# Display Technology Overview

Display technologies have come a long way since its introduction in the electronics scene. It plays a critical role in how information is conveyed. Today's display market offers an abundance of choices, each with their own advantages and disadvantages. The choice of technology greatly depends on the intended application, whether it is home entertainment, portable electronics, or industrial. Where CRTs had initially monopolized the display industry, they are now being replaced by newer technologies. Currently, LCDs using passive or active matrices have captured portable devices and are expanding into larger screen applications such as computer monitors and televisions. Today, different consumer products from HD TVs to handheld devices use a wide variety of display technologies

Over the years, full-colour flat panel displays, represented by thin-film-transistor (TFT) liquid crystal displays (LCD), have enabled many new applications, such as the digital camera, notebook PC and thin, flat-screen TV, through intensive research activities around the world. Recently, small-sized mobile display development has been leading the R&D effort to support the severe requirements of smartphones and tablet PCs. For the displays used in those applications, high definition, high visual quality, low power consumption, small form factor and easy-to-use touch user interface (UI) are critical values. The different types of display Technologies included are Liquid Crystal Displays, Organic Light Emitting Diodes, Digital Light Processing Technology, Plasma Displays, Field Emission Displays, and Electronic Paper.

Display technology is the most effective way to communicate information. As researchers continuously create innovative ideas, display technologies are becoming more sophisticated. Next generation displays will be lighter, thinner, flexible, more adaptable, power efficient, and conform to the changing needs of society. Organic LEDs, being composed of light emitting polymers, can emit their own light to offer thin and power-saving displays. Using many microscopic mirrors, DLP technology can generate large bright projections on screens with up to 35 trillion

colours. Plasma Displays generate excellent quality images on very large screens. Field Emission Displays can produce high resolution images like CRTs without the bulky appearance. The makers of Electronic Paper are trying to replace print by developing displays with many paper-like properties. Demand for higher quality displays will drive technology evolution.

## 1. Seven-segment display

Seven-segment displays are electronic display devices used as an easy way to display decimal numerals and an alternative to the more complex dot-matrix displays. Seven-segment displays first became widely used as a popular way of displaying numbers. They are called segment displays because they are composed of several segments that switch on and off to give the appearance of the desired glyph. The segments are usually single LEDs or liquid crystals. Seven-segment displays are widely used in digital clocks, electronic meters, basic calculators, displays in home appliances, cars, and various other electronic devices that display numerical information.

There are two different types of driving seven-segment displays. The common anode and common cathode types, in common anode all the anodes on the display are tied to a common pin, typically the power source, and the LED are controlled via the cathodes with the ground being on and power being off. In common cathode, all the cathodes are tied to a common pin, in this case generally ground, and the LED are driven by the state of the anodes where the ground is off and power is on. Hence a seven-segment plus decimal point package will only require nine pins, though commercial products typically contain more pins in order to match industry standard pin outs.

There are several types of Seven-segment display (most common, digits only) most of them are Fourteen-segment display, Sixteen-segment display. HD44780 is an LCD controller which is widely accepted protocol for LCDs. Seven-segment displays may use a liquid crystal display (LCD), a light-emitting diode (LED) for each segment, or other light-generating or control techniques such as cold cathode

gas discharge (Panaplex), vacuum fluorescent, incandescent filaments (Numitron), and others. For gasoline price totems and other large signs, vane displays made up of electromagnetically flipped light-reflecting segments (or "vanes") is still commonly used.

## 2. Liquid-crystal display (Alphanumeric)

LCD designs can vary depending on the desired application. Display format, resolution, response time, and contrast are all features that can vary depending on the desired use. On an LCD information is generally displayed in segments or pixels. Segments regions that can be arranged into different shapes. The most common segment configuration is the seven-segment display shown below. This format is commonly used in calculators, watches and other simple numerical displays. The LCD screen is more energy-efficient and can be disposed of more safely. Its low electrical power consumption enables it to be used in battery-powered electronic equipment.

There are many different types of character display modules available and choosing the right one will depend on the device in question. Alphanumeric LCD screens are the ideal option for projects that require a simple, non-graphical user interface. Since they offer basic functionality, they also require less electricity than more complicated display modules, and they are also a more affordable option.

To choose the right alphanumeric LCD display module one thing to consider is the technology used in the display - there are a number of different options available, including TN, HTN, STN and FSTN. These differ mainly in their speed, clarity and contrast. Another option to think about is the backlighting. RGB LED backlights, which provides a clear, white light, but which can also be programmed to display other colours as appropriate. Transflective, reflective and transmissive modules are both available as industry standard displays, and one can also choose from different character display modes. Of course, the size of the display is also something to think about. When measuring, one should try to ensure that the screen will comfortably fit within the

device, while still being large enough to read and operate effectively.

