

The Measurement of 6500K E27 LED Lamp's Light Intensity

John Elroy Godfrey^{2,3}, Arka Dwinanda Soewono^{1,4}, Eko Prasetyo Nugroho^{1,3}, Karel Octavianus Bachri^{1,5*}

¹Program Studi Program Profesi Insinyur, Fakultas Biosains, Teknologi, dan Inovasi, Universitas Katolik Indonesia Atma Jaya, Jalan Jenderal Sudirman 51 Jakarta 12930

²SMPK 7 BPK Penabur, Komplek Sunrise Garden, Jalan Surya Sarana No. 13, Kedoya Utara, Kota Jakarta Barat, DKI Jakarta 11520

³Nexcore Labs, Taman Kedoya Baru E2/18 Kota Jakarta Barat, DKI Jakarta 11520

⁴Program Studi Magister Teknik Mesin, Fakultas Biosains, Teknologi, dan Inovasi, Universitas Katolik Indonesia Atma Jaya, Jalan Jenderal Sudirman 51 Jakarta 12930

⁵Program Studi Magister Teknik Elektro, Fakultas Biosains, Teknologi, dan Inovasi, Universitas Katolik Indonesia Atma Jaya, Jalan Jenderal Sudirman 51 Jakarta 12930

Article Info	Abstract
<i>Article history:</i> Received June, 22 2025 Accepted July, 08 2025 <i>Keywords:</i> BH1750, Light Intensity, Sensor, Lux Meter, LED Lamp	<i>This paper discusses a light intensity test on a 6500K, Cool Daylight type, 9W E27 Light-Emitting Diodes (LED), that does not have any Internet of Things (IoT) features or additional sensors, using an Arduino GY-302 BH1750 sensor and two lux meters. Research was conducted in several steps on 35 lamps to observe and identify an interesting phenomenon related to the quality of light produced by these lamps. Experiment shows that a lamp with a high light flux does not necessarily produce high light intensity. This study also demonstrates that a diffusing globe on the lux meter makes the reading results different.</i>

Info Artikel	Abstrak
<i>Histori Artikel:</i> Diserahkan: 22 Juni 2025 Diterima: 08 Juli 2025 <i>Kata Kunci:</i> BH1750, Light Intensity, Sensor, Lux Meter, LED Lamp	Makalah ini membahas uji intensitas cahaya pada lampu tipe <i>Cool Daylight</i> , 6500K, <i>Light-Emitting Diodes</i> (LED) E27 9W, yang tidak memiliki fitur <i>Internet of Things</i> (IoT) atau sensor tambahan, menggunakan sensor Arduino GY-302 BH1750 dan dua lux meter. Penelitian dilakukan dalam beberapa langkah pada 35 lampu untuk mengamati dan mengidentifikasi fenomena menarik yang terkait dengan kualitas cahaya yang dihasilkan oleh lampu-lampu ini. Eksperimen menunjukkan bahwa lampu dengan fluks cahaya tinggi tidak selalu menghasilkan intensitas cahaya tinggi. Studi ini juga menunjukkan bahwa bola lampu yang menyebar pada lux meter membuat hasil pembacaan berbeda.

1. INTRODUCTION

LEDs are semiconductor devices based on p-n junctions made of direct bandgap material, invented by Oleg Vladimirovich Losev, an influential Russian scientist, through his discovery of electroluminescence in the early 1920s. These LEDs emit light at characteristic wavelengths specific to the silicon carbide (SiC) crystal material. Furthermore, LED's material development plays a crucial role in this technology.

*Corresponding author. Karel Octavianus Bachri
Email address: karel.bachri@atmajaya.ac.id

In the early stages, one of the major challenges in creating efficient LEDs was the low light extraction efficiency, primarily caused by absorbing substrates, which limited the amount of light that could escape the device. A breakthrough came in the late 1980s and early 1990s with the development of gallium nitride (GaN)-based materials. These materials significantly improved the efficiency of solid-state light emitters by enabling the production of high-brightness LEDs, especially in the blue and ultraviolet regions of the spectrum. This advancement laid the foundation for the widespread adoption of LEDs in applications ranging from general lighting to high-resolution displays. (Opel, D. R., Hagstrom, E., Pace, A. K., Sisto, K., Hirano-Ali, S. A., Desai, S., & Swan, J., 2015) (Bhattarai, T., Ebong, A., & Raja, M., 2024).

