16x2 LCD Display Module

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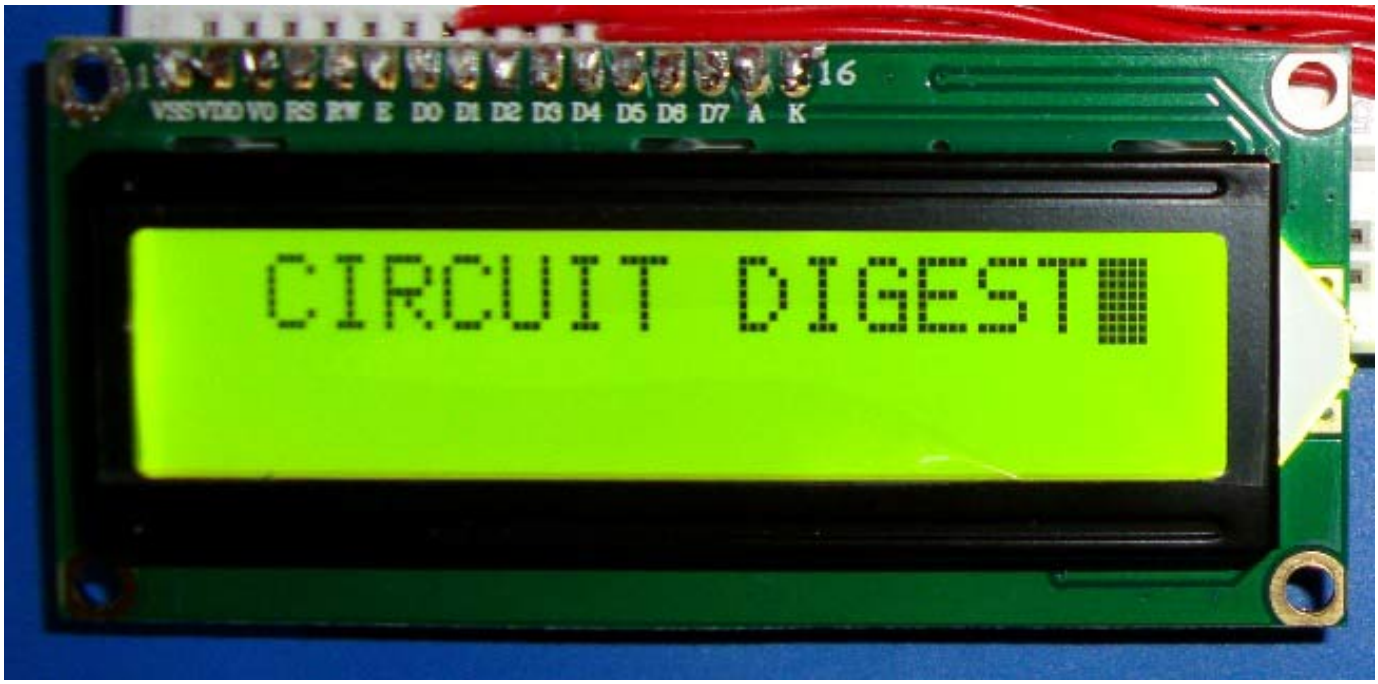
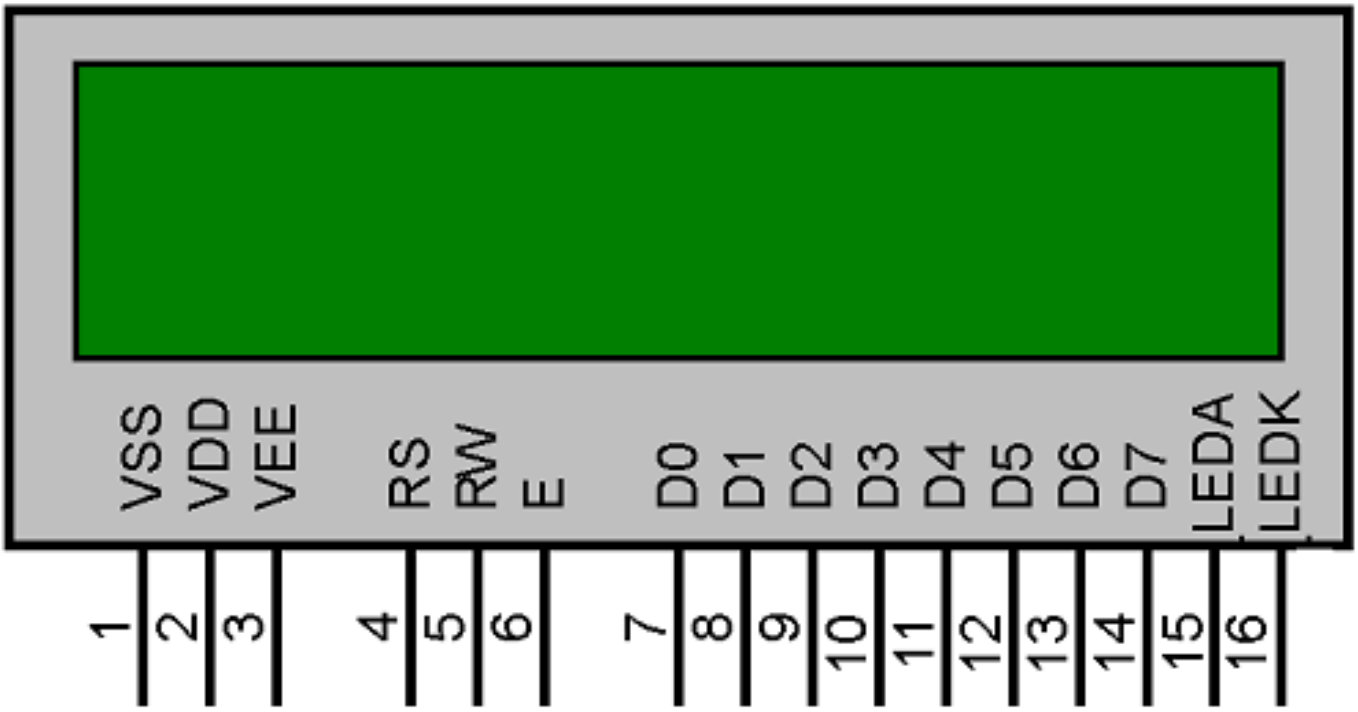


