

Progression of LED Technology in Aviation Applications

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Progression of LED Technology in Aviation Applications

Today's Agenda

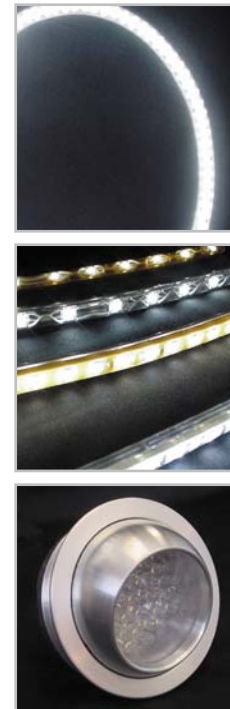
- **Company Introduction**
- **Why LEDs?**
- **A Brief History of LEDs**
- **Light Intensity Improvements**
- **LEDs in Aviation Applications**
- **LED Device Evolution**
- **Advances in Phosphor Technology**
- **Dynamic Lighting Systems**
- **Color Mixing / Optics**
- **Feedback Control**
- **Mood Lighting**

EMTEQ – A Family of Companies



EMTEQ Lighting and Cabin Systems

- LED Mood Lighting
- LED Upwash/Downwash Lighting
- LED Direct Lighting
- LED Flexible Accent Lighting
- LED Dome Lights
- LED Can Lights
- LED Reading Lights
- LED Emergency Lighting
- LED Marker Lighting
- LED Curved Lighting
- LED Custom Applications
- Air Gaspers
- Voltage Regulated Dimmer Modules
- Direct Fluorescent Tube Replacement Series
- Corporate / Military / Air Transport
- Interior and Exterior Lighting



EMTEQ[®]
Lighting & Cabin Systems

EMTEQ Aerospace

- Integrated Installation Kits
- LRU Equipment
- Wire Harnessing
- Avionics Support / Integration Packages
- RF Coax Cable Assemblies
- Equipment Mounting Trays & Rack Connectors
- Specialty Cables
- Panel Assemblies
- Installations



EMTEQ[®]
Aerospace & Defense Solutions

EMTEQ Aircraft Engineering and Consulting



Partial List of STC's

- B707 TCAS II, RDR-4B, Radar
- B727 HF, FDR, GPS, TCAS, EGPWS
- B737 FDR, GPS, TCAS/Mode S, RDR-4B Radar, EGPWS
- B747 ELT
- B757 EGPWS, TAWS, ELT
- B767 Interior Reconfig., TAWS, ELT, EGPWS
- B777 ELT
- AIRBUS A300 GPS/FMS, FDR, EGPWS
- AIRBUS A310 ELT
- AIRBUS A319/A320/A321 ELT
- Fokker F-50 TCAS/Mode S
- Beech 1900 GPWS, EGPWS, GPS, TAWS
- DC6 TCAS, RAD ALT, COMPASS
- DC9 TAWS, ELT
- DC10 ELT
- EMB120 TAWS
- LOCKHEED L382 EGPWS, GPS, TCAS, MODE S
- MD11 ELT
- MD80/90 ELT, EGPWS

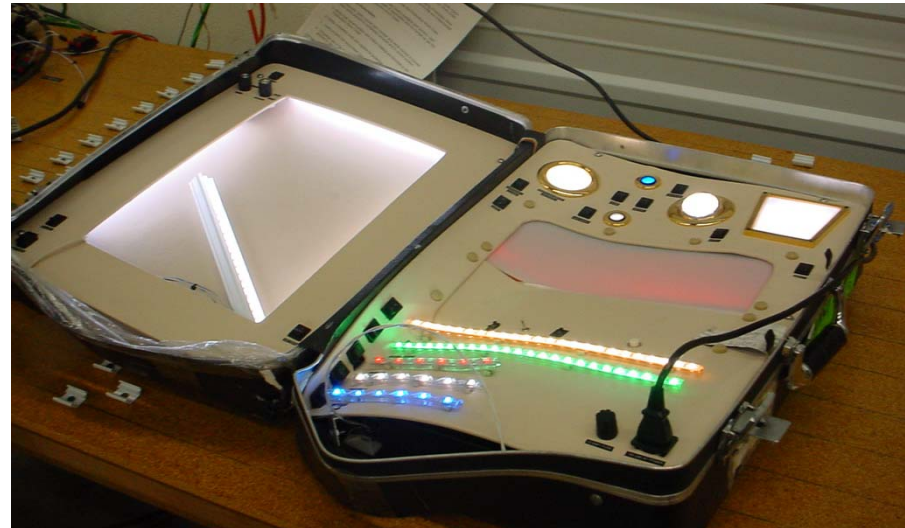
The collage includes several key documents:

