



# UVB-100 Operation Manual



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# Safety Notices

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The equipment manufactured by RBD Instruments, Inc. (RBD) is designed with consideration of the safety of those who use them. Towards this end, we have defined the skills and knowledge that operators and maintenance personnel must have to interact with our products.

## Authorized Personnel

Operators and maintenance personnel require specific skills to interact with RBD's products.

Operators of RBD equipment are expected to be familiar with the technical information and instructions provided in the included documentation. It is also expected that unless Operators have the skills and knowledge required by maintenance personnel, Operators will not attempt to repair or maintain the equipment without the assistance of someone who has such skill and knowledge.

Qualified and skilled maintenance personnel will have the following specific knowledge and experience:

- Have thoroughly read, understood, and adhered to the safety precautions and information provided in the "Important Safety Information for the UVB-100 Emitter & Control" document that was included with the UVB-100 packaging.
- Training and experience with voltages above 500 V.
- Familiarity with and understanding of the documentation included with the equipment
- Awareness, familiarity, and understanding of all safety notices and symbols that are included in the documentation and on the equipment
- Control of the location and use of the key that turns on the UVB-100 Control.

## Safety Symbols

To help you quickly recognize possible safety hazards, we have provided safety symbols below that are used elsewhere in this document as well as on the equipment itself, as applicable.

### General Safety Symbols

The following are general safety symbols.



This symbol indicates hazardous voltages may be present that could cause death or serious personal injury. Service to be done by trained personnel only.



This symbol indicates a risk of death, personal injury, and/or damage to equipment exists. Service to be done by trained personnel only.



This symbol indicates that the equipment must be unplugged from its power source before any service or maintenance is performed on the equipment.

### UV-Related Safety Symbols

The following symbols are specific to UV radiation exposure.



This symbol reminds you that you need to wear eye and skin protection to prevent exposure to UV radiation.



This symbol indicates the presence of UV radiation. Proper safety precautions must be taken to eliminate the possibility of exposure.

### Mercury and Ozone Safety Symbols

The following symbols specific to exposure to ozone and mercury.



The symbols shown to the left and right of this paragraph remind you that ozone and mercury vapors are highly toxic. When vapors could be encountered, protective devices should be worn to prevent inhalation.





The symbols shown to the left and right of this paragraph remind you to ensure that mercury does not come in contact with bare skin. Additionally, these symbols may also be used to remind you not to touch specific parts of the UVB-100 package with bare skin.



This symbol indicates that there is a risk of explosion if a vacuum system is pumped out with a hydrocarbon oil mechanical pump when large amounts of ozone are present.

## Procedural Warnings

When a step in a procedure presents a potential hazard or danger, we have identified the hazard or danger using the following words:

**Danger:** When an imminent hazardous situation is not avoided, serious injury, or death could result.

**Warning:** When a potentially hazardous situation is not avoided, serious injury, or death could result.

**Caution:** When a potentially hazardous situation is not avoided, minor or moderate injury to personnel or damage to equipment could result.

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## Limited Warranty

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RBD Instruments, Inc. (referred to as “Company”) warrants that the product(s) discussed in this document will perform substantially in accordance with the accompanying written materials, and will be free from defects in materials and workmanship for the period of one year from receipt by buyer. In the event applicable law imposes any implied warranties, the implied warranty period is limited to 90 days from the date of receipt. Some jurisdictions do not allow such limitations on duration of an implied warranty, so the above limitation may not apply to the buyer.

Other than as described here, there are no other expressed or implied warranties.

### Customer Remedies

The Company’s and its suppliers’ entire liability and Customer’s exclusive remedy shall be the repair or replacement of the product that does not meet this Limited Warranty. This Limited Warranty is void if failure of the product has resulted from accident, abuse, modification, or misapplication of the product(s). Any replacement product will be warranted for the remainder of the original warranty period or 90 days, whichever is longer.

### No Other Warranties

To the maximum extent permitted by applicable law, the Company and its suppliers disclaim all other warranties, either express or implied, including, but not limited to implied warranties of merchantability and fitness for a particular purpose. This limited warranty gives customer specific legal rights. Customer may have other rights depending on the jurisdiction.

### No Liability for Damages

To the maximum extent permitted by applicable law, in no event shall the Company or its suppliers be liable for any damages whatsoever (including without limitation, special, incidental, consequential, or indirect damages for personal injury, loss of business profits, business interruption, loss of business information, or any other pecuniary loss) arising out of the use of or inability to use this product, even if the Company has been advised of the possibility of such damages. In any case, the Company’s and its suppliers’ entire liability under any provision of this agreement shall be limited to the amount actually paid by the buyer.

In addition, this warranty does not cover loss, damage, or defects that result from transportation to buyer, improper care by buyer, buyer-supplied software or other components, unauthorized changes, use, or misuse (including, but not limited to, use outside of the specified environmental conditions).

