LCD and Touch Panel Glossary

Update February 2020

Note: This documentation is subject to change without any notice.

18-Bit RGB

Used to describe a clocked parallel TFT connection that uses 18 data lines (6 for Red, 6 for Green, 6 for Blue) as well as Hsync, Vsync, data enable, and pixel clock to transfer data to the TFT. Theoretical color depth is 2^{18} or 262,144 colors.

24-Bit RGB

Used to describe a clocked parallel TFT connection that uses 24 data lines (8 for Red, 8 for Green, 8 for Blue) as well as Hsync, Vsync data enable, and pixel clock to transfer data to the TFT. Theoretical color depth is 2^{24} or 16,777,216 colors.

6800

6800 is a parallel interface that uses Read/Write signal and an Enable signal to control the data bus. Communications with a display are only enabled when the enable signal is pulled high. The level of the Read/Write signal then determines whether data will be read from the display or written to the display. If the Read/Write signal is high, data will be read from the display whereas if the Read/Write signal is low, data will be written to the display. Sometimes the Write will be shown as a "notted" signal. For instance, there may be a bar over the name, a preceding exclamation mark, slash, or dash. While this looks like negation notation, in this context it simply means the signal is active low.

Difference Between 6800 and 8080

The other common parallel interface is 8080 which uses separate read and write lines and no enable signal.

8080

8080 is a parallel interface that uses separate Read and Write lines to control the data bus.

Difference Between 8080 and 6800

The other common parallel interface is 6800 which uses a single Read/Write signal in combination with an Enable signal to control the data bus.

Absolute White

In theory, a material that perfectly reflects all light energy at every visible wavelength. In practice, a solid white (with known spectral data) that is used as the "reference white" for all measurements of absolute reflectance.

Achromatic

A neutral color (white, gray, or black) that has no hue.

Active Area/Effective Area

In the viewing area of the LCD glass, area (L x H) of the LCD that has active segments.

Active Matrix

A liquid crystal display structure in which switching transistors or diodes are attached to each pixel to control the on/off voltage. It produces a brighter and sharper display with a broader viewing angle than a passive matrix display. Also known as AMLCD (active matrix liquid crystal display). See <u>TFT</u> (thin film transistor).

AD Board (Analog/ Digital conversion Board)

A/D or ADC converters must be used to process, store, or transport virtually any analog signal in digital form. TV tuner cards, for example, use fast video analog-to-digital converters. On-chip 8, 10, 12, or 16 bit analog-to-digital converters are common in microcontrollers. Digital storage oscilloscopes need very fast analog-to-digital converters. ADC converters are integral to current music reproduction technology. They are needed to create the pulse-code modulation (PCM) data streams that go onto CDs and digital music files.

AF (Anti-Fingerprint)

AF (Anti-fingerprint) is a surface coating agent containing a fluorinated polyether. Excellent water and oil repellency, as well as anti-fouling properties, are achieved without altering the appearance, by forming a thin monomolecular layer on a surface such as glass. Normally using wet coating, spray coating, dip coating and spin coating process.

AG (Anti-Glare)

This is often described as a matte coating as it is non-reflective to the user since it diffuses rather than reflects ambient light. It provides a method for manufacturers to avoid glare on the viewing surface from other light sources and has been used in the LCD monitor market for many years since the first TFT displays started to emerge. The matte coating is included as an outer polarizing later which has been coarsened by mechanical or chemical processes. This achieves a surface coating which is not smooth and so can diffuse ambient light rather than reflect it.

Air Bonding (Perimeter Bonding)

An adhesive is applied between the display and touch panel using the inactive area around the perimeter of the module. This bonding method results in some inactive space 'air gap' between the touch panel substrate and the display. This is the most cost-effective and common solution.

Alignment Layer

A PI (polyimide) layer that is applied by spin coating. This thin film is then treated to impart a desired direction at which the liquid crystal molecules will attach and align.

AMOLED

AMOLED is Active Matrix OLED. An Active Matrix OLED uses a TFT (Thin Film Transistor) transistor-per-pixel architecture. Using a transistor-per-pixel allows higher resolution displays to be made and avoids the problems associated with high duty cycle passive displays.

Amorphous Silicon (a-Si)

A semiconductor material that is used to make the thin film transistors (TFTs) layer of an active matrix LCD.

Annunciator

A word, phrase, or symbol; an active element.

Aperture Ratio

The ratio between the transmissive portion of the pixel and its surrounding electronics, also known as fill factor. Generally, this is a limiting factor for luminance, the higher the aperture ratio; the brighter the luminance.

Aspect Ratio

The width-to-height ratio of the active area of a display. Standard U.S. video has an aspect ratio of 4:3.

