

# Vio High Power White LED

The look that lasts.™

## Luminosity, Color Management, and Optics

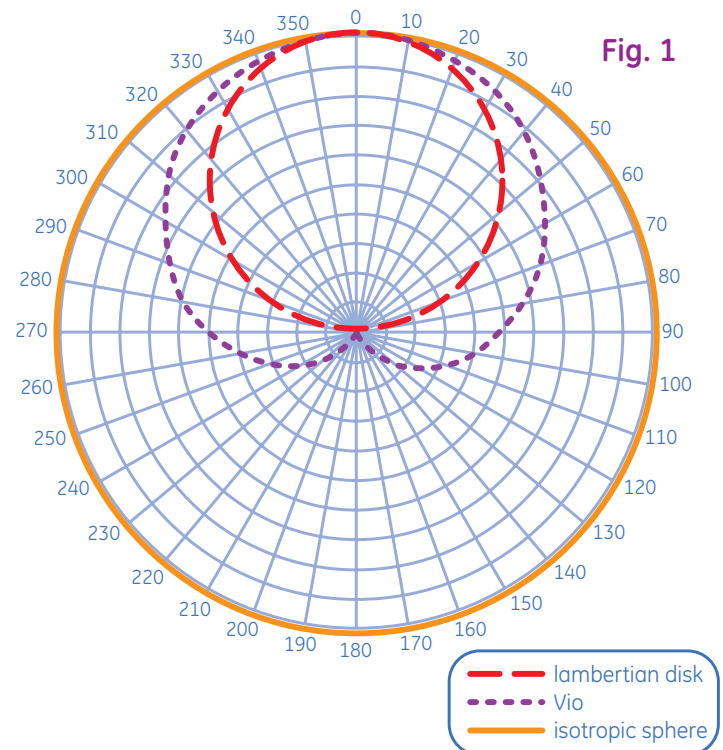
### O.1 Diffused source and considerations

Vio LEDs are a diffuse light source, which produce an effect similar to soft white incandescent and compact fluorescent lamps. Vio LEDs reduce unwanted glare produced by point source lighting technologies, by using a proprietary design and remote phosphors to “soften” and spread light over a larger area. The result is an energy efficient alternative to traditional light sources.

### O.2 Radiation pattern

The radiation pattern of Vio LEDs is hemispherical, (see Fig. 1). Unlike the theoretical lambertian pattern where the intensity falls off by a factor of 2 at 60 degrees angle, Vio LEDs extend further and do not fall off by the same factor until about 90 degrees (half beam angle). The Vio LED is therefore a 180-degree (full beam angle) source suitable for general and specialty lighting applications. The Vio LED provides relatively more emission in the forward direction than a 360-degree source (e.g. incandescent or fluorescent bulb).

### LED Far Field Distribution Patterns



### O.3 Source lumens and CCT

GE Lumination uses a spectroradiometer connected to an integrating sphere to acquire the full LED spectrum, and simultaneously determines the values of the luminous flux, color coordinates and CRI. GE Lumination’s measurement equipment is calibrated to NIST traceable lamps.

## 0.4 Color and lumen binning

Both the color binning and luminosity structures for Vio LEDs are illustrated in the data sheet. Examples of these structures are shown below. See Fig. 2 and Fig. 3.

### Color Bins

#### 4100K

411			412		
CCT	ccx	ccy	CCT	ccx	ccy
4300	0.364	0.351	4100	0.381	0.393
4100	0.372	0.357	3900	0.390	0.398
4100	0.381	0.393	3900	0.380	0.362
4300	0.372	0.387	4100	0.372	0.357

#### 3500K

351			352		
CCT	ccx	ccy	CCT	ccx	ccy
3700	0.389	0.367	3500	0.412	0.410
3500	0.399	0.373	3300	0.425	0.415
3500	0.412	0.410	3300	0.410	0.379
3700	0.401	0.404	3500	0.399	0.373

#### 3000K

301			302		
CCT	ccx	ccy	CCT	ccx	ccy
3200	0.416	0.381	3000	0.446	0.422
3000	0.428	0.387	2800	0.461	0.426
3000	0.446	0.422	2800	0.443	0.391
3200	0.431	0.418	3000	0.428	0.387

Bin 1  
<60°C T<sub>b</sub>

### Fig. 2

Bin 2  
>60°C T<sub>b</sub>

Illustrated in Fig. 2, the full distribution for each color point is +/-200K and +/- 0.015 dBB. Each full color bin is centered on a color point, based on an operating temperature of T<sub>b</sub>60°C. This minimizes the need for a complex binning and selection process. GE Lumination has developed a user friendly color binning system based on board temperature. The CCT of an LED device will change slightly with temperature. The binning

structure shown accounts for different ranges of board temperature, and ensures that a given color consistency will be achieved in your application.

