EXPOSURE UNIT USER'S MANUAL

Drix Semiconductor, optics by Ralon Labs

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Exposure Unit User's Manual

1.0 Package contents

The package contains:

- Exposure unit
- Cover glass (2pcs)
- Controller
- DB25 cable between controller and exposure unit
- Power cable
- External start button
- Calibration sensor
- Manual

1.1 Description and purpose

The unit is an UV exposure device, designed to be mounted into a table.
The unit produces a collimated beam of broadband UVA and blue light

The purpose of the unit is to copy high resolution mask or film images into photoresisted substrates, such as high density pcb's, thin or thick film circuits and gobo's. The unit may also serve as a mask copy unit for medium resolution masks.

The output beam is collimated and has a diameter of 150mm. As such all substrates up to 150mm can be exposed. The wavelength range is broadband UVA and blue light, from 350 to 460nm. Most positive photoresists are sensitive to this wavelength range.

The intensity uniformity over the 150mm diameter is +/-10%. This allows rastered images to be copied with high consistency. The latest light diffusing and collimating techniques have been implemented to obtain this result.

The tight beam collimation allows images to be copied with high precision with minimal contact pressure, preventing film, mask or photoresist damage. Films usually have a poor flatness, causing a varying film to substrate distance. Good beam collimation allows consistent image copying from films.

The unit uses a 35W Xenon lamp as light source. Except for the blue, visible light and IR is filtered out, so the film/mask/substrate is not heated during exposure. This is especially important for keeping the dimensional accuracy when using films.

With the use of such a Xenon lamp the unit consumes considerably less power than other commercial exposure units. Most exposure units based on Hg discharge lamps consume five to ten times as much power for a comparable output level. Also the cost of Xenon replacement lamps is very low while the lifetime and reliability are high.

The exposure time using the Xenon lamp is approximately 2 minutes.
For this unit a more expensive Mercury vapour lamp can be supplied which has the same form factor and electrical power level as the Xenon lamp. In this case the exposure time is generally less than one minute.

The unit is microprocessor controlled and has integrated light intensity sensors for making accurate exposures. The controller can hold up to 20 presets in either time or exposure dose mode.

WARNING: The unit emits UV-A light. Do not stare into the beam and wear protective glasses whenever necessary.

1.2 Unit installation

The unit is designed to be built into a table. For this purpose a square hole needs to be cut into a table, through which the unit can be mounted by lowering it into the opening. Both the power and control cable need to be plugged in once the unit has been lowered into final position.

The controller has been made as a separate unit, so it can be located on the table. A second opening may be cut into the table to pass the cable from the controller to the unit. Alternatively the cable can be passed behind the backside of the table.

An external start button is supplied for easing serial work, where many copies need to be made with the same settings. Please note that this external start button is optional. The exposure can be started from the controller itself at any time.

This external start button is supplied on a small plate. Another opening at a convenient location can be made into the table through which this switch can be mounted. The external start button is a simple normal open pushbutton switch, which can be changed to another model by the user as desired. For instance, a footpedal can be connected instead of the pushbutton, or such a footpedal can be connected in parallel.

A calibration sensor is supplied with the unit. This sensor can be used to check the beam uniformity, especially when exchanging the lamp.
This sensor is not required during normal operation.

Make sure the 25-pin sub-D cable is connected before applying power.
If the cable is not long enough, contact Drix for a longer cable. Please note this cable has all 25pins connected straight through, so a serial communications cable will not work.

The device is powered by a standard euro-plug from a line voltage between 115 and 240VAC. A 20mm 800mA fuse protects the power supply at the mains side.

The standard power cable is compatible with European wall sockets. If the power cable supplied with the unit does not fit your wall socket, it can be replaced with any computer power cable. Upon request, Drix can supply a power cable for UK or US wall sockets.

