*International Journal for Modern Trends in Science and Technology*, 7(11): 71-75, 2021

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST0711013
Available online at: http://www.ijmtst.com/vol7issue11.html

# UV Sterilizing Dustbin

**Vivek Manda[1] | Surender Balachandran[2] | Danaboina Mahesh[3] | Roopak Houji[4] | Batchu Sidharth Sarat Raj[5] | Janagam.Akhil Kumar[6] | Guna Shekar Govindu[7] | Ravi kumar vilasagaram[8]**

[1, 2, 3, 4, 5, 6,7,8] Stonedge Technologies and Robotics India Pvt Ltd, Hyderabad, Telangana, India.

**To Cite this Article**
Vivek Manda, Surender Balachandran, Danaboina Mahesh, Roopak Houji, Batchu Sidharth Sarat Raj, Janagam.Akhil Kumar, Guna Shekar Govindu and Ravi kumar vilasagaram. UV Sterilizing Dustbin. *International Journal for Modern Trends in Science and Technology* 2021, *7*, pp. 71-75. https://doi.org/10.46501/IJMTST0711013.

**Article Info**
Received: 21 October 2021; Accepted: 03 November 2021; Published: 08 November 2021

## ABSTRACT

This covid pandemic has taught us the core survival instincts & foresee technological need balance while spotlighting on the ways of garbage being handled manually in countries like India by local municipality workers and not using properly sealed and hygienic practices towards waste disposal have shown significant trouble and damage. Generally, people put waste materials in dustbins that are not treated. Many hazardous and pandemic-causing diseases can be mitigated and checked by proper treating of garbage and infected sewage. Used face masks, hand gloves, Diapers, and medical waste materials which are thrown in the dustbins are hazardous and while transferring this waste to dumping yards there are possibilities of germs and viruses to spread, mutate, contract disease to the garbage handler or people working in garbage Handling section. This must be discarded immediately upon throwing in the dustbin so that the first person at the base who handles the Garbage is also mitigated from the risk of contracting the virus. Instead of Discarding used Hygienic Products or Garbage into the disposal bin, disinfecting the Garbage seems significant in breaking the chain of contamination. This paper discusses an easy-to-manufacture or modified and easy-to-use Automated UV Sterilizing Dustbin is one of the solutions to attenuate the viruses/bacteria in the initial stage of garbage handling where waste management involves manual labor in countries like India. The dustbin neutralizes all the pathogens in it and makes it safe to handle by the sanitation workers, unchecked which involves many children who live in slums and are below poverty lines.

**KEYWORDS:** UV Sterilizing Dustbin, Face Mask, virus, dustbin, UV-C LED, Sterilization, UV Dose

## I. INTRODUCTION

Highly infectious microbial and viral diseases are a major challenge to global health as such, are also a significant risk to global financial stability and security. While vaccines and personal hygiene equipment like gloves, masks, sanitizer sachets, sanitizer bottles, and shields play a key role in preventing viral epidemics and pandemics, once an outbreak has occurred, the implementation of personal protective equipment (PPE) and disinfection measures to limit the contamination becomes paramount. Moreover, broadly applicable, yet environmentally friendly, disinfection methods play a key role beyond limiting the spread of viral agents. The number of antibiotic-resistant bacteria and fungi is rising every year. However, unlike in the past, the infections are originating "in the community". While this usage of PPE might help individuals from contaminating the virus at the individual or personal level these items which are mostly one-time use are generally being discarded along with normal garbage, unseparated, and unlabeled as medical waste. In countries like India where garbage collection, sorting,

and treatment are done mostly manually [12]. Unfortunately involves handling this dangerous, harmful, contaminated garbage be handled by children and families from below the poverty line thereby putting them on the line of risk of all the dangerous diseases from Hepatitis B, COVID, and TB. Many scenarios see the waste being untreated in the colonies that are further mixed with rainwater to worsen the situation [13]. Usage of technology to simplify appease this situation by making a cheap, easy to use, easy to manufacture, and easy to repair smart Automated UV Dustbins that works reliably with the extremely low number of components is expected to mitigate this hazardous risk at the base level preventing the manual labour in this sector from contracting this disease

*Fig 1: Garbage collection*

## OBJECTIVE

The main object of this product is to stop the spreading of viruses and bacteria. Kill the virus and germs that are present even in the waste that we throw. It can inactivate the virus and germs in less than a minute. It sanitizes the waste for a couple of minutes and turns off the LED, which even saves power consumption.