Nowadays, the increasingly severe effects of global warming, climate change, and environmental pollution have heightened awareness and urgency among experts. This growing concern underscores the need to find effective strategies to improve environmental quality and sustainability. Energy-efficient technologies in addressing these challenges, as they significantly reduce environmental damage and minimize energy waste. Efficient energy usage not only lowers economic and social costs but also helps reduce greenhouse gas emissions and atmospheric pollutants. LEDs, as one of the energy-efficient technologies, offer many advantages over conventional lamps. These include extended duration, lower energy consumption, diverse lighting designs, and multiple applications. (Tajudeen, F. P., Jaafar, N. I., Sulaiman, A., & Moghavvemi, S., 2020)

Technological advancements have led to the widespread adoption of LED lighting among Indonesian consumers. Numerous brands manufacture and distribute LED lamps in various models, with power outputs ranging from 3W to 130W. Today, LED lights are widely used by the Indonesian public, with many manufacturers producing and marketing them under various commercial brand names. This has led to an interesting phenomenon that can be studied, specifically, whether the quality of light produced aligns with the specifications stated on the product. In the Indonesian market, the most popular type is the 6500K, cool white light, 9W E27 LED. (Sahu Y, 2024)(Indonesia LED Market Report by Product Type (Panel Lights, Down Lights, Street Lights, Tube Lights, Bulbs, and Others), Application (Commercial, Residential, Institutional, Industrial), Installation Type (New Installation, Retrofit Installation), and Region 2025-2033, 2024). Therefore, this study conducted a light intensity test on 34 LED lamps with those specifications using an Arduino GY-302 BH1750 sensor and two lux meters.

This research utilizes three devices to measure light quality: the Arduino GY-302 BH1750, the KUBER AS803 Lux Meter, and the TASi TA636A, to assess the quality of commercially available LED lamps by analyzing their light intensity output relative to stated specifications.

2. RESEARCH METHODS

A sample of 34 LED lamps was acquired from multiple vendors in Jakarta, Indonesia, and each unit was tested sequentially using three distinct light measurement instruments.

2.1. Desk Lamp

A desk lamp is a small lamp placed on a table or other flat surface. It provides focused lighting for table activities such as reading, writing, or studying. In this research, we use an E27 socket desk lamp as the fixture for testing the LED lamps.

2.2. Arduino

Arduino is a versatile open-source electronics platform that combines user-friendly hardware and software. Arduino boards can interpret various inputs, such as light detected by a sensor, a button press, or a message from Twitter, and convert them into outputs, including activating a motor, illuminating an LED, or posting content online. You can instruct your board by transmitting commands to the embedded microcontroller. This is accomplished using the Arduino programming language, which is derived from Wiring, along with the Arduino Software (IDE), which is based on Processing. (Trinity L, 2020) (Lathifah, M. F., & Doyan, A., 2022) (Wijaya, N. H., & Sutrimo, S., 2020).

2.2.1. Arduino Uno R3

The Arduino Uno R3 is a microcontroller board from the Arduino family that uses the ATmega328 chip. It operates at 5V and features 14 input/output pins, 6 of which can be used as PWM outputs. It can be connected to a computer via a USB port.

2.2.2. LCD 16x2

It is one of the modules in the Arduino family, designed to display characters on a screen with 16 characters per line and 2 lines of text.

2.2.3. GY-302 BH1750 Sensor

The GY-302 BH1750 sensor is a light sensor module used to measure light intensity in lux (lx). It uses the ROHM BH1750FVI IC, operates at 5V and communicates via I2C (SDA and SCL pins).

