



Philips UV-C Application

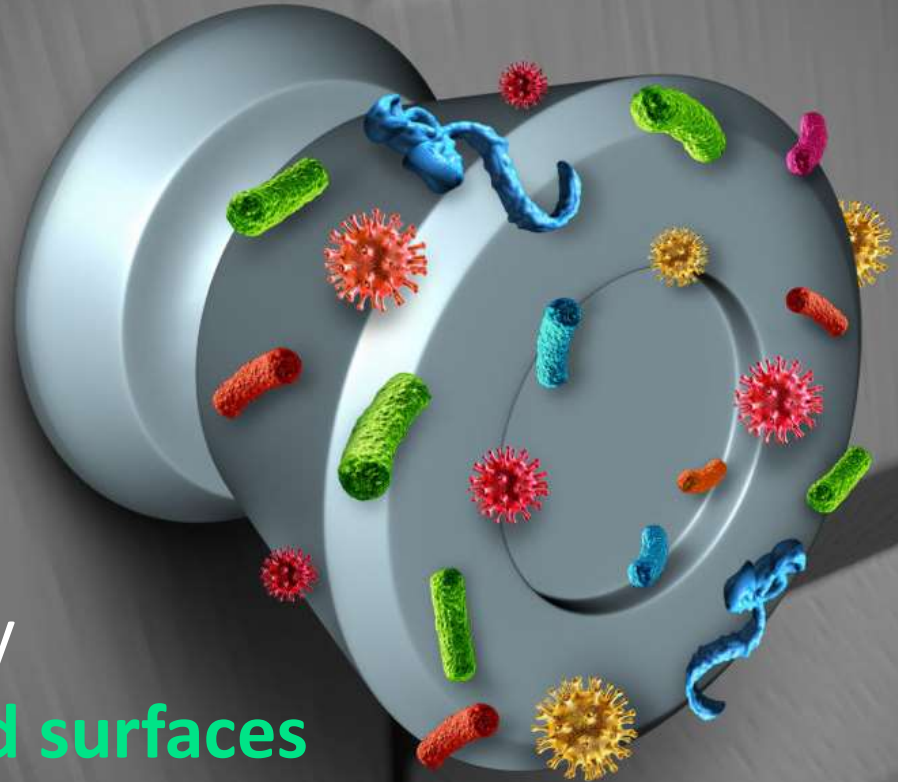
Signify Commercial Indonesia

June 2020

Why disinfecting is important?

Bacteria and viruses are present in the air, and on just about every other surface

That's why **disinfecting air, and surfaces** is important for our health & well-being

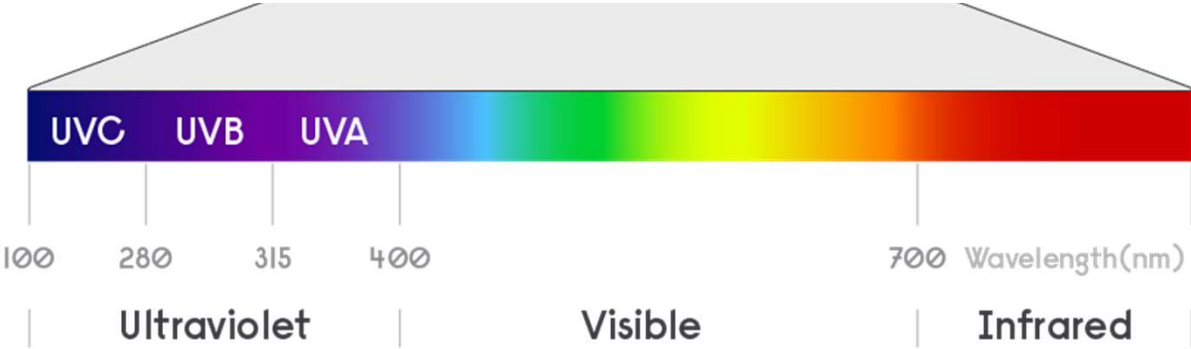


What is UV-C and how does it work?

UV-C Overview: What is UV lighting?

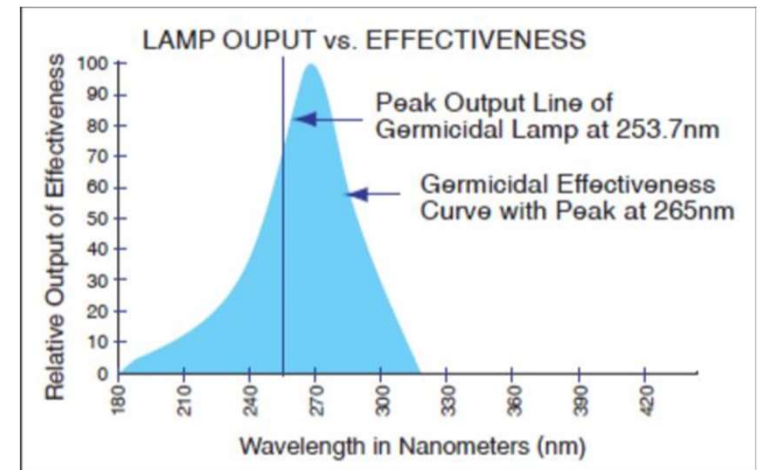
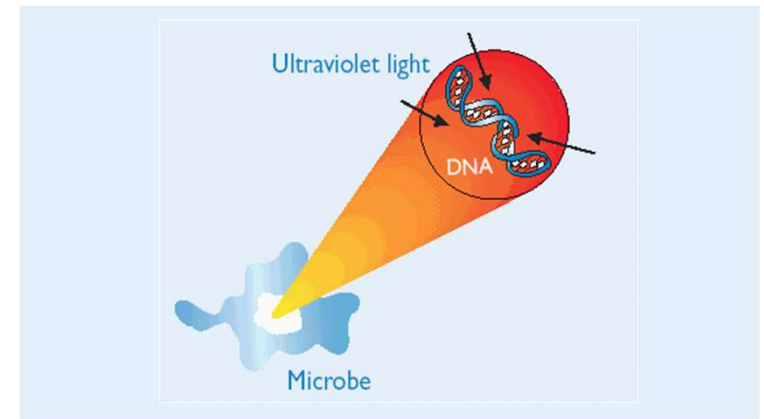
Ultraviolet (UV) light is invisible to human eyes. It can be subdivided into three categories:

UV-C from 100 to 280 nm	UV-B from 280 to 315 nm	UV-A from 315 to 400 nm
<ul style="list-style-type: none">For disinfection purposes and germicidal application	<ul style="list-style-type: none">For medical use (i.e. phototherapy to treat skin conditions, including psoriasis)	<ul style="list-style-type: none">For use with curing, suntanning and insect traps.



