PLANAR

Behind Every AMLCD Display is a Good Backlight

Light emitting diodes (LEDs) technology for AMLCD backlights

Table of Contents

LEDs Define the New Performance Standard

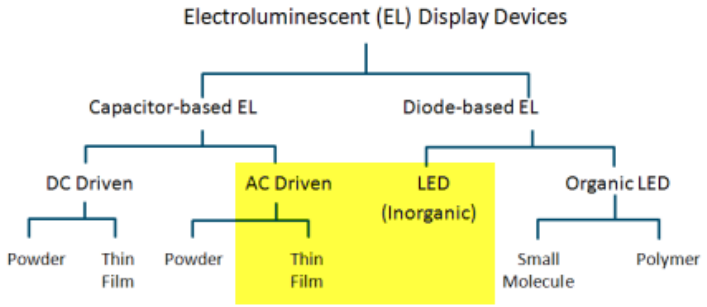
LEDs seem to be popping up everywhere. From light bulbs to rugged displays, light emitting diodes continue to follow a cost and performance curve that resembles the advances in microprocessors. This Ebook provides a quick overview of LEDs technology and how they can be used effectively to backlight displays.

What is Electroluminescence?

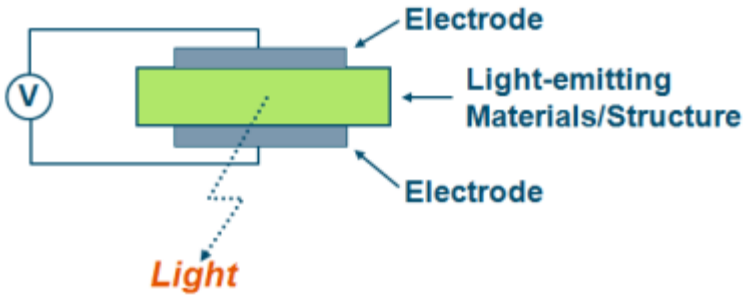
The Electroluminescence (not LED) Family Tree

Electroluminescence is process of generating light in an electric field. Applied voltage results in light emission. One or both electrodes may be transparent.

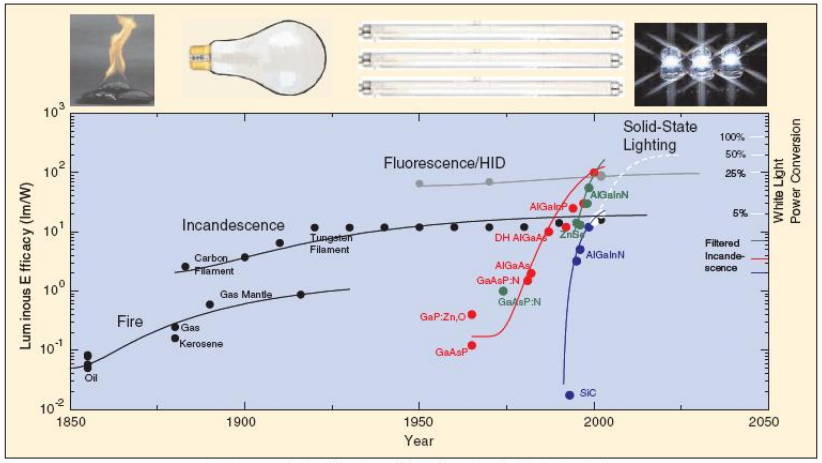
Planar's thin film electroluminescent displays (TFEL) are a proven technology with over 25 years in rugged and ultra-wide temperature applications. Our focus on this Ebook will be inorganic LEDs. You can see the relationship between these two technologies in the diagram to the right.



Taxonomy of electroluminescent technology



Haitz's Law



1. 200-year evolution of luminous efficacy for various lighting technologies.

Since the invention of the red LED in 1960, every 10 years the light output per device has increased by a factor of 20 and the cost per lumen has fallen by a factor of 10.

Roland Haitz, HP/Agilent Labs

LED vs CCFLs BLUs for Small, Ruggedized Displays

LED Advantages

LEDs offer a wide assortment of advantages over traditional backlighting technology, especially for rugged displays.

