Technology White Paper
Plasma Displays

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What is a Color Plasma Display Panel?

The term Plasma refers to a flat panel display technology that utilizes a gas discharge principle. Plasma display panels, or PDPs, possess a number of advantages that suit them to large screen formats. PDPs are thin and lightweight and take up less space than other displays which - makes them easy to install almost anywhere. They also offer display characteristics that lend themselves well to large screen usage. They offer uniform brightness, show images without distortion and avoid problems such as misregistered colors and lack of focus. They also resist interference from magnetic fields, are free from distortion and viewable from a wide angle. Additionally, PDPs are are suitable for multimedia usage because they can display computer images as well as full-color, full-motion pictures. Finally, PDPs offer a simple structure which makes them relatively easy to manufacture

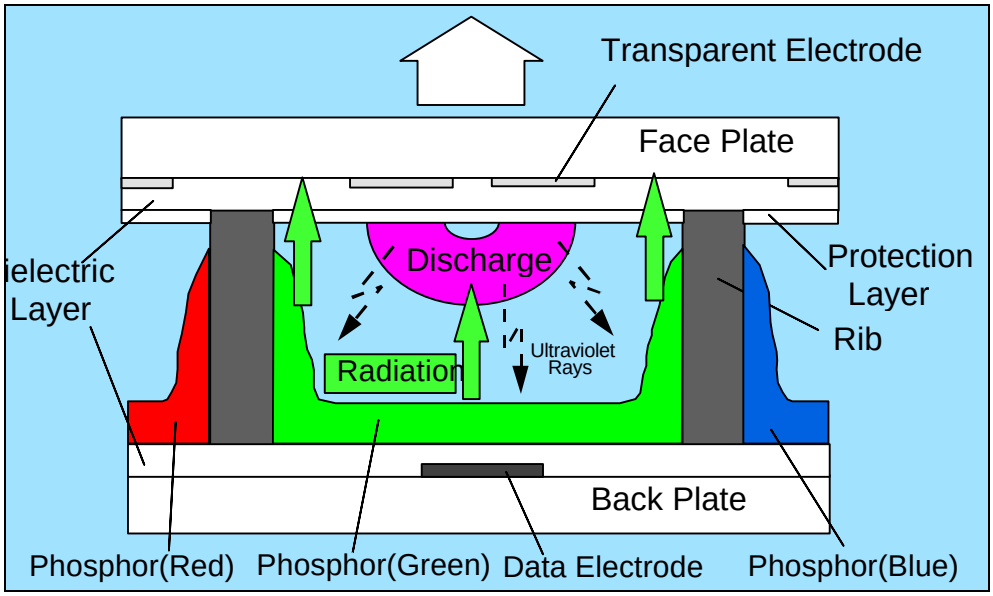
PDPs are an *emissive* display which means that the panel itself is the light source. In comparison to a *transmissive* display, where the light source is separate and light is passed through the panel to create an image, PDPs are extremely bright and light-tolerant.

How does a PDP work?

PDPs are composed of two parallel sheets of glass which enclose a mixture of discharge gases composed of helium, neon and xenon. Dike-like barriers, or ribs, keep the glass plates parallel. Groups of electrodes sit at right angles between the panes forming rectangular compartments, or cells, between the glass sheets. Phosphors are embedded within each cell that individually emit red, green or blue light and collectively create a single color pixel.

Selectively applying voltages to the electrodes causes them to generate a discharge in the panel's dielectric layer and on its protective surface. This generates ultraviolet light that excites the phosphors, stimulating them to emit light. This principle of operation is very similar to that of a flourescent lamp. In this sense, it is possible to think of a color PDP as a screen incorporating thousands of miniature flourescent lights.