16x2 LCD Display Module with HD44780 Controller

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. But the most used one is the 16*2 LCD, hence we are using it here.

All the above mentioned LCD display will have 16 Pins and the programming approach is also the same and hence the choice is left to you. Below is the **Pinout and Pin Description of 16x2 LCD Module**:

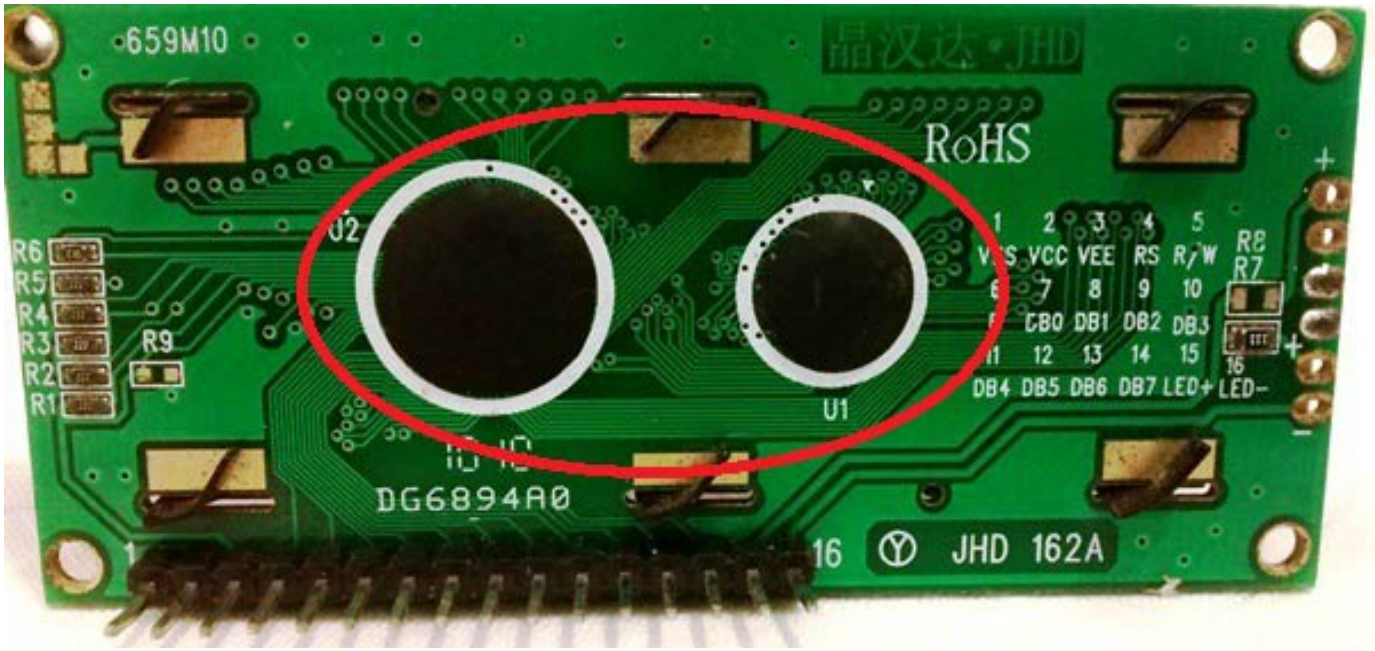


Sr. No	Pin No.	Pin Name	Pin Type	Pin Description	Pin Connection
1	Pin 1	Ground	Source Pin	This is a ground pin of LCD	Connected to the ground of the MCU/ Power source
2	Pin 2	VCC	Source Pin	This is the supply voltage pin of LCD	Connected to the supply pin of Power source
3	Pin 3	V0/VEE	Control Pin	Adjusts the contrast of the LCD.	Connected to a variable POT that can source 0-5V