### BACKGROUND OF UV

Sunlight contains three types of UV. First, there is UVA, which makes up the vast majority of the ultraviolet radiation reaching the Earth's surface. It's capable of penetrating deep into the skin and is thought to be responsible for up to 80% of skin aging, from wrinkles to age spots

Next, there's UVB, which can damage the DNA in our skin, leading to sunburn and eventually skin cancer (recently scientists have discovered that UVA can also do this). Both are reasonably well known and can be blocked out by most good sun creams.

There is also a third type: UVC. This relatively obscure part of the spectrum consists of a shorter, more energetic wavelength of light. It is particularly good at destroying genetic material – whether in humans or viral particles. Luckily, most of us are unlikely to have ever encountered any. That's because it's filtered out by ozone in the atmosphere long before it reaches our fragile skin.

### SIGNIFICANCE OF UV-C LIGHTS

In the electromagnetic spectrum, UV light falls between visible light and X-rays. UV light is categorized as Far UV from 100 to 200 nm, UV-C from 200 to 280 nm, UV-B from 280 to 315 nm, and UV-A from 315 to 400 nm. Previous research has shown that when microorganisms are exposed to UV-C, the absorption by DNA or RNA prevents cell multiplication and reproduction.

Ultraviolet radiation delivers maximum germicidal effectiveness to inactivate microorganisms when emitted at the optimal wavelength of 253.7 nanometers (nm), referred to as ultraviolet germicidal irradiation (UVGI) or UV-C. Germicidal effectiveness decreases when emitted at other than optimal wavelengths. This is why high-quality, UV sterilization lamps are so important, to effectively deliver the right amount of UV radiation for the desired application.

UV light sterilization effectively inactivates microorganisms by damaging the DNA of cells. DNA is responsible for cell replication, thus damaging the structure of the DNA renders cells unable to replicate and unable to spread disease. The UV photons are absorbed by the cell, creating pyrimidine dimmers. This causes two adjacent thymine or cytosine bases to bond with each other, instead of across the double helix as usual.

A DNA molecule with pyrimidine dimmers is unable to function properly, resulting in the organism's death or inability to replicate. An organism that cannot reproduce is no longer capable of spreading disease. This is the mechanism of UV-C disinfection of bacteria, viruses, fungi, and protozoa.

UV-C (also called germicidal UV) products tout pathogen kill rates higher than 99.9%. Because of their effectiveness, they're incredibly useful for hospitals, medical labs, senior care centers, fire and police stations, airports, transit stations, schools, government buildings, office buildings, and hotels.

UVC radiation is a known disinfectant for air, water, and nonporous surfaces. UVC radiation has effectively been used for decades to reduce the spread of bacteria, such as tuberculosis. For this reason, UVC lamps are often called "germicidal" lamps.

UVC radiation has been shown to destroy the outer protein coating of the SARS-Corona virus, which is a different virus from the current SARS-CoV-2 virus. The destruction ultimately leads to the deactivation of the virus.

## BLOCK DIAGRAM

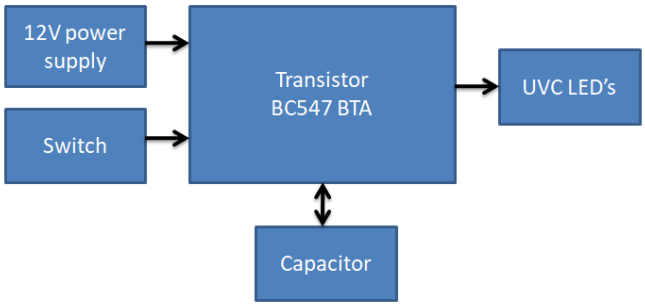


*Fig 2: Block diagram of UV Sterilizer dustbin*

## COMPONENTS USED

| S.no | Components | Spec's |
|---|---|---|
| 1 | UVC LED | 3535UVC2-270 ( 270 nm ) |
| 2 | Transistor | BC547 BTA |
| 3 | Resistors | 10kohm, 330kohm's |
| 4 | Capacitor | 470 µF |
| 5 | Power supply | 12 Volts |

Typically, LEDs emit a very narrow wavelength band of radiation. Currently, available UV LEDs have peak wavelengths at 265 nm, 273 nm, and 280 nm, among others. One advantage of LEDs over low-pressure mercury lamps is that they contain no mercury.