## **Product Service**

Any claims of product failure of performance must be reported to Company within one year of the product's receipt by buyer. During this time, the buyer may return the product to Company for repair at Company's cost.

The Company recognizes that expendable items may not function for the full year covered by this Limited Warranty. Expendable items, such as filaments, grids, special ceramics, and ionizers, are therefore excluded from the Limited Warranty for the specific product of which they are a part. However, each of these expendable items will have its own warranty and will be replaced or repaired in accordance with its warranty.

Buyers who purchased the product through one of the Company's international sales representatives should contact their sales representative to make arrangements for return, repair, or replacement.

## UVB-100 Introduction

This manual provides information about the UVB-100 Ultra-Violet Bakeout Enhancement System (referred to simply as the UVB-100), which comprises the UVB-100 Emitter Assembly and the UVB-100 Control, as well as additional options available for the UVB-100.

**Danger!** Use all safety protocols when using the UVB-100.

### UVB-100 Emitter Assembly

The Model UVB-100 generates short wave UV-C violet radiation in the range of 185 to 254 nm.



**Danger!** The UV-C radiation generated by the UVB-100 Emitter is a safety hazard to unprotected eyes and skin. The UVB-100 Emitter Assembly should never be operated in air, only in a sealed vacuum chamber. Most viewports are made out of glass and UV-C radiation does not penetrate this type of viewport. However, some vacuum chamber viewports are made out of quartz or other material that will allow UV-C radiation to penetrate. You will need to use a UV-C meter (such as the RBD UV-C Meter) to confirm that there is no UV leakage through the viewports on your vacuum chamber. For those viewports that allow UV-C to penetrate, UV-C shields must be installed over the viewports. (Snap-on UV-C shields are available from RBD Instruments.)

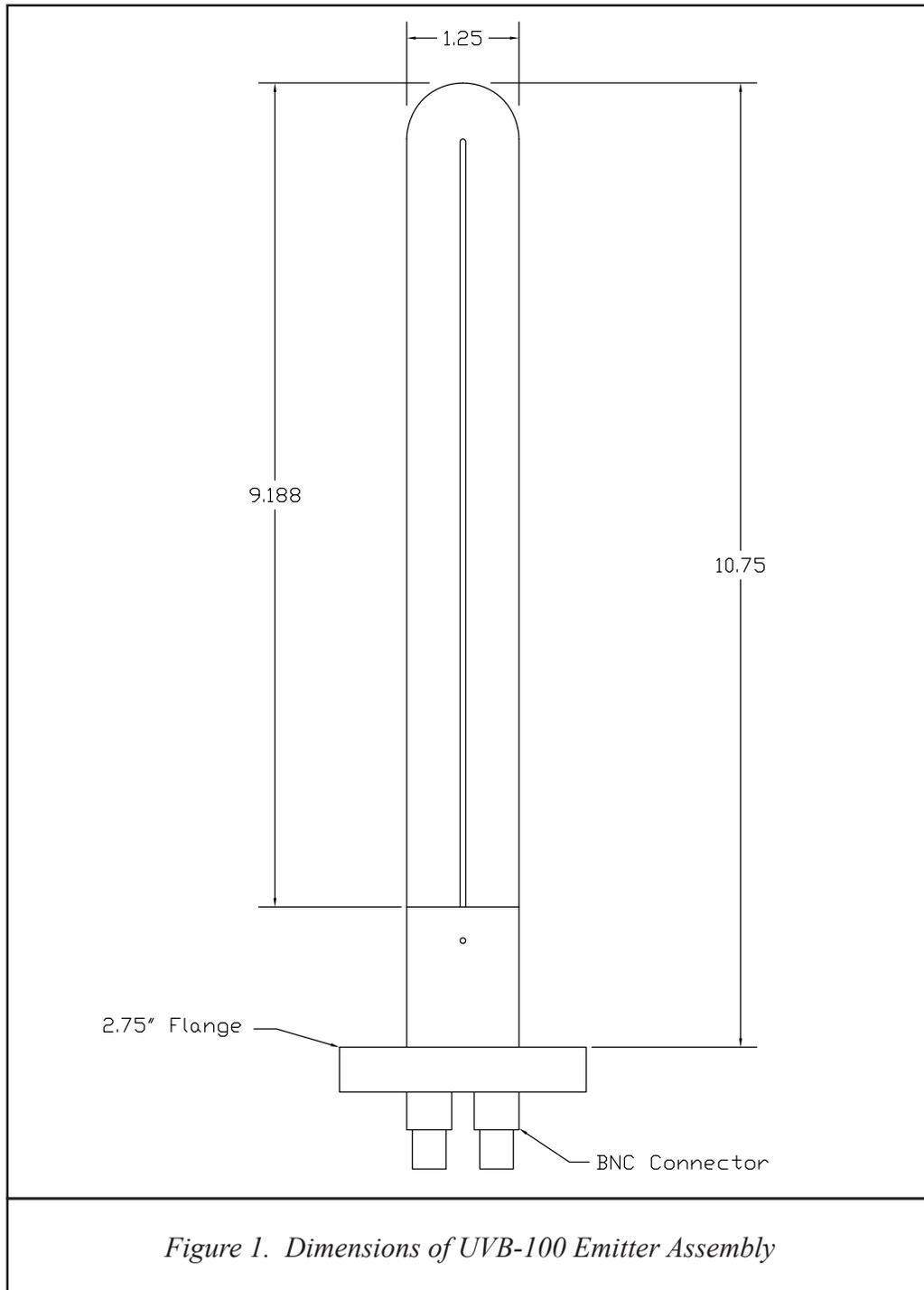
The standard UVB-100 Emitter Assembly fits on a 2.75" CF flange. A variety of emitter and flange sizes are possible.

