LCD Displays

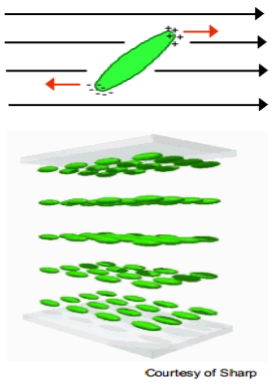
Liquid Crystal Displays (LCD) DISPLAYS

- How does it work
- Types of LCDs
- Comparison
- Types of displays
- Wearable LCD
- Interfacing
- Programming example

LCD- How Does it work

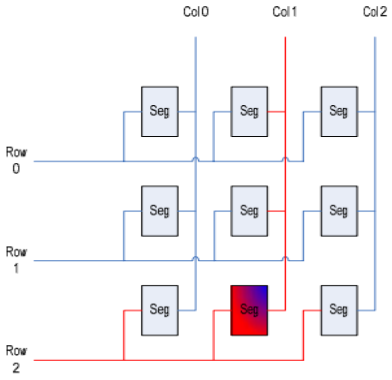
An array of Liquid Crystal segments

- When not in an electrical field, crystals are organized in a random pattern, thus blocking light
- When an electric field is applied, the crystals align perpendicular to the field "gating" the amount of light that can pass through them



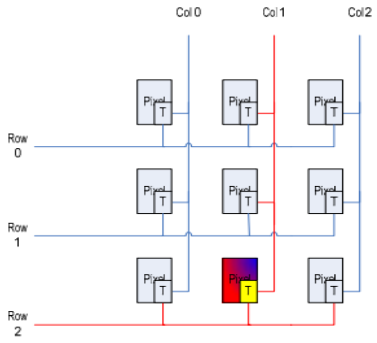
Types of LCDs: **Passive displays**

- Consists of a grid of row and columns perpendicularly connected to every pixel in the LCD
- An IC controls which column and row are selected to enable or disable the pixel at the row/column intersection
- Super-Twisted Nematic (STN) LCDs are passive displays



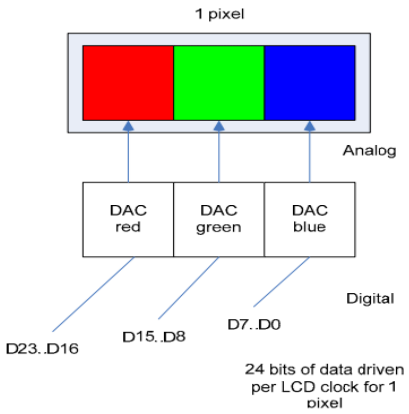
Types of LCDs : **Active displays**

- Columns and rows connect perpendicularly to an active device (transistor) for every segment in the LCD
- The selected row and column enable the transistor to store charge
- Thin Film Transistor (TFT) displays are active displays



Generating Color

- Displays drive 3 RGB segments within one pixel with variable electric field strength
- Color levels depend on the number of data lines

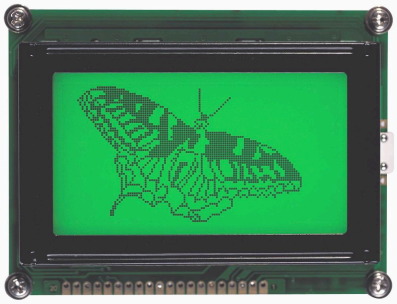


Courtesy : NXP

Display Types

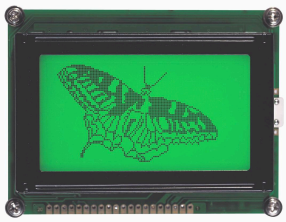
Character vs. Graphical LCDs

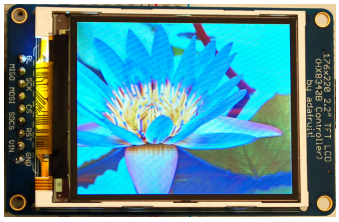
- Character LCDs are ideal for displaying text. Typically each character is displayed within a rectangle of 5x7 pixels
- The graphical LCD has one grid of pixels. It can display text but its best at displaying images. Graphical LCDs tend to be larger, more expensive and harder to use.