- Wiring Diagrams:** Labeled 'BOEING 737' and 'WIRING DIAGRAM MANUAL', showing complex electrical connections for various systems.
- Illustrated Parts Catalog:** A detailed diagram of an aircraft component with callouts for part numbers and descriptions.
- STC Form (Supplemental Type Certificate):** Issued by the Federal Aviation Administration (FAA) for the installation of TAWS on an Embraer EMB-120 aircraft. It includes sections for 'SUBJECT', 'OPERATOR', 'OPERATION', 'REFERENCES', and 'REVISIONS'. The form is signed by the FAA Administrator and the applicant, with a date of October 1, 1993.
- FAA Approved Form:** A form titled 'AIRPLANE FLIGHT MANUAL SUPPLEMENT FOR BOEING 737 SERIES AIRCRAFT WITH THE HONEYWELL ENHANCED GROUND PROXIMITY WARNING SYSTEM'. It includes fields for registration and serial numbers.

A Brief History of the LED

Why LEDs?

- Durability
- Longer Life (can be 50,000 - 100,000 hrs.)
- Weight Savings.
- Technological Advantages
 - Color mixing
 - Generally easier to customize designs



A Brief History of the LED

The Early Days

- Silicon Carbide (SiC) based electroluminescence research c. 1907 (Henry Joseph Round) and then in Germany in the late 1920's
 - Light was so dim, research was widely abandoned.
- First “modern” LED developed in the late 1950's / early 1960's in Britain.
 - First units had to operate in liquid nitrogen to operate!
 - Developing units that worked at room temperature was a major breakthrough.
 - First commercial available units produced invisible IR lighting that were used primarily for sensing and photo-electric applications.

A Brief History of the LED

“Crawling up the Visible Spectrum”

- First LEDs produced light in the Infrared range.
- First commercially available LED to produce visible light were developed in the late 1960's.
 - Red and then orange.
- Green and Yellow LEDs developed in 1970's.
- First “superbright” LEDs developed in 1980's
 - Red, then yellow and then green
- First blue LEDs developed in the 1990's.
- Late 1990's - Utilizing the newly developed blue LEDs, white LEDs were initially developed through the use of fluorescent phosphors.
- Recently developed LEDs are now emitting UV lighting

LED Light Intensity Improvements

“Moore's Law”

- Gordon Moore – Co-founder of Intel.
- Computers get 2x more powerful every 18 months.
- LEDs have proven to follow roughly the same trend.

LED Light Intensity Improvements

Package Improvements

- **Sample white Nichia SMT LED**
 - In 2000, it produced 300mcd at 20mA.
 - In 2006, the same package produces over 740mcd at the same 20mA.
- **Sample white Nichia Through hole LED**
 - In 2000, it produced ~400mcd at 20mA.
 - In 2006, it produces ~1800mcd at the same 20mA.



1998 - 60 LEDs - ~7.3fc intensity



2006 - 25 LEDs - ~7fc intensity

LEDs in Aviation Applications

First LED Applications

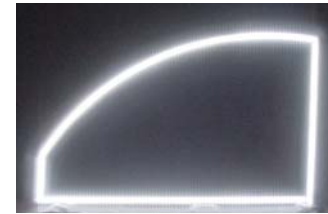
- Accent lighting and other low intensity applications.



LEDs in Aviation Applications

Corporate Aviation

- Next area of success in industry for LEDs due to aircraft size and high demand for custom products.



LEDs in Aviation Applications

Wide Body Aircraft

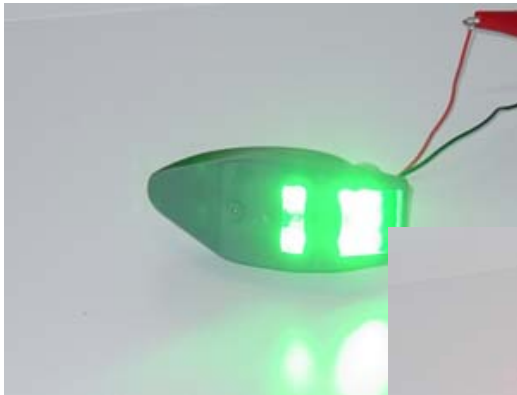
- With recent gains in efficiency, LEDs can now be used as main sources of lighting for larger wide body aircraft.
- 115VAC / 400Hz products
- 28VAC products
- 6 VDC emergency