### UVB-100 Emitter Assembly Specifications

| Specification          | Description  |
|------------------------|--|
| <b>Emitter Power</b>   | 50 W power, approximately 15W of UV-C in the 254 nm range.         |
| <b>Mounting Flange</b> | Standard 2.75" CF bored flange OD, 1.35" ID minimum tube required. |
| <b>Dimensions</b>      | See diagram on next page.  |

## UVB-100 Emitter Assembly Diagram

The diagram below shows the dimensions of the standard UVB-100 Emitter Assembly.



## UVB-100 Control

The UVB-100 Control provides all the necessary voltages and currents required to operate the UVB-100 emitter. One UVB-100 Control can operate up to two UVB-100 Emitter Assemblies.

### UVB-100 Control Specifications, Switches, and Meters

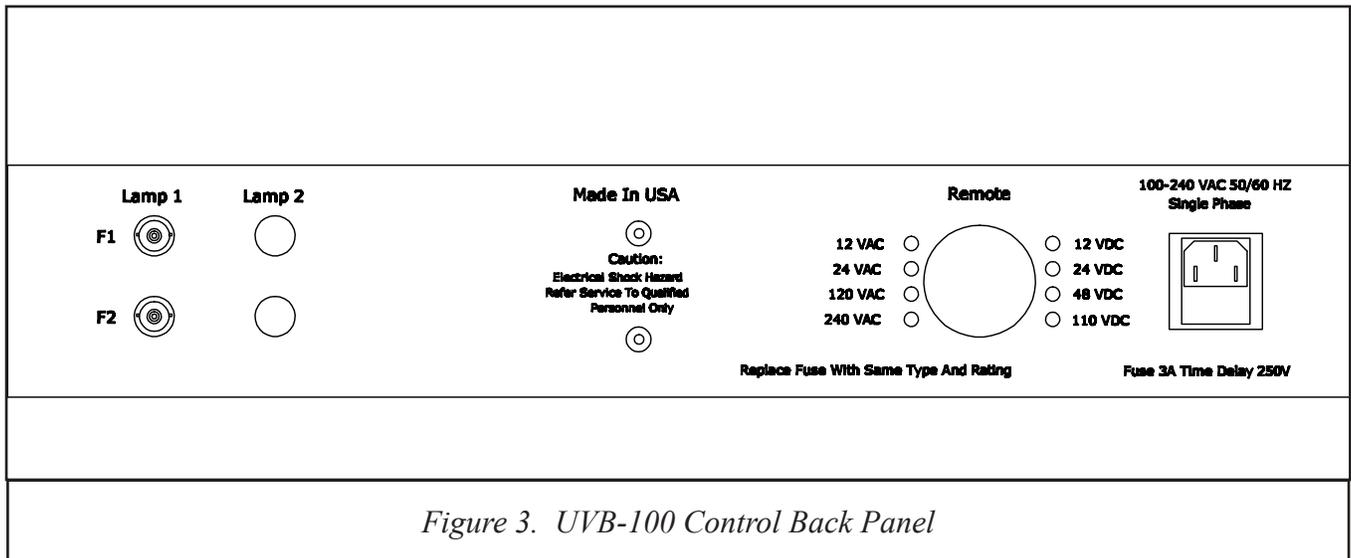
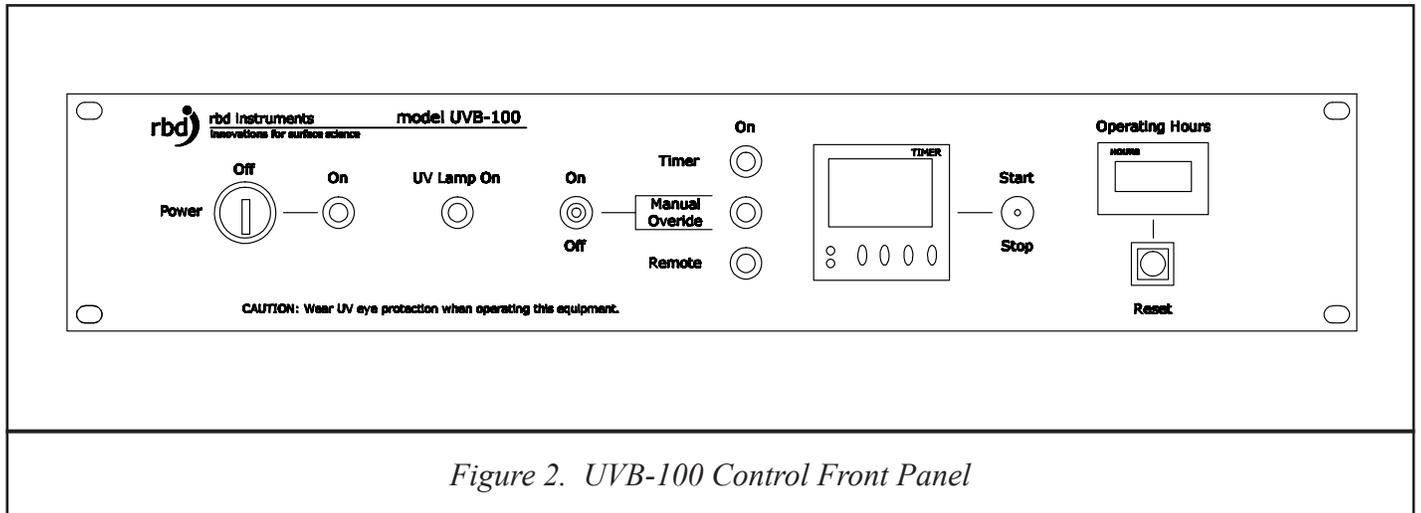
| Specification       | Description  |
|---------------------|--|
| <b>Input Power</b>  | 90-264 VAC @ 47-63 Hz, Single Phase  |
| <b>Output Power</b> | 50 W per standard Emitter Assembly; up to two Emitter Assemblies per UVB-100 Controller. |
| <b>Dimensions</b>   | 19" rack mount x 12" deep x 3" high  |

