Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Some comments on the power of LED light source for VLC]
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Re: [ ]

Abstract: [This document gives some comments on the power of LED light source for VLC.]

Purpose: [To provide some comments on the power of LED light source for VLC]

Some comments on the power of LED light source for VLC

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Specifications of Commercial LED Lighting Product (1)

LED PAR 16 Lamp

Specifications

	항 목	심 볼	전구색	주백색	주광색	Unit
	Power Consumption	P	4.5			W
2	입력 전압	Vin	220			VAC
3	역 률	PF	0.96이상			
	Total Luminous Flux	F	220	260	260	lm
5	광 효 율		48	57	57	lm/W
6	색 온 도	CCT	2,800/3,300	5,000	6,500	Kelvin
7	연 색 성	Ra	70 이상 (92이상 옵션)			
8	방 사 각	2θ1/2	60 (40, 30 옵션)			Deg
9	수 명	Lt	30,000			Hrs
10	동작 온도	Topr	−20 ~ +50			℃
11	제품 크기	Φ49 (지름) × 85 (높이)				mm
12	무 게	74				g

Tx Power / Link budget

Watt

Specifications of Commercial LED Lighting Product (2)

Specifications

Item	Symbol	Value			Unit
		Min.	Typ.	Max.	
Luminous Flux [1]	Φ_V[2]	2.6	4.0	-	lm
Luminous Intensity	I_V	-	2500	-	mcd
Chromaticity Coordinate[3]	x, y	x=0.31, y=0.31			-
Forward Voltage[4]	V_F	-	3.4	4.0	V
View Angle	$2\theta_{½}$	70			deg.
Thermal Resistance	$R\theta_{J-P}$	130			°C /W
Optical Efficiency	η_{opt}	-	38	-	lm/W
Reverse Current (at V_R = 5V)	I_R	-	-	5	µA

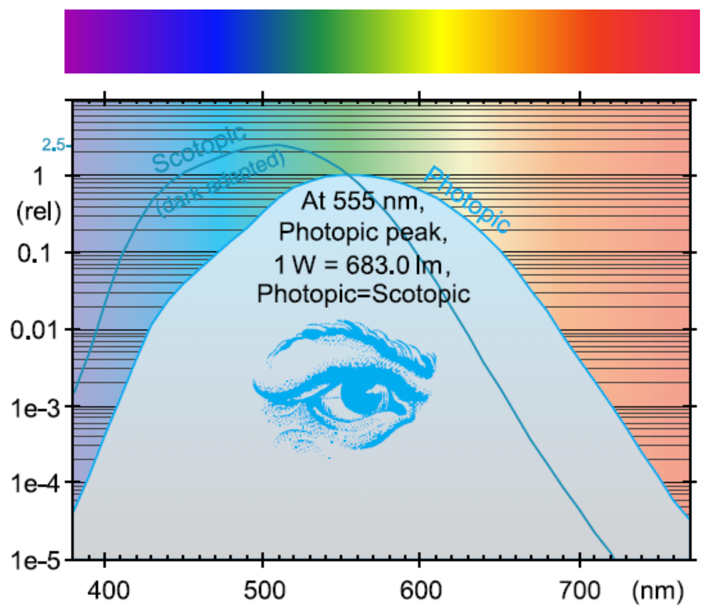
Watt

- At present, the output power of most commercial LED source is usually described by the photometry units such as lm and cd.
- **The units of photometry such as lm and cd are the physical dimension which is expressed in viewpoint of standard human eye as a kind of photodetector.**
- Phtodetectors such as Si-PD for VLC receiver have different responsivity or sensitivity depending on wavelengths(380 to 780 nm) from the standard human eye.

Characterization of Visible Light

Radiometric Units	
Radiant Flux	W
Radiant Intensity	W/sr
Radiance	$W/sr/m^2$
Irradiance	W/m^2

Photometric Units	
Luminous Flux	lm
Luminous Intensity	cd = lm/sr
Luminance	$cd/m^2 = lm/sr/m^2$
Illuminance	$lux = lm/m^2$

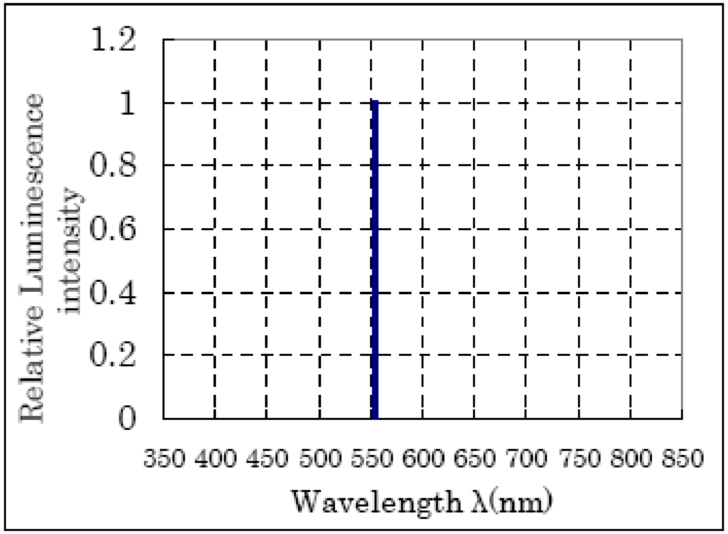


CIE Scotoptic and Photoptic Sensitivity Curves

[Eye Sensitivity Function : V(λ)]

Light Measurement Handbook © 1998 by Alex Ryer, International Light Inc.

