Liquid Crystal Displays (LCD) with Arduino

Find out how to wire an LCD to an Arduino, and how to use the LiquidCrystal library through a set of useful examples.

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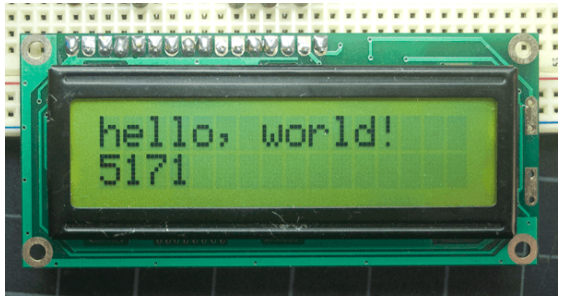
> *This article was revised on 2021/11/18 by Karl Söderby.*

The **LiquidCrystal library** allows you to control LCD displays that are compatible with the Hitachi HD44780 driver. There are many of them out there, and you can usually tell them by the 16-pin interface.



Output of the sketch on a 16x2 LCD

The LCDs have a parallel interface, meaning that the microcontroller has to manipulate several interface pins at once to control the display. The interface consists of the following pins:

A **register select (RS) pin** that controls where in the LCD's memory you're writing data to. You can select either the data register, which holds what goes on the screen, or an instruction register, which is where the LCD's controller looks for instructions on what to do next.

A **Read/Write (R/W) pin** that selects reading mode or writing mode

An **Enable pin** that enables writing to the registers

8 **data pins (D0–D7)**. The states of these

writing to a register when you write, or the values you're reading when you read.

There's also a **display contrast pin (Vo)**, **power supply pins (+5V and GND)** and **LED Backlight (Bklt+ and BKlt-)** pins that you can use to power the LCD, control the display contrast, and turn on and off the LED backlight, respectively.

The process of controlling the display involves putting the data that form the image of what you want to display into the data registers, then putting instructions in the instruction register. The **LiquidCrystal Library** simplifies this for you so you don't need to know the low-level instructions.

The Hitachi-compatible LCDs can be controlled in two modes: 4-bit or 8-bit. The 4-bit mode requires seven I/O pins from the Arduino, while the 8-bit mode requires 11 pins. For displaying text on the screen, you can do most everything in 4-bit mode, so example shows how to control a 16x2 LCD in 4-bit mode.

Hardware Required

- Arduino Board
- LCD Screen (compatible with Hitachi HD44780 driver)
- pin headers to solder to the LCD display pins
- 10k ohm potentiometer
- 220 ohm resistor
- hook-up wires
- breadboard

Circuit

Note that this circuit was originally designed for the Arduino UNO. As the Arduino is communicating with the display using **SPI**, pin 11 & 12 will change depending on what board you are using. For example, on a MKR WiFi 1010, the SPI bus is attached to pin 8 & 11.

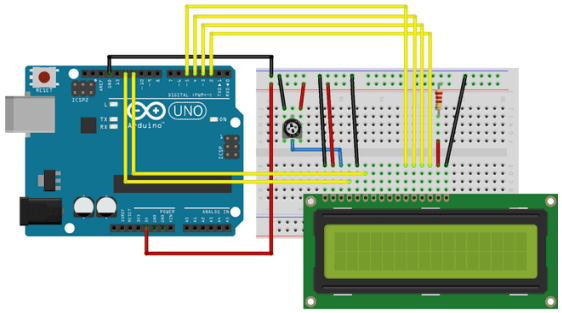
Before wiring the LCD screen to your Arduino

to the 14 (or 16) pin count connector of the LCD screen, as you can see in the image further up.

To wire your LCD screen to your board, connect the following pins:

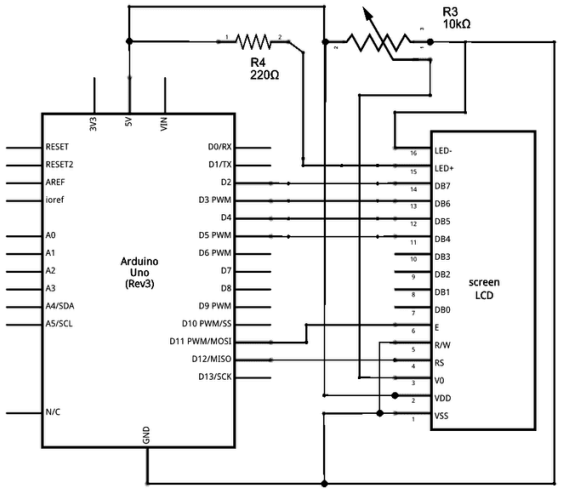
- LCD RS pin to digital pin 12
- LCD Enable pin to digital pin 11
- LCD D4 pin to digital pin 5
- LCD D5 pin to digital pin 4
- LCD D6 pin to digital pin 3
- LCD D7 pin to digital pin 2
- LCD R/W pin to GND
- LCD VSS pin to GND
- LCD VCC pin to 5V
- LCD LED+ to 5V through a 220 ohm resistor
- LCD LED- to GND

Additionally, wire a 10k potentiometer to +5V and GND, with it's wiper (output) to LCD screens VO pin (pin3).



