



Lighting & Display Products

Engineering Light for Better Products

Approved for
Export
DAR 2/15/11

10 Years of Leadership in LED Industry

- ◆ Purchased from TIR Inc. in 1997 to form Teledyne Lighting & Display Products
 - Focus on application specific, non-imaging optics
 - Licensing Teledyne Intellectual Property
 - Early expansion into LED backlighting for Microdisplays, and other application specific devices
- ◆ Industry's Technologically Advanced OEM Supplier
 - Vertical integration with capabilities to design, develop, certify, and manufacture LED products and systems
 - Integrating LEDs, both chip and package configurations, into valued added products built for reliability

Technical Capabilities

◆ Design

- Light source selection and optics design
- Full circuit design, materials and parts selection
- Product simulation and mechanical design
- Tooling design

◆ Fabrication

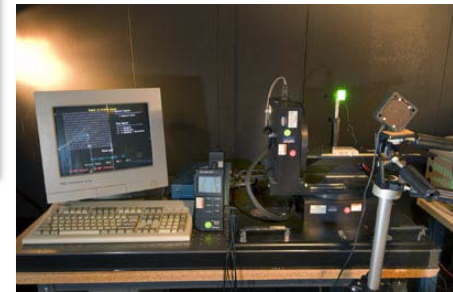
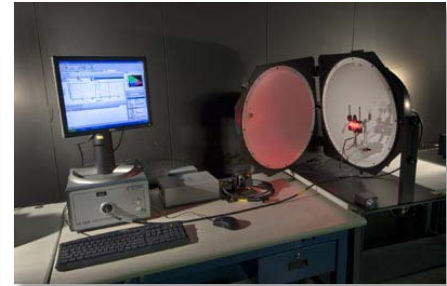
- In-house capabilities
- Prototype and small quantity
- Wire-bonding capabilities, including flip-chip bonding
- Teledyne Mexico Facility
- Medium and large quantity production



Technical Capabilities

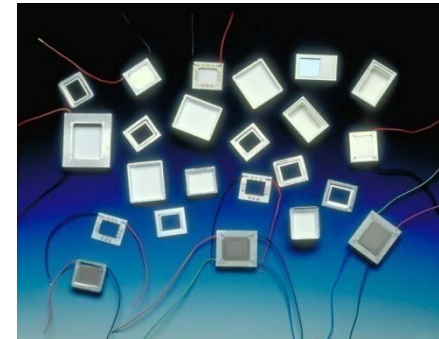
◆ Testing Capabilities

- Luminance and flux measurements
- Goniometer measurements
- Spectral characterization
- Image analysis
- Life Testing
- Environmental Testing

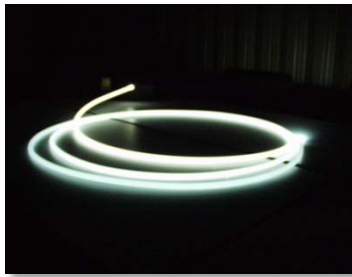


Teledyne LED Products & Optics

- ◆ High Density LED Engine (Photon Engine[®])
- ◆ Backlights and LED Engines
- ◆ Teledyne Patented Optics



High Density LED Engine Photon Engine®



- ◆ Optimized for Power LED die
- ◆ Integrates highly efficient collimating optics
- ◆ Couples to fiber optic bundles and solid core fiber

Non-Imaging Optic



Fan

Heat Sink



Ultrabright

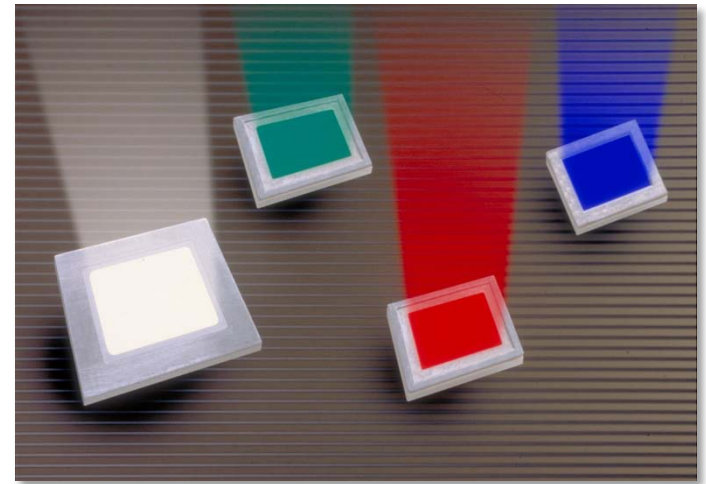
LED Collimating Backlight $\pm 6^\circ$



Commercially available in:
Red, Green, Blue

Alphalight™

LED Light Source for illuminating LCDs



Commercially available in:

