RADIATION PATTERN OF A LIGHT-EMITTING DIODE

Yehowshua Immanuel, Noah Daugherty

December 5, 2018

Contents

1 INTRODUCTION

The intention of this experiment is to characterize the radiation pattern of an LED empirically and verify it analytically. To do this, we make a few critical assumptions.

1. We treat the LED as uniform planar light source.
2. The radiation pattern of the LED is independent of angle ϕ.
3. The experiment is performed at a scale such that the we can treat LED as a point source and the aperture area as differential.

We mounted an LED on a rotating platform and recorded power perceived by a power detector at chosen distance R from the LED for angles between -90° and 90°. Using this data, we are able to determine the total power emitted by the LED and compare it with our analytically derived expected results. We refined our model in an attempt to account for numerical discrepancies between the expected and observed results. Unfortunately, in a hurry, we forgot to record our station number.

2 DATA

2.1 Collection Methodology

The following precautions were taken to minimize any error introduced in collecting data.

- We set the aperture radius precisely by closing it flush around a nominally .7mm stick of lead.
- We re-purposed multimeter boxes - which we used as four black walls surrounding our apparatus, minimizing variations in light noise which we noticed could be attributed to movements of the observer. The resulting change in milliVolts detected after installation of the black walls was notable, having decreased by about 20mV. Inevitable background radiation was still present, but having audited previous measurements at certain angles at random, and finding no difference, we safely conclude the background radiation was effectively constant, which we account for in our subsequent computations.

2.2 Tabulated Results

The raw collected data can be found in Appendix A

3 Appendices

3.1 Appendix A: Collected Raw Data

Measured Angle	Adjusted Angle	Measured Voltage (mV)
-42	-90	4.5
-35	-83	8.6
-30	-78	15
-25	-73	19.4
-20	-68	24.5
-15	-63	15.3
-10	-58	16.8
-6	-54	18.9
0	-48	20.5
5	-43	22.8
10	-38	23.4
15	-33	28.2
20	-28	32
22	-26	35.6
24	-24	44.4
26	-22	152.3
28	-20	225.9
30	-18	252.4
32	-16	424.8
34	-14	522.7
36	-12	515.5
38	-10	453.8
40	-8	411.7
42	-6	426.7
44	-4	414.8
46	-2	451.7
47	-1	461.7
48	0	511.2

Measured Angle	Adjusted Angle	Measured Voltage (mV)
49	1	510.8
51	3	322.1
53	5	237.1
55	7	123.9
57	9	119.9
59	11	51.5
61	13	32.2
63	15	30.8
65	17	28.3
67	19	26.3
69	21	26.9
71	23	24.7
73	25	23.1
75	27	22.9
77	29	21.2
79	31	20.2
81	33	19.6
83	35	19
85	37	18.3
87	39	18.2
90	42	17.2
95	47	15.6
100	52	14
110	62	18.9
115	67	14
120	72	8.8
125	77	5.1
130	82	4.1
138	90	4.2

3.2 Appendix B: Normalized Voltages

Measured Angle	Adjusted Angle	Normalized Voltage (mV)
-42	-90	-0.0012
-35	-83	0.0068
-30	-78	0.0191
-25	-73	0.0276
-20	-68	0.0375
-15	-63	0.0197
-10	-58	0.0226
-6	-54	0.0267
0	-48	0.0298
5	-43	0.0342
10	-38	0.0354
15	-33	0.0446
20	-28	0.0520
22	-26	0.0589
24	-24	0.0759
26	-22	0.2844
28	-20	0.4266
30	-18	0.4778
32	-16	0.8109
34	-14	1.0000
36	-12	0.9861
38	-10	0.8669
40	-8	0.7855
42	-6	0.8145
44	-4	0.7915
46	-2	0.8628
47	-1	0.8821
48	0	0.9778
49	1	0.9770
51	3	0.6124
53	5	0.4482
55	7	0.2295
57	9	0.2218
59	11	0.0896
61	13	0.0524
63	15	0.0497
65	17	0.0448
67	19	0.0410
69	21	0.0421
71	23	0.0379
73	25	0.0348
75	27	0.0344
77	29	0.0311
79	31	0.0292
81	33	0.0280
83	35	0.0269
85	37	0.0255
87	39	0.0253
90	42	0.0234
95	47	0.0203
100	52	0.0172
110	62	0.0267
115	67	0.0172
120	72	0.0071
125	77	0.0000
130	82	-0.0019
138	90	-0.0017