How does UV-C work?

- UV-C radiation can **break the DNA and RNA** of bacteria, viruses and spores, meaning that they leave them harmless. There are **no known micro-organisms resistant to UVC**.¹
- UV-C technology has been used **safely and effectively** in hospitals and governmental buildings for more than **40 years**²
- The **peak output of our germicidal lamps (253.7nm)** is the optimum effectiveness of UV-C
- **UV-C is harmful for human skin and eyes, the best safeguards are proper application design and user knowledge/usage**



¹Fluence (UV Dose) Required to Achieve Incremental Log Inactivation of Bacteria, Protozoa, Viruses and Algae Revised, updated and expanded by Adel Haji Malayeri, Madjid Mohseni, Bill Cairns and James R. Bolton. With earlier contributions by Gabriel Chevretils (2006) and Eric Caron (2006) With peer review by Benoit Barbeau, Harold Wright (1999) and Karl G. Linden

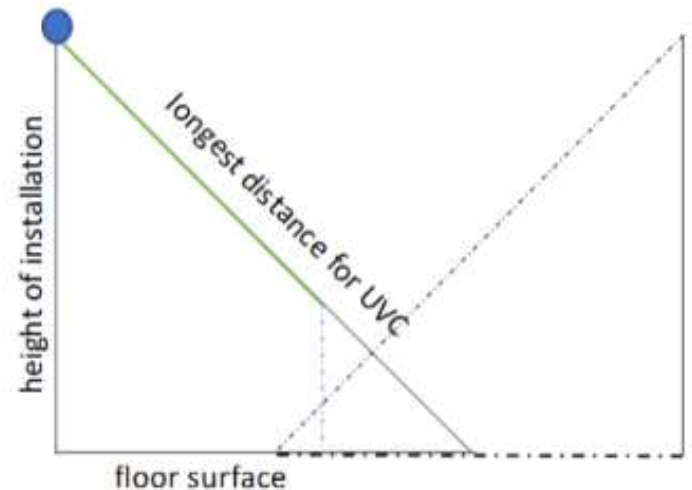
²EPA Report, "Building Retrofits for Increased Protection Against Airborne Chemical and Biological Releases" Pg. 56

Design Analysis

Calculations for surface disinfection

Dose = irradiance * time

- Irradiance is UVC radiation as a function of the distance from object
- Dose is a defined number based on log 1 reduction, defined by microbiological researchers
- If lamp is known and distance is known, radiance time can be calculated. The effect of distance is exponential.
- If preferred radiance time is known, lamp can be calculated.
- Depending on luminaire performance, no of lamps to be used to disinfect certain area can be calculated.
- Overlap is needed as UVC output reduces fast when distance increases.



Dose Disinfection

(defined by microbiological researchers)

- The higher/longer the distance, the longer treatment time
- You can reduce the treatment time, by increasing the wattage of the lamps
- 99.99% killing rate on a horizontal surface straight under the UVC source

UV dose to obtain 90% killing rate	Dose	k
Bacteria		
Bacillus anthracis	45.2	0.051
B. megatherium sp. (spores)	27.3	0.084
B. megatherium sp. (veg.)	13.0	0.178
B. paratyphosus	32.0	0.072
B. subtilis	71.0	0.032
B. subtilis spores	120.0	0.019
Campylobacter jejuni	11.0	0.209
Clostridium tetani	120.0	0.019
Corynebacterium diphtheriae	33.7	0.069
Dysentery bacilli	22.0	0.105
Eberthella typhosa	21.4	0.108
Escherichia coli	30.0	0.077
Klebsiella terrifani	26.0	0.089
Legionella pneumophila	9.0	0.256
Micrococcus candidus	60.5	0.038
Micrococcus sphaeroides	100.0	0.023
Mycobacterium tuberculosis	60.0	0.038
Neisseria catarrhalis	44.0	0.053
Phytomonas tumefaciens	44.0	0.053
Pseudomonas aeruginosa	55.0	0.042
Pseudomonas fluorescens	35.0	0.065
Proteus vulgaris	26.4	0.086
Salmonella enteritidis	40.0	0.058
Salmonella paratyphi	32.0	0.072
Salmonella typhimurium	80.0	0.029
Sarcina lutea	197.0	0.012
Serratia marcescens	24.2	0.095
Shigella paradysenteriae	16.3	0.141
Shigella sonnei	30.0	0.077
Spirillum rubrum	44.0	0.053
Staphylococcus albus	18.4	0.126
Staphylococcus aureus	26.0	0.086
Streptococcus faecalis	44.0	0.052
Streptococcus hemolyticus	21.6	0.106
Streptococcus lactis	61.5	0.037
Streptococcus viridans	20.0	0.115
Sentertidis	40.0	0.057
Vibrio cholerae (V.comma)	35.0	0.066
Yersinia enterocolitica	11.0	0.209

Table 2. Doses for 10% survival under 254 nm radiation (J/m^2) and rate constant k (m^2/J), Ref 2, 3, 4, 5, 6 and 7.

UV dose to obtain 90% killing rate	Dose	k
Yeasts		
Bakers' yeast	39	0.060
Brewers' yeast	33	0.070
Common yeast cake	60	0.038
Saccharomyces cerevisiae	60	0.038
Saccharomyces ellipsoideus	60	0.038
Saccharomyces sp.	80	0.029

UV dose to obtain 90% killing rate	Dose	k
Mould spores		
Aspergillus flavus	600	0.003
Aspergillus glaucus	440	0.004
Aspergillus niger	1320	0.0014
Mucor racemosus A	170	0.013
Mucor racemosus B	170	0.013
Oospora lactis	50	0.046
Penicillium digitatum	440	0.004
Penicillium expansum	130	0.018
Penicillium roqueforti	130	0.018
Rhizopus nigricans	1110	0.002

UV dose to obtain 90% killing rate	Dose	k
Virus		
Hepatitis A	73	0.032
Influenza virus	36	0.064
MS-2 Coliphage	186	0.012
Polio virus	58	0.040
Rotavirus	81	0.028

UV dose to obtain 90% killing rate	Dose	k
Protozoa		
Cryptosporidium parvum	25	0.092
Giardia lamblia	11	0.209

UV dose to obtain 90% killing rate	Dose	k
Algae		
Blue Green	3000	0.0008
Chlorella vulgaris	120	0.019

Eindhoven, the Netherlands – Signify (Euronext: LIGHT), the world leader in lighting, together with the National Emerging Infectious Diseases Laboratories (NEIDL)¹ at Boston University in the US have conducted research that validates the effectiveness of Signify’s UV-C light sources on the inactivation of SARS-CoV-2, the virus that causes COVID-19.