## CIRCUIT DIAGRAM

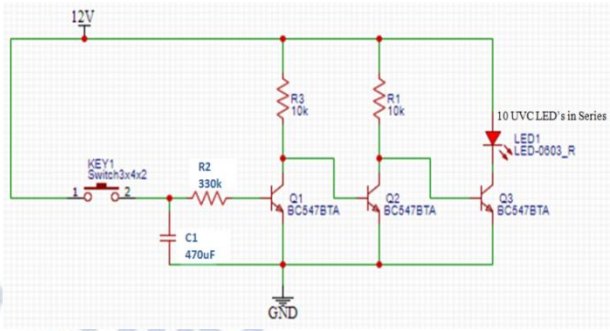


*Fig 3: Circuit connections*

This circuit is designed based on RC Circuit (resistor-capacitor circuit), when the limit switch is closed the capacitor will charge. If the limit switch is opened the capacitor will discharge. So when the dustbin is closed the capacitor will discharge and it flows through UVC LEDs. LEDs will be ON until the capacitor completely discharges.

**Discharge time calculation (LED ON Time)**

Discharge time of capacitor =5*R*C
(5*Resistance*capacitance)
= 5*330k ohms * 470 uF
= 775.5 seconds
= 12.925 Minutes

Due to losses, the practical Discharge time is around 7.5 Minutes

So LED's will be ON for around 7.5 Minutes

**Sterilization time calculation**

UV Dose = I*T (mJ/cm$^2$)

I – Intensity of UV

T – Expose time

Intensity of Light

I = Power of LED / Surface area of cylinder

I = Watts / $2\pi rh+2\pi r^2$

Each LED = 80mA*5v = 400 mW

As we are using 10 LEDs, total watts = 4000 mW = 4000 mJ/s

Max UV Dose Required to kill all the germs

For 90% Sterilization – 111.0 mJ/cm$^2$

For 99% Sterilization – 222.0 mJ/cm$^2$

For 99.9% Sterilization – 333.0 mJ/cm$^2$

***When the bin is empty***

Height = 30 cm

Radius = 15 cm
I = Watts / $2\pi rh+2\pi r^2$
I = 4000mW / $2*(3.14)*(15)*(30) +2*(3.14)*(15)^2$
I = 4000/4241.15 mJ/$cm^2$ s
I = 0.943 mJ/$cm^2$ s

Expose time for 99.9% sterilization
T= UV Dose/Intensity of UV
T= 333 / 0.943
T= 353.12 seconds
T = 5.88 minutes

***When the bin is full***

Height = 5 cm
Radius = 15 cm
I = Watts / $2\pi rh+2\pi r^2$
I = 4000mW / $2*(3.14)*(15)*(5) +2*(3.14)*(15)^2$
I = 4000 / 1884.95 mJ/$cm^2$ s
I = 2.122 mJ/$cm^2$ s

Expose time for 99.9% sterilization
T= UV Dose/Intensity of UV
T= 333 / 2.122 seconds
T= 156 seconds
T = 2.615 minutes

We reach 99.9% sterilization in 5.88 minutes when the bin is empty, so LEDs need to be on for 5.88 minutes, based on our practical implementation we are getting 7.5mins ON time for LEDs.
As the LEDs will be ON for more than 5.88 minutes we are sterilizing more than 99.9%.

**DESIGN**

UVC Circuit is fixed to Dustbin Lid and UVC LED's are spread across the complete Bin lid so that the UV light will spread over the bin. And the switch is placed at the closing of the bin lid, if the bin lid is closed the switch will be in OPEN STATE and if the bin lid is open the switch will be in CLOSED STATE.

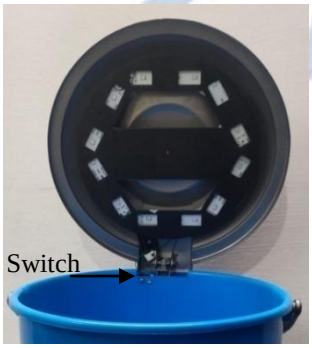


*Fig 4: UVC LED's and Switch Arrangement on Bin Lid*

**WORKING**

If Dustbin is opened in between 7.5 minutes duration when the UVC LED's are ON, the switch will be in CLOSED STATE and UVC LED's will be OFF, this will protect from UVC light falling onto human skin.


*Fig 5: UVC LED's OFF when the dustbin is open in between 7.5 minutes time duration*

Once the dustbin is closed the switch will be in Open STATE and UVC LED's will be ON for 7.5 minute. After 7.5 minutes UVC LED's will automatically be turned OFF


*Fig 6: UVC LEDs ON for 7.5 minutes*


*Fig 7: UVC LED's OFF after7.5 minutes*

**SPECIFICATIONS**

| | |
|---|---|
| Voltage | 12 Volts |
| Power | 24 Watts |
| Capacity | 12 liter's |
| Dimensions | 28*28*32 cm |