| Front Panel Controls           | Description/Function   |
|--------------------------------|--|
| <b>Key Lock and Switch</b>     | Turns on the UVB-100 Control power. This key should be stored in a secure location (for example, under the control of the person who is responsible for its safe-keeping or with your safety department) when the UVB-100 is not in use. Always follow all safety protocols for UV-C when operating the UVB-100. |
| <b>Manual Override</b>         | Turns on the UVB-100 Emitter Assembly and disables the Timer   |
| <b>Timer</b>                   | Allows you to set the time during which the UVB-100 Emitter Assembly is on   |
| <b>Timer Start/Stop Switch</b> | Starts and stops the time defined on the Timer   |
| <b>Hour Meter</b>              | Records the number of hours during which the UVB-100 Emitter Assembly has been on  |
| <b>Hour Meter Reset Switch</b> | Resets the Hour Meter to 0 hours.  |

| Back Panel Connections    | Description/Function  |
|---------------------------|---|
| <b>Remote Input</b>       | Amphenol connector to allow for the connection of a remote input device |
| <b>Emitter Connection</b> | BNC Connectors for F1, F2   |
| <b>AC Power</b>           | AC Power Module with fuse   |

## UVB-100 Control Diagrams

The diagrams below identify the switches, buttons, and connections on the front and back panels of the UVB-100 Control.



## Cable Diagrams

Please contact RBD Instruments for more information about what you need to do to connect your remote control device to the UVB-100 Control.

## UVB-100 Included and Optional Items

The following optional cables and components are available separately.

### Included Cables/Items

| <b>UVB-100 Cables<br/>(RBD p/n)</b> | <b>Description</b> |
|-------------------------------------|--------------------|
| SU-UVB100-CA1                       | 10' BNC Cable      |
| CA-Q102-ND                          | AC Power Cable     |

### Optional Cables

| <b>UVB-100 Cables<br/>(RBD p/n)</b>          | <b>Description</b>  |
|--|---|
| Contact RBD Instruments for more information | Remote Option Cable   |
| Contact RBD Instruments for more information | BNC Cable of length other than standard 10' (maximum length is 5 m) |