- Efficiency improvement
  - ~2x luminance for the same power, or half the power for same luminance, compared to CCFL BLUs
- Wide temperature range
  - Instant on
- Wide dimming range
  - >1000:1 possible
- Low voltage - minimal EMI
- Easier thermal and shock and vibration management possible
- Green
  - No mercury
- Efficiency will continue to increase and cost will decrease

Planar LED BLU Design Focus

Planar has chosen to focus its design efforts on LED Backlight Units (BLUs) for the following reasons:

- Use highest efficiency LEDs available/affordable which leads to premium performance
- Optimize thermal management and don't create a thermal hot spot issue
- Provide excellent uniformity (no headlight effect)

Approaches to Produce White Light from LED BLUs*

Single White LED v. RGB LED

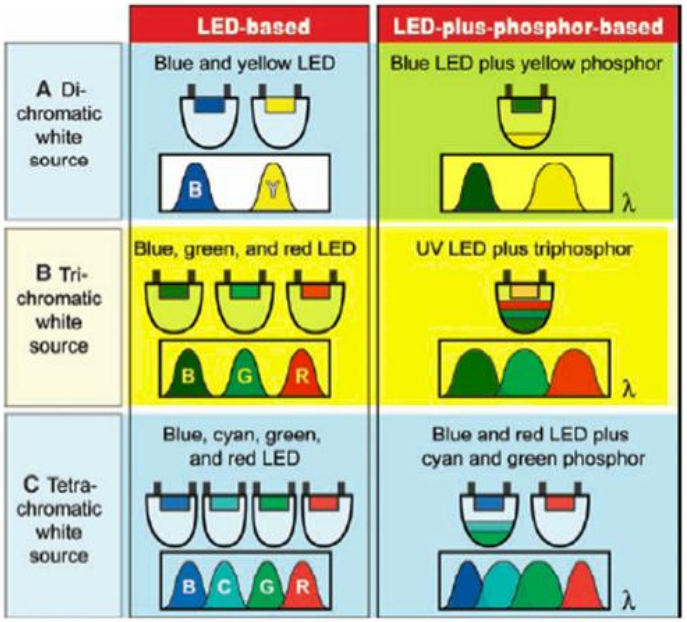
Single White LEDs (green box in diagram)

- Currently the highest volume
- Simpler
- One LED type
- Easiest transition from CCFL
- Fewer issues with brightness and color matching
- Lower level of color saturation (depends on color filters)
- Smaller color gamut
- No color adjustability

RGB LEDs (yellow boxes in diagram)

- More efficient for use in AMLCDs
- Wider color gamut, >NTSC
- Provides color adjustability
- More parts
- More difficult/expensive intensity and color matching

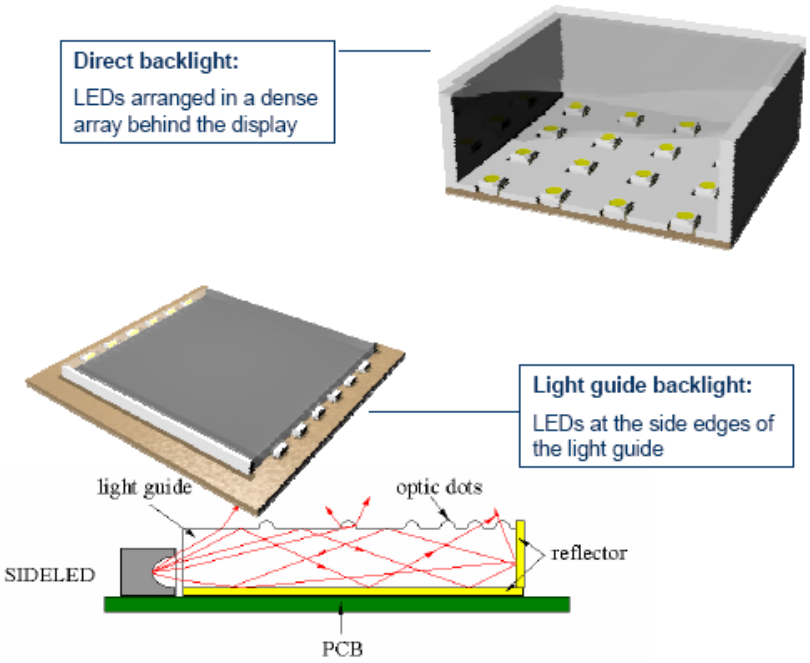
*BLU = Backlight Unit



LEDs for LCD Monitor Backlights – Two Types

Direct v. Light Guide Backlight

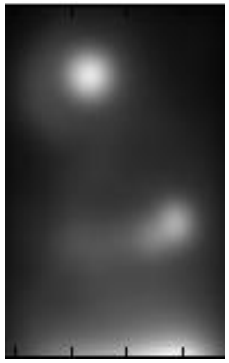
- Direct (or cavity) backlights are typically used on with LCD panels greater than ~26-inch diagonal
- Lightguide-based backlights have been demonstrated in LCD displays used in cell phones to over 50-inches
- Lightguide designs typically require fewer LEDs and so they are less expensive
- Cavity backlights can be used in LCD designs that reduce motion blur and for high dynamic range displays (see next slide)



Advantages of LED Cavity Backlight Units

In conventional AMLCD TVs, the Backlight Unit (BLU) is full-on all the time. This makes images with a wide range of grayscale values hard, or nearly impossible to reproduce accurately. High dynamic range (HDR) AMLCDs provide a wider dynamic range by modulating the BLU locally in response to the video content (i.e – when video scene is dark in part of the screen, the BLU output is reduced there). The LEDs are driven with the video signal, along with the AMLCD.

