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# SparkFun SerLCD v2.5 Application Note

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## Overview

The SerLCD v2.5 is a simple and cost effective solution for interfacing to Liquid Crystal Displays (LCDs) based on the HD44780 controller. The SerLCD module takes incoming 9600bps TTL level signals and displays those characters on the LCD screen. Only three wires – V+, GND, and Signal are needed to interface to the LCD.

## Compatible Products

This datasheet is relevant for several products in our catalog. There are a variety of Serial-enabled LCDs with different color schemes, sizes, and input voltages. The command set and configuration described here is compatible with all of these as well as the Serial Enabled LCD Backpack add-on which can be attached to any standard LCD screen.

			
SparkFun Serial Enabled LCD Backpack	SparkFun Serial Enabled 16x2 LCD - White on Black 3.3V	Serial Enabled 20x4 LCD - Black on Green 5V	Serial Enabled 16x2 LCD - White on Black 5V
LCD-00258	LCD-09067	LCD-09568	LCD-09395

## Features in Version 2.5

SerLCD v2.5 has some new features that make the SerLCD even more powerful and economical:

- New PIC 16F688 utilizes onboard UART for greater communication accuracy
- Adjustable baud rates of 2400, 4800, 9600 (default), 14400, 19200 and 38400
- Operational backspace character
- Incoming buffer stores up to 80 characters
- Backlight transistor can handle up to 1A and can be connected to external loads
- Pulse width modulation of backlight allows direct control of backlight brightness and current consumption
- User definable Splash Screen

## Interface Specifications

### Default communications

Set the serial interface to: 9600 baud, 8 bits of data, 1 start bit, 1 stop bit, and no parity (9600,8,1,1,N). This can be changed / updated using the following command set. However, be aware that if you change the communication protocol, you may not be able to re-connect or control the device.

## Data / Display Information

All settings are stored on onboard EEPROM and loaded during power up. To display data on the SerLCD, you simply send ASCII-formatted characters using a serial interface which matches the communication protocol. This means that if you pass the ASCII character 'r' to the module, an 'r' will be displayed on the LCD at the next cursor position.

## Configuration / Command Set

There are two reserved control characters used to configure and control various features on the LCD. These are the control characters 254 (0xFE) and 124 (0x7C). Sending a control character followed by a command will allow you to control the cursor, backlight, and other features on the SerialLCD. A complete table of commands are shown in Table 1.

Control Character	Command	Description
0xFE	0x01	Clear Display
	0x14	Move Cursor Right 1 Space
	0x10	Move Cursor Left 1 Space
	0x1C	Scroll Right 1 Space
	0x18	Scroll Left 1 Space
	0x0C	Turn Display On / Hide Cursor
	0x08	Turn Display Off
	0x0E	Underline Cursor On
	0x0D	Blinking Cursor On
	0x80 + n	Set Cursor Position
0x7C	0x03	20 Characters Wide
	0x04	16 Characters Wide
	0x05	4 Lines
	0x06	2 Lines
	0x0A	Set Splash Screen
	0x0B	Set Baud Rate to 2400
	0x0C	Set Baud Rate to 4800
	0x0D	Set Baud Rate to 9600
	0x0E	Set Baud Rate to 14400
	0x0F	Set Baud Rate to 19200
	0x10	Set Baud Rate to 38400
	0x80	Backlight Off*
	0x9D	Backlight Fully On*
0x12	Reset to 9600 Baud - send during boot-up	

Table 1: SerLCD Command Set

The HD44780 LCD controller is very common. The extended commands for this chip include but are not limited to those described in Table 1. Please refer to the HD44780 datasheet for more information.

Clear display and set cursor position are the two most frequently used commands. To clear the screen, send the control character 0xFE [254 (dec)] followed by 0x01. Clearing the screen resets the cursor position back to position 0, the first character on the first line. To set the active cursor position, send the control character 0xFE [254 (dec)] followed by 0x80 + n, where n is an offset as described in Table 2.