LEDs in Aviation Applications

Exterior Lighting

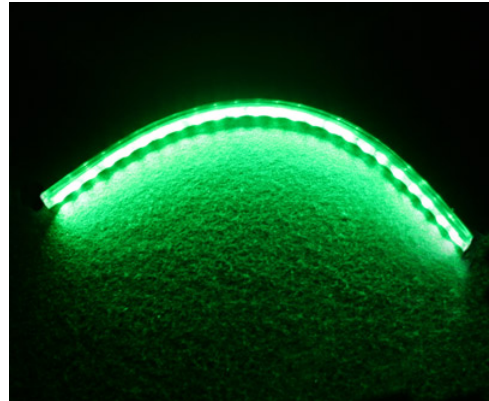
- Ideal for replacement of units with high failure rates.
- Immediate payback is often possible for larger fleets



LEDs in Aviation Applications

Other Areas of Success

- **Military**
 - Aviation
 - Ground Vehicles
 - NVIS



LEDs in Aviation Applications

Other Areas of Success

- LED Based Star Lighting
 - Compliments Mood Lighting very well.



LED Device Evolution

Through Hole Technology

- Very well established.
- First widely available white LED.
- Extremely efficient.
- Low Heat.
- Advanced color binning.
- Multi-Color Functional Flexibility.



LED Device Evolution

Surface Mount Technology (SMT)

- Very compact designs.
- Great thermal transfer.
- Extremely efficient.
- In many case, higher intensity then Through Hole.
- Generates heat that must be managed.
- Most “High Flux” LEDs are SMT.
- Multi-die devises.



LED Device Evolution

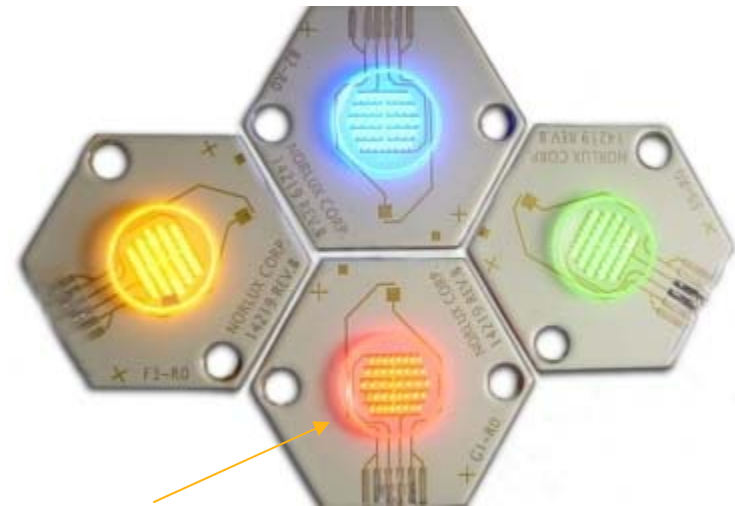
“High Flux” LEDs

- 1W, 3W, and 5 W SMT devices
- Great for high intensity / focused applications.
- With the right optical design, just 1 unit can rival traditional lighting technology.

LED Device Evolution

Chip-on-Board Technology (COB)

- Most compact designs
- Size allows for great flexibility
 - Intensity – more light for the space
 - Better mixing of colors
- Generates heat that must be managed



