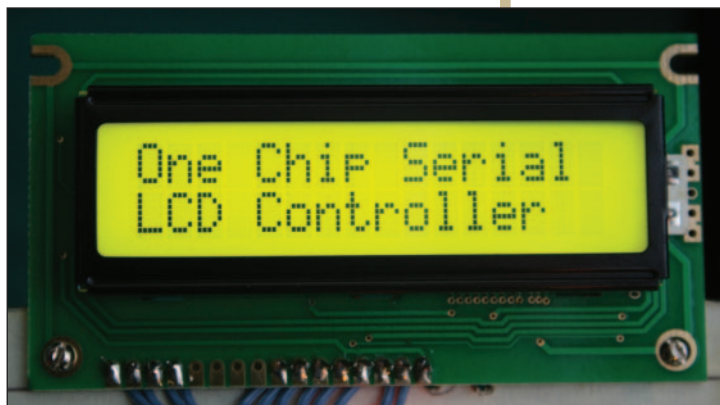




Small microcontrollers such as the BASIC Stamp have greatly simplified automation and electronics design, bringing many into a field once ventured by few. Many projects require interaction with the user, both for inputting data and to provide feedback and results.

A liquid crystal display (LCD) is often chosen for the user interface.

■ **FIGURE 1.** This photo illustrates an inexpensive two-line, character LCD displaying data from a microcontroller, (e.g., BASIC Stamp 1, BASIC Stamp 2, Nemesis, ZX-24, PIC, etc.).



MICROCONTROLLER LCD INTERFACE, A ONE-CHIP SOLUTION

LCDs range in size and capability, from the typical wristwatch display, to medical EKG monitors and advanced aviation-cockpit displays. Character (non-graphical) LCDs can be easily incorporated within microcontroller designs, as seen in Figure 1. This article provides a low-cost, one-chip solution for interfacing a microcontroller to an LCD.

Character-mode LCDs typically found in small projects come in a range of sizes, including one, two, or four lines of text. The number of characters per line typically ranges from eight to 40, with 16 and 20 being commonly used. Most LCDs incorporate an HD44780-compatible controller as part of the LCD module. Interfacing to the LCD requires four data lines and three control signals. Power, ground, and contrast round out the connections to the LCD. Interfacing to a microcontroller is straightforward, but can both tie up many of the available I/O pins, and consume a significant portion of the available

program memory.

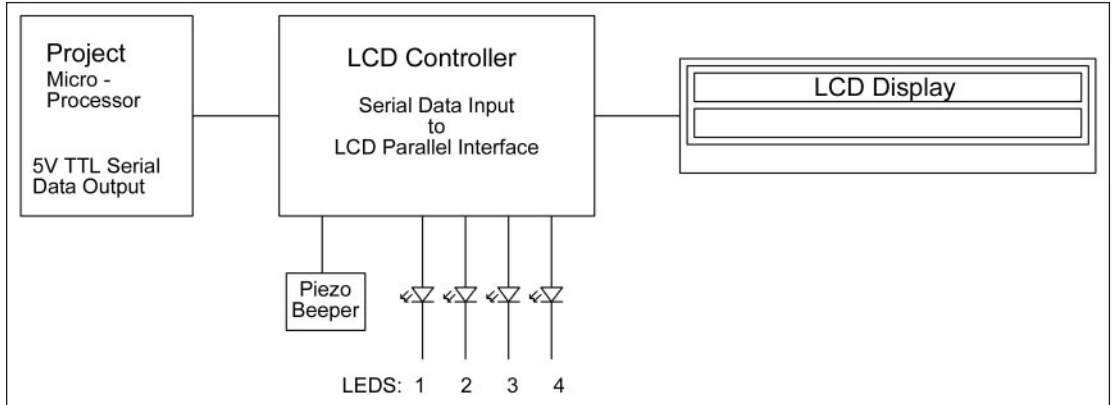
A good approach to alleviate these issues is to dedicate a microcontroller as an LCD driver. The main project's microcontroller can then dedicate a single I/O line for serial-data transmission to the LCD-driver microcontroller. The LCD driver then buffers the data and drives the LCD through its parallel interface. This concept is illustrated in Figure 2.

It is possible to purchase an LCD with a serial interface already incorporated into the LCD module. Unfortunately, one often pays a hefty premium for this convenience. By purchasing an LCD with a parallel interface, and adding one's own serial LCD driver, one can save money and incorporate any custom features desired.

The Nemesis is a Microchip PIC 16F88 available through Kronos Robotics. It is programmable in Athena, a PIC version of Basic. The language and development platform are available for download at no charge. The Nemesis includes an interrupt-driven hardware UART for serial communications. It has an 80-character buffer that virtually eliminates data-exchange synchronization and data-loss issues.

Figure 3 illustrates this microcontroller interfaced to a typical HD44780-compatible character

■ **FIGURE 2.** An inexpensive, Basic-programmable PIC can be easily programmed to serve as a serial interface to drive LCDs.



LCD. The extra I/O pins on the Nemesis are put to good use, too. One pin selects the baud rate used to send serial data from the main project's microcontroller. If

left unconnected, port 13 floats high, and the baud rate is 9600 (N81). If it is tied to ground, the baud rate is 2400 (N81). This slower baud rate was chosen since it is the fastest speed available on the BASIC Stamp 1.

Ports 7, 8, 9, and 14 are used to drive LEDs. Although LCDs can convey much more information than an LED, they are often still useful as status indicators. A quick glance can convey power on/off, signal acquired, error mode, awaiting user input, etc. As software controlled digital output ports, they can be used for other pur-

poses as well, such as driving a relay.

Port 11 is tied to a piezoelectric beeper to provide an audio alert to the user. Port 6 is driven by a hardware PWM (pulse width modulator). It is used to drive the LCD's backlight, giving one software control for On, Off, and Dim modes.

LCD Commands

In use, the main project's microcontroller sends serial data and commands to the LCD controller. The commands presently supported are

shown in the LCD Driver Features sidebar. The Nemesis has spare memory available and is programmed in Basic. This makes it easy to add new commands or incorporate custom features as desired. For example, if higher speeds are required, the Nemesis supports baud rates of up to

■ **FIGURE 3.** The Nemesis configured as an LCD driver. A jumper is used to set the baud rate for the data sent from the main project's processor. Software control of the LCD's backlight, four LEDs, and a piezoelectric beeper is included.