LCD Technology Types

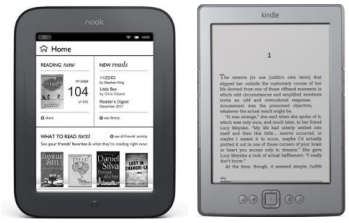
- **STN** - super-twisted nematic display is a passive monochrome display. They require less power and are less expensive to manufacture STN displays are used in some inexpensive mobile phones and informational screens
- **TFT** - thin-film-transistor liquid-crystal display uses thin-film transistor (TFT) (active) technology to improve image qualities such as addressability and contrast. Used in handheld video game systems, Car Instrument Clusters etc.





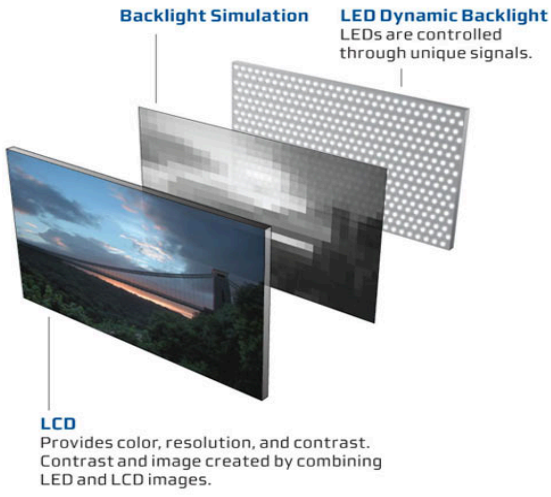
LCD Technology Types

- **IPS** - In-plane switching involves placing electrodes in parallel to the glass plates. IPS technology is widely used in panels for TVs, tablet computers and smartphones.
- **EINK** - Electronic ink displays reflect light like ordinary paper, making it more comfortable to read with a wider viewing angle. Typical applications include digital signage, electronic billboards, e-readers etc.



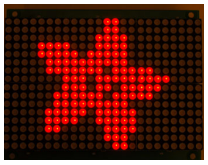
Lighting up the LCD display

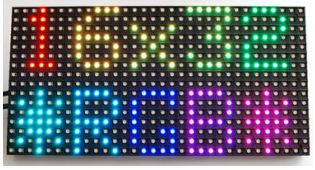
- LED-back light LCD Display

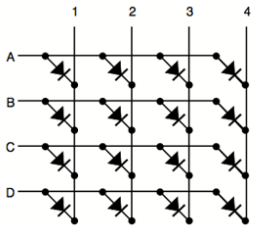


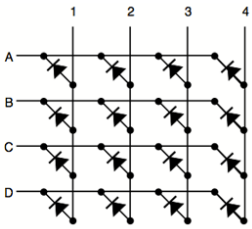
LED Display

- Matrix LED Display:



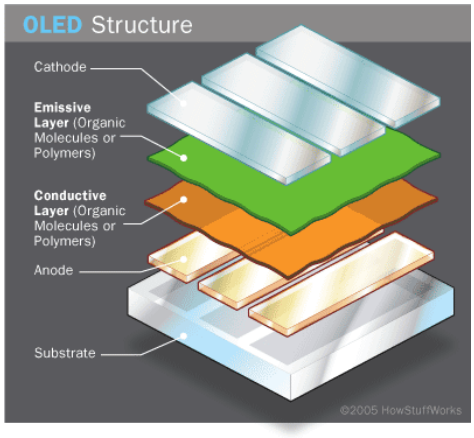






OLED Display

- An OLED (organic light-emitting diode) is a light-emitting diode (LED) in which the emissive electroluminescent layer is a film of organic compound which emits light in response to an electric current. This layer of organic semiconductor is situated between two electrodes.
- OLEDs are used to create digital displays in devices such as television screens, computer monitors, portable systems such as mobile phones, handheld games consoles and PDAs.