Since the start of the SARS CoV-2 pandemic, Dr. Anthony Griffiths, Associate Professor of Microbiology at Boston University School of Medicine and his team have been working on developing tools to support scientific advancement in this field.² During their research they have treated inoculated material with different doses of UV-C radiation coming from a Signify light source and assessed the inactivation capacity under various conditions. The team applied a dose of 5mJ/cm², resulting in a reduction of the SARS-CoV-2 virus of 99% in 6 seconds. Based on the data, it was determined that a dose of 22mJ/cm² will result in a reduction of 99.9999% in 25 seconds.³

Dose for Covid-19 according to research by Boston University School of Medicine:

220 J/m²

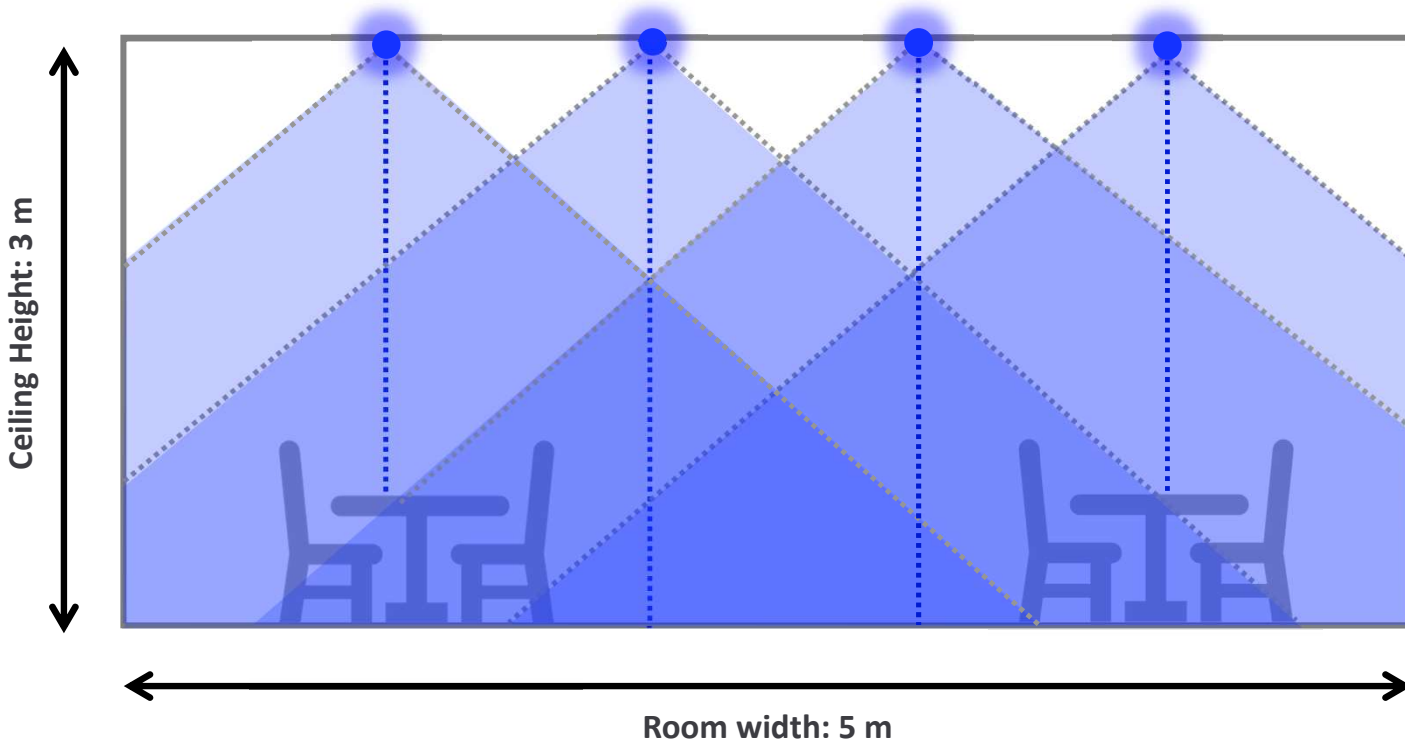
“ Our test results show that above a specific dose of UV-C radiation, viruses were completely inactivated: in a matter of seconds we could no longer detect any virus.”

Dr. Anthony Griffiths

Associate Professor of Microbiology at Boston University School of Medicine

“We’re very excited about these findings and hope that this will accelerate the development of products that can help limit the spread of COVID-19,” he added.

Application: Covid-19 Surface Disinfection with 4 x GUV 36W

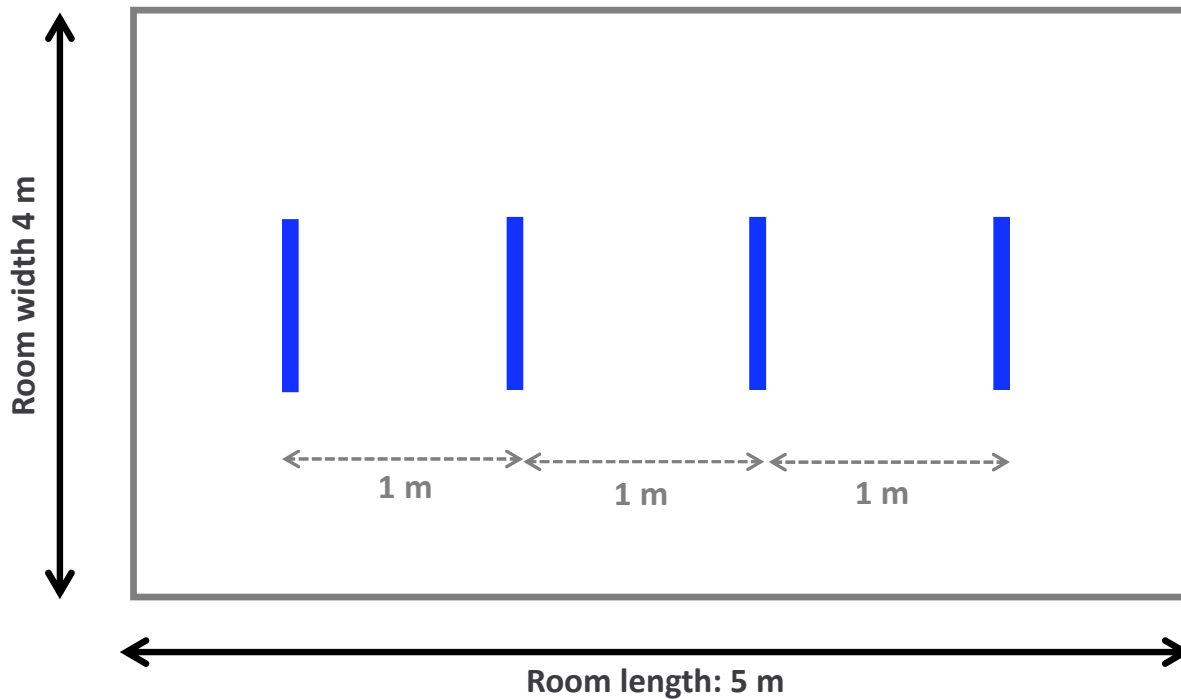


Select Lamptype	TUV 36W SLV/6
Irradiance (W/m2 @ 1m)	1.45
Distance from surface (m)	3
Dose (J/m2)	220
Treatment time at chosen distance (second)	5462.068966
Proposal for treatment time (min) log 4 reduction	
137	