Unit Conversion on Monochromatic Light

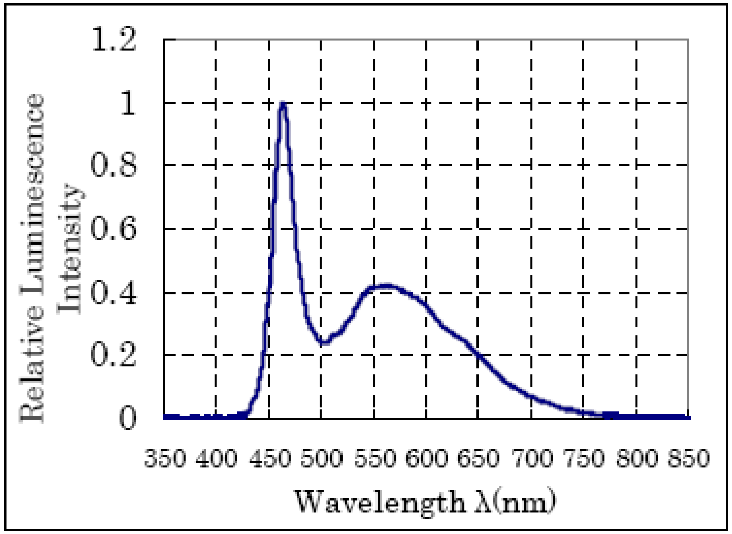


Spectral Distribution (Monochromatic)

- $1\ \text{Watt}\big|_{\lambda = 555\,\text{nm}} = 683\ \ (\text{lm})$
- $10\ \text{Watt}\big|_{\lambda = \text{x nm}} = 10 \times 683 \times V(\lambda)\big|_{\lambda = \text{x nm}}\ \ (\text{lm})$
- $1\ \text{lm}\big|_{\lambda = 555\,\text{nm}} = \dfrac{1}{683}\ \ (\text{Watt})$
- $100\ \text{lm}\big|_{\lambda = \text{x nm}} = \dfrac{100}{683 \cdot V(\lambda)}\Bigg|_{\lambda = \text{x nm}}\ \ (\text{Watt})$

- **In case of monochromatic light, if we use human eye sensitivity function V(λ), we can easily calculate unit conversion between photometry and radiometry.**

Unit Conversion on Non-Monochromatic Light



Spectral Distribution (White LED Light)

- $$X \ (\text{Watt}) = 683 \int_{380}^{780} P(\lambda) \cdot V(\lambda) \ d\lambda \ (\text{lm})$$

  $P(\lambda)$: Radiant Flux Spectral Distribution

- $$Y \ (\text{lm}) = \frac{1}{683} \int_{380}^{780} \frac{L(\lambda)}{V(\lambda)} \ d\lambda \ (\text{Watt})$$

  $L(\lambda)$: Luminous Flux Spectral Distribution

- **However, in case of non-monochromatic light, we need to know the radiant flux spectral distribution to calculate radiometry-to-photometry conversion,**
  or the luminous flux spectral distribution to calculate photometry-to-radiometry conversion in addition to human eye sensitivity function.

Discussion (1)

- ***At present, the output power of most commercial LED source for illumination is usually described by the photometry units.***
- ***The units of photometry such as lm and cd are the physical dimension which is expressed in viewpoint of standard human eye as a kind of photodetector.***
- ***Phtodetectors such as Si-PD for VLC receiver have different responsivity or sensitivity depending on wavelengths(380 to 780 nm) from the standard human eye.***

Discussion (2)

- ***So, we need to know the radiometric power (Watt) of LED light source for VLC phtodetectors such as Si-PD, not human eye, because the responsivities of Si-PD and human eye are different.***

- ***LED Light source (white LED) = Non-monochromatic***

- ***We need to know Radiant Flux Spectral Distribution for radiometry-to-photometry conversion or Luminous Flux Spectral Distribution for photometry-to-radiometry conversion in non-monochromatic light.***

Discussion (3)

- ***So, I think we have to require LED product companies to know the Luminous Flux Spectral Distribution or Radiant Flux Spectral Distribution of commercial LED light source.***

- ***or we have to measure the Luminous Flux Spectral Distribution or Radiant Flux Spectral Distribution of commercial LED light source.***