LASER PHOSPHOR DISPLAY (LPD)

Introduction to LPD Technology and its Advantages in Large Format Displays

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AGENDA

- Introducing Prysm & LPD: Basic LPD Architecture
- Key Features with few detailed examples
- Green Manufacturing
- LPD Application and Video
COMPANY OVERVIEW

About

Founded in 2005: Prysm Inc. is a privately held global manufacturer of large-format Laser Phosphor Display (LPD) systems
- Headquarters: San Jose CA
- Engineering offices: San Jose; Boston; Bangalore
- Manufacturing: USA Japan & China

Product & Technology

LPD – Laser Phosphor Display
A breakthrough phosphor screen technology powered by a laser engine, Prysm has introduced the most ecovative and high performance electronic display technology

Unique & Innovative

Exclusive and full ownership of this technology
• Raster scanning laser light excitation on a phosphor screen

The laser engine generates an array of beams which are directed onto the phosphor screen by the fold mirrors.
• LPD uses solid state lasers to excite phosphors that generate high-resolution images

• As lasers scan the surface, phosphors emit in the red, green & blue colors with very rapid response

• Lasers modulate by turning on & off for each pixel to create an image

• LPD is a surface emissive display with very fast response time; which translates into no motion blur with 180 degree viewing angles, incredible contrast and longer life than any conventional display
LPD ARCHITECTURE

Horizontal scan direction

Scanning Laser Beam

Laser Module
(Beam Scanning & RGB Channel Modulation)

One Unit Pattern of Stripes
Red Phosphor Stripe
Green Phosphor Stripe
Blue Phosphor Stripe

Photo of Panel Segment
Today’s display market is fragmented by use:
- Commercial (high brightness but low resolution, large)
- Consumer (high resolution but low brightness, small)

LPD is scalable in such it can offer high resolution AND high brightness in different sizes from 25” to 100s” in an Ecovative* way

* Ecovative: means GREEN throughout the life cycle, from manufacturing to use to recycling

More Key Functional Features Next…
• KEY FEATURES
  ▪ Low Power Consumption
  ▪ Wide Viewing Angle
  ▪ Long Lasting
  ▪ Visually Seamless Tiles
  ▪ Fast Pixel Response / No Motion Blur
• The power consumption of a display is determined by the illumination source throughput and utilization:

• Source Throughput:
  ▪ In LPD, most of the excitation laser light, around 80%, makes it to each sub-pixel at a point in time.
  ▪ The conversion efficiency of each subpixel from excitation light into color R, G or B light approaches 30%.
  ▪ The aggregate throughput of LPD “excitation light to viewer light” is > 20%. This makes it highly efficient when compared to other technologies such as LCD or RPTV.

• Source Utilization:
  ▪ Given that the source is modulated for video content, the average level of the source is only a fraction of the maximum power level.
  ▪ Example: for incoming video with 35% APL and gamma 2.2, the source light level is only 10% on average.
  ▪ This makes the display extremely efficient
LPD POWER CONSUMPTION 75% LOWER THAN OTHER DISPLAYS EXCEEDING HIGHEST ENERGY STAR RATING

- - Indicates demonstrated LPD power consumption 2010
LOW POWER CONSUMPTION LEADS TO LOWER COST OF OWNERSHIP

Electrical Operating Costs Display Comparison

<table>
<thead>
<tr>
<th></th>
<th>LPD</th>
<th>LED LCD</th>
<th>LCD Tile</th>
<th>LED</th>
<th>RP</th>
<th>LED RP or Front Projection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Power Consumption (kW)</td>
<td>2.5</td>
<td>5.4</td>
<td>9.0</td>
<td>11.1</td>
<td>13.2</td>
<td>17.3</td>
</tr>
<tr>
<td>Total Energy Cost ($/life)</td>
<td>$12,292</td>
<td>$26,747</td>
<td>$44,579</td>
<td>$54,543</td>
<td>$65,131</td>
<td>$85,224</td>
</tr>
<tr>
<td>Additional Cost vs. LPD</td>
<td>-</td>
<td>+$14455</td>
<td>+$32286</td>
<td>+$42251</td>
<td>+$52839</td>
<td>+$72931</td>
</tr>
<tr>
<td>Greenhouse Gas Produced (tons/life)</td>
<td>88</td>
<td>191</td>
<td>318</td>
<td>389</td>
<td>465</td>
<td>608</td>
</tr>
<tr>
<td>% Saved with LPD</td>
<td>-</td>
<td>54%</td>
<td>72%</td>
<td>77%</td>
<td>81%</td>
<td>86%</td>
</tr>
</tbody>
</table>