T31

- 4 GUV T8 36W requires **34 minutes** to disinfect surfaces with (max.) 3 m ceiling distance on the area 20 sqm
- Overlapping UV-C radiation makes the disinfection process faster since it doubles the intensity.
- Lamps should be positioned to reach more surfaces.

Application: Covid-19 Calculation for standard room 4 m x 5 m



- Four GUV T8 36W are positioned on the ceiling (3 m height).
- Time required to disinfect is approximately **34 minutes**.

Comparison Between Disinfectant Spray & UVC Light (w/o safety systems)

Monthly cost with **manual** disinfectant spray per 100 sqm

	Disinfectant Spray				UV-C Lamp			
	Tool	Price	Qty	Cost	Luminaire	Price	Qty	Cost
Investment (for 100 sqm)	Manual spray	Rp 2,000,000	3	Rp 6,000,000	TUV 36W full set	Rp 1,267,200	20	Rp 25,344,000
Daily cost*	Disinfectant liquid**	Rp 692,000	6	Rp 4,152,000	20 x TUV 36W***	Rp 1,182	6	Rp 7,092
Monthly cost	Disinfectant liquid	Rp 692,000	180	Rp 124,560,000	20 x TUV 36W	Rp 1,182	180	Rp 212,760
Total cost in first month	Manual spray + disinfectant			Rp 130,560,000	TUV 36W + electrical bill			Rp 25,556,760

Monthly cost with **automatic** disinfectant spray per 100 sqm

	Disinfectant Spray				UV-C Lamp			
	Tool	Price	Qty	Cost	Luminaire	Price	Qty	Cost
Investment (for 100 sqm)	Automatic spray	Rp 6,000,000	3	Rp 18,000,000	TUV 36W full set	Rp 1,267,200	20	Rp 25,344,000
Daily cost*	Disinfectant liquid**	Rp 692,000	6	Rp 4,152,000	20 x TUV 36W***	Rp 1,182	6	Rp 7,092
Monthly cost	Disinfectant liquid	Rp 692,000	180	Rp 124,560,000	20 x TUV 36W	Rp 1,182	180	Rp 212,760
Total cost in first month	Manual spray + disinfectant			Rp 142,560,000	TUV 36W + electrical bill			Rp 25,556,760

*Based on assumption that disinfection is done every 4 hours a day (standard WHO)

**Using Hospital Grade *Sanlene* disinfectant (Rp 517,000/5L), with 5L concentrate of 1:5 can cover 20 sqm

***Using 45W (36W + ballast lost) per lamp running for 38 minutes per session, and Rp 1.035,78/kWh (large business in Greater Jakarta area)

Safety Concern

Using UV-C in a safe way

- Like any disinfection system, **UV-C lamps and devices must be used properly to be safe.**
- UV-C light can cause a severe sunburn-like reaction to your skin and similarly, could damage the retina of your eye, if exposed. ...this is very painful. It is therefore key, that lamps are always shielded from direct radiation.
- All products need to **follow the standard product safety releases** and approbations.
- **All products require at least -**
 1. An Instructional Safeguard AND
 2. A Time Safeguard OR an Equipment Safeguard OR a Containment Safeguard



Safe controls for UV-C disinfection

Requirement:

- Decontamination UV-C luminaires by nature carry certain inherent safety risks, related to UV-C exposure
- Specific procedural and system measures are required to ensure minimal acceptable operational safety.

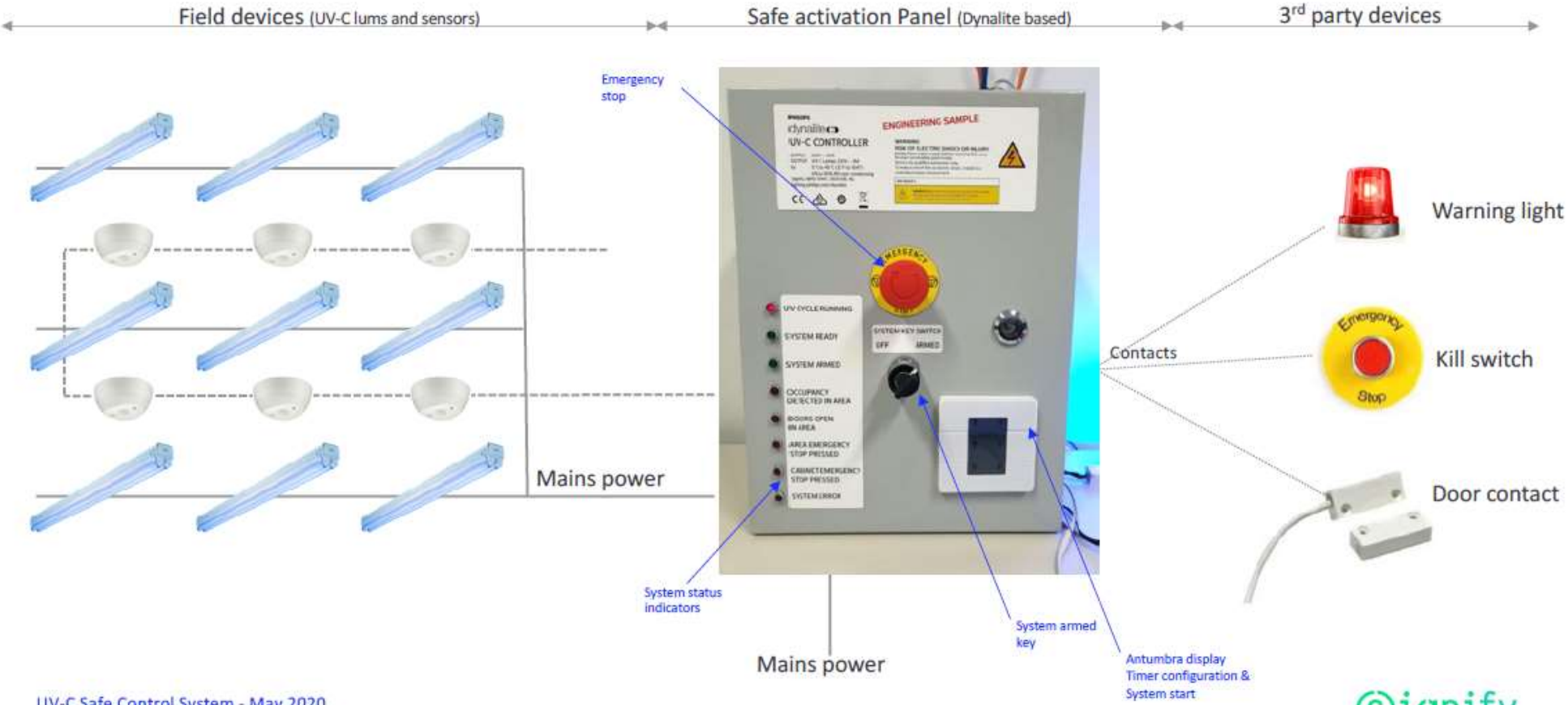
Proposition:

- **Enable an authorized operator to safely activate and operate UV-C surface disinfection luminaires.**

Control needs:

- Manual-on/timer-off by an authorized operator. Control actions performed outside of the room.
- Automatic safety overrides of the manual control.

Main Safety Control Systems



Commercial & Professional Applications

Air and Surface Purification

Applications: Looking at just surface and air, there are numerous real-world segments where UV-C lighting is a viable disinfection solution



Applications: Surface – Moveable Carts / Robots, Open Fixtures, Chamber

Moveable Cart / Robot (TBA)



Open air fixture



Chamber



- Robots equipped with multiple high-power UV-lamps to disinfect (patient)rooms within minutes
- No people should be present in the room when the system is in use.
- UV luminaires for disinfection of both surfaces and air
- No people should be present in the room when the system is in use.
- Chambers are commonly used to disinfect objects including tools (ie at a nail salon), mail, mobile phones.

Applications: Air – Upper Air, Coil Cleaning and HVAC

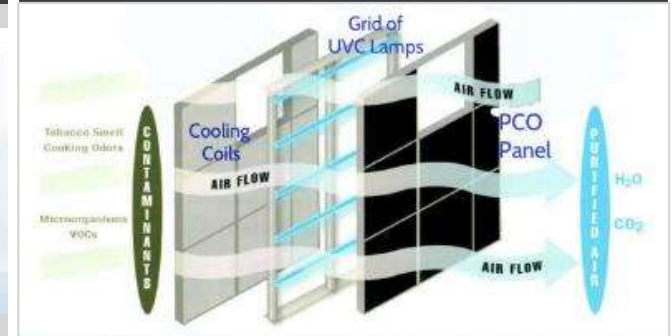
Upper Air Purification (TBA)



Cooling Coil Cleaning System (TBA)



HVAC Cooling Coil Cleaning (TBA)

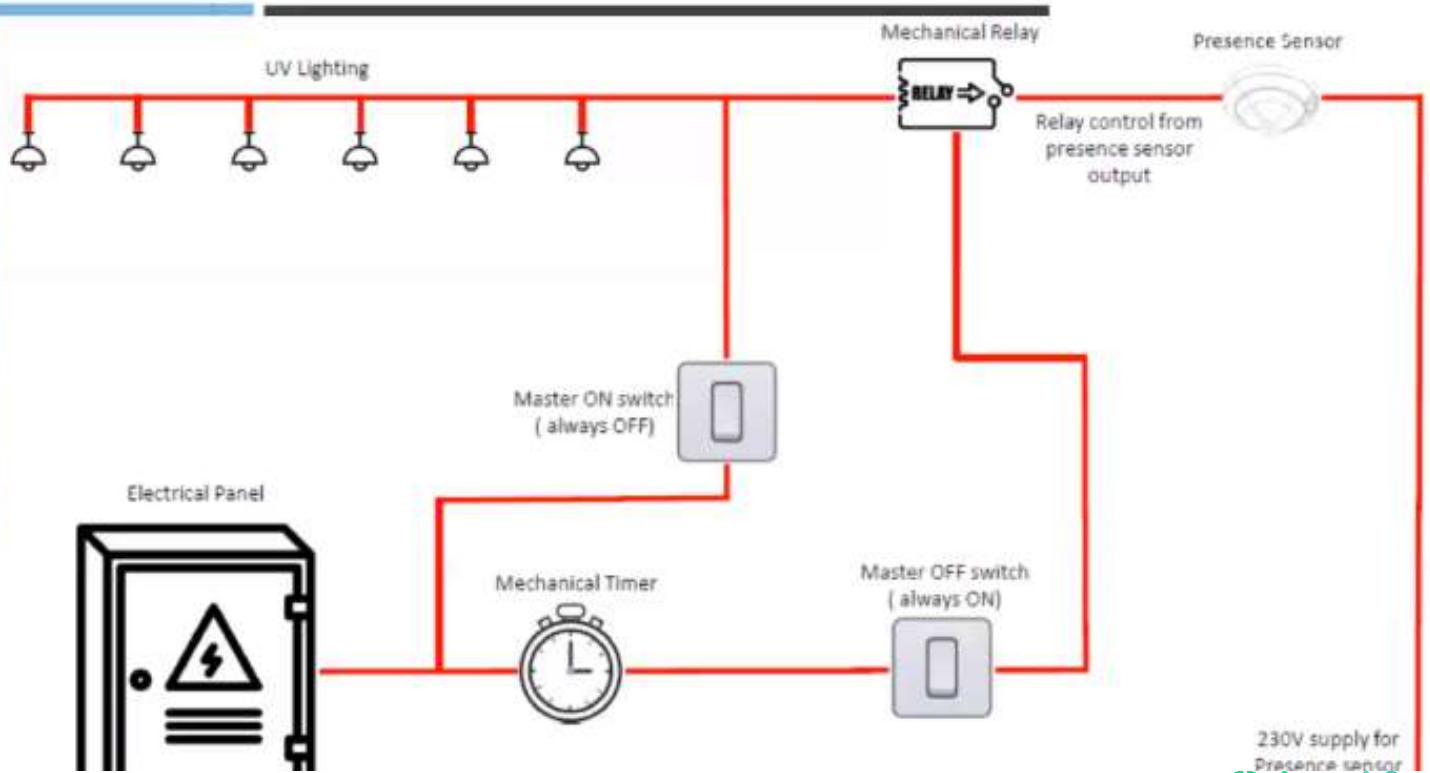
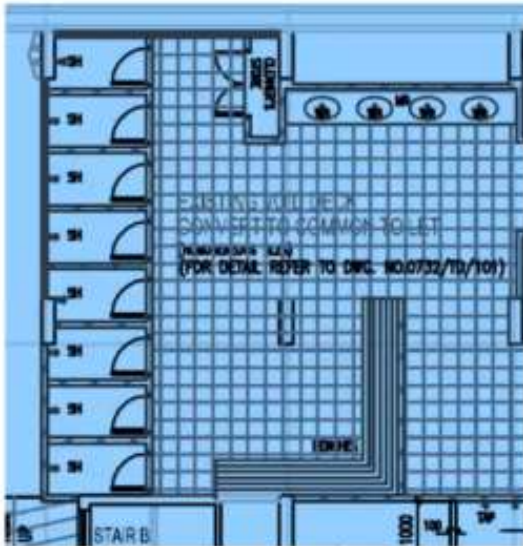