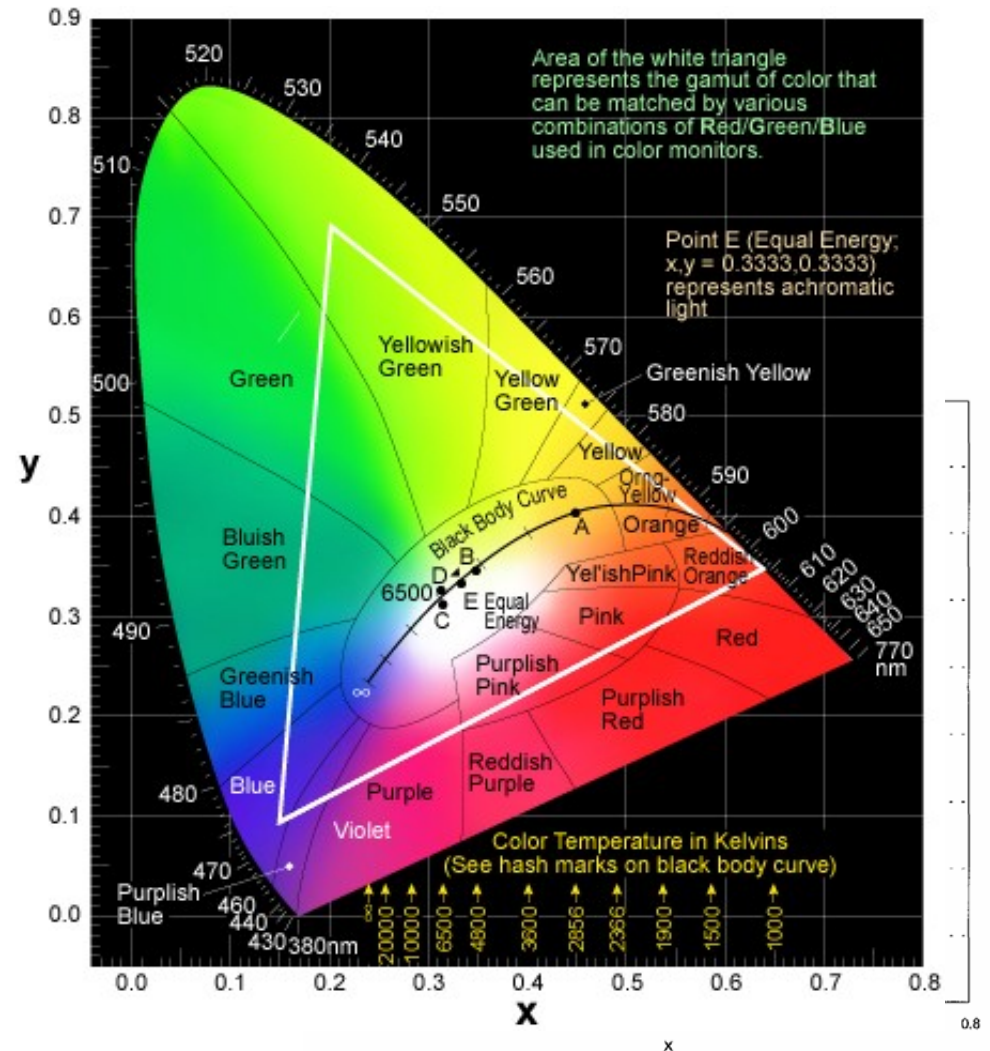
~60 LEDs in one package



Advances in LED Phosphor Technology

Introduction

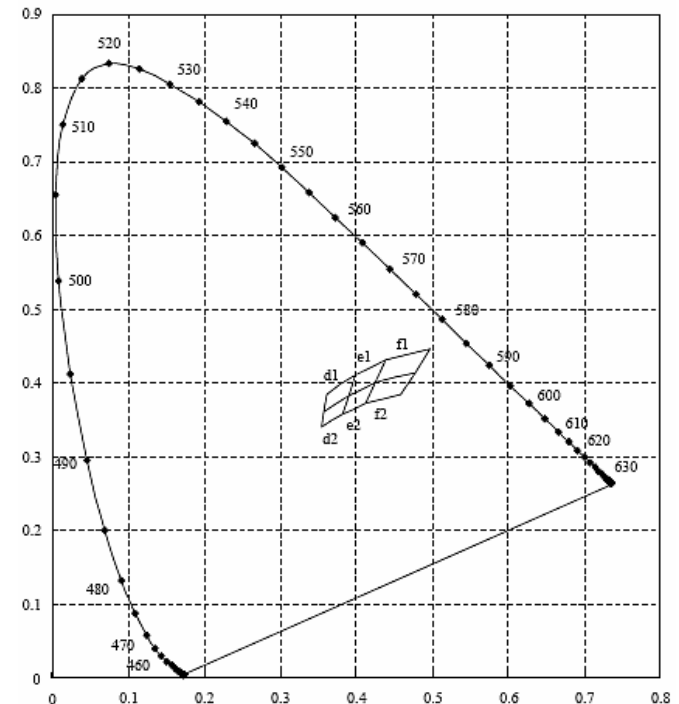
- White LEDs – Blue light shifted via fluorescent phosphors.
- Quality of this phosphor widely determines the quality and consistency of the white light.
- Color consistency is particularly important in *wash lighting* applications due to the ease of detecting such inconsistencies.