Gas discharge principle of PDP operation:

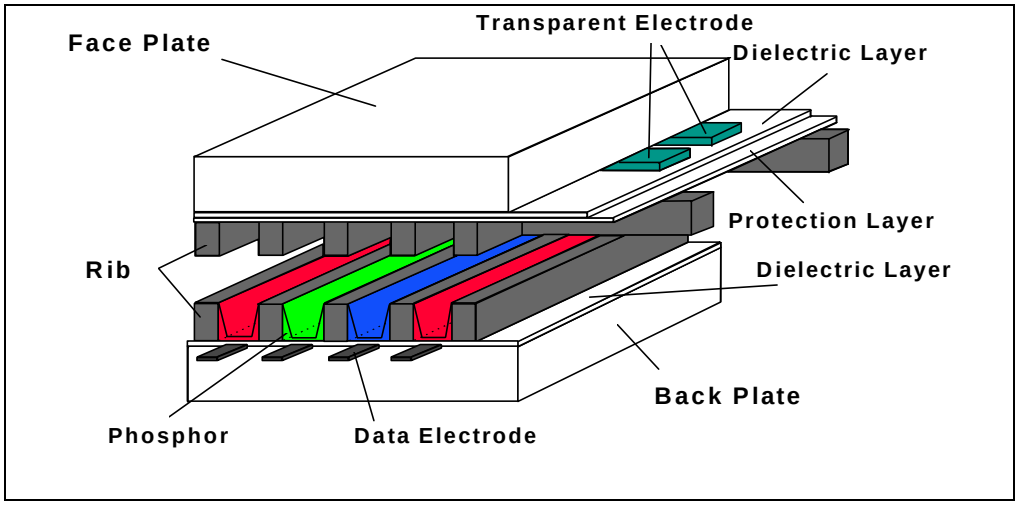


What is the structure of a PDP?

A color plasma display panel is composed of a face plate with pairs of transparent electrodes and a back plate which contains metal electrodes.

In the face plate the transparent electrodes are covered with a glass layer called the Dielectric Layer. A magmesium oxide coating, called the Protective Layer, is applied to this glass layer.

In the back plate, metal electrodes are covered with another Dielectric glass layer. On this layer ribs which are made from a glass material are placed. These barrier ribs serve to separate the plasma panel into separate discharge cells. Red, green and blue phosphors are alternately deposited between the ribs.



What does the term "AC" mean and how does it relate to other variations of Plasma technology?

AC displays use an internal dielectric glass layer to limit the current. This dielectric glass forms a small capacitor that is in series with every gas discharge in an AC Plasma display. Because the dielectric glass is an excellent insulator, no dc current can flow, so that an AC voltage must be applied to maintain a discharge. The major difference between AC and DC is that the DC electrodes are in intimate contact with the gas and the AC electrodes are insulated from it by the dielectric glass.

AC and DC type Plasma technology each have inherent advantages and limitations. DC Plasma provides higher contrast and the ability to reproduce a greater number colors but is inherently complex in structure and requires a coarse pixel array (similar to coarse dot pitch specification in a CRT-based monitor). AC Plasma offers a simpler structure and finer (more detailed) display but does so at the expense of lower contrast and more limited ability to display shades of color.

Another difference between the two has to do with the difference between resistive and capacitive charging methods. The capacitive method of AC Plasma requires a longer time for cells to charge and discharge while the resistive method of DC allows a faster drive capability that is better suited to moving images in high resolution and HDTV. This faster response time comes at the expense of higher power consumption.

Development efforts for both AC plasma panels are leading toward delivering better contrast and bigger displayable color palettes. In the case of DC plasma, efforts are concentrated on lowering its power usage and simplifying its manufacturing process.

Plasma Addressed Liquid Crystal - or PALC - is a hybrid of both Plasma and LCD displays . In this kind of panel an AC Plasma addressing method is used as a switch for LCD display cells instead of a Thin Film Transistor (TFT).

How does a PDP produce an image?

A PDP creates light emission by the selective application of high voltage pulses to the electrodes enclosed within the panel. Within the panel itself there are two types of electrodes. Those in the face plate are made of a transparent material and consist of *scan* electrodes and *sustain* electrodes. These are the means by which the panel determines which specific pixels or groups of pixels to "turn on" and for what duration they are to be illuminated.