It is highly recommended to install the exposure unit in a clean environment. If a true cleanroom is not available, it is recommended to install a laminar flow hood over the exposure unit, or to install a filter-fan HEPA unit above the exposure unit.
Such filter fan units can be obtained from Envicro Corp. You can also contact Drix for buying such a unit.

1.3 Power up

The on/off switch is located on the bottom of the unit, near the power entrance. When the unit is built into a table this switch location may be unfortunate. The power to the unit may be cut off externally if this is more convenient.

When the unit is powered up, the unit may turn on the lamp automatically, depending on the setup. Once the lamp is ignited, the unit will wait for the preset warm-up time before it can be used. The unit can be powered down at any time. There is no danger for the lamp for frequent power-up and power-downs.

Once the lamp is on, the beam will be turned on and off using a shutter. The lamp can be automatically turned off after some time.

1.4 Unit operation

1.4.1 Controls

The device has a choice menu which runs maximum 4 levels deep. A green led under the ENTER and CLEAR button indicates, if possible, to enter or cancel. LEFT and RIGHT will scroll you the options within one level. UP , DOWN (and ENTER in case of last menu option) will alter values if possible. When scrolling through alphanumeric characters, a simultaneous push on both UP/DOWN will fastscroll to UPPERCASE, LOWERCASE or NUMERIC. The external start button will only work when a manual or saved program is loaded and ready to start.

1.4.2 Lamp warm-up

When a command is given for the lamp to engage, an automatic warm-up procedure is started. The warm-up time can be programmed in the menu settings/lamp/warm-up time. The required warm-up time can be checked by watching the sensor variables. The warm-up time is required for a stable output. The intensity of the lamp in stable condition can be checked and stored for automatic comparison after each warm-up. This procedure is explained in the settings section.

1.4.3 Menu structure

INIT menu			
RUN Program	EDIT Program	SETTINGS	SHOW Variables
Manual	Select	Shutter	Intensity sensors
Preset		Buzzer/error	Calibrate
Film check LED		Lamp	
		Display	
		Calibrate New I	
		Film check LED	

1.4.3.1 RUN Program

Manual program: In this menu you can choose between an exposure time or an exposure dose. The maximum time span is 999 seconds. The maximum dose is 650mW/cm².

Preset Program: This menu gives the choice to select one of the pre-programmed settings for frequent use.

The external start button is enabled in the manual and preset menus.

Film check LED: pressing <enter> will toggle green LED's in the exposure unit which allows the user to align the film and to check the film for pinholes. Green light has been chosen as the human eye is very sensitive to this colour and green light does not expose the photoresist.

1.4.3.2 EDIT Program

There are 20 memory locations for a 16 character long program name and it's time/dose setting. When a program is selected, the Left/Right button will select program name editing, time or dose value. The program will only be saved when confirmed by the 'are you sure' acknowledgment.

Name editing:

When selected, an arrow cursor will indicate which character will be scrolled by the Up/Down buttons.
The name that will be saved is the text string preceding the arrow. A fast clear can be done by setting the arrow in the first position leaving the preceding string blank. After acknowledgement the program name is clear. Fast scroll between Upper/Lowercase and numeric is possible by holding up/down buttons.

1.4.3.3 SETTINGS

Shutter: Direct control of the shutter motor. The option open/closed is displayed as it would react when the enter button is pushed. (OPEN = open when enter, CLOSE is close when enter)

Buzzer/error: The main error response as well as event beeps can be enabled/disabled here.

Lamp:
1) Lamp control: direct control of the lamp. The option on/off is displayed as it would react when the enter button is pushed.

2) Warm-up time: manual setting to make sure the lamp is warm when starting the exposure. When the intensity value of a new lamp is stored after a stable output (calibrate new intensity) check. The device will warn (if error enabled) if the lamp is not stable yet after a certain warm-up time. To correct the error the warm-up time can be extended or if necessary the lamp can be renewed.

3) Lamp fixed on: when set the lamp will turn off when the power is interrupted. When lamp on 'at init' is disabled, the lamp will be turned on automatically when a program is started.

