

Mini RS-485 devices thriving in control applications

By David Goodin

A new class of small stepper and servo controllers is allowing control to be distributed close to the loads in instruments. The venerable RS-485 interface is still finding a place in connecting these controllers. When used in microscope automation instruments, these tiny controller boards can cut costs, improve scalability, and enable easy implementation of distributed automation systems.

System creators are always under pressure to get products to market as quickly as possible. Inventors and designers must control motor-driven mechanical parts in a reliable and effective manner. The steady increase in automation use requires ever-more powerful solutions for controlling electromechanical devices that often must react to inputs such as voltages, switches, and encoders to accomplish the task for which they were designed. Laboratory instruments, underwater robotic vehicles, and portable field equipment are just a few examples of application classes that benefit from smaller, lighter, and smarter board-level control solutions.

Today, more mechanical and chemical engineers, biologists, physicists, and technicians are tasked with the job of making the machine move. Not long ago, significant specialized electronics and motion-control knowledge was required to accomplish tasks such as moving a motor, turning on a relay, or sensing and reacting to inputs from the outside world. The mechanical engineer would design the mechanism and pass it on to the electrical engineer, who would design a control system to make the subsystems work. Then the systems engineer would meld the disparate parts into a cohesive, functioning whole.

New, easier-to-use control

These days, the mechanical engineer wants to make a mechanism move without obtaining a PhD in Proportional Integral Derivative (PID) servo tuning, having to learn complex automation system software, or being required to disassemble a computer. The mechanical engineer likely does not know exactly how a stepper motor works but does realize that spinning a motor and reading a sensor are necessary to accomplish the task at hand.

The semicustom manufacturing sector's growth is partially made possible by newer, smaller controls and electronic drive systems. However, being small is not enough; these systems typically must move several motors, drive solenoids, and read and react to switch inputs, potentiometers, and/or computer input. Tying the system together with classic computer-centric designs can require a specialist to accomplish even the most basic task of turning a relay on and off. Turning a variety of motors becomes a daunting task.



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The intricacies of programming possibilities, variety of available bus options such as CAN, and wide acceptance of Ethernet technology have contributed to the overall complexity of electromechanical interface options. As this interface complexity increases, so does the knowledge and experience required to employ the boards in the desired application. The

learning curve of highly complicated systems can be significant. Fortunately, new technology aids the neophyte and experienced control systems designer alike by not only being small, but also easy to use.

Keeping it simple

One of the most straightforward forms of communication among computers and peripherals for the past 30 years is a serial data link using RS-232 hardware and derivatives such as RS-485. This type of interface will always be available for one reason: simplicity. A mechanical engineer can easily type commands into a terminal program such as HyperTerminal and understand the ASCII characters returned from the hardware as a result. The interchange between what is sent and what is returned is highly visible, and there are no mysteries as to what is going back and forth between a computer and its peripherals.

The issue of size has been tackled in a couple of different ways. The processing power available in a small form factor board has increased exponentially in recent years. Eight-bit microcontrollers that ran at clock speeds of 4 MHz have been replaced by 16-bit DSP microcontrollers running at 160 MHz. Another important change is that power semiconductor manufacturers have reduced their products' on-state resistance and consequently their size by several orders of magnitude.

The increase in computational power and reduction in power dissipation in power control electronics have allowed intelligent control elements to be placed near the loads they control rather than in an isolated part of the instrument or a remote rack. Instead of large bundles of wires radiating from a central point to the loads, now it is possible to wire only power and communications to the loads, with intelligent power control electronic devices mounted at the same position as the load they control.

Focus on microscope automation

Today's automated solutions are taking advantage of miniaturized stepper and servo controllers. For example, TOFRA, Inc., a laboratory equipment company located in Palo Alto, California, is using AllMotion EZStepper driver+controller boards in its microscope automation instruments, shown in Figure 1. This line of equipment includes a motorized microscope focus actuator and filter wheel to automatically adjust the focus and vary the filter in use. Both mechanisms use small (size 17) stepper motors to turn the focus drive and filter wheel.

Using the EZHR17EN stepper drives (Figure 2), which are the same size (1.6" x 1.6") as the motors they control and located adjacent to the motors, helps lower costs, decrease required desk space, reduce cable clutter, and improve the scalability of the microscope automation equipment. The two released devices – the filter wheel and focus drive – can be daisy-chained together and with other filter wheels and stages (in development), creating an automated microscope system. The cables only carry direct current and communications signals, thus minimizing electromagnetic interference.

These microscope automation devices do not require additional control units; they connect directly to the computer serial port or to a USB port through a USB-to-serial converter via a custom cable and can be used with desktop or laptop computers. With distributed control, the user can decide beforehand on the composition of the whole microscope system or upgrade the control unit when new devices are added.

Features of a stepper motor controller that make it suitable for distributed automation include:

- Small size, corresponding to NEMA 17 motor
- No need for heat sinks
- Easy packaging, including connectors and output voltage for limit switches
- Ability to mount on-axis or off-axis and use with different motors
- Easy programmability



Figure 1

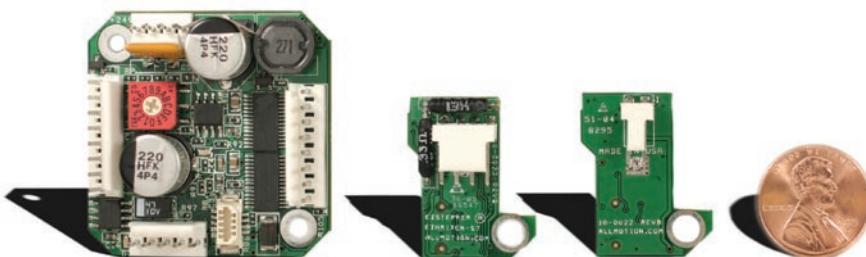


Figure 2

Driving more power

Onboard Electrically Erasable Programmable Read-Only Memory (EEPROM) and Field Effect Transistor (FET) drivers for driving solenoids or other unidirectional devices help facilitate easy implementation of a stand-alone control system. One can think of the units as having a built-in programmable logic controller. Each time the units are powered up, they execute the first program in memory.

Many applications require the same action to happen every time the user presses a button. Using onboard EEPROM, programs can wait for a switch input, move a motor, set an output, and enter the wait loop again. This technique can be employed in a wire-cutter application, for example. When the user presses a button, the motor is turned a certain number of revolutions and stopped. The motor turns a feed wheel that pays out a certain length of wire. After that, the onboard FET is turned on, actuating a solenoid-controlled wire cutter. The program then waits for another button press to start the whole process over again.

Shrink-to-fit controllers

Until recently, employing motion-control devices in mechanisms required designing and manufacturing custom electronics plus a great deal of experience and/or education. Now, even small instruments can be designed with miniature motion-control and I/O boards sprinkled throughout the instrument linked only by a four-wire bus containing two power and two communications wires. The latest stepper and servo controllers on the market today demonstrate this new paradigm in designing ever-smaller instruments. ➤



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