Notes:
- For 20 sq. m display operating 18hrs/day for 5 years
- $0.15 per kWh
- Does not include consumables, maintenance or floor space
- See dynamic web TCO calculator at prysm.com
• LPD is an emissive display like CRT
• When excited, the RGB phosphors emit light uniformly in all angles
• Phosphor emission and the fact that it is located in a layer closest to the viewer provides for a wide viewing angle.
• In addition to brightness uniformity vs. angular field of view, another important attributes for wide angular viewing are the black and color shifts of the display:
  ▪ In LPD the laser is OFF during black video, which means true black is rendered. This allows the contrast ratio to be constant vs. field of view.
  ▪ In LCD, contrast and color change vs. field of view have been noted in the literature and measured on certain off the shelf TVs.
<table>
<thead>
<tr>
<th>Axial View</th>
<th>60 deg. horizontal</th>
<th>45 deg. vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LPD</strong></td>
<td><img src="image1" alt="Image 1" /></td>
<td><img src="image2" alt="Image 2" /></td>
</tr>
<tr>
<td><strong>LCD TV (w/ LED Backlight)</strong></td>
<td><img src="image3" alt="Image 3" /></td>
<td><img src="image4" alt="Image 4" /></td>
</tr>
</tbody>
</table>
LPD MAINTAINS IMAGE QUALITY OVER WIDE VIEWING ANGLE

HORIZONTAL ANGLE

Luminance Maintained vs. Angle of View

Contrast Ratio Maintained vs. Viewing Angle
LPD MAINTAINS IMAGE QUALITY OVER WIDE VIEWING ANGLE

VERTICAL ANGLE
• LPD is a long lasting display with no panel burn-in / decay over many years
  - Excitation energy and the phosphor environment is “friendly” in comparison to other displays such as PDP or CRT
    - LPD 2.7 eV low energy no heat (source decoupled from phosphor) and no vacuum required
    - PDP 3.4-6.2eV high energy with heat (source close to phosphor) with VUV and vacuum/humidity degradation over time
    - CRT 25-30Kev catho-luminescence (heat) and vacuum required
  - Because of raster scanning, the amount of “exposure” is very short per sub-pixel
ACCELERATED PANEL TESTING: BRIGHTNESS

Normalized light output vs. operating time, hours

- RED
- GREEN
- BLUE
KEY FEATURE: Visually Seamless Tiles
LPD has “nearly” no seam from edge of sub-pixel to edge of panel
ADDITIONAL EDGE BOOST REDUCES SEAM VISIBILITY IN LPD TILE PRODUCTS

- Taken from 3 m distance
- Boost factor is 1.2x average
• LPD uses raster scanning to render an image
• This means that there is a blanking or “black field” between successive video fields
• This attribute is perfect for applications such as 3D or multiview as there is 100% no cross talk between video fields
• Also, the phosphor response time is < 2-3 usec, allowing for very high refresh rate between video fields—(currently set to 240 Hz or 4 msec per field)
The values of rise/decay times of all Prysm RGB phosphors are within 2-3 μs.
FAST PIXEL RESPONSE TIME ELIMINATES MOTION BLUR ARTIFACTS AND IMPROVES 3D PERFORMANCE

Millisecond frame response with microsecond phosphor response

No Motion Blur

Motion blur

LPD

LCD/Plasma
LPD GREEN MANUFACTURING

- 1000 times less emissions than conventional flat panel fabrication
  - Almost no production of waste water or greenhouse gas
  - LPD is assembled from components not a wafer or glass fab process
  - Low energy production
- No toxic materials used
  - RoHS compliant
  - Support LEED green building designs
- Recyclable parts & materials
LPD LIFECYCLE CARBON FOOTPRINT 90% LOWER THAN OTHER DISPLAYS

LPD eliminates requirement for large, energy intensive fabrication plants like the example shown here.

*Source: Sharp LCD
LPD OFFERS A BREAKTHROUGH FOR PUBLIC DISPLAYS

Company Confidential & Proprietary
THANK YOU

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