White, Red, Green, Blue, RGB, Infrared

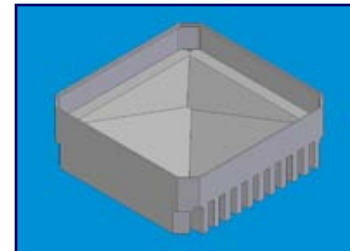
Avionic Displays

- ◆ LED 3-ATI RGB Backlight Technology with Color Correcting Sensor
- ◆ High Brightness, Sunlight Readable LED Backlight Technology



Parameters Ta = 25°C	Characteristics AL30ATIC-CC		
@ Steady State	Red	Green	Blue
Color (± 0.01)	x=.67-.43 y=.27-.33	x=.14-.28 y=.64-.73	x=.11-.15 y=.04-.10
Max Voltage (VDC) ($\pm .5V$)	7	12	12
Max Current (mA)	1400	1400	1400
Max Power (mW) ($\pm .5W$)	9.8	16.8	16.8
Projected Life (Hours) *	$\geq 20K$		
Pulsed @ 660 Hz	Red	Green	Blue
Current (mA)	600	568	548
Luminance (fL) ($\pm 10\%$)	> 9000		
Uniformity (Full Aperature)	$\leq 1.1:1$		

*Additional derating required for elevated temperatures



Parameter	Characteristics AL30ATIC-CC (dimensions in mm)
Aperture Size ($\pm .25$)	56.50 x 56.50
Aperture (Diagonal)	80.00
Body Dimensions	62.25 x 64.75
Height	22.50
Weight (grams)	146.00
Angular Radiation	$\pm 23^\circ$ FWHM
Operating Temperature	-40° to $+85^\circ C$

Avionic Displays

◆ Technology Attributes

- Avionics Displays
 - Sunlight readability
 - Pulsed backlight that can be synchronized with LCD frame rate
 - Custom Field of Views (FOVs) available



Alphalight™ Gen 2.0

- ◆ Alphalight™ Gen 2.0
 - ~2mm thick, $\eta=75\%$
 - BEF optical stack (+/- 23°)



Teledyne Patent # 6,647,199 B1

Alphalight™ Gen 2.0 Characteristics

- ◆ Architecture is thin waveguide (~1mm) with LED end coupling and proprietary hemispherical micro-ejection features
- ◆ Optical Efficiency modeled as 75%
- ◆ Uniformity modeled as better than 3% for the standard 9 point grid ($\eta = \text{max-min} / \text{max+min}$)
- ◆ Potential to eliminate BEF film stack and use holographic diffuser for customized FOVs