AR (Anti-Reflection)

An anti-reflection (AR) coating is a type of optical coating applied to the surface touch panel to reduce reflection. Many coatings consist of transparent thin film structures with alternating layers of contrasting refractive index. Layer thicknesses are chosen to produce destructive interference in the beams reflected from the interfaces, and constructive interference in the corresponding transmitted beams. This makes the structure's performance change with wavelength and incident angle, so that color effects often appear at oblique angles. Good performance can often be achieved for a relatively wide range of frequencies: usually a choice of IR, visible, or UV is offered.

Array Process

Method of manufacturing whereby displays are arranged in rows and columns on a large laminate, and separated after they are filled with LCD fluid.

Backlight

A backlight is used behind the LCD glass to allow the LCM to be read in dark conditions. The vast majority of backlights are now LED. Historically there were also EL (electroluminescent) and CCFL (Cold Cathode Fluorescent Light) backlights, but as LED efficiency has increased and cost has decreased, EL and CCFL backlights have all but disappeared.

Backplane

The common electrode connection. There can be multiple backplanes in a multiplexed display.

Bezel

A frame of plastic or metal, fitting over the LCD glass, to protect the edges of the glass and act

as a pressure device, compressing the elastomer connector between the PCB and LCD glass.

BGA

BGA stands for Ball Grid Array. A type of high-density electronic component package for integrated circuits. The BGA has solder balls on its backside, which line up with corresponding contacts on the front side of the PCB. The part and PCB are heated until the solder balls melt.

The surface tension of the molten solder makes the chip "float" on the board, which also aligns it perfectly with the pads on the PCB.

Blue Negative

Display configuration of a backlit negative image STN display

CABC (Content Adaptive Backlight Control)

Normally an LCD's backlight is set to the brightness that will make a white pixel fully illuminated. CABC automatically dims the backlight to the lowest level required for the brightest pixel on the display.

Simultaneously, the controller lightens the image by the same amount. Overall, there is no visible change in the image, but less power is used in the backlight for any image that does not contain a pure white pixel. In this way, CABC reduces the overall average power needed by the display and backlight.

Candelas (cd/m2)

An international unit of luminous intensity per projected area normal to the line of observation. Luminance may be described in units of Candelas per square meter, or nits.

CCFL (COLD CATHODE FLORESCENT LIGHT)

These are the fluorescent tubes that provide the light for the LCD unit. These tubes are generally very thin, approximately 2 mm in diameter.

Cell Gap

The space containing liquid crystal fluid between the two pieces of glass.

CGRAM (Character Generator RAM)

Character LCDs include a fixed CGROM to define the bulk of the characters they display. However, since the CGROM cannot be changed the designers also included the CGRAM — a small number of characters (typically 8) that can be redefined at run-time. These eight characters are usually mapped to characters 0DEC (0x00HEX) to 7DEC (0x07HEX). The CGRAM definitions can be used to make small animations, bar graphs, and similar small graphic or sprite images. This term very likely has its beginning in the granddaddy of all LCD controllers, the venerable Hitachi HD44780.

CGROM (Character Generator ROM)

The CGROM stores the font that is displayed on a character LCD. When you tell a character LCD to display the letter 'A', it needs to know which dots to turn on so that we see an 'A'. This information is stored in the CGROM. By definition, (since it is a ROM) the font that is stored in the CGROM cannot be

changed. Be sure to check the datasheet of the character LCD module to make sure that it can display the characters you need. Typically, a CGROM for a character display module has 240 characters defined. The lower half of the CGROM maps to the normal ASCII characters. Since the early character display controllers were designed in Japan, many CGROM have Japanese characters in the upper 128 positions. There are also some CGROMs that have European or Cyrillic characters in these upper locations.

The WS0010 is a more modern character OLED controller, and the designers have included several CGROMs that can be chosen at run-time, so there is not the need to lock in a particular character set at design time. Since the CGROM is completely determined at the time of manufacture of the LCD controller, the designers also included a CGRAM, which allows the bitmaps of a few characters to be redefined at run-time. This term very likely has its beginning in the granddaddy of all LCD controllers, the venerable Hitachi HD44780).

Fig.1 Typical CGROM in HD44780

Chromatic

Perceived as having a hue; not white, gray, or black.

Chromaticity

That part of color specification, which does not involve illuminance. Chromaticity is two-dimensional and specified by pairs of numbers such as dominant wavelength and purity.

Chromaticity Diagram, CIE x,y

A two-dimensional graph of the chromaticity coordinates, x as the abscissa and y as the ordinate, which shows the spectrum locus (chromaticity coordinates of monochromatic light, 380 nm-770 nm). It has many useful properties for comparing colors of both luminous and non-luminous materials.
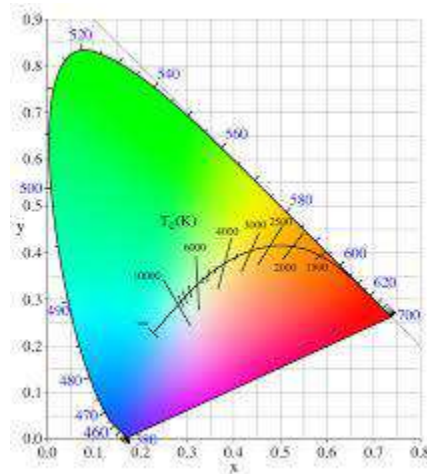

Fig.2 Chromaticity Diagram

COB (CHIP-ON-BOARD)

The LCD driver wafer is mounted on the PCB with gold wires used to connect it to other circuits. It is covered with epoxy.