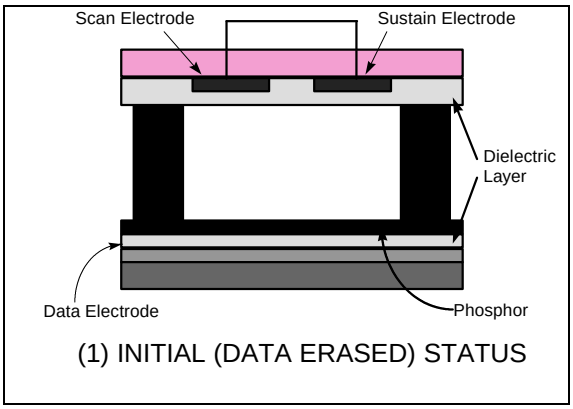
Metal electrodes that reside in the back plate are known as *data* electrodes. These are the means by which the source signal determines the parameters of the image that is to be "drawn" on the screen.

In the case of an AC Plasma display, all of the electrodes are covered by a dielectric layer and these electrodes and dialectic layers work as capacitors. Current flows through the dielectric layer at the rising and falling edges of high voltage pulses.

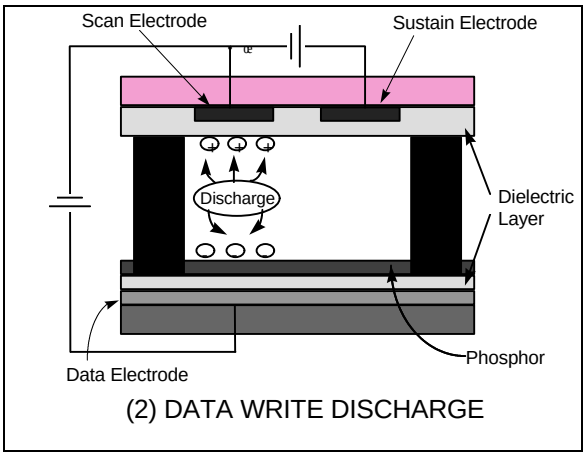
There are six steps in the process by which a PDP operates to produce an image.

1. Initial status - all cells are unlit
2. Data write discharge
3. Data written status
4. Data sustain discharge 1
5. Data sustain discharge 2
6. Data erase discharge

1. All cells are initially unlit and the screen is dark.

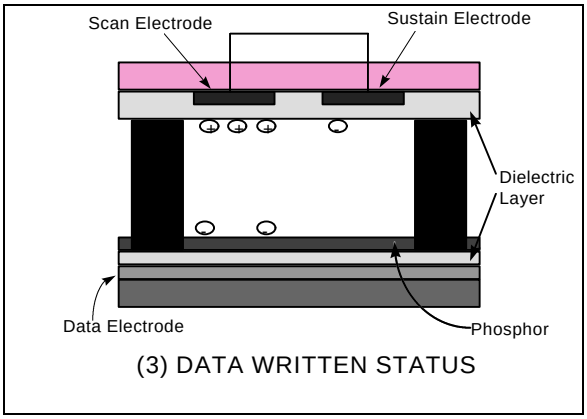


2. When a high voltage pulse is applied between the scan electrode and the data electrode a discharge occurs. The discharge occurs only in the cells selected by the scan electrode and data electrode.



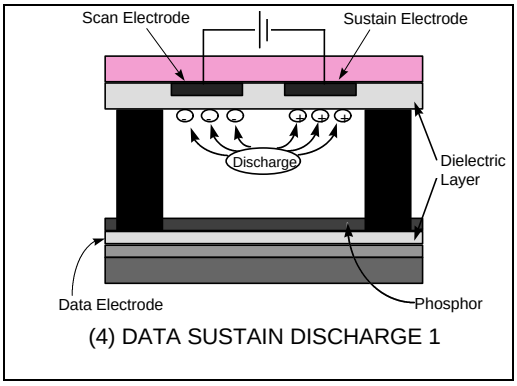
(2) DATA WRITE DISCHARGE

3. After the discharge is finished, charges remain on the surface of the dielectric layer in the selected (discharged) cells. These charges are called the “wall charge”.