4	Pin 4	Register Select	Control Pin	Toggles between Command/Data Register	Connected to a MCU pin and gets either 0 or 1. 0 -> Command Mode 1-> Data Mode
5	Pin 5	Read/Write	Control Pin	Toggles the LCD between Read/Write Operation	Connected to a MCU pin and gets either 0 or 1. 0 -> Write Operation 1-> Read Operation
6	Pin 6	Enable	Control Pin	Must be held high to perform Read/Write Operation	Connected to MCU and always held high.
7	Pin 7-14	Data Bits (0-7)	Data/Command Pin	Pins used to send Command or data to the LCD.	In 4-Wire Mode Only 4 pins (0-3) is connected to MCU In 8-Wire Mode All 8 pins(0-7) are connected to MCU

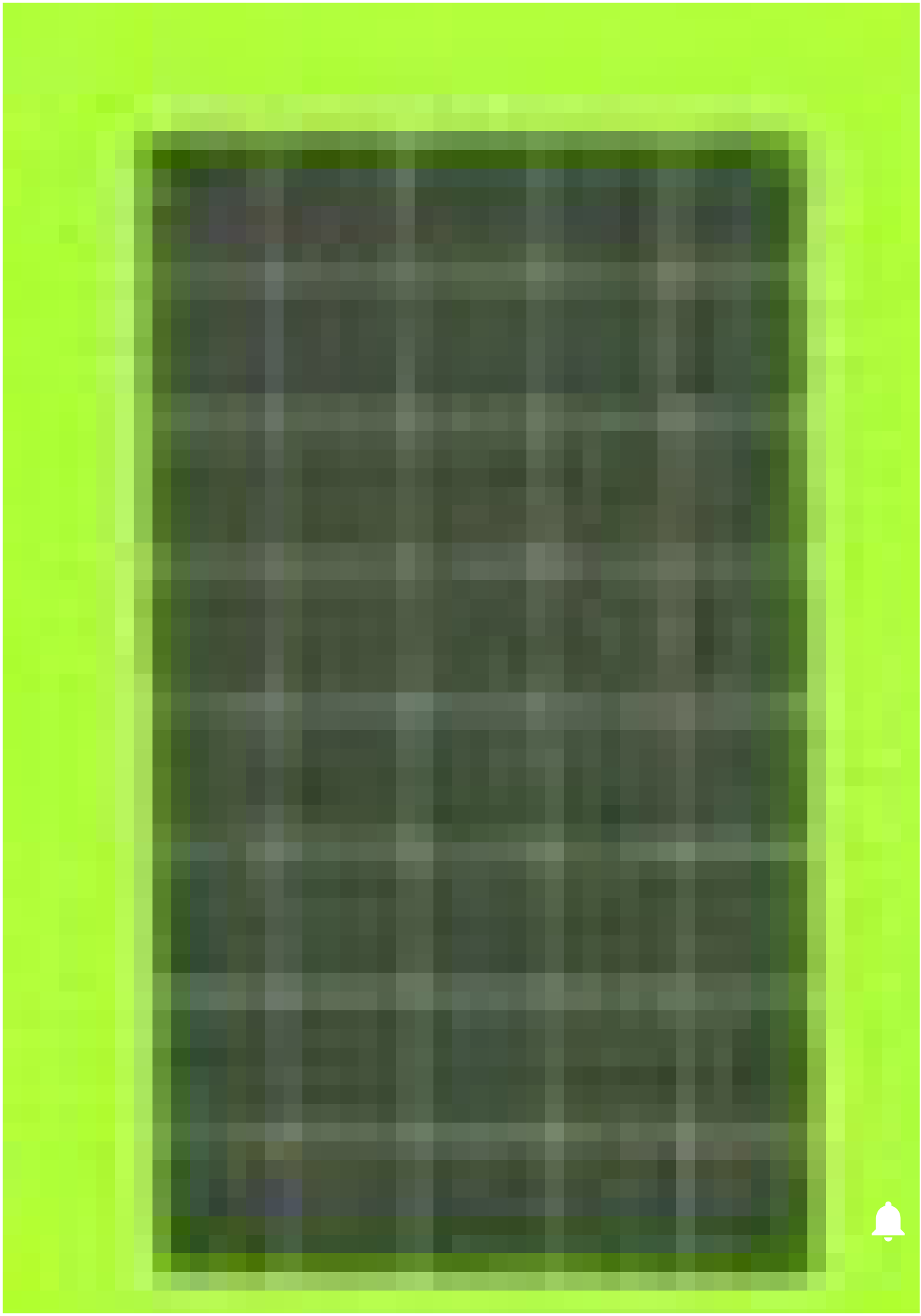
8	Pin 15	LED Positive	LED Pin	Normal LED like operation to illuminate the LCD	Connected to +5V
9	Pin 16	LED Negative	LED Pin	Normal LED like operation to illuminate the LCD connected with GND.	Connected to ground