COF (CHIP-ON-FLEX)

The contact edge of the LCD glass is mounted to a flex connector that incorporates an LCD

COG (CHIP-ON-GLASS)

A technology that mounts the LCD driver to the contact edge of the LCD glass.

Color Temperature

A measurement of the color of light radiated by an object while it is being heated. This measurement is express in terms of absolute scale, or degrees Kelvin. Lower Kelvin temperatures such as 2400° K are red; higher temperatures such as 9300° K are blue. Neutral temperature is white, at 6504° K.

Column Driver

Small electronic circuits that provide voltages to the individual sub-pixel through the source lines. These are generally 8-bit driver circuits that provide 256 unique values per sub-pixel.

Common/Backplane

The superimposition of the conductive pattern from one piece of glass to the second piece. The duty ratio is determined by the number of backplanes.

Contact Edge

The area of the LCD with conductive leads/traces where electrical connection is made by use of a connector.

Contrast Ratio

The difference in luminance between the unselected area and the selected area.

Cross-talk

Cross - Talk is the defect produced by the interference of the adjacent pixels. The contrast of these crosstalk areas is different from other areas. Crosstalk can appear only with certain display patterns.

CSP (Chip Scale Package)

A CSP is a very small electronic device package: one that similar in size to the integrated circuit — the "chip" — that it contains.

Fig.3 Top and bottom of a WL-CSP package sitting on the face of a U.S. penny. In the top-right, a SOT23 package is shown for comparison. Penny diameter: 19.05 mm (0.75 in).

CSTN (Color STN)

Color STN Technology. Each pixel of a CSTN display is actually 3 separate colored pixels of Red / Green / Blue. Each of those colors are controlled individually by the graphic controller chip. In fact, a 320 by 240 pixel CSTN display actually contains 960 by 240 individually colored pixels

CTP (Capacitive Touchscreen Panel)

A capacitive touchscreen panel consists of an insulator such as glass, coated with a transparent conductor such as indium tin oxide (ITO). As the human body is also an electrical conductor, touching the surface of the screen results in a distortion of the screen's electrostatic field, measurable as a change in capacitance. Different technologies may be used to determine the location of the touch. The location is then sent to the controller for processing.

Cursor

Dots used to indicate the location of the next character or symbol to be entered.

DC-DC

A DC-to-DC converter is an electronic circuit which converts a source of direct current (DC) from one voltage level to another. It is a class of power converter. DC-to-DC converters are important in portable electronic devices such as cellular phones and laptop computers, which are supplied with power from batteries primarily. Such electronic devices often contain several sub-circuits, each with its own voltage level requirement different from that supplied by the battery or an external supply (sometimes higher or lower than the supply voltage). Additionally, the battery voltage declines as its stored energy is drained. Switched DC-to-DC converters offer a method to increase voltage from a partially lowered battery voltage thereby saving space instead of using multiple batteries to accomplish the same thing.

DDRAM (Display Data RAM)

The Display Data RAM holds the letters that get shown on the LCD of a character LCD module. For instance, the letter 'A' is stored in its ASCII equivalent 65DEC (0x41HEX) in the DDRAM.

So a 20×2 character LCD would have enough DDRAM to store 40 letters. The value in the DDRAM is used to find the correct bitmap in the CGROM (Character Generator ROM) or CGRAM (Character Generator RAM), it is this small bitmap that gets displayed on the LCD. This term very likely has its beginning in the granddaddy of all LCD controllers, the venerable Hitachi HD44780.

DIL PINS (Dual in Line Pins)

Two rows of pins attached along parallel sides of a display.

Diffuser

Translucent material used for light diffusion placed between backlight lighting sources and the back side of an LCD. This material will create a more uniform backlight for an LCD from several unique sources of light.

Direct Drive

A method of driving a display whereby individual segments are driven from separate edge connections.

DITO/SITO

Apple has been granted a patent in 2011 that describes a method for fabricating thin DITO (Double-Sided Indium Tin Oxide) or SITO (Single-Sided Indium Tin Oxide) touch sensor panels with a thickness less than a minimum thickness tolerance of existing manufacturing equipment. In one embodiment, a sandwich of two thin glass sheets is formed such that the combined thickness of the glass sheets does not drop below the minimum thickness tolerance of existing manufacturing equipment when a thin film process is performed on the surfaces of the sandwich during fabrication. The sandwich may eventually be separated to form two thin SITO/DITO panels.