Alphalight™ Gen 3.0; 2011

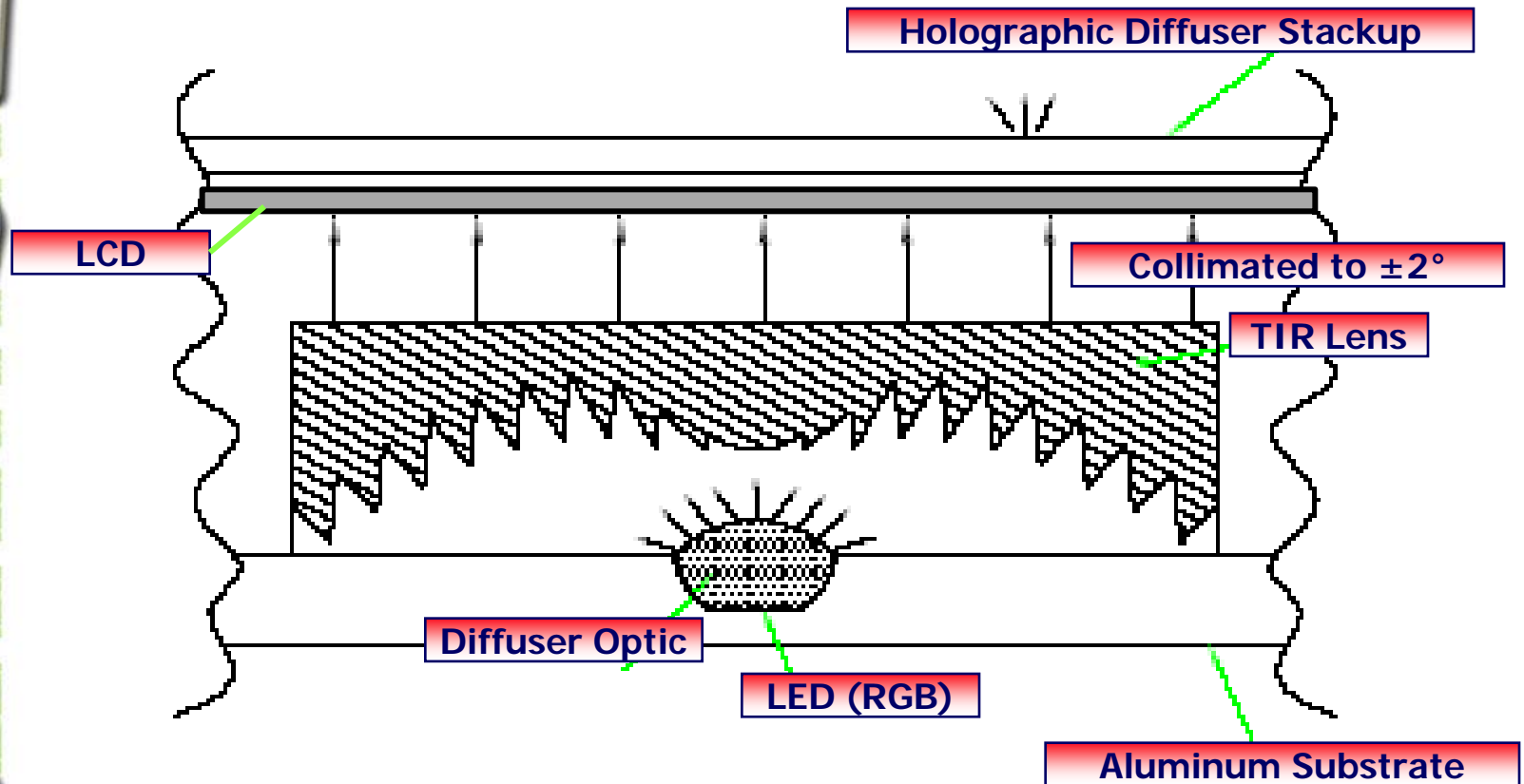
◆ Alphalight™ Gen 3.0 2011 (est.)

- ~4mm thick, $\eta=70\%$, selectable angular user spectrum
- Lowest power consumption, highest brightness, least LCD image distortion
- Customized to required footprint



Alphalight™ Gen 3.0 Patent Pending

- ◆ Collimated BLU using TIR lens TLDP patents
- ◆ User selectable FOV



Characteristics of Alphalight™ Gen 3.0

- ◆ Thickness ~ 4mm
- ◆ Lowest power consumption and highest brightness that laws of physics will allow
- ◆ Eliminates BEF filmstack
- ◆ User selectable FOVs
- ◆ Highest resolution image that LCD can provide
- ◆ Optical efficiency about 70%
- ◆ Color field sequential compatible