- These systems are usually installed at a height of 2.5m and work with natural convection of air. As air passes above, it gets disinfected.
- In air conditioning systems, high output (HO) UV lamps will keep the cooling coil free from biofilm.
- UV lamps can also be applied in the ducts of the air conditioning system. Due to high air speed, the required UV dose will be usually high.

User case : Migrant worker dormitory disinfection in Singapore

~ 84% of total Singapore covid-19 positive cases are the migrant workers living in dormitories

Pilot with 500 pcs ongoing, Potential order for this year ~ 40K pcs, € 2-2.5M



Extra protection with sensor, unwanted UVC exposure

Product

Why choose Philips UV lamps?



Reliable UV-C output

All our low pressure lamps come with a unique coating to ensure UV-C output never drops below 85% over the useful life of the lamp.



Highest lamp quality

Cutting edge automated production lines are used for electrode processing and emitter dosing. All lamps are checked to verify they meet our requirements to guarantee consistent quality.



Proven experience

20+ years experience in developing and manufacturing UV-C products



Application fields

Suitable in various applications, both professional and residential

Philips GUV T8 & TL Mini



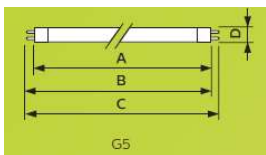
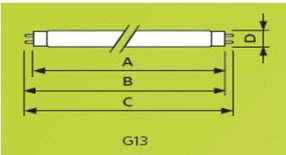
GUV T8 lamps are double-ended UVC (germicidal) lamps used in professional air disinfection units. GUV T8 lamps offer almost constant UV output over their complete lifetime. Moreover, they have a long and reliable lifetime, which allows maintenance to be planned for in advance.

Main applications

- Air disinfection systems in professional applications such as universities, hospitals, jails and laboratories
- Upper air and whole room disinfection equipment in hospitals, intensive care units and surgery rooms
- Areas with low maintenance and/or disruptive costs
- Fish ponds and process water units

Technical data

Type : 15W, 30W, 36 W / TL mini : 4W
 Cap Base : G13 / TL mini G5
 Lamp Voltage : 55v, 102V, 103 V / 25 V
 Lifetime : 9000 Hrs (EM gear) and 18000 Hrs (HF gear) TL mini : 6000 H
 Dimensi : (AxBxCxD) mm
 15W : 437.4 x 444.5 x 451.6 x 28
 30W : 894.6 x 901.7 x 908.8 x 28
 36W : 1199.4 x 1206.5 x 1213.6 x 28
 4W : 140.6 x 143.0 x 150.1 x 16 mm (AxBxCxD)



Features

- Short-wave UV radiation with a peak at 253.7 nm (UVC) for disinfection purposes
- Protective inside coating ensures constant UV output over the complete lifetime of the lamp
- Long lifetime of 18,000 hours*
- High reliability with the lowest percentage of lamps that fail prematurely in the market (90% of all lamps still operate on full output and quality after 15,000 hours*)
- Special lamp glass filters out the 185 nm ozone-forming radiation

Benefits

- Effective disinfection over the useful lifetime of the lamp
- Maintenance can be planned in advance, virtually eliminating the need for expensive spot replacement of prematurely failed lamps
- High Output versions available for optimum UVC output per lamp length, allowing for reduction of system size
- Good environmental choice because of lowest amount of mercury



Philips GUV PL-L



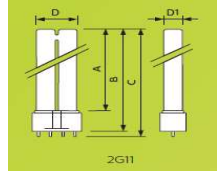
Philips GUV PL-L lamps are compact UVC (germicidal) lamps used in water and air disinfection units. The compact size of the lamp allows for a small system design and design flexibility. Philips GUV PL-L lamps offer almost constant UV output over their complete lifetime. Thanks to the single-ended lamp base, lamp replacement is easy, making maintenance hassle free.

Main applications

- Deactivation of bacteria, viruses and other micro-organisms
- Air disinfection systems in for example hospitals, universities and laboratories
- In-duct air treatment units
- Stand alone air purifiers
- Residential drinking water units
- Fish pond and process water units

Technical data

Type : 18W/4P , 36W/4P
 Cap Base : 2G11
 Lamp Voltage : 60V,106V
 Lifetime : 9000 Hrs
 Dimensi : (AxBxCxDxD1) mm
 18W : 195 x 220 x 225 x 18 x 39
 36W : 385 x 410 x 415 x 18 x 39



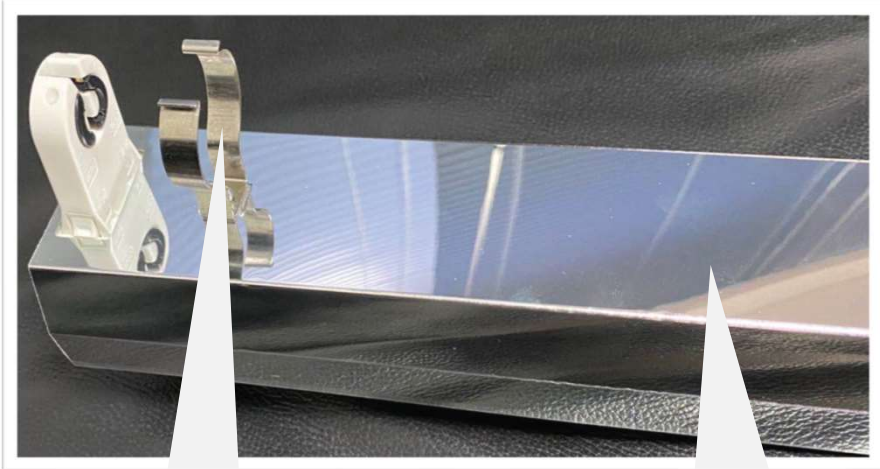
Features

- Short-wave UV radiation with a peak at 253.7 nm (UVC) for disinfection purposes
- Protective inside coating ensures almost constant UV output over the complete lifetime of the lamp
- Special lamp glass filters out the 185 nm ozone-forming radiation