Another fabrication process involves laminating two patterned thick substrates, each having at least the minimum thickness tolerance of existing manufacturing equipment. One or both of the sides of the laminated substrates are then thinned so that when the substrates are separated, each is a thin DITO/SITO panel having a thickness less than the minimum thickness tolerance of existing manufacturing equipment.

Dot/Pixel

An active element that forms a character or symbol when combined in a matrix.

Dot Matrix

A group of dots/pixels forming a character or symbol, usually five dots across and seven dots down.

Duty Ratio

1/N when N is equal to the number of segments selected by one complete cycle.

Effective Area

Same as "<u>active area</u>."

EMI (Electro Magnetic Interference)

EMI is disturbance that affects an electrical circuit due to either electromagnetic induction or electromagnetic radiation emitted from an external source. The disturbance may interrupt, obstruct, or otherwise degrade or limit the effective performance of the circuit. These effects can range from a simple degradation of data to a total loss of data. The source may be any object, artificial or natural, that carries rapidly changing electrical currents.

ESD (Electro Static Discharge)

The sudden flow of electricity between two electrically charged objects caused by contact, an electrical short, or dielectric breakdown. A buildup of static electricity can be caused by tribocharging or by electrostatic induction. The ESD occurs when differently-charged objects are brought close together or when the dielectric between them breaks down, often creating a visible spark.

ESD can create spectacular electric sparks (lightning, with the accompanying sound of thunder, is a large-scale ESD event), but also less dramatic forms which may be neither seen nor heard, yet still be

large enough to cause damage to sensitive electronic devices. Electric sparks require a field strength above approximately 40 kV/cm in air, as notably occurs in lightning strikes. Other forms of ESD include corona discharge from sharp electrodes and brush discharge from blunt electrodes.

ESD can cause harmful effects of importance in industry, including explosions in gas, fuel vapor and coal dust, as well as failure of solid-state electronics components such as integrated circuits. These can suffer permanent damage when subjected to high voltages. Electronics manufacturers therefore establish electrostatic protective areas free of static, using measures to prevent charging, such as avoiding highly charging materials and measures to remove static such as grounding human workers, providing antistatic devices, and controlling humidity.

ESD simulators may be used to test electronic devices, for example with a human body model or a charged device model.

EVE (Embedded Video Engine)

Refers to a graphic controller from Bridgetek/FTDI. EVE graphic controllers are easy to use and can control the display, touch, backlight, and audio features of an embedded system, with each appearing to the host MCU as a memory-mapped SPI device. The host MCU sends commands and data using SPI protocol. EVE modules accept high level commands, simplify writing images and fonts (included angled fonts) on TFTs. Fonts, buttons, and tables can each be easily sent to a TFT using a one-line command.

EVE Graphics Accelerator Features

- Support multiple widgets for simplified design implementation
- User interface design software (PC) simplifies the design process
- Hardware engine can recognize touch tags and track touch movement
- Enhanced sketch processing
- Anti-aliasing of primitive displayed objects for higher-quality graphics
- Assorted graphical effects such as alpha-blending, shadows, transitions, wipes, etc.
- Programmable interrupt controller provides interrupts to host MCU
- Support playback of motion-JPEG encoded AVI videos
- Mono audio channel output with wave playback and built-in sound synthesizer
- PWM output for display backlight dimming control

EL (Electroluminescence)

Electroluminescence (EL) is an optical phenomenon and electrical phenomenon in which a material emits light in response to the passage of an electric current or to a strong electric field.

Elastomer Connector

A silicone rubber strip made up of sequentially spaced conductive and non-conductive material. A thin conductive material used to make connections between an LCD and a PC board.

Electrophoresis

A dead short is created when excess DC voltage is applied to an LCD. Conductive particles from one piece of glass are transferred through the liquid crystal fluid and deposited on the conductive surface of the opposite piece of glass.

ELP

Electroluminescence Panel

FET (Field Effect Transistor)

Typical FETs are nearly perfect switches. Next to no current flows when they are off, and they drop only minuscule voltage when they are on. An N-FET (N-Type Field Effect Transistor) is typically used to switch a load to ground. The gate of a Logic Level N-FET can be driven by a 3.3v or 5v logic output (GPIO) of a microcontroller. A P-FET (P-Type Field Effect Transistor) is used to switch a load to a positive voltage, like 3.3v or 5v or more. Typically, you need to use a pull-up resistor and a small N-FET to create the gate drive for the P-FET.

FFC (Flat Flexible Cable)

Refers to any variety of electrical cable that is both flat and flexible, with flat solid conductors. A flexible flat cable is a type of flexible electronics. However, the term FFC usually refers to the extremely thin flat cable often found in high-density electronic applications like laptops and cell phones.

Fig.4 FFC

Fill Hole

The space left between the epoxy seals on one end of the LCD glass after assembly. This space,

used to fill the glass with the liquid crystal fluid, is noted by a mound of epoxy.