4) Lamp idle time: this time indicates how long the lamp will remain on when no program is running and no buttons are pushed.

5) Lamp on 'at init': when enabled, the lamp will be turned on when the unit is powered up.

Display: Display backlight off timer.

Calibrate New I (intensity): When the lamp is exchanged, the source (lamp) sensor can measure the intensity (after a stable output value). The previous value will be displayed as a reference. When acknowledged a new value will be stored. If the lamp is not yet on when calibrating the warm-up procedure will start automatically. Hence it is important to have a sufficient warm-up time in order to obtain a correct calibration value. The new value will be the indicator for an error when the lamp intensity falls below 90% at a later time.

Film check LED: pressing <enter> will toggle green LED's in the exposure unit which allows the user to align the film and to check the film for pinholes. Green light has been chosen as the human eye is very sensitive to this colour and green light does not expose the photoresist.

1.4.3.4 SHOW VARIABLES

Intensity sensors:

The readout values are divided in two groups:

1) Source (lamp) and lens absolute intensity with the lens average.
2) Calibration sensor absolute, average and total energy.

The calibration sensor samples at double speed to facilitate fast checking of the light intensity profile above the lens.

Calibrate sensors:
Each sensor can be calibrated seperatly with a factor of 0,01 to 200,00.
Adjusting the value takes an immediate effect, no enter is needed to confirm the new value.

1.5 Light levels, time and dose operation

Basically only the light level, and more specifically the light dose received by the photoresisted substrate is of importance.

This light level is measured indirectly by a light sensor mounted just below the lens, near the edge of the unit, so that the sensor is not obstructing the output light beam. Because the intensity below the lens is not the same as above the lens, and as a glass plate and a film or mask are between the glass plate and substrate, the light level being measured can be quite different. But as long the ratio between measured and output light is consistent, it is just a matter of calibrating the light sensor below the lens to show the actual output intensity of the unit. This light intensity is expressed in mW/cm^2. The dose is the energy multiplied by the exposure time.
The exposure dose is expressed in mJ/cm^2.

The sensor near the lamp (named source or lamp sensor) is calibrated in such a way that it shows the same intensity level. In this way the lamp intensity can be monitored even when the shutter is closed.
Note: this sensor is calibrated with a closed shutter. When the shutter is opened, the reading will differ slightly because of shutter reflections.

The unit is supplied with an external light intensity sensor. The purpose of this sensor is to place it on the glass plate to measure the output intensity of the unit. The unit is calibrated with this sensor in the centre position on the glass plate.

The main purpose of the external sensor is to re-calibrate the lens and source (lamp) sensor against it, and to check the intensity distribution across the glass

plate. It is advisable to do this after a lamp change.

The required exposure dose (energy) for most positive photoresists is in the range of 80mJ/cm^2. The actual required dose depends on the resist being used and the resist thickness, the film or mask light absorption and the application. For instance, exposing a rastered image may require a critical exposure dose, while an image with only large open white area's, may require overexposure.

Calculation example:
If the intensity is 1mW/cm^2, and the exposure time is 100s, then the exposure dose is 100mJ/cm^2.

The controller supports both time and dose mode.

In time mode, the shutter is opened for a fixed time. If the light intensity changes, the exposure dose will change also. This mode will work only if the lamp stability can be trusted.

In dose mode, the shutter is opened till the required dose is obtained. In this case the time varies, and a change in lamp intensity will be compensated automatically.
It is highly recommended to use this mode.

Note: in case the light sensor below the lens is defective, the unit can no longer work in dose mode, but time mode will still be possible.

