PLASMA TECHNOLOGY

B.G.K.S. Bandara

Department of Electronics, Faculty of Applied Sciences, Wayamba University of Sri Lanka, Kuliyapitiya

Plasma display

A **plasma display panel (PDP)** is a type of flat panel display common to large TV displays (32" inches or larger). Many tiny cells between two panels of glass hold a mixture of noble gases. The gas in the cells is electrically turned into a plasma which then excites phosphors to emit light. Plasma displays should not be confused with LCDs, another lightweight flatscreen display using different technology.

General characteristics

Plasma displays are bright (1000 lux or higher for the module), have a wide color gamut, and can be produced in fairly large sizes, up to 381 cm (150 inches) diagonally. They have a very low-luminance "dark-room" black level compared to the lighter grey of the unilluminated parts of an LCD screen. The display panel is only about 6 cm (2.5 inches) thick, while the total thickness, including electronics, is less than 10 cm (4 inches). Plasma displays use as much power per square meter as a CRT or an AMLCD television. Power consumption varies greatly with picture content, with bright scenes drawing significantly more power than darker ones, as is also true of CRTs. Nominal power rating is typically 400 watts for a 50-inch (127 cm) screen. Post-2006 models consume 220 to 310 watts for a 50-inch (127 cm) display when set to cinema mode. Most screens are set to 'shop' mode by default, which draws at least twice the power (around 500-700 watts) of a 'home' setting of less extreme brightness. The lifetime of the latest generation of plasma displays is estimated at 100,000 hours of actual display time, or 27 years at 10 hours per day. This is the estimated time over which maximum picture brightness degrades to half the original value.

Plasma displays have drawbacks other than power consumption. They are often criticized for reflecting more ambient light than LCD displays. The front screen is made from glass, which reflects more light than the material used to make an LCD screen, which results in glare from reflected objects in the viewing area. Companies such as Panasonic coat their newer plasma screens with an anti-glare filter material. Currently, plasma panels cannot be economically manufactured in screen sizes smaller than 32". Although a few companies have been able to make plasma EDTVs this small, even fewer have made 32" plasma HDTVs. With the trend toward larger and larger displays, the 32" screen size is rapidly disappearing.

History

The monochrome plasma video display was co-invented in 1964 at the University of Illinois at Urbana-Champaign by Donald Bitzer, H. Gene Slottow, and graduate student Robert Willson for the PLATO Computer System. The original neon orange monochrome Digivue display panels built by glass producer Owens-Illinois were very popular in the early 1970s because they were rugged and needed neither memory nor circuitry to refresh the images. A long period of sales decline occurred in the late 1970s because semiconductor memory made CRT displays cheaper than the 2500 US$ 512 x 512 PLATO plasma displays. Nonetheless, the plasma displays' relatively large screen size and 1 inch thickness made them suitable for high-profile placement in lobbies and stock exchanges.

Electrical engineering student Larry F. Weber became interested in plasma displays while studying at the University of Illinois at Urbana-Champaign in the 1960s, and pursued postgraduate work in the field under Bitzer and Slottow. His research eventually earned him 15 patents relating to plasma displays. One of his early contributions was development of the power-saving "energy recovery sustain circuit", now included in every color plasma display.

Native Plasma Solutions

Plasma televisions scale their incoming signals to their native resolutions, displaying either EDTV or HDTV outputs. Therefore picture quality varies depending on the type of video scaler, up or down scaling algorithm and video processing hardware chip involved by various manufactures.

Enhanced-definition plasma television

Early plasma televisions were enhanced-definition (ED) with a native resolution of 840x180 (discontinued) or 853x480, and down-scaled their incoming high definition signals to match their native display resolution.

Resolutions

- 840x180
- 853x480

Hi-definition plasma television

Early hi-definition (HD) plasma displays had a resolution of 1024x1024 and were Alternate Lighting of Surfaces (ALiS) panels made by Fujitsu/Hitachi. These were interlaced displays, with non-square pixels. Modern HDTV plasma televisions usually have a resolution of 1024x768 (720p) found on many 42" plasma screens, 1280x768, 1366x768 found on 50", 60", & 65" plasma screens or 1920x1080 found in plasma screen sizes from 42" to 103". These displays are usually progressive displays, with square pixels, and will up-scale their incoming standard-definition signals to match their native display resolution.