For example, if an application requires 4100 Kelvin, the designer should consider the part-to-part (LED) color variation that is acceptable. If ±200K meets this requirement, the designer should order full distribution of the 4100K SKU, and target a Vio T<sub>b</sub> of 60°C. If ±100K part-to-part color consistency is required, Bin 1 (411) or Bin 2 (412) should be selected. If the Vio T<sub>b</sub> in application will be above 60°C, Bin 2 is recommended. Otherwise, Bin 1 will provide ±100K color consistency. Therefore, Vio LEDs will provide the color consistency and the color temperature desired for applications operating below the maximum board temperature of 85°C.

### Luminosity

Bin	Min	Max	Bin	Min	Max
A	20	25	I	119	149
B	25	31	J	149	186
C	31	39	K	186	233
D	39	49	L	233	291
E	49	61	M	291	364
F	61	76	N	364	455
G	76	95	O	455	568
H	95	119	P	568	711

Fig. 3

Figure 3 illustrates the lumen intensity bins for Vio LEDs. LED production yields variation in lumen output, where LEDs are sorted in bins according to their performance. Not all of the bins shown here will be available at all times. Typical bins for the 4-watt Vio LED will be I, J, K. For example Bin J will have a minimum lumen output per package of 149 lumens, and a maximum of 186 lumens. Customers should consult with GE Lumination for bin availability and pricing information.

## 0.5 CRI options

GE Lumination currently offers a choice between high efficiency LEDs with a typical CRI of 70 (for maximum performance in applications where color rendering is less critical) and high color rendering LEDs with a typical CRI of 85. As with all LEDs available today, efficiency of the device will vary with CRI, where a higher CRI leads to a lower efficacy. Customers should refer to the data sheet for performance specifications for the different CRI offerings.

## 0.6 Budget for thermal and lumen degradation

When designing a new luminaire, thermal derating of the luminous flux needs to be considered. LED light output decreases with heat. The Vio LED design also simplifies this by providing a thermocouple measurement point, marked by  $T_b$  on the circuit board. This point correlates to the thermal derating charts found on the Vio data sheets. It is important to understand the operating temperature of the Vio LED in your application, and to accurately budget the appropriate amount of lumens. For example, designing a fixture for a total output of 450 lumens and a  $T_b = 50^\circ\text{C}$  (derating indicates that the luminous flux is ~88% of that at  $25^\circ\text{C}$ ) would require a total luminous flux of  $450/0.88=511$  lumens rated at  $25^\circ\text{C}$ . This type of application would then require, for example, 3 LEDs from intensity bin "J".

System designers may consider overdriving the LEDs in order to achieve higher luminous flux, but should be aware of the maximum operating conditions and thermal derating effect as previously explained. Exceeding maximum operating conditions could have a detrimental impact on life. Overdriving will be covered in the electrical portion of the application notes, as well as the thermal management application notes.

## 0.7 Color change vs. time

The patent-pending phosphor blend, invented by GE Lumination, exhibits less than 100K change in CCT over the lifetime of the LED.

## 0.8 Secondary optics

Additional light losses are possible in the fixture design when incorporating secondary optics. These losses can result from the use of inefficient reflectors, total internal reflection (TIR) and Fresnel loss in fully enclosed fixtures. Such losses also need to be considered in the total rated luminous flux values of the LEDs.

Continuing with the 450 lm example discussed in section 0.6, a second multiplier must be considered if secondary optics are used. For example, if an optical system is designed and deemed to be 85% efficient the 511-lumen requirement (based on thermal derating) would become  $511/0.85$ , or 601 lumens. This would require a fourth LED to be added to the system, along with appropriate adjustments made to the thermal design to maintain the  $50^\circ\text{C}$  board temperature.



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