Advances in LED Phosphor Technology

Color Temperature

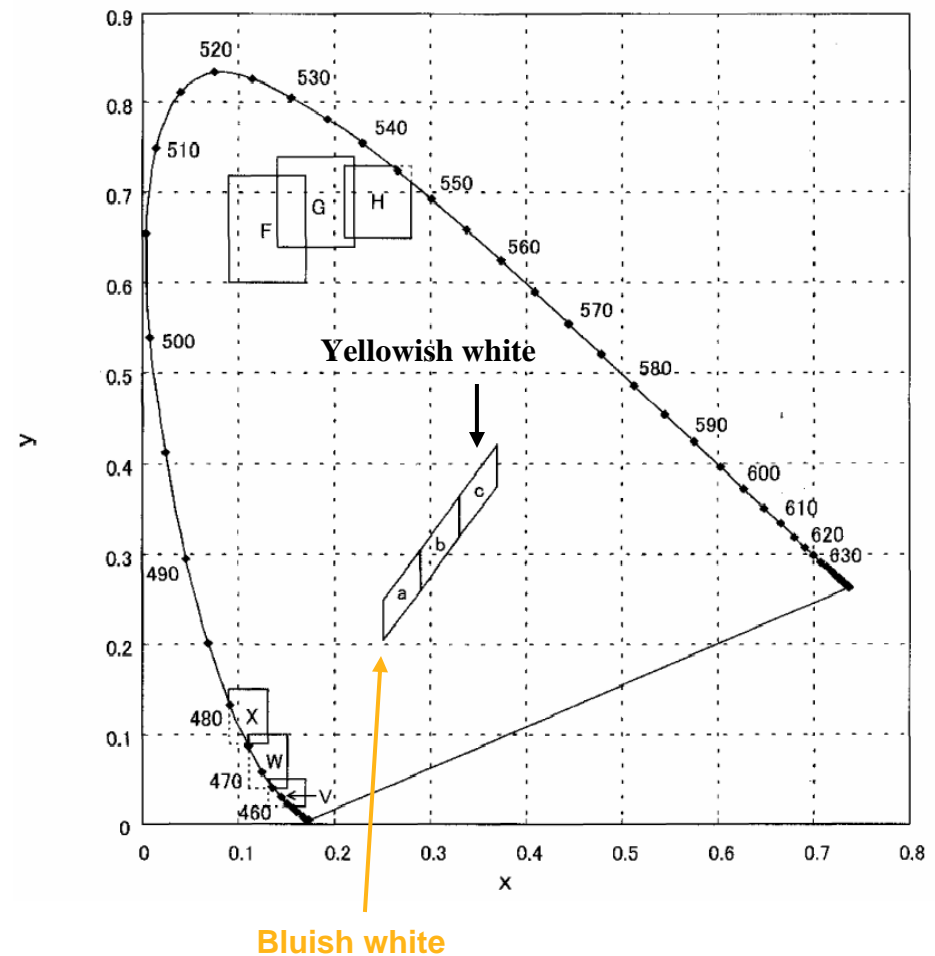
- Recent advancements in phosphor technologies – warmer (yellow) LEDs
- Closer in color to more conventional light sources.
- White LEDs are not always “bluish” anymore.