Resolutions

- 1024x1024
- 1024x768
- 1280x768
- 1366x768
- 1920x1080

Advantages

- Slim profile
- Lighter and less bulky than rear-projection televisions
- Achieves better color reproduction than LCDs (68 billion (2^{36}) versus 16.7 million (2^{24}))
- Produces deep, true blacks allowing for superior contrast ratios (up to 1:1,000,000)
- Far wider viewing angles than those of LCD (up to 178°), images do not suffer from degradation at high angles unlike LCD's
- Faster response times (upto 0.001 milliseconds) make Plasmas ideal for fast motion video (films or sports viewing)
- Can be wall mounted

Disadvantages

- Susceptible to Screen burn-in and image retention (however newer models have built-in technologies to prevent this such as pixel shifting)
- Phosphors lose luminosity over time, resulting in gradual decline of absolute image brightness (newer models are less susceptible to this, having lifespans exceeding 60,000 hours, far longer than older CRT technology)
- Susceptible to "large area flicker"

- Generally do not come in smaller sizes than 32 inches
- Susceptible to reflection glare in bright rooms
- Heavier than LCD due to the requirement of a glass screen to hold the gases
- Damage to the glass screen can be permanent and far more difficult to repair than an LCD

How plasma displays work

The xenon, neon, and argon gas in a plasma television is contained in hundreds of thousands of tiny cells positioned between two plates of glass. Long electrodes are also put together between the glass plates, in front of and behind the cells. The address electrodes sit behind the cells, along the rear glass plate. The transparent display electrodes, which are surrounded by an insulating dielectric material and covered by a magnesium oxide protective layer, are mounted in front of the cell, along the front glass plate. Control circuitry charges the electrodes that cross paths at a cell, creating a voltage difference between front and back and causing the gas to ionize and form a plasma. As the gas ions rush to the electrodes and collide, photons are emitted.

In a monochrome plasma panel, the ionizing state can be maintained by applying a low-level voltage between all the horizontal and vertical electrodes – even after the ionizing voltage is removed. To erase a cell all voltage is removed from a pair of electrodes. This type of panel has inherent memory and does not use phosphors. A small amount of nitrogen is added to the neon to increase hysteresis.In color panels, the back of each cell is coated with a phosphor. The ultraviolet photons emitted by the plasma excite these phosphors to give off colored light. The operation of each cell is thus comparable to that of a fluorescent lamp.

Every pixel is made up of three separate subpixel cells, each with different colored phosphors. One subpixel has a red light phosphor, one subpixel has a green light phosphor and one subpixel has a blue light phosphor. These colors blend together to create the overall color of the pixel, the same as a "triad" of a shadow-mask CRT or color LCD. By varying the pulses of current flowing through the different cells thousands of times per second, the control system can increase or decrease the intensity of each subpixel color to create billions of different combinations of red, green and blue. In this way, the control system can produce most of the visible colors. Plasma displays use the same phosphors as CRTs, which accounts for the extremely accurate color reproduction when viewing television or computer video images (which use an RGB color system designed for CRT display technology).

Contrast Ratio

Contrast ratio is the difference between the brightest and darkest parts of an image, measured in discrete steps, at any given moment. Generally, the higher the contrast ratio, the more realistic the image is (though the "realism" of an image depends on many factors including color accuracy, luminance linearity, and spatial linearity.) Contrast ratios for plasma displays are often advertised as high as 1,000,000:1. On the surface, this is a significant advantage of plasma over display technologies other than OLED. The ANSI standard uses a checkered test pattern whereby the darkest blacks and the lightest whites are simultaneously measured, yielding the most accurate "real-world" ratings. In contrast, a full-on-full-off test measures the ratio using a pure black screen and a pure white screen, which gives higher values but does not represent a typical viewing scenario.

Plasma is often cited as having better (i.e. darker) black levels (and higher contrast ratios), although both plasma and LCD each have their own technological challenges. Each cell on a plasma display has to be precharged before it is due to be illuminated (otherwise the cell would not respond quickly enough) and this precharging means the cells cannot achieve a true black. With LCD technology, black pixels are generated by a light polarization method; many panels are unable to completely block the underlying backlight.

Screen burn-in

With phosphor-based electronic displays (including cathode-ray and plasma displays), the prolonged display of a menu bar or other static (fixed in place and unchanging) graphical elements over time can create a permanent ghost-like image of these objects. This is due to the fact that the phosphor compounds which emit the light lose their luminosity with use. As a result, when certain areas of the display are used more frequently than others, over time the lower luminosity areas become visible to the naked eye and the result is called burn-in. While a ghost image is the most noticeable effect, a more common result is that the image quality will continuously and gradually decline as luminosity variations develop over time, resulting in a "muddy" looking picture image.

Plasma displays also exhibit another image retention issue which is sometimes confused with phosphor_burn-in damage. In this mode, when a group of pixels are run at high brightness (when displaying white, for example) for an extended period of time, a charge build-up in the pixel structure occurs and a ghost image can be seen. However, unlike burn-in, this charge build-up is transient and self corrects after the image condition that caused the effect has been removed and a long enough period of time has passed (with the display either off or on).

Environmental impact

Plasma screens have been shown to contribute to global_warming. This is due to the use of nitrogen_trifluoride, a very potent greenhouse_gas, which is used in the production of plasma screens. Plasma screens have also been lagging behind CRT and LCD screens in terms of energy consumption. The latter is however more of a problem when energy is used generated from fossil fuel power plants. To reduce the energy consumption, new technologies are also being found. Although it can be expected that plasma screens will continue to become more energy efficient in the future, a growing problem is that people tend to keep their old TVs running and an increasing trend to escalating screen sizes.