1.6 Using the exposure unit

When using the unit, make sure these guidelines are followed:
- Install the unit in a clean area, preferably under clean laminar airflow. A laminar flow hood with HEPA filters or a filter-fan HEPA unit is highly recommended. The distance from the HEPA filter to the working area should be less than one meter. The HEPA filter should offer a class 100 or better performance for an optimum result.
- Avoid daylight from entering the room. Cover all windows with a yellow filter blocking blue and ultraviolet light
- Do not use white light in the room. Cover all lights with a yellow filter. This is especially important when fluorescent light tubes are used, which contain mercury that emits spectral lines at 365/405/436nm. Contact Drix for a suitable yellow filter for such lamps.
- Make sure the glass plate is clean. If not, clean it with isopropylalcohol (IPA) or with a suitable cleaning agent which allows to clean the glass plate without leaving any marks. The glass plate can be taken out for cleaning. It is recommended to use an ultrasonic bath with a cleaning agent/soap to clean the glass plate.
- Avoid damaging the glass plate. If it gets scratched, such a scratch may appear in subsequent exposures because the scratch will deviate the light beam.
- Check your film or mask prior to use for pinholes and underexposed or underdeveloped area's. The quality of photosetter films can be poor, and films usually need to be corrected with a black ink marker before these can be used.
- Place the film or mask in centre position on the glass plate with the emulsion side upwards. Note: because the light from the unit is well collimated, the film can be reversed, in which case the emulsion and photoresist are separated by the film thickness. This can be done to avoid damage of the film emulsion when positioning the substrate at the expense of a little resolution loss.
- Place the substrate (wafer/pcb/gobo/…) with the resisted side downwards so it is in direct contact with the film or mask emulsion side.
- Do not move the substrate against the film/mask while these are in contact, as this may damage either the film/mask and the substrate.
- If required, place a small weight on the substrate prior to exposure. This may be necessary when using film which is not flat.
- Use dose mode by preference. Do not move the unit while the exposure is ongoing.
- After exposure, separate the substrate from the film/mask carefully without damaging either one. If the same film/mask is used repeatedly, check it for new pinholes. The repeated contact of a film/mask to the substrate may cause damage.
- Make sure that development is done correctly: use fresh chemicals at a known temperature (generally room temperature at 20°C) and for a preset time

(generally one minute). Please note that many developers react with CO_2 which is always present in the air, so the life of the development bath may be limited.

The unit has 20 memory locations which can be used to preset the exposure time or dose for various applications. It is recommended to invest some time to find the ideal exposure doses for different applications.

For instance, when exposing gobo's, one may preset a critical exposure dose for rastered images, a larger exposure dose for overexposure of vector images, and a specific exposure dose for exposing cyan, magenta and yellow substrates, as such substrates will pass or reflect back some of the blue/UV-A light and may require a lower or higher dose for rastered images. Yellow will reflect blue light (needs a lower dose), Magenta and Cyan will transmit blue light.

A specific problem is the appearance of black spots in the image.
Such black spots are caused by dirt on the glass plate, scratches in the glass plate, impurities in the film, limited contrast of the film, dust particles sandwiched between the substrate and the film, errors in the photoresist.
Such black spots are highly undesirable when making gobo's, as these are clearly visible in the image. For this reason, some degree of overexposure is required.
The amount of overexposure will be the choice of the user. It is recommended to invest some effort in finding the best exposure values. Because some degree of overexposure is required, it is necessary that the light is uniform and collimated.
Because the light of the exposure unit is well collimated, loss of resolution due to overexposure is limited. This exposure unit offers the user the process window required to obtain good exposure and high/consistent resolution at the same time.

Another specific problem is pinhole formation. Any defect in the film will be copied into the photoresist. If the film is not properly corrected before use, pinholes of the film will result in pinholes in the exposed image. This is certainly the case when overexposure is used. Very careful checking of the film/mask is a necessity.
Because the light of this unit is well collimated, light through film pinholes will not spread out, as the unit copies the image accurately.

Often a film is not flat. This leads to distance variations between film and substrate. The distance between film and substrate leads to loss of resolution. Because the light of this exposure unit is well collimated, small distance variations between film and substrate are generally not a problem. A small weight can be put on the substrate during exposure to apply some pressure.