Advances in LED Phosphor Technology

Color Binning

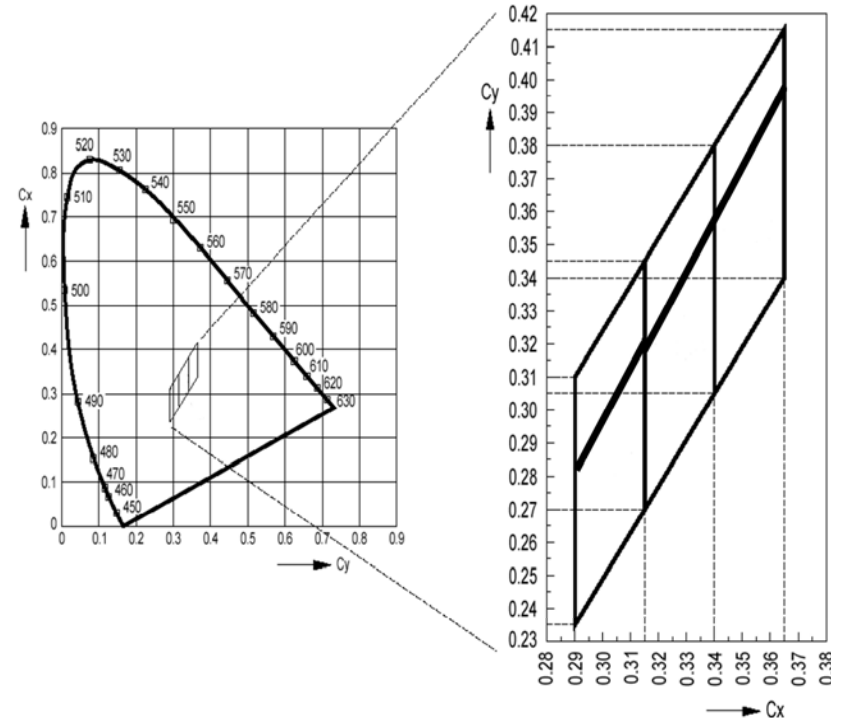
- “Bins” – Areas on the chromaticity chart that specify color tolerances of a given LED.
- The smaller the bin, the better the color consistency.
- White LED bins typically follow the “black body” radiator line.
- *White is not just white.*



Advances in LED Phosphor Technology

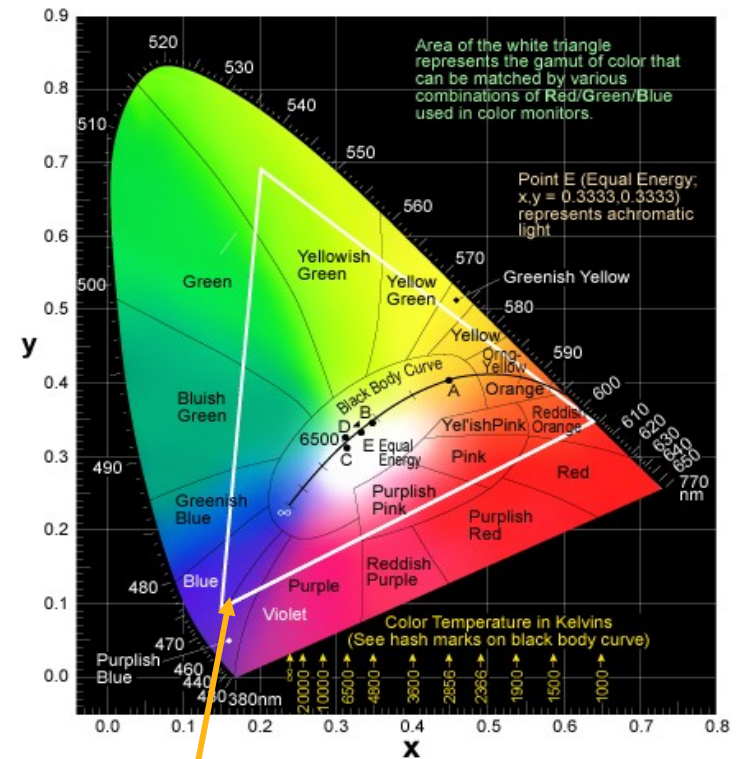
Advanced Color Binning

- First white LEDs were not binned or came from very large bins – color consistency was poor.
- Color bins get much smaller (split) as quantities increase and phosphor technologies advance.
- Not all white LEDs are the same.



Dynamic Lighting Systems

- Mixing component colors dynamically to create 1,000's of other colors.
 - RGB (Red, Green, and Blue)
 - RGBW (Red, Green Blue, and White)
 - RGBA (Red, Green, Blue, and Amber)



Gamut of colors available from mixing R, G, & B.

Color Mixing / Optics

Optics

- Allows systems to combine component colors into homogeneous light.
- Critical for high end aviation applications.
- Main challenge for first RGB products in industry.
- Ideal optic system does allow user to see individual component colors.

Feedback Control

- Controlling 3 or 4 channels independently to create a given color has its challenges
 - Temperature variations
 - LED binning
 - LED aging
- Feedback control is required to provide consistent color at all times.
- Real time measurements are made in the light to determine a light's performance.

Mood Lighting

- Sunrise, sunset, midnight sky, etc.
- Specialty colors for branding.
- Can be complimented well with Star Lighting.



Progression of LED Technology in Aviation Applications

- Thank you very much for your time and your attention.
- Please visit us in Hall 10 / Booth D15 to learn more about EMTEQ's products and services.



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