Benefits

- Compact system design
- Simple single-ended connection
- High Output versions for improved performance in moving air and reducing amount of required lamps
- Effective disinfection over the useful lifetime of the lamp
- Good environmental choice because of lowest amount of mercury

Philips GUV T8 Batten

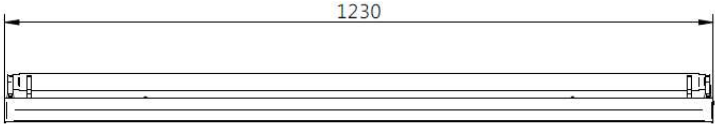


Aluminum Clip for extra safety for holding UV C lamp

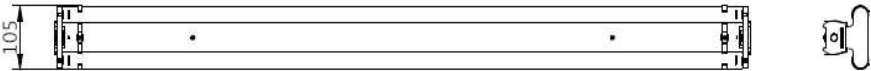
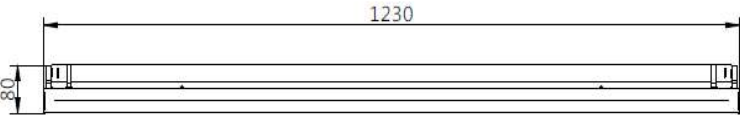
Aluminum cover for better housing protection & UV C efficacy improvement



GUV T8 Batten Dimension



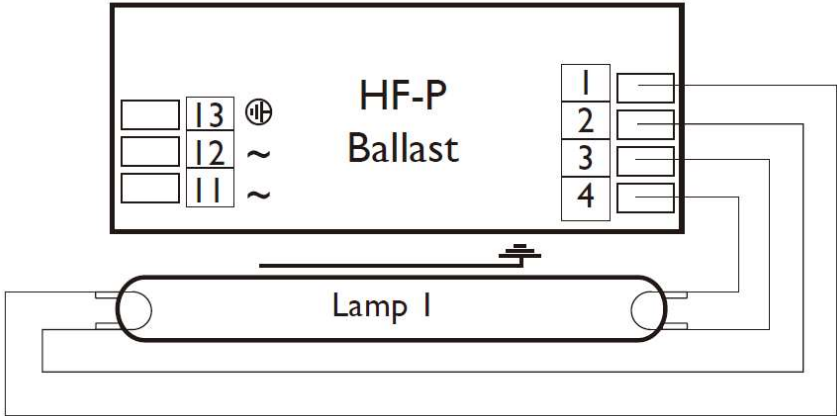
TMS160C 1X36W TUV SLV/6



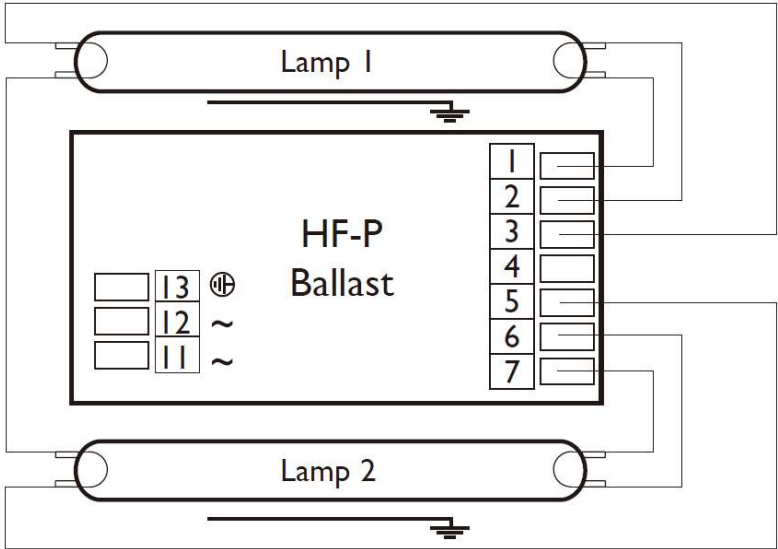
TMS160C 2X36W TUV SLV/6

GUV T8 + Ballast Wiring Diagram

TMS160C 1X36W



TMS160C 2X36W



Dynalite – UVC Safety Control Systems



The responsibility to switch the UV-C lighting ON lies with a certified operator.

- Key Activation
- Dose/Time adjustment on UI

The control system implements a safety net to prevent usage with people present.

- Door sensor(s) on doors
- Occupancy sensor(s) in room
- Signaling lights
- Emergency stop in room

The control system provides fault tolerance

- Hard user activation of the power
- Hard emergency stop on controller
- System fault and device-on-line checked periodically
- System logging

Dynalite – UVC Safety Control Systems



Authorized key armed system: Authorization key protected switch for system arming / disarming, 2 pole:

- 1st pole actuates dry contact input to DDMIDC8, indicating the system status (armed/disarmed).
- 2nd pole to enable or cut mains power to contactor actuator (added safety)

System ready : All required safety criteria has been met and the system is ready to be manually started.

UV Cycle Running: The system is armed, UV-C lights are ON, no issues detected.

System Error check: Dynalite system performing "watch dog" check on all network devices (sensors, dry contact interface, PDEG, Relay conn) If diagnostics shows any device is off-line a system fault is to be shown and the system is disabled

Cabinet emergency stop pressed: Emergency stop button to be mains rated, twist to release, double pole. 1st pole serves as dry contact to DDMIDC8. Indicating to system that the emergency has been pressed. 2nd pole to be used at breaking mains power to contactor actuator.

Area emergency stop pressed: Within areas that have UV light, Emergency push buttons to be mounted. Twist and releases. Dry contact back to DDMIDC8 or DLLI8180 and DyNet back to system cabinet. Required to show operator if a local emergency stop is currently pressed.

Area doors are closed: Within areas that have UV light any access doors to have magnetic reed switch, Dry contact back to DDMIDC8 or DLLI8180 and DyNet back to system cabinet, required to show operator if any local doors are currently open.