2.3 TASi TA636A

A portable digital lux meter designed to measure light intensity in lux (lx). It has a measurement range of 0.1 – 200,000 lux, which has a resolution of 0.1 lux and an accuracy of $\pm (4\% + 10 \text{ words})$. The device uses a silicon photodiode sensor with a filter and a 120° incident angle, with a sampling rate of 2 times per second, as shown in Figure 1.

2.4. KUBER AS803

It is a portable digital lux meter designed to measure light intensity in lux (lx). It has a measurement range of 1 – 200,000 lux, with a resolution of 1 lux and an accuracy of $\pm (5\% + 10 \text{ words})$. The device performs a sampling rate of 1.5 times per second, as shown in Figure 1.

2.5. Methods

Before the researcher measures the light intensity of the LED lamps, several steps must be taken to ensure accurate measurement results. (Nanda, R. A., Karyadi, & Dewadi, F. M., 2022) These steps are:

1. Room Temperature

Room temperature variations can influence the light intensity emitted by the lamp. A hotter room will reduce the light intensity, while a cooler room will increase it. In this study, the room temperature is set and maintained at 22°C.

2. Light Stability

LED lamps provide a constant output once the bulb has been operating for some time and has reached a steady operational temperature. Therefore, before measurements are taken, the lamp to be tested is turned on and allowed to run for at least 15 minutes.

3. Sensor Distance from Light Source (Lamp)

The farther the sensor is from the light source, the lower the measurement value will be, and vice versa. To ensure the precision of the measurements, a consistent distance is maintained for each lamp tested. The sensor is placed 10 cm from the light source (lamp) to ensure consistent measurement conditions in this research.

4. Incident Angle (Direction of Light Arrival)

Light that does not hit the sensor perpendicularly will cause the measurement result to be lower than the actual intensity produced by the light source. Therefore, the position between the light source (lamp) and the sensor is set to be perpendicular during measurement. (Lenk & Lenk, 2017)

5. Calibration

Each sensor/lux meter used in this study has been calibrated according to the manufacturer's standards.

6. Other Objects

Objects in the vicinity can either absorb or reflect light, thereby altering the intensity detected by the sensor/lux meter. Consequently, it is essential to ensure that no other objects are located near the light source during the measurement procedure.

2.6. Arduino Lux Meter

The working system of the Arduino Lux Meter is based on Tominikus Benyamin Bano's (Bano, T. B., Widagda, I. G. A., Trisnawati, N. L. P., Wibawa, I. M. S., Putra, I. K., & Sandi, I. N., 2024) methods. The Arduino Uno R3 is the receiver of the output from the GY-302 BH1750 sensor, which measures the light intensity emitted by the lamp. The Arduino Uno R3 then processes this data and displays the results on a 16x2 LCD screen, as shown in Figure 3. (Pamungkas, M., Hafiddudin, H., & Rohmah, Y. S., 2015) (Shiddiqy, M. I. A., & Sunardi, 2024).

3. RESULT & DISCUSSION

Once the room and all lux meters were properly prepared, the measurement process was carried out. Each bulb was installed in the desk lamp, which was configured according to the specified conditions. Results show significant variation and is shown in Table 1.