First Minimum

An LCD construction technique where the cell geometry is optimized for maximum contrast and viewing angle. The geometry is different for each LCD fluid.

Font

The active pattern containing the information to be displayed in the LCD glass.

Foot Lamberts (fL)

A unit of luminance. One foot Lambert is equal to 10.76/- (approximately 3.426) Candelas per square meter.

FPC (Flexible Printed Circuit)

Also known as **flex** circuits, is a technology for assembling electronic circuits by mounting electronic devices on flexible plastic substrates, such as polyimide, PEEK or transparent conductive polyester film. Additionally, flex circuits can be screen printed silver circuits on polyester. Flexible electronic assemblies may be manufactured using identical components used for rigid printed circuit boards, allowing the board to conform to a desired shape, or to flex during its use. An alternative approach to flexible electronics suggests various etching techniques to thin down the traditional silicon substrate to few tens of micrometers to gain reasonable flexibility.

Fig.5 FPC

FSTN

Film-compensated Super Twisted Nematic.

Gamma

Screen luminance as a function of video voltage approximately follows a mathematical power function of the input video signal, the exponent of which is called gamma.

Gate electrode

The "row" electrode in an active matrix LCD that controls whether a voltage is applied to a sub-pixel.

GF/GFF/GG

Capacitive touch can be classified into glass- or film-substrate produced. Glass-substrate capacitive touchscreens are found in Apple's iPhone and Samsung's Galaxy S phone. The iPhone uses a glass-

glass (GG) structure that forms the X-axis sensing electrode on the upper surface of a glass substrate and Y-axis sensing electrode on the bottom. While Apple's GG method and other mobile phone makers' glass/film (GF/GFF) designs are becoming mainstream, attempts to develop products such as G1F, and OGS (One Glass Solution) with better transmittance and thinness will continue. OGS is cover window integrated touch, which does not require separate touch sensor.

The advantages of GFF are low capital cost, suitable for small quantity batch production, and light structure. GG is suitable for mass production and has better appearance properties, but it has high investment costs and is heavier than film-based panels.

Ghosting

A phenomenon occurring when voltage from an energized element leaks to an adjacent OFF element and turns the adjacent element partially ON.

Grey Scale

Grayscale is a range of shades of gray without apparent color. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths. Intermediate shades of gray are represented by equal brightness levels of the three primary colors (red, green and blue) for transmitted light, or equal amounts of the three primary pigments (cyan, magenta and yellow) for reflected light.

HC Coating

HC stands for Hard Coating.

HDMI (High-Definition Multimedia Interface)

HDMI means it is able to send a lot of data, very quickly. However, HDMI isn't an analog communication like VGA, S-Video or parallel like 24-bit or 18-bit RGB TFTs. HDMI is actually a high-speed serial interface using a fancy TMDS (Transition Minimized Differential Signaling) protocol.

Unlike SPI where 1-bit is transferred per clock cycle, HDMI transfers 10-bits per clock cycle which further increases the bandwidth. The clock can be anywhere from 25 MHz all the way to 340 MHz. This intense bandwidth allows HDMI standard to support up to an amazing 48 bits of color depth (that's dense!).

For embedded applications, the typical color depth and resolution are well within HDMI's capabilities. The important thing about HDMI embedded displays is that they give you an easy way to connect an embedded display to the now small and low-cost embedded computers, such as a Raspberry Pi, or an Intel Compute Stick.

Heat Seal

A flexible adhesive connector bonded by heat to the contact edge of the glass.

Hue

The main attribute of a color that distinguishes it from other colors. For example, a color may have a green, yellow, or purple hue. Colors defined as having hue are known as chromatic colors. White, black, and grays possess no hue.

I2C or IIC (Inter-Integrated Circuit)

I2C is a bi-directional serial bus that was originally created by Philips (now NXP).

In a typical I2C application, there will be one master, and one or more slaves. The specification allows for multiple masters, but this is not common in the field. I2C has two signals: SCL: Serial Clock; SDA: Serial Data. The I2C transfer includes an address, so multiple slaves can exist on the same I2C bus.

Typically, both the master and slave are implemented in hardware. The I2C master can be implemented in software quite easily, but it can be rather difficult to meet the timing requirements of I2C in a software slave implementation. As micro controllers continue to get faster, writing an I2C software slave will become easier. The I2C standard is pretty well defined, so there is not a huge amount of variation in I2C as it is implemented on LCD, capacitive touch and OLED controllers.

In-Cell

An in-cell display is a touch display in which the touch sensors are embedded within the screen. Traditional capacitive touchscreens have multiple layers of glass, including a capacitive touchscreen layer. In-cell displays eliminate the need for these external touch panel. This results in a thinner and lighter display than a comparative display with an external touch panel, enabling a sleeker final product for devices using an in-cell display.

Ink Overlay

The process of applying opaque, colored inks to the display to provide colors, or highlight certain areas of annunciators.

Interconnect Dot

Consisting of silver impregnated epoxy, it connects the pattern piece of glass to each backplane.