Occupancies detected in area: Network sensors must not have detected occupancy within defined safety time prior to the UV-C activation

Local configuration of Timer

While system is locked



System is unlocked.
Authorised user can now
adjust UV-C total run time



2020



On-site adjustment of UV-C cycle run time:

Only to be enabled when key is in armed position. Allows authorized operator to adjust cycle run time in discrete time increments. Current timing shown as indicative only can be adjusted in final configuration

The Antumbra Display will also be used for managing the UV-C lamp life by displaying stages of life cycle and stopping the system if the lamps have reached the end of their economic life.

Field devices - Sensors



Network sensors:

DUS360CS is to be used for automatically detecting whether the area is occupied.

The system is to routinely check that the sensor is functioning correctly through the 'Watch Dog' function. If any sensor does not pass the 'Watch Dog' network check, the system will be disabled, and status shown on systems indicator panel. If a sensor fails the 'Watch dog' test, the system should keep continuously checking for failed device on-line response, before clearing the fault.

The system should only allow the UV cycle to trigger if the sensors have not detected any occupancy for a pre-defined safety time period

PHILIPS

Philips UV-C



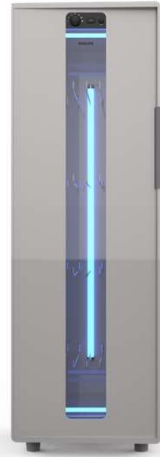
**Device
Disinfection**



Device
Disinfection

UV-C Chamber, Large

- Effectively kills 99.99% of viruses with Philips UV-C (253.7nm) lamps.
- Use with a recommended five-minute disinfection cycle
- Dimensions: 1700mm x 555mm x 535 mm



Safety

- ✓ Heavy-duty stainless-steel chamber
- ✓ Chemical-free disinfection
- ✓ Pass-through lockout protects against accidental exposure



Device
Disinfection

UV-C Chamber, Medium

- Effectively kills 99.99% of viruses with Philips UV-C (253.7nm) lamps.
- Use with a recommended five-minute disinfection cycle
- Dimensions: 600mm x 555mm x 535 mm



Safety

- ✓ Heavy-duty stainless-steel chamber
- ✓ Chemical-free disinfection
- ✓ Pass-through lockout protects against accidental exposure



Device
Disinfection

UV-C Chamber, Small

- Effectively kills 99.99% of viruses with Philips UV-C (253.7nm) lamps.
- Use with a recommended five-minute disinfection cycle
- Dimensions: 400mm x 555mm x 535 mm



Safety

- ✓ Heavy-duty stainless-steel chamber
- ✓ Chemical-free disinfection
- ✓ Pass-through lockout protects against accidental exposure

Signify Classified - Confidential

Execution Pictures

Installed UVC Battens



Press Release



Press Release

June 16, 2020

Signify and Boston University validate effectiveness of Signify's UV-C light sources on inactivating the virus that causes COVID-19

- Test results show that the virus could no longer be detected after seconds of exposure
- Signify to make its UV-C lighting technology widely available to other lighting companies
- Signify has been at the forefront of UV technology for more than 35 years

Eindhoven, the Netherlands – [Signify](#) (Euronext: LIGHT), the world leader in lighting, together with the National Emerging Infectious Diseases Laboratories (NEIDL)¹ at Boston University in the US have conducted research that validates the effectiveness of Signify's UV-C light sources on the inactivation of SARS-CoV-2, the virus that causes COVID-19.

Since the start of the SARS CoV-2 pandemic, Dr. Anthony Griffiths, Associate Professor of Microbiology at Boston University School of Medicine and his team have been working on developing tools to support scientific advancement in this field.² During their research they have treated inoculated material with different doses of UV-C radiation coming from a Signify light source and assessed the inactivation capacity under various conditions. The team applied a dose of 5mJ/cm², resulting in a reduction of the SARS-CoV-2 virus of 99% in 6 seconds. Based on the data, it was determined that a dose of 22mJ/cm² will result in a reduction of 99.9999% in 25 seconds.³

"Our test results show that above a specific dose of UV-C radiation, viruses were completely inactivated: in a matter of seconds we could no longer detect any virus," said Dr. Anthony Griffiths. "We're very excited about these findings and hope that this will accelerate the development of products that can help limit the spread of COVID-19."

Signify is the leader in UV-C light sources and has been at the forefront of UV technology for more than 35 years. It has a proven track record of innovation in UV-C lighting, which is designed, manufactured and installed in line with the highest safety standards.

"I'm very happy about the fruitful cooperation with Boston University in the fight against the coronavirus. Boston University has validated the effectiveness of our light sources as a preventive measure for companies and institutions as they seek ways to provide virus-free environments," said Eric Rondolat, CEO of Signify. "Given the potential of the technology to aid the fight against the coronavirus, Signify will not keep the technology for its exclusive use but make it available to other lighting companies. To service the growing need for disinfection we will increase our production capacity multifold in the coming months."

--- END ---

¹ The NEIDL is a state-of-the-art research facility that encompasses significant containment laboratories at Biosafety Level -2, -3, and -

4

² Dr. Griffiths' team develops vaccines and therapeutics for Risk Group 3 and 4 viruses, which include organisms that can cause serious or deadly diseases in humans

³ Research variables are available upon request



For further information, please contact:

Signify Corporate Communications

Elco van Groningen

Tel: +31 6 1086 5519

E-mail: elco.van.groningen@signify.com

About Signify

[Signify](#) (Euronext: LIGHT) is the world leader in lighting for professionals and consumers and lighting for the Internet of Things. Our [Philips](#) products, [Interact](#) connected lighting systems and data-enabled services, deliver business value and transform life in homes, buildings and public spaces. With 2019 sales of EUR 6.2 billion, we have approximately 38,000 employees and are present in over 70 countries. We unlock the extraordinary potential of light for brighter lives and a better world. We have been named [Industry Leader](#) in the Dow Jones Sustainability Index for three years in a row. News from Signify is located at the [Newsroom](#), [Twitter](#), [LinkedIn](#) and [Instagram](#). Information for investors can be found on the [Investor Relations](#) page.

For More information

<https://www.signify.com/global/our-company/news/press-releases/2020/20200616-signify-boston-university-validate-effectiveness-signify-uv-c-light-sources-on-inactivating-virus-that-causes-covid19>

<https://www.channelnewsasia.com/news/business/lighting-maker-signify--uv-light--degrades--coronavirus-quickly-12841980>

<https://www.cnbc.com/video/2020/06/17/signify-trialing-uv-c-light-as-disinfectant-against-covid-19.html?&qsearchterm=eric%20rondolat&linkId=91083742>

<https://inet.detik.com/science/d-5057484/riset-sinar-lampu-uv-lumpuhkan-corona-dalam-hitungan-detik>

Signify