The circuit (made using Fritzing).

Schematic



The schematic (made using Fritzing).

Hello World Example

This example sketch prints `Hello World!` to the LCD and shows the time in seconds since the Arduino was reset.

```
36
37   This example code is in the pu
38
39   https://docs.arduino.cc/learn/
40
41  */
42
43  // include the library code:
44  #include <LiquidCrystal.h>
45
46  // initialize the library by as
47  // with the arduino pin number
48  const int rs = 12, en = 11, d4
49  LiquidCrystal lcd(rs, en, d4, d
50
51  void setup() {
52    // set up the LCD's number of
53    lcd.begin(16, 2);
54    // Print a message to the LCD
55    lcd.print("hello, world!");
56  }
57
58  void loop() {
59    // set the cursor to column 0
60    // (note: line 1 is the secon
61    lcd.setCursor(0, 1);
62    // print the number of second
63    lcd.print(millis() / 1000);
64  }
```

Autoscroll Example

This example sketch shows how to use the `autoscroll()` and `noAutoscroll()` methods to move all the text on the display left or right.

- `autoscroll()` moves all the text one space to the left each time a letter is added
- `noAutoscroll()` turns scrolling off

This sketch prints the characters `0` to `9` with autoscroll off, then moves the cursor to the bottom right, turns autoscroll on, and prints them again.

```
95
96    }
97
98    // set the cursor to (16,1):
99
100   lcd.setCursor(16, 1);
101
102   // set the display to automa
103
104   lcd.autoscroll();
105
106   // print from 0 to 9:
107
108   for (int thisChar = 0; thisC
109
110     lcd.print(thisChar);
111
112     delay(500);
113
114   }
115
116   // turn off automatic scroll
117
118   lcd.noAutoscroll();
119
120   // clear screen for the next
121
122   lcd.clear();
123 }
```

Blink Example

This example sketch shows how to use the `blink()` and `noBlink()` methods to blink a block-style cursor.

```
71  const int rs = 12, en = 11, d4
72
73  LiquidCrystal lcd(rs, en, d4, d
74
75  void setup() {
76
77    // set up the LCD's number of
78
79    lcd.begin(16, 2);
80
81    // Print a message to the LCD
82
83    lcd.print("hello, world!");
84  }
85
86  void loop() {
87
88    // Turn off the blinking curs
89
90    lcd.noBlink();
91
92    delay(3000);
93
94    // Turn on the blinking curso
95
96    lcd.blink();
97
98    delay(3000);
99  }
```

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Cursor

This example sketch shows how to use the `cursor()` and `noCursor()` methods to control an underscore-style cursor.

```
/*

 LiquidCrystal Library - Curs

 Demonstrates the use a 16x2 L

 library works with all LCD di

 Hitachi HD44780 driver. There

 can usually tell them by the

 This sketch prints "Hello Wor

 uses the cursor()  and noCurs

 on and off the cursor.

 The circuit:

 * LCD RS pin to digital pin 1

 * LCD Enable pin to digital p

 * LCD D4 pin to digital pin 5

 * LCD D5 pin to digital pin 4

 * LCD D6 pin to digital pin 3
```

Display Example

This example sketch shows how to use the `display()` and `noDisplay()` methods to turn on and off the display. The text to be displayed will still be preserved when you use noDisplay() so it's a quick way to blank the display without losing everything on it.

```
/*
  LiquidCrystal Library - displ

 Demonstrates the use a 16x2 LC
 library works with all LCD dis
 Hitachi HD44780 driver. There
 can usually tell them by the 1

 This sketch prints "Hello Worl
 display() and noDisplay() func
 the display.

 The circuit:
 * LCD RS pin to digital pin 12
 * LCD Enable pin to digital pi
 * LCD D4 pin to digital pin 5
 * LCD D5 pin to digital pin 4
 * LCD D6 pin to digital pin 3
 * LCD D7 pin to digital pin 2
 * LCD R/W pin to ground
 * 10K resistor:
 * ends to +5V and ground
 * wiper to LCD VO pin (pin 3)

 Library originally added 18 Ap
 by David A. Mellis
 library modified 5 Jul 2009
 by Limor Fried (http://www.lad
```