**HIGHLIGHTS OF PRODUCT**

- Reduce the spread of germs and viruses from the wastes.
- Can effectively inactivate 99% of bacteria within a minute.
- Can be replaced with the existing Dust Bin to limit the spread of the virus.
- The model helps in killing the germs and viruses even from the wastes that we dispose
- This UV Dustbin is a green environment-friendly product.
- Can be used in Hospitals, municipal corporations, Schools, Mall's etc places

**BENEFITS**

- Non-Toxic
- Extremely Effective Form of Disinfection
- Kills Pathogens Without Immunity
- Affordable

**CONCLUSION**

The further models will include perfecting this Bin to be Eco-friendly and circuit long-lasting, reliable with better and certified tested with improvement in power electronics, with use of SMDs, PCB, high power UV LED will help to make the system smaller, even more reliable, efficient and makes the cost of the bins effective. The best and maximum Output of this technology will be delivered when this bin is used in all the places and make it a common practice everywhere which will be possible by reducing the manufacturing time, cost by better standardizing the Schematics, Model, Manufacturing, Mass Manufacturable model that has low margin error or damaged pieces in manufacturing output and bins with more capacity and better disperse of UV radiation 360°.

Through our intense research, we state that the waste sterilization time varies from the type of waste (Domestic, Industrial, and Biodegradable) to its amount (sizes of bins and amount of waste). So, we came up with a solution for such causalities. By manipulating the intensity and interval of UV ray exposure on the waste, we can achieve a 99.9% of decontamination. To tackle it, UV bins for all types of Sizes and harsh environments have been developed by Stonedge Technologies and Robotics Engineers.

**REFERENCES**


[1] Hijnen WA, Beerendonk EF, Medema GJ. Inactivation credit of UV radiation for viruses, bacteria, and protozoan (oo) cysts in water: a review. *Water Res.* 2006;40(1):3–22. doi: 10.1016/j.watres.2005.10.030. [PubMed] [CrossRef] [Google Scholar]

[2] She RC, Chen D, Pak P, Armani DK, Schubert A, Armani AM (2020) Build-at-home UV-C disinfection system for healthcare settings. arXiv preprint http://arxiv/abs/2003.12916

[3] Kowalski, W. Ultraviolet Germicidal Irradiation Handbook:UVGI for Air and Surface Disinfection; Springer: Berlin Heidelberg,2009. DOI: 10.1007/978-3-642-01999-9.

[4] Song, K.; Taghipour, F.; Mohseni, M. Microorganisms Inactivation by Wavelength Combinations of Ultraviolet Light-Emitting Diodes (UV-LEDs). Sci. Total Environ. 2019, 665, 1103–1110.

[5] Malayeri AH, Mohseni M, Cairns B, Bolton JR, Chevrefils G, Caron E, Barbeau B, Wright H, Linden KG. Fluence (UV dose) required to achieve incremental log inactivation of bacteria, protozoa, viruses and algae. *IUVA News.* 2016;18(3):4–6. [Google Scholar]

[6] Chang JC, Ossoff SF, Lobe DC, Dorfman MH, Dumais CM, Qualls RG, Johnson JD. UV inactivation of pathogenic and indicator microorganisms. *Appl Environ Microbiol.* 1985;49(6):1361–1365. doi: 10.1128/AEM.49.6.1361-1365.1985. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[7] Beck SE, Rodriguez RA, Hawkins MA, Hargy TM, Larason TC, Linden KG. Comparison of UV-induced inactivation and RNA damage in MS2 phage across the germicidal UV spectrum. *Appl Environ Microbiol.* 2016;82(5):1468–1474. doi: 10.1128/AEM.02773-15. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

[8] NIOSH (1972) Criteria for a recommended standard: occupational exposure to ultraviolet radiation, DHHS (NIOSH) Publication Number 73–11009.

[9] International Commission on Illumination (CIE) (2003) CIE 155:2003 ultraviolet air disinfection. https://files.cie.co.at/cie155-2003%2520(free%2520copy%2520March%25202020).pdf. Accessed 2 Jun 2020.

[10] International Commission on Illumination (CIE) (2003) CIE 155:2003 ultraviolet air disinfection. https://files.cie.co.at/cie155-2003%2520(free%2520copy%2520March%25202020).pdf. Accessed 2 Jun 2020.

[11] Tarka, P.; Nitsch-Osuch, A. No-Touch Automated DisinfectionSystem for Decontamination of Surfaces in Hospitals. Int. J. Environ.Res. Public Health 2020, 17 (14), 5131.

[12] https://www.thenewsminute.com/article/where-does-hyderabad-s-garbage-go-journey-through-city-s-waste-disposal-system-35840

[13] https://www.newindianexpress.com/cities/hyderabad/2020/nov/20/need-trash-off-our-hands-hyderabad-citizens-2225721.html