Inverter, DC to AC

Converts DC to AC at a high frequency, and powers electroluminescent lamps.

IPS (In-Plane Switching)

IPS is a type of TFT display that has better viewing angles, contrast and better color consistency compared with TN TFT displays.

Isotropic Stage

The point where the fluid heats or cools to where it is no longer in the twisted nematic state. Since the molecules can no longer twist light, all incoming light is absorbed.

ITO (Indium Tin Oxide)

Indium tin oxide (ITO) is one of the most widely used transparent conducting oxides because of its two main properties: its electrical conductivity and optical transparency, as well as the ease with which it can be deposited as a thin film. As with all transparent conducting films, a compromise must be made between conductivity and transparency, since increasing the thickness and the concentration of charge carriers increases the material's conductivity, but decreases its transparency. Thin films of indium tin oxide are most commonly deposited on surfaces by physical vapor deposition. Often used is electron beam evaporation, or a range of sputter deposition techniques.

Landscape

A page or screen orientation that is wider than it is tall, vs Portrait.

LCD (Liquid Crystal Display)

An LCD is composed of two pieces of glass with a thin layer of liquid crystals between the glass layers. When a voltage is applied to the glass, the orientation of the crystals can be changed. This change in the crystal's orientation (called polarization) will make either a dark or a light area, creating a character or image on the display.

LCM (LCD Module)

An LCD which includes a PCB, driver electronics, bezel, and possibly a backlight.

Leads

The conductive traces on the contact edge of the glass.

LED (Light-Emitting Diode)

A Light-Emitting Diode (LED) is a two-lead semiconductor light source which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor.

LED Driving

Many of today's portable electronics require backlight LED-drivers with the following features: direct control of current, high efficiency, Pulse-Width-Modulation (PWM) dimming, over-voltage protection, load disconnect, small size, and ease of use.

By driving LED light sources with a regulated constant-current power supply the light output variation and lifetime issues resulting from voltage variation and voltage changes can be eliminated. Therefore, constant current drivers are generally recommended for powering LED light sources.

Liquid Crystal Fluid

An organic material which has both liquid and crystalline properties.

Luminance

A measure of the brightness or luminous intensity of light, usually expressed in units of Candelas per square meter (cd/m2) or foot Lamberts. 1 fL = 3.426 cd/m2.

Multiplex (Mux)

A method of driving a display whereby multiple segments are driven from the same edge connection.

Nit

A unit of luminance equal to 1 cd/m2 or 0.292 fL.

Normally Black

A twisted nematic LCD design where the backlight is blocked when pixels are in the unselected state. Therefore, when no voltage is applied, the screen is black.

Normally White

A twisted nematic LCD design where light is transmitted when pixels are in the unselected state. Therefore, when no voltage is applied, the screen is white.

OCA (Optically Clear Adhesive)

OCA is also called dry bonding. Optical bonding, including LOCA (Liquid Optically Clear Adhesive) and non-liquid OCA tape, are used in a wide range of electronic equipment – especially those with touch panels. The adhesive is used to bond the touch panel to the main liquid crystal display, and also to bond any protective cover, such as the lens, to the touch panel. The adhesive is then cured onto the device through UV, heat, moisture, or a combination of these three methods, depending on the manufacturer and specifications. Major applications include capacitive touch panels, 3D televisions (3D TV), and glass retarders.

Optical bonding improves the optical performance of the display. It eliminates the air gap between the cover glass and the LCD, and usually includes an anti-reflective (A/R) coating (as well as anti-smudge and anti-glare treatments on the cover glass). Optical bonding improves the contrast ratio by reducing the amount of reflected light, thus improving the viewability of the LCD screen. This is especially important in outdoor.

Besides the optical advantages, bonding a sheet of glass to the LCD also improves the durability of the display. It can resist scratches, condensation, and has an improved range of operating temperatures. As touchscreen devices become ubiquitous in consumer markets, this increased ruggedness becomes even more important. Also, by reducing the light loss due to reflection, the battery life of the device can be extended as the device does not need as much backlight to power the display.

OCR (Optically Clear Resin)

OCR is also called wet bonding. It is mostly used for the uneven surface which is difficult for OCA process.

OGS (One Glass Solution)

One Glass Solution is a touchscreen technology which reduces the thickness of a display by removing one of the layers of glass from the traditional capacitive touchscreen stack. The touch sensor is made directly on the cover lens.

OLED (Organic Light Emitting Diode)

OLEDs are used to make OLED Displays, which can either be PMOLED (Passive Matrix OLED) or AMOLED (Active Matrix OLED).

On Cell

On-Cell Touch (OCT) technology permits the Projected Capacitive (PCAP) touch sensor layer to be built into the LCD structure. With this integrated structure, the touch functionality is embedded within the display itself rather than a separate touch screen component on top of the display. The reduction in the number of layers also reduces parallax errors providing a superior touch interface. Fewer layers also means backlight intensity can be reduced while providing the same brightness level. The usual multitouch display has an 88% transparency while an OCT display is 93%. This helps reduce lighting power requirements and extends battery life.