### Optional Components

| <b>UVB-100 Option<br/>(RBD p/n)</b>                     | <b>Description</b>   |
|---|--|
|   | 2 UVB-100 Emitters to be controlled with 1 Control               |
| Contact RBD Instruments for more information            | Remote Option relays   |
| M-8.0UVC  | UV-C Meter   |
| SU-SH-UVB100-2.75<br>SU-SH-UVB100-4.5<br>SU-SH-UVB100-6 | Viewport UV-C Shield (based on viewport size: 2.75", 4.5", 6.0)" |
| Contact RBD Instruments for more information            | Flange Adaptor/Extender Nipple                                   |

## **System Setup**

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This chapter provides information on setting up your UVB-100 components. This includes:

- Information about inspecting the packaging for damage
- Instructions for the unpacking and handling of the UVB-100 components
- Checkout procedures for the UVB-100 components

### **Inspecting the Packaging for Damage**

The packaging RBD Instruments uses when shipping components is designed to withstand the demands of normal shipping activities. However, once the boxes leave our facility, their treatment is out of our control. We recommend that you make a quick inspection of the boxes in the presence of the delivery person. Look for indications of mishandling such as dented corners or sides, punctures in the outer container, evidence of re-packaging, or a container that has been positioned in a direction other than that indicated by the arrows on the outside of the container.

Be sure to note any obvious shipping damage to the outer container and make the delivery driver aware of any damage. We suggest that all observations are provided to the delivery person in writing. In addition, please take photographs of damaged items whenever possible at the time of delivery.

Inspect the inner packaging and components as soon as possible so that you can report any necessary damage claims in a timely manner with the shipping company used. This is especially important when there is evidence of mishandling on the outside container.



**Warning!** Wear protective latex gloves whenever handling the UVB-100 Emitter. The oils on your hands and fingers can adversely affect the performance of the emitter and could create a hazardous condition.

### **Unpacking and Handling**

If you have not already done so, please follow the procedures outlined in the previous section, “Inspecting the Packaging for Damage.” Once you have confirmed that all components have arrived intact, verify that you have the following items. If any are missing, please contact RBD Instruments at 541-330-0723 or e-mail us at [tech@rbdinstruments.com](mailto:tech@rbdinstruments.com).

- UVB-100 Emitter Assembly(ies)
- UVB-100 Control
- UVB-100 BNC Cable Assembly(ies)
- UVB-100 AC Power Cable
- Protective eye goggles
- Gasket(s) for the flange(s) into which the UVB-100 Emitter Assembly(ies) will be mounted
- UVB-100 Safety Information envelope (which includes the key for the UVB-100 Control); this must always be available when the UVB-100 is being used
- UVB-100 Operation Manual (this document must **always** be available when the UVB-100 is being used)

## Installing UVB-100 Components

This chapter provides instructions for installing all UVB-100 components. This includes:

- Installing the UVB-100 Emitter Assembly on your vacuum chamber
- Installing the UVB-100 Control in your system's electronics rack.

### Installing the UVB-100 Emitter Assembly

To install the UVB-100 Emitter Assembly:

1. **Warning!** Do not touch the Emitter Assembly emitter without protective latex gloves on. The oils from your hands and fingers can adversely affect the performance of the emitter and could create a hazardous condition. Clean the Emitter Assembly with isopropyl alcohol if it accidentally comes in contact with skin.  

2. Choose a vacuum chamber port that allows for maximum exposure of the emitter to the interior space of the vacuum chamber.

**Warning!:** To avoid overheating, do not install the Emitter Assembly on a 2.75" flange port that has a tube length of greater than 4 inches. Additionally, the emitter should not touch any interior component or the inner wall of the vacuum chamber.

3. Remove the blank flange from the vacuum chamber port into which you are installing the emitter.
4. Install a new copper gasket between the Emitter Assembly and the flange. A gasket is included with your UVB-100 shipment for each Emitter Assembly you are installing.
5. Place the gasket onto the open vacuum chamber flange.
6. Insert the emitter portion of the Emitter Assembly into the test chamber.
7. Tighten the flange using the appropriate hardware.
8. Pump down the system.

## Installing the UVB-100 Control



**Danger!** Do not operate the UVB-100 when the system is up to air. The Control must be set to Off when the system is up to air. The UVB-100 produces ozone when operated in air.

To install the UVB-100 Control:



1. **Warning:** Ensure that the key lock power switch on the UVB-100 Control is set to Off.
2. Ensure that the power cord and Emitter Assembly cables are disconnected.
3. Slide the UVB-100 Control into a 19" electronics rack. It is recommended that the UVB-100 Control is supported with side rails in the electronics rack, if possible.

**Caution:** We highly recommend that an electronics rack be used. However, if an electronics rack is not available, the Control may be placed on a tabletop within the length of the Emitter Assembly cables. Ensure, however, that the Control cannot accidentally fall off the tabletop or be accidentally bumped.

4. Secure the UVB-100 control to the electronics rack by inserting screws through the four mounting holes that are provided on the front panel.