Often the exposure can be made without such a pressure. The good beam collimation allows to make many consistent exposures without excessive pressure/damage to the film or substrate.

The unit is shipped with two preloaded presets:
1: 80mJ/cm^2 in dose mode for rastered images
2: 160mJ/cm^2 in dose mode for vector images

These presets can be changed and more can be added as appropriate.
Please note that these presets are intended as a good starting point. The best value will depend on the amount of light absorption in the film, the kind of photoresist used, the quality of the film (pinholes/black spots).

Consider the automatic lamp turn-off function if the unit is not being used all the time.

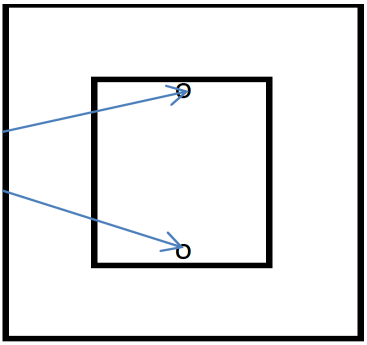
The units have a green LED source, intended to allow alignment of the film/mask and to check for pinholes or errors in the image. This LED source can be toggled on/off either from the run and from the settings menu.

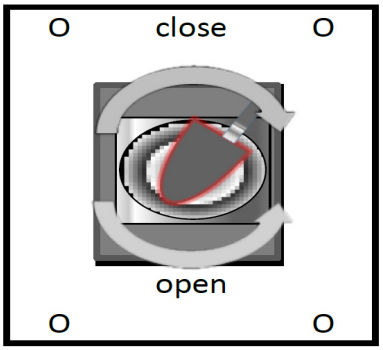
The green LED source has a wavelength of approx 550nm.
The human eye is very sensitive to this wavelength, whereas the photoresist is not sensitive to this wavelength.

Attention: a film itself, while not yet developed, will be exposed by green light.

Warning: use the green light to align the film, do not stare into the UV beam.

1.7 Lamp exchange





The bottom plate has a hatch that needs to be removed in order to get acces to the lamp socket. When opened, the aluminium ring can be screwed counter-clockwise to unlock and the lamp can **carefully** be removed from its housing. Now the lamp can be removed from its socket.

1.7.1 Removing the lamp from its socket:

The lamp is a plug-and-turn system. To remove the lamp you need to turn the gray plastic lamp ring counter-clockwise holding the plastic socket steady. When the aluminium screw ring is rotated with one of the two slits overlapping the slit in the lamp plastic, a small object can be inserted to make the ring grabbing the lamp socket. Now the ring can be used to facilitate the release (turn clockwise facing the lamp's top). A small rotation is sufficient to release the lamp from socket. Now the lamp can be simply pulled out with little force. The output field is subject to the lamp's rotation which can be oriented in two ways:
- a 180 degree turn by inserting the lamp in the socket
- a 0-90 degree turn when the aluminium socket ring is loosened.
(the power cable and socket will turn integrally)

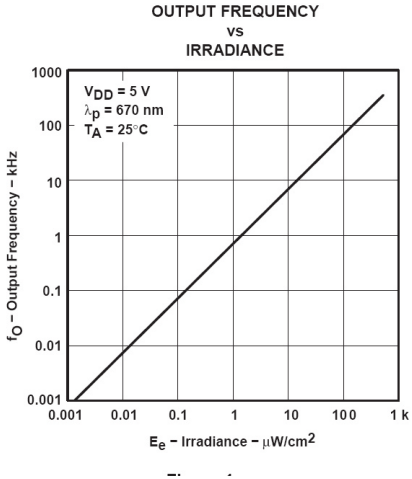
NOTE: USE EXTREME CAUTION WHEN REMOVING THE LAMP. THE FRAGILE BULB IS INSERTED IN A CUSTOMIZED DICHROÏC REFLECTOR HOUSING.