Scroll Example

This example sketch shows how to use the `scrollDisplayLeft()` and `scrollDisplayRight()` methods to reverse the direction the text is flowing. It prints "Hello World!", scrolls it offscreen to the left, then offscreen to the right, then back to home.

```
/*
  LiquidCrystal Library - scrol

 Demonstrates the use a 16x2 LC
 library works with all LCD dis
 Hitachi HD44780 driver. There
 can usually tell them by the 1

 This sketch prints "Hello Worl
 scrollDisplayLeft() and scroll
 the text.

  The circuit:
 * LCD RS pin to digital pin 12
 * LCD Enable pin to digital pi
 * LCD D4 pin to digital pin 5
 * LCD D5 pin to digital pin 4
 * LCD D6 pin to digital pin 3
 * LCD D7 pin to digital pin 2
 * LCD R/W pin to ground
 * 10K resistor:
 * ends to +5V and ground
 * wiper to LCD VO pin (pin 3)

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 library modified 5 Jul 2009
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 example added 9 Jul 2009
```

Serial to Display Example

This example sketch accepts serial input from a host computer and displays it on the LCD. To use it, upload the sketch, then open the Serial Monitor and type some characters and click Send. The text will appear on your LCD.

```
/*
  LiquidCrystal Library - Seria

 Demonstrates the use a 16x2 LC
 library works with all LCD dis
 Hitachi HD44780 driver. There
 can usually tell them by the 1

 This sketch displays text sent
 (e.g. from the Serial Monitor)

 The circuit:
 * LCD RS pin to digital pin 12
 * LCD Enable pin to digital pi
 * LCD D4 pin to digital pin 5
 * LCD D5 pin to digital pin 4
 * LCD D6 pin to digital pin 3
 * LCD D7 pin to digital pin 2
 * LCD R/W pin to ground
 * 10K resistor:
 * ends to +5V and ground
 * wiper to LCD VO pin (pin 3)

 Library originally added 18 Ap
 by David A. Mellis
 library modified 5 Jul 2009
 by Limor Fried (http://www.lad
 example added 9 Jul 2009
 by Tom Igoe
```

Set Cursor Example

This example sketch shows how to use the `setCursor()` method to reposition the cursor. To move the cursor, just call `setCursor()` with a row and column position. For example, for a 2x16 display:

```
lcd.setCursor(0, 0); // top left
lcd.setCursor(15, 0); // top righ
lcd.setCursor(0, 1); // bottom le
lcd.setCursor(15, 1); // bottom r
```

Here is the full example:

```
/*

 LiquidCrystal Library - setC

 Demonstrates the use a 16x2 L

 library works with all LCD di

 Hitachi HD44780 driver. There

 can usually tell them by the

 This sketch prints to all the

 setCursor() method:

  The circuit:

 * LCD RS pin to digital pin 1

 * LCD Enable pin to digital p

 * LCD D4 pin to digital pin 5

 * LCD D5 pin to digital pin 4

 * LCD D6 pin to digital pin 3

 * LCD D7 pin to digital pin 2
```

Text Direction Example

This example sketch shows how to use the `leftToRight()` and `rightToLeft()` methods. These methods control which way text flows from the cursor.

> `rightToLeft()` causes text to flow to the left from the cursor, as if the display is right-justified.
>
> `leftToRight()` causes text to flow to the right from the cursor, as if the display is left-justified.

This sketch prints `a` through `l` right to left, then `m` through `r` left to right, then `s` through `z` right to left again.

```
/*

 LiquidCrystal Library - TextD

 Demonstrates the use a 16x2 L

 library works with all LCD di

 Hitachi HD44780 driver. There

 can usually tell them by the

 This sketch demonstrates how

 to move the cursor.

 The circuit:

  * LCD RS pin to digital pin

  * LCD Enable pin to digital

  * LCD D4 pin to digital pin

  * LCD D5 pin to digital pin

  * LCD D6 pin to digital pin

  * LCD D7 pin to digital pin
```

Custom Character

This example demonstrates how to add custom characters on an LCD display.

Note that this example requires an additional potentiometer:

- Outer pins connected to 5V and GND.
- Inner pin (wiper) connected to A0.

This potentiometer controls the `delayTime` variable.

```
/*
  LiquidCrystal Library - Cust

 Demonstrates how to add custo
 The LiquidCrystal library wor
 compatible with the  Hitachi
 them out there, and you can u

 This sketch prints "I <heart>
 to the LCD.

  The circuit:
 * LCD RS pin to digital pin 1
 * LCD Enable pin to digital p
 * LCD D4 pin to digital pin 5
 * LCD D5 pin to digital pin 4
 * LCD D6 pin to digital pin 3
 * LCD D7 pin to digital pin 2
 * LCD R/W pin to ground
 * 10K potentiometer:
 * ends to +5V and ground
 * wiper to LCD VO pin (pin 3)
 * 10K poterntiometer on pin A

 created 21 Mar 2011
 by Tom Igoe
 modified 11 Nov 2013
 by Scott Fitzgerald
 modified 7 Nov 2016
```

DOCS

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