The New Light Behind LCD’s

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Why do we need a new light?

- Front of screen parameters limited by backlight performance
- Environmental laws will prohibit the use of Hg (CCFL) in future
LED Backlight features

- No mercury and > 50,000 hr life
- High Brightness
- Increased Color Gamut using Standard Color Filters, Super NTSC Gamut with LED Color Filters
- Dynamic Backlight Control
  - (Dynamic) White Point & Brightness Adjustment in Backlight
  - Motion Artifact Reduction (Blinking Backlight)
  - Potential use for Color Sequential
Overview

• LED B/L system
  • Lumileds Luxeon Emitters
  • Color Mixing Solutions for RGB
  • Performance Outlook
• Color Performance
  • Color Gamut
  • Efficiency
• Dynamic Backlight Features
  • Optical Feedback
  • Blinking Backlight
Luxeon B/L modules

- Arrays of Red, Green and Blue Emitters
- Binned and Matched to create 9000 K White Backlight
- Pitch ~ 9 mm

**Flux Density:**
- 60~75 lm/inch standard
- 125 lm/inch best lab results (typical in 1~2 years)
- 2.5 ~ 3.5 W / inch (driving conditions, color temperature)

*A single LED module replaces > 4 CCFL’s*
LED Performance Outlook

- LED Output is doubling approximately every 2 Years
- Green and Blue (InGaN) introduced in 1994, but now already ahead of Red Performance
- Power consumption of LED Backlight will be equivalent to CCFL within a year.
Backlight with Mixing Guide

- Edge-Lit, instead of CCFL an Array of Power LEDs (Luxeon™ Emitter Array) is used along Top and/or Bottom
- Additional mixing Light Guide
Backlight Without Mixing Guide

- First prototypes
- Same size as CCFL backlights
- Very good Color Mixing Properties
1. The light enters the guide at the thin end.
2. The taper collimates the light. No light is extracted.
3. A redirection surface reflects, scatters and redirects the light back into the guide, and makes the light distribution wider.
4. At every bounce, the taper makes the light distribution even wider, until there is no more total internal reflection (TIR), and the light leaves the guide.
5. A redirection film is used to redirect the light towards the optical axis of the guide.
6. A mirror at the bottom reflects light that left the guide at the bottom.
B/L Brightness Comparison

Harbers et. al., SID/IDMC 2002, Jan 29-31, Seoul, Korea

Effective Brightness (nits)

15000
12000
9000
6000
3000
0

18"
CCFL
Luxeon

22"
CCFL
Luxeon

CCFL edge
CCFL direct
LED
LED max
Best LED
Best LED max

LED in `boosted mode’
Best Lab results

Front of Screen brightness (nits) @ 3% transmission

LUMILEDS
B/L Brightness & Power

Harbers et.al., SID/IDMC 2002, Jan 29-31, Seoul, Korea
18” 4:3  22” 16:9

CCFL Direct-Lit B/L

Best Luxeon B/L @ Max Power

CCFL Edge-Lit

Luxeon B/L

Luxeon Edge-Lit

1~2 yr

Front of Screen brightness (nits)
@ 3% transmission

Effective Brightness (nits)

Power (W)
Super NTSC/EBU color gamut
C/F benefits with LEDs

- Toppan
- DNP

LED existing CF
LED Ideal NTSC C/F
Ideal max Gamut C/F

7%
15% ~ 30%

C/F Transmission (%)

Color Gamut (% NTSC)
Dynamic Control

- Color point stability
- Variable color temperature
- Blinking Backlight
- Color Sequential Operation
Blinking Backlight

- Blurring of Moving Picture Images largely reduced
- Larger contrast
- LEDs have rise times order(s) of magnitude lower than switching times of LCDs, Blinking Backlight can be implemented easily

Hirakata et. Al. (Hitachi) SID 2001 p.990
Conclusions

- LED performance has improved dramatically over the last years, especially in green and blue.
- LEDs will outperform CCFL’s in backlights and add new features which enhance the visual experience:
  - Light Density (brightness) >> CCFL
  - Color & Brightness Control
  - Motion Picture Quality
- LED backlights are environmental friendly & safe:
  - Power consumption expected to be lower than CCFL next year