1.8 Specifications

Wavelength range:	350 to 460nm
Beam collimation:	10°
Beam diameter:	148mm
Beam uniformity:	+/-10% over the 148mm beam diameter
Glass plate:	159x159mm
Dose accuracy:	+/-1% run to run.
Beam power:	0.8 mW/cm² typical.
Dose measurement:	0,01 to 650,00 mJ/cm²
Intensity measurement:	0,00 to 42949672 mW/cm²
Time:	1 to 999 seconds
Calibration range:	0,00 to 200,00 percent

The intensity sensors have a frequency output of 500 kHz at max intensity prescaled by 8 in the housing by means of a solder bridge. A resulting range of 0 to 62.5kHz is achieved which is fed to the controller.

The curves below are the specs of the unfiltered light sensor. In the unit, a filter is integrated in each sensor so it is sensitive the 350-460nm range only, so the sensors measure only the light to which the photoresist is sensitive.



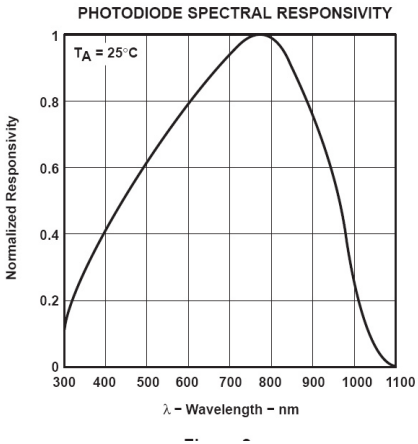


Image 1 : sensor spectral response

Lamp and light output specifications:

Lamp type: XENON 6000K 35W D2S socket.
Output power at glass plate : 0.8mW/cm^2 typical.
Output spectrum: broadband UVA-Blue
Lamp life : approx 2500 hours
The unit is delivered with this lamp type.

Alternative lamp type: High pressure mercury vapour lamp 35W D2S socket
Output power at glass plate : 2.0mW/cm^2 typical.
Output spectrum: discrete lines at 365/405/436nm
Lamp life : approx 400 hours

The Xenon lamp has a long lifetime. The exposure time will be 2 minutes typically. This time should be sufficient as usually other work needs to be done in the lab in the meantime. When buying a new lamp, make sure to make these checks:
- The colour temperature should be 6000K or higher to obtain as much as blue/UV as possible.
- The lamp type must be D2S = shielded for reflector-lens setup.
- The lamp should not have any built-in UV filter.
- The lamp should be of good quality. There are a lot of cheap Xenon lamp imitations floating on the market with low light output. There are even fake lamps in the market, such as D2C lamps which are marked as D2S. Many aftermarket suppliers label their lamp with a colour temperature which does not reflect reality.

If more throughput is desired, a mercury vapour lamp can be installed. Because such a lamp emits spectral lines to which the photoresist is highly sensitive, the exposure can be done much faster. The drawback is that such a lamp is expensive and has a short lifetime.
Attention! The light sensors in the exposure unit, as well as the separate calibration sensor, do not respond in the same way as the photoresist to these spectral lines, so the sensors will show a reading which is too low. This may be resolved in a future version of this unit. However, by making the proper changes to the sensor calibration settings in the controller, the sensors can be forced to reflect the correct readings with this type of lamp.

Contact Drix for the availability of lamps and prices.

1.9 Connector pinout

The device sub-D connector (25-pin):

Pin 1: Shutter Motor A1	Pin 14: 5VDC to sensor source/lens
Pin 2: Shutter Motor A2	Pin 15: 5VDC to sensor source/lens
Pin 3: N/C	Pin 16: 12VDC to control unit
Pin 4: N/C	Pin 17: Microswitch Shutter open
Pin 5: N/C	Pin 18: Microswitch Shutter closed
Pin 6: GND Microswitches shutter	Pin 19: GND to controller
Pin 7: GND sensor source	Pin 20: GND to controller
Pin 8: GND sensor lens	Pin 21: VCC solid state relay lamp
Pin 9: GND solid state relais lamp	Pin 22: VCC Fan
Pin 10: GND fan	Pin 23: sensor lens B
Pin 11: sensor lens A	Pin 24: sensor lamp B
Pin 12: sensor lamp A	Pin 25: optional sensor B
Pin 13: optional sensor A	Shield : connected to GND