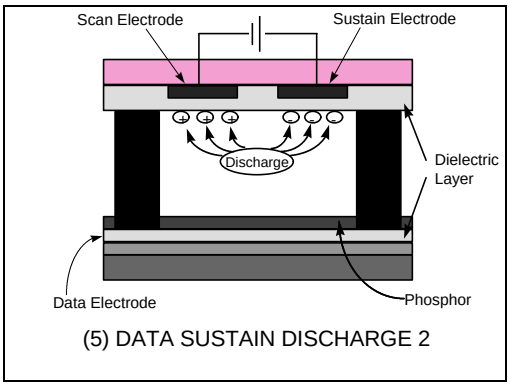
(3) DATA WRITTEN STATUS

4. Apply sustaining high voltage between Sustain electrode and Scan electrode. The electric field created by this sustain high voltage does not exceed the threshold required to create a gas discharge but the additional electric field made by the wall charge causes gas to discharge. By this method only selected cells are lit by applying the sustain high voltage. After the discharge is finished reverse polarity wall charge remain only on the dielectric layer of the selected cells.



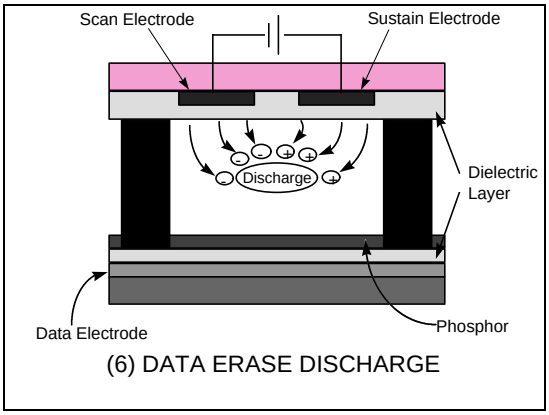
(4) DATA SUSTAIN DISCHARGE 1

5. Continue to apply reverse polarity sustain high voltage between Sustain electrode and Scan electrode for selected cells to continue discharge and emit visible light.



(5) DATA SUSTAIN DISCHARGE 2

6. When lower voltage than the sustain high voltage is applied between the sustain electrode and the data electrode small discharges are created in the selected cells. These small discharges absorb the wall charge into the cell and the wall charge is erased.