Optical Bonding

For optical bonding optically clear adhesive is applied over the entire surface between the display assembly and touch panel. This bonding method removes all air and air bubbles from the viewing area providing a more rugged and optically attractive solution. Removal of 'air gap' between the module and touch panel eliminates surface-to-surface reflections which degrade contrast and ultimately viewing angles, especially significant in sunlight conditions.

PCAP (Projected Capacitive Touch Panel)

See also "<u>CTP</u>".

PCB (Printed Circuit Board)

A printed circuit board (PCB) mechanically supports and electrically connects electrical or electronic components using conductive tracks, pads and other features etched from one or more sheet layers of copper laminated onto and/or between sheet layers of a non-conductive substrate. Components are generally soldered onto the PCB to both electrically connect and mechanically fasten them to it.

Printed circuit boards are used in all but the simplest electronic products. They are also used in some electrical products, such as passive switch boxes.

PCBA (Printed Circuit Board Assembly)

A circuit board prior to assembly of electronic components is known as PCB. Once electronic components are soldered, the board is called Printed Circuit Assembly (PCA) or Printed Circuit Board Assembly (PCBA) or PCB Assembly. Different Manual and Automatic PCB Assembly Tools are used in this process.

PCT (Projected Capacitive Touch Panel)

See also "<u>CTP</u>".

PCN

PCN stands for Product Change Notification. A product change notification (PCN) is a document issued by a manufacturer to inform customers about a change to a mass-produced product or its manufacturing process.

Pitch

The center dimension of adjacent conductive traces, dots, or connector holes.

Pixel

The same as "<u>dot</u>".

PMOLED (Passive Matrix Organic Light Emitting Diode)

Passive Matrix refers to the arrangement of the driving electrodes in the OLED display. In PMOLED displays, there is an array of horizontal conductors and an array of vertical conductors, with the OLED material between them. A pixel is formed where the vertical and horizontal conductors intersect.

Polarizer

A stretched polymer which transmits light in only one axis. A typical display has polarizers on the front and back.

Portrait

A page or screen orientation that is taller than it is wide, vs <u>Landscape</u>.

Positive Image
A display which has a light background and darker active segments, i.e. black characters on a silver background.

R5G6B5 or 565

A method of storing a full-color pixel in a single 16-bit word of memory. For each pixel, the red and blue channels can take on 32 levels, encoded as 5 bits each. The green channel can take on any of 64 levels, encoded as 6 bits. Theoretical color depth is 216 or 65,536 colors.

RAM (Random Access Memory)

This is memory that may be written to some value, then later read. RAM is the normal memory in a computer system. RAM only holds data when the RAM is powered. If power is interrupted, the data stored in the RAM is lost.

Reflective

A viewing mode which uses ambient or other front lighting to provide the illumination for the display.

Refresh rate

The number of times per second the screen is refreshed or redrawn. This number is usually stated in Hz (Hertz) or cycles per second. A rate of 60 Hz is equal to 60 times per second.

Reliability

The ability of an instrument to perform as specified without premature failure.

ROM (Read Only Memory)

This is memory that is factory pre-programmed to hold some data. ROM is data that can be read, but cannot be written or changed.

RTP (Resistive Touch Panel)

A resistive touch screen is made of two transparent layers of glass or plastic, each coated with a conducting layer of Indium Tin Oxide (ITO). The conducting sides face one another and are separated by an air gap. When pressure is applied by the user, the top layer bends and touches the bottom layer. This causes a small amount of current to flow at the point where they connect. The location of the touch event can then be measured by the sensors.
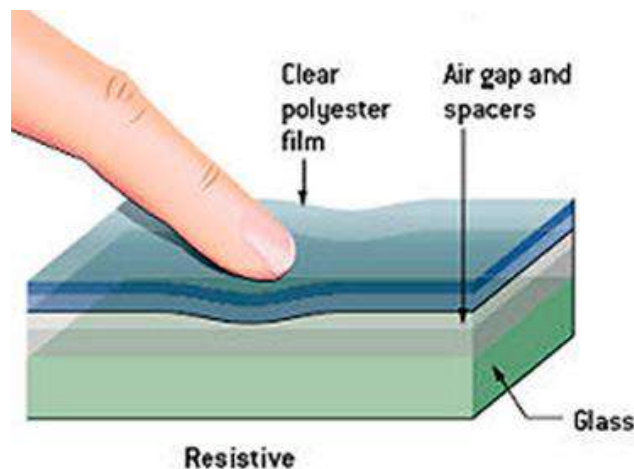

Fig.6 Resistive Touch Panel

Analog 4 wire resistive

In this variant, if the top sheet has electrodes for the vertical direction (Y), the bottom sheet will have electrodes for the horizontal direction (X). The top and bottom sheets measure each others' voltages and based on that sensors can determine the location of the touch point.