Pin 1 is placed at the top right when viewing the recepting side of the connector (looking in the holes) and increments going to the left in the same line.
GND connections may be interchanged due to facilitating cabling

Pinout for the solid state card for internal power distribution:

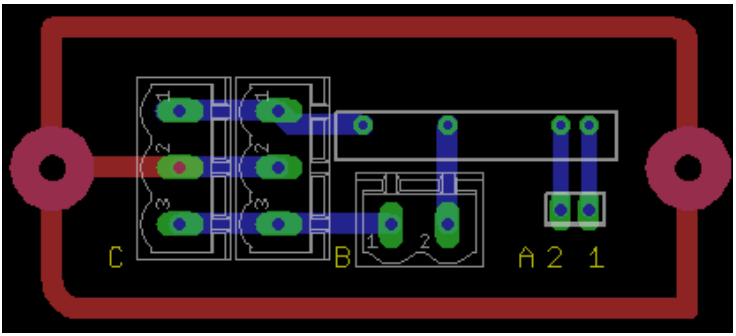


Image 2: Solid state power switch card

A	B	*C
1: GND Solid state relay input	1: Power Lamp Inverter	1: Mains 115-240V
2: VCC Solid state relay input	2: Power Lamp Inverter	2: EARTH
		3: Mains 115-240V

The C connector is implemented twice to function as a feed-trough to the mains of the switched power supply.

Pinout for the sensors:

3: COM A
4: GND
1: COM B
2: +5VDC

3-
1-
2-
4-

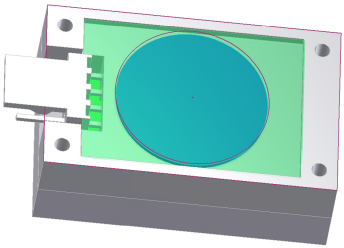
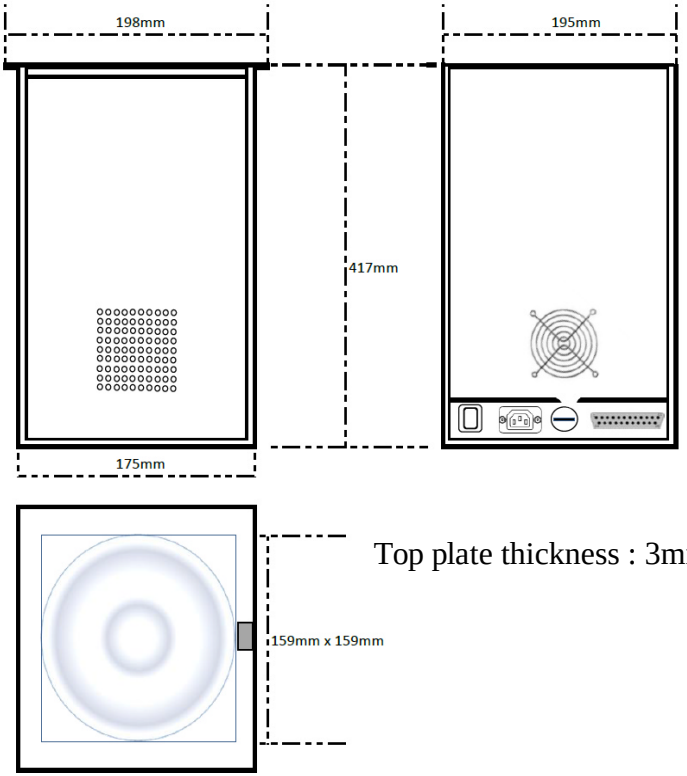