## Connecting the UVB-100 Emitter Assembly and UVB-100 Control

**Tips**

*It is **highly recommended** that the AC power to the UVB-100 Control is interlocked to your ion gauge so that the UVB-100 cannot be turned on if your vacuum chamber is up to air.*

*If you are using the Remote mode, you need to assemble a cable using the Amphenol circular connector supplied. Contact RBD Instruments for more information.*

To connect the UVB-100 Emitter Assembly and the UVB-100 Control.



1. **Warning:** Ensure that the key lock power switch on the UVB-100 Control is set to Off.
2. Connect the BNC cable assembly to the F1 and F2 connectors of Lamp 1 on the back of the UVB-100 Control.
3. Connect the opposite ends of the BNC cable assembly to F1 and F2 of the UVB-100 Emitter Assembly.
4. Plug in the AC power cable into the AC power connector on the back of the UVB-100 Control.

## UVB-100 Operating Procedure.

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This chapter provides instructions for using the RBD UVB-100.

### Getting Started with the UVB-100:

Before beginning to use the UVB-100, confirm the following:

1. Make sure that all the connections are correctly made according to instructions earlier in this manual.
2. Make sure that you have read all the safety information included in this document as well as the in Safety Information envelope that was shipped with your system. The information in the Safety Information is supplementary to the information in this document and is not meant to replace the information in this document.
3. Note that you will probably need to run some experiments to determine your optimal operating conditions (for example, the length of time that the UVB-100 is on.) Refer to the Principles of Operation later in this manual for more information.
4. Confirm that all viewports in your vacuum chamber are made of materials that do not allow for leakage of UV-C radiation.

If your viewports are not made up of UV-C resistant material, confirm that you have installed viewport covers, which are available from RBD Instruments..



5. Wear gloves and UV-protective eyewear and clothing when operating the UVB-100.



### Operating the UVB-100

You can use the UVB-100 in one of three modes: Timer Mode, Manual Mode, or Remote Mode. Instructions for using the UVB-100 in each of these modes are provided below.

#### Using the UVB-100 in Timer Mode

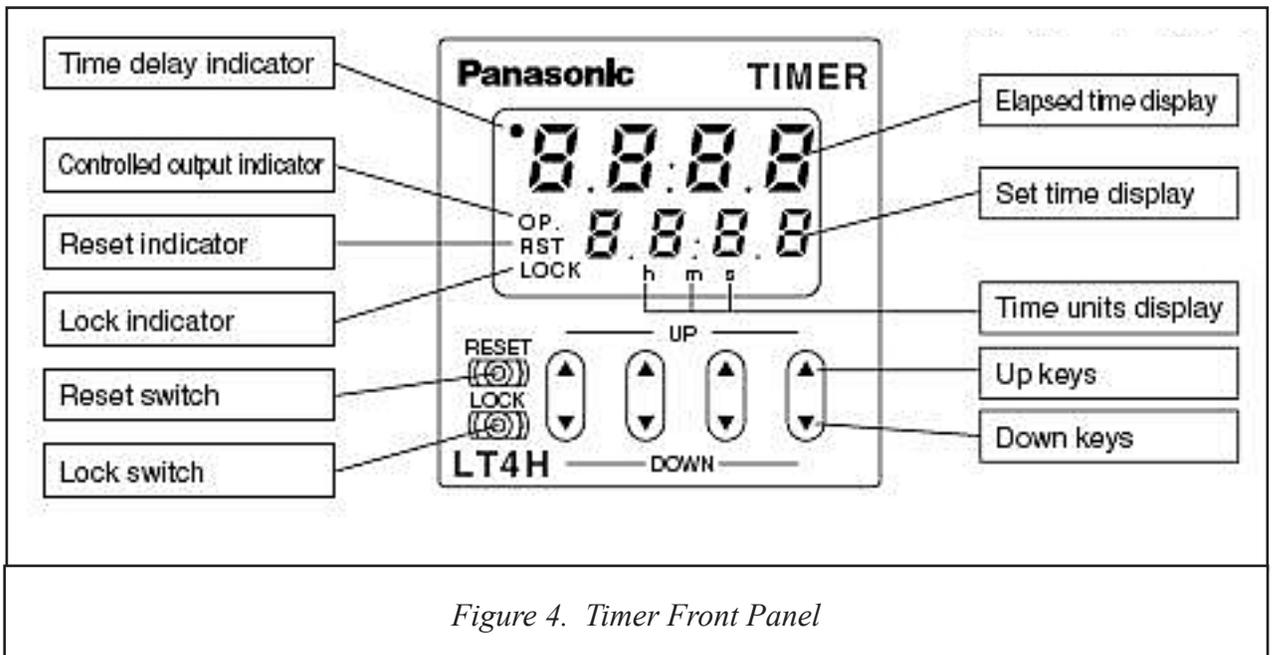
This is the default mode in which the UVB-100 operates.

