.

As discussed, however, Modbus is a simple, well-established protocol that can be configured to almost any type of process control automation. If your HVAC application requires control of devices other than fans – valves or pumps, for example – a custom solution might be more useful.

Depending on the scope of your needs, other communication protocols may also be appropriate. Although more complex than Modbus, both BACnet and LonWorks are commonly used in building automation.

LON is a trademark, which stands for Local Operating Network. LonWorks is a building automation protocol created by Eclelon Corporation in 1989. It is a peer-to-peer network, meaning there is no single master on the network. Control devices are free to communicate directly with each other, avoiding some of the problems that can occur if a single master fails.

BACnet stands for Building Automation and Control Network. It was officially unveiled by ASHRAE in 1996, and has been approved as ISO standard 16454-5. It is also becoming a standard in the European Union. It is a peer-to-peer
network, like LonWorks. As its name implies, this protocol focuses on building automation applications.

**Conclusion**

The advantages of Modbus controls for large HVAC systems are significant. Individual HVAC units controlled separately by individual user interfaces (wall-mounted thermostats) are unsuitable for large areas. At the same time, large conventional master/slave systems are also extremely inefficient and create buildings that are always too hot or too cold, sometimes on the same day!

Creating more comfortable indoor environments for commerce and industry while at the same time reducing energy costs, Modbus controls for HVAC fans represent a real solution for problems noted above.

The unique client/server architecture of the Modbus protocol allows a wide range of control options for large HVAC systems. Through one interface, building managers and system operators can monitor and control many separate devices, each supported by its own sensors and control circuitry.

Leading fan manufacturers are now providing advanced EC fans with built-in Modbus communication capabilities and Modbus interface software. With energy costs at record highs, the promise of energy savings and increased comfort should fuel the drive to Modbus.

In short, it has never been easier, or smarter, to connect HVAC fans in a Modbus network and control their operations for improved energy consumption management.

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