Image 3: Sensor device

2.0 Unit Dimensions



Top plate thickness : 3mm

Active lens diameter: 150mm
Active square = 1.41*75mm = 105x105mm

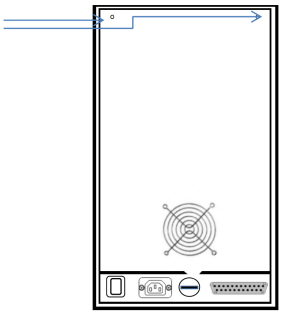
Embedding the unit in a desk top:

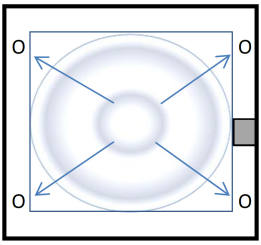
2.0.1: Basic fit (easy remove)

It‘s important to make a square opening of 195mm (+1mm) x 178mm(+1mm) to fit the unit through with it’s fuse holder and sub-d port. The top plate (198x195mm) should be embedded 3mm in the surface area. The top plate can then be fixed by the four holes in the top plate’s corners.

2.0.2: Optimal fit (fixed)

A better fit is achieved by making the square exactly 195x175mm. When fitting the device the top plate should be removed with the four hexagonal top screws and the two pairs at the top of the side shielding.





After removing the top lid the unit can slide in from underneath, top first. Screw on the top lid and lower the unit in the tight square.

2.0.3: External start button

The included stainless steel pushbutton has a diameter of 16 mm and can also be inserted in the table top. The connection of the 3.5 mono jack wire (blue/white) has no polarity and is **not** electrically isolated. Use potential free contacts/buttons only.

It is highly recommended to use this external start button for repeated exposures, to avoid damage or wear out of the <enter> button on the controller. Any type of normal-open pushbutton or footpedal can be wired.

2.1 Electrical characteristics

Input voltage	:	200-240VAC
Input frequency	:	50Hz/60Hz
Input current	:	0.67A (115V) -0.45A (240V)
Power consumption	:	50W / 100VA
Fuse	:	800mA

Note: at voltages below 115V the lamp intensity will become lower and unstable. The unit will work at voltages down to 105V, but in this case use the dose mode only as this will provide an automatic compensation for the intensity variation.

2.2 Glossary of terms and definitions

Black spot: a defect in the image resulting from local underexposure, usually caused by dust or dirt, or caused by a defect in/on the glass plate.

Collimated light: light consisting of parallel light rays.

Developing: dissolving the exposed photoresist on the substrate in a chemical solution, like NaOH or KOH or a more advanced commercial solution.

Diffusion: spreading out of light rays through a pinhole or by a rough surface.

Etching: removal of metallic or dichroic layers on the substrate with an acid in the area's where the photoresist has been removed by exposure and development.

Exposure unit: light emitting unit, with the purpose to copy an image into photoresist.

Exposure power: light intensity in mW/cm^2 on the substrate

Exposure energy: total light energy accumulated over time in mJ/cm^2 on the substrate

Exposure dose: same as exposure energy. Expressed in mJ/cm^2

Film: polyester film with photoemulsion which holds the image to be copied.

Mask: glass with a hard chrome layer which holds the image to be copied.

Photoresist: organic material of which the bonds can be broken by blue/ultraviolet light, so it becomes dissolvable in a developer.

Pinhole: white spot defect in the image resulting from unintended local exposure, usually caused by film or photoresist defects.

Resolution: smallest features which can be exposed consistently. The resolution is generally given in dpi or µm.
Substrate: material which is photoresisted and on which the image will be copied. The substrate can be a printed circuit board, thin/thick film hybrid circuit, gobo, etc…

Uniformity: amount of intensity/energy difference over the whole exposed area.

UVA: UV light in the 315-400nm range. Because of the limitations of the lamp, diffuser and lenses in the exposure unit, UV energy will be in the 350-400nm range.
The unit also emits blue light in the 400-460nm range.