16 Character Displays	
Line Number	Viewable Cursor Positions
1	0-15
2	64-79
3	16-31
4	80-95

  

20 Character Displays	
Line Number	Viewable Cursor Position
1	0-19
2	64-83
3	20-39
4	84-103

Table 2: Character and Cursor Offset positions

#### Example of setting the cursor position

- Determine the position offset for the display location using Table 2. For example, the position offset for the character on the second line of a 16 character display is 66.
- Add 0x80 [128 (dec)] to this value. For the third character on the second line:  $66 + 128 = 194$ .
- Send the command character 0xFE [254 (dec)] to tell the SerLCD you want to send a command followed by the number 0xC2 [194 (dec)].
- The cursor should now be sitting in the third position of the second line. Sending any other character will display on the LCD starting at this position.

#### LCD Type Setup

The SerLCD v2.5 firmware includes settings to interface to the following types of LCDs : 16x2, 20x2, 16x4, and 20x4. If you purchased the SerLCD pre-soldered to an LCD, it has already been configured to work with that specific LCD. You should not have to configure anything.

If you purchased the SerLCD backpack module by itself, you will have to configure the module what type of LCD it is going to be, or is currently, attached. To set the type of LCD the SerLCD module is attached to, transmit the control character 124 0x7C followed with either 3, 4, 5, or 6. These commands set the LCD character width and number of lines. These settings are used to correctly wrap the cursor to keep it within the viewable screen. The type of LCD is saved to EEPROM after each change.

#### Splash Screen

The SerLCD v2.5 displays a splash screen by default. This splash screen ('Sparkfun.com SerLCD v25') verifies that the unit is powered, working correctly, and that the connection to the LCD is correct. The splash screen is displayed for 500 ms during boot-up and may be turned off if desired.

A new addition to the V2.5 firmware is the ability for the user to set their own splash screen (2 lines). To do this, just set the top 2 lines as you would like them to appear, send the control character 0x7C [124 (dec)] followed by CTRL-J (0x09) to save it to memory. To test, just cycle power.

To disable the splash screen, send the control character 0x7C [124 (dec)] to the unit followed by CTRL-J (0x09). Every time this command is sent to the unit, the Splash Screen Display option will toggle. If the splash screen is currently being displayed, sending the 0x7C, 0x09 command will disable the splash screen during the next boot, and sending the 0x7C, 0x09 command again will enable the splash screen.

## Changing the Baud Rate

The Serial LCD V2.5 defaults to 9600 baud, but can be set to a variety of baud rates.

Caution: Once you change the baud rate, you need to change the baud rate of your controlling device to match this. To change the baud rate, first enter the control character 0x7C [124 (dec)], by 0x0B to 0x10 to set the baud rate to 2400 to 38400.

If the Serial LCD gets into an unknown state or you otherwise can't communicate with it, send a CTRL-R (0x12) character at 9600 baud while the splash screen is active (during the first 500 ms of boot-up) and the unit will reset to 9600 baud.

## Backlight Feature\*

The SerLCD v2.5 provides you with control of the backlight to one of 30 different brightness levels. To control the backlight, send the control character 0x7C [124 (dec)] followed by a number from 0x80 to 0x9D [128-157 (dec)]. 0x80 sets the backlight to off and 0x9D sets the backlight fully on.

This is handy when power consumption of the unit must be minimized. By reducing the brightness, the overall backlight current consumption is reduced.

## Hardware

### Vcc and Current Draw

The SerLCD v2.5 should only be powered by 5V DC. Higher than 5.5V will cause damage to the PIC, LCD, and backlight (if attached).

The SerLCD uses 3mA with the backlight turned off and -60mA with the backlight activated.

### Contrast Control

The SerLCD v2.5 comes equipped with a 10k potentiometer to control the contrast of the LCD. This is set by during assembly and testing but may need correcting for your specific LCD module. Temperature and supply voltage can effect the contrast of the LCD.

### Hi-Current Control Pin

The SerLCD v2.5 uses a general purpose, 1000mA NPN transistor to control the Backlight. If you purchased the SerLCD module, you may use this pin as a general purpose, high power control pin. If you issue the backlight on/off command to the SerLCD, the BL pin on the board can also be used to power / control other circuits with a maximum current of 1000 mA. This is usually the last pin on the top row of the LCD. Check your datasheet for proper pin outs.