Video Image



BLU output

Image optimized for low end of grayscale range

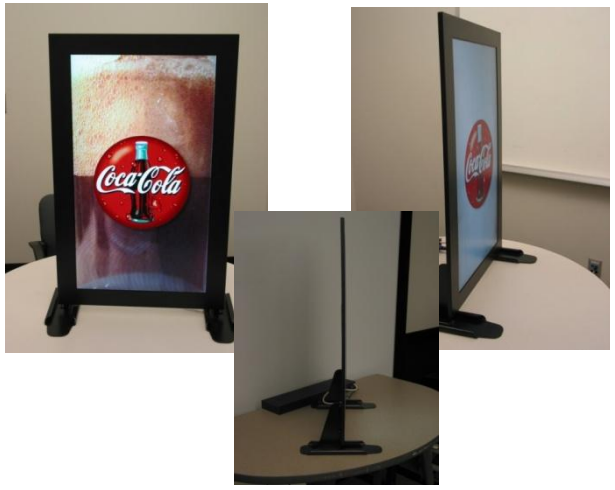
Optimized HDR

Image optimized for high end of grayscale range

32-inch AMLCD Monitor that's 0.5-inch Thick

Planar Digital Sign with LED-Illuminated Lightguide

- HD Resolution (1366x768)
- 500 nits @ ~60W vs. CCFL: 500nits @130W
- Two wires drive the panel: LVDS and LED power
- Video I/F card and power supply are out-boarded to adjacent module
- Uses all conductive cooling: can be used in portrait or landscape mode
- Concept can be applied to other sizes



Display in use as a digital sign for mass transit

So-called "LED TVs"

It's not really an LED TV – it uses an LED BLU with a conventional AMLCD, just like Planar's thin 32-inch

10.4-inch High Brightness/High Efficiency Rugged AMLCD

Planar 10.4-inch Specifications

- XGA (1024x768 resolution)
- 2300 nits at <10W (bare panel)
- 1000 nits at <5W (bare panel)
    - Cool to the touch
- >1000 nits at <10W possible with EMI and NVIS compliance
- NVIS B compliance demonstrated, NVIS A in process
- Viewing angle: H/V ±80° / ±65°
- Operating temperature range: -40° C to 80° C (with heater)
- LVDS interface

Current Trends in LED Usage for Displays

Application Versatility

Small displays for handheld devices: longtime white LED use for low power and brightness versus powder EL and CCFLs.

Notebooks/laptops: widespread offering of white LEDs for premium notebooks to save power and space (for driver board) versus CCFLs. Will be used increasingly in notebooks and laptops.

Rugged displays: LEDs offer significant advantages for low temperature operation, higher efficiency, easier thermal management, shake and shock design.

Desktop monitors: no obvious advantage for LED use. Possible exception: "Green" customers.

Consumer TV: initial use of RGB LEDs in cavity BLUs for premium displays has waned. Edgelit white LEDs dominate the trend, based on cost, but have a somewhat limited color gamut. High dynamic range w/ LEDs will be the "next big thing"

Projection: RGB LED die are being used to replace arc lamps. These are "instant-on" and provide improved color gamut.

Conclusion

LEDs Backlights for High Performance Displays

LED technology continues to improve, making it a viable alternative backlight source. The numerous advantages of this approach to backlighting is perfect for applications that require high performance.

We have consistently observed half the power for a given luminance or twice the luminance for given amount of power compared to CCFL BLUs.

LED costs will continue to decrease and their performance will continue to increase. LEDs are the future of AMLCD BLUs and are worthy of consideration for your next display project.

About the Author

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Pat Green is Advanced Programs Manager in the Industrial Business Group at Planar Systems in Beaverton, Oregon. He has over 25 years of experience in the development of displays and display-related components as a process engineer, program manager and engineering manager at Planar Systems and Tektronix.

He has been responsible for or contributed to device developments that include color avionics CRTs, liquid crystal displays, ink jet print heads, TFEL and OLED displays, touch input devices, stereoscopic/3D displays and LED backlit AMLCDs. He received a Bachelor's and Master's Degree in Chemistry from Portland State University and has been author or co-author of more than 20 scientific and engineering papers and five patents.

Define Your Project Online

For an interactive guide to defining and selecting a rugged or custom display, visit www.planarembedded.com/guide-to-custom-lcd.

This application will help you collect the answers you need for your project and will email you a summary of your project definition.