1. Verify that the Manual Override switch is set to its Off position. This ensures that you are operating the UVB-100 Control in Timer mode.
2. Insert the key into its place on the left side of the front panel. (The key is in the Safety Information envelope included with your shipment. Without the key, you will not be able to start the UVB-100 Control.)
3. Turn the key clockwise to its On position. The green Power On indicator will be illuminated.
4. Press the Up and Down keys on the front of the Timer unit to set the amount of time in hours and minutes the UV Emitter is to be on. See the picture on the following page to help locate these keys.

To ensure that changes cannot be made to the setting you define, press the Lock button. Changes will not be possible until the Lock button is pressed again to turn the lock off. (There is a Lock Indicator light in the upper left area of the Timer panel.)



5. Following all safety procedures, flip the Start/Stop switch up; it temporarily stays in the Start position to start the timer. The amber Timer On indicator and the red UV Lamp On indicator will be illuminated.
6. Verify that the UVB-100 Emitter in the vacuum chamber is glowing. Full intensity is reached in 2 to 3 minutes.
7. To temporarily stop the timer and turn off the UVB-100 Emitter, flip the Start/Stop Switch to the Stop position. The elapsed time display will reset to 0. The amber Timer On indicator and the red UV Lamp On indicator should not be illuminated.
8. To resume the timer function, flip the Start/Stop Switch up to the Start position. The amber Timer On indicator and the red UV Lamp On indicator will be illuminated again.
9. After the set time has elapsed, the Timer will turn off the UV Emitter. The amber Timer On indicator and the red UV Lamp On indicator should not be illuminated.



10. Turn the key counterclockwise to its Off position. The green Power On indicator and amber Timer indicator will turn off.

*Notes:*

- If you need to change the set time after timing has started, flip the Start/Stop switch to the Stop position and adjust set time as desired. Flip the Start/Stop switch to the Start position to re-start the timer. If you are unable to change the set time, confirm that the Lock button hasn't been pushed.
- The Timer retains all its settings when the power to the UVB-100 Control is Off.

- The Reset button on the Timer will stop the Timer function and will turn off the UVB-100 Emitter.

### **Using the UVB-100 in Manual Mode**

1. Insert the key into its place on the left side of the front panel. (The key is in the Safety Information envelope included with your shipment. Without the key, you will not be able to start the UVB-100 Control.)
2. Turn the key clockwise to its On position. This applies power to the UVB-100 Emitter Assembly. The green Power On indicator is illuminated.
3. Flip the Manual Override switch to its On position. This disables the Timer function. (The UVB-100's default operation mode is Timer mode. Therefore, you must flip the Manual Override switch to On to use the UVB-100 Control in Manual mode.) The following two indicators are illuminated:



- The amber Manual Override On indicator
- The red UV Lamp On indicator

4. Verify the UV Emitter in the vacuum chamber is glowing. Full intensity is reached in 2 to 3 minutes.
5. When your system reaches the desired vacuum, turn off the UV Emitter by flipping the Manual Override switch to its Off position. The amber Manual Override indicator and the red UV Lamp On indicator will not be illuminated.
6. Turn the key counterclockwise to its Off position. The green Power On indicator and the Timer On indicator will not be illuminated.

### **Using the UVB-100 in Remote Mode**

All On/Off and timing functions for the UV Emitter are done with the customer-supplied remote controller.

1. Insert the key into its place on the left side of the front panel. (The key is in the Safety Information envelope included with your shipment. Without the key, you will not be able to start the UVB-100 Control.)
2. Confirm that the key is set to its Off position. No indicators on the front panel of the UVB-100 Control should be illuminated.
3. Connect the remote option cable to your remote controller. (Please contact RBD Instruments for information regarding the building of this cable.)
4. Turn the key to its On position. If the key is set to Off, the UVB-100 Control will not work.
5. Flip the Manual Override switch to its Off position. Remote mode is available if the cable is connected to the back panel and Timer mode is not selected. All operations will be controlled by your remote control.

## Principles of Operation

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Energy, imparted to the sorbed water molecules, will raise their internal energy to a high enough level to exceed these weak bonds and allow the molecules to desorb. The two most common energy sources are heat and UV. Heat, the traditional energy source, will result in rapid desorption but it has the disadvantages of heat-up and cool-down time along with thermal pyrolytic degradation problems with some vacuum materials such as O-rings.

UV, though, is essentially a non-thermal effect where the UV energy is imparted directly from the UV source to the sorbed water molecules and thusly requires no heat-up or cool-down time penalty. For systems that will need to operate in the ultrahigh vacuum hydrogen zone below the drydown zone, heat is more effective since it can drive both adsorbed gases from surfaces and absorbed gases from the material's bulk. UV will only be effective on surface-sorbed gas or gas already released from its original source. UV, then, should be viewed as a pumpdown enhancement tool instead of a replacement for a 150° to 200° C bakeout with metal seals.