Small LCD screens are common in portable consumer devices such as digital cameras, watches, calculators, and mobile telephones, including smartphones. LCD screens are also used in consumer electronics products such as DVD players, video game devices and clocks. LCD screens are available in a wider range of screen sizes, with LCD screens available in sizes ranging from tiny digital watches to huge, big-screen television sets.

### 3. Liquid-crystal display (Graphical)

A liquid-crystal display (LCD) is a flat-panel display or another electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead of using a backlight or reflector to produce images in colour or monochrome. LCDs are available to display arbitrary or fixed images with low information content, which can be displayed or hidden, such as pre-set words, digits, and 7-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

TFT displays comprise thousands or millions of tiny transistors, each of which controls a single pixel. This construction allows the screen to show fast moving images, as the pictures can be redrawn rapidly. They provide high brightness with good contrast, backlighting and excellent colour quality. Most designs can also be provided with touch screen capability. TFT modules are also thin and lightweight, enabling them to be used for a variety of projects.

Liquid crystals are substances that exhibit properties of both solids and liquids; they are an intermediate phase of matter. Liquid crystals can be classified into three different groups, nematic, smectic, and cholesteric depending on the level of order in their molecular structure. Liquid crystals in the nematic group are most commonly used in LCD production because of their physical properties and wide temperature range. In the nematic phase, liquid crystal molecules are oriented on average along with a particular direction. By applying an

electric or magnetic field, the orientation of the molecules can be manipulated in a predictable manner; this mechanism provides the basis for LCDs. Simple LCDs consist of a liquid crystal cell, conductive electrodes and a set of polarizing lenses

There are a number of different technologies available to provide the touch function, such as SAW (surface acoustic wave), capacitive, infra red or analogue resistive. The input adapter for TFT modules can be along with built-in VGA, DVI and RGB compatibility to ensure simple plug and play operation. The latest technology uses Transflective Mode which uses mirror coating and colour filters to produce a unit which is sunlight readable

TFT or the thin-film transistor LCDs have been around the longest, and are used in many products. They are available in a wide range of sizes, which make them the preferred type of module for smartphone manufacturers who want to give their customers wider screens.

## 4. OLED

One of the next trends in display technology is Organic Light Emitting Diodes (OLEDs). Polymer Light Emitting Diodes (PLEDs), Small Molecule Light Emitting Diodes (SMOLEDS) and dendrimer technology are all variations of OLEDs. With all variations being made by electroluminescent substances (substances that emit light when excited by an electric current), OLED displays are brighter, offer more contrast, consume less power, and offer large viewing angles – all areas where LCDs fall short.

OLEDs are composed of light-emitting organic material sandwiched between two conducting plates, one of n-type material and one of p-type material. The molecular structure in the n-type material, although electrically neutral, has an extra electron that is relatively free to move around the material. In p-type material the opposite is true. The lack of an electron creates a hole that is free to move about. The creation of the extra electron or the hole comes about because of

the mismatch of valence electrons in the molecular structure of the p or n-type material.

An organic light-emitting diode (OLED) is a light-emitting diode (LED) in which the emissive electroluminescent layer is a film of organic compound that emits light in response to an electric current. This layer of organic semiconductor is situated between two electrodes; typically, at least one of these electrodes is transparent. OLEDs are used to create digital displays in devices such as television screens, computer monitors, and portable systems such as mobile phones, handheld game consoles and PDAs. A major area of research is the development of white OLED devices for use in solid-state lighting applications.

There are two main families of OLED one is based on small molecules and other those employing polymers. Adding mobile ions to an OLED creates a light-emitting electrochemical cell (LEC) which has a slightly different mode of operation. An OLED display can be driven with a passive-matrix (PMOLED) or active-matrix (AMOLED) control scheme. In the PMOLED scheme, each row (and line) in the display is controlled sequentially, one by one, whereas AMOLED control uses a thin-film transistor backplane to directly access and switches each individual pixel on or off, allowing for higher resolution and larger display sizes. An OLED display works without a backlight thus it can display deep black levels and can be thinner and lighter than a liquid crystal display (LCD). In low ambient light conditions (such as a dark room), an OLED screen can achieve a higher contrast ratio than an LCD, regardless of whether the LCD uses cold cathode fluorescent lamps or an LED backlight.