Table 1.
Comparison of Various Measurements on Various Brands of LEDs

6500K E27 9W LED LAMPS		LIGHT FLUX*	ARDUINO KUBER AS803	TASI TA636A
BRAND NAME	PRODUCT NAME	(LUMEN)	(LUX)	(LUX)
Midea	MDL-BUA6009W	1,100.00	18,183.00	24,720.00
Luxen	Cosmo Platinum	990.00	16,323.00	17,880.00
In-Lite	INB007	1,080.00	16,060.00	20,130.00
Philips	RadiantLine	950.00	16,050.00	20,600.00
Krisbow	LED LUMI	900.00	14,975.00	19,890.00
Fanos	ECO Series	900.00	14,655.00	17,950.00
Ecova		1,080.00	14,315.00	18,290.00
Shinyoku	Mutiara	870.00	13,870.00	17,710.00
Noci	Lume NCLEB27	1,107.00	13,865.00	18,530.00
Philips	Essential	950.00	13,860.00	18,060.00
Hannochs	Basic II	810.00	13,325.00	16,790.00
Visalux	Ektiv	990.00	13,010.00	16,030.00
Panasonic	LED NEO	810.00	12,925.00	16,210.00
LEDVance	Classic A Base 9W	900.00	11,680.00	15,080.00
Hannochs	Premier	1,090.00	11,530.00	14,860.00
Oppl	Ecosave Series	990.00	11,096.00	14,440.00
Luby	Prima	855.00	11,000.00	15,160.00
Hannochs	NEX	880.00	10,990.00	13,930.00
Hannochs	Avengers	880.00	10,925.00	14,010.00
Osram	ECO Classic A 75	720.00	10,595.00	13,540.00
Luxen	Classic Gold	900.00	10,450.00	13,060.00
Noci	ECO Series	900.00	10,355.00	13,520.00
PanaLED		765.00	10,246.00	14,010.00
Lanbo	LB-525	900.00	9,595.00	11,860.00
Interluc		630.00	9,386.00	12,540.00
Morgen	Grand	800.00	9,306.00	11,990.00
Shimura		900.00	8,345.00	11,340.00
Visero	Vintage	855.00	7,625.00	10,470.00
Surya	Stick LED	640.00	6,855.00	9,233.00
Arashi	Beat II	725.00	6,525.00	8,152.00
Mitech	Platinum	897.00	6,340.00	8,580.00
Pesonacom	Classic	765.00	6,153.00	8,203.00
Amasco	Classic	810.00	5,645.00	7,363.00
GT Lamps		N/A	2,580.00	3,303.00
NAC		N/A	1,915.00	2,553.00



Figure 1.
Lux Meter

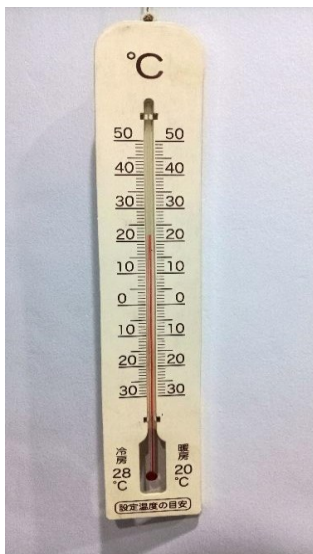


Figure 2.
Thermometer

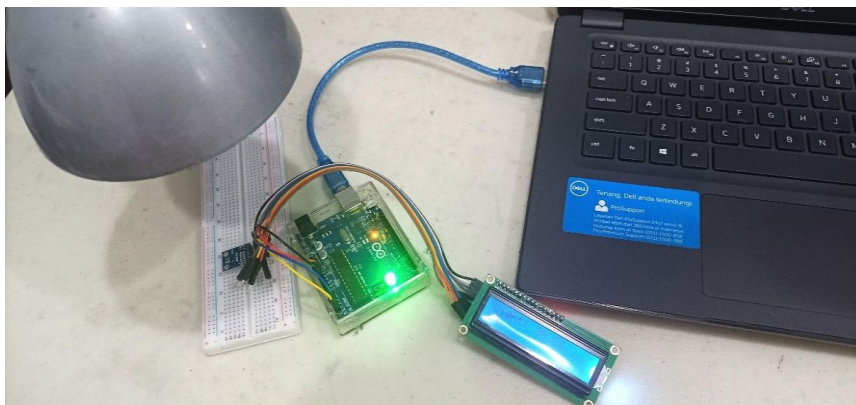


Figure 3.
Arduino Lux Meter

4. CONCLUSION

The results of the measurements lead to the following conclusions:

1. The diffusing globe affects the measurement results due to its shape, size and position between the lamp and the sensor. This can be observed from the differences in readings across the three lux meters.
2. The diffusing globe helps collect the light intensity emitted by the lamp. This is evident from the comparison between the TASI TA636A and KUBER AS803. The TASI TA636A, with its diffusing globe, is exposed to a wider spread of light compared to the KUBER AS803.
3. A lamp with a high light flux does not necessarily produce high light intensity. Further research using an integrating sphere would be beneficial to verify whether the information on the lamp packaging is accurate.

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