It is okay if you do not understand the function of all the pins, I will be explaining in detail below. Now, let us turn back our LCD:



Okay, what is this two black circle like things on the back of our LCD?

These black circles consist of an interface IC and its associated components to help us use this LCD with the MCU. Because our LCD is a 16*2 Dot matrix LCD and so it will have (16*2=32) 32 characters in total and each character will be made of 5*8 Pixel Dots. A Single character with all its Pixels enabled is shown in the below picture.



So Now, we know that each character has (5*8=40) 40 Pixels and for 32 Characters we will have (32*40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels.

It will be a hectic task to handle everything with the help of MCU, hence an **Interface IC like HD44780** is used, which is mounted on LCD Module itself. The function of this IC is to get the **Commands and Data** from the MCU and process them to display meaningful information onto our LCD Screen.

Let's discuss the different type of mode and options available in our LCD that has to be controlled by our Control Pins.

4-bit and 8-bit Mode of LCD:

The LCD can work in two different modes, namely the 4-bit mode and the 8-bit mode. In **4 bit mode** we send the data nibble by nibble, first upper nibble and then lower nibble. For those of you who don't know what a nibble is: a nibble is a group of four bits, so the lower four bits (D0-D3) of a byte form the lower nibble while the upper four bits (D4-D7) of a byte form the higher nibble. This enables us to send 8 bit data.

Whereas **in 8 bit mode** we can send the 8-bit data directly in one stroke since we use all the 8 data lines.

Now you must have guessed it, Yes 8-bit mode is faster and flawless than 4-bit mode. But the major drawback is that it needs 8 data lines connected to the microcontroller. This will make us run out of I/O pins on our MCU, so 4-bit mode is widely used. No control pins are used to set these modes. It's just the way of programming that change.

Read and Write Mode of LCD:

As said, the LCD itself consists of an Interface IC. The MCU can either read or write to this interface IC. Most of the times we will be just writing to the IC, since reading will make it more complex and such scenarios are very rare. Information like position of cursor, status completion interrupts etc. can

be read if required, but it is out of the scope of this tutorial.

The Interface IC present in most of the LCD is **HD44780U,** in order to program our LCD we should learn the complete datasheet of the IC. The datasheet is given here (http://circuitdigest.com/sites/default/files/HD44780U.pdf).

LCD Commands:

There are some preset commands instructions in LCD, which we need to send to LCD through some microcontroller. Some important command instructions are given below:

Hex Code	Command to LCD Instruction Register
0F	LCD ON, cursor ON
01	Clear display screen
02	Return home
04	Decrement cursor (shift cursor to left)
06	Increment cursor (shift cursor to right)
05	Shift display right
07	Shift display left
0E	Display ON, cursor blinking
80	Force cursor to beginning of first line
C0	Force cursor to beginning of second line
38	2 lines and 5×7 matrix

83	Cursor line 1 position 3
3C	Activate second line
08	Display OFF, cursor OFF
C1	Jump to second line, position 1
OC	Display ON, cursor OFF
C1	Jump to second line, position 1
C2	Jump to second line, position 2

Check our LCD interfacing Articles with different Microcontrollers:

- LCD Interfacing with 8051 Microcontroller (http://circuitdigest.com/microcontroller-projects/lcd-interfacing-with-8051-microcontroller-89s52)
- Interfacing LCD with ATmega32 Microcontroller (http://circuitdigest.com/microcontroller-projects/lcd-interfacing-with-atmega32-avr)
- LCD Interfacing with PIC Microcontroller (http://circuitdigest.com/microcontroller-projects/16x2-lcd-interfacing-with-pic-microcontroller)
- Interfacing 16x2 LCD with Arduino (http://circuitdigest.com/microcontroller-projects/arduino-lcd-interfacing-tutorial)
- 16x2 LCD Interfacing with Raspberry Pi using Python (http://circuitdigest.com/microcontroller-projects/raspberry-pi-lcd-display-tutorial)

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