Analog 5 wire resistive

In this variant, the voltage of the bottom sheet is measured by the top sheet, with electrodes placed at four corners of the bottom sheet. The top sheet does not have any electrodes.

Analog 8 wire resistive

These screens are similar to Analog 4 wire screens. The only difference is an extra set of electrodes, which automatically take care of alignment and recalibration issues that crop up in the 4 wire screens over long term use.

Rubbing Process

A technique where the alignment layer (Polyimide) on the LCD substrate is rubbed in one or more directions. This process aligns the liquid crystal molecules parallel to the buffing direction.

Saturation Voltage

RMS voltage required to turn fluid to 90% on.

Segment

An active element of a digit, usually 7 segments for numeric and 14 segments for alpha/numeric digits.

SIL (Single-In-Line)

An LCD module that has a single row of connection holes, and an LCD glass with a single contact edge.

SMT (Surface-mount technology)

Surface-mount technology (SMT) is a method for producing electronic circuits in which the components are mounted or placed directly onto the surface of PCBs. An electronic device so made is called a surface-mount device (SMD). In the industry it has largely replaced the through-hole technology construction method of fitting components with wire leads into holes in the circuit board. Both technologies can be used on the same board for components not suited to surface mounting such as large transformers and heat-sink power semiconductors.

An SMT component is usually smaller than its through-hole counterpart because it has either smaller leads or no leads at all. It may have short pins or leads of various styles, flat contacts, a matrix of solder balls (BGAs), or terminations on the body of the component.

SPI (Serial Peripheral Interface)

SPI is a simple serial bus that is often used by LCD or OLED controllers. SPI as implemented for OLED and LCD controllers typically uses a "3-wire SPI" or "4-wire SPI" scheme. SPI was originally championed by Motorola (now Freescale). In its original "pure" form SPI uses four signals:

- SCK: Serial ClocK
- MOSI: Master Out / Slave In
- MISO: Master In / Slave Out

- SS: Slave Select

Static Drive

Same as "<u>direct drive</u>".

STN (Super Twisted Nematic)

STN is the commonly used in passive character and graphic LCDs.

Sub-Pixel

Each pixel is made up of three independently controlled sub-pixels. In a color display these sub-pixels have red, green, or blue color filters. Or, in the case of a grayscale display, each sub-pixel will have a clear transparent filter, allowing the full grayscale range to be displayed. Each sub-pixel is capable of generating different intensities, creating a range of colors or grayscale values, which is perceived as a mixture of each sub-pixel value.

TAB (Tape Automated Bonding)

Tape-automated bonding (TAB) is a process that places bare integrated circuits onto a flexible printed circuit board (FPC) by attaching them to fine conductors in a polyamide or polyimide film, thus providing a means to directly connect to external circuits.

TFT (Thin Film Transistor)

TFTs are also known as "Active Matrix TFT LCD modules" and have an array of these thin film transistors fabricated on the glass that makes the LCD. By using this active transistor-per-pixel architecture, the contrast of each pixel is good, allowing bright full-color, full motion images to be displayed.

Threshold Voltage

RMS voltage required to turn fluid to 10% on.

Transflective

A type of backing, bonded to the rear polarizer, which enables light to pass through the back as well as reflecting light from the front.

Transmissive

An LCD which does not have a reflector or transflector laminated to the rear polarizer. A backlight must be used with this type of LCD configuration.

TN (Twisted Nematic)

A type of liquid crystal where the alignment surface, and therefore the liquid crystal molecules, is oriented 90 degrees from each surface of glass.

USB (Universal Serial Bus)

USB is an industry standard developed in the mid-1990s that defines the cables, connectors and communications protocols used in a bus for connection, communication, and power supply between computers and electronic devices.

VA (Vertical Alignment displays)

VA is also called VTN, PMVA, GDV, etc. it is a type of LCD in which the liquid crystals naturally align vertically to the glass substrates. When no voltage is applied, the liquid crystals remain perpendicular to the substrate, creating a black display between crossed polarizers. When voltage is applied, the liquid crystals shift to a tilted position, allowing light to pass through and create a gray-scale display depending on the amount of tilt generated by the electric field. VA displays have a deeper-black background, a higher contrast ratio, a wider viewing angle, and better image quality at extreme temperatures over traditional twisted-nematic displays.

Viewing Angle

A cone perpendicular to the LCD in which minimum contrast can be seen.

Viewing Area

The dimensions measured from the inside perimeter of the LCD bezel or LCD glass epoxy seal.

ZIF (Zero Insertion Force)

ZIF: Short for Zero Insertion Force connector. This kind of connector is intended to be used with FPC (Flexible Printed Circuit) or FFC (Flat Flexible Cable). Typically, a ZIF connector has a movable element that can be opened or closed. In the open position FPC/FFC can be easily slid in, then the connector is closed to make firm contact.