Teledyne Patented Optics

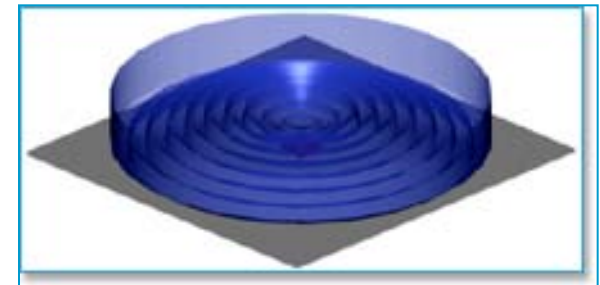
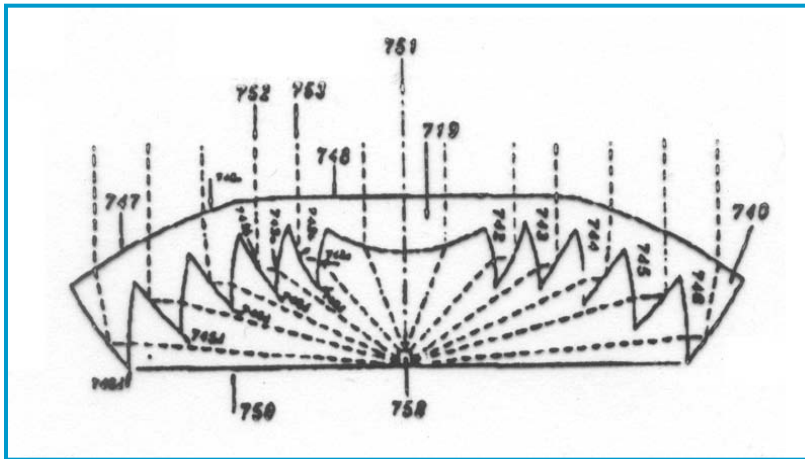
- ◆ TIR™ Lens
- ◆ Blackhole™
- ◆ Hammerhead™



Teledyne Patented Optics

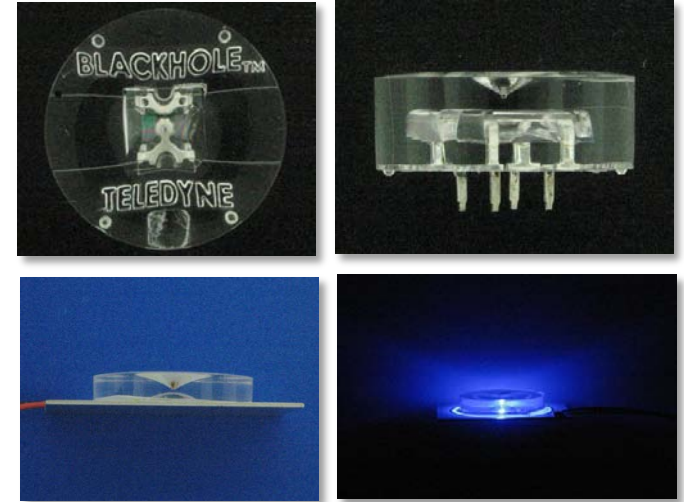
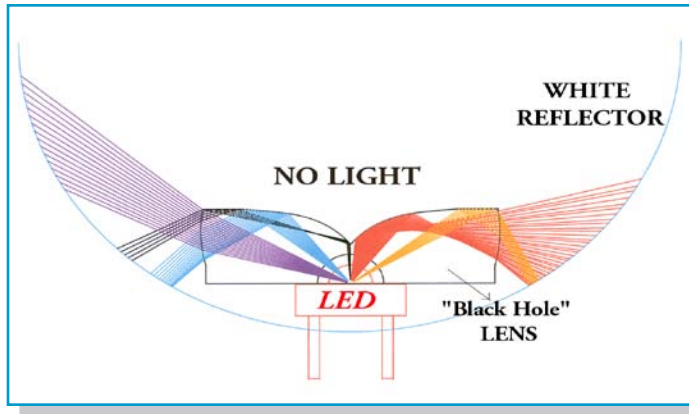
◆ TIR Lens™

- Low profile optics
- Collimates light source up to $\pm 2^\circ$



Teledyne Patented Optics

◆ Blackhole™ Side-emitting Optic



- Patented waveguide surface deflects the light from an immersed LED aimed perpendicular to the plane of the waveguide
- Provides uniform radial light distribution from the LED source for low profile applications

Teledyne Patented Optics

◆ Hammerhead™ Lens

- Asymmetrical, oval shaped field of view