### The UV Source

The UV band encompasses a wide range of wavelengths, and not all UV sources will provide effective energy for desorption. The best results are obtained with a hot cathode mercury (Hg) discharge tube of the type used for ozone (O<sub>3</sub>) formation. These are emitters fabricated from ultra-pure quartz and filled with inert gas and a trace of Hg.

When electrically energized, the Hg discharge emits UV light in two major wavelength peaks: 254 nm (about 90%) and 185 nm (about 10%). Only the highly energetic 185nm wavelength UV is effective in increasing net water vapor desorption, and it is the wavelength that converts oxygen (O<sub>2</sub>) to ozone (O<sub>3</sub>).

Since the 185 nm radiation will be adsorbed by the O<sub>2</sub> in air, the emitters must be operated in vacuum to allow the UV to reach the internal surfaces. This means operating the emitter within the chamber. Since the emitter will be exposed to the vacuum, it's important that they are constructed entirely of vacuum-compatible materials.

### The Process

Although it would seem to be intuitive that the emitter(s) should be mounted to provide direct line-of-sight to all surfaces, this is really not required. The UV energy will reflect from internal surfaces to spread through the chamber, but direct desorption is only part of the process. With 185 nm wavelength light flooding the chamber, water molecules that are desorbing or already desorbed will be continually energized with the UV, and as they impact other surfaces prior to being pumped away, they will transfer some of that energy to the molecules on the surfaces. Emitters can even be operated within an appendage nipple as a floodlight with only slightly reduced results.

Thusly, the UV serves, directly and indirectly, as an energy pump to maintain a total high energy level of all the water molecules within the system. In essence, this keeps them in motion until they enter the pump and reduces their chance of resorbing on a surface.

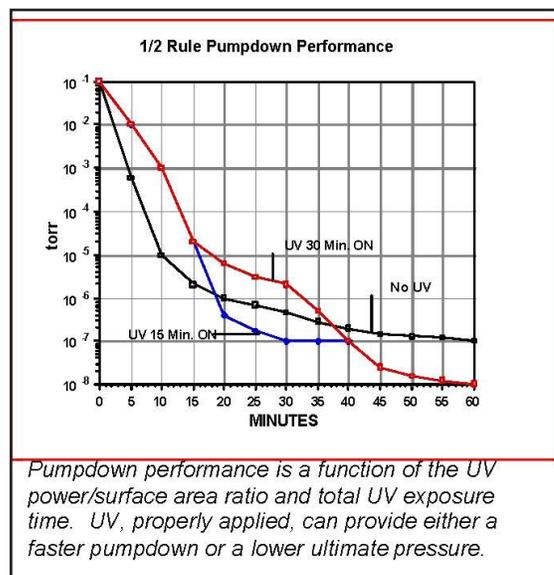
Additionally, the 185 nm radiation converts much of the water molecules to the energetic free radical OH<sup>8</sup>. The free radicals also serve to maintain a high energy level. Their effects can be seen in a large increase in carbon dioxide (CO<sub>2</sub>) in the residual gases while the emitter is operating. This is caused by oxidation

of carbon monoxide (CO) which is always present at 28 amu and the oxidation of hydrocarbons that are always present in trace amounts in the ambient air.

## Operation and Results

When used as a pumpdown enhancement tool, UV can accelerate the drydown process in terms of a faster pumpdown. It can also provide a lower ultimate pressure. This can be seen with the example of a working rule-of-thumb that makes use of power level to surface area ratios.

This is called the half-rule, which states that, at a power level of 0.4 mw of UV power (254 nm) / cm<sup>2</sup> of surface area, the pumpdown time to a given pressure will take half the the time it does with no UV if the system is exposed to UV for half of the target time. For example, a chamber that reaches 1 x 10<sup>-6</sup> torr in one hour will reach that pressure in 30 minutes if the UV exposure is one-half of that time, or 15 minutes. The second part of the half-rule is that the same system will reach a full decade lower pressure in the same time if is exposed to UV for 30 minutes.



The half-rule is based upon timing starting at pressures of about 20 torr. Waiting until a lower pressure is reached is inefficient since the time in attaining the lower pressure will be an effect of the slow net desorption rate. In practice, it's usually convenient to turn the UV emitter on at the onset of the roughing process.

UV exposure, then, can become a standard technique in enhancing the system's performance in the drydown zone as long as the UV power and exposure times are properly applied. The performance gains in terms of pumpdown time and/or lower ultimate pressures can result in substantial savings in terms of costs, product throughput rates, and quality.