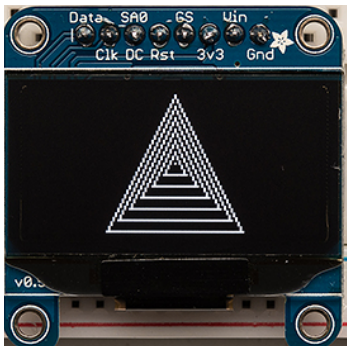


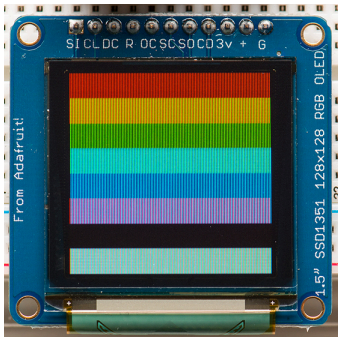
OLED Display

- PMOLED (Passive Matrix OLED)

- AMOLED (Active Matrix OLED)

OLED Display Modules



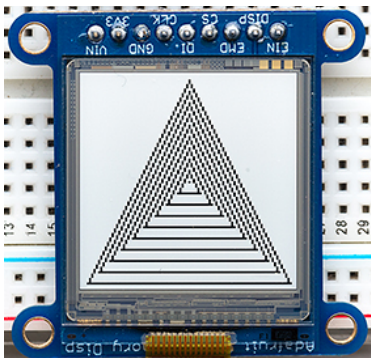


Sharp LCD Display:
PNLC and HR-TFT Modules

- Sharp's Polymer Networked Liquid Crystal (PNLC)-type Memory LCD is composed of a PNLC layer formed between a transparent surface electrode and mirror-reflective pixel electrodes. The PNLC module uses a scattering mode and does not require polarizers, which results in a very bright reflective display. A 1-bit memory circuit is embedded into each pixel, which retains the pixel information once it's written.
- Sharp's high-contrast HR-TFT technology adds a polarizer to the top layer to greatly enhance the contrast of the display. The black level is dramatically enhanced, resulting in an almost paper-like black and white image.

Sharp Memory Display Module

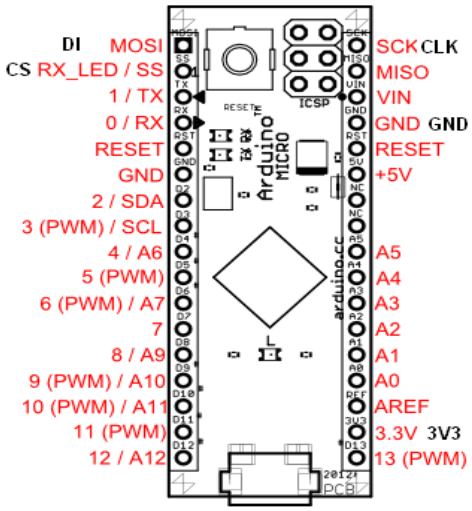
- We will be using a 1.3" 96x96 bits SHARP Memory LCD display. This display is a cross between an eInk display and an TFT LCD. It has a matt silver background, and pixels show up as little mirrors for a silver-reflective display, a really beautiful and unique look. It does not have a backlight, but it is daylight readable.
- Memory LCDs are used in smart watches like the Pebble and Agent.



Display Wiring

Wire the display as shown below:

3V3 -> 3.3V
GND -> GND
CLK -> SCK
DI -> MOSI
CS -> SS



Programming

Download the following Libraries:

- Sharp Memory Display Library (https://github.com/adafruit/Adafruit_SHARP_Memory_Display)
- Adafruit GFX Library (https://github.com/adafruit/Adafruit-GFX-Library)

Run the Example Code

Once your libraries are installed, open the Arduino IDE and select: "File->Examples->Adafruit_SHARP_Memory_Display->sharpmemtest"

Comment the following lines as shown below.

// #define SCK 10
// #define MOSI 11
// #define SS 13

Upload the example code to your Arduino

LCD Interface - Running

You should see the following test graphics drawn on the screen

Courtesy: http://learn.adafruit.co

Programming the Display

- Libraries
  - #include <Adafruit_GFX.h>
  - #include <Adafruit_SharpMem.h>
- Initiation:
  - display.begin(); Initialize the display
  - display.clearDisplay(); Clear Display
  - display.refresh(); Refresh the display