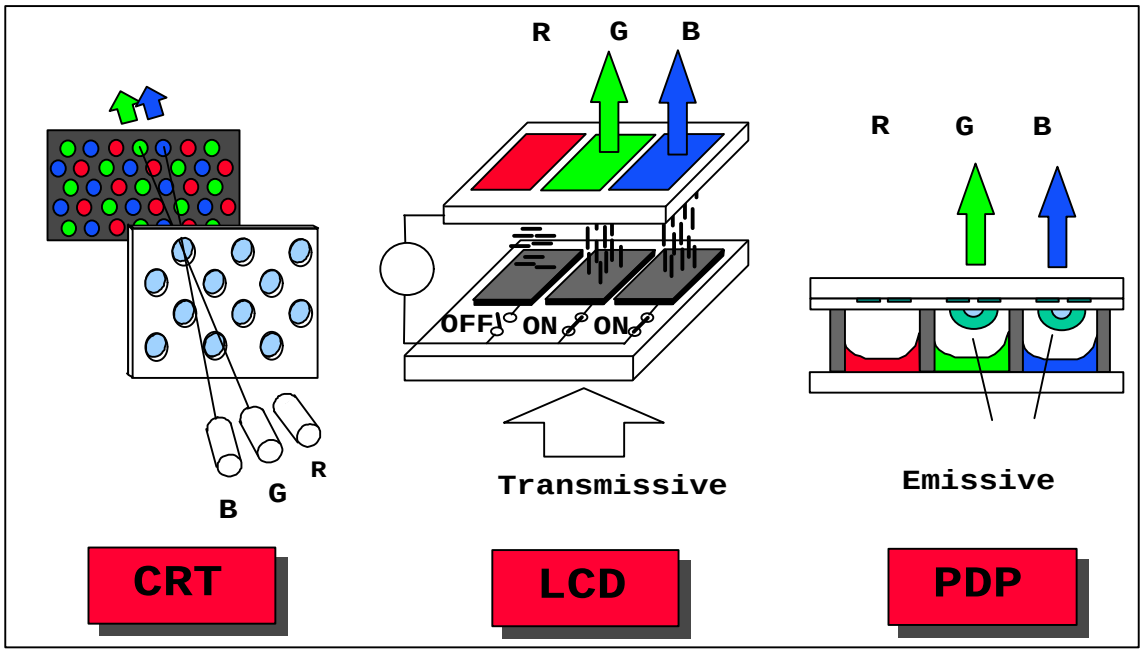


(6) DATA ERASE DISCHARGE

By repeating steps 2 through 6 the color PDP can create an image according to the input signals which are led to the driver circuits and these driver circuits instruct the sustain, scan and data electrodes.

How does Plasma compare to other display technologies?

This illustrates the differences between the methods used by CRT, LCD and PDP technologies to create an image.



Color PDPs compare favorably or acceptably to other technologies in several important display attributes including screen size, physical size, viewing angle, color capabilities, resolution, brightness, contrast and power consumption.

40" diagonal screen

	Large Size	Space Factor	View. Angle	Full Color	Reso-lution	Bright-ness	Con-trast	Power
C-PDP	1	1	1	1	2	2	2	3
CRT	3	4	1	1	2	1	1	3
LCD	4	1	2	1	1	2	2	1
Projector	1	4	3	1	2	3	3	3

1: Excellent 2: Good 3: Acceptable 4: Poor

What are the attributes of Plasma Displays?

Thin

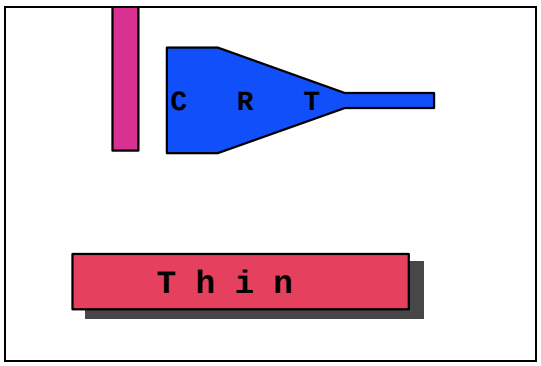
Plasma displays are very thin, averaging between 3" and 6" thick.

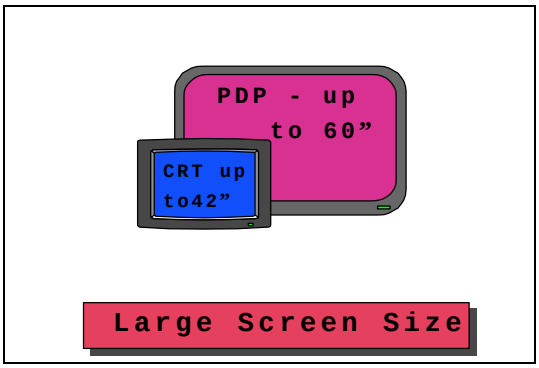
Lightweight

The weight of a PDP panel or monitor that incorporates a PDP panel is, on average about 40% to 50% of the weight of a CRT-based monitor of similar screen size.

Large Size

What screen size ranges of 30"+ are best prospects for Plasma. CRTs of 35-42" are extremely large and heavy. Above 42" direct view is served best by rear projection. Plasma is smaller, less expensive and simpler to use/operate. Under 30" CRTs are likely to remain predominant due to their low cost relative to Plasma.





Why is Plasma suited to large screen sizes? It is relatively simple to manufacture in comparison to an LCD panel due to its less complex structure and wider spacing tolerances between front and rear substrate layers.

Viewing Angle

Viewing angle is almost a full 180° with virtually no loss of readability due to the emissive nature of the plasma panel. In other words, the panel itself is the light source.